RPC Characterization

DRD1 school 2024

Group 8:

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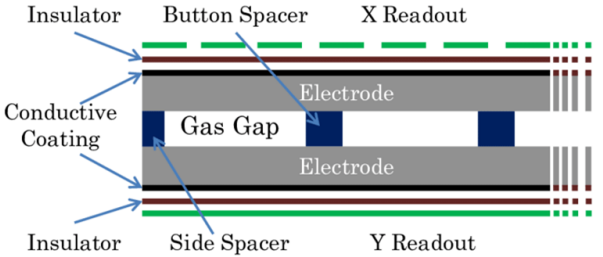
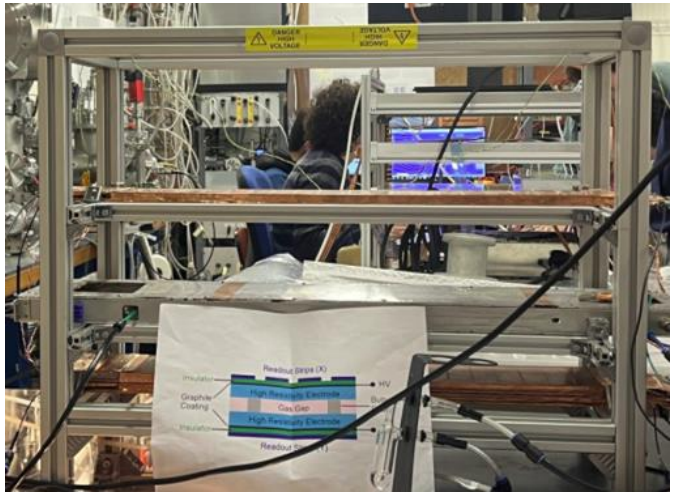
Experimental setup

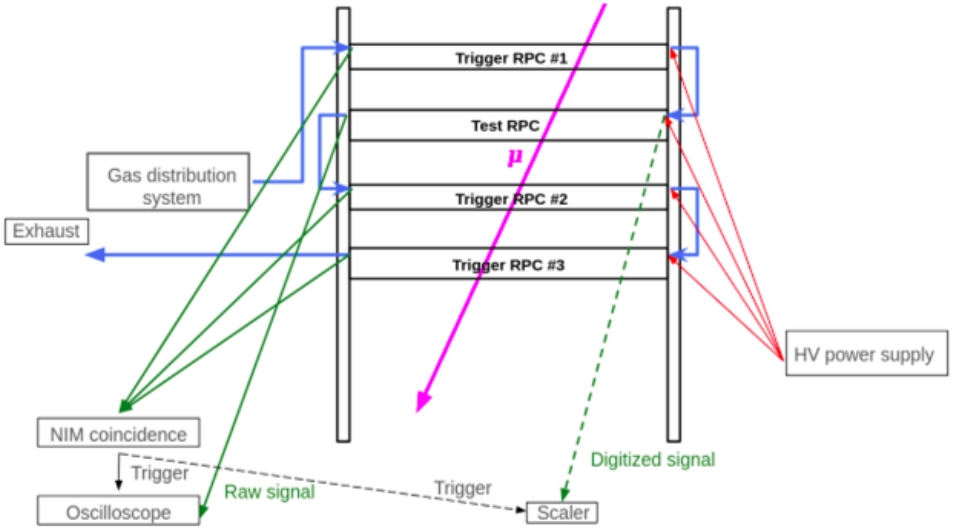


Main instrumentation:

- 3 RPCs with 1 mm gas gap used as **trigger** chambers
- 1 RPC with 1 mm gas gap used as **test** chamber
- Gas mixture (94.7% $C_2H_2F_4$, 5% i-C_4H_{10} , 0.3% SF_6)

Further instrumentation: oscilloscope, high voltage power supply, NIM modules, gas supply





Experimental setup

The coincidence of the 3 trigger chambers selects events from **cosmic muons**.

