Investigation of entrance channel effect on fusion-fission dynamics of ^{208}Rn

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Introduction

Nuclear reaction serves as a tool to study the collective behaviour of atomic nucleus. Heavy ion fusion reaction is widely explored to produce Super Heavy Element (SHE). It is a two-step processes where the projectile and target fuses together to form highly excited compound nucleus. Depending on several factors, compound nucleus formed may either undergo fission or may emit light particles or gamma rays to form an evaporation residue (ER).

As one proceeds towards heavy mass region, it is observed that compound nucleus formation is hindered by the non-equilibrium mode of fission, known as quasifission. Entrance channel mass asymmetry has greater impact on deciding the post capture dynamical evolution of the nuclei. Past studies has shown that the quasifission process is more dominant for a symmetric entrance channel compared to an asymmetric one [1, 2]. Additionally, several studies have reported an enhancement in the formation of ERs due to dissipation [3]. To gain a deeper understanding of these effects on the dynamics of fusion-fission process, N. Kumar *et al.* [2], measured pre scission neutron multiplicities. In their study, the compound nucleus, ^{208}Rn, was populated via two reactions: ^{30}Si + ^{178}Hf and ^{48}Ti + ^{160}Gd .

ERs are considered a definitive indicator of fusion, as their formation requires the nuclei to pass through the compound nucleus (CN) phase. Therefore, the ER and ER-gated spin distribution undoubtedly provides valuable information about the aforementioned effects on the dynamics of fusion-fission process [4, 5]. In this work, we aim to provide additional insights into the mechanisms governing the process and to address complete fusion-fission dynamics by measuring ER and ER-gated spin distributions for the same reactions as were used in the study by N. Kumar *et al.*[2]

Experimentail Details

The experiment was performed using the heavy ions accelerated by 15UD Pelletron + Superconducting LINAC at Inter University Accelerater Centre, New Delhi. Beams of ^{48}Ti and ^{30}Si were pulsed to provide the width of ~1 ns with the separation of 250 ns and 2 μs respectively. Isotopically enriched thin targets of carbon (~25 μg/cm^2) backed, ^{160}Gd(~220 μg/cm^2) and ^{178}Hf (~130 μg/cm^2) were bom-

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barded with ion beams at 9 diferent energies. The energies ranged from around the Coulomb barrier to 20% above the barrier.

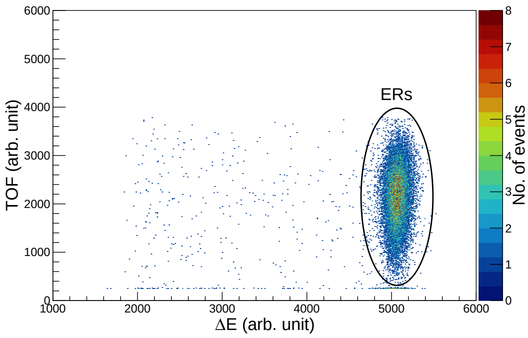

FIG. 1: 2-D plot showing ΔE vs TOF for ^{48}Ti + ^{160}Gd at beam energy 208 MeV .

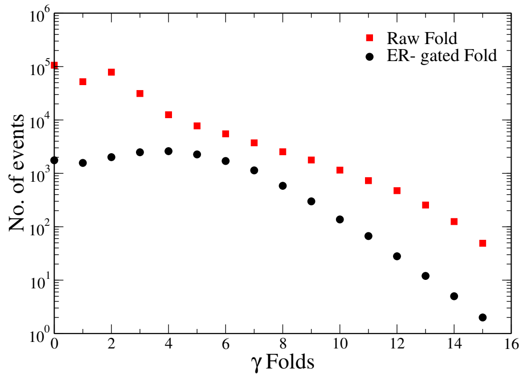

FIG. 2: γ folds for ^{48}Ti + ^{160}Gd at beam energy 208 MeV .

ERs were separated from other elements using the gas-filled separator, HYbrid Recoil mass Analayzer, HYRA [6]. Magnetic fields and the gas pressure of HYRA was optimised to attain the maximum transmission of ERs to the focal plane at each energy. The ERs were detected using position sensitive multiwire proportional counter (MWPC) located at the focal plane of HYRA.

For spin distribution measurement, γ rays emitted by ERs were detected using the TIFR 4π spin spectrometer. It consists of 32 NaI(Tl) scintillation detectors arranged in soccer-ball geometry, surrounding the HYRA target chamber. Out of 32 detectors, 3 were taken out to accommodate beam entrance and exit ports and the target ladder. The total solid angle covered by the 4π multiplicity array was ∼86% [7].

Discussions & Conclusion

A 2-D plot between the energy loss (ΔE) and time of flight (TOF) of ERs is shown in Figure 1. The plot shows the clear separation of ERs from other possible scattered particles reaching the focal plane. Figure 2 shows both raw γ folds and ER-gated folds. Initial analysis suggests that the outcome of fusion process depends on the specific choice of entrance channel. Detailed analysis is in progress and preliminary results will be presented during the symposium.

Acknowledgments

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