HIE-ISOLDE Status Report

Yacine Kadi on behalf of HIE-ISOLDE project team

CATHI Meeting, 14 November 2011

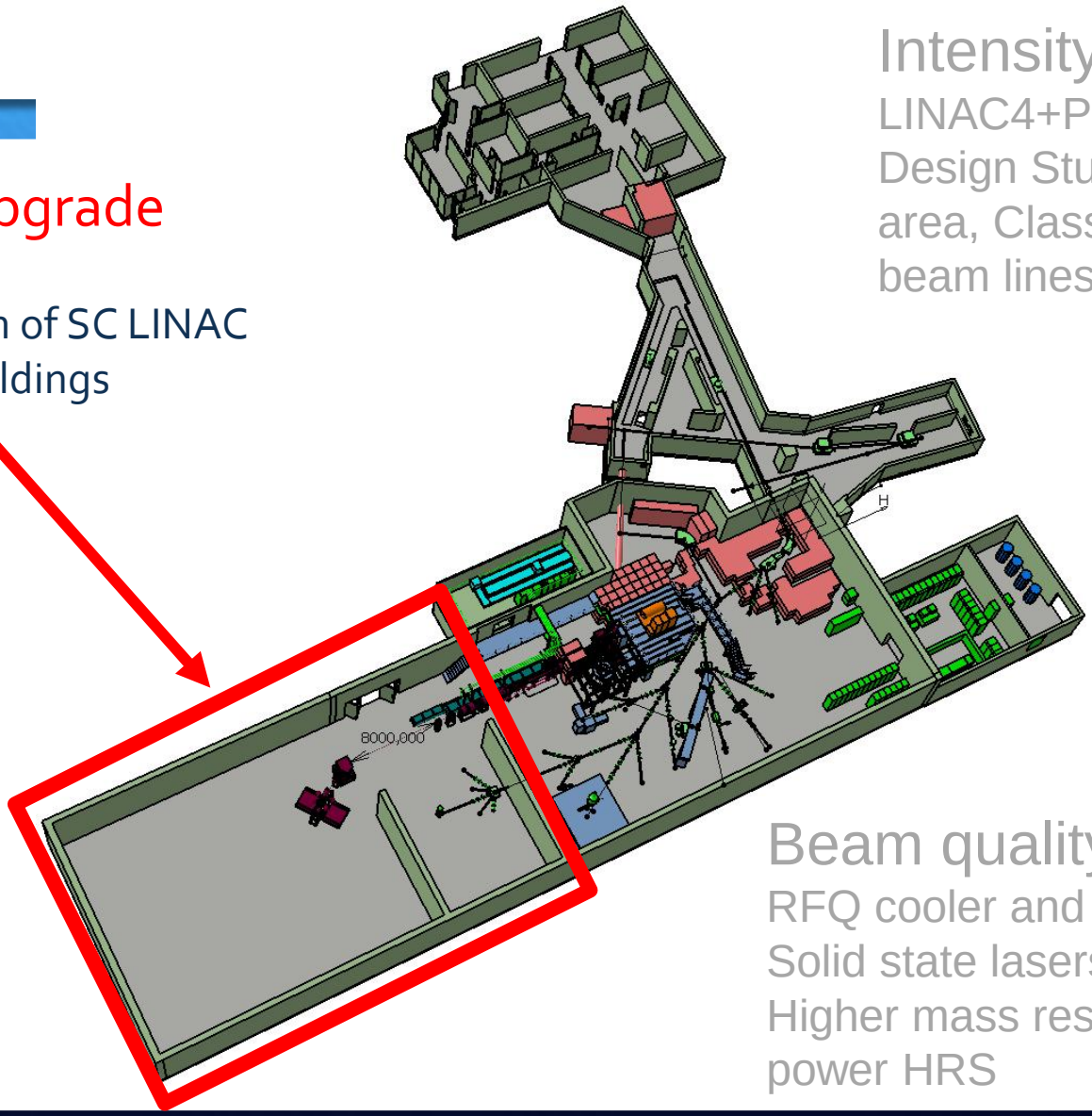
Outline

- **Future Upgrade of ISOLDE Facility: HIE-ISOLDE**
- **CATHI and HIE-ISOLDE**
- HIE-ISOLDE Schedule
- Budget Review
- Main Highlights & R&D Activities
- Int. Collaboration
- Conclusions and Prospects

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

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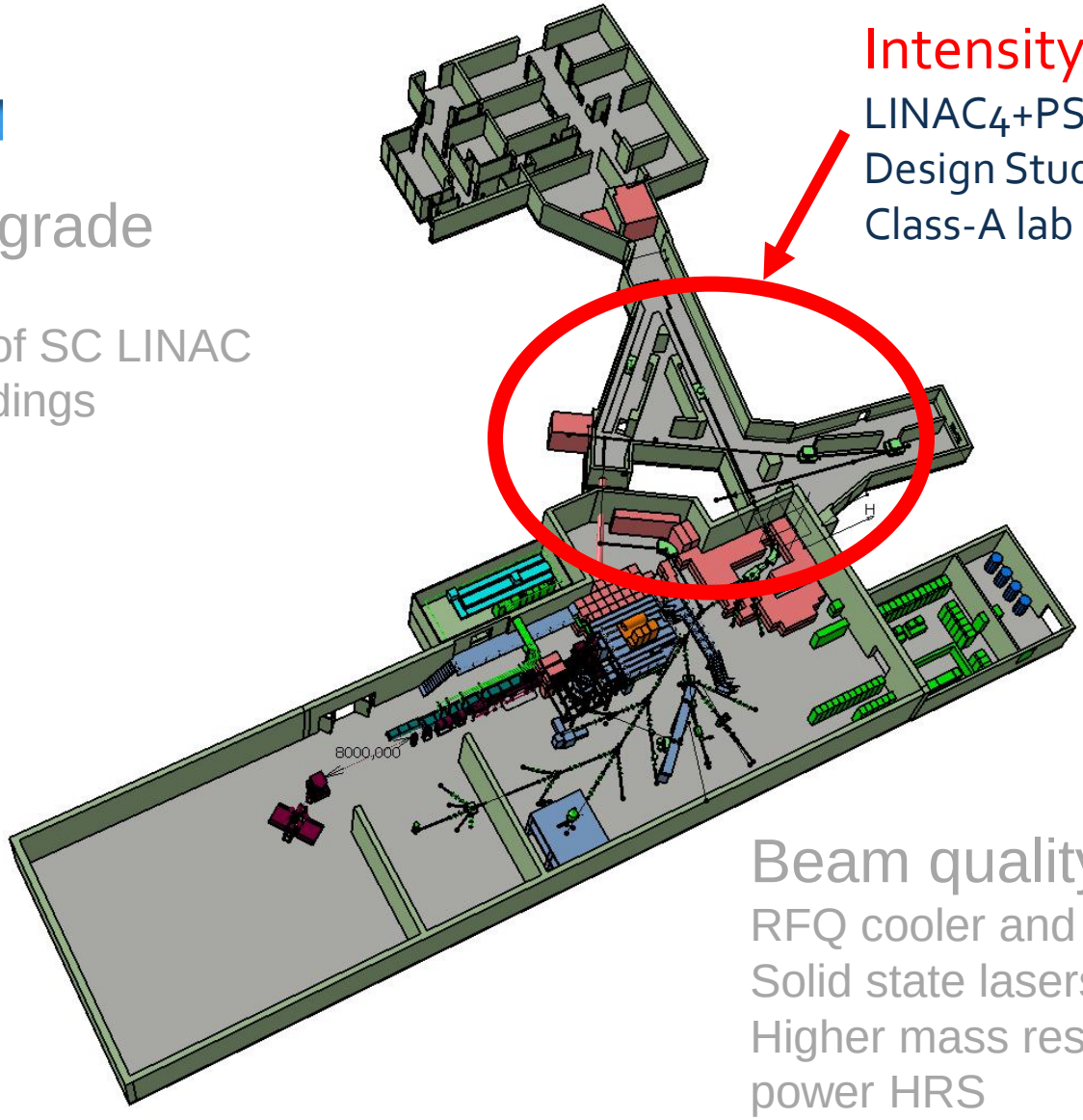


