PAUL SCHERRER INSTITUT

PSI

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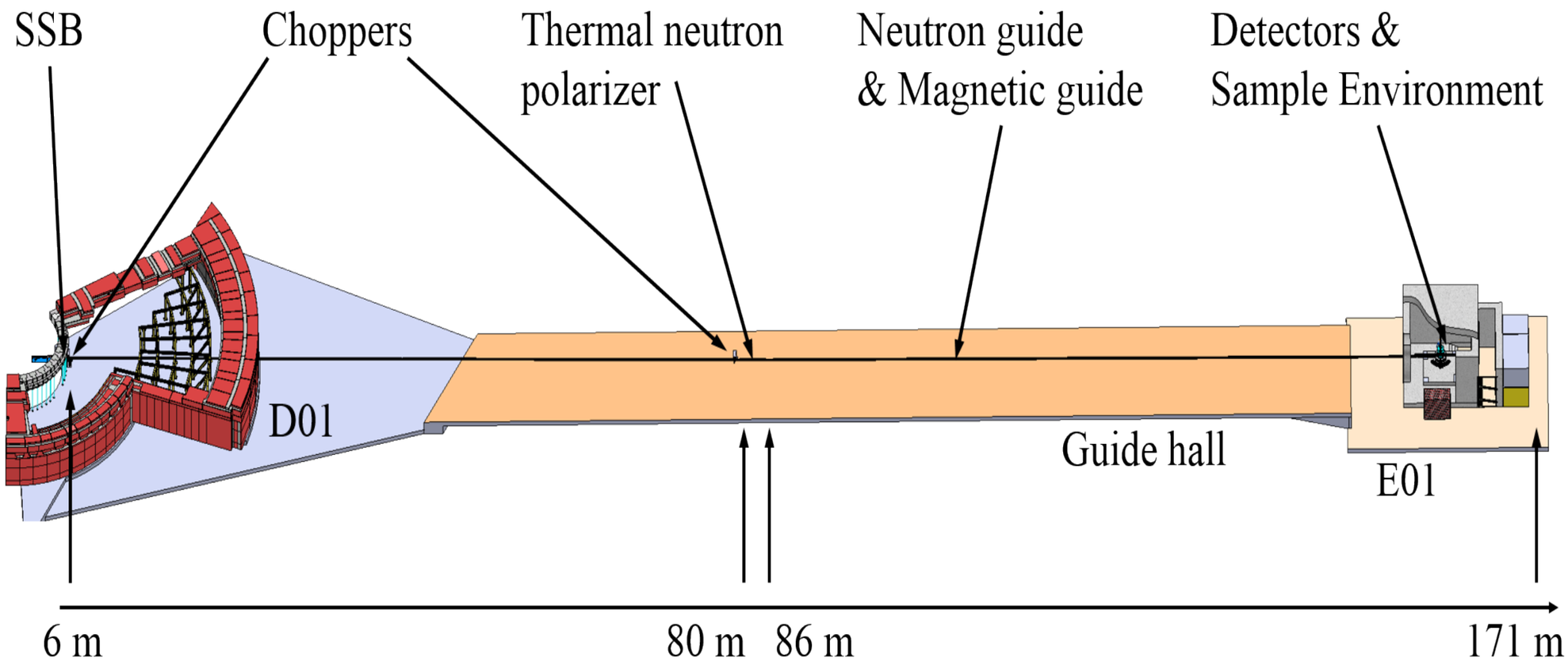
Paul Scherrer Institut

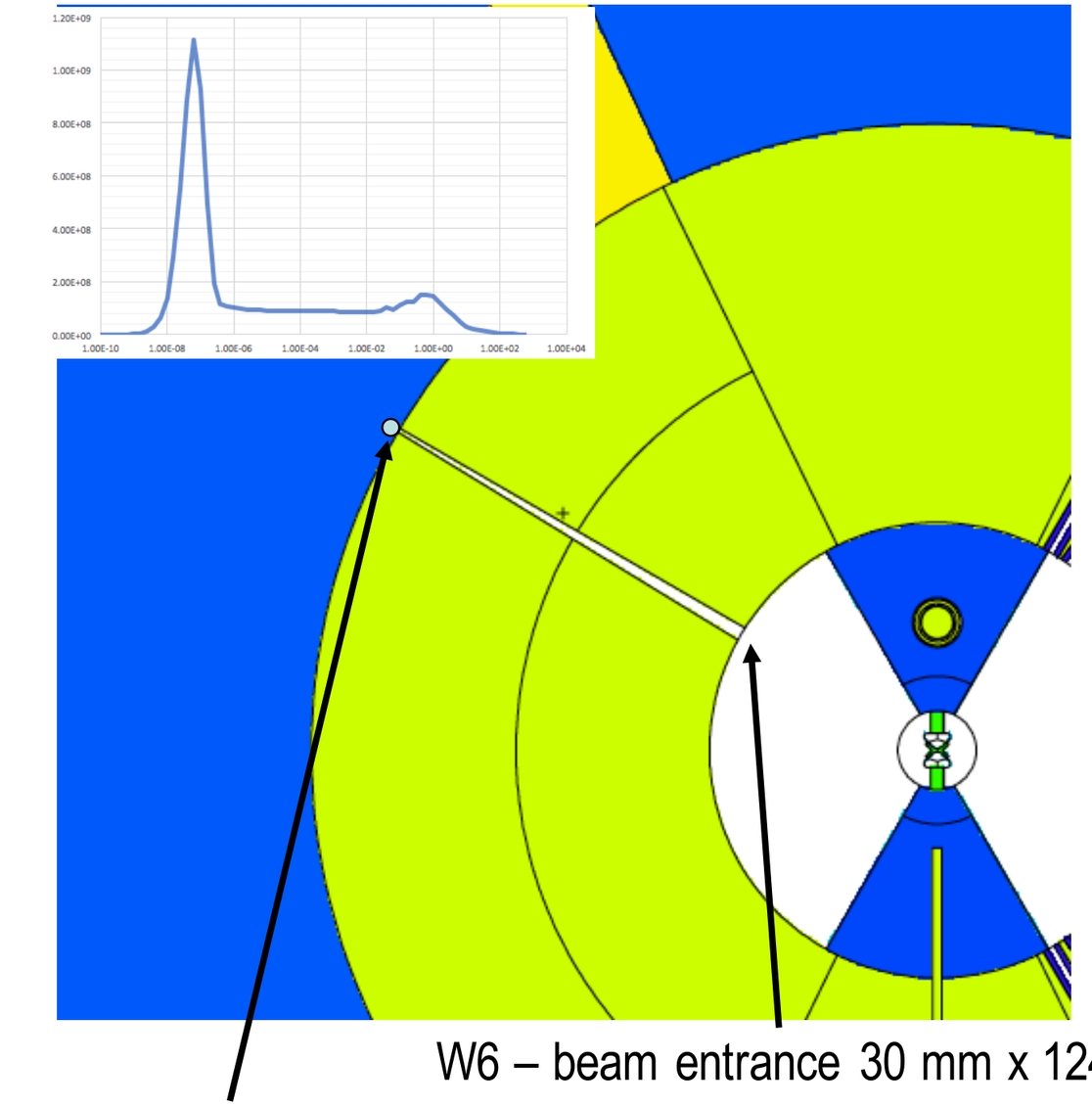
ESS Shielding Simulations
MaGIC and Estia

MAGiC beamline layout



- polarized single crystal diffractometer at beamport W6
- Cold & thermal beam extraction
- Elliptic guide system with a kink at 80 m

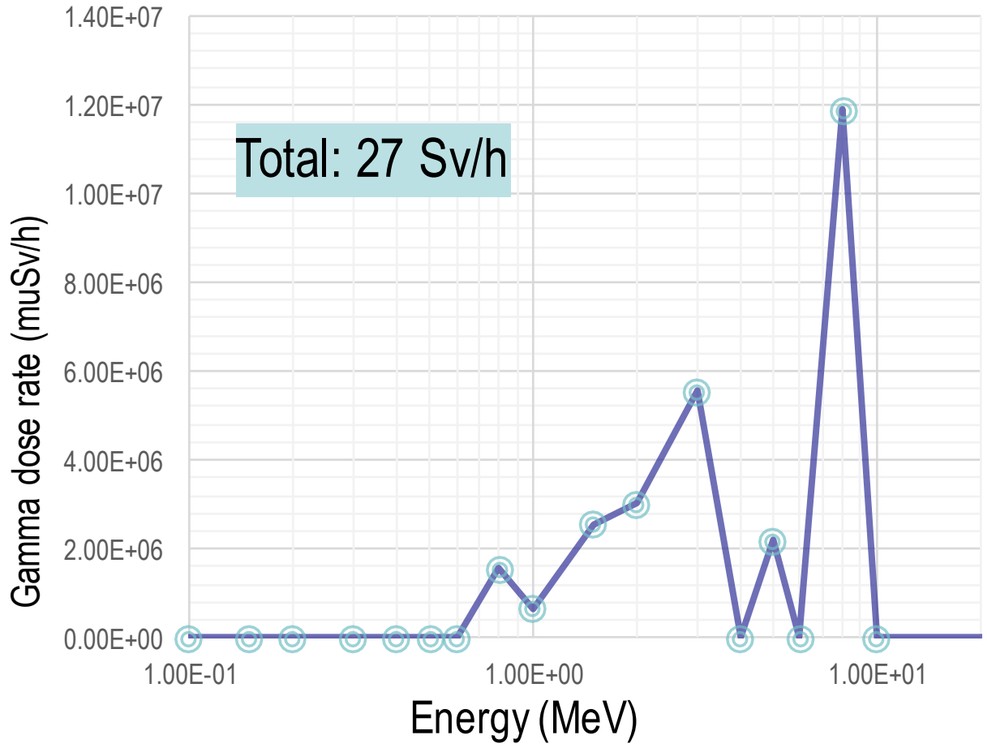
Neutron and prompt gamma dose rates at 5.5m (W6)

