Radiation and Activation with SoLID

Outline

1. Director's Review suggestions
2. Baffle Materials Activation
3. Radiation on Coil
4. Radiation in the Hall
5. Change of SoLID configurations
6. Another SoLID configuration (J/Ψ)
7. Estimated cost

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The University of Edinburgh

March 5, 2017

Director's Review: Replies to the Report

Areas of further investigation

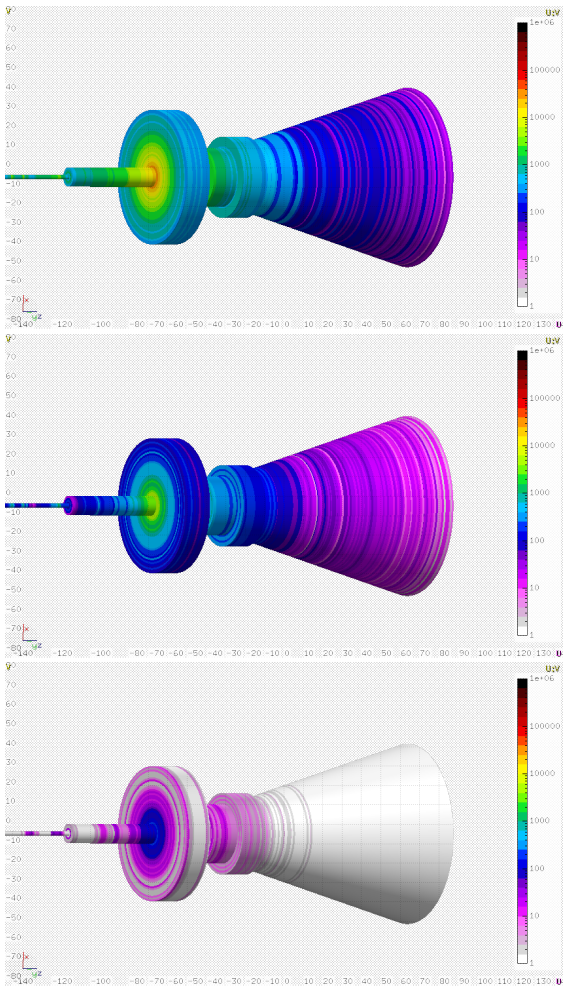
- Baffle material optimization
- More detailed study on radiation on magnet's coil
- More detailed on impact of radiation in the Hall with focus on areas where electronics will be present
- Planning on how to change from one SoLID configuration to another: Better understanding of effort involved and potential issues on radiation levels
- Complete different configurations for SoLID

