Proposal full title	**Cluster of Research Infrastructures for Synergies in Physics**
Proposal acronym	**CRISP**
Type of funding scheme	Combination of Collaborative Projects and Coordination and Support Actions for Construction of New Infrastructures – Implementation Phases
Work programme topics addressed:	INFRA-2011-2.3.4 Implementation of common solutions for a cluster of ESFRI Infrastructures in the field of Physics, Astronomy and Analytical Facilities.
Name of the coordinating person:	Michael Krisch

List of Participants

Participant no.	Participant Short Name	Participant organisation name	Country
1	ESRF (Coordinator)	European Synchrotron Radiation Facility	France
2	DESY	Deutsches Elektronen Synchrotron Hamburg	Germany
3	CERN	European Organisation for Nuclear Research	Switzerland
4	ESS	European Spallation Source	Sweden
5	GANIL	Grand Accélérateur National d'Ions Lourds	France
6	GSI	GSI Helmholtzzentrum für Schwerionenforschung GmbH	Germany
7	ILL	The Institut Max von Laue – Paul Langevin	France
8	XFEL	European X-Ray Free-Electron Laser Facility GmbH	Germany
9	ROMA1	Universita degli studi di Roma la Sapienza	Italy
10	FORTH	Foundation for Research & Technology Hellas	Greece
11	IST	Instituto Superior Tecnico Lisbon	Portugal
12	INFN	Istituto Nazionale di Fisica Nucleare	Italy
13	MTA SZTAKI	Magyar Tudomanyos Akademia Szamitastechnikai es Automatizalasi Kutato Intezet	Hungary
14	IFIN-HH	National Institute of Physics and Nuclear Engineering	Romania
15	UOXF.DB	Oxford University	United Kingdom
16	PSI	Paul Scherrer Institute	Switzerland

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1. Scientific and/or technical quality, relevant to the topics addressed by the call

1.1 Concept and objectives and progress beyond the state-of-the-art

The Cluster of Research Infrastructures and Synergies in Physics (CRISP) purpose is to create synergies and develop common solutions for an initial group of eleven ESFRI-PPs (European Strategy Forum on Research Infrastructure preparatory phase) projects in the field of Physics, Astronomy, and Analytical Facilities. Its ultimate aim is to supply the best service to the rapidly growing and largely diversified user community, and to ensure that the large investments made at the national and international levels result in significant progress in science.

CRISP's participating partners comprise operating facilities currently undergoing major upgrades (ESRFUP, FAIR, ILL 20/20, SLHC, and SPIRAL2), new Research Infrastructures (RIs) which have entered the implementation stage (ESS and XFEL), and RIs well advanced in their preparatory phase and ready to progress towards implementation (ELI, EuroFEL, ILC-HiGrade, and SKA). Their common intent is to provide a word-class level service to the European Research Area: sensitive to the needs of a broad range of user communities, responsive to diverse and changing demands in a highly dynamic environment. They cover a variety of scientific goals together with a range of experimental methods and techniques.

CRISP is a cooperative project. It offers the partners opportunity to enhance their own infrastructures whilst sharing research and development efforts. Under CRISP, the partners propose a greater exchange of ideas and expertise: to better serve user communities; to retain the lead in technological progress and scientific sophistication; to achieve enhanced levels of development; and to exploit complementary know-how.

Through the mutual exchange of test and commissioning results, an improved and accelerated learning curve shall be achieved, leading ultimately to faster implementation. Joining expertise and experience will avoid fragmented approaches and uncoordinated efforts; furthermore it will significantly reduce risks associated with individual RI projects.

The scientific and technical work to be completed as part of the CRISP project reflects the main challenges the RIs are facing or will face in the near future. Their solution requires a concerted action amongst the RIs, rather than the individual effort of single RIs, and thereby supports the implementation of these RIs. Key topics identified within these challenges have been clustered into Topic Groups (as shown in Table B1.1 below) namely: 1) Accelerators, 2) Instruments & Experiments, 3) Detectors & Data Acquisition, and 4) Information Technology & Data Management.

	ELI	ESRFUP	ESS	EuroFEL	FAIR	ILC-HiGrade	ILL 20/20	SKA	SLHC	SPIRAL2	XFEL
Accelerators	x	x	**X**	x	**X**	**X**			**X**	**X**	**X**
Instr & Exp	**X**	**X**	**X**	x	x		**X**			x	**X**
Det & DAQ	x	**X**	x	**X**	**X**		**X**	**X**	x	**X**	x
IT & DM	**X**	x	x	**X**	x	**X**	x	**X**	**X**	x	x

Table B1.1 Participation of ESFRI projects to the four CRISP topics Accelerators, Instruments & Experiments, Detectors & Data Acquisition, Information Technology & Data Management (small crosses). The bold crosses indicate their major areas of activity within the CRISP project.

The detailed objectives within the four scientific and technical topics of the CRISP project are outlined below.

