European Strategy Forum
on Research Infrastructures

ESFRI

EUROPEAN ROADMAP FOR RESEARCH INFRASTRUCTURES

Roadmap 2008

UPDATE 2008

Cataloguing data can be found at the end of this publication.

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>ESFRI and its mission

What Is ESFRI

ESFRI, the European Strategy Forum on Research Infrastructures, acts on issues related to the development of high scientific quality European research infrastructures. ESFRI gives national authorities the opportunity to exchange news and to explore common and integrated initiatives for the best development and use of research infrastructures of European relevance. As such, ESFRI contributes to the implementation of the Lisbon agenda by integrating national policies and thus providing Europe with the most up-to-date research infrastructures. This responds to the need of the scientific community to address the rapidly evolving science frontiers.

ESFRI's delegates are nominated and mandated by the Research Ministers of the Member States and Associated Countries, and include a representative of the European Commission.

ESFRI's mission

The mission of ESFRI is to support a coherent and strategy-led approach to policy-making on new and existing pan-European and global research infrastructures. ESFRI facilitates multilateral initiatives leading to the better use and development of research infrastructures, acting as an incubator for decision-making processes.

The mandate for the roadmap

Competitiveness Council Conclusions, 25-26 November 2004:

"In the context of developing research infrastructures of European interest, the Council of the European Union welcomes the development of a strategic roadmap for Europe in the field of research infrastructures and the role of the European Strategy Forum on Research Infrastructures (ESFRI) in this context.

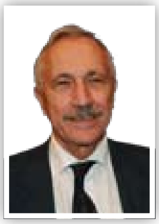
This roadmap should describe the scientific needs for Research Infrastructures for the next 10-20 years, on the basis of a methodology recognised by all stakeholders, and take into account input from relevant inter-governmental research organisations as well as the industrial community. The Council stresses that this roadmap should identify vital new European research infrastructures of different size and scope, including medium-sized infrastructures in the fields of humanities and bio-informatics, such as electronic archiving systems for scientific publications and databases, covering all scientific areas as well as existing ones that need to be upgraded."

Competitiveness Council Conclusions, 21-22 May 2007:

"The Council recommends that ESFRI updates this roadmap at regular intervals in order to cope with the rapid evolution of scientific and technological needs."

>Foreword

Dear Ministers,
Dear Commissioners,



The availability of open, competitive and quality-based access to pan-European and global research infrastructures is vital to make the European Research Area attractive at a global level. The ESFRI Roadmap for research infrastructures is a major contribution to this strategy, and one of the most successful European initiatives in attracting the interest of international players, as shown by the inclusion of research infrastructures in the agenda of the G8 Science and Technology Ministers' Meeting and in meetings of the OECD Global Science Forum.

This is the first update of the European roadmap for new, pan-European and global research infrastructures adopted by the European Strategy Forum on Research Infrastructures (ESFRI) on September 25th, 2008, fulfilling a request by the European Council of Research Ministers. This update presents new facilities tackling challenges in Environment, Energy and Health, while at the same time endorsing almost all the previous projects in the first edition, published in 2006.

Several of the projects presented in the first edition are now well advanced in their negotiation phases or have even entered the construction phase. Concerted action to ensure long-term commitment to the ESFRI projects is fundamental to ensure their successful implementation. In this respect, the ESFRI roadmap is increasingly accompanied by the elaboration and update of several national roadmaps and by the earmarking of national funds. This is helping to stimulate the coordinated use of the resources of the Member and Associated States, by far the largest contributors to pan-European and global research infrastructures.

The integration of the national budgets with EU funds (in particular the structural funds) and the "Risk Sharing Finance Facility", jointly set up by the European Investment Bank and the European Commission, will enhance Europe's capability to compete at a global level. Additionally, a new European legal framework, proposed by ESFRI and now in discussion at EU level, should facilitate and speed up the establishment of new research infrastructures and provide some of the privileges and tax exemptions now granted to international organisations. These actions are a concrete implementation of the Lisbon and Ljubljana strategies for the establishment of the European Research Area.

The already existing intergovernmental cooperation should be strengthened, and specifically supported in the future, to ensure the best use of existing and new research infrastructures in Europe in all fields of science and technology. Open and competitive access to all Pan-European research infrastructures should be effectively supported by national and EU funding, to increase the attraction of excellent scientists and engineers from all over the world and the training of young researchers in internationally competitive environments.

ESFRI's activities and discussion on the "Green Paper on the European Research Area" prepared by the European Commission have raised awareness of research infrastructures as a critical component for scientific competitiveness in Europe. Increased support and stronger joint action by the European governments are now needed to ensure the commitment of the national and EU resources, crucial for the realisation of these facilities responding to the emerging challenges.

Carlo Rizzuto
Chair of ESFRI

>Structure of the report

>Achievements of ESFRI

Projects under construction

Since the publication of the 2006 roadmap some projects have made sufficient progress in the technical, financial and legal agreements, and in some cases effectively started construction, that they can be considered as "started": these are **ESRF Upgrade**, **ILL20/20 Upgrade**, the **European XFEL**, the **Jules Horowitz Reactor**, **FAIR** and **SPIRAL2**. Others are in an advanced preparation stage (see projects status table). Through the continued incubator role of ESFRI it is expected that several more will follow in the future: the signs are encouraging.

Emergence of national roadmaps

ESFRI activities and its roadmap aim to integrate national resources into a common, pan-European effort. The first positive response in this direction has been the fact that the ESFRI Roadmap has prompted several countries to develop their own national roadmaps. The earmarking of national budgets for large research infrastructures is necessary to participate in a common pan-European effort.

Mobilisation of scientific communities

Several scientific communities are increasingly becoming organised and are producing their own thematic roadmaps, where the needs of their disciplines in the short, medium and long term are clearly identified. Recent examples are the Strategy for Particle Physics by the CERN Council, that for Nuclear Physics by NUPECC, and the roadmaps for astronomy by ASTRONET, and for Astroparticle Physics by ASPERA.

Development of legal instruments at EU level

ESFRI has recognised that there is a lack of appropriate legal instruments for setting up pan-European research infrastructures. On the basis of dedicated workshops, a proposal for a legal framework has been discussed. Based on ESFRI's recommendation, the European Commission has formulated a proposal to the Competitiveness Council for a regulation.

Development of funding instruments at EU level

Under the 7th Framework Programme, the Commission has funded the preparatory phases for 34 projects included in the 2006 ESFRI roadmap. First indications show that the effects induced by the preparatory phase have a positive impact in order to move these projects forward towards construction.

In terms of project financing, the joint action by the EC and the European Investment Bank, through the creation of the **Risk Sharing Finance Facility** opens up the use of another financial instrument which can be strongly synergic with national and EU funding for the projects of the ESFRI roadmap.

It is also encouraging to see that the EC **Structural Funds** are increasingly targeted for the funding of the construction of new research infrastructures.

Enhanced cooperation at global level

The publication of the ESFRI roadmap has raised awareness at global level. Global research infrastructures figured on the agenda of the first meeting of the G8+O5 Science Ministers in 2008, and roadmapping is being discussed in the context of the OECD Global Science Forum. This is giving Europe an important position in the development of policy and initiatives to increase its attractiveness for world level researchers and for the industries interested to be near research facilities of world level. A positive influence of ESFRI is now felt in the discussions on the establishment of some global infrastructures with countries like Australia, China, India, Japan, Russia, South Africa, and USA. It is an encouraging increase of the international collaboration for research infrastructures that is already a reality in facilities such as ITER in Cadarache, the LHC at CERN, and ARGO at world level.

We acknowledged the necessity of promoting international cooperation in large-scale research facilities through the exchange of relevant information, by allowing other countries access to such facilities in a proper way including wider access by industry, and by sharing information on plans to construct new large-scale research facilities in order to promote mutual international use by international groups or individuals to avoid international investment duplication and to facilitate cost sharing where appropriate.

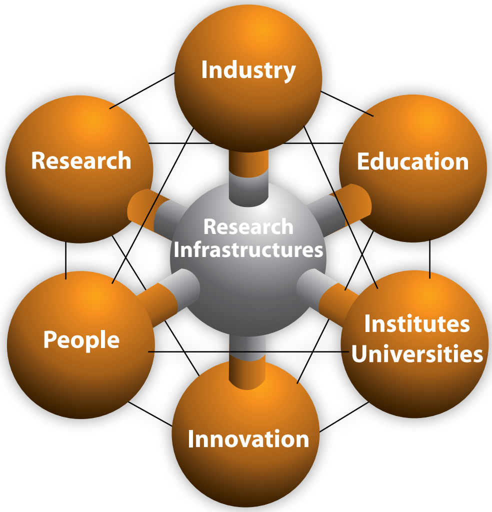
In strengthening such international cooperation in large-scale research facilities available for international use, we reached a consensus to exchange information, such as accessibility, on existing large-scale research facilities and basic information, such as the scale, priority and schedule for future facilities in each country. In order to continue the dialogue for international cooperation on large-scale research facilities in the future, including discussion of different models for their operation and their use, we reached a consensus to set up an ad-hoc group of senior officials, composed of representatives of G8 members as well as other invited countries.

[Chairman's Conclusions, first meeting of the G8+O5 Science Ministers, Okinawa, 15 June 2008]

Greater attention to the regional dimension

Considering the importance of involving the "newer" Member States in the development and implementation of their roadmaps in a meaningful way, ESFRI formed in 2007 a specific Working Group. The main idea presented in the 2007 report is the creation of "regional partner" infrastructure facilities connected to large research infrastructure centres, and distributed within regions of Europe.

The spring 2008 Council, on the basis of the conclusions of the Brdo conference and of the related ESFRI work, developed further this idea and invited therefore Member States and regions to continue developing, among others, "regional partner facilities" as a useful way of capacity building of all regions in Europe resulting in a balanced development of the ERA. The spring Council also recognised that regions are important drivers leading to the development of a knowledge-based society. Hence, ESFRI will continue its efforts to study possible recommendations to increase the capacity of regions across Europe.



What are research infrastructures?

They are facilities, resources or services of a unique nature that have been identified by pan-European research communities to conduct top-level activities in all fields.

This definition of research infrastructures, including the associated human resources, covers major equipment or sets of instruments, in addition to knowledge-containing resources such as collections, archives and data banks. Research infrastructures may be "single-sited", "distributed", or "virtual" (the service being provided electronically). They often require structured information systems related to data management, enabling information and communication. These include ICT-based infrastructures such as Grid, computing, software and middleware.

In all cases considered for the roadmap, these infrastructures must apply an "Open Access" policy for basic research, i.e. be open to all interested researchers, based on open competition and selection of the proposals evaluated on the sole criterion of scientific excellence by international peer review.

>The Updated Roadmap — what is new?

Clearer connection to landscape

In the updated roadmap, each group of research infrastructures is preceded by a short introduction outlining the context of the projects in the roadmap, including some emerging fields. More information can be found in the detailed reports of the Roadmap Working Groups on the ESFRI website. These reports also outline critical areas for society at large where a more proactive and strategic approach may be needed to foster the emergence of new research infrastructures of pan-European relevance in critical fields of research, such as systems biology, food, agriculture, and energy.

Introduction of new fields

A **specific effort** has been made to identify new research infrastructures of pan-European relevance for **Energy** (in particular non nuclear) **Biological and Medical Sciences** and **Environmental Sciences**. The Roadmap Working Groups have played a proactive role with several research infrastructure projects whose initial proposal did not appear sufficiently mature from the scientific and technical points of view, but whose strategic importance for the specific field was recognised.

Greater role of e-Infrastructures

e-Infrastructures are critical to all projects in this roadmap. The e-infrastructure aspect of each project has therefore been assessed in much greater detail than before.

A living document

The roadmap is the result of a continuous process. As facilities come to maturity and are constructed, they eventually disappear from the roadmap and are replaced by new projects. Similarly, ESFRI shall continuously monitor the roadmap projects. If, after three years, no government or national authority has formally committed itself, the project in question shall be removed.

Better definition of distributed facilities

In some cases it is difficult to distinguish between **distributed facilities** and networks of existing research infrastructures. The following definition has therefore been applied to underline the differences between the two:

- A European research infrastructure can adopt a single site or a multiple site structure according to their specific technical characteristics and mission. When a research infrastructure is structured with *more than one site* it could be defined as a distributed infrastructure.

- A European distributed infrastructure, as recognised by ESFRI, is a *singular* research infrastructure, having a *unique Name and legal status, Director or board of directors, Management Structure, Strategy and Development Plan, Access point for users, Annual Report and Fiscal address* although its research facilities have multiple sites.

- A European distributed infrastructure has to have a *pan-European interest*, i.e. *unique laboratories* or facilities rendering services for the efficient execution, with critical mass, of top-level Community research, ensuring *open access* to all interested researchers based on scientific excellence and on the quality of the user proposals, creating a substantial added value with respect to facilities with a more limited scope.

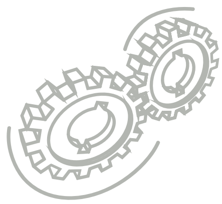
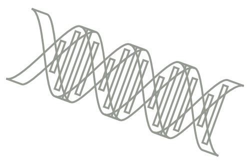
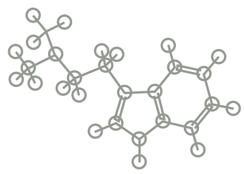
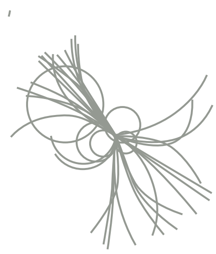
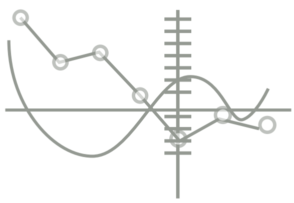
- A European distributed infrastructure must bring significant improvement in the relevant scientific and technological fields, establishing a common standard and metrology of the technical offer in all sites, and addressing a clear integration and convergence goal of the scientific and technical standards offered to the European users in its specific field of science and technology.

	PROJECTS	construction costs (M€)	Operations costs (M€/year)	first possible operations or upgrade
Social Sciences and Humanities	CESSDA	30	3	2013
	CLARIN	104	7.6	2014
	DARIAH	12	4	2013
	European Social Survey	54**	9**	2008
	SHARE	11.6	0.3	2008
Environmental Sciences	AURORA BOREALIS	635	32.5	2014
	COPAL (ex EUFAR)	50	3 (+6000€/hour)	2012
	EISCAT_3D Upgrade	60-250	4-10	2015
	EMSO	160	32	2013
	EPOS	500	80	2018
	EURO-ARGO (GLOBAL)	80	7.3	2011
	IAGOS	15	0.5-1	2012
	ICOS	128	14	2012
	LIFEWATCH	370	71	2019
	SIAEOS	50	9.5	2012
Energy	***ECCSEL***	81	6	2011
	HiPER	800	under discussion	2020+
	IFMIF (GLOBAL)	1000	150-80	2020
	JHR	500	24-33	2014
Biological and Medical Sciences	BBMRI	170	15	2013
	EATRIS	255	50	2013
	ECRIN	50	5	2014
	ELIXIR (GLOBAL)	470	100	2012
	EMBRC	100	60	2018
	EU-OPENSCREEN	40	40	2012
	EuroBioImaging	370	160	2012
	High Security BLS4 Laboratory	174	24	2018
	Infrafrontier	270	36	2010
	INSTRUCT	300	25	2012
Materials and Analytical Facilities	***EMFL***	120	8***	2015
	ESRF Upgrade	238	83	2009-2014
	EuroFel (ex-IRUV-FEL)	1200-1600	120-160	2007-2020
	European Spallation Source	1300	110	2019-2020
	European XFEL	1043	84	2014
	ILL20/20 Upgrade	171	5***	2007-2017
Physical Sciences and Engineering	***CTA***	150	10	2013
	E-ELT	950	30	2018
	ELI	400	50	2015
	FAIR	1187	120	2016
	KM3NeT	200	5	2016
	PRINS	1400	300	2009-2015
	SKA (GLOBAL)	1500	100-150	2016
	SPIRAL2	196	6.6	2014
e-Infrastructures	PRACE (ex EU-HPC)	200-400*	50-100	2009-2010

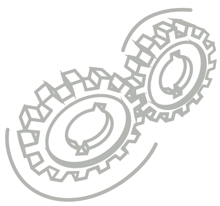
*estimated costs to renew the high-end infrastructure every 2-3 years
**for the integrated construction/operation process over 6 years.
***additional to current operations costs

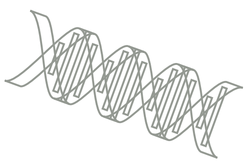
construction "started", meaning funding and agreements almost in place
advanced preparation for construction but agreements and funding not yet in place
in bold italic new facilities added since the 2006 roadmap

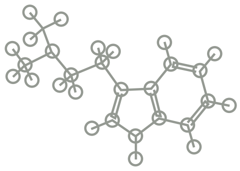
Description
Facility to provide and facilitate access of researchers to high quality data for social sciences
Research infrastructure to make language resources and technology available and useful to scholars of all disciplines
Digital infrastructure to study source materials in cultural heritage institutions
Upgrade of the European Social Survey, set up in 2001 to monitor longterm changes in social values
Data infrastructure for empiric economic and social science analysis of ongoing changes due to population ageing
Europeal polar research icebreaker
Long range aircraft for tropospheric research
Upgrade of the EISCAT facility for ionospheric and space weather research
Multidisciplinary Seafloor Observatory
Infrastructure for the study of tectonics and Earth surface dynamics
Ocean observing buoy system
Climate change observation from commercial aircraft
Integrated carbon observation system
Infrastructure for research on the protection, management and sustainable use of biodiversity
Upgrade of the Svalbard Integrated Arctic Earth Observing System
European Carbon Dioxide and Storage Laboratory infrastructure
High power long pulse laser for fast ignition fusion
International Fusion Materials Irradiation Facility
High flux reactor for fission reactors materials testing
Bio-banking and biomolecular resources research infrastructure
European advanced translational research infrastructure in medicine
Pan-European infrastructure for clinical trials and biotherapy
Upgrade of the European Life-science infrastructure for biological information
European marine biological resource centre
European Infrastructure of Open Screening Platforms for chemical biology
Research infrastructure for imaging technologies in biological and biomedical sciences
Upgrade of the High Security Laboratories for the study of level 4 pathogens
European infrastructure for phenotyping and archiving of model mammalian genomes
Integrated Structural Biology Infrastructure
European Magnetic Field Laboratory
Upgrade of the European Synchrotron Radiation Facility
Complementary Free Electron Lasers in the Infrared to soft X-ray range
European Spallation Source for neutron spectroscopy
Hard X-ray Free Electron Laser in Hamburg
Upgrade of the European Neutron Spectroscopy Facility
Cherenkov Telescope Array for Gamma-ray astronomy
European Extremely Large Telescope for optical astronomy
Extreme Light Intensity short pulse laser
Facility for Antiproton and Ion Research
Kilometre Cube Neutrino Telescope
Pan-European Research Infrastructure for Nano-structures
Square Kilometre Array for radio-astronomy
Facility for the production and study of rare isotope radioactive beams
Partnership for Advanced Computing in Europe

>The Roadmap: the landscape and its projects

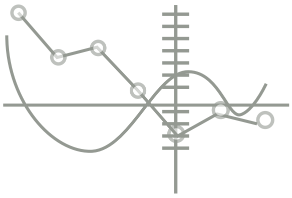






>Materials and Analytical Facilities 61

>Physical Sciences and Engineering 71



>e-Infrastructures 83

Estimated costs and timelines

A note of caution is required when dealing with the estimated costs of the facilities. This roadmap, differently from roadmaps developed by funding agencies on the basis of predictable budgets, is a proposal to several different funding Authorities and Governments, to help them orient their efforts in a more coordinated way. The cost estimates reported in the project descriptions are necessarily those indicated by the proponents themselves and represent the best estimate available at the time of writing. These figures are solely intended as a basis for interested countries to assess the possibility to participate or to bid for hosting a project, as a function of the size of their budgets and scientific communities. Similarly, timelines are in most cases approximate and will be refined as the project evolves.

>Social sciences and Humanities

The Social Sciences and Humanities contribute actively to and are necessary instruments for our profound understanding of the cultural, social, political and economic life in Europe as well as for the process of European cohesion and bringing about changes. In practice these disciplines make significant contributions to important areas like strengthening employment, modernising our social welfare and education systems, and securing economic reform and social cohesion as part of a knowledge- based economy.

Europe is a continent of diverse peoples, cultures, histories, economies, political systems and identities. To address and understand these complexities the research community needs high quality cross-national data and access to existing material for comparative studies.

To encourage and nurture international collaborative research within the Social Sciences and the Humanities in Europe, research infrastructures offering a series of crucial functions and resources must be established. Although they might very well be extensions of existing functions and resources, they need to be broadened in scope, strengthened or extended to other disciplines and across disciplines.

Challenges

Information and materials for research purposes are not a scarce resource in Europe, neither for the Social Sciences nor for the Humanities. In Social Sciences, well-developed official statistical systems combined with a variety of academically driven data gathering programs and activities have and are producing a wealth of data and information about various aspects of European society. However, the majority of these resources are country or nation specific. They are produced to meet national requirements and collected by means of nation and language specific instruments based on local methodologies and classifications. They are normally documented only in national languages and rarely published for general use outside the country of origin. Nation-specific access restrictions will often prevent information from travelling abroad. In addition, many data and information sources of importance in researching and understanding European society, economy and culture are created or compiled by commercial concerns and access and use by academics is effectively prohibited.

Yesterday's answers to these challenges would probably have been formulated in terms of centralisation and the establishment of large-scale European-wide institutions. Today's answers should rather focus on standardisation, the power of emerging information and communication technologies, harmonisation of data access restrictions and strengthening of and collaboration among already established groups and organisations engaged in the development of the European Research Area. Concerted efforts on a European scale are needed to bring about the necessary changes. The project Europeana can be seen as an example in this context.

The challenge for the Social Sciences and Humanities, therefore, is more than fibre-optic cables, storage area networks or basic communication protocols. Access to and common exchange of data is a prerequisite for the fruitful utilisation of the possibilities offered to the Humanities and Social Sciences by the emerging technologies. There is a common international understanding emerging in which it is believed that access policies and legal and financial conditions have a greater impact on the availability of data to the research community than do technological solutions. In both cases the development of research infrastructures must include facilities and means to make full use of the existing potential.

Social sciences

In Social Sciences, long-established data gathering projects like the European Social Survey (ESS) have set new standards for this type of operation and have demonstrated what can be achieved when data are collected according to the most stringent scientific methods. ESS can in this respect serve as a model and example of best practice for other European-wide data gathering projects within other social science disciplines.

The European population is growing older. The consequences of an ageing population will not only affect individuals but also have a great effect on European welfare provision. The pressure this creates will require reforms of pensions, health care systems and labour markets,

and will impact on the well-being of European citizens in general. It is therefore essential that we have instruments to monitor the situation. The **Survey of Health, Ageing and Retirement in Europe (SHARE)** has responded to this call and has established a baseline for such a longitudinal ageing survey in Continental Europe.

Within Europe a vast amount of data and metadata are produced for research purposes. A basic challenge is to provide necessary multidisciplinary access to these sources of information for research purposes. **The Council of European Social Science Data Archives (CESSDA)** is an umbrella organisation for social science data archives across Europe, the major objective of which is to improve access to data for researchers and students. A major challenge for CESSDA is to serve the growing number of European Social Sciences and Humanities researchers with the data resources they require. One major obstacle for access to empirical data in Europe is the multitude of data access policies and regulations implemented by national governments. To make data easily available for cross national research, a mapping of data resources in various countries is required, followed by the establishment of harmonised access regulations. One of CESSDA's tasks will be to address and resolve institutional and legal differences to ensure uniform data access policies and practices across the European Research Area.

Humanities

The Humanities are unique in their focus on the human element. Research involves the study of the diverse traditions of the humanities, what distinguishes cultures from each other and what they have in common. The inputs are basically different kinds of manifestations of culture outputs explored by the different disciplines, ranging from spoken and written language via music and art to artefacts and objects produced by human activities.

For the Humanities, new technological possibilities lead to public as well as scientific demand for online access to the full range of primary source materials housed in repositories such as museums, historical societies, local libraries and research libraries, special collections, archives, and privately held collections.

The **Digital Research Infrastructure for the Arts and Humanities (DARIAH)** is designed to facilitate the use of digital humanities and cultural heritage information. Sharing of expertise, tools, and ICT methods for creation, curation, preservation, access and dissemination are key elements in the infrastructure.

The volume of written texts, either as continuous discourse or, for example, descriptions of objects of cultural heritage and (more recently) recorded spoken texts is enormous, and it is growing exponentially. The sheer size of this material makes the use of computer-aided methods indispensable for many scholars in the humanities and in neighbouring areas who are concerned with language material. The **Common Language Resources and Technology Infrastructure (CLARIN)** project is a large-scale pan-European collaborative effort to create, coordinate and make language resources and technology available and readily useable. CLARIN offers scholars the tools to allow computer-aided language processing, addressing one or more of the multiple roles that language plays (i.e. carrier of cultural content and knowledge, instrument of communication, component of identity and object of study) in the Humanities in addition to Social Sciences.

CESSDA - Council of European Social Science Data Archives

The facility:

CESSDA is a distributed research infrastructure that provides and facilitates access to high quality data for researchers and supports their use. It promotes the acquisition, archiving and distribution of electronic data, and encourages the exchange of data. The infrastructure includes 20 social science data archives in 20 European countries. Collectively they serve over 30,000 researchers, providing access to more than 50,000 data collections per annum.

Background.

Data are the single most important component necessary for a science-based understanding of society. In recent years, there have been significant advances in making data available for scientific use but these have not been applied consistently by different countries resulting in large national differences in data availability and in the value that is attached to data access. In recent years CESSDA has developed a number of complex tools to facilitate cross-national resource discovery and data management and access. Despite these important developments which collectively form the basis of the current CESSDA Infrastructure, much work remains to be done to transform the existing set of arrangements into a fully-functioning research infrastructure in which data resources can be easily and seamlessly located and accessed.

