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

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	

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 (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.

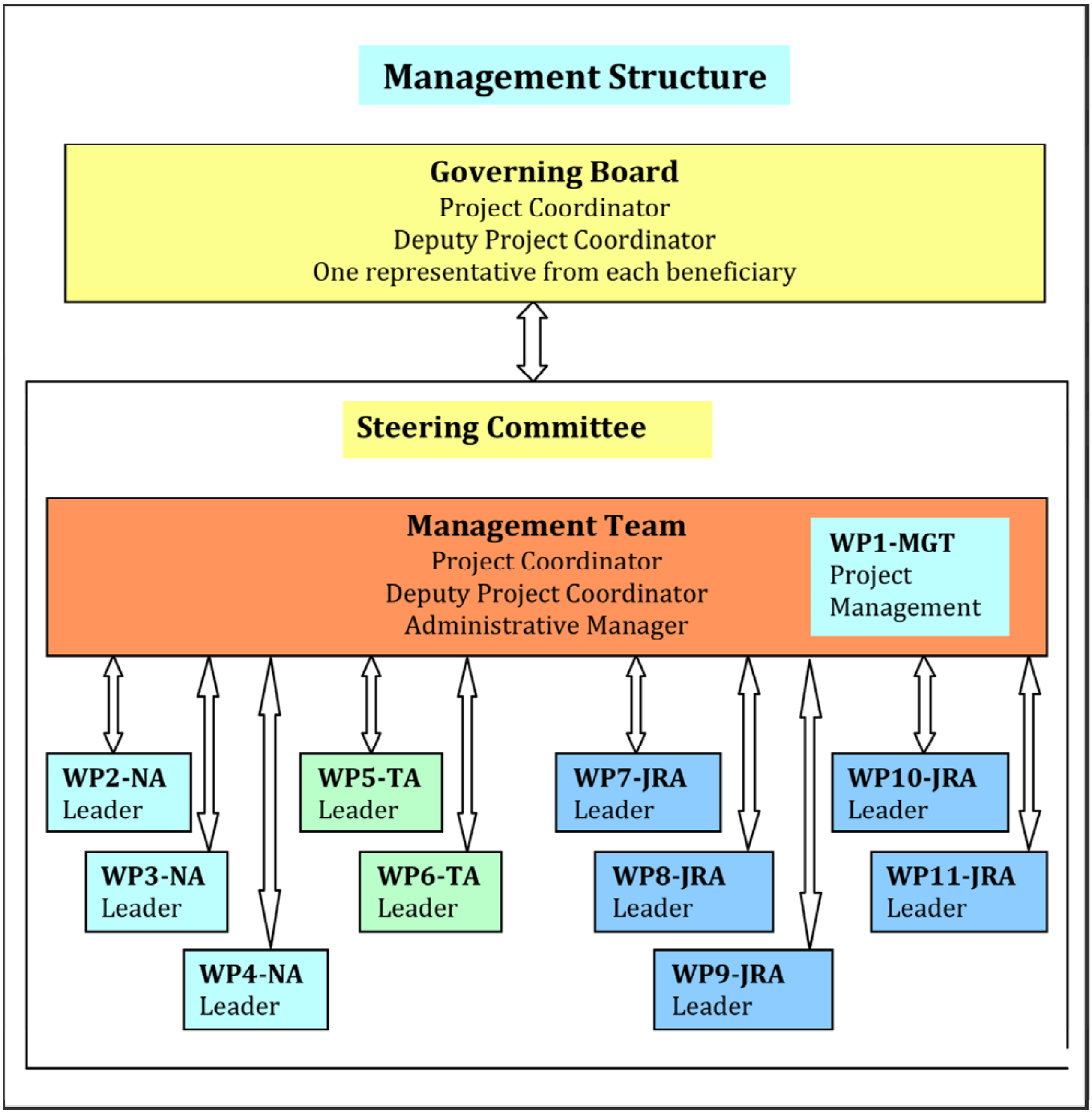

Figure 3. Management structure

- **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	

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.