

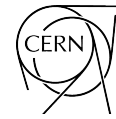
# Summary Lab

## 01-02/2026



EP-DT  
Detector Technologies

# MFC issue: Laboratory SF6 MFC



Binary gas analyser: tested by Mattia, Mariacristina  
Ongoing coding for logging: Max

Difference in reading between GIF and lab for the different MFC:

- R134a:  $(0.5 \pm 0.3) \%$

- CO2:  $(0.51 \pm 0.03) \%$

- iC4H10:  $(-0.2 \pm 0.2) \%$

- SF6:  $(-0.54 \pm 0.03) \%$

Recalibrated only SF6 MFC: now same reading between lab and GIF

# Efficiency: before and after SF6 calibration

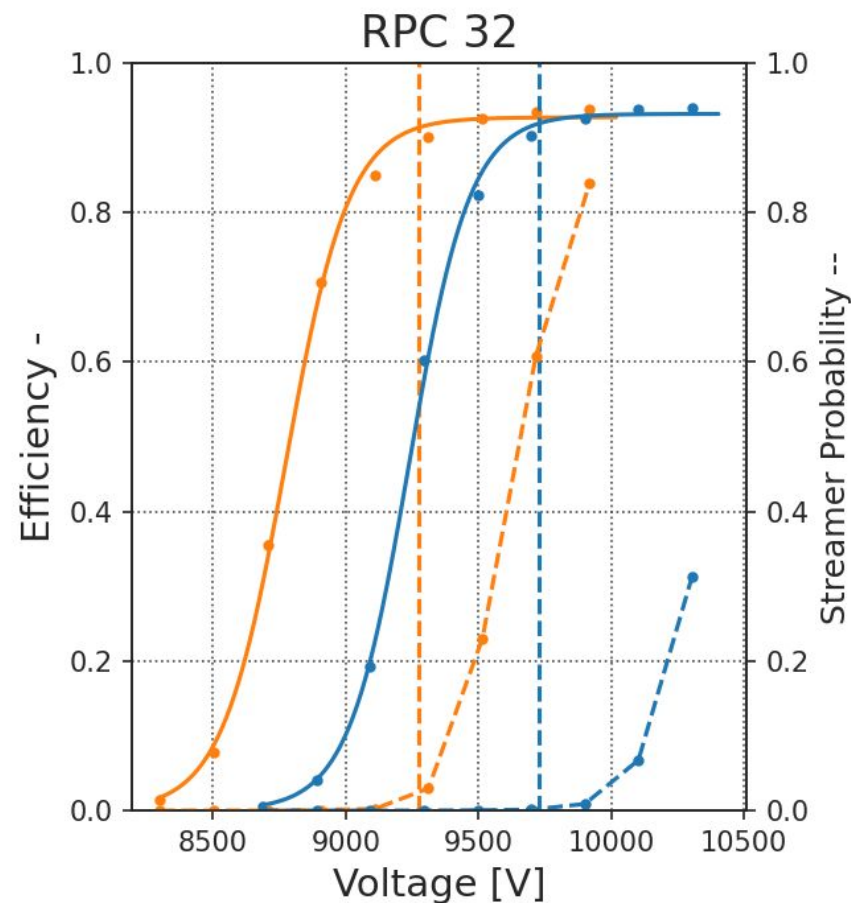
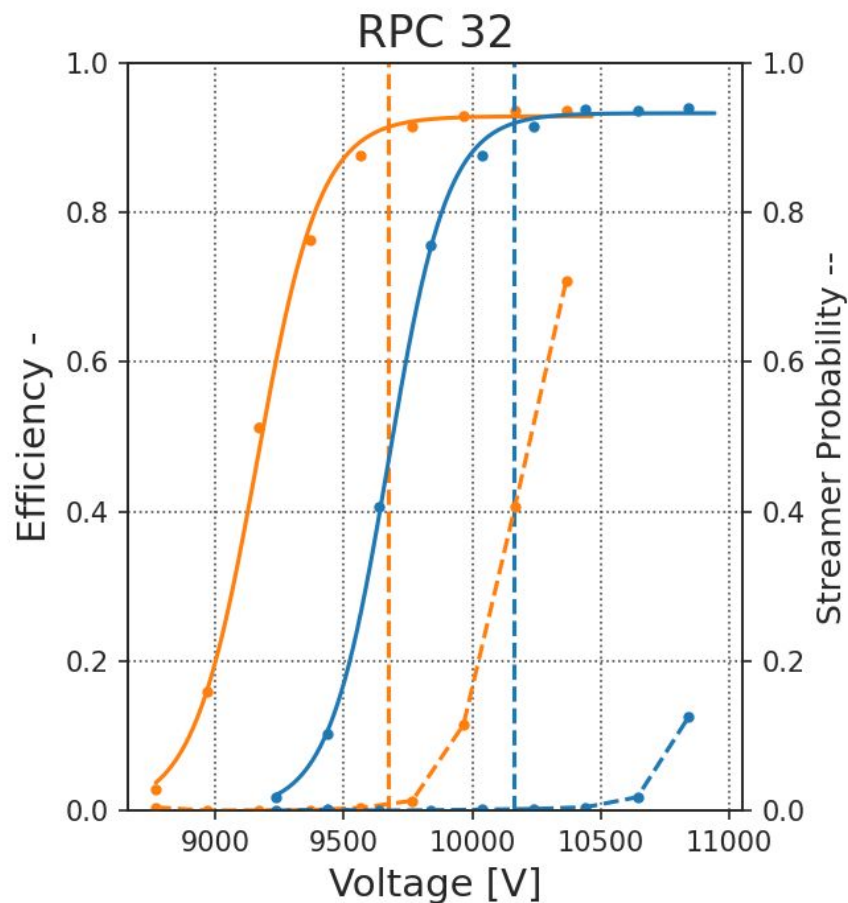


CO2 Op5, 2026\_01\_14  
Eff: 92.85 %,  $\bar{S}P$ : 0.88 %, WP: 9676 V

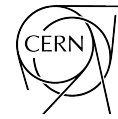
STD, 2026\_01\_24  
Eff: 93.26 %,  $\bar{S}P$ : 0.18 %, WP: 10164 V

