Aim: To measure the (a) I-V characteristics (Leakage current), (b) noise rate and efficiency of the Resistive Plate Chamber.

Theory:

Resistive Plate Chambers (RPCs) were introduced in 1981 and they belong to the family of gaseous detectors. They are fast gaseous detectors used for the detection of charge particles. The detection process is based on the principle of ionisation produced by the charged particle traversing the active area of the detector, under the influence of an appropriate electric field. The RPC is made up of two parallel electrodes with high resistive bulk material, having semi-resistive graphite coating on the surface

The readout is performed by means of pickup panels made up of copper strips pasted on one side of honey comb panel while the other is grounded. In order to understand the detector performance and optimal response, we need to study various detector characteristics like leakage current, noise rate and efficiency.

1. Leakage current: It is defined as the current flow in the detector with the application of high voltage on the respective electrodes. The total current is combination of ohmic component and gas amplification.
2. Noise rate: It is defined as the number of events per unit time above the trigger .
3. Efficiency: The efficiency of the RPC detector is defined as the ratio between the RPC coincidence counts and the reference trigger.
   Efficiency = (4fold/3fold) x 100
   where 4fold is defined as coincidence ANDing of three scintillators triggering paddles and RPC, and 3fold is defined as coincidence ANDing of three scintillators triggering paddle.

Apparatus:

1. Connectors and wires: Safe high voltage (SHV) connector for high voltage connections, Lemo 00 connector for carrying signals, high voltage wires (0-8 kV range) and RG 174 co-axial lemo wires.
2. Pre amplifiers and amplifiers(multichannel).
3. Scintillator paddles.
4. Nuclear Instrument Module (NIM) and VERSA-Module Euro card (VME) crate
5. High voltage power supply.
6. Discriminator, Logic unit and Scalar.

a) I-V (Leakage Current) characteristics measurement.

Experimental Set up and Procedure:

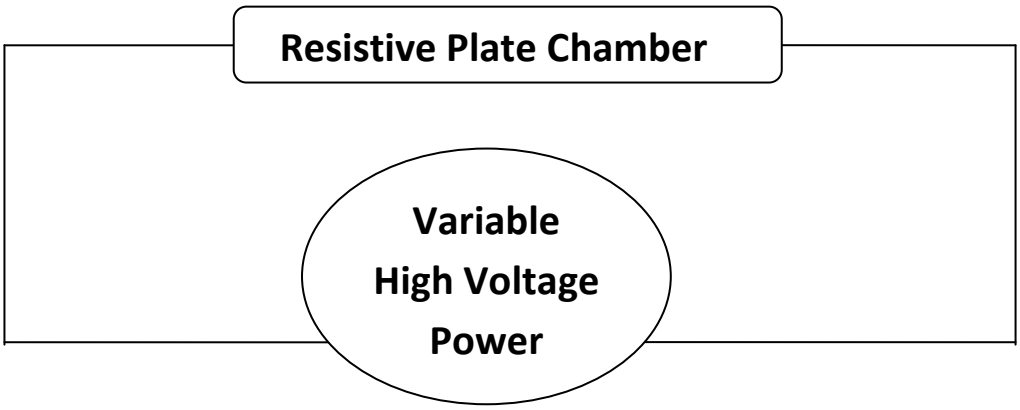
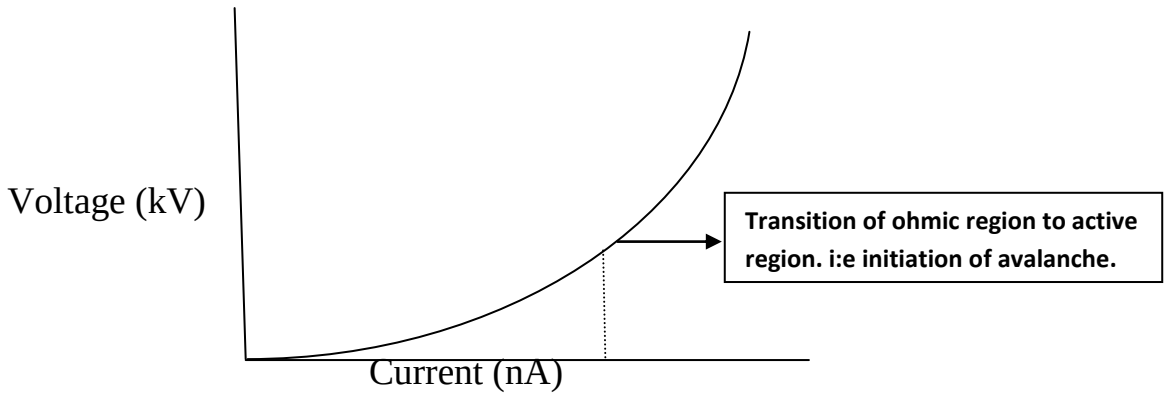


Figure: Experimental Set up for the I-V measurement.

