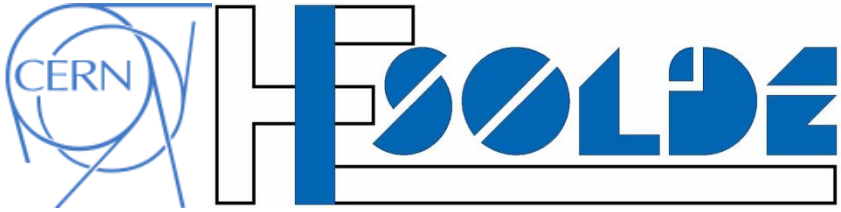


HIE-ISOLDE Project

Y. Kadi (EN-STI)

On behalf of the HIE-ISOLDE Coordination team

Overview

- HIE-ISOLDE Proposal
- Project Breakdown Structure
- Schedule
- Budget and Manpower Estimates
- Status of External Funding
- Status of HIE-ISOLDE
- Summary

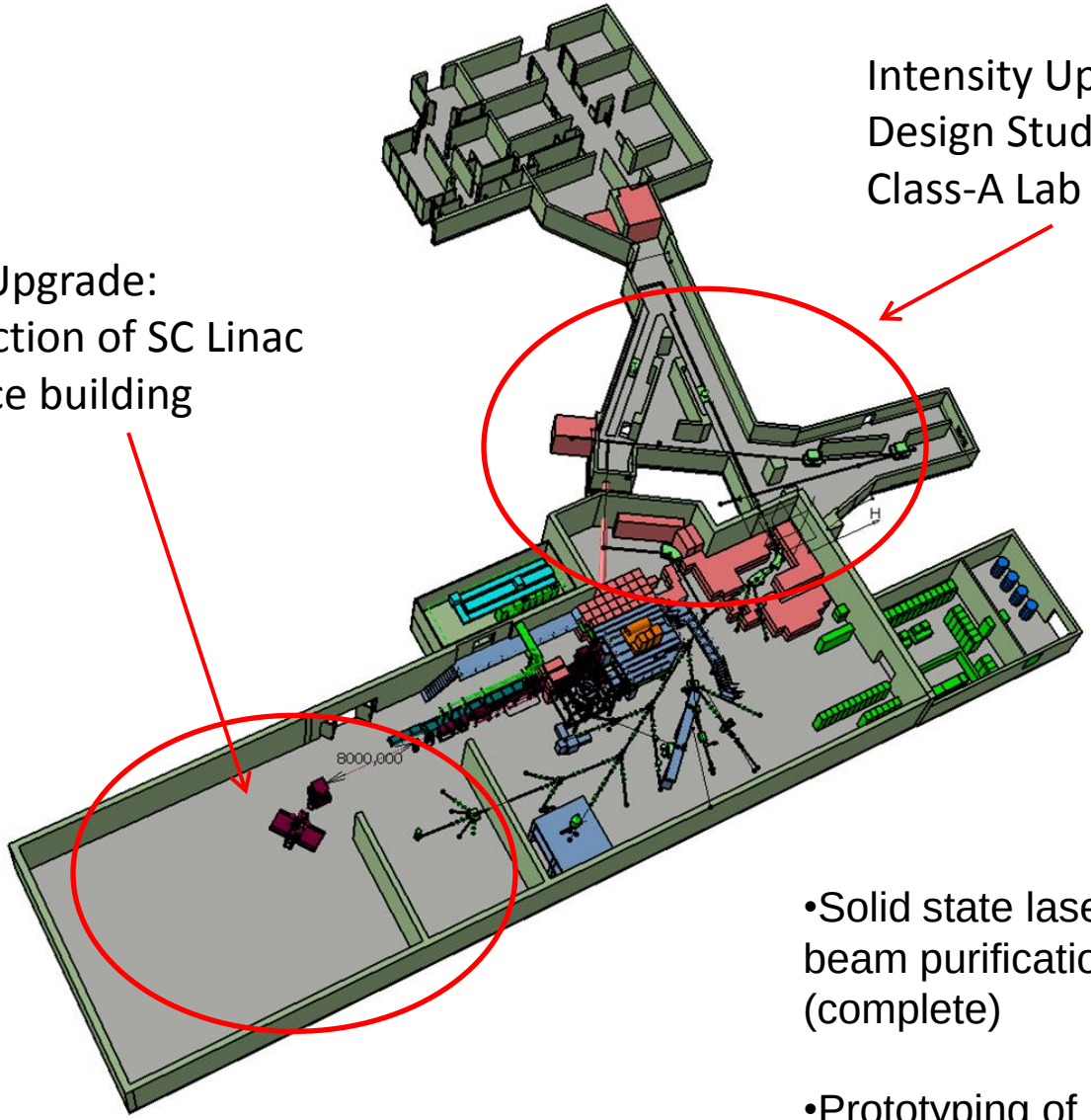
The HIE-ISOLDE Proposal

- **The High Intensity and Energy (HIE) ISOLDE proposal recently approved by CERN builds on the success of the REX-ISOLDE post accelerator and will focus on an upgrade of the REX facility that shall make available a higher final energy (10 MeV/u) and several intermediate energy levels improving the flexibility of the ISOLDE facility**
- **In order to cope with the limited resources available, the design study of the target and front-end part of ISOLDE to fully profit from upgrades of the existing CERN proton injectors, e.g. faster cycling of the PS Booster, LINAC4 (10 kW) and later LP-SPL (30 kW) is proposed to be delayed and eventually re-analyzed in 2011/2012.**

