Ammonia Irradiation Simulation

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I. Introduction

Slifer lab uses polarized targets to probe the spin structure of the proton. The polarized targets can be created by introducing free radicals to a material through radiation or chemical doping. Dynamic Nuclear Polarization (DNP) can be used with irradiated ammonia to reach up to 90% polarization.

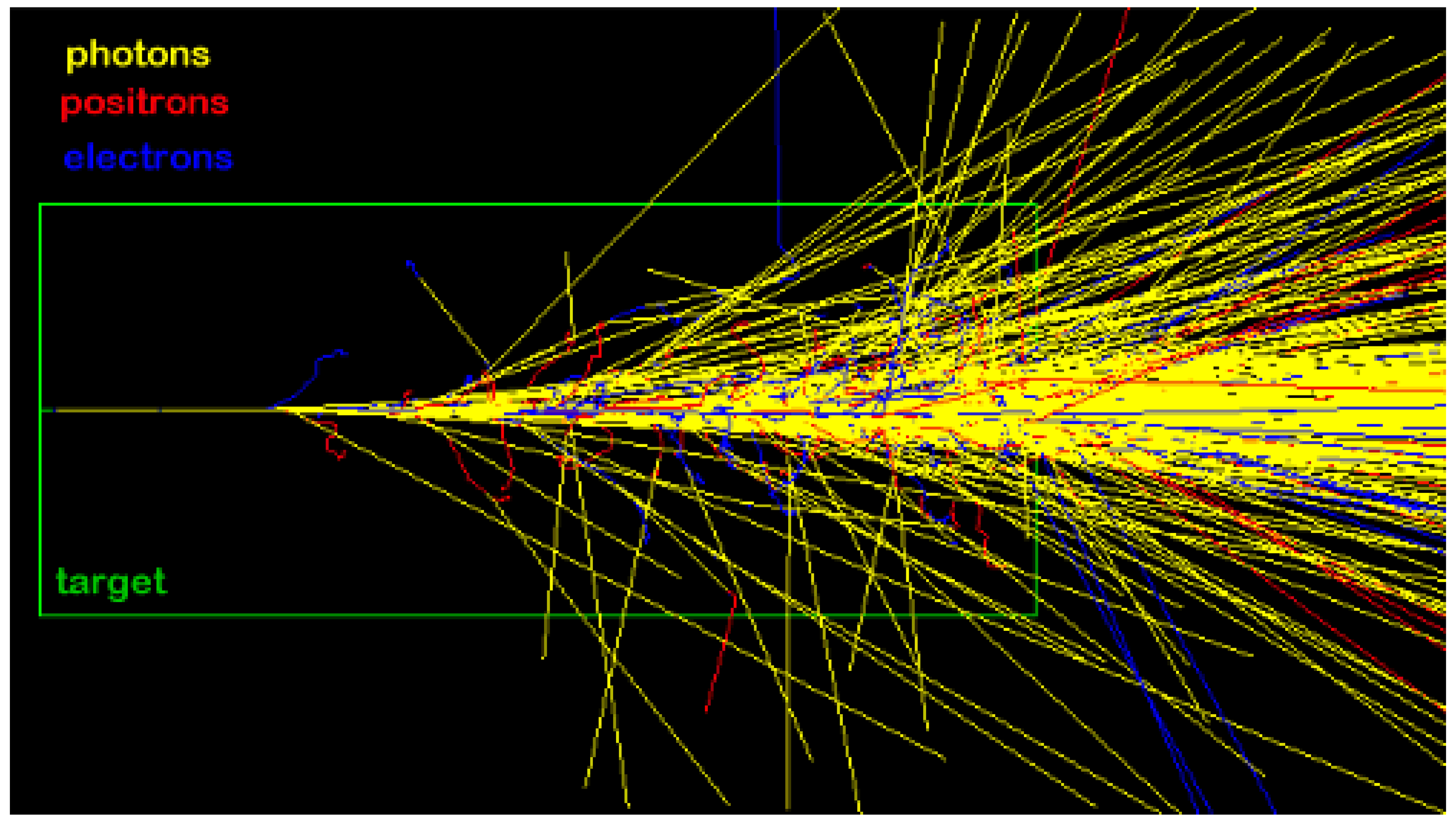

Fig 1: *Massive shower in a tungsten cylinder produced by a single 10 GeV incident electron*

II. Solidification

Solidified ammonia is created in on campus. A gas panel is used to regulate the flow of ammonia into a cryostat held at a temperature slightly below ammonia's freezing Point (195.5 K). Slower freezing allows for a creation of a crystalline solid as opposed to an amorphous glass. The frozen ammonia is crushed into 2mm thick beads.

