XV ICFA Instrumentation School

Characterization of Resistive Plate Chamber

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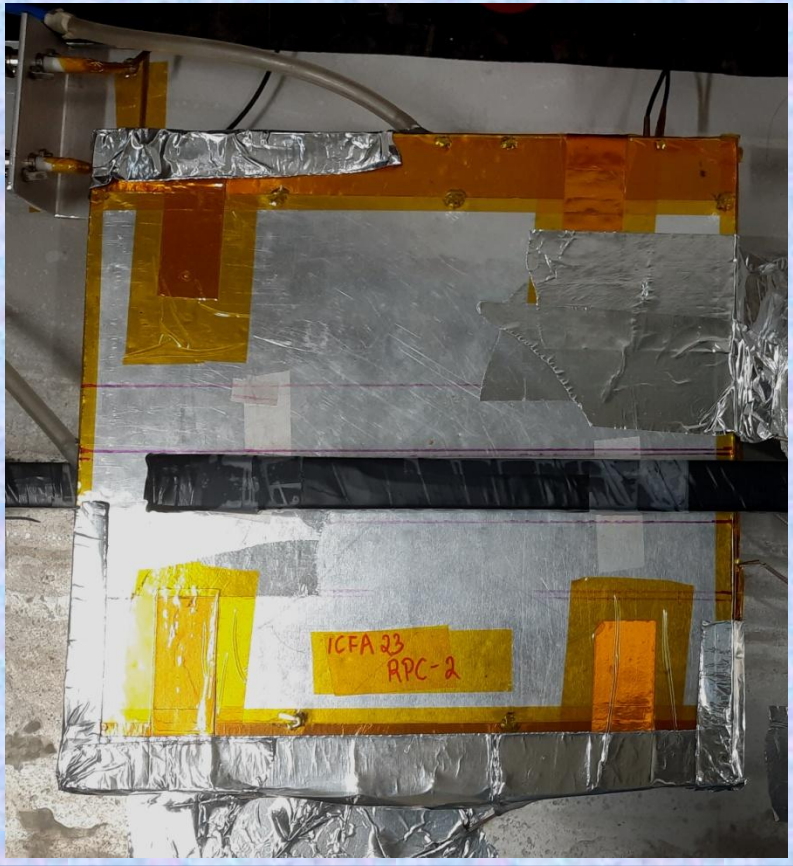
Introduction

RPC, what?

- RPCs are gaseous detectors based on the principle of Spark Chamber

Why use RPC?

- **Excellent time resolution, ~ few ns**
- **Good position resolution, ~ few mm**
- **Easy and cost effective** for covering large areas
- **Good performance stability**



