Fusion-fission dynamics of ^{188,190}Pt through mass distribution measurements

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Introduction

The synthesis of new super-heavy elements (SHEs) in heavy ion induced reactions is an important part of investigation of today's nuclear physics research [1, 2]. Presence of non-compound processes such as, quasi fission (QF) is the main obstacle in SHE production. Many experimental measurements of mass distribution of fission fragments (FF) using different projectile-target combinations are studied by different research groups to explore the characteristics of QF process in medium mass region [3]. The fission fragment mass distribution (FFMD) measurements provide valuable information about the potential energy landscape of fissioning nucleus. The variation of the width of fragment mass distribution with excitation energy is a promising probe for studying QF particularly at energies close to the Coulomb barrier [4]. The unexpected observation of asymmetric mass distribution of fission fragments of post β decay of daughter nucleus ^{180}Hg have increased the research interest in this area [5, 6]. In general, shell effects are responsible for the appearance of asymmetry and these effects washes out with increasing excitation energy [7, 8]. In the present work, we report the FFMD measurement for the reactions ^{28}Si + ^{160}Gd & ^{12}C + ^{178}Hf at various lab energies around the barrier.

Experimental details

The experiment was carried out at Inter University Accelerator Centre (IUAC), New Delhi, using general purpose scattering chamber (GPSC) setup and Pelletron accelerator facility. Pulsed beams of ^{28}Si & ^{12}C in the energy range of 120-140 MeV and 60-88.2 MeV respectively were bombarded on ^{160}Gd & ^{178}Hf targets of thickness 200μg/cm^2. Fig. 1 shows the experimental setup in GPSC.

Fig. 1: Experimental set-up inside the scattering chamber.

The coincident fission fragments were detected using two large area (6.4" x 4.4") Multi-Wire Proportional Counters (MWPCs) kept at folding angle for respective reactions. The target ladder was kept at 45º with respect to the beam direction in order to avoid the shadowing of either of the two detectors. Two silicon surface barrier detectors (SSBD) were mounted at ± 10º w.r.t beam direction for monitoring the beam throughout the experiment.

Data analysis & Results

The event mode data from MWPCs consist of time of flight (TOF) and position information (X, Y) of the fission fragments. The position calibration was done using the known geometry of the detectors. These X & Y calibrated positions were then converted to spherical- polar coordinate's θ & ϕ, whereas, TOF of each fragment was recorded w. r. t. the RF timing. Fig. 2 shows the time correlation of the two fragments for the reaction $^{12}C+^{178}Hf$ at 75 MeV of lab energy. The coincidence condition between the two TOF signals obtained from the two detectors ensures the removal of all elastic & quasi-elastic events.

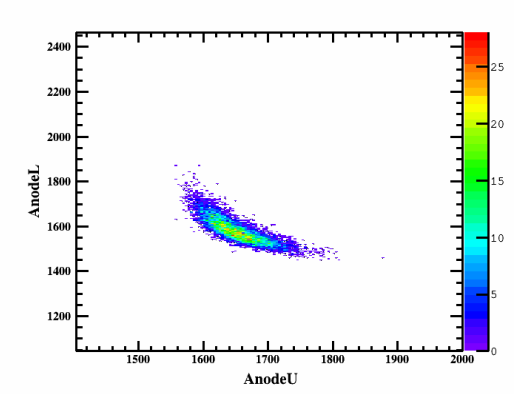

Fig. 2: Timing spectrum of two MWPCs at E_{lab}=75 MeV for the reaction $^{12}C+^{178}Hf$.

Following the formalism reported in [9-10], the measured mass distribution of fission fragments for the $^{12}C+^{178}Hf$ reaction at 75 MeV of lab energy is shown in Fig. 3. Single fitted Gaussian peak (red solid line) shows the symmetric nature of the mass distribution. Further analysis to extract the mass variance and folding angle variations for both the reactions at quoted lab energies is under process.

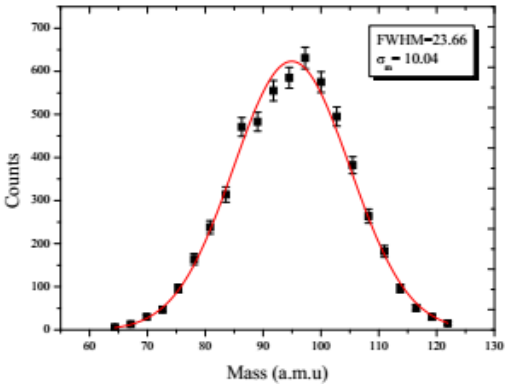

Fig. 3: Fission fragment mass distribution for the reaction $^{12}C+^{178}Hf$ at 75 MeV of lab energy.

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