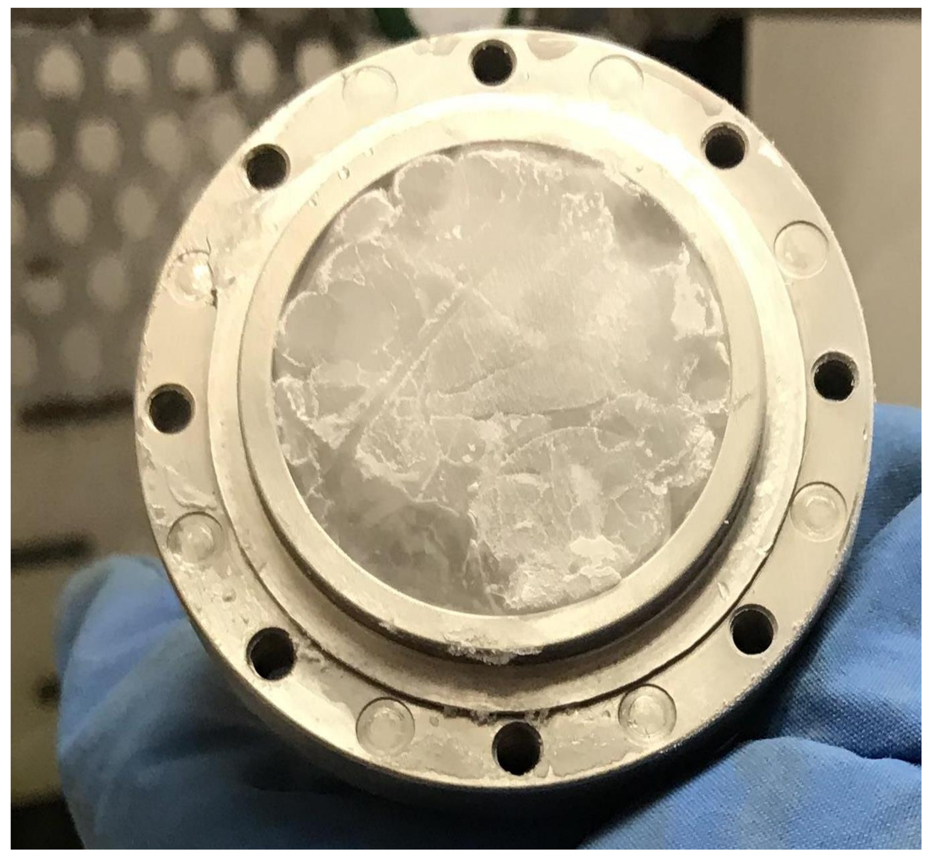

Fig 2: *A photo of the solidified ammonia created in lab*

III. Irradiation Process

The simulated process is done with a rectangular slug of Ammonia. I found the majority of the dose is deposited in the first six centimeters of material, in agreement with previously published results.