Procedure:

1. Initially supply the appropriate gas flow into the RPC detector for about 24 hours.
2. Ramp up the voltage of the detector in the step of 100V for both the polarity i:e negative and positive.
3. At each step wait for about 5 minute for the saturation of the current values corresponding to applied voltage.
4. Read the current values at each corresponding voltage and plot the graph for scan of whole voltage range.

Output of the Experiment:



From the graph, it is observed that the region in the lower voltage range is linear so it represents ohmic region as primary ionization does not lead to avalanche. Also, the resistance is offered only by the spacer. The gap resistance is infinite in this case. In

the region of high voltage there is zero gap resistance and there is contribution from ionization. So there will be a sharp increase and it occurs when avalanche initiate inside detector due to the presence of sufficient electric field. This is the active region of RPC.

b). Noise and efficiency measurement

Noise rate is defined as the events coming after the setting of proper threshold for operating the detector. The source of noise might be radioactivity, or from electronics, or from surrounding electromagnetic sources. The noise rate gives information about the unwanted signals generates in the detector. The efficiency study provides the detection capability at particular bias voltage along with different working region of the detector.

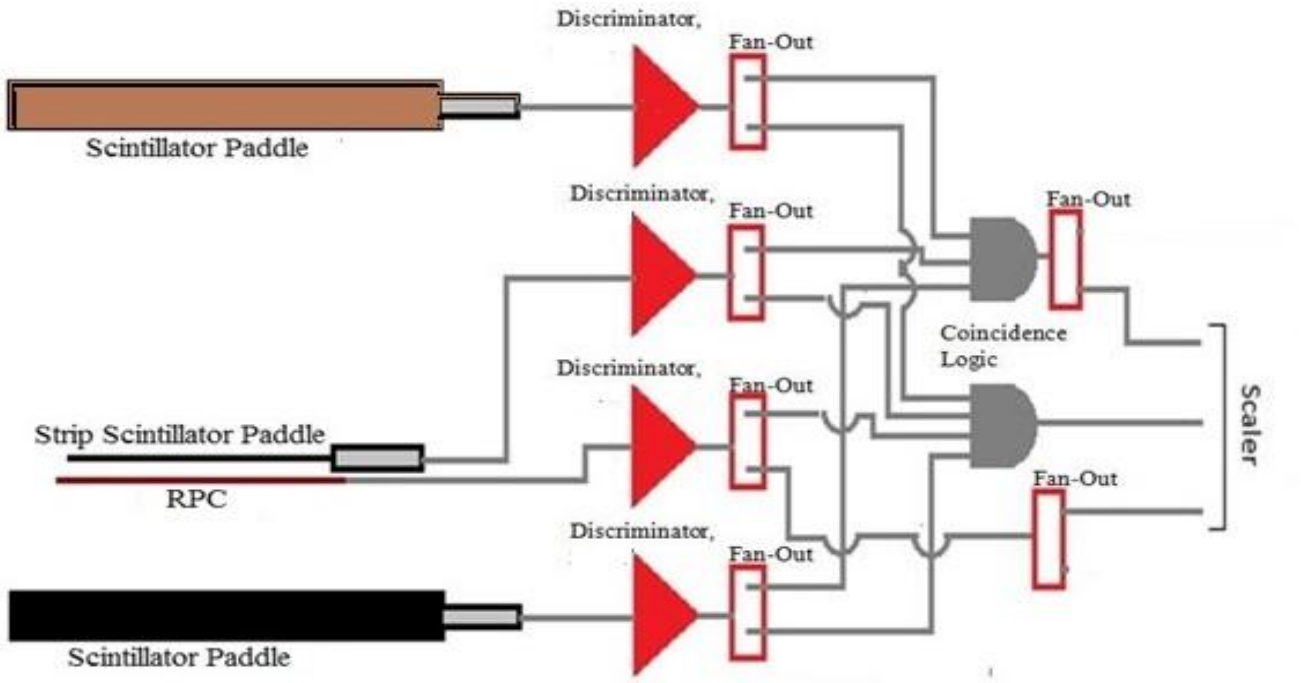


Figure: Schematic representation of experimental set up for the measurement of noise rate and efficiency

Procedure:

1. Initially ramp up the detector Voltage in the small steps(100-200V).
2. Fed the output of the detector in the input of preamp and utilize output of the preamp for the noise level information in one of the channel of oscilloscope.
3. Fed output of the preamplifier and scintillators in the different channel of the discriminator after setting proper threshold on the basis of noise level from oscilloscope.
4. Take digital output of the discriminators corresponding to detector output and Scintillator paddles.

5. Fed the digital output of the discriminators corresponding to detector and scintillators into the logic unit for logical ANDing
6. Utilize output of the logic units in the Scalar (counter) for noise rate and efficiency calculation

Output of the Experiment: