Present and future R&D @ Portugal

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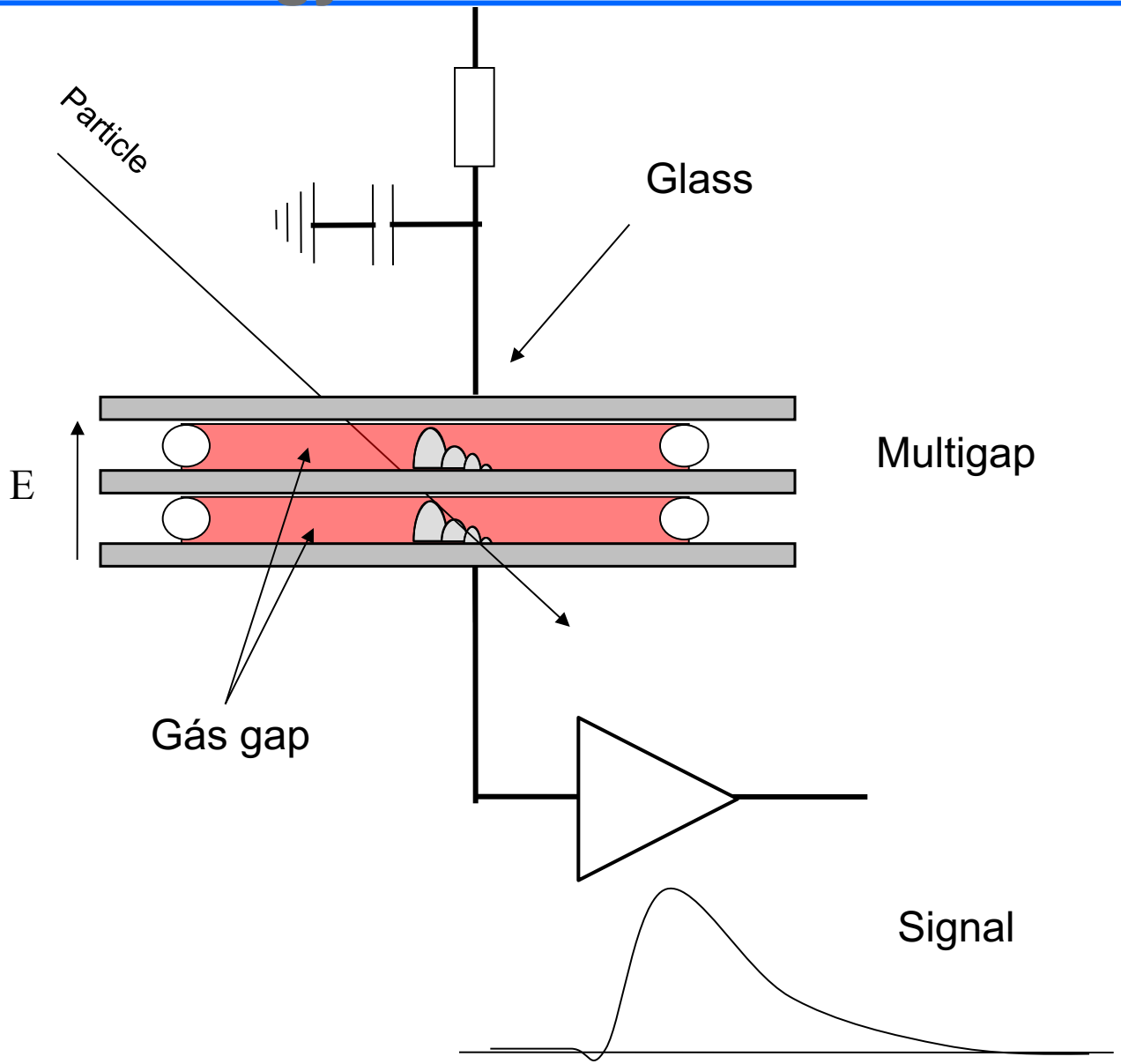
On behalf of the LATTES team

LIP

4th LATTES meeting, Rio de Janeiro, 19-20 May, 2017

RPC technology



REQUIREMENTS

1-Very large area @ low cost -> gaseous detector

2-Segmented readout for particle counting,
fiducial area selection, etc. -> gaseous detector

3-Reasonable timing (~5ns) -> gaseous detector

4-Standalone operation

5-Outdoors operation -> resilience to environmental effects

6-Low maintenance -> very low gas flow

7-Little aging at zero particle flow (mostly dark current)

Avalanche-mode glass RPCs fit well requirements 1-4 and we believe have fair chances for the rest.

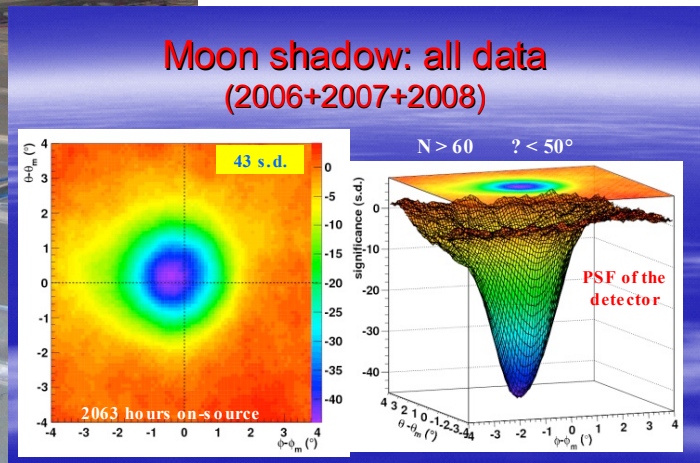
Main challenges:

