Physical Sciences and Engineering

Roadmap Working Group Report 2008

ESFRI

European Strategy Forum
on Research Infrastructures

Foreword

ESFRI asked the Physical Sciences and Engineering Roadmap Working group (PSE RWG) at its meeting in June 2007 to prepare a report for the update of the ESFRI roadmap. This report was supposed to cover the following three areas:

- A report on the 15 Physical Sciences and Engineering Research Infrastructures (RI's) which were in the ESFRI roadmap 2006 and are currently in their preparatory phase,
- Recommendations for new or upgraded RI's of European dimension, in particular in the field of Energy,
- A scientific landscape of the field in Europe.

ESFRI expected new proposals for RI's for the next decades to improve Europe's research competitiveness. For existing projects the progress compared to the roadmap 2006 was expected to be assessed.

Due to the heterogeneity of the field ESFRI PSE divided its work in three sub-panels:

- Energy research
- Materials Sciences and Engineering
- Astronomy, Astrophysics, Nuclear and Particle Physics

All 14 research infrastructures on the ESFRI roadmap 2006 in the field of the PSE RWG successfully applied for the Preparatory Phase. The projects now are funded by the European Commission to work on open legal, financial, governance and to a small extent technical issues in order to be able to start with the implementation of the projects at the end of the Preparatory Phase. An important issue is to seek support by a sufficient number of EU member states or associated states to support construction and guarantee sustainable operation.

The portfolio of the 21 proposals for the update of the ESFRI Roadmap PSE has received was of a rather heterogeneous nature: while most of the projects could clearly be assigned to one of the three sub-panels, some have had more the nature of testing facilities and / or were not easily to be attributed to one of the-subpanels. Especially in the field of Engineering the boundaries between Research Infrastructures on the one and Testing Facilities on the other hand are difficult to define. In the assessments of ESFRI PSE the definition of basic research – applied research and experimental development of the Frascati Manual was used. A number of projects assigned to PSE were also in the interest of other RWG's, mostly environment. In this case a consensus between the two groups to reach a final decision was found.

ESFRI PSE and its three sub-panels elaborated scientific landscapes in the respective fields and defined the role of the ESFRI roadmap projects in these. Strategies with respect to future challenges, especially for the field of Energy research, have been developed.

THE PSE RWG recommends four new projects to be included in the updated ESFRI roadmap, all of them being of clear relevance for their scientific fields. Two of these projects deal with topics being also of interest for the Environment roadmap working group. In addition the report gives guidance on how to proceed with the development of energy research infrastructures, as in particular developments in the field of new and sustainable energy are of importance in relation to energy policy issues like climate, security of supply and equitable economic development. With this recommendation PSE has strived to find the proper balance between exploratory research and the needs for research in strategic areas.

Jørgen Kjems

Chairman of the PSE RWG

Contents

1. Executive Summary of the Physical Sciences and Engineering Roadmap Working Group to ESFRI

The PSE RWG was appointed by ESFRI based on nominations from the member states and the PSE members represent a mixture of scientific expertise combined with science management and science policy experience.

This report recommends new or upgraded Pan European Research Infrastructures (RI's), to be included in the up-date of the ESFRI Roadmap for European Research Infrastructures and also contains an evaluation of the progress of the projects of the ESFRI roadmap 2006 in the field of the PSE group.

The PSE has considered and assessed the progress of the 15 projects included in the first edition of the ESFRI Road Map and currently being in their Preparatory Phase. In addition the PSE has assessed 19 proposals for new RI's submitted by the ESFRI delegation and assigned to the PSE by the ESFRI Executive board. The PSE has been consulting with other working groups on projects on the borders between the areas covered by the working groups. The infrastructures under consideration span very different types, lifetimes and costs, from large, single site laboratories based on a specific large equipment or facility, to distributed facilities and network of national facilities.

The PSE divided itself into 3 sub-panels for the evaluation of both the current project on the ESFRI Road Map and the new proposals in the different fields: (1) energy research; (2) materials research and general purpose facilities; and (3) astronomy, astrophysics, nuclear and particle physics. The sub-panels were also asked to develop an overall strategic view of the landscape, based on existing indications and opinions within the involved scientific communities. Some fields are well covered by individual Roadmaps, and/or strategy documents that have been published by international institutions, e.g. Particle Physics (by the CERN Council) and Space (by the European Space Agency).

The sub-panels have operated on the basis of terms of reference aimed at ensuring that the members acted in their personal capacity, and taking care that conflicts of interest were declared and dealt with.

The 34 projects were assessed in detail by the sub-panels and the assessments were combined and integrated by the PSE as a whole into an overall view coherent with a strategy-led approach to European policy-making. The scope has been to help ESFRI to choose those proposals which are deemed strategically most important and mature for inclusion on the second edition of the ESFRI Roadmap. An important task was to fill thematic gaps of the ESFRI roadmap 2006.

An interim status of the work by the PSE was presented to ESFRI at its meeting March 6-7, 2008. Based on this report, the ESFRI asked the PSE to engage in a dialogue with the groups behind the new proposals in the energy field and the relevant directorate of the European Commission in an effort to further develop the most promising proposals. This resulted in resubmissions of four energy RI proposals which were subsequently assessed by the sub-panel and the PSE. The results of the new assessments were presented to ESFRI at the meeting of June.

The work of the PSE has required a difficult balance between merits of the scientific need and excellence, pan-European nature and added value, and strategic and societal relevance combined with the realities of budget constraints and science policy priorities in the member states.

The results are presented and summarized in three areas of research: (1) Energy research (2) Materials Sciences and Engineering, and (3) Astronomy, Astrophysics, Nuclear and Particle Physics.

Table 1 gives an overview on the assessment of the individual proposals, whether they are recommended by the PSE to be included in the updated road map or whether they will be mentioned in the descriptions of the technology roadmaps of the three sub-panels. The RIs have further been classified according to their scale as global, European unique RIs, Distributed RIs or RI networks and RIs of national relevance. Some of the proposals concerned in addition to the PSE also the fields of one or more other ESFRI RWG's. This is referred to in the table as well.

The PSE recommends that the following new projects are included in the up-dated ESFRI Road Map list:

RU 07: Cherenkov Telescope Array (CTA)
RU 19: European high Magnetic Field Laboratory (EMFL)
RU 29: European Carbon Dioxide Capture and Storage Laboratory Infrastructure (ECCSEL)
RU 38: European Incoherent Scatter Radar System (EISCAT)

The PSE has carried out the assessment of the RU 38 in cooperation with the RWG ENV and by consulting experts external to those to RWGs.

The PSE was asked to pay particular attention to projects in the field of energy. It found that the following projects have both scientific and strategic merit, but they do not yet fully meet the criteria for inclusion in the ESFRI Road Map list:

RU 03: Multipurpose Hybrid Reactor for High Tech Applications (MYHRRA)
RU 34: European Renewable Energy Infrastructure – Solar (TEREI-SOLAR)
RU 36: European Centre for Turbulence and Wind Energy (Windscanner)

The remaining projects were found not to meet the criteria for inclusion in the ESFRI Road Map list.

The second major task of the PSE was the assessment of the progress of the projects of the ESFRI roadmap 2006. The table gives an overview on the findings of the group. The group suggests to introduce an additional category for projects that already been progressed beyond ESFRI. These are the projects where construction has already been decided or started. The table also gives the classification according to the scale of the RI.

The PSE RWG finds it very gratifying that all of the projects on the present ESFRI Road Map assigned to the PSE have made reasonable progress and recommends that they are included in the up-dated Road Map list. The following projects have advanced to or are very near to entering the construction phase based on national commitments or international agreements. These six projects are:

PSE 14: ESRF Up-grade
PSE 16: FAIR
PSE 18: ILL Up-grade
PSE 20: JHR
PSE 23: SPIRAL 2
PSE 24: XFEL

The PSE has noted the CERN Council strategy for the development of infrastructure in the field of particle physics, but has not assesses any of the proposed projects.

No.	Title	Other RWGs inwolved	Recommendation		Scale of the RI				
			Road Map	Landscape	Global	European unique	European distributed	National
RU03	MYRRHA			x		x		x
RU07	CTA		x			x		
RU08	3MERL	ENV + PSE	(x)				x	
RU12	FHS			(x)				x
RU13	ATRA			(x)				x
RU14	L-SURF			(x)				x
RU17	CECAM	eIWG + BMS, ENV, PSE, SSH						
RU19	EMFL		x				x	
RU20	CYCLOPE			(x)				x
RU21	DAFNE					x		x
RU26	LVR-HALE			(x)				x
RU27	NFFA			(x)			x	x
RU29	ECCSEL	ENV + PSE	x				x	x
RU31	Software services	eIWG + BMS, ENV, PSE, SSH						
RU33	IPURE	eIWG + BMS, ENV, PSE, SSH						
RU34	TEREI			x			x	x
RU36	Wind-Scanner (turbulence)	PSE + ENV		x		x		x
RU37	MAX-IV			x				x
RU38	EISCAT	PSE + ENV	x				x	
RU39	PRIN-CE			(x)				
RU40	DYNAMO							x

Table 1: Summary of the assessments of the new project proposals for the ESFRI Road Map from physical sciences and engineering

	Title	Progress	Recommendation		Scale of the RI			
			Approved launched	Road Map	Glo-bal	European unique	European distrib.	Natio-nal
PSE12	E-ELT	ESO decided to fund prep. project		x		x		
PSE13	HIPER	Delays		x		x		
PSE14	ESRF-UP	ESRF Council agenda next	x	x		x		
PSE15	ESS	Site discussions in ESFRI		x		x		
PSE16	FAIR	Int. negotiations ongoing	x	x		x		
PSE17	IFMIF	Int. negotiations ongoing		x	x			
PSE18	ILL	First stage on Board agenda	x	x		x		
PSE19	IRUVXFL	Scope Change in partner facility		x			x	
PSE20	JHR	Construction started 2007	x	x				x
PSE21	Km3Net	Communities coalesced		x		x		
PSE22	SKA	Global discussions ongoing		x	x			
PSE23	SPIRAL2	First construct. stage funded	x	x		x		x
PSE24	X-FEL	Int. owned company will be formed soon	x	x		x		
PSE31	PRINS	Moderate progress		x			x	
PSE36	ELI	Int. R&D effort		x		x		

Table 2: Summary of the assessments of the existing project on the ESFRI Road Map list.

2. Methodology

2.1 Setting up the PSE, collecting the proposals and developing the criteria and procedures

The PSE Roadmap Working Group has been (re-)appointed during 2007. The composition of PSE has been decided by ESFRI, and is listed in Annex I. The members of PSE are both Science Policy experts and Country Representatives having a scientific background, and act as a preparatory sub committee of ESFRI, therefore integrating science policy and technical aspects. The ESFRI Working Groups operate according to the Terms of Reference and Procedures (Annex V and VI). Tasks of the PSE as of all the other groups was to elaborate a comprehensive overview on the research infrastructure related aspects and challenges of their field, to assess the progress the projects on the ESFRI list 2006 and to assess the new proposals that have been submitted to ESFRI for this update.

The new proposals were collected by ESFRI through the national delegations, and forwarded to PSE for analysis in the beginning of December 2007. These proposals are listed in the Annex VII. The proposals were documented by a standard format “fiche”, which was used as basis for the assessments together with publicly available material in form of reports and web-pages including material used for the first edition of the ESFRI road map.

For the assessment of the progress of the project on the ESFRI roadmap 2006 the coordinators of the projects have submitted actualized project fiches for analyses by the PSE. PSE members from the European Commissions Services also gave regular oral reports on the progress in the negotiations of contracts concerning Preparatory Phase projects concerning the RI's on the ESFRI Road Map 2006 selected for support from FP7.

According to the ESFRI guidelines the PSE and the sub-panels followed a stage-gate procedure in the analysis and assessments of the proposals. First, the assignments of the individual proposals to a given RWG were discussed amongst the chairs of the RWG and the ESFRI Executive Board. Secondly, the PSE assigned the proposals to the three different sub-panels. The PSE established a common evaluation form (Annex IV) for the analysis and assessments of the development for the projects already included in the ESFRI Road Map and for the new proposals. Those projects that have been included as emerging in the ESFRI Road Map 2006 had to be resubmitted via the ESFRI EB and thus had to follow the same procedure as new proposals. There were two resubmitted emerging proposals for consideration of the PSE. Additionally 17 new proposals had been assessed by the PSE.

2.2 The assessment procedure and criteria

PSE decided at its first meeting in October (after the joint kick-off meeting September) to form three sub-panels:

- Energy research
- Materials Sciences and Engineering
- Astronomy, Astrophysics, Nuclear and Particle Physics

The proposals were divided between the sub-panels at the PSE meeting in December. The sub-panels have met in person and via telephone conferences and have in some cases, when necessary, also had meetings with the groups behind the proposals to clarify open questions. Sub-panels delivered progress reports at the meetings of the PSE in January and February. The assessment of the individual proposals was prepared by the sub-panels and finalized in discussions of the PSE. All decisions on individual proposals were taken by the PSE group as a whole. A small number of proposals dealing with specialized aspects of engineering and not easily to be assigned to one of the sub-panels by their topics have been discussed directly within the PSE without the assessment having been prepared by one the of sub-panels.

The third step was an evaluation of the **scientific case**. Here the PSE has introduced additional criteria to distinguish between science driven projects and the development of technologies and products. These were subsequently endorsed by the ESFRI. Following the definitions in the Frascati Manual the PSE decided that ESFRI Road Map in the area of PSE should only include Research Infrastructures with significant elements of user driven investigations in basic, oriented basic and applied research. Research Infrastructures primarily for experimental developments are less within the scope of ESFRI. They can be included in the landscape descriptions but should not be included in the Road Map.

Frascati Manual definitions:
Basic Research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of expected, current or future problems or possibilities.

Applied Research is also original investigations undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective

Experimental development is systematic work, drawing on knowledge gained from research and practical experience, that is directed to producing new material, products and devices; to installing new processes, systems and services; or to improving substantially those already produced or installed.

The fourth step was an evaluation of the **European significance** using the following criteria:

- *project ensures open access to all interested researchers based on the quality of the proposed activity*
- *infrastructure is either new or proposing a major upgrade which is fully justified by quality and user needs*
- *proposal has true pan-European value and relevance*
- *interconnections and links between distributed facilities are seen to create synergy in an European infrastructure complex*
- *links to national "road maps" and other vision documents are available*
- *proposal should be considered in context of the overall landscapes with ranking and prioritization*

The final step consisted in an evaluation of the **maturity** of the project, taking into account technical, economic and management issues. Here the PSE was guided by the following definition of project phases:

- *Concept phase: Preliminary idea and concept.*
- *Conceptual design phase: Detailed scientific concept preliminary estimates for technical, feasibility and management aspects; preliminary cost estimate.*
- *Engineering design phase: Elaborated technical concept and feasibility study; reliable cost estimate; known partnerships.*
- *Detailed engineering design phase: Detailed technical concept required for construction, budgets and government decision,*
- *Preparation phase: Preparation of formal, legal, organizational, financial issues for agreement between partners.*
- *Construction and commissioning phase.*
- *Operation phase.*
- *Decommissioning phase*.

Not all projects follow this route literally and some of the phases may overlap, but these definitions can nevertheless still be used pictorially to asses the degree of maturity of a given project. The projects also needed to be assessed with different weights for the different aspects relating to the scientific and technical maturity, the economic feasibility and the prospects for obtaining European wide support because they come from very different fields, having to serve scientific communities with very different needs. A project should typically be in or near the equivalent of the detailed engineering phase preferably in the preparation phase to be judged as fully mature.

In the end the PSE RWG arrived at unanimous conclusions and recommendations for this report. In the process care was taken to secure transparency by using the facilities for information sharing on the CIRCA web-site and to identify and deal with possible conflicts of interest.

2.3 Handling of the energy issue

The PSE RWG was asked to give special attention to projects within energy research. This was underscored by the approval of the European Strategic Energy Technology Plan (SET-Plan) by the European Council in March 2008 with a specific request to ESFRI:

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

To meet the European energy and climate goals as well as to improve the industry competitiveness, increased efforts in R&D and energy technology innovation will be necessary. This will require stronger cohesion among the European research actors in energy but also much better performance in the commercialization of new technologies. For research infrastructures, this will mean that stronger industrial orientation would be beneficial, but also employing RI more effectively in the innovation chain, for example demonstration or pilot plants serving as RIs. Public-private partnership would be quite essential in realizing such innovation driven research infrastructures. Potential vehicles for this development are the Technology Platforms and the Joint Technology Initiatives.

On the other hand, meeting Europe's challenging goals in renewable energy for the member states by 2020, or in average over 200% increase from the 2005 level, will require substantial increase in research budgets of renewable energy and carbon dioxide capture and storage, including major new research facilities. It would be highly relevant for the member states to coordinate their efforts, avoiding redundancy, and focusing on European wide larger RIs.

Energy proposals and assessments

The present ESFRI list includes 3 nuclear energy based projects from the first call, 2 in fusion and 1 in fission. These address the needs of the nuclear communities both for Generation IV reactors and global fusion research community. One of these projects (Jules Horowitz Reactor) is now under construction and the other two (HIPER, High Power Laser Energy Research Facility; and IFMIF, International Fusion Materials Irridation Facility) are candidates to be included in the up-dated ESFRI road map.

In the first round of inviting for the submission of proposals there have been no projects from the non-nuclear energy fields. In the second call of proposals by ESFRI (30 November 2007), five energy proposals were received, one on nuclear (MYRRHA, fast neutron accelerator driven system), one on magneto-hydrodynamics (DYNAMO), and three on non-nuclear energy (ECCSEL, carbon capture RI; TEREI, concentrated solar power RI; and Windscanner, turbulence and wind energy RI).

The preliminary findings of the PSE RWG was that none of the new energy proposals were mature enough to meet the criteria to be included in the ESFRI Road Map up-date even though the sub-panels had recommend the 3 non-nuclear energy RI’s. The PSE RWG found that two projects (RU_34 TEREI and RU_36 Turbulence, now Windscanner) were suitable for a 'fast track' maturing procedure.

The PSE reported its preliminary findings and recommendation to ESFRI at the meeting in March 2008 in Brdo, Slovenia. The discussions at ESFRI lead to the conclusion that - due to the strategic importance of the European energy research agenda - ESFRI would invite the delegations and the institutions behind the energy related proposals to engage in a dialogue with the PSE RWG about the proposals and to allow submission of amended/renewed proposals for the up-date of the ESFRI Road Map. To prepare this process the projects were also discussed with representatives of the two Energy Research Directorates in DG Research of the European Commission and letters were send by the end of March to four of the project coordinators asking for up-dated proposals. The up-dated energy proposals were received on May 15. (TEREI, ECCSEL, MYRRHA and Windscanner). They were subsequently processed by the same procedure used for the other projects and the evaluation and recommendations were concluded at the PSE meeting at the end of May, 2008.

In its meeting of May 30 the PSE RWG discussed the revised energy proposals RU03a MYRRHA, RU29a ECCSEL, RU34a TEREI-Solar, RU36a Windscanner. Background for the discussion was the updated project fiches as well as the positive assessments of the Energy sub-panel of ESFRI PSE and of the two Energy Research directorates. ESFRI PSE decided after along discussion to propose only RU 29a ECCSEL for the updated roadmap. The decision not to propose RU36a Windscanner and RU34a TEREI-Solar was taken in a majority vote.

The revised proposals were evaluated positively within the PSE Energy sub-panel and seen very positively by the two directorates on Energy and on Nuclear Energy. All projects were seen to deal with issues of high European relevance, were found to be in line with the major strategies in the respective energy fields and were found to be crucial for a further progress in their fields of research. Also, a stronger industrial opportunity to use research infrastructures in the field of energy would be beneficial. This could make RI more effectively involved in the innovation chain, for example in connection with demonstration or pilot plants also serving as RIs. This in turn could make public-private partnership more likely and effective in realizing such research infrastructures driven by science as well as innovation needs. Potential vehicles for this development are the Technology Platforms, the Joint Technology Initiatives and the new proposed Industrial Initiatives in the SET-Plan.

In the assessment process the PSE RWG and its sub-panels have employed the general ESFRI criteria (scientific, technical and financial criteria), and the strategic criteria arising from the EU policy side on energy and innovations. The work of the PSE RWG has required a difficult balance between merits of the scientific need and excellence, pan-European nature and added value, and strategic and societal relevance combined with the realities of budget constraints and science policy priorities in the member states.

The final assessments of the energy proposals were reported to ESFRI at the meeting on June 13, 2008. Following a debate the PSE RWG was asked to review the issue once again and it was recommended by the ESFRI executive board to solicit second opinions from experts in the field with knowledge of the ESFRI process. Second opinions were subsequently asked from professors Norbert Kroo, Yves Petroff and John V. Wood, and John Wood was asked to act as the convener. The three experts agree with the findings of PSE. They are concerned that ECCSEL does not involve several relevant partners and state that the recommendation to include it should emphasize the need to bring other groups in.

2.4 Conclusions by the chair of PSE road map working group concerning the energy issue

The four up-dated proposals were assessed positively by the energy PSE sub-panel and by the two directorates on Energy and on Nuclear Energy in the EC. The concepts and descriptions of the three proposals in the field of non-nuclear energy (ECCSEL, TEREI-SOLAR, and WINDSCANNER) were significantly developed in the up-dated descriptions and European wide engagements were documented. The nuclear energy proposal (MYRRHA) also documented a broad European interest among its stake-holders.

The majority of the PSE panel finds that only ECCSEL meets the ESFRI criteria of scientific merit, technical and financial maturity, and European added value to be recommended as a candidate for the ESFRI

Road Map Update. This view is supported by the second opinions from the outside experts. Summarizing the conclusions of PSE and the results of this second consultation process the chair concludes that only ECCSEL is recommended for the road map.

However, the chair also finds that this road map list cannot be the whole answer to the request by the European Council and ministers:

“.. *to identify the need for European research infrastructures in the field of energy technologies, such as renewable energy technologies.*

The proposals received by ESFRI in the field of renewable energy were found to be relevant to the respective communities, by the PSE energy sub-panel as well as by the two directorates on Energy and on Nuclear Energy that have been consulted. They represent strategic rather than basic research oriented facilities which have been evaluated to be of high quality and relevance in their fields.

As a conclusion the chair recommends that in addition to the road map a specific statement is issued by the ESFRI, which includes the energy proposals in the road map and the renewable energy proposals (TEREI-SOLAR and WINDSCANNER) as a response to the request by the council of ministers.

2.5 Lessons learned during the PSE RWG process

The following issues have emerged during the evaluation process for the Road Map Update in the PSE RWG.

Road Maps

Many scientific communities produce road maps showing that research infrastructures are important for the future developments in their fields. These kinds of roadmaps serve as the background for national roadmaps. The first ESFRI Road Map has triggered more nations in Europe to produce such maps. The ongoing work in the OECD Global Science Forum shows that this is a global trend.

The scientific status and merits of a project should be coming from the road map efforts outside ESFRI. Ideally it is the transnational scientific communities that should make the assessments of the scientific scope and priority of a given project. The ESFRI PSE RWG had the expertise to make a strategic assessment across fields and disciplines of projects that have been endorsed by the respective scientific communities but did not have enough specialized expertise to make a detailed scientific assessment of the individual projects.

Individual countries may decide to fully fund a project from their national budgets. Such national facilities are often made available to an international scientific community via merit based access procedure. Such national decisions should be applauded because they strengthen the research infrastructure in the European Research Area. They should be acknowledged by ESFRI in the landscape descriptions. There is no need for a process in ESFRI to realize such projects. Hence, they should not be on the list. The ESFRI PSE has a few examples of projects that are looking for an ESFRI stamp of approval. This should not be necessary.

Role of ESFRI

ESFRI and the ESFRI road map should be instrumental those projects that need approval and contributions from several governments (national funding agencies/research councils) to obtain a “go-decision”. ESFRI should be the market place for exchanges and discussions that can lead to joint funding and operation of pertinent European Research Infrastructures.

Once a “go-decision” is reached or when dedicated parties have taken ownership of the process the project can be elevated to an ESFRI “success roster”. It should no longer be counted in the ESFRI list as such. The PSE RWG has processed several projects that may be elevated to “success roster” either right away or in the coming months.

Networks and distributed infrastructures

There are many examples of networks of facilities/infrastructures both in the current Road Map list and the emerging projects as well as in the portfolio of new projects. These projects typical evolve with growing strength in the interaction between existing facilities in different countries or as a network of planned facilities. Some of the projects may make the transition from a Network to a Distributed Infrastructure which -in practice- act like one legal entity. The PSE RWG has discussed this issue and has concluded that networking alone does not merit inclusion in the ESFRI list. It typically does not need the attention at government level, and the EC has many schemes to promote networking at the European level. It is the credibility of the course towards a Distributed Infrastructure that should be criterion for inclusion in the list either as an emerging project or – if the transition to a Distributed Infrastructure is imminent – as is the case for a project on the list. A helpful question to ask is whether or not a collective “go-decision” is needed by two or more governments. Can the launch time be defined so that the project can move to the “success roster”? The PSE RWG has processed examples of both networks and emerging Distributed Infrastructures.

3 Landscapes of Physical Sciences and Engineering Research Infrastructures

The physical sciences and engineering cover a wide range of research areas and types of infrastructures. In the present context the main areas are: **astronomy, astrophysics, nuclear and particle physics**; **materials science, energy research and engineering research.** Research infrastructures (RIs) play an increasingly important role in the advancement of knowledge and technology in these areas. They are a key instrument in bringing together a wide diversity of stakeholders to look for solutions to many of the problems society is facing today. RIs offer unique research services to users from different countries, attract young people to science, and help to shape scientific communities. At the same time the new RI grow in size, complexity and resource requirements. A new large RI typically needs sponsoring from a consortium of nations. This has for a long time been recognized in the physical science and engineering communities. New knowledge and, by implication, innovation, can only emerge from high-quality and accessible RIs: for example, radiation sources, data banks, observatories for astronomy and astrophysics, systems of imaging or clean rooms for the study and development of new materials or nano-electronics are at the core of research and innovation processes. In the field of PSE the creation of such facilities depends heavily on international collaboration.

The development of the first ESFRI Road Map has shown that not all fields of research have developed the same degree of international cooperation concerning research infrastructures. This has led to the formation dedicated working groups for environmental sciences and e-science in the preparation of the second edition of the ESFRI Road Map. These fields were covered by the PSE in the first round. The PSE RWG had in addition been given the mandate by ESFRI to give special attention to the development of Energy Research Infrastructures in the field of non-nuclear energy. At present it is primarily nuclear energy research which is harvesting the benefits of international cooperation both within the European Research Area, ERA, and on the global scale with the EURATOM fusion program as the prime example.

The landscapes of the different areas reflect this difference in tradition. In addition there are several international European research organizations like CERN, ESO, ILL, ESRF and EMBL in the areas covered by the PSE. These organizations have prominent roles in their respective fields and have developed their own road maps. This means that there are different kinds of fora for strategic planning and decision making that eventually lead to the construction of a new international research infrastructure. This has been discussed in the recent report of the ERA Expert Group:” Developing World-class Research Infrastructures for the European Research Area” (Directorate for Research, EUR 23320 EN 2008).

The discussion concerning the development of ERA also shows that the roles of the different actors involved in the creation of new research infrastructures are changing. The member states remain central in the development and financing of the infrastructures and the Community can and should play a catalyzing and leveraging role by helping to ensure wider and more efficient access to, and use of, the infrastructures in the different Member States. The Community actions in the Framework Programs has also stimulated and coordinated development and networking of these infrastructures, and fostered the emergence and preparation of new ones. ESFRI is the Forum where these actors meet.

From the point of view of the scientific communities the process of development of new infrastructures has become more complex. On one hand there is a growing trend of increasing international collaboration at science community level and many international science communities are successful in their efforts to bring out consensus views on the needs for new facilities. This is helped and stimulated by the international scientific organizations like ESF, IUPAP and others. The descriptions of the individual landscapes in the following have drawn upon such work and the resulting reports. On the other hand the decision making process involves an increasing number of national governments and agencies, which has made the decision making process both cumbersome and slow.

The work of ESFRI and the new edition of the Road Map are intended to reverse that trend.

The term ‘research infrastructures’ refers to facilities, resources and related services used by the scientific community to conduct top-level research in their respective fields, ranging from astronomy to nanotechnologies. Examples include singular large-scale research installations, databases, clean rooms, integrated arrays of national research installations, high-capacity/high speed communication networks, telescopes, synchrotrons and accelerators connected to networks of computing facilities. RIs may be ‘single-sited’ (a single resource at a single location), ‘distributed’ (a structured network of distributed resources), or even ‘virtual’ (the service is provided electronically). The PSE has found it useful to make distinction between:

- Research infrastructures that are unique in the world and require collaborations on a global scale
- Single-sited research infrastructures that are unique in Europe and require ERA type-collaborations
- distributed infrastructures with unique features and roles in ERA and with joint management
- National facilities with international users
- ERA-networks of national facilities

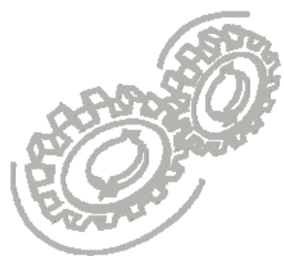
The PSE finds that ESFRI primarily has added value for the development of infrastructures in the first three categories.

Since the release of the first ESFRI Road Map there has been an increasing effort to establish similar tools for improving strategic decision making on both national level and on the international (OECD wide) level. Many governments around have prepared their own national road maps for research infrastructure. The OECD Global Science Forum has launched a study of road map practices. The comparison shows that it is very much the same large infrastructures in the fields of physical science and engineering that appear repeatedly in the different national road maps. This is illustrated in Table 1 which list the most frequent mentioned RIs in the area of physical sciences and engineering in the OECD survey of national road maps (Fontana, OECD, 2008).
This is encouraging and shows that the ESFRI Road Map has had a broad impact and has stimulated the international dialogue with the result that several of the large projects have moved closer to realization.

PSE	European XFEL	Hard X-ray Free Electron Laser in Hamburg
PSE	SKA	Square Kilometer Radiotelescope Array (in two phases)
PSE	ESS: The European Spallation Source	European Spallation Source for neutron spectroscopy
PSE	FAIR	Facility for Antiproton and Ion Research
PSE	ILC	International Linear Collider
PSE	ELT: The European Extremely Large Telescope	European Extremely Large optical telescope
PSE	IRUVX-FEL	Infrared to soft X-rays complementary Free Electron Lasers (in 5 users facilities)
PSE	LHC Upgrade	Large Hadron Collider and Upgrades
PSE	LIGO, VIRGO	Gravitational Wave Observatory (LIGO, VIRGO)
PSE	ESRF Upgrade	Upgrade of the European Synchrotron Radiation Facility (in 7 years)
PSE	ILL 20/20	Upgrade of European Neutron Spectroscopy Facility (in 2 phases)
PSE	KM3NET	Underwater Neutrino Observatory (in design phase)

Table 3: List of the most frequently mentioned research infrastructure projects in an OECD GSF initiated survey and comparison of national road maps for research infrastructures.

3.1 Landscape of research infrastructures for energy research



The threat of energy-induced climate change is one of the great challenges that modern man-kind currently faces. Within half a century a reduction of 60 to 80 per cent of all green house gas emissions is needed, which is turn is not possible without massive introduction of sustainable energy technologies and systems on a global scale. Moreover, 80 per cent of global energy production is still based on fossil fuels, and the emerging economies rely increasingly on these. This makes reaching the goals even harder. Europe has decided to take the lead in showing the way into a sustainable energy future. But huge research and development efforts will be needed to create the necessary technology solutions for the energy needs ahead. New energy technologies are needed to secure a diversity of supplies, and innovative solutions are needed for sustainable growth of the European and world economies.

3.1.1 General and background

The ESFRI/PSE working group was given a special assignment to assess the opportunities for the development and use of research infrastructures (RI) within the field of energy, also in the light of global change and the need for an integrated European energy policy. The Strategic Energy Technology Plan (SET-plan) communication from November 2007 emphasizes the need for RI in the field of energy. This was confirmed by the European Council of Ministers in March 2008. Public and private energy R&D budgets in the

EU have declined substantially in real terms since peaking in the 1980s. This has led to under-investment in energy research capacities and infrastructures. To meet the European energy and climate goals as well as to improve the industry competitiveness, increased efforts in R&D and energy technology innovation will be necessary. This will require stronger cohesion among the European research actors in energy but also much better performance in the commercialization of new technologies. For research infrastructures, this will mean that stronger industrial orientation would be beneficial, but also employing RI more effectively in the innovation chain, for example demonstration or pilot plants serving as RIs. Public-private partnership would be quite essential in realizing such innovation driven research infrastructures. Potential vehicles for this development are the Technology Platforms and the Joint Technology Initiatives as well as the new Industrial Initiatives as outlined in the SET-Plan.

On the other hand, meeting the challenging goals in renewable energy for the member states by 2020, or in average over 200% increase from the 2005 level, will require substantial increase in research budgets of renewable and carbon capture as well, including major new research facilities. Foreseeing this development, ESFRI is in a position to help the member states in coordinating their efforts, avoiding redundancy, and focusing on European wide larger RIs instead of isolated facilities that may prove to be sub-critical in size.

The present ESFRI list 2006 includes 3 nuclear energy based projects from the first call, two in fusion and one in fission. These address the needs of the nuclear communities both for Generation IV reactors and global fusion research community. There were, however, no projects from non-nuclear energy fields. This can be easily explained by the historical development as in nuclear physics international collaboration around large research facilities has been very strong since the 1950's. Whereas in non-nuclear energy the research to a large extend has had a national focus. As a result the research efforts have been dispersed, and the research financing has been quite modest in view by the number of technologies covered. In the light of the above facts, it was decided in PSE to provide a thorough updating of the landscape of non-nuclear energy technologies. Possible nuclear-based RIs are much easier to identify due to their massive and centralized character and several are already running.

In the second call of proposals for ESFRI (30 November 2007), five suggestions arrived, one on nuclear, one on plasma, and three on non-nuclear energy.

In the following, the working group has provided an update of the landscape of energy research infrastructures. The main sources used has been written material in particular from the Commission's Communication "An energy policy for Europe", Commission's SET-plan from November 2007 and the hearings in 2007, earlier ESFRI hearings from 2005, and individual interviews of research organizations, industry representatives and officials. Important criteria employed in the assessments have been the general ESFRI criteria (scientific, technical and financial criteria), and the strategic criteria arising from the EU policy side on energy and innovations.

3.1.2 Update of energy RI

The European policy goals for non-nuclear energy are challenging. The renewable energy contribution should be tripled up to 20% of primary energy, and the share of bio fuels should rise to 10%, all by 2020. The recent Strategic Energy Technology plan strives for major technology breakthroughs, for example by 2020 in large-scale wind energy, bio fuels, and carbon separation and storage, and in several other important areas such as fuel cells and hydrogen, solar cells, storage, etc. by 2050. On the 2050 scale, new nuclear technologies such as Generation IV and also fusion are perceived important. The Commission mentions different types of public-private-partnership models for realizing these visions – purely public efforts will not be adequate but strong industrial presence is necessary.

The RIs in energy should support this European vision. Considering the R&D demands in energy and the characteristics of the energy innovations and the energy systems, the definition of the traditional RI is extended in the energy context also to pilot and demonstration plants. To be relevant for ESFRI such energy RIs should, however, have a clear scientific purpose, for example the pilot plants should be employed for more fundamental scientific work. To enhance European competitiveness, these kind of energy RIs should in parallel with the industrial needs and therefore co-financing schemes between public and private bodies is foreseen for such installations.

3.1.3 Need for research infrastructures

Photovoltaic: The PV field is growing fast or by 40% per annum with global turnover in the range of 20 billion €. Much of the research in the PV field is done in dedicated research institutes and by the industry itself. Single major RI needs in PV is difficult to identify as this technology is already commercially available and R&D needs are covered by different market actors. FP7 and the PV technology platform provide improved focus and cohesion into the R&D efforts on a European level. The possible investment in new PV R&D-infrastructures should preferably cover the different parts of the value chain, with interlinked centres to ensure continuity and cost-effectiveness. Possible RIs could be related to platforms for advanced manufacturing systems and base materials for solar cells and development of new promising concepts like 'Concentrating PV'. In addition a RI platform for information exchange and benchmarking of the various approaches to thin film photovoltaic would be valuable.

Wind energy is the fastest growing electricity production form representing close to 2% of world electricity and a business area of over 20 billion €. Present research infrastructures are inadequate to address research needs on large-scale wind turbines and systems. With the move towards up-scaling of turbine technologies, there is a crucial need to build research infrastructures that are able to demonstrate the latest technology developments at a relevant scale, for example multi-MW systems in offshore environment. Relevant RIs could be related new generation of technology components at a relevant scale, wind research facilities with necessary enabling technologies and power infrastructures such as grid integration and storage. The Commission's new goals for renewable energy use in Europe from 24 January 2008, will put much emphasis on wind energy – it is possible that wind power would provide up to 15-20% of all electricity in Europe by year 2020. This will put very strong pressure to develop larger and more reliable wind machines, often in wind regimes and heights where little experience is available. The influence of turbulence in particular on performance and durability is a highly critical factor. European research infrastructures in this area but addressing in parallel local conditions (e.g. magnitude of micro-turbulence) would be beneficial. Proposal ***RU36 European Centre for Turbulence and Wind Energy*** fits well into the RI landscape.

Bio fuels for transport are highly strategic for Europe. There is a general debate on the effectiveness and sustainability of different biomass feedstock and bio fuel conversion paths. So-called 2nd generation bio fuels based often on lignocelluloses or waste are perceived as a benign solution and prerequisite for large-scale deployment of bio fuels. The R&D infrastructure for 2nd generation bio fuels is not available yet. There is a crucial need to demonstrate the technology at a relevant industrial scale. Such pilot plants could serve more profound research on advanced bio fuels. The R&D priority including RI is on the development of advanced conversion processes and bio-refineries, i.e. the integrated conversion plants for bio fuels and bio-products. Also, advanced biomass gasification plant could be a relevant topic in this context.

Ocean and marine energy is a new field of renewable energy, though having a relatively large potential in some ocean-shore sides of Europe. One RI identified here would be a versatile European test capability including cabling and grid connection covering the different technology approaches for marine energy. Some kind of networking between different European research institutes to form a virtual RI could be one possible approach.

Solar thermal power based on concentrating collectors has received renewed interest world-wide with interesting utilization possibilities in southern latitudes. Concentrators can be used for steam, electricity, fuels and chemicals production. There is a clear need for a truly European large-scale facility incorporating different concentrator technologies and energy processes and being located in the sun-belt. Such an effort could bring together dispersed skills and groups for Europe together, even more globally (e.g. Russia, USA, Japan, Central Asia). The key features of the proposal ***RU34a TEREI-Solar*** addressed the central RI issues of the concentrated solar power in Europe.

Smart-grids: Going for large-shares of intermittent energy and distributed production means major challenges for electricity transmission. Present solutions have a limited carrying on capacity. Smart grids could be one technical solution. Here a full scale European grid research infrastructure incorporating flexible production, load and grid set-ups would be an important RI enhancing innovation in the field.

Fuel cells and hydrogen: The Commission recently launched the first energy Joint Technology Initiative (JTI) in fuel cells and hydrogen. The JTI should pave the way for a breakthrough of this technology on a long-term run. A lot of R&D in different technologies and by different actors is foreseen. At this stage, the RI needs in fuel cells and hydrogen seems to be related to EU test facilities for H_2 safety and security, standardization work but also to full scale demonstration type projects on H_2 infrastructure. Additionally, R&D efforts on the production of hydrogen from -renewable energy sources will be necessary if hydrogen were become an important energy vector in the future.

Zero-emission plants: Fossil fuels play an important role in power production and in the years to come. Climate change mitigation will necessitate carbon removal and storage (so-called CCS). Large scale experimental facilities to enable research on both CO_2 removal from flue gas and storage of CO_2 in geological formations will be essential to enable CCS. Taking the global dimension and European competitiveness aspects, creating necessary RI would be urgent. This would in turn pave the way for zero-emission power plants. An important point with CCS research infrastructure is an adequate size of the facility (closer to a demonstration plant) and that key stages of the CCS, namely flue gas – sequestration-storage are present in the facility. Taken the scale of RI needed, it is perceived that a few European joint facilities would be an effective approach covering the different variants of CCS. Proposal ***RU29a European Carbon Dioxide Capture and Storage Laboratory Infrastructure*** is well in line with needs.

In other renewable energy sources not covered above such as solar heating, solid-biomass, hydro power, speculative energy forms, etc. the group could not identify relevant single RI needs. Some kind of networking among R&D performers or test centres to form virtual networks could provide additionally, but their link to ESFRI is not fully clear.

The PSE recommends that a RI facility for solar thermal energy (solar heating and cooling) may be formed as a network with experimental and demonstration facilities placed in different climatic zones. These sites could be used for explorations of different building designs and solar technologies with participation from industries and academia.

Oil and gas: No major RI needs identified.

Co-generation: No major RI needs identified.

Fission and fusion: Nuclear energy has been subject for intensive collaboration for a long time and much of the science is actually done around large facilities and The EURATOM programs has to a large extent provided the strategic stewardship. The ESFRI road map 2006 includes 3 projects in the field of nuclear energy. It is foreseen that e.g. Generation IV nuclear reactor R&D may create new RI ideas in the coming years, e.g. test reactors, which could be captured by future ESFRI landscape updates. The fusion side is well covered by ITER and IFMIF facilities; these are closer linked to the EURATOM than to national research infrastructure questions. The JHR facility is important for reactor material research. Proposal MYRRHA, Multipurpose Hybrid Research Reactor for High-tech Applications represents accelerator driven reactor research. The proposal MHD Dynamo Platform related to plasma physics and magneto hydrodynamic phenomena fall aside present priority areas.

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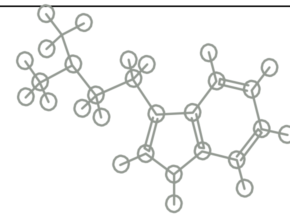
3.2 Landscape for Materials Research



The use and development of materials has been of enormous importance for the European civilisation and culture. In fact the different periods of our history is often named after the material used at the time, Stone Age, Bronze Age and Iron Age. The ongoing the progress of information and communication technology is largely based on the development materials for transistors and lasers. Another important contribution in this field comes from the discovery of the Giant Magneto Resistant, which is the scientific breakthrough for which A. Fert and P. Grünberg were awarded the 2007 Nobel Price in Physics and constitutes the basis for modern magnetic memories in our computers.

A most important trend in Materials Research today is the synthesis of materials and structures of materials with very small dimensions, which are popularly called Nano Materials. This type of materials has already proven their value in applications from catalysers to electronic components and is also used in medical, mechanical and many other applications. Some people believe that future historians may say the call the present time the Nano Age to follow the time period mentioned above.

3.2.1. General considerations

The advanced research on new materials needs access to well equipped laboratories both for synthesis and characterization. Among the necessary infrastructures for Materials research is: Clean rooms for synthesis and processing; Synchrotron radiation sources; Free electron lasers; Neutron sources; High power laser laboratories; High magnetic field laboratories; and High resolution electron microscopes.

The complexity of Materials research is large both what concerns the different classes of materials as well as their applications and most important in this case the size and cost of the infrastructure. Infrastructures in Materials research may be divided in two main categories: (a) Exceptional European, and (b) Networks of unique competence.