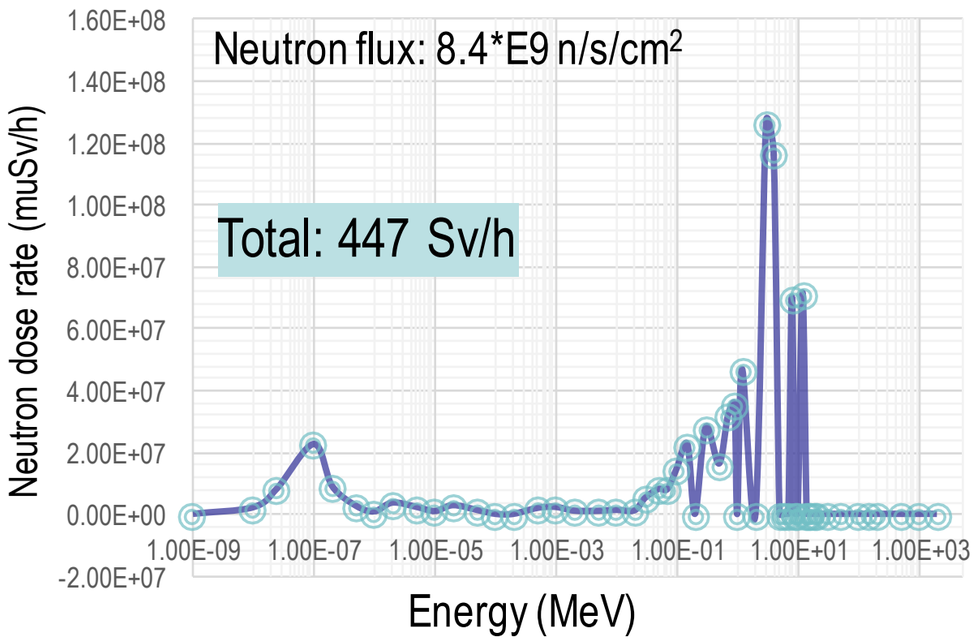


W6 – beam entrance 30 mm x 124 mm

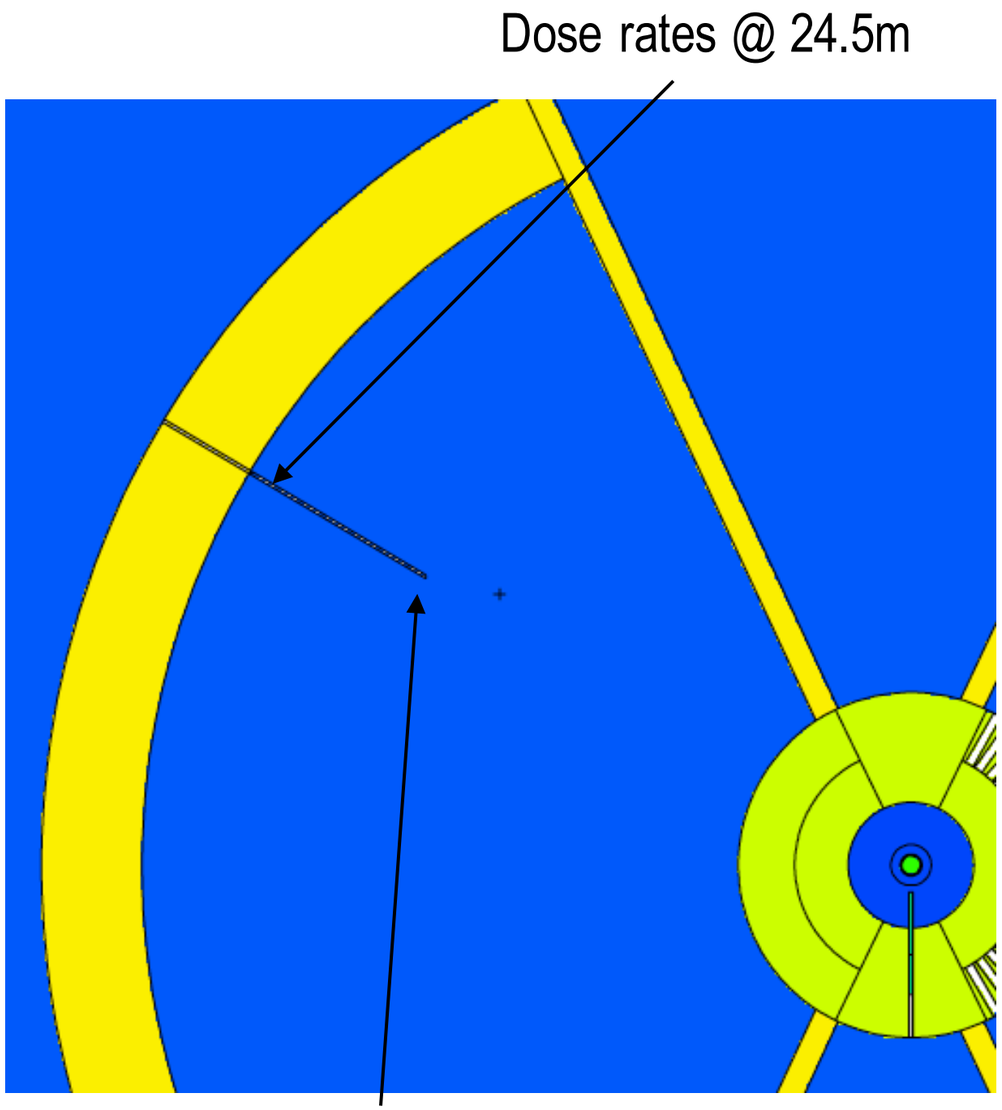
W6 – beam exit 30 mm x 38 mm

Note: no other beamports are modelled



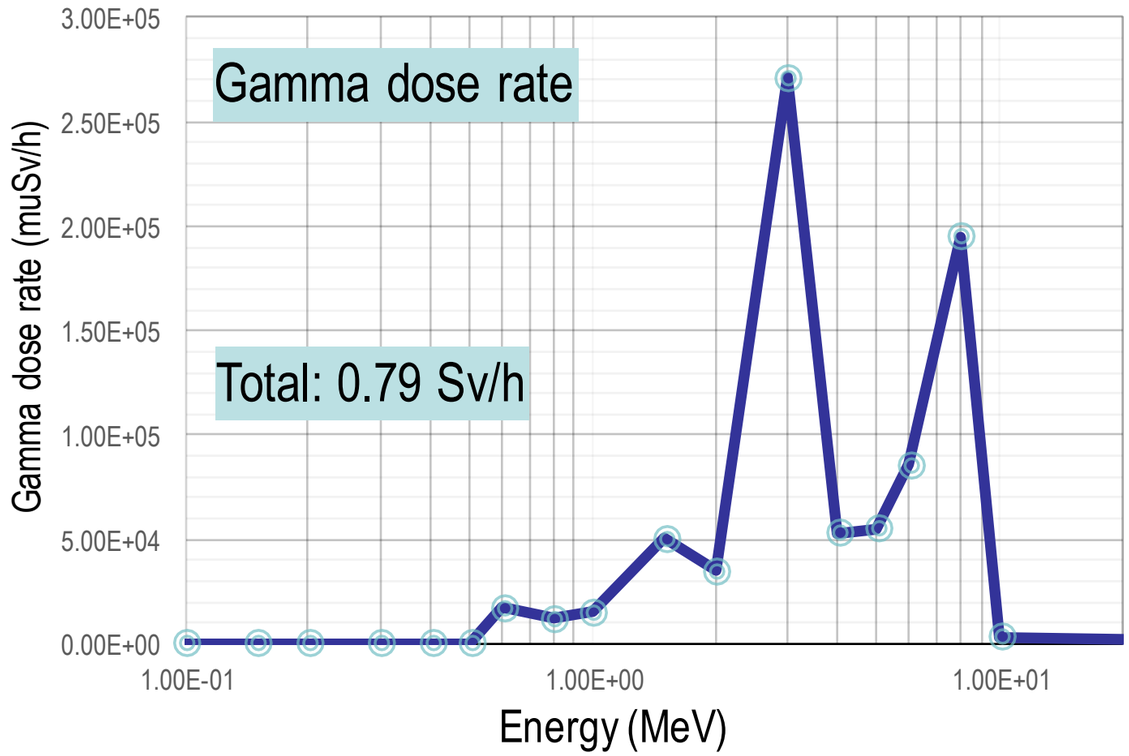


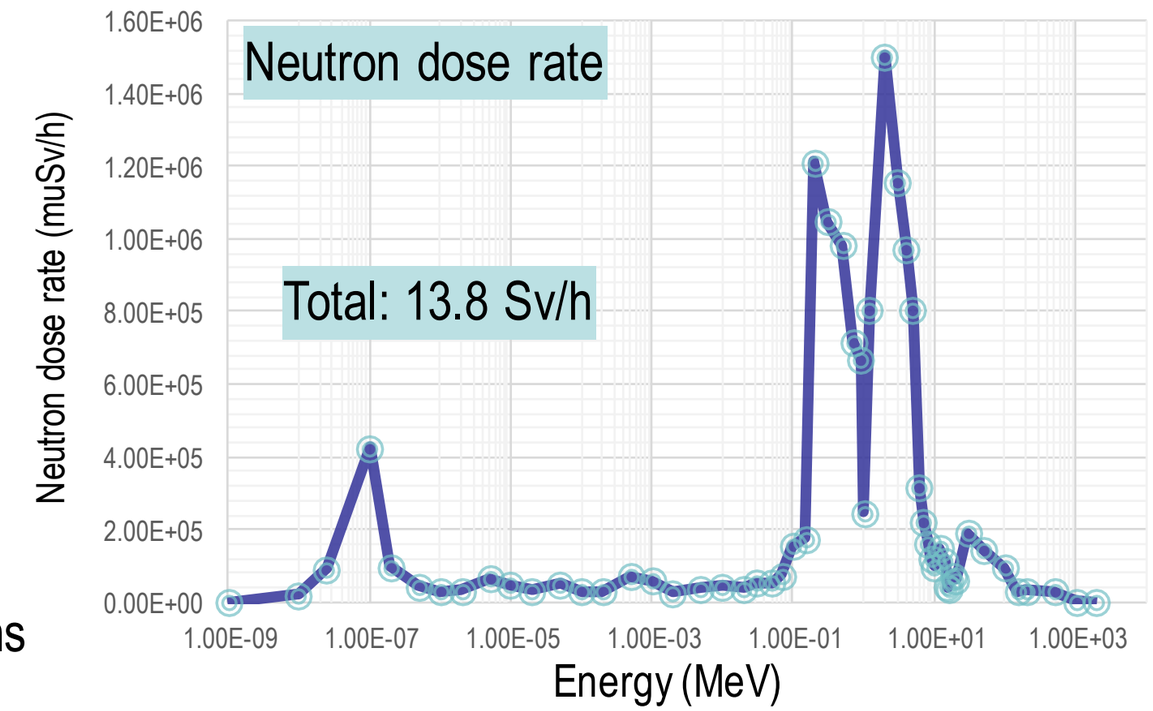
Neutron and prompt gamma dose rates at 24.5 m (W6)



W6 – vacuum channel 10 cm x 10 cm (0.5 deg tilt)