Sensors measuring temperature, pressure and humidity were employed in order to monitor the working condition of the detector

The properties of the gas molecules depend on its pressure and temperature → affect the HV working point:

$$HV_{corr} = HV_{app} \cdot \frac{P_0}{P} \cdot \frac{T}{T_0}$$

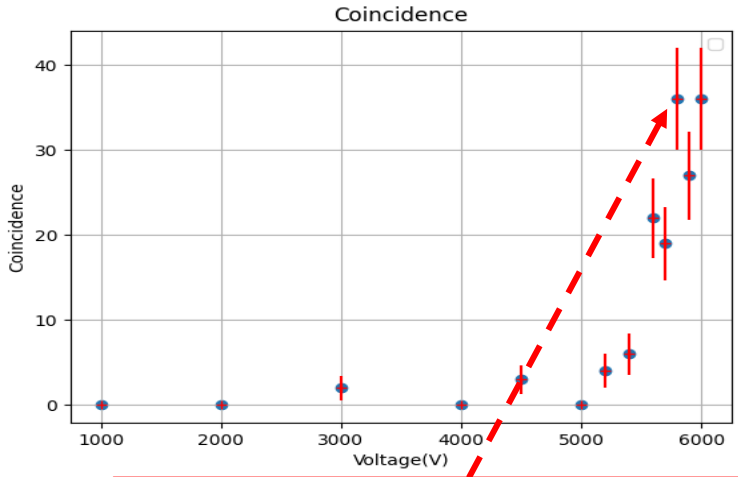
Pressure	966 mbar
Temperature	24.4 C°
P_0	1010 mbar
T_0	20 C°

E.g., in our laboratory condition for an applied voltage of 5800V, the effective HV is 6064V

Characterization of an RPC

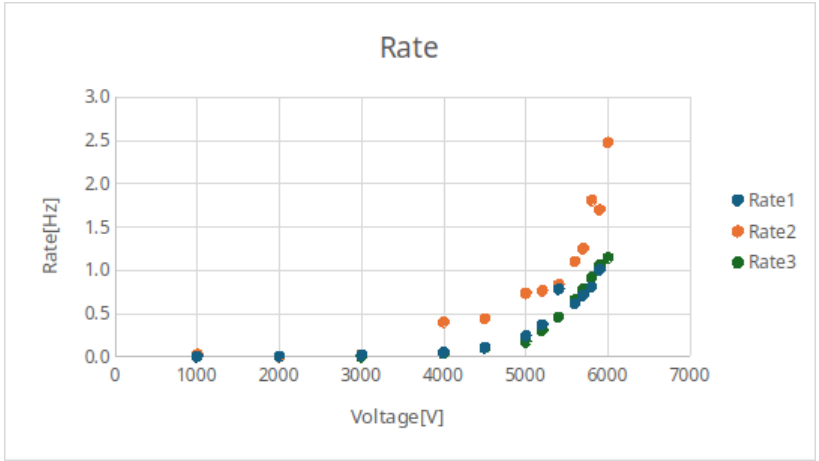
The working point is defined as the high voltage at which the number of coincidences plateaus, ensuring maximum efficiency and stable operation without excessive noise or discharge.

