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Title: Total Kinetic Energy and Fragment Mass Distribution of Neutron-Induced Fission of U-233

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Total Kinetic Energy and Fragment Mass Distribution of Neutron-Induced Fission of U-233

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Properties of fission in U-233 were studied at the Los Alamos Neutron Science Center (LANSCE) at incident neutron energies from thermal to 40 MeV at both the Lujan Neutron Scattering Center flight path 12 and at WNR flight path 90-Left from Dec 2016 to Jan 2017. Fission fragments are observed in coincidence using a twin ionization chamber with Frisch grids. The average total kinetic energy (TKE) released from fission and fragment mass distributions are calculated from observations of energy deposited in the detector and conservation of mass and momentum. Accurate experimental measurements of these parameters are necessary to better understand the fission process and obtain data necessary for calculating criticality.

The average TKE released from fission has been well characterized for several isotopes at thermal neutron energy, however, few measurements have been made at fast neutron energies. This experiment expands on previous successful experiments using an ionization chamber to measure TKE and fragment mass distributions of U-235, U-238, and Pu-239. This experiment requires the full spectrum of neutron energies and can therefore only be performed at a small number of facilities in the world. The required full neutron energy spectrum is obtained by combining measurements from WNR 90L and Lujan FP12 at LANSCE.

The energy of the fission fragments was determined from the energy deposited in coincidence in both volumes of the detector as measured by the anode signals. The angle of emission of the fragments is found using the Frisch grids. This allows for angle dependent energy corrections to be made to the anode pulse height spectra such as energy lost by the fragments in the target or backing material. The anode pulse height spectra are then calibrated to energy based on results from past experiments that utilized mono-energetic neutron sources.

The fragment masses and energies are then calculated using the double energy (2E) analysis method. The 2E method iteratively recalculates the fragment masses and energies based on the anode signal calibrated to energy and the mean mass of the combined nucleus. Each iteration recalculates energy and mass depending on mass dependent correction factors including pulse height defect and prompt neutron emission. Iterations are performed until the new calculated mass converges with the previous mass to within a threshold. The output values include the mass and energy of both the light and heavy fission fragments as well as the energy of the incident neutron. The energy of the two fragments is the total kinetic energy released from fission.

The average TKE is observed to steadily decrease with increasing incident neutron energy, a pattern similar to other measured isotopes. The fragment mass yields show a bimodal distribution at low incident neutron energy with an increasing prevalence of symmetric fission with increasing neutron energy. This analysis is ongoing and preliminary results are shown. For further information on this experiment please contact Daniel Higgins at dhiggins@lanl.gov, office (505) 665-1059, or cell (719) 650-9784.

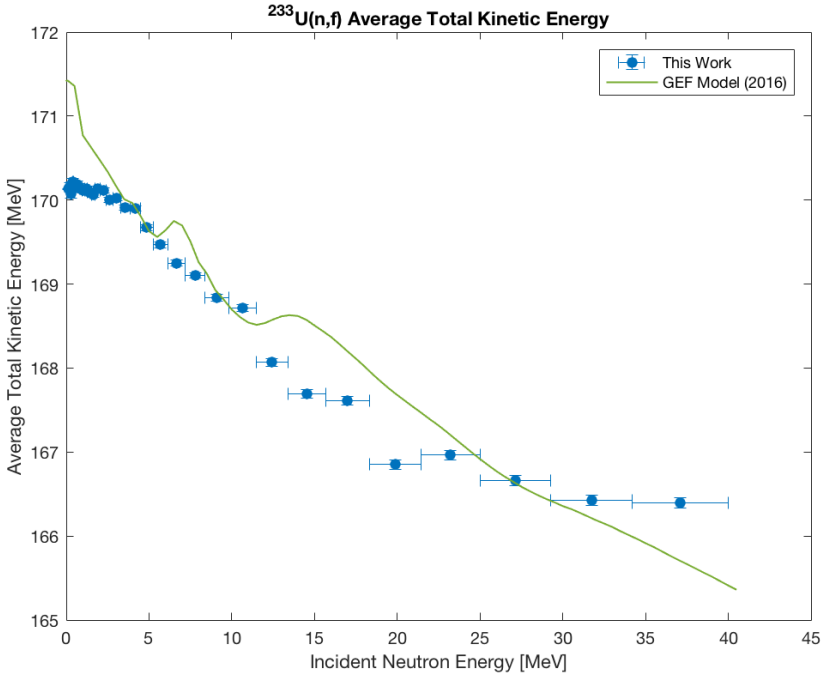

Figure 1. The average TKE of neutron-induced fission of U-233 is observed to decrease with increasing incident neutron energy, similar to other isotopes. It is shown here in comparison to the General Description of Fission Observables (GEF) model results.

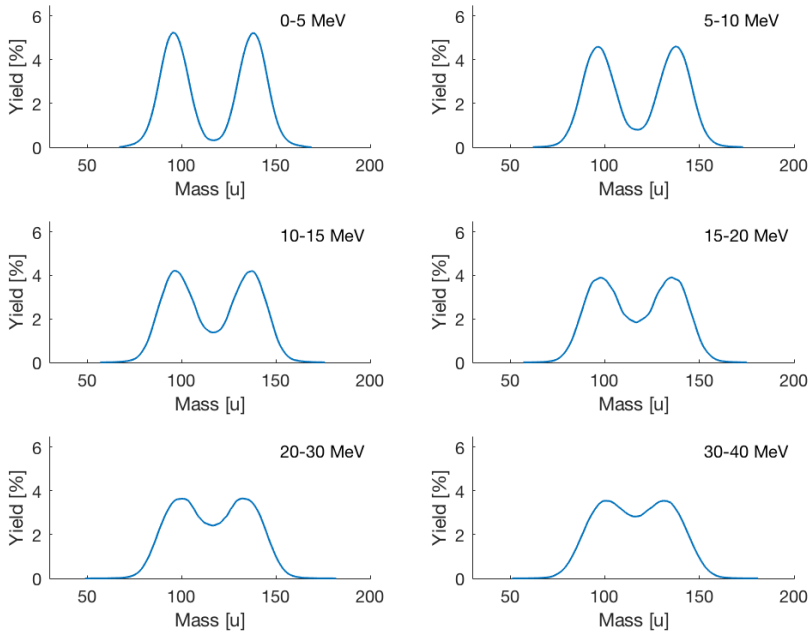

Figure 2. The fission fragment mass yields from neutron-induced fission of U-233 have a bimodal distribution at low incident neutron energy. An increasing prevalence of symmetric fission is observed with increasing incident neutron energy.