SEVENTH FRAMEWORK PROGRAMME

Capacities Specific Programme

Research Infrastructures

European Coordination for Accelerator Research and Development

http://www.cern.ch/EuCARD/

Combination of Collaborative Project and Coordination and Support Action

Grant Agreement number 227579

Annex I - "Description of Work"

19th December 2008

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Part A

A1. Project summary and budget breakdown

A.1 Project summary.

Particle physics stands at the threshold of a new era of discovery and insight. Results from the much awaited LHC are expected to shed light on the origin of mass, supersymmetry, new space dimensions and forces. In July 2006 the European Strategy Group for Particle Physics defined accelerator priorities for the next 15 years in order to consolidate the potential for discovery and conduct the required precision physics. These include an LHC upgrade, R&D on TeV linear colliders and studies on neutrino facilities. These ambitious goals require the mobilisation of all European resources to face scientific and technological challenges well beyond the current state-of-the-art and the capabilities of any single laboratory or country. EuCARD will contribute to the formation of a European Research Area in accelerator science, effectively creating a distributed accelerator laboratory across Europe. It will address the new priorities by upgrading European accelerator infrastructures while continuing to strengthen the collaboration between its participants and developing synergies with industrial partners. R&D will be conducted on high field superconducting magnets, superconducting RF cavities which are particularly relevant for FLASH, XFEL and SC proton linacs, two-beam acceleration, high efficiency collimation and new accelerator concepts. EuCARD will include networks to monitor the performance and risks of innovative solutions and to disseminate results. Transnational access will be granted to users of beams and advanced test facilities. Strong joint research activities will support priority R&D themes. As an essential complement to national and CERN programmes, the EuCARD project will strengthen the European Research Area by ensuring that European accelerator infrastructures further improve their performance and remain at the forefront of global research, serving a community of well over 10,000 physicists from all over the world.

The EuCARD project is a Combination of Collaborative Project and Coordination and Support Action with duration of 48 months and is formed by a consortium of 37 partners.

A.2 List of beneficiaries

List of Beneficiaries

Beneficiary Number	Beneficiary name	Beneficiary short name	Country	Date enter project	Date exit project
1	European Organization for Nuclear Research	CERN	INO	M1	M48
2	Austrian Research Centers GmbH	ARC	Austria	M1	M48
3	Helmholtz-Zentrum für Materialien und Energie	HZB	Germany	M1	M48
4	Budker Institute of Nuclear Physics	BINP	Russia	M1	M48
5	Commissariat à l'Énergie Atomique	CEA	France	M1	M48
6	Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas	CIEMAT	Spain	M1	M48
7	Centre National de la Recherche Scientifique	CNRS	France	M1	M48
8	Columbus Superconductors SpA	COLUMBUS	Italy	M1	M48
9	Instituto de Fisica Corpuscular (Consejo Superior de Investigaciones Cientificas – Universitat de València)	CSIC	Spain	M1	M48
10	Deutsches Elektronen-Synchrotron	DESY	Germany	M1	M48
11	Bruker HTS GmbH	BHTS	Germany	M1	M48
12	Ecole Polytechnique Fédérale de Lausanne	EPFL	Switzerland	M1	M48
13	Forschungszentrum Dresden-Rossendorf e.V.	FZD	Germany	M1	M48
14	Forschungszentrum Karlsruhe GmbH	FZK	Germany	M1	M48
15	Gesellschaft für Schwerionenforschung mbH	GSI	Germany	M1	M48
16	The Henryk Niewodniczanski Institute of Nuclear Physics Polish Academy of Sciences	IFJ PAN	Poland	M1	M48
17	Istituto Nazionale di Fisica Nucleare	INFN	Italy	M1	M48
18	The Andrzej Soltan Institute for nuclear studies in Swierk	IPJ	Poland	M1	M48
19	Politecnico di Torino	POLITO	Italy	M1	M48
20	Paul Scherrer Institut	PSI	Switzerland	M1	M48

21	Politechnika Wrocławska	PWR	Poland	M1	M48
22	Royal Holloway University of London	RHUL	United Kingdom	M1	M48
23	Russian Research Center “Kurchatov Institute”	RRC KI	Russia	M1	M48
24	University of Southampton	SOTON	United Kingdom	M1	M48
25	Science and Technology Facilities Council	STFC	United Kingdom	M1	M48
26	Politechnika Lodzka	TUL	Poland	M1	M48
27	Tampere University of Technology	TUT	Finland	M1	M48
28	Helsingin Yliopisto (University of Helsinki)	UH	Finland	M1	M48
29	Université Joseph Fourier Grenoble	UJF	France	M1	M48
30	University of Lancaster - Cockcroft Institute	ULANC	United Kingdom	M1	M48
31	University of Malta	UM	Malta	M1	M48
32	Université de Genève	UNIGE	Switzerland	M1	M48
33	University of Manchester - Cockcroft Institute	UNIMAN	United Kingdom	M1	M48
34	The Chancellor, Masters and Scholars of the University of Oxford	UOXF-DL	United Kingdom	M1	M48
35	Universität Rostock	UROS	Germany	M1	M48
36	Uppsala Universitet	UU	Sweden	M1	M48
37	Politechnika Warszawska	WUT	Poland	M1	M48

A.3 Overall budget breakdown for the project.

Participant number and short name		Estimated eligible costs in € (whole duration of the project)						Requested EC contribution
		RTD (A)	Coordination (B)	Support (C)	Management (D)	Other (E)	Total (A+B+C+D+E)	
1	CERN	5,782,181	824,707	287,380	831,360	0	7,725,628	2,268,558
2	ARC	61,880	0	0	0	0	61,880	30,940
3	HZB	281,050	0	0	0	0	281,050	76,000
4	BINP	103,858	0	0	0	0	103,858	31,150
5	CEA	3,359,706	0	0	0	0	3,359,706	1,030,795
6	CIEMAT	379,080	0	0	0	0	379,080	114,000
7	CNRS	2,072,006	92,202	0	0	0	2,164,208	697,570
8	COLUMBUS	88,320	0	0	0	0	88,320	28,300
9	CSIC	104,020	0	0	0	0	104,020	31,206
10	DESY	1,594,840	199,544	0	0	0	1,794,384	617,090
11	BHTS	82,324	0	0	0	0	82,324	29,000
12	EPFL	105,280	0	0	0	0	105,280	78,960
13	FZD	281,050	0	0	0	0	281,050	76,000
14	FZK	349,774	0	0	0	0	349,774	121,100
15	GSI	1,376,466	0	0	0	0	1,376,466	412,250
16	IFJ PAN	60,800	0	0	0	0	60,800	24,320
17	INFN	2,151,459	75,200	0	0	0	2,226,659	690,595
18	IPJ	319,480	0	0	0	0	319,480	125,860
19	POLITO	192,340	0	0	0	0	192,340	57,702
20	PSI	331,190	0	0	0	0	331,190	103,000
21	PWR	489,120	0	0	0	0	489,120	244,600
22	RHUL	712,016	0	0	0	0	712,016	216,220
23	RRC KI	151,200	0	0	0	0	151,200	45,000
24	SOTON	66,080	0	0	0	0	66,080	21,300
25	STFC	2,079,632	0	481,812	0	0	2,561,444	843,700
26	TUL	374,800	0	0	0	0	374,800	149,920
27	TUT	88,960	0	0	0	0	88,960	26,700
28	UH	824,320	0	0	0	0	824,320	249,000
29	UJF	0	199,544	0	0	0	199,544	125,900
30	ULANC	580,070	0	0	0	0	580,070	175,920
31	UM	48,480	0	0	0	0	48,480	14,544
32	UNIGE	120,000	266,592	0	0	0	386,592	151,700
33	UNIMAN	1,341,099	0	0	0	0	1,341,099	396,900
34	UOXF-DL	600,960	0	0	0	0	600,960	182,700
35	UROS	279,680	0	0	0	0	279,680	83,900
36	UU	735,296	0	0	0	0	735,296	220,300
37	WUT	258,000	161,402	0	0	0	419,402	207,300
Total		**27,826,817**	**1,819,191**	**769,192**	**831,360**	**0**	**31,246,560**	**10,000,000**

Part B

B1. Concept and objectives, progress beyond the state-of-the-art, S/T methodology and work plan

B.1.1 Concept and project objectives

Context

Particle physics stands at the threshold of a new era of discovery and insight. Results from the much-awaited Large Hadron Collider (LHC) are expected to shed light on the origin of the mass, on the existence of new particles predicted by supersymmetry, new forces and new dimensions of space. These observations will have relevance to fundamental questions in cosmology about antimatter, missing mass and energy.

Following any discoveries, a phase of precision physics is needed to measure and validate parameters and physics models. To reach the required precision, various solutions are foreseen, including significant upgrades to increase the LHC luminosity and/or energy, and TeV scale electron accelerators. They all require significant advancements of accelerator science and technology.

During the course of this process, applications in other branches of science and technology can emerge, such as superconducting accelerators for intense ion beams or a fourth generation of light sources (FEL), as well as important practical applications including non-invasive medical diagnostics, cancer therapy, biology, materials science and environmental monitoring.

The large research facilities in Europe, serving over 10,000 physicists from around the world, have made essential contributions to accelerator science throughout its history. These include the national laboratories and CERN, the largest particle physics laboratory in the world. The size, complexity and cost of their research infrastructures, coupled with the technological advances required to implement successful upgrades, clearly require that European efforts be further strengthened and integrated. This shall help facing the major international decisions to be made within the time scale of the FP7 program to choose and locate the next “world” accelerator.

Concept

The EuCARD concept is to improve the performance of the European accelerator infrastructures (Table B.1.1) while continuing to strengthen the collaboration between its European partners. It builds on and consolidates the extensive collaboration successfully initiated by FP6-CARE. In so doing, EuCARD offers a forum to all accelerator experts, including those engaged in other FP7 topical initiatives.

The relative importance of the IA components is tailored to accelerator R&D. Like in CARE, the emphasis is on Joint Research Activities (JRA), which are critical to the upgrade of the accelerators.

Networking activities (NA) are an essential ingredient to exchange and strengthen collaborations. Experts from other communities, including those outside the IA, will as well be invited, providing coordination with other European actions.

Accelerator laboratories have long established transnational access (TA) procedures for end users. In addition, two innovative accelerator test facilities will be opened for the first time to users from other fields.

Table B.1.1: List of Infrastructures concerned by the project with their relationship with the EUCARD WPs.

Laboratory	Infrastructure	Description	NA	TA	JRA
CERN, Geneva	LHC	7 TeV hadron collider	4		7, 8, 10, 11
	LHC Injectors	Proton linac, booster, PS, SPS synchrotrons	3, 4		7, 8, 10
	CNGS@SPS	450 GeV proton beam line and target to produce muon neutrinos for Gran Sasso detector	3		
	CTF3	2 beam CLIC test facility	4		9
	SRF test facility	Facility for the processing and test of superconducting RF cavities	4		
	HiRadMat@SPS	Beam induced shocks (SPS)	4	5	8
INFN, Frascati	DAΦNE	0.51 GeV e+e- collider, Φ-factory,	4		9, 11
	SPARC Lab	e- linac based VUV FEL as test facility for SPARCX	4		11
STFC Daresbury	EMMA	20 MeV non-scaling FFAG e-ring	3		11
GSI, Darmstadt	SIS, FAIR	Heavy ion acceleration	4		8
DESY, Hamburg	FLASH	Superconducting 1 GeV electron Linac/FEL	4		10
	PETRA III	6 GeV X ray light source			9
	TTF	Superconducting RF cavity processing facility: CHECHIA, clean rooms, EP, …	4		10
FZD Dresden, Rossendorf	ELBE	Quasi continuous wave mode Superconducting 12 MeV to 40 MeV electron linac based light and radiation source,			10
LOA/CNRS Paris	PlasmAc	Plasma wave acceleration test station	4		11
LAL Orsay	SupraTech RF infr	Coupler test facility	4		10
HZB, Berlin	Hobicat	CW RF cryo test facility	4		10
Cockcroft I. Daresbury	SRF test facility	RF infrastructure, ERLP, 4GLS	4		10
STFC-RAL, Oxford	**MICE**	Muon Ionization/Cooling Experiment	3	6	

Priorities and Objectives

The EuCARD activities follow closely the latest priorities defined by recognized European Associations and bodies:

a) EuCARD has been launched by the European Steering Group for Accelerator R&D (ESGARD), set up by the directors of CERN, CEA-DSM-IRFU, DESY, INFN-LNF, CNRS-IN2P3, PSI and STFC, in consultation with the European Committee for Future Accelerators (ECFA), for the optimisation and enhancement of R&D in the field of accelerator physics in Europe;

b) concerning particle physics, the priorities are those of the CERN Council document "The European strategy for particle physics", Lisbon, 2006.

c) Concerning nuclear physics and light sources, the priorities are consistent with the "roadmap of the European Strategy Forum on Research Infrastructures ESFRI", 2006.

The following scientific objectives of EuCARD match these priorities:

- Design, study and build prototype models of high field Nb_3Sn superconducting magnets, complementary to US and Japanese efforts with this forefront technology and to the more usual Nb-Ti based option, included in the SLHC-PP project.
- Design, study and test innovative collimators, for safe handling of higher power beams.
- Improve normal conducting linac technologies (acceleration, stabilization, vacuum dynamics).
- Explore fundamental issues concerning the high gradient superconducting RF cavity technology, study the physics processes involved and seek for implementing innovative techniques, beyond the ILC-PP work.
- Assess Novel Accelerator Concepts, addressing emerging technologies.

The R&D studies motivated by these objectives are carried out in the framework of the JRA's in a highly collaborative manner. Four networks are foreseen to support all JRA's and open them to outside experts. In addition, two technological test facilities will be opened to the broad scientific community through Transnational Access.

B.1.2 Progress beyond the state of the art

More precise indications on the above-mentioned EuCARD objectives are given for the three types of activities NA, TA and JRA.

Networking activities

The development objectives are often at the crossroad of several technologies and branches of accelerator sciences, requiring the collaboration of various competences. In this respect, the role of the networking activities will be of a catalysis nature, by circumventing the natural fragmentation into specialties. They will foster a coherent and multi-disciplinary approach.

A first domain of action shall be the efficient dissemination of information and generated results: the publications will be monitored and made accessible in a targeted manner and links will be established between close scientific fields of research inside and outside the consortium.

The second domain of action will be the scientific networks around three main scientific/technical themes: neutrino facilities, accelerators and colliders performance, and RF technologies. These networks shall be the backbone of the consortium, with, as their main tools, the organization of topical meetings and mini-workshops, and the capability of inviting or exchanging experts over periods of typically a week to a month. They shall contribute to the exchange of ideas and expertise between beneficiaries and between the consortium and external organizations, with the goal of identifying the most promising upgrade strategies and technologies. The networks will be the unique place where the particle physicists, users of the infrastructures, will be able to interact with the accelerator scientists at a detailed technical level and influence the upgrade paths for optimal overall performance of accelerators and detectors.

During the EuCARD period 2009-2013, major decisions on upgrades and new world-accelerators are expected to take place. For the neutrino facilities with a decision planned around the end of 2012, for the electron linacs with a decision between 2010 and 2012 when LHC results will be known and for the LHC major upgrade in 2010 or 2011. From the CARE experience and received expressions of interest, the EuCARD networks are expected to attract experts and organisations beyond the Consortium, from other related EU initiatives like SLHC-PP, ILC-PP, EuroNu DS and from large non-European partners like KEK in Japan and the US accelerator laboratories. The resulting concentration of world expertise shall be a solid asset for the development of the infrastructures concerned by this project and for the development of a dynamical European Research Area.

Transnational access activities

The two transnational installations are in construction with completion planned before or soon after the beginning of EuCARD:

i) the MICE (STFC) facility for experimentalists wishing to investigate muon ionization cooling or to perform tests with high quality low energy beams of muons, electrons, protons or pions,

ii) an irradiation facility on the SPS accelerator at CERN allowing to send MJ proton beams with a pulse length of a few μs to a target, and to perform experiments that are in the interest of many researchers investigating the impact of pulsed irradiation.

These facilities are also of primary importance for the beneficiaries of the Consortium within their joint research or network activities.

Joint research activities

- **High field magnets:**

The goal of this theme is the development of a new generation of accelerator quality magnets (dipoles, quadrupoles and undulators) able to exceed the capabilities of Nb-Ti magnets by a significant factor (potentially two or more with an HTS insert). The challenges are related to the brittleness of the Nb_3Sn material, its strain sensitivity, possible flux instabilities and practical implementation issues. No such magnet is presently installed in an accelerator. This theme is aimed at assessing the practical potential of this technology. The increased performance will serve the accelerator upgrades in various ways. For the LHC luminosity upgrade, the quadrupole aperture can be increased for a given gradient, thereby allowing a stronger focusing at the interaction point to produce a higher collision rate. The larger margin in critical temperature obtained with Nb_3Sn will be used to mitigate the larger heat deposition from the secondary particles emerging from the collisions. Altogether the LHC peak and integrated performance and the operation efficiency will be significantly improved, up to a factor of 10 when combined with other upgrades under other themes. The same technology can be applied to the dipole magnets receiving a large heat deposition, such as dispersion suppressor dipoles in the LHC, exposed to particles diffracted by the collimators. In combination with High Temperature Superconducting (HTS) coils the magnetic field could be further boosted. A success in increasing significantly and in a cost-effective way the field of magnets opens the possibility of doubling or tripling the LHC energy with a large enhancement of its physics reach. The undulators share a similar requirement of increasing the magnetic field by mastering the Nb_3Sn technology.

- **Collimators and materials:**

The beam stored energy in hadron accelerators has to further increase to allow higher performance. Yet, the machines have to be efficiently protected. A specialized “collimator” community is building up in Europe and elsewhere in the world with so far independent research programs in individual laboratories. The joint research activity will foster collaboration and further advances in this field. Important outcomes shall be i) a better modelling of the beam halo dynamics, a critical step in predicting the performance of collimators, ii) a selection of materials that at the same time can sustain the very high instantaneous energy deposition, are compatible with ultra-high vacuum and do not present to the beam a significant electro-magnetic impedance. These materials will also be characterized for their radiation resistance. Finally three technologies will be tested by prototyping and testing collimators: room-temperature, cryogenic and crystal-based collimators, the latter being entirely innovative.

- **Normal Conducting Linacs:**

Normal Conducting accelerating structures presently achieve useable accelerating gradients of up to 80 MV/m; for higher gradients the breakdown rate becomes unacceptably high – an as yet unsolved issue. Demonstration of high gradient acceleration is one of the main objectives of the purpose-built CTF3 facility at CERN. Both NC and SC linear colliders require extremely small (nanometre) beam sizes at collision, so common issues concern ultra-low emittance generation and conservation, and beam stability. The “NCLinac” work package focuses on major issues in high-gradient acceleration and beam stabilisation, complementary to current research programs: from simulation and understanding of break-downs in high-gradient accelerating structures to global integration of accelerator modules, mechanical and alignment constraints to the µm-scale and very high accuracy synchronisation (20 fs). The investigations on emittance preservation methods and beam handling in the final focus (ATF2 at KEK) will provide strategies and beam diagnostics prone to improving the performance of accelerators handling beams of very small size.

- **Superconducting RF:**

Pioneering R&D work on Superconducting Radio Frequency (SRF) accelerator systems was started in the field of electron storage rings for high-energy physics as well as heavy ion accelerators. Meanwhile, SRF technology has matured and is in operation in many particle accelerators. Energy recovery mode is a modern accelerator concept, which is made possible through the use of SRF technology. Today’s applications at the frontier of SRF accelerator technology are FEL linacs (XFEL) and linear colliders for high-energy physics (ILC). An operating gradient of 40 MV/m was demonstrated at the FLASH FEL. In contrast to the ILC-HiGrad Preparatory activities in FP7, which are related to establish a high performance yield in industrial fabrication, the aim of EuCARD is to push the R&D towards improving fundamental issues of superconducting RF as described below. The SRF activities in EuCARD cover a broad range from material investigation, improvements in cavity fabrication and processing, the design and fabrication of new prototypes, to beam based investigations in FLASH.

- **Assessment of novel accelerator concepts:**

This theme groups three important topics regarding novel accelerator concepts in three different fields: high luminosity colliders, technologies required by neutrino facilities and plasma wave accelerator techniques. The new collision scheme characterized by an innovative correction of higher order optics aberrations combined with large angle beam crossing holds the promise of increasing the luminosity by more than two orders of magnitude beyond the current state-of-the-art in colliders. The planned instrumentation for the world’s first so-called non-scaling FFAG (Fixed Field Alternate Gradient) (EMMA, STFC) shall allow a better understanding of the beam dynamics. Finally the measurement of ultra-short electron beams is instrumental to the assessment of laser plasma acceleration

B.1.3 S/T methodology and associated work plan

B.1.3.1 Overall strategy and general description

EuCARD has selected the high performance, and sometimes unique, research infrastructures of the particle accelerator community, and defined the following strategy with the aim of improving them:

1. establish a framework that will allow researchers from different scientific and cultural backgrounds to collaborate on clearly defined problems,
2. combine resources for targeted RTD tasks to make significant improvements in the field of accelerator-based physics (high energy and FEL light sources),
3. open some world class research facilities to a wider community of scientific users.

The strategy for networks is to enlarge their content and appeal, possibly resulting in new synergies, while limiting the scope sufficiently to allow productive participation. They are closely linked to the RTD activity described below and bring together the teams performing the technology research, but address in general a wider audience. According to these principles, two independent networks are foreseen: the accelerator neutrino community network NEU2012 and the accelerator technology network AccNet. The latter consists of two sub-units, EuroLumi for issues related to collective effects for higher brightness beams and RFTech which focuses on the issues of RF acceleration, control, power generation and distribution and SRF test infrastructures. A third network ensures overall dissemination, communication and outreach.

Guideline when structuring the RTD activities was to separate tasks only when the overall productivity would benefit, and combine where feasible in order to bring together experts in the same field, even if they are working on different projects in different accelerator facilities. These separate technological fields can be characterized as follows:

- HFM: superconducting high field magnets,
- ColMat: high performance collimation of intense beams,
- NCLinac: high gradient normal-conducting acceleration and beam stability issues for future linear colliders,
- SRF: exploration of new technologies to obtain higher performance superconducting cavities, and
- ANAC: assessment of novel accelerator concepts, including schemes for increasing the accelerator yield capacity and a promising laser-plasma technique for electron acceleration.

Two excellent and unique research facilities were identified which could benefit potential users outside the EuCARD community. The first, HiRadMat@SPS, is a purpose-built facility to test materials subjected to extremely high pulsed radiation; the second, MICE, is an accelerator facility built for muon cooling experiments, which provides a unique muon beam with well controlled characteristics.

The integration of the various activities creates natural links and emphasizes synergies (Figure 1). For example:

- the accelerator neutrino community network is closely linked to the muon cooling facility MICE and to the task aimed at improving the electron model for muon acceleration (EMMA) within the ANAC JRA;
- the community of experts working on collimators for very high intensity beams opens the facility HiRadMat@SPS for transnational access;
- the coordinated actions of overall project management and DCO (Dissemination, Communication and Outreach) extend to all other work packages, allowing progress monitoring and information dissemination.

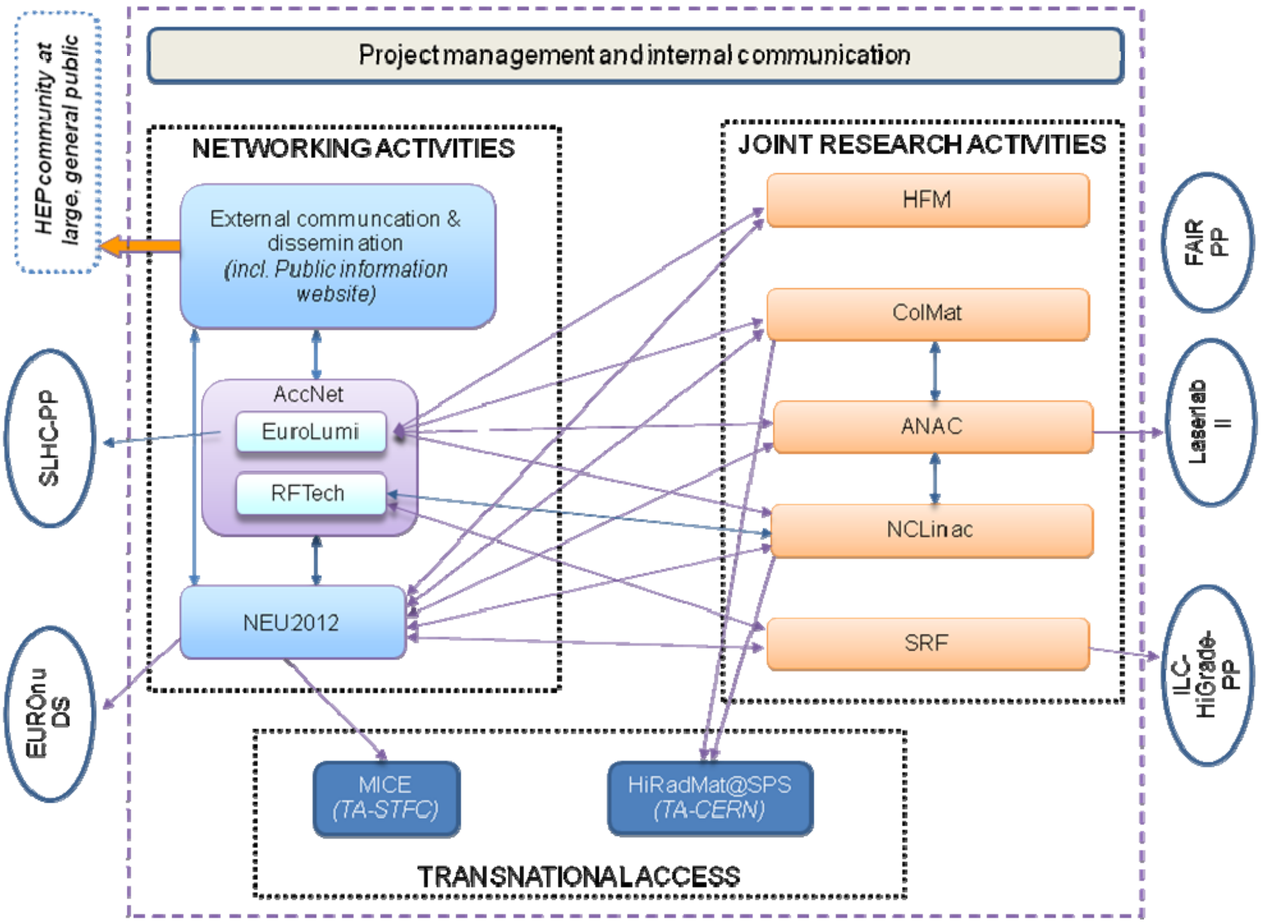

Figure 1. Diagram showing interdependencies

<u>Assessment of risks and contingency plans</u>

The EuCARD work packages and tasks, even though inter-related, are not critically interlinked, as can be observed on Figure 1. Therefore, no significant risk can be identified. Indeed several upgrade possibilities are explored in parallel with the final upgrades being a combination of the successful partial ones. Hence a partial failure in one of the 39 tasks is not going to compromise the success of the whole IA. Most of the deliverables are scientific/technical in nature and aim at an improvement in performance beyond the “state-of-the-art”. For this reason the achievement of the results cannot be guaranteed at 100%. The associated risks will be mitigated by the support of the best world experts in the field and a strong support, including financial, from their home institutes. Furthermore, the goals underlying the deliverables, even though beyond the state-of-the-art, have been judged reasonable given the duration and funding level of the IA, and the available expertise within the consortium.

