

Development and issues of bakelite RPC

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Introduction

For high energy experiments Resistive Plate Chamber (RPC) is a very important, low-cost detector for triggering and tracking. It is used in many experiments such as STAR, LHC experiments and also planned to be used in the Compressed Baryonic Matter (CBM) experiment at 'Facility for Antiproton and Ion Research'. RPC is a gaseous parallel plate detector made up of high bulk resistive materials i.e. glass or bakelite as electrodes. As filled gas medium generally tetrafluoroethane ($C_2H_2F_4$), Sulfer Hexafluoride (SF_6), Isobutane (iC_4H_{10}) are used[1].

In the Muon Chamber (MUCH) of the CBM experiment triple GEM (Gas Electron Multiplier) has been chosen for the 1st and 2nd stations and RPC is proposed choice for the 3rd and 4th station. From simulation particle rate will be 15 kHz/cm^2 in the 3rd and 5.6 kHz/cm^2 in the 4th station respectively in the CBM Muon Chamber (CBM-MUCH) for 8 AGeV Au-Au center of mass-energy. Rate handling capability is one of the important factors for CBM-RPC. Also, the use of non-Freon gas mixture is a serious challenge. An R&D has been started for RPC using different bakelite materials [2]. The details of this study will be presented.

Fabrication

Bakelite with resistivity $10^{11} \Omega\text{-cm}$ is used for the first module. Two plates each with thickness 2 mm is separated by 2 mm spacers made of perspex (resistivity $\sim 10^{15} \Omega\text{-cm}$). A layer of graphite is applied at the outer surfaces of the electrode plates for the distribu-

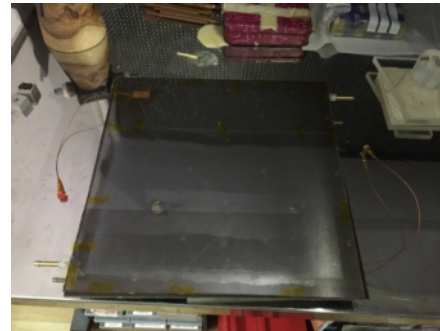


FIG. 1: Complete RPC module

tion of voltage. Two $1 \text{ cm} \times 1 \text{ cm}$ copper stripes are used at two diagonally opposite corners to apply high voltage (HV). HV of opposite polarities are applied on two sides. 2.5 cm copper strips are fabricated with 2 mm separation among two consecutive strips, to collect the signal. Premixed Ar/ CO_2 gas is used in 70:30 ratio. Signals from the strips are directly collected using LEMO cables [3].

A complete RPC module is shown in figure 1.

Results

To check the detector response the I-V characteristics are studied. The I-V characteristics curve is shown in figure 2. Since Ar/ CO_2 gas mixture is used the breakdown occurs at a comparatively lower voltage. Initially, the breakdown is used at about 4 kV. At this region the signal $\sim 20 \text{ mV}$ is observed in the oscilloscope and shown in figure 3.

The noise rate as a function of voltage also measured keeping the threshold to the discriminator at -15 mV and shown in figure 4.

Using 3 fold scintillator coincidence signal as trigger the efficiency of this detector is measured with cosmic muons with conventional

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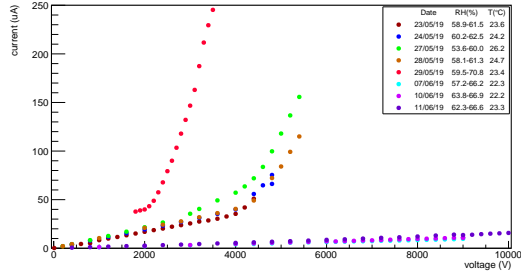


FIG. 2: I-V Characteristics of RPC

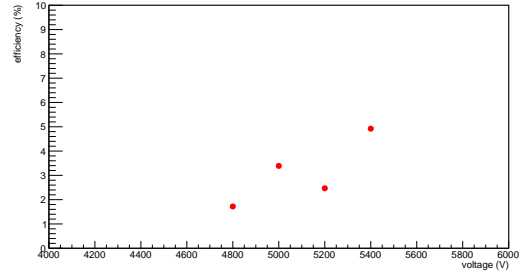


FIG. 5: Efficiency of The RPC on different voltage

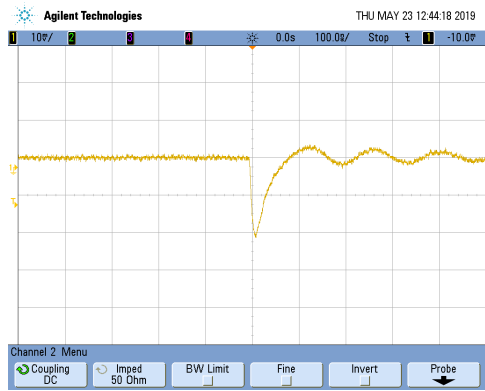


FIG. 3: RPC Signal

NIM electronics. Efficiency $\sim 5\%$ is achieved and not increased after that even after increasing the HV.

After a few days the detector shows an ambiguous nature of I-V characteristics as shown in 2.

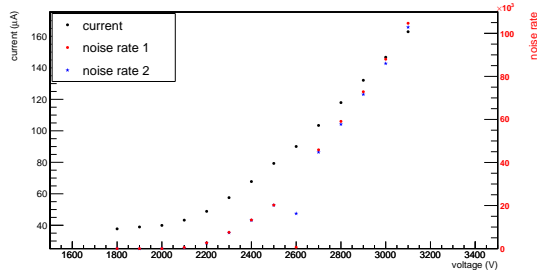


FIG. 4: Noise rate

Fig. 5 shows the efficiency of RPC with the voltage. From the figure, it is seen that efficiency is only 5% at around 5.4 kV.

Discussion

Usually, single gap RPC shows an efficiency $\sim 90\%$ for muon in the conventional gas mixture at > 8 kV. With Ar/CO₂ gas mixture although the breakdown in the I-V characteristics occurs relatively lower voltage but the efficiency of the detector is found to be also very low. For such a small module the overall current is also found very high. The reason behind this anomaly is under investigation.

Several RPC module with bakelite having different bulk resistivity are under fabrication for further studies.

Acknowledgement

We would like to thank Prof. S. K. Ghosh, Prof. S. Raha, and Dr. S. K. Prasad for their valuable discussion and suggestion during the work.

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