- Number of coincidence events for different voltages in 100 seconds

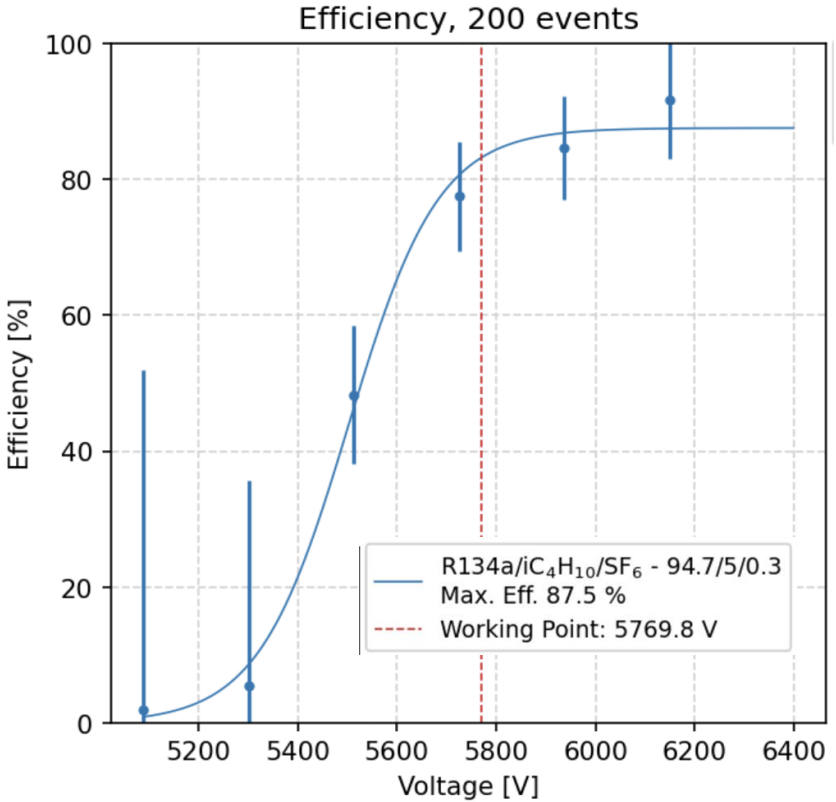


The HV of working point is 5800V

- Number of each trigger chamber for different voltages in 100 sec.



Efficiency curve



Sigmoid fit: $\epsilon(HV_{eff}) = \frac{\epsilon_{max}}{1 + e^{\gamma(HV_{eff} - HV_{50})}}$

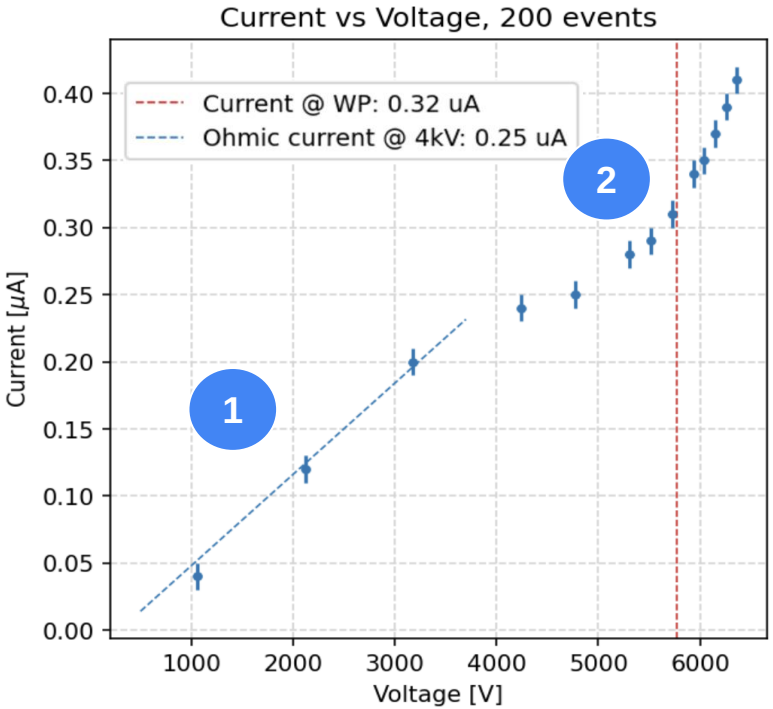
Where:
HV_{eff}: Applied voltage corrected by T/P
ε_{max}: Maximum efficiency
HV_{50}: Voltage where efficiency = 50%

Working point: voltage for which efficiency reach 95% of ε_{max}, plus 150 V.

The single point are obtained as:
Efficiency = N. signal / N. trigger

with the Standard poissonian errors.

