

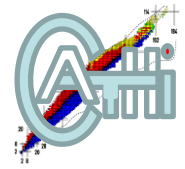
CATHI

Marie Curie Initial Training Network

Cryogenics, Accelerators and Targets at HIE-ISOLDE

Yacine Kadi (EN)

Kick-off Meeting, 23 May 2011



Outline

- + History
- + CATHI Initial Training Network
- + Research Work Packages
- + Milestones and Deliverables
- + Summary

Upgrade of the present ISOLDE Facility

Energy upgrade

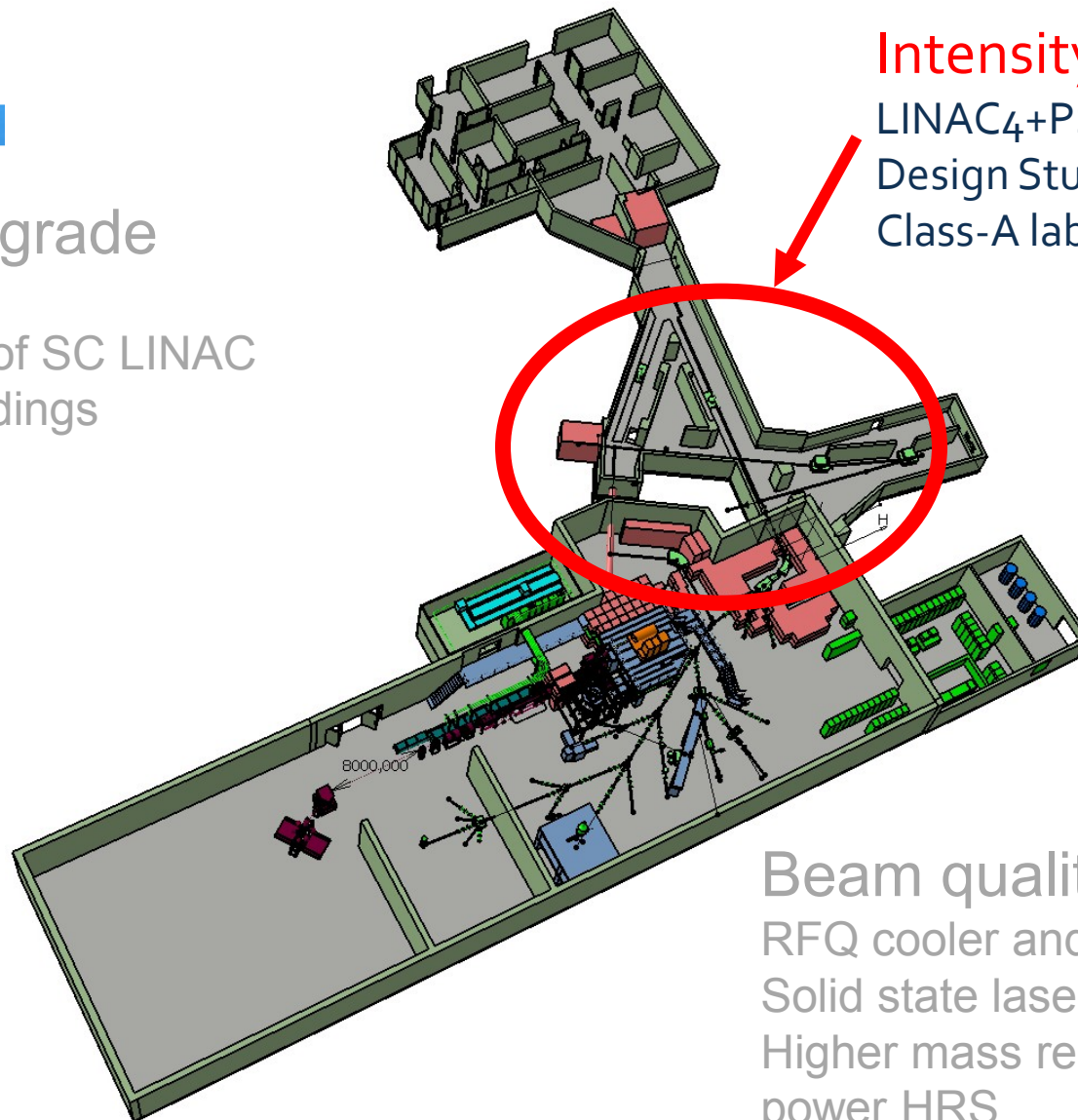
10 MeV/u

Construction of SC LINAC
+ service buildings

Intensity upgrade

LINAC₄+PSB

Design Study of target area,
Class-A lab and beam lines



Beam quality upgrade

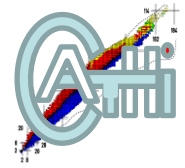
RFQ cooler and buncher

Solid state lasers for RILIS

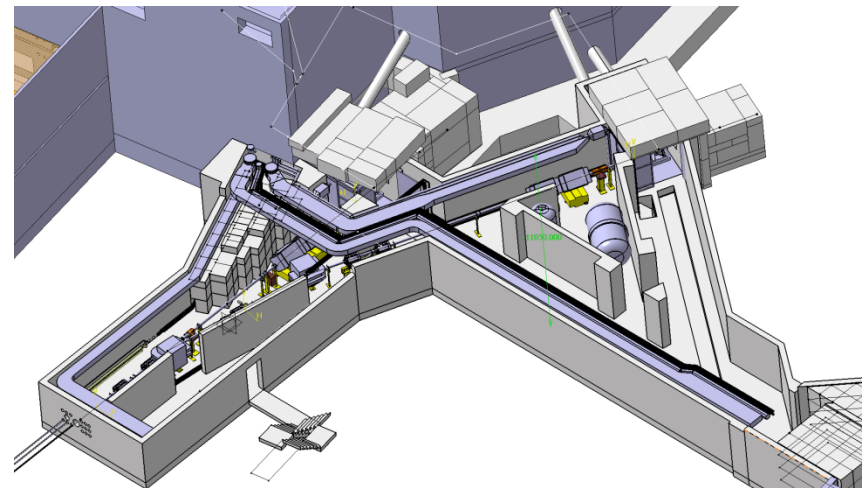
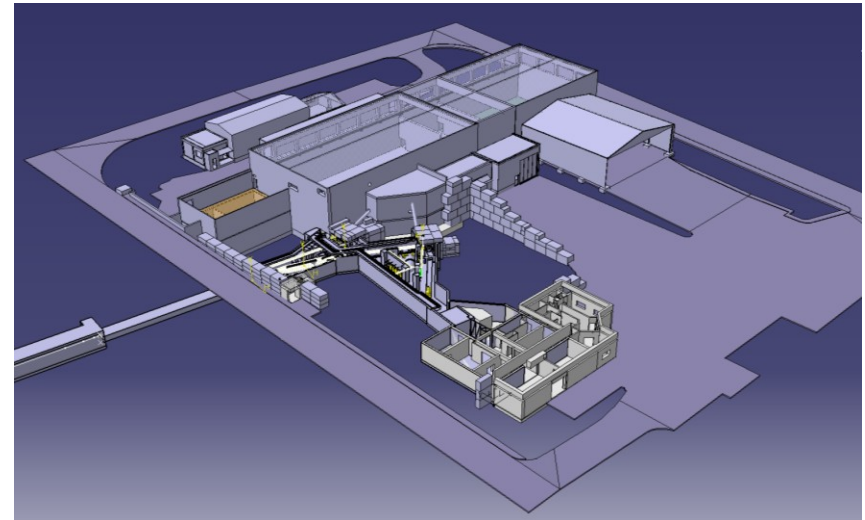
Higher mass resolving

power HRS

Scope of HIE-ISOLDE Design Study for Intensity Upgrade



- Target Area
 - Target & Front end Design
 - HV and High Current Systems
 - Cooling and Ventilation
 - Vacuum
- Beam Quality
 - Beam Diagnostics
 - Beam lines
 - Experiment Hall
 - Separator areas
 - Off line separator
- Infrastructure and Support
 - Layout upgrade
 - Electrical systems
 - Transport & Handling
 - Survey
 - Civil engineering
 - LL controls

