Experimental report

17/09/2018

Proposal: 3-01-624 **Council:** 4/2014

Title: Isotopic and Isomeric Yields Measurement in the Near Symmetric Mass Region of the 241Pu(nth,f) Reaction

Research area: Nuclear and Particle Physics

This proposal is a new proposal

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Samples:

Instrument	Requested days	Allocated days	From	To
PN1	20	14	06/11/2014	13/11/2014
			28/06/2016	05/07/2016

Abstract:

We propose to investigate isotopic and isomeric yields from 241Pu thermal neutron induced reaction, in the heavy mass region (close to the symmetry): A=125 up to A=134. For that, fission products selected by Lohengrin will be implanted in a moving tape placed inside a vacuum chamber. Then, two ILL clover Ge detectors will be used to measure gamma-rays which follow beta-decays of fission products. In this way, the contributing nuclear charges can be identified. This method has already been applied successfully to measure isotopic yields of 239Pu(n_th,f) and 233U(n_th,f) reactions. This proposal is motivated for both nuclear energy applications and the expected improvement of our fission process understanding.

Experimental Report on Isotopic and Isomeric Yields Measurement in the Near Symmetric Mass Region of the ^{241}Pu(n_{th},f) Reaction

The goal of the submitted proposal was to study the isotopic and isomeric yields in the near symmetric mass region of the ^{241}Pu($n_{th,}$f) reaction. In July 2016, we had the opportunity to also measure the local odd-even effect as function of the kinetic energy with a thin target of ^{241}Pu. We remind that for each kinetic energy, a scan over the ionic charge distribution must be performed.

Because of the low thickness of the target (needed to see such fine effect), statistical uncertainties are important. Here we presents and discuss the result on mass 139. Figure 1 shows the evolution of the independent isotopic yield as function of the kinetic energy. The high errors bars come from the Bateman equation resolution, and the statistical uncertainty. It seems that the independent isotopic yield is not the best observable. If we look at the cumulative isotopic yield, the uncertainties are reduced.

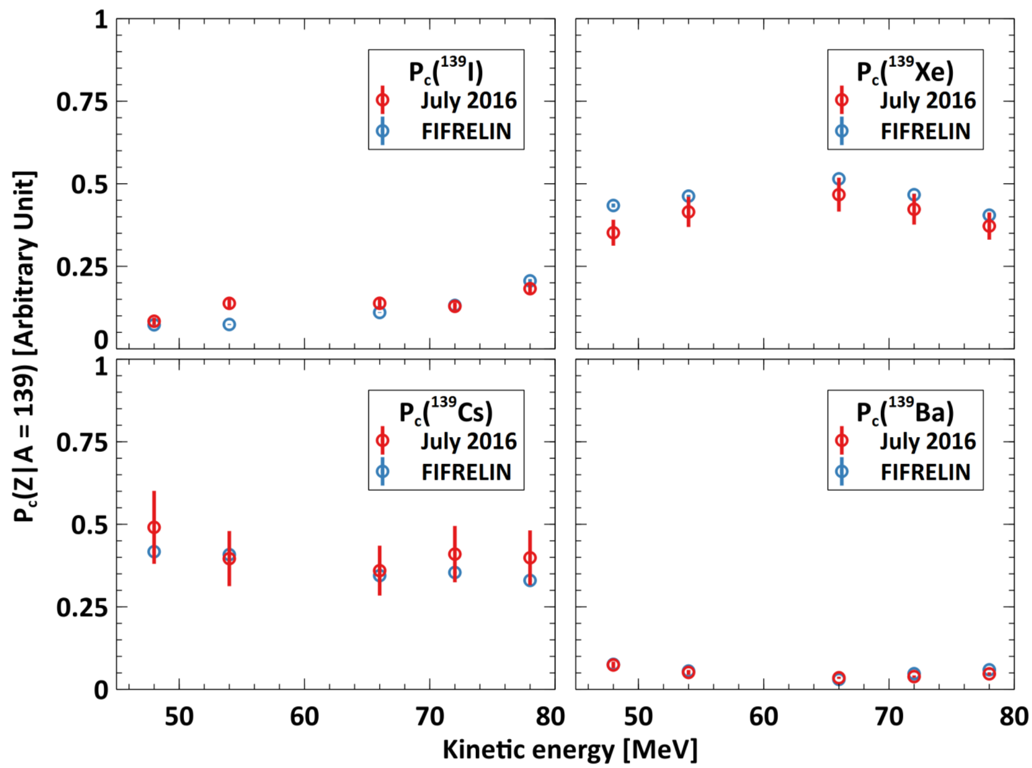

Figure 1: Probability to obtain ^{139}I (top left), ^{139}Xe (top right), ^{139}Cs (bottom left), ^{139}Ba (bottom right) as function of the kinetic energy. Red points are the experimental data and blue points are the FIFRELIN calculations

Then a comparison with a calculation can be done. Here we used FIFRELIN [1-2], which is a Monte Carlo code developed by CEA. It describes the de-excitation of the nascent fission fragments. Instead of corrected the experimental data, the proposed solution is to correct the simulated point, in order to match the experimental conditions.

First we need to take into account the energy loss through the fissile target (see Figure 2). Then, we resolve the Bateman equation to go from independent to cumulative yield (see Figure 3).

