Cold Moderator Test Facility (CMTF) at the Budapest Research Reactor

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LENS WG meeting
Garching, March 2023

BNC
Budapest Neutron Centre

BUDAPEST RESEARCH REACTOR
60 YEARS OF RESEARCH & INNOVATION

Budapest Research Reactor (BRR)

Commissioned in 1959 at 2.5MW
Refurbished, upgraded to 10 MW in 1992;
Maximum thermal flux: 2.5×10^{14}
Cold source, SM guide system installed in 2000.

Fuel: 20% (LEU Russian) until 2028
Operation licence 2023/33

Application of a low-D moderator at BNC

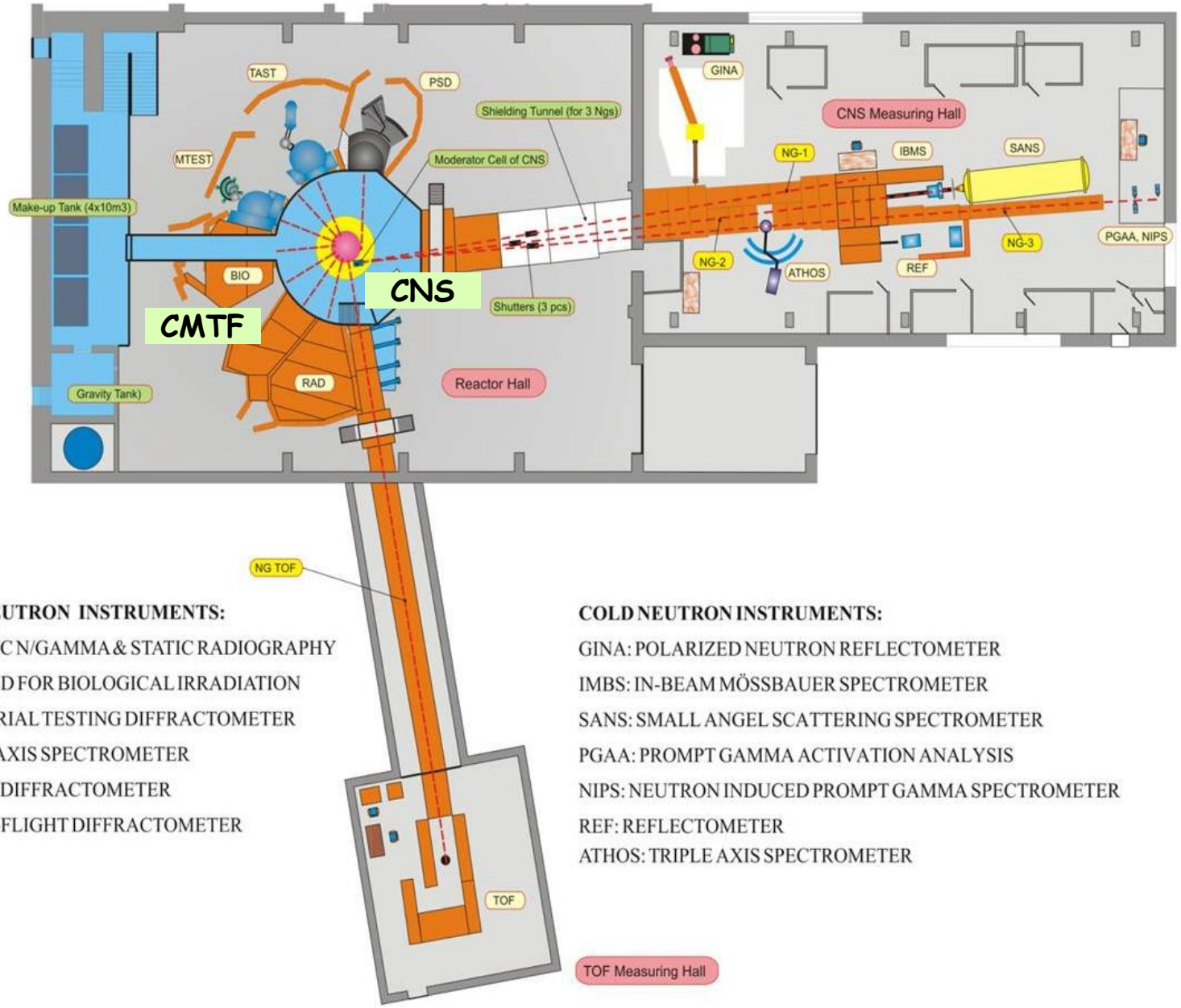
Emerging need to rebuild the BNC cold source in operation since 2000.

MCNP calculations showed that a 1D cylindrical para-H moderator could increase the brightness by a factor of 2 compared to the existing 'volume' moderator.

Creating a moderator test facility
(Cold Moderator Test Facility – **CMTF**)

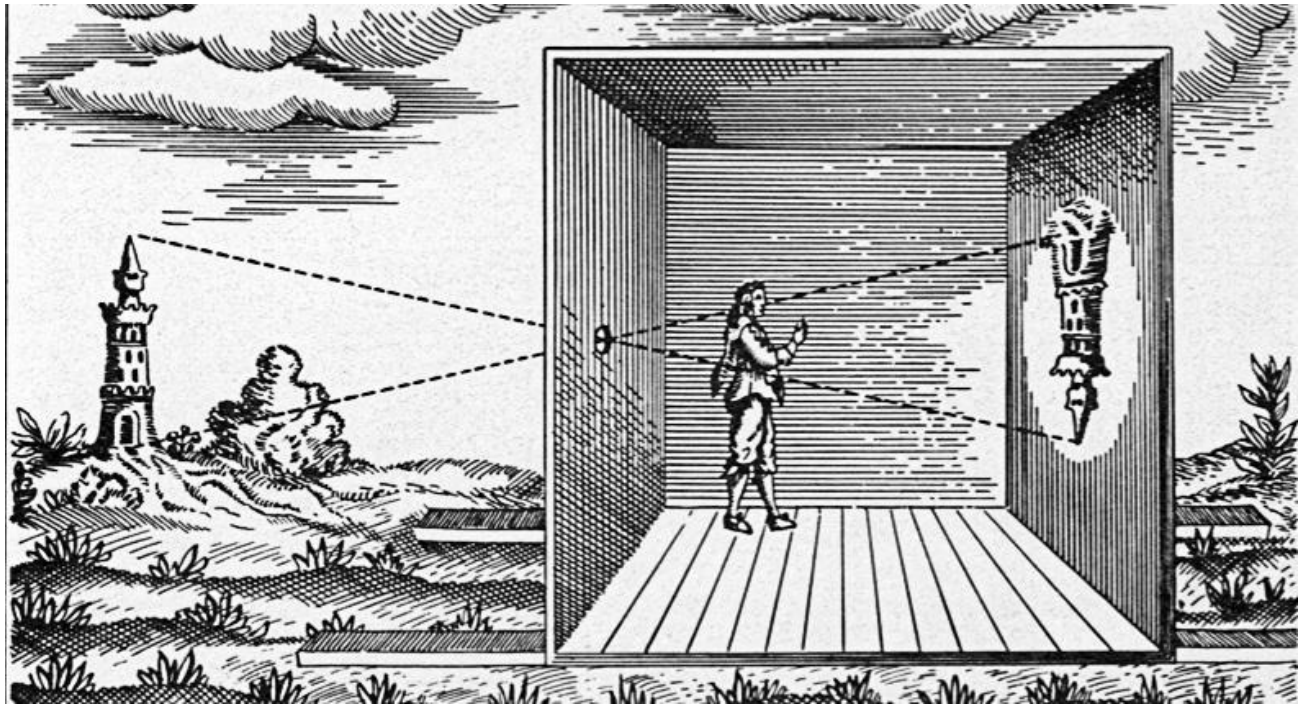
The aim of the project to validate the low-dimensional moderator concept *and* open the possibility for other collaborations e.g.: VCN/UCN moderators, CANS moderators

- Modelling moderation process outside the reactor core
- Flexible operation
- Relatively easy change of moderator parameters



The cold moderator test station:

- Horizontal channel of the reactor
- Out-of-pile reflector
- Cryostat with the ***cold moderator***
- Energy resolved imaging device
- Biological shielding – CMTF bunker

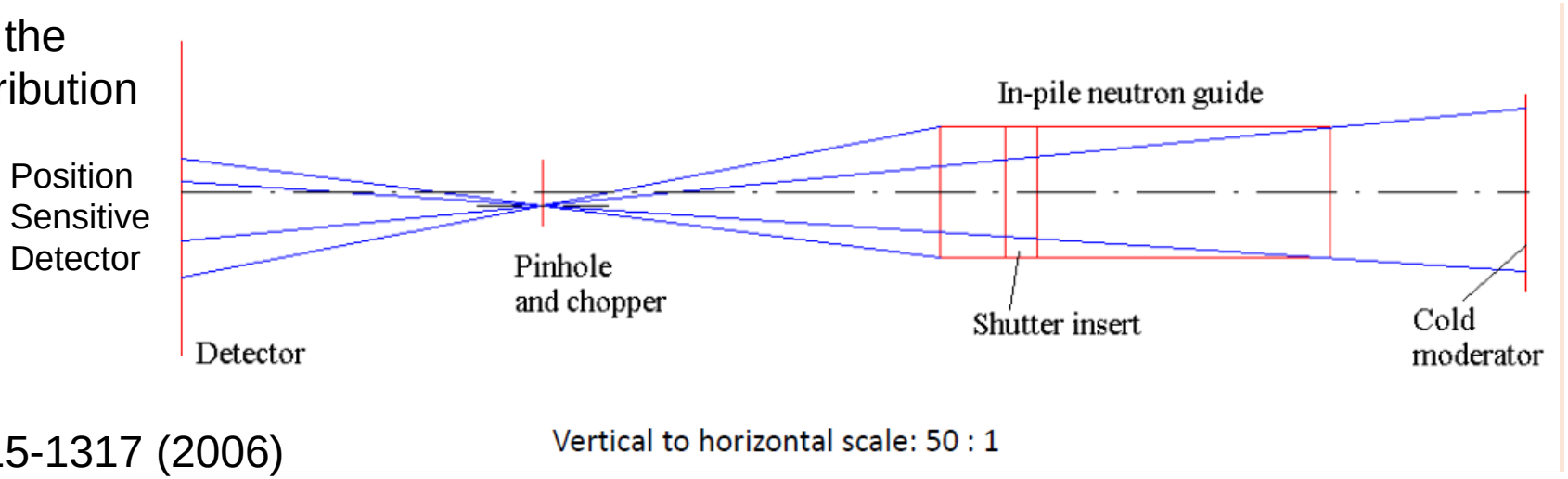


Imaging the moderator using the “camera obscura” method

TOF technique is used for recording the wavelength and spatial intensity distribution