With Exceptional European installation are understood infrastructures, which due to their high costs only one can be build in Europe. Examples of laboratories in the first group are the X-ray Free Electron Laser and the European Spallation Source. To the second group belongs network various synthesis and characterization laboratories for materials, such as clean rooms, high magnetic fields and electron microscope installations.

The RI landscape for materials research can be described in three parts: (1) nanomaterials: (2) light sources; and (3) neutron sources. The Nanomaterial part encompasses network of synthesis and characterization laboratories, the Light sources are both network and Exceptional European installations and the Neutron sources are now Exceptional European Installations.

3.2.2. Nanomaterials

Nanotechnology is the manipulation or self-assembly of individual atoms, molecules, or molecular clusters into structures to create material and devices with new properties. As such it covers a very broad domain of applications which can be divided in following categories on which research is performed in many research infrastructures spread over Europe: nanomaterials; electronics and systems; fundamental research (chemistry and physics); analytical and diagnostics; engineering and fabrication; nanobio-technology and energy.

There is no doubt that nano-science and technology is and will be one of the major research and development areas for the coming decade. 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 side in order to be able to perform all processing and characterization steps needed. An overview of the future areas on nano-science and -technology was already given in the previous roadmap report and is still valid.

According to the recent (July 2007) report "European Nanotechnology Infrastructure and Networks" of the Nanoforum (www.nanoforum.org), a total of 303 research infrastructures dealing with nano-science and -technology can be identified in Europe. The centers are spread over 30 countries. 18 centers can be considered as major EU research infrastructures with large scale facilities (clean rooms and state of the art equipment) and annual budgets in the multi-million range. These large centers are concentrated in Belgium (1), France (6), Germany (3), Ireland (2), Switzerland (2) and United Kingdom (4). 102 centers are engaged in the field of nanomaterial research and fabrication. 58 international networks dealing with nanosciences exist in Europe.

The nanoforum report illustrates however that significant difference exists between countries. The centers in France for example have a focus on electronics and nanobiotechnology while Germany has an infrastructure covering all areas. Like the United Kingdom, Poland has a strong base in nanomaterials, electronics, fabrication and analysis.

Some countries have more limited facilities and no large scale centers. They would benefit from better information on the existing infrastructure and from easier access to these facilities. The report clearly shows that Europe has already a large number of research centers dealing with nano-sciences and -technologies.

To avoid unwanted duplication of large infrastructures and the high associated investments and running costs, it makes sense to put the leading centers in specific fields in network and to stimulate the access from other, smaller centers and research groups from all countries to this virtual pan-European large infrastructure.

This is what is proposed in the already listed (ESFRI report 2006) project **PSE31; *Pan-European Research Infrastructure for Nano-Structures (PRINS)*** which is focusing on existing large scale facilities dealing with ultimate silicon and heterogeneous integration and is grouped around CEA-LETI (France), FhG (Germany) and IMEC (Belgium). The three consortium partners are in the list of 18 major research infrastructures for nanoscience in Europe as identified in the Nanoforum report. This distributed (ultra)large scale facility will collaborate with the European nanoelectronics community through the strategic European Technology Platform "ENIAC". The total cost of the PRINS project is estimated to be of the order of 3 B€ whereof a significant amount will be raised by industry in a public-private partnership.

The new ESFRI project proposals ***RU027 Nanoscience Foundries and Fine Analysis (NFFA)*** and ***RU039 Pan European Research Infrastructures for Nano-Structures – an extension to central Europe (PRIN-CE)*** can in some sense be considered as projects that fit well in the PRINS initiative.

NFFA covers a broad range of nanoscience areas and proposes a close linkage of nanoscience facilities with existing or planned large scale facilities for material analysis. Only one of the five partners of the NFFA consortium is a large research infrastructure (CMF in United Kingdom) as identified in the above mentioned list of 18 while the other partners can be considered as medium or small sized infrastructures. As commitments and budgetary aspects are not yet clear nor is the relation with the PRINS project, NFFA should be considered as an emerging project. The proposal could be further developed in close connection with the PRINS consortium during the preparatory phase of the PRINS project.

PRIN-CE is very much a Polish national project with weak international involvement at the moment. The intention is to set up a large research facility for nanoscience research. In view of the large number of already existing facilities in Europe it would be good to explore synergies and complementarily during the preparatory phase of PRINS. At the moment the PRIN-CE proposal seems to be still in an immature phase.

High magnetic fields: A powerful tool to modify and study materials is also provided by high magnetic field laboratories, operating both in continuous and pulsed modes. High magnetic fields are used in a variety of applications, ranging from materials research (including superconducting materials) to

physics, chemistry and life science. The current plan to upgrade and integrate the four existing European high magnetic field laboratories into one distributed pan-European research infrastructure, the **European Magnetic Field Laboratory (EMFL)** will allow Europe to strengthen its competitiveness in this field of research. The project ***RU19 European Magnetic Field Laboratories (EMFL)*** is a network of high magnetic field laboratories. High magnetic field studies are an important characterization in many areas of materials research. The EMFL proposal aims to create an integrated facility of four existing 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.
The connection of this new infrastructure with the neutron and photon sources, in particular ILL and ESRF in Grenoble, is also currently under discussion and, if approved, it will provide a truly multi-source multi-disciplinary user instrument for the investigation of matter.

Traditionally Europe has had a strong position for high magnetic field studies. At present, however, the state of the laboratories is in the USA. This proposal addresses this situation and aims to strengthen the European position. The laboratories involved in the proposal provide an excellent basis for a new network ESFRI network of high magnetic field laboratories. The PSE working group strongly recommends this proposal for further considerations within ESFRI.

3.2.3 Large Neutron Infrastructures in Europe

It is widely acknowledged that neutron science is one of the scientific techniques in which Europe has clearly been world leading over the last 30 years. It is estimated that there are currently about 5000 European scientists using neutron scattering as part of their research programmes.

This success has been based on several factors:

(i) A network of small and medium national sources, mainly multi-purpose reactors, which have made key contributions to scientific achievement, technical development and training of students and researchers, and to the growth and support of the scientific user community. These include the steady-state reactors BENSC in Berlin, Germany, FRG-1 in Geesthacht, Germany, FRM-II in Garching, Germany, LLB in Gif-sur-Yvette, France, BNC in Budapest, Hungary, RID in Delft, the Netherlands, JEEP-II in Kjeller, Norway, NPL-NRI in Řež, Czech Republic as well as the continuous spallation source SINQ in Villigen, Switzerland. Some sources were closed in recent years but this has been compensated for by new facilities such SINQ (1998) and FRM-II (2005). The second target station of the ISIS pulsed spallation source in the UK will be open for experiments in the autumn of 2008. The more recent sources were all purpose built for neutron science.

(ii) The Institut Laue Langevin (Grenoble, France), acknowledged as the world leading facility for neutron science, is a very good example of successful collaboration between European countries. France and Germany made the initial agreement in 1968 and were followed soon after by the UK as the third associate member. Since 1987 the ILL has incorporated 9 more countries as new scientific members, making it a real European centre of excellence. It acts as the focal point of the European neutron community and is a centrepiece of the European Research Area. An ambitious modernisation programme was started in 1999. The ILL 20/20 Upgrade project to be implemented between 2007 and 2016 is part of the ESFRI Roadmap and will retain the leading-edge character of this facility.

(iii) The operation of most European facilities, particularly the larger ones, has been primarily for the research programmes of external users (e.g. university researchers), with a culture of scientific excellence based on peer review.

Neutron scattering is one of the few scientific methods that have no ‘small-scale’ equivalent. Successful scientific exploitation of neutrons, as realised in Europe over the past 30 years, requires the maintenance of a number of sources providing for three key factors, viz. capability, capacity and variety. This should be the basis for the development of a strategy for neutron scattering in Europe over the coming decades.

During the 1990’s attention was drawn to the fact that 2/3 of the existing neutron reactor sources would be approaching the end of their expected operating life between 2000 and 2020, and that steps should therefore be taken to provide for new capability. It was recommended that a ‘next-generation’ source should be built in each of the major world regions – America, Europe and Oceania. In the USA and Japan it was recognised that, as well as replacing capacity, there was a need to significantly improve capability.

Following a design study in the USA it was realised that a high-flux reactor source of significantly higher power than the ILL (50 MW) was not a realistic or cost effective option, so it is now generally accepted that all new high power sources will be based on spallation. Therefore it is questionable whether the 100-MW reactor PIK presently under construction in St. Petersburg, Russia will ever become a high-performance facility. The USA and Japan have, accordingly, made major investments, of order 1.5 billion euro each, in new, pulsed spallation sources. SNS in Oak Ridge, USA has become operational since 2006. J-SNS in Tokai, Japan will become operational soon. Conversely, the 1.5-MW pulsed reactor IBR-2 in Dubna, Russia is being reconstructed and will go into operation in 2010 with water moderator and in 2012 with a cryogenic moderator complex. This long-pulse facility may play a significant role until a powerful long-pulse spallation will be constructed in Europe.

Project ***PSE15 ESS, European Spallation Source***, part of the ESFRI Roadmap should become the world’s most powerful neutron source. The decision on the site of this 5-MW long-pulse source is due in 2008. Provided that its construction starts in 2010, the facility may become operational in 2017. This will ensure Europe’s leading role in neutron scattering in the twenties. In the course of the work of the PSE the ESS project has been the subject of specific ESFRI initiatives. Three countries have announced their bids to host the ESS at specific sites and ESFRI has responded by forming a Working Group on ESS Siting in December 2007. The Working Group has established an international expert Site Evaluation Group SRG to conduct individual assessments of the proposed sites. The results will be presented to ESFRI at the meeting in September 2008.

3.2.4 Photon Sources

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Photon Sources: Light photons are only one, but the most flexible, of the many complementary “probes” which can be used. They are needed over a large range of “colours”, from the Far Infrared range up to the Hard X-Rays. Large related instruments are Synchrotrons, Integrated Laser Laboratories or High Power Lasers. They serve a broad community of users far beyond physics and material sciences. This is particularly true for synchrotron light sources. Biology and life sciences, environmental sciences as well as earth and universe ones and more recently archaeology and palaeontology are now their main users. High power lasers and Synchrotron light sources are also used to produce and study plasmas, e.g. the conditions for energy production by fusion, or to produce devices through lithography.

A technological breakthrough is now occurring with the ***Free Electron Lasers (FELs).*** They are capable not only of much higher brilliances than third generation synchrotron sources, but also of fentosecond short time “flashes” opening the dynamic “filming” of atom related properties. Their new capabilities will allow the exploration of a new terra incognita by opening novel areas of research inaccessible with the third generation synchrotrons. Actually, the first exciting results in atomic and molecular physics are already coming out from the operation of the Flash soft X-ray facility in Hamburg. In this range of photon energies, Europe is well endowed since several

European national projects with different characteristics are presently in construction or in design. They have joined within the consortium of the project ***PSE19 IRUVX-FEL*** to develop R and D together and to coordinate their programs. In the hard x-ray domain, the size and cost of a FEL facility imply international collaborations at continental levels such as the international European XFEL facility. Project ***PSE24 X-FEL*** aims at the measurement of the structures of clusters and single macromolecules with atomic definition, as well as at time resolved “atomic movies “. The project has moved on much in the past two years with the agreement of many European countries to join it. It is now close to start its construction. Its characteristics will make it the most powerful and the brightest X-FEL worldwide and should give Europe a dominant position in the field. It is thus vital that its construction moves on as quickly as possible.

In the field of ***synchrotron light sources*** where Europe has a long tradition of excellence with the ESRF leading the field worldwide, the landscape has evolved much in the last past years thanks to a continuous effort made by several EU countries. Three new bright medium energy facilities, SLS in Switzerland, Diamond in UK and Soleil in France are now in full or partial operation, while a fourth one, ALBA, is in construction in Spain. There are also new projects coming out like the innovative project ***RU037 MAX IV*** in Sweden, as well as suggestions for implementing new facilities in central Europe. This increase in the European capacity is a necessary answer to the ever-increasing demand of the still growing user community of more than 10,000 researchers. These new facilities are also complementary to a significant extent in terms of their experimental possibilities and scientific programs. In the field of hard X-rays, the rebuilding of a part of PETRA at Hamburg will provide a new low emittance high energy facility, Petra 3, which will significantly increase the European capacity. However, the International facility *ESRF* in Grenoble, which is one of the most successful European scientific initiatives, has to keep its position of leader for X-ray science worldwide. It is thus vital that its ambitious upgrade program, which is supported in the ESFRI Roadmap with the project PSE14 ***ESRF-UP*** is expected to be implemented soon.

The frontier of laser science is presently progressing at an extremely steep gradient in many different directions. New projects of extremely high power lasers are coming out opening new perspectives not only in basic research (ultra-relativistic intensity regime) but also as in applied areas (particle acceleration, development of efficient compact secondary sources of electron, ions and photons). Europe is in a good position in that competitive field with quite a few excellent institutes already working together within an I3 program and with the ambitious and innovative project ***PSE36 ELI*** that gathers most of them. *ELI* aims at building the most powerful short pulse laser installation worldwide. The decision to build such a European facility is a necessity to maintain the European leadership in this very rapidly evolving domain. Important societal applications might greatly benefit from it (compact accelerators, hadrons and radiation therapies, medical imaging, etc…).

3.3 Landscape for engineering research

Engineering research typically has components of basic and applied research as well as experimental development. This means that many of the RI used for materials research also serves the engineering research communities. In other words many of the users at these facilities come from engineering departments at European universities and from industrial R&D departments. This is particularly true for the neutron beams and synchrotron radiation facilities. Engineering research communities are also heavily involved in the development of the RI’s in PSE areas. New RI’s take advantage of the latest advancements in technology and in many cases are key drivers for such advancements. The long string of spin-offs from RI-institutions like CERN is a testimony to that effect. Many of the ESA projects have an industrial engineering rationale as well as the scientific rationale.

The new proposals in the field of engineering research were related to aeronautical and aerospace research; safety research and fluid dynamics.

3.3.1 Aeronautical and aerospace research

Here the proposed ***LVR-HALE (ESFRI proposal RU26)*** research platform is envisioned to be a flying laboratory capable to perform aeronautical research that meets requirements in terms of altitude, endurance and autonomous mission management. Its nominal performances are: 30 days endurance; 20 km altitude; fully autonomous flight; quasi-geostationary flight. LVR-HALE will provide a flying platform for a wide range of applications and needs for research in aerodynamics, material technology, innovative structural concepts, and innovative air transport system operational concepts. In addition auxiliary technologies can be tested such as on-board clean energy systems using fuel cells and photovoltaic cells, atmospheric pollution. LVR-HALE will also offer options for real-time monitoring of seismic areas, hydrograph monitoring, telecommunication services.

Another specialized flying test bed is ACT/FHS. It is operated and owned by DLR and has been operational since the end of 2002. It is a European oriented flying test bed for innovative aeronautics technologies. The basic aircraft, an Eurocopter EC135, has been converted to fly-by-light helicopter with variable stability characteristics in order to allow research tasks to be performed in Flight dynamics, Flight systems, Flight guidance, Aerodynamics, measurement technologies and avionics. The ACT/FHS contributes to various initiatives such as FRIENDCOPTER, the smart rotorcraft, the quiet rotorcraft.

The DLR also intends to develop an Advanced ***Testing Research Aircraft, ATRA (ESFRI proposal RU13).*** This airplane will be operational by the end of 2009. It will be unique in Europe because providing the widest scope of research possibilities in the area of flight testing, and it is oriented test innovative aeronautics technologies. The basic aircraft, an Airbus A320 -232, will be converted in order to allow research tasks to be performed in Flight systems, Flight guidance, Aerodynamics, Cabin research, measurement technologies and avionics. ATRA will give the European community of universities and Research establishments the possibility to test technologies on an industry standard aircraft.

3.3.2 Safety research

The proposed project ***RU14 L-SURF*** addresses the safety research needs from their increasing level of public mass transportation interconnections – especially underground - between different means of transportation (e.g. airport connected with rail and metro through a hub with a shopping mall included). The relevant boundary conditions of such spaces are limited access and therefore also provide limited escape routes as well as very special ventilation systems, resulting in safety risks in connection with dispersion of gases, spread of fire or distribution of Chemical, Biological, Radiological, and Nuclear material. The proposed L-SURF facility will offer flexibility of boundary conditions regarding the shape of cross sections, the ventilation of tubes and hubs, the surface properties – which is of importance for human behavior – and the combination (like links and crosses) of different types of subsurface spaces. L-SURF will also cover all environmental aspects being it waste air, waste water and solid waste.

3.4.3 Fluid dynamics

The proposed project ***RU20 CICLOPE*** is a new “single-site” RI created to develop high Reynolds number experimental facilities for detailed turbulence measurements. In combination with computational resources, the facility will provide a focus of activity for leading international researchers in the field of high Reynolds number turbulent flows. The main experimental apparatus, i.e. a large pipe flow facility (pipe diameter of the order of 1 meter and a length larger than 100 meters), is intended for at least ten years of basic research and has the potential for extensions with more direct impact on applications, such as the study of the effect of non-smooth walls or non-isothermal conditions, the evolution of various non-equilibrium flows, and of flows with some particulates. It is a national initiative aimed at an international user community.

3.4 Astrophysics, Astronomy, Particle, Nuclear, and Ionospheric Physics

The subfields of ***Astronomy and Astrophysics, Nuclear Physics, Particle Physics, and Ionospheric Physics*** have a long tradition of coordination and international Institutions developing internationally agreed, designed and open-access projects, which ensure both a rational use of resources and the capability of long-term planning to develop a coherent set of specialized roadmaps. In the case of Astronomy, Astrophysics, and Ionospheric Physics as well as in Astro-particle Physics, the issue of Space borne instruments is of obvious importance. One issue that has been brought to attention is the need of better coordination between Space and Ground long term planning of the needed infrastructures.

In the subfield of Nuclear Physics, the NUPPECC organization has been the main reference to converge towards a selection of proposals joining the criteria of Pan-European impact with the need of a small and significant set of major proposals. Some proposals by NUPPECC have been not included but the EWG recognizes their importance in the overall field, although they are of a size that can be easily realized within the existing resources of the Institutions operating in the field.

3.4.1 The overall landscape

In the exploration of the universe as a whole, of the objects in it and in a better understanding of the constituents of matter and their behavior science has made enormous progress in the recent decades. But this progress has produced a lot of new fundamental questions which are today on the agenda of ***astrophysics, astroparticle physics, particle physics and nuclear physics***. Now these research areas are in many ways interconnected. Examples are the search for dark matter or dark energy, the origin of mass or nuclear astrophysics. The exciting scientific perspectives and new technological developments have inspired the creativity of the scientists and led to a lot of proposals with a sound scientific and technical justification.

Basic science has always been a driving force for the development of new technologies to improve the collection of information from the farthest distances and from the smallest dimensions of space. On the other hand new instruments have always led to new discoveries and new insight. But in the course of this development the facilities in fundamental physics and astronomy have become much larger, technically more complicated and very expensive. More than ever before it has become a necessity to join the intellectual and financial resources of many countries to realize these projects.

In ***astronomy*** outstanding discoveries in recent years have induced new fundamental problems. These include the nature of Dark Energy and Dark Matter, the emergence of the first stars and galaxies in the universe and their evolution, the description of gravity, and planet formation around other stars. To tackle these and other questions a new suite of instruments is required to provide data across the electromagnetic spectrum.

Current ***ground-based optical astronomy*** can use as largest instruments a set of 8-10 m telescopes, but it has become clear that the challenge of the new fundamental questions require still larger collecting area and larger angular resolution. The ***Extremely Large Telescope (ELT; ESFRI project PSE 12)*** has been proposed as the follow-up project of the current generation of optical telescopes. With segmented mirrors and adaptive optics it seems possible to construct telescopes with diameters of up to 100 m. For many reasons there is now a concentration on 30-50 m class telescopes, which represent a natural scientific and technological step towards larger sizes.

The ELT will enormously deepen the knowledge in nearly all fields of astronomy, e.g. will help to investigate the formation of structure in the very young Universe and will allow studies of extra-solar planets in our galactic neighborhood.

In ***radio astronomy*** there is consensus in the scientific community that the next generation telescope should be the ***Square Kilometer Array (SKA; ESFRI project PSE22)***. The SKA will have a collecting area of one million square meters distributed over a distance of at least 3000 km. This area will result in a 100 times higher sensitivity compared to existing facilities necessary to see the faint signals from the early universe. The radically new concept of an “electronic” telescope will allow very fast surveys. Thus it will be possible to tackle many important problems in cosmology and fundamental physics, e.g. tests of the theory of relativity or the formation and evolution of galaxies. The site for SKA is likely to be outside Europe.

Neutrino detectors have opened a new window for observations and a new field in astroparticle science, that of ***neutrino astronomy***. The ***Cubic Kilometer Neutrino Telescope (KM3Net; ESFRI project PSE21)*** will consist of thousands of optical sensors distributed in a volume of about one cubic kilometer in the depth of the Mediterranean Sea. The sensors detect the light which is produced in the water by charged particles originated from neutrinos and the earth. It is aimed to monitor the universe continuously – together with the ICECUBE neutrino detector currently under construction on the South Pole. It will search for distant sources like gamma ray bursters, supernovae or colliding stars.

In ***gamma ray astronomy***, a ***Cherenkov Telescope Array (CTA; ESFRI proposal RU07)*** is proposed. There has been major progress in this field, where the HESS and MAGIC projects have observed a multitude of gamma ray sources both within the plane of our galaxy and outside our galaxy. The CTA will greatly extend the reach of these current projects and allow for further exciting scientific discoveries. The idea of CTA is now mature enough and the relevant research groups have coalesced into a coherent structure. The promise of this approach has also been noted in a recent ApPEC statement.

Nuclear physics has been revolutionized by the recent development of the ability to produce accelerated beams of radioactive nuclei. For the first time it will be possible to study reactions between the 6000 to 7000 nuclei we believe exist rather than the 300 stable ones that nature provides. Modern nuclear physics has two main aims. At the larger scale one wants to understand the limits of nuclear stability by producing exotic nuclei with vastly different numbers of neutrons and protons. At the smaller scale one wants to explore the substructure of the constituent neutrons and protons, for it is in the interaction of their constituent parts that the ultimate description of nuclei must lie.

There are two approaches to producing radioactive beams – the “In-Flight Fragmentation” and the “ISOL (isotope-separation on-line)” techniques. The In-Flight production technique is fast and can produce the shortest-lived radioactive nuclei, whereas the ISOL technique can provide more intense and better controlled beams for detailed studies. So both techniques are complementary.

The leading In-Flight facility will be the ***Facility for Antiproton and Ion Research (FAIR; ESFRI project PSE16)*** planned as an international research centre in Darmstadt (D). The technical plan for the first stage and the legal documents will allow starting the centre in 2008. The central part of the facility are two superconducting synchrotrons which will deliver high intensity ion beams up to 35 GeV per nucleon for ions up to uranium and with secondary radioactive beams and antiprotons. FAIR will allow a broad spectrum of research programs e.g. with cooled beams of antiprotons, for nucleus-nucleus collisions and for nuclear astrophysics investigations.

SPIRAL-2, ESFRI project PSE23, is a major expansion of the SPIRAL facility at GANIL in Caen(FR) which will help to maintain European leadership in ISOL development and is an essential step on the road to EURISOL**.** The technical challenges of the acceleration, targetry and experimental equipment will provide essential knowledge and continuity. The **EURISOL** facility is intended to be the ultimate ISOL facility, for which a design study is under way, but the start of this facility is not expected before 2018, since formidable technical challenges have to be tackled. Therefore an intermediate step as SPIRAL 2 is required and essential.

DAΦNE II (roadmap update proposal RU21) is a high luminosity e+e – collider in the energy range between 1 and 2.4 GeV based at Frascati(I) has been proposed in Nuclear Physics. This facility will allow precision experiments in fundamental symmetry violations in the Kaon system, which is a probe of physics beyond the Standard Model. A program in Hypernuclear physics will also be carried out, which bridges the disciplines of High Energy and Nuclear Physics. In addition this collider will be the tested for the development of beam handling techniques crucial to the operation of all future high luminosity colliding beam facilities.

Particle physics stands on the threshold of a new and exciting era of discovery. The next generation of experiments will explore new domains and probe the deep structure of space-time. European particle physics is founded on strong national institutes, universities and laboratories and the CERN Organization. The CERN Council created a Strategy Group which elaborated a Roadmap for the needs of the field, with the following major elements (reference):

- The Large Hadron Collider LHC at CERN will be the energy frontier machine for the foreseeable future and should fully exploit its physics potential. R&D has to be pursued now for a luminosity upgrade by around 2015.

- In order to be in the position to push the energy and luminosity frontier even further it is vital to strengthen the advanced accelerator R&D program (CLIC technology, high performance magnets, and high intensity neutrino facility).

- It is fundamental to complement the results of the LHC with measurements at a linear collider. In the energy range of 0.5 to 1 TeV, the ILC, based on superconducting technology, will provide a unique scientific opportunity at the precision frontier."

Ionospheric physics studies the earth's nearby space environment and its interaction with the solar radiation. As such it provides crucial input to the overall study of the Earth as a system and is of significance in the study of the Earth's long term climate. ESFRI roadmap update proposal ***RU38 EISCAT 3D*** intends to develop an incoherent scatter system based in the northernmost parts of the European continent will allow for the first time the three dimensional real time mapping of the ionosphere and lead to a more complete and coherent view of the near earth space environment.

3.4.2 Particle Physics

Particle physics stands on the threshold of a new and exciting era. The next generation of experiments will explore new domains and probe the deep structure of space-time. Long-standing puzzles such as the origin of mass, the matter-antimatter asymmetry of the Universe and the mysterious dark matter and energy that permeate the cosmos will soon benefit from the insights that new measurements will bring.

The facilities in experimental particle physics are large and technically challenging. More than ever before it has become a necessity to join intellectual and financial resources to realize these projects. European particle physics is currently world leading, and has developed an efficient model for constructing and operating large research facilities, based on national institutes, a very large number of universities and laboratories, and the CERN Organization.

Constructing such facilities requires focused R&D and technological innovation in a number of fields, covering from superconducting RF cavities and magnets, to new sensor technologies, advanced electronics and computing methods. The particle physics community has a strong tradition for efficiently developing and improving technologies, in collaboration with industrial partners, for use in new projects, often with significant applications outside the field of particle physics. Recent examples are light sources, GRID computing and medical applications for treatment and diagnosis. With very ambitious technical specifications for new projects, an international network of expertise throughout European research facilities and industries, a large participation of young researchers, engineers and students, particle physics has become a model for how large research facilities are planned, constructed and operated, and how large collaborative European and global research projects can be organized.

In 2006 the CERN Council created a Strategy Group that elaborated a Roadmap for the field. The follow-up of this strategy is done in regular European Strategy Sessions of the CERN Council. Currently the European particle physics community enters a particularly exciting period, where large facilities are operating collecting unique data, while in parallel extensive R&D is ongoing for new projects. This is reflected in the Roadmap, where the major scientific elements are:

- The Large Hadron Collider (LHC) at CERN now starting will be the energy frontier machine for the foreseeable future and it has the highest priority to fully exploit its physics potential. Depending on the nature of the discoveries made at the LHC, higher-statistics studies of these phenomena would naturally call for an increase in luminosity. This upgrade – referred to as Super-LHC – should increase the luminosity by a factor ten.

- It is vital to strengthen the advanced accelerator R&D programmed in Europe, providing a strong technological basis for future projects in particle physics.

- It is fundamental to complement the results of the LHC with measurements at an electron-positron linear collider. Such a linear collider will provide a unique scientific opportunity at the precision and energy frontiers. This programme can be carried out by the International Linear Collider (ILC) or if multi-TeV energies are needed, a novel design called the Compact Linear Collider (CLIC) has the potential to deliver such energies. For essentially every new physics scenario involving particles in the linear collider energy range, detailed and very promising research programmes have been formulated. The linear collider studies are in the R&D and technical design phase, and also here LHC results will guide the way.

- Neutrino physics opens another exciting window to study physics beyond the standard model. Recent measurements of neutrino oscillations and masses, and the possibility of observing CP violation in this sector, point forward to the need of constructing more advanced neutrino facilities, and design studies are ongoing. Which route to take, depends on the result of accelerator R&D, and on results from experiments now starting.

- New initiatives and plans are being developed in the field of flavour physics where the Super-B facility near the INFN National Laboratory of Frascati is a possibility being pursued.

- Several important experiments take place and are planned in the overlap region between Particle and Astroparticle Physics, or between Particle and Nuclear Physics. Examples of such experiments can be found in Europe’s four world-class deep underground laboratories: Boulby (UK), Canfranc (Spain), Gran Sasso (Italy) and Modane (France). These facilities study neutrinos – including in some cases long baseline experiments with accelerator neutrinos, and search for dark matter and for proton decays.

Common for several of the large future facilities mentioned above is that they are now in the preparation phase, and before definite construction programs can be launched, the scientific case has to be confirmed and elaborated with detailed measurements in ongoing projects, the technical solutions and designs have to be further developed and supported by rigorous R&D programs, and the formal collaboration agreements and organizations prepared.

At the time of the next major update of the European Strategy for Particle Physics foreseen for 2011, these preparatory studies will be reaching conclusions, paving the way for new major construction projects.

4. Projects from the 2006 ESFRI Road Map

4.1 Progress in the Preparatory Phase

After the first ESFRI Roadmap was published in October 2006, the EC decided to support the Preparatory Phase for the preparation of the RIs of the ESFRI Roadmap through their first FP7 Research Infrastructure call for proposals. The main goal of this action was to provide catalytic and leveraging support, helping RIs to reach the level of technical, legal, and financial maturity required to enable their construction.

All 15 research infrastructures on the ESFRI roadmap 2006 in the field of the PSE RWG successfully applied for the Preparatory Phase. The projects now are funded by the European Commission to work on open legal, financial, governance and to a small extent technical issues in order to be able to start with the implementation of the projects at the end of the Preparatory Phase. An important issue is to seek support by a sufficient number of EU member states or associated states to support construction and guarantee sustainable operation.

One of the tasks of the PSE RWG is to deliver an ongoing strategic process to help ESFRI to implement the RIs already on the RM (incubator role). One aspect of this role is supporting the consortia and giving advice. ESFRI PSE prepared a template, similar to the first one used to apply for inclusion on the ESFRI RM, to ask for the current status of the RI, including the PP, which is still a part of the implementation of the RIs. The result of this procedure is shown in more detail in section 5 of this report.

Most of the consortia started their negotiations for the PP in summer 2007 and began their work around half a year afterwards. The number of partners within these consortia varies between 1 and 27 and the EC contribution is between 1.5 and 6.5 Mio €. Project duration is between 24 and 48 months.

4.2 Assessments of the individual projects

Each of the coordinators for the projects in the 2006 ESFRI Road Map assigned to the PSE RWG was asked to submit an up-dated description of the project. PSE members from the European Commissions Services also gave regular oral reports on the progress in the negotiations of contracts concerning Preparatory Phase projects concerning the RI's on the ESFRI Road Map 2006 selected for support from FP7. On this basis the sub-panels of the PSE made an assessment of the progress changes in scopes, budgets and needs and international relations.

The conclusion was that all of the projects are recommended to be included in the up-dated ESFRI Road Map list. The PSE RWG finds very gratifying that all of the projects on the present ESFRI Road Map assigned to the PSE have made reasonable progress and recommends that they are included in the up-dated Road Map list. The following projects have advanced to or are very near to entering the construction phase based on national commitments or international agreements. These six projects are:

PSE 14: ESRF Up-grade
PSE 16: FAIR
PSE 18: ILL Up-grade
PSE 20: JHR
PSE 23: SPIRAL 2
PSE 24: XFEL

Status and progress of the PSE projects on the ESFRI list 2006 and in the Preparatory Phase are described in the following updated project descriptions.
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PSE12_ELT

1. Project's name and descriptive title
E-ELT – European Extremely Large Telescope
2. Short description of project and main characteristics
The largest optical-IR telescopes in operation or construction have collecting areas 8-10 meters in diameter. Using Adaptive Optics techniques to correct in real-time for distortions caused by the Earth's atmosphere, they can take pictures even sharper than those made by the Hubble Space Telescope. However, as the present generation observational limits in terms of depth and image sharpness become apparent, European astronomers are looking towards a 42-m collector with exquisite image quality that could be in full operation by the end of the next decade.
3. Science case (scientific justification, including new areas to be opened)
Key science avenues for the E-ELT are to probe the extreme of Physics (quantum gravity effects, dark energy & dark matter, black-hole horizons) and follow the full history of our Universe build-up from nuclei synthesis in its first 4 minutes to nearby planetary systems, including our own Solar System. Along these lines, a comprehensive science case has been built and is being refined by the astronomical community under the aegis of the FP6 Opticon Program.
4. Impact to society and to new technologies for industry
The Project is pushing many technologies well past their present performance limits. This includes mirror fabrication, position sensors and actuators, detector arrays, cryogenic pickers and a whole gamut of Adaptive Optics advanced components and systems. It also requires the development of a new generation of data analysis systems which will most likely flow through to other applications. On a more general note, astronomy is one of the most popular science topics in our society and the E-ELT will largely contribute through many exciting developments.
5. Strategic importance to ERA
The E-ELT project already began exerting a strong structuring influence on the astronomical communities, R&D suppliers and partners from Industry in the 13 present ESO Member States and, beyond, across most of the enlarged Europe. The E-ELT Facility will be accessible world-wide and in particular to all nations of the ERA through an open peer review process.
6. Maturity of proposal (including possible timetable)
Based on a Concept Reference Design developed through the year 2006, the 3-year Design Phase for the 42-m diameter E-ELT started in January 2007. In parallel an extensive R&D development, in particular within the FP6 ELT Design Study, has/is establishing the major enabling technologies needed for the project. The goal is to start Telescope Construction in 2010 for first light in 2017.
7. Budgetary information (preparation, construction and operation costs)
The current phase up to end 2009 brings together the design of the E-ELT facility (57.2 M€), the FP7 E-ELT Preparation contract (5.0 M€) and about 40 M€ in technological developments in the 2005-2009 period, in particular through the FP6 Opticon and ELT Design Study programs. Provisional construction cost is 750 M€ with about 35 M€ annual operating cost.
8. Comments on possible partnerships (optional)
The E-ELT design is conducted with fruitful and frequent contacts with its North-American counterpart, the TMT project, also currently in design phase. Within the FP7 EELT-preparation grant, partnerships in particular with non ESO European Member States will be explored.

PSE13_HIPER

1. Project's name and descriptive title
HiPER – The European High Power laser Energy Research Facility.
2. Short description of project and main characteristics
HiPER is a multi-national laser facility designed to allow Europe to take a leading position in the pursuit of Inertial Fusion Energy, whilst offering an internationally unique capability for science in extreme conditions. It will open up entirely new areas of research, providing access to physics regimes which cannot be explored on any other science facility. The preparatory phase project has been formally endorsed by 7 European nations at the governmental or national funding agency level, 2 regional governments, over 20 scientific institutions and has direct involvement from industry. Inertial Fusion Energy (IFE) lies at the heart of the design of HiPER. Fusion is the holy grail of energy sources – combining abundant fuel with no greenhouse gas emissions, minimal waste products, and a scale that can meet mankind's long-term energy demands. Fusion combines hydrogen isotopes to create helium gas and a neutron which is captured to provide heat for a steam turbine. The IFE solution for fusion is a proven scientific concept. A laboratory demonstration of net energy production using lasers for IFE is now only 3 to 5 years away, marking the culmination of 40 years research. This will attract significant public and political attention, and so the HiPER project has been developed to provide a route towards a commercial energy plant, based on a strong science mission.
3. Science case (scientific justification, including new areas to be opened)
IFE has been studied for many years as an attractive long-term energy solution, and as a means for creating the most extreme conditions achievable anywhere on Earth. This is the approach adopted by Nature– inertial fusion powers the stars. Far more importantly, the process of net energy production from inertial fusion has already been demonstrated on Earth in an offshoot of the US defence mission in the 1980s. Demonstration of net energy production using a laser is now anticipated in 2010 to 2012. It is essential that our scientific community clearly understands the future path to an energy programme following this landmark event. The field is still in the Research and Development phase, requiring international cooperation over the next decade centred on a next generation laser facility. Europe is ideally placed to lead the world in this journey, but requires a focused programme to ensure timely progress Analysis during the 2-year design study clearly indicated that a particular type of laser fusion known as "fast ignition" was the prime technical solution that could provide an optimum balance of scientific excellence and long-term energy options. The design of HiPER to meet this solution provides a step-change in laser capability, opening up entirely new research programmes in: • Extreme matter studies *(the highest magnetic fields and energy densities in the world)* • Fundamental atomic physics *(e.g. radiative opacity)* • The unexplained field of warm dense matter *(e.g. for planetary geophysics)* • Laboratory astrophysics *(studying dynamical processes and testing predictive models)* • The physics of turbulence *(one of the remaining puzzles in classical physics)* • Non-equilibrium nuclear physics *(otherwise inaccessible through conventional techniques)* • Production and interaction of relativistic matter *(enabling a wide range of applications)* • Fundamental physics at the strong field limit (*e.g. the physics of the quantum vacuum*) By opening up laser science into wholly new regimes, HiPER will attract scientists from many communities not traditionally associated with lasers. The anticipated size of the user community is thus many times that of the existing laser plasma groups, to be easily in excess of 1000 scientists.
4. Impact to society and to new technologies for industry
The pursuit of a long-term, sustainable, clean, safe source of energy is one of the key challenges facing society. The energy mission of HiPER is aimed at establishing the case for the exploitation of laser driven fusion. It is timed to coincide with the upcoming demonstration of energy production

from lasers (in ~2010-2012 in the USA). HiPER will illustrate the route to viable power generation by addressing the key R&D challenges – both scientifically and technologically. Multiple energy solutions are demanded by a risk-balanced strategy for energy supply, with this approach being highly complementary to ITER.
Whilst the energy mission addresses one of the highest societal priorities, the scientific impact of HiPER will be unique. No comparable laser system is underway anywhere in the world – HiPER will be a highly effective international attractor to Europe.
European industry is very well placed to capitalise on HiPER – in the design and build phase, the operational phase, and from the ensuing technical spin-out opportunities. Indeed, this is a cornerstone of one key aspect of the consortium negotiations to date. The laser and optics industry will clearly benefit enormously in the design and build phase. The project also plans to advance significantly the area of solid state (diode-pumped) technology. This progression will be relevant to the development of a wide range of opportunities within the traditional laser field, as well as for next-generation accelerator and intense light sources, and related industrial markets.
With regard to the future energy applications of HiPER, the potential economic impact cannot be overstated. The energy market is currently 3 trillion € pa.

5. Strategic importance to ERA

HiPER represents a globally unique facility, which will lead the world in terms of its scientific output and its technological implementation. It will therefore provide a strong attractor for international scientists into the ERA, both to the facility itself and to the broad base of allied laboratories.

The scope of the HiPER project has been designed to make best use of European expertise and thus maximise the potential of the facility. The HiPER philosophy is to build upon local capabilities to create a "hub and spoke" European consortium of institutions centred on the major facility. The nature of laser science allows this distributed model to function very effectively. The role of smaller nations, convergence nations and neighbouring regions can therefore have a disproportionate impact to the benefit of both the project and the local region. The distributed model is also effective in developing the capability of the members of the ERA to play a greater role in international projects centred on facilities in the USA and (increasingly) in Asia. Thus, through a combination of national, regional and EC funded activity, this proposal seeks to pull together and enhance expertise in:

- High power, high energy laser beam line design and operation (principally involving UK, France, Germany and Czech Republic)
- Novel high power laser solutions (principally involving Russia, Portugal, UK, France and Germany)
- Target Fabrication technology (principally involving Spain, France, Russia, USA and UK)
- Diode pumped technology for high efficiency, high repetition rate sources (principally involving France and Germany)
- Plasma physics and applications (involving Italy, Spain, Portugal, France, UK, Russia Greece and Poland)
- Detector and diagnostic development techniques to ensure broad-based application and high quality, quantitative scientific delivery (principally involving Italy, Poland, Greece and France)
- Major facility construction and operation (principally France and UK)

Each of these areas has substantial "spin-out" potential – both for local programmes and for technological applications outside the scope of HiPER. International experience in this field has demonstrated that such knock-on impact can be truly significant.

Finally, HiPER positions Europe to take a leading role in the subsequent development of fusion power production, which is the only credible long-term option that meets the global demand for clean energy into the next century. The economic and industrial opportunities this represents cannot be overstated, nor can the security implications of energy self-sufficiency in the long term.

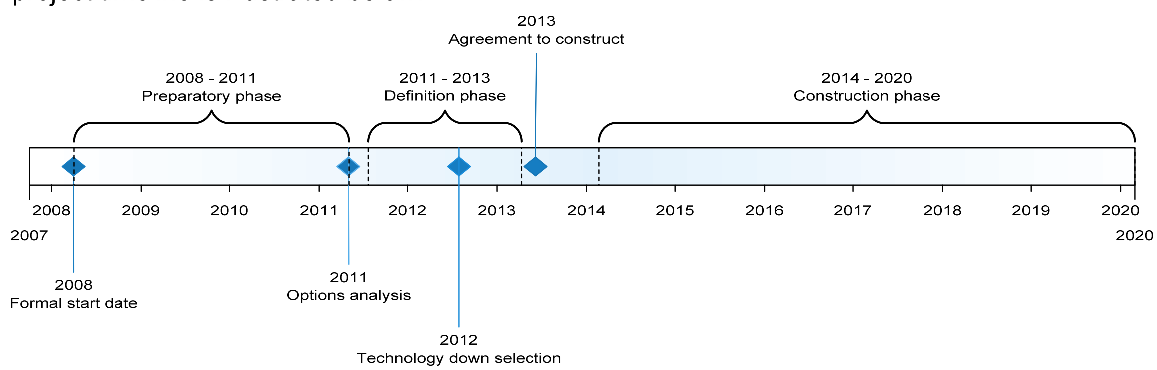
6. Maturity of proposal (including possible timetable)

Following the acceptance of the HiPER project onto the ESFRI roadmap in October 2006, the project submitted a proposal to the FP7 Infrastructures call in May 2007. The proposal subsequently passed this independent review process and is now preparing the ground work to formally start the 3 year preparatory phase project in April 2008.

Following guidance from the FP7 review process, the HiPER project will extend the period before construction of the facility to 5 years, consisting of a 3 year preparatory phase to allow a full review of future options to be assessed, followed by a 2 year definition phase where the specifications of the facility will be defined and agreed.

This "follow-on" preparatory phase advised by the EC (and fully accepted by the project board) will require continued presence on the ESFRI roadmap.

The project timeline is illustrated below:



7. Budgetary information (preparation, construction and operation costs)

The 3 year preparatory phase project consists of 15M€ in new funding, with 3M€ from the EC and approximately 12M€ from member states. Significant levels of co-funding have been made available by participating nations and institutes. This includes the 40M€ PETAL laser in France (an intermediate facility strategically aligned to develop the technical basis of HiPER), and ring-fenced access for HiPER experiments on the European high power lasers PALS, LULI and VULCAN.

The construction costs will be investigated as part of the next phase of the project for each possible future option of HiPER. Currently, the estimated construction cost is of the order of 800M€ based on conventional laser technology. A second (preferred) option based on diode pumped laser technology will be fully explored in the preparatory phase.

Operational costs are envisaged to be of the order of 3 times the construction costs over the lifetime of the facility (~ 30 years)

8. Comments on possible sites and possible partnerships (optional)

Site analyses will be undertaken as part of the next phase of the project. Several host sites are already under discussion.

