Study of fission dynamics in $^{32}S + ^{184,186}W$ reactions using Neutron Multiplicity as a probe

Prashant N. Patil[1],* N. M. Badiger[1], B. K. Nayak[2,3], P. C. Rout[2,3], A. Pal[2,3], G. Mohanto[2], S. Santra[2,3], D. Chattopadhyay[2,3], K. Mahata[2,3], R. G. Thomas[2,3], N. Madhavan[4], M. M. Hosamani[1], A. Vinayak[1], S. P. Behera[2,3], A. Kundu[2,3], R. Gandhi[2], S. De[2], E. T. Mirgule[2], R. Kujur[2], and V. D. Bharud [5]

[1]*Department of Physics, Karnatak University, Dharwad - 580003, INDIA*
[2]*Nuclear Physics Division, Bhabha Atomic Research Centre, Mumbai - 400085, INDIA*
[3]*Homi Bhabha National Institute, Anushaktinagar, Mumbai - 400094, INDIA*
[4]*Inter University Accelerator Centre, Aruna Asaf Ali Marg, New Delhi - 110067, INDIA and*
[5]*Department of Physics, Savitribai Phule Pune University, Pune- 411007, INDIA*

Introduction

Study of fission dynamics has been current area of research due to strong singature of entrance channel effects in experimental observations such as in mass distributions and particle multiplicities. Among many probes the pre-scission neutron multiplicity (ν_{pre}) is one of the prominent probe to study the fission dynamics. Measured excess ν_{pre} values compared to the standard statistical model predictions indicates the dynamical behaviour of nuclear fission. Shell effects have been played a crucial role in the study of fission dynamics. It is reported that a nucleus with shell closure configuration has high binding energy which lowers the probability of particle emission and in the same time nucleus with shell closure configuration has high fission barrier, which enhance the probability of particle emission. Investigations have also reported weaker dissipation for a shell closed nucleus compared to the adjacent non-shell-closed nuclei.

In the present work our aim is to measure the mass−gated neutron multiplicity for $^{32}S + ^{184,186}W$ reactions forming the fissioning nuclei $^{216,218}Th$. In above reactions, out of two fissioning nuclei, ^{216}Th has shell closure (N=126) configuration while the other one ^{218}Th is non-shell-closed nucleus. Besides, the present investigation would also facilitate to study the fission fragments (FF) mass distribution in these reactions. In the present paper, we report some of the preliminary results of the analysis.

*Electronic address: prashant.patil0032@gmail.com

Experimental Details

The reaction on $^{32}S + ^{184}W$ system for 180 MeV beam energy and $^{32}S + ^{186}W$ system for 171 MeV and 180 MeV beam energies were carried out using BARC−TIFR Pelletron+LINAC facility. Pulsed beam of ^{32}S with a repetition rate of 106 ns from 14 UD Pelletron+LINAC accelerator was bombarded on $^{184,186}W$ targets of thickness 300 μg/cm^2 and 100 μg/cm^2 respectively. Two 5 cm × 5 cm single sided silicon strip detectors (S1, S2) were used to detect the fission fragments. Each of these detectors have 16 strips and were placed at a distance of 10 cm and 12.6 cm from the target on moveable arms on either sides of the beam axis at angles of 66^0 (S1) and 75^0 (S2) respectively with respect to beam direction to enable the detection of both the complimentary fragments simultaneously. The timing signals from the S1 and S2 were used to obtain the TOF of the fission fragments. An array consisting of 14 liquid scintillators (5 inch dia and 2 inch thick) [1] was used to determine neutron energy by measuring time of flight (TOF). The liquid scintillator detectors were kept at a distance of 70 cm from the target. Pulse shape discrimination (PSD) technique was used for n-γ discrimination. Detector thresholds were adjusted to 120 keV $\gamma - ray$ energy using ^{137}Cs and ^{60}Co

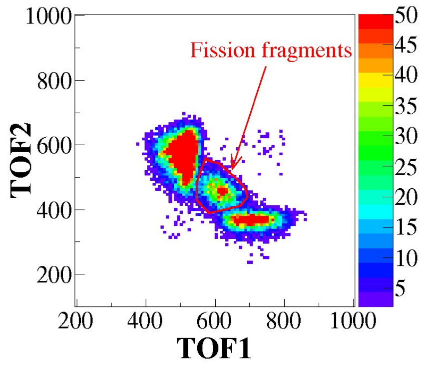

FIG. 1: Timing correlation spectrum obtained from silicon strip detectors.

sources. The filtered RF (logical OR of the two fission fragments AND-gated with RF of the beam) was used as the trigger of the data acquisition system. VME based data acquisition using LAMPS software was used to acquire data in list mode.

Results and Discussion

A typical timing correlation spectrum obtained from S1 and S2 has been shown in FIG. 1. The timing correlation corresponds to the FF in the above spectrum is shown by a red arrow line. Applying time difference method [2] the mass distribution for the reaction $^{32}S + ^{184}W$ at 180 MeV is obtained when one of the fission fragment is detected only in 5^{th} strip (81^0), 6^{th} strip (79^0), 8^{th} strip (75^0), 9^{th} strip (73^0) and 10^{th} strip (71^0) of S2 detector and other fission fragment is detected in any strip of S1 detector among its 16 strips. The mass distribution thus obatained is shown in FIG. 2.

Energy spectra of neutron detected in 79^0 and 143^0 angles are obtained by putting gate of FF detected in 8^{th} strip (75^0) and 16^{th} strip (60^0) of S2 detector respectively and is shown in FIG. 3. In FIG. 3 black squares (red circles) corresponds to the spectra of neutrons emitted in forward (backward) angle with respect to fission fragments. The pre-scission and post-scission neutron multiplicity will be extracted from moving source fit method. More detailed analysis is in progress.

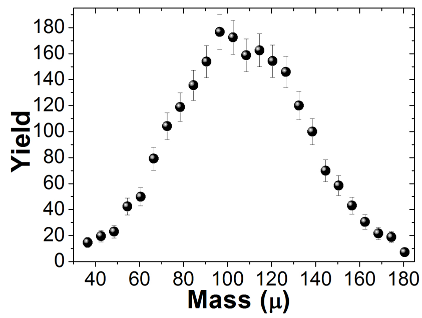

FIG. 2: Mass distribution of $^{32}S + ^{184}W$ reaction at 180 MeV.

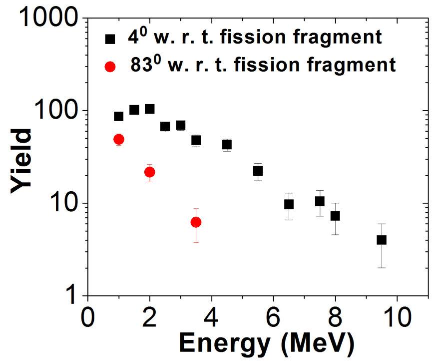

FIG. 3: Energy spectrum of neutron emitted in 4^0 and 83^0 with respect to fission fragment.

Acknowledgments

Authors wish to thank Pelletron+LINAC facility staff of the BARC-TIFR, Mumbai for the smooth running of the accelerator during the experiment. Authors wish to thank IUAC, New Delhi for providing targets to the experiment.

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