

Experimental report

17/01/2025

Proposal: 3-01-706

Council: 10/2022

Title: 235U(nth,f) : Search for a direct experimental signature of fission modes in the symmetry mass region

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	33	33	30/11/2023	12/12/2023

Abstract:

Since its discovery, the fission process understanding heavily relies on fission yields. Nowadays, the theoretical description of the fission process is directly used in the evaluation process of fission yields data. In the international framework of a CRP organized by the IAEA, both experimental and theoretical researches will be combined to improve the knowledge on fission process and the modeling of fission yields. Fission models are therefore mandatory in order to complete the experimental data and improve the coherence of the evaluation. Majority of the fission models used for the evaluation process are based on the Brosa-like fission modes. The symmetric mass region is of particular interest due to various intriguing properties of the Fission Fragments, in particular in the thermal neutron induced fission for which the fission barrier effect is major. Nevertheless, this mass region presents a contaminant event due to the ionic charge change by atomic collisions in the residual gas of the instrument. Thus, the goal is to develop a new system to measure Time of Flight (TOF) and thus improve the mass identification by an additional condition, thus eliminating contaminant ions.

The purpose of the experiment was to test the new time of flight device. The experimental setup consisted of one start detector, one-stop detector, and a diamond detector inside a vacuum pipe of 70 cm long. Both start and stop detectors are made of thin SiN foils (covered by a thin layer of Al) positioned at 45° with the fission product beam axis. Parallel with the beam axis, a Multi-Channel Plate detects the electrons emitted by the interaction of the fission products and the SiN foil. Figure 1 shows a photograph of the experimental setup. Note that a secondary vacuum is needed to make the device work. Therefore additional pumps were provided to reach such a level of pressure.

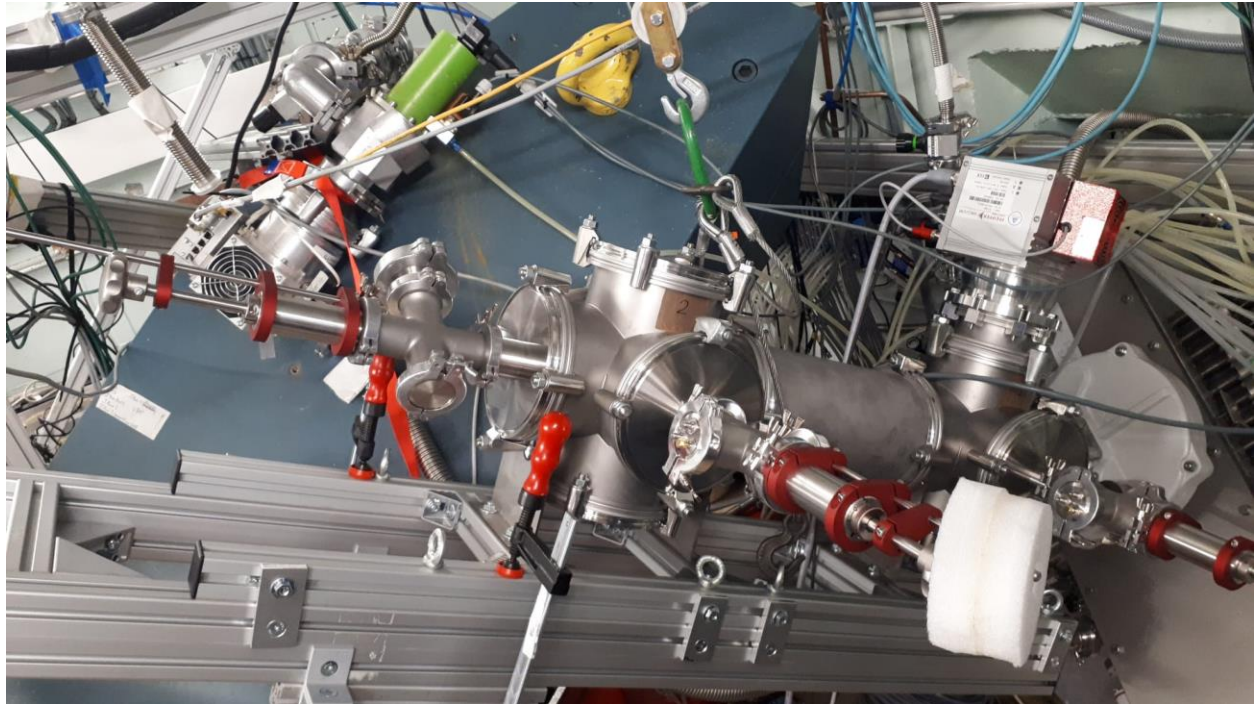


Figure 1: Photography of the coupling of the time of flight device and LOHENGRIN.

