HIE-ISOLDE Design Study

Richard Catherall EN-STI-RBS

ISOLDE Workshop and Users Meeting 2013

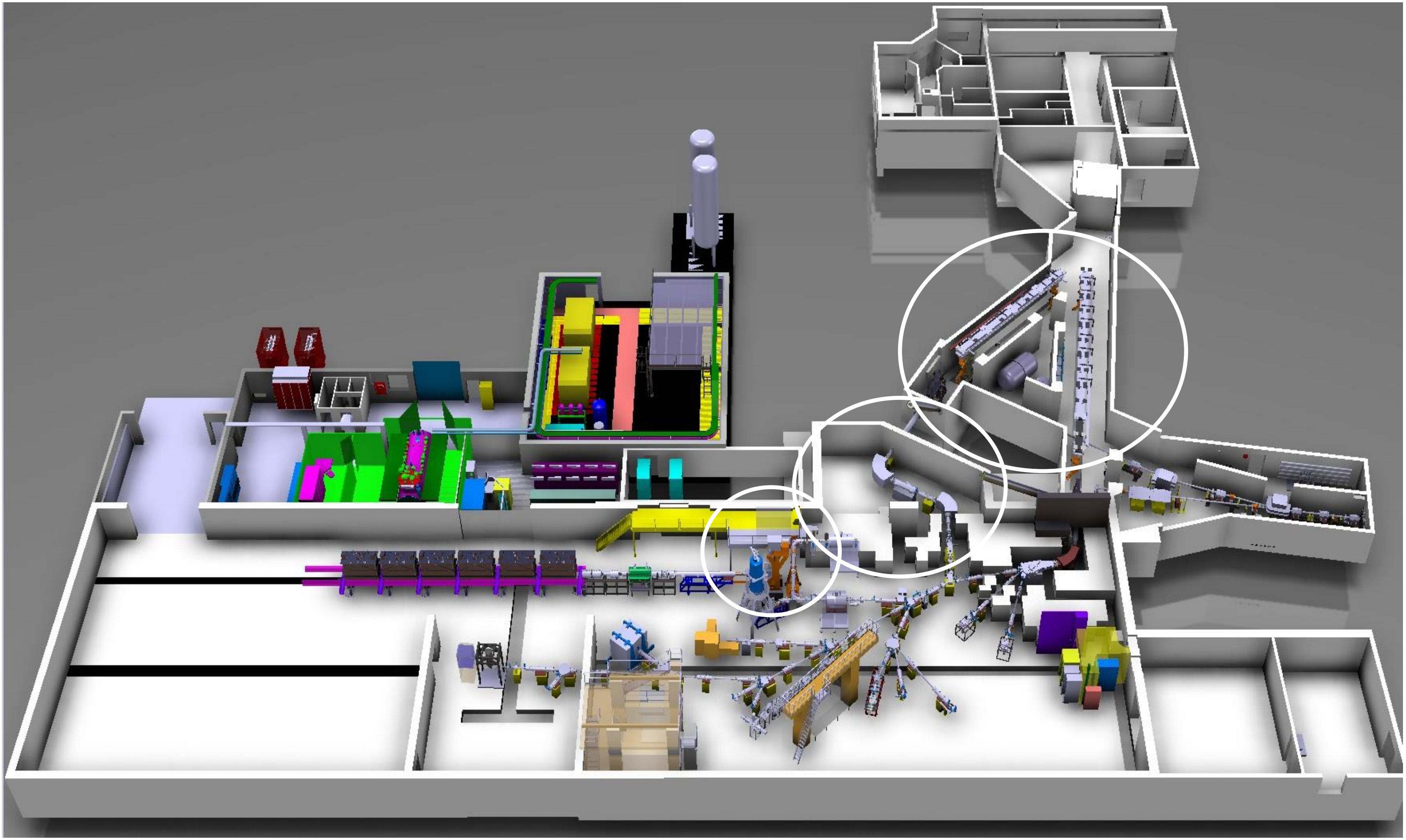
25th – 27th November 2013

- High Energy Upgrade
  – SC Linac to attain 10Mev/u

- High Intensity Upgrade
- Beam quality improvement

= HIE-ISOLDE Design Study

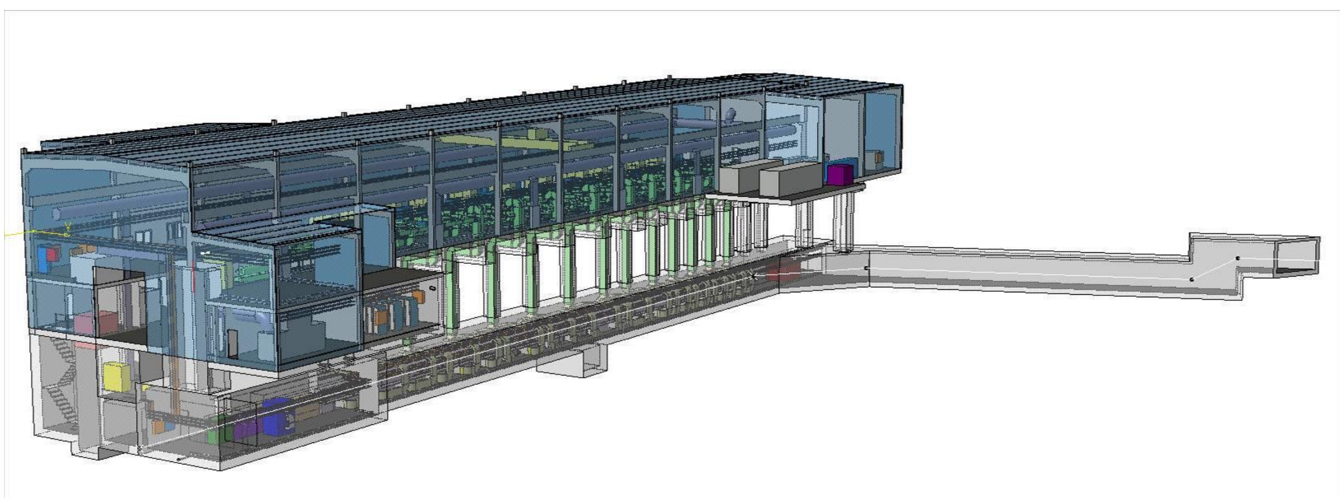
The ISOLDE Facility



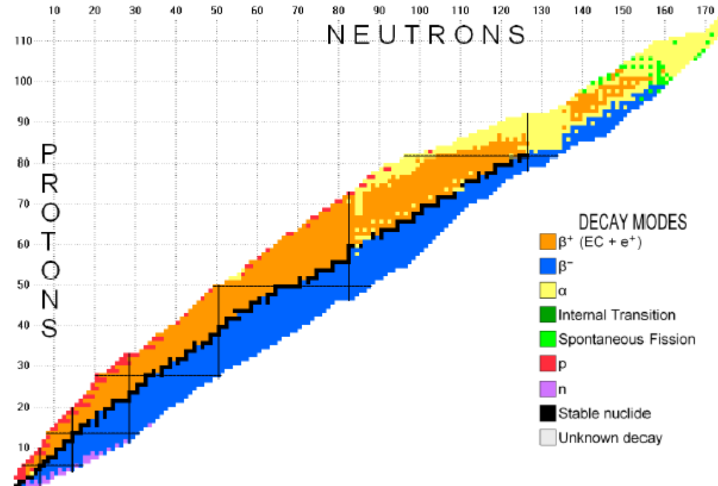
High Intensity Upgrade

Protons/pulse	Intensity (μA)	Energy (GeV)	Cycle (s)	Power (kW)
3.3×10^{13}	2.2	1.4	1.2	3.1
1×10^{14}	6.7	1.4	1.2	9.3
1×10^{14}	6.7	2.0	1.2	13.3

Projected beam parameters considered within the HIE- ISOLDE Design study.
Based on ISOLDE receiving 50% of available proton pulses from the PS-Booster.



Benefits For ISOLDE



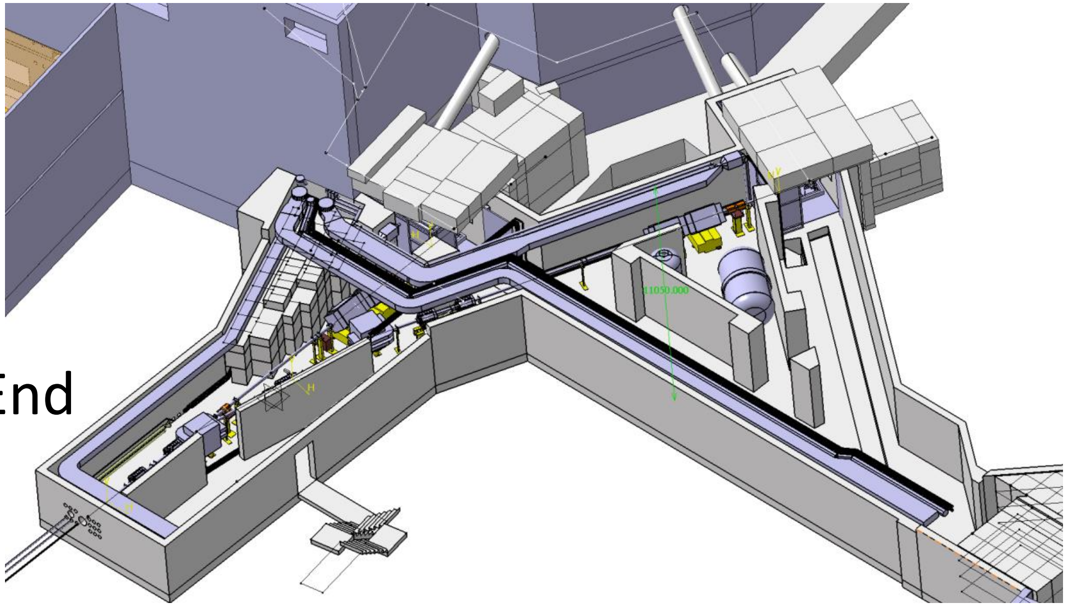
- High Intensity
  - Improve the production rate of exotic nuclei
  - More efficient operation of the Facility
- High Energy
- *Based on the extrapolation of previous measurements of isotope production at 600 MeV, 1 GeV and 1.4 GeV and on cross-section calculations;
