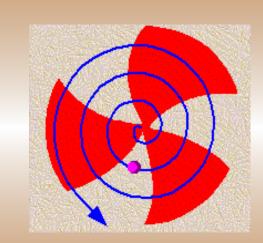


Feasibility Study of Using RPCs in CBM-MUCH

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In this poster, we report the feasibility study of using Resistive Plate Chambers (RPCs) for detection of muons at high interaction rate in CBM Muon Chamber (MUCH). CBM-MUCH is a segmented detector system consisting of several layers of absorber with detectors placed in between. RPCs has been successfully used for muon detection and triggering in ALICE, ATLAS, CMS, etc. However, given the very high interaction rate at CBM, we re-investigate its different parameters which need to be properly optimized to make it suitable for the purpose.

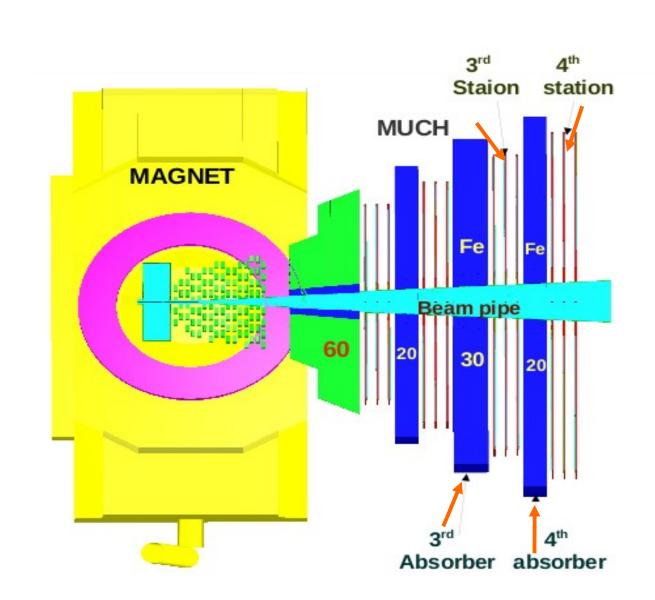
CBM experiment @ FAIR

The Compressed Baryonic Matter (CBM) experiment at the Facility for Antiproton and Ion Research (FAIR) in GSI, Germany is a future fixed target experiment which will perform the precision measurement of dilepton pairs in the full mass region (low mass to charmonium) in the energy range 4-40 AGeV using very high-intensity (10° Au ions/sec) heavy-ion beams.

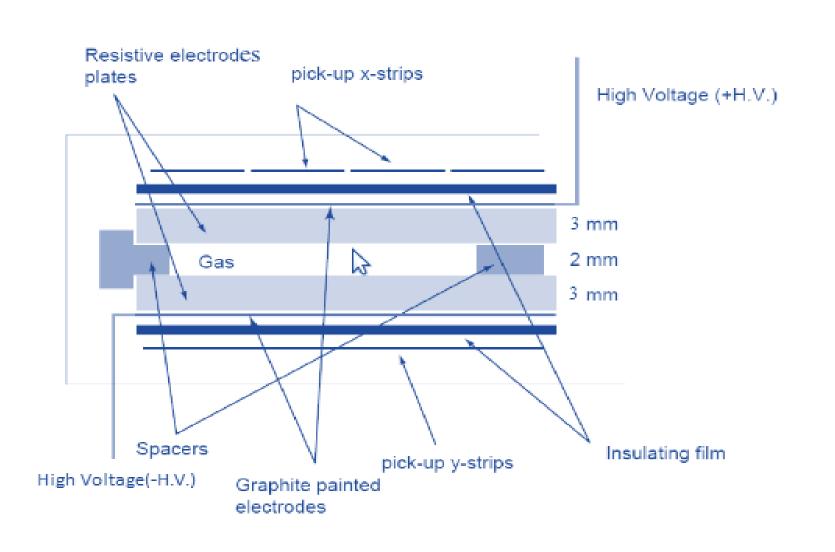
The given experimental conditions demand detectors to be radiation hard, together with high rate handling capability.

The MUCH (Muon Chamber) detector system [1] in CBM is a segmented absorber system with detectors placed in between them. Here GEM chambers will be used as active detector elements in the first 2 stations

STRAW TUBES were the baseline detector technology for the 3 rd and 4 th stations. Recently it was discussed in the collaboration to replace the STRAW TUBE detectors with Resistive Plate Chambers (RPCs).



Resistive Plate Chamber (RPC)



