STARTPAGE

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Marie Curie Initial Training Networks (ITN)
Call: FP7-PEOPLE-2010-ITN

PART B

Cryogenics, Accelerators and Targets at HIE-ISOLDE

CATHI

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B.1 LIST OF PARTICIPANTS

	Private Sector Participant	Country	Legal Entity Name	Department /Division/ Laboratory	Scientist-in-charge
Full Network Partner					
1		Switzerland	European Organization for Nuclear Research	Engineering Dept.	Yacine Kadi
Associated Partners					
1	√	Italy	CINEL		Sergio Bongiovanni
2		France	CNRS/IN2P3	IPN-Orsay	Sebastien Bousson
3		France	CNRS/IN2P3	LPC- Caen	Nigel Orr
4		UK	Cockroft Institute	Accelerator Science and Technology Center	Peter McIntosh
5		France	GANIL	Technique de la Physique	Pierre Delahaye
6		Italy	Istituto Nazionale di Fisica Nucleare	Laboratori Nazionali di Legnaro - LNL	Gianfranco Prete
7		Germany	Max Planck Institute	MPI- Heidelberg	Klaus Blaum
8		USA	Michigan State University	National Superconducting Cyclotron Laboratory	C. Konrad Gelbke
9	√	UK	Scientific Magnetics		Peter Penfold
10	√	France	SDMS		Pierre Maccioni
11	√	Italy	SIDEA		Marco Mauri
12		Finland	University of Jyvaskyla	Physics Dept.	Ari Jokinen
13	√	Italy	ZANON		Ettore Zanon

B.2 PROJECT OVERVIEW AND OBJECTIVES

We propose a mono-site Initial Training Network (ITN), with CERN as main host institution, offering research training in the application of advanced accelerator technology, beam instrumentation, ultra-high vacuum, cryogenics, radiation protection and advanced material technologies in one of Europe’s leading Radioactive Ion Beam facilities (ISOLDE) at CERN, and its future upgrade (HIE-ISOLDE). By integrating the complementary, multidisciplinary and intersectorial expertise of the associated partners, and through visiting scientists and the secondment of young researchers to the associated partners, this ITN will help strengthen Europe’s human resources in key technologies for enhancing industry competitiveness in domains where there exist technology gaps with other high-tech economies.

The present CERN-ISOLDE facility was commissioned in 1992 and has been expanded several times, the latest addition being the REX-ISOLDE post-accelerator that started operating in 2001. The proposed upgrade (HIE-ISOLDE, 2010-2014, which consists in the design and construction of a Super-Conducting linear accelerator and associated high-power target) offer tremendous opportunities for research training in an international, multidisciplinary environment, thereby ensuring that the expertise present in Europe will continue playing an important role in the progress of nuclear physics and related fields. Training projects will have concrete objectives and deliverables in the domains of super-conducting RF structures, controls, electronics, ultra-high-vacuum technology, cryogenic systems and advanced material development.

CERN contributes to overcoming fragmentation in European Research through its well-established international network of universities, partnerships with technology research centres, technology transfer policy and history of joint developments with industry. This ITN will complement and reinforce that contribution.

The young researchers will be supervised and mentored by internationally recognized experts and have access to state-of-the-art equipment. Hands-on project training will be supplemented with formal training courses in relevant and related fields, and a wide variety of complementary training courses, colloquia and seminars. Mobility within the ITN will ensure exposure to complementary research and industry environments. Supervision will follow a model similar to CERN’s established and successful Fellowship Programme, in which projects/objectives are defined and monitored by a CERN supervisor.

The CATHI proposal will provide Early Stage Researchers (ESRs) and Experienced Researchers (ERs) with unparalleled research training opportunities in the framework of established, trans-national research networks (ISOLDE Collaboration, EURONS, ENSAR). It will provide hands-on experience through participation in the R&D, construction and commissioning of the super-conducting linac systems and in the design study to prepare for a future increase in intensity of the PSB beam.

The young engineers and scientists trained within CATHI will play a major role in the construction and exploitation of next European Large Scale Facilities for Nuclear Physics: EURISOL, ESS, ISIS Upgrade, CERN-SPL, Med-AUSTRON, MYRRHA, Neutrino Factory, for which they will no doubt be in great demand. This well defined long term European roadmap ensures for many years a vigorous job market for their talents.

B.3 SCIENTIFIC & TECHNICAL QUALITY

B.3.1 S&T Topics Objectives

This proposal is for a mono-site Initial Training Network in cryogenics, accelerators, and targets, for the future upgrade of the ISOLDE facility.

The majority of the research topics presented in this proposal will be carried out within the accelerators and technology sector of CERN, complemented with the 13 associated partners listed in B.1, of which 5 are from industry. CERN already has collaboration with most of the ITN associated partners through the ISOLDE and EURISOL Collaborations; the SAFERIB JRA Network within FP6. Close contacts already exist with the industry partners: LHC collimation system (SDMS and SIDEA), thin-film technology for superconducting RFQs and resonators developed within the TRASCO research programme (ZANON and CINEL), and cryogenic magnets (Scientific Magnetics). The associated partners will contribute to the research & development and training in specific work packages, review individual ESR/ER research projects, and participate in the organization of workshops and other training events. The complementarities and synergy among the associated partners are discussed in sections B.4 and B.5.

The research training topics of the proposed ITN are in accelerator physics, cryogenics, applied informatics, mechanical and electronics engineering projects related to the design and construction of a 10 MeV/u super-conducting linac and R&D for the future intensity upgrade of the HIE-ISOLDE facility. Table 1 lists the themes in which individual research training projects for a total of 20 young researchers (a maximum of 672 person-months of Early Stage and Experienced Researchers are proposed). There are nine main themes covering the three main HIE-ISOLDE subsystems described above. For each of these themes the state-of art, research objectives, and the roles of the associated partners are outlined in the remainder of this section.

Table 1: Overview of the 9 research training themes addressed by this ITN proposal

HIE-ISOLDE Subsystem	Research Training Theme	No. ESR	No. ER
I. SC Linac	1. Super-Conducting Cavity Development an tests	2	1
	2. Beam Instrumentation Development	1	1
	3. New Magnets	1	-
	4. Linac Integration and Innovative Alignment Method	2	-
	5. Linac Commissioning	1	-

II. Design Study for intensity upgrade	6. New Target and Front-End Design	5	-
	7. ISOLDE target area and Class-A Laboratory Upgrade	2	-
	8. Beam Quality Improvements	2	1
III. Safety	9. General Safety and Radiation Protection Implications Studies	-	1
	TOTAL	16	4

B.3.1.1 Research Themes 1 to 5: Super-Conducting Linac System

The HIE (**H**igh **I**ntensity and **E**nergy)-ISOLDE project embraces new developments in radioisotope selection, improvements in charge-breeding and target-ion source development. For extending the physics reach of the facility, the most significant component is the Superconducting linear accelerator with a minimum energy of 10 MeV/u (HIE-LINAC) which will replace most of the existing ISOLDE post accelerator.

The basic element for the radioactive ion acceleration consists in a Superconducting resonant cavity of the quarter-wave type (QWR). For the QWRs there are two competing technologies that can be used for the production of the cavity itself. The first one is based on 3-4mm sheets of high grade niobium. The shape can be obtained by deep-drawing, rolling, hydro-forming etc. and all the parts are subsequently electron beam welded. An external vessel is also made in order to contain the liquid helium. This technology is in general referred as bulk niobium.

An alternative technology is based on a copper cavity in which a layer of a few microns of niobium is deposited via a sputtering technique. In this case only the internal conductor is cooled directly by liquid helium since the excellent thermal conductivity of copper assures a homogeneous temperature distribution in the cavity. This technology is in general referred to as sputtered niobium. The nominal parameters in term of accelerating gradients for the SC cavities for HIE-ISOLDE are quite demanding. Nowadays only bulk niobium technology has proven to systematically reach value of Q_0 in the order of $5{\cdot}10^8$ for accelerating gradient larger than 6MV/m (with associated peak electric fields larger than 30 MV/m), while sputtering technology has only reached similar values on test cryostats and to date, not in operational machines. Sputtering technology has the distinct advantage because its dominant copper base it is mechanically more stable than its bulk niobium counterpart. Consequently, the resonant frequency of the accelerating mode is hardly affected by external noise sources (vibrations, LHe pressure variations) and this allows for substantially simplification in the tuning system. This leads to a more robust overall accelerator with no appreciable sensitivity to microphonics. Finally, there are substantial cost savings as sputtering onto copper is expected to be at least a factor of 2 or more less expensive than fabricating bulk Nb cavities. This technology is however not available to the industry and the research proposed in CATHI aims to improve the sputtering technique to the point to be able to transfer the technology to industry and consequently to make available this technology to a wider number of accelerator laboratories.

It must be stressed that the design and construction of a SC accelerator is a highly multidisciplinary task. For example the cavity RF design will have a big impact on the cavity construction technique that will be chosen. Similarly the configuration of the sputtering process is very much dependent on the internal geometry of the resonator. Additionally, the mechanical behaviour of the cavity will have influence of the choice of the main parameters for the Low Level RF system that will be used to drive the cavity in a stable way. Moreover, each cavity must be aligned within the cryomodule with high precision along with the diagnostics boxes that are employed to measure the beam properties.

The ESRs and ERs will work on individual projects in the context of the following R&D themes but they will necessarily be exposed to a variety of disciplines that will complement the technical training:

B.3.1.1.1 Research Theme 1: SC Cavity Development

<u>Cavity and Cryomodule tests (ESR)</u>

The ESR will take part in the specification and conceptual design of the cavity and subsequent realization of the cavity and cryomodule test stand. The research activity will allow him the get familiar with industrial controls and with tests at the cryogenics temperature. This requires also some mechanical assembly in clean room environment for which he will receive a specific training. The ESR will collaborate and supervised by a member the RF control group at CERN. A second activity of the ESR is the data analysis of the cold tests of the SC cavities with the creation of a database. The research will also focus on the investigation of certain unexplained RF behaviour such as the Q-drop effect that is typical of the sputtered cavities.

LLRF system (ER)

The ER will take part in the specification and conceptual design of the Low Level RF system for the HIE-ISOLDE QWR. The challenge of the task is to create a system that allows stable operation with a high Q-loaded (10^7). The ER will contribute to define the architecture of the system and to implement some parts of it. The research activity will include simulations, implementation of the control system in custom made electronic cards and finally intense testing of the different components.

Cavity manufacturing and surface treatment (ESR)

The HIE-ISOLDE project will require several low-beta superconducting cavities, which will be made at CERN using the technology of niobium films sputtered over a copper substrate. Obtaining good-quality films in such a complex geometry is a challenging task that will require several optimization runs, in order to fully study and understand the superconducting film characteristics. The candidate will be in charge of this optimisation process in cavities of different betas and directly perform or participate to qualification measurements of the films with several techniques (RRR, SEM, XRD, RF,…) , correlating the results with the deposition conditions. In a second phase of the project, the coating will have to be carried out in a "production" environment and the role of the Fellow will be to set-up the procedures and guarantee the quality of the process.

B.3.1.1.2 Research Theme 2: Beam Instrumentation Development

Design of beam instruments (ER)

The ER will be responsible for the specification and conceptual design of the beam instrumentation for the REX upgrade. This includes the design of the position, profile and intensity monitors, phase and energy monitors and emittance meters in all required variants. The ER will then coordinate the mechanical and electronics designs, the fabrication of the required components, the assembling and testing of the devices and the installation. The ER will also be responsible for the supervision of an ESR working in closely related projects.

R&D on solid state detectors (ESR)

The ESR will participate in the development of a particle detector suitable for measuring very faint radioactive beams. Techniques usually employed in beam instrumentation for the detection of particles are not well suited for radioactive beams due to the limited sensitivity of these devices and the small currents obtained with radioactive beams. On the other hand the technologies used in particle physics are also not well suited due to the limited radiation resistance of the materials used. The case of radioactive beams falls in-between well established technologies and requires R&D work in order to either increase the sensitivity of the devices already used in beam instrumentation or increase the radiation resistance of particle detectors used in high energy physics. The result of this development will then be directly used in the beam monitors to be developed for the upgraded REX-ISOLDE and the ESR will thus actively participate and contribute to these developments.

B.3.1.1.3 Research Theme 3: New Magnets

New Magnet (ESR)

The objective of this task is to design, manufacture and commission compact warm magnets for the HIE-ISOLDE accelerator and transfer line. This task starts with the iteration with beam physicists to set the magnet parameters and trim them towards integration and to make them compatible with technical and economical aspects and finally the successful commissioning of all magnets once installed in the HIE experiment. The ESR will participate in the design and implementation of the whole magnet system for HIE-ISOLDE. He/she will work in the TE-MSC-MNC team but also in close connection with the rest of other project teams (beam physics, manufacturing, layout, alignment, cooling and ventilation, etc). In addition to a wide spectrum of internal contacts with other CERN teams, the ESR will also participate in the elaboration of the technical specifications and in the call for tender for the magnets procurement in industry.

B.3.1.1.4 Research Theme 4: Linac Integration and Innovative Alignment Method

Development and participation to the integration studies (ESR)

The ESR will participate to the full integration studies for the different accelerator and experimental beam lines of HIE-ISOLDE, and provide the most up-to-date view of the project to the users' community. This task includes the collaboration with all the different participants to the project and the collection of their CAD layout data to build up the most accurate view of the state of the project.

In general terms, the ESR will participate in the design and space arrangement of the HIE-ISOLDE area for the Design Study phase, together with an experienced integration designer. He/She will be part of the EN-MEF-LI section and work together with the rest of the team to build up the project integration and reference the most up-to-date designs from the equipment providers groups. Different solutions for the Design Study layout will have to be experienced in order to choose the most adequate solution. The management, the validation and the availability of the data is an essential part of the integration process and he/she will be responsible for it. The ESR will profit from the integration processes applied during the LHC construction phases and in use in the team today. Contacts and extended visits will enable the ESR to compare these processes with the ones in usage in industry (Hydro-Quebec, Bobst SA) or in other institutes (ITER, CNRS/IN2P3) that are not partners.

Development and participation to the control, alignment and positioning metrology (ESR)

The ESR training programme will focus on the accurate geometrical positioning of all the elements of the HIE-ISOLDE project, namely the SC accelerating cavities, the beam monitors and the magnets. This task comprises the project of implementing permanent internal monitoring lines to follow the relative movements of the cryo-cavities and the solenoid inside each tank plus the relative positioning during the runs of all the tanks. A preliminary proposal of using specific electro-optics cameras BCAM (Brandeis Camera Angle Monitor) for the cavities and tanks monitoring was presented. The alignment of the other elements will be carried out on the base of the metrology techniques applied to accelerators and detectors: laser tracker, metrology distance meters and theodolites, adapted tooling and analysis/data-taking software. In general terms, the ESR will participate in the design and implementation of the whole metrology system for the HIE-ISOLDE project. He/she will work in the BE-ABP-SU team but also in close connection with the rest of other project teams (manufacturing, layout, etc). The initial phase will be the design of the BCAM monitoring lines and the basic development of the mechanical elements and data-acquisition with control tools - these required applications exist but have to be studied and adapted to the specific layout and conditions. This preliminary phase implies obligatory contacts with the system manufacturer (Brandeis University), plus optics firms and the existing collaborations that are the main users of the system at CERN (ATLAS, ALICE and CMS).