  - an average gain of 40% for fission products
  - a factor of x2 to x5 gain for fragmentation products
  - an increase by a factor of 6 for exotic spallation products.

*LOI submitted to INTC

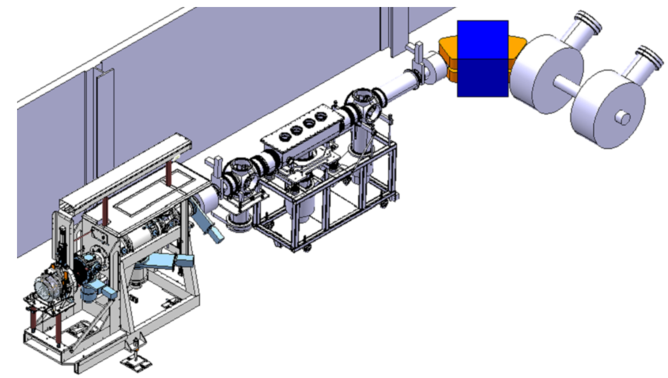
M. Borge et al. Motivations to receive a 2 GeV proton beam at ISOLDE/HIE-ISOLDE: Impact on radioisotope beam availability and physics program. CERN-INTC-2012-069 / INTC-O-016

High Intensity Upgrade

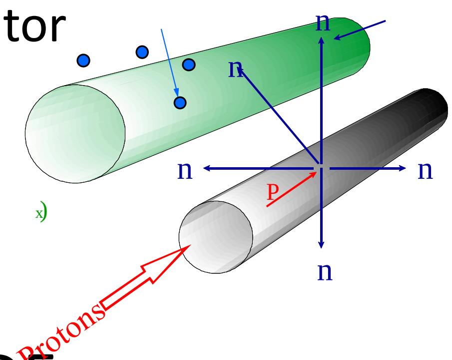
- Issues being addressed:
  - Radiological
    - Interventions/maintenance
    - Air activation
    - Contamination
  - Infrastructure
    - Shielding
    - Target and Front End
    - High Voltage
    - Beam dumps



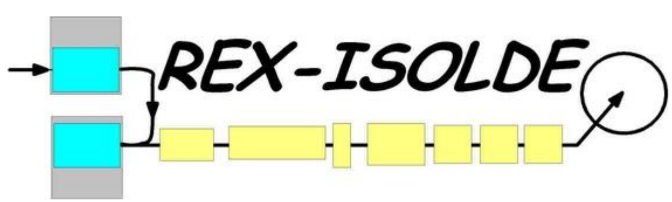
Beam quality improvement



- Improved mass resolution
  - RFQ Cooler placed before the separator magnets
  - Pre-mass separator
  - New HRS magnet design
    - Construction of a new off-line separator
- Converter targets



