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Measurements of cumulative fission product yields and their impact on reactor antineutrino spectra

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A TUNL-LLNL-LANL collaboration has employed a rapid target transfer system to measure cumulative fission product yields (FPYs) following neutron-induced fission of ^{235}U, ^{238}U, and ^{239}Pu at a neutron energy of 2.0 MeV. This work expands our previously published measurements of end-chain FPYs to include fission products up to four nuclides away from stability. The cyclic activation technique was used with a variety of irradiation and counting times to probe fission products with half-lives as low as 0.5 s. Using literature γ-ray intensity values, cumulative FPYs were determined for approximately 50 short-lived fission products from each of the three actinides. These include most of the key fission products expected to contribute to the structure observed in the reactor antineutrino spectrum around 5 MeV. Overall, comparison of our FPY data with the ENDF/B-VIII.0 and JEFF-3.3 evaluations shows very good agreement; however, there exist differences in some cumulative FPYs, such as in cases where the yield is split between the ground state and a long-lived isomeric state. Substituting the present FPY data into the ENDF/B-VIII.0 and JEFF-3.3 evaluations and using the summation model to calculate the reactor antineutrino energy spectra does not eliminate the 5 MeV bump feature. Instead, it provides stronger evidence for the bump and improves agreement with the Daya Bay data. We also present preliminary FPY data at lower incident neutron energies, 60 and 560 keV, for ^{235}U and ^{239}Pu.

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