CO2 Op5, 2026\_02\_04  
Eff: 92.71 %,  $\bar{S}P$ : 2.48 %, WP: 9276 V

STD, 2026\_02\_03  
Eff: 93.17 %,  $\bar{S}P$ : 0.23 %, WP: 9726 V

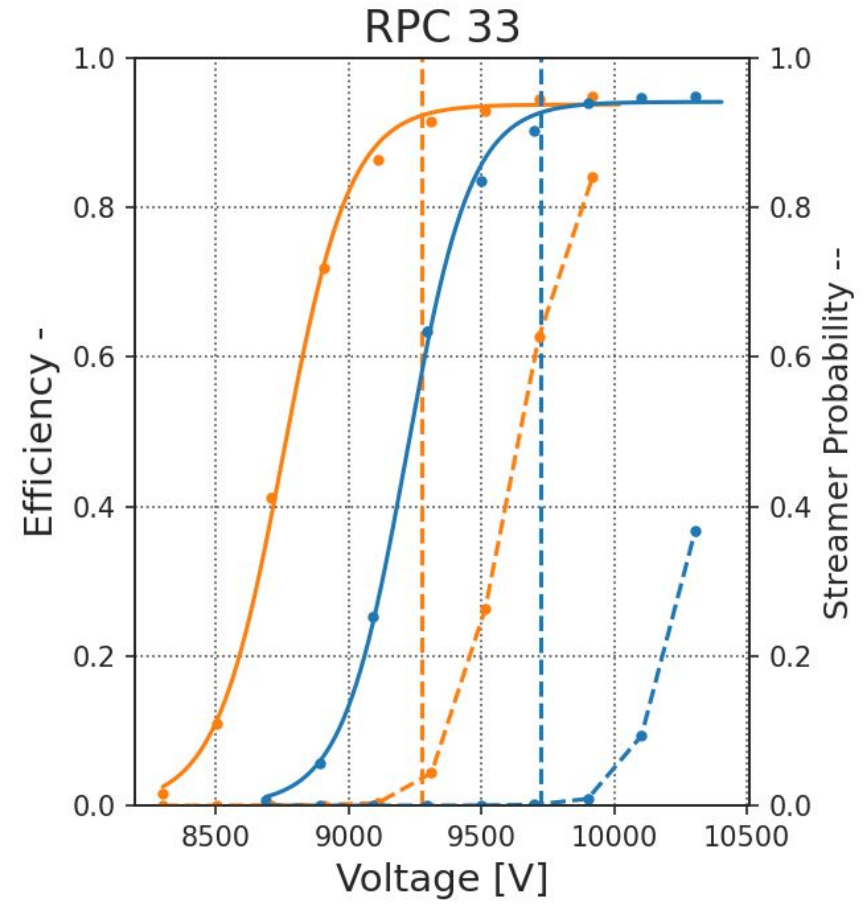
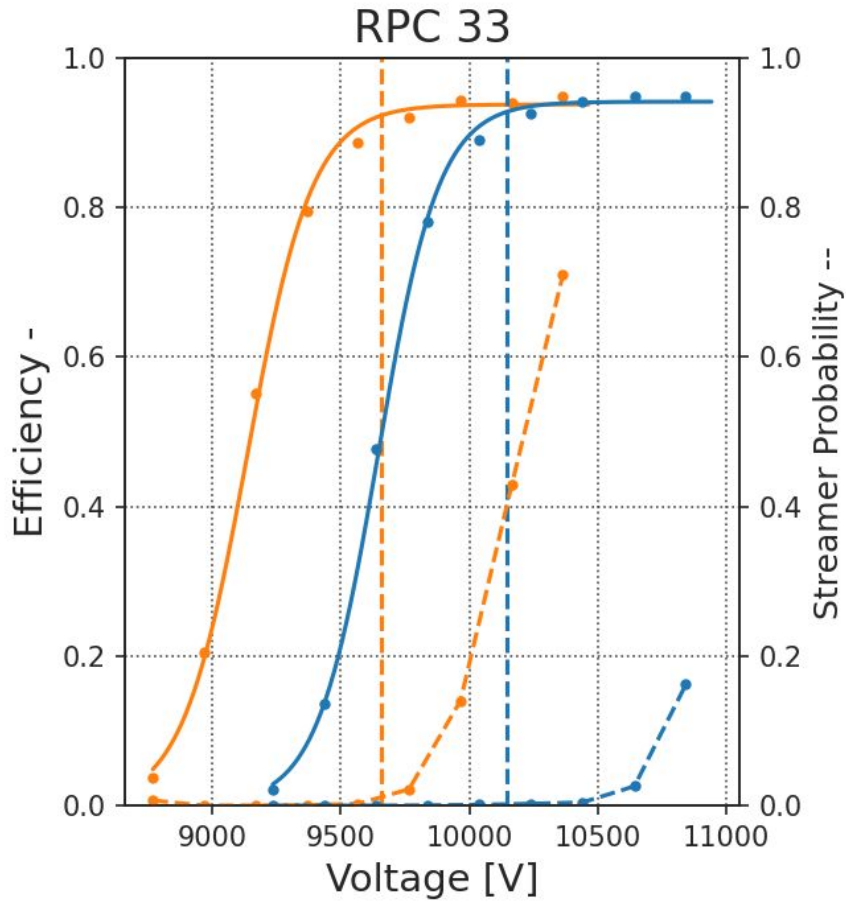


# Efficiency: before and after SF6 calibration

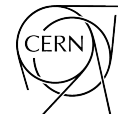


CO2 Op5, 2026\_01\_14  
Eff: 93.77 %, SP: 1.14 %, WP: 9659 V  
STD, 2026\_01\_24  
Eff: 94.14 %, SP: 0.18 %, WP: 10145 V

CO2 Op5, 2026\_02\_04  
Eff: 93.76 %, SP: 3.62 %, WP: 9275 V  
STD, 2026\_02\_03  
Eff: 94.11 %, SP: 0.21 %, WP: 9725 V