International options for HiPER are also being explored, in which relevant programs in Asia and North America could be strategically aligned as part of a global effort.

PSE14_ESRF-UP

1. Descriptive title, and information on the ESFRI delegation submitting the proposal (or one of the member of EIROForum)

ESRFUP – A programme to upgrade Europe's synchrotron radiation centre for science and technology research. It has been developed by the ESRF together with its User community, the various advisory committees and the ESRF's governing body, the Council, which represents its 18 member countries. The ESRFUP proposal has been submitted by the ESRF on behalf of its 18 members and the preparatory phase project is managed by the ESRF.

2. Synthesis description of the new RI (or major upgrade) and S&T fields involved at Pan EU level in its use. Add links to relevant data/web pages (half page max)

The European Synchrotron Radiation Facility (ESRF) is a storage ring based X-ray source, which provides the research user community in Europe and beyond with world-class experimental stations, exploiting the unique properties of synchrotron radiation for research in a large variety of fields. In order to maintain its leading role and to respond to the emerging scientific challenges, the ESRF is envisaging an ambitious Upgrade Programme, comprising (i) the extension of the experimental hall to enable the construction of new and upgraded beamlines with largely improved performance and new scientific opportunities, as well as improved infrastructures for the preparation of experiments, (ii) a programme of improvements of the accelerator complex, and (iii) the development of productive science and technology driven partnerships. The upgraded ESRF facility, together with the neighbouring international research institutes the Institut Laue-Langevin (ILL) and the European Molecular Biology Laboratory (EMBL), will constitute a unique centre with highly optimized research and support infrastructures.

The planned Upgrade will enable significant progress in S&T fields such as nanoscience and nanotechnology, structural and functional biology, health, environment, energy and transport, information technology, and materials engineering. The Science case and the related technological challenges are laid out in an exhaustive document, the so-called Purple Book, which has been already widely disseminated, and is available on the ESRF website (http://www.esrf.fr/AboutUs/Upgrade/purple-book/).

3. Science case: scientific area(s) and potential and/or explicit users, how the new RI will fit into the existing and future landscape of Research and of existing RI's, at EU and World level (one page max, links to relevant documents, references).

The proposed portfolio of experimental stations aims at fully exploiting the unique properties of synchrotron radiation with a combined use of diffraction, scattering, imaging and spectroscopic techniques to further push the limits in terms of spatial and temporal resolution and detection. The following major scientific areas will largely profit from the planned Upgrade:

<u>Nanoscience and nanotechnology:</u> Exploring, manipulating and designing matter on the nanometre scale is essential for developments in electronics (quantum computing, spintronics), medical diagnosis and treatment, and consumer manufacturing. Analytical tools are needed to investigate the structure and behaviour of objects at the nano-scale. New beamlines in which X-ray beams are focused into minute spots about 20 nanometres, or less, across will be able to pick out individual biomolecular processes in living cells and characterize structures such as quantum dots or complex magnetic arrangements at the atomic level.

<u>Structural and functional biology:</u> Synchrotron radiation has revolutionized our understanding of biology, allowing the three-dimensional structure of large biomolecules to be analysed routinely. Samples of the proteins and assemblies of proteins (molecular machines), relevant to human health, may be very small and difficult to crystallize for diffraction experiments, but new beamlines with advanced detectors will allow the development of new techniques not requiring large crystals or even allow direct imaging of single particles. New avenues will be paved in the study of multiscale

structures and non-equilibrium dynamics of soft matter and molecular machines with unprecedented resolution in time and space using scattering and imaging techniques.

Material science: The design of new, more performing materials necessitates a thorough understanding of their structural properties and chemistry, and is of central importance in a large range of scientific disciplines ranging from catalysis research to aerospace applications. Furthermore, studies at extreme conditions of pressure, temperature, electric and magnetic fields will allow synthesizing and characterizing novel compounds and open new windows in Earth and Planetary Science. The planned combined use of scattering, imaging and spectroscopic x-ray tools with unprecedented time, spatial and elemental resolution will have a major impact.

Emerging applications: The development and implementation of novel techniques and approaches has been a key mission of the ESRF, and shall be emphasized within the planned Upgrade. These shall comprise (i) Environmental science: study of biodiversity, groundwater and soil contamination, waste management and air pollution, (ii) Paleontology, archaeological science and cultural heritage to understand and learn from our past, and (iii) the development of therapeutic applications to the (pre-)clinical stage with an updated infrastructure and potential evolution into a clinical facility.

The ESRF, as a European synchrotron radiation facility, has the unique ability to respond to target science at the European scale by developing new opportunities with specific and innovative instrumentation. It therefore not only complements the portfolio of the national synchrotron facilities, but acts as a catalyser and promoter of new science and technology. The ESRF is one of the three world-leading high-energy third generation synchrotron sources, along with the APS in the USA and SPring-8 in Japan. It is the most productive in terms of refereed publications in scientific journals. The APS and SPring-8 are currently planning major upgrades similar to that of the ESRF. The ESRF Upgrade is therefore critical for the European Research Area, its associated universities, institutes and industry to maintain their competitive edge on the world stage, and stay at the forefront of 21st century synchrotron radiation research.

4. Technical case: summary of results (technical specifications) of conceptual and/or technical design studies (half page, list references/links).

The technological and engineering challenges are summarized in Part 2 of Volume 1 of the Purple Book (http://www.esrf.fr/AboutUs/Upgrade/purple-book/). These comprise:

1. Accelerator and X-ray source developments to provide X-ray beams with higher flux, brilliance, and stability, and increased capacity for further experimental stations.
2. Buildings and infrastructure extensions for the creation of 21,000 m^2 of new surface for very long experimental stations and largely improved infrastructure in terms of laboratories and office space.
3. Beamline engineering developments in the field of X-ray optics, complex sample environments, X-ray detectors, as well as control of X-ray beam and sample on the nanometre scale.
4. Computing support and infrastructure upgrades in order to collect, store, analyse and disseminate data/scientific results efficiently (see as well point 5).

The conceptual design reports of the new experimental stations are documented in Volume 2 of the Purple Book. The ESRF and the user community, together with its advisory committees, have identified a list of 11 flagship experimental stations, for which detailed technical design studies shall be started, should the Upgrade be approved by the ESRF Council.

5. e-infrastructure: what does the new RI require as far as e-infrastructure? How is it integrated with the existing EU e-infrastructure (e.g. Geant, grid, digital repositories).

The planned Upgrade of the experimental facilities and the site infrastructure must go hand in hand with a substantial upgrade of the computing facilities. Within this frame the following developments are envisaged:

1. New and updated software for on-line data analysis and on-line data collection strategies.
2. A new data centre for increased data storage, processing power, and network bandwidth to handle the increased flow of data coming from the experimental stations.
3. New management information software for efficient management of scientific experiments, data handling, and the storage of results in permanent archives that can be consulted via the web.
4. Unified data formats, compatible with international standards, to enable European- and worldwide collaborative efforts in data analysis, data storage and dissemination.
5. A Grid environment to allow analytical algorithms to be run faster and allow users to transfer data reliably to their home institutes.

The European network infrastructure Geant is of utmost importance to the ESRF for transferring data sets from the ESRF to the national research institutes. With the increasing number of synchrotron radiation centres throughout Europe it will become common place that experimental results need to be analysed using Grid technologies. In this context ESRF is currently studying the feasibility to actively participate in the **E**nable **G**rids for **e**Scienc**e** (EGEE) initiative. Grid technologies will furthermore play a central role in data archiving and curation.

6. Other expected socio-economic impacts: development of new technologies, effects on training, involvement of industries, local impact, other (one page, references).

The enhanced experimental facilities, in conjunction with intense efforts towards an integrated approach using synchrotron and laboratory-based techniques, promise major impacts in information and communication technologies, health and environment, as well as cultural heritage. To cite only the most prominent examples: (1) The provision of nanometer scaled X-ray beams will help revealing the relation between structure, magnetism and function of quantum confinement- induced properties of nanoscale materials, crucially required for novel (opto)-electronic and magnetic storage media. (2) Three-dimensional sub-micrometer and nano-tomographic imaging and spectroscopy tools will allow the location and role of metals in biology and medicine to be addressed, in particular in connection with neurodegenerative diseases or for cancer treatments; (3) massive throughput macromolecular crystallography facilities will face the key tasks of the pharmaceutical industry – generation of new drugs, where an essential aspect of this endeavor is the screening and analysis of thousands of compounds. (4) The multiscale investigation of in-situ growth/failure of materials, behavior of porous (rocks) or granular materials and storage materials for solar and hydrogen energy as well as nuclear waste will be essential to enable new technologies aiming at preserving our planet and our quality of life.

ESRF contributes significantly to the education of young researchers. Students, postdoctoral fellows and young scientists constitute the majority of the more than 6000 annual user visits. The ESRF has its in-house PhD and postdoctoral programme, working in close collaboration with universities and research institutes throughout Europe. More than ten workshops or schools are organised by, and held, at the ESRF every year, attracting young researchers to learn more about synchrotron science. These programmes shall be continued within the Upgrade, with the aim of allowing young researchers to fully exploit the planned unique facilities.

Industry has access to ESRF through the peer-review system on the basis of scientific excellence and through proprietary research. In the latter case industry has to pay for the beam time, but is not obliged to publish the results. A substantial part of the ESRF's industrial activity comes from pharmaceutical companies that use the macromolecular crystallography beam lines for drug design. Other activities relate to experiments for cosmetics, food products, materials design, and microelectronics. The Upgrade will enhance the unique facilities available to further strengthen the links to European industry.

7*. Commitments / maturity: which States and Organizations have demonstrated interest / commitment in supporting and/or funding the proposal?*

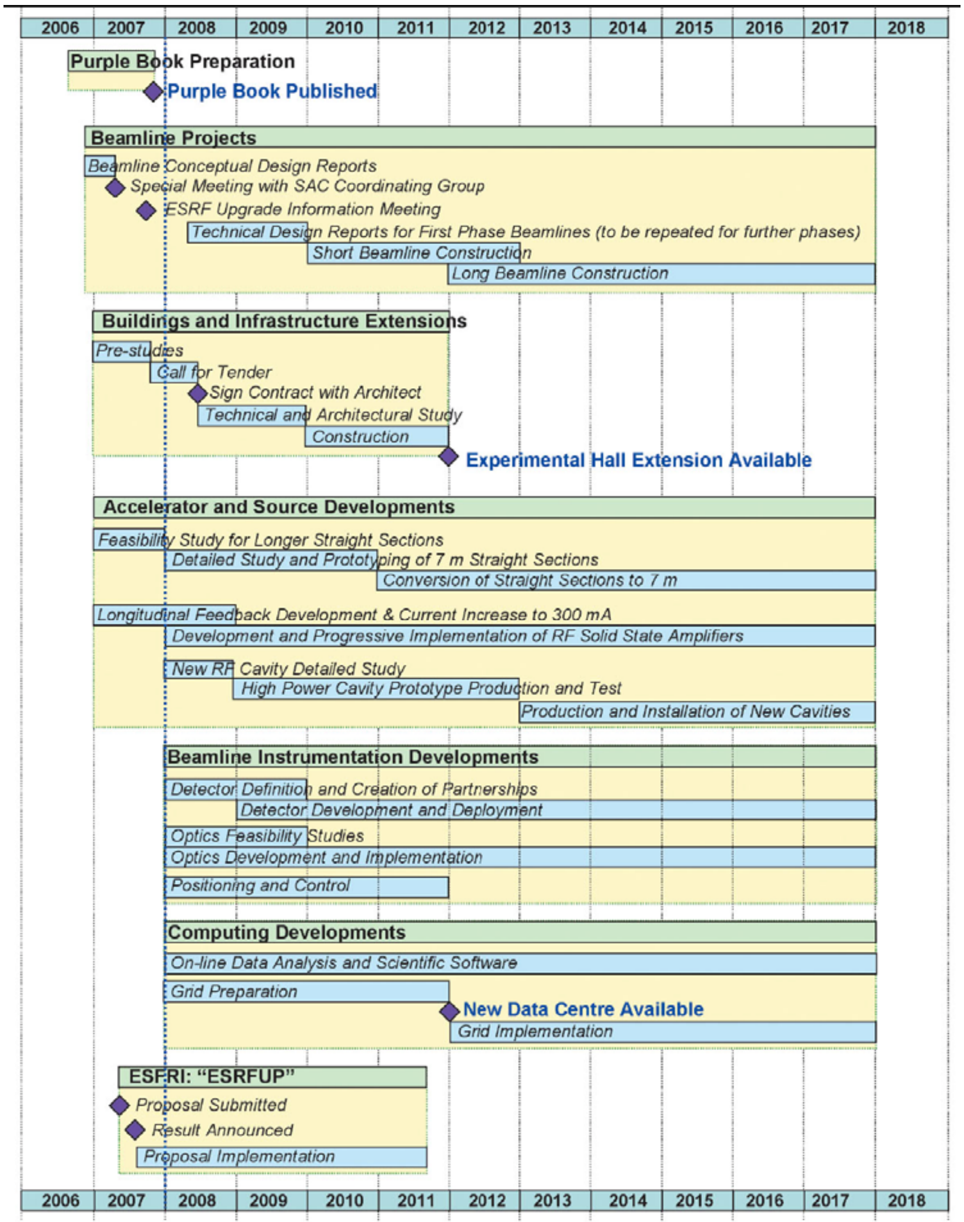
The planned Upgrade has been presented and intensively discussed with the ESRF's user community, the advisory committees and the Council. ESRF management has undertaken individual discussions with representatives of all 18 member countries, and has received strong support. It is expected that Council will make a firm financial commitment in June 2008, at the latest.

8. Costs for construction, operation and decommissioning, indications on project financing (half page, with references/links). Give budget info in M€

The upgrade program sets out the plans for **286.70 M€** (in 2008 prices) of expenditure resourced from 200.68 M€ of Members' contributions (corresponding to an annual share of 22.30 M€ over the 9-year period 2009 – 2017), from 9.37 M€ of Scientific Associates' contributions and from 76.65 M€ of the "regular" budget. This includes the option for a high magnetic field laboratory, estimated at 35 M€ in total (capital = 25 M€ and operating costs = 10 M€). In its current stage the programme consists of two phases, each with options.

Nature of expenditure	**Phase I**	**Phase II**	**Total**
A. Minimal Phase I+II			
Personnel	13,65	7,12	20,77
Recurrent	10,53	5,06	15,59
Capital	148,09	39,65	187,74
Total	172,27	51,83	224,10
B. Options Phase I+II			
Personnel			
Recurrent	1,20	10,70	11,9
Capital	16,4	34,3	50,7
Total	17,6	45	62,60
Grand Total A+B	**189,87**	**96,83**	**286,70**

Total preparatory cost	Total construction cost	Operation cost /year	Decommissioning cost
8.8 M€ (as referred to in ESRF proposal in response to FP7 RI call)	286.70 M€	74 M€/year, on average, over the period 2008-2017, to be funded by the ESRF members.	Not foreseen

9. Timetable for construction, operation and decommissioning (half page, with references/links) with duration and possible starting dates.			
			
Preparatory phase 2008 - 2011	Construction phase 2010 - 2017	Operation RI already operating	Decommissioning Not foreseen

10. Reference: Person who has submitted the proposal, and will follow up in ESFRI
Dr. Michael Krisch

PSE15_ESS

1. Project's name and descriptive title
European Spallation Source (ESS), a new generation neutron source for the study of matter.
2. Short description of project and main characteristics
The ESS, highest priority of all neutron centres and scientists since the early nineties, will be the world's leading neutron source, providing a combination of the highest neutron intensity (factors of 10 to several 100s compared to current top facilities) and novel instruments, to form a unique tool for research into structure, characteristics, functions and dynamics of matter. The initial long pulse configuration of ESS provides maximum complementarity and the largest instrument innovation potential. Its unique upgradeability guarantees a long-term top position. ESS will offer new modes of operation and user support to facilitate industry, next to university and research lab users.
3. Science case (scientific justification, including new areas to be opened)
ESS will allow for the first time real time, real size, real life, in-situ neutron measurements of both static and dynamic phenomena, including movies of nano-scale events. The neutron's unique probing potential (magnetic moment, observation of hydrogen, penetration, etc.) coupled with the unprecedented step in intensity opens the door to dynamics and structural studies in biology and large molecules in solutions (folding of proteins), research into polymers and soft condensed matter, real scale tomography and radiography of engineering materials, solid state physics and chemistry, but also to studies in particle physics using ultra-cold neutrons.
4. Impact to society and to new technologies for industry
ESS will be the necessary tool to investigate the ultra-thin and laterally confined structures for e.g. reading devices in the ICT industry, the active site structures in enzymes, technologies for storing hydrogen for a sustainable energy economy, multi-component complex fluids in porous media for tertiary oil production, or the templating of nanostructures for catalysts, medical implants, pharmaceuticals, photonic materials, etc. The need for novel detector, instrument and software technologies will be drivers of innovation. ESS, a multifunctional facility with applications in many industries, will also have a marked regional impact (new firms in areas of regional specialisation, positive effect on regional as well as European talent pool, etc).
5. Strategic importance to ERA
ESS is the pinnacle of a network of neutron sources and will be the key driver for a vibrant European community of 5000 neutron scientists. ESS is needed to maintain or reclaim the lead of Europe in neutron science and technology, one of very few areas of acclaimed European leadership. The US have set a new power record, on its way to 1.4 MW in 2010; the Japanese MW source is due for 2008. With ESS and e.g. X_FEL Europe will be in top position in fine analysis of matter.
6. Maturity of proposal (including possible timetable)
15 Labs and organisations from 11 countries and hundreds of scientists have produced the Technical Design and the Science Case. The ESS-Initiative, based at ILL, took over from the ESS Council to advance the case of ESS. An EU FP7 Preparatory Phase project (5 M€) is going to investigate more general, strategic and non-site specific issues, starting January 2008. Three countries (Spain, Sweden and Hungary) have bided to host the ESS and aim for a site decision in parallel, early 2008. Negotiations with European governments are ongoing by Sweden on the one hand, and Spain and Hungary, who have concluded an MoU, on the other hand. Sweden organised a Round Table in October 2007. 23 Governments agreed that ESS should be ready for full operational use in 2020; a second one will be in February 2008. Spain/Hungary have invited the governments to send representatives to a meeting in January 2008. Construction will take 7-8 years.
7. Budgetary information (preparation, construction and operation costs)
Optimisation scope/engineering design completion: M€ 20. Construction costs: B€ 1.2 . Operating costs: M€ 95. Costs are in €s of 2006
8. Comments on possible partnerships (optional)
The leading European neutron labs and accelerator teams will partner for the construction.

PSE16_FAIR

1. Project's name and descriptive title
Facility for Antiproton and Ion Research (FAIR). International facility for high energy primary and secondary beams of ions of highest intensity and quality, including an "antimatter beam" of antiprotons.
2. Short description of project and main characteristics
FAIR, planned by the European and international science community for construction at the GSI Laboratory in Darmstadt, Germany, foresees the broad implementation of ion storage/cooler rings and of in-ring experimentation with internal targets. Two superconducting synchrotrons will deliver high intensity ion beams up to 35 GeV per nucleon for experiments with primary beams of ion masses up to Uranium and the production of a broad range of radioactive ion beams including antiprotons. This will provide the European community with worldwide unique accelerator capabilities. It will allow the broad, and in many respects novel use of stored, cooled ion beams with superior beam phase space. It will open new frontiers in several areas of research and allow experimentation at high luminosity with unsurpassed precision.
3. Science case (scientific justification, including new areas to be opened)
The concept of FAIR was developed by the international science community and the GSI Laboratory. It builds, and substantially expands on the many seminal developments made by GSI and its international users over the last decade in cooler-ring technology and physics for high-energy heavy ion beams. The ring system will provide for a highly parallel operation between several research programs, from QCD studies with cooled beams of anti-protons, to nucleus-nucleus collisions at highest baryon density, to nuclear structure and nuclear astrophysics, high-density plasma physics, atomic and material science studies and other interdisciplinary uses. The FAIR Baseline Technical Report and the Cost Book has been completed in March 2006.
4. Impact to society and to new technologies for industry
GSI has demonstrated with the worldwide unique development of the cancer therapy with heavy ion beams and by many other technical developments that a facility for basic research delivers important novel scientific and technical methods with a large impact for society and a broad potential use in industry. The FAIR facility will contribute not only to a better understanding of several areas of basis research, but also of the physics in the future energy production method of "Inertial Confinement Fusion", or to a better knowledge of the cosmic ray effect on humans.
5. Strategic importance to ERA
FAIR will provide the European science communities in nuclear physics with a world wide competitive and in many respects superior facility. FAIR will be fully competitive with RIKEN in Japan. It will be unique with its bunched beams. FAIR will be also unique with its antiproton beams for QCD studies.
6. Maturity of proposal (including possible timetable)
In 2003 the German Federal Government announced approval of the project, with Germany providing up to 75% of the needed funding (65% federal, 10% State of Hessen). An International Steering Committee has been installed in February 2004 with the intention to work out and agree on a contract for the establishment of the international accelerator laboratory FAIR. The FAIR project has been launched with an official start event and the signing of a joint communiqué on November 7, 2007 between Austria, Finland, France, Germany, Poland, Romania, Russia, Spain, Sweden, United Kingdom. It is planned to sign an intergovernmental agreement (convention) between these and several additional partner countries defining the contributions (in-kind or financial) to the construction and for establishing the legal entity, FAIR GmbH in May 2008. The start of the construction is foreseen for end of 2008. The operation of FAIR will begin in 2012 for part of the accelerators. The full performance with the parallel operation of all experimental programs is reached in 2015.
7. Budgetary information (preparation, construction and operation costs)
The investment costs including personnel for the construction period amounts to 1.187 million €. The operating costs are estimated to be approximately 120 Mio€ per year.
8. Comments on possible partnerships (optional)
FAIR is to be built by its member states and their institutions constituting as international shareholders the FAIR GmbH. The FAIR Company is open for additional partners.

PSE17_IFMIF

1. Project's name and descriptive title
IFMIF - The International Fusion Materials Irradiation Facility
2. Short description of project and main characteristics
IFMIF is a proposed accelerator-based materials testing facility. IFMIF is an accelerator-based Deuteron-Lithium (D-Li) neutron source to produce an intense flux of high energy neutrons with a sufficient irradiation volume to enable realistic testing of candidate materials to be used for fusion reactors up to about a full lifetime of their anticipated use in a demonstration reactor plant for electricity production and beyond.
3. Science case (scientific justification, including new areas to be opened)
It is an essential adjunct to ITER. The preparation for the construction of IFMIF through a phase of Engineering Validation, Engineering Design Activities (EVEDA phase: 2007-2013) is part of the activities of the so-called "Broader Approach" agreement establishing collaboration between Europe and Japan on the way to a fusion reactor. Scientific scope is the study of the effects on materials of 14 MeV neutrons in order to choose and optimise structural materials for a fusion reactor. An intense source of 14 MeV neutrons (10^{18} n/s) needs to be developed with only < 10^{12} n/s sources presently available.
4. Impact to society and to new technologies for industry
Essential step on the road to fusion for the production of electricity. During the Engineering Validation, Engineering Design Activities phase (EVEDA phase: 2007-2013) the main objectives are to study and validate the three major components of IFMIF: - The Accelerator. Design and build in EU the components of a low energy (9 MeV) prototype. Install and test the accelerator in Japan with full beam current. - The flowing Lithium Target. Build a 1:3 prototype circuit in Osaka and test it. - The Test facility. Design and build a prototype of the high flux test rig. Check performance under irradiation.
5. Strategic importance to ERA
In addition to the already well established ERA centred on the work of the European Fusion Associations, strong collaboration between research institutes working on accelerator technology will take place.
6. Maturity of proposal (including possible timetable)
Detailed design to be made and the remaining validating R&D to be carried out. On present plans and with current resource constraints, first operation is presently not envisaged until 2021. IFMIF construction, which is expected to take 8 years, will not start for several years. However if there is increased commitment internationally to the "fast track" approach, serious discussions about its schedule may start once ITER is fully launched.
7. Budgetary information (preparation, construction and operation costs)
The initial construction cost would be in the region of 800Meuro.
8. Comments on possible partnerships (optional)
The construction of IFMIF could be agreed in the frame of an international agreement which would also fix the site of the facility. Europe will likely have to compete for the site with other countries.

PSE18_ILL

1. Descriptive title, and information on the ESFRI delegation submitting the proposal (or one of the member of EIROForum)

ILL 20/20 - the UPGRADE PROGRAMME of the Institut Laue-Langevin.

Unlike most projects on the ESFRI Roadmap, ILL's proposal does not envisage the creation of a new research facility; its objective is the necessary upgrade of ILL's instruments' suite and neutron infrastructure in order to maintain Europe's lead in neutron science covering condensed matter and nuclear and particle physics.

The Institute's Steering Committee and Scientific Council, on which all its member countries are represented, has endorsed this upgrade program. Via these official bodies all ILL's member countries and the organizations through which they are represented participate in the upgrade program and its preparatory phase. In the present proposal the ILL is therefore acting as coordinator on behalf of its Associates and Scientific Members.

2. Synthesis description of the new RI (or major upgrade) and S&T fields involved at Pan EU level in its use. Add links to relevant data/web pages (half page max)

In order to keep the ILL at the forefront of neutron science and to provide the best possible experimental facilities and support to its European users over the next two decades, the Institute needs to modernize its infrastructure and instrument suite. This is the scope of the proposed ILL20/20 upgrade program, which can be summarized as follows:

(i) improving neutron moderators and delivery systems;
(ii) planning and prototyping new instruments and neutron technologies;
(iii) strengthening the links with the European Synchrotron Radiation Facility (ESRF), creating partnerships for science and joint scientific facilities accessible to ILL and ESRF users;
(iv) developing the site shared by the ILL, the European Molecular Biology Laboratory (EMBL) and the ESRF.

This proposal aims at optimizing the preparatory phase of this ambitious program. The preparation of the upgrade will involve:
(i) feasibility studies on challenging technical projects to renew the ILL's neutron moderators and neutron delivery systems, and on novel neutron scattering technologies and techniques;
(ii) preparing the framework for a Partnership for Soft Condensed Matter;
(iii) planning the development of the ILL/EMBL/ESRF site, including the resolution of the administrative issues;

Link: http://www.ill.eu/about-ill/esfri-project/

3. Science case: scientific area(s) and potential and/or explicit users, how the new RI will fit into the existing and future landscape of Research and of existing RI's, at EU and World level (one page max, links to relevant documents, references).

As a user facility ILL provides some 5000 European researchers with access to low-energy-neutron instruments of unequalled range and quality. Whilst there are few scientific areas in which Europe leads the world, research with slow neutrons is undoubtedly one of them.

The new programme aims at optimising the scientific potential of the European user community and at maintaining ILL's position in the field.

The upgrade will concentrate on ILL's demonstrated scientific and technical strengths. As all the ILL's technological innovations have been and will be available to national neutron sources in ILL's Scientific Member countries, Europe's existing network of neutron facilities will be a major and direct beneficiary of the ILL's upgrade and modernisation. This programme will therefore have a significant impact on the European Research Area.

It is the ILL's mission to provide for European communities world-class instruments for condensed matter research and for nuclear particle physics, both today and for the future. The institute is therefore committed to responding to the changing requirements of its scientific users, and to attracting users from further fields of applied science. In this modern context the ILL must offer facilities for sophisticated sample preparation and complementary sample characterisation. It can achieve this through the establishment - in partnership with the ESRF and other European laboratories and universities - of laboratories in specific disciplines. This will transform the three institutes' site into a European campus internationally recognized as a centre of scientific excellence for Europe as a whole.

4. Technical case: summary of results (technical specifications) of conceptual and/or technical design studies (half page, list references/links).

In this project technical design studies are foreseen essentially in two areas:

1- **Ultra-cold neutron (UCN) sources**: In the short term, the present UCN source will be replaced by a super-fluid helium-4 (^{4}He) UCN source. The individual constituents of the new source are technologically feasible, but their integration has yet to be designed and demonstrated. The gain in UCN density expected will be in the order of 30. A solid deuterium (s-D_2) UCN source, the feasibility of which has yet to be shown, has the potential to increase the density of UCN in the long term by even 2 or 3 orders of magnitude. Therefore studies are aimed at incorporating a s-D_2-UCN source within a potential new 3rd cold neutron source or a stand-alone version with a dedicated pre-moderator and to install the whole assembly in about 2013.

2- **Novel neutron scattering techniques**: we will explore the potential for new and imaginative instruments that play to the strengths of the ILL in a number of areas:

- *New concepts for hot neutron instrumentation to challenge the brightest pulsed sources*

Calculations have shown that a flux gain of 3 for hot neutrons can be achieved by increasing the temperature of the hot source at ILL from 2000°C to 3000°C using better heat isolation.

- *High frequency beam modulation through beam-bunching methods*

Future pulsed neutron sources will set new standards for time–dependent experiments and high time-resolution instruments. In specific cases, continuous sources such as the ILL source can outperform future pulsed sources by making use of beam modulation methods: by bunching continuous polychromatic beams, time-modulated signals of MHz frequency and of high contrast can be achieved many tens of metres downstream of the modulator.

- *White beam energy analysis*

Traditional neutron spectroscopy at a reactor source involves discarding most of the neutrons in an energy selection process. We propose to explore methods of using much more of the incident white beam by, essentially, developing methods of determining the energy of the scattered neutrons simultaneously across much of the spectral range.

5. e-infrastructure: what does the new RI require as far as e-infrastructure? How is it integrated with the existing EU e-infrastructure (e.g. Geant, grid, digital repositories).

ILL is investigating the potential of EU e-infrastructure, for example through the Eiroforum Grid Group (EGG) for grid computing. Currently, the grid is not adapted to the computational needs of the ILL but this situation is likely to change with the evolution of grid technology. Digital repositories have not been used to date for neutron scattering data, partly because the volume of data is modest and almost 40 years worth of data is easily stored at ILL. However, the project EDNS (European Data Infrastructure for Neutron and Synchrotron Sources), which will federate ISIS, ILL, Diamond and ESRF, was well-received in Brussels recently. This project will harmonise the handling of large user communities, the experimental programs and the scientific output of the four facilities. It will be based on digital repositories for collective data storage and grid technology for real-time (user and experiment) data management.

6. Other expected socio-economic impacts: development of new technologies, effects on training, involvement of industries, local impact, other (one page, references).

For over forty years now the ILL has been a centre of state-of-the-art research, developing new technologies and contributing to the local economy.

As part of its current upgrade programme it is working on plans to enhance its capacity to diffuse the technology developed in-house. The spearhead of the programme will be a new Technology Centre, which will provide the platforms required for the production of components in neutron (and also photon) research. This includes the construction of furnaces for the growth of monochromator crystals and the technologies underlying the thin-film coatings used in optical and beam polarizing devices. The Centre will also be involved in the development of new detectors and the sample environment facilities now being requested by the highly diverse neutron user community.

The expansion of the ILL/EMBL/ESRF site will necessarily involve the local authorities. It will also depend on input from local industry through the construction of new buildings, access roads and technical infrastructure.

7*. Commitments / maturity: which States and Organizations have demonstrated interest / commitment in supporting and/or funding the proposal?*

The ILL is governed by an International Convention signed at Foreign Ministry level by three countries: France, Germany and the United Kingdom. Our Associates own and administer the institute. Since 1987 nine European countries have joined the ILL as Scientific Members (Spain, Italy, Switzerland, Austria, Czech Republic, Hungary, Poland, Sweden, Belgium). The membership agreements are renewed every five years and specify the share (expressed in terms of requested beam time) the contracting Scientific Member desires to hold. ILL's nine Scientific Members currently contribute a combined share of 17% to the ILL's annual budget. Apart from this regular contribution, Scientific Members may and do contribute additional investment capital, to boost ILL initiatives or their own priority projects. In particular, most Scientific Members take the opportunity to build and operate *Collaborative Research Group Instruments (CRG instruments). CRG instruments are not part of the ILL's public instrument suite; they are designed to satisfy the scientific objectives of the particular* *national or international collaborative research group.*

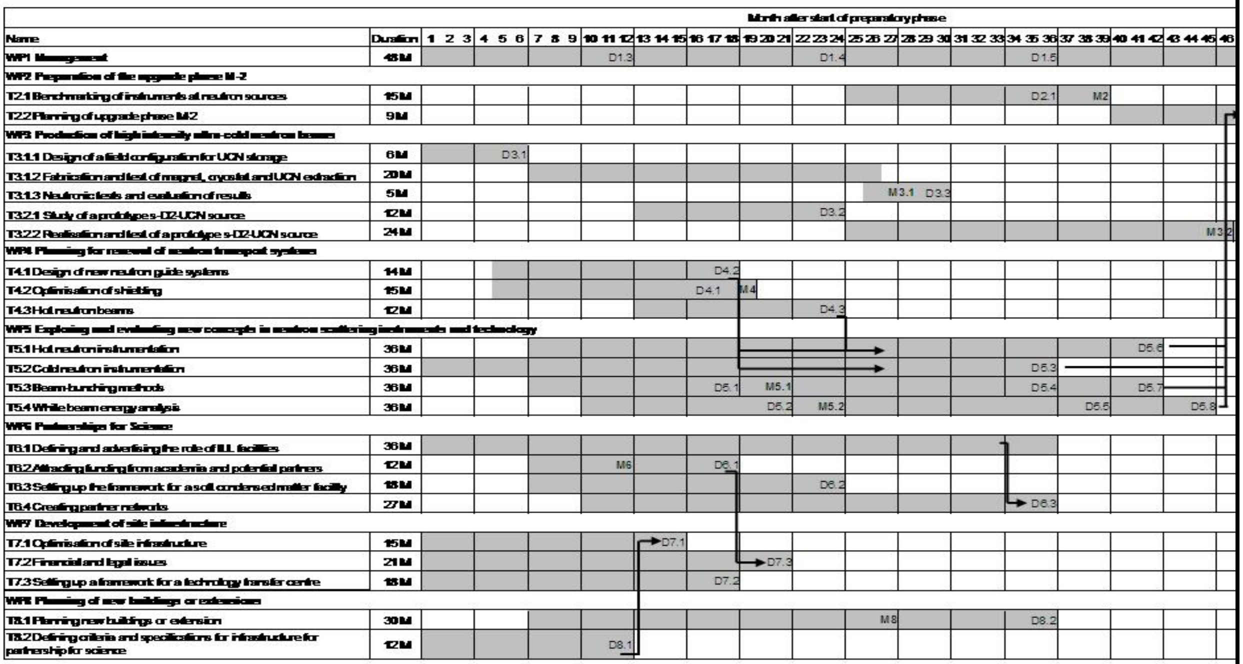
8. Costs for construction, operation and decommissioning, indications on project financing (half page, with references/links). Give budget info in M€

The costs for the whole upgrade programme amount to around 88.0 M€. In December 2006 the ILL Steering Committee, representing the ILL's twelve member countries, endorsed the new Multiannual Financial Estimates thus approving the allocation of 52 M€ in investment capital for the 1st phase of the instrument upgrading programme, with a further 19.9 M€ for the upgrade of key reactor components over the next five years. The key reactor components programme foresees resources of the order of 4.1 M€ for prototype hardware on new ultra-cold neutron sources.

The 2nd phase of the upgrade programme (which covers the period from ~ 2013-2017, with envisaged costs ~ 35 M€ as described in the document *Future Perspectives and Opportunities for the ILL/* http://www.ill.eu/about-ill/future-planning/po/) has been endorsed by both the Scientific Council and the Steering Committee. Budgetary planning is at an early stage.

Total preparatory cost	Total upgrade cost	Operation cost /year	Decommissioning cost
7.5 M€ (4.7 M€ funded by the EC)	88 M€	69.5M€/year excl. investment for upgrade programme and VAT, (funders: ILL's Associates: 17% CEA, 17% CNRS, 33% Forschungszentrum Jülich, 33% STFC)	200.4 M€ excl. VAT and incl. 78.4 M€ staff costs (funders: ILL's Associates)

9. Timetable for construction, operation and decommissioning (half page, with references/links) with duration and possible starting dates.



Preparatory phase	Upgrade phase	Operation	Decommissioning
01/12/07-30/11/11	2011-2017	RI already operating	Not foreseen

10. Reference: Person who has submitted the proposal, and will follow up in ESFRI

Prof. Richard Wagner, Director General of the ILL, *wagner@ill.eu*

PSE19_IRUVXFL

1. Project's name and descriptive title

IRUVX-FEL: An European Network of Complementary Infrared to Soft X-ray Free Electron Laser Laboratories

2. Short description of project and main characteristics

The development and construction of a European network of high-brilliance short-pulse Free Electron Lasers (FEL) operating in the infrared to soft X-ray wavelength region (down to about 1 nm or 1000 eV) is now in progress. It will exploit several technical approaches which allow the production of radiation beams optimized for different scientific applications with different requirements with regard to peak brilliance, repetition rate, synchronization, etc. At present, the FLASH facility in Hamburg is in operation with roughly half the time dedicated to user experiments and the other half to technical developments.

FERMI@ELETTRA is under construction, the commissioning is expected in 2009. Seven other projects are in the design or R&D phase. All teams involved are interacting with each other as well as with user communities discussing possible complementarities in the design of the facilities and their instrumentation. The development of these projects as an integrated trans-European network will give Europe a first class infrastructure which is unprecedented worldwide, complementing

present synchrotron radiation sources and "table top" lasers.
3. Science case (scientific justification, including new areas to be opened)
The present number of users of synchrotron light in Europe is about 10 000, and the number of potential users interested in light based techniques ranging from microscopy to photolithography is presumably about ten times larger. The introduction of sources generating femtosecond flashes of light with a peak brilliance up to a billion times higher than present synchrotron sources allows the spectroscopy and microscopy of dynamical phenomena in any material as well as ablation photolithography. This will open new important areas in the study of materials and plasmas, and allows the investigation of very small or dilute systems with unprecedented definition. The infrared to soft X-ray interval covers the largest part of physical chemistry phenomena. Each source will provide a limited number of measuring stations (up to about 10) for a maximum of 500 users per year. The network allows serving a sizeable fraction of users.
4. Impact to society and to new technologies for industry
The advancement of materials, biomaterials and nano S&T has been the basis for the most long-lasting and effective industrial growth in the past century, and this area is the major mover in the growth of new economic and environment-friendly applications ranging from ICT to medicine.
5. Strategic importance to ERA
The competitiveness of the European science and industry is directly connected with the competitiveness in the research fields listed in point 4.
6. Maturity of proposal (including possible timetable)
Two nodes of the network are already being developed, and decisions on the other nodes are expected in the next few years. The overall network could be realized in the next 8-12 years.
7. Budgetary information (preparation, construction and operation costs)
The construction costs for each node can be estimated between about 150 and 200 million Euros. Assuming a final network of nine laboratories (comparable to the present network of 3^{rd} generation synchrotrons), the total costs will be between 1.3 and 1.8 billion Euros in 12 years, mainly on national resources. The EU contribution could be 10 to 20 % of the total investment, aiming at opening the construction and use of the network to all EU countries. Running costs are estimated to less than 10% of the overall investment costs, taking into account possible synergies with several of the existing SR laboratories where the FELs will be sited. The Hamburg site was largely financed by the German government. The Trieste site is built on a project financing based on state, regional and EIB financing, and the government of Italy has proposed to other interested countries to participate, on the basis of the development of a common European Network.
8. Comments on possible partnerships (optional)
Five partners (BESSY, DESY, ELETTRA, MAX-Lab, STFC) have signed a Memorandum of Understanding. Four new FEL projects (SPARX in Italy, PSI-FEL in Switzerland, POLFEL in Poland and Arc-en-Ciel in France) have requested to become member of the consortium. The inclusion in the Roadmap would reinforce the integration of the new FEL projects and may also support the participation of institutions from other EU countries e.g. based on joint development of instruments and training.

PSE20_JHR

1. Project's name and descriptive title
The JHR project, new European Material Testing Reactor
2. Short description of project and main characteristics
The JHR Project aims the construction of a new material testing reactor in Europe. Operated as an international user-facility, JHR will address the development & qualification of materials and fuels under irradiation with sizes and environment conditions relevant for nuclear power plants in order to optimise and demonstrate safe operations of existing power reactors as well as to support future reactors design. JHR is 100MW, pool-tank reactor, including hot cells for an integrated experimental process. With a high core density power, JHR will create high neutron flux necessary to accelerate irradiation mechanisms. JHR is a multi-customers facility that supports typically 20 simultaneous experiments relevant for different nuclear plant technologies in use in Europe.
3. Science case (scientific justification, including new areas to be opened)
With enhanced online instrumentation, JHR will cope with advanced material and fuel science coupled with modelling and with tests necessary for industrial qualification, including experiments on transients regime necessary for the safety demonstrations. The up-to-date modelling of material and fuel behaviour under irradiation needs data that can be obtained in JHR by highly instrumented separated effect experiments. For example, the “fission products lab” is a unique feature that will provide real-time fission gas information during the irradiation process.
4. Impact to society and to new technologies for industry
The facility with its experimental programs will preserve cutting-edge expertise in Europe and provide the long-term capability not only to support the continuing safe operation and competitiveness of the nuclear power plants in Europe, but to provide a necessary resource for the development of advanced future reactor designs.
5. Strategic importance to ERA
The need for renewing MTRs in Europe was assessed by the Commission in the 5th FP thematic network FEUNMARR (Future European Union Needs in MAterial Research Reactors, Nov. 2001 – Oct 2002) with the following conclusion: “There is clearly a need as long as nuclear power provides a significant part of the mix of energy production sources” • “Given the age of current MTRs, there is a strategic need to renew MTRs in Europe; At least one new MTR shall be in operation in about a decade from now”. The shared development of JHR and of innovative experimental devices (in the 6^{th} FP) has a significant impact on fission R&D activities and future EURATOM programmes i) by gathering the European expertise in material and fuel under irradiation science, ii) by updating experimental strategies coupled with hot labs activities and with advanced modelling, iii) by attracting and training a new generation of scientists and engineers.
6. Maturity of proposal (including possible timetable)
The JHR construction schedule is the following: • Completion of definition studies in 2005 ; Decision for construction: second half 2005 • Development studies: 2006-2007 ; excavation started at mid-2007 • Construction phase & tests: 2008-2013 • Start of operations: 2014
7. Budgetary information (preparation, construction and operation costs)
The construction is 500M€. The operation cost will range from 20M€/y to 30M€ depending the use of the facility.
8. Comments on possible partnerships (optional)
Partnership with European research institutes and industry has been concluded in a Consortium Agreement signed on March 2007. EC will participate through the 7^{th} and 8^{th} FP, securing the JHR project as a major research infrastructure of European interest in the field of fission.

