Test beamline (TBL) @ESS

15 April 2024

Test beamline (TBL)

Team

Thawatchart Chulapakorn
TBL Instrument Scientist

Robin Woracek
TBL Instrument Scientist

Mary-Ellen Donnelly
Instrument Operations Engineer

Alejandro Tobias Quispe Mamani
TBL Lead Engineer (80%)
Will slowly transition into new role

Michaela Eriksson
Design Engineer (70%)
Consultant

Gabor Laszlo
NSS Lead Engineer
(prev. TBL Lead Engineer)

Douglas Di Julio
Neutron Physics

Irina Stefanescu
Detector Scientist

Test beamline (TBL)

- ❑ Recap: What do we actually want to do?
- ❑ How do we want to do it?
- ❑ Overview of Layout
- ❑ Spectrum & Shielding & Flux
- ❑ Detectors
- ❑ Feedback & Discussion

What do we actually want to do?

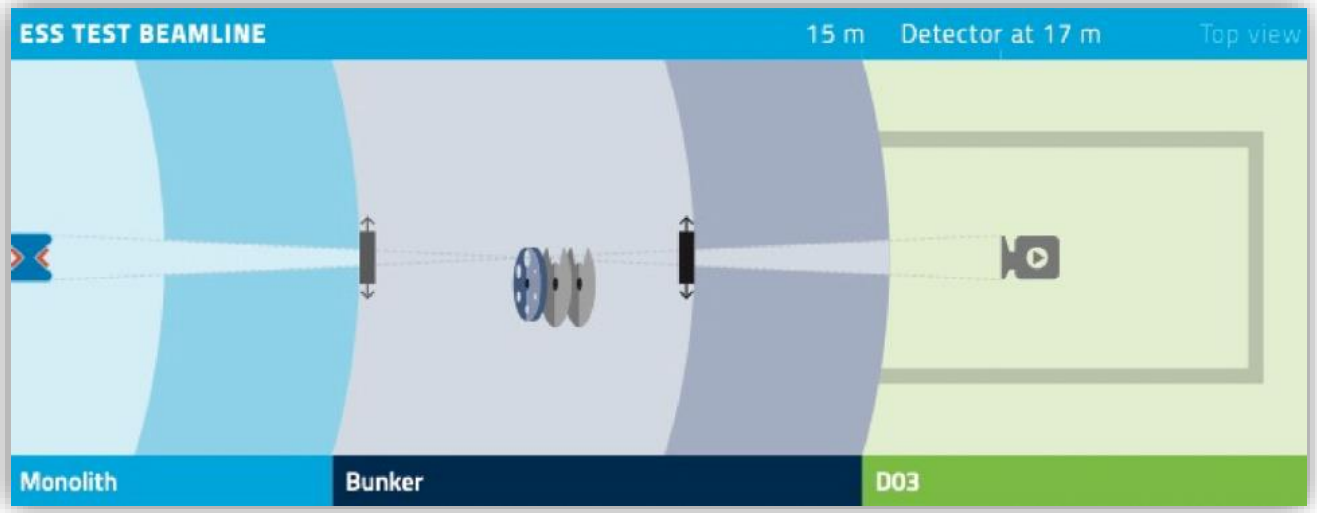
Intro

The Test Beamline (TBL) is designed to validate the successful commissioning of the ESS spallation source. The beamline is located in direct line-of-sight to the neutron moderator and will allow characterization of **fast to cold neutrons as well as prompt gammas**.

The TBL design is simple and consists of a **changeable pinhole** and a **double-disk chopper**. The modular designs allows for future upgrades.

The goal of the TBL is to characterize/support:

- Characterization of the ESS moderator system
- Proton beam stability/Moderator stability
- Spatial distribution of neutron beam
- Characterize neutron spectrum
- Pulse-shape of cold-thermal neutrons
- Detectors and data processing systems
- Sample (e.g. singe crystal) alignment
- Simple imaging and diffraction experiments



ESS Ramp up

Assuming BOT July 2025

Accelerator commissioning & TBL

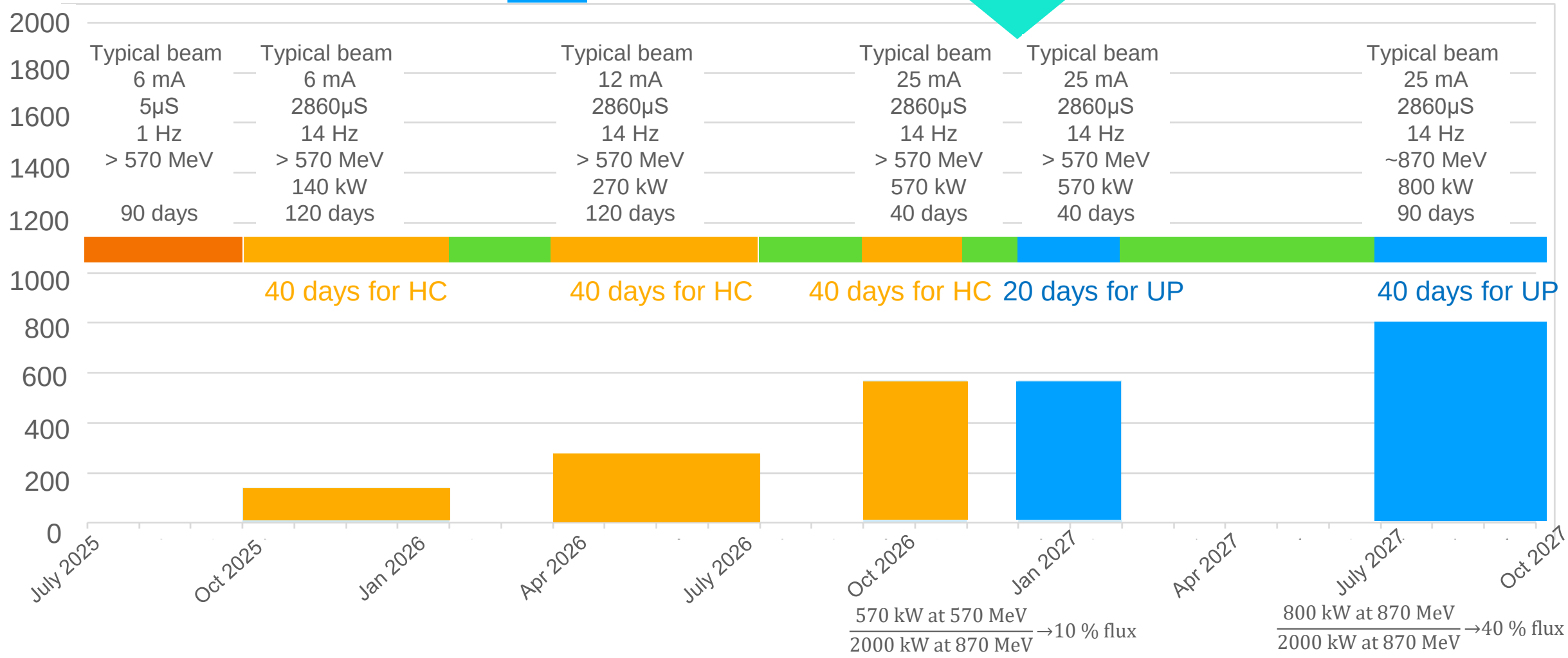
Hot commissioning

Shutdown

Users

First users

18 months after BOT



See ESS-0420218 “Early operations of ESS and prerequisites for first scientific results” for more details

The Goal – EOC definition for council

- Delivery of an accelerator-based long-pulse neutron scattering source capable of 2MW beam power on target with each parameter **demonstrated separately**
  - Duty factor (14 Hz, 2,86 ms beam pulse)
  - Beam energy (0,800 GeV)
  - Peak proton current accelerated (62,5 mA)
  - Source power > 1MW, reliability > 80%
- 15 neutron scattering instruments delivered and installed, of which
  - 10/6 are in the User Programme (P0/P80)
  - 5/9 are in hot commissioning with beam (P0/P80)
- **Test beamline neutron flux for beam energy of 0,570 GeV measured as at least:**

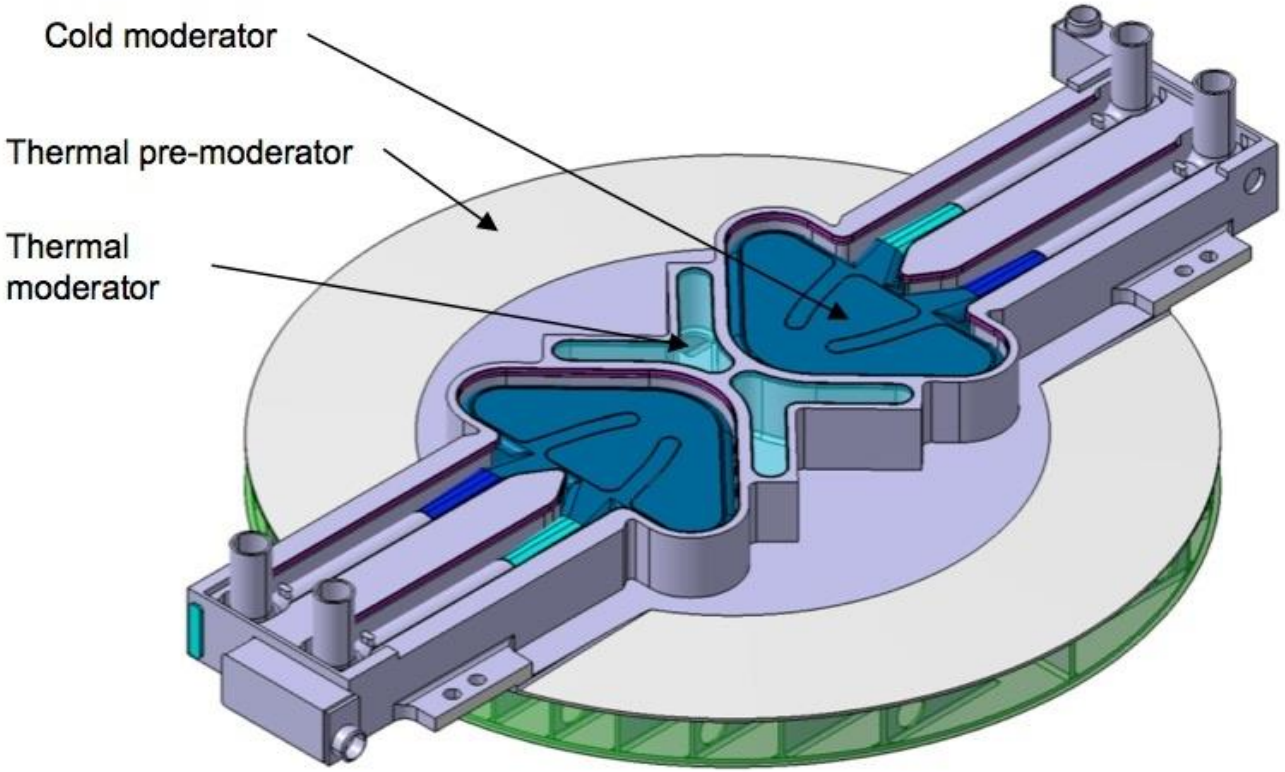
	threshold value	objective value
	n/sr/p over a 3x6 cm^2 area	n/sr/p over a 3x6 cm^2 area
cold brightness	3.58E-03	8.96E-03
thermal brightness	2.56E-03	6.40E-03