Current curve

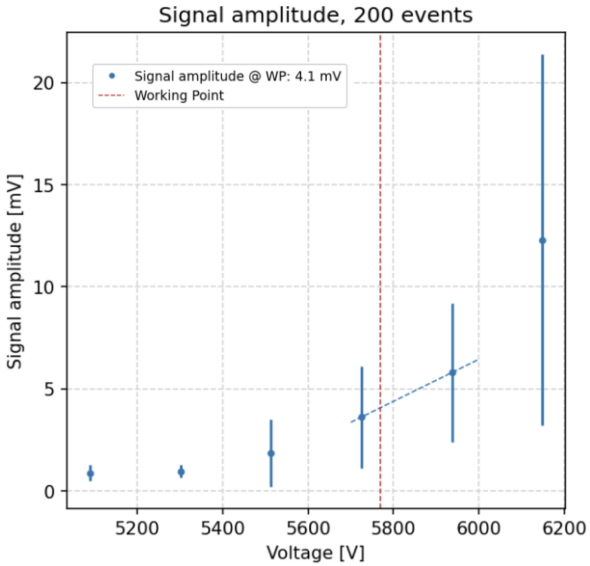


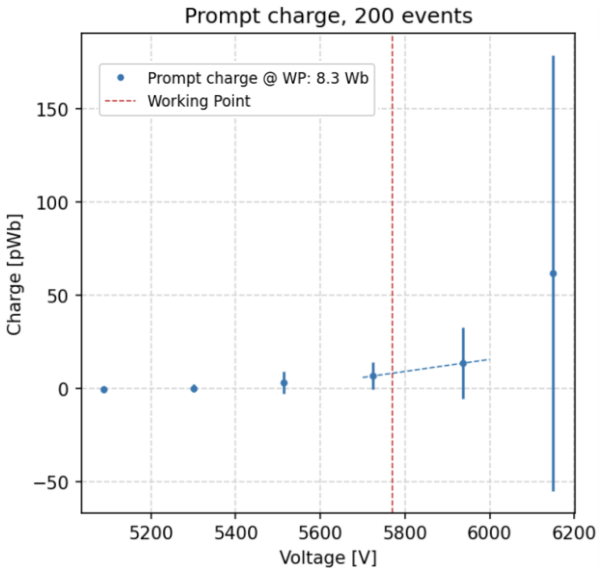
Two different trends:

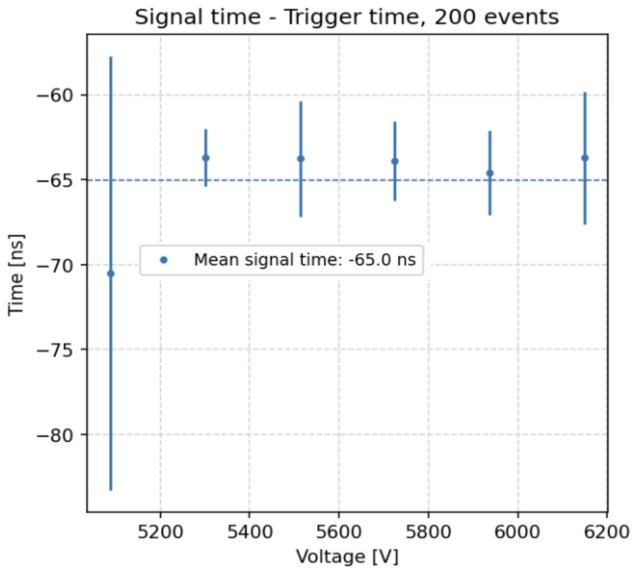
1) **Ohmic linear contribution** up to 4 kV:
   This take in account all the possible ohmic current due to detector's imperfection;

1) **Physics exponential contribution** after 4 kV:
   This is the contribution of the ionization inside the gas gap, and it shows an exponential increase.

