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MINISTÈRE
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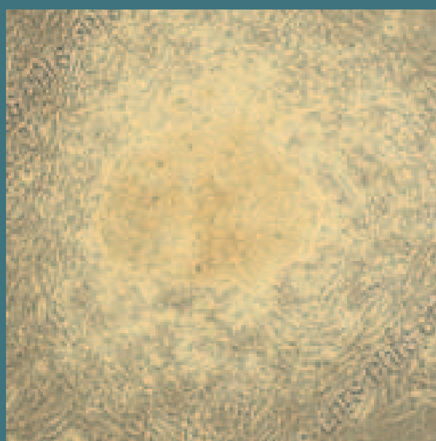
Research infrastructures

Road map 2012-2020

october 2012



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ROAD MAP 2012 – 2020

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INTRODUCTION

More than ever in the course of history, today's science is confronted with the challenge of building research infrastructures at the cutting edge of scientific and technological knowledge.

The current conditions in which science is developing have no common factors with the past. The frontiers of knowledge have been pushed back to such extremes that only major technological advances can cope with experimental reality.

New experimentations and discoveries, as well as the new computational tools used to produce scientific breakthroughs, require new large infrastructures, capable of carrying technological capacities beyond the existing limits. These facilities are to incorporate interdisciplinary synergies as sources of innovations, and to aggregate, within a common structure, the consideration of complex problems.

Such facilities are as essential for future discoveries as are the latest scientific breakthroughs. Credibility, competitiveness and success are at stake. Large research infrastructures have been created, in most instances managed by international organizations. They are based on a wide range of well-coordinated top class instruments that necessitate substantial human and financial resources.

As a consequence, they depend on public authority support and incentives and they may include several different nations working together through international organizations.
The creation in 2002 by the member States of the first European forum dedicated to research infrastructures (ESFRI) is an illustration of the determination to give such facilities a major role in the building of a European research space. They form an interstate collaboration scheme in which France is an active participant.

Over the past decades, concurrently with the large international and European programs, many new instruments have been developed to take advantage of the latest technological breakthroughs. They are the shared work of a large number of participants across Europe, and among them: new microscope and imaging methods, high throughput genomic analysis systems, virtual experimentation developments, social databases, corpus of digitally stored texts with their own exploitation tools.

In this context, it is vital to define a national strategy for developing new infrastructures that integrates the major international programs, the European infrastructures and the infrastructures whose collaborations are less institutionalized, each category being required to meet the criteria of scientific and technological excellence, efficient governance and access legibility. Also should be taken into account the latest technological advances, the evolution of scientific practices, the human and financial investments, the impact on innovation as well as the reconfigurations of the French scientific landscape, notably the creation of the programming Alliances. Such a strategy should also have the ambition to map out a course of action for the future.

The French *Direction Générale pour la Recherche et l'Innovation* (DGRI) has implemented a twofold approach to this problem. The first step consists of consultations at several levels (a scientific level with various taskforces working on a given main theme, another scientific and programming level in consultation with the major actors and Alliances) to elaborate the strategic part. The second step being to collect data and analyses on the total costs involved, and consequently on the financial needs, on a short, medium and long term basis in order to implement a multi-year program planning for the very large research infrastructures.

The present 2012-2020 roadmap reflects the French Government's determination, through its main research institutions, to best address the demands of innovation by submitting an open and regulated ensemble of infrastructures. Elaborated from "a state of the art" report compiled by scientists from all disciplines, the roadmap establishes a variety of instruments (from traditional localized large infrastructures to dispersed facilities, from high tech tools to international centers for scientific cooperation) all addressing the same criteria of openness, governance and quality.

This roadmap has a threefold ambition: to explain the French Government's political orientations regarding infrastructures; to draw up a global governance scheme adapted to the coordination requirements of the various operators; to propose flexible and reactive annual updating procedures for all of the infrastructures (annual dashboards) together with, for the large infrastructures, an exhaustive financial follow-up concerning all costs.

Infrastructures in France - Key figures in 2013

International organizations in which France is involved	**3: CERN, ESO, EMBL**
% of ESFRI infrastructures where France participates	**100% of implemented infrastructures** **75% of others**
Number of Very Large Infrastructures (international, European, inter-ministerial agreements))	**18***
Number of infrastructures	**45***
Number of projects	**7***

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STRATEGY 2012 – 2020

THE SCOPE OF ACTION

The diversity of the concerned tools and schemes requires an explicit description of the founding principles of research infrastructures. A simple classification system is needed to distinguish the large bodies for which political decision and financial commitments are by nature different.

An open but well defined scope of action

The principles connecting the research infrastructures can be stated as follows:

- A tool (or system) with unique characteristics that is identified by the user scientific community as necessary to implement high-level research activities. The targeted scientific communities are primarily national; European or international infrastructures are those recognized by the relevant communities with the purpose of international cooperation, for instance to address issues of global concern.

- The infrastructure may conduct a specific research project and/or provide services to a user community (including players from the economic sector) either on-site or interacting remotely.

- The infrastructure should possess identified, centralized and effective governance and scientific steering bodies.

- The infrastructure should be open and accessible on the basis of scientific excellence evaluated by international peer groups; it must therefore have adequate evaluation bodies.

- The infrastructure should have a financing plan and be able to produce a consolidated budget.

- A research infrastructure is often a privileged place for collaboration with the economic sector, especially in the phases of design, of engineering and of implementation but also via the possibility to resolve technological barriers thus leading to innovation. This may also be achieved through education and dissemination of knowledge.

Three sets of infrastructures

The desire to have a strategy that draws a more updated and exhaustive picture of the instruments serving research, has led to open discussion on the long term tools and features that have been built in the framework of major international agreements (IO for "international organizations").
A second set of infrastructures has been recognized, bringing together instruments under international or European partnerships, linked notably with the European strategic forum (ESFRI) road map, or with major instruments through the industrial and innovation collaboration networks. This set is placed under the realm of national policy or of governmental strategy as a "very large research infrastructure" (VLRI) and implemented by the LOLF through differing actions.

The third set aims at recognizing research infrastructures (RI) fitting the above-mentioned criteria and responds to the choices of the different research operators. In particular, those able to enter this category, possibly after a "project" phase, are:

- Infrastructures operated by programming Alliances or their members, or by public establishments on the basis of their particular missions.

- Infrastructures labelled under governmental incentive programs, in particular the "Equipment of Excellence" label in the framework of investments for the future.

- Infrastructure networks pooling human resources or research equipment and having centralized, identified and effective governance.

Compliance with these criteria and the implementation of transparent and objective procedures based on high level scientific evaluation by peers, ensures coherent efforts from all research players: state, regional and territorial collectivities, European Union.

These categories were established from an objective set of data. There is no hierarchy of excellence nor of a technological nature between the three levels, that could correspond to distinct phases of one and the same infrastructure.

This broad conception brings this strategic exercise closer to the viewpoints adopted by many European countries. Its originality lies in the identification of criteria applying to the three afore-mentioned sets (international organizations, VLRI, RI).

GENERALIZATION OF RESEARCH INFRASTRUCTURES

Several factors justify the acknowledgement of generalization: the diversification of tools and measures, the evolution of the range of disciplinary sectors, the requirements of the economic sector.

The diversification of instruments

Infrastructures today are not only limited to the single site "large facilities" but are now taking on various forms to meet the needs of scientific communities. Some of these forms are totally reliant on new capabilities resulting from information and communication technologies; others take the forms of global human community networks. Five forms have been identified which cover all of the large infrastructures:

- localized infrastructures
- platform networks
- virtual research infrastructures, databases
- collections, archives and scientific libraries
- infrastructures based on human networks of very high scientific value

A quick evaluation of infrastructure growth shows the fast development of network infrastructures confirming the central role of digital data (collection, treatment and long term storage) in contemporary scientific activity.