- Very low gas flow operation

- Resilience to humidity

MUON DETECTION AT ARGO-YBJ@TIBET,

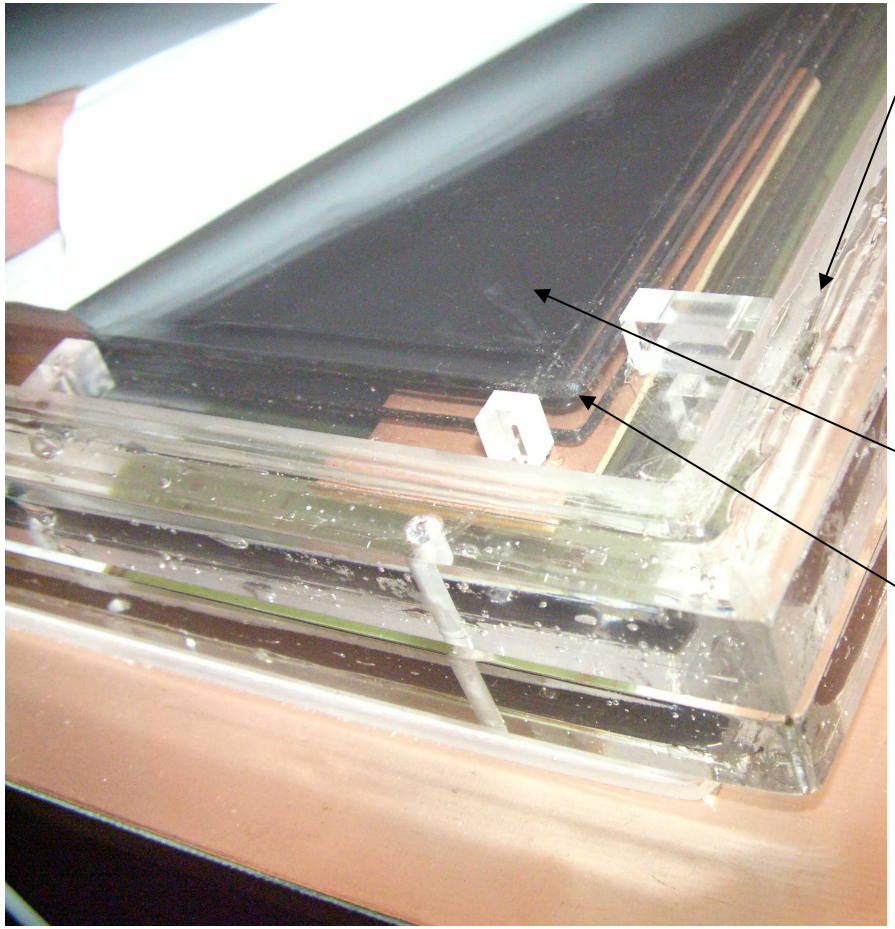
Bakelite, streamer-mode RPCs



CHOICES

Electrodes	2 mm soda-lime glass
Gap thickness	2 x 1 mm gaps, “multigap” construction
HV, signal-transparent layer	Controlled resistivity acrylic paint
Gas tightness, HV insulation	Acrylic box
Mono-component gas mixture	R-134a (tetrafluorethane)
Gas flow rate	0.5 cc/min, equivalent to 1 kg/year
Signal pick-up electrodes	8x8 pad matrix, with 180x140 mm^2
Electromagnetic shielding and structural case	Aluminium box

CONSRUCTION DETAILS



Signal-transparent and nice-looking acrylic box, 1mm thick covers

Permanently glued

RPC fits tightly inside

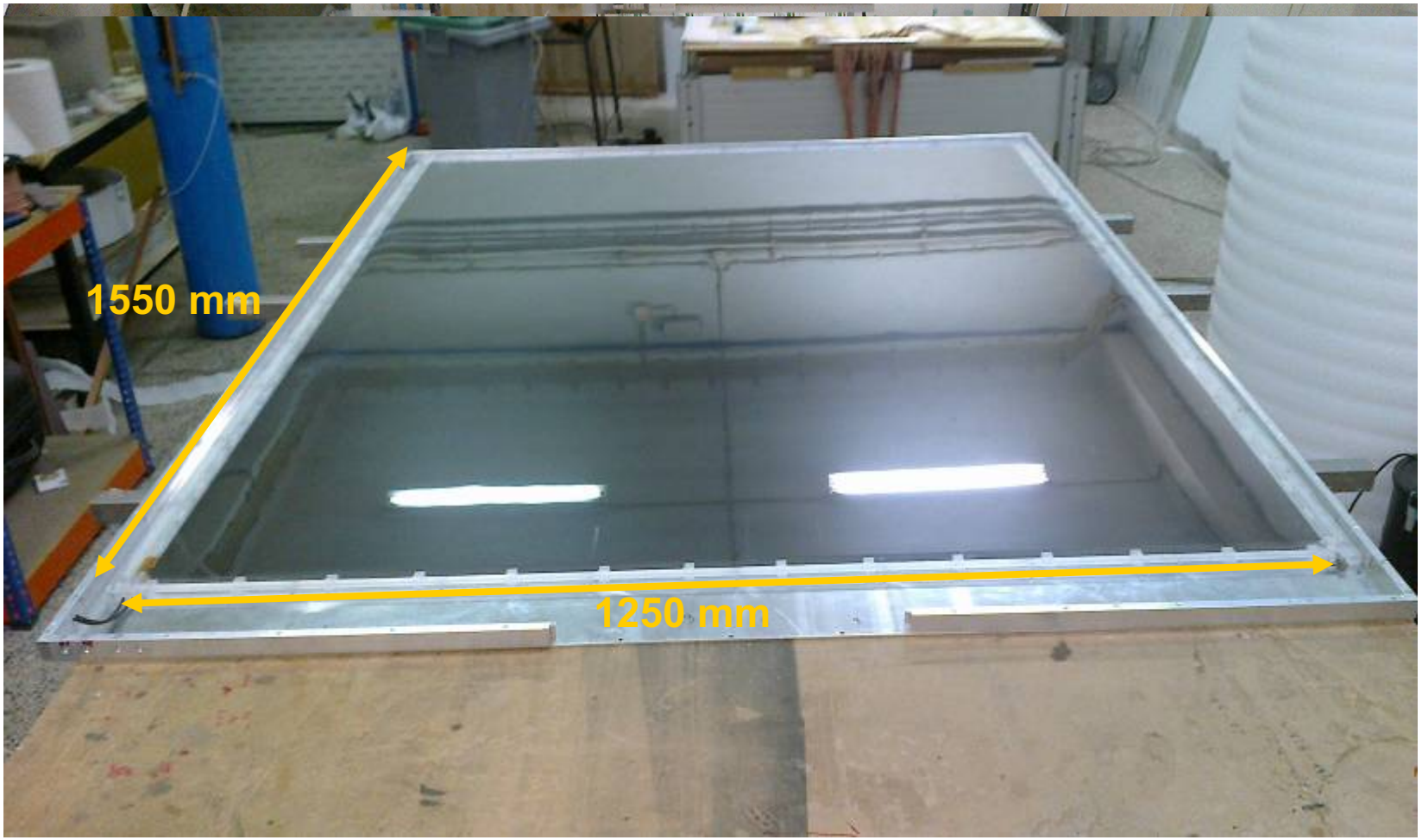
- ✓ good electrode support mechanics
- ✓ excellent HV insulation
- ✓ excellent gas tightness

