The Bunker : Going from 5.5m to 1μSv/hour

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Fundermental Simulation problem

We start with 10^{16} neutrons per second $>$1MeV.

- Elastic interactions require $\sim$100 collision to get to 1eV
- Very thin monolith
- High divergence beam on monolith exit
- Ports provide significant channels of low collision number neutrons

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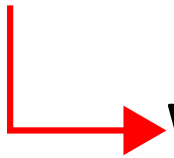
Calculation Process

CombLayer *C++ code (350k lines)*

- Fully interchangable/connectable component geometry
- Variable driven
- Variance reduction
- Open source



Writes MCNP/Fluka/PHITS input decks

Used by

- Delft/Bilbau/Culham/ITER/RAL/Aldermaston

This allows the rapid development of complete semi-engineering models.

https://github.com/SAnsell/CombLayer

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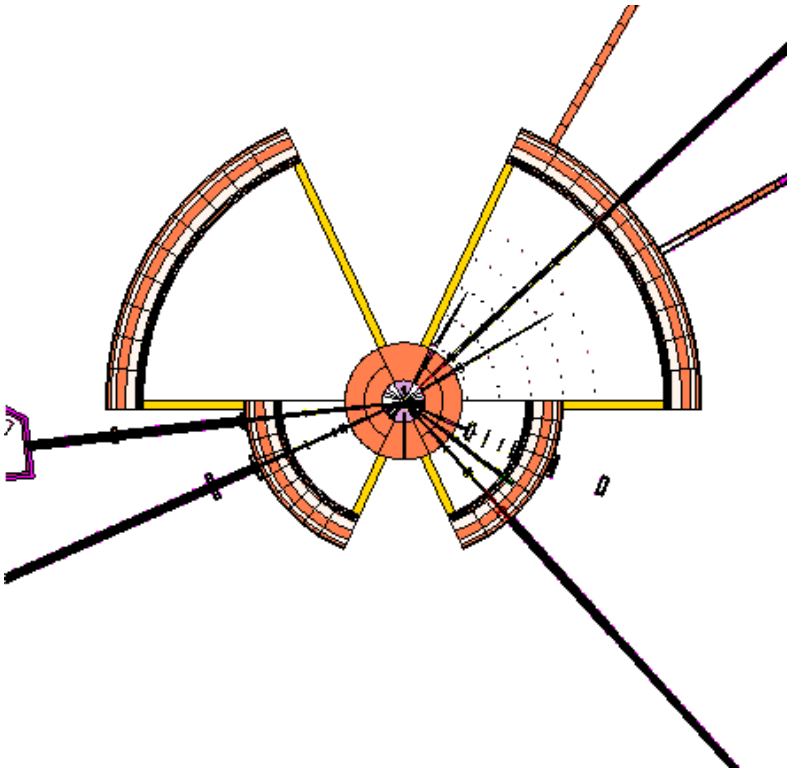
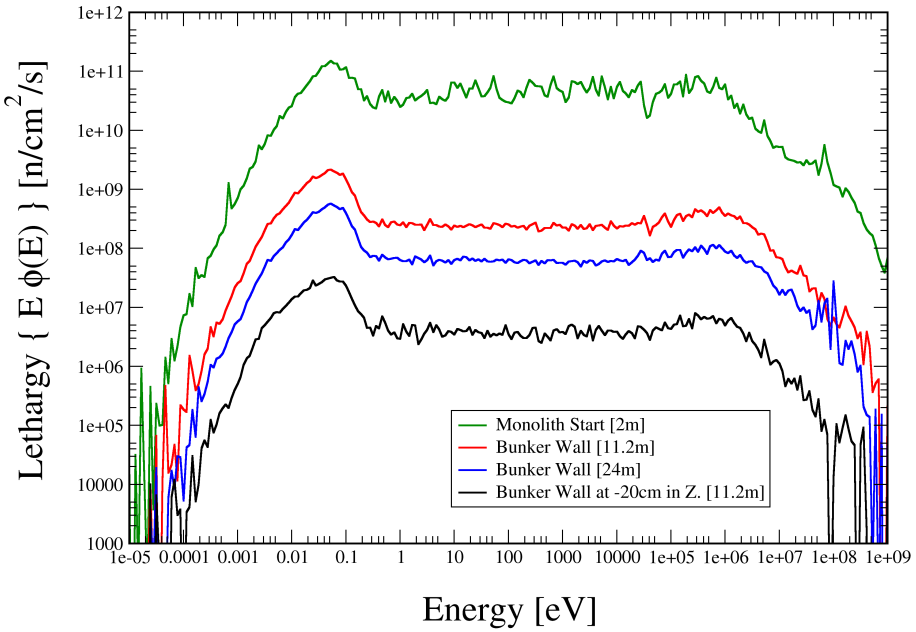
Bunker Concept