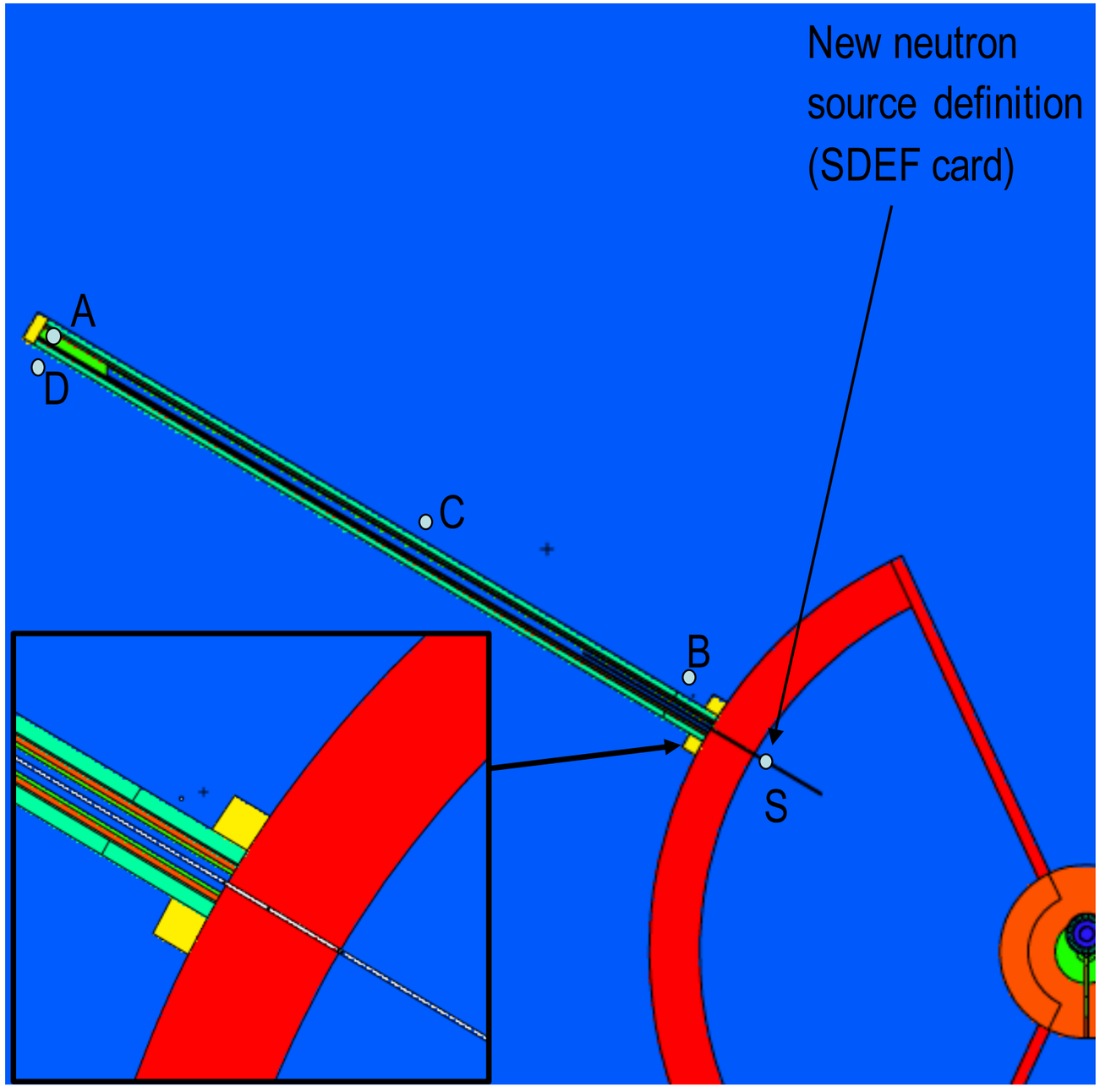
New SDEF-card defined for guide shielding calculations





Neutron dose rates along guide system (W6)

cross section inside shielding: 50 cm x 50cm



Shielding around guide:

10 cm borated concrete
10 cm standard steel
50 cm standard concrete

Source – tally S: 13.8 Sv/h

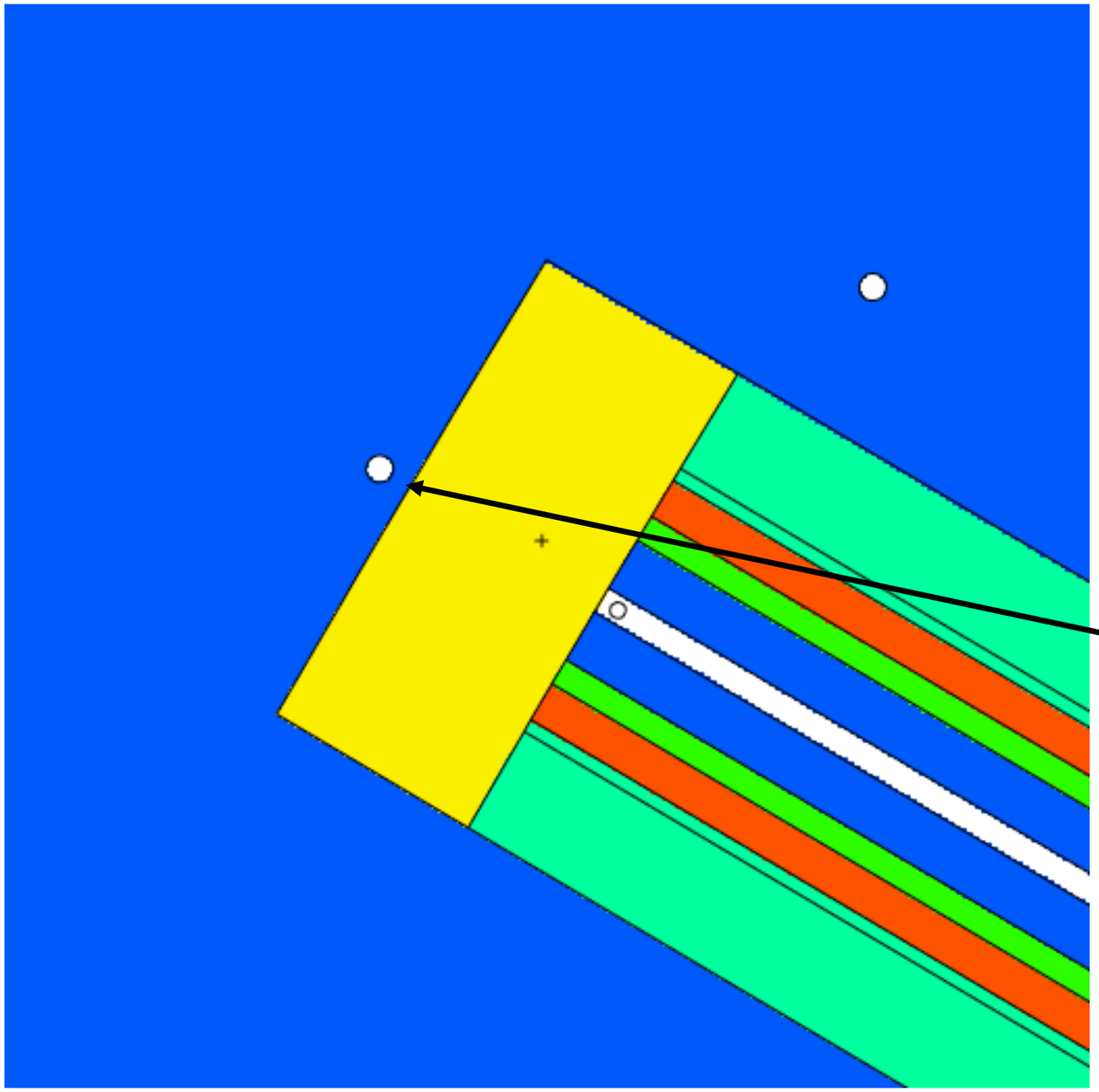
@77m - tally A: 8.8 mSv/h
fast neutron flux: 4.7E4 n/cm^2/s

@30m – outside guide shielding
tally B: 3.4 µSv/h

@50m ouside guide shielding
tally C: 1.9 µSv/h

@77m ouside guide shielding
tally D: 1.1 µSv/h

Shielding the direct beam at 77m



Remember:
@77m center of beam: 8.8 mSv/h
neutron dose rate

Beam dump consists of 50 cm heavy concrete (4.9 g/cm^3)

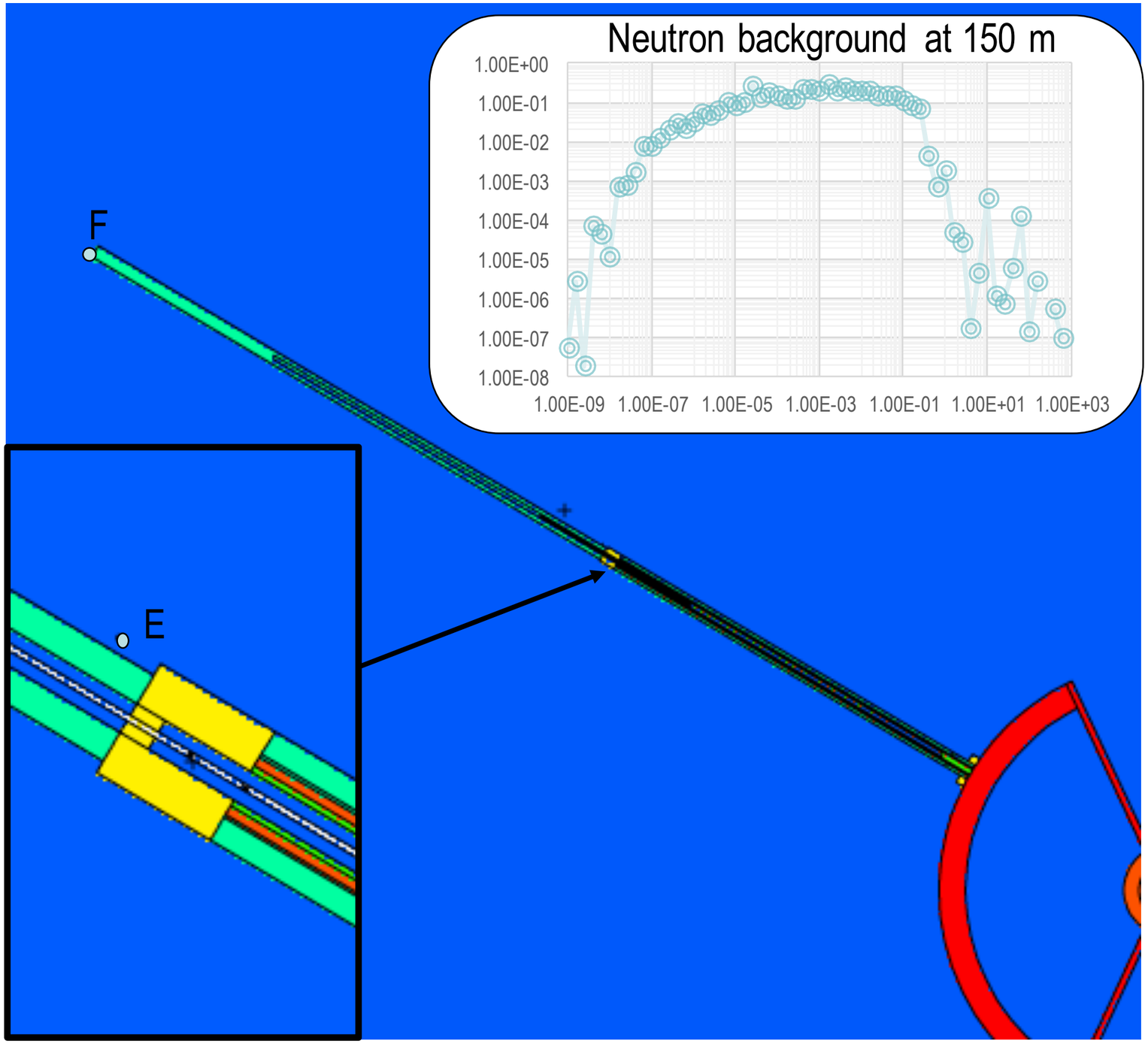
Concrete includes 5 % B_4C

Behind beam dump:
n-dose rate : 1.6 µSv/h
g-dose rate : < 0.1 µSv/h

30 n/s/cm^2

Detector size: d=6 cm

150m Guide Shielding



Shielding around guide behind 77m:

- 2m heavy concrete with vacuum tube belt
- 75m standard concrete (0.5 m thickness)

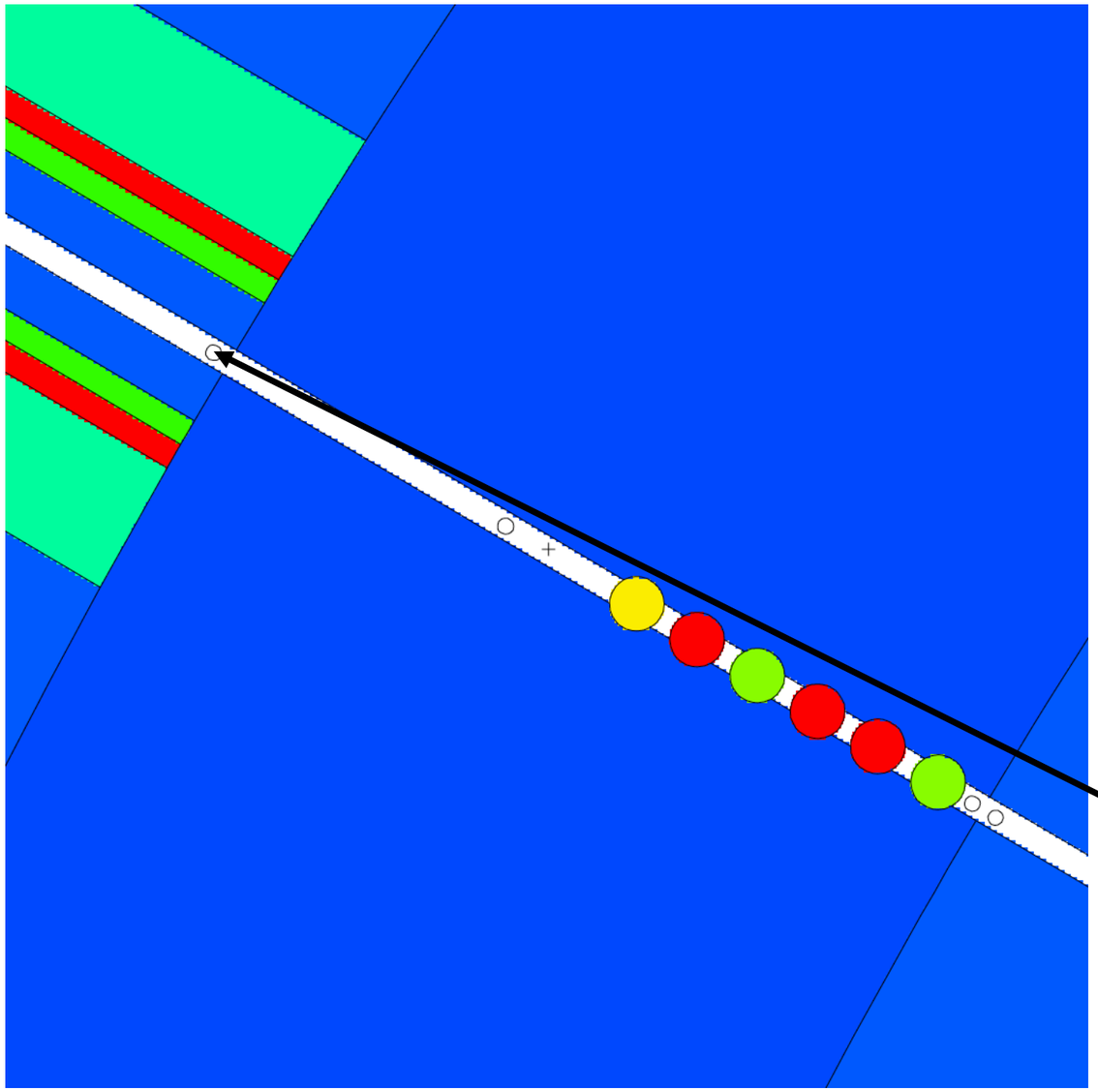
neutrons

Source – tally S: 13.8 Sv/h

@80m ouside guide shielding
tally E: 1.3 µSv/h

@150m inside guide shielding
tally F: 0.2 µSv/h
4.2 n/s/cm^2

High energy shutter setup



6 drums are positioned within the neutron bunker wall.

Drum Sequence:

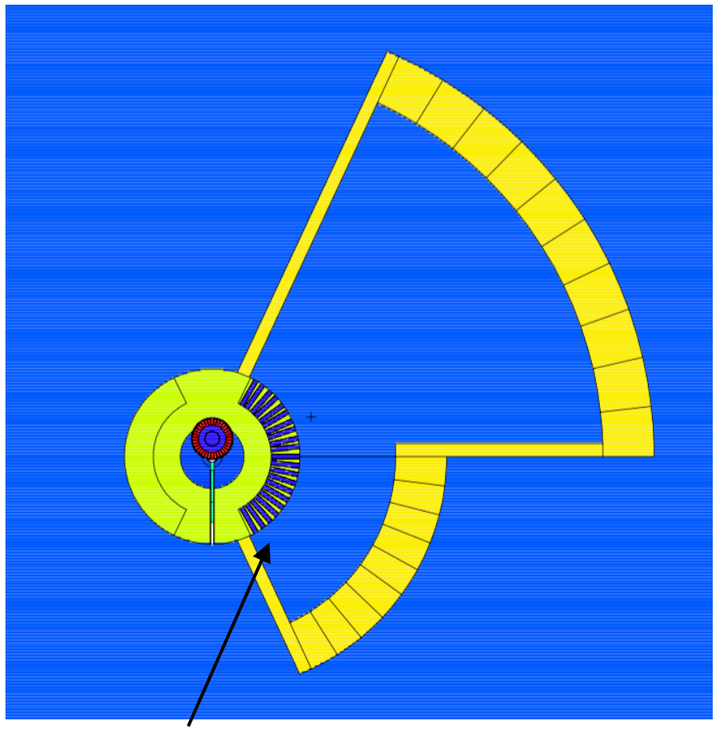
1. Borax (50% epoxy / 50% B_4C)
2. Standard steel
3. Standard steel
4. Borax
5. Standard steel
6. Tungsten/parafin (density 11.8 g/cm^3)

Effective thickness: each drum 20 cm

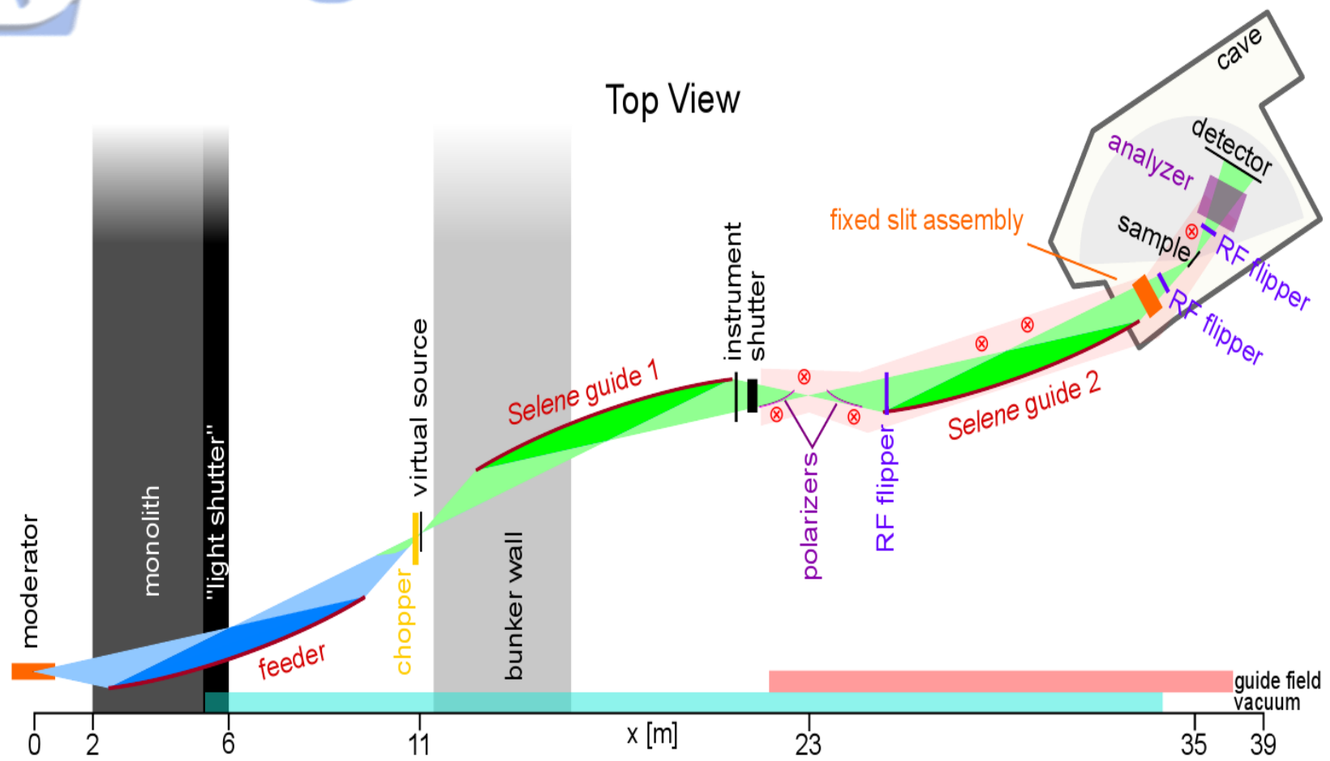
n-dose rate: 15.2 µSv/h
g-dose rate: 0.5 µSv/h
(only prompt gammas from the drums)

N-Dose rate can be reduced more by replacing steel with tungsten drums.