Beam quality upgrade

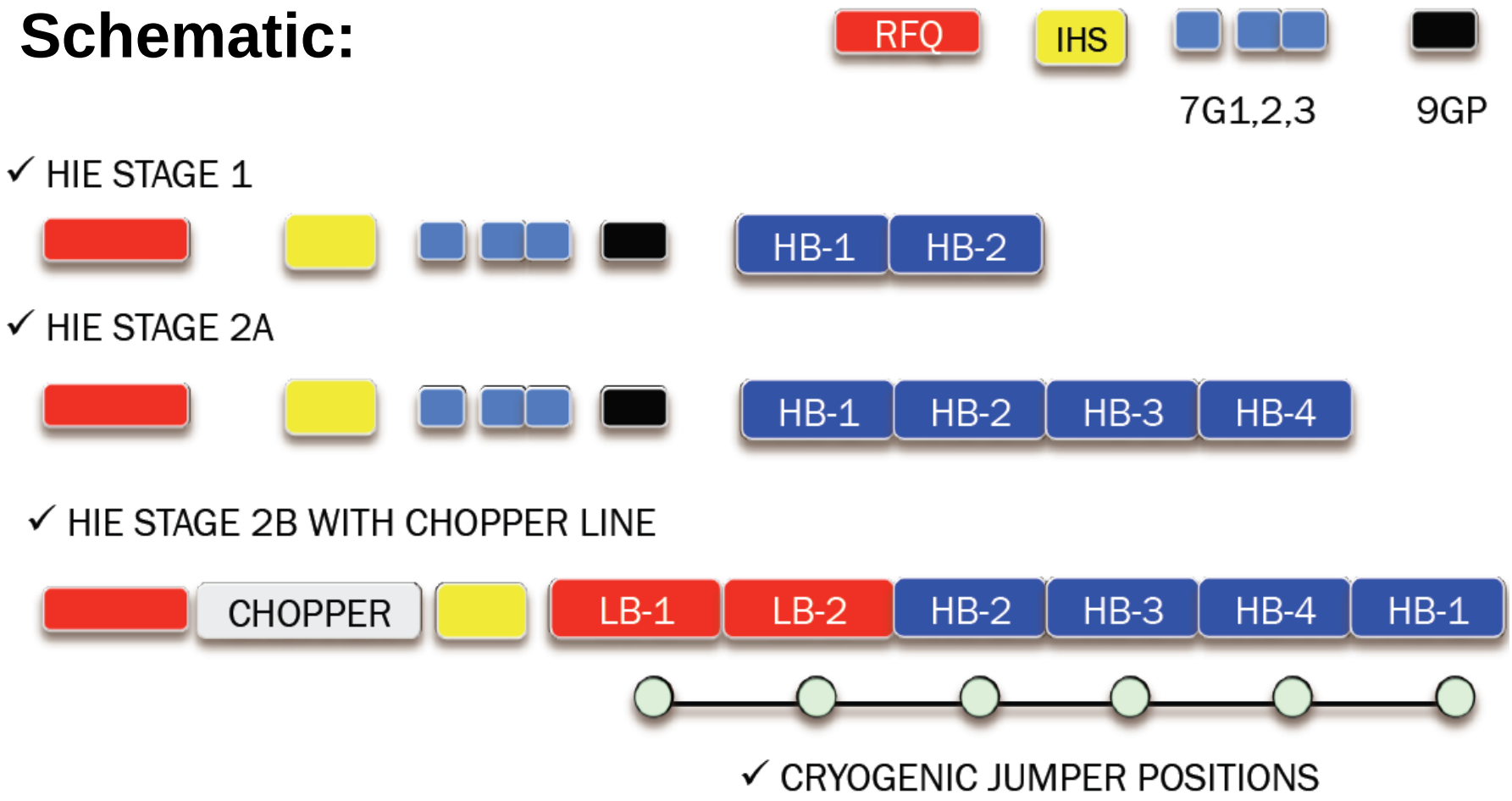
RFQ cooler and buncher

Solid state lasers for RILIS

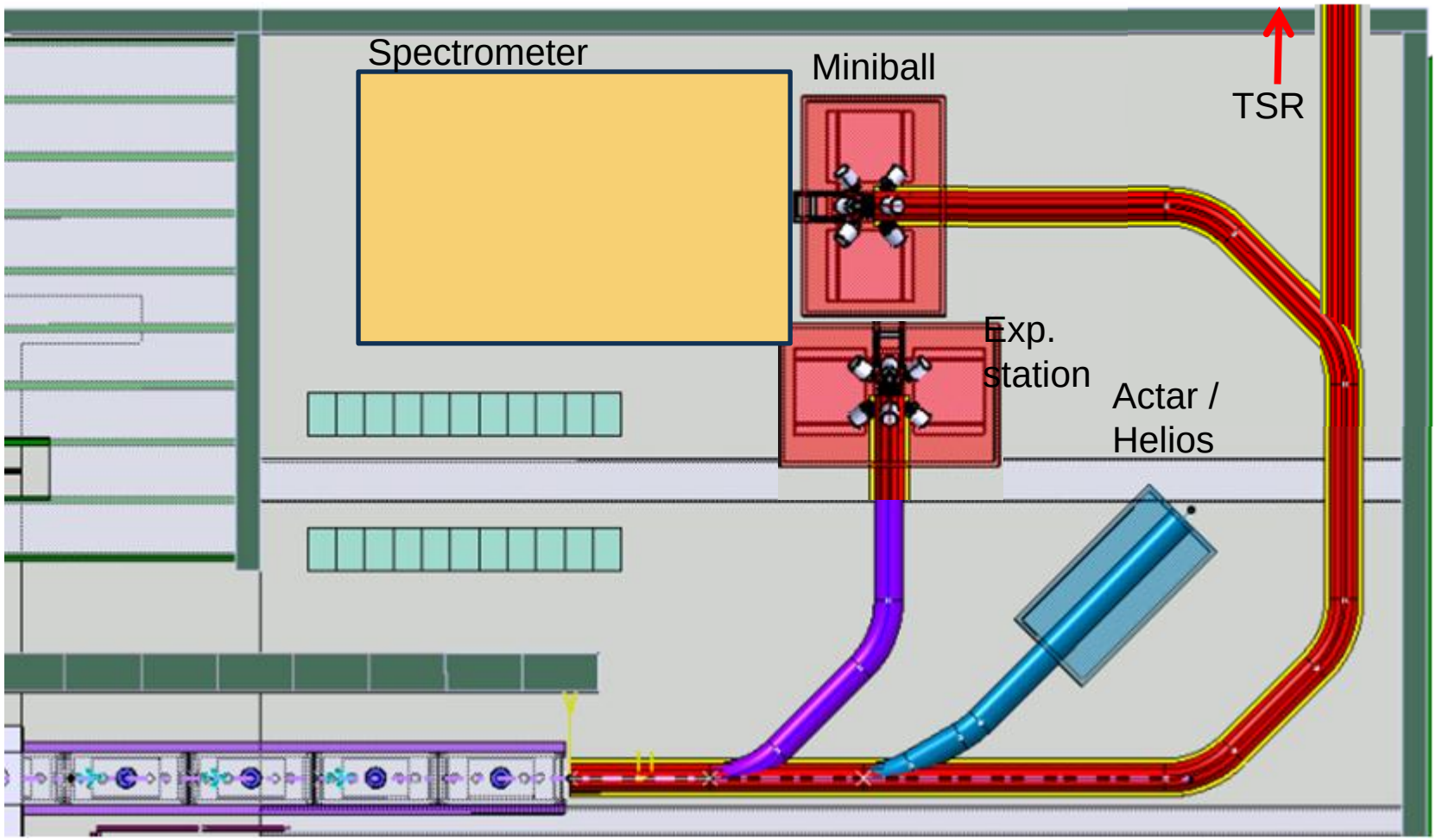
Higher mass resolving power HRS

Modular installation

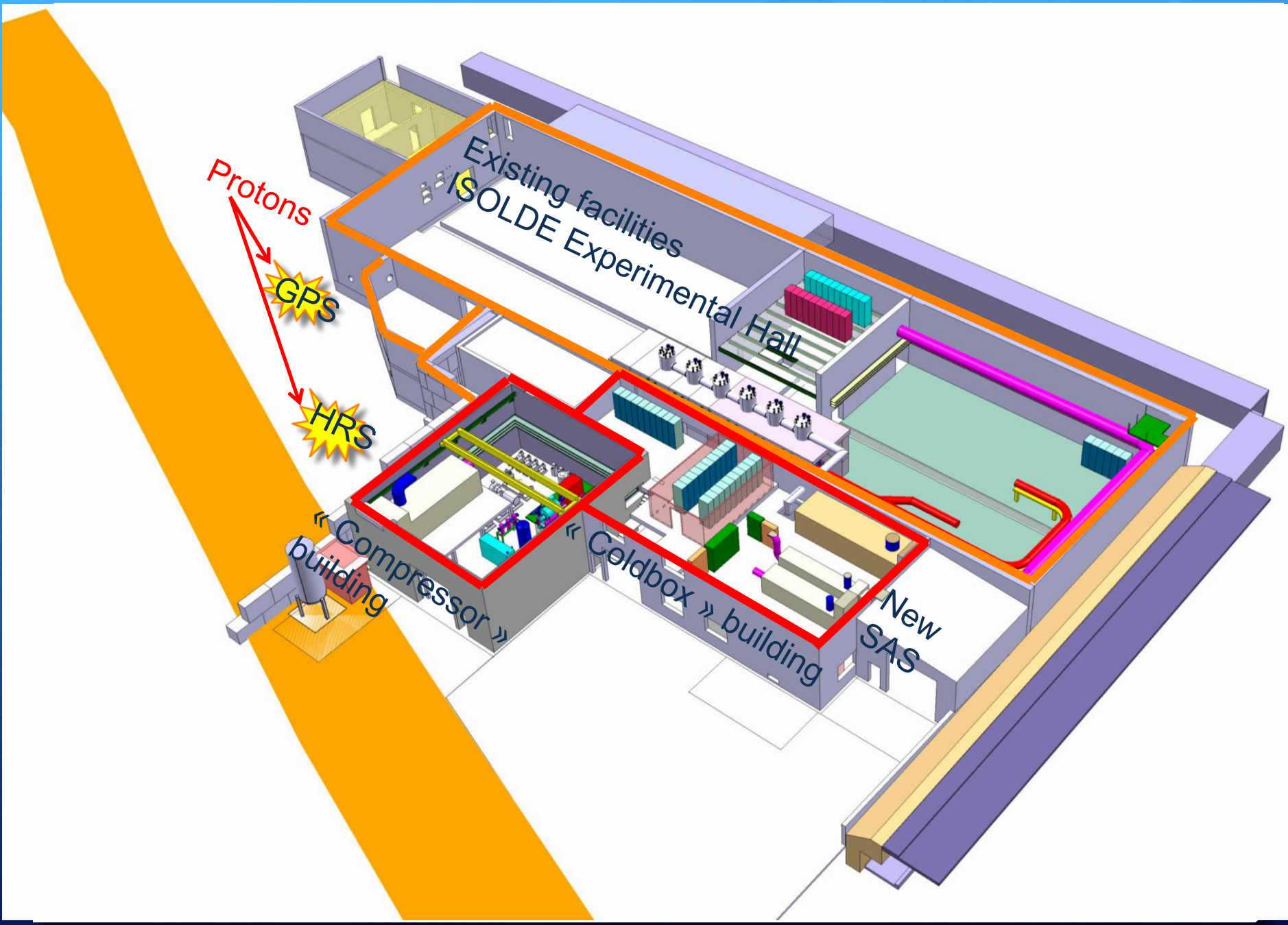
Schematic:



SC Linac & Beam Transfer Lines



Main Services


Protons
GPS
HRS
Existing facilities
ISOLDE Experimental Hall
« Compressor »
building
« Coldbox » building
New
SAS

HIE-ISOLDE Design Study

- Address the consequences of an increase in primary beam power following the commissioning of Linac 4 and possible future modifications of p-beam parameters.
- Outline the needs for an upgrade of secondary beam quality

Intensity (p/p)	Intensity (uA)	Energy (GeV)	Cycle (s)	Power (kW)
3×10^{13}	2	1.4	1.2	2.8
6×10^{13}	4	1.4	1.2	5.6
6×10^{13}	5.3	1.4	0.9	7.5
6×10^{13}	4	2	1.2	8
6×10^{13}	5.3	2	0.9	10.7

Design Study

Intensity Upgrade

- Ventilation issues
- Vacuum issues
- Targets
  - Fluka simulations
  - Target design
  - Materials
- Front End
  - Mechanics
  - Optics
- HV systems

Beam Quality Upgrade

- High resolution magnet
- RFQ Cooler
- REXEBIS upgrade
- Off-line separator
- Pre-mass separator

Through previous experiences and collaborations, identify the issues associated with the existing facilities.

Extrapolate these issues as a function of proton intensity increase and secondary beam requirements.

Address the issues and provide acceptable solutions in the form of conceptual designs and reports.

Assess the implications of any modifications in terms of resources, infrastructure and planning.

Identify priorities and plan their implementation as a function of overall schedule and the existing facility

Deliverable – Final Design Study Report

CATHIE-ISOLDE

CATHI and HIE-ISOLDE

- CATHI – Cryogenics, Accelerators and Targets at HIE-ISOLDE.
- The HIE-ISOLDE project at CERN is an ideal R & D opportunity to train young engineers over a range of disciplines relevant to the accelerator and nuclear industry.
- CERN and the associated partners of CATHI can provide excellent hands-on and academic training.
- ISOLDE provides a multi-disciplinary environment on a scale that encourages collaboration and teamwork.

	Discipline	ESR	ER
High Energy Linac	Cavity and cryomodule tests	ESR2	
	Beam Instrumentation	ESR3	ER2
	Magnet Design	ESR4	
	Low level RF		ER1
	Cavity fabrication and surface treatment	ESR1	
	Integration	ESR5	
	Alignment and Control	ESR6	
	Operations software programming	ESR7	
Design Study	Target material studies	ESR8	
	Target conceptual design	ESR9/10	
	Extraction optics and Front end	ESR11	
	Low level controls	ESR12	
	Cooling and ventilation	ESR13	
	Vacuum development	ESR14	
	Off line separator and HRS magnet	ESR15	
	RFQ cooler and pre-separator	ESR16	
	Upgrade of REXEBIS		ER3
Safety	Radiation Protection		ER4

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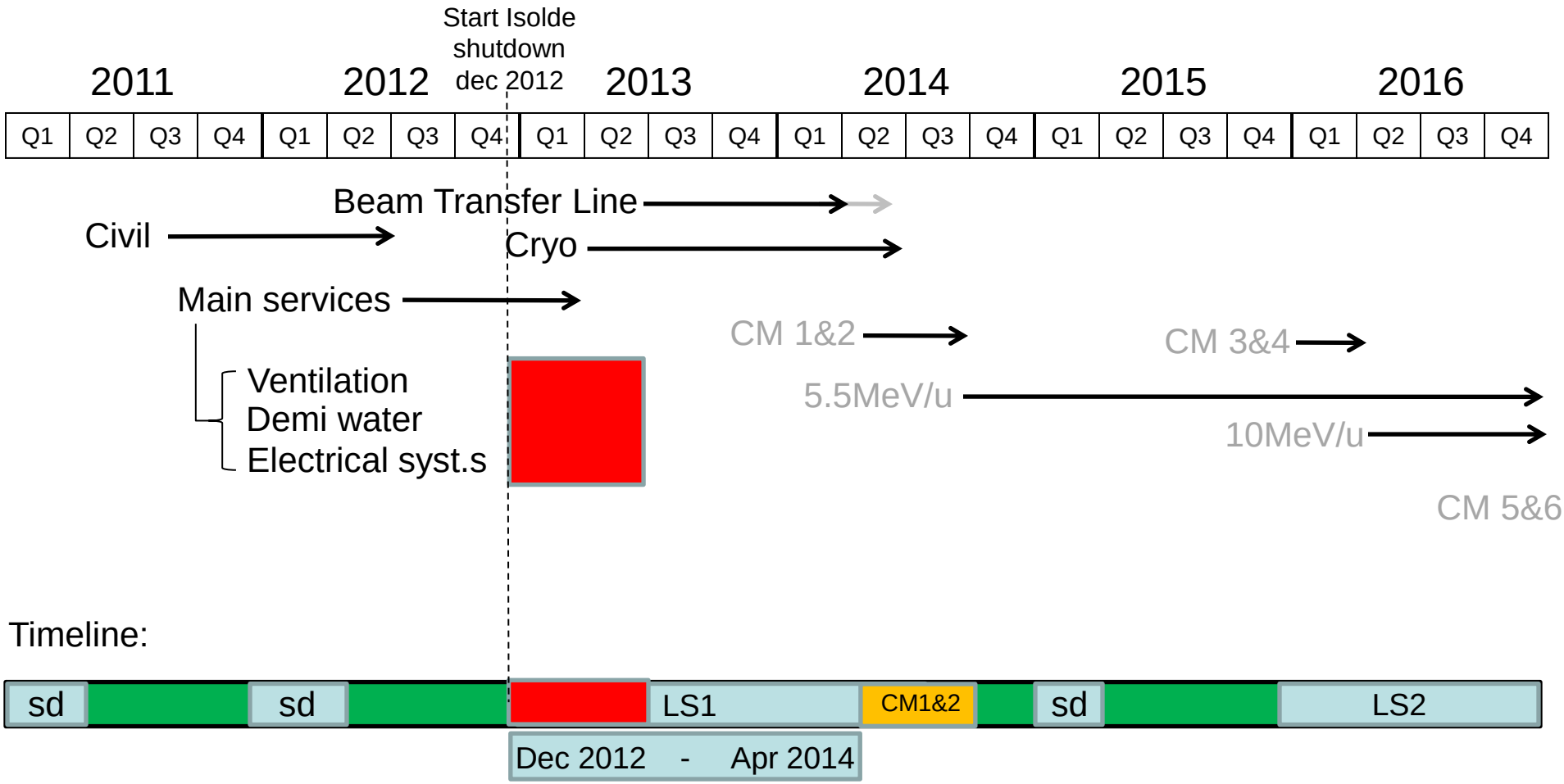
Hie-Isolde versus LS1



