# A time zero MWPC detector for fission TOF experiments

*A. Jhingan[1], P. Sugathan[1], K. S. Golda[1], E. Prasad[2], P. K. Rath[3], S. Appanababu[3] B. R. Behera[4], B. K. Nayak[5], S. Santra[5], A. Saxena[5]

[1]Inter University Accelerator Centre, P. O. Box 10502, New Delhi - 110067, INDIA
[2]Department of Physics, University of Calicut, Calicut 673635, INDIA
[3]Department of Physics, Faculty of Science, The M. S. University of Baroda, Vadodara 390002, INDIA
[4]Deptartment of Physics, Panjab University, Chandigarh- 160014, INDIA
[5]Nuclear Physics Division, Bhabha Atomic Research Centre, Mumbai 400085, INDIA

* email: akhil@iuac.res.in

## Introduction

A transmission type fast timing multi wire proportional counter (MWPC) has been developed for investigating fission products in a nuclear reaction. The detector has been used in combination with large area position sensitive MWPCs [1] to get absolute timing of the fission fragments and the subsequent extraction of their mass-energy distributions. The detector can be used as a trigger in multi-detector setups for measuring neutrons and gammas in coincidence with the fission fragments. As a standard practice RF signal of pulsed beam is used to measure time of flight (TOF) of the fission fragments and coincident neutrons. In such case stability of RF is very important and can drift with time and energy changes. In such cases a time zero detector can provide the time of arrival in TOF measurements.

## Description of the detector

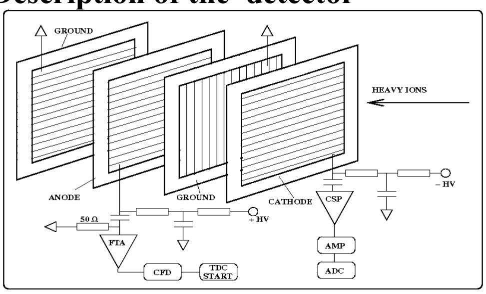


**Fig.1:** Schematic of MWPC

Fig.1 shows the schematic of the time zero MWPC. The core of the MWPC consists of four wire frames each with an active area of 3.7 x 3.7 cm$^2$. The wire frames are a cathode, a grounded wire frame, a central anode, and another grounded wire frame. The distance between adjacent wire frames is 1.6 mm. All wire frames are made from gold plated tungsten wires of 20μm diameter stretched on a 1.6 mm thick printed circuit board. The separation between adjacent wires is 0.025" (~0.63 mm). Cathode and the first ground at entrance operates in drift region whereas the anode sandwiched between two grounds operate in avalanche or proportional region. Such a design was preferred over the conventional PPAC using two parallel aluminised mylars to minimize straggling of low energy heavy ions (0.5 MeV/A in mass 100 region). Geometrical transmission of the MWPC is ~ 93%. The electrodes are housed inside a rectangular chamber milled out from a solid aluminum block. The detector is operated with iso-butane gas at pressures 2-4 mbar. To avoid straggling, entrance and exit foils used are 0.5 μm mylar. Anode is read using fast current amplifier OrtecVT120 whereas cathode is read using in-house developed charge sensitive preamplifier having a sensitivity of ~ 7 mV/MeV (Si equivalent).

## Performance

The detector was tested off-line with radioactive sources $^{241}$Am alpha and $^{252}$Cf fission fragments. For alpha detection detector was operated at 3 mbar gas (isobutane) pressure. A bias voltage of +450 V and -180 V was applied at anode and cathode respectively. As shown fig.2, signal strengths upto 300 mV with rise times ~3.5 ns were observed.

