

The Bunker : Neutronic Shielding and Activation

Stuart Ansell
Valentina Santoro
Douglas Di Julio
Günter Muhrer

European Spallation Source, Lund, Sweden.

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The Wall is going to be made from Steel and Polyethene

Considerations:

- 1 Polyethylene became the primary candidate material due to roof limits on lower AND upper surfaced
- 2 Polyethylene is non-structural unlike concrete
- 3 The wall needs more-multi steel layers to distribute the load evenly
- 4 Lead active steel shield considered an engineering liability
- 5 The upstream of the wall needs to interface with a intercollated instrument join (a single piece for simplicity)

The Roof needed to be made thinner

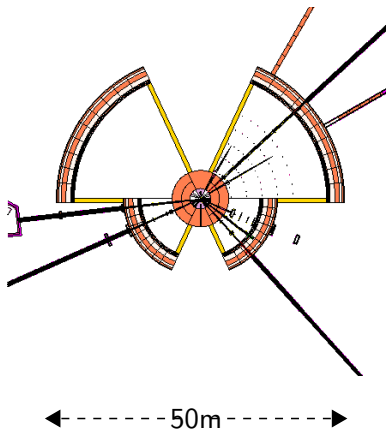
Considerations:

- 1 Polyethylene became the primary candidate material due to the sprinkler system
- 2 The roof is reduced in top height [Crane hook height]
- 3 The roof cannot be lowered [Chopper housing] (170cm)

Full detailed engineering **MUST** be included

- 1 Gaps, earthquake and pillar/support beams included on sector by sector basis
- 2 Vertical mis-match approximated by density reduction and increase of height by 5cm (3%)

Bunker Concept

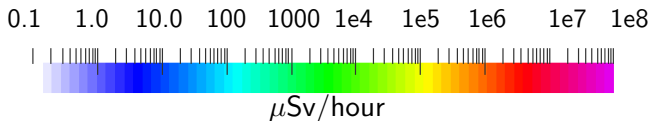
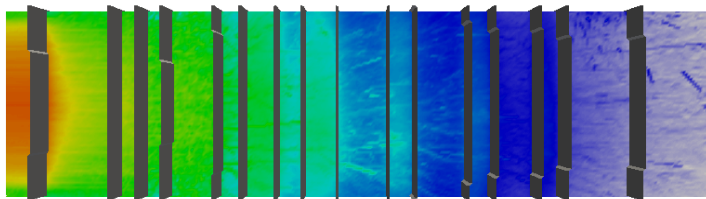


- Bunker contains >90 choppers/
 >140 flanges
- Current MCNP model is 20,000 bunker components
- Essential that model input is prepared by computer code, and results are processed by computer code.

Considerations:

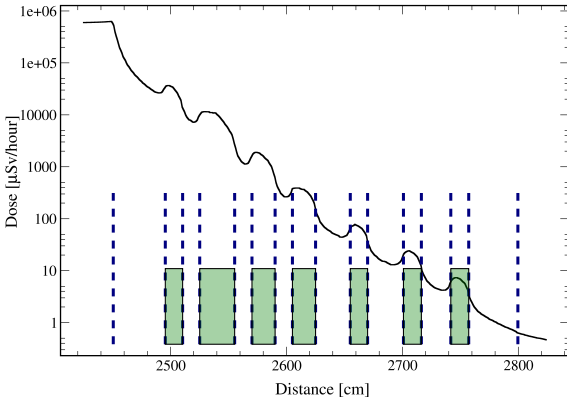
- 1 For the wall a $8 \times 10 \text{ cm}^2$ monolith opening is used
- 2 For the roof a simple focused beamline guide is used
 - 78% scattering is achieved (wall+guide) [$E > 1 \text{ eV}$ above]
 - Buildup is greater than a blocking scatter because as only half the neutron can exit the blocking source
- 3 Materials are HDPE / mid-Carbon mild Steel
- 4 Dose integrations done on average of highest 1 m^2 zone

Dose through Poly Wall



- Wall has no lead
- Thick initial poly layer to avoid activation of primary steel layer