During this experiment, we were able to test the evolution of the recorded ToF as a function of the fission product mass and kinetic energy. Several acquisition systems were used to determine the best solution regarding the timing resolution. Due to the fast time of the MCP detectors, the LOHENGRIN cards (namely CAEN v1730/v1724) cannot read directly the signal. A combination of analogic modules allows to produce of a rectangular output pulse with a width of a few microseconds, and height proportional to the time difference between two detectors. This signal is then processed by the LOHENGRIN cards. However, a dedicated digital acquisition system (wave catcher) allows to direct process the input signals of the MCP and diamond detectors and produces a time difference between the two detectors. Figure 1 shows the time of flight between each detectors.

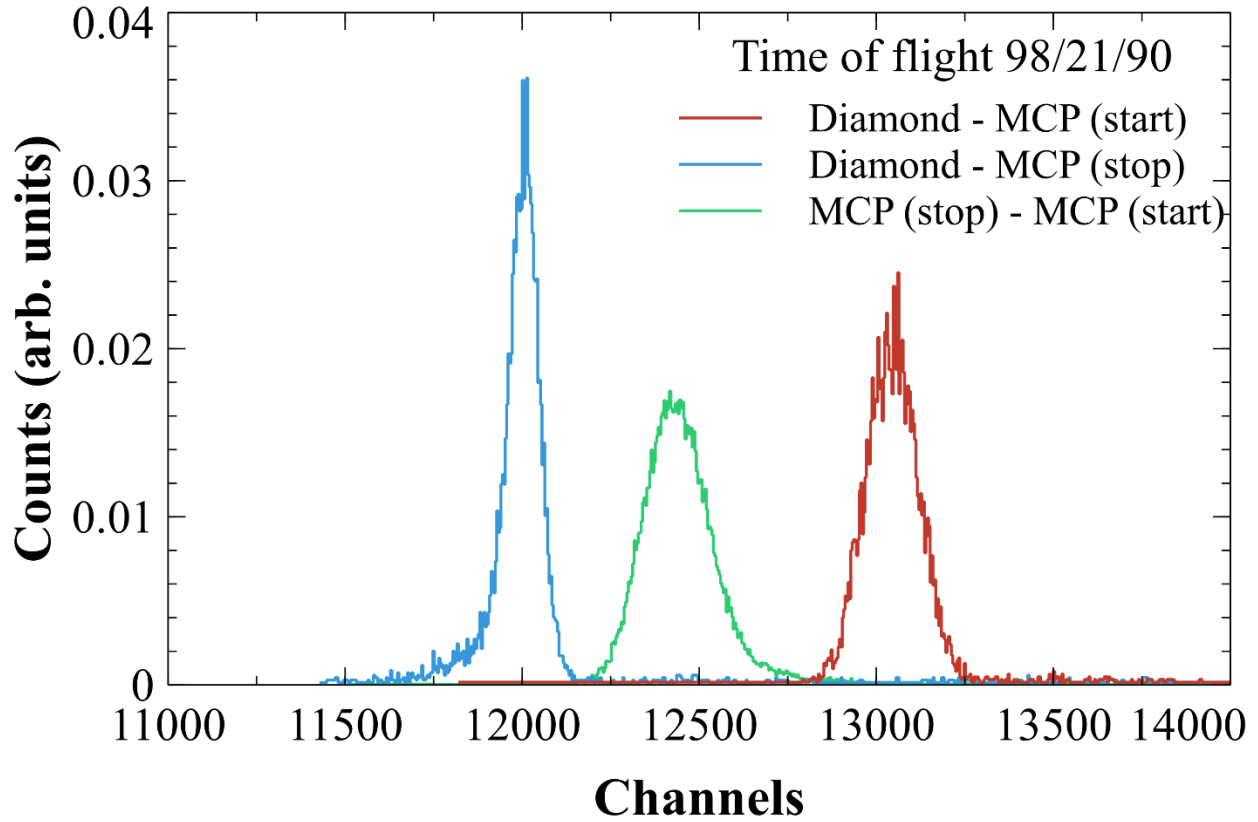


Figure 2: Time of flight between the diamond detector and MCPs.

Preliminary results highlighted several outcomes. First, a strong difference between analogic and digital processing arises. Work needs to be done to improve the accuracy of the analogic treatment. Secondly, the measured time resolution is not good enough to be used for disentangling the contamination in the symmetry region (which is the ultimate goal of this device). This is coming from the 45° configuration which is sensitive to the angular straggling of the fission products. Therefore, a 90° configuration is under construction to remove the angular straggling and improve the total time resolution of the time-of-flight device. This new configuration will be tested in 2025 at LOHENGRIN.