Heavy Shutter, Bunker insert and neutronics for the teast beam line

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Outline

- Brief overview of the test beam line and neutronics calculations
- Heavy Shutter calculations
- Bunker insert activation studies

Test Beam Line parameters (I)

ROPEAN
ALLATION
URCE

Summary of main components:

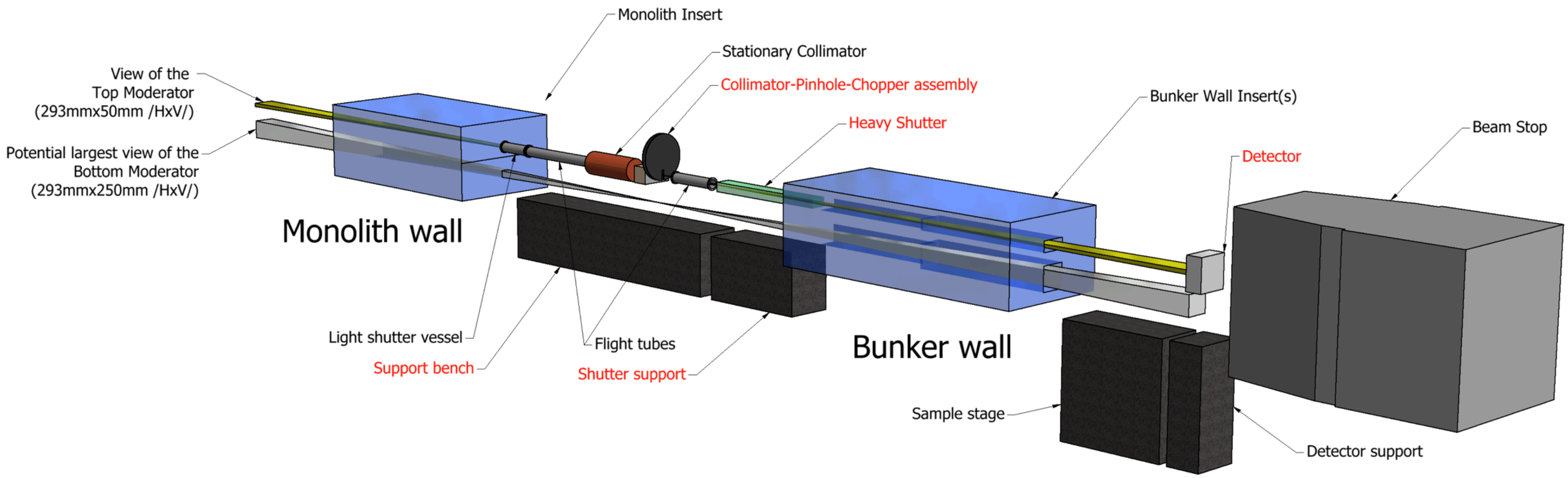
Nr	Component Name	Distance from TCS	Properties
1.	Monolith Insert	2.7m-5.5m (2.8m)	Penetration (Assymmetric! With 2mm gap around beam): 204.5mmx45.7mm->108.5mmx32.7mm (Hz x V)
2.	Gamma Shutter Insert	5.5m-6m (0.5m)	ID120mm /5mm B4C attenuator inside Argon filled
3.	Flight Tube 1.	6m-7.4m (1.4m)	ID120mm /5mm B4C attenuator inside
4.	Stationary Collimator	7.4m-8.2m (0.8m)	63mmx28mm-36mmx34mm (Hz x V) /10mm larger (around) than the beam/ /Copper with lead shielding around
5.	Adjustable Collimator	8.3m-8.5m (0.2m)	310mmx260mm (Hz x V), Ø3mm 15deg cone angle /Initial composition: Fe+Pb+Mirrobor+Pb+Fe/ MR304-2000-00-PE.pdf
6.	Pinhole	8.5m	1mm thick Cd, Ø0.5mm, Ø1mm, Ø1.5mm, Ø2mm MR304-2000-00-PE.pdf
7.	Double Disk Chopper	8.6m	D=500mm, 2000RPM MR Chopper general .pdf MR304-3000-00-PE.pdf
8.	Flight Tube 2.	8.7m-9.5m (0.8m)	ID120mm /5mm B4C attenuator inside
9.	Heavy Shutter	9.5m-11.3m (1.8m)	Attenuator: 400mmx300mm*1600mm /Pb+HDPE+B4C+Copper+Pb/
10.	Bunker Wall Insert	11.5-15m (3.5m)	Steel insert. Penetration: (Assymmetric! With 2mm gap around beam): 108.4mmx24.2mm -> 228.4mmx55.3mm (Hz x V)
11.	Detector	17m	Area: 300mmx300mm
12.	Beam Stop	17.5m	

with ~21 cmx5cm aperture in the monolith

and straight guide ….

Test Beam Line parameters (II)