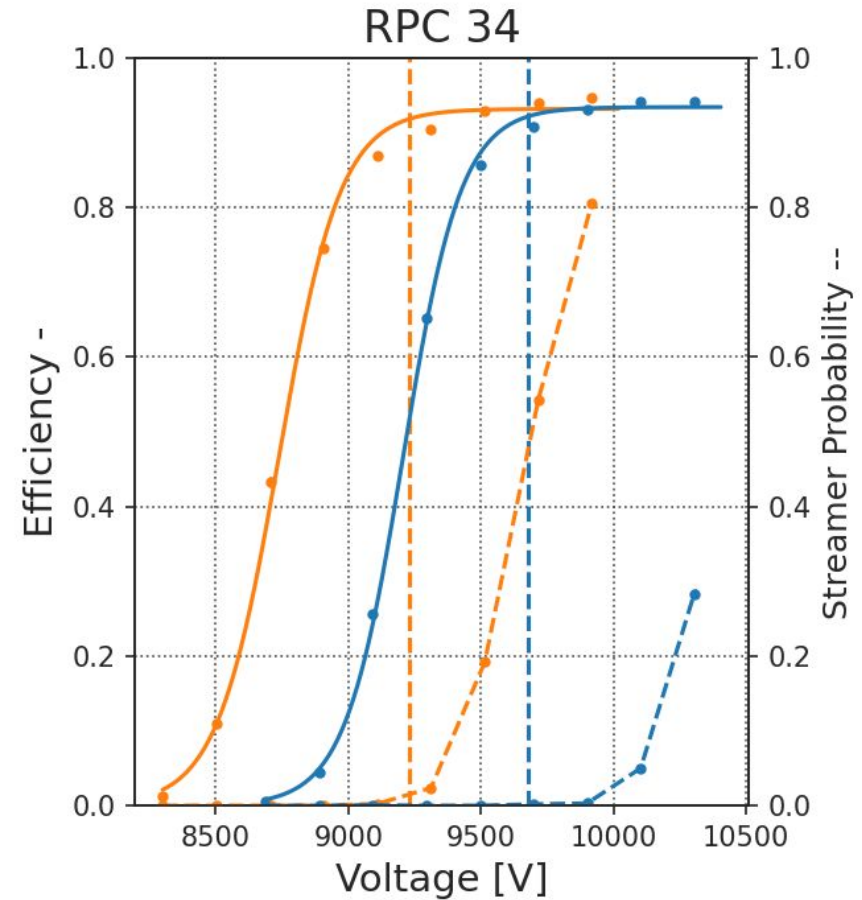
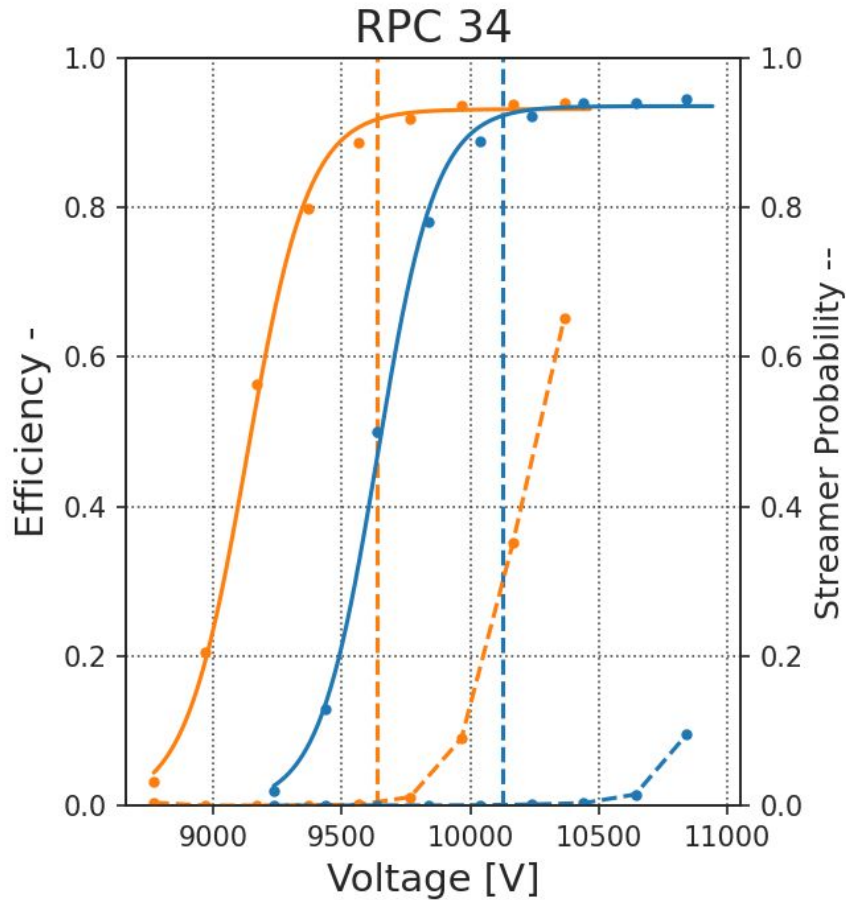


# Efficiency: before and after SF6 calibration

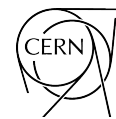


CO2 Op5, 2026\_01\_14  
Eff: 93.13 %,  $\bar{S}P$ : 0.47 %, WP: 9635 V  
STD, 2026\_01\_24  
Eff: 93.54 %,  $\bar{S}P$ : 0.10 %, WP: 10124 V

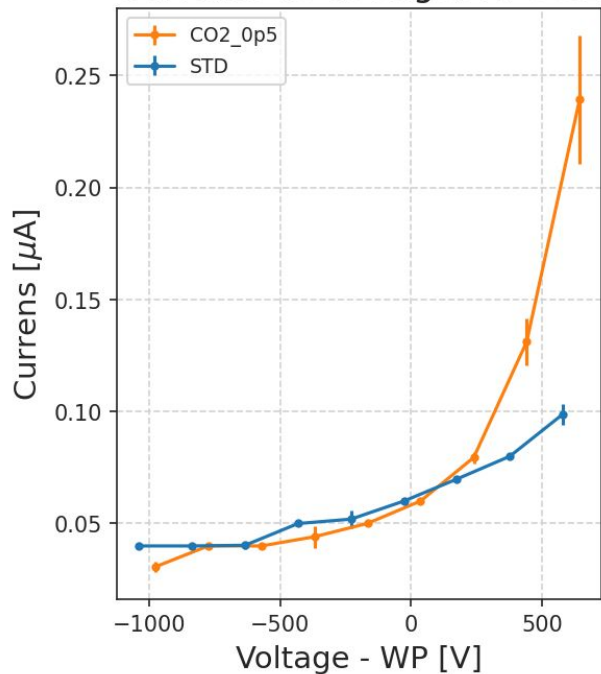
CO2 Op5, 2026\_02\_04  
Eff: 93.16 %,  $\bar{S}P$ : 1.50 %, WP: 9231 V  
STD, 2026\_02\_03  
Eff: 93.41 %,  $\bar{S}P$ : 0.17 %, WP: 9680 V