HV layer, also signal-transparent

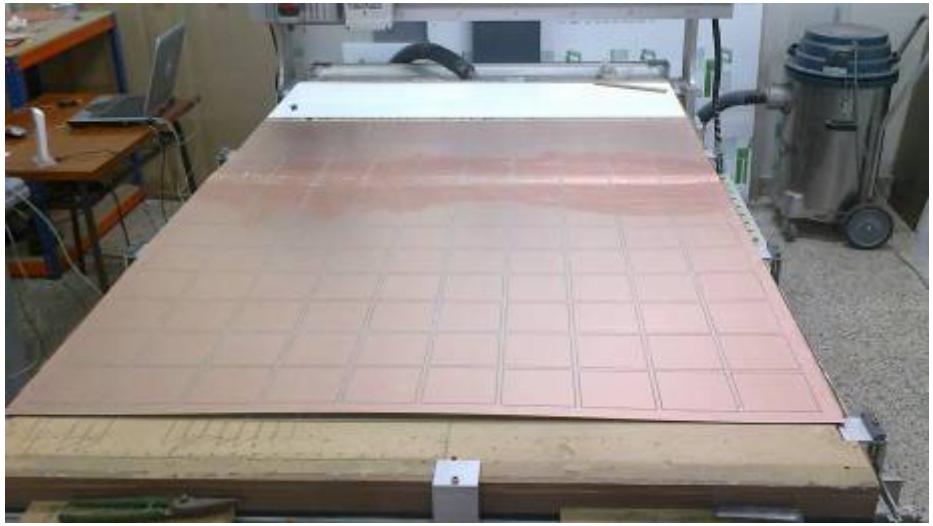
3 RPC glasses (2mm soda-lime)