The Scope of the Project

Intensity Upgrade:
Design Study of target Area,
Class-A Lab and beam lines

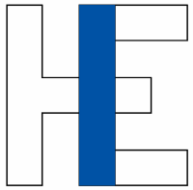
Energy Upgrade:
Construction of SC Linac
& service building



•Solid state laser, prototype RFQ cooler for beam purification and quality improvement (complete)

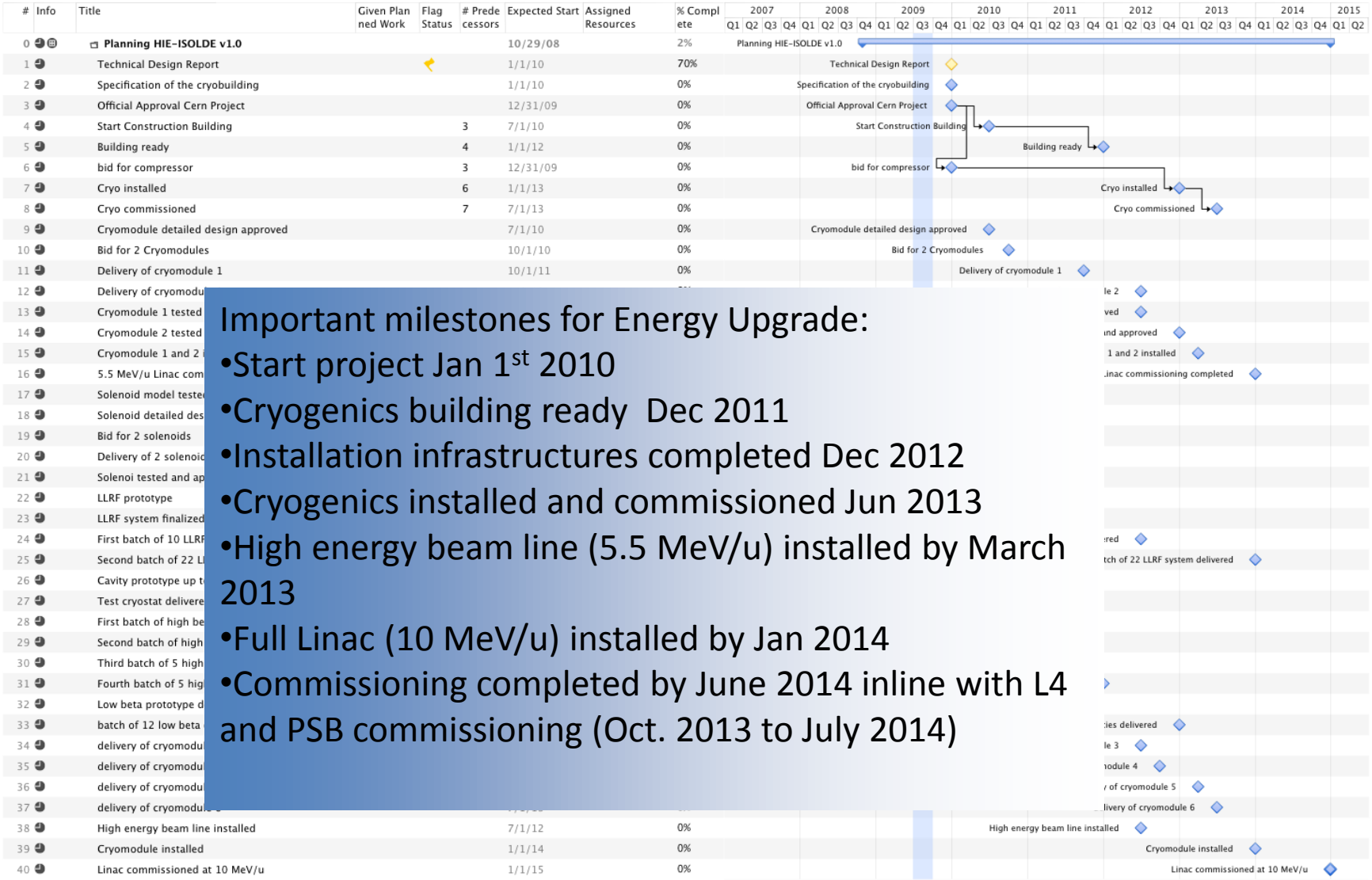
•Prototyping of linac cavities (ongoing),

Project Breakdown Structure Overview



	Steering Committee		Safety Coordination	
	1. Project Management			
HIE-ISOLDE Project	HIE-Linac	2. Linac Systems		
		3. Infrastructure and Integration		
		4. Installation and Commissioning		
	Target Area Design Study	5. Target Study		
		6. Target Area and Class A Lab		
		7. Injection and Beam Preparation		
		8. Safety	8.1 Radiation Protection	Simulations, shielding, operation, waste…
			8.2 General Safety	Risk analysis, safety files…
			8.3 Access	Interlocks, control…
			8.4 Fire Detection	