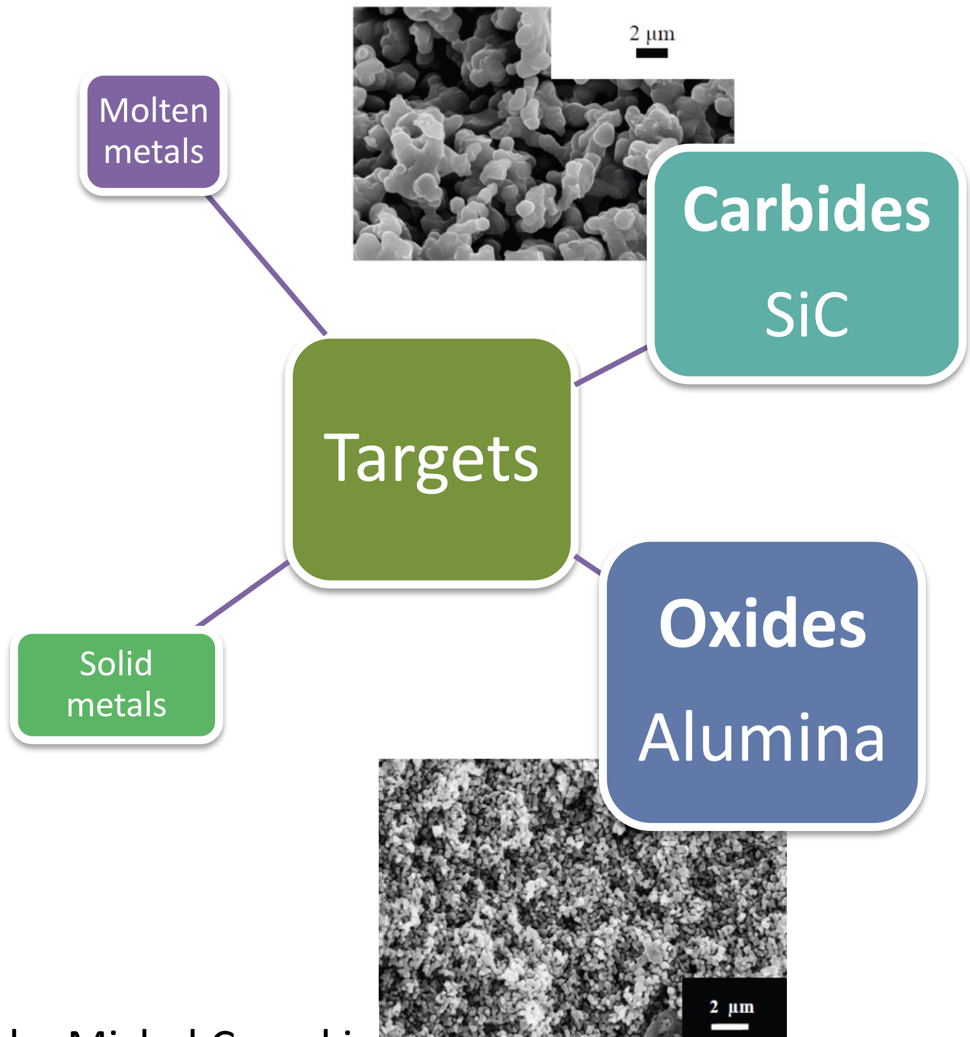
- High Energy Compression and Current (HEC^2) EBIS for REX-ISOLDE



Target Materials

- Carry out simulations of proton beam interactions with existing and potential target materials using FEM structural codes
- Establish experimental programme to validate the simulations and verify the production rates and diffusion constants for different material prototypes.
- Post analysis of samples

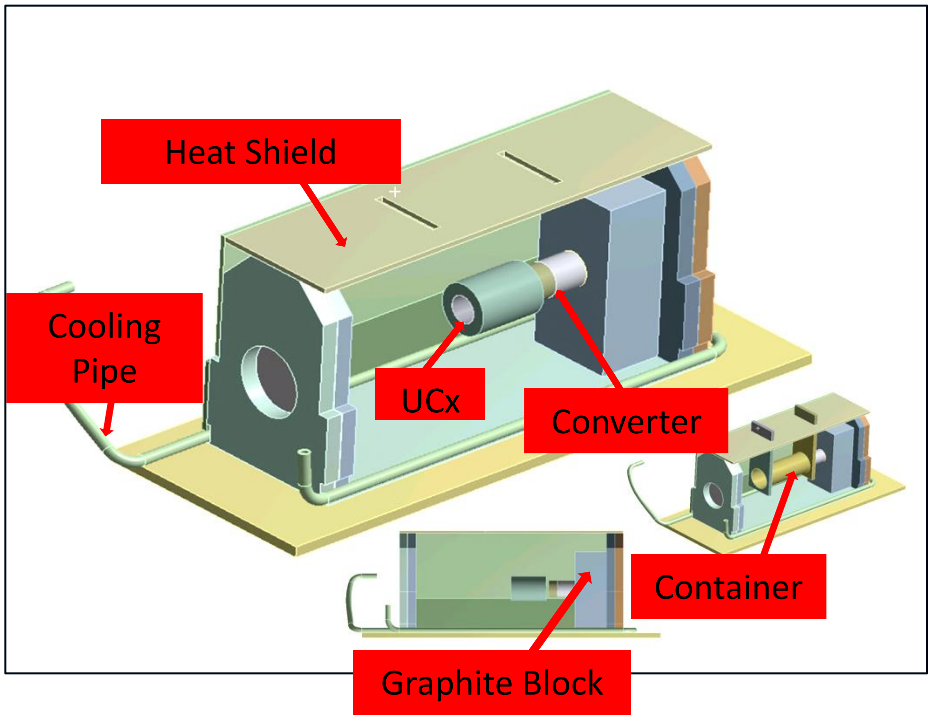
- *Silicon Carbide and Alumina prepared with ice-templating method in collaboration with St. Gobain*
- *Irradiation of SiC samples already done*
- *More samples to be irradiated using the HIRADMAT facility*

