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Meeting on Compact Photon Source Simulations

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Dear All,

I've got the first estimates of doses around the toy CPS shielding spheres, and also a couple numbers for the boundary dose rates expected from the toy runs in Hall C.
I did run the simulations using my old DINREG/GEANT3 package.

The runs evaluating the source terms were set in vacuum, using the 300 cm dia. Fe and 150 cm dia. W spheres, irradiated by 11.5 GeV electron beam from inside as specified, and scoring the matrix of the dose rates and spectral responses around them, function of energy and polar angle. In addition I also ran the same setups but with the spheres surrounded by the 10 cm layer of standard Borated Polyethylene (5% Boron by weight), to help thermalize and absorb the low energy neutrons exiting the heavy metal spheres. This would be important for the dose rates around the CPS, especially in the case of iron shielding, as the iron layers do not stop low energy neutrons effectively enough.

The integrated numbers are given for the points at 90 degrees around the spheres, at 3 m radial distance from the beam line. Other angles and also energy spectra are available for further discussion if needed.

Setup / Score	Only the metal sphere shielding Dose rates in rem/h at 90 degrees 3 m from the beam	Including 10 cm outer Borated Poly layer Dose rates in rem/h at 90 degrees 3 m from the beam	Dose rate estimate in microrem/h RBM-3 Boundary position
Iron 7.8 g/cm^3, 300 cm dia sphere 11.5 GeV, 30 kW beam starting inside, 30 cm upstream from the center	neutrons: 146.0 gamma: 0.44 total: 146.4	neutrons: 0.8 gamma: 2.8 total: 3.6	neutrons: 0.19 gamma: 0.05 total: 0.24
Tungsten 15.6 g/cm^3, 150 cm dia sphere 11.5 GeV, 30 kW beam starting inside, 15 cm upstream from the center	neutrons: 13.0 gamma: 0.06 total: 13.1	neutrons: 2.7 gamma: 0.003 total: 2.7	neutrons: 1.9 gamma: 0.5 total: 2.4

The results are interesting, in terms of how different Iron and Tungsten solutions are.

The same thickness in (g/cm^2) in Iron, compared to Tungsten, suppresses almost by a factor of ten better the neutron high energy spectral components (which are important for doses at the boundary). At the same time, lower energy neutrons, exiting Iron in the Hall, produce way too much radiation and have to be shielded by extra Borated Poly layer. With the BP layer, Iron and Tungsten produce comparable dose rates in the Hall, with almost reversed roles of neutrons and gamma.

Not really intuitive. But it should be optimizable using various cross-checked simulations, and including the additional details from the internal design, entrance and exit parts of the CPS, plus the exit photon beam line and the target.

The conclusion seems to be coming up that the optimized design is possible, satisfying requirements in the Halls and outside. I haven't run FLUKA to estimate the activation after a 1000 hour runs, but the "intuition" says it should be OK.

2.4 microrem/h at the boundary correspond to a "regular" normal experiment, not requiring extra shielding measures, corresponding to about the "200% of allowable design boundary dose rate" (that is, the dose rate at which the dose accumulation would be 10 mrem if such conditions are run for a half of the calendar year continuously)

The simple illustrations of the toy CPS setups are attached. Particles exiting the sphere in the second plot correspond to the heavy biasing scheme helping particles in the cascade to penetrate thick shielding.

Mistakes cannot be excluded of course; to weed them out and to get to the common understanding, independent simulations and discussions are needed.

Best regards,
Pavel
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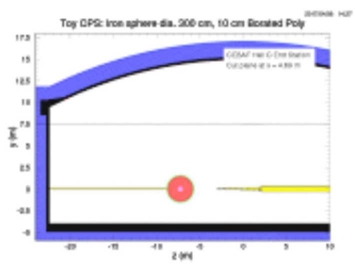
2 attachments



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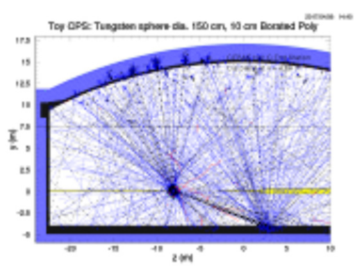

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