- Bunker is a huge open void
- Non-directed neutrons become lost in the huge surface area of the bunker
- Ideally every neutron has one scatter on the beamline
- This is a long pulse source and 90+ choppers do not allow close shielding

Empty Bunker Lethargy



Green : At monolith exit

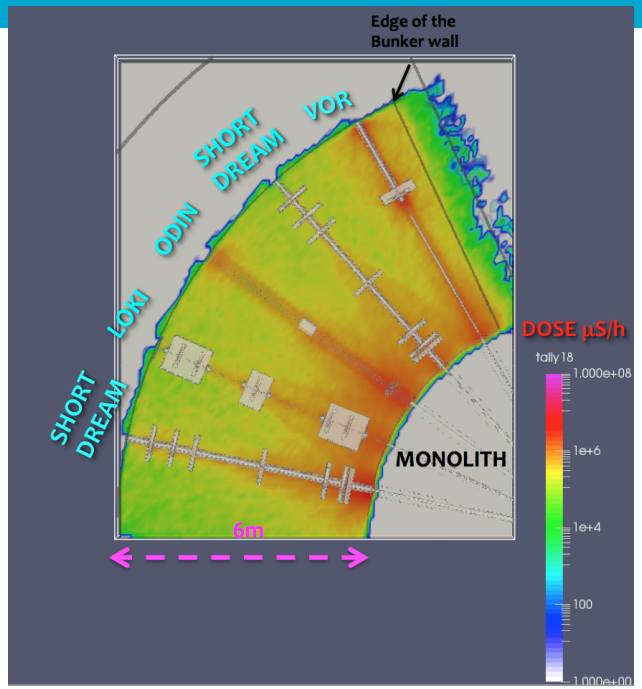
Red : Centre short sector

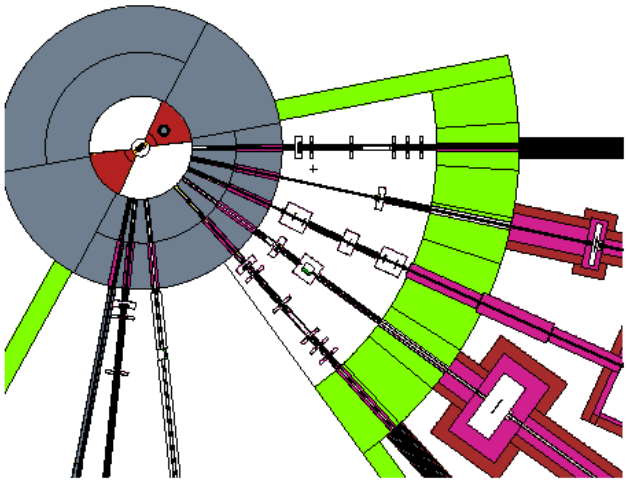
Blue : Centre long sector

Black : 20cm off Z axis (Short)

Off axis is the most significant modifer in an empty bunker BUT only gains $\sim 10^3$

Filled Bunker





- Despite the open bunker – interferance is weak after 9m
- Cross talk can be further supressed by steel strips at beam height

