

ISOLDE Technical Report

46th Meeting of the INTC

12th – 13th February 2014

Richard Catherall, EN-STI

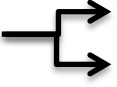
Outline

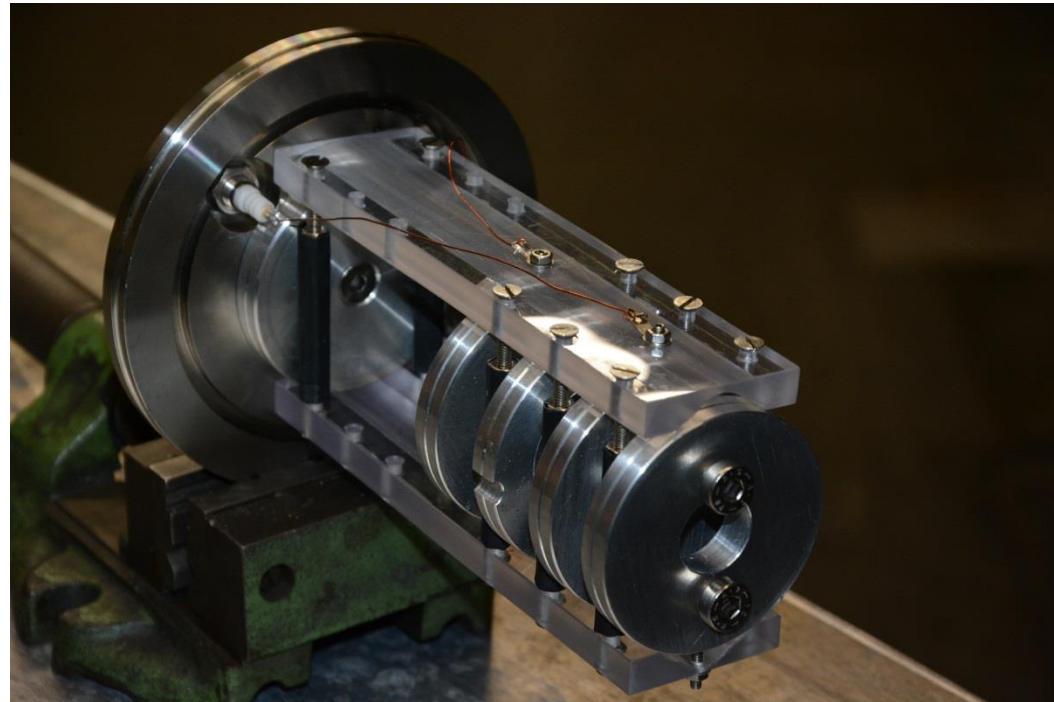
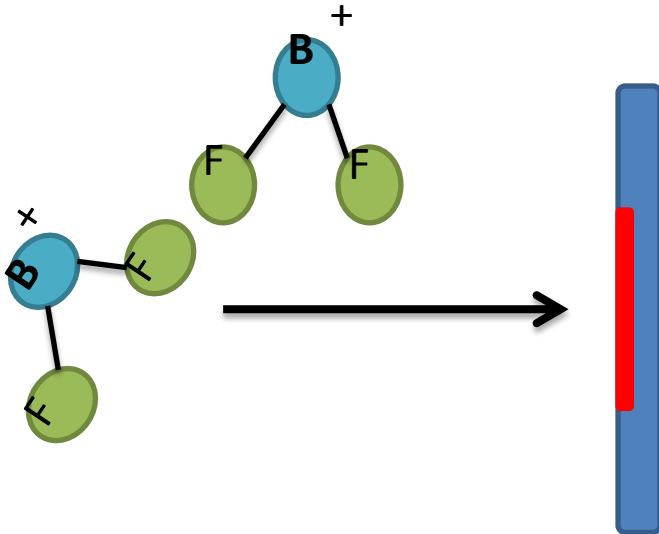
- Targets
 - Boron diffusion characterisation
 - Actilab activities
 - LIEBE Developments
- RILIS
- REX
- Tape station
- RFQ Cooler
- Target Area
 - Hot cell, Robots, PAD/MAD, FE Modifications,
 - MEDICIS
- Start up schedule



Diffusion characteristics of Boron

- Phd project Christoph Seiffert
- Diffusion studies of Boron in possible target materials [1]
- High neutron capture cross section allows efficient detection via alpha particle
- Implantation of $^{10}\text{-BF}_2^+$ at offline separator with 30kV-80kV into target material samples (Al_2O_3 , CNT, MgF_2 ,...)
- **In collaboration with SARAF – Soreq Applied Research Accelerator Facility, Israel**

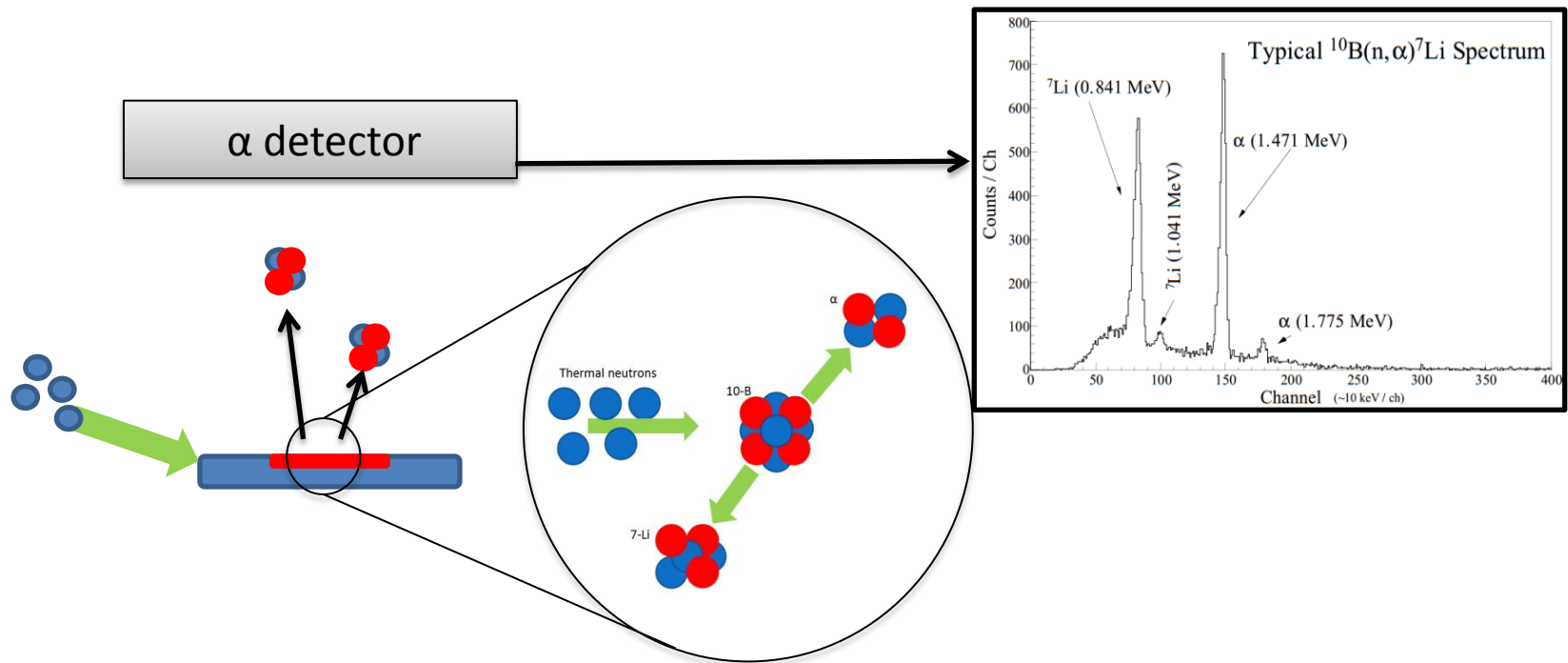
- $\sigma_{[^{10}\text{-B}(n,\alpha)^7\text{-Li}]} = 3840$ barn
- $^{10}\text{-B} + 1n$ 
 - 6%: $^7\text{Li} (1.015\text{MeV}) + \alpha (1.777\text{MeV})$
 - 94%: $^7\text{Li} (0.840\text{MeV}) + \alpha (1.470\text{MeV}) + \gamma (0.478\text{MeV})$