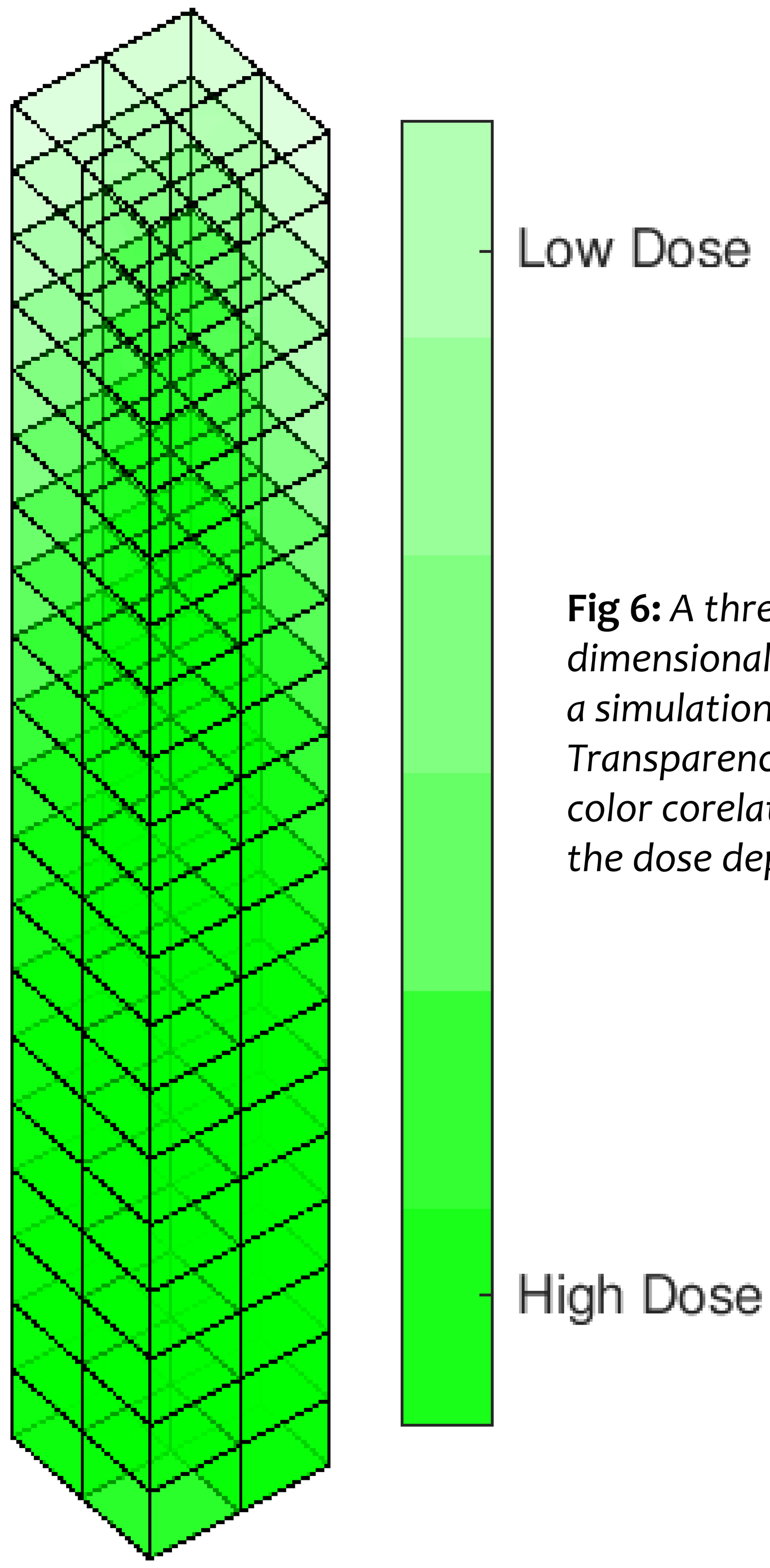

Fig 6: *A three dimensional plot of a simulation run. Transparency of color corelates to the dose deposited*

IV. Polarization

The maximum polarization achievable is dependent on the doping achieved through irradiation.