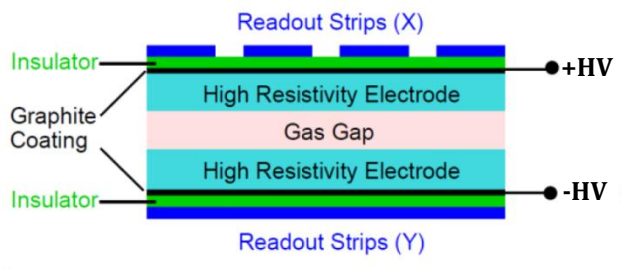
Usage

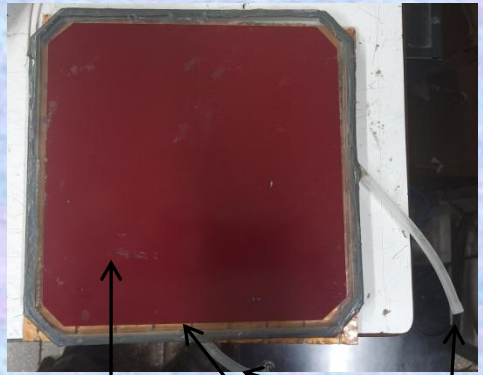
- For triggering
- Counters
- Tracker

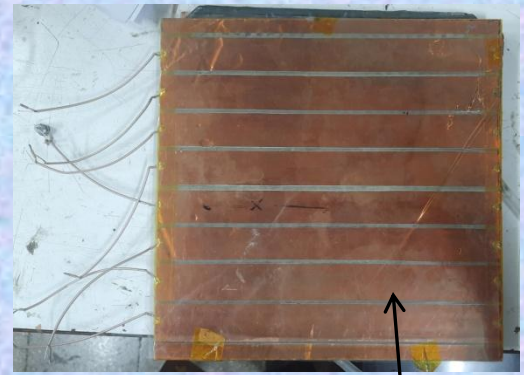
Example

- Cosmic muon tracker in **mini-ICAL**
- Muon trigger in **CMS**

Construction





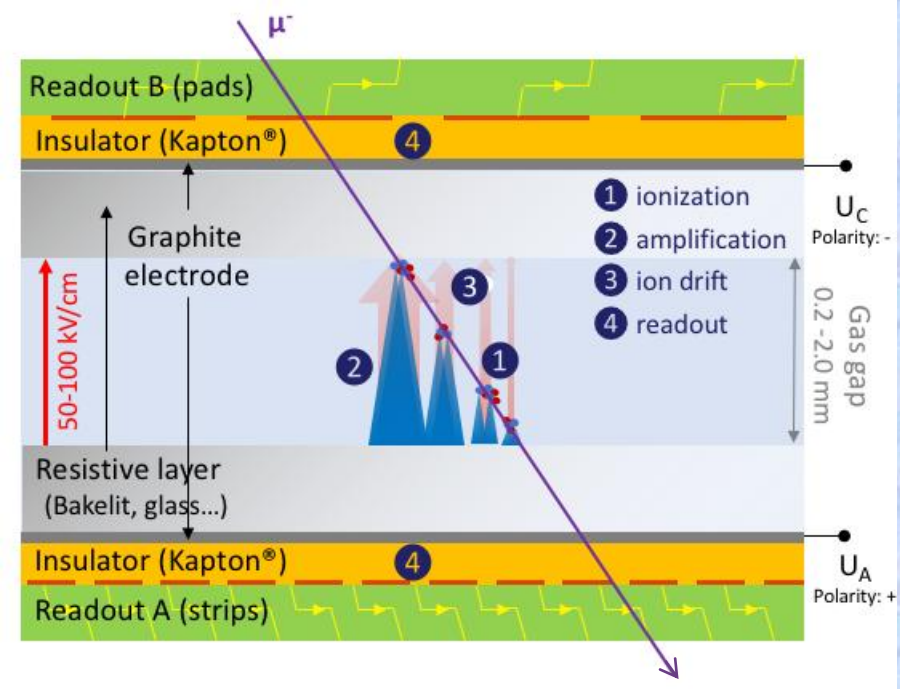


Gas Mixture

$R134a + C_4H_{10} + SF_6$

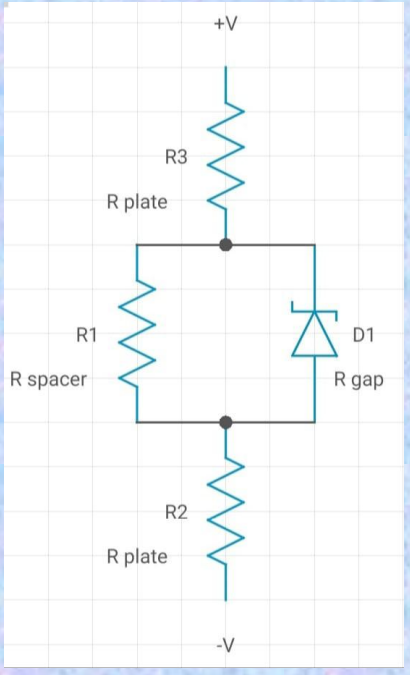
95.2% + 4.5%+ 0.3%

Working Principle

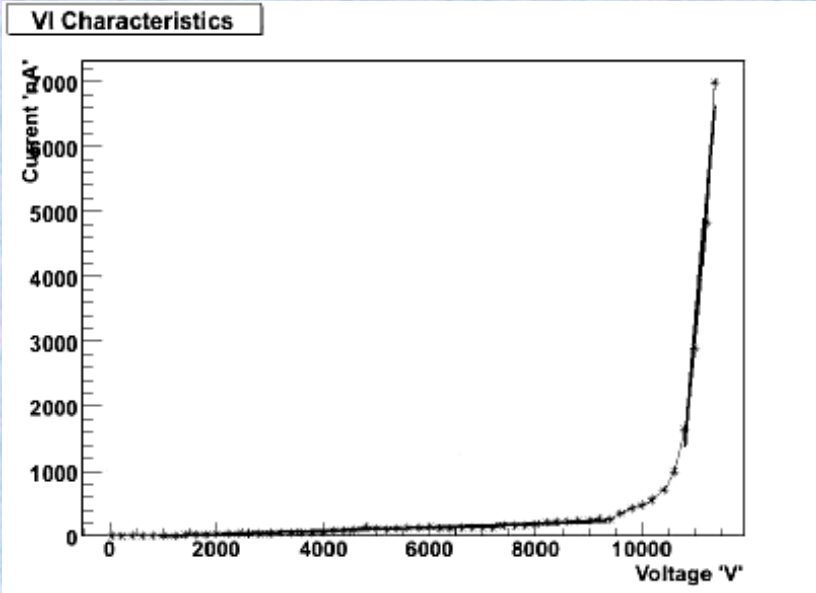


- Charged particles traversing the gas medium causes **primary ionization**