B.3.1.1.5 Research Theme 5: Linac Commissioning

LINAC Commissioning (ESR)

The specificity of the REX linac is the need for a high flexibility as the ion mass, charge and final energy can vary widely depending on the physics case, and the need for a fast and reliable tuning procedure to allow for frequent change of mass and energy with often invisible radioactive beams. The ESR training will be focused on the development of machine tune-up procedures that will later be implemented in the control software for the linac operation and active participation in the startup of the machine. He/she will draft the specification of the controls and of the beam monitoring tools specific to the HIE-REX linac, and participate in the definition of tuning procedures and the management of machine protection and alarm system. He/she will write console applications to be used by the operators for the linac tuning and monitoring. The candidate should also follow the progress of the different aspects of the linac design, construction and installation. The ESR will profit from the close collaboration between the PS Booster operation team and the accelerator physicists responsible for the linac design, beam optics, beam diagnostics and controls.

B.3.1.2 Research Themes 6 to 9: Design Study for the Intensity Upgrade of HIE-ISOLDE

The objective of the HIE-ISOLDE Design Study is to design and validate future modifications of the existing facility with respect to the implications of a proton-beam intensity increase. These modifications should include an improvement in beam quality and equipment lifetime while minimizing the radiation exposure to all those involved with its operation. The research themes 6 to 9 provide a unique opportunity for young researchers and engineers to work together as a cohesive team. The different work packages are closely linked in terms of design and engineering where the base-line parameters or results of one WP will have an important influence on the boundary conditions of another. While gaining invaluable experience throughout their training period, the team will be expected to work together to exchange ideas, define specifications, compare innovations and achieve the common goal of providing a complete design study for the HIE-ISOLDE target area.

The ESRs will contribute to different work packages in the context of the following R&D themes:

B.3.1.2.1 Research Theme 6: Studies for ISOL Target & Front-End upgrades

The targets and the target station (also known as Front End) are at the heart of all operations at ISOLDE. Although continuous R & D work on ion sources, target materials and beam purification contributes to the quality of the RIBs provided at ISOLDE, the proposed increase in proton beam intensity implies a completely new challenge in terms of operation and equipment lifetime. Key issues include the study of target materials and maintaining the production rates of radio-isotopes, thermal and shock studies, radiation protection and beam optics. All these issues will be the focus of training for the ESRs and are described in detail below.

Target material studies (ESR)

The life-time of the present Target and Ion Source Units is of 1e19 integrated protons delivered as pulsed beam obtained typically after two weeks of operation. The increased proton beam intensity poses a number of challenges in particular heat dissipation and fatigue issues. After gaining a sound knowledge of the existing facility and target materials, the ESR will use FEM numerical codes to simulate proton beam interactions with existing and potential target materials. The ESR will establish an experimental program to validate the simulations and verify the production rates and diffusion constants for different material prototypes. Hands-on training will be provided to acquire practical experience, using unique state-of-the-art equipment such as a laser Doppler vibrometer and electron bombardment for high temperature heat conductivity measurement. The ESR will be seconded to Paul Scherrer Institute (Villigen, Switzerland) which is not a partner, in order to gain valuable experience and to participate in post irradiation analysis.

Target conceptual design (2 ESRs)

In line with the target material studies, further developments will be required for the conceptual design of future target units with emphasis on overall target and ion source design in terms of thermal dynamics, shock effects and fatigue. Other target related issues include the radiation protection issues associated with the increase in p-beam intensity and which will have consequences on air activation, shielding, target geometry and beam dumps. The first ESR will carry out simulations of fatigue and thermo-mechanical effects on target units using FEM numerical codes. He/she will look after the post irradiation analysis of used target and ion source systems with respect to fatigue and failure. Other tasks will include off-line studies, by modification of the electron beam equipment, to induce cyclic stresses on various components and on-line tests with specific proton-beam pulse sequences and measurements using the Laser Doppler Vibrometer. The second ESR will make use the particle simulation code FLUKA for the optimization and design of the target(s) for the study and optimization of different layout scenarios in terms of radiation protection issues. The ESR will work in direct collaboration with the code developers and with engineers to exchange energy deposition maps. The ESR will collaborate with the Radiation Protection Group at CERN and will participate in benchmarking experimental campaigns to verify simulation results.

Extraction optics and front-end design (ESR)

The extraction optics plays an important role in the initial beam transport and the quality of the beam supplied to the mass separators. Important factors include the emittance of the beam and the beam profile to avoid any beam losses. Furthermore, due to the increased radiation levels proportional to a higher proton beam current, the new FE design must be more radiation resistant and will require a minimum of hands-on maintenance. As part of the Front End design, the ESR will carry out beam optics simulations as a function of target and ion source parameters and the beam profile requirements for mass separation and both the functional and conceptual design of a new Front End including its integration into the existing facility. Finally he/she will participate in the provision of a safety file of the new design. The ESR will collaborate with engineers and physicists in various specialist domains.

Low-level controls (ESR)

The ESR will participate to the low level control design study of the new front end and the High Resolution Separator (HSR) magnet. The front end control includes high accuracy positioning of the extraction electrodes as well as the control of devices for the target manipulation safety (i.e. clamps, pistons, shutters). Although seemingly a typical example of industrial control, many challenges have to be addressed as result of the new target increased energy and consequent increasing of the radiation integrated dose on the front end (i.e. several hundreds of Gray). For this reason a dedicated study on the state of the art movement and sensor systems that accommodate that challenging environment will be the main task. The HRS dipole integrated magnetic field has to be controlled to an accuracy of a few ppm. In order to achieve this requirement an accurate model of the magnet has to be determined. This should be able to predict the integrated magnetic field value by the knowledge of the supply current and the current value of the magnetic field. This latter is given by a punctual measurement performed with an NMR (Nuclear Magnetic Resonance) probe. The model should take into account the multi-poles errors so to elaborate in the future correction laws using the high order magnets to be installed on-line. The control system prototype will be implemented on a PXI platform from National Instruments (NI).

The ESR will be seconded to the SEDEA company labs to gain valuable experience on NI LabView RT control systems for a maximum period of 3 months.

B.3.1.2.2 Research Theme 7: ISOLDE target area and Class-A Laboratory Upgrade

Cooling and Ventilation Design Study (ESR)

Given the exposure to highly radioactive environment the cooling and ventilation system has to guarantee the highest standards in terms of efficiency, safety and ease of maintenance. The ESR will join in different activities and in particular he/she will interface with the others groups and CERN staff (engineers and physicists) to collect performance needs for the HVAC and cooling systems in order to start-up their final design for the HIE-ISOLDE. The ESR will acquire the necessary knowledge and collaborate to the different phases of the design of HVAC and cooling systems for the future HIE-ISOLDE. In particular the main tasks shall include the dimensioning of the components of the installations, the definition of the layout of the stations, the integration of the plant in the general layout of the building. All the engineering activities will be reviewed.

Although no specific associated partners have been identified, the ESR will be expected to compose a report on the different regulations and procedures used at various nuclear sites throughout the European community. This will entail frequent visits and short stays at various sites throughout the EU.

Design study of the vacuum system for the Front End of the Isolde facility (ESR)

This particular theme covers the integrated vacuum system, the target units, the primary pumping systems, and the collection, storage, and exhaust of radioactive gases. All these issues have to be addressed with the increase of proton beam intensity.

In collaboration with the technical team of the HIE-ISOLDE project and the VSC vacuum controls staff, the ESR will detail the extent of the work and present a planning, perform the engineering study, organize tests and work with the drafting office for preliminary design and integration. The ESR will participate to the optimization of the choice of control and diagnostic equipment with respect to measurement reproducibility and precision versus radiation hardness and will design a new gas recuperation system taking into account radiation safety and contamination hazards.

B.3.1.2.3 Research Theme 8: Radioactive Ion Beams Quality Improvements

Beam quality is an important factor for the success of many experiments at HIE-ISOLDE and covers many different aspects. For example, transverse emittance will greatly enhance the selectivity of collinear spectroscopy, bunched beams will simplify and improve injection into other devices such as the REX electron beam ion source, cooled beams will improve ion transport through the complex beam line system at ISOLDE and the improved resolution of mass separation will contribute to better ion beam selectivity.

Off-line separator and High-resolution separator magnet (ESR)

An off-line separator will be used for both the testing of prototype targets and eventually provide ion beams for the off-line physics program where long-lived radio-isotopes produced by other means can be made available to physicists outside the normal operational period. A new HRS separator magnet design is an important element for the separation of isobaric beams with a mass resolution of up to 20000. The ESR will define the functional and technical specifications for the production of an off-line separator; he/she will participate in the assembly and commissioning of the off-line separator. The following tasks will consist of using simulation codes to provide a full design report of a high resolution magnet including the integration of multi-pole corrections and preparation of the functional and technical specifications for submission to a call for tender.

RFQ cooler and pre-separator (ESR)

In parallel to the high resolution magnet design, the beam quality before mass separation plays a major role towards the high resolution of the separator magnet. The beam should have an emittance of < 3 pi.mm.mrad to be able to achieve a mass resolution of ~ 20000. This can be done using a Radio Frequency Quadrupole Cooler and Buncher (RFQCB) prior to injecting the beam into the magnet. However, to minimize space charge effects of the total beam, a pre-separator should be installed prior to beam injection into the RFQCB. The ESR will provide a functional and conceptual design of an RFQBC compatible with the existing infrastructure at ISOLDE and to investigate the options and provide a design for a pre mass separator, set up a test stand and elaborate a proof of principle program.

Design study of a replacement charge breeder for REXEBIS (ER)

The present accelerator scheme makes use of a charge-breeder source, but the higher beam intensities anticipated with HIE-ISOLDE and the desire to charge breed heavy elements within a shorter time ask for an upgrade of the present breeding system. A new-generation charge breeder would be based on cutting-edge EBIS technology with ideas taken from other highly performing EBIS presently under construction. The training program offered for this ER span from new beam simulation models, mechanical engineering, beam optics physics in addition to hand-on experience.

Within the BE/ABP group the ER should carry out high-current electron beam simulations in order to establish a viable electron beam design. The research activity will imply beam simulations and tests on the present REX-EBIS. An additional task is the beam-optics simulation of the A/q-separator connecting the EBIS breeder to the existing linac. The candidate will be seconded at MSU for training on simulation tools.

B.3.1.2.4 Research Theme 9: General Safety and Radiation Protection Implications Studies

Radiation Protection, as one of the aspects of overall Safety of the planned HIE-ISOLDE facility, is the responsibility of the project management in charge of planning, building and operating the future installation. The mandate of the radiation protection group is to support the decision-making of the HIE-ISOLDE project management in matters of Radiation Protection. For this purpose, the radiation protection group accompanies all design stages of the new project with guidance on applicable rules, and with numerical estimates of radiological impact. It collaborates with the project management in the optimization process. The goal of this process is to converge to technical solutions and administrative procedures ensuring the lowest reasonable radiological impact of the project on workers and the environment (ALARA–principle).

The HIE-ISOLDE project is an ideal environment to train nuclear engineers or physicists in the various phases of radiation protection for a new project. One researcher will accompany the radiation protection aspects of the extension of the REX post-accelerator for radioactive ions, whereas a second will collaborate with the teams charged with the rebuilding of the target area for allowing a primary beam power between 10 kW and 30 kW – a factor of 3 to 10 above the present beam power at ISOLDE.

<u>Safety and Radiation Protection (ER)</u>

The ER will work in the radiation protection group and have access to senior colleagues who are experienced in all aspects of planning and designing radiation protection measures for a new research facility. He/she will be the editor in charge of those parts of the HIE-ISOLDE safety file dealing with radiation protection and may also be called occasionally to give professional assistance to solving questions of radiation safety. The ER will be trained in comparing different Monte-Carlo radiation transport codes for heavy ions at energies below 20 MeV/u, in estimating the activation and radiation levels from beam loss of heavy ions, in estimating the radiation levels from x-ray emission of RF cavities and comparing with measurements and in applying and monitoring the foreseen protection systems.

B.3.2 Scientific Quality

The aim of the HIE-ISOLDE CERN project is to train young researchers in a large spectrum of accelerator related technologies and to greatly expand the physics programme compared to that of REX-ISOLDE. HIE-ISOLDE science covers the majority of the key questions in nuclear structure and astrophysics pursued by nuclear physics community. The availability of high quality and versatile RIB from this facility is crucial for studies of nuclear symmetries and modes of collective motion, shell behaviour under extreme conditions, nuclear matter near the drip lines, and critical reactions in nucleosynthesis (r-process, rp-process) found in violent stellar interactions. All the main choices for the particle accelerator and for the target design are setting new technological challenges that many other European facility could profit of. The innovative construction technique for the SC cavities could lead to significant saving for the construction of future low energy accelerators and the developments of all subcomponents (magnets, beam instrumentations, cryogenic position monitoring system) will greatly used in several other accelerator projects.

The radiological challenges associated with the HIE-ISOLDE project are no less apparent than in the surrounding infrastructure. Due to the activation of air during operation, the target area, like many installations at CERN, is kept at an under-pressure compared to its neighbouring environment. At HIE-ISOLDE, the immediate neighbouring environment is the Class A radiation laboratory where the handling of open radioactive sources also requires a reduced atmospheric pressure. The maintaining of a cascade of under-pressures can only be achieved by the continual extraction of activated air to the atmosphere and for obvious environmental reasons there are limits to the amount of air that can be extracted. The challenge therefore is to maintain a minimum air release despite an expected factor of 5 increase of air activation while respecting the cascade of under-pressures required for operation. The ESR for Cooling and Ventilation will be expected to address these issues and to investigate the target cooling schemes in collaboration with the target design engineers.

The variety of beams that will be provided by the HIE-ISOLDE facility is directly proportional to the amount of different targets used throughout the running period. Due to contamination and the production of volatile radio-isotopes, all gases from the vacuum systems either from pumping a new target or throughout operation, require containment. Similarly, the incidental trapping of radio-isotopes within the vacuum systems and access for pump maintenance are also major issues that will be addressed by the ESR for Vacuum Technology.

B.3.3 Appropriateness of the Research Methodology

Accelerator engineering and applied physics projects in the CERN Accelerators and Technology Sector, of the kind described in this proposal, are driven by the concrete needs and requirements of the physics programme, and they represents unique training opportunities for the young researchers to learn a scientific working method that will allow to advance in their future career. The ITN will employ an R&D methodology which includes the following steps:

- Understand the “problem” and through discussions between engineers and physicists develop a concept for a “solution”;
- Through study of the literature, conference attendance, interactions with advanced technology suppliers (industry and/or specialized institutes) understand previous approaches to similar problems and the state-of-the-art; explore potential architectural and technology options;

- Carry out feasibility studies based on theoretical analysis, modelling and/or simulation; understand achievable performance and the limitations (e.g. power dissipation, cost);
- Establish partnerships for the R&D; propose and document a development plan; obtain Management approval and commitment to provide required resources;
- Development and characterisation of a prototype or demonstrator in the laboratory and/or in a beam test. Peer review of results and approval for next phase:
- Detailed specification, review and approval of an engineering design; construction and testing in the lab; integration into a larger set up for system-level verification in a beam test;
- Production readiness review, organization of production and test
- Installation and commissioning of the different subcomponents. Calibration and performance optimization.

The researchers will take part in as many project phases as is possible within the duration of their Fellowships. They will be given a complete overview of the project and will be embedded in small, dedicated but multidisciplinary teams. Team objectives and progress will be subject to external peer review and regular detailed reporting in project meetings. The individual projects of the researchers will form part of their team's larger objectives, and the researchers will report at team meetings as well as at the Project meetings. Team objectives and deliverables are defined in the work packages.

B.3.4 Originality and Innovative Aspects of the Research Programme

CERN is the world's largest particle physics laboratory, and it is one of Europe's first joint ventures (1954) for fundamental research and technology developments. It has 20 Member States and hosts a community of over 10,000 visiting scientists from more than 500 Institutes worldwide: a significant fraction of them are students coming to CERN to complete their scientific training. The training capacity offered by CERN has been discussed in Section B.4.3.

