The HIE-ISOLDE Project

Yacine Kadi on behalf of HIE-ISOLDE project team

FPRIB 2012 , 16-18 April2012

Outline

- **Scope of HIE-ISOLDE**
- Upgrade of ISOLDE Facility: HIE-ISOLDE
- R&D Activities
- Outlook for 2012

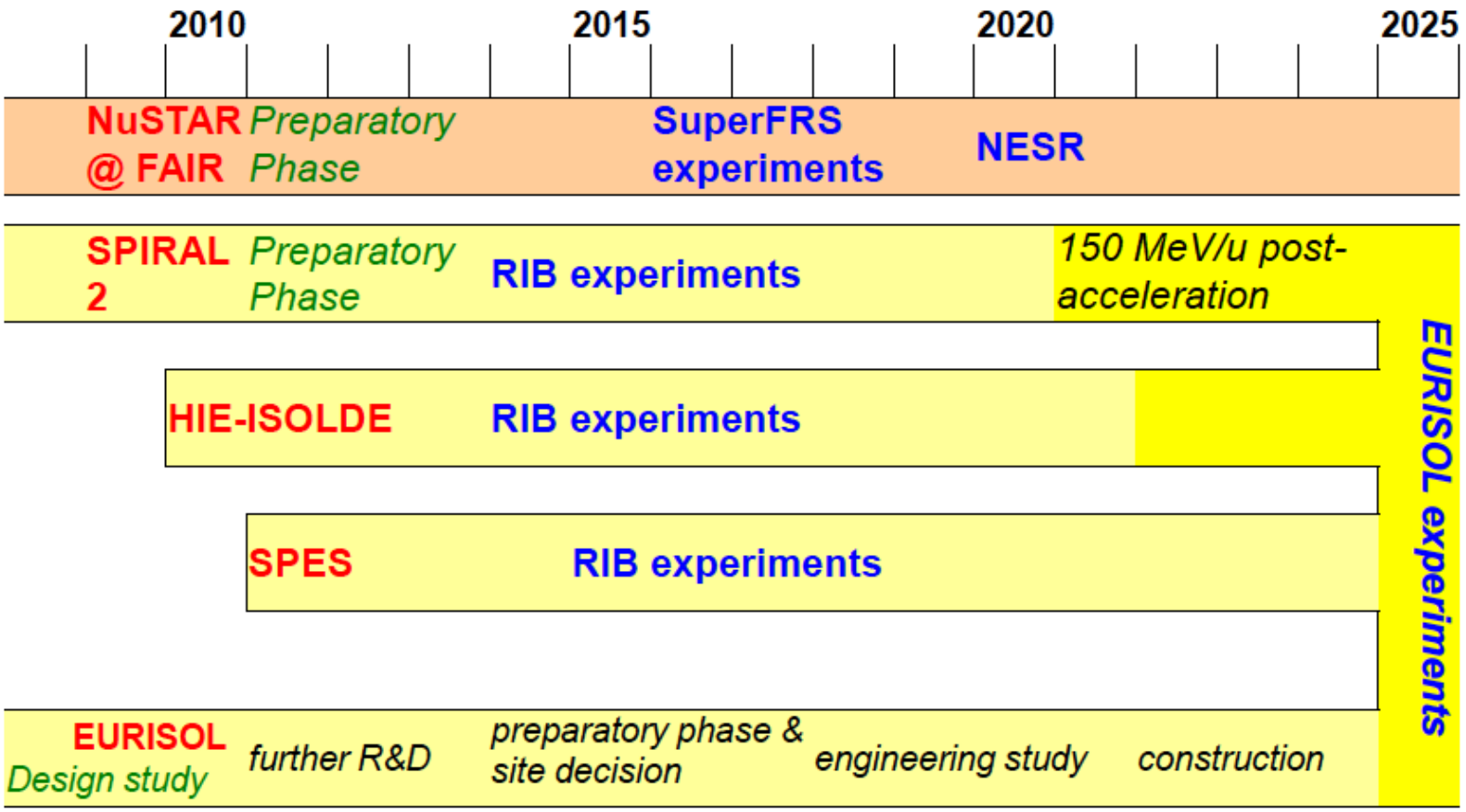
Scope

The High Intensity and Energy (HIE) ISOLDE project builds on the success of the REX-ISOLDE post-accelerator and will focus on the upgrade of the REX facility but also aims to improve the target and front-end part of ISOLDE to fully profit from upgrades of the existing CERN proton injectors (LINAC4 and PSB Upgrade):

- Higher energy for the post-accelerated radioactive beam
- More beams (Intensity wise and different species)
- Better beams (High purity beams, low emittances, more flexibility in the beam parameters)

NuPECC Long Range Plan 2010 Timeline
RIB Facilities

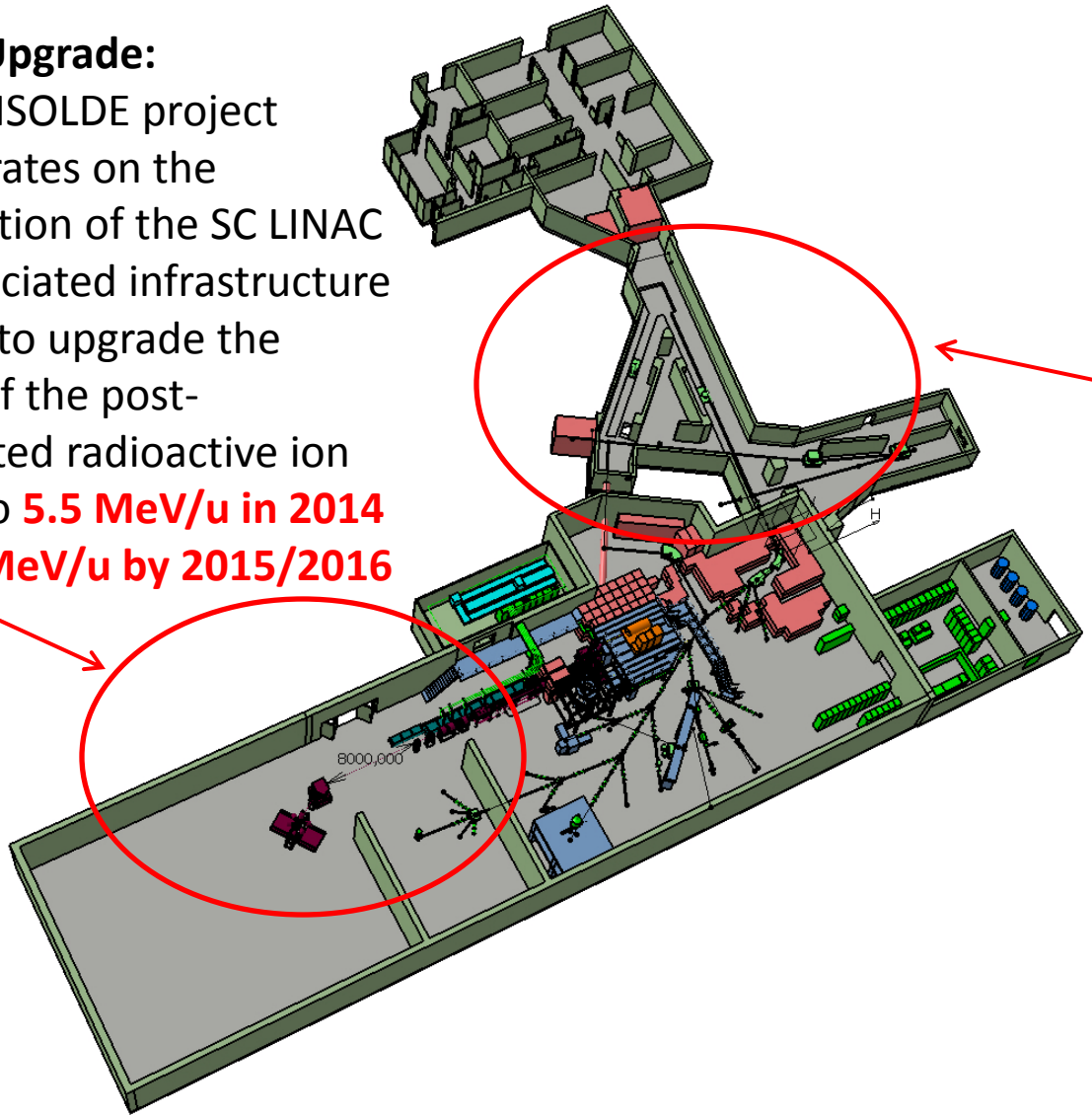
HIE-ISOLDE will play an important role in the network of ISOL facilities preparing EURISOL (with SPIRAL2 and SPES)



Worldwide: Oak Ridge; TRIUMF; KoRIA...