Some external risks are listed in Table B.1.3. Most work packages involve collaboration from 3 to 14 institutes allowing mitigation by the WP coordinators in case of delays or excessive work load. Risks in terms of coordination have been mitigated by choosing two co-coordinators per WP. There is a certain risk that the scientific manpower to be hired is not immediately available on the market with the correct competence profile. In such a case, the workload will have to be re-distributed and/or specialised training will be organized. This would delay the production of the deliverables concerned. Failures in timely delivery of components to the specification may disorganise a task’s work plan or even endanger it. Constant project monitoring done at three levels (tasks, WP’s, IA) will help detecting critical situations early. CERN has a long-standing tradition in the implementation of complex projects in terms of technical progress and financial follow-up, and modern project management tools will be employed to insure the consistent review of expenditures and achievement of technical milestones and deliverables, so that appropriate counter-measures can be initiated in a timely manner by the Project Steering Committee. The most likely consequence is a delay in producing deliverables.

In the unlikely event that significant delays or major disruptions of the work programme occur, the Governing Board will be convened and corresponding adjustments of the work programme and schedule will be agreed upon by the Consortium. In such a case, the EC Project Officer will be notified immediately of the situation, and the proposed adjustments of the work programme will be discussed.

Table B.1.3: Significant risks and contingency

WP	Significant risks	contingency
3	Missing conclusions from neutrino facility studies outside IA	Continuous follow-up and collaboration, otherwise delay.
7	FP6-CARE-NED Nb_3Sn conductor not available from supplier	2 alternative suppliers available
9	Unavailability of ATF2 (Japan)	Reschedule, identify what can be done in ANKA and DAΦNE
10.6	Too few beam time in FLASH	carry all tests not involving beam cavity interactions in the CHECHIA cryostat facility

B.1.3.2 Timing of work packages and their components

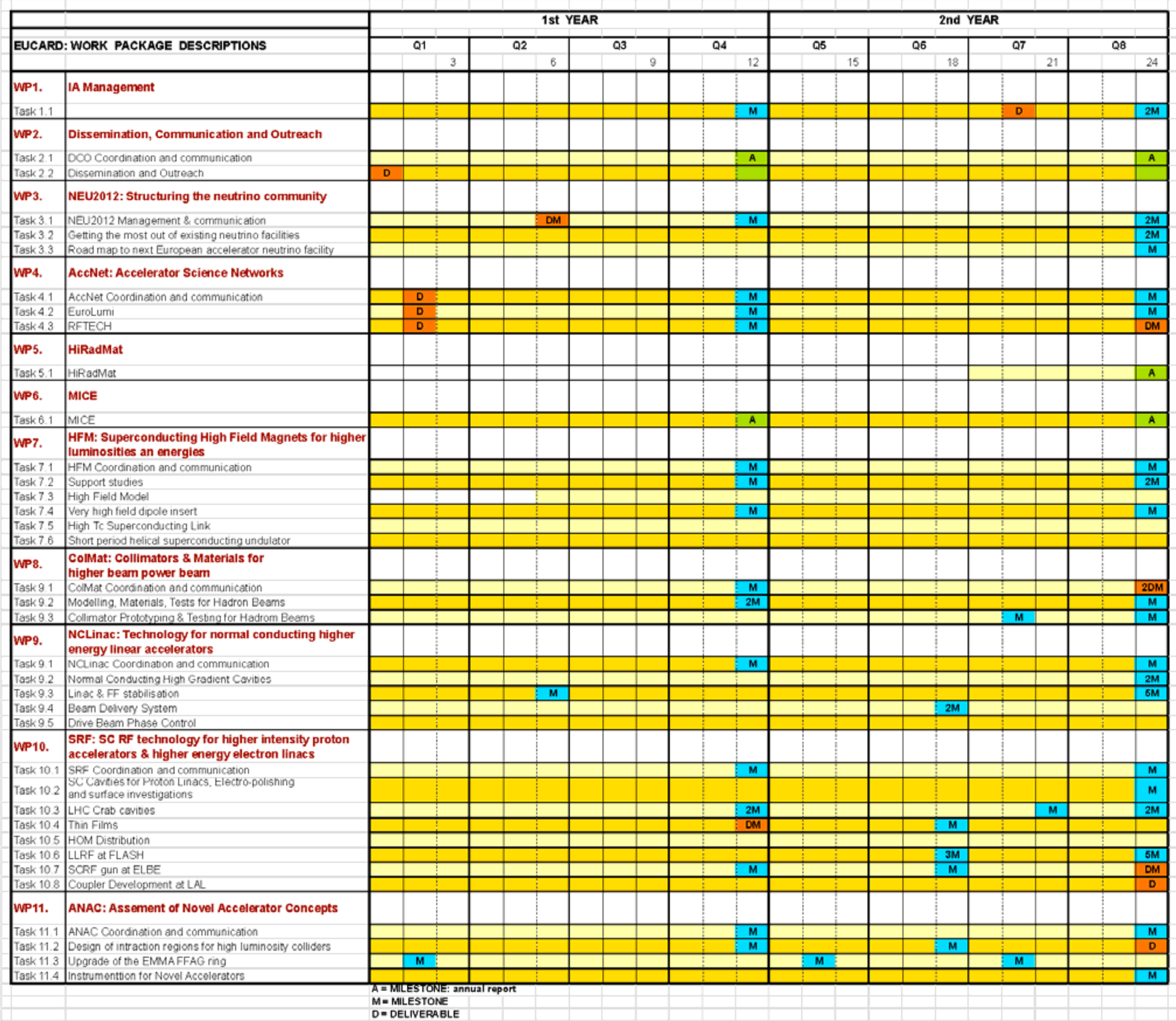

Figure 2a. Timing of the WPs, tasks, Milestones and Deliverables, first 2 years

		3rd YEAR												4th YEAR													
	EUCARD: WORK PACKAGE DESCRIPTIONS	Q9			Q10			Q11			Q12			Q13			Q14			Q15			Q16				
				27			30			33			36			39			42			45			48		50
WP1.	IA Management																										
Task 1.1													M		D										M		D
WP2.	Dissemination, Communication and Outreach																										
Task 2.1	DCO Coordination and communication												A												DA		
Task 2.2	Dissemination and Outreach																								D		
WP3.	NEU2012: Structuring the neutrino community																										
Task 3.1	NEU2012 Management & communication												M												DM		
Task 3.2	Getting the most out of existing neutrino facilities																D										
Task 3.3	Road map to next European accelerator neutrino facility																D										
WP4.	AccNet: Accelerator Science Networks																										
Task 4.1	AccNet Coordination and communication												M												DM		
Task 4.2	EuroLumi												M												DM		
Task 4.3	RFTECH												M												DM		
WP5.	HiRadMat																										
Task 5.1	HiRadMat												A												A		
WP6.	MICE																										
Task 6.1	MICE												A												A		
WP7.	HFM: Superconducting High Field Magnets for higher luminosities an energies																										
Task 7.1	HFM Coordination and communication												M												DM		
Task 7.2	Support studies												D						D								
Task 7.3	High Field Model												M						M						D		
Task 7.4	Very high field dipole insert																								D		
Task 7.5	High Tc Superconducting Link										M						D										
Task 7.6	Short period helical superconducting undulator												M												D		
WP8.	ColMat: Collimators & Materials for higher beam power beam																										
Task 8.1	ColMat Coordination and communication												M												DM		
Task 8.2	Modelling, Materials, Tests for Hadron Beams												D														
Task 8.3	Collimator Prototyping & Testing for Hadrom Beams		M				DM						M						D								
WP9.	NCLinac: Technology for normal conducting higher energy linear accelerators																										
Task 9.1	NCLinac Coordination and communication												M												DM		
Task 9.2	Normal Conducting High Gradient Cavities												M												2D		
Task 9.3	Linac & FF stabilisation																								2D		
Task 9.4	Beam Delivery System																		D				D				
Task 9.5	Drive Beam Phase Control												M				M					D			D		
WP10.	SRF: SC RF technology for higher intensity proton accelerators & higher energy electron linacs																										
Task 10.1	SRF Coordination and communication												M												DM		
Task 10.2	SC Cavities for Proton Linacs, Electro-polishing and surface investigations						M			D			D2M						D						D		
Task 10.3	LHC Crab cavities						M			2M			3D														
Task 10.4	Thin Films						D3M						2D														
Task 10.5	HOM Distribution												M												2D		
Task 10.6	LLRF at FLASH												2M						D								
Task 10.7	SCRF gun at ELBE									D																	
Task 10.8	Coupler Development at LAL																										
WP11.	ANAC: Assement of Novel Accelerator Concepts																										
Task 11.1	ANAC Coordination and communication												M												D		
Task 11.2	Design of intraction regions for high luminosity colliders												D														
Task 11.3	Upgrade of the EMMA FFAG ring												D														
Task 11.4	Instrumenttion for Novel Accelerators												D														

A = MILESTONE: annual report
M = MILESTONE
D = DELIVERABLE

Figure 2b. Timing of the WPs, tasks, Milestones and Deliverables, last 2 year

B.1.3.3 Work package list / overview

WP No	Work Package Title	Type of Activity	Lead beneficiary No.	Person Months	Start Month	End Month
WP1	Project management	MGT	1	84	M1	M48
WP2	Dissemination, Communication and Outreach	COORD	37, 1	24	M1	M48
WP3	Structuring the accelerator neutrino community	COORD	17	45.8	M1	M48
WP4	Accelerator Science Networks: EuroLumi and RFTech	COORD	1, 7	24.7	M1	M48
WP5	HiRadMat@SPS	SUPP	1	3	M1	M48
WP6	MICE	SUPP	25	3	M1	M48
WP7	Superconducting High Field Magnets	RTD	1, 5	446	M1	M48
WP8	Collimators and materials	RTD	1, 15	315.4	M1	M48
WP9	Technology for normal conducting linear accelerators	RTD	1, 22	593.2	M1	M48
WP10	Superconducting RF technology for proton accelerators and electron linear accelerators	RTD	10, 5	529.5	M1	M48
WP11	Assessment of novel accelerator concepts	RTD	17, 25	258.9	M1	M48
	TOTAL			2327.5		

B.1.3.4 Deliverables list

Del. no.	Deliverable name	WP no.	Lead Bene-ficiary	Nature	Dissemination level	Delivery date
2.2.1	EuCARD web site implementation	2	WUT, CERN	O	PU	M1
4.1.1	Continually updated AccNet web site	4	CERN, CNRS	O	PU	M2
4.2.1	Continually updated EuroLumi web site	4	CERN	O	PU	M2
4.3.1	Continually updated RFTECH web site	4	UJF, TUL	O	PU	M2
3.1.1	NEU2012 Website operational	3	INFN	O	PU	M6
10.4.1	QE data for Pb/Nb deposited photo cathode samples	10	CERN	R	PU	M12
1.1	1st periodic EuCARD report	1	CERN	R	PU	M20
4.3.2	strategy/result for SRF test infrastructures	4	CERN, TUL	R	PU	M24
8.1.2	Collimator specification for LHC upgrade parameters	8	CERN, GSI	R	PU	M24
8.1.3	Collimator specification for FAIR	8	CERN, GSI	R	PU	M24
10.7.1	Results of slice measurements	10	FZD	R	PU	M24
10.8.1	Test and operation of the couplers preparation procedure	10	CNRS	R	PU	M24
11.2.1	DAFNE IR design for the upgraded KLOE detector	11	INFN	R	PU	M24
8.3.2	One cryogenic collimator, tested with beam	8	CERN	P	PU	M30
10.4.4	New thin film techniques for SC cavities and photo cathodes	10	CERN	D	PU	M30
10.2.1	Results of SC proton cavity tests (b = 1 and b = 0.65)	10	CEA	R	PU	M33
10.7.2	Results for GaAs photocathodes	10	FZD	R	PU	M33
7.2.2	Thermal model for a dipole Nb_3Sn model magnet	7	PWR	R	PU	M36
8.2.1	Report on modelling and materials	8	CERN	R	PU	M36
10.2.2	Reproducibility of the process as a Function of the EP-Mixture	10	CEA	R	PU	M36
10.3.1	LHC crab cavity final report	10	UNIMAN	R	PU	M36
10.3.2	CLIC crab cavity final report	10	UNIMAN	R	PU	M36
10.3.3	LHC and CLIC LLRF final reports	10	UNIMAN	R	PU	M36
10.4.2	RF measurements on thin film deposited QRW prototype	10	CERN	R	PU	M36
10.4.3	Cold test results for the test cavities w/out the deposited lead photo cathode	10	CERN	R	PU	M36
11.2.2	Study of an IR design for LHC upgrade	11	INFN	R	PU	M36
11.3.1	Results from the operation of EMMA using the new diagnostics	11	STFC	R	PU	M36
11.4.1	Preliminary electron beam emittance measurement report	11	CNRS	R	PU	M36

1.2	2nd periodic EuCARD report	1	CERN	R	PU	M38
3.2.1	Performance analysis and physics potential of upgrades of existing neutrino facilities	3	INFN	R	PU	M40
3.3.1	Proposal of the next global accelerator neutrino facility for Europe to build or help build.	3	INFN	R	PU	M40
7.5.1	HTS 20 m 600 A link assembled	7	CERN	P	PU	M40
7.2.1	Certification of the radiation resistance of coil insulation material	7	PWR	R	PU	M42
8.3.1	One primary collimator with optional crystal feature, tested with beam	8	CERN	P	PU	M42
9.4.1	ATF2 tests and CLIC IR study	9	RHUL	R	PU	M42
10.2.3	Summary of test results with vertical EP	10	CEA	R	PU	M42
10.6.1	Report on system test and performance	10	DESY	R	PU	M42
9.5.1	RF phase monitor final report	9	INFN	R	PU	M45
9.4.2	Laser Wire and Beam Position Monitor tests	9	RHUL	R	PU	M46
2.1.1	Final report of WP2 DCO	2	WUT, CERN	R	PU	M48
2.2.2	Final plan for the use and dissemination of foreground	2	WUT, CERN	R	PU	M48
3.1.2	Final NEU2012 guidelines for an accelerator neutrino experiments programme	3	INFN	R	PU	M48
4.1.2	AccNet Strategy for future proton & electron facilities in Europe	4	CERN, CNRS	R	PU	M48
4.2.2	EuroLumi Strategy and issues for LHC IR, LHC injector and beam-parameter upgrade path(s), with comment on longer-term prospects, and for FAIR	4	CERN	R	PU	M48
4.3.3	RFTECH strategy/result for cavity design, LLRF & HPRF systems and design integration, and costing tools	4	CERN, TUL	R	PU	M48
7.1.1	HFM web-site linked to the technical & administrative databases	7	CERN, CEA	O	PU	M48
7.3.1	Dipole model test results analyzed	7	CEA	R	PU	M48
7.4.1	A HTS dipole insert coil constructed	7	CNRS	D	PU	M48
7.6.1	Final prototype SC helical undulator measured	7	STFC	R	PU	M48
8.1.1	ColMat web-site linked to the technical and administrative databases	8	CERN, GSI	O	PU	M48
9.1.1	NCLinac web-site linked to the technical and administrative databases	9	CERN, RHUL	O	PU	M48

9.2.1	Simulation and experimental results with report on the theoretical and scientific aspects of the CLIC module	9	CERN	R	PU	M48
9.2.2	Prototypes with descriptive report (technical, design and fabrication) of the hardware prepared for the test module.	9	CERN	P	PU	M48
9.3.1	CLIC Quadrupole Module final report	9	CNRS	R	PU	M48
9.3.2	Final Focus Test Stand final report	9	CNRS	R	PU	M48
9.5.2	Electro optical monitor final report	9	INFN	R	PU	M48
10.1.1	SRF web-site linked to the technical and administrative databases	10	DESY, CEA	O	PU	M48
10.2.4	Evaluation of enhanced field emission in Nb samples	10	CEA	R	PU	M48
10.5.1	HOM electronics and code to probe beam centring on 3.9 GHz cavities	10	DESY	R	PU	M48
10.5.2	Report on HOM experimental methods and code	10	DESY	R	PU	M48
11.1.1	ANAC web-site linked to the technical and administrative databases	11	INFN	O	PU	M48
1.3	3rd periodic EuCARD report	1	CERN	R	PU	M50
1.4	Final project report	1	CERN	R	PU	M50

Note for tables B.1.3.4:
R = Report, P = Prototype, D = Demonstrator, O = Other
PU = Public

Summary of transnational access provisions

Participant number	Organisation short name	Short name of infrastructure	Installation: number[3]	Installation: Short name	Installation: Estimated costs[4]	Operator country code[1]	Unit of access	Estimated unit cost (€)	Min. quantity of Access to be provided	Access costs charged to the GA[2]	Estimated number of users	Estimated number of projects
1	CERN	HiRadMat@SPS	1	HiRadMat @SPS	801,698 €	INO	1 beam-hour	0 €	50	0 €	20	10
25	STFC	MICE	1	MICE	1,306,159 €	UK	1 beam-hour	6.95 €	3384	23,511 €	28	8

[1] Give the country code of the operator of the infrastructure or INO if the operator is an international organization
[2] Cost of the access provided under the GA. It results from the unit cost by the quantity of access provided
[3] Number progressively the installations of a same infrastructure. An installation is a part of an *infrastructure* that could be used independently from the rest.
[4] Estimated total costs of providing the total quantity of access to the installation over the duration of the project

B.1.3.5 Work package descriptions

Work package 1 description: Project management

Work package number	WP1	**Start date or starting event:**			M1		
Work Package title	Project management						
Activity type	MGT						
Participant id	**CERN**						
Person-months per beneficiary:	84						

Objectives:

- management and steering of the project
- monitoring and reporting of scientific and technical progress
- contractual and financial follow-up

Description of work:

This task comprises a number of management and coordination activities under the responsibility of the Project Coordinator, the Deputy Project Coordinator and the Administrative Manager. The management duties are carried out within the proposed management structure of the project, as described in Section 2.1. They include the overall coordination of the activities, ensuring the consistency of the project and continuous monitoring of the progress in each Work Package, the organization of the Project Governing-Board and Steering-Committee meetings, the preparation of the annual review meeting with all the beneficiary contributors as well as the regular communication with the EU Commission. The administrative and contractual follow-up of EuCARD will be carried out in this WP under the responsibility of the Administrative Manager. This work includes the preparation of the periodic and final activity reports and the reviewing of the Deliverable and Milestone reports. The financial follow-up encompasses the distribution and payments of the EU funding, the budget control, the cost reporting and the collection of the forms on Financial Statements, with the support of the CERN financial services. The management will use the Dissemination Network for communicating inside and outside the consortium activities and results.

Deliverables of tasks	**Description/title**	**Nature**	**Delivery month**
1.1	1st periodic EuCARD report	R	M20
1.2	2nd periodic EuCARD report	R	M38
1.3	3rd periodic EuCARD report	R	M50
1.4	Final project report	R	M50

Mile-stone	**Description/title**	**Nature**	**Delivery month**	**Comment**
1.1	1st annual EuCARD meeting	O	M12	
1.2	2nd annual EuCARD meeting	O	M24	
1.3	Mid-term review	O	M24	
1.4	3rd annual EuCARD meeting	O	M36	
1.5	Final annual EuCARD meeting	O	M48	

Work package 2 description: Dissemination, Communication and Outreach

Work package number	WP2		**Start date or starting event:**			M1	
Work Package title	Dissemination, Communication and Outreach						
Activity type	COORD						
Participant id	**WUT**	**CERN**					
Person-months per beneficiary:	14	10					

Objectives:

The Dissemination, Communication and Outreach (DCO) Work Package will organize and implement efficient communications inside and outside the consortium. They should enhance the internal synergies and provide added value by allowing information flow to/from other projects and the general public. DCO will equally support the management for internal communication and follow-up of EuCARD results. The objectives of this Work Package are as follows:

- To create and maintain the EuCARD web site for internal and external communication and dissemination, including the transnational access activities.
- To publish a periodic EuCARD Newsletter.
- To monitor the results and publications and inform the project management and participants.
- To maintain a database for all publications supported by EuCARD.
- To provide web-based tools to support EuCARD project management and coordination.
- To promote awareness and understanding of accelerator science in the community at large, which includes industrial partners, academics in other related fields, teachers and students, by organizing outreach events such as public talks, lectures, workshops, and online outreach via the web.
- To publish a dedicated series of monographs on advanced accelerator technology.

Description of work:

Task 1. DCO Coordination and Communication.
The purpose of this task is to oversee and coordinate all aspects of the DCO Work Package and ensure its consistency according to the project plan. The coordination duties include organizing DCO internal steering and annual meetings, setting up formal reviews, reporting to the project management, and distributing detailed information throughout the project. The task could include organizing workshops or specialized working sessions during the Annual EuCARD meetings.

Task 2. Dissemination and Outreach.
The IT infrastructure and support needed by the DCO Work Package will be set up in this task. Web-based technology and a database system will be used to implement convenient information storage and recovery mechanisms for documents and publications, as well as for engineering data and methods if the need arises. Significant EuCARD results will be published in a series of monographs on advanced accelerator technology as they become available.

Support will be given to the EuCARD management for coordination and scheduling, including calendars of meetings and workshops, an inventory of resources, an overview of transnational access facilities, and links to the websites of the other EuCARD Work Packages. A periodic Newsletter will be published on the EuCARD website, highlighting the project achievements.

The last component of DCO will be an Education and Public Outreach (EPO) web-page which will promote awareness and understanding of accelerator science in the community at large, including potential industrial partners, students and teachers.

Deliverables of tasks	Description/title	Nature	Delivery month
2.1.1	Final report of WP2 DCO	R	M48
2.2.1	EuCARD web site implementation	O	M1
2.2.2	Final plan for the use and dissemination of foreground	R	M48

Mile-stone	Description/title	Nature	Delivery month	Comment
2.1.1	Annual status of DCO, first year	R	M12	
2.1.2	Annual status of DCO, second year	R	M24	
2.1.3	Annual status of DCO, third year	R	M36	
2.1.4	Final status of DCO	R	M48	

Work package 3 description: NEU2012: Structuring the accelerator neutrino community

Work package number	WP3		**Start date or starting event:**				M1	
Work Package title	NEU2012							
Activity type	COORD							
Participant id	**INFN**	CERN	UNIGE					
Person-months per beneficiary:	3.6	21.6	20.6					

Objectives:

The "European Strategy for Particle Physics" emphasizes the importance of accelerator-based neutrino experiments, and sets the milestone for the next major undertaking in this field in 2012. The NEU2012 goal is to offer a platform for consolidating the European neutrino community and enhancing collaborative work and exchanges in view of delivering at the end of 2012 an agreed programme of neutrino experiments, based on upgrades of existing infrastructures and/or on the proposal of a new one.

Among the possibilities the following will be considered and evaluated:

- Upgrade of CNGS (CERN Neutrinos to Gran Sasso, c.f. Table B1.1); understanding of the ultimate upgrade potential (neutrino flux, neutrino spectra, flux monitoring and far detector design and location).
- A new neutrino facility, including a ring, (beta-beam or a neutrino factory complex) offering much higher rate and purer flavour content, allowing for a more ambitious programme of complete determination of the physical quantities governing neutrino oscillations: mass splits, flavour mixings and charge-parity violating phase.

The NEU2012 network should be the forum where the community will discuss the results of the CNGS upgrade studies, the solutions proposed by EuroNu for its beam options, the outcome of international design studies in progress in Japan and USA and of the state of the art R&D projects in progress or being proposed, in particular, in the framework of EuCARD.

Description of work:

Task 1. NEU2012 Coordination and Communication

The activities of this task are to oversee, co-ordinate the work and do the financial follow-up for all tasks in NEU2012. It shall ensure the consistency of the WP work according to the project plan and coordinate the WP technical and scientific tasks with the tasks carried out by the other work packages when it is relevant. The coordination duties also include the organization of WP internal steering meetings, topical workshops, working sessions and reviews as necessary and contributions to the Annual Meetings. Participants from inside and outside the consortium will be invited.

In addition to the coordination work, this task will take responsibility for the production of a final document making the synthesis of the findings of the two other tasks, proposing an agreed programme of neutrino experiments, based on upgrades of existing infrastructures and/or on the proposal of a new one.

Task 2. Getting the most out of existing neutrino facilities

This task will scrutinize the performance of operating neutrino facilities, i.e. of the CNGS in its international context and assess their potential for performance improvement. The parameters of importance are the neutrino flux, neutrino spectra, flux monitoring abilities and far detector design and location. The performance shall be evaluated depending on the evolution of physics needs. A synthesis on the upgrade option will be prepared, including flexibility and risk analysis, to clarify the best upgrade paths.

Task 3. Road map to the next European accelerator neutrino facility

This task will contribute to a synthesis on the European and worldwide research performed on possible future new facilities while surveying the coherence with the physics needs. It will conclude with recommendation for the choice of the next global accelerator neutrino facility, taking into accounts the technological risks and possible synergies with all other programmes worldwide. To fulfil this goal, both the potential of existing accelerators for a new neutrino facility and the new neutrino facility options will be evaluated, using all the results available from all design studies worldwide.

The following Institutes have declared their strong interest in the NEU2012 activities: CEA (F), STFC (UK), CSIC (Spain), UCLN (Belgium), UniSofia (Bulgaria), CNRS-IN2P3 (F), CHIPP(CH), MPG-MPIK (D), Crackow U (Poland), UAM (Spain), Imperial (UK). Outside Europe, Osaka U. and KEK (J), FNAL/BNL/LBNL (USA), TIFR (India).

Deliverables of tasks	Description/title	Nature	Delivery month
3.1.1	NEU2012 Website operational	O	M6
3.1.2	Final NEU2012 guidelines for an accelerator neutrino experiments programme	R	M48
3.2.1	Performance analysis and physics potential of upgrades of existing neutrino facilities	R	M40
3.3.1	Proposal of the next global accelerator neutrino facility for Europe to build or help build.	R	M40

Mile-stone	Description/title	Nature	Delivery month	Comment
3.1.1.1	Calendar of workshops & conferences concerning NEU2012	O	M6	
3.1.2.1	Intermediate review of NEU2012 recommendations on neutrino experiments	R	M24	Road map for a programme of neutrino experiments
3.1.3.1	NEU2012 first annual workshop	O	M12	
3.1.3.2	NEU2012 second annual workshop	O	M24	
3.1.3.3	NEU2012 third annual workshop	O	M36	
3.1.3.4	NEU2012 final annual workshop	O	M48	
3.2.1.1	Intermediate review of NEU2012 recommendations on existing accelerator neutrino facilities.	R	M24	Road Map for upgrading existing accelerator neutrino facilities
3.3.1.1	Intermediate review of NEU2012 recommendations on new accelerator neutrino facilities.	R	M24	Road Map to new accelerator neutrino facilities

Work package 4 description: AccNet: Accelerator Science Networks

Work package number	WP4		**Start date or starting event:**		M1			
Work Package title	AccNet							
Activity type	COOR							
Participant id	**CERN**	**CNRS**	DESY	UJF				
Person-months per beneficiary:	11	4.5	3.6	5.6				

Objectives:

AccNet will coordinate and integrate the activities of the European accelerator communities in order to guide significant upgrades of European research accelerator infrastructures and to prepare the way for new infrastructures, within a time scale of four years. In particular AccNet aims at realizing the full potential of the LHC, at optimizing the upgrades of other high-energy hadron and electron facilities (GSI/FAIR, PSI, LHC injector complex, FLASH, CTF3), at advancing novel extremely bright light sources (XFEL), and at laying the foundation for a future linear collider (ILC or CLIC). AccNet includes two distinct networks as tasks. They aim at providing a platform for information exchange and collaboration between JRA's and the various presently separated communities (e.g. proton and electron accelerators; magnet designers and collimation experts; FLASH upgrade, XFEL, CLIC and ILC technology; DAΦNE and LHC upgrade; European industry, European universities and laboratories).
To meet these goals, the tasks will organize annual workshops and topical mini-workshops, participate to related events in other projects or context, support exchange of experts, propose and follow-up beam experiment results to improve the knowledge and involve largely students and fellows. The results will be disseminated by journal publications and by seminars at partner institutes, conferences, and European universities, and via web documentation, e.g. web databases. The participation shall be largely open inside and outside the consortium.