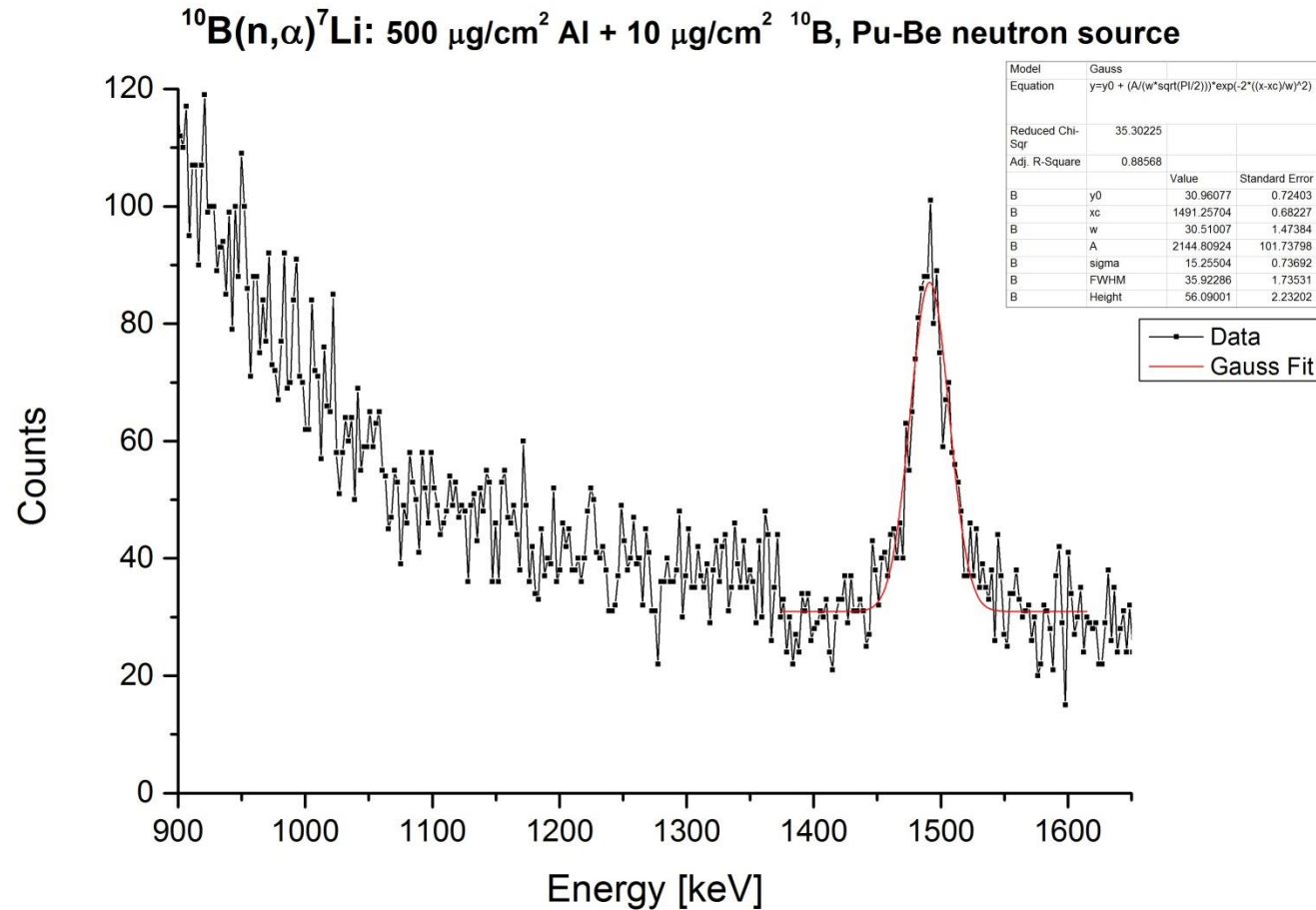
Christoph Seiffert

Diffusion characteristics of Boron

- Irradiation with thermal neutrons : measure distribution
 - Pu-Be Source $1.1 \cdot 10^8$ n/s @ 4π
- Heating of sample \leftrightarrow diffusion



Diffusion characteristics of Boron

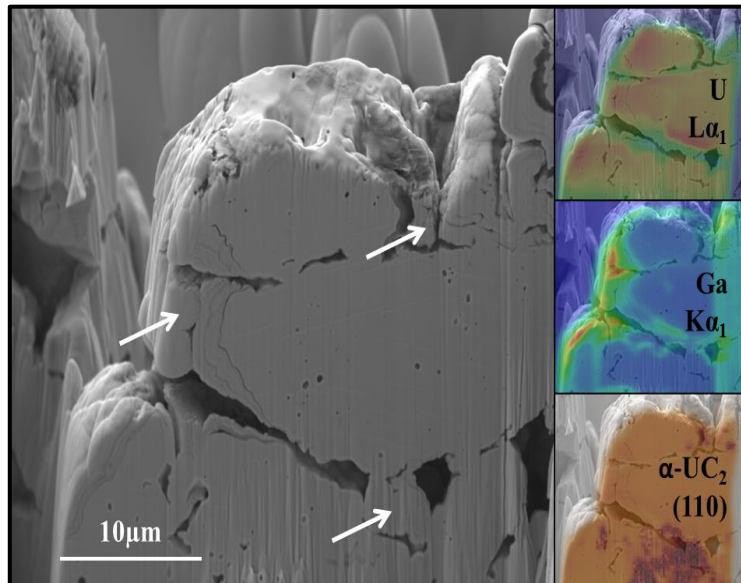


ENSAR – JRA: ActLab ACTIVITIES

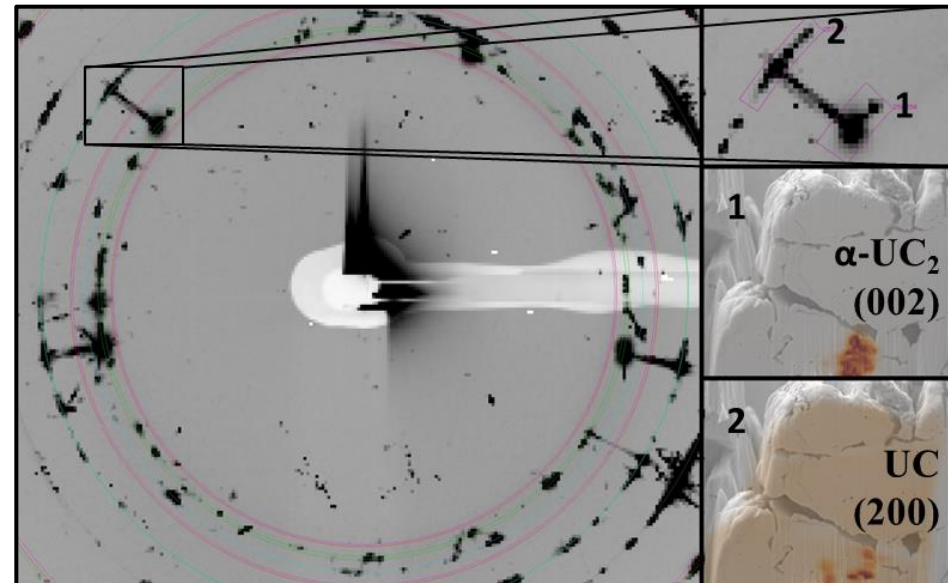


Characterization of conventional UC_x using synchrotron-based micro-beam analysis:

Microscopic morphology – buried porosity & chemistry



Kinetic stabilization by sub-microscopic UC – UC₂ phase competition

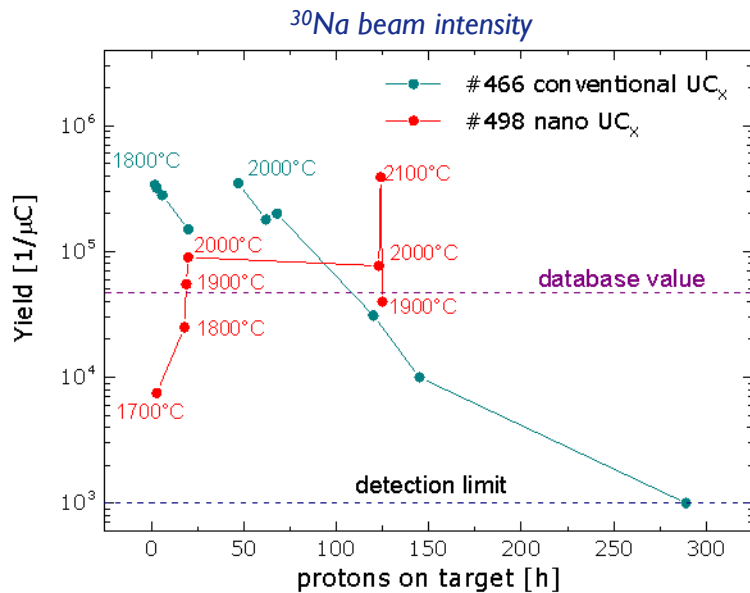


- Grain size of material is smaller than previously estimated; global phase transition observed at 2100°C
- Phase competition between UC and α -UC₂ as yet missing explanation of performance and durability of this material

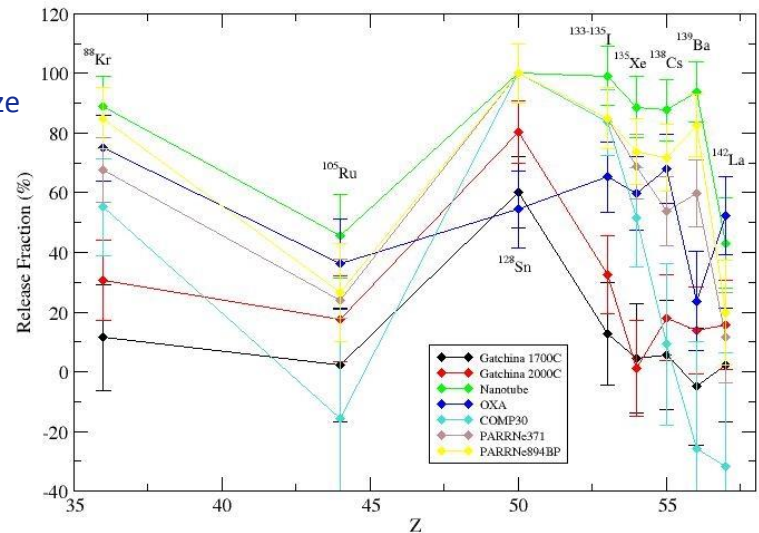
Online tests and synthesis of de-novo designed uranium carbide matrixes:

