XV Workshop on Resistive Plate Chambers and Related Detectors RPC2020

New advances in very low gas consumption

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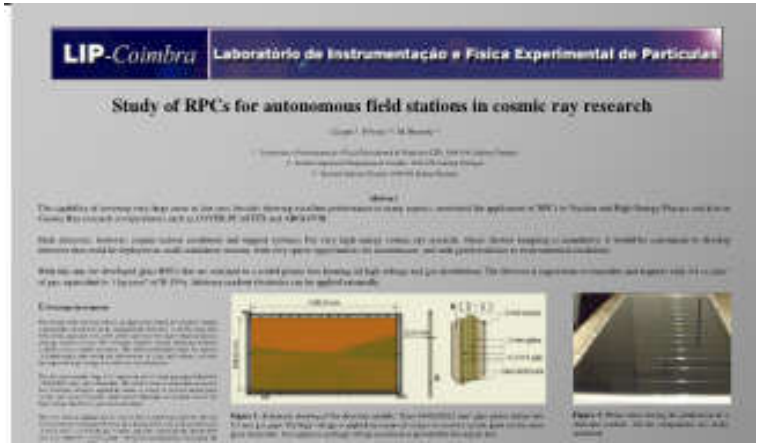
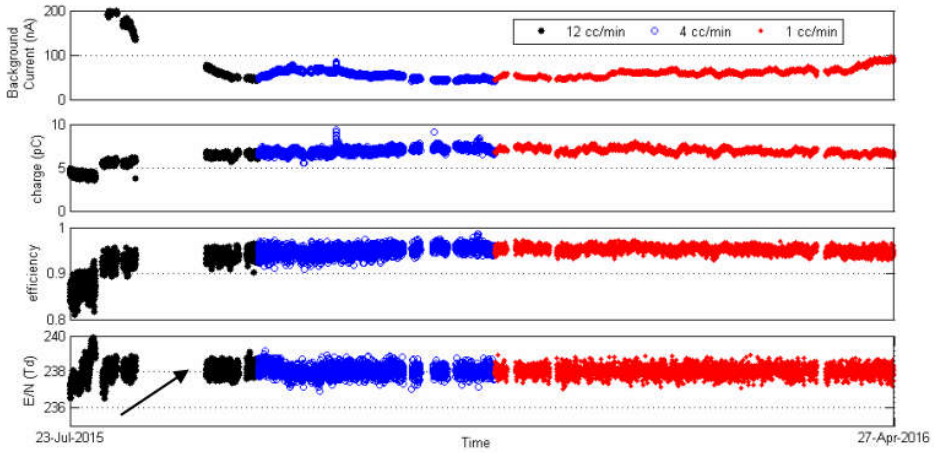
CERN/FIS-PAR/0034/2019
CERN/FIS-PAR/0031/2019

From to past to now

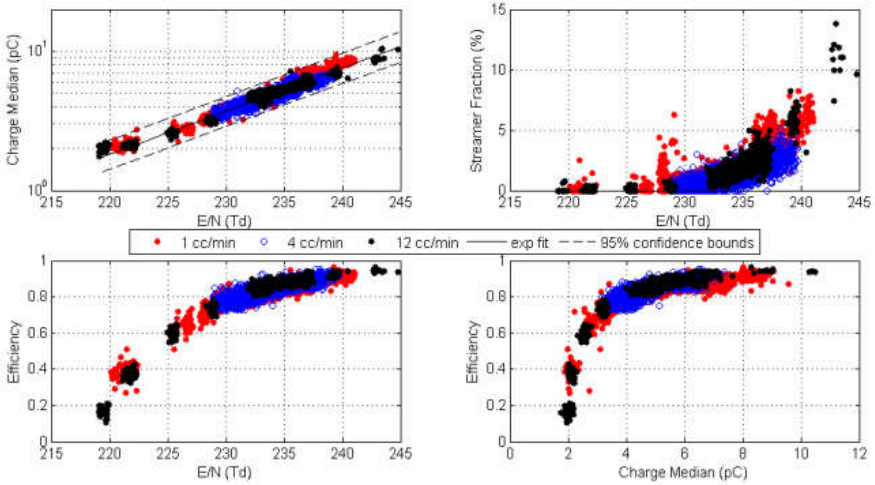
11th Workshop



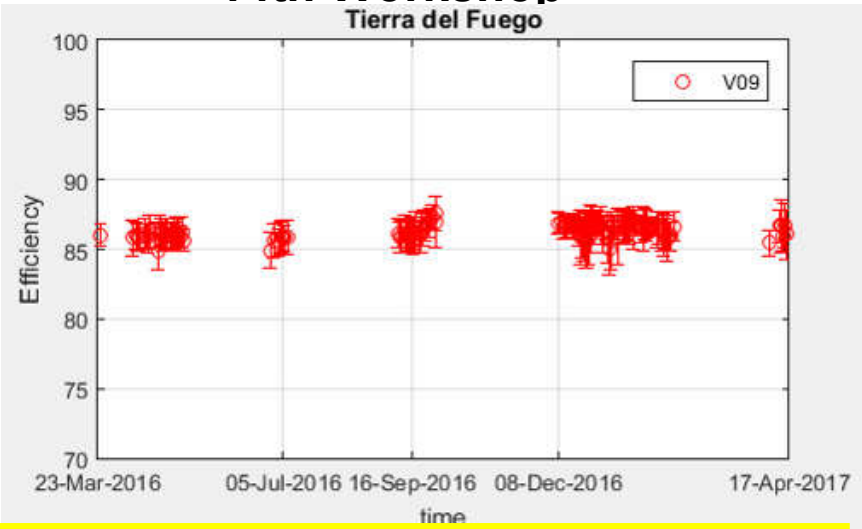
13th Workshop



12th Workshop



14th Workshop



In last years a constant efficiency has been demonstrated at very low gas flow rates

