Simulation studies of the effect of electrode coating on the efficiency and induced pulse height in Resistive Plate chambers(RPCs)

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ABSTRACT.

In our work an attempt is made to calculate in simulation the effect of coating parameters such as its thickness (or surface resistivity) on performance characteristics of the RPC such as the induced pulsed height on pickup strips and hence the RPC efficiency for charge particle detection. The results will be compared with the corresponding experimental results later.

INTRODUCTION

1. Resistive Plate Chambers are the parallel plate gas based particle detectors, which are being extensively used for trigger and timing applications in modern nuclear and high energy physics experiments
2. The proposed large magnetized iron calorimeter at the India-based Neutrino Observatory is planned to have a total mass of 50 Kton, will deploy about 28,800 RPCs each of about 4 m^2 in area as its active detector elements
3. In order to apply uniform electric field for creating avalanche inside the gas gap, high voltage of about 10KV is applied across the parallel glass electrode plates of the RPC.
4. A semi-resistive coat of paint is applied on the outer surfaces of both the electrodes, which facilitates application of high voltage.

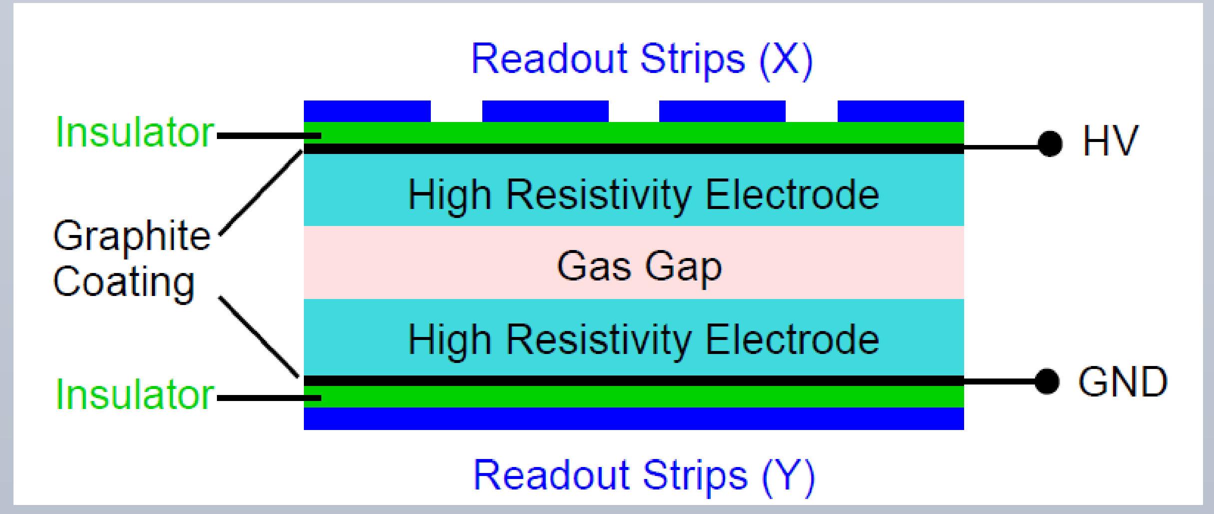


FIG1. Resistive plate chamber

SIMULATION SCHEME

1.In our simulation we have used neBEM SOLVER .Once the detector geometry is made in neBem Solver, we then calculate Electric field and Weighting fields.

2. We have calculated efficiency and pulse height with the variation of the graphite coating. We have varied the thickness of coating from 200µm to 1000µm.

$$\varepsilon = \sum_{n=1}^{\infty} P_n = 1 - e^{-(1-\eta/\alpha)d/\lambda}\left[1 + \frac{V_w}{E_w}\frac{\alpha-\eta}{e_0}Q_t\right]^{1/\alpha\lambda}$$

