Energy Dependence of Prompt Fission Neutron Multiplicity in the ^{239}Pu(n, f) Reaction

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Prompt neutron emission is a challenge in nuclear fission research. Accurate values of the number of prompt fission neutrons emitted in fission reaction and their kinetic energy distributions are essential for fundamental and applied nuclear physics. Indeed, they provide valuable information on the amount of excitation energy of the heated fissioning system transferred to the primary fragments. Moreover, these data, for the fissile ^{235}U and ^{239}Pu isotopes and the fertile ^{238}U nuclide, are vital inputs to calculate next-generation nuclear reactor neutronics.

Measuring them to high precision for radioactive fissioning nuclides remains, however, an experimental challenge. We present here a recent and novel measurement of the average prompt-neutron multiplicity from the ^{239}Pu (n,f) reaction as a function of the incident-neutron energy, over the range 1-700 MeV. The experiment was carried out at the Los Alamos Neutron Science Center of the Los Alamos National Laboratory. An innovative setup, coupling the Chi-nu liquid scintillator array to a newly developed, high-efficiency, fast fission chamber was used. The combined setup, the double time-of-flight technique and the high statistics collected allowed to minimize and correct for the main sources of bias and thus achieve unprecedented precision. Corrections needed to account for neutron angular and energy distributions, as well as detector dead-time and beam characteristics will be discussed in details.

Our data were compared to the most recent ENDF/B-VIII.0 and JEFF3.3 nuclear data evaluations. We will show that, at low energies, our data validate for the first time the ENDF/B-VIII.0 evaluation with an independent measurement and reduce the evaluated uncertainty by up to 60%. This work opens up the possibility of precisely measuring prompt fission neutron multiplicities on highly radioactive nuclei relevant for an essential component of energy production.