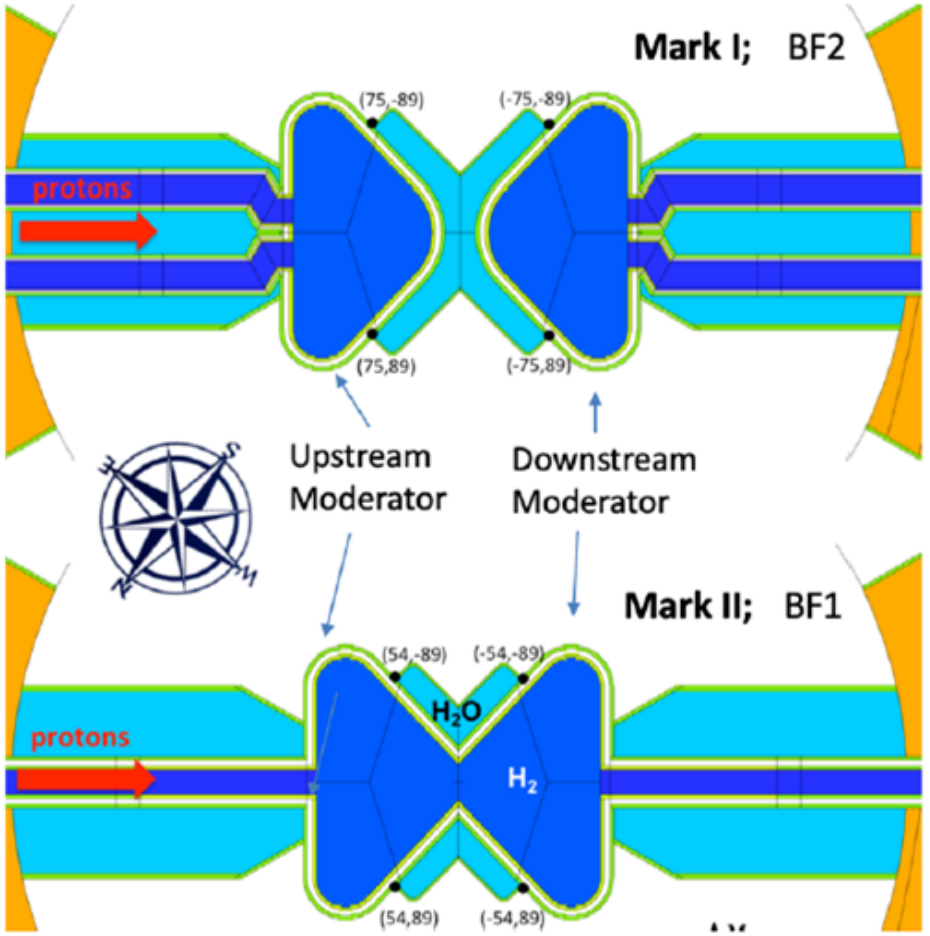
- Infrastructure supporting user programme operational (e.g. user office, data management, sample environment, user labs, central polarisation service)
- Trained staff, operating permits, and system documentation in place

For Information

Moderator

MARK-I: initial moderator
MARK-II: (neutronically optimized moderator)

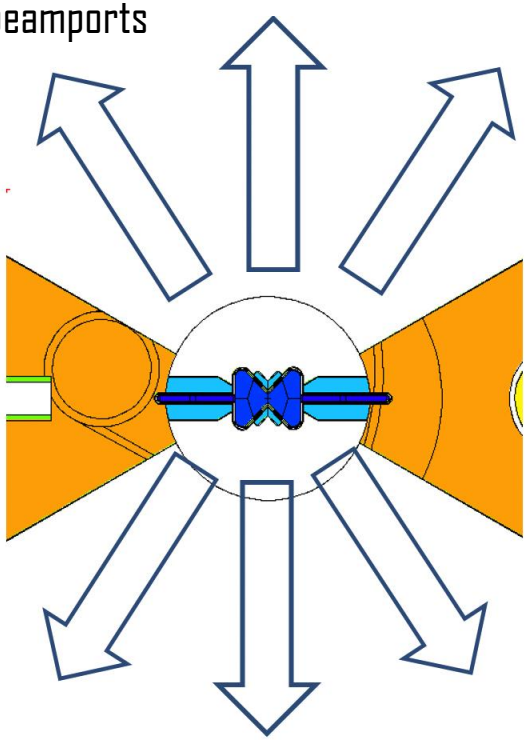


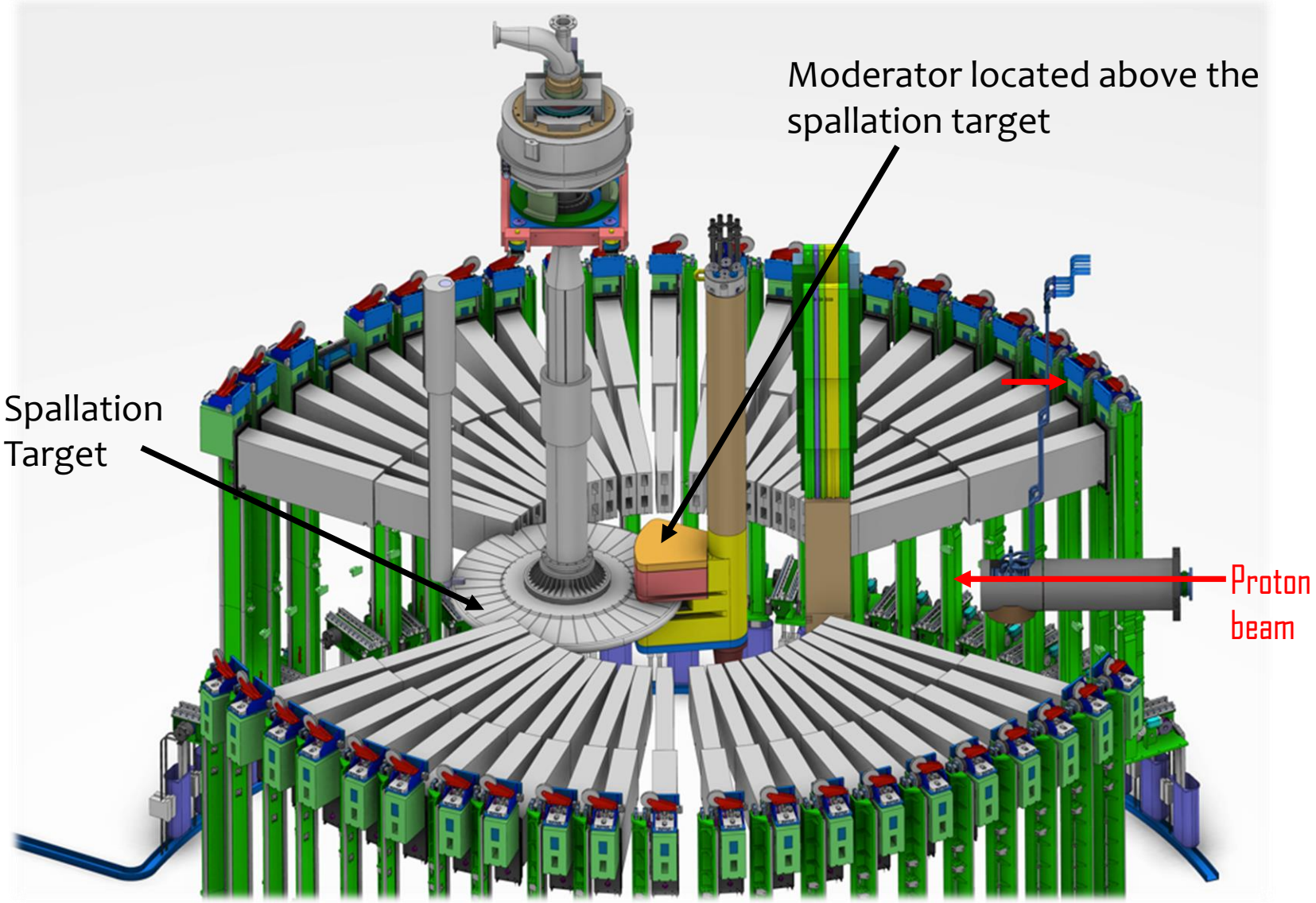


For Information

Target - Moderator

ESS moderator unprecedent brightness to all the available beamports

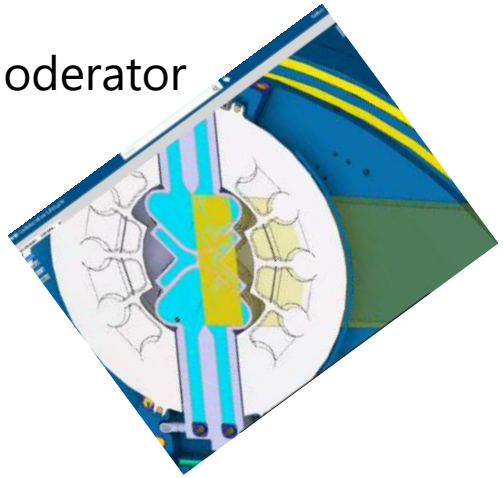


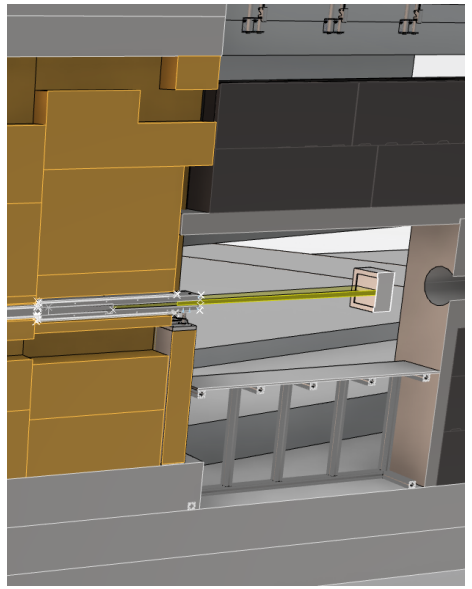


For Information

Target - Moderator

Moderator





TBL Detector in direct line of sight

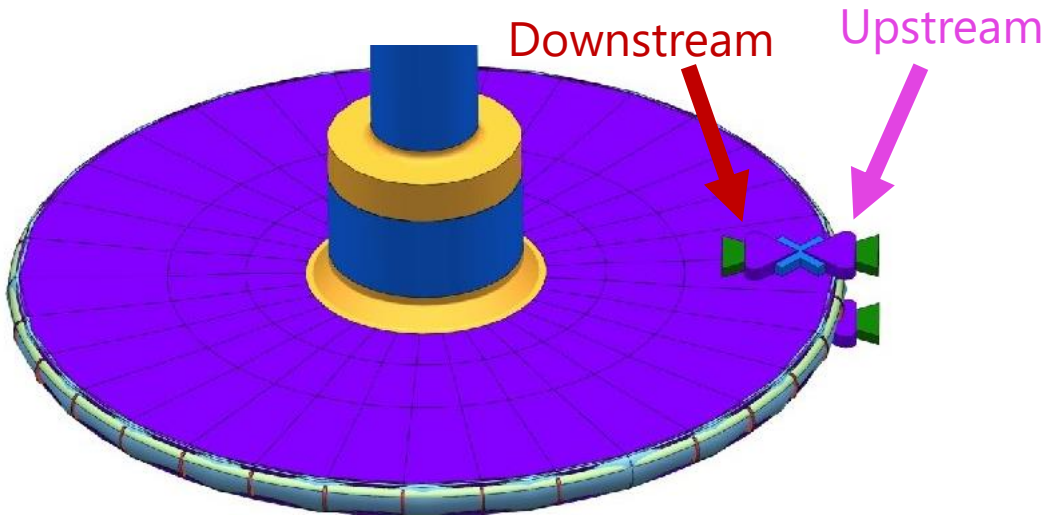
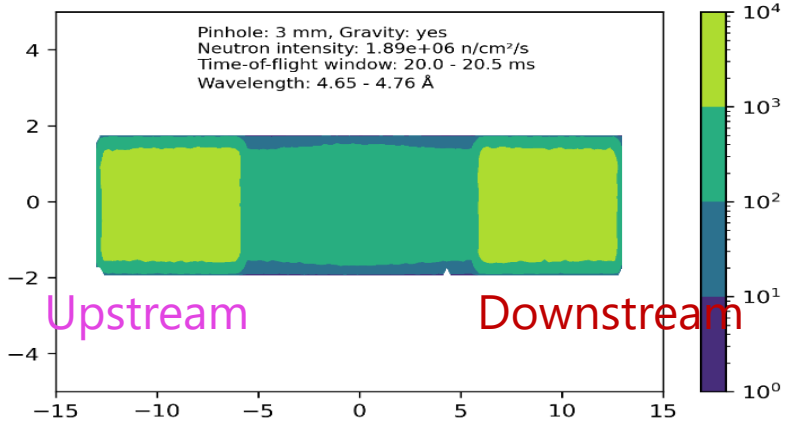


Image at TBL by ‘pinhole imaging’



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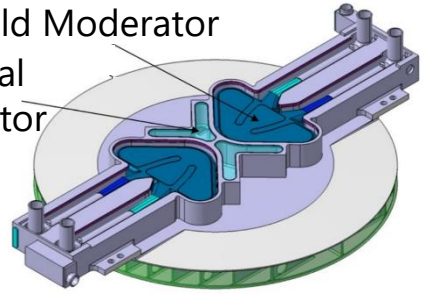
How we want to do it?