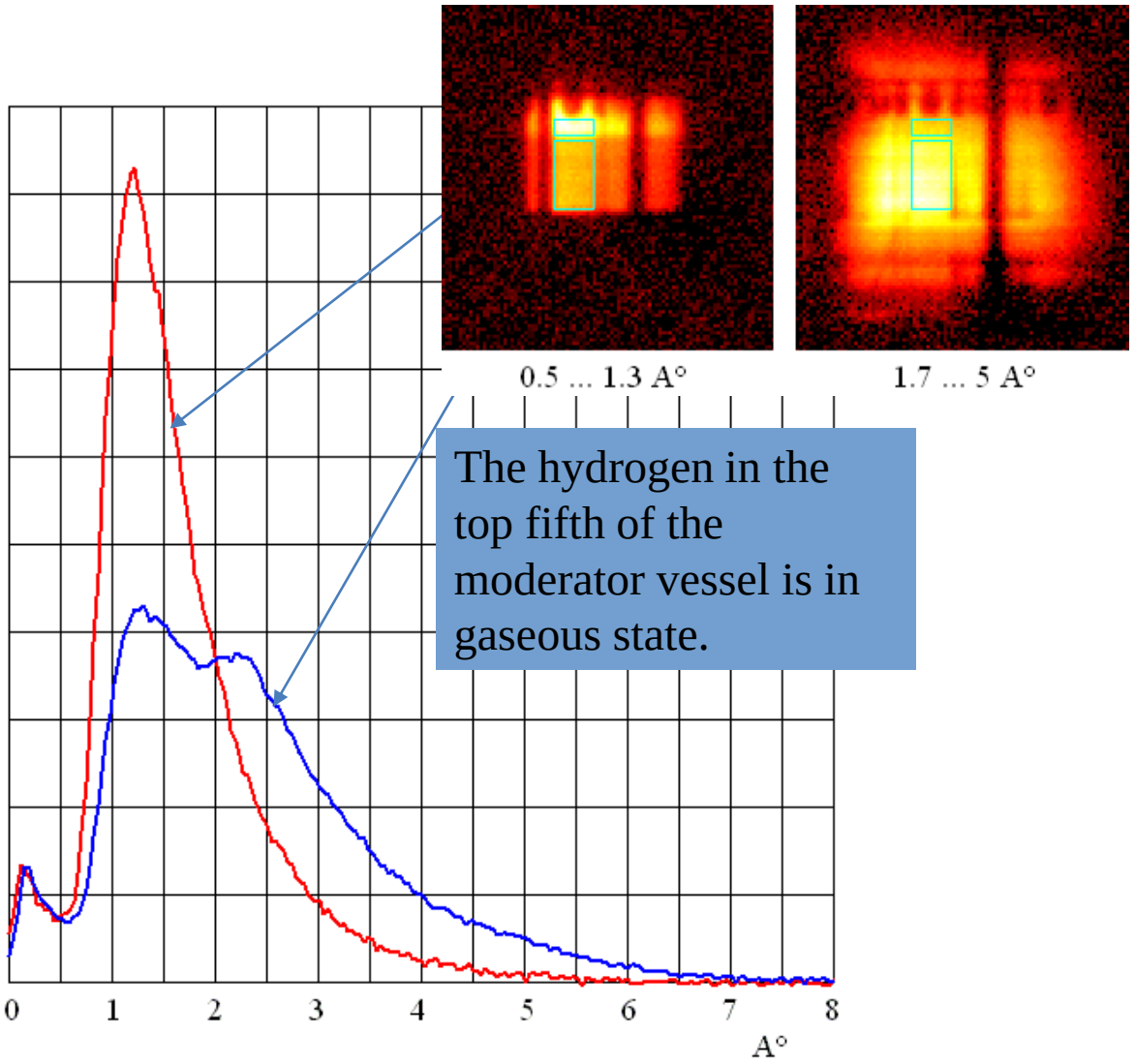
$$V = S / t$$

$$\lambda\ [\text{Å}] = 3956 / v\ [\text{m/s}]$$

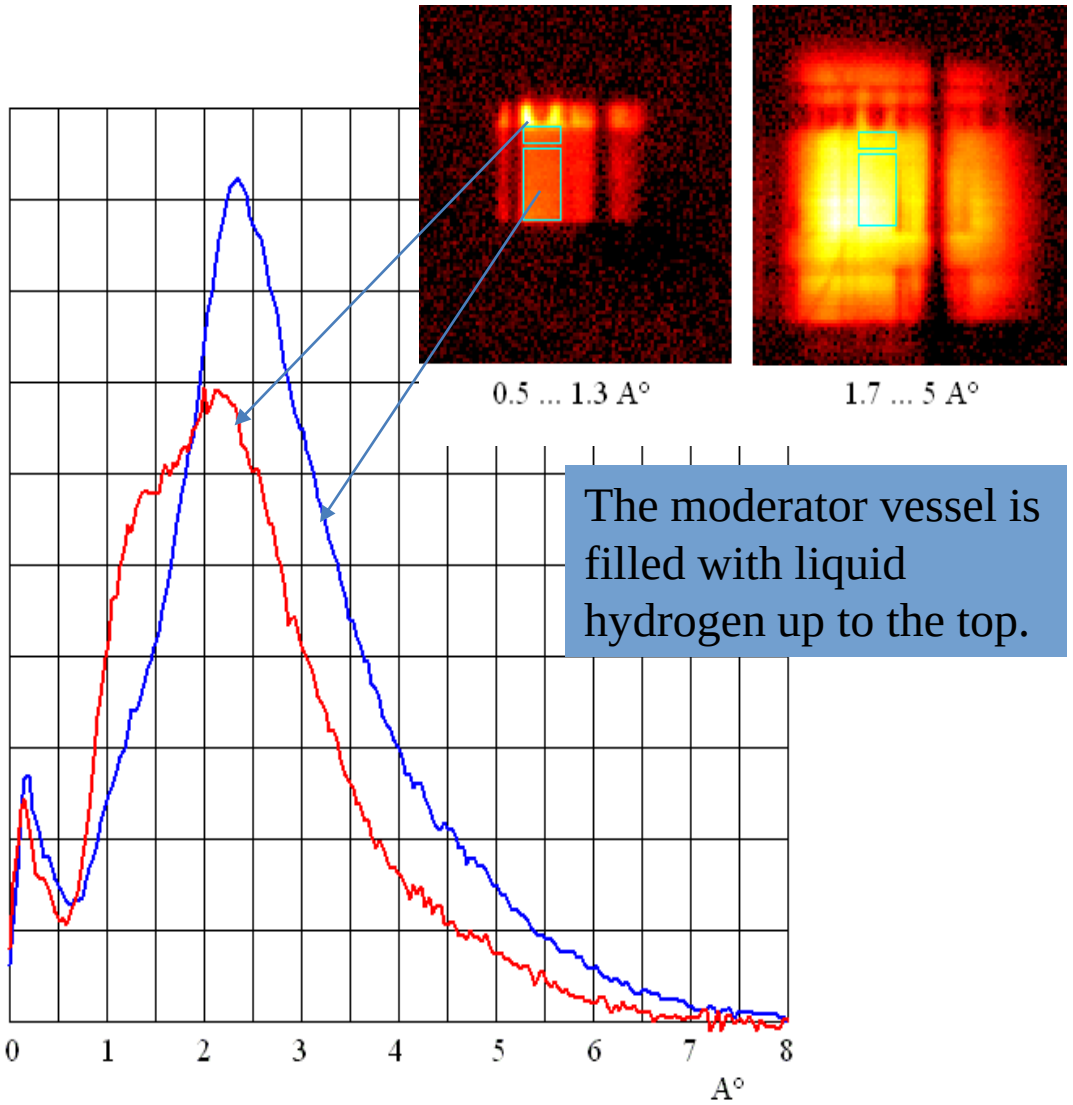


Füzi J et al, Physica B; **385-386**, 1315-1317 (2006)

Previous example

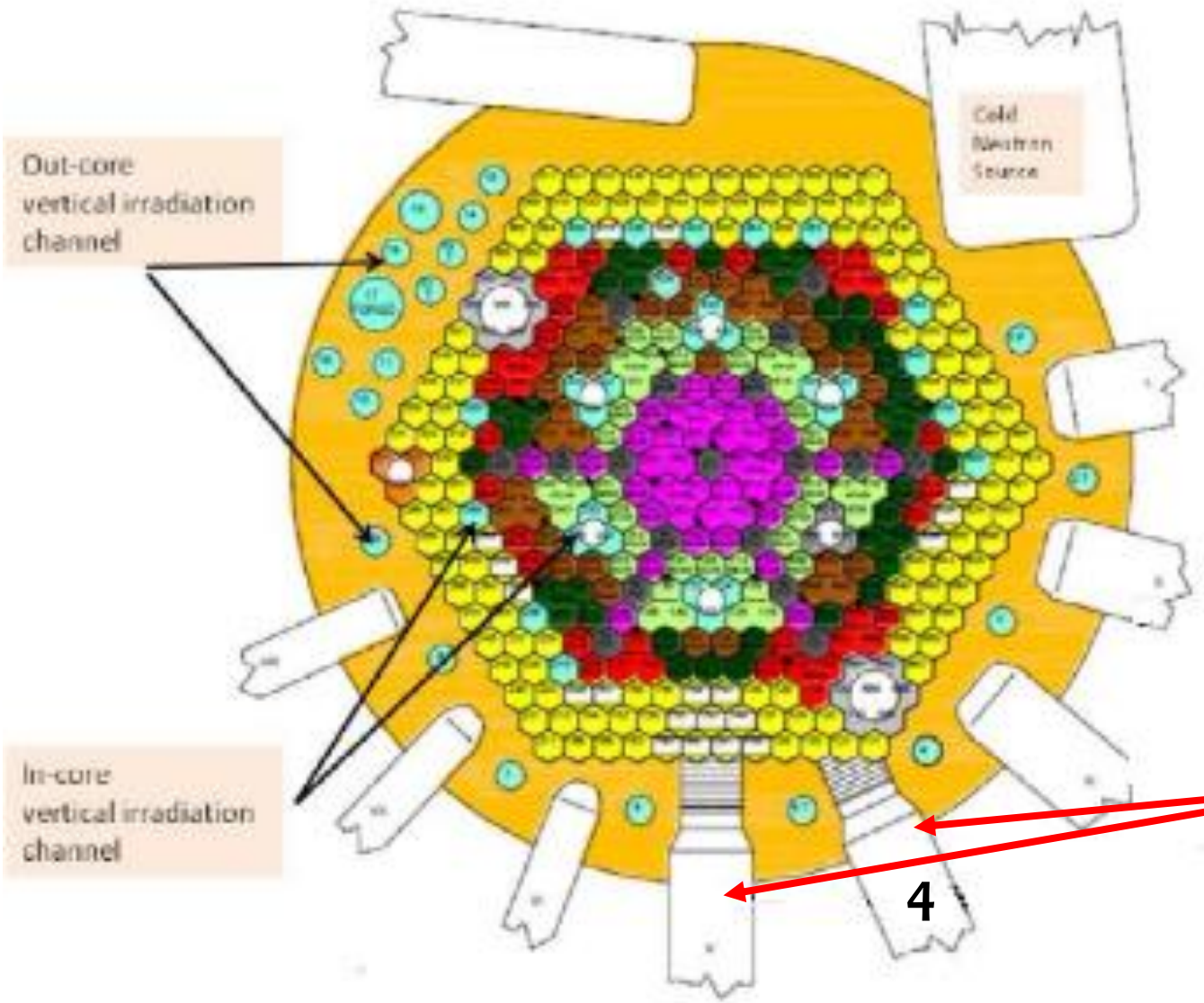


The hydrogen in the top fifth of the moderator vessel is in gaseous state.



