# Investigation of fission reaction dynamics and neutron multiplicity in the mass region ~ 200

Savi Goyal[1,*], S. Mandal[1], P.Sugathan[2], K.S.Golda[2], Akhil Jhingan[2], Sunil Kalkal[1],Varinderjit Singh[3],Davinder Siwal[1], Ritika Garg[1],Maninder Kaur[3], Mansi Saxena[1],S. Verma[1], Suresh Kumar[1],Mohini Gupta[4], Subinit Roy[5], B.R.Behera[3], R. Singh[6]

[1]*Department of Physics & Astrophysics, University of Delhi-110007.*
[2]*Inter University Accelerator Centre, New Delhi..*
[3]*Department of Physics, Panjab University, Chandigarh.*
[4]*Manipal University, Karnatka*
[5] *Saha Institute of Nuclear Physics, Calcutta*
[6] *AINST, Noida*
* *email: savi.november@gmail.com*

## Introduction

It is a well established fact that the fission process in hot nuclear systems is strongly hindered relative to expectations based on a statistical model description of the process [1]. Measurements of neutrons, charged particles, and $\gamma$-ray multiplicities in various fission systems have already been performed and have shown unexpected enhanced particle emission occurring prior to scission with increasing excitation energy. It has been found that the reason why the statistical model fails to interpret the enhancement of pre-scission particle emission is that it does not consider dissipation in the fission process. Shell effects play an important role in determining the nuclear structure, and the related information of the shell effects in the fission process is valuable. Nuclear dissipation has a possible relation with neutron closure shell.

Here the experiment was performed to find neutron multiplicity [2] and neutron angular distribution for $^{16}$O + $^{204,206,208}$ Pb systems. Present study, revolves around the effect of shell closure of projectile and target on the neutron multiplicity near and above the Coulomb barrier. $^{208}$Pb is closed shell nuclei, and on the other hand, $^{206,204}$ Pb has two and four nucleons less than the closed shell respectively, which allows us to investigate the effects of shell closure on the neutron multiplicity.

## Experimental Setup

The experiment was performed with pulsed $^{16}$O beam having a repetition rate of 250 nsec using National Array of Neutron Detectors (NAND) at Inter University Accelerator Centre (IUAC), New Delhi. The targets used were isotopically enriched $^{204,206,208}$Pb of thickness ~ 1.5 mg/cm$^2$ (self-supporting ), prepared at target lab of IUAC. In the chamber of NAND, two Multi-Wire Proportional Counters [3] (MWPC) of active area 20×10 cm$^2$ were placed at the folding angles (70$^o$ and 80$^o$) for the detection of fission fragments. The distance of these detectors from the target was 19.7 cm. Two silicon surface barrier detectors were also placed at ±16$^o$ with respect to beam direction for monitoring purposes. Inside view of the chamber is shown in the fig.1.

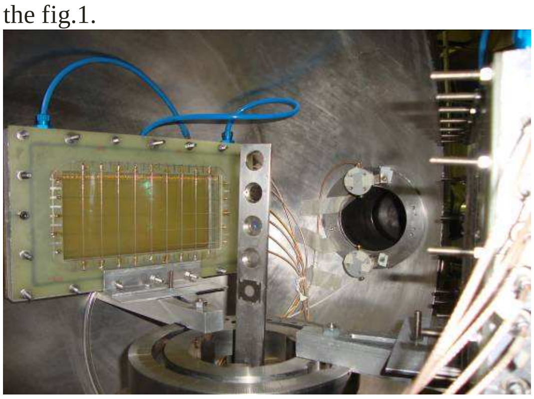

**Fig.1** Inside view of the NAND chamber

For neutron detection, twenty four liquid scintillator detectors were used, out of which 16 were in reaction plane and 8 were placed at $\pm 15^{o}$ with respect to the reaction plane. Among the detectors which were placed in plane, eight were at a distance of 2 meters and remaining eight were at a distance of 1 meter from the target. The threshold and gain settings of pulse shape discrimination modules [4] were done by using $^{137}$Cs source. The timing information (TOF) was obtained with arrival of particles at MWPC anded with RF as start and neutron as stop. The measurements were performed for the systems $^{16}$O+$^{204,206,208}$Pb from 90 MeV to 120 MeV (in lab) in steps of 6 MeV ($E^*_{CN}$ = 40 to 64 MeV).

## Results

One dimensional spectra of time of flight (TOF) for $^{16}$O + $^{208}$Pb at 119.3 MeV is shown in Fig.2. This detector was placed at a distance of 2 meters from the target, and it clearly shows the well separated peak for neutron and gamma particles.

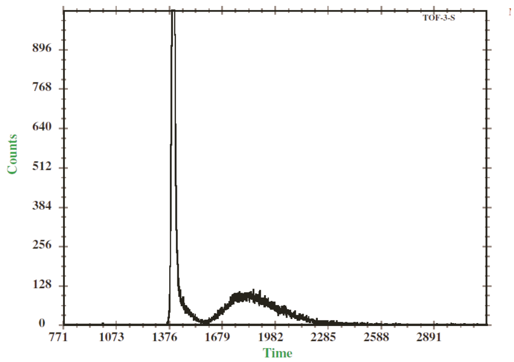


**Fig.2** TOF spectrum for n-γ separation for $^{208}$Pb at 119.3MeV

Fig. 3 shows a two dimensional plot between the X-positions of both the MWPC's placed at folding angles. A two dimensional plot was generated from the energy and the timing signal of the MWPC which helps to separate the fission fragments from the elastic and target like particles(fig.4)

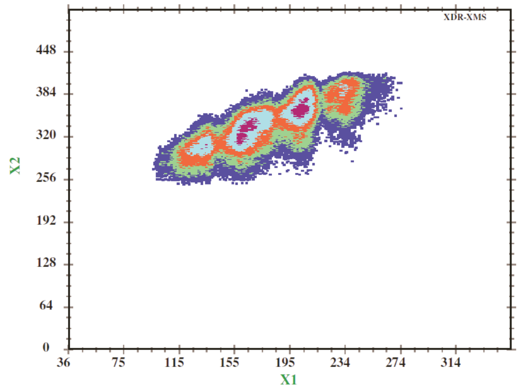


**Fig.3.**Two dimensional spectrum of X-position of both MWPC's

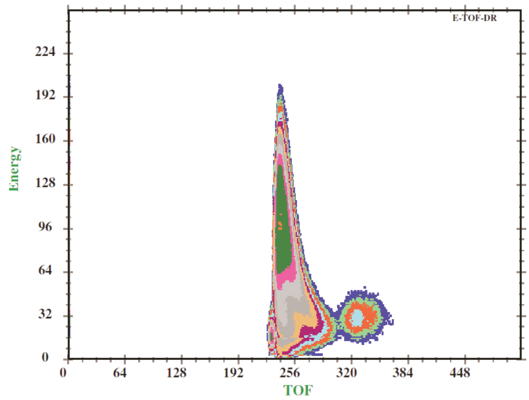


**Fig. 4** Two dimensional plot between energy and time of flight of MWPC.

Further Analysis is in progress.

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## References

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