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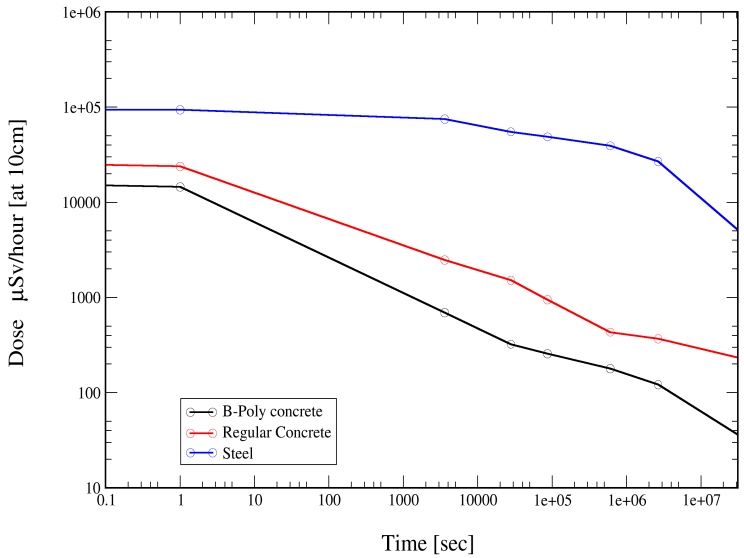
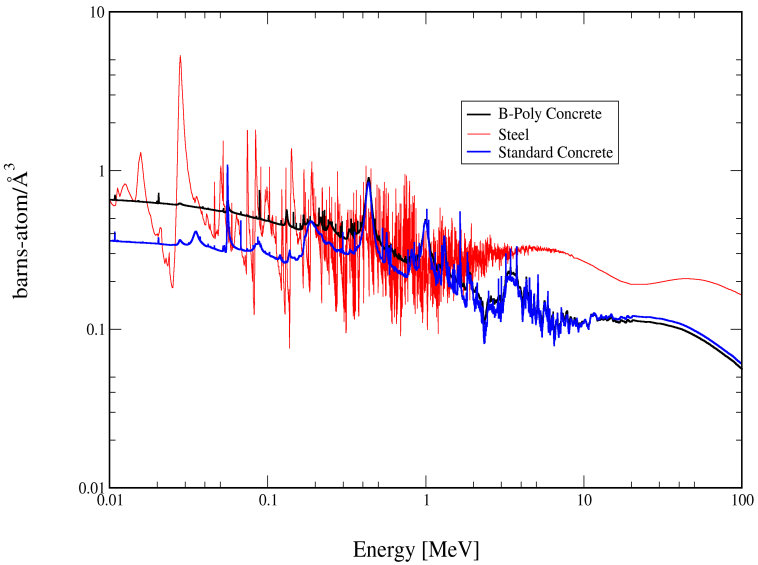
Bunker Wall Layout





- Complementary combination of *B-Poly Concrete* and steel.
- Gain in the intermediate energies
- Less activation