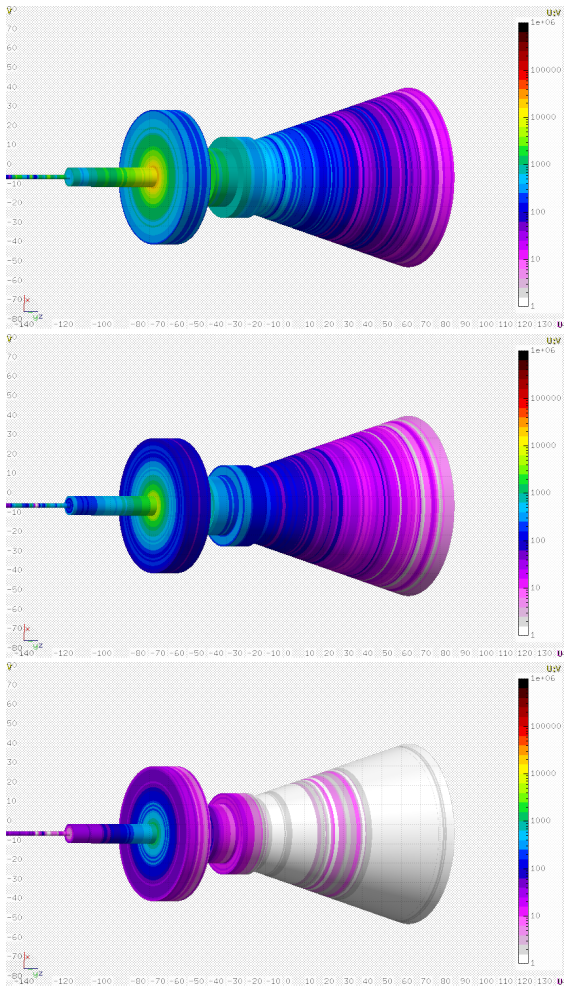
Baffle: Different Material Activation

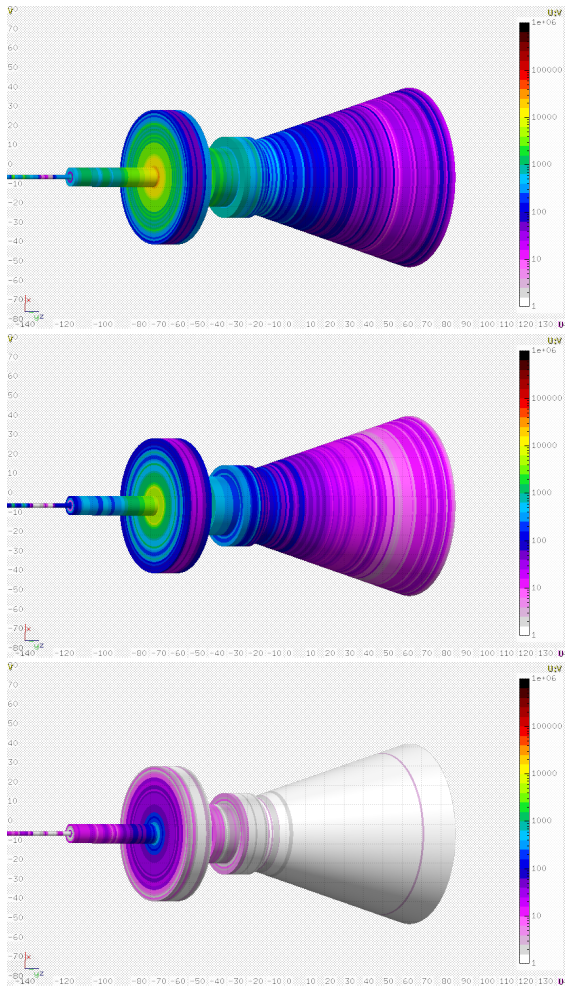
LEAD

COPPER

TUNGSTEN







Baffle: Different Material Activation

Baffle's material Activation

- Different material were tested for the first 3 layers of baffle/shielding
- At this presentation just shown the first baffle, but material dependence is comparable also for the other baffles analyzed
- Copper shows a longer decaying time for the activated isotopes (after 1month radiation is ¡ 1 order of magnitude respect to Lead and Tungsten)
- If Copper is chosen some shielding enclosure will be needed to be placed for dispose of the baffle.

Director's Review: Replies to the Report

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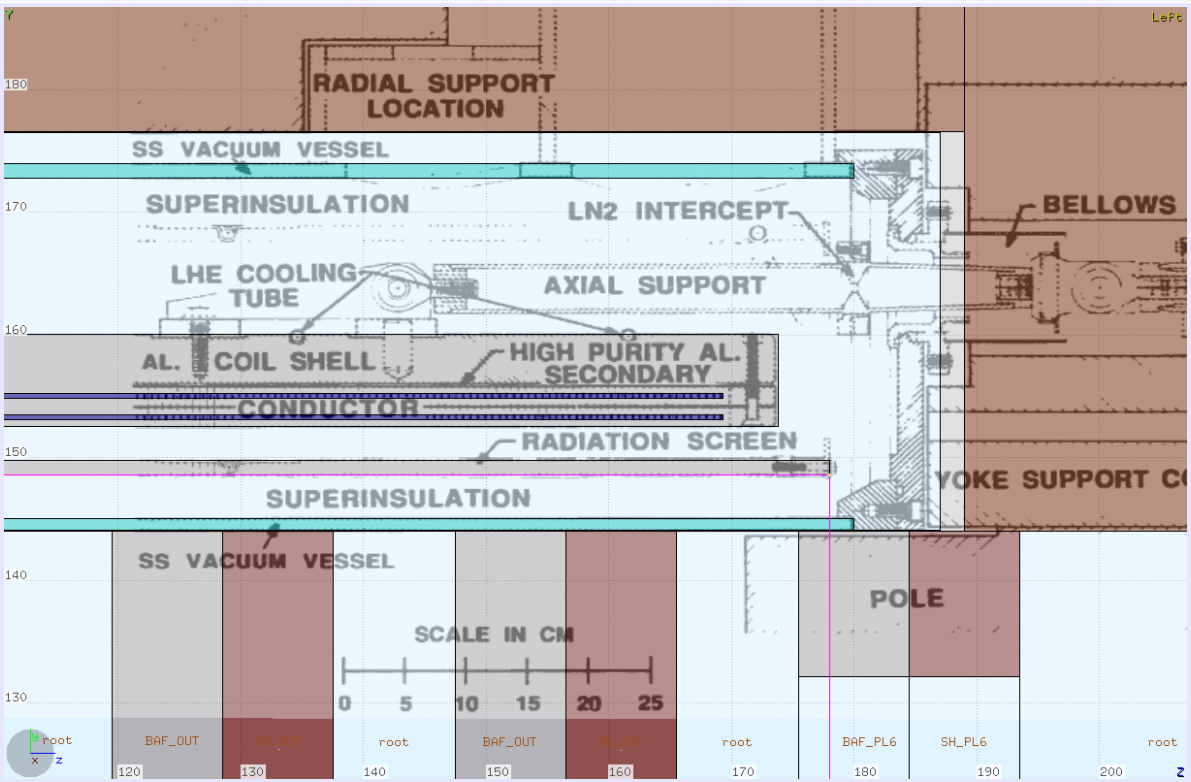
Lifetime on NbTi superconductor carried by SoLID