Different microstructures, densities, grain sizes, crystal structures tested → tailor-made matrix:

- Suspension grinding of UO_2 powder to 160nm average particle size
- Wet-mixing with multi-walled carbon nanotubes
- Ultrasound drying of mixture and pressing to 1.6 g/cm^3 pellets
- Fast reactive sintering to mixed uranium carbide in carbon nanotube matrix



Release fractions from RaBIT irradiations, ALTO 2013



IS540:

Despite major technical difficulties (RFQ, tape station, separator):

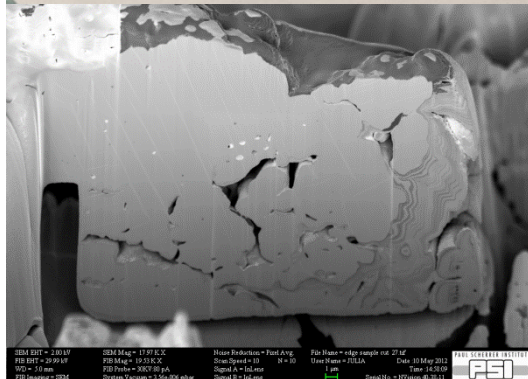
- record yield of ^{11}Be : $6.0 \times 10^7 \text{ I}/\mu\text{C}$, database: $7 \times 10^6 \text{ I}/\mu\text{C}$ (confirmed)
- Structure appears to be widely conserved over time and temperature (see ^{30}Na evolution)

Repeat tests at ISOLDE and at ALTO within ActILab in 2014

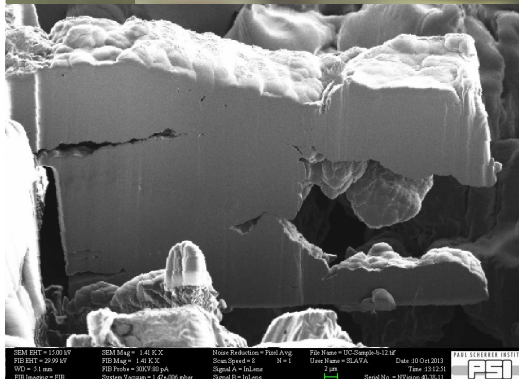
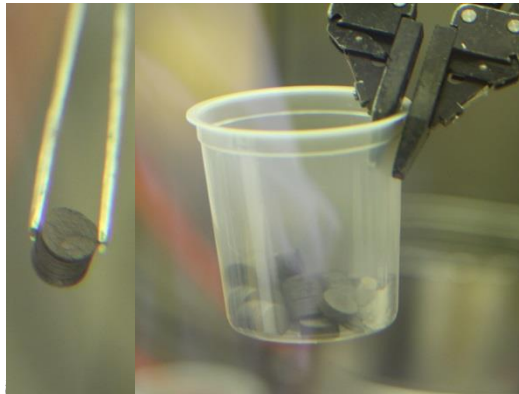
Post-irradiation analysis:

- First analysis of an irradiated UC_x target in the history of ISOLDE
(important to understand ageing processes and for upcoming waste campaign)
- Opening target unit #466 ($8.8 \cdot 10^{18}$ protons in 2011) in inert-gas hot-cell at PSI, 19 mSv/h on contact with Ta beam window

before irradiation



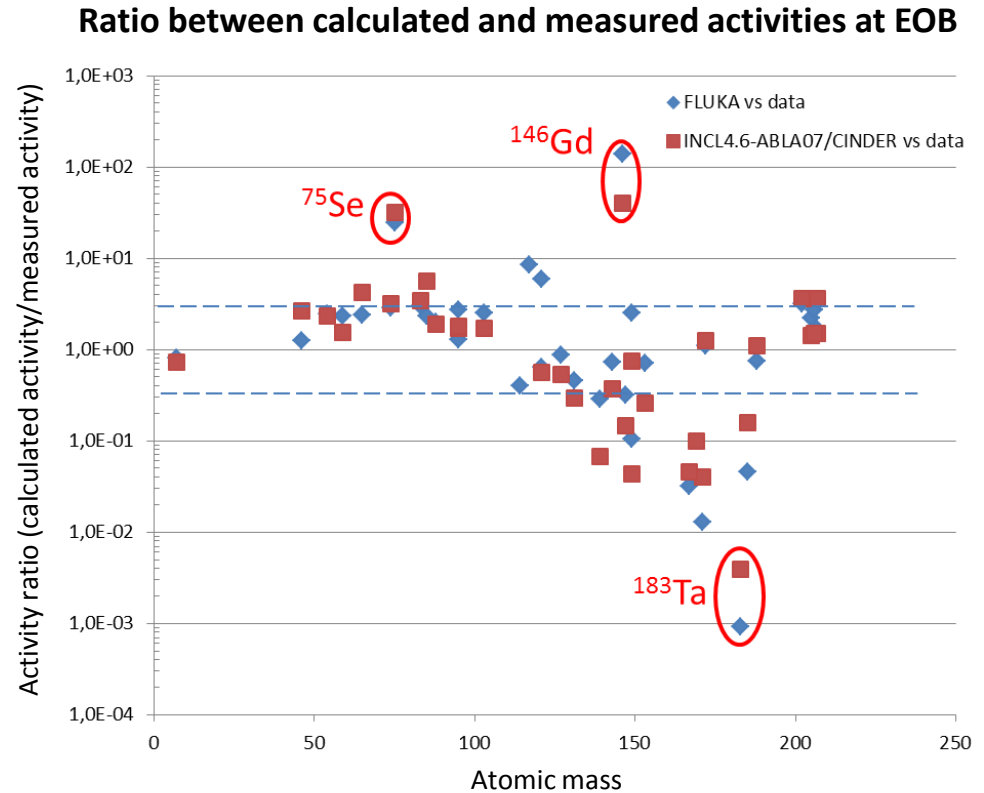
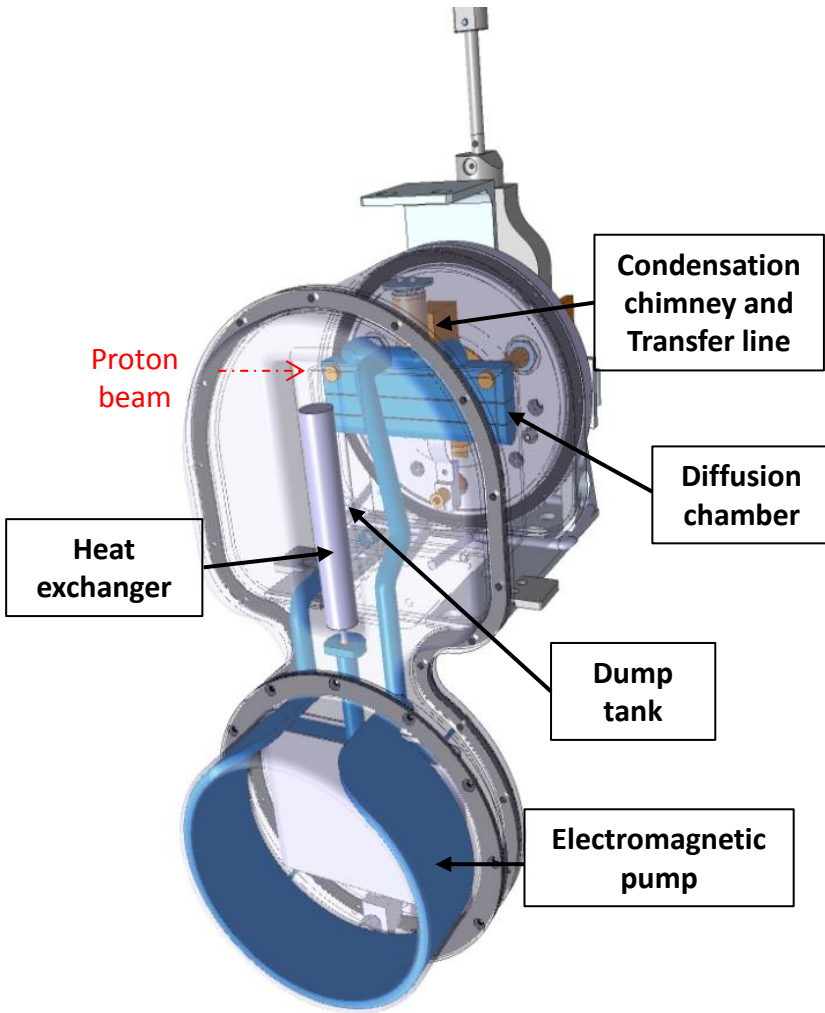
after irradiation



- Pellets appear macroscopically unchanged
- Microscopic evolution of pore distribution and grain size under irradiation observable
- 500 μ Sv/h on contact with single pellet
- Results of synchrotron investigations under analysis
- Ceramography and electron microprobe analysis scheduled for April

