FLUKA Update

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Simulation Meeting

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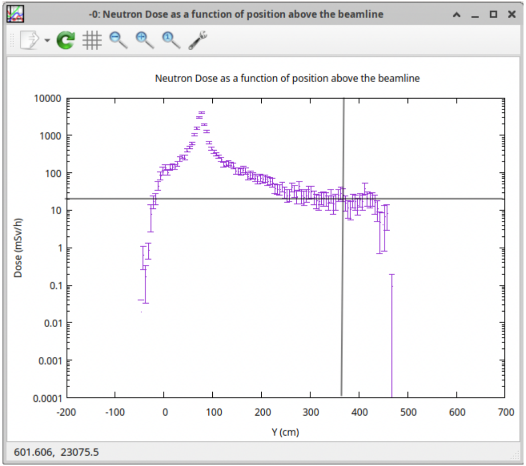
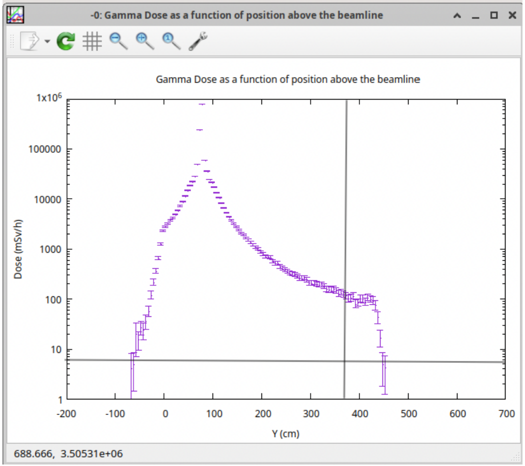
Current Status

We have performed many FLUKA calculations to determine if DarkLight can run safely. Some summary points:

- We are not overly sensitive to neutron doses.
- We do need to check the neutron dose near the focal plane detectors
- Gammas are a real problem, we sit at 100 mSv/h and want to be at 5 mSv/h
  - Aveen's new focus reduces gamma dose by $\approx$10x compared to no focus at all
  - This tells us that while we should avoid scraping the beam pipe, much of the dose comes upstream of any focusing fields
  - Focus in FLUKA not identical to transoptr focus, work in progress
- This problem must be fixed with shielding
  - I fear lead shielding of the beam line is prohibitively expensive
  - Initial tests indicate a beam pipe made of aluminum instead of stainless steel helps, but does not solve. Will this cause panic attacks amongst engineers?

Current Status





We want to be below the horizontal line at the position of the vertical line.

Shielding

The limit of 5 mSv/h comes from an assumption of the attenuation of gammas through concrete.

Location	Distance (m)	Concrete Thickness (cm)	Gamma Attenuation	Gamma Dose (μSv/hr)	Neutron Attenuation	Neutron Dose (μSv/hr)	Total Dose (μSv/hr)
A (0°)	4.6	360	6.25E-08	2.22E+00	4.13E-10	1.69E-05	2.22E+00
B (90°)	6.3	180	1.57E-04	1.00E+01	3.43E-05	7.60E-01	1.08E+01
C (90°)	10.2	150	7.04E-04	1.71E+01	2.26E-04	1.90E+00	1.90E+01

Attenuation through concrete. From Safety Report.

Attenuation factor comes from "Tenth Value Layer" for concrete.

Table 6-1 Different material Tenth Value Layer (TVL) thicknesses for 50 MeV electrons incident on a thick, high-Z target

Material	0° -TVL (meter)		90° - TVL (meter)	
	TVL_1	TVL_n	TVL_1	TVL_n
Bremsstrahlung photons				
Concrete	0.56	0.49	0.51	0.46

TVL

TVL is thickness of material needed to reduce dose to 0.1 of original dose

$$D = D_0 \times 0.1^{\text{Number of TVL}} \tag{1}$$

For our thickness concrete and different TVL_1 and TVL_n

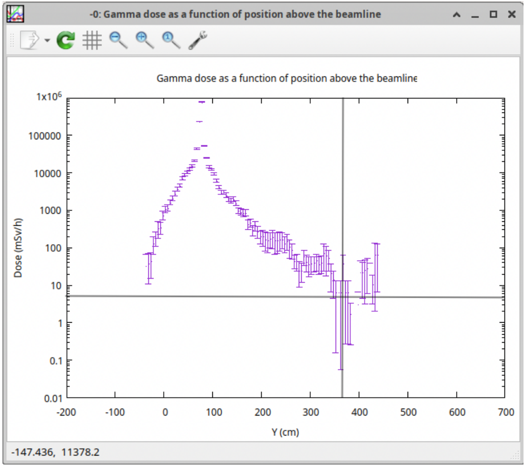
$$D = D_0 \times 0.1^{1+(180-\mathrm{TVL}_1)/\mathrm{TVL}_N} \tag{2}$$

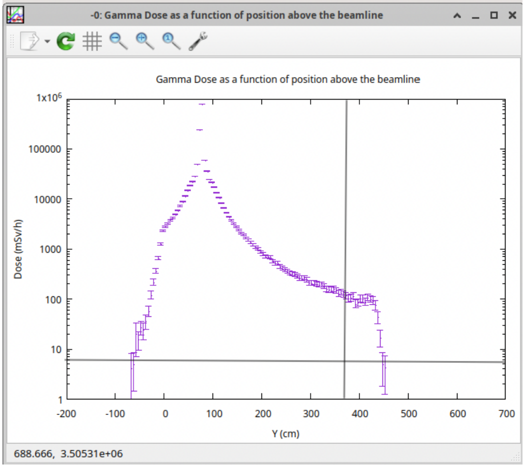
However, the TVL varies with gamma energy. Lower energy gammas have less penetrating power. Previous TVL calculated for brem from 50 MeV electrons. What is it for brem from 30 MeV electrons?
Safety report quotes some documents I cannot access. Have asked Kate.
However, I know variation of TVL with energy is not linear. If we assume TVL improves by 6 cm (I think this is an overestimate), we would only gain in our attenuation by a factor 3.7. So we go from a 5 mSv/h requirement to 18.5 mSv/h. Still short of 100 mSv/h.

Moving Forward

- Kate and I spoke with Luka yesterday. He suggested contacting TRIUMF safety experts to see what they suggest.
- Kate has set up meetings with TRIUMF safety personnel, including one person who has moved to BNL. I will meet with all of them this week on Thursday and Friday.
- Aveen working on focus to improve agreement between FLUKA and transoptr

Current Status





We want to be below the horizontal line at the position of the vertical line. Left plot is with an aluminum beam pipe, right is with stainless steel according to current design.