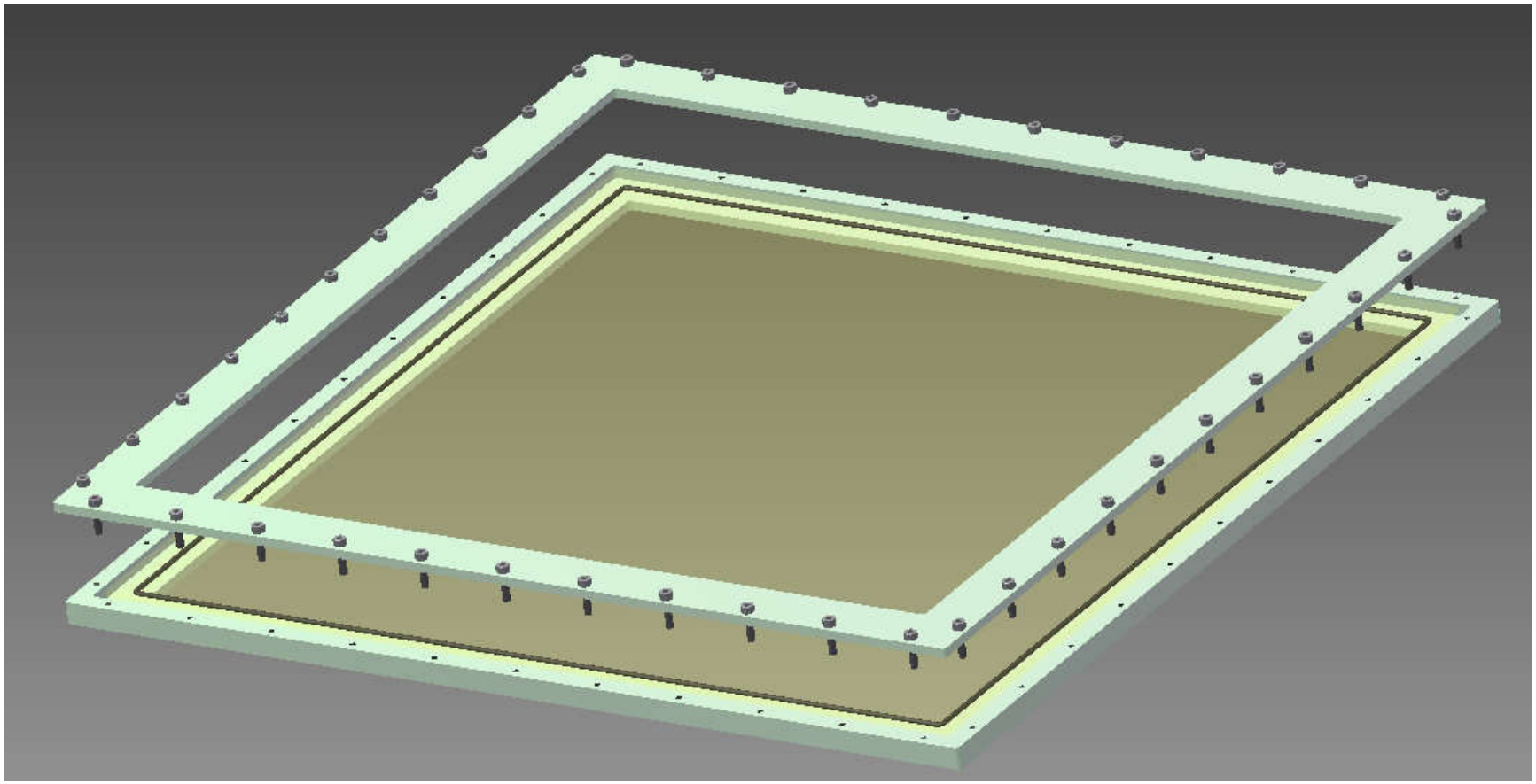
Motivation

- Need something to present at the workshop!!
- Idea with some years but no time to work on that
- The “open” questions related with R-134a and SF_6
  - GWP
  - Price increase
  - No “real” substitutes that assure acceptable performances
- The challenge, for sure the most important
  - Build a zero gas flow RPC

The history – first attempt

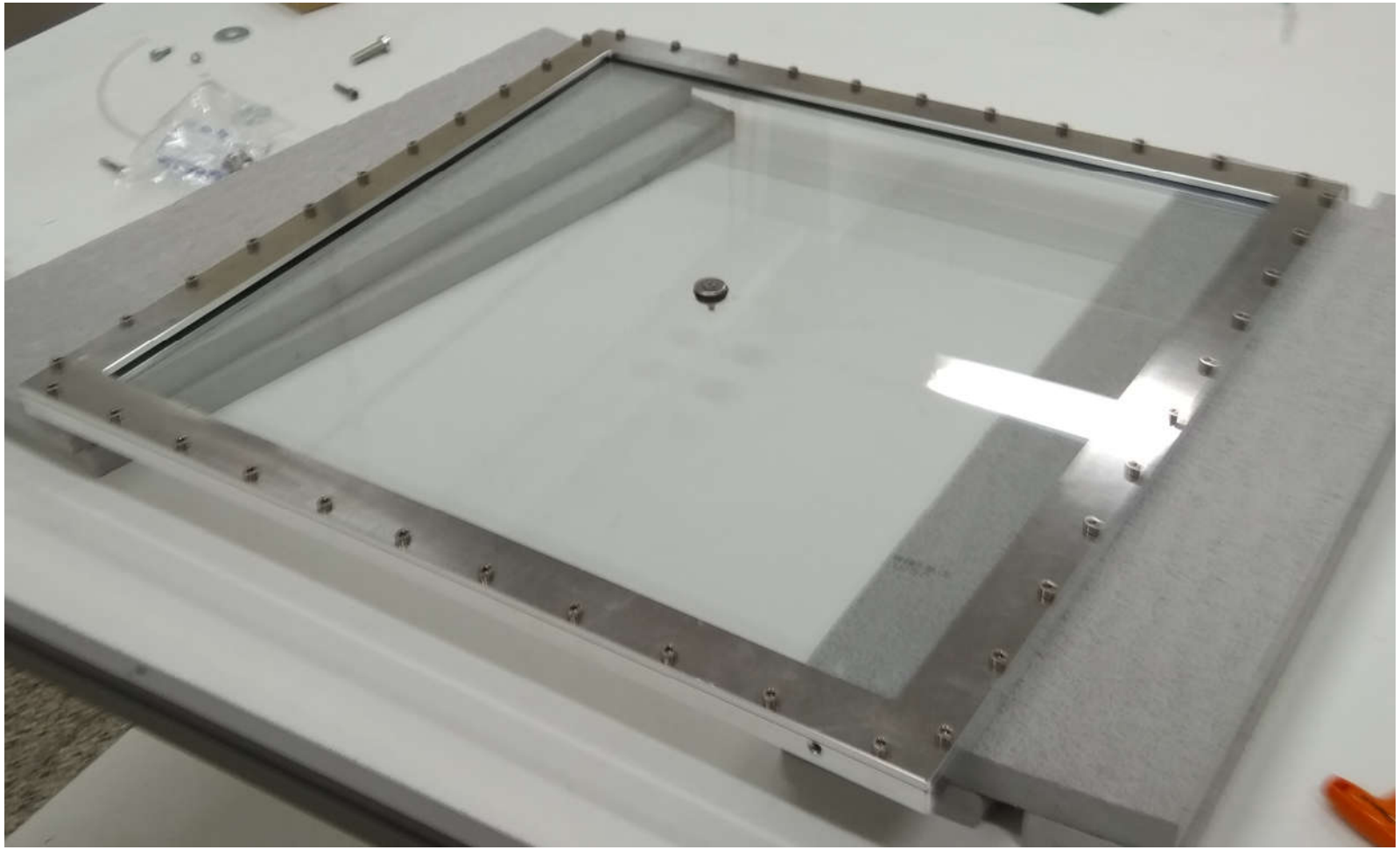
Very ambitious, no good result!!

2 glass sheets (420x420 cm^2), O-ring and 2 aluminum frames to press the glasses and define a 2 mm gap. Gas will be injected with needles through the O-ring



