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# The development and testing of a Resistive Plate Chamber of Low resistivity at GIF++, CERN in 2023

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## Introduction

The primary emphasis of the future high-energy physics experiment lies in the pursuit of the QCD critical point and the investigation of constraints in the equation of state for nuclear matter at high baryonic density. The future experiment, CBM (Compressed Baryonic Matter) with unprecedented interaction rate, aims to determine the equation of state for strongly interacting QCD matter dominated by baryons (with a baryon chemical potential of $\mu_B$ 540–800 MeV). As a part of dilepton measurement, Muon Chamber (MuCh)[1] will be installed. Resitive plate Chamber (RPC) will be used in 3rd and 4th station of MuCh where the particle rates is expected to be 30 KHz/cm$^2$ and 10 KHz/cm$^2$ respectively. A real-size RPC prototype with 2 mm gas gap has been developed and rigorously tested at Gamma Irradiation Facility(GIF++), CERN. The aim of the exercise was to study the different detector parameters such as time-correlation, efficiency, rate handling capability etc. with different photon-flux, different operating voltages and different thresholds . The details experimental set-up followed by **preliminary result and discussion** are given below.

## TEST SET-UP AT GIF++

GIF++ accommodates a Cs-137 gamma source with an activity of approximately 14 TBq (as of 2014). This facility features various attenuation filters to adjust the photon flux. Positioned on the H4 beamline at the EHN1 North Area of CERN, it offers a high-energy muon beam (up to 150 GeV/c). The RPC Fig.[2] was housed within a rectangular aluminum enclosure equipped with an adjustable support structure, allowing for flexibility in positioning the detector relative to both the gamma source and the muon beam impact point on the detector Fig.[1]. Four Front-end Electronics Boards (FEBs) were connected to the PCB to facilitate the reading of each individual pad. To create a trigger signal, we utilized a coincidence of signals from three distinct scintillators, two positioned in the upstream and other in downstream direction.The detector was supplied with a wet gas mixture

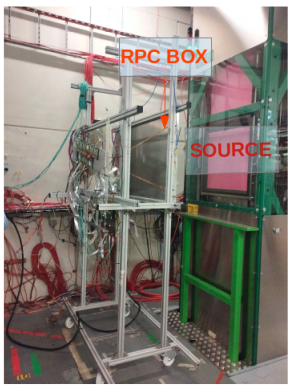


FIG. 1: Experimental Set-up at GIF++, CERN. The RPC box was positioned 60 cm away from the source wall in the downstream direction.

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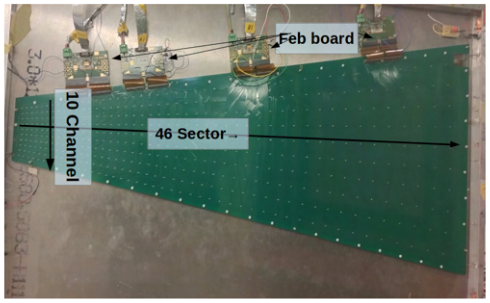


FIG. 2: RPC detector inside aluminium box with Front-end elctronics. Left to right there are 46 sectors and in each sector there are 10 channels.

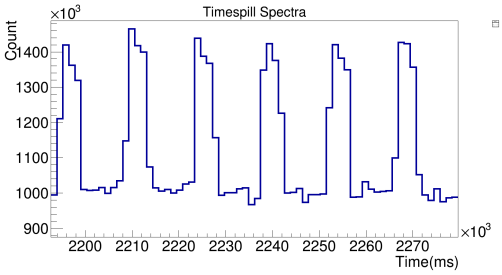


FIG. 3: spill structure measured by RPC with only muon data

consisting of R134a : iC4H10 : SF6 in a ratio of 95.2 : 4.5 : 0.3, along with 40% humidity, at a constant flow rate of 4.0 lt/hr.

## Result and Discussion

Time correlation with the trigger system is crucial for calculating efficiency. Genuine RPC hits must be correlated with the trigger. Fig.4 illustrates a typical time correlation spectrum of the detector at 9200 V with only muon setup. Valid RPC hits are those that exhibit a strong correlation with the trigger signal. A time difference window spanning from 450 ns to 500 ns was employed for calculating valid hits. Fig.5 illustrates the illuminated region of the detector where valid hits from the muon beam were registered. We achieved the preliminary efficiency of 92.6% at 9800 Volts.

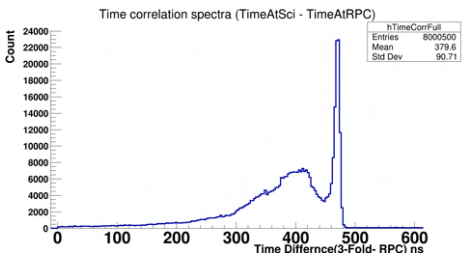


FIG. 4: Time- correlation Spectra at 9800 Volt. similar behaviour was also seen in gif++ test 2021[2].

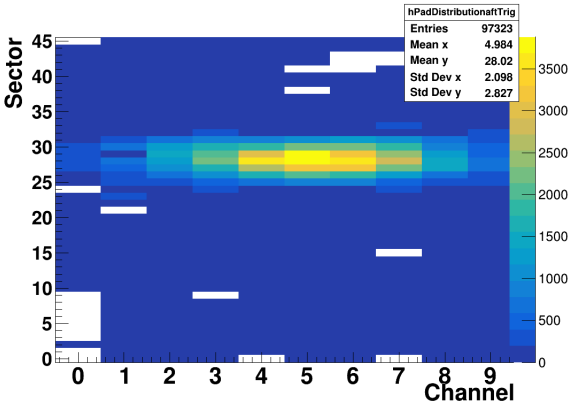


FIG. 5: Pad distribution after trigger

## Summary

A full-scale single gas RPC, complete with a cushioned readout PCB and a dedicated self-triggered electronics chain, has been designed for use in the third station of the MuCh detector setup of the CBM experiment. Initial results with time-correlation and spill structure have been shared. More comprehensive findings will be presented at an upcoming symposium.

## References

[1] Technical Design Report for the CBM : Muon Chambers (MuCh), https:// repository.gsi.de/record/161297.

[2] Development and performance studies of a real size RPC tested at GIF++, CERN