Prompt and isomer gamma-ray spectroscopy at the edges of neutron-induced fission product distributions at IFMIF/DONES

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The discrete gamma-ray spectroscopy of nuclei produced in spontaneous or thermal-neutron induced fission of actinides has extensively been used in the past to study yrast and near-yrast structures in neutron-rich species. For example, the nuclides lying near the doubly magic nucleus ^{132}Sn with Z=50-58 [e.g., 1,2] or the products with Z=36-44 located near N=60 [e.g.,3], where a drastic change of the nuclear shape occurs, have been investigated by this technique. In spontaneous or thermal-neutron induced fission, however, the region of neutron-rich species with Z=46-48 is not populated with yield sufficient to perform gamma-gamma coincidence measurements. This can be overcome by using fission induced by 14 MeV neutrons on actinide targets. Fig. 1 shows product yield distributions as a function of mass A (Fig.1a) and atomic number Z (Fig.1b) for three processes: spontaneous fission of ^{248}Cm, thermal-neutron induced fission of ^{241}Pu and 14 MeV-neutron induced fission on ^{232}Th. It is clear that fission induced by 14-MeV neutrons is more symmetric, giving rise to a sizeable population of nuclei with Z=46-48. In this case, also the production of light species with Z=28-30 is enhanced by more than one order of magnitude.

To study gamma rays from isomeric states decay in nuclei accessible with 14-MeV neutrons, a fission fragment spectrometer could be used – gamma quanta would be detected in the focal plane of that spectrometer by a Ge detection system. Also, prompt gamma rays from fission products identified in the spectrometer or from their fission partners could be measured by a Ge array surrounding the target.

In this way, for example, yrast structures could be accessed in neutron-rich nuclei around the N=50 isotones - one would aim at hard-to-reach Ni, Cu, Zn, Ga, Ge, As, Se species. Also, the excited structures in Pd, Ag and Cd nuclei would become available for medium-high spin yrast spectroscopy.

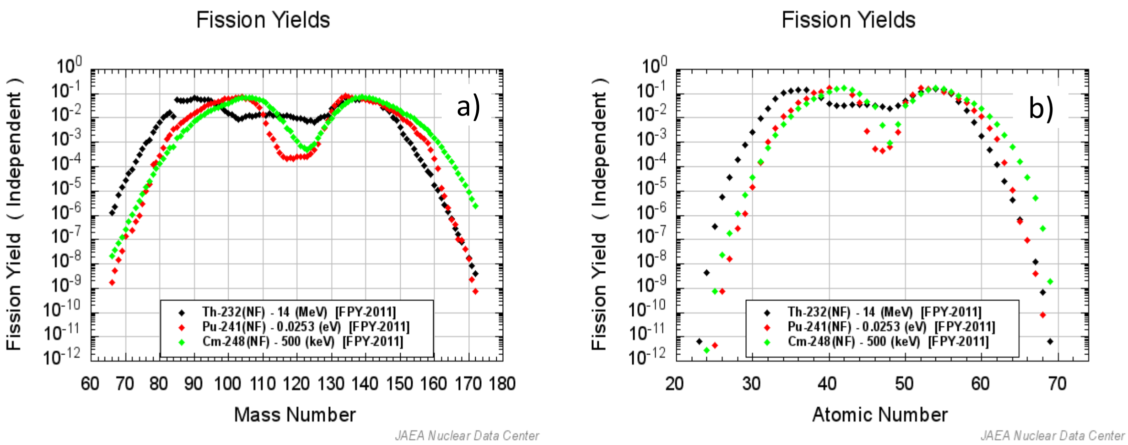

Figure 1. *Fission product yield distributions as a function of: (a) mass number and, (b) atomic number. Data for spontaneous fission of ^{248}Cm, thermal-neutron induced fission on ^{241}Pu, and 14-MeV-neutron induced fission on ^{232}Th are shown (taken from Japan Atomic Energy Agency, Nuclear Data Center).*

References:

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