Measurement of mass dependent prompt fission γ-rays in ^{28}Si+^{238}U reaction

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Introduction

The study of prompt fission γ-ray is important for understanding of fusion-fission dynamics relevant for synthesis of super heavy nuclei involving various projectiles with actinide targets. The prompt energy released from the nuclear fission process is dominated by the kinetic energy of the FFs and then followed by the prompt neutron and γ-rays emission from the fully accelerated fission fragments. The measurement of γ-ray multiplicity strongly depends on symmetric and asymmetric mode of nuclear fission [1]. The γ-ray multiplicity in coincidence with the fission fragment(FF)s has been investigated in heavy ion induced reaction on preactinide targets which shows a strong mass dependency in ^{40}Ar+^{154}Sm, ^{20}Ne +^{197}Au systems [2]. It would be interesting to measure the γ-ray energy spectra and multiplicity in heavy ion induced reaction with actinides targets around and above the Coulomb barrier. In this article, we have present the FFs mass ratio dependent prompt γ-ray energy distribution produced in the system of ^{28}Si+^{238}U at two beam energies.

Experimental set-up

The measurement has been carried out using ^{28}Si pulsed beam from the Pelletron Linac Facility (PLF), Mumbai, bombarding on actinide target ^{238}U. Two beam energies 161.1 and 180.0 MeV are considered near and above the Coulomb barrier to measure both the FFs mass ratio and energy dependent γ-rays spectra. Typical beam current is about 10.0 enA. The experimental setup details can be found in Ref. [3]. A 100.0 μg/cm^2 thick ^{238}U target with 10 μg/cm^2 carbon backing is used in this experiment. Both fission fragments are detected using two position-sensitive multi-wire proportional counters (MWPCs) as stop and two PPAC as start detectors. Two LaBr$_3$(Ce) detectors are used to measure the high energy γ-rays emitted due to de-excitation of FFs, mounted in thin window stain-less steel cups. Both LaBr$_3$(Ce) detectors are positioned at 18.2 cm and 15.9 cm from the target and the corresponding angles are 120° and 150°, respectively with respect to the beam direction. The time and energy calibration of detectors are also carried out. The coincidence data

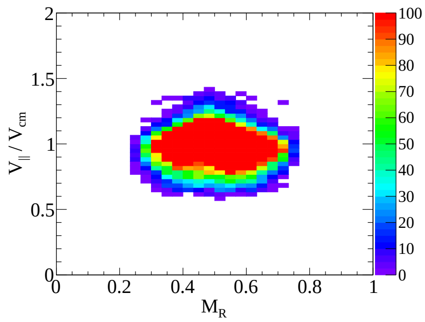

FIG. 1: Two dimensional distribution of FFs mass ratio(M_R) and parallel component of velocity($V_{\parallel}$) normalized with respect to center-of-mass velocity(V_{cm}) at beam energy of 161.1 MeV.

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has been recorded in a list mode using using a VME based LAMPS data acquisition system [4].

Results and Discussion

In the analysis, kinetic energy loss corrected of fission fragments mass distributions are obtained from the position spectrum measured by MWPC. In order to find out the fragments masses, we have applied the conservation law for momentum and mass with the assumption that mass of the composite system is equal to the sum of the projectile and target masses. The two dimensional distribution FFs mass ratio(MR) and parallel component of velocity normalized with respect to center-of-mass velocity at beam energy of 161.1 MeV is shown in Fig. 1. The projected mass spectrum is shown in Fig. 2. The fission fragment mass ratio distribution is centred about 0.5 for the symmetric fission and the sigma of the mass distribution ($\sim$ 26.6 u) compares well with that ($\sim$26.1u) for the system ^{30}Si +^{238} [5]. So both $V_{\|}/V_{cm}$ (centered around 1.0) and the mean value of mass distribution indicate that in most of the time the compound nucleus undergoes a symmetric full momentum transfer fission.

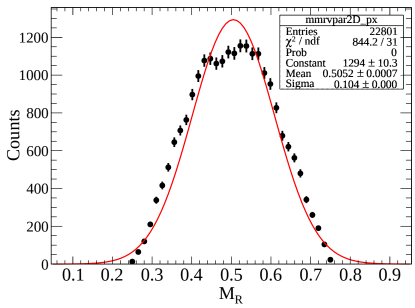

FIG. 2: Projected FFs mass ratio(MR) at beam energy of 161.1 MeV fitted with Gaussian distribution(red line).

The γ-rays energy spectra are obtained gated with prompt gamma peak in the time-of-flight spectrum of LaBr$_3$(Ce) detector measured with respect to pulsed beam. The measured gamma rays are energy calibrated and efficiency corrected. The integrated number

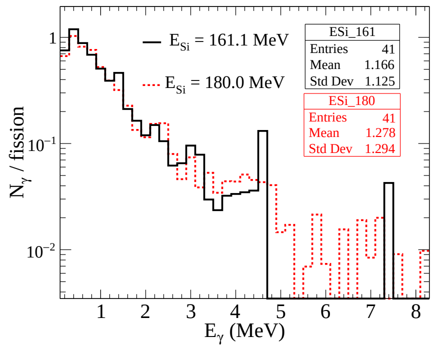

FIG. 3: Number of γ-rays per fission emitted in coincidence with the FFs at beam energies of 161.1 MeV and 180.0 MeV.

of photons(in the range of 0.1 to 10.0 MeV) emitted per fission are $\sim$5.95 and $\sim$6.04 for for beam energies of 161.1 and 180.0 MeV, respectively. The mean energies of γ-rays are found to be 1.16 and 1.27 MeV for beam energies of 161.1 and 180.0 MeV, respectively. It is observed that the mean energy of γ-rays is found to be independent of the excitation energy. The number of γ-rays emitted from the CN($^{266}_{106}Sg$) formed due to ^{28}Si+^{238}U reaction is estimated from the GEF code [6]. The experimental results and its comparison with statistical model calculation will be presented.

Acknowledgments

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