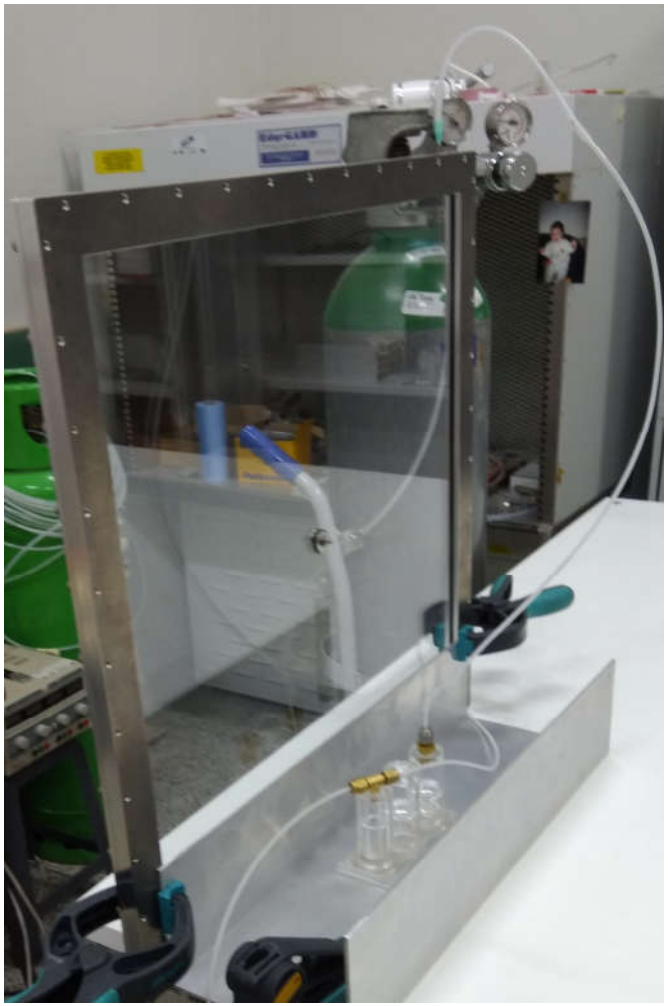
The history – first attempt

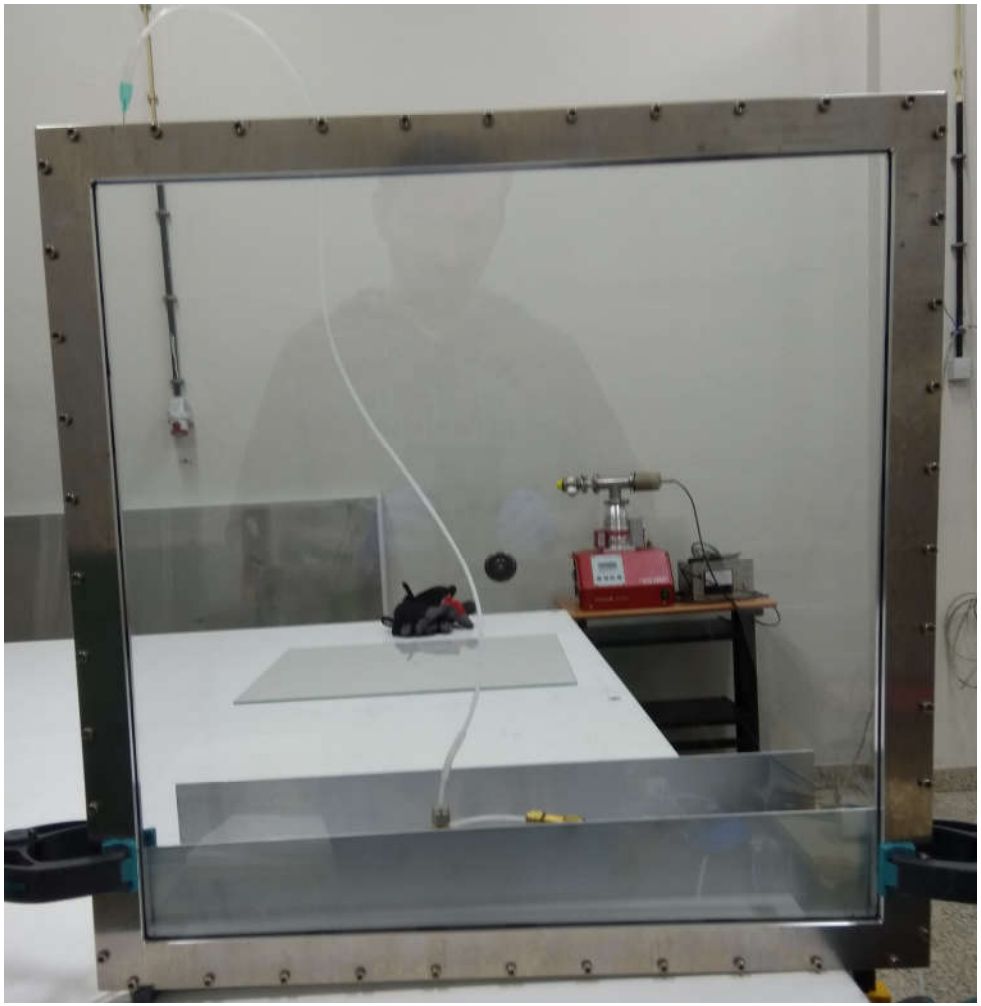
To complicate a bit more we decide to drill a hole in the center of the glass sheets and add a small O-ring and pressure screw to get more gap uniformity



The history – first attempt

After some glass brakes and many hours we finally finish one. Flushed with Argon, and immediately learn that sealing was not perfect… We even tried 2 O-rings.





The history – first attempt

Nevertheless, we paint the HV electrodes, flushed with R134a and took some data. It works nicely as RPC , but not as a zero gas flow RPC.

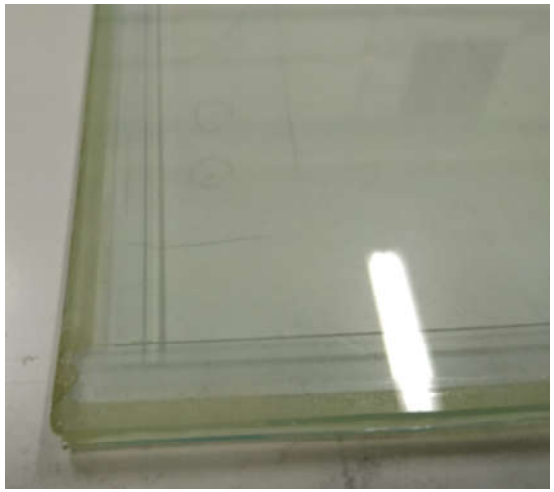
Some show stoppers:

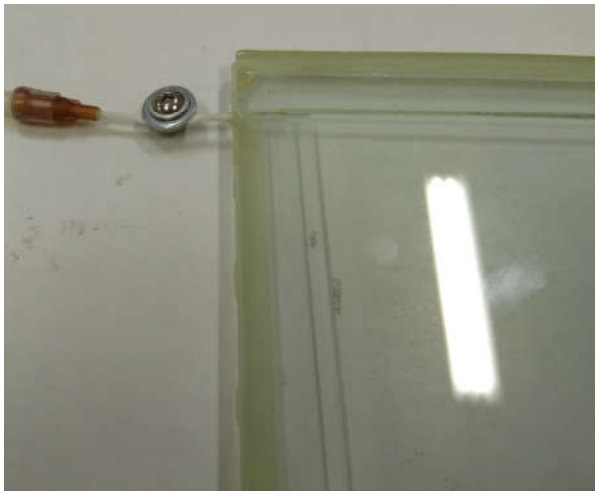
- Very complicate assembly
- Glass plates easily broke
  - In the center holes
  - During gap pressure
- Leaks in the glass/O-ring
  - Mostly in the corners
  - Where we use the needles to flush the gas

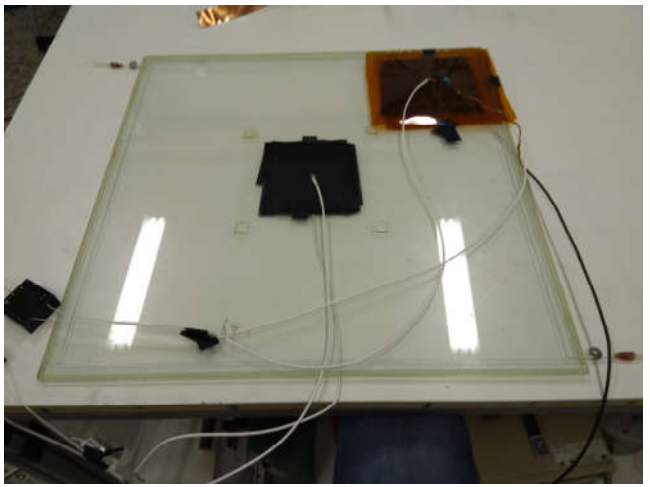
The history – Second attempt

Eliminate the O-ring and assure that outgassing is "zero"

- All the surfaces in contact with the gas should be made from glass
  - 2 glass sheets 420x420x2 mm^3 and 4 glass bars to close the loop between the sheets
  - This bars should be wide enough to prevent epoxy to flow between them and the glass sheets to reduce to "zero" the gas contamination by the epoxy vapors.
  - To flush the gas we just use plastic "needles", that can be easily "sealed".

