HIE-ISOLDE Design Study

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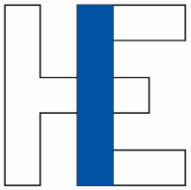
ISOLDE Workshop and Users Meeting 2013

25th – 27th November 2013

Overview

- Introduction
- Technical Advances
  - Targets
  - Front End
  - Beam Quality
    - REX EBIS
    - Off-line
    - HRS
  - Infrastructure
    - Ventilation
    - Fluka simulations
- Time line
  - The Design Study report
  - Implementation
- HIE-ISOLDE workshop: The Technical Aspects

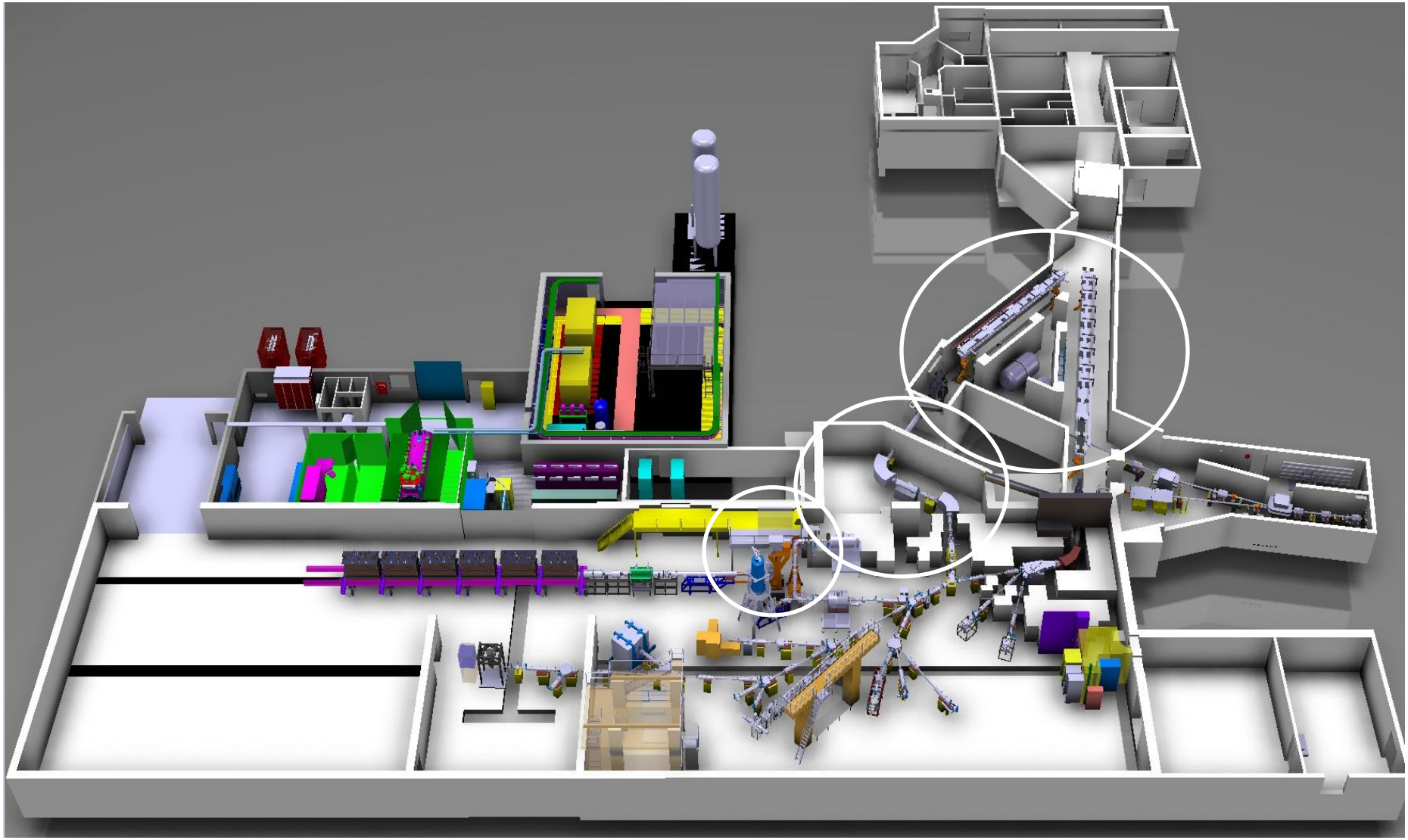


- High Energy Upgrade
  - SC Linac to attain 10Mev/u

- High Intensity Upgrade
- Beam quality improvement

= HIE-ISOLDE Design Study

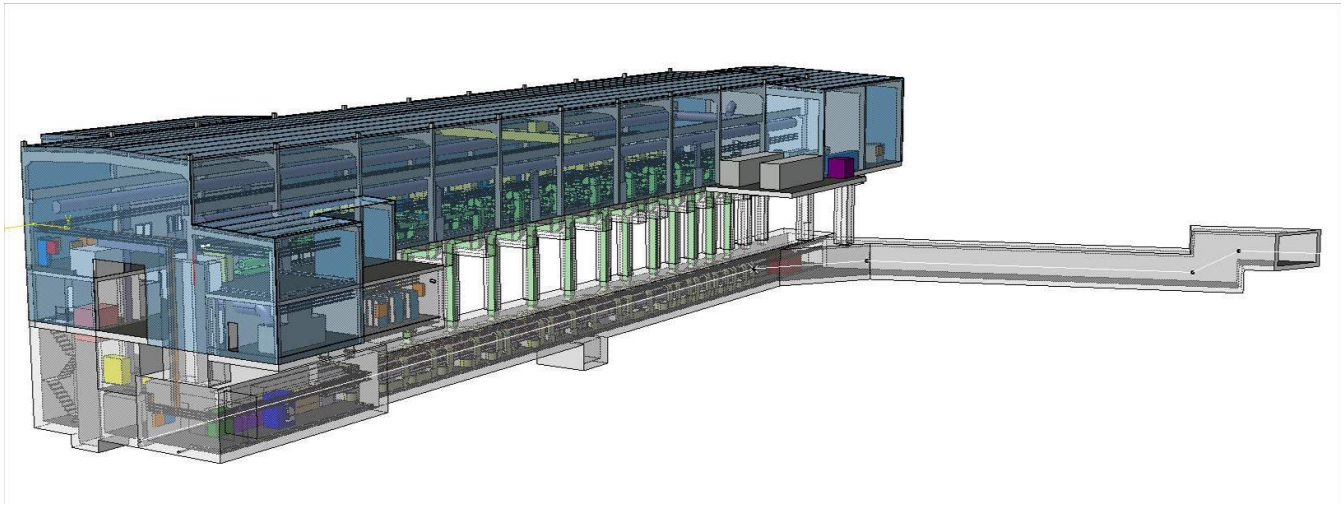
The ISOLDE Facility



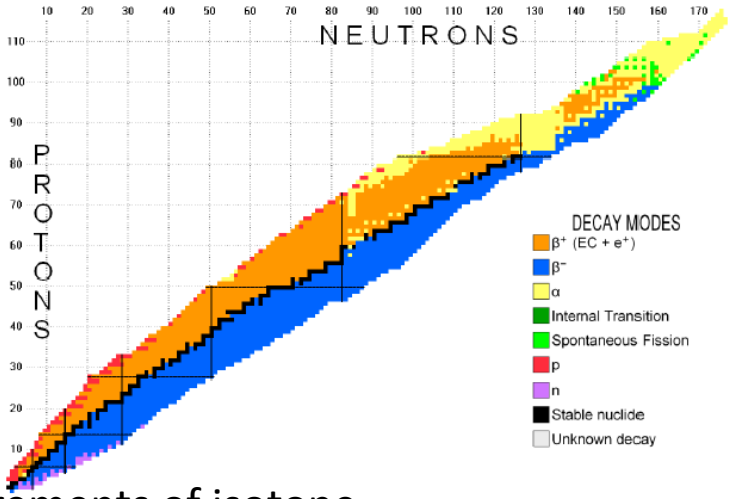
High Intensity Upgrade

Protons/pulse	Intensity (μA)	Energy (GeV)	Cycle (s)	Power (kW)
$3.3x10^{13}$	2.2	1.4	1.2	3.1
$1x10^{14}$	6.7	1.4	1.2	9.3
$1x10^{14}$	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