PSE21_Km3Net

1. Project's name and descriptive title
KM3NeT: European deep-sea research infrastructure hosting a neutrino telescope with a volume of at least one cubic kilometre and facilities for marine research.
2. Short description of project and main characteristics
The KM3NeT neutrino telescope will be the single deep-sea neutrino telescope of this size in the world. It is only complemented by the US-lead IceCube project, which has the same scientific aims, but as compared to IceCube (under construction in the permanent ice of Antartica) the European KM3NeT proposal has two advantages: its angular resolution (of 0.2 degree) will be better by a factor of 5 and it will be able to see neutrinos originating from the region of the galactic centre and most of the galactic plane. These advantages are very important for the potential of KM3NeT to observe and identify neutrino sources, which will represent the start of neutrino astronomy.
3. Science case (scientific justification, including new areas to be opened)
By measuring neutrinos originating from point sources in the universe, it will be possible to open an entirely new field of astronomy, i.e. neutrino astronomy. For the first time compact astrophysical objects can be studied with neutrinos which do not suffer from the interaction with magnetic fields, radiation background or dust clouds. Such observations will be essential in understanding the mechanism of the most energetic objects in the universe such as Gamma-Ray Bursts, Active Galactic Nuclei and micro-Quasars. The observation of neutrinos from galactic sources like Supernova Remnants will also provide key information to solve the puzzle of the origin and production mechanism of galactic cosmic rays. Moreover, observation of neutrinos originating from the centre of the galaxy or the sun may enable us to observe – for the first time – the decay of dark matter particles and determine their mass. This will represent a breakthrough, now that it has been found that the mysterious dark matter constitutes some 23% of the energy content of the universe. Finally, the measurement of the diffuse neutrino flux from the cosmos will make it possible to study the unknown origin of extragalactic cosmic rays (and why they reach such extremely high energies) with in an independent probe.
4. Impact to society and to new technologies for industry
KM3NeT has attracted the interest of marine scientists, since the installation of specialised instrumentation for seismology, radioactivity, geology and geophysics (including Tsunami studies), marine biology, oceanography, geochemistry and environmental sciences will make the KM3NeT infrastructure an abyssal multidisciplinary observatory for deep-sea science, offering a unique opportunity to explore and monitor the properties of the deep Mediterranean Sea over a period of many years. The infrastructure will form an integral part of the Mediterranean segment of the future European Multidisciplinary Seas Observatory (EMSO). As the operation of the detector involves the generation, transport and storage of huge amounts of data, there is a common interest with groups involved in developing e-science and computer grid technologies. KM3NeT will also provide a platform for testing of advanced deep-sea engineering solutions.
5. Strategic importance to ERA
The construction and exploitation of a research infrastructure of the size of KM3NeT can only take place at the European level. The unique features of KM3NeT will make it the leading instrument in its field (astroparticle physics) in the world. Its governance, legal and funding aspects, that will be addressed in a recently approved European Preparatory Phase project, will represent a unique test case and provide input to national and EU research agencies alike.
6. Maturity of proposal (including possible timetable)
The collaboration for this project was formed while preparing the proposal for the EU Design Study. The design of the infrastructure (as approved by the EU 6th Framework Programme) has started in 2006 with a 3 year programme. A Preparatory Phase project (approved by the EU 7th FP) will start in 2008 paving the way to the start of the construction by defining the governance, legal and funding aspects. Construction can start in 2011 and will take another 5 years. However, due to its modularity, the operation of the new deep sea neutrino telescope can begin in or shortly after 2012.
7. Budgetary information (preparation, construction and operation costs)
For the Design Study of KM3NeT a budget of 9 M€ has been granted by the EU, under the 6th Framework Programme. A budget of 5 M€ has been approved, under the 7th Framework

Programme, for the Preparatory Phase project. Additional budget to the Design Study and Preparatory Phase, for a total of about 16 M€, will be provided by the participating agencies and institutes. The construction costs for the Research Infrastructure are estimated to be about 200 M€. Operational costs have not yet been estimated, but are known to be a small fraction of the investment costs. Although the construction of the KM3NeT research infrastructure is not yet funded, the project has triggered expression of interest and commitment by several national or regional authorities like the Sicilian Regional Government (30 M€), the Greek Government (50 M€).
8. Comments on possible partnerships (optional)
Three sites in the Mediterranean Sea are being considered: near Toulon (France), Capo Passero (Italy) and Pylos (Greece). These sites are the location of the pilot studies, which are known as ANTARES, NEMO and NESTOR. The members of these collaborations are all partners in the KM3NeT projects, which include participants from Cyprus, France, Germany, Greece, Ireland, Italy, The Netherlands, Romania, Spain and the United Kingdom. Participation of further partners, European and world-wide, will be sought for the realisation of the KM3NeT infrastructure; this is one of the tasks to be performed in the framework of the KM3NeT Preparatory Phase project.

PSE22_SKA

1. Project's name and descriptive title
Square Kilometre Array radio telescope (SKA)
2. Short description of project and main characteristics
A unique facility, which will be the most sensitive radio telescope in the world, 100x more sensitive than existing telescopes. The SKA will consisting of an array of antennas delivering a million square meters of collecting area. The antennas will be spread across an area 3000km in diameter, providing a single, unique, global radio astronomy facility.
3. Science case (scientific justification, including new areas to be opened)
With 100x greater sensitivity than possible to date, it will be possible for the first time to observe normal galaxies, black holes and other extreme physical phenomena over the entire history of the Universe (currently one detects objects far enough away that the signals have taken a third of the age of the Universe to arrive at Earth). Some of the most interesting and extreme phenomena can only or best be studied with radio waves, but the sensitivity of SKA will greatly improve the impact of other telescopes (optical, x-ray etc) as well.
4. Impact to society and to new technologies for industry
The SKA project will stimulate global cooperation. The operation of such a multi-cultural research facility will contribute to global social coherence. With early funding Europe could play a leadership role. SKA will also provide a strong technology push for the ICT-sector that is of direct relevance to the future commercial market, including computing capacity well beyond current capabilities and extremely wide band fibre optic connections also well beyond current possibilities.
5. Strategic importance to ERA
The project will stimulate cooperation across the continent as well as strengthen cohesion among European researchers in their negotiations and cooperation with researchers in other countries. It will ensure a much closer cooperation between academic research and industry, because involvement of the latter is essential from the beginning to achieve a design involving mass production of highly integrated electronic components.
6. Maturity of proposal (including possible timetable)
SKA is the subject of an FP6 Design Study (SKADS project) and now a FP7 Preparatory Study in DG-Research. Antenna site selection is expected to take place in 2009. A European project office and design centre has been created at the University of Manchester.. Construction of several Pathfinder telescopes is underway, with construction of a 10% SKA scheduled to begin in 2013 .
7. Budgetary information (preparation, construction and operation costs)
The FP6 Design Study will cost € 38M, whilst the FP7 Preparatory Study is expected to commit a

further €20M. Additional design studies and prototyping are currently under way in Australia, Canada, China, South Africa, and USA. The total construction cost is estimated to be in the region of € 1000M, with Europe contributing at least € 400M (i.e. 40%). Operations costs for Europe are estimated to be about € 30M annually, excluding long distance fiber optic data transmission costs.
8. Comments on possible partnerships (optional)
The site of the SKA is likely to be in either South Africa or Western Australia. Both sites are under detailed investigation and will host Pathfinder test telescopes. Operations will be organized from centres scattered around the world. European astronomers wish to have one or more operations centres in Europe that are connected to the antennas by wide band connections. Currently more than 30 institutes in 14 countries around the world are working together to plan and develop the technologies for SKA.

PSE23_SPIRAL 2

1. Project's name and descriptive title
SPIRAL2@GANIL: A new facility for intense secondary unstable rare isotopes up to mass A=150 (Neutron rich fission fragments)
2. Short description of project and main characteristics
SPIRAL 2 facility is an essential intermediate step towards the design of the ultimate long range goal of the European Nuclear Physics community to design and build the ultimate ISOL European facility EURISOL, supported by EU 6th FP as a Design Study (10 M€). **NuPECC roadmap has examined four candidates for this decisive step and has placed SPIRAL2 as the top priority among those.** SPIRAL 2 is based on a high power ,CW, superconducting driver LINAC ,producing 5 mA of deuteron beams at 40MeV (200KW) directed on a Uranium target and producing therefore more 10^{13} fissions/s .After diffusion from the U target , ionization , mass separation and if needed re-acceleration, two to three different beams of “exotic” neutron rich fission fragments will feed the experimental areas of the GANIL facility at Caen (FRANCE). The produced beams intensities for exotic species in the mass range from A=60 to A=140, of the order of 10^6 to 10^{11}pps **will surpass by two order of magnitude any existing facilities in the world**. These unstable ions will be available at energies between few keV/n to 15 MeV/n. The same driver will accelerate at high intensity (100MicroA to 1 mA, world record), heavier ions up to Ar at 14 MeV/n. Deep-inelastic, transfer and fusion evaporation reactions induced by these beams will produce lighter neutron- and proton-rich exotic nuclei close or at the limits of stability.
3. Science case (scientific justification, including new areas to be opened)
The physics case is clearly to extend our knowledge of the **limit of existence of nuclei** deeply in the medium and heavy mass region (A=60 to 140) which is to day an almost unexplored continent. This is largely un unknown area of science where one expects on theoretical grounds to encounter a whole set of new phenomena. Namely: - Nuclei which are along the astrophysics path (r-process ,s and p processes) and which properties are essential in the understanding of **the origin of the elements in the cosmos** - Nuclei with a neutron skin (prototype in laboratory of neutron matter) - Nuclei which structure will depart strongly form the well know shell model, leading to cluster or molecular types of structure. - New “exotic shapes at very high spin with extreme neutron to proton ratios
4. Impact to society and to new technologies for industry
The accelerator structure based on superconducting RF cavities will be at the forefront of superconducting technologies, which are the basis of developments in accelerators and instrumentation of a large numbers of new projects (X-Fel, High – energy colliders, Neutron spallation sources, instrumentation for new imaging devices in life sciences). This project will clearly strengthen EU industries in the domain. In connected applied areas SPIRAL 2 could be considered as a powerful neutron source peaked at 14 MeV, a must to study the impact of nuclear fusion on material used in the upcoming fusion facilities.

The intensities of these unstable species are excellent opportunities for new tracers and diagnostics either for solid state, material or for radiobiological science and medicine.

5. Strategic importance to ERA

SPIRAL 2 is necessary to maintain European leadership in the field of exotic nuclei far of stability and will serve a community of about 600 scientists from 34 countries with ¾ from EU . In a very competitive domain where Japan has invested more than 500M€ in its RIKEN-RIBF facility which is under construction and where the US are proposing to build an "Rare Isotope Facility " (priority 2 in the DOE twenty years outlook report) with a price tag of about 500M$,it is of the outmost importance than EU maintain its present leadership and prepared its future in the field with SPIRAL 2 @ GANIL and later (2017-2020)

EURISOL for the low energy domain (10-50 MeV/n) and FAIR@GSI for the high energy complementary branch (1000 MeV/n). SPIRAL2 will be with its expected performances at the horizon of 2013 a world leading facility.

6. Maturity of proposal (including possible timetable)

The conceptual design and later the technical design of SPIRAL2 has been developed by more than 20 laboratories from 10 countries from 2001 to 2004 and hundred of scientists have contributed to the science and technical case through more than two workshops per year.

The technical design has reached the point where an important part of the SPIRAL2 facility is ready for construction.

The decision to launch the construction phase was taken by the French Government in 2005.

The investments costs is 130 M€ (2007 estimate) and personnel costs of 50 M€, for the construction period 2006-2012.

The construction of some components of the linear accelerator started in 2006, production of the exotic beams part and all buildings are in the detailed technical design phase. All documents necessary to obtain a licence for the construction of the facility are expected to be ready in the end of 2008.

7. Budgetary information (preparation, construction and operation costs)

Construction budget (investments) 136 M€ (including 13M€ of the risk budget) (2006-2014) for the baseline project without detectors. Estimated additional cost for new detectors 40M€.

The FP7 SPIRAL 2 Preparatory Phase (2008-2010) with expected EC contribution of 3.9 M€ (Grant Agreement under negotiation) will deal with both remaining technical design challenges for the baseline project and necessary new instrumentation for experiments. The main goal of the FP7 SPIRAL 2 Preparatory Phase, namely, the preparation and signature of the international agreement on the construction of the facility should allow to complete the necessary investment budget for the baseline project (by about 41M€) and to ensure, at least partially, funds for the new detector systems (estimated investments cost 40M€).

Estimated operation costs of SPIRAL 2 is 8.5 M€/per year.

8. Comments on possible partnerships (optional)

The site is the GANIL laboratory a joint venture between CEA and IN2P3/CNRS (FRANCE) at Caen (FRANCE).

Funding institutions with granted contributions:

CNRS (FRANCE)	18.65 M€ (investments)	30 M€ (personnel)
CEA (FRANCE)	18.65 M€ (investments)	30 M€ (personnel)
Partner Region Basse-Normandie	35,16 M€ (investments)	
CPER (French Government)	1,4 M€ (investments)	

Additional funds requested in 2007:

CNRS (FRANCE)	9,6 M€ (investments)	
CEA (FRANCE)	9,6 M€ (investments)	
Partner Region Basse-Normandie	14,0 M€ (investments)	
Partnership EU countries and EC	29,2 M€ (investments)	
Grand Total :	136,66 M€ (investments)	60 M€ (personnel)
New instrumentation for experiments:	40 M€ (investments)	

PSE24_XFEL

1. Project's name and descriptive title
European X-Ray Free-Electron Laser Facility (European XFEL)
2. Short description of project and main characteristics
The European XFEL will provide coherent radiation in the hard X-ray regime with pulse durations below 100 fs. The peak brilliance will surpass the best existing storage-ring-based X-ray light sources by 10^9. The light will be generated by electrons accelerated in a 2 km linear accelerator.
3. Science case (scientific justification, including new areas to be opened)
The very short pulse length and the extremely high brilliance of the radiation provided by the European XFEL facility will enable scientists to move from the observation of equilibrium states to the dynamics of (bio-) chemical reactions. “Movies” of such reactions with single atom resolution will be recorded. The X-ray laser opens up completely new opportunities to decipher biological molecules by creating high resolution images from single molecules without the need of growing crystals, as well as for novel studies in materials sciences on nanometre length scales. Hitherto unreachable regimes for plasma physics and other research areas will become accessible.
4. Impact to society and to new technologies for industry
The European XFEL will provide a new tool for many different research fields. The detailed understanding of chemical reactions, of the way how molecular machines work will be essential for future drug and material design. The big leaps in brilliance and pulse duration have already triggered the development of novel detector technologies and high power optical lasers which could be expected to be drivers of further innovation. The European XFEL will use a new superconducting technology to accelerate electrons. This technology is expected to be the basis of many future accelerators for free electron lasers, high energy physics, nuclear physics, neutron spallation sources and other applications. With the experience gained with the realization of the XFEL, industry in Europe could achieve a world leadership in these technologies.
5. Strategic importance to ERA
Thanks to the recent achievement of 6.5 nm wavelength laser radiation at the FLASH user facility constructed at DESY, Hamburg, with the same basic technology as the European XFEL, Europe is leading the world in free-electron laser research. The European XFEL will be essential to keep this leadership and to apply the breakthroughs expected from research at X-ray free electron lasers. Such lasers are being constructed in the US and Japan. The experience gained with the application of superconducting accelerator technology at the European XFEL will be crucial for the involvement of Europe's science and industry in future large accelerator-based research facilities.
6. Maturity of proposal (including possible timetable)
The successful operation for users of FLASH down to 6.5 nm wavelength and the breakthroughs achieved in the superconducting RF technology, in the injector gun technology, and in undulators during the Preparation Phase provide very strong validation of the technical choices described in the Technical Design Report, delivered in July 2006. The Report was prepared by the European XFEL Project Team, installed at DESY in 2005 on the basis of a Memorandum of Understanding signed by 13 countries. The construction of the facility is expected to last six and a half years. Presently negotiations are under way to create a limited liability Company with shareholders from the participating countries.
7. Budgetary information (preparation, construction and operation costs)
The full costs for the preparation and construction of a first stage (with six experimental stations and a reduced accelerator performance) of the European XFEL are 902 M€ (year 2005 prices). The second stage (altogether 10 stations, upgrade of the accelerator capabilities) costs an additional 153 M€ (2005 prices). The yearly operational costs will amount to 84 M€ (year 2005 price).
8. Comments on possible partnerships (optional)
The European XFEL will be constructed close to DESY, Hamburg, as a limited liability company. Nine countries have so far expressed a commitment to participate.

PSE31_PRINS

1. Project's name and descriptive title
Pan-European Research Infrastructure for Nano-Structures (PRINS)
2. Short description of project and main characteristics
The project will focus on constructing a research infrastructure (especially advanced equipment and facilities) to enable European innovative research for the ultimate scaling of electronic components and circuits. The platform will be truly interdisciplinary by allowing the convergence of top-down technology, which is today the main enabler of Moore's law, with bottom-up methods derived from fundamental disciplines such as materials physics, chemistry and biotechnology. The open access of this infrastructure will enable the cross-disciplinary implementation of academic and industrial competencies in the areas of nanoelectronics, nanosystems, nanobiology, nanophotonics etc. To maximize the cost-effectiveness and efficiency of implementation it will build on existing facilities operated by the main European research actors in nanoelectronics research, three of which are already united in the "STAR" project of FP6 on research infrastructures as a distributed European Research Platform. Around these, a network of R&D centres will be established, consisting mostly of academia, SMEs and other industrial partners. The new research infrastructure will allow a seamless transition of research to the ultimate silicon applications, research on emerging information processing devices, as well as the expansion to novel domains created by top-down/bottom-up convergence. The project will strive towards a unique platform and optimal use of the new infrastructure by the European research community. Special mechanisms will be implemented to facilitate access for these research groups.
3. Science case (scientific justification, including new areas to be opened)
Since 1959 the technology of miniaturization has been driven by the fabrication of integrated circuits. The shrinking of the electronic components on chip is expected to continue for at least 14 years on the base of silicon technology. During this period, the critical feature size of the transistors (i.e. the physical gate length) will drop (in the development environment) from 32 nm in 2005 to 7 nm in 2018, allowing unprecedented leaps in performance and circuit complexity. Against this background of further-shrinking devices, several disruptive approaches have been explored during the last decade to fabricate novel nanometer-sized functional structures. Some of these alternatives have become known under the generic name of "bottom-up fabrication" (mainly self-assembly of chemical and biochemical structures as well as atomic manipulation). In the future, nanotechnology will move towards the *convergence of top-down and bottom-up techniques*. Fast progress on both sides is now bringing this convergence closer to reality, and the combined power of both approaches will bear fruit in a wide variety of application fields of strategic importance for the European economy. In order to combine all top-down and bottom-up approaches, including materials research, new device concepts and the integration of all above towards a proof-of-concept mode, a dedicated state-of-the-art research infrastructure is needed which will focus on the integration of heterogeneous approaches in the silicon technology. Such research infrastructure requires some unique and characteristic features, as it will bring together advanced equipments and expertise related to multiple disciplines such as: materials research and atomic scale characterization, new device concepts, nano-scaled CMOS and post-CMOS processing, bottom-up self-assembly processing methods, reliability studies and the integration of such concepts and devices in complex systems. This state-of-the-art research infrastructure will be much needed to support the future development of the European semiconductor industry, which is one of the most dynamic industrial sectors of our continent. Moreover, the role played by the semiconductors as enabling products is crucial for the performance of the final value-added markets (telecommunications, aerospace, automotive...), as witnessed by the increasing pervasiveness of IC technologies. These features compel us to consider the semiconductor industry among the top strategic priorities of future economic development in Europe.
4. Impact to society and to new technologies for industry
It can be stated that nanotechnology will be the ultimate accomplishment of Moore's law. In the longer term the evolution of nanoelectronics will shift from pure scaling to applications, e.g. as an enabler for the

pervasive electronic environment known as "Ambient Intelligence". Unleashing the full power of nanotechnology will raise the huge challenge of "*nanoelectronics with giga-complexity*", yet its socio-economic rewards should be comparable to the benefits currently achieved by Moore's law in electronic applications. The major application areas, which will drive technological innovations, are safety & security, communications, health, mobility, education and entertainment. In order to make this happen, a dedicated research infrastructure is needed -- as described below – (1) suitable for enhanced fundamental insights when combining all technological aspects and (2) providing proofs-of-concept when implementing the various multidisciplinary technology dimensions into reproducible and reliable processes and methods. The successful implementation of the top-down and bottom-up approaches in manufacturing will create the first wide-scale industrial application area for nanotechnology and silicon technology fully qualifies as the convergence platform for both paths: as such this research infrastructure should have a huge industrial and economical impact resulting in the creation of jobs and a renewed leadership of Europe.

5. Strategic importance to ERA

The ERA aims at exploiting the high European potential by combining the efforts of individual nations to reach a critical level of resources and expertise in strategic areas. The European nanoelectronics community has already established itself as a forerunner through the creation of the European Technology Platform "ENIAC". Still, European academia in nanoelectronics experiences difficulties in gaining access to state-of-the-art research infrastructure to carry out their work. The total level of investment and running cost available in individual laboratories cannot match the requirements of advanced materials research, new technologies, device research and device implementation, and this gap threatens to widen with the newest technologies. The PRINS approach aims at providing a co-ordinated European answer to this challenge, driven by a pan-European combined vision and enough critical mass to match cross-Atlantic research competition. The PRINS project is strongly supported by the ENIAC board, which considers the project of key importance for the realization of the Strategic Research Agenda.

6. Maturity of proposal (including possible timetable)

The PRINS proposal has been prepared in line with the Strategic Research Agenda for ENIAC, which considers this RI of key importance and therefore gives its full support. A comprehensive work plan, including partners, timeline and detailed budget has been worked out in order to submit a proposal within FP6 (INFRA-2007-2.2.1.27).

Presently the EU has approved to start with the Preparatory Phase of the project, which will run for 24 months, covering the period 2008-2009. In that phase the full details for the implementation phase (legal aspects, logistic issues, research areas to be covered, operation modes for Access/Hosting academic researchers, funding schemes and long term sustainability, etc) will be worked out in detail.

After the Preparatory Phase (2008-2009), the Implementation Phase of the PRINS RI is envisaged to comprise *two main phases*:
Implementation Phase 1 (2010 – 2013):

- tools for reinforcing the European leadership in equipments and materials, including new smart substrates
- tools for ultimate silicon processing research infrastructure, including: advanced lithography (EUVL,…), deposition and patterning of nano-materials (ultrathin and nanostructured layers), nanometer-scale metrology and characterization
- tools for heterogeneous integration in and above silicon of disruptive and unconventional structures
- first generation of bottom-up research infrastructure for exploration of robust and silicon-compatible solutions (nano-wires, nano-dots, self-assembled monolayers a.s.o.)

Implementation Phase 2 (2013 – 2015):
research infrastructure for combination of top-down /bottom-up based nano-fabrication (molecular manipulation, on-chip positioning, control at the nanometer scale) of devices and circuits, fully compatible with nanoelectronics reliability and reproducibility requirements.

7. Budgetary information (preparation, construction and operation costs)

The cost for the Preparatory Phase is limited to 1 M€. Although full details of the budget for the Implementation Phase will be worked out during the PP, it is presently envisaged that the costs to cover Nano CMOS, heterogeneous integration and Nanofabrication will be in the following order

Tools : 1000 - 1500 M€
Building: 150 - 250 M€
Operational cost: 1500 - 1750 M€
Decommissioning (7%): 185 - 245 M€

In the Preparatory Phase the research areas to be covered will be defined in detail, allowing to determine the overall budget, which is presently estimated around 2835 - 3745 M€.
The infrastructure will be distributed in a complementary mode over a limited number of participating European sites, involving (i) research centres with state-of-the-art device processing and top-down/bottom-up integration capabilities, (ii) specialized centres for research on heterogeneous integration and (iii) centres for research on advanced materials and novel device concepts
Because the tools will be housed in and combined with existing facilities, research infrastructure costs will be mainly needed to extend existing utilities, guaranteeing further research functionality whilst maintaining a strongly needed critical mass to cope with international competition. Complementary funding will be raised from private sources in a public-private partnership mode.

8. Comments on possible partnerships (optional)

The new PRINS research infrastructure will be distributed over a number of existing sites, grouped around IMEC (Belgium), CEA-LETI (France) and FhG (Germany) operating in a research platform mode. These three institutes will act as the main integration centres for ultimate silicon and heterogeneous integration, whereas a number of linked sites will provide complementary research on advanced materials and specific technologies for heterogeneous integration. The collaboration with and active involvement of the full European nanoelectronics community - linking the three types of centres as mentioned under 7 - will be pursued through the strategic European Technology Platform “ENIAC”. There will also be a very close interaction and collaboration with other so-called flexible platforms (e.g. SINANO) which are presently under discussion. The Academic community, the Industry and the Public Authorities are as stake holders invited to play an important role in the different PRINS Advisory Boards. During the execution of the Preparatory Phase a large number of potential stake holders will be contacted. The opinions of these Boards will be taking into account in the final conclusions of the Preparatory Phase, which will be forming the basis for the implementation phase.

PSE36_ELI

1. Descriptive title, and information on the ESFRI delegation submitting the proposal (or one of the member of EIROForum)
Extreme Light Infrastructure Preparatory Phase

2. Synthesis description of the new RI (or major upgrade) and S&T fields involved at Pan EU level in its use. Add links to relevant data/web pages (half page max)

ELI will be the first infrastructure dedicated to the fundamental study of laser-matter interaction in a new and unsurpassed regime of laser intensity: the ultra-relativistic regime (I_L>10^{23} W/cm^2). At its centre will be an exawatt-class laser ~1000 times more powerful than either the Laser Mégajoule in France or the National Ignition Facility (NIF) in the US. In contrast to these projects, ELI will attain its extreme power from the shortness of its pulses (femtosecond and attosecond). The infrastructure will serve to investigate a new generation of compact accelerators delivering energetic particle and radiation beams of femtosecond (10^{-15} s) to attosecond (10^{-18} s) duration. Relativistic compression offers the potential of intensities exceeding I_L>10^{25} W/cm^2, which will challenge the vacuum critical field as well as provide a new avenue to ultrafast attosecond to zeptosecond (10^{-21} s) studies of laser-matter interaction. ELI will afford wide benefits to society ranging from improvement of oncology treatment, medical imaging, fast electronics and our understanding of aging nuclear reactor materials to development of new methods of nuclear waste processing.

See www.eli-laser.eu

3. Science case: scientific area(s) and potential and/or explicit users, how the new RI will fit into the existing and future landscape of Research and of existing RI's, at EU and World level (one page max, links to relevant documents, references).

ELI will extend the field of laser-matter interaction, now limited to the relativistic regime 10^{22}W/cm^2, into the ultra-relativistic regime 10^{24}-10^{26}W/cm^2. By means of relativistic effects, these extreme intensities will provide access to extremely short pulse durations in the attosecond regime. ELI will comprise three branches: **Ultra-High-Field Science** focusing on the direct interaction between target and light of unprecedented laser field strength, **Attosecond Laser Science**, which will capitalize on new regimes of time resolution, and **High-Energy Beam Facility**, responsible for development and use of ultra-short pulses of high-energy particles and radiation stemming from the ultra-relativistic interaction.

ELI will open the possibility of taking snap-shots in the attosecond scale of the electron dynamics in atoms, molecules, plasmas and solids. With the possibility of going into the ultra-relativistic regime, ELI will afford new investigations in particle physics, nuclear physics, gravitational physics, nonlinear field theory, ultrahigh-pressure physics, astrophysics and cosmology. Besides its fundamental physics mission, a paramount objective of ELI will be to provide dedicated ultra-short energetic particle (10 GeV) and radiation (up to few MeV) beams produced from compact laser plasma accelerators. ELI will mate its scientific, with its engineering and medical missions for the benefit of industry and society. For instance, the secondary sources will provide X-ray technologies to clarify the complete time history of protein activity such as protein folding, radiolysis, monitoring of chemical bonds and catalysis processes. This will lead to a better understanding and control of key events during chemical bond formation and destruction. A high impact on society and on new technologies for industry is then expected since these processes will play a major role in creating new drugs or in improving their efficiency.

See scientific case in www.eli-laser.eu

4. Technical case: summary of results (technical specifications) of conceptual and/or technical design studies (half page, list references/links).

One of these is the so-called Extreme Light Infrastructure (ELI). It will host an exawatt class laser. The ultra-high peak power will be achieved by extending current high-energy laser technology (kJ energy level) to support extremely short pulse durations of the order of 10 fs. This will enable ELI to study light-matter interaction in the ultra-relativistic regime. The design of the ELI laser system delivering peak powers in the exawatt (10^{18}W) range is presented here. As a first step, a front-end delivering pulses in the petawatt (10^{15}W) regime at a repetition rate of up to 1 kHz could be constructed. This front-end could be complemented with a power amplifier in a single beamline to deliver 70 PW at 1 shot/minute, and later up to 1Hz. This beam would deliver peak intensities of 10^{25}W/cm^2 when focused. As a last step, coherent combination of 10 such laser lines could allow to exawatt peak powers to be attained and would make a hitherto completely unexplored research field accessible, spanning physics, material science, biology, chemistry and medical research. This laser will serve as the backbone of a future European experimental facility called Extreme Light Infrastructure (ELI).

See scientific case in www.eli-laser.eu

5. e-infrastructure: what does the new RI require as far as e-infrastructure? How is it integrated with the existing EU e-infrastructure (e.g. Geant, grid, digital repositories).

ELI will be connected with le laser Hiper dedicated to laser fusion by fast igition. Although with very different goals Hiper and ELI may share some common technology with large optics. It will also be linked to the Large Base Telescope for its deformable mirror and phasing technology.

6. Other expected socio-economic impacts: development of new technologies, effects on training, involvement of industries, local impact, other (one page, references).

ELI will develop a new field, the field of relativistic microelectronic and photonic engineering in partnership with industry for practical and compact MeV-GeV electron acceleration. It could result in a major revolution in the field of accelerator electronics.

In material science ELI will make possible to clarify the mechanisms leading to defect creation and material aging in nuclear reactors. In its intermediary stages, ELI will be able to produce large quantities of positrons that could be used in positron microscopy and in low dielectric constant studies for fast electronic devices. ELI could also be used to investigate the transmutation of long-lived radioactive elements into short-lived ones for the protection of our environment.

ELI revolutionary approach will offer great benefits to Society in the field of medicine, energy, environment. fast electronics and material science. ELI will also pursue an aggressive **technology transfer to European SMEs and large companies**.

High on the ELI agenda will be the **training of aspiring scientists and engineers** in the numerous disciplines associated with the Extreme Light.

The number of potential users is large, exceeding, **50 laboratories and 1,000 users in Europe**. ELI will represent a scientific "beacon" for the research community.

See scientific case in www.eli-laser.eu

7***. Commitments / maturity: which States and Organizations have demonstrated interest / commitment in supporting and/or funding the proposal?***

France, Germany, Romania, Czech Republic, Bulgaria, Spain Italy, Greece, Hungary, Latvia, Poland, Portugal, United Kingdom

8. Costs for construction, operation and decommissioning, indications on project financing (half page, with references/links). Give budget info in M€

Rough estimation: (the gross budget of the project is under evaluation during the first year of the Preparatory Phase

Cost for construction: $\approx$ 400M€
Cost for operation (per year) 40- 50 M€

Cost of decommissioning ≈ 50M€ The country which will be selected to host the infrastructure must finance at least 40% of the construction cost. If France is selected to host ELI, we could expect a strong support and commitment from Germany, Italy, leading to a financial support of these 3 countries higher than 70% of the budget. The remaining part could come from the 10 others European countries involved in the project. It is too early to move to more details (Preparatory Phase is just starting now)			
Total preparatory cost	Total construction cost	Operation cost /year	Decommissioning cost
(of which already spent or committed) 6 M€ (Preparatory Phase EC contribution)	(specify contributions committed or indicated by possible funders) ≈400M€	(specify contributions by possible funders) 40-50M€/year	(possible funders) 50M€
9. Timetable for construction, operation and decommissioning (half page, with references/links) with duration and possible starting dates.			
Construction could start just at the end of the preparatory Phase (early in 2011) Construction duration (3-4 years) Ready for operation in 2014 Operation period over 30 ans Decommissioning : 1 year			
Preparatory phase 2008- 2010 (3 years)	Construction phase 2011- 2013) 3 years	Operation 2014- 2044	Decommissioning 1 year
10. Reference: Person who has submitted the proposal, and will follow up in ESFRI			
Gerard Mourou *Project coordinator* *Head of Laboratoire d’optique Appliquée* *ENSTA- Ecole Polytechnique* *91761 Palaiseau Cedex* *France* *33 169319708* *gerard.mourou@ensta.fr*			

5. Evaluation of new proposals

The portfolio of the 34 proposals for new RI's ESRFI PSE has received was of a rather heterogeneous nature:
Due to the heterogeneity of the field ESFRI PSE divided its work in three sub-panels:

- Energy research
- Materials Sciences and Engineering
- Astronomy, Astrophysics, Nuclear and Particle Physics

While most of the projects could clearly be assigned to one of the three sub-panels, some have had more the nature of testing facilities and / or were not easily to be attributed to one of the esubpanels. Especially in the field of Engineering the boundaries between Research Infrastructures on the one and Testing Facilities on the other hand are difficult to define. In the assessments of ESFRI PSE the definition of basic research – applied research and experimental development of the Frascati Manual was used. A number of projects assigned to PSE were also in the interest of other RWG's, mostly environment. In this case a consensus between the two groups to reach a final decision was found.

The sub-panels were also asked to develop an overall strategic view of the landscape, based on existing indications and opinions within the involved scientific communities. Some fields are well covered by individual Roadmaps, and/or strategy documents that have been published by international institutions, e.g. Particle Physics (by the CERN Council) and Space (by the European Space Agency).

5.1 Methodology

The working group set out by discussing the guidelines given in the mandate from ESFRI. It was agreed that every member should explicitly declare any conflict of interest in relation of specific projects being discussed in the course of the work of the group. It was also agreed that such conflicts will not necessarily bar them from participating in the Group. The group also discussed the need and best way to protect the confidentiality of their deliberations, to allow for open discussions within the group. It was agreed that, while keeping internal discussions confidential, member of the group was allowed to communicate with their back offices and with the scientific community in an appropriate way, in order to gather all the necessary information and assure the transparency of the process. It was also noted that different opinion should be recorded in the reports to ESFRI.

Initially it was decided that the working group and the three sub-panels would do the analysis without the explicit use of outside experts. In the later stage it was decided to seek independent scientific, technical or socio-economic advice from specific experts.

The PSE has considered and assessed the progress of the 15 projects included in the first edition of the ESFRI Road Map and currently being in their Preparatory Phase. In addition the PSE has assessed 19 proposals for new RI’s submitted by the ESFRI delegation and assigned to the PSE by the ESFRI Executive Board. The PSE has been consulting with other working groups on projects on the borders between the areas covered by the working groups. The infrastructures under consideration span very different types, lifetimes and costs, from large, single site laboratories based on a specific large equipment or facility, to distributed facilities and network of national facilities.

Following the directions from ESFRI the group did not generate or attempted to modify projects. An interim status of the work by the PSE was presented to ESFRI at its meeting March 6-7, 2008. Based on this report, the ESFRI asked the PSE to engage in a dialogue with the groups behind the new proposals in the energy field and the relevant directorate of the European Commission in an effort to further develop the most promising proposals. This resulted in resubmissions of four energy RI proposals which were subsequently assessed by the sub-panel and the PSE. The results of the new assessments were presented to ESFRI at the meeting of June.

5.2 Assessment criteria

The panels used the same format for their assessments (see Annex V). The projects that were included in the 2006 ESFRI Road Map were judged on the development in the project and the scientific landscapes, while the new proposals were scrutinized on their scientific merit, role in the European landscape, degree of maturity and over all European added value.

PSE RWG has introduced additional criteria to distinguish between science driven projects and the development of technologies and products. These were subsequently endorsed by the ESFRI. Following the definitions in the Frascati Manual the PSE decided that ESFRI Road Map in the area of PSE should only include Research Infrastructures with significant elements of user driven investigations in basic, oriented basic and applied research. Research Infrastructures primarily for experimental developments are less within the scope of ESFRI. They can be included in the landscape descriptions but should not be included in the Road Map.

The 34 projects were assessed in detail by the sub-panels and the assessments were combined and integrated by the PSE as a whole into an overall view coherent with a strategy-led approach to European policy-making. The scope has been to help ESFRI to choose those proposals which are deemed strategically most important and mature for inclusion on the second edition of the ESFRI Roadmap. An important task was to fill thematic gaps of the ESFRI roadmap 2006.

The work of the PSE has required a difficult balance between merits of the scientific need and excellence, pan-European nature and added value, and strategic and societal relevance combined with the realities of budget constraints and science policy priorities in the member states.

5.3 Evaluation results

In addition to the 15 projects that were included in the 2006 ESFRI Road Map, the PSE RWG recommends four new projects to be included in the updated ESFRI roadmap. All of the projects are deemed to be of clear relevance for their respective scientific fields. Two of the new projects deals with topics, which also have been dealt with by the Environment roadmap working group. Furthermore, the PSE recommend ESFRI to proceed with the development of Energy research infrastructures, as in particular developments in the field of new and sustainable energy are of importance in relation to energy policy issues like climate, security of supply and equitable economic development. With these recommendations PSE has strived to find the proper balance between exploratory research and the needs for research in strategic areas.

5.3.1 Proposals for the updated Road Map

RU07_CTA - Cherenkov Telescope Array

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 gamma-rays having energies of a TeV and above. It will provide the first complete and detailed view of the universe in this part of the radiation spectrum and contribute towards a better understanding of astrophysical and cosmological processes.

The proposed facility will consist of arrays of Cherenkov telescopes will increase the sensitivity for deep (distant object) observations by an another order of magnitude, provide better angular resolution and lead to better study of the structure of gamma-ray sources, allow a wider field of view for the study of transient phenomena, enhance all sky survey capability, and have wide and uniform coverage for gamma-ray energies from 10 GeV to beyond 100 TeV. The array will be built at two separate sites, one in the southern hemisphere with wide gamma-ray energy range and high resolution to cover the plane of the Milky Way, and the second in the northern hemisphere specialised for lower energies, which will focus on extragalactic and cosmological objects.

The CTA will investigate cosmic non-thermal processes, in cooperation with observatories in other wavelength ranges of the

electromagnetic radiation spectrum, as well as with those using other messenger types (i.e. neutrino telescopes, cosmic ray arrays). This multi-messenger approach to astronomy will lead to deeper understanding of major astrophysical processes and of the creation of the universe.
The CTA facility will be operated as a proposal-driven observatory, with a Science Data Centre providing transparent access to data, analysis tools, and user training.

Assessment by PSE

The PSE RWG finds that there has been major progress in this field, where the HESS and MAGIC projects have observed a multitude of gamma ray sources both within the plane of our galaxy and outside our galaxy. The CTA will greatly extend the reach of these current projects and allow for further exciting scientific discoveries. The idea of CTA is now mature enough and the relevant research groups have coalesced into a coherent structure. The promise of this approach has also been noted in a recent ApPEC statement. There is a growing user community in Europe and good contact to scientists in related fields like radio, neutrino astronomy and dark matter research.

CTA will combine the existing efforts in Europe to construct a next-generation world-leading state-of-the art facility, and will capitalize on the expertise and diverse instrumental developments. A similar project is under way in the United States. Eventually, it is desirable to have observatories in both hemispheres and given the cost of these facilities the European and the US initiatives need to be strongly coordinated to provide full-sky coverage under a common framework. Contacts exist between the two projects and there is a policy of open exchange of information.

The European added value is documented in the recent ASTRONET Road Map which gives highest priority to CTA. The project is in the later stages of the conceptual design phase and engineering design has started in 2006. The project will now need a concerted European effort to move forward in order to maintain the proposed schedule. Implementation is planned to start in 2010 with the construction of prototype telescopes, with partial operation in 2013. The construction budget of 150 MEuros is deemed well founded and reasonable at this stage of planning.

The PSE find the scientific case strong and recommends CTA as a candidate for the road map.

RU19 EMFL – European Magnetic Field Laboratory

EMFL will be a dedicated magnet field laboratory providing the highest possible fields (both continuous and pulsed) for 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: Grenoble High Magnetic Field Laboratory (GHMFL), Laboratoire National des Champs Magnétiques Pulsés (LNCMP) in Toulouse, Hochfeld-Magnetlabor Dresden (HLD), 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.

High magnetic fields, both static and pulsed, are one of 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 characterization of superconductive materials. Europe has been leading the development of high magnetic fields and their use for science and technology. At present, however, the USA's National High Magnetic Field Laboratory (NHMFL) is the leading facility in the field, distributed over three sites. For Europe to regain its competitiveness, it is urgently necessary to coordinate and upgrade Europe's high field activities to an effective size and efficiency comparable to that of the NHMFL.

Assessment by PSE

The PSE RWG finds that high magnetic field studies are an important for many areas of materials research. Traditionally Europe has had a strong position for high magnetic field studies. At present, however, the premier state of art is found the laboratories in the

USA. This proposal addresses this situation and aims to significantly strengthen the European position. The EMFL is a based on a network of well recognized 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). The four laboratories provide a basis for an excellent an integrated facility of existing European high magnetic field laboratories. The laboratories have already started the collaboration within several FP6 projects, and have concluded a formal agreement of collaboration. The PSE RWG has been convinced that the managements of the laboratories are committed to the formation of a distributed infrastructure in line with the evolving ESFRI criteria. EMFL will provide European added value by carrying out tightly coordinated upgrades of Europe's high field facilities. EMFL as a distributed facility will allow different national and local funding agencies to coordinate their support of the high field research in Europe and thus achieve results that go beyond the possibilities of a single nation. The EMFL will result in a coordinated up-grade of the high magnetic field research infrastructures in Europe. EMFL will also manage the scientific access of its users to all its installations, the selection of the proposals being made by an independent external Selection Committee.

The proposed joint investment budget of 120 Mio Euros is of the same order as the combined budgets of the four partner laboratories are thus deemed reasonable. The planning of the EMFL is also realistic with expected start of construction in 2010 after a 2 years preparatory phase, and duration of 5 years.

The PSE RWG recommends the EMFL as a candidate for the up-dated EFRI Road Map list.

RU29 ECCSEL - European Carbon Dioxide Capture and Storage Laboratory Infrastructure

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, but in particular in emerging economies. Europe lacks presently a large research infrastructure in this field. The ECCSEL proposal combines three approaches to capture (pre and post combustion and O_2/CO_2 -oxyfuel- recycle combustion capture) and three approaches to carbon storage (aquifers, depleted oil/gas fields, coal bed methane). The proposal includes upgrading existing national infrastructure into a European level. The research facility composes of distributed parts in partner countries with a core hub in Norway. This is a natural selection as Norway owns the best facilities in this field in Europe. All labs in the ESFRI proposal have been participating in the most important European research consortia.

The infrastructure in the proposal is unique world-wide and it is made open to European researchers through a joint management structure. The planned research infrastructure enables advanced level of research in post combustion absorption, new materials and processes, combustion facilities and storage facilities. 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 in aquifers and to develop qualification methods and mitigation strategies.

Assessment by PSE

There is a strong need for activities in this field and the topic is highly relevant for the EU SET plan. The PSE RWG finds that the up-dated project proposal and supplementing documentation has clarified many of the outstanding issues. The project deals mainly with upgrades and integration of existing facilities at different locations in Europe with a central node in Norway. It involves the best current infrastructures in the field. It is likely to evolve into a distributed infrastructure according to the ESFRI criteria and according to commitments in the proposals to joint planning and financial contributions from the partners. The ESFRI process helps to promote the research infrastructure aspects in the project which until now is based on research cooperation supported by the frame work programs in FP5, FP6 and FP7. The proposal includes merit based open access to the facilities and that there will be a coherent strategic management of new investments, up-grades and utilization. The core consortium consists of 10 European partners, but the network behind CCS is much broader, and the PSE RWG recommends that the consortium broadens its European base. Nevertheless, the proposals is unique in European and has with its present membership substantial European added value.

