Future Developments at ISOLDE

Richard Catherall
ISOLDE Technical Coordinator
ISOLDE Workshop and Users Meeting
17th – 19th December 2012

Outline

- Introduction …the last few years
- Target area
  - Robots
  - Hot cell
  - Access
  - New storage
- Target Development
  - Recent developments
  - RILIS
  - 2GeV @ ISOLDE
- Experimental Hall
  - TSR@HIE-ISOLDE
- HIE-ISOLDE Design Study
  - Extraction electrode
  - Target developments
  - Off-line separator
  - RFQ Cooler
  - Charge Breeder upgrade

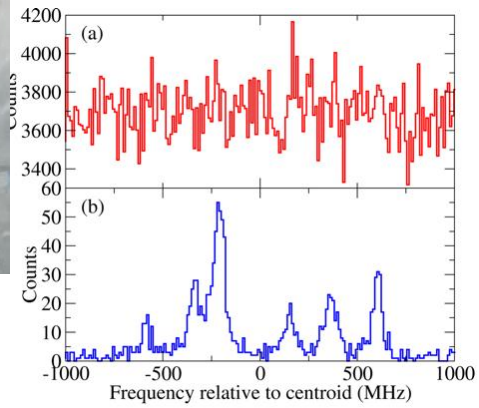
The last few years…

2005 The Class A Labs

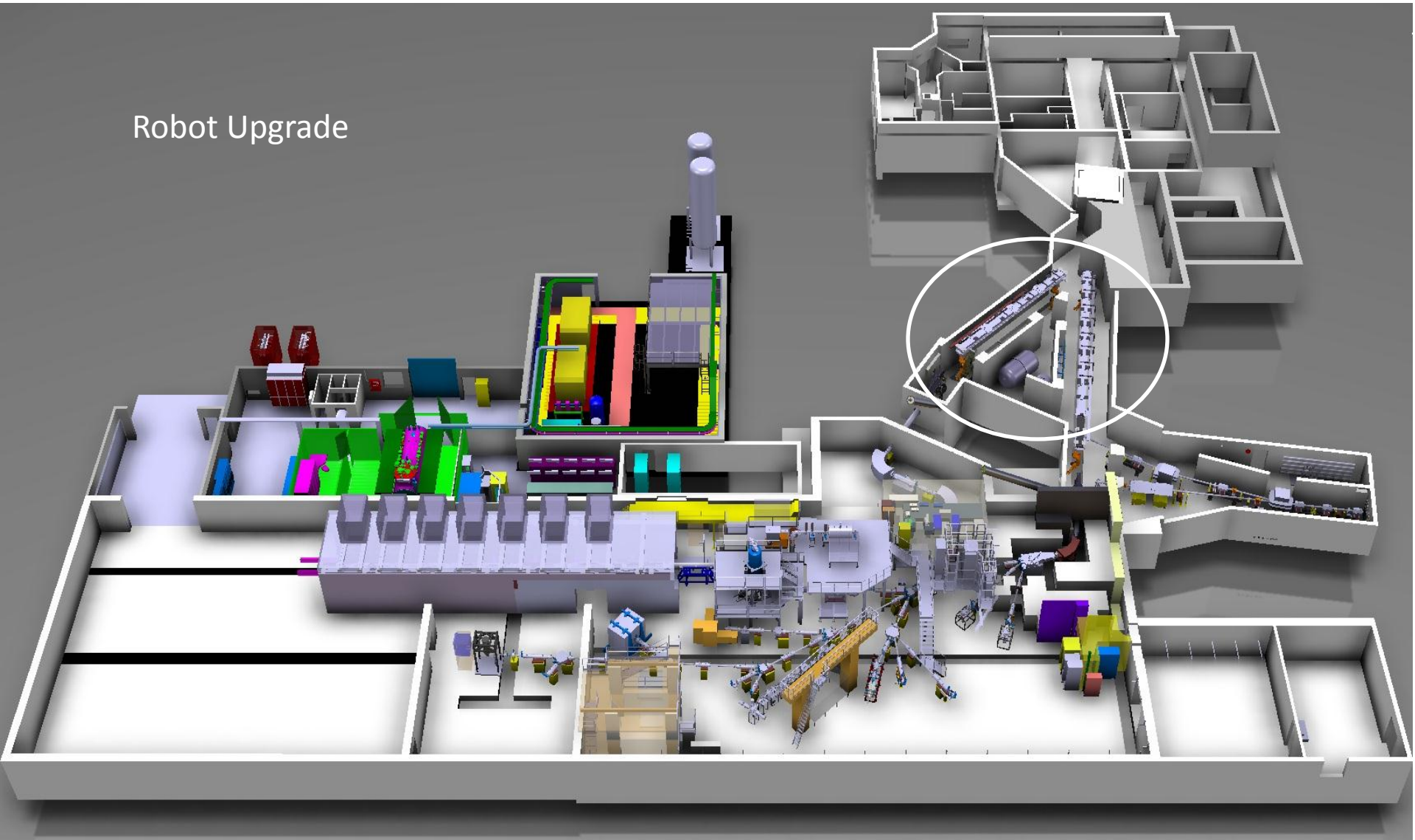
2008 ISCOOL

2009 REX Shielding

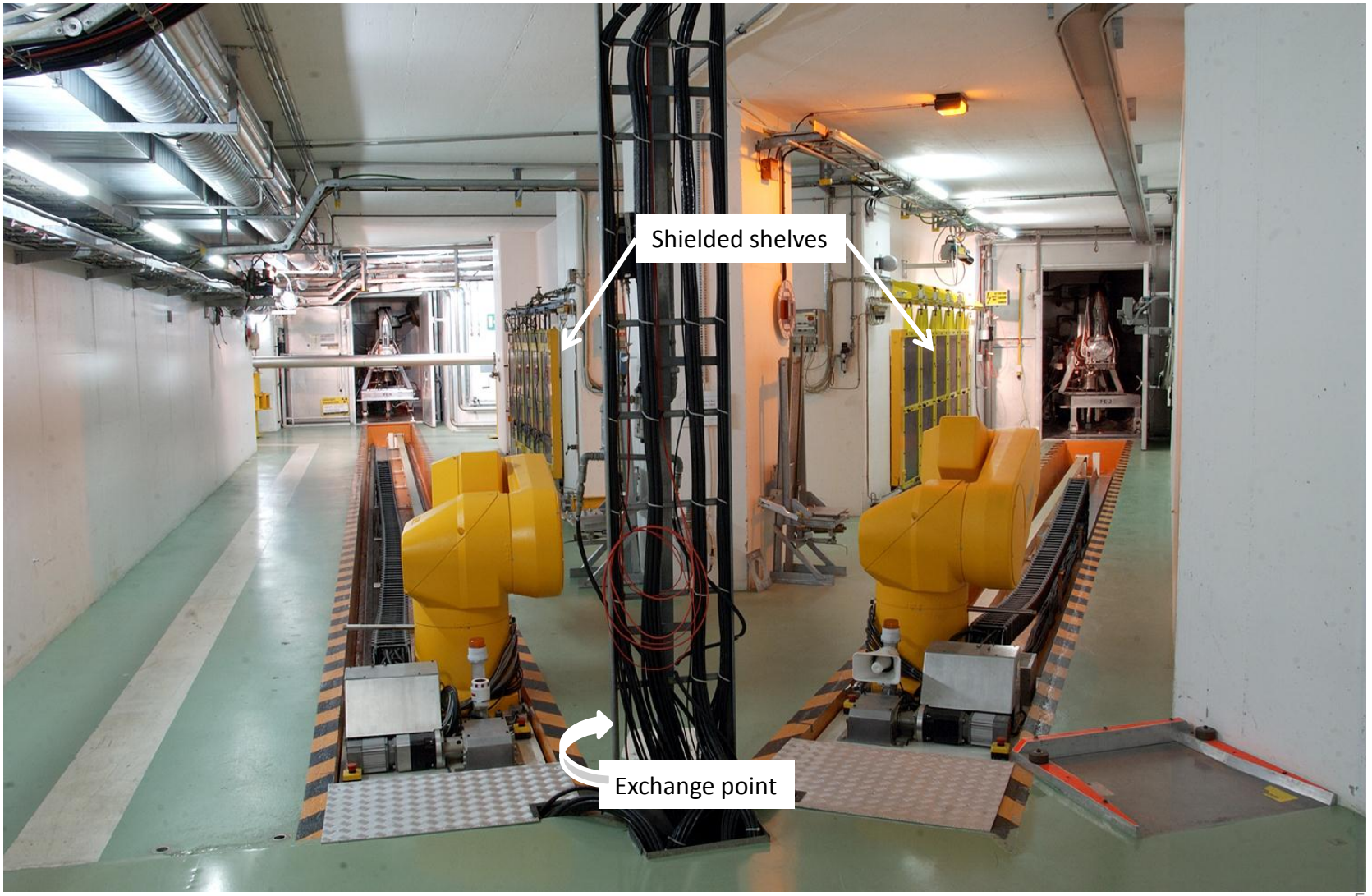
2010 & 2011 Front End and
HT tube insulator replacement



