High Power Targets

FP7 TIARA Project

WP9 - Test Infrastructure for High Power Accelerators Components

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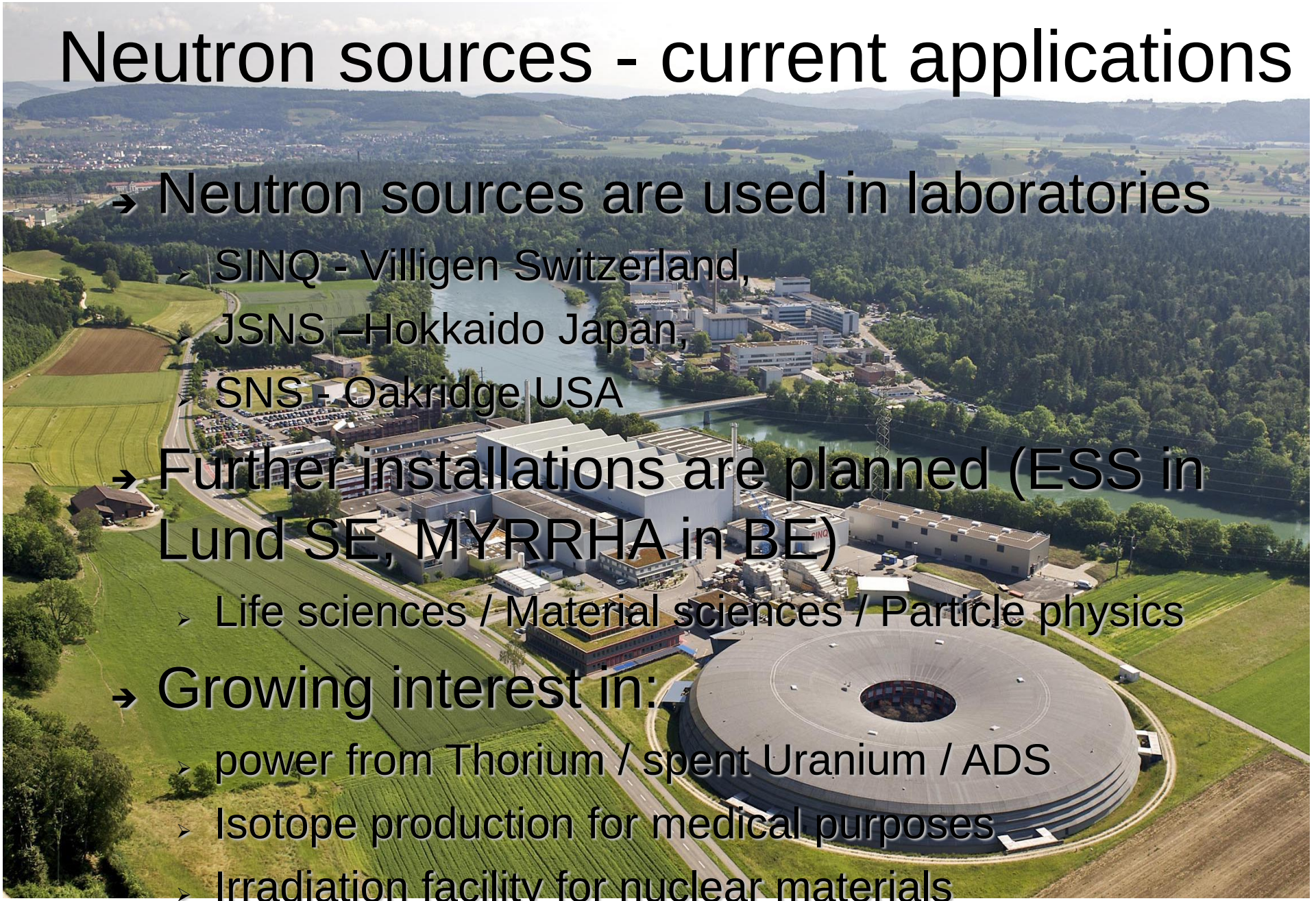
Development and testing of spallation neutron sources

WP9 – Targets

1. Introduction
2. Recent achievements: Eurisol & Megapie
3. Requirements on testing facilities
4. Proposed facilities & potential Partnerships

1. Introduction

Neutron sources - current applications



- Neutron sources are used in laboratories
  - SINQ - Villigen Switzerland,
  - JSNS –Hokkaido Japan,
  - SNS - Oakridge USA
- Further installations are planned (ESS in Lund SE, MYRRHA in BE)
  - Life sciences / Material sciences / Particle physics
- Growing interest in:
  - power from Thorium / spent Uranium / ADS
  - Isotope production for medical purposes
  - Irradiation facility for nuclear materials

TIARA identified needs

➔ Need: Reliable neutron sources to be developed to accommodate the growing power delivered by accelerator facilities located in Europe.

➔ Rationale: higher neutron fluxes are demanded from spallation sources … leading to ever higher beam power deposition densities.

➔ Consequence: testing facilities are required.

2. Recent achievements: Eurisol & Megapie

Neutron sources – high-power tests

➔ Two recent tests at high power illustrate increasing neutron source capabilities in Europe :

- MEGAPIE: tested under proton beam at 0.76 MW
- EURISOL: tested under full-scale hydraulic conditions representative of 4 MW

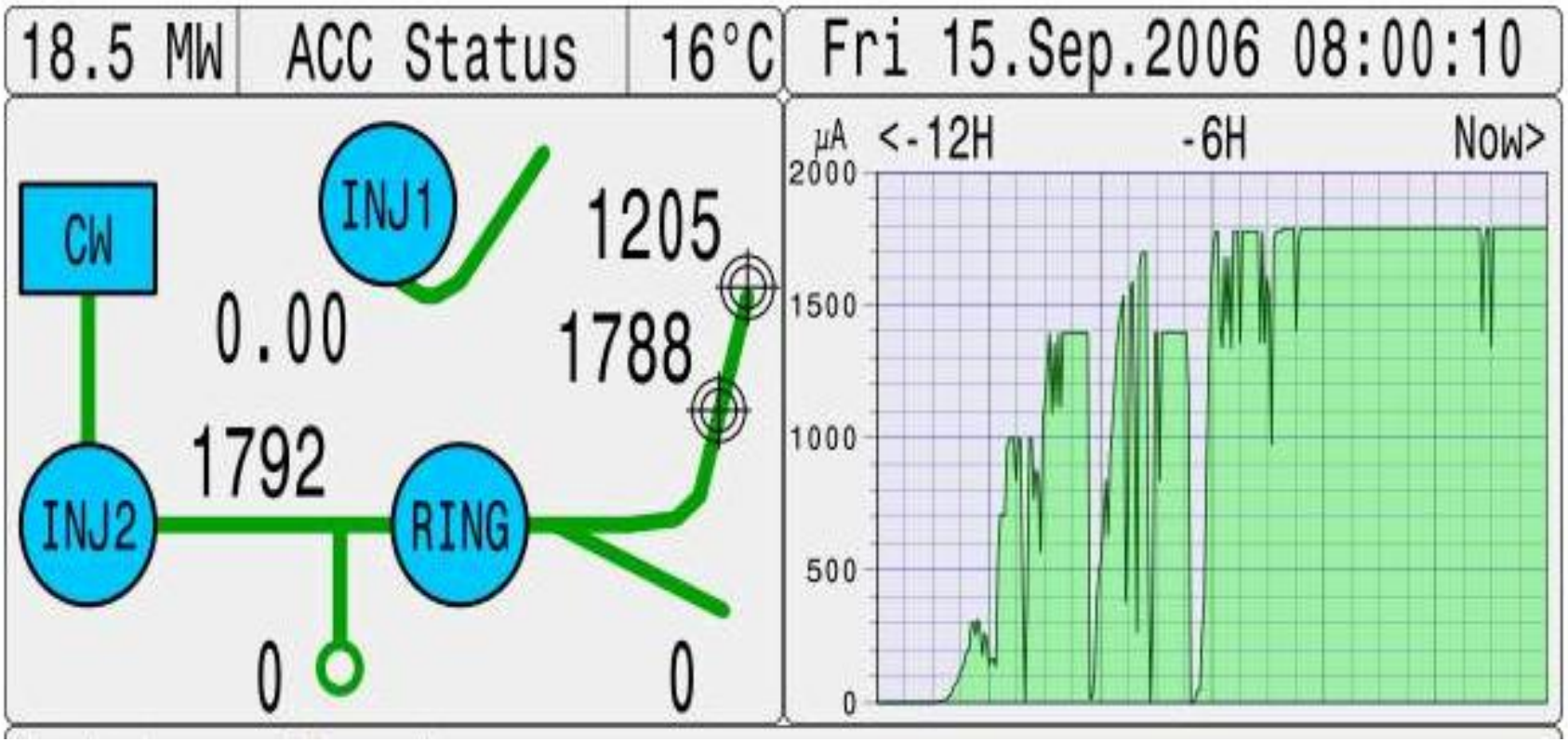
➔ Although succesful, the tests were short-lived.

