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Calculation of Delayed-Photoneutron Production in Heavy-Water Reactors using Geant4

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Understanding and predicting the dynamic behaviour of nuclear reactors is of paramount importance for reactor safety. This time-dependent behaviour is primarily driven by the emission of beta-delayed neutrons and photoneutrons following the decay of neutron-rich fission products. It is the production of these delayed neutrons which allows for a system-dependent "sluggishness"during power maneuvers, and are governed by the decay constants of the relevant precursors.

In this work we apply the Geant4 toolkit and recent fission yield data to calculate the photoneutron production from the thermal fission of ^{233,235}U and ^{239}Pu within a quasi-infinite bath of D_2O. The simulated photoneutron production rate was fit to a series of exponential terms enabling a direct comparison to historical "11 group" photoneutron data. Significant discrepancies were found comparing the simulation results to the recommended ^{235}U photoneutron yields within the shortest and longest half-life groups, including the 55.7 second half-life group; raising concerns on the validity of the yields derived from experimental data. A detailed discussion on the origin of the historical data will be presented along with explanations for the observed disagreement.

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