The proposal meets the different needs from the basic research to other experimental activities and measurements. The facility supports well European industrial competitiveness in this field. ESFRI would be an optimal instrument to pull together such a research infrastructure and creating a kind of “super site” for CCS RI in Europe.

The proposal was not found fully matured in the first round, but based on the up-dated proposal and supporting documentation, and after extensive discussions the PSE RWG gave the ECCESEL proposal the highest ranking of the energy proposal found that the ECCSEL project is a suitable candidate for the roadmap update.

The cost of the facility is 81 million € is well founded and financing is likely to be obtained from a range of stake holders and current sponsors including both governments and industries. The yearly cost of operation is around 6 million €. The facility could be in operation in 2010 and would well meet the urgent needs in this field.

The ECCSEL proposal is recommended as a candidate for the up-date ESFRI Road Map list.

RU38 EISCAT 3D - European Incoherent Scatter radar system

EISCAT_3D is the upgrade of the existing EISCAT (European Incoherent SCATter) facility, which provides state-of-the-art radar facilities to study various processes taking place in Earth’s atmosphere. These studies can help understanding the formation and evolution of our own, and other, solar systems The EISCAT Association provides state-of-the-art radar facilities which allow studies of various processes taking place in Earth’s atmosphere. EISCAT_3D will be a major upgrade of the existing infrastructure that will improve the range of available data as well as the temporal and spatial resolution of data. This upgrade is based on an ongoing design study. EISCAT is a facility for both physical studies environmental issues such as space weather. The upgraded facility will provide high-quality ionospheric and atmospheric parameters on an essentially continuous basis for users as well as providing near-instantaneous response capabilities those users who need data to study unusual and unpredicted disturbances and phenomena in the high-latitude ionosphere and atmosphere. The present members of the EISCAT Scientific Association are China, Finland, Germany, Japan, Norway, Sweden and the United Kingdom.

The Earth’s atmosphere, if properly characterized, can be used as a “scintillator” for the detection of particles from our solar system and beyond (e.g. micrometeorites, dust, and cosmic rays), the tracks of which can be recorded in three dimensions using the radars. The radars can also be used to study aspects of the Earth that are essential for future searches for, and investigations of, Earth-like extra solar planets.

Assessment by PSE

The proposed concept of the new radar facility using the array antennas with a multi-static approach is sound. It should be possible to construct and fully evaluate the performance of the first phase of EISCAT_3D within the requested budget before moving on to a larger system. The general concept of the project is mature although the prototype and the precise definition are being developed as yet. The association is certainly able to build, to solve the potential problems and to run the new system. Lower power coherent scatter radars have successfully used imaging techniques to study the spatial distribution and motion of ionospheric irregularities for many years. The same techniques can be readily adapted to incoherent scatter observations. The engineering requirements of an imaging ISR are sufficiently well understood for the project to be successfully completed within the requested budget.

The major value of the proposed EISCAT_3D project is that it will enable a major upgrade of the EISCAT radar in northern Scandinavia. The data from EISCAT_3D will be used not only by the EISCAT community, but also by scientists from many other countries within Europe and internationally. EISCAT_3D will provide the primary data set, it will also provide a supporting data set that will help resolve and understand measurements obtain from spacecraft launched by ESA, NASA, and other nations. The proposed access to data and experiments will be open and based on the quality of the proposed research is a major improvement of the actual way of proceeding.

The present community working in these fields is rather small but it exists in each European country and the inclusion in the road map of this project will certainly reinforce this community. EISCAT 3D will be a unique European facility with a clear role in the global landscape, and it will cater to both a European and a global community of space science, atmospheric science and environmental science

Both the internal and external reviews have provided very favorable assessments of the scientific scope, the economical and technical feasibility, the technical maturity and the European added value of the EISCAT-3D proposal.

The project is recommended as a candidate for the ESFRI Road Map.

5.3.2 Emerging energy proposals

Five new energy proposals were received for consideration by the PSE RWG. The preliminary findings of the PSE RWG was that none of the new energy proposals were mature enough to meet the criteria to be included in the ESFRI up-date Road Map even though the sub-panels had recommend the 3 non-nuclear energy RI's. The PSE RWG found that three projects (RU_29 ECCSEL, RU_34 TEREI and RU_36 Turbulence, now Windscanner) were suitable for a 'fast track' maturing procedure. In the assessment process the PSE RWG and its sub-panels have employed the general ESFRI criteria (scientific, technical and financial criteria), and the strategic criteria arising from the EU policy side on energy and innovations. The work of the PSE RWG has required a difficult balance between merits of the scientific need and excellence, pan-European nature and added value, and strategic and societal relevance combined with the realities of budget constraints and science policy priorities in the member states. This was reported in the interim status report of the PSE RWG to the ESFRI meeting March 6-7, 2008. Based on this report, the ESFRI asked the PSE to engage in a dialogue with the groups behind the new proposals in the energy field and the relevant directorate of the European Commission in an effort to further develop the most promising proposals.

These subsequent consultations resulted in resubmissions of four of the energy RI proposals by May 15 (ECCSEL, MYRRHA, TEREI, and Windscanner). These were then assessed by the energy sub-panel
in a telephone conference on May 19, discussed in a telephone conference on May 26 with delegates from the the two energy directorates within DG RTD, and finally assessed by the PSE RWG on May 30. The projects were seen very positively in terms of their quality as well as theit relevance by the EC energy research directorates. In the assessment by the energy subpanel of the PSE RWG this positive opinion was confirmed for the three non-nuclear projectrs. Except for MYRRHA the energy subpanel was of the opinion tha this project should remain 'emerging'. This opinion was justified by the not yet clear financial situation and the fact that strategic decisions concerning Ge. IV reactors are still to be taken. (The latter had also been a concern of the representatives of the nuclear directorates.)

Bases on this the energy projects were finally discussed in the PSE group as a whole. The result was that only ECCSEL was recommended for the Road Map up-date. It should be noted that only two members from the PSE-energy sub-panels were present at this discussion. Furthermore, the chair and the Spanish delegate had declared conflict of interest and were not present during the final discussions of the energy projects.

The decisions on the Energy proposals were finally taken by a simple majority vote.

The final assessments of the energy proposals by the PSE RWG were reported to ESFRI at the meeting on June 13, 2008. Following a debate the PSE RWG was asked to review the issue once again and it was recommended by the ESFRI executive board to solicit second opinions from experts in the field with knowledge of the ESFRI process. Second opinions on MYHRRA, TEREI-SOLAR and Windscanner were subsequently asked from professors Norbert Kroo, Yves Petroff and John V. Wood, and John Wood was asked to act as the convener. The three experts agreed with the findings and conclusions of PSE RWG. Furthermore, they express concern that ECCSEL does not involve several relevant partners in Europe and suggested that the recommendation to include the project should emphasize the need to bring other groups in.

RU03 MYRRHA - Multipurpose Hybrid Reactor for High-tech Applications

MYRRHA is a plan for a European fast spectrum experimental facility able to demonstrate efficient transmutation and associated technology through a system working in a sub-critical mode. The proposed facility combines both a fast neutron spectrum and a high flux level (up to 3 10^{15} n/cm².s). The technical concept is based on employing a particle acceleration that generates high energy protons (350/600 MeV) which in turn create fast neutrons when colliding with a spallation target. For the accelerator, either a cyclotron or a linear accelerator system (LINAC) will be employed. The accelerator is coupled with a reactor core which consists of 30 wt% Pu-enriched MOX fuel pins. The spallation target module is located in the centre of the core. The whole installation is placed inside a reactor vessel including all equipment needed to operate the system. Rather than going for a critical reactor core, a sub-critical level has been chosen with k_{eff} ~ 0.95 to assure better safety. The thermal power is in the range of 50-80 MW_{th}. The basic concept for producing fast neutrons is well-known.

The facility is intended to be used to demonstrate the applicability of partitioning and transmutation of long-lived fission products and actinides into less harmful elements. Another research aim is nuclear reactor research, in particular sodium, gas, and lead fast reactors. Fast neutrons can be used to a range of other applications as well for example production of radioisotopes or more fundamental physics research such as fusion physics. MYRRHA is foreseen as a flagship facility for innovative research on radioactive waste management and Generation IV reactor systems, taking in particular advantage of the fast neutron spectrum.

The facility is proposed by SCK-CEN from Belgium. The project is still in the conceptual design phase. The detailed engineering and planning would take 4 years and the construction about the same time The facility could be ready for operation around 2017 at earliest. The construction cost of the facility is 700 million € and for operation around 40 million €/year is needed.

Assessment by PSE

The PSE noted that MYRRHA was proposed but not selected for the first ESFRI Roadmap 2006 as it was considered not sufficiently mature and it was then classified as 'emerging' project.

MYRRHA has matured over the last two years and will be ready for detailed engineering design in 2009. The associated R&D projects have been supported by FP5 and FP6 and the EC RTD strategy for FP7. The project is supported by the research community in the Platform for Sustainable Nuclear Energy (PSNE), and the R&D efforts are part of the global GEN IV cooperation. It has official support from the Belgian government and institutions but need substantial funding contributions from other partners. The only fast neutron facility in the EU is the French reactor PHOENIX, which will be closed down in 2014 and MYRRHA will then be the only EU installation in the field of fast neutron spectrum.

The Strategic Research Agenda of the SNE-TP (Sustainable Nuclear Energy Technology Platform) has not yet concluded which Generation IV reactor systems and which actinide recycling technologies will be developed in the EU. Decisions on the technology paths to be chosen are expected in 2010 – 2012. The PSE found that decisions on possible new European nuclear facilities should follow these prioritizations.

The project requires considerable financial contributions from the participating agencies and industries. It is recommended that the continued preparation work should enhance the European dimension, provide a plan for how the project will be financed, and include mechanisms for making the financial decisions for the construction. The PSE RWG finds the MYRRHA project is not sufficiently matured for the ESFRI Road Map, mainly due to the open questions on the final specifications for such a fast neutron facility as well as on the financing issues.

The proposal was in the first round recommended to be maintained as an “emerging” project. After extensive discussions in the second round the PSE RWG maintained is recommendation of MYRRHA as an emerging project pending the definition of the final specifications. This assessment was subsequently confirmed by the external expert panel.

RU34 TEREI-SOLAR (previously TEREI)

TEREI-SOLAR focuses on concentrating solar technologies, both solar thermal and photovoltaic. The research facility is located in Spain and is an upgrade of a national facility to a European RI. The core facility and new infrastructure is built around the well-known Spanish ‘Plataforma Solar de Almeria’ located in Almeria, which is a world-class solar research centre with over 30 years of experience in solar concentrating technologies. The location of such as facility in southern Spain is highly recommendable due to the high solar irradiance necessary for this kind of research.The facility can be used for a wide range of solar energy related research topics such as high flux R&D, solar and high temperature chemistry, photovoltaic, solar optics, energy applications, material research, etc. Moreover TEREI-SOLAR provides a platform and test facility for development of advanced concentrating solar technologies. European industries would directly benefit of it. The proposal has a strong European dimension and a joint management structure enabling effective use of the facility by the European researchers.

The total cost of the construction is estimated at around 90 million € and the yearly operation will cost 3 million. The funding seems probable. The facility could be fully operational by 2013. The core partnership consists of 10 European institutions and support to this venture is also given by several European industry associations and local Spanish industries.

Assessment by PSE

The proposal tackles with key energy technologies of the EU SET-Plan and there is a European need for such a facility. It is well in line with the Council’s request to ESFRI to identify the need for European research infrastructures in the field of energy technologies, such as renewable energy technologies. The project is relevant for stimulating partnerships with Mediterranean countries. The proposal is of relevance for renewable energy R&D in Europe and satisfies an important demand of this kind of RI. The facility will be used mainly for engineering research, technical developments and testing.

The reformulated proposal now focused on concentrated solar power; it deals with an upgrade of existing facilities located at Almeria in Spain. The project has much improved and it has changed its name from TEREI to TEREI Solar. The clear focus on the field of concentrating solar is appreciated. The best infrastructure facilities and the leading user groups in the field are involved from several countries in Europe. The need by the research community for both basic and applied research as well as technical development work and testing has been outlined by the European Photovoltaic Technology Platform. The proposal aims at a broad European partnership led by the Spanish partner. The project presents itself as an open access facility and solicits investments from European partners. Financing is probable and the project is flexible for the accommodation of new partners. The project covers all the necessary facilities to support progress in the field of solar energy technology. The plan is ambitious, but realistic. The European dimension is sufficient for the moment but needs to be worked on further as the project evolves.

After extensive discussions on the balance between exploratory research and strategic research combined with engineering research, development and testing the PSE decided by majority vote to maintain its recommendation as an emerging project. This assessment was subsequently confirmed by the external expert panel.

RU36a Windscanner (previously Turbulence)

The proposal European Centre for Turbulence and Wind Energy introduces a unique research infrastructure to measure 3-dimensional wind vectors around static or rotating objects. The primary aim of the wind scanning measurements is to increase the understanding of the aerodynamics and structural dynamics of wind turbines, a highly important field for enabling improved and more effective turbine designs. This so-called Windscanner facility is based on a set of laser Doppler based measuring systems which operating together are able to remotely sense the 3D wind vector field at a distant point at a rate of 500 Hz. Thus for the first time full-scale 3D wind fields around a wind turbine rotor can be measured. This information can be used in Computational Fluid Dynamisc (CFD), aero dynamical as well as structural analyses. The kind of measurements cannot be made in artificial wind tunnels but needs natural winds and terrains for this type of research.

The proposed research infrastructure is planned to become a type of new distributed European research facility consisting of mobile 3-D remote sensing stations that will be installed across Europe at 6-8 sites using the new wind scanning technology currently under development at Risø DTU Denmark. This approach is necessary in order to cover the relevant terrains that affect the wind profiles. A number of European wind turbine test sites have been identified as the ‘home bases’ for each Windscanner facility. The RI will be a Pan-European extension of a recently proposed Danish large scale facility. Since the Windscanner facility is mobile, measurements are by no means limited to take place at the research stations only.

Assessment by PSE

The PSE review confirmed the need for and the uniqueness of the possibility of mapping the flow in mountainous terrain. This would support computer model development and validation, as well as provide insight in real-life problems – e.g. the reason for excessive wind turbine damage at a particular site. Key issues are to understand the influence of turbulence on construction, siting, and operation of both on-shore (complex terrain) and off-shore wind turbines

The PSE RWG has noted that the proposal is identified important within the Wind Energy Technology Platform, and that it fits in to the SET-Plan and Council’s request on renewable energy RI. The proposal is also supported by the European Academy of Wind Energy (ÈAWE) for a new distributed infrastructure based on comprehensive laser-based determination of wind fields combined with sophisticated computer simulations. The project is deemed very relevant for further research and development in the field with links to the large FP6 project UPWIND

The construction of the RI will cost 45 million € and yearly operation 4 million €. Financing outlooks are promising, but the ESFRI process will help to bring the national contributions together. The RI will be governed by a board also granting access to do research with the facility. There is a strong backing for the proposal both from the research and industrial community. Plans for financing and broad European participation still needs to be worked out .

After extensive discussions on scientific merits, the European dimension and the degree of maturity the PSE decided by majority vote to maintain its recommendation as an emerging project. This assessment was subsequently confirmed by the external expert panel.

5.3.3 Other proposals

Engineering

Engineering research typically has components of basic and applied research as well as experimental development. This means that many of the RI used for materials research also serves the engineering research communities. In other words many of the users at these facilities come from engineering departments at European universities and from industrial R&D departments. This is particularly true for the neutron beams and synchrotron radiation facilities. Engineering research communities are also heavily involved in the development of the RI’s in PSE areas. New RI’s take advantage of the latest advancements in technology and in many cases are key drivers for such advancements. The long string of spin-offs from RI-institutions like CERN is a testimony to that effect. Many of the ESA projects have an industrial engineering rationale as well as the scientific rationale.

The new proposals in the field of engineering research were related to aeronautical and aerospace research; safety research and fluid dynamics. Their main scopes are experimental developments and hence they fall outside the categories of the RI's to be included in the ESFRI Road Map. The PSE has found that none of the proposals in the area of engineering research meets the science criteria based on the Frascati Manual definitions.

Experimental development is systematic work, drawing on knowledge gained from research and practical experience that is directed to producing new material, products and devices; to installing new processes, systems and services; or to improving substantially those already produced or installed.

RU08 3MERL

Proposal of upgrades and networking of earth quake science and monitoring facilities for

1) Integrated geophysical and geodetical instruments for post-seismic (aftershock) research
2) Multi-disciplinary (geophysical, geodetical and geochemical) earthquake research monitoring
3) Marine Geophysical instrumentation for sea bottom imaging, fault and structure mapping

The proposed research infrastructure will be used after devastating earthquake to capture the "volatile" data and help the assessment of damage as well as assessment of the next vulnerable area. They will also create new possibilities for pre- and post-seismic researches. Multi-disciplinary earthquake researches in pre-seismic period are very limited and need to be extended to include observations in different tectonic regimes in the European continent.

The assessment of this project has been transferred to ENV RWG.

RU12 ACT/FHS

ACT/FHS, Advanced Control Technology / Flying Helicopter Simulator (EC135), operated and owned by DLR, the German Aerospace Centre

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ACT/FHS is specialized flying test bed. It is operated and owned by DLR and has been operational since the end of 2002. It is a European oriented flying test bed for innovative aeronautics technologies. The basic aircraft, and Eurocopter EC135, has been converted to fly-by-light helicopter with variable stability characteristics in order to allow research tasks to be performed in Flight dynamics, Flight systems, Flight guidance, Aerodynamics, measurement technologies and avionics. The ACT/FHS contributes to various initiatives such as FRIENDCOPTER, the smart rotorcraft, the quiet rotorcraft.

PSE RWG finds that the ACT/FHS is mainly for experimental development work and lies outside the scope of research infrastructures in the ESFRI Road Map.

RU13 ATRA

ATRA, Advanced Testing Research Aircraft (A 320), operated and owned by DLR, the German Aerospace Centre.

This airplane will be operational by the end of 2009. It will be unique in Europe because providing the widest scope of research possibilities in the area of flight testing, and it is oriented test innovative aeronautics technologies. The basic aircraft, an Airbus A320 -232, will be converted in order to allow research tasks to be performed in Flight systems, Flight guidance, Aerodynamics, Cabin research, measurement technologies and avionics. ATRA will give the European community of universities and Research establishments the possibility to test technologies on an industry standard aircraft.

PSE RWG finds that the ACT/FHS is mainly for experimental development work and lies outside the scope of research infrastructures in the ESFRI Road Map.

RU14 L-SURF

Large Scale Underground Research Facility on Safety and Security Research.

The proposed project addresses the safety research needs from their increasing level of public mass transportation interconnections – especially underground - between different means of transportation (e.g. airport connected with rail and metro through a hub with a shopping mall included). The relevant boundary conditions of such spaces are limited access and therefore also provide limited escape routes as well as very special ventilation systems, resulting in safety risks in connection with dispersion of gases, spread of fire or distribution of Chemical, Biological, Radiological, and Nuclear material. The proposed L-SURF facility will offer flexibility of boundary conditions regarding the shape of cross sections, the ventilation of tubes and hubs, the surface properties – which is of importance for human behavior – and the combination (like links and crosses) of different types of subsurface spaces. L-SURF also covers all environmental aspects being it waste air, waste water and solid waste.

PSE RWG finds that the ACT/FHS is mainly for experimental development work and lies outside the scope of research infrastructures in the ESFRI Road Map.

RU26 LVR-HALE

High Altitude and Long Endurance Flying Laboratory for Aeronautical Research.

The proposed research platform is envisioned to be a flying laboratory capable to perform aeronautical research that meets requirements in terms of altitude, endurance and autonomous mission management. Its nominal performances are: 30 days endurance; 20 km altitude; fully autonomous flight; quasi-geostationary flight. LVR-HALE will provide a flying platform for a wide range of applications and needs for research in aerodynamics, material technology, innovative structural concepts, and innovative air transport system operational concepts. In addition auxiliary technologies can be tested such as on-board clean energy systems using fuel cells and photovoltaic cells, atmospheric pollution. LVR-HALE will also offer options for real-time monitoring of seismic areas, hydrograph monitoring, telecommunication services.

PSE RWG finds that the ACT/FHS is mainly for experimental development work and lies outside the scope of research infrastructures in the ESFRI Road Map.

RU17 CECAM

A European Nexus & Network for Exploration Using Simulation in Science.

This is a proposal to establish a European nexus for Computational Science Software Infrastructure, and secure Europe’s leading role in this increasingly important field into the future. Computational science has now become a crucial and integral part of almost all sciences and much engineering, including mineralogy, molecular biology, astronomy, chemical catalysis, biochemistry, geo-physics, climatology, semiconductor physics, nano-technology, meteorology, climatology, aircraft design and material science. The first component of the Cyber-infrastructure is a drive for “plug-and-play” standardisation. Interdisciplinary and multi-scale, multi-paradigm simulations, which require using several programs in a work-flow or in concurrence, require code interoperability and would therefore benefit from defining standards for data exchange.

The assessment of this proposal was transferred to the e-Science RWG.

RU20 Cyclope

Center for International Cooperation in Long Pipe Experiments, a laboratory for the study of high Reynolds number turbulence-Area of “Physical sciences and Engineering”

The proposed project is a new “single-site” RI created to develop high Reynolds number experimental facilities for detailed turbulence measurements. In combination with computational resources, the facility will provide a focus of activity for leading international researchers in the field of high Reynolds number turbulent flows. The main experimental apparatus, i.e. a large pipe flow facility (pipe diameter of the order of 1 meter and a length larger than 100 meters), is intended for at least ten years of basic research and has the potential for extensions with more direct impact on applications, such as the study of the effect of non-smooth walls or non-isothermal conditions, the evolution of various non-equilibrium flows, and of flows with some particulates. It is a national initiative aimed at an international user community

The PSE WG found that this project is too narrow in scope and lacks European added vale to be considered for the ESFRI Road Map.

Physical sciences

RU21 DAFNE-II

DAFNE-II, is a planned major upgrade of the Frascati e+e- Collider. It is a high luminosity e+e – collider in the energy range between 1 and 2.4 GeV based at Frascati(I). It has been proposed in Nuclear Physics. This facility will allow precision experiments in fundamental symmetry violations in the Kaon system, which is a probe of physics beyond the Standard Model. A program in Hypernuclear physics will also be carried out, which bridges the disciplines of High Energy and Nuclear Physics. In addition this collider will be the tested for the development of beam handling techniques crucial to the operation of all future high luminosity colliding beam facilities.

PSE RWG finds that DAFNE represents a large national infrastructure that attracts international use, and which is capable producing first class results in particle and nuclear physics. The international community is supportive of a major upgrade of the machine performances. The proponents have demonstrated in the last years, through detailed studies, that interesting and unique opportunities could be made available by the DAFNE-II machine.

PSE finds that the DAFNE II has limited European added value and that is not the technical and financial mature to be considered for the ESFRI Road Map at this stage.

RU27 NFFA

Nanoscience Foundries and Fine Analysis.

NFFA is proposed as a European Research Infrastructure built as a cluster of 3-6 nanoscience Centers closely attached to selected Large Scale Facilities for fine analysis of matter
(synchrotron radiation sources, neutron scattering sources, high power lasers including free electron lasers and high performance computing, etc). NFFA will cater to a broad user community to conduct advanced research in nanoscience by offering access to State-of-the-art synthesis, nanofabrication, analysis, metrology and fine analysis experiments and modeling at the nanoscale.

PSE RWG finds that NFFA covers a broad range of nanoscience areas. The project proposes an interesting linkage of nanoscience facilities with existing or planned large scale facilities for material analysis. Only one of the five partners of the NFFA consortium is a large research infrastructure (CMF in United Kingdom) as identified in the above mentioned list of 18 while the other partners can be considered as medium or small sized infrastructures. Commitments and budgetary aspects are not yet clear nor is the relation with the PRINS project, NFFA is judged immature and should not be considered for the ESFRI Map. The proposal could be further developed in close connection with the PRINS consortium during the preparatory phase of the PRINS project.

RU37 MAX IV

MAX IV - ultra low emittance synchrotron.

MAX IV in Lund Sweden is a proposed ultra-low-emittance synchrotron radiation facility. It is based on a combination of a 3 Gev storage ring for hard X-rays, a 1.5 GeV ring for soft X-rays both with emittance below 1nmrad and a 0.7 GeV ring for VUV radiation. A 3 GeV linear accelerator (Linac) is used for top-up injection as well as for the generation of femtosecond X-ray pulses. The Linac also provides a possibility for a free electron laser in the soft X-ray regime. The ultra-low emittance leads to unique brilliance, exceptional opportunities to focus the beam down to a few nm and excellent coherence properties. The new facility will be used for important areas like materials research, nanoscience, life sciences, geosciences, energy research, environmental science, archaeology, etc.

PSE RWG finds that MAX-IV is innovative design which offers new science potential. It is an important national response to the increasing demand of the still growing user community of synchrotron radiation users. If realised, it will undoubtedly attract a community of international users. It is still in the conceptual design. These new facilities are also complementary to a significant extent in terms of their experimental possibilities and scientific programs

RU39 PRIN-CE

PRIN–CE stands for: Pan European Research Infrastructure for Nano-Structures – an extension to Central Europe.

The present proposition's main goal is to create a research infrastructure (laboratories, especially highest purity clean rooms with appropriate fabrication and characterization equipment together with supporting facilities) that will enable to carry out nano-structural research in the part of Europe which is visibly underdeveloped in terms of such infrastructure, i.e., in eastern and central Europe. The PRIN-CE facilities are proposed to be located in Celestynów near Warsaw on the premises of the planned regional innovation park. The creation of the centre in Celestynów will have two phases:
Phase I: detailed planning, construction and purchasing of basic equipment and its installation (2009-20013); and Phase II: Commencement of research operation, further development of the infrastructure (2013-2016).

PSE RWG finds that PRIN-CE is very much a Polish national project with limited international involvement at the moment. The intention is to set up a large research facility for nanoscience research. In view of the large number of already existing facilities in Europe it would be good to explore synergy and complementarities during the preparatory phase of PRINS. At the moment the PRIN-CE proposal seems to be still in an immature phase.

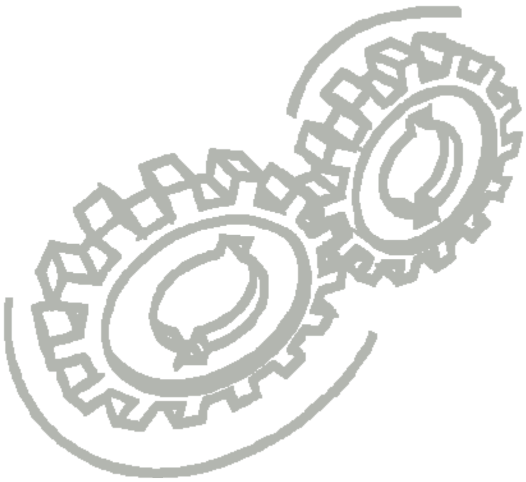
RU40 DYNAMO

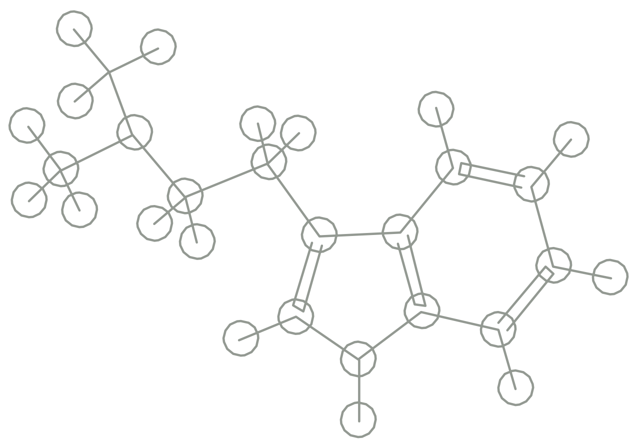
It is proposed to create an experimental platform for magneto-hydrodynamics (MHD) dynamo experiments in the interests of researchers from all European countries. MHD Dynamo Platform is a next generation MHD Dynamo Facility with potentially changeable geometry. The Platform would allow testing several geometries of the Dynamo experiment in the range of several cubic meters of liquid sodium and power in MW (megawatts). Additionally separate laboratories will be created for research in liquid metal technologies, applied MHD, and magnetic fluids and nano-devices.

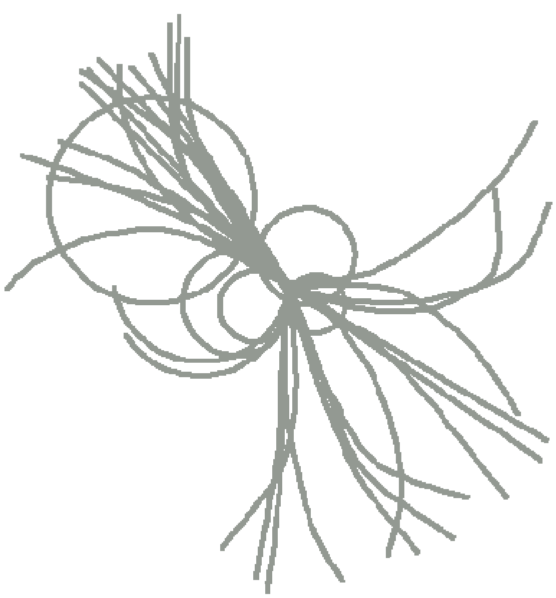
The PSE RWG finds that the DYNAMO project has a quite narrow scope. At this stage it lacks contact to a broader European community and that its character is more a national facility with international participation and exploitation. It should not be considered for the ESFRI Road Map.

5.4 Proposal templates

5.4.1 Mature proposals







1. Descriptive title, and information on the ESFRI delegation submitting the proposal (or one of the member of EIROForum)
The Cherenkov Telescope Array CTA – an advanced facility for ground-based high-energy gamma-ray astronomy The proposal is submitted by the German, French and Polish delegations to ESFRI.
2. Synthesis description of the new RI (or major upgrade) and S&T fields involved at Pan EU level in its use.
The present generation of imaging atmospheric Cherenkov telescopes (HESS and MAGIC) have recently opened the realm of ground-based gamma ray astronomy in the energy range above a few tens of GeV. The Cherenkov Telescope Array CTA will thoroughly explore our universe in Very High Energy (VHE) gamma-rays and deeply investigate cosmic non-thermal processes, in close cooperation with observatories in other wavelength ranges of electromagnetic radiation, and those using other messenger types. The proposed facility will consist of arrays of Cherenkov telescopes, aiming to (a) increase sensitivity by another order of magnitude for deep observations, (b) boost significantly the detection area and hence the detection rates, particularly important for transient phenomena and at the highest energies, (c) increase the angular resolution and hence the ability to resolve the morphology of extended sources, (d) provide wide and uniform energy coverage from some 10 GeV to beyond 100 TeV in the energy of the photons, and (e) enhance the all sky survey capability, the monitoring capability and the flexibility of operation. CTA will be operated as a *proposal-driven open observatory*, with a Science Data Center providing transparent access to data, analysis tools and user training. To allow viewing the whole sky, two CTA sites are foreseen, with the main one in the Southern hemisphere, given the wealth of sources in the central region of our Galaxy and the richness of their morphological features. A second complementary Northern site will be primarily devoted to the study of AGNs and cosmological galaxy and star formation and evolution. CTA is in the PSE field, with main issues in Astrophysics and Particle Physics. More information can be found at http://www.mpi-hd.mpg.de/CTA .
3. Science case: scientific area(s) and potential and/or explicit users, how the new RI will fit into the existing and future landscape of Research and of existing RI's, at EU and World level.
Science case. Data from Cherenkov telescopes of the current generation have revealed a sky rich in features at Tera electronvolt (TeV) energies. First sky maps have shown the band of the Milky Way lined with cosmic accelerators, with complex and resolved morphology. Their energy spectra extend beyond tens of TeV; some of the objects emit most of their energy in the TeV range. Diffuse TeV emission in the Milky Way appeared correlated to the spatial distribution of a molecular tracer. Binary stellar systems and young stellar clusters have been seen at very high energies, as well as a number of TeV sources still entirely unknown at other frequencies. Extra-galactic sources at unprecedented distances up to redshift z=0.5 have been detected, some of them showing amazingly fast variability on minute time scales. The shape of their gamma ray spectra relates to the density of diffuse background radiation in the space between galaxies, and thus to the hotly debated history of cosmological structure evolution and star formation. Gamma rays from distant galaxies can also probe effects of quantum gravity. While the results achieved with current instruments are already very impressive, they just give a first taste of the high-energy cosmos, with a sample of about 70 detected TeV gamma-ray sources. The detailed under-standing of processes in cosmic particle accelerators as well as their use for cosmological applications requires wider energy coverage, improved spatial, spectral and temporal resolution, and higher detection rates. A number of highly interesting source classes, such as clusters of galaxies, await detection, with flux levels predicted just below the sensitivity of current instruments. The performance in this domain can be improved

dramatically by a much larger deployment based on now well-established techniques and observation strategies. The opportunity for discoveries and growth similar to the one experienced some time ago in space-based gamma ray astronomy is now clearly perceived in the adjacent domain of ground-based VHE astronomy. The proposed facility should result in breakthroughs in several fields of astronomy such as the origin of cosmic rays, the environment of compact objects, the physics of pulsars and black holes, and it may offer one of the rare possibilities to detect signatures of the nature of dark matter.

An important aspect driving the timing of the CTA project is the overlap with GLAST. GLAST and CTA together will provide seamless coverage of the high-energy sky over 7 decades in energy, crucial for identifying the mechanisms at work in the cosmic particle accelerators. GLAST will furthermore serve as a trigger for CTA, monitoring continuously the sky for high-energy activity and helping to select flaring objects of interest.

The science case for CTA was examined in the ApPEC/ASPERA roadmap of astroparticle physics (http://www.aspera-eu.com/images/stories/files/Roadmap.pdf) where CTA was ranked as a top project for the near future.

User community. In Europe, about 300 scientists are currently involved in smaller-scale instruments for high-energy gamma-ray astronomy with Cherenkov instruments - H.E.S.S., MAGIC, and VERITAS - and will join forces for CTA. We expect that a similar number of astronomers and astrophysicists working in related fields, in particular in X-ray astronomy, in radio astronomy and in neutrino astronomy, as well as particle physicists working on dark matter detection will request and use CTA data.

CTA in the European and international landscape. Currently, European experiments in ground-based high-energy gamma-ray astronomy are world-leaders, although the European efforts are split among partly competing projects, with MAGIC and some European contribution (UK and Ireland) to the US VERITAS experiment in the northern hemisphere, and H.E.S.S. in the southern hemisphere. CTA will combine these existing efforts to construct a next-generation world-leading state-of-the art facility, and will capitalize on the expertise and diverse instrumental developments. In the United States, motivated by the CTA initiative in Europe, the AGIS proposal is being prepared; in its science goals and instrumental concepts, AGIS is very similar to CTA. Given the desire for observatories in both hemispheres and given the not insubstantial cost of these facilities, it seems likely that at some stage the two initiatives will coordinate or merge to provide full-sky coverage under a common framework. Already now, close contacts exist between the two projects and there is a policy of open exchange of information.

4. Technical case: summary of results (technical specifications) of conceptual and/or technical design studies).

The performance and scientific potential of arrays of Cherenkov telescopes has been studied in significant detail; what remains to be decided is the exact layout of the telescope array. Ample experience exists in constructing and operating telescopes of the 10–12 m class (H.E.S.S., VERITAS). Telescopes of the 17 m class and 28 m class are operating (MAGIC) or under construction (H.E.S.S. II) and will serve as prototypes. The structural and optical properties of such instruments are well understood, not only in this domain but also in adjacent domains (such as radio astronomy, particle detection by fluorescence). The major development effort yet required concerns aspects related to industrialisation of the production and economies of scale.

The fast electronics needed in this field in order to capture the nanosecond-scale Cherenkov pulses have long been mastered in this domain, even before such electronics became commonplace with the GigaHertz transmission and processing used today in telephony, internet, television, and PCs. There is a remarkable convergence between the groups joining together for the CTA project in the particular solutions to be applied.

Photon detectors with improved quantum efficiency are under advanced development and testing and may be available when the array is constructed; however, the long experience in the area of conventional photo-multiplier tubes provides a solid and certain basis, and a base-line for studies of the instrument's performance.

In short, all technical solutions exist today in order to carry out this project, with the main challenge being in the industrialization of all aspects of the production.

5. e-infrastructure: what does the new RI require as far as e-infrastructure? How is it integrated with the existing EU e-infrastructure (e.g. Geant, grid, digital repositories).

Given the large amounts of data generated by the instrument (and by simulations of its characteristics), close cooperation with efforts in e-science and grid computing is envisaged. Some of the laboratories involved with the project are indeed Tier 2 and even Tier 1 centres on the LHC computing grid, and others on the Cosmogrid. Therefore, the simulation and analysis packages for the CTA will be developed to be grid-aware. The consortium is going to setup a CTA-Virtual Organization within the EGEE (Enabling Grids for E-sciencE; funded by the European Union) grid project which will allow to use grid infrastructure and to share computing resources. This solution will facilitate worldwide collaboration in the context of simulation studies and in the processing and analysis of scientific data.

Unlike current instruments, CTA will be an open observatory, and will include a Science Data Centre (SDC) which provides pre-processed data to the user, as well as tools for the common analysis techniques. The software tools to be developed aim to provide for all scientists an easy-to-use controlled access to this unique research infrastructure, again making use of the emerging e-Infrastructures and of grid tools. CTA data will be accessible through the Virtual Observatory, with varying interfaces matched to different levels of expertise. Development of the toolkit will benefit from the experience of those partners who are already experienced in SDC management, e.g. via the INTEGRAL space mission.

The CTA consortium will also request to be a recognized experiment by the CERN community, as many of the laboratories involved in CTA are also active participants in CERN, such as to provide access to the computing and meeting facilities at CERN, and to interact with the scientists there.

6. Other expected socio-economic impacts: development of new technologies, effects on training, involvement of industries, local impact, other.

Development of technologies: The design and implementation of CTA requires technological developments in a number of areas, such as large-scale production of cost-effective telescope mirrors, high-bandwidth signal-recording electronics which is both relatively simple to implement yet very powerful, or photon detectors with improved photon detection efficiency which might help to reduce cost for a given light-collection power, or control and robotic operation of large and complex systems. These developments will be pursued in close cooperation with industrial partners. Many of these topics have in common that they have applications in science and commerce which go beyond the scope of CTA. Instrument development carried out in the context of the CTA design has significant potential for technology transfer.

Operation of the instrument requires precise understanding of atmospheric characteristics, fostering cooperation with environmental science and development of advanced instruments for atmospheric monitoring, such as specialized Lidar systems.

Structuring European research: Resolution of the governance, legal and funding aspects of such a project will provide significant input to future European-scale research infrastructure projects, and national and EU research agencies, and is likely to represent the first field test of concepts derived within the ASPERA ERA-NET.

Education and training: Experiments in astroparticle physics have proven an excellent training ground for young scientists, providing a highly interdisciplinary work environment with ample opportunities to train not only physics skills but also to learn data processing and data mining, programming of complex control and monitoring systems, design of electronics, all that embedded in large collaborations and in a genuinely multinational environment, working across borders and enhancing presentation skills, communication abilities and management and leadership proficiency. Young scientists frequently participate in outreach activities and hone their respective skills. Training of young scientists will significantly contribute to the impact of CTA.

Outreach. Another impact area concerns public outreach. Scientist involved in the current projects

of high-energy gamma-ray astronomy frequently engage in public lectures and always experience great interest and enthusiasm for astronomy and astrophysics by the public. Outreach activities will form an integral part of the CTA observatory, with lectures and demonstrations augmented by web-based non-expert tools for viewing CTA data, and coverage of particularly interesting objects, along the lines of the “Source of the Month” featured on the H.E.S.S. web pages. CTA can be expected to make highly visible contributions towards popularising science and generating enthusiasm for research at the cosmic frontier and interest in the technologies applied in this field.

Local impact. Almost by definition, candidate sites – required to be remote from cities due to light pollution - will be in less developed countries or regions. Depending on technology chosen for the telescopes and on the local production capability, between 1/5 and 1/3 of the construction cost of the new infrastructure is expected to be spent in the (wider) host region; this concerns site infrastructure, the telescope foundations and possibly the telescope structures or parts thereof. A significant fraction of the annual operating costs will be spent locally. While these costs are not insignificant on the scale of science projects, they will, however, be marginal on the scale of even a developing country’s economy. The impact on science in the host country or host region is expected to be significantly larger, given that CTA will be the world’s premier facility in its domain. Strong involvement by local scientists in the operation of the facility and in the analysis and dissemination of data is highly desirable and will be encouraged and supported. We will also aim to involve the local population at all levels, by general outreach activities, by lectures and courses offered at schools and at university level by CTA scientists, and by involving local students in undergraduate and graduate programs either locally or at participants’ institutes.

7. Commitments / maturity: which States / Organizations have demonstrated interest / commitment in supporting and/or funding the proposal?

The CTA design study involves members from Armenia, the Czech Republic, Germany, Finland, France, Ireland, Italy, the Netherlands, Poland, South Africa, Spain, Switzerland, and the United Kingdom. While firm commitments are still open, we expect the CTA project and in particular, in the near future, the technical design of CTA to be supported by the German BMBF, MPG and HGF/DESY, the French CNRS, the Italian INFN and INAF, the Polish ministry as well as other funding agencies. The Spanish MEC is also showing interest in the project, conditioned to the potential future incorporation of CTA into the Spanish national roadmap, if and when so decided.

CTA has been mentioned as an emerging project on the ESFRI roadmap document in 2006. It is also on the ApPEC/ASPERA astroparticle physics roadmap with an unconditional recommendation that the project be pursued; a recommendation is also expected in the upcoming ASTRONET roadmap.

Finally, we note that the H.E.S.S. experiment has been awarded the 2006 Descartes Prize for Research (together with two other European projects) for excellence in scientific collaborative research.

8. Costs for construction, operation and decommissioning, indications on project financing (half page, with references/links). Give budget info in M€

Depending on the exact number and size of the telescopes to be deployed, about 100 M€ are required for a southern site which will cover a wide energy range from some 10 GeV to 100 TeV for observations of our Galaxy at high resolution. A complementary site in the northern hemisphere would focus on extragalactic and cosmological objects, with instrumentation specialized for low energies, at a cost of about 50 M€. The stations would be constructed and operated by a single consortium. Total operating and maintenance costs are currently estimated to be around 4 M€ per year, not including salaries and the Science Data Center. Approx. 10 M€ are estimated for site exploration, detailed design and industrial prototypes. These costs concern only investment costs. Of the order of 1000 person-years will be needed for construction and operation to 2018, amounting to an estimated 60 M€ for manpower costs, not reported in the table below.