The moderator vessel is filled with liquid hydrogen up to the top.

Realizing the CMTF - Channel selection



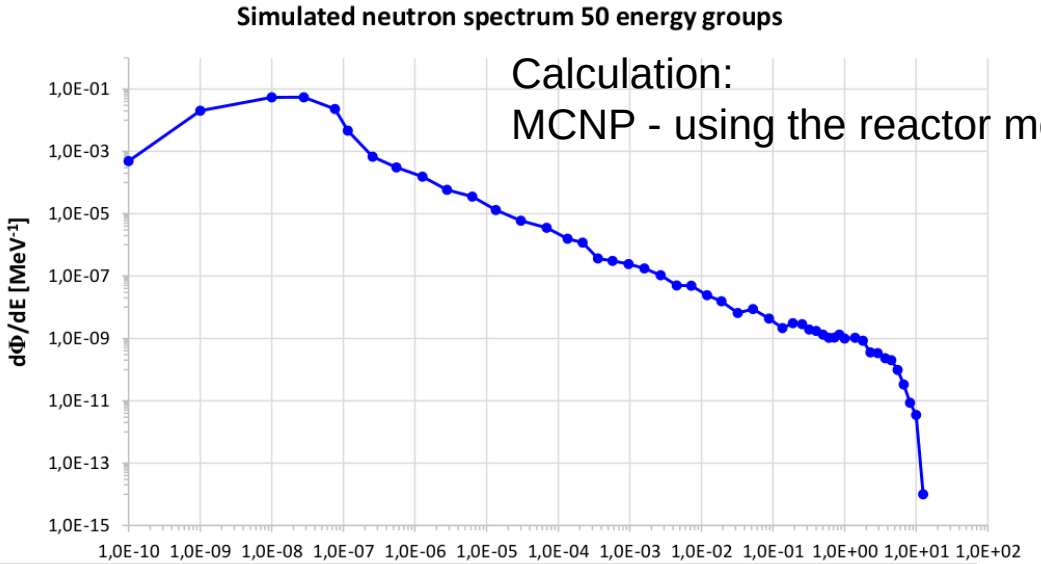
Channel #4 was selected for the test station

- Radial channel
- Aluminium in the Be reflector
- Fast neutrons can escape with less attenuation

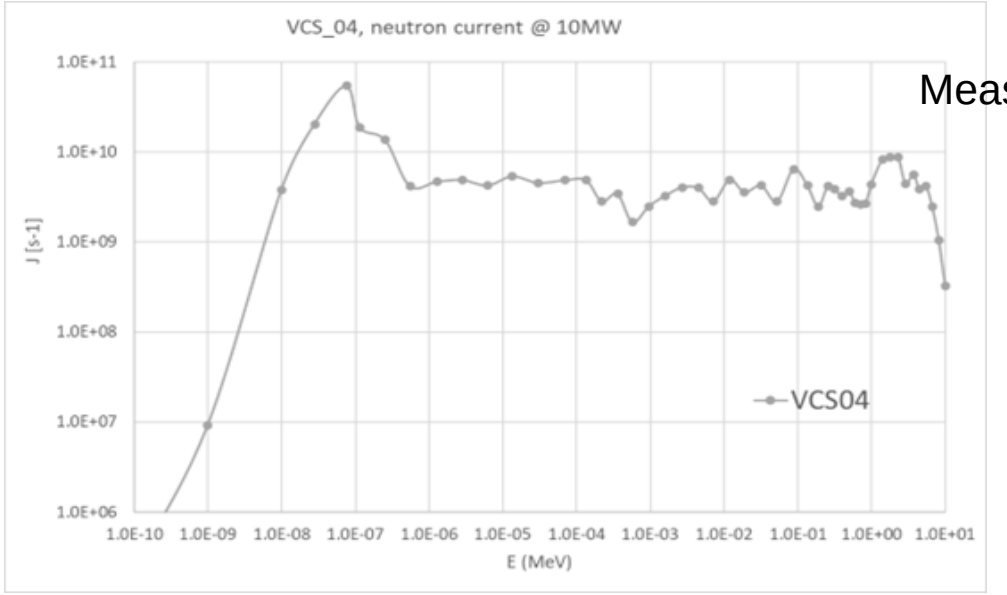
Epithermal neutron channels #4 & #5

Spectrum measurement and simulation with MCNP

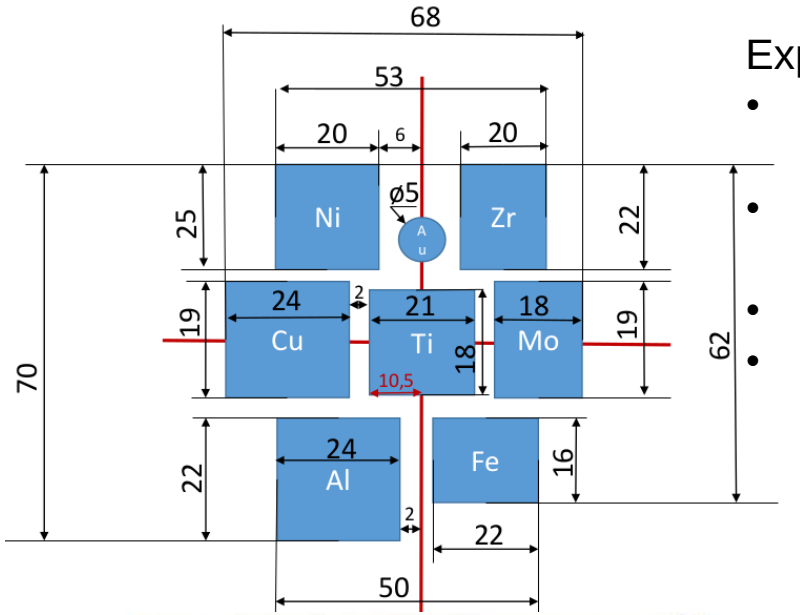
The spectrum is important: for the shielding design &
for the measurement validation, instrument performance



Calculation:
MCNP - using the reactor model

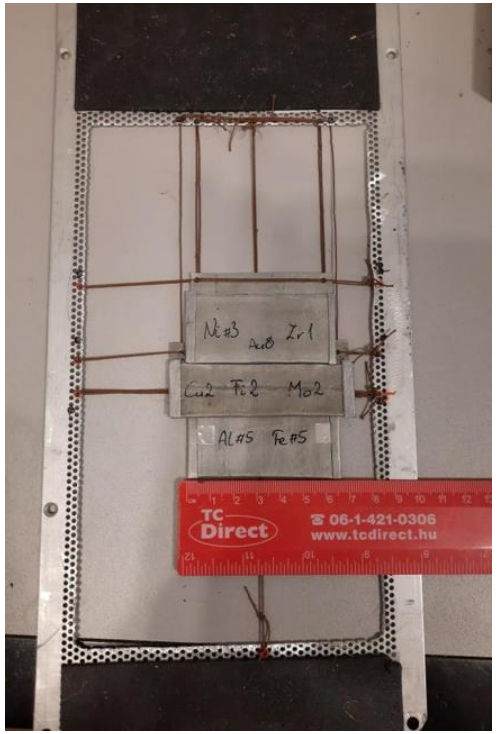


Measured



Experiment:

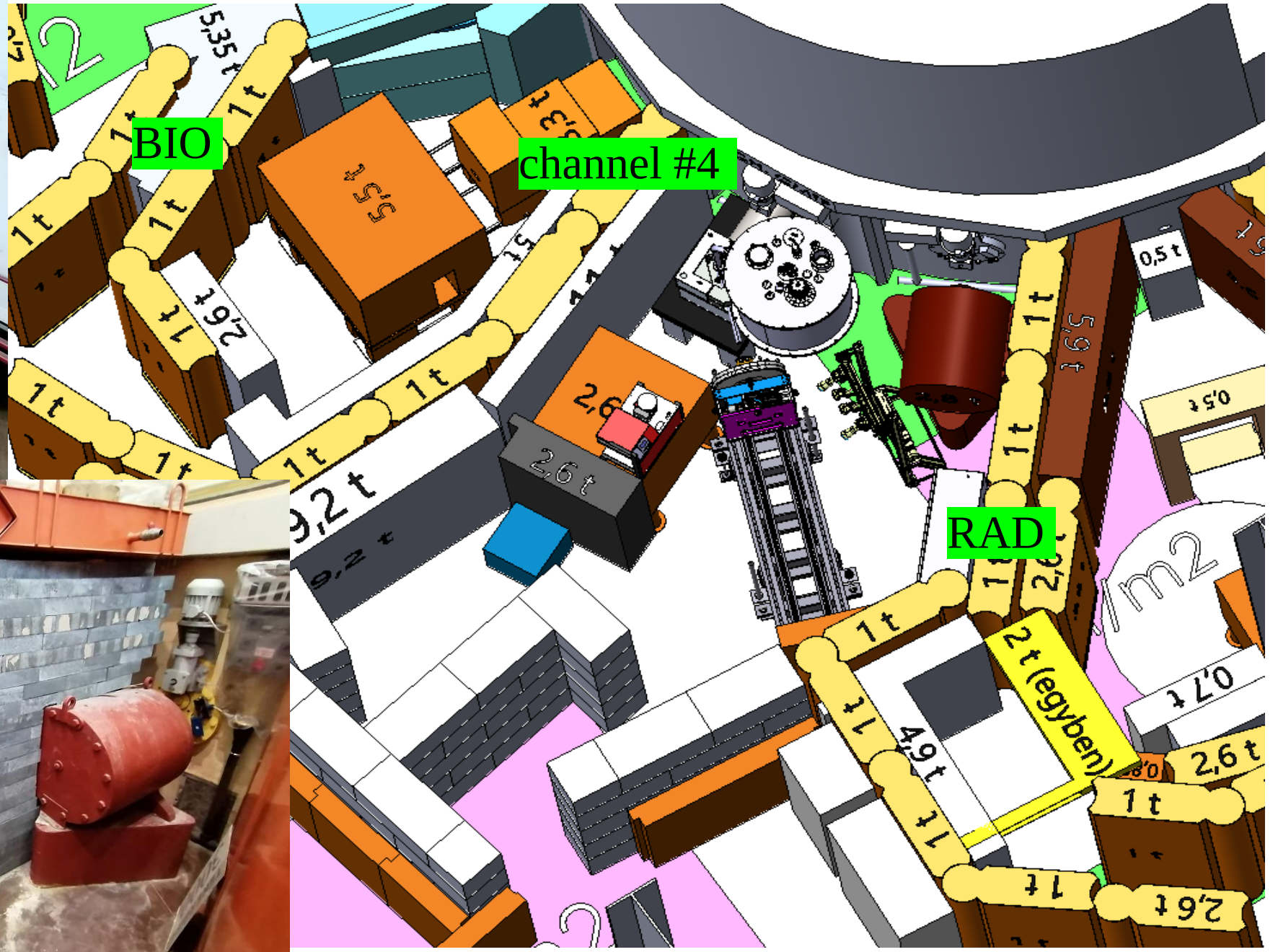
- For the validation of calculations
- 2x 24h irradiation (naked and covered with Cd)
- 50cm from the channel exit
- Measurement with 2 HpGe detectors in a low background chamber

