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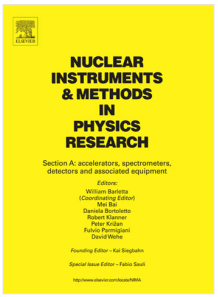

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Optimization of ^{6}LiF:ZnS(Ag) Scintillator Light Yield Using GEANT4

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Abstract

A new cold neutron detector has been developed at the NIST Center for Neutron Research (NCNR) for the CANDoR (Chromatic Analysis Neutron Diffractometer or Reflectometer) project. Geometric and performance constraints dictate that this detector be exceptionally thin (~ 2 mm). For this reason, the design of the detector consists of a ^{6}LiF:ZnS(Ag) scintillator with embedded wavelength shifting (WLS) fibers. We used the GEANT4 package to simulate neutron capture and light transport in the detector to optimize the composition and arrangement of materials to satisfy the competing requirements of high neutron capture probability and light production and transport. In the process, we have developed a method for predicting light collection and total neutron detection efficiency for different detector configurations.

The simulation was performed by adjusting crucial parameters such as the scintillator stoichiometry, light yield, component grain size, WLS fiber geometry, and reflectors at the outside edges of the scintillator volume. Three different detector configurations were fabricated and their test results were correlated with the simulations. Through this correlation we have managed to find a common photon threshold for the different detector configurations which was then used to simulate and predict the efficiencies for many other detector configurations. New detectors that have been fabricated based on simulation results yielding the desired sensitivity of 90% for 3.27 meV (5 Å) cold neutrons.

The simulation has proven to be a useful tool by dramatically reducing the development period and the required number of detector prototypes. It can be used to test new designs with different thicknesses and different target neutron energies.