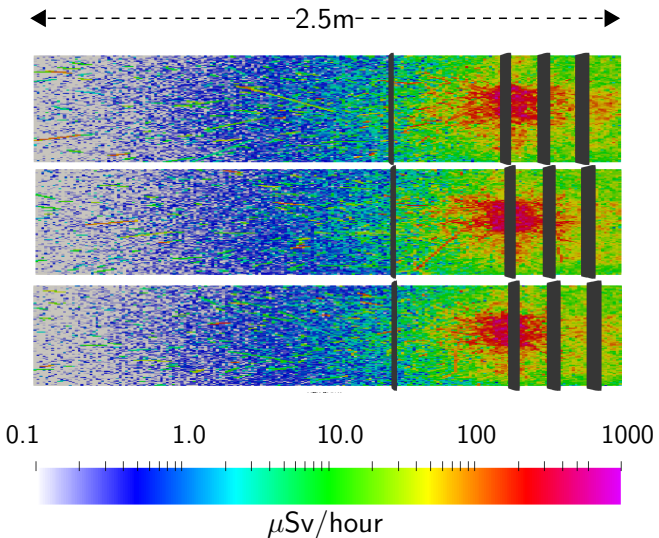
Dose through Poly Wall



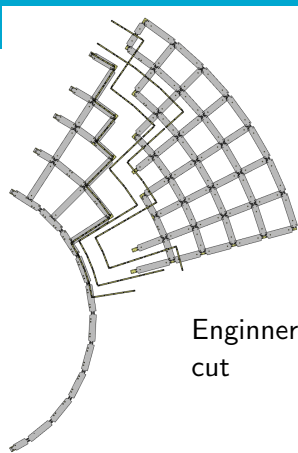
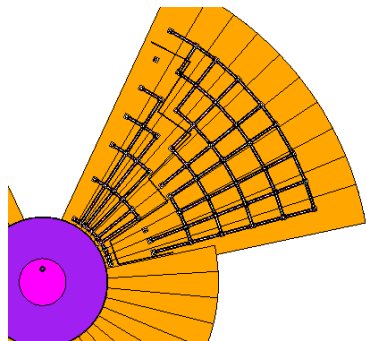
- Steel shows the neutron dispersion effect



Wall Activation: Gamma flux after 1/3/7 days cooldown



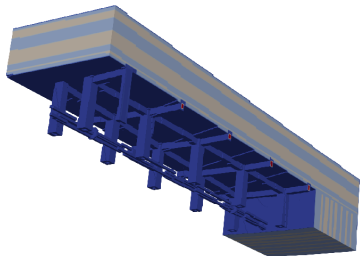
■ Activity statistically unchanged over 1 to 7 days.



Engineering plan cut

←----- 28m -----→

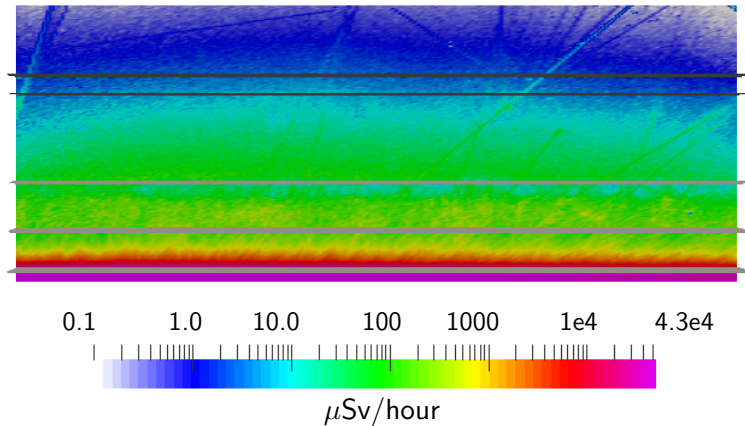
- Roof is now modeled with engineering gaps
- Clearance gaps extend through complete layers
- Represent 12% of the total roof volume [current CombLayer model]



←----- 14m -----→

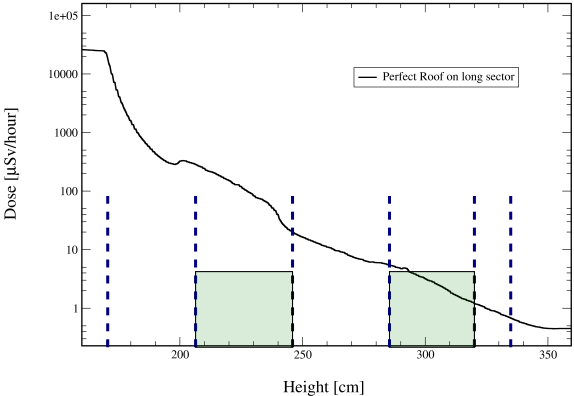
- Bunker roof supports models in full 3D
- 10cm cut into roof and 20cm underhang
- Filled with Poly - (modeled at 1/2 density)