- The primary electrons produce secondary electrons by elastic and inelastic collisions due to the presence of high electric field
- This causes amplification of the primary signal also called **gas amplification**
- As the e-ions drift under the field they induce a signal on the readout strips
- The RPC is operated in **avalanche mode**

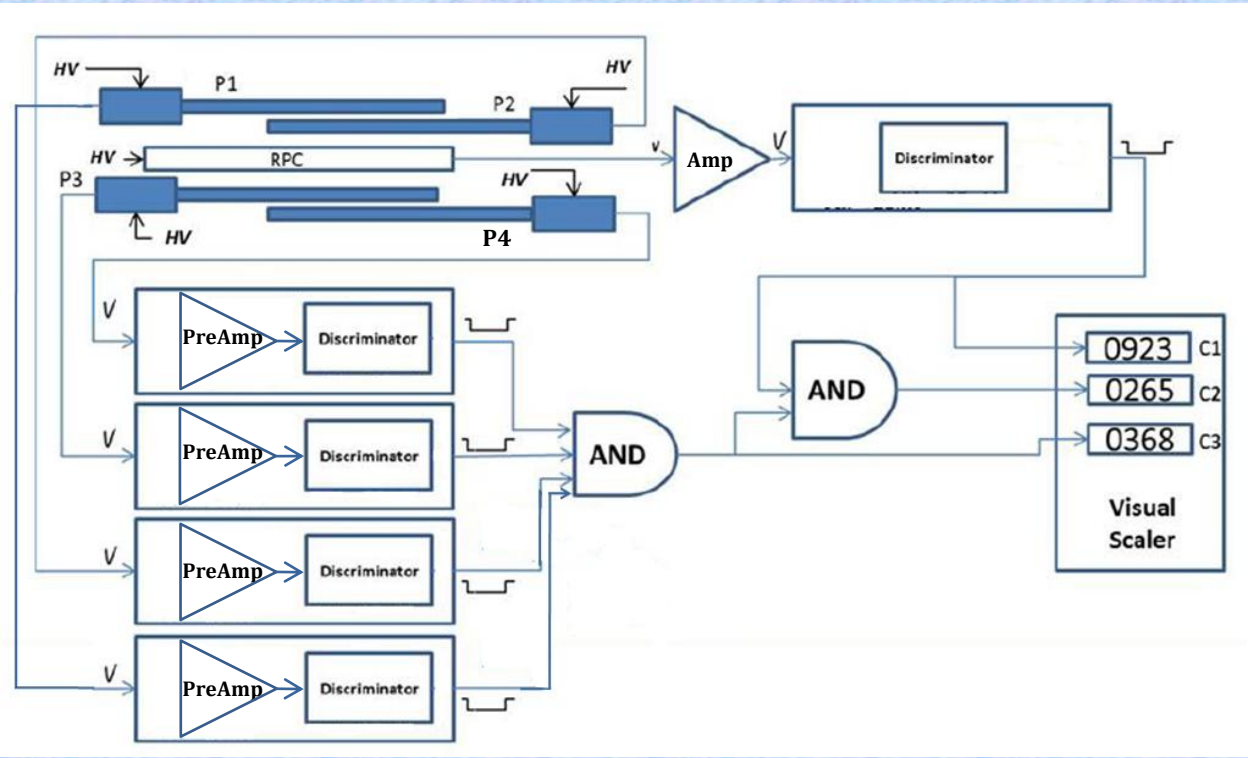
RPC Equivalent Circuit



- At low voltage:
  - $R_{gap} \approx \infty$
  - $\Delta V/\Delta I = R_{spacer}$
  - no multiplication
- At high voltage:
  - $R_{gap} \approx 0$
  - $\Delta V/\Delta I = R_{plate}$
  - high multiplication



