MCNPX Simulation:An Analysis on D2O

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Abstract

A simulation was conducted using MCNPX to determine how the directionality of Neutrons is interupted in air, D2O, and H2O.

In the first presentation given lastweek the Neutrons were ejected uniformly out of a cylindrical bottle and detected one meter away. A picture of the collisions during the simulation is shown below in Figure 1.

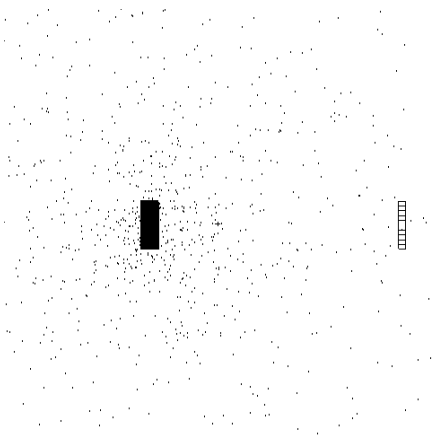


Figure 1: MCNPX simulation tracking Neutrons generated inside D2O bottle isotropically ejected.

For the simulation done this week the Neutrons were still created uniformly throughout the cylindrical bottle, but initially ejected in the direction of the detector. The Neutrons could still be scattered from the "stuff" inside the cylindrical bottle and the air. Figure 2 below shows how the majority of the particles reach the detector, but many are scattered.

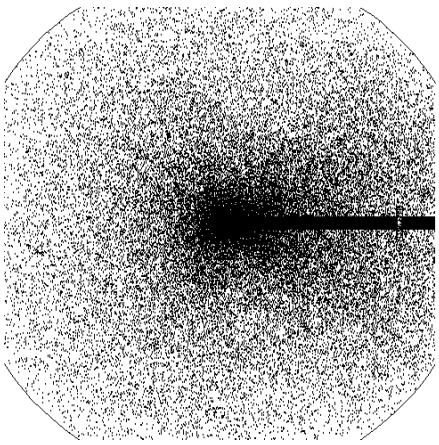
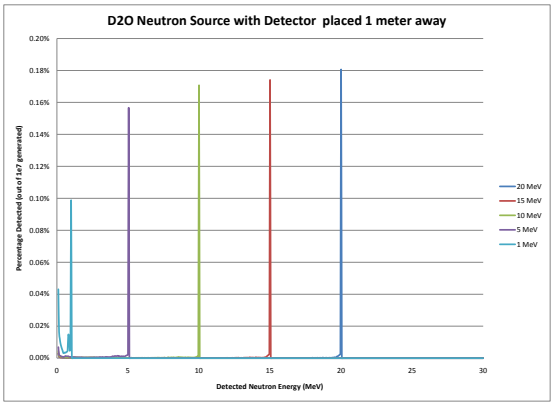
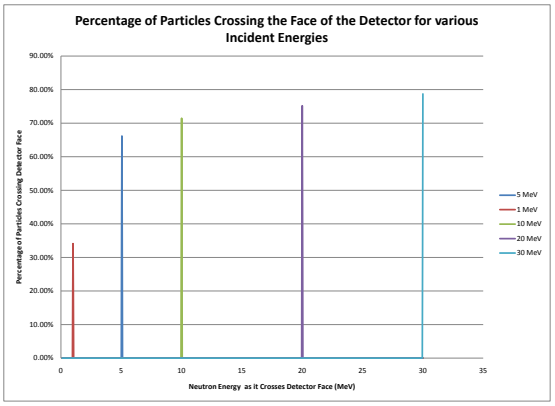


Figure 2: MCNPX simulation tracking Neutrons generated inside D2O bottle initially directed towards the detector.

A simulation was run geenrating 10 million neutrons inside a bottle of D2O. Figure 3 shows the results of the simulation where neutrons had an initial direction in the x-drection compared to a simulation where the neutrons were isotropically directed.