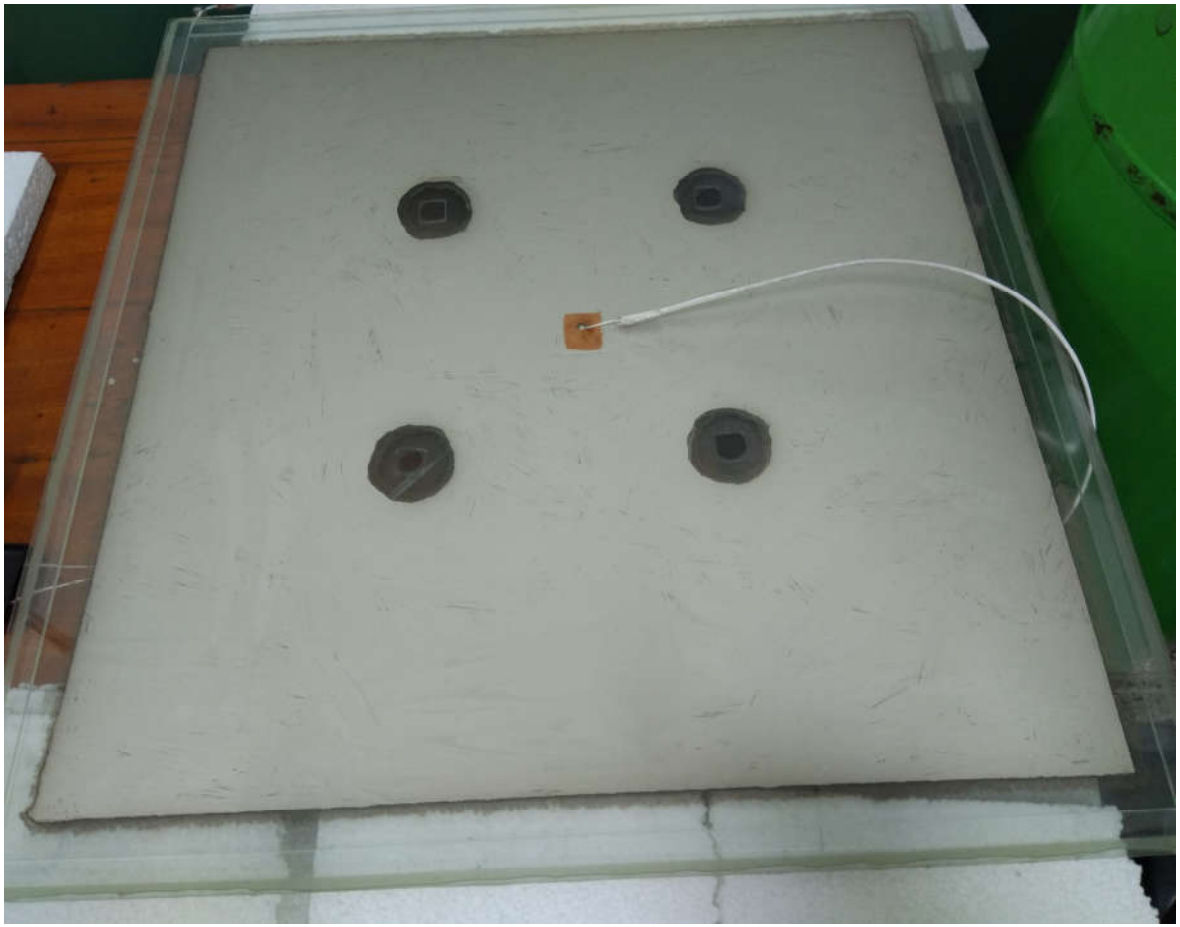






The history – Second attempt

Build 2 chambers, using silver paint as HV electrodes and mostly test with permanent Argon discharge



Important advances

•Very easy to assembly

•“Perfect” sealing

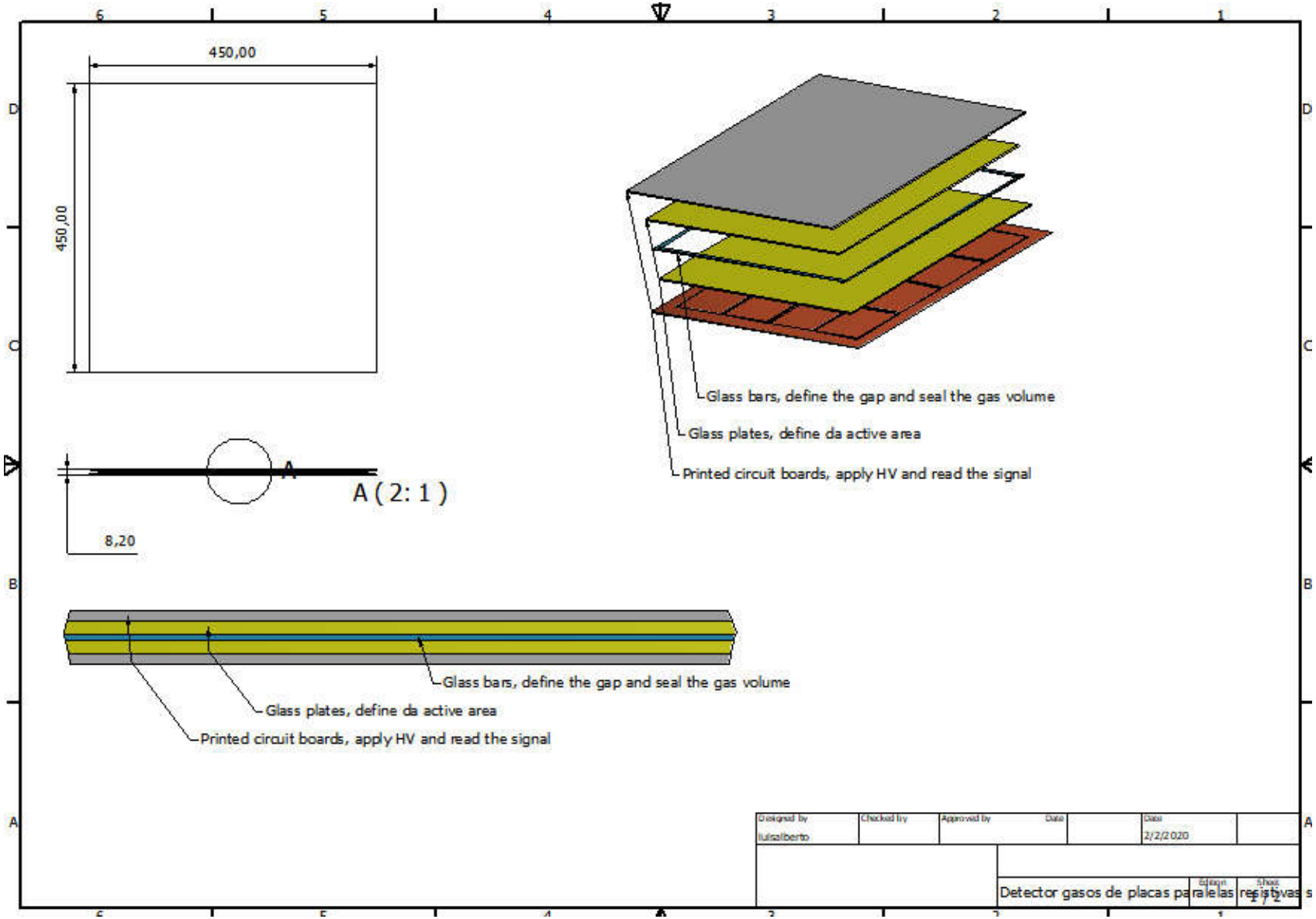
•Stable performance over time with permanent Ar-discharge

•First signals with R134a

Some show stoppers:

•HV insulation and signal pickup

The history – Third attempt, probably not the last



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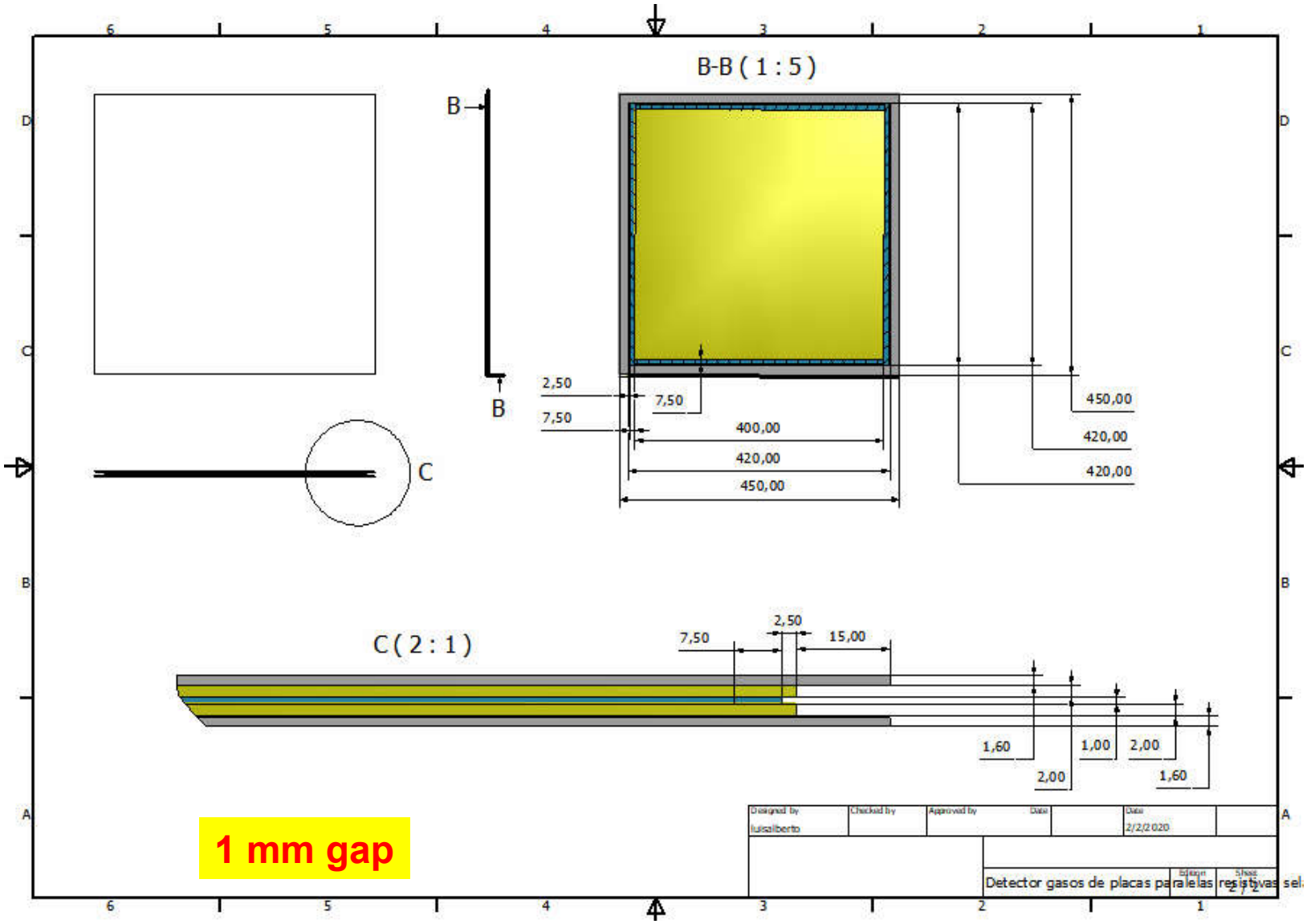