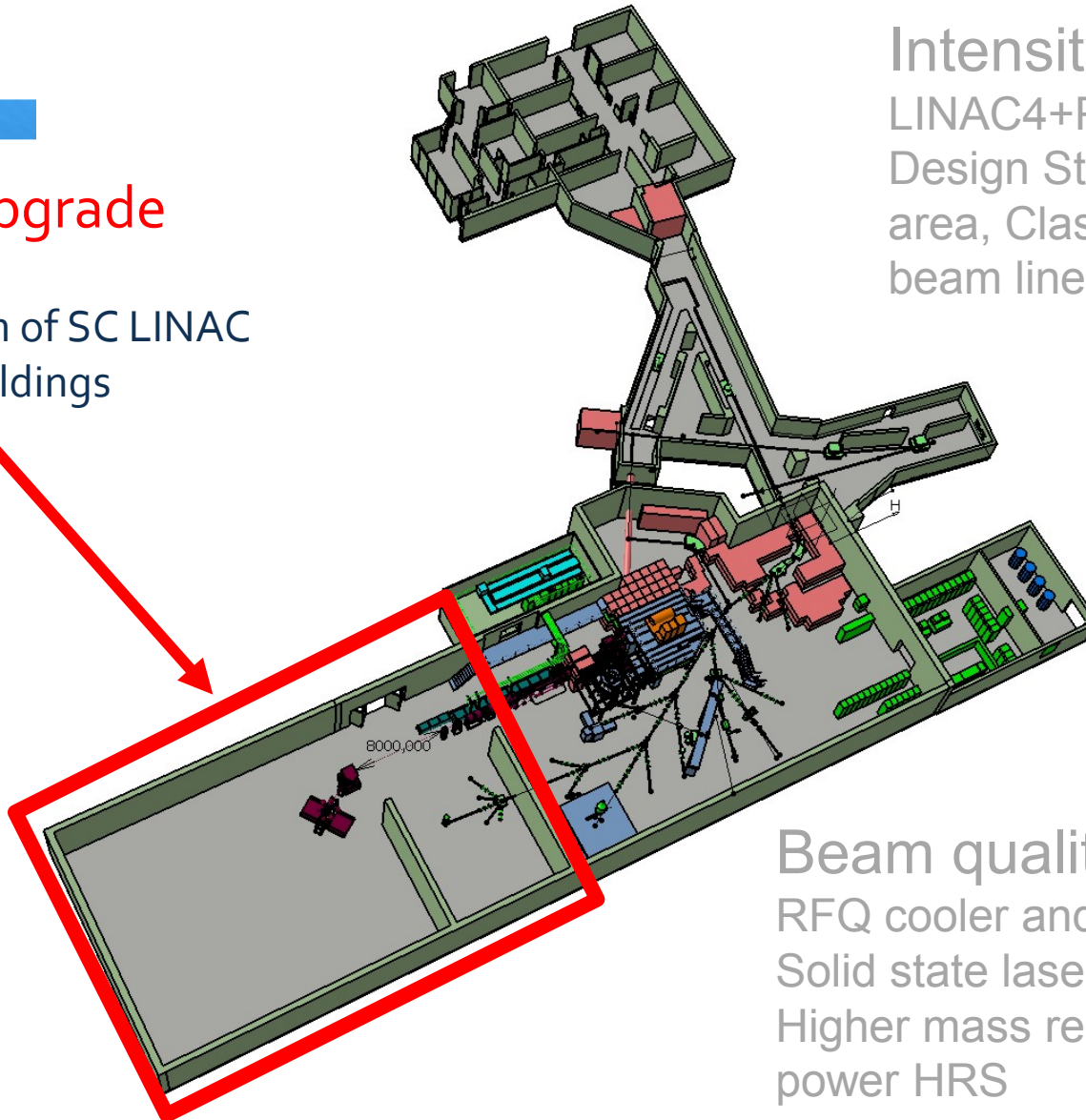
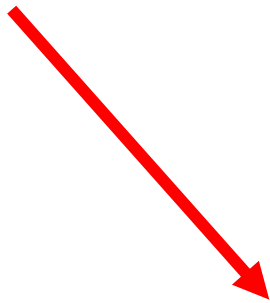


Upgrade of the present ISOLDE Facility

Energy upgrade

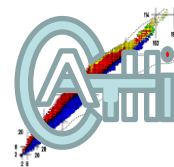
10 MeV/u

Construction of SC LINAC
+ service buildings



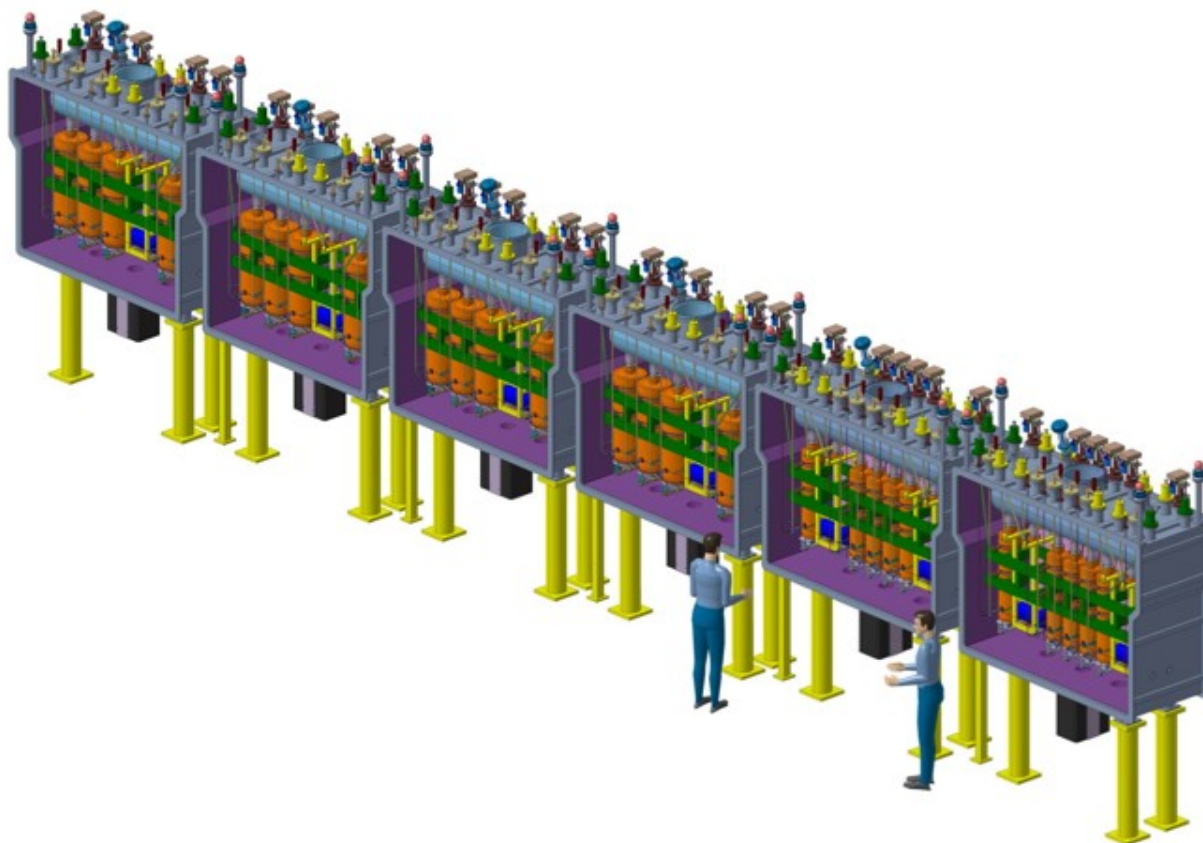
Intensity upgrade
LINAC4+PSB
Design Study of target
area, Class-A lab and
beam lines

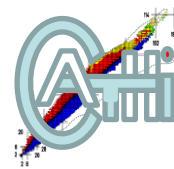
Beam quality upgrade
RFQ cooler and buncher
Solid state lasers for RILIS
Higher mass resolving
power HRS



The HIE-ISOLDE SC linac

Ligne Cryomodules





The Initial Training Network (ITN)

+ Initial Research Training

- + Early Stage Researchers (ESR) experience < 4 yr
- + Experienced Researchers (ER) 4 yr < experience < 5 yr

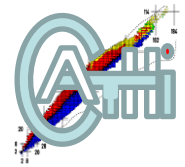
+ CATHI = Monosite ITN

- + CERN (the grant recipient and coordinator)
- + + 13 Associated Partners

+ General ITN Objectives

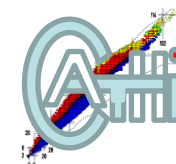
- + International mobility
- + Intersectorial experience (academia + industry)
- + Complementary skills (language, communication & management, IPR issues etc.)
- + Dissemination of results (workshops etc)

Research Training Themes (20 Fellows over 4 years)



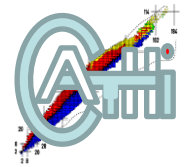
HIE-ISOLDE Subsystem	Research Training Theme	No. ESR	No. ER
I. SC Linac	1. Super-Conducting Cavity Development an tests	2	1
	2. Beam Instrumentation Development	1	1
	3. New Magnets	1	-
	4. Linac Integration and Innovative Alignment Method	2	-
	5. Linac Commissioning	1	-
II. Design Study for intensity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

List of Participants

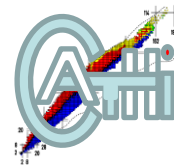


	Private Sector Participant	Country	Legal Entity Name	Department /Division/ Laboratory	Scientist-in-charge
Full Network Partner					
1		Switzerland	European Organization for Nuclear Research	Engineering Dept.	Yacine Kadi
Associated Partners					
1	√	Italy	CINEL		Sergio Bongiovanni
2		France	CNRS/IN2P3	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 Magnetism		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