CERN has a solid experience in training of Marie Curie Fellows through six Early Stage Training Host Fellowships of the 6th Framework Programme, accommodating some 150 fellow-years. Currently under FP7, CERN coordinates three ITNs (85 fellow-years) and hosts five individual fellows. This experience, combined with the existing well-established international collaborations, leads CERN to believe that all the necessary elements of the research training programme of this ITN can be delivered by the Organization through collaborations with other research institutions without the latter formally being part of the network. Therefore, this is a mono-site proposal with 13 associated partners, 5 of which are in the industry sector (ZANON, CINEL, SDMS, SIDEA and Scientific Magnetics), and 8 are technical research centres with the mission to be at the interface between the academic world and industry. CERN already has collaboration with most of the CATHI associated partners within ISOLDE.

ISOLDE is a world leading Radioactive Ion Beam facility, contributing to the field of the study of nuclei far from stability which is attracting increasing interest worldwide. The main fields of science addressed at ISOLDE comprise nuclear structure, nuclear reactions, nuclear astrophysics, fundamental interactions, solid state physics and biophysics.

HIE ISOLDE is a major upgrade project of the current ISOLDE facility. The main goal is to increase the final energy of the post-accelerated beams to 10A MeV throughout the periodic table. This will be achieved by adding innovative state of the art sputtered superconducting cavities to the current REX LINAC. Higher energies will significantly increase the scientific reach of the facility by opening the possibility of studying throughout the period table various types of nuclear reactions which do not occur at the present energy of 3A MeV, and of performing deep implantations for material science applications. Moreover the current room temperature LINAC will be replaced by low beta superconducting cavities allowing for CW operation. It will also be possible to deliver beams with energies down to 1A MeV or below for astrophysics oriented measurements. These new opportunities are expected to significantly increase the user base by attracting new groups experts in these domains. The possibility of providing polarized beams will also be investigated. A second aspect of HIE ISOLDE consists in an improvement of the target areas and ion sources in order to make use of the more intense proton beam from the new CERN injector LINAC4, enabling up to an order of magnitude more RIB intensity to be delivered for many nuclides.

In a longer term view, HIE ISOLDE has been recognized as a major milestone in the preparation of the long term future of the field. An unprecedented European integration of RIB Physics is expected in the next decades as the field moves from a distributed network of complementary facilities towards the next generation high power facility EURISOL, which has been designed within the EURISOL Design Study funded in FP6. The young engineers and scientists trained within CATHI will play a major role in the construction and exploitation of EURISOL, for which they will no doubt be in great demand. This well defined long term roadmap ensures for many years a vigorous job market for their talents. It is also important to note that the site investigation committee of the EURISOL Design Study recognized CERN as one of the most attractive potential sites for EURISOL, which could benefit from the new SPL injector, expected to be operational in 2019.

The improved performance of the sputtered cavities and the eventual industrialization of the sputtering process with the consequent costs reduction can also serve as a test-bed of the methodology for other larger accelerator projects that are in the process of being planned. For example, in the field of RIB facilities, future projects such as EURISOL and SPIRAL-II could profit from the cavity development that will be done for HIE-ISOLDE. Moreover an increasing number of nuclear physics laboratories based on old Tandem accelerators are looking at SC linacs as a practical replacement for normal conducting linacs as the machines are approaching the end of their effective working lifetime.

It should be said also that a highly performing EBIS of the type that will be developed under Research Theme 8 could, apart from being used as a charge breeder, act as a heavy-ion injector for Linac3-LHC.

B.3.4.1 Plans for Exploitation of the Results

The plans for the scientific exploitation are numerous and extend well beyond HIE-ISOLDE (see details in B.3.2, and B.6.2). Potential market opportunities will result from the development work on sputtering, cavity manufacturing, Low-Level RF control systems, Cryomodule design and fabrication, radiation-hard, robust and reliable beam diagnostic sytems. Estimates for the accelerator projects scheduled for the next decade and beyond indicate a potential investment in SC components of the order 1.5 billion euro (see details in section 6.3).

B.3.5 Private Sector Contribution in the Research Programme

The participation of industrial partners in this training network is essential, since the development of accelerator components and infrastructures relies on close collaboration with competent companies, and a mutual understanding of the requirements and constraints. Furthermore, the large number of components usually required cannot be manufactured by academic institutions. The demands on quality and quality assurance are such that they can only be met when a close collaboration with industry is realized. The SMEs involved in this proposal will gain access to world-class equipment which might otherwise be beyond their means.

This joint research training programme will contribute to lifting the barriers between different sectors and disciplines, thus promoting the movement of knowledge and persons between the academic and business worlds. It will help industry identify research opportunities and develop them together with academic partners, fostering the emergence of new technologies and products.

For example, the cavity manufacturing we require for the HIE-ISOLDE project is similar for niobium-sputtered copper and bulk niobium cavities, utilising e-beam welding, clean room assembly, and specific procedures to reduce contamination. This places the SMEs involved in this proposal in a position to bid for the cavity manufacturing for a number of future projects utilising superconducting radio-frequency (SRF) cavities or normal-conducting cavities. In addition, the adherence to strict manufacturing procedures will lead to a track record in successful accelerator cavity fabrication. This will allow opportunities to be developed for the manufacturing of cavities using other techniques. This is the case of SDMS which is currently manufacturing bulk Niobium cavities for SPIRAL2 and is contemplating developing a new assembly line for Niobium coated Copper cavities given the new opportunities with HIE-ISOLDE.

In concrete terms, the contribution of the private sector to the research programme will include performing prototyping and development work in the areas of:

- Design and prototyping of normal conducting magnets;

- Copper cavity machining and electron beam welding for superconducting cavity construction;
- Thin-film technology;
- Design and manufacturing of liquid helium based cryogenic transfer lines;
- Yoke sub-assembly of super conducting magnets;
- Design and construction of RF cryostat;
- Clean room assembly of RF ancillaries;
- Beam instrumentation.

B.4 TRAINING

This ITN targets young scientists who have recently completed formal university training. In order to progress to become independent research scientists with leadership potential, they need to complement their university training with more specialized and hands-on training, with practical experience in real "high-tech" projects. For the research topics of this proposal, CERN and its associated partners offer specialized courses given by leading scientists from European universities and research laboratories, with hands-on training using unique state-of-the-art equipment not easily found elsewhere, and supervised by world experts in the domain.

CERN has its own in-house Training & Development service that has a very strong track record as a European training centre. The annual volume of training given is of the order of 11,000 person-days. Large fractions of such training activities, including specific training actions for Marie Curie fellows, are geared towards, and have been used extensively by, FP6 and FP7 researchers.

B.4.1 Quality of the Training Programme

The best training for young researchers is to participate in frontier science projects driven by world-renowned scientists, such as those at CERN and its associated partner institutes. The proposed ITN prepares young scientists for their future roles in European Research by exposing them to well-established research environments that are international, multidisciplinary and intersectorial (mixing universities, specialized technology research centres, and industries).

To complement hands-on training, the young researchers can take advantage of CERN's formal training programme, covering a number of different types of learning (summarized in Table 2), many directly relevant to their projects, and all of which will broaden their horizons. The CERN seminars and colloquia will provide highly relevant and topical training by specialists in accelerator technology, electronics, and informatics. The technical training programme provides a rich spectrum of courses covering engineering software packages, modern electronics design methods and tools, database technology, programming languages, and office automation software.

Table 2: Relevant elements of CERN's formal training programmes

Type of training	***Content***
Academic Training	• 14 series of 3-5 lectures each; • University postgraduate level; • Particle physics and related fields of applied science.
CERN Schools	• Accelerator School, School of Computing, European School of High Energy Physics and the Latin-American School of High Energy Physics; • Annual events organized in different countries to enhance the relationship between young students and senior physicists and engineers.
CERN Seminars and Colloquia	• Regular sessions throughout the year include specialist seminars on detectors, accelerators science and technology, electronics, informatics, and theory; delivered by specialists in each domain
Management & Communication courses, including language courses	• Extensive curriculum of management and communication topics ranging from basic communication to project management and team management for more established supervisors; • Language courses, English and French. 75 sessions with 900 participants.

Safety training	• Compulsory sessions for anyone at CERN; • Covers hazards and risks for all environments.
Science & Society Seminars	• Delivered by leading speakers to raise general awareness of the effect that science and research can have on society.
Summer Student Programme	• 6 weeks July & August, 3 hours per day on topics including accelerators, detectors, electronics, DAQ; 3rd year undergraduate level.

Technical Training	• On-demand training via 1- to 5-day courses and seminars ;
	• Topics include electronics, software & systems technologies, engineering, office software and automatio .
	  • Mechanical design e.g. ANSYS, AutoCAD, CATIA
	  • Electronics design e.g. MAGNE, MATLAB, LabVIEW
	  • Software and system technologies e.g. C++, JAVA, PERL 5, Python, XML

Web-based training	• Many of the lectures, seminars and courses are recorded and available via the web;Instructor-led topics also available in the form of web-based training.

The researchers will also be able to participate in highly relevant schools, international workshops and conferences, such as those described in table 3:

Table 3: Schools, Workshops and Conferences of particular relevance to the ESRs and ERs of CATHI

• The CERN Accelerator School holds training courses for accelerator physicists and engineers twice a year. The courses take place in conference centres in different member states of CERN and consist of a programme of lectures and tutorials spread over a period of one or two weeks. The school offer basic, intermediate and specialist courses.
• The ***LINAC conference*** is bi-yearly international conference series that provide a unique opportunity for LINAC specialists from around the world to interact and to exchange their achievements. It includes keynote presentations by industry and academic researchers, panel discussions, and parallel oral and poster presentation sessions especially suitable for first conference presentation experiences by young researchers.
• The ***IPAC conference*** is a yearly international conference on particle accelerators. It includes keynote presentations by industry and academic researchers, panel discussions, and parallel oral and poster presentation sessions. Typically it host about 2000 participants.
• The ***SRF workshop*** will cover the latest advances in the science, technology, and applications of superconducting RF. The program consists of invited review talks, poster sessions and "hot-topic" discussion sessions. A special emphasis will be placed on providing a forum for student researchers to present their results. Special tutorials will be held before the actual conference start. These are designed to provide an in-depth overview of SRF related subjects for scientists and engineers new to the field, or those who simply want a refresher.
• ***International Conference on Ions Sources (ICIS)*** dedicated to the development and results from various types of ion sources for accelerators.
• ***International Conference on Electromagnetic Isotope Separators and Techniques Related to their Applications (EMIS)*** is a conference dedicated to the production of radioactive nuclear beams and covers all aspects of mass separators and accelerators.
• ***Radioactive Nuclear Beams (RNB) and Exotic Nuclei and Atomic Masses (ENAM)*** are now a combined conference covering all aspects of nuclear physics as well as the tools for their production.

In addition, specialized training courses and tutorials by CERN experts and visiting scientists from the associated partners will be arranged at CERN. For instance, the ESR working on the SC linac integration and alignment will be trained to suitable courses covering data-acquisition and analysis methods; additional in-field courses will be also given for practicing surveying instrumentation and methods by the survey team.

Within the SC Linac Commissioning work package, the ESR will attend the basic and intermediate CERN Accelerator Schools in order to obtain a general knowledge about accelerators. He/she will follow specific courses relevant for the project (for example on beam diagnostics) and will be trained to suitable technical courses covering control software, Java programming etc. The candidate will also receive practical training from the PSB and ISOLDE operators and may collaborate with the Linac4 commissioning team where synergies are possible.

The Researchers assigned to the Radiation Protection Studies will have to participate in a training course relative to the MonteCarlo particle transport codes employed (FLUKA, GEANT4) where they will be able to discuss common issues, compare different approaches and review their individual projects with the visiting scientist and other senior experts from the FLUKA Team. Similarly, tutorials by visiting scientists and reporting by the ER and ESR working on radiation implications will take place in specialized workshops like SATIF, dealing with shielding applications.

The ERs and ESRs involved in Super Conducting cavity development, beam instrumentation, cryomodule and magnets design, beam quality improvements, will undergo specialized training through the associate partners in order to acquire knowledge of beam simulations programmes (Vector Fields, Field Precision or similar) and of beam optics programmes (Trace3D, Path, COSY infinity or similar).

B.4.1.1 Complementary Training

Considering that CERN has two official languages, English and French, a language-training programme is offered to help or perfect written and/or oral communication in each of the two languages. Regular evaluations ensure an appropriate match between the attendant’s ability and the level and speed of the course.

Also as part of the complementary training, the CERN Management & Communication Training Programme has courses addressed to all staff, fellows and students. They include:

• Language courses	• Managing Time and Stress
• Effective Communication	• Working Effectively in Teams
• Presentation skills	• Report Writing
• Chairing or Participating in Meetings	• Job Application
• Rapid Reading	• Proposal Writing

All of the Management and Communication Training courses are taught with a mix of theory and practical exercises. The CERN EU Office regularly organizes training courses on Framework proposal writing, as well as the management and evaluation of projects. In line with their preparation as future research leaders, the ERs will be requested to follow some of the Management courses.

The CERN Technology Transfer unit plans to introduce new courses on an *Introduction to the Management of Intellectual Property Rights* and *Technology Transfer*.

In fact, a core syllabus of OBLIGATORY courses will be defined at the outset, in the Career Development Plan of the ERs and ESRs. It will include at least one course per semester.

For the formal training programme of the Experienced Researcher in Theme 9 (General Safety and Radiation protection), we foresee the obtention of a professional certificate, allowing the researcher to become responsible for radiation protection in the trainees home country or in a European country of his choice. The qualification would be equivalent to the “ Personne competente en radioprotection (PCR)” in France or the “ Expert en matiere de radioprotection” in Switzerland. This implies 1 course of 2 to 3 weeks in the first year.

Flexible, assisted self-paced learning facilities, using a variety of pedagogical and technology-based materials and an on-site language laboratory, are also available.

B.4.2 The Importance and Timeliness of the Training needs

Accelerators and related technologies are finding more and more applications in basic and applied sciences, including domains other than nuclear and particle physics. The field needs more well-trained experts. The timing of the research training proposed in this ITN matches well with the recently approved HIE-ISOLDE project, thus opening up opportunities for training young researchers in a forefront project. Preparation work has already started with a definite project plan submitted to the CERN management and a project breakdown structure distributed. Concerning the high energy upgrade and the SC linac, certain pre-requisites for the ITN contribution are under way from other work packages namely in the form of infrastructure and overall building layout. The timeline of the design study part of the project corresponds to the planned on-line commissioning of the Linac 4 injector in 2014 which will provide the increase in proton beam intensity. The design study will prepare the necessary ground work prior to the implementation phase during the 9 months before the Linac 4 start up.

This is a unique opportunity for the ERs and ESRs where they will be involved at the beginning of a pioneering research and development engineering project that is the pre-cursor for new scientific discoveries.

B4.2.1 Inter/multi-disciplinary and Inter-sectorial aspects

The very nature of research projects at CERN, involving a very wide spectrum of technologies in various fields (including electronics, electrical and mechanical engineering, vacuum technologies and cryogenics, superconducting magnets, software, data acquisition and signal processing) requires the capability to adopt a multi-disciplinary approach. This aspect is emphasized in all training activities from the R&D for the superconducting linac and its integration to the demanding multidisciplinary requirements for the high intensity design study. The young researchers from the ITN will be exposed to an array of different specialists, both at CERN and through close international collaboration with European universities, other research institutes and high-tech industry. This will enable them to broaden their horizons into many disciplines.

For the high energy linac, the trainees will learn to integrate with a wide variety of specialist groups including building engineers and infrastructure engineers for the integration of their designs into the final complex. This will require that the trainee participates in meetings for planning and defining the final specifications in terms of infrastructure. Externally, the trainees will be required to collaborate closely with other institutes and industry to fully comprehend all aspects of production and operation of the final design.