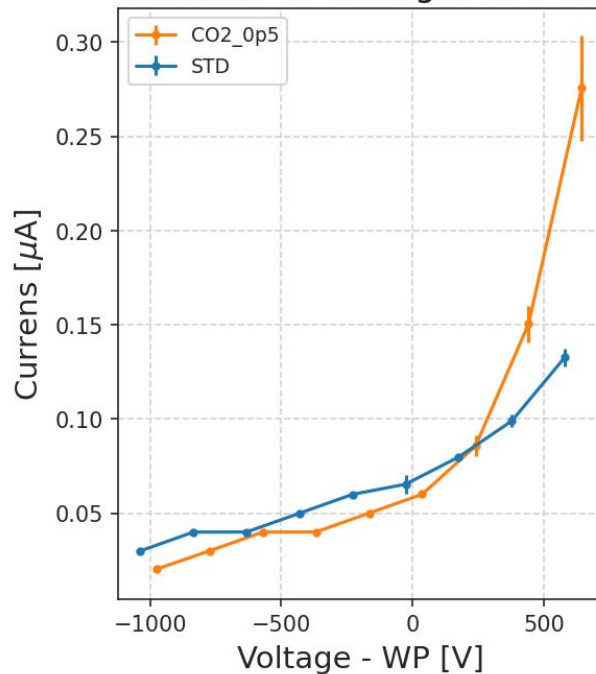
# Currents (calibrated)



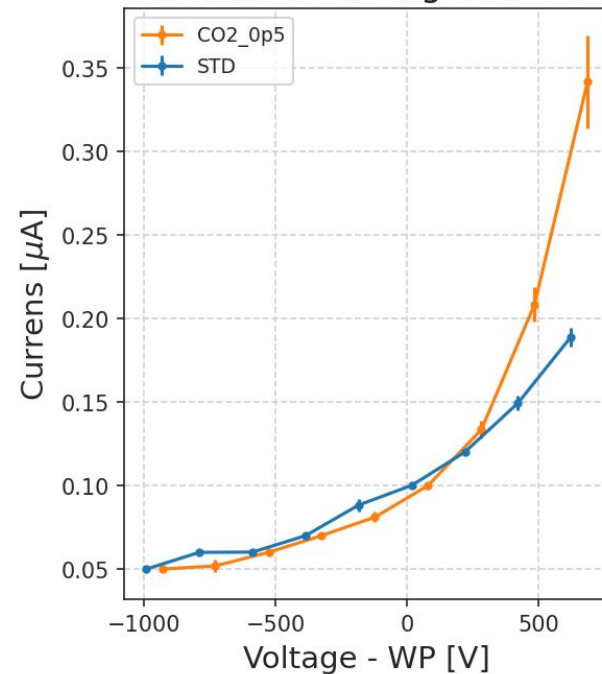
Currents vs voltage, RPC 32



Currents vs voltage, RPC 33

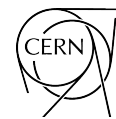


Currents vs voltage, RPC 34

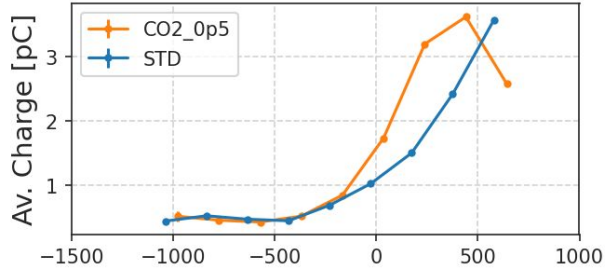


- Similar current values between the detectors, higher for RPC 34

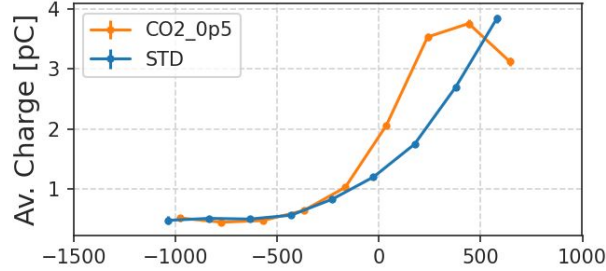
# Charge (calibrated)



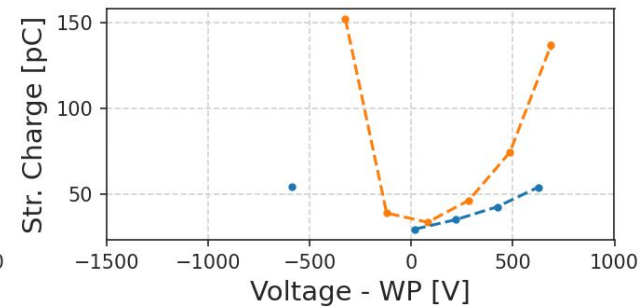
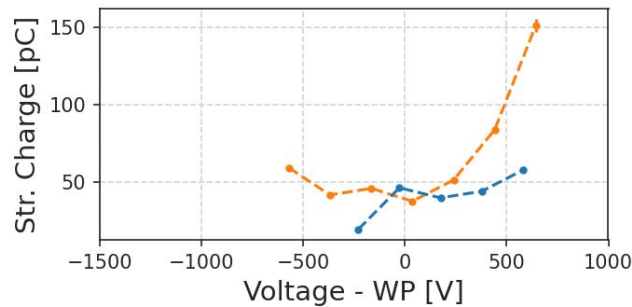
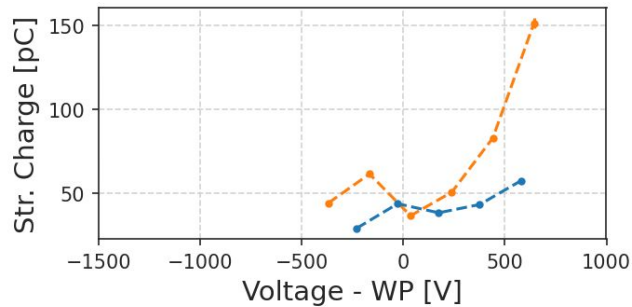
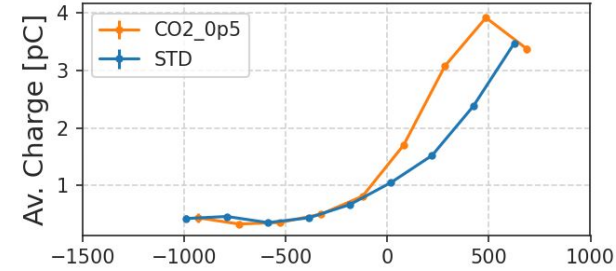
Charge vs voltage, RPC 32



