DD generator shielding

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Simulation

- While we typically use ‘track individual particles’ simulation, sub MeV neutron simulation is not well suited to this approach.
- For things like ‘reactor’ and ‘shielding’ purposes, the dominant simulation framework is closer to a Computational Fluid Dynamics simulation.
- Neutrons grouped in energy bins (typically 69, ~logarithmically from 10 MeV down to sub-thermal energies). Cross sections, including epithermal resonances, are averaged over energy bins.
- MCNP is one example of such simulation code, but is hampered by security restrictions, so I use DRAGON from

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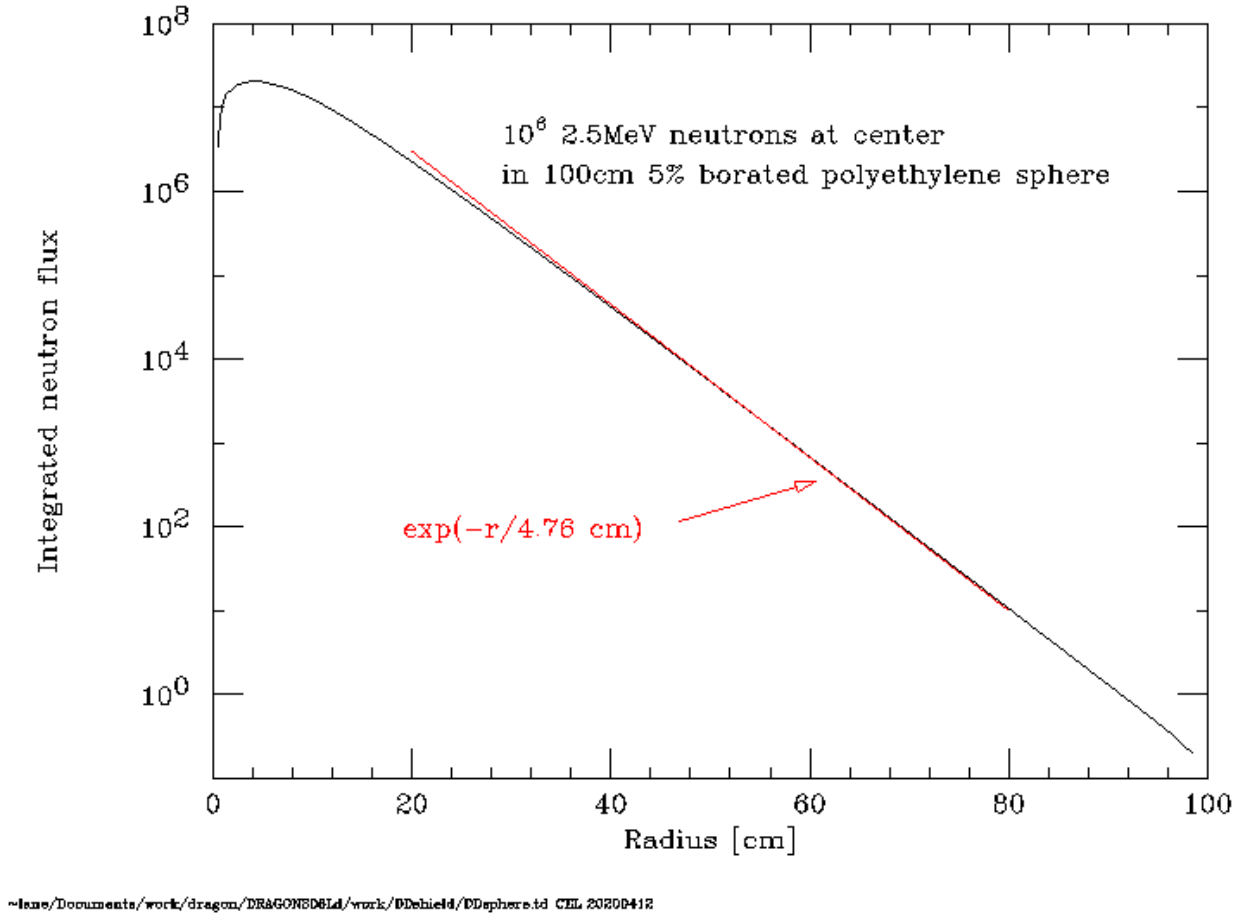
Simple setup