Liquid Eutectic Pb/Bi loop for EURISOL

LIEBE project



A. Marchix, J. Blaha, M. Maiti, S. Lahirir

Courtesy of V. Barozier and M. Delonca

LIEBE project: Institutes and Timeline

Q2-12	Kick-off meeting
Q3-12	
Q4-12	RaBIT irradiations
Q1-13	
Q2-13	Risk analysis
Q3-13	Comparison MC code
Q4-13	Instrumentation definition
Q1-14	Offline tests: shower feasibility
Q2-14	Pump construction Offline tests: loop Final design Modification target area
Q3-14	Construction
Q4-14	Comissioning
Q1-15	Modification target area
Q2-15	1 week online Report
2018	Final report

WP Definition

WP1: Coordination

WP2: Conceptual Design and Simulation

WP3: Construction, Assembly

WP4: Instrumentation

WP5: Safety and Licensing

WP6: Target characterization and analysis

WP7: Radiochemistry

WP8: Offline Commissioning

WP9: Online Operation

WP Holder

CERN

SCK-CEN

CERN

CERN

CEA

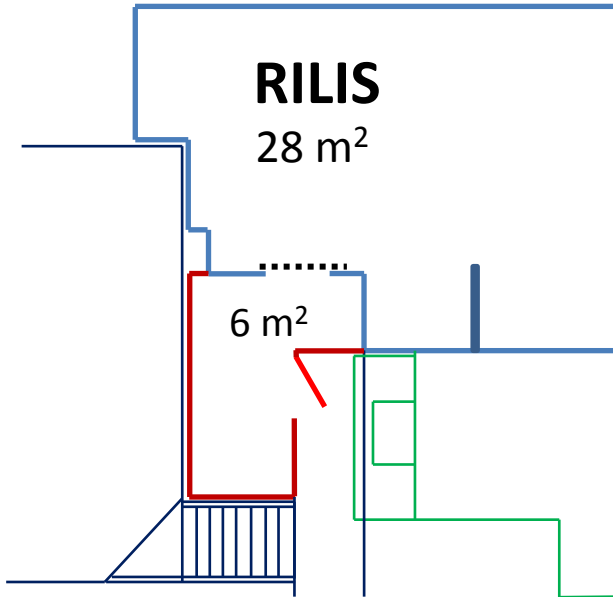
PSI

SINP

IPUL

CERN

RILIS room extension



**Needed for
improvement of
work safety**

New SAS for RILIS laser room is built in December 2013

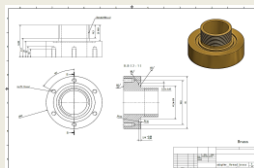
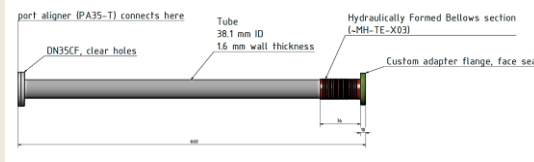
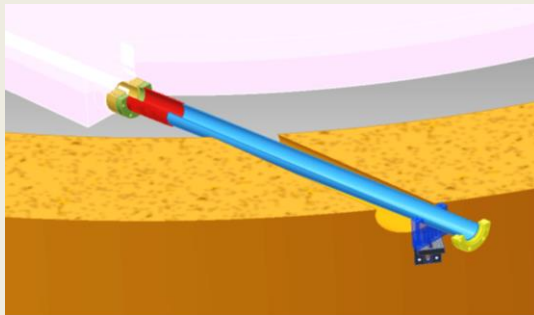
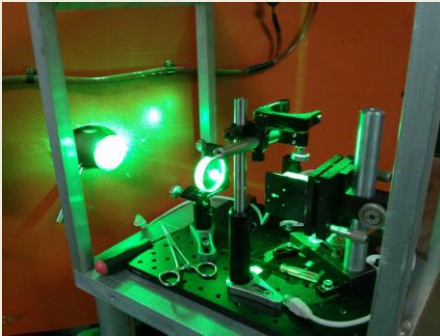
HRS laser window

New features add safety and usability

- ease of access for inspection
- use of a standard CF mounted viewport (stocked item)
- no special tools required for exchange
- preserve thread in HRS Al vacuum tank
- adding port aligner makes window useful as additional reference point for RILIS

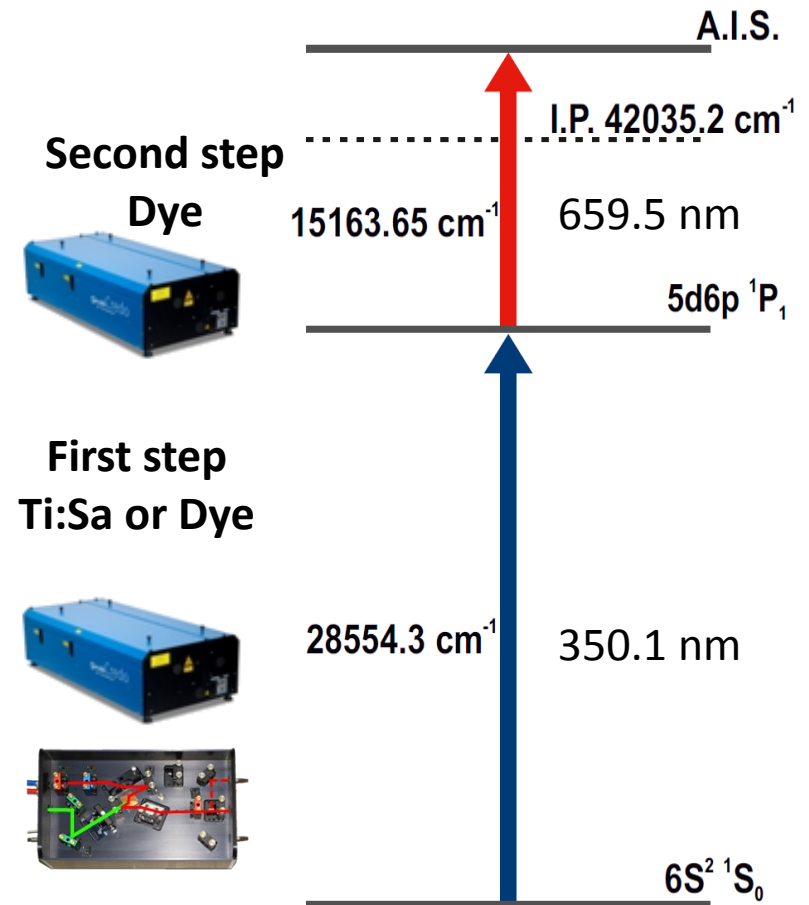
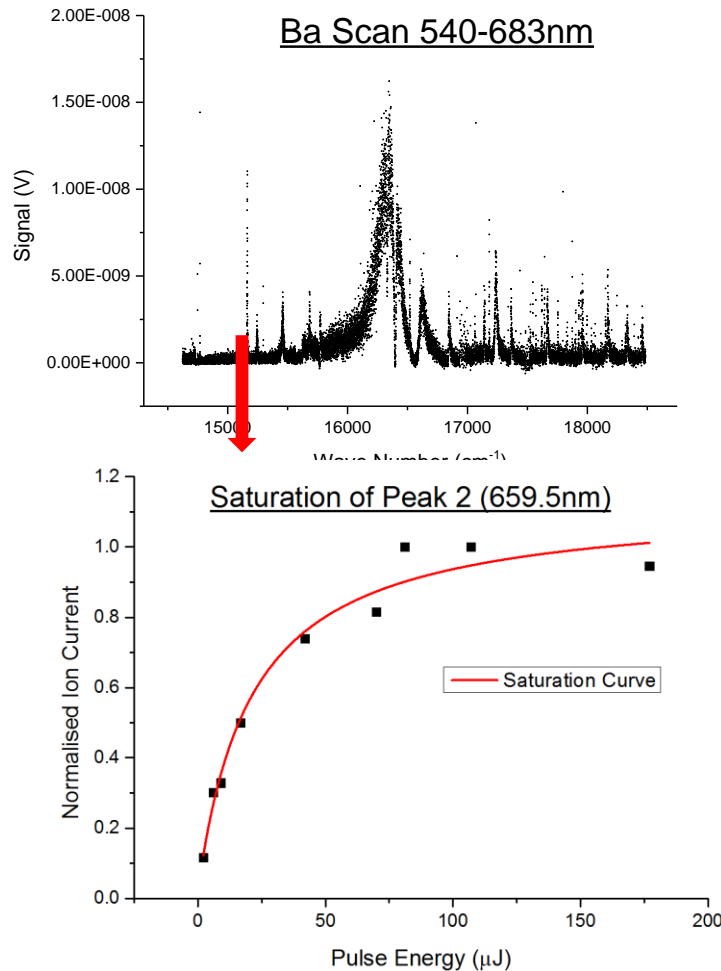
Process and Status

- lack of drawings of the current window required intervention to get dimensions
- drawings are now with the ISOLDE workshop and the manufacturer
- port-aligner and viewport are currently tested at ISOLDE-OFFLINE
- required torque will be measured prior to installation at HRS



Barium Scheme Development

- From a first step of 350.1 nm, scans of the second step were made offline at the LARIS lab
- 3 potential auto-ionizing schemes were identified
- These will be compared @ ISOLDE with efficiency measurements being taken



REXEBIS

Last INTC: Repair of REXEBIS magnet cryostat initialized

LHe holding time 6 days and could fall abruptly (nominal 14 days).