Orientations as regards science

During 2011, analysis work on the existing and proposals for evolution have been the subject of discussions amongst work groups organized around seven major scientific fields. The following propositions are the result of a systematic state of the art study, of international comparisons and of reflections on the future.

Nuclear and High-Energy Physics

The first large research facilities have met the physicists community's requirements, the aim of which was to study the ultimate constituents of matter. Today the large nuclear physics infrastructures, where French scientists are mostly present, in France and Europe, are heavy ion accelerator and antiprotons complexes situated at the GANIL site in Caen and the GSI one in Darmstadt, Germany, both delivering stable and radioactive beams. This strategy aims at maintaining leadership in this field. At the dawn of horizon 2014-2020, these sites intend to house Europe's spearhead nuclear physics programs SPIRAL2 and FAIR.

SPIRAL 2, together with today's GANIL, will form a unique tool for radioactive ion beams. SPIRAL 2 will also be amongst the world's best performing sources of fast neutrons (14MeV) for the next ten years. As a whole, FAIR, will be unique due to its significance of the scientific fields covered by the variety of its beams (heavy ions, antiprotons), in its synergy with SPIRAL 2 for radioactive beams, and in hadron physics with the LHC experiments at CERN and RHIC and JLAB in the United States. SPIRAL 2 and FAIR are the priorities in the recently established European nuclear physics road map (2010) under the auspices of the "Nuclear Physics European Collaboration Committee" (NuPECC) and are included in the ESFRI road map.

High energies physics have world-class facilities. The CERN Council leads Europe's strategy with France playing an important role, reinforced as much by its participation in experiments and in the facilities' conception, as by its cooperation in research and industry. This is facilitated by CERN's location near the French boarder. For instance, cryogenic magnets and computer-controlled beams are examples of advanced technologies conceived or validated by CERN. Projects are ambitious on a technical level, both for accelerators and for detectors and instruments. They need a design work in connection with the research subject definition and a simultaneous technological R&D effort coordinated at world level and in close collaboration with industrial partners. Often, the conception and implementation phase takes more than a decade, preceding an exploitation phase lasting several decades. The European strategy road map for particle physics is to be updated in the Spring 2013, and presented to the European Commission. An optimized use of the LHC plans a second phase of high luminosity with changes to the accelerator and to the detectors, to be implemented in 2018 and 2021 and which will require discussions regarding funding capacities. Looking beyond the current LHC, future infrastructures could be the HE-LHC ("High Energy LHC") which should be considered as a new machine or a linear electron collider (ILC or CLIC) in the frame of a global effort.

The constituents of matter are also the constituents of the universe. Astroparticle and cosmology physics are currently making rapid progress, placing these themes amongst the highest priorities on the main global research strategies list, at the meeting point of high-energy physics and sciences of the universe. This field includes the study of cosmic radiation (photons, charged particles, neutrinos or gravitational waves) and is also opening up new and major fundamental research challenges such as matter content and dark energy, or the study of atmospheric neutrinos, which have recently been rewarded with two Nobel prizes. In this field, France has played a major role in the building of several infrastructures, making it possible to fathom the constituents of the universe (HESS Cherenkov telescope in Namibia, ANTARES neutrinos telescope in Toulon, and Virgo global gravitational interferometer in Pisa, Italy). Two types of priority coexist: in the short term (2014-2015) the completion of the advanced VIRGO and ANTARES projects. In the mid-term, the completion of the preparatory studies led by the Cherenkov Telescope Array (CTA), a project gathering together the world-wide research community of high energy gamma astronomy, whilst LSST (Large Synoptic Survey Telescope), a major cosmology project in which French groups enjoy a remarkable scientific visibility in the fields of supernovae, making them the key partner of the United States the leader of the project.

Targets

- To maintain France's position of excellence in the nuclear physics and high energies community
- To highlight the innovative technological achievements of the large facilities
- To develop interest for science and the appeal of scientific careers through large experiments of global interest

Material Sciences and engineering

The infrastructures dedicated to sciences of matter and engineering mainly located on one site (ESRF and ILL and EMFL in Grenoble, SOLEIL and LLB in Ile-de-France, XFEL in Hamburg…), but also with distributed platform networks (EMIR, RENATECH), are characterized by the use of probes of different natures: non coherent photons covering a wide electromagnetic spectrum, from millimetric waves to very hard X rays and gamma rays; coherent photons delivered by Ultra-High intensity (UHI) or High Density Energy (HDE) lasers; neutrons with a strong capacity to penetrate matter and intense magnetic fields for RMN type spectroscopies.

The combined, and often complementary, access to various infrastructures allows scientists to achieve unique headways in the knowledge of matter in all its forms (gas, liquid, solid, plasma) and by reproducing natural conditions (very high pressure, very high and very low temperatures, high magnetic fields) in laboratories. All scientific fields are invested: Physics, Chemistry, Astrophysics, Geology, Biology, Archeology, Paleontology, and cultural heritage. Thus these infrastructures play an important role in advances in energy and health. Through enabling the characterization of materials, they contribute to developing nanoelectronics and nanotechnology. The infrastructures cover therefore a variety of instruments: synchrotron accelerators (SOLEIL, ESRF), lasers (LULI), magnetic fields (EMFL), tokamaks (JET, ITER, Tore Supra), neutron scattering centres (LLB, ILL) and reactors (RJH, MYRRHA), nano-scale characterization plants.

The development of nano metric scale technologies has led engineers in several key economic sectors to shape and observe matter using synthesis and observation tools, until then almost exclusively used by researchers. This tendency will foster in the coming years, giving sites equipped with large infrastructures an additional attractiveness for industrial developments.

In the field of material integration technologies, an indispensable vector for new digital technologies, the national network of large technological centers (RENATECH), founded in 2003, must remain a competitive tool, by world standards, in the development of future nanoelectronic systems. Its large expertise allows for the transfer of know- how, notably to emerging countries, thus planting the seeds for future cooperation. It will be helpful, in the future, to make this network consistent with the new equipment being developed in emerging technologies.

> ITER. Whilst managed under specific frameworks and therefore not reported in the IO and VLRI annual score boards, ITER must be mentioned for the importance of this infrastructure in today's scientific landscape. The mastering of fusion energy is one of the tasks put into place in global cooperation. The Tokamak, soon to be installed in *Cadarache*, France, will play an important part of the project's European contribution. The objective is to progress towards the use of magnetic confinement fusion process for sustainably producing energy. This program includes a consistent part covering specific materials' research. Globally, this project carries the whole world hopes of developing, in the long term, a new sustainable form of energy and the appropriate industrial environment to exploit it.

Today, with DEMO, Europe is planning the post ITER era. A review of the whole of Europe's facilities for magnetic confinement fusion has already been carried out and needs be completed with the updating of the European support program included in the European Union FP8 frame program. This support program, currently under discussion, will include existing or new European machines (JET, ToreSupra, W7X…). Europe, and more specifically France, take part with the "Broader Approach" agreement, in the building of several facilities in Japan, IFERC, IFMIF, EVEDA and JT60SA. IFERC and IFMIF/EVEDA are for the preparation of DEMO and JT60SA for ITER.

These programs require a specific treatment due to the duration of their projects, which can span over several decades, and therefore add to associated investment costs. Developments over the last ten years have required a shift in national policies that have led to investment in infrastructures outside of France. Examples of this would be investments in XFEL, located in Hamburg, and in ESS in Lund, Sweden, which should be considered in the context of international agreements. In any case, they promote the idea of co-financing operations developed by the various users. The European program "access" (I3), which provides financing to host European users in national infrastructures, should be pursued.