Principle

'Camera obscura' concept

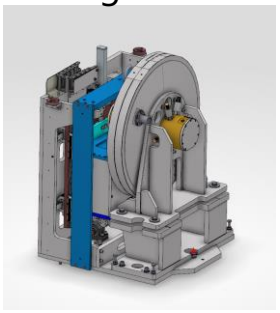
Cold Moderator

Thermal Moderator

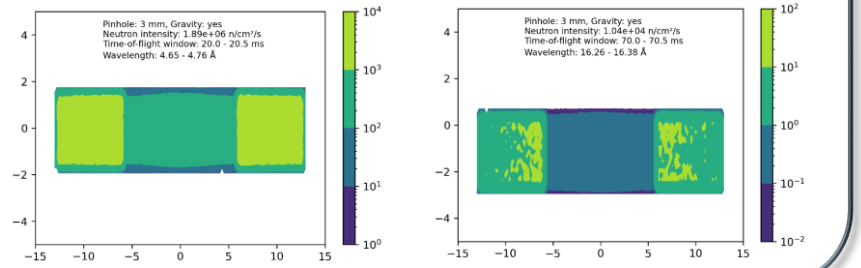


Upgrade from MARK-I (initial) to MARK-II (neutronically optimized) moderator

Wavelength Selection

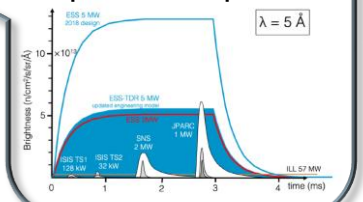


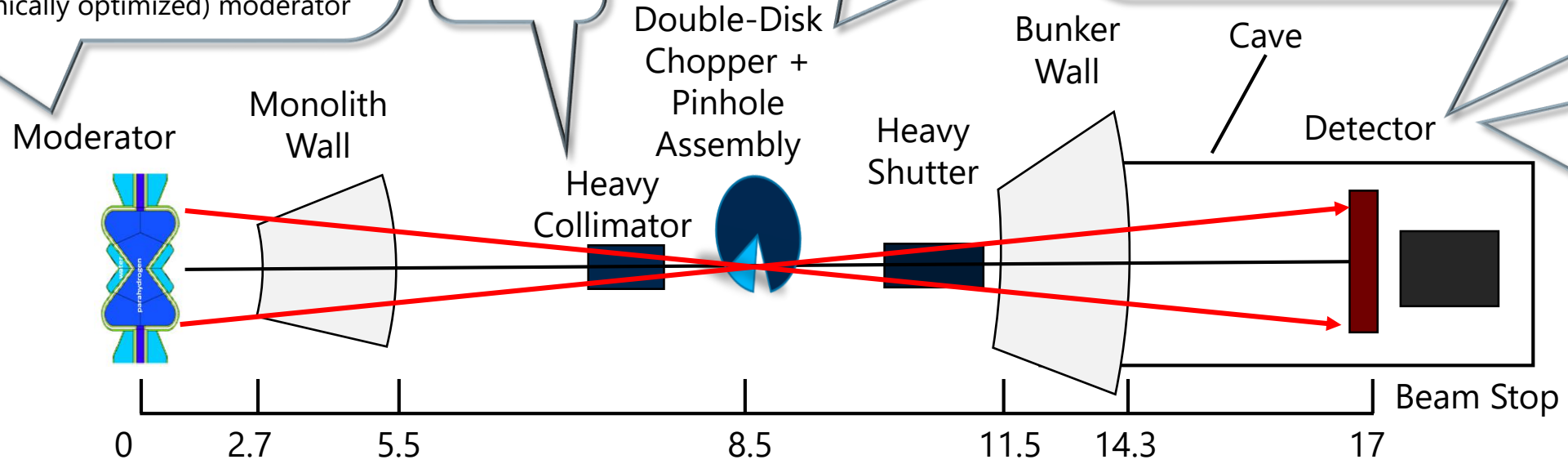
A 2D image of the moderator is obtained the detector by 'pinhole camera concept' and allows to study intensity distributions at different neutron energies



Blocks unwanted radiation

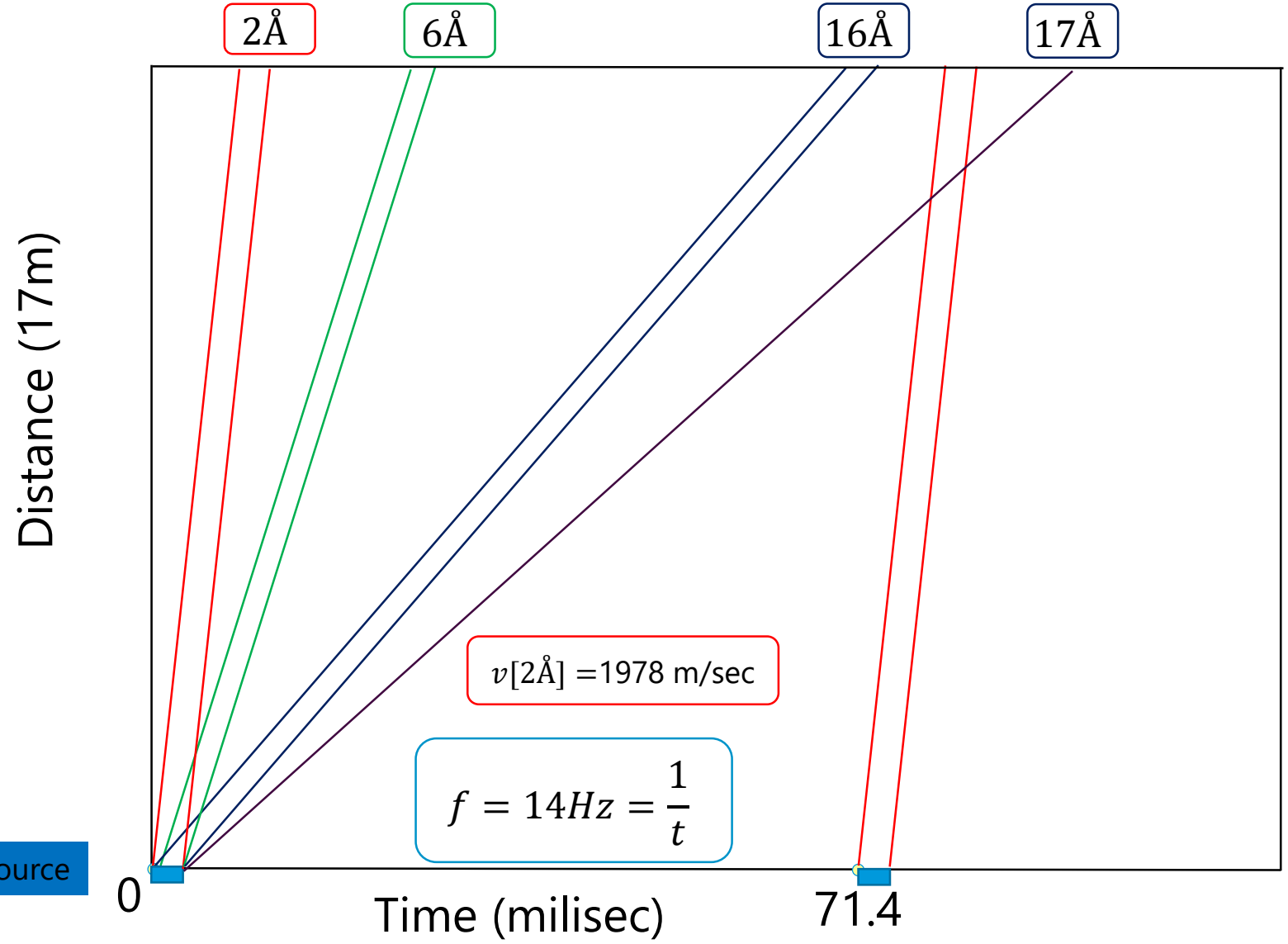
Measure the pulse shape



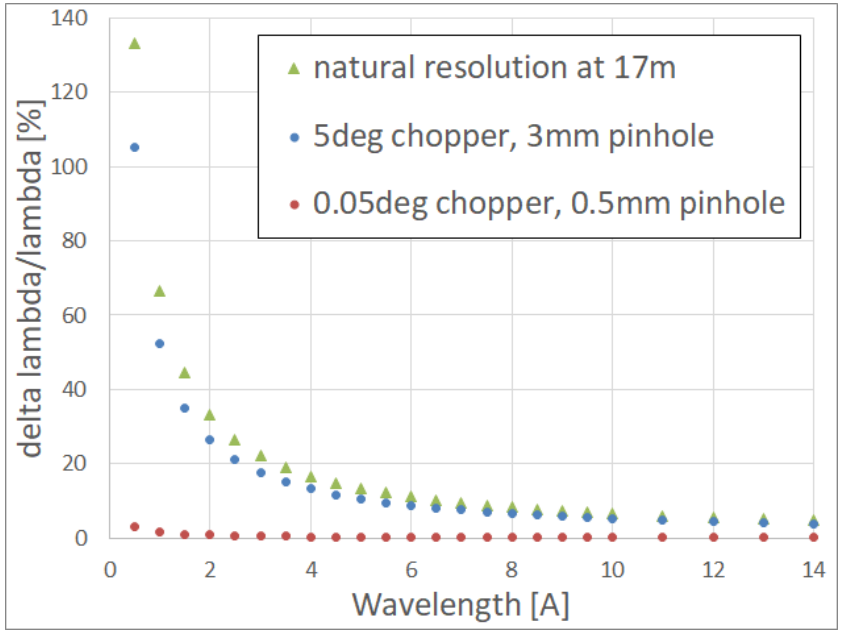


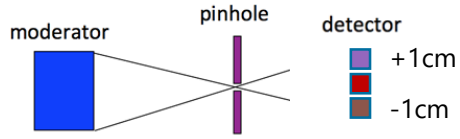
How we want to do it?

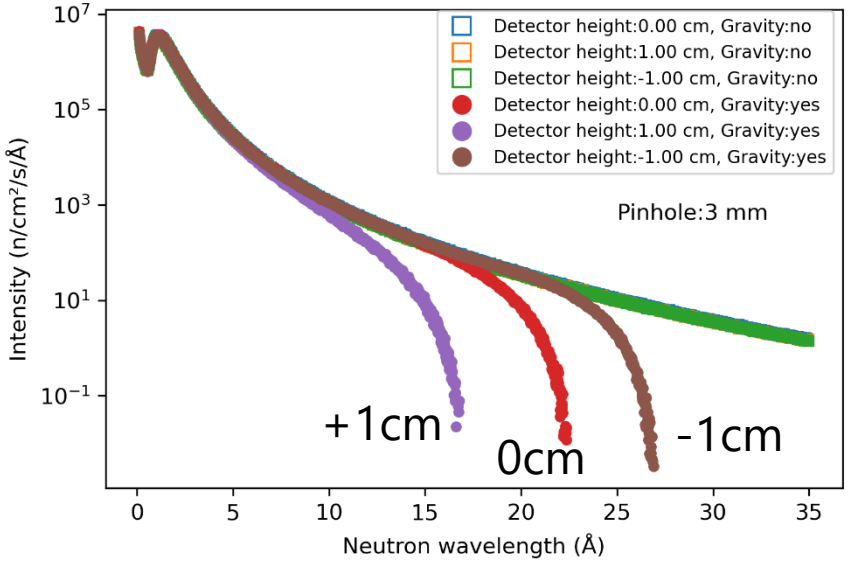
Schematic: natural resolution ToF diagram