Updated Coil design to CLEO

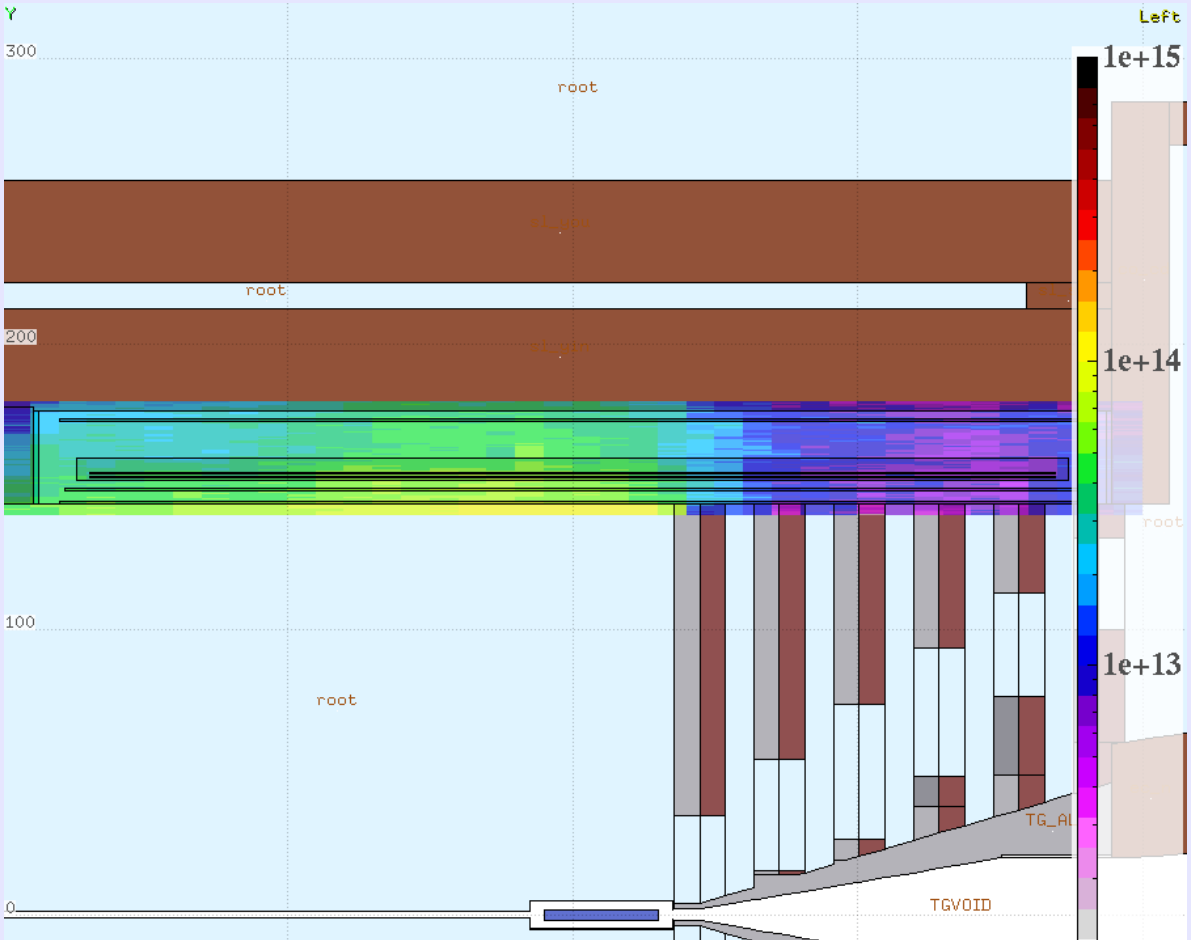
The PVDIS configuration with Deuterium target present the main source for neutron fluxes on the coils