Likewise, those trainees working on the design study and beam quality will be required to cooperate within a multidiscipline environment both internally and externally to learn from past experiences and to validate proposed solutions using state of the art technologies.

B4.2.2 Newly emerging Supra-disciplinary Fields

CERN's R&D in SC linacs, beam quality improvement and radiation hard apparatus are technologies eagerly awaited by the nuclear physics community who will only benefit from CERN's experience. From a scientific point of view, the completion of the project will provide a new and exciting tool for future physics experiments.

B.4.3 Appropriateness of the Size of the Training Programme with respect to the Host Capacity

The R&D training projects proposed will have a mix of tasks of different levels of complexity, expected duration, and calling for more or less previous research experience.

As shown in Table 4 most training projects will be for ESRs and these will require 3 years to achieve the level of expertise and project results corresponding to a PhD. A smaller number of ERs positions are foreseen for young researchers to complete their research training, to develop their independence and provide them with the skills and training to become team leaders in the near future.

Table 4: Proposed distribution of different categories of researchers between the 9 research themes.

Individual Research Training Theme	**ESR person-months** (post-grads) Includes secondment to associated partners	**ER person-months** (post-docs) Includes secondment to associated partners	**ESR & ER person-months on secondment** to associated partners	**Visiting Scientist person-months** (>10 yr experience) Invited for research training at CERN
1. Superconducting cavity development and tests	2 x 36	1 x 24	4 (IPN-Orsay) 4 (INFN-LNL) 2 (SDMS) 2 (ZANON) 2 (CINEL) 4 (Cockroft Inst.)	-
2. Beam instrumentation development	1 x 36	1 x 24	2 (LPC-Caen) 2 (NSCL-MSU) 2 (CINEL)	-
3. New Magnets	1 x 36	-	6 (Cockroft Inst.) 3 (Scientific Magnets)	-
4. Linac integration and innovative alignement methods	2 x 36	-	2 (GANIL) 2 (CNRS/IN2P3)	-
5. Linac commissioning	1 x 36	-	3 (INFN-LNL)	-
6. New target and front-end design	5 x 36	-	6 (INFN-LNL) 4 (GANIL) 3 (IPN-Orsay) 3 (SIDEA)	-
7. ISOLDE target area upgrade	2 x 36	-	3 (INFN-LNL) 3 (GANIL)	-
8. Beam quality improvements	2 x 36	1 x 24	5 (JYFL-Jyvaskyla) 5 (MPI-Heidelberg) 5 (NSCL-MSU)	-
9. Safety	-	1 x 24	3 (GANIL)	-
TOTAL	16 x 36 = **576**	4 x 24 = **96**	**80**	**-**

B.4.3.1 Capacity to accommodate Post-grads and Post-docs

CERN has a long experience in the coordination of research activities that promote the production and dissemination of high-level, interdisciplinary knowledge worldwide. Particular emphasis is given to training of students and young post-docs through the existing Technical and Doctoral Student programmes, and the CERN Fellowship scheme. CERN has a solid experience in training of Marie Curie Fellows through six Early Stage Training Host Fellowships of the 6th Framework Programme, accommodating some 150 fellow-years, as well as 3 ITNs and 5 individual fellowships in the 7th Framework Programme with some 85 fellow-years. In doing so, a specialized unit in the Human Resources (HR) Department coordinates all administrative processes from project proposal to recruitment to production of the interim and periodic reports. The number of potential supervisors and CERN's training capacities and infrastructures are such that the Laboratory can host many more young researchers than its current student and post-doc programmes are able to fund.

As for the CATHI proposal, ISOLDE has a long standing tradition in training young researchers from around Europe. During the last 5 years alone, close to 20 PhD theses based on work performed at ISOLDE have been defended. Many examples can be found of leading scientists and engineers holding key positions in RIB facilities throughout Europe and beyond who received doctoral and/or postdoctoral training at ISOLDE.

B.4.4 Exploitation of the International Network, including the Private Sector

The HIE-ISOLDE project is unusual in having a very strong interaction between potential users (the nuclear physics community) and those who will design (CATHI participants) and construct the accelerator (SMEs). It is vital to capitalize on this excellent working relationship by ensuring that there is an effective dialogue and feedback mechanism. Prominent members of this project are all experienced users of accelerated radioactive beam facilities.

B.4.4.1 For the ERs and ESRs participation in the SC Linac Development

The hands-on, project-driven learning and the in-house CERN training schemes will be supplemented by external training at the associated partners, as indicated above in Table 4. For instance, LPC-Caen, GANIL and JYFL-Jyvaskyla have excellent track record in the development of RFQ Coolers, beam transport, target and ion source development and mass separation. Training in these domains will be organized using the lab facilities available.

The industrial partners, CINEL, SMDS and ZANON will provide appropriate industrial training in cavity and cryomodule design and manufacturing processes through the secondment of researchers on their premises.

Training through the associated partner Cockroft Institute will enable the researchers to follow a series of lectures on Magnet Design in collaboration with the Universities of Liverpool and Manchester.

The ESRs and ERs will also be able to deepen their knowledge through selective participation in the well-known, high-quality series of courses organized by the Joint Universities Accelerator School in Archamps (France), 7 km from Geneva (Switzerland).

B.4.4.2 For the ER and ESRs participation in the Design Study for Intensity Upgrade

The researchers training plan will have two different phases. They will start with a 6 month familiarization phase of training on the job in their respective groups. The experience from this phase will allow them to understand the needs for optimization of the facility in the light of a future intensity upgrade. The deepened knowledge acquired in this phase will then be applied to the practical problems, closely followed by their supervisors. In this second phase the ERs and ESRs will be hosted by our associated partners for periods varying between 1 and 2 months to get practical experience. In this respect, due to the advancement of their projects, INFN-Legnaro and IPN-Orsay are in an excellent position to provide in-situ practical and research training in the field of actinide target and ion sources development for high intensity upgrade and operation. Other possibilities include detail thermo-mechanical and structural analysis.

To succeed with the electron beam simulations for the beam quality improvements, a close contact with specialists at NSCL at Michigan State University is essential. Secondment at MSU will be proposed to the Experienced researcher in charge to obtain sufficient base knowledge. The ER should act as the CERN link person with the established network for next-generation EBIT charge breeder, which recently received the approval from DOE, US. Initial contacts with electron cathode and magnet producers (e.g. AP Tech, Oxford Instruments, Accel Instrumens) should be taken in order to discuss electron gun and solenoid design issues.

B.4.4.3 For the ER participation in the General Safety and Radiation Protection Studies

The Safety aspects of the RIB production targets, comparable in radioactive inventory to the fuel element of a research reactor, will become decisive in limiting the intensities, in selecting the production method and in the cost of the future target area upgrade within HIE-ISOLDE. With its dedication to radiation protection and safety issues the ER training programme in this theme, represents an indispensable complement to the intense efforts towards the realization of highest-quality radioactive ion beams for forefront nuclear physics research in Europe. As European radiation safety standards converge, it is intended that the Experience Researcher in charge carries out an exchange of safety studies, computer simulations and a coordination of specific and innovative technological developments in collaboration with the European network SAFERIB. This will increase the safety of the facility, avoids costly parallel developments and leads to a new evaluation and perspective for the realization of the high-intensity upgrade for HIE-ISOLDE. The ER should act as the CERN link person with the SAFERIB network partners.

SAFERIB is a Joint Research Activity on Radiation Protection Issues related to Radioactive Ion Beam Facilities established within the EURONS Integrated Infrastructure Initiative of the European 6th Framework Programme. Secondments at SAFERIB participating institutes will be proposed to the Experienced researcher in order to obtain sufficient base knowledge.

B.4.5 Research Training Programme Monitoring and Follow-up

As stipulated by the ITN requirements, a Supervisory Board will be established in order to approve and oversee the implementation of the training programme for scientific, technical and complementary skills, and coordinate the network-wide training activities. The Management Committee will monitor and evaluate the overall progress of the research training programme, ensuring the exchange of best training practice with the associated partners, in particular with the industrial partners. Tools, technologies, methodologies and review schedules will be agreed early in the work plan in concertation with the lead scientist(s) of the associated partners.

As for the young researchers, the training objectives will be clearly defined in the Career Development Plan and regularly monitored to ensure coherence and monitor any deviation from the Plan (be it under-achievement of targets or identification of additional objectives). Great importance is given to regular and frequent contact between the Researcher and the supervisor and is considered the main mechanism for meeting the scientific and training objectives set out in the Career Development Plan. Regular meetings and an annual plenary of Researchers and supervisors will also be organized. EC Project Officers will be invited. Researchers will all make short presentations and/or provide posters on their work.

B.5 IMPLEMENTATION

B.5.1 Capacities to achieve the Research Programme

This mono-site proposal is submitted by CERN and the associated partners listed in section B.1.

Full Partner: CERN, International Organization	
General description	CERN is the world's largest particle physics centre. Currently more than 10,000 visiting scientists from more than 500 external institutes worldwide are involved in the research and technology programme of the Laboratory. CERN’s flagship project is the Large Hadron Collider (LHC), which began colliding proton beams in November 2009. In addition CERN R&D includes applied physics, engineering and Information Technology (as the birthplace of the World Wide Web).
Role	CERN’s role in CATHI will be to host and coordinate the mono-site initial training network, in collaboration with the associated partners listed below.
Key competences and facilities	CERN can offer research training in advanced accelerator technology, beam instrumentation, ultra-high vacuum, cryogenics, radiation protection and advanced material technologies in one of Europe’s leading Radioactive Ion Beam facilities (ISOLDE) at CERN, and its upgrade HIE-ISOLDE, 2010-2014, which consists in the design and construction of a Super-Conducting linear accelerator and associated high-power target.
Key persons	• Dr Yacine Kadi (Applied Physicist): Proposal coordinator; Expertise: nuclear physics,

	accelerator physics and nuclear engineering. Coordinated the Multi-MW target design within EURISOL and currently HIE-ISOLDE Project Manager. Prof at SKKU (Korea), Supervised 4 PhD students and several postdocs and technical students. Section leader at CERN. • Dr Matteo Pasini (Accelerator Physicist): will be directly responsible of the technical aspect of the HIE-LINAC project. Expertise: Beam Dynamics, RF normal conducting and SC cavity studies. Given lectures in electronic optics in 2003, now supervising a PhD student and a Post-doc. • Dr Fredrik Wenander (Senior physicist): supervision for charger breeder upgrade. Expertise: Ion source (1+ and n+, stable and radioactive) and Penning trap specialist; charge breeding specialist; heavy ion linac operation; beam diagnostics and spin-polarized beams. • Dr Thierry Stora (Senior Physicist): WP coordination for target and ion source development and Front Ends. Expertise: High power targets; Ion sources; radioactive Ion Beam development. Supervision of PhDs & Marie Curie fellows. Coordination of multisite intersectorial (industry-academia) projects. Lecturer. • Dr Thomas Otto (Radiation Protection Physicist): Supervision of Trainees. Extensive expertise in radiation protection at nuclear research facilities, dosimetry, Monte-carlo radiation transport programs. Previous supervision of approx. 5 techn. Students, 2 PhD students, 3 fellows (of which 1 Marie-Curie EST)
Previous training programs and research	Recent publications within the domain of the HIE-ISOLDE project 1. Charge state breeders: on-line results, F. Wenander, Nuclear Instruments and Methods in Physics Research, B266 (2008), pp.4346-4353. 2. Radioactive beams at REX–ISOLDE: Present status and latest developments, D. Voulot et al. Nuclear Instruments & Methods in Physics Research B266 (2008) pp.4103-4107 3. The REX-ISOLDE charge breeder as an operational machine, F. Wenander et al.Review of Scientific Instruments, 2006, vol.77, no.3, article number: 03B104-1-5 4. EURISOL High Power Targets; Kadi, Yacine et al. Nuclear Physics News 18(3) 2008, p19. 5. Development of High Efficiency Versatile Arc Discharge Ion Source (VADIS) at CERN Isolde L. Penescu et al. Rev. Sci. Instruments, in press.

Associated Partner: CINEL, Italy	
General description	Industry specializing in design and production of scientific instruments for nuclear physics research.
Role	ESR secondment for superconducting cavity manufacturing training
Key competences and facilities	Superconducting cavity fabrication
Key persons	Sergio Bongiovanni
Previous training programs and research	• Radio Frequency Quadrupole G.S.I. • Ion beam injector made of copper plated carbon steel • Resonant cavity L.N.L.S Campinas • Elliptical resonant cavity operating at 500MHz with tuning system and frequency shifter. Recent publications within the domain of the HIE-ISOLDE project: 1. Upgrading of medium beta ALPI resonators by Nb sputtering, A.M. Porcellato et al., in Proc of EPAC 2002, Paris, France 2. The TRASCO-SPES RFQ, A. Pisent et al., in Proc. of LINAC 2004, Lubeck, Germany 3. Superconducting RFQ's ready for ion beam operation at INFN-LNL, G. Bisoffi et al., in Proc. of EPAC 2002, Paris, France

Associated Partner: CNRS/IN2P3 IPN-Orsay, France	
General description	National laboratory involved in the conception and design of particle accelerators and instrumentation with experience in ion sources. Associated with IN2P3 and CRNS.
Role	Secondments for practical and research training especially in the field of actinide target and ion sources development for high intensity upgrade and Super-conducting cavities and cryomodule tests. Lectures at CERN from visiting scientists.
Key competences and facilities	Working on the Spiral 2 project for the target and ion source development. Collaboration existing between IPN and ISOLDE for target development.
Key persons	Dr. Sebastien Bousson
Previous training programs and research	Recent publications within the domain of the HIE-ISOLDE project: 1. Tests of high-density UC targets developed at Gatchina for neutron-rich radioactive-beam facilities, Lhersonneau G et al, NIM B - *(EMIS2007)*, 2. Construction of a 700 MHz Prototypical Cryomodule for the Eurotrans ADS Proton Linear Accelerator, F. Bouly et al, SRF 2009 3. Two-dimensional/three-dimensional simulations for the optimization of an-electron-beam-generated-plasma-based-type ion source, Cheikh Mhamed et al.RSI (ICIS2007), (2007) 4. Spoke Cavity Developments for Eurisol Driver, S. Bousson et al., LINAC 06

Associated Partner: CNRS/IN2P3 LPC-Caen, France	
General description	A laboratory specialized in fundamental physics and associated with IN2P3, CRNS and the University of Caen
Role	ESR secondments, lectures at CERN from visiting scientists.
Key competences and facilities	Mass spectroscopy with a keen interest in beam quality and beam diagnostics.
Key persons	Dr Nigel Orr Nuclear structure group leader. Member of the INTC (ISOLDE and Neutron Time of Flight Committee)
Previous training programs and research	Recent publications: 1. Single-Proton Removal Reaction Study of 16B, J.L. Lecouey, N.A. Orr, F.M. Marquéset al., Phys. Lett. B672 (2009) 6 2. Mass Measurments of Neutron-Rich Nuclei Near the N=20 and 28 Shell Closures, B. Jurado, H. Savajols, W. Mittig, N.A. Orr et al., Phys. Lett. B649 (2007) 43 3. Structure of 12Be: Intruder d-wave Strength at N=8, S.D. Pain, W.N. Catford, N.A. Orr, et al, Phys. Rev. Lett. 96 (2006) 032502

Associated Partner: Cockcroft Institute, UK	
General description	Institute for accelerator science and technology. A collaboration between academia, national laboratories and industry.
Role	Secondment of ESRs, training in the form of lectures through the University of Liverpool and University of Manchester.
Key competences and facilities	Specialists in the research, design and development of particle accelerators
Key persons	Dr. Peter MacIntosh, Radioafrequency and Diagnostics Group Leader
Previous training programs and research	Recent publications within the domain of the HIE-ISOLDE project: 1. HIE-ISOLDE High Beta Cavity Study and Measurements, A. D'Elia et al. Proceedings of SRF2009, Berlin, Oct 2009. 2. Compensation of Transverse Field Asymmetry in the High-beta Quarter-wave Resonator of the HIE-ISOLDE Linac at CERN, M.A. Fraser et al., Proceedings of SRF2009, Berlin, Oct 2009. 3. Beam Dynamics Studies for the HIE-ISOLDE Linac at CERN, M.A. Fraser et

	al. Proceedings of Particle Accelerator Conference (PAC09), Vancouver, 2009.