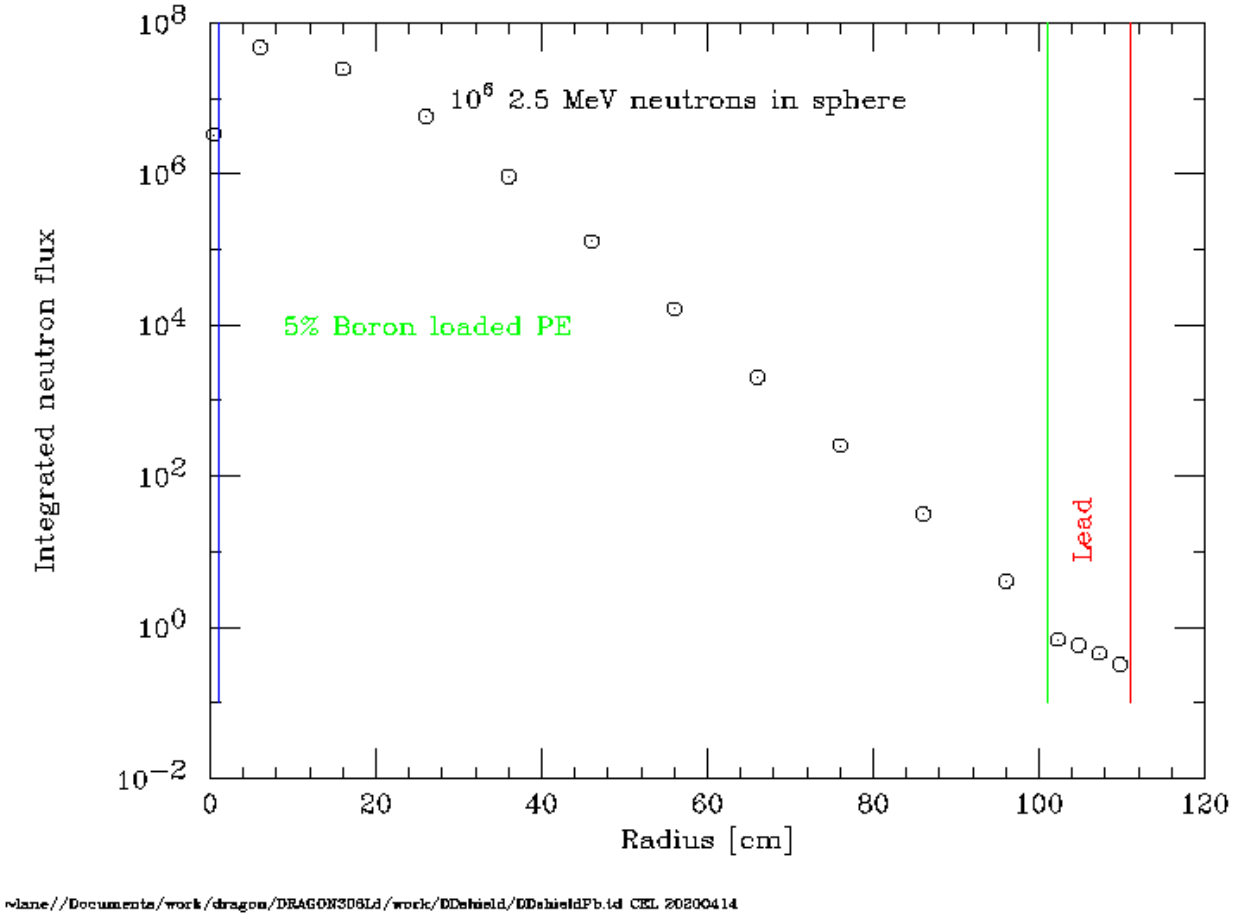
- DDgenerator producing 1E6 monoenergetic 2.5MeV neutrons at the center of a sphere.
- Polyethylene (density=1) with 5% Boron loading by weight, 100cm thick spherical shell around DDgenerator.
- (optional) 10 cm thick Pb or Fe jacket around the borated polyethylene.
- NOTE: borated PE is typically 1%, 2% or 5%.

No jacket



higher flux near center from neutrons scattering to lower radius.

Pb jacket



Pb doesn't absorb neutrons much, but there's a flux drop from leakage from the outer surface.

Shielding estimates

- These plots can give a rough estimate for how much borated PE is needed for a particular neutron flux reduction.
- Note that the plots were “total integrated neutron flux” over all angles, so 1/r^2 factor is removed.
- Can pull out the neutron energy spectrum as a function of radius, but first just looking at overall flux.
- Can also use 3D rectangular geometries, but much more computation and only worthwhile if we have a definite geometry to simulate.

Gamma generation

- While neutron simulation is the primary feature of the DRAGON code, one can get some information about neutron capture to produce gammas.
- However, it is treated like a “fuel burnup” situation in reactor, and is harder to set up properly. Just the neutron capture rate and capture cross-section can give gamma production estimates.
- Then put the gammas in GEANT? Maybe.