Budget Review

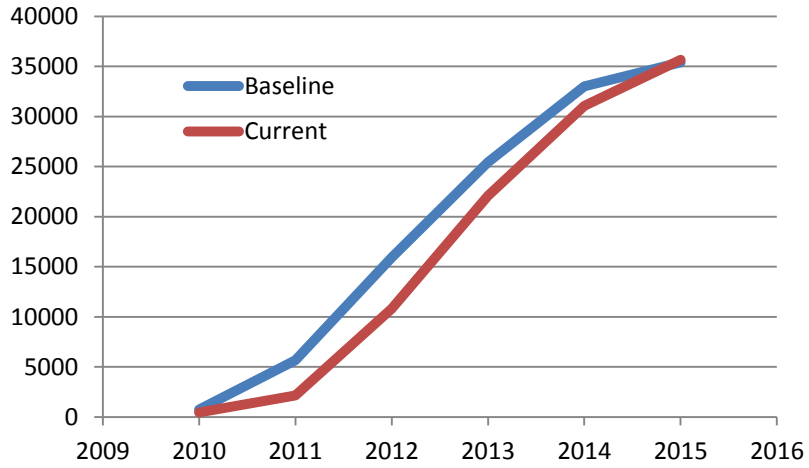
As defined in MTP 2010

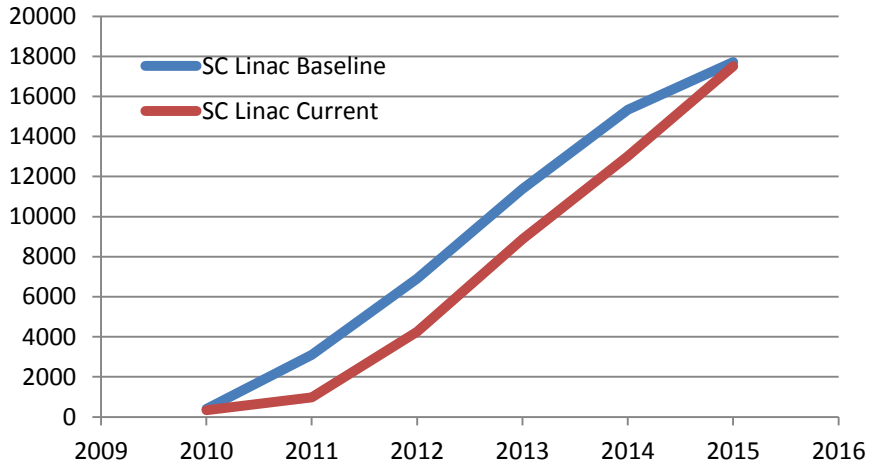
(175 FTE)

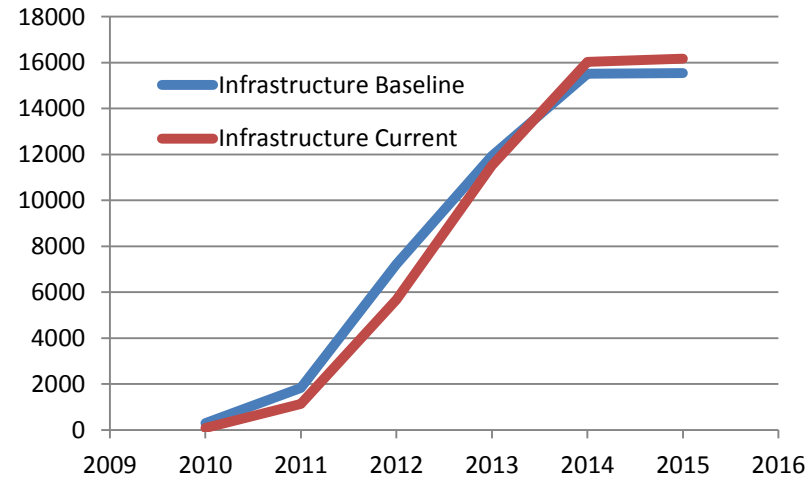
Total budget of 35.3 MCHF (2010 – 2016) with two funding sources:

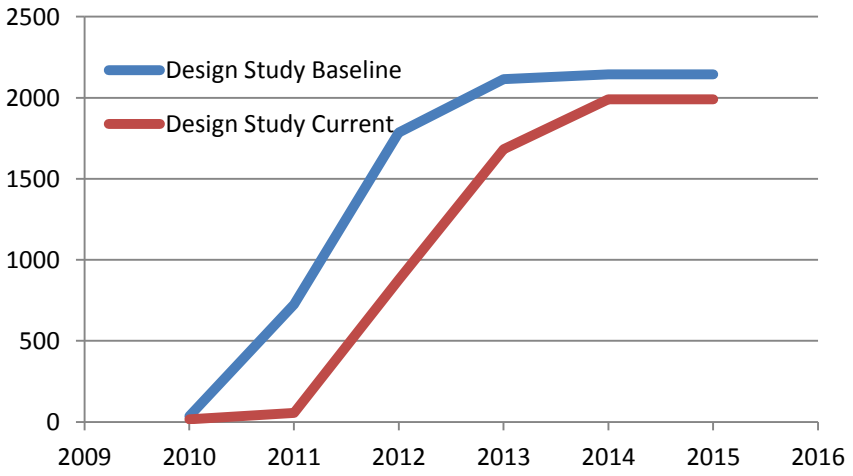
- External funding (incl. Isolde Coll.)
  - LINAC (17.7 MCHF)
    - **5.5 AMeV + beam line stage1 ~ 8.5 MCHF (6.3 MCHF secured)**
- CERN
  - Management (0.2 MCHF)
  - Infrastructure (14.7 MCHF)
  - Design studies for intensity upgrade (2.1 MCHF)
  - Safety (0.8 MCHF)

Projected expenditures (kCHF)









6 CATHI Positions still open (selection ongoing)

- ESR9: Target conceptual design#1
- ESR10: Target conceptual design#2
- ER1: LLRF Control
- ER2: Beam Instrumentation
- ER3: Design study of a replacement charge breeder for REXEBIS
- ER4: Radiation Protection Studies

14 CATHI positions already filled

Highlights

- Dismantling and relocation of "hangar à camion" over => start of civil engineering at ISOLDE
- Invitation for Tenders are being launched
  - Cryogenic Plant
  - Cooling and Ventilation
- Market surveys are being launched
  - Cryomodule vessel and support
  - SC solenoid
  - Clean room at SM18
- SC cavity activities reviewed by international expert panel
  - Increase sputtered film RRR to at least 20
  - Increase the number of substrates available
  - Increase the testing throughput in SM18

R&D Activities

- **Pre-series High-Beta Cavity**
- High-Beta Cryomodule Design
- RF Measurements
- Sputtering Developments

⇒ Detailed presentations at 7th HIE-ISOLDE Steering Committee meeting:

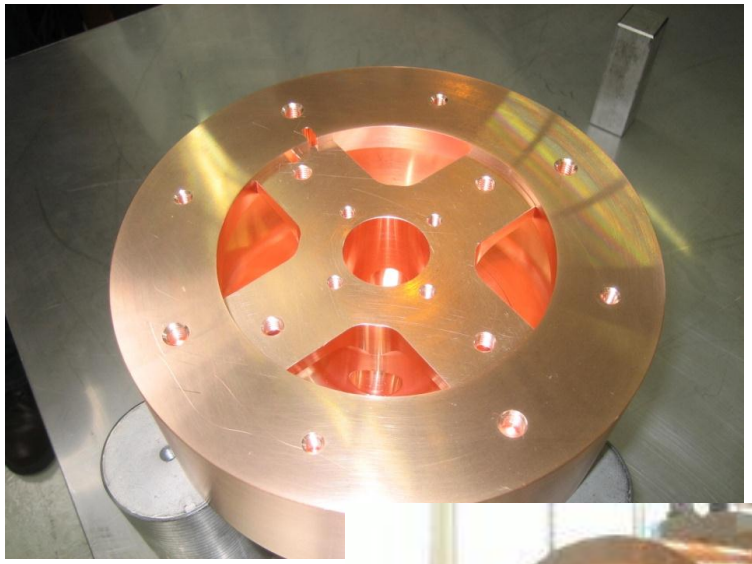
https://indico.cern.ch/conferenceDisplay.py?confId=159608

Superconducting RF cavity (by O. Capatina EN/MME)

- Design high- beta cavities – NEW VERSION
  - Material: Cu-OFE 3D forged
  - Manufacturing technique for serial production: 3D machning, EB welding
    - Reduces considerably the number of critical welds
    - No annealing
    - Repetitive precision of beam ports
  - By design
    - Reduce sensibility to pressure fluctuation
    - Increase final precision with no need of plastic deformation
    - The same external envelope as the old design

Superconducting RF cavity (by O. Capatina EN/MME)

- Manufacturing high- beta cavities – NEW VERSION
  - One prototype of the “new version” manufacturing ongoing
    - Concept validation by calculations and tests



