Fission fragment mass distributions from ^{193}Tl

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Introduction

The process of nuclear fission remains one of the long standing puzzle in the field of nuclear physics since last 80 years. While the importance of shell effects in the nascent fragments is well-established for low-energy fission of (trans-) actinides [1], the origin of asymmetric fission of n-deficient Hg [2], and more generally, pre-actinides [3], remains un-explained. According to liquid drop model as well as from the consideration of shell correction in the nascent fragments, proton rich ^{180}Hg was expected to exhibit symmetric mass distribution centered around semi magic ^{90}Zr. However in contrast to the anticipation, low energy fission of ^{180}Hg showed a pronounced asymmetric mass distribution, suggesting that shell structures other than those of the fragments may play a vital role in shaping fission outcomes. Different theoretical models proposed to explain these results give contradictory interpretations. More measurements to study the evolution of the fission fragment mass distributions with the N/Z and excitation energy E* of the fissioning nucleus, spanning region between actinides and pre-actinides are required to understand the origin of shell effect and discriminate between various models. The present measurement aimed at contributing to the worldwide intense effort in this field. Using heavy ion induced fission, recent measurements have reported presence of asymmetric fission mode for fissioning nucleus with Z= 78, 79 and 80 [1, 4]. With Z=81, Tl lie closest to Hg for which a most asymmetric distribution is obtained using heavy ion induced as well as β-delayed fission. In the present work we have studied ^{28}Si+^{165}Ho system, producing ^{193}Tl with the CN excitation energy above saddle (E^{*}_{saddle}) in the range of 16 to 30 MeV.

Experimental Details

The experiment was performed at the Pelletron-Linac Facility, Mumbai by bombarding a 230μg/cm^2 thick ^{165}Ho target (90 μg/cm^2 Al backing) with a ^{28}Si beam at three lab energies of 138, 128 and 119 MeV. Two large-area (12.5 × 7.5 cm^2) multi-wire proportional counters (MWPCs) [5], were used to measure the time-of-flight(TOF) with respect to the RF filtered with fission and (x,y) position information of fragments in coincidence. Cathode signals were also recorded using QDC to get the energy loss of each fragment in the active volume of detector. The detectors were placed in transmission geometry at an angle of $\pm 71^\circ$ on both sides of beam direction, such that distance between the target and the center of the cathode were 25 cm for both detectors. Two solid-state detectors, mounted at 13 with respect to the beam axis, were used to monitor and position the beam at the center of the target in each run.

Analysis and Summary

The fission events were selected by putting two dimensional gates in TOF difference(T1 -T2)(where T1 and T2 are TOF of fragments detected in MWPC 1 and 2 resp.) vs energy loss spectra shown in Fig. 1. The calibrated

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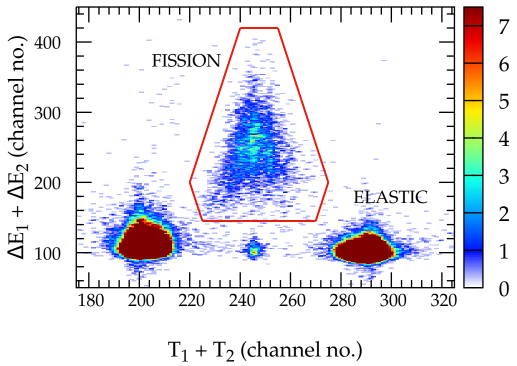

FIG. 1: TOF difference T_1-T_2 where T_1 and T_2 are TOFs of fragments detected in MWPC 1 and 2 resp. vs total energy loss spectra for incident beam energy of 138 MeV.

positions and the TOF information from the MWPCs were used to obtain the fragment emission angles and velocities. A correlation plot of the folding angle and azimuthal angle along with parallel and perpendicular components of velocities of the fragments (not shown) were used to ensure the selection of fission events. Fission fragment mass distributions were deduced using the TOF difference method assuming two body kinematics. Further these obtained masses were corrected on event by event basis for energy loss inside the target considering reaction had taken place at the center of the target. The obtained mass-angle correlation at the three measured energies are shown in Fig. 2. The fragment mass distributions shown in Fig. 3 were obtained by projecting the mass angle correlations with angular cut(shown in figure 2) to remove the bias due to geometrical acceptance of the detection setup. In Fig. 2 and 3, the yields are scaled as 1.5 times for incident energy E_b=128 MeV and 5 times for E_b=119 MeV to show different energies in a single plot.

The obtained mass distribution widths after assuming single Gaussian distribution have been compared with Statistical model as well as advanced semi-empirical code GEF predictions. A systematic comparison of the result with all available experimental data in pre-actinide region has also been performed. These interesting results will be presented.

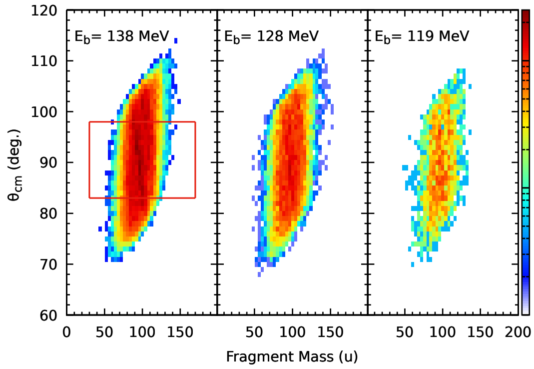

FIG. 2: Fission fragment mass angle correlation for ^{28}Si+^{165}Ho at three incident energies.

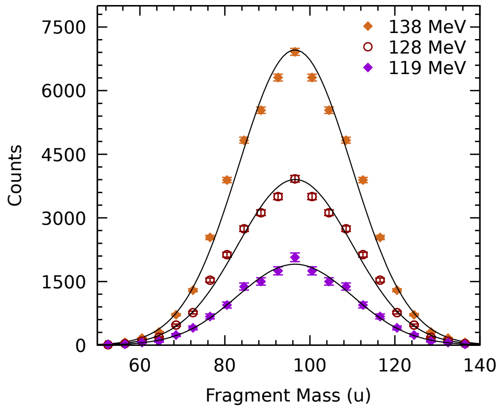

FIG. 3: Fission fragment mass distribution for ^{28}Si+^{165}Ho at three incident energies .

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