1 Accelerators

The development of novel accelerator components and their characterisation is a pre-requisite to reach beyond state-of-the-art performance of accelerator complexes which are in turn one of the key elements for the majority of the participating RI projects. The proposed developments constitute the basis to deliver beams with superior intensity, operate accelerators with high reliability, and achieve beam characteristics which will allow opening new perspectives and opportunities for the next generation of nuclear and high energy physics projects and experiments in photon, neutron and ion beam science. Within the accelerator topic nine of the ESFRI projects are participating in the following tasks:

1.a) The development of an ion source and related beam diagnostics is of central importance for FAIR and SPIRAL2. The FAIR and SPIRAL2 facilities both need a high performance electron cyclotron resonance ion source (ECRIS) to create the high intensity beams required for the envisaged nuclear studies. The two former ion sources financed in the framework of the FP6-EURONS – ISIBHI (MS-ECRIS, A-PHOENIX) are both facing R&D challenges, while the foreseen start of beam delivery is approaching very fast (2012 for SPIRAL2 and 2014 for FAIR). A new design of ECRIS is required by both facilities. SPIRAL2 and FAIR shall engage themselves in the joint development and construction of a new prototype 28 GHz ECR ion source. Joining efforts and expertise is particularly important for the construction of a cost-effective ECRIS and to minimise the project risk of the superconducting magnet design. A second task is related to the common development of a diagnostic device for the non-intercepting bunch shape measurement for the linear accelerator section of the FAIR and SPIRAL2 projects. No standard device for the determination of this important beam parameter exists. Due to the comparable beam parameters for the FAIR and SPIRAL2 machines, development and construction costs can be reduced.

1.b) Superconducting radio-frequency (SRF) technology is used for almost all future large scale accelerator projects. New accelerator structures with improved characteristics were or are to be developed for the participating projects ESS, ILC-HiGrade, SLHC, and XFEL. Highest accelerator performance requires optimised production, surface treatment, and diagnostics of the accelerating structures. The knowledge and mastering of these technologies becomes even more important since large scale production involves large scale series production in industry. The accumulated know-how of EuroFEL, ILC-HiGrade, SLHC (at CERN) and XFEL (at DESY) shall be exploited to further improve the quality of the SRF accelerator cavities by pushing further the detailed diagnostics tools and the surface treatment of the cavities. At DESY an optimised procedure for a second surface treatment required to improve the performance of returns will be investigated and established as a critical element to reach the performance goals of XFEL. At CERN the upgrade of the SM18 test facility is a central ingredient for the common activities. A comprehensive transfer of knowledge to new projects e.g. ESS and SLHC is an essential part of the work, thus guaranteeing an optimum sharing of the acquired know-how and ensuring the best performance of the accelerators at these and other future facilities.

1.c) The development of fast ramped superconducting magnets is of central importance for the planned synchrotron SIS300 at the FAIR facility. For SLHC it is important to assess whether the technology is suitable and adapted to the construction of the future injector chain of the LHC. The proposed common development is furthermore of key importance as well for accelerator-based medical applications (e.g. hadron therapy). ELI, FAIR and SLHC (at INFN, GSI and CERN, respectively) engage themselves in a joint effort to further optimise the design of the magnet. Future accelerator facilities will rely on the use of these magnets in order to meet their ambitious goals.

1.d) The joint design of a compact high brightness electron beam and of laser-induced secondary particle sources is of direct benefit to ELI and EuroFEL. It shall create synergies between the “classical” and the laser-based accelerator community. Its interest is to overcome limits that both communities are facing. The high intensity laser community is proposing a laser induced secondary particle source as the next generation of particle accelerators able to produce within the same scheme high quality electron beams as well as protons or other ions with an accelerating gradient of the order of TV/m which cannot be achieved with conventional accelerators. Similarly, other novel acceleration schemes rely on high brightness electrons, presently used in conventional free-electron lasers (FEL), to be fed by plasma accelerators. Moreover, there is a growing interest in developing compact (e.g. X band structures) high brightness electron sources directly for FEL applications as well as more innovative ones. The proposed development of laser induced particle sources and compact electron sources aims at joining the competences of ELI and EuroFEL demonstrating and implementing groundbreaking solutions for the particle accelerators of the next generation.

1.e) The ESFRI projects ESRFUP, ESS, FAIR and SLHC all require Megawatts of radio-frequency (RF) power to accelerate particles. Conventionally, this power is generated by klystrons, but in recent years LDMOS-FET transistors have become an attractive alternative. The CRISP project aims to take forward the preparatory phase by elaborating a new efficient way to combine the power of many RF transistor modules by means of a single cavity combiner. This concept will result in a more compact, flexible and cost effective design with improved operation reliability. Within the frame of the proposed work, a prototype will be built for ESRFUP and design studies for ESS, FAIR and SLHC shall be performed; these will have a significant impact on the way these projects will envisage the implementation of the high power RF generators that are needed to power their accelerating RF cavities.

Existing synergies within the accelerator based research infrastructures will be strongly supported by the tasks defined within this proposal. Superconducting technology, either applied to radio-frequency cavities or to beam transport magnets, will be used for most of the upcoming large scale accelerator projects; the use of solid state amplifiers adapted to a variety of accelerating structures strongly supports this. All participating projects require ambitious particle sources design, either for high intensity ion beams or to drive free-electron lasers with their high brilliance electron beams. These initiatives will push accelerator facilities to performances beyond state-of-the-art.