Source

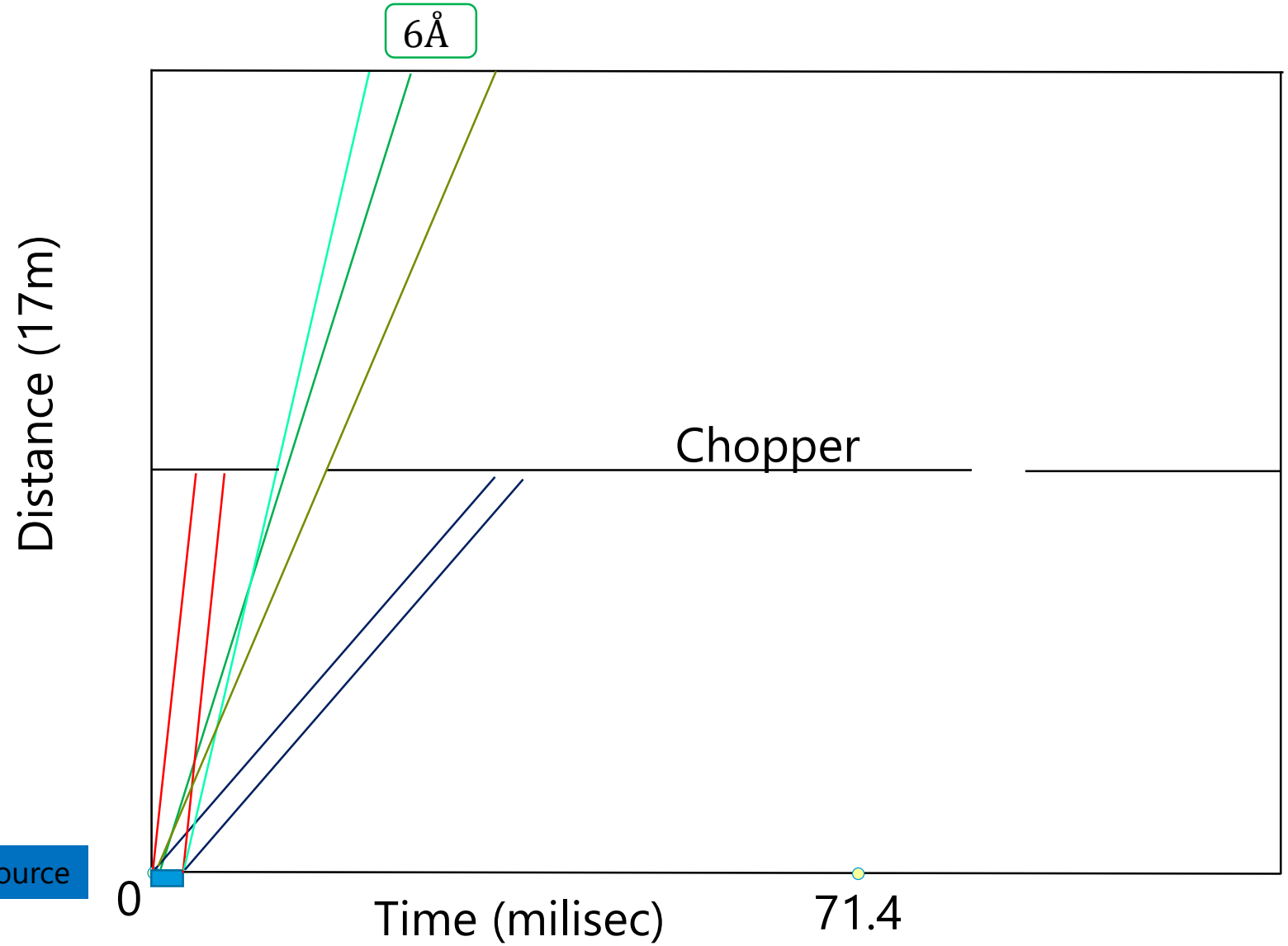






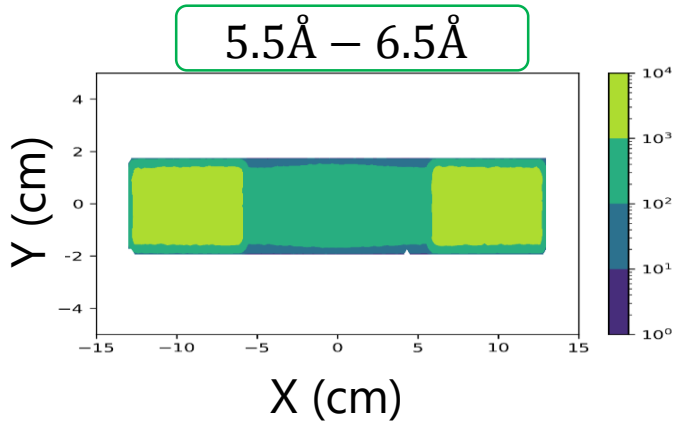
How we want to do it?

Schematic: Study wavelength/energy ranges with spatial resolution



1) Simply by ToF (no chopper, or chopper to prevent FO)

2) Using chopper to create distinct wavelength bands



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- Recap: What do we actually want to do?
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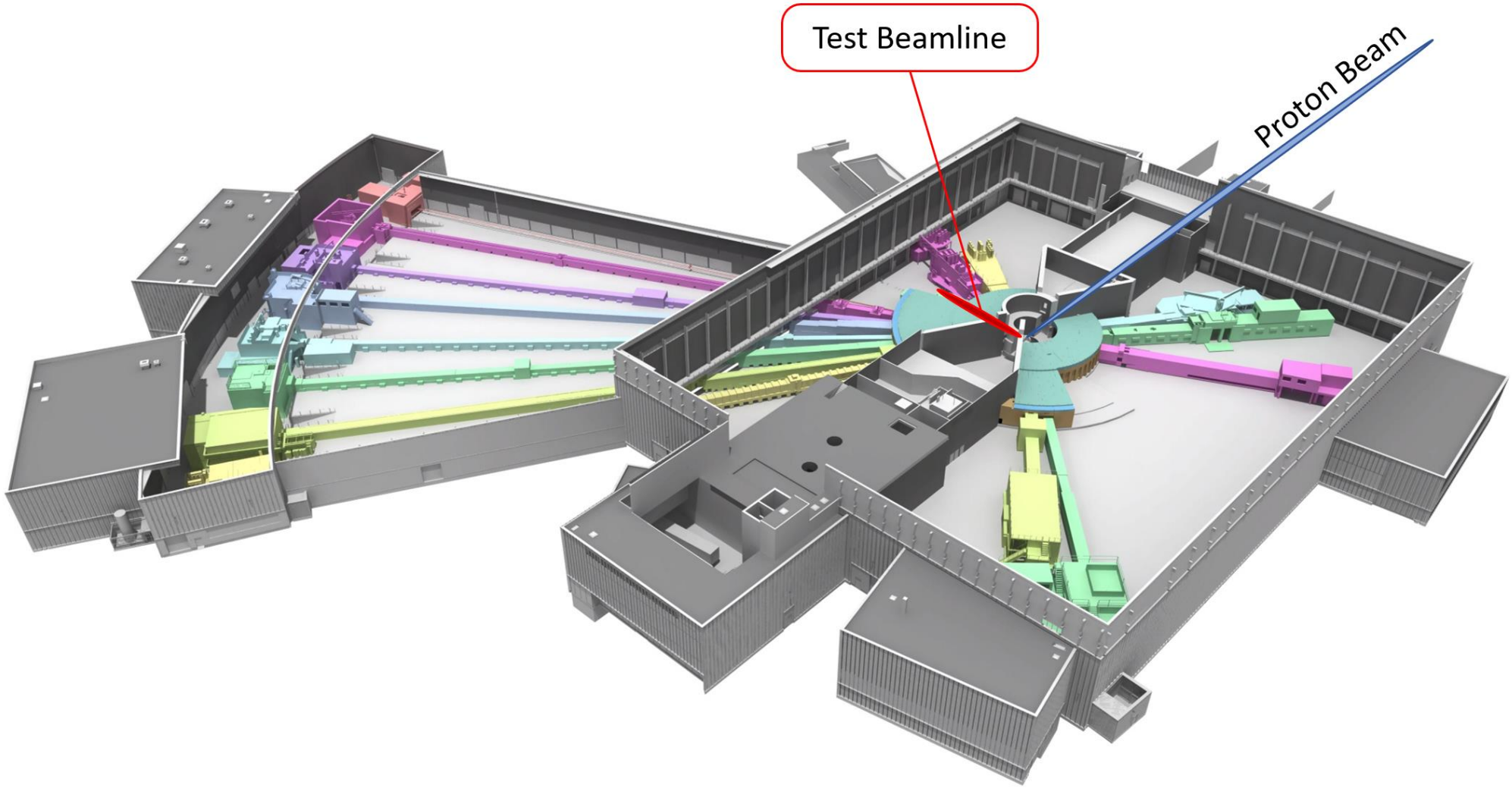
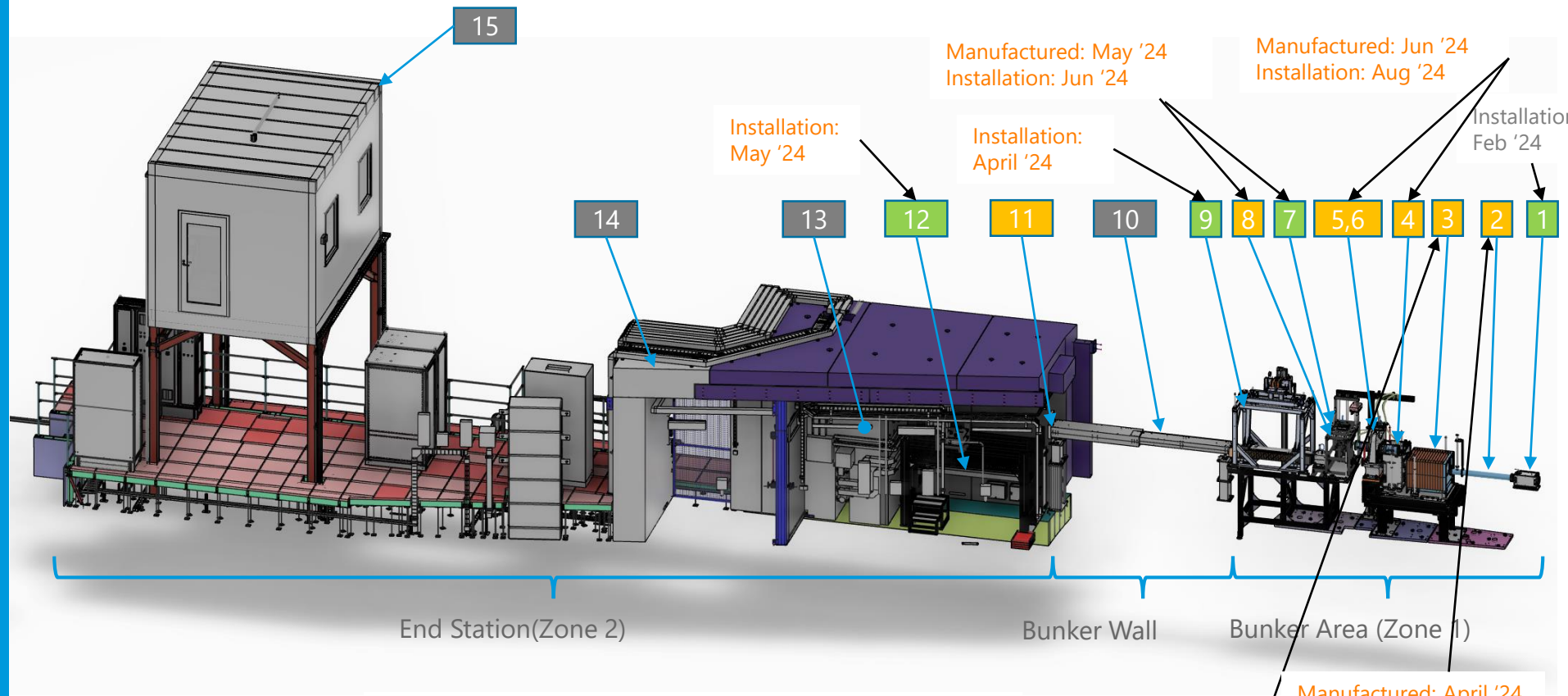
Overview

Location in Facility: W11 (North Sector)



TBL Status (SPI: 0,96 SV: -739kSEK)

Start Int. CC:	Sep 2024
TG5/SAR mtg:	Dec 2024
iSRR mtg:	Feb 2025



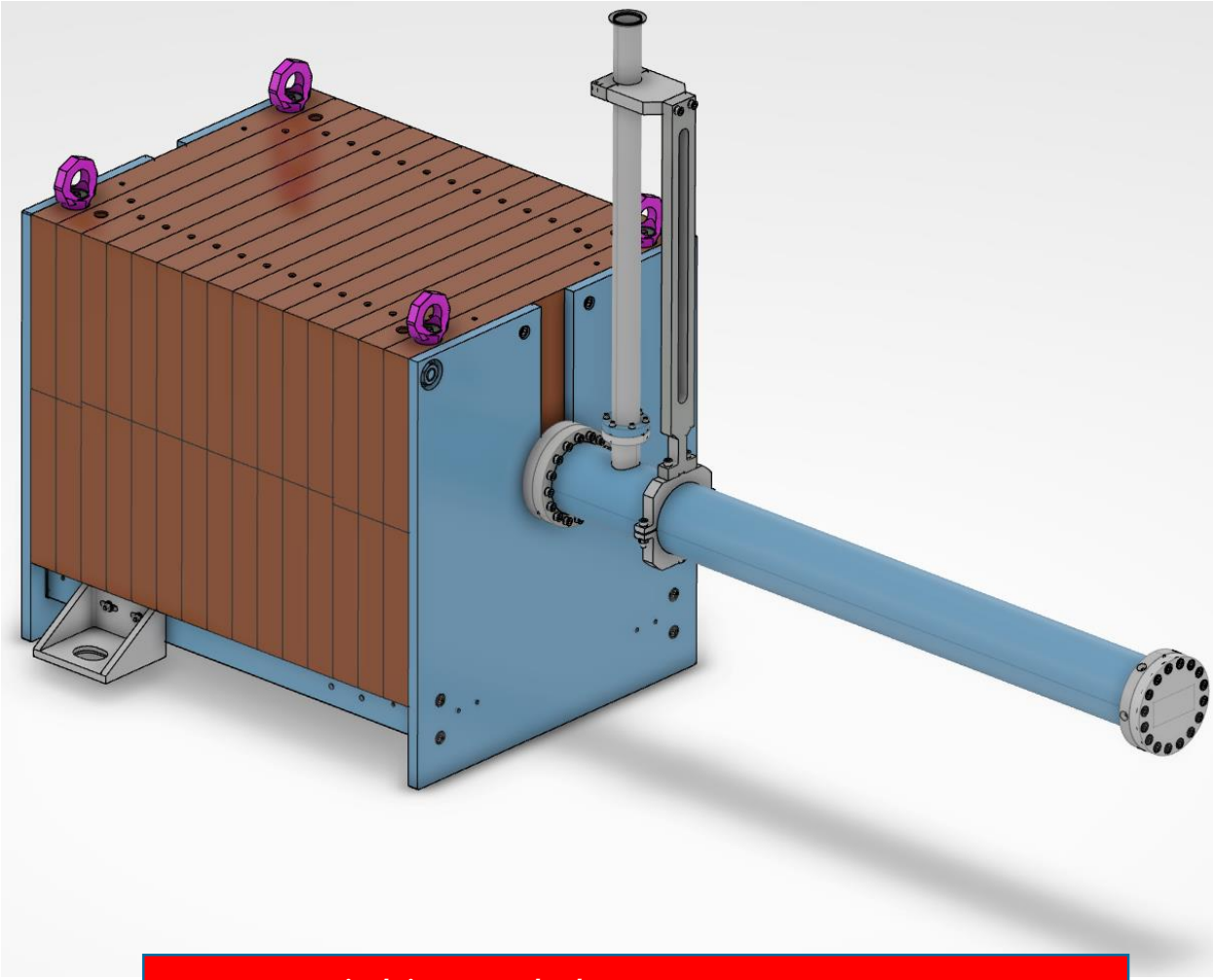
Ref.	Component
1	BBGOA (delivered)
2	Flight Tube 1
3	Fixed Collimator
4	adjustable Collimator
5,6	Chopper, Flight tube 2
7	Beam Monitor 1 (delivered)
8	Filter stage
9	Heavy Shutter (delivered)
10	Bunker Wall Feedthrough
11	Beam Monitor 2
12	Detector Table (delivered)
13	Beam Stop
14	Experimental Cave
15	Control Hutch