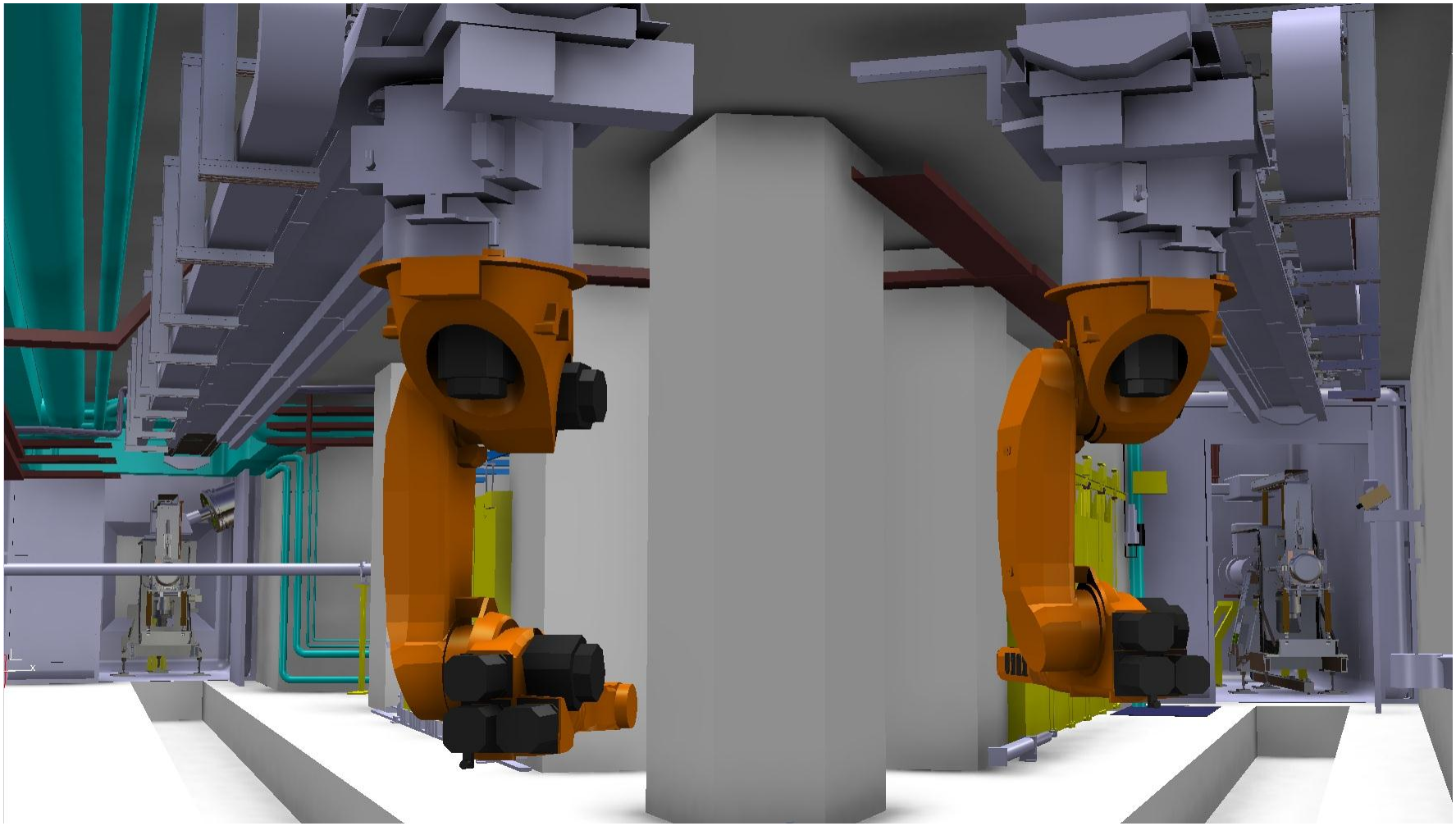
The Future ISOLDE Facility



The Target Handling Robot Upgrade



The New ISOLDE Robots

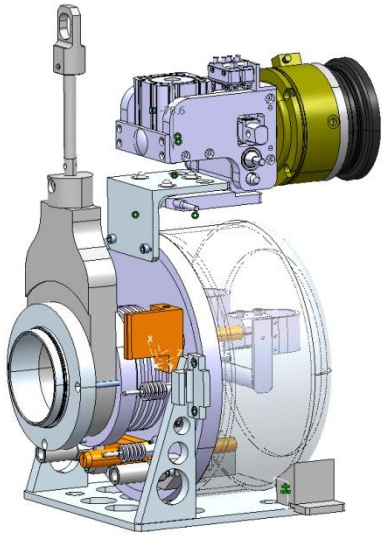


The Target Handling Robot Upgrade: The New Remote Handling System

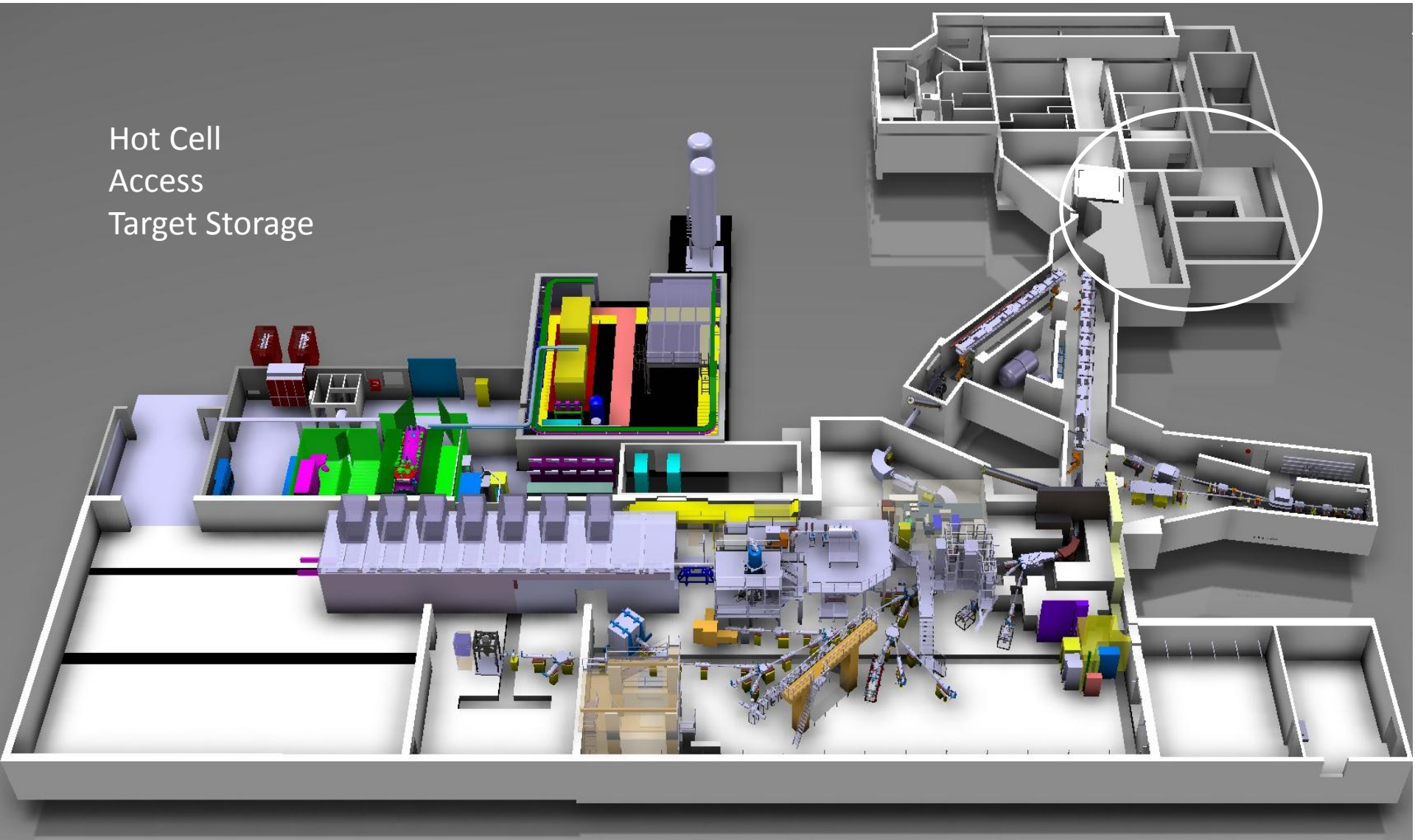
- Two industrial 6 axis robots fixed to a suspended 7th linear axis
- Radiation resistant
  - Deported electronics, radiation resistant materials…
- Complete refurbishment of the system
- Improved functionalities
  - Storage, visual inspection
- More flexibility
- Large scale mock-up testing before installation

Design changes for the new remote handling system

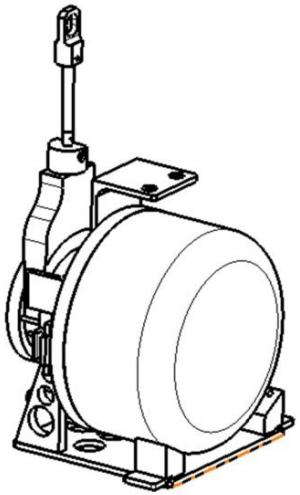
- Design change of specific parts
  - New gripper with redundant functions
  - Implementation of feedback of each status
  - Control system includes recovery method
  - No electronics in the target area
  - Based on a industrial robot and linear transport system

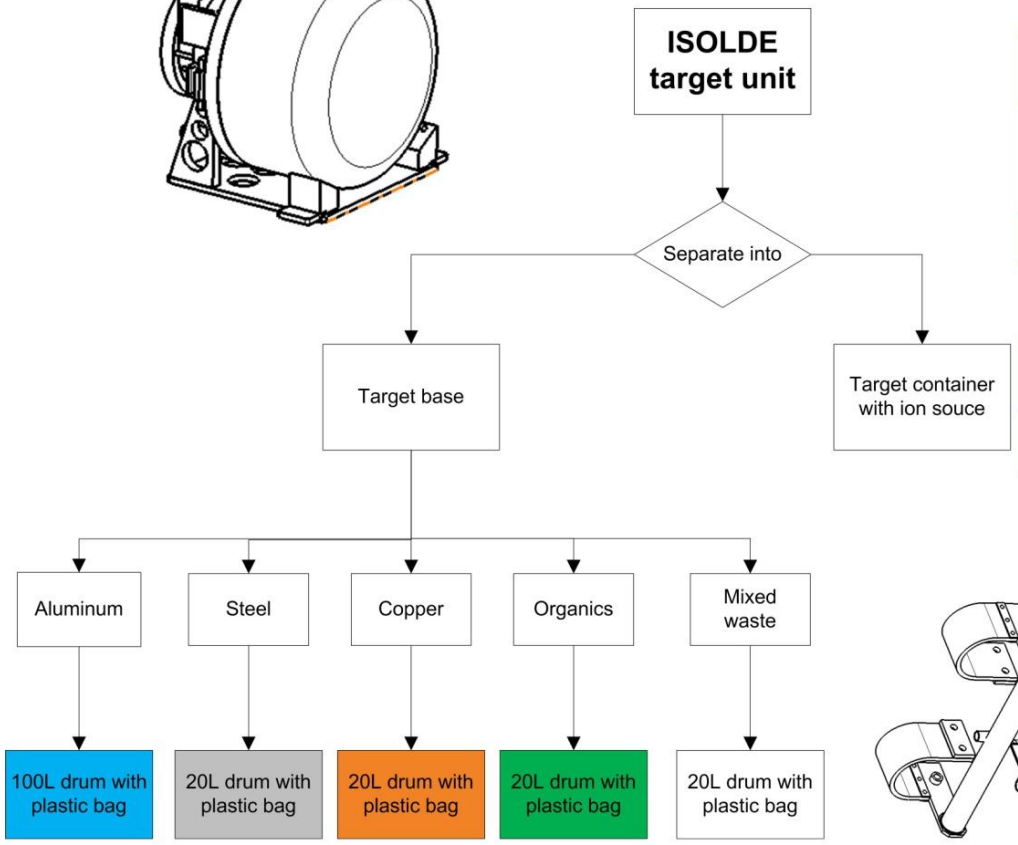


The Future ISOLDE Facility



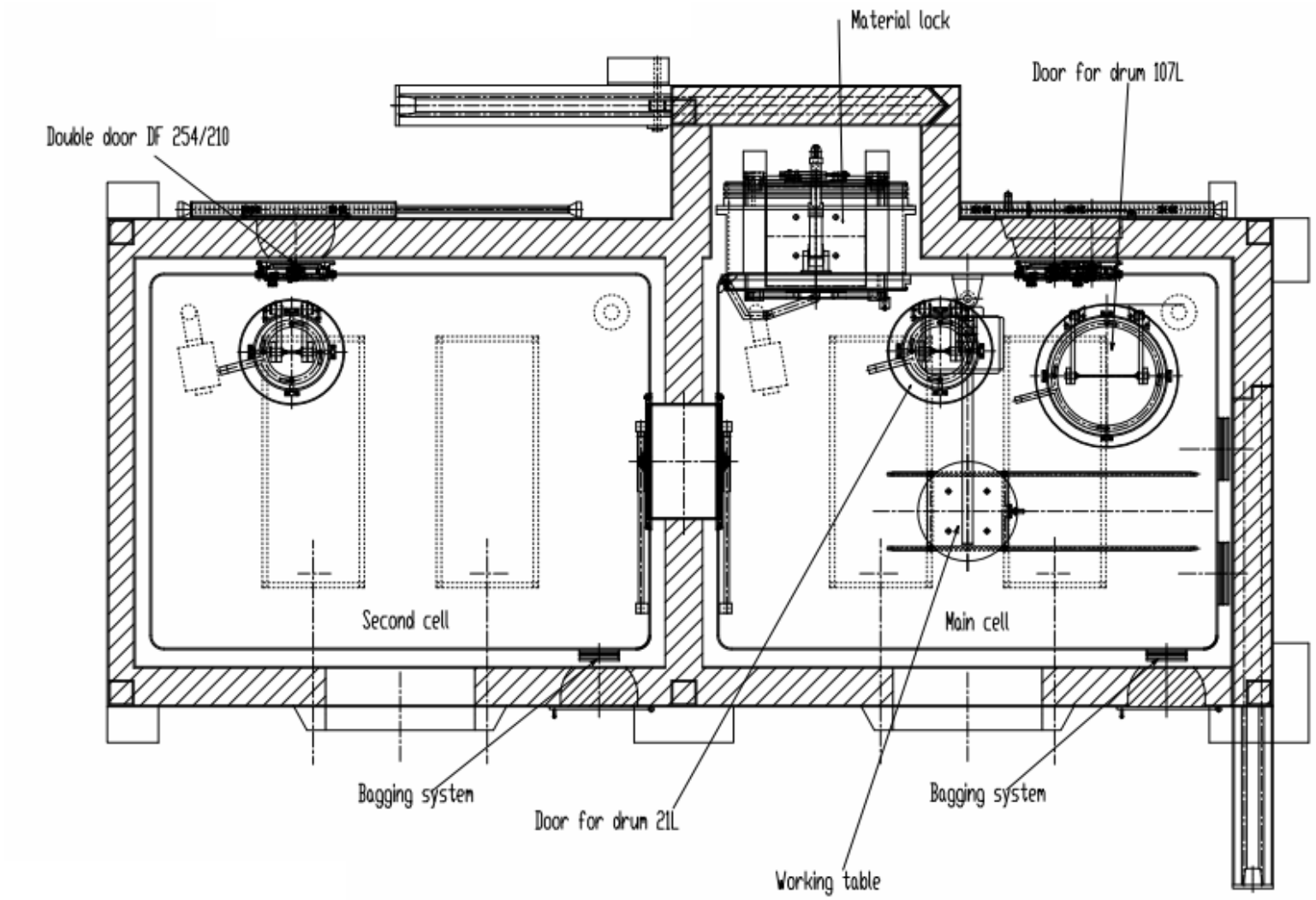
Hot Cell:
Requirements for waste treatment and packaging