Experimental Setup

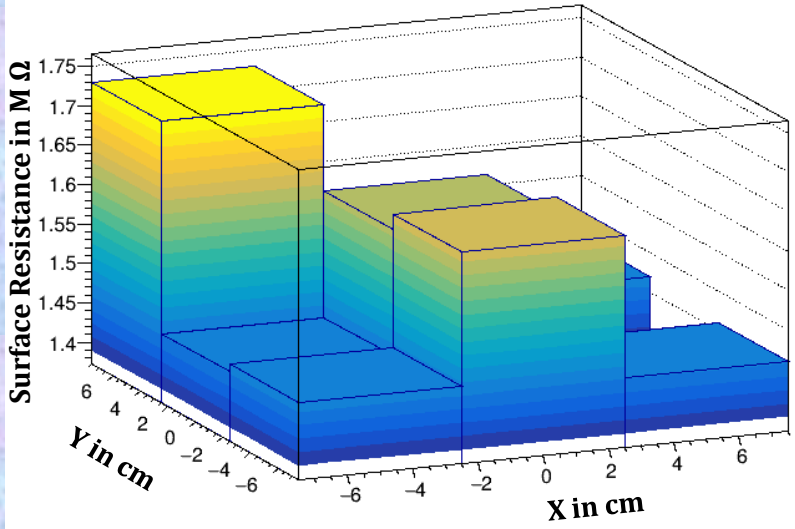


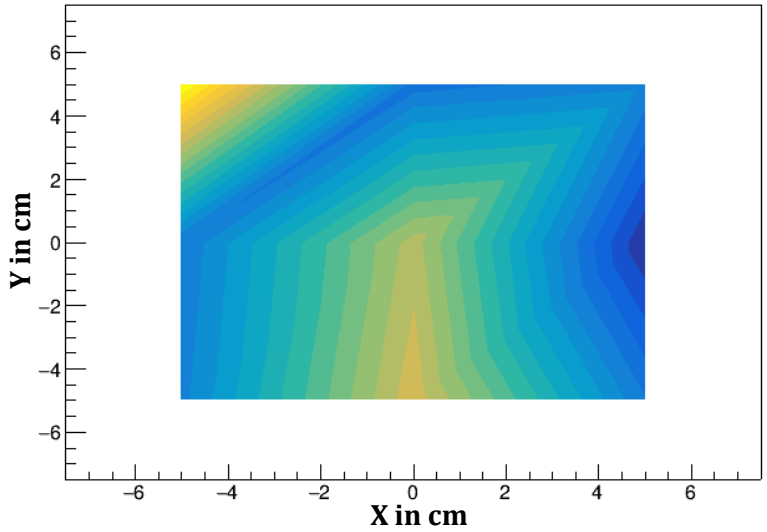
P1, P2, P3 and P4 are plastic scintillators coupled to SiPM