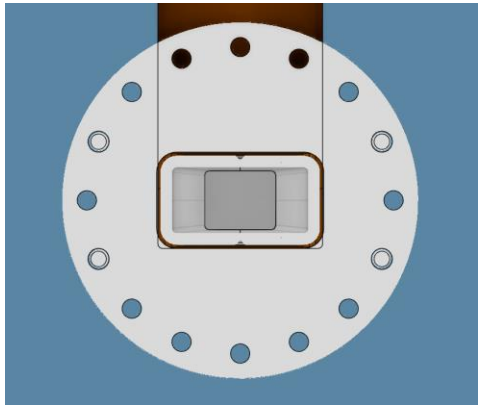
Infrastructure installation:
CEP: In-bunker: March '24 / Out of bunker: May '24
CUP: In-bunker/Out of bunker: April '24
MCA: In-bunker/Out of bunker: May '24

Slide updated mid Jan.

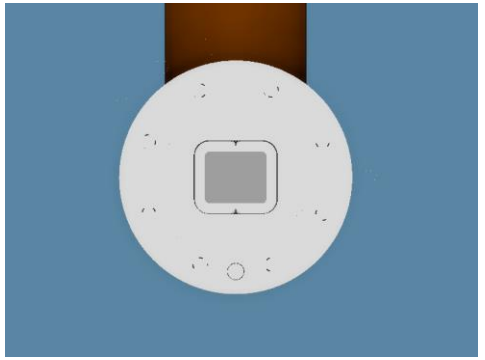
Overview

Heavy Collimator





Upstream opening:
H:68 mm x V:28 mm

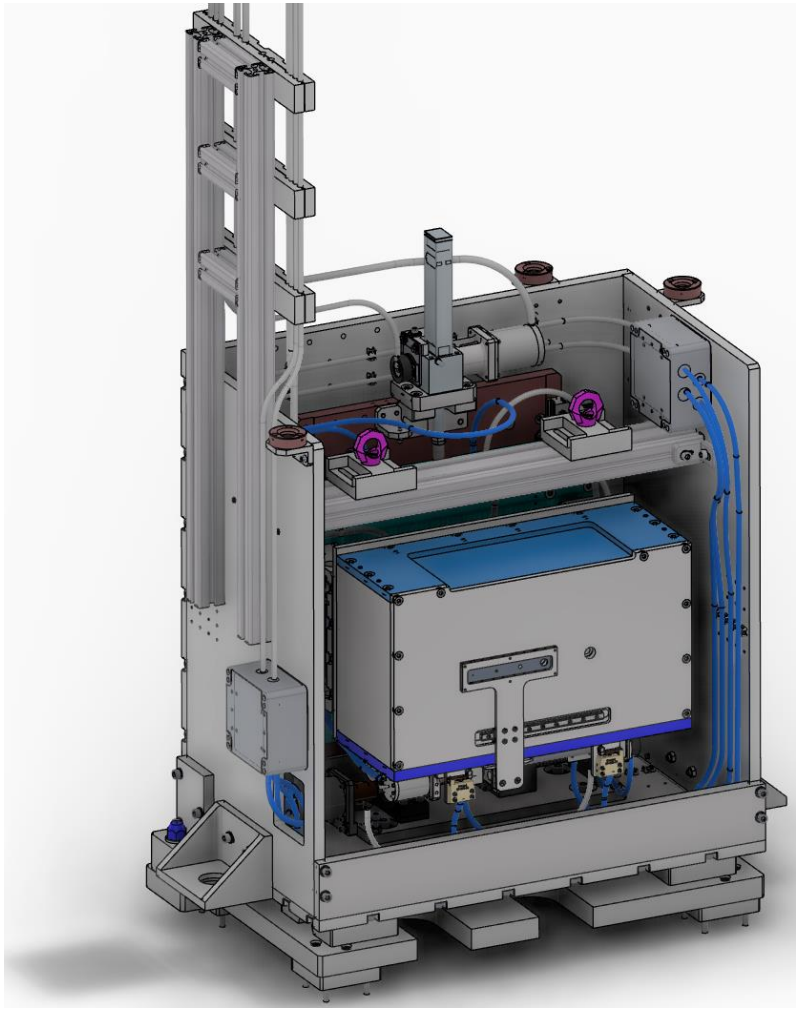


Downstream opening:
H:30 mm x V:25 mm

- *Material in workshop*
- *see ODIN presentation on waiting times…*

Overview

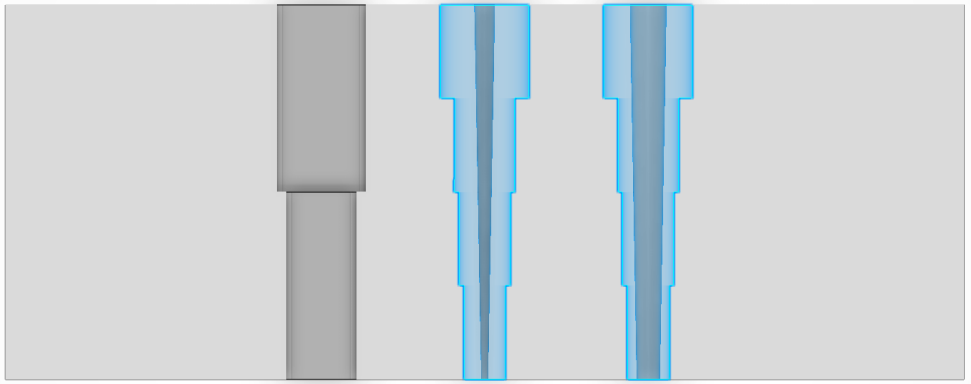
Adjustable Collimator



- Attenuator selector (3mm, 2mm, 1mm, 0)

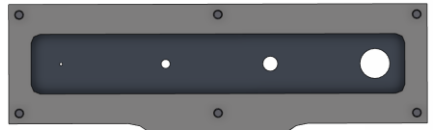
- Copper block with inserts

Upstream: 38x33mm 9 mm 16 mm



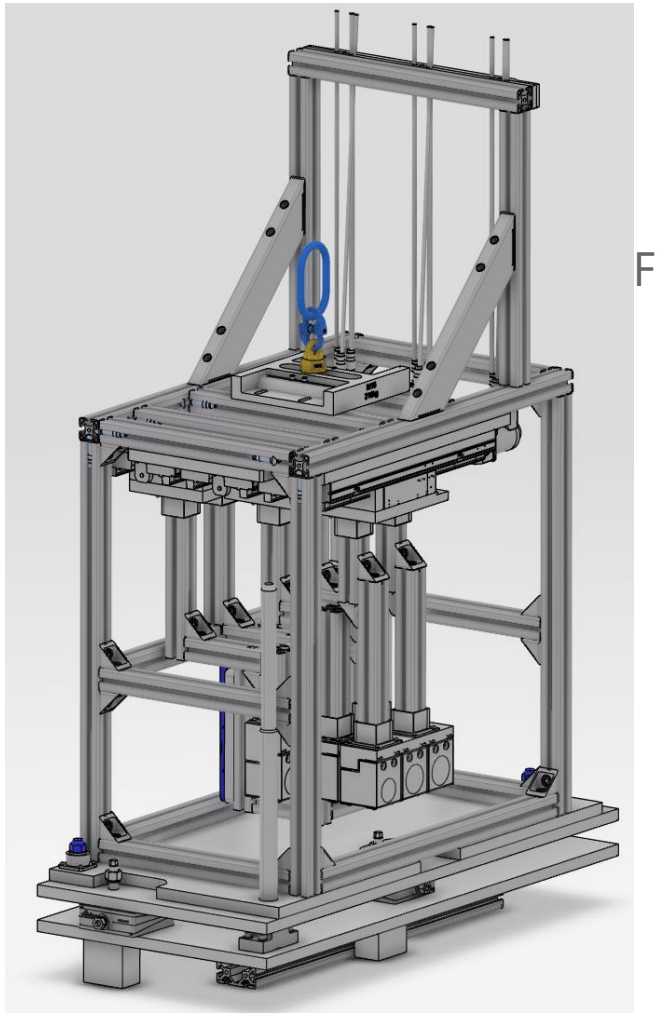
Downstream: 30x25mm 3 mm 10 mm

- Pinhole selector (1mm, 3mm, 5mm, 10mm, open)