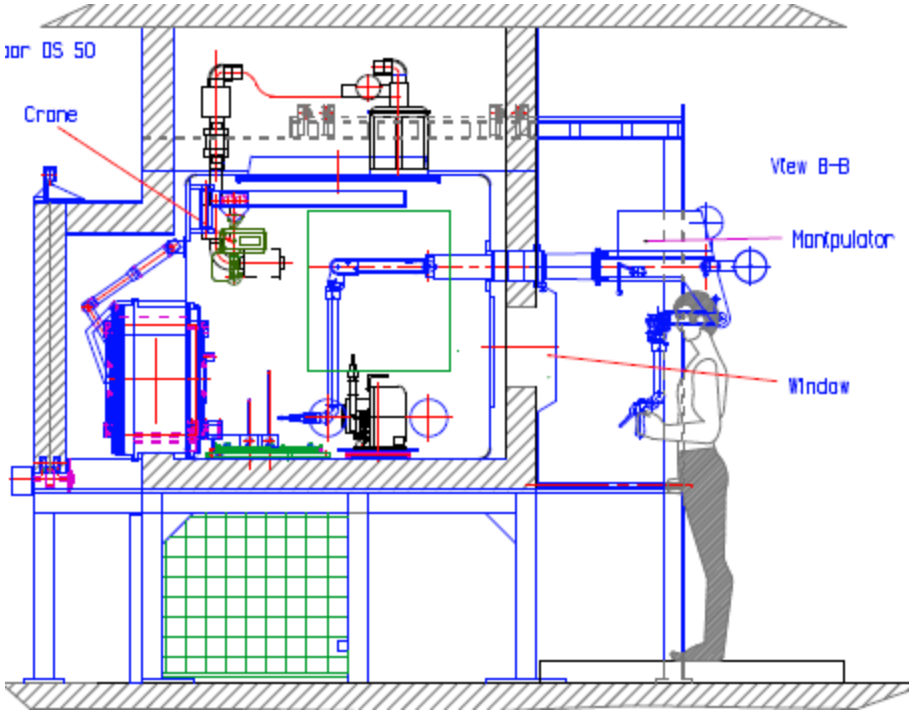
Waste type
ThO_2 and U_3O_8 mixed with mortar
Ion-sources, empty tantalum container + graphite tubes of ThC_2 and UC_2 targets
Non actinide powders/pills/fibres mixed with mortar
Complete metal target containers Ion-sources, empty tantalum container + graphite tubes of the powders/pills/fibres targets
Aluminium
Steel
Copper
Non-metals (Organics and ceramics)
Mixed waste (anything that is left, cannot be separated)

Hot cell layout



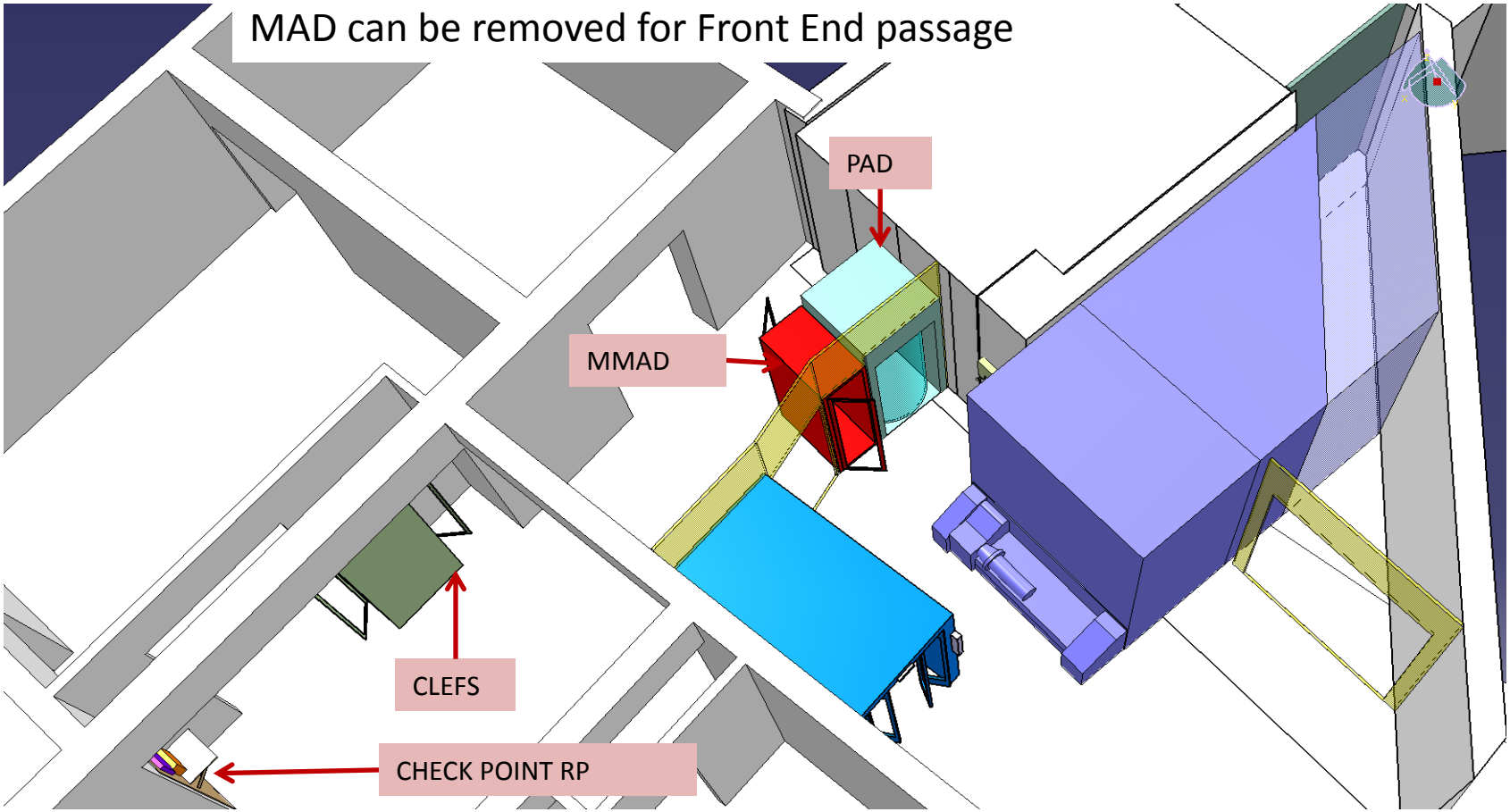
Alpha Gamma Hot Cell: Status

- Functional and technical specifications prepared.
  - In collaboration with the Paul Scherrer Institute.
- Invitation to tender September 2012
- Project approved by Finance Committee
- Delivery expected January 2014



PAD-MAD Access

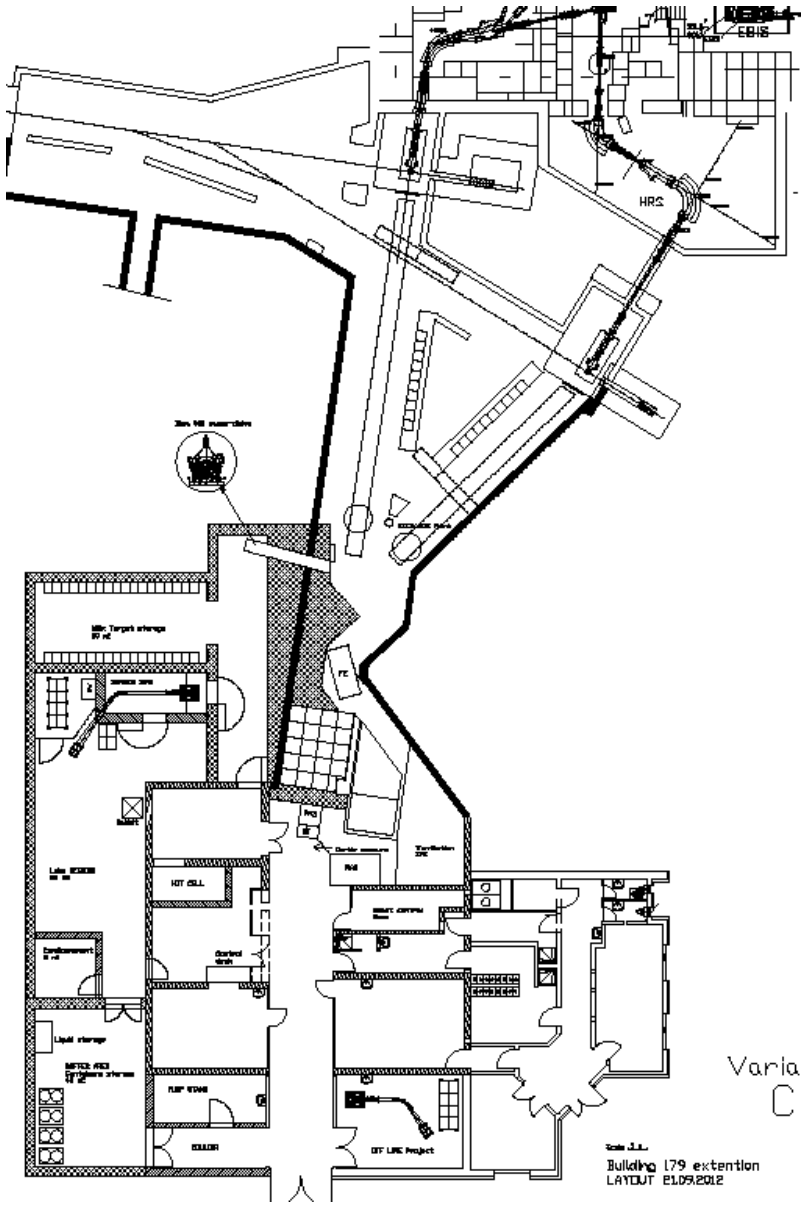
Installation planned for the end of 2013
Robot barrier will be integrated
MAD can be removed for Front End passage



