R&D for NeuLAND development for R3B, FAIR at SINP, Kolkata

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In the upcoming R3B-FAIR facility, to achieve the design goal for high resolution neutron time-of-flight [1,2], various types of prototypes have been explored at several places [3,4,5,6]. The possible candidates for active material of such a spectrometer can be either Multi-gap Resistive Plate Chamber (MRPC) or conventional plastic scintillators. At initial stage of NeuLAND development, at Saha Institute of Nuclear Physics, Kolkata, MRPC design feasibility was studied extensively[3,5].

Multi-strip Multi-gap Resistive Plate Chambers (MMRPC) has been built at SINP, Kolkata using local infrastructure (SINP workshop, dedicated laboratory, etc.) and major local raw materials [3]. The design of the detector elements is as followed: double stack MRPC with glass resistive plates and two gas gaps of 0.3 mm, each[3]. The Anode plate was segmented with 2cm wide strip. The detector was first tested in the laboratory using cosmic muons and gamma rays in coincidence with cerium doped $LaBr_3$ detector. Fig. 1 shows the experimental setup for testing MMRPC in coincidence with $LaBr_3$:Ce detector. Timing response corresponding to cosmic muons was observed to be around 150±30ps without slew correction.

The electron response of our developed detector was studied using the electron linac ELBE at Helmholtz-Zentrum Dresden-Rossendorf. The electron energy was chosen to 29 MeV with pulse width less than 10 ps. To find the optimum operational condition of the prototype, the detector was scanned with beam focused on a single strip of MMRPC. Measurements were also performed with the beam spot focused on each of the other individual strips of MMRPC. The absolute efficiency of the detector was measured to be more than 90% with cathode voltage above -7KV. Fig. 2(a) shows the 2-D plot for slew corrected ToF of developed MMRPC against deposited charge on a single strip. Measured time resolution (σ_t) after slew correction was 98.0±2.7 ps (Fig. 2(b)). 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.

Recently, an extensive test and characterization of Plastic scintillators have been started at our laboratory at SINP, Kolkata. In laboratory, various types of plastic scintillator (BC408, BC422q etc) of several dimension coupled with PMTs at both ends have been procured.

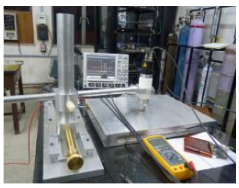

Fig: 1

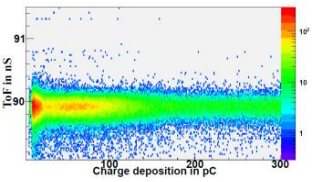

Fig: 2 (a)

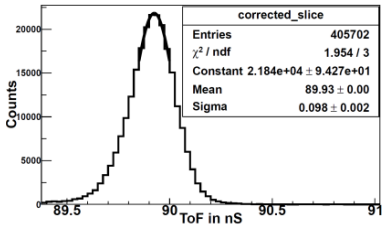

Fig: 2 (b)

Fig. 1: Testing of MMRPC in coincidence with $LaBr_3$:Ce detector at SINP laboratory; Fig 2(a) Slew corrected time vs charge deposition for electron at ELBE; Fig 2(b) Slew corrected ToF spectrum of MMRPC

Detector specification (PMT type)	Bias Voltage (V)	Rise time (ns)	Decay time (ns)	Pulse Height (mV)
HPK H3164-10	-1200	0.8-1.2	~80	200-300
HPK H6533	-2000	1.2-2	~80	200-320

Table - I: Properties of the various plastic scintillator tested at SINP Laboratory.

Response of these detectors to gamma and charge particle has been studied using available radioactive source ^{60}Co, ^{152}Eu, ^{22}Na, ^{241}Am etc. Timing responses are comparable with MMRPC. More extensive studies are going on.

References

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