Overview

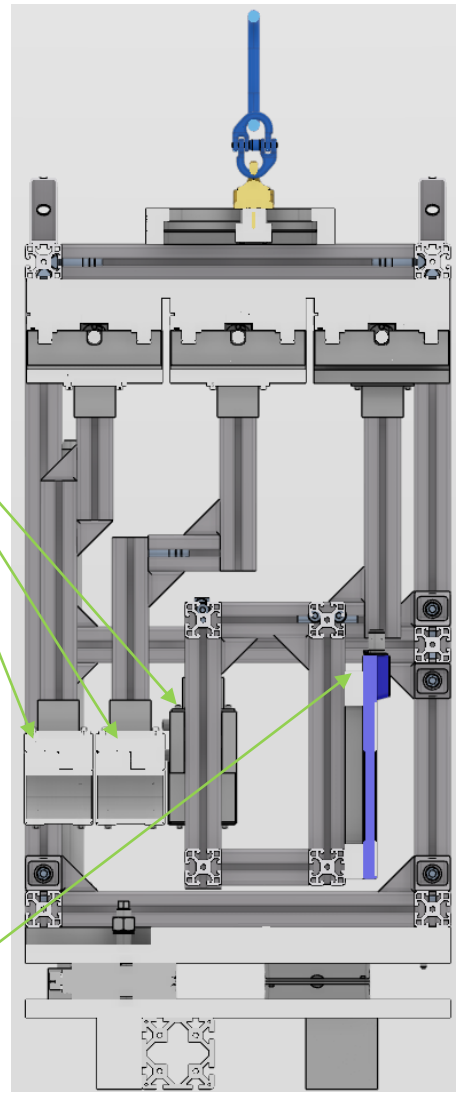
Filter Stage

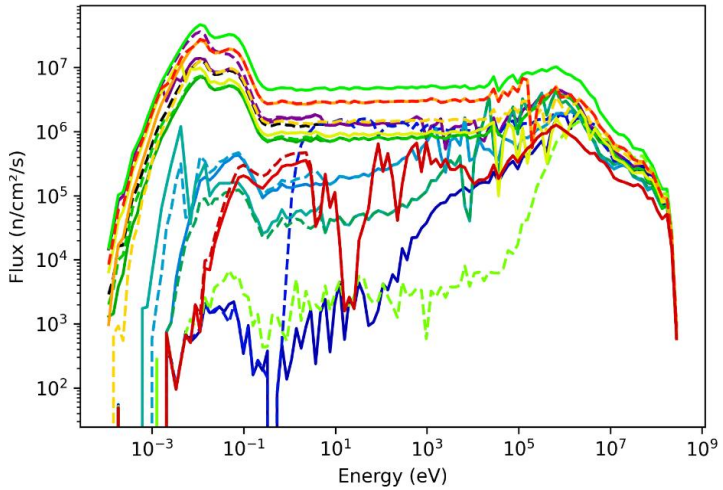


Filter cassettes

Beam

Beam Monitor

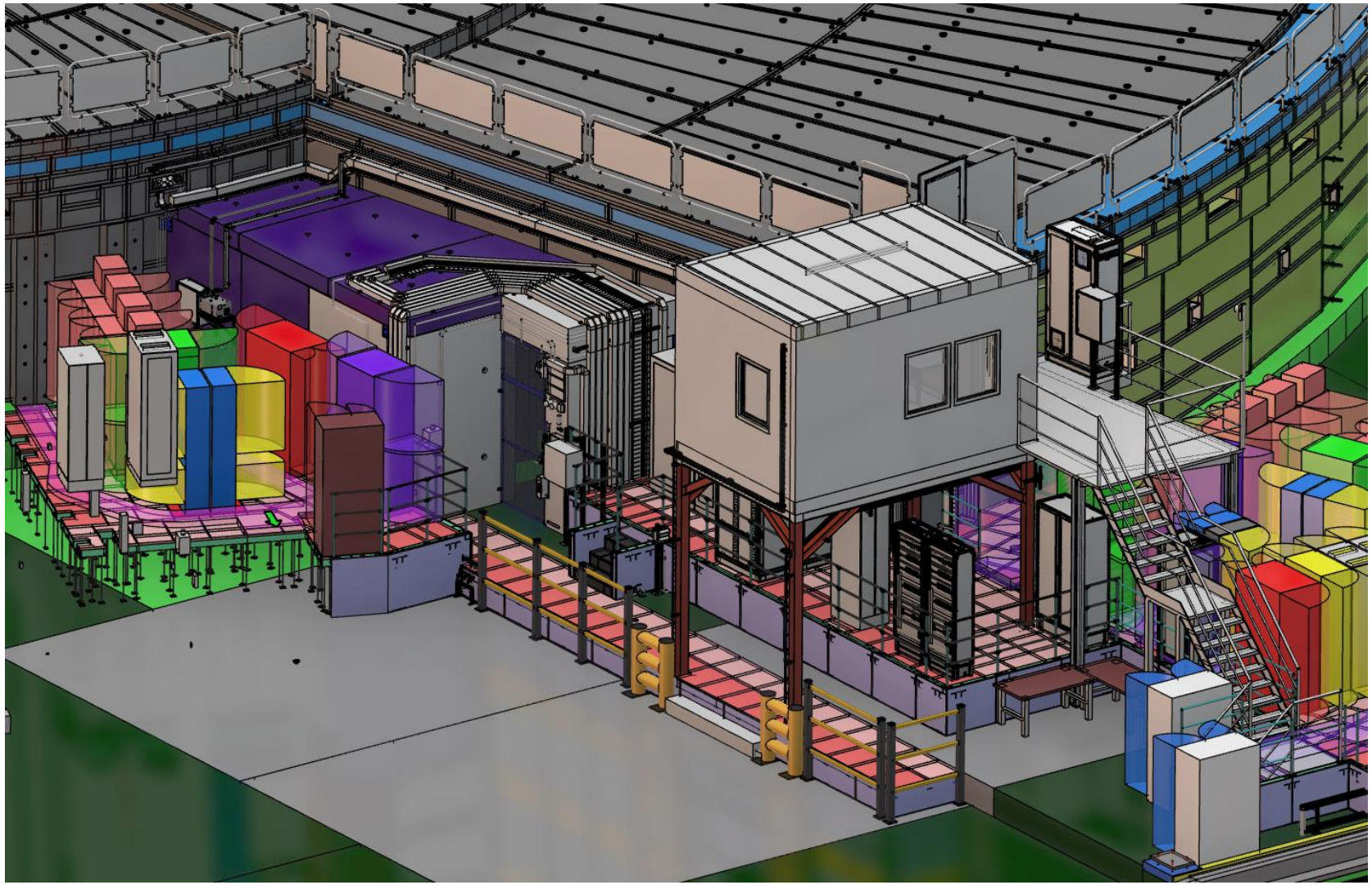




Filters on-site: Fe, HDPE, Bi, Cd, Sapphire, Si

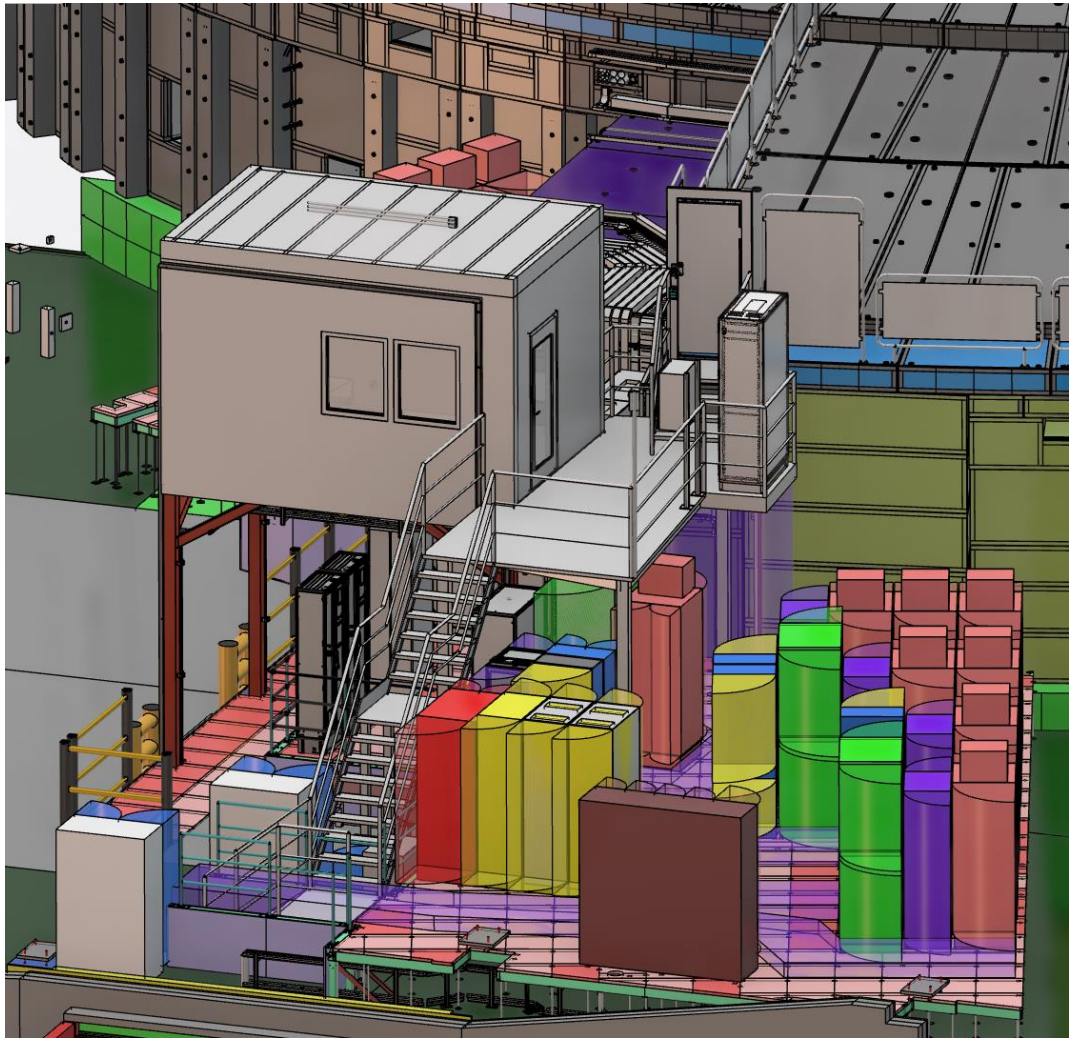
Overview

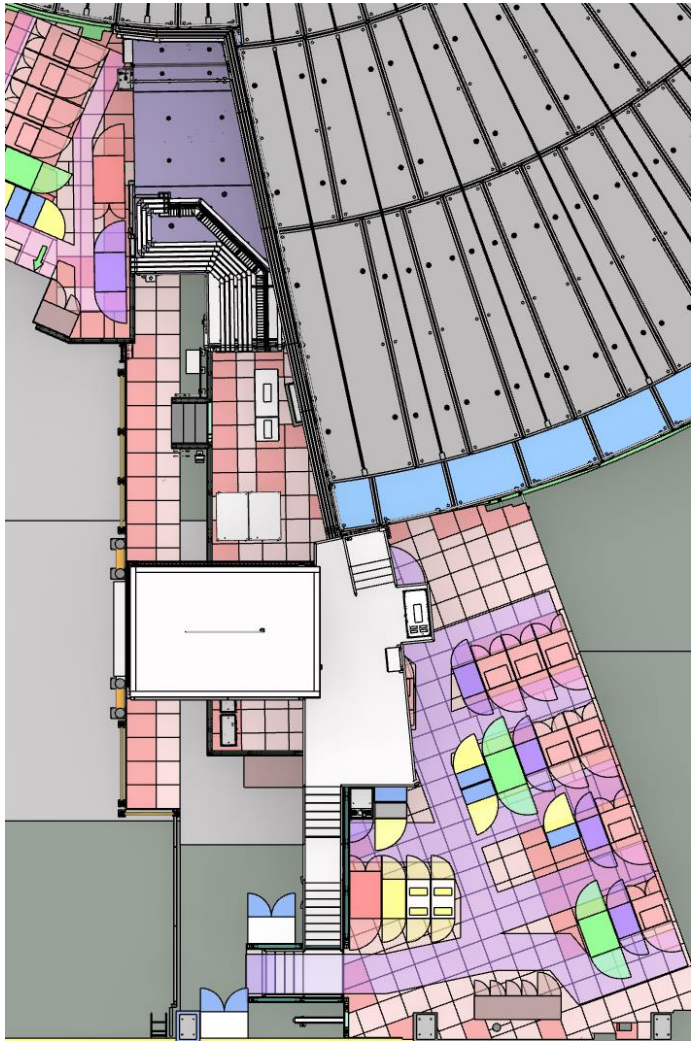
Picture from above



Overview

Picture from above





Overview

Control racks

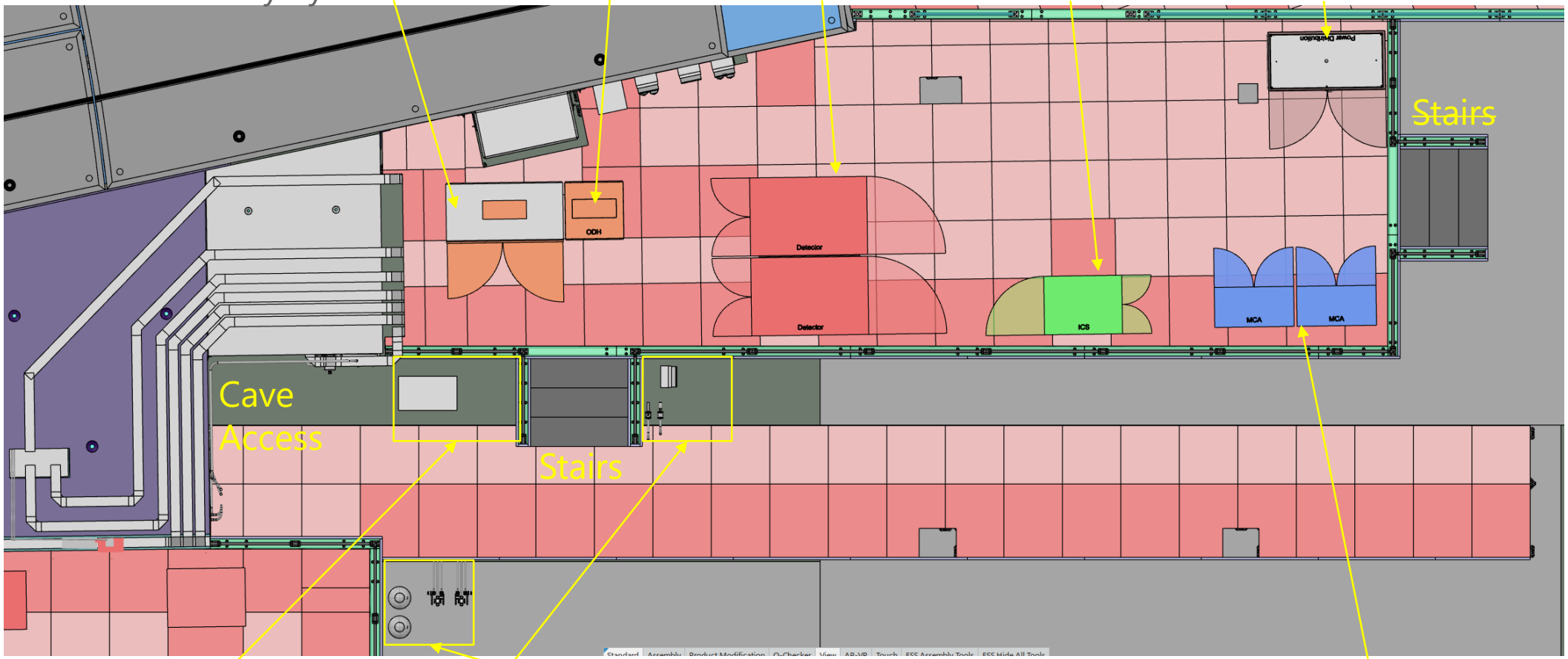
ODH Rack
Oxygen Deficiency Hazard.