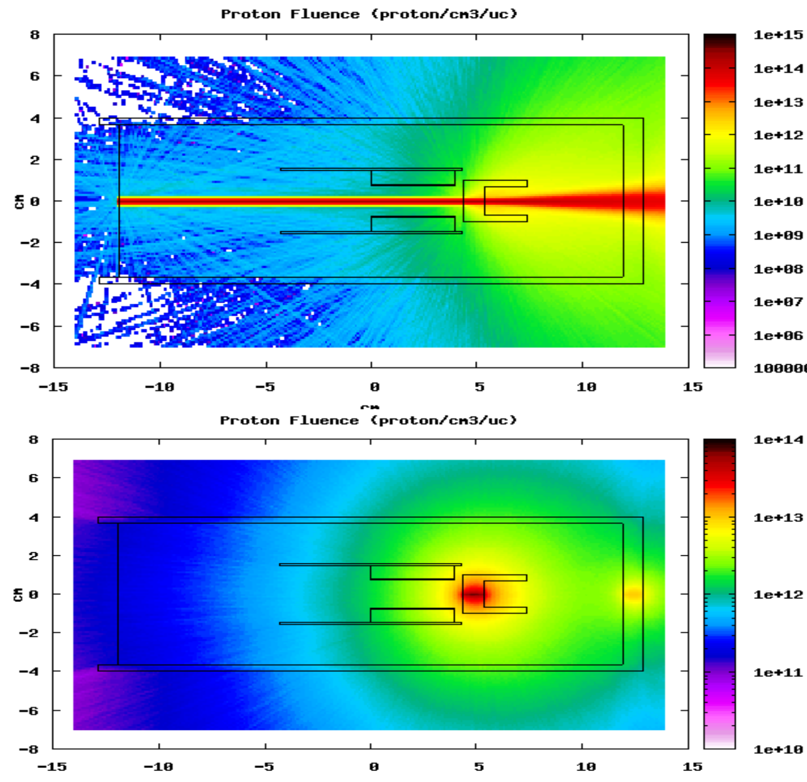


See presentation by Michal Czapski

Targets: RIB Purification

- Neutron spallation source design study:





Online tests at TRIUMF in 2014.
Energy: 500 MeV;
Intensity: 100uA.

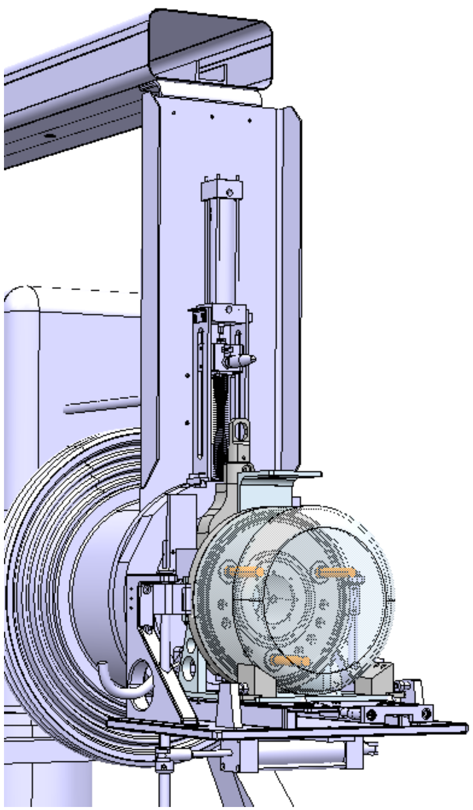
See presentation by S. Cimmino

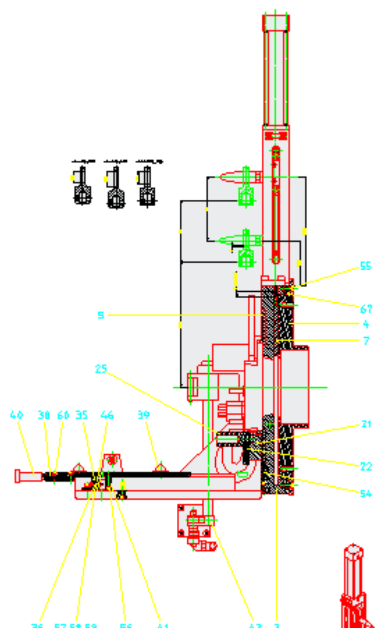
Targets: Design

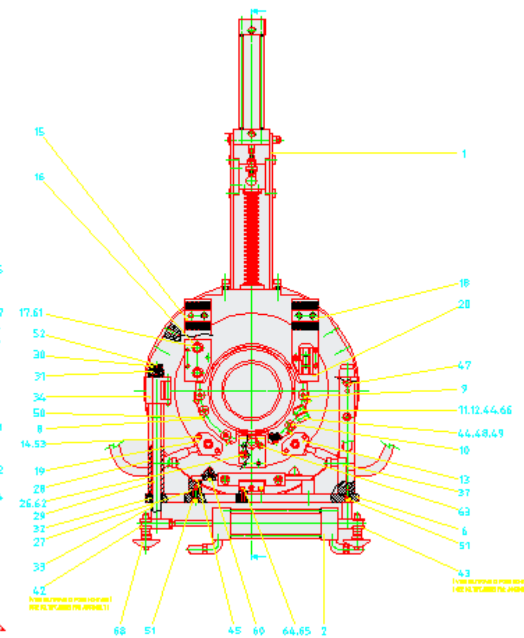
Study on possible installation of heat pipes