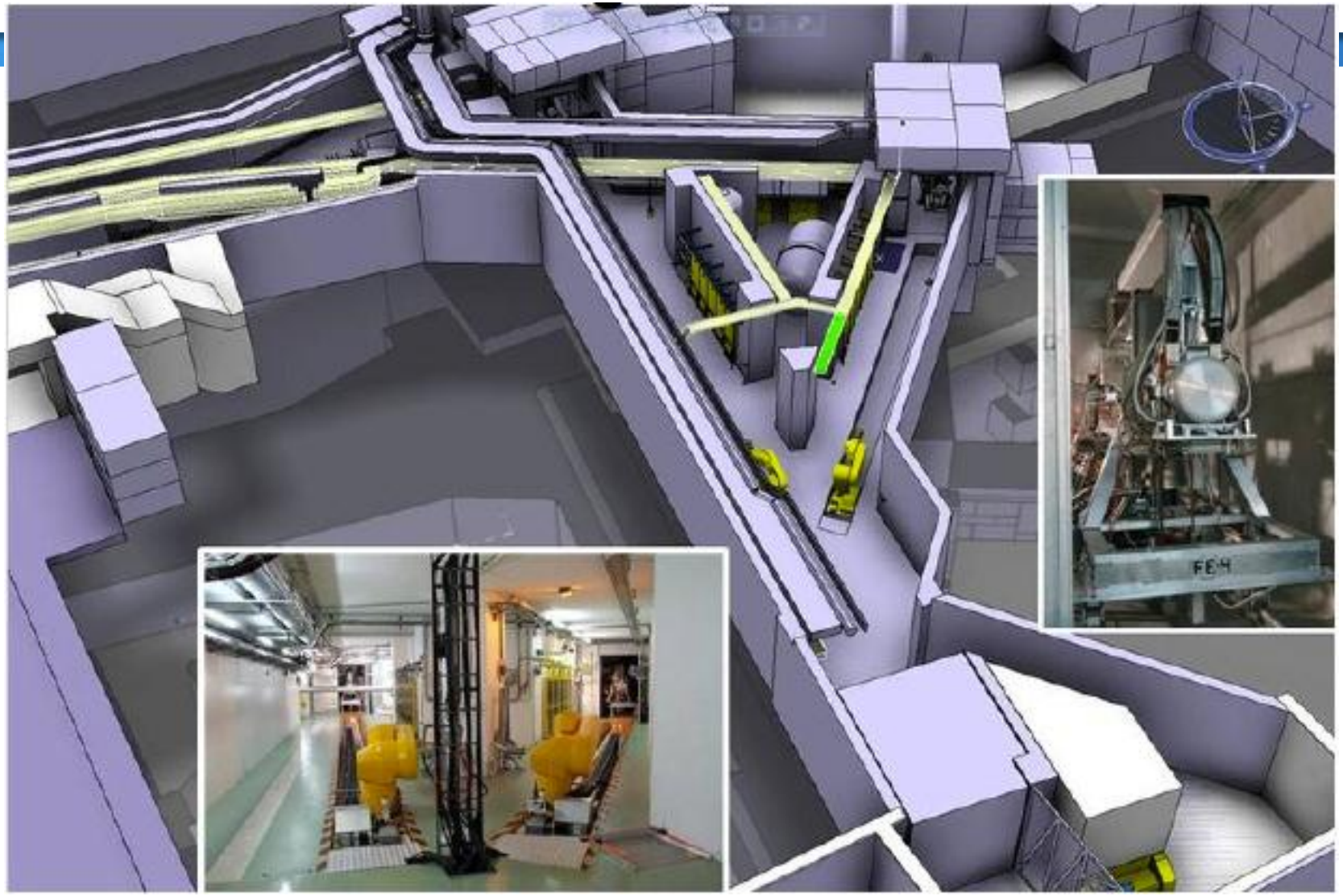
Scope of HIE-ISOLDE

Energy Upgrade:
The HIE-ISOLDE project concentrates on the construction of the SC LINAC and associated infrastructure in order to upgrade the energy of the post-accelerated radioactive ion beams to **5.5 MeV/u in 2014** and **10 MeV/u by 2015/2016**

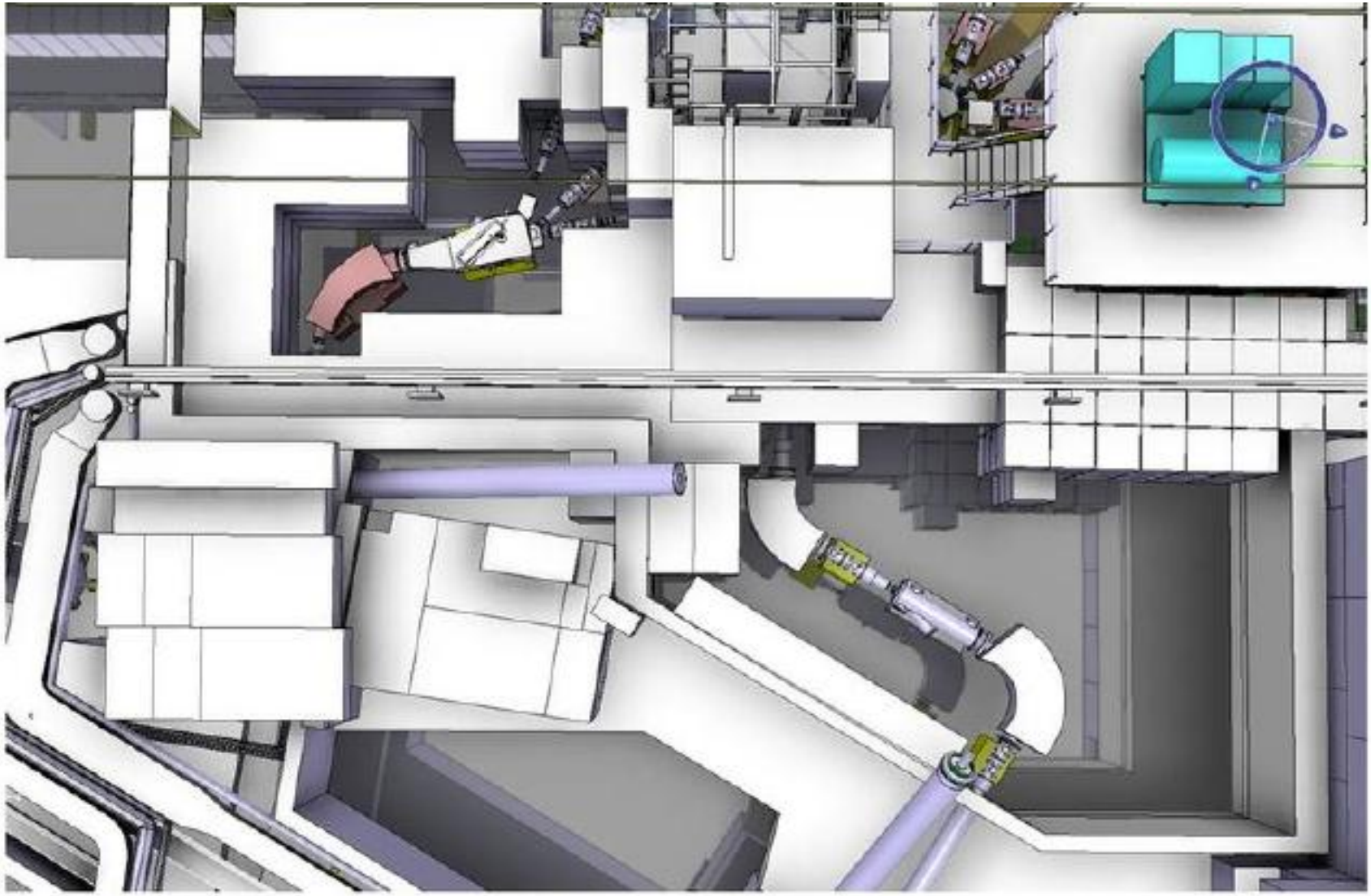


Intensity Upgrade:
The design study for the intensity upgrade, also part of HIE-ISOLDE, **starts in 2012**, and addresses the technical feasibility and cost estimate for operating the facility at **10 kW** once LINAC4 and PS Booster are online. **The 30 kW option (SPL beam) will be studied at a later stage**