EUROPEAN SPALLATION SOURCE

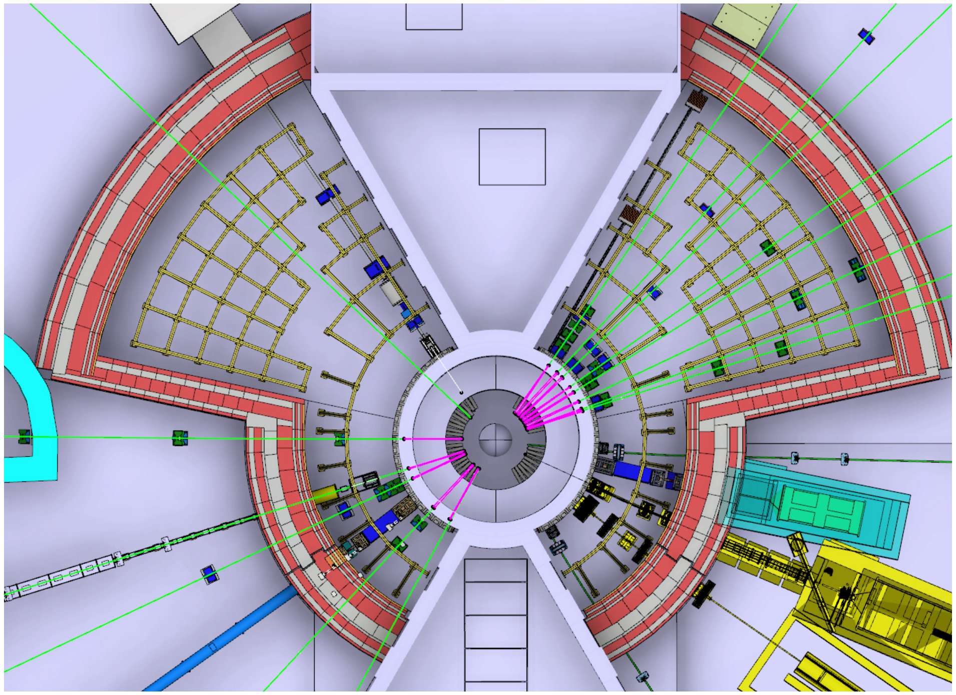


Test Beam Line is really the bad* guy of the ESS beamlines

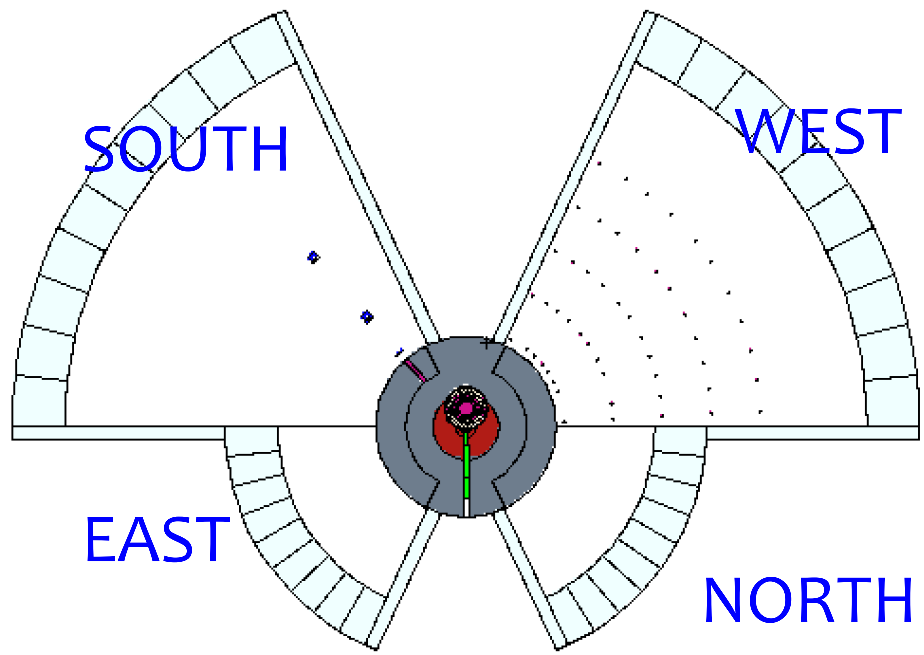
* from shielding point of view

The MCNP model

Engineering Model

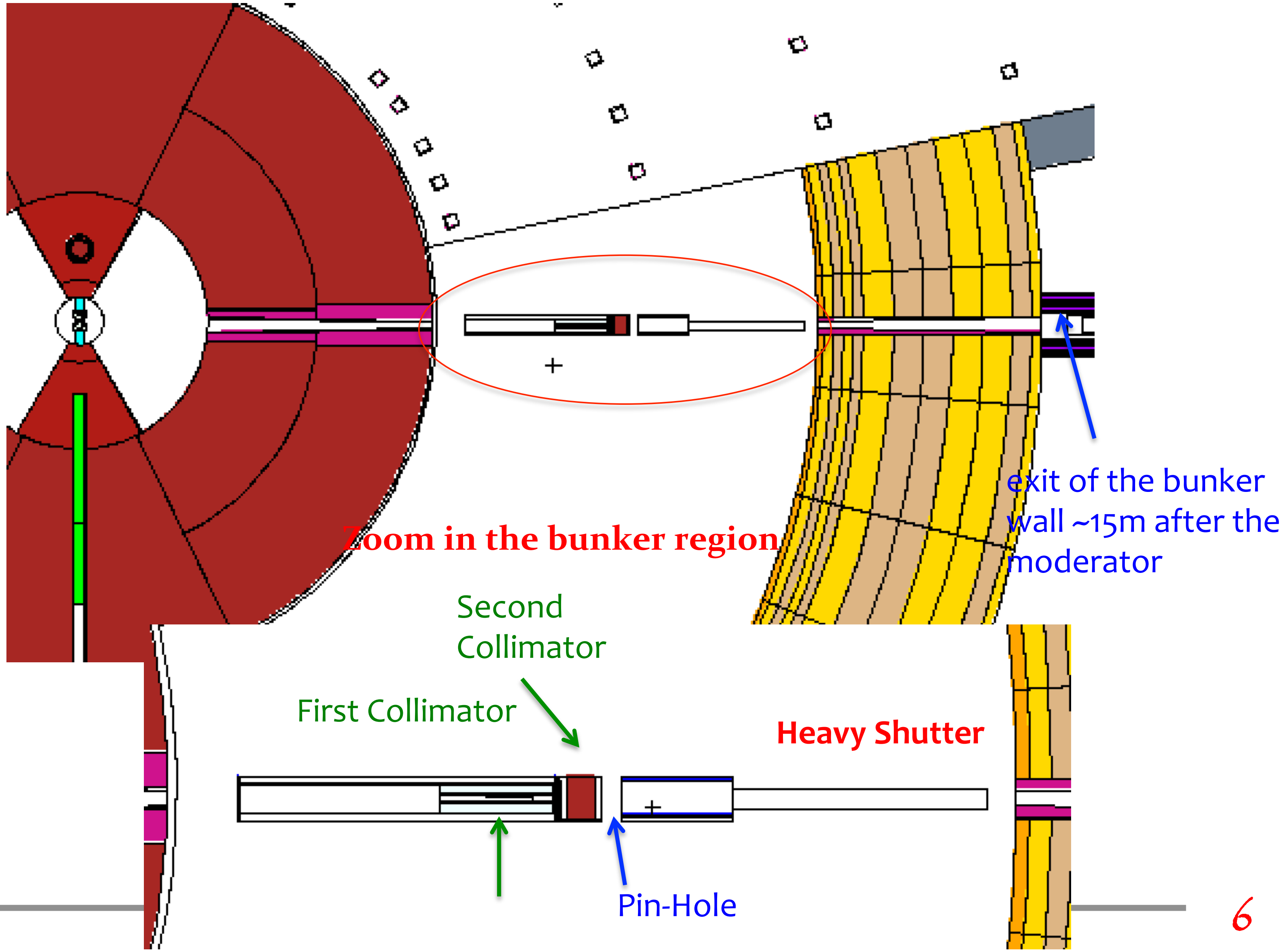


MCNP Model

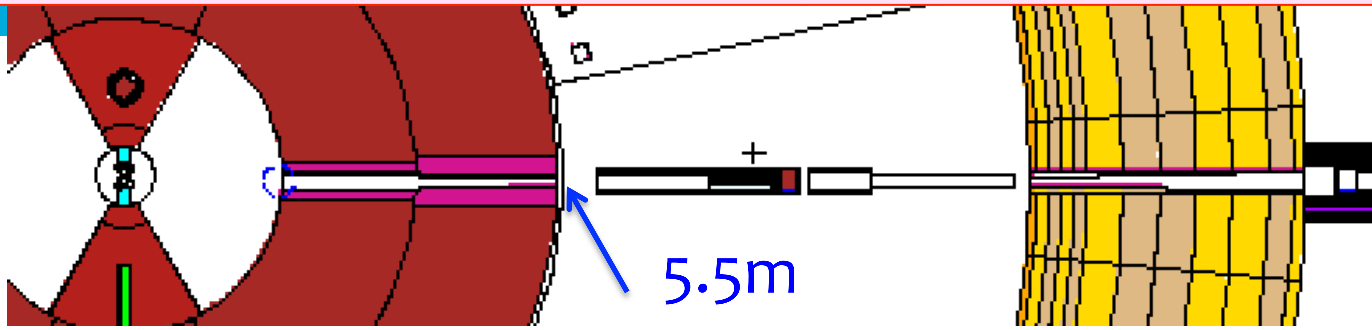


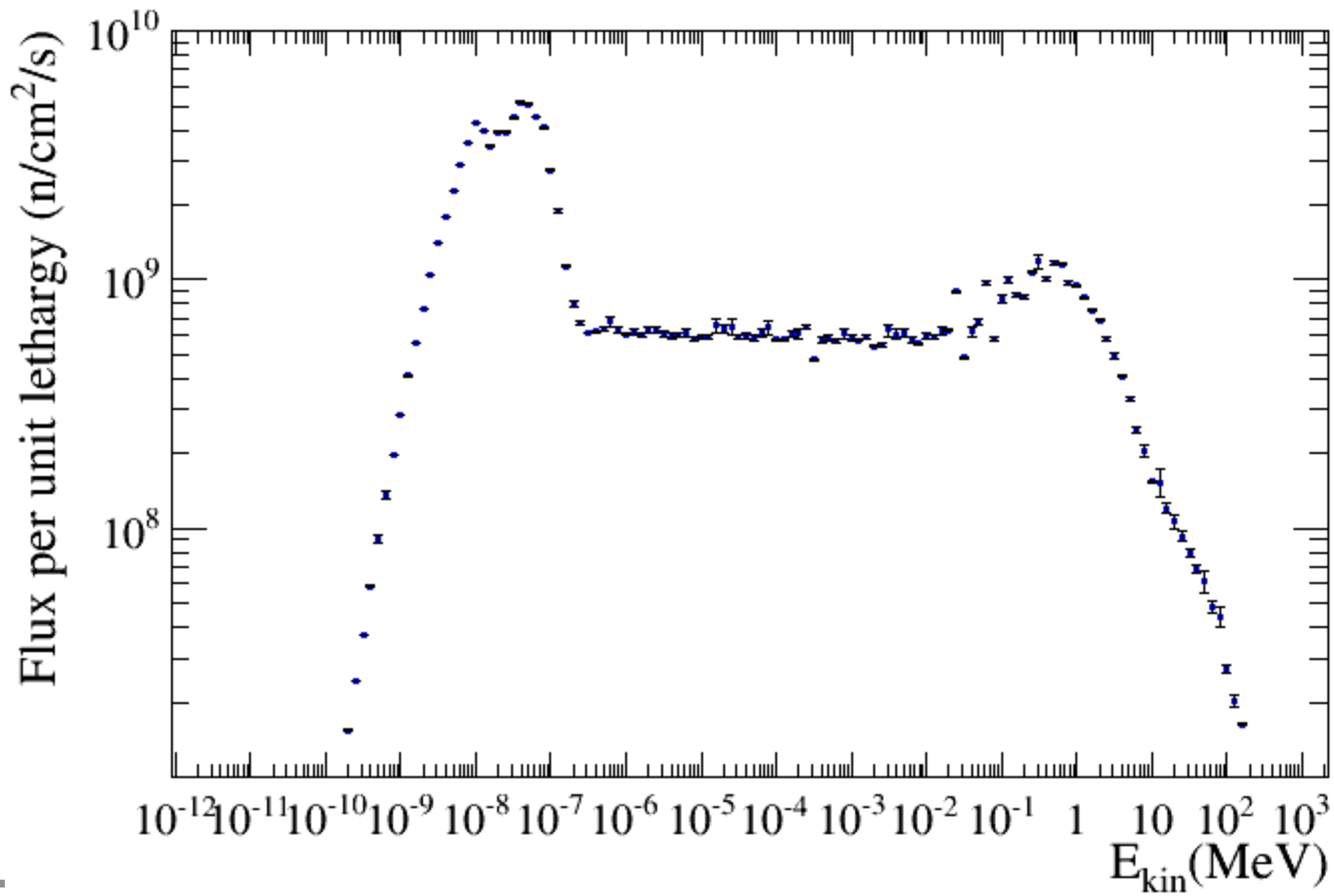
MCNP Model for target +Bunker+instrument hall +instrument cave produced with Comblayer package developed by Stuart Ansell
https://github.com/SAnsell/CombLayer

