# Evaporation Residue studies for the $^{16}$O + $^{208}$Pb and $^{18}$O + $^{206}$Pb systems

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## Introduction

It is well known that the nuclear dynamics at different stages of fusion-fission process can be understood using heavy ion reactions. The dynamics of a fused system can be studied by measuring neutrons, charged particles, high energy gamma radiations and evaporation residues (ERs). It is also known that the excess of pre-scission particles in comparison with standard statistical model predictions indicates that the fission process in heavy ion reaction is delayed. Frobrich et al. [1] pointed out that evaporation residues (ERs) are the most sensitive probes for studying the dynamics of fusion-fisson process. The hindrance in nuclear fission process due to nuclear viscosity leads to enhancement of evaporation residues, with higher spin values. Therefore, measurements of ER cross sections and spin distributions would, undoubtedly, provide information on nuclear viscosity of nuclear fluid at high excitation energies. Already two groups [2, 3] have measured the ER cross sections of $^{224}$Th and found that measured data not only disagree with one another but also observe unpredicted oscillating nature at higher excitation energies. In view of these, we have undertaken this work. The objective of which is to understand fission hindrance in $^{224}$Th by measuring ER cross sections and spin distributions. To understand the role of excess two neutrons in ER cross sections and spin distributions, the highly excited $^{224}$Th compound nucleus was formed using $^{18}$O + $^{206}$Pb system in addition to $^{16}$O + $^{208}$Pb system.

## Experimental techniques

The ER measurements were carried for above mentioned systems using the gas filled mode of HYbrid Recoil mass Analyzer (HYRA) coupled with 4$\pi$-spin spectrometer of TIFR at IUAC, New Delhi [4, 5]. The $^{16}$O and $^{18}$O pulsed beams were provided by the 15UD Pelletron accelerator and the first module of the LINAC accelerator at IUAC. The measurements of $^{16}$O + $^{208}$Pb system, were carried out for the energies ($E_{Lab}$) from 108 MeV to 125 MeV with 4$\mu$s pulse separation. For $^{18}$O + $^{206}$Pb system, after ensuring no contamination of beam and target like particles in the ER spectrum (fig. 1), we reduced the pulse separation from 4 $\mu$s to 2 $\mu$s in order to improve the intensity of $^{18}$O beam. The ER cross sections and spin measurements of de-exciting $^{224}$Th formed by $^{18}$O + $^{206}$Pb was also carried out at the same excitation energies as the previous system by adjusting

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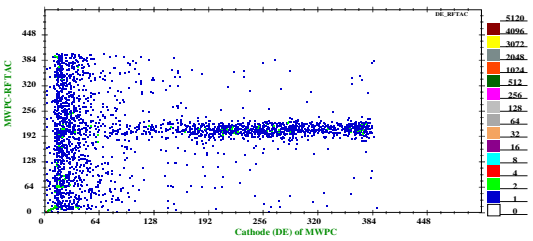


FIG. 1: Two dimensional ER spectrum for $^{16}$O + $^{208}$Pb system at 125 MeV .

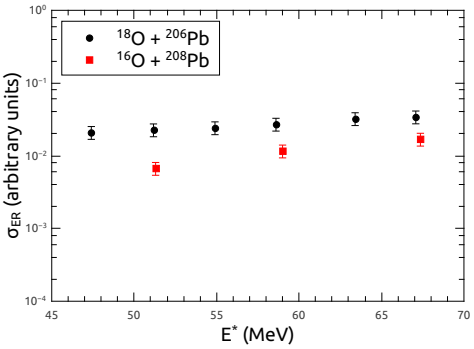


FIG. 2: Preliminary ER cross sections (in normalized arbitrary units) for $^{16}$O + $^{208}$Pb and $^{18}$O + $^{206}$Pb systems.

beam energies in the laboratory system from 103 MeV to 124 MeV. The remaining low energy range part near to the Coulomb barrier for both systems will be carried out with only Pelletron beams at IUAC, New Delhi, later.

## Preliminary results

The ER cross sections and ER spin distributions have been measured using HYRA coupled with 4$\pi$ spin spectrometer. Preliminary ER cross sections (in normalized arbitrary units) as a function of excitation energy (E$^*$) in MeV for both systems is shown in fig. 2. From the figure we notice that the ER cross sections of $^{18}$O + $^{206}$Pb system are higher than for $^{16}$O + $^{208}$Pb system. It indicates that the two neutrons may play significant role in the fusion-fission process. As experiment has been done recently the data analysis is in progress with regard to determination of efficiency of HYRA and 4$\pi$ spin spectrometer for these systems. The typical spectrum of ER-gated gamma fold distribution for $^{16}$O + $^{208}$Pb at 125 MeV lab energy is shown in fig. 3. Such data will be used for determination of spin distributions of ER. The data analysis is in progress.

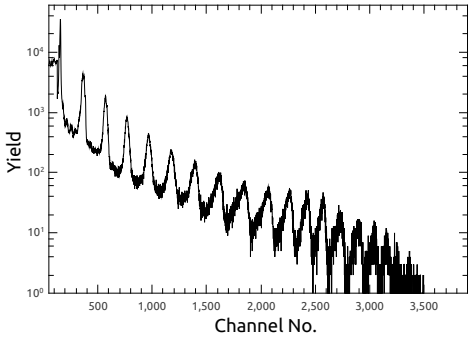


FIG. 3: ER-gated gamma fold distribution for $^{16}$O + $^{208}$Pb system at 125 MeV (Lab energy).

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