2 Instruments & Experiments

Parallel to the further development of accelerators, new concepts and technological advances beyond the current state of knowledge need to be developed for the scientific experiments and their related instrumentation in order to keep pace with the more performing sources. During the past decade the research community has witnessed a trend to more sophisticated experimental set-ups, increasingly complex sample environments, and a suite of novel applications in a broad range of scientific disciplines. This has often stimulated new developments, which have been undertaken, to a large extent, within a single research infrastructure. In order to fully exploit the capabilities of the upgraded and new facilities, a joint effort needs to be made, aimed at common developments and deployment of common protocols, tools and equipment. This shall offer unity to a portfolio of experimental stations offering unprecedented performances to the rapidly growing user community. Added to this, it shall facilitate the user migration from one RI to another. Within the Instruments & Experiments topic eight RI projects are participating and the proposed work shall focus on four main aspects.

2.a) The advent of free-electron lasers has opened the door to time-resolved studies with femto-second resolution, considerably extending the nano- to pico-second time regime available at storage ring based synchrotron radiation sources. The study of phenomena on the *μs to fs* time scale is of central relevance across all disciplines of natural science and is one of the most rapidly growing research fields. Time resolved studies will impact the design of the new instruments for ESRFUP, EuroFEL, and XFEL, and prepare perspectives for ESS and ILL 20/20. The central aim is to consolidate the needs and the new tools for time resolved studies, as only a concerted approach will be able to unify the different user communities and provide them with the best instrumentation and expertise. The work comprises the establishment of a white book on common needs and instrumentation for time-resolved studies at free-electron laser, synchrotron, and neutron facilities and the joint development of specific electronic devices.

2.b) The success of the currently operating facilities is the motivation for the new projects at ESS, FAIR, ILL 20/20 and SPIRAL2. The research to be performed at these RIs covers a broad range of physics including nuclear structure, astrophysics, neutrino and plasma physics, applied science like material and biophysical research, and many more. One of the common features of all these future facilities is the tremendous increase of beam intensities of several orders of magnitude compared to the present situation. In general this requires new concepts, methods, and equipment to be used in highly-activated areas with very restricted access which can only be jointly developed. Innovative solutions for remote handling will allow an efficient maintenance of equipment and will lead to an optimisation of the facilities operation in terms of, for example, secondary beam delivery time. The participating RI projects will profit from an advanced radioactive waste management by avoiding the amount of radioactive waste as much as possible already from the outset, i.e. from the overall conception to the engineering detail design of equipment, consumables, and tools required to operate the experiments. All the achievements of the CRISP project will be implemented directly into the conceptions and the construction phase of the upcoming facilities and will thus contribute to a limitation of investment costs.

2.c) The explosion of interest in the study of biological systems over the past decade has been driven by rapid developments in biotechnology as well as increased exploitation of physical techniques in studying biological phenomena and inspiring rational design of biomedical and functional materials. The trend towards integrative approaches in characterising biological systems is clearly set to grow rapidly in the coming decade. These approaches place increasing demands on the combined and synergistic deployment of neutron and x-ray methods in structural characterisation. It is evident that efficient exploitation will benefit hugely from the development of common environments involving standardised approaches at all levels of experimental investigation, regardless whether experiments require neutrons or X-rays, and regardless of the facility at which they are carried out. The ESRFUP, ESS, EuroFEL and ILL 20/20 partners involved in this task shall develop an environment that will put x-ray and neutron biological experiments on a common experimental interface such that everything from sample mounting to data collection, reduction and analysis will be carried out in a standardised way. The ILL20/20 partner will benefit from combined neutron/x-ray capabilities, adding considerable value to neutron measurements alone. In the case of high-resolution macromolecular crystallography and fibre diffraction, this will occur through the ability of joint x-ray/neutron datasets to enhance data/parameter ratios. Furthermore, x-ray data, used alongside neutron datasets, provide powerful insights arising from the use of much smaller beams (micro and nano beams) - this is of particular importance for the study of partially ordered biological systems where structural heterogeneity is often a key aspect relating structure to function. ESRFUP will benefit from joint exploitation of neutron and x-ray results; high resolution crystallographic neutron data provides information on the location of hydrogen atoms and the specific orientation of water molecules that for the vast majority of cases is simply inaccessible to x-ray crystallography. At low resolution, neutron small-angle solution scattering allows contrast variation to be used to distinguish between different domains of a macromolecular system, strongly complementing small-angle x-ray scattering data and providing structural envelope information required for x-ray FEL structure determination and inferred dynamics. This work will be essential for EuroFEL to exploit the potential of free electron lasers for the study of biological systems.

2.d) The expected increased performance of existing and future neutron sources critically depends on joint efforts in instrumentation. The goal within this project is to develop instrumentation which will increase the intensity of neutron beams by up to two orders of magnitude. This task will focus on three major issues: the feasibility of directional neutron moderators, the design of optimised ultra cold neutron (UCN) sources and innovative neutron delivery devices. Experimental tests and numerical simulations will be performed to check the feasibility of neutron moderators, especially in the range of cold neutrons that will make neutron sources more directional, therefore increasing the brightness of the sources. The current design for UCN sources ought to be enhanced by increasing existing volume and density of super fluid ^{4}He as neutron moderator. Finally, more efficient neutron supermirrors with reduced γ–ray emission and long lifetime will be developed at ILL20/20 and ESS. Such developments will strongly impact the performance of the instruments at the two facilities, and in conjunction with the proposed detector developments, offer the neutron user community completely new perspectives in their research fields.