Test Beam Line @ W11

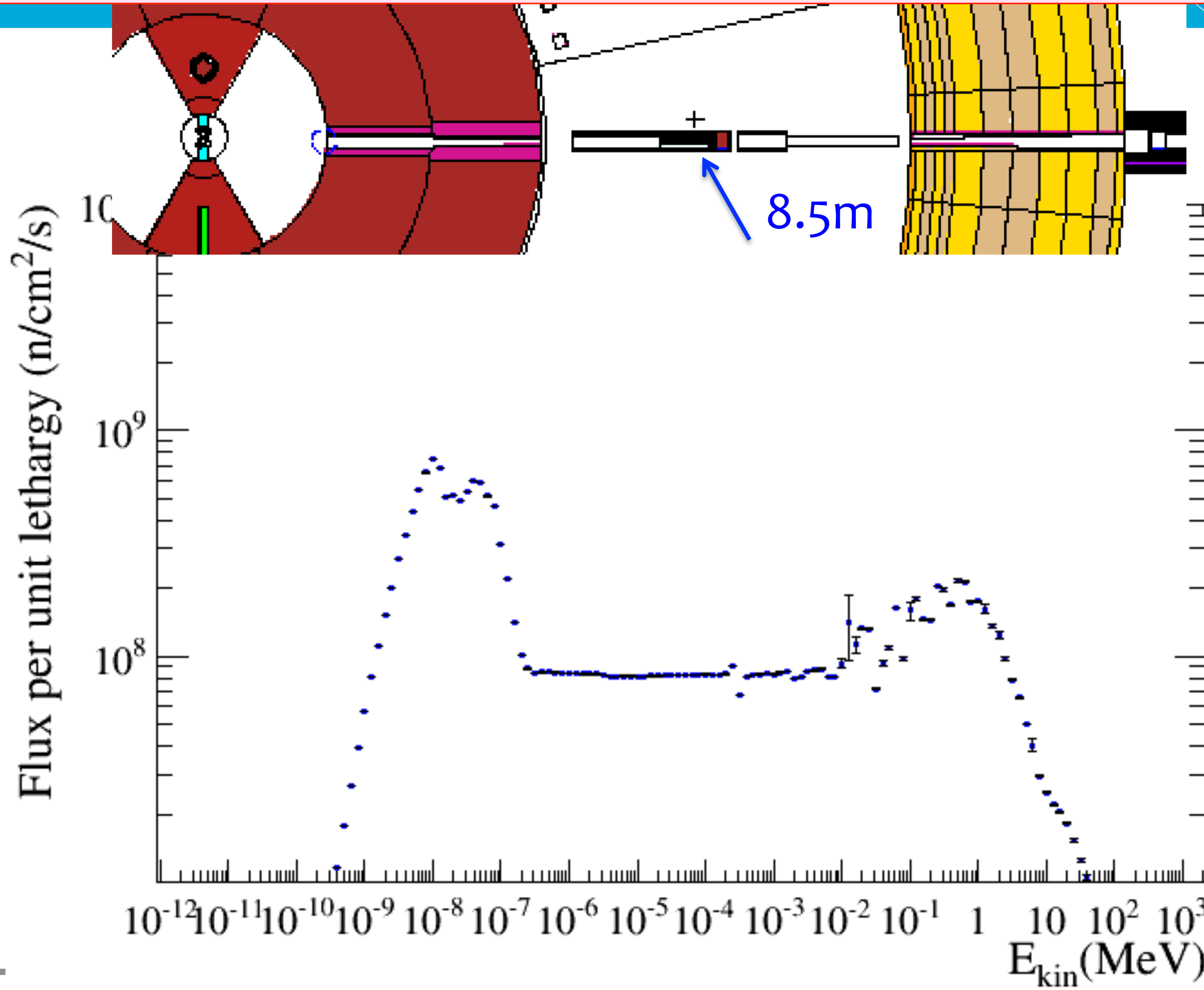


Neutron Energy Spectrum Out of the monolith

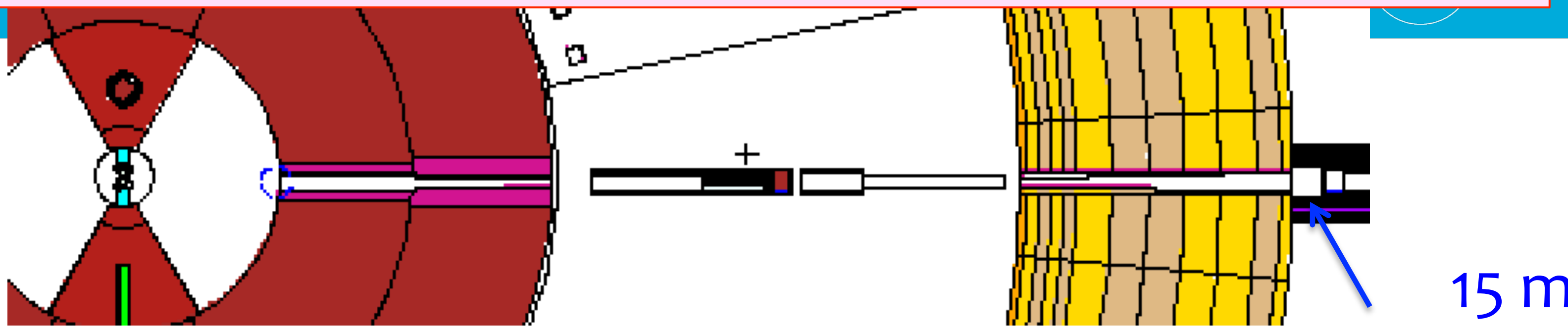


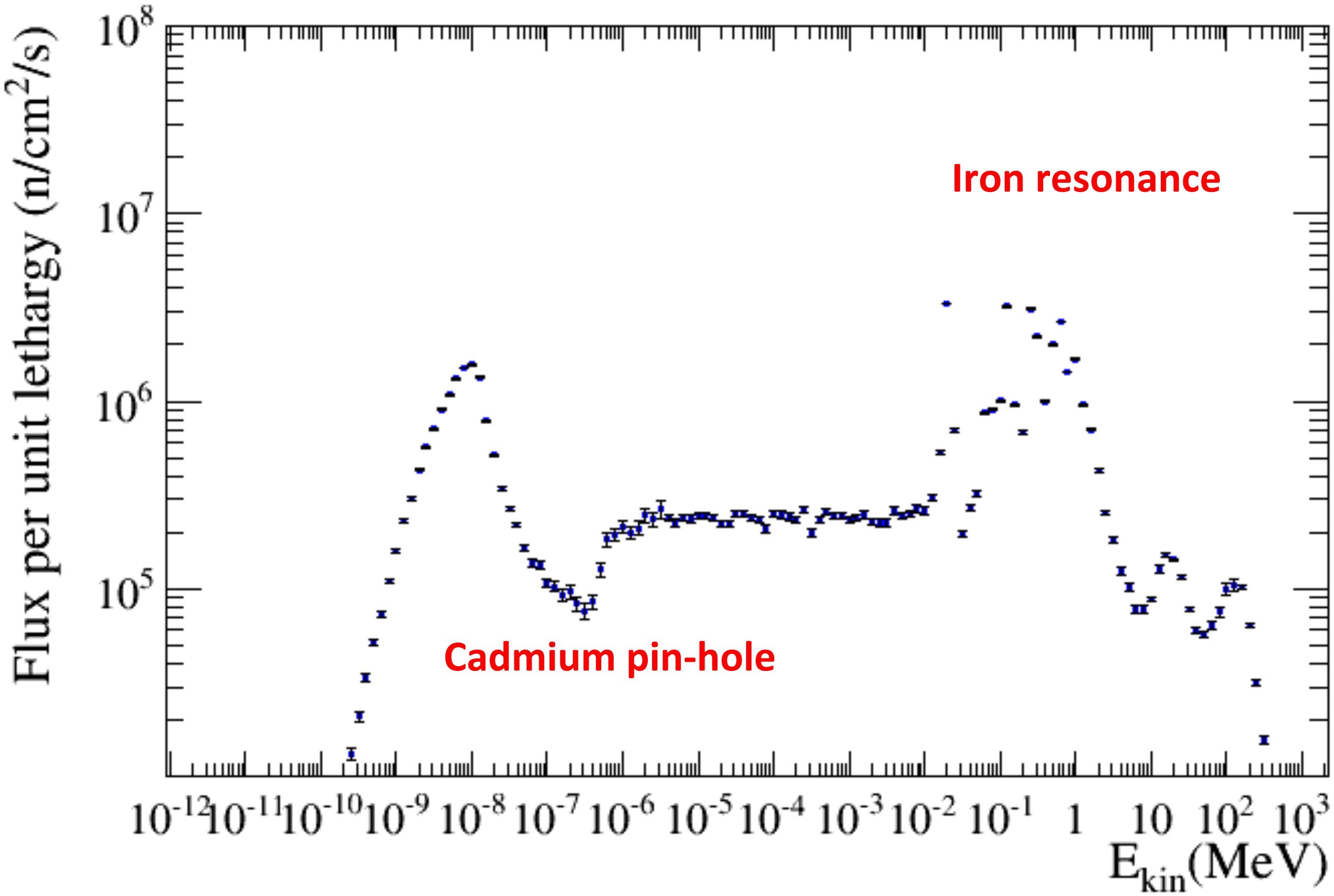


Neutron Energy Spectrum before the pin-hole



Neutron Energy Spectrum out the bunker wall





Some numbers

5.5 m out the monolith

Φ= 2.5e+10 (n/s*cm^2) Flux

Total number of neutrons in the beam

$\Phi \times A$ =3.1e+12 n/s

A is the size of the opening at the end of the monolith

Total dose= 474200 Sv/h