What's new? Impact foreseen?

CESSDA already has a critical impact on the social science research community by providing access to large amounts of data. The upgrade will increase CESSDA's impact by integrating the work of members and by setting standards which will enhance the one-stop shop for data location, access, analysis and delivery. Software development will increase the quality of available data. Data from sources currently outside the CESSDA membership will also become available. CESSDA will create a more dynamic knowledge management web and will contribute to metadata initiatives. The upgrade will also improve the existing technical infrastructure; promote capacity building; support less developed and less well resourced organisations; and increase CESSDA membership.

>Timeline.

The preparatory phase of CESSDA runs from January 1st 2008 until December 31st 2009. The length of the construction phase will be decided during the preparatory phase but is expected to be between 3 and 5 years, dependent on funding decisions. The facility will remain open to users during the upgrade.

>Estimated costs.

Preparation costs:	4.17 M€.
Total construction costs:	30 M€.
Operation costs:	3 M€/year once fully developed.
Decommissioning costs:	not yet assessed but they are expected to be modest.

>Website: http://www.cessda.org

CLARIN - Common Language Resources and Technology Infrastructure

The facility:

CLARIN is a large-scale pan-European coordinated infrastructure effort to make language resources and technology available and useful to scholars of all disciplines, in particular the humanities and social sciences. It will overcome the present fragmented situation by harmonising structural and terminological differences, based on a Grid-type infrastructure and by using Semantic Web technology.

Background.

The volume of written texts and spoken or audiovisual recordings is enormous, and it is growing exponentially. The sheer size of this material makes the use of computer-aided methods indispensable for many scholars in the humanities and in neighbouring areas who are concerned with language material. At present 133 institutions from 32 European countries are registered as CLARIN members.

What's new? Impact foreseen?

The CLARIN Infrastructure aims to provide a comprehensive and easily accessible archive of language resources and technology, covering not only the languages of all member states, but also languages studied there and language issues related to migration. The tools and resources will be interoperable across languages and domains. They will contribute to preserving and supporting multilingual and multicultural European heritage. An operational open infrastructure of web services will introduce a new paradigm of distributed collaborative development and will allow many contributors to add new services ensuring reusability and allowing scaling up to suit individual needs. CLARIN will provide preferably existing tools and solutions and the necessary training and advice to customise the resources in order to suit the particular needs of humanities researchers. It will strengthen the European position in standardisation efforts, function as a pivotal and exemplary case for international initiatives and it will help Europe to train young researchers to use and contribute to an infrastructure enabling e-Humanities.

>Timeline.

The CLARIN preparatory phase, which currently includes 32 partners from 22 countries, will last 36 months (2008-2010); construction phase, 2011-2013; operations 2014-2018.

>Estimated costs.

Preparation costs:	4.1 M€.
Total construction costs:	104 M€.
Operation costs:	7.6 M€/year.
Decommissioning costs:	not applicable.

>Website: http://www.clarin.eu/

DARIAH - Digital Research Infrastructure for the Arts and Humanities

The facility:

DARIAH provides long-term access to and preservation of research data and digital heritage materials for the arts and humanities in Europe. DARIAH connects information users (researchers), information managers and information providers. It gives them a technical framework that enables enhanced data sharing among research communities.

Background.

The changing nature of research practices in the arts and humanities has created a pressing need for an international digital infrastructure. At the same time, developments in information and communication technology are raising exciting new opportunities for using just such an infrastructure. The total number of participating organisations is currently 14, of which two are funding organisations.

What's new?

Impact foreseen? DARIAH will contribute to the efficiency and effectiveness of arts and humanities research by:

- making sure data can be found and accessed without any need for extensive travel;
- making innovative interpretation tools available to the broader research community;
- preserving data for future analysis;
- Standardising tools and datasets to allow for interoperability.

The work in the preparatory phase preceding DARIAH addresses coordination, strategic, financial, governance, logistical, legal and technical issues, as well as management and dissemination activities to support this work. The activities foreseen vary from desk research, agenda setting meetings and forums to surveys, mailings and testing of prototype technologies. The preparatory phase specifically aims to deliver:

- a business plan for the construction and operation of DARIAH;
- a consortium committing to the construction and operation of DARIAH;
- a legal document laying down the rights and obligations of different types of DARIAH partners and allowing for the inclusion of new partners;
- sufficient financial support for the construction and initial operation of DARIAH.

>Timeline.

The preparatory phase runs from September 2008 to September 2010, during which period the funding for both the construction and operation will be secured. The construction will take place during the period September 2010 - September 2013.

>Estimated costs.

Preparation costs:	3.7 M€.
Total construction costs:	12 M€.
Operation costs:	4 M€/year.
Decommissioning costs:	not applicable.

>Website: http://www.dariah.eu

ESS - European Social Survey Upgrade

The facility:

The European Social Survey is an academically driven long term pan-European instrument designed to chart and explain the interaction between Europe's changing institutions and the attitudes, beliefs and behaviour patterns of its diverse populations. The original infrastructure was set up in 2001 as a time series survey for monitoring change in social values throughout Europe and to produce data relevant to academic debate, policy analysis and better governance, and as an important resource for training new researchers in comparative methods.

Background.

The European Science Foundation initiated developmental work on the ESS in 1998 as an embryonic infrastructure designed to provide the framework and content of a comparative time series of data. With the twin aims of monitoring attitudinal and value changes and of improving social measurement in Europe, three biennial ESS rounds have so far been conducted and a fourth round is underway, using the most rigorous methodologies. More than 30 European countries will be covered, including the EU (apart from Malta so far), several associated and candidate countries, and Russia. The infrastructure has a complex network of management and advisory committees, representing scientists in different nations as well as funding councils, and technical academic specialists. Its costs so far have been shared between the EC, the ESF, and 34 national academic funding bodies. The data from ESS are made publicly available as soon as they are available - with no prior access given to anybody.

What's new? Impact foreseen?

As each new survey round builds upon prior rounds, data of considerable value to the social sciences are being accumulated. These data are exploited by advanced and early-stage researchers, politicians, policy makers and the public to construct long-term accounts of change and development in the European social world. However, a large and complex time series such as the ESS requires more secure continuity of funding than it has enjoyed hitherto, to enable appropriate planning and to achieve maximum impact. New organisational, legal and financial arrangements for the upgraded Infrastructure will allow experiments into new and alternative survey methods as well as extend further the reach of ESS findings to both academic and policy communities.

>Timeline.

An upgraded ESS infrastructure will in the first instance embrace at least three further rounds of data design, collection and dissemination, plus associated programmes of training, dissemination and exploitation activities over 6 years. The facility will remain open to users during the upgrade.

>Estimated costs.

Preparation costs:	2 M€.
Total construction costs and operation costs:	combining all sources of present finance, the total annualised costs of the ESS infrastructure at present is around 6 M€ per year. The upgrade would bring the total annual costs to around 9 M€ per year (a 50% overall increase), i.e. an overall financial commitment of around 54 M€ over 6 years.
Decommissioning costs:	not applicable.

>Website: http://www.europeansocialsurvey.org

SHARE – Upgrade of the Survey of Health, Ageing and Retirement in Europe

The facility:

SHARE is the upgrade to a lasting infrastructure of a multidisciplinary and cross-national panel database of micro data on health, socio-economic status and social and family networks of more than 30,000 individuals aged 50 or over. SHARE is coordinated centrally at the Mannheim Research Institute for the Economics of Ageing and is accessible free of charge. It is harmonised with the U.S. Health and Retirement Study (HRS) and the English Longitudinal Study of Ageing (ELSA).

Background:

SHARE was initially set up as a part of the Fifth Framework Programme key action on Population Ageing. Eleven European nations were included in the first SHARE wave (2004 to 2005). Four more nations were added to the second wave of data collection, which has been supported through an Integration Activity of the Sixth Framework Programme. The third wave of data collection, which specialises in life histories, is conducted in 19 nations.

What's new? Impact foreseen?

SHARE is a novel combination of an inter-disciplinary, cross-national, and longitudinal study. These features are important to understand individual and social ageing as a process. In the context of the EU research infrastructure policy, the Seventh Framework Programme preparatory phase project for a major upgrade of SHARE has two dimensions: a) to generate a genuine 8-wave panel that follows individuals for up to 15 years and b) to expand to all EU Member States (plus associated Switzerland and Israel). The upgrade will therefore bring the existing SHARE prototype to the level of financial, legal, governance and technical maturity needed to achieve these objectives.

>Timeline.

The preparatory phase will run from January 2008 to December 2009. The upgrade will continuously run in waves every two years until 2020. The facility will remain open to users during the upgrade.

>Estimated costs.

Note that costs are roughly proportional to the number of participating countries, the number of respondents in each country, and the number of waves. Current funding is mainly from EU (almost 80%), with additional funding from U.S. National Institute of Aging and national sources. Such cost sharing is also expected in the future.

Preparation costs:	250 k€ per country and wave (= 7.25 M€ for 29 countries).
Total construction costs:	400 k€ per country/per wave (= 11.6 M€ for 29 countries).
Operation costs:	300 k€ per year.
Decommissioning costs:	not applicable.

>Website: http://www.share-project.org/

>Environmental Sciences

The Environmental Science or earth system research community is focusing on the knowledge needed for the promotion of sustainable management of the natural and human environment and its resources. Current emphasis is on the prediction of climate, ecological, earth, atmosphere and ocean systems changes, on tools and technologies for monitoring, prevention and mitigation of environmental risks and pressures. International cooperation in this area is crucial given the fact that problems have a trans-boundary, regional or global dimension. Europe-wide cooperation is further motivated by the fact that critical mass is needed given the scale, scope and high level of complexity of environmental research. Pan-European research facilities and open access to scientifically useful data collected for various purposes are essential to fulfil this challenge.

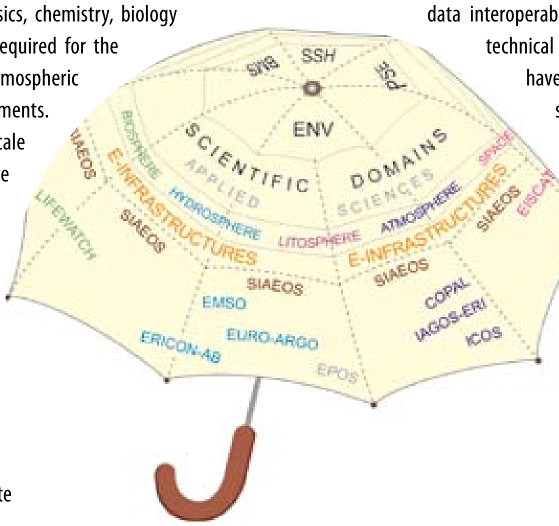
International collaboration

International collaboration is essential to realise facilities in environmental sciences, both because environmental aspects are not bound by political borders and because the complexity of environmental research requires infrastructure that is too costly to be provided on a national basis. Europe is particularly well-placed to make world-leading advances in addressing key environmental issues both for the strength of its scientific capability and its focus on wide impact geographical regions, for example the Arctic, the Mediterranean and the Alps.

- Unique facilities of which only one is needed on an European or even global scale: examples are the major upgrade of the European Incoherent Scatter radar system, EISCAT_3D and the icebreaking vessel Aurora Borealis;
- Distributed facilities built by integrating a European network of coordinated nodes into a common development and use: an example is the new project EMBRC;
- Facilities which have a clear link to global programs, such as the European Plate Observing System EPOS, Euro-ARGO, IAGOS, ICOS and LIFEWATCH.

Complex problem-solving

The environmental sciences need a wide range of research infrastructures that involve complex systems and human interactions. Measurements and monitoring are required from fixed (such as ground-based radar) and mobile (such as research ships and aircraft, satellites, buoys) platforms and range across physics, chemistry, biology and the geosciences. They are required for the terrestrial, marine, freshwater, atmospheric and cryospheric environments. Sophisticated analytical large-scale facilities such as synchrotrons are also increasingly being used by environmental scientists. Remotely controlled distributed research infrastructures, observatories applying state of the art and new technologies are of key importance to develop new predictive models of earth- and ecosystems, biodiversity, hydrology, climate change etc.



The new or upgraded facilities for Environmental Sciences presented in the roadmap address these needs. They can be divided in three broad categories:

Environmental facilities as distributed research infrastructures

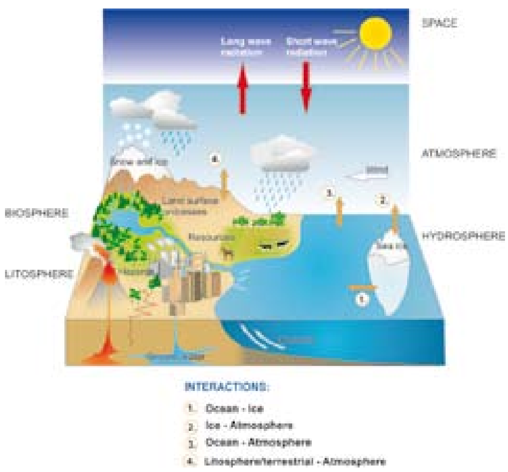
Distributed research infrastructures are essential for environmental sciences. To be effective, they need central coordination in order to maintain efficient knowledge exchange, maximum accessibility and data interoperability, and to keep up with scientific and technical developments. Therefore they need to have a clear central service, together with well structured links and virtual connections to partner centres, which may be located far away from each other in the world. Scientific nodes and hubs are integral parts of multidisciplinary and cross-sectoral environmental research infrastructures. The local partners may have different roles, responsibilities, and consequently different investment shares for the research infrastructure. The central scientific service has a key role and challenge in coordinating the research activities, and in management, legal, and IPR issues. The e-services are a critical part in distributed research infrastructures. Additionally, the distributed structure can offer outreach points to the public, such as for education.

Atmospheric sciences

The atmosphere is the central component of the Earth's climate system. It interacts with all the other components (the hydrosphere, biosphere, cryosphere, pedosphere and lithosphere) on time scales from hours to millennia. In the atmospheric sciences and biogeochemistry, three infrastructure projects already presented in the first edition of the roadmap have been re-confirmed: **COPAL, Community heavy-Payload Long Endurance Instrumented Aircraft for Tropospheric Research** in Environment and Geo-Sciences, will improve our capacity. **ICOS, Integrated Carbon Observation System**, will improve our estimates of the carbon budget and how this will later evolve with human activities and mitigation policy. **IAGOS, In-Service Aircraft research infrastructure for a Global Observing System**, will monitor high tropospheric trace gases using regular airlines. Among **the new initiatives, EISCAT_3D, Incoherent Scatter radar system**, will extend the research to space weather and the interaction of the ionosphere with the solar plasma. Europe has reached a leading position in many fields of atmospheric sciences and the advantage will be increased if the projects of the ESFRI roadmap will be brought to full operation in an overall systemic approach.

Solid Earth Sciences

Infrastructures for Solid Earth Observation are the pillar for research, monitoring, scenario assessment and forecasting for processes of crucial importance for the sustainability of the environment and society. The processes include the evolution and dynamics of the tectonic plates and of the interior structure of our planet, geo-hazards, natural resources, water cycle, exploration and exploitation of energy and mineral resources, oceanography, climate change and the interactions between the natural and built up environments. **EMSO, European Multidisciplinary Seafloor Observation** infrastructure for long-term permanent monitoring of the ocean margin environment around Europe, is an essential tool for deep-sea research including geosciences and geo-hazards, physical oceanography, biology and non-living resources as well as for research on CO2-sequestration. Among the new initiatives, **EPOS, European Plate Observing System**, aims to create a geographically distributed and multidisciplinary infrastructure to monitor the main tectonic plates active in Europe. It will allow Europe to maintain a leading role in solid earth science research, and to increase the predictive and mitigation capacities.



Biodiversity

The challenge for ecosystem research over the next 20-30 years is to enable society to maintain ecosystem services on a European scale in the face of conflicting demands for resources across different sectors of society. A research infrastructure that especially supports the research on ecosystem processes and biodiversity is **LIFEWATCH**, science and technology infrastructure for biodiversity data and observatories. This important project will integrate the full potential of taxonomic and ecosystem information with genomic data from other sources in an international virtual laboratory environment.

Climate change

Global warming and growing anthropogenic pressures are affecting the structure and functioning of ecosystems and consequently their sustainability, on which the continuity of life on Earth depends. First signs of climate change are expected to occur in the Arctic areas. Research infrastructures included in this roadmap that are relevant to these issues and geographical area are the icebreaking research vessel **Aurora Borealis** and the **Svalbard Integrated Arctic Earth Observing System, SIAEOS**. Both are multipurpose research platforms that support diverse fields of research. **EURO-ARGO** is the European contribution to a worldwide distributed research infrastructure for ocean science and observations, and a unique source of information on the role of the oceans in the climate system, providing data for the scientific study of the Earth system in ice-free areas of deep oceans.

AURORA BOREALIS

The facility:

AURORA BOREALIS will be an extremely powerful research icebreaking vessel (50,000 tons displacement, 200 meters long) with 80 Megawatt installed propulsion power and deep-sea drilling capability between 100 and 5000m water depth under extreme conditions. It will support massive research interventions in the Polar Oceans related to climate change and its impacts.

Background.

Polar research and the properties of northern and southern high latitude oceans are subjects of intense scientific and environmental attention, since they underlie rapid and dramatic change. The Polar regions react more rapidly and intensely to global changes than other regions of the Earth. AURORA BOREALIS will act as a base to support European research efforts and fulfil the scientific needs and political obligations of European governments. The European Research Icebreaker Consortium (ERICON, composed of 10 Countries) is preparing the strategic, scientific, legal and financial frameworks for implementation. AURORA BOREALIS will significantly strengthen European and International cooperation in the Polar regions and support the development of joint thematic research programs.

What's new? Impact foreseen?

The European Polar Research Icebreaker AURORA BOREALIS will be a unique new large-scale facility for scientific research investigations of the Polar Oceans in particular the Arctic Region. This new icebreaker is conceived as an optimised science platform that will serve as the base for long, international and interdisciplinary year-round expeditions to the central Arctic Ocean and other ice covered waters such as the Antarctic marginal Oceans. AURORA BOREALIS has no competitor worldwide because of its deep drilling capability, its moon pools for drilling and the deployment of Remotely Operated Vehicles (ROV) and Autonomous Underwater Vehicles (AUV) for sub-ice surveys, its propulsion and dynamic positioning systems, its capability to undertake Arctic expeditions even during the unfavourable seasons of the year and its sophisticated, partly modularised mobile laboratory systems allowing mission-specific laboratory selections. This will for the first time make possible year-round research, on e.g. the effects of global climate change. A worldwide unparalleled high-performance dynamic positioning system shall enable this ship to keep position during science operations, even under the most unfavourable conditions with pack ice more than two metres thick.

The AURORA BOREALIS project will support many multidisciplinary research areas such as global climate and environmental change, glaciology, biology, meteorology and geosciences and act as a mobile ocean observatory and platform for ground-testing of satellite information. The vessel's unrivalled operational capabilities will constitute the most significant technical enhancement for launching scientific expeditions and experiments in polar regions of the world ocean for decades.

>Timeline.

Preparatory phase 2007-2012; construction phase 2011-2013; operations 2014 onwards; decommissioning 2050 approximately.

>Estimated costs.

Preparation costs:	9.7 M€ (national German and EU contributions).
Total construction costs:	635 M€ (revised).
Operation costs:	32.5 M€/year (revised).
Decommissioning costs:	not applicable.

>Website: www.eri-aurora-borealis.eu

COPAL (ex EUFAR) – Heavy Payload Long endurance Tropospheric Aircraft

The facility:

COPAL will be a Heavy-Payload Long-Endurance Tropospheric Aircraft to complete the European fleet of airborne research in environmental and Geo-Sciences. With the HALO jet operated by DLR (DE) for upper troposphere and lower stratosphere research, the COPAL turboprop aircraft, specifically dedicated to the lower and middle troposphere, will be the only European aircraft capable of operating in any area of the world.

Background.

COPAL is supported by the European consortium of research aircraft operators and users under the umbrella of the EUFAR Integrated Infrastructure Initiative (European Fleet for Airborne Research). National management of research aircraft in Europe has resulted in a diverse fleet of small to large size aircraft. Today more than 30 instrumented aircraft are available for research, with a sampling speed from 30 to 200 m/s, a payload of 80 to 4500 kg, and a ceiling from the boundary layer up to 21 km. All aircraft of the European fleet are however limited to a practical endurance of 5 hours. This situation prevents European scientists from performing research over oceanic, polar and remote continental areas, which are especially crucial for climate studies.

What's new? Impact foreseen?

A heavy payload (10 tons) and long endurance (12 hours) aircraft would make it possible to overcome present space and payload constraints making European cooperation in the development of instrumentation feasible. Such an option has many benefits in term of innovation. One single aircraft operator can hardly maintain expertise in all the scientific fields of environmental research. At the national level, operators of large aircraft, mainly in the UK, Germany and France capitalise on their national academic community of experts in environmental research. With a heavy payload aircraft, such a mobilisation of experts can be extended to the European level, in particular from countries which are not operating research aircraft, hence increasing significantly the level of expertise. COPAL will be designed as a pan-European project, enabling research that has not been possible within Europe before.

COPAL
European Community Airborne Laboratory

>Timeline.

Four years (2008-2011) of preparatory phase are presently supported by the European Commission for the selection of the aircraft model, and the definition of the legal structure for its management and operation. Among the three aircraft models that have been considered, the Hercules C130 is the only one that fulfils the user requirements in term of payload and endurance, within the expected level of investment (30 M€ for procurement, and modification). The life time of such an infrastructure is ~ 25 years, with a potential of 15000 flight hours.

>Estimated costs.

Preparation costs:	~1 M€.
Total construction costs:	40 M€ for procurement, modification, and civil certification costs of the aircraft; 10M€ for scientific equipment. A significant part of the airborne instrumentation already exists in Europe. It is maintained and operated by the members of the consortium and will be made available to COPAL.
Operation costs:	fixed costs 3 M€/year; variable costs: ~6000 €/flight hour.
Decommissioning costs:	not applicable.

>Website: www.eufar.net

EISCAT_3D – The next generation European incoherent scatter radar system

The facility:

EISCAT_3D is the upgrade of the existing EISCAT (European Incoherent SCATter) facility, which provides state-of-the-art radar facilities to study various processes taking place in Earth's atmosphere. These studies can help understanding the formation and evolution of our own, and other, solar systems.

Photo by Torbjörn Lövgren

Photo by Lars-Göran Vanhainen

Background.

EISCAT_3D will be a major upgrade/replacement of the existing infrastructure that will improve the range of available data as well as the temporal and spatial resolution of data. This upgrade is based on an ongoing design study. EISCAT is a facility for studies of both fundamental physical processes and environmental issues such as space weather. The upgraded facility will provide high-quality ionospheric and atmospheric parameters on an essentially continuous basis for users as well as providing near-instantaneous response capabilities for those users who need data to study unusual and unpredicted disturbances and phenomena in the high-latitude ionosphere and atmosphere. The present members of the EISCAT Scientific Association are China, Finland, Germany, Japan, Norway, Sweden and the United Kingdom.

What's new? Impact foreseen?

The EISCAT_3D radar system is heavily modular and lends itself to phased construction, both on the large scale, where the multiple radar sites can be constructed either sequentially or in parallel, and on a smaller scale where individual sites are made up of very large numbers of identical elements clustered into larger and larger sub-systems until the full system driven by the scientific requirements has been constructed. This design feature allows great flexibility in the implementation of the construction phase; the system will provide unique monitoring capabilities from a relatively early point in the construction though the more difficult scientific goals so far identified can only be addressed with completion of the full system.

The new facility will greatly extend the range of available data, improving its temporal and spatial resolution by about one order of magnitude as well as the geographic, altitude, and temporal extent. The goals for real time data availability place extreme demands on both data distribution and data storage and will exploit and extend European expertise in ultra-high bandwidth data distribution amongst large numbers of simultaneous data providers and users.

>Timeline.

Preparatory phase: 2009-2011; construction phase: 2011-2015; operation: 2015-2045.

>Estimated costs.

Preparation costs:	6 M€.
Total construction costs:	construction cost is estimated at 60 M€ for one active site but may expand up to 250 M€ for all sites.
Operation costs:	4-10 M€/year.
Decommissioning costs:	10-15% of construction costs.

>Website: www.eiscat.se

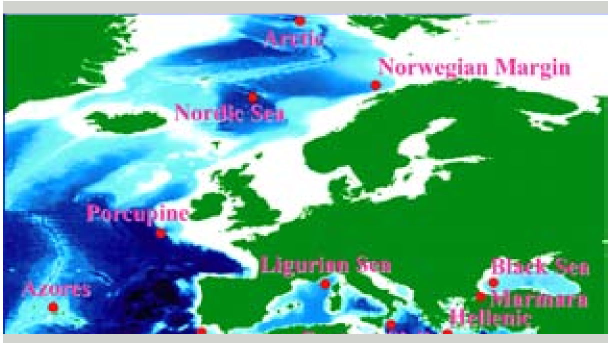
EMSO - European Multidisciplinary Seafloor Observatory

The facility:

EMSO is a European-scale network of seafloor observatories, constituting a widely distributed infrastructure for long-term monitoring of environmental processes related to ecosystem life and evolution, global changes and geo-hazards. EMSO will be deployed on specific sites around European waters from the Arctic to the Black Sea passing through the Mediterranean Sea. It will be a key component of GMES and GEOSS.

Background.