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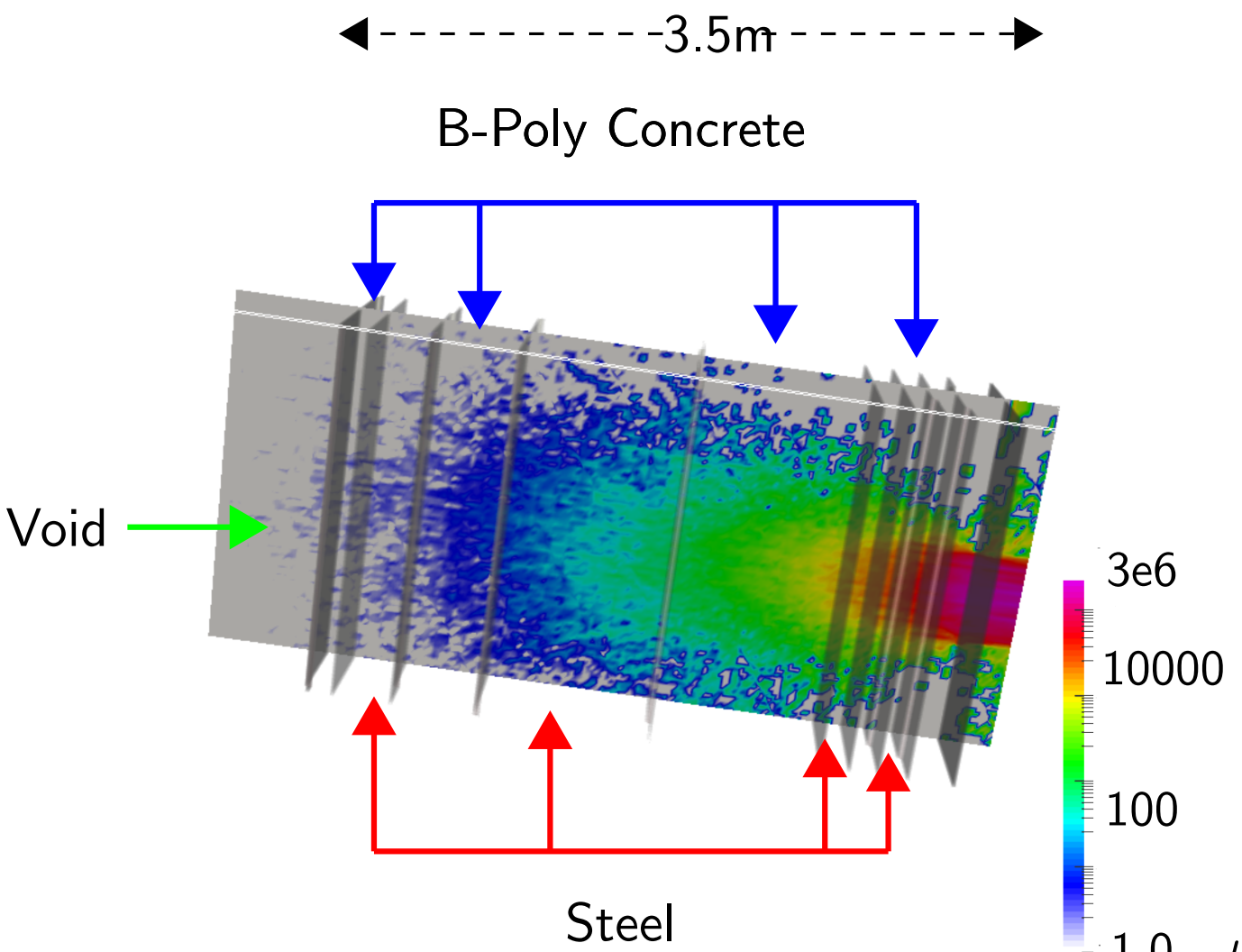
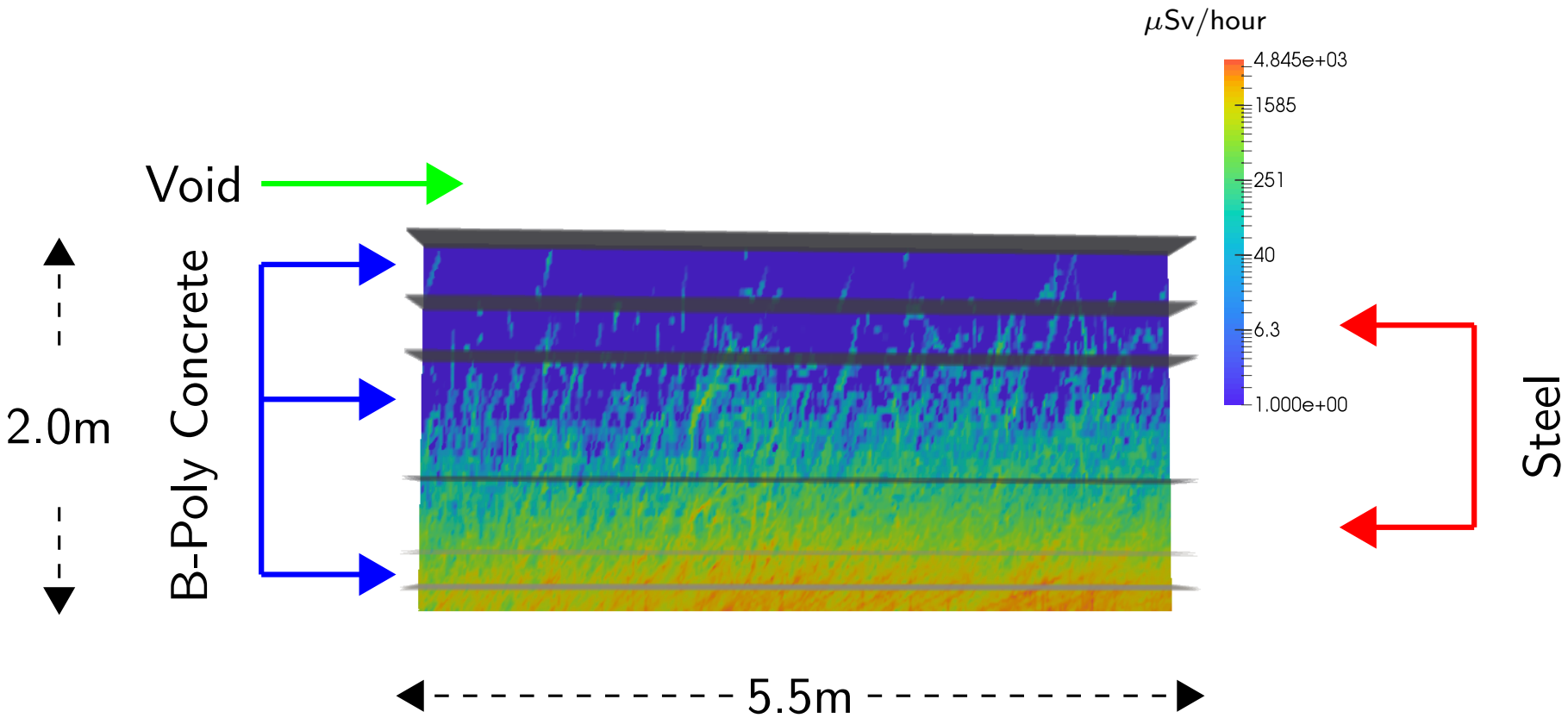
Bunker Wall Dose



