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Quasi-Differential Neutron Scattering Measurements of 181Ta and Teflon from 1.75 to 20 MeV

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To better understand the accuracy of current evaluated nuclear data, measurements of the neutron emission spectrum from the 181Ta, 19F, and 12C nuclei were conducted using the time-of-flight technique at the Gaerttner Linear Accelerator Laboratory at Rensselaer Polytechnic Institute. An array of eight EJ-301 organic liquid scintillator detectors coupled to photomultiplier tubes were used to detect neutrons and photons resulting from nuclear interactions between the pulsed white neutron source and the nuclei of interest. These detectors were positioned at angles from 28 to 150 degrees relative to the incident neutron beam, and recorded radiation interactions concurrently throughout the experiment. The experimental system electronics were upgraded to utilize an SIS-3305 10-bit analog-to-digital converter that converted raw electrical signals to digital waveforms for these experiments. Each digitized waveform underwent postprocessing routines and pulse shape analysis to determine whether it originated from a neutron or photon interaction in the scintillator. The resulting neutron emission spectra were compared to detailed Monte Carlo neutron transport simulations using MCNP6.2. Integral normalized results from the 12C validation measurements agreed within 2% of neutron transport simulations using ENDF/B-VIII.0 data; thus, allowing the 181Ta and 19F nuclei results to be examined. Preliminary investigation of the 181Ta experiment highlighted large disagreements between the experimental data and the JEFF-3.3 evaluation at all angles below 12 MeV. Overall, the ENDF/B-VIII.1 (β2) and JENDL-5.0 evaluations best match the current experimental results. Upon investigating the results of the 19F experiment, large discrepancies were also observed between the experimental data and the ENDF/B-VIII.0 and JEFF-3.3 evaluations above 2 MeV. Across all angles the JENDL-5.0, ENDF/B-VIII.1 (β2), and INDEN 2022 evaluations trend similarly and are observed to overpredict backscattering between 3.5 and 7 MeV. Furthermore, all evaluations were observed to poorly predict the 2.25 MeV, and the 2.6 MeV 19F resonance structure at 150 degrees. Work is ongoing at RPI to improve the pulse shape discrimination methods used for the analysis of these experiments to enhance statistical accuracy and expand the region of results of these experiments to 500 keV.

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