Description of work:

Task 1. AccNet Coordination and communication
The activities of this task are to oversee and coordinate the EuroLumi and RFTECH networks between them and with all other relevant Work Packages in EuCARD, to ensure the consistency of the WP work according to the project plan and allocate and control network budgets. The coordination duties also include the organization of AccNet internal steering meetings, the setting up of proper reviewing, the reporting to the project management, the contribution to the Annual Meetings and the distribution of the information within AccNet as well as to the other work packages running in parallel. The task also covers the organization of and/or support to activity workshops or specialized working sessions, implying the attendance of invited participants from inside and outside the consortium.

Task 2. EuroLumi
EuroLumi will coordinate and integrate the activities of the accelerator and particle physics communities towards *realizing the full potential of the LHC*, by means of LHC *luminosity upgrades* and *new or enhanced LHC injectors*. Several scenarios for increasing the LHC performance by at least an order of magnitude were developed in the FP6 CARE-HHH network. They all combine an upgrade of the two high-luminosity interaction regions (IRs), with modified beam parameters, and with an enhanced higher-brightness injector complex. EuroLumi will create strong synergies by also supporting the *SIS upgrade* and the *FAIR* project at GSI, another major hadron facility in Europe.
Taking into account the results of CARE-HHH and interfacing with the US-LARP programme, the

EuroLumi network will be *THE European forum for discussing performance limitations of high-intensity high-brightness hadron accelerators*, *and for analyzing and optimizing the proposed upgrade paths* of these facilities. EuroLumi will bring together experts in *beam dynamics* with specialists of *magnets* and *collimation* to arrive at optimum upgrade solutions with minimum risk. EuroLumi will also help guiding the FP7 CNI for the LHC IR upgrade. Calculations performed within EuroLumi can be benchmarked via beam experiments at the operating LHC, as well as at PS, SPS, RHIC, Tevatron, or DAΦNE. EuroLumi will integrate the efforts of the large laboratories, smaller institutes and universities, and it will form and maintain a community capable of advancing the technical realization & scientific exploitation of the European hadron facilities. The following institutes have expressed interest in the EuroLumi activities: BINP (R), BNL (USA), Bologna U (I), CERN (INO), CI (UK), CINVESTAV (Mexico), CNRS-LAL (F), CNRS-LPSC (F), CSIC-IFIC (E), DESY (D) , FNAL (USA), GSI (D), IHEP (R), INFN–LNF (I), JINR (R), KEK (J), RCC KI (R), LBNL (USA), RHUL (UK), UJF (F), UM (M), Sannio U. (I), SLAC (USA), STFC (UK), Texas A&M (USA), TU Berlin (D).

Task 3. RFTECH: Exploitation of synergy on developments of high and low power RF systems for new accelerator projects

RFTECH will coordinate and integrate the European development of radiofrequency (rf) technology for future particle accelerators and associated research infrastructures, in a worldwide context. RFTECH encompasses all aspects of RF technology, e.g. klystron development, RF power distribution system, cavity design, and low-level RF system, for linear accelerators and storage rings, including transversely deflecting (crab) cavities and financial aspects such as costing tools. The following institutes have expressed interest in the RFTECH activities: BNL (USA), CEA-DSM (F), CERN (INO), CI (UK), CNRS-LPNHEP (F), CNRS-LPSC (F), DESY (D) , FNAL (USA), GSI (D), INFN –LNF (I), JLAB (USA), KEK (J), LBNL (USA), IFJ PAN (P), SLAC (USA), STFC (UK), THALES (F), TUL (P), UJF (F), WUT (P).

Deliverables of tasks	Description/title	Nature	Delivery month
4.1.1	Continually updated AccNet web site	O	M2
4.1.2	AccNet Strategy for future proton & electron facilities in Europe	R	M48
4.2.1	Continually updated EuroLumi web site	O	M2
4.2.2	EuroLumi Strategy and issues for LHC IR, LHC injector and beam-parameter upgrade path(s), with comment on longer-term prospects, and for FAIR	R	M48
4.3.1	Continually updated RFTECH web site	O	M2
4.3.2	strategy/result for SRF test infrastructures	R	M24
4.3.3	RFTECH strategy/result for cavity design, LLRF & HPRF systems and design integration, and costing tools	R	M48

Mile-stone	Description/title	Nature	Delivery month	Comment
4.1.1	Annual AccNet steering meeting, first year	O	M12	
4.1.2	Annual AccNet steering meeting, second year.	O	M24	
4.1.3	Annual AccNet steering meeting, third year.	O	M36	
4.1.4	Final AccNet steering meeting	O	M48	
4.2.1	Annual EuroLumi workshop, first year	O	M12	
4.2.2	Annual EuroLumi workshop, second year.	O	M24	
4.2.3	Annual EuroLumi workshop, third year.	O	M36	
4.2.4	Final EuroLumi workshop	O	M48	
4.3.1	Annual RFTECH workshop, first year	O	M12	

4.3.2	Annual RFTECH workshop, second year.	O	M24	
4.3.3	Annual RFTECH workshop, third year.	O	M36	
4.3.4	Final RFTECH workshop	O	M48	

Work package 5 description: HiRadMat@SPS

Work Package number	5		**Start date or starting event:**				M19	
Work Package title	HiRadMat@SPS							
Activity type	SUPP							
Participant number	**1**							
Participant short name	**CERN**							
Person-months per Participant	3							

Description of the infrastructure
Name of the infrastructure: HiRadMat@SPS
Location (town, country): Geneva, Switzerland
Web site address: http://lhc-collimation-project.web.cern.ch/lhc-collimation-project/default.htm
Legal name of organization operating the infrastructure: CERN, European Organization for Nuclear Research
Location of organization (town, country): 1211 Geneva 23, Switzerland
Annual operating costs (excl. Investment costs) of the infrastructure (€): 320,679 €

Description of the infrastructure:

The HiRadMat@SPS facility will use the extracted proton and ion beams from the existing CERN SPS synchrotron in a time-sharing mode. The facility will use an existing fast extraction channel which coupled to a new beam line will transport the high-power short-duration beam from SPS to the test area, where samples of materials will be exposed to beam-induced shock waves for the study of the robustness of accelerator components.
The SPS allows accelerating beams with some 10^{13} protons to a momentum of 450 GeV/c. For protons, the energy in one pulse can be up to 2.4 MJ with a pulse length of ~7 μs. For heavy ions the beam energy is 177.4 GeV/nucleon (36.9 TeV per ion), the pulse energy up to 28 kJ, and the pulse length about 12 μs. For both protons and ions, the beam spot size at the target position is variable, around 1 mm^2.
The implementation studies of the beam line and the test facility are on-going. The installation of the beam line is planned in 2009 and the first half of 2010. After commissioning and an initial running for performance evaluation, the facility will open to external access starting November 2010. The facility is required to become operational in 2010 for tests of materials and collimators.

Description of work:

Modality of access under this project:
During several periods of the SPS operational year, windows for experiments with beam will be provided. The dates for these windows will be defined in the framework of the yearly SPS operation scheduling. One experiment is expected to require two beam-hours, possibly in several sequences. Preparation of the experiment and first evaluation of the results will depend on the experiment complexity and will require a few days of presence, up to five.

Support offered under this project:
The beam will be provided free of charge to the external users, including support for travel and subsistence expenses related to the stay at CERN. CERN will ensure compliance with CERN regulations for the handling of activated materials: safety inspections before and after tests, special packaging and logistics and handling of wastes. CERN operates the accelerator complex including the SPS and HiRadMat@SPS facility based on a yearly schedule. CERN support includes the basic infrastructure for the experiments (electricity, network connectivity, office

space, internet connections, control room, limited technical support for last minute corrections or modifications, etc.), installation of the experiments, preparation of the beams, and the beam operation during the experiments.

Outreach of new users:
A dedicated web-page on the EuCARD web-site will describe the facility, the conditions of access, and the application procedure. Advertising the Transnational Access opened under the project will be also made in physics journals, other web sites and via e-mailing to the particle physics community. The results of the experiments using this facility will be presented to the scientific community on a regular basis in workshops and conferences, in synergy with the dissemination activities of WP2.

Review procedure under this project:
The requests from external users will be handled by the senior physicist responsible for the coordination of HiRadMat@SPS. They will be peer-reviewed by an international dedicated panel. If needed, the requests will be submitted to the SPSC, existing international committee making peer reviews of proposed SPS experiments.

Implementation plan

Short name of installation	Unit of access	unit cost (€)	Min. Quantity of access to be provided	Estimated number of users	Estimated number of days spent at the infrastructure	Estimated number of projects
HiRadMat@SPS	1 beam-hour	0 €	50	20	200	10

Work package 6 description: MICE

Work Package number	WP6	**Start date or starting event:**				M1		
Work Package title	MICE							
Activity type	SUPP							
Participant number	**25**							
Participant short name	**STFC**							
Person-months per Participant	3							

Description of the infrastructure
Name of the infrastructure: MICE
Location (town, country): Didcot, UK
Web site address: http://mice.iit.edu
Legal name of organization operating the infrastructure: Science and Technology Facilities Council
Location of organization (town, country): Didcot OX11 0QX
Annual operating costs (excl. Investment costs) of the infrastructure (€): 435,386 €
<u>Description of the infrastructure:</u> MICE (Muon ionisation cooling experiment) is a new specialized beam line on the STFC ISIS facility at RAL, including source, linac, synchrotron and targets normally operated for the production of pulsed neutron and muon beams. The new beam line is equipped with high-accuracy instrumentation to characterize the beams and unique absorbers and re-acceleration station to assess the efficiency of ionization cooling. This facility offers: • Muon beams of either sign, pulsed at 1 Hz, momentum from 120 MeV to 350 MeV/c. Also protons, pions and electrons from 100 MeV/c to 400 MeV/c. Precision beam line particle identification. Precision axial field spectrometers with scintillating fibres. Precision (70 ps) time measurement at three locations. Particle identification detectors (Cherenkov and calorimeter). All this commissioned first semester 2008. • Muon ionization equipment comprising solenoid optics, liquid hydrogen absorbers, RF cavities; Liquid hydrogen safe infrastructure; RF power station with 8 MW peak power at 200 MHz. All this will be commissioned in 2009.

Description of work:
<u>Modality of access under this project:</u> Each experiment is expected to require about 2 beam-weeks and the presence of up to six external users in addition to the MICE collaborators. More specifically, experimental activity supported will encompass: • The presence at RAL of external users and MICE experiment collaborators for equipment delivery and commissioning, data taking, analysis, in support of muon cooling experiments. • The presence at RAL of external users of the beam for tests of particle physics detectors in a low energy beam. • The presence at RAL of proponents of new cooling experiments to undertake studies, installation and eventually data taking <u>Support offered under this project:</u> The beam will be provided free of charge to the external users, including support for travel and subsistence expenses related to stay at RAL using housing on-site or in the local vicinity. STFC-

RAL operates the ISIS source based on a yearly schedule. Its support includes the basic infrastructure for the experiments (electricity, network connectivity, office space, internet connections, control room) and the beam operation during the experiments.

Outreach to new users:
A dedicated web-page on the EuCARD web-site will describe the facility, the conditions of access, and the application procedure. Advertising the Transnational Access opened under the project will be also made in physics journals, other web sites and via e-mailing to the particle physics community. The results of the experiments using this facility will be presented to the scientific community on a regular basis in workshops and conferences, in synergy with the dissemination activities of WP2.

Review under this project:
A selection committee involving MICE scientific and technical management and outside experts will review applications and select supported projects. The review committee will meet twice a year.

Implementation plan

Short name of installation	Unit of access	unit cost (€)	Min. Quantity of access to be provided	Estimated number of users	Estimated number of days spent at the infrastructure	Estimated number of projects
MICE	1 beam-hour	6.95 €	3384	28	864	8

Work package 7 description: HFM: Superconducting High Field Magnets for higher luminosities and energies

Work package number	WP7	Start date or starting event:			M1		
Work Package title	HFM						
Activity type	RTD						
Participant id	**CERN**	**CEA**	CNRS	COLUMBUS	DESY	BHTS	FZK	INFN
Person-months per beneficiary:	116	139	28	4	11	4	16	18
Participant id	PWR	SOTON	STFC	TUT	UNIGE			
Person-months per beneficiary:	49	7	36	8	10			

Objectives:

Magnets with Nb_3Sn conductors are needed to upgrade existing accelerators in Europe such as the LHC on the medium long term and to prepare for new projects on a longer time scale. Their high current density properties in high fields and large temperature margin will be needed to meet the fields and gradient requirements and to withstand the heating due to the radiation in these new and upgraded machines. On the very long term (> 20 years), an LHC upgrade to 2-3 times the energy is an option to be considered. For such an energy level, dipole magnets with a field of around 20 T would be needed. These accelerator magnets are beyond the possibilities offered by using Nb-Ti or Nb_3Sn conductors alone. A possibility is to use a layered coil with an outer coil of 14 T in Nb_3Sn conductor and an inner coil of HTS conductor, delivering a field contribution of 6 T. High field capabilities are also the limiting parameter for undulators when increasing the central field and reducing the period of the field. These limitations can be overcome using Nb_3Sn conductors also for these devices. The management of this WP has also the role to identify synergies between the various applications of Nb_3Sn.
The LHC is the existing infrastructure that will directly benefit from the work in this WP.

Task1. Coordination and Communication.
- Coordination and scheduling of the WP tasks
- monitoring the work, informing the project management and participants within the JRA
- WP budget follow-up

Task 2. Support studies
- Certify radiation resistance of radiation resistant coil insulation and impregnation
- Make a heat deposition and heat removal model for the dipole Nb_3Sn model with experimental validation and determine the thermal coil design parameters for the dipole model magnet.

Task 3. High field model
- Design, build and test a 1.5 m long, 100 mm aperture dipole model with a design field of 13 T using Nb_3Sn high current Rutherford cables.

Task 4. Very high field dipole insert
- Design, build and test HTS solenoid insert coils for a solenoid background magnet aiming at a field increase up to 6 T to progress on the knowledge of HTS coils, their winding and behaviour. This as in intermediate step towards a dipole insert.
- Design, build and test an HTS dipole insert coil for a dipole background magnet aiming at a field increase of about 6 T.

Task 5. High Tc superconducting link

- Design of HTS bus: choice of HTS material definition of thermal conditions, requirements for stabilization and quench protection, modelling of quench propagation.
- Design. realization and test of electrical joints and electrical terminations.
- Mechanical design and assembly of a 20 m long superconducting link (26 pairs of 600 A).

Task 6. Short period helical superconducting undulator

- Design, build and test a prototype helical coil undulator magnet with 11.5 mm period, high peak magnetic field in Nb_3Sn technology.

Description of work:

Task 1. Coordination and Communication.

The activities of this task are to oversee and co-ordinate the work of all the other tasks of the work package concerned, to ensure the consistency of the WP work according to the project plan and to coordinate the WP technical and scientific tasks with the tasks carried out by the other work packages when it is relevant. The coordination duties also include the organization of WP internal steering meetings, the setting up of proper reviewing, the reporting to the project management and the distribution of the information within the WP as well as to the other work packages running in parallel.

The task also covers the organization of and support to the annual meetings dedicated to the WP activity review and possible activity workshops or specialized working sessions, implying the attendance of invited participants from inside and outside the consortium.

Task 2. Support studies

Magnets in accelerators like the upgraded LHC and neutrino factories be subjected to very high radiation doses. The electrical insulation employed on the coils need to be resistant to this radiation. A certification program for the radiation resistance is needed in parallel to the modelling efforts for such magnets. The same radiation is also depositing heat in the coils. The heat removal from the coils needs to be modelled. These models have to be supported with measurements. A thermal design of the dipole model coil can then be made.

- **Sub-task 1: Radiation resistance certification for radiation resistant coil insulation and impregnation.**
  CERN will lead this activity and provide irradiation time at its accelerators. Other irradiation facilities from the partners might be envisaged. The exact work distribution between the 3 partners PWR, CEA-DSM and CERN still has to be determined.

- **Sub-task 2: Thermal models and design.**
  PWR will lead this activity. Thermal tests will be done in the various specialized cryogenic facilities at the 3 partner laboratories. All 3 partners will contribute to the modelling efforts aimed at producing a thermal model for the Nb_3Sn dipole model magnet.

Task 3. High field model

The technologies to be used for Nb_3Sn magnets, which are residing with the partners (e.g. high current density conductors, Nb_3Sn wind-and-react coil fabrication, insulation) are to be brought together and tested in short models. Several of these technologies (superconducting cable, insulation, coil design, support structures) were partly developed during the FP6-CARE-NED project.

The proposed dipole model will test these technologies for large accelerator magnets and the model will afterwards be used to upgrade the superconducting cable test facility FRESCA at CERN from 10 T to 13 T. The issues are to reach high fields in large apertures with good temperature margins in the coil, beyond the possibilities of Nb-Ti conductors.

As a test bed for high field accelerator magnets a 1.5 m long dipole model will be build with an aperture of 100 mm and a design field of 13 T. For this dipole model, CEA-DSM and CERN will design together the magnet. CERN will do the conductor characterization. PWR will do the thermal design and thermal component tests. CEA-DSM will fabricate the coils and CERN will build the mechanical support structure. Combined teams will integrate the coils into the support structure. The cryogenic test of the model will be done in the CERN test station.

Task 4. Very high field dipole insert

Recent progress has shown outstanding performance on the intrinsic current transport properties of HTS Bi-2212 round wires, well adapted to magnets (J_e=450 MA/m^2 and J_c=1800 MA/m^2 at 4 K under 25 T). This should open the road to higher magnetic fields. This work package is a very first step to prospect for this possibility. The dipole model constructed in task 3 of this WP will serve the role of the outer layer. The development will pass in three steps. The first studies will deal with the specification of several HTS conductors. This will be completed by modelling work focused on stability and quench. The quench of HTS coils with their very often degradation is an identified issue. Due to the difficulty of making in one go a dipole insert coil of HTS conductor, several HTS solenoid insert coils will be made and tested in existing high field solenoid magnets at the partner's labs. The experience, which will be gained, will be used to construct a dipole insert coil. These sub-tasks are fully interdependent with strong interactions.

- **Sub-task 1: Specifications, characterizations and quench modelling.** The candidate conductors will be specified in this sub-task with as aim to select the best suitable product. The expertise of the partners CNRS, CEA-DSM, FZK, INFN, TUT and UNIGE will be needed for these specifications on electrical, mechanical and thermal behaviour and are of prime interest for our high field objective. Quench behaviour of these HTS magnets will be studied using quench modelling codes. The aim is to propose quench protection and detection strategies to avoid any degradation.

- **Sub-task 2: Design, construction and tests of solenoid insert coils**. This activity will be lead by CNRS-Grenoble with contributions of FZK and INFN for the design and the tests. The design issues for low temperature superconductors and HTS are different. Two major concerns, operating margins and quench protection, are very distinct. Several solenoids will be wound by CNRS-Grenoble with assistance of the partners. The coils will be instrumented to catch the maximum of information. They will be tested at CNRS-Grenoble or at FZK in very high field bores. In particular, the quench behaviour and protection strategies will be studied and analyzed.

- **Sub-task 3: Design construction and tests of a dipole insert coil.** Using the results of the solenoid insert coils, a dipole insert coil will be constructed. CEA-DSM will have the responsibility for this sub-task and will wind the insert coil. As for the solenoids, the partners will bring their know-how for design and manufacturing and the dipole-insert will be instrumented. The coil will be tested at a later stage in the upgraded FRESCA facility of CERN in the dipole model magnet from task 3.

Task 5. High Tc superconducting link

The use of HTS material in buses linking superconducting magnets is of great interest for accelerators such as the LHC. Existing buses use Nb-Ti superconductors, maintained at temperatures below 6 K. The use of HTS enables operation at higher temperatures and offers a convenient gain in temperature margin during operation. In the case of the LHC, the use of HTS links is of specific benefit to an upgrade, in that it provides long distance electrical connections between power converters and superconducting magnets. It links cold magnets electrically. In cases where space is limited and the radiation environment is harsh, it also provides more flexibility in the location of the cryostats supporting the current leads. HTS links of the type required for the accelerator technology do not exist yet, and significant work has to be done to develop a long-length multi-conductor operating in helium gas at about 20 K. Considerable R&D

is being done on HTS cables for electrical utilities, and it might be thought that one could simply apply these technologies. However, at present this work is focused on using single or 3-phase AC conductors with high voltage insulation and liquid nitrogen cooling, and it should be noted that this is still development work yet to be concluded. Particle accelerators require high quasi-DC current carrying links with many cables (up to about 50) in parallel and cooled with liquid or gaseous helium. In the LHC there are over 50000 connecting cables with a total length of 1360 km. Thus the need specific to accelerator applications, is for a new type of link with multiple circuits, electrically isolated at around 1 kV - 2 kV, carrying quasi-DC currents. The design study has to cover the option to use MgB_2 at a temperature of 20 K as well as the electrical connections between HTS and LTS.

- **Sub-task 1: Studies on thermal, electrical and mechanical performance.** Performance tests on short samples of HTS material. CERN, COLUMBUS, BHTS and SOTON will study together the performance of HTS conductors at low temperatures. Existing test stations at CERN and in SOTON, which are used for measurements at 4.2 K, will have to be adapted to enable measurements of critical currents at 20 K. CERN, COLUMBUS and the SOTON will model the quench propagation in the HTS cables and define the requirements for stabilization and protection. CERN, COLUMBUS and BHTS will perform measurements of mechanical properties of short samples at liquid nitrogen temperature.

- **Sub-task 2: Design and test of electrical contacts HTS-HTS and HTS-Cu.** CERN, COLUMBUS and BHTS will prepare short samples and test their electrical resistance at cryogenic temperature. CERN and DESY will design together the electrical terminations of the HTS link.

- **Sub-task 3: Design and assembly of a 20 m long HTS multi-conductor 600 A link.** CERN, DESY, BHTS, COLUMBUS and SOTON will design together a 20 m long link containing 26 circuits operating at 600 A. The design includes both the superconducting bus and the mechanical envelope providing the vacuum insulation. The cryogenic test will be done at CERN. COLUMBUS and CERN will design and test the electrical insulation of the circuits.

Task 6. Short period helical superconducting undulator

This task is focused on increasing the achievable magnetic field levels in short period magnets through the use of advanced materials (Nb_3Sn conductors) and innovative designs (helical coils). For example, single pass free electron lasers (e.g. X-FEL, FERMI@ELETTRA) could cover a wider wavelength range through field enhancement, or alternatively, operate at significantly lower electron energy. Additionally, short period magnets could be used in the production of positrons for any future lepton collider and increased magnetic field levels will increase the positron yield and also allow for savings. The first part of this task will be a design study of the undulator using an Nb_3Sn conductor. A comparison will be made with existing Nb-Ti. Following this design stage a short prototype (~300mm) will be manufactured and tested magnetically. The results from this prototype will inform the study and the design will be iterated in order to provide the strongest possible field level. This second design will then be prototyped (~500mm) and characterised. The results will be analysed and a full description of the study will be given in a final report.

Deliverables of tasks	Description/title	Nature	Delivery month
7.1.1	HFM web-site linked to the technical & administrative databases	O	M48
7.2.1	Certification of the radiation resistance of coil insulation material	R	M42
7.2.2	Thermal model for a dipole Nb_3Sn model magnet	R	M36

7.3.1	Dipole model test results analyzed	R	M48
7.4.1	A HTS dipole insert coil constructed	D	M48
7.5.1	HTS 20 m 600 A link assembled	P	M40
7.6.1	Final prototype SC helical undulator measured	R	M48

Mile-stone	**Description/title**	**Nature**	**Delivery month**	**Comment**
7.1.1	1st annual HFM review meeting	O	M12	
7.1.2	2nd annual HFM review meeting	O	M24	
7.1.3	3rd annual HFM review meeting	O	M36	
7.1.4	Final HFM review meeting	O	M48	
7.2.1	Methodology for the certification of radiation resistance of coil insulation material	R	M24	
7.2.2	Preliminary heat deposition model for a dipole Nb_3Sn model magnet	R	M12	publication on web
7.2.3	Engineering heat deposition model for a dipole Nb_3Sn model magnet	R	M24	publication on web
7.3.1	Dipole Nb_3Sn coils finished	D	M36	2 coils ready for mounting
7.3.2	Dipole Nb_3Sn model magnet finished	D	M42	Ready for cold test
7.4.1	HTS conductor specifications for insert coils	R	M12	
7.4.2	Two HTS solenoid insert coils	D	M24	
7.5.1	Final design report HTS link	R	M34	
7.6.1	Short prototype SC helical undulator fabricated and tested	D	M36	

Work package 8 description: ColMat: Collimators & materials for higher beam power beam

Work package number	WP8		**Start date or starting event:**		M1	
Work Package title	ColMat					
Activity type	RTD					
Participant id	**CERN**	ARC	CSIC	EPFL	**GSI**	INFN
Person-months per beneficiary:	84	4	18	8.4	116	24
Participant id	POLITO	RRC KI	UM			
Person-months per beneficiary:	14	35	12			

Objectives:

Modern hadron accelerators like LHC and FAIR operate at the beam intensity frontier for allowing the exploration of unknown territories in basic research with proton and ion beams. As a consequence, new challenges arise for the materials that are placed close to or into the high intensity beams, mainly but not exclusively inside collimators. Full intensity and performance can only be reached if collimation works reliably (minimum downtime) with excellent efficiency. Damage must be avoided or, if it cannot fully be excluded, handled in a safe manner (self-repairing devices). This work package addresses R&D on materials and collimators for high intensity beams. The following objectives have been defined:

- Coordination and scheduling of the WP tasks
- Monitoring the work, informing the project management and participants within the JRA
- WP budget follow-up
- Design collimation systems for high-intensity proton and ion beams, adequate for achieving the performance goals of LHC and FAIR.
- Predict energy deposition from different sources for LHC and FAIR.
- Identify and fully characterize in experiment and simulation materials that are adequate for usage in high power accelerators.
- Predict residual dose rates for irradiated materials and their life expectancy due to accumulated radiation damage.
- Design, construct and test a collimator prototype for upgraded LHC performance
- Design, construct and test one cryogenic collimator prototype.
- Develop crystal engineering solutions for collimation.

Description of work:

Task 1. ColMat Coordination and Communication.

The activities of this task are to oversee and co-ordinate the work of all the other tasks of the work package concerned, to ensure the consistency of the WP work according to the project plan and to coordinate the WP technical and scientific tasks with the tasks carried out by the other work packages when it is relevant. The coordination duties also include the organization of WP internal steering meetings, the setting up of proper reviewing, reporting to the project management and the distribution of the information within the WP as well as to the other work packages running in parallel.
The task also covers the organization of and support to the annual meetings dedicated to the WP activity review and possible activity workshops or specialized working sessions, implying the attendance of invited participants from inside and outside the consortium.

