Test on new RPC prototypes for applications in future cosmic ray experiments

Luca Carfora

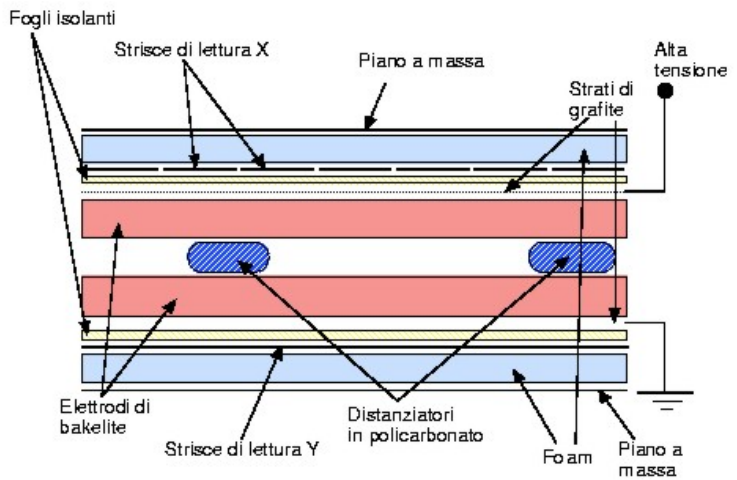
Università degli Studi di Roma Tor Vergata - INFN Roma2

Cosmic Ray Physics in Space - June 15th 2017

RPC: Resistive Plate Chambers

Gas detectors with high **time resolution**. Used as **counters** or **trackers** of charged particles in high energy physics experiments. ATLAS and CMS in **LHC** at CERN and **ARGO-YBJ** in Tibet (4300 m a.s.l.).

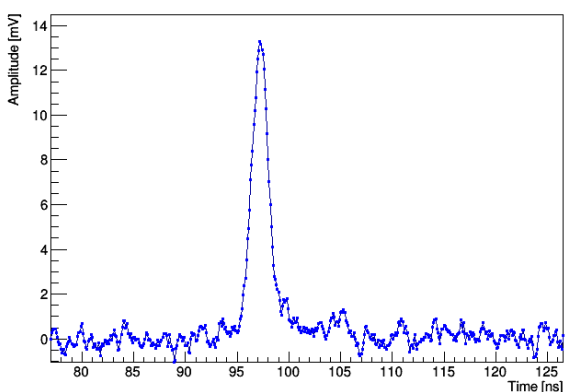
- **Gas** volume (94.5% TFE, 5% isobutane, 0.5% SF_6);
- **Resistive** plane electrodes with $\vec{E}$ field for charge multiplication;
- One or more **readout strips**, separated from electrodes with an insulating.



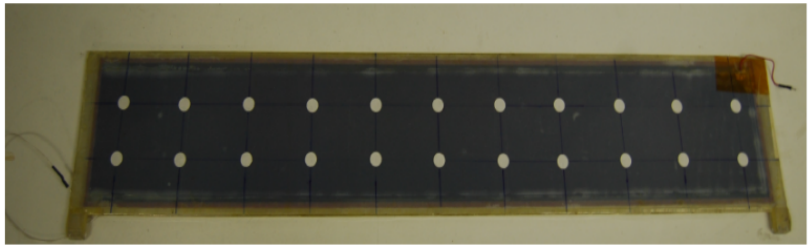
Two working modes: **avalanche** mode and **streamer** mode (local high field effects).

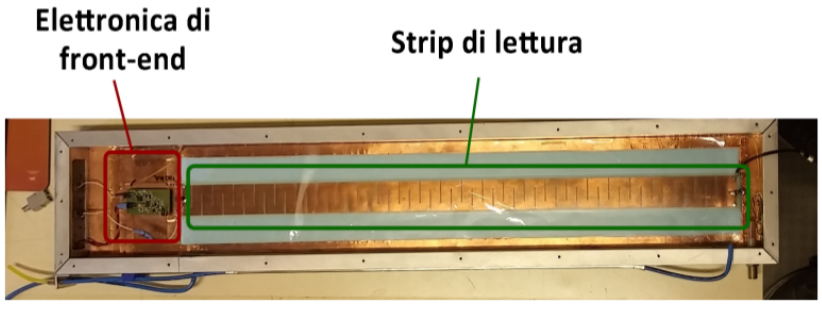
2 mm gap	Amplitude	Length	Charge
Avalanche	$\simeq$ mV	2-5 ns	1 pC
Streamer	100 mV	20 ns	100 pC