Total preparatory cost	Total construction cost	Operation cost /year	Decommissioning cost
Approx. 10 M€, depending on the number and type of	Estimated to 150 M€ for the full-scale facility covering both hemi-	Estimated at 4 M€ per year plus salaries, not including upgrades of	Will depend strongly on final choice of site and

prototype telescope(s). About 10% spent.	spheres. No funding commitments yet.	detection systems over the lifetime of the observatory. No funding commitments yet.	contractual details, ranging from 0 to a worst case around 10 M€
9. Timetable for construction, operation and decommissioning with duration and possible starting dates.			
After a phase of detailed design which started in 2006, implementation is planned to start in 2010 with the construction of prototype telescopes, with partial operation in 2013. This schedule perfectly fits into the global agenda of the Cherenkov experiments (MAGIC II and HESS 2) now in their final phase of construction. After starting their operation in 2008/2009, respectively, the technical teams which are involved, with the relevant expertise, will have the available manpower to immediately enter into the CTA construction phase. This timetable also allows significant overlap with the GLAST satellite instrument to be launched in Spring 2008, which for emission from compact sources covers the energy range up to 100 GeV and which serves as an all-sky monitor, triggering pointed and deep observations at VHE by CTA. It will strengthen the vivid interplay between high-energy instruments and other domains of astronomy from radio to X-rays which has now emerged, with common observation campaigns and exchange of data which clearly optimizes the scientific return compared to instruments operating in isolation.			
Preparatory phase Technical design: 2006-2009 Prototype construction: 2010-2011	Construction phase Construction: 2012 - approx. 2017	Operation Partial operation beginning in 2013, full systems in 2018	Decommissioning Open Expected lifetime of 20-30 years
10. Reference: Person who has submitted the proposal, and will follow up in ESFRI			
Prof. Werner Hofmann, MPI für Kernphysik, Heidelberg, Germany Email: wh@mpimail.mpi-hd.mpg.de			

1. Descriptive title, and information on the ESFRI delegation submitting the proposal (or one of the member of EIROForum)
EMFL - European Magnetic Field Laboratory proposed by the French ESFRI delegation
2. Synthesis description of the new RI (or major upgrade) and S&T fields involved at Pan EU level in its use. Add links to relevant data/web pages (half page max)
High magnetic fields are one of the most powerful tools available to scientists for the study, the modification and the control of the state of matter and Europe needs a dedicated magnet field laboratory (EMFL) which provides the highest possible fields (both continuous and pulsed) for its researchers. Therefore a EMFL should be founded that will unite, coordinate and reinforce the four major existing 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), in a single body in order to provide such a needed facility. This new facility needs investment in its installations, human resources, running budget and the scientific infrastructure around them to become a global leader in the production and use of very high magnetic fields for scientific goals. The high field facility project under consideration at the ILL/ESFR (Grenoble), if realized, should eventually also become part of the EMFL. LNCMP: www.lncmp.org, GHMFL: ghmfl.grenoble.cnrs.fr, HFML: www.hfml.sci.kun.nl, HLD: www.fzd.de/db/Cms?pNId=580.
3. Science case: scientific area(s) and potential and/or explicit users, how the new RI will fit into the existing and future landscape of Research and of existing RI's, at EU and World level (one page max, links to relevant documents, references).
Europe has always played the leading role in the development and application of high magnetic fields, both static and pulsed. In the 20th century, the research in this domain has been an extraordinary asset allowing many new discoveries of primary interest important for their scientific and their technological impacts, and in total 14 Nobel prizes in physics, chemistry and medicine have been attributed to research related to magnetic fields. Europe has currently four mid-scale facilities that have the necessary installations, knowledge and manpower to operate resistive static and pulsed high magnetic fields (GHMFL, LNCMP, HLD and HFML). All four are involved both in science (in house research and as user facility) and magnet technology. Currently, together they handle 250 user projects per year, approved by independent external experts in the context of FP6-TransNational Access, and this number is steadily increasing. In Japan, five mid-scale installations exist but these put more emphasis on materials research and less on general user operation. However, the state of the art in high magnetic field science and technology is set by the USA's National High Magnetic Field Laboratory (NHMFL), distributed over three sites: Tallahassee (FL), Gainesville (FL) and Los Alamos (NM). This national facility largely surpasses the manpower and budget of Europe's four high field facilities put together. The NHMFL yearly hosts around 900 users, amongst which a non-negligible fraction coming from Europe. In order for Europe to regain its competitiveness, it is urgently necessary to coordinate and upgrade Europe's high field activities to an effective size comparable to that of the NHMFL. Conscious of this necessity, the four laboratories mentioned above (GHMFL LNCMP, HLD, HFML) have started to collaborate within several FP6 projects, and have recently concluded a formal agreement of collaboration. Implementation of an even more structured collaboration between them, although clearly necessary, is currently hampered by the particular constraints that the different national and local funding agencies of these laboratories impose, and by the lack of financial means to do so. Furthermore a truly competitive EMFL on a global scale requires resources and investments that go beyond the possibilities of a single nation. The recent investments in Dresden (25 M€ for a new 50MJ capacitor bank paving the way to 100T pulsed fields) and Nijmegen (23M€ for a new 20MW installation, a 45T hybrid and a dedicated free electron laser to work with the magnets) constitute what may be achieved on a national level. The necessary investments to become a global player matching the US effort can only be done on a European level. The newly formed multi-site EMFL will develop common magnet technology and magnets but complementary scientific specialisations. The HFML will concentrate on advanced spectroscopy

through the unique combination with a FEL and the dedicated 40T vibration-poor hybrid magnet site for local nano-spectroscopy (STM, AFM and confocal spectroscopy), while Grenoble will house a new 40MW installation and a record field hybrid. This EMFL site will also profit from the vicinity of the ILL/ESRF where plans for combining high magnetic fields with neutrons and synchrotron radiation exist. 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 magnetic fields. LNCMP will expand its activities in X-ray and visible spectroscopy, and strengthen its magnet materials development program to the benefit of all EMFL partners.
NHMFL: www.magnet.fsu.edu

4. Technical case: summary of results (technical specifications) of conceptual and/or technical design studies (half page, list references/links).

Upgrade Grenoble-site:

40 MW power supply + cooling circuit	40 M€
50 Tesla hybrid magnet	25 M€
Increase annual operating budget	3 M€

Upgrade Toulouse-site

Upgrade of the capacitor bank generator with 6 MJ fast modules	5 M€
Extension of the building with fail-proof experimental sites	4 M€
Construction of a small X-ray source	4 M€
Magnet materials research and development centre	1 M€
Increase annual operating budget	1 M€

Upgrade Dresden-site:

Extension of the laboratory space for additional user cells	8 M€
Upgrade of the capacitor bank generator for flat top pulsing	5 M€
Extension of the optical beam line to additional magnet cells	1 M€
Increase annual operating budget	1 M€

Upgrade Nijmegen-site:

40T local probe measuring station	25 M€
Upgrade cooling installation to 24hrs/day operation	5 M€
Increase annual operating budget	3 M€

5. e-infrastructure: what does the new RI require as far as e-infrastructure? How is it integrated with the existing EU e-infrastructure (e.g. Geant, grid, digital repositories).

-

6. Other expected socio-economic impacts: development of new technologies, effects on training, involvement of industries, local impact, other (one page, references).

High magnetic fields provide important characterisation possibilities in many areas of materials research. For the future, the association of high magnetic fields with other large instruments (neutrons, synchrotrons, free electron lasers) will further boost the research potential of all these facilities.
High magnetic field facilities are used as technological platform to characterise new materials for European or global projects, like the superconducting wires for ITER or NMR magnets. The construction of new magnets necessitates the research of industrial materials with low electrical resistivity and high mechanical resistance. Special technologies are developed by small and medium scale industries for the fabrication of new coils, with local impact.
Working in high magnetic fields, with its strong restrictions in space and time, is an excellent training ground for experimentalists.

7. Commitments / maturity: which States / Organizations have demonstrated interest / commitment in supporting and/or funding the proposal?

CNRS-France
Leibniz Gesellschaft-Germany
University of Nijmegen-the Netherlands

8. Costs for construction, operation and decommissioning, indications on project financing

(half page, with references/links). Give budget info in M€			
Total preparatory cost	Total construction cost	Operation cost /year	Decommissioning cost
(of which already spent or committed) 1 M€	(specify contributions committed or indicated by possible funders) 123 M€	(specify contributions by possible funders) + 8 M€	(possible funders) n.a.
9. Timetable for construction, operation and decommissioning (half page, with references/links)with duration and possible starting dates.			
Preparatory phase 2 years	Construction phase 5 years	Operation 15 years	Decommissioning n.a.
10. Reference: Person who has submitted the proposal, and will follow up in ESFRI			
Jean-Louis Tholence, director of LCMI, Grenoble jean-louis.tholence@grenoble.cnrs.fr			

1. Descriptive title, and information on the ESFRI delegation submitting the proposal (or one of the member of EIROForum)

European Carbon Dioxide Capture and StoragE Laboratory Infrastructure (ECCSEL)

2. Synthesis description of the new RI (or major upgrade) and S&T fields involved at Pan EU level in its use. Add links to relevant data/web pages (half page max)

The current ECCSEL proposal addresses the need for a powerful European research infrastructure within Carbon dioxide Capture and Storage (CCS). This requires major and strategic upgrading of existing CCS research infrastructures, development of new unique laboratories, as well as goal-oriented strengthening of networks between European CCS laboratories. Such a RI will enhance European competitiveness within CCS technologies, contribute to the defragmentation of work within this topic and improve security of supply for energy in Europe.
The following aspects are currently characterizing the CCS situation:
i) CO2-reduction is a European political priority
Europe has adopted aggressive targets for curbing carbon dioxide (carbon) emissions, the aspiration is 20% cut by 2020 and to push for 50% by 20501.
ii) States are making slow progress towards these targets, in part because cost-effective technological solutions for a) alternative energy supply and b) capturing and storing CO2 are developing slowly. This is in strong contrast to the ambition in the SET plan2
iii) There is an urgent need to develop more cost effective and inherently environmentally benign CCS technologies. At present the added cost of CCS applied to conventional fossil fuelled power plants is in the range of 45-60€/MWh3. This hampers the deployment of CCS and more efficient technologies are needed. CCS is a major tool in curbing emissions and may contribute by 20-30% of the needed emission cuts by 20504.

Current technologies (utilising chemical solvents and sorbents, membranes and power cycles deploying existing materials and components and present understanding of storage options and management) are thus sub-optimal. A new generation of research activities, encouraging some of Europe's best researchers to address these problems through in-depth/advanced quality research, requires a major upgrade of existing facilities (more advanced equipment and technologies) to bring about a critical mass of advanced and integrated facilities. An important location identified is the

Trondheim cluster where 650 researchers current work on greenhouse gas management technologies in two facilities previously recognized as European Research Infrastructures (ENGAS - for environmental gases management/replacement, and the Multiphase flow facilities). Trondheim researchers (from NTNU, the national technical university, and SINTEF, one of Europe's largest research institutes) work directly with all of the oil and gas companies involved in Europe's largest oil and gas fields (in the North Sea, and increasingly further North), and have been heavily engaged in several of the EU Framework Programme and national CO2 management projects undertaken to date (see Enclosure, Appendix 2) To address the current research challenges, a major upgrade of existing facilities in Europe are needed. The goal of this initiative brought forward by Norway is to start up a process where this may be achieved by a Pan-European team work. This initiative is focusing on the challenges to establish infrastructures for new materials and processes, new absorption processes, new combustion facilities, freeze-out labs and storage test labs.

This major and strategic upgrading of existing Carbon dioxide Capture and Storage (CCS) research infrastructures clearly needs a pan-European approach to optimally build further on existing critical mass and expertise. ECCSEL will therefore continue development of this initiative with European partners further detailing their contribution. In combination with infrastructure, network enhancements will facilitate an integrated programme of research with other leading European CCS-related laboratories. This will create the major next-generation infrastructure needed to tackle CCS, and to integrate research teams and laboratories in a more coherent approach / scale of effort to help bring about the rapid technological advances now required.

3. Science case: scientific area(s) and potential and/or explicit users, how the new RI will fit into the existing and future landscape of Research and of existing RI's, at EU and World level (one page max, links to relevant documents, references).

a) CCS combines three approaches to capture (pre and post combustion and O2/CO2 -oxyfuel- recycle combustion capture) and three approaches to storage(aquifers, depleted oil/gas fields, coal bed methane). Attempts to develop new and improved methods of achieving this have been pursued in national and EU programmes by specialist groups and facilities such as those in Stuttgart and DLR (strong in oxy-fuels, coal, hydrogen combustion), NTNU/SINTEF/TNO/TUD/IFP (Absorption for CO2 capture, utilising new materials and processes; pre-combustion), IFP/ELGI/TNO (CO2 storage monitoring and integrity) and other specialist labs involved in EU projects such as ENCAP, CASTOR, CACHET, DYNAMIS, COACH, DECARBit, CESAR and CAESAR.

Outside of Europe leading centres include University of Regina Canada (post-combustion), MIT (CCS processes and integration) and Stanford (GCEP programme) in USA, CO2CRC, Australia (storage and absorption, capture in general), AIESTE and RITE (new materials, membranes, sorbents) in Japan. b) Individually some of these groups are world leaders in specific fields, and in combinations for research have made substantial progress in developing advanced integrated solutions to specific CCS problems (e.g. CASTOR pilot plant for CO2 capture and SLEIPNER CO2 storage (through the SACS project)) c) The development of the next generation CCS lab (ECCSEL) and enhanced integration network for European research on CCS is intended to facilitate a comprehensive approach to CCS. Individual researchers and research teams will be able to work on the most promising routes. Further to optimize the science needed for more strategic research to underpin applied technological advances. In particular the upgrades facilities 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).

The results generated within this field will be of utmost importance in a global context to curb emissions. Globally we see the developing economies now ramping up energy use and some studies have shown that China is now the largest emitter of greenhouse gases5 in the world- taking over the leadership from the US. China alone developed 102GWe new capacity in 20066, 85% by coal- this is near equivalent to the generating capacity of France. CCS R&D and deployment strategies is thus very important on a global scale, it is a matter of developing new technologies in Europe, for Europe and from Europe for curbing global carbon emissions.

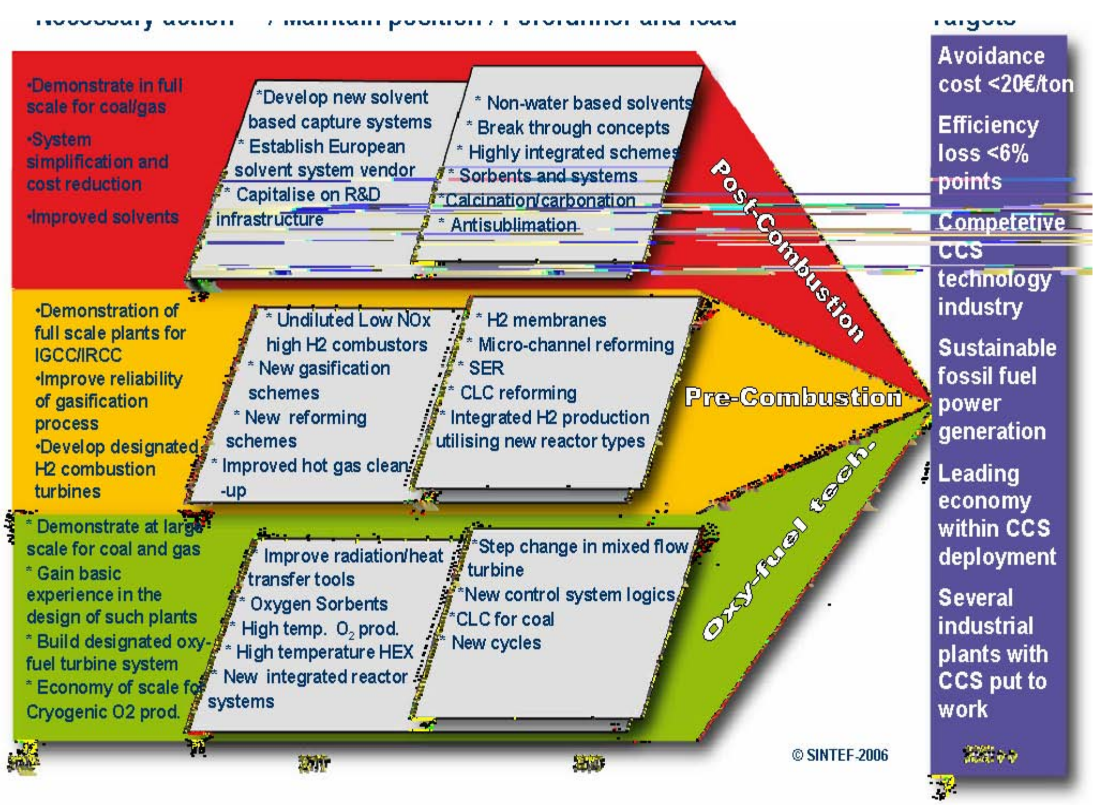
3. Science case: scientific area(s) and potential and/or explicit users, how the new RI will fit into

the existing and future landscape of Research and of existing RI's, at EU and World level (one page max, links to relevant documents, references).
a) CCS combines three approaches to capture (pre and post combustion and O2/CO2 -oxyfuel- recycle combustion capture) and three approaches to storage(aquifers, depleted oil/gas fields, coal bed methane). Attempts to develop new and improved methods of achieving this have been pursued in national and EU programmes by specialist groups and facilities such as those in Stuttgart and DLR (strong in oxy-fuels, coal, hydrogen combustion), NTNU/SINTEF/TNO/TUD/IFP (Absorption for CO_2 capture, utilising new materials and processes; pre-combustion), IFP/ELGI/TNO (CO_2 storage monitoring and integrity) and other specialist labs involved in EU projects such as ENCAP, CASTOR, CACHET, DYNAMIS, COACH, DECARBit, CESAR and CAESAR. Outside of Europe leading centres include University of Regina Canada (post-combustion), MIT (CCS processes and integration) and Stanford (GCEP programme) in USA, CO2CRC, Australia (storage and absorption, capture in general), AIESTE and RITE (new materials, membranes, sorbents) in Japan. b) Individually some of these groups are world leaders in specific fields, and in combinations for research have made substantial progress in developing advanced integrated solutions to specific CCS problems (e.g. CASTOR pilot plant for CO_2 capture and SLEIPNER CO_2 storage (through the SACS project)) c) The development of the next generation CCS lab (ECCSEL) and enhanced integration network for European research on CCS is intended to facilitate a comprehensive approach to CCS. Individual researchers and research teams will be able to work on the most promising routes. Further to optimize the science needed for more strategic research to underpin applied technological advances. In particular the upgrades facilities 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). The results generated within this field will be of utmost importance in a global context to curb emissions. Globally we see the developing economies now ramping up energy use and some studies have shown that China is now the largest emitter of greenhouse gases5 in the world- taking over the leadership from the US. China alone developed 102GW_e new capacity in 20066, 85% by coal- this is near equivalent to the generating capacity of France. CCS R&D and deployment strategies is thus very important on a global scale, it is a matter of developing new technologies in Europe, for Europe and from Europe for curbing global carbon emissions.
4. Technical case: summary of results (technical specifications) of conceptual and/or technical design studies (half page, list references/links).
The huge advantage that has come from cooperation through transnational and national programmes, has helped to clarify where the major challenges are and where the ECCSEL is needed to reduce the current deficits for the next generation research. A Gap analysis performed by the ZEP and IPCC is presented in the ENCLOSURE, APPENDIX 1. To handle the tough challenges facing us in bringing forward energy efficient and economic solutions, the following need for new infrastructures have been identified for the Trondheim hub of ECCSEL in the first phase • Absorption Laboratory • New Materials and Processes Laboratory • Combustion Laboratory • Storage Laboratory • Freeze-out Laboratory • Mongstad Research Laboratory **These labs are described in *Annex-1* and also include Pan-European partner labs as described in section 7. See also Letters of Intent (LoI's) in *Annex-2* and the ENCLOSURE Memo which discusses the European dimension of ECCSEL in more detail.** **The ECCSEL will be addressing the following span of test facility capabilities:**

CO_2 concentration : 3-15% by volume
Capture rates : 0,1 – 200 kg/hr of CO_2
Thermal capacity : 0,1 – 1000 kW (note MW's available for the industrial lab sites)
Impurities : 1-10000 ppm of various impurities (SO_2, H_2S, NO_x,…)
Pressure : 1-40 atm, from post-c conditions to high rated gas turbine cond.
Temperature : (-80)10- 1000 ^{0}C ((freeze out) to post-C and pre-C conditions)
Fuel feed/exhaust : coal and gas exhaust
Hydrogen feed : equivalent to up to 500kW H_2
Oxygen feed : as required
Storage capacity : from some kilos to megatonnes (lab to full scale operations)

See *Annex-1* for description of the specific laboratories.

The ECCSEL laboratories will contribute substantially to the realization of the tough targets brought forward in the Road Map for EU ZEP Technology Platform (see below).



5. e-infrastructure: what does the new RI require as far as e-infrastructure? How is it integrated with the existing EU e-infrastructure (e.g. Geant, grid, digital repositories).

The sites and governing body will be connected through a network utilising web-hotels and make use of internet facilities for net meetings, transfer of data and monitoring of experiments, setting up databases etc. A feature of the collaboration is that it will be built upon an infrastructure, comprising for instance of grid computing software, which can provide researchers with shared access to large data collections, advanced ICT tools for data analysis, large scale computing resources, and high performance visualisation, among other examples. The RI will encompass a type of virtual research environments (VRE), i.e. working together effectively through the use of information and communications technology. Within the community, researchers can collaborate, communicate, share

resources, access remote equipment or computers and produce results as effectively as if they, and the resources they require, were physically co-located.
A VRE will be able to cope with the cultural and methodological differences of different disciplines. It will enable effective team work that can be as open and participative, closed and private, formal or informal and structured or unstructured as required; it will change between these states dynamically, depending on the nature and the stage of the research. A separate homepage has been established for the ECCSEL proposal, see: www.eccsel.no

6. Other expected socio-economic impacts: development of new technologies, effects on training, involvement of industries, local impact, other (one page, references).

The ECCSEL RI will enable the European innovation cluster to effectively develop competence and to test at various maturity new technologies. The market prospect for CCS plants is estimated to be between 5000 and 7500 in total by year 2100. If Europe succeeds in capturing part of this market it will be of great benefit for the European society in terms of job creation and improved living conditions/security. CCS will enable coal to be used in a sustainable manner and thus improve security of supply for the Europeans and on a global scale. It is estimated that 100-200 researchers per year can make use of the RI's included in the ECCSEL which not would have been possible without such RI's. An overview of current R&DD efforts within CCS is given in ENCLOSURE APPENDIX 3. As seen from these diagrams, all routes for CCS is pursued by the industry and there are substantial interest to develop this within 2015-2020.

The proposed ECCSEL location hub in Trondheim is one where NTNU and SINTEF employ 650 researchers in the current ENGAS Research Infrastructure, and the research headquarters of the largest Norwegian oil and gas company (StatoilHydro), itself a large stakeholder in many large EU Integrated Project on CCS is located. NTNU and SINTEF currently **work with the following partners** on CCS research: ALSTOM, BGR, IFP, BRGM, DONG, ENItechnologie, GdF, GEUS, GVS, Imperial College, OGS, Doosan Babcock, TNO, E.ON, PPC, REPSOL, ROHÖEL, RWE, SIEMENS, StatoilHydro, Univ. of Stuttgart, Twente, Delft, Ulster, Paderborn, Sofia, Roma, ETH, TUM, Tsinghua, Vattenfall, Air Liquide, BOC, Chalmers, DLR, Linde, Lurgi, Air Products, Chevron, ConocoPhillips, CSIC, ENDESA, ECN, Fraunhofer, SHELL, Technip, BP, BGS, ECOFYS, Schlumberger, IEA-GHG, JRC, Progressive Energy, Societe General, SNSK, Harriot-Watt, IRIS, DNV, GFZP, PAS, TOTAL, Wintershall, KTH, PetroChina and TPRI.
NTNU has been heavily involved in European research training, with 14 EU-supported doctoral researcher training centres including the following:

- CombuSite - Combustion technology for a better environment
- Echochem - Eco-efficient design and control of environmentally-friendly reactors and processes
- MP Multiphase Flow
- SurFace - The Membrane Surface as a Catalyst/Barrier
- EcoEffDryers - New Eco-efficient drying technologies

NTNU and SINTEF are presently involved in CCS projects exceeding 125M€, and are leading CCS projects for the total budget of approximately 90M€.

NTNU-SINTEF was able to support Statoil and Kværner in the successful development of the CO_2 capture and injection system at the Sleipner field and for monitoring and assessing the suitability of the Utsira aquifer to store CO_2. The Sleipner project was the world's first commercial-scale off shore storage of CO_2 for mitigation of climate change. The CO_2 is injected into a large, deep saline reservoir, the Utsira formation, 800m below the bed of the North Sea (http://www.ieagreen.org.uk/sacshome.htm). The storage at Utsira has been subject to many R&D projects funded by the EU framework programmes for research and international collaboration (DoE). At **local level**, NTNU and SINTEF are actively engaged in the development of spin-out companies, with dedicated services providing advice and coaching for new entrepreneurs. The local research park has more than 100 spin out companies which are exploiting the science and technologies developed in either NTNU or SINTEF (or both).

7*. Commitments / maturity: which States and Organizations have demonstrated interest / commitment in supporting and/or funding the proposal?*

This proposal is for a major upgrade of existing facilities to enable a major advance in the scale of research to be implemented in a faster timescale than is currently possible - and to enable this to be done with the engagement and collaboration of a wider international research community. In the sense that this builds on existing facilities that have been developed for ad hoc (but highly significant and industrially influential) research projects with individual partners, and transnational collaborative projects with strong teams of researchers outside Norway, the facility and its development plans may be considered to be 'mature'.

Contributions linked to the Norwegian Roadmap NCCL: What is proposed here in terms of upgrades / new infrastructure is based on the following commitments:
Norway is promoting this proposal and supports this initiative. Within Norway there are several partners which operate research infrastructures that will contribute to the totality of ECCSEL that will become available through the ESFRI for collaborative research with other European researchers. These laboratories are linked by a Norwegian Roadmap NCCL. Examples of these facilities include:
SINTEF – large research institute- operating two principal labs- Heat and Power labs and the Chemistry and Materials labs proposing 6 new subordinate labs relevant for this proposal (absorption, separation, combustion, freeze-out, societal and storage labs)
NTNU- sharing above infrastructure with SINTEF, and also operate additional infrastructures under the EUFP6 ENGAS RI (Environmental Gas Management)
IFE- large energy research institute- labs for advanced CO_2 separation techniques to hydrogen, fluid mineral reactions, CO_2 corrosion testing and tracer monitoring technology
CMR- Christian Michelsen Research- fuel cell lab, visualization facility. measurement technology lab
UIB- University of Bergen – reservoir technology lab, geology analysis lab, geobio lab, seismic lab, computational science facility
IRIS and University of Stavanger- test lab for CO_2 absorbents
DNV- Det Norske Veritas- qualification/verification labs for CCS technologies, test lab for transport solutions- verification.
TCM-Test Center Mongstad (near Bergen)- European CO_2 test center - test center for new CCS Technologies operated by StatoilHydro, Shell, DONG, Vattenfall and the Norwegian Government (through Gassnova). We need this pilot plant scale-up to see “what does work”.
UNIS- The University Centre in Svalbard- researching storage possibilities at Spitsbergen- is conducting well drilling and geological investigations for a storage field lab in Longyearbyen.
StatoilHydro including R&D Centres - operate CCS facilities at Sleipner gas field and Snøhvit LNG plant CCS - storing 1.7 million tons of CO_2 annually- several R&D test facilities.
Aker Kværner labs, operated by Aker Kværner- facility at Kårstø for capturing CO_2 from a natural gas processing plant.
CO_2 Alliance, informal group of Norwegian R&D providers within the CO_2 topic, encompasses all mentioned R&D providers mentioned above.

The list of additions to the existing infrastructures which would represent a major upgrade of the facilities (absorption labs, CO2 storage labs, etc) are proposed following consultations with a) industrial companies involved in oil, gas and coal industries, b) international research partners with which NTNU / SINTEF currently work / exchange researchers / collaborate in research planning, and c) the national research council and relevant Ministries in Norway.

Contributions by Pan-European partners and their facilities:
International discussions with leading European laboratories have identified the need for a Pan-European network of research labs (focused, highly capable, and mature) to be partners with the upgraded ECCSEL facilities in the future development of advanced co-operative CCS research. These leading laboratories (current list - but not an exclusive list, nor one that would be fixed) include:

DLR Stuttgart – Institute of Combustion Technology – together with the ***University of Stuttgart*** (UStutt) Test facility and lab for high pressure combustion testing of hydrogen, oxy-fuel and other CCS fuel gases also test labs for coal research. Planning for a major upgrade of the labs for CCS purposes in order of several million Euros although not detailed here at this stage. LoI attached
Technical University of München (TuM)- Labs for exploring safety aspects of enriched H_2 combustion relevant for CCS plants. In particular planning for a facility upgrade of 1.5M€. LoI attached
ELGI- (Eotvos Lerand Geophysical Institute of Hungary) having at disposal and for future development passive/active seismic systems for CO_2 monitoring and storage integrity. Plans include infrastructure for 50 seismic stations to be deployed at a storage site for on-line monitoring- 1 M€, 5% per year operating cost. LoI attached
Eidgenossische Technische Hochschule Zürich (ETH)- New materials and processes labs- focusing adsorption processes for CO_2 and the requirement for high pressure/temperature resistant materials with high capacity. An investment exceeding 3M€ is foreseen. LoI attached
Polish Academy of Sciences- Institute of Chemical Engineering (PAS)- Adsorption lab and mineralization lab at hand, planning for a hybrid membrane adsorptive (PSA) system to study pre-combustion separation (around 250 m^3 (STP)/hr of syngas)and a packed absorption column for high pressure applications, cost estimate 1 M€, 10% operating cost per year. LoI attached.
University of Zagreb(RGN)- Planning a future laboratory system for studying the dynamics of CO_2 percolation through samples of cap rocks. New equipment and laboratory facilities are planned which can amount up to 1 M€ in investment. LoI attached.

Netherlands Organisation for Applied Scientific Research (TNO)
CCS is an important topic for TNO, the largest fully independent non-profit research organization in the Netherlands (4,500 employees). We cover the whole chain of CCS from generation up to storage. Our contribution to ECCSEL can be extended but is currently focussed on two main topics:

- Absorption labs: TNO is planning the extension of its absorption labs in cooperation with TU Delft. TNO works specifically towards improved and alternative solvent systems for CO_2 capture, membrane contactors that allow compact/effective mass transfer as well as process integration. Planned investments concern facilities for advanced screening of solvents, facilities for the generation of thermo-dynamical data required for scale-up and capture testing at site.

- Storage Labs: TNO is planning to develop state of the art lab facilities to investigate the effect of CO_2 under in situ conditions on the reservoir rock, the seal and the near well materials and equipment (cement, steel and technical (long term monitoring)equipment. This will be done by HP/HT reaction vessels in combination with full analytical facilities (e.g. CT scans, SEM, conductivity). Part of the equipment is already operational whereas other equipment needs to be upgraded or acquired.

LoI attached.

Technical University of Delft (TUD)- Labs for combustion technologies (post- and pre-combustion, oxyfuel, pilots), capture technologies (solvents development, conceptual design, scale up, optimization and development of (new) equipment, gas treatment), integrated processes, capture/storage research (mineralization), materials and corrosion research related to power generation.

Among others TUD is planning the extension of the high pressure absorption unit (e.g. two columns for continuous ab-/desorption), pressurized gasification unit, mini/micro-plant technology for systems analysis and adsorption and mineralization technology. LoI attached.

IFP - CCS is the first strategic priority for IFP (1,720 employees) the French R&D, training and information body which main mission is to develop the transport energies of the 21^{st} century. Our research activities cover the whole chain of CCS including capture, CO_2 conditioning and transportation, injection and storage. Our contribution to ECCSEL will include 4 main topics:

- Absorption pilot: this pilot will allow development of amines based process, test of equipment such as membrane contactors and new packings but also breakthrough process for CO2 capture such as the solvent demixing process studied by IFP at lab scale;

- Adsorption pilot: this pilot will allow test of sorbents studied by IFP at lab scale;

- Kinetics lab: this lab will be equipped for studying mainly the rate of CO_2 capture by chemical solvents.

- Storage lab: this lab will be equipped for injectivity evaluation, characterization of cap rock for leakage prevention, characterization and understanding of cement chemical degradation in contact with acid gases.

These sites constitute an informal network in Europe within CCS research due to close cooperation within FP5 and FP6/7, and will form an excellent basis for the further development of ECCSEL. Further support have been received from GEUS- The Geological Survey of Denmark and Greenland for the establishment of ECCSEL and to support this with designated lab facilities in due time. GEUS is a key R&D provider for geological storage of CO_2 and has/is co-ordinating many EU FP5 and FP6 research projects within this field (GESTCO, Geocapacity)

8. Costs for construction, operation and decommissioning, indications on project financing (half page, with references/links). Give budget info in M€

Total preparatory cost
(million €)
Total construction cost (million €) 81
Operational cost/year 6,3
(million €)
Decommissioning cost (million €)

All costs are in the Responsibility of site owners
NTNU-SINTEF Absorption labs*
NTNU-SINTEF New materials and processes lab*
NTNU-SINTEF Combustion lab*
NTNU-SINTEF Storage lab *
NTNU-SINTEF Freeze-out lab*
Mongstad Research Labs
TNO-TUD Absorption labs
TNO Storage
IFP absorption pilot, adsorption pilot and kinetics lab
IFP Storage

* Input to National infrastructure roadmap-Norway

Total construction cost	Operation cost /year	Total preparatory cost	Decommissioning cost
81 m€	6,3 m€		

9. Timetable for construction, operation and decommissioning (half page, with references/links) with duration and possible starting dates.

The timing for the development of ECCSEL is dependent upon the extent to which it is prioritised at European level. If ESFRI considers that the major upgrade proposed deserves inclusion in the ESFRI roadmap by 2008 it is expected that major partners will commit themselves to realise this significant European Research Infrastructure. The envisaged timetable would then be as follows:

	Start (year)	**Operation (target)**
NTNU-SINTEF Absorption labs*	2008	2010
NTNU-SINTEF New materials and processes lab*	2008	2010
NTNU-SINTEF Combustion lab*	2008	2010

NTNU-SINTEF Storage lab*	2008	2009
NTNU-SINTEF Freeze-out lab*	2009	2010
TNO-TUD Absorption labs	2009	2010
TNO Storage Labs	2009	2009
IFP pilots and labs	2009	2010
Other European labs	to be determined	to be determined
Mongstad Research Labs	to be determined	to be determined

Decommissioning cost and responsibility will be covered by the hosting lab party- this will be specified in separate agreements. Preparations for the ECCSEL can start immediately after a clarification of inclusion in the European Infrastructure Roadmap. It is foreseen to take approximately 6 months.

Preparatory phase	Construction phase	Operation	Decommissioning

10. Reference: Person who has submitted the proposal, and will follow up in ESFRI

Arne Bredesen (NTNU) and Nils Røkke (SINTEF) in collaboration with Sissel Hertzberg (NTNU) with the following Working Group members: Bjørg Andersen - IFE; Eli Aamot - StatoilHydro, Oscar Graff - AkerKværner, Stein B. Jensen – DnV, Geir A, Johansen – UiB and Hallvard Svendsen, NTNU. Close discussions with key personell at the supporting Pan-European entities.

Submitted by NTNU – The Norwegian University and Science and Technology (www.ntnu.no) and SINTEF (www.sintef.no), one of the largest research institutes in Europe. Both institutions are situated in Trondheim and are working closely with European R&D institutes and industry (oil and gas, power generators, vendors and engineering companies) to find new and better ways for capture and storage of CO_2 from fossil fuel energy conversion.

NTNU also host the Environmental Gas Management Research Infrastructure ENGAS RI, consisting of 14 unique laboratories, where people work to goal-oriented on environmental gas management from source to end-user (www.ntnu.no/engas).

All information about the ECCSEL initative, proposal, Letters of Intent, contacts and references may be found on the ECCSEL home page (www.eccsel.no).

[1] European Spring Council, March 2007- declaration

[2] SET-PLAN, communication from the commission to the council, the European parliament, the European economic and social committee and the committee of the regions – 22 November 2007

[3] IPCC Special Report, 2005 – Carbon Dioxide Capture and Storage- see www.ipcc.ch , ISBN 92-9169-119-4

[4] IEA 2006, Energy Technology Perspectives

[5] For instance press release from Netherlands Environmental Assessment Agency, 19 June 2007 www.mnp.nl/en/dossiers/Climatechange/moreinfo/Chinanowno1inCO2emissionsUSAinsecondposition.html

[6] The Wall Street Journal, 15-17 June 2007- page 20

1. Descriptive title, and information on the ESFRI delegation submitting the proposal (or one of the member of EIROForum)
EISCAT_3D: The next generation European Incoherent Scatter radar system Proposed by the Swedish delegation
2. Synthesis description of the new RI (or major upgrade) and S&T fields involved at Pan EU level in its use. Add links to relevant data/web pages (half page max)
The high latitude environment is of increasing importance, not only for purely scientific studies, but because of the direct effects on technological systems and climate which are principally mediated through interactions with solar produced particles and fields and whose effects are overwhelmingly concentrated in the polar and high latitude areas. These effects are of importance not only from a European dimension, but globally, since the European arctic and high arctic areas are the most accessible, and best supported by installed infrastructure and existing communities, of any place on the Earth from which the necessary observations and measurements can be made. Noting that the driving issues in ionospheric and related research fields continuously evolve, European scientists have outlined the required specifications of a new concept in incoherent scatter radars which can both replace the two existing, but now aging, European mainland systems operated by the EISCAT (European Incoherent SCATter) Scientific Association[1] ,www.eiscat.se and also substantially extend the systems' capabilities as required to address the scientific and service requirements of the next fifteen to twenty years and beyond. The facility will surpass all other such facilities in the World, both existing and under construction, and will provide European researchers with access to the World's most advanced and capable facility. The EISCAT_3D system is being designed (using funding under the EU 6th Framework program: EISCAT_3D European Next Generation Incoherent Scatter Radar, Design Study Implemented as a Specific Support Action, Contract #011920) as a major component of the Research Infrastructure of Northern Europe and it will provide European scientists, technologists, and service providers with access to facilities of the highest calibre to support research and observations in the high latitude ionosphere, neutral atmosphere, and the low-Earth orbit environment.
3. Science case: scientific area(s) and potential and/or explicit users, how the new RI will fit into the existing and future landscape of Research and of existing RI's, at EU and World level (one page max, links to relevant documents, references).
The EISCAT Association provides state-of-the-art radar facilities which allow studies of various processes taking place in Earth's atmosphere. These studies have the capacity to make crucial impacts on some of the major scientific questions of the next 30 years. Understanding the formation and evolution of our own, and other, solar systems and quantifying several terms in the Drake equation to compute the probability of civilizations on Earth-like exoplanets. The Earth's atmosphere, if properly characterised, can be used as a "scintillator" for the detection of particles from our solar system and beyond (e.g. micrometeorites, dust, and cosmic rays), the tracks of which can be recorded in three dimensions using the radars. The radars can also be used to study aspects of the Earth that are essential for future searches for, and investigations of, Earth-like extrasolar planets. Auroral Kilometric Radiation (AKR) is of a process which we know exists on Earth but about which we do not have an adequate understanding: AKR could tell us about the magnetic field of an extra-solar planet which is almost certainly an essential pre-requisite for life. In addition, laboratory studies indicate that energetic particle precipitation reaching stratospheric ice crystals is an efficient method for generating amino acids and so may be part of the origin of life. These science questions mean that the radars are vital facilities for forward-looking science and are of great value to various other agencies as they can make vital contributions to future technologies. The

[1] The EISCAT Scientific Association is an international organisation currently supported by, Finland (SA), Germany (DFG), Norway (NFR), Sweden (VR), and the United Kingdom (STFC) within Europe, as well as Japan (NIPR and STEL, Nagoya), and China (CRIRP), see www.eiscat.se

radars have already shown unique abilities to monitor high altitude climate change and space debris, the latter representing an ever-increasing problem that has huge implications for the safety of both humans and equipment in space.

Understanding of the Earth's environment as part of the linked Sun-Earth system is essential and it is important to exploit existing advantages to provide effective and continuous monitoring of the critical interaction regions. Incoherent scatter radar is the most effective, ground-based technique for studying and monitoring the upper atmosphere and ionosphere.

The EISCAT_3D system will provide extensive and unique observational data directly relevant to such programs allowing both qualitative monitoring of high altitude changes and efforts to understand the energy budget and dissipation of solar wind energy in the circumpolar regions and its effects on the geospace environment of Mankind. Such efforts will not only be extremely valuable in their own right but will also provide crucial contextual data which will be invaluable to the Integrated Arctic Earth Observing System (IAEOS), another major RI proposed for the current ESFRI roadmap revision.

Besides supporting data consumers for service driven applications (such as Space Weather effect forecasting), the new facility will support studies of ion outflow to the magnetosphere, auroral acceleration, small scale plasma physics, induced changes in the ionosphere, magnetic reconnection, sub-storms, ionosphere-neutral atmosphere coupling, mesospheric Physics, and solar wind acceleration.

The radar system also occupies a unique position on the edge of the polar vortex and offers the opportunity to study the dynamics and chemistry of the various atmospheric layers and the coupling between them. These studies are particularly important in view of long-term change induced by anthropogenic greenhouse gases and century-scale solar change.

It has become increasingly clear that the processes which mediate even the largest scale effects are predominantly controlled by very the physics of small scale rapid interactions and this has led to a renewed interest in auroral electrodynamics and plasma physics.

While this section concentrates on the longer–term goals to place the present studies, and those that will continue in the immediate future, into context, in pursuing the 30-year goals stressed in this approach, many of the current ionosphere-thermosphere, auroral and solar wind-magnetosphere-ionosphere coupling studies will be an integral and important part, both because of the science that they will produce and because of the techniques that they will drive.

4. Technical case: summary of results (technical specifications) of conceptual and/or technical design studies (half page, list references/links).

The EISCAT Scientific Association, in co-operation with the University of Tromsø, Luleå University of Technology, and the Rutherford Appleton Laboratory, started a four-year design exercise, supported by European Union funding under the Sixth Framework initiative, which builds on its past successes and aims to maintain its world leadership role in this field.

It requires the development of new radar and signal processing technology, together with crucial developments in polarisation control, built-in interferometric capabilities, the provision of remote receiving installations with electronic beam forming, signal processing, and automated data analysis.

The EISCAT_3D facility is a flexible, expandable group of active and passive phased-array radar elements consisting of at least one active radar illuminator, operating at around 230-240 MHz, coupled with at least four major passive receive arrays separated from the illuminator by horizontal distances of the order of a few 100 km. The scientific and technical capability of the system can be expanded dramatically if some, or all, of the passive arrays are replaced by active systems and the design, based on assembling large numbers of essentially identical individual antenna and transmit/receive units, lends itself readily to such extensions as well as providing many effective opportunities for phased construction. The present plan is detailed in the formal project mid-term report[2], and in many intermediate reports and documents at the same site. Various distributions of the active and passive elements can be accommodated, but initial surveys of the sites indicated in the accompanying map[3]

[2] https://e7.eiscat.se/groups/EISCAT_3D_info/2nd_Activity_Report_EISCAT_3D.pdf

demonstrate that suitable locations are available in Northern Europe.

The new facility will greatly extend the range of available data, dramatically improving its temporal and spatial resolution as well as the geographic, altitude, and temporal extent. The design goals mandate improvements in the achievable temporal and spatial resolution (both parallel and perpendicular to the radar line-of-sight) by about an order of magnitude, to extend the unambiguous instantaneous measurement of full-vector ionospheric drift velocities from a single point to cover the entire altitude range along multiple, simultaneous, spaced radar beams and to increase the operational time by a factor of at least four (from 12 to 50%), and possibly to full-time.