Estia – E2 Beamport

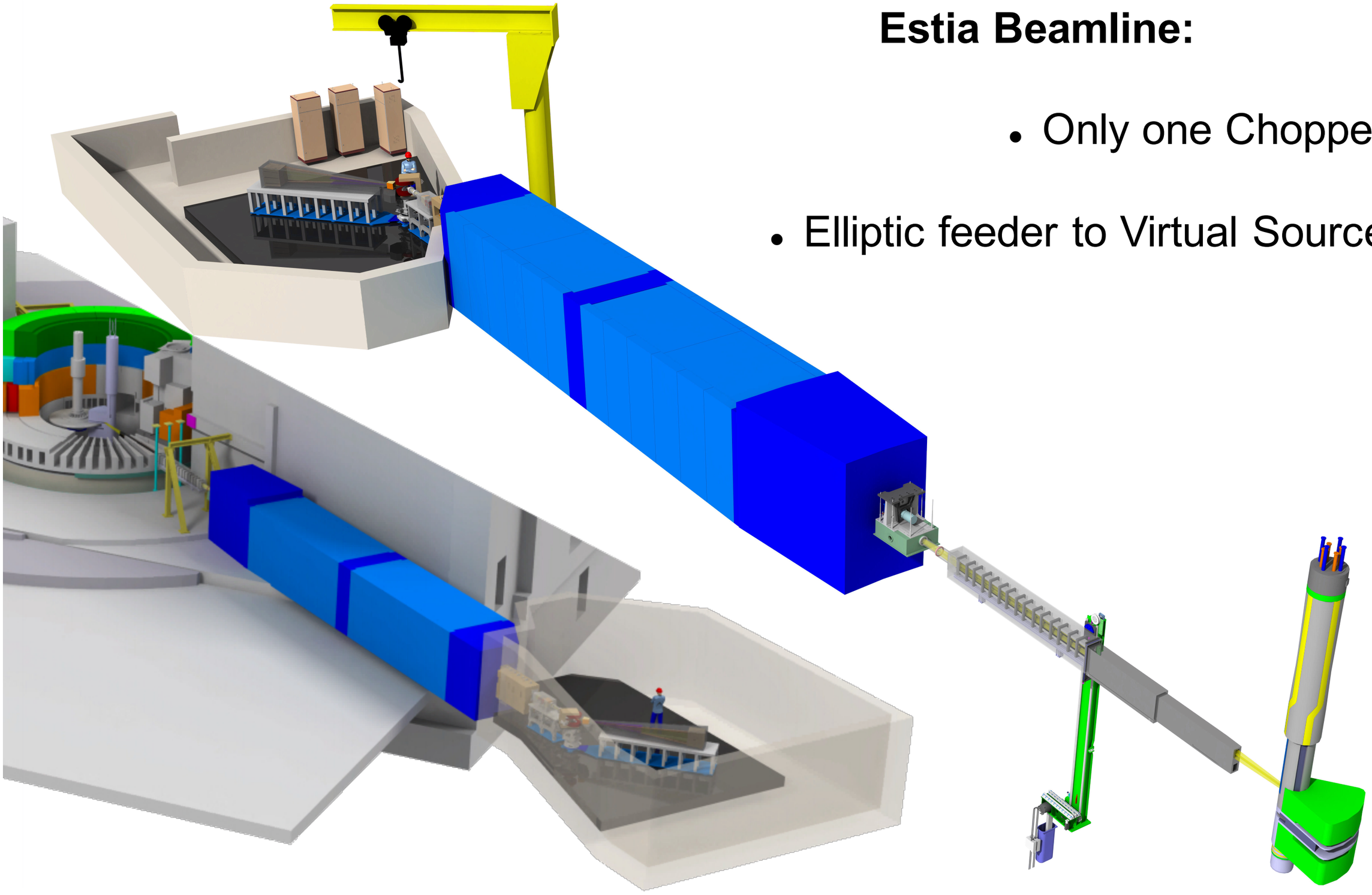


E2 – Estia beamport



- Reflectometer at beamport E
- Cold neutron beam line
- Elliptic guide system (Selene) – only 40 m long

Instrument Design Overview

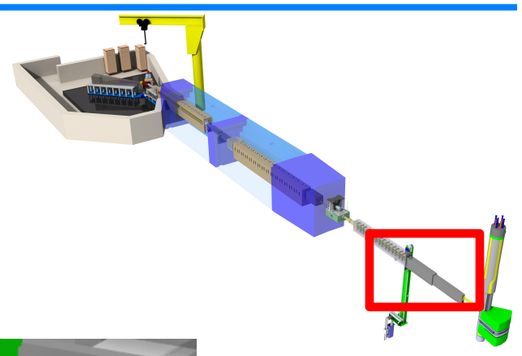


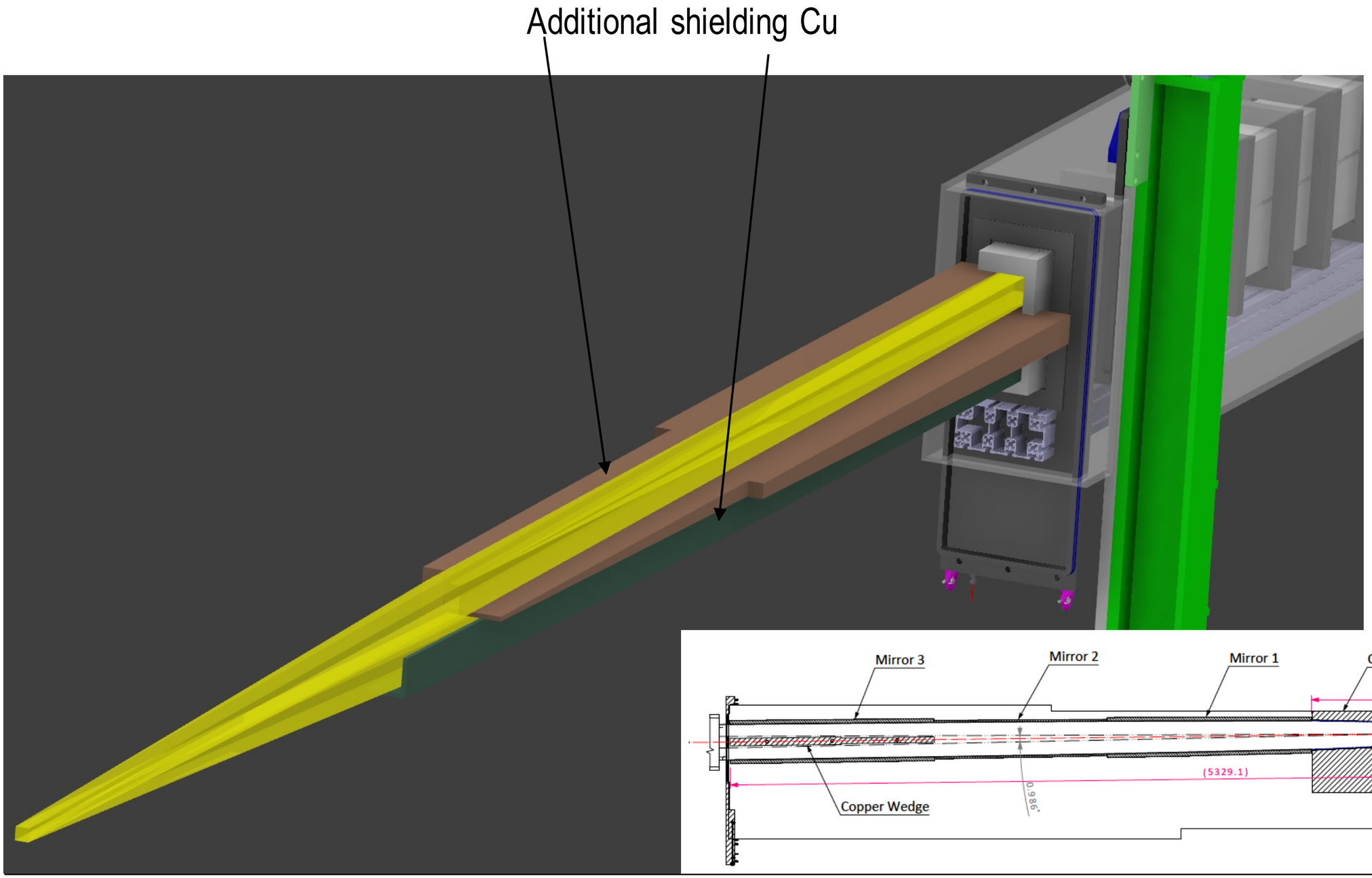
Estia Beamline:

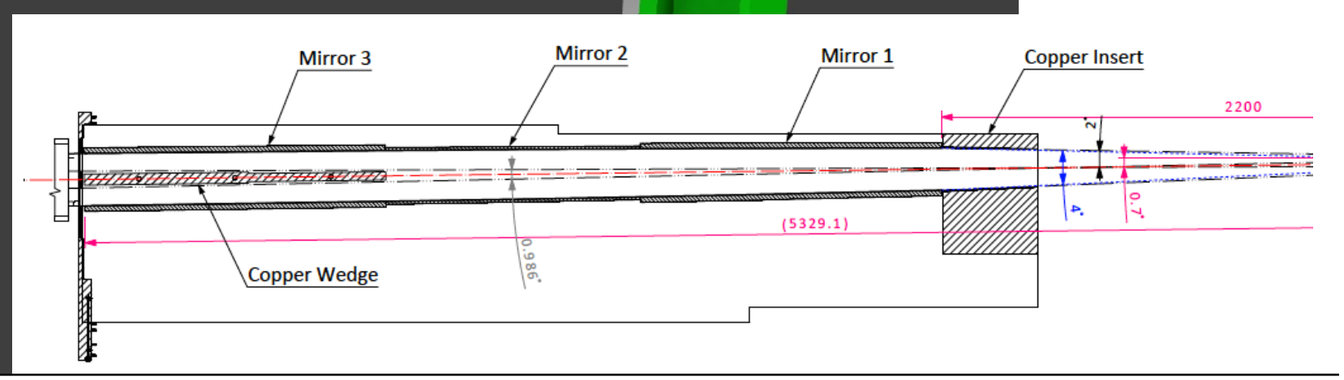
- Only one Chopper
- Elliptic feeder to Virtual Source

Shielding Concept - Insert

- large dimensions of the feeder (opening 210 mm x 68 mm)
- Dose rate reduction by factor 2-3 by additional shielding inside feeder