Task 2. Modelling, Materials, Tests for Hadron Beams.
The first challenge concerns safely intercepting and efficiently absorbing unavoidable losses from high intensity proton and ion beams. This includes protection of the accelerator against excessive energy deposition (leading to quenches of superconducting magnets and interruption of operation) and beam-induced damage, while maintaining an ultra-high vacuum. The study of innovative collimation systems is required, which place appropriate materials at optimized locations in the accelerator rings. This topic is addressed in sub-task 1. Connected to this is the energy deposition from particle losses and their associated particle cascades. This includes energy deposition in warm regions, in superconducting magnets and in experimental insertions (problem of background) for losses from different sources. This topic is addressed in sub-task 2. The third research theme is the study of appropriate materials for usage with high intensity beams. Issues include a review of suitable materials, characterization of standard and advanced materials, mechanical modelling of material behaviour and resistance to extreme thermal shock waves. This topic is addressed in sub-task 3. Finally, the fourth research topic treats the residual doses due to irradiation with lost particles (protons and ions) and the radiation-induced damage to materials. This topic is addressed in sub-task 4.

- **Sub-task1: Halo studies and beam modelling.**
    1. Nature, magnitude and location of beam losses in modern accelerators.
    2. Dynamics of the beam halo and proper diffusion models.
    3. Design and optimization of multi-stage collimation systems.
    4. Simulation of multi-turn collimation processes, including nuclear interactions of halo particles in the collimator materials.

  The following institutes contribute to this work: CERN, GSI, CSIC, INFN, ULANC, UM and UNIMAN.

- **Sub-task2: Energy deposition calculations and tests.**
    1. Showering models with protons and ions in the relevant energy range.
    2. Modelling of the accelerator geometry and materials.
    3. Energy deposition calculations for various operational assumptions.
    4. Calculation of residual dose rates.
    5. Modelling of radiation-induced displacements per atom (dpa).

  The following institutes contribute to this work: CERN and GSI.

- **Sub-task3. Materials and thermal shock waves.**
    1. Selection of candidate materials for usage in high intensity accelerators. This includes also special materials, like modern composite materials and crystals.
    2. Mechanical, electrical and vacuum characterization of materials.
    3. Simulations of thermal shock waves due to impacts of beam particles.
    4. Experimental tests on material resistance to beam-induced thermal shock waves.
    5. Modelling of beam shock-induced damage of accelerator materials.

  The following institutes contribute to this work: ARC, CERN, GSI, EPFL, RRC KI and POLITO.

- **Sub-task4: Radiation damage.**
    1. Experimental tests on material resistance to beam-induced radiation.
    2. Modelling of radiation damage for accelerator materials.
    3. Prediction of material life expectancy in accelerator environment.

  The following institutes contribute to this work: CERN, GSI and RRC KI.

Task3. Collimator Prototyping & Testing for Hadron Beams
The robustness, efficiency and vacuum quality of the collimator solutions specified in Task 2 must be established with prototypes and realistic particle beams before installation into a sensitive accelerator environment. This task supports the construction of prototype collimators for LHC and FAIR and the subsequent tests. Required resources are centred at the big

accelerator laboratories, as these have the knowledge to build such devices. It is, however, mentioned that LHC upgrade collimators are also prototyped in collaborating institutes in the United States through the DOE funded collimation work package in the LARP program (total value of 5M$). This task foresees the prototyping and testing of both room-temperature (LHC baseline type) and cryogenic (FAIR baseline type) collimators: • One room temperature collimator will be designed for collimation close to the circulating beam. The design should improve the cleaning efficiency, reduce collimator-induced impedance, optimize radiation impact, improve operational handling and provide ultra-high vacuum. Optionally it can include a bent crystal for exploitation of crystal-enhanced collimation, an advanced R&D topic in the accelerator field. • A cryogenic collimator will be designed to avoid uncontrolled beam losses and therefore the production of desorption gases. A comparatively warm 0.6 m long wedge (50 K - 70 K) will be situated in a chamber cooled by liquefied helium at a temperature below 10 K. Therefore the wedge will desorb only a small amount of gas when hit by the beam, while the cold surfaces act as cryo pumping system. The two types of collimators complement each other and can be used also in the other accelerator, for example LHC collimation could be improved with cryogenic collimators originating from a FAIR design. This illustrates the highly beneficial impacts of European collaboration. • **Sub-task1:** Prototyping, laboratory tests and beam tests of room-temperature collimators (LHC type). The following institutes contribute to this work: CERN, INFN. Collaboration with BNL, FNAL and SLAC in the United States. • **Sub-task2:** Prototyping of cryogenic collimators (FAIR type). The following institutes contribute to this work: GSI, CERN

Deliverables of tasks	Description/title	Nature	Delivery month
8.1.1	ColMat web-site linked to the technical and administrative databases	O	M48
8.1.2	Collimator specification for LHC upgrade parameters	R	M24
8.1.3	Collimator specification for FAIR	R	M24
8.2.1	Report on modelling and materials	R	M36
8.3.1	One primary collimator with optional crystal feature, tested with beam	P	M42
8.3.2	One cryogenic collimator, tested with beam	P	M30

Mile-stone	Description/title	Nature	Delivery month	Comment
8.1.1	1st annual ColMat review meeting	O	M12	
8.1.2	2nd annual ColMat review meeting	O	M24	
8.1.3	3rd annual ColMat review meeting	O	M36	
8.1.4	Final ColMat review meeting	O	M48	
8.2.1	Functional specification LHC of beam loss and collimator design	R	M12	Simulations and design completed.
8.2.2	Upgrade LHC collimator specification	R, D	M24	Materials characterized and tested. Review of results and specification.
8.2.3	Functional specification FAIR of beam loss and collimator design	R	M12	Simulations and design completed.
8.3.1.1	LHC type collimator designed	R	M20	warm collimator

8.3.1.2	LHC type collimator constructed	P	M26	
8.3.1.3	LHC type collimator tested	R	M30	
8.3.2.1	FAIR type collimator designed	R	M24	cryogenic collimator
8.3.2.2	FAIR type collimator constructed	P	M36	

Work package 9 description: NCLinac: Technology for normal conducting higher energy linear accelerators

Work package number	WP9	**Start date or starting event:**			M1	
Work Package title	NCLinac					
Activity type	RTD					
Participant id	**CERN**	CIEMAT	CNRS	INFN	PSI	**RHUL**
Person-months per beneficiary:	88.4	32	50.4	30.4	15	53
Participant id	STFC	UH	UNIMAN	UOXF-DL	UU	
Person-months per beneficiary:	16	112	75	53	68	

Objectives:

NCLinac concentrates on the identified issues in R&D to prepare for the future HEP Particle colliders that can reach beyond the LHC; it is generally agreed that a collider of this next generation will be a linear electron-positron collider. The issues to be addressed are primarily i) how to reach a high accelerating gradient reliably and ii) how to stabilize the beams and the machine to allow collisions of nm-sized beams without loss of luminosity. For the first, NCLinac limits its scope to normal conducting accelerator structures, complementary to work on superconducting accelerator structures foreseen in the work package SRF. For the latter issue, synergy is actively sought and implemented between the superconducting (SC) and normal conducting (NC) linear collider approaches, where we have observed in the past that the communities of researchers had formed two separate camps. Searching their similarities rather than their differences, one goal of NCLinac is to bring these communities together again wherever possible. Issues concerning the longitudinal phase-space (phase stabilisation) are included. Other topics are the need to measure beam positions, profiles and movements to the required level of precision and to elaborate and test algorithms for their active steering.
NCLinac is complementing a presently ongoing program of R&D; it uses and enforces readily established global research networks like the CLIC/CTF3 collaboration or the Global Design Effort (GDE) for the ILC. The high-gradient research will be coordinated with the existing US High-Gradient Collaboration. NCLinac will improve and make available for a wider community of researchers purpose built and recognized world-class Research Infrastructures like the CLIC Test Facility CTF3 at CERN and the DAΦNE facility at Frascati, but also the world-wide only facility to address issues for extremely small emittances, ATF2 at KEK in Japan, is included.

Task1. NCLinac Coordination and Communication

- Coordination and scheduling of the WP tasks
- monitoring the work, informing the project management and participants within the WP
- WP budget follow-up

Task2. Normal Conducting High Gradient Cavities

- Investigate fundamental high-precision, high-power and HOM damping technical and scientific issues underlying the CLIC module
- Prepare hardware to test a CLIC module in the two-beam test stand of CTF3

Task3. Linac & FF Stabilisation

- Design, build and test for stabilisation a CLIC quadrupole module in an accelerator environment
- Design, build and test for stabilisation a Final Focus test stand

Task 4. Beam Delivery System

- Develop tuning strategies at ATF2
- Optimize the Linear Collider interaction region

Task 5. Drive Beam Phase Control

- Design, build and test a low-impedance RF beam phase monitor with a resolution of 20 fs
- Design, build and test an electro-optical phase monitor with a resolution of 20 fs

Description of work:

Task 1. NCLinac Coordination and Communication

The activities of this task are to oversee and co-ordinate the work of all the other tasks of the work package concerned, to ensure the consistency of the WP work according to the project plan and to coordinate the WP technical and scientific tasks with the tasks carried out by the other work packages when it is relevant. The coordination duties also include the organization of WP internal steering meetings, the setting up of proper reviewing, the reporting to the project management and the distribution of the information within the WP as well as to the other work packages running in parallel.
The task also covers the organization of and support to the annual meetings dedicated to the WP activity review and possible activity workshops or specialized working sessions, implying the attendance of invited participants from inside and outside the consortium.

Task 2. Normal Conducting High Gradient Cavities

The energy and luminosity design parameters for CLIC are 3 TeV and $6*10^{34}$ cm^{-2} s^{-1} respectively, and CLIC stands here synonymous for any future multi-TeV linear collider. These parameters result in extremely demanding requirements for the accelerating structures in terms of the accelerating gradient (100 MV/m or higher), high-power (of the order of 100 MW), tight mechanical tolerance (microns to tens of microns) and strong higher-order mode damping (complex geometries). A further level of difficulty is encountered when the challenges must be addressed simultaneously as is the case in the CLIC module.
The CLIC Test Facility 3 (CTF3) has been constructed to address the above issues to demonstrate feasibility of a multi-TeV linear collider based on CLIC technology. This project seeks to complement ongoing efforts, which are addressing the individual requirements, by concentrating primarily on questions of the integration, i.e. to simultaneously satisfy requirements of highest possible gradient, power handling, tight mechanical tolerances and heavy HOM damping. In addition this project will enhance the expansion of the CLIC study from its origins as a CERN project to a truly international collaboration. Existing collaborations with SLAC and KEK will be built upon and included in this project.

- **Sub-task 1:** Design, manufacture, and validate experimentally a Power Extraction and Transfer Structure (PETS) prototype to improve CTF3.

- **Sub-task 2:** Explore influence of alignment errors on wake fields, elaborate and demonstrate appropriate High Order Mode (HOM) damping in the presence of alignment errors.

- **Sub-task 3:** Breakdown simulation: Develop and use atomistic simulations of atom migration enhanced by the electric field or by bombarding particles, understand what kind of roughening mechanisms lead to the onset of RF breakdown in high gradient accelerating structures.

- **Sub-task 4:** Design and build equipment to diagnose the electrons, ions and light emanating from the breakdown event both in the CTF3 Two-Beam Test-Stand at CERN and inside a scanning electron microscope in UU to analyze the surface science relevant to RF-breakdown.

- **Sub-task 5:** Precise assembly: Develop a strategy of assembly for the CLIC accelerating and power extraction structures satisfying the few to 10 micrometer precision requirement of positioning both radial and longitudinal taking into account dynamical effects present during accelerator operation.

Task 3. Linac & FF stabilisation

In the future linear colliders such as ILC and CLIC, beam sizes will be of the nanometre scale. In a real accelerator environment, many sources of noise such as ground motion, pumping devices, acoustic vibrations, cooling systems and others are present, sources which generate vibrations several orders of magnitude larger than the beam size. Stabilization of accelerator components such as the final focus (FF) is critical if the desired nanometre beam sizes are to be reached. It is particularly challenging for the CLIC project, where a stability of 1 nm above one Hertz is required even in the linac section, 0.1 nm above a few Hertz in the FF section. In a laboratory environment, these values could already be demonstrated. It is planned in this project to study the effectiveness of stabilisation equipment (such as seismic sensors, actuators, interferometers etc…) in a real accelerator environment. The equipment will be implemented at a CLIC quadrupole module inside the CTF3 facility, in the first stage with a quadrupole mock-up. In addition it is planned to use a CLIC standard module for comparing the vibration measurements with a laser interferometer (which can also serve as an alignment device) and the seismic sensors. The compatibility of these stabilisation devices with the alignment system that will be used in CLIC will be checked. A dedicated FF test stand will be built with a support and magnet prototype where the stabilisation will be developed. Furthermore, the stabilisation procedures will be simulated to ensure a better understanding of the beam-based feedback, stabilisation and the alignment. This will be tested on different accelerator facilities such as ATF2, CTF3 in preparation of ILC and CLIC.

- **Sub-task 1: CLIC quadrupole module.** CERN together with LAPP aims at demonstrating 1 nm quadrupole stability for the CLIC main linac quadrupole. Investigation of stabilisation feedback performance in different locations, e.g. an accelerator test tunnel will be performed. The aim is to demonstrate better than 1 nm stability of the main linac quadrupoles in an accelerator environment above frequencies of approximately 1 Hz. Inertial sensors will be tested and evaluated for accelerator environment (magnetic field, radiation, electrical and acoustic noise from accelerator components). The module needs a main beam linac support: study vibration isolation for the main beam quadrupole (principle, mock-up, feedback to be adapted to new boundary conditions) and build a test bench. The interferometric measurement system, developed in UOXF-DL, will be installed at the Final Focus Test stand and will be used to cross check results and extend the frequency range. CERN will also study the design and construction of main linac prototype magnet. The stabilisation of the main linac quadrupoles is one of the fundamental issues of CLIC. This activity aims to design and build a quadrupole mock-up that can serve as a model for the main linac quadrupole. New magnet manufacturing and assembly methods will be studied and implemented. The model will be used to investigate the performance of the stabilisation equipment that is also developed in this task.
  CERN aims at testing the compatibility (space, interferences, and complementarities) between the repositioning system (movers + associated sensors) and the stabilization system foreseen for the main beam quadrupole of CTF3/CLIC, in the real environment of the two beam test stand.

- **Sub-task 2: Final Focus Test stand.** LAPP together with CERN aims at exploring the potential to achieve 0.1 nm stability scale for the final doublet quadrupoles above a few Hz by working on the design, simulation, construction and installation of the support (final doublet mock-up, eigenmode analysis) and on the feedback design depending strongly on the final doublet support chosen. LAPP will adapt feedback software to new configuration and boundary conditions and continue work to reduce costs.
  Oxford aims at studying the design, construction and deployment of an interferometric

system to measure the motion between the proposed test magnet/girder and floor. This task includes the installation of interferometric system with the goal to push for maximum resolution and the possibility to correlate results with measurements done by inertial sensors. UOXF-DL will contribute to the Development of optimized low-emittance beam transport and feedback for ILC and CLIC by completing an ILC prototype ATF2 intra-train and pulse-pulse Feedback and Final Focus system. In addition, they will study the simulation of the global luminosity performance of ILC and CLIC.

Task 4. Beam Delivery System

Key aspects and sub-systems of the ILC/CLIC beam delivery system will be developed and tested. The projects proposed here are new initiatives emerging from the results of the FP6 scheme (EUROTeV) with particular emphasis on developing and exploiting existing infrastructure at ATF2, CTF3, and PETRAIII. ATF2 will be the main international test facility for beam delivery studies over the period of FP7. Tuning procedures will be developed and tested at ATF2 and they will provide essential input into optimizing the CLIC IR region, which will also be performed in this context. Advanced BPMs will be employed and tested at the ATF2 and their integration with other systems optimized. Laser-wire measurements will also be made at PETRAIII, where a fast scanning system will be tested and the challenges of integrating a laser-wire as a reliable machine diagnostic tool will be met.

- **Sub-task 1:** The CI at Manchester (UNIMAN) and STFC at Daresbury will test the tuning procedures at the ATF2 and use this knowledge to optimize the designs of the interaction region of both ILC and CLIC. Different tuning procedures and tuning knobs will be tested at ATF2 to achieve the vertical beam size down to 35 nm; the proposed local chromaticity correction final focus system will be tested experimentally for the first time and various tuning procedures will also be applied to ILC and CLIC to optimize the interaction region (IR). The CLIC IR will be studied in detail, and the impact and mitigation of CLIC detector solenoid effects on the beam orbit, coupling and extraction will be considered. A further goal is to strengthen the computing infrastructure for tracking tools to be used at ATF2/ILC/CLIC and validate them experimentally.
- **Sub-task 2:** At RHUL, high precision BPMs will be developed and tested at the ATF2 with particular emphasis on systems integration. The implications for ILC and CLIC beam diagnostics will be determined via full simulations using these experimental results.
- **Sub-task 3:** At RHUL, Laser-Wire systems will be developed and tested at the ATF2 and PETRAIII with particular emphasis on high-speed operation. The implications for ILC and CLIC beam diagnostics will be determined via full simulations using these experimental results.

Task 5. Drive Beam Phase Control

Very precise synchronization between main and drive beams is required in CLIC to avoid excessive luminosity loss due to energy variations. For this reason drive beam phase errors should be reduced by a phase feedback system within about 0.1 degrees (23 fs @ 12 GHz). The front end of this feedback system will consist of a monitor able to detect the longitudinal position of the bunches with a resolution of the order of 20 fs. The coupling impedance of the monitor has to be very low due to the high beam current. RF noise and wake fields in the beam pipe must not affect the measurement and have to be rejected by proper designed filters. This device will find applications in other machines where precise high frequency beam phase detection is required. Two possible solutions will be investigated at the same time. A low impedance RF phase monitor with an integrated noise filter will be designed and built by CERN and INFN. It will be tested in CTF3 where it will also play an important diagnostic role in the optimization of the machine performances. An electro-optical monitor using periodic train of laser pulses to sample signal from wide bandwidth beam pickup will be developed and built by PSI and will be tested at the existing facilities at PSI.

- **Sub-task 1:** CERN will determine the specifications and will produce a conceptual design report of the RF monitor. CERN and INFN will attend together to the electromagnetic design and then they will produce a building design of the monitor. CERN will develop and realize the related electronics. INFN will build prototypes of the monitor that will be measured and tested in lab. A final version of the monitor will be built and the performances of the system will be tested in CTF3.

- **Sub-task 2:** The electro-optical monitor will be designed by PSI. PSI will implement prototypes of the system, which includes pick-up, laser, electro optical detector and electronics. The performances of the system will be tested in the existing facilities at PSI.

Deliverables of tasks	**Description/title**	**Nature**	**Delivery month**
9.1.1	NCLinac web-site linked to the technical and administrative databases	O	M48
9.2.1	Simulation and experimental results with report on the theoretical and scientific aspects of the CLIC module	R	M48
9.2.2	Prototypes with descriptive report (technical, design and fabrication) of the hardware prepared for the test module.	P	M48
9.3.1	CLIC Quadrupole Module final report	R	M48
9.3.2	Final Focus Test Stand final report	R	M48
9.4.1	ATF2 tests and CLIC IR study	R	M42
9.4.2	Laser Wire and Beam Position Monitor tests	R	M46
9.5.1	RF phase monitor final report	R	M45
9.5.2	Electro optical monitor final report	R	M48

Mile-stone	**Description/title**	**Nature**	**Delivery month**	**Comment**
9.1.1	Annual NCLinac review first year	O	M12	
9.1.2	Annual NCLinac review second year	O	M24	
9.1.3	Annual NCLinac review third year	O	M36	
9.1.4	Final NCLinac review	O	M48	
9.2.1	Modification of NCLinac computer codes and first round of simulations.	R	M24	
9.2.2	Design of NCLinac hardware for test module	R	M24	
9.2.3	Prototype components for CLIC module prepared	P	M36	
9.3.1	Characterization of noise/vibrations sources in an accelerator	O	M24	
9.3.2	Installation of interferometers at CTF3 Module	D	M24	
9.3.3	Installation of ATF2 final-focus alignment monitoring system	D	M6	
9.3.4	Installation of ILC prototype FB/FF at ATF2	O	M24	
9.3.5	Commissioning of CLIC quadrupole module	D	M30	Complete module with girder and accelerating structure
9.3.6	Quadruple mock-up manufactured and ready for installation	D	M30	
9.4.1	Training at ATF3	O	M18	Commissioning at ATF2
9.4.2	LW and BPMs installed	D	M18	Hardware at ATF2 and PETRAIII

9.5.1	RF phase monitor prototype finished	P	M36	Prototype ready for test
9.5.2	Electro optical monitor prototype finished	P	M40	Prototype ready for test

Work package 10 description: SRF: SC RF technology for higher intensity proton accelerators & higher energy electron linacs

Work package number	WP10		**Start date or starting event:**				M1
Work Package title	SRF						
Activity type	RTD						
Participant id	**DESY**	HZB	**CEA**	CERN	CNRS	FZD	IFJ PAN	INFN
Person-months per beneficiary:	88	10	85.5	38	50.5	16	8	18
Participant id	IPJ	STFC	TUL	ULANC	UNIMAN	UROS	WUT	
Person-months per beneficiary:	26	18	38	42.5	45	24	22	

Objectives:

The main activities in the SC RF Technology WP concentrate on two different areas: cavity improvements and beam experiments. Improved methods for cavity treatment such as vertical electro-polishing or sputter coating will be investigated. Prototype work on superconducting (SC) crab cavities will be launched with the goal to increase the luminosity of colliders such as LHC, CLIC or ILC. The second research activity concentrates on further developing Low Level RF techniques and on new diagnostic tools based on the analysis of Higher Order Modes (HOM). These advanced and challenging concepts and ideas will be tested in the FLASH linac, and they are important for the extreme beam stability requirements and control problems in future projects.

Task 1. SRF Coordination and communication
- Coordination and scheduling of the WP tasks.
- Monitoring the work, informing the project management and participants within the JRA.
- WP budget follow-up.

Task 2. SC Cavities for Proton Linacs, Electro-polishing and surface investigations.
- Design and fabrication of $\beta = 0.65$; 704 MHz elliptical cavity equipped with a titanium helium reservoir.
- Design and fabrication of $\beta = 1$; 704 MHz elliptical cavity.
- Study of interfaces between the cavity and the cryomodule.

Task 3. LHC Crab cavities
- Design, build and test a single LHC and CLIC crab cavity module, including input coupler, mode couplers and tuners.
- Design, build and test a LLRF and synchronization system that meets the crab cavity phase and amplitude control specifications for LHC and CLIC.
- If the beam time and the necessary hardware become available, validate and test the assembled crab system solutions and LLRF control systems on LHC and CTF3 in 2011; otherwise make performance predictions based on the measured noise characteristics.

Task 4. Thin Films
- Improve the Nb sputtering technology for low beta cavities such as QWR to reach 6 MV/m at a Q-value of $5 \cdot 10^8$.

- Perform arc sputtering of photo cathodes (Pb) and test the performance of the developed systems.
- Research on new technologies for thin film depositing of superconductors for SC cavity applications.

Task 5. HOM Distribution
- Development of HOM based beam position monitors (HOMBPM).
- Development of HOM Cavity Diagnostics and ERLP (HOMCD).
- Measurement of HOM Distributions and Geometrical Dependences (HOMDG).

Task 6. LLRF at FLASH
- ATCA developments of carrier boards with FPGA and DSP.
- Development of AMC modules with fast analogue IO and digital IO.
- Development of special power drivers for AMC modules.
- Development of beam based feedback.

Task 7. SCRF gun at ELBE
- Installation of an energy spectrometer in the ELBE beam line for slice diagnostics and slice emittance measurements for different emittance compensation schemes.
- Design, built and test the set-up for preparation and application of GaAs photo cathodes in the SRF-Gun.
- Evaluation of critical R&D issues of SRF guns like photocathode compatibility, advanced emittance compensation and application as a high-brightness polarized electron source.

Task 8. Coupler Development at LAL
- Cleaning, HP rinsing and tests results on samples copper plated ad TiN coated ceramics.
- Argon discharge cleaning measurements and coupler test
- Realization of a system for automatic couplers cleaning

Description of work:

Task 1. SRF Coordination and Communication.

The activities of this task are to oversee and co-ordinate the work of all the other tasks of the work package concerned, to ensure the consistency of the WP work according to the project plan and to coordinate the WP technical and scientific tasks with the tasks carried out by the other work packages when it is relevant. The coordination duties also include the organization of WP internal steering meetings, the setting up of proper reviewing, the reporting to the project management and the distribution of the information within the WP as well as to the other work packages running in parallel.
The task also covers the organization of and support to the annual meetings dedicated to the WP activity review and possible activity workshops or specialized working sessions, implying the attendance of invited participants from inside and outside the consortium.

Task 2. SC Cavities for Proton Linacs, Electro-polishing and surface investigations

Since a few last years, different options for the upgrade of the Large Hadron Collider were investigated. A very promising option is based on a superconducting proton linac (SPL), which can advantageously replace the injector of the CERN complex. It also offers new possibilities, since such an accelerator could be used as a proton driver for EURISOL or/and a neutrino factory. All these applications require acceleration up to 5 GeV of a high intensity proton beam. The beam is delivered by the LINAC4 injector at the energy of 180 MeV and at a frequency of 352.2 MHz. The optimized design of the SPL accelerator is based on two families of SC cavities ($\beta = 0.65$ and $\beta = 1.0$) operating at 704.4 MHz at gradients of 19 MV/m and 25 MV/m, respectively. Obtaining reliably such accelerating field values on multicell cavities requires following a well-defined protocol for the preparation of the cavity surface. In particular, electro-polishing (EP) of the surface requires the design of a new vertical EP set-up which fits the cavity size. In the standard electro-polishing apparatus the cavity is treated with its axis being aligned horizontally. At Cornell University an EP apparatus with a vertical cavity axis was explored. We propose to investigate this option in more detail because it promises a more uniform flow of electrolyte. The COMSOL code will be used to look in details of the fluid distribution for the vertical process as well as to find the optimum cathode geometry. Furthermore, the vertical process, thanks to its simpler geometrical configuration, would be well appropriate to treat large-size elliptical resonators. We intend then to design the bench to treat proton cavities as well as nice-cell electron cavities. The bench would be used to treat prototype cavities of Task 6, which require high accelerating gradients. In addition surface investigations like field emission scanning microscope (FESM), in-situ SEM/AES and ex-situ high resolution HRSEM/EDX will be used to characterize the surface quality.

- **Sub-task 1:** Design and fabrication of $\beta = 0.65$; 704 MHz elliptical cavity equipped with a titanium helium reservoir. Preparation and assembly in clean room. Modification of the vertical cryostat and adaptation to the cavity size. Test of the cavity in vertical cryostat. This sub-task is under responsibility of IPN-Orsay. The cavity interfaces with a cryomodule will be studied with CERN.

- **Sub-task 2:** Design and fabrication of $\beta = 1$; 704 MHz elliptical cavity. Preparation of the cavity and assembly in clean room. Development of a vertical EP bench and upgrade of HPR and field-flatness set-ups suited to the cavity size and weight. This sub-task is under responsibility of CEA-DSM-Saclay. The cavity interfaces with a cryomodule will be studied with CERN.