The basic scientific approach is the long-term monitoring, mainly in real-time, of environmental processes related to the interaction between the geosphere, biosphere, and hydrosphere, including natural hazards. Major advances in the understanding of environmental processes require the identification of temporal evolution and cyclic changes and the capturing of episodic events relative to oceanic circulation, deep-sea processes and ecosystems evolution. Long-term monitoring will allow the capture of episodic events such as earthquakes, submarine slides, tsunamis, benthic storms, biodiversity changes, pollution and other events that cannot be detected and monitored by conventional oceanographic sea-going campaigns. The development and establishment of underwater networks is based on previous EU projects, funded from early '90, aimed at realising and validating seafloor observatory and network prototypes (such as GEOSTAR, GEOSTAR-2, ASSEM and ORION-GEOSTAR-3). The creation of a multidisciplinary network of seafloor observatories is currently supported by the EU through the ESONET Network of Excellence (http://www.esonet-emso.org). This project aims at gathering together the community interested in multidisciplinary ocean observatories. Within the EC-FP7 EMSO-Preparatory-Phase was launched in April 2008, with the aim to design and create the entities in charge of managing EMSO, i.e. the legal and organisational structure to coordinate the financial effort among the Countries.



What's new? Impact foreseen?

The establishment of the EMSO network of seafloor observatories will represent a change of direction in Ocean Science research - considering that over the 70% of Earth's surface is covered by oceans - to provide truly global geophysical and oceanographic coverage. The EMSO infrastructure will enhance our understanding of processes that require long time series data appropriate to the scale of the phenomena. The new frontier of multidisciplinary understanding of ocean interior, deep-sea biology and chemistry and ocean margin processes will be addressed by permanent monitoring of key areas around Europe. This research infrastructure will be the sub-sea segment of the GMES initiative and will significantly enhance the accessibility of observational data for the Scientific Community. A close link has been already established with the KM3NeT infrastructure for reciprocal scientific and technological benefit. The EMSO development is based on the synergy between the scientific community and the industry with the aim of significantly improving marine technologies and developing strategies to improve European capacities and competitiveness with respect to countries such as USA and Japan.

>Timeline.

Surveys, cables, junction boxes and boreholes in 8 different places will be gradually implemented from 2008 to 2012.

>Estimated costs.

For eight sites:

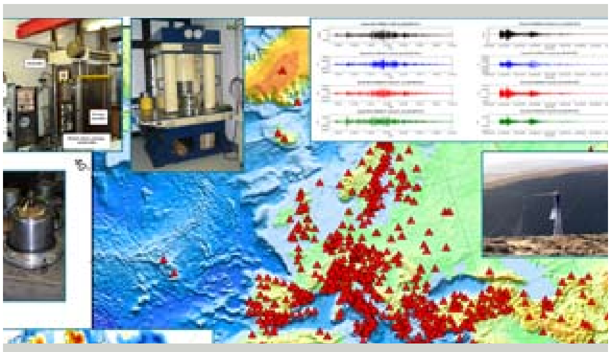
Preparation costs:	80 M€.
Total construction costs:	~160 M€.
Operation costs:	32 M€/year.
Decommissioning costs:	to be estimated.

>Website: http://www.emso-eu.org

EPOS – European Plate Observing System

The facility:

The European Plate Observing System (EPOS) will be a distributed infrastructure integrating the currently scattered, but highly advanced European facilities, into one distributed but coherent multidisciplinary research infrastructure promoting innovative approaches for a better understanding of the physical processes controlling earthquakes, volcanic eruptions and tsunamis, as well as those driving tectonics and Earth surface dynamics. EPOS will be connected to similar initiatives in satellite Earth observing systems and ocean sciences within GEOSS and GMES.



Background.

A tectonic plate is a single dynamic system requiring a unique integrated multidisciplinary and long-term sustainable observing system. Presently, different European countries own a mosaic of hundreds of impressive, but separated networks, observatories, temporary deployments and facilities for solid Earth studies. Combining a wide variety of data and modelling tools are prerequisites for innovative research and for better understanding of the physical processes controlling earthquakes, volcanic eruptions and other catastrophic events, such as landslides and tsunamis. Europe's most active areas are also those where population density is high. Even moderate-size earthquakes may turn catastrophic when they strike large urban agglomerations with poor building construction practice. Advances in understanding of the behaviour of faults or volcanoes as well as quantifying hazards largely rely on strategic investments in research infrastructure in this field.

What's new? Impact foreseen?

EPOS represents a key research infrastructure for solid earth sciences in Europe. Establishment of the basis for a multinational large scale geographically distributed research infrastructure for observational seismology has been tackled in an innovative way through co-operative efforts by European countries within an EC funded project NERIES, which provides the basic design elements required for the design of EPOS. The facility will integrate and upgrade in-situ real time observatories, laboratories and experimental facilities and will provide open-access to data and modelling tools. This integration will facilitate the development of multi-disciplinarity in various fields of geo-sciences, which is important for the study of natural hazards (seismic, volcanic, etc.) and represents a real advance for high quality and frontier science. Integration of all relevant top-level institutions and organisations is foreseen on a global scale. Within Europe the EPOS e-infrastructure will rely on Géant to integrate observations, and on the high performance computing infrastructure and GRID computing initiatives to integrate computational resources.

>Timeline.

Preparatory phase 2008-2012; construction phase 2012-2018; operation 2018-2048 onwards.

>Estimated costs.

Preparation costs:	12 M€.
Total construction costs:	500 M€.
Operation costs:	80 M€/year.
Decommissioning costs:	not applicable.

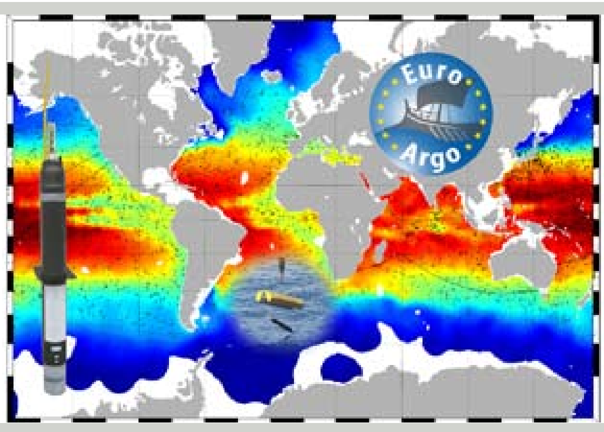
>Website: www.epos-eu.org

EURO-ARGO – Global Ocean Observing Infrastructure

GLOBAL

The facility:

The Euro-Argo array is the European component of a world wide in situ global ocean observing system, based on autonomous profiling floats. The Argo objective is to develop a global array of floats (spaced 300 km apart, on average) throughout the ice-free areas of the deep ocean. It is estimated that some 3000 floats are required to reach this objective. The floats are battery powered, with a design life of between 3/4 to 5 years, i.e. about 800 floats must be deployed per year to maintain the target array. The data are transmitted in real time by satellite to data centres for processing, management, and distribution. The Euro-Argo objective is to provide a sustained European contribution to the international Argo programme.



Background.

Argo is an international programme for global in situ ocean observations. It is endorsed by the World Meteorological Organisation's Climate Research Programme, the Global Ocean Observing System (GOOS), and the Intergovernmental Oceanographic Commission. This observing programme is complementary to the remote sensing observations from satellites (particularly altimetry). The deployment of the global array is under way, with significant contributions from the USA, Japan, China, India, Canada, Australia, and several European countries. The challenge is to complete it and to maintain it on a sustained basis.

What's new? Impact foreseen?

The Argo programme has become the primary source of data on the ocean interior. Argo is a unique system to monitor heat and salt transport and storage, ocean circulation and global overturning changes and to understand the ability of the ocean to absorb excess CO_2 from the atmosphere. One of Argo's most important contributions so far is a huge improvement in estimations of heat stored by the oceans. Argo has also brought remarkable advances in ocean forecasting and seasonal climate predictions and is giving new insights into hurricane activity. Argo is also the single most important in-situ observing system for the Kopernicus Marine Core Service (MCS). It delivers critical data for assimilation into ocean forecasting models, climate monitoring and seasonal to decadal forecasting.

>Timeline.

The Argo array was initiated in 2000 and has reached its world target of 3000 floats in operation during 2007. The individual lifetime of a profiling float being around 4 years, the maintenance of the infrastructure would consist in 800 floats deployed per year over the period 2007 - 2010, with full implementation over the extended period of 2011 - 2020. The European contribution will consist in the deployment of ~ 250 floats per year as well as the operation of the CORIOLIS Data Centre (one of the two Global Data Assembly Centres) to collect, validate and deliver the data to users. Because of the multi-year research objectives linked with the Euro-Argo infrastructure, a twelve year period has been considered as a typical lifetime, including the build-up period 2008-2010.

>Estimated costs.

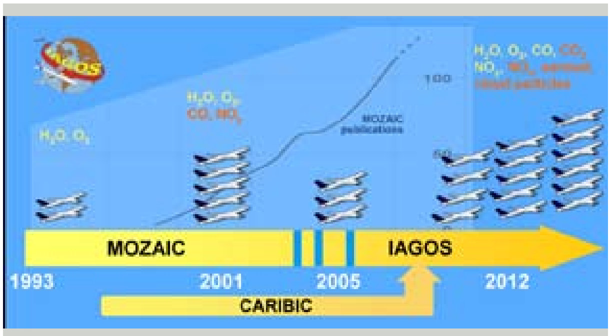
Preparation costs:	4.2 M€.
Total construction costs:	~80 M€.
Operation costs:	7.3 M€/year.
Decommissioning costs:	not applicable.

>Website: http://www.euro-argo.eu/

IAGOS – In Service Aircraft for a Global Observing System

The facility:

IAGOS will establish and operate a sustainable distributed infrastructure for regular observations of atmospheric composition on a global scale from in-service aircraft. This will be achieved by installing and operating autonomous instruments, certified for commercial aircraft, on a fleet of initially 10-20 long haul aircraft (Airbus).



Background.

This facility draws on and further develops the experience gained in two distinct projects using passenger aircraft for atmospheric measurements. The first project, MOZAIC (Measurement of Ozone and Water vapour by Airbus In-service airCraft), for example, utilised 5 long haul aircraft to measure ozone and water vapour and later also carbon monoxide and nitrogen oxides. The instruments were carried by 4 European airlines. The flight routes of the MOZAIC aircraft covered a large fraction of the Northern Hemisphere and parts of the Southern Hemisphere. The second project, CARIBIC, uses a different approach by deploying a cargo container with a larger suite of scientific instruments aboard one long haul aircraft on a monthly basis.

What's new? Impact foreseen?

The particular value of routine measurements from commercial aircraft is that they provide fundamentally calibrated long term observations of critical chemical species, aerosols and clouds in the upper troposphere and lower stratosphere, a region which is critical for climate change and for which there is very little data. The use of commercial aircraft allows the collection of highly relevant observations on a scale and in numbers impossible to achieve using research aircraft, and where other measurement methods (e.g., satellites) have technical limitations. Besides providing improved technology for sustainable operation and improved global coverage, IAGOS uses newly developed instruments for regular high quality measurements of O_3, CO, CO_2, NOy, NOx, H_2O, aerosol and cloud particles. Regular vertical profiles will provide a unique set of information for the validation of regional and global air quality, climate models, including those used in the GMES Atmospheric Service, and the carbon cycle models used for the verification of CO_2 emissions and Kyoto monitoring. With IAGOS the past activities will be extended to a worldwide sustainable operation.

>Timeline.

The preparation of the infrastructure is carried out within the ongoing design study IAGOS, followed by the Preparatory Phase project IAGOS-ERI. Cooperation with international airlines has been established since 2006. The IAGOS infrastructure is expected to be fully operational in 2012. Operation is envisaged to continue at least for 10 years.

>Estimated costs.

Because of its nature, the need for investment is modest and concerns the special instrumentation to be installed on the different aircraft and the cost for aircraft modification. The total cost of these investments scales closely with the number of aircraft to be operated.

Preparation costs:	5-7 M€.
Total construction costs:	15 M€ for instrumentation of 20 aircraft during the first 9 years.
Operation costs:	5-10 M€ over 10 years.
Decommissioning costs:	0.5 M€ for removal of the instrumentation from all aircraft.

>Website: www.iagos.org

ICOS – Integrated Carbon Observation System

The facility:

ICOS (Integrated Carbon Observation System) is an infrastructure for co-ordinated, integrated, long-term high-quality observational data of the greenhouse balance of Europe and of adjacent key regions of Siberia and Africa. Consisting of a centre for co-ordination, calibration and data handling in conjunction with networks of atmospheric and ecosystem observations, ICOS is designed to create the scientific backbone for a better understanding and quantification of greenhouse gas sources and sinks and their feedback with climate change.

Background.

Unlike meteorological parameters that have been routinely collected by meteorological services for 50 years and for which global satellite observations have existed for 30 years, with secure commitments for the future, there is no co-ordinated system to measure atmospheric greenhouse gas concentrations in Europe. Only about half of the anthropogenic CO_2 emissions accumulate in the atmosphere, while the remainder is taken up by land and oceans on average in similar proportions. However, these sinks vary strongly in time and space. Quantifying present-day carbon sources and sinks and understanding the underlying carbon mechanisms are pre-requisites for informed policy decisions. This is fundamental to develop strategies to manage carbon emissions.

What's new? Impact foreseen?

Better understanding of vulnerability and regional feedbacks between climate and biosphere is the prerequisite for predicting the response of the Earth system to global change. Research priorities for the coming years in the field of global and regional climate-biosphere feedbacks cannot be addressed without the dense, consistent, long-term, integrated observations of trace gases and relevant environmental tracers and ecosystem parameters of the sort provided by ICOS. The ICOS observational data and secondary data products form the basis for improved understanding and adequate human action. ICOS will significantly enhance the observational basis and accessibility of observational data to the benefit of the applied and basic scientific community.

>Timeline.

ICOS will start its operational phase in 2012, enabling the coverage of future Kyoto commitment periods, with a 20 years perspective. Most elements already exist in a research mode, and can be easily transferred into ICOS. Major milestones are decisions about location of the ICOS-Centre facilities, and then their installation and equipment. Once the decision about funding and the location of the ICOS-Centre is made, the preparatory phase will take place during the period 2008-2012.

>Estimated costs.

Preparation costs:	6.7M€.
Total construction costs:	~128 M€.
Operation costs:	~14 M€/year.
Decommissioning costs:	not applicable.

>Website: www.icos-infrastructure.eu

LIFEWATCH – Science and Technology Infrastructure for Biodiversity Data and Observatories

The facility:

LifeWatch will be a world leading e-infrastructure to support research on the protection, management and sustainable use of biodiversity. The infrastructure provides special services for scientists and policy users of biodiversity research, including training and research opportunities for young scientists. The core components are a network of observatories and biological collections for data generation and processing, together with facilities for data integration accessible through virtual laboratories offering a wide range of analytical and modelling tools. The infrastructure has the support of all major European biodiversity research networks.

Background.

While we are exploring other planets, it is surprising how little we still know about our own planet Earth. This is especially true for our understanding of the living world, the biological diversity of species, their genes and the ecosystems in which they occur. We also need novel approaches to understand and sustainably manage our environment so that human activities and the natural environment are balanced. EU projects and the Global Biodiversity Information Facility have made much progress in providing access to interoperable biodiversity databases, but data integration and large-scale analytical and modelling facilities have to provide to the research community a new methodological approach to understand the biodiversity system. It is now urgent to complement remote earth observations (GMES, GEOSS) with a ground-level biodiversity infrastructure covering terrestrial and (coastal) marine ecosystems, and their species-level and genetic components.

What's new? Impact foreseen?

The LifeWatch infrastructure for biodiversity research addresses the huge gaps we face in our understanding of life on Earth. Its innovative design supports access to and the integration of large-scale data resources, advanced algorithms and computational capability, also from associated infrastructures. Data mining, data analysis and modelling support the study of patterns and mechanisms across different levels of biodiversity. User groups can create their own e-laboratories or e-services within the common architecture of the infrastructure. They may share their data and analytical and modelling algorithms with others, while controlling access. LifeWatch enables "distributed large scale" and collaborative research on complex and multidisciplinary problems. The infrastructure will not only serve pure scientific research, but also various users in the public and private sector committed to the understanding and the rational management of our living world. The facility supports the research necessary to meet the EU policy objectives on biodiversity and is a major component of the European contribution to GEOSS.

>Timeline.

Preparation phase 2008-11; construction 2010-18.

>Estimated costs.

Preparation costs:	9.4 M€.
Total construction costs:	~370 M€.
Operation costs:	71 M€/year.
Decommissioning costs:	not applicable.

>Website: http://www.lifewatch.eu/

SIAEOS – the Svalbard Integrated Arctic Earth Observing System

The facility:

SIAEOS is the upgrade of the present infrastructure and research activities on Svalbard to become an Integrated Arctic Earth Observing System. SIAEOS integrates the studies of geophysical, chemical and biological processes from all research and monitoring platforms – land, sea, ice/glacier and atmosphere/space based - thus responding to a highly relevant need to monitor global environmental change. The research infrastructure is mainly European, with the presence of a large number of research institutes and a broad and interdisciplinary user community from all over the world. SIAEOS offers unique opportunities for education and training of young scientists, since the operational centre will be integrated with the international University Centre in Svalbard (UNIS).

Background.

Svalbard's geographical location and extensive research infrastructure provides excellent opportunities for studies of ecosystem changes and their effects on the food chain, oceanic and atmospheric transport patterns which prevail in the Arctic region, integrating observations and analysis of the changing Arctic ice cover, unique studies of the energy balance between layers of the atmosphere, from the borders of space to the surface of Earth and for dense satellite monitoring. The impact of climate change, pollution and other pressures on the environment appear sooner and with more severe consequences in the high Arctic than in regions at lower latitudes. The high Arctic can therefore be seen as an early warning region.

What's new? Impact foreseen?

As an observation platform, SIAEOS will be complementary to projects like SAON (Sustaining Arctic Observing Networks), and could be developed as a major hub in the SAON system. SIAEOS will establish a framework of database and meta-database tools offered to the circum-arctic and European research communities. The database services will aim at the full and open access and exchange of the temporal and spatial resolved data within multiple disciplines which constitute the 4 dimensional SIAEOS knowledge base. A portal for online earth observation system (EOS) data in Svalbard will be offered in close collaboration with the European and circum-arctic research community, as well as in close coordination with and links to global and circum-arctic initiatives and databases like AMAP Thematic Data Centres, GEOSS and a number of other relevant networks and repositories for arctic environmental data.

Svalbard is already a strong research site with large scale research facilities and many medium-size laboratories, the international university and the necessary support structure to host international research consortia. The proposed "link" would not only underline the leading role of European institutes in polar research, but it would also highlight a successful EU-Research policy. The global research presence is based on a general open-door policy and the Spitzbergen-Status.

>Timeline.

Preparatory phase 2008-2010; construction phase; 2010-2012; operations 2012 onwards.

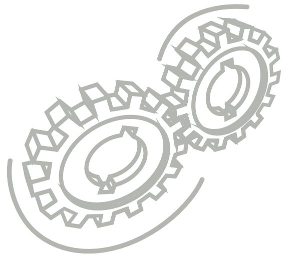
>Estimated costs.

Preparation costs:	2-5 M€.
Total construction costs:	50 M€.
Operation costs:	9.5 M€/year.
Decommissioning costs:	not applicable.

>Website: www.unis.no/SIAEOS

>Energy

The availability of economically competitive, environmentally friendly and sustainable energy resources within the framework of a politically secure supply is a key for European development. At present the EU leads the world in the efficient use of energy, in promoting new and renewable forms, and in the development of low carbon emission technologies. All these aspects rely on a multitude of test facilities and a diverse range of research infrastructures. A coherent policy for research infrastructures for Energy is therefore needed.



Europe has adopted an ambitious energy policy, balancing the security of energy supply, its sustainable use, environmental protection, and economic growth, while at the same time controlling energy demand. All regions in the world will face similar challenges for their economies, societies and ecosystems. A sustainable energy future is possible if a large mix of energy technologies are developed and deployed. The approach to energy problems must be systematic and address the production, transport, transformation and final use of energy. To meet these challenges in a sustainable way, for the satisfaction of the demands of over 450 million consumers, Europe will need to invest in new systems and in the replacement of older infrastructures by investing around one trillion Euros over the next 20 years.

The European energy policy goals are challenging. By 2020 the emission of greenhouse gases should be reduced by 20%, the renewable energy contribution should be tripled up to 20% of primary energy, and the share of appropriate biofuels will rise, while reducing the foreign dependence on the supplies. On the 2050 scale, new nuclear technologies such as Generation IV fission reactors and fusion energy are deemed to make important contributions in order to meet climate and environment goals.

The SET Plan

The European Union has adopted a *Strategic Energy Technology Plan (SET-Plan)* in order to meet these goals. The SET-Plan emphasises the need for new research infrastructures in the field of energy. This was confirmed by the European Council of Ministers in March 2008 by the following statement:

- To improve and enlarge the Community's world-class knowledge base of energy researchers and research institutes ("capacity building"), including by reducing barriers to mobility, attracting world-class human capital, improving science education, and by asking the European Strategy Forum on Research Infrastructures (ESFRI) to identify the need for European research infrastructures in the field of energy technologies, such as renewable energy technologies.

To meet the European energy and climate goals in addition to improving industrial competitiveness, increased efforts in R&D and energy technology innovation are necessary. This will require stronger cohesion among the European research actors in energy but also much better performance in the commercialisation of new technologies. For research infrastructures, this will mean that stronger industrial orientation is required coupled with employing research infrastructures more effectively. Public-private partnership would be essential in realising such innovation-driven research infrastructures. Potential vehicles for this development are the Technology Platforms and the Joint Technology Initiatives. It would be highly advantageous for the Member States to coordinate their efforts, to avoid redundancy, and to join forces in new research infrastructures.

Carbon dioxide capture and storage

Fossil fuels currently cover about 75% of Europe's energy supply. While their share in Europe's energy system is by far the highest, their use is also the major cause for global warming. Coal reserves are abundant, but gas and oil prices have risen significantly due to the decrease of easily accessible resources. New technologies and new reserves in addition to increasing the availability of existing ones are required. More attention needs to be paid to improving the efficiency of transforming oil and natural gas into cleaner energy, and to reducing both production costs and environmental impact. Carbon dioxide capture and storage (CCS) is identified as a key technology for reducing emissions from fossil energy use in the future. Presently, Europe lacks a large research infrastructure in this field. **The European Carbon Dioxide Capture and Storage Laboratory Infrastructure, ECCSEL** is a proposed new distributed facility that responds to this need. It will be unique world-wide combining three approaches to capture and three approaches to carbon storage. It will be built by upgrading existing national infrastructures to a European level.

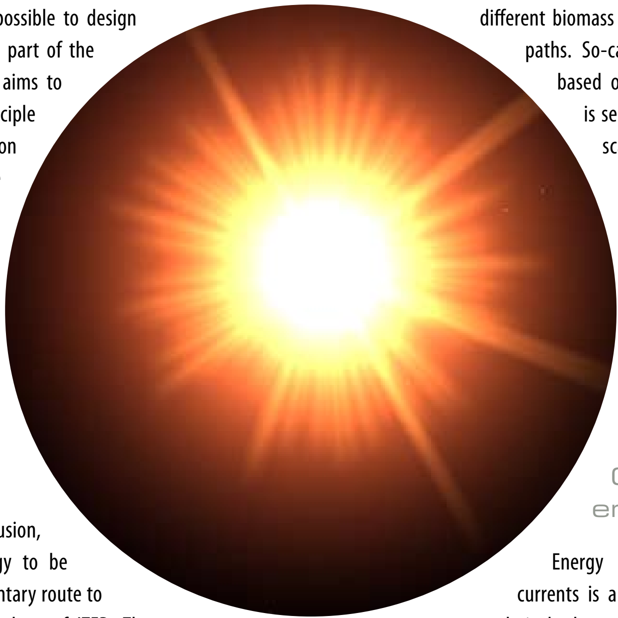
Nuclear energy

The nuclear industry supplies one-third of the EU's electricity. Several Member States are currently reviewing their nuclear energy policies. Existing installations, based on *fission*, will continue to be operated and research & test facilities are needed to understand and develop aspects such as the improvement in the efficient use of nuclear fuels, the reliability of construction materials, and the management of radioactive waste and stocks of spent fuel. The **Jules Horowitz high flux reactor (JHR)**, currently under construction, will help with materials and fuel testing.

A *Sustainable Nuclear Energy Technology Platform (SNE-TP)* has also been established. It includes international R&D on Generation-IV fast-neutron reactor systems with closed fuel cycles to substantially minimise the volume, the radiotoxic content and thermal load of the residual high-level waste requiring geological disposal. Decisions on the technology paths to be chosen are expected in 2010 – 2012 timeframe. In this context, the *MYRRHA* project is a planned European accelerator-driven fast neutron experimental facility to demonstrate efficient transmutation and associated technology (in sub-critical and critical modes). The longer R&D perspectives include the development of new applications of nuclear energy in Europe, based on the development of gas cooled thermal or fast neutron reactors which could allow efficient production of alternative fuels for transport and high temperature industrial processes.

Fusion has the potential for producing large scale sustainable electricity supplies but still needs substantial research and development over a number of decades before it will become a reality. Strong R&D in recent decades has made it possible to design the experimental reactor *ITER* as part of the world fusion programme. ITER aims to demonstrate proof-of-principle magnetically confined nuclear fusion as a viable energy source. The **International Fusion Materials Irradiation Facility (IFMIF)**, a global project, is an accelerator-based very high flux neutron source with the aim to provide timely a suitable data base for irradiation effects on materials needed for the construction of an industrial fusion reactor.

Another approach is laser fusion, now recognised as a technology to be explored as a possible complementary route to the magnetic-confinement technology of ITER. The proposed **High Power Laser Energy Research Facility (HiPER)** exploits the new fast ignition approach to laser fusion.



Solar Energy

Systems for utilising solar power for energy production are presently growing by 40% yearly, for both thermal and electrical applications. Much of the research and development in this field is performed in dedicated research institutes and by the industry itself. The planned *TEREI-SOLAR* facility focuses on concentrated solar energy science and technology. Solar thermal power based on concentrating collectors has received renewed interest worldwide.