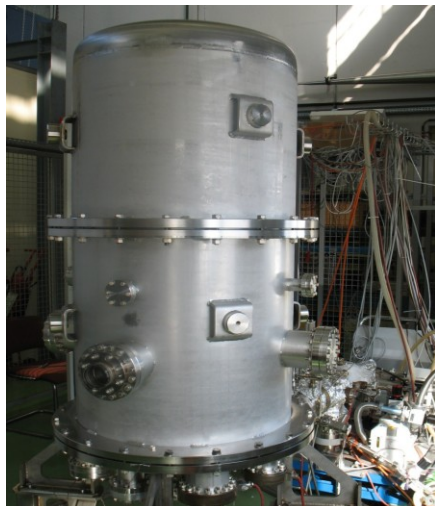
Description of the Work Packages



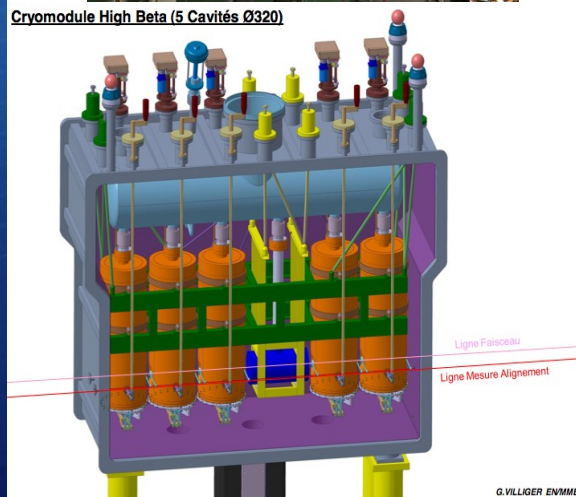
Work package number	1	Start date or starting event:	Month 3
Work package title	Superconducting Cavity Development and Tests		
Activity Type	RTD		
Person-months	96 (ESR1: 36 months; ER1: 24 months and ESR2: 36 months)		
Associated Partners	IPN-Orsay, INFN-LNL, SDMS, ZANON, CINEL, CI		
Objectives	Develop techniques to realize and test a Superconducting resonant cavity of the quarter-wave type (QWR) using the technology of niobium film sputtering over a copper substrate at HIE-ISOLDE.		
Description of work	<ol style="list-style-type: none"> 1. ESR2: Specification and conceptual study of the SC cavity and subsequent realization of the prototype low-beta cavity. 2. ESR2: Setup of the cryomodule test stand and cold tests of the SC cavity (investigation of Q-drop effect). 3. ER1: Development and commissioning of fast digital electronics (FPGA) for the control of the QWR cavities. 4. ESR1: Development and qualification of Niobium thin film sputtering techniques on copper cavities of different betas. 		
Deliverables	<p>D06. Report on the Optimization of the sputtering processes (ESR1) D07. Report on the SC cavity qualification measurements (ESR1) D08. Report on the Operational prototype of the LLRF system (ER1) D09. Report on LLRF tests (ER1) D10. Final report and/or journal publications on the QWR Cavity Dev. and Tests (ESR2)</p>		



Key Technologies



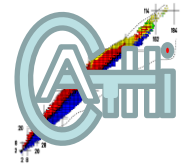
Cryomodule High Beta (5 Cavités Ø320)



G.VILLIGER ENVMME

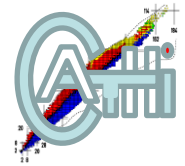


Description of the Work Packages



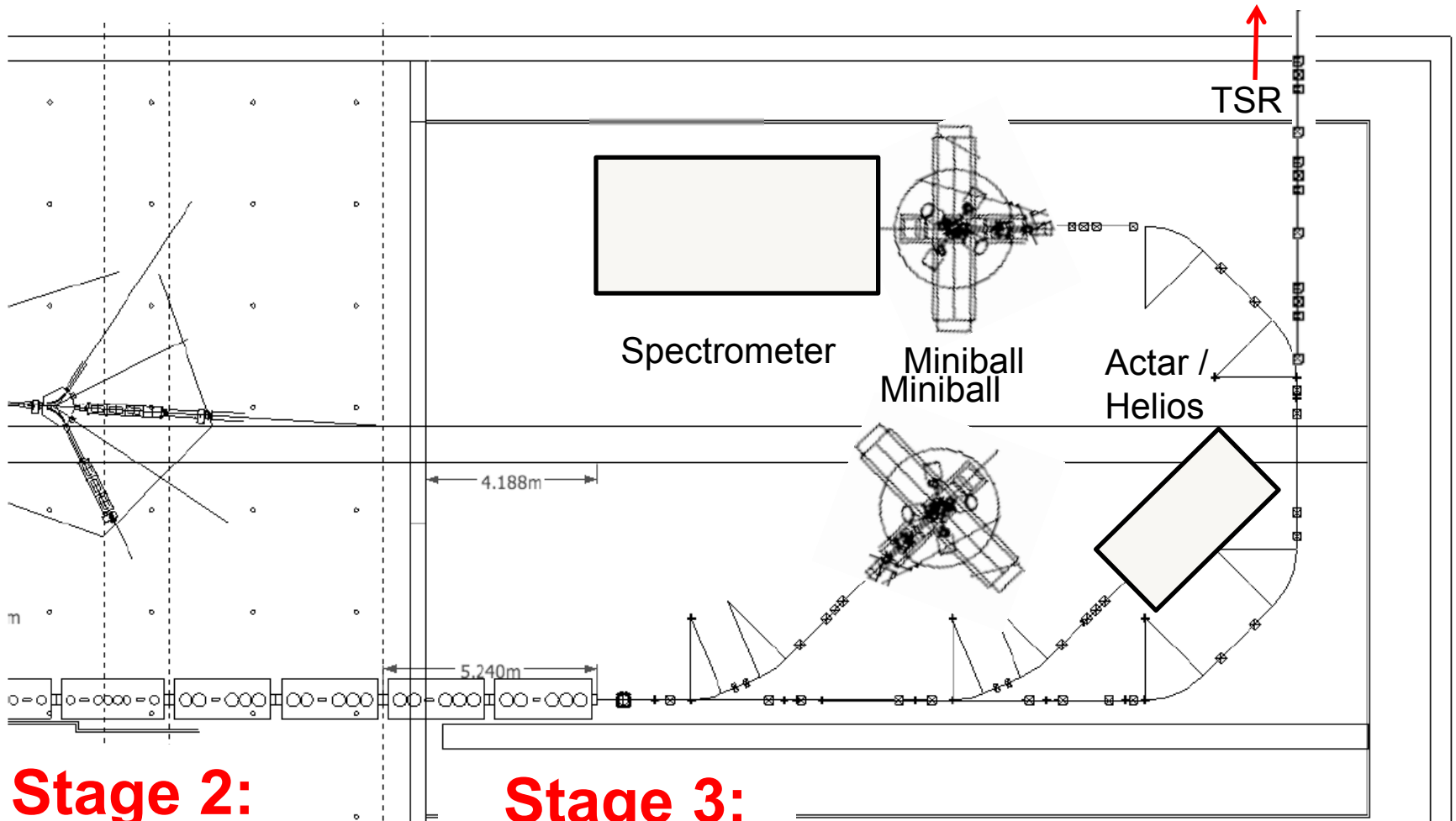
Work package number	2	Start date or starting event:	Month 7
Work package title	Beam Instrumentation Development		
Activity Type	RTD		
Person-months	60 (ER2: 24 months and ESR3: 36 months)		
Associated Partners	LPC-Caen, NSCL-MSU, CINEL, GANIL, INFN-LNL, CI, IPN-Orsay		
Objectives	Develop radiation-hard beam instrumentation for the 10 A*MeV Superconducting LINAC and a particle detector suitable for measuring very faint radioactive beams.		
Description of work	<ol style="list-style-type: none"> 1. ER2, ESR3: Design, fabricate and lab test prototype of position, profile and intensity monitors 2. ER2, ESR3: Design, fabricate and lab test prototype of phase and energy monitors. 3. ER2, ESR3: Design, fabricate and lab test prototype of emittance meter 4. ER2, ESR3: Carry out irradiation tests. 5. ER2: Carry out system-level integration tests and supervision work. 		
Deliverables	<p>D11. Conceptual design and sign-off specifications of beam instr. for SC Linac (ER2)</p> <p>D12. Define procedures for assembly, installation and commissioning (ER2)</p> <p>D13. Conceptual design and specifications of solid state beam instrumentation (ESR3)</p> <p>D14. Complete testing/irradiation and system-level integration test. Final conference report and/or journal publication (ESR3)</p>		

Description of the Work Packages



Work package number	3	Start date or starting event:	Month 3
Work package title	New Magnets		
Activity Type	RTD		
Person-months	36 (ESR4: 36 months)		
Associated Partners	Scientific Magnetics and CI		
Objectives	Design, manufacture and commission compact warm magnets for the 10 A*MeV Superconducting LINAC and new beam transfer line.		
Description of work	<ol style="list-style-type: none"> 1. Specification of the magnet parameters. 2. Design and implementation of the whole magnet system. 3. Sign-off call for tender for the magnets procurement in industry. 4. Participate in preliminary system tests using the 5.5 A*MeV Superconducting LINAC. 		
Deliverables	<p>D15. Conceptual design of beam line magnets and distribution</p> <p>D16. Technical specifications of beam line magnets and distribution. Final conference report and/or journal publication</p>		

Beam Transfer Line

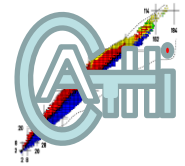


Stage 2:
The bend

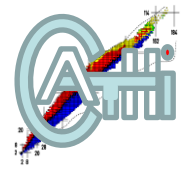
Stage 3:
TSR and beyond..