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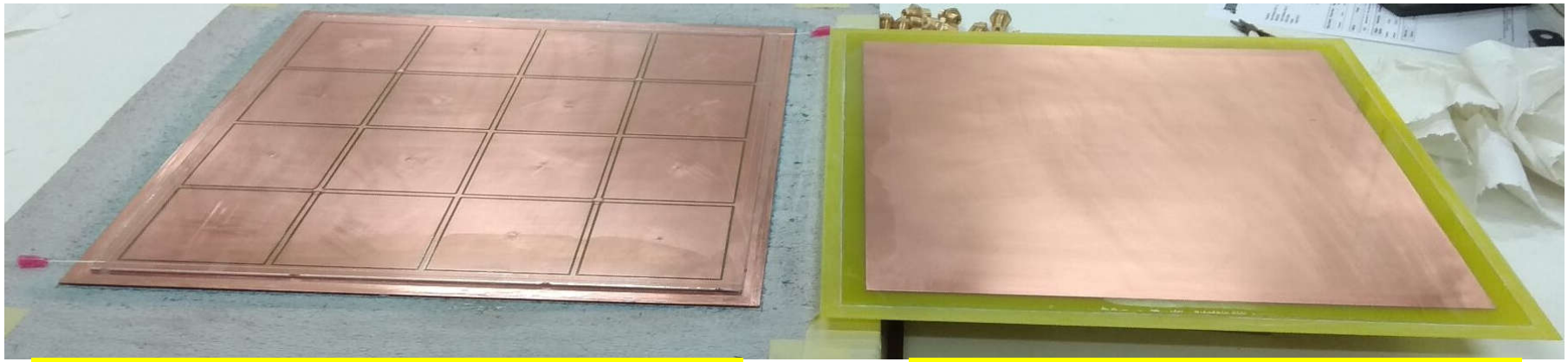
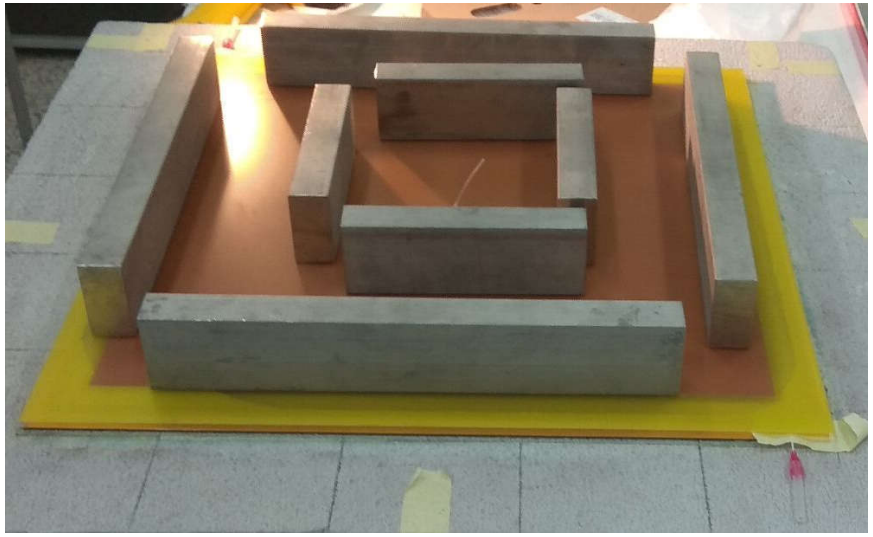
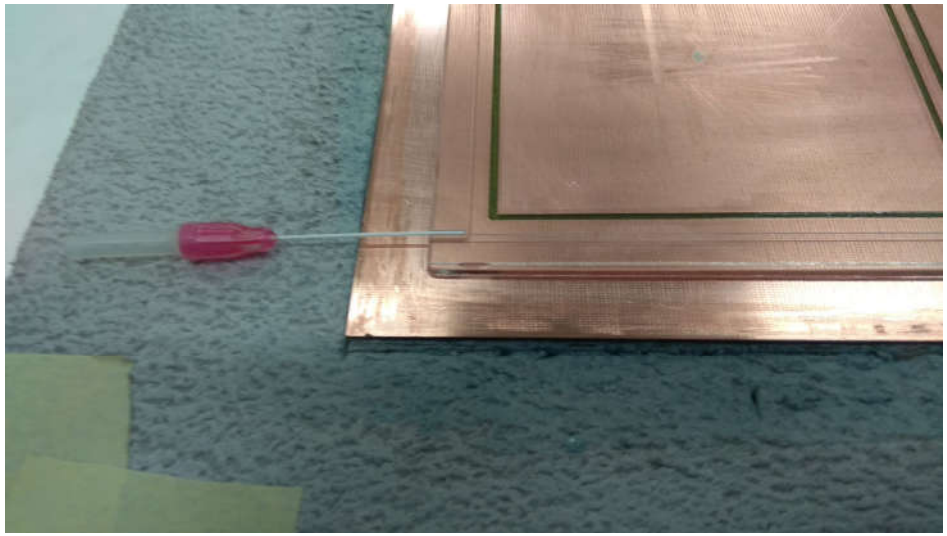