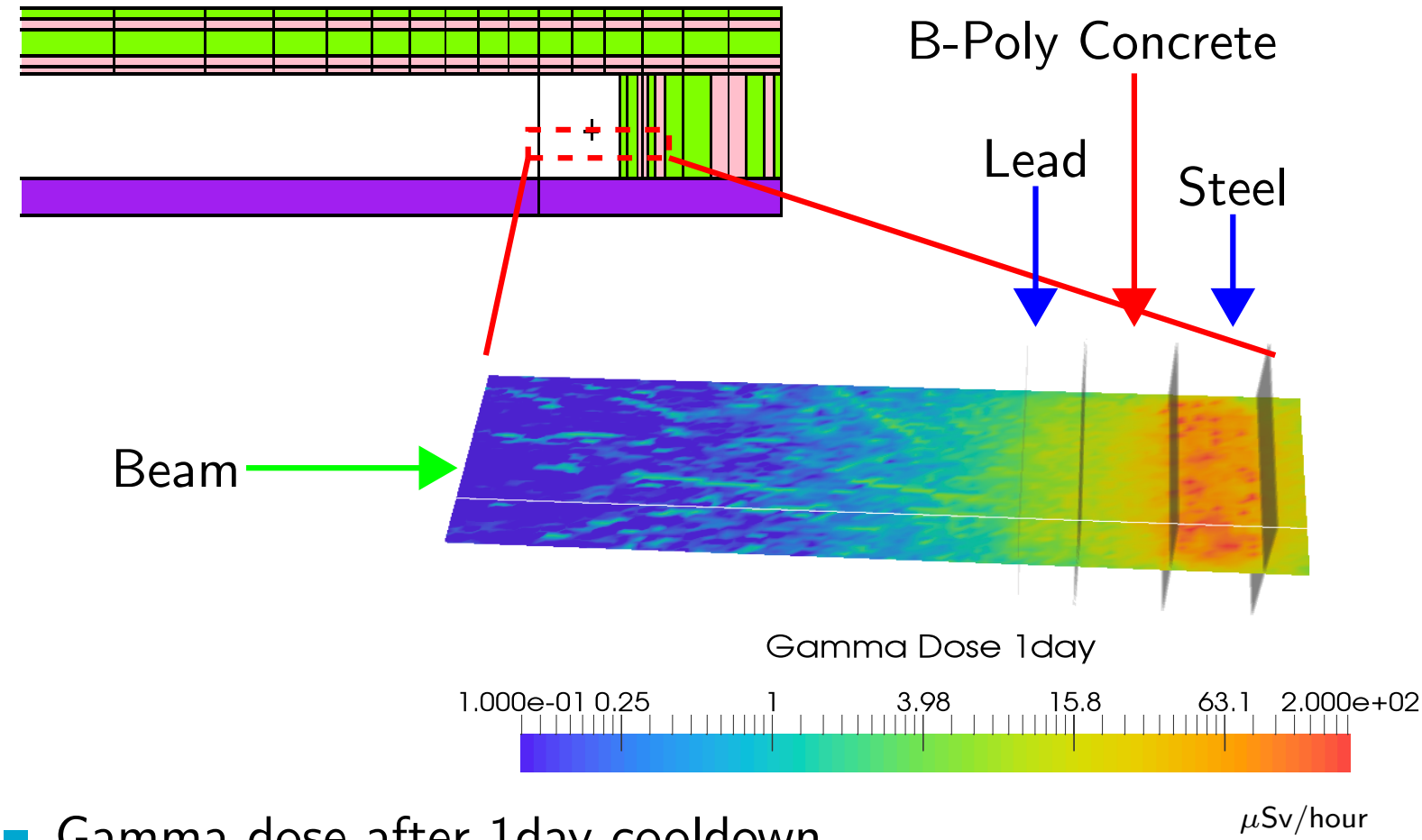
Beam from open monolith beam port hitting wall.
Grayed area all cells below 1.0μSv/hour

