Response of Multi-strip Multi-gap resistive Plate Chamber using pulsed electron beam

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Introduction: A prototype of Multi-strip Multi-gap Resistive Plate chamber (MMRPC) with active area 40 cm × 20 cm has been developed at SINP, Kolkata[1]. Electron response of the developed detector was studied using the electron linac ELBE at Forschunszentrum Dresden-Rossendorf. The development of this detector started with the aim of developing a neutron detector but this ultra-fast timing detector can be used efficiently for the purpose of medical imaging, security purpose and detection of minimum ionising particle. In this article detailed analysis of electron response to our developed MMRPC will be presented.

Experiment and Analysis: Fig. 1 shows a picture of the experimental setup. A 29 MeV pulsed electron beam (pulse width < 10 ps) with rate of 13MHz was used for studying the response of our detector to

Fig. 1 Picture of the experimental setup.

electrons. The exclusive facility at ElBE can provide a pulsed beam with single electron per bunch mode. The RF frequency producing this exclusive pulsed beam was used as the reference for our MMRPC detector. Before and after MMRPC different fast scintillators were placed in the same beam line. For details see [2]. Master trigger used for data acquisition was a logical AND of RF, and two scintillator before and after MMRPC. All timing measurements were performed w.r.t the RF and a

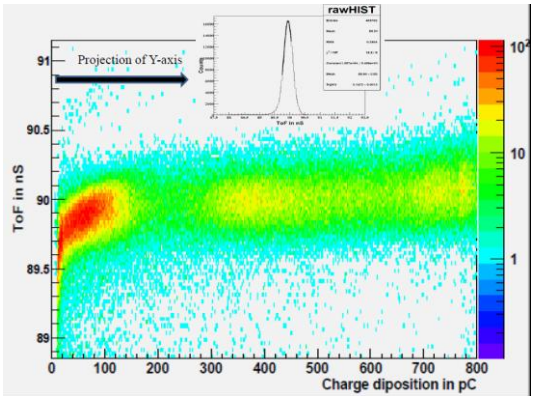

Fig. 2 Raw time against charge distribution. (insight) ToF spectra of MMRPC.

mean timing from the either end of the strips were considered for ToF measurements. Fig. 2 shows the raw time against charge distribution and 2(insight) shows the raw ToF spectra of MMRPC w.r.t RF. The

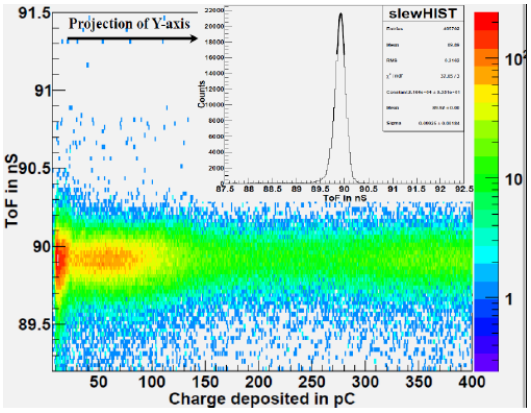

Fig. 3 Slew-corrected time against charge distribution (insight) Slew corrected ToF spectra of MMRPC.

raw time resolution (σ_t) was measured to be 147.3±1.3 ps. The correlation plot of raw ToF against deposited charge showed a bending structure due to walk problem. Hence, slew corrections were performed. Time resolution (σ_t) after slew correction was obtained to be 96.7±2.7 ps (Fig. 3) using our developed algorithm. Further, using standard algorithm slew corrected time resolution (σ_t) was measured to be 116.7±3.0ps.

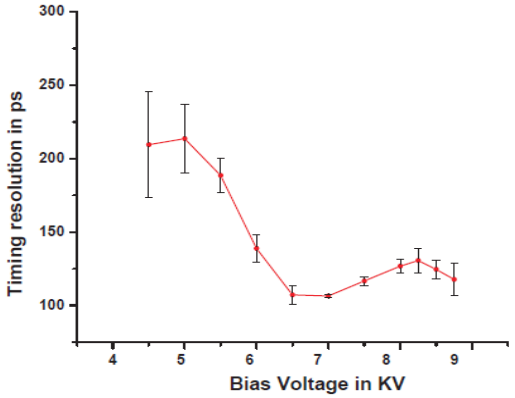

Fig. 4 Variation of time resolution against bias voltage.

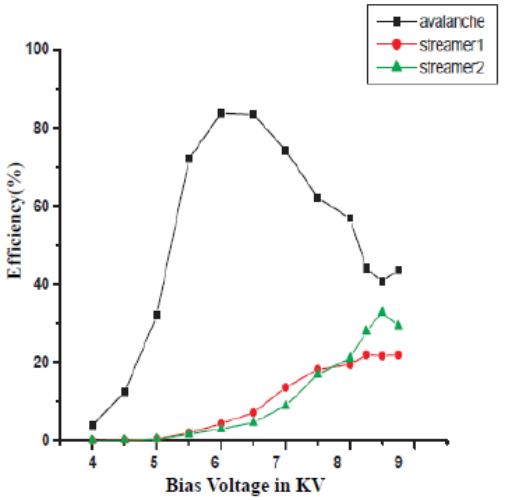

Fig. 5 Contribution of different avalanche streamer at different bias voltage.

Fig.4 shows a plot for the variation of time resolution against bias voltage. The absolute efficiency of the detector was measured to be more than 90% with cathode voltage above -7KV. All time resolutions mentioned above are corresponding to events with absolute efficiency more than 90%. Table 1 shows time resolution and efficiency with different analysis methods. Position information was extracted from the difference in time from either end of a strip. Position resolution along the strip (σ_x) was found to be 1.9±0.7 cm.

Two patches (Fig. 2), in addition to the one at lower charge deposition, were observed in ToF against deposited charge at intermediate and higher charge deposition. Fig. 5 shows the efficiency of the three patches at lower, intermediate and higher charge distribution against bias voltage. These patches could be due to streamer mode.

Table:1 Time resolution and efficiency at various conditions and constraints.

Analysis methods	**σ_t for 1σ fitting (ps)**	**σ_t for 2σ fitting (ps)**	**Absolute efficiency (%)**
Slew-corrected by curve fitting method	116.7± 3.0	119.13± 0.9	95.77± 1.2
Slew-corrected by QDC slice method	96.68± 2.7	101.75±0.5	95.77± 1.2
Making graphical cut at low deposited charge	77.45±5	83.43±1.4	26.11± 2.9
For events hitting only strip-4 and slewing	89.65± 3.5	92.43±0.9	31.69± 1.5

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