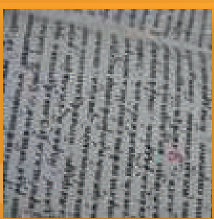
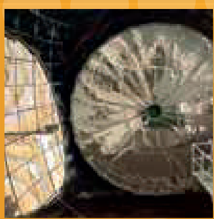
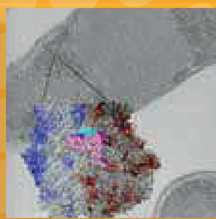
European Strategy Forum
on Research Infrastructures

ESFRI

Strategy Report on Research Infrastructures

Roadmap 2010



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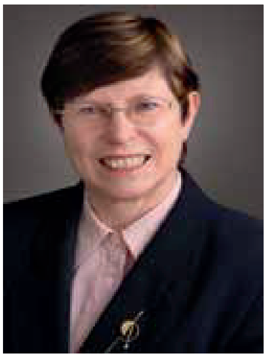
March 2011

European Strategy Forum on Research Infrastructures

ESFRI

Foreword



Dr.-Ing. Beatrix Vierkorn-Rudolph
ESFRI Chair

Dear Ministers,

Dear Commissioners,

It is with great satisfaction and pleasure that ESFRI is now able to inform you that, by the end of 2010, the implementation phase has begun for 10 Research Infrastructures from the ESFRI roadmap. This progress was possible only thanks to the large support ESFRI has received from you over the last few years. The Research Infrastructures now in the implementation phase span the whole range of science and technology, ranging from the Social Sciences and Humanities to Physical Sciences and Engineering. They include distributed Research Infrastructures as well as single sited ones.

Especially in difficult economic circumstances, research and innovation are the key drivers for Europe's welfare. Excellent Research Infrastructures enable the cross disciplinary, frontier research and innovation that is needed to address the Grand Challenges – including the tightening supply of energy, greenhouse gas emissions, and an ageing population.

Research Infrastructures contribute to the implementation of the Europe 2020 strategy and its Innovation Union Flagship Initiative and enable the building up of the European Research Area. They also support the Joint Programming Initiatives by providing researchers with excellent research platforms dealing with pressing societal challenges, and ESFRI uses the same approach of cross-border cooperation in a variable geometry.

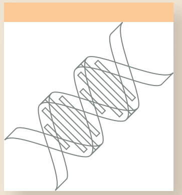
Research Infrastructures also play a crucial role in the training of young scientists and engineers: they attract thousands of scientists and students from universities, research institutions and industry, from Europe and from outside Europe. They guarantee the generation of new ideas and developments which turn into innovations and therefore support the creation of jobs.

ESFRI would like to present you with its Strategy Report and Roadmap Update 2010 and also its "work programme" for the coming years, and would appreciate your support in developing further its vision for Research Infrastructures. We are looking forward to discussions with the Research and Innovation Organisation in Europe and with other European Initiatives.

The landscape and its projects

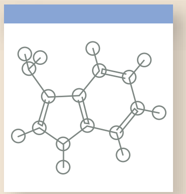
Roadmap 2010

SOCIAL SCIENCES AND HUMANITIES

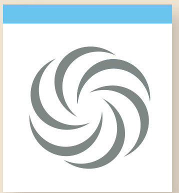


BIOLOGICAL AND MEDICAL SCIENCES

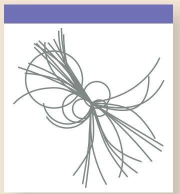
ENVIRONMENTAL SCIENCES



MATERIALS AND ANALYTICAL FACILITIES



ENERGY



PHYSICAL SCIENCES AND ENGINEERING

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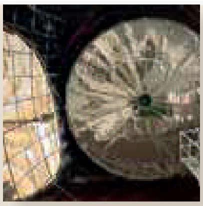
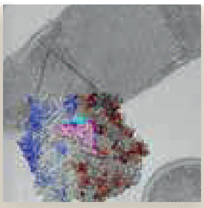



ESFRI Strategy

PART 1

1. Introduction

The success of the European economy is increasingly dependent on scientific and technological innovation. At the same time, we face a growing number of "Grand Challenges" such as global warming, tightening supplies of energy, water and food, or securing quality of life for an ageing population. Progress in all of these areas depends upon strong innovation capabilities that require access to the highest quality Research Infrastructures. Research Infrastructures are a key instrument in attracting and bringing together researchers, funding agencies, politicians and industry to act together and tackle the cross-disciplinary scientific and technical issues of critical importance for our continued prosperity and quality of life.

Research Infrastructures contribute to the implementation of Europe 2020 strategy and its Innovation Union Flagship Initiative, especially in the multidisciplinary domains of the "Grand Challenges". Research Infrastructures enable excellent research not being realisable without the access to these facilities and they provide environments for excellent researchers to do outstanding science at European and international level, contributing to benchmark frontier research. In addition, they also enable research not realisable so far due to a lack of capacities (e.g. lacking opportunities to obtain the necessary mouse mutants, access to research data or beam time at excellent instruments).

Research Infrastructures are facilities, resources or services of a unique nature that have been identified by 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 technology-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 scientific excellence by international peer review.

Furthermore, Research Infrastructures provide unique opportunities to train scientists and engineers while facilitating knowledge, technology transfer and innovation. Research Infrastructures offer stimulating research environments that attract researchers from different countries, regions and disciplines. Thousands of researchers and students from universities, research institutions and industry, from Europe and from outside Europe, use Research Infrastructures each year. About 55% are researchers from universities, 20% are from public laboratories, 20% are from non-European research institutions, and 5% are from industry.

Research and innovation are the key drivers of Europe's future, especially in periods of economic instability. Europe has to make full use of its available talent and resources. To achieve this, every effort should be made to implement the Research Infrastructures on the ESFRI roadmap since they are the guarantee for producing new ideas and developments which turn into innovations and hence, in a longer term, into jobs. It is however necessary to coordinate better and more efficiently the different funding instruments. Therefore ESFRI will enhance its cooperation especially with the Joint Programming Initiatives and the Joint Technology Initiatives to fully exploit the capabilities of these instruments. Likewise, collaboration with other European Research Organisations and with international organisations will be increased. The work already started on evaluation and prioritisation will be continued to develop the necessary methodology to make best use of the existing infrastructures and to fully exploit the capabilities of new ones. It is necessary to improve the coordination of all efforts made at national and European level. Additionally, the concept of Regional Partner Facilities has also to be fully implemented (see also page 17). The suggestion of an increased and more efficient cooperation is fully in line with the recommendations of the European Research Area (ERA) expert group which stated that *"new approaches to European wide collaboration in construction and using Research Infrastructures should be established. Developing distributed pan-European Research Infrastructures, e-infrastructures and related services can be used as a tool for building an efficient and effective ERA" and that "more support should be given by Member States to the development of "Regional Partner Facilities".*

ESFRI, the European Strategy Forum on Research Infrastructures [1], is a strategic instrument created in 2002 by the Member States and the European Commission to develop the scientific integration of Europe and to strengthen its international outreach. ESFRI gives national authorities the opportunity to explore common and integrated activities for the best development and use of Research Infrastructures of pan-European relevance. In this way, ESFRI contributes to the implementation of a critical, strategic part of the Lisbon agenda by integrating

[1] http://ec.europa.eu/research/esfri

national policies and bringing together national and EU resources to develop the European Research Area. **The ESFRI delegates** are nominated by the Research Ministers of the Member States and Associated Countries, and include a representative of the Commission. The delegates work together to **develop a joint vision and a common strategy** including regularly updated Roadmaps, reports and criteria as tools for planning and implementing of new pan-European Research Infrastructures. This strategic approach aims at providing Europe with the most up-to-date Research Infrastructures, responding to the needs of rapidly evolving fields of science, advancing knowledge-based technologies and their extended use. Research Infrastructures are very diverse, in many cases distributed over various sites and increasingly interconnected and supported by the e-Infrastructures, ranging from Human and Social Science libraries, surveys and other data banks, to interconnected Biomedical Sciences laboratories, Environmental Sciences observational networks, Physical, Materials, Astronomical and Engineering Sciences accelerators, synchrotrons, observatories and energy demonstrators.

The Roadmap Mandate

"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 for 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, 25-25 November 2004.

"The Council recommends that ESFRI updates this roadmap at regular intervals in order to cope with the rapid evolution of scientific and technological needs."
Competitiveness Council Conclusions, 21-22 May 2007

The ESFRI roadmap addresses all scientific disciplines that require a large scale Research Infrastructure with a joint effort on European or international scale. In some cases "single sited" Research Infrastructures provide the best solution for the necessary research. In other cases a "distributed" Research Infrastructure is best suited from the scientific viewpoint as well as for the sustainability and optimisation of partially existing resources.

To distinguish between networks or "collaborations" and distributes Research Infrastructures, ESFRI has therefore developed a definition for **European Distributed Research Infrastructures**.

- A **European Distributed Research Infrastructure**, as recognised by ESFRI, is a Research Infrastructure with a common legal form and a single management board responsible for the whole Research Infrastructure, and with a *governance structure* including among others a Strategy and Development Plan and one access point for users although its research facilities have multiple sites.

- It must be of *pan-European interest*, i.e. shall provide *unique* laboratories or facilities with user services for the efficient execution of top-level European research, *ensuring open access* to all interested researchers based on scientific excellence thus creating a substantial added value with respect to national facilities.

- A European Distributed Research Infrastructure must bring *significant improvement* in the relevant scientific and technological fields, addressing a clear integration and convergence of the scientific and technical standards offered to the European users in its specific field of science and technology.

ESFRI has the responsibility to disseminate the roadmap and its updates and to assist the scientific communities with the implementation and use of new Research Infrastructures. The ESFRI delegates play a crucial role in working with Governments and the European Commission to allocate the necessary funding for the Research Infrastructures and to inform at political level of the possibilities to use (for example) structural funds for funding of Research Infrastructures. ESFRI will also discuss with the Commission how the development, operation and sustainability of Research Infrastructures could be addressed within the 8th Framework Programme.

Irrespective of the field of research, pan-European Research Infrastructures, new or existing, must provide:

- **scientific and technological cutting edge and managerial excellence**, recognised at European and international level (in research, education and technology);

- **clear pan-European added value**, linked with facilities which deliver **top-level services** attracting a widely diversified and international community of scientific users; host institutions awarding **open access through international competition on the basis of excellence** (selection by peer review since demand exceeds supply) and results published in the public domain (additional access might be offered either for training or for industrial research, the latter on a payment basis, as a marginal, non economic, activity, not interfering with the peer reviewed access).

2. ESFRI Success Stories: Research Infrastructures in the implementation phase

Since the publication of the first roadmap in 2006 and its update in 2008, 10 projects of the 44 roadmap projects are already in the implementation phase, four of which are distributed Research Infrastructures. These are very diverse in size and character: the construction costs vary between 2 M€ and 1.100 M€, the operation costs between 2 M€ and 120 M€.

The Research Infrastructures in the implementation phase are listed at the end of this section.

Sixteen additional projects are proceeding so well that the start of their implementation could be envisaged by the end of 2012. These projects are marked in light green in the "Quick View" on page 22.

If ESFRI reaches this goal, it will fulfil the commitment in the "Europe 2010 Flagship Initiative – Innovation Union" which stated that *"by 2015, Member States together with the Commission should have completed or launched the construction of 60% of the priority European Research Infrastructures currently identified by the European Strategy Forum for Research Infrastructures (ESFRI)"* [2].

There might be very good reasons, however, why these projects could not reach the implementation phase in the next two years, since the implementation process is always complex and time consuming. The difficult situation which arose in some countries due to the financial crisis could also be a factor influencing the speed and extent of implementation.

[2] COM (2010) 546 final; SE (2010) 1161.

Research Infrastructures in the implementation phase: Social Sciences

CESSDA: Facility to provide and facilitate access of researchers to high quality data for social sciences

CESSDA is a **distributed** Research Infrastructure that provides and facilitates access for researchers to high quality data 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.

Construction costs	Operation costs	Decommissioning
30 M€	3 M€/year	not applicable
Information: Steering committee established, will go for ERIC application soon.		http://cessda.org

European Social Survey: Upgrade of the European Social Survey, set up in 2001 to monitor long term changes in social values

The European Social Survey is an academically driven long term pan-European **distributed** 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, better governance, and as an important resource for the training of new researchers in comparative methods.

©: ESS

Construction costs	Operation costs	Decommissioning
2 M€	2 M€/year	not applicable
Information: Steering committee established, will apply for ERIC status soon.		http://www.europeansocialsurvey.org

SHARE: A data Infrastructure for the socio-economic analysis of ongoing changes due to population ageing

SHARE is a pan-European social science project which was during the preparatory phase centrally coordinated at the MEA Institute in Germany. SHARE ERIC is the upgrade into a long term research infrastructure of a multidisciplinary and cross-national panel database of micro data on health, socio-economic status and social and family networks of about 45,000 Europeans aged 50 or over. The data are harmonised with the U.S. Health and Retirement Study (HRS) and the English Longitudinal Study of Ageing (ELSA) and accessible free of charge to the scientific community.

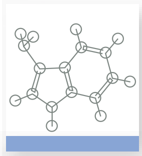
©: Mea SHARE

Construction costs	Operation costs	Decommissioning
23 M€	**1,4 M€/year**	**not applicable**

Information: ERIC application adopted. 5 countries have already signed the ERIC Statutes. 8 more have signed the Memorandum of Understanding and 6 of these have already announced to step into the ERIC-agreement soon. SHARE-ERIC will be seated first in Tilburg, the Netherlands.

http://www.share-project.org

Research Infrastructures in the implementation phase: Materials Sciences



ESRF: Upgrade of the European Synchrotron Radiation Facility

The European Synchrotron Radiation Facility (ESRF), located in Grenoble, France, is a joint facility supported and shared by 17 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.

Construction costs	Operation costs	Decommissioning
241.3 M€	**93.5 M€/year**	**not applicable**

Information: capital costs 241.3 M€ (in 2010 prices), of which 67 M€ from the regular budget, recurrent costs 16.4 M€, personnel costs 18.5 M€. Upgrade ongoing.

http://www.esrf.fr

European XFEL: Hard X-Ray Free Electron Laser

The European X-ray Free Electron Laser, under construction 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.

©: XFEL

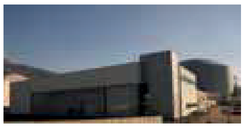
Construction costs	Operation costs	Decommissioning
1082 M€ (incl. commissioning)	**77 M€/year**	**80 M€**

Information: Limited Liability Company under German Law with international partners founded in 2009; Council, Scientific Advisory Committee and Administrative and Finance Committee are working.

http://www.xfel.eu

ILL 20/20: Upgrade of the European Neutron Spectroscopy 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. ILL 20/20 upgrade plans to optimise its potential to deliver to users' needs in the future.



Construction costs	Operation costs	Decommissioning
171 M€	5 M€/year (additional to recurrent costs)	161 M€

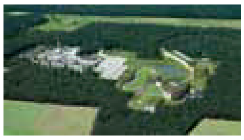
Information: construction costs include 15 M€ of regional and local government funding towards additional infrastructural aspects for the proposed joint site together with ESRF. Upgrade is ongoing.

http://www.ill.eu/science-technology/the-esfri-projects/the-ill-2020-upgrade-project

Research Infrastructures in the implementation phase: Physical Sciences

FAIR: Facility for Antiproton and Ion Research

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. High intensity ion beams up to 35 GeV /nucleon will be delivered.



©: GSI, FAIR

Construction costs	Operation costs	Decommissioning
1027 M€ (2005)	118 M€/year (2005)	to be estimated

Information: Limited Liability Company under German law with international partners founded in 2010; Council and Administrative and Finance Committee are working, the Scientific Council is being assembled in early 2011. Civil construction will start at the end of 2011.

http://www.gsi.de/fair/

SPIRAL2: Facility for the production and study of rare isotope radioactive beams

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.

©: GANIL/Ph. Bisson

Construction costs	Operation costs	Decommissioning
196 M€	10-12 M€/year	to be estimated

Information: The construction phase is being coordinated within a consortium between CNRS, CEA and the region of Basse-Normandie and in collaboration with French, European and international institutions.

http://www.ganil-spiral2.eu/spiral2

Research Infrastructures in the implementation phase: e-Infrastructures

PRACE: Partnership for Advanced Computing in Europe

The Partnership for Advanced Computing in Europe is a European strategic approach to high-performance computing. It concentrates the resources **distributed** 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. 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.	
Construction and operation costs: 100 M€ within the next 5 years + fees	**Decommissioning not applicable**
Information: Company under Belgian Law founded.	http://www.prace-project.eu

Research Infrastructures in the implementation phase: Energy

JHR: High flux reactor for fission reactors material testing

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.		
Construction costs 750 M€	**Operation costs 35 M€/year**	**Decommissioning ~80 M€**
Information: construction costs come from consortium agreement (~500 M€) plus support from French "emprunt national" (~250 M€).		http://www-cadarache.cea.fr/rjh/index.html

National Roadmaps

The publication of the ESFRI roadmap has also stimulated national governments in most of the Member States to develop their national roadmap for Research Infrastructures. Some countries have also earmarked national budgets for large Research Infrastructures, which is necessary to ensure participation in a common pan-European effort. The national roadmaps can be found on the ESFRI webpage (*http://ec.europa.eu/research/infrastructures/index_en.cfm?pg=esfri-other-roadmap*).

In addition, several scientific communities have become increasingly organised and are producing their own roadmaps, where the needs of their disciplines in the short, medium and long term are clearly identified. An authoritative example is the "Strategy for Particle Physics" by the CERN Council, as well as the roadmaps by ASPERA (Astroparticle Physics) and ASTRONET (Astronomy).

3. Vision 2020 of ESFRI

Pan-European Research Infrastructures provide an important contribution to the development of European culture and competitiveness and have a successful track record in taking Europe to the forefront of Science, Technology and Innovation. As part of the European Research Area, many of the ESFRI Research Infrastructures are already providing an environment supporting research to address high priority areas such as the "Grand Challenges". Research Infrastructures can only play this role effectively if they provide a high level of support for users allowing them to perform excellent research. In order to attract and retain world-class scientists, Europe should continue to focus its efforts on the creation of such top level Research Infrastructures and build up their reputation and recognition on an international scale. During the 6th European Conference on Research Infrastructures (ECRI 2010 [3]), ESFRI has re-affirmed that peer reviewed open access is essential to promote excellence.

Therefore, ESFRI proposes a focused and ambitious 2020 vision, which has recently been published [4], to meet major challenges by addressing the following specific actions:

- Evolve better governance and sustainability, by shared evaluation and prioritization of pan-European Research Infrastructures, based on national, international and ESFRI's best practices;
- Consolidate this approach by focusing and increasing European and national funding in support of internationally benchmarked activities;
- Extend inclusiveness and outreach, thus ensuring cohesion and increased growth, and fuel the positive loop between excellence in research and education and relevance for industry, further attracting public-private partnerships and developing high-quality procurements;
- Strengthen the attraction and mobility of human resources, by advanced training of personnel and free movement of knowledge in Europe and from other parts of the world.

[3] ECRI 2010 was organised under the Spanish Presidency of the European Union on 23 -24 March 2010 in Barcelona.

[4] http://ec.europa.eu/research/infrastructures/pdf/esfri/home/esfri_inspiring_excellence.pdf#view=fit&pagemode=none

4. ESFRI's Action Plan

To fulfil its mission, ESFRI has discussed an overall strategy to develop the European Research Area, and Research Infrastructures in particular. This strategy has evolved from discussions within ESFRI and with the ESFRI Thematic Working Groups, as well as with major European Research Organisations. To develop this strategy further, a combination of visionary thinking about the future with practical and achievable steps for the near term is necessary. ESFRI will continue to develop and advocate its vision for Research Infrastructures while working on practical implementation issues including the following:

- Monitoring scientific developments and emerging research challenges also taking innovation into account, and supporting the implementation of as many of the projects on the ESFRI roadmap as possible;
- Developing an evaluation methodology for pan-European Research Infrastructures with the goal that it could also be used for Research Infrastructures of national and regional importance;
- Strengthening cooperation with European research and innovation organisations (EIROForum, EUROHORCS, TAFTIE, ESF, and others);
- Development of closer cooperation and alignment between Joint Programming Initiatives, Joint Technology Initiatives and Research Infrastructures and with initiatives under the umbrella of the European Innovation Partnerships;
- Building up cooperation with European industry;
- Expanding training possibilities and fostering mobility schemes (including also technology transfer issues);
- Addressing the issue of socio-economic impacts;
- Promoting greater regional cooperation;
- Stimulating increased international (global) cooperation, to ensure that the full scientific and educational potential is used by the Member States;
- Supporting and promoting the use and development of e-infrastructures.

Scientific developments and implementation

ESFRI has devoted considerable efforts in recent years to the identification of new or upgraded pan-European Research Infrastructures for the benefit of European research and innovation. In addition, ESFRI has given assistance to consortia in finding new partners, in shaping the research and innovation scope of the respective Research Infrastructures and in helping funding agencies and Ministries to allocate the necessary funding resources. The next four to five years ESFRI will concentrate on the implementation of the different roadmap projects and not extent the project list apart from emerging projects.

The Thematic Working Groups of ESFRI have a special task in the development of the European landscape for Research Infrastructures: they do not only organise and lead the evaluation of new proposals for the incorporation into the roadmap, but also help e.g., with the implementation of the projects by giving advice on issues such as the appropriate legal structure, statutes and funding requirements.

To support the implementation of the roadmap projects, the so-called Preparatory Phase has been introduced by the European Commission. This Phase supports the consortia in all legal, governance, strategic, financial and such technical work as is needed to reach an agreement for the realisation of a specific Research Infrastructure on the ESFRI Roadmap. The Preparatory Phase aims to take the projects to the level of maturity required for their implementation. Most of the Roadmap projects have been selected and supported within the Seventh Framework Programme through Preparatory Phase projects. At the end of 2010, 34 projects have Preparatory Phase projects underway or have already finished their Preparatory Phase. For the additional 10 projects from the 2008 Update of the roadmap, the Preparatory Phase projects are currently in their final stages of negotiation or have already started their work.

This instrument has been quite successful but nevertheless there are still some obstacles in particular regarding rapid implementation of the projects. ESFRI has recognised that the Preparatory Phase project coordinators might need some more help from ESFRI delegates to get in contact with the appropriate funding agencies and Ministries at an early stage, to obtain both the approval of the foundation of the Research Infrastructures and the necessary funding.

This is a task the Thematic Working Groups are already dealing with, and which should be enhanced in future. The coordinators of the Preparatory Phase projects should be invited on a regular basis to the meetings of the Thematic Working Groups to report on the ongoing work and to inform about possible problems so that solutions can be found in time. ESFRI will also establish means to intensify the contacts between the Preparatory Phase Project coordinators and the ESFRI delegates from the potential host country or countries of the Research Infrastructures. It would be appropriate if, in future, the ESFRI delegates of the possible host country or the chair of the respective Thematic Working Group would report to ESFRI about the status of the implementation on a more regular basis. To foster the implementation of the different projects on the ESFRI roadmap the forum is currently reflecting to create a working group for implementation.

One of the main obstacles for the realisation of pan-European Research Infrastructures has been so far the absence of a suitable legal and governance framework at European level. For this reason a new legal structure "**ERIC – European Research Infrastructure Consortium**" has been developed by the European Commission together with ESFRI and was approved by the Council on 25 June 2009 and entered into force two months later. The first ESFRI project, which will have an ERIC legal structure in place, is SHARE which will be registered in the Netherlands. Other projects are expected to follow soon (namely CESSDA, the European Social Survey, ECRIN, BBMRI and Euro-ARGO).

The European Research Infrastructure Consortium (ERIC)

With the support of ESFRI, the European Commission launched a proposal for a Regulation at Community level in July 2008. Following intense discussions at inter-institutional level, this EC-Regulation, defining the European Research Infrastructure Consortium (ERIC), was approved by the Council on 25 June 2009. Since summer 2009, ESFRI has been involved in the refinement of the related guidelines for application, highlighting the need for scientific and technological excellence as well as defending the important role of Research Infrastructures of pan-European interest to foster mobility of researchers within and to Europe.