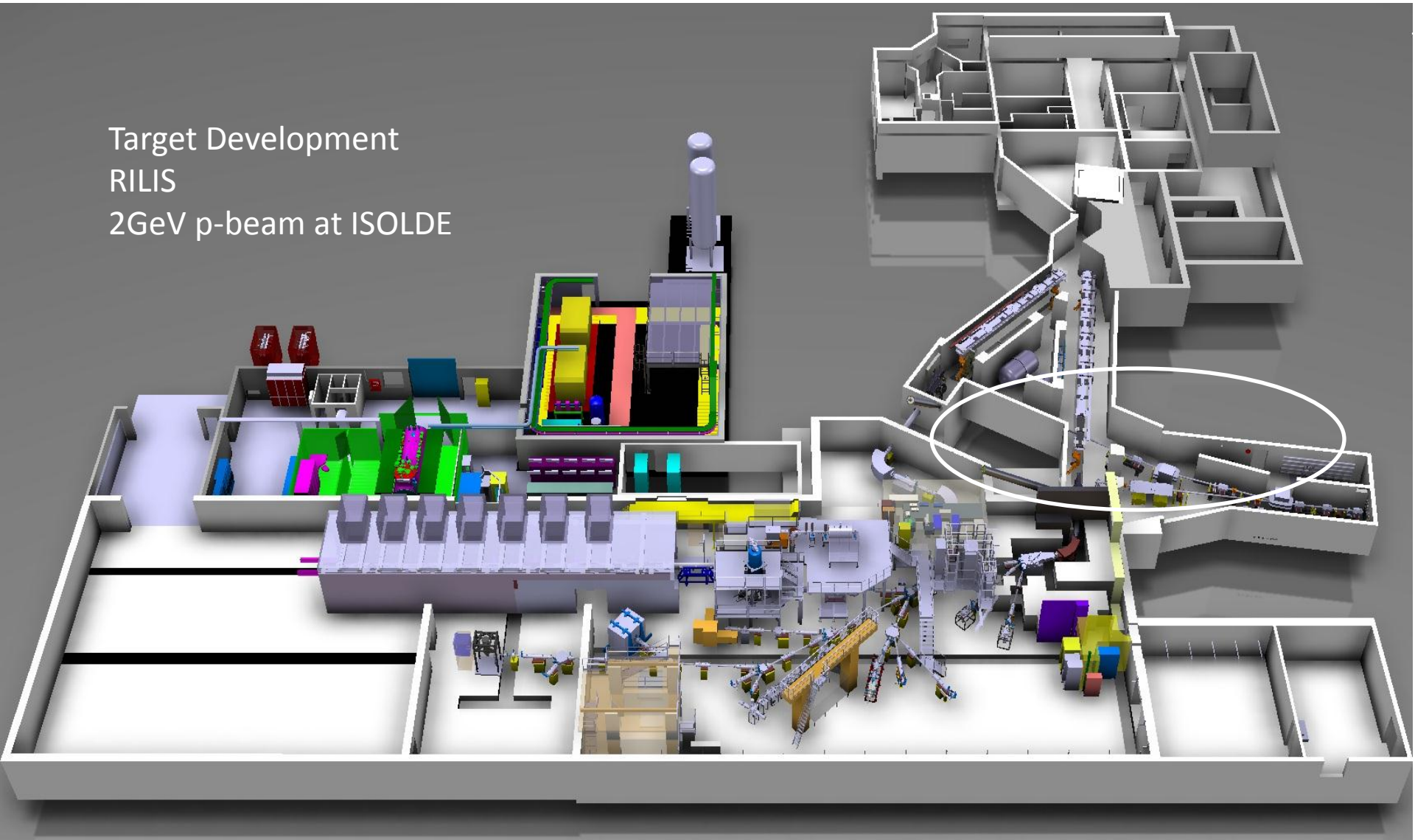
EDMS no.1145495

Building 179 extension

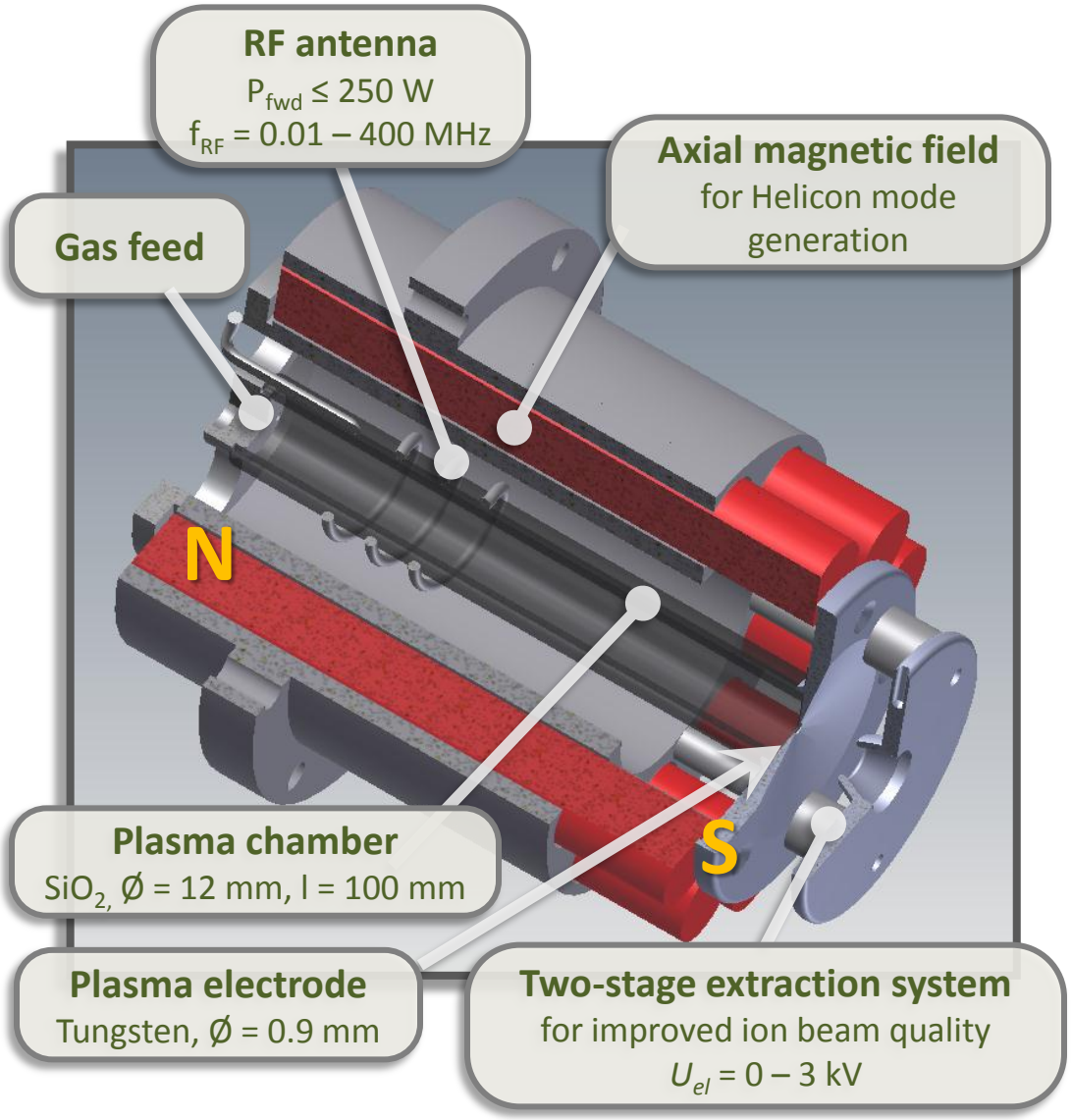
- New storage
  - Eliminate the need to transport irradiated targets on the CERN site
  - Easier handling for access to new hot cell
  - Compatible with new CERN access system (PAD/MAD)
  - Compatible with new robots
  - Buffer zone/dispatch
- Medicis laboratory
  - New off-line separator connected to RABIT system
  - Preparation laboratory

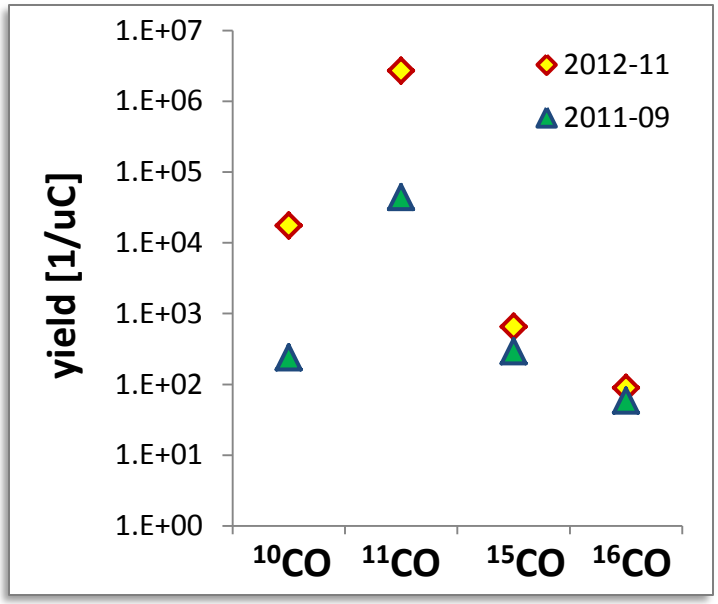


The Future ISOLDE Facility



The Helicon ion source

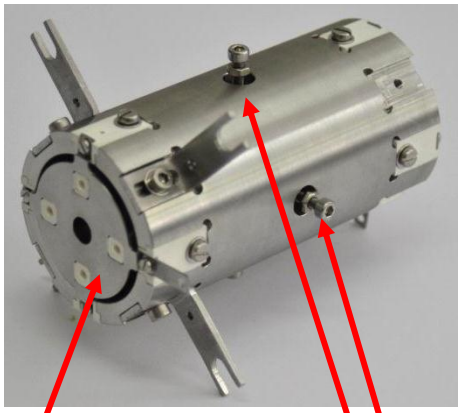




- Developed by the TISD group for the production of **CO^+ and CO_2^+ , N_2^+, and noble gas beams;**
- First online operation **2011/09, upgraded system tested 2012/11;**
- **Strong gain achieved on ^{10}CO and ^{11}CO;**

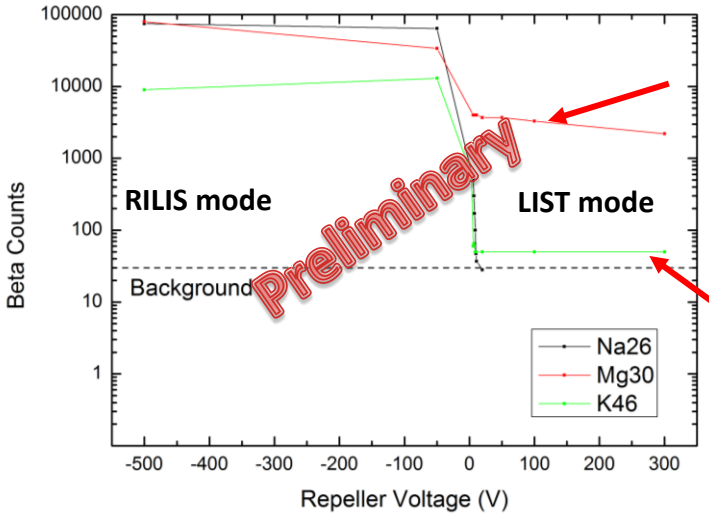
Laser Ion Source and Trap (LIST) On-Line at ISOLDE

LIST device:



LIST assembly:

Ionization and suppression of contaminants by LIST:



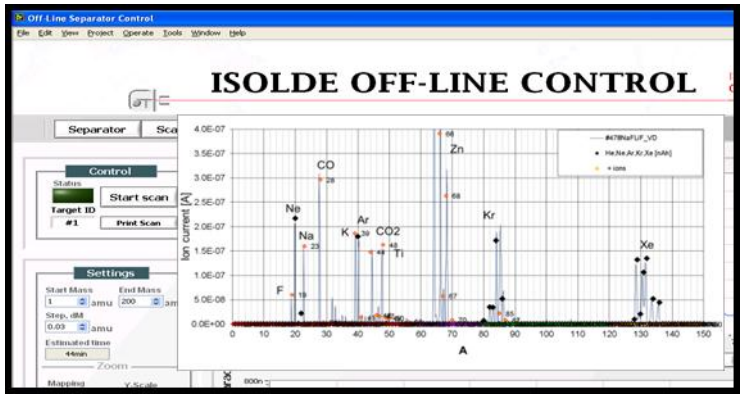
- LIST was successfully tested with UCx-target -> No loss of performance over 5 days
- Suppression of Na-, Al-, K-, Fr-, U-isotopes studied -> Suppression factors varied from 100 to 1000
- Laser ionization of radioactive Mg and Po in LIST

Fr suppression and laser ionization of Po in LIST → First ever LIST on-line physics result: hyperfine structure of ^{217}Po