Spectrometer installation and 2nd Miniball move

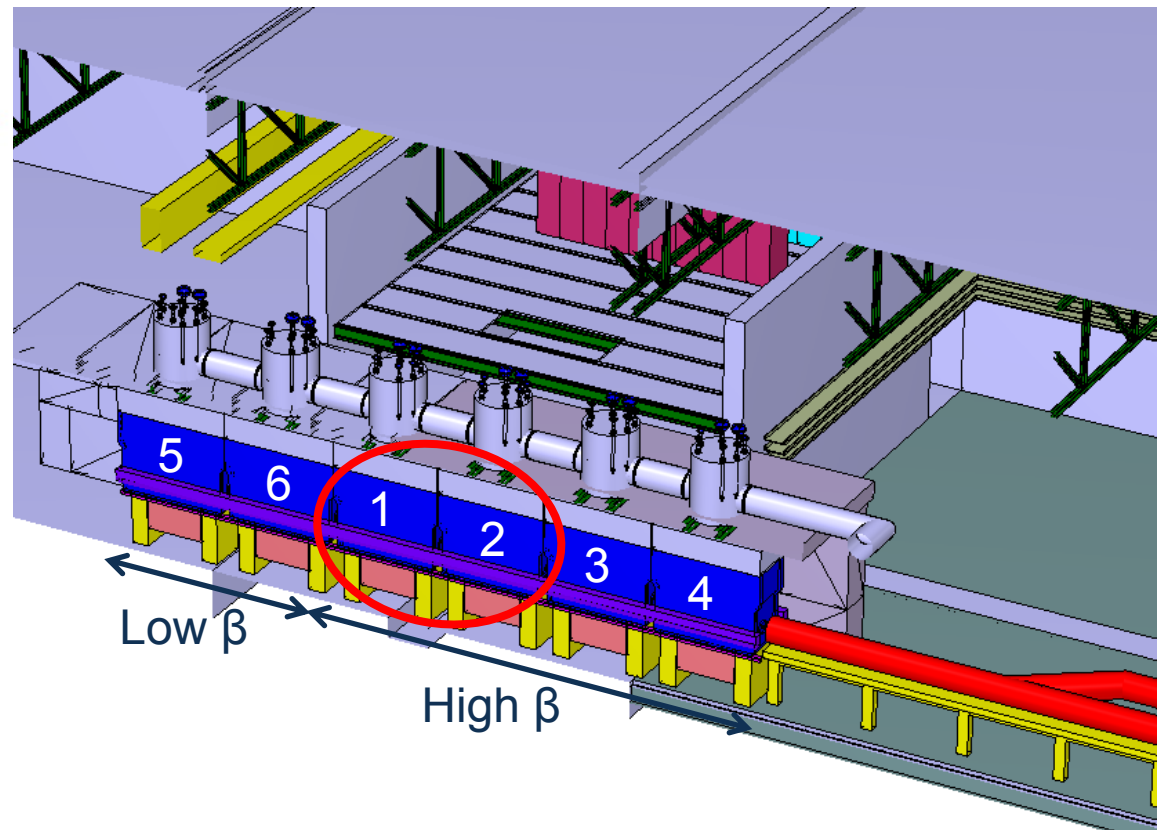
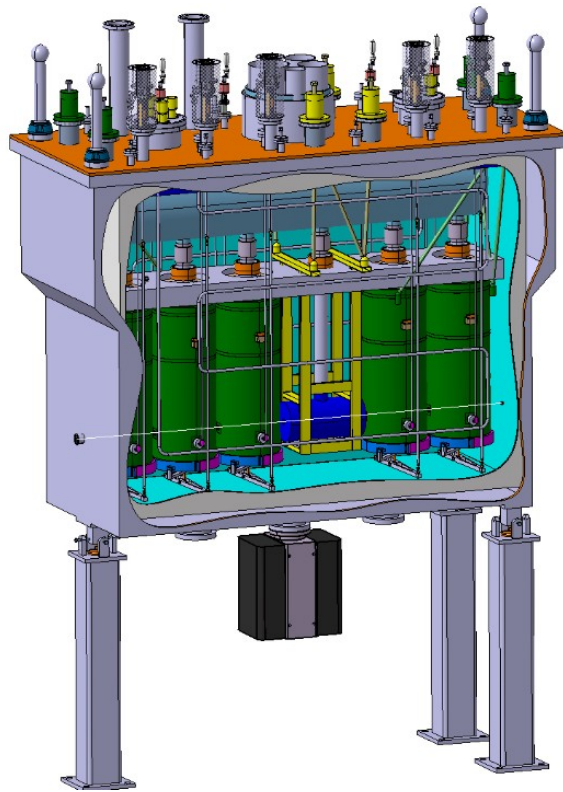
Description of the Work Packages



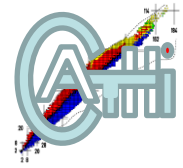
Work package number	4	Start date or starting event:	Month 3
Work package title	Linac Integration and Innovative Alignment Method		
Activity Type	RTD		
Person-months	72 (ESR5: 36 months and ESR6: 36 months)		
Associated Partners	GANIL, INFN-LNL, CI, IPN-Orsay		
Objectives	Carry out full integration studies for the different accelerator and experimental beam lines of HIE-ISOLDE and subsequent alignment of all the SC accelerating cavities, the beam monitors and the magnets.		
Description of work	<ol style="list-style-type: none"> 1. ESR5: Carry out design and space arrangement of the HIE-ISOLDE area. 2. ESR6: Implement permanent internal monitoring lines to follow the relative movements of the cryo-cavities and solenoid inside each vacuum vessel. 3. ESR6: Design of specific electro-optics cameras and control applications. 4. ESR6: Electro-optical & environmental characterization of optical packages. 		
Deliverables	D17. Final report on integration studies (ESR5) D18. Report on implementation and commissioning (including procedures) of the complete alignment system (ESR6)		



Linac Integration



A proposal for a novel alignment monitoring system



<http://alignment.hep.brandeis.edu/>



SURVEILLER UN POINT ... UNE LIGNE ... A QUELQUES MICRONS
SYSTEME ELECTRO-OPTIQUE BCAM

'BRANDEIS' CAMERA ANGLE MONITOR

Caméra:

lentille, focale 75mm
capteur CCD (2,4mm x 3,4mm).

Sources:

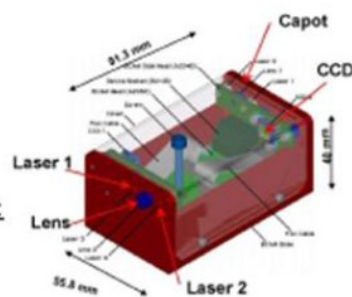
diodes laser rouges,
aucun objectif de collimation,

Interface d'acquisition et analyse:

LWDAQ via Ethernet et TCP/IP
Windows, Linux, and MacOS.

Reconstruction 3D:

ARAMyS fonctionne sous Linux



Les BCAM se fixent sur les
trois billes de manière
isostatique (point-trait-plan)

Elles sont fixées à la plaque à
l'aide d'une vis.

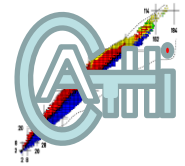
Les coordonnées des centres
des trois billes définissent le
système de coordonnées de la
BCAM



Features:

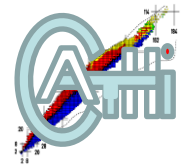
- Allows almost continuous monitoring of the position of cavities and solenoids
- Allow reconstruction of positions of cold elements in the whole linac (not limited to a single cryomodule)
- Radiation resistant and ... It's affordable

Description of the Work Packages

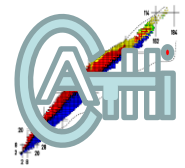


Work package number	5	Start date or starting event:	Month 13
Work package title	Superconducting Linac Commissioning		
Activity Type	RTD		
Person-months	36 (ESR7: 36 months)		
Associated Partners	GANIL, INFN-LNL, CI, IPN-Orsay		
Objectives	The ESR training will be focused on the development of machine 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.		
Description of work	<ol style="list-style-type: none"> 1. Draft the specification of the controls and of the beam monitoring tools specific to the HIE-REX Linac 2. Definition of tuning procedures and management of machine protection and alarm system 3. Draft console applications to be used by the operators for the Linac tuning and monitoring 4. Follow progress of the different aspects of the Linac design, construction and installation 5. Assist in the commissioning of the new machine 		
Deliverables	<p>D19. Report on commissioning schedule, general tuning procedure, specifications for controls and beam diagnostics</p> <p>D20. Commissioning report. Final conference report and/or journal publication</p>		