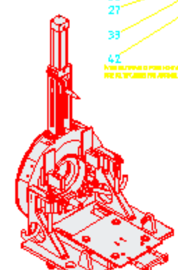
Standard calibration procedure

New coupling system design



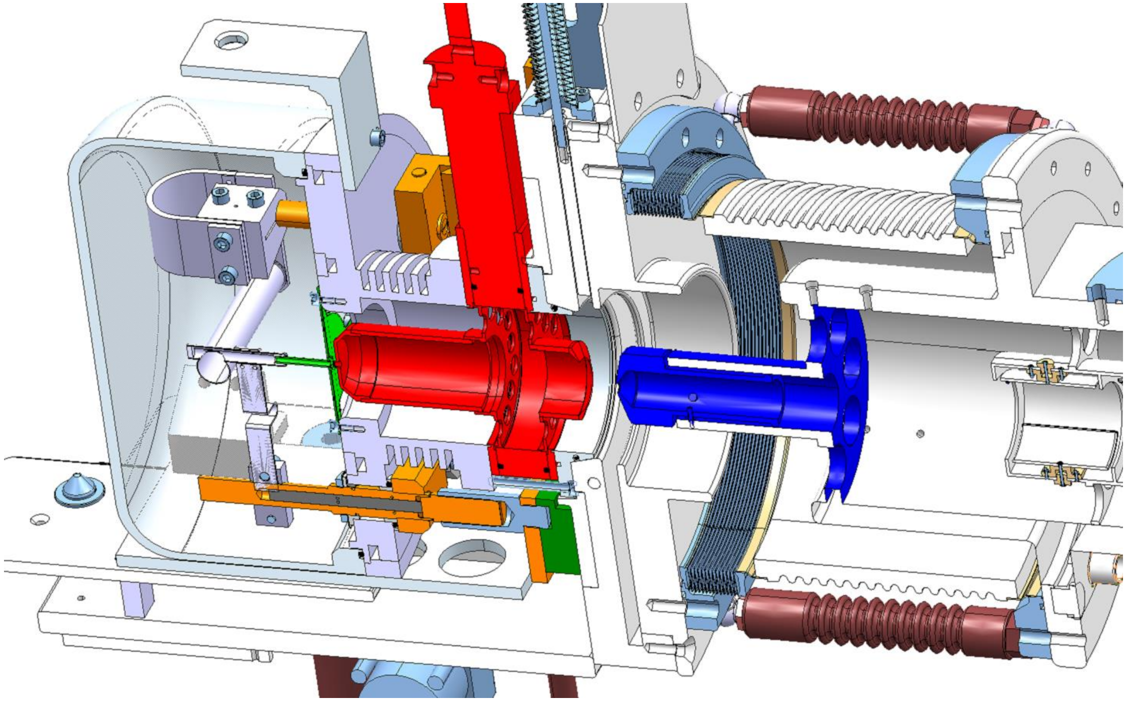






See presentation by S. Cimmino

Front End: Pre extraction prototype



60 kV 57 kV Ground

- Without electrode movement mechanism
- Electrode head exchanged with target unit without human intervention
- Intermediate voltage works as focalization lens
- Intermediate electrode customizable for each target unit

See presentation by J. Montano

REX-EBIS: Electron Beam Ion Source for HIE-ISOLDE

Priorities and the goal setting

Design values for EBIS (HIE-ISOLDE/TSR@ISOLDE application) / available now with REXEBIS	
Electron energy [kV]	150 / 5
Electron current [A]	2-5 / 0.2
Electron current density [A/cm^2]	1-2x10^4 / 100

New EBIS – High Energy Compression and Current (HEC^2) EBIS

Main challenge – produce the high compression electron beam

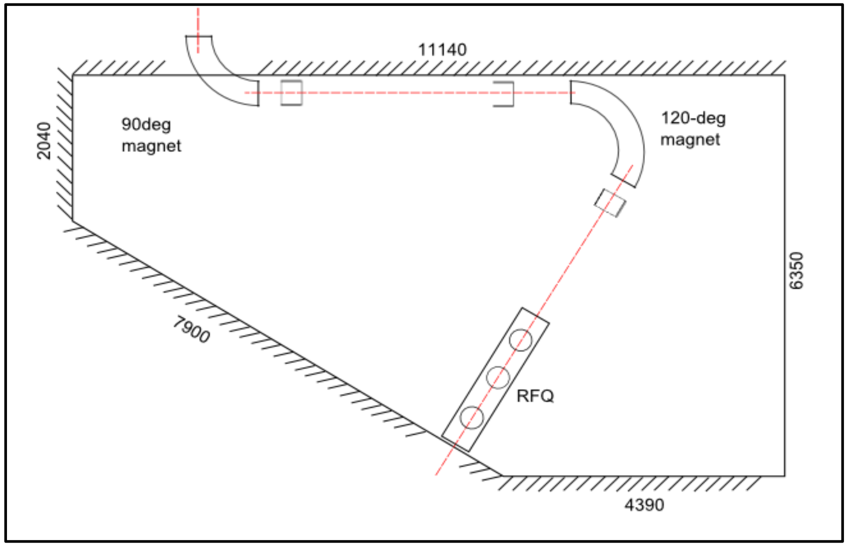
Goal – have a reliable design of the HEC^2 electron gun on earliest possible stage

Realization – in a joint effort with BNL, based on BNL design and infrastructure (BNL Test-EBIS), funded and manned by CERN

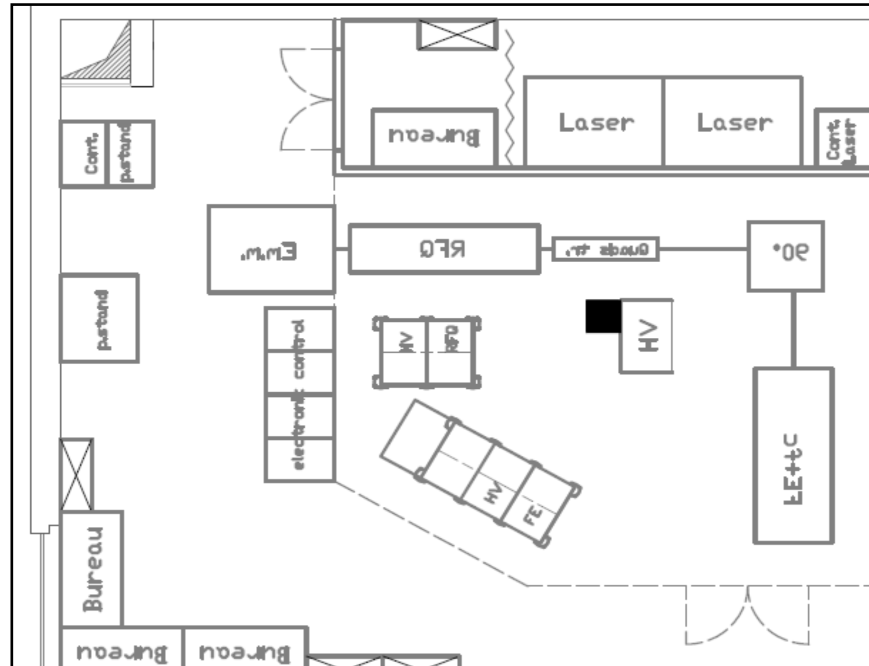
See presentation by A. Shornikov

ISOLDE offline separator #2

Purpose: testbench for the validation of principles regarding the High Resolution Separator upgrade