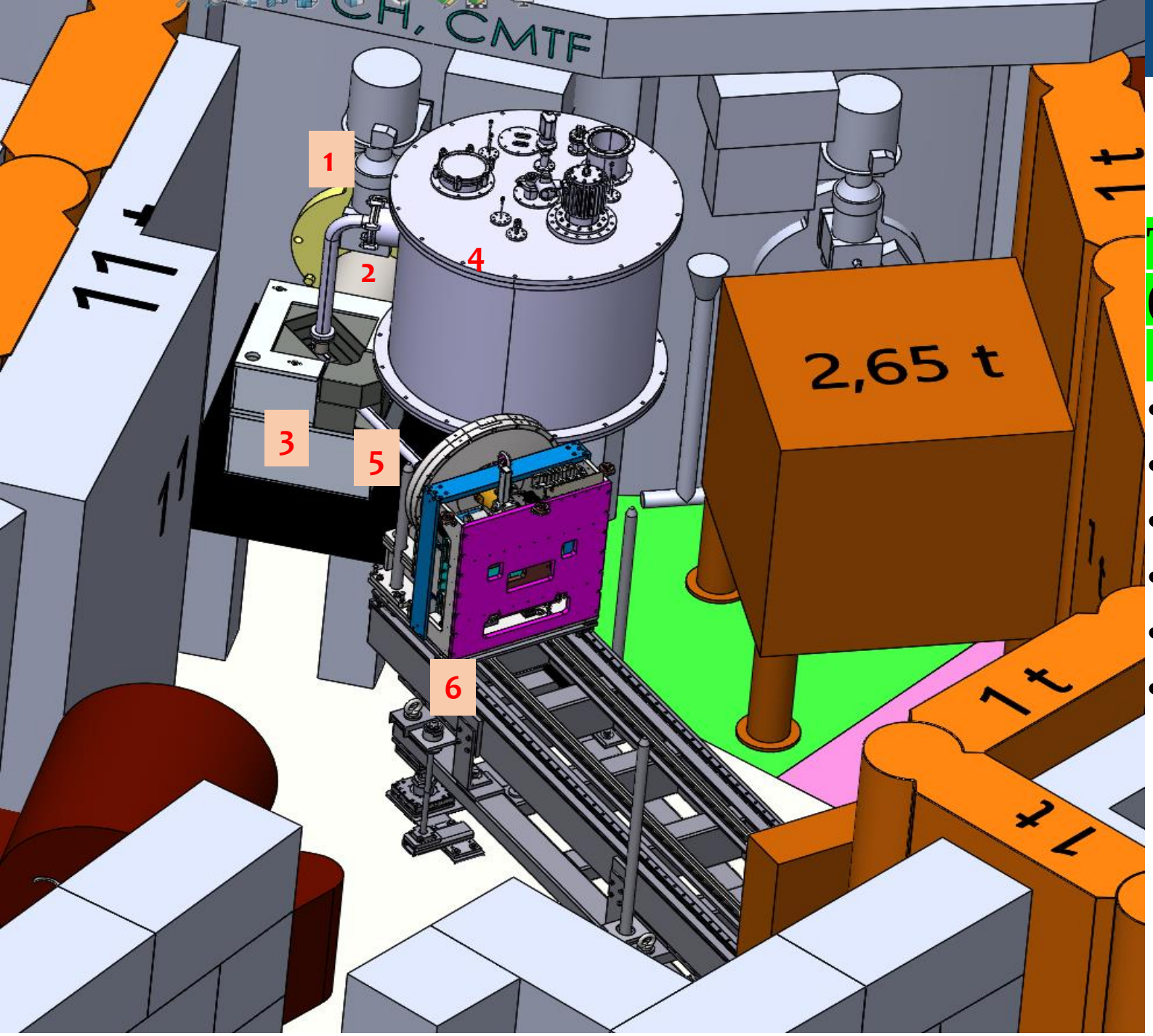


Centre for Energy Research

The sheme of the CMTF at the BRR channel #4

Budapest Neutron Centre



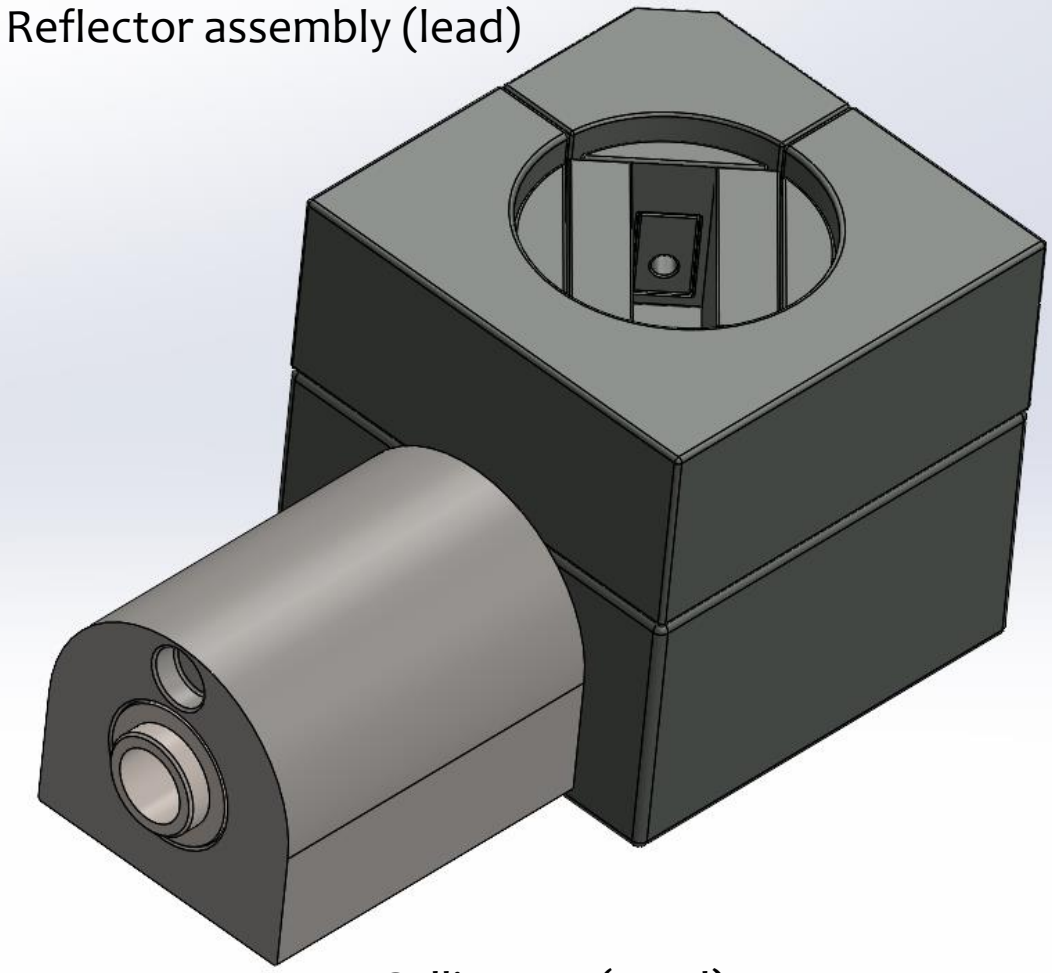


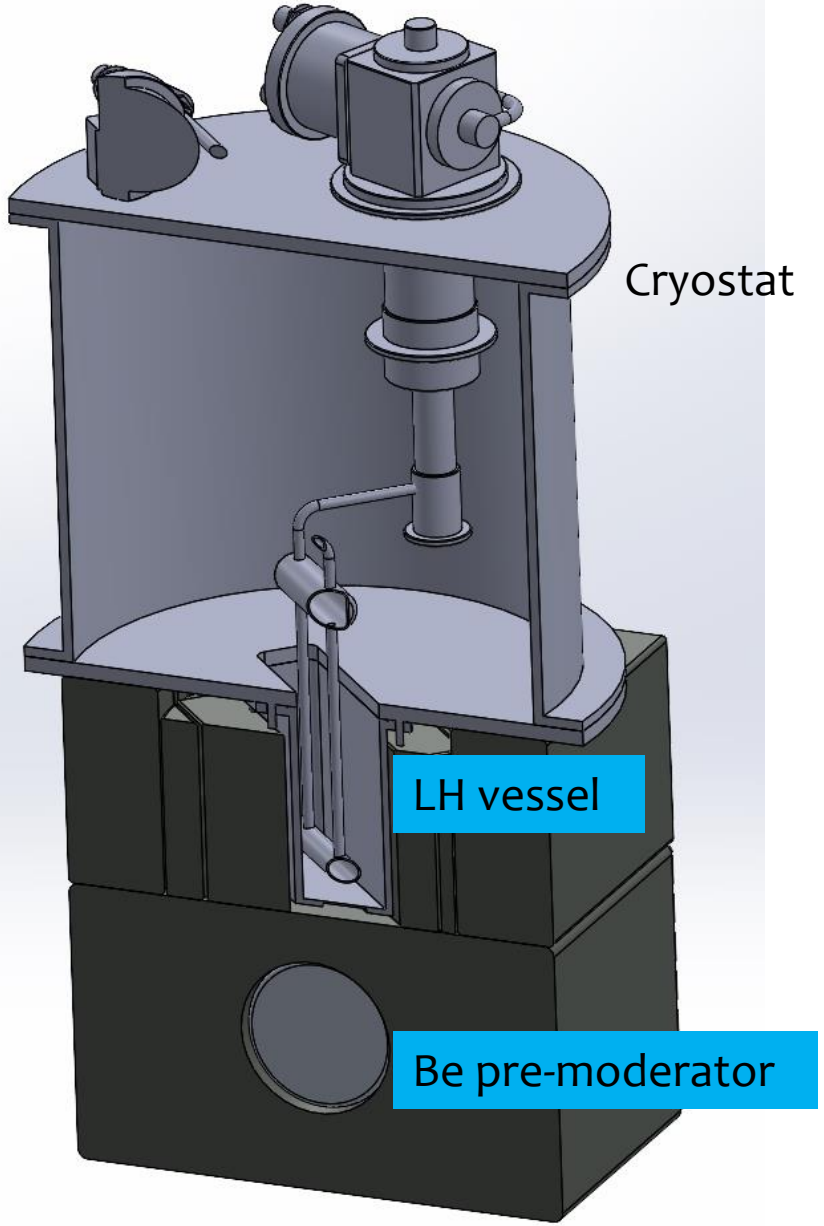
Budapest Neutron Centre

The Cold Moderator Test Facility (CMTF) at BRR

- channel #4 (1)
- the beam take-off collimator (2),
- out-of-pile neutron reflector (3),
- cold moderator cryostat (4),
- cold neutron beam optical guide (5)
- the pin-hole camera device (6) for TOF spectral measurements.