R&D Activities

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- **High-Beta Cryomodule Design**
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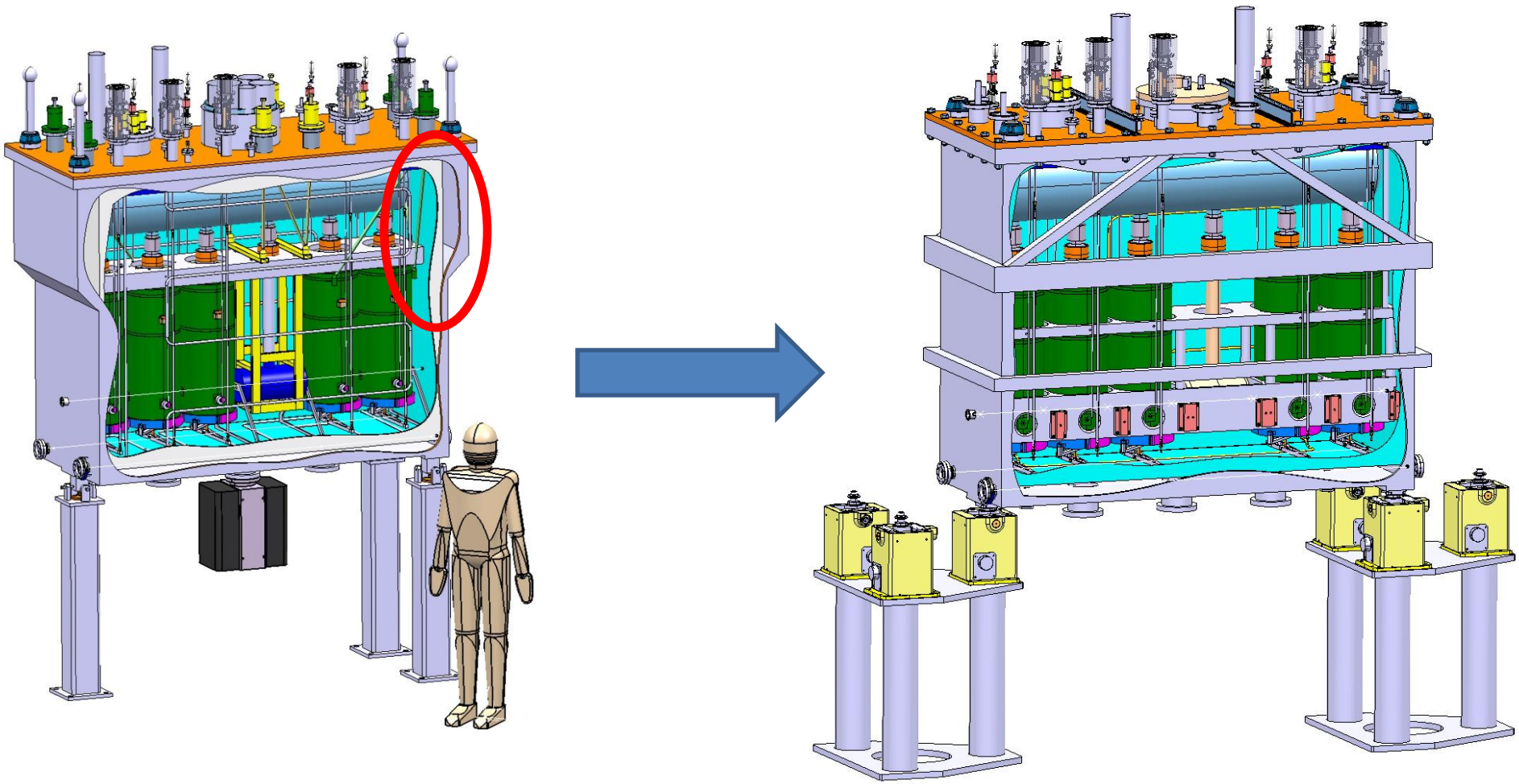
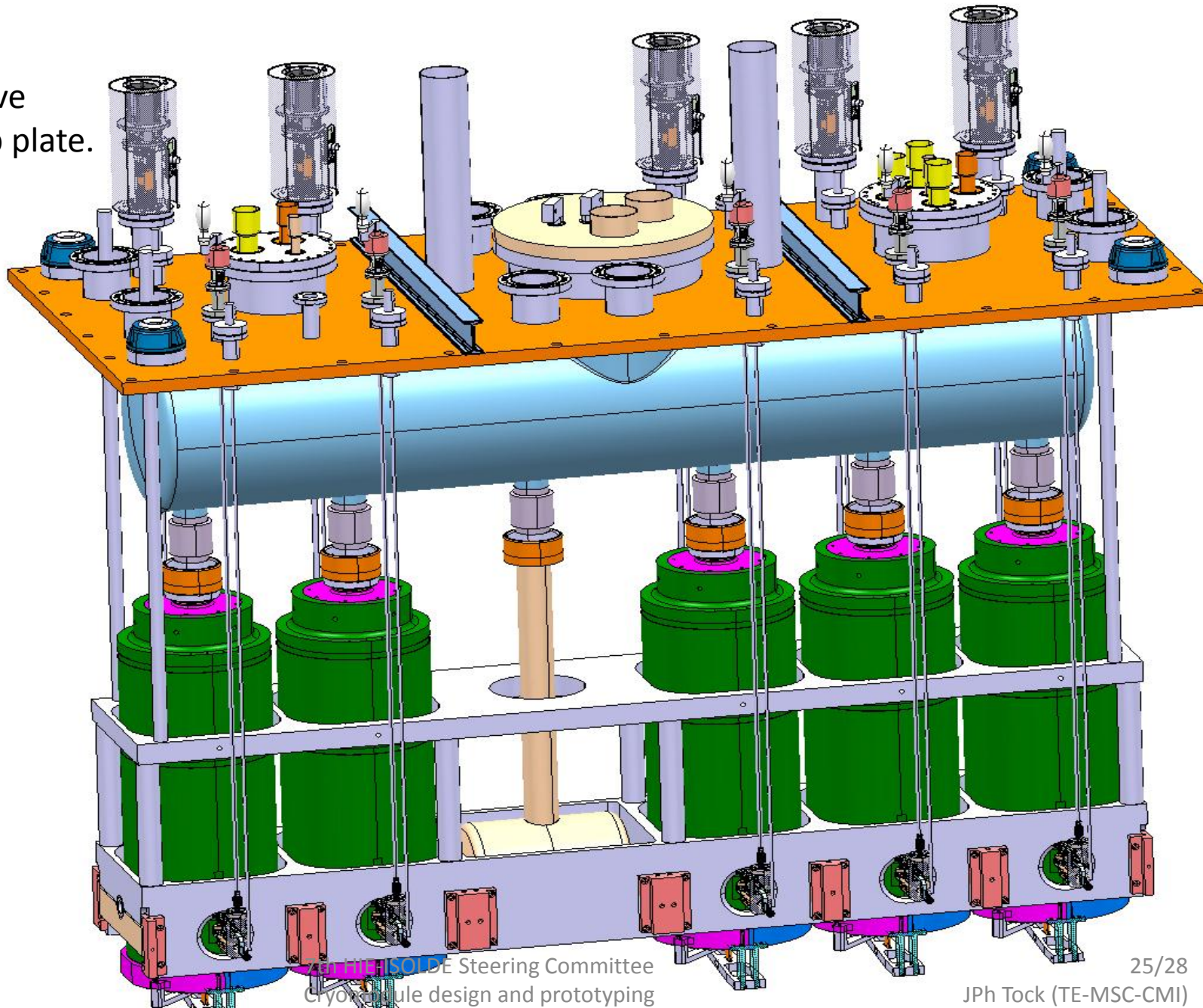
The HIE-ISOLDE cryomodule: the vacuum vessel (2/3)

Shape simplified thanks to optimisation of the inner components

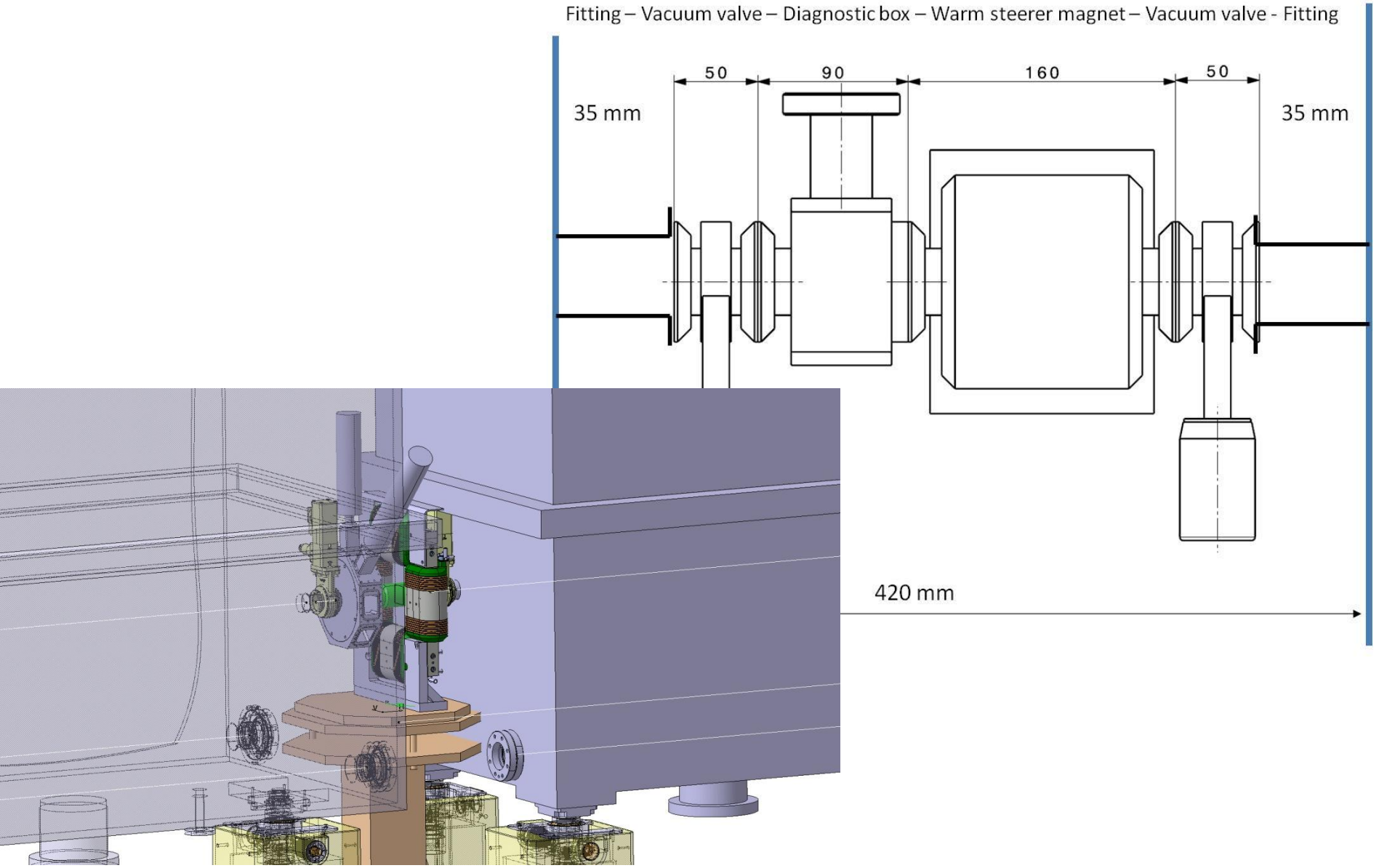


The HIE-ISOLDE cryomodule: Top plate

All services arrive through the top plate.



The HIE-ISOLDE cryomodule: Interconnection module



The HIE-ISOLDE cryomodule: Cleanroom (O Brunner BE/Rf)

Specification available

Cryomodule assembly procedure definition started

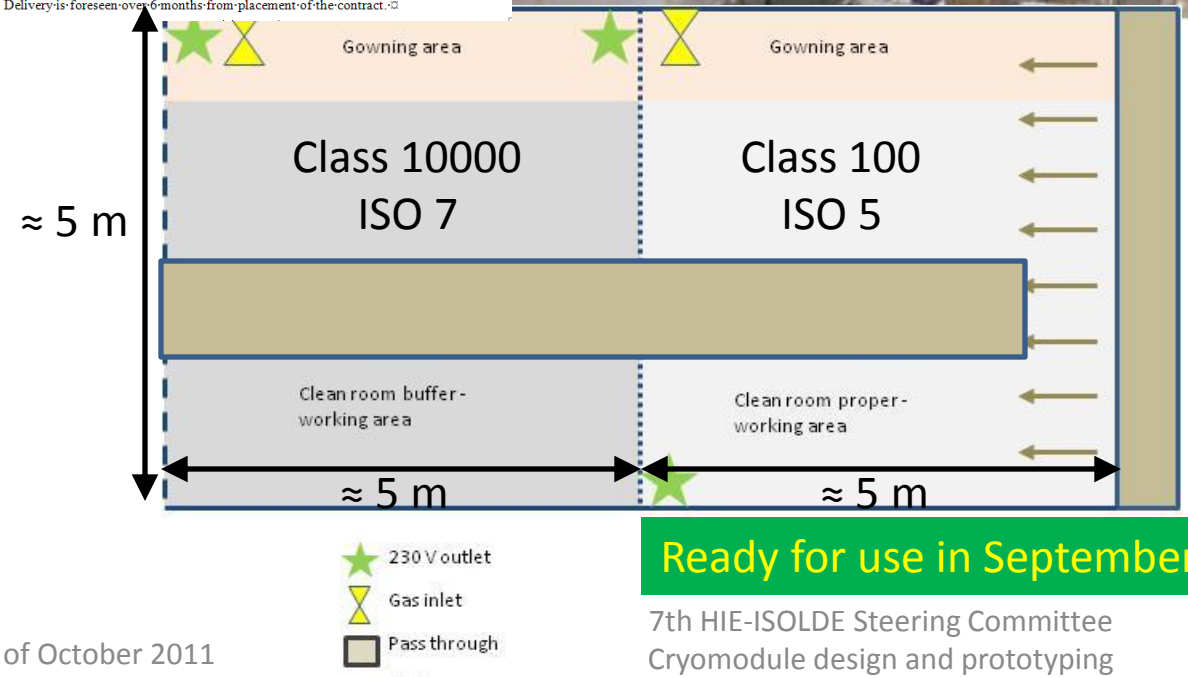
The·HIE·ISOLDE·Project¤ Original:·English

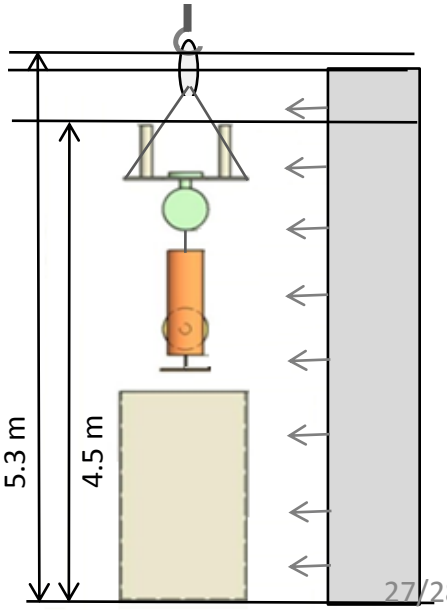
Invitation·to·Tender¶

Technical·Specification·for·the·Supply·of·a·Clean·Room·Facility·for·the·assembly·of·the·HIE·Isolde·Cryomodules¤

Abstract¶

This·technical·specification·concerns·the·supply,·delivery·and·installation·of·a·Clean·Room·Facility,·consisting·of·the·Clean·Room·Proper·and·a·Clean·Room·Buffer,·for·the·assembly·of·the·HIE·ISOLDE·cryomodules·in·SM18.¶ Delivery·is·foreseen·over·6·months·from·placement·of·the·contract.·¤