Associated Partner: GANIL, France	
General description	Heavy ion accelerator with experience in secondary beam production from Spiral and a new project, complementary to HIE-ISOLDE, for radioactive ion beam production, Spiral 2
Role	Contributions to the ITN include secondments to GANIL in the field beam instrumentation, radiation protection, multi charge breeding and ion beam transport of radioactive ions.
Key competences and facilities	The SPIRAL2 project is based on a multi-beam driver in order to allow both ISOL and low-energy in-flight techniques to produce radioactive ion beams.
Key persons	Dr. Pierre Delahaye, Senior Physicist with experience in beam transport and beam cooling techniques.
Previous training programs and research	Recent publications: 1. About the production rates and the activation of the uranium carbide target for SPIRAL2, M. Fadil and B. Rannou, Nucl. Instrum. Meth. B *266* (2008) 4318-4321 2. Development of a surface ionisation source for the production of radioactive ion beams in SPIRAL, C. Eléon et al., Nucl. Instrum. Meth. B *266*(2008) 4362-4367 3. Neutron yield from carbon,light-and heavy-water thick targetsirradiated by 40MeV deuterons. G. Lhersonneau et al. Nucl. Instrum. Meth. A *603* (2009) 228-235

Associated Partner: Istituto Nazionale di Fisica Nucleare (INFN), Laboratori Nazionali di Legnaro (LNL), Italy	
General description	National laboratory specialized in nuclear research. LNL has a close collaboration with CERN-ISOLDE especially concerning the SPES project.
Role	Due to the advancement of their project, INFN is in an excellent position to provide in-situ training in the target and ion source group and the operation of an identical spectrometer. Other possibilities include the thermal analysis and finite element simulation codes and Superconducting cavity development.
Key competences and facilities	The Project SPES (Selective production of exotic nuclei) aims at the full design of a facility based on a 100 MeV, 1–30 mA CW proton Linac used for production of fission fragments. Neutron rich ion species are extracted, selected, further ionized at high charge state, isotopically purified and then accelerated through a superconducting Linac at energies up to 20 MeV/A.
Key persons	Gianfranco Prete SPES Project Leader
Previous training programs and research	Recent publications: 1. The radioactive ion beam facility project for the Legnaro Laboratories. L.B. Tecchio, PAC99 conference proceedings, 1999 2. Project of an Advanced ISOL Facility for Exotic Beams at LNL, L.B. Tecchio et al. RNB 2000 conference proceedings, 2000

Associated Partner: Max Planck Institute, MPI Heidelberg, Germany	
General description	The MPI-Heidelberg specializes in astro-particle physics and quantum dynamics.
Role	Opportunities for the ITN include secondments to Heidelberg and lectures at CERN from visiting scientists.
Key competences and facilities	MPI-Heidelberg is a key stake holder within the ISOLDE Collaboration by participating in the future developments of the facility with a means to providing improved beam quality for their experiments. It has shown a keen interest in all magnet design both for post accelerator upgrade and improved resolution of the separator magnets.

Key persons	Dr K. Blaum, Institute Director, Member of the ISOLDE Collaboration Committee
Previous training programs and research	Recent publications: 1. K. Blaum, High-accuracy mass spectrometry with stored ions, Physics Reports (2006), Vol. 75, 1-78. 2. D. Neidherr et al. Discovery of 229Rn and the Structure of the Heaviest Rn and Ra Isotopes from Penning Trap Mass Measurements, Physical Review Letters (2009), Vol. 102, 112501. 3. G. Eitel et al. Position-sensitive ion detection in precision Penning trap mass spectrometry, Nuclear Instruments and Methods A (2009), Vol. 606, 475-483.

Associated Partner: Michigan State University (MSU) National Superconducting Cyclotron Laboratory, USA	
General description	National Superconducting Cyclotron Laboratory (NSCL) operates two superconducting cyclotrons and is a world leader in rare isotope research and nuclear science education.
Role	ESR secondments
Key competences and facilities	Experienced in superconducting cavities and a key player in electron beam ion source developments
Key persons	C. Konrad Gelbke
Previous training programs and research	Recent Publications: 1. S. Schwarz, G. Bollen, M. Kostin, F. Marti, P. Zavodszky, J. R. Crespo Lopez-Urrutia, J. Dilling, O. Kester 'A high-current electron beam ion trap as a charge breeder for the reacceleration of rare isotopes at the NSCL', Rev Scient Instr 79 (2008) 02A706 2. S. Schwarz, G. Bollen, J.R. Crespo Lopez-Urrutia, J. Dilling, M. Johnson, O. Kester, M. Kostin, F. Marti, C. Wilson, P. Zavodszky 'An electron beam ion trap for the NSCL reaccelerator', Nucl Instr Methods B 266 (2008) 4466–4470 3. S. Schwarz, G. Bollen, M. Johnson, O. Kester, M. Kostin, J. Ottarson, M. Portillo, C. Wilson, J. R. Crespo Lopez-Urrutia, J. Dilling 'The NSCL EBIT for the reacceleration of rare isotopes coming to life: First extraction tests with a high-current electron gun', Rev Scient Instr xx (accepted for publication, Proc of ICIS'09)

Associated Partner: Scientific Magnetics, UK	
General description	Industry specializing in the fabrication of super conducting magnets
Role	Secondment in training for SC magnet development
Key competences and facilities	Specialist in superconducting magnets and cryogenics
Key persons	Dr Peter Penfold
Previous training programs and research	Publications: 1. Testing and Final Construction of the Superconducting Magnet for the Alpha Magnetic Spectrometer Stephen Harrison et al ,2008 2. High Temperature Superconducting Magnets for use in Electron Cyclotron Resonance Ion Sources Stephen Harrison, 2004

Associated Partner: SDMS, France	
General description	Industry specializing in cryogenics systems, HF power components including SC accelerating cavities
Role	Training of ESRs in design and fabrication processes of SC cavities
Key competences and facilities	**Cryogenic Systems**: cryostats, cryotanks, Dewars, cryopumps, cryomodules, cryogenic valves boxes, cryogenic transfer lines, siphons and transfert pipes, HTS current leads, cold neutron sources, thermal shields and shrouds, cryogenic

	electrovalves.
Key persons	Dr. Pierre Maccioni
Previous training programs and research	**Instruments for Nuclear Physics and Particles**: CEA (DEN & DSM), IRSN, CERN, GANIL, CNRS (IPNO, LAL, LULI, LAPP, LPSC, etc.), US LABS... Publications 1. P. Maccioni et al. "Recent UHV Realizations for Large Scientific Instruments at SDMS", SFV Workshop (French Vacuum Society), Grenoble (F) 2008 2. E. Rousset et al., "Passive Active Multifunction RF launcher for TORE SUPRA long pulse experiments", SOFT Conference (Symposium On Fusion Technology), Rostock (D) 2008 3. P. Maccioni et al., "Design and Realization of RF Accelerating Cavities and Spatial Simulation Chambers at SDMS", SVF Workshop, Marseille (F) 2009

Associated Partner: SIDEA, Italy	
General description	Industry specializing in electronics and programming
Role	Training in LabView RT control systems and secondment
Key competences and facilities	Development of data acquisition and control systems for the scientific environment all around the world. NI Certified Alliance Partner with particular reference to the activities concerning the "Big Physics" area
Key persons	Dr. Marco Mauri
Previous training programs and research	The infrastructure comprises a fully equipped laboratory to design and test control systems providing expertise, tutoring and training in control systems for accelerators, timing and synchronization, beam diagnostic, power supplies, RF engineering.

Associated Partner: JYFL-Jyvaskyla, Finland	
General description	The Finnish Centre of Excellence in Nuclear and Accelerator Based Physics
Role	Secondments offered especially in the field of beam quality where JYFL and ISOLDE have already worked together on RFQ Cooler development and magnet design.
Key competences and facilities	JYFL has an excellent track record in the development of RFQ Coolers, beam transport, target and ion source development and mass separation
Key persons	Dr. Ari Jokinen ISOLDE Collaboration Committee representative for Finland
Previous training programs and research	Publications 1. Development of a carbon-cluster ion source for JYFLTRAP, V.-V. Elomaa et al. Nuclear Instrument and Methods in Physics Research B 266 (2008) 4425-4428 2. Ultra-high resolution mass separator - Application to detection of nuclear weapons tests, K. Peräjärvi et al. Applied Radiation and Isotopes (2009) 3. Beam cooler for low-energy radioactive ions, A. Nieminen et al. 4. Nuclear Instruments and Methods A 469 (2001) 244

Associated Partner: ZANON, Italy	
General description	The company manufactures equipment for Conventional and Nuclear Power Stations and also for Physics Research Institutes
Role	Training of ESRs in cavity design and manufacturing processes
Key competences and facilities	The company is highly specialized in the manufacturing of components for UHV (Ultra High Vacuum) and it has experience in specialized fields such as Cryostats and RF Cavities for superconducting and non-superconducting applications
Key persons	Ettore Zanon
Previous training programs and research	Publications 1. Test Results of The LANL 350 MHz, Beta=0.175, 2-Gap Spoke Resonator, T. Tajima et al., in Proc. of LINAC 2002, Gyeongju, Korea

B.5.2 Work Plan, Deliverables, Milestones and the Schedule

The work plan covers the nine research training themes described in detail in sections 2 and 3.

B.5.2.1 Project Deliverables and Milestones

Figure 1 provides an indicative overview of the work plan, the milestones and the deliverables for the proposed research training described in the preceding sections. The specific training, conferences and workshops will take place across the whole duration of the contract period with the bulk of specific training taking place within the first year. Internship dates with industry and associated partners are indicative and are subject to change.

Please note that, although the timescales for the research training projects show them running from month 1 through to month 36 but due to staggered starting dates we expect the ITN project activities to run throughout the full 4-year funding span.

Figure 1 Indicative work plan overview for the 9 research training themes
D denotes 'deliverable'; M denotes 'milestone'

			1st ESR or ER year (months) 3 6 9 12	2nd ESR or ER year (months 15 18 21 24	3rd ESR or ER year (months) 27 30 33 36
		RESEARCH TRAINING THEME & TASK DESCRIPTION			
	M01	Kick-off meeting of Management Committee.			
	M02	First ESR appointment			
	M03	Complete selection and recruitment of all ESR s			
	D01	First progress report (management)			
	D02	First periodic report (management)			
	D03	Second progress report (management)			
	D04	Second periodic report (management)			month 48 >
	D05	Final project report (management)			month 48 >
1		*Theme 1: SC cavity design & tests*			
1.1		*Cavity development*			
	M04	Conceptual design and specifications			
	D06	Participating in the sputtering processes			
	D07	Final report on cavity test results			
		Internship to industry			
1.2		*LLRF system (ER)*			
	M05	Conceptual design and specifications			
	D08	Operational prototype of low level RF system			
	D09	Final report on test results			
		Internship to IPN-Orsay			
1.3		*Cavity and cryomodules test*			
	M06	Conceptual design and specifications for QWRs			
	M07	Cold test of QWR cavity prototype			
	M08	procedures and recording of test results			
		Internship in industry and associated partners			
	D10	Reports and publications			
2		*Theme 2: Beam instrumentation development*			
2.1		*Beam instruments (ER)*			
	D11	Conceptual design			
	D12	Commissioning procedures			
		Internship			
2.2		*Solid state detectors*			
	D13	Conceptual design & specifications			
	M09	Prototyping and tests			
	D14	Publication			
		Internship			

3		*Theme 3: Transfer Line magnets*
	M10	Identification of requirements report
	D15	Conceptual design of beam line magnets
	D16	Technical specifications
	M11	Commissioning of magnets
		Internship (Cockcroft Institute)
4		*Theme 4: Integration studies and alignment*
4.1		*Integration studies*
	M12	Identification of equipment and infrastructure
	M13	CAD of integration studies
	D17	Final report and documentation
		Internship
4.2		*Innovative alignment method*
	M14	Requirements for BCAM tests
	M15	Modifications
	D18	Commissioning procedures
	M16	Alignment of SC Linac
		Internship
5		*Theme 5: Line commissioning*
	D19	Commissioning schedule, specifications
	M17	First tests with beam
	M18	Full scale test
	D20	Commissioning report
		Internship
6		*Theme 6: ISOL Targets & FE's upgrades*
6.1		*Target material development*
	M19	Identification of materials
	M20	Off-line studies of materials
	M21	On-line studies of materials
	D21	Post analysis and publication
		Internship
6.2		*Target conceptual design*
	D22	Simulations on target fatigue
	M22	Post irradiation analysis
	M23	Off-line studies
	M24	On-line studies
	D23	Final report
		Internship
6.3		*Target conceptual design (simulations)*
	M25	Simulation of present layout
	M26	Design of new target
	M27	Design of shielding layout
	D24	Safety file & risk analysis
	M28	Validation
	D25	Final report
		Internship to GANIL
6.4		*Extraction optics and Front End design*
	M29	Identification of requirements for project
	D26	Functional specifications
	D27	Conceptual design, risk analysis and safety file
6.5		*Low level controls*
	M30	Control system functional specifications
	M31	Front-end control system design study
	M32	HSR magnet control system design study
	D28	Report on front-end and HSR magnet specs
	D29	Prototype of front-end control system
	D30	Simulator of the HSR magnetic field
	D31	Prototype of the HSR magnet control system
		Internship of 3 months at SEDEA

7		*Theme 7: ISOLDE target area upgrade*
7.1		*Vacuum developments*
	D32	Report on existing facilities
	D33	Design report on HIE-ISOLDE upgrade
	M33	Call for tender documents
		Internship
7.2		*Cooling and ventilation*
	M34	Identification of vacuum requirements
	D34	Engineering study of upgrade
	M35	Prototype testing
	D35	Gas recuperation design report
		Internship
8		*Theme 8: Radioactive ion beams quality upgrade*
8.1		*Off-line separator and HRS magnet*
	D36	Off-line separator specifications
	M36	Assembly and commissioning
	D37	Design report for HRS magnet
	D38	Specifications for HRS magnet
		Internship
8.2		*RFQ Cooler and Pre-separator*
	D39	RFQBC design report
	D40	Pre-mass separator design report
	M37	Prototype testing
	D41	Publication
		Internship
8.3		*Charge breeder replacement (ER)*
	M38	Evaluation of requirements
	M39	Magnet configuration and EB design
	D42	Mass separator design
	D43	Final report
	M40	Cathode test bench
	D44	Reports on test results
		Internship to NSCL-MSU
9		*Theme 9: Safety & radiation protection (ER)*
	M41	Comparison of different codes
	M42	Beam loss estimations
	M43	X-ray emission of RF cavities
	D45	Post accelerator shielding design
	M44	Incurred radiationlevel for maintenance
	D46	Waste disposal and inventory
		Internship to GANIL

B.5.3 Private Sector Involvement

B.5.3.1 Involvement of Industry in the Superconducting Linac Development

The major role of the associated industries is to provide training to the ESRs in the form of secondments at the various industries. Scientific Magnetics, SDMS, CINEL and Zanon will specifically provide training in cryogenic systems and superconducting solenoids, a key technological domain for the success of the HIE-ISOLDE project, as well as design and manufacturing processes. The enclosed letters of intent include a commitment by the industrial partners to provide an internship for a period of 1 to 6 months.