Objectives

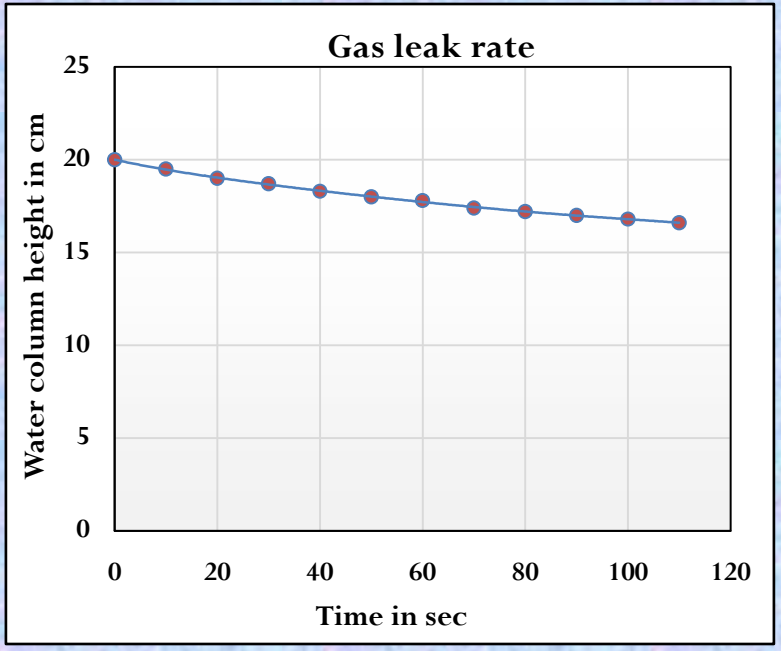
- Surface resistivity
- Leak test
- Dark current
- Noise rate
- Muon detection efficiency