Description of the Work Packages

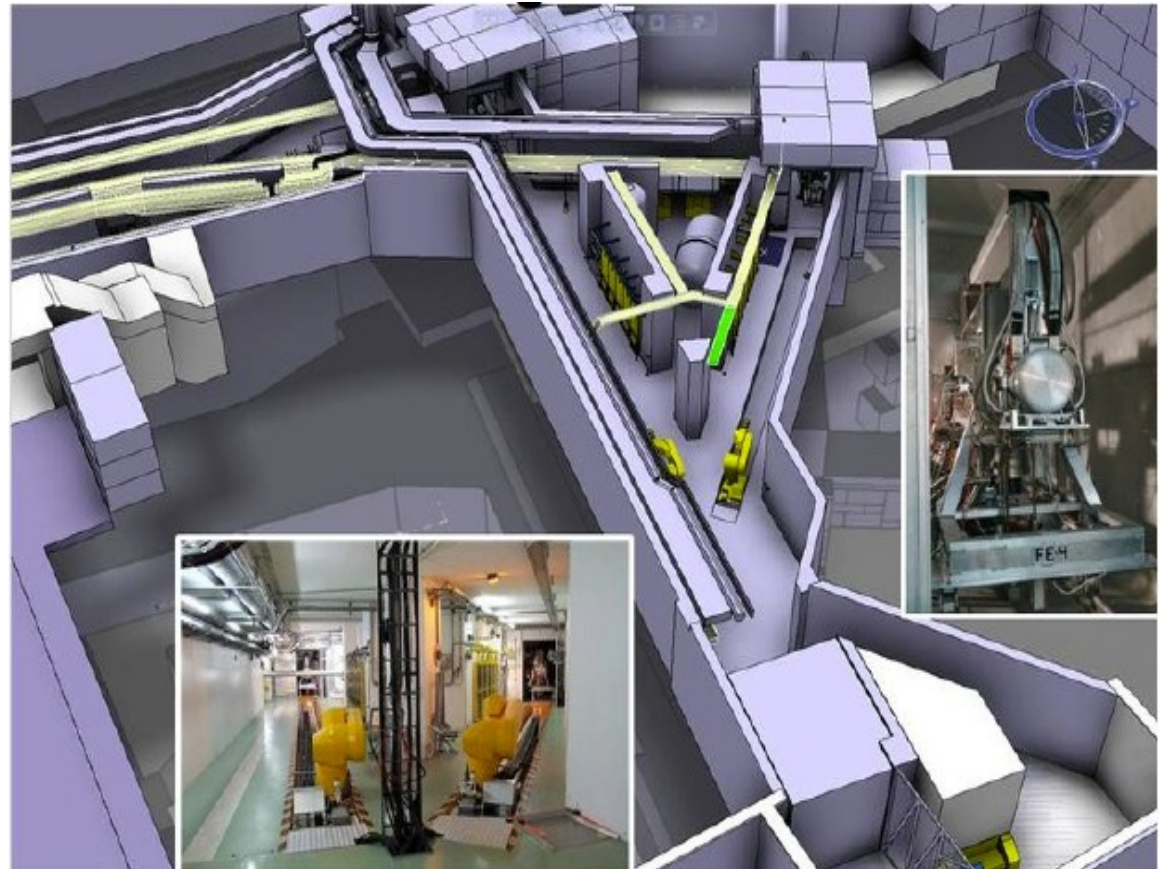


Work package number	6	Start date or starting event:	Month 3
Work package title	Studies for ISOL Target and Front-End Upgrades		
Activity Type	RTD		
Person-months	180 (ESR8; ESR9; ESR10, ESR11 and ESR12: 36 months each)		
Associated Partners	GANIL, INFN-LNL, IPN-Orsay, JYFI, SIDeA		
Objectives	The ESR training will be focused on R&D work on ion sources, target material and beam purification. Key issues include the study of target materials and maintaining the production rates of radioisotopes, thermal and shock studies, radiation protection and beam optics.		
Description of work	<ol style="list-style-type: none"> 1. ESR8: Carry out simulations of proton beam interactions with existing and potential target materials using FEM structural codes 2. ESR8: Establish experimental programme to validate the simulations and verify the production rates and diffusion constants for different material prototypes 3. ESR9: Carry out post irradiation analysis of used target and ion source systems with respect to fatigue and failure 4. ESR9: On-line tests with specific proton-beam pulse sequences and measurements using the Laser Doppler Vibrometer 5. ESR10: Optimization of the target(s) design for the study and optimization of different layout scenarii in terms of radiation protection issues, including benchmarking of code 6. ESR11: Carry out beam optics simulations as a function of target and ion source parameters and beam profile requirements for mass separation 7. ESR11: Draft functional and conceptual design of a new Front End including its integration into the existing facility 8. ESR12: Perform design study for the low-level control of the new front end and the High Resolution Separator (HSR) magnet 9. ESR12: Carry out dedicated study on state-of-the-art high accuracy positioning and sensor systems for the extraction electrodes as well as the control of devices for the safe manipulation of the target 		

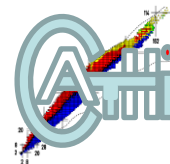


Target & Front End Design

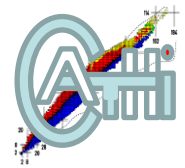
- + Issues to be addressed
 - + Targets
 - + Target lifetime, material science, ion source optimization, geometry, energy deposition, handling, elimination pathway.
 - + Front Ends
 - + Material resistance, maintenance, optics, vacuum systems, remote operation...
- + Starting point
 - + Fluka simulation of induced radiation
 - + Necessary for both Design Study and High Energy project
 - + Will provide input for shielding studies



Description of the Work Packages

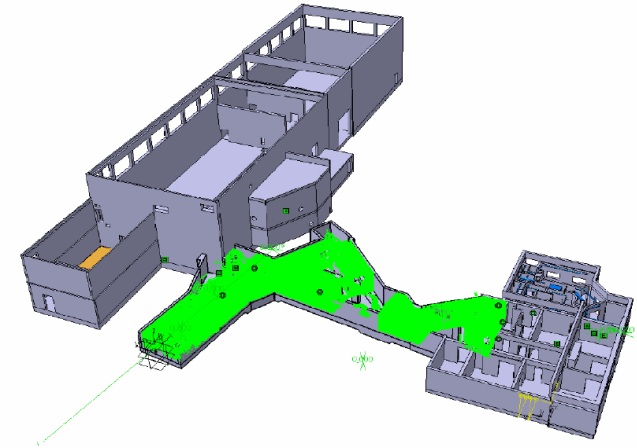


Work package number	7	Start date or starting event:	Month 3
Work package title	ISOLDE Target Area and Class-A Laboratory Upgrade		
Activity Type	RTD		
Person-months	72 (ESR13: 36 months and ESR14: 36 months)		
Associated Partners	GANIL and INFN-LNL		
Objectives	The ESRs will acquire the necessary knowledge and collaborate to the different phases of the design of HVAC and cooling systems for the future HIE-ISOLDE facility and participate actively in the startup of the machine.		
Description of work	<ol style="list-style-type: none"> 1. ESR13: Dimension the components of the Cooling and Ventilation installations 2. ESR13: Define and integrate the Cooling and Ventillation plant in the general layout of the building 3. ESR13: Elaborate the technical specifications and participate in the call for tender for the procurement in industry 4. ESR14: Present a planning, perform the engineering study, organize tests and carry out the preliminary design and integration of the new vacuum system 5. ESR14: Optimize the choice of control and diagnostic equipments 6. ESR14: Design a new gas recuperation system taking into account radiation safety and contamination hazards 		
Deliverables	<p>D32. Report on existing facilities (ESR13)</p> <p>D33. Design report on the Cooling and Ventilation upgrade for HIE-ISOLDE (ESR13)</p> <p>D34. Engineering study on the High-Vacuum requirements (ESR14)</p> <p>D35. Design report on the gas recuperation system upgrade for HIE-ISOLDE (ESR14)</p>		