Targets

- To maintain France's position of research excellence in Material Sciences and in the Energy field
- To develop a multidisciplinary and transdisciplinary research strategy and to give priority to the "fundamental research/technological research" continuum, through a combined access to large infrastructures
- To promote the link between the scientific community and the industrial world

Digital sciences and mathematics

The infrastructures in this field are distributed and some are networked platforms. These infrastructures are recent and aim to coordinate an ensemble of national actions, related most often to European partners.

The requirements in all sciences have considerably increased and there is now a very strong demand for simulation, treatment and storage of large masses of information. To meet this demand, it has been decided to consolidate the highly visible, very large research infrastructure, High Performance Computing for computing and storage of data in massive quantities (target 2020: exascale). Mastering this data requires the development of a pyramid shaped physical infrastructure to house and process the data.

The top of the pyramid is comprised of the national high-performance computing agency (GENCI), France Grilles, and the data processing centres of the CNRS, the CEA, and the Universities (CINES, TGCC, IDRIS, CC-IN2P3). They have the ability to efficiently accommodate large volumes of data and to pair them with computational resources. This VLRI is linked with intermediary hosting and treatment platforms, structured nationally - as with genomics - and is designed to be coupled with instruments located close to the data production sites.

The RENATER network, a service infrastructure available to the whole scientific community, will have to be developed in coherence with the requirements of the VLRI GENCI. It should, in addition, be a core player in cloud computing developments.
Overall strategy aims at supporting these schemes and reinforcing partnerships with the economic sector, mainly through GENCI’s HPC PME programs, INRIA, OSEO, through the “maisons de la simulation” network and the mesocentres, offering expertise and computing resources to SME’s as well as large industrial companies.

The large equipment project for research in mathematics (GERM) aims at rapidly becoming a national research infrastructure (RI), implemented by the CNRS, to support French leadership in fundamental and applied research in mathematics, with the development of world famous hosting and exchange structures comparable to other leading centers such as the MSRI in the United States or Oberwolfach in Germany.

Computer science research has specific requirements in terms of infrastructures. The first one was created over the last 10 years ago and is concerned with massively parallel and distributed systems (GRID 5000). For the coming financial year, the emphasis has been placed on the one hand on virtual and increased reality and on the other on the internet of the future and ambient intelligence. Network platforms will be put into place on a national level.

The last few years have confirmed the growing commitment of the scientific community to robotics, mainly structured around the GDR Robotics and reinforced in the frame of future investments by the structuring project of the Robotex platform. In strong interaction with many disciplinary fields and confronted by ever increasing societal demand, especially in the health and security sectors, it is now important to speed up the emergence of a leading national network of world level, whilst favouring a leverage effect with European actions. Major technological and scientific issues will address the development of robots' autonomous operating and decision making capacities (humanoid robotics, drone systems), the Human-Robot cooperation and the support functions (health, well-being) by reinforcing interdisciplinary research with human and social sciences. The networking project for this theme's expertise should allow the rapid identification of a national research infrastructure, able to rally the community and bring answers to the domain's triple challenge: scientific, industrial and societal.

Targets

• To contribute to French leadership in Mathematics through world-renowned hosting and exchange infrastructures (GERM)

• To reinforce the role of numerical simulation by providing searchers with competitive resources for intensive computing

• To contribute to R&D competitiveness in ICT and nanotechnologies by giving access to appropriate research infrastructures

• To stimulate and support innovation, notably through a policy of openness towards industries and SME's

Earth and universe sciences

The effects of world demography and current development patterns on the planet come together and induce irreversible changes of the environmental conditions upon which populations and societies depend. The terrestrial environment is also subject to natural external disturbances (solar activity for instance) and to natural phenomena that need to be understood and anticipated to limit the risk to humanity. In order to analyze and to better control such changes, it is necessary to continue the effort of development and networking of the environmental observation tools as well as the associated data bases in a European and international framework (GMES-GEOSS). It is essential to have data - and therefore the infrastructures to collect and store them – and to use them in a scientific approach that combines models, numerical or experimental simulations and risk assessment. Thanks to their large diversity, research infrastructures take part in this whole process. Infrastructures extend throughout the globe, and in their close environment through a variety of international and intra-European cooperation. Their uses are of societal and economic interest: meteorology and forecasting of rare events, seismic events and tsunamis, management of water resources and other natural resources.

Earth system knowledge is therefore of primary importance both for understanding physical, chemical and biological processes that govern the environment in which we live and for comprehending the mechanisms by which humans modify the environment. It is therefore a major scientific challenge.

Some research infrastructures can implement scientific projects of different communities. This is the case for the research instrumented aircraft (SAFIRE) and the ocean research fleet (FOF). This is also the case for the international polar base CONCORDIA (French-Italian cooperation) in Antarctica. Other infrastructures are intented to provide data from observations and numerical simulations leading to forecasts on the state of the atmosphere such as The European Centre for Medium-Range Weather Forecasts (ECMWF), or MERCATOR OCEAN which produces forecasting of the state of the oceans linked to climate evolution and which develops tools for operational oceanography.

The French seismological and geodetic network RESIF studies the deformation of the earth's crust and the associated hazards. The distributed platform, CALIFF, gathers the facilities for the exploration by drilling and coring of continental, glacial and oceanic areas, the collected samples and the participation of France to the European program (ECORD) and the international program (IODP) of deep-ocean drilling. Argo France contributes to Euro Argo that brings together around 3000 floats and aims to monitor the ocean temperature and salinity from the surface up the 2000 m deep. The multi-disciplinary European deep-sea observatory (EMSO) is, for its part, intended to gather both physical data (seismicity…) as well as biological data (nutriments…). Gathered in the Bure underground laboratory, several research infrastructures represent the National center for memory and conservation in the field of environment (SOMET). Lastly, several large research infrastructures coordinate systems of observation and experimentation for research and environment (SOERE), of the continents, of the continent/ocean interface (TRN), of the oceans and climate variations (MOVC), of the atmosphere (IAGOS, ICOS), in particular for greenhouse gases and global warming (MARC).

Astronomy has always devoted a large part of its resources to the operation of large shared scientific instruments in national or international observatories. The race for sensitivity and to angular and spectral resolution as well as the interest in carriers other than light (gravitational waves, neutrinos, cosmic rays) require very large instruments, unaffordable by just one nation. They are now developed in the frame of companies (CFHT, IRAM…) or international organizations (ESO, ESA). This science is therefore very well structured at the European level and the priority for European or international programs has a strong impact on national strategies. France is a major player in the large international organization ESO, today involved in two out of the four VLT second generation instruments selected by the ESO advisory board. They bear the responsibility for MUSE, a facility dedicated to exoplanet imaging. Additionally, ESO has selected two out of three second-generation instruments for the very large telescope Interferometer (VLTI). France is responsible for one of these projects and co-responsible for the second.

Priority projects in this discipline are the next generation of large ground based instruments, with the development of the world's largest optical and infrared observatory, the E-ELT (European Extremely Large Telescope) in the framework of the international organization ESO; of the international Cherenkov telescope project, the CTA (Cherenkov Telescope Array), in the field of very high energy gamma rays and of the international project for low frequency radio-telescope network SKA (Square Kilometer Array).