➔ The next logical step: dedicated test facilities to validate neutron source long-term operation

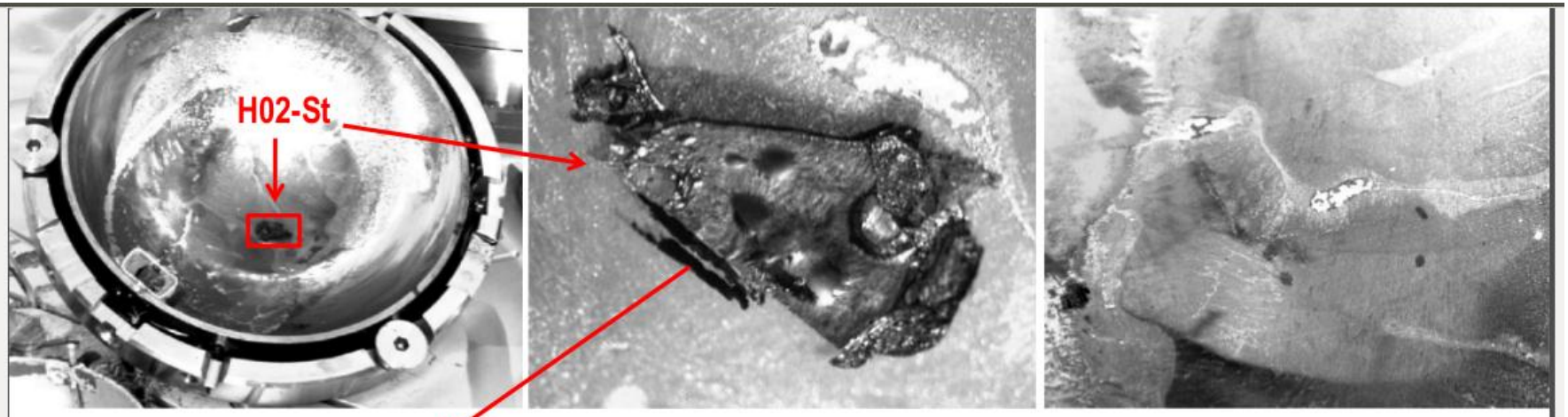
2006 - MEGAPIE experience

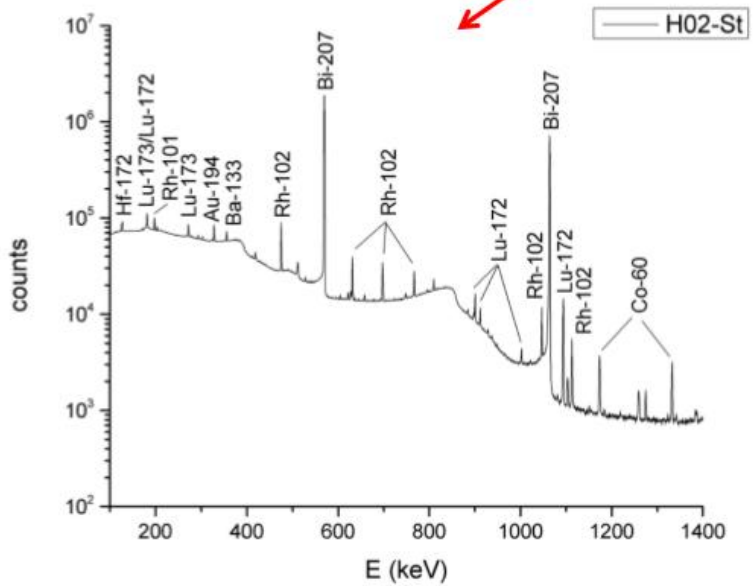
- Megapie is a 10 year endeavour culminating in 2006 with an irradiation test and continuing today with post-irradiation analysis
- 4 months @ 0.76 MW - 600 MeV, 1.3 mA
- Recorded beam interruptions – no negative effect on operation
- Polonium production remains in LBE
- Beam window intact
- Leak from faulty heat exchanger contained

Beam interrupts in MEGAPIE



Megapie Beam window



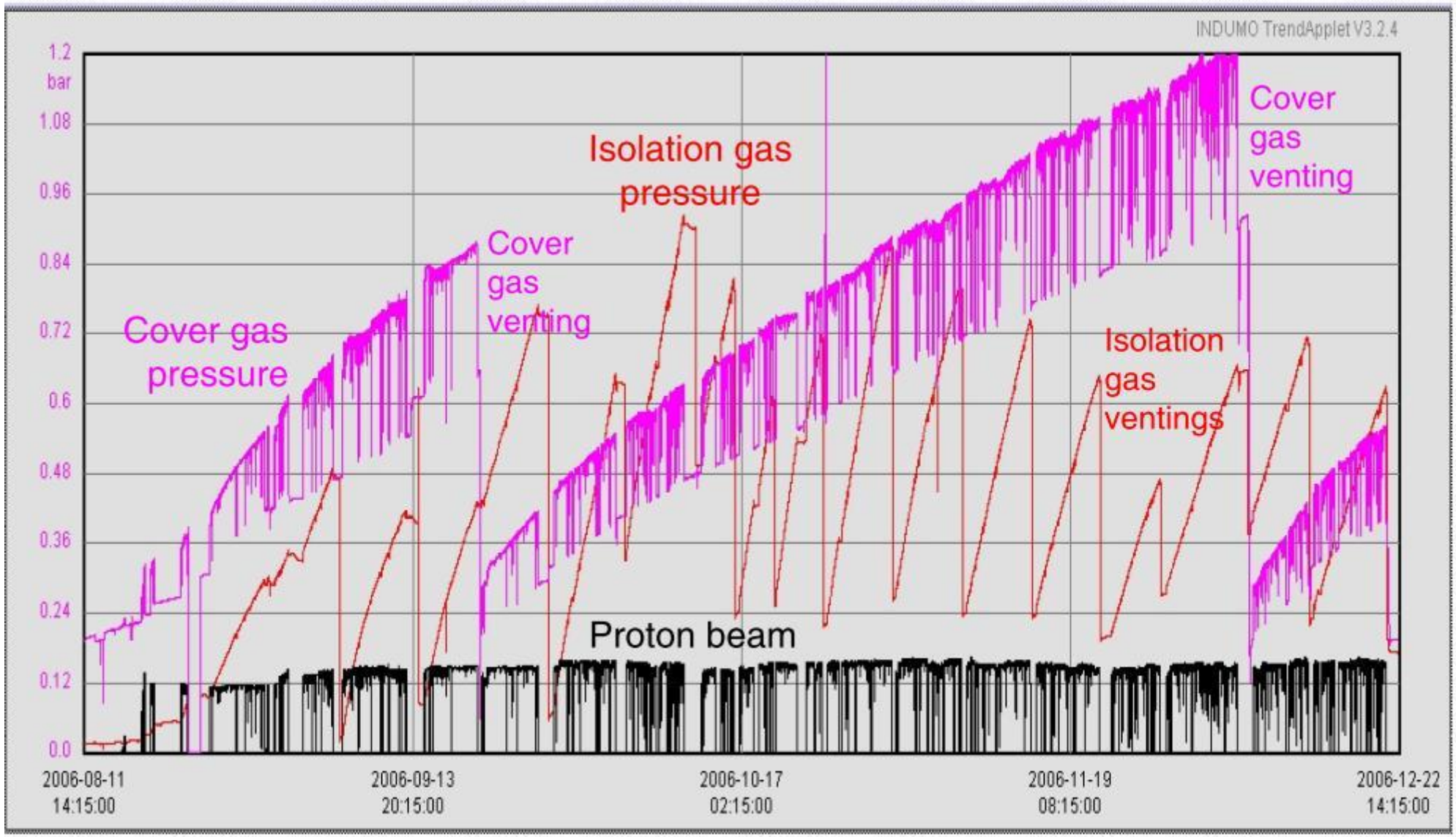


nuclide	A [kBq/g]
^{60}Co	4.44E+00
^{101}Rh	2.74E+01
^{102}Rh	4.63E+00
^{133}Ba	2.68E-01
^{172}Hf/Lu	2.99E+00
^{173}Lu	1.21E+00
^{194}Hg/Au	5.20E+01
^{207}Bi	1.74E+03

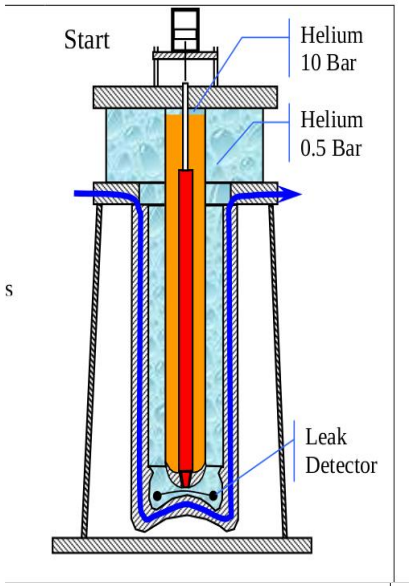
Results:

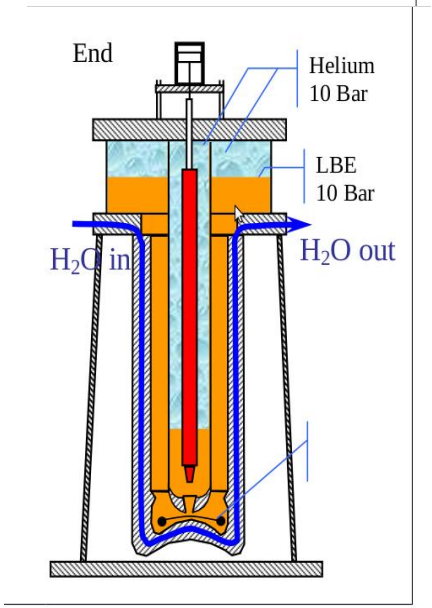
- H02-St was taken after the first melt
- 30 μSv/h dose rate in 10 cm
- $m_{H02\text{-}St}$ = 0.2908 g
- It seems that H02-St adhered to the calotte on 4 points