5. e-infrastructure: what does the new RI require as far as e-infrastructure? How is it integrated with the existing EU e-infrastructure (e.g. Geant, grid, digital repositories).

The design study also includes components to design communication, data distribution, and data archiving systems which leverage the available skills and existing network and Grid structures within the Community. These developments will allow European scientists and other users to access data from the new systems irrespective of their location within the community.

A crucial feature of the radar arrays involves making the sampled signals at each array element available throughout the entire array both in real time and for at least 24 hours after the observations have been taken, which allows post-observation generation of radar beams which are both appropriate to specific investigations and can be modified to suit the features of the actually observed instantaneous radar targets. This goal places extreme demands on both data distribution across the arrays and data storage and will both exploit and extend European expertise in ultra-high bandwidth data distribution amongst large numbers of simultaneous data providers and consumers.

After routine data processing, the facility will provide high-quality ionospheric and atmospheric parameters on an essentially continuous basis for both academic researchers and practical consumers as well as providing near-instantaneous response capabilities for scientists and users who need data to study unusual and unpredicted disturbances and phenomena in the high-latitude ionosphere and atmosphere.

While users will sometimes visit the facility to obtain maximum access and response from the system, it will be possible for the radar to be operated entirely remotely and access to both the control and monitoring systems and the raw and processed data streams will be provided through secure network connections.

6. Other expected socio-economic impacts: development of new technologies, effects on training, involvement of industries, local impact, other (one page, references).

The European arctic and high-arctic regions are amongst the most heavily populated and travelled such regions in the World with many important towns and industries as well as substantial tourist-related activities. The area remains important in military terms, even after the obvious ending of the cold war, has important implications with regard to Norwegian control of the sea areas around Svalbard and to current and future national territorial claims involving the sub-ice arctic seafloor, and is becoming of increasing significance as oil and gas exploration and extraction moves poleward through the Barents Sea.

The reliability and accuracy of navigational and positioning systems in this area is therefore of exceptional importance. Unfortunately, signals broadcast from satellites such as those of the American GPS, Russian GLONASS, and, in due course, European Galileo navigation systems are affected by the Earths ionosphere as they travel between the orbiting satellites and receivers on the ground, in planes, and on ships. Over much of the globe, these effects are very small and of little practical significance. However, near the equator, and especially at high latitudes in the auroral zones and in the polar cap, the effects can become dramatic leading to positioning errors of the order of 100m and, in extreme cases, to complete loss of ‘lock’ on the satellite signals. In the high European region, these effects are caused both by large-scale circulating currents and plasma flows and by variations in the ionospheric density, temperatures, and height distribution caused by interactions between the solar wind (a highly variable supersonic flow of magnetised material ejected from the solar surface which fills all near-Earth space and constantly interacts with and effects the terrestrial environment) and the Earth’s magnetic field.

Both as a result of the unusually long history of human activity in the European arctic, compared with other high latitude areas elsewhere in the World in both the northern and southern hemispheres, and the seminal early work of such pioneers as Birkeland, Størmer, Alfven, Harang, and others, the

European high latitude regions are exceptionally well equipped with observational facilities which can routinely monitor and categorise the overlying ionosphere to a degree impossible anywhere else on the planet.

With some further developments in infrastructure, to support real-time assimilation of the rich observational data available, data processing and modelling, to support now-casting of the four-dimensional ionospheric plasma environment, and on-demand product distribution (typically ionospheric parameters along ray paths between arbitrary specified points), the European high-latitude region can provide tailored corrections to secure and improve the quality, accuracy, and reliability of all systems in use throughout the region which depend on trans-ionospheric propagation of radio signals.

The construction and development of the EISCAT-3D system will also provide important drivers in European radar, signal processing, high-bandwidth local data distribution, and wide-area raw and processed data distribution, as well as in the development of remote operation, monitoring, and fault control systems. As in the case of the existing EISCAT facilities (www.eiscat.se), these activities provide a rich environment for advanced teaching and training in both the technological fields required and the expected scientific fields.

The present EISCAT facilities support the European ionospheric research communities in Germany, the United Kingdom, Sweden, and Finland, as well as those in Norway, France, and an increasing number of other European, and related, countries (whose scientists are currently supported under a European Union 6th Framework TransNational Access award) including Belgium, Poland, and Bulgaria. In the future, enhanced network remote access and control will allow the EISCAT-3D system to support even larger pan-European communities of scientists, technologists, and data consumers.

7. Commitments / maturity: which States / Organizations have demonstrated interest / commitment in supporting and/or funding the proposal?

The present European members of the EISCAT Scientific Association (Sweden, Finland, Germany, the United Kingdom, and Norway) have all recently expressed their enthusiasm for the EISCAT_3D goals and plans. The independent mid-term review of the EISCAT_3D design study conducted by the European Union project officers strongly endorsed the development of the project and led to EU encouragement of this effort to introduce the EISCAT_3D radar system as a major European Research Infrastructure into the current round of revisions of the ESFRI roadmap for such major, pan-European facilities.

8. Costs for construction, operation and decommissioning, indications on project financing (half page, with references/links). Give budget info in M€

The design study (4M€) supported by the EISCAT Scientific Association and its partners (Lulea Technical University, University of Tromsø and the Rutherford Appleton Laboratory, UK) with matching funding provided under the EU 6th Framework program. Approximately 2-4M€ required for further preparatory work to bring the design blueprint to the point where construction contracts can be placed.

Best current estimate of construction costs, based on work completed at the half-way point of the design study is 60M€ for one active site supported by four additional, passive receiver systems, raising to 250M€ if all sites are constructed as active elements and if the three inner elements include the full number of elements currently estimated to provide the functionality required to address the science issues effectively.

Operating costs for these unique facilities are difficult to estimate accurately at this time but, based on current experience with the existing EISCAT radars, could amount to 4-10M€ per year. The operations budget depends heavily on the total annual runtime adopted and the number of active elements constructed. Finally, if the budget should include provision for a program of further development and upgrades than a component based on the total construction cost would need to be added.

Decommissioning costs will depend on the final construction techniques adopted. Estimate at 10-15% of construction cost.

Total preparatory cost	Total construction cost	Operation cost /year	Decommissioning cost
6M€	60-250M€	4-10M€	10-15% of construction cost.

9. Timetable for construction, operation and decommissioning (half page, with references/links)with duration and possible starting dates.

The EISCAT_3D design project is scheduled to be completed in the summer of 2009. Early contacts with potential system component fabricators could commence up to one year before the completion of the design phase but the main effort cannot be undertaken until the full design has been completed.

The EISCAT_3D radar system is heavily modular and lends itself to phased construction, both on the large scale, where the multiple radar sites can be constructed either sequentially or in parallel, and on a smaller scale where individual sites are built up of very large numbers of identical elements clustered into larger and larger sub-systems until the full system driven by the scientific requirements has been constructed. This feature of the design allows great flexibility in the implementation of the construction phase; the system will provide unique monitoring capabilities from a relatively early point in the construction though the more difficult scientific goals so far identified can only be addressed with completion of the full system. Likewise, further refinements in the scientific requirements which may evolve either in parallel with the development of the infrastructure, or, more likely, from the exploitation of the unique capabilities of the system, can be addressed through subsequent upgrades of the system either by enlarging the individual elements using essentially similar components or by upgrading the capabilities and performance of the elements during routine development and maintenance.

All dates are estimates only pending further refinement as the design project nears completion.

Preparatory phase	Construction phase	Operation	Decommissioning
2009-2011 (18 months)	2011-2013 (3 years)	2013-2043 (>30 years)	2044

10. Reference: Person who has submitted the proposal, and will follow up in ESFRI

Lars Börjesson and Mats Johnsson, Swedish delegation

5.4.2 Emerging energy proposals

1. Descriptive title, and information on the ESFRI delegation submitting the proposal (or one of the member of EIROForum)
MYRRHA, **M**ultipurpose h**Y**brid **R**esearch **R**eactor for **H**igh-tech **A**pplications (http://www.sckcen.be/myrrha) submitted by the Belgian delegation in ESFRI

2. Synthesis description of the new RI (or major upgrade) and S&T fields involved at Pan EU level in its use. Add links to relevant data/web pages (half page max)

ESFRI in its report of 2006, concerning research infrastructures for fission, says: "*Regardless of future trends, existing installations based on fission, will continue to be operated and test facilities are needed to develop aspects such as reliability of construction materials, and the management of radioactive waste and stocks of spent fuel in a safe and environmentally sound manner.*

The FP5 FEUNMARR thematic network (2002) stated in its conclusions concerning Accelerator Driven Systems (ADS): "*The coupling of an accelerator and a low power fast reactor will address key issues,…The power has to be carefully fixed to minimise the cost and to be relevant as a nuclear facility*".

In this context, SCK•CEN is offering to host MYRRHA/XT-ADS the European fast spectrum experimental facility able to demonstrate efficient transmutation and associated technology through a system working in subcritical mode (ADS) and/or critical mode.

The European Commission in its vision report on "The Sustainable Nuclear Energy Technology Platform" (EUR 22842, 2007) that was endorsed by a large number of stakeholders, clearly indicates the need for "*a fast spectrum experimental system to support the development and demonstration of a fast spectrum technology alternative to sodium*"

Therefore, the fast spectrum facility MYRRHA is proposed to be based on lead-alloy technology and to embark for its construction at the horizon of 2012 with the following objectives:

- To demonstrate Accelerator Driven System technology in the frame of the research on transmutation of High Level Waste (HLW);
- To be operated as a flexible fast spectrum irradiation facility for testing material and innovative fuel for ADS and GEN IV systems and fusion reactors;
- To contribute to the demonstration of GEN IV Lead Fast Reactor (LFR) technology without jeopardizing the two above objectives;
- To perform fundamental and applied research making use of fraction of the proton beam available within the facility.

The MYRRHA project was already identified as an "emerging proposal" in the ESFRI 2006 Roadmap. Its strategic value for Europe is to further develop nuclear fission energy in order to contribute to the security of energy supply and to the transition to a low-carbon energy mix to mitigate the climate change, by alleviating the burden due to radioactive waste and spent fuel for the future generations.

3. Science case: scientific area(s) and potential and/or explicit users, how the new RI will fit into the existing and future landscape of Research and of existing RI's, at EU and World level (one page max, links to relevant documents, references).

The fast spectrum facility MYRRHA, which SCK•CEN is offering to host at its site, will be organised as an open users' facility in a European and international context. This leads to a formation of an owner consortium group that develops and later on operates the facility whereas the operational costs are covered by a sort of subsidy contributed by the owner consortium group members of the countries they represent and by an open-users programme based on a selection to be made among collaborating research groups by a technical advisory committee.

Since the MYRRHA facility is proposed to operate as a subcrtitical (ADS) and as critical system, the following user communities can be clearly identified:

- The Accelerator Driven System (and Partitioning and Transmutation) community
- The nuclear fuel community and material fission and fusion community
- The Lead Fast Reactor technology community
- The nuclear physics community

Transmutation of high level long lived waste (minor actinides) can be completed in an efficient way in fast neutron spectrum facilities. Both critical reactors and sub-critical Accelerator Driven Systems (ADS) are potential candidates as dedicated transmutation systems. However, in order to maintain a sufficient safety level, critical reactors cannot be loaded with large fraction of MA due to unfavourable reactivity coefficients and the small delayed neutron fraction. An ADS operates in a flexible and safe manner even with a core load containing a high amount of MA leading to a high transmutation rate. Thus the sub-criticality is not a virtue but a necessity for efficient and economical burning of the MA. **MYRRHA is the first large facility in the world allowing the demonstration of the ADS concept that would be triggering a large programme of research in the field of Partitioning and Transmutation.**

Due to its characteristics; the fast neutron spectrum and high flux levels (up to 3 10^{15} n/cm².s), MYRRHA 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. Flexibility and representativeness in irradiation conditions and operation modes and availability of large irradiation volumes are key elements for these user communities. MYRRHA is designed from the very beginning to respond to these conditions. Therefore, the MYRRHA facility offers unique conditions to respond to the needs expressed by the nuclear fuel community and material fission and fusion community in the framework for the development of GEN IV systems (Sodium Fast Reactor, Gas Fast Reactor, Lead Fast Reactor) and ITER and DEMO facilities. As Phenix reactor in France will be closing in 2009, **MYRRHA will be the only fast spectrum irradiation facility in the EU**.

Due to the higher flux levels that can be generated in thermal flux traps in MYRRHA and its operational flexibility, another attractive aspect of MYRRHA is the capability to produce specific medical radioisotopes contributing as such to the research field of curative medical radioisotope.

After the demonstration of the ADS technology demonstration and the demonstration of efficient transmutation in ADS, the accelerator can be decoupled from the reactor system and the reactor can be run in a critical mode. As a critical lead-alloy based reactor, the MYRRHA facility can significantly contribute to the demonstration of the Lead Fast Reactor technology. In this sense, MYRRHA can also partly or fully respond to the need for a 50-100 MWth European Technology Pilot Plant (ETPP) identified in the roadmap for LFR development and taken up in the draft document for the Strategic Research Agenda of the Sustainable Nuclear Energy Technology Platform.

Research and experimental reactors in Europe were for the majority built in the years 1960's. SCK•CEN, by proposing to host **MYRRHA as a fast spectrum irradiation facility at Mol (BE)**, besides the JHR thermal spectrum research reactor whose construction started in March 2007 in Cadarache (FR) and the PALLAS project, proposed at Petten (NL) to replace the HFR for radioisotopes production, **will be contributing to** the establishment of **the European Research Area of Experimental Reactors (ERAER)**. This will put Europe in a leading position in the field of the development of sustainable nuclear fission systems for the welfare and wellbeing of its population as proposed in the Strategic Research Agenda (SRA) of SNE-TP.

4. Technical case: summary of results (technical specifications) of conceptual and/or technical design studies (half page, list references/links).

Since 2005 and the start of the FP6 EUROTRANS integrated project of the European Commission, MYRRHA is serving as basis of the small-scale, short-term eXperimental facility demonstrating the technical feasibility of Transmutation in an Accelerator Driven System (XT-ADS) machine. The main parameters and characteristics of the MYRRHA facility are summarized hereunder:

- The accelerator of MYRRHA is based on LINAC technology in order to be fully demonstrative for the industrial scale ADS and to be responding to the very demanding conditions in terms of beam reliability (less than 5 beam trips per year that can be relaxed to 5 beam trips per MYRRHA cycle of 3 months).

- The windowless spallation target concept of MYRRHA has progressed in terms of design and demonstration on the basis of an important international experimental programme complemented by an international Computational Fluid Dynamics (CFD) effort for the free surface treatment. The evidence of the feasibility of the proposed design is no longer questioned with respect to its fundamental aspects but still remains in terms of its fine tuning and advanced design that will be addressed in the coming 3 years.
- The core maximum sub-criticality level of k_{eff} ~ 0.950 (k_s ~ 0.96) assures a comfortable margin for safe operation. The total power ranges between 50 to 80 MWth (depending on the core loading and the experimental rigs inserted). The total neutron flux levels (1.0 10^{15} to 5.0 10^{15} n/cm².s) achieved within the facility in large irradiation volumes in the core (about 20.000 cm³ in total), allow very high performance testing conditions.
- The MYRRHA fuel design is based on Fast Reactor (FR) MOX fuel technology (30% Pu contents) with ferritic-martensitic steel T91 for the cladding and for the fuel assembly wrapper. The inlet temperature is 300°C and the outlet temperature is 380°C. The targeted fuel residence time is 3 years. Nevertheless, the MYRRHA core is designed to accept MA based fuel assemblies whenever these will be available.
- The primary system of the MYRRHA is made of a pool design cooled with Pb-Bi for the primary coolant and boiling water as a secondary fluid. The heat exchangers and primary pumps are immerged in the reactor vessel in dedicated casings. Interim fuel storage inside the primary vessel can host the used fuel for decay heat before transfer out of the vessel.
- The MYRRHA building has been conceived from the very beginning taking into account remote handling (RH) and robotics based operation and maintenance within a controlled atmosphere limiting the LBE contamination by O_2 trapping. The remote handling for both out-of-vessel and in-vessel operation and maintenance has been developed on the basis of existing and demonstrated technology in the Joint European Torus (JET) fusion facility.

More details can be found in the attached documents listed hereunder and further on in the list of publications given in Annex 1:

MYRRHA Project – Business Plan 2007, SCK•CEN Report reference ANS/HAA/DDB/3900. B043000/85/07-17, April 2007, 52 p.

MYRRHA Project – Technical description, SCK•CEN Report reference ANS/HAA/DDB/3900. B043000/85/07-17bis, April 2007, 57 p.

In April 2008, SCK•CEN together with its European partners answered to a FP7 call for establishing a Centralised Design Team for a Fast Spectrum Transmutation Experimental Facility to be able to work in subcritical and/or critical mode. In this framework starting in 2009, the MYRRHA design will be updated to allow for critical mode operation.

5. e-infrastructure: what does the new RI require as far as e-infrastructure? How is it integrated with the existing EU e-infrastructure (e.g. Geant, grid, digital repositories).

Up to now, the MYRRHA Project has developed its own centralised document management system and as part of the FP6 IP EUROTRANS project all documents produced are centralised at the FZK (D) EUROTRANS Documentation centre. These documents are retrievable by the members of the consortium via web-application.

Concerning the design work a Remote Handling Design handbook has been developed in the frame of this project including a design tools data base and these have been made available to all design teams (SCK•CEN, Tractebel Engineering, OTL, AREVA, Ansaldo Nucleare and Empresarios Agrupados) involved in the development of the project. These design tools are made compatible to various CAD systems such as Pro-E, CATIA or AUTOCAD.

6. Other expected socio-economic impacts: development of new technologies, effects on training, involvement of industries, local impact, other (one page, references).

MYRRHA, as a large Research Infrastructure to be developed at Mol aims to mobilise the European scientific and industrial expertise in nuclear fuel reprocessing, nuclear fuel development, nuclear reactor research and engineering design, and high power proton accelerator research to provide advanced options for high level waste management leading to the relaxation of the conditions of the waste geological disposal.

The high level waste management is clearly identified in the EURATOM Sixth Framework programme (FP6) as a society problem to be solved. In particular, research is needed to explore the technical and economical potential of concepts for nuclear energy generation systems able to make a better use of fissile material and generate less waste and of partitioning and transmutation (P&T) to reduce the hazard of the nuclear waste. The same is true for FP7. In the second call of FP7, the EC asks for the establishment of a central design team (CDT) for a Fast-Spectrum Transmutation Experimental Facility where SCK•CEN with its European partners responded to in April 2008.

Concentrating the effort of this research community towards the construction of such an innovative RI will allow the structuring and the integration of the European activities related to advanced fuel cycle and innovative fast spectrum irradiation facility for the development of GEN.IV systems as it will :

a) avoid the fragmentation of the present advanced fuel cycle and innovative systems community by focusing the objectives towards a mid-term objective of realizing a fast spectrum experimental facility based on heavy liquid metal technology and ADS concept and testing at large scale the economical feasibility of the transmutation of MA in a dedicated core within this test facility;

b) serve as a trigger for maintaining the national funding in this field at a reasonable level;

c) encourage the realization of the objective of solving the society problems of waste management;

d) develop and demonstrate one of the GEN IV concepts and contribute to the development of other GEN IV concepts;

e) attract young researchers in the domain of advanced reactor technology;

f) give a major boost to national and international industry.

Like any large research infrastructure, the MYRRHA construction will generate hundreds of jobs for the management of the project, for the support R&D programme, licensing, detailed engineering design for the period 2009-2013 and will be culminating in a few thousands jobs during the construction and assembling periods during 4 years (that is foreseen between 2013 and 2017). A more detailed evaluation is in preparation during the reviewing of the business plan of the project.

When put in operation, MYRRHA will generates direct jobs at the facility site (operation team ~100 persons, support services 100 jobs), and a scientific user community locally or at their labs of around 1000 scientists on annual basis. Every direct job will be creating about three indirect jobs in the implantation region in terms of services, maintenance and support. The indirect jobs projection is based on present day situation of large facilities present at the Mol site of SCK•CEN. A detailed analysis can be found in the attached business plan.

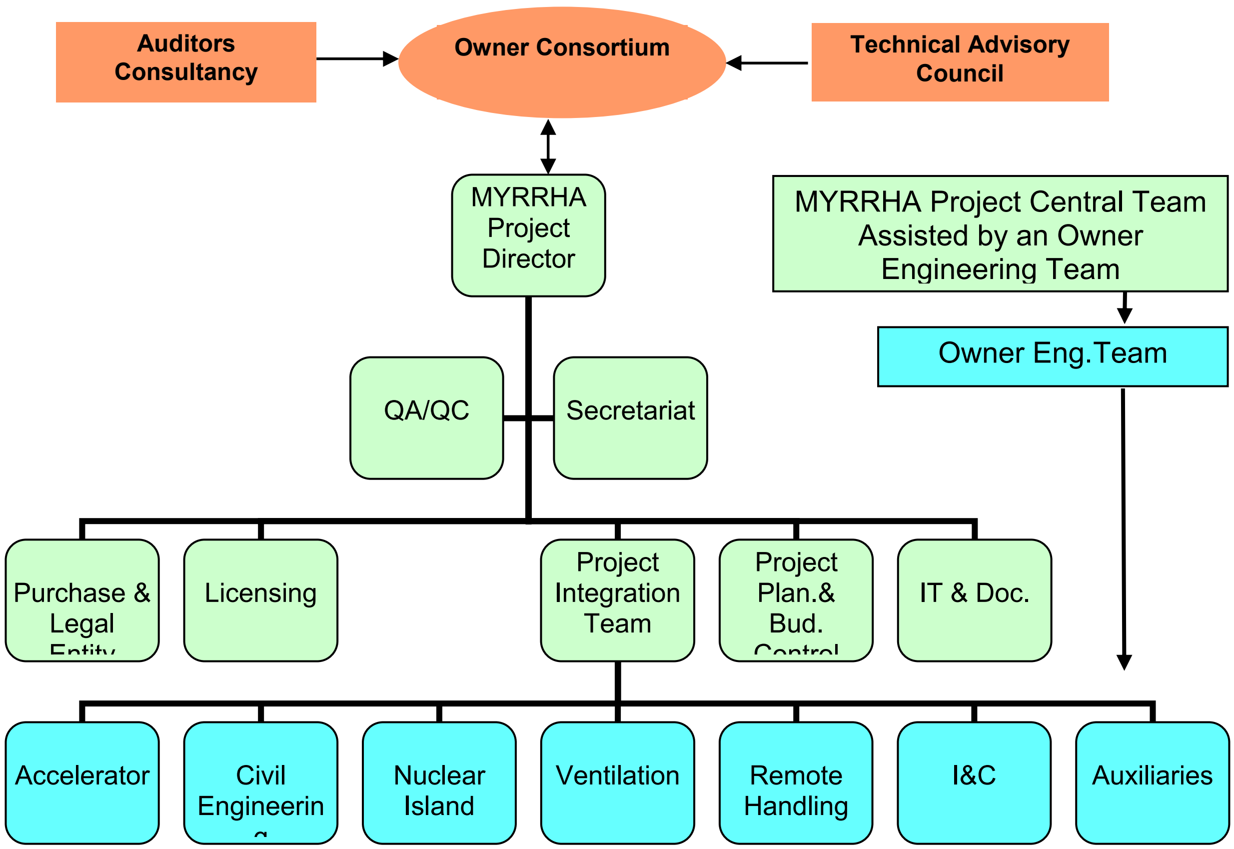
7*. Commitments / maturity: which States / Organizations have demonstrated interest / commitment in supporting and/or funding the proposal?*

Either through bilateral collaboration or contractual servicing to the MYRRHA project or through the FP6 EUROTRANS Integrated Project more then 50 institutions from research centres, industries and universities are contributing to the progress of the MYRRHA/XT-ADS RI. Among those partners we can mention from the research institutions CEA (FR), CNRS (FR), FZK (DE), CIEMAT (ES), ENEA (IT), INFN (IT), KTH (SE), NRG (NL) and ITN (PT) and nuclear industry such as Suez-Tractebel (BE), IBA (BE), Ansaldo Nucleare (IT), AREVA (FR), Empresarios Agrupados (ES) and OTL (UK) and universities UCL (BE), UPM (ES) and UFrankfurt-IAP (DE). Outside Europe contacts are established with the following institutions for possible contributions: DoE (USA), JAEA (Japan), CIAE (China) and KAERI (Korea).

For the submission of the FP7 proposal for the "The establishment of a Centralised Design Team for a Fast spectrum transmutation experimental facility", a European partnership was established with research organisations, CEA (FR), CNRS (FR), FZK (DE), FZD (DE), CIEMAT (ES), ENEA (IT), NRG (NL) and ITN (PT), nuclear industry, Ansaldo Nucleare (IT), Del Fungo di Giera Energia S.p.A. (IT), AREVA NP S.A.S (FR), AREVA NP GmbH (DE), Empresarios Agrupados (ES), SENER (ES), ADEX (ES), OTL (UK) and CRS4 (IT), and universities UPM (ES) and UPV (ES). Since the MYRRHA project is moving to an industrialisation phase, the partners leading the major work-packages are coming from industry: Ansaldo Nucleare (IT), AREVA NP GmbH (DE) and Empresarios Agrupados (ES).

The MYRRHA project (technical description and business plan) has been submitted to the competent Belgian minister with a request for financial intervention for an important part of the cost of the engineering phase of MYRRHA in a first stage and for its realisation in a later stage. As a result, in the governmental agreement of the new Belgian federal government "Leterme I", installed in March 2008, supports the MYRRHA project as an international research infrastructure serving the research programmes for the reduction of long lived waste and the production of radio-isotopes for medical applications. Currently, the SCK•CEN is in discussion with the Belgian government to set the specific conditions of this support.

The proposed organisation of the project from 2009 on is summarized in the figure below:



MYRRHA is proposed as an open user facility for the international research community in the fields of physical science and engineering as well as for material and nuclear fuel science.

SCK•CEN is establishing an International Advisory Council to guide:

- The further development of the facility
- The establishment of a Centralised Design Team
- The creation of the Owner Consortium Group
- The establishment of a Users/Customers Group of the facility

The work of the International Advisory Council (IAC) would be to guide the further development of the facility, the settlement of the Owner Consortium Group (OE) and the establishment of a Users/Customers Group of the facility.

The Owners Consortium **(OC)** will consist of partners that are interested in the realisation and later on in the operation of MYRRHA. These partners are acting in their name or as representative of their countries. Both possibilities are considered presently but will be fixed in the coming two years after negotiation with the representatives of the Belgian government and some European research institutions interested in the MYRRHA project.

The OC will be taking the overall responsibility of the project and will be led by SCK•CEN as it is the hosting organisation of the facility on its site. The OC will establish a MYRRHA Central Project Management Team (CPMT) based at Mol and responsible for the daily project management, control and follow-up of the project. The CPMT is composed of a Project management team (PMT) and an Owner Engineering team (OET) as indicated above. The PMT will be a team of 25 to 30 persons, whereas the OET will consist of 30-35 persons.

Also, a Users/Customers group will be set up to define the future needs for the installation and to survey its possible realisation in the facility.

At present time, the organisation (and the contacts at high level) at Belgian level is under way.

8. Costs for construction, operation and decommissioning, indications on project financing (half page, with references/links). Give budget info in M€

A detailed business plan of MYRRHA exists (see attached document) from where we extract the global numbers given hereafter: the total investment costs expressed in current value (2007), spread over 12 years, amounts to: ~700 M€ including contingencies. This amount includes the total investment, the project management costs and the Licensing costs. The operational costs are estimated to 38 M€ per year.

Total preparatory cost 40 M€	Total construction cost 700 M€ (design, licensing and project management 130 M€ are excluded)	Operation cost /year 38 M€ / year	Decommissioning cost 150 M€
(of which already spent or committed) 100%	under discussion with European research institutes, international industrial partners and government institutions	under discussion	under discussion

9. Timetable for construction, operation and decommissioning (half page, with references/links)with duration and possible starting dates.

The key dates are the following; more detail can be found in the Business plan already mentioned above:

- End 2008: Freezing of the conceptual design in the EUROTRANS framework
- 2009-2013: Detailed Engineering Design, PSAR and site preparation
- 2014-2016: Fabrication of the components by the manufacturers and civil engineering realisation on the site
- 2017: Assembling on site
- 2018-2019: commissioning of the facility at progressive levels
- 2020: full-power operation
- 2050: shut down of the machine and preparation of decommissioning.

Preparatory phase	Construction phase	Operation	Decommissioning
until 2013	2014 - 2019	from 2020 at full power	from 2050

10. Reference: Person who has submitted the proposal, and will follow up in ESFRI

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1. Descriptive title, and information on the ESFRI delegation submitting the proposal (or one of the member of EIROForum)

THE EUROPEAN RENEWABLE ENERGY INFRASTRUCTURE, TEREI-Solar, submitted by the Spanish delegation on the ESFRI Forum.

2. Synthesis description of the new RI (or major upgrade) and S&T fields involved at Pan EU level in its use. Add links to relevant data/web pages (half page max)

In the coming 50 years, it will be crucial that the world's energy systems be made environmentally benign and sufficient to meet everybody's energy needs. We have better technologies than ever before to use energy efficiently and to use the world's renewable energy resources without harming the environment.

By 2030, import dependency for oil is expected to reach 94% in the EU. Trying to fight this problem, the 27 EU states have adopted in a recent decision the target to contribute to meeting a 20% of primary energy consumption from renewable sources by 2020. On the other hand, the International Panel of Climate Change recommends a reduction of 80% of CO_2 emissions in the next 20 years in order to maintain the concentration of this component in the atmosphere.

Then, as stated at the EC's SET-PLAN, it is of enormous relevance for Europe to improve the current performance of the different applications of concentrating solar technologies.

Some countries have already taken the initiative of launching R&D programs on concentrated solar energy, as Germany, Italy or the USA, China or Australia, outside Europe.

The Spanish delegation believes that this target can be achieved by setting-up a European research infrastructure. With the proposed infrastructure the objective is to consolidate the competitiveness and leadership of the European scientists, research centers and the relevant industry in the field of concentrated solar energy. The proposed European Renewable Energy Infrastructure (TEREI-SOLAR) aims at providing the S&T with innovative capabilities in order to support the research and development of advanced concentrating solar technologies, value and enlarge its scope of utilities with major test facilities and laboratories.

Furthermore the active involvement of European Industry, in its two-fold role of user and developer of technologies, would facilitate the technology transfer needed for extending the fastest introduction of these resources in the energy market.

TEREI-SOLAR is focusing on concentrating solar technologies, both thermal and photovoltaics. It is proposed and conceived as a research infrastructure, based in Spain, but with an European dimension and management.

As renewable energy sources are strongly dependant on indigenous resources, it is very clear that such a solar institute must be located in a solar resource-rich location like South-Eastern Spain is.

The 'Plataforma Solar de Almeria' (PSA) [1], a world-class solar research centre, with most of 30 years of experience in solar concentrated technologies, will serve as basement for this new infrastructure so the proposal consider that TEREI-SOLAR will be located in Almeria (Spain).

Though TEREI-SOLAR is going to be a separate, autonomous entity, its activity will take advantage of the experience of The Institute for Concentration PV Systems in Castilla-La Mancha (ISFOC) [4]

Additionally, The Andalusian Renewable Energy Center (CTAER) (in design phase) will be constructed aside to PSA, so a synergistic effect will be of benefit for TEREI-SOLAR.

The creation of TEREI-Solar will be the most outstanding R&D infrastructure pole in solar energy in the world.

The proposed structure has the advantage of building upon the investments already made in Spanish concentrated solar energy RIs and on new investments foreseen in the near future, included in the Spanish roadmap of research infrastructures 'MAPA' [7].

For that purpose, the following governing structure is proposed. There will be a Council composed by representatives of all member countries. This Council would:

- determine TEREI-SOLAR's policy in scientific, technical and administrative matters,

- approve the working programme

- adopt the budget

- decide on the appointment of senior staff

The person in charge of day-by-day management is the Director-General, appointed by the Council, acting as chief executive officer and legal representative of TEREI-SOLAR.

Each country is expected to contribute in an agreed, fixed percentage to the budget of TEREI-SOLAR. The weight of each country in the decision-making processes will be proportional to its fixed annual contribution to the budget.

The Council will be the decision-making body to distribute such a budget into the following items:

- Running costs of the institution itself: personnel, maintenance, auxiliary services…
- Funding of access to existing facilities

An Administrative and Finance Committee is envisaged to deal with these matters in a professional way.

The Council will be assisted by a Scientific Committee which will provide scientific guidance and advice.

Such a Scientific Committee will be in charge of assignment of facility time of use in a competitive way. This SC will select among all proposals received according to its scientific merit.

Formerly existing facilities will be accessible by groups from member countries from 'day 1' of TEREI-Solar constitution.

Links/References:

-[1] CIEMAT's Plataforma Solar de Almeria: **www.psa.es**

-[2] IEA's Implementing Agreement about Concentrating Solar Technologies: **www.solarpaces.org**

-[3] Info about the 'Alliance of European Laboratories for Research and Technology on Solar Concentrating Systems' (Sol LAB): **www.sollab.eu**

-[4] Institute for Concentration Photovoltaics Systems: **www.isfoc.es**

-[5] IEA-SolarPACES Annual Report 2006. (edited by Deutsche Zentrum für Luft-und Raumfahrt e.V.)

-[6] The European PV Technology Platform : **www.eupvplatform.org**

-[7] **http://www.mec.es/ciencia/instalaciones/files/2008-folletook.pdf**

3. Science case: scientific area(s) and potential and/or explicit users, how the new RI will fit into the existing and future landscape of Research and of existing RI's, at EU and World level (one page max, links to relevant documents, references).

The solar concentrating technology tracks the sun and concentrates its rays through the use of parabolic mirrors onto a receiver located at the focal point, in this point a heat engine or a chemical reactor transforms the solar energy to thermal energy and then to electricity or chemical fuels.

Solar energy is by far the largest candidate of inexhaustible primary energy sources; solar concentrating can be used directly as high temperature thermal energy or transformed by conventional power cycles to electricity or by chemical process to fuels.

Innovative activities and processes require the demonstration of its suitability, durability, reproducibility, efficiency and economical cost as its application at an industrial scale is starting now. To do these it’s necessary to do experimental tests from small to medium and, finally, large-scale demonstration plants. The proposed facilities are intended to fit very well with the ‘large-scale’ step but preliminary studies at small or medium scale will be also possible.

The steps of the process are: Solar radiation collection –> Concentration –> Conversion of radiant energy into thermal energy of a fluid –> Controlled, efficient use in profitable industrial processes. For concentrated photovoltaic, there are fewer steps as once concentrated the solar radiation is applied to a PV cell where electricity is directly generated by photovoltaic effect.

There are only a few test sites for CSP applications in the world, being PSA the largest one [1]. The proposed improvements would complete the range of applications to be studied and adapt the existing facilities to the new and advanced applications of the solar concentrating technologies. The upgrade of this test site will definitively give Europe the leading position in the concentrating solar thermal science and technology development around the world.

Activities carried out by TEREI-SOLAR (concentrated solar thermal and photovoltaic) will range from basic research at laboratory scale to demonstration at medium to large scale.

As far as **concentrated solar thermal** is concerned, the intended lines of work are listed below:

- Hybridisation and heat storage for different heat transfer fluids
- Integration of distributed renewable energy resources in the grid (DRER)
- Advanced materials, thermal fluids and chemical processes, in this line, techniques for accelerated aging of materials under high flux and temperature conditions
- New and advanced power cycles designed specifically for solar thermal electricity production, dry cooling (removal of water needs for the plant cooling circuit)
- Solar hydrogen, and other solar fuels
- Advanced optical concentrating systems, as second stage concentrators, parabolic trough collectors or heliostats
- Water treatment by the use of concentrated UV radiation from the Sun: disinfection, detoxification
- Process heat for industrial applications other than electricity generation, like water desalination, for instance
- Generation of standards and measurement tools and procedures
- Enhancement of heat transfer at medium and high temperatures and in different media such as dispersed particles, fluidized beds, porous media (metallic and ceramic foams), nano-fluids, and micro channels

Most relevant disciplines concerned are: Optics, thermodynamics, materials science, heat transfer and storage, thermo-chemistry, automatic control, industrial design, process optimization, photo-catalysis, electronics, etc.

CPV has just begun its commercial deployment, and it is now that the need of a common strategy for future developments has to be designed. TEREI proposal is focused in becoming the leading initiative that will allow CPV science and technology running five to ten years ahead of the industry.

The research in the field of Solar Concentration Photovoltaic (CPV) systems is quite new, being ISFOC one of best well-established research facilities in the world today. The research lines to be implemented at TEREI-Solar would serve to accomplish these challenges and to better serve the research and industrial CPV communities. [3].

Concerning CPV, the main research lines of TEREI-Solar will be the following:

- Generation of standards and measurement tools and procedures (as for CSP)
- Characterisation of CPV cells and modules.
- Generation of energy production models, so that the industry may predict technical and economical performance.
- Technical and economical impact studies and grid safety for grid connected CPV utility-scale power plants.
- Coupling of CPV systems with other industrial applications to make use of the residual low temperature heat (up to 60 ºC) resulting from cells cooling (water and space heating).
- Dissemination of results.

There are a large number of common scientific and technical issues for both CSP and CPV. The exact evaluation of the solar resource, its seasonal dependence and the location dependent solar radiation spectrum are of key interest for developments in both fields.

Links/References:

[1] http://**www.psa.es**

[2] European distributed energy partnership for large-scale implementation of distributed energy resources in Europe: www.eudeep.com (FP6 Integrated Project)

[3] EC (2007). A Strategic Research Agenda for Photovoltaic Solar Energy Technology. The European Photovoltaic Technology Platform, available at:

http://www.eupvplatform.org/fileadmin/Documents/PVPT_SRA_Complete_070604.pdf

4. Technical case: summary of results (technical specifications) of conceptual and/or technical design studies (half page, list references/links).

Renewable energy technologies have different maturity levels. From the technological point of view, there are high maturity processes and technologies like biomass combustion or wind energy while other like concentrating solar photovoltaics, hydrogen production or valorization of industrial and refinery sub products are much more innovative, technologically complicated and in a development phase.

There are also various intermediate maturity levels where the different technologies associated to solar concentrated power are placed. Activities related with more mature processes will be directed to enhanced reliability cost competitiveness and radical innovative steps in order to assure European technological leadership, while activities linked to less mature technologies will be focused to demonstrate ‘proof of concept’ so the companies involved consider them attractive enough to continue to the prototype phase.

Overall, the technologies associated to the different applications of concentrating solar technologies still require a qualitative step ahead, as the one proposed with this new ESFRI infrastructure, for allowing their definitive and effective deployment.

In the following a non-exhaustive list of new test facilities is proposed:

Concentrated Solar Thermal:

- A thermal and chemical energy storage (molten salts, synthetic fluid, phase change, chemical reaction, etc) laboratory and a complete experimental test loop with 1.5 MW_{th} thermal energy source (up to 450ºC)
- Replacement of tracking mechanisms of 300 heliostats of tower system CESA-1 facility, thus increasing available power on receiver aperture from 3 MW_{th} to 7 MW_{th} .
- Design and implementation of a control system for CESA-1 that might allow the facility to carry out testing at different test levels of the tower simultaneously
- A central receiver system with hyperbolic, secondary reflector to have the ‘beam-down’ effect is

proposed. This facility would yield 1 MW power on the 'on-ground' receiver aperture. A hyperbolic mirror of 400 m^2 located at a 70 m-high tower and 25 heliostats with reflective surface of 80 m^2 each would make the sun tracking. [3], [4]

- Combined solar thermal power plant linked to a thermal application as a multi-effect distillation system downstream. It's proposed a test loop based on the refurbishing of facilities already existing at PSA: a 200 kW_{th} multi-effect-distillation plant, a 150 kW_{th} absorption heat pump, a 1,2 MW_{th} parabolic-trough solar field and a 500 kW_e set turbine-alternator. [1], [2], [5], [6].
- A controlled-atmosphere chamber with 2m-diameter quartz window and all necessary instrumentation will be set up in one of the test rooms available at the CESA-1 tower for testing of innovative materials (ceramic, nanoestructural materials, composites, etc,) under severe conditions (high flux, temperature gradients, heating rate) as an example the aerospace materials that requires testing temperatures up to 1.800ºC.
- FRESNEL collector technology claims to be the cheapest one in comparison with: parabolic trough, central receiver or parabolic dish systems. A 2.500 m^2 mirror area demo loop will be constructed with the goal to determine the efficiencies of different configurations (thermal fluid, direct conversion solar-to-steam, etc.) at different operating conditions (temperature and pressure ranges, thermal fluid flow regime, etc.). [7]
- 1 MW hybrid solar-biomass test facility, including solar field, biomass gasification plant and power cycle.
- Hybrid systems laboratory, oriented to the development of specific components for solar-gas hybrid plants.
- DRER test facility. This facility will be oriented to explore the integration of small, distributed solar thermal systems into the power grid.
- Solar Hydrogen and Solar Chemistry Test Facility, capable to achieve temperatures close to 2000 ºC and high radiant flux.
- Advanced Concentration facility, to develop and test advanced concentrator concepts: beam down, secondary concentrators, etc.

As a complement, a new offices building of 1.000 m^2 is being constructed using the most advanced energy saving techniques. This building will be monitored in order to demonstrate that it's possible to reduce energy consumption up to a 90% with non-relevant cost increase. [8]

Concentrated Photovoltaics: Some technological challenges associated to concentrating solar photovoltaic systems are:

- to improve the performance of the modules multiplying the amount of light reaching the cell,

- improve the performance of sun trackers.

- development of testing standards for prototypes and performance rating.

- dealing with the high temperatures due to the high concentration.

So the following new facilities are considered:

- A laboratory scale test facility for the new and advanced material synthesis and characterization of second and third generation cells, cell manufacturing and assembly,
- Medium an large scale test facility to a complete manufacturing process (chemical reaction and purification, photovoltaics material deposition and cells characterization.
- A laboratory scale test facility for concentration photovoltaics prototype testing and performance rating.
- A laboratory for concentrated solar photovoltaics system design (concentration module, cell, cooling system design, etc.) and
- A large scale test facility installed power capacity of 3 MW under real working conditions.

- Distributed solar radiation evaluation facilities.

Links/References:

[1] http://www.dlr.de/tt/en/desktopdefault.aspx/tabid-3525/5497_read-6611/

[2]http://www.dlr.de/tt/en/Portaldata/41/Resources/dokumente/institut/system/projects/AQUA-CSP_Flyer.pdf

[3] 'Ciemat's proposal to develop a 1 MW beam-down prototype at PSA within MRN activities'. Eduardo Zarza. July, 2007. Available at PSA.

[4] Hasuike, H.; Yoshizawa, Y.; Suzuki, A.; Tamaura, Y. 'Study on design of molten salt solar receivers for beam-down solar concentrator'. Solar Energy, nº80 (2006) pp. 1255-1262.

[5] Minutes of the 72 ExCo Meeting of 'SolarPACES': 72ExCo_AI4_Solwatergy_JBlanco.pdf. Available at PSA.

[6] 'Integration of MED systems into solar power plants'. Julián Blanco & Eduardo Zarza. July 2007. Available at PSA.

[7] Morin, G.; Häberle, A. 'Roadmap towards the demonstration of a linear Fresnel collector using a single tube receiver'. 13th SolarPACES Symposium. Proceedings. 2006.