Readout pads 4x4 with 90x90 mm^2

Glass sheets glued to copper





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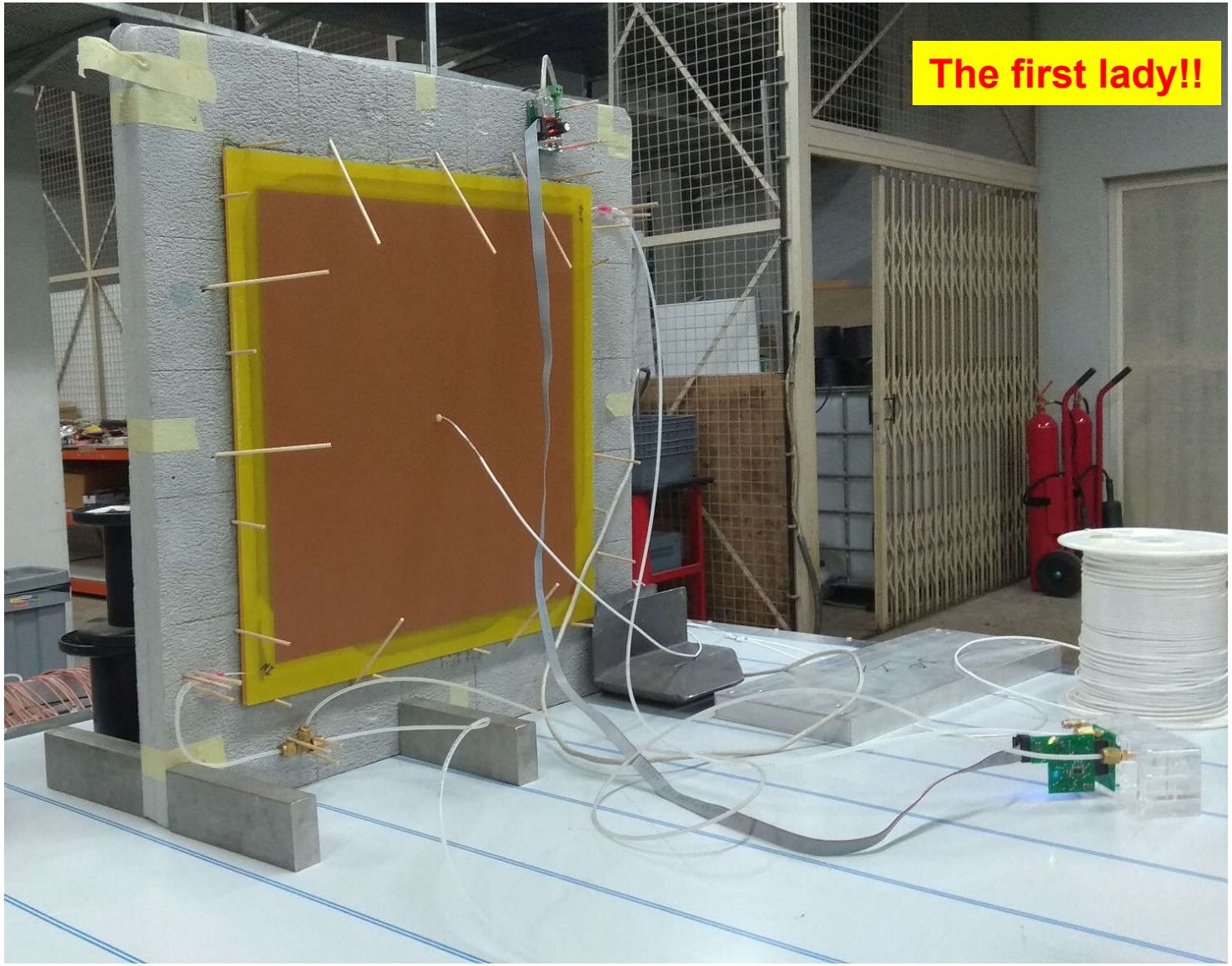
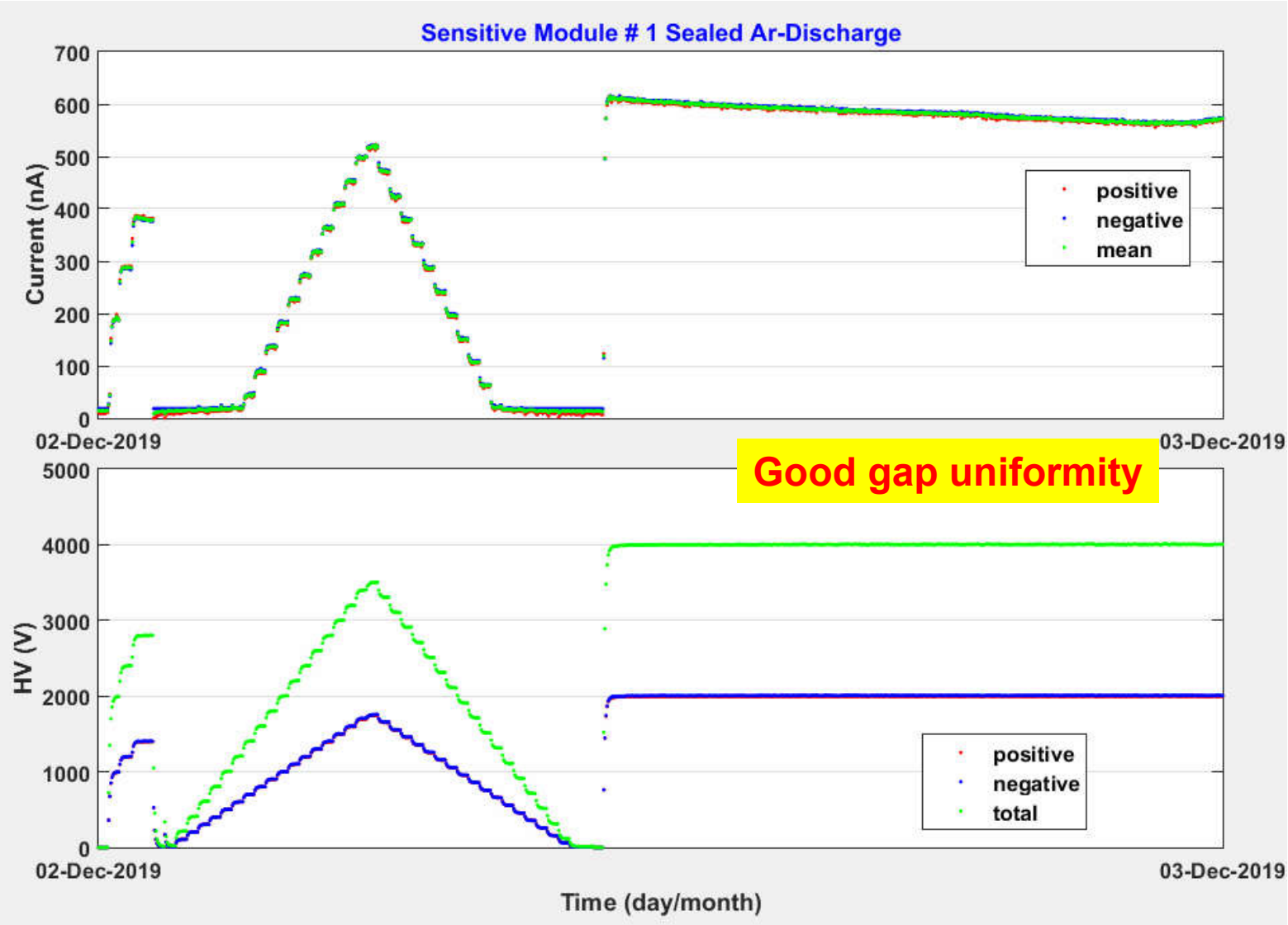