- **Sub-task 3:** Study of interfaces between the cavity and the cryomodule. This sub-task is under the responsibility of CERN. CEA-DSM-Saclay and IPN-Orsay will participate in order to fix the design in accordance with components specification and to adapt the prototypes to make it fit the cryomodule.

Task 3. LHC Crab cavities

- **Sub-task 1:** STFC, ULANC and CERN will determine the full LHC system requirements for the crab cavity system and then STFC and CERN will develop a suitable crab cavity design which meets these requirements; ULANC will develop suitable input and mode couplers to allow for damping of the dangerous trapped modes. The global non-EU collaboration will develop the SOM and HOM couplers. A suitable frequency tuner will be developed by ULAN-CI and CERN. Validation of expected cavity performance will be completed by fabrication of a model test cavity and collectively STFC, ULAN-CI and CERN will perform mode characterization measurements.

- **Sub-task 2:** ULANC, UNIMAN and CERN will determine the full CLIC system requirements for the crab cavity system and then UNIMAN and CERN will develop a suitable crab cavity design which meets these requirements; UNIMAN and ULANC will develop suitable input and mode couplers to allow for damping of the dangerous trapped modes. A suitable frequency tuner will be developed by ULANC and CERN. Validation of expected cavity performance will be completed by fabrication of a model test cavity and collectively ULANC and UNIMAN will perform mode characterization measurements. A complete X-band crab cavity will be fabricated by STFC and its performance verified by ULANC and UNIMAN.

- **Sub-task 3:** ULANC will develop suitable LLRF systems that can control the amplitude and phase of the crab cavities required for both LHC and CLIC. Low power phase and amplitude qualification measurements will be performed with their respective model cavities.

Task 4. Thin Films

Thin films depositing techniques has made major progress since the last large scale use of sputtering deposition techniques for Nb coated Cu SC cavities in the 1990's in the LEP-II and ALPI projects. The classical sputtering technique has been improved with e.g. new processes for: surface preparation, surface cleaning, cavity shaping and biased sputtering. The arc coating technology has been further developed and SC photo cathodes made with this technique shows promising performance. For the longer term, new thin film depositing techniques such as Atomic Layer Deposition will through experimental studies and theoretical studies using measured input data improve our understanding of thin film properties. This work should eventually permit the production of a new generation of high performance thin film SC cavities made with new methods and maybe with new superconducting materials.

- **Sub-task 1:** New and improved techniques for the production of Nb sputtered Quarter Wave (QW) cavities. QW cavities are highly suitable for heavy ion SC linacs, which today are used (or widely proposed to be used) for applications such as accelerators for radioactive ions beams, for low energy injectors and other ion beam applications. The work, led by CERN in collaboration with INFN-LNL, will focus on magnetron sputtering, high peak power magnetron sputtering and better shaping (techniques) of the cavities. The target value is to reach accelerating field of 6 MV/m with a Q-value of at least $5*10^8$.
- **Sub-task 2:** Arc coating of super conducting photo-cathodes. Metallic superconducting photo cathodes in superconducting RF guns have a long life time and avoids the severe problem with contamination from the exchange and conditioning required for a normal warm photo cathode. The work will focus on the coating of SC photocathode with a highly emission efficient lead layer with the goal of reaching a quantum efficiency of $3\ 10^{-3}$ for 213 nm wavelengths. The plan is to demonstrate operation of it in two high purity Nb cavities with a field of 40 MV/m at the emitting spot. The work is lead by DESY with the arc sputtering of lead performed by IPJ-Swierk.
- **Sub-task 3:** The development in thin film techniques is making steady progress and there are new developments of techniques such as atomic layer deposition (ALD), which appear versatile enough to be applied for the manufacturing of SC cavities. The work, led by CI in collaboration with CEA, LNL, CERN, and IPNO-IN2P3 will cover experimental studies of new methods for thin film deposition and the characterization of RF properties of the films which will be performed with resonators for sample tests (e.g. TE011 cylindrical bulk niobium cavity, quadrupole resonator, etc.) using the thermometric/calorimetric method.

Task 5. HOM Distribution

The wake-field excited by multi-bunch particle beams has the beneficial quality that it is, in essence, its own built-in diagnostic and this is the area of research for the proposed work package. An attenuated portion of the field radiated to the attached HOM (Higher Order Mode) damping ports provides information as to the location of the beam with respect to the electrical axis of the accelerating cavities and this provides a BPM (Beam Position Monitor). A suitable combination of the cavity eigenmodes provides essential information on the cavity to cavity and indeed on cell-to-cell alignment. Research in this area on the FLASH-TTF linac has allowed the emittance of the beam to be improved significantly. Use of the unique experimental facility, FLASH-TTF at DESY and the recently developed ERLP at Daresbury will allow these HOMs to be probed and their capability of improving the emittance of future colliders and light sources assessed. This research has particular relevance to the ILC, XFEL, and 4GLS. Furthermore, the new 3.9 GHz cavities to be installed at FLASH have an increased wake-field as the iris is more than a factor of 2 smaller than the TESLA cavity and the associated modes will require careful monitoring to ensure that they do not appreciably dilute the emittance of the beam.

We expect this research to have a significant experimental component associated with it, together with theoretical and experimental modelling. The former will be conducted at FLASH-TTF, DESY labs and ERLP, STFC Daresbury labs and the latter at the UNIMAN, UROS and CEA-DSM (Saclay). Considerable success on using these signals as a BMP has been achieved

with room temperature copper structures and we will exploit these techniques in the superconducting accelerating cavities.
This project aims at developing HOM based monitors and analyzing the modal distribution within the cavities:

- **Sub-task 1:** HOM based beam position monitors (HOMBPM). Improve the speed of existing HOMBPM installations, measure each bunch of every bunch train, and compare the resolution with various modes in order to verify the accuracy of the technique.
- **Sub-task 2:** Cavity Diagnostics and ERLP (HOMCD). From the HOM spectrum one can ascertain the cavity alignment and cell geometry. In particular we will investigate: mechanical deviations of individual cells from the ideal geometry, cell-to-cell misalignment and deformation of fields by couplers.
- **Sub-task 3:** HOM Distributions and Geometrical Dependences (HOMGD). Combining finite element and S-matrix cascading techniques allows the eigenmodes in multiple accelerating cells and cavities to efficiently modelled. This will allow an investigation of the implication of typical fabrication errors, on the mode distribution –in particular the splitting of the mode degeneracy and the influence of the couplers on the mode frequencies will be investigated.

Task 6. LLRF at FLASH

The present LLRF control system at FLASH will satisfy user needs for the next 1-2 years but does not fulfil the long term (3-10 years) requirements in several areas: field regulation, availability, maintenance and operability. The demand for high availability (HA), modularity, standardization and long time support favours the choice of the ATCA and uTCA standards with carrier boards and AMC modules. This technology comes from telecommunication industry and therefore lacks instrumentation needed for High-Energy Physics experiments. However the ATCA architecture for instrumentation in HEP experiments is already being developed (AGATA project) or is considered as strong candidate (XFEL, ILC instrumentation). The LLRF control system will be build using modular approach basing on ATCA architecture.
The input signals will be processed by AMC plug-in modules hosted by carrier board providing communication for the system components and supporting signal processing by embedded FPGAs and DSPs. Presently none of the required AMC boards for ADCs, DACs, down-converters, clock synthesizers etc. are available. Therefore a development of these boards using state-of-the-art technology is necessary in a way that optimizes the total costs while keeping high commercial standards on reliability, availability, maintainability and others. Several components of the LLRFsystem (controller, distribution of reference frequency, radiation monitoring) and control software were developed partly in the frame of FP6-CARE-JRASRF. They will be extended and implemented in the ATCA based LLRF system installed in FLASH accelerator.

- **Sub-task 1:** The LLRF control system will be build using modular approach basing on ATCA. The ATCA carrier board equipped with AMC sockets and huge processing power (FPGA and DSP) will be developed. Particular focus will be paid for transmission of analogue signals with low crosstalk from digital section.
- **Sub-task 2:** The main goal of this sub-task is a development of AMC and RTM modules required IO functionality. For RF signals processing of direct and downconverted signals will be investigated and compared. For radiation monitoring the AMC with integrated radiation level sensor will be developed. For synchronization of digital signal processing with RF field the special AMC with timing signals (clocks and event triggers) will be developed. Inter-module communication will be crucial for machine operation. To achieve High Availability (HA), High Maintainability (HM) and High Operability (HO), protocols for remote diagnostics are needed.
- **Sub-task 3:** The actuators (step motors, piezos) of the tuning system require power signals that cannot be supplied directly from LLRF system. Therefore special power drivers must be

developed together with AMC modules interfacing between drivers and LLRF system and software performing tuning algorithms must be implemented in firmware.

- **Sub-task 4:** The goal of this task is to explore the possibility to build up beam-based feedbacks and test a prototype at FLASH. The diagnostic devices (measuring longitudinal beam parameters like beam energy, bunch arrival etc.) will be connected by developed interfaces to ATCA based LLRF system and fast low level algorithms to extract relevant correction parameters will be implemented. The corrections will be then fed back to the LLRF system within a bunch train.

Task 7. SCRF gun at ELBE

- **Sub-task 1:** For the slice diagnostics system, beam dynamic simulations will be carried out. Commissioning of the diagnostics at ELBE, measurement of slice emittance and energy spread of the SRF-Gun beam, in particular for high bunch charges around 1 nC will be performed by HZB and FZD.
- **Sub-task 2:** Improvement of the GaAs photo-cathodes preparation chamber which is now used for Cs2Te photo-cathodes. Lenses and mirrors in the laser beam line will be replaced since green laser light will be used for the operation of the gun. For this work FZD is responsible for this work.
- **Sub-task 3:** The measurements in this sub-task concerns the i) properties of photo-cathodes like quantum efficiency, live time, thermal emittance, ii) the long term behaviour of the RF cavity, i.e. unloaded quality factor, maximum gradient, field emission, iii) later measurements with GaAs photo-cathodes.

Task 8. Coupler Development at LAL

CNRS-LAL Orsay is producing a considerable effort in setting up an international station to study, develop and test all the designs and applied technologies for high power coupler for SC cavities in the framework of the VUV, X FEL and ILC projects.

One of the most critical aspects in the coupler preparation before conditioning is the surface cleaning that should respect the same constraints of the cavities. During these years a clear correlation between the preparation procedure of the couplers and their conditioning time has been established. The followed procedure is extremely time consuming and it is very different from the SC cavity one, due to the geometrical and technology constraints imposed by the couplers. This involves both the copper plated parts and the coated ceramic windows. LAL wants to develop a R&D program, the goal of which is to improve the preparation procedure for the couplers both on cleaning aspects (to reduce the conditioning time and to guarantee the SC cavity cleanness) and on washing automatic procedure (to reduce the preparation time in large series). This program will allow studying the effect high pressure rinsing on different samples with different plating and coatings (for example tin on ceramics) and of the argon discharge cleaning on power couplers.

- **Sub-task 1:** Concerning high pressure rinsing, different samples will be analyzed by MEB, XDR and profilometer to assess the effect of the cleaning procedure and the applicability to the couplers. Tests on a multipactor resonator are foreseen to assess their behaviour under a strong electric field. The argon cleaning will be applied by polarizing the central antenna of a coupler.

- **Sub-task 2:** Concerning the automation of the coupler washing, LAL wants to test a prototype for series couplers washing and rinsing. This technique will also allow in drastically reducing the couplers handling during the preparation, which is one of the most delicate phase in coupler assembly. The treated couplers will be tested to compare the conditioning time with the ones that have been prepared with the established procedure.

Deliverables of tasks	Description/title	Nature	Delivery month
10.1.1	SRF web-site linked to the technical and administrative databases	O	M48
10.2.1	Results of SC proton cavity tests (β = 1 and β = 0.65)	R	M33
10.2.2	Reproducibility of the process as a Function of the EP-Mixture	R	M36
10.2.3	Summary of test results with vertical EP	R	M42
10.2.4	Evaluation of enhanced field emission in Nb samples	R	M48
10.3.1	LHC crab cavity final report	R	M36
10.3.2	CLIC crab cavity final report	R	M36
10.3.3	LHC and CLIC LLRF final reports	R	M36
10.4.1	QE data for Pb/Nb deposited photo cathode samples	R	M12
10.4.2	RF measurements on thin film deposited QWR prototype	R	M36
10.4.3	Cold test results for the test cavities w/out the deposited lead photo cathode	R	M36
10.4.4	New thin film techniques for SC cavities and photo cathodes	D	M30
10.5.1	HOM electronics and code to probe beam centring on 3.9 GHz cavities	R	M48
10.5.2	Report on HOM experimental methods and code	R	M48
10.6.1	Report on system test and performance	R	M42
10.7.1	Results of slice measurements	R	M24
10.7.2	Results for GaAs photocathodes	R	M33
10.8.1	Test and operation of the couplers preparation procedure	R	M24

Mile-stone	Description/title	Nature	Delivery month	Comment
10.1.1	Annual review SRF first year	O	M12	
10.1.2	Annual review SRF second year	O	M24	
10.1.3	Annual review SRF third year	O	M36	
10.1.4	Final SRF review	O	M48	
10.2.1	Cavity fabrication (proton linac)	P	M30	
10.2.2	Definition of cryomodule interface	R	M36	
10.2.3	Tests achieved for 1st recipe	O	M24	
10.2.4	Tests achieved for 2nd recipe	O	M36	
10.3.1	LHC crab cavity specifications completed	R	M12	LHC beam dynamics studies complete and impedance specifications defined
10.3.2	LHC model crab cavity completed	P	M24	Prototype cavity fabricated and tested
10.3.3	LHC input and LOM mode coupler design development finished	P/R	M33	Prototype mode couplers designed, fabricated and tested with the prototype cavity model
10.3.4	CLIC crab cavity specifications completed	R	M12	CLIC beam dynamics studies complete and impedance specifications defined
10.3.5	CLIC model crab cavity completed	R	M24	Prototype cavity fabricated and tested
10.3.6	CLIC input and mode coupler design	P/R	M33	Prototype mode couplers

	development finished			designed, fabricated and tested with the prototype cavity model
10.3.7	Development of LHC LLRF system	P	M21	LHC LLRF system prototype available for tests with prototype cavity
10.3.8	Development of CLIC LLRF system	P	M30	CLIC LLRF system prototype available for tests with prototype cavity
10.4.1	Lead deposition on samples for photocathode development	O	M12	Samples
10.4.2	Lead deposition on half cells and 1.5 cell cavities	O	M18	Report and samples
10.4.3	QWR sputtering with Nb using the magnetron technique	P	M30	
10.4.4	Report on new thin film coating techniques for SC cavities	R	M30	
10.4.5	Improved RF-design of 1.5 cell	R	M30	
10.5.1	HOM alignment for 3.9 GHz cavity electronics verification	D	M36	
10.6.1.	Design and manufacturing of the carrier board prototypes.	P	M18	
10.6.2	Design and manufacturing of the AMC modules with fast analogue and digital IO (at least 100 Ms/s, 14 b).	P	M24	
10.6.3	Design and manufacturing of the AMC board with ultra fast ADC (at least 2 Gs/s, 10 b)	P	M24	
10.6.4	Design and manufacturing of AMC radiation dosimeter	P	M18	
10.6.5	Report on tests and calibration of the radiation dosimeter	R	M36	
10.6.6	Designed and manufactured Frequency Synthesizer Board (AMC)	P	M24	
10.6.7	Design and manufacturing of high linearity multichannel downconverter	P	M18	
10.6.8	Integration of downconverters and upconverters in RTM (ATCA)	P	M24	
10.6.9	Design and fabrication of AMC modules for controlling step motors, piezo and waveguide tuners	P	M24	
10.6.10	Report on longitudinal beam parameter studies and their controllability by fast feedback systems in conjunction with the LLRF system	R	M36	
10.7.1	Preparation system for GaAs finished	O	M12	
10.7.2	Installation spectrometer dipole	O	M18	
10.7.3	GaAs photocathodes produced	D	M24	

Work package 11 description: ANAC: Assessment of Novel Accelerator Concepts

Work package number	WP11		**Start date or starting event:**		M1		
Work Package title	ANAC						
Activity type	RTD						
Participant id	**INFN**	BINP	CERN	CNRS	**STFC**		
Person-months per beneficiary:	110	24.5	32	46.4	46		

Objectives:

This WP merges three important topics regarding novel accelerator concepts in three different fields: high luminosity colliders (Task 2), technologies required by neutrino facilities (Task 3) and plasma wave accelerator techniques (Task 4).

Existing infrastructures used in the three Tasks:

- DAΦNE e+e- storage ring, INFN Frascati National Laboratories
- LHC collider, CERN
- EMMA FFAG Ring, Daresbury Laboratories
- SPARC LAB, INFN-Frascati National Laboratories
- LOA, CNRS

Task 1. ANAC Coordination and Communication.

- Coordination and scheduling of the WP tasks
- Monitoring the work, informing the project management and participants within the JRA
- WP budget follow-up

Task 2. Design of Interaction Regions for high luminosity colliders.

- Feasibility study of a new IR based on the Crab Waist concept for the upgraded KLOE experiment at DAΦNE.
- Study the possible integration of the Crab-Waist collision scheme into the LHC collider upgrade

Task 3. Upgrade of the EMMA FFAG Ring.

- Design, build and test the external diagnostics systems for EMMA.
- Commission EMMA using the diagnostics and perform the necessary experiments to evaluate non-scaling optics for a variety of applications.

Task 4. Instrumentations for novel accelerators.

- Design, build and test of detectors for emittance measurements of electron beams delivered by laser plasmas accelerators.

Description of work:

Task 1. ANAC Coordination and Communication.

The activities of this task are to oversee and co-ordinate the work of all the other tasks of the work package concerned, to ensure the consistency of the WP work according to the project plan and to coordinate the WP technical and scientific tasks with the tasks carried out by the other work packages when it is relevant. The coordination duties also include the organization of WP internal steering meetings, the setting up of proper reviewing, the reporting to the project management and the distribution of the information within the WP as well as to the other work packages running in parallel.

The task also covers the organization of and support to the annual meetings dedicated to the WP activity review and possible activity workshops or specialized working sessions, implying the attendance of invited participants from inside and outside the consortium.

Task 2. Design of Interaction Regions for high luminosity colliders.

The main purpose is to prove the compatibility of large detectors with a novel Interaction Region (IR) design relaying on large Piwinski angle, low–β and crab waist, a configuration capable to provide for the DAΦNE electron/positron collider a significantly larger luminosity than in the original configuration and a collision scheme which can be applied to other existing and future lepton colliders in order to reach unprecedented luminosities. Compatibility between the conflicting requirements of high luminosity IRs and experimental detectors is also an issue in terms of IR mechanical structure design, collider optics, beam dynamics and background rejection. The KLOE detector at DAΦNE will be upgraded in order to cope with the higher luminosity rates expected from the improved collision scheme. The study proposed is aimed at designing a new IR fitting inside the KLOE detector and implementing the new collision configuration, which will be tested at DAΦNE in 2008 with the SIDDHARTA detector. The experience gathered on the DAΦNE collider will be crucial to address possible issues in view of successful runs with more demanding detectors as KLOE, FINUDA or other possible future experiments. This activity will be of interest also the most advanced non-EU Laboratories, such as the Japanese KEK and the Chinese IHEP, as well as for the hadron collider LHC coming into operation at CERN, for which several approaches are under study in order to increase the collider luminosity beyond Phase-I.

- **Sub-task 1:** DAΦNE IR design for the upgraded KLOE detector. INFN will provide the infrastructure and perform beam parameter optimization, beam-beam simulations, Touschek lifetime calculations, background remediation studies. BINP will contribute with dynamic aperture optimization, beam-beam simulations, intra-beam scattering (IBS) and Touschek computation. CNRS will take part to the design of the luminosity monitor and to the beam measurements.

- **Sub-task 2:** Study of an IR design with large Piwinski angle and crab waist collision scheme for the LHC upgrade. CERN will take care of beam parameter optimization, IR design and bb simulations

Task 3. Upgrade of the EMMA FFAG Ring.

The Electron Model of Many Applications (EMMA) ring will be the world's first so-called non-scaling FFAG. It is being constructed at the STFC Daresbury Laboratory to prove the principle of this type of accelerator and its successful operation could have far reaching consequences. Construction of the EMMA ring is due for completion in early to mid-2009. As EMMA is a proof-of-principle accelerator, diagnostic devices to measure all aspects of the machine operation are very important. The EMMA ring will be instrumented with devices to measure the beam position, transverse profile, time of flight and beam intensity. However, certain measurements can only be made in an external beamline, for example emittance, longitudinal profile and momentum. In this project, we plan to design, prototype, test, construct, install and commission the diagnostics devices for these measurements. In addition, an emittance measurement system will be constructed for the injection line to allow a study of emittance growth in the ring.

- **Sub-task 1:** External diagnostics design, construction and testing. The requirements for the diagnostics will come from tracking studies performed by CNRS-Grenoble and STFC at the Daresbury Laboratory. The design, construction and testing of the devices will be undertaken by staff in STFC. The installation in the beam-lines will also be done by STFC staff.

- **Sub-task 2:** Commissioning and experimental running. Commissioning of EMMA using diagnostics will be undertaken by staff from STFC and CNRS. The experimental measurements with these devices required to determine the applicability of non-scaling optics for the applications being studied will also be made by staff at STFC and CNRS.

Task 4. Instrumentations for novel accelerators.

The need of new instrumentation to diagnose parameters of electron beam produced by laser plasma accelerator is extremely important. An experimental methodology in needed to investigate their parameters, such as emittance or relative energy spread, since they are not today produced with a very high shot to shot reproducibility than the one currently produced using RF cavities based accelerators. We propose to study the different approaches for measuring emittance of these electron beam delivered by laser plasmas accelerators. The emittances are expected to be in the mm.mrad range. The diagnostic which satisfies the best criteria will be then developed and tested using ultra short electron beams produced in European accelerator facilities or laser based accelerators.

Different approaches for measuring the beam emittance have also been suggested or tested in the past. To avoid errors induced shot to shot fluctuation in the emittance measurement INFN will develop a single shot emittance measurement or a specific technique to reduce those errors. This diagnostics will be tested at the SPARC Lab in Frascati, where a low emittance RF gun is available. The selected technique will be then tested and used at LOA where a laser plasma accelerator will be developed for this purpose.

Deliverables of tasks	Description/title	Nature	Delivery month
11.1.1	ANAC web-site linked to the technical and administrative databases	O	M48
11.2.1	DAΦNE IR design for the upgraded KLOE detector	R	M24
11.2.2	Study of an IR design for LHC upgrade	R	M36
11.3.1	Results from the operation of EMMA using the new diagnostics	R	M36
11.4.1	Preliminary electron beam emittance measurement report	R	M36

Mile-stone	Description/title	Nature	Delivery month	Comment
11.1.1	1st annual ANAC review meeting	O	M12	
11.1.2	2nd annual ANAC review meeting	O	M24	
11.1.3	3rd annual ANAC review meeting	O	M36	
11.1.4	Final ANAC review meeting	O	M48	
11.2.1	DAΦNE beam parameters definition for KLOE	O	M12	Preparatory for IR study
11.2.2	Compatibility of new IR scheme and LHC	O	M18	Preparatory for IR study
11.3.1	Requirements for electron beam diagnostics	R	M2	
11.3.2	Construction of the electron beam diagnostics completed	R	M14	
11.3.3	Commissioning of EMMA completed	R	M20	
11.4.1	Electron beam emittance meter finished	P	M24	Alignment and pre test

B.1.3.6 Efforts for the full duration of the project

Project Effort Form 1 - Indicative efforts per beneficiary per WP

Project number (acronym): 227579 (EuCARD)

Beneficiary no./Short name	WP 1	WP 2	WP 3	WP 4	WP 5	WP 6	WP 7	WP 8	WP 9	WP 10	WP 11	Total person months
1 CERN	84	10	21.6	11	3		116	84	88.4	38	32	**488**
2 ARC								4				**4**
3 HZB										10		**10**
4 BINP											24.5	**24.5**
5 CEA							139			85.5		**224.5**
6 CIEMAT									32			**32**
7 CNRS				4.5			28		50.4	50.5	46.4	**179.8**
8 COLUMBUS							4					**4**
9 CSIC								18				**18**
10 DESY				3.6			11			88		**102.6**
11 BHTS							4					**4**
12 EPFL								8.4				**8.4**
13 FZD										16		**16**
14 FZK							16					**16**
15 GSI								116				**116**
16 IFJ PAN										8		**8**
17 INFN			3.6				18	24	30.4	18	110	**204**
18 IPJ										26		**26**
19 POLITO								14				**14**
20 PSI									15			**15**
21 PWR							49					**49**
22 RHUL									53			**53**
23 RRC KI								35				**35**
24 SOTON							7					**7**
25 STFC						3	36		16	18	46	**119**
26 TUL										38		**38**
27 TUT							8					**8**
28 UH									112			**112**
29 UJF				5.6								**5.6**
30 ULANC										42.5		**42.5**
31 UM								12				**12**
32 UNIGE			20.6				10					**30.6**
33 UNIMAN									75	45		**120**
34 UOXF-DL									53			**53**
35 UROS										24		**24**
36 UU									68			**68**
37 WUT		14								22		**36**
Grand Total	**84**	**24**	**45.8**	**24.7**	**3**	**3**	**446**	**315.4**	**593.2**	**529.5**	**258.9**	**2327.5**

Project Effort Form 2 - indicative efforts per activity type per beneficiary (1/5) Project number (acronym) : 227579 (EuCARD)

Activity Type	CERN	ARC	HZB	BINP	CEA	CIEMAT	CNRS	COLUMBUS
RTD/Innovation activities								
HFM	116				128		28	4
ColMat	84	4						
NCLinac	88.4					32	50.4	
SRF	38		10		72.5		50.5	
ANAC	32			24.5			46.4	
Total 'research'	**358.4**	**4**	**10**	**24.5**	**200.5**	**32**	**175.3**	**4**
Coordination activities								
DCO	10							
NEU2012	21.6							
AccNet	11						4.5	
Total 'coordination'	**42.6**	**0**	**0**	**0**	**0**	**0**	**4.5**	**0**
Support activities								
HiRadMat@SPS	3							
MICE								
Total 'support'	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Consortium management activities								
Project management	84							
Total 'management'	**84**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
TOTAL	**488**	**4**	**10**	**24.5**	**224.5**	**32**	**179.8**	**4**

Project Effort Form 2 - indicative efforts per activity type per beneficiary (2/5) **Project number (acronym) : 227579 (EuCARD)**

Activity Type	CSIC	DESY	BHTS	EPFL	FZD	FZK	GSI	IFJ PAN
RTD/Innovation activities								
HFM		11	4			16		
ColMat	18			8.4			116	
NCLinac								
SRF		88			16			8
ANAC								
Total 'research'	**18**	**99**	**4**	**8.4**	**16**	**16**	**116**	**8**
Coordination activities								
DCO								
NEU2012								
AccNet		3.6						
Total 'coordination'	**0**	**3.6**	**0**	**0**	**0**	**0**	**0**	**0**
Support activities								
HiRadMat@SPS								
MICE								
Total 'support'	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Consortium management activities								
Project management								
Total 'management'	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
TOTAL	**18**	**102.6**	**4**	**8.4**	**16**	**16**	**116**	**8**

Project Effort Form 2 - indicative efforts per activity type per beneficiary (3/5) **Project number (acronym) : 227579 (EuCARD)**