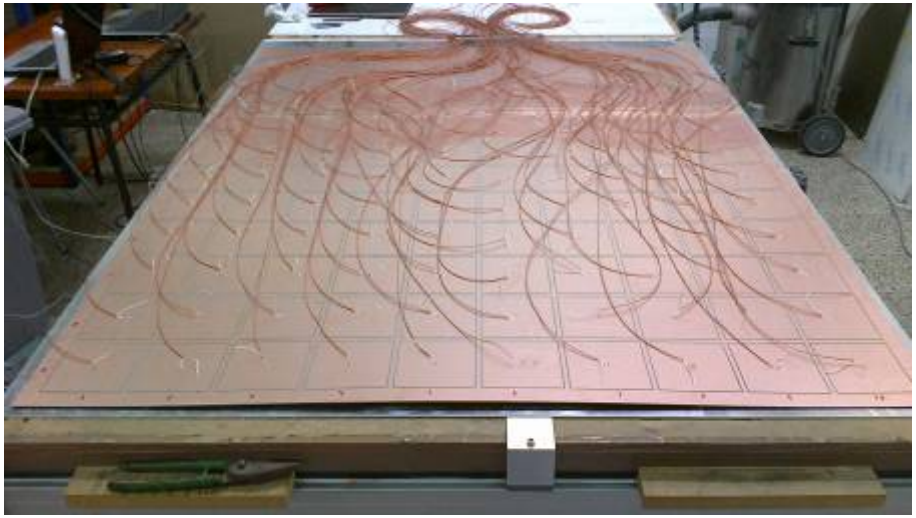
External pickup electrodes

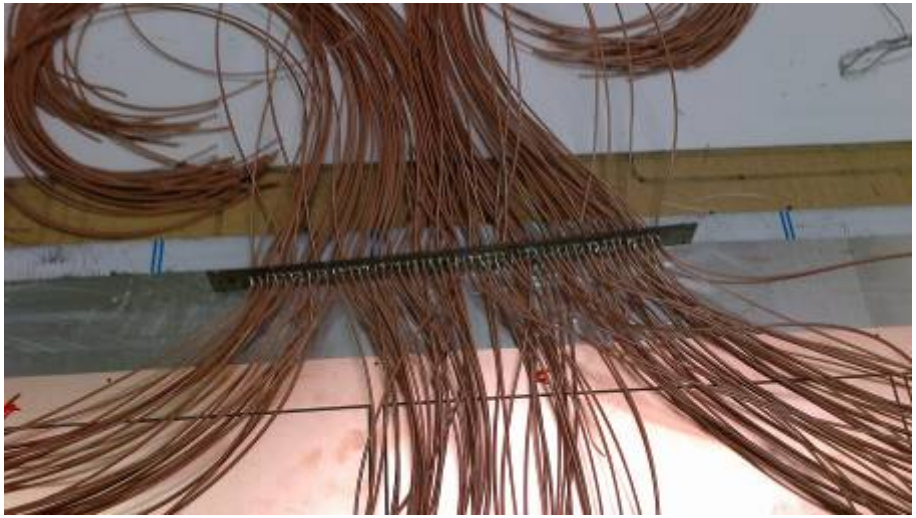
CONSRUCTION DETAILS. RPC and gas volume



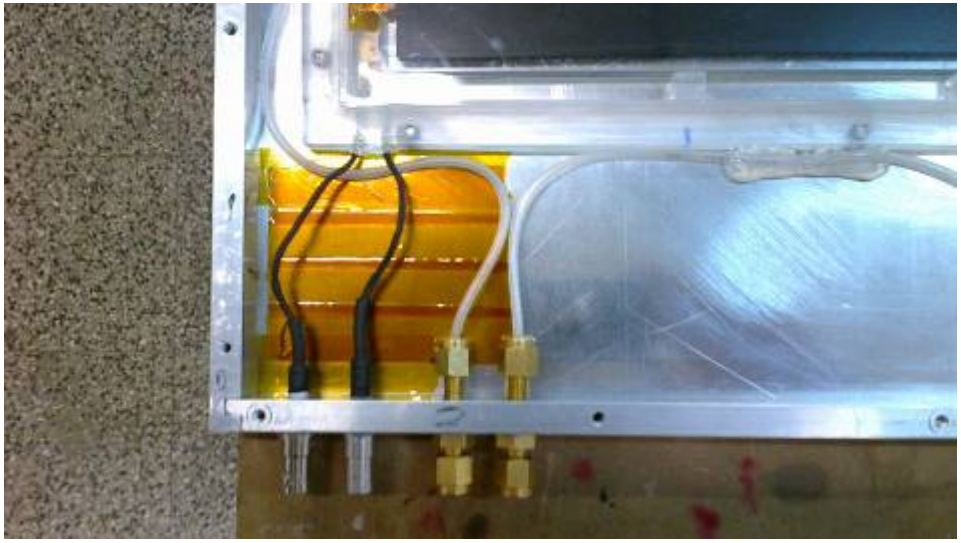
CONSRUCTION DETAILS. Readout 8x8 pads

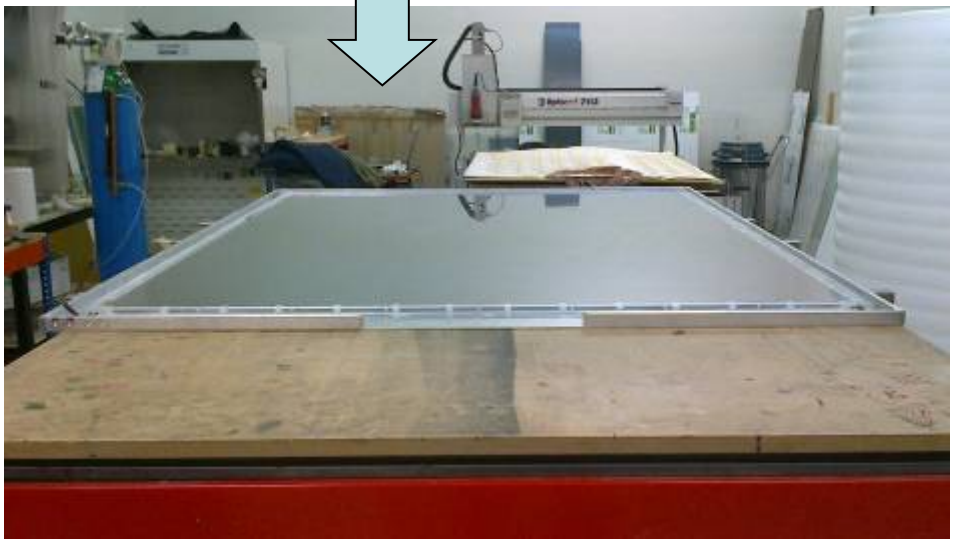






CONSRUCTION DETAILS. Assembly





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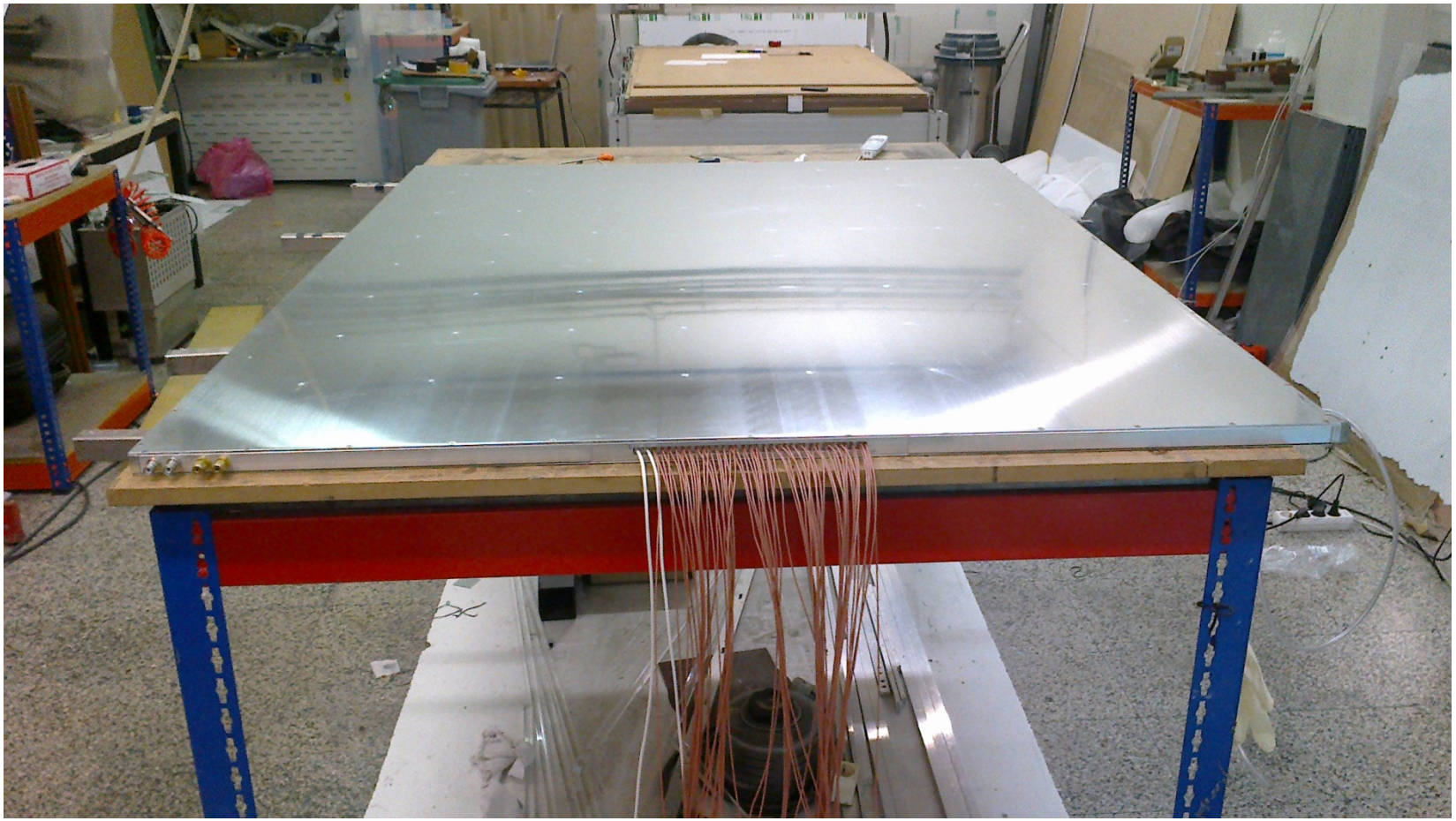


RPC - where they are?