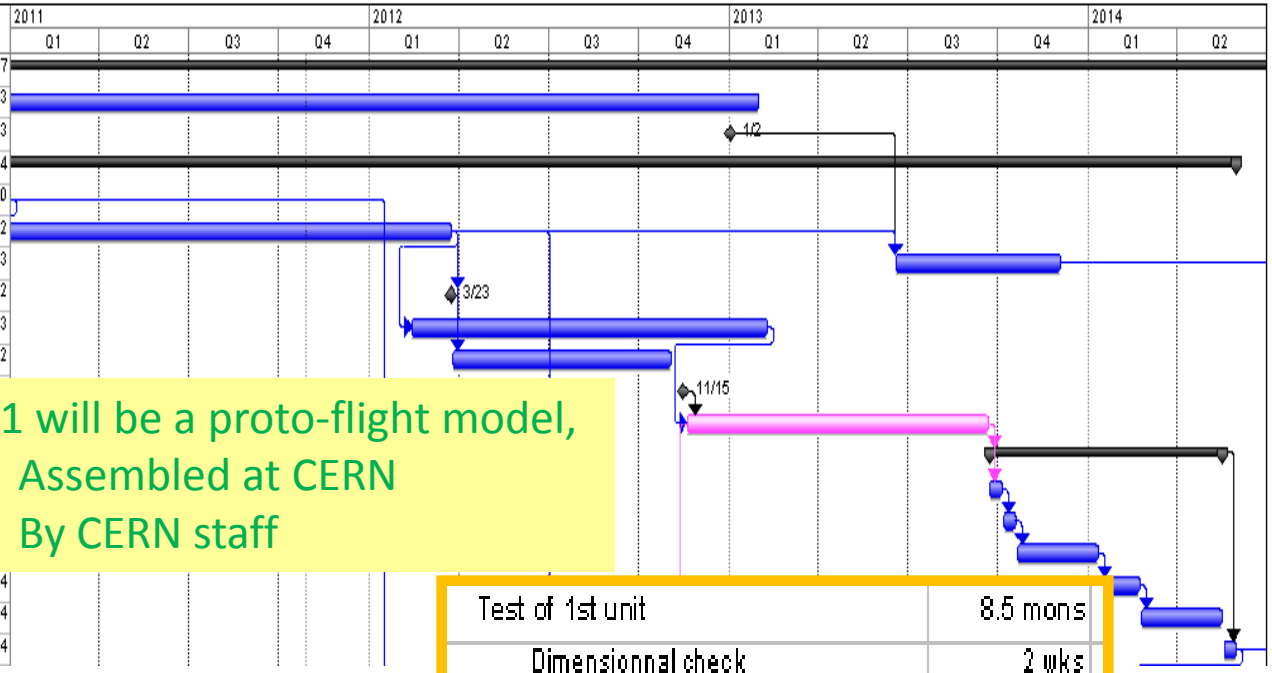




Ready for use in September 2012

Planning: Details of cryomodule 1 (proto)

ID	Task Name	Duration	Start	Finish
1	Cryomodule	96 mons	3/1/10	7/7/17
2	Fellowship	653 days	8/2/10	1/30/13
3	OK for low B	0 mons	1/2/13	1/2/13
4	First unit (Proto)	55.5 mons	3/1/10	5/30/14
5	Finalise concept	11 mons	3/1/10	12/31/10
6	Cryomodule detailed design	19 mons	10/11/10	3/23/12
7	Low B design update	6 mons	6/19/13	12/3/13
8	Cryomodule design review	0 mons	3/23/12	3/23/12
9	Procurement for 1st unit	260 days	2/13/12	2/8/13
10	Tooling development	8 mons	3/26/12	11/2/12
11	Cleanroom commissioned	0 mons	11/	
12	Assembly of 1st unit (proto)	11 mons	11/	
13	Test of 1st unit	8.5 mons	9/	
14	Dimensionnal check	2 wks	9/	
15	LeakTest	2 wks	10	
16	Thermal test	3 mons	10/	
17	RF test	6 wks	1/13/14	2/21/14
18	Correction	3 mons	2/24/14	5/16/14
19	Proto Accepted	2 wks	5/19/14	5/30/14



CM 1 will be a proto-flight model,
Assembled at CERN
By CERN staff

Test of 1st unit	8.5 mons
Dimensionnal check	2 wks
LeakTest	2 wks
Thermal test	3 mons
RF test	6 wks
Correction	3 mons

<u>Vacuum vessel (long lead item) including top plate</u>

Nov 2011: Design completed

Dec 2011: IT sent out / 1unit + 1 in option

March 2012: Cryomodule detailed design review

Nov 2012: Start of assembly in cleanroom / All components available

Sep 2013: Cryomodule 1 assembled

May 2014: CM available for installation including 3 months allocated for corrective actions

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! Cryo shutdown in SM18 not taken into account !

Back-up: thermal test with thermal models

R&D Activities

- Pre-series High-Beta Cavity
- High-Beta Cryomodule Design
- **RF Measurements**
- Sputtering Developments

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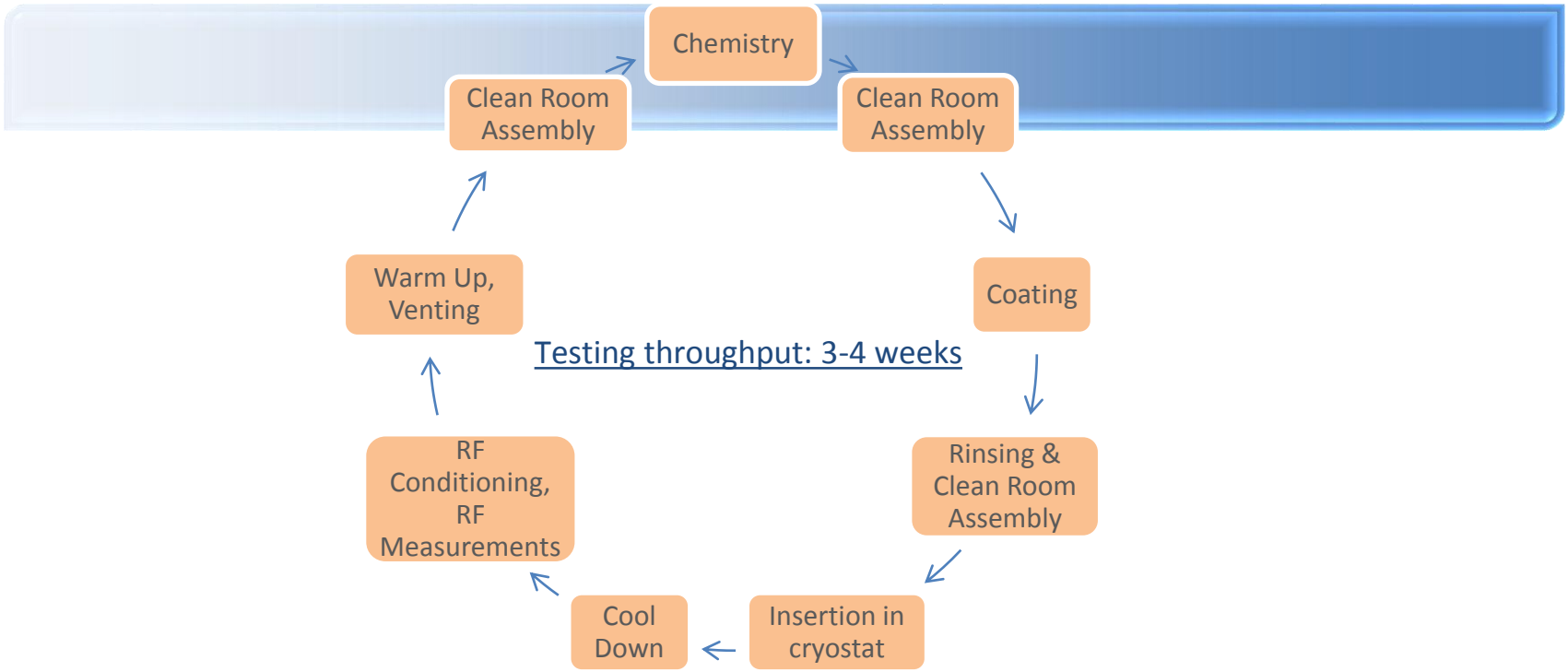
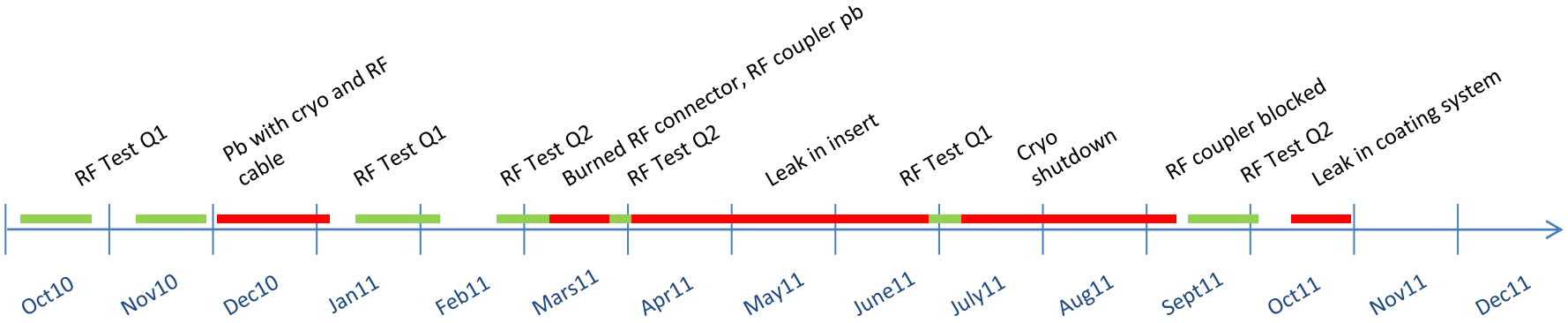
"A long and winding circle..." (O. Brunner BE/RF)

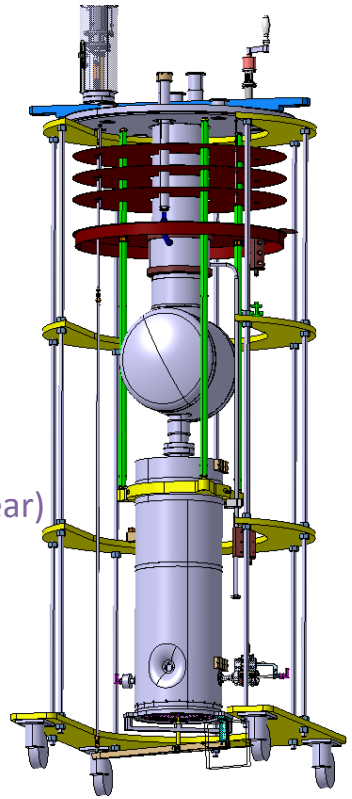




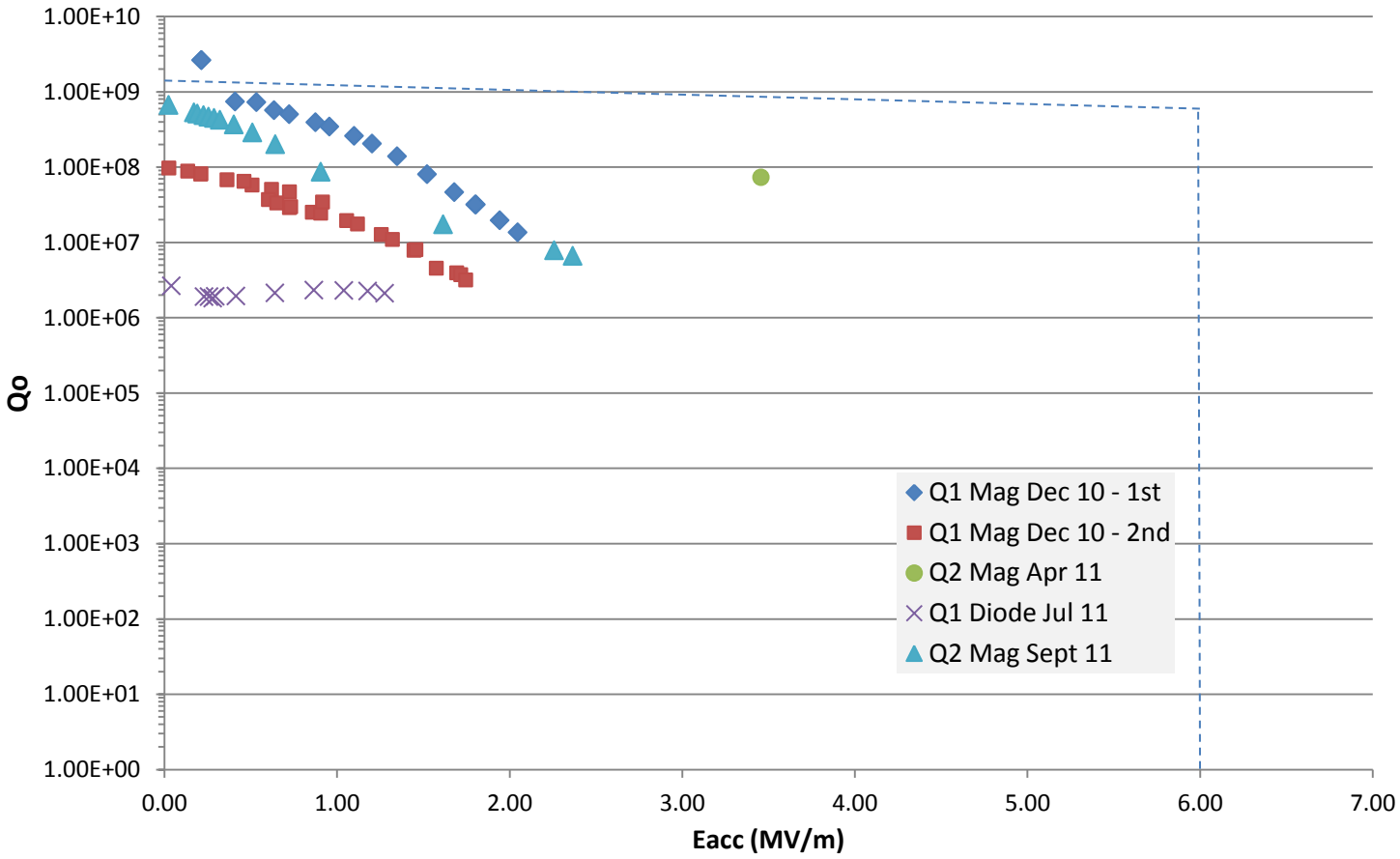
Clean room assembly & RF testing (2)