Evaluation method for pan-European Research Infrastructures

Further development of the European Research Area requires not just the creation of new pan-European Research Infrastructures but also the support of the existing ones. Many of them have so far only had a national or regional importance. To improve the overall situation in Europe and to make best use of limited financial and human resources, an **evaluation and prioritisation scheme** has to be developed to distinguish at least between Research Infrastructures with a real pan-European dimension and others which will remain important for regional and/or national needs and to balance their evolution in view of the scientific landscape.

ESFRI will therefore develop, in collaboration with the relevant European Research Organisations having significant interests in Research Infrastructures (see the next section) a process firstly to evaluate new and existing Research Infrastructures and secondly to develop a prioritisation scheme. Such an evaluation has to be based on the national roadmaps and on national evaluation schemes but has to develop on top of that an evaluation methodology which will allow definition of the criteria for pan-European Research Infrastructures. ESFRI has set up **a working group on evaluation** which is developing such a methodology. ESFRI will discuss this scheme during the coming months with the European Research Organisations and with Organisations which have been involved in evaluation/prioritisation duties for a long time already, such as Research Councils in the different Member and Associated States, funding agencies and organisations representing scientific communities (e.g. NuPECC, ApPEC).

In future, an important evaluation element should also be the "economic cycle" of Research Infrastructures. In the past, a lot of work has already been devoted to the socio-economic benefits of Research Infrastructures, but some new insight is needed to also "measure" the impact of Research Infrastructures for industry due to the large procurement market during the construction of new Research Infrastructures (short and medium-term impact). Also the long-term impact of research and innovation on the development of new products, materials, instruments, services for the use in industry should be considered as one aspect in the evaluation of pan-European Research Infrastructures. Another aspect is the availability of highly specialised and experienced researchers and engineers for industry due to the training possibilities of these facilities.

Strengthening cooperation with other European Research and Innovation Organisations

Recently, it has become clear that a better and **closer cooperation between ESFRI and the European Research Organisations** (such as EIROForum, EUROHORCS, EARTO, ESF, and others) should be established to develop a common vision of the European Research Area and to support the construction and operation of pan-European Research Infrastructures. The first steps in this direction have already been taken. A discussion with EIROForum has taken place with the conclusion that cooperation for **training of engineers and technicians for Research Infrastructures** is urgently needed to secure the necessary support for the operation of Research Infrastructures. The RAMIRI initiative (Realizing and Managing International Research Infrastructures) is a useful step to train managerial staff. An additional scheme should also be developed to help improve the exchange of personnel in the more technical areas. Two meetings between ESFRI and European funding organisations and advisory bodies on Research Infrastructures have taken place and will continue with the aim of exchanging views on coordination needs and feasibility for European Research Infrastructures. Different issues were discussed with the goal of producing a "Declaration of Common Intent". These issues are, as would be expected, very similar to the ones discussed within ESFRI:

- Develop a common approach for evaluation;
- Identify and promote best practices for RI governance including long-term sustainability of resources;
- Human resources and mobility together with training and education needs;
- Improved interactions between the RI providers and the user communities, including industry as user and supplier;
- Management of knowledge and the role of e-Research Infrastructures.

Development of a broad cooperation between Joint Programming Initiatives and Research Infrastructures

In the context of globalisation and the intensification of global competitiveness, Europe has recognised that there are societal challenges which no Member State is capable of solving alone. Therefore the Joint Programming Initiative (JPI) [5] was set up with the aim of increasing the cooperation in R&D between the Member States to better confront the major societal challenges such as an ageing population and stimulating sustainable development. Other issues were combating climate change, securing the supply of energy, preserving human and environmental health, ensuring food quality and availability as well as safeguarding citizen security.

Since ESFRI deals with most of these societal challenges as well and follows the same philosophy of peer review procedures, with a coherent approach for cross-border cooperation in a variable geometry, it is clear that the cooperation between ESFRI and the Joint Programming Initiatives should be increased.

The Pilot Initiative on **Neurodegenerative Diseases**, in particular on Alzheimer's disease, has the objective to pool the resources and better coordinate the research efforts of Member States in this field. The BMS Research Infrastructures contribute in many areas to this initiative via cutting edge bio-imaging tools combined with technologies, methods and (bio-banked) materials, or disease models applicable in diagnostics. SHARE (Survey of Health, Ageing and Retirement in Europe), a Research Infrastructure in the area of Social Sciences and Humanities would be an ideal cooperation partner for this initiative. The BMS and SSH Research Infrastructures can also provide a significant contribution to the Joint Programming Initiative in the area of diet and health – **A Healthy Diet for a Healthy Life**.

The aim of the Joint Programming Initiative in the area of **Agriculture, Food Security and Climate Change** is to integrate adaptation, mitigation and food security in the agriculture, forestry and land use sector. The Research Infrastructures in the BMS area as well as in the Environmental area are obvious candidates for close cooperation.

The Joint Programming Initiative **Cultural Heritage and Global Change** calls for closer cooperation with the Research Infrastructures in the Social Sciences and Humanities. The use of e-infrastructures in this area should be encouraged.

Therefore ESFRI will foster the already existing links with the Joint Programming Initiatives in the coming months to define common areas of interest which should be further elaborated. The Joint Programming Initiatives together with the ESFRI Research Infrastructures provide major pillars of the European Research Area.

Strengthening cooperation with industry

To contribute to the economic and social impacts of the ERA and to promote knowledge and innovation oriented partnerships, ESFRI will need to establish closer links with industry and with Ministries and funding agencies dealing with innovations in the different Member States. ESFRI will contact the relevant European Industrial Organisations to identify common goals.

The development of components and materials for Research Infrastructures acts as a driver of industrial innovation. It is therefore important that industry is involved in the design and construction of Research Infrastructures and is informed at an early stage about upcoming procurements. Many Research Infrastructures, like the materials research facilities, also have important industrial users. Tightening the links to industry will support technology transfer and ensure that scientific results are transmitted rapidly to industry.

[5] http://ec.europa.eu/research/era/areas/programming/joint_programming_en.htm

A first step in this direction has been the interaction with the European Strategic Energy Technology Plan (SET Plan), providing strong motivation to include new energy Research Infrastructures in the present update of the ESFRI Roadmap. During the ENERI 2010 Conference [6], it was concluded that the Research Infrastructures in the area of Energy will be implemented through a dialogue with the Industrial Initiatives in the respective areas, the consortium of energy research institutions, the European Energy Research Alliance (EERA), and other stakeholders. The EERA members are natural host and user organisations for the energy Research Infrastructures. Member States can use the representatives in the SET Plan Steering Group and in ESFRI to match their participation in the construction and operation of Research Infrastructures in the energy area. Contacts with the Joint Technology Initiatives and the European Technology Platforms as well as with the European Institute of Technology and the European Innovation Partnerships will be enhanced. In special cases, the inclusion of Public Private Partnerships should be considered.

Training and mobility

Research Infrastructures need qualified managers in order to ensure cost-effective exploitation of the available resources and best use of the scientific results. Successful operation requires training of staff and users. Adequate training provision should be planned from the very beginning of a Research Infrastructure to ensure that requirements are met at the right time.

ESFRI is well aware of the need to find and train managers for Research Infrastructures, originating from the scientific community or from the economic sector. To prepare these future managers for the challenges ahead, a series of Symposia for Realising and Managing International Research Infrastructures (the RAMIRI Symposia) were started in 2009, with the support of Community funding. A "toolbox" for the Research Infrastructure managers could be ultimately developed to prepare them better for the challenges ahead. Such a toolbox will need to be accompanied by further actions and training to ensure that existing expertise is disseminated as widely as possible and that it will be continuously developed.

One idea which should be developed further is the establishment of a "network" of engineers and technicians who are actively involved in the Construction Phase of a Research Infrastructure. Such a "network" could promote mobility and help to guarantee that highly-specialized, trained and experienced engineers and technicians are available when new Research Infrastructures are ready for construction. Needless to say, such a network could also help highly specialised staff to find appropriate follow-up jobs without lengthy periods of uncertainty or even unemployment and ensure that valuable expertise is retained within the European Research Area. For other areas like Social Sciences and Humanities, a similar scheme should be developed for experts working in this area.

With the growing demand for mobility of staff, particular attention should be paid to aspects of social security and retirement benefits. Scientists who are willing to provide their manpower at various places in Europe must be sure that their flexibility will not have a negative impact on their pensions. Therefore, ESFRI will continue to ask the appropriate authorities to deal with this very important aspect of the mobility of researchers and engineers.

The already existing European network EURAXESS [7] is very helpful in this context and a good starting point. EURAXESS has a national information point in each Member State and provides very detailed information on the different pension schemes and other important issues on its Internet site. These common European regulations mean that as a rule, skilled personnel should be able to have the pension entitlements acquired in other European countries recognized and transferred anywhere else in the European Union for their final pensions. EURAXESS has also links with China, Japan, Singapore and USA.

Socio-economic Impact

The socio-economic impact of Research Infrastructures in the host country and in the region is often considerable. Although this impact is still difficult to measure, it is important that ESFRI deal with this aspect.

The ERIDWatch project, funded by the European Commission, has shown that Research Infrastructures offer a qualified public procurement market worth ~ 8–9 billion Euro per year to European industries. This amount has increased by ~ 5.5 % per year over the last 10 years.

According to the recommendations of the Competitiveness Council of May 2009, ESFRI has also the mandate "*to promote the further use of existing financial tools, in particular the Structural Funds and EIB instruments for the construction, upgrading or maintenance of Research Infrastructures, including Regional Partner Facilities*". Therefore, the awareness of the socio-economic impact on the regions surrounding Research Infrastructures should be promoted to convince Politicians and Ministries that the use of Structural Funds for the construction of Research Infrastructures may be a significant contribution to the development of that region. The use of Structural Funds is especially important for the newer Member States to help them to be involved in the construction and operation of Research Infrastructures. One example for the use of Structural Funds for Research Infrastructures is ELI (Extreme Light Infrastructure) which will be financed in large part via this instrument.

Regional cooperation

To foster regional cooperation, ESFRI has set up a Working Group on regional issues. The Working Group started its work in 2007 by evaluating the European regional Research Infrastructure landscape and in particular, the participation of the Eastern and South Eastern European Member States in Research Infrastructure activities at pan-European level. In its 2008 report, the Working Group recommended that ESFRI engage in actions for the development and use of Research Infrastructures throughout the European Research Area. This would allow more widely spread ESFRI proposals leading to the active involvement of a greater number of researchers and scientific areas.

[6] The Conference was held during the Belgian Presidency of the EU, see http://www.eneri2010.be/

[7] http://ec.europa.eu/euraxess/index.cfm

In this context, the idea of Regional Partner Facilities was identified as a promising concept and was recognised as such by the Competitiveness Council [8]. Regional Partner Facilities would be either associated with large scale Research Infrastructures or with other complementary infrastructures (e.g. in a pan-European distributed Research Infrastructure). Thus, regional capacity could be built up engaging smaller countries and regions in competitive research and innovation performance. This could in some cases be also a good use of the Structural Funds. The Regional Partner Facilities could therefore contribute to a more balanced development of the European Research Area, and to the "circulation of knowledge" throughout Europe, thus converting "brain drain" to "brain gain".

A "**Regional Partner Facility**" (RPF) to a Research Infrastructure of pan-European interest must itself be a facility of national or regional importance in terms of socio-economic returns, training and attracting researchers and technicians. The quality of the facility including the level of its scientific service, management and open access policy must meet the same standards required for pan-European Research Infrastructures. The recognition as an RPF should be under the responsibility of the pan-European Research Infrastructures itself (or the members of a to-be ERIC) based on regular peer-review.

International cooperation

In varying areas of research and innovation some challenges are such as to require closer scientific collaboration and the pooling of financial and human resources on a global scale. Some of the pan-European Research Infrastructures are aiming at international partnerships such as Euro-ARGO, SKA, SHARE, EMSO, EPOS or EISCAT. ESFRI will therefore strengthen cooperation with countries and research organisations outside EU. The process of engaging with partners outside the EU will be developed to complement national and European policies and efforts.

ESFRI, together with the European Commission, has established regular contacts and meetings with organisations in USA, India and Russia and will extend them to countries such as Australia, Brazil, Canada and China. In its efforts, ESFRI coordinates its work with that of the European Commission, the Strategic Forum for International Scientific and Technological Cooperation (SFIC) and also the OECD Global Science Forum (GSF) [9].

e-Infrastructures

Research Infrastructures are becoming increasingly diverse and distributed over various sites and are increasingly interconnected and supported by e-Infrastructures. Research Infrastructures ranging from Human and Social Science libraries and surveys, to interconnected Biomedical Sciences laboratories, Environmental Sciences observational networks, Physical, Materials, Astronomical and Engineering Sciences accelerators, synchrotrons, observatories and energy demonstrators are all dependent upon e-Infrastructures.

Across all research areas, e-Infrastructures are playing an ever increasing role in data acquisition and management, digital repositories, access to standardised, calibrated and inter-operable data, data curation, the mining of archived data and its release for broad access. Data taking and data management is something that is often overlooked at the beginning of a Research Infrastructure project, as is the financing of the necessary e-Infrastructures.

The e-Infrastructure Reflection Group (e-IRG) has prepared a Blue Paper in response to a request from ESFRI to examine ways in which ESFRI Research Infrastructures and their users can engage and exploit common e-Infrastructure service to satisfy their requirements [10].

Because of the growing importance of e-Infrastructures in Research Infrastructures, these aspects are now directly included in the Thematic Working Groups, and a dedicated Thematic Working Group for e-infrastructures is no longer appropriate. Direct cooperation with e-IRG has increased significantly and has already led to the preparation of the above mentioned Blue Paper. ESFRI plans to increase this cooperation even further in future.

5. The Future Structure of ESFRI

In discussing ESFRI's tasks and challenges for the next few years, it has become apparent that ESFRI needs to think about establishing a more formal legal framework for its activities. Since ESFRI plans to be involved more strongly in evaluation and prioritisation issues, an area where developments are crucial for the future of the European Research Area, it would be helpful to create a mechanism for supporting those activities through some kind of a common fund.

Similarly, if ESFRI is to increase its activities in international cooperation it also will be necessary to act in a more legal framework than it does now.

ESFRI will therefore start to examine possibilities for a "light structure" which secures the original spirit of ESFRI but nevertheless would help to deal with the above mentioned issues.

[8] Presidency conclusions of the Competitiveness Council of 29 May 2009.

[9] http://www.oecd.org/topic/0,3699,en_2649_34319_1_1_1_1_37437,00.html

[10] http://www.e-irg.eu/images/stories/eirg_bluepaper2010_final.pdf

The Roadmap

PART 2

1. Roadmap update 2010

As described above, ESFRI is committed to support the implementation of as many Research Infrastructures on the roadmap as possible in a timely manner: this will be one of the main responsibilities in the coming years and a success here would be a vindication of ESFRI's strategy approach.

Accordingly, further updates of the roadmap now have a lower priority. After the publication of the 2008 Roadmap update, it was recognised that there were still some gaps in the areas of Energy and Biological and Medical Sciences. Therefore a call for new proposals was published in these areas in 2009, with deadline for submission at the end of the year. After a careful evaluation of the 22 proposals received, 6 projects have been chosen to be included in the ESFRI roadmap. It should be noted that it was difficult in the Energy area to always clearly distinguish between Distributed Research Infrastructures and networks or test facilities.

The evaluation was carried out mainly by the Energy and the BMS Thematic Working Groups with the help of external experts. Where necessary, the other Thematic Working Groups were also involved to give an additional opinion.

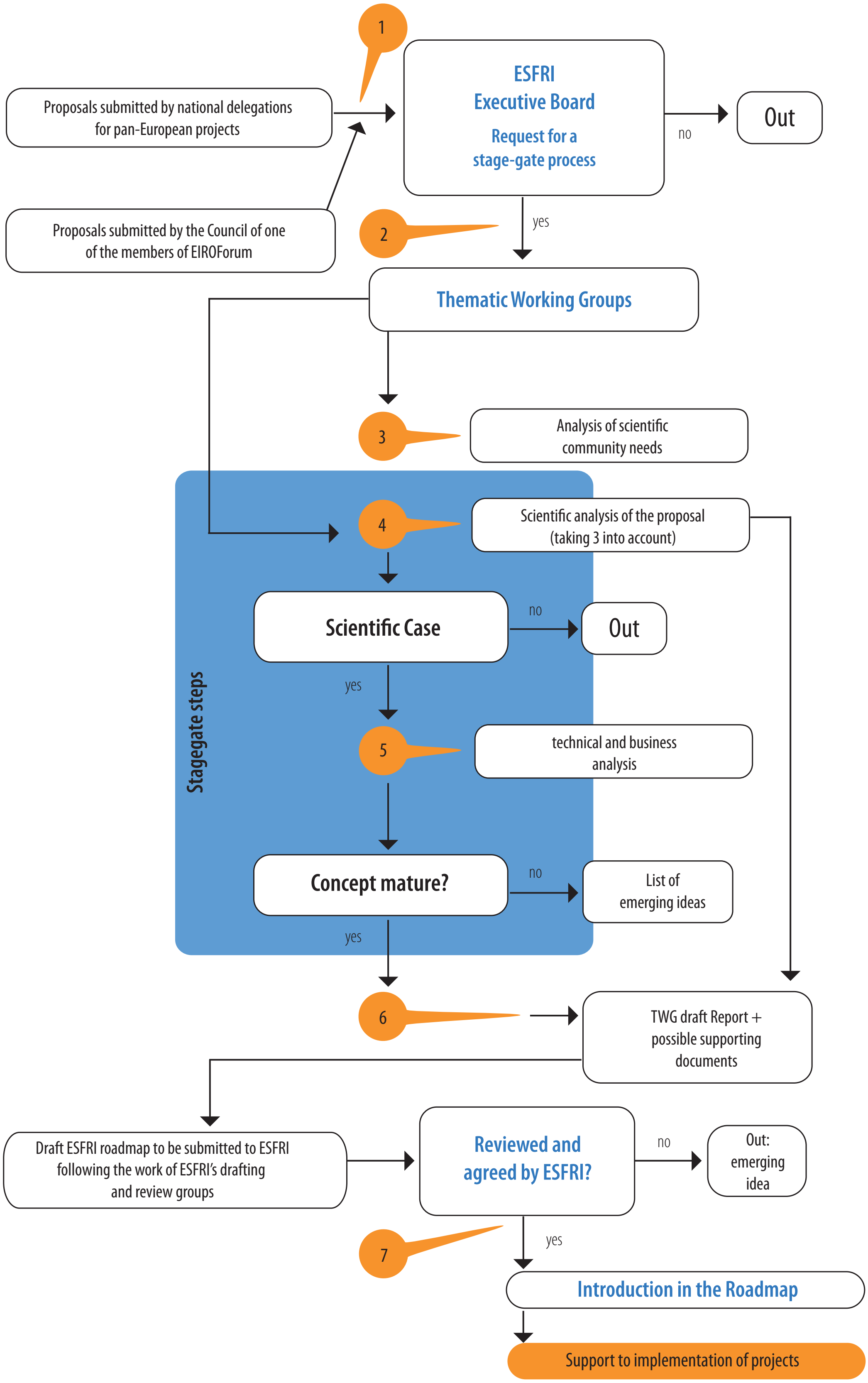
The criteria for the evaluation which has been defined by ESFRI are, among others, the uniqueness of the facility for the scientific community, proven pan-European interest, maturity of the concept in scientific/technological as well as financial aspects. The evaluation process follows the presented scheme which has already been used by ESFRI for the setting up of the first roadmap.

In addition to the evaluation of the new proposals, the Research Infrastructure projects already on the roadmap were also scrutinised to assess whether there was sufficient progress on their route to implementation. The outcome of this process was that two projects – PRINS (Pan-European Research Infrastructure for Nanostructures) and ERICON AB (Aurora Borealis) - have been removed from the roadmap.

The **PRINS** Consortium has recognised that the research and innovation service work which was planned could be carried out in the most appropriate way in a network of different research facilities. Therefore no further developments towards a distributed Research Infrastructure have been made. The evolution of PRINS demonstrates the difference between a network and a distributed Research Infrastructure.

ESFRI has recognised that the level of funding required for the realisation of **ERICON AB** will be highly unlikely during the next few years. This decision was also in part triggered by the outcome of an evaluation which has been performed by the German Science Council as Germany was the main funding provider. Nevertheless, the Preparatory Phase will continue to allow the Consortium to elaborate a proposal with a somewhat less ambitious goal.

Figure 1: the ESFRI process for inclusion of a proposal in the Roadmap for pan-European reseach infrastructures



As a result of the evaluation of the new proposals, six new Research Infrastructures were chosen for inclusion in the roadmap. Three of the successful proposals came from the Energy, and three from the BMS areas. These are:

ENERGY

› EU-SOLARIS
The European SOLAR Research Infrastructure for Concentrating Solar Power (CSP)

› MYRRHA
Multipurpose hYbrid Research Reactor for High-technology Applications

› Windscanner
The European Wind Scanner Facility

BMS

› ANAEE
Infrastructure for Analysis and Experimentation on Ecosystems

› ISBE
Infrastructure for Systems Biology-Europe

› MIRRI
Microbial Resource Research Infrastructure

The projects in the implementation phase have been summarised in a separate table on pages 9-12. These projects are still represented in this roadmap but only with a sentence about their mission. The full description can be found on the project web pages listed in the table. Although these projects can be considered as successfully implemented, there is still work to be done, for example, in assuring the funding of the operations phase. Where relevant, these necessities are also included in the table.

The description of the new proposals as well as the ones of all projects still under implementation can be found on the following pages. These projects are summarised in the "Quick View" of the Roadmap on pages 22-23.

Quick view

Roadmap

	PROJECT	Construction costs (M€)	Operation costs (M€/year)	First possible operation or upgrade
Social Sciences and Humanities	CLARIN	104	7.6	2011
	DARIAH	20	2,4	2016
Environmental Sciences	COPAL (ex EUFAR)	50-60	3	to be defined
	EISCAT_3D Upgrade	60 (up to 250)	4-10	2016
	EMSO	160	32	2014
	EPOS	500	80	2020
	EURO-ARGO	3*	8,4	2011
	IAGOS	15	5-10	2012
	ICOS	130	36	2013
	LIFEWATCH	255	35,5	2012
	SIOS	50	10	2013
Energy	ECCSEL	81	6,3	2015
	EU-SOLARIS	80	3	2016
	HiPER	under discussion		2028
	IFMIF (GLOBAL)	1000	150	2020
	MYRRHA	960	46,4	2020
	Windscanner	45-60	4	2013
Biological and Medical Sciences	***ANAEE***	210	12	2015
	BBMRI	170	3	2012
	EATRIS	20-100	3-8	2016
	ECRIN	0**	3,5	2011
	ELIXIR	470	100	2012
	EMBRC	100	60	2014
	Erinha	174	24	to be defined
	EU-OPENSCREEN	40	~40	2015
	EuroBioImaging	600	160	2013
	Infrafrontier	180	80	2011
	INSTRUCT	300	25	2012
	ISBE	300	100	2017
	MIRRI	190	10,5	ongoing
Materials and Analytical Facilities	EMFL	115	8***	2014
	ESS	1478	110	2019-2020
	EUROFEL (ex-IRUVX-FEL)	1200-1600	120-160	2007-2020
Physical Sciences and Engineering	CTA	150	10	2019
	E-ELT	1000	30	2018
	ELI	~700****	~70	2015
	KM3NeT	220	4-6	2016
	SKA (GLOBAL)	1500	100-150	2017

Description
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
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
The EUropean SOLAR research InfraStructure for Concentrating Solar Power
High power long pulse laser for fast ignition fusion
International Fusion Materials Irradiation Facility
Multipurpose hYbrid Research Reactor for High-technology Applications
The European Windscanner Facility
Infrastructure for Analysis and Experimentation on Ecosystems
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
Upgrade of the High Security Laboratories for the study of level 4 pathogens
European Infrastructure of Open Screening Platforms for chemical biology
Research infrastructure for imaging technologies in biological and biomedical sciences
European infrastructure for phenotyping and archiving of model mammalian genomes
Integrated Structural Biology Infrastructure
Infrastructure for Systems Biology – Europe
Microbial Resource Research Infrastructure
European Magnetic Field Laboratory
European Spallation Source
Complementary Free Electron Lasers in the Infrared to soft X-ray range
Cherenkov Telescope Array for Gamma-ray astronomy
European Extremely Large Telescope for optical astronomy
Extreme Light Intensity short pulse laser
Kilometre Cube Neutrino Telescope
Square Kilometre Array for radio-astronomy

facilities likely to be implemented
by the end of 2012

in bold italic:
new facilities added in 2010

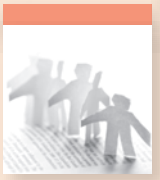
Estimated costs and timelines

A note of caution is required when dealing with the estimated costs of the facilities. This roadmap, differently from roadmaps developed from 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 this document 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.