Targets

• To maintain French leadership in the field of climate studies

• To develop and sustain environmental observation and experimentation infrastructures as well as ones dedicated to the earth crust deformation and related hazards

• To ensure the sea worthiness of the ocean research fleet

• To contribute to the development and scientific exploitation of the large ground-based astronomical observatories, their instrumentation and associated data centers

• To develop the technological innovations necessary for these instruments

Agricultural, ecological and environmental sciences

Final research objectives have been examined in relation to the SNRI priorities on health-food and environmental emergency: a) crop productions (food or nonfood); b) animal productions (land and water); c) biodiversity and environment[1]; d) nutrition and human health.

Infrastructure needs fall into 4 broad categories: i) **instruments**: from omics (from gene to metabolite: genomics, transcriptomics, proteomics, metabolomics…) to phenotyping and imaging including in bioinformatics; ii) **SOERE: experimental facilities** (experimental ecological stations, equipped sites and ecotrons) and long term observation systems; iii) **biological collections and resources** (CRB, CRG, collections, chemical libraries); iv) **groups** in the general population (food industry).

Databases, information systems and a quality management system can be found in each one of the categories.

Each category includes databases, information systems and quality control.

The main issues for which these infrastructures should be mobilized are five fold: i) adaptation to climate change; ii) management, conservation, and recovering of biodiversity; iii) performance of agrosystems: input/output, life cycle analysis; iv) biological resources management; v) production chain of food and human health; vi) renewable energies.

Many challenges are to be met, from increasing availability of more spatial and temporal data to regionalizing climatic evolution models through better understanding of the roles played by the different compartments and their interactions. Regarding climate, a major step forward will be the establishment of long-term models of the evolution of ecosystems. Such models require understanding of the dynamics of ecosystem biodiversity and its long term evolution, and being able to

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[1] With the increasing issues concerning biodiversity, the logics of organization for biodiversity research infrastructures relies on the tripod Observation-Experimentation-Modeling. This corresponds to 4 t infrastructure categories: collections (*ex situ*, databases), *in situ* observations (SOERE), *in situ* and *ex situ* experimentation (SOERE and ecotrons), and modeling, feeding back experimentation and exploitation of data bases.

qualify and quantify ecosystem services as well as the impact of human activities. It is then necessary to mobilize large-scale research infrastructures intensively - often in an international framework- and gather a wide range of localized or distributed instruments. Two network projects stand out in this respect: ANAEE and ECOSCOPE.

ANAEE aims at implementing, at European level, a coordinated network of experimental infrastructures to perform integrated research on ecosystems and agro-systems, on their dynamics, their management and their evolution in relation to global change.

The ECOSCOPE is a national platform for identifying, implementing and coordinating the research observatories on biodiversity and ecosystem services, taking into account the taxonomic, genetic and functional dimensions of biodiversity at various levels of integration. The target of the ECOSCOPE is to better organize and integrate the collection, storage, management and exploitation of data coming from the various biodiversity observatories.

Targets

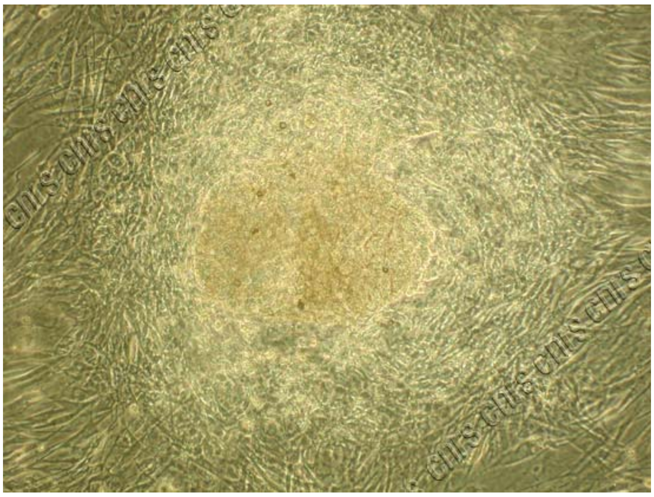
- To meet the demand regarding environmental emergency and health/food challenges

- To contribute to global issues regarding environment, climate and biodiversity

- To facilitate multidisciplinary cooperation to mobilize knowledge and tools developed by a wide range of disciplines and research infrastructures

- To allow for collection and management of long term data to assess the evolution of the systems under scope

Biological and medical sciences



The infrastructures in these fields are distributed and some are network platforms. They have been developed recently and aim at coordinating a range of actions in France and are mostly linked with European partners.

To address societal challenges linked with increasing life expectancy and the emergence of new diseases, infrastructures in biology/health are necessary to develop new diagnostic concepts, more rational treatments and a new approach to personalized medicine, based on fundamental, state of the art research. France has decided to catch up in this field and accelerate the implementation of research infrastructure in biology / health through semi-perennial financing (10 years).

These highly technical infrastructures contribute to the training of future researchers, and to the development of multi-disciplinary projects including all the fields in biology, chemistry, physics, mathematics, information technologies, and human and social sciences. Thus these infrastructures form a major structuring tool for research on health in our country and should strengthen our international scientific positioning and contribute to the creation of European research space (most of ESFRI infrastructures in biology/health now have a French component).

One of France's strong points: Cell and molecular imaging. France possesses many imaging centers whether they be for fundamental biology or for medical imaging. French nodes of the ESFRI / Eurobioimaging are the France Bioimaging and France Live Imaging projects.

From integrating structural biology to the emergence of personalized medicine. High technology genomic centers (France Genomics), or proteomic (PROFI) metabolomics /fluxomic (metaboHUB) and more specifically structural biology (Frisbi, the French node of ESFRI / INSTRUCT) allow for the improved understanding of diseases' molecular mechanisms and the targeting of the molecular entities concerned. Systemic biology, allowing for an integrated interdisciplinary approach and for the modelling of diseases, is emerging in France. As of yet, the actors are of small size and not very visible in spite of encouraging signs such as the installation of the European Institute for Systems Biology and Medicine, in Lyon, in partnership with China and the United States. National strategy aims at reinforcing this sector, with new methods and work tools, to take into account the life science revolution.

The research in bioinformatics via the RENABI network, the French node of ELIXIR, allows for the management, storage and analysis in exponential quantities of biological data gathered by all of these infrastructures.

Medical research is focused on translational and clinical research with university hospital institutes (UHI), Neuratris, forming with the UHI, the French node of the European project for neurosciences ESFRI/ EATRIS; the IDMIT project for clinical research into infectious diseases; F-CRIN (including 53 CIC[2], France coordinates ESFRI / ECRIN) for the development of high security laboratories (HIDDEN project, France coordinates ESFRI /Erinha). Large cohorts are also supported. The implementation of biological resource centers with the Biobanques project (French node of the ESFR/BBMRI project) and relevant animal models for the pre clinical research on diverse diseases with the Celphedia/ PHENOMIN projects (the French node of the ESFRI /Infrafrontier project) and TEFOR, allow consolidating the structuration of Biology and health research. Innovative therapies are being developed thanks to the emergence of biotherapies, such as in the stem cell sector and their use in regenerative medicine (EUCELL France infrastructures for the mesenchymal stem cells and Ingestem for the IPS around key industrials).

The 2012-2020 strategy aims at increasing the structuring of this group of projects.