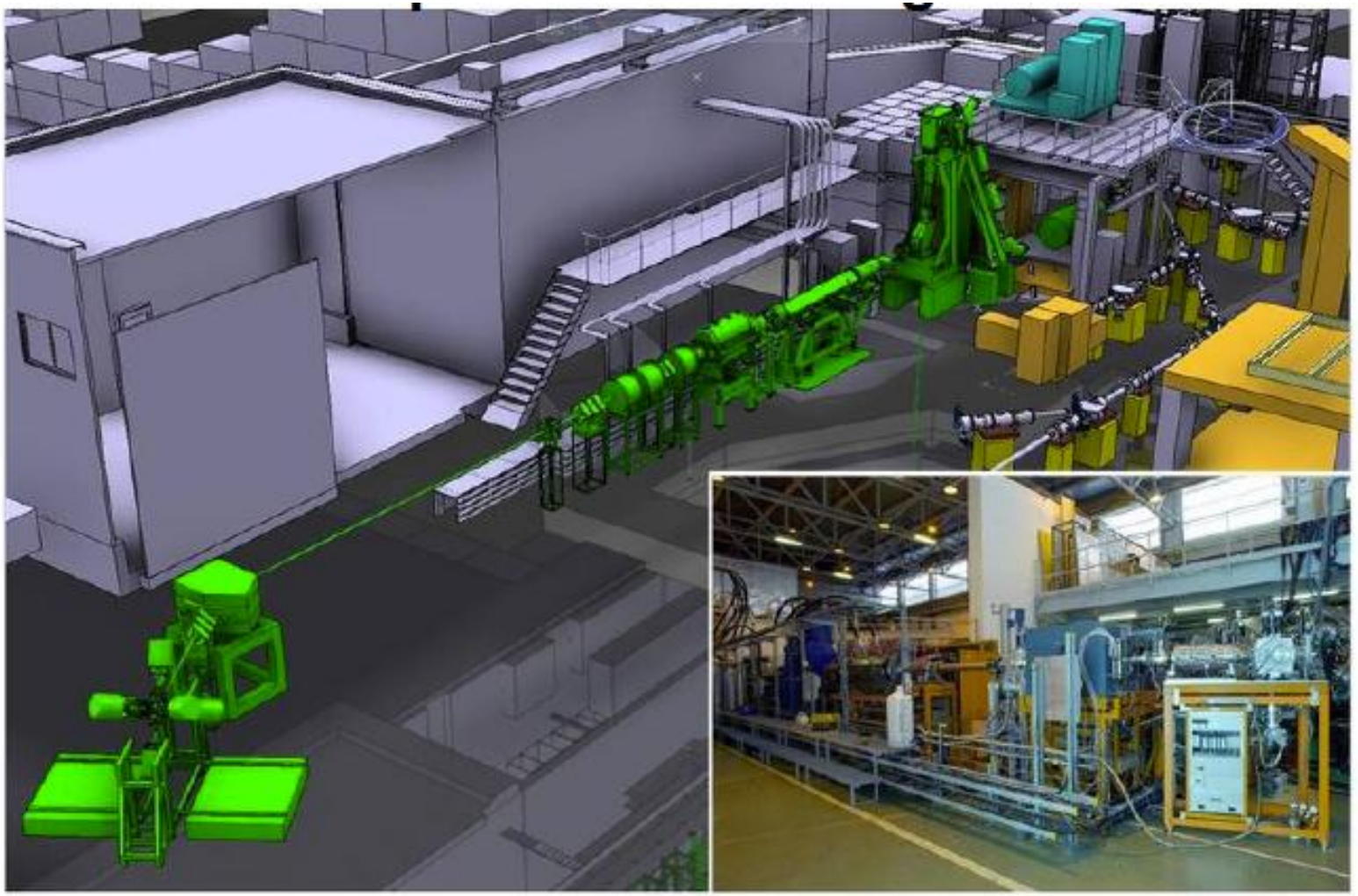
Target Zone



GPS and HRS Separators

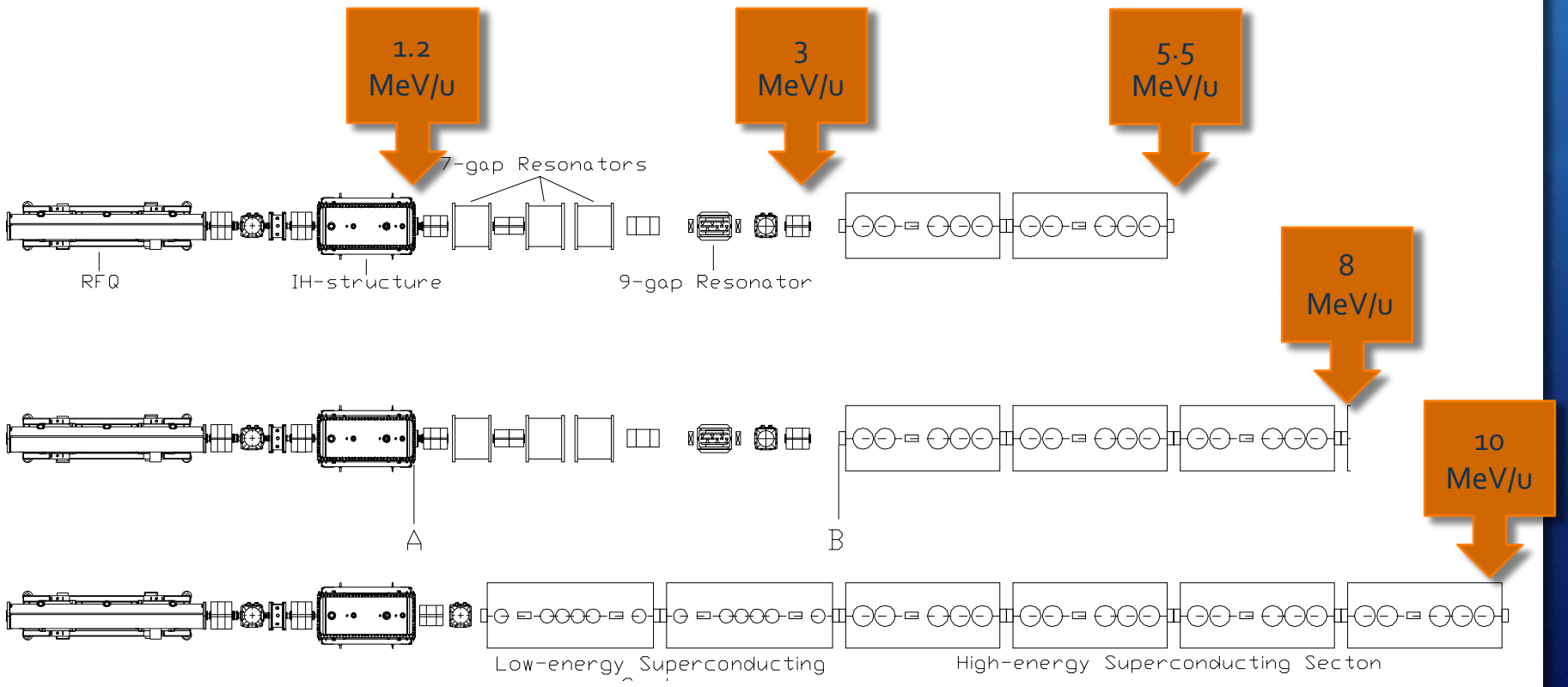


REX Post-Accelerator Linac

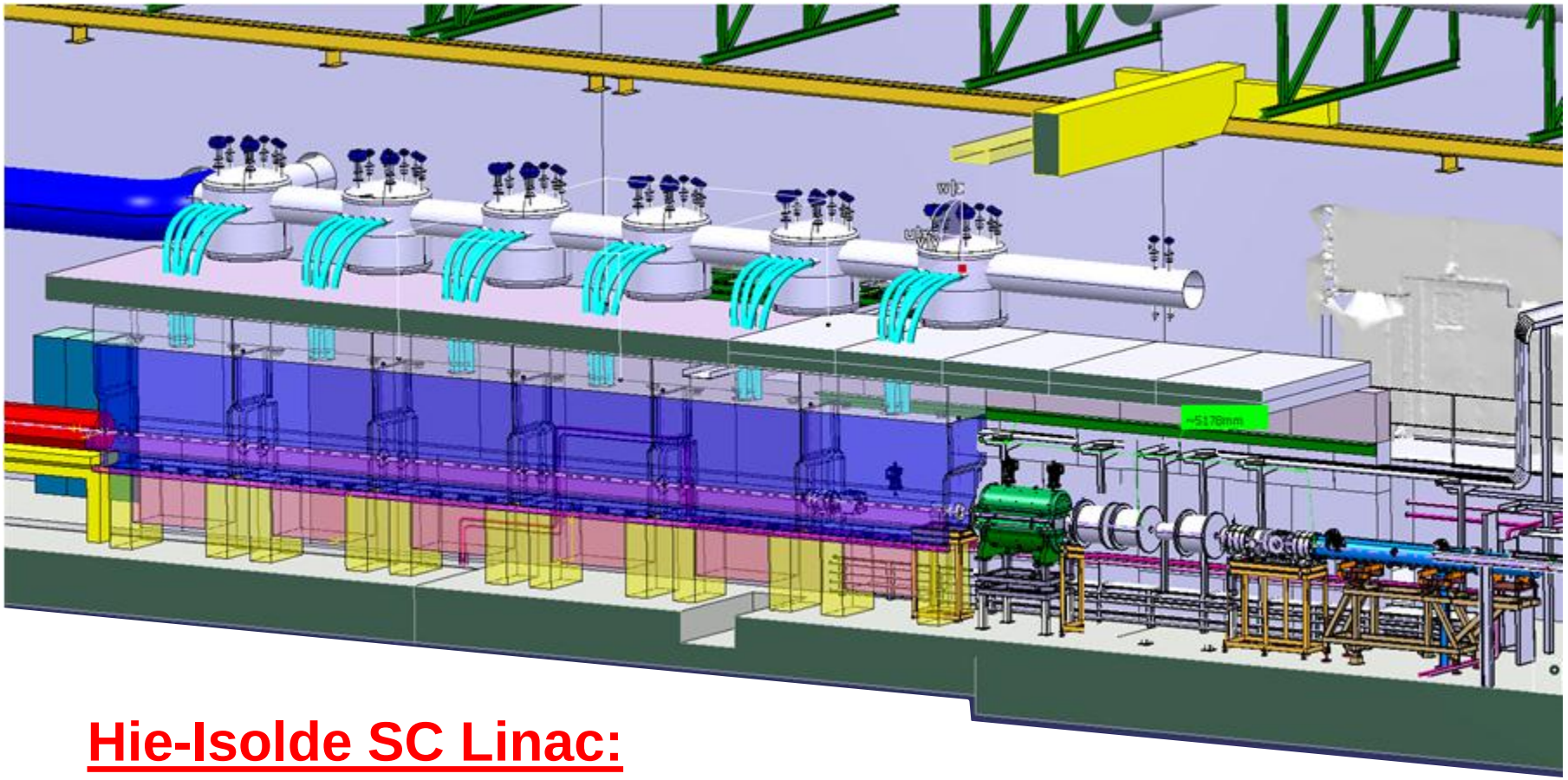


Miniball experiment

Energy Upgrade: Modular SC Linac



Hie-Isolde SC Linac



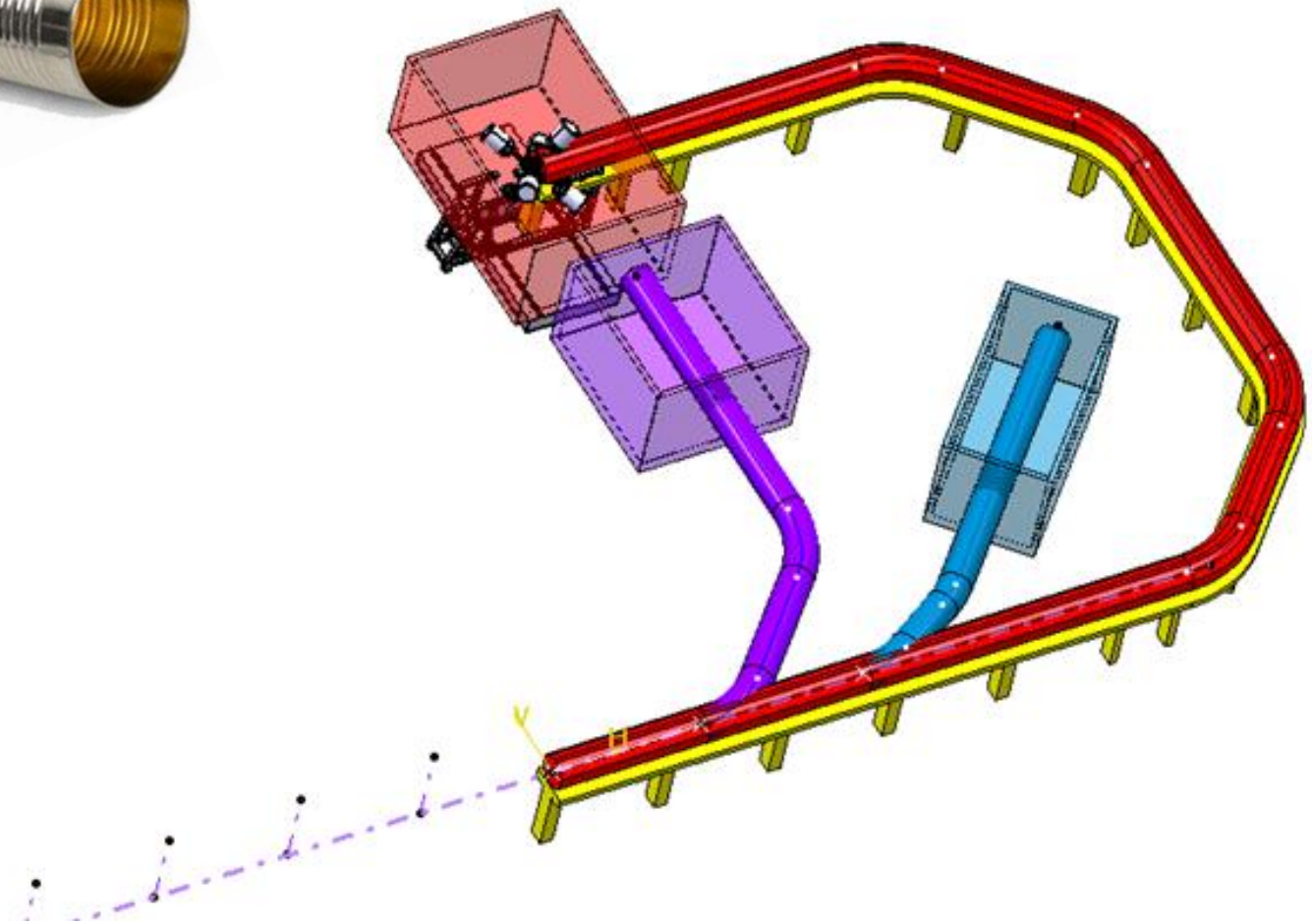
Hie-Isolde SC Linac:

5.5MeV/u by late autumn of 2014

First 10MeV/u by March 2016

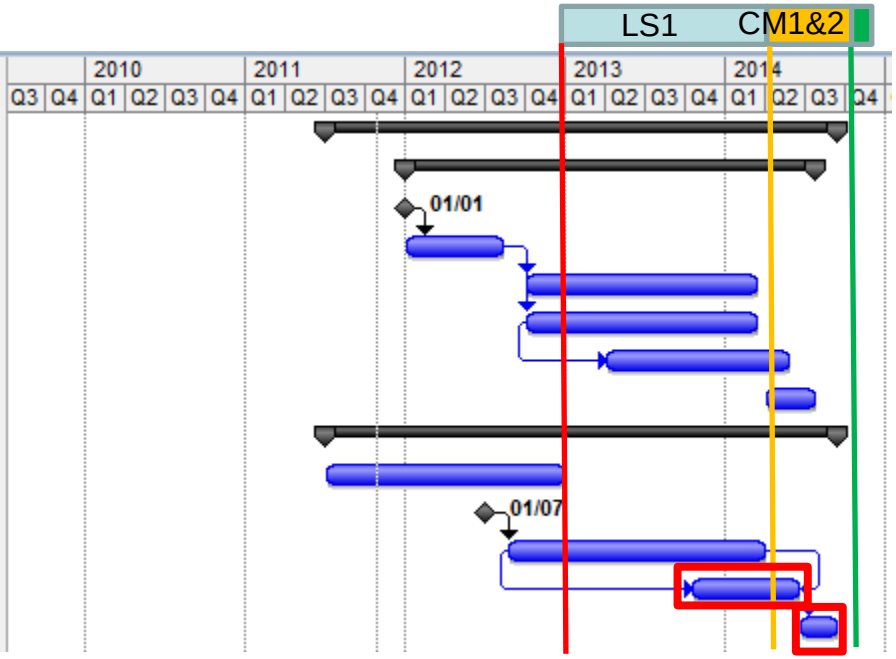
Bunched beam by 2017 ?

Beam Transfer Line



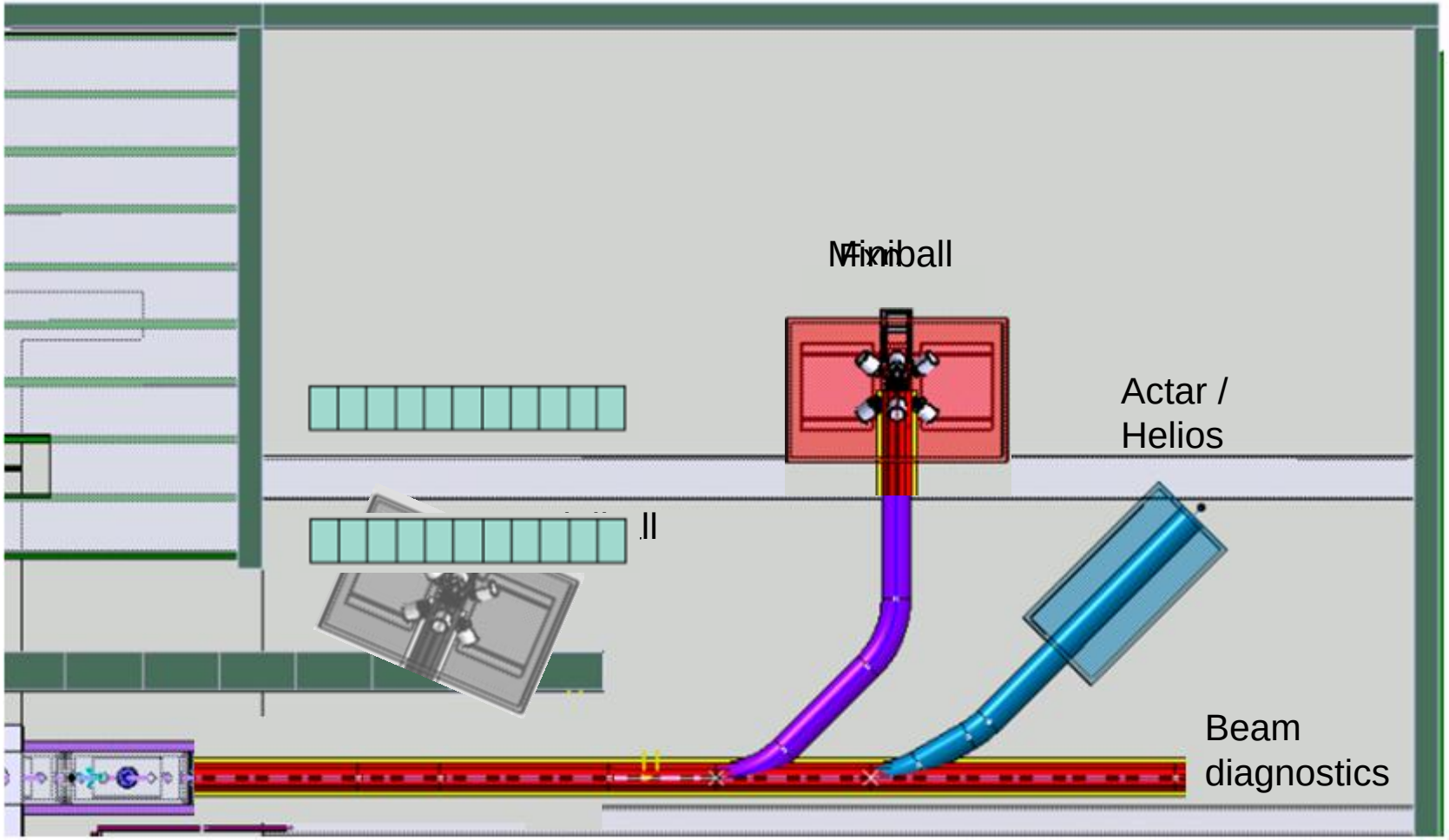
Beam Transfer Line

Task Name	Duration	Start	Finish	Pr
New Beam Transfer line	**833 days?**	**Fri 01/07/11**	**Tue 09/09/14**	
Power Converters	**666 days?**	**Sun 01/01/12**	**Mon 21/07/14**	
Technical Design Report	0 hrs	Sun 01/01/12	Sun 01/01/12	
Prototype construction & valid	8 mons	Mon 02/01/12	Fri 10/08/12	1
Procurement of 110 power co	380 days?	Mon 01/10/12	Fri 14/03/14	1
Controls for 110 power conve	380 days?	Mon 01/10/12	Fri 14/03/14	1
Reception and Testing	300 days?	Mon 01/04/13	Fri 23/05/14	1
Installation & Commissioning	4 mons	Tue 01/04/14	Mon 21/07/14	
Stage#1 Transfer line magnet	**833 days**	**Fri 01/07/11**	**Tue 09/09/14**	
Design specification and tende	391 days	Fri 01/07/11	Fri 28/12/12	
Contract signature	0 hrs	Sun 01/07/12	Sun 01/07/12	
magnet production and testing	21 mons	Tue 21/08/12	Mon 31/03/14	1
Preparation and installation	8.8 mons	Tue 15/10/13	Tue 17/06/14	
commissioning	3 mons	Wed 18/06/14	Tue 09/09/14	1