Charge vs voltage, RPC 33

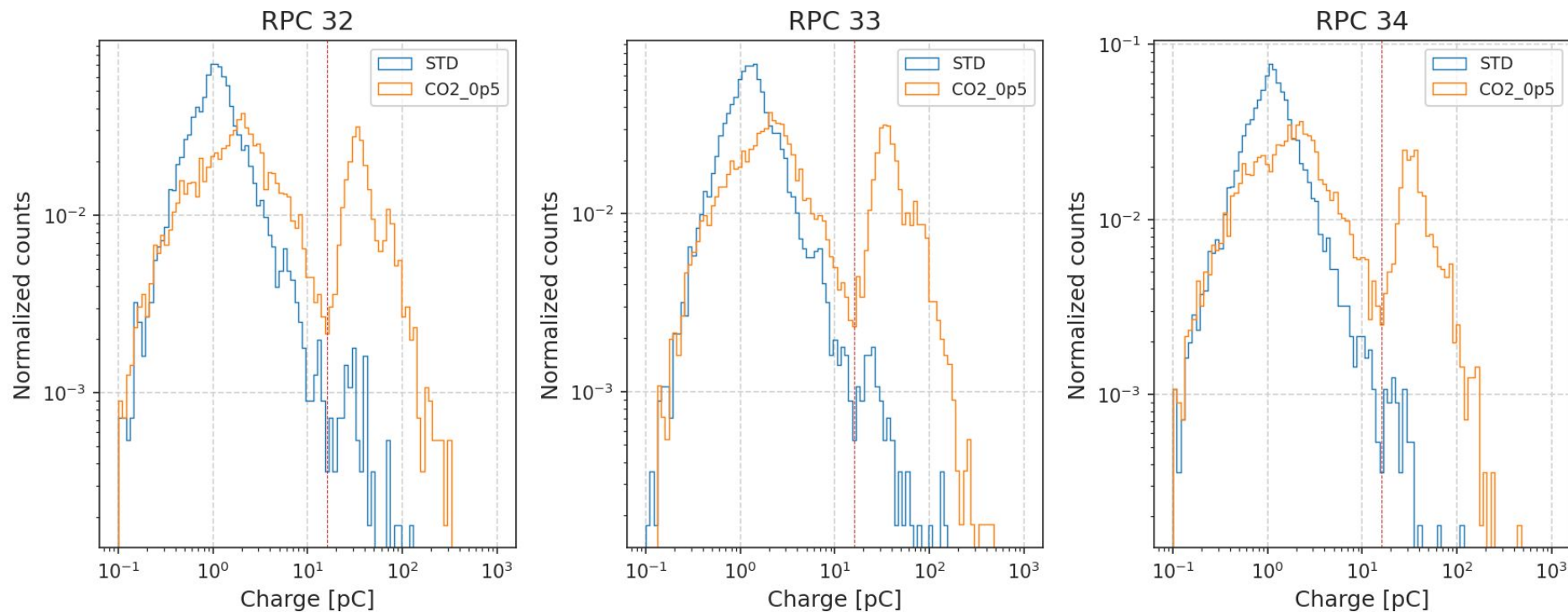
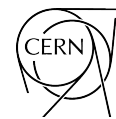


Charge vs voltage, RPC 34



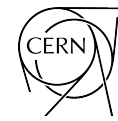
- Similar charge values between the three detectors

# Charge distribution (calibrated)

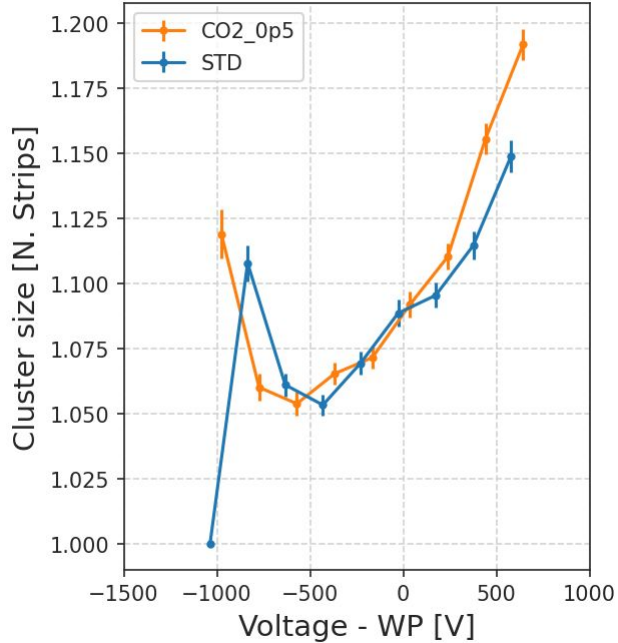


- Avalanche-streamer separation at the correct values

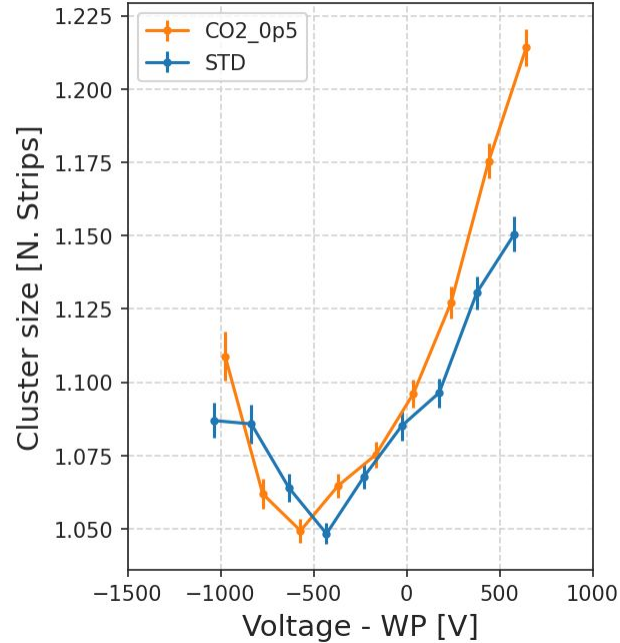
# Cluster size (calibrated)