Biofuels

Biofuels for transport are a strategic topic for Europe. There is a general debate on the effectiveness and sustainability of different biomass feedstock and biofuel conversion paths. So-called second generation biofuels based often on lignocelluloses or waste is seen as a benign solution for large-scale deployment of biofuels. An R&D infrastructure for second generation biofuels needs to be developed including research services for the integrated conversion plants for biofuels, bio-products and advanced biomass gasification.

Ocean/Marine energy

Energy from ocean/marine tides and currents is a form of renewable energy with a relatively large potential in some ocean-shore and channel regions of Europe. R&D infrastructure needs to be developed including test facilities.

Wind energy

Wind energy is the fastest growing renewable form of electricity production representing close to 2% of world electricity production and annual business volumes over 20 billion €. The trend is towards up-scaling of turbine technologies especially for off-shore use. The influence of turbulence in particular on performance and durability is a critical factor. The planned *European Centre for Turbulence and Wind Energy (*the *Windscanner* facility*)* should provide a unique research infrastructure to support in-situ research on wind fields over a large volume by laser Doppler techniques. It can be regarded as a natural wind-tunnel with an air volume of the dimensions of the largest wind turbines. It will increase the understanding of the structural dynamics of wind turbines, leading to improved turbine designs. New research infrastructures are also needed for (1) next generation components, (2) new materials, measurement and control technologies, and (3) power infrastructures for grid integration and storage of wind energy.

Hydrogen

Hydrogen, as an energy carrier derived from a number of other fuels and fuel cells, as energy transformers, is expected in the near to medium term to play a major role, for both mobile and stationary applications. The Commission recently launched the first energy Joint Technology Initiative in fuel cells and hydrogen including storage and transportation.

Smart energy grids

The increase of efficiency, the integration of different energy technologies, and the nature of national or regional grids for distribution requires further research and the application of smart energy grids could be one technical solution. In this context, a full scale European grid research infrastructure incorporating flexible production, load and grid set-ups is required.

ECCSEL – European Carbon Dioxide Capture and Storage Laboratory Infrastructure

The facility:

The ECCSEL facility combines three approaches to capture (pre and post combustion and O_2/CO_2 -oxyfuel- recycle combustion capture) and three approaches to carbon storage (aquifers, depleted oil/gas fields, coal bed methane). The project includes the upgrading of existing national infrastructures to European level. The upgraded facility is composed of distributed parts in different countries and a coordination centre in Norway.

Background.

Carbon dioxide capture and storage (CCS) is identified as a key technology for reducing emissions from fossil energy use in the future. The demand for it is globally large, in particular in emerging economies. Europe lacks presently a large research infrastructure in this field. There is a very strong need for activities in this field and this topic is highly relevant for the EU Strategic Energy Technology (SET) plan. The core consortium of the upgraded facility consists of 10 European partners, but the network behind CCS is much broader.

What's new? Impact foreseen?

The ECCSEL infrastructure will be unique world-wide in its comprehensiveness for research in CCS and will be open to researchers through a joint management structure. It builds up on developments of the partners' specialised labs in course of national and EU programmes. The core hub of ECCSEL will be in Norway with partner institutions in Germany, the Netherlands, France, Denmark (including Greenland), Poland, Hungary, Switzerland and Croatia. The planned research infrastructure meets the different needs from basic research to experimental activities. In particular it will enable more advanced levels of research in post combustion absorption (needed to address the more near term options), new materials and processes (needed to reduce the cost and reliability of next generation CCS processes), combustion facilities (to enable oxy-fuel CCS processes and efficient hydrogen combustion) and storage facilities (needed for improving the knowledge of storage in aquifers and to develop qualification methods and mitigation strategies). These are all highly relevant to reduce the costs of CCS, improve the reliability of the various concepts and in particular to improve the knowledge of CO_2 storage and to develop qualification methods and mitigation strategies.

By facilitating international research and development ECCSEL will contribute substantially to the targets brought forward in the Road Map for EU Zero Emission Fossil Fuel Power Plants (ZEP) Technology Platform to achieve CO_2 reduction costs of less than 20€/ton, reduce efficiency loss to less than 6% and to help develop and implement competitive and sustainable CCS technologies.

>Timeline.

The facility will be in operation in 2011 and will meet the urgent needs in this field.

>Estimated costs.

Preparation costs:	3-4 M€.
Total construction costs:	81 M€.
Operation costs:	6 M€/year.
Decommissioning costs:	2 M€.

>Website: www.ntnu.no/eccsel

>Energy

HiPER – High Power Laser Energy Research Facility

The facility:

HiPER is an initiative for Europe to take a world leading position in the science of extreme conditions and the development of a credible path to Inertial Fusion Energy. This is made feasible by the advent of a new approach to laser-driven fusion known as "Fast Ignition". HiPER will consist of a unique configuration of long pulse and short pulse beamlines. Adaptation of the LIL laser to incorporate a single short pulse beamline (called PETAL) will be used to provide early demonstration of the Fast Ignition technique and associated infrastructure, and as a means of developing the laser community.

Background.

High power lasers enable the physics of matter at extreme densities and temperatures to be studied in the laboratory, with applications ranging from fundamental science, to new technological opportunities (e.g. compact particle accelerators and laboratory based astrophysics) and high impact industrial exploitation (e.g. fusion energy).

Energy production from inertial fusion was proven in the 1980s, with laser driven inertial fusion due to be demonstrated in the laboratory in the period 2010-2012. To date, however, research in inertial fusion has been limited to the defence sector. The advent of Fast Ignition completely changes the landscape, permitting a wholly civilian approach using purely optical (rather than x-ray) driven implosions.

What's new? Impact foreseen?

The Fast Ignition technique is a new approach to inertial fusion, calculated to lead to an order-of-magnitude reduction in the scale (and thus cost) of the laser facility. Recent demonstration experiments have been published in a series of articles in Nature and have led to the 2006 American Physical Society award for Excellence in Plasma Physics. The unique laser configuration creates the opportunity to provide a world-leading, broad-based research infrastructure in Europe. This type of laser fusion facility will open up a wide range of applications in laboratory astrophysics, nuclear physics, atomic physics, plasma science and material studies under extreme conditions.

>Timeline.

The maturity of the scientific and technological basis of the facility has allowed a 3-year preparatory phase to start in 2008, with construction envisaged for late next decade and delivery to users in the 2020s. The timing of this phase has been designed to take full advantage of international work in this area. It will establish the preferred solution for the facility (technical, political and strategic).

>Estimated costs.

Preparation costs:	13 M€.
Total construction costs:	~800 M€ (to be updated during the preparatory phase).
Operation costs:	to be estimated during the preparatory phase.
Decommissioning costs:	to be estimated during the preparatory phase.

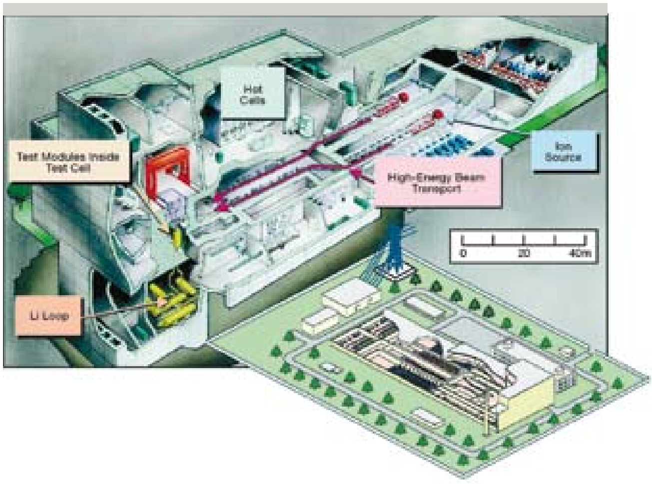
>Website: www.hiper-laser.org

IFMIF – International Fusion Materials Irradiation Facility

GLOBAL

The facility:

IFMIF is an accelerator-based very high flux neutron source utilizing the deuteron lithium-stripping reaction with the aim to provide timely a suitable data base on irradiation effects on material needed for the construction of a fusion reactor. Although IFMIF does not rely on aggressive innovative technologies, its design beam power of 2 x 5 MW is by far the most intensive that has ever been built.



Background.

As the qualification of materials under fusion-specific conditions for lifetimes of at least 10-15 MWy/m2 is a critical requirement on the path to fusion power, the timely availability of a suitable neutron source, IFMIF, has become a major element in fusion strategy scenarios. A series of international workshops held over many years developed a consensus view that an accelerator based D-Li source with an energy spectrum peaked at 14 MeV is the best choice for a high performance materials irradiation facility. IFMIF will achieve this using two 40 MeV deuteron continuous-wave linear accelerators, each delivering a 125 mA beam current. Both beams strike a common flowing lithium target, thus providing an intense neutron flux of about 1018 n/m2/s.

What's new? Impact foreseen?

The primary mission of IFMIF will be the timely generation of a materials irradiation database for the design, construction, licensing, and safe operation of a Fusion Demonstration Reactor (DEMO). This will be achieved through testing and qualifying materials performance under neutron irradiation that simulates service up to the full lifetime anticipated for DEMO. The source requirements include high availability, fusion adequate neutron spectrum and temperature controlled high flux irradiation (20-50 displacements per atom per full power year) of more than one thousand qualified specimens. In addition, various in-situ experiments and tests of blanket elements will be an important use of the facility, and will complement the tests of blanket test modules in the International Thermonuclear Experimental Reactor (ITER).

>Timeline.

Construction: ~ 2015 to 2019 (first phase), first operation: ~ 2020 with one beam; 2022 start operation with two beams (second phase), lifetime 20-30 years. Engineering Validation and Engineering Design Activities have been started in 2007, in the frame of the Broader Approach activities, an agreement between the EU and Japan. Scope of these activities is to produce, by the end of 2013, a detailed, complete and fully integrated engineering design of IFMIF and all data necessary for future decisions on the construction, operation, exploitation and decommissioning of IFMIF, and to validate continuous and stable operation of each IFMIF subsystem.

>Estimated costs.

Preparation costs:	~150 M€ as part of the EU-JA contribution to the Broader Approach activities of which ~100 M€ will be provided by Europe.
Total construction costs:	~1000 M€ (over 7 years).
Operation costs:	~150 (over first 3 years), 80 M€/year from the 4th year.
Decommissioning costs:	~50 M€.

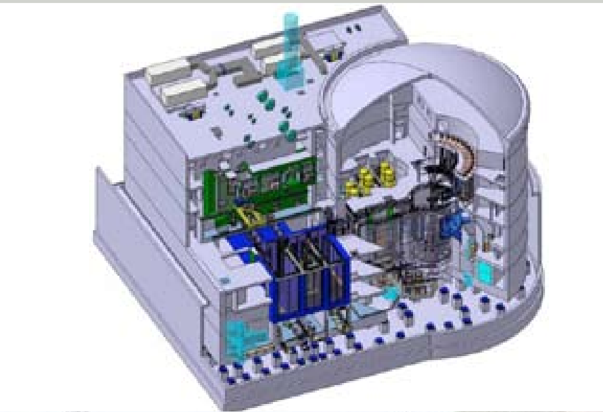
>Website: http://fusionforenergy.europa.eu/3_3_broader_approach_en.htm

JHR - Jules Horowitz Reactor

STARTED

The facility:

This new research reactor will allow high flux neutron irradiation experiments dedicated to the study of the materials and fuel behaviour under irradiation with sizes and environment conditions relevant for nuclear power plants in order to optimise efficiency and demonstrate safe operations of existing power reactors as well as to support future reactor design.



Background.

European nuclear industry and research institutes need to develop expertise and to access improved experimental Material Testing Reactor (MTR) capabilities (larger neutron flux, on line instrumentation, specific safety capabilities) consistent with scientific and modelling state of art as well as industrial and public needs. This is consistent with the assessment performed within the FEUNMARR thematic network (Future European Union Needs in Material Research Reactors, 5th FP, 2002), "given the age of current MTRs, there is a strategic need to renew material testing reactors in Europe; At least one new MTR shall be in operation in about a decade from now". JHR is now under construction and will be operated by a consortium of government agencies and industrial partners from several European states: eleven partners from Europe and outside have now joined the project.

What's new? Impact foreseen?

JHR meets industrial and public needs and supports major stakes in the European energy policy. JHR is a flexible experimental infrastructure providing high neutron flux (twice larger than the maximum available today in MTRs), supporting advanced modelling development with highly instrumented experiments and, operating experimental devices with environment conditions (such as pressure, temperature, flux, coolant chemistry) and coupled phenomena (e.g. mechanics, irradiation corrosion) relevant for the different present and future power reactor technologies. This irradiation experimental capability will address material ageing and plant life management, design evolutions for water reactors (in operation for all the century), fuel performance and safety margins improvements, fuel qualification in incidental or accidental situations, fuel optimisation for high temperature reactors, and innovative material & fuel development for future reactors. This raises challenging scientific and technological issues to be addressed by a modern experimental irradiation infrastructure like JHR.

>Timeline.

JHR is now a mature project; detailed design, public consultation and safety files have been completed and construction phase has been launched early in 2006 for a start of operation scheduled in 2014.

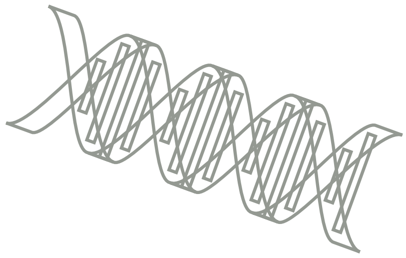
>Estimated costs.

Preparation costs:	70 M€.
Total construction costs:	~500 M€.
Operation costs:	24-33 M€/year.
Decommissioning costs:	~80 M€.

>Website: http://www-cadarache.cea.fr/fr/actualite/RJH/BAT%20RJH%20A5.pdf

>Biological and Medical Sciences

Health and food are two major challenges arising from the rapidly increasing population worldwide and the increase in its average age. Improving health, including the increase of effectiveness in fighting emerging epidemics, in addition to responding to the growing demand for food and for bio-resources are topics requiring urgent attention. Life Sciences infrastructures will contribute to the solution of these important questions.



Current research infrastructure initiatives.

The recombinant DNA techniques are revolutionising the way in which research is developed in Life Sciences. This development is accompanied by high-throughput analytic techniques leading to tremendous amounts of data which need to be made available in the most effective way. Bio-informatics is more than ever a prerequisite for both experimental and applied biology. The production of the data is strongly coupled to the development of high-throughput methods for sequencing and synthesis of DNA and proteins, for high resolution imaging and other methods of data capture on a large scale basis.

Modern Life Sciences are inconceivable without access to well structured, continuously upgraded and freely accessible databases. The Biological and Medical Sciences research community relies on exchanging data and information from distributed and heterogeneous sources. One of the main challenges is to develop the infrastructures required to ensure that these data have been collected in harmonised ways and made accessible to the research communities. The ELIXIR European research infrastructure will be developed to address these needs.

The pan-European Biobanking and Biomolecular Resources Research Infrastructure (BBMRI) collects human biological samples, such as blood, tissues or DNA. It also includes associated clinical and research data, as well as biomolecular research tools, which are key resources in unravelling genetic and environmental factors underlying diseases and influencing their outcome. These resources are required for identification of new targets for therapy and may help to reduce attrition in drug discovery and development. BBMRI is strongly cooperating with EATRIS, which is dealing with translational research. The translation of basic research discoveries into clinical applications, including the scientific validation of experimental results, should support a faster and more efficient transfer of research findings into the development of innovative strategies for the prevention, diagnosis and treatment of diseases of particular relevance for Europe, reducing the high medical and economic burden.

There is a strong connection of EATRIS with ECRIN as ECRIN follows EATRIS in the development chain of new therapies and diagnostics. ECRIN deals with clinical trials from phase II onwards, whereas EATRIS covers the research up to clinical trials phase II. The collaboration between both research infrastructures facilitates the transfer of innovations into improved medical care and health strategies.

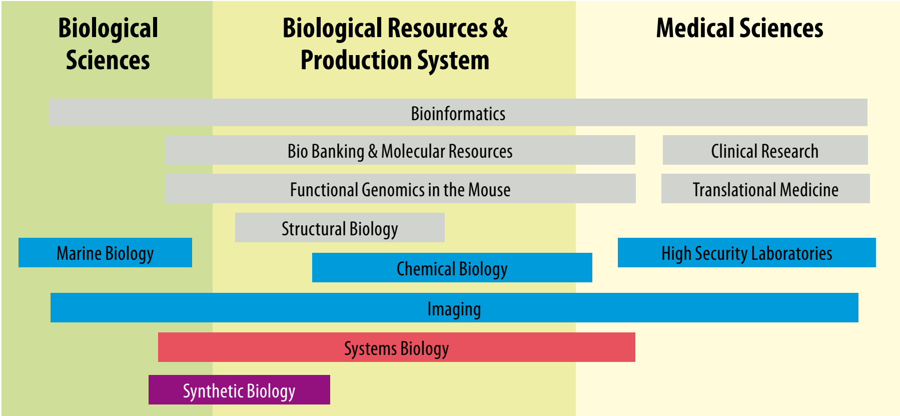
Having a similar goal, but coming from a different aspect of science, Infrafrontier deals with functional genomics and mouse genetics. Since the mouse genome was completely sequenced it became clear that the differences in the genome between mouse and man are very small. The mouse was established as a model organism for human diseases. In the 21st century the generation of mouse mutations for every gene in the mouse genome, creating a huge and vital resource of models for the study of human disease is expected. Tens of thousands of mouse disease models will become available, all of which will ultimately require archiving, dissemination and phenotyping. Therefore there is a necessity for close cooperation with respect to data management (ELIXIR), with biobanks (BBMRI) and, with respect to the design of animal models, with EATRIS.

INSTRUCT combines integrated structural biology with cell biology, leading to the study of more complex systems within the cell and starting from the study of single protein molecules, thereby bridging the gap between genetic information and its use in therapeutic interventions strongly cooperating with ELIXIR and analytical research infrastructures.

The Biological and Medical Sciences Roadmap Working Group was led by three aspects in updating the scientific landscape. Firstly for all future research infrastructures it is important that the basic tools required to generate optimal results are provided, e.g. ELIXIR and Imaging technologies. Secondly, in the first edition of the roadmap there were gaps in health research that need to be filled, thus providing a much more efficient output. The third important aspect was the completion of the landscape through widening its scope to cover problems and fields currently not considered (e.g. food) and to integrate the research areas, forming the basis of biological resources and the basis of basic research (e.g. marine biology).

Potential future research infrastructure initiatives.

Over the last two years since the first ESFRI roadmap was published, the main development in Biological and Medical Sciences has been the increased demand for novel interdisciplinary approaches including biological and functional imaging and chemical biology. One of the basic needs in Life Sciences is the access to and the development of novel Imaging Technologies. The recent developments in advanced light microscopy methodology and biomedical imaging have rapidly evolved in the last decades accompanied by the explosion in the use of digital imaging techniques especially used in basic research. The challenge



for biomedical imaging is to translate the tremendous achievements of molecular biology into early diagnosis and efficient follow-up of therapeutic treatments as well as developing novel imaging-guided drug delivery and minimally invasive treatments.

A great chance for the scientific community as well as for industry is the research area of **Chemical Biology**, studying probe systems in vitro and in vivo with low molecular weight compounds (small molecules). This approach offers the possibility to systematically screen on a large scale basis for new bioactive agents covering a wide range of areas from human and veterinary medicine, to agriculture and nutrition. New findings in this field, especially the identification of specific small-molecule agonist or antagonist available to modulate each protein function could directly be used for analysis in the framework of Systems Biology.

In the context of emerging and re-emerging infectious diseases involving highly pathogenic micro-organisms it is vital that Europe is fully prepared. In the case of the H5N1 virus, no human cases have so far been detected in Europe and no inter-human contaminations have been demonstrated. However, in contrast, the pandemic outcome of SARS and avian flu epidemics has represented worldwide threats. Also viral haemorrhagic fevers such as Ebola and viral encephalitis like Nipah could represent a major burden on socio-economic development in the developing countries and through migrations and global travel increasingly threaten the population of Europe. These emergences have demonstrated the need to work on highly infectious pathogens, making it necessary to establish a research infrastructure of **High Security Laboratories**.

Europe has a distinguished history in **Marine Biology** with many marine biological stations established in the late 19th century. They now support the needs of the scientific community in basic biology, marine biology and ecology by developing and applying new technologies using molecular biological and genomic approaches. The demand for marine organisms used as models to investigate fundamental questions in biology is constantly increasing. The marine biological stations provide access to these organisms. On the other hand results from experimental work in biomedicine, biochemistry, physiology and systematics can further be used in areas like aquaculture and in the development of sustainable new materials and processes, e.g. medicines and bio-fuels.

Future perspective.

Today biologists can obtain a tremendous insight into the functions of life. The understanding of how various systems work, what they have in common and what is different and how processes of life and their variations have survived the evolutionary process has increased. This knowledge opens up ground breaking new dimensions, and is used in the area of **Synthetic Biology and Systems Biology**. This area provides the analytic framework in which synthetic biology operates, by developing the high-throughput/high –resolution type of analysis on which synthetic biology depends. Both fields will be of huge importance for the future.

Currently Life Sciences operate through a transition on the one hand from traditional models (e.g. worm, fly) to target organisms (e.g. mammals) and on the other hand from the level of discovering molecules to understanding how whole organisms function. Therefore biological resources are considered as the essential raw material for the advancement of biotechnology, human health and research and development in Life Sciences. There is an evident need for additional **Biological Resource Centres** that focus on the collection and distribution of materials and reagents for the study of species other than humans (animals, plants, bacteria).

Another fast developing area which crosses Life Sciences, engineering and material sciences, is the area of **Biomedical Engineering**. Biomaterials stand as a potential solution for medical applications and many other biotechnological applications including sensors that would help monitoring and cleaning biohazards. Accordingly, state of the art research infrastructures are needed to organize, stimulate and amalgamate cross disciplinary efforts into world leading scientific and technological leaps for Europe.

The efficient implementation of the **European Innovative Medicine Initiative** (IMI) platform agenda requires the development of appropriate research infrastructures providing high quality and certified services. The cooperation of IMI and the Biological and Medical Sciences Roadmap Working Group will be strengthened and increased in the future.

Finally, particular attention will need to be given to identifying and supporting the new infrastructure requirements of agricultural research. **Agriculture** is indeed facing important challenges linked in particular to globalisation, consumer demands and environmental concerns. Future work in the area of Biological and Medical Sciences will in particular incorporate the outcome of the infrastructure analysis currently carried out by the Standing Committee for Agricultural Research (SCAR).

BBMRI - Biobanking and Biomolecular Resources Research Infrastructure

The facility:

A pan-European distributed infrastructure of existing and de novo biobanks and biomolecular resource centres providing access thereto. The infrastructure will include biological material from patients and healthy persons, typically DNA, tissues, cells, blood or other body fluids, with links to clinical and research data. It will also comprise biomolecular research tools and bio-computational tools to optimally exploit this resource for global biomedical research.

Background.

Following the rapid progress of genomic research in humans and their ancestors, biomedical and health research has expanded from the study of rare monogenic diseases to common, multi-factorial diseases. However, most complex diseases are elusive as they do not root in single defects, but are caused by a large number of small, often additive effects from genetic predisposition, lifestyle and the environment. Discovery, that is separating the signal from the noise, will depend critically on the study of large collections of well-documented, up-to-date epidemiological, clinical and biological information and accompanying material from large numbers of patients and healthy persons in so-called biobanks. Biobanks are widely considered as a key resource in unravelling the association between disease and variations in genotype, phenotype, and lifestyle.

What's New? Impact foreseen?

The preparatory phase of the construction started in February 2008, for 27 months. The project mobilises 50 Organisations (including 21 Funding Organisations), as well as 182 associated partners (including 8 Funding Organisations). Key components of BBMRI are comprehensive collections of biological samples, linked with continuously updated data on the health status, lifestyle and environmental exposure of the sample donors. This can only be achieved in a federated network of centres established in most, if not all, European Member States. Therefore, the format of BBMRI should be a distributed hub structure in which the hubs coordinate activities, including collection, management, distribution and analysis of samples and data for the major domains. The biobanks, biomolecular resources and technology centres will be associated with their specific domain hub. Users will come from different fields of academia and industry, and access will be provided in the context of specific research projects and on the basis of medical relevance and scientific excellence. BBMRI will speed up development of personalised medicine and disease prevention and will embrace some of the needs of basic research as well as of the biotech and pharmaceutical industries. Thus it will enable improvements in public health and will reduce some bottlenecks in the drug discovery and development process.

>Timeline.

Preparatory phase: 2008-2010; construction phase: 2010-2013.

>Estimated costs.

Preparation costs:	5 M€.
Total construction costs:	170 M€ (to be updated during the preparatory phase).
Operation costs:	15 M€/year (to be updated during the preparatory phase).
Decommissioning costs:	not applicable.

>Website: www.bbmri.eu

EATRIS – European advanced translational research infrastructure in medicine

The facility:

EATRIS will be a distributed infrastructure implemented through several biomedical research centres across Europe, with the task of translating basic discoveries into clinical practice. The centres will include cutting edge technologies for translational research and will cover the major disease fields: cancer, metabolic diseases, neurological disorders, cardiovascular diseases and infectious diseases. The EATRIS consortium is open to all countries which want to contribute to new European translational research infrastructure.

Background.

Despite tremendous progress in the life sciences, there is a gap between discovery and translation into medical products and applications. New results from basic science are not translated into clinical practice and patient care – or the translation is slow and incomplete. Translation of laboratory findings into diagnostic, therapeutic and preventive clinical applications indeed poses a major challenge: It requires considerable know-how and infrastructure for preclinical development in several areas such as for example screening of molecular and chemical libraries, in vitro and in vivo validation, toxicological analysis or production of therapeutic agents under Good Manufacturing Practice conditions. Such a task can only be mastered in a dedicated translational R&D infrastructure.

What's new? Impact foreseen?