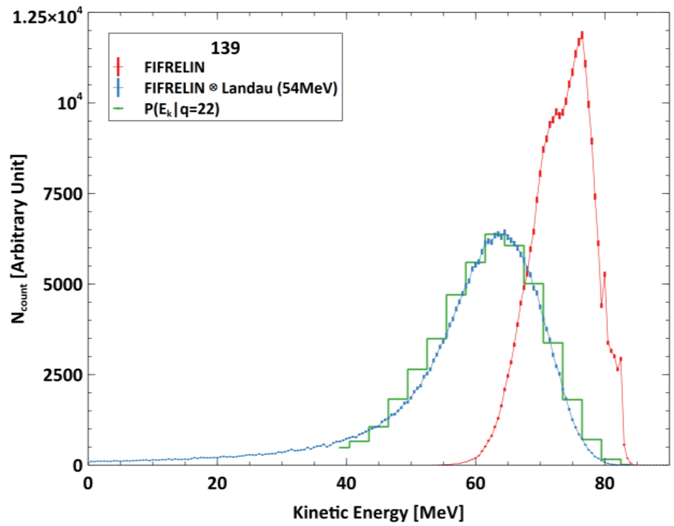

Figure 2: Kinetic energy distribution of mass 139. Green histogram is experimental data, red lines is FIFRELIN calculation and blue lines are FIFRELIN calculations corrected from target energy loss (within Landau theory)

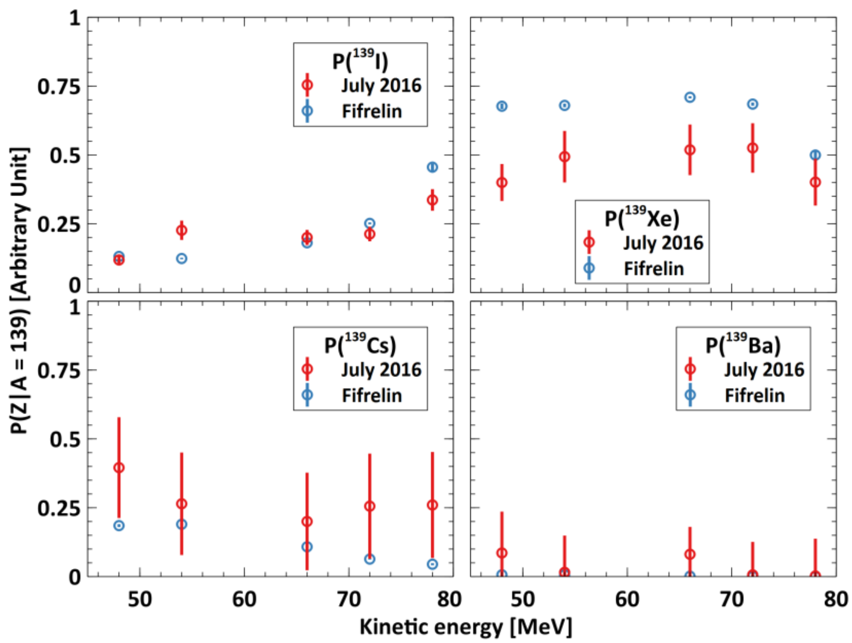

Figure 3: cumulative yields of ^{139}I (top left), ^{139}Xe (top right), ^{139}Cs (bottom left), ^{139}Ba (bottom right) as function of the kinetic energy

Since the experimental data and calculated one are perfectly matching, we consider that FIFRELIN is validated for this specific case. Then we can look at the behavior of the local odd-even effect as function of the kinetic energy with FIFRELIN (see Figure 4).

It can be seen, that the different structures are mainly coming from the neutron emission. This work is a part of the thesis of Sylvain Julien-Laferrière and will be submitted to a peer-review journal in the next weeks.

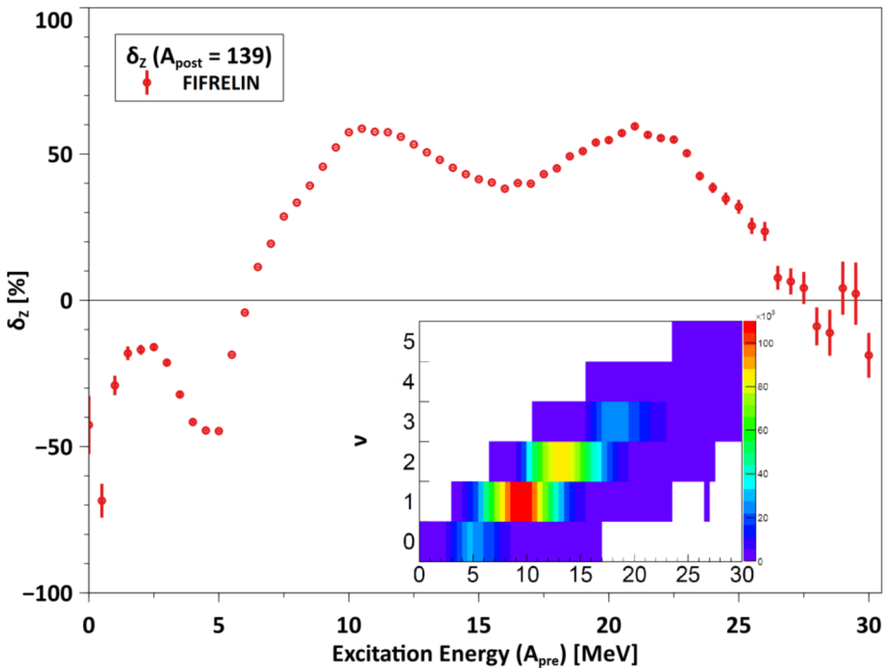

Figure 4: Local odd-even effect for mass 139 coming from FIFRELIN calculations. The behavior as function of kinetic energy exibit the impact of the neutron emission on the observable

[1] O.Litaize and O.Serot, Phys. Rev. C 82, 054616 (2010).

[2] D. Regnier, O. Litaize and O. Serot, Comput. Phys. Commun. 201, 19 (2016).