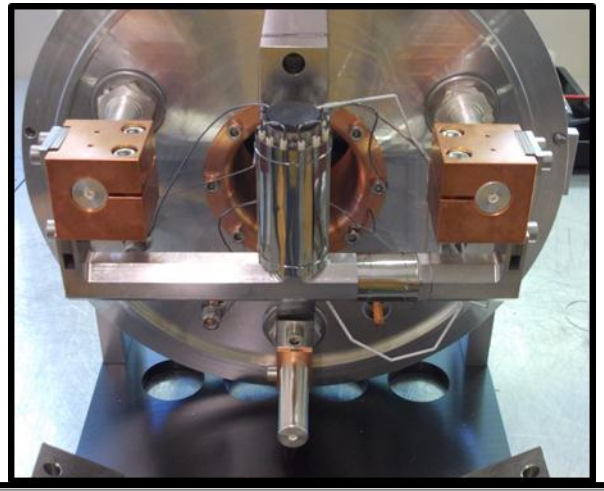
By Daniel Fink

Static molten salt target for ^{18}Ne* for β-beams

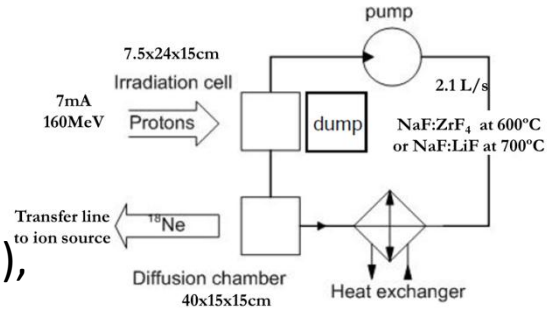
Featured (with ^{6}He beams) in CERN activity report and EPN (43/5)

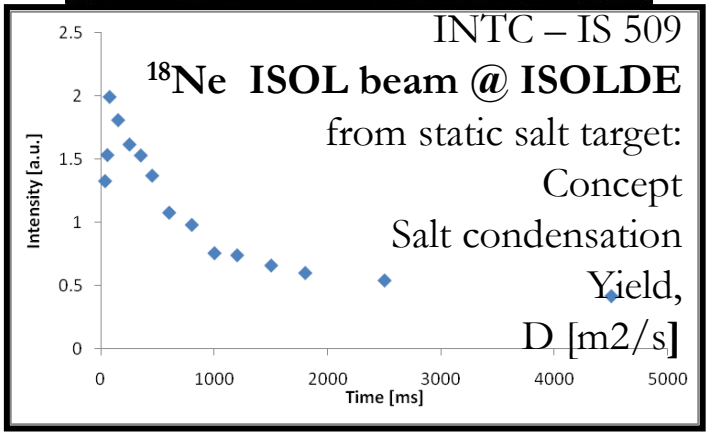


* And record yields of 11C as CO+



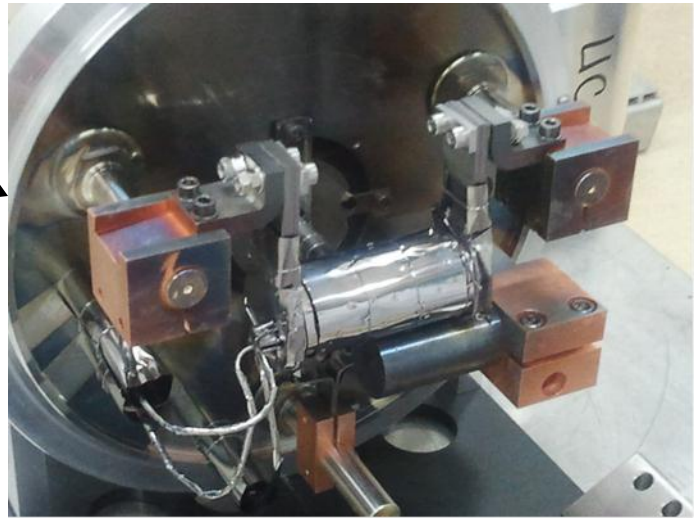
T. Mendonca (CERN),
E. Noah (UNIGE),
R. Hodak (Comenius univ),
M. Allibert, V. Ghetta (LPSC)
TISD team (S. Cimino, S. Marzari),
EN-MME, TE-VSC





New n converter – phase I

Tests of simulations with geometry I:
Predicted n-rich Zn/Rb improvement of ~ x20

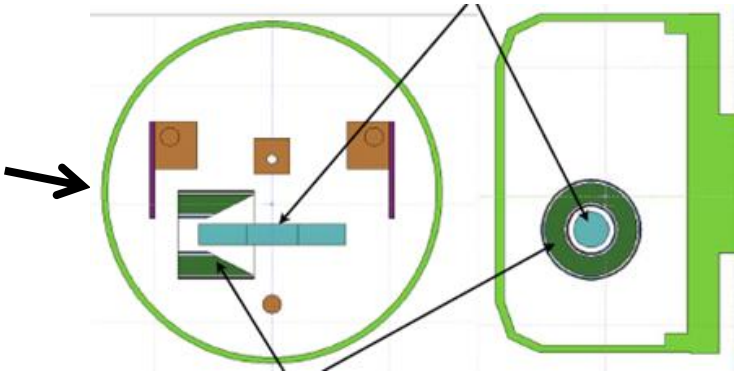


New converter geometry I :
5^e3 80Zn, 5^e1 80Rb /μC
600 81Zn, ~5^e2 81Rb/μC

➔ Measured improvement ca x200 (instead of x20)

Yet some teething problems:
clear thermal and mechanical weaknesses

Onboard for phase II (2014): Keeping the same
Impurity/beam improvement, and increase of yield



R. Luis et al, EPJ A 2012
TISD team, S. Marzari, B. Crepieux

ISOLDE RILIS future developments

GENERAL RILIS DEVELOPMENTS

- Extension of RILIS cabin
  - Enlarged entrance/storage and work area to maximize the useable laser laboratory space
- Implement a dedicated, high power Nd:YAG laser for non resonant ionization
  - High beam quality industrial laser could significantly improve efficiency for many schemes.
  - Would simplify RILIS setup, increase reliability and reduce setup time.
  - Testing is underway *this week*
- On-call operation
  - Installation of a machine protection and monitoring system to reduce reliance on shift-based operation
  - To be implemented during LS1

IONIZATION SCHEMES

- Investigate RILIS for refractory metals at ISOLDE
- Improved RILIS schemes for the Dual RILIS system

IN-SOURCE SPECTROSCOPY

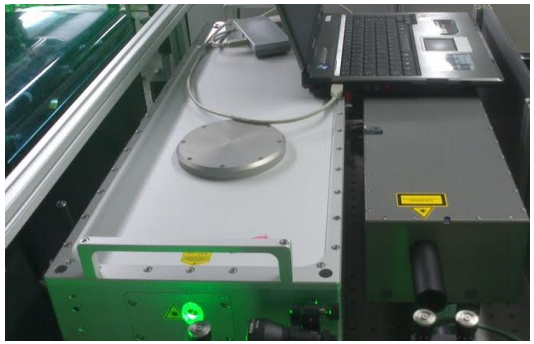
- Installation of a reference cell at RILIS
- Pulsed amplification of CW seeded Dye laser or TiSa
- Improved motorzation of Narrow-band TiSa

SELECTIVITY IMPROVEMENTS

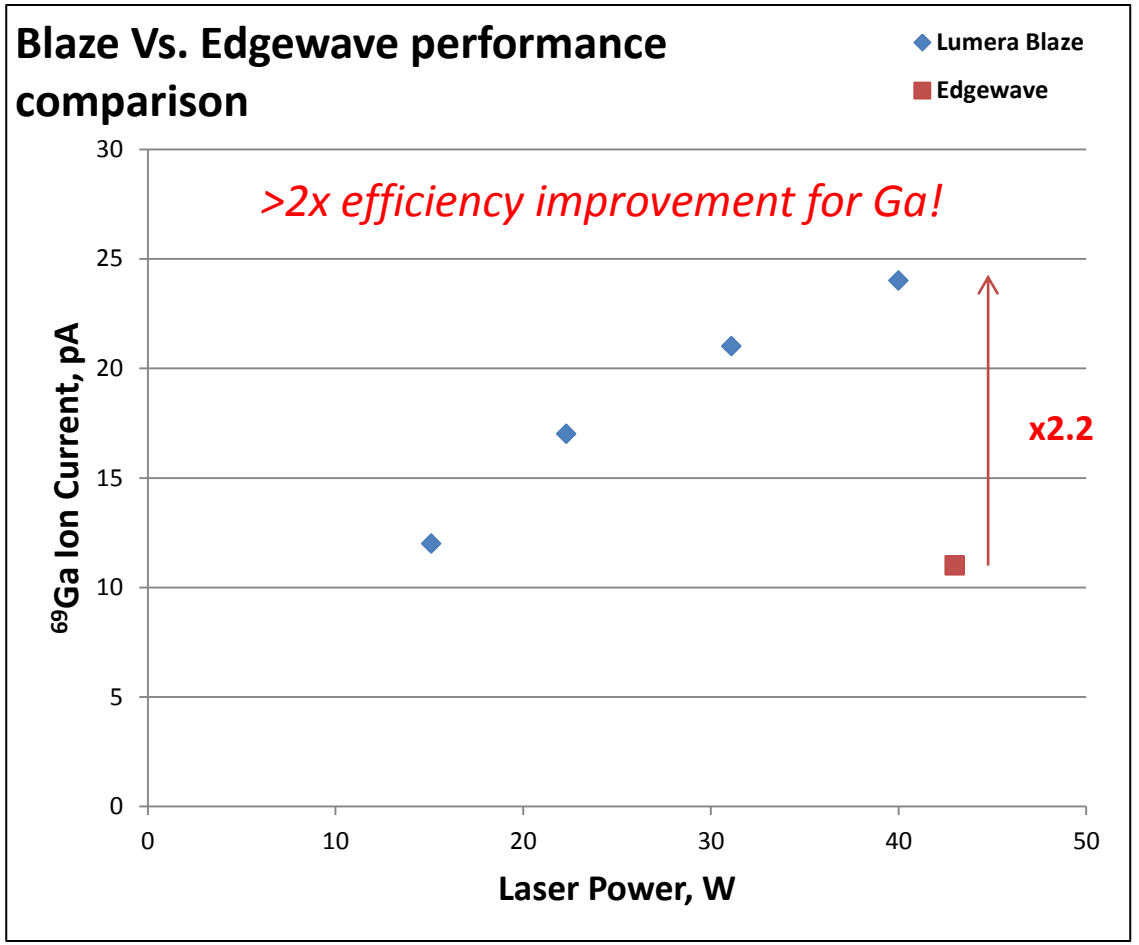
- Further optimization of LIST
- Improving the laser ion time structure or using a time focus for effective beam gating

Blaze laser test

Blaze laser installed at RILIS on Monday 17th Dec!



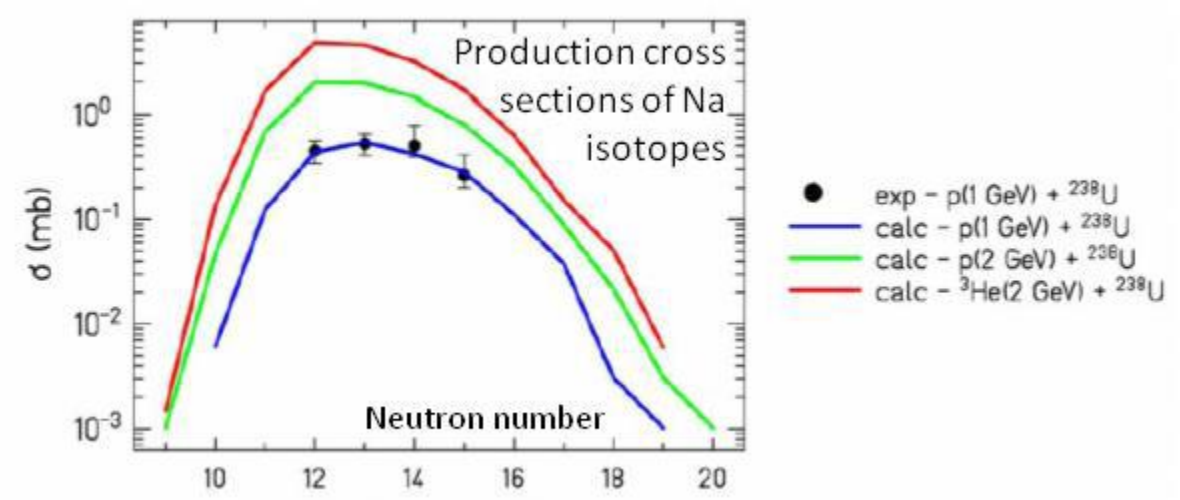
- 40W at 10 kHz
- 17ns Pulse
- Low Jitter
- Gaussian beam
- Much better transmission efficiency to ion source



A similar efficiency improvement should be expected for the **17** RILIS elements that use non-resonant ionization for the final step!