The preparatory phase of the construction started in January 2008, for 36 months. The project mobilises 17 Organisations (including 7 Funding Organisations), as well as 3 associated partners (Funding Organisations). EATRIS aims at building on existing translational centres to provide a distributed European translational infrastructure. The strategy is to use, upgrade and complement available facilities to allow a smooth and flexible transition and at the same time strengthen and complement the current translational research infrastructures. In addition to the European concertation an important goal of EATRIS is also to catalyse an efficient national coordination. The EATRIS centres will offer access to a number of physical components which include state of the art animal facilities for preclinical validation studies, small molecule screening facilities to identify and characterise new drug targets, facilities to validate and improve new diagnostic and therapeutic strategies, disease specific patient and population cohorts, centralised GMP facilities for bioprocess development and manufacturing, and facilities to carry out clinical phase I studies. Training facilities and programmes specifically dedicated to translational research will also be developed. EATRIS will initially cover the following five disease areas: cancer, metabolic diseases, neurological disorders, cardiovascular diseases and infectious diseases. As a whole, EATRIS will provide a central gateway for essential resources necessary for translational research and form a nucleus for the development of European Translational Medicine.

EATRIS

European Advanced Translational Research Infrastructure in Medicine

>Timeline.

Preparatory phase: 2008-2010.

>Estimated costs.

Preparation costs:	6 M€.
Total construction costs:	255 M€ (to be updated during the preparatory phase).
Operation costs:	50 M€/year (to be updated during the preparatory phase).
Decommissioning costs:	not applicable.

>Website: www.eatris.eu

ECRIN – Pan-European infrastructure for clinical trials and biotherapy

The facility:

ECRIN is designed to bridge the fragmentation of clinical research in Europe through integration of national networks of clinical research infrastructures. It will provide 'one-stop shop' services to investigators and sponsors in multinational studies. Users will be investigators and sponsors in the academic and SME sector.

Background.

The development of therapeutic innovations requires access to large populations of patients. Infrastructures supporting patient enrolment in clinical trials, data management, quality assurance, monitoring, ethics and regulatory affairs are required for quality and credibility of data and successful performance of clinical trials. Such networks covering clinical research centres and clinical trial units were recently created at national level in some Member States of the European Union. However the need for harmonisation and the ability to conduct multi-centre projects is even greater at the European level. Fragmentation of health and legislative systems in Europe indeed hampers the competitiveness of its clinical research.

What's new? Impact foreseen?

The preparatory phase of the construction started in March 2008, for 36 months. The project mobilises 20 Organisations (including 6 Funding Organisations), as well as 13 associated partners (including 11 Funding Organisations). ECRIN will be an integrated, and professionalised EU-wide infrastructure, based on competence centres able to provide efficient support through a consistent set of services for the conduct of multinational clinical trials in Europe. World-class services will be provided to users through a network implementing harmonised practice and SOPs, with staff trained to multinational studies, and with high quality data centres and GMP facilities: support to the interaction with ethics committees, to the interaction with competent authorities and in regulatory affairs, to adverse event reporting, to drug dispensing, to the circulation of blood and tissue samples, to study monitoring, data management, GMP manufacturing of biotherapy products, and patients recruitment and investigations. Users will be investigators and sponsors in both the academic and industry sector, and services provided by this infrastructure are particularly relevant for research on rare diseases, for academic clinical research institutions, and for clinical trials steered by biotechnology SMEs who often lack the capacity to manufacture biotherapy products and to act as a sponsor in the conduct of EU-wide studies. Hereby ECRIN will take advantage of the EU population sise and unlock latent expertise. It will stimulate EU research on prevention, diagnosis and treatment, hence improving healthcare delivery to patients and citizens.

>Timeline.

Preparatory phase: 2008-2011; construction phase 2011-2014.

>Estimated costs.

Preparation costs:	8 M€.
Total construction costs:	50 M€.
Operation costs:	5 M€/year.
Decommissioning costs:	not applicable.

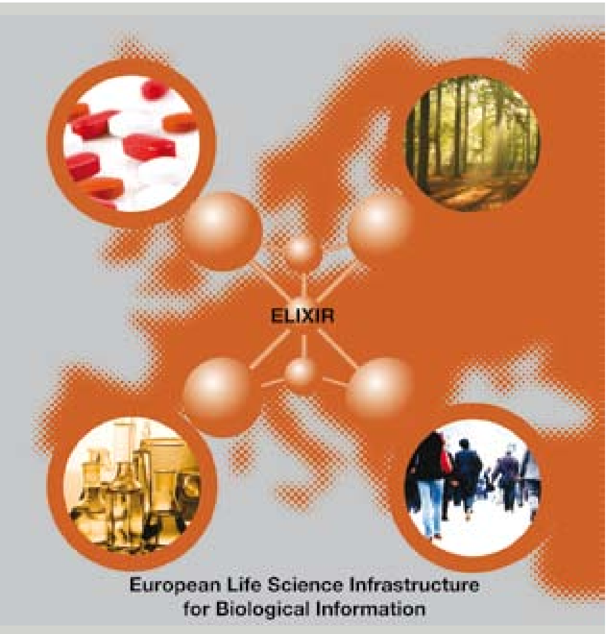
>Website: www.ecrin.org

ELIXIR - European Life-Science Infrastructure For Biological Information – A Major Upgrade.

GLOBAL

The facility:

It will be a secure but rapidly evolving platform for biological data collection, storage, annotation, validation, dissemination and utilisation, consistent with the unique requirements of shared resources in the life sciences. ELIXIR will comprise a distributed but interlinked collection of core and specialised biological data resources and literature. The core, aiming for completeness and universally used, will include a substantial upgrade to the existing molecular data resources at the European Bioinformatics Institute (EBI), as well as new resources as appropriate. The specialised resources, each serving more limited communities, will be distributed across Europe.



Background.

The world's body of biological data is a critical input for all Biological and Medical Sciences and related industries, even more so in the current era of high-throughput data collection in genomics, proteomics etc. and requirements for large scale integrated analysis, for example for systems biology. The value of the data that is being collected far exceeds the cost of storing and providing access to it, however investment in infrastructure has not kept pace with the very rapid rate of data growth. In addition to this fast increase, new categories of data are emerging, e.g. three-dimensional dynamic images, high-throughput mass spectrometric proteome identification, phenotypic and physiological data, polymorphism and chemo genomic data.

What's new? Impact foreseen?

The preparatory phase of the construction started in November 2007, for 38 months. The project mobilises 32 Organisations (including 16 Funding Organisations). The proposed infrastructure will ensure free provision of this essential biological data to the entire scientific community. It will encompass an interlinked collection of robust and well-structured and evaluated core databases, capable of accommodating the ongoing massive accumulation and diversification of data. It will permit the integration and interoperability of diverse, heterogeneous, potentially redundant information that is essential to generate and utilise biomedical knowledge. It will encompass the necessary major computer infrastructure to store and organise this data in a way suitable for rapid search and access, and will provide a sophisticated but user-friendly portal for users. It will be embedded in a database-related research programme that supports the development of critically important standards, ontologies and novel information resources. It will also link to specialised data resources that are distributed across Europe such as organism specific knowledge resources and, as appropriate, speciality and emerging databases of wide interest. This infrastructure will enhance all Life Sciences research and its translation to medicine, the environment, the bio-industries and society. EMBL plays a key role in coordinating the infrastructure through EBI, and also in developing the legal and financial framework to fund this complex infrastructure.

>Timeline.

Preparation phase: 2007-2010; construction phase: 2011-2018.

>Estimated costs.

Detailed costs will be specified in the preparatory phase.

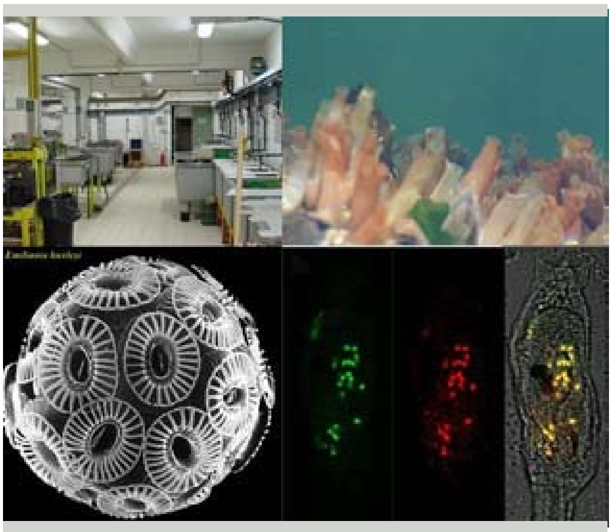
Preparation costs:	4.5 M€.
Total construction costs:	470 M€ for hardware and networking.
Operation costs:	~100 M€/year – a major commitment is needed to support ongoing resource development, data collection and curation.
Decommissioning costs:	not applicable.

>Website: www.elixir-europe.org

EMBRC - European Marine Biological Resource Centre

The facility:

This distributed pan-European infrastructure will provide access to model marine organisms and related genomic resources. It will promote access for both research and training. The main existing costal marine laboratories will be integrated within this research infrastructure to provide access to model marine organisms and their ecosystems together with modern technology and 'omic' platforms.



Background.

Rapid progress in the field of genomics has transformed the nature of European marine laboratories over the last 10 years by opening up new opportunities and additional model organisms for basic and applied research. This process is enabling the delivery of services to an increasing number of scientists who have turned to marine model organisms to investigate fundamental questions in biology. Based on several marine stations, some of which founded in the 19th century, EMBRC promotes a completely new structure: a single focused and fully integrated infrastructure with a single entry point.

What's new? Impact foreseen?

By offering direct access to the different marine ecosystems in European costal waters, EMBRC will align genomic and ecosystems research within a single research infrastructure with a major capacity for access to or provision of marine model organisms, and modern "omic" technologies. EMBRC will allow access to presently unknown biological mechanisms which can in turn be used for biomedicine or for biotechnologies. The infrastructure will capitalise on the complementarity and interoperability between marine institutes. Integrating actions between partners will involve i) improving instrumentation for access to the biodiversity of coastal ecosystems (stressing genomic technology), ii) improving the production, maintenance, provision and utilisation of key marine models for biological sciences and iii) promoting the functional analysis of ecological and biological models, using modern 'omic' and computational based approaches. EMBRC will be governed by a board representing all partners. A unique access point for the infrastructure with a dedicated management team and an e-interface for acquisition of requests of access and the exchange of data and information will be built. Access will be in 'open-mode'. Nine Marine Institutes located in different countries are committed to a rapid process of convergence. EMBRC is open to other partnerships, especially from the Baltic Sea States and the Eastern Mediterranean, to provide a more comprehensive coverage of European Costal Ecosystems and Model Organisms. A great deal of economy in effort and cost will be achieved by the new pan-European Research Infrastructure operated by EMBRC.

>Timeline.

Preparatory phase Years 1-2; construction phase years 3-8; operation phase Year 5 onwards.

>Estimated costs.

Preparation costs:	10 M€.
Total construction costs:	100 M€.
Operation costs:	60 M€/year.
Decommissioning costs:	not applicable.

>Website: www.embrc.eu

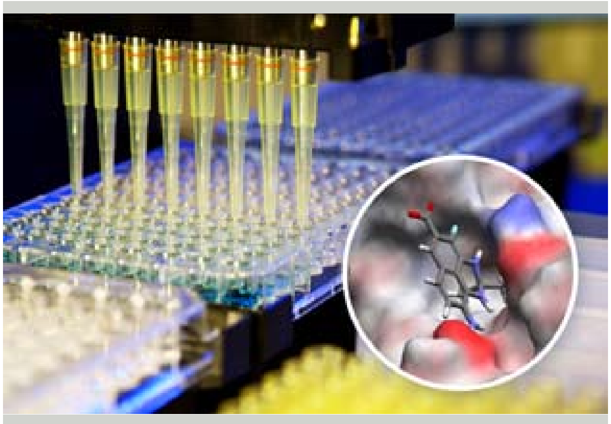
EU-OPENSCREEN - European Infrastructure of Open Screening Platforms for Chemical Biology

The facility:

EU-OPENSCREEN will allow researchers in academia and SMEs to access resources for the development of bioactive small molecules. It will be an association of high throughput screening (HTS) centres. These offer chemical resources for hit discovery and optimisation, bio- and cheminformatics support, and a publicly accessible database. This database combines screening results, assay protocols, and chemical information. A central facility will make available a large collection of diverse compounds representing the chemical knowledge of Europe.

Background.

Chemical Biology, the use of small organic molecules to explore biology, provides unique means for unravelling complex biological processes. As a major goal, Chemical Biology aims to identify small-molecule modulators for individual functions of proteins. As tools for academic research, these will enable a deeper exploitation of the wealth of genomic information. The efficacy and impact of the approach depends largely on the availability of a diverse and well-designed compound collection, the most advanced screening technologies, chemistry resources, special cell line collections, bio- and cheminformatics capacities, and a comprehensive database.



What's new? Impact foreseen?

For the first time, European researchers from academia and SMEs will obtain access to the most advanced screening technologies. This will allow the researchers to identify compounds affecting new targets. The interdisciplinary approach of EU-OPENSCREEN will bring together chemists, engineers, informaticians and biologists, overcoming the fragmentation of European research in the field of Chemical Biology. Through EU-OPENSCREEN´s coordinated and transnational activities, a substantially accelerated generation of knowledge will be achieved. Regarding in particular the responses of biological systems challenged by small molecules, EU-OPENSCREEN aims to satisfy the needs for new bioactive compounds in many fields of the Life Sciences (e.g. human and veterinary medicine, systems biology, biotechnology, agriculture and nutrition).

EU-OPENSCREEN will primarily support projects on unconventional targets and that address fundamental biological questions. In this respect, the activities of EU-OPENSCREEN will precede commercial development. They will open new paths for research in the post-genomic era, and a more direct translation from basic science into an improved quality of life. EU-OPENSCREEN will be open to all European organisations involved in Chemical Biology and committed to open access. In order to facilitate both collaboration amongst members and their interaction with stakeholders and external users, it is envisaged to create a legal entity.

A flexible framework for Intellectual Property (IP) issues will be established to allow for an early protection of knowledge before publishing in the database. Thus, the necessary balance between rapid knowledge sharing and exploitation activities will be secured.

>Timeline.

Preparatory phase: 2009-2011; construction phase: 2011-2012; operation phase: starting in 2012.

>Estimated costs.

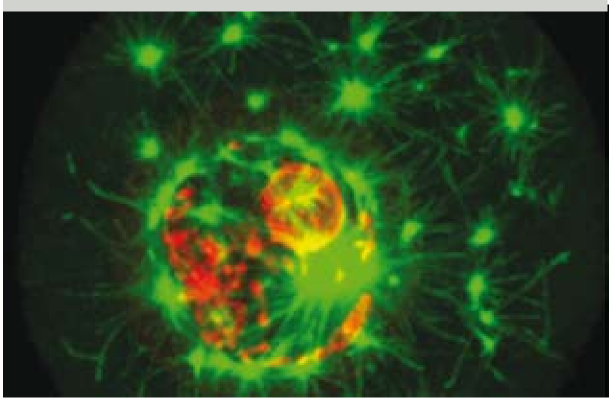
Preparation costs:	4-5 M€.
Total construction costs:	40 M€.
Operation costs:	40 M€/year.
Decommissioning costs:	not applicable.

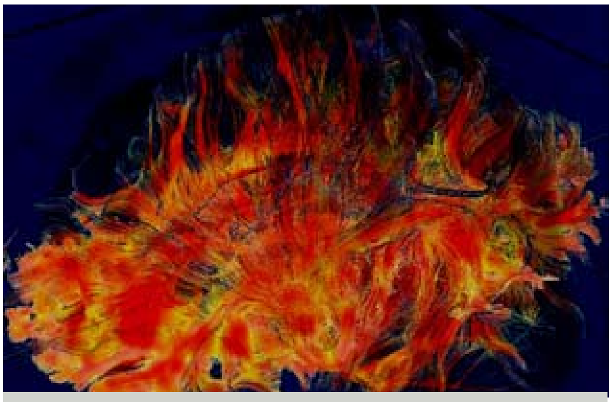
>Website: www.eu-openscreen.eu

EURO-BioImaging – European Biomedical Imaging Infrastructure

The facility:

Euro-BioImaging will provide access to imaging technologies across the full scale of biological and medical applications, from molecule to patient. It will be organised as a pan-European distributed research infrastructure focused on complementary imaging technologies from advanced light microscopy to medical imaging. The research infrastructure will be mainly newly constructed to devote a significant part of its capacity to external users.





Background.

Research in, and application of, biomolecular and biomedical imaging is progressing rapidly and increasingly this growth is multidisciplinary. Innovative imaging techniques are key tools for all life scientists to understand living systems at both the molecular and the physiological level, from biological model systems to patients. Imaging technologies are core disciplines of tomorrow's biology and medicine, and represent essential new research infrastructure for the life sciences. Euro-BioImaging brings together the imaging field at both the basic biological imaging level, with advanced light microscopy, as well as at the clinical level with medical imaging.

What's new? Impact foreseen?

Euro-BioImaging will address the imaging requirements of both basic and medical imaging communities by a coordinated and harmonised imaging infrastructure deployment in Europe and thus address the fragmentation of such efforts currently present in Europe. Euro-BioImaging will develop and provide access to new imaging technologies in key areas of biomedical imaging. In the long term, Euro-BioImaging will provide the technology to visualise the macromolecules of life in their natural environment to enable basic research, diagnosis, therapy and drug design. The Euro-BioImaging research infrastructure will meet the challenge for access to state of the art equipment as well as provide training and continue the development of imaging technologies. As imaging methods are grouped around different scales of biological organisation, from the molecule to the human organism, it will bring together complementary world leading research centres. The over-arching Euro-BioImaging goal is to provide pan-European research infrastructures for multidisciplinary bio-imaging projects that combine biologists, chemists, physicists, computer scientists, imaging technologists and clinicians.

>Timeline.

Preparatory phase: 2009-2010; construction phase: 2010-2014; operation: 2012 onwards.

>Estimated costs.

Preparation costs:	10 M€.
Total construction costs:	370 M€.
Operation costs:	160 M€/year.
Decommissioning costs:	not applicable.

>Website: www.eurobioimaging.eu

European High Security BSL4 Laboratories

The facility:

The new pan European BSL4 infrastructure will help to face any pandemic outcome from emerging and re-emerging infectious diseases. This is a scientific challenge that implies coordinated survey and study of level 4 pathogens. This new research infrastructure is realised through a major upgrade of existing High Security Laboratories, building new ones, and support infrastructures integrated through a European coordination body.

Courtesy Christian Ganet

Background.

One of the great challenges of the 21st century is the capability to react to human and animal highly pathogenic micro-organisms. Several emerging and re-emerging infectious diseases including viral haemorrhagic fevers, such as Ebola, viral encephalitis, like Nipah and others, could have a major burden on socio-economic development in the developing countries and, through migrations and global travels, increasingly threaten the population of Europe as well. These micro-organisms highly pathogenic for humans are classified as biosafety level 4 (BSL4) pathogens and must be handled in high-security BSL4 laboratories. Recently occurring SARS and avian flu epidemics have demonstrated the reality of infectious threat and worldwide vulnerability to emerging and re-emerging infectious diseases. European coordinated strategy is needed to ensure prompt diagnosis and treatment. This implies the construction and implementation of a pan-European BSL-4 research infrastructure.

What's new? Impact foreseen?

The main objectives of this project consist in increasing and coordinating (1) research activities from basic to applied research, (2) diagnosis activities development in conjunction with industrial health partners, (3) implementation and organisation of mutualised and shared biological resources centres, linked with the BBMRI-ESFRI project and (4) construction of training facilities to develop, share and implement common procedures that guarantee safe and secure working conditions for technicians and scientists as well as environmental protection. Each laboratory needs to be designed and scaled to host these four main activities: diagnosis, micro-organisms collection, research and training. This new research infrastructure will permit to address scientific urgent questions in term of diagnosis, prophylaxis, therapy and to face efficiently the emergency of new viruses. The new distributed infrastructure will take advantage of distributed competences and expertise accros Europe.

>Timeline.

Preparatory phase: 2010 - 2012; construction phase: 60 months (2013 - 2017).

>Estimated costs.

Preparation costs:	5 M€.
Total construction costs:	174 M€.
Operation costs:	24 M€/year.
Decommissioning costs:	not applicable.

>Website: http://www.hbsl.eu

INFRAFRONTIER – The European infrastructure for phenotyping and archiving of model mammalian genomes

The facility:

INFRAFRONTIER will organise two complementary and interlinked distributed infrastructures. (1) "*Phenomefrontier*" will provide a European platform equipped with the latest technologies, in particular in vivo imaging and data management tools, for the phenotyping of medically relevant mouse models; (2) "*Archivefrontier*" will provide a European resource for state of the art archiving and dissemination of those mouse models and will consist in a major upgrade of the European Mouse Mutant Archive (EMMA).

Background.

Medically related Life Sciences use the mouse as a model system to understand the molecular basis of health and disease in humans. The main goal of functional genomics and mouse genetics in the 21st century will be the generation of mouse mutations for every gene in the mouse genome, creating a huge and vital resource of models for the study of human disease. Over the next decade, we can expect that tens of thousands of mouse disease models will become available, all of which will ultimately require archiving, dissemination and phenotyping. Current capacity to achieve this goal is limited. Indeed, existing facilities across Europe can offer capacity for the dissemination and analysis of around a few hundred disease models per year. It is thus necessary to organise phenotyping, archiving, and distribution of mouse models on a well-concerted, large-scale, pan-European level.

What's new? Impact foreseen?

The preparatory phase of the construction started in March 2008, for 36 months. The project mobilises 22 Organisations (including 12 Funding Organisations). The goal of the "*Phenomefrontier*" part of the project is to provide a European platform offering access to comprehensive phenotyping to every laboratory, including the latest in vivo imaging technologies using non-invasive methods, as well as informatics tools to handle the phenotype data. Facilities will be upgraded and new ones will be constructed for assigning phenotypes to new mouse models from different pipelines. Archiving and distribution of mouse models under highest quality standards as well as dissemination of knowledge are the main goals of the second part, "*Archivefrontier*", of the project. "Archivefrontier" will consist in a major upgrade of the existing European Mouse Mutant Archive (EMMA). New facilities will be constructed. New mouse models will be archived, including attached data sets within an upgraded database. New methods to optimise and speed up the freezing of biological materials will also be implemented. Altogether, these two parts of the project will enable European laboratories to make effective use of the mouse models in the global effort to understand the logic complex systems and human disease. INFRAFRONTIER is expected to give Europe a leading position in a worldwide competition for resources and knowledge for medically relevant mouse models.

>Timeline.

Preparatory phase: 2008-2011; construction phase: 2011-2020.

>Estimated costs.

Preparation costs:	6 M€.
Total construction costs:	270 M€.
Operation costs:	36 M€/year.
Decommissioning costs:	not applicable.

>Website: www.infrafrontier.eu

INSTRUCT – An Integrated Structural Biology Infrastructure for Europe

The facility:

The new distributed infrastructure will consist of Core and Associate Centres for Integrated Structural Biology. All centres will maintain and further develop a set of core technologies such as protein production, NMR, crystallography, and different forms of microscopy. Each centre will have a specific biological focus that will shape its infrastructure development plan according to scientific need and improve the production and structural analysis of functional complexes. The network of centres will be organised in order to obtain multi-scale structural data and translate these data into functional knowledge.

Background.

The major challenge for structural biology in the next two decades will be the integration of structural knowledge at different resolution levels into specific cellular contexts which will underpin biomedical sciences. This challenge requires a combination of techniques providing information in different resolution ranges and bridging the gaps between them. Furthermore, besides this static picture of a cell, there is a temporal component that is crucial to understanding cell biology including the dynamics of different cellular processes. Going beyond the single protein approaches to identify, characterise and analyze the individual structural assemblies and subassemblies of a cell, it is now important to integrate information obtained by the major core techniques (NMR, X-ray and electron crystallography, electron and light microscopy) and develop the necessary mathematical methodology to integrate the resulting information. In addition, integration with state-of-the art cell biology techniques (of which light microscopy of living cells is already an important part) is another essential aspect, providing a dynamic picture of many of the key cellular processes (intra-cellular trafficking, for instance) at all scales.

What's new? Impact foreseen?

The preparatory phase of the construction started in April 2008, for 24 months. The project mobilises 13 Organisations (including 5 Funding Organisations). Each core centre will develop its own scientific program and continue to develop technological and methodological cutting edge expertises in various approaches. The core centres will each provide specific expertise in one of the major technologies. In addition to the Cores, complementary technology will be made available from associate centres, where smaller, more focused technologies will be developed for access. Both cores and associates will deliver a significant fraction of their activity via open-access for the user community. Access will be facilitated by a network of national coordinators who represent the interests of national stakeholders, both to the local funding bodies and, in INSTRUCT, to help establish strategic priorities.

>Timeline.

Preparatory phase: 2008-2010; construction phase: 2010-2017.

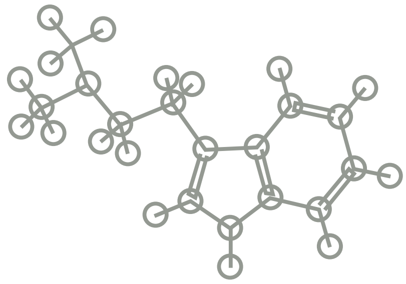
>Estimated costs.

Preparation costs:	7 M€.
Total construction costs:	300 M€.
Operation costs:	25 M€/year.
Decommissioning costs:	not applicable.

>Website: www.instruct-fp7.eu

>Materials and Analytical Facilities

The development of new materials contributes to all areas of human activity from energy generation and storage through to medical implants and computer components. Advances in materials from steel blades to biological materials, including fluids and plasmas, has been fuelled by the capability to observe, design and assemble or manipulate them at an ever increasing definition of scale. This has supported a century-long durable and effective industrial and economic growth based on increasingly sophisticated new products, from catalysers or cell phones to new pharmaceutical drugs, and the continuous improvement in traditional products, from car engines to glass cover for housing or fabrics for clothing.



