ER Gated light particle spectra at various energies to study the entrance channel effect due to mass asymmetry

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Introduction

The fusion hindrance effect for the mass symmetric systems having energy less than 10 MeV/nucleon has been extensively studied in the past [1]. The relevance of this effect has been observed at energies much above barrier hitherto and it is suggested hypothetically that it should be absent at near barrier energies. But no study has been performed so far to either prove or disprove the same. Considering the limited data present in this domain, a comprehensive study was proposed and recently carried out at Inter University Accelerator Center (IUAC), New Delhi.

For this study, systems selected are $^{16}O+^{64}Zn$ (mass asymmetric) and $^{32}S+^{48}Ti$ (mass symmetric), both populating the same ^{80}Sr evaporation residue (ER). Both these systems have been broadly studied before at above barrier energies, which showed that for mass symmetric systems the experimentally observed particle spectra could be explained only by the inclusion of dynamical effects [2,3]. But contrary to that when the cross sections for these systems were experimentally measured, the observations were reproduced theoretically by Time Dependent Hartree-Fock calculations [4] without including the contribution due to dynamical effects.

In the present case, both the systems were studied at various energy points at near as well as above barrier energies, by either matching the excitation energy (E*) or the maximum angular momentum (l) values. For $^{16}O+^{64}Zn$, the energy points selected are 45 MeV, 59 MeV and 89 MeV; whereas for $^{32}S+^{48}Ti$ the energy points are 85 MeV, 94 MeV and 125 MeV.

Experimental Details

The experiment for the same was performed using the General Purpose Scattering Chamber (GPSC) at IUAC. For this experiment, a special MWPC/ER (Multi-Wire Proportional Counter/ Evaporation Residue) detector was designed with three electrode geometry, which was kept at highly forward angles to detect the ERs obtained. The active region of this detector was 2°-10°, which is good enough for our experimental requirements, as the probability of ERs being

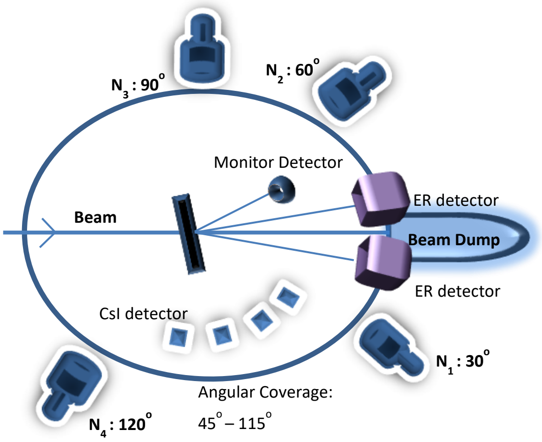

Fig. 1 Experimental Setup

formed is maximum in that region only. The ERs detected will be used to obtain the exclusive particle spectra. Along with this, 16 CsI crystals were used with an angular coverage of 45°-115° to detect the light charged particles and 4 neutron detectors at angles 30°, 60°, 90° and 120° were used to get the neutron spectra. Detailed experimental setup used is shown in Fig. 1.

Preliminary Analysis

The ER spectra, as obtained from the MWPC detector by plotting ER energy (which is obtained from the anode signal by using MPD-4 module) versus ER time of flight (TOF) for the system $^{32}S+^{48}Ti$ at 125 MeV are shown in Fig. 2(a). These spectra are gated by the neutrons obtained to reduce the spurious events. Relatively clean spectrum is obtained after gating, as could be seen in Fig. 2(b)

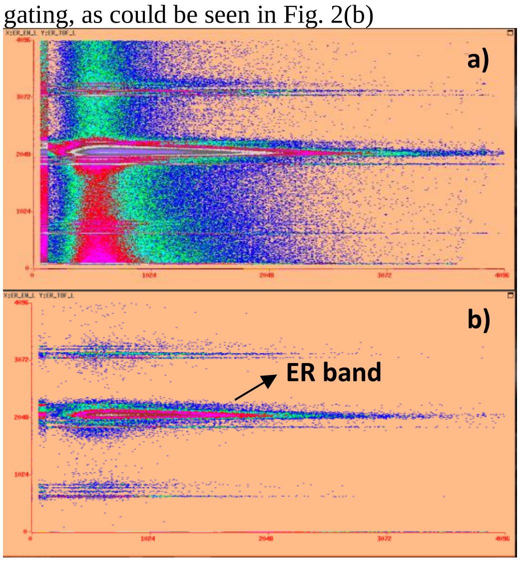

Fig. 2 ER spectra obtained from MWPC detector for $^{32}S+^{48}Ti$ at 125 MeV. a) Ungated b) Neutron gated.

The ER band obtained from these spectra are taken and the charged particle and neutron spectra are gated to get the ER gated spectra. The 2D neutron spectra are obtained by plotting PSD v/s TOF while the charged particle spectra are obtained by plotting PID v/s long shaping time of CsI (Fig. 3).

Here, PID is defined as:

$$\text{PID} = \frac{\text{Long Shaping Time} - \text{Short Shaping Time}}{\text{Long Shaping Time}}$$

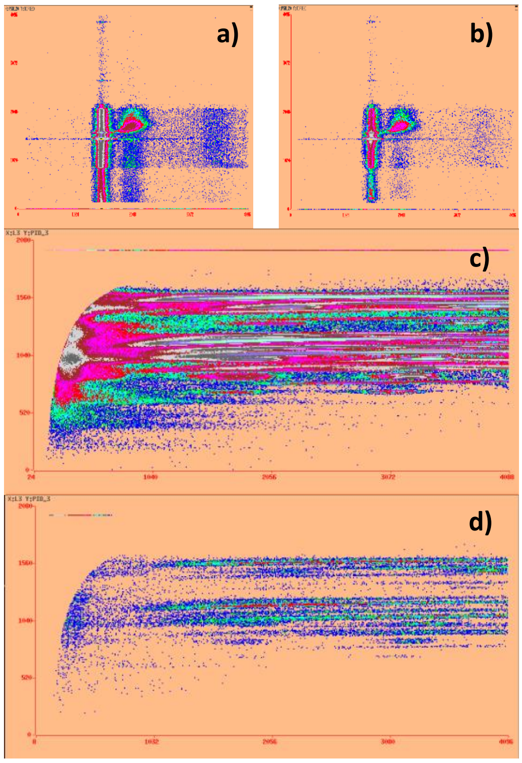

Fig. 3 a) Ungated Neutron Spectra, b) ER gated Neutron spectra, c) Ungated Charged particle spectra and d) ER gated charged particle spectra. (Refer text for more information)

Similarly, the spectra for $^{16}O+^{64}Zn$ at 89 MeV can be obtained.

Analysis of the experimental data to obtain the neutron as well as charged particle spectra is yet to be proceeded with, as it was carried out only few days back. The exclusive as well as inclusive light charged particle as well as neutron spectra will be obtained and presented during the conference.

References

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