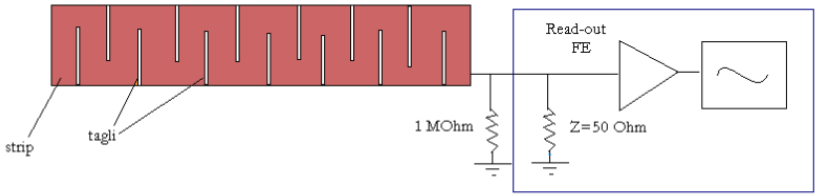
Prompt signal ES electrodes:



Test detectors





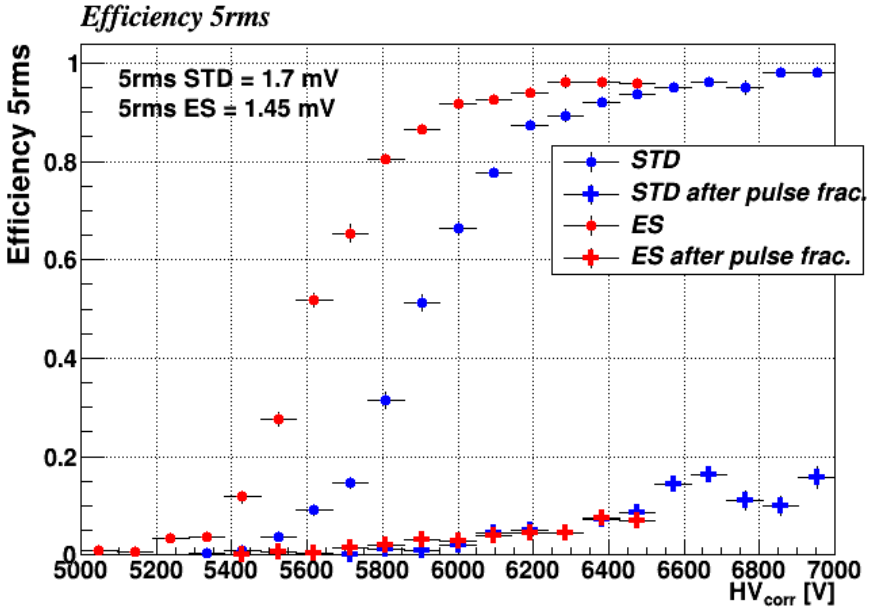


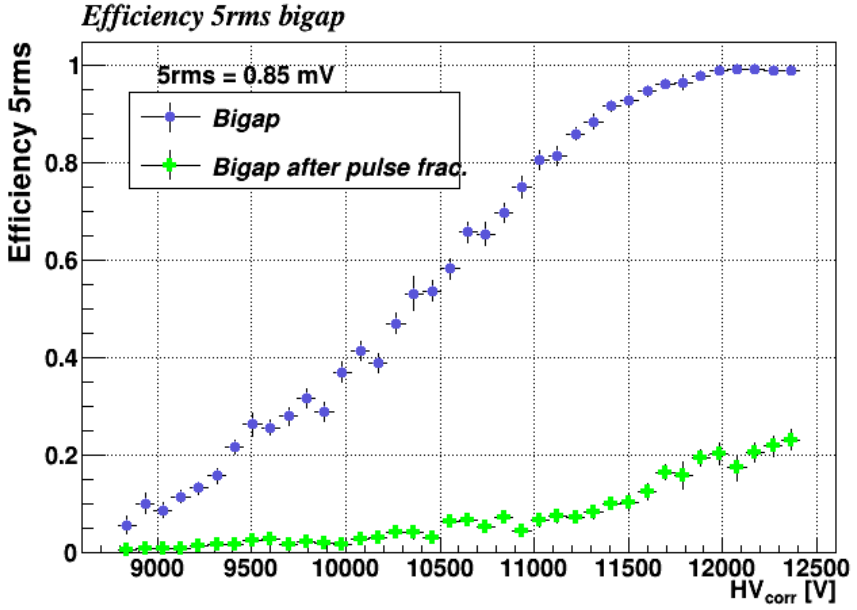
- **Monogap** 1 mm gap with 1.8 mm electrodes (phenolic resin with cellulose fiber) - STD;
- **Monogap** 1 mm gap with 0.8 mm electrodes (phenolic glass) - ES;
- **Bigap** $1 + 1$ mm gap with 0.5 mm electrodes (phenolic glass); inner electrode: 170 μm of phenolic glass.