Targets

• To address the societal challenge of an ageing population and maintain their well-being. To prepare tomorrow's medical sciences revolution, personalized and regenerative medicines

• To provide France with international level biology-health infrastructures. To promote the construction of the required expertise base to accompany the development and adaptability of these new structures

• To facilitate interdisciplinary cooperation (principally with physics, chemistry and SHS) or multidisciplinary cooperation allowing biology to benefit from the progress, accessible through research infrastructures whatever their main discipline might be

• To facilitate the use of results and the cooperation with the private sector targeting transfer and innovation

[2] Clinical investigation centers

Human and social sciences

Conceived in the middle of the first decade of the second millennium, alongside the reflections led by the ESFRI European forum, the two large infrastructures in HSS are digital (ADONIS/CORPUS and PROGEDO for social sciences) and take into account the French part of one or more European projects mentioned on the ESFRI road map (DARIAH and CLARIN, for ADONIS/CORPUS, CESSDA, ESS and SHARE for PROGEDO). The choice has been made to take part in the building of the European project whilst maintaining the possibility to add other projects developed on the national territory, bearing in mind that it was preferable not to multiply infrastructures. Thus ADONIS /CORPUS has as its aim the creation of conditions favorable for the development of a navigation space for all scientific documents on a European and international scale. It is organized around the different large scientific communities and aims at giving them tools adapted for the totality of their requirements.
PROGEDO, VLRI for social sciences, favors the participation of French teams in large European investigations and ensures that public statistics are available to all researchers.
As with the mathematics infrastructures, two network infrastructures have been recognized as national infrastructures: the MSH network destined to consolidate territorial poles of excellence, and NEFIAS – Network of French Institutes for Advanced Study – relying notably on the national and international networking of Institutes for advanced studies created in France from 2006 onwards and French laboratories abroad.

The strategy for this sector is marked by the desire to comfort the existing infrastructures and to confirm the French participation in the European projects DARIAH (digital infrastructure to study source materials in cultural heritage institutions), SHARE (data infrastructure for analysis of ongoing changes due to population ageing) and CESSDA (facilitate access of researchers to high quality data for social sciences) and to carry on the study for CLARIN (language resources) and ESS (European social survey).

Targets

- To develop infrastructures in social sciences so as to establish European leadership notably for the exploitation of public statistics
- To develop a French presence in the ESFRI road map infrastructures and to expand the French navigation system for large bodies both quantitative and textual
- To facilitate multi-disciplinary cooperation in particular in the health and environment fields (data bases, cohorts…)
- To contribute to European networks of excellence for hosting foreign researchers

The documentary infrastructures

Documentary infrastructures have seen their role transformed with the development of scientific digital publications and their associated bibliometric tools.

The first national road map on research infrastructures mentioned the urgency in developing a digital scientific library (DSL) on the national territory, taking into account the lack of coherence in the current measures and the amount of investment concerned (over 100M euros per year for all of the research operators). DSL has two main objectives: to respond to the needs of researchers and teacher-researchers by raising the quality of IST to a level of world excellence and to improve the visibility of French research. It relies on the implementation of political steering shared by the main actors of the ESR, offering services to all the communities whatever their status; to create new models and economic balances between the public and private sectors for scientific publications.

DSL is composed of 9 segments of activity for which actions have been initiated by different operators (documentation specialists, IST, research laboratories…). The DSL infrastructure aims at increasing quality, giving coherency to their actions (networking) and at improving the cost/efficiency ratio. Since 2010, several operations have been carried out (national license scheme, archive storage scheme, inter-organisation protocol on the opened archives), this new period should see the consolidation of the scheme and the implementation of all its various parts.

Although less visible on the internet (CollEx), certain large documentary data bases, of international repute, are nevertheless major tools for many researchers. The gathering of collections of documentary excellence has the aim of coordinating a patrimonial policy on the territory to maintain a leading role at an international level for certain exceptional documentary resources.

Targets

- To respond to the needs of researchers and teacher-researchers by raising the availability of scientific information to a level of world excellence
- To improve the visibility of French research
- To consolidate collections of unique and globally attractive documentaries

The needs of the economic sector

The needs of the economic sector in terms of research infrastructures can be considered from several perspectives:

- **The development of "key" or "enabling" technologies** put forward in the document "Technologies Clés 2015"[3] as well as in the European Commission "Horizon 2020" proposal
- The need for cutting edge experimental infrastructures **to ensure better risk management** inherent in the process of innovation or to the external processes of industrial exploitation.
- **The capacity to innovate, the search for competitiveness and the need to consider societal needs** notably in the fields of natural resources, climate change, security and health.
- **The development of Human Resources** principally in innovative technologies implemented in research infrastructures – with possibilities in new sectors such as decarbonized energies or the exploitation of genomic information in the health field – or for the appeal of the exploration of new boundaries for knowledge that infrastructures allow.
- **Capacities to increase investment in industry thanks to public procurement by research infrastructure**: the developing of extreme technologies, the crossing of technological thresholds beyond the acceptable risk limits allowed for by private financing.

Targets

• To develop human scientific and technological resources by highlighting technological blockages associated in the conception and the operation of research infrastructure - as well as the resulting successes

• To facilitate partnerships between infrastructures and economic players principally by being aware of each others' expectations and by the insertion of research infrastructures in national (ANR, OSEO) or territorial (Poles, IRT…) innovation programs

• To allow research infrastructures to play a leading role in national and European industry financed by public procurement schemes, notably through in-depth analysis of the available tools put forward by the European commission in the Horizon 2020 program

• To publicize research infrastructure results, notably in the fields of health and environment, for information and risk reduction purposes

[3] The document « Technologies Clés 2015 » http://www.industrie.gouv.fr/tc 2015/technologies-cles-2015.pdf

FRENCH POLICY KEY GUIDELINES ON INFRASTRUCTURES

Leader in the construction of a Europe of infrastructures

The Europe 2020 strategy implemented by the European Commission, gives a major role to infrastructures in the creation of the European research space. It attaches great importance to their catalyzing role in the process of knowledge creation, in facilitating the searchers networking and stimulating the flow of knowledge. Its objective is that Europe relies on a range of tools adapted, optimized according to the needs and managed by ad hoc organizations, whose partners belong to European Union member States or associated States.

From this perspective, the European Strategy Forum for Research Infrastructure (ESFRI), is a strategic orientation tool. In order to facilitate the implementation of consortiums, gathering several State members and destined to manage high level research infrastructures, the European Commission has constituted the legal structure ERIC, based on the Article 187 of the Treaty on the Functioning of the European Union.

France houses several very renowned research infrastructures on its territory and is very keen to maintain its leadership on the European and international levels concerning both scientific exploitation or conception and implementation of innovative research infrastructures.

Targets

- To participate in the implementation of the European innovation and scientific capacities development program
- To assume a leading position in the conception, building and implementing of innovative research infrastructures
- To continue hosting globally visible infrastructure, in order to contribute to large societal and strategic challenges

Ensuring French presence in large international organizations

Large international organizations correspond with the States' common desire to either contribute to the progress in fundamental knowledge, or to tackle together the challenges with which humanity is confronted. The archetypes of the first model are, undoubtedly, CERN, whose aim is to explore the fundamental laws governing matter and the mechanisms at work in the first moments of the universe after the "Big bang". ESO, in the field of astrophysics, is responsible for the creation of the world's largest telescopes, which has led to major scientific breakthroughs.

The French presence in these large international organizations is a significant asset in developing high-level scientific research and attracting renowned scientists of renown. It also enables cutting edge technologies to be mastered, thus removing a large number of obstacles towards innovation. It raises visibility for experimental scientific research and crystallizes its issues. This presence is a powerful way to attract the interest of the young in sciences and to make scientific progress a tangible reality for our fellow citizens. Beyond the wonder that comes with increased knowledge, the tangible benefits of these advances relate to key aspects on which energy policy, economics and health are based.

New societal challenges, such as health, conservation of natural resources and biodiversity could be the object of new international organizations; the same is true for abilities to exploit new digital and electronic communications technologies in the making of research infrastructures.