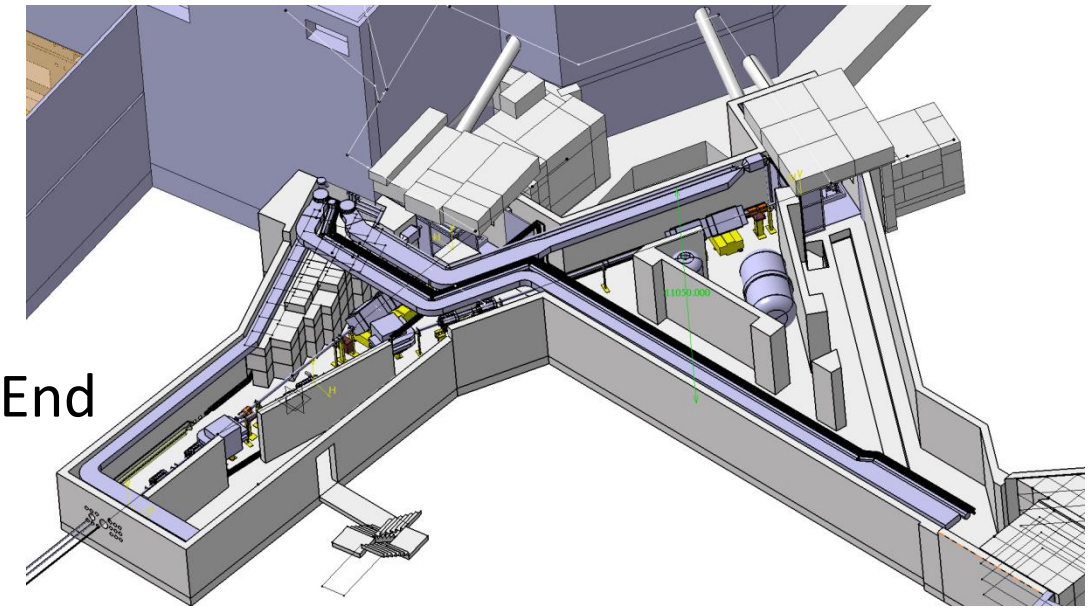
- High Intensity
  - Improve the production rate of exotic nuclei
  - More efficient operation of the Facility
- High Energy
- *Based on the extrapolation of previous measurements of isotope production at 600 MeV, 1 GeV and 1.4 GeV and on cross-section calculations;
  - an average gain of 40% for fission 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

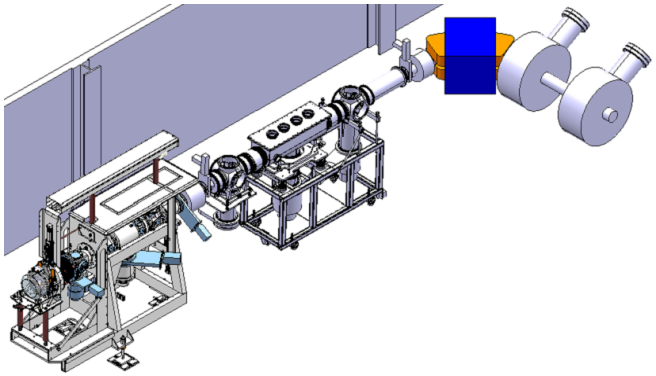
M. Borge et al. Motivations to receive a 2 GeV proton beam at ISOLDE/HIE-ISOLDE: Impact on radioisotope beam availability and physics program. CERN-INTC-2012-069 / INTC-O-016

High Intensity Upgrade

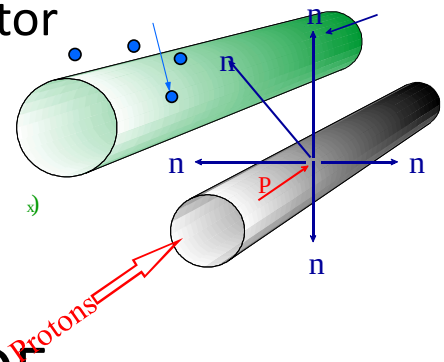
- Issues being addressed:
  - Radiological
    - Interventions/maintenance
    - Air activation
    - Contamination
  - Infrastructure
    - Shielding
    - Target and Front End
    - High Voltage
    - Beam dumps



