Monte Carlo Analysis of Energy Deposition in a Cryogenic Neutron Detector

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The detection of gamma rays and neutrons with cryogenic detectors has been reported for a number of years [1] – [8]. By cooling an absorber to temperatures well below 1 K, the absorber’s heat capacity is lowered sufficiently that the deposition of a few MeV from neutron capture reactions results in a measurable increase of temperature. These devices hold out the promise of exquisite energy resolution because, effectively, they measure the number of phonons with energy kT (T << 1 K) generated by the interaction of incident radiation with an absorber. Consequently, it is necessary to model accurately the deposition of energy.

In this paper we present the results of modeling the absorption of neutrons in blocks of $^{10}$B and $^6$LiF with the MCNP-PoliMi code [9]. MCNP-PoliMi correctly links secondary gamma ray production to the neutron interaction type and permits an accurate accounting of the energy deposited as a result of capture reactions (kinetic energy of reaction products), the energy deposited by recoiling ions (elastic and inelastic scattering), and the energy deposited by de-excitation gammas resulting from inelastic scattering on an event-by-event basis. The response to spontaneous fission sources, as well as ($\alpha$, n) sources, is presented. In addition, we discuss the possibility for cryogenic neutron spectroscopy to distinguish between these different sources.

References
3. See, for example, The University of California, Berkeley, web site http://cdms.berkeley.edu for a link to dozens of references.