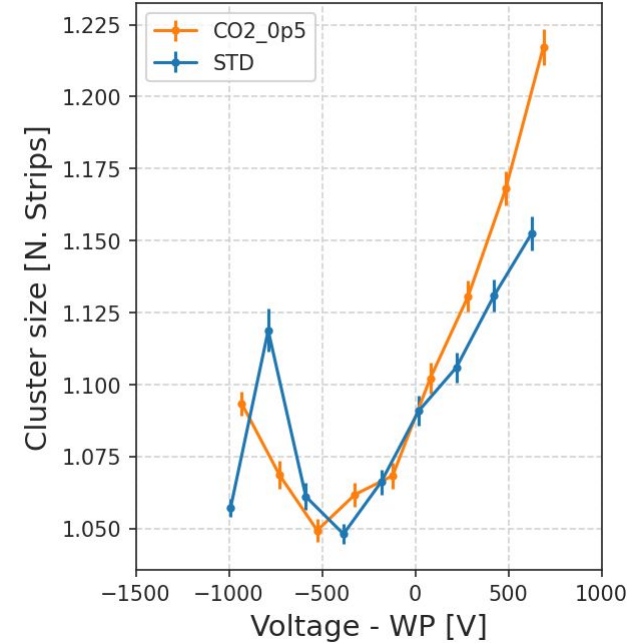
Cluster size vs voltage, RPC 32



Cluster size vs voltage, RPC 33

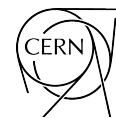


Cluster size vs voltage, RPC 34

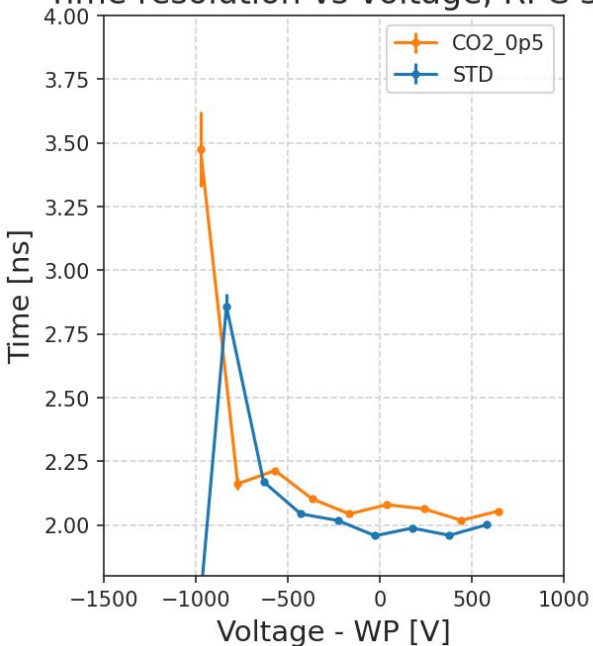


- Cluster size similar between the three detectors

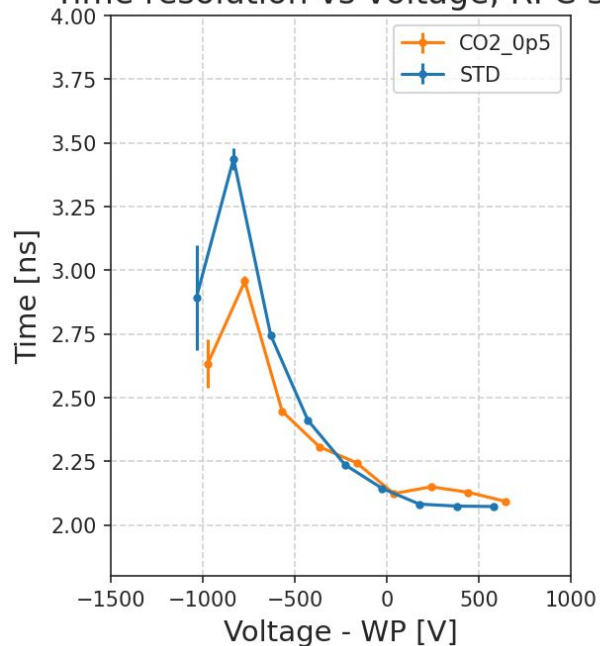
# Time resolution (calibrated)



