VARIATIONS IN FISSION FRAGMENT MASS DISTRIBUTIONS AS A FUNCTION OF INCIDENT NEUTRON ENERGY MEASURED IN A LEAD SLOWING-DOWN SPECTROMETER

by

Catherine Romano

An Abstract of a Thesis Submitted to the Graduate

Faculty of Rensselaer Polytechnic Institute

in Partial Fulfillment of the

Requirements for the degree of

DOCTOR OF PHILOSOPHY

Major Subject: Nuclear Engineering/Engineering Science

The original of the complete thesis is on file
In the Rensselaer Polytechnic Institute Library

Examining Committee:

Yaron Danon, Thesis Adviser

Robert Block, Member

George Xu, Member

Li Liu, Member

Jim Napolitano, Member

Rensselaer Polytechnic Institute
Troy, New York

May, 2009
(For Graduation August 2009)

ABSTRACT

A new method of measuring fission fragment mass and energy distributions as a function of incident neutron energy in the range from below 0.1 eV to 1 keV has been developed. The method involves placing a double sided Frisch-gridded fission chamber in Rensselaer Polytechnic Institute's lead slowing–down spectrometer (LSDS). The high neutron flux of the LSDS allows for the measurement of the energy dependent, neutron induced fission cross sections simultaneously with the mass and kinetic energy of the fission fragments of various small samples. The samples may be isotopes that are not available in large quantities (sub-micrograms) or with small fission cross sections (microbarns). The fission chamber consists of two anodes shielded by Frisch grids on either side of a single cathode. The sample is located in the center of the cathode and is made by depositing small amounts of actinides on very thin films. The chamber was successfully tested and calibrated using 0.41 ± 0.01 ng of ^{252}Cf and the resulting mass distributions were compared to previous work. As a proof of concept, the chamber was placed in the LSDS to measure the neutron induced fission cross section and fragment mass and energy distributions of 25.3 ± 0.6 μg of ^{235}U and 26.1 ± 0.8 μg of ^{239}Pu.

Fluctuations in the mass distributions as a function of incident neutron energy are evident and are examined in terms of the multi-modal fission model. For ^{235}U, an anticorrelation between Standard I mode and Superlong mode symmetric fission, as well as a correlation between TKE and the Standard I mode was observed. An exception to these correlations was found in the energy region of 225 – 275 eV where there was an uncharacteristic drop in TKE. For ^{239}Pu an anticorrelation was found between the symmetric fission and average heavy mass as well as an anticorrelation between symmetric fission and TKE. Similar to the ^{235}U experiment, an exception to these correlations was found in the 260 – 340 eV region.