15 m out the bunker wall

Φ= 1.05e+07 (n/s*cm^2) Flux

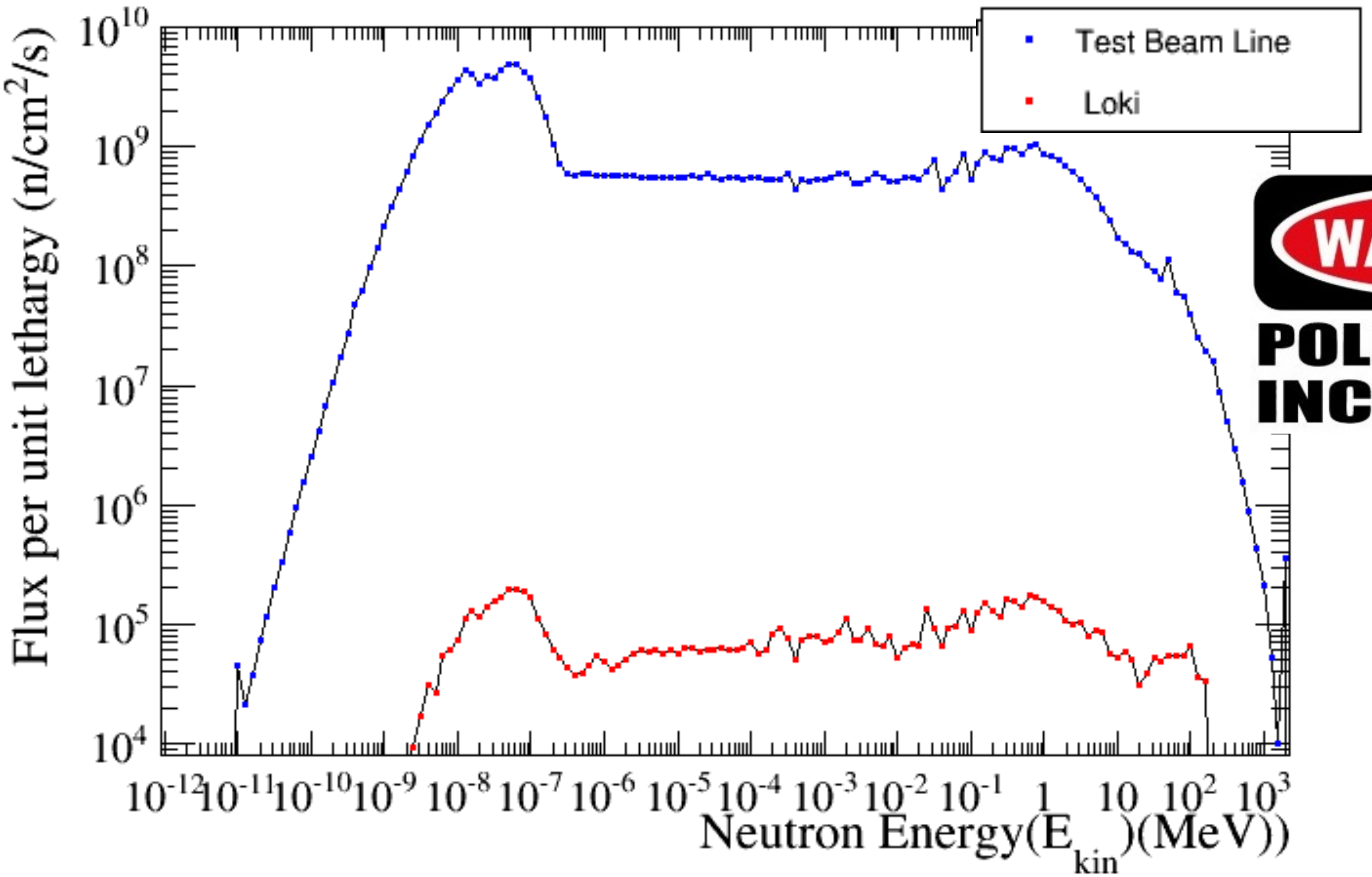
Total number of neutrons in the beam

$\Phi \times A$ =1.31e+09 n/s

A is the size of the opening at the end of the bunker wall

Total dose= 400 Sv/h

Spectra Out of the monolith

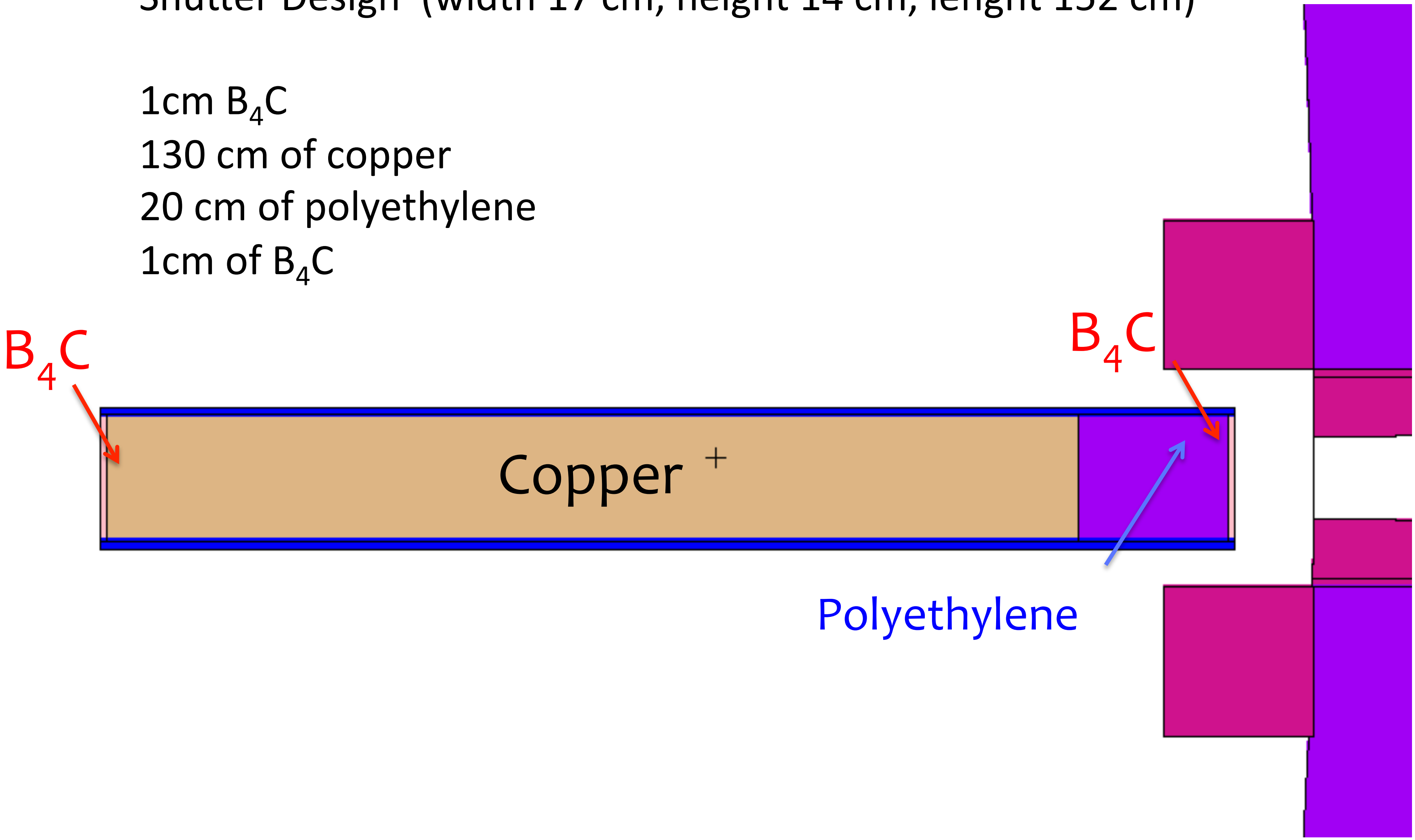


Test Beam Line: Big Opening Straight instrument
Loki: Bender in the monolith

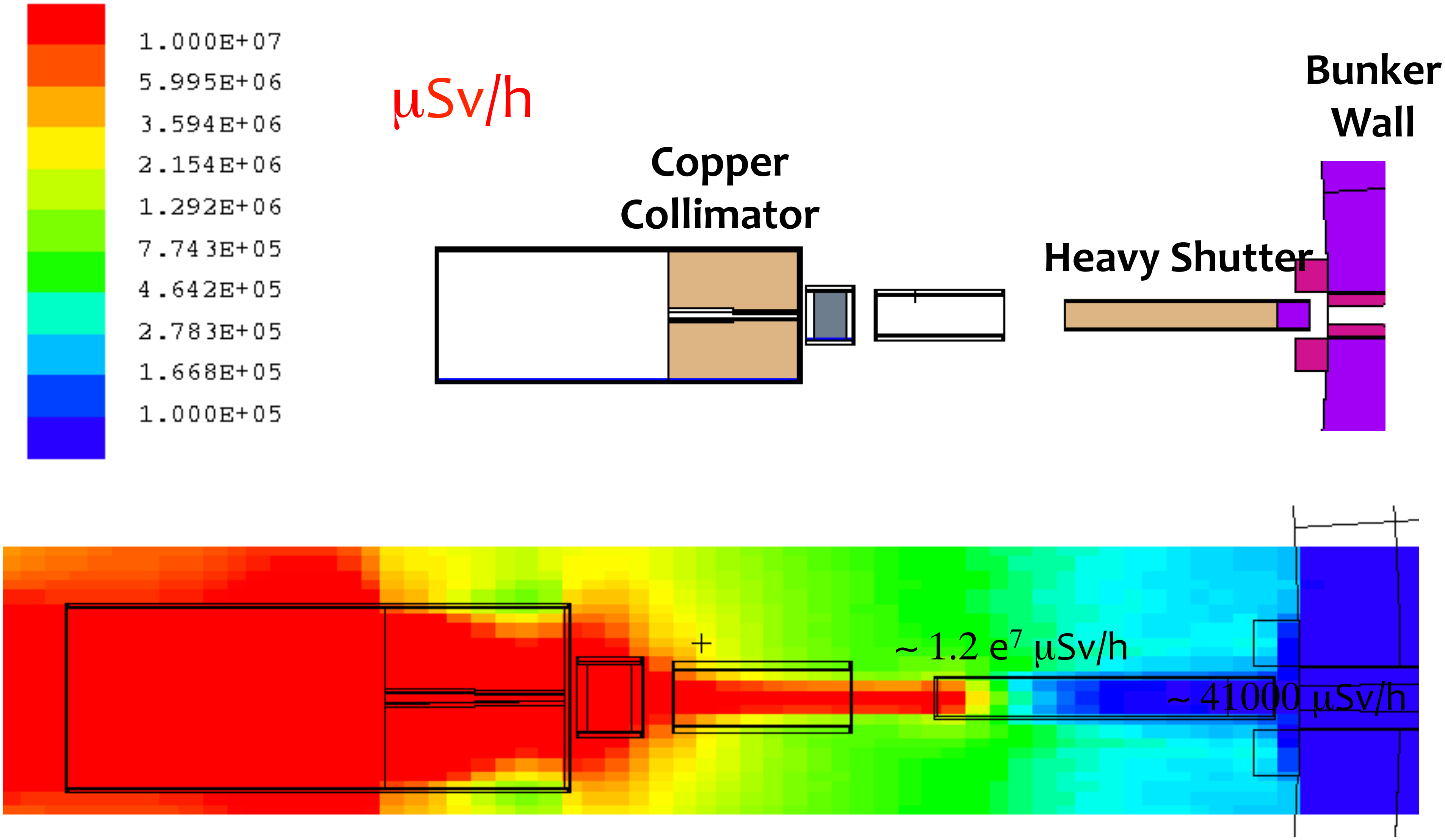
Heavy Shutter Current Design

Shutter Design (width 17 cm, height 14 cm, lenght 152 cm)

