Neutron and Gamma Ray Multiplet Analysis for the Determination of Plutonium Mass

Nuclear safeguards methods are being developed at ORNL and elsewhere to nondestructively determine the mass of fissile material. Recent efforts have studied the multiplicity of neutrons and gamma rays emitted by spontaneous and induced fissions in fissile samples. The present work aims at developing a reliable method for determining the mass of the samples. The proposed analysis relies on a series of experiments that were conducted on plutonium oxide samples at the JRC in Ispra, Italy, using a GHz processor developed at ORNL. The detectors used were liquid scintillators, which are sensitive to fast neutrons and gamma rays. The setup consisted of two 2x2 detector arrays, placed opposite each other, with a plutonium oxide sample set equidistant from them, inside of an AT400 container. The measurement setup was simulated using the MCNP-PoliMi code, and multiplet analysis was performed on both the simulated and the measured data. The distribution of multiplets describes the number of times *n* detections occur following a single fission, where *n* includes neutron and gamma ray counts. This work shows that it is possible to determine a relationship between the multiplet distribution and the mass of Pu-240 in the sample. Our results show that the Pu-240 mass can be predicted to within 7.8% in the mass range of 50 to 2500g. This information, together with information on the sample's composition, allows us to determine the mass of Pu-239. This work has a bearing on nuclear nonproliferation programs and will lead to more sophisticated analyses that can be applied to homeland security issues.

Student's Name: **Melissa Crawford**
School Student Attends: University of Florida
Name of Mentor: **Sara Pozzi**
Division: Nuclear Science and Technology
Program: DOE Science Undergraduate Laboratory Internship