Results – Argon discharge



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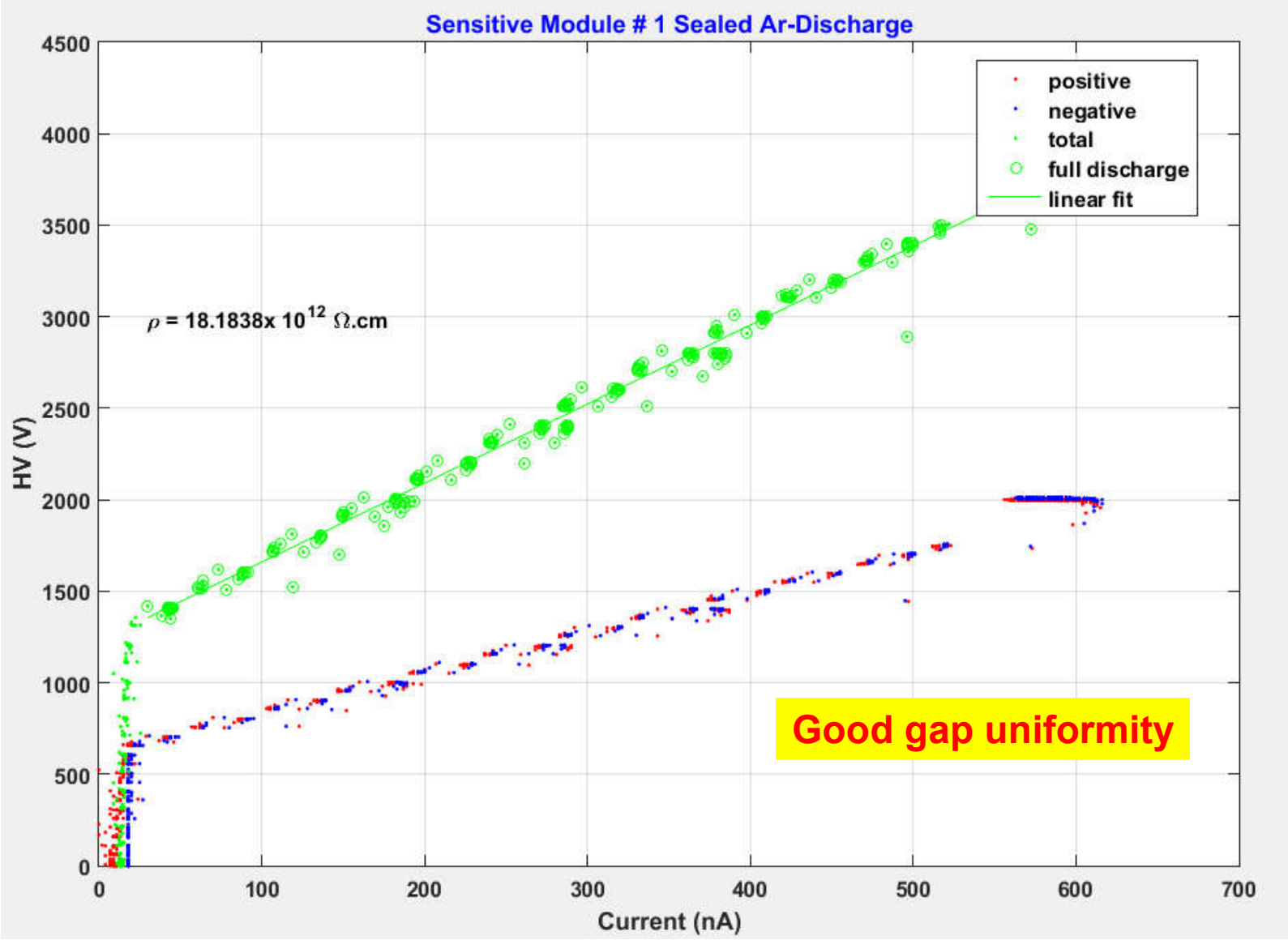
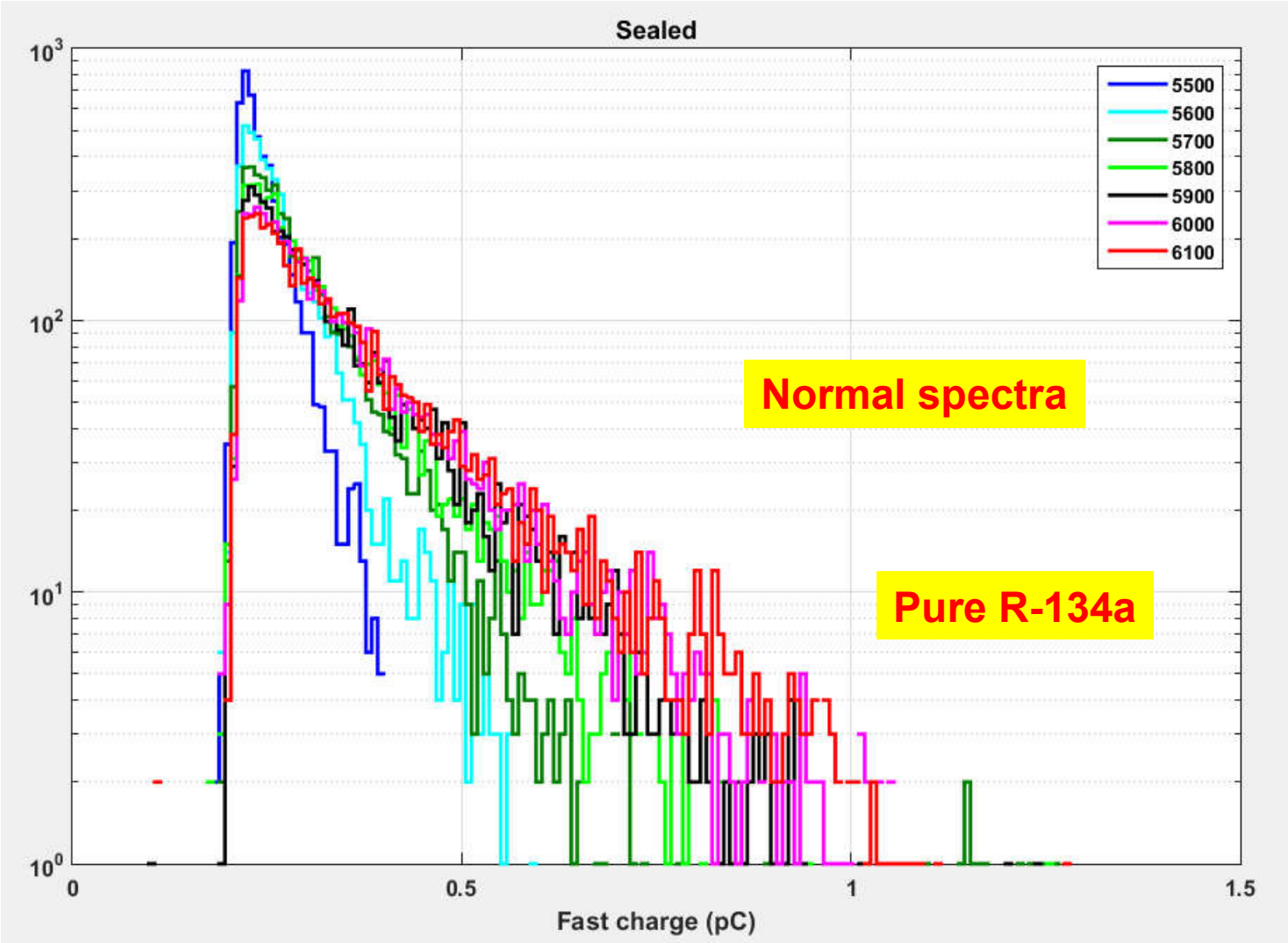
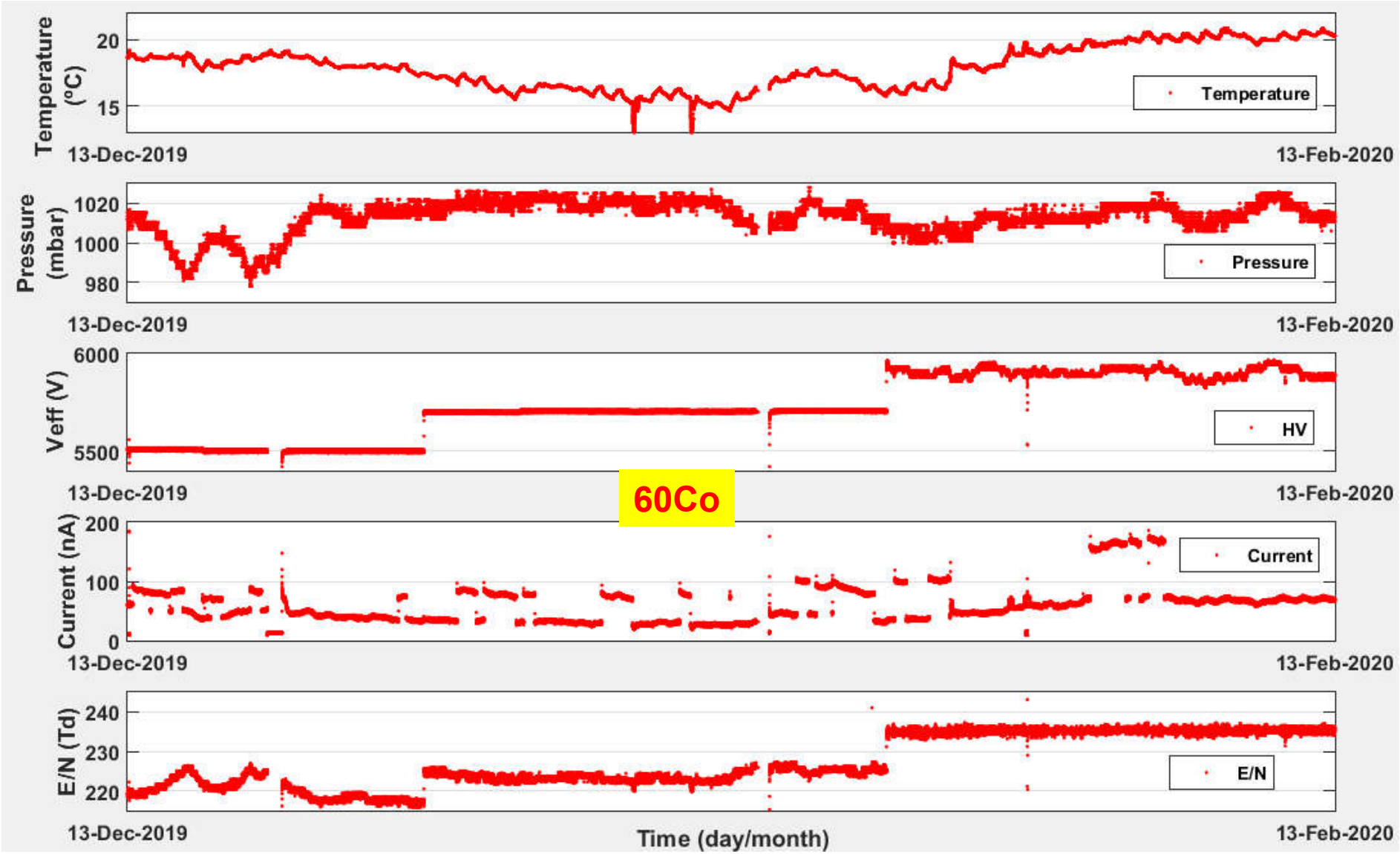