Proposed HRS layout



Courtesy of Stefano Marzari

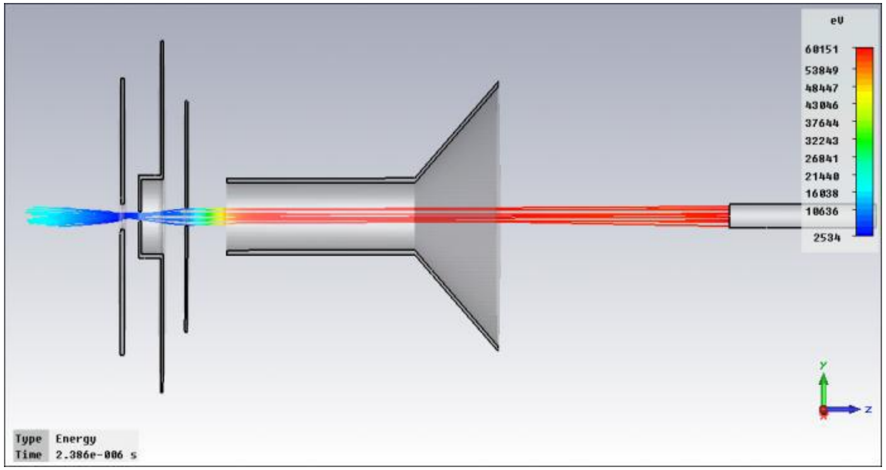
Foreseen layout of ISOLDE offline #2

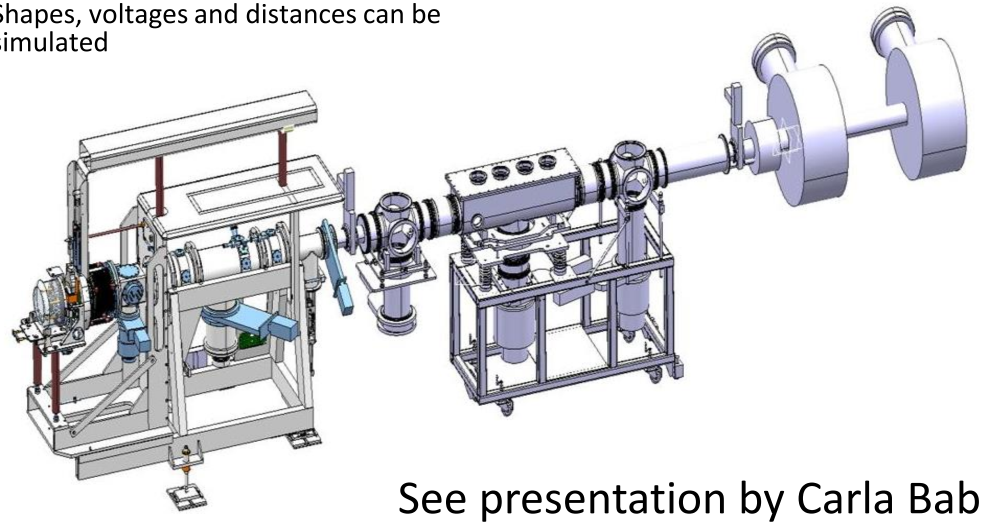
- ✓ Detailed definition of experimental setup
- ✓ Dipole characterization
- ✓ Magnetic field mapping

See presentation by M. Augustin

RFQ Cooler

- RFQ Cooler will be part of the test stand
- Under construction
- Approach
  - Alignment
    - Adjustable alignment of the electrodes
  - Pressure gradient
    - Reduce pressure at injection and extraction electrodes by adding more holes to the plates
  - 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

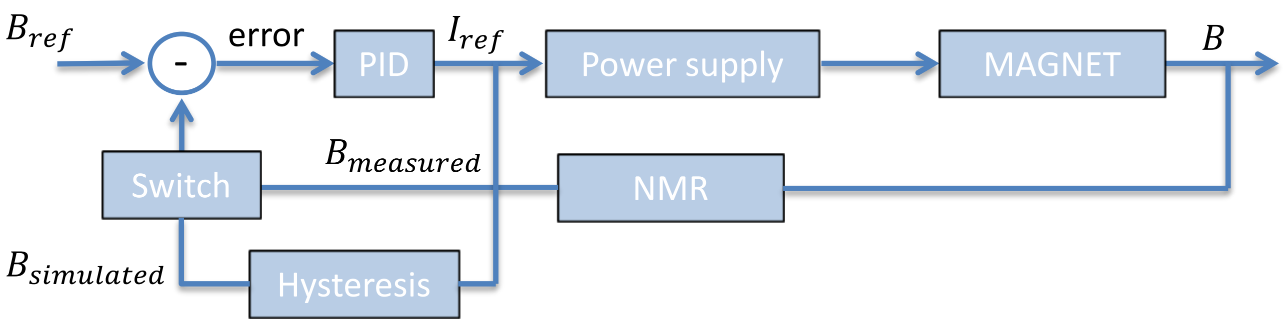




See presentation by Carla Babcock

Magnet Controls

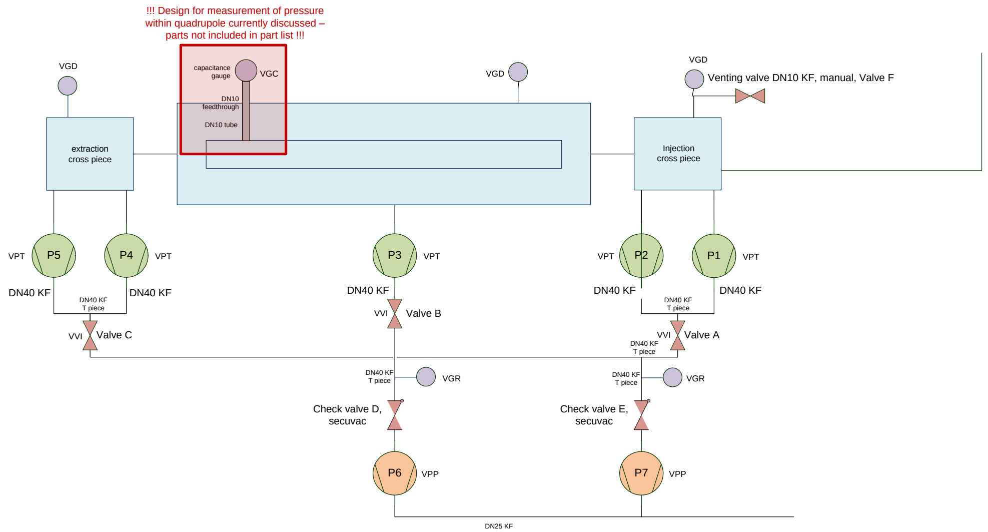
- New control under development using LabVIEW Real Time
- Control loop



  - Use an industrial control: Proportional-integral-derivative control (PID) with anti-windup scheme
  - Develop a Hysteresis model to support the NMR during blind time
  - Matlab-Simulink is used as simulation software