The following table presents various international organizations main issues and objectives:

	Brief description	Issues and objectives
CERN	International large experimentation program, exploring the limits of knowledge regarding fundamental laws of physics. Contributes to bringing light to issues related to the origins ad the future of the universe.	• To maintain Europe's world leadership and France's position • To maximize technological and industrial impacts • To develop public's interest in sciences
EMBL	International molecular biology program, targets analyzing living organizations of all sizes: from the molecule to the full organism. World leader in bioinformatics, digital simulation in biology and systems biology. .	• To maintain European leadership and facilitate the integration of European research in molecular biology • To tackle the large obstacles of "information biology" : their comprehension of biological processes beyond the mass of data • To provide access to a wide range of infrastructures exploitable in biology
ESO	European Observatory in the Southern Hemisphere. Major international partnership using exceptional tools for exploration of the universe.	• To build and operate a range of the most advanced ground-based telescopes • To maintain Europe's leadership in astronomy

Overall targets

- To take part in the conception and the implementation of large international research infrastructure programs, notably by widening the scope to life sciences and exploiting the capabilities of digital technologies
- To make available the achievements of large programs for scientific and technological development
- To continue to promote a national scientific interest by taking part in the major challenges addressed by experimental projects and ambitious research

Serving all major societal issues

A large number of research infrastructures with common characteristics fall under a national steering or labeling scheme, these characteristics are: a) their ability to measure major societal issues on a global basis; b) their role in the development of fundamental knowledge, often as part of large international collaborations; c) their contribution to innovation and economic development.
Research infrastructures can be structuring, ie. they can be essential in implementing a global research strategy or to theme strategy in large fields. The labeling, at the state level, harmonizes actions for public bodies (regional or territorial authorities, other ministries) and may help in opening up to the private sector or in finding future European partnerships.

Targets

• To increase cooperation between research infrastructures and private and public sectors' researchers, contributing to the resolution of large societal challenges and governmental or European priorities

• To confirm the significance of society in the contribution of infrastructures, especially experimental or observation infrastructures, and in the development of knowledge

• To confirm the opening of the defining frame of research infrastructures from infrastructures covering multi-disciplinary approaches, to new disciplines and new capabilities offered by digital information and communication technologies

• To include research infrastructures in projects aiming at a better structuration of research and higher education

Sustain fundamental research in all sectors of knowledge

If many instruments are a direct and obvious motor for technological research and innovation, all are indispensable in allowing the observation and experimentation necessary for understanding natural phenomena and their reproduction or simulation, as to facilitate the analysis of human societies or push back the limits of knowledge on matter.

Fundamental research's choice lies in a frame marked by the "basic research/applied research" continuum, infrastructures being the principal sites for constructive interaction between different viewpoints. The review of the evolution of French and European participation in programs such as EMBL, ESO, or the CERN for instance, demonstrates the renewed commitment of the State to large international organizations, the only structures likely to allow the building of such facilities.

Over the last 20 years, disciplinary or multi-disciplinary fields in which research is dependent on access to research infrastructures have expanded. This may result from expanding observation capabilities, from the smallest (light sources) to the largest (data collections on the earth system or the universe). In other cases, the critical factor lies in the new capabilities for systematic representation and handling of information, either genomic for biology, or textual and statistical for human and social sciences. Generically, the resources for calculation and manipulation of mass data are now significant infrastructures at all levels.

The development of scientific exchange programs, leads to the need to recognize amongst the research infrastructures, several infrastructures based on very high-level human networks, for ensuring hosting and managing events of international impact. One can also mention the European network for advanced mathematics centers, in which France holds a significant role through the GERM including IHES and IHP, and in the field of the SHS, the NEFIAS project for the networking of advanced research institutes.

As well as the afore mentioned infrastructures, we can include the innovative approaches made possible by the following: lasers and very short impulse sources (XFEL, LULI), bioinformatics (EMBL/EBI) and *in vivo* imaging (FBI, Neurospin) very high definition imaging (synchrotrons, neutrons, very high field RMN and EMFL), network of nanotechnology centres (RENATECH), simulation and intensive computation (PRACE), database in SHS and health (ELFE cohort).

Targets

• To maintain the effort of design and installation of research infrastructures for fundamental research

• To ensure the opening of a palette of infrastructures corresponding to disciplines (and multi-disciplinary projects) whose infrastructure needs are emerging

• To take into account, more broadly, the new needs and opportunities emerging from massive data treatment, collection and analysis

• To facilitate staying in touch with disciplines in which the needs are satisfied by high-level human networks and their collaborative tools

Reinforce partnerships with the economic sector

Infrastructures have significant potential to promote innovation and industrial development in particular due to extreme technological requirements. They therefore provide the opportunity for creating relationships between the scientific and industrial worlds, whether it be in sharing the conception process with cutting edge technological industries, producing advanced technological services and products, or opening infrastructures to industrial research

In this dimension, one must consider the contributing capacity of network infrastructures. As an example we can cite the network infrastructures involved in Nano technologies research as much for their clean rooms as for their large characterization apparatus. These networks must be supported by human networks with complementary skills.

As an example, we can simply name the activities of CERN as it is summed up[4] in the conclusion of this study “on the extension of high-technology contracts that have been granted – about one billion euros – to 630 societies involved in the building of the LHC: of the 178 respondents, 30% said they had developed new products having no connection with high energy physics, 17% had created new markets and 14% new commercial units”. And if we refer to astronomy and the consequent impact on the industrial sector, there is a return on investment close to one for most large programs.

Targets

• To promote the contribution of research infrastructures to innovation, economic development, and job creation

• To ease the opening of research infrastructures to the private sector and to favor research and industrial innovation

• To promote the networking of research infrastructures, notably to sustain ambitious joint ventures with industry

[4] http://www.wipo.int/wipo_magazine/fr/2008/06/article_0005.html

Master the costs related to the new needs of infrastructures

The instrumentation needs from all sciences and the major issues with which society is confronted (particularly energy, health, environment) lead, in terms of infrastructures, to permanent innovation with the risk of an ill-advised, ever-expanding budget.

The road map 2012-2020 is an opportunity for the State and its operators to show their determination to keep the costs under control by implementing a plan shared by all the participants. This plan is based upon: a clear delimitation of the concerned scope of action, the creation of steering committees in charge of defining priorities and avoiding any overlap (directing committee of the TGIR and OI and partnerships), a multi-annual programming, and the implementation of a procedure for creating and ending infrastructures. In fact, the necessity to adapt to new realities supposes the anticipation of infrastructures becoming obsolete.

APPLICATION FIELDS

In broad terms, research infrastructures possess many similarities, allowing them to integrate into the framework of national research and innovation: unique characteristics acknowledged by the user community, providing an opening on the basis of scientific excellence; governance and mid or long-term financing plans, the ability to collaborate with the economic sector.

Their difference lies in their subject matter and in the challenges met by every community or discipline, which leads us to define the strategy of the various fields where research infrastructures intervene.

Training, scientific culture and communication

Infrastructures take part in the training of researchers, students and specialists on the specific technologies they implement. We can mention, as examples, the programs put together by LLB[5], SOLEIL[6], EMBL(EBI)[7], PRACE[8].

The targets and success of large international organisations, such as CERN and ESO are widely covered by the press and media. They contribute to the diffusion of scientific culture and have created vocations at a time when a general disinterest for scientific studies conflicts with the hopes of developing the economy of knowledge.

Targets

• To contribute to the attractiveness of scientific careers by disseminating accessible scientific culture to the greatest number of people, from high school onwards

• To provide high-level technical training, allowing the diffusion of know-how in the ecosystem of national innovation, and to increase high-level proficiency available in research and industrial production

Synergy between scientific and technological research

Research infrastructures provide the opportunity for ambitious projects in total synergy with advanced researchers and cutting edge industries. In fact, the creation of research infrastructures frequently calls for developing original technologies or improving them beyond the current state of the art. Their exploitation also allows completing the range of tools that the industry uses to conceive and analyse mass data, and characterize or observe the behaviour of systems on various scales.