EN/HDO: YACINE KADI, TE/EPC: DAVID NISBET, TE/MSC: JEREMY BAUCHE, TE/ABT: BRENNAN GODDARD, BE/OP: DIDIER VOULOT

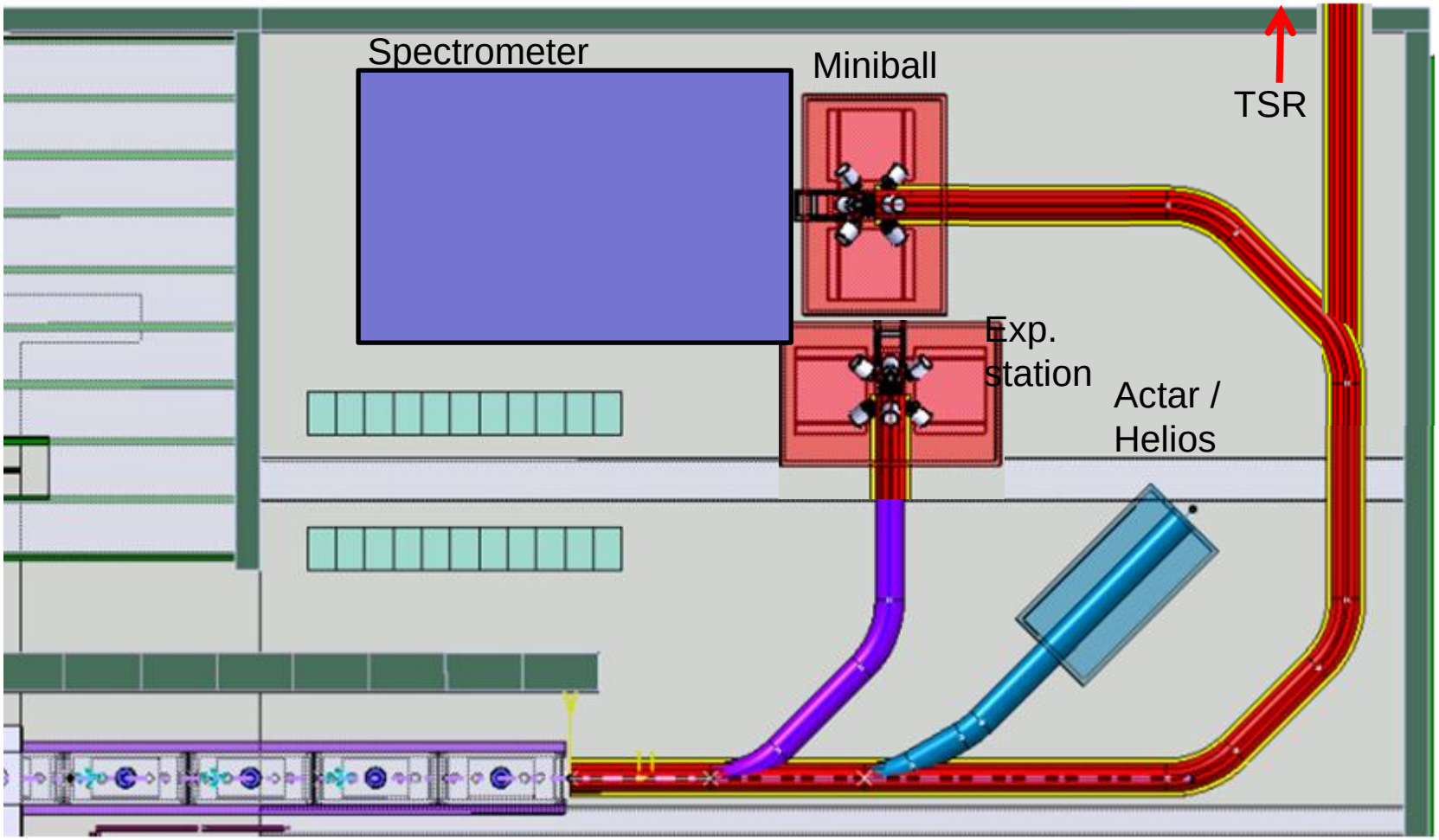
Beam Transfer Line Stage 1



Straight line with 2 branches – Oct 2013 - Sept 2014

Miniball move: Oct 2013 – April 2014

Beam Transfer Line Stage 3



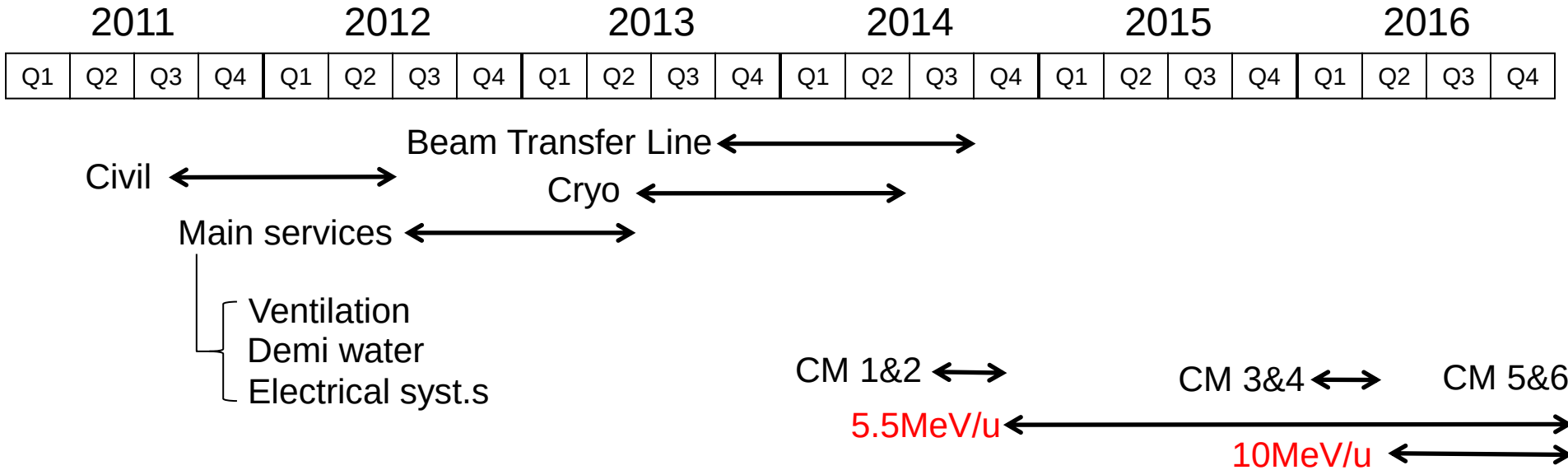
Stage 3:

TSR and beyond..

I Spectrometer installation

Hie-Isolde Planning

A simplified presentation of the different stages:



Timeline:

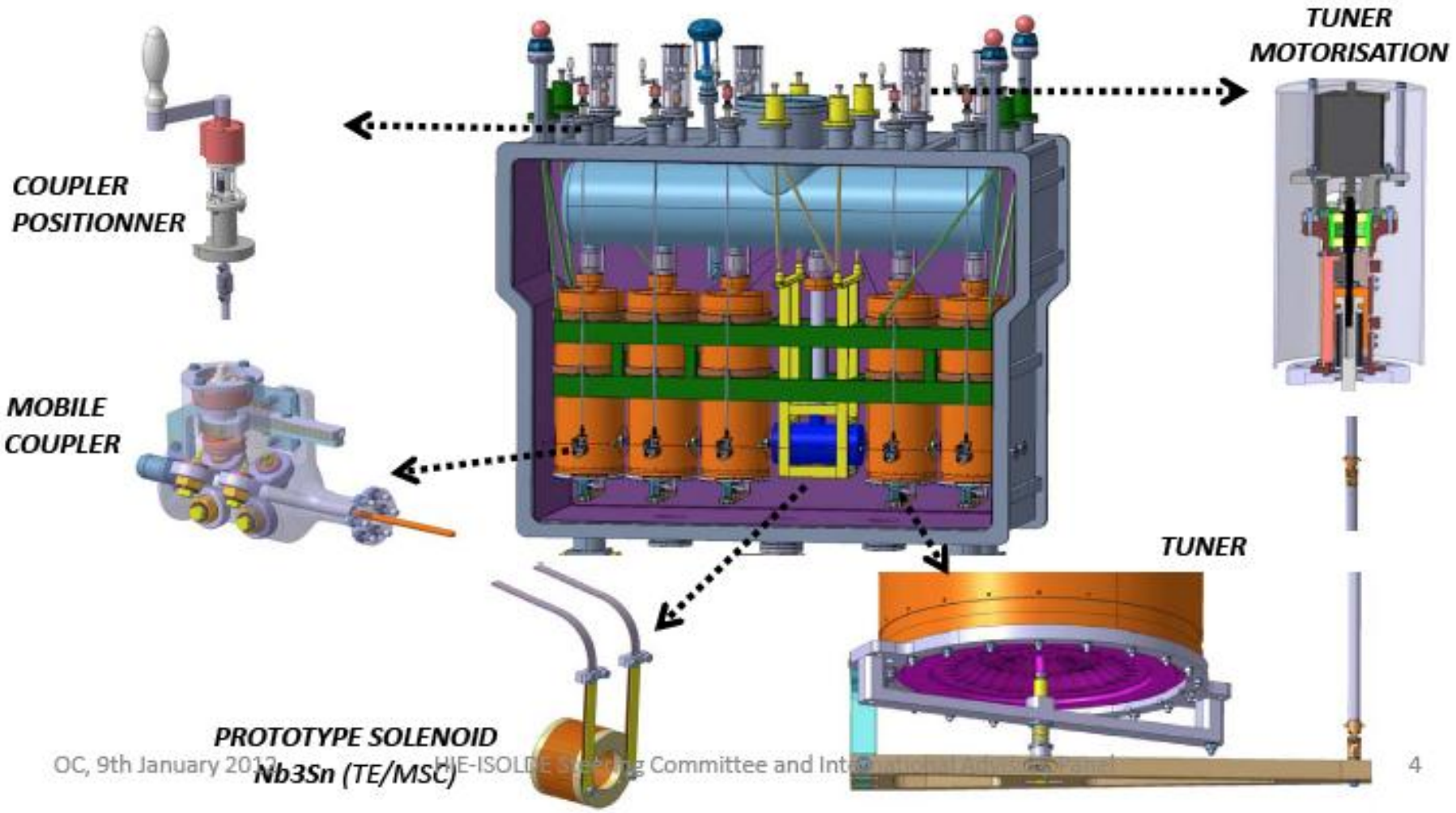
shutdown | Isolde & REX Ops | Cryo Mod 1 & 2 install | (Isolde normal operations) (REX perturbations)

Outline

- Scope of HIE-ISOLDE
- Upgrade of ISOLDE Facility: HIE-ISOLDE
- **R&D Activities**
- Outlook for 2012

R&D activities (2008 – 2010)

- What has been done
  - Ancillaries: one of each has been designed and manufactured
  - SC cavities: two designs high beta, several cavities manufactured



QWR cavities (Nb sputtered)