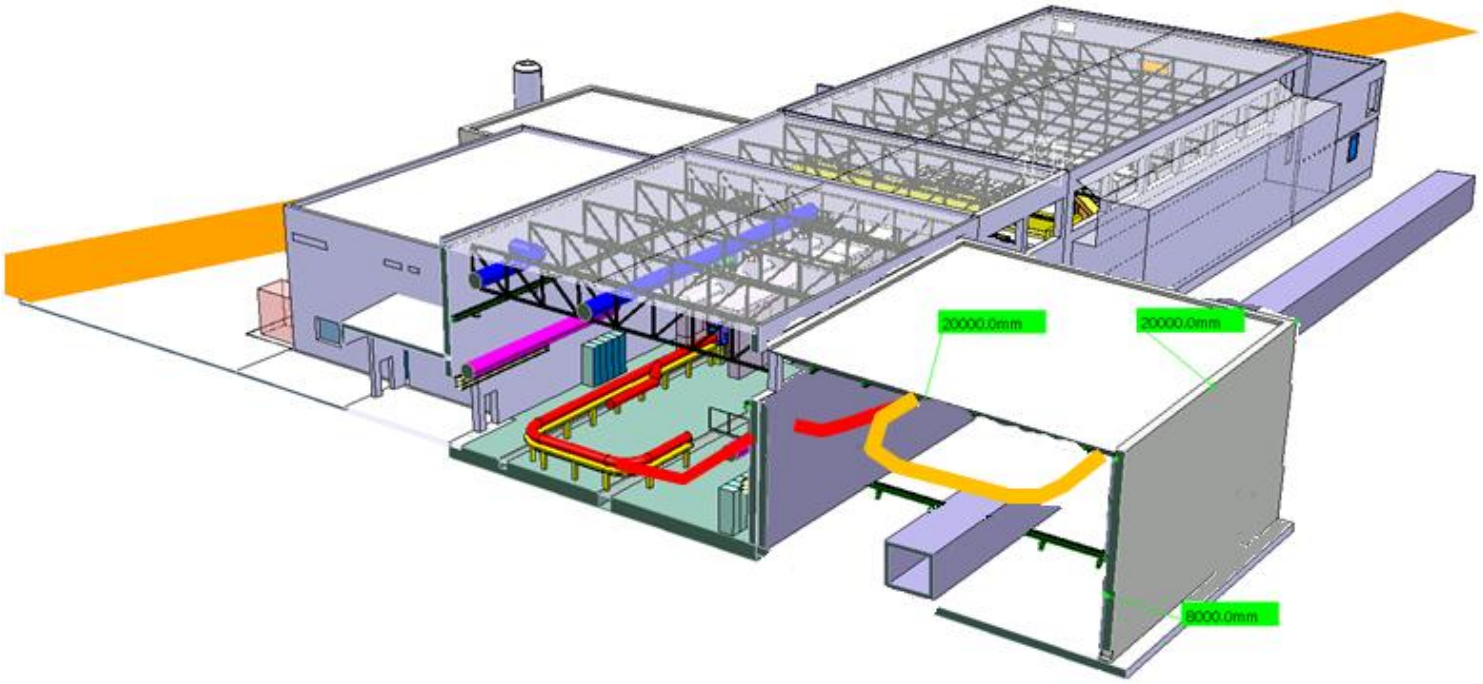
2 GeV proton beam @ ISOLDE

- Extension of the 2GeV energy upgrade of the PS-Booster
- Letter of Intent submitted to Research Board
- Isotopes produced from fission reactions gain x1.4 on average
- Fragmentation products gain x2 to x5
- Spallation products gain of more than x6 for exotic isotopes.



The Future ISOLDE Facility

- TSR @ ISOLDE



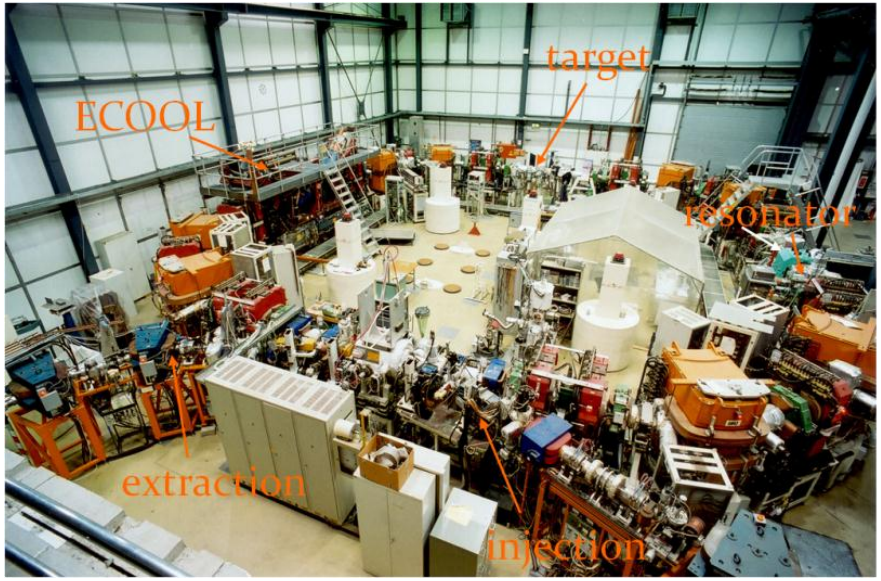
TSR@ISOLDE

Combine HIE-ISOLDE beams with Heidelberg heavy-ion Test Storage Ring

TSR and HIE-ISOLDE, a nice couple with:

- broad range of elements and isotopes
- wide energy range
- e-cooled beams
- cw beams
- in-ring and external experiments

First storage ring with ISOL-facility!



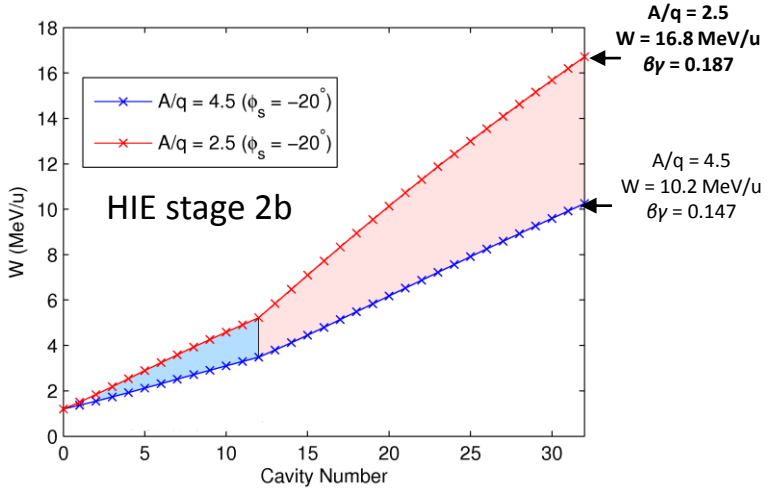
TSR at MPI-K Heidelberg

Circumference:	55.42 m
Vacuum:	~few 1E-11 mbar
Acceptance:	100 mm mrad
Multiturn injection:	mA current
Electron cooler:	transverse T_{cool} in order of 1 s

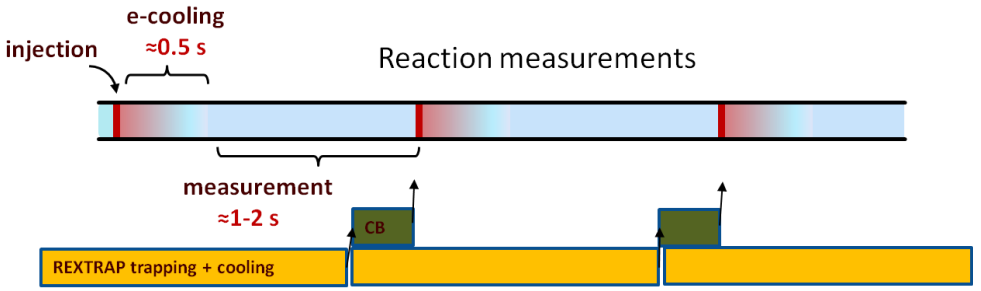
RF acceleration and deceleration possible

HIE/REX and TSR compatible

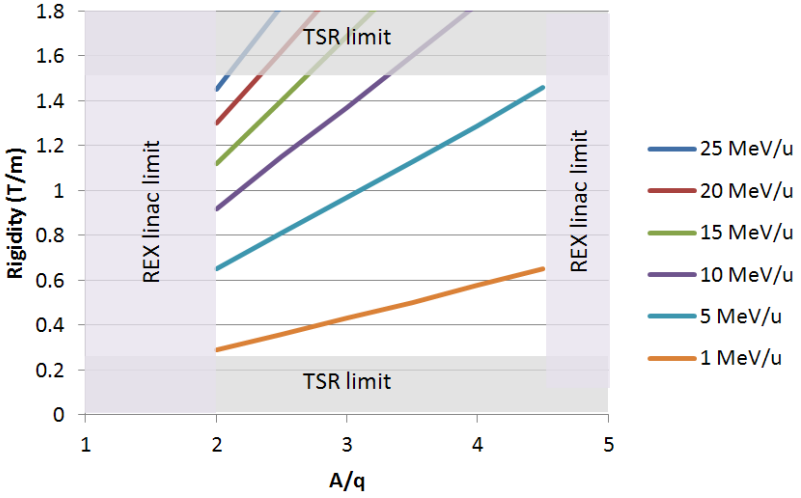
1. REX/HIE and TSR well adapted energy wise



Many different ways of operating the TSR



2. Need to hold the ions for up to 2 s in REX low energy stage => REXTRAP essential



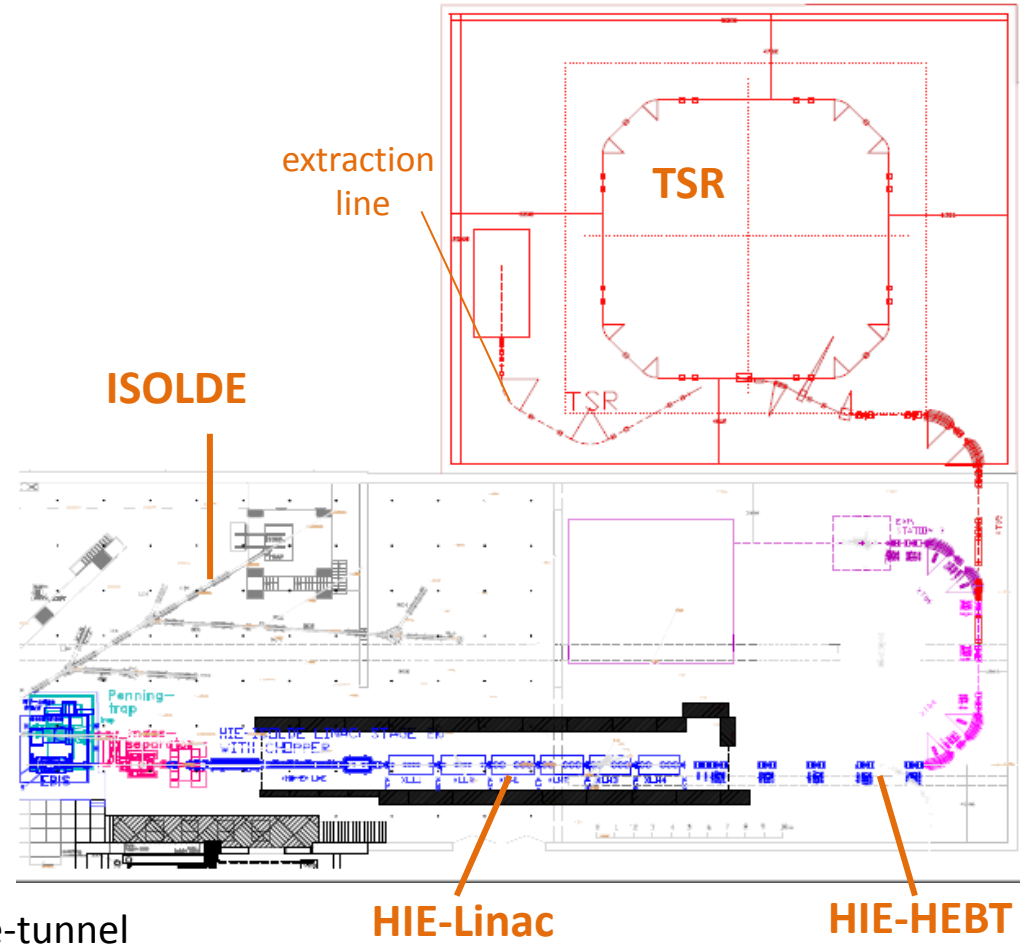
Ion	Z	q	A/q	Breeding time (ms)
^{7}Be	4	3	2.33	20
^{18}F	9	9	2	100
^{70}Ni	30	25	2.33	350
^{132}Sn	50	30	4.4	120
^{132}Sn	50	39	3.38	700 *
^{182}Pb	82	53	3.43	1000 *
^{182}Pb	82	64	2.84	EBIS upgrade needed

