Fabrication of an ionization chamber for Heavy Ion Reaction Analyzer

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Heavy Ion Reaction Analyzer (HIRA) [1] has been used extensively for studying the reaction dynamics via evaporation residue (ER) measurements [2], transfer measurements [3] and quasielastic measurements [4]. Conventionally a multi-wire proportional counter (MWPC) [5] has been used to detect the reaction products at HIRA focal plane (FP). A scatter plot between ΔE (energy loss in MWPC) and "time-of-flight (TOF)" of the particles through the separator would help in selecting the reaction products. Here, TOF refers to the time to amplitude converter (TAC) output, taking MWPC anode as START and radio frequency signal used for beam pulsing as the STOP. However, as the cross-section for the reaction channels to be measured decreases, the relative population of the background due to scattered primary beam increases. This makes identification of events of interest difficult and imposes a limit on the measurement. Therefore, a multi-anode deep ionization chamber (IC) has been recently fabricated and installed at HIRA FP behind the MWPC. This setup aims to extend the measurement limits for sub-barrier fusion, quasielastic above the barrier and to improve background rejection for unambiguous identification of transfer channels.

The detector has a cylinderical housing of approximately half a meter length and a matching diameter with the MWPC installed at HIRA FP [5]. The detector dimensions were decided with an intention of enabling it to fully stop the highest-energy recoils, while operating it at an optimum pressure. It has an active area of 150×50 mm^2, equivalent to

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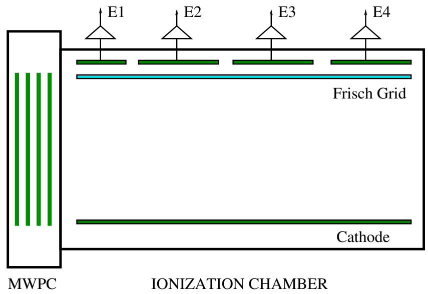

FIG. 1: Schematic diagram of the ionization chamber.

that of the preceeding MWPC, and operates with a transverse field geometry. The three electrodes realized on 3.2 mm thick G10 PCBs are cathode, Frish grid and anode. The anode is divided into four segments, with the first segment being 5 cm long and the remaining three segments each 11 cm long. Entrance window foils used for both MWPC and IC are made of mylar (0.5 micron). Fig. 1 shows a schematic diagram of the IC. The whole detector assembly can slide over linear motion rails. This makes any change in the configuration much easier.

First the 0.5 micron foils were tested for isobutane pressure up to 75 mbar in IC, 5 mbar in MWPC and a vacuum of the order 10^{-6} Torr in HIRA FP chamber. For this a dummy MWPC and the IC chamber without any electrode assembly were installed in place. Subsequently, it was tested using ^{241}Am α-particles. The detector is given a single bias through the cathode. An electric field of approximately 2 V cm^{-1} Torr^{-1} is maintained between the cathode and the Frisch grid, and 5 V cm^{-1} Torr^{-1} is maintained between the Frisch grid and the anode. Differential energy signals are collected from all four anode segments, which can be summed to provide the total energy. The IC signals are processed through indigeneously developed charge sen-

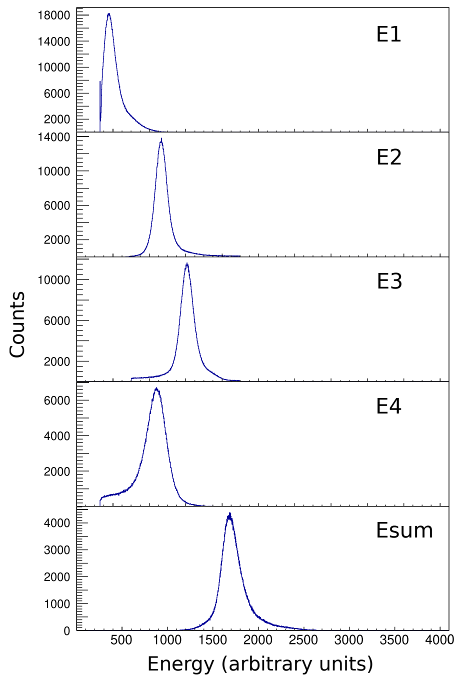

FIG. 2: Individual and sum spectra from the IC anode segments for ^{241}Am α-particles at 35 mbar.

sitive preamplifiers [6] and shaped through Mesytec amplifiers MSCF-16. Initial tests have shown that all the segments of the detector are responding and summing them a clean single peak is observed. The detector performance is tested at different gas pressures and electronic settings. Fig. 2 shows individual and sum spectra from the IC for ^{241}Am α-particles at 35 mbar isobutane pressure. It has also been tested with ^{252}Cf fission source in order to see its response for heavier ions.

The detector has also been tested for fusion and quasielastic events in a recent beam run [7]. Fig. 3 shows the two scatter plots (a) ΔE (from MWPC cathode) vs TOF and (b) E$_{Total}$ (sum of all the individual ΔE signals from the IC) vs TOF, to emphasize the capability of the IC to identify the particles of interest (target like events in this case) at HIRA FP.

Due to its increased depth, the present IC can operate at a relatively lower gas pressure and is capable of handling more energetic particles.

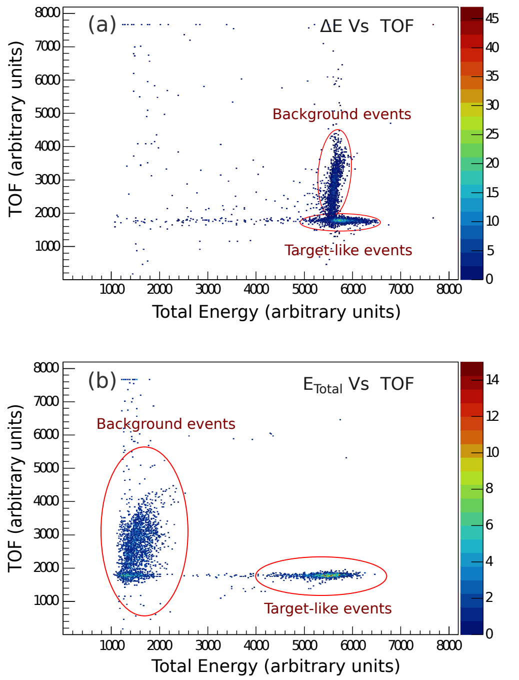

FIG. 3: Scatter plots to select target like events for ^{28}Si + ^{180}Hf at projectile energy 80 MeV (a) ΔE (from MWPC) vs TOF (b) E$_{Total}$ (from IC) vs TOF.

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