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Low-energy neutron cross-talk between organic scintillator detectors

Due to high Q-values and low neutron separation energies, β-decay of neutron-rich nuclei can often populate neutron unbound states in the daughter nuclei, and close to the dripline, β-delayed multi-neutron emission becomes possible. Decay schemes are commonly studied via neutron time-of-flight (TOF) spectroscopy using modular arrays based on organic scintillators.
In principle, the use of multi-detector arrays facilitates the detection of events with two or more neutrons. However, of critical importance in such measurements are the effects of cross-talk, whereby a single neutron incident on one detector is detected and scattered to another detector where it is also detected, thus mimicking the detection of two neutrons.
Cross-talk has been reasonably well characterised at intermediate (~10-70 MeV) and high (~100-300 MeV) neutron energies. As evidenced by reaction studies at these energies, a clear and reliable understanding of cross-talk is crucial for planning measurements, for the analysis and for the interpretation of the results. At energies below ~10 MeV, however, there is a lack of data available to enable low-energy cross-talk to be properly characterised and reliably simulated.
In this talk, we present a series of measurements performed with low-energy monoenergetic neutrons to characterise cross-talk between two organic scintillator detectors. Cross-talk time-of-flight spectra and probabilities are determined for neutron energies from 1.4 to 15.5 MeV and effective scattering angles ranging from ~50° to ~100°, and compared to Monte-Carlo simulations incorporating both the active and inactive materials making up the detectors. In the light of the results and simulations, the neutron interaction processes producing cross-talk at the energies explored here are discussed.

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