Schematic diagram of Resistive Plate Chamber

Gaseous Parallel Plate detector

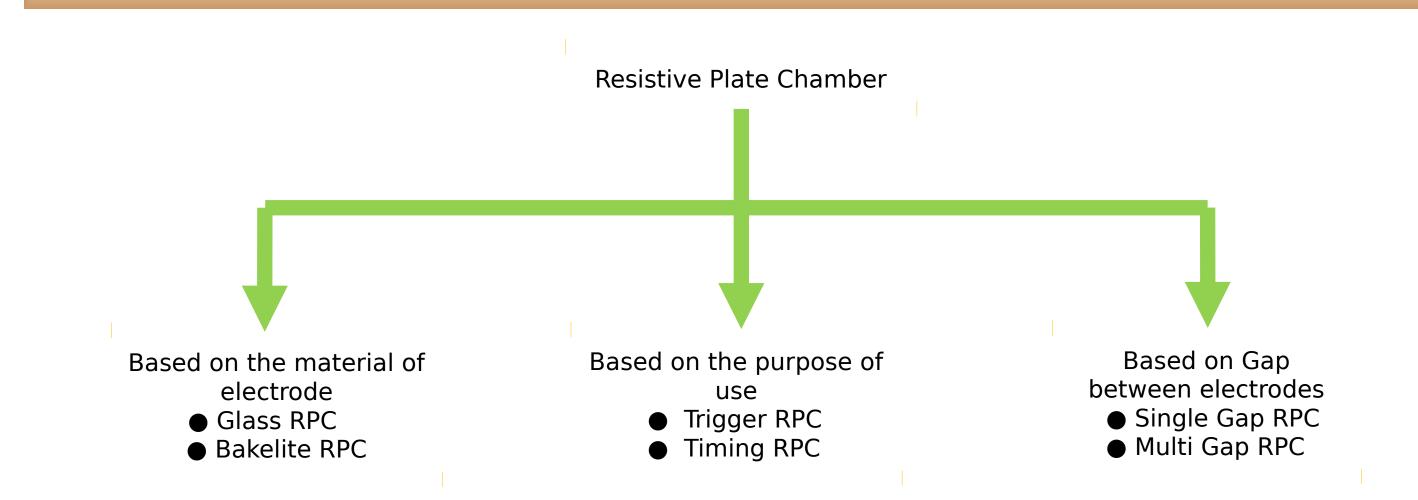
Developed by R. Santanico and R. Cardarelli in 1981

Working principle ~ gas ionisation

Resistivity of electrode plates, $\rho = 10^9 - 10^{12} \Omega$ -cm

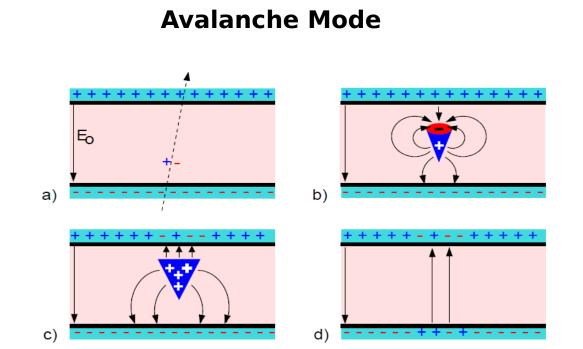
Surface Resistivity of Graphite painted electrodes, $\rho = 100 - 300 \text{ k}\Omega / \square$

Classification of Resistive Plate Chamber



Bulk Resistivity of glass : $10^{11} - 10^{14} \Omega$ -cm Bulk Resistivity of Bakelite : $10^9 - 10^{14} \Omega$ -cm

Operating Modes: Avalanche mode & Streamer mode

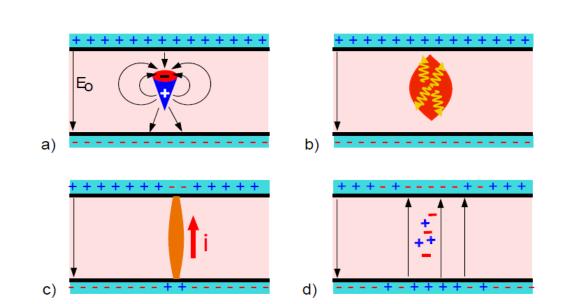


Gas mixture ratio : Freon : Isobutene : SF_6 95.0 : 4.5 : 0.5 Signal strength ~ 5 mV.

Charge ~ 1pC, current low in detector good rate capability (~ 1 kHz/cm²)

Required low noise pre-amplifier

Streamer Mode



Gas mixture ratio : Argon : Freon : Isobutene

34 : 57 : 9

Signal strength ~ 150 mV.

No need to amplify the signal

High Charge ~ 100pC, current high in detector

poor rate capability (~ 100 Hz/cm²)

Rate capability = 1/ρt<Q>[2]

- "<Q>" is the average charge collected. It depends on:
- --the gas mixture
- --gas gap width
- --the number of gas gaps
- "t" is the electrode plate thickness which depends on the material of the electrodes (Bakelite, glass, ceramics...)
- " ρ " is the bulk-resistivity of the electrodes(10 5 10 10 Ω *cm).

If $\rho = 10^8 \, \Omega^* \text{cm},$ $t = 0.3 \, \text{cm and}$ $< Q > \approx 1 \text{pC}, \text{ (avalanche)}$

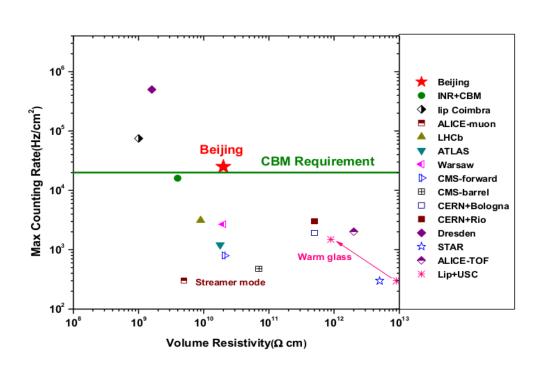
mode)
then
RPC rate handling capacit

RPC rate handling capacity >16 kHz/cm²

Experiments at CERN using RPCs at high particle rate

Experiment	Rate (kHz / cm²)	Resistivity of electrode (Ω.cm)
ALICE	~ 10	10 ⁹ - 10 ¹⁰
ATLAS	~ 14	~ 10 ¹⁰
CMS	~ 10	~ 10 ¹⁰

Summary and Outlook



Bulk-resistivity of RPCs v/s counting rate

- Counting rate capability can be optimized by using electrodes of suitable bulk resistivity, electrode thickness and operating in avalanche mode.
- Recent development of low resistive electrodes may perform better results in CBM MUCH.

Particle rate estimation at CBM

Standard particle rate (max) at 3rd and 4th station : 20 kHz/cm² and 5.6 kHz/cm²

Absorber thickness modified to bring down particle rate within RPCs rate handling capacity.

