

CENNS Neutron Shielding Monte Carlo Study

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Abstract

The Coherent Elastic Neutrino Nucleus Scattering or CENNS experiment at Fermi National Accelerator Laboratory is a neutrino detector proposed to search for CENNS interactions between low energy neutrinos and argon nuclei. A search for CENNS interactions could put new limits on background rates for dark matter experiments and influence sterile neutrino searches, both of which contribute to priorities for Fermilab. The CENNS experiment will place a detector near the Booster Neutrino Beam to maximize the flux of low energy neutrinos through the detector. However, the Booster Neutrino Beam also produces many neutrons in a low enough energy range to cause nuclear recoil events identical to the results of neutrino-nucleus scattering. Therefore, the CENNS collaboration will study arrangements of concrete blocks to shield a detector sensitive to neutrons from this background. Monte Carlo simulations are essential to planning shielding for the CENNS detector, but current simulation models produce unreliable results for neutron interactions in concrete. I have implemented simulations of several concrete structures using G4Beamline and the ROOT analysis framework to predict which of several shielding strategies is most effective. My results can be used to evaluate the effectiveness of G4Beamline neutron shielding simulations and indicate improvements to be made before using this simulation package for the CENNS detector. My work has produced neutron kinetic energy spectra for several planned shielding configurations, and I have shown that strategies such as stacking blocks in alternating layers are expected to reduce neutron flux. I expanded my experience with the ROOT analysis framework used by many high-energy physics experiments and built connections within the CENNS collaboration through weekly presentations. By contributing to the understanding of G4Beamline simulations of neutron interactions in concrete, I have gained experience working in neutrino physics with which I plan to pursue a career in high-energy physics.