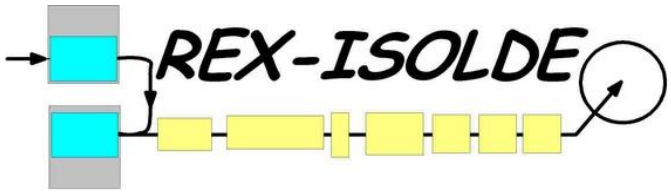
Beam quality improvement



- 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

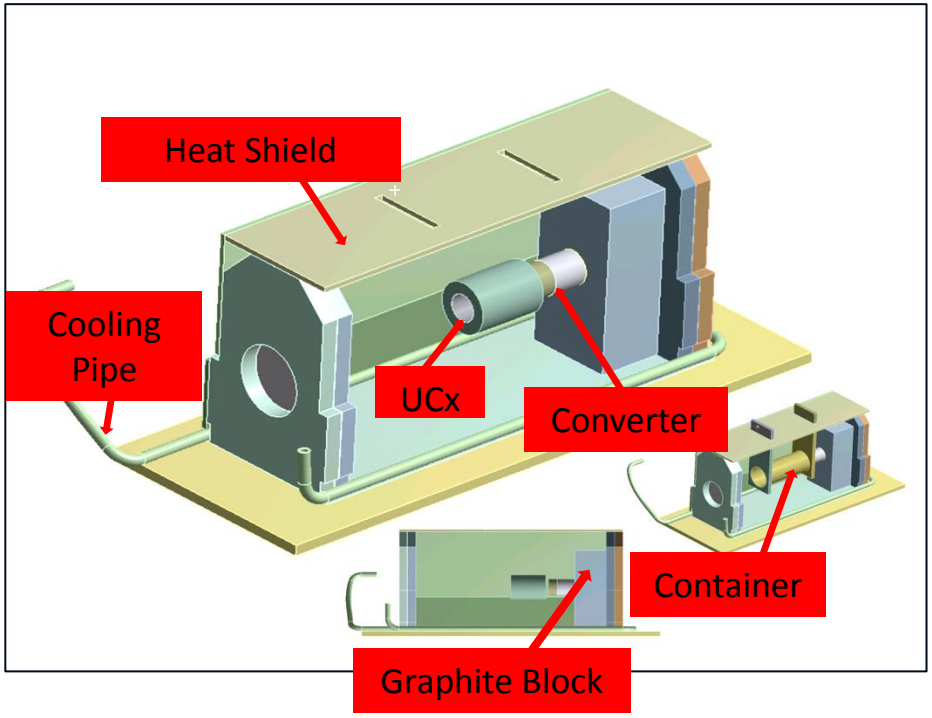


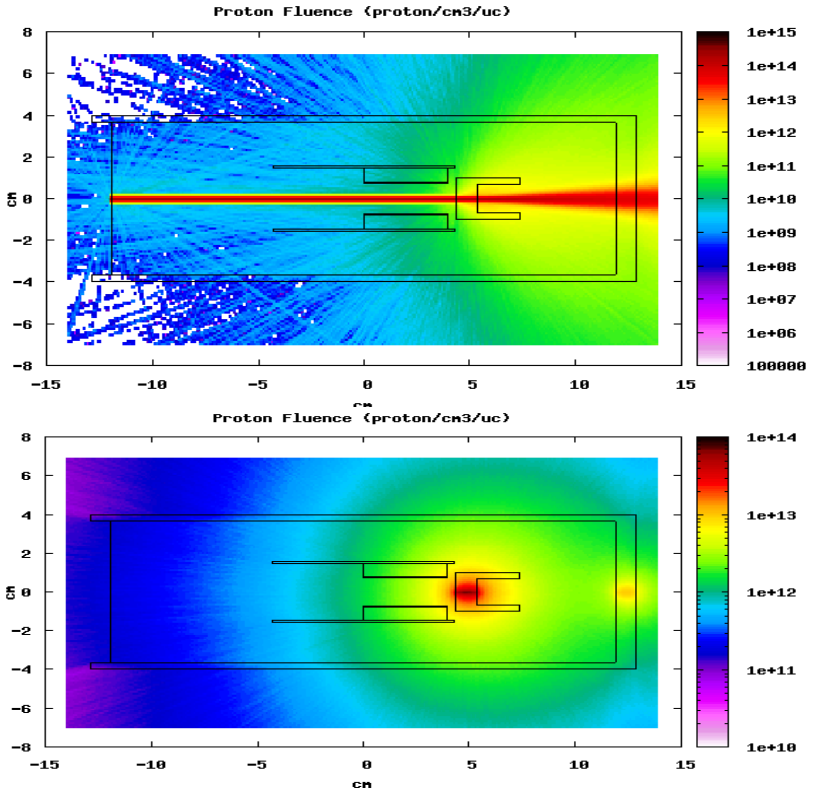
Introduction

- The research leading to these results has received funding from the European Commission under the FP7-PEOPLE-2010-ITN project CATHI (Marie Curie Actions - ITN). Grant agreement no PITN-GA-2010-264330.

Targets: RIB Purification

- Neutron spallation source design study:





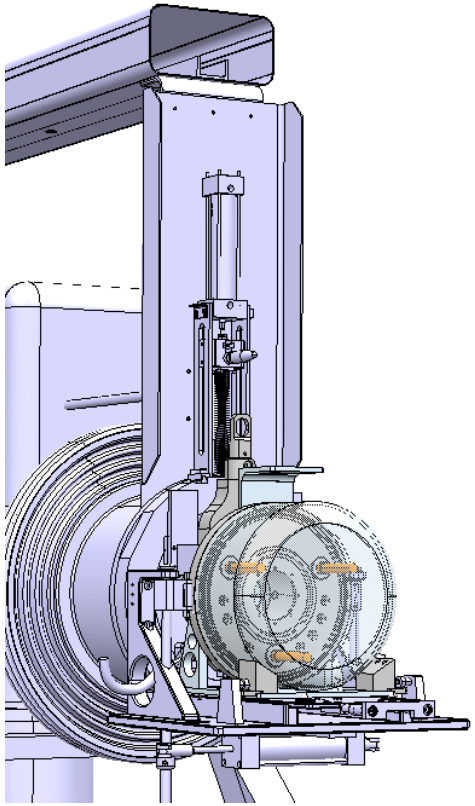
Online tests at TRIUMF in 2014.
Energy: 500 MeV;
Intensity: 100uA.