HIE-ISOLDE Schedule



#	Info	Title	Given Planned Work	Flag Status	# Predecessors	Expected Start	Assigned Resources	% Complete
0		**Planning HIE-ISOLDE v1.0**				10/29/08		2%
1		Technical Design Report				1/1/10		70%
2		Specification of the cryobuilding				1/1/10		0%
3		Official Approval Cern Project				12/31/09		0%
4		Start Construction Building			3	7/1/10		0%
5		Building ready			4	1/1/12		0%
6		bid for compressor			3	12/31/09		0%
7		Cryo installed			6	1/1/13		0%
8		Cryo commissioned			7	7/1/13		0%
9		Cryomodule detailed design approved				7/1/10		0%
10		Bid for 2 Cryomodules				10/1/10		0%
11		Delivery of cryomodule 1				10/1/11		0%
12		Delivery of cryomodu						
13		Cryomodule 1 tested						
14		Cryomodule 2 tested						
15		Cryomodule 1 and 2						
16		5.5 MeV/u Linac com						
17		Solenoid model teste						
18		Solenoid detailed des						
19		Bid for 2 solenoids						
20		Delivery of 2 solenoi						
21		Solenoi tested and ap						
22		LLRF prototype						
23		LLRF system finalized						
24		First batch of 10 LLRF						
25		Second batch of 22 L						
26		Cavity prototype up t						
27		Test cryostat delivere						
28		First batch of high be						
29		Second batch of high						
30		Third batch of 5 high						
31		Fourth batch of 5 hig						
32		Low beta prototype d						
33		batch of 12 low beta						
34		delivery of cryomodu						
35		delivery of cryomodu						
36		delivery of cryomodu						
37		delivery of cryomodu						
38		High energy beam line installed				7/1/12		0%
39		Cryomodule installed				1/1/14		0%
40		Linac commissioned at 10 MeV/u				1/1/15		0%

Important milestones for Energy Upgrade:

- Start project Jan 1st 2010
- Cryogenics building ready Dec 2011
- Installation infrastructures completed Dec 2012
- Cryogenics installed and commissioned Jun 2013
- High energy beam line (5.5 MeV/u) installed by March 2013
- Full Linac (10 MeV/u) installed by Jan 2014
- Commissioning completed by June 2014 inline with L4 and PSB commissioning (Oct. 2013 to July 2014)

Current Cost Estimate

	Materials MCHF	staff	Fellows/students
Beam quality improvements	**4**		
Prototyping, Linac up to 5.5 MeV/u	**8**	**21**	**26**
Infrastructure, management and safety	**14**	**30**	**7**
Linac up to 10 MeV/u	**8**	**6**	**3**
Design study for intensity upgrade	**2**	**14**	**17**

The current cost of HIE-ISOLDE 1 is **36 MCHF materials** and **124 FTE** (71 staff + 53 Fellows/Phd)

This includes the beam quality improvement and part of the linac design study & prototyping costs (**5 MCHF** including FTE) that have already been spent, and necessary consolidation costs. Of the assured external funding (see below) **5 MCHF** remains unspent

Cost and Manpower for Linac

Code	Description	Total Cost (kCHF)	2010	2011	2012	2013	2014
1	Project Management						
1.1	Project leader						
1.2	Linac coordination						
1.3	Design study coordination						
1.4	Budget and planning management						
2	Linac system						
2.1	Cavity RF						
2.1.1	Cavity Design						
2.1.2	LLRF system	1930	300	700	500	320	110
2.1.3	Power RF system	300	200	100			
2.1.4	Tuning and interlocks	390	20	145	145	80	
2.2	Cavity Manufacturing						
2.2.1	Copper Substrate	2350	700	700	700	250	
2.2.2	Surface treatment NB Sputttering	553	200	200	153		
2.2.3	IS TE/VSC	355	25	110	80	70	70
2.3	Beam Dynamics						
2.4	Cryomodules	4600	800	650	2500	650	
2.4.1	Design Office EN/MME	413	161	96	116	29	11
2.5	Beam Instrumentations	1406.5	100	500	500	150	156.5
2.6	SC solenoids						
2.6.1	Solenoid	360	45	90	90	90	45
2.6.2	Current leads	240	30	60	60	60	30
2.6.3	Power supply	56	7	14	14	14	7
2.7	Beam transfer line						
2.7.1	Magnets	1463	146	293	585	439	
2.7.2	Supports	250			250		
2.8	Linac integration	80	80				
3	**Infrastructure & Integrations**						
3.1	Civil engineering	1460	1000	460			
3.2	Cooling & ventilation	3065	350	2015	700		
3.3	Electrical systems	734			734		
3.4	Vacuum	1400		500	500	400	
3.5	Cryogenic system	3500	350	2800	350		
3.6	Power converters	2400	50	1400	950		
3.7	Control system	15				15	
3.8	Survey	439.44	11.6	104.16	175.68	99	49
4	Installations and commissioning						
4.1	Single cavity test						
4.2	Cryomodule test						
4.3	Linac commissioning						
4.3.1	Control applications						
	TOTAL	**27761**	**4576**	**10937**	**9103**	**2666**	**479**