B.5.3.2 Involvement of Industry in the Design Study for the Future Upgrade in Intensity

Apart from the training prospects in Labview programming for the low level controls provided by SEDEA, all other involvement of industry within the design study will be through contacts with non-associated industries. This will include contacts with manufacturers of warm magnets for the high resolution separator, the vacuum industry, the cooling and ventilation industry and manufacturers specialized in the production of prototype equipment. The ESRs will be expected to inform themselves of the latest available technologies in the pursuit of finalizing the study report. There will also be contacts with suppliers of pure materials for the testing and benchmarking of potential target materials

B.5.4 Complementarities and Synergy among the Partners

The tables within B5.1 highlight the key competences of CERN and the associate partners. All associated partners have a strong connection to the ISOLDE Collaboration either as members or as users within the physics community. Furthermore, the recent FP6 EURISOL Design Study has reinforced these collaborations. One excellent example was the recent successful target test at TRIUMF, Vancouver of an aluminium oxide target developed at ISOLDE to withstand up to 30 microamperes of proton beam intensity.

Concerning beam quality, the ESR will gain invaluable experience during their secondment at Jyvaskula which has an excellent reputation in beam transport and purification. Also, the Department of Energy (DOE) Office of Nuclear Physics, USA, has recently approved funding for the research proposal entitled “Efficient and fast EBIT charge breeder for intense rare isotope beams” of which MSU and ISOLDE are key collaborators. The ESR associated with the design study of a replacement charge breeder for REXEBIS can only benefit from this endorsed collaboration.

B.5.5 Other Third Country Participation

The two Other Third Country participants are Michigan State University (MSU), USA, and TRIUMF, Canada. Both participants have an excellent track record in the parallel fields associated with the HIE-ISOLDE project. These include charge breeding, high power targets, mass spectrometry and superconducting cavities. A constructive collaboration agreement already exists between CERN and the two participants where there is an open sharing of knowledge and to some extent a healthy competitively in future developments. Furthermore, the excellent facilities and specialized equipment available at both institutes are a great asset for prototype development and training.

B.5.6 Plans for the overall Management of the Training Programme

B.5.6.1 Organizational Management of the ITN

The organisational structure of this ITN project will be based on the corresponding management structure of successful FP6 RTN projects, in which CERN has participated, taking into account the specific requirements of the new ITN scheme. The management of the ITN project and the role and responsibilities of each body is described in Table 5. The monitoring and follow-up of the research training programme is the sole responsibility of the Supervisory Board and Management Committee as mentioned in section B.4.5.

Table 5 ***Roles and responsibilities in the ITN Management***

	Membership	Role
Supervisory Board	Project Co-ordinator as Chairperson, the Chair of the Marie Curie Selection Committee, and the Head of the HR Recruitment, Programmes & Monitoring Group of CERN. One representative from each Associated Partner will be welcome to attend. The Supervisory Board will have a kick off meeting, with a follow up meeting after 6 months, and annual meetings thereafter.	• Approving and overseeing implementation of the training programme for scientific, technical and complementary skills, and co-ordination of the network-wide training activities; • monitoring and evaluating overall progress of the research training programme; • ensuring exchange of best training practice with the associated partners, in particular with the industrial partners.

Management Committee	Project Co-ordinator and the individual Work Package Leaders. It will have regular meetings at least every 6 months, or more frequently if required. Representative of the Associated Partners will be invited to attend.	• overall management of the research programme; • implementation of the training activities with the associated partners; • management and follow-up of the progress of the individual research projects; • organization of network-wide training (courses, workshops, summer schools); • overview of the integration of the Researchers into the research team(s); • review of the Personal Career Development Plans; • dissemination of best practices and project results.
Project Coordinator	The Project Coordinator will be a senior applied scientist/engineer from CERN's Engineering Department. The project Coordinator will have appropriate career experience in the domains of nuclear physics and accelerator science and technology.	• coordination of the ITN research training programme; • organizing and chairing the Management Committee meetings; • communication to/from the associated partners; • communication and reporting to the European Commission.
Selection Committee	The CERN Marie Curie Selection Committee will comprise the coordinators of all Marie Curie projects at CERN and representatives of all CERN departments. It is chaired by a senior CERN physicist. Meetings of the Selection Committee will be scheduled according to the ITN selection rounds. ITN Work Package Leaders will be invited as required.	• selection and appointment of the Researchers; • monitoring of gender balance and equal opportunities.

Rules for decision-making (in the ITN)

The executive decisions for the implementation of the research training programme will be taken by the Management Committee. Any changes in the research and/or training programme will have to be approved by the Supervisory Board. Where such changes may have impact on the contractual obligations of the ITN, the EC Project Officer in charge of the ITN will be informed in due course.

Conflict resolution

The Marie Curie Steering Committee chairperson and the HR Coordinator in charge of the specific project, with input from the researcher and the supervisor, will intervene to solve disputes amicably. In case amicable settlement cannot be reached, disputes will be settled in accordance with CERN's arbitration procedure as laid down in the Organization's Staff Rules and Regulations.

B.5.6.2 Financial Management

The financial management will be centralized in CERN's Budget Planning Group which will take responsibility for creation of budget codes and all necessary monitoring tools as well as other formal financial arrangements; the Group works in very close collaboration with the HR Department. Expenditure for each Researcher is monitored closely according to expenditure type in order to ensure compliance with the relevant ceilings and rules of the Commission.

B.5.6.3 Management of Intellectual Property Rights

The general rules for access, use and dissemination of Intellectual Property, defined in the FP7 Rules for Participation, will be applicable to this ITN project.

Non-disclosure agreements may be required by industrial partners (be they formally associated ITN partners or not) and/or some of the associated technology institutes before granting access to detailed information about their research work or proprietary technologies, or for example to govern the publication of comparative performance figures measured for different commercial equipment or technologies. In order to ensure that the IP rights and policies of all partners are respected agreements between the ITN and some of the industrial associated partners may need to be established early in the work programme; that concerns in particular results which may have industrial or commercial applications.

As a beneficiary of an ITN Grant, CERN will ensure that the project results be disseminated as swiftly as possible. Nonetheless, the dissemination activities shall be compatible with the protection of intellectual property of the associated partners involved.

B.5.7 Recruitment Strategy

Introduction - Charter and Code of Researchers

CERN recognises the value of all forms of mobility as a means for enhancing the professional development of researchers and considers that the mobility of researchers is one of the strengths of the international research organizations, where international recruitment and/or mobility, on the basis of excellence, is part of their mission. On 15 November 2006, the Directors-General of CERN and the other six large European Intergovernmental research organizations (EFDA, EMBL, ESA, ESO, ESRF and ILL) signed a Statement of Support to the European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers, adopted by the European Commission.

The CERN recruitment policy, employment conditions, and staff career development prospects are in good compliance with the guidelines of the Charter and the Code, and most of the recommendations contained therein are effectively implemented and part of internal practice. This concerns in particular the recommendations on non-discrimination, gender balance, research environment, funding and salaries, continuous training, evaluation and appraisal systems, complaints and appeals, supervision, working conditions, and career development.

Advertisement of Marie Curie positions:

All positions will be advertised on the specially-created project web site, EURAXESS, the CERN electronic recruitment tool e-RT as well as via networks inside the project and its partners. At CERN an extensively-used web-site contains information about possible Marie Curie Actions for which there are openings at CERN. In 2004, following the introduction of the electronic recruitment system e-RT, 19,000 applications to all CERN recruitment programmes were submitted by ~7000 candidates.

CERN participates in many career fairs, exhibitions, visits to technical schools, colleges, universities and job centres, with presentations, posters and brochures. Information on the Marie Curie Initial Training Network programme is a specific part of these presentations.

B.5.7.1 How Researchers will be selected

Applicants will submit their applications via CERN's electronic recruitment system e-RT and, following screening of applications by the HR Department, will undergo rigorous selection on grounds of quality and potential, as well as a matching of their scientific profile with the job specification. Assessment is made according to academic qualifications, experience, achievements, and other elements including language knowledge, mobility and volunteer work. Candidates may be invited to meet their potential supervisors, but the final selection is under the responsibility of the Selection Committee which makes appointments under the auspices of the HR Department to ensure correct application of the rules and criteria.

The HR Department acts as guarantor for the fair and uniform application of CERN policies, in particular with regard to gender balance and related equal opportunities issues. The chairperson of the Marie Curie Selection Committee guarantees the scientific quality of appointed Researchers.

Given that the planned individual research projects for the ESRs are expected to require 3-year appointments the aim will be to recruit all of them within the first year of operation of the ITN. Furthermore, considering that there are few significant interdependencies between the individual ESR projects that would impose a specific sequence of recruitment, all Fellowships will be advertised as soon as the proposed ITN is approved, and each individual Fellowship will be filled as soon as a suitable, high-quality candidate is identified. To ensure quality the advertisement of posts and the timetable of the selection committee meetings will be adjusted as necessary so that recruitment for each individual research project is made from an adequate pool of applicants. To this same end the vacancy notices for ESR and ER Fellowships will remain open for a minimum of 4 weeks. Experience with recruitment of ESTs for Marie Curie projects at CERN has shown that in practice this method results in individual appointment starting dates being distributed reasonably evenly across the first year of the project.

B.5.7.2 Strategy to encourage an Equitable Gender Balance

Recent surveys have shown that female students and scientists are under-represented in many engineering and scientific fields. Particle Physics is one of these fields. In the present project, the promotion of gender balance in will be addressed through several lines of actions, such as:

- encouraging applications from female individuals at all levels within the ITN.
- inviting female Researchers to deliver talks at the annual workshops and topical meetings, organized by the ITN.

Since 1993 CERN has been actively applying its strong Equal Opportunities (EO) policy. With emphasis initially placed on recruitment and gender-related issues, activities have now broadened to include other EO issues such as dignity and respect, life-work balance, culture, age and gender diversity. With the aim of increasing the number of women coming into and retaining them in the field of particle physics, CERN has also been an active member of the FP6 initiative SET-Routes and has introduced new courses in its internal Management & Communication curriculum which specifically address issues of women in management.

To minimise gender bias and achieve a broader perspective in the approach to work, statutory working groups and selection boards at CERN are required to include women and this is also the case for the Marie Curie Selection Committee. In addition, potential supervisors will be asked to pay particular attention to female candidates when applications are circulated.

To improve female participation in all job categories and at all levels, gender distribution is monitored and statistics are published annually (experience has shown the absence of any gender bias at the selection level). In training lectures and seminars, particular attention is paid to choosing, whenever possible, women scientists as speakers in order to provide positive role models to young female scientists.

B.5.8 Networking, Dissemination of Best Practices, clarity of Plans for Training Events, and Dissemination of Results

B.5.8.1 Networking

By the very nature of the large, international scientific collaborations at CERN, all Researchers will be immersed in a pool of *networking* possibilities. Whether it be via inter-team meetings or via collaboration meetings and international conferences, the Researchers will have excellent networking opportunities both in CERN's areas of activity and with the industrial partners involved in the ITN.

B.5.8.2 Dissemination of Best Practices

Upon arrival at CERN, training starts on day one: all Researchers receive an *induction briefing* session on issues regarding CERN administration related to the Marie Curie project. In addition to this, the CERN managers are well used to setting objectives for newcomer staff, so this is particularly useful when drawing up the compulsory Career Development Plan with the Researcher.

Looking towards the end of the Researcher's contract: as a contribution to CERN's plans for best HR practices, the HR Department asks Researchers to fill in an exit questionnaire and is working on an *Alumni project* to keep in touch with former employees - this would be used in the compulsory follow-up of Researchers who have been at CERN on all of the Framework Programme projects.

B.5.8.3 Dissemination of Results

The Management Committee will stimulate the Early Stage Researchers to submit the publications, resulting from the project, to open access repositories and journals, in line with the recommendations of the EC on open access to scientific information. Similarly, the Management Committee will stimulate the ESRs to make workshop and conference talks and presentations. In particular, the Early Stage Researchers involved in this ITN will present their results and receive feedback at the annual ISOLDE Workshop and other workshops organized by the associated partners. Conference presentations will be expected at IoP Nuclear Physics, EMIS, EURORIB and RNB-ENAM where the progress on the HIE-ISOLDE project is eagerly awaited by the international community.

The different mechanisms described above give the young Researchers ample opportunity to hone their skills in writing or making presentations. Project web sites will also be used to disseminate information on the project in so far as industrial / confidentiality clauses allow. The location of HIE-ISOLDE at CERN will allow young Researchers to tap into ongoing high profile public engagement work there, much of which is already heavily supported by the CERN Press Office and Visits Service. There is a large footfall of visitors who could include a tour of HIE-ISOLDE during their visit. HIE-ISOLDE is readily accessible and is on a more human scale than many of the accelerators at CERN and will give visitors a better sense of how accelerators work if accompanied by suitable supporting materials.

B.6 IMPACT

B.6.1 Contributions to the Improvement of Career Prospects

To aid young scientists in their transition from university education to independent research, the CATHI proposal is providing specialized training and supervision from leading nuclear physics experts along with hands-on experience of frontier research projects at CERN’s ISOLDE facility.

Within this mono-site and international network, researchers are exposed to a wide range of specialised disciplines, such as electronics, accelerator technology, software development and simulation, enabling their knowledge to be extended and enriched. In addition, complementary training courses are available on informatics, languages, academic subjects, management and communication (see section B4: Training). The knowledge and skills acquired can give researchers an unprecedented boost, whether they pursue careers in the public and private sectors.

Young scientists and engineers trained within CATHI will be called upon to contribute to advances in accelerator science and technology throughout Europe. Since superconducting linear acceleration is also the preferred technology for several other international projects, investment in this technology would allow the trained researcher to play a key role in these future facilities.

CERN has a partly industrial environment and collaborates with industry in all of the domains covered by this proposal. It has a large number of joint projects and contracts with industrial firms, and has many links to commercial enterprises in the 20 member states. Due to the multidisciplinary nature of the research projects to which they will contribute, and to the personal contacts with industry, the ITN researchers will acquire experience in working and communicating across disciplines and sectors. Many early stage researchers are thus expected to seek employment in industry after completing their fellowships, often specializing in different disciplines.

An illustration of the latter point, data collected by the OPAL experiment at CERN shows that about half of their PhD students found employment in industry immediately following completion of their doctoral studies. This is typical of many high-energy physics experiments. As far as the CATHI proposal is concerned, the ISOLDE Collaboration at CERN has a long standing tradition in training young researchers from around Europe. During the last 5 years alone, close to 20 PhD theses based on work performed at ISOLDE have been defended.

Several European companies have expressed interested in participating at some level in this project. SDMS is already involved in bulk-niobium superconducting cavity fabrication and would like to acquire the technology related to niobium-sputtered copper cavities. Opportunities exist for several other manufacturers to acquire the necessary capabilities to build the components of the cryomodules - superconducting solenoids, cryogenics.

To summarize, the ESRs will receive high-quality technical, organizational, management and communication training, which will significantly benefit them and their future employers. By collaborating with established world-renowned scientists and presenting their results in high-level conferences, the researchers' work will become internationally visible, maximizing their career opportunities. With such a background, the young researchers will find it natural in their future work to profit from and set up links among research teams from all over the world. Their career prospects in both the public and the private sectors will be improved by the broadening of their scientific and generic skills, and by their enhanced mobility and adaptability due to exposure to an international, inter-sectorial and multi-disciplinary environment.

B.6.2 Contribution to the Policy Objective of Structuring Initial Research Training Capacity at the European level

CATHI will work towards a more co-ordinated approach to research training at an international level, and foster mutual recognition of training modules.

