Trigger Detector Study for Resistive Plate Chamber Detectors

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Introduction

Prototype glass Resistive Plate Chamber (RPC) detectors are under fabrication at Banaras Hindu University as shown in Fig. 1. The RPC shown in Fig. 1 is made of two parallel float glass sheets of thickness 2.0 mm each and a gas gap of 2mm. The dimension of the RPC is 50×50 cm^2. Two Mylar sheets of same size have been placed just above the glass plate to provide better isolation. Pickup strips are placed over the Mylar sheet one set along X-axis another over Y-axis. The width of the pickup strip is 2.5cm each.

FIG. 1: A 50×50cm^2 RPC.

Fig. 2 shows schematic representation of the testing setup of RPC. RPC module is sandwiched between two plastic scintillators (PS1 and PS2) each with dimension of 10cm × 33cm. In order to obtain efficiency in a region within one pickup strip, the trigger setup is further zoomed into a region of finger scintillator (PSF) of dimension 2.9cm×35cm and placed above the pickup strip. The trigger signal is obtained as PS1.AND.PS2.AND.PSF.

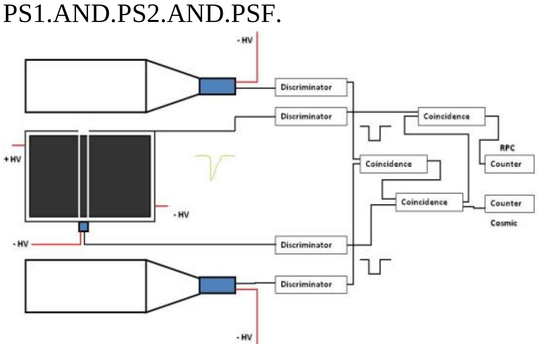

FIG. 2: Schematic layout of RPC testing trigger scheme [1].

Motivation

It is common in nuclear and high energy physics experiments to measure the efficiency of cosmic-ray charged particle detector using plastic scintillator. The detection efficiency is used for evaluation of cosmic-ray charged particle detector performances [2]. To test the RPC detector, PS is the best suited detector to trigger the system due to its very fast rise time. Four different size PS detectors have been fabricated. Complete characteristics have been described in this article and will be presented.

Plastic Scintillation Detector Fabrication

Various stages involved in the fabrication of PS detectors [3] as follows. Cutting PS requires expert hands and equipment since PS is not a hard solid material and it is easy to crack it. The sides of the PS (except the top and bottom surfaces) were polished using 800, 1000 & 1500-grid 3M Emery papers. The sand paper was made wet before polishing. All dirt and dust was washed off with cold water while polishing the PS with sandpaper. Two pieces of black cardboard were used for covering the top and bottom surfaces of the PS. The size of the cardboard should be a little bit smaller than the surface of the PS. The PS is then coupled to the PMT using silicone optical grease (BC-630). After the PS is coupled to the PMT, it is ready to be wrapped. At first, the PS is wrapped with aluminum foil, and then the two cardboards were taped onto the top and bottom surfaces of the PS.

FIG. 3: Complete set of PS detectors.

While covering with tape it was made sure that the cardboard was touching the PMT. A static shield, MIL-PRF-817505D Type 1 Class 1 black paper and a tape covering over it was put on all sides of the PS. Black tape was used to wrap around the contact area between the PMT and the PS. Hamamatsu (29mm (D), 86mm (L), 14-pin) PMTs are used in these PS detectors along with coaxial, Lemo, BNC and SHV (F) cables. PS detectors thus made are shown in Fig. 3.

PS Detector Characterization

First of all, healthy pulse shapes of expected amplitude have been seen as shown in Fig. 4. For each detector PMT an operating voltage has been obtained from plots between counts per minute verses applied voltage at certain threshold voltage. A saturated region of voltages is observed in which counts were constant within error and values are tabulated in Table 1.

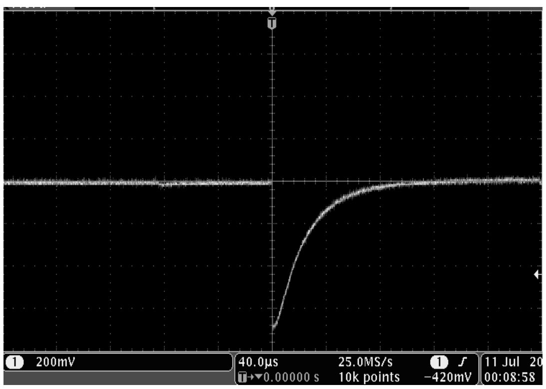

FIG. 4: PS detector pulse shape.

Table 1: Operating voltage values in volts for PS detectors.

PMT	PSF1	PSF2	PS1	PS2
Voltage	750	750	800	650

The detectors were checked for any light leak. No extra or unwanted spikes that indicate possible light leak were seen on oscilloscope. Cosmic ray muon data were taken at the above mentioned operating voltage for 20 minutes per day for around 60 days for each PS detectors and a stability plot of count rate versus days shows that all detectors are stable in terms of count rate as shown in figure 5.

Long term cosmic ray muon data were taken and the spectral shape was found to be as expected. Also data with ^{137}Cs source were taken with each detector and Compton continuum was observed.

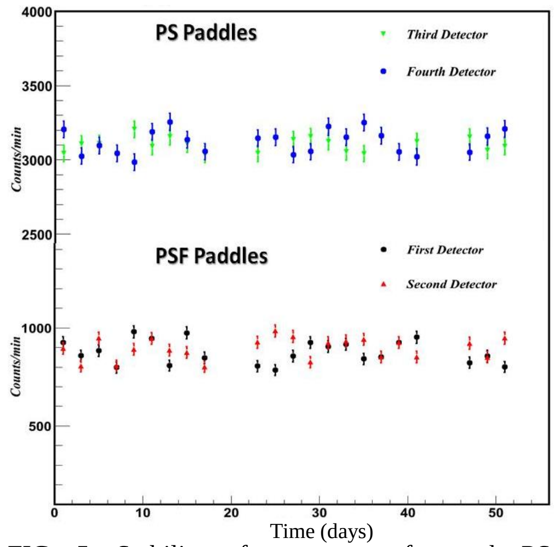

FIG. 5: Stability of count rate for each PS detector.

Efficiency of PS Detector

To get the efficiency of PS detectors 3-fold and 2-fold coincidence logic were used. Efficiency has been calculated as a ratio of count of observed detector with signal in coincidence with other detectors trigger to total trigger count. The observed efficiency is tabulated in table 2.

Table 2: Observed efficiencies of PS detectors.

PSDs	PSF1	PSF2	PS1	PS2
Efficiency (%)	97.8	98.9	93.8	95.4

It can be seen from table 2 that the detection efficiency of all four PS detectors is in normal range.

All the above mentioned exercises reflect that the working of all PS detectors is satisfactory and can be used for triggering of RPC detectors.

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References

[1] INO meeting at VECC, Kolkata

[2] A. A. Moiseev et al., NIM A, 583, 372 (2007)

[3] G.F. Knoll, Radiation Detection and Measurement, 3rd ed., p. 47, John Wiley & Sons, Inc., New York (1999)