* preparation costs
** actual construction costs absorbed by the update and certification of national IT components
*** additional to current operation costs
**** includes costs of three Regional Partner Facilities

Social Sciences and Humanities

PART 2 Areas of the Roadmap



Brief Description of the Field

The Social Sciences and Humanities (SSH) 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 system, and securing economic reform and social cohesion as part of the knowledge-based economy.

The SSH Thematic Working Group covers disciplines of the social sciences and humanities concerned with Research Infrastructures at large. It monitors the development and implementation of the ESFRI roadmap projects; explores common needs of the roadmap projects; observes scientific dynamics in its disciplinary fields in order to detect emerging new roadmap projects; documents the establishment of national roadmaps in its fields. Finally, it addresses conceptual issues concerning whether the instruments being developed by ESFRI are well adapted to SSH Infrastructures.

All five SSH initiatives have participated in the EC call on construction activities for the "implementation of common solutions for a cluster of ESFRI Infrastructures in the field of SSH", published in July 2010. A common proposal for identifying and constructing a cluster based on common development needs has been submitted. To facilitate this process, the SSH Thematic Working Group has invited representatives of the five Preparatory Phase Projects to its June 2010 meeting. The Thematic Working Group will monitor the dynamics of this collaborative endeavour, and is ready to give additional stimulus and continued support if desired and useful.

Research Infrastructures on the Roadmap

Out of the five Research Infrastructures in the area of Social Sciences and Humanities the three dealing with Social Sciences are already in the implementation phase (CESSDA, European Social Survey and SHARE). The two remaining SSH Research Infrastructures on the roadmap are also proceeding quite well on their route to implementation:

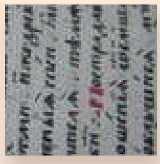
Humanities

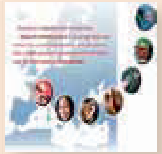
› **CLARIN**

The Common Language Resources and Technology Infrastructure

› **DARIAH**

The Digital Research Infrastructure for the Arts and Humanities





What is missing – emerging fields

A detailed survey of current National Roadmaps (done by the SSH Thematic Working Group) showed that governments often include the ESFRI projects in their roadmaps but that they are hesitant to consider other potentially eligible Research Infrastructures. Hence appropriate ESFRI support would help such Infrastructures to get additional profile.

Some indications on potential gaps:

• **Social sciences:** Longitudinal general population surveys like household panels or cohort studies, electoral surveys, regular surveys of organisations.

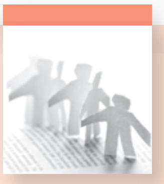
• **Humanities:** Cultural heritage preservation and conservation initiatives like CHARISMA.

In general, coordination with ERANET actions like the NORFACE (Migration in Europe – Social, Economic, Cultural and Policy Dynamics) or the HERA (Humanities in the European Research Area) programmes and contacts with activities of the ESF Standing Committees for social sciences and for humanities should be intensified. Regular exchanges between the Chairs and/or invitations for joint meetings to discuss issues of common interest might be considered.

International cooperation

Many of the Research Infrastructures in the Social Sciences and Humanities have strong international links, for example SHARE and CLARIN.

The German and the UK Data Forums have taken the lead to formally establish exchanges between different social science initiatives in the realm of longitudinal studies like, for example, the Seventh Framework Programme Design Study "Generations and Gender Programme" or the household surveys in Europe. The Thematic Working Group will monitor this development and eventually invite representatives of the new forum to one of its next meetings. ■



CLARIN The Common Language Resources and Technology Infrastructure

PREPARATORY PHASE

Coordination: The Netherlands

Number of participating countries: 26

TIMELINE

- **Start of construction:** 2008
- **Start of operation:** 2011

ESTIMATED COSTS

- **Construction:** 104 M€
- **Operations:** 7.6 M€/year
- **Decommissioning:** not applicable

www.clarin.eu

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.

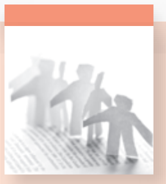
After two and a half years of its existence as a project, CLARIN seems to be making good progress towards its goals. The shift from exploration to convergence and consolidation has been made and the first prototypical implementations aimed at validating the first results are now in sight. This applies to technical, linguistic as well as legal aspects of the infrastructure.

Steps for implementation

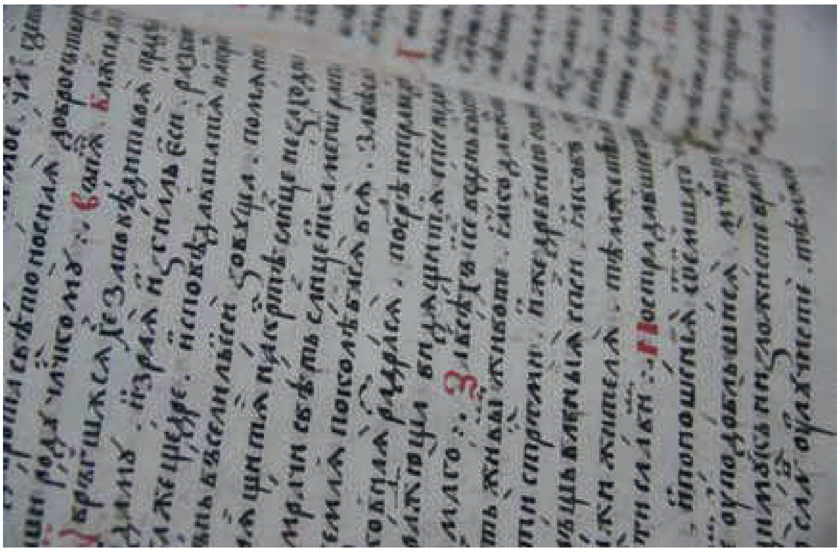
Even if the national roadmap processes in many of the CLARIN countries take much longer time than originally anticipated, there appears to be support for CLARIN in an increasing number of countries, from both within and outside the CLARIN consortium. At this moment the consortium comprises 36 partners in 26 countries, with more countries preparing to join.

The invitation sent out by the Dutch Minister of Education, Science and Culture to move towards the creation of an ERIC for CLARIN will no doubt have an accelerating effect on the process. An application for the creation of an ERIC for CLARIN is expected to be submitted in 2011.

CLARIN's ambition is to look at language in all its manifestations in all languages relevant for the European research community.



DARIAH The Digital Research Infrastructure for the Arts and Humanities



Manuscript studies (Copyright: DARIAH).

PREPARATORY PHASE

Coordination: The Netherlands

Number of participating countries: 10

TIMELINE

- **Start of construction:** 2011
- **Start of operation:** 2016

ESTIMATED COSTS

- **Construction:** 20 M€
- **Operations:** 2.4 M€/year
- **Decommissioning:** not applicable

www.dariah.eu

The facility

DARIAH aims to conceptualise and build an infrastructure in support of ICT-based research practices in the arts and humanities and to support researchers in the creation and use of research data and tools. DARIAH connects information users (researchers), information managers and information providers, providing a technical framework that enables enhanced data sharing among research communities.

Background

DARIAH begins with the observation that just as astronomers require a virtual observatory to study the stars in the galaxy, researchers in the arts and humanities need a digital infrastructure to bring together and collaboratively work with dispersed scholarly resources (e.g. digital content, services, methodologies). DARIAH will be such an infrastructure with a European dimension by promoting, supporting, and advancing the use of digital content, tools and methods in research. The DARIAH infrastructure will connect people, information, tools and methodologies for investigating, exploring and supporting work across the broad spectrum of the humanities.

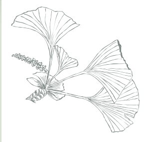
The DARIAH network will be designed to be as decentralised as possible, empowering individual contributors (e.g. individual researchers; national centres; specialised/thematic centres) to work with and within the DARIAH community and shape its features to their needs. Each contribution builds DARIAH, and all is linked together in DARIAH's architecture of participation. At the same time, however, collaboration across the borders of individual centres requires the usage of common technologies e.g. for authentication or federation of archive contents. These considerations also have a place at the core of DARIAH.

Steps for implementation

DARIAH is currently in its Preparatory Phase, which will design the infrastructure and build a sound business and governmental model. From 2011 DARIAH will begin its Construction Phase. To start with, six partners will join the DARIAH ERIC as a Member for the Construction Phase: Germany, France, The Netherlands, Ireland, Austria, and Denmark (in 2011). Potentially UK will join as Observer in 2011. Other European and non European countries (e.g. Canada, Australia and Taiwan) have already expressed their interest in possibly joining DARIAH in late 2011.

Environmental Sciences

PART 2 Roadmap



Brief description of the field

The Environmental Sciences or Earth system research community is focused 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 and on tools and technologies for monitoring, prevention and mitigation of environmental risks and pressures.

Environmental issues will dominate the 21st century and access to natural resources is likely to cause conflicts. International collaboration is essential for all the environmental Research Infrastructures 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.

Europe is particularly well-placed to make world-leading advances in addressing key environmental issues because of the strength of its scientific capability as well as a focus on particular geographical regions and ecosystems. Most environmental ESFRI projects have either a global dimension or the potential to assume a leading role in international environmental collaborations.

European Environmental Research Infrastructures are fundamental for world-leading environmental research, education and training by clustering and networking of existing and new facilities at European or global level. They are the flagships for the Europe 2020 strategy for smart, sustainable and inclusive growth as well as answers to the Grand Challenges. The competitive and open access to high quality Research Infrastructures supports and benchmarks the quality of the activities of European scientists, and attracts the best researchers from around the world.

Distributed, long-term remote controlled observational networks applying state of the art technologies are of key importance to increase our understanding of processes to develop new predictive power in solid Earth systems and ecosystems, biodiversity, hydrology, climate change, etc. Environmentally controlled rooms, research vessels and drilling capabilities, satellite Earth observation systems, airborne and sea-floor sensors, all need advanced technology and communication capacities, linked to computing power and data management resources.

Environmental sciences therefore need a wide range of Research Infrastructures that involve complex systems and human interaction. Measurements and monitoring are required from fixed and mobile platforms and range across physics, chemistry, biology and geosciences. They are required for the terrestrial, marine, freshwater, atmospheric and cryospheric environments. Sophisticated large-scale analytical and informatics facilities from physical and biological sciences are likely to be used with increasing intensity by environmental scientists.

The environmental sector draws on a particularly wide range of science disciplines (ranging from mathematics, to ecology and engineering) and interacts with an equally wide range of users (from energy to overseas aid to conservation). The ENV Thematic Working Group has recognised the importance of a better dialogue with our scientific and user communities to understand the requirements of Research Infrastructures and the opportunities for collaboration and synergies.

E-infrastructures play an ever increasing role in the environmental sciences since environmental time series data can never be recovered, thus secure archiving is important. Simulations using high performance computers are increasingly providing a large fraction of data. There is a strong need to develop standards and software for interoperability and access for scientific and socio economic purposes.

Research Infrastructures on the Roadmap

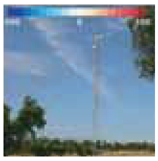
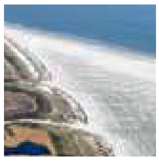
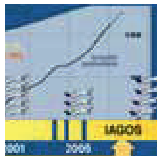
Based on the update information requested from the coordinators of the Preparatory Phase Research Infrastructure projects, the ENV Thematic Working Group concluded that more or less all projects have made satisfactory progress. However none of them has yet secured long-term commitments by partner countries. These projects are:

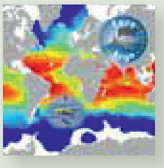
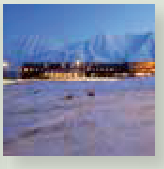
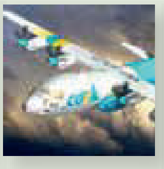
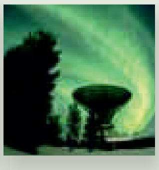
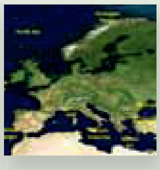
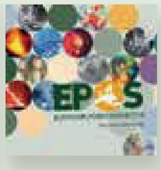
› **COPAL**
Heavy Payload Long endurance Tropospheric Aircraft

› **EISCAT_3D**
The next generation European incoherent scatter radar system

› **EMSO**
European Multidisciplinary Seafloor Observatory

› **EPOS**
European Plate Observing System

› EURO-ARGO
Research Infrastructure for ocean science and observations

› IAGOS-ERI
In-service Aircraft for a Global Observing system

› ICOS
Integrated Carbon Observation System

› LIFEWATCH
Science and technology infrastructure for biodiversity data and observatories

› SIOS
Svalbard Integrated Arctic Earth Observing System

The ENV Research Infrastructures on the ESFRI Roadmap are in some cases in between 'site specific' and 'distributed'. For example, COPAL is a mobile 'site specific' multipurpose platform, while EISCAT_3D and SIOS are essentially site specific Arctic Research Infrastructures though based at more than one site. Others, such as LifeWatch and EURO-ARGO, are fully distributed, mostly building on existing facilities and networks. The selection of Headquarters and Distributed Nodes requires the same rigorous process as for site specific Research Infrastructures.

ESFRI has recognised that the level of funding required for the realisation of **ERICON AB** will be highly unlikely during the next few years, and therefore took the decision to remove this project from the Roadmap. This decision was also in part triggered by the outcome of an evaluation which has been performed by the German Science Council as Germany was the main funding provider. Nevertheless, the Preparatory Phase will continue to allow the Consortium to elaborate a proposal with a somewhat less ambitious goal.

What is missing – emerging fields

The ENV Thematic Working Group considered that observational, experimental, analytical and modelling facilities in ecosystem science, in mainland Europe and in the Arctic, and the water/hydrological cycle are important parts of the landscape of the environmental Research Infrastructures. Of these, the existing Research Infrastructure initiatives on water/hydrological cycle are still in the emerging stages of development.

There are potential emerging projects in a broad area of geosciences related for example to water cycle or in marine research, such as aquaculture or research vessels. ENV TWG welcomes the first steps taken by the European Geosciences Union on Research Infrastructure policy.

New potential may arise in the area of waste management and eco- industrial processes.

A very important part of the environmental Research Infrastructures is the knowledge-based resources such as scientific collections of various kinds (biological, geological, including soils, ice cores, fossils, animals, plants etc.). The LIFEWATCH initiative is a step in this direction and includes several scientific collections (museums) for biodiversity research. However, there is no over-arching coordination of collections in all areas presented to ESFRI so far. In its GSF 'Progress Report on Activity on Policy Issues Related to Scientific Research Collections' the OECD dealts with the global dimension of this issue now. At a European level, an integrating body for scientific collections is also needed and the collections treated as a Research Infrastructure. In this area a close cooperation with the SSH Thematic Working Group is advisable. Basic data from the natural environment are gathered from monitoring and observation networks, and from experimentation and modelling. Interoperability between disciplines emphasizes the need for well designed and managed database systems, knowledge centres, shared expertise, services, dedicated training and communication, and e-infrastructure in environmental research. Data service and storage needs are increasing with resolution, model complexity and simulation length reaching soon the 100 TB range. Software development and services have not kept pace with the development of hardware, and the challenges are increasing with the emergence of networking and new synergies associated with the new Research Infrastructures. The importance of training users should be emphasised.

New facilities will be needed in the near future in the following areas: Environmental engineering and technology, water cycle, scientific collections, air pollution and aerosols, e-Infrastructure.

International cooperation

Because of the global scale and complexity of environmental research, and due to high costs of environmental Research Infrastructures, international collaboration is essential. The number of new users of ENV Research Infrastructures in and outside Europe is expected to grow in future years. Natural partners of pan-European Research Infrastructures are global research and monitoring programmes launched by international organisations. Some Research Infrastructures, in particular SIOS, EISCAT_3D and EPOS have participating organisations from outside Europe. Others, such as ICOS, EURO-ARGO and Lifewatch have activities with international research programmes. Currently discussions are on-going with NSF (National Science Foundation) and NOAA (National Oceanic and Atmospheric Administration) to establish closer cooperation between ESFRI and these organisations. ■

COPAL Heavy Payload Long endurance Tropospheric Aircraft

PREPARATORY PHASE

Coordination: France

Number of participating countries: 9

TIMELINE

- **Preparatory phase:** 2007-2011
- **Start of construction:** not yet defined
- **Start of operations:** not yet defined

ESTIMATED COSTS

- **Preparation:** 1 M€
- **Construction:** 50 to 60 M€
- **Operations:** 3 M€/year
- **Decommissioning:** not applicable

www.eufar.net/copal

The facility

COPAL aims at providing the European scientific community in the field of environmental and Geo-sciences, with a unique research aircraft platform, capable of reaching and operating in any remote area in the world. It will offer an unprecedented opportunity to countries that are not yet operating research aircraft to develop expertise in airborne measurements and participate to international multidisciplinary experiments.

With a payload of 10 tons or more and an endurance of 10 hours, a heavy-payload, long endurance (HPLE) aircraft will more than double the capabilities offered to European scientists. 15 to 20 research laboratories will contribute to the multidisciplinary instrumental setup.

With the permission of Lockheed Martin

Background

COPAL (ex EUFAR) is supported by the European consortium of research aircraft operators and users under the umbrella of the EUFAR (European Fleet for Airborne Research) Integrating Activity. 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 from 80 to 4500 kg, and a ceiling from the boundary layer up to 21 km. All aircraft of the European fleet however are limited to a practical endurance of 5 hours. This situation has so far precluded European scientists from performing research over oceanic, polar and remote continental areas, which are especially crucial for climate studies. COPAL will fill this gap in the European research aircraft fleet by providing a research aircraft platform capable of reaching and operating in any remote area in the world and offering a heavy-payload for integration of a wide range of instruments for research in environmental and geo-sciences. The design and implementation of the COPAL research aircraft will be done in cooperation with the operator of community research aircraft in the USA, and with the other Preparatory Phase studies, especially those with points of similarity with COPAL, such as the research vessels.

Steps for implementation

The Preparatory Phase of COPAL started in November 2007 and is supported by the European Commission with 1.0 M€ funding. The consortium today consists of 13 partners (including one funding organisation). France has offered to host the headquarters of COPAL and many Member States have expressed their interest in this Research Infrastructure.

EISCAT_3D The next generation European incoherent scatter radar system

The facility

EISCAT_3D will be a three-dimensional imaging radar for atmospheric and geo-space research, which constitutes an upgrade to EISCAT, an existing international infrastructure based in Europe and devoted to the study of the upper atmosphere, ionosphere and geospace. This new large-scale European Research Infrastructure will have applications in a wide range of European research areas including Earth environment monitoring and technology solutions supporting sustainable development, well beyond atmospheric and space sciences.

Background

EISCAT_3D represents a new concept in research radars for the upper atmosphere, based on multi-static phased arrays with state-of-the-art digital signal processing, which are intended to replace EISCAT's existing radars in northern Scandinavia. The new design will greatly extend EISCAT's data coverage and provide unique volumetric and small-scale imaging capabilities. It will also allow major improvements in temporal and spatial resolution, as well as producing new data products.

EISCAT_3D will contribute to Environmental sciences through studies of space weather and global change, as well as addressing atmospheric science and plasma physics. In addition to the EU-funded Preparatory Phase, a technology prototyping project has received 1M€ funding from regional development funds, to build a multi-beam test receiver at Kilpisjärvi in Northern Finland. The test station will use hardware concepts developed by the radio astronomy facility LOFAR. If successful, LOFAR hardware might provide the basis for the EISCAT_3D receiver sites.

Steps for implementation

This upgrade was prepared by a Design Study funded under the 6th Framework Programme (2005-2009). The Preparatory Phase will clarify the remaining design issues, and explore the logistical, organisational and financial questions which need to be resolved before construction can begin. The consortium consists of 8 partner institutions (including 1 with official mandate from funding organisation) from 5 countries. Three additional countries are participating in research activities. Several countries outside Europe have also expressed interest. EISCAT_3D is a development project of the EISCAT Scientific Association, whose headquarters are located in Kiruna, Sweden.

The current EISCAT host countries (Sweden, Norway and Finland) should play a key role in EISCAT_3D, and it is expected that the other EISCAT members (UK, Germany, China and Japan) will participate at some level. Japan has invested strongly in Northern Scandinavia, financing one of EISCAT's two radar dishes on Svalbard, and has organized a national group discussing possible future participation in EISCAT_3D. There are also indications of interest by third countries, who are currently not members of EISCAT, such as Russia and US.

PREPARATORY PHASE

Coordination: Sweden

Number of participating countries: 5

TIMELINE

- **Preparatory phase:** 2010-2014
- **Construction phase:** (2012) 2014-2016
- **Operation phase:** 2016-2046

ESTIMATED COSTS

- **Preparation:** 3 M€
- **Construction:** 60 M€ (up to 250 M€)
- **Operations:** 4-10 M€/year
- **Decommissioning:** 10-15% of construction costs

www.eiscat.se

EMSO European Multidisciplinary Seafloor Observatory

PREPARATORY PHASE

Coordination: Italy

Number of participating countries: 12

TIMELINE

- **Start of construction:** 2013
- **Start of operation:** 2014

ESTIMATED COSTS (for eight sites)

- **Preparation:** 80 M€
- **Construction:** ca. 160 M€
- **Operations:** 32 M€/year
- **Decommissioning:** to be estimated

www.emso-eu.org

The facility

EMSO is the European Multidisciplinary Seafloor Observatory, a Research Infrastructure for long term permanent monitoring of the ocean margin environment around Europe. It is considered critical by the European Science Foundation marine board. EMSO is an essential tool for deep sea research including geosciences and geo-hazards, physical oceanography, biology and non-living resources.

Background

Cabled sea-floor observatories are needed to collect simultaneously long time series of data identifying temporal evolutions, cyclic changes and capturing episodic events related to oceanic circulation, deep-sea processes and ecosystems evolution. In addition, long-term monitoring will allow the capture of episodic events such as earthquakes, submarine slides, tsunamis, benthic storms, bio-diversity changes, pollution and other events that cannot be detected and monitored by conventional oceanographic sea-going campaigns.

A final detailed plan of involving the e-tools in EMSO is also needed. The plan should clearly state all connections with e-infrastructures for data gathering, processing, storage and transfer. A very good connection with other European projects has been developed by the EMSO Consortium, including not only projects from the field of environmental sciences but also with other domains (e.g. Km3NeT). Stronger links should nevertheless be forged with the Research Infrastructure Euro-Argo. EMSO has strong potential for international collaboration outside Europe.

Steps for implementation

The Preparatory Phase of EMSO started in April 2008 and is supported by the European Union with 3.9 M€. The consortium consists of 12 partners (including 8 with official mandate from ministries and funding organisations) from 12 countries.

Even though firmly on the way towards implementation, there are still several steps EMSO should take towards full operability. Thus, efforts should be taken towards achieving the ERIC status for its consortium EMSO will propose an ERIC in 2011. There is no leading country for Construction Phase yet.

Map of EMSO observatories.

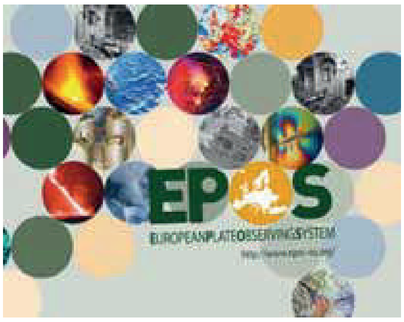
EPOS European Plate Observing System

The facility

EPOS will create a single sustainable, permanent observational infrastructure, integrating existing geophysical monitoring networks (e.g. seismic and geodetic networks), local observatories (e.g. volcano observatories) and experimental laboratories (e.g., experimental and analytic lab for rock physics and tectonic analogue modeling) in Europe and adjacent regions. It will coordinate the currently scattered, but highly advanced, European facilities into one distributed, coherent multidisciplinary Research Infrastructure.