Santiago Compostela, Spain

Coimbra, Portugal

Rio de Janeiro, Brasil

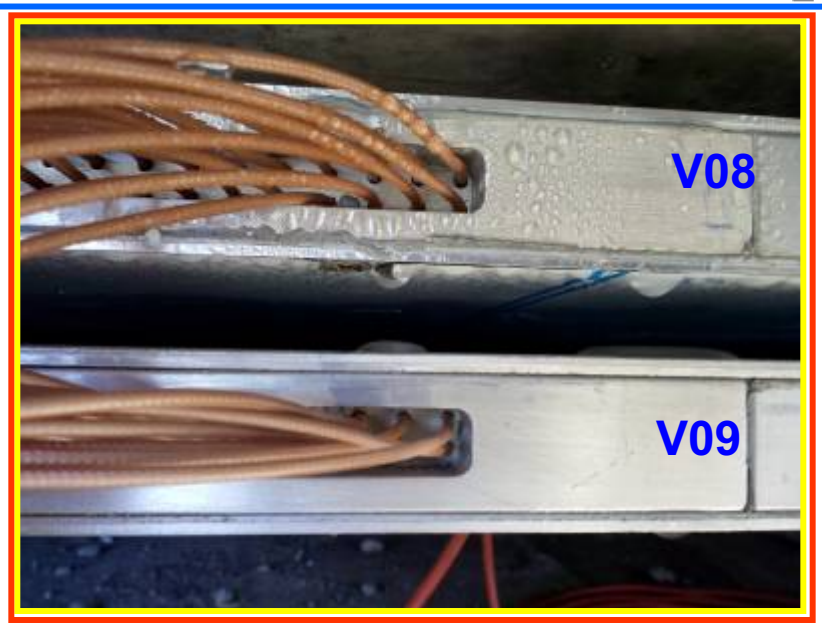
Lisbon, Portugal

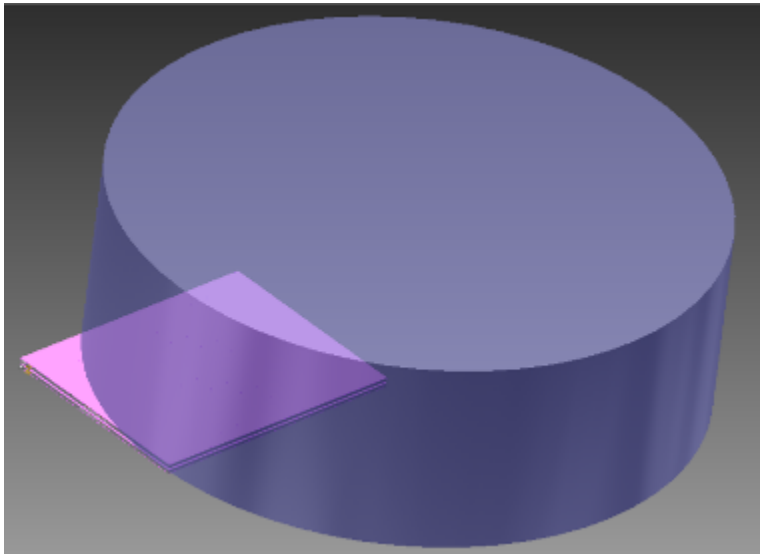
São Paulo, Brazil

Outdoor Malargue, Argentine

Tierra del Fuego setup @ BATATA site, AUGER

Tierra del Fuego setup @ BATATA site, AUGER

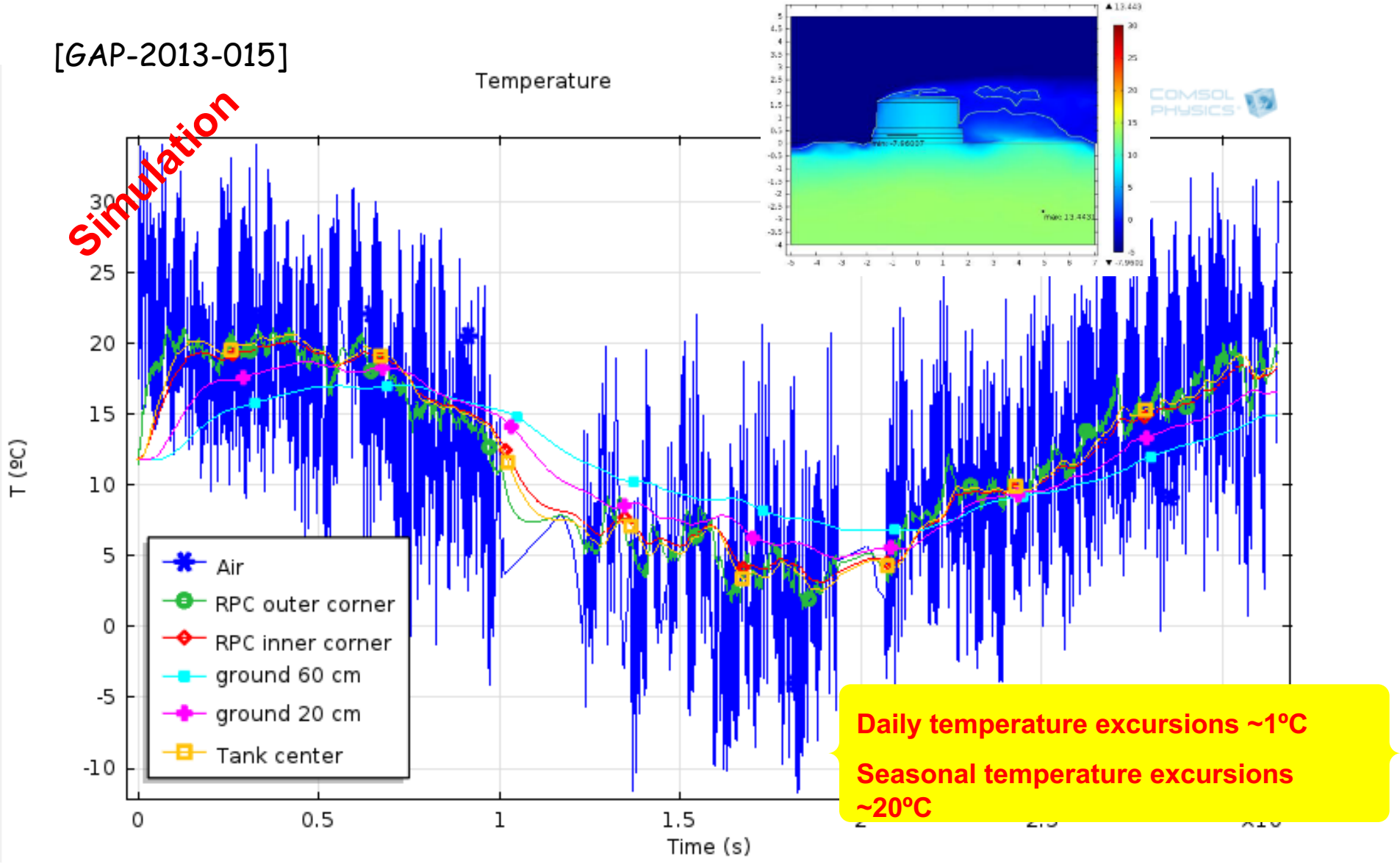




A concrete precast structure is needed to support the tank, filter the electromagnetic component of the shower and act as a protecting house for the RPCs.
Two overlapping RPCs underneath the tank. This way we can use the tank and one RPC to define the trigger and measure the efficiency in the other RPC