It is now increasingly possible to operate at the nanometre scale, observing and manipulating, as well as designing, atom by atom, increasingly complex materials.

Most techniques can be available in relatively small laboratory environments (like the atomic force microscope, or the atomic-layer deposition chambers), but, when it comes to operating with increasing definition on larger pieces of materials, the need is to be able to "illuminate and reach" all atoms of the materials under investigation. This requires "large facilities" capable of providing the adequate "brilliances", much like the need for a strong light to explore a dark environment.

The overall situation of the main research infrastructures in this field in Europe can be summarised as follows.

Photon Sources.

Light photons are only one, but the most flexible, of the many complementary "probes" which can be used. Large related instruments are Synchrotrons, Integrated Laser Laboratories or High Power Lasers. A recent technological breakthrough is adding the Free Electron Lasers (FELs) capable not only of much higher brilliances but also of short time "flashes" opening the dynamic "filming" of atom-related properties. Photon sources are needed over a large range of "colours", from the low Infrared range up to the Hard X-Rays. High power lasers and Synchrotron light are also used to produce and study plasmas, e.g. the conditions for energy production by fusion, or to produce devices through photolithography.

Europe has a long tradition of excellence in the development and use of these sources and related instruments. Several new 3rd and 4th generation light sources are now in operation, under construction or planned in order to satisfy the rapidly increasing demand for beam time and new capabilities. The European Synchrotron Radiation Facility (ESRF) and its planned 10-year upgrade programme is the prime example of the evolution of the landscape in this field due to the continuous effort made by several EU countries.

The new capabilities offered by FELs will allow the exploration of a new terra incognita. State of the art 3rd generation synchrotron sources will be surpassed in peak intensity by 8-9 orders of magnitude and by 3-4 orders of magnitude in average intensity and short-time capabilities, pushing research to new frontiers and opening novel areas of research.

The first exciting results in atomic and molecular physics are already coming out from the operation of the *FLASH* facility in Hamburg (UV to soft X-ray range). In this range of photon energies, several other national projects of European relevance and with different characteristics are currently either under construction or in the design stage. Some of these are *FERMI@ELETTRA* (Italy), *MAX IV* (Sweden), and *PSI FEL* (Switzerland). Some other facilities are currently under consideration. EuroFEL is coordinating these activities aiming at integrating them into a unique distributed infrastructure.

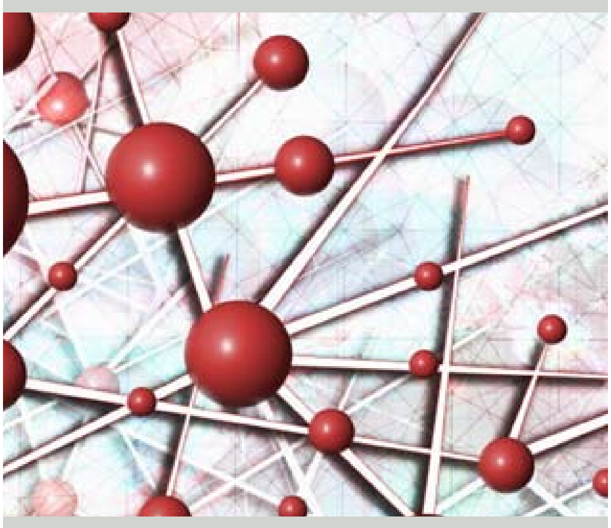
The most notable success of the roadmap so far is certainly the progress of the European XFEL. The new facility is hosted in Hamburg, with the participation of 11 EU Member and Associated States. This has also been a pioneer project for developing new finance, governance and management models for European research infrastructures.

Neutron Sources.

The use of neutrons as a probe of matter is complementary to photons and they are unique for measuring and detecting very important aspects of materials and biological matter. Infrastructures for neutron spectroscopy use low energy neutrons. Their magnetic moment allows the detection of magnetic structures, while their small momentum allows the measurement of thermal and mechanical properties, and the differential measurement of hydrogen and deuterium enables important sites in biological matter to be studied. As a result of the great transparency of materials to neutrons, neutron radiography of large and thick machinery is possible, to study directly some important engineering aspects.

Beams of neutrons can be generated either by fission in nuclear reactors or by spallation by the impact of protons on targets. Europe has been leading in both types of neutron sources in the past 20-25 years, but new and increasing competition from the USA and Japan is rapidly eroding this advantage. Currently there are about 5000 users of neutron spectroscopy in Europe. This number is continuously increasing and attracting researchers in biology, biochemistry, biophysics and nanoscience.

To ensure that Europe has access to world leading facilities, the **European Spallation Source (ESS)** is a high priority together with the upgrade of the **Institut Laue-Langevin (ILL)**. The European Spallation Source will become the world's most powerful neutron source. It will be particularly suited to elucidate complex biological structures and processes. Studies of biomaterials, foods, pharmaceuticals, and systems relevant to environmental health will also be possible in addition to the existing applications. Candidate countries to host the European Spallation Source are Hungary, Spain and Sweden. If a decision on the site of this 5-MW long-pulse source is taken in 2008 and construction starts in 2009, the facility may become operational in 2019/20. This will ensure that Europe's leading role in neutron scattering is kept and strengthened.



High magnetic fields.

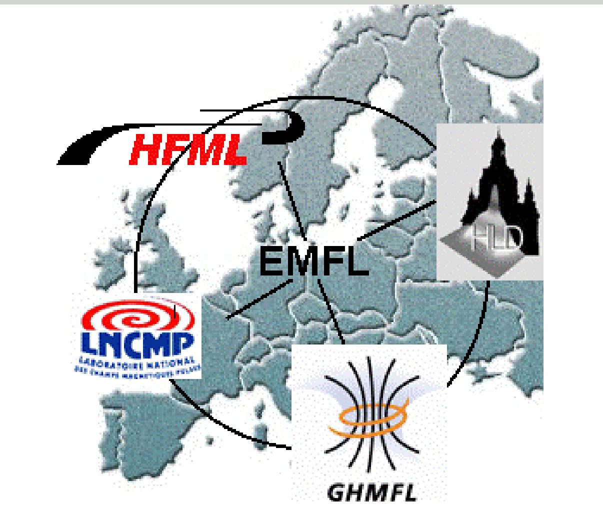
A powerful tool to modify and study materials is also provided by high magnetic field laboratories, operating both in continuous and pulsed modes. High magnetic fields are used in a variety of applications, ranging from materials research (including superconducting materials) to physics, chemistry and life science. The current plan to upgrade and integrate the four existing European high magnetic field laboratories into one distributed pan-European research infrastructure, the **European Magnetic Field Laboratory (EMFL)** will allow Europe to strengthen its competitiveness in this field of research.

The connection of this new infrastructure with the neutron and photon sources, in particular ILL and ESRF in Grenoble, is also currently under discussion and, if approved, it will provide a truly multi-source multi-disciplinary user instrument for the investigation of matter.

EMFL - European Magnetic Field Laboratory

The facility:

EMFL will be a dedicated magnet field laboratory providing the highest possible fields (both continuous and pulsed) to European researchers. It will be operated as a single distributed research infrastructure which integrates and upgrades the four already existing major European high magnetic field laboratories: the Grenoble High Magnetic Field Laboratory (GHMFL), the Laboratoire National des Champs Magnétiques Pulsés (LNCMP) in Toulouse, the Hochfeld-Magnetlabor Dresden (HLD), and the High Field Magnet Laboratory (HFML) in Nijmegen. EMFL will allow Europe to take the lead in the production and use of very high magnetic fields for scientific goals.



Background.

High magnetic fields, both static and pulsed, provide the most powerful tools available to scientists for the study, the modification and the control of the state of matter. They are extensively used in a variety of scientific domains, from physics and material science to chemistry and life sciences. Technological applications include the characterisation of superconductive materials. Europe has been leading the development of high magnetic fields and their use for science and technology. At present, however, the USA's National High Magnetic Field Laboratory (NHMFL), distributed over three sites is the leading facility in the field. For Europe to regain its competitiveness, it is urgently necessary to coordinate and upgrade Europe's high field activities to an effective size and efficiency comparable to that of the NHMFL.

What's new? Impact foreseen?

The multi-site EMFL will develop common magnet technology and magnets with the goals to take the lead in the production of very high fields and to develop unique experimental facilities worldwide. EMFL will coordinate the science and technology programs by developing complementary scientific specialisations at each of the four sites. HFML will concentrate on advanced spectroscopy through the unique combination with a FEL and the dedicated continuous 40 T low vibration hybrid magnet for local nano-spectroscopy, while GHMFL will house a record field hybrid magnet (50 T) with a new 40 MW installation. ESRF and ILL (Grenoble) are also planning a major upgrade of their installations by combining very high magnetic fields with neutrons and synchrotron radiation. To do so, they will cooperate with the EMFL to design, build and operate the necessary magnets for beam scattering and will share the new high power installation. HLD will fully exploit the coupling to the ELBE FEL for infrared spectroscopy and will develop magnets for the production of the highest available pulsed fields, while LNCMP will expand its activities in X-ray and visible spectroscopy, and strengthen its magnet materials development program. EMFL will also manage the scientific access of its users to all its installations, the selection of the proposals being made by an independent external Selection Committee.

>Timeline.

The construction of the new EMFL facility is expected to start in 2011 after a 2 years preparatory phase, and to last for 5 years. The facility should remain in operation for at least 15 years.

>Estimated costs.

Preparation costs:	10 M€.
Total construction costs:	~120 M€.
Operation costs:	8 M€/year additional, or 22 M€/year including existing budgets.
Decommissioning costs:	not applicable.

>Website: http://www.emfl.eu/

ESRF Upgrade

STARTED

The facility:

The European Synchrotron Radiation Facility (ESRF), located in Grenoble, France, is a joint facility set up by international agreement, supported and shared by 18 European countries and Israel. It operates the most powerful high energy synchrotron light source in Europe and brings together a wide range of disciplines including physics, chemistry and materials science as well as biology, medicine, geophysics and archaeology. There are many industrial applications, including pharmaceuticals, cosmetics, petrochemicals and microelectronics.

Background.

The ESRF's 6 GeV storage-ring light source built in the early nineties was the first insertion-device-based ("third generation") synchrotron radiation (SR) source. The ESRF has been extremely successful, both in terms of technical innovation and also where the very large volume of new and exciting science is concerned. With some 6200 scientific user visits each year, resulting in more than 1500 refereed publications, the ESRF is recognised as one of the world's most innovative and productive synchrotron light sources. This success is also measured by requests for beamtime from the community of users of the ESRF, consistently greatly exceeding the available beamtime.

What's new? Impact foreseen?

In order to maintain its leading role and to respond to the emerging scientific challenges, the ESRF is planning an ambitious Upgrade Programme, comprising (i) the extension of the experimental hall to enable the construction of new and upgraded beamlines with largely improved performance and new scientific opportunities, as well as improved infrastructures for the preparation of experiments, (ii) a programme of improvements of the accelerator complex, (iii) a strong supporting programme of engineering and technology developments, and (iv) the development of productive science and technology driven partnerships. The option for a joint high magnetic field laboratory with ILL and other European high field laboratories is also foreseen. The planned Upgrade will enable significant progress in fields such as nanoscience and nanotechnology, structural and functional biology, health, environment, energy and transport, information technology, and materials engineering. The Science case and the related technological challenges are laid out in the so-called Purple Book, available on the ESRF website.

>Timeline.

Pending a positive decision of the ESRF Council, ESRF is expected to start its 10-year upgrade programme in 2009.

>Estimated costs.

Preparation costs:	6.8 M€
Total construction costs:	capital costs 238 M€ (in 2008 prices), of which 77 M€ from the regular budget, recurrent costs 28 M€, personnel costs 21 M€.
Operation costs:	83 M€/year.
Decommissioning costs:	not applicable.

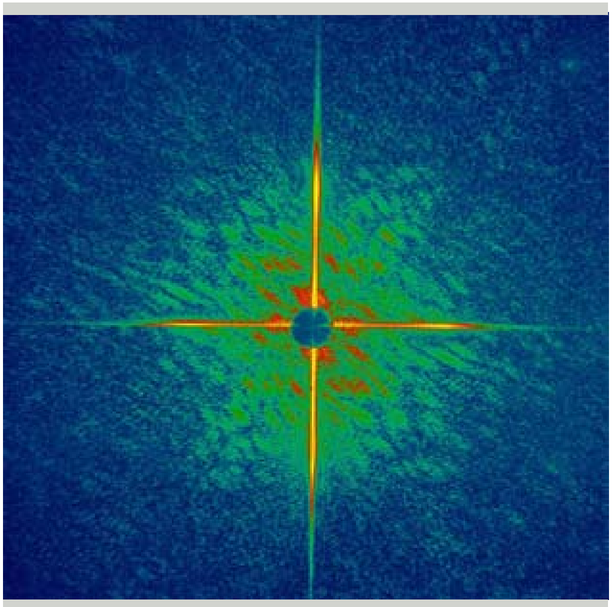
>Website:

http://www.esrf.fr/ http://www.esrf.fr/AboutUs/Upgrade/purple-book/

EuroFEL (ex-IRUVX-FEL)

The facility:

Intense light beams with infrared to soft X-ray wavelengths are the major probe to study the electronic properties of matter, involving a very large user community. Free Electron Lasers (FELs) can now produce such beams of coherent, femtosecond light pulses with unprecedented intensities. The EuroFEL Consortium (previously called IRUVX-FEL) aims at integrating the national FEL based facilities currently in operation or emerging in Europe in a single, distributed and internationally open research infrastructure. The integration will exploit in the best way the complementary specifications and instruments of each facility for wide-ranging studies of matter by a large science community.



Background.

Recent technological advances have allowed developing new light sources based on free electron lasers for a broad spectral range from infrared to X-ray wavelengths. These sources produce collimated beams of femto-second pulses with high coherence and unprecedented brilliance to study the structure and dynamical behaviour of materials at the atomic level. The development of a set of complementary FEL sources as an integrated pan-European research infrastructure will give Europe a first-class infrastructure, unprecedented worldwide, complementing present synchrotron radiation sources and "table top" lasers.

What's new? Impact foreseen?

The interaction between matter and intense electromagnetic radiation in this spectral range is virtually unexplored. The photon beams of soft X-ray FELs have completely new qualities compared to those of synchrotrons and also exceed other sources based on conventional lasers. Europe has the unique chance of consolidating its world leadership in a field of highest relevance. Scientific challenges and opportunities will open for a wide range of scientific disciplines, ranging from nanosciences, materials and biomaterials sciences, plasma physics, molecular and cluster, femto- and nano-physics and chemistry, with various connections to life, environmental, astrophysical and earth sciences and the development of technologies ranging from micro electronics to energy. Some novel emerging synchrotron techniques, like holographic coherent imaging or ultra fast pump-probe studies will greatly benefit from the enhanced beam properties.

>Timeline.

The overall EuroFEL facility could be realised in the next 8–12 years. One facility, FLASH in Hamburg, is already in operation, another, FERMI in Trieste, is under construction, with an overall financing provided by the two hosting country and regional governments, the European Investment Bank and EU projects, for a total estimated cost, including design and preparatory phases, of about 300 M€. Assuming that all currently proposed FEL projects will be financed, the EuroFEL consortium may finally include up to eight facilities.

>Estimated costs.

Preparation costs:	150-200 M€ (approximately 15% of the investment costs. EC contribution 5.7M€).
Total construction costs:	1200 - 1600 M€, including FLASH and FERMI, costing between about 150 and 200 M€.
Operation costs:	approximately 10% of the overall investment costs.
Decommissioning costs:	not applicable.

>Website: http://www.eurofel.eu

ESS - European Spallation Source

The facility:

The European Spallation Source will be the world's most powerful source of neutrons. Its built-in upgradeability (more than the initial 20 instruments, higher power) will make it the most cost-effective top tier source for 40 years or more. A genuine pan-European facility, it will serve a community of 5,000 researchers across many areas of science and technology.

Background.

Fine analysis of matter requires the complementary use of diverse "probes" and techniques: light scattering, neutron scattering, NMR, computer modelling and simulations and so on. Among them, neutrons are particularly important for soft and hard condensed matter, magnetism and biology as well as for nuclear physics. The intense beams of low energy neutrons which will available at the ESS will create entirely new opportunities for real time, real size, in situ, in vivo measurements, including movies of nano-scale events. They will allow understanding of the structure, dynamics and functions of increasingly complex systems covering the broad field of inorganic and organic materials as well as biomaterials.

What's new? Impact foreseen?

Neutron beams produced by reactors are inherently intensity-limited. The ESS R&D and design phase involving all major European Labs, has demonstrated the feasibility of MW-power spallation sources. In line with the global neutron strategy endorsed by OECD ministers in 1999, the US is now commissioning its facility SNS at Oak Ridge, and Japan is preparing for the first neutrons at J-PARC. In comparison with them, the long pulse configuration of ESS provides substantially higher power, maximum complementarities and the largest instrument innovation potential. Its performances guarantee a long-term world leading position. ESS will also offer new modes of operation and user support to maximally facilitate the industrial access, next to university and research lab users. The higher neutron flux will allow advanced and more effective investigations of ultra thin and laterally confined structures for ICT reading devices, active site structures in enzymes, technologies for storing hydrogen, multi-component complex fluids in porous media for tertiary oil production, the templating of nanostructures for catalysts, medical implants, pharmaceuticals, photonic materials etc. Requirements for novel detectors, instrument and software technologies will be additional drivers of innovation. ESS, a multifunctional facility with applications in many industries, will also have a marked regional impact.

>Timeline.

The science case and the preliminary baseline range (design and costing) are ready and allow formal negotiations to start in parallel to ongoing work to complete the detailed engineering design including detailed costing and optimisation. Sweden (leading a Scandinavian consortium), Spain and Hungary are presently candidates to host the ESS. Further characterisation of the three sites is currently underway, assisted by ESFRI. Assuming that construction will start in 2009, first neutrons will be delivered in 2017 and the facility will be opened for access in 2019/2020.

>Estimated costs.

Preparation costs:	30 M€.
Total construction costs:	1300 M€.
Operation costs:	110 M€/year.
Decommissioning costs:	300 M€.

>Website: http://neutron.neutron-eu.net/n_ess

European XFEL

STARTED

The facility:

The European X-ray Free Electron Laser, which is being built in Hamburg, Germany, will be a world leading facility for the production of intense, short pulses of X-rays for scientific research in a wide range of disciplines.

Background.

The European X-ray Free Electron Laser (European XFEL) project foresees the construction in Hamburg, Germany of a new international user facility for the production and scientific use of ultra-bright and ultra-short pulses of spatially coherent hard X-rays. The facility comprises a 1.7 km long superconducting linear accelerator accelerating electrons up to energy of 17.5 GeV, which will distribute up to ~30,000 electron bunches per second, with an energy of 17.5 GeV, into three undulators. These will generate spatially coherent X-ray radiation pulses shorter than 100 fs in duration and with peak power exceeding 10 GW, in a wavelength range from 0.1 nm to 1.6 nm (or even longer at lower electron energy). An additional set of two undulators can later on be added to generate hard X-rays down to 0.01 nm wavelength by spontaneous emission. The facility includes an initial set of six (expandable to ten) experimental stations with state of the art equipment for the scientific use of the radiation.

What's new? Impact foreseen?

It is anticipated that the availability of X-ray pulses with peak brilliance of up to nine orders of magnitude greater than existing 3rd generation light sources shall allow the performance of presently impossible and potentially revolutionary experiments in a variety of disciplines from condensed matter and materials physics to nanoscience, from plasma physics to chemistry and to structural biology. The European XFEL will provide a new tool for many different research fields. The detailed understanding of chemical reactions and the way how molecular machines work will be essential for future drug and material design. The big leaps in brilliance and pulse duration have already triggered the development of novel detector technologies and high power optical lasers, which could be expected to be drivers of further innovation. The European XFEL will use a new superconducting technology to accelerate electrons at high repetition rate, enabling a combination of high peak and high average brilliance. This technology is expected to be the basis of many future accelerators. With the experience gained with the realisation of the XFEL, industry in Europe could achieve a world leadership in these technologies.

>Timeline.

Starting in 2004, the Memorandum of Understanding (MoU) on the preparatory phase of the European XFEL has been signed by representatives of 11 EU Member States, China, Russia and Switzerland. The start of the construction was formally announced in a communiqué signed by the representatives of ten MoU partner states, the Free and Hanseatic City of Hamburg and the Federal State Schleswig-Holstein on 5 June 2007. The contracts for the main civil construction will be signed in November 2008, while the signature of the intergovernmental convention is scheduled in early 2009. The accelerator and the first six experimental stations will be commissioned starting in 2014.

>Estimated costs.

At 2005 prices:

Preparation costs:	39 M€.
Total construction costs:	1043 M€ (including commissioning).
Operation costs:	84 M€/year
Decommissioning costs:	100 M€.

>Website: http://www.xfel.eu

ILL 20/20 Upgrade

STARTED

The facility:

The reactor-based laboratory at the Institut Laue Langevin (ILL) is recognised as the world's most productive and reliable source of slow neutrons for the study of condensed matter, and its overall upgrade is the most cost-effective response in the short to medium term to users' requirements.

Background.

The ILL has been and remains a European success story, having been set up with a full complement of beam-lines and experimental instruments from its beginning in the mid 70's, and continuously improved. The near-siting of the European Synchrotron Research Facility has added value for European users offering them access to complementary techniques and joint support laboratories at the Grenoble site. Recently the second phase of a wide-ranging upgrade programme – the Millennium Programme – began; this will ensure world level competitiveness and scientific value for the international user community. The programme includes the optimisation of the neutron source and its moderators, the neutron delivery (guides and beam tubes) and the neutron instrumentation. Access to new scientific areas will be strengthened through enhanced support facilities for users. The first such facility, the Partnership for Structural Biology, a joint project together with ESRF and three other laboratories, opened in November 2005. It provides special services, such as the growing of deuterated single crystals, for visiting research teams using the neutron and synchrotron instruments on site.

What's new? Impact foreseen?

The renewal of the neutron production and instrumentation of the Institut Laue-Langevin in Grenoble, the so-called 20/20 plan, will give a longer perspective of competitiveness. Added value is given by the partnerships for materials science and engineering, and soft condensed matter. A High Magnetic Field laboratory in collaboration with ESRF will support instruments on both the neutron and the synchrotron radiation sources. Specific measures will be implemented to facilitate Technology Transfer.

>Timeline.

The upgrade will be implemented in two consecutive 5 years phases from 2007 to 2012 and from 2013 to 2017.

>Estimated costs.

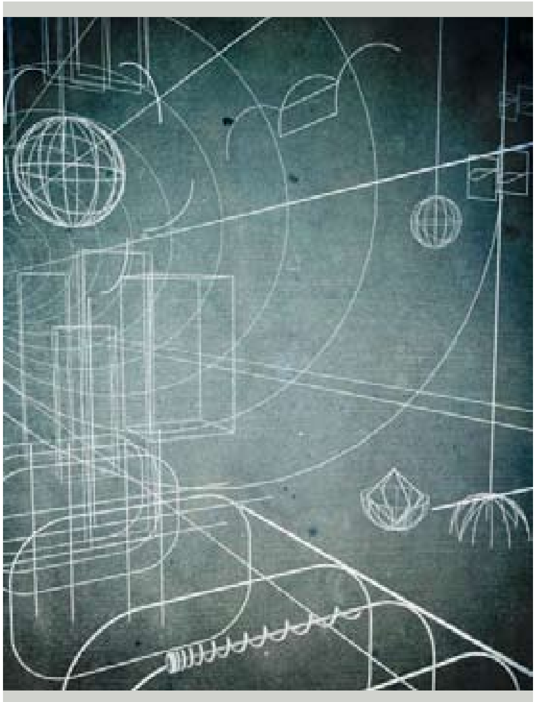
Preparation costs:	6.2 M€.
Total construction costs:	171 M€, including 15M€ of regional and local government funding towards additional infrastructural aspects for the proposed joint site together with ESRF.
Operation costs:	5 M€/year additional to the current operation costs.
Decommissioning costs:	under definition.

>Website: http://www.ill.eu/about/future-planning/perspectives-opportunities/

>Physical Sciences and Engineering

Physical sciences deal with phenomena at all scales and complexities, from the extremes of the universe to the smallest elementary particles. Through the years, scientific progress has generated many new fundamental questions which are today on the agenda of astrophysics, astroparticle physics, particle and nuclear physics, and are in many ways interconnected.

In the course of these developments, the facilities for fundamental physics and astronomy have become much larger, technically more complicated and expensive. More than ever before it has become a necessity to join intellectual and financial resources to realise these projects. Such facilities drive the development of new technologies and new ways of working for instance in ICT and in the applications of nanotechnology and superconductivity.



Astronomy and Astroparticle Physics

Europe has a long tradition in astronomy with a strong community working across a diverse range of fields from studies of the interaction of the solar wind with the Earth's upper atmosphere to cosmology.

Discoveries in recent years have raised new fundamental problems. These include the nature of dark energy and dark matter, the emergence of the first stars and galaxies in the universe and their evolution, the description of gravity, and planet formation around other stars. To tackle these and other questions new instruments are required to provide data across the electromagnetic spectrum:

- *Ground-based optical astronomy* can now use as largest instruments a set of 8-10 m telescopes, but it has become clear that the challenge posed by the new fundamental questions requires still a larger collecting area and stronger angular resolution. The **European Extremely Large Telescope (E-ELT)** is the follow-up project of the current generation of optical telescopes. With segmented mirrors and built-in adaptive optics, it is feasible to build a 40-m class telescope. Locations that are currently being characterised as possible sites of the E-ELT include Cerro Macón (Argentina), North Paranal and Vizcachas (Chile), Aklim (Morocco) and La Palma (Spain).

- *Neutrino astronomy:* The **Cubic Kilometre Neutrino Telescope (KM3NeT)** will consist of thousands of optical sensors distributed in a volume of about one cubic kilometre in the depth of the Mediterranean Sea. The sensors detect the light which is produced in the water by charged particles originated from neutrinos. It aims to monitor the universe continuously together with the IceCube Neutrino Detector, currently under construction at the South Pole.