Last repaired 2005 by external firm Ice Oxford; this time in-house repair.

Major and risky job; complete EBIS needs to be dismantled.

Goal: EBIS re-assembled by March 2014.



Nov and Dec: Moderate modifications and reassembly

Holding time only ~ 7 days

Further discussion with magnet team in ATLAS

Jan - ??: ATLAS magnet team involved

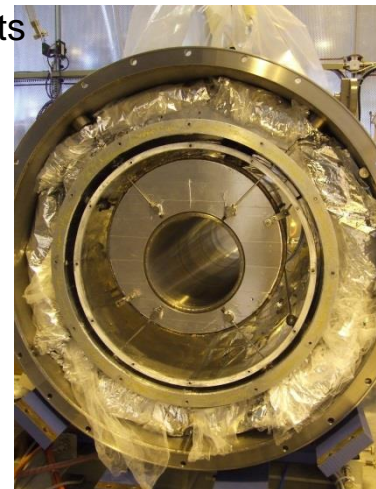
Magnet disassembled again

No clear loss cause identified

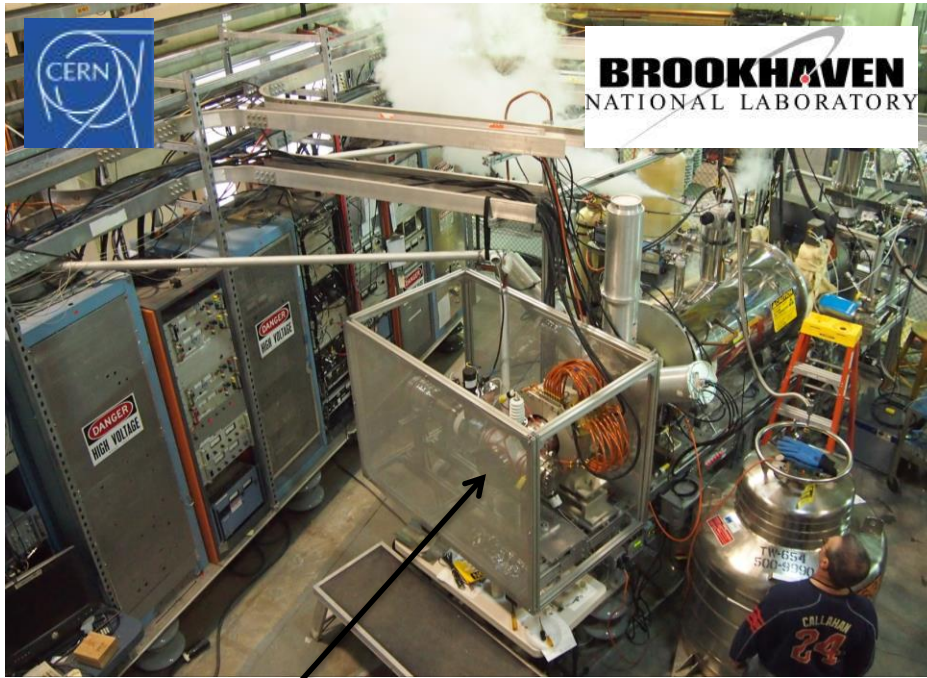
Discussing more complex improvements

* Timeline unsure as the magnet team has other higher priorities.

* Worries: still no cathode tests started
lack of results for PhD student

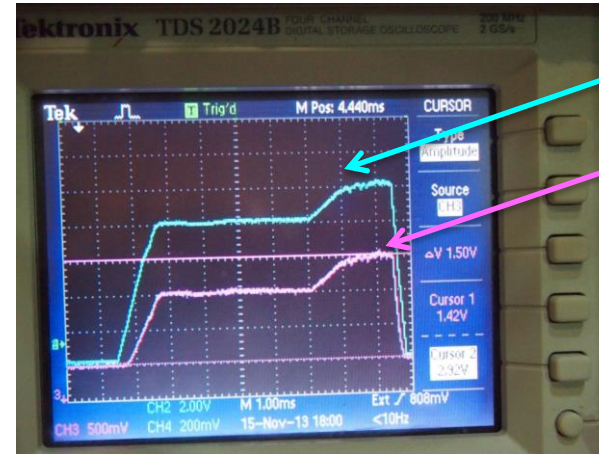


HEC² prototype tests at BNL



Prototype gun design by BNL, built by CERN being tested at BNL by joint team at BNL TEBIS

First beam time – 08.11.2013-15.11.2013



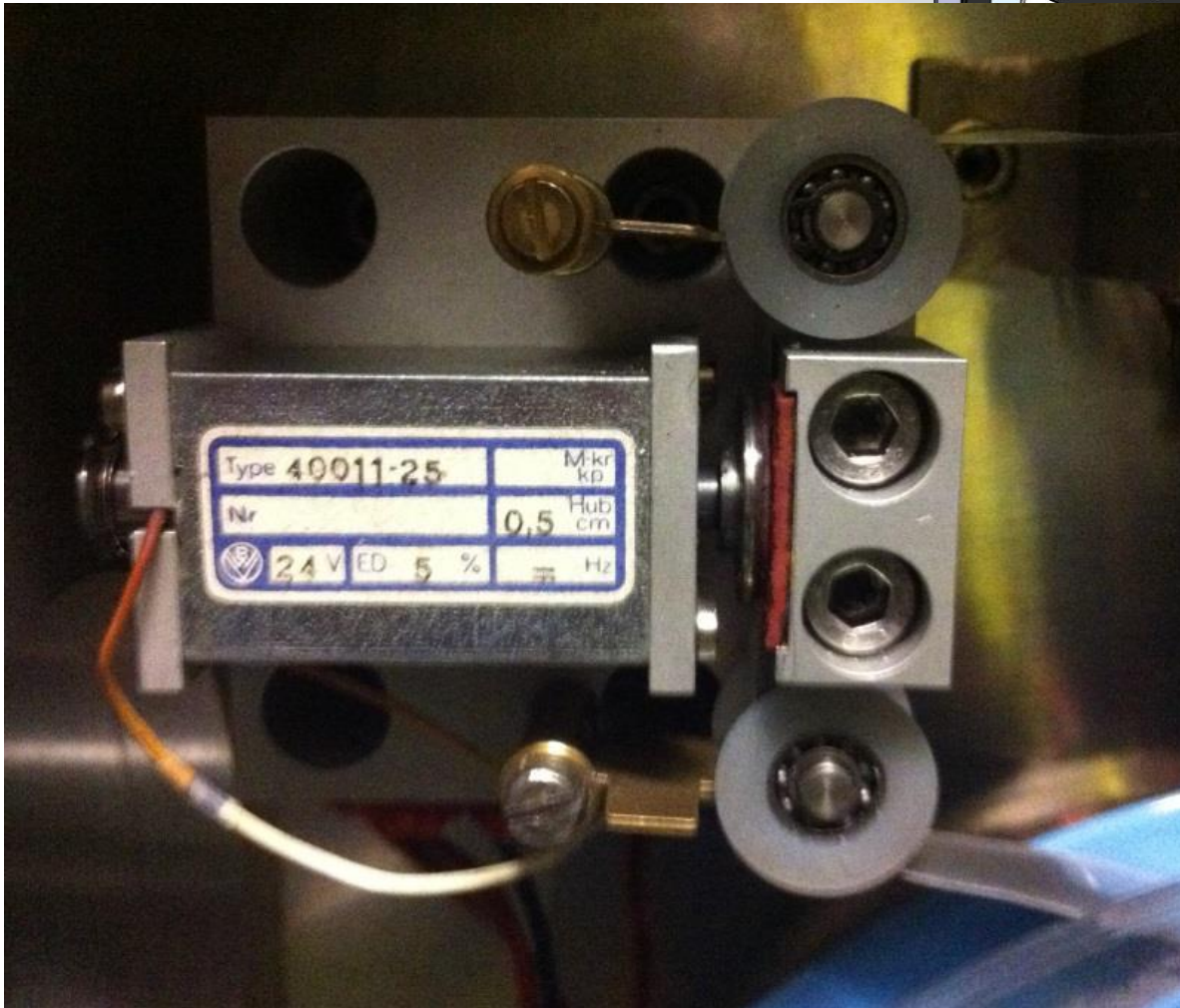
Anode voltage

Extracted current (1V=1A)

Scenario	E_e , keV	I_e , A	J_e , kA/cm ²
HEC ² ultimate spec	150	5	10-20
Test stand limit <i>as is</i>	40	2.2	5
Achieved in 1-st run	30	1.54	tba
<i>REXEBIS today</i>	5	0.2	0.01