Tierra del Fuego setup @ BATATA site, AUGER

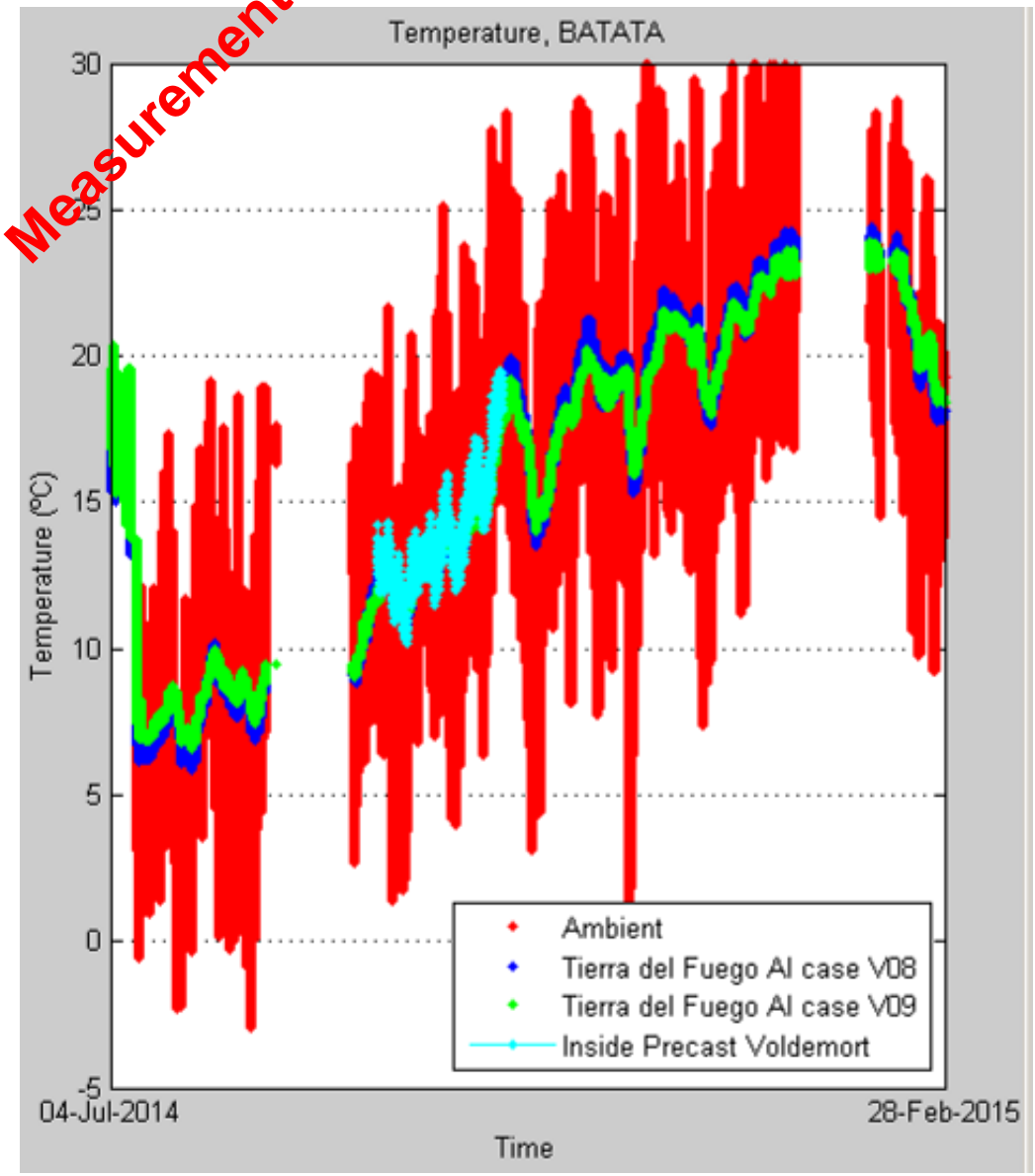
[GAP-2013-015]



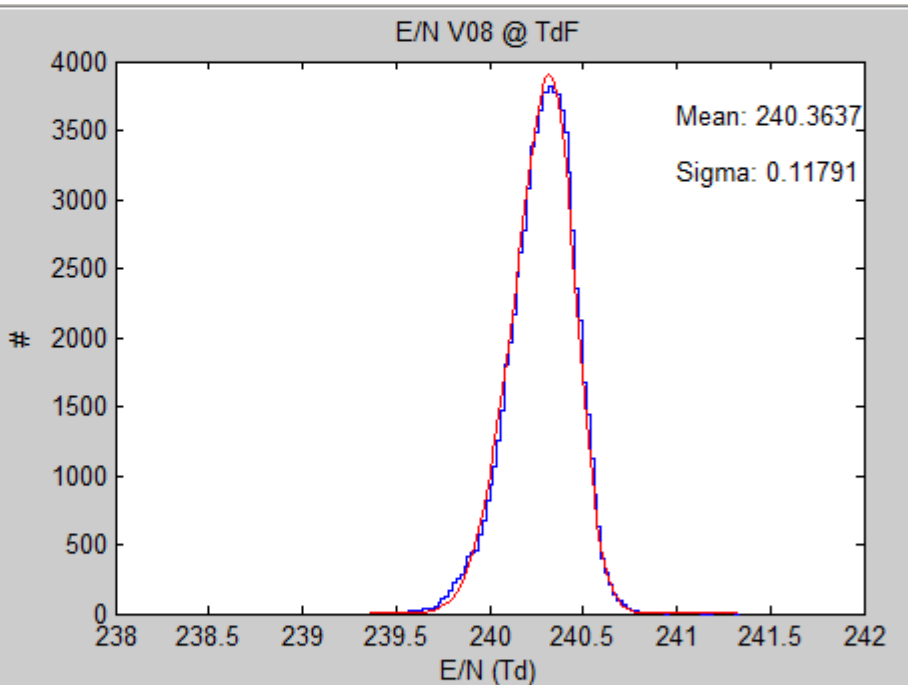
Tierra del Fuego setup @ BATATA site, AUGER

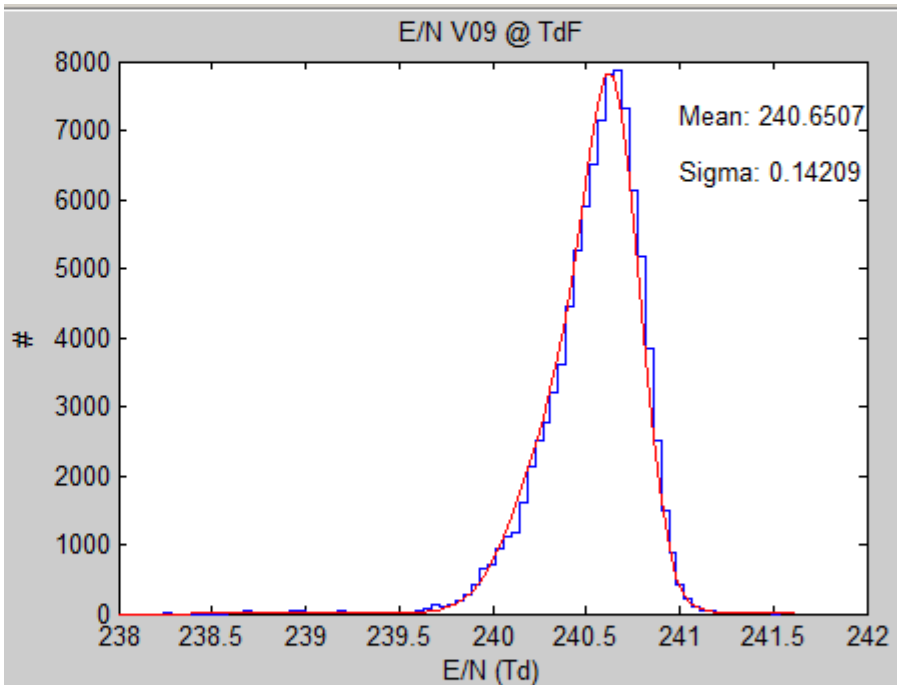
Daily air temperature excursions around 25 ºC

