Time Correlation Studies of a Real Size Single Gap Resistive Plate Chamber in Presence of Photon Background

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Introduction

The Compressed Baryonic Matter (CBM)[1] is an upcoming experiment in the future Facility for Anti-proton and Ion Research (FAIR) in Darmstadt, Germany. The CBM experiment will have various detector systems like Silicon Tracking System (STS), Ring Imaging Cherenkov detector (RICH), Muon Chambers (MuCh) among others. The muon detection system of the CBM experiment - Muon Chamber (MuCh) will have a unique feature that its total absorber will be sliced with muon-detectors placed in between them in order to facilitate momentum dependent track identification, hence improving the efficiency of detection of low momentum muons. MuCh will have 4 different stations to house detectors for muon detection and each station will house three detector layers. Gas Electron Multiplier (GEM) based gaseous chambers will be used as active detector elements in the first 2 stations. As for the 3^{rd} and 4^{th} stations, Resistive Plate Chambers (RPCs) are being considered as a cost-effective technology option[2]. In this report, we have presented the timing behavior of the real size RPC for MuCh tested at GIF++, CERN, Switzerland.

Time correlation studies of the RPC

A real size bakelite RPC for the 3^{rd} and 4^{th} stations of MuCh has been tested at GIF++ facility at CERN, Switzerland. The details of the experimental set up has been described in [3]The RPC alongwith the readout electronics were housed inside a aluminium box. A wet gas mixture of R134a : iC4H10 : SF6 :: 95.2% : 4.5% : 0.3% (with 40 % humidity) was flown through the detector with a flow rate maintained at 5.0 l/hr. Self-triggered ASIC, MuCh-XYTER, was used to read out the signals from the RPC with the help of pick-up panel containing (45 × 10) pads[4].

GIF++ houses Cs-137 gamma source having activity ∼14 TBq with different attenuation filters to vary the photon flux. The incident photon flux at our detector with different attenuation factors has been tabulated in Table I.

Attenuation factor	Photon flux (MHz/cm^2)
22	2.72
46	1.36
100	0.69

Table I: Photon flux incident on RPC at different attenuation factor.

The time correlation spectra of the RPC was also obtained at different high voltages as well as different photon rates. As a standard practise the timing information of the hits have been measured w.r.t to the trigger time. Figure 1 shows one such typical time correlation spectra of the detector at 9200 V with source OFF condition. As it can be seen from the Figure 1 that there are two peaks in the time correlation spectra v.i.z "Main peak" and "Tail peak". The hits within the main peak are of interest for efficiency studies. In

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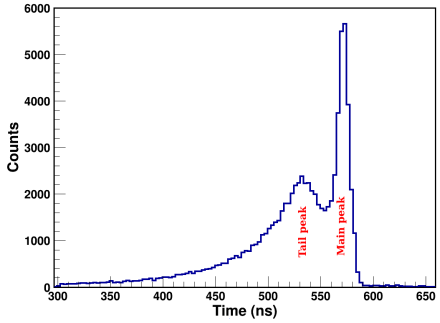

Figure 1: *[Colour online] Obtained time correlation spectra at 9200 V and no photon flux incident on the detector.*

any particular given gas mixture, an increase in the applied high voltage may lead to the formation and followed by the statistical growth of the tail peak. This is due to the fact that increase in the voltage causes an increase in the gain which results in relative increase in the number of high amplitude pulses resulting in different timing values to cross the detection threshold for low amplitude pulses and high amplitude pulses. Working in low threshold enviornment (as in our case) makes this observation more understandable. This effect can be clearly seen in Figure 2. As the high voltage is increased from 8600 V to 9600 V, the tail peak becomes more and more dominant. Figure 3 shows the comparison of time correlation spectra obtained from the RPC at a voltage of 9600 V with different photon rates on the detector. From the figure, we can observe that as the photon rate falling on the detector is increased the grass-level of the time correlation spectra also increases. MuCh-XYTER, being a self-triggered electronics records all the hits crossing the threshold from all 460 pads. More and more photons incident on the detector may increase the number of recorded hits in each and every pad pad resulting in increment of the gass-level.

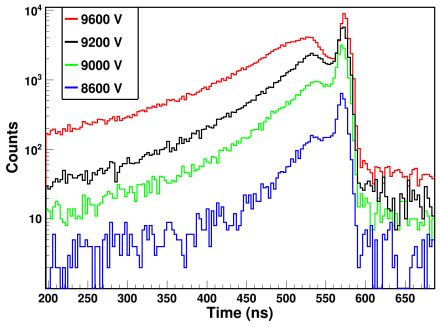

Figure 2: *[Colour online] Comparison of time correlation spectra at different applied voltages with no photon flux incident on the detector.*

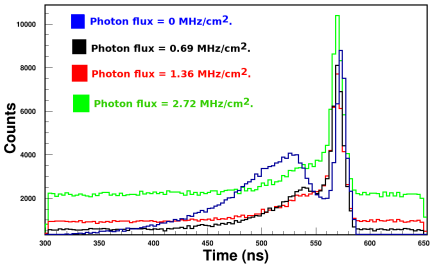

Figure 3: *[Colour online] Obtained time correlation spectra at different photon flux incident on the detector.*

Summary

The timing behaviour of the RPC was studied both as a function of applied high voltage and incident photon flux. The nature of the time spectra was found to be different for both these parameters. A second peak was obtained in the time correlation spectra which needs to be investigated further in details.

References

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[4] Rafal Kleczek, Analog front-end design of the STS/MUCH- XYTER2—full size prototype ASIC for the CBM experiment, **JINST 12 (2017) C01053**.