Personal Safety Systems Rack

2x Detector Rack

ICS Rack

Power dist. Rack



PSS Area

Utilities Areas

2x Motion Control Rack
(32 axis in cave total)

Overview

Overview

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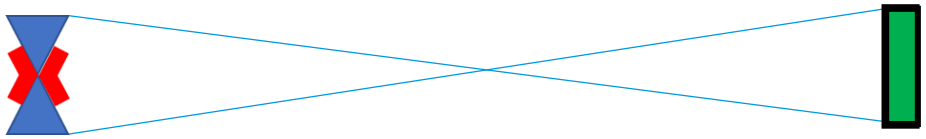
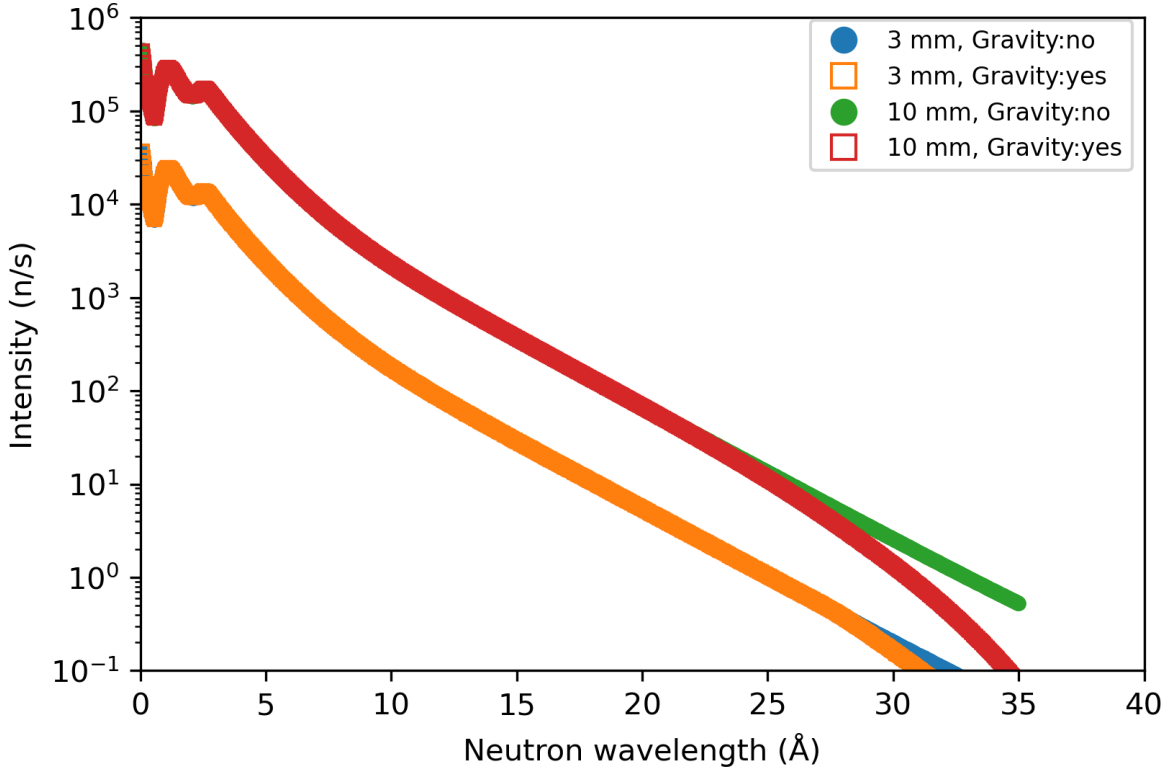
Neutron flux at detector position (McStas)



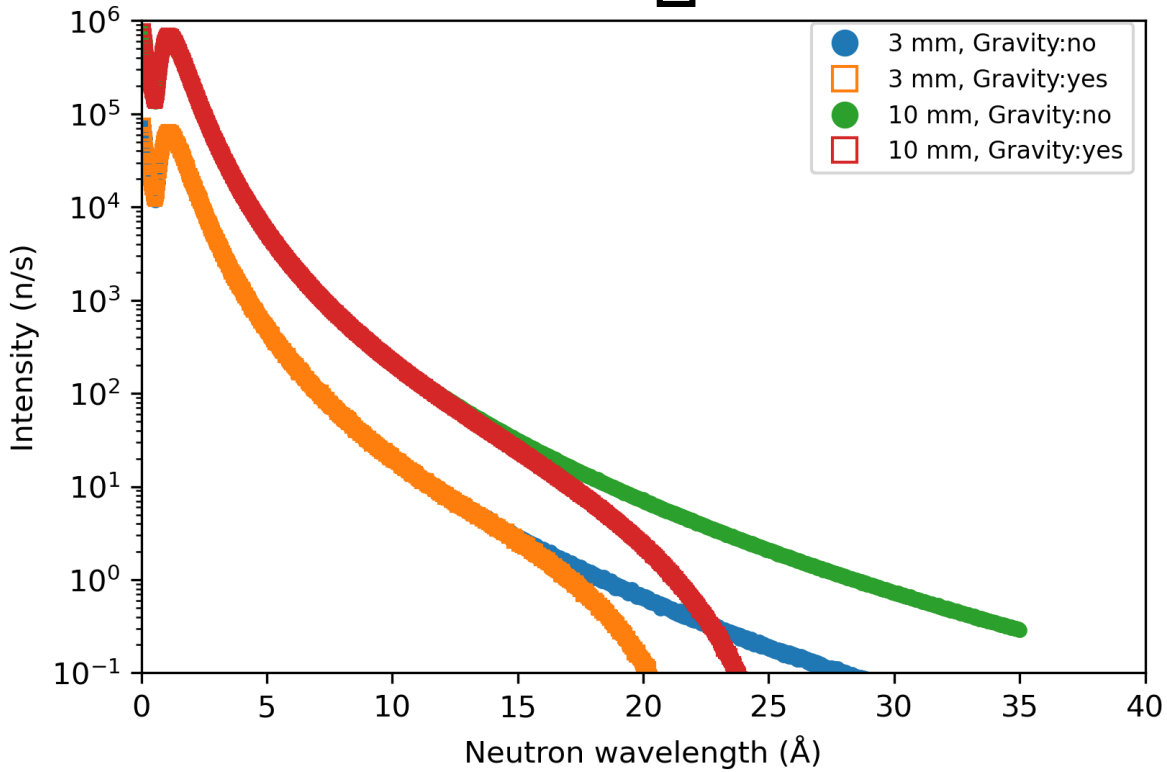
Complete detector view

Center part



Thermal and cold (0.1 - 25 Å) flux: 3.39e+06 n/s/cm² at pinhole 3 mm

Thermal and cold (0.1 - 25 Å) flux: 4.16e+07 n/s/cm² at pinhole 10 mm



Thermal and cold (0.1 - 25 Å) flux: 4.90e+06 n/s/cm² at pinhole 3 mm

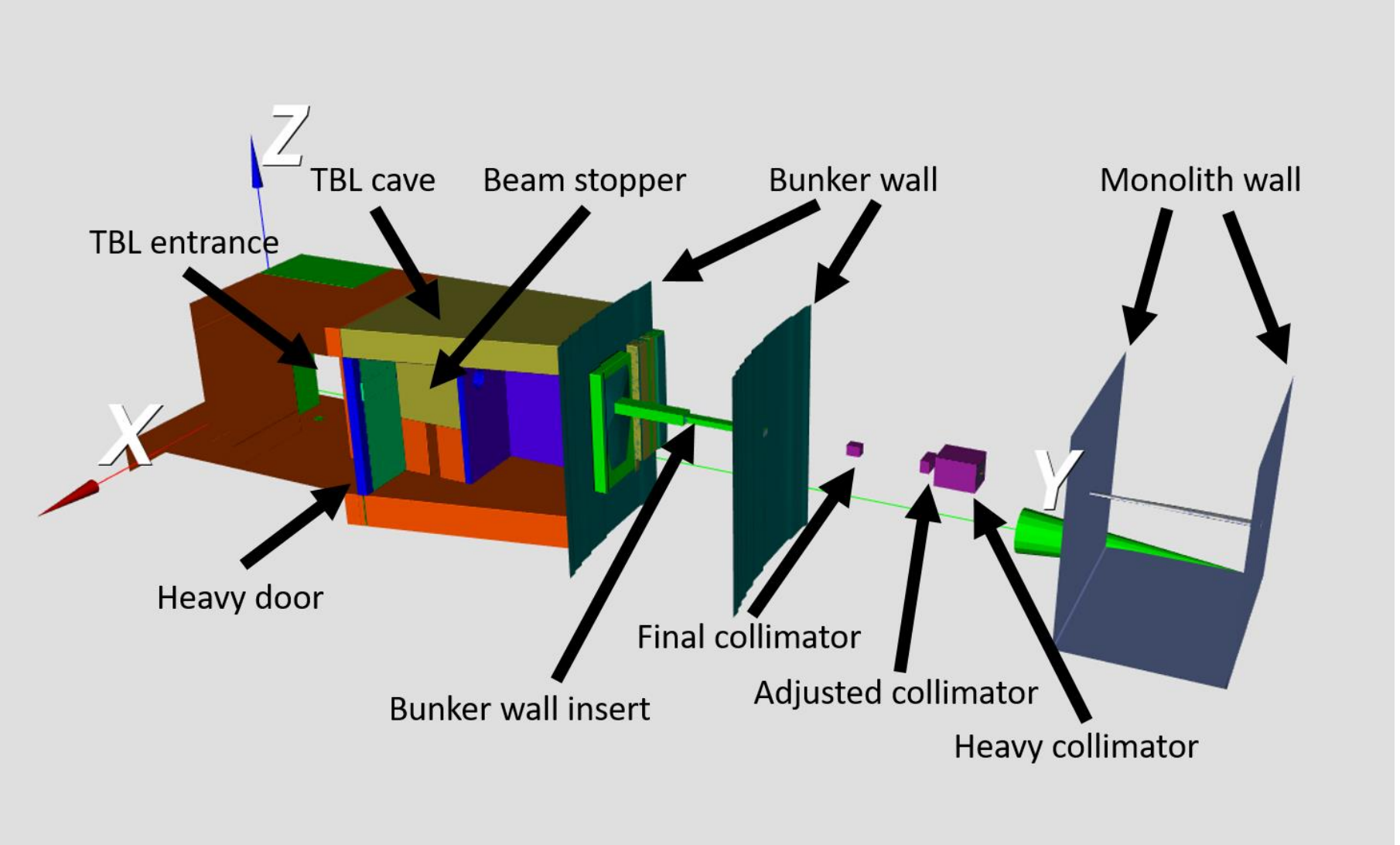
Thermal and cold (0.1 - 25 Å) flux: 5.40e+07 n/s/cm² at pinhole 10 mm

Thermal and cold flux: ~1+08 n/s/cm² at 30mmx25mm

Neutron flux obtained from neutron intensity divided by estimated imaging area (3x24 cm²)