Chambers daily temperature excursions below 3 ºC



Tierra del Fuego setup @ BATATA site, AUGER

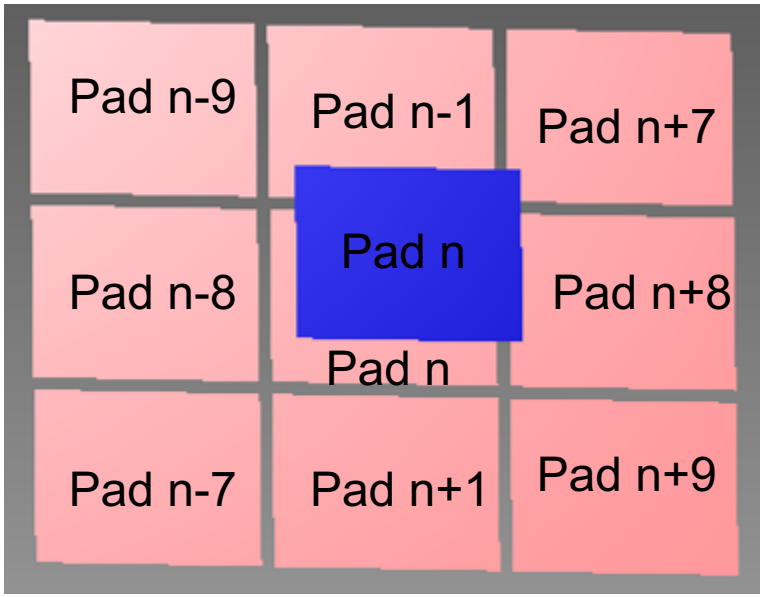




Narrow Reduced Electric Field, E/N, distributions

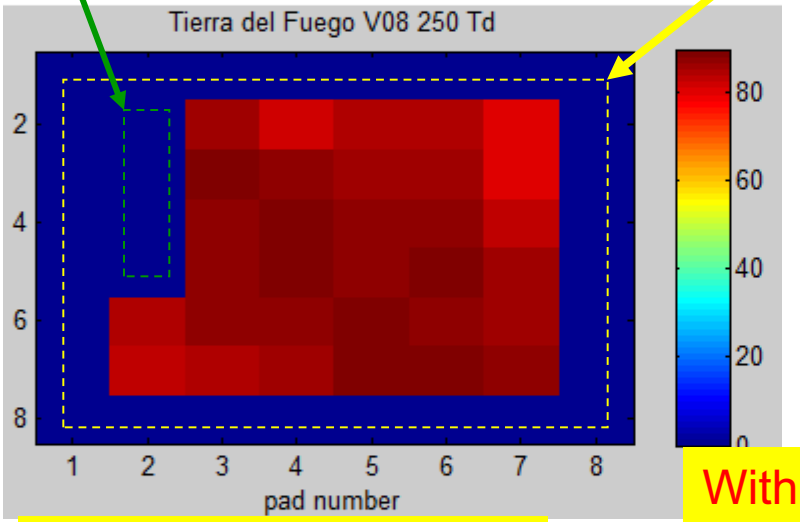
Tierra del Fuego setup @ BATATA site, AUGER

Trigger is defined by a coincidence between tank and chamber 9.
Efficient event is when we have a hit in a pad in chamber 9 and one hit in the same pad of chamber 8 or in any neighbor pad

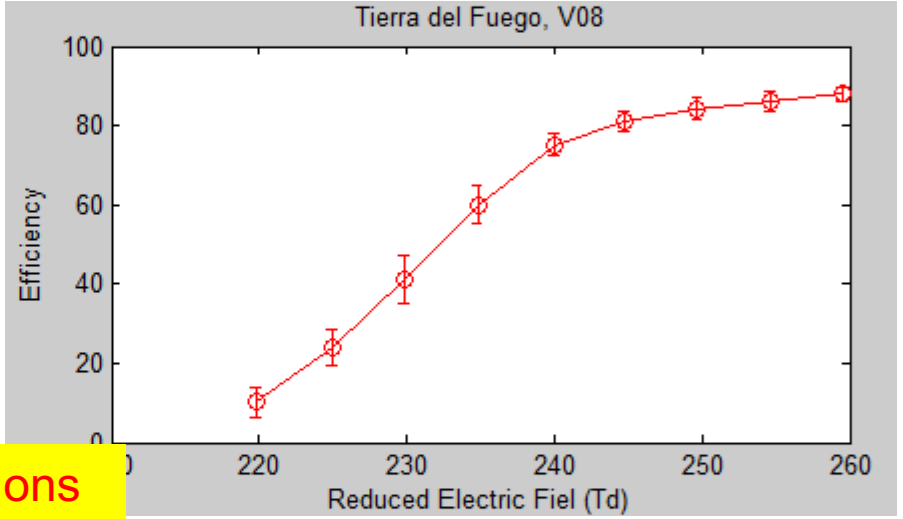


Due to the efficient event definition, all the border pads are not taken into account