Efficiency

$$I(t) = \frac{E_w}{V_w} e_0 v N(t),$$

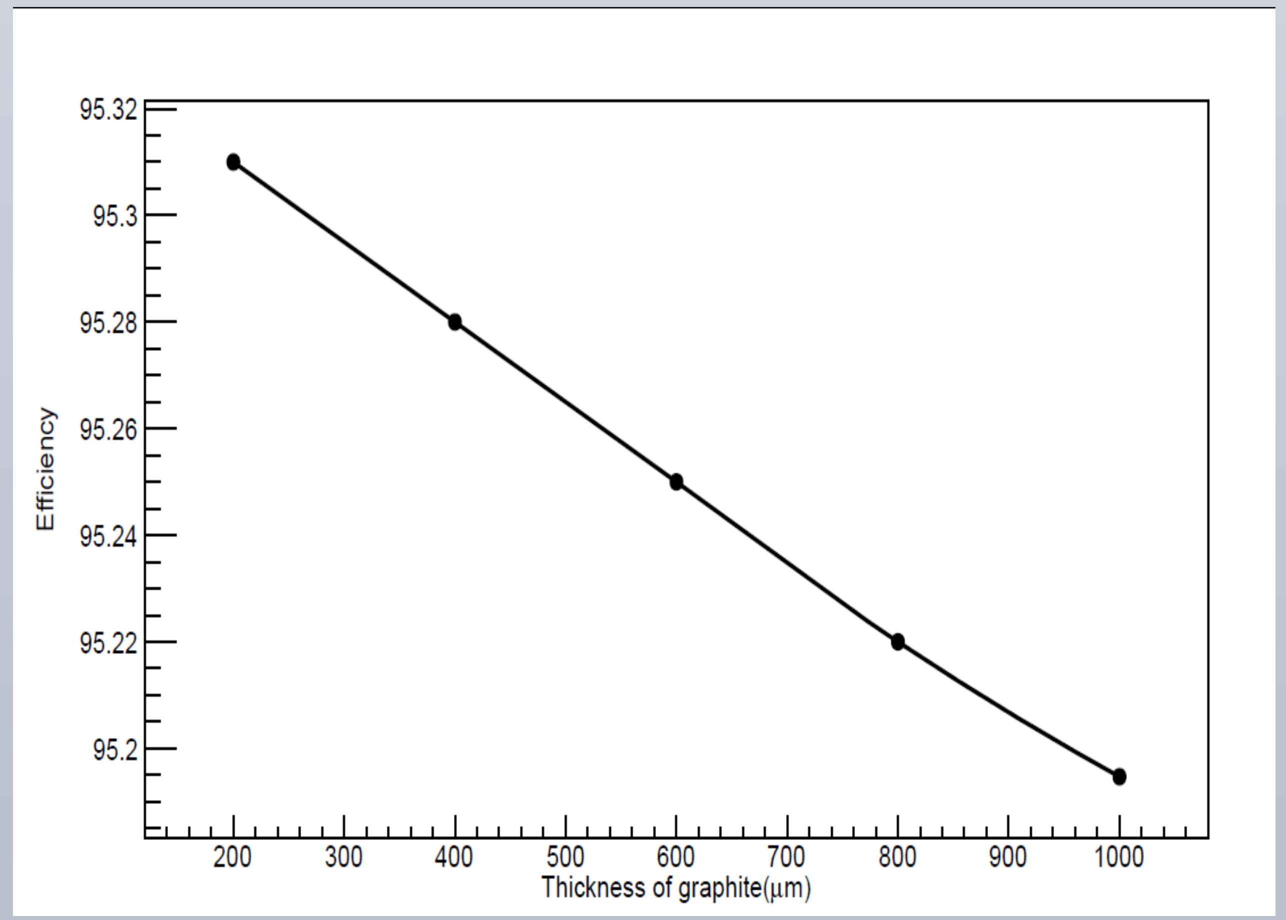
Current Signal

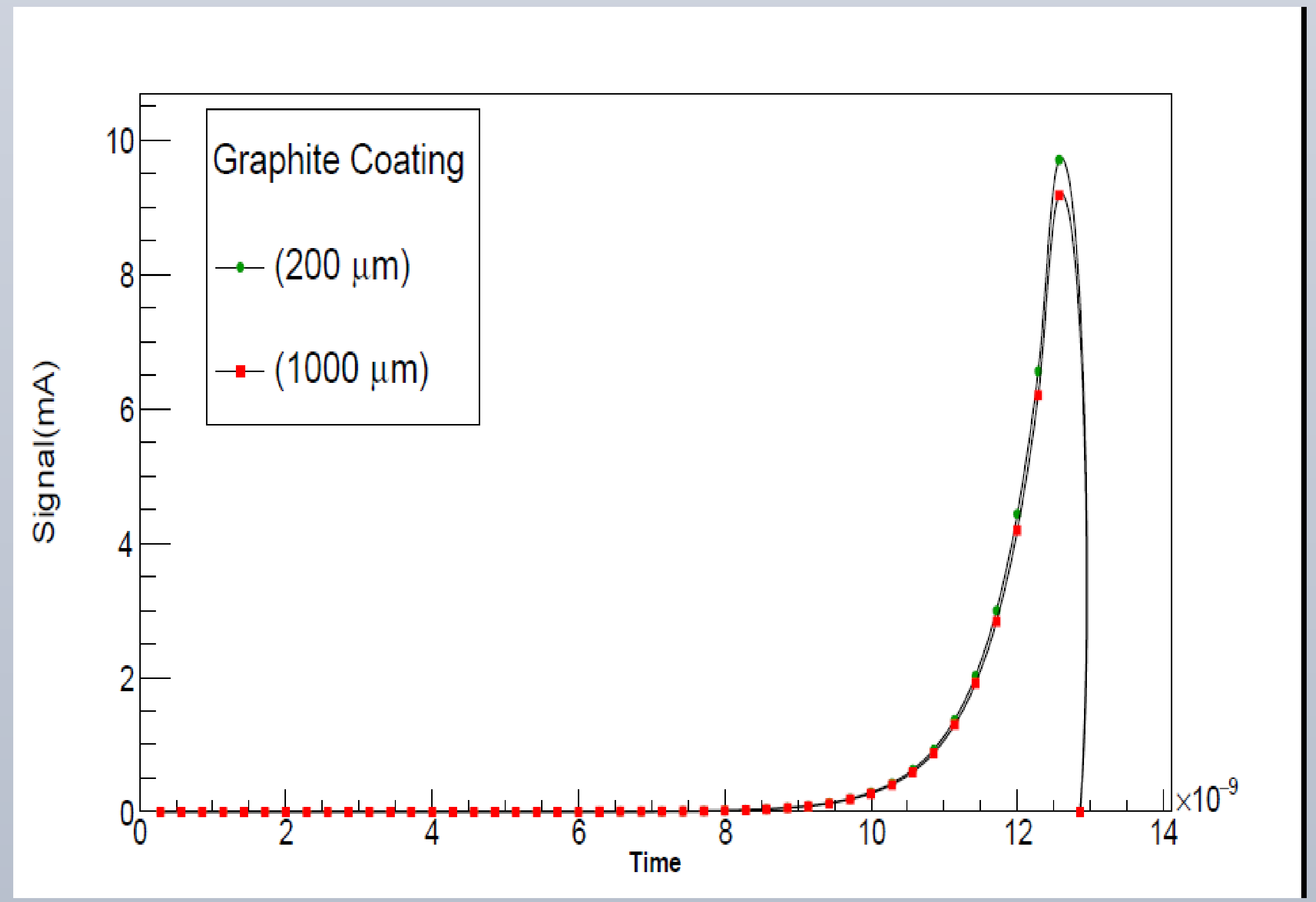
$$N(t) = \sum_{n=1}^{N_0} n_{av} e^{(\alpha-\eta)vt}\,\Theta\left[\frac{d}{v}\left(1-\frac{n}{N_0}\right) - t\right]$$

Avalanche development

η=Attachement Coefficient
α = Townsend coefficient.
V_w= Weighting Potential.
E_w= Weighting Field.
Q_t=Thresh hold Charge.
λ= Mean Free path.
v= Drift Velocity.
t= time taken in gas gap.
n_{av}= Average number of electrons in cluster

RESULTS AND DISCUSSION





CONCLUSION

1. The Resistive coating of the outer surface of electrodes play a crucial role in the operation of RPC detector operation. As the bias voltage that is required for the RPC operation can be applied on these coats for uniform supply of voltage distribution.
2. Crosstalk between two adjacent pickup strips increases with the graphite coating.
3. Efficiency and pulse height both decreases with the increase in the graphite coating. Because signal transparency is less with the increase in thickness.

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