The early stage trainees will be part of a multidisciplinary, international collaboration involving other young postgraduates from different countries, as well as several research institutions and/or universities across Europe and North America (US, Canada). Some of the training will take place in collaborating universities or research laboratories, in both the public and private sectors. The active links with colleagues from other countries will enhance the European dimension of the training, and provide momentum to a more coordinated approach to research training.

CATHI institutes have extensive experience in running Doctoral Student programmes in very close collaboration with other universities/institutes, in addition to hosting a large number of PhD students funded by national agencies. Through these, and the large number of trainees supported through current Marie Curie projects in which some members of the network were involved (CERN, GANIL, INFN, CNRS, Max Planck Institute), the partners contribute significantly to encouraging synergies and structuring effects, and actively foster the mutual recognition of training and mobility. This will continue and will be further developed under the present action.

CATHI researchers in the field of superconducting cavity development, will profit from the set-up at CERN of a state-of-the-art test stand facility to measure and characterize new niobium-coated cavities, to qualify new Low-Level Radio Frequency control systems and to perform mechanical studies under cryogenic conditions. This facility could also serve other European or International projects like SPIRAL2, EURISOL, ESS and FAIR.

Potential for establishing long-term collaborations and lasting structured training programmes.

Radioactive beams, for which ISOLDE was a precursor, have transformed the landscape of low energy Nuclear Physics and several new (SPES at INFN-LNL) or upgraded facilities (HIE-ISOLDE at CERN and SPIRAL2 at GANIL) are currently being constructed or discussed. All three European ISOL facilities, and as well as FAIR will be necessary to cover the broad physics programme laid out for radioactive beams in the next decade and the needs of the community. This has been recognized in the long range plan of NuPECC, in which HIE-ISOLDE is cited as an essential "intermediate generation" facility on the path to EURISOL.

Individual researchers will be involved in a large spectrum of research activities, spanning from cryogenics, RF, beam dynamics, cavity fabrication, control systems, target/ion source development, and UHV technology, carried out via joint projects with industrial and academic institutions. Through the network's existence, they will have access to an outstanding range of expertise and infrastructure, and will be part of forefront R&D activities at an international level. Having profited from the numerous advantages and having appreciated the value of such international collaborations, they are likely to use this approach in their future research projects.

The mobility of young researchers and visiting scientists within the ITN will reinforce the longer-term collaboration between the partners, who will profit not only from cross-fertilization between sectors, but also from synergies and the pooling of resources between partners with similar research goals.

The necessary research and development, prototyping, construction, installation and commissioning will be carried out at CERN in close collaboration with the associated partners listed in B1. Those partners have a wealth of skills, recently applied within the ERLP/ALICE and EMMA projects (Cockroft Institute), ALPI (INFN-Legnaro), SPIRAL2 at GANIL and ISAC2 (TRIUMF), which are well matched to the requirements of the CATHI proposal.

B.6.3 Contribution to the Policy Objective of Enhancing Public-Private Sector Collaborations in Terms of Research Training

The participation of industrial partners in this training network is essential, since the development of accelerator components and infrastructures for HIE-ISOLDE relies on close collaboration with competent companies, and a mutual understanding of the requirements and constraints. There will be research opportunities in beam dynamics, SC cavity and cryomodule design and fabrication, low-level RF control system and beam diagnostics, target material development, fostering the emergence of new technologies and products.

In North America, both the ISAC2 facility at TRIUMF (which has recently started operation with a restricted range of radioisotopes developed as beams) and the Holifield Radioactive Ion Beam Facility at Oak Ridge have plans to upgrade their RIB capability to include intense photofission production. Additionally, funding opportunities have been announced for the Facility for Rare Isotope Beams (NSCL-MSU), of comparable physics reach to EURISOL. There is a clear opportunity for the European initiatives to lead in this area and by participating in CATHI the industrial partners can play a central role in European ISOL strategy.

By developing expertise in SC linear accelerator technology, the industrial partners would be in an excellent position to play a role in the replacement of CERN's injector chain of accelerators scheduled for the next decade. For facility developments beyond the middle of the next decade, the EU Design Study for EURISOL has carried out the R&D necessary to overcome the most technologically demanding challenges presented by this third-generation ISOL source, as well as a conceptual study for neutrino beta-beam production. CATHI associated institutional partners played leading roles in this Design Study. Since the EURISOL post-accelerator will be superconducting, investment in SC technology will allow the industrial partners to play a key role in this future facility and in other RIB devices, such as the beta-beam decay ring that requires RIB injection. The construction of a high-power proton driver at CERN would allow the HIE-ISOLDE facility to evolve towards EURISOL during 2015-2020.

The following list illustrates the potential market for European industry following technology transfer from this project. Specific examples are:

CERN SPL (project timescale:2018, potential market for cavities, LLRF, Diagnostics: €195M)
The situation to date is that Daresbury will design and prototype the RF distribution system and the collimation system for both LINAC4 (the low energy injector) and the 4 GeV Superconducting Proton Linac. Companies based in Canada (Vancouver) and France are currently expected to provide cavities and cryomodules respectively. There is an opportunity for European industry to provide the high-β elliptical cavities and the diagnostics units, and there may be an opportunity for EU cryogenics manufacturers to provide for these too. Construction of SPL components could form the basis for negotiations for in-kind contributions to CERN.

EURISOL (project timescale:2020, potential market for cavities, LLRF, Diagnostics: €440M)
In accelerator technology, high-gradient niobium-sputtered cavities are likely to be adopted for the 1 GeV driver and the 150 MeV/u post accelerator of EURISOL. As far as the strategy in nuclear physics is concerned, it should be remarked that NuPECC has recommended that both EURISOL *and* FAIR are the highest priorities for European nuclear physics. As CERN is likely to go ahead with the SPL in the next decade, HIE-ISOLDE is well placed to be a central component of the first phase of EURISOL, i.e. post-acceleration of radioactive ion beams using ~100 kW 1 GeV proton beams directly onto ISOLDE targets (upgraded within the HIE-ISOLDE project). The second phase of EURISOL requires a multi-MW mercury converter target for fission production and post-acceleration of RIB to 150 MeV/u.

ESS (project timescale:2015, potential market for cavities, LLRF, Diagnostics: €110M)
The European Spallation Source at Lund (Sweden) will be a SC linac operating at 500, 700 or 1120 MHz. There are opportunities for EU involvement in the cavity technology, which could be considered as in-kind contributions following the negotiations on national contributions.

ADSR (project timescale:2018, potential market for cavities, LLRF, Diagnostics: €220M)

Demonstrators for accelerator-driven sub-critical reaction systems require ~600 MeV proton beams at 1-2 MW, with a particular requirement for ultra-reliability. The MYRRHA project has chosen a linac design employing SC spoke cavities (medium energy) and elliptical cavities (high energy).

IFMIF (project timescale:2010, potential market for cavities, LLRF, Diagnostics: €35M)
The International Fusion Materials Irradiation Facility (IFMIF) consists of two 40 MeV high current D+ accelerators running in parallel. Each accelerator will consist of 24 HWR SC cavities and 17 SC solenoids distributed in 4 cryomodules. Development of the cavities and the cryomodules will be carried out by EU.

Hadron therapy (project timescale:2015, potential market for cavities, LLRF, Diagnostics: €110M)
In order to minimise collateral damage to healthy tissue, proton irradiation is preferable to conventional IMRT, while the use of carbon beams has clinical advantages over proton beams. The accelerator should provide low current beams of 250 MeV p or 450 MeV/u C. It is anticipated that hadron therapy will eventually replace IMRT in all major NHS hospitals, and there is already an immediate market for such facilities world-wide. Candidates for possible accelerating structures include synchrotrons using SC cavities or the use of linac post-accelerators. Cockcroft and John Adams are involved in prototype construction for FFAG devices (EMMA and PAMELA), but these may require injector accelerators such as SC linacs.

Security (project timescale:2011, potential market for cavities, LLRF, Diagnostics: €22M/yr)
Neutron scanning of freight and luggage (to detect, e.g., plastic explosives) at seaports and airports employ low-energy (~few hundred keV) deuteron accelerators to generate neutrons from (d,d) and (d,t) reactions. Applied research in this area, such as that within the EPSRC funded DISTINGUISH project (Liverpool physics, Manchester engineering and Lancaster engineering) has highlighted the need for highly pulsed neutron beams that have good timing (for ToF measurements). The use of linacs of compact design would provide neutron generators of the desired specifications. In addition there is a requirement for compact X-ray linacs utilising copper linac cavities to accelerate electrons to 1-10 MeV. The Cockcroft Institute is currently involved in a UK compact linac prototype. A global market of around 100 units per year is foreseen.

B.6.4 Mutual Recognition of the Training Acquired

All research institutes in the network have a long tradition in hosting masters, diploma and PhD students and several network participants are research institutes with direct links to universities.

The network partners, in particular the large national and international research institutes, have invested significant resources in building up in-house training programmes. Adapted and improved over the years to cover new technologies and newly arising aspects, they contain many elements that are well suited to the needs of young researchers. New courses will be created, partly based on available training modules, in order to specifically meet the requirements of the network.

Following the rules defined for the European Credit Transfer System (ECTS), this ITN plans to implement a system of network-wide credits, in agreement with the universities where PhD students are involved. The researchers participating in network training events will receive certificates about the level, contents and volume of the attended training units that will enable the home university of the student to judge the value of the training and grant the corresponding credit.

Reviews of the training contents by peers external to the network and feedback questionnaires filled by the students, will contribute to assuring training of the highest quality.

Finally, CERN's active links with about 500 institutions around the world provides momentum to a more co-ordinated approach to research training, and to international recognition of the training and qualifications offered.

B.7 ETHICAL ISSUES

None of the issues listed in the "ETHICAL ISSUES TABLE" of the "Guide for Applicants" applies to this proposal.

More generally, CERN's Technology Transfer unit monitors closely any industry collaboration or transfer of technology which might contravene Article II.1 of CERN's Founding Convention, signed on 1st July 1953 and revised on 17th January 1971. This states that *"the Organization shall have no concern with work for military requirements…………".*

ANNEX: Evidence of the Commitment of the Industry Partners

As evidence of the commitment of the industry partners we attach below letters of intent from ZANON (Italy), CINEL (Italy), SDMS (France), SIDEA (Italy) and Scientific Magnetics (UK).

To Whom It May Concern

Letter of Intent

Ref.: Participation in the FP7 Marie Curie Training Network CATHI

I hereby certify that Ettore Zanon s.p.a. intends to participate in the FP7 Initial Training Network CATHI, coordinated by CERN, should the network be selected for funding by the European Commission.

Our company will participate in this ITN as **associated partner** in the following ways:

- A senior staff member of the company will have a seat in the Supervisory Board of the network.
- The company will offer possibilities to accommodate 1 young researchers from the ITN for practical placements of *1* to *3* months. The researchers will receive practical and research training in Super-Conducting cavity construction.
- Members of our staff will deliver training courses to the researchers from the ITN in the fields of Super-Conducting cavity construction. The courses will be delivered at the premises of CERN (and/or the company).

The participation of Ettore Zanon s.p.a. in the research and training programme of the ITN is described in sections [*B3.1*] and [*B4.5*] of the CATHI proposal.

Ettore Zanon s.p.a. will participate in the Marie Curie ITN on the condition that all costs incurred by the company and related to the implementation of practical research and/or complementary training including courses, workshops, secondments and visits, will be reimbursed by CERN (and/or other network participants), where the researchers will be appointed. For this purpose Ettore Zanon s.p.a. shall invoice these research training costs to the full network partner(s) concerned.

Schio (VI-Italy) 14 December 2009

Signed: Ing. Ettore Zanon

signature

Position in the company: President

SDMS
la chaudronnerie blanche®

CERN

CH-1211 GENEVE 23 (Suisse)

For the attention of Mr Yacine KADI

O/Ref. : N° L/8753/9 – PMA/MAP

Subject : **Participation in the FP7 Marie Curie Training Network CATHI**

Saint-Romans, December 15th, 2009

Letter of Intent

I hereby certify that SDMS intends to participate in the FP7 Initial Training Network CATHI, coordinated by CERN, should the network be selected for funding by the European Commission.

Our company will participate in this ITN as **associated partner** in the following ways:

- A senior staff member of the company will have a seat in the Supervisory Board of the network.
- The company will offer possibilities to accommodate 2 young researchers from the ITN for practical placements of *1* to *6* months. The researchers will receive practical and research training in Super-Conducting cavity development and Low-level RF.
- Members of our staff will deliver training courses to the researchers from the ITN in the fields of Super-Conducting cavity RF and Low-level RF. The courses will be delivered at the premises of CERN (and/or the company).

The participation of SDMS in the research and training programme of the ITN is described in sections [*B3.1*] and [*B4.5*] of the CATHI proposal.

.../...

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N° L/8753/9

Page 2

SDMS will participate in the Marie Curie ITN on the condition that all costs incurred by the company and related to the implementation of practical research and/or complementary training including courses, workshops, secondments and visits, will be reimbursed by CERN (and/or other network participants), where the researchers will be appointed. For this purpose SDMS shall invoice these research training costs to the full network partner(s) concerned.

Signed : Dr Pierre H. D. Maccioni, signature

Position in the company : Business Development Vice President

SDMS
D.P. 4 - 38160 ST-ROMANS
TÉL. 04 76 64 ...

SDMS Company recent publications :

- P. MACCIONI et al, "Recent UHV Realizations for Large Scientific Instruments at SDMS", SFV Workshop (French Vacuum Society), Grenoble (F) Mai 2008
- E. ROUSSET et al, "Passive Active Multijunction RF launcher for TORE SUPRA long pulse experiments", SOFT Conference (Symposium On Fusion Technology), Rostock (D) October 2008
- P. MACCIONI et al, "Design and Realization of RF Accelerating Cavities and Spatial Simulation Chambers at SDMS", SFV Workshop (French Vacuum Society), Marseille (F) June 2009

16/12/2009 15:54 0220970113 NUM967 P02

SIDeA

Via Oslavia, 17/19a - 20134 Milano
tel. 0220970097 fax 0220970113

Via S. Rossa, 13 - 35020 Roncaglia di Ponte San Nicolò (PD)
tel. 0498960360 fax 0498969498

e-mail: info@sidea.it
Web site: http://www.sidea.it

SIDeA

Letter of Intent

Ref.: Participation in the FP7 Marie Curie Training Network CATHI

I hereby certify that SIDEA s.r.l. intends to participate in the FP7 Initial Training Network CATHI, coordinated by CERN, should the network be selected for funding by the European Commission.

Our company will participate in this ITN as **associated partner** in the following ways:

- A senior staff member of the company will have a seat in the Supervisory Board of the network.
- The company will offer possibilities to accommodate 1 young researcher from the ITN for practical placements of *3* months. The researcher will receive practical and research training in LabView RT based control systems.
- Members of our staff will deliver training courses to the researchers from the ITN in the fields of LabView. The courses will be delivered at the premises of CERN (and/or the company).

The participation of SIDEA s.r.l. in the research and training programme of the ITN is described in sections [*B3.1*] and [*B4.5*] of the CATHI proposal.

SIDEA s.r.l. will participate in the Marie Curie ITN on the condition that all costs incurred by the company and related to the implementation of practical research and/or complementary training including courses, workshops, secondments and visits, will be reimbursed by CERN (and/or other network participants), where the researchers will be appointed. For this purpose SIDEA s.r.l. shall invoice these research training costs to the full network partner(s) concerned.