Bunker Roof Dose



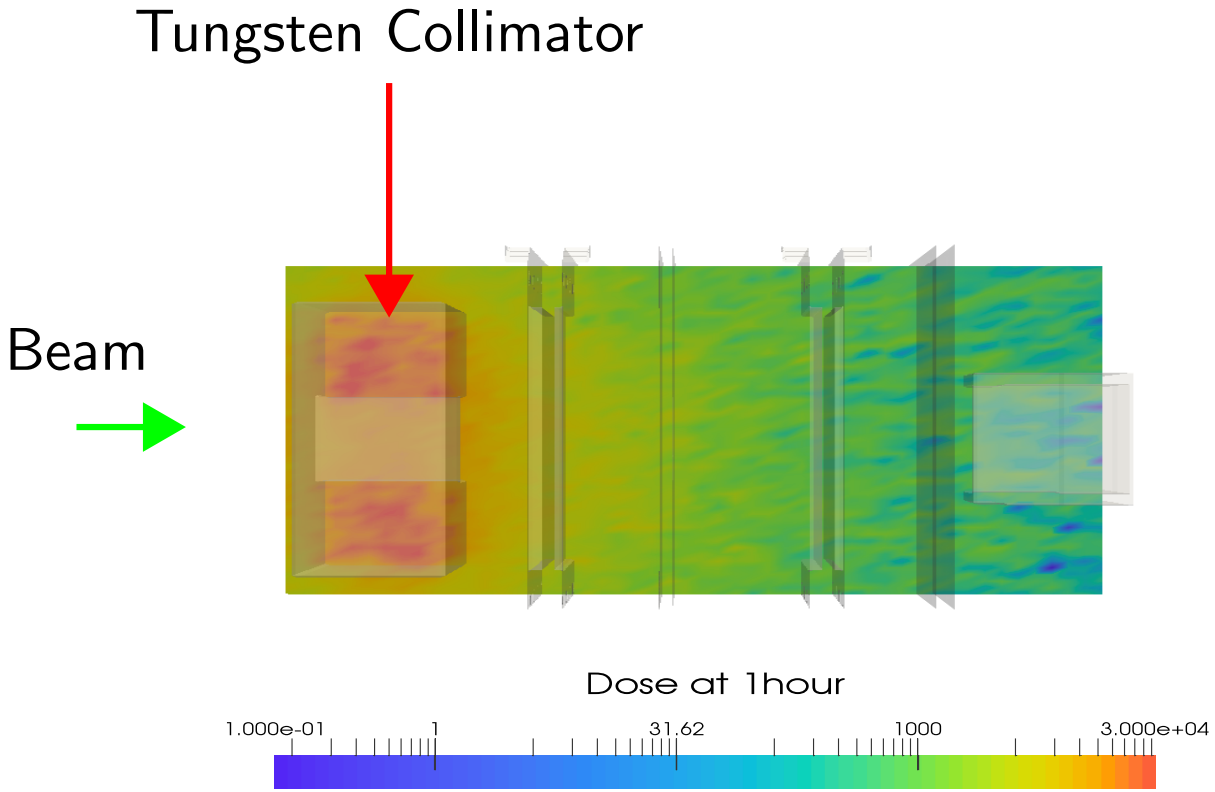
- Classic 5-layer design
- Beamline is metal guide tapered to a point at 11m.

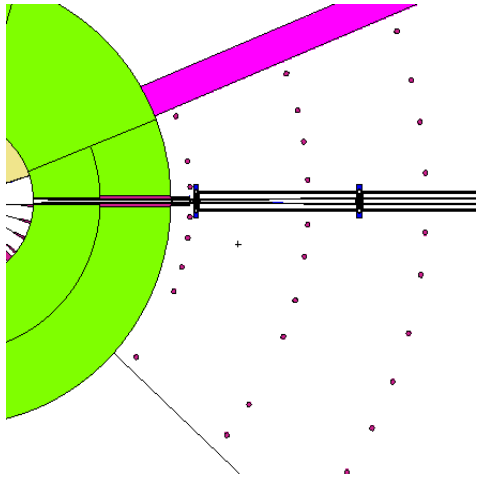
Bunker Wall Dose [90days irradiation]



- Gamma dose after 1day cooldown
- Concrete protects the steel layers [somewhat]
- Lead layer is worth about x3