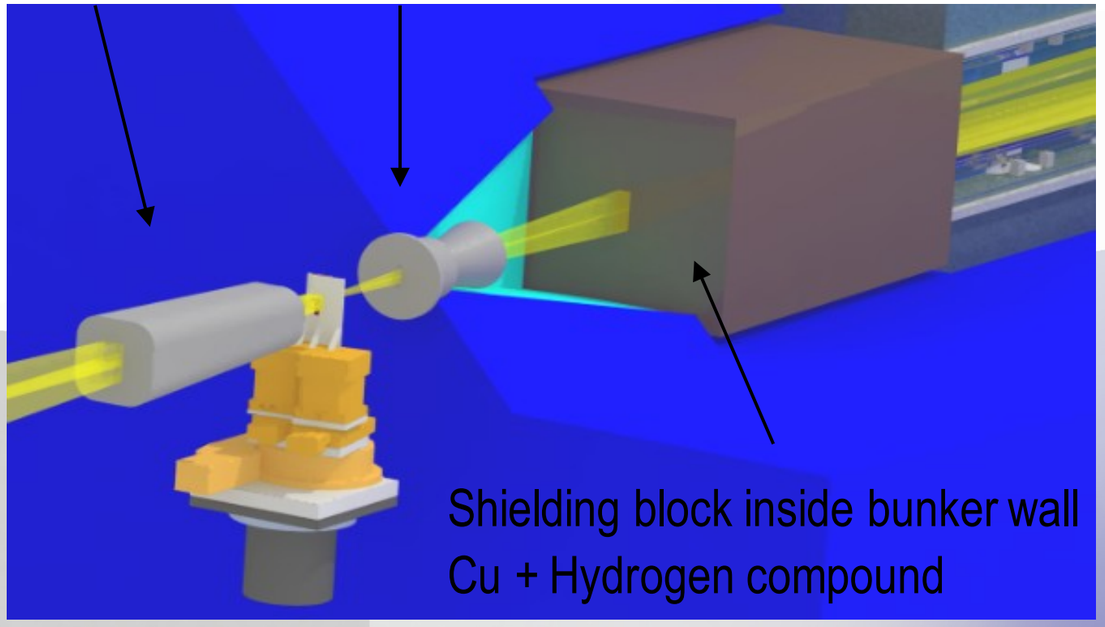


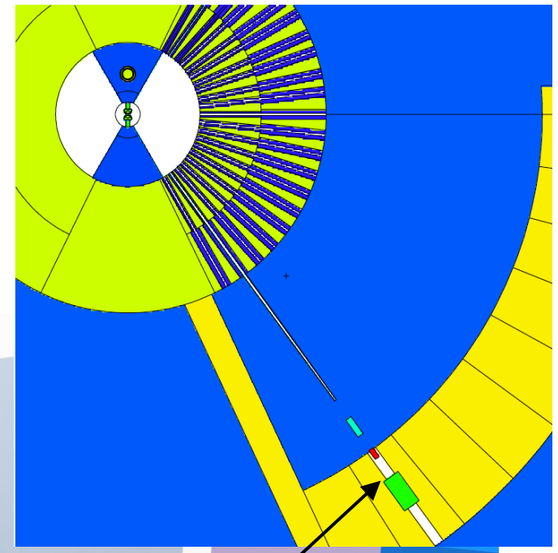


Shielding concept - inside the bunker

Virtual Source collimators

FeNi Tungsten





L_{FeNi} = 60 cm (opening 37 mm x 84 mm)

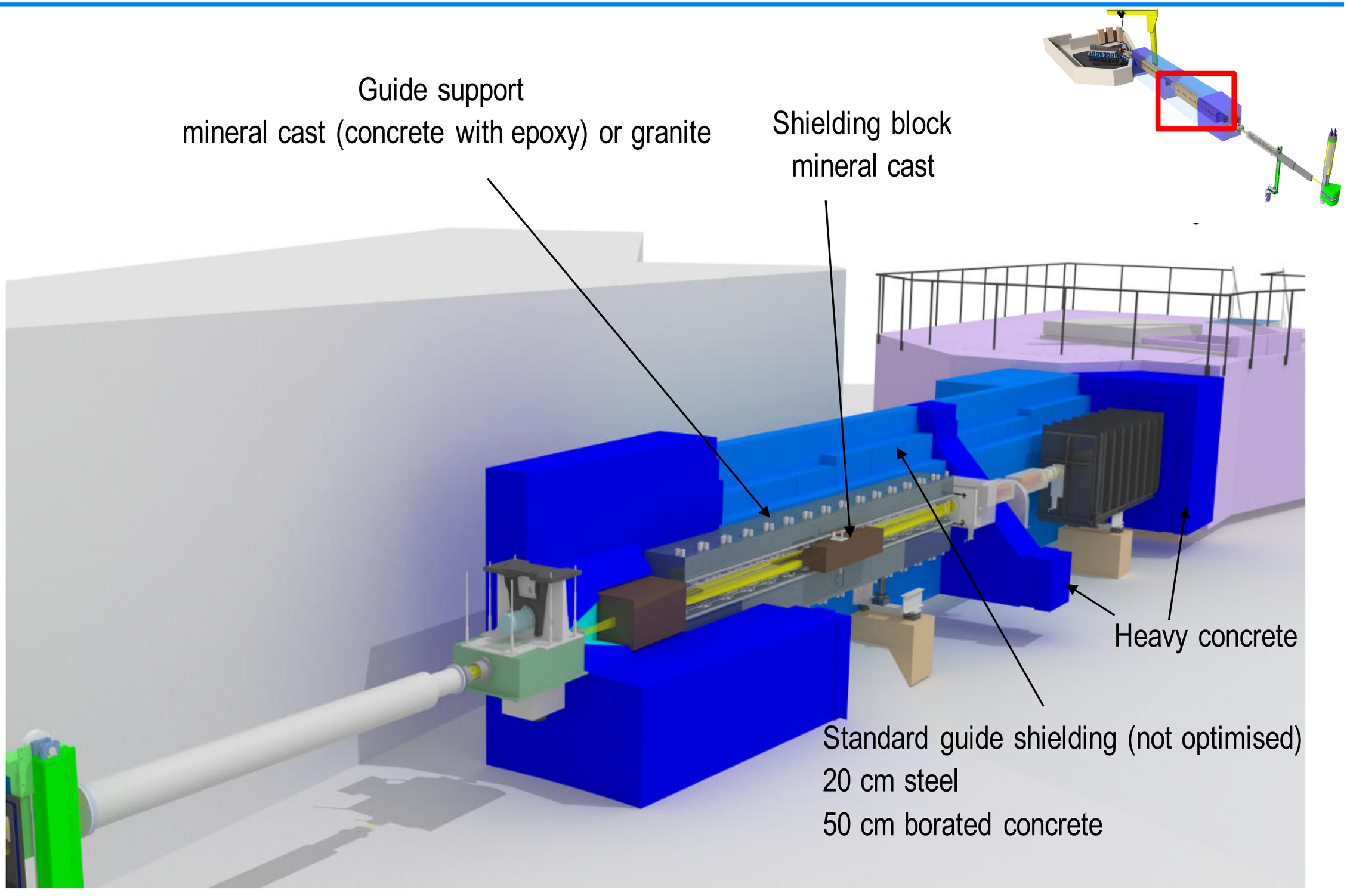
L_{W} = 30 cm (opening 20 mm x 70 mm)

L_{Cu} = 99.5 cm

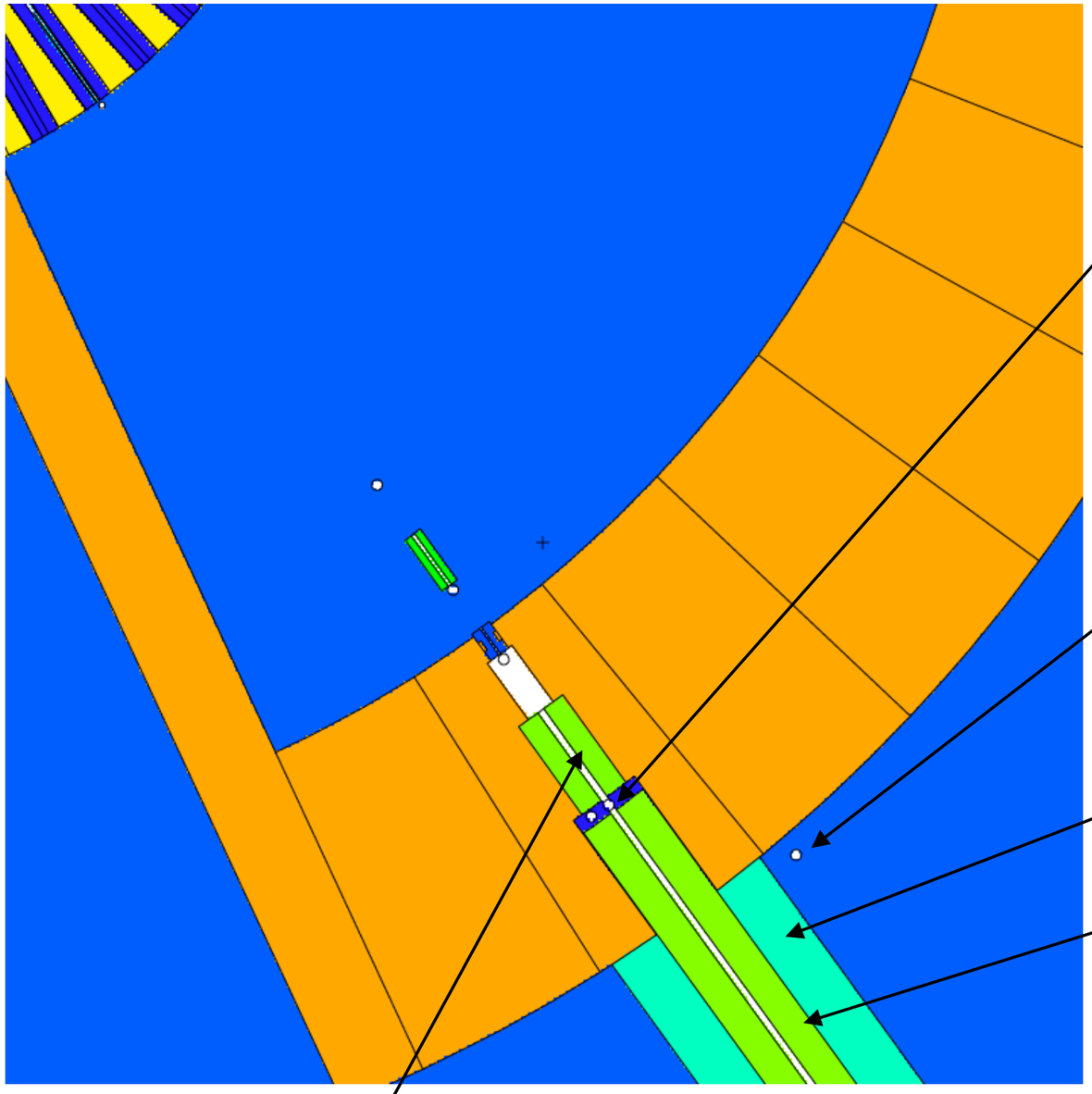
35 kSv/h (n-dose rate)