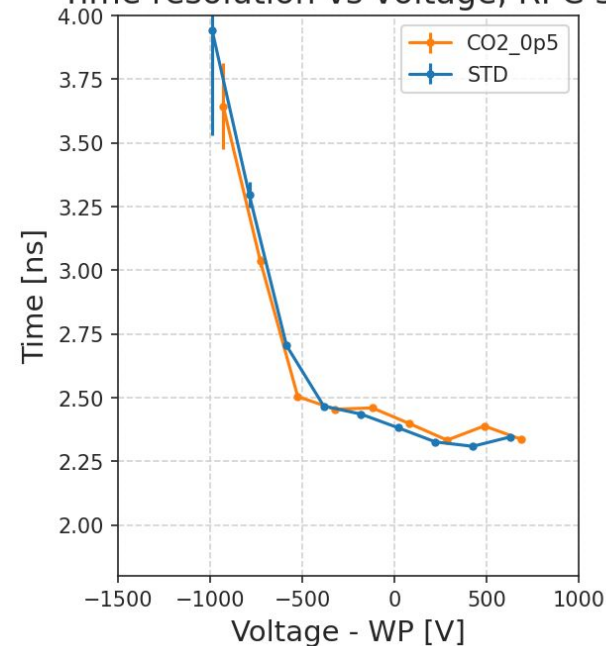
Time resolution vs voltage, RPC 32



Time resolution vs voltage, RPC 33

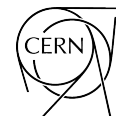


Time resolution vs voltage, RPC 34

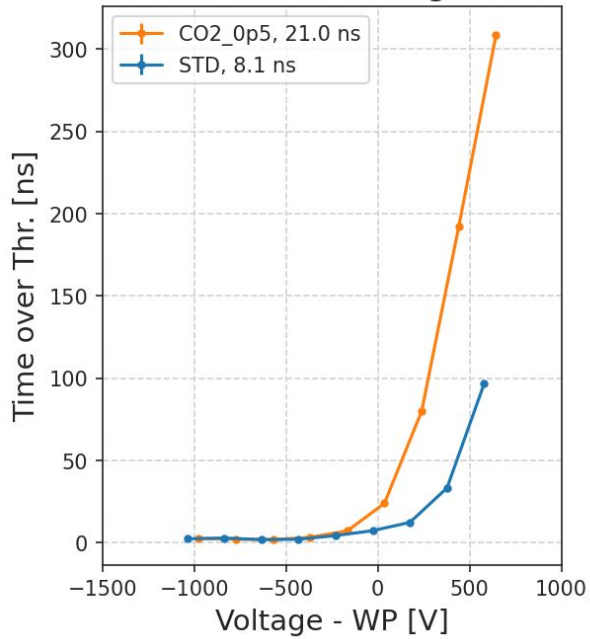


- Time resolution similar between the RPCs

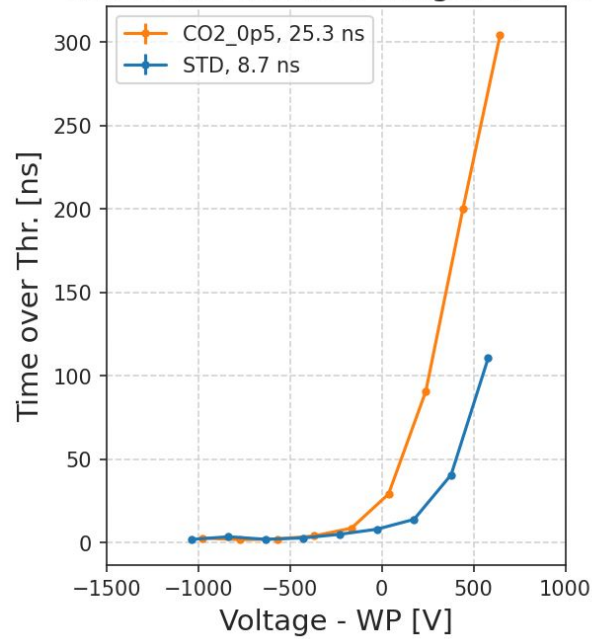
# Time over threshold (calibrated)



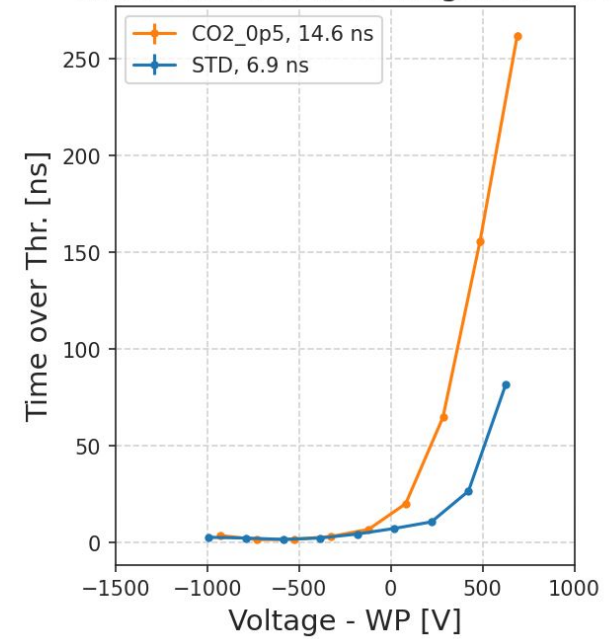
Time over thr. vs voltage, RPC 32



Time over thr. vs voltage, RPC 33



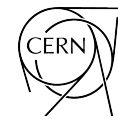
Time over thr. vs voltage, RPC 34



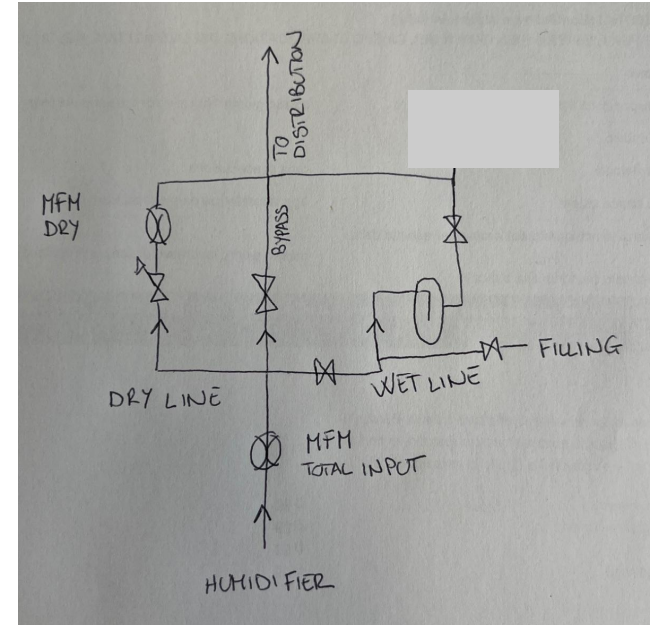
- Time resolution similar between the RPCs

- Ongoing commissioning of RPC 34
  - Depending of the performance, RPC 33 or RPC 34 will be used for the ecogas collaboration
- Waiting material for new frames -> then constructions (x4)
- ISE measurements with Ar for RPC 25 (old ecogas)
- Start testing HFO-1336mzz(E) + commissioning npentane setup (next slide)