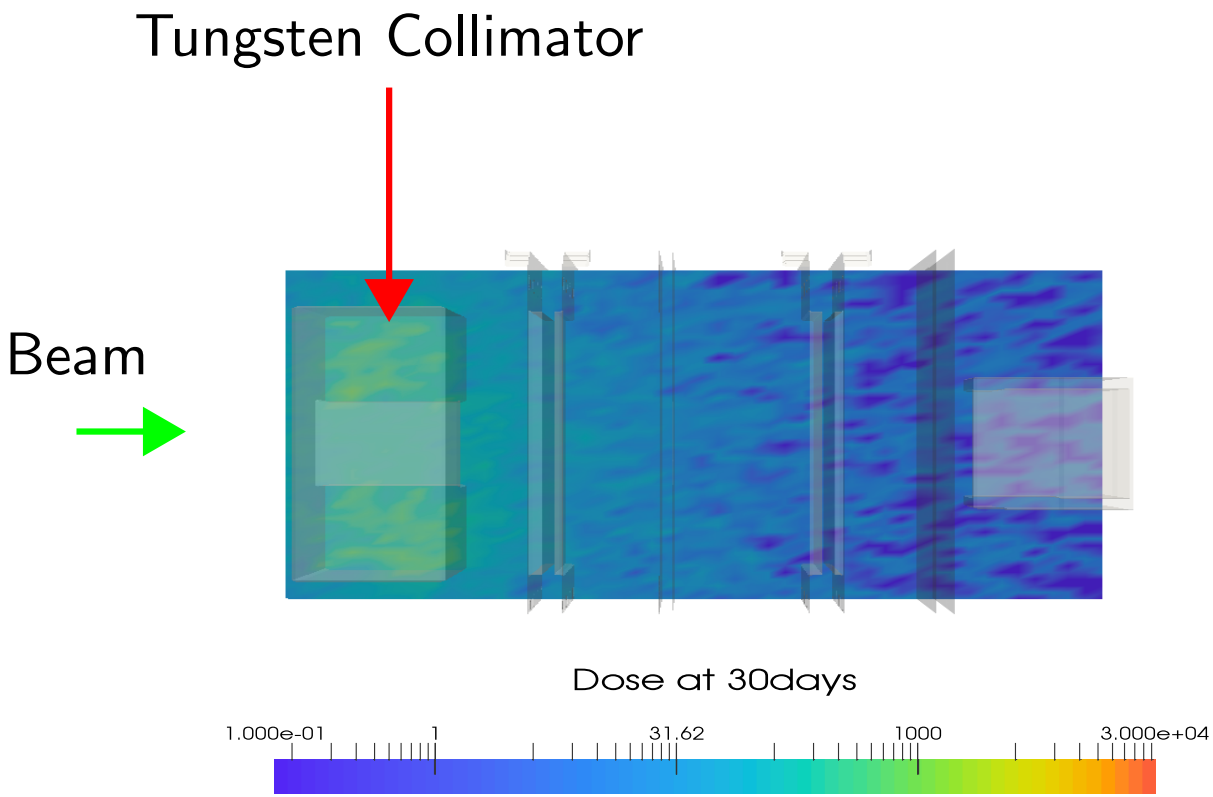
First beamline component [BiFrost]

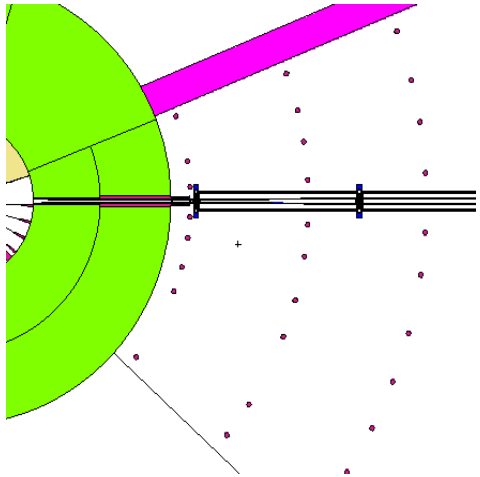




- Irradiation for 90days + 1 hour off
- Tungsten self shields to a large extent

Front beamline [BiFrost]