These activities supported by HIE-ISOLDE design study will continue in 2014

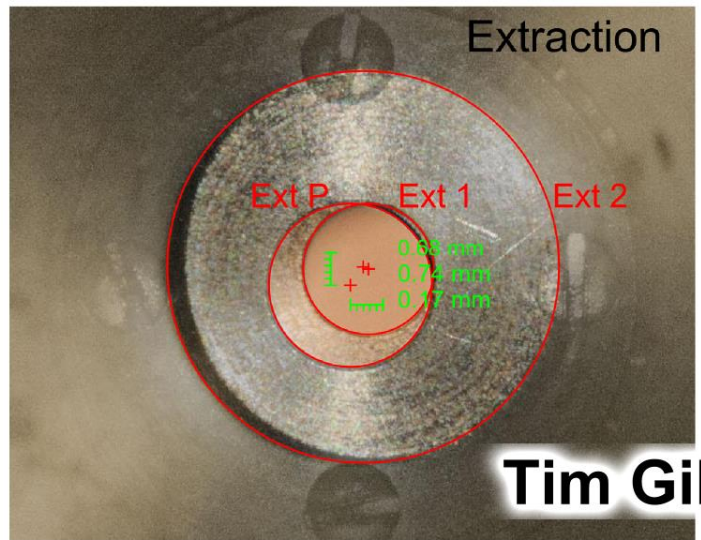
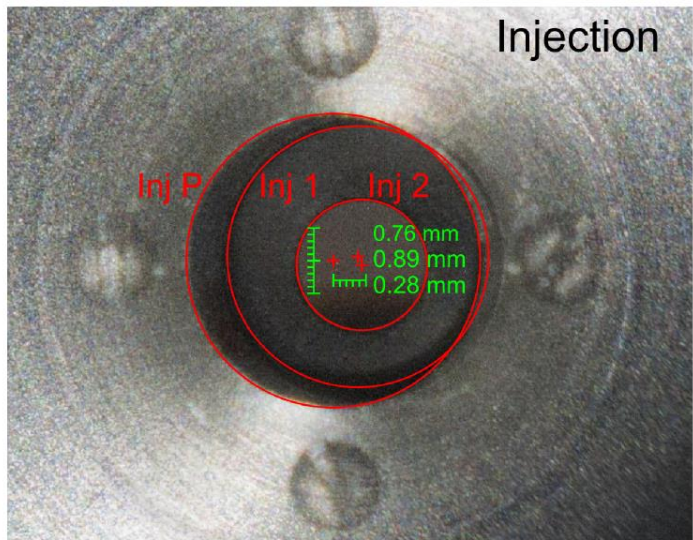
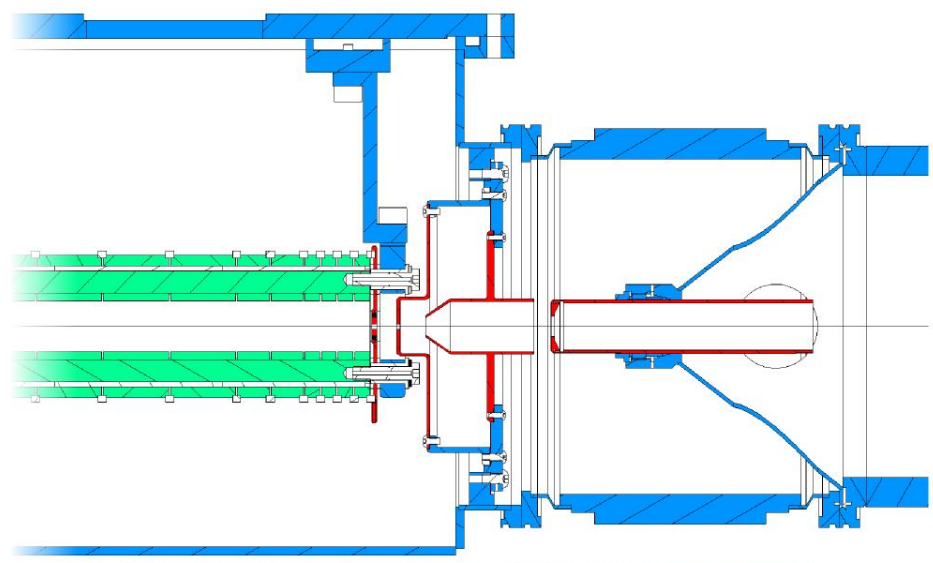
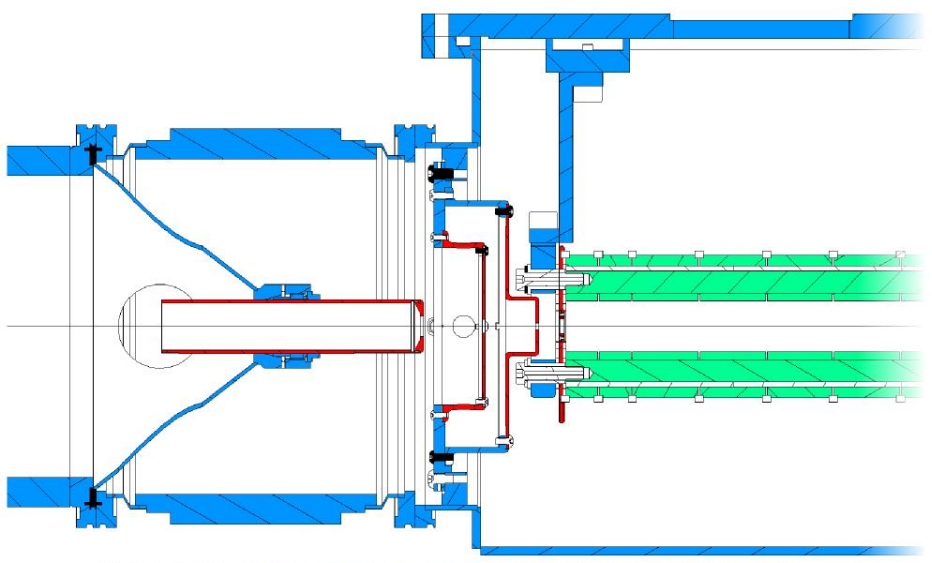
Tapestation



- Old tape station will be used for the start up.
- Investigations show that the solenoid brake is sticking
- Repair and test as soon as beam is available
- Construction of new tape station throughout 2014
- EN-STI/PH-SME collaboration

Tim Giles

RFQ cooler



Tim Giles

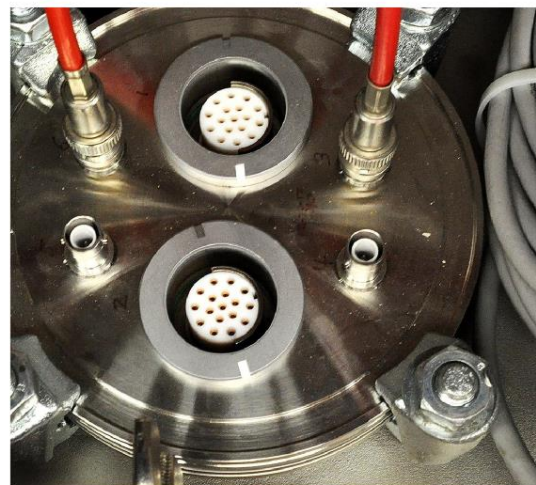
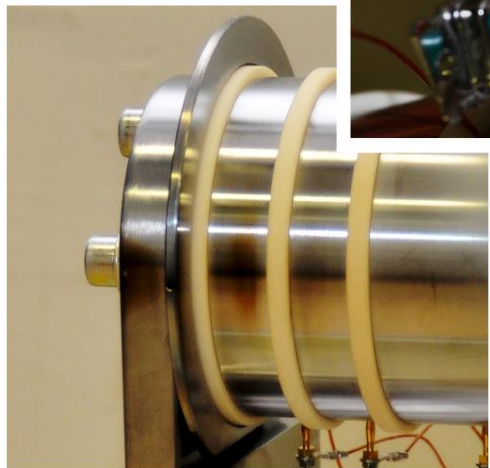
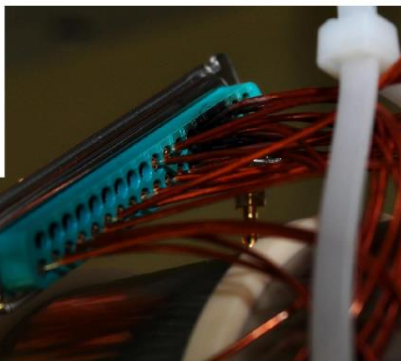
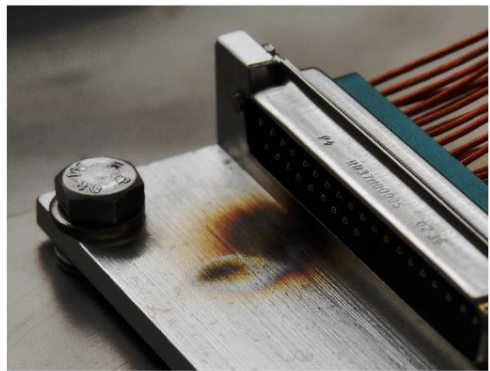
RFQ cooler

Electronics

Arcing and insulator breakdown

Over-stressed insulators can take years or months before breakdown occurs

Diagnosis and repair are difficult and time-consuming
RFQ cooler is critical for 50% of ISOLDE's output



