Identification of fission fragments from tracks measured by the FDC1

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The purpose of the experiment NP1306-SAMURAI14 is to characterize parameters of fission of neutron rich heavy nuclei, like the fission barrier heights and the fragment distributions. As a first step, we performed in April 2014 a 24-hour beamtime experiment using ^{238}U as primary beam at 250 MeV/u and an intensity of 5×10^4 pps. A liquid hydrogen target in the setup of NP1306-SAMURAI17 was used as a secondary target.

In this report we present a method to identify fission fragments by the forward drift chamber 1 (FDC1) which is positioned upstream in front of the SAMURAI spectrometer. In the beam direction, the FDC1 has 14 layers. For each layer the positions of the particles passing the active volume are determined. The most likely trajectory is defined as the composition of the available positions in all layers which has the smallest χ^2. When two fission fragments are incident, there are two possible positions for all the layers and their tracks are given by the two smallest χ^2 values.

In Fig. 1 we show examples of trajectories through the 14 layers in beam axis of the FDC1. In Fig. 1(a) the number of possible positions of the particles in each layer is one. Hence the track corresponds to a beam-like particle, showing no fission reaction is induced. The situation in Fig. 1(b) is totally different where each layer has two entries and two tracks with a large gap can be reconstructed. Such events are interpreted as two particles crossing the FDC1 at the same time.

For these cases the distance b between their intersection points and the first layer of the FDC1 in beam direction is obtained by

$$b = \frac{a_1 + a_2}{tan\theta_1 + tan\theta_2} \quad (1)$$

where $\theta_{1/2}$ are the angles of the two fission fragments 1 and 2 in respect to the beam axis and $a_{1/2}$ are defined as their most probable intersection point with the first layer of the FDC1.

The results for two 1/2 h runs with each with the filled target or with the empty one are shown in Fig. 2(a) and (b). In both cases the maximum of the very broad peak is in good agreement with the real distance to the target of 2215 mm. The sharp peak at $b \approx$ 4600 mm also appears in both spectra but it is not yet understood. The peak in the case of the empty run can be considered as interactions of the beam with the target foil. The main and important difference is the number of events which drops down from over 100.000 to ~5000 entries removing the liquid hydrogen from the target.

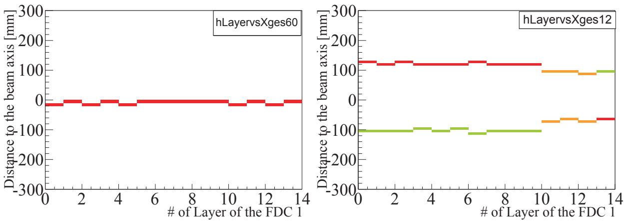

Fig. 1. Online plot of typical tracks observed in the FDC1

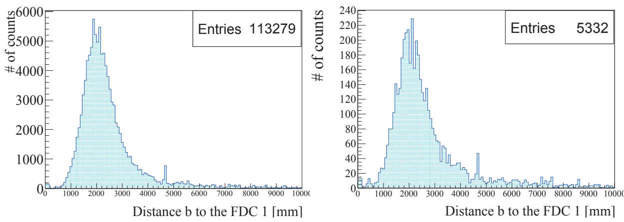

Fig. 2. Intersection point of two tracks of the FDC1 in respect to the beam axis. (a) is the result where the target was mounted, in (b) there was no liquid hydrogen between the target foils.

This method seems promising for a fast and reliable way to identify fission stemming from reactions inside the target. However the uncertainty in the reconstructed vertex position b is very large, $\sigma \sim 600$ mm. In the future this might be improved, e.g., by including the position of the incoming beam by the beam drift chambers. A precise beam position and incident angle is also needed for determining the A/Q value of the fission fragments in the downstream part of the SAMURAI spectrometer.

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