FTE	2009	2010	2011	2012	2013	2014	2015
4.5		0.9	0.9	0.9	0.9	0.9	
2.5		0.5	0.5	0.5	0.5	0.5	
2.0			0.5	0.5	0.5	0.5	
1		0.2	0.2	0.2	0.2	0.2	
0.45		0.25	0.2				
6		1	1.5	1.5	1.5	0.5	
1.55		0.75	0.8				
4.4		1	1	1	1	0.2	0.2
8.48	0.78	2.4	3.1	1.05	0.95	0.2	
1.5		1	0.5				
7.75	0.6	1.9	2.95	1.5	0.7	0.1	
8.04		1.5	1.5	1.5	1.5	1.34	0.7
0.4	0.4						
6.7		1.3	2.1	2.3	1		
1		0.2	0.2	0.2	0.2	0.2	
2		1	1				
2.6		0.5	1.1	1			
2.8		0.55	0.55	0.9	0.6	0.1	0.1
6.0	0.1	0.7	2.7	2.5			
1					0.5	0.5	
4.6			1.4	1.4	1.4	0.4	
5		2	2	1			
2				1	1		
3						2	1
2						1	1
87.27	**1.88**	**17.65**	**24.7**	**18.95**	**12.45**	**8.64**	**3**

Design Study Cost and Manpower

Code	Description	Principal Groups Involved	**Total (kCHF)**	2010	2011	2012	2013		**Total FTE**	2010	2011	2012	2013
5	**Target Study**												
5.1	Conceptual target design												
5.1.1	Target Material	EN/STI	150	75	75				3	1.5	1.5		
5.1.2	Target Design	EN/STI	200	100	100				3	1.5	1.5		
5.1.3	Target handling and storage	EN/HE	150	75	75				3	1.5	1.5		
5.2	Front ends	EN/STI											
5.2.1	HV and high current systems		250	50	75	75	50		4.3	1.1	1.2	1	1
5.2.2	Extraction optics		50		50				0.5	0.25	0.25		
5.2.3	FE design	EN-TE	200	100	100				3	1.5	1.5		
5.3	Beam diagnostics	BE/BI							0.2	0.1	0.1		
6	**Target Area and Class-A lab Integration**												
6.1	Layout upgrade	EN/MEF	120		120								
6.2	Cooling and Ventilation	EN/CV	115	115					1	1			
6.3	Electrical systems	EN/EL							0.4	0.1	0.1	0.1	0.1
6.4	Vacuum	TE/VSC	100	50	50				2	1	1		
6.5	Survey	BE/ABP							0.4	0.1	0.1	0.1	0.1
6.6	Civil engineering	GS/SEM	50		50				0.4	0.1	0.1	0.1	0.1
6.7	LL controls	EN/STI	100	50	50				2	0.25	1	0.75	
7	**Injection and beam preparation**												
7.1	Beam line magnets	TE/MSC							0.1		0.1		
7.2	Off line separator	EN-STI	200	100	100				1	0.5	0.5		
7.3	Separator areas												
7.3.1	HRS magnet	EN/STI	25		25				1	0.5	0.5		
7.3.2	RFQ cooler	EN/STI	50	25	25				1	0.5	0.5		
7.3.3	Pre Separator	EN/STI	50	25	25				1	0.5	0.5		
7.4	Experiment Hall	EN/MEF	100	50	50				0.2	0.1	0.1		
7.5	Beam lines	PH/SME	100	50	50				0.2	0.1	0.1		
8	**Safety**												
8.1	Radioprotection												
8.1.1	Linac	SC/RP	500			250	250		4	1	1	1	1
8.1.2	Design study	SC/RP							4	1	1	1	1
8.2	Safety	DG/SCR							4	1	1	1	1
8.3	Access system	GS/ASE	165				165						
8.4	Fire detector	GS/ASE	40			40							
		Total	**2715**	**865**	**1020**	**365**	**465**		**39.7**	**15.2**	**15.15**	**5.05**	**4.3**

Status of External Funding

- Main funds from K.U. Leuven – Belgium (**4.3 MCHF + 4 FTE, 1 MCHF + 2 FTE already spent on R&D activity)**
- Additional funds provided by ISOLDE coll. (**2.0 MCHF**)
- Other beam quality investments (new RILIS, RFQ cooler,…) – funded by Sweden, UK (**4 MCHF already spent**)
- Other opportunities (**Scandinavian** Interregional Package, **KoRIA** Project) being explored.
- **Special Technical Training Program (2 FTE funded by Spain)**
- **Marie-Curie Fellowships within ITN3 (Fall 2010 / 2011**) – request for 21 fellows for 3 years = 63 FTE's (deadline Dec. 22, 2009)