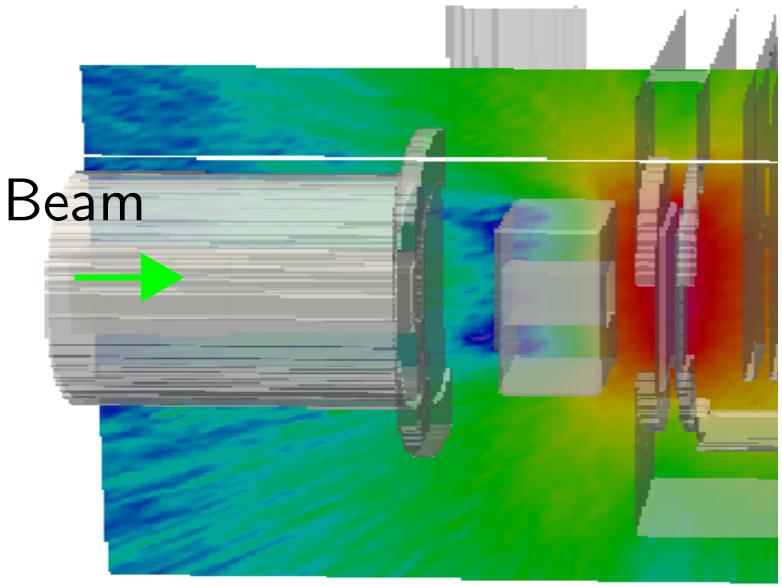


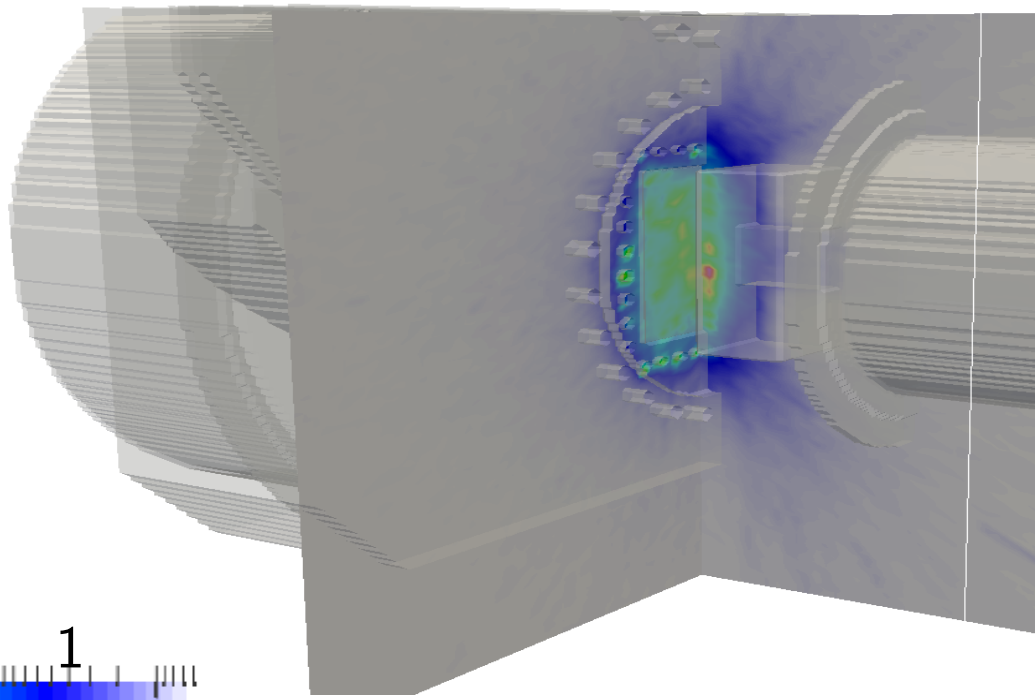
- W-187 gone – very few gamma sources

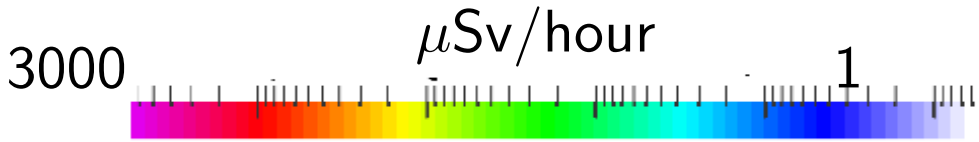
Front double disk chopper [BiFrost - worst case example]

1 day after beam

30 days after beam [linear scale]







- $3mS$/hour (peak) after a day
- $15\mu S$/hour (peak) after a month [dominated by steel bolts/Silicon window]

Summary

- Bunker is has sufficient shielding to allow **ANY** in beamline object.
- Instrument teams should only need to worry about their own exits
- The less material closer to the beamline the better the instrument background and activity [first approximation].

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