- Cryostat and vertical RF test stand
  - Cavity insert
  - Actively
- Operatio
  - Improve
    - Wa
    - Col
  - Large ef
    pressure
    - Act
    - Try
  - Cavity h
  - **Problem**
    - Dev
    - Lea

year)



RF Test Results (O. Brunner BE/RF)



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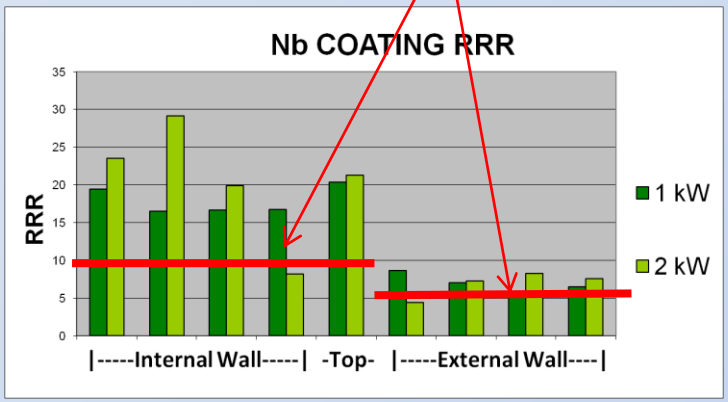
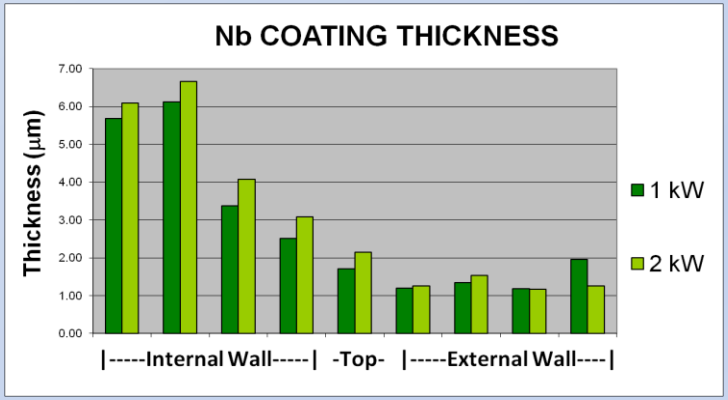
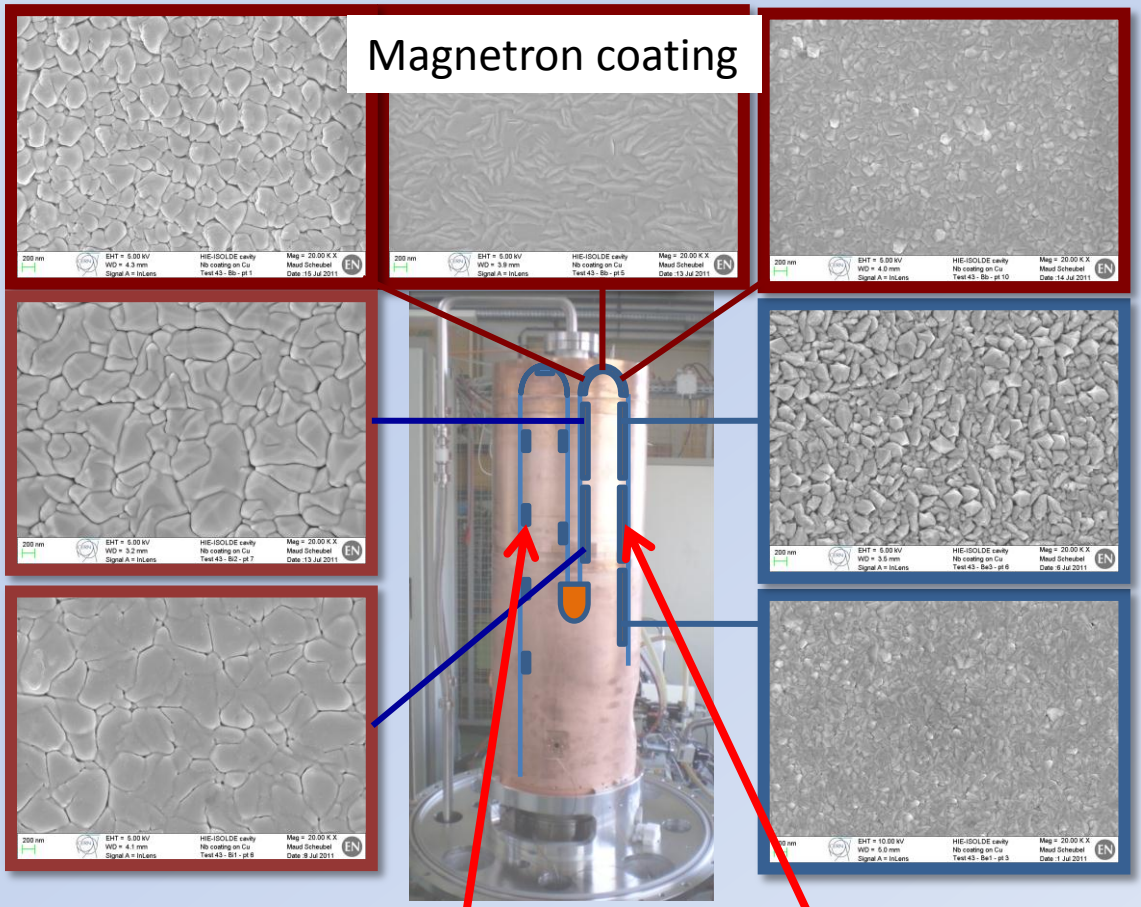
Coatings without cooling

RRR for 150 °C coatings







..."increase sputtering temperature":
270 °C (1kW) and 330 °C (2 kW)

Now:
Double number of quartz samples (RRR measurement)
Full length of cavity surface lined with copper strips for SEM analysis

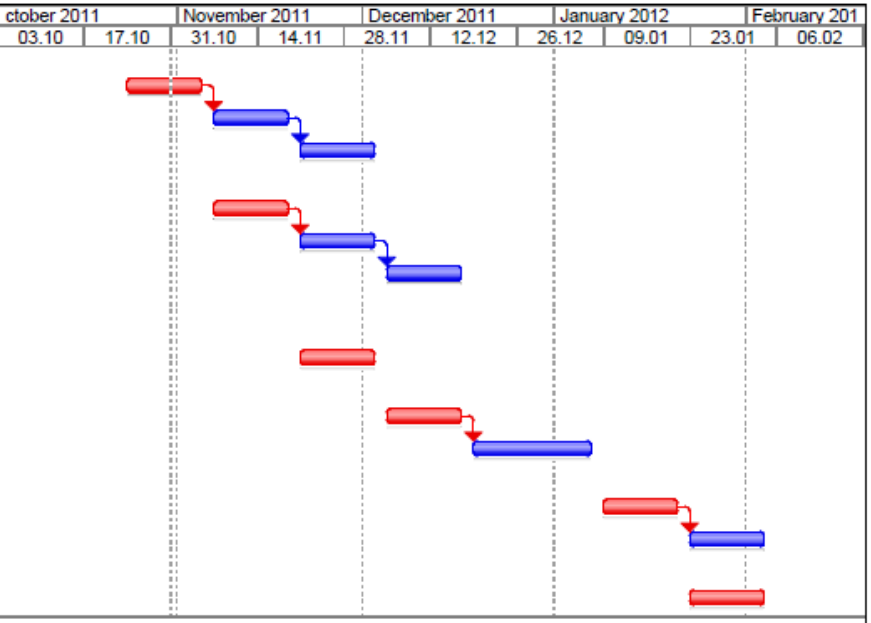
Cavity coatings

	Q2.3	Q1.5	Q2.5	Q1.7
Type	Magnetron	Diode	Magnetron	Magnetron
Coated	March	April	September	(this week)
Nominal pressure	$8x10^{-3}$ mbar	$1.5x10^{-1}$ mbar	$8x10^{-3}$ mbar	$8x10^{-3}$ mbar
Nominal power	1 kW	1 kW	1 kW	2 kW
Coating time	8 h	38 h	8h	3.5 h
RF test	Only one RF point measured	Yes	Yes	Next
Comments		No coating on beam line of inner conductor	Repetition of Q2.5 No sputter etching	No cooling (test: 410 °C) NEG assisted pumping

Future plans

- Validate high-temperature coatings by magnetron sputtering by end 2011

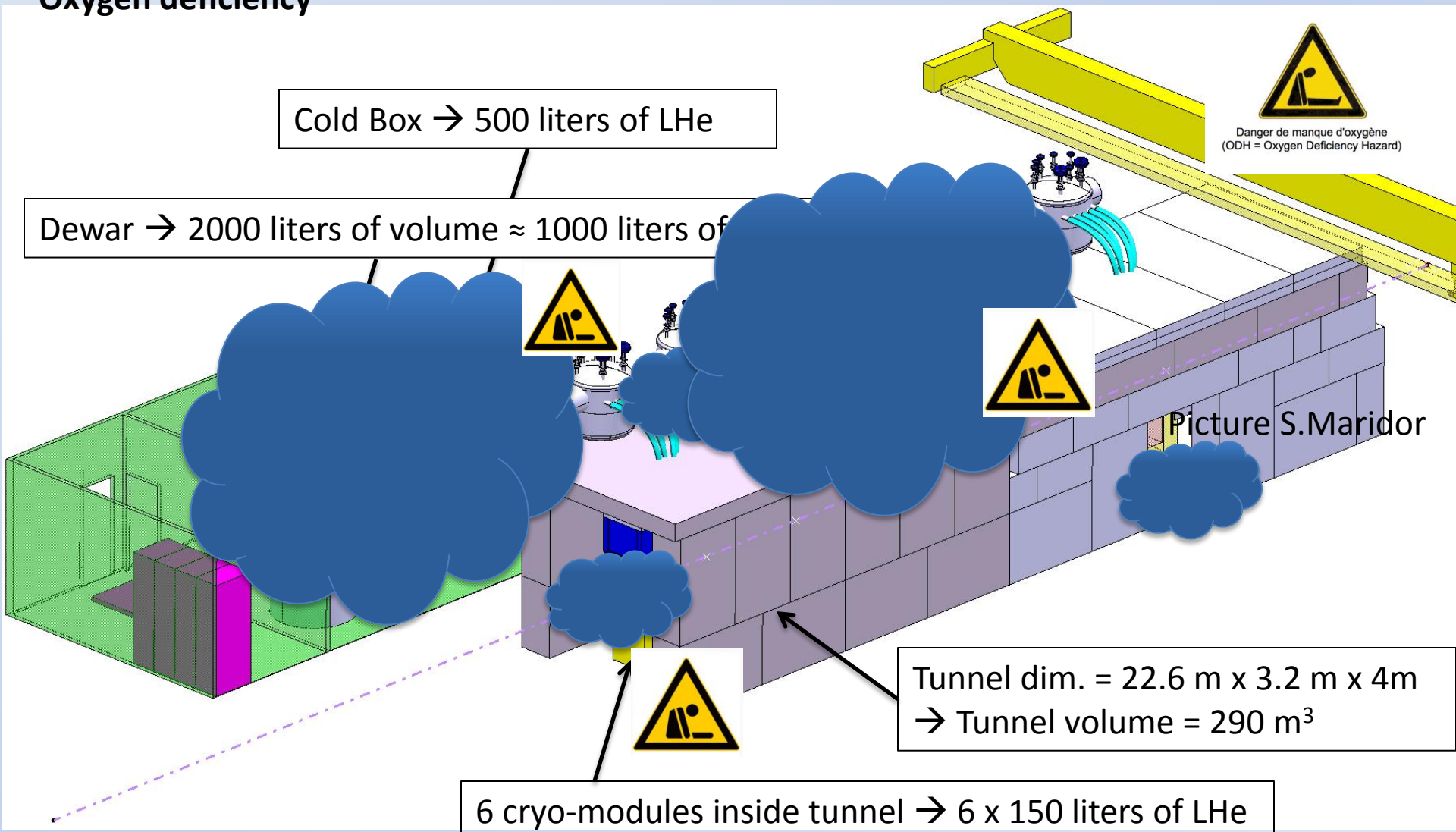
ID	Task Name
1	
2	High temperature coating cavity Q1 (magnetron)
3	RF testing
4	Metrology
5	
6	High temperature coating cavity Q2 (diode)
7	RF testing
8	metrology
9	
10	
11	Sample testing (higher power)
12	
13	Repetition of best perfoming previous coatings (Q1)
14	RF testing
15	
16	High power liquid cooling coating (Q2)
17	RF testing
18	
19	Sample testing on Q4 / Coating of Q3