Low β

High β

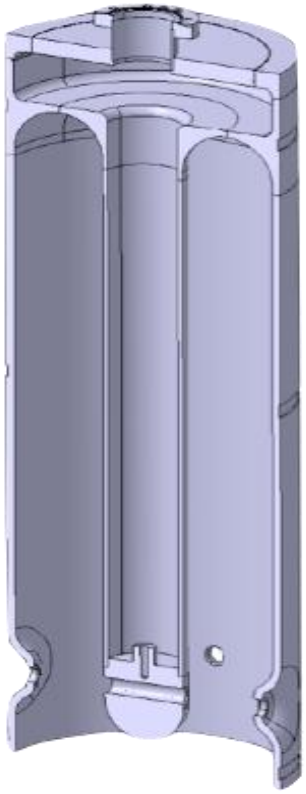


Table 1: Cavity design parameters

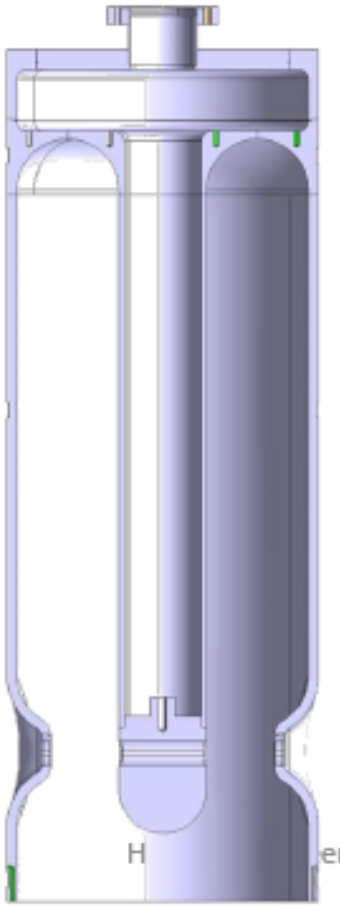
Cavity	**Low β**	**highβ**
No. of Cells	2	2
f (MHz)	101.28	101.28
β_0 (%)	6.3	10.3
Design gradient E_{acc}(MV/m)	6	6
Active length (mm)	195	300
Inner conductor diameter (mm)	50	90
Mechanical length (mm)	215	320
Gap length (mm)	50	85
Beam aperture diameter (mm)	20	20
$U/E_{acc}{}^2$ (mJ/(MV/m)^2	73	207
E_{pk}/E_{acc}	5.4	5.6
H_{pk}/E_{acc} (Oe/MV/m)	80	100.7
R_{sh}/Q (Ω)	564	548
$\Gamma = R_s \cdot Q_0$ (Ω)	23	30.6
Q_0 for 6MV/m at 7W	$3.2 \cdot 10^8$	$5 \cdot 10^8$
TTF max	0.85	0.9
No. of cavities	12	20

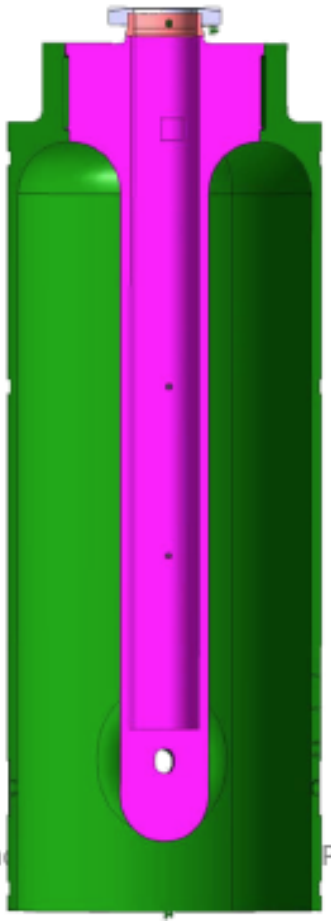
Superconducting RF cavity

- Cavity design
  - Only high-beta cavities have been designed so far
  - Very tight geometrical tolerances required
  - Two versions were designed

OLD VERSION

- Rolling, Deep-drawing, EB welding





NEW VERSION

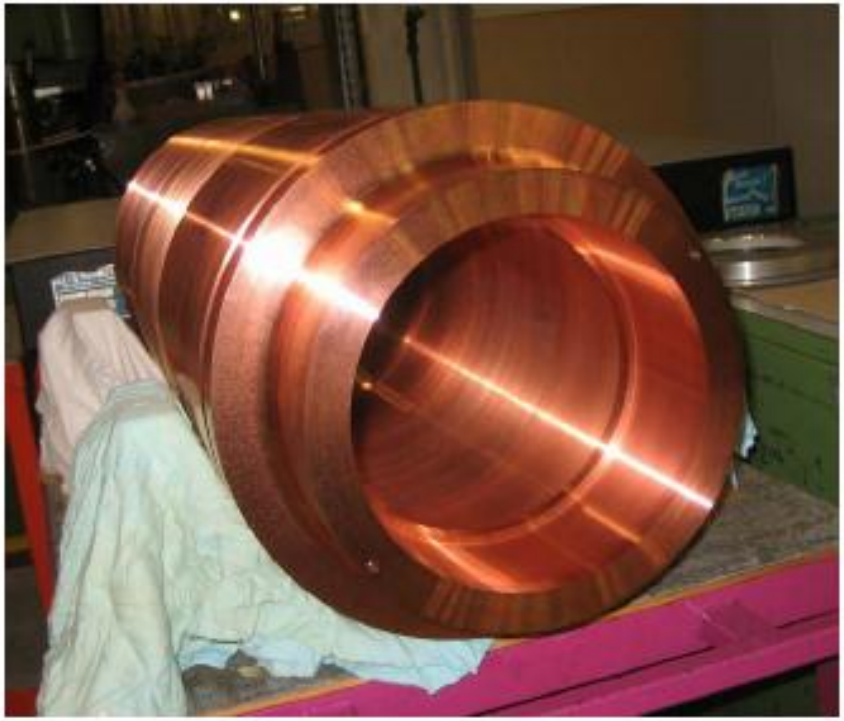
- Machining bulk copper, EB welding

Superconducting RF cavity

- Manufacturing high- beta cavities – OLD VERSION
  - Inner and outer cylinders assembly

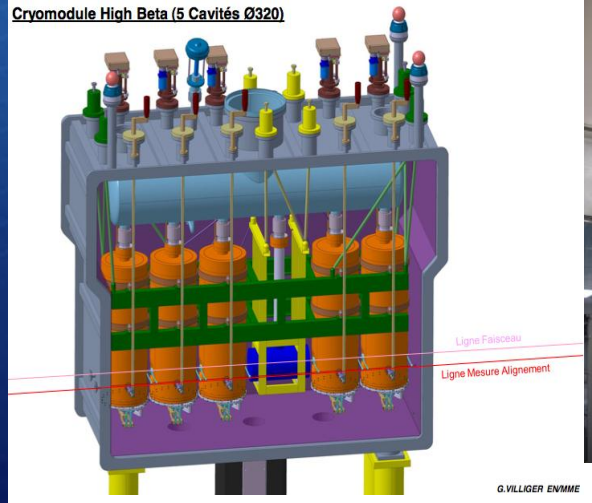
Superconducting RF cavity

- Manufacturing high- beta cavities – NEW VERSION
  - One prototype of the "new version" manufacturing ongoing