Lifetime on NbTi superconductor carried by SoLID

Expected PVDIS neutron fluence $\frac{N}{cm^2}(E > 1MeV)$

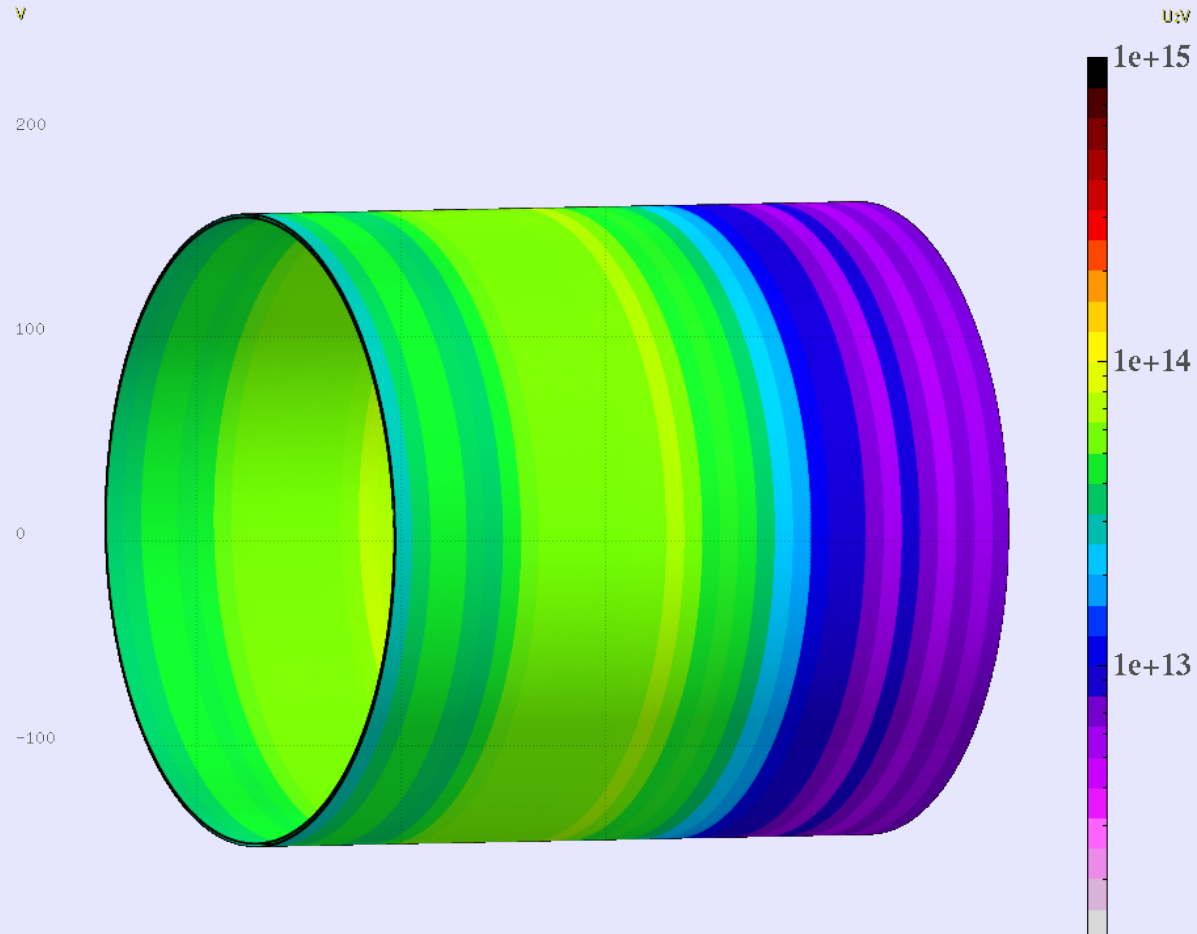
Dose for 2000h at $100\mu A$



Lifetime on NbTi superconductor carried by SoLID

Expected PVDIS neutron fluence $\frac{N}{cm^2}(E > 1MeV)$

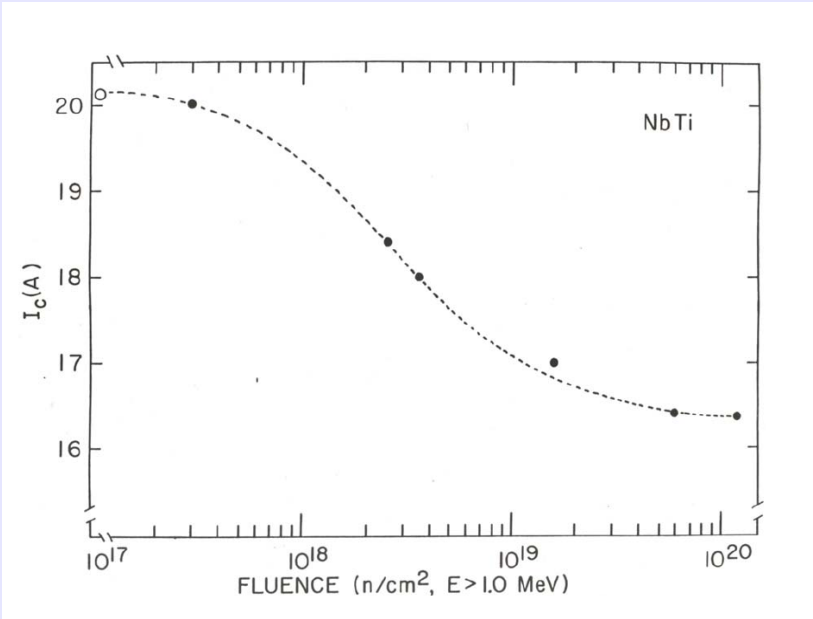
Dose for 2000h at $100\mu A$ (Flux on coils)



Lifetime on NbTi superconductor carried by SoLID

Expected PVDIS neutron fluence $\frac{N}{cm^2}(E > 1MeV)$

Dose



- A reduction of $\sim 20\%$ in I_c is expected in the range $2x10^{17} < \frac{N}{cm^2} < 2x10^{19}$
- **The expected accumulated fluence for PVDIS is $< 10^{14} \frac{N}{cm^2}$**

Director's Review: Replies to the Report

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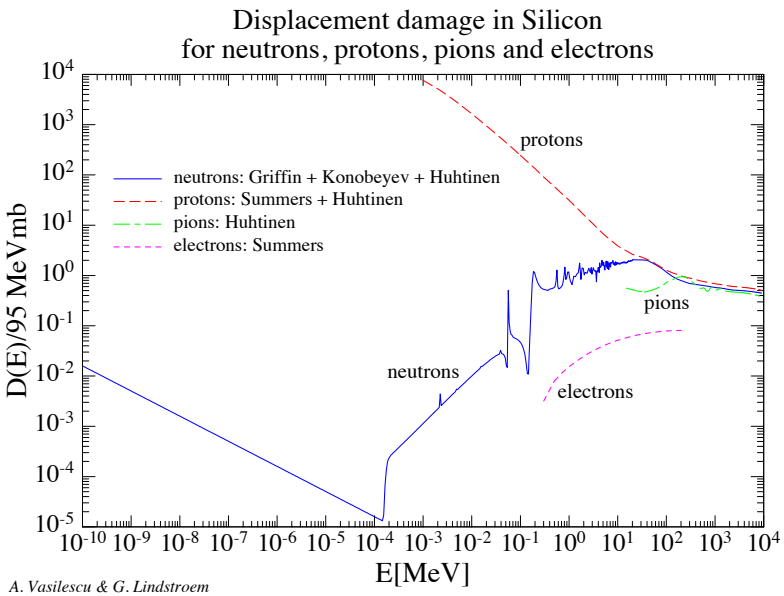
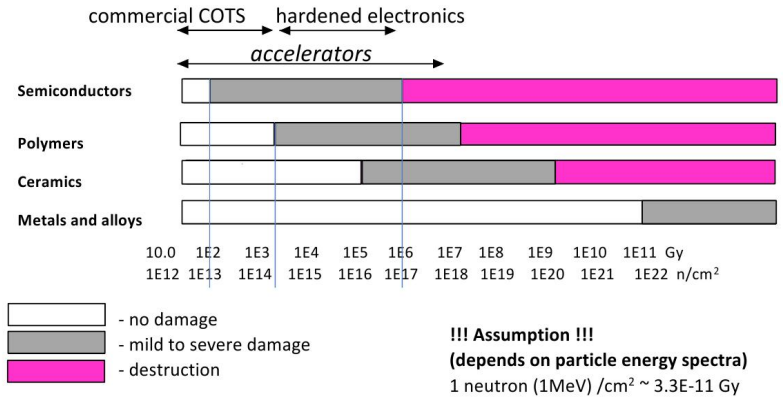
Radiation Estimates and Tolerance

Radiation Estimates



A. Vasilescu & G. Lindstroem

Tolerance (guideline)



!!! Assumption !!!
(depends on particle energy spectra)
1 neutron (1MeV) /cm² ~ 3.3E-11 Gy

