New Detector Development for NAND: Silicon strip detector, MWPC and CsI

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Introduction

National Array of Neutron Detector (NAND) is a versatile facility used for fusion-fission studies at IUAC. We are presenting the developement of new detector systems in NAND for the exploration of advanced reaction mechanisms, such as; transfer induced fission, evaporation residues (ER)/fission gated charge particle and neutron multiplicity. Silicon strip detectors (SSD) based detector systems along with readout electronics have been developed for the detection of transfer products. An upgrade has been done on previously used multi-wire proportional counters (MWPC) used for ER gated charge particle multiplicity measurement in GPSC [1]. In this work, characteristics and performance of detector setups are discussed.

Silicon strip telescope detector setup

The SSDs telescope systems are developed for the investigations of multi-nucleon transfer induced fission. Two sets of telescoped detector were prepared. All the four Si strip detectors (Model-W, Micron Semiconductor) having an active area of 5 × 5 cm^2 were used. Each telescope detector is designed in a $\Delta E - E$ configuration, with a 40 µm thin detector used for ΔE measurement and a 300 µm thick detector for E. For signal transmission, special multi-pin cables compatible with FRC34 connectors (in SSD and feed-through flange) and D-Connector (25 pin) for MPR-32 units were also fabricated. Mesytec preamplifier MPR-32 units were utilized to process 16 vertical strips from the front detector (Δ E) and 16 horizontal strips from the back detector (E) for X and Y position extraction, respectively. Preamplifier signals were processed using STM16+ spectroscopy amplifier units, and data was collected using VME-based data acquisition system.

FIG. 1: Transfer induced fission setup at NAND.

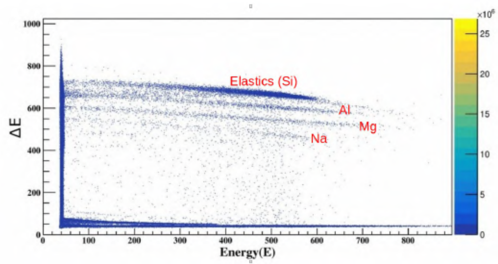

FIG. 2: ΔE-E spectrum for the system ^{28} Si + ^{232} Th, showing different transfer channels .

FIG. 1 showing the transfer induced fission setup. The performance of setup was evaluated using a radioactive alpha source (^{229}Th), where a resolution of 65 keV was observed for the 8.37 MeV alpha particle. Further a transfer induced fission measurement was carried out for the system ^{28}Si + ^{232}Th at 190 MeV with the Pelletron + LINAC facility. Two

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FIG. 3: Schematic of CsI and MWPC setup at NAND.

SSD telescope were placed at the grazing angle of 80 degree on either side of beam direction to capture beam like transfer product and two large area MWPC were also mounted at the folding angle to capture fission events in coincident with transfer events. For the Z identification, scatter plot of Δ E against E for the above system is shown in Fig 2. Various transfer channels were identified in the experiment.

CsI detector and MWPC setup

Two MWPCs that were previously utilised in GPSC for ER measurements were modified and installed at forwards angles in the NAND chamber. The wire pitch of the X electrode was reduced from 1.27 mm to 0.63 mm in order to increase the signal strength, and an earlier wire-based central electrode was replaced with an alluminized Mylar foil. The detectors were setup at 45 cm away from the target, covering ERs from 4 to 15 degrees.

16 CsI detector having active area of (2×2) cm^2 and 3 mm thick coupled to photo-diodes were also installed [2]. Special preampliers card were fabricated and attached at the back plane of the crystals. For signal transmission, coaxial cable were utilized from preamplifer to feed through flange of NAND chamber.

ER gated charge particle measurements was performed for the system ^{48}Ti+^{48}Ti. ERs were detected in MWPCs, where detectors were exposed to a high count rate of 10^5 pps along with high intensity delta rays. Light charged particle were detected in CsI array whereas 16 in plane neutron scintillation detectors of NAND were utilized for neutrons detection [FIG. 3]. FIG. 4 shows the plot displaying separation between various light charge particles.

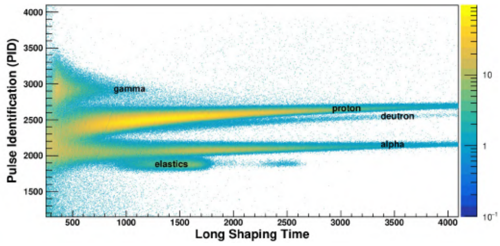

FIG. 4: CsI plot showing, different light charged particle.

FIG. 5: Setup for fission gated light charged particle experimetent.

Fission gated neutron and charge particle multiplicity measurements were also performed for the ^{12}C+^{198}Pt system with large area MWPC (20×10) cm^2 [FIG. 5]. Two MWPC were placed at folding angle of the system for fission detection in coincidence with light charge particle.

Conclusion

Design and performance of detectors was found promising in transfer induced fission, evaporation residues (ER)/fission gated charge particle multiplicity studies. SSDs have shown low noise performance with a resolution of 65 keV for 8.7 MeV alpha particles. CsI detector system was efficient in light charge Particle identification in coincidence with evaporation. MWPC effectively resolved evaporation residue from elastic particles.

References

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