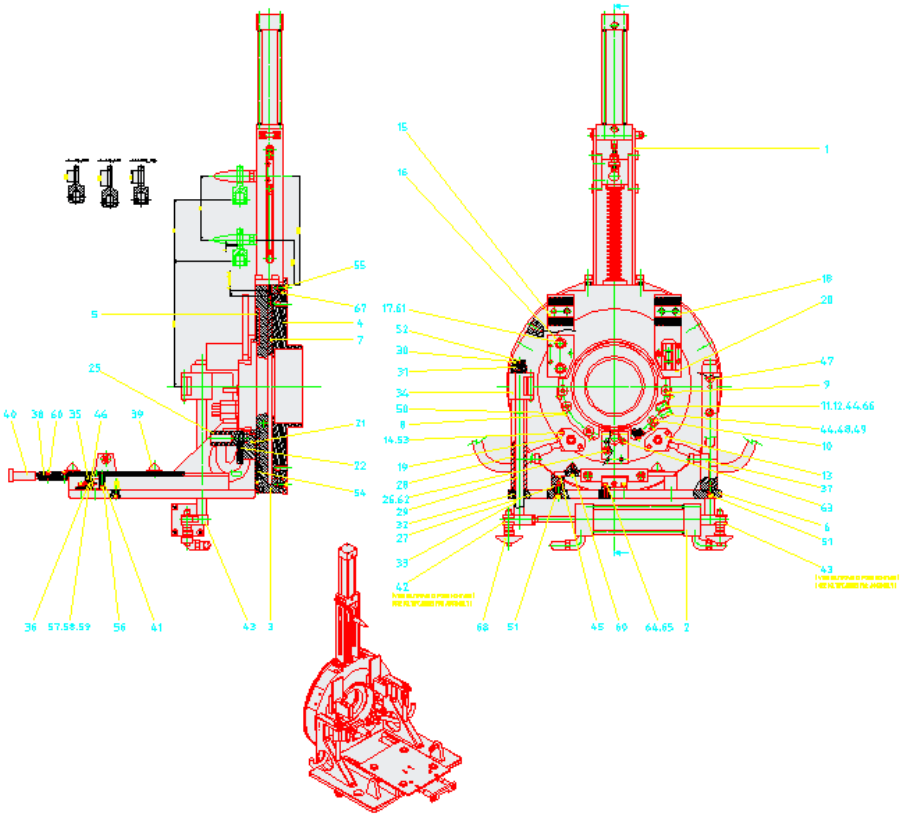
Targets: Design

Study on possible installation of heat pipes

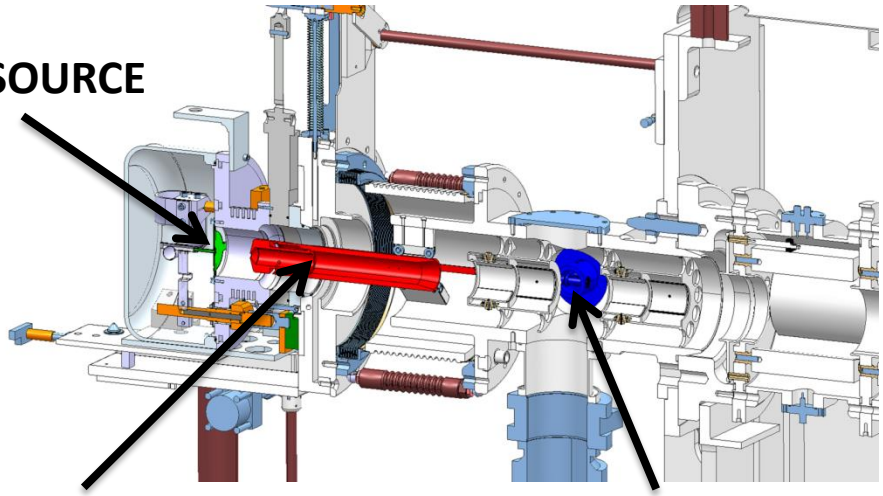
Standard calibration procedure

New coupling system design



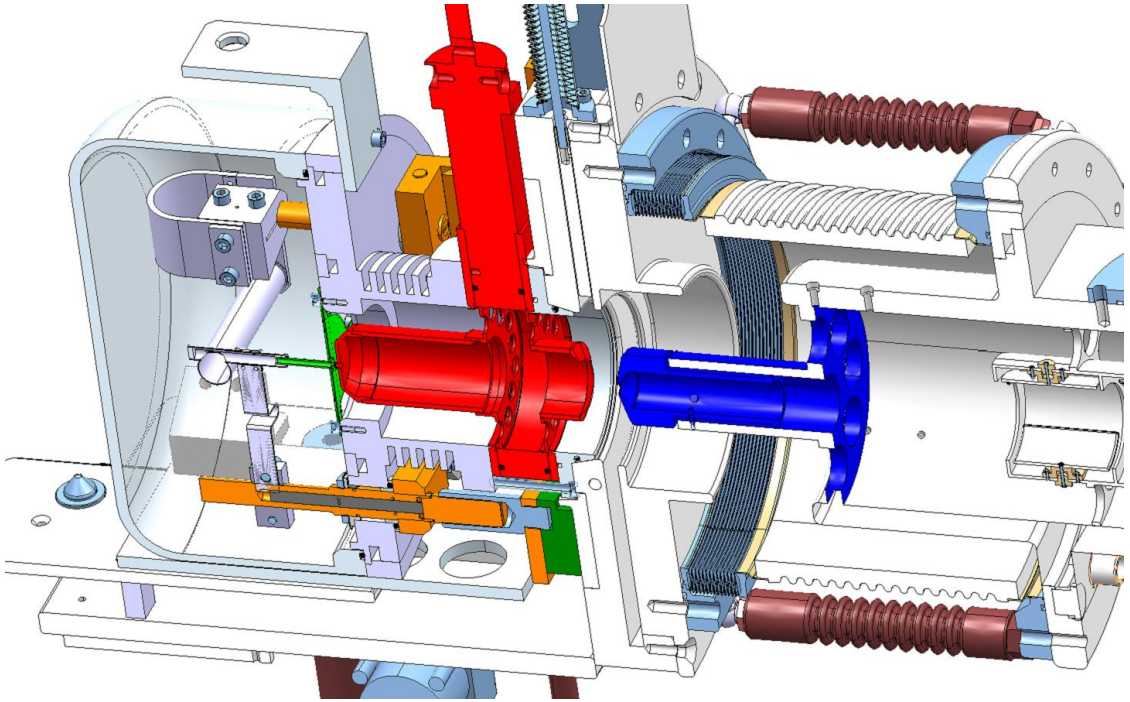


Front End: Current extraction system



- Variable electrode position (degree of freedom for extraction optics and different sources)
- Efficient as tested for many years
- Risk of mechanical failure
- Difficult operation for replacement of electrode cap (human intervention required in radioactive environment)

Front End: Pre extraction prototype

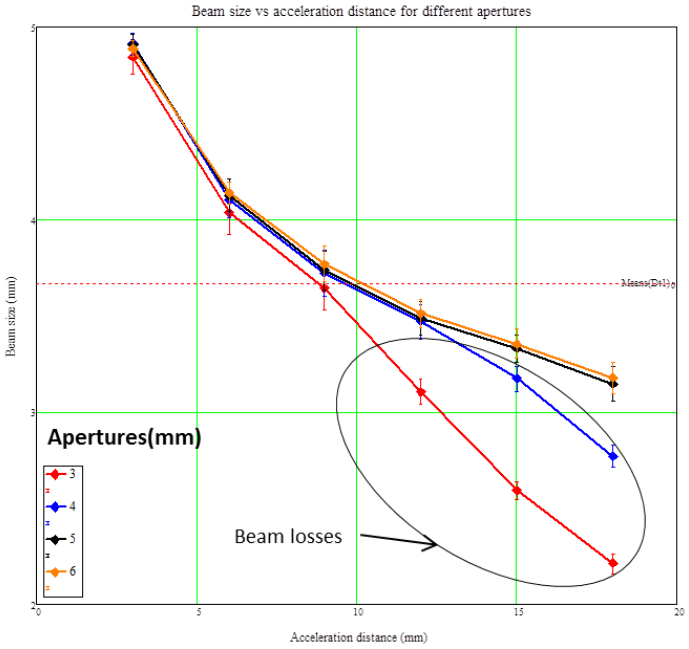


60 kV 57 kV Ground

- 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

Technical advances

Front End: Geometrical optimization



… A numerical optimization of the geometry has been performed. The criteria were mostly based on extracted beam quality and minimum losses

… prototypes have been constructed and are under experimental tests to validate the results

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

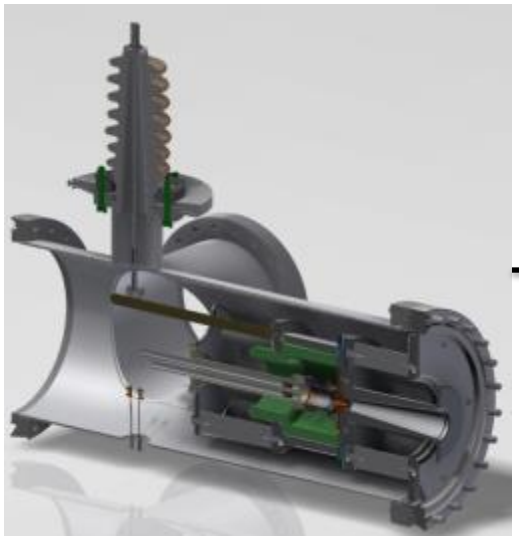
New EBIS – High Energy Compression and Current (HEC^2) EBIS

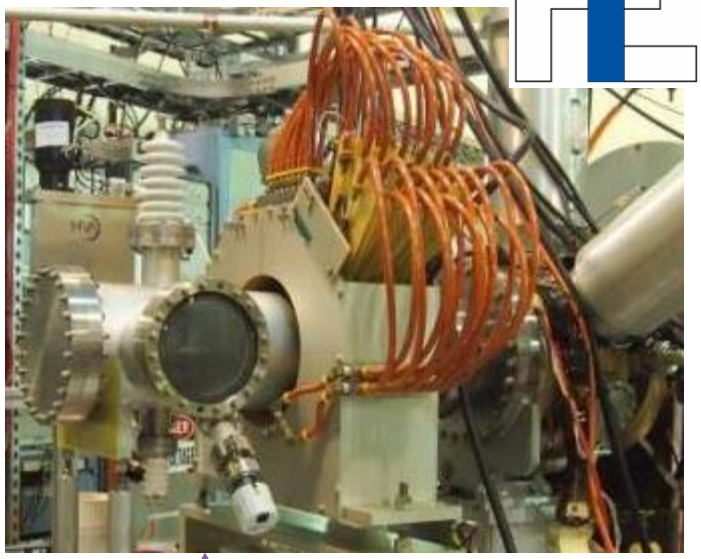
Main challenge – produce the high compression electron beam