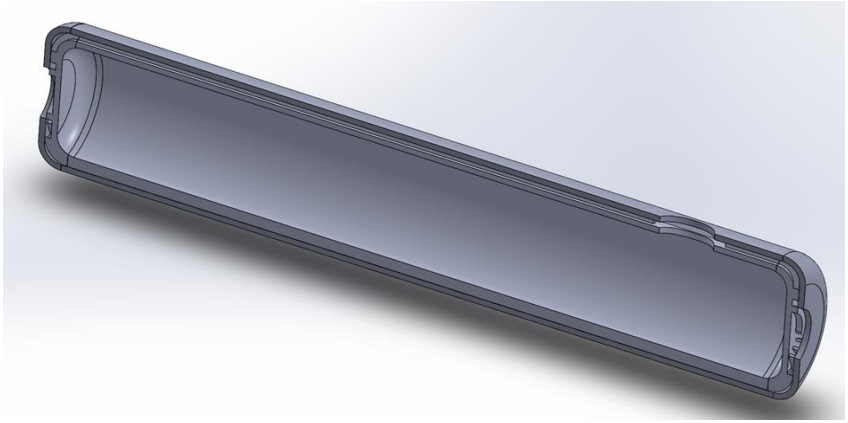
Beam collimator – reflector block



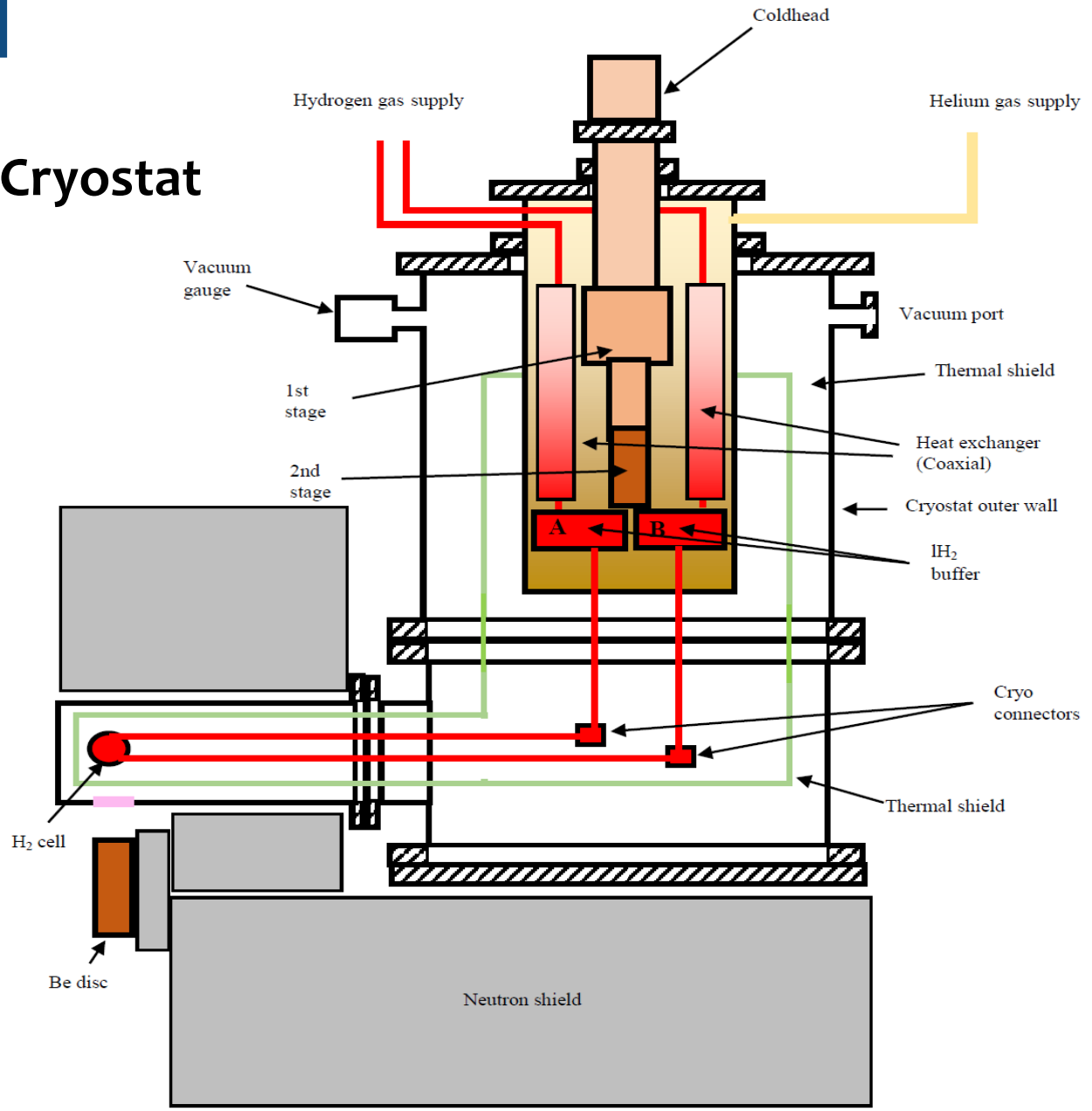


CMTF components

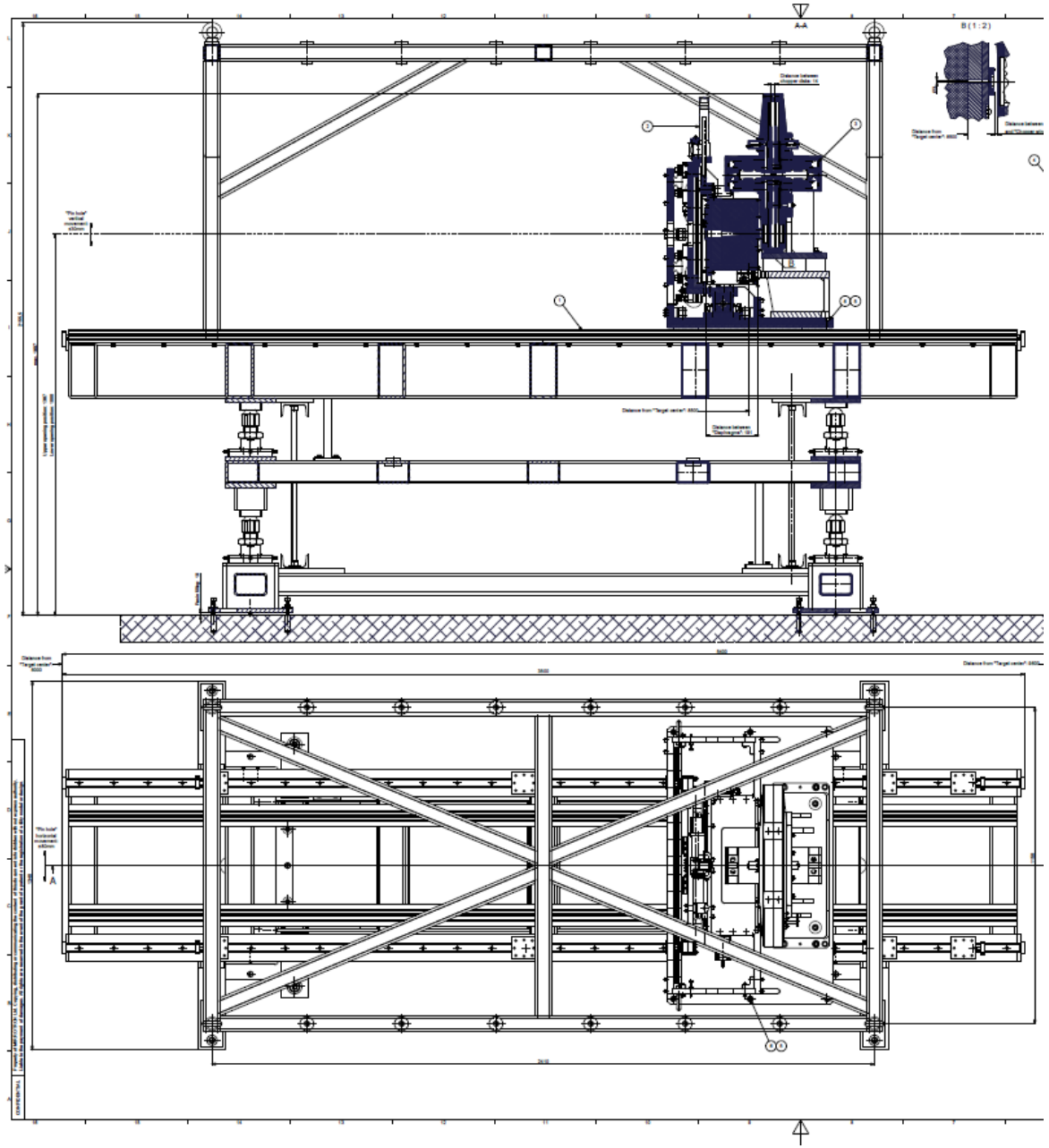
L-H_2 moderator vessel

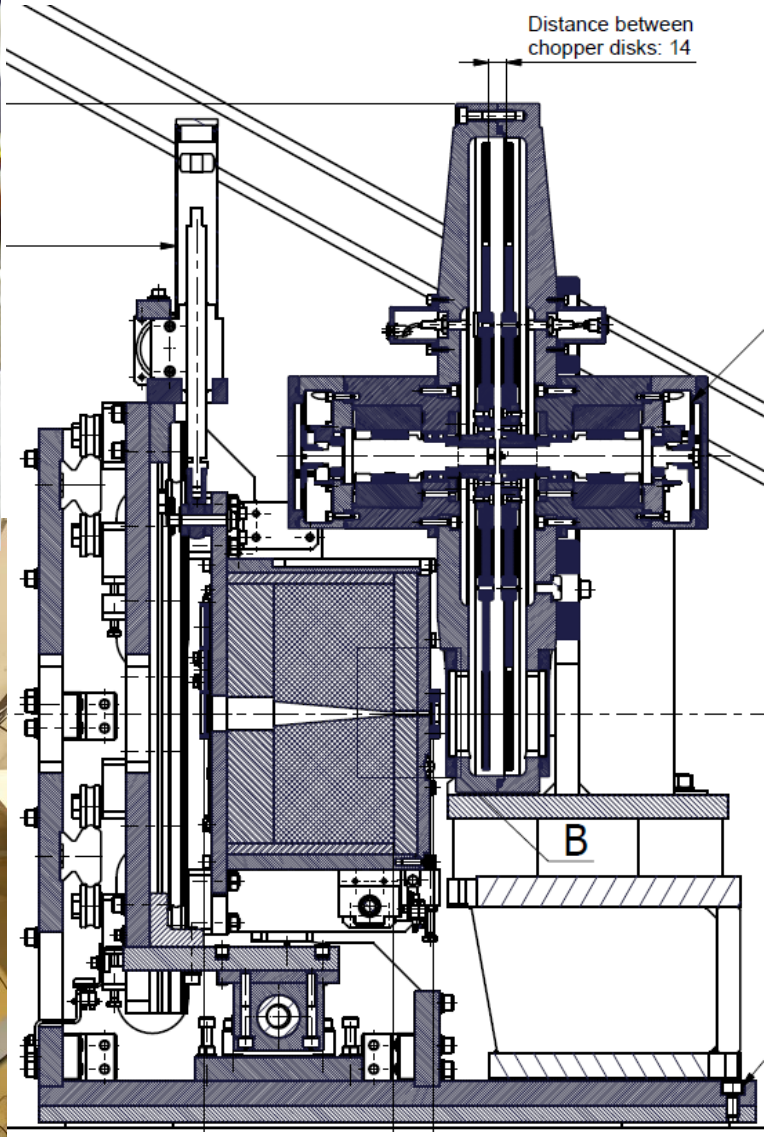


BNC Cryostat



CMTF components

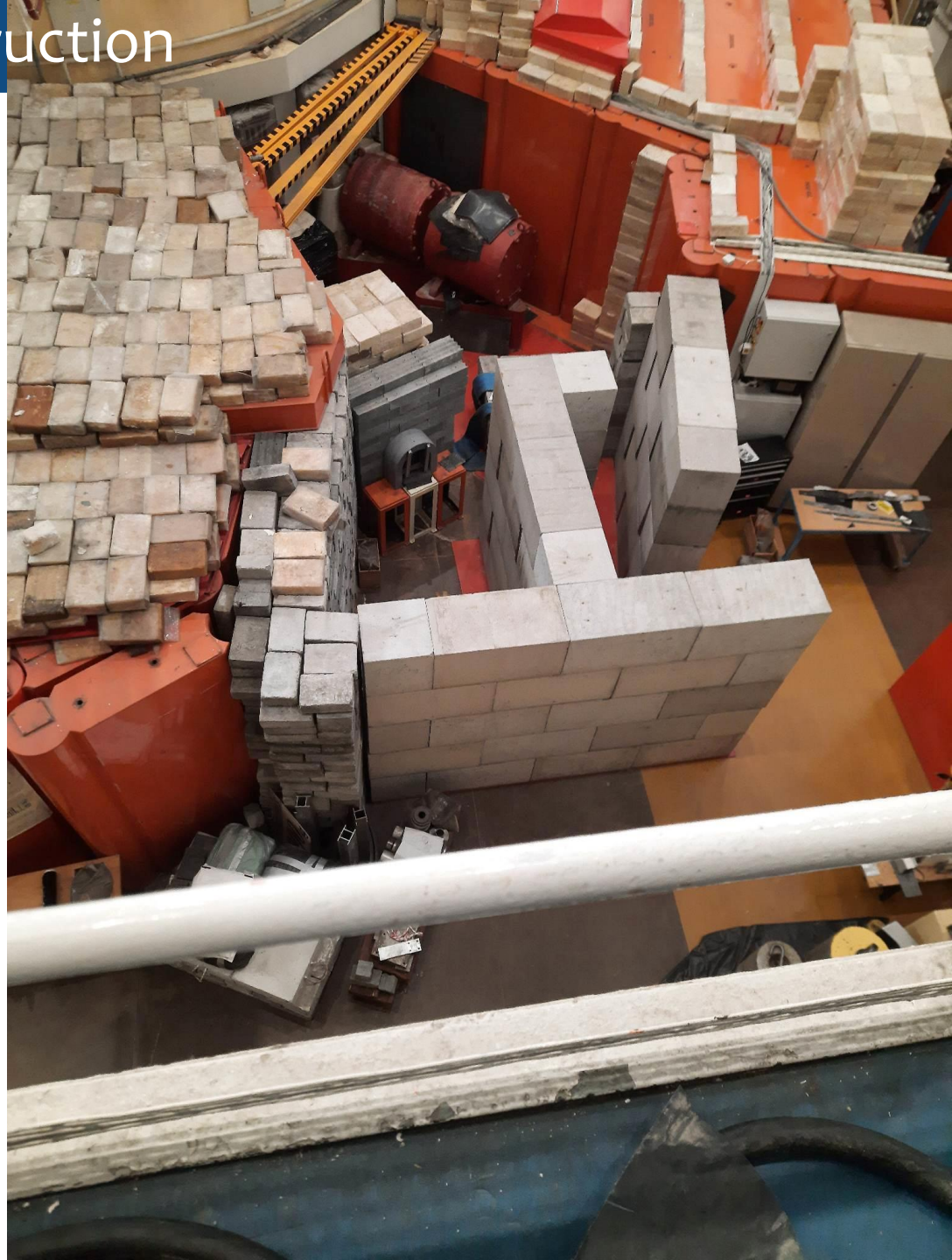




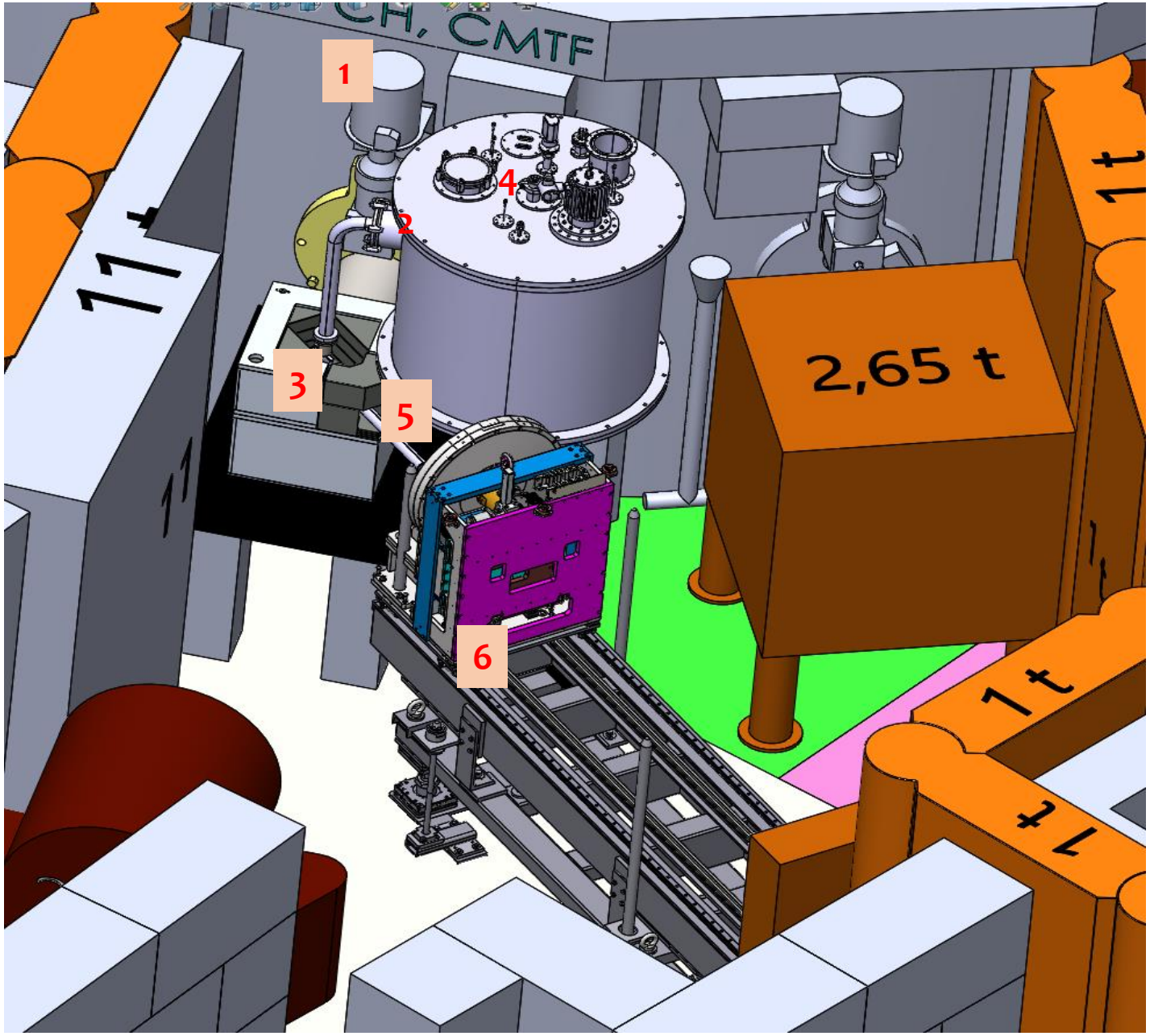