3 Detectors & Data Acquisition

The need for efficient and high performance detectors and their associated instrumentation is common to essentially all RI projects. Some of the new RIs in preparation heavily rely on the construction of new detector systems that go beyond current, well established technologies. Other RIs need to develop completely new approaches. Research and development efforts, undertaken by individual facilities, are, however, cost intensive; and common developments and sharing of expertise and know-how are often key ingredients for significant progress. Furthermore, with the expected increased performance of the upgraded and new RIs, novel and more performing data acquisition and signal processing standards need to be developed. Ten of the ESFRI projects take part in the Detectors & Data Acquisition topic as follows:

3.a) High-throughput detector data streaming is of direct relevance to ELI, ESRFUP, EuroFEL, SKA, and XFEL. The tremendous improvements promised by the new or upgraded light sources (storage rings, FELs, lasers) will be compromised if the detectors do not cope with the timing and/or information rates that are likely to be produced by the very intense photon beams produced at those facilities. In a similar way, the performance of radio telescope arrays is also directly related to the capability of processing in real time the very large data records produced by the thousands of sensing elements and antennas that constitute this kind of instrument. The work will address the selection, definition and development of various techniques and methods to reduce, transmit and process high throughput data streams produced by the last generation detector systems. In addition to technical and scientific performance, the aim is to establish a certain level of standardisation of methods and interfaces. The implementation of common interfaces for the data streams will have a substantial impact on interoperability of the detector systems, both within and across the facilities, and therefore should imply a substantial reduction of deployment and operation costs.

3.b) The development of CO_2 cooling systems is indispensable for the next generation of particle detectors. SLHC is the driving project in this development, and EuroFEL and FAIR will strongly benefit for their own applications of this technology, in particular for high-performance silicon tracking detector systems and highly integrated electronic assemblies where efficient low-mass cooling is a key prerequisite for novel system concepts. In comparison to fluorcarbon based cooling fluids, CO_2 two-phase cooling possesses superior thermodynamic properties, is less expensive, and is much more environment-friendly. This cooling scheme, whilst serving the CRISP participants, will find wide-spread applications well beyond the CRISP project. The common work plan shall join forces and expertises in the design and construction of these devices.

3.c) The common development of advanced electronics and software for neutrons and γ-ray detectors is of direct benefit to ELI, FAIR, and SPIRAL2 for their upcoming accelerator facilities. Nuclear structure and radioactive ion beam experiments at these facilities require modern data acquisition electronics and algorithms adapted to the advanced γ-ray tracking and neutron detection systems that will become operational on a time scale of a few years. Common solutions for the realisation of the experimental set-ups are planned by expanding the developments and standards performed during the SPIRAL2 preparatory phase and making them applicable also for ELI and FAIR. The work shall focus on the preparation of front-end electronics cards with improved data throughput, calibration and post-processing performance to be deployed across the facilities.

3.d) Neutron detectors require the use of neutron absorbing elements. Until recently, ^{3}He was widely exploited because of its easy use and the high neutron capture efficiency. However, ^{3}He has become a very scarce and highly expensive material for several reasons: decrease in the production rate (most of the nuclear reactors producing tritium from which ^{3}He is generated have been stopped) and the increase in the demand for neutron science (large area detectors) and homeland security in the United States. All neutron facilities worldwide are impacted by this situation. Finding a substitute to ^3He is a formidable task which is to be tackled in the long term by the whole neutron scattering community. However, both ILL20/20 and ESS projects rely on rapid progress on a new detector technology. Several technological options exist (solid ^{10}B, ^{10}B in highly toxic gaseous BF_3, scintillators). ILL20/20 and ESS are proposing to establish collaborative plans for the design and feasibility studies of a neutron detector based on solid ^{10}B films technology as a substitute to ^3He gas. Once the feasibility of this technology is demonstrated in terms of efficiency, and manufacturing & maintenance costs, a global evaluation of the different methods will be done at the European and worldwide levels.

4 Information Technology & Data Management

The importance of experimental data for modern science is growing daily, and new initiatives are required to cope with the resulting "data deluge". The rapid development and increasing complexity of experimental techniques, instruments and detectors requires developments beyond the current state-of-the-art. To fully justify the huge investments made in scientific instruments, the data produced by these instruments must be securely and efficiently stored, archived, annotated, queried, and linked.

A number of concrete examples can be easily identified. A sustainable and interdisciplinary metadata management service bridging a federation of data catalogues across RIs can significantly enhance scientific progress by reducing the time to discover distributed resources. Proper curation of open scientific data, linked to corresponding publications, can help to foster a wider public understanding of fundamental scientific achievements. An authentication and authorisation mechanism common to all users of different RIs can greatly simplify the access to distributed resources. These examples show how a common IT platform for the storage, discovery, access, and processing of data can improve the current status of research in Europe.

These needs are of common interest to all the ESFRI projects involved in this proposal. They will participate in the development and prototype deployment of solutions for IT and Data Management (DM) co-operating in different aspects as follows:

4.a) The development of a common user identity system, Authorisation and Authentication Infrastructure (AAI), permitting access to data and IT resources of the following RIs: ESRFUP, ESS, EuroFEL, FAIR, ILL 20/20, and XFEL will follow a modular design to allow its incorporation with minimal effort into existing and future IT systems. Because of its federated structure, this solution will be cost and resource effective and will allow for the first time a single user identification system between the participating RIs. A prototype of a unique user identification system is developed in EuroFEL by PSI.