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

REX-EBIS: Progress since April





Apr May Jun Jul Aug Sep Oct

The gun manufactured at CERN

Gun shipped to BNL

Gun mounted on Test EBIS

Conditioning EBIS

First complete EBIS simulation with high compression beam

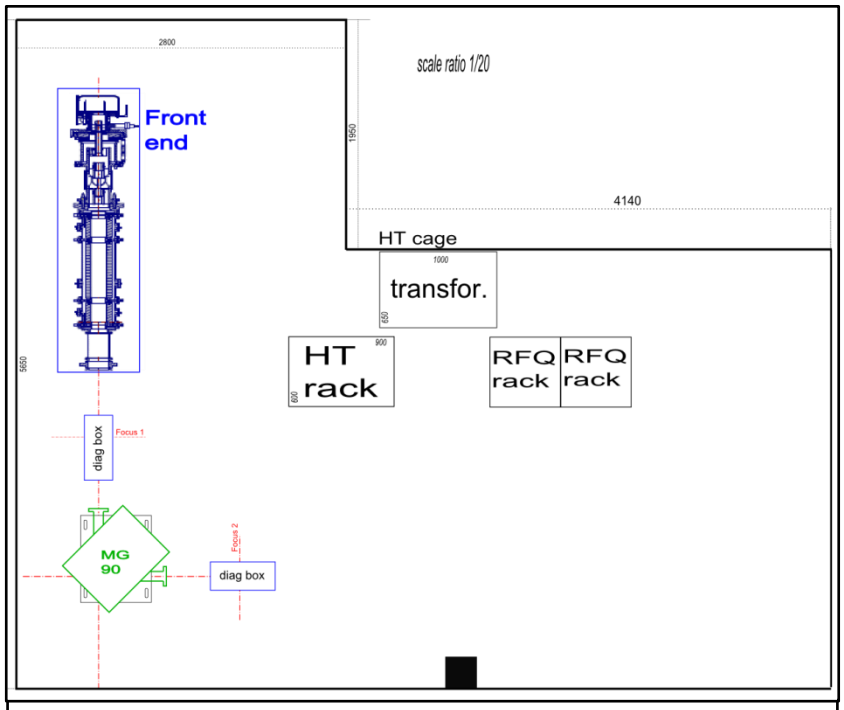
Preparing for tests

Working at BNL

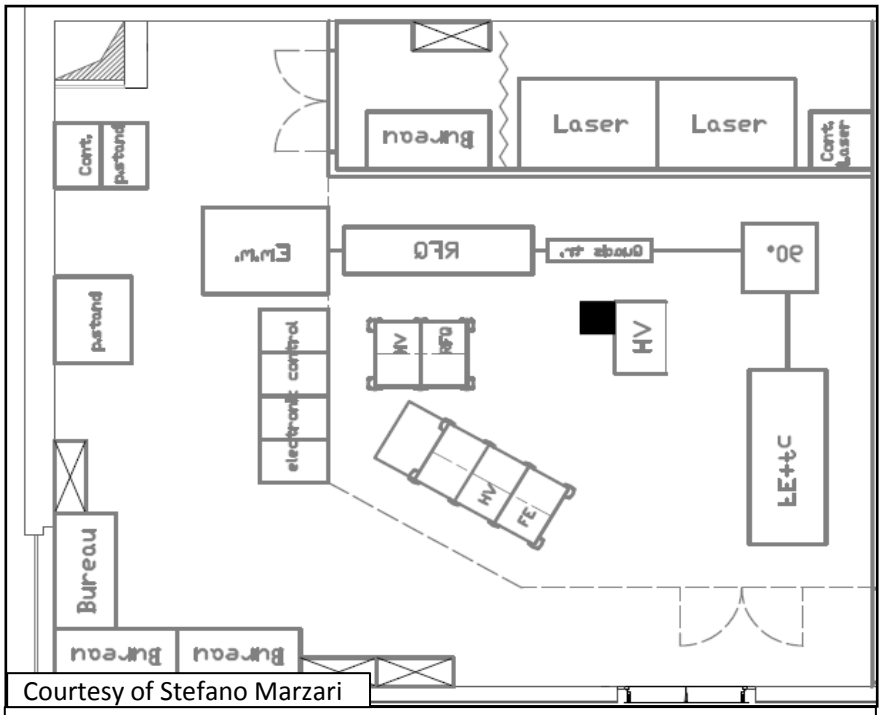
Technical advances

ISOLDE offline separator #2

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



ISOLDE offline #2 (current status)



Courtesy of Stefano Marzari

Foreseen layout of ISOLDE offline #2

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

- ✓ Ion source characterization
- ✓ Separation test
- ✓ RFQCB test

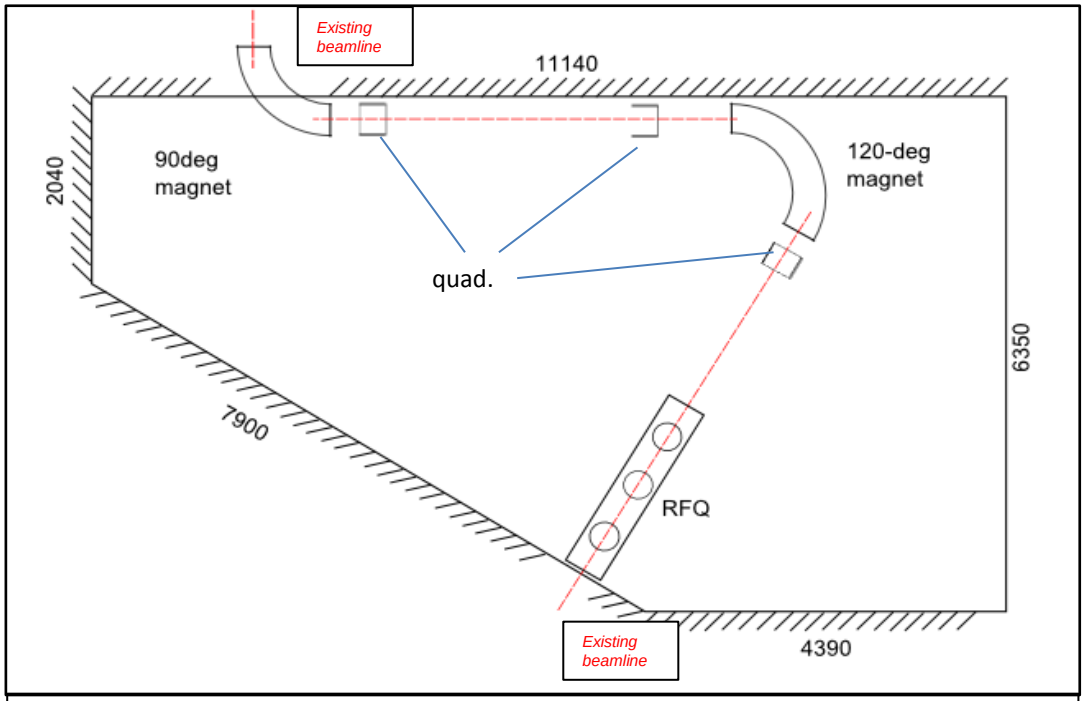
Status on 11/10/2013 : FE and MG90 operational, RFQ under assembly

Technical advances

High Resolution Separator (HRS) upgrade design study

Moving of Radio Frequency Beam Cooler (RFQBC) foreseen more upstream of beamline, in the separator room.

➔ Constraints regarding the available space in separator room and regarding the positioning of already existing beamlines upstream and downstream

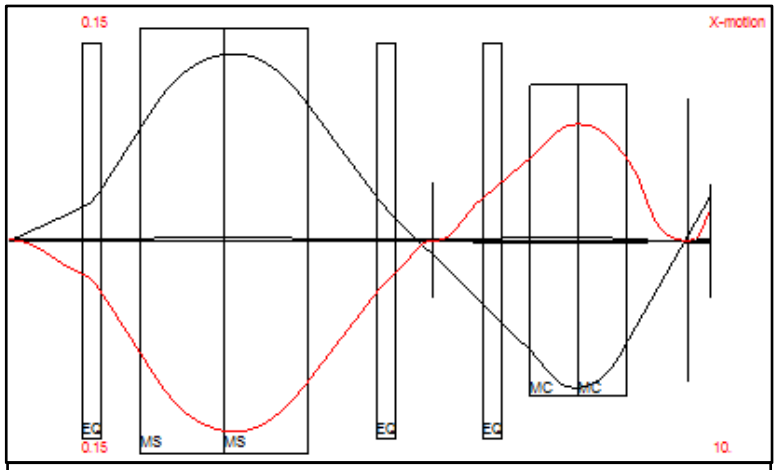


Layout proposal schematic

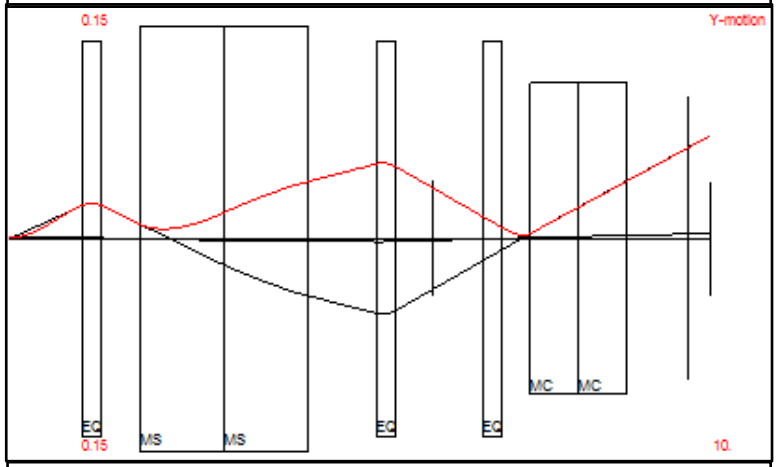
- ✓ Low beam emittance at exit of RFQBC
- ✓ Beam shaping before magnetic stages with quadrupoles
- ✓ 120º dipolar separator magnet (including quadrupolar and sextupolar components)
- ✓ 90º dipolar separator magnet