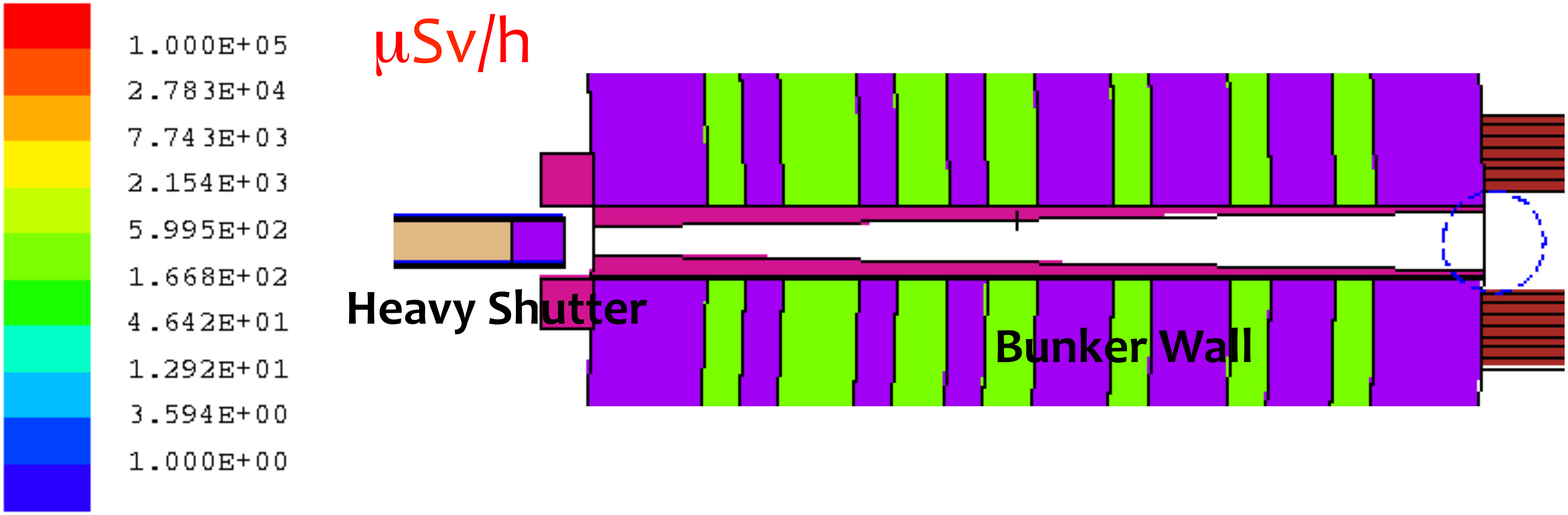
1cm B_4C
130 cm of copper
20 cm of polyethylene
1cm of B_4C

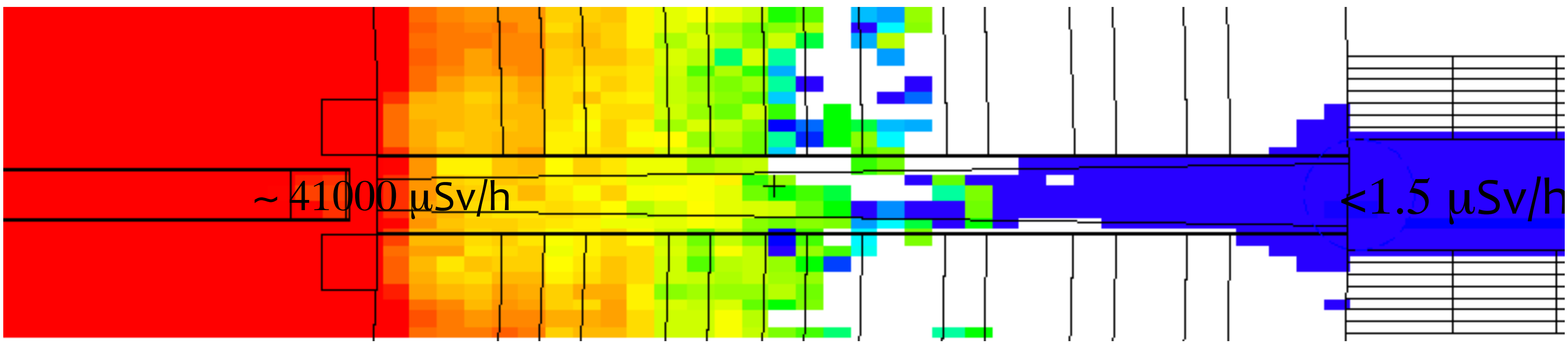


Heavy Shutter Neutron Dose Rate in the bunker

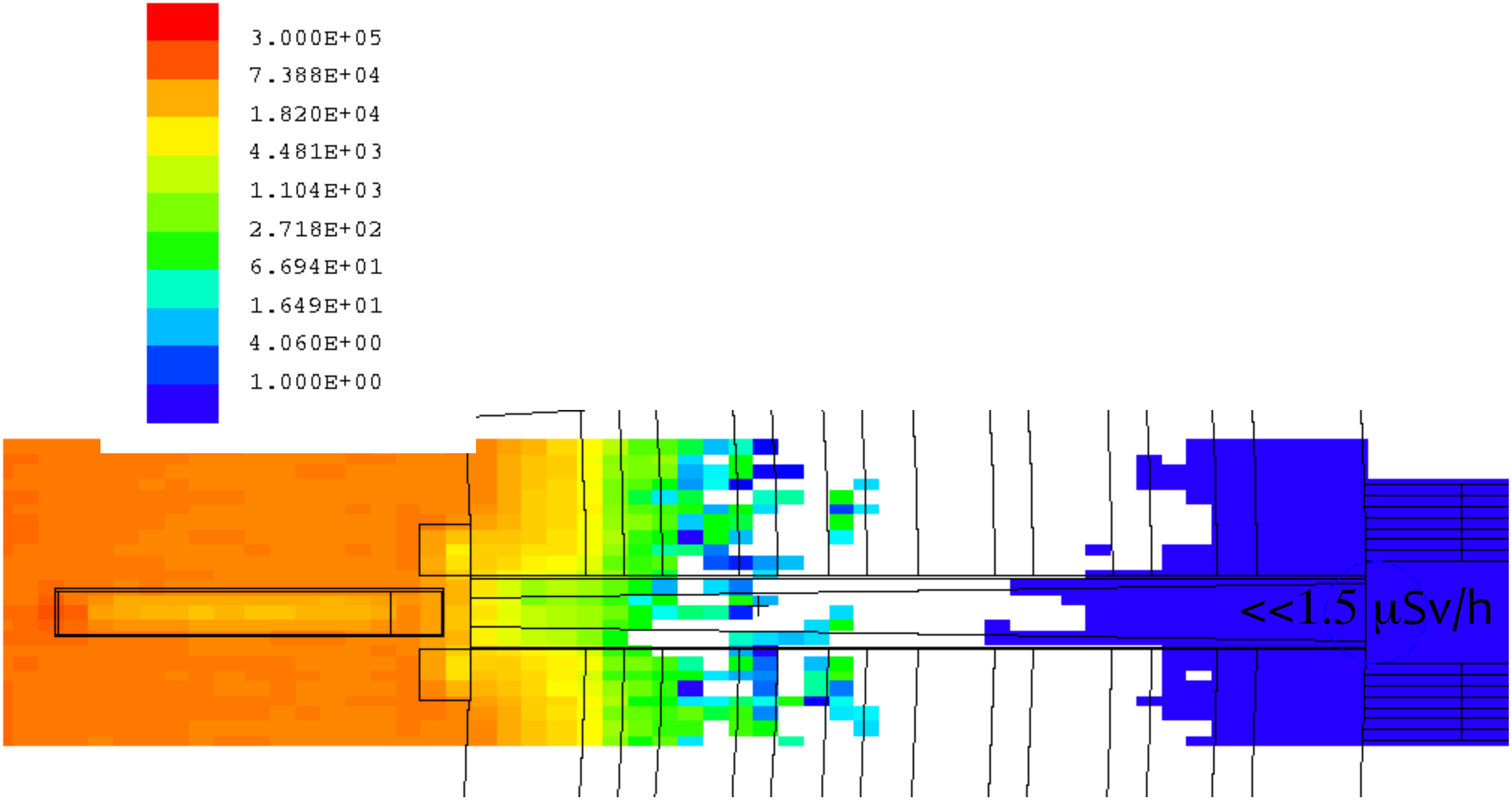


Heavy Shutter Neutron Dose rate, from the bunker wall to the end of the bunker wall





