THEORETICAL AND EXPERIMENTAL INVESTIGATIONS IN CHARACTERIZING AND DEVELOPING MULTIPLEXED DIAMOND-BASED NEUTRON SPECTROMETERS

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ABSTRACT

In this work a novel technique of multiplexing diamond is presented where electronic grade diamond plates are connected electrically in series and in parallel to increase the overall detection efficiency of diamond-based neutron detection systems. Theoretical results in MCNPX indicate that further development in this software is required to accurately predict the response of diamond-based neutron spectrometers. However, the results accurately indicate that an equivalent diamond plate 1cm thick only lowers the energy resolution of the $^{12}C(n,\alpha_o)^9Be$ peak from a 14.1 MeV interrogating neutron by a factor of two compared to a single diamond plate 0.5mm thick while increasing the detection efficiency from 1.34 percent for a single diamond plate to 25.4 percent. Further, the number of secondary neutron interactions is approximately 5.3 percent for a 1cm thick diamond plate. In addition, photons can interfere with lower energy neutron signals when multiplexing is used, especially at low photon energies, although the full energy peak still does not dominantly present itself in the pulse height spectrum for multiplexed arrays approaching 1cm with respect to the incident neutron vector.

Experimental results indicate that series multiplexing is not capable for use as a means of increasing the active detection volume because of the interaction of the diamond plates in series with each other, where severe signal degradation is seen due to the equal impedances of the single crystal diamond plates. However, parallel multiplexing is shown to have great promise, although there are limitations to this technique due to the large capacitance at the preamplifier input for a large parallel multiplexed array. Still, the latter multiplexing technique is shown here to be capable of producing the largest diamond detection medium in a single detector with spectroscopic capabilities reported to date.