- In *radio astronomy* the next generation telescope should be the **Square Kilometre Array (SKA)**. The SKA will have a collecting area of one million square metres distributed over a distance of at least 3000 km. This area, necessary to collect the faint signals from the early universe, will result in a 100 times higher sensitivity compared to existing facilities. The radically new concept of an "electronic" telescope will allow very fast surveys. Candidate sites for SKA are Australia/New Zealand and Southern Africa.

- In *gamma-ray astronomy* a similar role will be played by the **Cherenkov Telescope Array (CTA)**. The pioneering Cherenkov telescopes HESS and MAGIC have observed a multitude of gamma ray sources both in our galactic centre and outside our galaxy. The CTA will greatly extend the reach of these two projects and allow for further exciting scientific discoveries. The CTA will be deployed in two locations, one in the southern hemisphere and one in the northern hemisphere (likely sites are in Namibia and in the Canary Islands).

Particle Physics and Space Physics

Particle physics is entering in a new and exciting era of discovery, exploring new domains and probing the deep structure of space-time. European particle physics is based on strong national institutes, universities and laboratories and on the CERN Organisation.

The CERN Council has adopted a strategy for the field and follows up its implementation in regular European Strategy Sessions. An update is foreseen for 2011. The current strategy is:

- The Large Hadron Collider (LHC) at CERN, now starting, will be the energy frontier machine for the foreseeable future and it has the highest priority to fully exploit its physics potential. Depending on the nature of the discoveries made at the LHC, higher-statistics studies of these phenomena would naturally call for an increase in luminosity. This upgrade – referred to as Super-LHC – should increase the luminosity by a factor ten.
- It is vital to strengthen the advanced accelerator R&D programme in Europe, providing a strong technological basis for future projects in particle physics.
- It is fundamental to complement the results of the LHC with measurements at an electron-positron linear collider. Such a linear collider will provide a unique scientific opportunity at the precision and energy frontiers. This programme can be carried out by the International Linear Collider (ILC) or, if multi-TeV energies are needed, by a novel design called the Compact Linear Collider (CLIC) which has the potential to deliver such energies. For essentially every new physics scenario involving particles in the linear collider energy range, detailed and very promising research programmes have been formulated. The linear collider studies are in the R&D and these studies will, together with results from the LHC, guide the way towards realisation.
- Neutrino physics opens another exciting window to study physics beyond the standard model. Recent measurements of neutrino oscillations and masses, and the possibility of observing CP violation in this sector, point forward to the need of constructing more advanced neutrino facilities, and design studies are ongoing. Which route to take, depends on the result of accelerator R&D, and on results from experiments now starting.
- Several important experiments take place and are planned in the overlap region between Particle and Astroparticle Physics, or between Particle and Nuclear Physics. Examples of such experiments can be found in Europe's four world-class deep underground laboratories: Boulby (UK), Canfranc (Spain), Gran Sasso (Italy) and Modane (France). These facilities study neutrinos – including in some cases long baseline experiments with accelerator neutrinos - and search for dark matter and proton decays.
- New initiatives and plans are being developed in the field of flavour physics where the Super-B facility at the INFN National Laboratory of Frascati is a possibility being pursued.

In the field of **Space Science**, the European Space Agency has outlined the future plans for future space missions in its Cosmic Vision paper.

Nuclear Physics

Modern nuclear physics has two main goals. At the larger scale one wants to understand the limits of nuclear stability by producing exotic nuclei with vastly different numbers of neutrons and protons. At the smaller scale one wants to explore the substructure of the constituent neutrons and protons, for it is in the interaction of their constituent parts that the ultimate description of nuclei must lie. Such a description is much needed in order to reduce uncertainties on the nuclear data upon which design and operation of fission reactors are based.

There are two approaches to producing radioactive beams – the "In-Flight Fragmentation" and the "Isotope-Separation On-Line" (ISOL) techniques. The In-Flight production technique is fast and can produce the shortest-lived radioactive nuclei, whereas the ISOL technique can provide more intense and better controlled beams for detailed studies. So both techniques are complementary.

The leading in-flight facility is the **Facility for Antiproton and Ion Research (FAIR)**, which will soon become an international research centre in Darmstadt (Germany). The technical plan for the first stage and the legal documents will allow starting construction in 2009.

SPIRAL2, a major expansion of the SPIRAL facility at GANIL in Caen (France), will help to maintain the European leadership in the ISOL development. It is an essential step on the road to EURISOL, the ultimate ISOL facility. The objective is to realise the project with international participation.

Engineering

Within engineering, nanotechnology is the manipulation or self-assembly of individual atoms, molecules, or molecular clusters into structures to create material and devices with new properties. Nano-science and technology is and will be one of the major research and development areas for the coming decade. As a result of its multidisciplinary nature, the question of research infrastructure needs is quite different from that of other fields. A broad range of often smaller but dedicated and complementary equipment for nano-scale synthesis is needed in order to be able to perform all processing and characterisation steps needed.

The **Pan-European Research Infrastructure for Nano-Structures (PRINS)** will be a distributed facility of leading centres, smaller centres and research groups from all countries to form a large pan European infrastructure dealing with the ultimate silicon and heterogeneous integration. This distributed facility will collaborate with the European nano-electronics community through the strategic Joint Technology Initiative "ENIAC". A significant amount of the total cost is expected to be raised by industry in a public-private partnership.

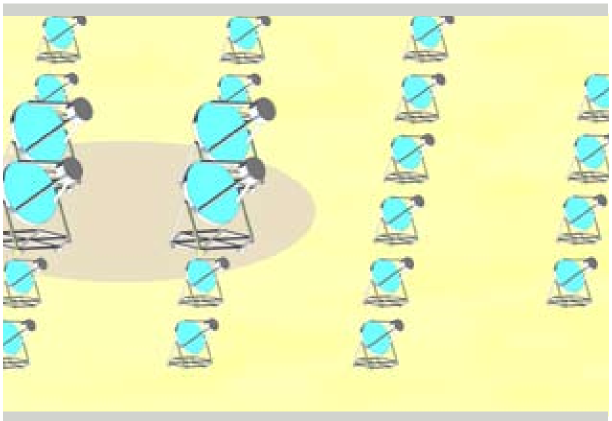
High Intensity Lasers

The frontier of laser science is progressing at an extremely steep gradient in many different directions, opening new perspectives in basic research (ultra-relativistic intensity regime) as well as in applied areas (particle acceleration, development of efficient, compact secondary sources of electrons, ions and photons). The high power, short pulse laser installation **ELI** appears thus appropriate to maintain or even increase the European leadership in this very rapidly evolving domain. Important societal applications will greatly benefit from it (compact accelerators, hadron and radiation therapies, medical imaging, etc.).

CTA – Cherenkov Telescope Array

The facility:

The Cherenkov Telescope Array will be an advanced facility for ground-based high-energy gamma-ray astronomy. With two sites, in both the southern and northern hemispheres, it will extend the study of astrophysical origin of gamma-rays at energies of a few tens of GeV and above. It will provide the first complete and detailed view of the universe in this part of the radiation spectrum and will contribute towards a better understanding of astrophysical and cosmological processes.



Background:

In the last years the present generation of imaging atmospheric Cherenkov telescopes have allowed the first detailed observations of the sky using gamma-rays of energies of a TeV and above. They have revealed a sky unexpectedly rich in gamma-rays features such as extended sources with complex and resolved structure lining the central band of the Milky Way, and extragalactic sources at very large distances with some showing very fast variability on a time scale of minutes. Extending these observations is an important future avenue of inquiry for astronomy.

What's new? Impact foreseen?

The proposed facility will consist of arrays of Cherenkov telescopes which will increase the sensitivity for observations of distant or faint objects by another order of magnitude, provide better angular resolution and lead to improved images of the structure of gamma-ray sources, allow a wider field of view enhancing all-sky survey capability and the study of transient phenomena, enhance all sky survey capability, and have wide and uniform coverage for gamma-ray energies from tens of GeV to hundreds of TeV. The array will be built at two separate sites, one in the southern hemisphere with wide gamma-ray energy range and high resolution to cover the plane of the Milky Way, and the second in the northern hemisphere specialised for lower energies, which will focus on extragalactic and cosmological objects.

The CTA will investigate cosmic non-thermal processes, in cooperation with observatories in other wavelength ranges of the electromagnetic radiation spectrum, as well as with those using other messenger types (i.e. neutrino telescopes, cosmic ray arrays). This multi-messenger approach to astronomy will lead to deeper understanding of major astrophysical processes and of the evolution of the universe.

The CTA facility will be operated as a proposal-driven observatory, with a Science Data Centre providing transparent access to data, analysis tools, and user training.

>Timeline.

Technical design and prototype construction 2006-2011; construction 2012-2017; operation 2018 (partial operation starting after 2013); expected lifetime is 20-30 years.

>Estimated costs.

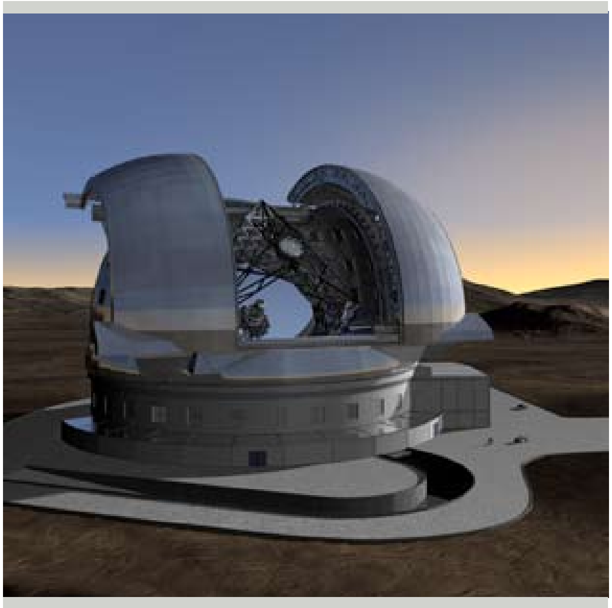
Preparation costs:	~8 M€.
Total construction costs:	~150 M€ (100 M€ for the southern site, 50 M€ for the northern site).
Operation costs:	~10 M€/year.
Decommissioning costs:	~10 M€.

>Website: http://www.mpi-hd.mpg.de/CTA

E-ELT – European Extremely Large Telescope

The facility:

ELTs are seen world-wide as one of the highest priorities in ground-based astronomy. They will vastly advance astrophysical knowledge allowing detailed studies of inter alia planets around other stars, the first objects in the Universe, super-massive Black Holes, and the nature and distribution of the Dark Matter and Dark Energy which dominate the Universe. The 42m European Extremely Large Telescope (E-ELT) project will maintain and reinforce Europe's position at the forefront of astrophysical research.



Background:

Extremely Large Telescopes allow the next major step in addressing the most fundamental properties of the universe. All areas of known astronomy, from studies of our own solar system to the farthest observable objects at the edge of the universe, will be advanced by the enormous improvements attainable in collecting area and angular resolution. Following a resolution by the ESO Council in 2004 instructing ESO to ensure European leadership in ground-based optical/near infrared astronomy in the ELT era, ESO completed at the end of 2006 the Reference Design of the 42 meter European Extremely Large Telescope (E-ELT). In parallel, the E-ELT's scientific case has been developed and is being refined by the astrophysical community through the EC-funded OPTICON program as well as by various ESO Committees. Major enabling technologies are being pursued by European research institutes and high-tech companies within the ELT Design Study FP6 project, with ESO and the Commission as the main funders. These efforts are conducted in close contact with the other similar projects all around the world.

What's new? Impact foreseen?

Astronomy is a technology-enabled science. Recent technology developments, especially in real-time control of complex systems, now allow the next generation of telescopes to be built. Improvements in light collection and spatial resolution, needed to go from the present 8-10 metres to over 30 metres in diameter, will improve on current limits by tens to hundreds of times, providing the critical increase in sensitivity and resolution to solve outstanding scientific questions and almost certainly open new ones. Astronomy is known to be the most effective topic attracting young people to science and technology careers. Astronomical telescopes, being large precision opto-mechanical systems in hostile environments, develop advanced technologies in many state-of-the-art areas with spin-offs ranging from medicine to image data processing.

>Timeline.

ESO is currently undertaking a 3-year 57 M€ detailed design study. The preparatory and design phase of the E-ELT will last until 2009, with final site selection in 2010. Construction is expected in the period 2010-2017.

>Estimated costs.

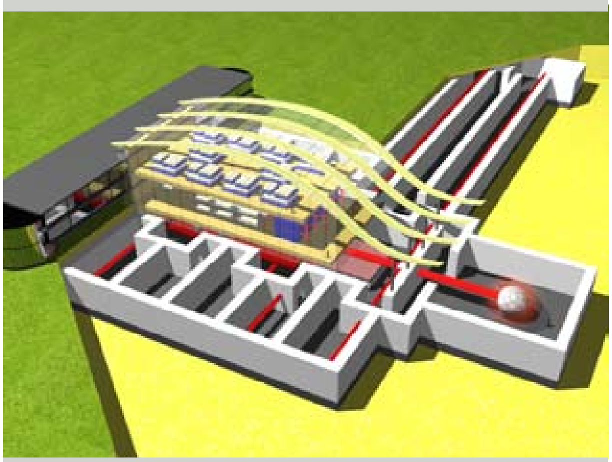
Preparation costs:	100 M€ is covered mainly by ESO, with additional funding by the EU.
Total construction costs:	950 M€, including 1st instrument complement.
Operation costs:	30 M€/year.
Decommissioning costs:	to be evaluated following negotiations with the host country.

>Website: http://www.eso.org/projects/e-elt/

ELI – Extreme Light Infrastructure

The facility:

ELI will be an international research infrastructure open to scientists dedicated to the investigation and applications of laser matter interaction at the highest intensity level, i.e. more than 6 orders of magnitude higher than today's state of the art. ELI will comprise three branches: ultra high field science that will explore laser matter interaction up to the nonlinear QED limit including the investigation of pair creation and vacuum structure; attosecond laser science designed to conduct temporal investigation at the attosecond scale of electron dynamics in atoms, molecules, plasmas and solids; lastly, the high energy beam facility devoted to the development of dedicated beam lines of ultra short pulses of high energy radiation and particles up to 100GeV for users.



Background:

Laser intensities have increased by 6 orders of magnitude in the last few years. These are now so large that the laws of optics change in a fundamental way. This new optics field is called relativistic optics. Among the important by-products of this field are the generation of particle, x-ray and gamma-ray beams. The wealth of discoveries made in the relativistic regime justifies going further to the ultra-relativistic regime. One important aspect of ELI is the possibility to produce ultra-short pulses of high energy photons, electrons, protons, neutrons, muons, and neutrinos in the attosecond and possibly zeptosecond regimes on demand. Time-domain studies will allow unravelling the attosecond dynamics in atomic, molecular physics and plasma physics.

What's new? Impact foreseen?

ELI will be the first facility in the world dedicated to laser-matter interaction in the ultra-relativistic regime, providing unprecedented intensity levels. It will be the gateway to new regimes in physics. At the same time, it will also promote new technologies such as relativistic microelectronics with the development of compact laser-accelerators delivering >100GeV particles and photon sources. ELI will have a large societal benefit in medicine with new radiography and hadron therapy methods, in material sciences with the possibility to unravel and slow down the ageing process in a nuclear reactor and in environment by offering new ways to treat nuclear waste. The completed machine will provide laser pulses with a peak power above 200PW, a power level 200000 higher than the power of the entire European electric grid, but only for a millionth of a billionth of a second.

>Timeline.

ELI is in its preparatory phase for the next two years, followed by two years of design study and a five year construction period. The conceptual design calls for construction in three stages. The first pulses at the 100 TW level will be available for users at the end of the second construction year, while the next stage, providing pulses with a few PW level, will operate from the fourth construction year.

>Estimated costs.

Preparation costs:	85 M€.
Total construction costs:	400 M€.
Operation costs:	50 M€/year.
Decommissioning costs:	30 M€.

>Website: www.eli-laser.eu

FAIR – Facility for Antiproton and Ion Research

STARTED

The facility:

FAIR will provide high energy primary and secondary beams of ions of highest intensity and quality, including an "antimatter beam" of antiprotons allowing forefront research in five different disciplines of physics. The accelerator facility foresees the broad implementation of ion storage/cooler rings and of in-ring experimentation with internal targets. Two superconducting synchrotrons will deliver high intensity ion beams up to 35 GeV per nucleon for experiments with primary beams of ion masses up to Uranium and the production of a broad range of radioactive ion beams.

Background:

The concept for the Facility for Antiproton and Ion Research (FAIR), planned for construction at the GSI Laboratory in Darmstadt, Germany, has been developed by international working groups. In 2001, GSI, together with a large international science community, presented a Conceptual Design Report (CDR). Following an in-depth evaluation by the German Wissenschaftsrat (the science advisory committee of the German government) and its recommendation to realise the facility, the German Federal Government announced in February 2003 approval of the project, with Germany providing up to 75% of the needed funding. Since 2004 the FAIR project is governed by the International Steering Committee with 14 countries participating as members, which declared to participate in the construction and operation of the facility. The FAIR project developed significantly since the CDR. About 2500 scientists from 44 countries submitted Letters of Intent in 2004 and Technical Proposals in 2005 for the experiment programs at FAIR. Significant R&D has been carried out and detailed design has been developed. A large fraction of this effort is funded by the European Commission. The 3500-page long FAIR Baseline Technical Report was published in April 2006.

What's new? Which impacts?

FAIR has a broad scientific scope allowing forefront research in nuclear structure physics and nuclear astrophysics with radioactive ion beams, QCD studies with cooled beams of anti-protons, physics of hadronic matter at the highest baryon density, plasma physics at very high pressure, density and temperature, atomic physics and applied sciences. It will provide the European science communities with a world-wide competitive facility. The central program, nuclear physics, is in its totality of first class internationally. FAIR is also unique in areas such as highly-compressed intense heavy-ion beams for plasma physics, and in its unparalleled research program with cooled antiproton beam and internal-target storage-ring capabilities for QCD studies.

>Timeline.

The start of the construction is projected for 2009, following the political declaration launching the project in November 2007 and the expected signature of the legal documents and establishment of the FAIR Company with international participation towards the end of 2008. The initial agreement is expected to cover a start-up version of the facility, while additional contributions (also from additional partner countries) will be sought to complete the full facility by 2015. The full performance with the parallel operation of all experimental programs will be reached in 2016.

>Estimated costs.

Preparation costs:	~120 M€.
Total construction costs:	~1187 M€ (total investment, plus costs for manpower - price index 2005).
Operation costs:	120 M€/year (price index 2005).
Decommissioning costs:	to be estimated.

>Website: http://www.gsi.de/fair/index_e.html

KM3NeT – Kilometre Cube Neutrino Telescope

The facility:

KM3NeT will be a deep-sea research infrastructure in the Mediterranean Sea hosting a cubic-kilometre sized deep-sea neutrino telescope for the astronomy based on the detection of high-energy cosmic neutrinos and giving access to long-term deep-sea measurements.

Background:

Since they are not deflected and can travel cosmological distances without absorption, neutrinos are ideal messengers for studying the highest-energy, most violent processes in the universe. However, due to their weak interaction with ordinary matter, huge detectors are required to measure them. Several first generations of such neutrino telescopes in the Mediterranean Sea are currently in operation or under construction. However, only future installations of cubic-kilometre size will exploit the full scientific potential of neutrino astronomy. These installations can be built in synergy with environmental observation underwater stations such as EMSO.

What's new? Impact foreseen?

The KM3NeT neutrino telescope will be the leading European facility for neutrino astronomy. It will be the only deep-sea installation of this size in the world and only be complemented by the US-led IceCube project currently under construction in the Antarctic ice at the South Pole. Compared to IceCube, KM3NeT will determine direction and energy of the neutrinos with higher precision, it will have a significantly higher sensitivity for source detection and it will have the major advantage of being able to observe neutrinos originating from the central region of the Milky Way. The design of KM3NeT poses substantial challenges concerning e.g. photo-detection, data acquisition and processing, deep-sea technology, installation and maintenance procedures, cost effectiveness and stability of operation. These issues are being addressed in a FP6 design study (2006-9), building on technology at the forefront of science. KM3NeT will be a truly interdisciplinary research infrastructure: It will provide access to neutrino observations for the astronomy, astrophysics, astroparticle and particle physics communities and, in addition, allow for long-term measurements in the deep-sea environment that are of utmost interest for biologists, geophysicists and oceanographers.

>Timeline.

By 2009, the design study will culminate in a Technical Design Report laying the technical foundations for the construction of the KM3NeT infrastructure. A 3-year preparatory phase project started in March 2008. Thereafter, 4 to 5 years time will be required to establish funding, for industrialisation and deployment.

>Estimated costs.

Preparation costs:	Design Study 20 M€; preparatory phase 12 M€.
Total construction costs:	a solid estimate of the construction cost will result from the design study; the objective is to achieve a price tag of 200 M€ or below for a cubic-kilometre installation (salaries not included).
Operation costs:	~5 M€/year.
Decommissioning costs:	~5 M€.

>Website: http://www.km3net.org/

PRINS – Pan-European Research Infrastructure for Nanostructures

The facility:

The Pan-European Research Infrastructure for Nano-Structures (PRINS) is the research infrastructure arm of a broader initiative, the ENIAC European Technology Platform. PRINS will bridge the area between research and market-driven applications and provide Europe with the ability to master the revolutionary transition from Microelectronics to Nano-electronics, i.e. down to the level of individual atoms.

Background:

PRINS has been conceived as a distributed infrastructure based essentially in 3 European countries (Belgium, France and Germany) that will jointly address the new challenges in a coordinated and complementary way. Academic access to these pre-existing centres of excellence (IMEC, CEA-LETI and Fraunhofer Group for Microelectronics, respectively) will be put under a common umbrella. These three scientific and technical integration centres will be supported by a complementary network of flexible rapid-prototyping laboratories. Their role will be the validation of innovative device and materials steps in the nano-scale CMOS and beyond-CMOS areas as well as More-than-Moore.

What's new? Impact foreseen?

PRINS will enable European research to move into the ultimate scaling of electronic components, the combination of digital signal processing with other types of functionality, the exploration of novel device concepts and the integration of components and materials into Systems in a Package (SiP). PRINS will contribute to realising the goals of the ENIAC Strategic Research Agenda. It will bring together an unprecedented array of equipment and know-how in topics like high-resolution lithography, advanced process steps and modules, electronic systems integration, imaging devices, silicon-based micro-systems, and miniaturized devices addressing the nano-bio convergence. It will give a boost to European RTD performance in the area of Nano-electronics and combined Nano-Structures. The applications that PRINS will generate will serve the future demands of European society, will increase high-skilled employment, will reinforce the competitiveness of European industry and will secure global leadership in high-tech multidisciplinary research.

>Timeline.

The PRINS project is now executing the preparatory phase, to define the operational modes and required infrastructure at the three integration centres. The latter will be built in a modular way in the period 2009-2015. The infrastructure will be partly operational in 2009, while major additional research equipment will be brought in until 2015, in response to quickly changing needs and new technologies becoming available.

>Estimated costs.

Preparation costs:	3.5 M€.
Total construction costs:	1400 M€.
Operation costs:	300 M€.
Decommissioning costs:	not applicable.

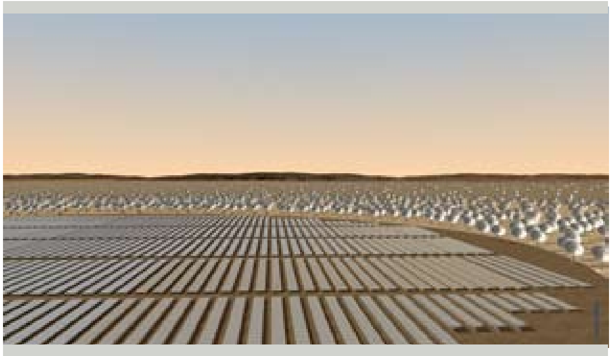
>Website: www.prins-online.eu

SKA – Square Kilometre Array

GLOBAL

The facility:

The Square Kilometre Array will be the next generation radio telescope. With an operating frequency range of 70 MHz - 25 GHz and a collecting area of about 1.000.000 m^2, it will be 50 times more sensitive than current facilities. With its huge field-of-view it will be able to survey the sky more than 10,000 times faster than any existing radio telescope. The SKA will be a machine that transforms our view of the universe.



Background:

The development of radio telescopes and radio interferometers over recent decades has helped drive a continuous advance in our knowledge of the universe, its origins and evolution, and the enormously powerful phenomena that give rise to star and galaxy formation. Radio astronomy also provides one of the most promising search techniques in humanity's quest to determine if life exists elsewhere in the universe.

What's new? Impact foreseen?

The huge collecting area of the SKA will result in sensitivity 50 times greater than any existing interferometer, a requirement to see the faint radio signals from the early universe. The radically new concept of an "electronic" telescope with a huge field-of-view and multiple beams will allow very fast surveys. The SKA will be the most sensitive radio telescope ever built and will attack many of the most important problems in cosmology and fundamental physics. Observations of pulsars will detect cosmic gravitational waves and test Einstein's General Theory of Relativity in the vicinity of black holes. The SKA will study the distribution of neutral hydrogen (the most common element in the universe) in a billion galaxies across cosmic history, thus making it possible to map the formation and evolution of galaxies, study the nature of dark energy and probe the epoch when the first stars were born. The SKA will be the only instrument that will map magnetic fields across the universe, allowing us for the first time to study the nature of magnetism. Last but not least, the SKA will study the formation of planetary systems and address the question "does life exist elsewhere in the Universe?"

>Timeline.

Preliminary design and technology development: 2000-2007; costed system design from 2008-2012. Phase 1 construction and first data: 2012-2016, completion of the full SKA at low and mid frequencies (up to 10 GHz): 2016-2020; construction of high frequency segment: post-2020.