Prompt signal acquired with a **Greek-like strip** properly adapted to the input oscilloscope impedance.

Efficiency

After pulse fraction: defined as the # events where there is at least a streamer normalized to the total # events.



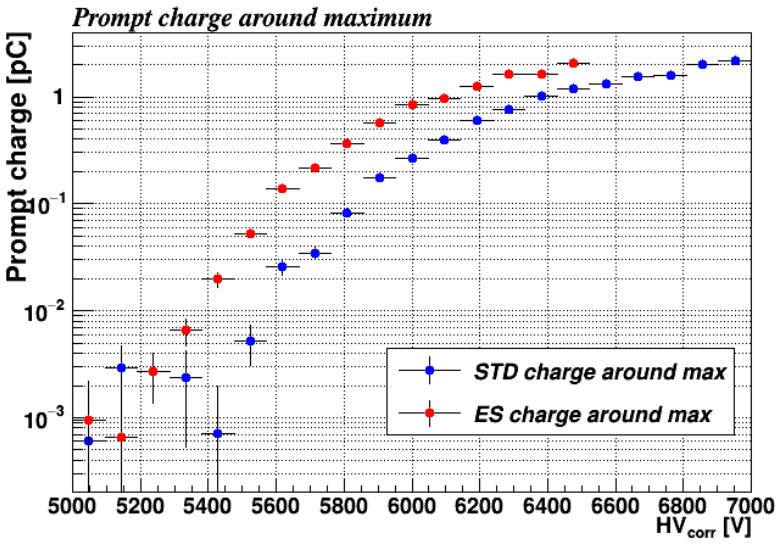


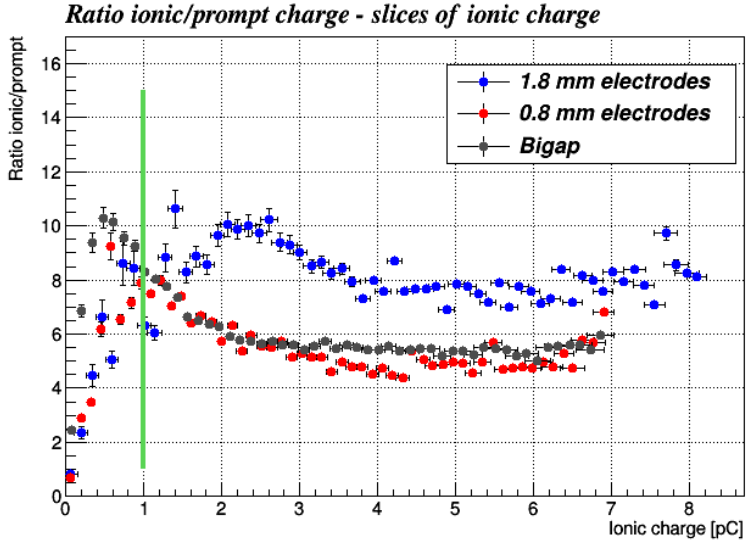
- Max efficiency 94%;
- ES anticipates of 300 V on STD;
- A. p. phenomenon does not depend on electrode thickness.

- Max efficiency: 99%;
- From 5 to 99% in 3 kV
- A. p. phenomenon appears at 10 kV.

Charges

Prompt signal (a few ns): induced on copper strips; it depends on thickness electrodes. **Ionic** signal (tens μs): induced on a graphite electrode and read as current signal on a 10 kΩ resistance.





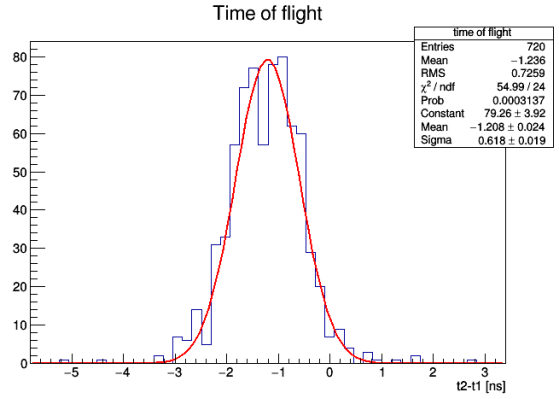
- Max induced charge in full efficiency: 1.2 pC for STD and 1.4 pC for ES;
- ES anticipates of 300 V on STD.