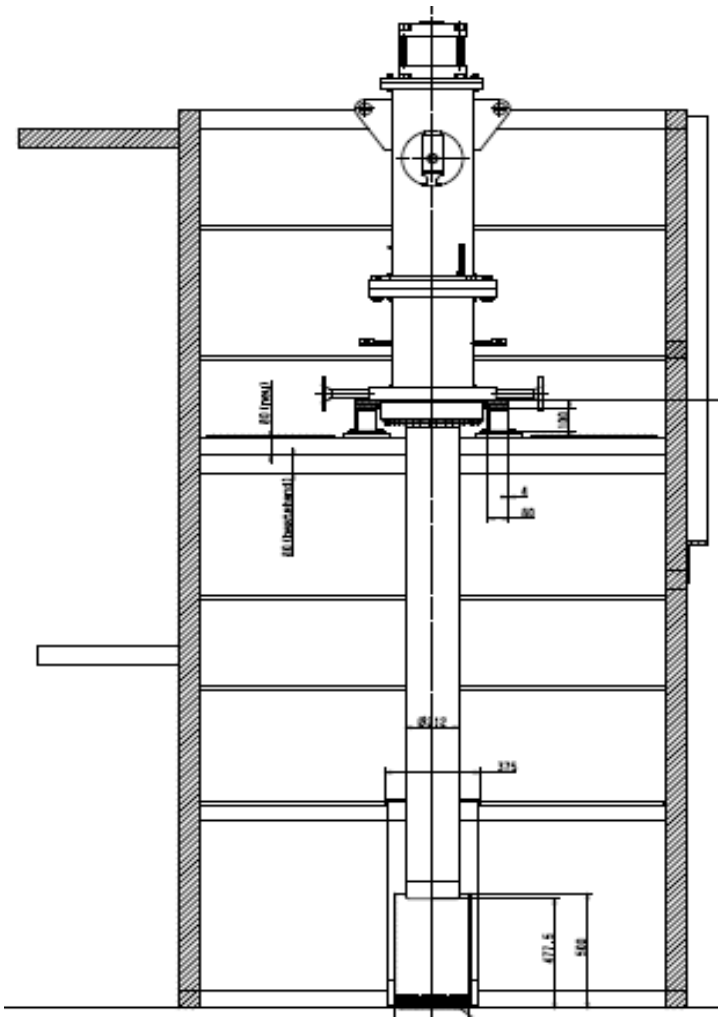
MEGAPIE operational experience

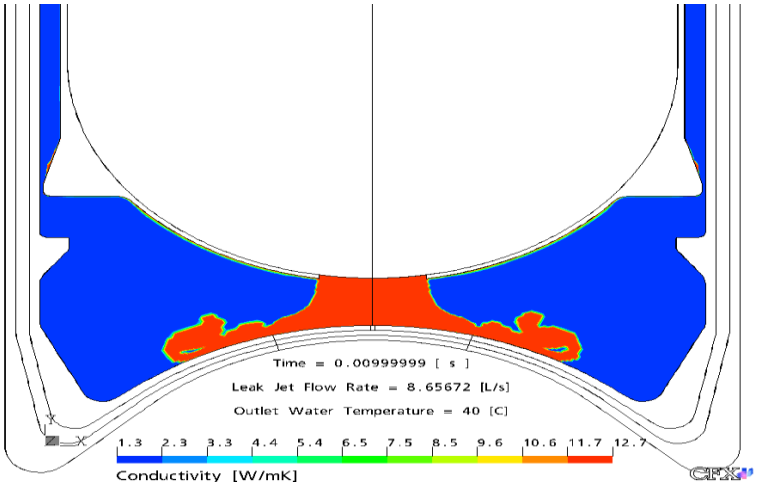


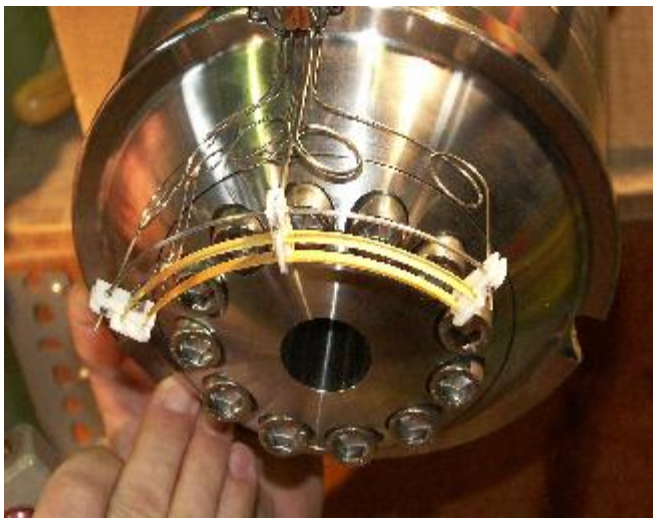
Leak test in MEGAPIE containment







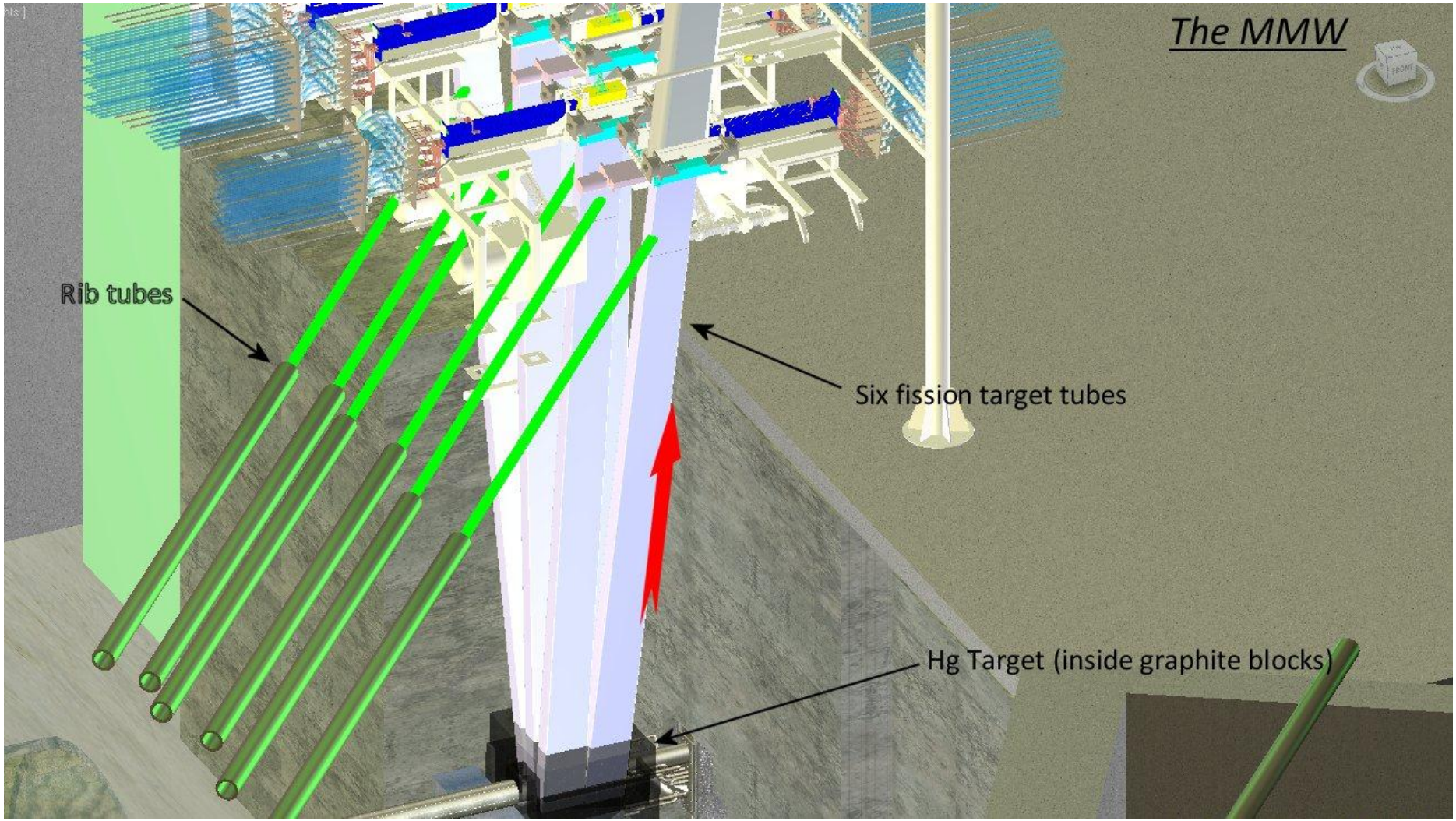




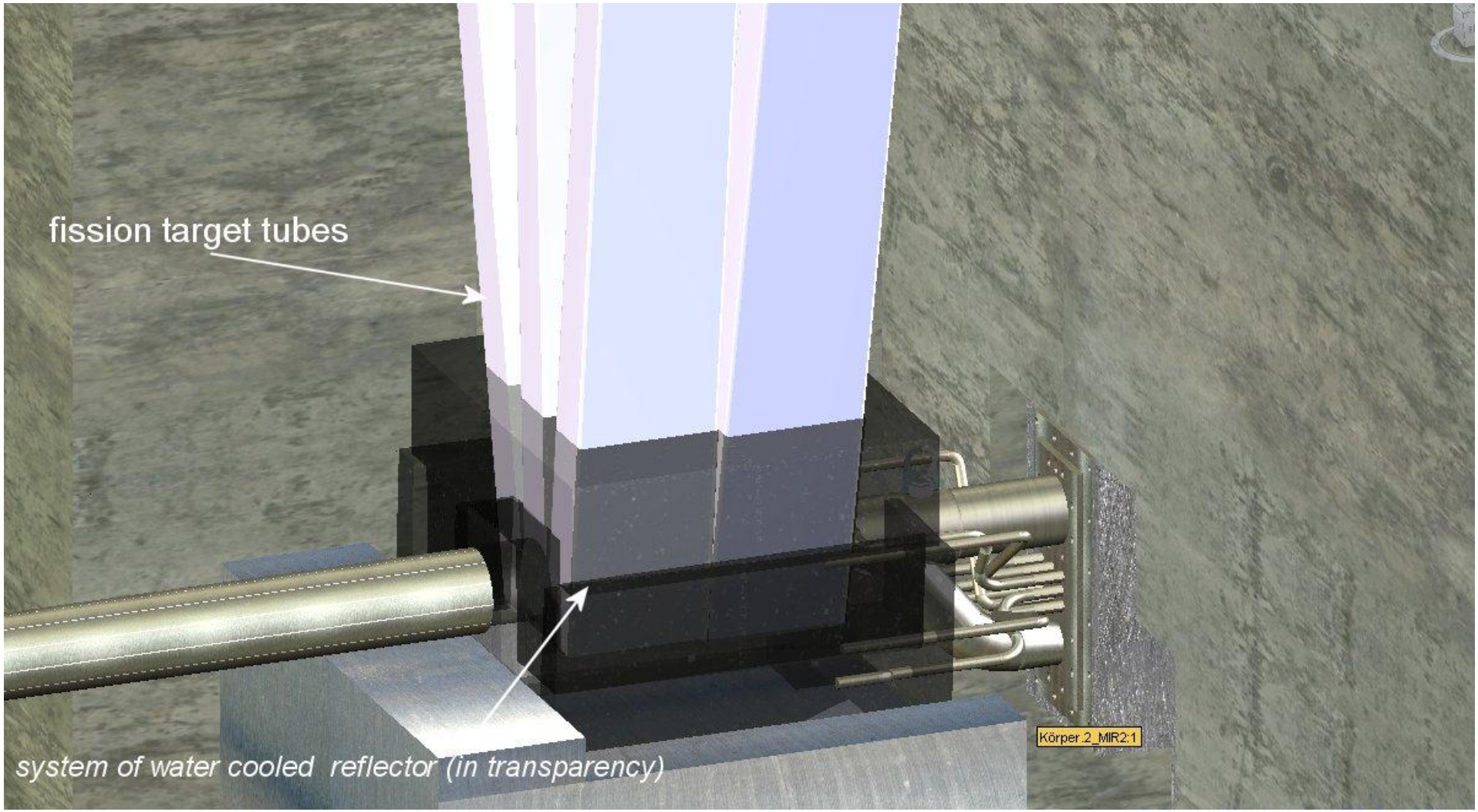
2009 - EURISOL experience

- Eurisol, FP6 funded from 2005 to 2009, 10 M€
- The primary goal of the Eurisol program was a design study to prove the feasibility of producing „exotic“ isotopes.
- In addition the program also proved experimentally a novel neutron source with:
  - Very high flowrates sufficient to absorb 4 MW beam
  - Compact design, 15 cm outer diameter
  - High speed in Hg and small diameter of the source for a dense neutron flux