>Estimated costs.

Preparation costs:	~150 M€.
Total construction costs:	~1500 M€ (low and mid frequencies). Cost of the high frequency segment to be defined.
Operation costs:	100-150 M€/year.
Decommissioning costs:	to be defined during the preparatory phase.

>Website: http://www.skatelescope.org/

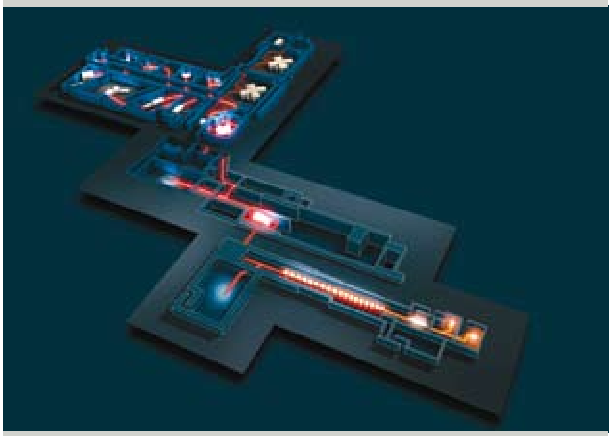
>Physical Sciences and Engineering

SPIRAL2

STARTED

The facility:

SPIRAL2 is a new European facility to be built at GANIL laboratory in Caen, France. The project aims at delivering stable and rare isotope beams with intensities not yet available with present machines. SPIRAL2 will reinforce the European leadership in the field of nuclear physics based on exotic nuclei.



Background:

The frontier of nuclear physics is advancing through the study of nuclear reactions between diverse types of stable and rare isotope ions, covering the widest possible range of different nuclei and energies. The approach of SPIRAL2, complementary to that of FAIR, is based on the ISOL (Isotope Separation On Line) technique and aims at two orders of magnitude increase of the rare isotope beams available for nuclear physics studies. The SPIRAL2 facility will produce beams of excellent optical quality for moderately short-living radioactive nuclei in the energy range from 30keV to 20 MeV/nucleon.

What's new? Impact foreseen?

The scientific programme, prepared by a team of six hundred world class specialists, proposes the investigation of the most challenging nuclear and astrophysics questions aiming at the deeper understanding of the nature of matter. SPIRAL2 will contribute to the physics of nuclei far from stability, nuclear fission and fusion based on the collection of unprecedented detailed basic nuclear data, to the production of rare radio-isotopes for medicine, to radio-biology and to material science. The SPIRAL2 project is an intermediate step toward EURISOL, the most advanced nuclear physics research facility presently imaginable and based on the ISOL principle. It is expected that the realisation of SPIRAL2 will substantially increase the know-how of technical solutions to be applied not only for EURISOL but also in a number of other European and world projects. The current negotiations with international partner countries should allow them to join the ongoing construction and future operation phase, turning the present GANIL facility into a fully international legal entity.

>Timeline.

The construction will last about seven years (2006-2013).

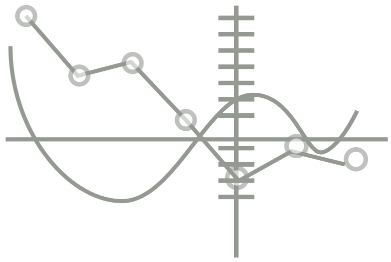
>Estimated costs.

Preparation costs:	8.8 M€.
Total construction costs:	196 M€.
Operation costs:	~6.6 M€/year.
Decommissioning costs:	10 M€.

>Website: http://www.ganil.fr/research/developments/spiral2/

>e-Infrastructures

e-Infrastructures are critical to all projects in this roadmap. The expanding use of e-infrastructures will rapidly change the landscape of science. Remote access to computing services, new instrumentation and virtual organisations in general, creates new opportunities for researchers to bring existing applications to higher levels of usability and performance. Additionally, it enables researchers to deploy new strategies in approaching scientific problems with simulation tools and intensive applications. Young people will be growing up in this "Virtual Research Environment" and research training will need to reflect this.



e-Infrastructures stimulate the identification and creation of new scientific communities, uniting researchers who are working on similar challenges and are willing to share resources and reach new levels of collaboration. Researchers can gain access to scientific data and instruments located in top level laboratories around the world without the need to travel.

The emergence of virtual organisations distributed throughout the world, helps researchers to share resources and to strengthen collaboration on common issues. Widespread use of e-infrastructures represents also an effective answer to problems such as the digital divide and brain drain. This is demonstrated by the Large Hadron Collider at CERN, which is serving the worldwide community of particle physicists.

The major components of e-infrastructures are communication networks, distributed grids, high performance computing facilities and digital repositories. The e-infrastructure viewpoint is to consider them as a fully integrated system. There are many interdependencies between the components, so their evolutions should be planned in a highly consistent manner.

At the European level, the e-IRG (e-Infrastructure Reflection Group) has a mandate to define a common policy for accompanying the development of e-infrastructures and works closely with ESFRI to ensure a common approach.

However, the project also covers a number of other activities relating to ICT research networking. These include network testing, development of new technologies and support for large scale research projects with specific networking requirements. As a hybrid network, recognised as the most powerful academic network in the world, it provides standard connectivity based on Internet protocols and end-to-end services for large scale research projects.

Communication networks

The European communication network for research relies on the existence in all Member States of a National Research and Education Network (NREN), which is in charge of each country's national infrastructure. NRENs are responsible for organising the connectivity of all academic communities in their country. They are also partners of the EC funded GEANT network, which interconnects all partners (EU Member States and Associated Countries), and provide very high bandwidth connectivity to all other academic networks in the world. Associated with GEANT, there are a number of networks which bring connectivity of Europe scientific communities to regions which are less organised in terms of academic networking, like the Mediterranean, South and Latin America and Asia-Pacific regions.

The GEANT network - a multi-gigabit pan-European data communications network, is dedicated to research and education use.

Among projects benefiting from end-to-end services, the CERN LHC Computing Grid (LHC-LCG) is certainly one of the most challenging services, as it aims to distribute an unprecedented amount of data, generated by the four LHC experiments to the worldwide distributed particle physicist community. Another example of such large scale project is DEISA, which interconnects the biggest high performance computing centres in Europe, to allow them to operate as a unique high performance computing resource for cutting edge simulation requirements. A third example is the Very Long Baseline Interferometry (VLBI) network, which allows the interconnection of many radio-telescopes in the world, bringing all radio-images on a single correlator to produce the finest sky imaging in real time.

Distributed GRID infrastructures

One of the most significant news in the outline of global e-infrastructures is the so-called "**grid paradigm**", a revolutionary distributed environment for sharing computing and storage resources, allowing new methods of global collaborative research.

A large number of international GRID projects are underway, with different purposes and concern a large variety of categories of users and applications. An example is the Enabling GRIDs for E-science in Europe (EGEE), which brings together scientists and engineers from more than 240 institutions in 45 countries world-wide to provide a seamless GRID infrastructure for e-science that is available to scientists 24 hours-a-day. Originating from two different scientific fields, high energy physics and Life Sciences, EGEE now integrates applications from many other scientific fields. In addition, there are several applications from the industrial sector running on the EGEE GRID, such as applications from oil and plastic industries.

High performance computing facilities

The resources for high performance computing are the third component of the e-Infrastructures. There is a fundamental difference between capacity and capability in terms of computing resources. GRID infrastructure is a good answer for capacity, for which the aggregated power of many processors is the measure of the total capacity of the computing infrastructure.

A different aspect is capability computing. In this case, not only the power and/or the number of processors are relevant, but also the system architecture, and especially the size of the core memory and the throughput bandwidth between the computing engine and the memory are of vital importance for performance. Examples of disciplines for which capability computing is needed are weather forecasting, climatology, fluid and plasma dynamics, combustion, nuclear fusion.

The European project called **PRACE**, **(Partnership for Advanced Computing in Europe)**, (EU-HPC in the 2006 roadmap) aims at implementing, within Europe, such configurations with a new operational model where demands for using the resources will be evaluated at a European scale.

These pan-European resources are complemented by existing national resources, such as BSC in Spain, CSC in Finland, IDRIS in France, SARA in Netherlands or Jülich in Germany. Most of these centres are already operating as a network of supercomputers, through the project DEISA.

Digital repositories

Digital repositories are the fourth component of the e-infrastructures. Data in their various forms (from raw data to scientific publications) will need to be stored, maintained and made available and openly accessible to all scientific communities. ESFRI has produced a communication on digital repositories, which highlights the key ingredients required from such repositories:

- Availability
- Permanency
- Quality
- Right of use
- Interoperability.

All e-Infrastructure components are transverse to serve all research infrastructures. Only one of them, PRACE, aimed at providing the European research community with world-class computing power, has been reviewed exclusively by the e-Infrastructure Working Group.

PRACE (ex EU-HPC) – Partnership for Advanced Computing in Europe

The facility:

The Partnership for Advanced Computing in Europe (PRACE) is a European strategic approach to high-performance computing. It concentrates the available resources in a limited number of world-class top-tier centres in a single infrastructure connected to national, regional and local centres, forming a scientific computing network to utilize the top-level machines. This overall architecture will respond both to capability and capacity computing needs. Different machine architectures will fulfil the requirements of different scientific domains and applications. This can be represented as a pyramid, where local centres would constitute the base of the pyramid, national and regional centres would constitute the middle layer and the high-end HPC centres would constitute the top.

Background.

The dramatic growth in the available processing power, memory, and data transmission capabilities has revolutionised many aspects of science. In many application areas, computation is the essential method for achieving high-quality results. Examples include climate research, earth science, nanotechnology, computational chemistry, high-energy physics, nuclear fusion, and life sciences. The European research community needs access to adequate computational facilities in order to stay at the forefront of research.

What's new? Impact foreseen?

Effective mechanisms for the allocation of computing time will avoid a fragmented use of the top level computers and speed up adaptation/ development of codes and algorithms for the new computers: an essential step for their effective use. High-performance computing has a strong impact in terms of maintaining the strategic competitiveness of Europe and increasing its attractiveness for foreign researchers and for supporting industrial development. Due to the rapid evolution, the commercially available hardware for High Performance Computing has a short life cycle. Therefore, the large investments in the field need to be carefully planned. The high-end resources should be replaced every 2-3 years with supporting actions in the national and regional centres to maintain the transfer of knowledge.

>Timeline.

The preparatory phase spans 2008-2009. Construction will take the form of continuous upgrade of the high end infrastructure including several installations, of different architectures in different locations, starting in 2009-2010.

>Estimated costs.

Preparation costs:	20 M€.
Total construction costs:	High-end (capability) infrastructure 200-400 M€ every 2-3 years.
Operation costs:	50-100 M€/year. In addition, software development and optimisation and training will require 30-50 M€/year.
Decommissioning costs:	not applicable.

>Website: http://www.prace-project.eu/

>What next?

Implementation of the roadmap: a top priority

Top priority for the next few years will be the implementation of the projects presented in this roadmap.

ESFRI will therefore concentrate on the timely implementation of new research infrastructures, in addition to increasing the effective use of existing ones, thus contributing to a more integrated and effective European Research Area.

Reinforcing international dialogue

The roadmap process has raised strong awareness and expectations at the political level, as shown by the recent recommendations from different Councils of Ministers.

Following the first meeting of the G8 Science Ministers in June 2008, an ad-hoc group of senior officials has been formed to discuss:

- The state of play of national roadmaps and priority setting;
- An overview of existing global projects and their technical, financial and legal issues;
- Identification of possible new areas of cooperation ("gap analysis");
- Promotion of mutual use of existing research infrastructures.

ESFRI will follow the process with great interest and assist where needed.

A European legal framework for European research infrastructures

It is essential that a decision is taken at Council level before the beginning of 2009 to allow implementation of this new legal structure. A future task of ESFRI could be to assist with the assessment of the appropriateness of granting the legal label.

Increased attention to management of research infrastructures

The management of research infrastructures is increasingly becoming complex. It is therefore crucial that managers and decision-makers are trained to cope with the demands of these facilities at all levels. In answer to these increasing needs, training activities related to the management of research infrastructures will start soon.

Better involvement of industry

The issue of better interaction with industry will be given continued attention by ESFRI in the years to come. In this context, dialogue with industry-related EC programs, e.g. the Joint Technology Initiatives, is ongoing. ESFRI has paid specific attention to this and adopted a proactive role by asking the coordinators of the Joint Technology Initiatives and Technology Platforms to send proposals directly to ESFRI for possible insertion in the roadmap.

Making the socio-economic case

Policy makers increasingly want to know the socio-economic returns in the regions hosting a research infrastructure. These aspects are still very rudimentary, and ESFRI will act to understand and improve them.

Better foresight

In order to further strengthen the description of the landscapes, ESFRI will encourage the scientific communities to carry out foresight studies in the different fields of science.

Efficient use of the e-infrastructures

One of the real challenges for research, and especially for research infrastructures, is the explosion of data to be stored, maintained and accessed. Researchers will face the need to deal with the production and use of unprecedented quantities of scientific data, from those coming directly from facilities to those contained in scientific publications. ESFRI intends to prepare a long term strategy for those specific actions needed to support the most efficient use of the e-infrastructures. The availability and use of data will then evolve into an overall knowledge infrastructure.

Demonstration facilities

ESFRI will develop a deeper view on the concept of R&D infrastructures including technological test/demonstration facilities by a careful assessment of the balance between Research and Development, both in terms of initial design and operation.

The analysis of some proposed projects points to a basic difference between research infrastructures designed and managed for service to knowledge production, which address the discovery of previously unknown quantities (i.e. research), and test and/or demonstration facilities addressing the need to experiment technological solutions, aiming at the improvement of their technical and economic performance and reliability (i.e. experimental development).

A further update of the roadmap in the energy field

Considering the strategic importance of the European energy research agenda, ESFRI will continue and strengthen its dialogue with the countries and institutions proposing new research infrastructures of European relevance in the energy field, to be considered as soon as possible for a new update of the ESFRI roadmap.

ESFRI will also adopt a proactive role with other fields not yet fully covered by the roadmap but connected to major ongoing challenges, such as Environment and Food supply. Additionally, ESFRI will try to identify specific needs for new research infrastructures and integrate different types of infrastructures in a multidisciplinary effort.

Space Council Conclusions, 21-22 July 2008:

EU Ministers in charge of space affairs meeting on 21-22 July 2008 in Kourou, French Guiana, discussed a French initiative to establish a European climate research centre to better exploit the data collected via meteorological satellites and bring together European climate change researchers. Ministers decided that no separate new centre was necessary, and stressed that cooperation between national activities in this regard would be strengthened within the framework of the European Strategy Forum on Research Infrastructures (ESFRI).

The regional dimension

ESFRI will monitor and support the balanced involvement of all European Countries in the construction and operation of research infrastructures on the roadmap as well as the development of associated regional partner facilities.

>Glossary

Antiproton is the antiparticle of the proton. Antiprotons are short-lived in nature, since any collision with a proton will cause both particles to be annihilated in a burst of energy. Their formation requires energy equivalent to a temperature of 10 million °C.

Atomic force microscope (AFM) is a very high-resolution type of scanning probe tunnelling microscope. The Tunnelling Microscope was invented by Binnig, Quate and Gerber in 1985, and is one of the most advanced tools for the manipulation of matter at nanoscale.

Biobank. A biobank is a repository for human cells, tissues, blood or DNA, which can be linked to data and information on the respective donors. The data could contain information on health and life style. Biobanks are thus key resources to be used for epidemiological studies e.g. trying to identify factors determining the development of multifactorial diseases.

Bioinformatics is a scientific discipline that comprises all aspects of the gathering, storing, handling, analysing, interpreting and spreading of biological information. It involves computers and the development of innovative programmes which handle vast amounts of coding information on genes and proteins from genomics programmes.

Chemical biology is a discipline that studies effects of small molecules on biological processes. Small molecules with specific biological properties may be designed or may be discovered by screening. The approach is highly interdisciplinary and can involve the interaction of, for example, synthetic chemists with protein engineers.

Clinical research is the research based on humans for answering questions about health and disease. This includes the study of individual patients and populations as well as of biological samples and personal data from these patients. It also includes research related to a disease on healthy individuals.

Clinical trials are studies to evaluate the effectiveness and safety of medications or medical devices by monitoring their effects on large groups of people.

Data curation corresponds to all the actions needed to maintain digital research data and other digital materials over their entire life-cycle and over time for current and future generations of users. This covers the processes of digital archiving and preservation but it also covers all the processes needed for good data creation and management, and the capacity to add value to data to generate new sources of information and knowledge.

DNA (DeoxyriboNucleic Acid) is the molecule that carries the genetic information specifying the biological development of all cellular forms of life (and many viruses).

Electron microscope is a microscope using electrons as probes that can magnify very small details with high resolving power due to the very small size of electrons. Its magnifying levels reach the atomic definition (the nanometre).

ERA – The European Research Area is a vision for pan European organisation and co-ordination of scientific research allowing the EU to compete effectively in the global knowledge economy.

FEL - a free electron laser generates tuneable, coherent, high power collimated light, currently ranging in wavelength from millimetres to the ultraviolet. While a FEL laser beam shares the same optical properties as conventional lasers such as coherent radiation, the operation of a FEL is quite different. Unlike gas or diode lasers which rely on bound atomic or molecular states, FELs use a relativistic electron beam as the lasing medium, hence the term free-electron. Free electron lasers can be used to generate radiation from the terahertz to the hard x-rays range.

Galileo is the satellite navigation system, to be built by the European Union (EU). The system should be operational by 2010.

Gene. A gene is a sequence of DNA (see above) that represents a fundamental unit of heredity.

Genomics, or genomic research, is the study of the complete genetic information (DNA and genes, see above) in a living organism (humans, animals, plants…).

Functional genomics is the knowledge that converts the molecular information represented by DNA into an understanding of gene functions and effects.

Global Science Forum is a specific body of the OECD, gathering 30 member countries, with active relationships to 70 more, sharing a commitment to democratic government and the market economy. Best known for its publications and its statistics, OECD's work covers economic and social issues from macroeconomics, to trade, education, development and science and innovation.

Genotyping is the process of analysing an individual genotype, i.e. the particular genetic variations (polymorphisms) existing in an individual DNA sample.

GMES Global Monitoring for Environment and Security is a joint initiative of European Commission and European Space Agency

High security laboratories are laboratories with the highest level of bio-safety (level 4), for research on pathogens that pose a high risk of aerosol-transmitted infections and life-threatening disease, such as the viruses responsible for the Ebola and Marburg hemorrhagic fevers. These laboratories have special engineering and design features to protect personnel and to prevent microorganisms from being disseminated into the environment.

Hub. A hub is a common connection point for devices in a network. Hubs are commonly used to connect segments of a Local Area Network.

Ion is an atom, group of atoms, or subatomic particle with a net electric charge. The simplest ions are the electron (single negative charge, e–), proton (a hydrogen ion, H+, positive charge), and alpha particle (helium ion, He2+, consisting of two protons and two neutrons)

ITER is an international tokamak experiment designed to show the scientific and technological feasibility of a full-scale fusion power reactor. It builds upon research conducted on devices such as TFTR or JET. The program is anticipated to last for 30 years—10 years for construction, and 20 years of operation. ITER will be built in Cadarache, France.

Laser (Light Amplification by Stimulated Emission of Radiation) is an optical source that emits photons in a coherent beam. Laser light is typically near-monochromatic, i.e. consisting of a single wavelength or hue, and emitted in a narrow beam. This is in contrast to common light sources, such as the incandescent light bulb, which emit incoherent photons in almost all directions, usually over a wide spectrum of wavelengths.

Laser Fusion Source is a potential future and alternative mechanism to generate an intense source of fusion energy and of neutrons. The process is based on the confinement of a fusion fuel, deuterium, within a pellet upon which a very short laser pulse is fired igniting the fuel and generating neutrons through fusion.

Linac - Linear accelerator. A technology that accelerates charged particles to very high speeds, energies, in a straight line using radio waves.

Moderator. A body of material that surrounds the source of neutrons, spallation or fission. Containing light atoms, for example heavy water or methane, the moderator slows neutrons by repeated collisions to deliver the required energy distribution for neutron scattering experimentation.

More-than-Moore is the approach to increase the functionality of the circuits rather than miniaturise them.

Muon (from Greek letter μ) is a semi-stable fundamental particle with negative electric charge and a spin of 1/2. Together with the electron, the tau lepton and the neutrinos, it is classified as part of the lepton family of fermions. Like all fundamental particles, the muon has an antimatter partner of opposite charge but equal mass and spin: the antimuon.

Neutrinos are exotic particles generated in nuclear reactions, for example in the sun, that interact very weakly with matter. Interest in neutrino science stems from the belief that it may answer fundamental questions about the origin and mass of the universe. One route to generating an intense neutrino beam, as a basis for neutrino investigation, is through proton collision with a target.

Neutron. In physics, the neutron is a subatomic particle with no net electric charge and a mass of $1.6749 \times 10\text{-}27$ kg, slightly more than a proton. Its spin is ½. Its antiparticle is called the antineutron. The neutron and proton are instances of a nucleon. The nucleus of most atoms (all except the most common isotope of hydrogen, protium, which consists of a single proton only) consists of protons and neutrons.

Non-invasive imaging refers to the methods used for obtaining pictures or more complicated spatial representations, such as animations or 3-D computer graphics models, from living systems ranging from single cells to model animals cells and internal human body structures. These methods can in particular be based on X-rays, magnetic resonance, ultrasound waves or fluorescence.

Nuclear Magnetic Resonance (NMR) is a physical phenomenon based upon the magnetic property of an atom's nucleus. All nuclei that contain odd numbers of nucleons and some that contain even numbers of nucleons have an intrinsic magnetic moment. The most often-used nucleons are hydrogen-1 and carbon-13. NMR studies a magnetic nucleus, like that of a hydrogen atom, it being the most receptive isotope at natural abundance, by aligning it with a very powerful external magnetic field and perturbing this alignment using an electromagnetic field. The response to the field by perturbing is what is exploited in nuclear magnetic resonance spectroscopy and magnetic resonance imaging.

Nuclear waste transmutation is a process by which the radioactive components of waste arising from, e.g. a nuclear reactor, are changed to non radioactive material by neutron capture or fission.

Pedosphere is the outermost layer of the Earth that is composed of soil and subject to soil formation processes. It exists at the interface of the lithosphere, atmosphere, hydrosphere and biosphere.

Phenotyping is the process of analysing an individual phenotype, i.e. the particular observable characteristics that result from the interaction of an individual genotype with the environment.

Photochemistry, a sub-discipline of chemistry, is the study of the interactions between atoms, small molecules, and light (or electromagnetic radiation).

Photolithography is a process used in semiconductor device fabrication to transfer a pattern from a photo-mask to the surface of a substrate. Often crystalline silicon in the form of a wafer is used as a choice of substrate, although there are several other options including, but not limited to, glass, sapphire, and metal. Photolithography (also referred to as "micro- or "nanolithography") bears a similarity to the conventional lithography used in printing and shares some of the fundamental principles of photographic processes.

Plasma, in physics and chemistry, is typically an ionised gas, and is usually considered to be a distinct phase of matter in contrast to solids, liquids and gases. "Ionised" means that at least one electron has been dissociated from a proportion of the atoms or molecules. The free electric charges make the plasma electrically conductive so that it responds strongly to electromagnetic fields.

Polarisation is a property of waves, important as a specific property of light and other electromagnetic radiation. Unlike more familiar wave phenomena such as water or sound waves, electromagnetic waves are three-dimensional, and it is their vector nature that gives rise to the phenomenon of polarisation.

Polygeneration means an energy supply system, which delivers more than one form of energy to the final user, for example: electricity, heating and cooling.

Positron is the antiparticle or the antimatter counterpart of the electron. The positron has an electric charge of +1, a spin of 1/2, and the same mass as an electron. When a low-energy positron annihilates with an electron, their mass is converted into the kinetic energy of two gamma ray photons.

Proteomics is the study of the structure and function of proteins, including the way they work and interact with each other within the cell and organism.

Scanning Tunnelling Microscope (STM) is a non-optical microscope that scans an electrical probe over a surface to detect a weak electric current flowing between the tip and the surface. The SPM can obtain images of conductive surfaces at an atomic scale 2 × 10–10 m or 0.2 nanometre, and also can be used to manipulate individual atoms, trigger chemical reactions, or reversibly produce ions by removing or adding individual electrons from atoms or molecules.

Social Survey to monitor long term changes in social values throughout Europe and produce data relevant to academic debate, policy analysis and better governance

Spallation is a process in which fragments of material are ejected from a body due to impact or stress. In nuclear physics, it is the process in which a heavy nucleus emits a large number of nucleons as a result of being hit by a high-energy proton, thus greatly reducing its atomic weight.

Structural biology is a branch of biology dedicated to the study of the three-dimensional structures of proteins and other molecules to help understand the function of these molecules in the cell and organism.

Synchrotron. A cyclic accelerator of large radius that can accelerate charged particles, electrons and protons, to very high energy. Synchrotron radiation is generated when charged particles are deflected by magnets or magnetic structures, emitting highly focussed and intense beams covering the range from infrared to x-rays. These beams are used to probe the basic structure of materials.

Synthetic biology is the engineering of biology: the synthesis of complex, biologically based (or inspired) systems which display functions that do not exist in nature, applicable at all levels from individual molecules to whole organisms.

Systematics is in biology the study of the diversity of life on the planet Earth, both past and present, and the relationships among living things through time.

Systems biology is a new field that seeks to bring together information on genes, proteins, interactions and metabolic pathways, to help understand the function of complex cellular systems and of the whole organism. To accomplish this goal, these efforts must also incorporate what we know about biology with expertise in physics, chemistry, mathematics, and the computer sciences.

Translational research is the process of bidirectional transfer of knowledge between basic work (in the laboratory and elsewhere) and that in clinical practice. Translational research ranges from exploring fundamental scientific questions and applying the resulting knowledge to the patient, to bringing insights from studies in the patient back to the laboratory in model systems for further exploration.

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