Activity Type	INFN	IPJ	POLITO	PSI	PWR	RHUL	RRC KI	SOTON
RTD/Innovation activities								
HFM	18				49			7
ColMat	24		14				35	
NCLinac	30.4			15		53		
SRF	18	26						
ANAC	110							
Total 'research'	**200.4**	**26**	**14**	**15**	**49**	**53**	**35**	**7**
Coordination activities								
DCO								
NEU2012	3.6							
AccNet								
Total 'coordination'	**3.6**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Support activities								
HiRadMat@SPS								
MICE								
Total 'support'	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Consortium management activities								
Project management								
Total 'management'	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
TOTAL	**204**	**26**	**14**	**15**	**49**	**53**	**35**	**7**

Project Effort Form 2 - indicative efforts per activity type per beneficiary (4/5) **Project number (acronym) : 227579 (EuCARD)**

Activity Type	STFC	TUL	TUT	UH	UJF	ULANC	UM	UNIGE
RTD/Innovation activities								
HFM	36		8					10
ColMat							12	
NCLinac	16			112				
SRF	18	38				42.5		
ANAC	46							
Total ‘research’	**116**	**38**	**8**	**112**	**0**	**42.5**	**12**	**10**
Coordination activities								
DCO								
NEU2012								20.6
AccNet					5.6			
Total ‘coordination’	**0**	**0**	**0**	**0**	**5.6**	**0**	**0**	**20.6**
Support activities								
HiRadMat@SPS								
MICE	3							
Total ‘support’	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Consortium management activities								
Project management								
Total ‘management’	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
TOTAL	**119**	**38**	**8**	**112**	**5.6**	**42.5**	**12**	**30.6**

Project Effort Form 2 - indicative efforts per activity type per beneficiary (5/5) **Project number (acronym) : 227579 (EuCARD)**

Activity Type	UNIMAN	UOXF-DL	UROS	UU	WUT	**TOTAL ACTIVITIES**
RTD/Innovation activities						
HFM						**446**
ColMat						**315.4**
NCLinac	75	53		68		**593.2**
SRF	45		24		22	**529.5**
ANAC						**258.9**
Total ‘research’	**120**	**53**	**24**	**68**	**22**	**2143**
Coordination activities						
DCO					14	**24**
NEU2012						**45.8**
AccNet						**24.7**
Total ‘coordination’	**0**	**0**	**0**	**0**	**14**	**94.5**
Support activities						
HiRadMat@SPS						**3**
MICE						**3**
Total ‘support’	**0**	**0**	**0**	**0**	**0**	**6**
Consortium management activities						
Project management						**84**
Total ‘management’	**0**	**0**	**0**	**0**	**0**	**84**
TOTAL	**120**	**53**	**24**	**68**	**36**	**2327.5**

B.1.3.7 List of milestones and planning of reviews

List and schedule of milestones					
Milestone no.	**Milestone name**	**WP No.**	**Lead beneficiary**	**Delivery date From Annex I**	**Comments**
11.3.1	Requirements for electron beam diagnostics	11	STFC	M2	
3.1.1.1	Calendar of workshops & conferences concerning NEU2012	3	INFN	M6	
9.3.3	Installation of ATF2 final-focus alignment monitoring system	9	CNRS	M6	
1.1	1st annual EuCARD meeting	1	CERN	M12	
2.1.1	Annual status of DCO, first year	2	WUT, CERN	M12	
3.1.3.1	NEU2012 first annual workshop	3	INFN	M12	
4.1.1	Annual AccNet steering meeting, first year	4	CERN, CNRS	M12	
4.2.1	Annual EuroLumi workshop, first year	4	CERN	M12	
4.3.1	Annual RFTECH workshop, first year	4	CNRS, TUL	M12	
7.1.1	1st annual HFM review meeting	7	CERN, CEA	M12	
7.2.2	Preliminary heat deposition model for a dipole Nb_3Sn model magnet	7	PWR	M12	publication on web
7.4.1	HTS conductor specifications for insert coils	7	CERN	M12	
8.1.1	1st annual ColMat review meeting	8	CERN, GSI	M12	
8.2.1	Functional specification LHC of beam loss and collimator design	8	CERN	M12	Simulations and design completed.
8.2.3	Functional specification FAIR of beam loss and collimator design	8	CERN	M12	Simulations and design completed.
9.1.1	Annual NCLinac review first year	9	CERN, RHUL	M12	
10.1.1	Annual review SRF first year	10	DESY, CEA	M12	

10.3.1	LHC crab cavity specifications completed	10	UNIMAN	M12	LHC beam dynamics studies complete and impedance specifications defined
10.3.4	CLIC crab cavity specifications completed	10	UNIMAN	M12	CLIC beam dynamics studies complete and impedance specifications defined
10.4.1	Lead deposition on samples for photocathode development	10	CERN	M12	Samples
10.7.1	Preparation system for GaAs finished	10	FZD	M12	
11.1.1	1st annual ANAC review meeting	11	INFN	M12	
11.2.1	DAΦNE beam parameters definition for KLOE	11	INFN	M12	Preparatory for IR study
11.3.2	Construction of the electron beam diagnostics completed	11	STFC	M14	
9.4.1	Training at ATF3	9	RHUL	M18	Commissioning at ATF2
9.4.2	LW and BPMs installed	9	RHUL	M18	Hardware at ATF2 and PETRAIII
10.4.2	Lead deposition on half cells and 1.5 cell cavities	10	CERN	M18	Report and samples
10.6.1.	Design and manufacturing of the carrier board prototypes.	10	DESY	M18	
10.6.4	Design and manufacturing of AMC radiation dosimeter	10	DESY	M18	
10.6.7	Design and manufacturing of high linearity multichannel downconverter	10	DESY	M18	
10.7.2	Installation spectrometer dipole	10		M18	
11.2.2	Compatibility of new IR scheme and LHC	11	INFN	M18	Preparatory for IR study
8.3.1.1	LHC type collimator designed	8	CERN	M20	warm collimator
11.3.3	Commissioning of EMMA completed	11	STFC	M20	
10.3.7	Development of LHC LLRF system	10	UNIMAN	M21	LHC LLRF system prototype available for tests with prototype cavity
1.2	2nd annual EuCARD meeting	1	CERN	M24	
1.3	Mid-term review	1	CERN	M24	
2.1.2	Annual status of DCO, second year	2	WUT, CERN	M24	

3.1.2.1	Intermediate review of NEU2012 recommendations on neutrino experiments	3	INFN	M24	Road map for a programme of neutrino experiments
3.1.3.2	NEU2012 second annual workshop	3	INFN	M24	
3.2.1.1	Intermediate review of NEU2012 recommendations on existing accelerator neutrino facilities.	3	INFN	M24	Road Map for upgrading existing accelerator neutrino facilities
3.3.1.1	Intermediate review of NEU2012 recommendations on new accelerator neutrino facilities.	3	INFN	M24	Road Map to new accelerator neutrino facilities
4.1.2	Annual AccNet steering meeting, second year.	4	CERN, CNRS	M24	
4.2.2	Annual EuroLumi workshop, second year.	4	CERN	M24	
4.3.2	Annual RFTECH workshop, second year.	4	CNRS, TUL	M24	
7.1.2	2nd annual HFM review meeting	7	CERN, CEA	M24	
7.2.1	Methodology for the certification of radiation resistance of coil insulation material	7	PWR	M24	
7.2.3	Engineering heat deposition model for a dipole Nb_3Sn model magnet	7	PWR	M24	publication on web
7.4.2	Two HTS solenoid insert coils	7	CERN	M24	
8.1.2	2nd annual ColMat review meeting	8	CERN, GSI	M24	
8.2.2	Upgrade LHC collimator specification	8		M24	Materials characterized and tested. Review of results and specification.
8.3.2.1	FAIR type collimator designed	8	CERN	M24	cryogenic collimator
9.1.2	Annual NCLinac review second year	9	CERN, RHUL	M24	
9.2.1	Modification of NCLinac computer codes and first round of simulations.	9	CERN	M24	
9.2.2	Design of NCLinac hardware for test module	9	CERN	M24	
9.3.1	Characterization of noise/vibrations sources in an accelerator	9	CNRS	M24	
9.3.2	Installation of interferometers at CTF3 Module	9	CNRS	M24	

9.3.4	Installation of ILC prototype FB/FF at ATF2	9	CNRS	M24	
10.1.2	Annual review SRF second year	10	DESY, CEA	M24	
10.2.3	Tests achieved for 1st recipe	10	CEA	M24	
10.3.2	LHC model crab cavity completed	10	UNIMAN	M24	Prototype cavity fabricated and tested
10.3.5	CLIC model crab cavity completed	10	UNIMAN	M24	Prototype cavity fabricated and tested
10.6.2	Design and manufacturing of the AMC modules with fast analogue and digital IO (at least 100 Ms/s, 14 b).	10	DESY	M24	
10.6.3	Design and manufacturing of the AMC board with ultra fast ADC (at least 2 Gs/s, 10 b)	10	DESY	M24	
10.6.6	Designed and manufactured Frequency Synthesizer Board (AMC)	10	DESY	M24	
10.6.8	Integration of downconverters and upconverters in RTM (ATCA)	10	DESY	M24	
10.6.9	Design and fabrication of AMC modules for controlling step motors, piezo and waveguide tuners	10	DESY	M24	
10.7.3	GaAs photocathodes produced	10	FZD	M24	
11.1.2	2nd annual ANAC review meeting	11	INFN	M24	
11.4.1	Electron beam emittance meter finished	11	CNRS	M24	Alignment and pre test
8.3.1.2	LHC type collimator constructed	8	CERN	M26	
8.3.1.3	LHC type collimator tested	8	CERN	M30	
9.3.5	Commissioning of CLIC quadrupole module	9	CNRS	M30	Complete module with girder and accelerating structure
9.3.6	Quadruple mock-up manufactured and ready for installation	9	CNRS	M30	
10.2.1	Cavity fabrication (proton linac)	10	CEA	M30	
10.3.8	Development of CLIC LLRF system	10	UNIMAN	M30	CLIC LLRF system prototype available for tests with prototype cavity

10.4.3	QWR sputtering with Nb using the magnetron technique	10	CERN	M30	
10.4.4	Report on new thin film coating techniques for SC cavities	10	CERN	M30	
10.4.5	Improved RF-design of 1.5 cell	10	CERN	M30	
10.3.3	LHC input and LOM mode coupler design development finished	10	UNIMAN	M33	Prototype mode couplers designed, fabricated and tested with the prototype cavity model
10.3.6	CLIC input and mode coupler design development finished	10	UNIMAN	M33	Prototype mode couplers designed, fabricated and tested with the prototype cavity model
7.5.1	Final design report HTS link	7		M34	
1.4	3rd annual EuCARD meeting	1	CERN	M36	
2.1.3	Annual status of DCO, third year	2	WUT, CERN	M36	
3.1.3.3	NEU2012 third annual workshop	3	INFN	M36	
4.1.3	Annual AccNet steering meeting, third year.	4	CERN, CNRS	M36	
4.2.3	Annual EuroLumi workshop, third year.	4	CERN	M36	
4.3.3	Annual RFTECH workshop, third year.	4	CNRS, TUL	M36	
7.1.3	3rd annual HFM review meeting	7	CERN, CEA	M36	
7.3.1	Dipole Nb_3Sn coils finished	7	CEA	M36	2 coils ready for mounting
7.6.1	Short prototype SC helical undulator fabricated and tested	7	STFC	M36	
8.1.3	3rd annual ColMat review meeting	8	CERN, GSI	M36	
8.3.2.2	FAIR type collimator constructed	8	CERN	M36	
9.1.3	Annual NCLinac review third year	9	CERN, RHUL	M36	
9.2.3	Prototype components for CLIC module prepared	9	CERN	M36	
9.5.1	RF phase monitor prototype finished	9	INFN	M36	Prototype ready for test
10.1.3	Annual review SRF third year	10	DESY, CEA	M36	
10.2.2	Definition of cryomodule interface	10	CEA	M36	
10.2.4	Tests achieved for 2nd recipe	10	CEA	M36	

10.5.1	HOM alignment for 3.9 GHz cavity electronics verification	10	DESY	M36	
10.6.5	Report on tests and calibration of the radiation dosimeter	10	DESY	M36	
10.6.10	Report on longitudinal beam parameter studies and their controllability by fast feedback systems in conjunction with the LLRF system	10	DESY	M36	
11.1.3	3rd annual ANAC review meeting	11	INFN	M36	
9.5.2	Electro optical monitor prototype finished	9	INFN	M40	Prototype ready for test
7.3.2	Dipole Nb_3Sn model magnet finished	7	CEA	M42	Ready for cold test
1.5	Final annual EuCARD meeting	1	CERN	M48	
2.1.4	Final status of DCO	2	WUT, CERN	M48	
3.1.3.4	NEU2012 final annual workshop	3	INFN	M48	
4.1.4	Final AccNet steering meeting	4	CERN, CNRS	M48	
4.2.4	Final EuroLumi workshop	4	CERN	M48	
4.3.4	Final RFTECH workshop	4	CNRS, TUL	M48	
7.1.4	Final HFM review meeting	7	CERN, CEA	M48	
8.1.4	Final ColMat review meeting	8	CERN, GSI	M48	
9.1.4	Final NCLinac review	9	CERN, RHUL	M48	
10.1.4	Final SRF review	10	DESY, CEA	M48	
11.1.4	Final ANAC review meeting	11	INFN	M48	

Tentative schedule of project review

Review no.	**Tentative timing**	***planned venue of review***	***Comments***
1	After project month: 24	**CERN**	**Mid term review**

B2. Implementation

B.2.1 Management structure and procedures

The project management will be implemented through the management structure shown in Figure 3.

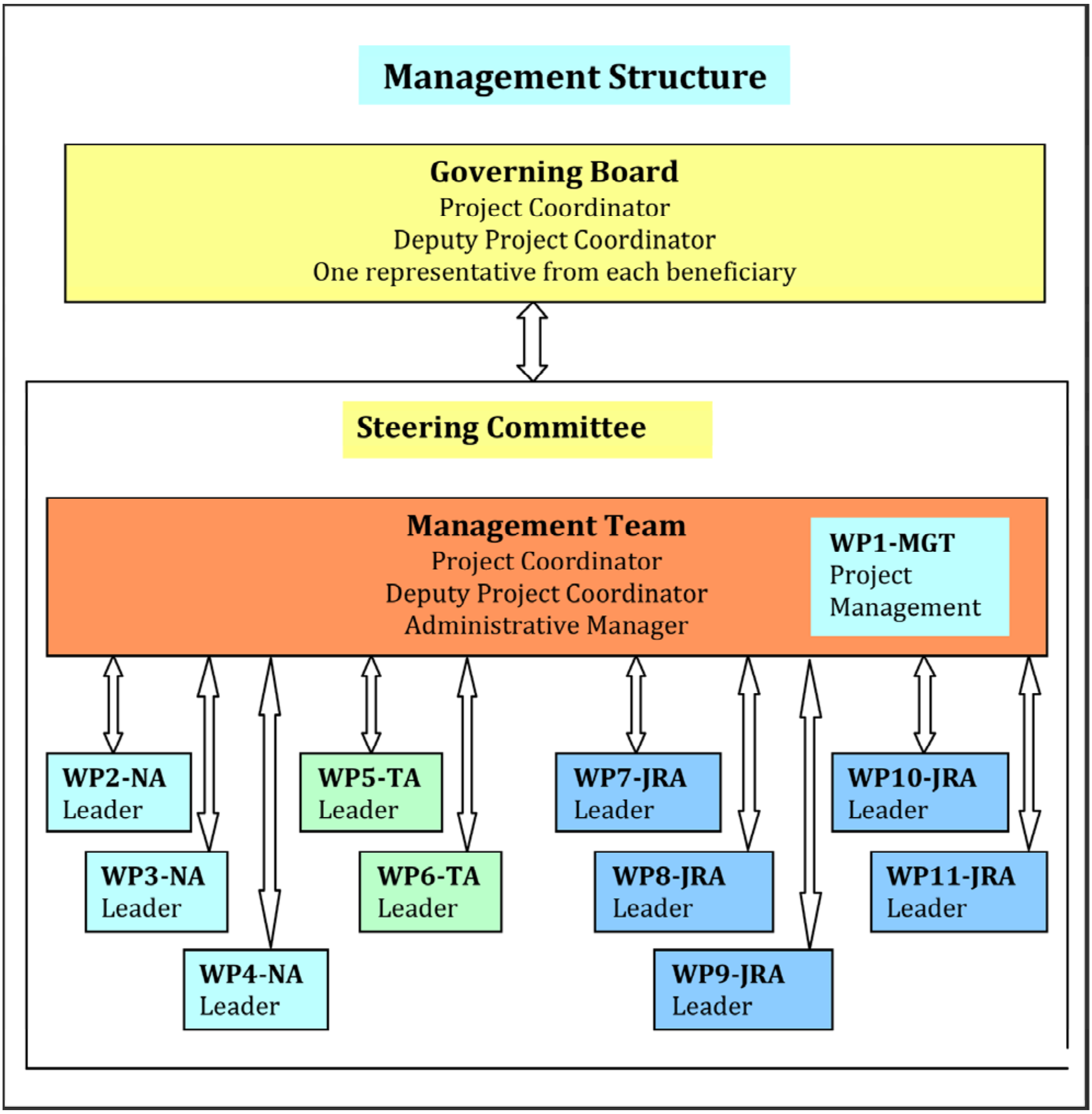

Figure 3. Management structure

- **Governing Board (GB)**

The EuCARD Consortium is composed of 37 legal entities. The Governing Board (GB) is the top-level decision-making and arbitration body. It has one representative from each beneficiary in the project and includes the Project Coordinator and the Deputy Project Coordinator. Each beneficiary has one vote and decisions will be taken by a majority of the votes. The GB has the power to decide, upon Steering Committee proposals, on strategic issues, such as modifications of the project programme of work (if necessary) and admission of new beneficiaries. The GB will be convened for the first time one month before the start of the project. The Governing Board will review the progress of the project at the annual EuCARD meetings, and, where necessary, decides on changes in the work plan and budget allocation for the next reporting period. In addition to the annual meetings, the GB may be called for extraordinary meetings. The chair of the GB will be elected by its members.

- **Steering Committee (SC)**

The SC is composed of the Project Coordinator and Deputy Project Coordinator, the Administrative Manager, the Work Package Coordinators of WP2 to WP11 and their Deputies. It is the executive body of the Consortium in charge of the coordination and management of all activities in the project. It shall monitor the work progress and will take executive decisions on scientific and administrative issues that may arise during the implementation of the project. The SC will have regular meetings, typically four times a year.

- **Project Coordinator (PC)**

The PC will be responsible for the daily scientific management of the EuCARD project, including the regular follow-up of the progress in all Work Packages. Within these activities, he/she will have the responsibility of the coordination of Work Package 1 (IA Management). The PC will chair and organize the Steering Committee meetings, and will be in charge of the preparation of the Periodic Reports and the Final Report. The PC will maintain a tight link with the policy-making bodies in the relevant fields, to maximize the impact of EuCARD on the emergence of lasting collaborative structures. For High Energy Physics, this shall be done through his membership to the ESGARD steering group. For Nuclear Science and Light sources, the PC will remain informed of the development of ESFRI activities.

- **Deputy Project Coordinator (DPC)**

The DPC will assist the Project Coordinator in the daily scientific management and coordination tasks, and will replace the PC in case of absence.

- **Administrative Manager (AM)**

The AM will be responsible for the administrative and contractual follow-up of the project, including budget control and cost reporting. The AM will monitor the contractual deadlines for deliverables and milestones, and will assist in organising the Annual Review, Mid-term Review and Final Review meetings. The AM will be in charge of financial issues, such as payments and distribution of EU funding received, collection of certificates on financial statements, of periodic reports and justification of costs, as well as of legal issues, such as the implementation of the Consortium Agreement and Intellectual Property Rights agreed by the beneficiaries. In addition, the AM will monitor the application of gender equality practices in conformity with the European Charter and Code of Recruitment of Researchers.

- **Management Team**

The Project Coordinator, Deputy Project Coordinator, and Administrative Manager will form the Management Team. The Management Team will be supported in their various activities by CERN administrative, legal and financial services.

- **Work package Coordinators (Leaders)**

The WP Leaders will coordinate the Network-, Transnational-Access- and Joint-Research-Activities in the framework of their own WP. They will have the responsibility for ensuring the effective cooperation between the beneficiaries in each WP, for monitoring the progress of all tasks in the WP, and for reviewing the milestone and Deliverable reports within their WPs. They will contribute to the preparation of all other reports regarding the activities of their WPs, which are requested by the Management Team.

- **Task Coordinators (Leaders)**

The Task Leaders will coordinate the activities in the framework of their own Task. They will have the responsibility for ensuring the effective cooperation between the beneficiaries in the task, for monitoring the task progress, and for producing the milestone and Deliverable reports within their Tasks. They will contribute to the preparation of all other reports regarding the activities of their Task, which are requested by the Work Package Coordinators or the Management Team.

- **Management Procedures**

Modern project management tools and methods, which have proved their efficiency in other large projects, may also be used for EuCARD. An efficient tool has been developed in the Information Technology Department of CERN for Progress Project Tracking, and a special version is available for management of EU projects. This tool is in use in major CERN/EU co-funded projects, such as EGEE. It aims at making available a common system of reporting and at centrally collecting the financial and administrative information requested. A customization for the EuCARD project will be evaluated. A EuCARD template will be provided on the web for reporting on milestones under a standardized format as a means of monitoring and verification by the Coordinator.

- **Reporting Procedures**

The reporting procedures of EuCARD will be described in an Annex to the Consortium Agreement.

B.2.2 Beneficiaries

Full name of beneficiary: European Organization for Nuclear Research	**1**
Short name of beneficiary: CERN	
Description of beneficiary: CERN is the European Organization for Nuclear Research, the world's largest particle physics centre. With some 2500 staff members and 6500 visitors CERN is involved in a large number of particle physics activities and is presently completing the world most powerful particle accelerator, the LHC. CERN has experience in managing the largest world accelerator infrastructures and by its very nature of International Organization the expertise in leading large-scale collaborations involving a large number of institutes from all over the world. The CERN administrative, legal and financial services are competent to process all issues the consortium may have to face, including at the highest political level if required.	
Tasks in EuCARD: Project management, coordination of: WP4 (AccNet), WP7 (HFM), WP8 (ColMat), co-coordination of WP9 (NCLinac), TA HiRadMat@SPS, and participation in: WP1, WP2, WP3, WP4, WP5, WP7, WP8, WP9, WP10 and WP11	

Full name of beneficiary: Austrian Research Centers Gmbh - ARC	2
Short name of beneficiary: ARC	
Description of beneficiary: The Austrian Research Centers GmbH- ARC is Austria's largest contract research enterprise. Founded in 1956, the ARC understand their role as innovation partners of industry and of public organisations. They act as a service provider in the field of application-oriented research and technology development combining a broad interdisciplinary catalogue of skills with specialised know-how. In addition they have a strategic look on topics which will be of importance for the future. The Powder Technology Center at ARC is equipped with different facilities for the research and manufacturing on diamond based composites using a powder metallurgical approach. Facilities for pressing, sintering, hot pressing, rapid hot pressing or gas pressure sintering as well as the complete process chain of the powder injection moulding process is available. The available testing facilities cover a laser flash system for the measurement of the thermal diffusivity, a differential scanning calorimeter for specific heat measurement, different dilatometer for the measurement of the coefficient of thermal expansion and a system for thermal cycling. Of course the equipment for testing the mechanical properties is available as well. The different properties can be measured as a function of the temperature.	
Tasks in EuCARD: Task 8.2.3 Materials and thermal shock waves	

Full name of beneficiary: Helmholtz-Zentrum für Materialien und Energie	3
Short name of beneficiary: HZB	
Description of beneficiary: HZB operates the largest 3rd generation SR facility in the XUV range in Europe (HZB II) with over 1200 users per year. HZB carries out and supports technological development in fields ranging from fundamental sciences, such as surface physics, magnetism, and structural biology, to new technologies and applications exploiting synchrotron radiation. HZB is also the European radiation standard and services European radiometric laboratories and legal certification institutions. HZB now plans to build a new free electron-laser facility (HZB-FEL). It will employ a 2.3 GeV superconducting driver linac based on accelerator technology developed at DESY for the TESLA project. As a precursor, HZB will build the HGHG-FEL demonstrator STARS, a 325 MeV linac-based FEL. To enable the development of CW linac technology, HZB has been operating the HoBiCaT superconducting RF test facility since 2004. As part of the FP6 EUROFEL Design Study, and in close collaboration with DESY, HoBiCaT has become the leading European centre for CW SRF TESLA cavity development.	
Tasks in EuCARD: Task 10.7.1 SRF-Gun beam measurements. Task 10.10 Upgrade and operation of an RF station	

Full name of beneficiary: Budker Institute of Nuclear Physics	4
Short name of beneficiary: BINP	
Description of beneficiary: BINP (Novosibirsk) was established in 1958 with the main research directions included HEP, accelerator physics (e+e- colliders mainly), thermonuclear physics, SR generation and utilization, etc. Nowadays the following facilities are in operation at BINP: e+e- colliders VEPP-4M (energy up to 6 GeV) and VEPP-2000 (round beams, energy 1 GeV), FEL with the world record power in the THz radiation region, SR source VEPP-3, two open traps for plasma researches. The total staff of BINP now is around 3,000.	
Tasks in EuCARD: Task 11.2.1 Beam simulations.	

Full name of beneficiary: Commissariat à l'Énergie Atomique	**5**
Short name of beneficiary: CEA	
Description of beneficiary: DSM is the 'Directorat' (about 1700 permanent staff) of CEA, involved in various kinds of physics and associated technologies. Within CEA-DSM, Irfu (Institut de recherche sur les lois fondamentales de l'Univers) with about 120 permanent staff, will be the main contributor to the program, with the contribution of SIS (Structure engineering department).	
Tasks in EuCARD: WP4, Networking activities in EuroLumi and RFTECH. WP7, WP Co-coordination, task leader for models task, coil construction, thermal measurements and modelling, HTS insert dipole coil construction WP10, WP Co-coordination, important contributions in nearly all tasks.	