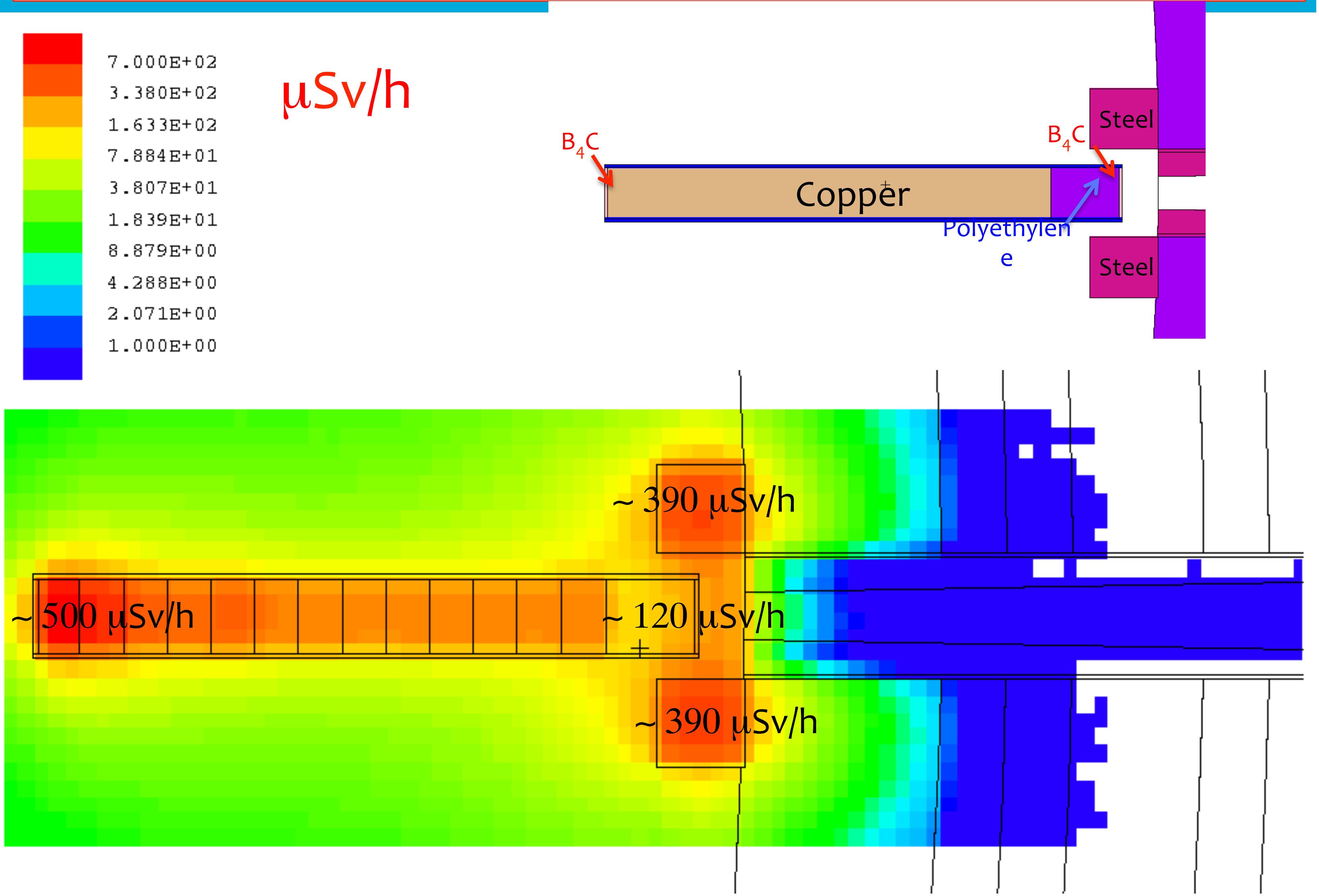
Heavy Shutter Photon Dose map with current Design



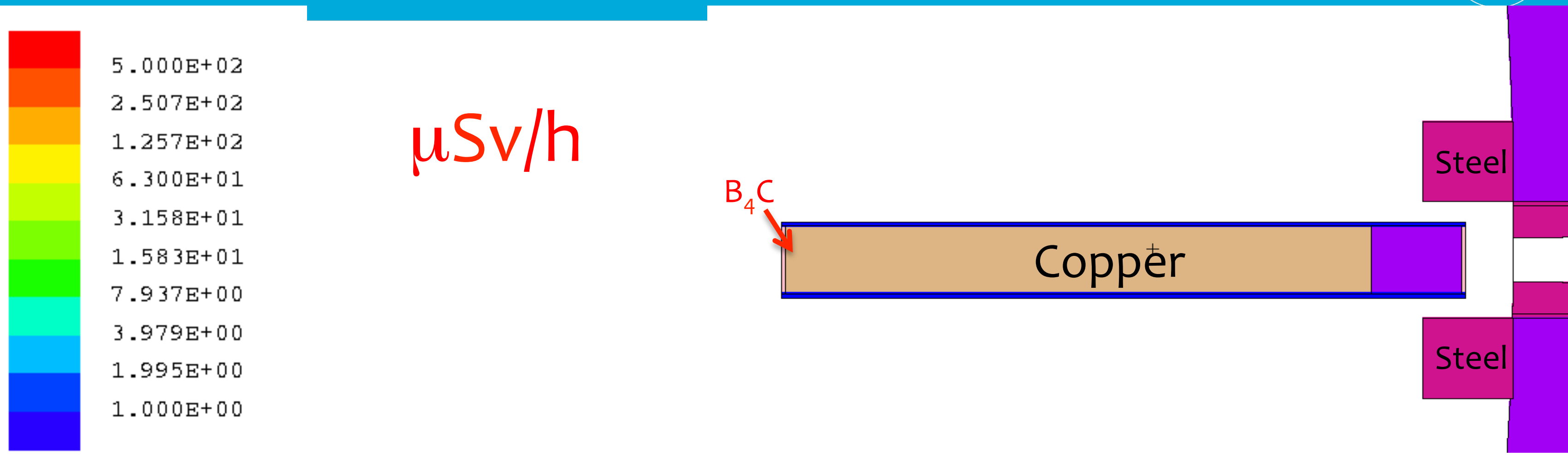
ACTIVATION OF THE HEAVY SHUTTER AND BUNKER INSERT

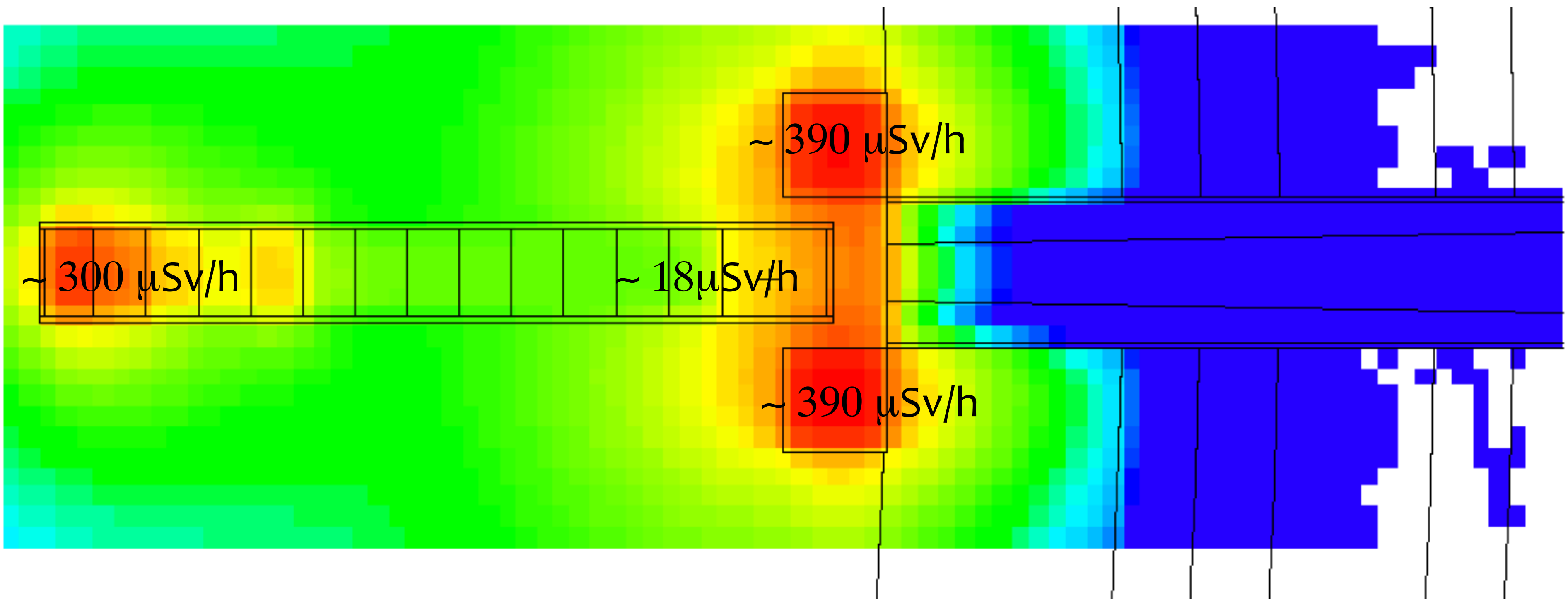
Irradiation conditions: 10 years of operation beam @2GeV 5MW