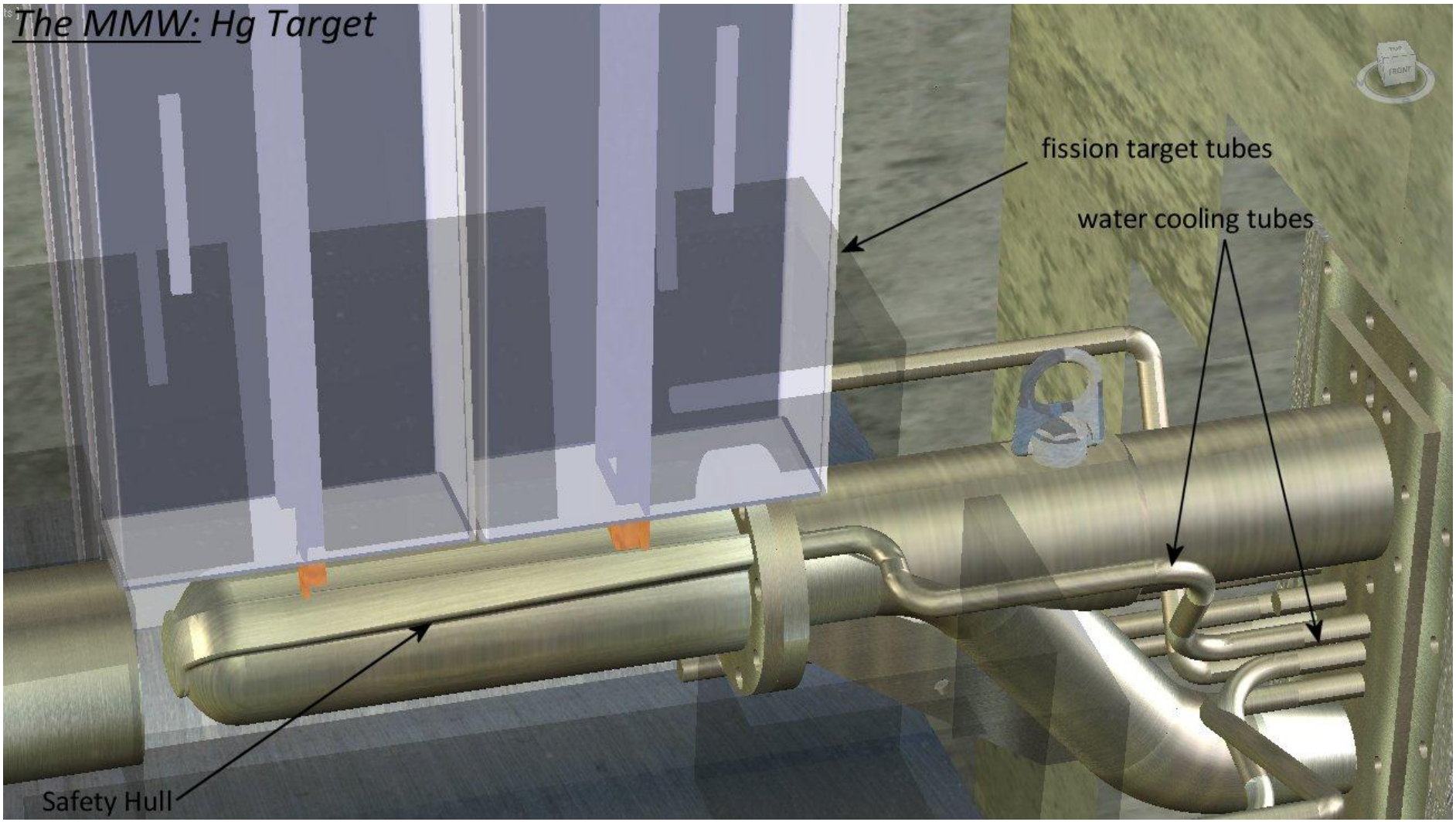
Overall view of projected EURISOL MMW



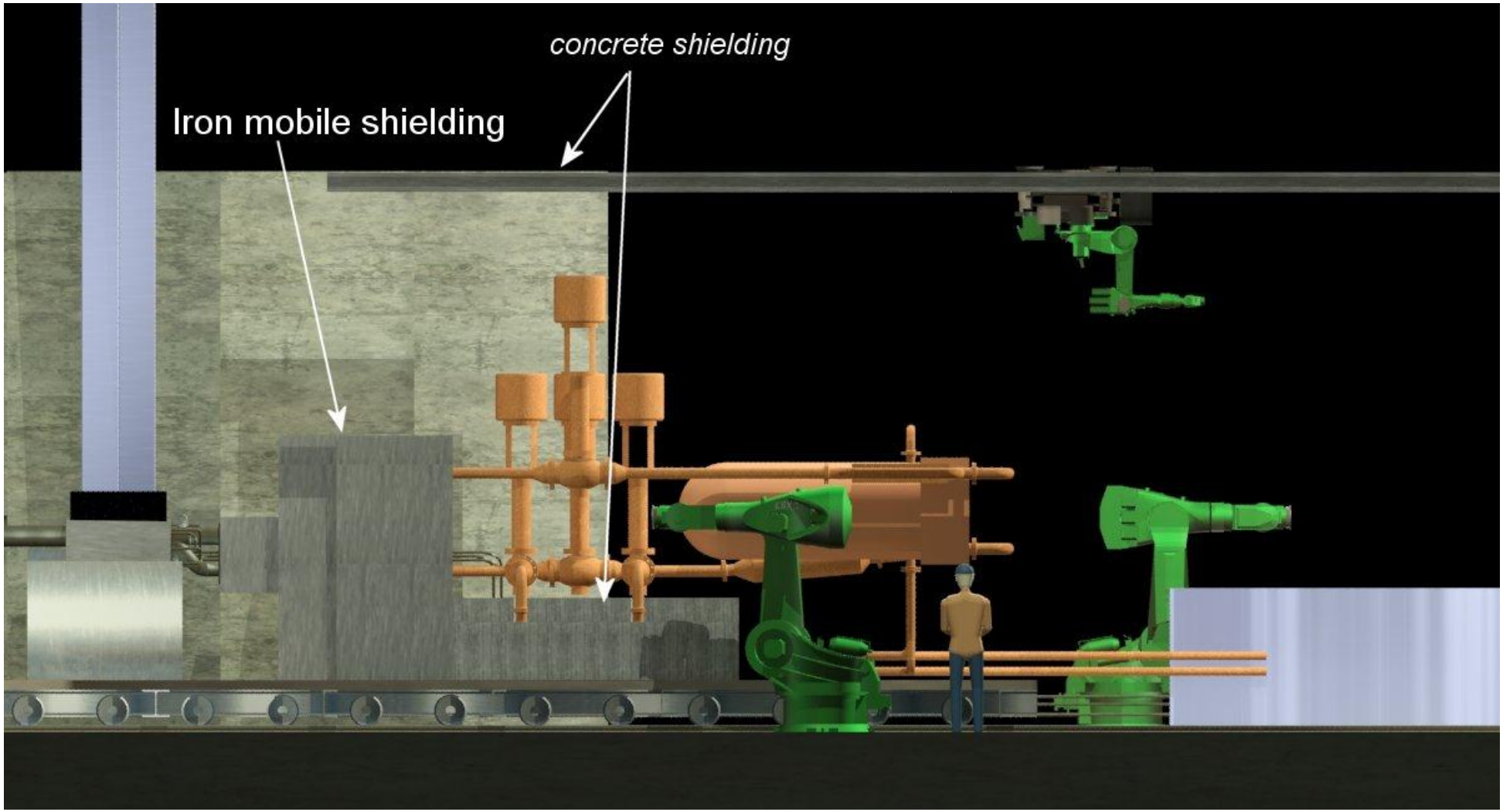
Isotope targets around spallation source