Other relevant parameters



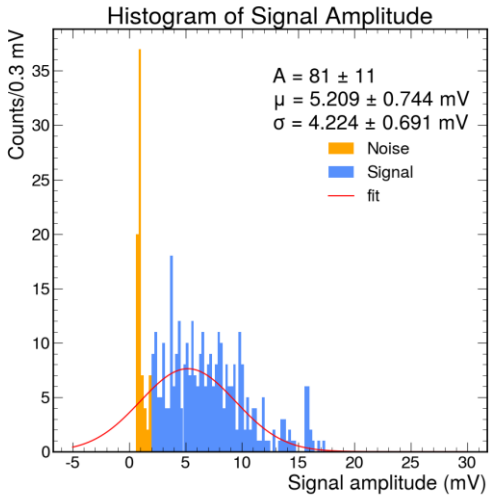




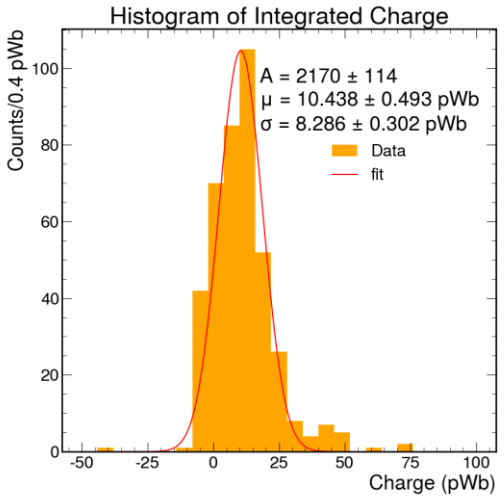
- Increase as the Voltage increases;
- Similar trend to the increase of the prompt charge:
  - The charge is the integral of the signal in mV

- The time difference between the signal and the trigger remain constant over the Voltage applied.

High statistics run at the Working Point



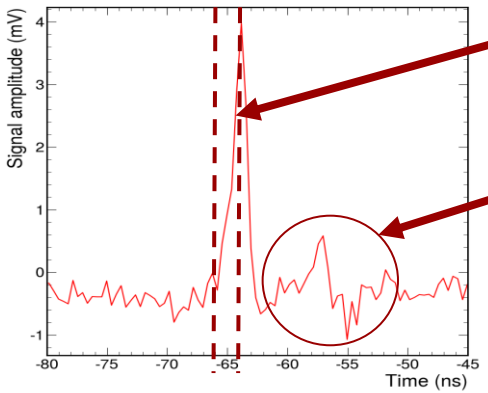
Integrating the signals



At the working point (5800 V) → higher statistics run:

- low signal amplitude (<2 mV): **noise**
- intermediate signal amplitude (<15 mV): signals generated by **avalanches**
- high signal amplitude (>15 mV): signals generated by **streamers**

Time resolution

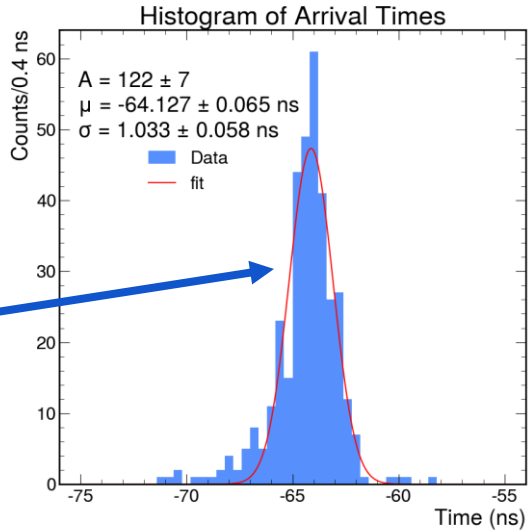


Rising time of the signal: ~2 ns

Delayed signal probably due to an afterpulse generated by photon induced avalanche

From the peaking time distribution, performing the gaussian fit

→ **time resolution of ~1 ns**



Conclusions

We operated RPC chambers and measured some relevant parameters:

- With a trigger made of 3 RPCs in **coincidence** aligned with one RPC under test
- A maximum efficiency of **~90%** was reached at a working point of 5800V
- The average signal amplitude (and integrated charge) **increases** as the voltage increases, as expected
- The signal time resolution of the chamber was **1 ns** at the working point

Thank you for your attention!