Tim Giles

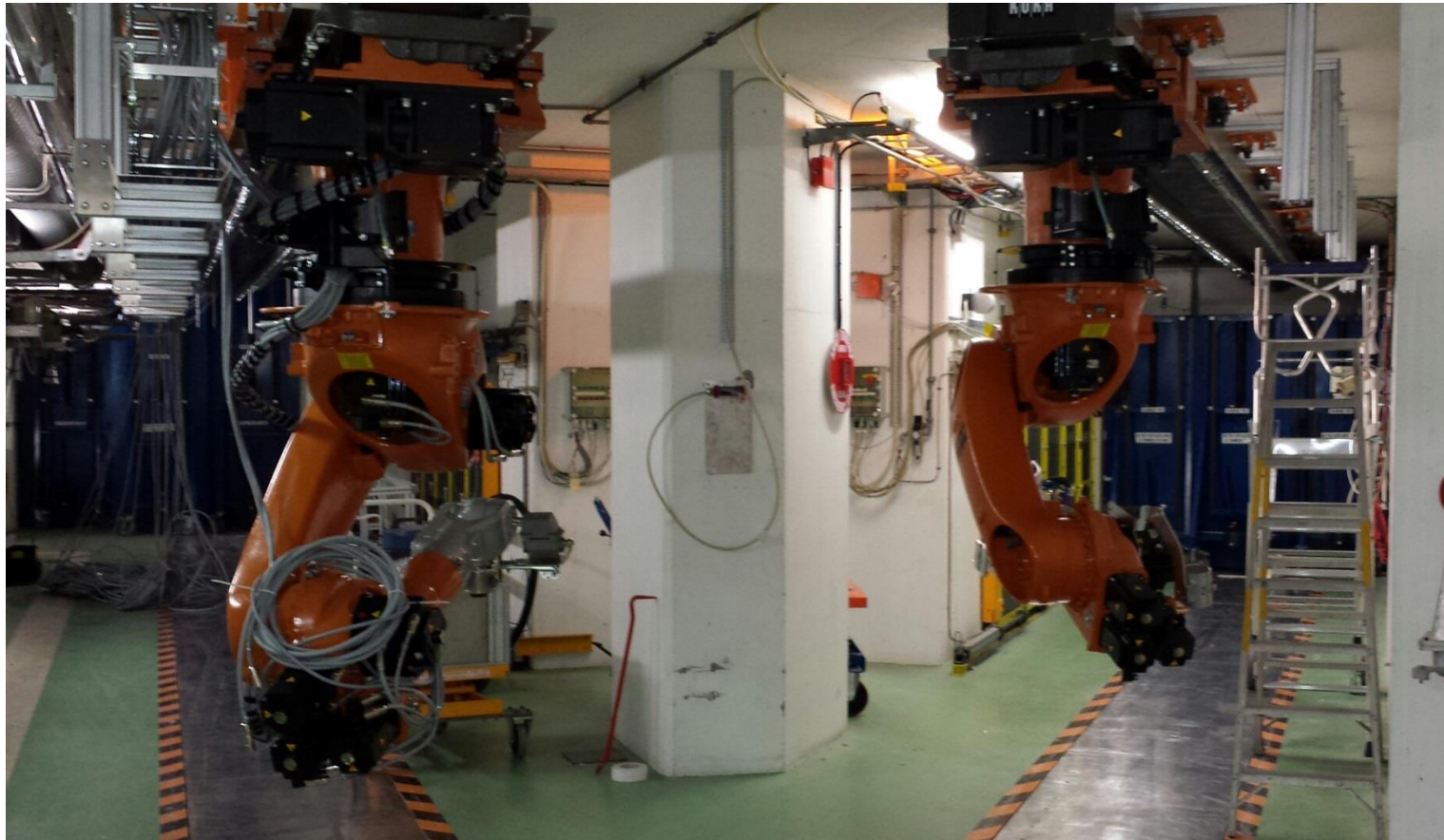
The Target Dismantling Hot Cell

- Factory acceptance tests successfully completed.
- Delivery and start of assembly 18th March
- 4 weeks to assemble



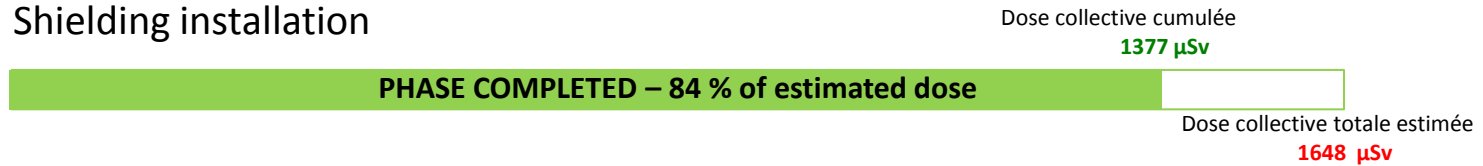
Target Handling Robots

Installation progressing, cabling under way.
Shelf and door modifications planned for Feb 2014

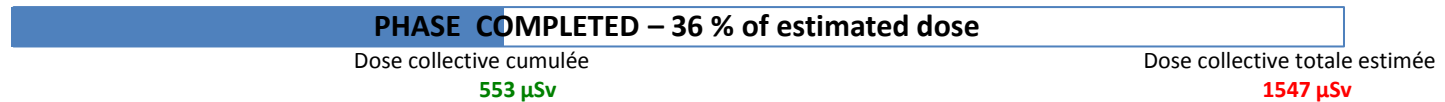


Collective Dose Summary for Robot Installation

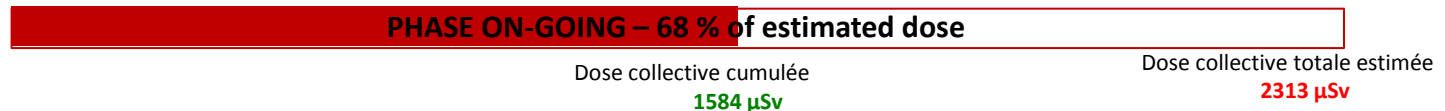
- Phase 1: Shielding installation



- Phase II: Robot dismantling



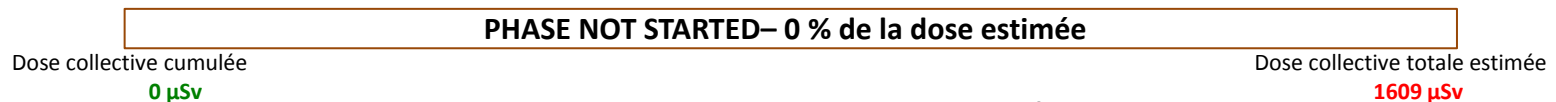
- Phase III: Services modification



- Phase IV: Robot Installation



- Phase V: Robot commissioning



PAD/MAD Access to Target Area

- Tests – 18th February, 10-16 March, 1-6 April
- No access to target and separator areas



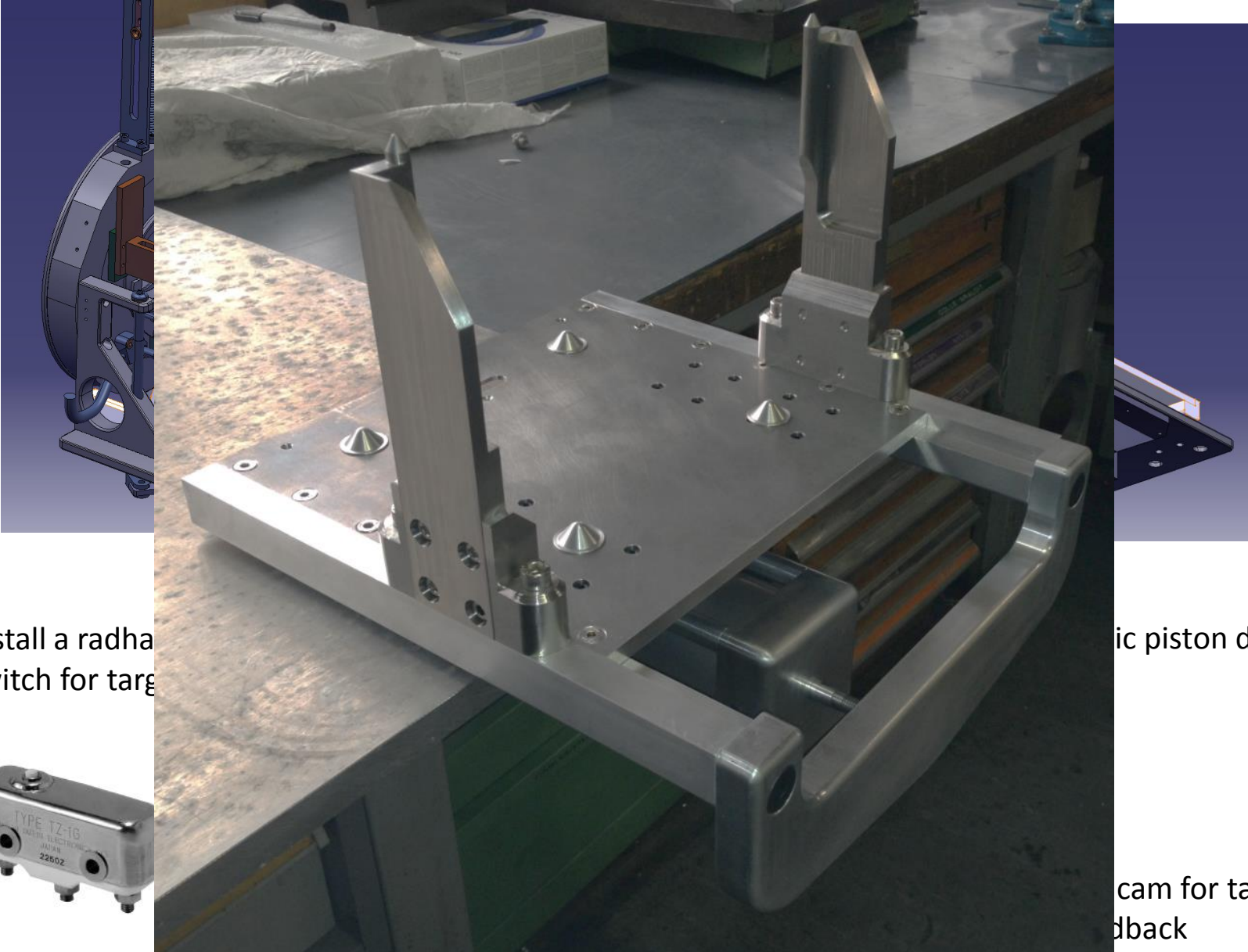
Front End Modifications

- New coupling tables compatible with new robots
- Pneumatic pistons for faraday cage door
- Repair of GPS extraction electrode