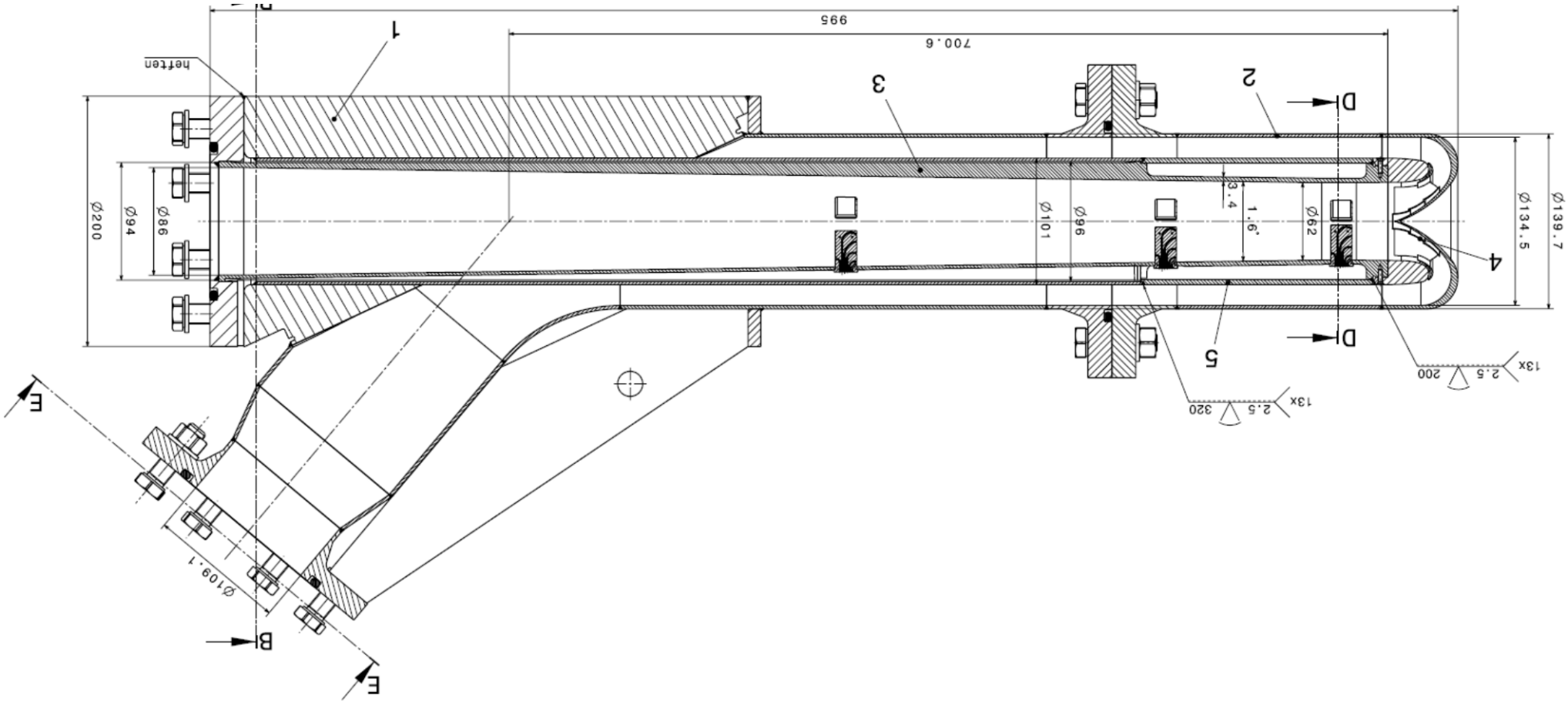
EURISOL spallation target



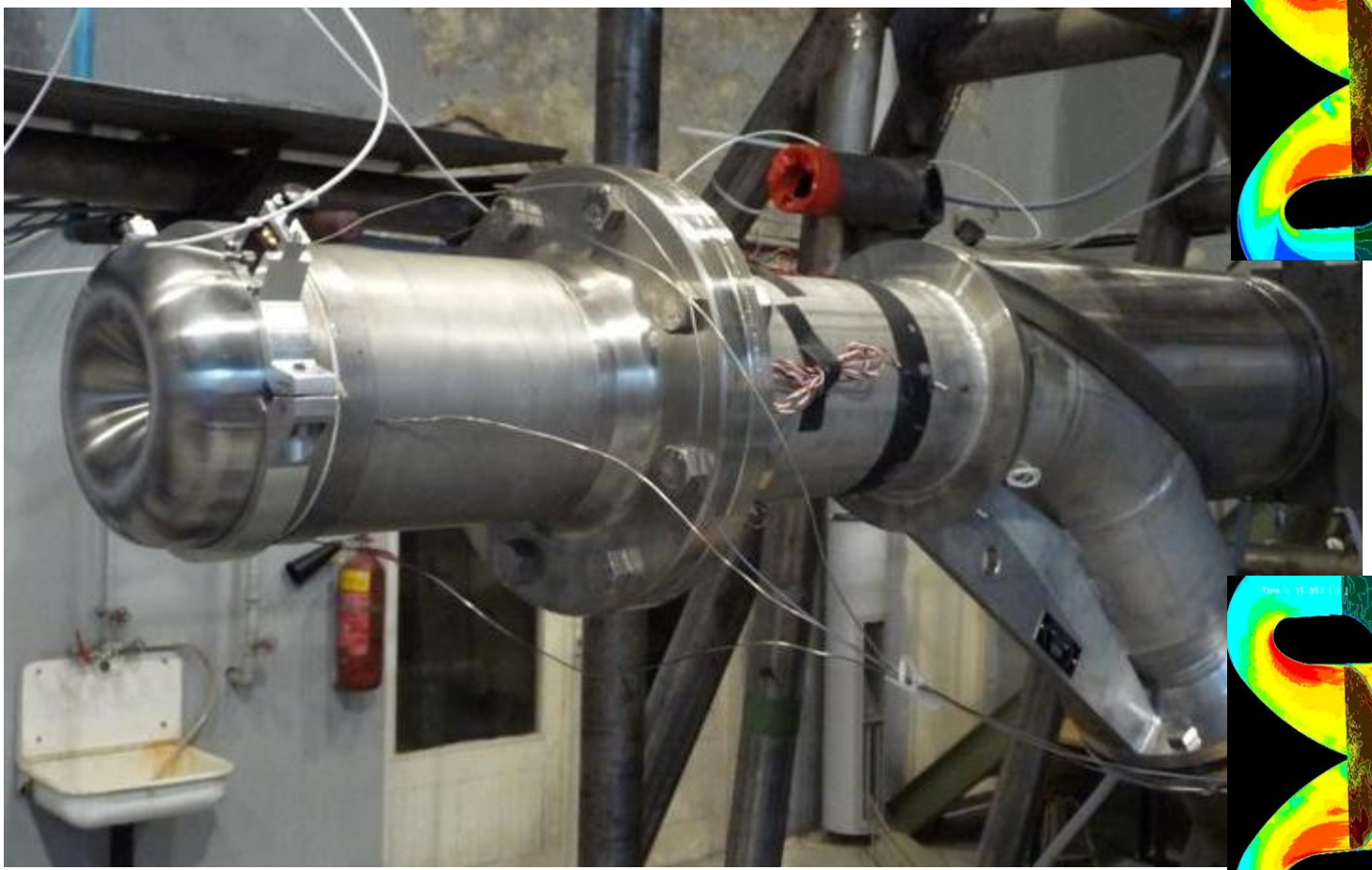
Target station handling EURISOL

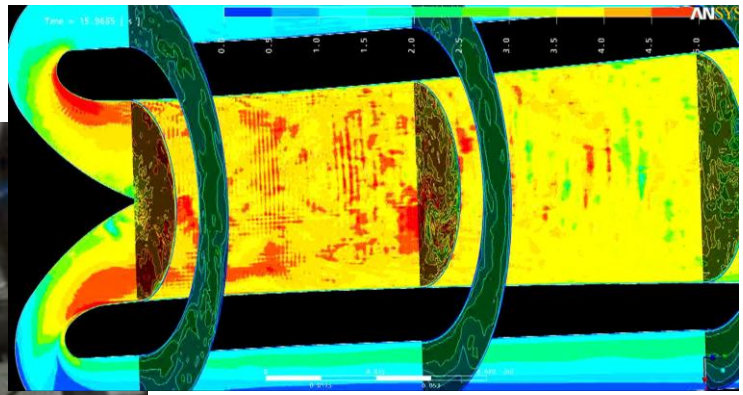


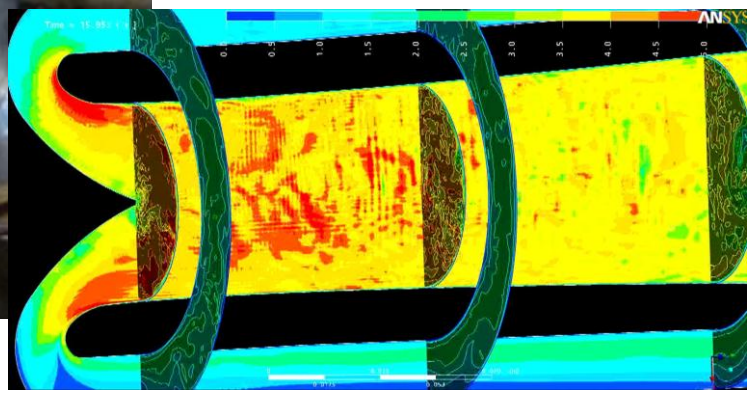
Design of tested EURISOL



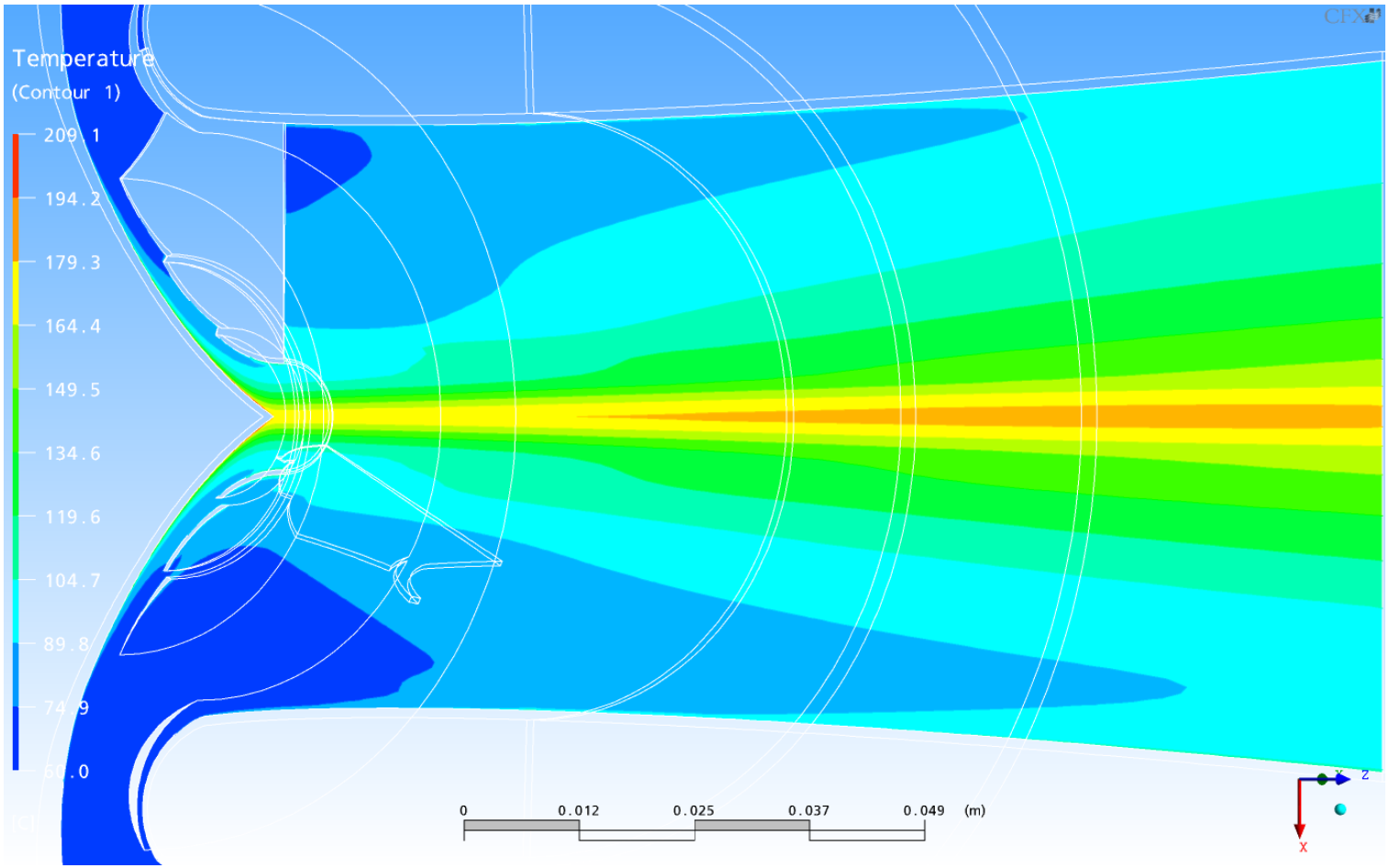
Test at full speed 6 m/s