Dose through Poly Roof - Perfect Roof



- Poly layers and steel to get 1.6m distance

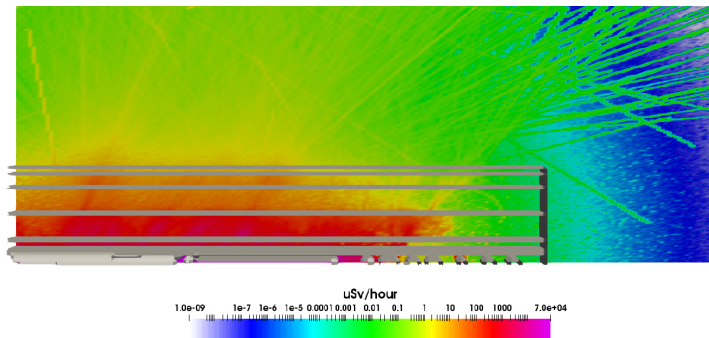
Dose through Perfect Poly Roof



- Roof is viable assuming no gaps

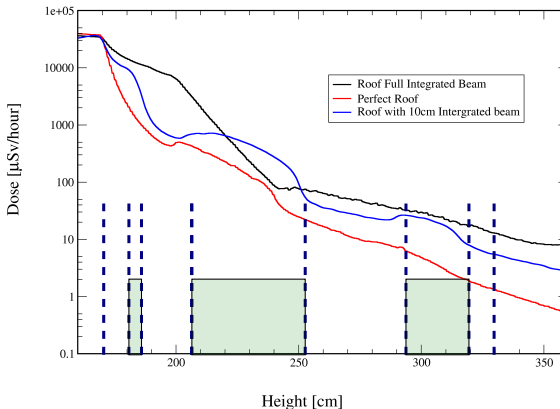


Dose through CATIA Roof - With 10cm level support



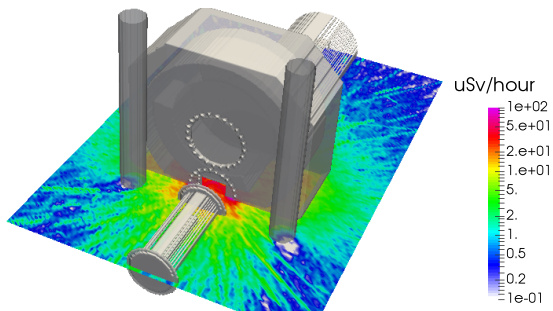
- Beamline : LOKI on short – Modified to have straight $8 \times 10 \text{cm}^2$ opening in monolith
- Cut through roof over support beam

Dose through Poly Roof - with lower level support



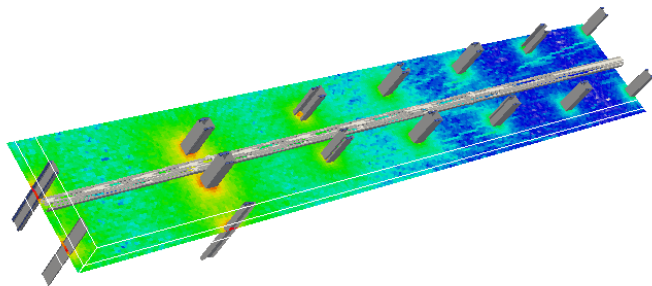
- Gap Steaming will produce local hot-spots
- Roof structure changed between Perfect/Integrated/10cm

Activation in T0 Chopper

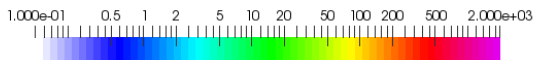


T0-Chopper 7 day: Activation from: Tungsten hammer /
Inconel (80A) rotor / Steel body

Activation of Pillars round a beamline

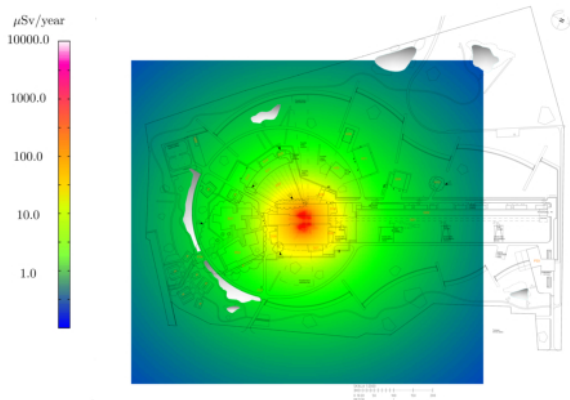


uSv/hour



Pillars 1 day: After 10 years at 5MW.

Skyshine Contribution to Environment



- High energy neutron field transported by block band air contribution
- Site boundary contribution just respected for 16 instruments

- Bunker is ok with supervised zone over the top
- No requirement for high B4C in Polyethelene [can use 0.5% which is fire-retardent grade]