Full name of beneficiary: Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas	**6**
Short name of beneficiary: CIEMAT	
Description of beneficiary: CIEMAT is a research Institute mainly focused on Energy and Technology topics. The contribution to this Project will be performed by means of the Superconductivity Group. This group was born 20 years ago, when the first magnet prototypes for LHC project were starting. We have designed and fabricated superconducting magnets and current leads for LHC, TESLA500, XFEL and GSI. In 2004, we started the collaboration with the experimental facility CTF3 at CERN. In that framework, we have also developed other non-superconducting devices, as precision movers for quadrupoles, kickers, septa and a special device so-called PETS to extract RF power from an electron beam. Our group keeps a close and fruitful relationship with Spanish companies devoted to the fabrication of electromechanical devices, especially with those able to manufacture electromagnets and cryostats. Those companies have been actively participating in the LHC construction. In the same way, they are interested in R+D activities for future facilities like CLIC and ILC.	
Tasks in EuCARD: WP9, task 2: Normal conducting high gradient cavities (PETS)	

Full name of beneficiary: Centre National de la Recherche Scientifique	**7**
Short name of beneficiary: CNRS	
Description of beneficiary: The Centre National de la Recherche Scientifique (National Centre for Scientific Research) is a government-funded research organization, under the administrative authority of France's Ministry of Research. The CNRS operates thanks to a structure of 1,260 research unities, more than 30,000 employees (~ 90 % are fixed term researchers, engineers, technicians and administrative staff) and a global 2007 budget of 3.080 billion euros. As the largest fundamental research organization in Europe, CNRS carried out research in many fields of knowledge, through its six research departments: • Mathematics, Physics, Earth Sciences and Astronomy (MPPU) • Chemistry • Life Sciences • Humanities and Social Sciences • Environmental Sciences and Sustainable Development (EDD) • Information and Engineering Sciences and Technologies (ST2I) and two national institutes: • The National Institute of Nuclear and Particle Physics (IN2P3) • The National Institute of Earth Sciences and Astronomy(INSU)	

At the time of the Grant Agreement negotiations, it is expected that the following CNRS research units will participate in the project: LAL Laboratoire de l'accélérateur linéaire (WP4, WP9, WP10, and WP11), Institut Neel (WP7), LAPP Laboratoire d'Annecy le Vieux de physique des particules (WP9), IPNO Institut de physique nucléaire d'Orsay (WP10), LPSC Laboratoire de physique subatomique et de cosmologie (WP11) and LOA Laboratoire d'optique appliquée (WP11). The Institut Polytechnique de Grenoble - Grenoble INP participates as Third Party linked to the CNRS in WP7, for the research conducted at the Institut Neel.
Tasks in EuCARD: WP4, WP7 on high-field dipole insert, WP9, WP10 on proton superconducting cavities, WP11 on luminosity monitoring and beam measurements.

Full name of beneficiary: Columbus Superconductors SpA	**8**
Short name of beneficiary: COLUMBUS	
Description of beneficiary: COLUMBUS is an small company founded in 2003, with the aim of developing and commercializing superconducting wires based on innovative superconducting materials, as MgB_2. The company activities currently involve 30 people, and has a new manufacturing plant covering an area of 3,400 m^2 with capability to produce up to 2,000 Km/year. COLUMBUS is now developing MgB_2 based conductors for a variety of applications, going from medical to the electro-technical field.	
Tasks in EuCARD: Task 7.5.1 Studies on thermal, electrical and mechanical performance Task 7.5.2 Design and test of electrical contacts HTS-HTS and HTS-Cu Task 7.5.3 Design and assembly of a 20 m long HTS multi-conductor 600 A link	

Full name of beneficiary: Instituto de Fisica Corpuscular (Consejo Superior de Investigaciones Cientificas – Universitat de València)	**9**
Short name of beneficiary: CSIC	
Description of beneficiary: The CSIC is a Spanish laboratory having a long-standing reputation in theoretical and experimental physics. From the experimental point of view, it has expertise in the design and construction of detectors and beam instrumentation for nuclear, medical and particle physics.	
Tasks in EuCARD: Task 8.2.1 Halo studies and beam modelling	

Full name of beneficiary: Deutsches Elektronen-Synchrotron	**10**
Short name of beneficiary: DESY	
Description of beneficiary: DESY is a German research centre for High Energy physics, synchrotron light and FEL physics. DESY has a long lasting experience in accelerator design and operation such as HERA, PETRA, DORIS and FLASH. Superconducting magnets and cavities were developed for the storage ring HERA, FLASH and XFEL. FLASH is the most advanced SASE FEL infrastructure and serves also as unique test bed for superconducting RF technology. The approved XFEL project with its 800 superconducting 1.3 GHz cavities will be the largest superconducting RF accelerator for the near future. DESY is the most advanced centre of superconducting RF components with respect to design, preparation, fabrication, and industrialization. DESY plays a leading role in the TTC (TESLA Technology Collaboration) which is a scientific consortium of 49 international laboratories the mission of which is to advance SCRF technology R & D and related accelerator studies across the broad diversity of scientific applications, and to keep open and provide a bridge for communication and sharing of ideas, developments, and testing across associated projects.	

Tasks in EuCARD:
Coordination of WP10, Participation in WP4, WP7 on HTS link, WP10 on electropolishing HOM and LLRF.

Full name of beneficiary: Bruker HTS GmbH, Hanau	**11**
Short name of beneficiary: BHTS	
Description of beneficiary: BHTS is a member of the BRUKER group and is active in research and production of high temperature superconductivity. The company's research and development team includes 30 people who work on BiSCCO and YBCO-based high temperature superconducting technologies. BHTS provides industrial superconductors and application solutions to a wide range of customers, and performs also own development of HTS devices for power applications. One example is the delivery of Bi-2223 HTS wire for the CERN LHC HTS current leads. BHTS is and was involved in different German national and EU projects like the EU-projects Acropolis, SLIM Former or Super3C. The expertise of BHTS covers the development, production and characterization of HTS.	
Tasks in EuCARD: Task 7.5.1 Studies on thermal, electrical and mechanical performance Task 7.5.2 Design and test of electrical contacts HTS-HTS and HTS-Cu Task 7.5.3 Design and assembly of a 20 m long HTS multi-conductor 600 A link	

Full name of beneficiary: Ecole Polytechnique Fédérale de Lausanne	**12**
Short name of beneficiary: EPFL	
Description of beneficiary: The Laboratory for Mechanical Metallurgy has a long standing record of processing, characterizing and modelling of advanced metal based composite materials, both regarding their structural and thermo-physical properties.	
Tasks in EuCARD: Task 8.2.3 Materials and thermal shock waves	

Full name of beneficiary: Forschungszentrum Dresden-Rossendorf e.V.	**13**
Short name of beneficiary: FZD	
Description of beneficiary: FZD operates the radiation source ELBE, a user facility with a medium energy, high current, CW SRF linac (1.3 GHz TESLA) and two free electron lasers. In 2007 a superconducting RF photo injector was put into operation and is in use as an injector test facility now. Fields of excellence are design and construction of SRF accelerator modules and SRF photo injectors, beam dynamics and diagnostics, photocathode development, CW RF techniques, high-power lasers and laser plasma acceleration.	
Tasks in EuCARD: WP 4, Task 3, Task 10.7.1 SCRF gun at ELBE	

Full name of beneficiary: Forschungszentrum Karlsruhe GmbH	**14**
Short name of beneficiary: FZK	
Description of beneficiary: Activity fields of the Institute for Technical Physics (ITP) are superconductivity and cryogenics and their applications. The activities span over nuclear fusion, electric power equipment and high field magnets. Essential are developments of superconductors, mainly high temperature superconductors, cryogenic components and the characterisation of structure materials at low	

temperature. ITP operates a high field laboratory with superconducting magnets up to 20 T in a 185 mm bore. The "Institut für Synchrotron Strahlung" (Institute for Synchrotron Radiation) ISS at FZK operates the synchrotron light source ANKA, a 2.5 GeV storage ring (http://ankaweb.fzk.de/). ANKA provides light from hard X-rays to the far-infrared for research and technology. ANKA is operated as a user facility for the national and international scientific community, for the Helmholtz Society research programs and for industrial customers. Collaborations exist with MAXLAB (Sweden), ELETTRA (Italy) and ESRF (France) within FP6. ISS works closely with the Institute for Solid State Physics and the Institute for Technical Physics at the FZK, with the Laboratory for Application of Synchrotron Radiation of the University of Karlsruhe, and with the University of Erlangen-Nürnberg.
Tasks in EuCARD: Task 7.4 Very high field dipole insert

Full name of beneficiary: Gesellschaft für Schwerionenforschung mbH, Darmstadt	**15**
Short name of beneficiary: GSI	
Description of beneficiary: The laboratory operates the heavy ion linear accelerator UNILAC, the synchrotron SIS and the cooler storage ring ESR. GSI is presently concentrating on the design work for the international Facility for Antiproton and Ion Research FAIR that will be build on the laboratory site during the next years. GSI will contribute its broad experience in accelerator design for high intensity ion beams, in RF cavity design and in space charge and other collective effects to the project.	
Tasks in EuCARD: WP4 contributions to EuroLumi and RFTECH. WP 8 contributions to all aspects of the WP.	

Full name of beneficiary: The Henryk Niewodniczanski Institute of Nuclear Physics Polish Academy of Sciences, Krakow	**16**
Short name of beneficiary: IFJ PAN	
Description of beneficiary: The Institute carries out basic and applied research in physics, with emphasis on nuclear physics. This research is aimed at explaining the structure of matter from microscopic to cosmic scales, through experiments and/or application of theoretical methods. Its activity extends into interdisciplinary research in a range of related fields and also stimulates technology transfer to the industry and to spin-off companies.	
Tasks in EuCARD: WP10, task 6 LLRF at FLASH	

Full name of beneficiary: Istituto Nazionale di Fisica Nucleare	**17**
Short name of beneficiary: INFN	
Description of beneficiary: The INFN - the National Institute of Nuclear Physics - is the major Italian research organization dedicated to the study of the fundamental constituents of matter, and conducts theoretical and experimental research in the fields of subnuclear, nuclear, and astroparticle physics. Fundamental research in these areas requires the use of cutting-edge technologies and instrumentation, which the INFN develops both in its own laboratories and in collaboration with the world of industry. These activities are conducted in close collaboration with the academic world. The INFN workforce includes about 2,000 of its own employees, almost 2,000 university employees involved in research conducted by the Institute, and 1,300 young researchers, including undergraduate and graduate students and research fellows. ***Fields of excellence***: High Energy and Nuclear Physics Accelerators and Experiments, operation of Particle Accelerators and Colliders, Accelerator Controls, Computing, Synchrotron	

Radiation Sources and Experiments, Astroparticle physics, Free Electron Lasers.
Tasks in EuCARD: WP3, WP4, WP7 on high-field dipole insert, WP8 on halo studies and collimation tests, WP9, WP10 on Nb coating, WP11 on design of Interaction Region design for high luminosity, with tests in DAΦNE.

Full name of beneficiary: The Andrzej Soltan Institute for nuclear studies in Swierk	**18**
Short name of beneficiary: IPJ	
Description of beneficiary: IPJ is a National Laboratory carrying out fundamental and applied research on subatomic physics, It also produces specialized equipment for various applications (e.g. medicine and environmental protection). Main Activities: nuclear physics, elementary particle, astro-particle, cosmic ray, neutrino, plasma. Technologies: plasma, detectors, electronics, accelerators, materials science, informatics. Applications: research, medicine, environment, energetics, safety, archaeology and arts. IPJ has six Research Departments in addition to a Training and Consulting Department, a Division of Information Technology, and a Department for Nuclear Equipment “HITEC”. IPJ closely cooperates with the Institute of Atomic Energy (IEA), located in the same area. Technical Services of IPJ serve the research nuclear reactor MARIA, the Department of Radioactive Waste Neutralization and other research facilities within Swierk’s boundary. IPJ participates in leading international research projects, like FAIR, LHC, FLASH and XFEL The Institute constructs radiation detectors and electronics for experiments. The main IPJ Research Infrastructures and laboratories of interest in the context of accelerator physics are: an isochronous cyclotron (30 MeV proton energy), a laboratory for modifying surfaces, a laboratory for detectors, a muon telescope and a laboratory for thin superconducting films deposition.	
Tasks in EuCARD: Task 10.4.2 Arc coating of cavities and photo-cathodes.	

Full name of beneficiary: Politecnico di Torino	**19**
Short name of beneficiary: POLITO	
Description of beneficiary: Politecnico di Torino participates into the project through the Mechanics Department. The research team has a specialised laboratory for material characterisation in case of dynamic and impact loading and has widely recognised experience in modelling the behaviour of the materials of interest for the particular application considered in the present research project, taking into account the results of the experimental tests. The research team has also a good expertise in the development of new material test methodology and of the correlated experimental test apparatus.	
Tasks in EuCARD: Task 8.2.3 Materials and thermal shock waves	

Full name of beneficiary: Paul Scherrer Institut, Villigen	**20**
Short name of beneficiary: PSI	
Description of beneficiary: The Paul Scherrer Institute (PSI) is a multi-disciplinary research centre for natural sciences and technology. In national and international collaboration with universities, other research institutes and industry, PSI is active in solid state physics, materials sciences, elementary particle physics, life sciences, nuclear and non-nuclear energy research, and energy-related ecology. PSI’s priorities lie in areas of basic and applied research, particularly in fields which are relevant	

for sustainable development, as well as of major importance for teaching and training, but which are beyond the possibilities of a single university department. PSI develops and operates complex research installations which call for especially high standards of know-how, experience and professionalism, and is one of the world's leading user laboratories for the national and international scientific community. Through its research, PSI acquires new basic knowledge and actively pursues its application in industry.
Tasks in EuCARD: WP9 on phase control systems

Full name of beneficiary: Politechnika Wrocławska	**21**
Short name of beneficiary: PWR	
Description of beneficiary: Wrocław University of Technology, Faculty of Mechanical and Power Engineering employs about 100 staff members and educates over 1000 students including 50 doctoral students. The Faculty is specialized in thermal processes including combustion, thermodynamics, fluid mechanics, heat transfer studies, refrigeration and cryogenics and power generation technologies. There is a long time experience in design, commissioning and operation of complex thermal and cryogenic test stands as well as modelling of thermo-mechanical objects and devices. The Faculty collaborates with the laboratories and organizations active in the field of cryogenics and thermal processes, like: CERN in Geneva, ITER in Cadarache, CEA Saclay, Forschungszentrum Karlsruhe, Interuniversity Accelerator Centre in New Delhi, EDF R&D in Chatou.	
Tasks in EuCARD: Task 7.2 task coordination thermal modelling and measurements, Task 7.3 Thermal design.	

Full name of beneficiary: Royal Holloway University of London	**22**
Short name of beneficiary: RHUL	
Description of beneficiary: RHUL is a research-led multi-faculty higher education institute within the federal University of London; its performance in the latest UK wide Research Assessment Exercise placed it 9th nationally, with its physics department scoring a grade 5 for research. RHUL is part of the John Adams Institute for Accelerator Science (JAI), which was established in 2005 as a partnership between RHUL, Oxford University and the UK Science and Technology Facilities Council. The key strategic aim of the JAI is to develop a Centre of Excellence in the UK for advanced and novel accelerator technology providing expertise, research, development and training in accelerator techniques, and promoting advanced accelerator applications in science and society. RHUL are leaders in advanced beam diagnostics, including laser-based systems and cavity BPMs; they are also leaders in advanced simulation techniques and radiative processes.	
Tasks in EuCARD: Task 8.2.2 Energy deposition calculations and tests, Task 9.1 Work package co-coordination, Task 9.4.3 BPMs development and test, Task 9.4.4 Laser wire system development	

Full name of beneficiary: Russian Research Center "Kurchatov Institute"	**23**
Short name of beneficiary: RRC KI	
Description of beneficiary: The Russian Research Center "Kurchatov Institute" is renowned internationally, well beyond the borders of Russia. Its main scientific directions are related to fundamental research in nuclear physics, plasma physics and solid state physics. RRC KI is the leading in the development of new types of atomic and fusion reactors, including ITER. RRC KI has is deeply involved in the research of radiation resistant materials for fission and fusion reactors.	
Tasks in EuCARD: Task 8.2.3 Materials and thermal shock waves	

Full name of beneficiary: University of Southampton	**24**
Short name of beneficiary: SOTON	
Description of beneficiary: The Institute of Cryogenics at University of Southampton has been for more than 15 years an active player in HTS applications with a cumulated funding of more than 5 M€ from governments and industry. It has worked closely with CERN on the successful HTS current leads project for LHC, involving in the design/manufacture of prototypes and the full cryogenic tests for all of the 600 A assemblies.	
Tasks in EuCARD: Task 7.5.1 Studies on thermal, electrical and mechanical performance Task 7.5.3 Design and assembly of a 20 m long HTS multi-conductor 600 A link	

Full name of beneficiary: Science and Technology Facilities Council	**25**
Short name of beneficiary: STFC	
Description of beneficiary: The Science and Technology Facilities Council is one of Europe's largest multidisciplinary research organisations supporting scientists and engineers world-wide. The Council operates world-class, large scale research facilities and provides strategic advice to the UK government on their development. It also manages international research projects in support of a broad cross-section of the UK research community. The Council also directs, coordinates and funds research, education and training.	
Tasks in EuCARD: WP6, WP7 on SC undulator, WP9, WP10 on crab cavity and HOM, WP11 on EMMA ring.	

Full name of beneficiary: Politechnika Lodzka	**26**
Short name of beneficiary: TUL	
Description of beneficiary: The Technical University of Lodz provides teaching courses in over 20 different disciplines with 60 specialisations. TUL offers a possibility of obtaining the following degrees: Bachelor of Art, Bachelor of Science, Master of Science and Doctorate of Philosophy. There are 21,000 students (including 800 PhD students) and approximately 3,000 staff members at the University. The Technical University of Lodz has nine faculties and six and other organisational units included International Faculty of Engineering. The Electrical, Electronic, Computer and Control Engineering covers a wide spectrum of knowledge, including microelectronics, computer science and power electronics. In this project, the Department of Microelectronics and Computer Science headed by Prof. Andrzej Napieralski will contribute in work package 4.3 RFTech to the development of Advanced Telecommunication Carrier Architecture (ATCA)-based Low Level RF control system. Electrical Engineering branches. The Department has modern educational laboratories created during 7 TEMPUS projects: JEP 2031 and 4343, JEN 02031-93, CME-01059-95, SJEP-09159, SJEP 12204-97 and SJEP 12216-97. As an effect of the latter, the ASIC Design Centre (ADEC) has been created, with the purpose of technology transfer for small and medium enterprises. The international co-operation of the Department involves participation in many international scientific projects, e.g. “Coordinated Accelerator Research in Europe” CARE 2003-2007 RII3-CT-2003-506395, “Pervasive computing framework for modelling complex virtually-unbounded systems” PERPLEXUS 2006-2009 FP6-34632. In addition, currently the Department takes part in over twenty research projects with grants from Ministry of Science and Higher Education.	
Tasks in EuCARD: WP4 RFTech to the development of ATCA-based Low Level RF control system with Advanced Mezzanine Card (AMC) modules, gamma and neutron radiation sensors and piezo and waveguide control subsystem. Design of neutron sensor as custom Application Specific Integrated Circuit (ASIC).	

Full name of beneficiary: Tampere University of Technology	**27**
Short name of beneficiary: TUT	
Description of beneficiary: The Institute has been involved with superconductivity nearly 25 years. The electromagnetic properties of both low temperature (LTS) and high temperature superconductors (HTS) have been modelled which describes well the flux dynamics and transport current behaviour of these materials. Calculation models for ac and thermal losses and thermal stability have been created which support the work of magnet designer. The research work has been demonstrated within numerous, mainly energy applications (SMES, motors, cables).	
Tasks in EuCARD: Task 7.4.2 HTC conductor characterization, specification and quench modelling.	

Full name of beneficiary: Helsingin Yliopisto (University of Helsinki)	**28**
Short name of beneficiary: UH	
Description of beneficiary: The University of Helsinki (http://www.helsinki.fi/university/), established in 1640, is the largest and most diversified university in Finland with eleven faculties. The university has around 38000 students working on degrees and 7700 employees. High-level research is carried out at the departments of the faculties as well as at independent research institutes like the Helsinki Institute of Physics (HIP, http://www.hip.fi). HIP carries out physics research and technology development at international accelerator laboratories and is responsible for Finnish research collaboration with CERN. HIP have a longstanding record of internationally recognized involvement in experimentation at high energy physics colliders as well as basic research in theoretical physics.	
Tasks in EuCARD: WP9, task 2 High gradient cavities.	

Full name of beneficiary: Université Joseph Fourier Grenoble	**29**
Short name of beneficiary: UJF	
Description of beneficiary: UJF is the Scientific and Medical University in Grenoble, France. It has a large contribution to Physics, Mathematics (pure and applied), Computing, Chemistry, Biology, Mechanics, Medicine and Pharmacy, as well as new domains like nano-sciences and nanotechnologies, biotechnologies and environmental sciences. In parallel, UJF is open to the socio-economical world, via technological platforms and valorisation.	
Tasks in EuCARD: Task 4.3 Coordination of the RFTECH network.	

Full name of beneficiary: University of Lancaster-Cockcroft Institute	**30**
Short name of beneficiary: ULANC	
Description of beneficiary: Part of the larger Cockcroft Institute, a consortium of three universities of Liverpool, Manchester and Lancaster, Science and technology Facilities Council (STFC) and the Northwest Development Agency (NWDA). The mission to do advanced R&D in accelerators, be the central point for national deliverables to large international projects, education and training of next generation scientists and technologists, critical core competencies in niche areas and transfer/exchange of knowledge to industry. There are about 100 FTEs in CI, with Univ. of Lancaster-CI having two senior professors, a dozen of various post-docs in various stages, many Ph. D. students, in-house RF tube and cavity design capability as well as RF testing and advanced electromagnetic codes.	

Tasks in EuCARD: Task 8.2 Modelling, Materials, Tests for Hadron Beams. Task 9.4 Beam delivery systems for electron beams, Task 10.3 Crab cavities.

Full name of beneficiary: University of Malta	**31**
Short name of beneficiary: UM	
Description of beneficiary: Department of Micro- and Nano-electronics, Faculty of Information and Communications Technology.	
Tasks in EuCARD: WP8 collimation studies.	

Full name of beneficiary: Université de Geneve	**32**
Short name of beneficiary: UNIGE	
Description of beneficiary: Department of Nuclear and Particle Physics. Long experience in particle physics experiments and strong neutrino physics group. Has played leading roles in the HARP, K2K, T2K and MICE experiments, and in the studies of neutrino factory and muon collider facilities. Connected to other neutrino groups in Switzerland. Solid State Physics Department and Institute of Applied Physics. Strong experience in low temperature /high field measurements. Several facilities for testing prototype superconducting wires and tapes at 4.2 K – 77 K, up to a magnetic field of 21 T, under the effect of various mechanical loads.	
Tasks in EuCARD: WP3 Co-coordination of the NEU2012 network, Task 7.4.1 HTC conductor characterization and specification	

Full name of beneficiary: University of Manchester-Cockcroft Institute	**33**
Short name of beneficiary: UNIMAN	
Description of beneficiary: Part of the larger Cockcroft Institute, a consortium of three universities of Liverpool, Manchester and Lancaster, Science and technology Facilities Council (STFC) and the Northwest Development Agency (NWDA). The mission to do advanced R&D in accelerators, be the central point for national deliverables to large international projects, education and training of next generation scientists and technologists, critical core competencies in niche areas and transfer/exchange of knowledge to industry. There are about 100 FTEs in CI, with Univ. of Manchester-CI having three professors, eight post-doctoral fellows and many Ph. D. students. In-house microwave laboratory and electromagnetic codes.	
Tasks in EuCARD: Task 8.2 Modelling, Materials, Tests for Hadron Beams. Task 9.4 Beam delivery systems for electron beams, Task 10.3 Crab cavities, Task 10.4.3 New methods for thin films.	

Full name of beneficiary: The Chancellor, Masters and Scholars of the University of Oxford	**34**
Short name of beneficiary: UOXF-DL	
Description of beneficiary: The University of Oxford is globally renowned for the quality and diversity of its research, with over 3000 academic staff and 3000 postgraduate students working on research. Oxford has a total staff of over 8,500, including about 4,860 research-active personnel. Amongst its 20,000	

students, one quarter are of European and international origins, covering 130 nationalities. The University consists of over 100 departments structured into four academic Divisions and housing a variety of sub-departments, schools, institutes and research centres of international standing. All European research projects are supported by administrative staff and experienced personnel drawn from across the University of Oxford, in particular from Research Services for management, contractual and legal issues, Research Accounts for financial reporting, Departmental Administrators for the day-to-day project management and ISIS Innovation Ltd., the University of Oxford’s knowledge and technology transfer company, for the protection and exploitation of knowledge-related issues.
Tasks in EuCARD: Task 9.3 Linac & FF stabilisation

Full name of beneficiary: Universität Rostock	**35**
Short name of beneficiary: UROS	
Description of beneficiary: • Founded in 1419. Oldest university in Northern Europe. • Nine faculties are located at the university. More than 55 course offerings. • There are around 13,500 students including approximately 1,000 students from abroad. • Faculty of Computer Science and Electrical Engineering: 32 full professors, 1 junior professor. • Cooperation with DESY, Hamburg, since 1998.	
Tasks in EuCARD: Task 10.5 Experimental modelling HOM distribution.	

Full name of beneficiary: Uppsala University	**36**
Short name of beneficiary: UU	
Description of beneficiary: Uppsala University was founded in 1477 and is the oldest university in Scandinavia. Presently it has a staff of 6000, about 40000 undergraduate students enrolled in courses offered by nine faculties.	
Tasks in EuCARD: Task 9.2.4 Scanning electron microscope analysis.	

Full name of beneficiary: Politechnika Warszawska	**37**
Short name of beneficiary: WUT	
Description of beneficiary: Warsaw University of Technology (WUT), Institute of Electronic Systems (ISE); web: www.pw.edu.pl for WUT and www.ise.pw.edu.pl for ISE; 19 Faculties, 35000 students, 1200 Ph.D. students, ISE is located inside the Faculty of Electronics and Information Technologies (FE&IT), of around 5000 students and 200 Ph.D. students; Major Faculties: FE&IT, El.Eng., Mechatronics, Physics, Chemistry, Civil Engineering, Material Engineering, Environmental Engineering, Mechanics Energy and Aviation, Mathematics and Information Sciences, Manufacturing Eng., Transport Eng,. etc. FE&IT celebrated in 2007 the 50th anniversary; Research and didactic specialization of ISE: theory of electronic circuits and systems; DSP algorithms, radar technology, RF technology, FPGA algorithms, novel electronics applications; optical fibre measurement data networks.	
Tasks in EuCARD: WP2 leader and main actor, Task 10.6.1 support, Task 10.6.2 main executer, Task 10.6.5 support, Task 10.6.6 support.	

B.2.3 Consortium as a whole

The consortium partners include most European laboratories operating large and medium size accelerators for research. Altogether, they represent the leading world competence in the field with the largest and often most innovative research instruments. This puts this consortium as a whole in a privileged position to achieve the scientific and technical project objectives with a maximum chance of success and minimum risks.

As coordinator of the project, CERN, one of the central partners of the consortium, regroups the efforts of 20 member States of which 18 are from the European Union. In addition, many participants in the project are major organisations at national level or parts of larger national research infrastructures (among the latter CEA, CIEMAT, CNRS, DESY, GSI, INFN, STFC). These large laboratories have a wide competency domain oriented towards partly complementary and partly common infrastructures.

Besides these large organisations, the consortium includes a number of smaller more specialized institutes with specific competencies and test infrastructures (e.g. HZB, FZD, CNRS-LOA) and of universities (e.g. UNIGE, UM, WUT) with relevant expertise in innovative domains. The consortium includes two high-tech industries motivated by one of the themes.

In the main area of the project research activities, the consortium has the top-of-the–art competency, as illustrated hereafter. HERA (DESY) till recently was and LHC (CERN) is a world leading accelerator using superconducting technologies, the LHC becoming the unique 27 km long machine operated at 1.9 K, cooled by superfluid helium. The LHC beam is orders of magnitude more powerful than any other accelerated beam and has required the study and develop-ment of very high efficiency collimation, of interest for pulsed superconducting synchrotrons considered at GSI. With the TESLA studies (DESY), the superconducting RF acceleration has reached world records in gradients and has already found several applications in a new generation of (X)FEL light sources like FLASH (DESY). The two-beam acceleration principle investigated at CLIC-CTF3 (CERN) appears as the most promising candidate for electron and positron beam acceleration beyond one TeV in the next decade. The transnational accesses, networks and other joint activities are all at a world level and carried out in collaborations including at least one recognized world leader.