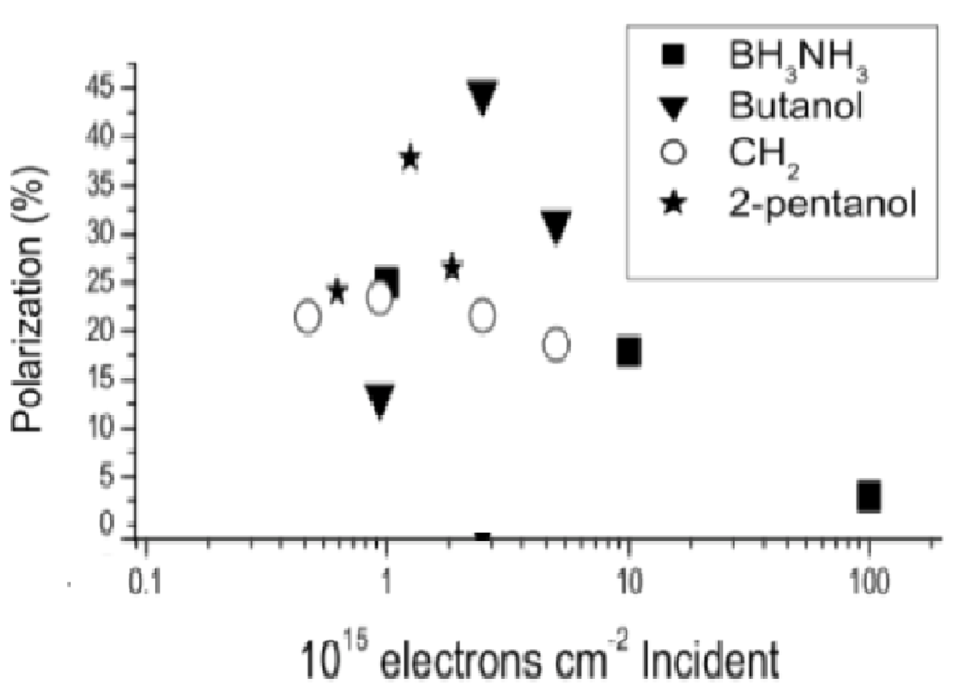

Fig 3: *Polarization versus incident dose.*

Acknowledgements:

- A large portion of this project was developed in conjunction with Lucas Jameson
- This code relied heavily on instructions sent by Dr. Rodon-Amaryo from the University of Virginia

References:

- Jonathan Mellor, "Studies and Measurements of Irradiated Solid Polarized Target Materials", University of Virginia, 2006

IV. EGS4

The irradiation simulation is done by the Monte Carlo tool EGS4 (Electron Gamma Shower) to track the deposited dose in a material. The code simulates the energy loss of charged particles through discrete interactions such as pair production, Compton scattering and the photoelectric effect