Results – Self trigger 60Co, fast charge spectra



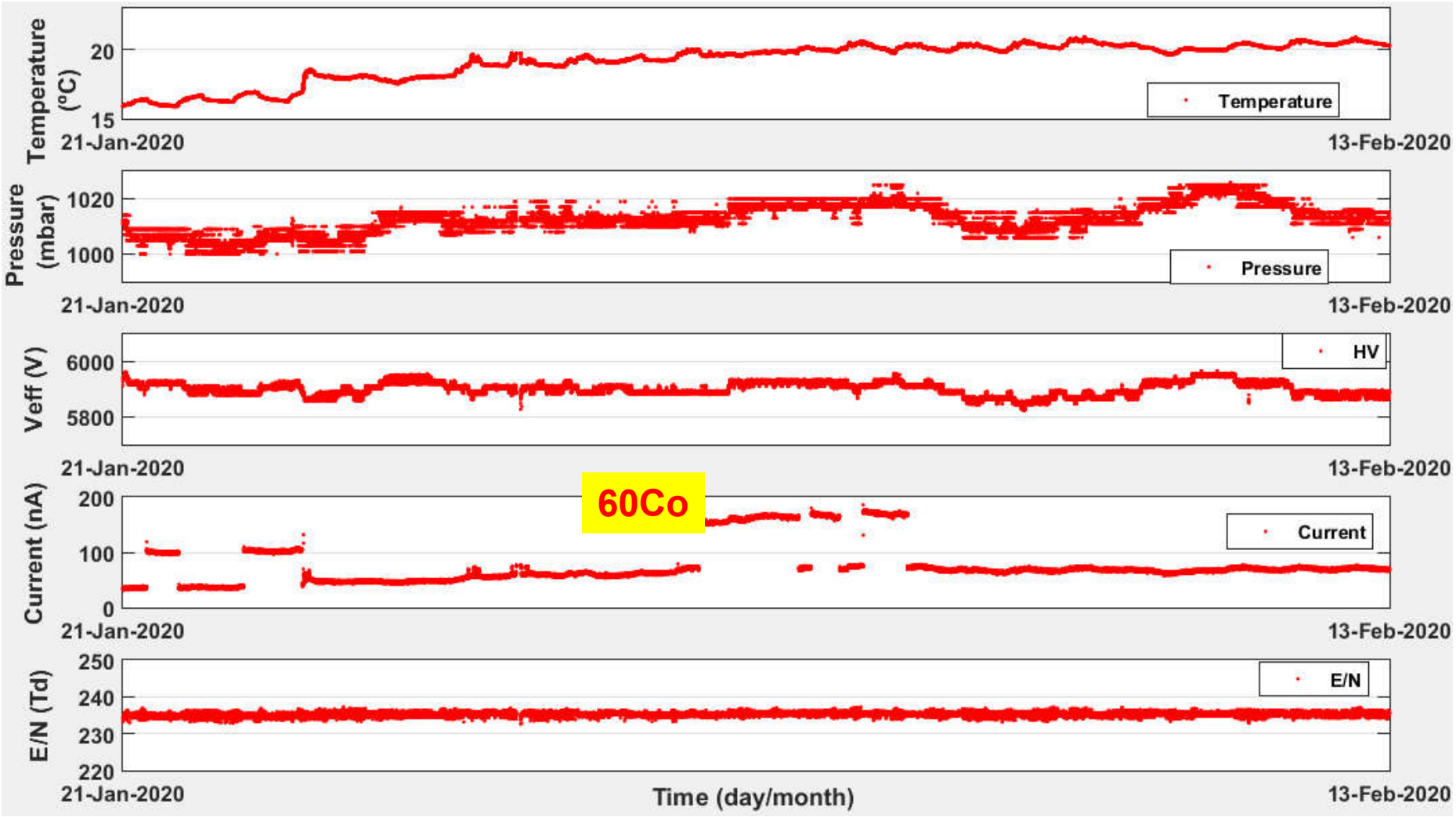
The history – Zero gas flow from 13-12-2019



Results – “Constant” E/N from 21-01-2020

$$V_{eff} = V_{ref} \times \frac{T_{ref}}{T_{measured}} \times \frac{P_{measured}}{P_{ref}}, \quad [V(V), T(^{o}C), P(mbar)]$$

$$\frac{E}{N} = 0.0138068748 \times \frac{V_{eff,Volts}}{d_{cm}} \frac{(T_{^{o}C} + 273.15)}{P_{mbar}}, \quad [Td]$$



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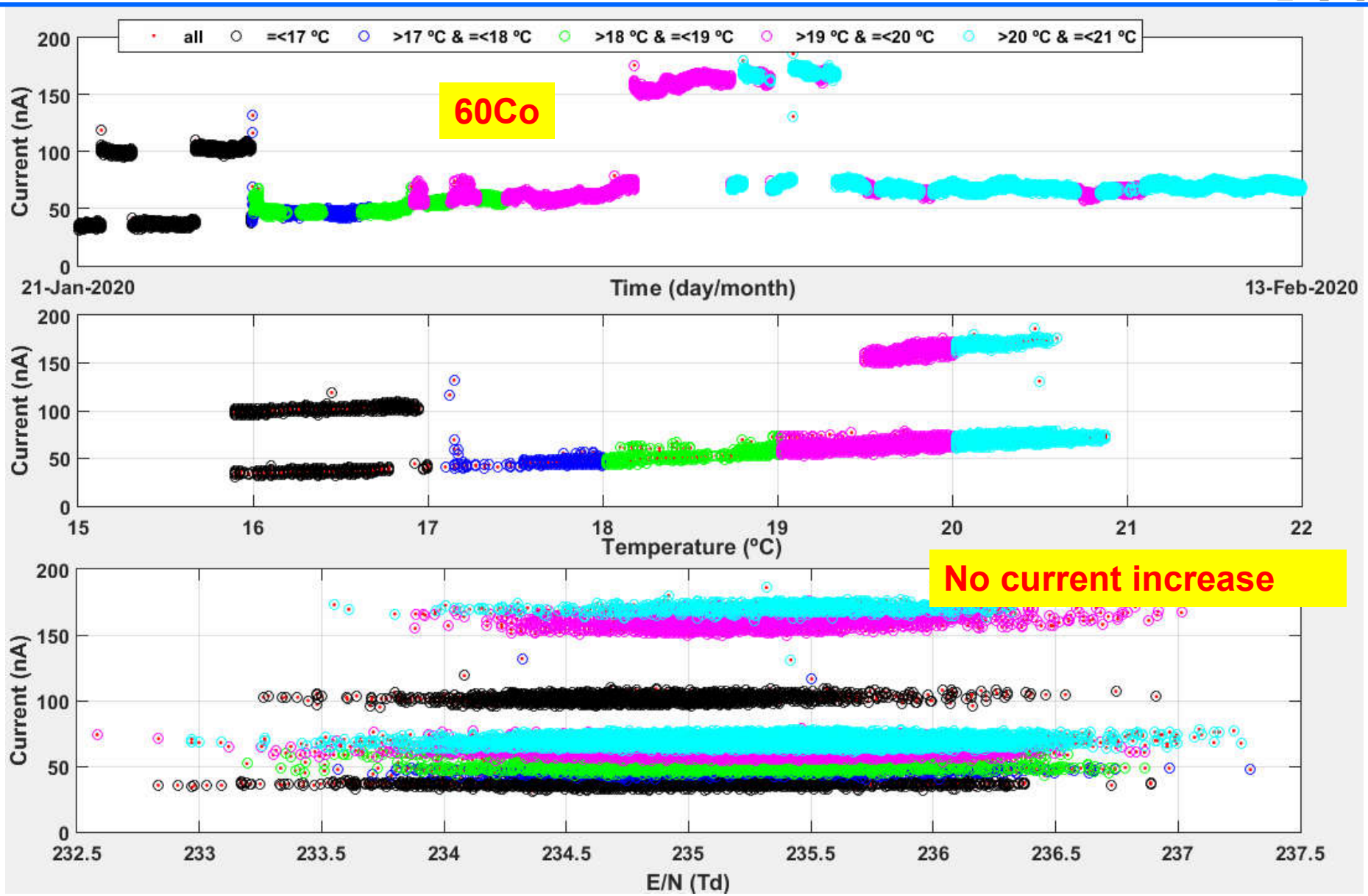

CONCLUSIONS and Future Work

• After 2 months the chamber stays stable and no degradation is observed.

•Chamber is frequently irradiated with 60Co, increasing the current by a factor 3 and no effect is observed in the "background" current.

•We are far from claiming the miracle!!, but it seems to be a productive way to go.

A second chamber (twin) was build and has shown the same performance.

•Continue data taking over time

- •Different temperature and pressure (daily excursions, 30-40 mbars maximum).
- •All practical quantities important for a clear characterization of a RPC