The proposed activities are in line with the European priorities defined by independent European bodies and with the R&D programmes of individual national or European laboratories that provide the matching funds. This guaranties a major individual and collective interest from all laboratories and institutes to meet the goals and produce the announced deliverables.

The work packages involve typically from 4 to 18 partners; tasks or even sub-tasks involve several of them. The deliverables relying largely on collaborative efforts, care was given to preparing a solid framework for the consortium, using the experience gained in the FP6 CARE I3.

Most partners and their staff have a long practice of collaborations as detailed in the next section. Taking advantage of this experience and mutual knowledge, the distribution of responsibilities (coordination of work packages and tasks) is made according to leading competence in the topics and collaboration requirements. As most fields enter in the competence domain of several institutes, work packages are led by two coordinators from two different leading laboratories in the domain. This large but focused distribution of responsibilities aims at forming a consortium both efficient and motivating for the partners.

<u>Participation of third parties</u>

The Institut Polytechnique de Grenoble (Grenoble INP), through the participation of one senior researcher, expert in the field, will be involved in the project with a major contribution to the work performed by one of the beneficiaries (CNRS) in Work Package 7, Task 7.4 Very High Field Dipole Insert. CNRS and Grenoble INP collaborate in the framework of a multi-annual agreement, and Grenoble INP will participate in EuCARD as a third party carrying out part of the work in WP7, linked to the beneficiary CNRS.

Collaboration with external Institutions

The consortium as a whole will interact with a significant number of external European and international organizations who have expressed their interest like the accelerator laboratories and programs in the USA (e.g. US-LARP) and Japan, funded by their own agencies. On invitation in the networks activities, their presence and contribution will enrich the investigations on the most performing upgrades and innovative solutions.

Table 2.3 a: Institutes associated[1] to the EuCARD project

Associate institute short name	Associate institutes full name	Country	Work package involvement
ANL	Argonne National Laboratory	USA	WP10
ANU	The Australian National University	Australia	WP10
BNL	Brookhaven National Laboratory	USA	WP3, 4
BUT	Bialystok University of Technology	Poland	WP10
CHIPP	Swiss Institute for Particle Physics	Switzerland	WP3
CIAE	China Institute of Atomic Energy	China	WP10
Cracow-U	University of Cracow	Poland	WP3
FNAL	Fermi National Accelerator Laboratory	USA	WP3, 4, 7
GANIL	Grand Accelerateur National d'Ions Lourd	France	WP10
IHEP	Institute for High Energy Physics, Protvino	Russia	WP4
Imperial	Imperial College London	United Kingdom	WP3
INR RAS	Russian Academy of Sciences, Institute for Nuclear Research, Moscow	Russia	WP8
IPCP	Institute for Problems of Chemical Physics, Chernogolovka	Russia	WP8
ITEP	Institute for Theoretical and Experimental Physics, Moscow	Russia	WP8
JINR	Joint Institute for Nuclear Research, Dubna	Russia	WP4
KEK	High Energy Accelerator Research Organization, Tanashi	Japan	WP3, 4, 7, 9
LBNL	Lawrence Berkeley National Laboratory	USA	WP3, 7
LUT	Lublin University of Technology	Poland	WP10
MIT	Massachusetts Institute of Technology	USA	WP4
MPG-MPIK	Max Planck Inst. für Kernphysik, Heidelberg	Germany	WP3
MSU	Michigan State University	USA	WP10
Osaka U	Osaka University	Japan	WP3
SLAC	SLAC National Accelerator Laboratory	USA	WP9, 10
Texas A&M	Texas A & M University	USA	WP4
THALES	Thales Group	France	WP4
TIFR	Tata Institute for Fundamental Research	India	WP3
TJNAF	Thomas Jefferson National Accelerator Facility	USA	WP10
TRIUMF	Tri-University Meson Facility	Canada	WP10

TUBERLIN	Technische Universität Berlin	Germany	WP4
UErlangen	University of Erlangen	Germany	WP10
CINVESTAV	Centro de Investigacion y de Estudios Avanzados del Instituto Politecnico Nacional	Mexico	WP4
UAM	Universitad Autonoma Madrid	Spain	WP3
UBOL	University of Bologna	Italy	WP4
UCLM	University of Castilla La Mancha, Ciudad Real	Spain	WP8
UCLN	Université Catholique Louvain-la Neuve	Belgium	WP3
UHAM	University of Hamburg	Germany	WP4
UniSofia	Sofia University St Kliment Ohridski	Bulgaria	WP3
USAN	University of Sannio	Italy	WP4
USTOCK	University of Stockholm	Sweden	WP4
UT	Technical University Twente	The Netherlands	WP7

[1]An associate Institute is an organisation external to the EuCARD consortium and contributing to specific activities

Complementarity and collaboration between partners.

For the very high field dipole magnets, all the partners have some experience in superconducting magnet design and construction as well as in sc cable developments. CERN has the obvious experience gained on the construction of the LHC dipole and on the liquid helium superfluid system and DESY acquired experience with the construction of the HERA magnets. CNRS, CEA-DSM, FZK, INFN, TUT and UNIGE have expertise on electrical, mechanical and thermal behaviour of sc magnets. CNRS has an additional experience in cryostat design and in working with superfluid liquid helium. CEA, INFN, STFC and PWR contributed to the NED (Next European Dipole) activities within CARE aiming at developing a high performance Nb_3Sn wire in collaboration with industry, development which will serve as a starting point for WP7 activities.

Concerning collimator and material tasks, CERN and GSI have worked on collimation issues for LHC and FAIR respectively. They are developing experience on energy deposition, associated material properties, radiation damage and thermal shock waves. CSIC and INFN, ULANC and UNIMAN will contribute to halo studies and beam modelling, while ARC, EPFL, RRC KI and POLITO will participate in the development of advanced composite materials, material characterization and experimental tests.

For the normal conducting (NC) linac technology, a large number of the interested partners, CEA-DSM, CIEMAT, CNRS-LAPP, CSIC, INFN, PSI, STFC, UH and UU, are also members of the multi-lateral collaboration built around the test facility CLIC-CTF3 at CERN, working on various aspects of this evolving facility testing the two-beam acceleration scheme and the high-gradient NC cavities. They all developed specific expertise directly applicable to the tasks pursued in WP9. UNIMAN and STFC will use their experience on beam delivery systems in linear colliders and special cavity development. Institutes like CEA, INFN, PSI, RHUL and UOXF-DL bring their know-how on diagnostics and monitoring.

For the superconducting (SC) RF technology, beneficiaries bring their expertise in various techniques of preparation, construction and testing of SC cavities. DESY has the obvious experience of building high-field cavities for the XFEL project, in particular on surface preparation and cryo-modules. CERN has expertise in cryogenics techniques and development of different types of cavities for proton beams. Both laboratories and CNRS have complementary infrastructures for testing SC cavities, which can be used and developed within the EuCARD activities. CEA, CERN, DESY, INFN and Polish Universities have knowledge on Nb coating techniques.

In the assessment of novel accelerator, there is a particularly welcome complementarity between the accelerator expertise of INFN and the knowledge recently developed by CNRS-LOA (Laboratoire d'Optique Appliquée) on plasma accelerating technique, which bring together two communities which had first contacts through the CARE initiative. INFN, CERN, CNRS and BINP will put in common their experience in designing interaction regions of colliders and associated monitoring. STFC will also add its expertise in diagnostics and running accelerator facilities.

All the institutes mentioned above have collaborated together in the past. In particular, 14 of the EuCARD beneficiaries are participating in the still going-on CARE project, so that both the complementarity and the continuity are ensured. Many of the participating institutes have in addition the experience of networking activities, successfully and strongly developed since several years within projects like CARE and EURONS, as well as in transnational access activities, as EURONS is a good example.

B.2.4 Resources to be committed

Strategy for allocation of EU funding

The EC funding of 10.0 M€ represents about 30% of the total estimated costs of the EuCARD project. Given the significant matching funds required to implement the Work Programme of the project, commitment to the deliverables and the corresponding budgets was requested and obtained from the participants. The large national laboratories and CERN, contributing to most of the project resources, will secure the necessary funding from their annual R&D budgets and/or their funding agencies.

The general principles for the use of the EC contribution will depend on the types of activities of the project:

- For the Management Activities, the EC funding will be used only to cover travel costs for participation in management meetings.
- For the RTD Activities, the EC funding will be mainly used to support personnel costs. Most of the other major expenses (e.g. for materials and consumables) will be covered by the matching funds of the participants.
- For the Networking Activities, the EC funding will be used to cover partly the personnel costs of the NA Coordinators, and mainly for support of travel costs and the organisation of topical workshops and exchange of experts.
- For Transnational Access Activities, the EC funding will be essentially used to cover the travel and stay of the external users of the facilities offering access under the IA programme, as well as to support a small fraction of the operating costs of MICE (WP6).

After the end of each reporting period, each beneficiary, in accordance with the GA rules, will report on at least the fraction of the full costs sufficient to justify the EC contribution.

Description of resources for the different activities

The total estimated budget of EuCARD is given in section A3, whereas the budget breakdown per beneficiary is described in the Grant Preparation Forms. An overview of the estimated staff efforts per work package and per activity type and beneficiary is given in the *Project Effort Forms* 1 & 2 of section B.1.3.6.

The table below gives the estimated budget breakdown per Work Package:

WP no.	Activity	WP short title	Total cost (k€)	EC request (k€)
1	MGT	**Project Management**	831	22
2	NA	**DCO**	273	137
3	NA	**NEU2012**	548	278
4	NA	**AccNet**	998	594
5	TA	**HiRadMat@SPS**	287	59
6	TA	**MICE**	482	222
7	RTD	**HFM**	6,438	2,057
8	RTD	**ColMat**	4,090	1,279
9	RTD	**NCLinac**	6,551	2,001
10	RTD	**SRF**	7,730	2,416
11	RTD	**ANAC**	3,018	0,934
Total (k€)			**31,247**	**10,000**

- **Management and Coordination (WP1)**

  CERN, the Coordinator of EuCARD, being a European Organisation, has agreed to provide full funding for the management manpower costs. Based on the experience of FP6-I3 CARE project, the manpower efforts are estimated at 60 person-months (p-m) for the Management Team, consisting of the Project Coordinator, his Deputy, and the Administrative Manager. In addition, 24 p-m are foreseen for the administrative support (Project Assistant, Financial Officer, Legal Advisor, part-time each). The requested EC contribution of 22 k€ will cover travel costs for participation to project management meetings.

  Each of the other Work Packages includes a coordination task with associated budget line to cover the costs incurred by the WP Coordinators and Deputy Coordinators in the scientific coordination of their Work Packages, as well as the project reporting. This budget line includes also allowances for participation to the consortium management and coordination meetings, such as the Steering Committee and Governing Board meetings.

- **Dissemination and Communication (WP2)**

  24 p-m are planned for the WP2 Coordinator and Deputy Coordinator, and the necessary Information Technology support for this Work Package. Apart from a fraction of the manpower costs, the EC contribution of 137 k€ for this WP will support dissemination activities in networks outside the project or other European initiatives, publication of booklets and monographs, publications in Open Access Journals, as well as some outreach activities and events.

- **Networking Activities (WP3 and WP4)**

  The NAs being considered as the backbone of EuCARD and gateways for communication with the scientific community outside the project consortium, the EC funding – 278 k€ for WP3 and 594 k€ for WP4 – will be essentially allocated for the organisation of topical mini-workshops (two 3-day workshops per network or network task and per year are planned), with financial support (travel and daily allowances) for some 15-20 external participants and speakers for each workshop, e.g. from the Associated Institutes, given in Table 2.3.

  The networking activities will include and fund also the exchange of experts between the consortium partners and the Associated Institutes (6 experts for 1 week per year for each NA). Finally, a modest contribution of the EC funding will be allocated for the coordination tasks of the WP Coordinators.

- **Transnational Access Activities (WP 5 and WP6)**

  For both TA facilities, opened under this IA project (at CERN and STFC), most of the EC funding (59 k€ for WP5 and 222 k€ for WP6) is intended for the support of the external users that will benefit from the TA, and a small budget is allocated for the manpower costs for management of the access. The operating costs of HiRadMat@SPS (TA-WP5) will be fully funded by CERN. The anticipated number of users of MICE (TA-WP6) is expected to be significant, so that some of the EU funding for this WP will be used to cover a fraction (around 2%) of the annual operating cost of the facility. The rest of the operating costs that will be incurred by the two TA operators have been evaluated and committed for the full duration of the project.

- **Joint Research Activities (WPs 7 to 11)**

  The Joint Research Activities mobilise the largest fraction of the IA budget (around 27.8 M€ of the total estimated costs). This is due to the complexity and high costs of the equipment necessary to be developed for the upgrades and improvements of the large accelerators and test facilities that contribute to the IA Work Programme.

  The costs of the JRAs will be supported at a level of some 30% by the EC funding. The estimated personnel and material budgets are roughly equal for these RTD activities. The EC funding distribution is well balanced between participants and countries. The EC contribution to the JRA activities (some 8.7 M€) will be used mainly for covering the personnel costs of the beneficiaries.

  Subcontracting is not foreseen for this project. Orders placed to industrial suppliers will only concern individual components and fabrication through standard manufacturing techniques. The budget of one of the beneficiaries, CNRS, includes funding for a third party (Grenoble INP), as explained in section B2.3.

B3. Impact

B.3.1 Strategic impact

Contribution to policy developments

The EuCARD participants, representing the major European laboratories, research institutes and universities active in the field of accelerator R&D, have expressed a strong interest and commitment to extend existing collaborations and create further synergies at European level, including industrial partners. EuCARD shall be one component of an on-going structuring process briefly summarized in the following:

1. **Definition of strategic European goals**

In the field of High Energy Physics (HEP), the CERN Council, representing the 20 Member States, has taken up the responsibility, defined in its mandate, to define and follow up the European Strategy for Particle Physics. A CERN Council Strategy Group has been formed and a major step was carried out with the publication of the strategic goals of HEP in Europe endorsed in Lisbon in 2006. In March 2008, a Secretariat of the European Strategy Session of the CERN Council was formed. The European Strategy Forum on Research Infrastructures (ESFRI) refers to the CERN Council Strategy Document for High Energy Physics. As regards the fields of Nuclear Physics and Light Sources, ESFRI has defined a European roadmap in its 2006 Report on large-scale Research Infrastructures: the motivation, requirements and priorities for photon sources and neutron sources are presented here, spelling out the European priorities for these disciplines.

2. **European projects**

In order to handle the future approved European projects in HEP, a board of Directors of Accelerator Laboratories was recently formed and had its second meeting in October 2008. Its goal is to be the executive body for the implementation and follow-up of the decided common projects. In the field of Light Sources and Nuclear Physics, several accelerator projects have been identified for support by ESRFI: XFEL, FAIR, FLASH, MAXIV, HZB and 4GLS. For XFEL and FAIR the formation of an international consortium is in the final stage of negotiation.

3. **European R&D Studies**

To allow decision making on common projects, significant collaborative work is needed in Research and Development. With the support of the European Committee for Future Accelerators (ECFA), and the Board of Directors, the European Steering Group for Research and Technical Development on Particle Accelerator (ESGARD) has the mandate to promote coordination and pan-European collaborations in the field of accelerator sciences and related technologies. , and prepare a coherent set of bids to apply for EU funding. The EuCARD project (like its predecessor FP6-CARE) was prepared under the auspices of ESGARD. Like CARE, EuCARD will act at the execution level, fostering direct contact between scientists and engineers of the partners. The EC funding that the community will receive is at the level of a few per mil of the laboratories budgets, and thus fulfils the condition for “independence of external EC funding” mentioned in the EuCARD Evaluation Summary Report. The EC funding is highly leveraged, focused on concrete R&D collaborations between the participants to reach common S&T goals. The joint efforts under EuCARD will maintain a culture of collaboration that will gradually create the conditions for a more coherent and effective sharing of the work on very large projects far exceeding the possibilities of any partner.

A significant number of non-European Institutes or Organizations have expressed their interest to collaborate with EuCARD, among which several accelerator laboratories and programs from the USA, Japan, Russia and China, funded by their own national agencies (Table 2.3 a). Therefore, through the EuCARD Integrating Activity, the European Accelerator Infrastructures will strengthen their links with other laboratories around the world so that Europe could benefit from the worldwide advances and developments of accelerator technologies, and could continue to play a leading role in international initiatives in the field. This is fully in line with the priorities of the European Research Area for development of world-class infrastructures and opening of the ERA to the world.

Development of world-class infrastructures

The LHC being the flagship of particle physics, its upgrade will have a significant impact at worldwide level. At ten-fold its nominal luminosity, a new physics reach opens, and will allow Europe to maintain the leadership in this field by providing solid ground for fundamental advances and insights in particle physics.

Several other world-class level accelerators are involved in EuCARD and will benefit from the Joint Research Activities of this project: DAΦNE (electron-positron collider), with a potential very large luminosity increase, CNGS (intense neutrino beam), SIS and FAIR (heavy ion accelerators and project) and MICE (Muon ionization and cooling experiment) and EMMA (a world first implementation of non-scaling FFAG principle).

Besides particle physics, FLASH, central in EuCARD WP11, stands as a pioneering fourth generation light source (superconducting electron linac) in the VUV and soft X-ray domain. It is the test bed of a unique XFEL project producing high intensity ultra-short X-ray coherent flashes and opening up a whole range of new perspectives for the natural sciences and industry. Other sources are equally concerned by EuCARD: ESRF, PETRA and ANKA. Altogether, the accelerator infrastructures involved in this project, serve a large community of well over 10,000 physicists from all over the world.

In addition to accelerators, the goal of EuCARD is to improve and strengthen world-class test facilities for investigating the technologies needed for future accelerators. These are mainly the CLIC test facility CTF3, regarded as a key element in deciding the future world accelerator and the consortium of SC RF test stations of highest importance for all machines and projects based on superconducting RF acceleration.

During the course of EuCARD, new facilities from other branches of accelerator science and technology may use the project results, such as innovative cancer therapy centres using particle beams for patient treatment (e.g. ETOILE in France).

The novel accelerator technologies that will be developed by EuCARD will reinforce the European capacity of producing not only high-energy and high-intensity proton and electron beams in the years to come, but also in a more distant future intense neutrino and muon beams. As a consequence, the scientific excellence of Europe will also be reinforced with the potential increase of the flux of neutrinos and the flux of protons for next generation of fixed target experiments in both particle physics and nuclear physics.

Impact of the scientific and technological results

The EuCARD project is oriented towards maximum impact on high priority programs:

The **luminosity upgrade of the LHC** will be carried out in two phases. The technological requirements for the first phase are included in the SLHC-PP project. Success in the second phase, which aims to increase the luminosity by a factor of ten, will depend on the results of several EuCARD work packages. This level of performance was inconceivable during the LHC design phase. However, innovative solutions have been proposed in the framework of FP6-CARE I3 and their performance and associated risks will be evaluated by EuCARD AccNet (WP4). This will facilitate the decision making process for the LHC accelerator and its detectors, ATLAS and CMS. The successful development of accelerator quality Nb_3Sn magnets (WP7) will lead to more compact and better performing final focus systems, beyond the capability of Nb-Ti magnets. The development of Nb_3Sn magnets also opens up the possibility of an energy upgrade by a factor of 2 to 3, which would extend significantly the physics reach of the LHC. The availability of high performance cost-effective Nb_3Sn magnets would rapidly have a large impact on other projects with similar requirements. The FRESCA test station for superconducting cables is a good example, since it requires a higher field to test new superconductors. Wigglers and undulators used to control beam parameters in electron rings and linacs are another example.

An improved efficiency of **collimators** and of the resistance of jaw materials to beam losses from higher beam currents (WP8) will have a key impact on accelerator performance. Indeed the demand for higher intensities in most accelerators highlights the need for efficient control of beam losses to protect delicate equipment and minimize localised machine activation. This is typically the case for the LHC upgrade and for heavy ion projects such as FAIR at GSI.

In the post-LHC era, accelerator-based research in particle physics will be at a crossroad. New concepts will be needed to reduce the size, cost and complexity of higher energy machines. Solutions could include **lepton linear colliders** with significantly higher accelerating gradients, neutrino factories and novel accelerating techniques. In all cases, the challenges are exceptional. The expected long lead-time requires that technology decisions be made within the time scale of this IA. The current preference and largest investment is oriented towards lepton colliders with a high enough energy and luminosity to determine the precise properties of any new particles discovered by the LHC. EuCARD results will have an impact on two lines of research, namely high efficiency superconducting linacs (ILC) and two-beam acceleration with large accelerating gradients (CLIC). Decisions concerning the next “world” machine will have a major impact on European infrastructures; the feasibility of CLIC technology must be demonstrated and the ILC technical design must be improved. The two largest EuCARD JRA work packages and one network will contribute to these investigations (WP 4.2, WP 9, and WP 10).

Technological developments are the focus for **superconducting RF**. The results will contribute to the understanding of phenomena, which currently limit superconducting cavity performance, thereby improving the technology beyond what is presently available. The better understanding of parameters, test results and manufacturing quality will benefit applications in several other fields, such as light sources like FLASH, XFEL projects and proton linacs for the LHC injector chain. This experience will allow performance and cost evaluation for the ILC. If the size and cost of superconducting linacs would become excessive because accelerating gradients are limited to no more than about 30 MV/m to 35 MV/m, the **two-beam acceleration principle** used in CLIC offers a more compact solution with significantly higher gradients up to 100 MV/m. EuCARD will explore various challenges offered by CLIC, including high power, high mechanical precision, HOM damping in the CTF3 test station. Whether normal or superconducting, these high-energy linacs must guarantee the production, preservation and control of extremely small (nanometre) beam sizes to reach the required luminosity. Therefore, the beam control experience gained in the CTF3 and ATF2 test facilities will be essential to find ways of **preserving emittance** at the required level when facing problems of stability, reproducibility and vibration (WP9).

The precise control of **RF phase** is also a common challenge for future linear colliders and free electron lasers. The development of phase control to well below the picosecond level will have an important impact in an even wider domain. **Crab cavities** are one example; if the required accuracy is obtained, it will be possible to upgrade the LHC luminosity with minimal beam current increase and interference with the detectors.

The likely impact of **innovative concepts** emerging from ANAC (WP 11) can be estimated but not guaranteed. Nevertheless it is clear that a successful demonstration of the crab waist principle could lead to an increased luminosity in DAΦNE and beauty factories by an unexpectedly large factor with only minimal changes to the collider hardware. Similarly, an implementation of the non-scaling FFAG principle is expected to provide suitable accelerators for the generation of intense neutrino beams as well as for cancer therapy with hadrons. Likewise, the ability to measure ultra-short pulses is critical for the development of laser-plasma acceleration that opens the way to very high accelerating gradients.

Finally, the NEU2012 network (WP3) will strengthen the European neutrino community and create opportunities for collaboration on a global scale. The impact is expected to include long term plans for neutrino facilities, incorporating the results from CNGS upgrade studies, the EuroNu design study and other options.

Impact on European industry

European industry is a natural partner capable of supplying advanced devices to the accelerator laboratories and institutes, often requiring serial production of high-tech components. A salient example is the fabrication of some 1300 15 m long superconducting dipoles at the tip of technology by 3 European firms in 3 countries for a approximate total cost of 1.2 BCHF. The funding strategy chosen for EuCARD exploits the leverage offered by EU investment to promote collaboration with industrial partners and develop synergies. Consequently, the investment in material is expected to be much greater than the EU funding, allowing procurement of technologically advanced components, such as Nb_3Sn superconducting cables. Similarly, the industrial production of superconducting RF cavities with reproducibly high performance will be possible. Orders like these, together with the planned prospective meetings, should have a favourable impact on European industry, while remaining within the available budgets.

B.3.2 Plan for the use and dissemination of foreground

The free and timely dissemination of information to all participants is a key feature of EuCARD. As project coordinator, CERN is in the best position to guarantee the widest possible audience, manage intellectual property rights and exploit results to their fullest. The DCO network will reinforce this role and provide project management support.

The majority of EuCARD beneficiaries are public institutions and the intention is to make public almost all research reports and results. The few exceptions, such as those subject to specific confidentiality clauses and Intellectual Property Rights (IPR) safeguards, will be dealt with explicitly in the Consortium Agreement.

Highly developed tools for the global dissemination of information in accelerator sciences already exist. The International, European and US Accelerator Conferences, as well as topical workshops share a unique database of articles with a simple web interface (http://www.JACoW.org/). A number of academic journals, some web-based, accept contributions on accelerator science. Registered users can receive automatic notification of new publications. The EuCARD Dissemination network (WP2) will ensure that all significant results of the IA are published using these facilities and specific measures will be taken to increase the awareness, usefulness and impact of the IA results on a targeted public.

1. EuCARD Web-site: The site will inform internal and external users about EuCARD opportunities, transnational accesses, meetings and forthcoming events such as workshops. The site will be easily accessible from the participants' web sites and will provide links to more detailed and specialized project information.
2. Publication monitoring: The DCO coordinator will monitor the quality and quantity of publications. He will inform WP and task coordinators in the event of complementary or possibly duplicated work to maximize synergies and efficiency within the Integrating Activities. He will report to the Coordinator and Governing Board.
3. Efficient and targeted access to scientific published information: The DCO network will maintain a relational database of EuCARD supported publications with easy Web access.
4. Open Access Publications: Open Access Publications will be encouraged for EuCARD publications. Each WP task will receive the full support of EuCARD, subject to approval from the Coordinator, to publish at least one refereed article in an academic journal participating in OAP. Under the OAP agreement, readers have free access to these publications.
5. Fast dissemination of workshop information: The impact of network workshops will be enhanced by an internal publications policy designed to ensure rapid distribution of their main results. Documents will be stored in a dedicated relational database with simple access via the web. Publication in traditional journals will be required for research reaching maturity.

6. Information centre on transnational accesses and other infrastructures: This database will contain information about
    a. Infrastructures open to transnational access, with their main characteristics, an inventory of state-of-the art equipment and access rules.
    b. Shared infrastructures not formally open as TA's. These would include facilities forming part of a JRA which could be opened to outside users on request at the discretion of the hosts.
    c. Infrastructures being upgraded within the framework of this IA. The planned completion date and characteristics of the facility would be shown.
7. EuCARD Who's-Who will be available on the Web site as a list of IA work packages and tasks, together with the names and contact details of the scientists involved, and a short summary of their interests and expertise.

The DCO network will collect information about other European activities that could either benefit from EuCARD or have an impact on accelerator sciences (e.g. material sciences and superconductivity, plasma wave physics, synchrotron light sources, energy transport).

Intellectual Property Rights management

The principles for dissemination, access and use of knowledge generated through the project (Foreground), as well as the access to previous knowledge and knowhow (Background) will be agreed by the beneficiaries in the Consortium Agreement, and will be in compliance with the Rules for participation in FP7, adopted by the European Council and Parliament in December 2006. The participants will specify in an annex to the Consortium Agreement all Background, which will be needed for the project work, and the conditions for granting access to this Background. Unless stipulated otherwise, the access rights to Foreground shall not include the right of sub-licensing to third parties. As a general principle, the access rights to Foreground needed by other participants for use for research purposes shall be granted on a royalty free basis, and access needed for possible commercial / industrial applications will be given on fair and reasonable conditions. Access rights to third parties, whether for research or for commercial purposes, shall be granted upon written request, and with the agreement of all participants that own the Foreground.