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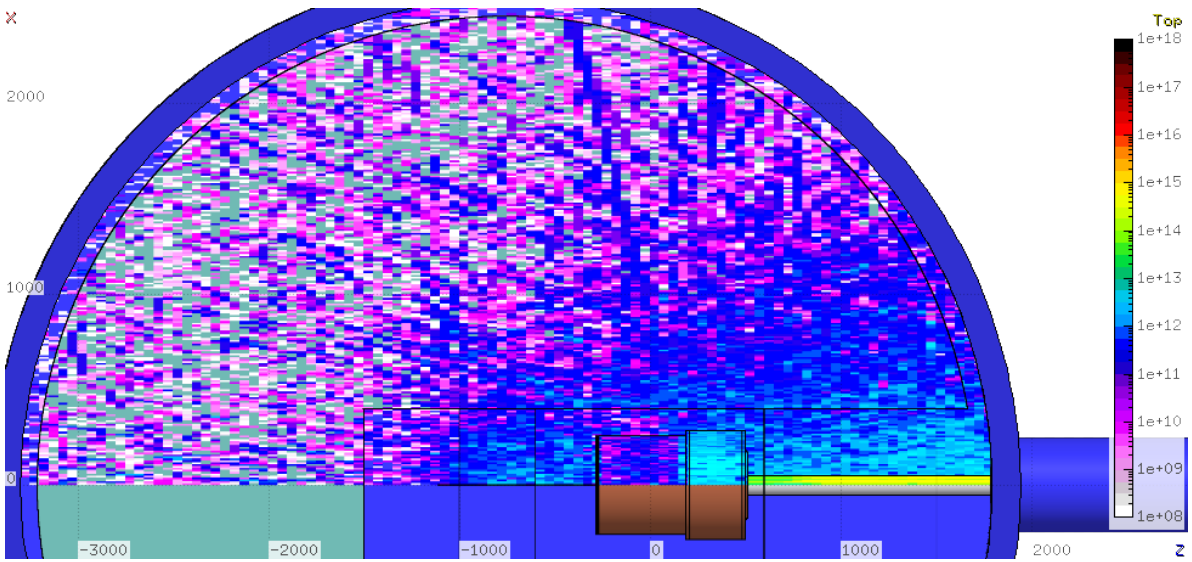
More detail on Radiation in the Hall

Updating design

- Outside the beamline enclosure (2m) accumulated radiation dose should be below the 10^{13} $\left(\frac{1MeVNeutron}{cm^2}\right)$
- At this level of accumulated radiation no expected damage is expected to detectors



Director's Review: Replies to the Report

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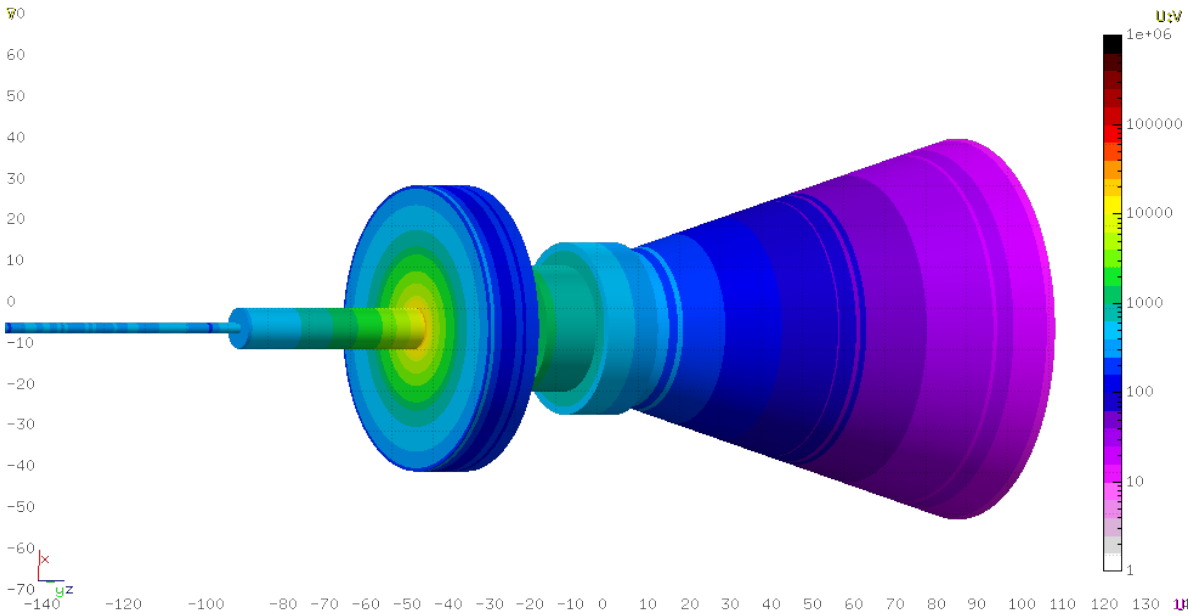
Change of SoLID configurations

Considering just radiation level issues

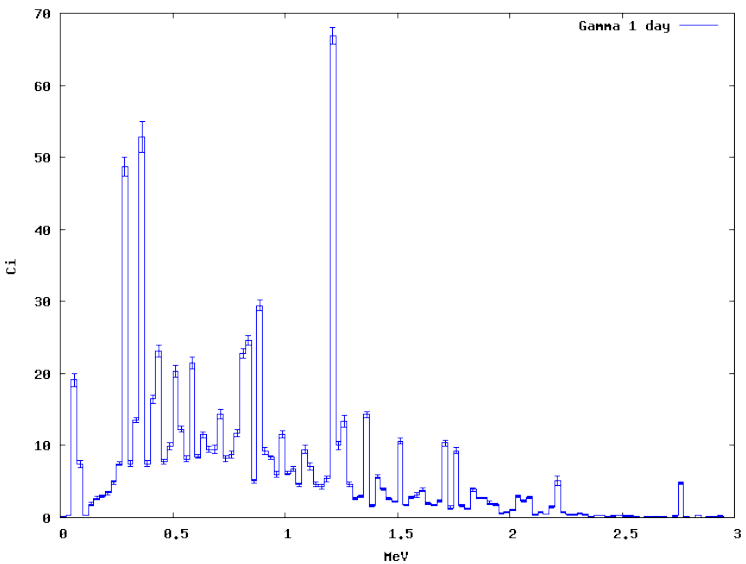
The PVDIS configuration with Deuterium target presents strong activation on the first baffle