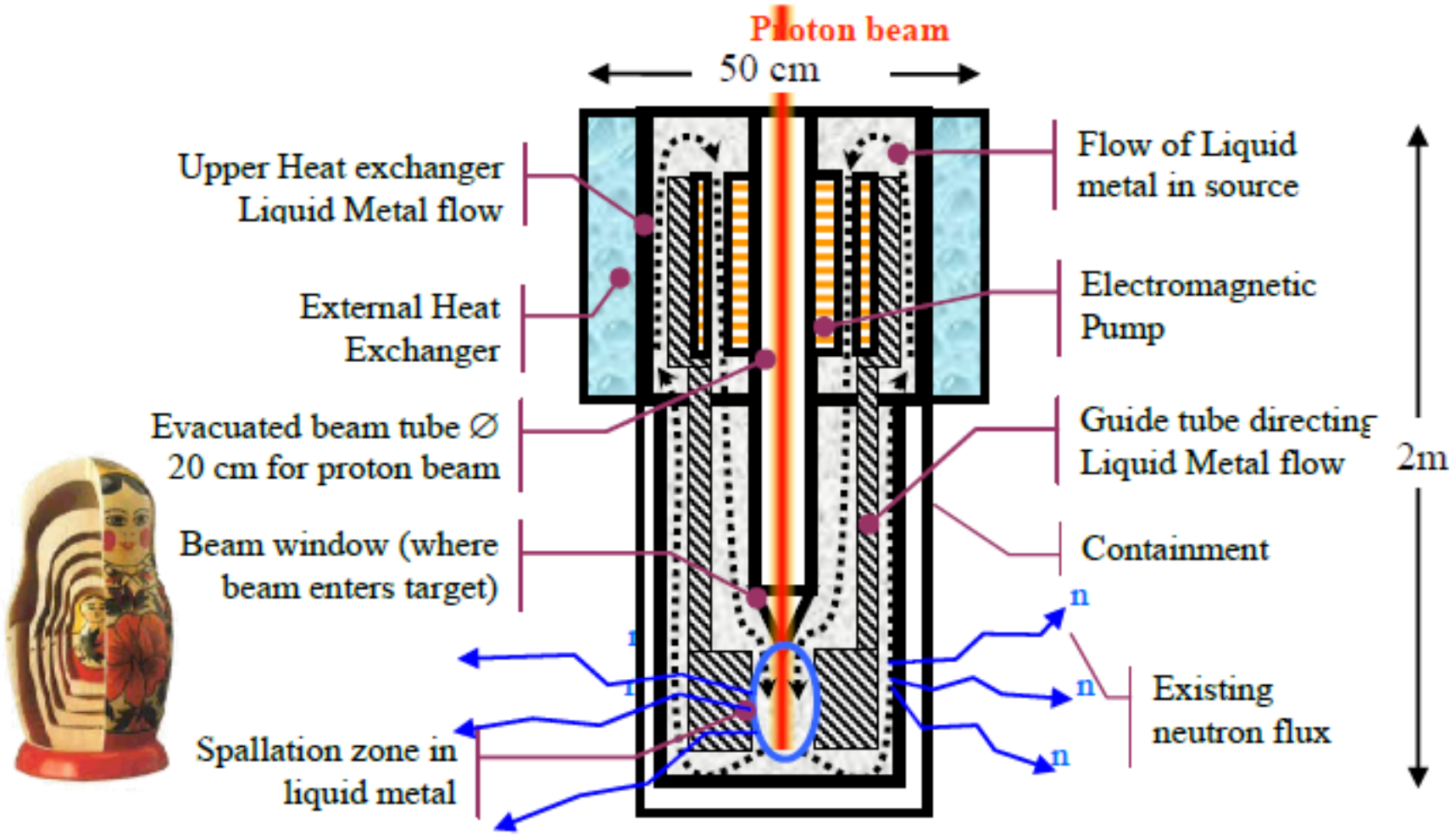




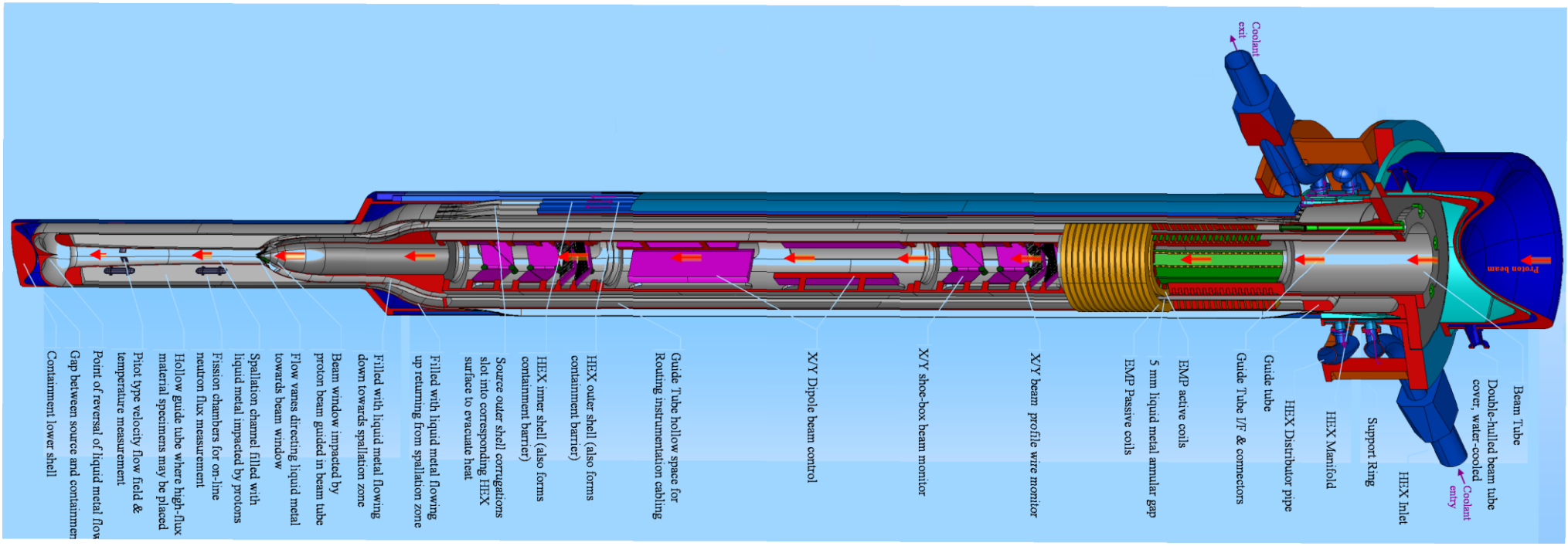
CFD of beam impact (calculated not tested)



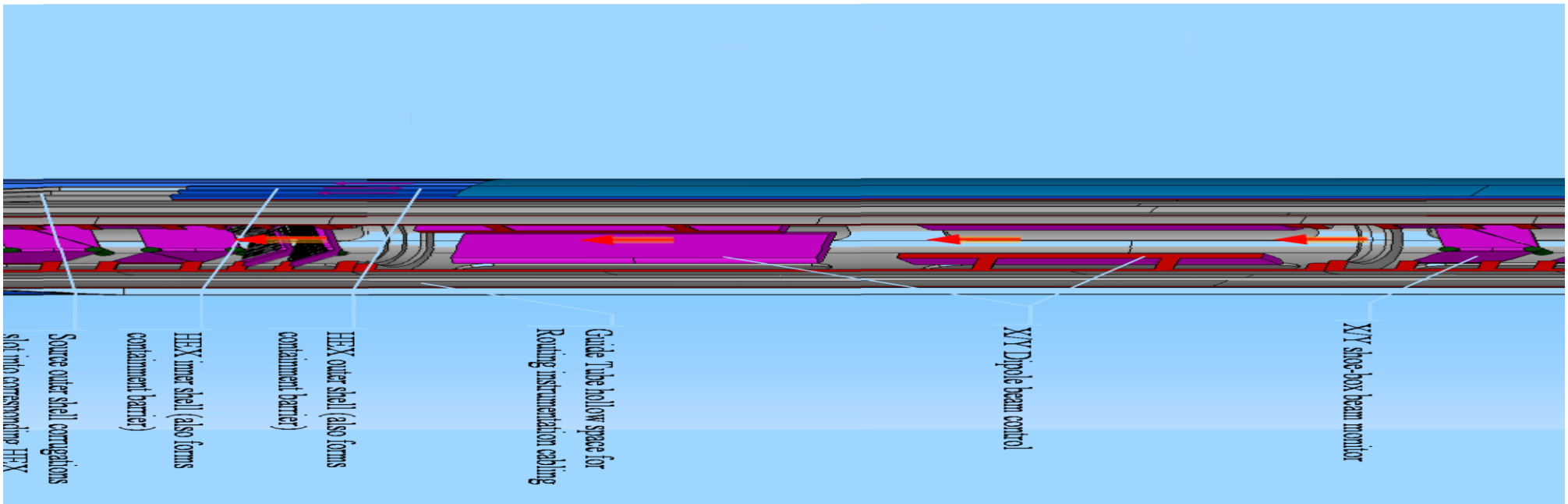
New improved design



New improved design



New improved design



3. Requirements for testing facilities

Conclusion from recent testing