- At high charges, STD arrives to 8, ES to 5, the bigap to 6;
- Ionic charge sensitivity is 1 pC for ES and bigap, 2 pC for STD.

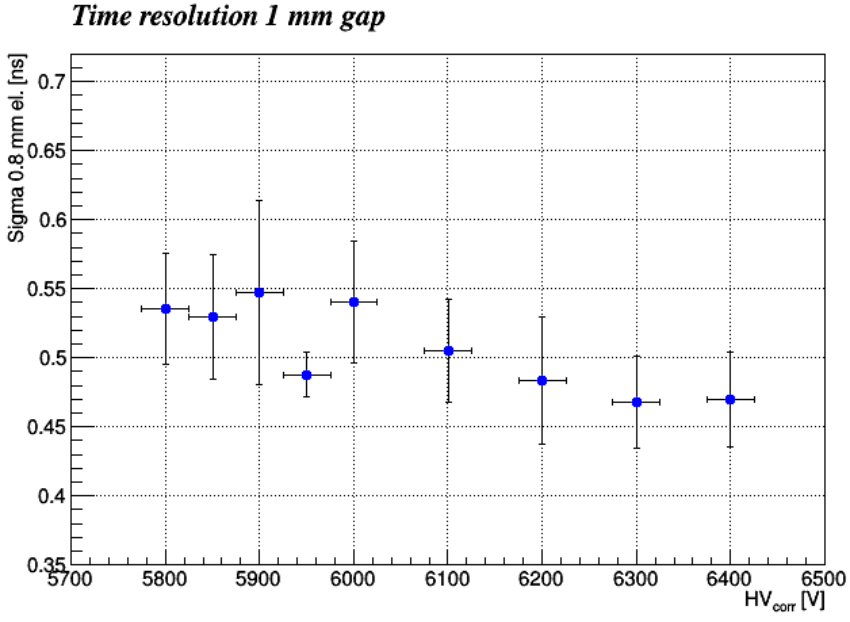
Time resolution

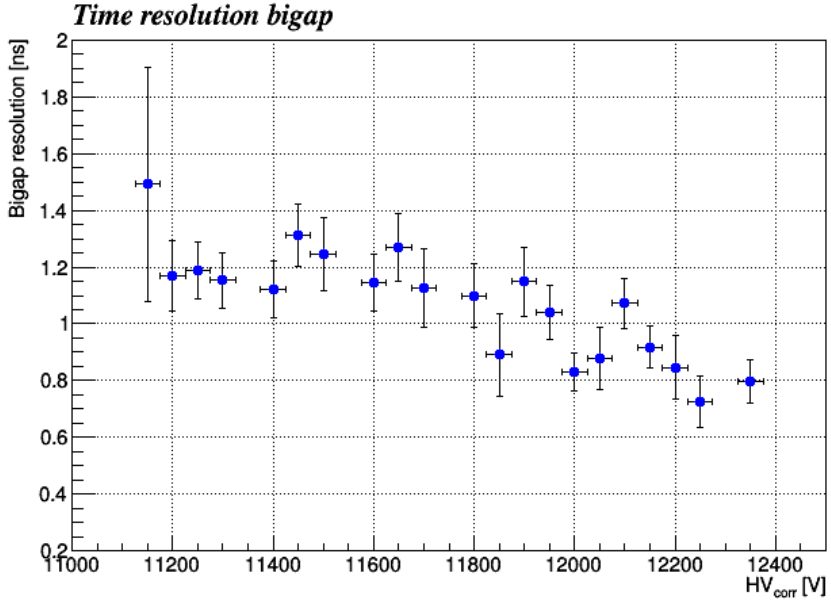
TOF distribution between ES and STD:
Gauss fit $\rightarrow$ sigma $\sigma(t_2 - t_1) \rightarrow$

$$\sigma^2(t_2 - t_1) = \sigma^2_{STD}(t_1) + \sigma^2_{ES}(t_2) = 2\sigma^2_{1\,\mathrm{mm}}$$



Let's repeat for each HV:





$\sigma_{1\,\mathrm{mm}} = (470 \pm 30)\mathrm{ps}$

$\sigma_{bigap} = (800 \pm 70)\mathrm{ps}$