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 to 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. EPOS is already actively networking the existing European facilities on seismological and geodetic monitoring as well as solid Earth observations. It will promote 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.



Steps for implementation

The EPOS Preparatory Phase started in November 2010 with 4.5 M€ of EU funding. The consortium today consists of 20 partners (including the non-governmental organisation ORFEUS) and 6 associated organisations from 23 countries. The site to host the EPOS Headquarter will be decided during the PP. The first step for implementation will integrate existing national Research Infrastructures through the EPOS Data Centres, a network of community service providers for distributed data storage and processing. For seismology in particular, ORFEUS already integrates seismic monitoring infrastructures and has developed a first ICT infrastructure for data archiving and mining. In a second step, innovative and coherent e-infrastructure architecture will be developed, which will form the platform and data service infrastructure (not community specific). By means of the EPOS Core Services, it will provide interdisciplinary data and metadata exchange, processing tools and computational simulations.

PREPARATORY PHASE

Coordination: Italy

Number of participating countries: 18

TIMELINE

- **Preparatory phase:** 2010-2014
- **Construction phase:** 2015-2020
- **Operation phase:** 2020-2040+

ESTIMATED COSTS

- **Preparation:** 12 M€
- **Construction:** 500 M€
- **Operations:** 80 M€/year
- **Decommissioning:** not applicable

www.epos-eu.org

EURO-ARGO Global Ocean Observing Infrastructure

PREPARATORY PHASE

Coordination: France

Number of participating countries: 12

TIMELINE

- **Start of construction:** 2001
- **Start of operation:** 2011

ESTIMATED COSTS

- **Preparation:** 3 M€
- **Construction:** not applicable
- **Operations:** 8.4 M€/year
- **Decommissioning:** not applicable

www.euro-argo.eu

The facility

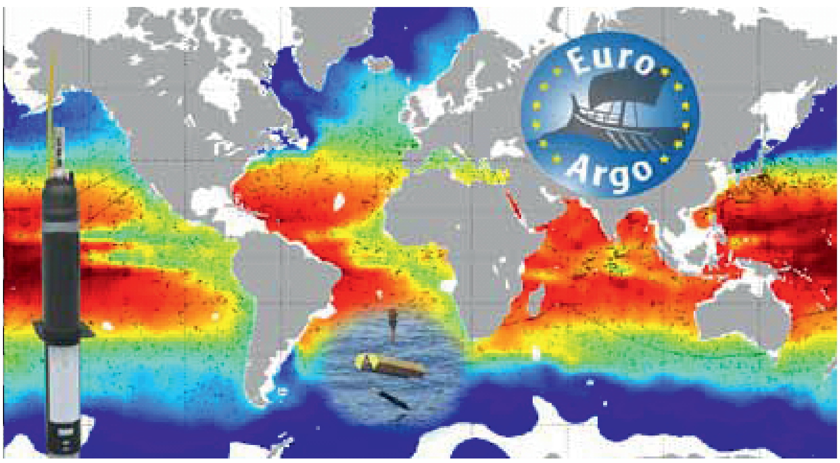
Argo is a global ocean observing system with the primary goal to maintain the 3000 floats array over the next 10 to 20 years. This is extremely challenging and success in such a major undertaking can be achieved only through a very high degree of international cooperation and integration. Euro-Argo will develop and progressively consolidate the European component of the global network. Specific European interests also require increased sampling in some regional seas. Overall, the Euro-Argo infrastructure should comprise 800 floats in operation at any given time. The maintenance of such an array would require Europe to deploy about 250 floats per year. Euro-Argo must be considered in its entirety: not only the instruments, but also the logistics necessary for their preparation and deployment, field operations, the associated data streams and data centres

Background

Argo is endorsed by the Climate Research Programme of the World Meteorological Organisation (WMO), the Global Ocean Observing System (GOOS), and the Intergovernmental Oceanographic Commission (IOC). In November 2007, the international Argo programme reached its initial target of 3,000 profiling floats. These floats measure every 10 days temperature and salinity throughout the deep global oceans, down to 2,000 metres. Argo is now the major, and only systematic, source of information and data over the ocean's interior. Argo is widely recognized as a revolutionary achievement in ocean observation. The Argo array is an indispensable component of the Global Ocean Observing System required to understand and monitor the role of the ocean in the Earth's climate system. Satellite observations constitute a useful complement to the Argo observations. The Argo data are readily assimilated with those from satellites into ocean circulation and climate models, in support of research and operational applications. Argo is the single most important in-situ data set used today for the Global Monitoring for Environment and Security (GMES) Marine Core Service.

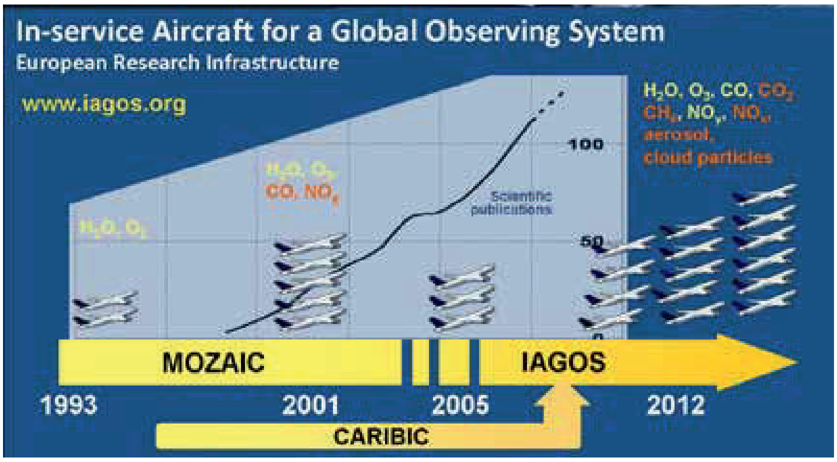
Steps for implementation

The Preparatory Phase of Euro-Argo started in January 2008 and is supported by the European Union with 3.0 M€. Eight European countries have indicated their interest in the Construction Phase, while 3 - 4 countries will likely have observer status. The consortium will submit an application for the ERIC in 2011. The implementation will be done in two phases: For phase 1 (2011-2013) funding by the Member States only is foreseen, for phase 2 (2014-2020) funding by the Member States and the European Commission (GMES) is envisaged. The Euro-Argo structure will include a central facility and distributed national facilities. The central facility will have a European legal structure (ERIC) to receive EC and national (member states) funding, to procure floats (includes logistics and test facilities) and to provide funding to the international structure. The governance model for the structure has been defined and its main characteristics have been agreed by all partners.



Euro-Argo is the European contribution of the Argo array of profiling floats. These are essential observations for ocean and climate research and prediction.

IAGOS In service aircraft for a global observing system



IAGOS will monitor the atmospheric composition at the global scale based on autonomous instrumentation installed on a fleet of long-range passenger aircraft *(Copyright: IAGOS).*

The facility

IAGOS will be established and operated as a distributed infrastructure for long term observations of atmospheric composition, aerosol and cloud particles on a global scale from a fleet of initially 10-20 long range in-service aircraft of internationally operating airlines. It will likely become a key component of a GMES service on air quality.

Background

IAGOS is an efficient and cost-effective approach to monitor the long-term variations of the atmospheric chemistry on the large scale, including many chemical species and aerosols. Data obtained by means of routine aircraft measurements have been widely used at the international level and notably within the Intergovernmental Panel on Climate Change (IPCC) process. Under full European leadership, IAGOS is important for long-term observations, given the scientific objectives of global climate change research. The first IAGOS aircraft was equipped in 2009 (deliverable of the Design Study IAGOS-ERI), while the CARIBIC aircraft is part of IAGOS since the start of Preparatory Phase. Three MOZAIC aircraft will be brought back to operation in 2010 as part of IAGOS.

Steps for implementation

The Preparatory Phase of IAGOS started in September 2008 and is supported by the European Union with 3.3 M€. The consortium consists of 16 partners (including 2 ministries and funding organisations, 2 airlines and 2 industrial partners and manufacturers of instrumentation) and one associated organisation. The EU-funded Design Study of IAGOS-ERI was running from April 2004 until January 2010.

At present the preparation and decision of an appropriate legal structure for IAGOS as distributed infrastructure, as well as a sustainable funding scheme; the integration of new partners (research institutions and airlines); the preparation of the operational basis (certification and maintenance) and new technical developments is discussed. Germany is currently negotiating to host the headquarters of IAGOS and many Member States have expressed their interest in the facility. The legal structure (International Association or ERIC) is under discussion between partners.

PREPARATORY PHASE

Coordination: Germany
Number of participating countries: 4

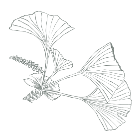
TIMELINE

- **Preparation phase:** 2008-2011
- **Construction phase:** 2011-2016
- **Operation phase:** 2012-2035

ESTIMATED COSTS

- **Preparation:** 5-7 M€
- **Construction:** 15 M€
- **Operations:** 5-10 M€/year
- **Decommissioning:** 0.5 M€

www.iagos.org



PREPARATORY PHASE
Coordination: France
Number of participating countries: 14

TIMELINE
- **Preparation phase:** 2008-2011
- **Construction phase:** 2010-2015
- **Operation phase:** 2013 onwards

ESTIMATED COSTS
- **Preparation:** 5 M€
- **Construction:** 130 M€
- **Operations:** 36 M€/year
- **Decommissioning:** not applicable

www.icos-infrastructure.eu

ICOS Integrated carbon observation system

The facility

ICOS will provide across Europe and adjacent regions a distributed infrastructure for standardised long-term high precision monitoring of atmospheric and oceanic greenhouse gas concentrations, ecosystem fluxes and essential carbon cycling variables. These measurements will allow daily determination of sources and sinks at scales down to about 100 km2, and will be a basis for understanding the carbon exchange processes between the atmosphere, the terrestrial surface and the ocean.

Background

ICOS has a high scientific and societal pan-European and global relevance in the field of long term monitoring and research of greenhouse gases, their fluxes between atmosphere and continental biosphere and storage in the ecosystem. This distributed Research Infrastructure is both research and operational oriented (in the frame of GMES) and will enable European Member States and the EC to better respond to the obligations of the United Nations Framework Convention on Climate Change (UNFCCC). ICOS is the continuation of an ongoing preliminary project (through the Integrated Project CarboEurope) that demonstrates its feasibility and the maturity of the scientific and technical concepts. To secure the continuation of these observations a long term perspective should be guaranteed through the set up of an institutional concept (Research Infrastructure).

Steps for implementation

The Preparatory Phase of ICOS started in October 2008 and is supported by the European Union with 5.0 M€. The consortium consists of 18 partners (including ministries and funding organisations) from 13 countries. ICOS will soon move to its construction phase. Finland and France offered to host the headquarters of ICOS, and have submitted a joint application for the Atmospheric Thematic Centre. Italy, Belgium and France have submitted a joint application for the Ecosystem Thematic Centre.

ICOS will provide in situ observations of greenhouse gases, data processing and user-friendly access to data products for validation of remote sensing products, scientific c assessments, modelling and data assimilation.

LIFEWATCH Science and Technology Infrastructure for Research on Biodiversity and Ecosystems

(Copyright: Phernambucq)

PREPARATORY PHASE

Coordination: The Netherlands

Number of participating countries: 20

TIMELINE

- **Preparation phase:** 2008-2011
- **Construction phase:** 2011-2016
- **Operation phase:** 2012 (first release), 2016 (full operation)

ESTIMATED COSTS

- **Preparation:** 5 M€
- **Construction:** 255 M€
- **Operations:** 35.5 M€/year
- **Decommissioning:** not applicable

www.lifewatch.eu

The facility

LIFEWATCH is an e-science and technology infrastructure for biodiversity and ecosystem research to support the scientific community and other users. It is putting in place the infrastructure and information systems necessary to provide an analytical platform for the modelling and simulation of both existing and new data on biodiversity to enhance the knowledge of biodiversity functioning and management.

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 the research community with a new methodological approach to understand the biodiversity system. The LifeWatch Research Infrastructure will contribute as a European component to the Global Earth Observation System of Systems (GEOSS) 10-year implementation plan, particularly in relation to enabling global, multi-system capabilities for research, ecosystem management and biodiversity conservation; and improving the coverage, quality, and availability of essential information from a variety of data resources, including in situ observatories and the integration of in situ and satellite data.

Steps for implementation

The Preparatory Phase of LifeWatch started in February 2008 and is supported by the European Union with 5.0 M€. Presently eight countries signed a Memorandum of Intent. These countries did enter the final negotiations towards submitting the ERIC Statutes for approval, and will establish a start-up organisation as a transition to the construction phase. Three countries (Italy, the Netherlands and Spain) offered to take lead with advance funding to allow for continuity. The transition activities include efforts with respect to detailed financial rules, the process of recruitment of senior executives, processing of the first year construction logistics, and orchestrating the distributed construction work. These three countries will host the common facilities of the infrastructure. Thus, Spain will host the Statutory Seat and ICT core facility, The Netherlands will host the LifeWatch IT Research and Innovation Centre, and Italy will host the Service Centre.

SIOS The Svalbard Integrated Arctic Earth Observing System

(Copyright: Nils Petter Dale)

PREPARATORY PHASE

Coordination: Norway

Number of participating countries: 14

TIMELINE

- **Start of preparatory phase:** 2010
- **Construction phase:** 2011-2013
- **Start of operation:** 2013

ESTIMATED COSTS

- **Preparation:** 2-5 M€
- **Construction:** 50 M€
- **Operations:** 10 M€/year
- **Decommissioning:** not applicable

www.unis.no/SIOS
www.forskningsradet.no/sios

The facility

The goal of SIOS is to establish an observational Research Infrastructure for the Arctic Earth System, integrating studies of geophysical, chemical and biological processes from the research and monitoring platforms. It corresponds to a need concerning climate change monitoring. The Research Infrastructure is mainly European with a strong international component, with the presence of a large number of research institutes from all over the world (EU Member States and associated states, and other countries such as Russia, China, Japan, Korea, USA and India). It is of use for a very broad and interdisciplinary user community and offers opportunities for education and training of young scientists - also in a broad international context. It has a high level of maturity regarding all aspects (technical concept, timetable, availability of trained personal, budget).

Background

Svalbard's geographical location and extensive Research Infrastructure provides excellent opportunities for studies of ecosystem changes and its 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 compared to regions at lower latitudes. The High Arctic can therefore be seen as an early warning region.

Steps for implementation

The Preparatory Phase of SIOS started in October 2010 and is supported by the European Union with 4.0 M€. Norway has offered to host the headquarters of SIOS. SIOS has already a strong international character. There are 14 countries having activities on Svalbard that are also partners in SIOS: Germany, Poland, Italy, UK, Russia, Denmark, Finland, The Netherlands, China, France, The Republic of Korea, Sweden and Japan.

Brief description of the field

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. A strong research effort is needed to cope with the European ambitions for the reduction of greenhouse gas emissions by 20%, to ensure 20% of renewable energy sources in the European energy mix and to reduce European primary energy use by 20% by 2020. Even more effort is necessary to meet the ambitious 2050 objectives of reducing greenhouse gas emissions by 60-80%. This will only be possible with major breakthroughs enabling technological innovation.

Energy as a scientific discipline differs from the traditional ones, such as nuclear physics, astronomy or medicine, being more a kind of platform where different scientific fields meet each other to provide solutions to the energy problems and challenges.

Energy is thus a highly multi- and interdisciplinary field which cannot be viewed from one perspective only. In energy R&D, the integration of knowledge from different disciplines is not only important, but essential when striving for innovative technology solutions.

Several European initiatives already strongly contribute to the strategic definition and to operational programmes:

- The European Strategic Energy Technology Plan (SET-Plan) was adopted by the Commission on 22 November 2007 as an integral part of the Energy and Climate Change policy package. It constitutes a global framework to foster innovation by a closer cooperation between research organisations and European Industry. The ESFRI decision of creating the Energy Thematic Working Group results in part from a SET-Plan request.

- The European Energy Research Alliance (EERA) aims to accelerate development of new energy technologies by harmonizing the national and European Commission programmes and decreasing fragmentation. Fourteen European research centres form the leading core of this institution, to which several other laboratories are associated. Several common programs are under implementation and they constitute the first operational examples of EU Joint Programming.

- The various EU "energy platforms" and Joint Technology Initiatives actively contribute to the definition of the European strategy.

Research Infrastructures on the Roadmap

For the Energy area the ESFRI roadmap 2008 includes four Research Infrastructures, one of them is already implemented, while three are still working towards implementation. These are:

› ECCSEL
European Carbon Dioxide ND Storage Laboratory Infrastructure
› HIPER
High power long pulse laser for fast ignition fusion
› IFMIF
International Fusion Materials Irradiation Facility

In addition to the Research Infrastructures already on the roadmap, the Energy Thematic Working Group recommends including three new proposals in the ESFRI roadmap. These Research Infrastructures will strongly contribute to reinforce the European Research Area and optimise the European R&D efforts in the domain. Together with the existing facilities, they will constitute a unique set of tools which will be largely used by scientists and engineers, in particular those of the European Energy Research Alliance partners.

The important changes in the energy domain, which will take place in the next few years, need to be anticipated and studied by social scientists. Scientists and engineers can conceive and realize new schemes, new technological opportunities, but any innovation to be viable needs to be accepted by the citizens. It is therefore essential that the social consequences of these behaviour changes are taken into account from the very beginning and dedicated funds have to be allocated for this purpose.

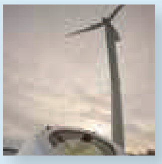
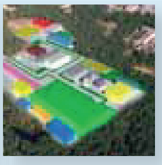
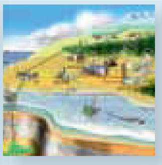
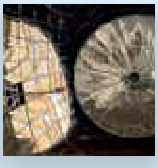
The new proposals are the following:

› EU-SOLARIS
The EUropean SOLAR Research Infrastructure for Concentrating Solar Power
› Windscanner
The European Wind Scanner Facility
› MYRRHA
Multipurpose hYbrid Research Reactor for High-technology Applications

What is missing – emerging fields

With the current update of the ESFRI roadmap, some decisive steps have been taken to close the most urgent gaps. The Energy Thematic Working group considered however, that there are still a number of emerging projects to be further developed as well as new fields not yet sufficiently covered by Research Infrastructures. The current rapid development, triggered by the SET-Plan and the support of demonstration sites via the European Recovery package and the NER-300 New Entrants' Reserve 300[11] will lead to increased research and development and corresponding Research Infrastructure needs.

[11] DIRECTIVE 2009/29/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL; a financing instrument managed jointly by the European Commission, European Investment Bank and Member States, to set aside 300 million allowances in the New Entrants' Reserve of the European Emissions Trading Scheme for subsidising installations of innovative renewable energy technology and carbon capture and storage (CCS).

These needs include testing facilities mainly for industrial users, owned and operated by private companies; in addition there is substantial need for publicly owned Research Infrastructures to meet the still existing needs in basic science and pre-commercial research and as independent reference facilities. Research Infrastructures will play an increasing role in the development of common standards and quality criteria.

Substantial additional need for new Research Infrastructures or increased networking and opening of existing Research Infrastructures has been identified for several areas. In bio-energy research, these are Research Infrastructures in the fields of thermo-chemical conversion as well as biochemical conversion and bio-refineries, 3rd generation of biofuels and a better access to existing data. As for electricity networks, the current Research Infrastructures need to be significantly upgraded and better networked. Significant related Research Infrastructure need has further been identified for the large field of energy storage. For hydrogen and fuel cells research, the stock of existing Research Infrastructures needs to be jointly developed and opened to researchers. For research in photovoltaic energy upgrading and a better coordination of existing facilities are needed to serve researchers in the various PV technology paths. As for marine energy technologies, in parallel to the current implementation major future Research Infrastructure needs arise. In the field of nuclear fission, the need for further experimental reactors in addition to MYRRHA has been identified.

The need for additional Research Infrastructures has been identified for the topics energy efficiency, Smart Cities and sustainable transport.

Finally, as already mentioned, to address energy user aspects and the implementation of new energy technologies, Research Infrastructures in Social Sciences will play an increasingly important role and their use for these purposes needs to be encouraged.

The Research Infrastructures dealt with in this Energy update, as well as this paragraph on future needs, are restricted to facilities that have the characteristics of providing open access, i.e. Research Infrastructures mainly aiming at supporting scientific research and being subject to independent evaluation. Additionally, there it needs development of more demonstrators to show the viability of the respective technologies. The use of these Demonstrators for accompanying research is another important field that needs to be further explored.

International cooperation

The energy issue is a global one and international cooperation has a long-standing tradition in energy policy as well as in energy research. The first international organisation in the energy domain was the International Energy Agency (IEA). It was founded during the oil crisis of 1973-74 as an intergovernmental organisation within the OECD and acts as energy policy advisor to 28 member countries in their effort to ensure reliable, affordable and clean energy for their citizens.

The IEA runs more than 40 multilateral Technology Initiatives (also known as Implementing Agreements) as the longest existing framework for international research collaboration in energy. Most of the European research institutions and Research Infrastructure operators, including those involved in the Research Infrastructure programme, are participating in these programs, delegated and supported by EU Member States.

Through its Implementing Agreements, the IEA enables member and non-member countries, businesses, industries, international organisations and non-governmental organisations to share research on breakthrough technologies, to fill existing research gaps, to build pilot plants and to carry out deployment or demonstration programmes. In short, their work can comprise any technology-related activity that supports energy security, economic growth, environmental protection and engagement worldwide. Research Infrastructures have always played a key role in these efforts.

More recently, in 2009, the EU and the US have set up a joint energy council at ministerial and commissioner level to streamline policy initiatives relating to green technologies, research and energy security on both sides of the Atlantic. This EU-US Energy Council is a formal framework for deepening the transatlantic dialogue on strategic energy issues of mutual interest. It is also the platform for cooperation on energy policies and research collaboration on sustainable and clean energy technologies. The European SET-Plan makes provision for intensified international cooperation, in order to promote the development, marketing, deployment and accessibility of low carbon technologies worldwide. ■

ECCSEL European Carbon Dioxide Capture and Storage Laboratory Infrastructure

PREPARATORY PHASE

Coordination: Norway

Number of participating countries: 10

TIMELINE

The facility will be in operation in 2015

ESTIMATED COSTS

- **Preparation:** 3-4 M€
- **Construction:** 81 M€
- **Operations:** 6.3 M€/year
- **Decommissioning:** 2 M€

www.eccsel.org

The facility

The ECCSEL facility combines three approaches to capture (pre and post combustion and O_2/CO_2 –oxy-fuel-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.

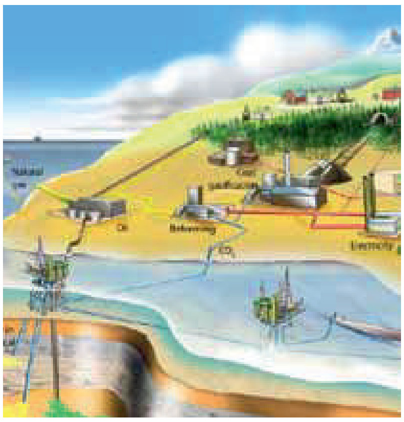
Background

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 CCS and this topic is highly relevant for the SET-Plan and the current demonstration projects. The core consortium of the upgraded facility consists of 10 European partners, but the network behind CCS is much broader. 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 taking place in national and EU programmes. 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 implementation and further development of CCS technologies via the SET-Plan Industrial Initiative on CCS and will help to realise the targets 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.