CMTF bunker construction

Current state
at March 2023

Safety report
for the
authorisation
by the
‚Regulator'
is close to
completion



CMTF collaborations



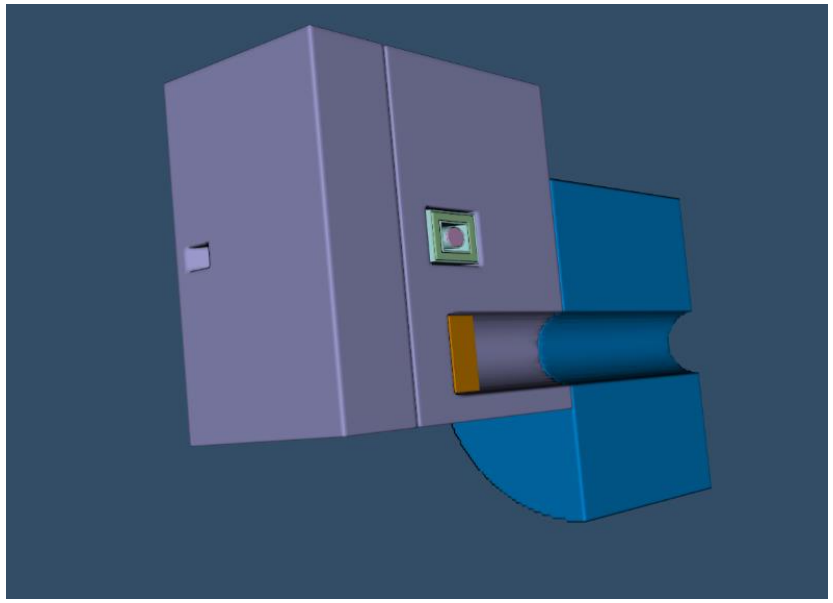
The Cold Moderator Test Facility at BNC is foreseen as a user instrument for collaborative research and technology development