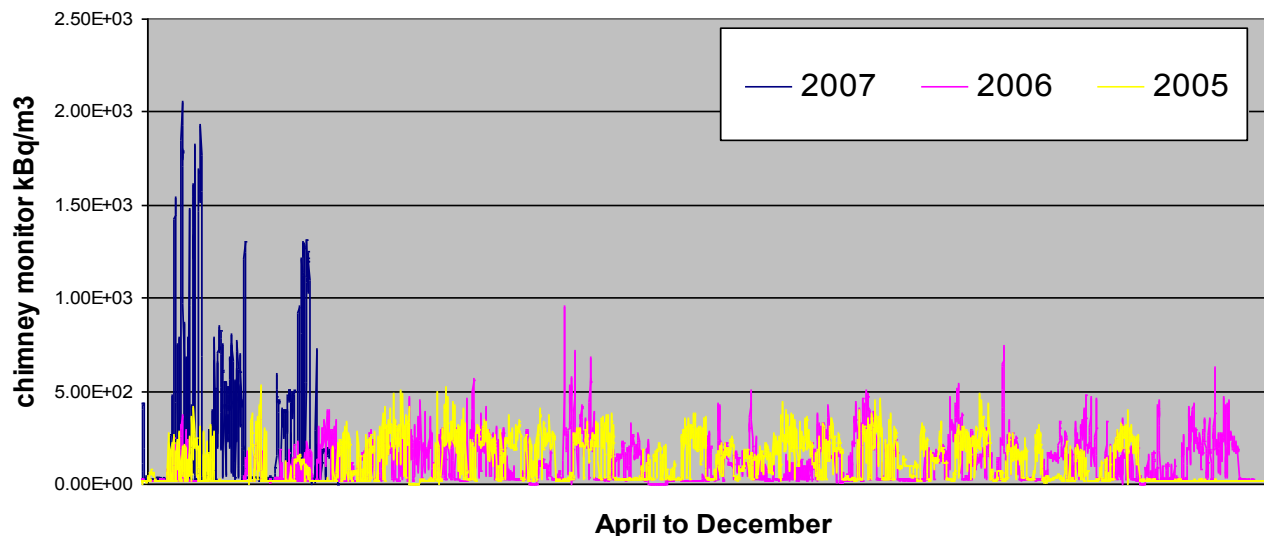


Cooling and Ventilation

- + Issues to be addressed
 - + Air activation
 - + Separation of ventilation systems
 - + Separation of ventilated zones
 - + Activated cooling water

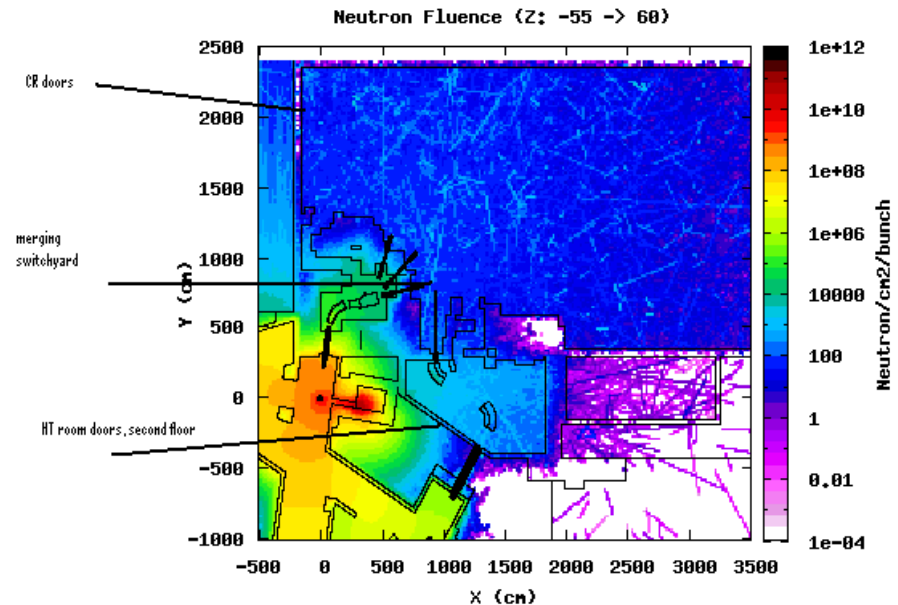
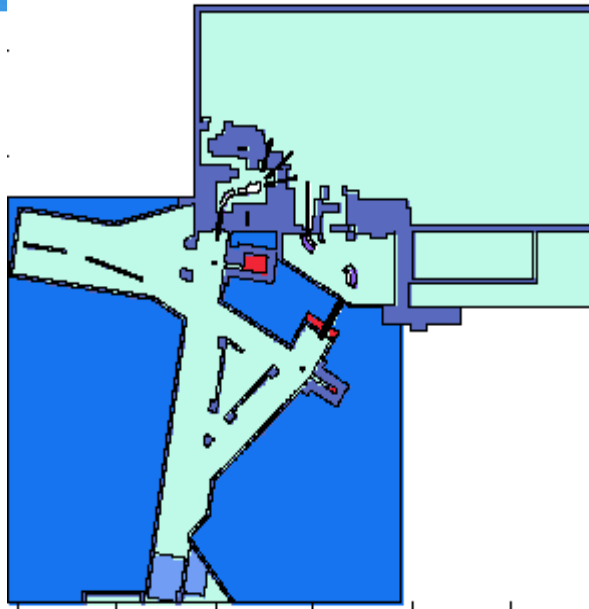
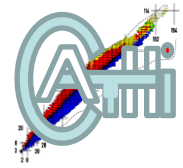


Air activation levels over 3 years as measured in chimney



April to December

Fluka Simulations: a step forward

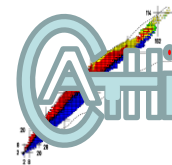


- + Improved geometry for Fluka simulations
- + Different colours represent different materials
- + First steps in defining shielding requirements for HIE-Intensity ISOLDE

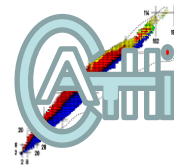
- + HRS Neutron Fluence at target height
- + 1 pulse at $1E+13$ protons
- + Need to run further simulations
- + Tools are available

Thanks to Agnieszka Leyko:
Report: Radiation Study for the ISOLDE Experimental Hall

Description of the Work Packages

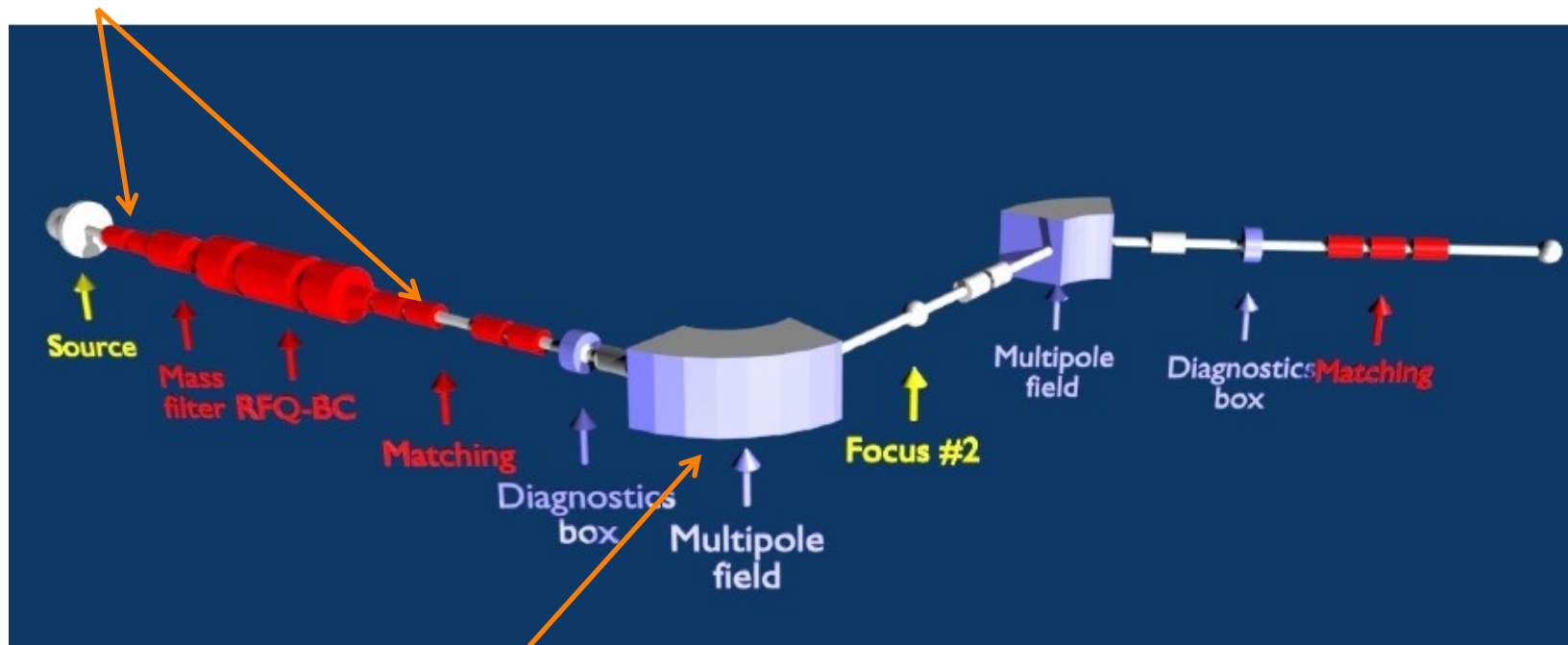


Work package number	8	Start date or starting event:	Month 7
Work package title	Radioactive Ion Beams Quality Improvements		
Activity Type	RTD		
Person-months	96 (ESR15: 36 months; ESR16: 36 months and ER3: 24 months)		
Associated Partners	JYFI, MPIK, NSCL-MSU, Scientific Magnetics,		
Objectives	The ESRs will acquire the necessary knowledge and collaborate to the different studies for the improvements of the radioactive ion beam quality in both resolution and purity.		
Description of work	<ol style="list-style-type: none"> 1. ESR15: Define the functional and technical specifications for the production of an off-line separator 2. ESR15: Assembly and commissioning of the off-line separator 3. ESR15: Carry out design study of a high resolution magnet including the integration of multi-pole corrections 4. ESR15: Elaborate the technical specifications and participate in the call for tender for the procurement in industry 5. ESR16: Elaborate a functional and conceptual design of a Radio Frequency Quadrupole Cooler and Buncher (RFQCB) 6. ESR16: Provide a design for a pre-mass separator and setup a test stand 7. ER3: Carry out high-current electron beam simulations in order to establish a viable electron beam design 8. ER3: Carry out beam-optics simulation of the A/q-separator connecting the EBIS breeder to the existing linac 		