Change of SoLID config: baffle activation for PVDIS

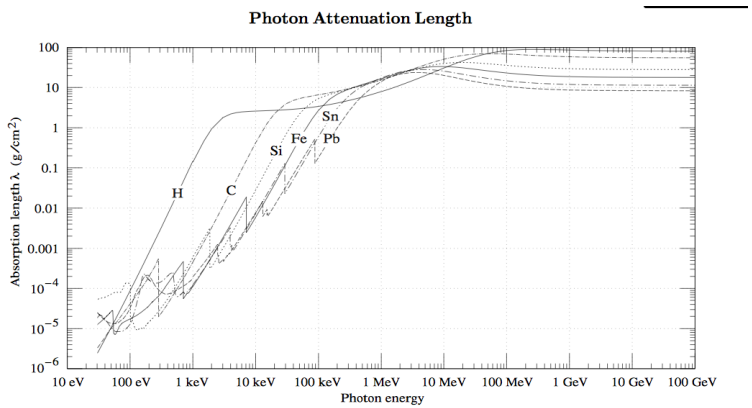
Goal for activation $\Rightarrow < 10 mrem/h$

Gamma Spectrum after 1day



$\sim 8cm$ of Lead for goal

- factor of ~ 20 reduction
- (Real baffle has 50% of this activation)



Director's Review: Replies to the Report

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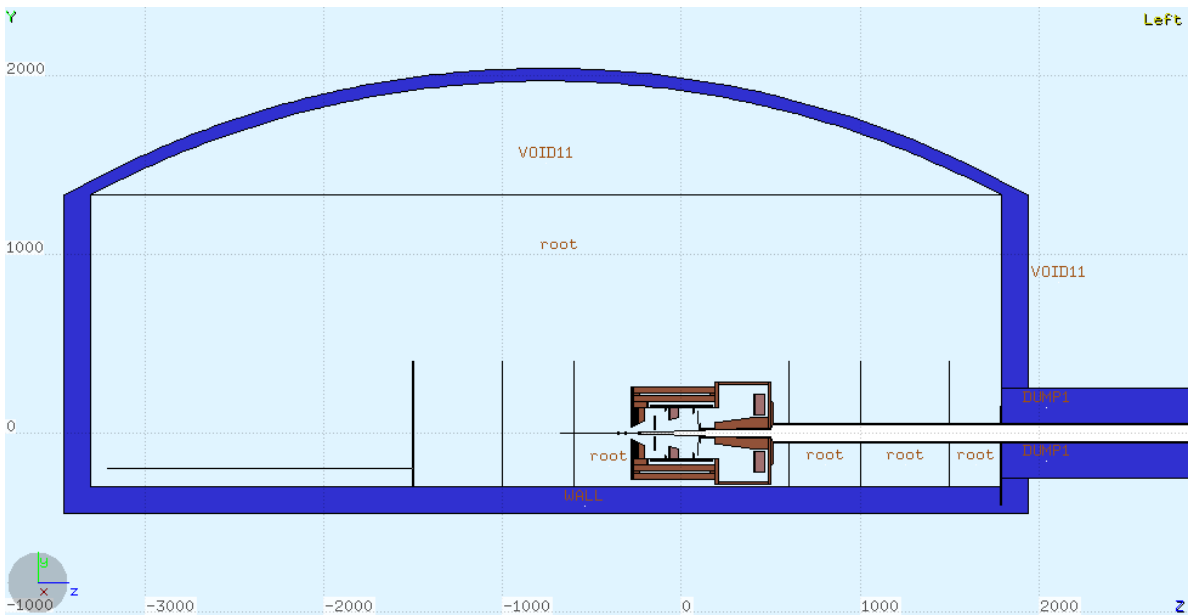
- Planning on how to change from one SoLID configuration to another: Better understanding of effort involved and potential issues on radiation levels (more detail here) V
- Complete different configurations for SoLID (shown here)

Another SoLID configuration (J/Ψ)

From all APPROVED configurations

J/Ψ configuration test was still missing:

- Approved for 50+10 days (physics+chekcs)
- $3\mu A$ beam at 11GeV
- 15 cm Liquid Hydrogen target