Planned for the first two week in March

FE Modifications: Proposition



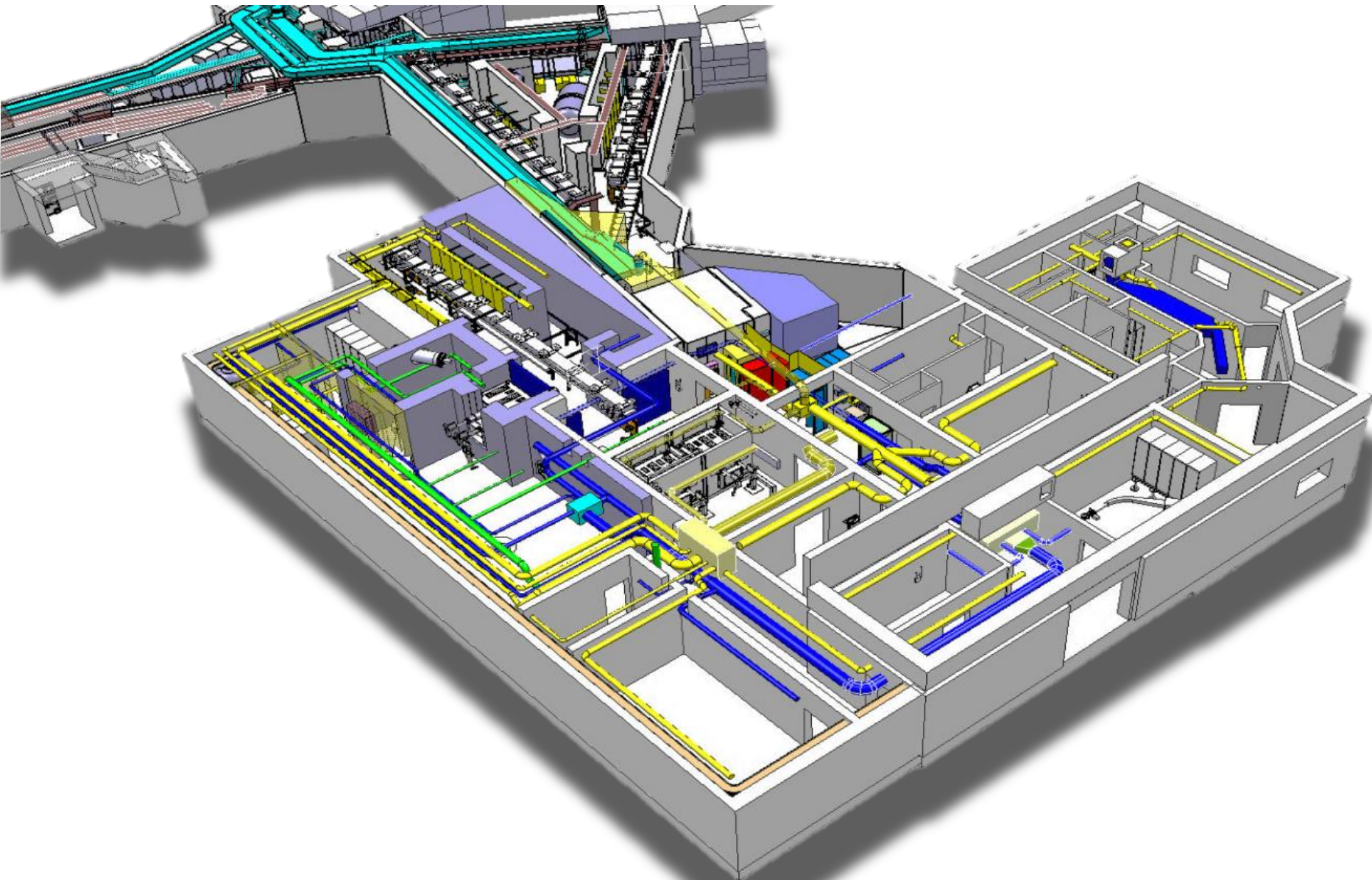
Install a radha switch for target



S. Marzari

ic piston diam.80

cam for table
dback



Ground-breaking ceremony 4th September 2013



Earth works November 2013



December 2013



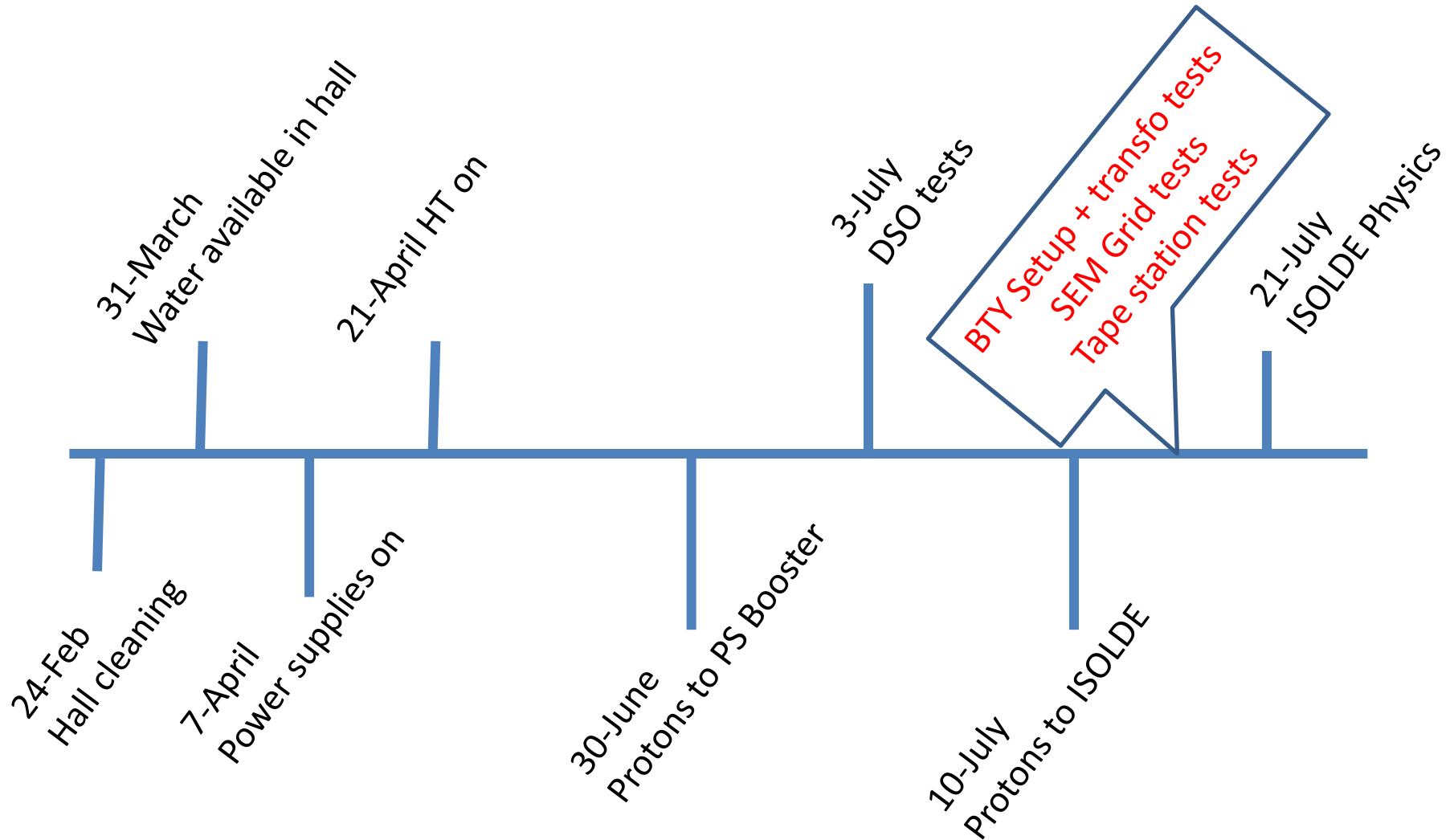
January



February



ISOLDE Start-up: Some Key dates



- Only 21 weeks before protons to ISOLDE!
- Thank you for your attention.