New HRS Layout

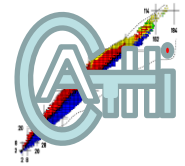
quads



$$B = B_0 \left[1 - 0.2580 \cdot \left(\frac{x}{r_0} \right)^2 \right]$$

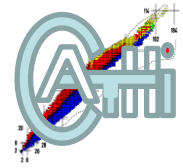
Special field shaping

Description of the Work Packages



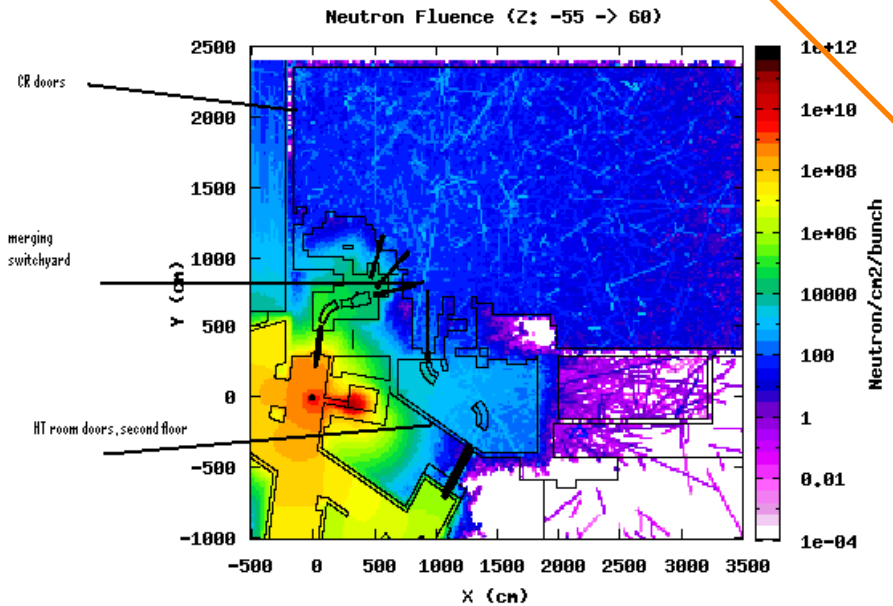
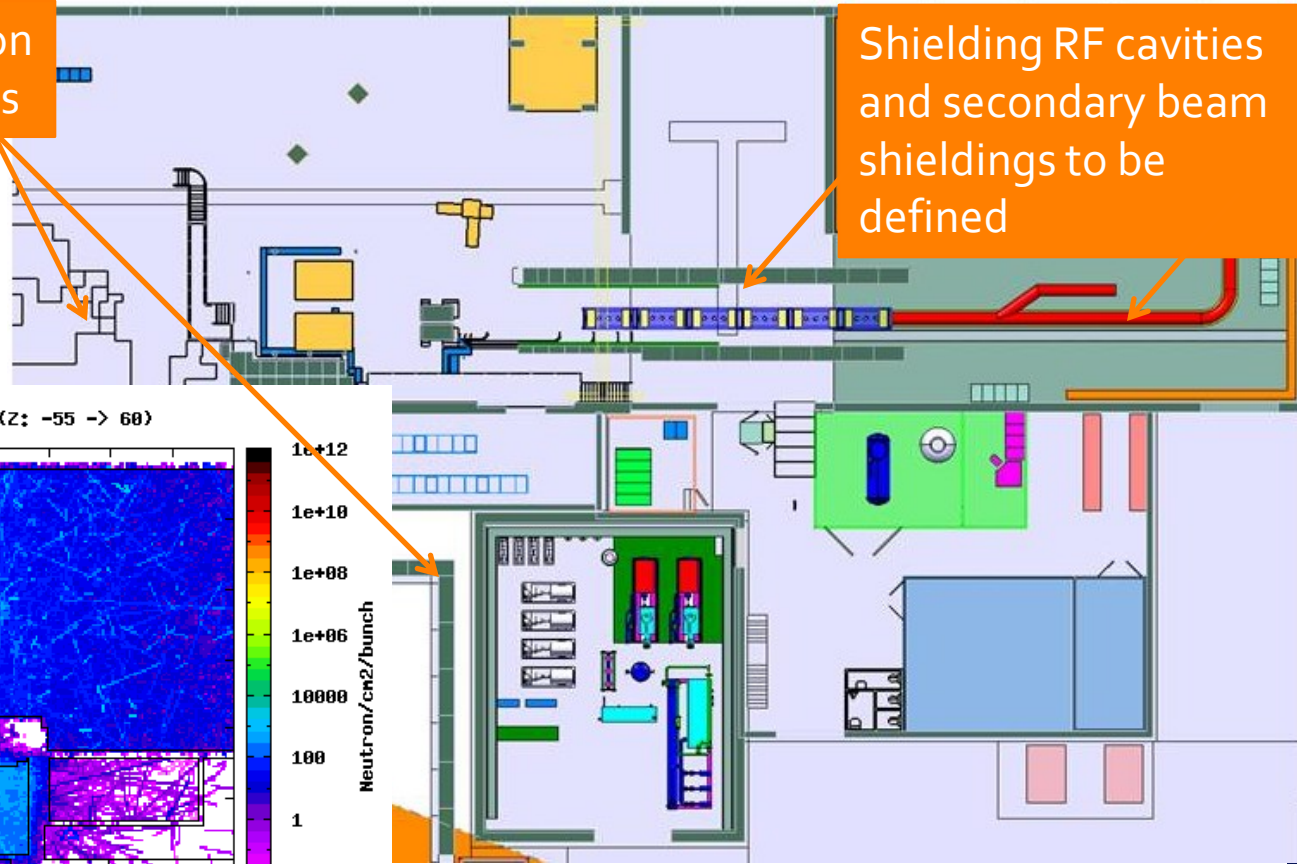
Work package number	9	Start date or starting event:	Month 13
Work package title	General Safety and Radiation Protection Implication Studies		
Activity Type	RTD		
Person-months	24 (ER4: 24 months)		
Associated Partners	GANIL and IPN-Orsay		
Objectives	<p>The ER will acquire the necessary knowledge in the radiation protection aspects of the extension of the REX post-accelerator for radioactive ions He will collaborate with the teams in charge of 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. The ER will also participate actively in the startup of the machine.</p>		
Description of work	<ol style="list-style-type: none"> 1. Draft parts of the HIE-ISOLDE safety file dealing with radiation protection 2. Provide professional assistance to solving questions of radiation safety 3. Estimate the activation and radiation levels from beam loss of heavy ions 4. Estimate the radiation levels from x-ray emission of RF cavities 5. Apply and monitor the foreseen protection systems 6. Assist in the commissioning of the new machine 		
Deliverables	<p>D45. Design report on the shielding of the future post-accelerator D46. Final report on the radioactive waste disposal and inventory</p>		

CONSTRUCTION PHASE



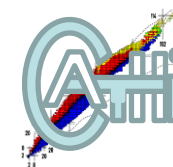
Radiation levels impact on existing and new facilities

Shielding RF cavities and secondary beam shieldings to be defined



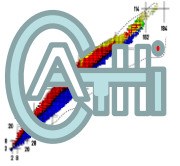
EXAMPLE OF TIMESCALE & MILESTONES

(see Fig. 1 and Table 5 of Annex I for all WPs; *May need updating*)



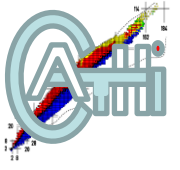
Theme number	Del. no.	Titles of the Research Training Themes and description of deliverables and milestones	Nature	Dissemination level	Delivery date (month)
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1		SC Cavity Development and Tests			
	D10	Final report on the QWR Cavity Development and Tests	R	Public	36
2		Beam Instrumentation Development			
	D14	Complete testing/irradiation and system-level integration test	R	Public	42
3		Transfer Line Magnets (ESR#4)			
	D16	Technical specifications of beam line magnets and distribution	R	Public	18
4		Integration Studies and Alignment			
	D18	Final integration and commissioning procedures	R	Public	24
5		Line Commissioning			
	D20	Commissioning report	R	Public	48
6		Studies for ISOL Target & Front End Upgrades			
	D25	Final report of the target layout optimization	R	Restricted	36
	D29	Prototype of front-end control system including actuators and sensors	P	n/a	24