These synergies are not limited to the implementation of the technical capacities of instruments or research infrastructures, they also allow an interaction between the human networks concerned, the tacit or explicit transmission of knowledge, and to consolidate and confront field expertise. It is generally a matter of externalising the building and operating the research infrastructures, which is difficult to evaluate financially, but easy to assess, for example, by observing the innovative companies or SMEs linked to infrastructures.

It is worth mentioning that measures initiated by the European Commission in the frame of the “Europe 2020 “ initiative, to promote the strategic use of public procurement, notably through the R&D Pre-Commercial Procurement, should allow these synergies to be strengthened even further.

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[5] http://www-llb.cea.fr/cours/cours_p.php
[6] http://www.synchrotron-soleil.fr/RessourcesPedagogiques#AteliersPedagogiques
[7] http://www.ebi.ac.uk/training/
[8] http://www.prace-project.eu/Training?lang=en

Research infrastructures must nevertheless appropriate this method, of which many examples can be found at international level. [9]

Targets

• To develop synergies between research infrastructures and economic or technological orientated networks including local “anchoring”

• To spotlight the benefits brought to competitiveness through public procurement made by research infrastructures

Assessment of scientific practices and methods

A major application is the evolution of science itself. Research infrastructures are very intimately associated with scientific methods, as it has been emphasised several times in this document. The mechanisms are manifold:

- **Give access to new experimental information.** For instance: complete genome sequencing (from the complete genome of a single species to comparative studies between genomes), identification of non-observable matter in the universe (astrophysics), large statistical cohorts.

- **Allow the implementation of new methodologies**. For example: the use of digital simulation to study complex phenomena (disturbances, combustion, climatology, meteorology), statistics and studies of large networks of communicating objects (internet of the future), SHS analysis of entire bodies of text.

- **Encourage the emergence of new theories, for instance, by highlighting the insufficiencies of existing theories**. For example: developments encouraged by the LHC experiments at CERN, which called into question the size of the proton[10].

- **Allow new forms of interaction with objects or phenomena**. For instance: atomic force microscopy and nano-manipulator (METSA network).

To maintain French research at the forefront implies therefore the capacity to implement an ambitious policy in research infrastructures, in order to gain from the economic or strategic innovation possibilities that they allow.

Targets

• To rely on infrastructures and joint ventures to maintain France at the highest level of scientific evolution

• To adopt an agile planning for infrastructures based upon proven and reactive methods

• To facilitate risk research, following SNRI recommendations, reduce cultural biases and evaluation if they are an obstacle to change, facilitate the transfer and associated industrial innovation

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[9] http://www.progreat.eu/event/106-high-level-event :<<High Level Event on the Pre-Commercial Procurement”, Budapest, 11-12/04/2011
[10] « The proton is smaller than we thought » http://www.psi.ch/media/le-proton-est-plus-petit-que-ce-que-lon-pensait (international partnership in which the Kastler Brossel laboratory represents France.

GOVERNANCE

The state of the art established in this strategic note has highlighted the complexity of the range of research infrastructures. To respond to the desire to strengthen the coordination between players, two types of governance are adopted which are accompanied by a budgetary follow-up of a different nature.

IO AND VLRI GOVERNANCE

A steering committee (CD-TGIR) and a high council (HC-TGRI) bear the responsibility of advising the Research Minister on his Ministry's (MESR) position, giving an opinion on high-level structuring decisions and to follow up on its implementation. The State's position will be established through the articulation of the MESR position with that of the other ministries concerned in the instruction and decision making processes. This applies to commitments in large projects as much as for the preparation of State budgetary documents.

The Steering Committee is presided by the DGRI and is composed of a representative of the Ministry in charge of foreign affairs, the CEA Administrator General, the CNRS President and the Presidents of each alliance. Leaders of other institutions involved in VLRI and IO are invited to the CD-TGRI if the agenda concerns them. Its mission is five fold:

- To propose to the Minister high level structuring decisions such as France's participation in large international projects, necessary rejuvenation/updating and the stop of obsolete installations
- Suggest a short-term investment policy
- Define and validate the updating of the scope of expertise and the VLRI multi annual programming
- Validate cost and valorisation models
- Validate and follow up on the implementation of national policies related to VLRI

The CD-TGIR meets at least twice a year when convened by the Minister in charge of research; for the completion of its missions the CD-TGRI will rely on the HC-TGIR opinion; the CD-TGRI is assisted by a permanent secretariat granted by DGRI.

The high council of VLRI is composed of a president and ten personalities chosen for their scientific influence and their expertise in the fields of large research tools. The HC-TGIR constitutes a group representative of scientific disciplines. These personalities are nominated for a four-year mandate by the Minister in charge of Research and on a proposition of the Steering Committee. The HC TGIR gives its scientific and strategic advice on selected topics on the request of the Steering Committee, and by analogy with the governances implemented at CNES or ESA, or a similar authority to facilitate the Research Ministry's decision making. This advice takes the shape of a report where the scientific and strategic pertinence of the study is analysed and commented upon. The High Council will rely as much as it needs to upon the works of the alliances related to infrastructures and will see to it that advice be coordinated with national strategy priorities in terms of research infrastructures and compatible with financial capacities. The opinion of the HC/ TGIR is consultative. HC/ TGIR can ask questions of scientific interest.

France funds IO and VLRI through the MIRES budget, and applies the following programs and actions:

- IO (CERN, ESO and EMBL) are on program 172 (actions 8, 9 and 5 respectively)
- VLRI are essentially funded through the budgets of the organisms by programs 172 (action 13 mainly) and 187 (action 7)

The DGRI coordinates the definition of national orientations in accordance with the governmental policies on VLRI, taking into account the international and European framework. It ensures that the policy is put into action by consolidating and coordinating on a national level the actions needed for the implementation and by ensuring the follow-up. It optimises the allocation of resources according to national priorities in the frame of the multi-annual programming. Lastly, in consultation with the organisms, the DGRI structures crosscutting policies applicable to the whole of VLRI, notably in developing new relations with industrials.

Research operators sit on the VLRI's decision-making boards that are related to their scope of action. Thus they vote the budget, validate, or not, investment programs, and define the strategy of each VLRI. They organize performance and management dialogue with VLRI and more specifically, see to the implementation of crosscutting policies defined on a national level.

RESEARCH INFRASTRUCTURES GOVERNANCE

RI Programming policy is steered by alliances or ad-hoc consultation committees between research operators, in the frame set by the national strategy for research infrastructures.

There is no state centralized budgetary follow up for RI. Their budget is directly followed by the operating research bodies.

The list of research infrastructures is examined every year within the various alliances, discussed and validated by the steering committee (CD/VLRI). Such a scheme aims at combining respect for the commitments and the need for reactivity.

