In-beam performance of a two-dimensional cathode strip detector for fission fragments

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Introduction

In the recent past we have developed a gas filled two-dimensional cathode strip detector (CSD) for the detection of fission fragments (FFs) [1]. The detector has three electrode planes consisting of cathode strip(X-plane), anode wires and split-cathode wires(Y-plane) and the fully assembled detector is shown in Fig.1. In this detector, each thin wire of the anode plane placed between the two cathode planes is essentially independent and behaves like a proportional counter. The construction of the detector in detail has been given in our earlier paper [1]. The position information has been obtained by employing high impedance discrete delay line read out method for extracting position information in X and Y-directions. The details of similar delay line read out system and its performance has been reported earlier for use in silicon strip detectors [2].

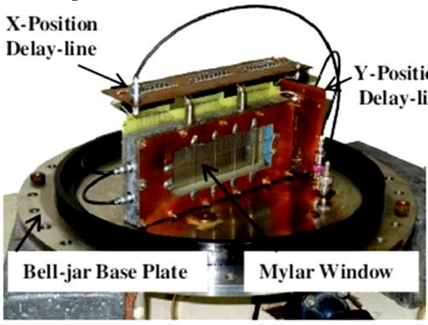

Fig. 1: Experimental setup showing a photograph of the two-dimensional CSD mounted on the base-plate of a glass bell-jar vacuum chamber for testing with radioactive sources.

The response of the detector has been studied earlier with FFs from a ^{252}Cf source. The position information was obtained from the measurement of time delay signals of the cathode strips (X-direction) and split-cathode wires (Y-direction) with respect to the timing signal from the anode wires [3]. The position resolution was found to be about 1.0 and 1.5 mm in X and Y-directions respectively**.**

We report here the performance of the detector for measuring FFs produced in heavy-ion induced experiments in ^{6,7}Li+^{232}Th reactions at energies around the Coulomb barrier.

In-beam performance of the detector for heavy ion reactions

The CSD has been used in an in-beam experiment at BARC-TIFR pelletron accelerator facility, Mumbai for measuring the fission cross section in ^{6,7}Li+^{232}Th reactions. The CSD was mounted on a movable arm inside a scattering chamber at a distance of 21 cm from the target position with angular coverage of 35º. It was operated at a pressure of 20 mbar. The anode and the split-cathode wires were biased at +330 V and -260 V respectively, whereas the cathode strips were grounded through the delay line. A monitor detector (Si surface barrier detector of thickness 300 μm) was mounted at 20º to normalize the data for measuring the fission cross section. For angular calibration and to check the linearity of the position spectrum, two thin silicon detectors of thickness 12 μm with opening angle of 1º were mounted in a separate rotatable arm inside the scattering chamber. The cross section measurements were carried out in the beam energy range of 26 to 42 MeV. The 2D spectrum of X-position vs anode energy for fission fragments produced in ^{7}Li+^{232}Th reaction is shown in Fig. 2.

By taking the y-projection, we have obtained the energy spectrum of the fission fragments as shown in Fig. 3. In the present experiment, we could separate the fission fragments from the PLFs at all energies using this detector. We have measured the coincidence between the fission fragments detected in the silicon detectors and in the gas detector mounted at the folding angle. The data were obtained for four different settings of the silicon detector for θ_{si} = 80-95º in steps of 5º and the corresponding

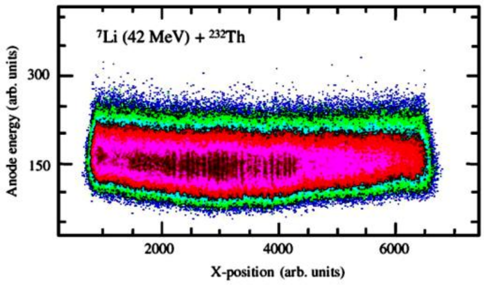

Fig. 2: Two dimensional plot of X-position vs anode energy for ^{7}Li+^{232}Th reaction at 42 MeV.

fragment angular distribution in this detector is shown in Fig. 4. The folding angle (θ_{fold}) of the fission fragments has been calculated to be ≈ 170.5º. To calibrate the gas detector, the angle of the gas detector corresponding to the maximum fission yields have been obtained from the calculated folding angle and known angle of the silicon detector.

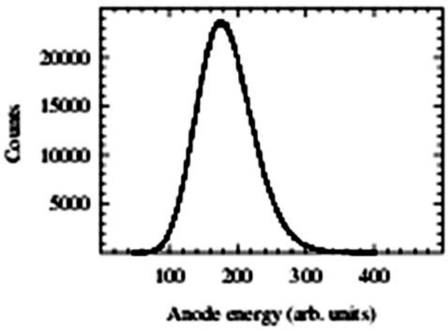

Fig. 3: Y-projection of the two-dimensional plot of Fig. 2, showing the anode energy spectrum for FFs produced in ^{7}Li+^{232}Th reaction.

The cross section of the fission fragments have been measured from energies above the CB to deep sub-barrier energies (≈20% below CB for both the systems). In Fig. 5, we have plotted the fission cross section as a function of beam energy. It is seen that at sub-barrier energies, the fission cross section for ^{6}Li+^{232}Th reaction is significantly large in comparison to ^{7}Li+^{232}Th

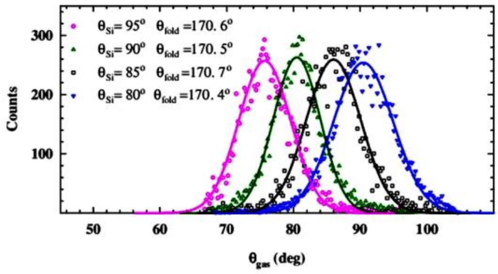

Fig. 4: Angular distribution of FFs in CSD in coincidence with FFs detected in silicon detector at θsi = 95º, 90º, 85º and 80º. Solid lines are Gaussian fit to the data.

system. Similar behavior of fission excitation function has been reported earlier by measuring the fission fragments using silicon surface barrier detectors [5]. As the CSD has large active area, it is found to be very suitable at deep sub-barrier energies, where the count rate is very low.

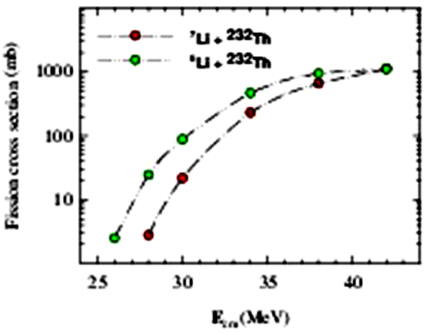

Fig. 5: Fission cross section in ^{6,7}Li+^{232}Th reactions measured upto deep sub-barrier energies. Smooth dashed lines are guide to the eye.

References

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