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Measuring and Simulating Capture γ-Ray Spectra using the RPI γ-Multiplicity Detector

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Accurate modeling of neutron induced capture γ-production is essential for reactor and shielding calculations, understanding γ-heating in critical systems, and non-proliferation applications. To determine the accuracy of nuclear data evaluations and simulation tools used to transport capture γ-cascades, the 16-segment γ-multiplicity NaI(Tl) detector at the Rensselaer Polytechnic Institute (RPI) Gaerttner Linear Accelerator Center (LINAC) has been upgraded to measure capture γ-ray spectra and multiplicity as a function of energy. Several samples including Fe, Mn, Co, Ta, and ^{235,238}U have been measured using the time-of-flight (TOF) method for incident neutrons in the low-energy region from 0.01 – 100 eV. A new method has been developed to model the event-by-event capture γ-cascade energy deposition in the detector array using DICEBOX and a modified version of MCNP-6.2. The method has been validated using ^{22}Na and ^{60}Co coincidence sources and the well-studied thermal ^{56}Fe(n,γ) capture γ-ray intensities. Additional measured samples will be used for further validation and analysis. The new modeling capabilities coupled with measured γ-ray spectra can be used to test transport codes and nuclear data evaluations of capture γ-rays used to simulate experimental results.

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