[8] **http://ffii1.etsii.upm.es/renovalia/ponencias/ARFRISOL-CIEMAT.pdf** (in Spanish)

5. e-infrastructure: what does the new RI require as far as e-infrastructure? How is it integrated with the existing EU e-infrastructure (e.g. Geant, grid, digital repositories).

TEREI-SOLAR will make use of the European e-infrastructures such as 'Geant'. All experimental data acquisition systems and generated data bases will be designed using the most suitable standards with the aim to facilitating the open access to the scientific community of all member countries.

6. Other expected socio-economic impacts: development of new technologies, effects on training, involvement of industries, local impact, other (one page, references).

The European Union countries are interested and almost obliged to seek new clean and inexhaustible energy sources and even more to diversify these sources by using in each country or region its own endogenous energy sources, as the solar energy is for Mediterranean countries.[1]

-Involvement of industries

All industries listed in point 7 (below) are involved in different concentrated-solar projects. Some of them are promoting ambitious deployment plans for CSP electricity generation plants in Spain, USA and North Africa and the first contracts for CPV deployment worldwide.

The possibility of using these specialized installations in the concentrating solar technologies is doubtlessly attractive for all European countries and their industrial sector.

The activities carried out by TEREI-SOLAR will demonstrate the reliability and durability in real conditions of the concentrating solar technologies, what will be the basis to the technology transfer towards the European industry.

R&DD activities related with the different concentrating solar energy applications like plant engineering, collector design, cost-effective tracking structures manufacture, electronics and control systems, high-temperature materials, thermo-chemical processes, electricity grid management, heat storage media, etc. should be reinforced by using the potential results obtained by the proposed infrastructure making the European sector more competitive in world markets.

-Effects on training

PSA is already the world reference centre for training activities in CSP technologies and TEREI-SOLAR would 'keep the flame' in this line of activity. The ruling principle of the PSA's Training Program is the creation of a generation of young researchers who can contribute to the deployment of concentrated solar energy applications. Through this program, about thirty students of different nationalities are admitted each year so that the knowledge of solar thermal technology accumulated at the PSA in its twenty-five years of experience is transmitted to new generations of university graduates. The main features of this training program are:

- Management of the Ph.D. fellowship and traineeship program in association with the University of Almería (UAL)
- European funded ‘Leonardo da Vinci’ grants, for students from other countries, mainly from Germany.
- Management of miscellaneous specific educational cooperation agreements with other entities worldwide for sending students to the PSA.

A one-year-long master’s course in solar energy has been launched in cooperation with the UAL. This master’s degree is given in Spanish at present, but the intention is to also give it in English, thus opening it to the widest possible audience.[3]

Additionally, one of TEREI-SOLAR objectives is to train a group of experts capable of promoting both high level research and local industrial development by means of setting up pilot photovoltaic concentration plants.

-Local impact

TEREI-SOLAR will be located in the Spanish ‘Andalusia’ Region. This is a ‘Phasing in’ area as far as cohesion funds are concerned.

TEREI’s infrastructures will increase the number of visiting scientists to Almeria and most probably lead to the establishment of an industrial techno-pole, so a source of regional wealth and employment would be set up.

From a more global point of view, Solar Thermoelectric Power Plants (STPPs) are mainly located in desert and uncultivated lands. Commercial activity on these lands will benefit local communities directly and indirectly. Direct benefits include the collection of taxes and the creation of new jobs and indirectly an increase in local services to support the new jobs created.

The plants will require skilled labour to construct, maintain and operate them. The types of jobs initially created would most likely be technical or construction, but opportunities for manufacturing and service jobs may also develop as facilities evolve. The calculus of the new jobs created is based on a survey of current industry practices to asses the number and type of jobs that will result from the enactment of renewal energy programs in recent years. According to the survey, for STPPs, every 100 MW installed will provide 400 full-time equivalent manufacturing jobs, 600 contracting and installation jobs, and 30 annual jobs in O&M.

Economic development can benefit a community indirectly, such as an increase demand in local service commodities. It is widely accepted that for each construction job, four service jobs are created to support it and once construction is completed, O&M will require local services as well.

-Impact on the EU-MENA (Europe, Mediterranean Northern Africa) area:

Fresh water, the primary resource of life, is limited in most MENA countries. If the MENA countries would build, with Eureopean technology, solar thermal electricity and desalination facilities to supply around 1 billion m^3 water per year; the installation of such a capacity would be sufficient to mature concentrating solar thermal technology to a point where it would begin to provide solar heat at costs lower than from fossil fuels.

Such a project will induce significant economic development in the MENA region and generate a powerful instrument to fight global climate change. If it would be started now, this aim could be achieved until 2015. By 2025, solar electricity could be produced and exported to Europe, while desalinated water could be co-generated to cover the needs of Northern Africa countries.

Employment related to the erection and operation of CSP plants in the EU-MENA region according to the scenarios mentioned above was estimated within the MED-CSP study to be beyond 500,000 persons by 2025 and well over 1 million by 2050.

Concentrated solar energy has a key role for a secure, diversified and sustainable electricity supply for Europe, as it can provide balancing power capacity within a renewable electricity mix. In addition, CSE may contribute to:

- Stabilization of North African and Middle East countries trough revenues for CSE electricity generation.
- Combination of CSE power generation with local sea water desalination plants would avoid CO_2 emissions during water desalination and mitigate the increasing problem of water shortage. [4]

Links/References:

[1] Martinot E. *et al* (2007). Renewable Energy Futures: targets, scenarios, and pathways forthcoming, in *Annual Review of Environment and Resources 2007.*

[2] European Commission (2007). Renewable Energy Road Map. Renewable energies in the 21st century: building a more sustainable future. COM (2006) 848 final.

[3] www.ciesol.es

[4] http://www.dlr.de/tt/desktopdefault.aspx/tabid-2885/4422_read-6575/

7. Commitments / maturity: which States / Organizations have demonstrated interest / commitment in supporting and/or funding the proposal?

Spain, as one of the European leading countries in the solar energy field, can offer at the highest level to this European infrastructure the experience in creating and managing three resource installations in the solar energy field included in the Spanish National Roadmap (PSA, CTAER and ISFOC) and their existing capabilities in support of TEREI-Solar.

An International Working Group (IWG) has been set up with representatives of interested European institutions; so far from: Germany (DLR), Italy (Univ. Napoli2), Switzerland (PSI and ETH), Greece (CRES Ministry of Development), Portugal (Technical University of Lisbon and private industrial groups) and Turkey (Selcuk Univ.). Suggestions coming from a first meeting and a questionnaire have been included in this proposal.

Institutions from other EU countries such as France (CEA and CNRS) have expressed interest in concentrated solar energy and would support increasing the European cooperation in this field. Besides, some other countries of the Mediterranean basin have expressed a strong interest in TEREI-Solar, i.e. Morocco (CNRST) and Algeria (NEAL).

Support from other institutions has been confirmed through letters of interest, as this is the case of EUREC (The European Renewable Energy Research Centres Agency), ESTTP (European Solar Thermal Technology Platform), ESTELA (European CSP Industry Association), PROTERMOSOLAR (Spanish CSP Industry Association) and the European Photovoltaic Technology Platform.

There are also a large number of Spanish companies involved in the energy sector that have shown interest in the promotion of the infrastructure proposed here, for instance: ABENGOA, IBERDROLA, ACCIONA, SENER, ENDESA, COBRA, ISOFOTON, SOLFOCUS, CONCENTRIX.., they all are main players in the current deployment of the first CSP and CPV plants worldwide.

8. Costs for construction, operation and decommissioning, indications on project financing (half page, with references/links). Give budget info in M€

TOTAL	PREPARATORY	CONSTRUCTION	OPERATION	DECOMISSIONING
90,5 + Operation	4,0	88,74	3,0/year	3,0

The above table compiles the estimated cost of TEREI-Solar new infrastructures, part of which is already foreseen to be funded by the Spanish National Fund for Research Infrastructures.

The preparatory phase include conceptual and detailed engineering plant design, components specifications, definition of control and auxiliary systems, water and energy supply, analytical instrumentation ,etc.

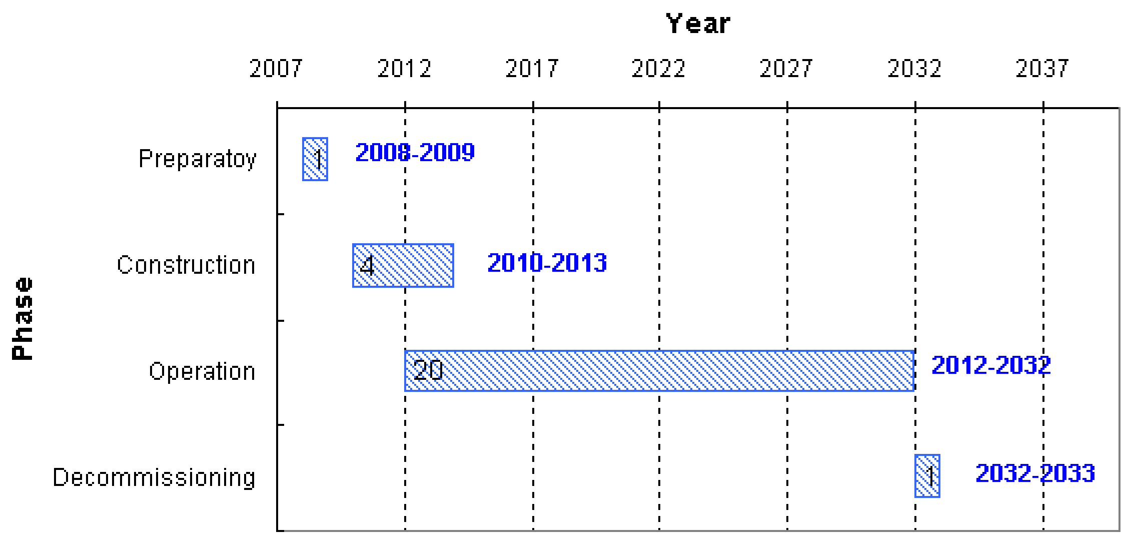
Construction cost contemplates civil works, building construction, auxiliary supplies (water, electricity, fuels, computer), specific instrumentation, test facilities, etc.

Operational costs comprise at least insurances, water, electricity and phone supply, chemical products, in-house staff and other indirect cost.

Decommissioning costs include all works necessary to close the infrastructure and restoration of lands.

9. Timetable for construction, operation and decommissioning (half page, with references/links)with duration and possible starting dates.

Preparatory phase: 1 year (2008-2009)
Construction phase: 4 years)(2010-2013)
Operation phase: 20 years (2012-2032)
Decommissioning: 1 year: (2032-2033)



10. Reference: Person who has submitted the proposal, and will follow up in ESFRI

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Head of ‘Plataforma Solar de Almeria’ (SPAIN)
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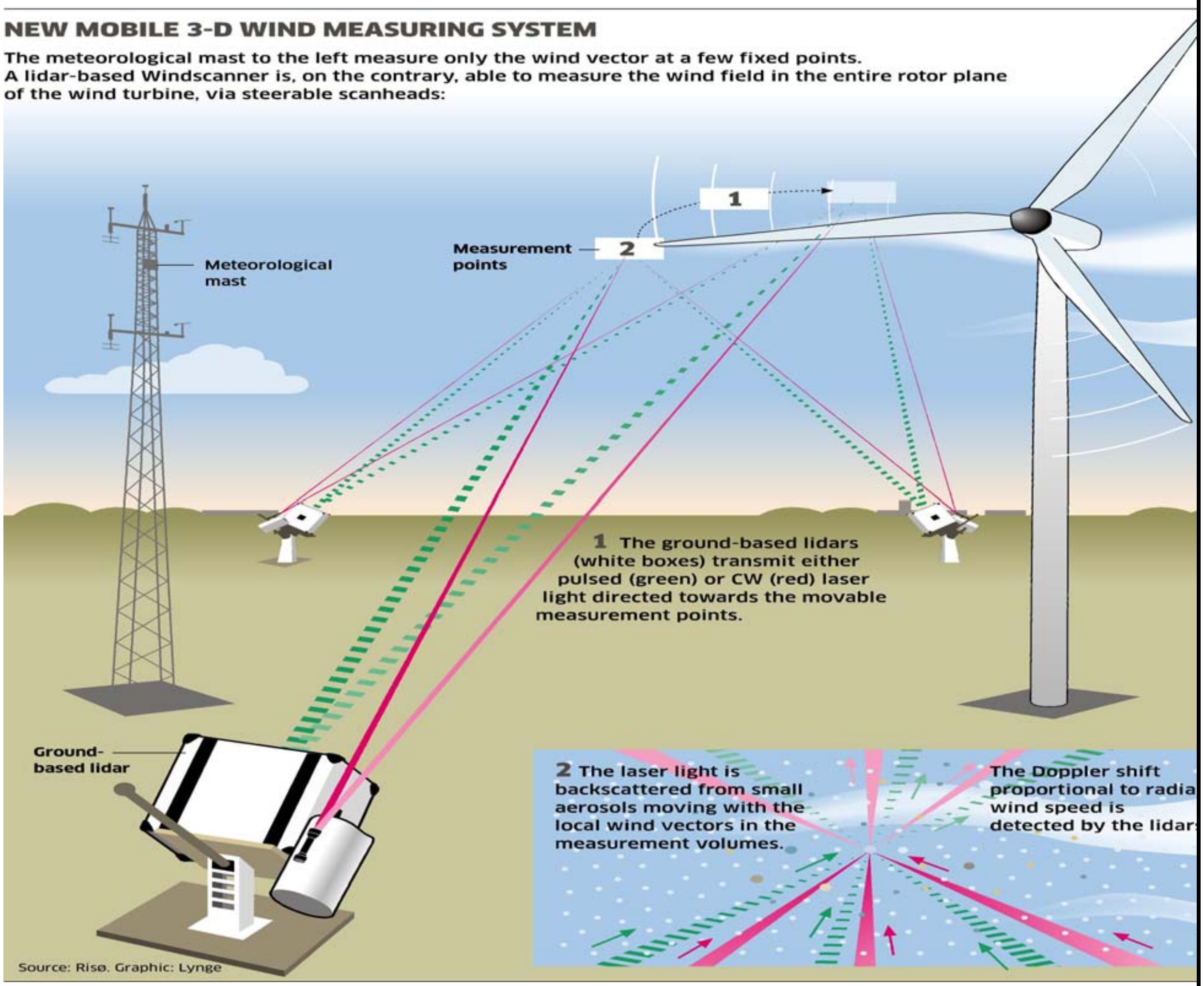
1. Descriptive title, and information on the ESFRI delegation submitting the proposal (or one of the member of EIROForum)

The European Centre for Wind Energy and Turbulence Research - boosting European wind energy with ground-breaking 3D laser wind measurements

Submitted by a European consortium lead by Risø DTU, National Laboratory for Sustainable Energy, Danish Technical University (DTU), supported by the European Academy of Wind Energy (EAWE).

risoe.dtu.dk; www.dtu.dk; Windscanner.eu



2. Synthesis description of the new RI (or major upgrade) and S&T fields involved at Pan EU level in its use. Add links to relevant data/web pages (half page max)

Our aim is to provide a major boost to the development and penetration of wind energy world wide.

This will be achieved by improving our understanding of the turbulent wind and its interaction with wind turbines. We will radically improve the ability to measure the turbulent wind, using state-of-the-art laser Doppler techniques (‘remote sensing’) and equally importantly, by major improvements in the abilities to generate accurate, efficient and validated computer flow models.
Improvements in flow modelling go hand-in-hand with advances in three dimensional (3D) remote sensing. Results from full-scale wind field measurements will provide new and important information to

validate and improve the computer codes. Through improved performance and reduction in materials, the end result will be cheaper and better wind turbines.

Major benefits that can give improved power production and reduced structural loads on both land-based and offshore wind turbines, are:

- Improvement to wind resource models allowing us to choose better locations for wind turbines, especially in mountainous and forested terrain, and off-shore.
- Better understanding and reduction of the turbulence related loads on wind turbines.
- Improving the layout of wind farms by minimising the adverse effects of wind turbine wakes. Optimised blade designs giving better aerodynamic performance.
- Integration of remote sensing as an active component in wind turbine control systems.
- Measurement and modelling of wakes and resource optimisation in offshore wind parks.

The physical manifestation of our proposed **Research Infrastructure (RI)** Windscanner.eu will be:

- Mobile 3-D remote sensing stations installed across Europe using a new Wind scanning technology currently under development at Risø DTU Denmark. This will give a new paradigm in wind energy field testing, moving us ahead and beyond the era when we were limited by large and costly measuring towers.
- Flow modelling efforts will be boosted by major investments in computer clusters together with large databases providing open access to significant windscanner results.

3. Science case: scientific area(s) and potential and/or explicit users, how the new RI will fit into the existing and future landscape of Research and of existing RI's, at EU and World level (one page max, links to relevant documents, references).

Wind measurements are traditionally made using cup anemometers mounted on a measuring mast. This gives good measurements of the wind speed, but only at a few points and usually at some distance from the wind turbine. The wind is truly three-dimensional both in the sense that all three components of the wind are important and in the sense that it is important to understand both the temporal and the spatial structures in the wind field approaching the rotor plane. Today we know rather little about the wind arriving and leaving a wind turbine rotor and this is limiting our understanding and ability to model accurately. As a result, turbine designs are not as effective as possible and are overly conservative, resulting in a large waste of glass-fibre and steel.

Recent advances in laser Doppler measuring techniques make it possible for the first time, to build ground based systems that can measure the true 3D wind around a wind turbine rotor. This new capability will radically expand our understanding of the underlying fluid dynamics and drive major advances in our ability to model the aerodynamic and structural behaviour of wind turbines, resulting in cheaper, more efficient, quieter and safer wind turbine systems.

For **off-shore** wind parks, the big challenge is to design the array of turbines to maximise the power production and to minimise structural loads due to wake interactions and shear. An offshore Windscanner system will provide ground-breaking new information about the formation and decay of wind turbine wakes in the typically low turbulence environments that will drive major advances in this optimisation.

A majority of **on-shore** wind turbines are installed in mountainous and forested areas. Here the challenge is to model how the wind is affected by the terrain and thus allow developers to find the best sites for their wind turbines and avoid areas with damagingly high turbulence. Mobile windscanners can be deployed in such inaccessible areas and provide new datasets for developing and validating computer models.

All major national wind energy research centres across Europe, organized through the European Academy of Wind Energy will via the proposed RI Windscanner.eu gain access to a new research tool that will enable them to map complex three-dimensional atmospheric flows and correlate these to simultaneous load and vibration measurements on wind turbines.

Forty European research laboratories, wind turbine manufactures, and consultants are already united in the EU project *UpWind* wth the purpose of providing the design basis of future wind turbines. The proposed RI will build upon flow modelling and remote-sensing aspects of *UpWind* and extend this effort into the following decades. Also two new FP7 projects, *NORSEWInD* with more than 13 lidar wind profilers operating off-shore, and *SafeWind,* including lidar measurements of extreme wind, will soon emerge on the European research scene.

Beyond Europe, Risø DTU has a collaboration agreement with National Renewable Energy Laboratory (NREL), and the Collaboratory CREW , both Colorado, USA, who share many of the visions of the proposed RI. A twinning agreement between the Chinese Meteorological Administration and Risø DTU , Denmark was signed in December 2007.

4. Technical case: summary of results (technical specifications) of conceptual and/or technical design studies (half page, list references/links).

Laser Doppler based remote sensing of wind (wind lidar) is becoming a well established tool in wind energy. Two commercial lidar profiler systems have been extensively evaluated by Risø DTU, who have made significant contributions to this technology. However, these commercial devices are only suitable for measurement of vertical mean wind profiles of speed (and direction) over flat terrain. For measurements in mountainous terrain or where the flow is rapidly changing, such as in front of a wind turbine, it is necessary to use a number of lidars operating in concert, in order to measure the full 3-dimensional wind vector at predefined points in space and time. By sweeping the lidar beams around in front of a rotor plane or volume of air, we can obtain scans of the true 3-D wind vector fields at a rate of 500 Hz. Such a 3-D, full-scale wind scanning measurement system is termed 'Windscanner' and is currently under development and test at Risø DTU. Full-scale three-dimensional wind lidar measurements, the first in the world, were successfully made at the Høvsøre National Test Station for Large Wind Turbine in December 2007, cf. windscanner.dk .

The potential new insights gained by these innovative Windscanner systems can be capitalised by encapsulating the knowledge in improved computer flow models (CFD) for wind turbine design. It is therefore essential to strengthen and coordinate the current research efforts in atmospheric CFD. Increased computer power will furthermore enable us to capture the ever finer details of 3D flow structures and this is an important underpinning feature of the RI. At the same time, the currently rather dispersed research teams within boundary-layer meteorology and manufactures of wind turbines will be encouraged to collaborate and share the proposed new Windscanner resources under the auspices of a new EU RI.

On-shore the Windscanner facility will consist of easy moveable mobile units, consisting of sets of 3 lidars linked to a control center/database. **Off-shore** the equipment will be positioned fixed to platforms or wind turbine array pylons. It is proposed to concentrate on the German FINO-1 platform, pt. owned by the German Government - and include this and some new (movable) platforms in the vicinity around it, for detailed offshore measurement campaigns. A new EU FP7 project, *NORSEWInD* kicks off mid-2008, with Risø DTU as WP leader for RTD. The *NORSEWInD* project will be based on lidar data from 13 commercial wind profiling lidars1, to be operated over the North Sea 2009-2010. The scientific questions addressed offshore will focus on measuring the 3-D turbulence fields (and not only the mean wind profiles as today) measured e.g. in several transects in front of, through, and behind (in the wakes of) wind turbine parks. Similarly, the scientific aims **on-shore** is to measure and model fluctuations, gusts and (negative) shear in 3-dimensions over forested area and over complex terrain.

5. e-infrastructure: what does the new RI require as far as e-infrastructure? How is it integrated with the existing EU e-infrastructure (e.g. Geant, grid, digital repositories).

The Windscanner.eu RI will establish and maintain a public and open-accessible Web-based database with both measurement data and corresponding modelling results.

6. Other expected socio-economic impacts: development of new technologies, effects on training, involvement of industries, local impact, other (one page, references).

The European dimension: EU's target is that 20 % of the electricity used in EU must origin from sustainable energy resources in 2020, and much of this will come from wind energy.

This is quite a challenge which cannot be met without a significant strengthening of enhanced RTD within wind energy. Wind power is already competitive with conventional power generation technologies; however wind energy competitiveness can be further improved through cost reductions and performance enhancements. A significant part of the cost reductions achieved in the last two decades is a result of economies of scale. The remaining cost reductions can be directly attributed to research and development (R&D). Thus, R&D, as proposed here, is a direct driver towards the achievement of European Union's ambitious targets for renewable energy market penetration, see www.windplatform.eu

Several types of organisations and companies identified **needs** will be met via our proposed RI, see e.g. www.windplatform.eu . The involved **European research organisations**, see section 7, will perform very relevant research project during the development, establishment and use of the described infrastructure. This will further enhance an already strong research environment and will attract researchers and students to wind energy at all the involved research organisations. This flourishing research environment will strengthen the world's first master education in wind energy at the Technical University of Denmark.

Companies having knowledge of wind lidar technology, such as Leosphere in France and QinetiQ in United Kingdom among others, will actively participate in the project.
The knowledge obtained using the RI will reach the **wind turbine manufacturers** through collaborations and education. The RI will be a valuable tool for the wind turbine manufacturers to develop more efficient wind turbines. It will measure complex real life conditions far more accurately than wind measuring methods of today. As a consequence, a given wind turbine will be sited under more optimal wind conditions. The wind turbine manufacturers located in the EU are thereby in a position to receive by far the most benefit from the RI since they already have close relations to the research partners in this RI. In the period 2002-2007 the wind turbine market has experienced an average growth rate of more than 20 % per year and a similar growth is expected for the next 5 years. This means that the accumulated total market for wind energy turbines for the next 5 years will exceed 200 billion €. Today wind turbine manufacturers from EU have a dominating market position, but with increased competition from China, India and the US. By providing our EU-based wind turbine manufacturers with a **unique measurement tool** in the R&D-process they will be in a stronger position to maintain a **high market share** for years to come.
Developers within wind energy and primarily of **wind farms** can benefit through the access to the Windscanners as customers. This Windscanner.eu RI will enable the developers to make better choices of where to site a wind farm and furthermore of how to design the wind farm to avoid strong turbulence and devastating negative wind shear. Another very important area for developers, where the RI can provide useful information, is its ability to measure the local wind conditions, on- and off-shore, and thereby the potential energy production of the wind turbines and hence the revenue of the wind farm. This means that typical developers receive a significantly more accurate set of information about the potential revenue.
Benefits outside wind energy can also be significant. Wind loading on and the flow around buildings and bridges can be documented in a way never before possible. The enhanced understanding will give cheaper and safer constructions.

7. Commitments / maturity: which States and Organizations have demonstrated interest / commitment in supporting and/or funding the proposal?

The described lidar based Windscanner technology is currently under development at Risø DTU with an internal investment of 3 M€. The first system consists of three modified wind lidars from the UK company QinetiQ and a pulsed lidar from the French company Leosphere . Although fully mobile, the first wind measurement system will have its home base at Risø DTU's Test Station for Large Wind Turbines at Høvsøre , western Denmark, which is already a well-established Danish infrastructure both for wind turbine and remote sensing testing.

Wind Turbine Test Station Høvsøre, Denmark

The RI will be a **Pan-European** extension of a recently proposed Danish large scale facility www.windscanner.dk . Extension to a number of European wind energy centres will increase the overall testing capacity and allow for research and development in terrain and conditions not readily available in Denmark. The following research institutes and organizations, each with specific national characteristics, have agreed to be partners and participate in the preparatory phase of the project:

1. Spain: CENER (inland mountain wind turbine test station)
2. The Netherlands: ECN (research scale wind farm)
3. Greece: CRES (coastal complex terrain)
4. Germany: University of Stuttgart (inland, low wind speed sites)
5. Denmark: DONG Energy (full scale offshore wind parks)
6. Denmark: Risø DTU (flat terrain wind turbine test station)

The RI consortium is currently also seeking contact to the following national facilities:

7. Germany: FINO platforms (offshore research platforms)
8. Great Britain: Myres Hill (highlands test station)
9. Germany: DLR (lidar technology)

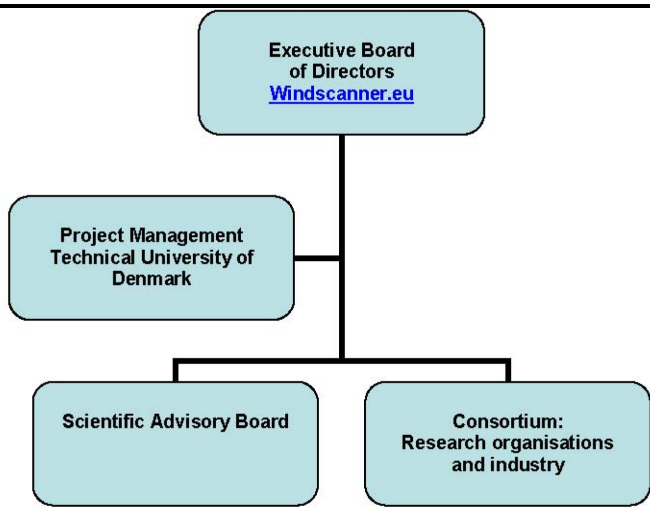
The Windscanner.eu facilities will be open to all potential users with priority to Consortium members and other EU users.

Organisation:

1. The Windscanner.eu RI facility will be established as a truly European organisation governed by an **Executive Board of Directors** with members from the partners. The Technical University of Denmark, Risø, will host the project management and secretariat, especially during the research and development phases.

2. A **Scientific Advisory Board** will assist and advise the Executive Board on scientific, technical matters.

3. A **Consortium** will be established at day one to safeguard the interests of private and public users.



Access conditions: Access to the facility will be based upon applications to the **Scientific Advisory Board**. The selection criteria will emphasize scientific quality of the proposed projects, geographical and science policy parameters following the procedures already used by existing European large scale RI facilities.

8. Costs for construction, operation and decommissioning, indications on project financing (half page, with references/links). Give budget info in M€

Detailed planning: 8 M€
Construction : 45 M€ (Construction period 4 years)
Operation: 60 M€ (for 15 years, of which the first 2 years will be testing and adjustments)
Decommissioning : 1 M€
Total estimated cost = 114 M€

Total preparatory cost	Total construction cost	Operation cost /year	Decommissioning cost
(of which already spent or committed)	(specify contributions committed or indicated by possible funders)	(specify contributions by possible funders)	(possible funders)

9. Timetable for construction, operation and decommissioning (half page, with references/links) with duration and possible starting dates.

Preparatory phase	Construction phase	Operation	Decommissioning
2008 - 2010	2010-2013	2011-2025	2015

10. Reference: Person who has submitted the proposal, and will follow up in ESFRI

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Annex 1 - List of members of the PSE RWG

Name	Country	Email	Organisation, Adress
Joergen KJEMS	Chair	jkj@oersted.dtu.dk	Technical University of Denmark, Oersted-DTU Building 349, DK - 2800 Kgs Lyngby, jkj@oersted.dtu.dk
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Hans CHANG	Netherlands	hans.chang@fom.nl	Directeur FOM (Stichting Fundamenteel Onderzoek der Materie), Postbus 3021, NL-3502 GA Utrecht, The Netherlands
Simona GOLIC-GRDADOLNIK	Slovenia	simona.grdadolnik@ki.si	National Institute of Chemistry, Haydrihova 19, SI - 1001 Ljubljana
Ulf KARLSSON	Sweden	ulfka@kth.se	Royal Institute of Technology, KTH - Kista SE - 16440 Kista
Rainer KOEPKE	Germany	Rainer.Koepke@BMBF.BUND.DE	BMBF, Heinemannstrasse 2, D-53175 Bonn, ermany
Jacek KOSSUT	Poland	KOSSUT@IFPAN.EDU.PL	Director Polish Academy Of Sciences Physics Institute
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Denis RAOUX	France	denis.raoux@synchrotron-soleil.fr	Institut Louis Néel, CNRS Grenoble, CNRS, Av des Martyrs 38042 Grenoble, France
Petros RAPIDIS	Greece	rapidis@inp.demokritos.gr	Institute of Nuclear Physics, National Centre for Scientific Research "DEMOKRITOS" P.O.Box 60228 Neapoleos 27 153 10 Aghia Paraskevi Attikis, Greece

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Magdalen STAVINSCHI	Romania	magda@aira.astro.ro	Director General Institute for Astronomy of the Romanian Academy
Rasit TURAN	Turkey	turanr@metu.edu.tr	Middle East Technical University (METU), nonu Blvd Ankara, Turkey
Jan VAN HELLEMONT	Belgium	jan.vanhellemont@ewi.vlaanderen.be	Flemish Authority - Department Economy, Science and Innovation
Brian WARRINGTON	Malta	brian.warrington@gov.mt	Chief Executive OfficeR, Malta Council for Science and Technology, Villa Bighi, Kalkara, Malta
Brigitte WEISS	EC	brigitte.weiss@ec.europa.eu	European Commission, Square de Meeus 8, 1050 Bruxelles; Belgium
Alexander WOKAUN	Switzerland	alexander.wokaun@psi.ch	Paul Scherrer Institut, CH-5232 Villigen Switzerland
John WOMERSLEY	UK	John.Womersley@stfc.ac.uk	Director, Science Strategy, Science & Technology Facilities Council, Rutherford Appleton Laboratory, Chilton, Didcot OX11 0QX, UK

Annex II - PSE RWG subpanels

Name of expert	e-group	Astronomy, Astrophysics, Nuclear and Particle Physics	Materials	Energy
KJEMS - chair				
BERTOLUCCI	**X**	**X**		
CHANG			**X**	
GOLIC			**X**	
KARLSSON			**X,C**	
KOEPKE(SCHROTH)		**X**		
KOSSUT			**X**	
KUHN	**X**	**(X)**		
LUND				**X,C**
MARTINEZ				**X**
NAGY				**X**
RAOUX			**X**	
RAPIDIS		**X,C**		**(X)**
REKSTAD				**X**
STAVINSCHI		**X**		
TURAN			**X**	
VAN HELLEMONT	**X**		**X**	
WARRINGTON				
WOKAUN			**(X)**	**X**
WOMERSLEY		**X**		
WEISS – EC representative				

Annex III – Declaration of conflict of interest

Name	Country	Proposals with conflicts interest (no participation in the decision on these projects)
Joergen KJEMS	Chair	PSE015, RU36, RU36a
Sergio BERTOLUCCI	Italy	RU21
Hans CHANG	Netherlands	none
Simona GOLIC-GRDADOLNIK	Slovenia	none
Ulf KARLSSON	Sweden	none
Rainer KOEPKE	Germany	none
Jacek KOSSUT	Poland	RU 39
Dietmar KUHN	Austria	none
Peter LUND	Finland	none
Diego MARTINEZ-PLAZA	Spain	RU34, RU34a
Dénes Lajos NAGY	Hungary	none
Denis RAOUX	France	none
Petros RAPIDIS	Greece	PSE21
John REKSTAD	Norway	none
Magdalen STAVINSCHI	Romania	none
Rasit TURAN	Turkey	none
Jan VAN HELLEMONT	Belgium	none
Brian WARRINGTON	Malta	none
Brigitte WEISS	EC	n.a.
Alexander WOKAUN	Switzerland	none
John WOMERSLEY	UK	none

Annex IV - Evaluation form for new projects

Evaluation form ESFRI proposal 2007.

Proposal Name and Number:

New proposal: ☐

Updated proposal: ☐

Updated proposal:

Please give your comments about:

Changes in:

- **Scientific case:**
- **Impact of research:**
- **Change of landscape:**
- **European character:**
- **Progress in scientific and technical developments:**
- **Other important information:**

New proposal:

Please mark from 1-5, 5 highest.

1. Scientific Need:
   - Future
   - Present
2. Impact on scientific development:
3. New ways of doing science:
4. Growth of European Research areas:

5. European character:

Global Exceptional European Network of unique competence Other

☐ ☐ ☐ ☐

………………………………………………………………………………………………..

Technical and business case:

Please give your marks from 1-5, 5 highest.

Technologically feasible:

Financially feasible:

Concept mature:

Degree of readiness:

Timing:

Recommendation:

ESFRI list: Yes: No: Emerging ideas:

::

Comment:
(Please give your written statement about the new infrastructure)

Annexe V – Mandate of the PSE RWG (inauguration of the RWG, meeting 10/09/2007)

Regarding the Roadmap update process:

- The RWGs have a main task: to evaluate the new proposals forwarded by ESFRI, assessing their feasibility on all relevant aspects; in addition, they may re-examine the existing Roadmap and assess the progress in the implementation of the projects therein by identifying bottlenecks and/or proposals needing a possible update;
- Regarding timing, ESFRI shall receive all new proposals by November 2007[4], and the RWGs should begin the development of the landscape as soon as possible. All projects to be evaluated should be in by the first half of December 2007. The final draft reports are due by Spring 2008; the final decision on which projects make the Roadmap will be made by ESFRI by July 2008 – leading to the first draft of the Roadmap update. It is suggested to send in the final draft on the landscape (introduction to the final report) as soon as ready allowing to anticipate the development of the introduction to the Roadmap update. The final editing of the draft reports of the RWGs must be ready by september 2007;
- Regarding the evaluations of proposals themselves, CR clarified the procedure prepared by ESFRI, in particular concerning the fact that the RWGs shall assess the proposals on the basis of identified scientific needs and feasibilty studies, keeping in mind that financial issues should not be considered 'knock-out criteria';
- However, the recommendations of the RWGs should be so well argued that they can be defended not only at the level of Science Ministers, but that the Science Ministers can use them to persuade their Finance Ministers;
- Regarding the method of working, the RWGs should facilitate open internal discussion and agree which parts of their work should be communicated outside; Conflicts of interest should be declared and all different opinions recorded and reported to ESFRI;
- A “transversal” WG is being set-up to assess the e-infrastructure needs and aspects of each proposal, so that these are integrated into each project selected for the Roadmap.

Physical Sciences and Engineering RWG:

Key points

- The composition of the RWG is well balanced and posesses the necessary discipline to embark upon the work ahead;
- The PSE field intrinsically relies on large facilities and good international collaboration for success; there are few new RIs in the PSE field on the horizon; Momentum towards implementation of RIs on the current Roadmap will be a fundamental priority of the RWG;
- 5 or 6 of the projects on the Roadmap are of a global nature; the RWG will address the global dimension of these projects and how to facilitate decision-making on a global scale;
- The biggest challenge for this group is addressing the needs of **Energy**; RIs and energy are fundamentally linked and this is an area very much science driven; JK drew attention to a note highlighting several initiatives by Commission identifiying energy policy and needs; the RWG shall use this as a basis for discussion.

[4] The ESFRI Executive Board (EB) will receive proposals through the delegations or intergovernmental organisations; after checking formal requirements, the EB shall transmit the proposals to the RWGs.

Annex VI - Terms of Reference of Road Map Working Groups (RWG's)

After September 2006

Preamble

- The ESFRI roadmap, as approved in September 2006, has been built to identify needs of the European research communities for new or major upgrades of pan-European Research Infrastructure (RI), covering all scientific areas.
- All selected projects have been identified as important to impact on the science and technology development at international level, supporting new ways of doing science in Europe and the growth of the European Research Area (ERA).
- New RI's (or major upgrades) in the Roadmap have different degrees of preparedness, but all of them need to find long-term commitments by a relevant European partnership including intergovernmental organisations. This needs to be effectively realised as soon as technically feasible. Therefore the roadmap has been presented to all relevant actors, including Governments and the EU.
- The ESFRI roadmap is an ongoing process and the construction of the scientific landscapes has also identified a number of Emerging proposals, as well as some further Pan-European needs, to be taken into account in view of the future periodic updates.
- The European Commission, on its side, will use the list of projects in the Roadmap as a base to activate preparatory actions to facilitate their realization, during the 7th Framework Programme, and will be supporting design studies to help the maturity of emerging proposals.

Rationale for the RWG's

- ESFRI has decided to set-up the Roadmap Working Groups (RWG) as specific Working Groups aimed at supporting, from a scientific point of view, a coherent and strategy-led approach to European policy making on new RIs of pan-European interest.
- Specific Road Map Working RWGs have been set-up, for activities related to the Roadmap in four main areas as identified by ESFRI members. These are the Social Sciences and Humanities (SSH), the Environmental Sciences (ENS), the Bio and bioMedical Sciences (BMS), the Physical Sciences & Engineering (PSE)[5].
- The RWGs should fulfil an ongoing strategic process to help ESFRI and its stakeholders to implement and update the Roadmap.
- It is reminded that only ESFRI is responsible for the identification of individual projects within the roadmap.

[5] In addition the e-IRG group is providing input to ESFRI in the e-infrastructure domain.

Creation and update of an RWG

- An RWG is set-up by ESFRI and chaired by an ESFRI member, having expertise and/or qualifications in the general field of the RWG that would inspire the confidence of that community. The nomination of the chair of an RWG is made according to the rules of procedure of ESFRI.
- The duration and composition of the RWG, its field of activity, and its specific terms of reference are indicated by ESFRI. ESFRI will also update the composition, field and terms of reference, as necessary.
- It is essential that RWGs represent the whole range of topics to be discussed. On this basis, the members of the Group are proposed and finally nominated after discussion with the chair through the national delegations (with CV)[6]. They should have high scientific and/or managerial qualification and integrity, capable to integrate his/her contribution in developing a strategic and independent science-policy advice. If the balance of the nominations is not correct the RWG chair alerts the ESFRI chair, who in turn alerts the ESFRI delegations.
- In all applicable cases, with the agreement of ESFRI, the RWG should liaise with the intergovernmental and/or international organizations already acting in the relevant fields.
- ESFRI agrees the final composition of the RWG, which is then published on the website.

Activities

- The activities of the RWGs are the following:

  - Monitor and advise ESFRI on the best procedure to support the efforts for the implementation of the Roadmap, reporting to ESFRI on the specific RIs and on strategic aspects and/or bottlenecks, e.g. suggesting proper initiatives to support negotiations between the interested parties and/or overcome the lack of appropriate institutional arrangements;

  - Follow the general development of the EU and Global RI landscape in the field, advise ESFRI on the best procedures to stimulate the maturity of emerging or missing proposals and evaluate new (limited amount of) proposals forwarded by ESFRI delegations.
- The process of evaluation of existing and new projects must be transparent in every aspect of its definition, in order that all stakeholders can be confident in the final recommendations;
- The RWG chair is responsible for the timetable and good organisation of the meetings, for which he/she may be helped by an EC official assigned to each Group[7].
- RGW reports are regularly presented to ESFRI and published in the ESFRI web site.

Method of working:

- Meetings of the RWG will be held in closed-sessions; all information exchanged and prepared within is meant for internal use only, unless explicitly stated.
- Members of the RWG must declare any conflict of interest whenever it occurs, in relation of specific projects being discussed; such conflicts will not necessarily bar them from participating in the Group.
- Each Group should discuss the need and best way to protect the confidentiality of their deliberations, to allow for open discussions within the group. In addition, while keeping internal discussions confidential, the method of working should allow the group to communicate with the scientific community in the most appropriate way, in order to gather all the necessary information and assure the transparency of the process. Every different opinion should be recorded in the reports to ESFRI.

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[6] Member State could decide whether they wish to be represented in every RWG provided that the group is balanced.

[7] Other EC official(s) who are specialists in the field might attend the meetings as observers.

- The RWG may seek independent scientific, technical or socio-economic advice, making use, as necessary, of existing bodies and/or specific experts e.g. through workshop or time-limited expert groups to deepen the discussion in specific fields.
- The RWG should not become the expression of any specific lobby-group supporting or opposing a specific proposal.
- The RWG should not generate itself projects but should advise ESFRI on the best process to stimulate important proposals which are missing in their fields, and evaluate the proposals emerging from this process.
- The Groups should meet and consult as necessary and in accordance with the needs of the timetables set down by ESFRI.
- The Chairs of the RWG should report to ESFRI whenever required by ESFRI. Specific evaluations of projects proposed for the Roadmap and specific suggestions for strategic initiatives should be presented in written reports, detailing procedures followed and experts used.

Resources, time scale, deliverables and review

- Resources to cover travel expenses of RWG members will be covered by each delegation.
- Chairs of the RWG must be able to provide their own secretarial support.
- The Roadmap and RWG deliberations are an ongoing process, and ESFRI indicates the required timescales for specific deliberations.
- General information on the RWG activities and the RWG reports should normally be circulated through the ESFRI Secretariat.
- The work, rationale and composition of each Group will be reviewed by ESFRI on a yearly basis, and after approving each edition of the Roadmap.

Annex VII – List of proposals received

No.	Title
RU03	MYRRHA
RU07	CTA
RU08	3MERL
RU12	FHS
RU13	ATRA
RU14	L-SURF
RU17	CECAM
RU19	EMFL
RU20	CYCLOPE
RU21	DAFNE
RU26	LVR-HALE
RU27	NFFA
RU29; RU29a	ECCSEL
RU31	Software services
RU33	IPURE
RU34, RU 34a	TEREI; TEREI Solar
RU36, RU 36a	WindScanner; Turbulence
RU37	MAX-IV
RU38	EISCAT
RU39	PRIN-CE
RU40	DYNAMO

Physical Sciences and Engineering

Roadmap Working Group Report 2008

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