- Goals set by the project:
  - on-specs by March 2012
  - Production coatings start 1Q2013

General Safety (A.-P. Bernardes)

Oxygen deficiency

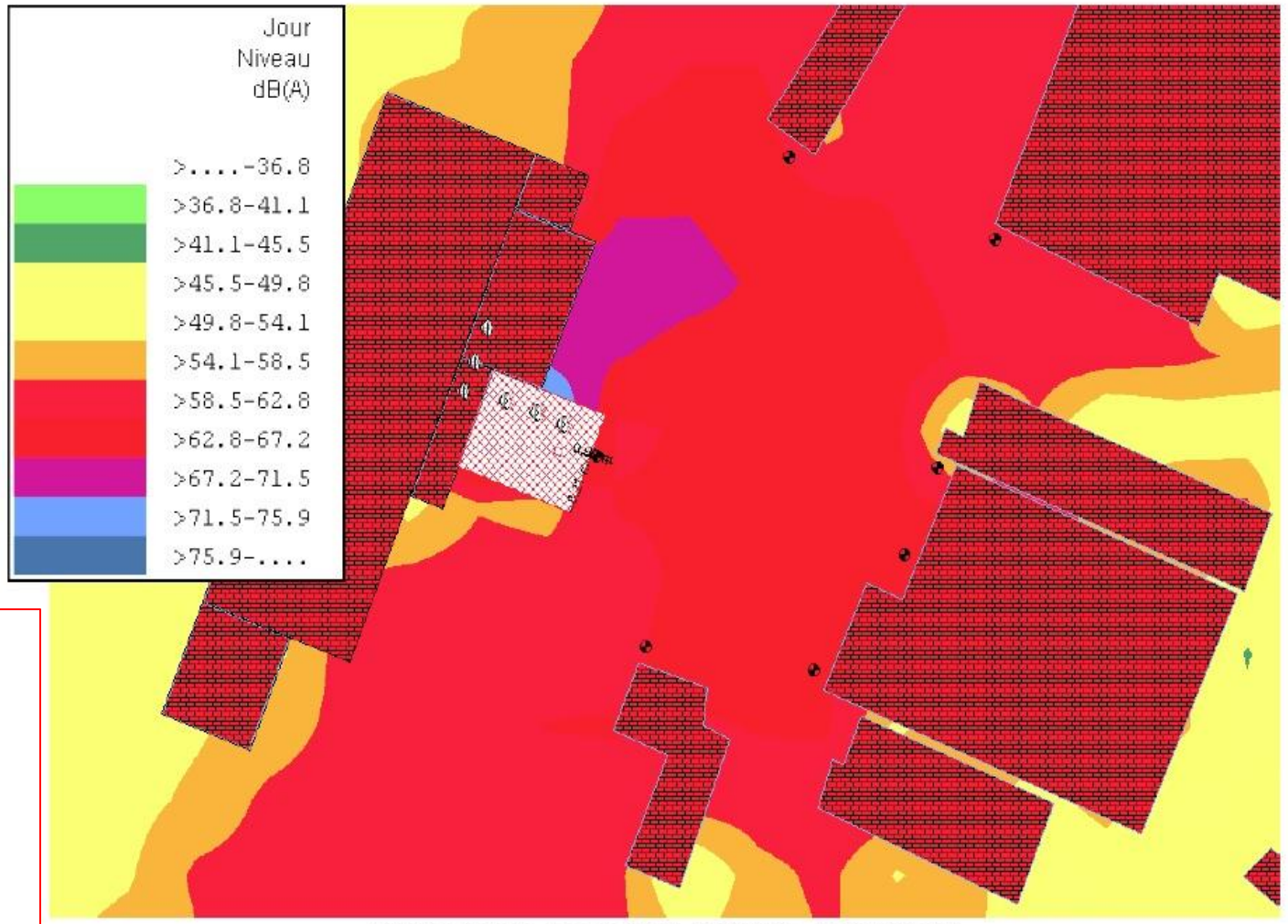


In collaboration with N.Delruelle (TE/CRG)

General Safety (A.-P. Bernardes)

- Noise propagation impact on nearest buildings

- Noise impact outside of CERN

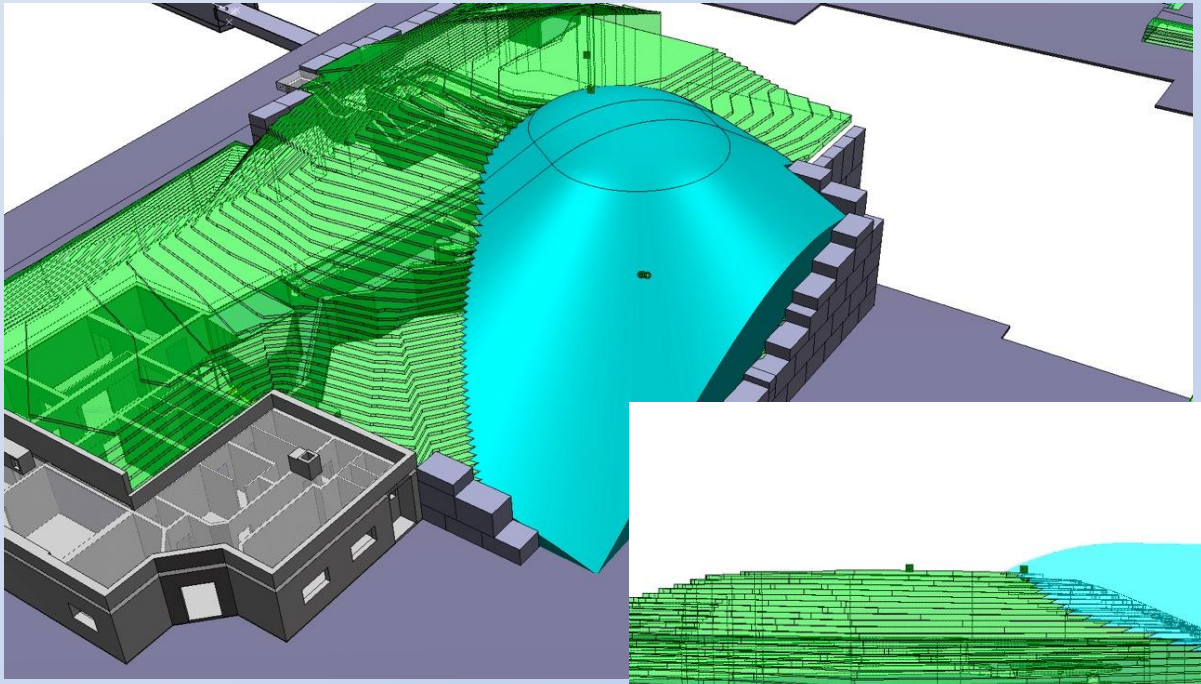


Cartographie acoustique à 1.50 m de hauteur

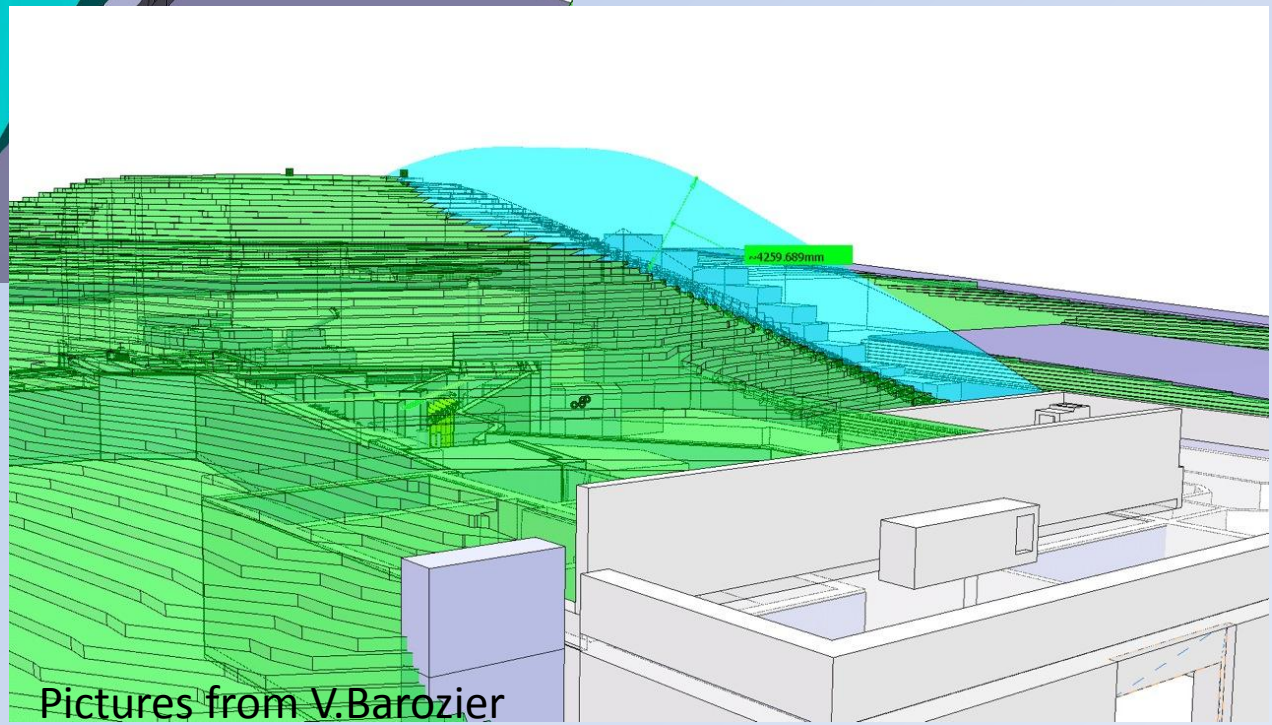
Impact outside of CERN too high – Need to invest on “Low noise equipment” - Collaboration with EN/CV on going

Radioprotection (A.-P. Bernardes)

Radiation shielding In collaboration with A.Dorsival, J.Vollaire DGS/RP and V.Vlachoudis EN/STI



First estimation of shielding reinforcement→ civil engineering of the primary area tunnel will not support so much weight