4.b) Selection and implementation of metadata management and data mining services common to ESRFUP, ILL 20/20, and SLHC will enable an efficient discovery of the data produced by the participating RIs instruments. Such services will also contribute to the set up of a data continuum environment where published scientific results are connected to raw data. The development and deployment of common metadata services and a data continuum environment will provide concrete tools to support new scientific methods and paradigms while improving both the efficiency of the scientific process and its impact across distributed RIs.

4.c) Development of a common solution for the high-speed recording of data to permanent storage and its long-term archival within a single site will be undertaken by ESRFUP, ESS, EuroFEL, ILL 20/20, SKA and XFEL. This work will: (i) address the challenges faced by increased data volumes and data rates delivered by the latest generation of scientific instruments; (ii) improve the availability of data by properly archiving it for many years; and (iii) enable an easy integration of domain-specific software by exploiting standard data-access protocols. The development of a common approach for all RIs will enable knowledge transfer and the deployment of cost-effective solutions.

4.d) Analysis and deployment of prototype distributed computing data infrastructures, to support the expanding data management needs for ELI, EuroFEL, FAIR, SKA, and SLHC will be carried out. The work will focus not only on data management services and tools but also on the associated network aspects, which will result in the experimentation and the definition of a roadmap of a common distributed data infrastructure among the participating RIs. This target is of central importance for researchers which utilise several RIs and need to have access to their personal computing environment, collected data and results, quickly and as easily as possible.

All the previously mentioned aspects are important points in the internal programme of work of the different participating RIs. Working together on the delivery of common solutions brings two immediate advantages: internally, the deployed IT solutions represent complete solutions resulting from a larger development effort; externally, the deployed IT solutions are not limited to the RIs scope but have instead concrete links to other RIs.

The CRISP project will also contribute to the on-going activity to develop a European Roadmap on e-infrastructure and the adoption of open standards. This will include availability within the project to contribute to workshops and other dissemination activities in the FP7 SIENA project. Representing a domain cluster of leading RIs, which all have stringent requirements will also contribute to an e-infrastructure use case that is relevant to the user community. Where appropriate contact shall be made with the ongoing efforts in Standards Development Organisations to ensure that the standards developed within them are relevant to our use case. This may occur either through supporting e-infrastructure providers or directly for community groups relevant to our users.

Participating Beneficiaries / ESFRI projects

P No.	ESFRI-PP Projects	ELI	ESRFUP	ESS	EuroFEL	FAIR	ILC-HiGrade	ILL 20/20	SKA	SLHC	SPIRAL2	XFEL
CRISP Beneficiaries												
1	ESRF – Coordinator		**CO ORD**									
2	DESY				**CO ORD**		**CO ORD**					P
3	CERN									**CO ORD**		
4	ESS			**CO ORD**								
5	GANIL										**CO ORD**	
6	GSI					**CO ORD**						
7	ILL							**CO ORD**				
8	XFEL											**CO ORD**
9	ROMA1	P										
10	FORTH	P										
11	IST	P										
12	INFN	P			P	P				P		
13	MTA SZTAKI	P										
14	IFIN-HH	P									P	
15	UOXF.DB								**CO ORD**			
16	PSI				P							

Table B1.2 Overview of participating ESRFI projects and involved beneficiaries: Coordinators (COORD) and participating beneficiaries (P) are indicated.

The table shows the initial eleven ESFRI projects participating in the CRISP proposal and their respective Beneficiaries. The CRISP project will be open to all the remaining six ESFRI-PP projects in the cluster of Physics, Astronomy and Analytical Facilities, being: CTA-PP, E-ELT, EMFL, KM3net, PRINS and TIARA, at such time as they would wish to join the project as beneficiaries, and have reached the stage of moving from preparatory to implementation phase. They are invited to join the Steering Committee as observers (see section B2.1).

ELI The Extreme Light Infrastructure (ELI) is a European project, involving nearly 40 research and academic institutions from 13 EU Members Countries, and a pan-European Laser facility, aiming to host the most intense lasers world-wide. The facility will form an integrated infrastructure based on four sites. The first three sites will be situated in Prague (Czech Republic), Szeged (Hungary) and Magurele (Romania) and should be operational in 2015. The fourth site will be selected in 2012 and is scheduled for commissioning in 2017. In the Czech Republic, Prague, the ELI pillar will focus on providing users with high energetic particle (10 GeV) ultra-short particle bunches and radiation (up to few MeV) beams produced from compact laser plasma accelerators. In Hungary, Szeged, the ELI pillar will be dedicated to extremely fast dynamics by taking snap-shots of the electron dynamics in atoms, molecules, plasmas and solids on the attosecond scale. In Romania, Magurele, the ELI pillar will focus on laser-based nuclear physics. ELI will make possible radiation and particle beams with much higher energy suited to nuclear process studies. 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 (generating intensities exceeding 10^{23} W/cm^2). The ELI-PP started in November 2007, and is coordinated by the CNRS Paris. It will finish on 31 December 2010; at that time it is expected that the facility in the Czech Republic will receive first funds.