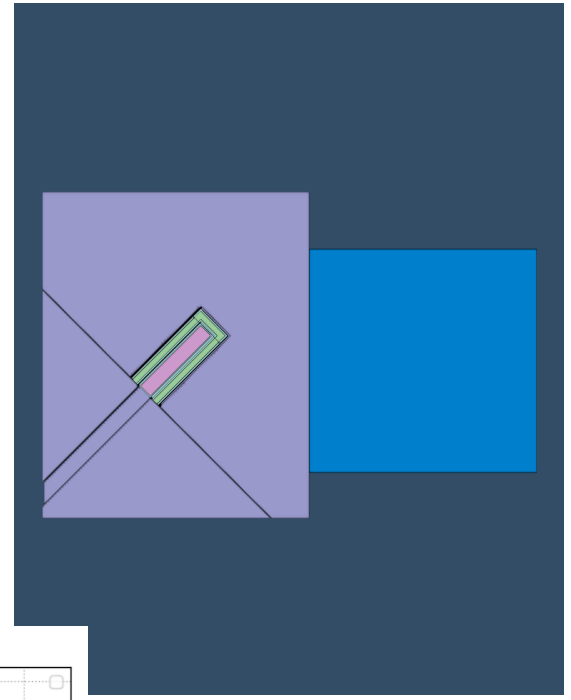
Collaboration with the HighnESS project

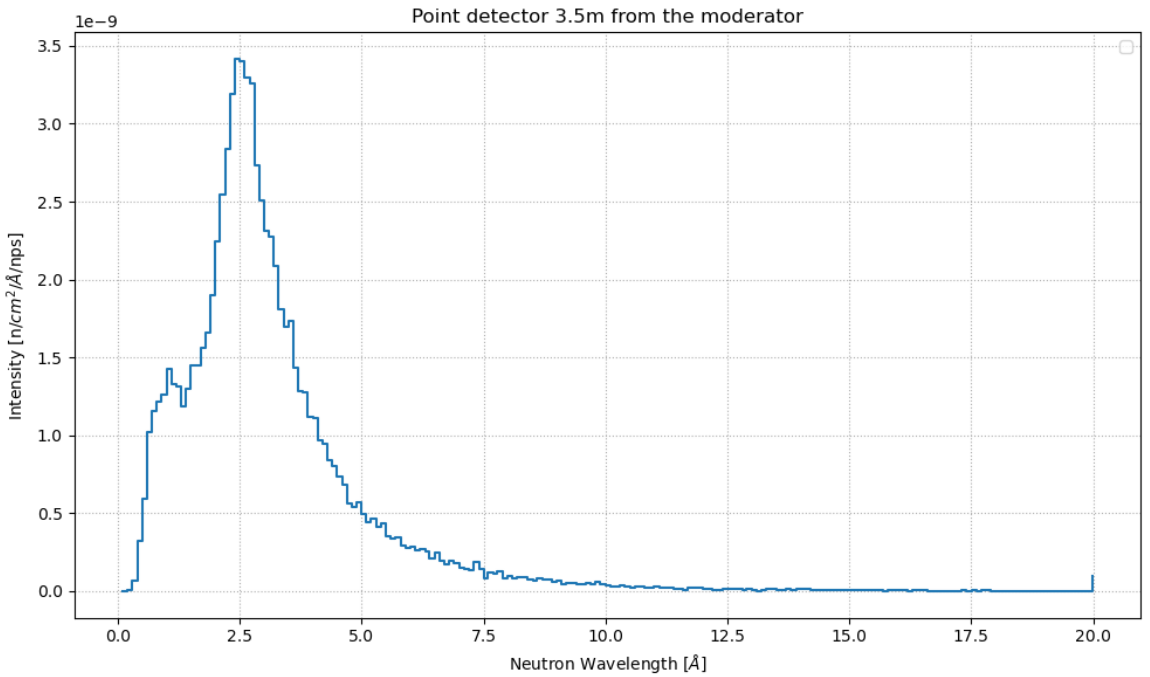
The facility will have a cold source but not a VCN/UCN source.

The performance of the advanced reflectors (e.g. nano-diamonds, MgH etc.) are planned to be investigated at the facility.

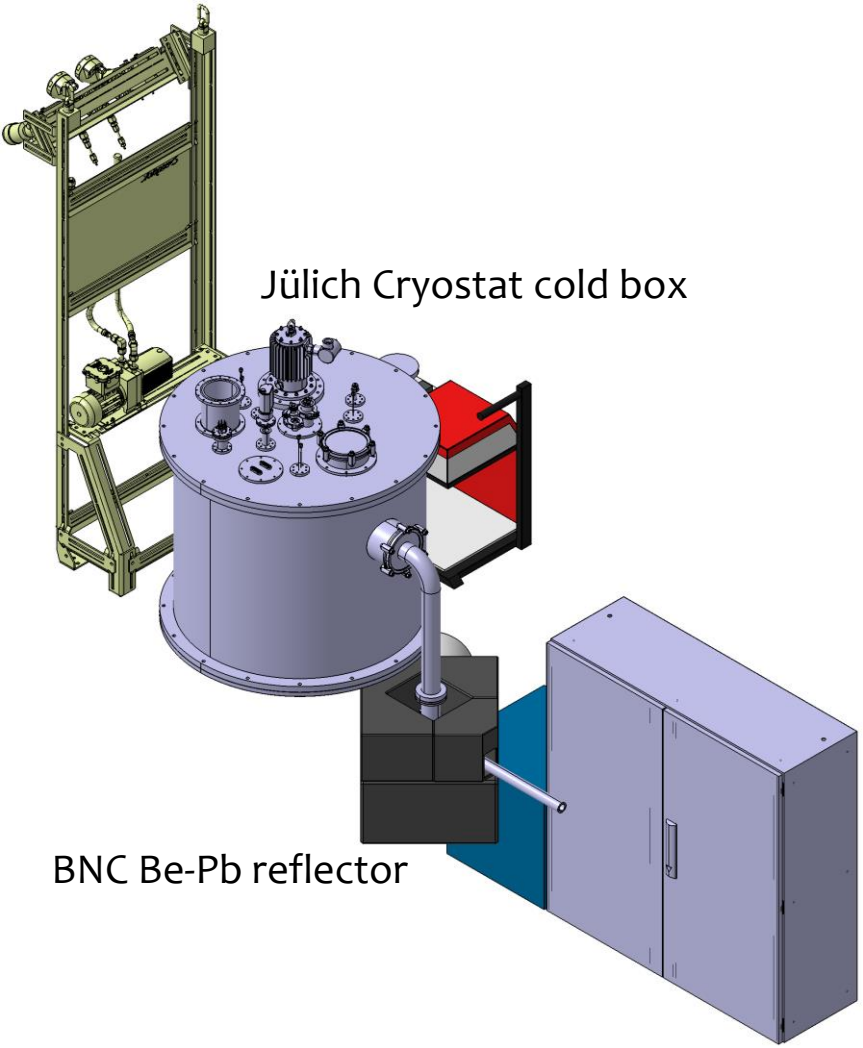
MCNP modeling was done by L Zanini (ESS) and N Rizzi (DTU)





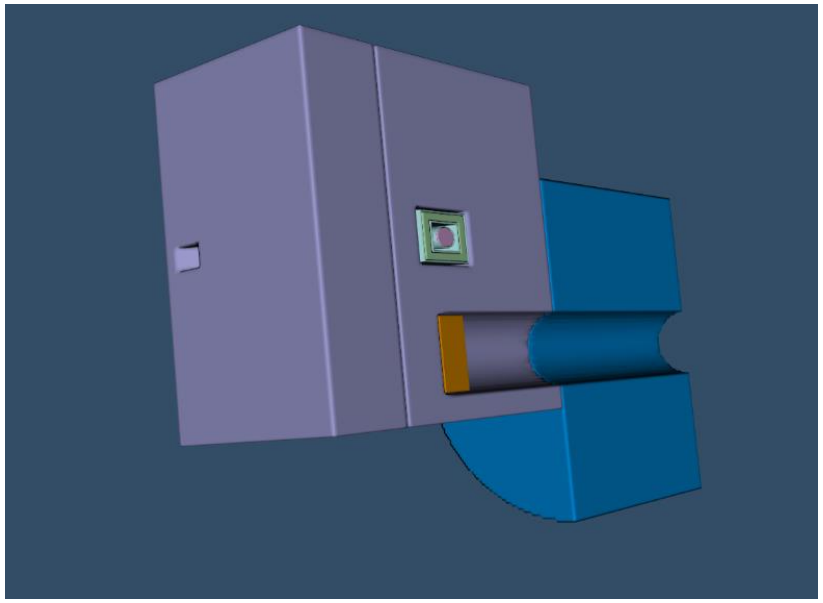


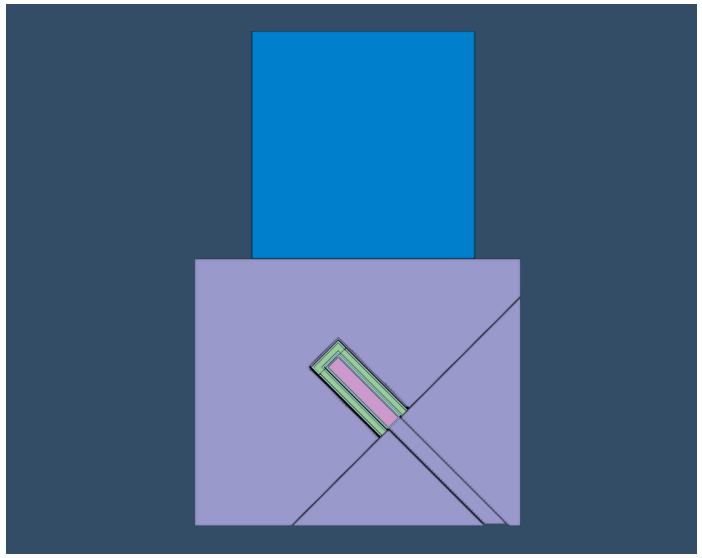
Collaboration with the HighnESS project



Jülich Cryostat cold box

BNC Be-Pb reflector





“Budapest Experiment”