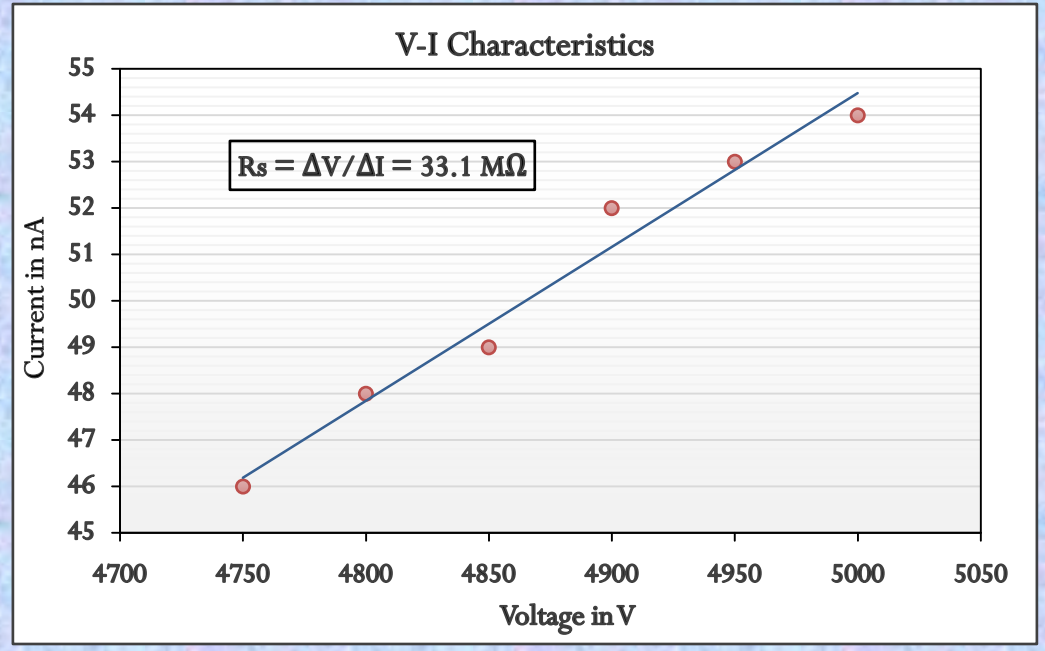
Surface Resistance Measurements



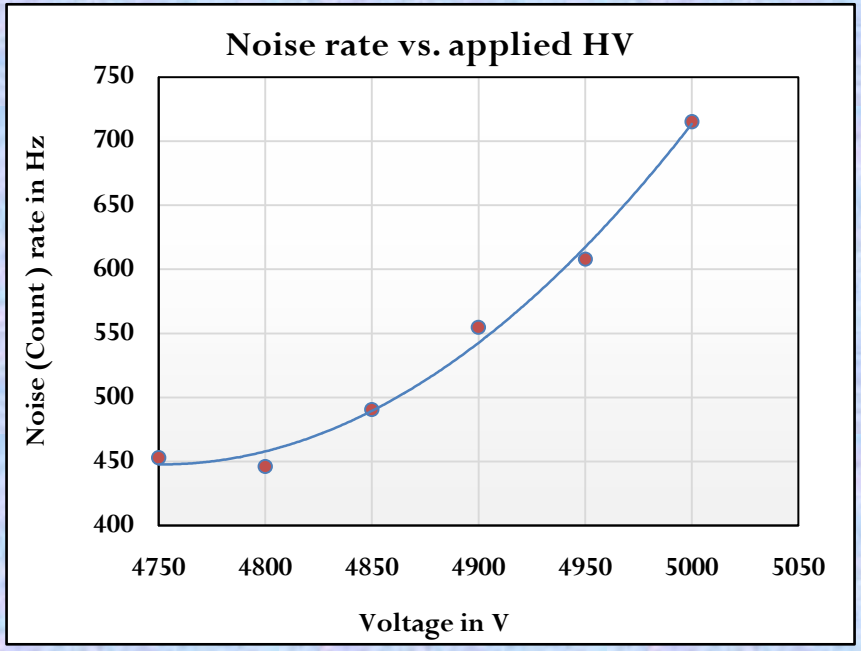


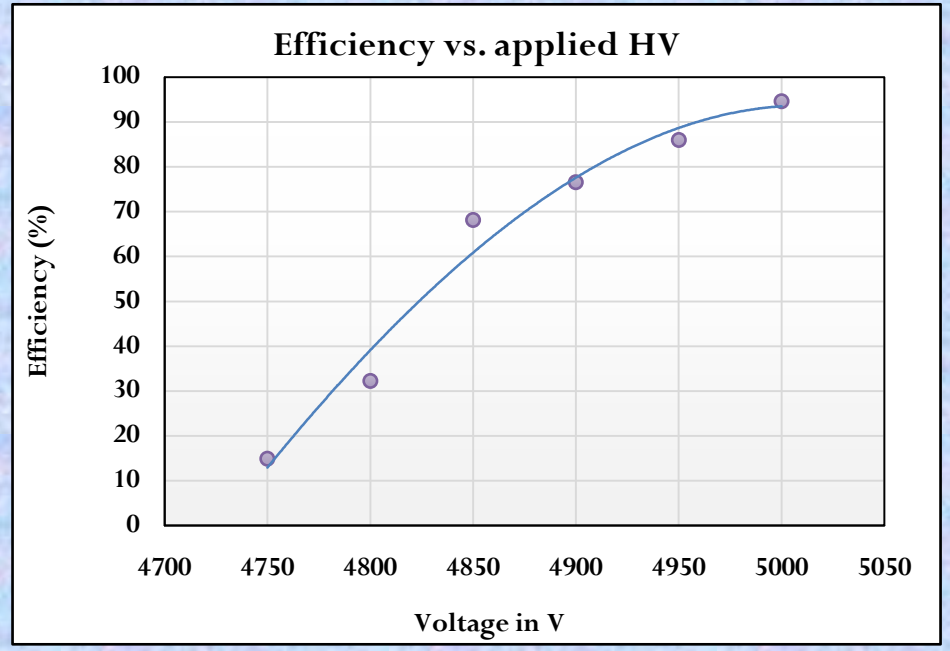
Results


Gas leak rate
Water column height in cm
25
20
15
10
5
0
0
20
40
60
80
100
120
Time in sec


V-I Characteristics
Rs = ΔV/ΔI = 33.1 MΩ
Current in nA
55
54
53
52
51
50
49
48
47
46
45
4700
4750
4800
4850
4900
4950
5000
5050
Voltage in V

Results


Noise rate vs. applied HV
Noise (Count) rate in Hz
750
700
650
600
550
500
450
400
4750
4800
4850
4900
4950
5000
5050
Voltage in V


Efficiency vs. applied HV
Efficiency (%)
100
90
80
70
60
50
40
30
20
10
0
4700
4750
4800
4850
4900
4950
5000
5050
Voltage in V

Conclusion

- The **surface resistance of the conductive layer** was found to be **quite uniform** across the surface. This ensures that the electric field is uniform across the gas-gap.
- The **V-I characteristic followed linear relationship** which indicates that the voltage is below breakdown. The resistance of the spacer was determined to be **33.1 MΩ**
- The **single count rate** of the RPC increases with the applied voltage and follows **a non-linear relationship**.
- The **efficiency** initially increases with the applied voltage and then **starts saturating after about 9.9 KV**.

THANK YOU!

BACKUP SLIDES

Electronic Setup