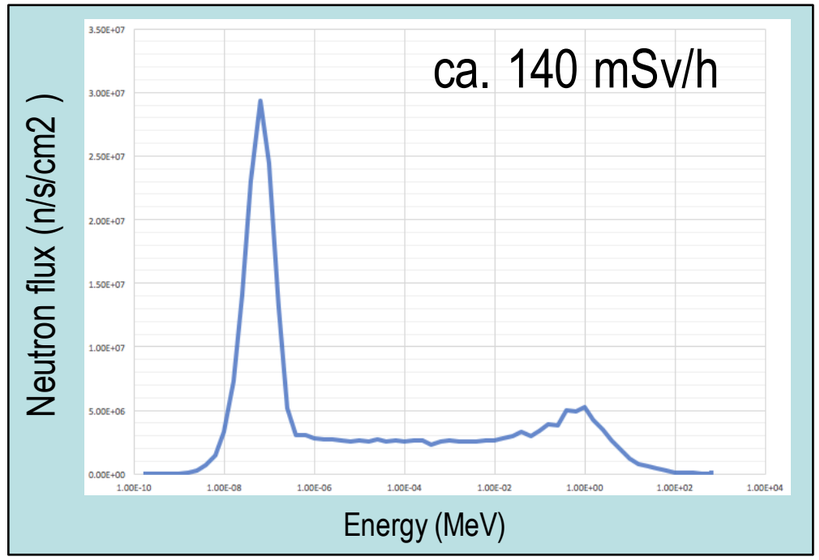
750 Sv/h (n-dose rate)
mainly neutrons < 8 MeV

Shielding Concept – Along the Selene guide



Dose rates outside the bunker



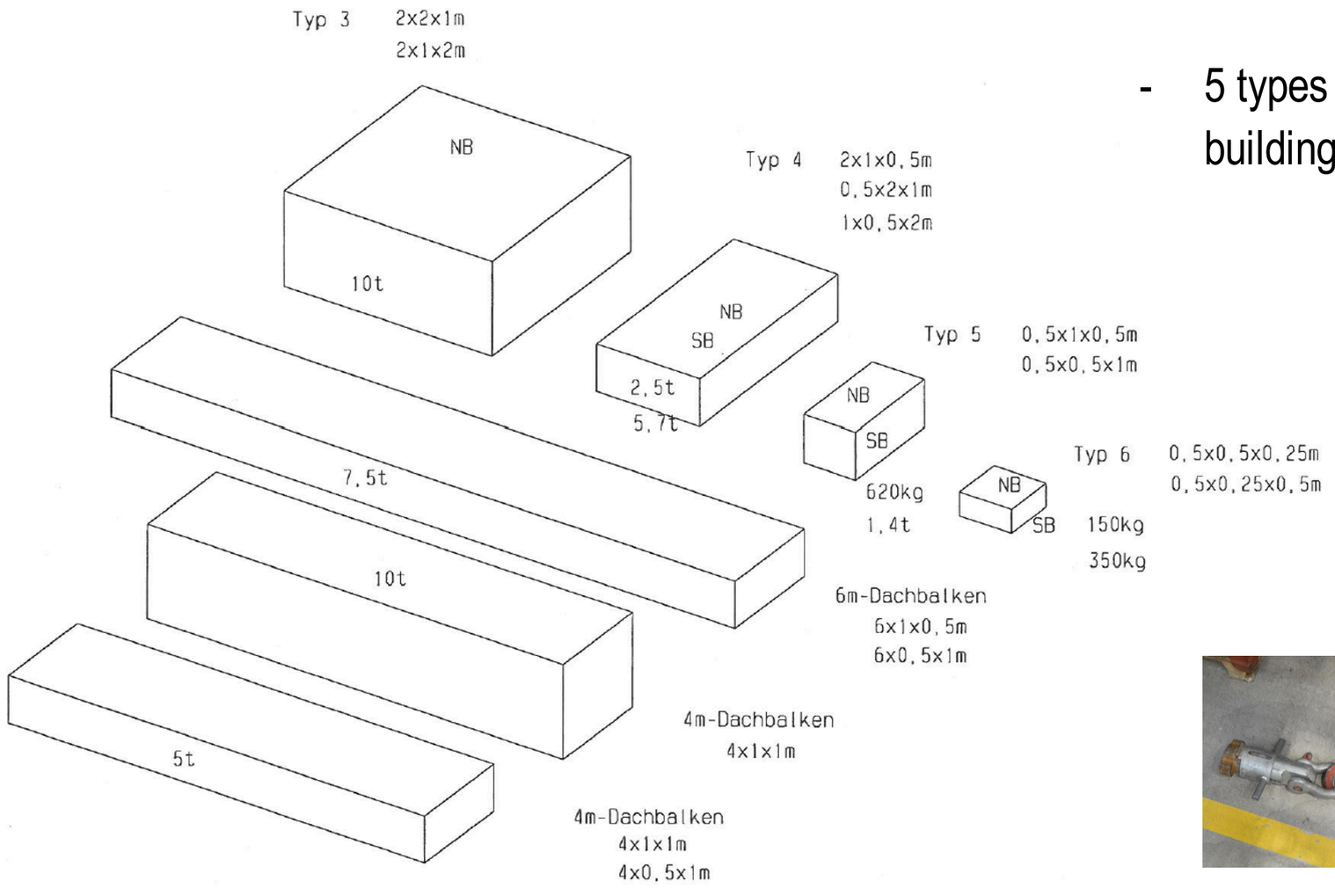


Neutron flux after copper collimator

PSI standard shielding

Materials

- normal concrete
- borated concrete (5% boron carbite)
- scrap metal concrete (density around 4g/cm3)

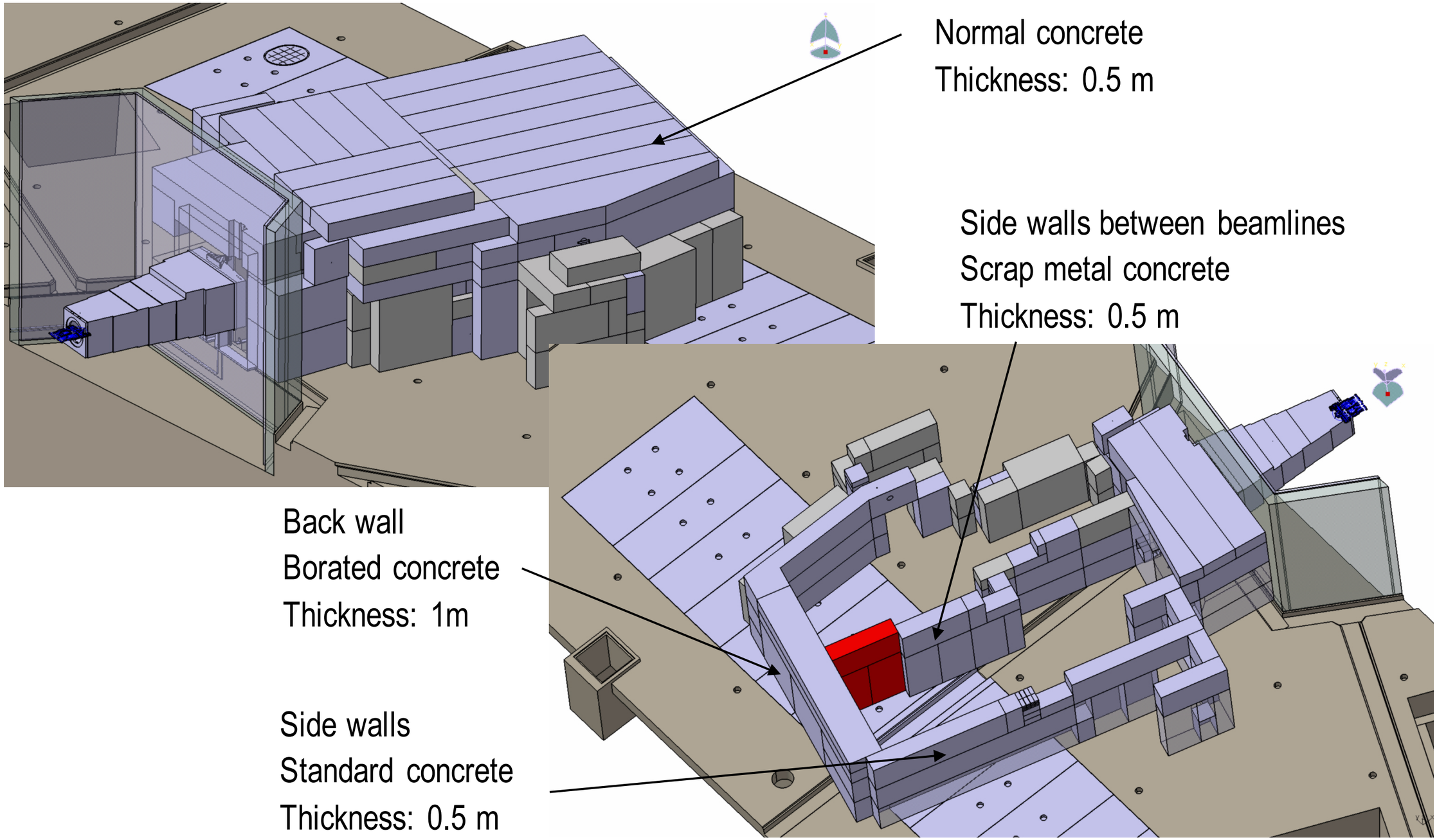


- 14 different standard geometries are available
- 9 types are used side-walls
- 5 types are special made for building bunker roofs