Steps for implementation

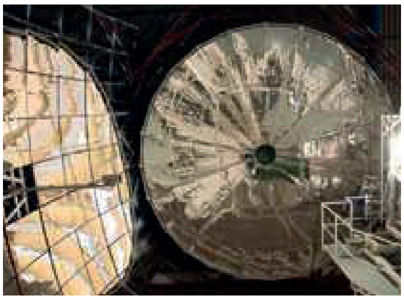
The core hub of ECCSEL will be in Norway with partner institutions in Germany, the Netherlands, France, Poland, Switzerland, Italy, Spain, UK and Greece. The Preparatory Phase starts in January 2011. Construction costs for the major upgrade of the participating facilities amount to around 80 M€, operation costs will be around 6 M€/year.



EU-SOLARIS European Solar Research Infrastructure for Concentrating Solar Power

The facility

EU-SOLARIS is a networking approach from outstanding solar research centres in five European countries to support the scientific and technological development of Concentrating Solar Power Systems. The core activities will be carried out in the Centro Tecnológico Avanzado de Energías Renovables (CTAER)/ Plataforma Solar de Almería (PSA) installations in Almería (Spain), which are currently the world leading facilities in this field. The project includes the upgrading of existing infrastructures along with new installations.



Concentrating sun rays is the most effective way to obtain the highest value of the inexhaustible and most abundant energy resource over the Earth: Solar Energy.

Background

Energy is becoming one of the most urgent and strategic issues on policy maker's agendas. Renewable energies are the only sustainable alternative to meet the increasing energy demand, providing security of supply, avoiding CO_2 emissions and preventing the uncontrolled impact of fossil fuel price increases on countries' economies. Solar technologies show the largest renewable potential and concentrating solar technologies can provide the basis for electricity generation, as well as for other purposes (chemicals, water desalination, etc.). European industry is currently leading in this technology at international level, but great R&D efforts are needed to maintain this position and to improve its performance and competitiveness. New scientific and technological developments require the experimental demonstration of the suitability, durability, reproducibility, efficiency and competitiveness of this concept, as they are intended to be deployed at a large scale. The EU-SOLARIS facility will fill the gap from the theory or the lab scale test to a demonstration plant of almost commercial size, offering room and favourable conditions for the implementation of advanced pilot projects. EU-SOLARIS will be supportive to the implementation and further development of CSP technologies via the SET-Plan.

Steps for implementation

The Preparatory Phase will focus on the definition of the organisational structure and rules, the detailed commitments of the partners from the different countries (Spain, Portugal, Italy, Greece, Germany and Turkey) and the drafting of a general strategic plan, as well as the identification of the synergies and complementarities among the participating research centres. Contacts with other research organisations from North Africa and Middle East countries will be made in order to incorporate them as associated partners. The access rules to the facilities in all the countries and the general terms applicable to joint research projects will be defined.

In parallel to this phase, existing installations will continuously be improved and new facilities built. In particular, CTAER and PSA will continue with their infrastructure investment plans along with their outstanding research activities with the financial support of the Ministry of Science and Innovation of Spain and the Regional Government of Andalusia.

EU-SOLARIS will pay special attention to the involvement of Industry. For that purpose, specific working groups - consisting of experts from research centres and companies - will be formed with the support of the industrial associations Protermosolar and Estela.

PREPARATORY PHASE

Not yet started

Coordination: Spain

TIMELINE

The upgrading and new installations are expected to be completed by 2016

ESTIMATED COSTS

- **Preparation:** 3.5 M€
- **Construction:** 80 M€
- **Operations:** 3 M€/year
- **Decommissioning:** 5 M€

www.ctaer.com

HIPER High Power Laser Energy Research Facility

PREPARATORY PHASE

Coordination: United Kingdom

Number of participating countries: 11

TIMELINE

- **Preparation phase:** 2008-2018 (includes risk reduction phase)
- **Construction phase:** 2016-2023
- **Operation phase:** 2028-2033

ESTIMATED COSTS

- **Preparation:** 15 M€ (EU contribution 3 M€)
- **Total development costs:** ca. 500 M€
- **Total construction, operation and decommissioning costs:** to be determined during the next phase.

www.hiper.org

The facility

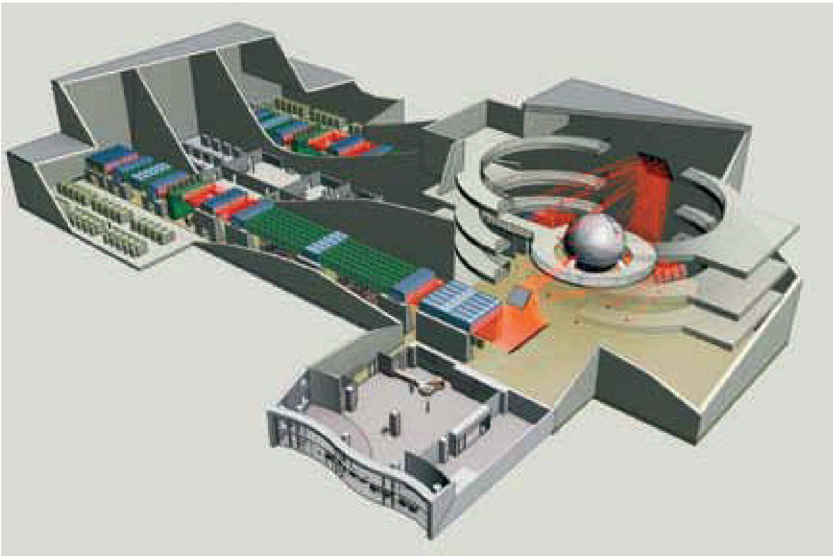
The primary goal of the HiPER project is to demonstrate the feasibility of laser fusion energy as a future energy source. Fusion is recognised as a viable long-term solution to the energy problem of security of supply, availability and environmental impact. It can provide a safe, effectively inexhaustible supply of energy with minimal waste products and inherent security of base-load supply to the national grid.

Background

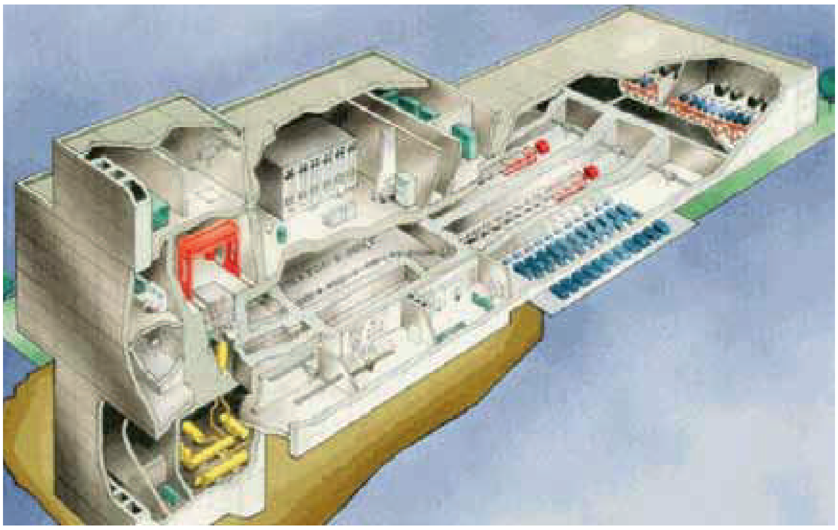
The underlying concept of 'inertial' fusion (the basis of Laser Energy) was demonstrated in the 1980s. Duplication of these results using a laser driver to produce net energy gain is anticipated in the period 2010-2012 at the National Ignition Facility (NIF) at the Lawrence Livermore National Laboratory in the United States. Success at NIF will be a full and sufficient demonstration of physics of laser-driven fusion. HiPER will define the path to viable power production from Laser Energy, following the proof of principle demonstration at NIF. Near term benefit will arise as a result of the innovation, captured intellectual property, spin outs and the generation of technological "know how". In addition, much of the innovation can be exploited by industry and other sectors. As an example, the laser technology required for HiPER has commercial applications ranging from laser treatment of highly stressed engineering components (e.g. turbines, aerospace and reactor components, etc.), large area surface treatment and materials processing. Scientific impact will result through the development of intense radiation sources, particle beams for medical applications and incorporation of high repetition rate laser technology with novel particle acceleration schemes. The technology development programme will advance the required technology from the current state of the art. Essential elements of this programme and will include the development of the next generation laser technology, reactor technology, micro-fabrication, high damage threshold coatings, robotics and optical components.

Steps for implementation

The EC-funded Preparatory Phase focuses on non-technical issues crucial for the project's realisation. In parallel, the Technical Preparatory Phase (2008 – 2011) aims to progress the technical deliverables of HiPER and is funded externally through contributions from national funding agencies. Following these Preparatory Phases, the Technology Development Phase will deliver technology development and prototyping of individual technology elements. Lastly, during the construction phase the HiPER facility will be constructed and integration of the individual technologies will be proven. The timeline for these last two phases is being developed.



IFMIF International Fusion Materials Irradiation Facility



The facility

IFMIF is an accelerator-based very high flux neutron source utilizing the deuteron lithium-stripping reaction with the aim to provide a timely and suitable data base on irradiation effects on materials needed for the construction of a fusion reactor. Although IFMIF does not rely on aggressive innovative technologies, its design beam power of 2x5 MW is by far the most intensive that has ever been built.

Background

The timely availability of a suitable neutron source such as IFMIF has become a major element in fusion strategy scenarios for the qualification of materials needed for a fusion reactor. The primary mission of IFMIF will be the 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 the performance of materials under neutron irradiation that simulates their use up to the full lifetime anticipated for DEMO. The source requirements include high availability, a neutron spectrum appropriate for fusion and temperature controlled high flux irradiation of more than one thousand 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 modules in the International Thermonuclear Experimental Reactor (ITER).

Steps for implementation

Engineering Validation and Engineering Design Activities (EVEDA) started in 2007, with the launch of the IFMIF/EVEDA project under the Broader Approach Agreement between Euratom and Japan. The aims of this project are to produce, by the end of 2013, an intermediate engineering design report for IFMIF and all the data necessary to aid future decisions on the construction, operation, exploitation and decommissioning of IFMIF, and to validate the continuous and stable operation of each IFMIF subsystem. Following the production of the Engineering Design Report, the recommendations of an external design evaluation panel will be sought and the siting request prepared. In parallel, additional input to the design evolution will be available from engineering validation experiments to be carried out as part of the IFMIF/EVEDA project up to 2017.

PREPARATORY PHASE

Not applicable – Project covered by Euratom/Japan Broader Approach Agreement

TIMELINE

2015 to 2019

ESTIMATED COSTS

- **Preparation:** 150 M€
- **Construction:** 1000 M€ (over 7 years)
- **Operations:** 150 M€/year
- **Decommissioning:** 50 M€

www.ifmif.org

MYRRHA European Fast Spectrum Irradiation Facility

PREPARATORY PHASE

Not yet started

Coordination: Belgium

TIMELINE

- **Preparation phase:** 2009-2013
- **Construction phase:** 2014-2019 (including commissioning)
- **Operation phase:** 2020-2050

ESTIMATED COSTS

- **Preparation:** 40 M€
- **Construction:** 960 M€
- **Operations:** 46.4 M€/year
- **Decommissioning**: 105 M€

http://myrrha.sckcen.be

The facility

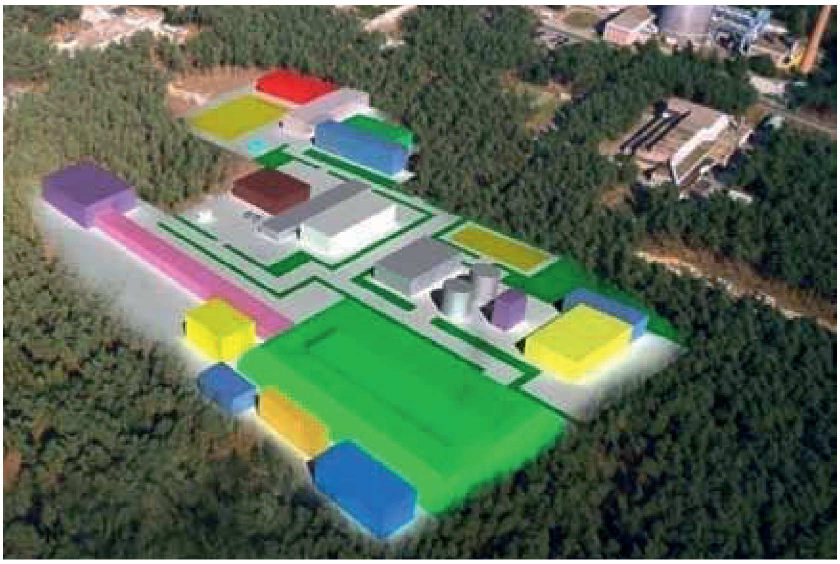
MYRRHA (Multipurpose hYbrid Research Reactor for High-Tech Applications) will be an innovative pan-European large Research Infrastructure. It is a hybrid system that consists of the combination of a high energy proton linear accelerator and a lead-alloy cooled fast spectrum irradiation facility. MYRRHA can be operated in both sub-critical (accelerator driven system mode) and critical mode.

Background

Security of energy supply is of paramount importance for Europe. The SET-Plan has identified nuclear fission energy as one of the contributing sources within the energy mix, if nuclear fission is made sustainable. The Sustainable Nuclear Energy Technology Platform (SNETP) indicates that GEN IV fast neutron reactors supplemented by a closed fuel cycle is the way towards sustainable nuclear fission. MYRRHA contributes to both of the above objectives and therefore is included in the Strategic Research Area (SRA) 2009 of the SNETP. It was chosen in 2010 as one of the three projects of the European Sustainable Nuclear Industrial Initiative (ESNII). MYRRHA, as a fast spectrum irradiation facility, completes the renewal of European research area of experimental reactors. MYRRHA will be the unique first large facility in the world that will allow the demonstration of the accelerator driven system (ADS) concept, thus initiating a large programme of research in the field of spent fuel partitioning and transmutation. It will be the only fast spectrum irradiation facility in the EU. Due to its characteristics, the facility offers the opportunity to respond to the needs of the nuclear fuel community and material fission and fusion community in terms of technological development and demonstration. As a critical lead-alloy based reactor, the facility will also significantly contribute to the demonstration of the GEN IV Lead Fast Reactor technology. This will put Europe in a leading position in the field of the development of sustainable nuclear fission systems as part of the transition to a low-carbon energy mix to mitigate climate change. Part of the proton beam can serve as a source of radioactive ion beams for fundamental physics research. It also offers the capability to produce specific medical radioisotopes.

Steps for implementation

A detailed business plan has been worked out and has been updated in 2009 to reflect the latest technical specifications and the project strategic developments. Belgium has committed itself to 40% of the construction costs and there is a broad international consortium supporting the project. MYRRHA could be constructed and operated as a European Research Infrastructure Consortium (ERIC).



MYRRHA will serve a large research community for the development of future fission and fusion energy systems *(Copyright: SCK-CEN)*.

WINDSCANNER The European WindScanner Facility

The facility

WindScanner is a unique, distributed Research Infrastructure providing fundamentally new knowledge about the wind, which will lead to more efficient, stronger and lighter wind turbines. Exploiting recent advances in laser wind measurement techniques, mobile 3-D remote sensing wind scanners will be deployed by seven large energy research institutes across Europe. This will provide an important catalysis for the future cooperation and integration of the European wind energy Research Infrastructures.

Background

The EU Directive on Electricity Production from Renewable Energy Sources demands a high rate of deployment of renewable energy, to which wind is expected to contribute significantly. This demand corresponds approximately to the installation of one large turbine every hour for the next decade. WindScanner contributes to the realization of the SET-Plan goals by establishing this new and truly distributed European facility. It is a scientific challenge to measure and understand the three-dimensional and time varying wind field as it passes through and interacts with the huge rotor of a modern wind turbine. Using traditional wind measurements made by anemometers mounted on meteorological masts, it is practically impossible to acquire the necessary 3-D wind information. Our present comprehension of the turbulent wind flow and its interaction with wind turbines is correspondingly limited. Conversely, WindScanner is based on remote sensing measurement concepts based on portable and easy deployable wind lidars and wind scanners. The new measurement technology will be disseminated and operated at both national and regional nodes, and interconnected throughout Europe via fast, scientific computer networks. The results obtained will foster improved computer models and permit a more optimal design of wind turbines. Ultimately, this will lead to better located, better wind turbines thus reducing the cost of renewable energy. Measurements with WindScanner facilities will therefore have a lower uncertainty than alternative wind tunnel scale testing or computer modelling.

Steps for implementation

WindScanners are based on portable and easy deployable wind lidars and wind scanners. During the preparation phase 2011-2013, the technology will be disseminated via the ESFRI process to the EERA participants' national and regional nodes. WindScanners will subsequently become operational and interconnected throughout Europe via fast, scientific computer networks.

Short-range Windscanner situated in front of a test wind turbine at Risø DTU.

PREPARATORY PHASE

Not yet started

Coordination: Denmark

TIMELINE

- **Preparation phase:** 2010-2012
- **Construction phase:** 2012-2015
- **Operation phase:** 2013 onwards

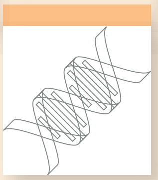
ESTIMATED COSTS

- **Preparation:** 8 M€
- **Construction:** 45-60 M€
- **Operations:** 4 M€/year
- **Decommissioning:** 0.1 M€

www.windscanner.eu

Biological and Medical Sciences

PART 2 Roadmap



Brief description of the field

Health and food are two major challenges arising from the rapidly increasing population worldwide and its 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, is a topic that requires urgent attention. Life sciences infrastructures will contribute to the solution of these important questions.

The Biological and Medical Sciences (BMS) initiative is a constituent pillar to implement the ERA by providing world-leading Research Infrastructures in a field of growing economic and societal importance. Biological and Medical Sciences Research Infrastructures (BMS Research Infrastructures) will provide an interdisciplinary, innovative environment where world-leading scientists conduct top-level research and use cutting-edge technologies to generate the new knowledge in the Biological and Medical Sciences that Europe needs in order to respond effectively to the "Grand Challenges". The generated knowledge will be transformed into technical and industrial developments and will provide tools for concerted European policies and coordinated actions.

Research Infrastructures on the Roadmap

In order to address the growing challenges and pressures in an effective and successful manner, strong research-driven insights will be required. Europe will only be able to develop these insights if the right Research Infrastructures are in place. For the Biological and Medical Sciences, the ESFRI Roadmap contains 10 Research Infrastructures which are essential to realize Europe's potential to meet the "Grand Challenges".

› **BBMRI**
Biobanking and Biomolecular Resources Research Infrastructure

› **EATRIS**
European Advanced Translational Research Infrastructure in Medicine

› **ECRIN**
European Clinical Research Infrastructures Network

› **ELIXIR**
European Life Science Infrastructure for Biological Information

› **EMBRC**
European Marine Biological Resource Centre

› **ERINHA**
European Research Infrastructure on Highly Pathogenic Agents

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

› **Euro-BioImaging**
European Biomedical Imaging Infrastructure

› **Infrafrontier**
European Infrastructure for Phenotyping and Archiving of Model Mammalian

› **INSTRUCT**
An Integrated Structural Biology Infrastructure for Europe

Delivery and operation of these 10 BMS Research Infrastructures will overcome the fragmentation of the European research landscape and will provide researchers with state-of-the-art technologies and world-class research facilities. Ensuring open access across all BMS Research Infrastructures will enable scientists to conduct and share cutting-edge research.

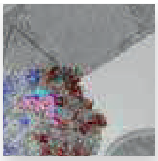
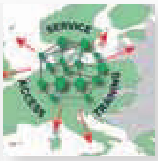
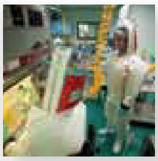
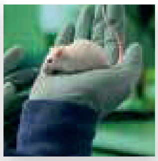
Implementation of the BMS Research Infrastructures would generate momentum across more than 1000 institutions and 2.000.000 researchers from more than 37 ESFRI Member States and Associated Countries, and act as a major catalyst for realisation of the European Research Area. This initiative will provide access to essential infrastructures across Europe, allowing the full potential of research in all countries across the ERA to be realised and to propel Europe to the forefront of Biological and Medical Science research globally, while simultaneously improving Europe's competitiveness in the BMS and health-related economies.

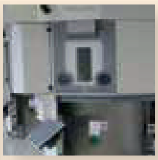
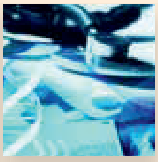
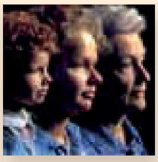
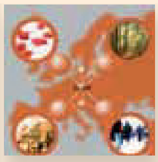
In addition to the afore mentioned 10 Research Infrastructures, the Biological and Medical Sciences Thematic Working Group decided to propose to ESFRI three new infrastructures to be included into the Roadmap 2010 after a thorough evaluation by independent experts and an in depth discussion among its members from almost 30 Member States:

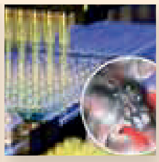
› **ANAEE**
Infrastructure for Analysis and Experimentation on Ecosystems

› **ISBE**
Infrastructure for Systems Biology – Europe

› **MIRRI**
Microbial Resource Research Infrastructure



What is missing – emerging fields

Synthetic Biology

Synthetic biology is an innovative and growing field which, by applying the principles of engineering to the biosciences, seeks to design and construct new biological parts and systems, and to redesign existing biological systems to deliver novel functions that do not exist in nature.

Synthetic biology is highly interdisciplinary, bringing together biologists of many expertises, engineers, chemists, physicists, computer scientists and many others to achieve an unprecedented insight on how biological systems function and how they can be improved to optimize certain biological activities. Building on the powerful research originating from recombinant DNA technology, genome sequencing and proteomics analysis, it aims to significantly deepen our understanding of the origin and function of living systems and to rebuild them to work better in the context of a wide range of biomedical, agricultural and food science, and environmental applications.

Biological energy production

Bioenergy is a relatively new area of science. The term "bioenergy" encompasses the use of biological feedstocks as sources of energy. Europe needs to develop a variety of renewable energy technologies to meet its targets for reduction in greenhouse gas emission and bioenergy will be included in the future energy portfolio. The majority of renewable energy sources involve the production of heat and or electricity; in contrast biofuels are currently the only source of liquid transport fuels, which can be derived from non-fossil sources. The advantage of using biofuels is that they can be used in existing vehicles using the existing fuel delivery infrastructure.

Europe has the potential for greater biofuel production but requires expanding research activities to achieve it. Current challenges in bioenergy include the development of new feedstock and/or the improvement of existing ones to enable growth of biomass crops on marginal land, with minimal water and fertiliser input, increased photosynthetic conversion, and better disease resistance. There is concern about the use of food crops as biofuel feedstock, because it can push up food prices to unaffordable levels in developing countries. Current research focuses on non-food crops, or agricultural waste, in order to reduce competition for land which might otherwise be used to grow food.

Agricultural Research

In the year 2050, the global agrifood and biomass industry has to deliver double output with half the resources. This simple statement is the outcome of three challenges, yet implies a fundamental re-consideration of our current systems for production and consumption:

(1) Three planets are needed for food, materials and energy usage should the expected 9 billion human beings follow a western consumption style;

(2) obesity and related diseases are increasingly putting pressure on health care costs, especially in ageing societies;

(3) shortage of clean water and oil threatens the full agrofood chain. Failure to overcome these challenges will result in further destruction of our ecosystem, a further bimodal distribution of hungry and obese people and collapsing health care systems.

These three societal challenges have been recognized by the European Commission and others, and are addressed by the Joint Programming Initiatives on "Agriculture, Food Security and Climate Change" and on "Healthy diet for a healthy life". However, taking up and dealing with these challenges is mainly done separately, in political terms, policy goals, business cases, up to R&D funding schemes, missing the fact that the three challenges are highly interrelated. Currently, first integrated visions and integrated R&D approaches are being developed; however, an integrated R&D infrastructure does not exist and is proposed by e.g. the working group on Infrastructures of the Standing Committee on Agricultural Research (SCAR).

The "agricultural research" working group in SCAR is proposing novel food research facilities consisting of integrated R&D Infrastructures, designed as a limited number of interlinked Infrastructures with the state-of-the-art equipment.

