Examining Particle Interactions for Detector Shielding Using G4Beamline

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Particle colliders are an important tool for physicists to understand the subatomic particles that constitute our universe. However, for these collider experiments to be a success, the backgrounds produced from particle decay processes and other phenomena must be adequately reduced. Computer simulations can be utilized to research, develop, and optimize detector shielding for particle physics experiments such as a Muon Collider or the more imminent Mu2e Experiment at Fermilab. Such shielding studies also have applications in the fields of nuclear and medical physics. This project involved running Monte Carlo simulations of neutron beam interactions with various materials using G4beamline, a user-friendly front-end to Geant4. G4Beamline validation studies were done by comparing neutron absorption cross sections calculated from simulation results to known cross sections obtained from the National Nuclear Data Center. These studies specifically examined thin targets of Lithium, Boron, Cadmium, and Gadolinium. Since these elements absorb low energy neutrons best, polyethylene is used in detector shielding to slow the neutrons. Therefore, a series of studies examining neutron absorption by polyethylene doped with Lithium and Boron was also performed. Target performance was studied for incident neutron energies ranging from 1 eV to 100 MeV. Various target thicknesses were also considered. This work is being conducted in collaboration with members of the Northern Illinois Center for Accelerator and Detector Development (NICADD) group at Northern Illinois University and Muons, Inc.