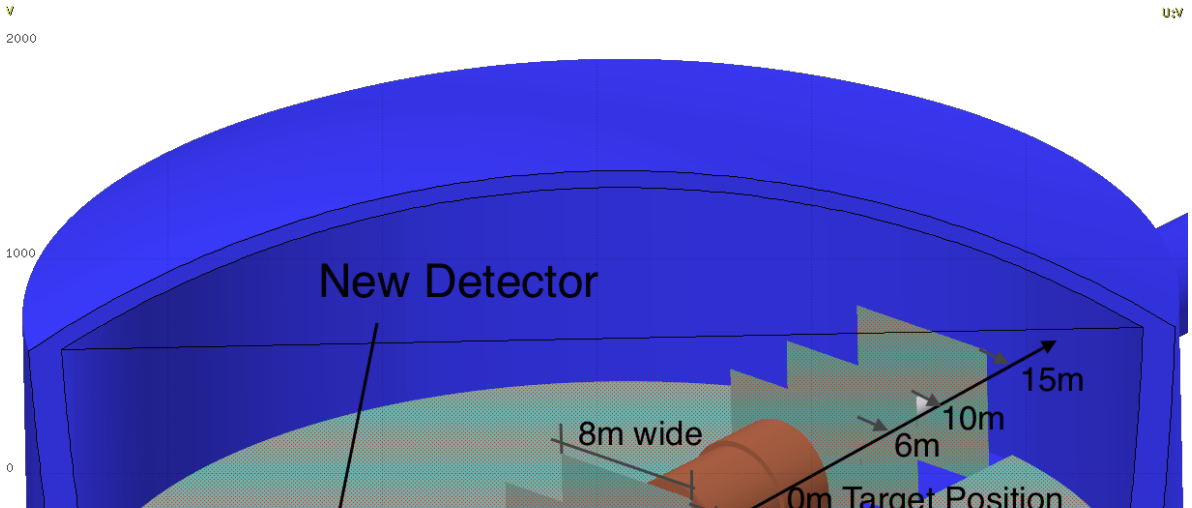


Detector planes layout

FLUKA can show flux on surfaces

Extra surfaces have been added in post-production to highlight the fluxes at different location

- Extra surfaces have been added to highlight the fluxes at different location
- Material is the same as surrounding at running time (AIR)
- Material is switched to physical material so that the flux is shown

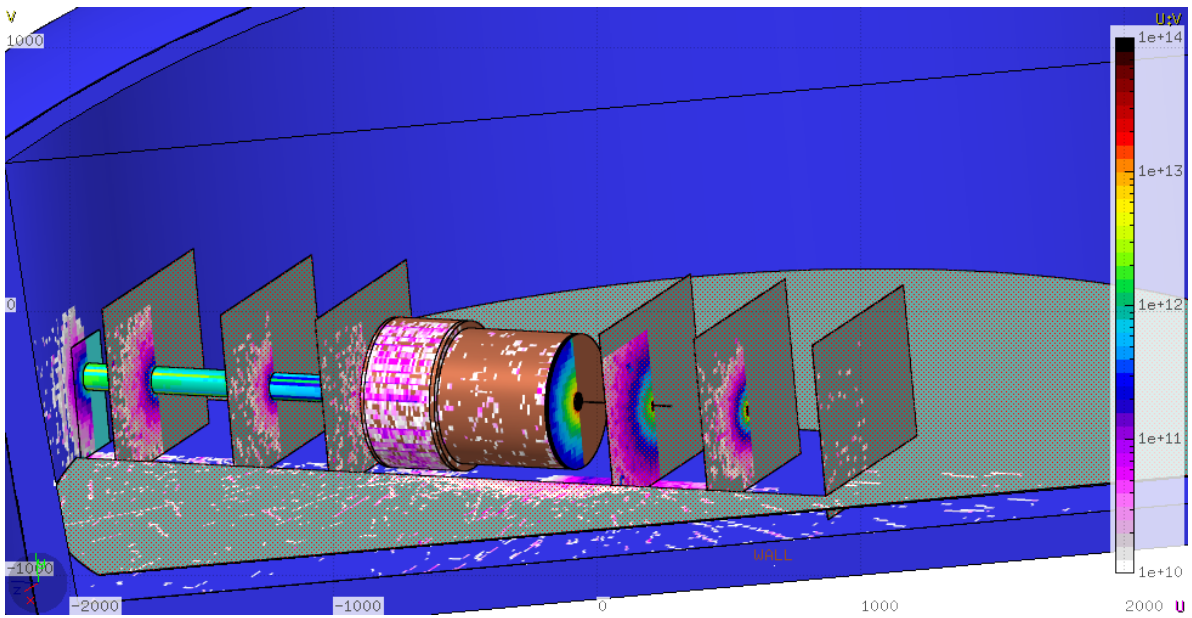


Radiation in the Hall (J/Ψ)

Accumulated fluence in the Hall

Accumulated $\left(\frac{1MeV_{eq}Neutron}{cm^2}\right)$ for 60 days, $3\mu A$ beam at 11GeV

- 10^{13} $\left(\frac{1MeVNeutron}{cm^2}\right)$ as goal for safety
- Radiation in the Hall seems well under control