International cooperation

The BMS Research Infrastructures seek to establish and renew international collaborations and to construct solid, long-lasting partnerships that will secure a sustained and effective progress in critical areas, enhance the mobility of researchers and promote the efficient sharing of resources. The process of engaging with partners outside Europe is intended to complement national and EU policies and efforts to address these challenges and other global research activities. The national priorities for international cooperation serve as vehicles to reach out to Research Infrastructures in countries hosting equivalent resources and capacity, or hosting very specific yet essential resources from which BMS Research Infrastructures may benefit. The international partnerships developed by the Research Infrastructures may, in turn, have an influence in the development and implementation of national policies. ■

ANAEE Infrastructure for Analysis and Experimentation on Ecosystems

PREPARATORY PHASE

Not yet started

Coordination: France

TIMELINE

- **Preparation phase:** 2011-2014
- **Construction phase:** 2012-2017
- **Operation phase:** 2015-2035

ESTIMATED COSTS

- **Construction:** 210 M€
- **Operations:** 12 M€/year
- **Decommissioning**: not applicable

Website under construction.
For related activities see:
www.anaee.com

The facility

ANAEE aims at developing a coordinated set of experimental platforms across Europe to analyse, detect, and forecast the responses of ecosystems to environmental and land use changes. An additional aim is to engineer management techniques that will allow buffering of and/or adaptation to these changes. The distributed and coordinated network of in-situ and in-vitro experimental platforms of ANAEE will be associated with analytical and modelling platforms. Links with networks of instrumented observation sites will be established. The ANAEE data will be freely and openly available.

Background

Ecosystem research is increasingly vital to addressing policy issues facing Europe. Biogeochemical cycles coupled with biodiversity are central to climate change and food security issues. Yet European infrastructure to address such research is badly fragmented and uncoordinated. Progress in environmental research so far has been mainly the result of disciplinary and reductionist attempts to analyze separate compartments of the environmental systems. As a consequence, many current environmental problems cannot be clearly related to anthropogenic forcings despite large and costly research efforts. ANAEE will bring together, for the first time, the major experimental, analytical and modelling facilities in ecosystem science in Europe. In uniting under the same umbrella and with a common vision these highly instrumented ecosystem research facilities, ANAEE will be a key instrument in both structuring and improving the European Research Area in the field of terrestrial ecosystem research.

Steps for implementation

The Design Study carried out in 2008-2009 structured the scientific community and matured the infrastructure project to a level compatible with starting a Preparatory Phase. Repeated contacts with research organisations and ministries representatives during the course of the Design Study raised their interest for developing new infrastructures under an ESFRI ANAEE project. While several of them will need additional discussions during a Preparatory Phase before deciding any funding, representatives of a few countries already included ANAEE infrastructures in their national roadmaps and planned future funding.

The four complementary components and their associated analytical and modelling platforms.

BBMRI Biobanking and Biomolecular Resources Research Infrastructure

BBMRI includes a sample storage infrastructure. See here a hermetic semi-automated cryo-storage system.

The facility

BBMRI will be a pan-European distributed infrastructure of existing and new bio-banks and bio-molecular resource centres. It will provide access to human biological samples that are considered as essential raw material for the advancement of biotechnology, human health and research and development in Life Sciences (e. g. blood, tissues, cells or DNA that are associated with clinical and research data). It will also comprise bio-molecular research tools and bio-computational tools to optimally exploit this resource for global bio-medical research.

Background

BBMRI will build on existing sample collections, resources, technologies, and expertise, which will be specifically complemented with innovative components. In particular, BBMRI will comprise:

- all major population-based and disease-oriented bio-bank formats,
- bio-molecular resources, such as collections of antibodies and other affinity binders and a variety of molecular tools to decipher protein interactions and function,
- bio-computing and sample storage infrastructure,
- scientific, technical as well as ethical and legal expertise.

All resources will be integrated into a pan-European distributed network structure, and will be properly embedded into European scientific, ethical, legal and societal frameworks. Specific tasks in the planning of BBMRI include the generation of an inventory of existing resources, technologies and know-how that serve as building blocks of BBMRI, the implementation of common standards and access rules, the establishment of incentives for resource providers, and the development of solutions that facilitate international exchange of biological samples and data which properly consider the heterogeneity of pertinent national legislation and ethical principles.

Steps for implementation

The consortium today consists of 53 partners (including 19 ministries and funding organisations) and 222 associated organisations from 33 countries. The Preparatory Phase will end in 2011. For the construction phase BBMRI plans to adopt the European Research Infrastructure Consortium (ERIC) legal framework that supports the distributed architecture of BBMRI with operational sites in multiple Member States. A formal application for the creation of an international organisation under the ERIC legal status is expected for early 2011. Austria has offered to host the headquarters of BBMRI-ERIC and several Member States have officially expressed their interest in becoming members of BBMRI-ERIC and in committing funding for its operation. Construction and start of operation is foreseen for spring 2012.

PREPARATORY PHASE

Coordination: Austria

Number of participating countries: 16

TIMELINE

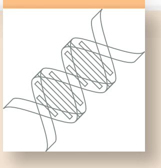
- **Preparation phase:** early 2008 – early 2011
- **Construction phase:** 2011-2012 for ERIC
- **Operation phase:** 2012 onwards

ESTIMATED COSTS

- **Preparation:** 3 M€
- **Construction:** 170 M€
- **Operations:** 3.5-5 M€/year for Headquarters, ~17M€/year for resource centres
- **Decommissioning**: n.a.

www.bbmri.eu

EATRIS European Advanced Translational Research Infrastructure in Medicine



PREPARATORY PHASE

Coordination: The Netherlands
Number of participating countries: 10

TIMELINE

- **Preparation phase:** 2008-2010
- **Construction phase:** 2011-2015
- **Operation phase:** 2016 onwards

ESTIMATED COSTS

- **Preparation:** 6 M€
- **Construction:** 20-100 M€ per Centre
- **Operations:** 3-8 M€/year per Centre
- **Decommissioning**: n.a.

www.eatris.eu

EATRIS is speeding up the process of translational research in Europe.

The facility

The European Advanced Translational Research Infrastructure in Medicine (EATRIS) will provide infrastructure allowing a faster and more efficient translation of research discoveries into new products to prevent, diagnose or treat diseases. EATRIS will operate through a pan-European consortium of leading biological and medical sciences research centres providing the necessary infrastructure facilities and expertise. They will form strong new innovation clusters, the EATRIS Translation Centres. These centres will provide cutting edge infrastructure and knowledge for the entire development from basic research to the clinic. According to their core expertise the EATRIS Centres will focus on certain disease(s) and product(s). The EATRIS consortium is open to all countries which want to contribute to new European translational Research Infrastructure.

Background

Translational research – the process of developing new tools or treatments to improve human health from initial discoveries – is not efficient enough. Too few findings from research make their way to the clinic. Infrastructure and targeted support for biological and medical scientists is needed to increase the number of innovative new medicinal products. EATRIS will fill this gap between discovery and clinical practice by developing a European Research Infrastructure consisting of key pre-clinical and clinical facilities having the translational expertise necessary to support the development of new preventive, diagnostic or therapeutic strategies.

At the core of the infrastructure are the EATRIS Translation Centres organised in a pan-European consortium. These EATRIS Centres will be opened up to all researchers for the translation of their research findings. Sharing experience and powerful translational infrastructures will lead to better healthcare provision and provide a bridge between countries of different translational capacity, making Europe more competitive.

Steps for implementation

A Memorandum of Understanding has been signed by seven countries who want to follow up EATRIS and create it as an independent legal entity under the ERIC regulation. An Implementation Agreement is currently underway to secure funding until the final establishment of the legal entity by 2011-12.

During the transition, the countries will already implement the EATRIS Centres and start first pilot projects to demonstrate the operation of EATRIS. Training facilities and programmes specifically dedicated to translational research will also be developed.

ECRIN European Clinical Research Infrastructures Network

Clinical research often involves patients with specific health conditions who then benefit from receiving otherwise unavailable treatments.

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 clinical research 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.

Steps for implementation

The Preparatory Phase will end in 2011. It is almost completed and a wide range of actions was implemented to achieve ECRIN's goal to enable multinational cooperation in investigator-driven clinical research in Europe.

ECRIN's organisation is based on the connection of a national hub coordinating national networks of clinical Research Infrastructures. ECRIN currently covers 14 EU countries and therefore reaches a critical mass which has no equivalent in Europe.

ECRIN's staff benefits from the know-how accumulated during the previous FP6 funded projects and the first 'pilot' projects have started with the support of ECRIN consultancy and services.

A formal application for the creation of an international organisation under the legal status of an ERIC, which should be hosted by France, is expected for mid 2011.

PREPARATORY PHASE

Coordination: France

Number of participating countries: 14

TIMELINE

- **Preparation phase:** 2008-2011
- **Construction/operation phase:** 2011 onwards

ESTIMATED COSTS

- **Preparation:** 5.8 M€
- **Construction:** actual construction costs absorbed by the update and certification of national IT components.
- **Operations:** 3.5 M€/year
- **Decommissioning**: not applicable

www.ecrin.org

ELIXIR European Life-Science Infrastructure for Biological Information

PREPARATORY PHASE
Coordination: EMBL
Number of participating countries: 14

TIMELINE
- **Preparation phase:** 2007-2011
- **Construction phase:** 2011
- **Operation phase:** 2012 onwards

ESTIMATED COSTS
- **Preparation:** 4.5 M€
- **Construction:** 470 M€
- **Operations:** 100 M€/year
- **Decommissioning**: not applicable

www.elixir-europe.org

The facility

ELIXIR will be a secure, rapidly evolving platform for collection, storage, annotation, validation, dissemination and utilization of biological data. It will comprise a distributed, and interlinked collection of core and specialized biological data resources. The core resources 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 specialized resources will be distributed across Europe. ELIXIR will also include the necessary major upgrade to the computer infrastructure to store and organize this data in a way suitable for rapid search and access, and will provide a sophisticated but user-friendly portal for users. Additionally, it will provide the infrastructure necessary to utilise data in a manner that is most appropriate for users of other Research Infrastructures in biological and medical sciences and environmental sciences.

Interactions within the European Life-Science Infrastructure for Biological Information.

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. Investment in infrastructure, however, has not kept pace with the very rapid rate of data growth. Additionally, 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. In this context, ELIXIR will permit the integration and interoperability of diverse, heterogeneous, potentially redundant information that is essential to generate and utilize biomedical knowledge, and it will support the development of critically important standards and ontologies.

Steps for implementation

Several countries (Spain, Sweden, Finland, Denmark and the UK) have already provided funds to the nucleation of what would become their national nodes of ELIXIR, and it is also being included on the roadmap in an increasing number of countries. A 10 M£ investment by the UK is being used to initiate the implementation of the ELIXIR European data centre. Most recently ELIXIR has been included in the Spanish roadmap related with ESFRI infrastructures. Applications are pending in several countries.

A hub and node structure has been identified as the only realistic structure for ELIXIR. The hub will be located at EMBL-EBI and will continue to host core data-collections. It will also host the secretariat, manage its European data centre, and coordinate the nodes. ELIXIR nodes will be distributed throughout Europe and will provide components of the European infrastructure. They will be configured to interoperate both with the central hub and with each other. They will need to be able to enter into an agreement with the hub and be funded by the member states.

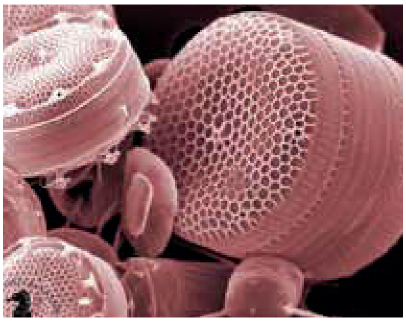
EMBRC European Marine Biological Resource Centre

The facility

The European Marine Biological Resource Centre (EMBRC) will comprise a consortium of key European marine biological and molecular biology laboratories, together providing:

- access to a wide range of European coastal marine biota and their ecosystems;
- an integrated supply of marine organisms for interdisciplinary research, including existing and new models;
- coordinated services including state-of-the-art bio-banks and dedicated platforms for genomics, structural and functional biology, microscopy and bioinformatics;
- interdisciplinary training in marine biological sciences and genomics; and
- outreach to stakeholders, users and the public at large.

Access to resources will be provided both on site (to resident and non-resident users) and remotely (e.g. sending samples, e-resources). End users are expected to comprise not only marine biologists and in-house staff, but also researchers from other scientific institutes, universities, governmental and NGO agencies, SMEs and industry.



A phytoplankton sample featuring Thalassiosira species, for one of which the genome has been sequenced *(Copyright: SZN)*.

Background

Marine biodiversity is essential in ecosystem functioning and for our quality of life. This has stimulated construction of marine biological research institutes around the European coastline over the last 125 years. Over time, these have developed, largely independently, into world renowned facilities. Taken together, the European marine biological stations represent a critical mass of infrastructure and human resources that has had a significant influence on the history of worldwide marine research.

Marine biology is currently experiencing ground-breaking technological and theoretical advances, notably associated with the introduction of state-of-the-art '-omics' approaches. This is facilitating rapid progress in existing disciplines, integration of this field into a range of other research domains, and creation of major new avenues of research. The need for integrated study in marine biology is becoming increasingly compelling as global warming and ocean acidification start to affect whole ecosystems. In parallel, the pressure on stocks of commercial marine bio-resources is rapidly escalating, resulting in increasing focus on mariculture alternatives, and biotechnological interest in the extremely diverse pool of materials, molecules and genes from marine organisms is booming.

Steps for implementation

The Preparatory Phase will start in February 2011. The aim is to develop a coherent pan-European strategy for interconnecting, harmonising and upgrading the actual infrastructures and the common services they provide in light of common analysis and projection of Europe-wide user requirements. This will significantly enhance competitiveness of European research and industry in a global context.

PREPARATORY PHASE

Coordination: Italy
Number of participating countries: 9

TIMELINE

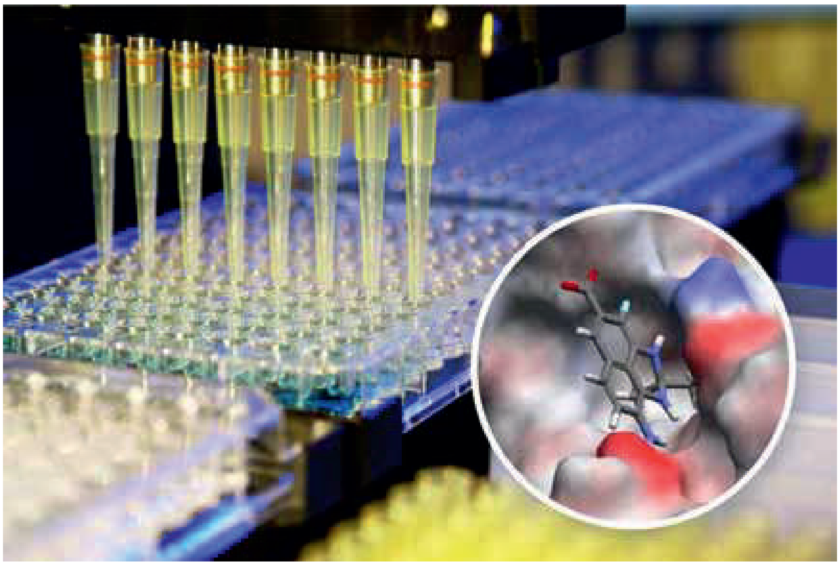
- **Preparation phase:** 2010-2013
- **Construction phase:** 2010-2017
- **Operation phase:** 2014-2034

ESTIMATED COSTS

- **Preparation:** 7.5 M€
- **Construction:** 100 M€
- **Operations:** 60 M€/year
- **Decommissioning**: not applicable

www.embrc.eu

ERINHA European Research Infrastructure on Highly Pathogenic Agents



PREPARATORY PHASE

Coordination: France

Number of participating countries: 13

TIMELINE

- **Preparation phase:** 2010-2013
- **Construction phase:** 2014-2019
- **Operation phase:** to be determined

ESTIMATED COSTS

- **Preparation:** 4.4 M€
- **Construction:** 174 M€
- **Operations:** 24 M€/year
- **Decommissioning**: not applicable

www.erinha.eu

The facility

Erinha will be a pan-European distributed Research Infrastructure aiming to reinforce the European coordination and capacities for the study and the surveillance of highly pathogenic micro-organisms. It will provide open access to state-of-the-art BSL4 facilities for the European scientific community to enhance basic and targeted research activities and diagnostic activities. The infrastructure aims to promote the harmonization of bio-safety and bio-security procedures, to develop standards for the management of biological resources, diagnosis of group 4 pathogens, and to develop training of BSL4 labs users.

Background

One of the great challenges of the 21st century is the capability to react to human and animal highly pathogenic micro-organisms. In the past, Nipah outbreaks and the more recent SARS and avian flu epidemics have demonstrated the reality of infectious threat and worldwide vulnerability in the face of emerging and re-emerging infectious disease.

A European coordinated strategy such as Erinha is needed to ensure access to diagnosis, vaccine and treatment for each European citizen. This implies the construction and implementation of a new pan-European Research Infrastructure dedicated to highly pathogenic agents.

Steps for implementation

The Preparatory Phase started on the 1st November 2010 and will have a duration of 36 months. The objective of the Preparatory Phase work plan is to implement a strong and efficient governing structure and reach the legal, financial and technical maturity to be able to proceed to the construction of the infrastructure. Erinha actually gathers relevant and complementary expertise of 20 partners and 15 associated partners from 15 countries across Europe. These participants comprise research institutions involving all existing running BSL4 laboratories, and government bodies.

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

The facility

EU-OPENSCREEN will be an open-access infrastructure for the development of bioactive small molecules. It will include a large collection of diverse compounds (at least 0.5 million), high throughput screening (HTS) centres, hit optimisation facilities, and a publicly accessible database combining screening results, assay protocols, and chemical information. This integrated infrastructure will meet the needs for new bioactive compounds in all fields of life sciences (human and veterinary medicine, systems biology, biotechnology, agriculture, nutrition, etc.).

Background

EU-OPENSCREEN brings together chemical and biological expertise to overcome the fragmentation of European research in the field of chemical biology. Through the transnational and coordinated activities of EU-OPENSCREEN, a substantially accelerated generation of knowledge on the bioactivities of chemicals as well as on the responses of biological systems will be achieved. European researchers from academia will obtain access to the most advanced screening technologies that are currently only available in an industrial environment.

Steps for implementation

The infrastructure will be composed of integrated screening platforms hosting high-throughput methodologies, a coordinated compound management and distribution and, as a key element, a database. Common standards will be established for efficient transfer of materials and procedures. There will be a restricted number of screening centres with copies of the compound collection, applying various methodologies and operating at a high degree of automation. The Preparatory Phase started in November 2010. During the Preparatory Phase the design of the infrastructure will be planned in further detail and specifications will be elaborated. Technical challenges are the creation of a large compound collection (> 0.5 million substances) and the establishment of a high degree of automation at the major sites.

It is envisaged to create a legal entity, such as a European Research Infrastructure Consortium (ERIC), in order to facilitate the interaction of the stakeholders involved and their cooperation with the external users. EU-OPENSCREEN membership will be open to all European organisations involved in chemical biology and will offer access to external scientists. A coordinated research and training program will be developed and a central management office will be set up.

Copyright: Inserm, P. Latron

PREPARATORY PHASE

Coordination: Germany

Number of participating countries: 12

TIMELINE

- **Preparation phase:** end 2010 – end 2013
- **Construction phase:** 2014
- **Operation phase:** 2015 onwards

ESTIMATED COSTS

- **Preparation:** 3.7 M€
- **Construction:** 40 M€
- **Operations:** ca. 40 M€/year
- **Decommissioning**: not applicable

www.eu-openscreen.eu

EURO-BIOIMAGING European Research Infrastructure for biomedical imaging

PREPARATORY PHASE

Coordination: EMBL

Number of participating countries: 17

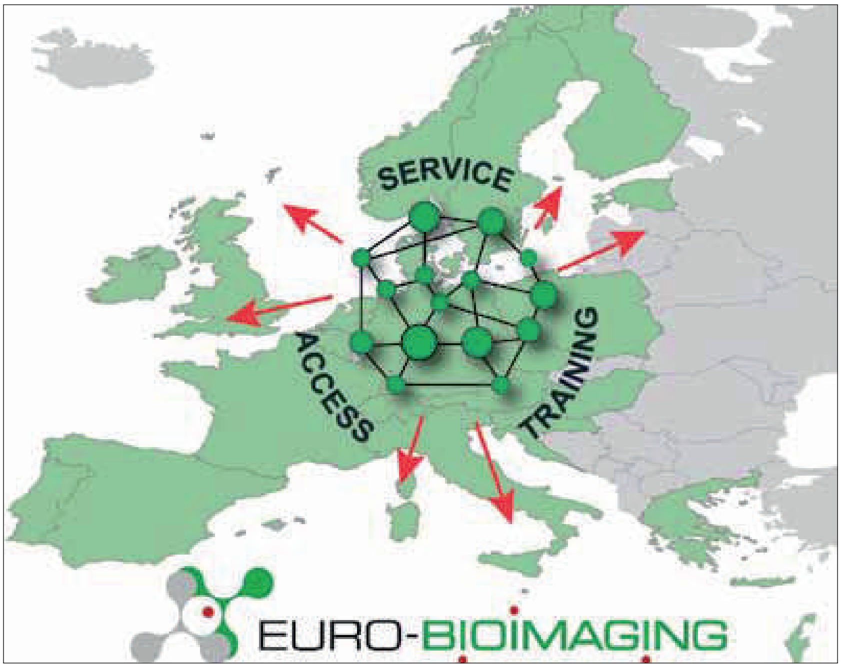
TIMELINE

- **Preparation phase:** 2010-2013
- **Construction phase:** 2013-2017
- **Operation phase:** 2013 onwards

ESTIMATED COSTS

- **Preparation:** 7.9 M€
- **Construction:** 600 M€
- **Operations:** 250 M€/year
- **Decommissioning**: not applicable

www.eurobioimaging.eu



The facility

Euro-Bioimaging will be a European Research Infrastructure for biomedical imaging stretching from basic biological imaging up to medical imaging of humans and populations. It will consist of a number of distributed and strongly coordinated biomedical imaging infrastructures ("nodes"), which will serve European scientists by providing access to, and training in, advanced imaging technologies across the full scale of biological and medical applications. At the same time, the infrastructure will provide the possibility for many existing imaging research institutions or laboratories to contribute to technology development and training. Euro-BioImaging will also serve as a platform delivering knowledge and expertise, allowing exchange of methodologies and the joint use of acquired data.

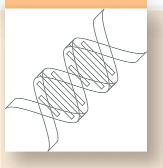
Background

Research in and application of bio-molecular and biomedical imaging is progressing rapidly and in a multidisciplinary manner. 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. It is now necessary to provide broad access to state-of-the-art and new emerging imaging technologies to the European scientific community, to strengthen research and training in imaging and to ensure European leadership in this competitive field.

Steps for implementation

The planning and construction of future nodes of Euro-BioImaging will be an open and transparent process aligned with the different phases of the Euro-BioImaging project. They include: i) a *Consultation phase* (2011-2012) to develop and publish eligibility criteria for nodes of the planned infrastructure. Common criteria for all Euro-BioImaging nodes will be scientific/technological excellence, open access for external users and support from funders; ii) a Planning phase (2012-2013) whereby an open call for future Euro-BioImaging nodes based on the defined eligibility criteria will be published; iii) a Construction phase (2014-2017) whereby Euro-BioImaging nodes will be newly constructed or existing facilities will undergo major upgrades, subject to the results of the Planning phase and the availability of funding. Imaging facilities (Euro-BioImaging) are currently listed on the national roadmaps of CZ, EE, IL, ES, FI, FR, IE, IT, NL, NO, SE.

INFRAFRONTIER European Infrastructure for phenotyping and archiving of model mammalian genomes



The facility

Infrafrontier will be a distributed Research Infrastructure offering access to systemic phenotyping, archiving and distribution of mouse models for human diseases to the biomedical research community. The Infrafrontier Research Infrastructure will be composed of mouse clinics and mouse repository facilities. Mouse clinics are high-throughput phenotyping centres that carry out a comprehensive clinical characterisation of mouse mutants in order to reveal the molecular and functional basis of human diseases and to identify mouse models for biomedical research. Scientifically valuable mouse models are archived and distributed by EMMA (the European Mouse Mutant Archive), which is an intrinsic part of the Infrafrontier Research Infrastructure.