- High-power spallation sources are ***feasible up to ~ 5 MW*** range

- Tests require ***dedicated facilities*** rather than one-off experiments

- Emphasis on ***mitigating development risk*** by partial testing prior to beam testing

- ***Safety is integral*** part of testing requirements

Testing Facility wish list

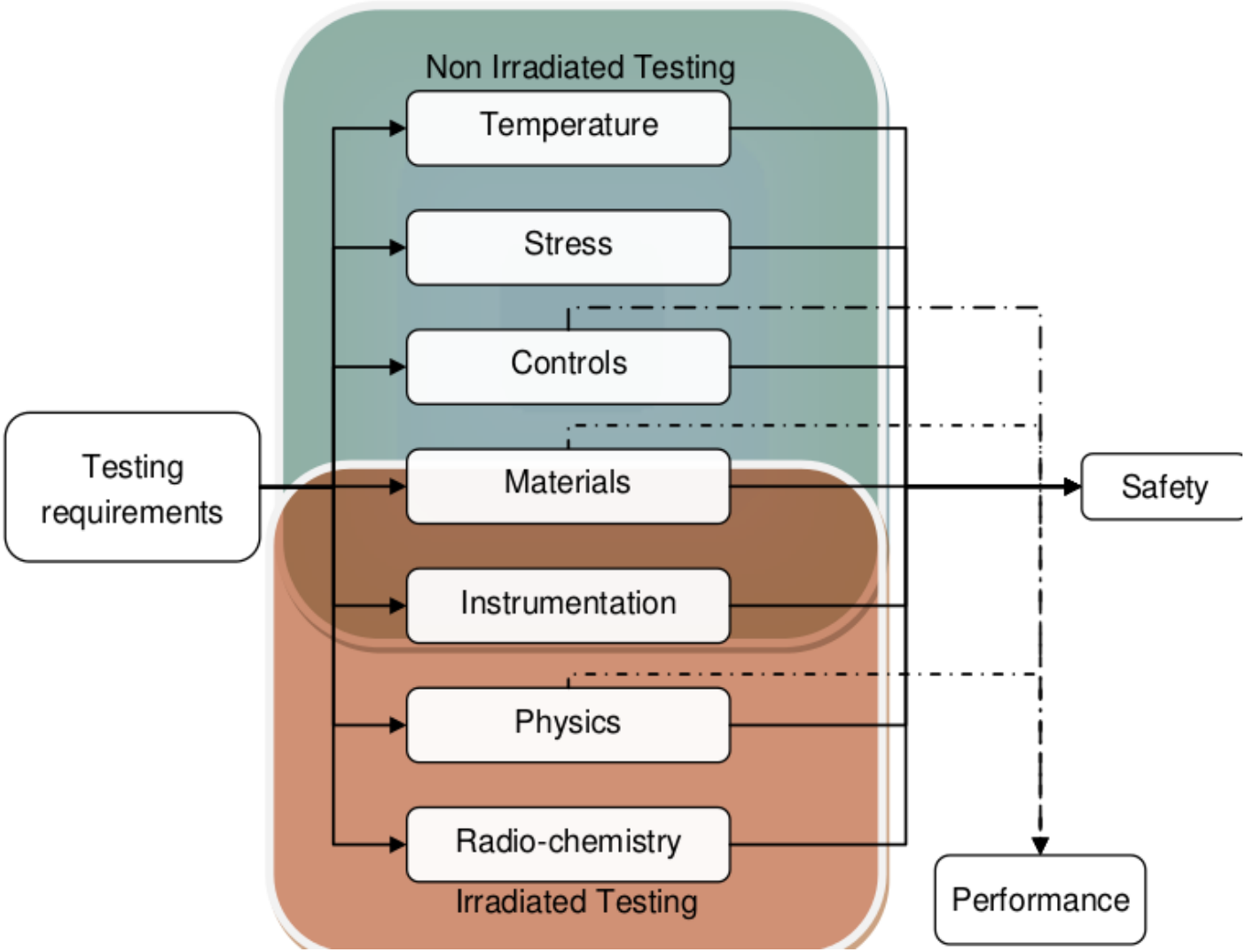
➔Goal:

- Power densities critical up to 10 kW/cm^3 / 5 MW total power
- Safety over performance.
- Liquid target / solid target in parallel

➔Means:

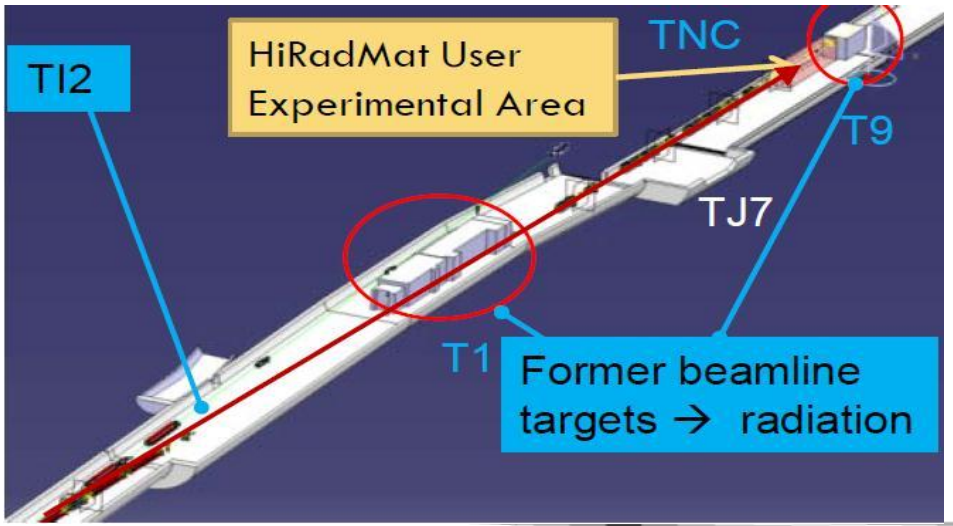
- Upgrade existing facilities
- Safety concept integral to upgrade
- Distinct facilities for TH / structural / radiation
- Use subscale testing: kW before MW
- Develop laboratory - industrial partnerships

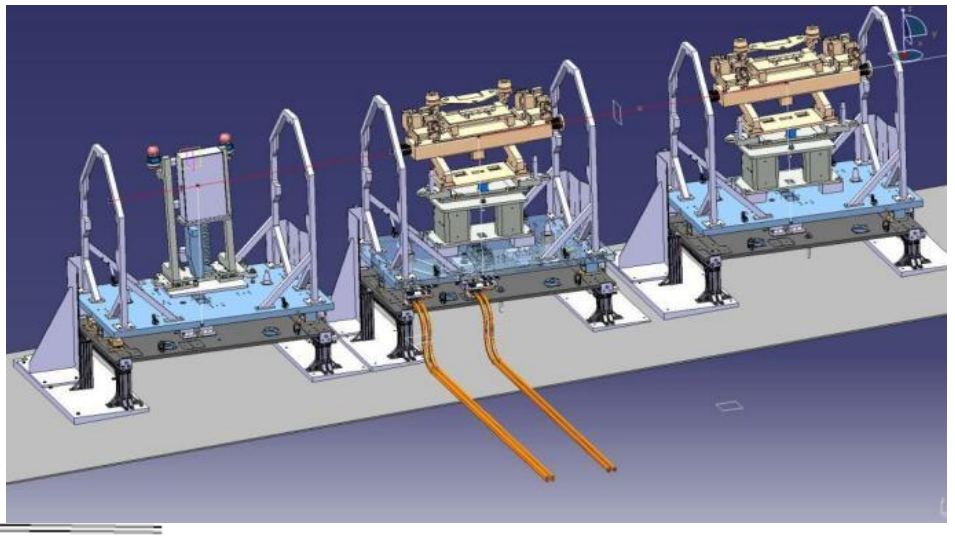
Testing Facility characteristics

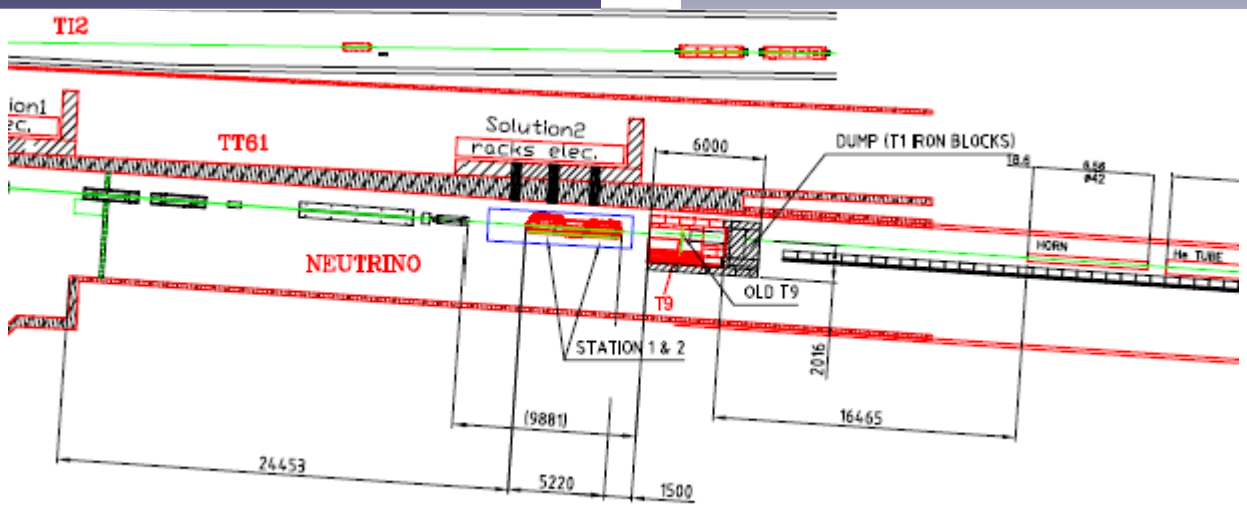


4. Proposed facilities & potential Partnerships

Potential facility at CERN: HiRadMat



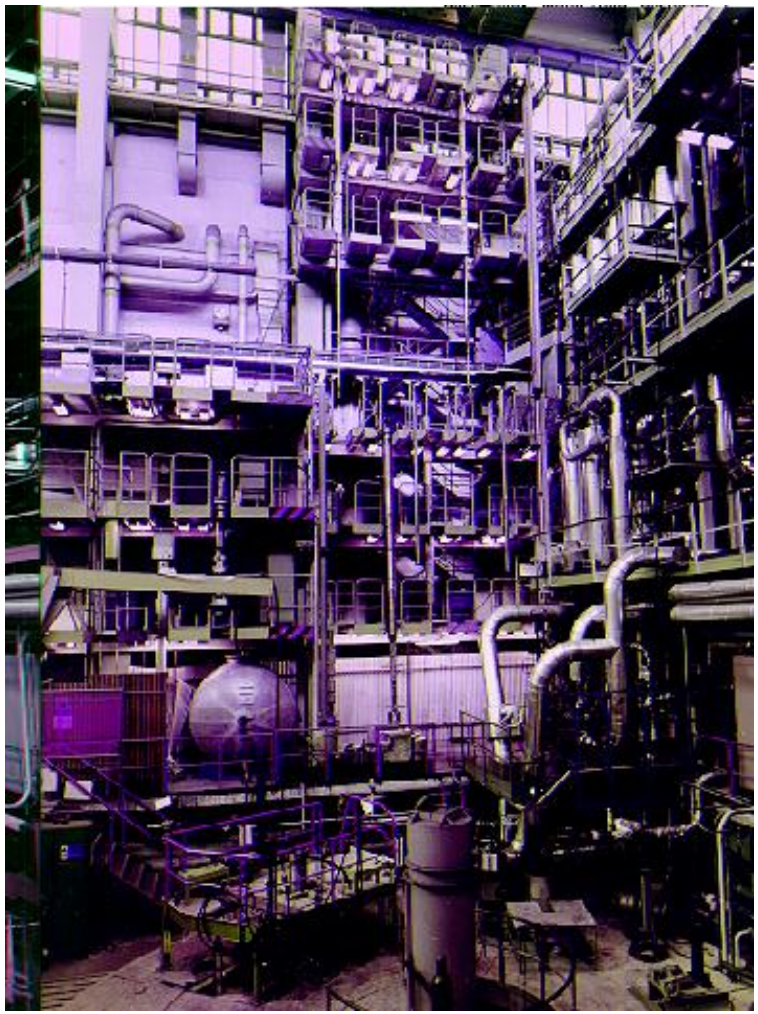




Potential industrial partner Škoda-JS facilities

Skoda heavy production facilities

Skoda heavy production facilities



Concluding remarks

- High power spallation targets are currently under development. The “market” is there.
- Next step is design work on an irradiation station. Start date: september 2012
- Challenges can not all be addressed by a single facility. Hence interest is primarily on providing a credible dedicated irradiation test facility