Technical advances

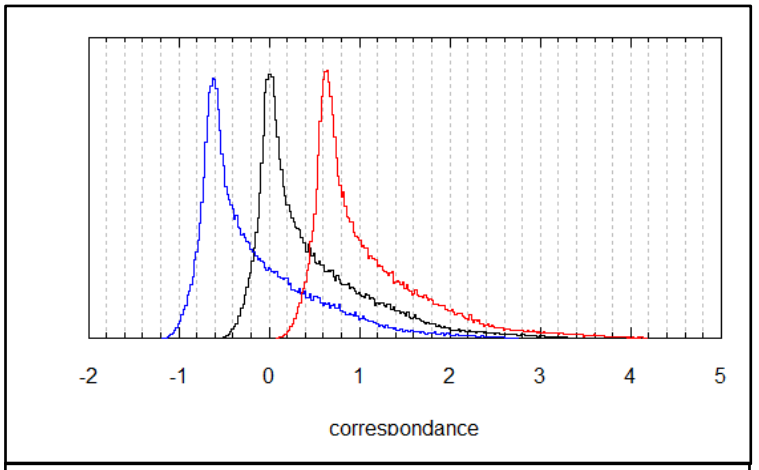
High Resolution Separator (HRS) upgrade design study



© COSY simulation of HRS proposed layout : x-axis



© COSY simulation of HRS proposed layout : y-axis



Separation power computation with © Octave

- ✓ Considered mass M=100
- ✓ $\Delta M/M=2.10^{-4}$
- ✓ Computation performed at 3rd order

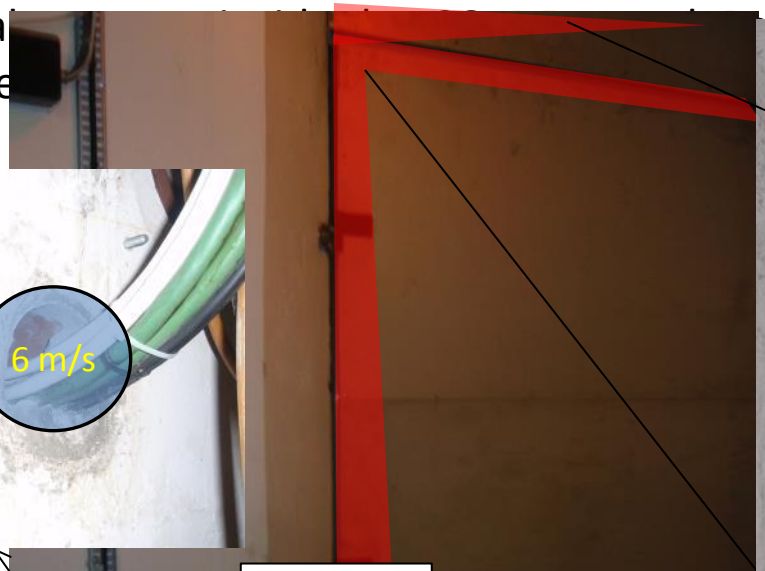
<u>Next steps :</u>

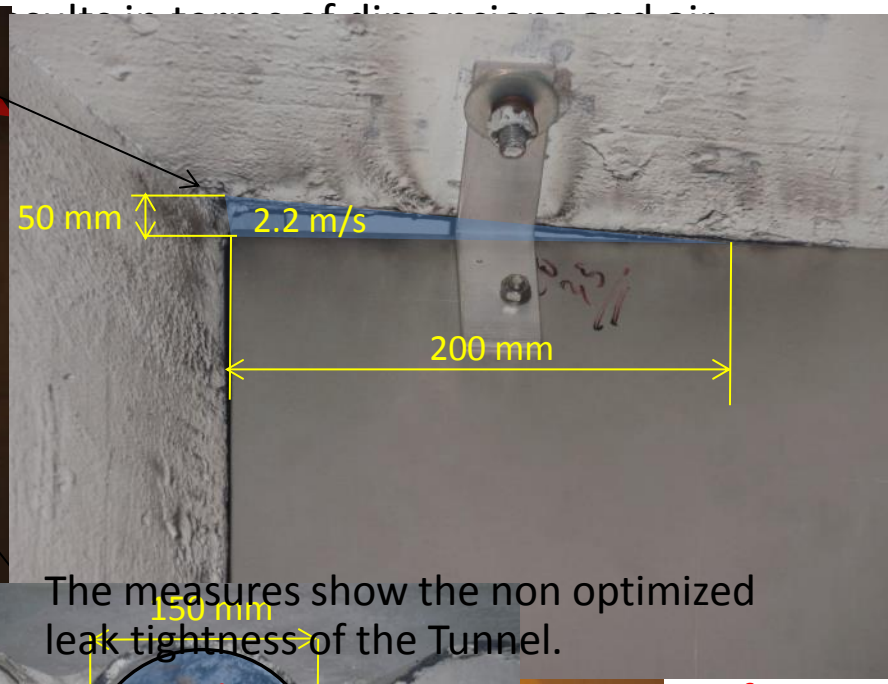
- ➢ Tuning for compensation of aberrations at 3rd order on MG120
- ➢ Tuning of quadrupole and sextupole components on MG90 °
- ➢ © Opera simulations of MG120°

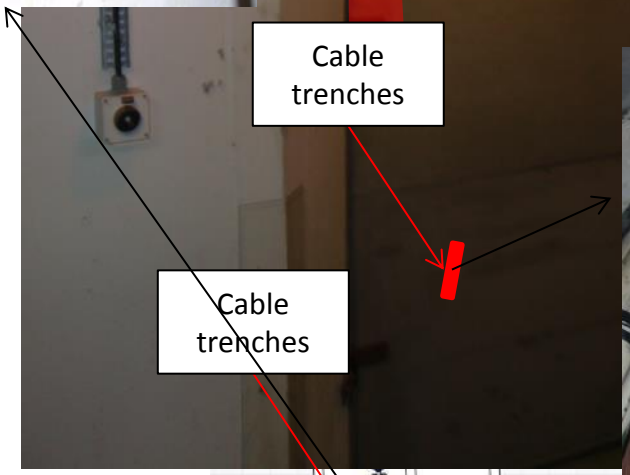
Ventilation

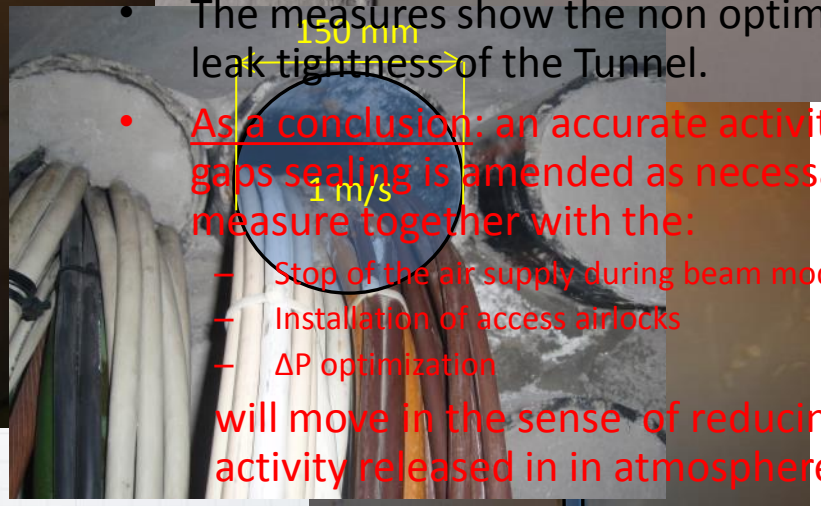
Tunnel and HT Room surveys to measure existing air Leaks

- On-field activity to measure the entities and positions of the main sources of air lea… spe…