See presentation by M. Colciago

Vacuum

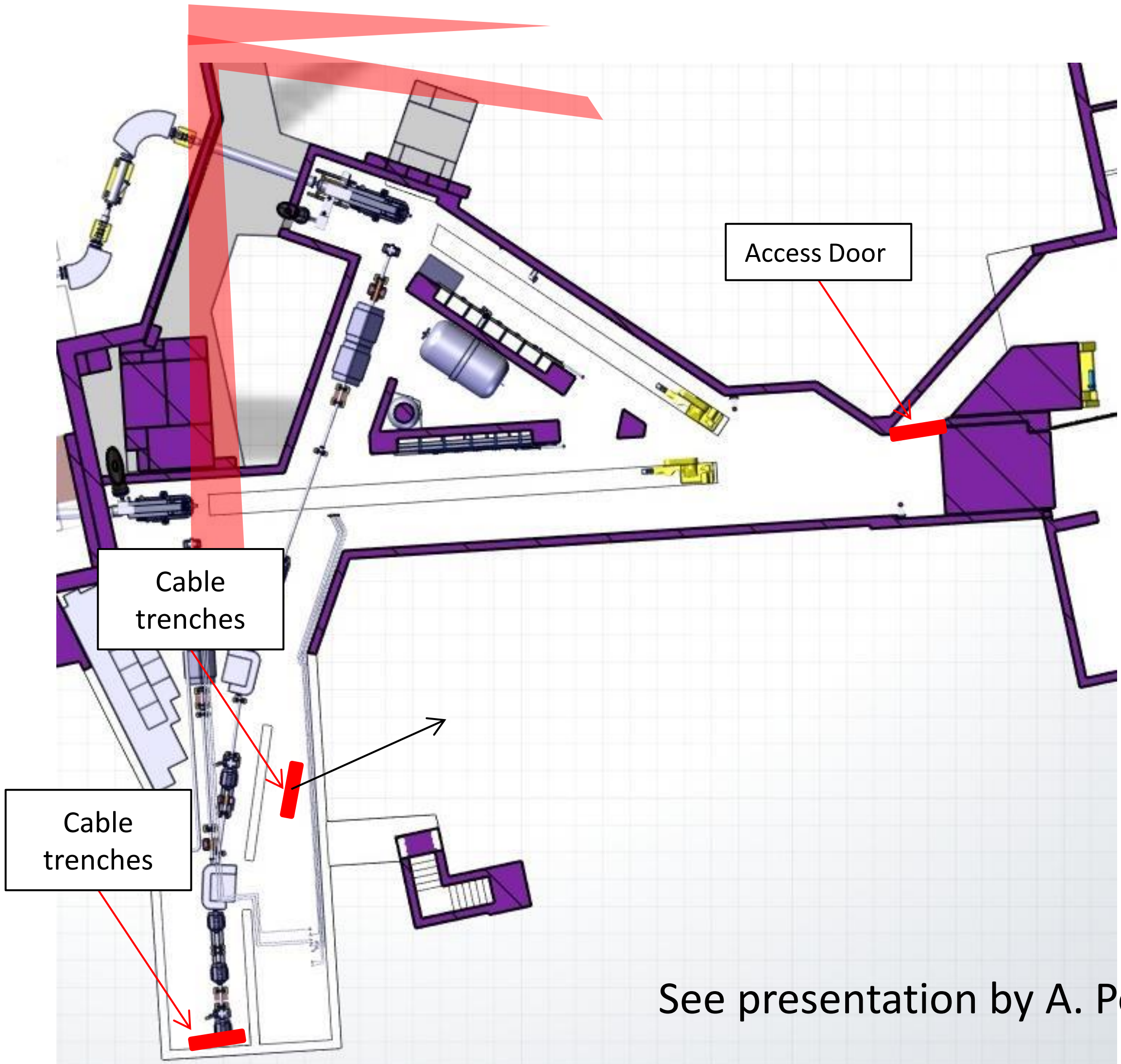


Sketch of vacuum layout for offline RFQCB test stand:

- Fast Valve Systemfor SC Linac
- To avoid contamination of clean cavity surfaces in the event of an accidental air leak.
- Gas dynamics and choice of material will be presented

See presentation by M. Hermann

Ventilation



See presentation by A. Polato

Status of FLUKA simulations for the Experimental Hall, Storage Area and MEDICIS

In the current layout:

Direct dose (neutrons from target) - a

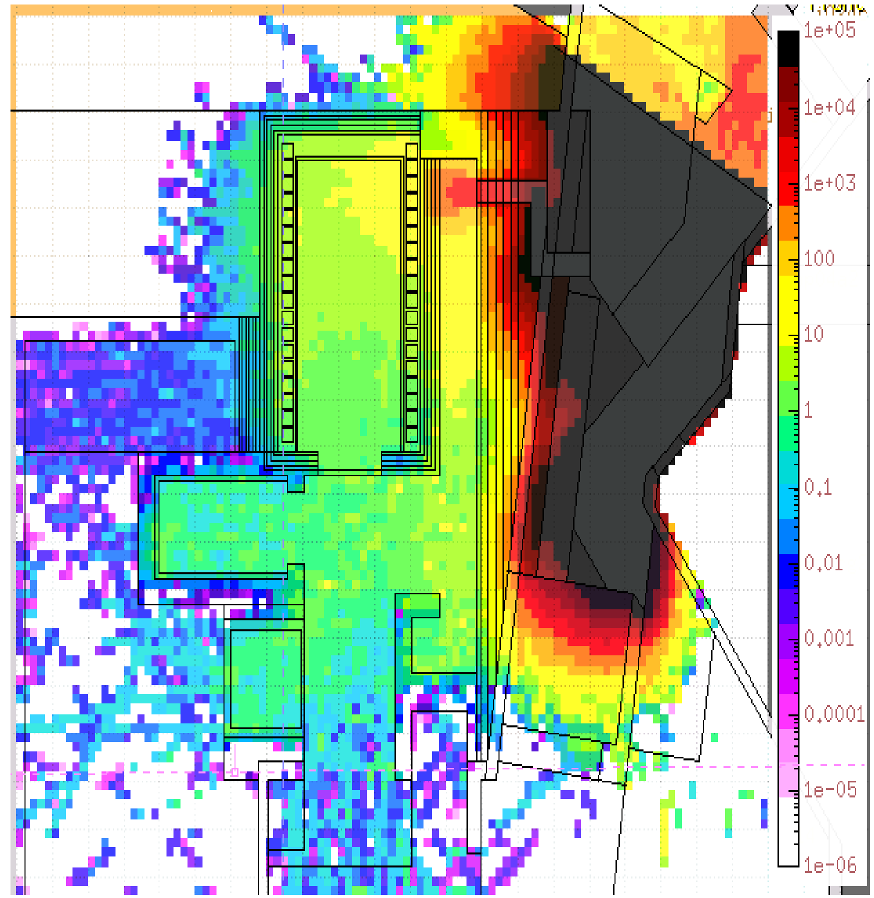
> Levels obtained too close to limits, leaving almost no margin.