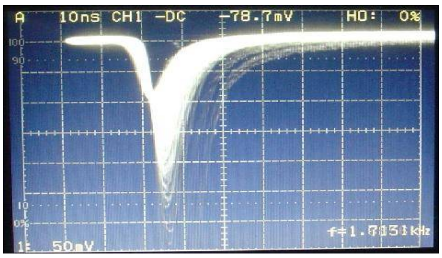


**Fig.2:** Anode signal from fast preamp

To evaluate the timing performance, TOF was setup between time zero MWPC and large area MWPC [1]. Both the MWPCs were exposed to alphas and fission fragments. Large area MWPC acts as a stop detector. The distance between two MWPCs is 15 cm. For alphas a TOF resolution of only 1.5 ns (position gated) could be achieved owing to the inferior timing response of the large area (20 x 10 cm$^2$) MWPC for alpha particles. For fission fragments (from a $^{252}$Cf source of about 5μC ), a neutron detector (BC501 liquid scintillator 5" x 5") was also placed at distance of 1m from the source to collect coincident neutrons and gammas. Both the detectors were operated at 2mbar gas pressure. TOF was also generated between start MWPC and neutron detector.

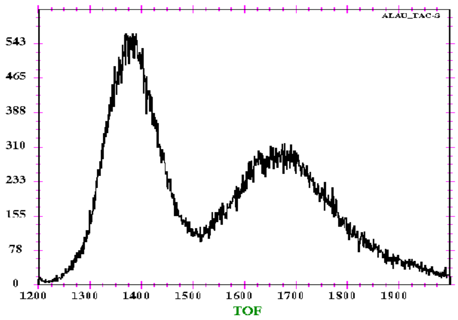


**Fig.3:** TOF spectrum of fission fragments

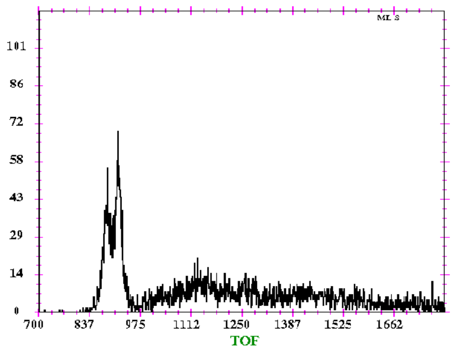


**Fig.4:** Raw γ, n TOF spectrum

Fig.3 shows the TOF spectrum for the fission fragments. Fig.4 shows the raw TOF between fission and neutron detector showing the splitting of gamma peaks due to two different groups of fission fragments. From the fragment velocity (fig.3) we correct this splitting which merges back the double peak of gamma into one peak as shown in fig.5.

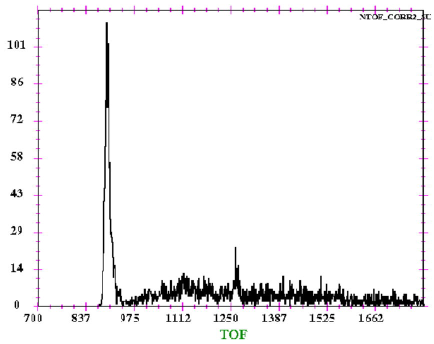


**Fig.5:** Corrected γ, n TOF spectrum

Corrections such as position gate (from large area MWPC) and TOF spread due to energy straggling in foils etc. has not been applied. Such corrections is expected to give a narrower gamma peak. Timing resolution of BC501 was found to be 1.5 ns with respect to $BaF_2$ scintillator. Further tests are being planned out to determine the exact time resolution.

The detector system was used in one of the experiments to study the mass distribution for the system $^{6,7}$Li + $^{238}$U at energies 30 – 50 MeV. The start MWPC was placed at a distance of 7.5 cm from the target on one of the GPSC arms followed by large area position sensitive MWPC at a distance of 45 cm from it. The second MWPC was placed on the other arm at folding angle at distance of 40 cm from the target. The time zero detector provided master trigger (start for TDC) for all timing signals such as TOF for two position sensitive MWPCs and their position signals. The electronic delay between start and stop detectors were determined using mono-energetic alphas from $^{241}$Am source.

Absolute TOF is obtained for one of the fragment whereas time difference between one fragment and its complementary fragment is recorded for the other fragment. This causes time jitter because start MWPC can be triggered by lighter fragment and stop signal from heavy fragment or vice-versa. In future we plan to add another time zero MWPC on the other arm to get absolute timing for the other fragment as well.

**References :**

[1] "Compact multi wire proportional counters for the detection of fission fragments" A. Jhingan et. al. Rev. Sci. Instrum. 80, 123502 (2009)