ESRFUP The European Synchrotron Radiation Facility Upgrade (ESRFUP) project supports activities being completed as part of the wider upgrade programme at the ESRF. The research facility is the European flagship of synchrotron radiation research with a portfolio of top-class instruments and more than 6000 scientific user visits across all disciplines of natural sciences from physics over life sciences to new areas such as palaeontology and cultural heritage. The academic output accounts for more than 1600 publications per year in peer-reviewed journals. ESRFUP started in October 2007 for a duration of four years, and in November 2008 the ESRF Council approved the official launch of Phase I of the ESRF Upgrade (2009 -2016). The upgrade shall further strengthen the scientific programme with new and upgraded experimental stations, and an increased emphasis on scientific partnerships, applied sciences and industrial applications. It is expected that the facility will stay at the forefront of synchrotron radiation research for the next 20 to 30 years. As an existing RI, the most important challenges to face are (i) to further improve the performance of the accelerator complex, (ii) to develop new and better instruments with increased performance and an optimised scientific infrastructure, (iii) to attract new user communities and offer an efficient user support, (iv) to cope with the constantly increasing amount of data recorded and to be managed. All these aspects are addressed within the CRISP proposal.

ESS The European Spallation Source (ESS) will be a joint European neutron source for studies of properties of materials in disciplines ranging from physics and engineering science to life sciences and medicine serving a community of more than 5000 users. ESS will be the first long pulse spallation source and will, based on proton accelerator and target technology capable of unprecedented power levels, provide users with new and world leading capabilities for research at 22 or more dedicated instruments. Currently, sixteen European countries are represented in a Steering Committee and collaborate to update the design of ESS with the intention to build it in Lund, Sweden. Collaborations between laboratories to design and prototype the accelerator, target and instruments are at an advanced stage with collaboration agreements and contracts drafted. After the completion of the design update phase in 2012 and the signing of an international convention for the construction and operation of the facility, construction will start in 2013. First neutrons will be produced in 2019 and full power with 22 instruments in operation will be reached in 2025. Full scientific output is expected a few years later and it is foreseen that the ESS will stay in the world lead for decades to follow.

EuroFEL The Free Electron Laser Facility (EuroFEL) will be the future consortium of national free electron laser (FEL) facilities in Europe. As a distributed research infrastructure EuroFEL will offer a unique set of novel laser light sources with complementary characteristics and instrumentation for a wide range of scientific applications, combining the scientific potential of the exceptional spectral range of synchrotrons and the femtosecond pulse duration and coherence of conventional lasers. The efficient construction and operation of the new FEL facilities require cutting edge developments in accelerators, experimental techniques, fast two-dimensional pixel detectors and data handling as well as a common user identity system to access the data and IT infrastructure. These topics are addressed in CRISP, and EuroFEL contributes to the work and benefits from the collaboration and synergies with the other research infrastructures. It is intended to set up EuroFEL as an ERIC although the construction and operation of the individual FEL facilities are predominantly funded by the national governments. The facilities include initially FLASH at DESY (in operation since 2005), FERMI@Elettra (starting operation in 2011), SwissFEL at PSI (funding approval expected 2011) and the Short-Pulse-Facility of MAX IV (under construction). The preparatory phase project IRUVX-PP has worked out a structure and a statute for EuroFEL and is currently preparing a detailed activity plan for the intermediate phase between the end of IRUVX-PP in the summer of 2011 and the foundation of the EuroFEL ERIC.

FAIR The Facility for Antiproton and Ion Research in Europe (FAIR) will generate antiproton and ion beams of a previously unparalleled intensity and quality. About 3000 scientists and engineers are already involved in the planning and development of the facility and its experiments. FAIR will support a wide variety of science cases: extreme states of matter using heavy ions, atomic physics, nuclear structure- and astrophysics, hadron physics with antiprotons, atomic and plasma physics as well as biological and material sciences. The high intensities at FAIR constitute various challenges, which are addressed in the present proposal. High intensities require very efficient accelerators, remote handling in activated areas, novel methods of cooling for the detectors, progress in collaborative computing and synergies between the various RI concerning the interaction with industry. In October 2010 FAIR was founded by means of an international agreement. Already six countries became official share holders of the company (Germany, Russia, Sweden, Finland, Romania and India). More countries are actively pursuing their parliamentary ratification processes in order to join FAIR.

ILC-HiGrade The International Linear Collider (ILC) is a proposal for an electron-positron collider to operate at energies up to 500 GeV with a possible extension up to 1 TeV to perform precision studies that have had in the past a profound impact on shaping and testing our current understanding of the universe. The importance of such a machine was recognised in the European Strategy for Particle Physics promulgated by the CERN Council, in which it was characterised as “fundamental to complement the results of the LHC” and “a unique scientific opportunity”. The decision of ESFRI to incorporate the CERN Council Strategy into its Road Map thus underlined the importance of the ILC in the future landscape of European research infrastructures.