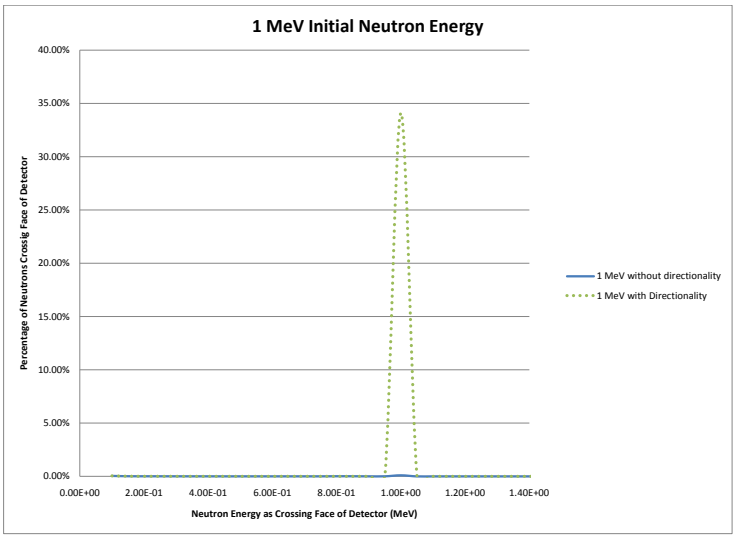
(a) Isotropically generated Neutrons



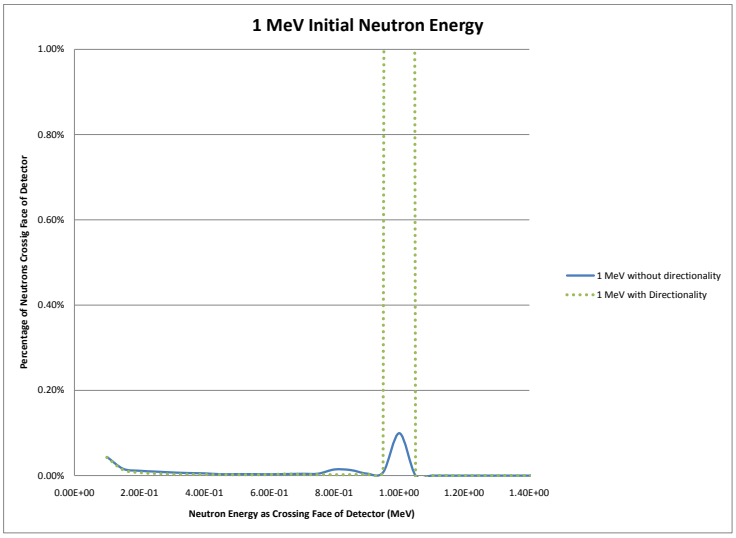
(b) Neutrons given initial directionality

Figure 3: Comparison of Neutrons generated in D2O with and without directionality.

The figures above show how the percentage of particles increases dramatically with the directionality turned on as compared to the isotropically generated. An upclose comparison of only one energy was done and shown below.



(a) Isotropically vs Non-Isotropically generated Neutrons



(b) Close-up illustrating the weird bump in at 0.8 MeV

Figure 4: Comparison of 1 MeV Neutrons generated in D2O.

As can be seen in the figure above, the bump at 0.8 MeV disappears when the directionality is turned on.

Looking back at the isotropic simulation, in order to see if neutrons were being double counted, via back-scattering once the particle has already passed through the surface, the direction the neutron was traveling as it crossed the face of the detector was looked at. Figure 4 shows the percentage of particles passing through in the x-direction vs the negative x-direction.

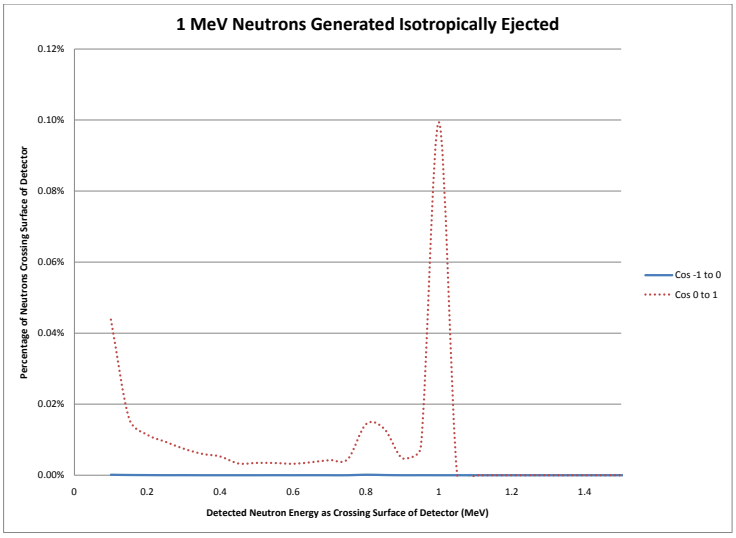


Figure 5: MCNPX simulation tracking Neutrons generated inside D2O bottle initially directed towards the detector.

As can be seen, there are very few traveling backwards meaning that bump at 0.8 MeV is probably not back-scattering.

Next, the Photon physics was turned on in MCNPX to see how many photons were generated and traveled through the detector. For the isotropic simulation, no photons traveled through the detector in either direction. For the non-isotropic simulatuion, no photons were detected in the 1 or 5 MeV simulations, but the others had a small photon counts as compred to the neutron counts.