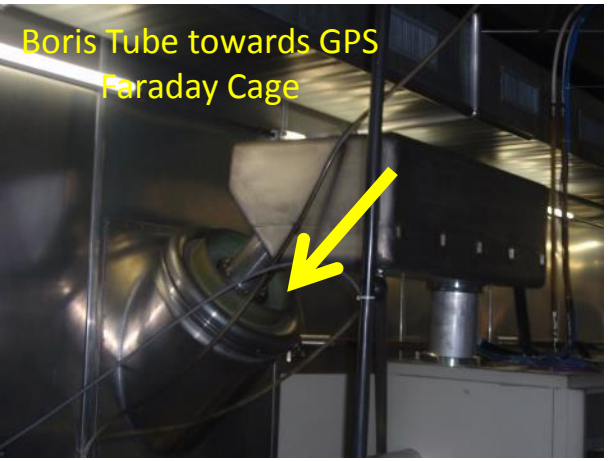
- The measures show the non optimized leak tightness of the Tunnel.
- As a conclusion: an accurate activity of gaps sealing is amended as necessary. This measure together with the:
  - Stop of the air supply during beam mode
  - Installation of access airlocks
  - ΔP optimization

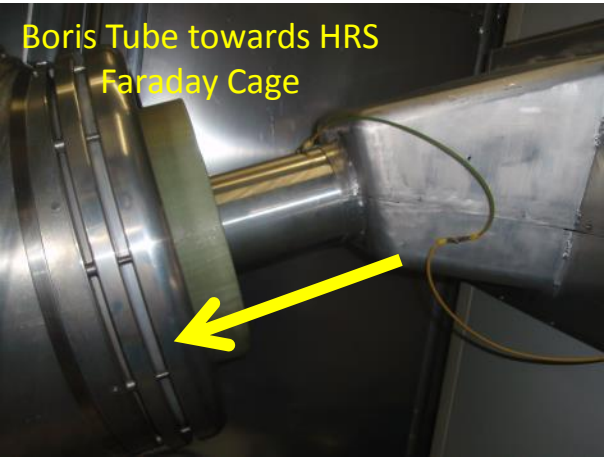
will move in the sense of reducing the activity released in in atmosphere

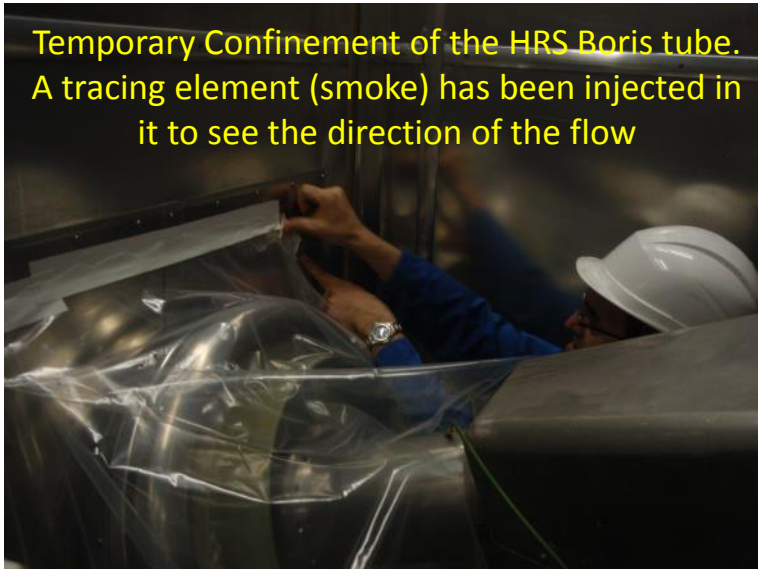
Ventilation

Tunnel and HT Room surveys to measure existing air Leaks

- Verification of the correct pressure cascade between HT room and ISOLDE Tunnel, to confirm that the traces of activation in the HT Room are not caused by an air backflow (but most probably by direct radiations in the room)







- The test showed that the tracing element was flowing towards the Faraday Cage, hence no air backflows are present (in accordance with the initial evaluations)
- As a conclusion: due to the contamination present in the room, a confinement system of the HT room vs. the Experimental hall will be proposed in the Design Study

Precious help from:  H. Sabri  A. Garcia

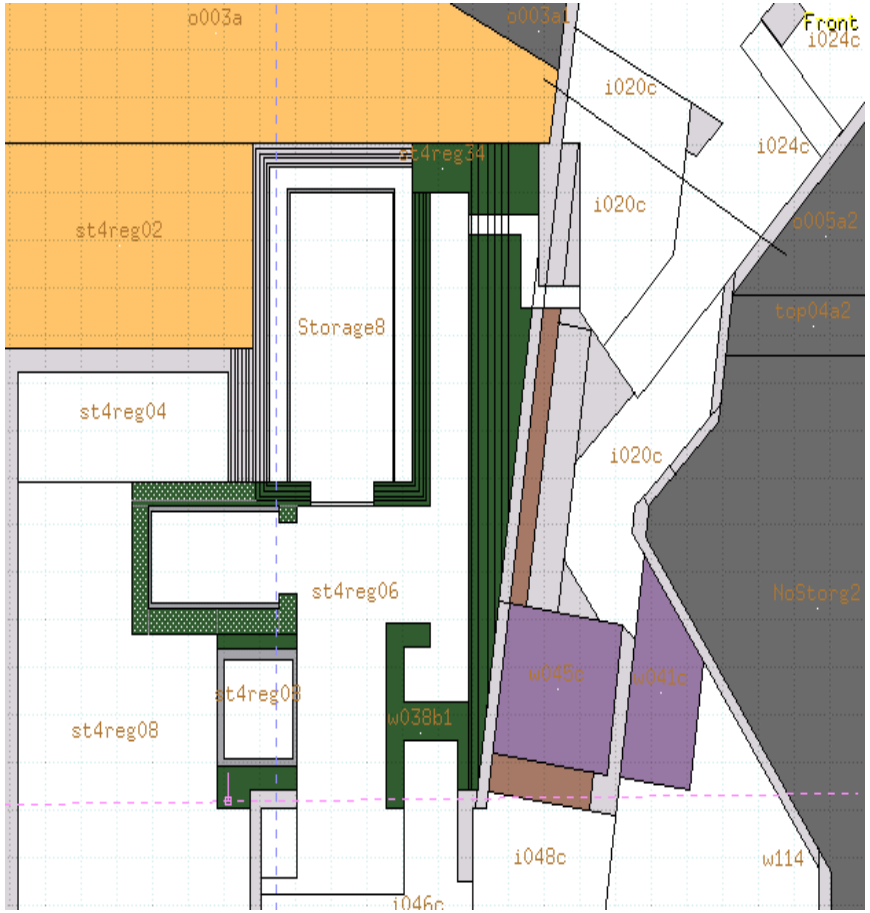
Status of FLUKA simulations for the Experimental Hall, Storage Area and MEDICIS

Geometry and simulation input ready for optimization

The external structure of the new storage and MEDICIS is set and integrated in the simulations in such a way that allows varying of several parameters to minimize dose.

Shielding composition not checked as feasible

The shielding used in simulations is an optimistic case which might not be realistic. Thus still not the final decision.