The ILC is based on superconducting radio-frequency (SRF) accelerating structures, as pioneered by the TESLA Technology Collaboration predominantly based in Europe. The technology is now being applied in the construction of the European XFEL. The same accelerating structures will be used for the ILC. If the ILC is to be affordable, it is essential to maximise the accelerating gradient in the cavities to minimise the length and thereby the cost of the collider. This improvement in gradient constitutes the main difference with respect to the cavities of the European XFEL. The FP7 PP programme ILC-HiGrade started in February 2008 and addresses this point using technical infrastructure in European laboratories. ILC-

HiGrade is developing advanced technical tools to explore the quality of the produced SRF structures. With hundreds of cavities being produced for the European XFEL in the next years, the European partners are in an excellent position to monitor and understand the technical features that limit the gradient in the structures. Whilst this effort is primarily targeted to satisfy the demands of the ILC it will be beneficial for the European XFEL and future projects such as ESS and other users of SRF accelerating structures.
The Global Design Effort (GDE) for the ILC is carried out in a global context with roughly equal contributions from the three regions Americas, Asia and Europe. The GDE will summarise its work in a Technical Design Report in 2012. This report will form the basis for a decision for construction of the ILC and in particular of hosting the facility in any of the three regions. The CERN Council has commissioned an update of the European Strategy for Particle Physics, due in 2012, which may include a plan to bid for hosting a linear collider in Europe. The engagement of ILC in CRISP thus underlines this important role in the context of large research facilities.

ILL 20/20 The Institut Laue Langevin (ILL) has been at the forefront of neutron science and techniques for almost 40 years. It operates the most intense slow neutron source in the world, feeding intense beams of neutrons to a suite of 40 high-performance instruments that are constantly upgraded. Every year around 2000 scientists visit the ILL from over 1000 laboratories, in 45 different countries across the world: at ILL they perform over 700 experiments per year, in fields as diverse as solid-state physics, condensed matter physics, material science, chemistry, biology, nuclear physics and engineering. The scientific activities at ILL lead to the publications of over 600 articles by ILL users appearing in peer-reviewed journals per year.

A key factor in this success has been successive campaigns to ensure its instruments enable the community to perform the best possible science. The latest renewal project – the Millennium Programme – has completed its first phase (2001-2008), and is well into its next phase (2007-2014) of development and upgrade. It has already delivered 14 new or radically upgraded instruments, increasing the average instrument detection rate by a factor of almost 20. The current phase will deliver 8 new or upgraded instruments, as well as supporting infrastructure. The work at the institute on the ESFRI-PP project ILL 20/20 is integral to the sustained development of ILL's service provision. It is instrumental in the preparation and delivery of initiatives to boost the overall efficiency of ILL's instrument suite by a factor of thirty by 2011. Taking forward the ESFRI-PP activities, ILL plans to address challenges faced by neutron facilities in general and the ILL in particular to include research on soft condensed matter the enhancement of neutron source brightness, an alternative to ^{3}He neutron detectors, a synergetic approach for scattering methods in biology, and the handling of metadata. These tasks will improve ILL capacities to respond to users' needs, in the next twenty years paving the way for the next phase of the *Millennium Programme*.

SKA The Square Kilometre Array (SKA) will be an ultrasensitive radio telescope, built to further the understanding of the Universe, including the birth and eventual death of the Universe itself, fundamental physics and the origins of planets, stars and galaxies. The SKA will be an array of coherently connected antennas (aperture arrays plus dishes) concentrated in a core but with antennas reaching distances about 3000 km, from the core. With an aggregate antenna collecting area of up to 10^6 m^2 at centimetre and metre wavelengths it will outperform existing facilities by orders of magnitude. There are currently precursor facilities being developed on both of the possible sites for the core of the SKA.

SKA is a global project with partners from all the major developed nations engaged in astrophysics. 20 countries have been making a commitment to the ongoing support of SKA through financial contributions to the SKA Science and Engineering Committee (SSEC). The current project execution plan for the SKA envisages the formation of a new legal entity to

govern the SKA project from 2012 onwards and this entity will, through a board, take over managing the construction and operational budgets and will ensure future sustainability.
The physical scale of the project will introduce significant technical challenges. The strong demands SKA places on signal and data processing, and the need to find scalable solutions for these challenges means implementation of solutions developed for SKA and its precursors have the potential to positively impact on solutions developed across the ESFRI projects, combined and coordinated through CRISP.

SLHC The Large Hadron Collider Upgrade project SLHC at CERN, the European Organisation for Nuclear Research, aims at a ten-fold luminosity increase to optimally exploit the unique discovery potential of this world's most powerful accelerator. The LHC provides research facilities for several thousand high-energy physics researchers. Its experiments are designed and constructed by large international collaborations and will collect data over a period of 10-15 years generating around 15 petabytes of data per year. The three year preparatory phase project for the LHC luminosity upgrade (SLHC-PP) started in 2008 and is preparing for a smooth increase of performance of the LHC. This upgrade involves several new elements and technical improvements, both in the chain of LHC injectors, in the LHC itself (new focusing magnets in the interaction regions) and in the general purpose LHC experiments ATLAS and CMS. It is planned to proceed with the upgrade of the injectors and a first step of the upgrade of the detectors during a one year shutdown in 2016, and to implement the complete upgrade of the LHC Interaction Regions and a second phase upgrade of the ATLAS and CMS detectors during a long shutdown in 2020. Afterwards, the LHC is expected to deliver an integrated luminosity per year between 5 and 10 times of the design value until ~2030.