Two types of crane connectors

Bunker design

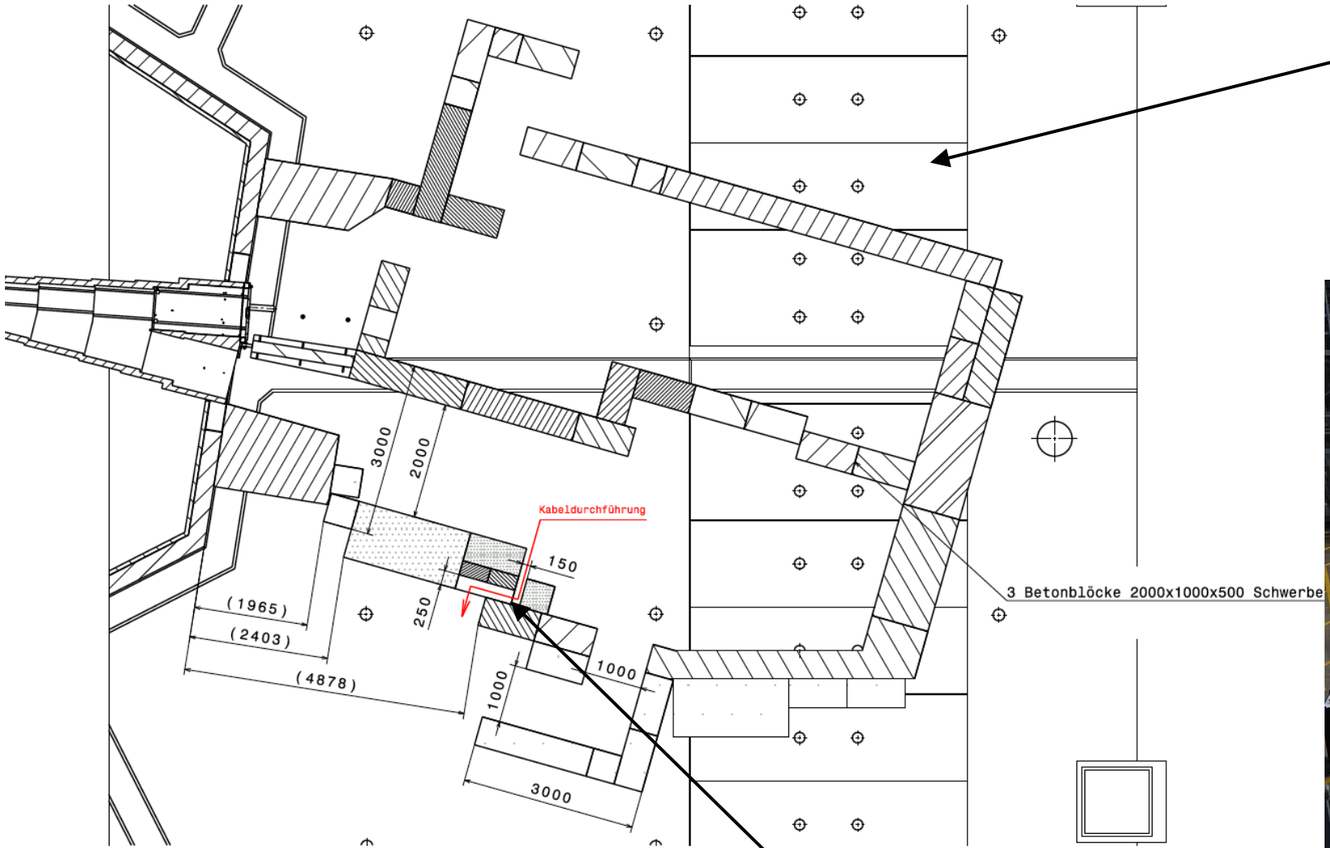
BOA % ICON beamline



Cabling in the bunker

Chicane: yes or not ?

Cable channel never at the back-side



ICON: no chicane but the cable channel is in 2.5 m heigth from the floor

BOA: chicane with standard elements in 1 m height from the floor

Handling – practical issues

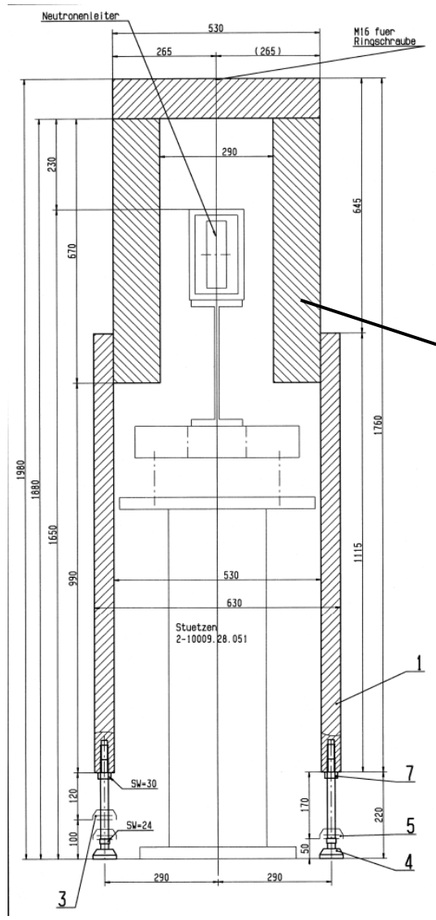
Standard blocks are built with a 45 deg edge around the block -> avoiding spalling/peeling during positioning

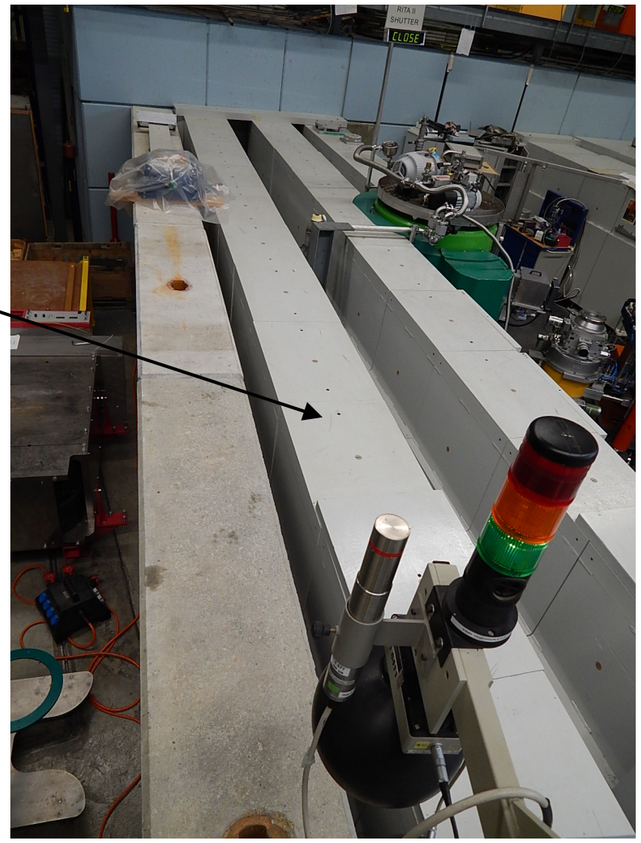
Another aspect: turning of the elements is possible

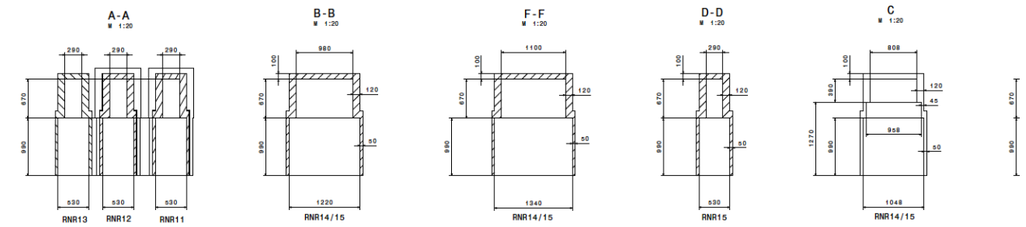
Problem: 4 blocks assembled results in a 2 cm x 2 cm gap !!

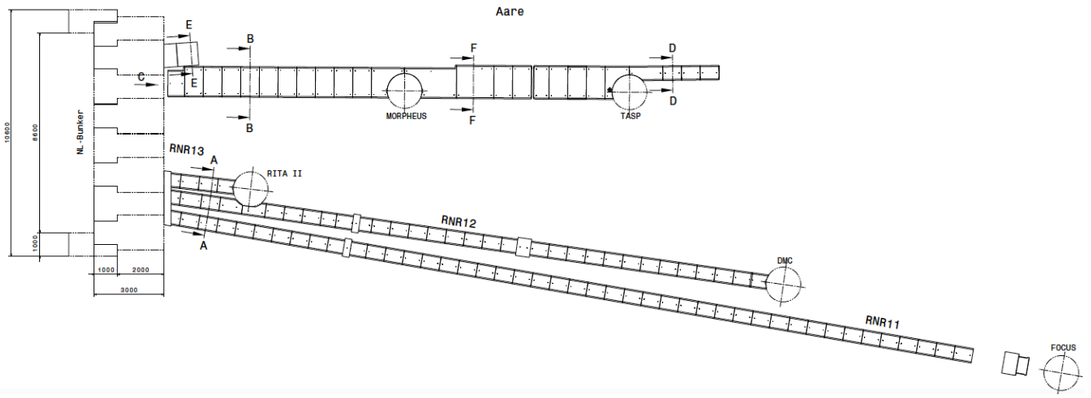
Solution: gap filled with a Pb / PE laminat structure

Guide shielding outside the bunker





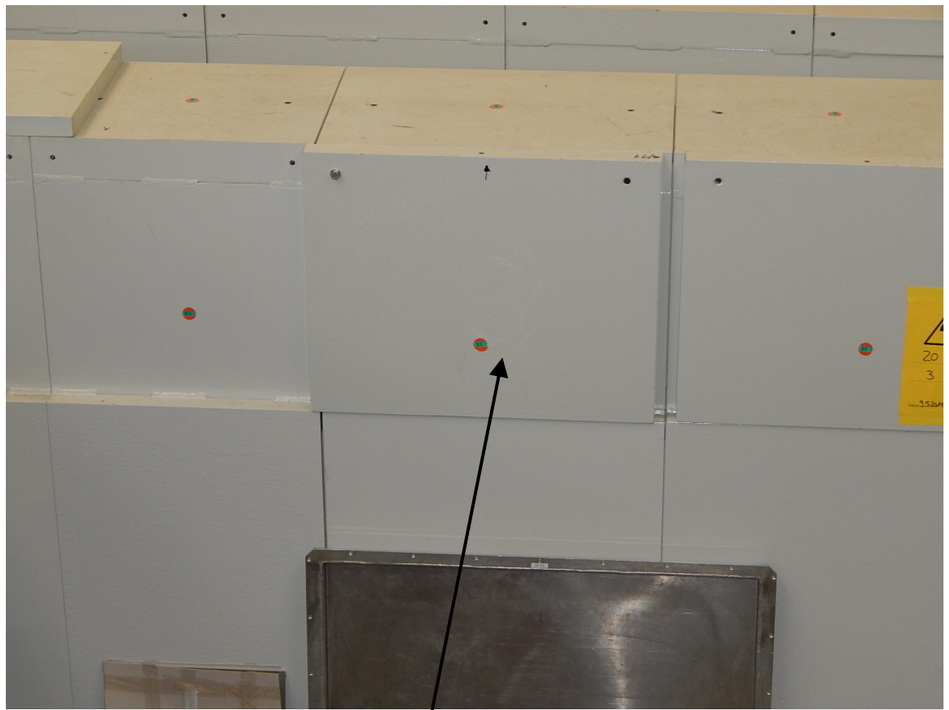




- shielding: 120 mm steel around the guide; 50 mm on the lower region
- Additional shielding to public ways: 500 mm standard concrete blocks (fullfiled < 1 µSv/h)

Guide shielding – Design

Guide shielding stays on 10 cm foots.



Shielding can be extended.

Guide shielding has steps.

Thank you for your attention!