Research Training Themes Addressed by this ITN Proposal

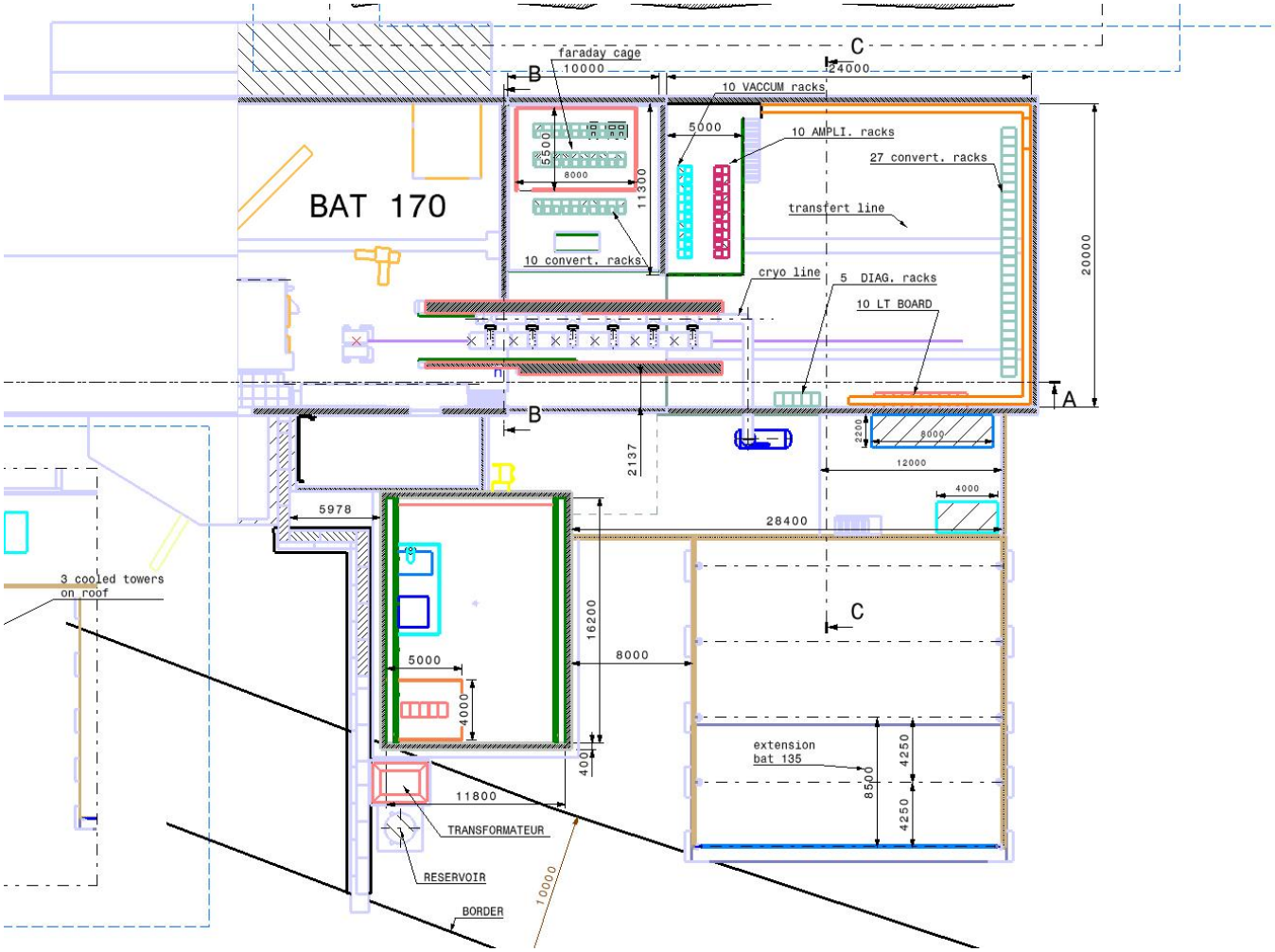
HIE-ISOLDE Subsystem	Research Training Theme	No. ESR	No. ER
I. Linac	1. Super-conducting Cavity RF (LLRF system)	1	-
	2. Super-conducting Cavity manufacturing	1	-
	3. Beam Instrumentation	1	1
	4. Transfer Line magnets	1	-
	5. Linac Integration	1	-
	6. Linac Alignment	1	-
	7. Single Cavity and complete Cryomodule tests	1	-
	8. Linac commissioning and control applications development	1	-
II. Design Study for intensity upgrade	9. Target Material Development	1	-
	10. Target design	2	-
	11. High voltage and high current systems	1	-
	12. Extraction optics and front-end design	1	-
	13. Cooling and ventilation	1	-
	14. Vacuum systems	1	-
	15. Low-Level controls	1	-
	16. Off-line separator and HRS magnet	1	-
	17. RFQ cooler and Pre-separator	1	-
	18. Beam lines (REX-EBIS studies)	1	-
III. Safety	19. Radiation protection systems for the Linac.	-	1
	20. Radiation protection studies for the Intensity Upgrade	1	-

R&D activity on HIE-LINAC

- RF – Beam dynamics studies
- High β cavity prototype
  - Copper substrate manufacturing
  - Chemical etching
  - Nb sputtering
- RF sub-system prototypes
  - Tuner
  - Power coupler
- SC solenoid prototype
- Cryomodule design

➢In parallel preparation of a test stand for QWR at CERN

The HIE-ISOLDE facility



Summary (1/2)

HIE ISOLDE R&D activity is in good health and ongoing:

- Cavity prototype completed. Tests to be done @ TRIUMF
- Cryomodule concept design completed, will start detailed design as soon as manpower is available
- Preparation of test bench at CERN of QWR resonators (new test cryostat is planned to be ready by Feb/Mar 2010)
- Complete Cavity configuration test is planned by the end of 2010.