Experimental investigation of advanced cold neutron reflector materials

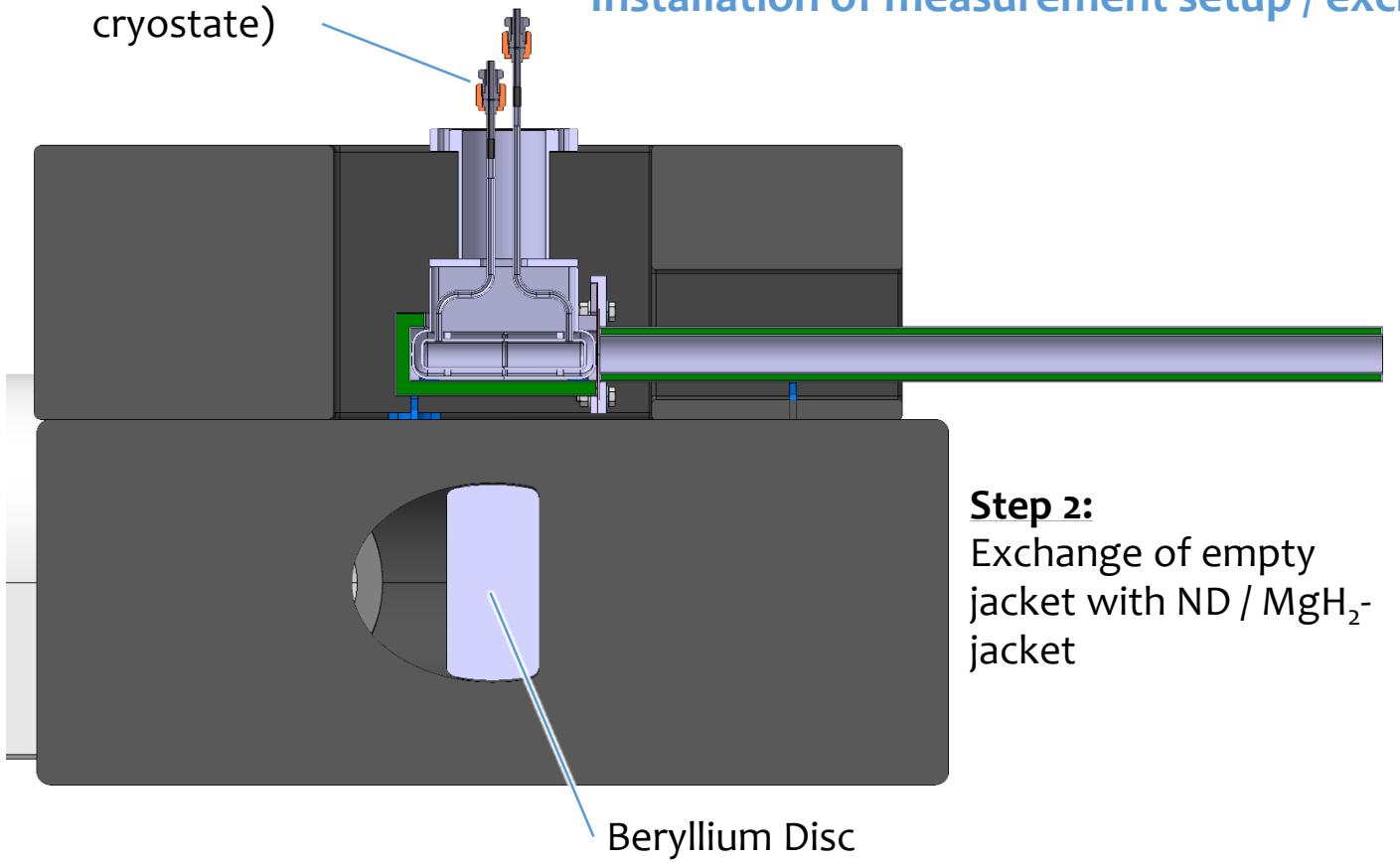
Jülich collaboration

Y. Beßler, C. Happe & Mathias Strothmann

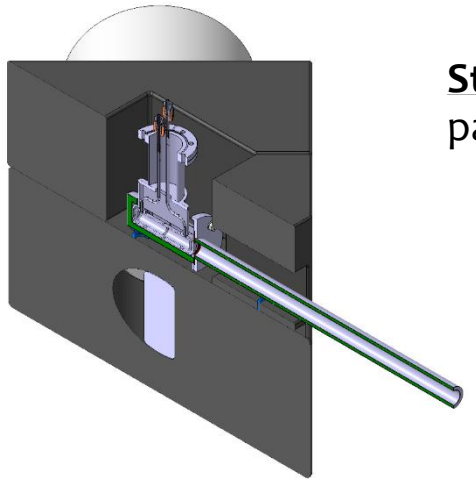
"Budapest Experiment"

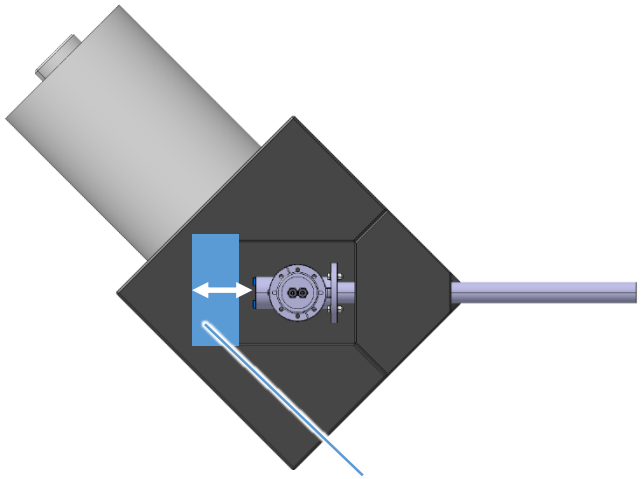
Experimental investigation of advanced cold neutron reflector materials

Installation of measurement setup / exchange of jacket's



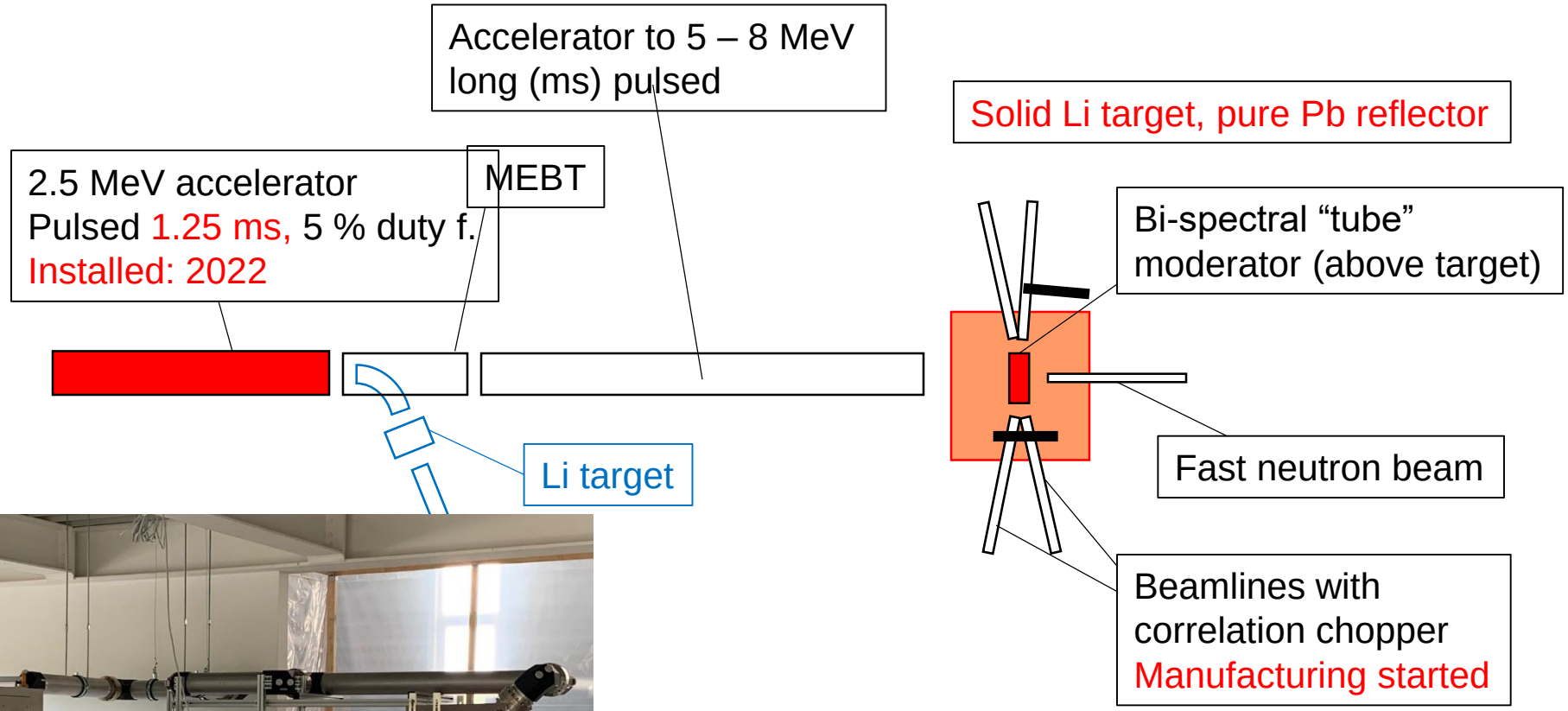
Step 2:
Exchange of empty jacket with ND / MgH_2-jacket





Step 1: removing shielding partilally

Collaboration with the Mirrotron LvB project



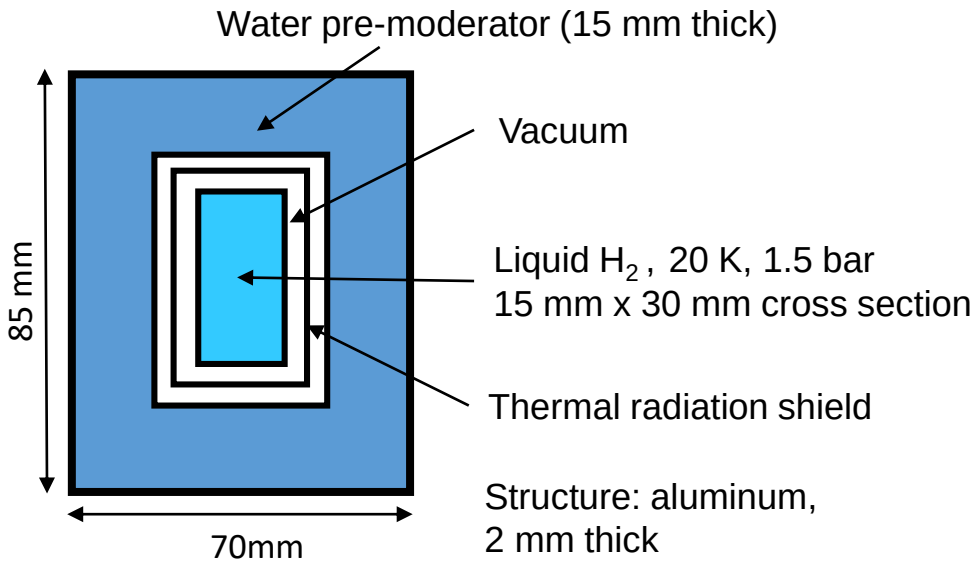
Liquid H_2 moderator
volume: 150 mm x 15 mm x 30 mm.

The center of the Moderator
~ 100 mm above proton beam center

LvB moderator and cooling system
Neutronic test at BNC Reactor

Liquid H_2 moderator
volume: 150 mm x 15 mm x 30 mm.

The center of the Moderator
~ 100 mm above proton beam center



We are looking forward to further proposals and collaborations

We are looking forward to recruit an instrument scientist

Thank you for your attention

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