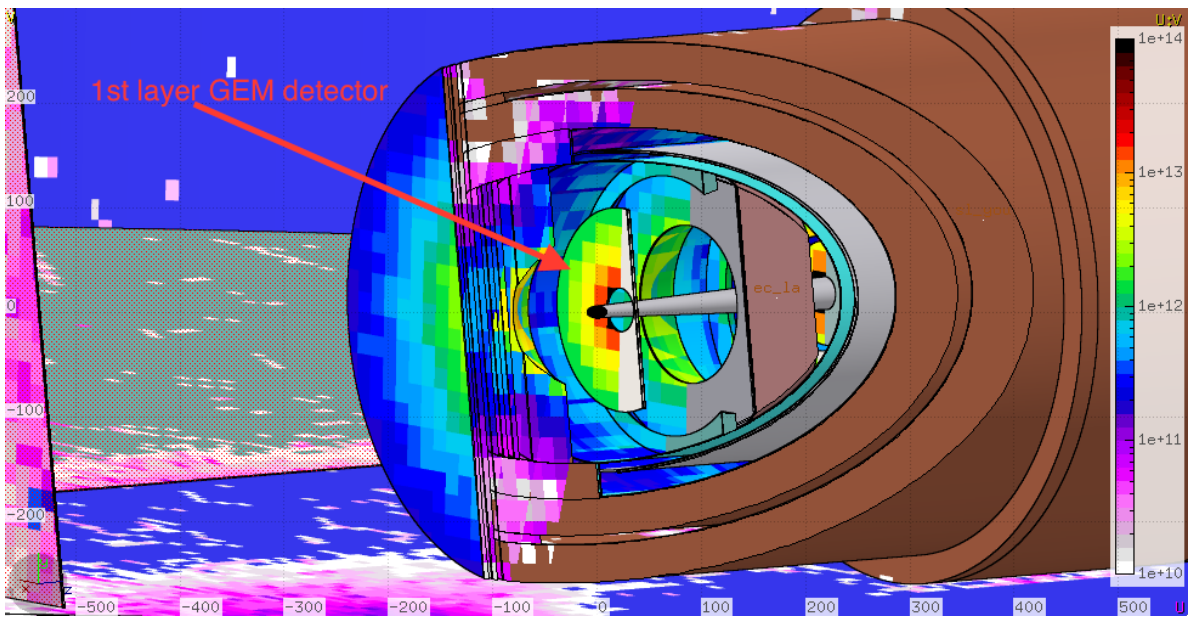


Radiation inside the Solenoid (J/Ψ)

Accumulated fluence in the Hall

Accumulated $\left(\frac{1MeV_{eq}Neutron}{cm^2}\right)$ for 60 days, $3\mu A$ beam at 11GeV

- The GEM readout system was developed to sustain $2.4x10^{14}$ $\left(\frac{1MeVNeutron}{cm^2}\right)$
- Radiation is well below the threshold for the electronics



Estimated cost of shielding

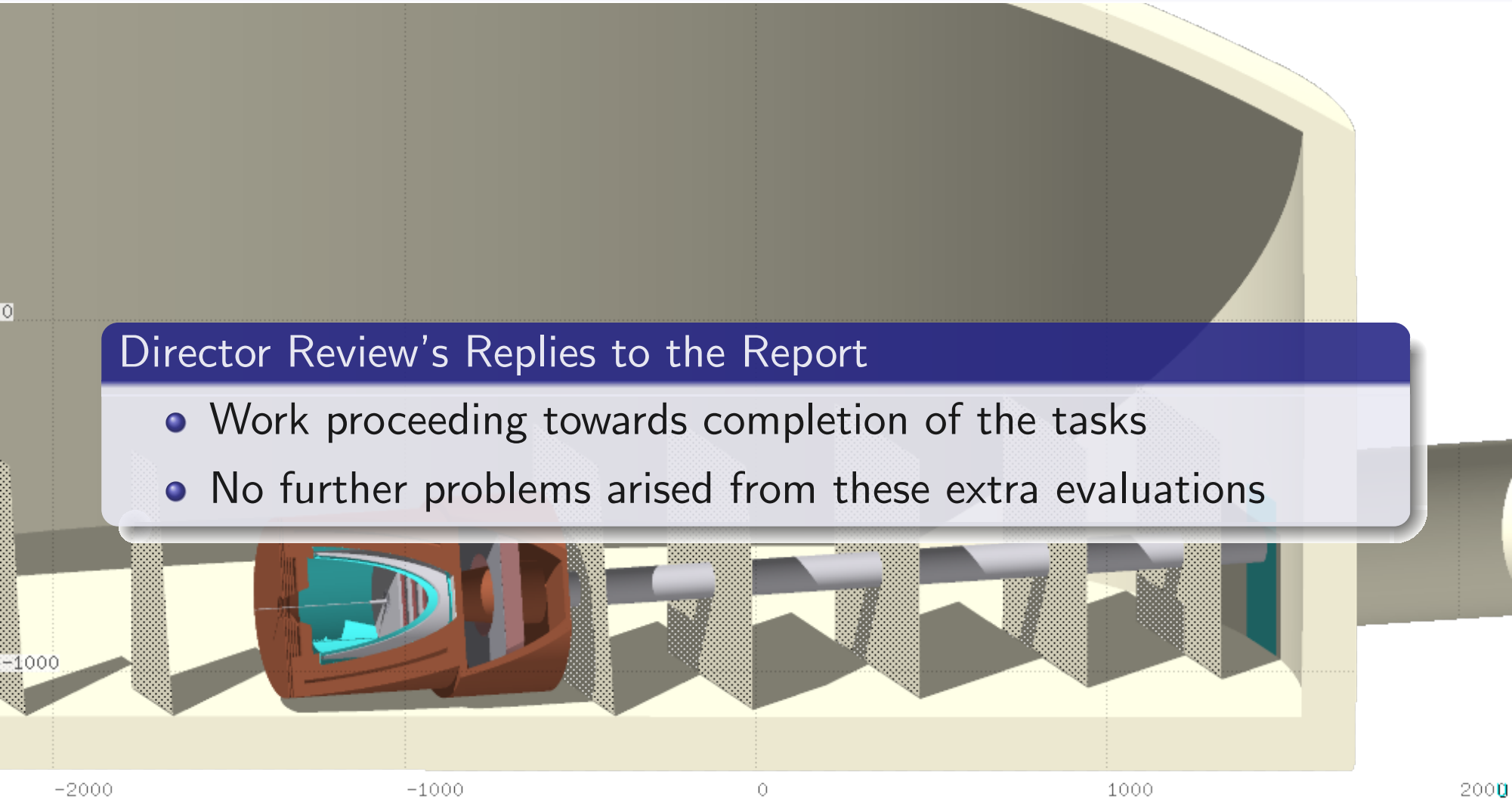
Choice for shielding

- Polyethylene
- Borated Polyethylene (2.4 times more expensive): Estimated %10 more effective on open fluxes, but more important in a close environment like PVDIS.

Estimated price for material for PVDIS (3.5 million cm^3 before cutting to shape)

- Polyethylene ($13300)
- Borated Polyethylene (2.4 times more expensive) ($32000)

Conclusions



Director Review's Replies to the Report

- Work proceeding towards completion of the tasks
- No further problems arised from these extra evaluations