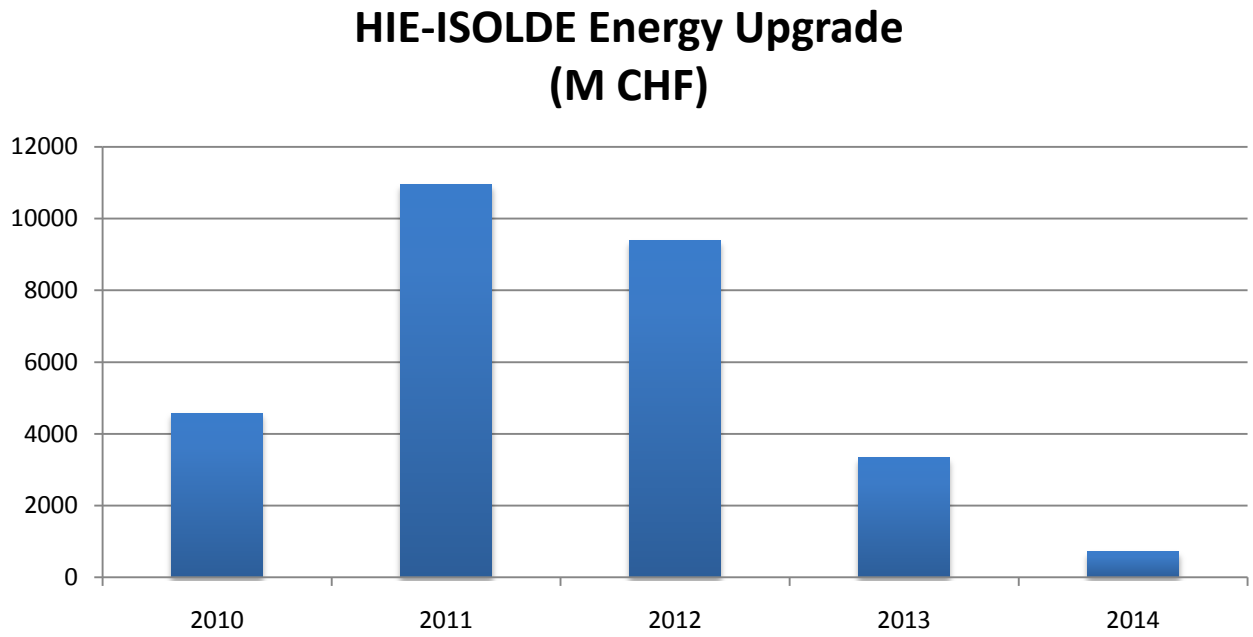
Summary (2/2)

- Submit Marie-Curie Fellow request
- Fellow for RF Cavity Tests => launch fabrication of 5 series cavities
- Fellow for Cryomodule detailed design due by mid-2010
- Prepare Resource-loaded Plan for CERN Management => release resources as early as possible (mid-2010/2011)
- If construction starts by mid-2010, then installation and commissioning of the first 2 cryo-modules for 2013

Acknowledgements

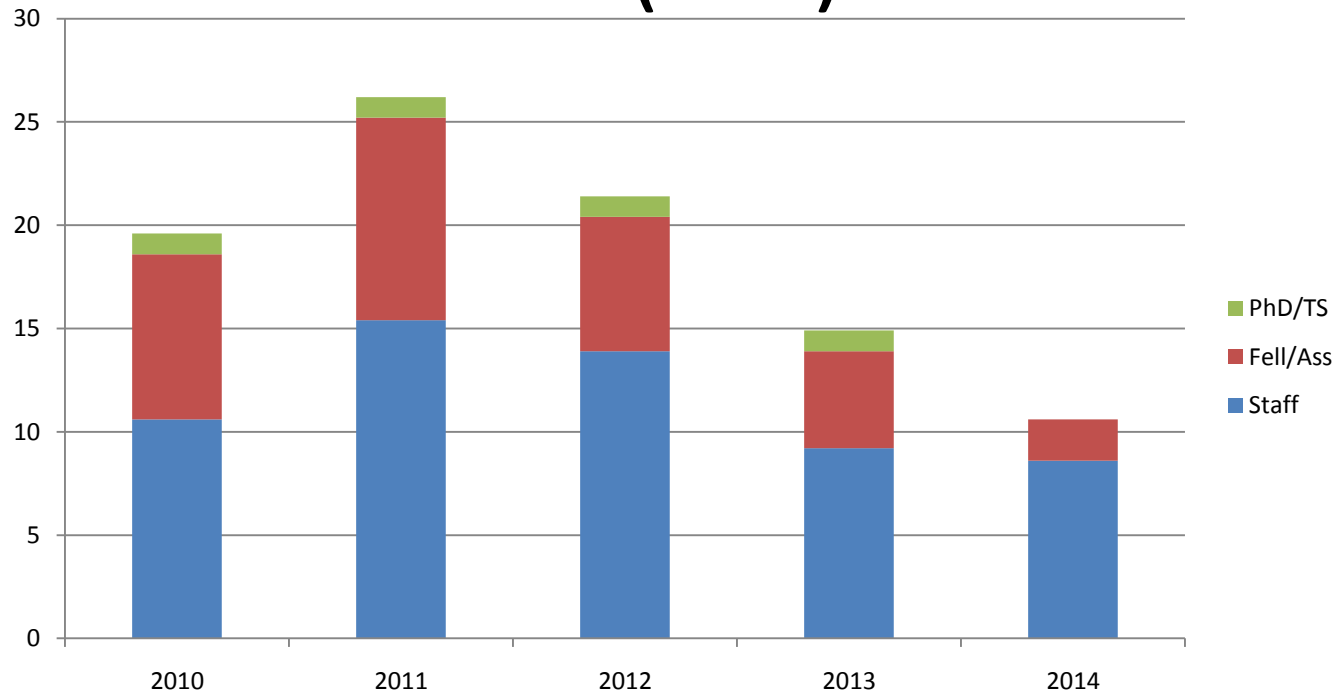
- The coordination team would like to express their sincere gratitude to all those who have contributed to this project plan.

