Proton induced fission of ^{232}Th at E_p=14 and 23 MeV

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Introduction

The history of fission research started over 75 years ago with the discovery of neutron-induced fission of uranium. From that time onward neutron and charged particle induced fission of actinides has been the subject of both fundamental and applied studies. In the past, tremendous effort has been put into studies of low energy actinide fission because of the particular importance of this process for nuclear energy applications. Nowadays, there is an increasing interest in studying nucleon-induced fission of actinides at intermediate energies, i.e., between 20 and 200 MeV due to worldwide interest in accelerator-driven systems (ADS) for nuclear applications. Such systems consist of subcritical reactors driven by neutrons produced in a spallation subactinide target irradiated with energetic protons. This spallation process produces also energetic secondary protons which will still significantly contribute to the overall induced reactions. Neutron- and proton- induced reactions in this energy range are among the very important ones for the ADS design [**?**]. The most probable process resulting from these reactions is fission, which will be accompanied by non-negligible pre- and post-scission neutron emission which will surely affect the subcriticality aspect of the proposed ADS reactor. Therefore, it is important to study neutron multiplicities and compare them with evaluations and predictions presently used for establishing the subcriticality concept and criteria of a reactor design. We have a program to measure prompt fission neutron spectrum in neutron and proton induced fission of U and Th isotopes. Here we report our measurements on the prompt fission neutron spectra in ^{232}Th fission induced by proton at energies 14 and 23 MeV

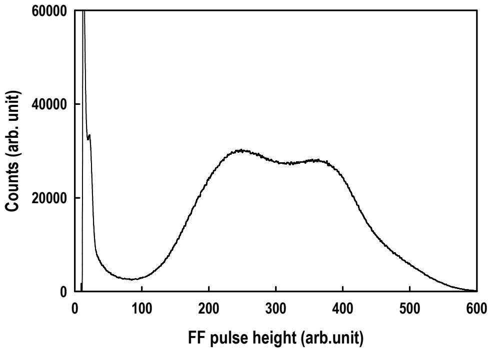

FIG. 1: Typical fission-fragment (FF) pulse height spectrum.

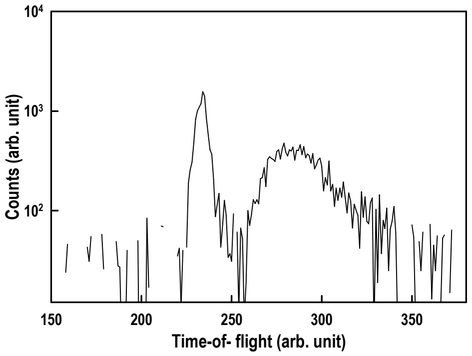

FIG. 2: Time of flight spectrum in p+^{232}Th reaction at 14 MeV.

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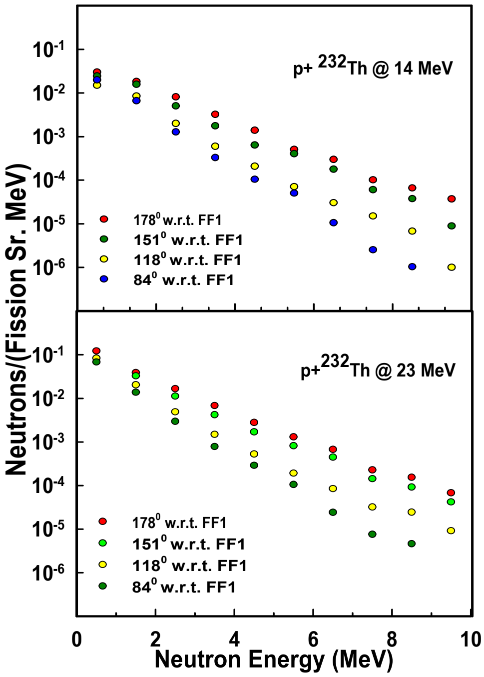

FIG. 3: Measured neutron energy spectra.

Experimental Details and Data Analysis

The experiment was performed using a proton beam, obtained from the Bhabha Atomic Research Centre-Tata Institute of Fundamental Research 14UD Pelletron accelerator. A self-supporting thin metallic foil of ^{232}Th of thickness 2.3 mg/cm^2 was used as the target. Measurements have been carried out at two bombarding energies 14 MeV and 23 MeV of proton. Two silicon surface barrier detectors F_1 (450mm^2) and F_2 (50mm^2) were placed at backward angles of 150° and -123° respectively. A thin-walled (3 mm) scattering chamber was used to minimize multiple neutron scattering. A typical fission-fragment spectrum in obtained in p+^{232}Th fission reaction at 14 MeV is shown in Fig.1. The neutrons emitted in the treaction were detected by four NE213 neutron detectors (2 inch thick and 5 inch in diameter) positioned outside the scattering chamber at a distance of 1.0 meter from the target. The neutron detectors N1,N2,N3,N4, subtends an angles of 180°,151°,118°, 84° w.r.t. fission detector F1 and 94°, 67°, 34°, 180° w.r.t. fission detector F2 respectively. A pulse shape discrimination technique is used to discriminate neutron and gamma rays in the neutron detector. The neutron energy has been measured using time of flight(TOF) technique. The TOF signal of each neutron detector was obtained with reference to the start pulse derived from either of the two fission detectors. A typical TOF spectra after subtracting the contribution from the random coincidences is shown in Fig.2. The time calibration was done using a precision time calibrator. The position of the gamma-ray peak in the TOF spectrum was used as the reference for calibrating the TOF spectrum.

Results and Discussion

The laboratory neutron energy spectra were determined from the observed TOF spectra after correcting for the neutron detection efficiency for each neutron detector. Typical neutron energy spectra are shown in Fig.3. In the further analysis of the present data, the observed neutron energy spectra will be fitted with three moving-source evaporation components (the prescission component corresponding to emission from composite nucleus and the postscission components corresponding to emission from the two fission fragments) to obtain the prescission and postscission neutron components. Detailed analysis being carried out and presented during the symposium.

Acknowledgments

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References

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