* to be tested

3. REXEBIS capable of producing sufficiently low A/q for almost all elements (< 10 MeV/u)

Possible TSR installation

* Injection beam-line calculated
* Study of building performed



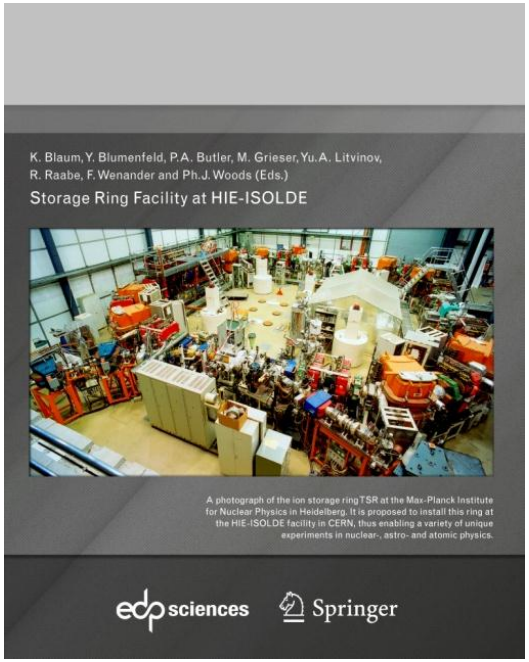
Proposed layout to fit the TSR:

* Installation above the CERN service-tunnel
* Tilted beam-line coming up from the machine.

Next steps

1. TSR at ISOLDE technical design report

M. Grieser et al., EPJ Special Topics May 2012, vol 207, Issue 1, pp 1-117



2. Approved by CERN Research board, May 2012

"**The installation of TSR, as an experiment to be included in the HIE-ISOLDE programme, was approved by the Research Board. The timescale will be defined once the study of its integration has been completed.**"

3. Integration study on-going

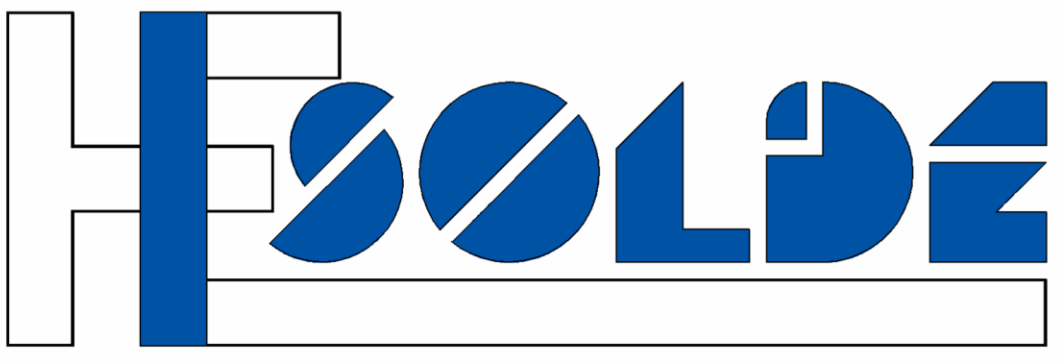
Report to CERN management Q3 2013

Within HIE-ISOLDE project

Charge breeder upgrade study to:

A. Cover all TSR physics cases
   - Bare nuclei up to Z~60
   - Li-like to U

B. Go to >10 MeV/u beam energy



The HIE-ISOLDE Design Study

Baseline parameters due to Linac 4 and PSB upgrade

$1x10^{14}$ protons per bunch ($3x10^{13}$)

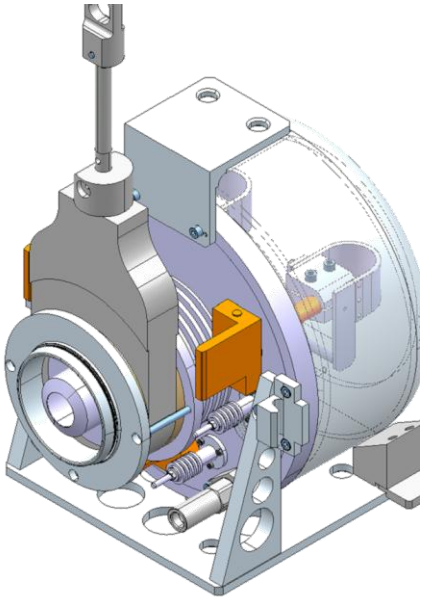
900ms Booster supercycle? (1200ms)

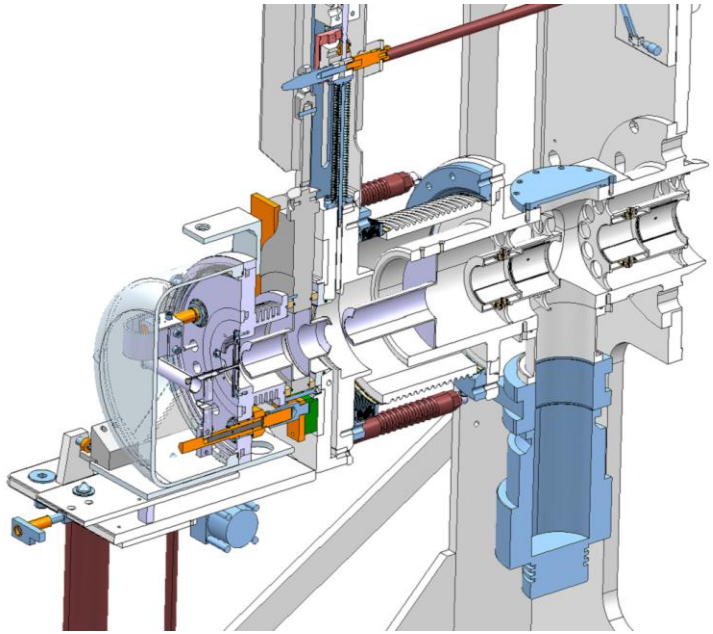
2GeV beam energy? (1.4GeV)

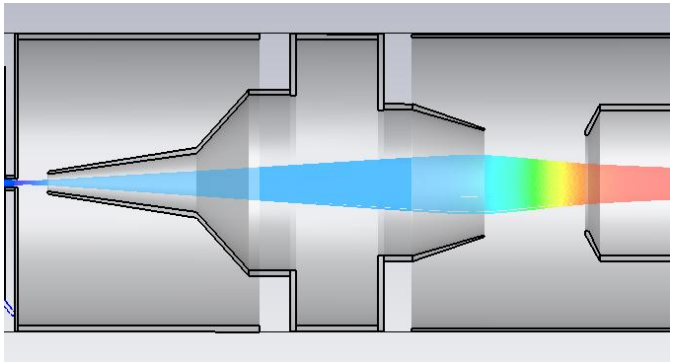
~ 14kW of primary beam (2.8kW)