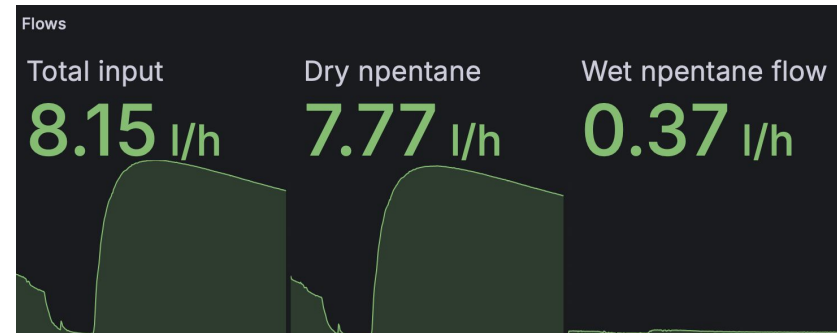
# Npentane setup



- Installed and ready to be tested



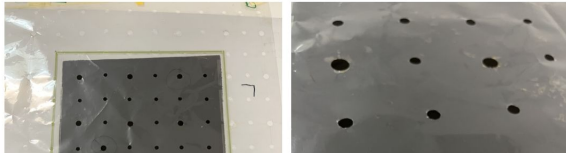
- Test it first with mzz (not flammable) and GC
- MFC calibration ongoing, panel presents on Grafana



## Lyon-style Build procedure



- Create a mylar mask with the hole needed for the spacer, of the same dimension of the detector. The distance between the spacer should be of around 5 cm.
- Put the mask on the surface of the detector and add the spacer in all the hole.



- Spacers attached with double-sided tape, only on one side
- Gas flow directly in the glass gaps

This can bring to inflation and efficiency loss

## Modified Lyon building paper

Contents lists available at ScienceDirect

Nuclear Inst. and Methods in Physics Research, A

ELSEVIER journal homepage: www.elsevier.com/locate/nima

Full Length Article

Characterization of glass multigap RPC detector with alternative gas to SF<sub>6</sub>

Mattia Verzeroli<sup>a,\*</sup>, Roberto Guida<sup>b</sup>, Imad Laktineh<sup>a</sup>, Beatrice Mandelli<sup>b,1</sup>, Gianluca Rigoletti<sup>b</sup>

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ARTICLE INFO ABSTRACT

**Keywords:**  
Gaseous detectors  
Multigap Resistive Plate Chamber  
SF<sub>6</sub>  
Eco-friendly gases

**ABSTRACT**  
Glass Multi-gap Resistive Plate Chamber detectors are primarily valued for their exceptional time resolution and are widely used in fields such as high-energy physics and tomography applications. Traditionally, these detectors are operated using fluorine-based gas mixtures, primarily composed of C<sub>2</sub>F<sub>4</sub>, (E134a) and SF<sub>6</sub>, both classified as greenhouse gases.  
This study investigates the development and performance of a novel 4-gap glass MRPC prototype. A simplified construction method, using circular spacers instead of fishing lines, ensures structural integrity while maintaining low production costs. The work focuses on identifying alternatives to SF<sub>6</sub>, which is being phased out due to its high global warming potential and environmental impact.  
New EU regulations on fluorinated gases mandate restrictions on SF<sub>6</sub> usage, including a complete ban in some applications by 2026, significantly impacting its use and availability. Initial tests evaluate gas mixtures of R134a and C<sub>2</sub>F<sub>4</sub> with fixed 5% iC<sub>4</sub>H<sub>10</sub> and SF<sub>6</sub> concentrations ranging from 2% to 6%. Novoc™ 4710 is also evaluated as a potential SF<sub>6</sub> alternative with a significantly lower global warming potential (GWP).  
Preliminary results indicate that Novoc™ 4710 demonstrates comparable efficiency curves while achieving a significant GWP reduction, paving the way for further investigations.

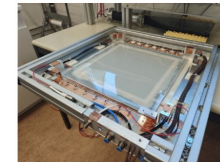
- Similar procedure to Lyon, but:
- Spacers glued with resin on both side

This avoid inflation but reached around 80% of efficiency  
-> combination of not homogeneous graphite layers and non perfect spacers separation

## Flowing in a box, new varnish ss report

### III.1.2 Detector installation in the setup

The MRPC module is mounted in its mechanical frame and centred between the scintillators. Gas tubes (inlet/outlet) are connected, the chamber is flushed to remove air and a quick leak check is performed. Readout connections are made by soldering the wires and resistors (50 Ω) to the copper strips (Fig. 13). The detector HV is then connected and kept on HV to get rid of impurities and dust. A short acquisition with the scintillator trigger confirms signal presence and time windows selection for the digitizer acquisition. After these checks, the setup is considered ready for systematic scans (HV, thresholds) and data taking.



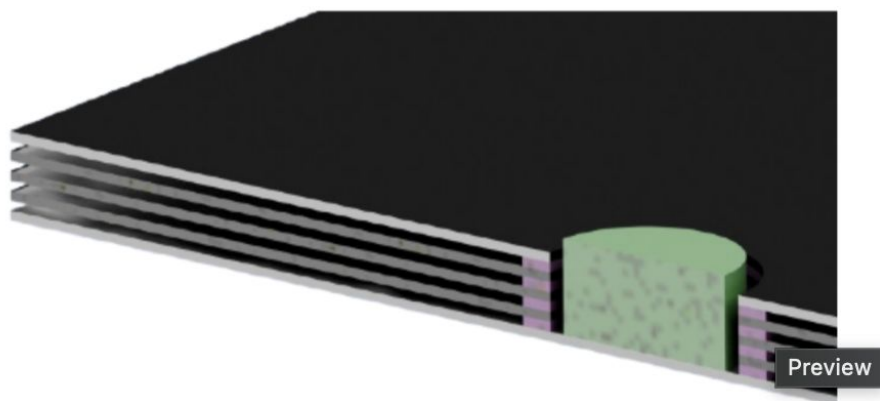
Preview

Figure 13: MRPC installed in the mechanical frame: gas ports, readout cabling and HV connections visible along the perimeter.

- Gas flow in an external box, with the gaps inside
- new graphite varnish, from Coimbra
- same way to apply spacers

After testing, the detector reached at maximum 60% efficiency. Checking, it was possible to see that some gaps collapse one to the other during the curing

Future idea  
[ss report](#)



(b) Half-cut view of the stacked glass layers with washer spacers (pink) guided by alignment cylinders (green).

- having plate with hole in the position of the spacers
- rods through all gaps
- mylar oring to create the gaps

This detector is thought to be closed in a box flushed with the gas under test

Needs to investigate the possible current leaks through the rods surface.