Heavy Shutter Activation after 24 hour of beam off

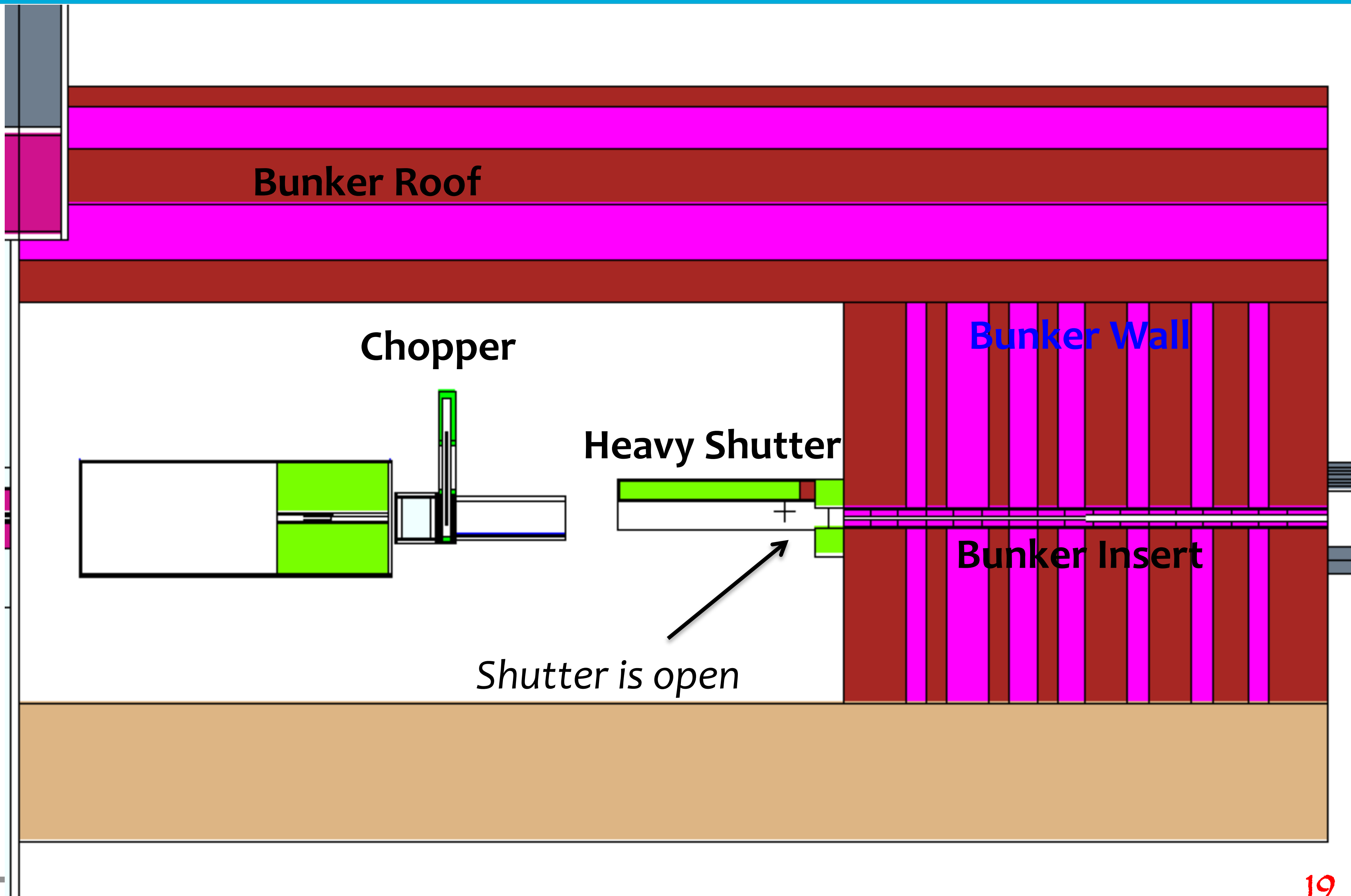


Heavy Shutter Activation after 3 days beam off

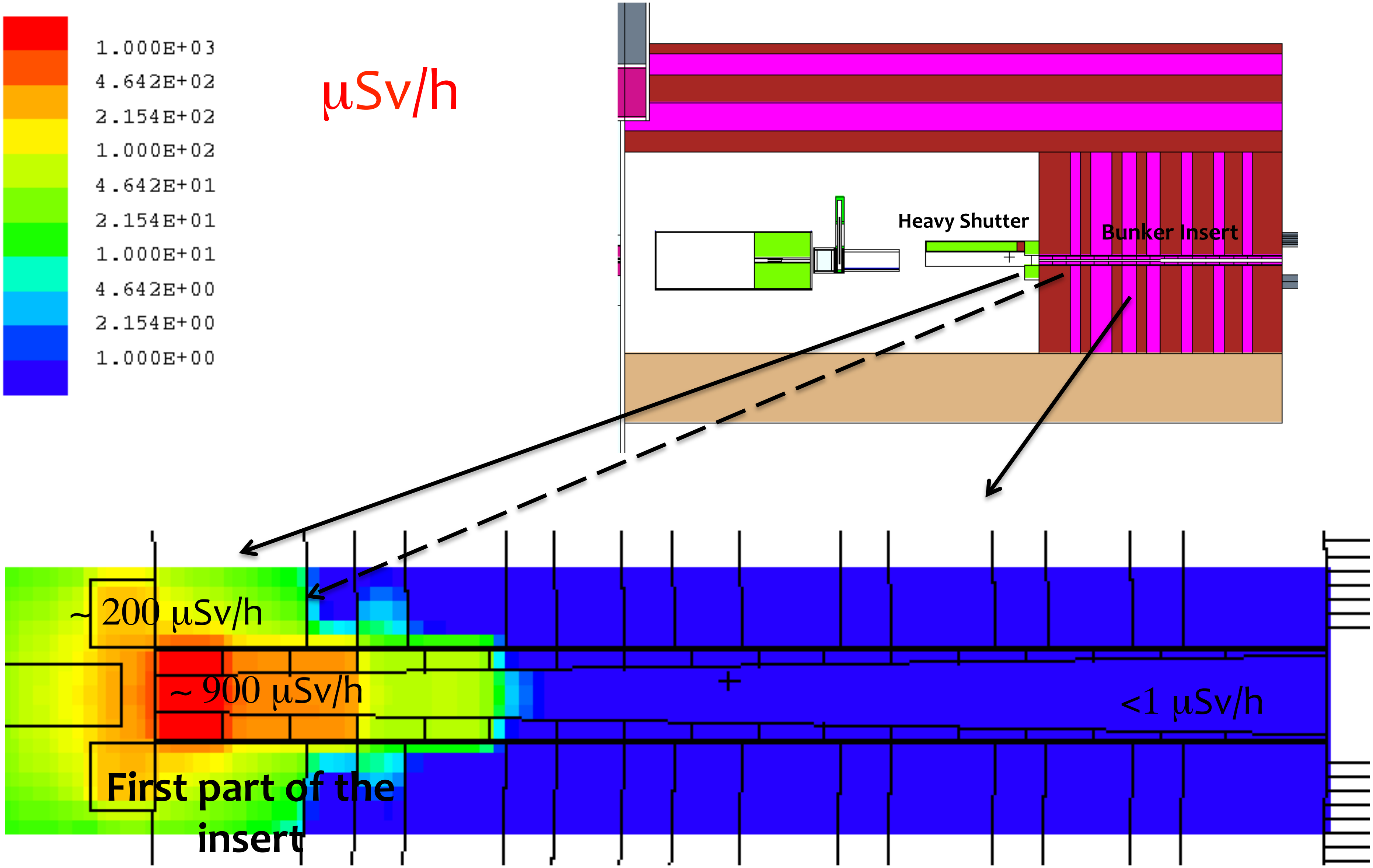




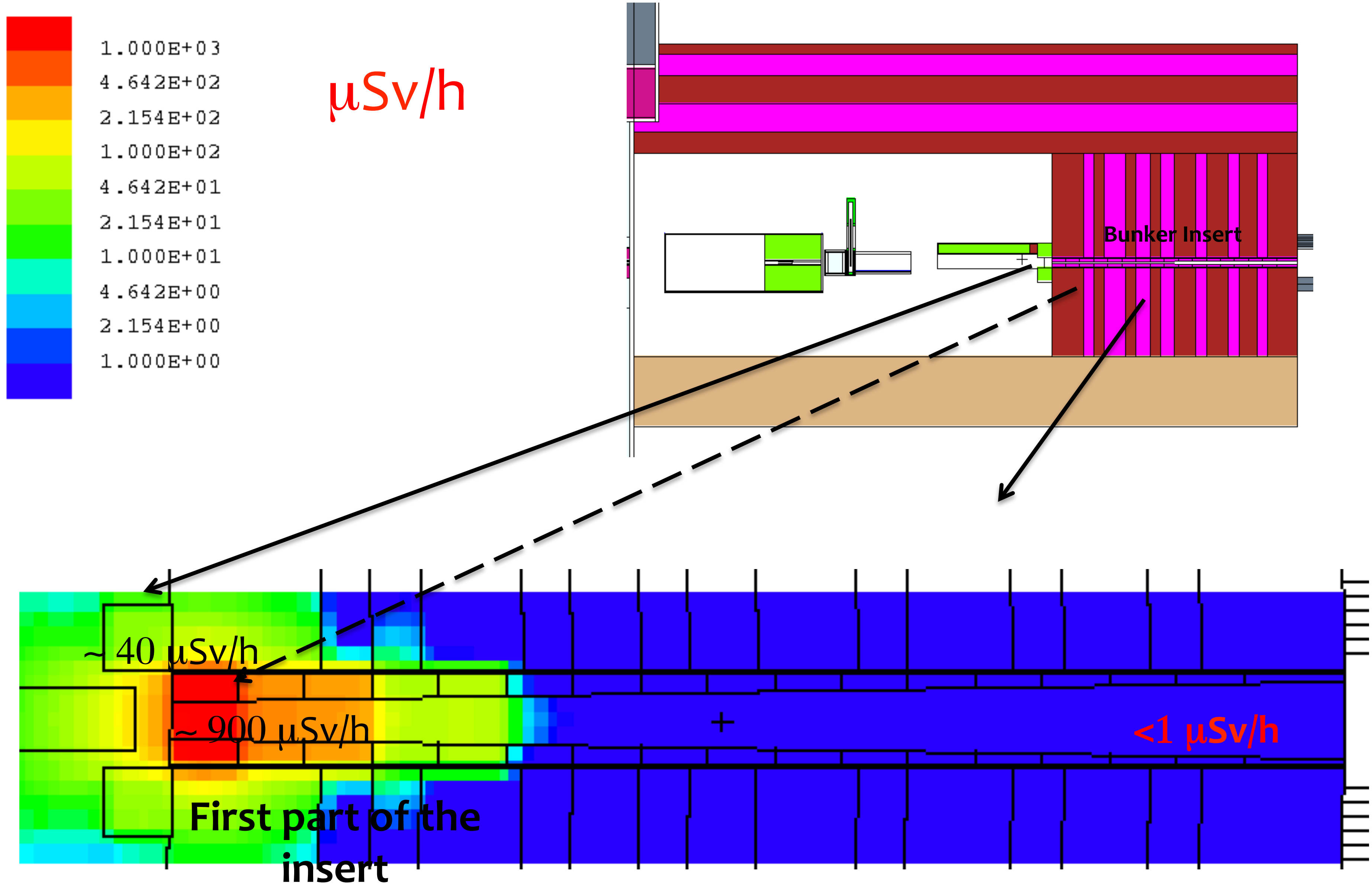
Bunker insert Geometry



Bunker insert activation after 1 day beam-off



Bunker insert activation after 3 days beam-off



Conclusions (I)

