

# Response of a multistage MWPC at higher pressure for $\alpha$ -particles

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Since Charpak *et al.* introduced the MWPC for high-energy physics experiments, widely different configuration of varying sizes and geometries have been evolved over the years [1–3]. Due to fast-timing and very good position resolution, MWPCs are being used quite routinely in nuclear physics experiments, particularly in the study of heavy-ion-induced fission reactions [4]. Employing delay line method, the position information from MWPCs is obtained in the two dimensions, making them highly useful for coincidence measurements of the fission fragments in folding angle configuration in a heavy-ion induced fission reaction [5].

Technological advances made in the field of nuclear physics research, could be of potential use for condensed matter research using thermal neutrons. These experiments require a two dimensional position sensitive detector for the scattered thermal neutrons. Using a suitable converter foil at the entrance window of a multi-stage MWPC is a feasible solution for the aforesaid condensed matter research using thermal neutrons.

We are developing a position sensitive neutron detector by employing an enriched  ${}^6\text{Li}$  foil in front of the MWPC. In  ${}^6\text{Li}(n, \alpha){}^3\text{H}$  reaction,  $\alpha$ -particles of energy 2.05 MeV and tritons of energy 2.73 MeV, are produced. Owing to high cross section (940 barns) for  ${}^6\text{Li}(n, \alpha){}^3\text{H}$  reaction, this combination would provide high efficiency and very good position resolution for the thermal neutrons. Before

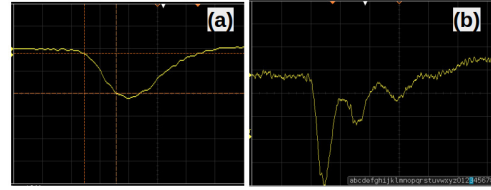


FIG. 1: Anode output pulses through fast pre-amplifier for FFs produced from  ${}^{252}\text{Cf}$  source (at 2 mbar in panel (a)) and  $\alpha$ -particle (at 35 mbar in panel (b)).

placing the converter foil, it is important to investigate the response of the MWPC for the  $\alpha$  particles of similar energies as would be produced in the aforesaid reaction. We have characterized a multi-stage MWPC (five plane geometry) for  $\alpha$ -particles emitted from a  ${}^{241}\text{Am}$ - ${}^{239}\text{Pu}$  radioactive source.

The MWPC consists of one anode wire plane, two sense wire planes ( $X$  and  $Y$ ) for position information and two cathode ( $C$ ) wire planes. The anode wire plane is placed between the  $X$  and  $Y$  planes. A pitch of 2 mm is kept in each wire plane. The orientation of the  $X$  and  $Y$  sense wire planes is orthogonal to each other. We have employed the delay-line read out method for deriving  $X$  and  $Y$  position information of the detector. The delay time between the two successive sense wires (both  $X$  and  $Y$ ) is kept 2 ns. The overall configuration of this MWPC is similar to that discussed in Ref. [4].

A  ${}^{241}\text{Am}$ - ${}^{239}\text{Pu}$  radioactive  $\alpha$ -source was mounted inside the detector at distance of 25 mm from the first cathode wire plane. It was covered by an aluminium foil of thickness 14.9

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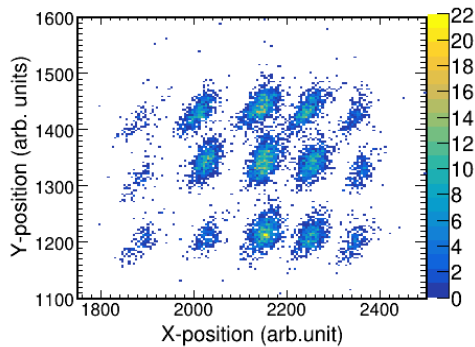


FIG. 2: A 2D position spectrum obtained while bombarding  $\alpha$  particle through a mask (see text).

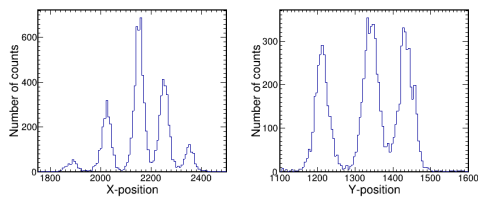


FIG. 3: X- and Y-projections of the above 2D position spectrum.

$\mu\text{m}$  so that resulting energies of emerging alpha particles are very close to the ones produced in  ${}^6\text{Li}(n, \alpha){}^3\text{H}$  reaction. The detector was placed inside a vacuum chamber. We used isobutane gas in continuous flow mode and performance was evaluated at varying gas-pressure. The aim was to look for a minimum pressure which can provide decent pulses for these low ionizing  $\alpha$ -particles (in comparison to fission fragments). The voltages to anode and cathode planes were adjusted to the maximum possible values. It is observed that decent pulses from anode, cathode, X, and Y planes are obtained at a gas pressure of 35 mbar and at this pressure applied bias voltages were kept at 820 V to the anode and 720 V to the cathode. Anode, X, and Y, signals were processed through fast amplifiers. Anode pulse for  $\alpha$  particles at this high pressure is compared with that for FFs obtained at 2 mbar pressure in Fig.1. The rise time for anode pulse is about 8 ns which is very close to

5.5 ns obtained at low pressure of 2 mbar for FFs. Interestingly,  $\alpha$ -particle pulse exhibits more ringing in the decay time as shown in Fig. 1 (a) which is absent for FFs at lower pressure (see Fig. 1 (b)). However, this ringing structure does not affect the overall performance of the counter, still it would be interesting to understand the origin of this weird structure at this high pressure.

In order to quantify the performance of the counter for  $\alpha$  particles, we measured its position resolution by placing a thin teflon mask just on top of the first cathode plane. The mask was having 5 holes in the X-direction and 3 holes in Y-direction, each of 1 mm diameter. The distance between two holes were 8 mm in both the directions. The X- and Y-signals were further processed through TFAs. The time difference between the anode signal and the X and Y signals provides the position information.

A two-dimensional position spectrum is shown in Fig. 2, exhibiting distinct spots corresponding each hole in the mask. The X and Y projections of the 2D plot are shown in the Fig. 3. One can see five and three clear peaks in the X- and Y- directions, respectively corresponding to the respective number of holes in the two-dimensional mask. A preliminary analysis yield position resolution of 2.4 mm and 2.1 mm in the X- and Y-directions, respectively. These numbers are very close to those obtained at lower pressure, around 2 mbar.

Details about the experimental setup and measurement of position resolution will be presented.

## References

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