SPIRAL2 SPIRAL2, a new European facility is to be built at GANIL laboratory in Caen, France. The project aims at delivering stable and rare isotope beams with intensities not yet available with present machines. SPIRAL2 together with FAIR will reinforce the European leadership in the field of nuclear physics based on exotic nuclei and as such was selected for the ESFRI road-map. The main goal of SPIRAL2 is clearly to extend the knowledge of the limit of existence and the structure of nuclei to presently unexplored regions of the nuclear chart, in particular in the medium and heavy mass regions. The scientific program proposes the investigation of the most challenging nuclear and astrophysics questions aiming at the deeper understanding of the nature of matter. It also addresses many different types of applications of nuclear physics of interest to the society, such as nuclear energy and medicine, radiobiology and material science.

The construction of SPIRAL2 is going to last about 7 years (2006-2014) and will benefit from knowledge transfer in the field of ion source and beam diagnostic development as well as concepts for highly activated areas with only very restricted access. The project is co-funded by CEA/DSM, CNRS/IN2P3, local authorities in Normandy, EC and international partners. It is expected that the realisation of SPIRAL2 will substantially increase the know-how of technical solutions to be applied not only for EURISOL but also in a number of other European and world projects.

XFEL The European X-Ray Free-Electron Laser Facility (XFEL) is an international research infrastructure for the usage of coherent, intense and ultrashort soft and hard x-ray free-electron laser (FEL) radiation. Operated as a user facility the European XFEL will enable completely new research opportunities in a wide range of scientific disciplines with an enormous impact in areas such as energy research, health medication and nano-sized and functional materials. The European XFEL will provide access for a large user community by simultaneous operation of many experiments. New technologies, like super-conducting acceleration, dedicated instrumentation, novel detectors and data acquisition concepts and high throughput data handling, are required to enable operation at high repetition rates from several kHz up to few MHz. All of these goals are in line with the scope of this proposal. A major research infrastructure item is the super-conducting accelerator built through collaborations with scientific institutes and European industry. This proposal aims at the optimisation of several of the interfaces between scientific institutes and industrial providers and thus constitutes an important milestone for future implementation of large accelerator-based projects, such as ESS, SLHC, ILC-Higrade, and even for smaller projects as those envisioned by EuroFEL and ELI. European XFEL is organised as a limited liability company under German law, according to the terms established by an inter-governmental Convention signed so far by 11 countries. Construction of the facility started in 2008 and first beam is scheduled for 2014. In 2016 the facility will commence its initial 11 years operation phase.

1.2 S/T methodology and associated work plan

i) Overall strategy of the work plan

The overall strategy as contained in the Pert diagram, work plan, Gantt charts, and Tables 1.2a-e, is summarised as follows:

WP1 Management: The Coordinator, ultimately responsible for the implementation of the CRISP project, will ensure delivery of the project through the conduct of rigorous legal and financial administration. Procedural mechanisms will be established by the Coordinator to facilitate performance monitoring and reporting; detect problems and execute corrective actions; and provide good communication and sound decision making.

WP2 Dissemination and Industry Related Activities: Will be managed in close collaboration with the Coordinator, the Topic Leaders (see below), the participating RIs and the Beneficiaries. This will ensure full communication of the achievements across the CRISP project and facilitate outreach and dissemination activities, including: non-academic publications, engagement in promotion events, communication via a dedicated website, and topical workshops on industry related activities. In particular the establishment of relations with industry shall provide the essential link between the technological achievements within CRISP and its exploitation and further development by European industries.

WP3 to WP6 Scientific and Technical Activity:

Concept: The eleven ESFRI projects initially involved in the CRISP proposal cover a diverse range of methodologies forming a heterogeneous group. They however share a collective interest in the CRISP topics, albeit with variable geometry, and are therefore formed into *Topics*, namely: Accelerators (WP3 A-E), Instruments & Experiments (WP4 A-D), Detectors & Data Acquisition (WP5 A-D), and Information Technology & Data Management (WP6 A-D) to reflect the natural flow of scientific and technical activity of the RIs.

Work Packages: Each WP within a Topic Group (TG) will be supervised by a manager (WPM) responsible for leading the work package team, to execute the defined tasks, to produce the WP's deliverables, and to liaise with the respective Topic Leader.

Topic Leaders (TL): Will form a layer between the Steering Committee and individual work packages by acting as mentors within their TG to: encourage common solutions and create synergies between WPs; hold 6-monthly Topic Meetings; provide the conduit between the WP managers and the Executive Group; and attend the Steering Committee meetings.

Executive Group: Will be responsible for the overall management of operations and report to the Steering Committee. It will be led by the Coordinator and shall comprise the WP2 leader and the four Topic Leaders.

The Steering Committee: Will meet on an annual basis and shall guide the project within the parameters of the Grant Agreement. It shall receive reports of activity through the Executive Group and oversee the direction and delivery of the project. Its voting members, being the beneficiaries of the involved eligible ESFRI projects participating in CRISP, shall form the decision-making body of the consortium.

Reporting Flow: The activities of the WPs will be monitored to ensure compliant use of allocated funds. The WPMs will report performance on a regular basis to their Topic Leaders to enable early detection of problems/delays in the execution work. This will be reported to the Executive Group. Where corrective action is required, this shall be communicated to the Steering Committee: if of material importance, the SC's formal decision shall be called for.

Financial Control: Funds shall be distributed to the beneficiaries by the Coordinator in accordance with the Grant Agreement and its Annexes. In addition to the obligatory financial declarations at the end of each year, the Coordinator shall request provisional expenditures from the beneficiaries every other six months, in order to detect significant deviation.