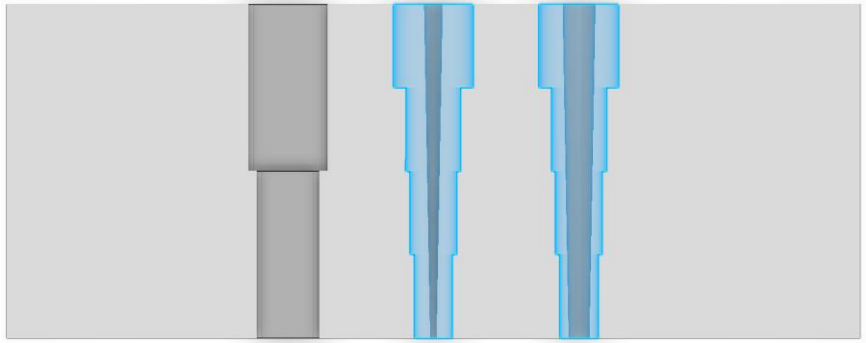
Neutronics

PHITS model



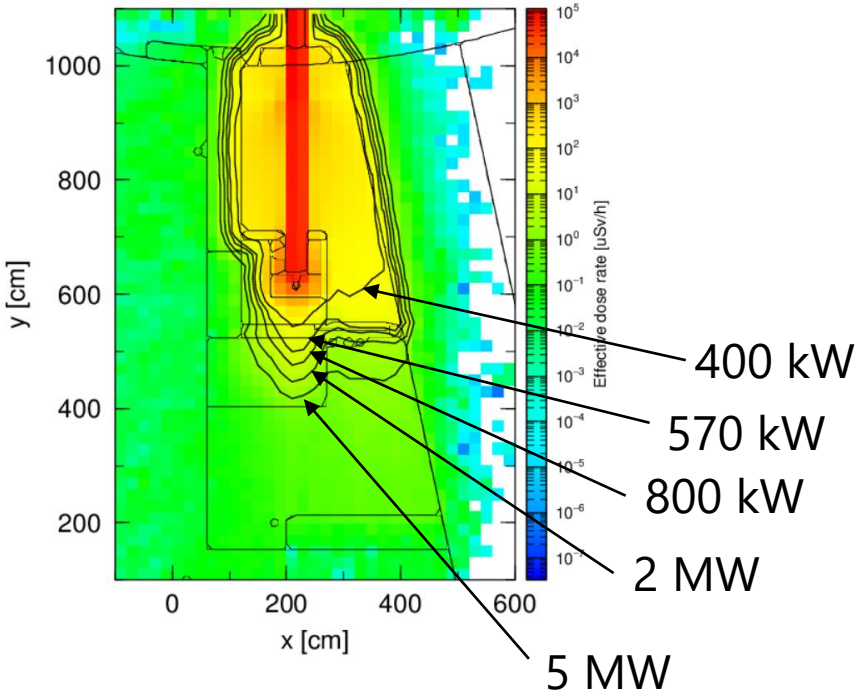
Neutronics

Shielding H1-8 (Water Target) Result

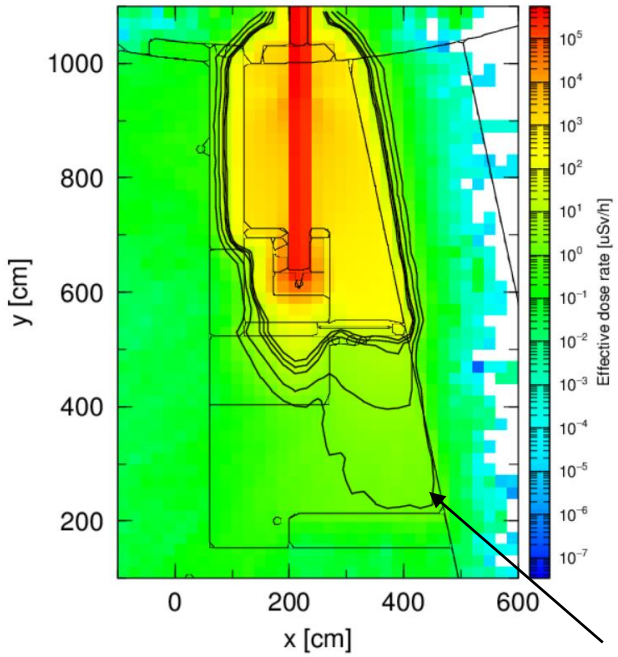


1.5 μSv/h countour maps @400 kW to 5WM

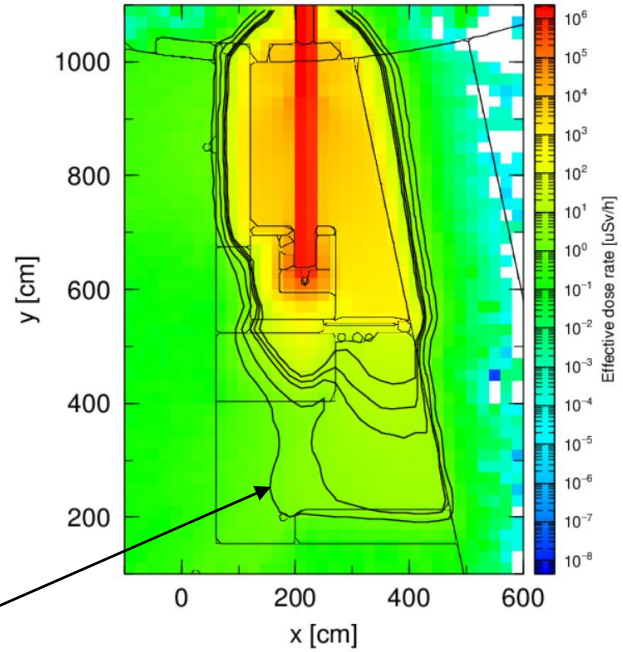
3 mm



10 mm



30x25mm



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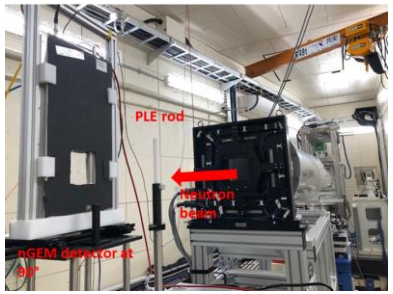
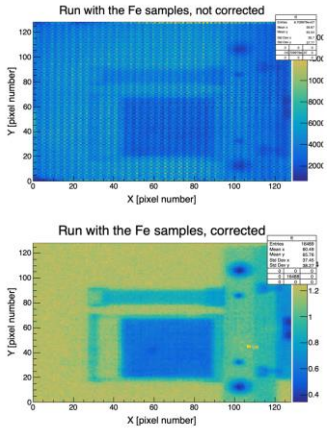
Test beamline (TBL): Detectors

nGEM

Detector	nGEM
Type	Micropattern
Neutron converter	^{10}B
Area (mm^2)	100 × 100
Time resolution (ns)	15
Spatial resolution (mm)	1
Efficiency @25.3 meV (%)	10
Peak count-rate capacity	4.6 Mcps
Effective peak count-rate	180 kcps

Detector uniformity measured by recording data with a PLE rod (isotropic scattering in 4pi)

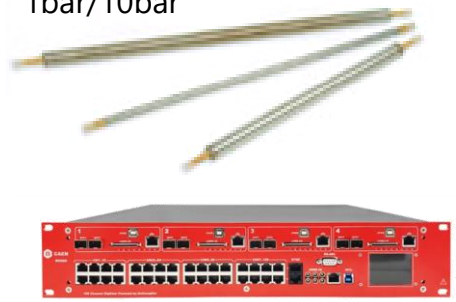




tested @J-PARC: works acc. to specs

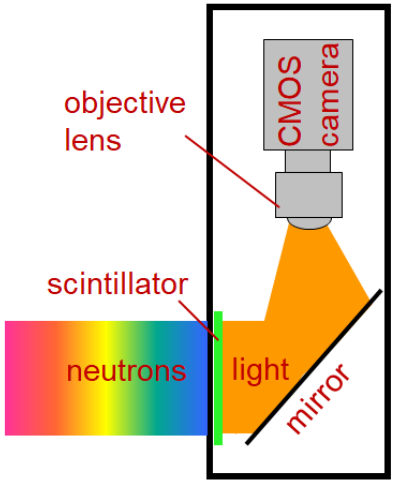
^{3}He PSD tubes

1bar/10bar



Scintillator

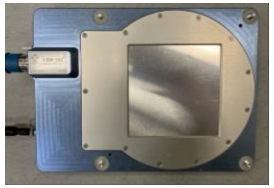
CMOS
+ gated
intensifier



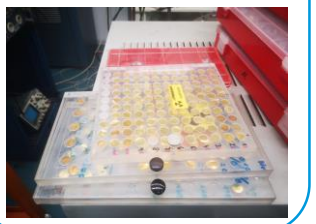
TPX3cam (LumaCAM)

Beam Monitors

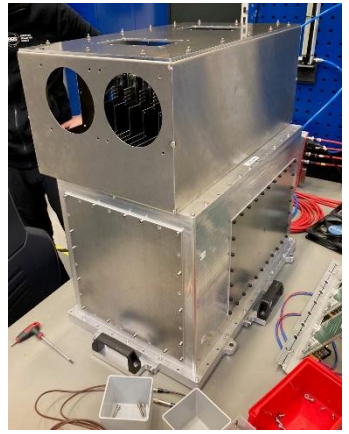
- In bunker (moveable, 5% efficiency)
- In cave (moveable, 5% efficiency)



Gold foils



Multiblade

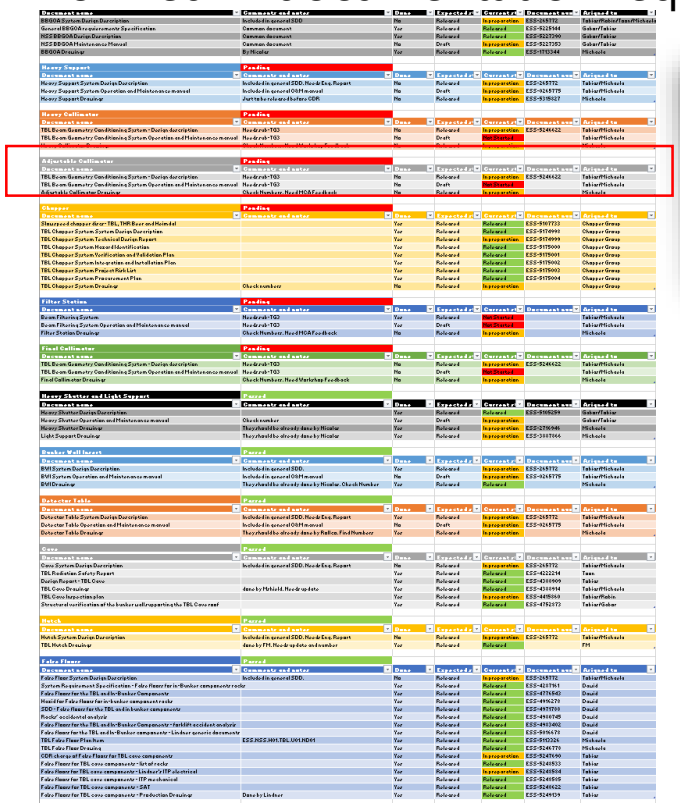


Test beamline (TBL)

- ❑ Recap: What do we actually want to do?
- ❑ How do we want to do it?
- ❑ Overview of Layout
- ❑ Spectrum & Shielding & Flux
- ❑ Detectors
- ❑ Feedback & Discussion

Current Challenges

- Drowned in documentation requirements that slow down the ‘real work’



Adjustable Collimator
Document name
TBL Beam Geometry Conditioning System - Design description
TBL Beam Geometry Conditioning System Operation and Maintenance manual
Adjustable Collimator Drawings

reviewed + released drawings before any manufacture

Operation + Maintenance Manuals for all components (reviewed + released)

- Very long lead time for internal workshop (e.g. collimators)
- Computing infrastructure for Instrument Control and DAQ: uncertain timeline (is there enough time to implement and test the ‘high standard ESS solutions’?)
- Quality gates potentially delaying an already challenging installation schedule
- General lack of designated working space *(work benches, workstation to analyze data; seems hard to imagine – we know…)*

Questions to STAP

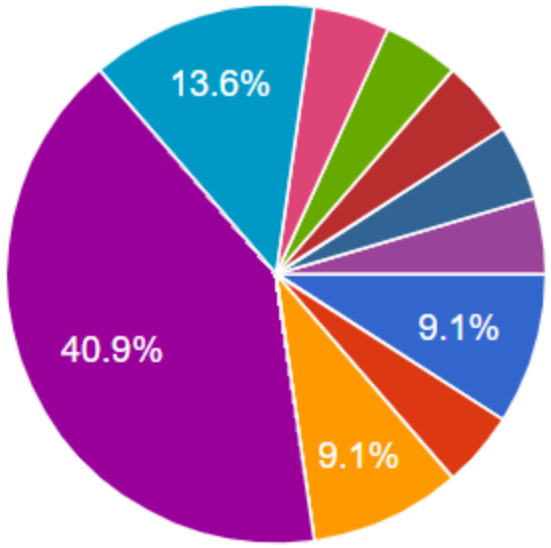
- Are there any ‘last minute’ design adjustments that TBL should consider?
- Would the STAP advise to take initial neutron data with ‘standalone’ solutions or using the ‘integrated event mode’ (EFU) – *‘as required by ESS’*?
- Pulse width (and shape) could be done in the beginning (short to long pulse) by a simple diffraction setup – any advise/concern?
- Would the STAP advise for the TBL to play a role for ‘First Science at ESS’?

Questions to STAP

- Should we attempt to re-name (re-brand) the TBL?

Your vote

22 responses



- Tora - "Testing of Radiation Analyzer"
- Magni - "Multiple Application Giving N…
- Tyr (pronounced tier) - "Test Your Req…
- Åse - "A Simple Experimental" Beamline
- Thor - "Test Hub of Radiation"
- Pia - because I fixed the funding:)
- HEL
- YMIR - no acronym. Ymir is the primor…
- Åsna
- DJ
- Yggdrasil

Thank you!