Dose from stored targets - b

> Levels within limits, any further shielding to fix the previous issue can only improve this.

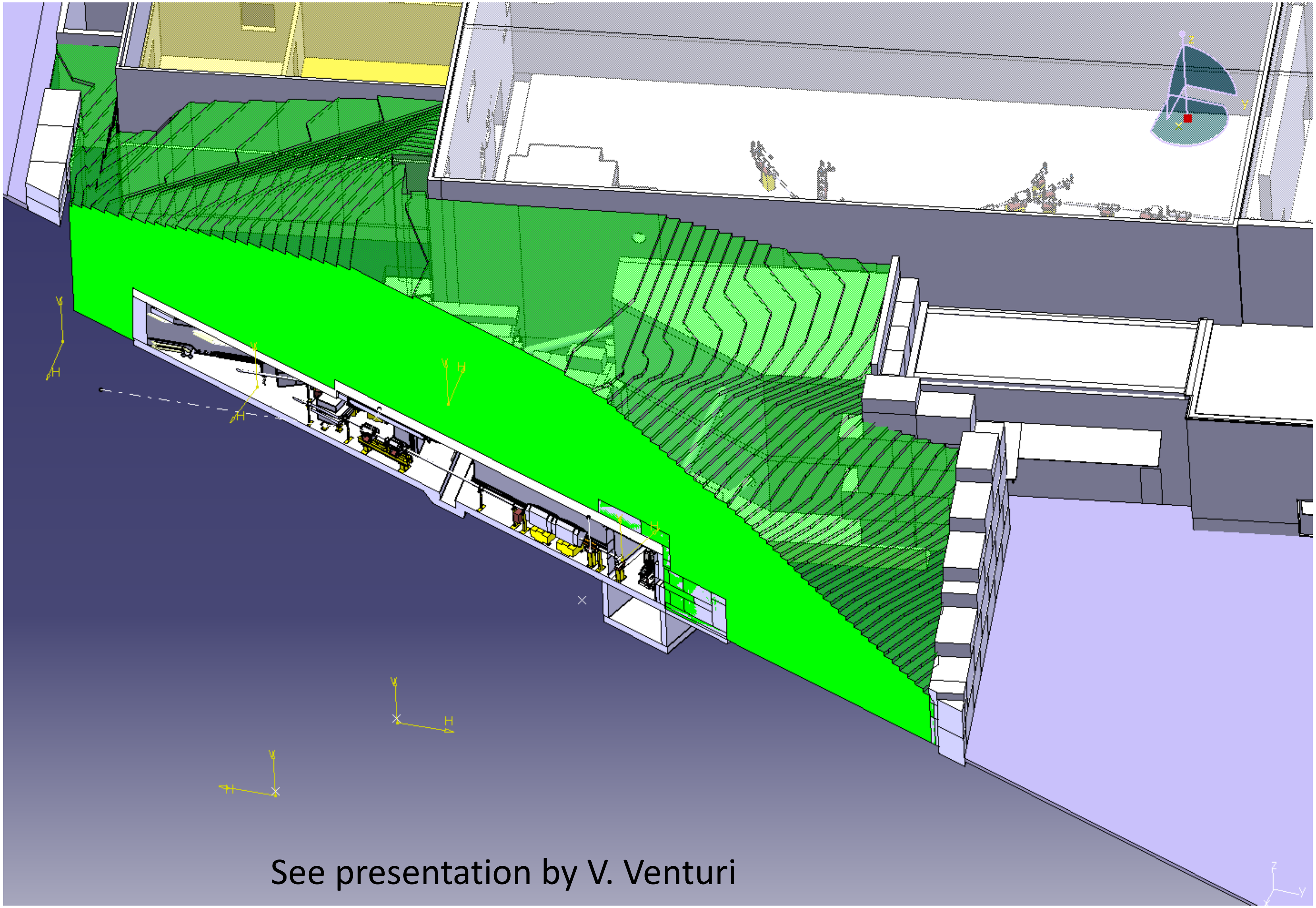
Dose from activated elements

> Still under evaluation. Might cause changes and lead to re-evaluate a & b.



See presentation by L. Morejon

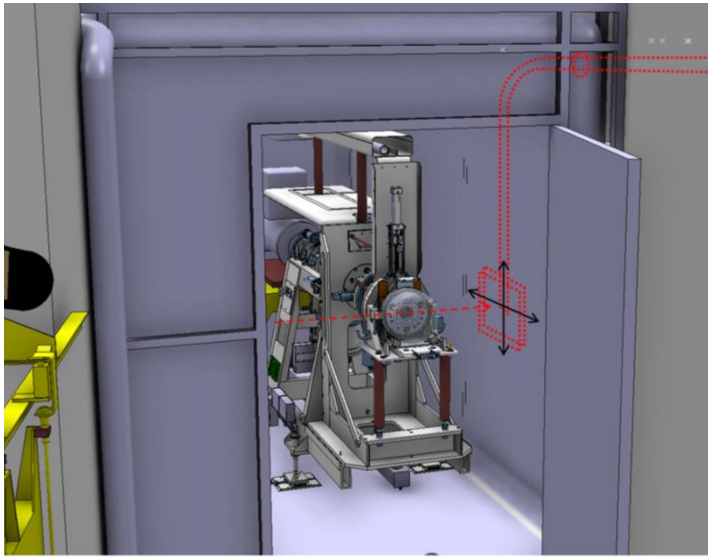
HRS Beam Dump



See presentation by V. Venturi

High Voltage

- During proton beam impact extremely high ionization of the volume around the target gives rise to significant leakage current.
- loss of charge on the effective target capacitance
  - mitigated by modulating the target voltage to zero just prior to beam impact
  - HT pulsing
- The new design is based on a HV MOSFET switch technology of type ‘Behlke’



See presentation by R. Barlow

The Design Study Report

- Document describing all the issues addressed throughout the design study period
- High Intensity
  - Targets; thermal analysis, design and materials
  - Front ends
  - High voltage
  - Operation
- Infrastructure
  - Beam dumps
  - Radiation protection
  - Ventilation and cooling
  - Vacuum
- Beam Quality
  - RIB Purification
  - HRS magnet design
  - RFQ Cooler
  - New REX-EBIS
- Cost and Timeline

Report: Deliverable for the Autumn 2014

Time line

New EBIS??

Vacuum systems

Targets

2014 Final Report

2014/2015

Separation of ventilation systems.

Installation of airlocks

2016/2017?
New HT power supplies/modulator

LS2 & Linac 4 (2018)?

New FE's

Beam dumps

Shielding

New HRS

…

- Thank you for your attention