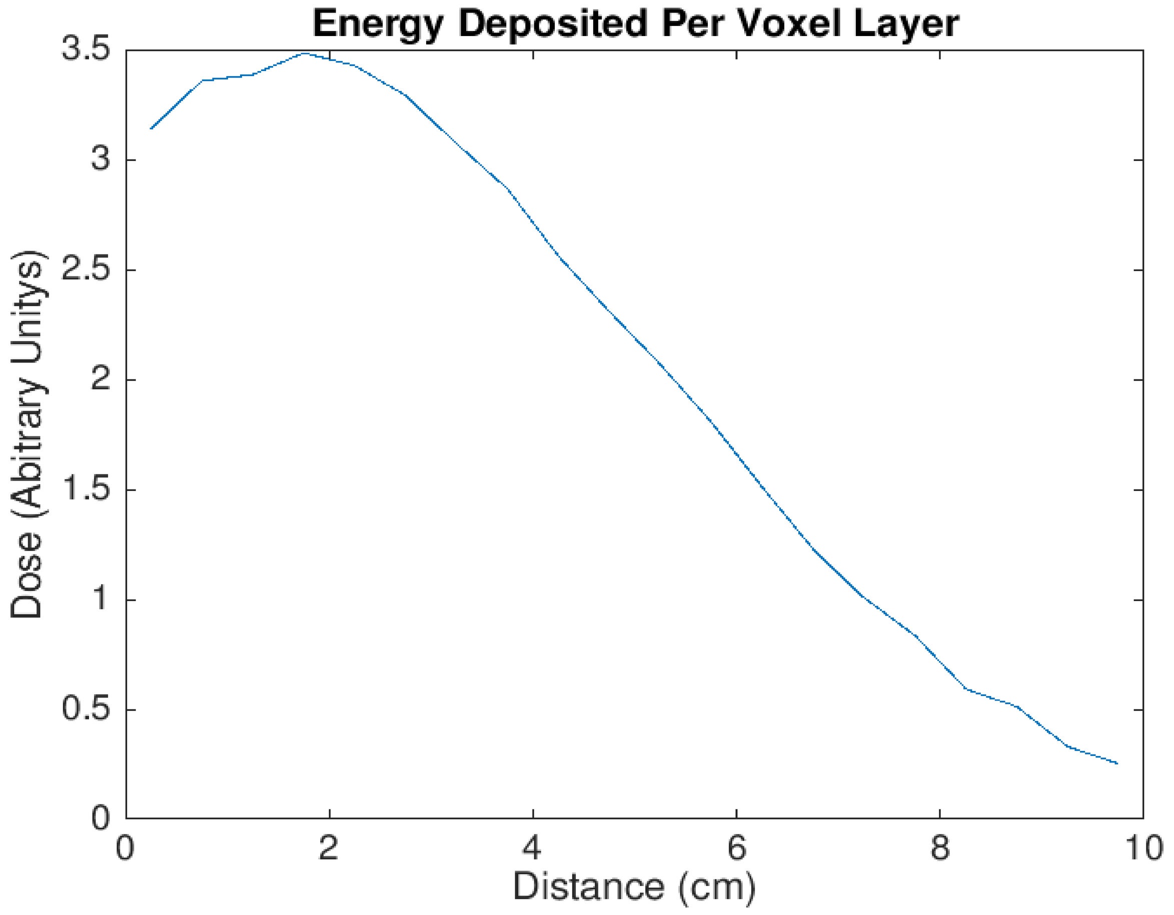

Fig 4: *The energy deposited by a 19 MeV electron per voxel layer.*

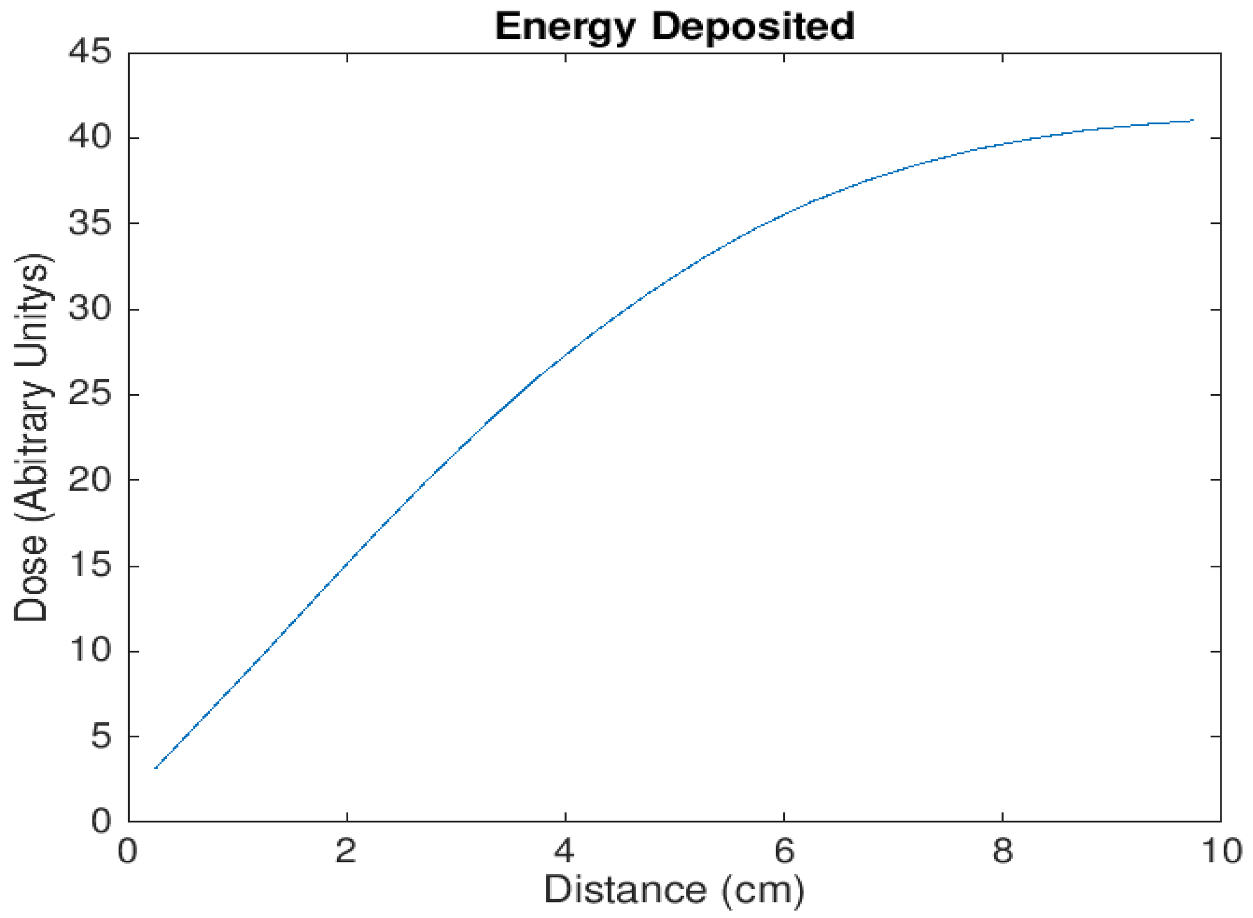

Fig 5: *The sum of energies in the z-direction by a 19 MeV electron*

V. Conclusions & Future

The results show an ability to predict a dose applied to a material successfully. Future advances to the code include adding a second material for the dewar wall and the liquid medium the ammonia will be stored in.