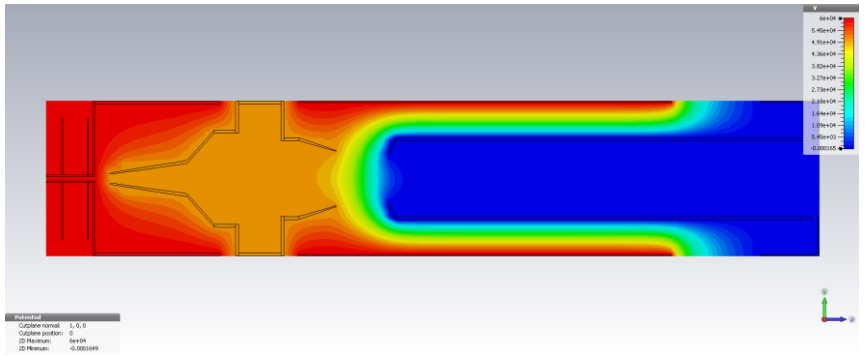
Redesign of Extraction System

Fixed electrodes, larger apertures, simpler and more compact frame



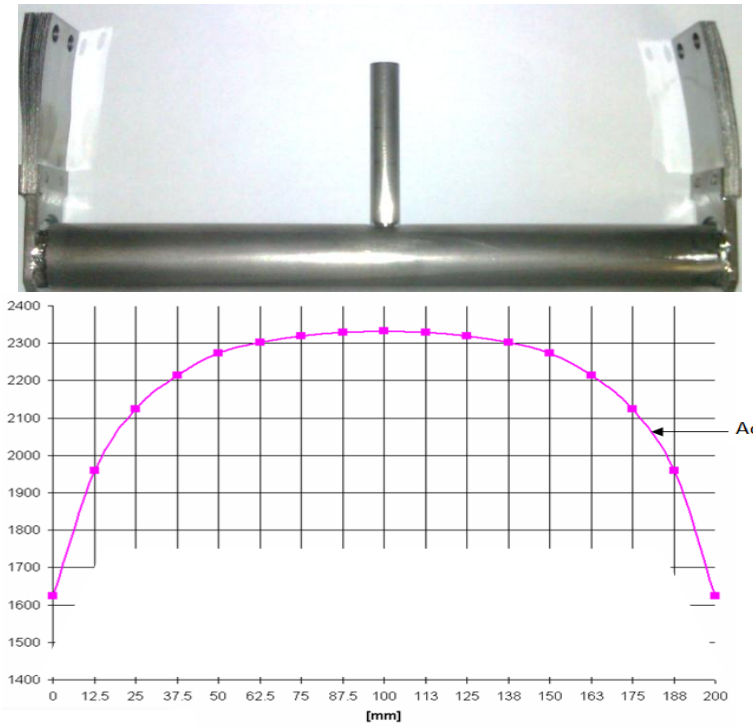


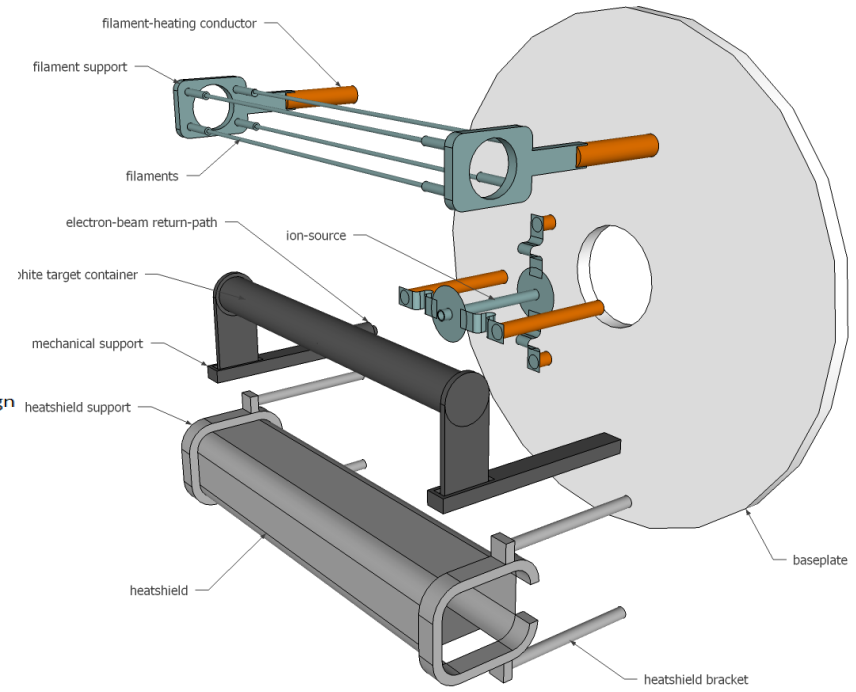




See poster by Jacobo Montano Carrizales

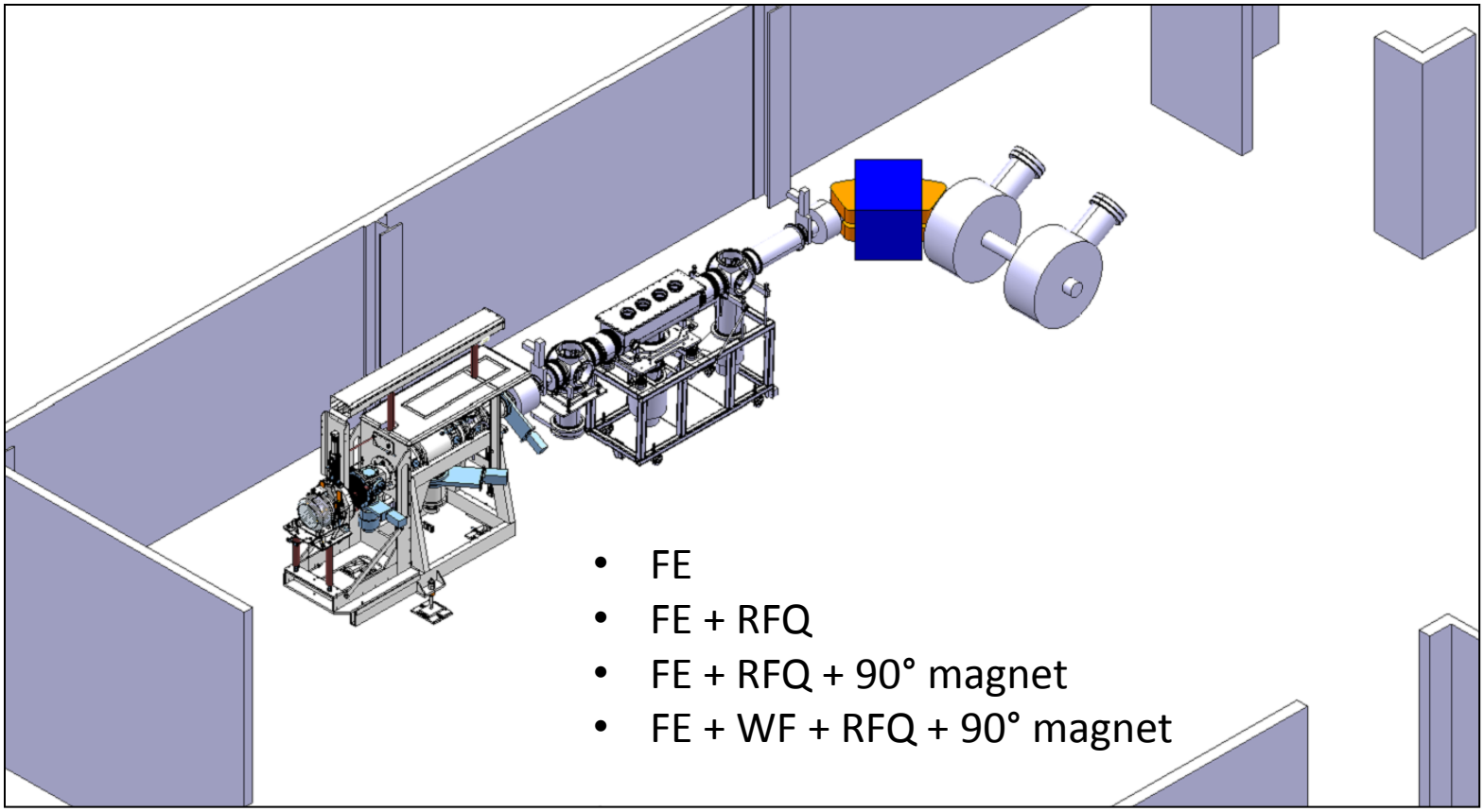
Thermal Studies





- Re-design of target
  - Indirect heating of target container
  - Uniform heat distribution across the target container
  - Heat pipes for cooling

Off-line 2 Mass Separator Layout
A test bench for validation

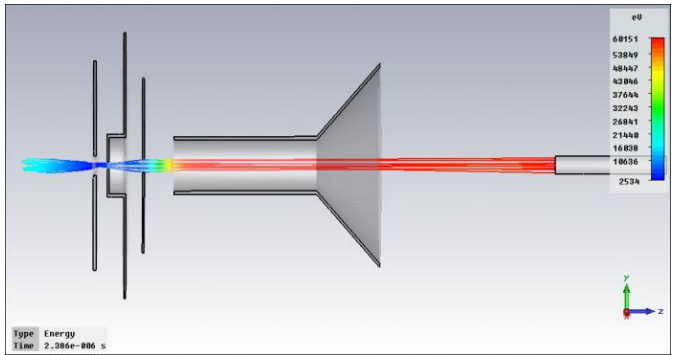


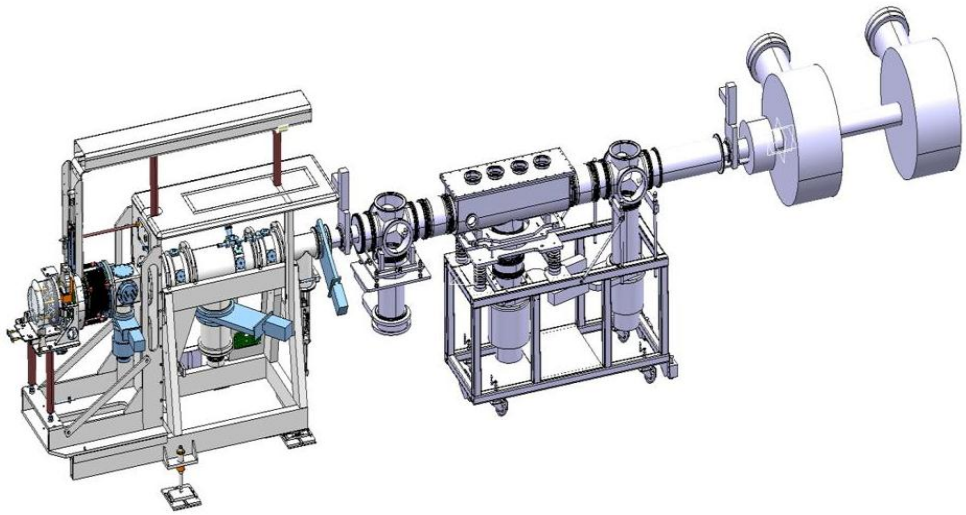
- FE
- FE + RFQ
- FE + RFQ + 90° magnet
- FE + WF + RFQ + 90° magnet

RFQ Cooler

- Approach
  - Alignment
    - Adjustable alignment of the electrodes
  - Pressure gradient
    - Reduce pressure at injection and extraction electrodes by adding more holes to the plates
- RFQ Cooler will be part of the test stand
- Drawings done and procurement started
- RFQ Cooler design report done

- CST Particle Studio used:
  - To simulate particle trajectories
  - To provide acceptances on parts of the machine
  - To diagnose electrical charge build up
  - Shapes, voltages and distances can be simulated

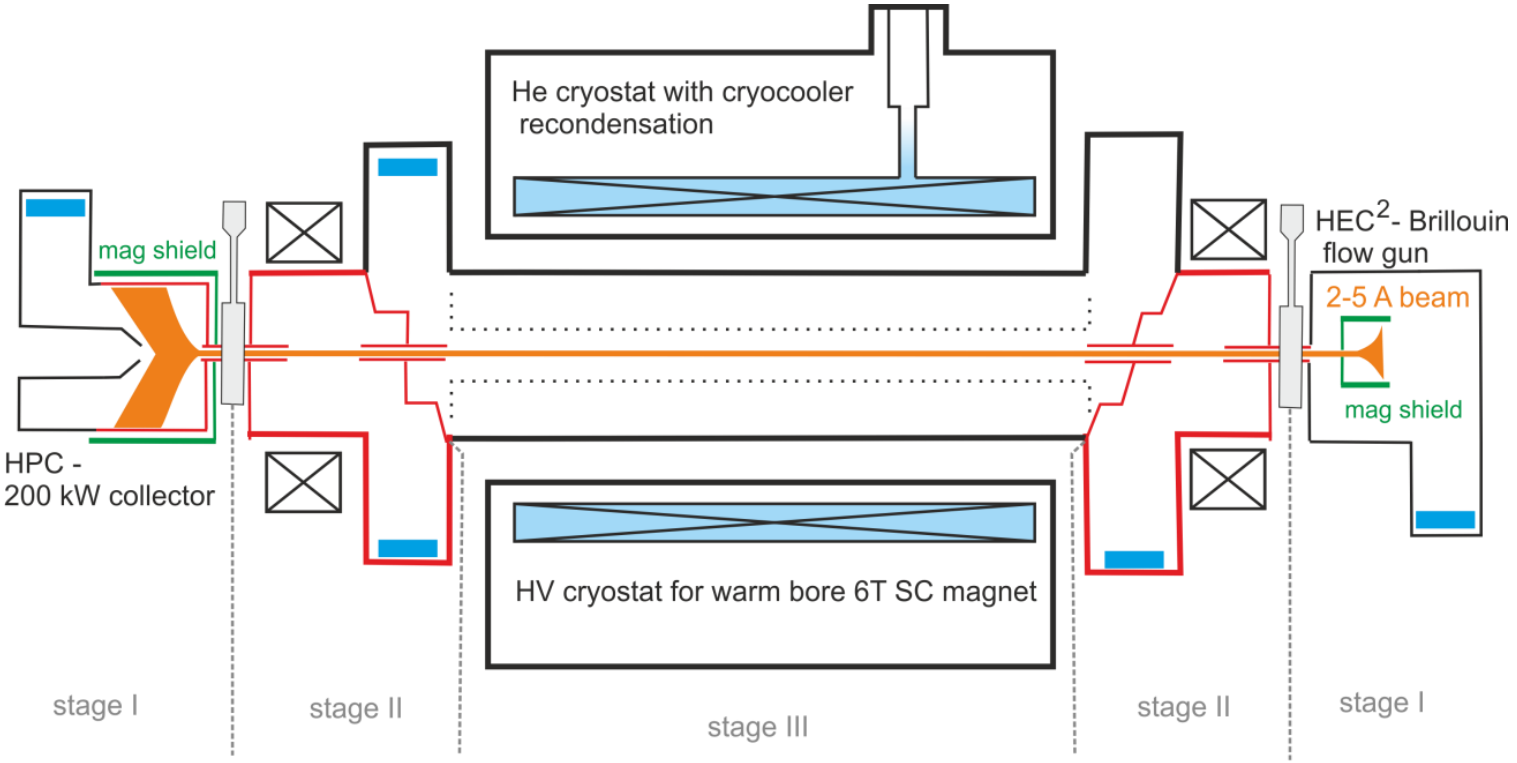




Carla Babcock

Design layout for breeder upgrade

Important changes compared to REXEBIS:
Electron energy increase (x30) : HV design
Electron current increase (x10-20): HEC^2 electron gun
Current density increase (x50-100) : high compression Brillouin type gun, magnetic field increase (2→6 T)
Current increase (x10-20) + HV: high power dissipation at the collector
Current increase + XHV: distributed differential pumping system



3 stages, separable, high differential,distributed pumping system with redundance

Summary

- An impressive transformation of the ISOLDE Facility is planned for the coming years
  - Target area
  - Medicis
  - HIE-ISOLDE
  - TSR@ISOLDE
  - Target development
- There will be an inevitable impact on operations
  - Resources
  - RIBs > from target to TSR
  - Safety, Access…

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