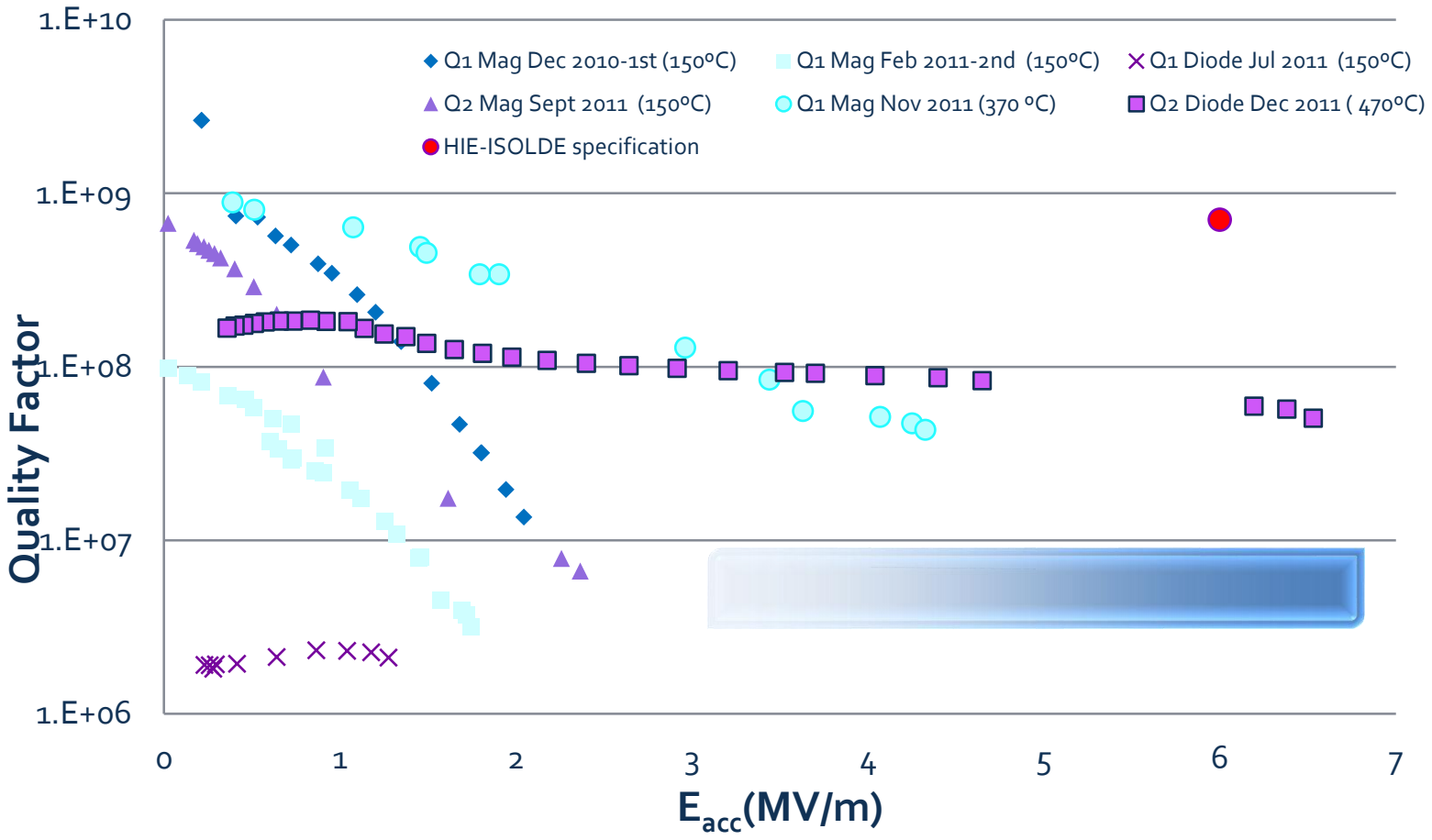


Key Technologies

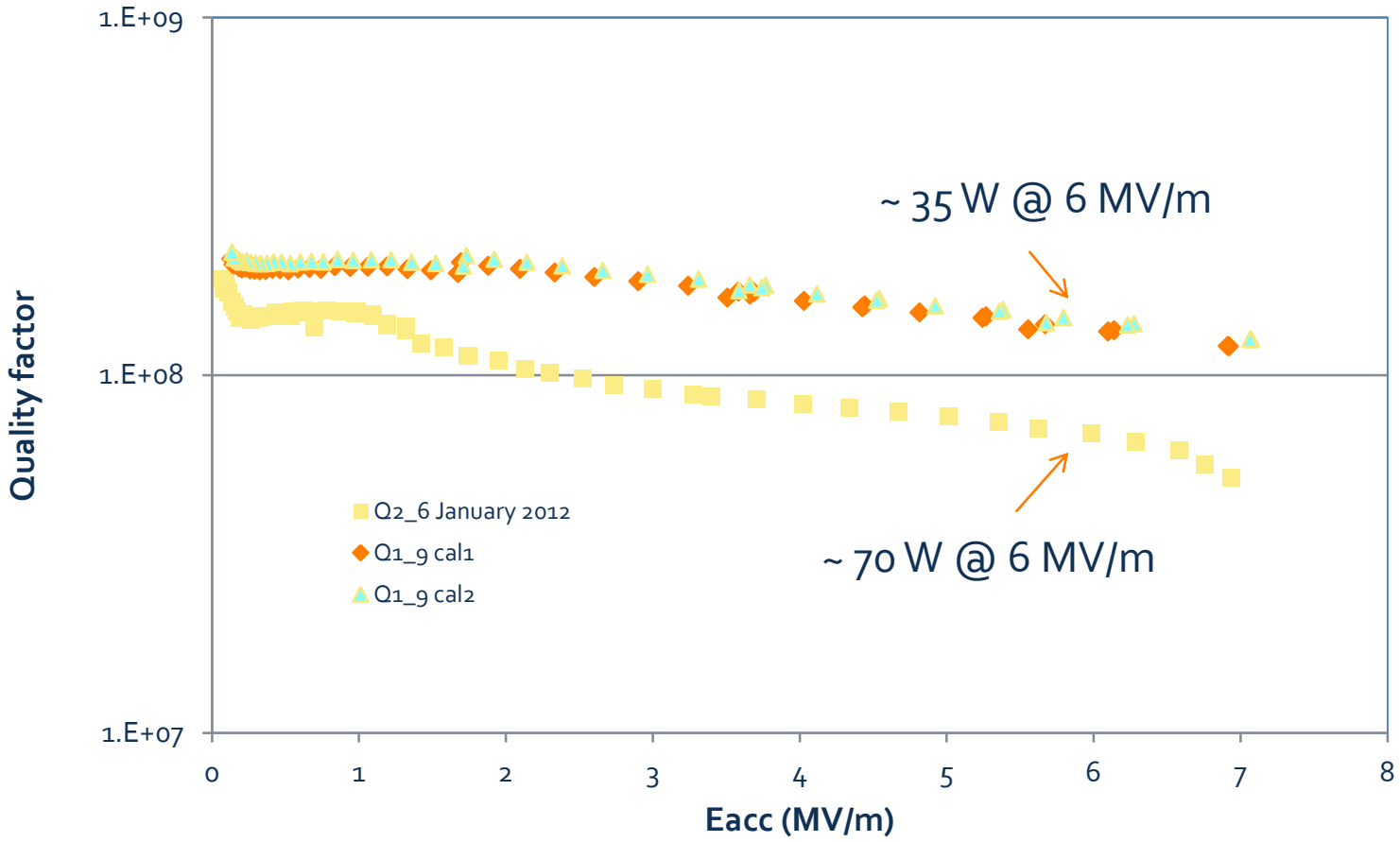
Cryomodule High Beta (5 Cavités Ø320)



RF Measurements @ 4.5K (2011)



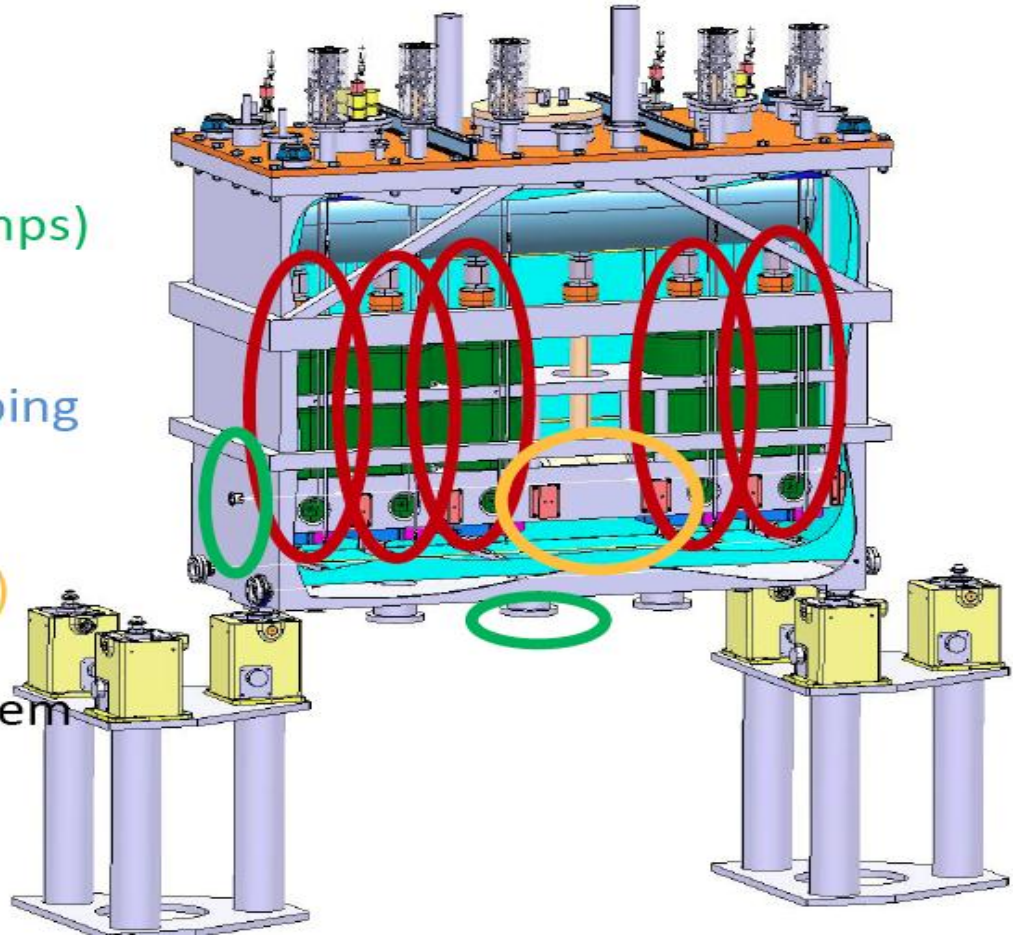
RF Measurements (2012)



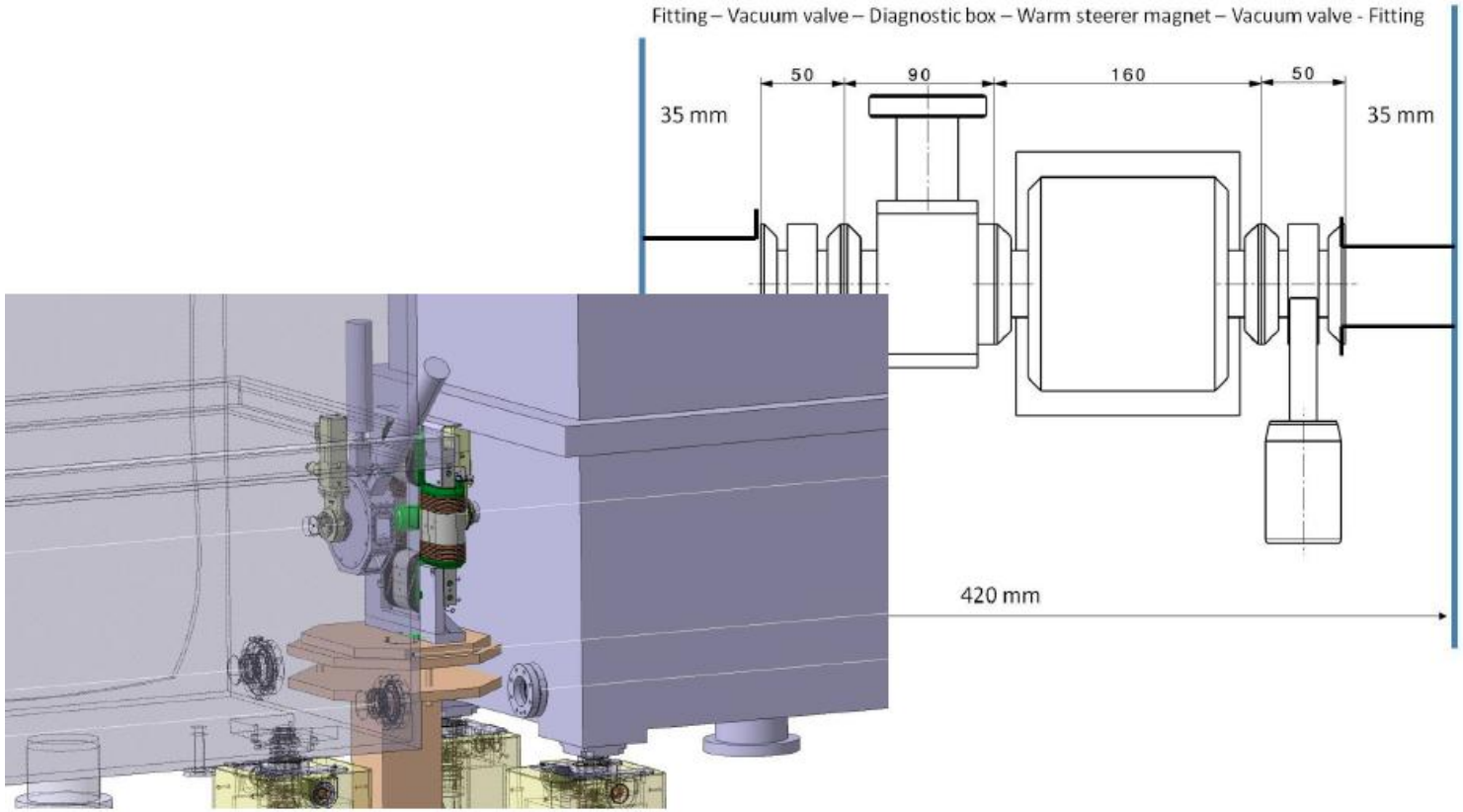
The HIE-ISOLDE Cryomodule

From outside to inside:

- External supports
- Vacuum system (valves, pumps)
- Vacuum vessel
- Thermal shield (50-75 K)
- Cryogenics reservoir and piping
- Internal support structure
- RF cavities (5 or 6)
- SC (Nb3Sn) solenoid (1 or 2)
  Up to 600 A
- Alignment / monitoring system
  0.15 mm at cold !
- Interconnection module



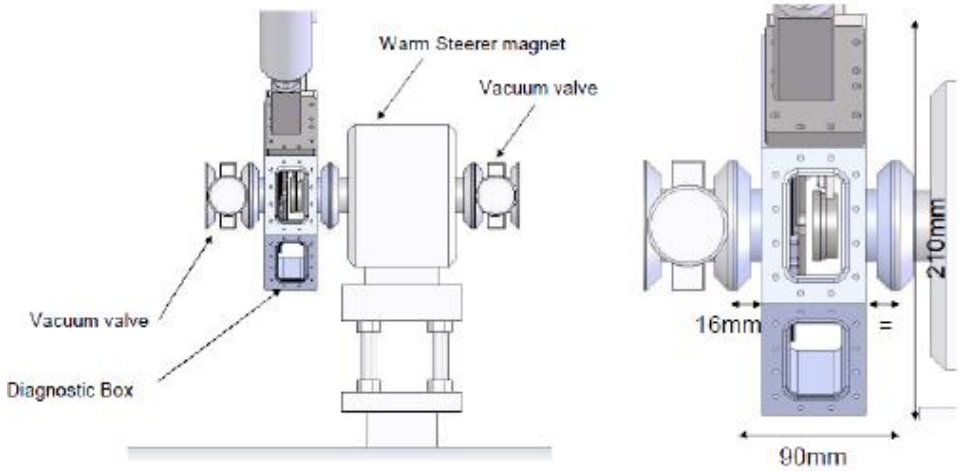
The Interconnection Module

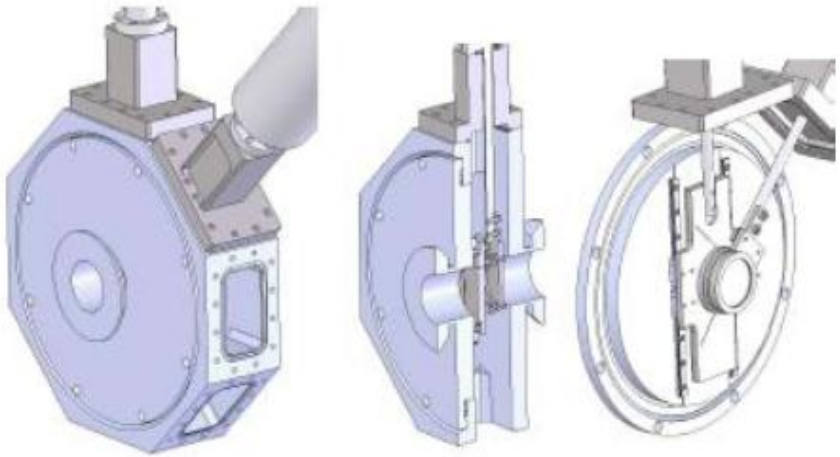


- Bakeable in-situ (temperature > 150 deg C)
- Cleanable to ISO 5 standard

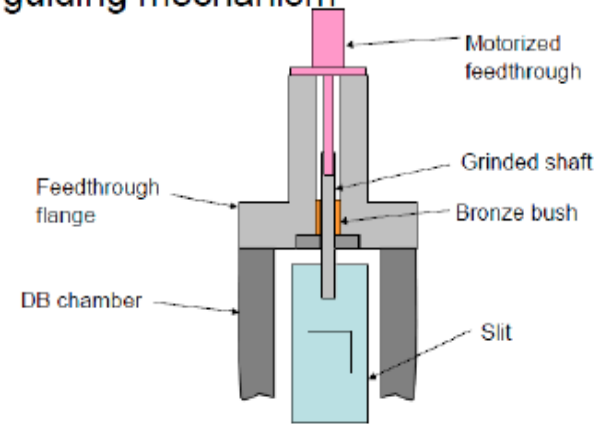
Diagnostic Box Design

- Location of the DB in the intertank region





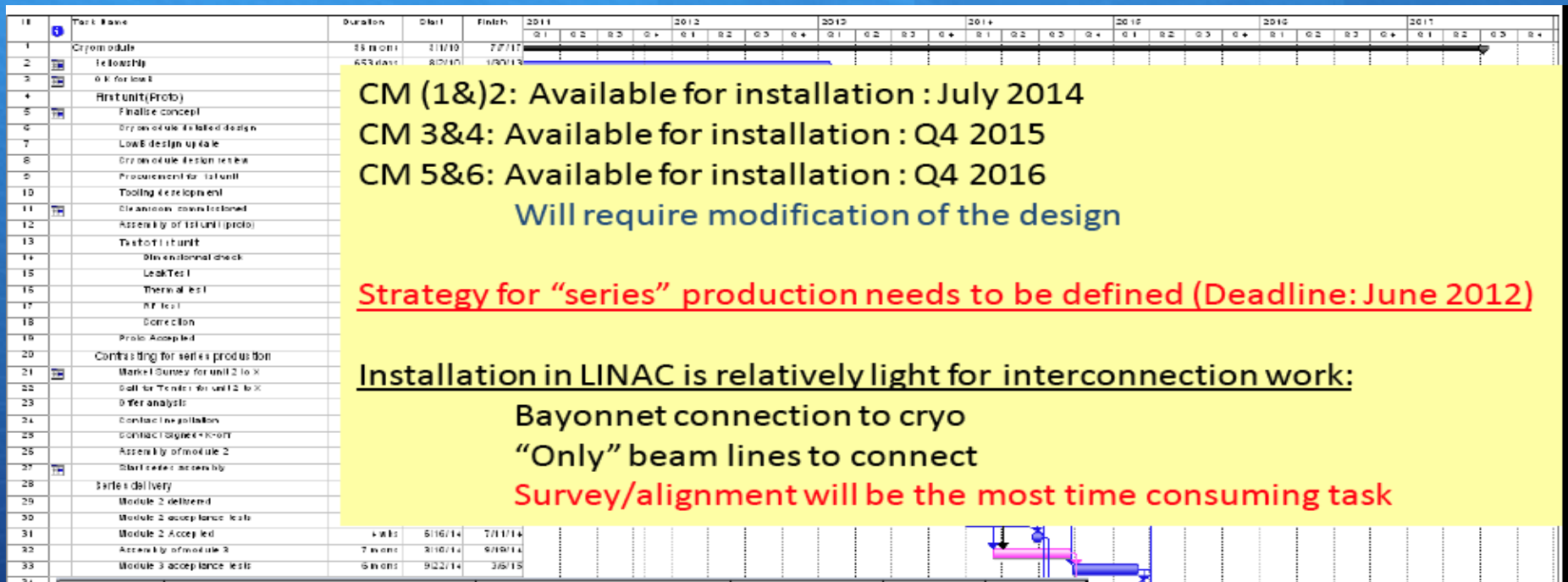
- Second configuration to avoid in-vacuum guiding mechanism



- Advantages
  - No oils, greases nor plastic components (apart from vespel in the FC)
  - No coatings
  - No need to dismount the DB from the beamline for Slit or feedthrough replacement

- Drawbacks
  - No lubrication, metallic particle emission
  - Minimum play between bush and shaft (H7-g6 tolerance, 0.05mm missalignment)
  - Stick-slip effect→ However, we expect to reach the 50µm step requirement

Planning for the 6 cryomodules



CM (1&)2: Available for installation : July 2014

CM 3&4: Available for installation : Q4 2015

CM 5&6: Available for installation : Q4 2016

Will require modification of the design

Strategy for "series" production needs to be defined (Deadline: June 2012)

Installation in LINAC is relatively light for interconnection work:

Bayonnet connection to cryo

"Only" beam lines to connect

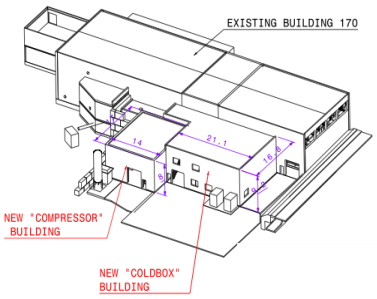
Survey/alignment will be the most time consuming task

Cryomod.	Assembly		Acceptance		Availability	Margin	Interval
#	Duration [mth]	End	Duration	End	Need	[months]	[months]
1	11	September-13	8	May-14	June-14	1	
2	11	December-13	6	July-14	September-14	2	3
3	7	September-14	6	March-15	December-15	9	9
4	7	April-15	6	October-15	January-16	3	7
5	8	November-15	7	June-16	December-16	6	7
6	7	May-16	6	November-16	January-17	2	6

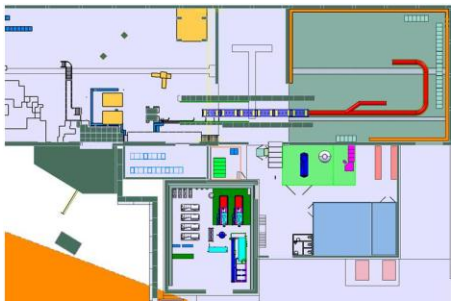
NB: CM1 acceptance duration includes 3 months for corrective actions

Outlook for 2012

- Completion of Civil Engineering Works by Q3 2012
- Installation of Main Services (EL, CV, Transport)
- **Launch procurement of Cryogenic Plant (FC Sep. 2012)**
- **Launch procurement of first batch of 5 (+ 15 ?) high-beta cavities by Q1 2012.**
- **Review Cryomodule Design (26-27 Apr. 2012) and launch procurement of CM1 by Q2 2012.**
- Review HEBT Layout (25 Apr. 2012) and launch procurement
- Validate LLRF system and tuner plate design



Thank you



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