TRAINING

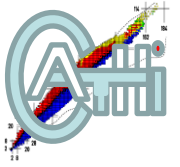
- + Hands-on research training complemented by formal training:
- + Individual training allowances (600 €/month)
- + CERN Training Programmes
 - + Academic Training
 - + CERN Seminars
 - + CERN Accelerator School
 - + Technical Training
- + International Conferences
 - + LINAC, IPAC, SRF, ICIS, EMIS, RNB, IEEE Real-Time.....
- + Training during secondment
 - + Up to 30% of contract duration
- + Complementary Training
 - + CERN Management and Communication courses
 - + Other external training courses



WORKING TOGETHER (1/2)

- + CATHI partners
 - + Pre-existing relationships and/or collaborations
 - + CERN services tailored to support international collaborations

- + EU funding covers People:
 - + Researcher salaries + social conditions
 - + Training & Mobility
 - + ITN Management
 - + Organization of workshops, conferences
 - + *See Seamus' presentation*
 - + **It does not cover research project costs**
 - + That's why CATHI research programmes have been integrated into approved HIE-ISOLDE project



WORKING TOGETHER (2/2)

Supervisory Board (once per year)

- + Approve and oversee implementation of training programme for scientific, technical and complementary skills;
Co-ordination of the network-wide training activities;
- + Monitor/evaluate overall progress of research training program;

Management Committee (At least twice per year)

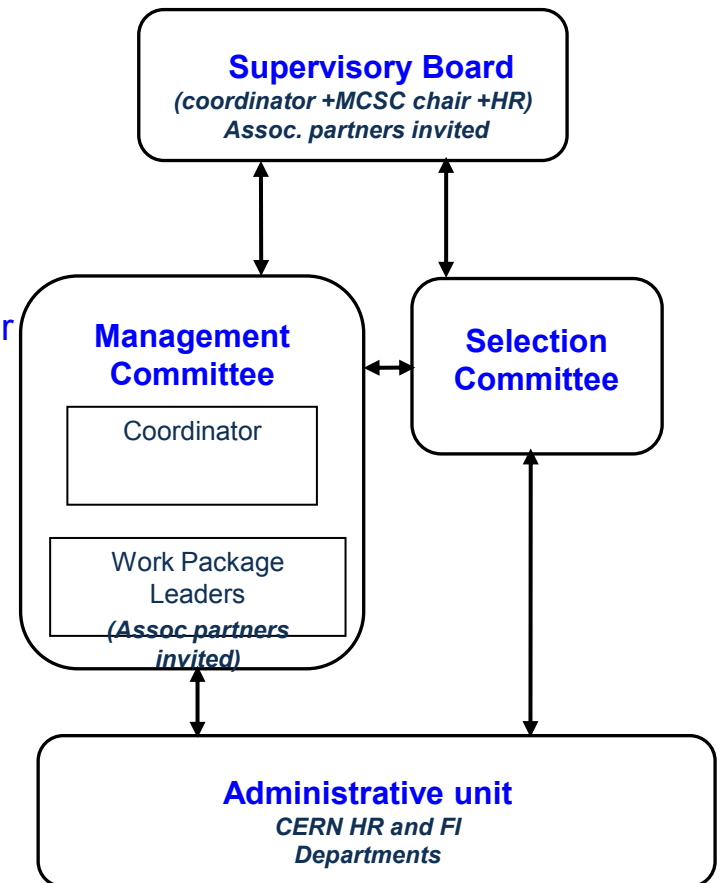
- + Overall management of research programme;
- + Implement training activities with associated partners;
- + Management & follow-up progress of the individual projects;
- + Organization network-wide training (courses, workshops, etc);
- + Overview integration of Researchers into research team(s);
- + Review of the Personal Career Development Plans;
- + Dissemination of best practice and project results.

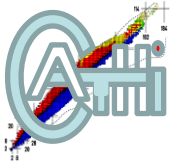
Sharing information

- + Use of SharePoint tool (www.cern.ch/cathi)

Deliverables

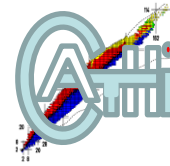
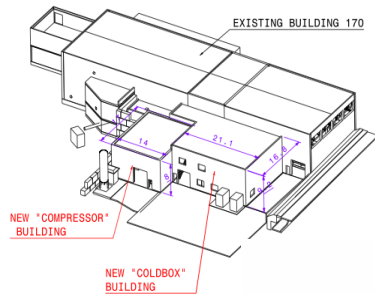
1. Annual S&T and management/financial reports
2. Prepare workshops & training events



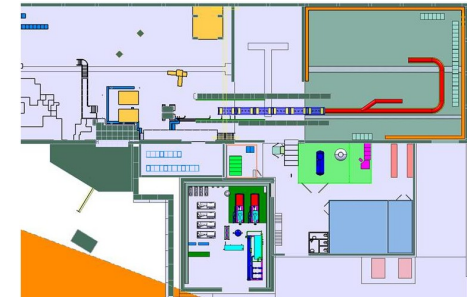


Summary

- + Start of CATHI-ITN → Nov. 1st 2010
- + Application via..... → Dec. 1st 2010
- + First ESR appointment → Apr. 1st 2011
- + Complete Selection and Recruitment of all ESRs and ERs → Oct. 31st 2011



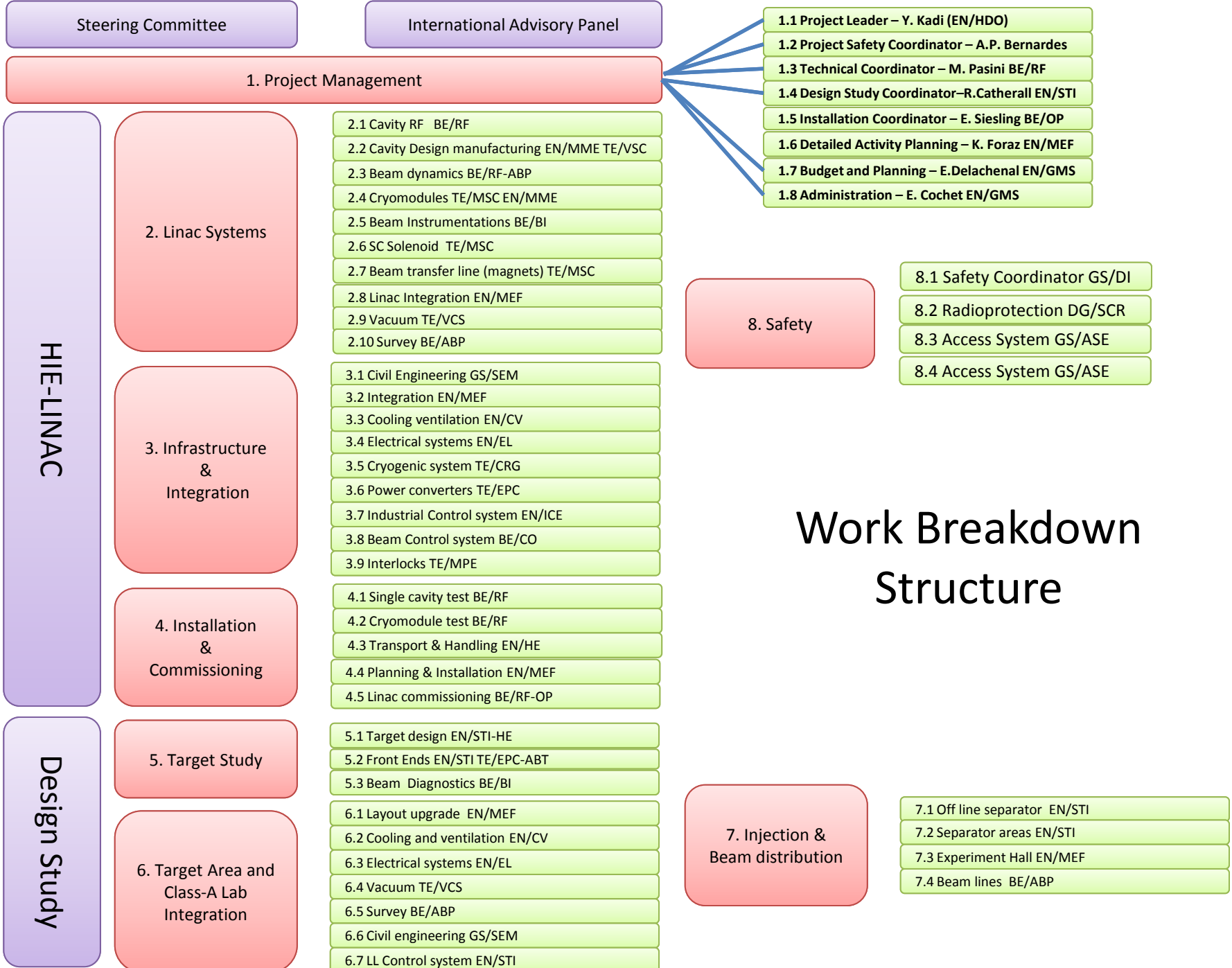
Thank you very much for your
attention



HIE-ISOLDE web site -> <http://hie-isolde.web.cern.ch/hie-isolde/>

CATHI-ITN web site -> <https://espace.cern.ch/Marie-Curie-CATHI/default.aspx>

HIE-ISOLDE Project



Work Breakdown Structure