Background

The mouse has become a central tool for the study of the functional basis of human diseases. Men and mice share 95% of their coding genes and researchers have developed an extensive methodology for targeted intervention in the mouse genome to unravel gene function. Mouse models are used in all disease areas, and hundreds of new mouse strains are created each year by the biomedical research community. This creates an enormous demand for access to a comprehensive characterisation, archiving and distribution of these mice that cannot be accommodated with the capacities currently available in Europe. Therefore the Infrafrontier partners are scaling-up capacities, both by building new facilities and upgrading existing ones, and by providing an efficient framework for pan-European cooperation in the Infrafrontier Research Infrastructure.

Steps for implementation

The Infrafrontier consortium started out with 22 members from 10 European countries and has meanwhile become a global initiative with 28 members from 12 European countries and Canada. The signing procedure for a Memorandum of Understanding between the Infrafrontier Member States for setting up Infrafrontier ERIC is currently under way. A formal application for the creation of Infrafrontier ERIC, based on the Infrafrontier business plan, is expected for mid 2011.

The mouse as model organism for biomedical sciences.

PREPARATORY PHASE

Coordination: Germany
Number of participating countries: 15

TIMELINE

- **Preparation phase:** 2008-2011
- **Construction phase:** 2011-2014
- **Operation phase:** 2011 onwards

ESTIMATED COSTS

- **Preparation:** 4.8 M€
- **Construction:** 180 M€
- **Operations:** 80 M€/year (0.9-1 M€/year for central coordination unit)
- **Decommissioning**: not applicable

www.infrafrontier.eu

INSTRUCT Integrated Structural Biology Infrastructure

PREPARATORY PHASE

Coordination: United Kingdom

Number of participating countries: 6

TIMELINE

- **Preparation phase:** 2008-2011
- **Construction phase:** 2011-2018
- **Operation phase:** 2012 onwards

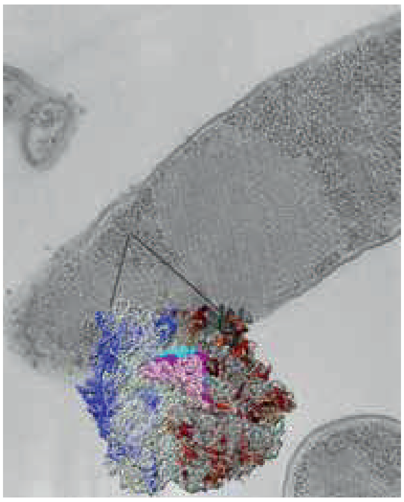
ESTIMATED COSTS

- **Preparation:** 4.5 M€
- **Construction:** 300 M€
- **Operations:** 25 M€/year (750 k€/year for coordination office)
- **Decommissioning**: 50 M€

www.instruct-fp7.eu

The facility

INSTRUCT is a European distributed infrastructure that will promote integrative science by providing open access to state-of-the-art structural biology technologies to researchers in member countries. INSTRUCT will facilitate research that brings together biological structure with cellular function by not only providing infrastructure but also engaging in development of instrumentation, technologies and methodologies. INSTRUCT will enable its members to access instrumentation and expertise through a dynamic, sustainable infrastructure which will stimulate innovation at the boundary between technologies, and foster a valuable relationship with industry.



Virus particles along with ribosomes – an expanded structural representation.

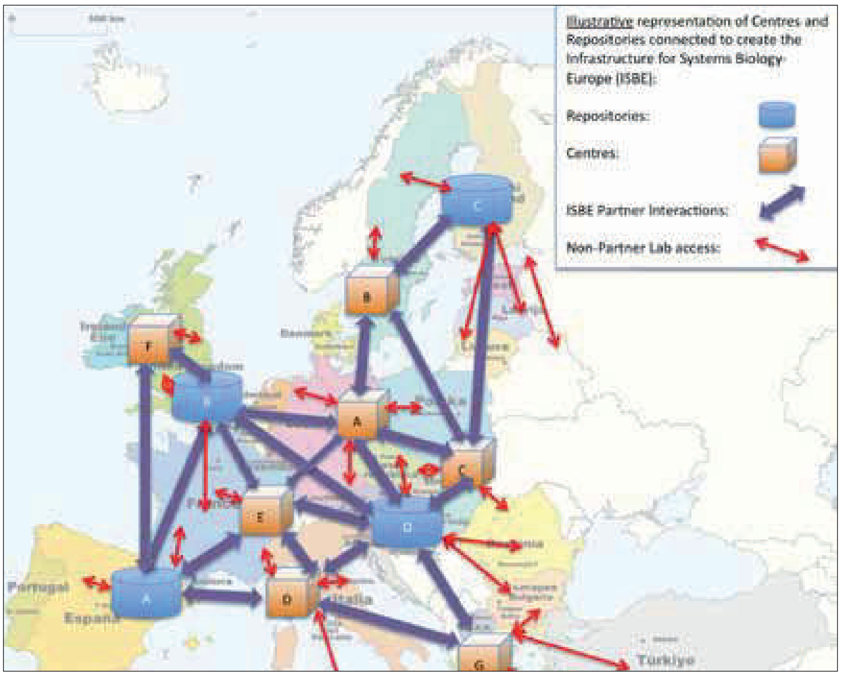
Background

Europe has, for many years, demonstrated world-leading strength in structural and cell biology. Both disciplines advance our understanding of how biological systems function, and underpin progress in biomedicine and biotechnology, thus benefiting public health, the environment and the economy. Integrated structural biology will allow us to see in atomic detail the mechanisms by which healthy cells function and diseases progress, and help to provide new therapeutics to meet the grand challenges of an ageing society, public health and global pandemics. The equipment at the frontier of today's structural biology is expensive to build and maintain and will become more so in the future. A co-ordinated European infrastructure will allow ongoing development of, and user access to, state-of-the-art sample preparation and characterisation facilities and core structure determination technologies, as well as novel structural biology technologies that are developing at the interface with cell biology. INSTRUCT will therefore help to drive the co-ordinated development across Europe of the next generation of technologies.

Steps for implementation

INSTRUCT comprises 14 centers providing infrastructure for access to scientists. A membership fee of €50K per annum per member state has been agreed. Letters of support have also been sent to INSTRUCT by the Directors of major funding bodies in UK, Germany, France and Italy and discussions are in progress in a large number of other member states. A Memorandum of Understanding has been drafted, a legal model has been agreed and the process towards establishing a Special Purpose Legal Entity for INSTRUCT operations is well advanced. INSTRUCT will be launched officially on 1st April 2011. On that date, the first calls for access proposals will be published, kick-starting the infrastructure provision for an ambitious programme of integrated biology in Europe.

ISBE Infrastructure for Systems Biology-Europe



The facility

ISBE will (I) interconnect hubs of technological excellence in Systems Biology, offering the best European research expertise, and experimental and modelling facilities, necessary for systems biology, (II) establish and make available repositories of data and models, and (III) enable real-time connections within and between components of (I) and (II) and with external 'user' laboratories, through the provision of high performance connections to existing high capacity electronic network infrastructures. Hubs will contribute specific skills and expertise to functional clusters focused on a variety of topics in an operational matrix, and some hubs may have groups that participate in different and/or multiple clusters. This structure will also facilitate efficient interaction with the substantial technology development efforts relevant to Systems Biology already funded by national and EU programmes. ISBE will enable all European laboratories to model, conduct experiments and undertake other essential activities remotely, where they cannot be done locally.

Background

Detailed information on components of living systems continues to increase, but our ability to understand the dynamic interactions within systems remains a challenge. Hitherto it has not been possible to tackle this challenge effectively because of technical limitations and limited accessibility to a small number of specialised groups. This situation is rapidly changing and this is a timely opportunity to coordinate the distributed European research effort in Systems Biology within an infrastructure, the focus of which will be to enable researchers to address how the interaction of biological components leads to the functioning of living organisms in a constantly changing environment, create models of living organisms at various scales representing these interactions, and exploit this information to generate major-socio-economic benefits in areas including healthcare, agricultural science and the environment.

Steps for implementation

Early in the Preparatory Phase of ISBE, memoranda of understanding between the component institutions will be put in place. The Preparatory Phase will organise calls for, and subsequent evaluations of, proposals for additions to the infrastructure. A Scientific Advisory Board of international scientists will be asked to check on the excellence of ISBE, its governance structure and its membership. Standards and IP issues will then be discussed and agreed.

PREPARATORY PHASE

Not yet started

Coordination: United Kingdom

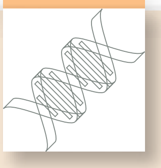
TIMELINE

- **Preparation phase:** 2012-2014
- **Construction phase:** 2014-2017
- **Operation phase:** 2017 onwards

ESTIMATED COSTS

- **Preparation:** 6 M€
- **Construction:** 300 M€
- **Operations:** 100 M€/year
- **Decommissioning**: not applicable

Website under construction
For related activities see
www.erasysbio.net



MIRRI Microbial Resource Research Infrastructure

PREPARATORY PHASE

Not yet started

Coordination: France

TIMELINE

- **Preparation phase:** 2012-2014
- **Construction phase:** 2014-2017
- **Operation phase:** 2014 onwards

ESTIMATED COSTS

- **Construction:** 190 M€
- **Operations:** 10.5 M€/year
- **Decommissioning**: not applicable

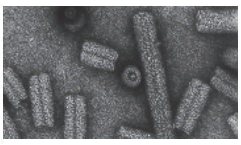
Website under construction.
For related activities see
www.embarc.eu and www.gbrcn.org

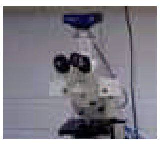
The facility

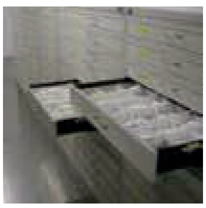
MIRRI will be a pan-European distributed Research Infrastructure that will provide microbiological services facilitating access to high quality microorganisms, their derivatives and associated data for research, development and application. It will connect resource holders with researchers and policy makers to deliver the resources and services more effectively and efficiently to meet the needs of innovation in biotechnology. The infrastructure project includes over 70 microbial domain resource centres in 26 European countries; collectively they provide access to more than 350,000 strains of microorganisms.

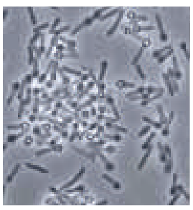
Background

Microorganisms provide essential raw material for biotechnology – but to date less than 1% of the estimated number of species are described and available to be harnessed. As new species are discovered, the expertise is difficult to locate to ensure its correct identification and this human resource is diminishing. Public sequence databases are expanding, rapidly providing modern tools for identification but the information is often of poor quality and not backed up by the biological material which would enable validation of data. The current fragmented resource distributed across Europe needs to be coordinated by a network of microbial domain Biological Resource Centres (BRC) operating to common standards with facilitating policy. This can help focus activities to resolve key problems and address the big challenges in healthcare, food security, poverty alleviation and climate change.





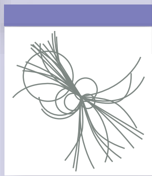


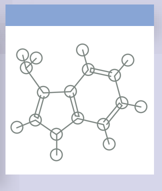


Steps for implementation

The key resource centres have been identified and are well established across Europe. Lacking infrastructure, policy framework and governance structures will be defined in the Preparatory Phase, as will be the links to researchers and policy makers and their roles in the future development. Identified representative groups will evaluate their best contribution to this Research Infrastructure. Envisioned specialist clusters will address priority issues, their structure and output steering. Cross discipline interaction with other Research Infrastructures (such as BBMRI and ELIXIR) will lead to new approaches. An appropriate data mining solution will enable MIRRI to focus its acquisition strategy, to ensure its partners' high performance allocation of required strains and hence bridge current gaps.

Priority activities will be: define form and governance mechanisms; identify and engage researchers, users and policy makers; define scope, work programmes and business plans; establish implementation mechanism i.e. secretariat and clusters; establish data interoperability and support innovative information systems.





Brief description of the field

Engineering and physical sciences (EPS) cover a wide range of research areas and types of infrastructures as well as materials and analytical facilities. In the present context, the main areas are: engineering research (e.g. fluid dynamics, hydraulics and nano-technology), materials science (focused on analytic facilities), astronomy, astrophysics, nuclear physics and particle physics. Research Infrastructures play an increasingly important role in the advancement of knowledge and technology in all these areas. New knowledge and innovation can only emerge from high-quality and easily accessible Research Infrastructures like radiation sources, data banks, observatories for astronomy and astrophysics, imaging systems and clean rooms for the study and development of new materials or nano-electronics. The communities in the physical sciences and engineering have known for a long time that such large Research Infrastructures require typically funding from international consortia, but as the ESFRI Roadmap exercise has shown, not all fields of research have developed the same degree of international co-operation regarding Research Infrastructures. The landscapes of the different scientific areas reflect this difference in tradition.

Research Infrastructures on the Roadmap

Out of the 14 Research Infrastructure projects published in the 2008 Roadmap update, five are now implemented: ESRF Upgrade, European XFEL, FAIR, ILL 20/20 upgrade and SPIRAL2. The on-going upgrade process of the existing Research Infrastructures ESRF and ILL will be completed in 2015, construction work for the European XFEL has started in 2009 and FAIR has reached the next stage of implementation with the official signing of the convention by several partner countries. The start of construction for this facility is foreseen for the end of 2011.

The European Spallation Source (ESS) has made a huge step forward into the implementation phase by deciding to locate the facility in Lund (Sweden). First results have been achieved in setting up the necessary legal and administrative framework for an ESS company. E-ELT and ELI are also making good progress towards implementation, since in both cases the decision on the location of the facility has been taken.

PRINS, as already mentioned at the beginning of this section, has chosen another approach for its implementation; therefore, it has been taken out of the roadmap.

The remaining projects considered in this section of the ESFRI roadmap are:

› **CTA**
Cherenkov Telescope Array for Gamma-ray astronomy
› **E-ELT**
European Extremely Large Telescope for optical and infrared astronomy
› **ELI**
Extreme Light Infrastructure: ultra high intensity short pulse laser
› **EMFL**
European Magnetic Field Laboratory
› **EuroFEL**
Complementary Free Electron Lasers in the Infrared to soft X-ray range
› **European Spallation Source**
European Spallation Source for neutron spectroscopy
› **KM3NeT**
Cubic Kilometre Neutrino Telescope
› **SKA**
Square Kilometre Array Radio Telescope

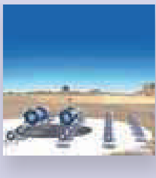
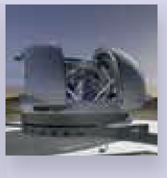
What is missing – emerging fields

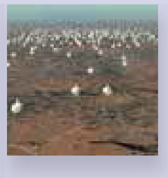
There are several common issues to be tackled for the Research Infrastructures in engineering and physical sciences. Many of these need to be dealt with in a global dialogue. ESFRI will continue to develop a structured outreach to the organised scientific communities in these fields. ESFRI encourages closer and enhanced cooperation and networking of Research Infrastructures to form new European Strategic Partnerships. The EPS TWG believes that ESFRI should also encourage new forms of partnerships with industry to accelerate technological developments and secure strategic materials, which may be unique to Research Infrastructure use like ^{3}He. Finally, ESFRI will work towards common approaches to handling the increased streams of data from the new Research Infrastructures – the "data deluge" – that can be foreseen in the physical sciences in particular.

With regard to the highly differentiated scientific landscapes in the broad area of Engineering and Physical Sciences the vast potential of Research Infrastructures to make a valuable contribution to intensify interdisciplinary co-operation in science and technology development is remarkably high.

Engineering sciences

Engineering research typically has components of both basic and applied research as well as experimental development. Therefore many of the Research Infrastructures used for materials research also serve the engineering research communities. A survey of existing engineering Research Infrastructures showed that there are well functioning European networks of national facilities in the fields of fluid-/aerodynamics (e.g. wind tunnels), hydraulics and nano-technology.



Fluid dynamics is a scientific field in which turbulent flows as one of the major challenges in physics and engineering are examined. High Reynolds-number turbulence is ubiquitous in aerospace engineering, ground transportation systems, flow machinery, energy production (from gas turbines to wind and water turbines), as well as in nature, e.g. various processes occurring in the planetary boundary layer. Wind tunnels and other Research Infrastructures in this area are typically national or regional with mixed scientific and commercial missions. The collaboration on methodology and standards in European programmes should be developed into strategic partnerships.

Water is one of the essentials of life. In this section, just those aspects of water classed as **hydraulics** in the sense of natural flows in rivers, estuaries and the sea, the use of water for transport, and the consequences of ice in the environment shall be considered. Experiments in hydraulics are fundamental for creating the necessary tools for predictions of such phenomena as flooding, coastal inundation, impact on water quality in rivers, estuaries, coastal and marine areas, exploitation of ocean-based resources, ship design and ice engineering. Over the last sixty years, the balance has shifted from an emphasis on experimental laboratory and field research to an emphasis on numerical modelling. Field experiments and experimental laboratory research are nevertheless indispensable to the synergetic approach of hydraulic research. A promising example of the urgently needed co-ordination and co-operation on a European scale is the Integrating Activity HYDRALAB. Hydraulic research facilities have been established as national or regional Research Infrastructures and are typically operated with both commercial and scientific missions. The European co-operation is focused on co-ordination, common transnational access procedures, development of new experimental methods and analytical tools. ESFRI encourages further strengthening of these activities.

Nano-science and technology embraces materials science, materials technology and engineering. It studies the manipulation or self-assembly of individual atoms, molecules, or molecular clusters into structures to create materials and devices with new properties. There is no doubt that nano-science and technology is, and will be, one of the major research and development areas for the coming decades. Due to its very multidisciplinary nature, the question on Research Infrastructure needs is quite different from that of other fields. A broad range of often smaller but dedicated and complementary equipment is needed in one single site in order to be able to perform all processing and characterization steps needed. A recent report of the Nanoforum [12] clearly shows that Europe already has a large number of research centres dealing with nano-science and – technology. Organising these typically smaller centres into a network and stimulating transnational access to all existing facilities could help to avoid duplication and also could reduce costs. Great advantage could come from co-location of analytical facilities and nano-science centres, for example. Such a growing concentration of capability adds value to the scientific landscape of Europe as a whole, but on the other hand it needs to be balanced by a broad geographic distribution of partner facilities and networks, and by mechanisms to ensure broad scientific use and access to the facilities. In general, a closer and enhanced co-operation of Research Infrastructures to form new European strategic partnerships should be encouraged.

[12] See *www.nanoforum.org*: "European Nanotechnology Infrastructure and Networks" (published July 2007).

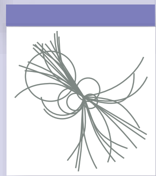
Materials and analytical facilities

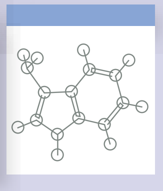
The rate at which new products can be developed, and pressing societal challenges can be met, is closely linked to our ability to characterise materials across a range of spatial and temporal scales. For example, our capacity to analyse in detail key processes related to catalysis, smart materials, biomedical devices, tissue regeneration or even to threats to global security will profoundly affect our standard of living and general well-being. Similarly, the speed of our response to global challenges such as pandemics or natural disasters is also closely linked to the ability of scientists and engineers to have access to analytical infrastructures. Having access to high class Research Infrastructures has enabled us now for more than a century to live in durable and effective industrial and economic growth, based on increasingly sophisticated new products from catalytic converters or cell phones to new pharmaceutical drugs, accompanied by continuous improvement in traditional products, from car engines to glass cover for housing or highly developed functional fabric for clothing.

Well equipped laboratories are necessary for carrying out advanced research on these new materials. Among the necessary infrastructures are: clean rooms for synthesis and processing, high quality analytical facilities based on synchrotron radiation sources, free electron lasers, neutron sources, high power laser laboratories, high magnetic field laboratories and high resolution electron microscopes. ESFRI will explore ways in which networking and linking of these facilities can create European added value.

Astronomy and astroparticle physics

In the exploration of the universe as a whole, of the objects in it and in the quest to gain a better understanding of the constituents of matter and their behaviour, science has made enormous progress in





recent decades. In turn, this progress has generated a lot of new fundamental questions which are today on the agenda of astrophysics, astroparticle physics, particle physics and nuclear physics. These research areas are in many ways interconnected. Examples are the search for dark matter and dark energy, the origin of mass and understanding the origin of the chemical elements through nuclear astrophysics.

Basic science has always been the driver for the development of new technologies to improve the gathering of tiny bits of information from the farthest distances and from the smallest dimensions of space and time. New instruments have always led to new discoveries and new insight. In the course of this development the facilities in fundamental physics and astronomy have become definitely larger, technically more sophisticated and much more costly. This means that more than ever before it has become a necessity to combine the intellectual and financial resources of many countries to realise these projects.

In astronomy, outstanding discoveries in recent years have highlighted new fundamental issues to be addressed. These include 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, a new suite of instruments is required to provide data across the electromagnetic spectrum with greater sensitivity than ever before.

Nuclear and Particle Physics

Nuclear physics has been revolutionized by the recent development of the ability to produce accelerated beams of radioactive nuclei. Modern nuclear physics puts the focus on two main aims. At the larger scale we want to understand the limits of nuclear stability by producing exotic nuclei with vastly different numbers of neutrons and protons. At the smaller scale, we want 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. There are two approaches to producing radioactive beams – the "In-Flight Fragmentation" and the "ISOL (isotope-separation on-line)" techniques. These techniques provide complementary information and both need to be pursued.

Particle physics stands on the threshold of a new and exciting era of discovery. The experiments now collecting data at the LHC will explore new domains and probe the deep structure of space-time. European particle physics is based on national institutes, universities and laboratories and on CERN as a jointly operated international organisation. The European Strategy for Particle Physics was adopted in 2006 by the CERN Council, with the following main elements:

(1) The LHC machine at CERN, now in operation, will be the energy frontier machine for the foreseeable future and its physics potential should be fully exploited. R&D should be pursued for luminosity upgrades and a potential energy upgrade;

(2) In order to be in a position to push the energy and luminosity frontier even further, an advanced accelerator R&D programme is needed (involving high performance magnets, Compact Linear Collider (CLIC) technology and work towards a high intensity neutrino facility); and

(3) the results of the LHC should be complemented with measurements at an electron-positron linear collider. Three on-going preparatory phase projects have been established to address these priorities (see short descriptions on page 67. The European Strategy for Particle Physics also emphasizes the importance of the links to Astroparticle and Nuclear Physics and the potential of regional projects in the area of flavour physics, the latter being addressed by the plans for the SuperB facility in Italy.

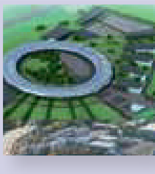
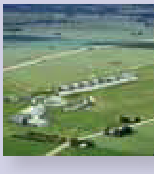
Generally, the contribution of facilities to interdisciplinary science should be promoted. There should be increased co-ordination and networking in support of breakthroughs in areas of societal relevance. The goals would include identifying new opportunities, new challenges, entirely new fields in science and impact of new facilities. Such initiatives should couple research, education, and innovation in partnership with universities and industry.

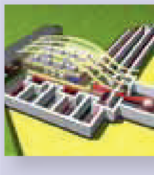
ESFRI and the European Commission should continue their important role in incubating and catalysing decision processes for future large Research Infrastructures, and supporting their development through Preparatory Phase programmes, integrating activities and design studies.

The European Commission should also consider playing a role in catalysing new technological developments in areas such as accelerators and detectors in partnership with industry. Detector developments should be handled co-operatively between neutron and synchrotron facilities and in collaboration with High Energy Physics projects. A particular challenge to neutron scattering techniques is posed by the current worldwide 3He shortage; there is a consequent urgency to develop novel detection systems and to improve the alternative existing detectors.