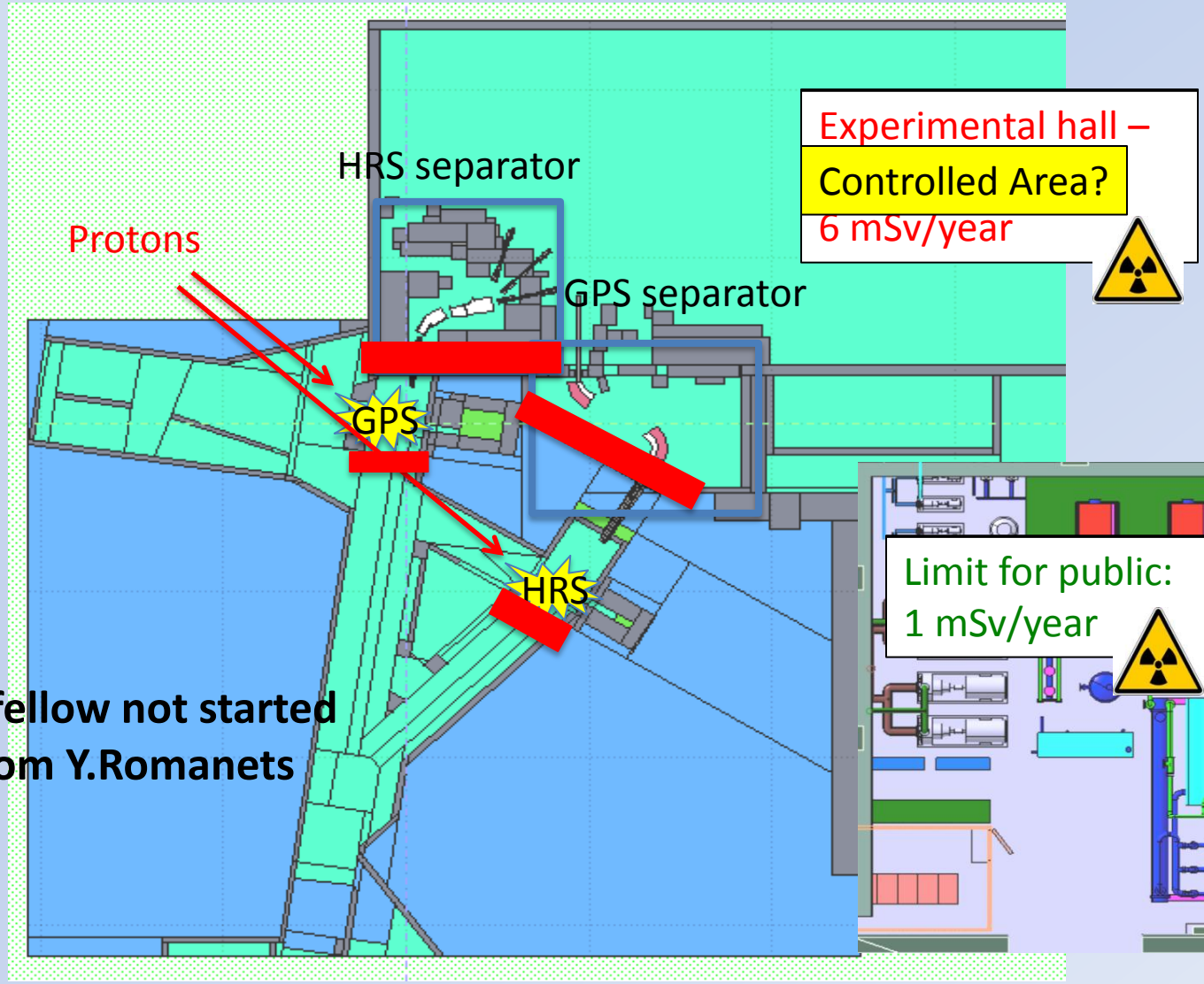
Pictures from V.Barozier

Radioprotection (A.-P. Bernardes)

TO BE DONE In collaboration with A.Dorsival, J.Vollaire DGS/RP and V.Vlachoudis EN/STI

- Respect of actual radioprotection limit values ??

- Impact on actual existing shieldings ??



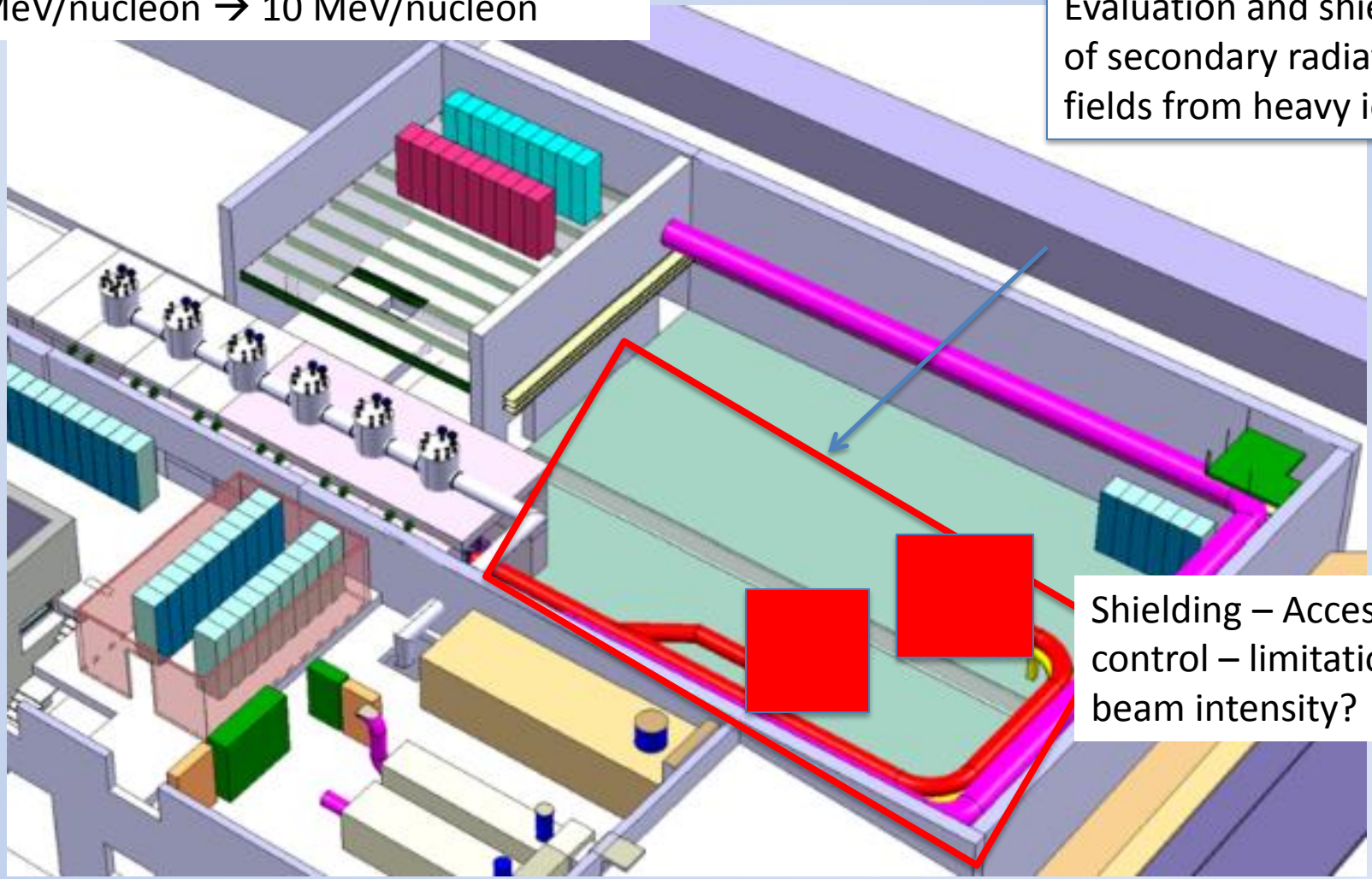
ESR10 Marie-Curie fellow not started
No more support from Y.Romanets

Radioprotection

TO BE DONE In collaboration with A.Dorsival and J.Vollaire DGS/RP

3MeV/nucleon → 10 MeV/nucleon

Evaluation and shielding of secondary radiation fields from heavy ions

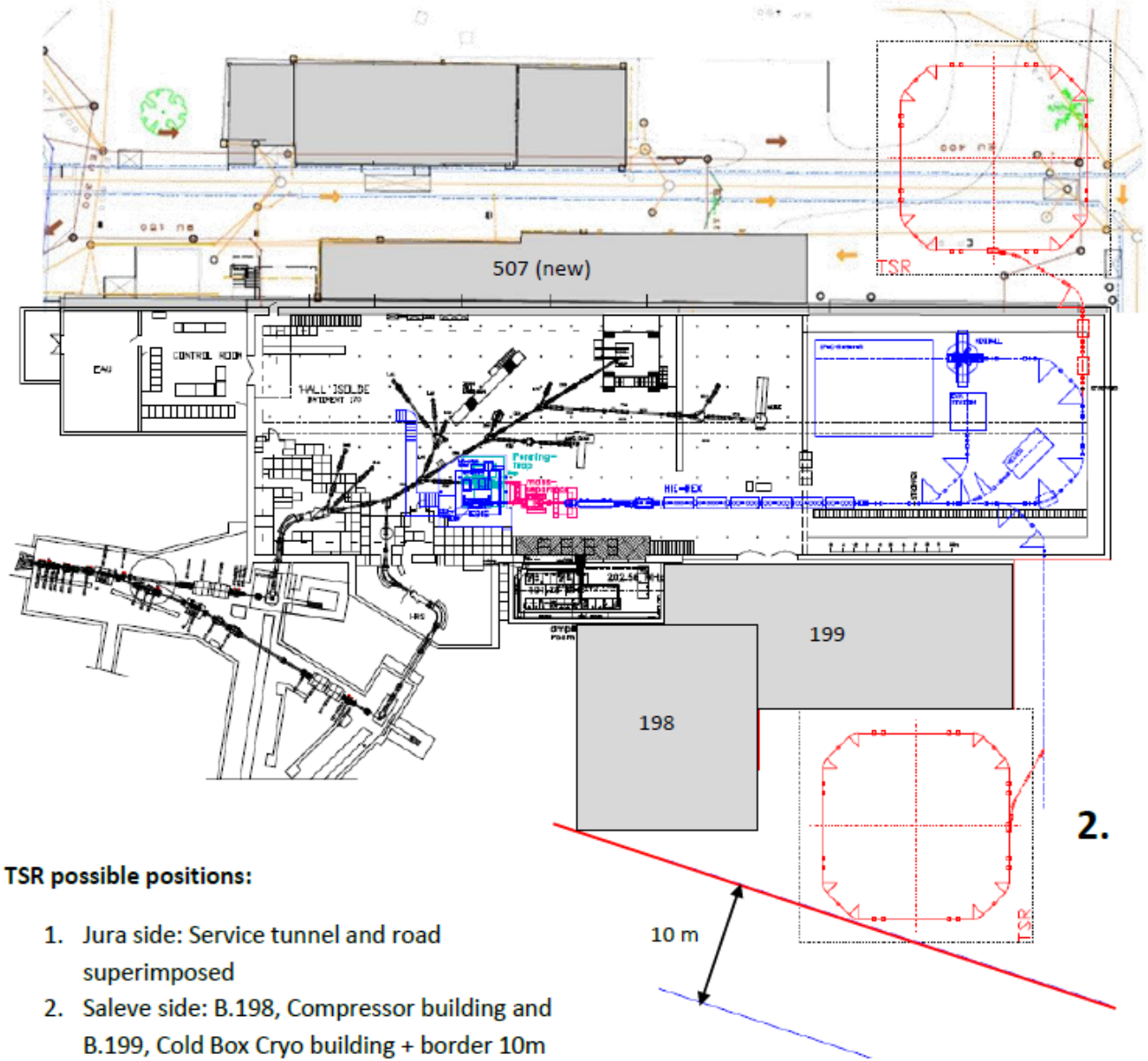


Shielding – Access control – limitation of beam intensity?

Status of HIE-ISOLDE Collaborations

- IPN-Orsay
  - Discussions concerning special contribution (LLRF, cavity ancillaries
  - Availability of test cryostat for HIE-ISOLDE cavity RF tests
  - MoU in preparation
- Korean MEST to allocate 200 kUSD/year for joining ISOLDE Collaboration => now awaiting final approval by Korean Parliament
- BARC (India)
  - Discussion concerning in kind contribution (production of copper cavity substrates and cryostats)
  - Discussion with DAE (funding agency) for joining ISOLDE Collaboration
- Application to Wallenberg Foundation on priority list

Layout



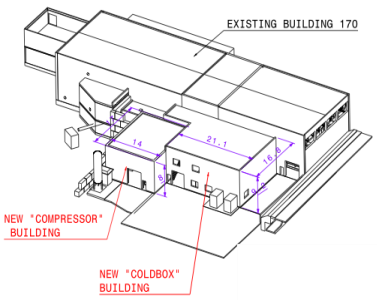
TSR possible positions:

1. Jura side: Service tunnel and road superimposed
2. Saleve side: B.198, Compressor building and B.199, Cold Box Cryo building + border 10m

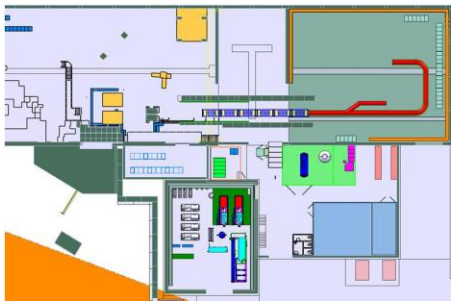
Outlook

- SC Cavity prototype cold tests @ SM18
  - IAP cavity review
- Cryomodule Design
- Procurement of Cooling & Ventilation Plant
- Procurement of the Cryogenics Plant
- Start of the civil engineering works
- Kick-start of Design Study for intensity upgrade

Good News !



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