Material Cost Spending Profile



- Linac + Infrastructure 28.97 MCHF
- Fell/Ass 3.72 MCHF
- PhD/TS 0.20 MCHF

Manpower Requirements (FTE)



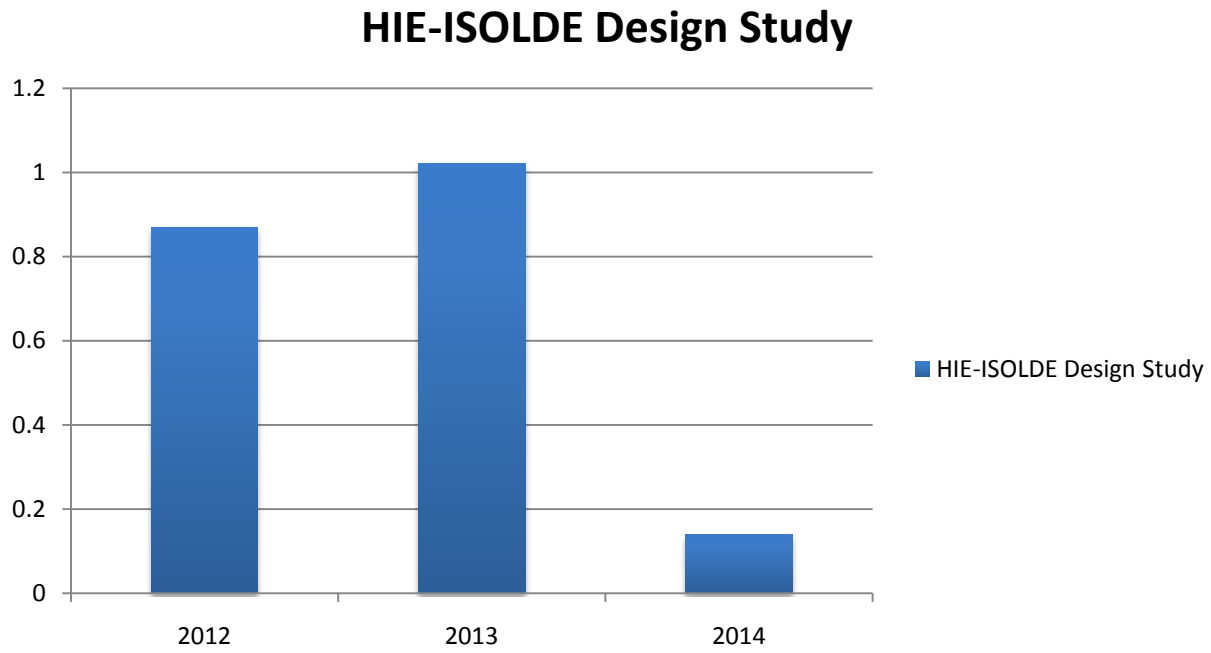
Staff:

- Management 14.5 FTE
- HIE-Linac 40.2 FTE
- Safety 3 FTE

Material spending per FTE/year:

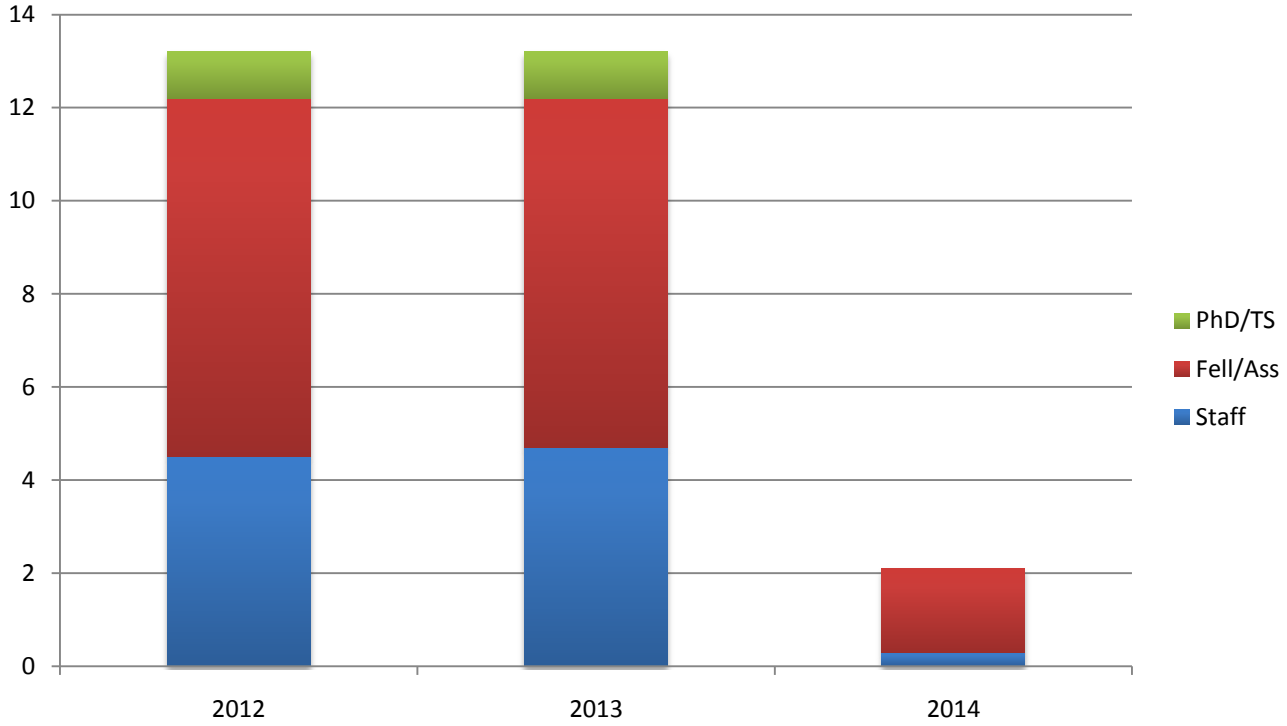
<u>100kCHF</u>

Material Cost Spending Profile



- Design Study 2.03 MCHF
- Fell/Ass 2.04 MCHF
- PhD/TS 0.10 MCHF

Manpower Requirements



Staff:

- Design Study 7.5 FTE
- Safety 2 FTE

INTERREG_IV_A Proposal (Norway)

A University Cluster and Regional Industry Collaboration in High-Tech Accelerator Development for Subatomic Physics and Neutron Scattering

The aim is to provide the opportunity for local companies to take part in an ongoing accelerator development project to enhance the long term capability and competence of these companies to participate in the continuous maintenance and development of the ESS proton driver and associated equipment. The project falls under eligibility criteria A of interregional program IV of the European Union. It aims to support sustainable economic development in the region by developing local enterprise with the regional profile provided by ESS.

Participating universities in the region include Lund University, Aarhus University, Chalmers University of Technology and Oslo University. Contacts have also been initiated with local companies such as Danfysik. The groups at these participating universities have long standing knowledge of accelerator based research and are currently participating in a development project for a new accelerator for radioactive ion beams at CERN.

The aim of the collaboration is to perform prototyping and development work within the following areas or a subset thereof:

- Design and prototyping of normal conducting magnets
- Copper cavity machining and electron beam welding for superconducting cavity construction
- 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

The gain for the participating university groups is also the establishment of a close collaboration in the field of subatomic physics within the region that will be
maintained over at least the coming 20 years and this in collaboration with local industry.

HIE-LINAC WBS

2.0 Linac system				Groups
	2.1 Cavity RF			BE/RF
		2.1.1 Cavity Design		
		2.1.2 LLRF system		
		2.1.3 Power RF system		
		2.1.4 Tuning and interlocks		
	2.2 Cavity Manufacturing			EN/MME-TE/VSC
		2.2.1 Copper Substrate		
		2.2.2 Surface treatment Nb Sputtering		
	2.3 Beam Dynamics			BE/RF-ABP
	2.4 Cryomodules			TE/MSC-EN/MME
	2.5 Beam Instrumentation			BE/BI
	2.6 SC solenoids			TE/MSC
		2.6.1 Solenoid		
		2.6.2 Current leads		
		2.6.2 Power supply		
	2.7 Beam transfer line			TE/MSC
		2.7.1 Magnets		
		2.7.2 Supports		
	2.8 Linac integration			EN/MEF
3.0 Infrastructure				
	3.1 Civil engineering			GS/SEM
	3.2 Cooling & ventilation			EN/CV
	3.3 Electrical systems			EN/EL
	3.4 Vacuum			TE/VSC
	3.5 Cryogenic system			TE/CRG
	3.6 Power converters			TE/EPC
	3.7 Control system			BE/CO
	3.8 Survey			BE/ABP
4.0 Installations and commissioning				
	4.1 Single cavity test			BE/RF
	4.2 Cryomodule test			BE/RF-TE/MSC
	4.3 Linac commissioning			BE/RF
		4.3.1 Control applications		BE/OP

Target Area Design Study WBS

5.0 Target Study				GROUPS
	5.1 Conceptual target design			EN/STI-HE
		5.1.1 Target Material		
		5.1.2 Target Design		
		5.1.3 Target handling and storage		
	5.2 Front ends			EN/STI-TE/EPC/VSC/ABT
		5.2.1 HV and high current systems		
		5.2.2 Extraction optics		
		5.2.3 FE design		
	5.3 Beam diagnostics			BE/BI
6.0 Target Area and Class-A lab Integration				
	6.1 Layout upgrade			EN/MEF
	6.2 Cooling and Ventilation			EN/CV
	6.3 Electrical systems			EN/EL
	6.4 Vacuum			TE/VSC
	6.5 Survey			BE/ABP
	6.6 Civil engineering			GS/SEM
	6.7 LL controls			EN/STI
7.0 Injection and beam preparation				
	7.1 Beam line magnets			TE/MSC
	7.2 Off line separator			EN/STI-TE/EPC/VSC/ABT
	7.3 Separator areas			
		7.3.1 HRS magnet		EN/STI-TE/MSC
		7.3.2. RFQ cooler		EN/STI-TE/EPC/VSC/ABT
		7.3.3 Pre Separator		EN/STI-TE/EPC/VSC/ABT
	7.4 Experiment Hall			EN/MEF
	7.5 Beam lines			PH/SME

Safety

- All safety aspects of the project should be addressed by an independent safety commission who should evaluate and approve the proposed modifications to the facility. However the following tasks should be a part of the safety work package.
- Radiation Protection
  - Fluka simulations, shielding calculations
  - Radioactive waste inventory and conditioning, transport, elimination pathway.
  - Operational boundary conditions
- Safety
  - Risk analysis, safety files, safety management plan, general safety
- Access
  - Interlocks, protocol, primary and secondary areas.
- Fire detection