International cooperation

None of the above mentioned facilities could possibly be implemented without truly international collaboration, but one of these projects even has inherently a global character: the Square Kilometre Array (SKA) for radio-astronomy joining the astronomer's communities of Europe, North America and East Asia together with those of the host candidate countries Australia and South Africa. But also other projects – like E-ELT, CTA, European XFEL, FAIR or ELI – which are primarily supported by European actors do attract non-European science organisations and researchers as they offer unique opportunities for R&D and may open doors to a new quality of science.

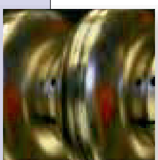
This trend has also to be followed on the political and administrative level. Networking of science administrators working in different jurisdictions must be further developed by systematic exchange of information and for best practices in planning, prioritising and executing large projects. Best practices in project management including cost control, quality assurance and data management must be employed. Policies for international, quality-driven access to the front rank facilities need to be in place.

The stewardship of the fast growing experimental data files also calls for a global approach, where the Research Infrastructures and the e-infrastructure communities need to come ever closer in the pursuit of common solutions that are beneficial to a broad spectrum of stakeholders. Modern ICT technologies allows for a much broader access and use of high quality data for scientific, educational, commercial and political use.

For this vision to be fully realised, the culture and regulation of data generation, validation, curation, transformation and use needs to be much better understood and appreciated in wide stakeholder circles. ESFRI will enhance international outreach on these issues both via bilateral contacts together with European Commission initiatives and via the overlap in memberships of international fora like the OECD Global Science Forum (GSF).

Preparatory Phase projects for the European Strategy for Particle Physics (CERN)

ILC-HiGrade – Preparatory Phase for the International Linear Collider

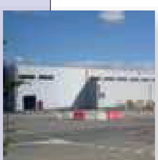


The ILC-HiGrade project brings together the key players in Europe to engage towards the realisation of the International Linear Collider. They constitute a large fraction of the European element of the Global Design Effort (GDE) that has recently led to the publication of the Reference Design Report (RDR). The report forms the basis for the Engineering Design Phase of the ILC. Starting in 2008, the ILC-HiGrade Consortium will address important elements in this 2-stage process with siting of the facility as one major ingredient. Currently there are site proposals in Japan, US and in Europe. Their benefits will be evaluated and the international framework in which the project will be realised will be developed.

ILC-HiGrade encompasses the European side in this global endeavour. The participating laboratories and universities contribute their long-standing experience in conceiving large-scale experiments and the organisation of large collaborations to a process that establishes the global framework for an organisation that will support start of construction matching the technical timelines.

Website: www.ilc-higrade.eu

SLHC – Preparatory Phase for the Large Hadron Collider Upgrade



The Preparatory Phase project of the LHC-upgrade will prepare the ground for a decision on the approval of the project's implementation. Beside the justification of SLHC by the physics results and operational experience from the first years of LHC running, the necessary ingredients for the approval will include: the maturity of new technologies required for SLHC, solutions for critical safety issues, and the formation of collaborations for the implementation, including the definition of work sharing and financial commitments. The SLHC-PP project is fully set up to address these issues and to prepare for the approval by the CERN council and by all other funding agencies involved.

The SLHC-PP project runs in parallel with an extensive SLHC-oriented R&D program, funded by CERN together with important contributions from many CERN member and non-member states. In order to prepare for the SLHC project implementation as a whole, the coordination tasks within SLHC-PP include the coordination of these developments carried out outside SLHC-PP.

Website: http://cern.ch/SLHC-PP/

TIARA - Test Infrastructure and Accelerator Research Area

The main objective of TIARA (Test Infrastructure and Accelerator Research Area) is the integration of national and international accelerator R&D infrastructures into a single distributed European accelerator R&D facility. This will include the implementation of organisational structures to enable the integration of existing individual infrastructures, their efficient operation and upgrades, and the construction of new infrastructures as part of TIARA.

TIARA will enable full exploitation of the complementary features and expertise of the individual member infrastructures, maximizing the benefits for both the owners of these infrastructures and their users. This unique distributed facility will also support the development of an integrated R&D programme embracing the needs of many different fields, as well as medical and industrial sectors, both on technical and human resource aspects.

Website: http://www.eu-tiara.eu

CTA Cherenkov Telescope Array

PREPARATORY PHASE
Coordination: Germany
Number of participating countries: 14

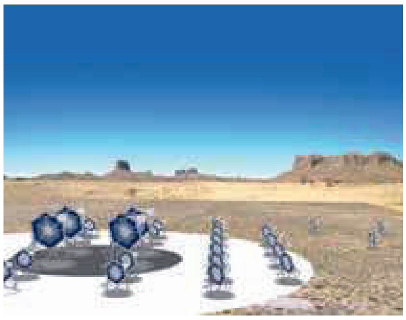
TIMELINE
- **Preparation phase:** 2011-2014
- **Construction phase:** 2014-2015
- **Operation phase:** 2019

ESTIMATED COSTS
- **Preparation:** 8 M€
- **Construction:** 150 M€
- **Operations:** 10 M€/year
- **Decommissioning**: 10 M€

www.mpi-hd.mpg.de/CTA

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.



Artist's conception of a CTA site *(Copyright: ASPERA).*

Background

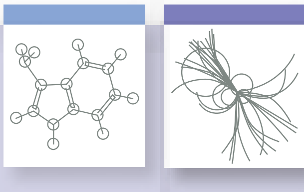
The present generation of imaging atmospheric Cherenkov telescopes has allowed the first detailed observations of the sky using gamma-rays of energies of a TeV and above. They have revealed a sky unexpectedly rich in gamma-rays features such as extended sources with complex and resolved structure lining 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.

The CTA 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 facility 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.

Steps for implementation

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

An ongoing design study supported by national sources shall be finished at the end of 2011. Starting in 2011, an EU funded 3-year preparation phase project shall prepare the ground for the start of construction which is currently foreseen for 2014/2015. Start of operation is expected for 2019; expected lifetime will be 20-30 years.



E-ELT European Extremely Large Telescope

The facility

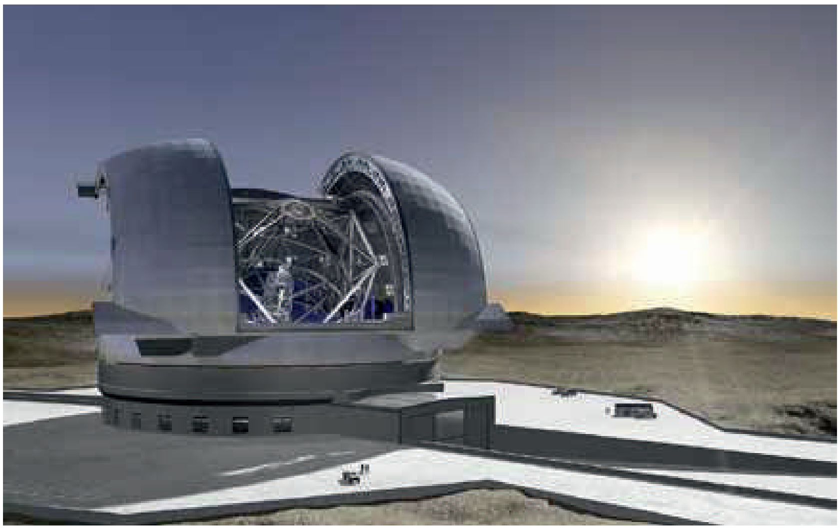
ELTs are seen world-wide as one of the highest priorities in ground-based astronomy. They will vastly advance astrophysical knowledge allowing detailed studies of inter alia planets around other stars, the first objects in the Universe, super-massive Black Holes, and the nature and distribution of the 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. 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.

Steps for implementation

E-ELT will be implemented and operated on behalf of ESO, and all 14 ESO member states formally give support to this project. Additionally, a consortium led by ESO and 26 institutions from 8 ESO member states is completing the EU funded E-ELT Preparatory Phase project. Furthermore, 10 nationally funded consortia are developing instrument design studies for the E-ELT. The telescope will be located at Cerro Armazones, Chile. Construction decision by the ESO Council is expected in December 2010, along with a final implementation plan. The E-ELT Instrumentation Project Office has been established to work on the instrument studies and the telescope interface. So far, ten instrument consortia have been formed. A full suite of instruments covering a wide parameter space will be built up over the first decade of E-ELT operations.



PREPARATORY PHASE

Coordination: ESO

Number of participating countries: ESO Member States

TIMELINE

- **Construction phase:** 2013-2021

ESTIMATED COSTS

- **Preparation:** 100 M€
- **Construction:** 1000 M€
- **Operations:** 30 M€/year
- **Decommissioning**: not applicable

www.eso.org/projects/e-elt

ELI Extreme Light Infrastructure

PREPARATORY PHASE

Coordination: France

Number of participating countries: 13

TIMELINE

- **Construction phase:** 2011-2013
- **Operation phase:** late 2015

A fourth site will be selected in 2012 and is scheduled for commissioning in 2017.

ESTIMATED COSTS

- **Construction:** ca. 700 M€ (includes estimated costs of three Regional Partner Facilities)
- **Operations:** ca. 70 M€
- **Decommissioning**: not applicable

www.extreme-light-infrastructure.eu/

The facility

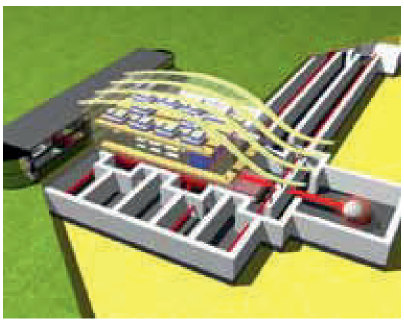
ELI will be an international Research Infrastructure for the investigation and applications of laser matter interaction at more than 6 orders of magnitude higher than today's state of the art. ELI will explore laser matter interaction up to the nonlinear quantum electrodynamics (QED) limit along with atto-second laser science designed to conduct temporal investigation at the atto-second scale of electron dynamics in atoms, molecules, plasmas and solids and development of dedicated beam lines of ultra short pulses of high energy radiation and particles up to 100GeV for users. ELI will be a pan-European multi-sited infrastructure with three pillars: Atto-second Pillar (Szeged, Hungary), Beamlines Pillar (Dolni Brezany near Prague), and Photonuclear Pillar (Magurele, Romania). ELI will become the first genuinely international large-scale laser facility.

Background

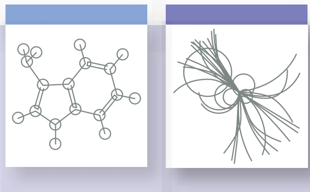
Laser intensities have increased by 6 orders of magnitude in the last few years. These are now so large that the laws of optics change in a fundamental way, thus opening up the new field called relativistic optics. One important aspect of ELI is the possibility to produce ultra short pulses of high energy photons, electrons, protons, neutrons, muons, and neutrinos in the atto-second and possibly zepto-second regimes on demand. Time-domain studies will allow unravelling the dynamics in atomic, molecular physics and plasma physics. ELI will be the first facility in the world dedicated to laser-matter interaction in the ultra-relativistic regime. It will provide unprecedented intensity levels and will be the gateway to new regimes in physics while at the same time promoting new technologies. 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.

Steps for implementation

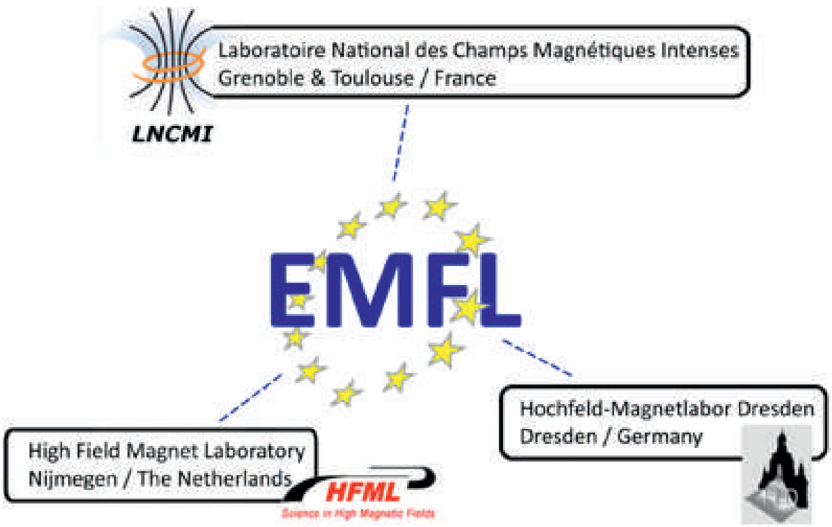
A Memorandum of Understanding on the Establishment and Operation of ELI was signed on 16 April 2010 in Prague by the governments of the Czech Republic, Hungary and Romania. The MoU lays out steps towards future establishment of the ELI-ERIC infrastructure with single governance, and establishes the pan-European ELI Delivery Consortium with a mission to implement the designed ELI Pillars. It is expected that other countries will soon join the MoU. Funding approval for the Pillar of the ELI Beamline Facility in the Czech Republic is expected for January 2011, the launch of the implementation for January- February 2011 and start of construction of the building for the ELI beamlines in September 2011. Completion and commissioning of the building and start of installation of the laser systems and other equipment are expected by mid 2013; with commissioning of the completed facility and entry into operation in late 2015. Negotiations on funding schemes for the ELI-Atto-second and Photonuclear facilities from the respective national programmes of the Structural Funds of the EU are underway.



ELI will be the first ESFRI Roadmap project implemented in new Member States *(Copyright: ELI Delivery Consortium).*



EMFL European Magnetic Field Laboratory



PREPARATORY PHASE

Coordination: The Netherlands

Number of participating countries: 3

TIMELINE

- **Start of preparatory phase:** 2011
- **Start of construction:** 2014

ESTIMATED COSTS

- **Preparation:** 6.7 M€
- **Construction:** 115 M€
- **Operations:** 8 M€/year additional to existing budget

www.emfl.eu

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.

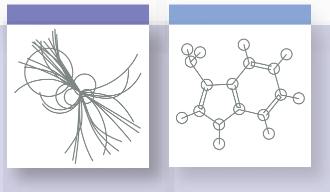
Background

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. At present the USA's National High Magnetic Field Laboratory (NHMFL), distributed over three sites is the leading facility in the field. EMFL will coordinate and upgrade Europe's high field activities to an effective size and efficiency comparable to that of the NHMFL. EMFL will coordinate joint development programs. HFML will concentrate on advanced spectroscopy through the unique combination with a FEL and the dedicated continuous 40 T low vibration hybrid magnet, while GHMFL will house a record field hybrid magnet (50 T) with a new 40 MW installation. ESRF and ILL (Grenoble) 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.

Steps for implementation

EMFL has been granted a 3-year EU Preparation Phase Project and 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.

The construction of the new EMFL facility is expected to start in 2014 after the Preparatory Phase, and to last for 5 years. The facility should remain in operation for at least 15 years.



EuroFEL (ex-IRUVX-FEL)

PREPARATORY PHASE

Coordination: Germany

Number of participating countries: 5

TIMELINE

- **Preparatory phase project:** 2008-2011

ESTIMATED COSTS

- **Preparation:** 150-200 M€
- **Construction:** 1200-1600 M€
- **Operation:** ca. 10% of total investment costs
- **Decommissioning:** n.a.

www.eurofel.eu

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, femto-second light pulses with unprecedented intensities. The EuroFEL Consortium (previously called IRUVX-FEL) will integrate the national FEL based facilities currently in operation or emerging in Europe into 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. 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. 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 nano-sciences, materials and biomaterials sciences to plasma, molecular, cluster, femto-, 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.

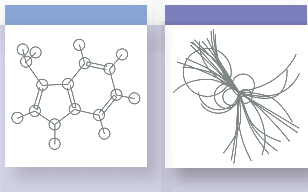
Steps for implementation

EuroFEL will develop common strategies between IR, UV and X-FELs, sharing know-how, software and technological developments. The core activities of EuroFEL are:

(1) ensuring efficient construction and operation of complementary, world-class FEL facilities for multi-disciplinary research with pan-European access,
(2) coordinating technical developments,
(3) coordinating training and education,
(4) ensuring efficient external and internal communication, and
(5) representing European FEL science and technology within the consortium. A web-based single-entry access for users is also envisaged.

The first two operational X-ray FELs of EuroFEL in Germany and Italy and two advanced projects in Switzerland and Sweden *(Copyright: Maxlab, PSI, DESY, FERMI/G. Crozzoli).*

ESS European Spallation Source



Visualisation from EAST *(Photo credit: ESS AB).*

POST-PREPARATORY PHASE

Coordination: Sweden

Number of participating countries: 9

TIMELINE

2010-2071

ESTIMATED COSTS

- **Preparation:** 30 M€
- **Construction:** 1478 M€
- **Operations:** 110 M€/year
- **Decommissioning:** 300 M€

http://ESS-Scandinavia.eu

The facility

The European Spallation Source will be the world's most powerful long-pulse source of neutrons at 5 MW. Its built-in upgradeability will make it the most cost-effective top tier source for the next 40 years. A genuine pan-European facility, it will serve a community of 5,000 researchers across many areas of science and technology. The ESS will be co-hosted by Sweden and Denmark and built in Lund with a Data Management Centre located in Copenhagen. Additionally, an important infrastructure site, an ESS Laboratory Test Facility and Accelerator Components Factory, will be located in Bilbao (Spain).

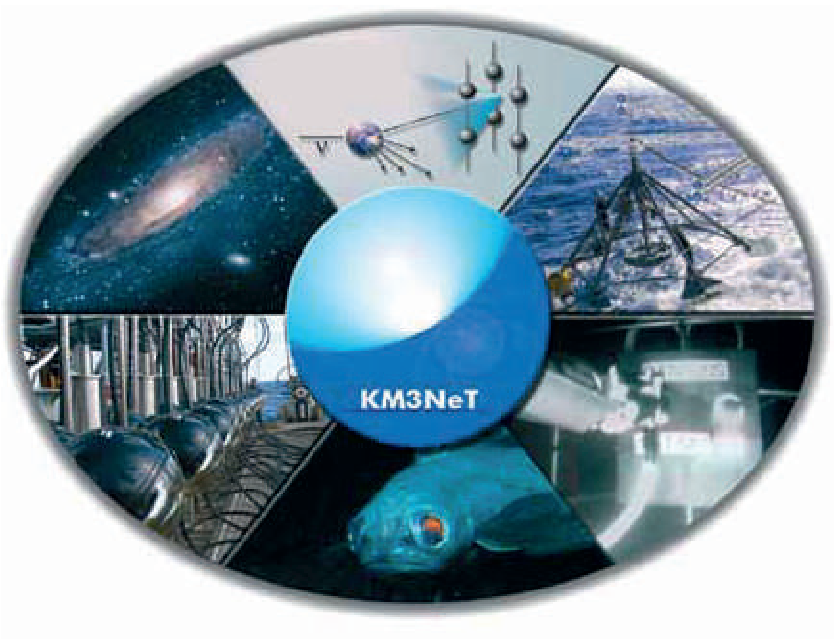
Background

Fine analysis of matter requires the complementary use of diverse "probes" and techniques, such as light scattering, neutron scattering, Nuclear Magnetic Resonance (NMR), computer modelling and simulations. 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 that will be available at the ESS are 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. The long pulse configuration of ESS provides substantially high power and the largest instrument innovation potential. Its performances guarantee a long-term world leading position for Europe. 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 high neutron flux will allow advanced and effective investigations in a wide range of fields. 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.

Steps for implementation

In line with the global neutron strategy endorsed by OECD ministers in 1999, the US is now commissioning its SNS facility at Oak Ridge and Japan is preparing for the first neutrons at J-PARC. The ESS conceptual design and cost-estimation phase involved all major European laboratories and demonstrated the feasibility of a MW-power spallation source for Europe. ESS is now established as a Swedish company (ESS AB) with international governing board, management and advisory committees that reflect the partnership of 16 countries, including Sweden and Denmark. The latter became shareholder of ESS AB at 26.3% on 21 December 2010. Negotiations with new countries are underway. Detailed design is ongoing (until end 2012) and co-operation agreements with a range of partner laboratories and organisations are in place.

KM3NET Kilometre Cube Neutrino Telescope



PREPARATORY PHASE

Coordination: Italy

Number of participating countries: 10

TIMELINE

2008-2014

ESTIMATED COSTS

- **Preparation:** 32 M€
- **Construction:** 220 M€
- **Operations:** 4-6 M€/year
- **Decommissioning:** 5 M€

www.km3net.org

The facility

KM3NeT will be a deep-sea Research Infrastructure in the Mediterranean Sea hosting a cubic-kilometre sized deep-sea neutrino telescope for astronomy based on the detection of high-energy cosmic neutrinos and giving access to long term deep-sea measurements. The goal of KM3Net is to investigate neutrino "point sources" (gamma ray bursts, supernovae or colliding stars) in the energy regime of 1-100 TeV. The telescope will also be a powerful tool for the indirect detection of dark matter. It will have improved sensitivity (> factor 50) compared with the current Northern hemisphere telescopes (ANTARES) and will also exceed the sensitivity of the US-led IceCube experiment. The observatory would also provide a facility for Earth and marine sciences.

Background

Neutrinos are ideal messengers for studying the highest-energy, most violent processes in the universe, since they are not deflected and can travel cosmological distances without absorption. 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. 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.

Steps for implementation

The design, construction and operation of KM3NeT will be pursued by a consortium formed around the institutes currently involved in the ANTARES, NESTOR and NEMO pilot projects, which have been investigating technologies relevant to KM3NetT and deploying small-scale prototype telescopes. Critical issues for the facility have been addressed in a FP6 design study (2006-9). The EU-funded Preparatory Phase project started in March 2008 and is expected to be completed by March 2012. In July 2010 the consortium published a preliminary Technical Design Review. A decision on the final design and the site is expected for October 2011. Start of construction is intended for 2013, with data acquisition from 2014 onwards.

SKA Square Kilometre Array

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. 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.

The SKA will consist of an inner core and outer stations arranged in a log-spiral pattern and extending to distances of up to at least 3,000 km *(Copyright: SPDO).*

Steps for implementation

SKA is conceived as a global project bringing together the astronomy communities of Europe, North America, and East Asia, together with those of the host candidate countries Australia and South Africa. 55 institutes in 19 countries around the world are working together to plan the SKA and develop the technologies required. The two candidate host countries, Australia and South Africa, are constructing specific SKA pathfinder telescopes (Australia: ASKAP (~AU$100M); South Africa: MeerKAT (~ZAR800M). A top-level policy steering group, the Agencies SKA Group (ASG) is chaired by the UK and involves representation from, among others, the United Kingdom, The Netherlands, Italy, France, the United States, South Africa, Australia, Germany and Canada. The SKA Program Development Office (SPDO) coordinating global design activity is located at the University of Manchester, United Kingdom.

At the end of the Preparatory Phase project of SKA, a legal entity based on national law (site to be decided in spring 2011) should be established in 2011 to oversee the pre-construction phase, expected in 2012-2016. A site decision is expected during 2012. Construction will be executed in two phases: 2016-2018 and 2018-2022. Early shared risk science is expected to begin in 2017.

PREPARATORY PHASE

Coordination: United Kingdom

Number of participating countries: 13

TIMELINE

- **Preparation Phase:** 2008-2012
- **Pre-construction phase:** 2013-2015
- **Construction phase:**
  phase 1 2016-2018,
  phase 2 2018-2022
- **Start of operations (Phase 1):** 2017

ESTIMATED COSTS

- **Preparation:** ca. 200 M€ (R&D and Pathfinders)
- **Construction:** 1500 M€ (350 M€ for Phase 1)
- **Operations:** 100-150 M€/year

www.skatelescope.org/

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Chairperson – Eckhart CURTIUS
Vice Chairperson – Murat ÖZGÖREN
Secretariat – Silke GUNDEL, Marie-Christine MAHLKE

Members

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CARRASCOSA José Lopez (Spain)
FAURE Jean-Emmanuel (EC representative)
FRØKJÆR Jørgen (Denmark)
FRONCISZ Wojciech (Poland)
GUDBJARTSSON Hakon (Iceland)
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HENGARTNER Michael (Switzerland)
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Chairperson – Eeva IKONEN
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Secretariat – Saara LILJA-ROTHSTEN, Timo SARENEVA

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