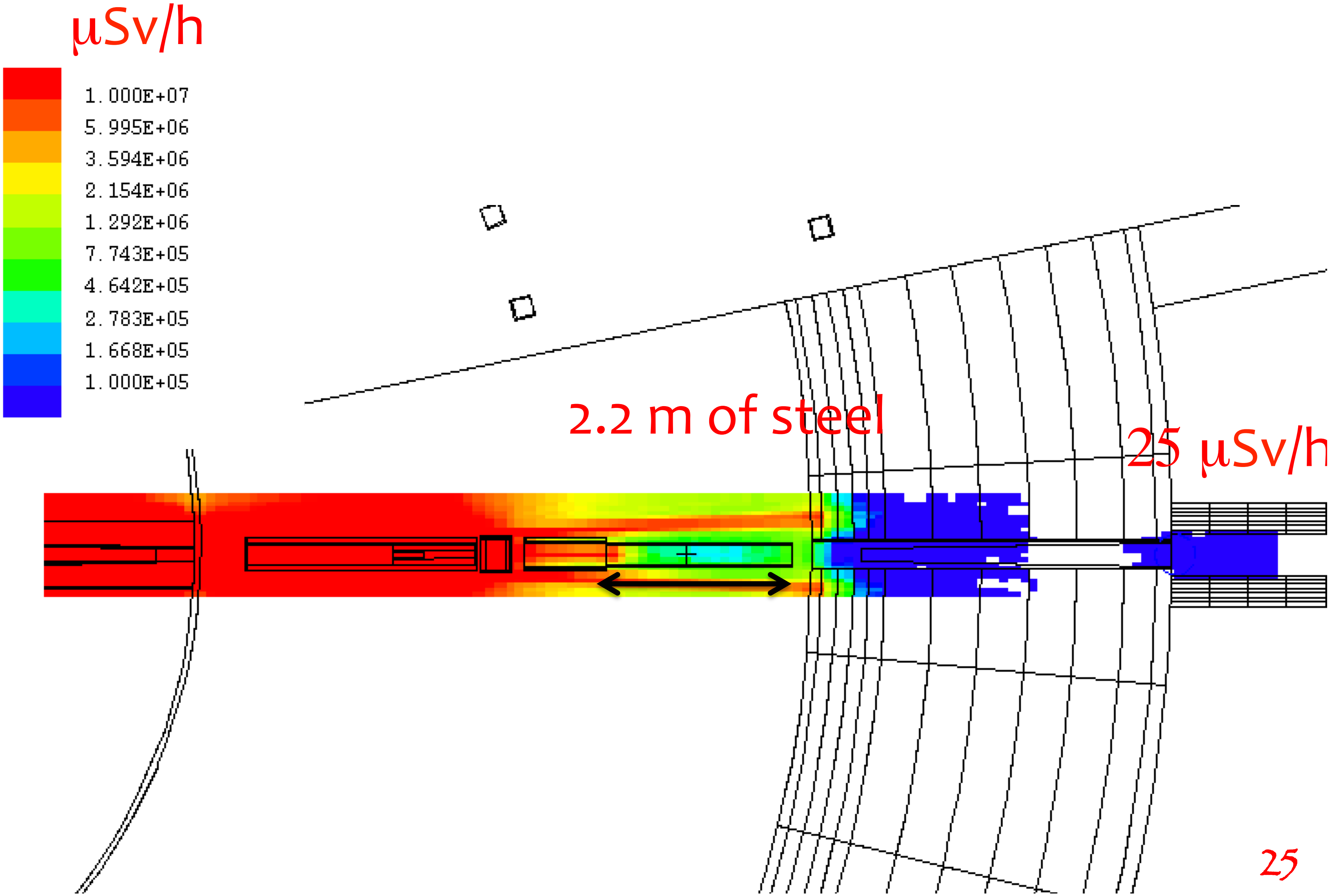
- Test Beam Line neutronics have been performed
- Shielding could have been a challenge but the use of a relatively cheap collimator can help you a lot
- Heavy Shutter calculation done
- Bunker insert activation does not seem an issue

Conclusions (II)

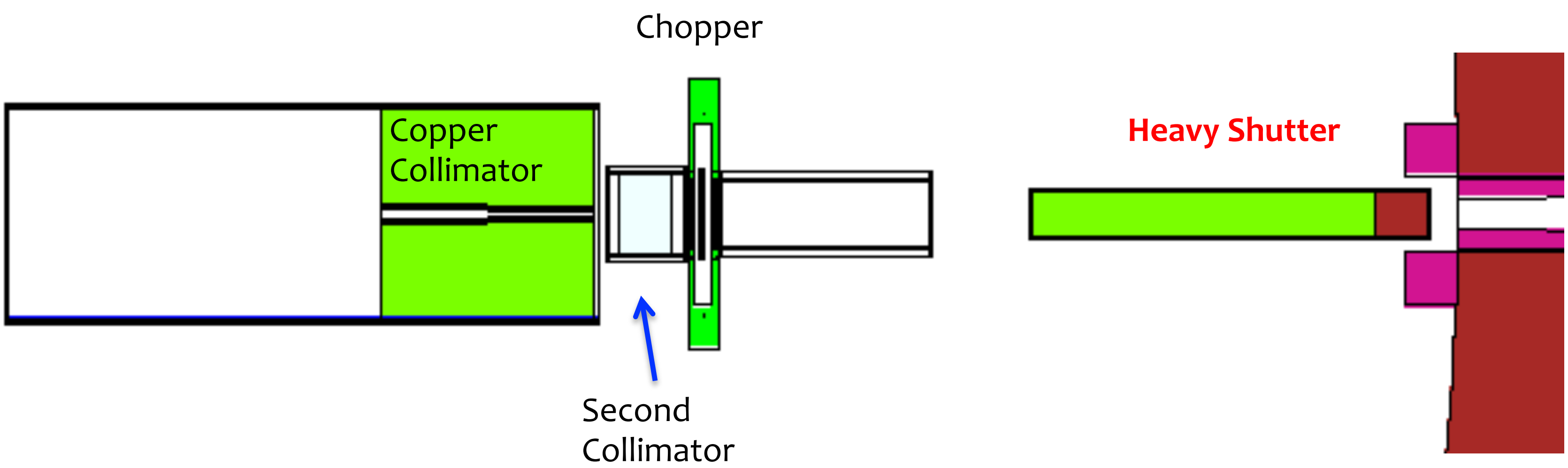
Even the "bad" radiation from the beam line can be fixed with some shielding simulation

BACK –UP SLIDES

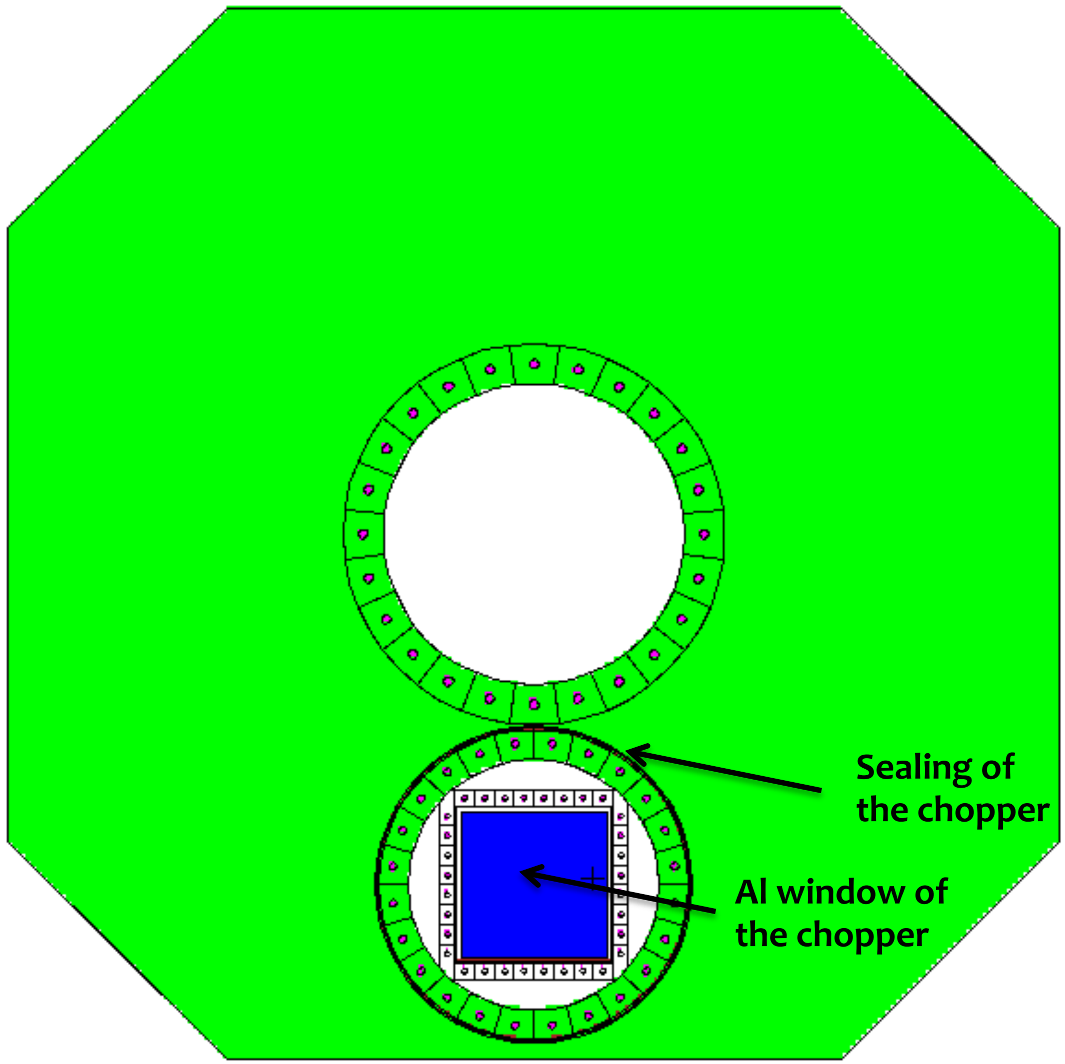
Heavy Shutter simulation



Absorbed Dose for the chopper sealing



View of the chopper



Chopper Sealing Absorbed dose Gy/s