ANNEX: SCORE BOARD 2013

OI, TGIR, IR, PROJECTS 2013
2012 LIST OF RESEARCH INFRASTRUCTURES

Nuclear and High Energy Physics

Category	Group	Name	Full name
OI	**CERN**	**CERN**	European Organization for Nuclear Research
		CERN - LHC	Particle accelerator LHC at CERN
TGIR		**GANIL-Spiral 2**	Large national accelerator of heavy ions (project Spiral 2 included – laboratories part excluded)
TGIR		**FAIR**	Facility for Antiproton and Ion Research
TGIR		**EGO-VIRGO**	European Gravitational Observatory (project VIRGO included)
IR		**ANTARES**	Astronomy with a Neutrino Telescope and Abyss environmental research

Material and Engineering Sciences

Category	Group	Name	Full name
TGIR		**ESRF**	European Synchrotron Radiation Facility
TGIR		**XFEL**	European X-ray free electron laser
TGIR		**ILL**	European neutron source - Institut Laue Langevin
TGIR		**ORPHEE**	Orphée reactor. Excluding LLB part (Laboratoire Léon Brillouin)
TGIR		**SOLEIL**	3rd generation synchrotron radiation source
IR		**CESTA Lasers**	High-density energy lasers - CEA / CESTA
IR		**EMIR**	Network of accelerators for material irradiation
IR		**LNCMI**	Laboratoire des champs magnétiques intenses
IR		**LULI**	Laboratory for the use of intense lasers
IR		**METSA**	National network for electronic microsocopy (transmission and atomic probe)
IR		**Renard**	National network of interdisciplinary RPE (paramagnetic electronic resonance)
IR		**RENATECH**	Network of nanotechnology centres
IR		**RMN**	Network of high-field NMR platforms
PROJET		**ESS**	European spallation source

Digital and Mathematical Sciences

Category	Group	Name	Full name
TGIR	**GENCI**	**IDRIS**	Institute for development and resources in scientific informatics
		CINES	National Center of Informatics for Higher Education
		TGCC	Very Large Computing Centre
		PRACE	European Strategy Forum on Research Infrastructures – ESFRI
TGIR		**RENATER**	National telecommunications network for technology, education and research
IR		**CC IN2P3**	Computing Centre of the National Institute of Nuclear Physics and Particle Physics
IR		**France Grilles**	Grid Institute: Informatics Production Grid
IR		**Grid 5000**	Grid 5000 Research infrastructure on massively parallel and distributed systems
PROJET		**GERM**	Large Equipment for Research in Mathematics
PROJET		**Net-Robotic**	National network of Robotic Platforms

Earth and Planetary Sciences – Planetary Sciences

Category	Group	Name	Full name
OI	**ESO**	**ESO**	European Southern Observatory
		ALMA	Atacama Large Millimeter/submillimeter Array; World class interferometric observatory in millimeter/submillimeter domain
		ELT (Projet)	European Extremely Large Telescope – Biggest telescope in visible and infrared lights
		VLT	Very Large Telescope (Interferometer): network of 4 optical telescopes with interferometric capability
TGIR		**CFHT**	Canada-France-Hawaï Telescope; Telescope in the visible and near infrared domain
TGIR		**IRAM**	Institut for Milimeter RadioAstronomy / NOEMA (Northern Extended Millimeter Array)
IR		**CDS**	Centre for astronomical data of Strasbourg
IR		**HESS**	High Energy Stereoscopic System; Network of Cherenkov telescopes in very high-energy gamma rays
IR		**LOFAR**	LOw Frequency ARray; Radiotelescope in the meter/decameter domain using a network of 41 stations in Europe
PROJET		**CTA**	Cherenkov Telescope Array; Very high-energy gamma ray telescope

Earth and Planetary Sciences – Earth Sciences

Category	Group	Name	Full name
TGIR		**Concordia**	French-Italian polar scientific base
TGIR		**EURO-ARGO**	Infrastructure of submersible floats for ocean observation, ESFRI
TGIR		**FOF**	French ocean research fleet
TGIR		**IODP/ECORD**	The Integrated Ocean Drilling Program / European Consortium for Ocean Research Drilling – International program of deep sea drilling
IR		**ICOS**	Integrated Carbon Observation System, ESFRI
IR		**RESIF/EPOS**	European Plate Observing System - Research infrastructure for the observation of the earth's crust
IR		**CEPMMT**	European Center for Medium-range Weather Forcasts ECMWF -
IR		**EMSO**	European multidisciplinary seafloor observatory - ESFRI
IR		**GODAE - MERCATOR**	Global Ocean Data Assimilation Experiment) – MERCATOR
IR		**IAGOS**	In service Aircraft for Global Observing System (CNRS, *Météo France*, CNES, ADEME)
IR		**SAFIRE**	French Instrumented Aircraft Service for Environmental Research
IR		**SOMET**	Structure for the observation and the memory of the environment and the earth

Agronomy, ecology and environmental Sciences

Category	Group	Name	Full name
IR		**ECOTRONS**	Platforms for ecological experimentation at ecosystem level
IR		**ANAEE**	Network for ecosystems and agrosystems
IR		**EMBRC**	National Center for Marine Biological Resources
IR		**ECOSCOPE**	Network of research observatories on biodiversity and ecosystem services
IR		**GOPS**	Large scale Observatory for Environment and Biodiversity in the South Pacific
IR		**ReNSEE**	Experimental Ecology Network
PROJET		**R2AE**	Research Network on anthropo-ecosystems
PROJET		**Marine and littoral environment**	Observations on physical and ecological condition of the marine and littoral environment
PROJET		**Continental areas**	Functioning and evolution of continental areas and their interfaces

Biological and Medical Sciences

Category	Group	Name	Full name
OI	EMBL	**EMBL**	European Molecular Biology Laboratory
		EMBO	European Molecular Biology Organisation
		EMBC	European Molecular Biology Conference
IR		**CELPHEDIA/Phenomin**	Resource center animal models ESFRI : INFRAFRONTIER (mouse, drosophila, zebra fish…)
IR		**Biobanques**	Coordination of Biobanks, CEPHE – ESFRI : BBMRI-MIRRI- Cohortes
IR		**Ingestem et Eucellfrance**	Structuration of Stem cells and regenerative medicine fiels
IR	ECRIN	**F-CRIN**	Clinical Research infrastructures network ESFRI ECRIN
		ECRIN	European Clinical Research Infrastructures Network (ESFRI).
IR		**France Bio Imaging**	Cellular imaging ESFRI EUROBIOIMAGING
IR		**France Life Imaging**	Biomedical Imaging ESFRI: EUROBIOIMAGING
IR		**France Génomique**	Genotyping and sequençing platform network
IR		**FRISBI**	Integrated Structural Biology ESFRI INSTRUCT
IR		**HIDDEN**	BSL4 laboratory Inserm/Merieux ESFRI ERINHA
IR		**MetaboHub**	Metabolomic platform network
IR		**ProFI**	Proteomic platform network
IR		**NEURATRIS and IDMIT**	Translational research based on, among others, MIRCEN and NEUROSPIN platforms, for neurosciences ESFRI EATRIS and for infection diseases: IDMIT

Human and Social Sciences

Category	Group	Name	Full name
TGIR		**Humanités numériques**	Platform network for digitization, standardization and access interface resulting from coupling of ADONIS (Digitized access to scientific resources and archives) and CORPUS (Cooperation of research operators for the use of digital sources)
TGIR		**PROGEDO**	International surveys and platforms for access to public statistics
IR		**NEFIAS**	Large networked equipment for internationalizing SHS (IEA, IFRE…)
IR		**RMSH**	Network of collaborative platforms for “Maisons des Sciences de l’Homme”

Documentation Infrastructures

Category	Group	Name	Full name
IR		**BSN**	Digital scientific library
IR		**CollEx**	Collections of excellence – Network of libraries

ITER is a unique object on an international scale, for validating the scientific and technological feasibility of fusion energy by magnetic confinement. Given the stakes and the specific financial weight of ITER, it is not included in the perimeter of the VLRI steering committee.

Ministère de l'Enseignement supérieur et de la Recherche

1, rue Descartes - 75231 Paris cedex 05
www.enseignementsup-recherche.gouv.fr