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

In the current layout:

Direct dose (neutrons from target) - a

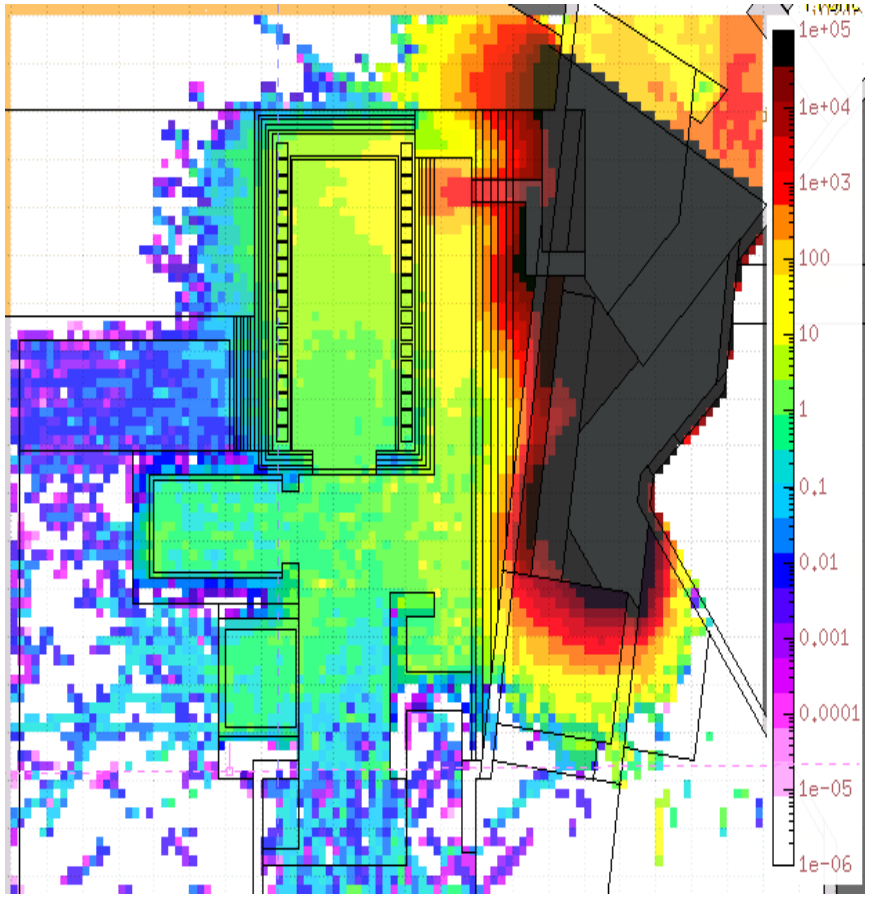
> Levels obtained too close to limits, leaving almost no margin.

Dose from stored targets - b

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

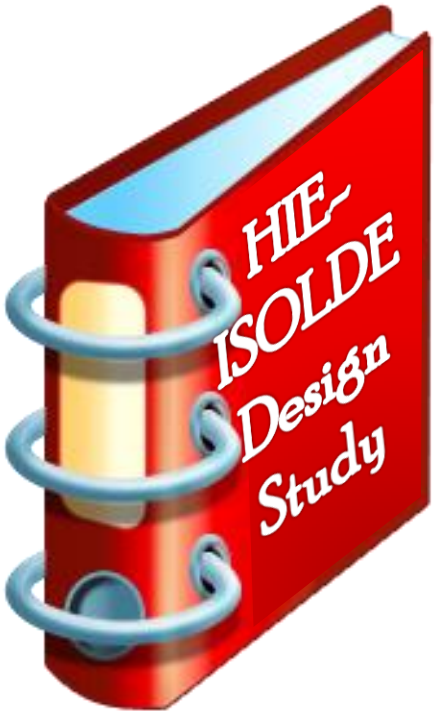
Dose from activated elements

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



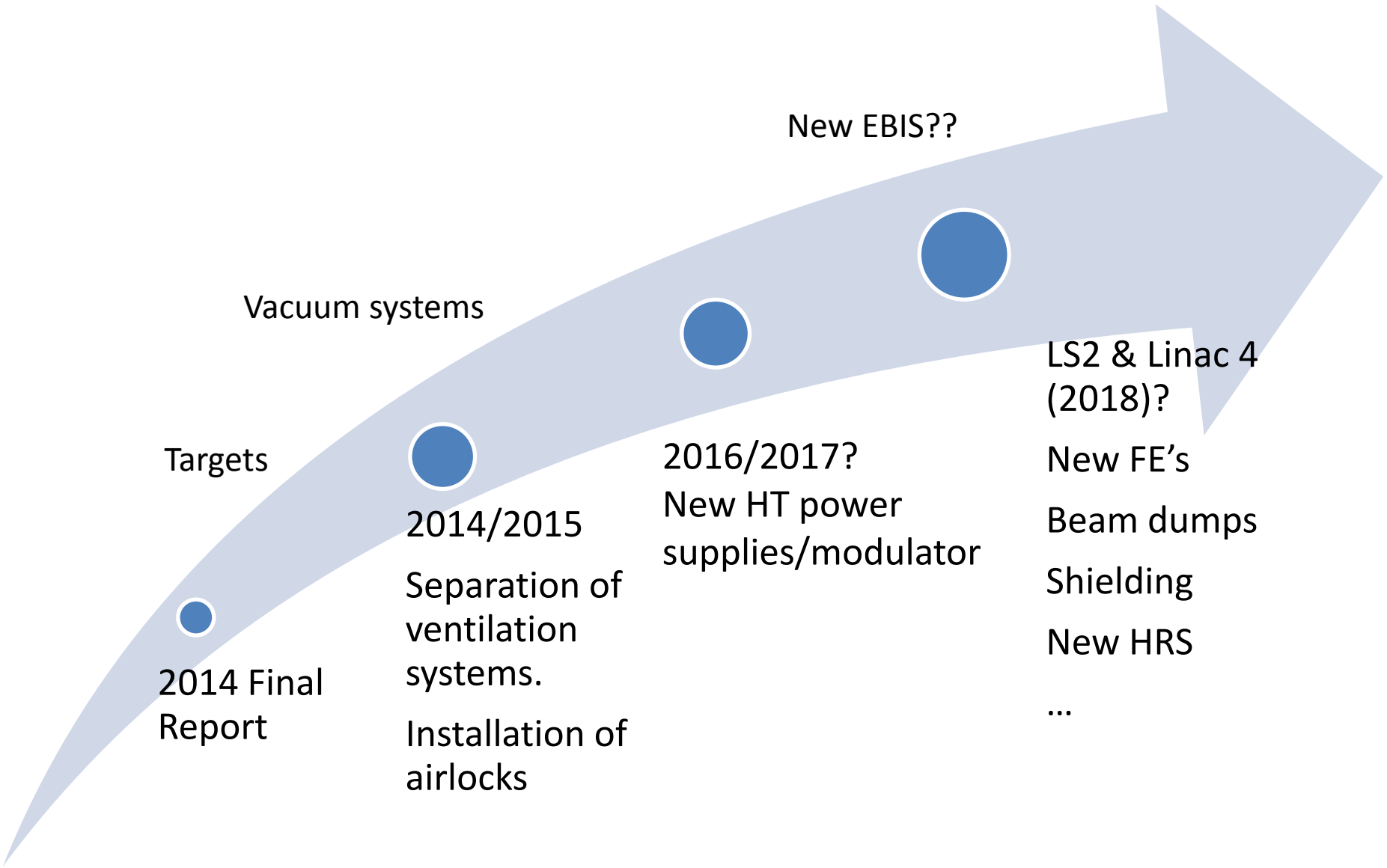
The Design Study Report

- 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
…

HIE-ISOLDE WORKSHOP
The Technical Aspects

28th-29th November 2013, Globe of Science and Innovation, CERN, Geneva, Switzerland

Scientific Advisory Committee:

Richard Catherall
Maria Garcia Borge
Thomas Otto
Thierry Stora
Walter Venturini Desolaro
Didier Voulot
Fredrik Wenander

Local Organizing Committee:

Richard Catherall (Chairman)
Michal Czapski
Geraldine Jean
Yacine Kadi
Ayse Karatepe
Annelie Rasmussen

Conference Page:
http://indico.cern.ch/e/HIE-Isolde-Workshop

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FP7-PEOPLE-2010-ITN project CATHI (Marie Curie Actions - ITN), Grant agreement no PITN-GA-2010-264330.

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- Serena Cimmino – Targets
- Jacobo Montano - Front End
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- Mathieu Augustin – Off line & HRS
- Andrea Polato – Ventilation
- Leonel Morejon – Fluka simulations
- Michal Czapski – Poster

- Thank you for your attention