Date: 16/12/2009

Signed: Fausto Distante

Position in the company: General Manager

NATIONAL INSTRUMENTS Alliance

SIDeA S.r.l.
Sede Legale: Via Oslavia, 17/19a - 20134 MILANO
C.F. e P. IVA 09816810152 - Capitale sociale 110.000 € i.v. – C.C.I.A.A. n° 1328525 - Reg. Soc. Trib. Milano n° 301077

STRUMENTI SCIENTIFICI CINEL

SINCERT

To Whom It May Concern

Letter of Intent

Ref.: Participation in the FP7 Marie Curie Training Network CATHI

I hereby certify that Strumenti Scientifici CINEL srl intends to participate in the FP7 Initial Training Network CATHI, coordinated by CERN, should the network be selected for funding by the European Commission.
Our company will participate in this ITN as **associated partner** in the following ways:
A senior staff member of the company will have a seat in the Supervisory Board of the network.
The company will offer possibilities to accommodate 1 young researchers from the ITN for practical placements of 1 to 3 months. The researchers
will receive practical and research training in Super-Conducting cavity construction.
Members of our staff will deliver training courses to the researchers from the ITN in the fields of Super-Conducting cavity construction. The courses will be delivered at the premises of CERN (and/or the company).
The participation of Strumenti Scientifici CINEL srl in the research and training programme of the ITN is described in sections [B3.1] and [B4.5] of the CATHI proposal.
Strumenti Scientifici CINEL srl will participate in the Marie Curie ITN on the condition that all costs incurred by the company and related to the implementation of practical research and/or complementary training including courses, workshops, secondments and visits, will be reimbursed by CERN (and/or other network participants), where the researchers will be appointed. For this purpose Strumenti Scientifici CINEL srl shall invoice these research training costs to the full network partner(s) concerned.

Sergio Bongiovanni
legal rapresentative

Bongiovanni

Scientific Magnetics
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Culham
Abingdon
Oxfordshire OX14 3DB
Tel: +44 (0)1865 409200
Fax: +44 (0)1865 409222
info@scientificmagnetics.co.uk

16th December 2009

To Whom It May Concern

Letter of Intent

Ref.: Participation in the FP7 Marie Curie Training Network CATHI

I hereby certify that Scientific Magnetics intends to participate in the FP7 Initial Training Network CATHI, coordinated by CERN, should the network be selected for funding by the European Commission.

Our company will participate in this ITN as **associated partner** in the following ways:

- A senior staff member of the company will have a seat in the Supervisory Board of the network.
- The company will offer possibilities to accommodate 1 young researcher from the ITN for practical placements of *1* to *3* months. The researchers will receive practical and research training in Super-Conducting magnet development
- The participation of Scientific Magnetics in the research and training programme of the ITN is described in sections [*B3.1*] and [*B4.5*] of the CATHI proposal.

Scientific Magnetics will participate in the Marie Curie ITN on the condition that all costs incurred by the company and related to the implementation of practical research and/or complementary training including courses, workshops, secondments and visits, will be reimbursed by CERN (and/or other network participants), where the researchers will be appointed. For this purpose Scientific Magnetics shall invoice these research training costs to the full network partner(s) concerned.

Signed:

Peter N Penfold

Peter N Penfold

Position in the company: Director

Scientific Magnetics is a trading name of Space Cryomagnetics Ltd
Registered in England and Wales Company No. 3950388 Registered for VAT in the UK; VAT number 749 9266 70

ANNEX: Evidence of the Commitment of the Institutional Partners

As evidence of the commitment of the institutional partners we attach below letters of intent from Michigan State University (NSCL, US), LPC-Caen (CNRS/IN2P3, France), University of Jyvaskyla (JYFL, Finland), Max Planck Institute (Heidelberg, Germany), GANIL (France), Cockroft Institute (UK), Legnaro National Laboratory (INFN-Legnaro, Italy) and Institut de Physique Nucleaire d'Orsay (CNRS/IN2P3, France)

MICHIGAN STATE
UNIVERSITY

December 9, 2009

Letter of Intent

Ref.: Participation in the FP7 Marie Curie Training Network CATHI

I hereby certify that National Superconducting Cyclotron Laboratory/MSU intends to participate in the FP7 Initial Training Network CATHI, coordinated by CERN, should the network be selected for funding by the European Commission.

NSCL's participation in this ITN as associated partner could include the following provisions:

- A senior staff member of the institute will have a seat in the Supervisory Board of the network.
- The institute will offer possibilities to accommodate 1 young researcher from the ITN for practical placements of 1 to 3 months. The researcher will receive practical and research training in Electron Beam Design and Ion trapping simulation.
- Members of our staff will deliver training to the researchers from the ITN in the fields of Electron Beam Dynamics. The courses will be delivered at the premises of the institute.

The participation of National Superconducting Cyclotron Laboratory/MSU in the research and training program of the ITN is described in sections [*B3.1*] and [*B4.5*] of the CATHI proposal.

National Superconducting Cyclotron Laboratory/MSU will participate in the Marie Curie ITN on the condition that all costs incurred by the laboratory and related to the implementation of practical research and/or complementary training including courses, workshops, secondments and visits, will be reimbursed by CERN (and/or other network participants), where the researchers will be appointed. For this purpose National Superconducting Cyclotron Laboratory/MSU shall invoice these research training costs to the network partner(s) concerned.

Sincerely,

C. Konrad Gelbke
Director & University Distinguished Professor

NSCL
Dr. Claus-Konrad Gelbke
University Distinguished
Professor and Director
NATIONAL
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[illegible]

To Whom It May Concern

Letter of Intent

RE : Participation in the FP7 Marie Curie Training Network CATHI

I, the undersigned, certify that LPC-Caen (IN2P3/CNRS laboratory – UMR6534) is willing to participate in the FP7 Initial Training Network CATHI, coordinated by CERN, should the network be selected for funding by the European Commission.

Our laboratory will participate in this ITN as an **associated partner** in the following ways:

- A senior member of the laboratory will have a seat on the Supervisory Board of the network.
- The laboratory will offer the possibility of training placements of 1 to 3 months duration to young researchers from the ITN.
- Members of our staff will provide training to the researchers from the ITN in the field of Beam Instrumentation and development.

The participation of LPC-Caen in the research and training programme of the ITN is described in sections [*B3.1*] and [*B4.5*] of the CATHI proposal.

LPC-Caen will participate in the Marie Curie ITN on the condition that all costs incurred by the laboratory related to the implementation of practical research and/or complementary training including courses, workshops, secondments and visits, will be reimbursed by CERN (and/or other network participants), where the researchers will be based. For this purpose LPC-Caen shall invoice these research training costs to the full network partner(s) concerned.

Signed:

C.N.R.S IN2P3 Laboratoire de PHYSIQUE Corpusculaire ENSICAEN

Jean-Claude Steckmeyer
Director LPC-Caen

To Whom It May Concern

Letter of Intent

Ref.: Participation in the FP7 Marie Curie Training Network CATHI

I hereby certify that JYFL-Jyvaskyla intends to participate in the FP7 Initial Training Network CATHI, coordinated by CERN, should the network be selected for funding by the European Commission.

Our company will participate in this ITN as **associated partner** in the following ways:

- A senior staff member of the company will have a seat in the Supervisory Board of the network.
- The company will offer possibilities to accommodate 2 young researchers from the ITN for practical placements of 1 to 3 months. The researchers will receive practical and research training in Injection and Beam Preparation.
- Members of our staff will deliver training courses to the researchers from the ITN in the fields of Injection and Beam Preparation. The courses will be delivered at the premises of CERN (and/or the company).

The participation of JYFL-Jyvaskyla in the research and training programme of the ITN is described in sections [*B3.1*] and [*B4.5*] of the CATHI proposal.

JYFL-Jyvaskyla will participate in the Marie Curie ITN on the condition that all costs incurred by the company and related to the implementation of practical research and/or complementary training including courses, workshops, secondments and visits, will be reimbursed by CERN (and/or other network participants), where the researchers will be appointed. For this purpose JYFL-Jyvaskyla shall invoice these research training costs to the full network partner(s) concerned.

Professor Rauno Julin
Head of the Accelerator Laboratory

Max-Planck-Institut für Kernphysik
Max Planck Institute for Nuclear Physics

MPI für Kernphysik · Postfach 103980 · D69029 Heidelberg

Gespeicherte und gekühlte Ionen
Stored and Cooled Ions
Prof. Dr. Klaus Blaum
Tel: 06221-516 850/1
Fax: 06221-516 852
sekretariat.blaum@mpi-hd.mpg.de

11 December 2009

To Whom It May Concern

Letter of Intent

Ref.: Participation in the FP7 Marie Curie Training Network CATHI

I hereby certify that the Max Planck Institute, Heidelberg intends to participate in the FP7 Initial Training Network CATHI, coordinated by CERN, should the network be selected for funding by the European Commission.

Our research institute will participate in this ITN as **associated partner** in the following ways:

- A senior staff member of the university will have a seat in the Supervisory Board of the network.
- The company will offer possibilities to accommodate 2 young researchers from the ITN for practical placements of *1* to *3* months. The researchers will receive practical and research training in development of beam instrumentation and beam dynamics.
- Members of our staff will deliver training courses to the researchers from the ITN in the fields of beam instrumentation and beam dynamics. The courses will be delivered at the premises of CERN (and/or the company).

The participation of MPI-Heidelberg in the research and training programme of the ITN is described in section [*B3.1*] of the CATHI proposal.

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MAX-PLANCK-GESELLSCHAFT

The Cockcroft Institute
of Accelerator Science and Technology

Daresbury Science and Innovation Campus,
Keckwick Lane, Daresbury, Warrington,
WA4 4AD, Cheshire UK

Office of the
Director
Prof. Dr. Swapan Chattopadhyay, *PhD. (Berkley)*
F Inst P, FAPS, FAAAS
SIR JOHN COCKCROFT CHAIR OF PHYSICS
UNIVERSITIES OF LIVERPOOL, MANCHESTER AND LANCASTER

December 15, 2009

TO:
Marie Curie Grant Administration

REFERENCE: Letter of Intent for Support of CATHI

Dear Sir/Madam:

Please accept this letter as a Statement of Intent from the Cockcroft Institute and its partnering institutions Univ. of Liverpool and Univ. of Manchester in particular, to support the Mary Curie grants application CATHI by CERN.

The Cockcroft Institute has many projects involving cryogenics, superconducting RF, vacuum and targets that will be useful for future EU projects such HIR-ISOLDE at CERN. Our institute is committed to hosting visitors and students and any other activity that is relevant in support of the application. For further information on the mission and capabilities of the Cockcroft Institute, please visit http://www.cockcroft.ac.uk.

I hope this unambiguous letter of support from our institute will enable you to decide in favour of funding this application.

Please do not hesitate to contact me should you need further information.

With my best regards, sincerely yours

Swapan Chattopadhyay

Director, Cockcroft Institute

Tel: +44 (0) 1925 603242 +44 (0) 1925 603820 (PA) Fax: +44 (0) 1925 864303 Mobile: +44 (0) 7796 993898
Email: swapan@cockcroft.ac.uk Website: www.cockcroft.ac.uk

To Whom It May Concern

Letter of Intent

Ref.: Participation in the FP7 Marie Curie Training Network CATHI

I hereby certify that GANIL intends to participate in the FP7 Initial Training Network CATHI, coordinated by CERN, should the network be selected for funding by the European Commission.

Our company will participate in this ITN as **associated partner** in the following ways:

- A senior staff member of the company will have a seat in the Supervisory Board of the network.
- The company will offer possibilities to accommodate 3 young researchers from the ITN for practical placements of *1* to *3* months. The researchers will receive practical and research training in Targets and Ion Sources Development and Safety.
- Members of our staff will deliver training courses to the researchers from the ITN in the fields of Targets/Ion Sources Development and Safety. The courses will be delivered at the premises of CERN (and/or the company).

The participation of GANIL in the research and training programme of the ITN is described in sections [*B3.1*] and [*B4.5*] of the CATHI proposal.

GANIL will participate in the Marie Curie ITN on the condition that all costs incurred by the company and related to the implementation of practical research and/or complementary training including courses, workshops, secondments and visits, will be reimbursed by CERN (and/or other network participants), where the researchers will be appointed. For this purpose GANIL shall invoice these research training costs to the full network partner(s) concerned.

Signed: [name], signature Galy Sydney

Position in the company:
DIRECTOR GANIL

ISTITUTO NAZIONALE DI FISICA NUCLEARE
LABORATORI NAZIONALI DI LEGNARO

DIVISIONE RICERCA
Ufficio per le Attività di Ricerca con Finanziamenti Esterni
(UNIONE EUROPEA ed altri soggetti Pubblici e Privati)

Legnaro, 16 December 2009

To Whom It May Concern

Letter of Intent

Ref.: Participation in the FP7 Marie Curie Training Network CATHI

I hereby certify that LNL-INFN intends to participate in the FP7 Initial Training Network CATHI, coordinated by CERN, should the network be selected for funding by the European Commission.

Our institute will participate in this ITN as **associated partner** in the following ways:

- A senior staff member of the company will have a seat in the Supervisory Board of the network.
- The institute will offer possibilities to accommodate 1 young researcher from the ITN for practical placements of *1* to *3* months. The researcher will receive practical and research training in Super-Conducting cavity development.
- Members of our staff will deliver training courses to the researchers from the ITN in the fields of Super-Conducting cavity RF. The courses will be delivered at the premises of CERN (and/or the company).

The participation of LNL-INFN in the research and training programme of the ITN is described in sections [B3.1] and [*B4.5*] of the CATHI proposal.

LNL-INFN will participate in the Marie Curie ITN on the condition that all costs incurred by the company and related to the implementation of practical research and/or complementary training including courses, workshops, secondments and visits, will be reimbursed by CERN (and/or other network participants), where the researchers will be appointed. For this purpose LNL-INFN shall invoice these research training costs to the full network partner(s) concerned.

Dr. Gabriele Puglierin
Director

35020 LEGNARO (PD) – Viale dell'Università, 2 – Tel. 049/80.68.311 – Telefax 049/8068513
Codice Fiscale 84001850589 - Tel. 049/8068.508-681

CNRS - IN2P3 – UNIVERSITE PARIS SUD
Institut de Physique Nucléaire - Orsay

Letter of Intent

Ref.: Participation in the FP7 Marie Curie Training Network CATHI

I hereby certify that IPN-Orsay (CNRS) intends to participate in the FP7 Initial Training Network CATHI, coordinated by CERN, should the network be selected for funding by the European Commission.

Our company will participate in this ITN as **associated partner** in the following ways:

- A senior staff member of the company will have a seat in the Supervisory Board of the network.
- The company will offer possibilities to accommodate 2 young researchers from the ITN for practical placements of *1* to *3* months. The researchers will receive practical and research training in Super-Conducting cavity development and Low-level RF.
- Members of our staff will deliver training courses to the researchers from the ITN in the fields of Super-Conducting cavity RF and Low-level RF. The courses will be delivered at the premises of CERN (and/or the company).

The participation of IPN-Orsay in the research and training programme of the ITN is described in sections [*B3.1*] and [*B4.5*] of the CATHI proposal.

IPN-Orsay will participate in the Marie Curie ITN on the condition that all costs incurred by the company and related to the implementation of practical research and/or complementary training including courses, workshops, secondments and visits, will be reimbursed by CERN (and/or other network participants), where the researchers will be appointed. For this purpose IPN-Orsay shall invoice these research training costs to the full network partner(s) concerned.

Signed: [name], signature Daniel Gardès
Position in the company: Director of the accelerator Division

IPN – 91406 ORSAY Cedex – Tél. + 33 1 69 15 72 17 – fax +33 1 64 46 62 58
Email gardes@ipno.in2p3.fr - web http://ipnweb.in2p3.fr

ENDPAGE

PEOPLE
MARIE CURIE ACTIONS

Marie Curie Initial Training Networks (ITN)
Call: FP7-PEOPLE-2010-ITN

PART B

STAGE 2 – FULL PROPOSAL

CATHI