Dead channels

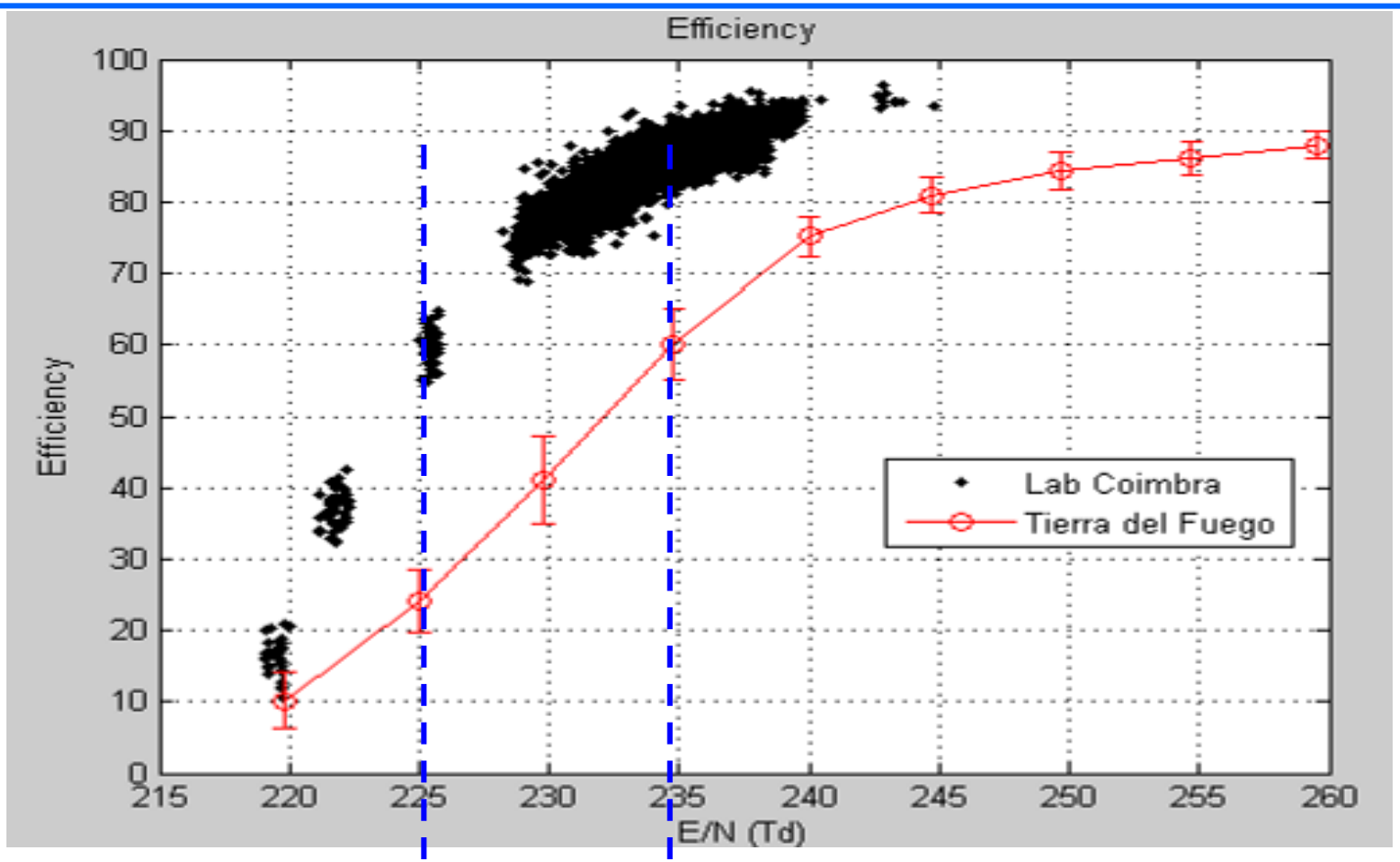


Uniform over all area



With muons
1 day / point

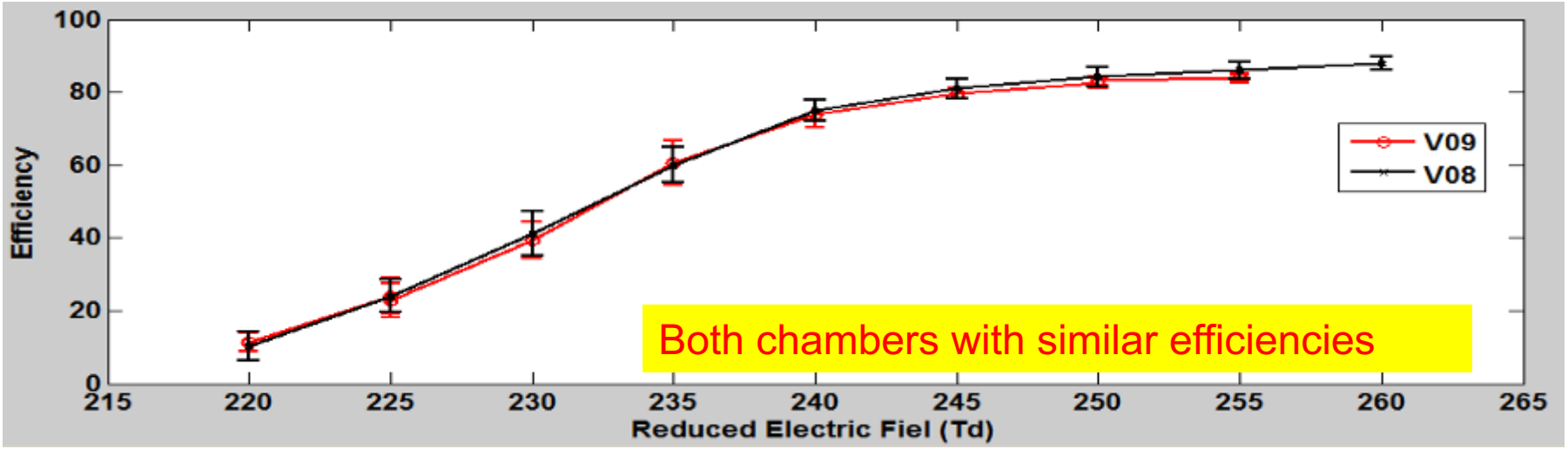
Tierra del Fuego setup @ BATATA site, AUGER

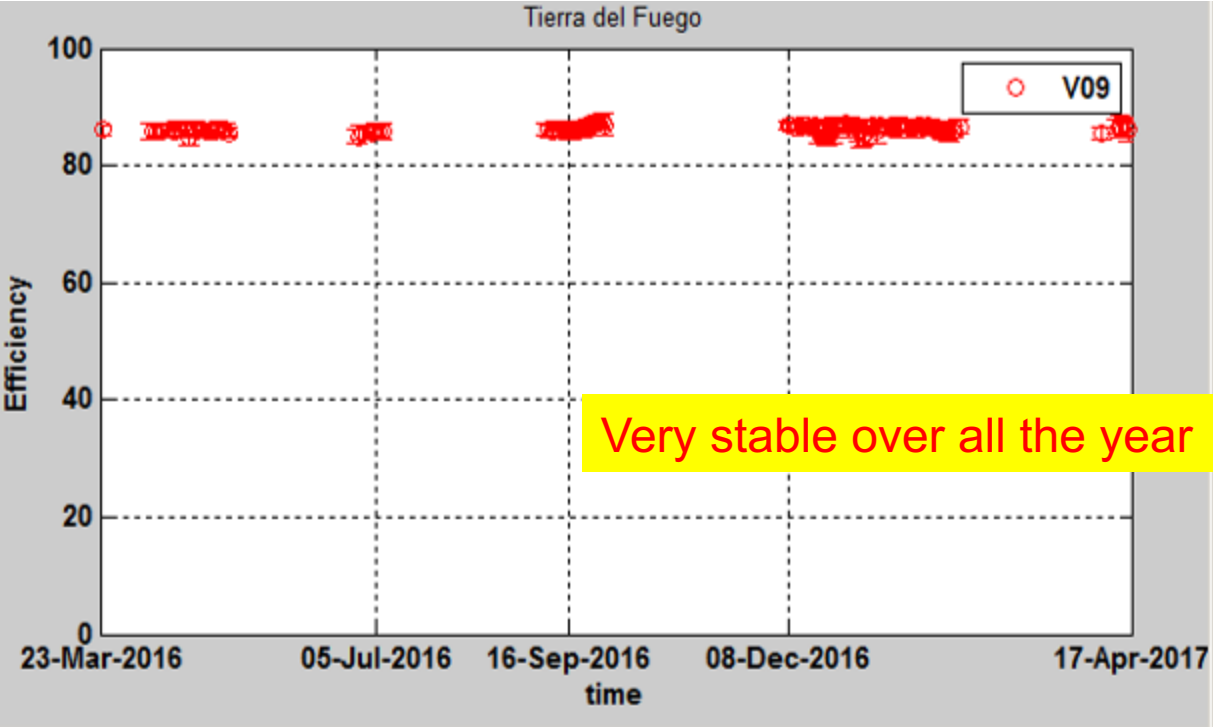


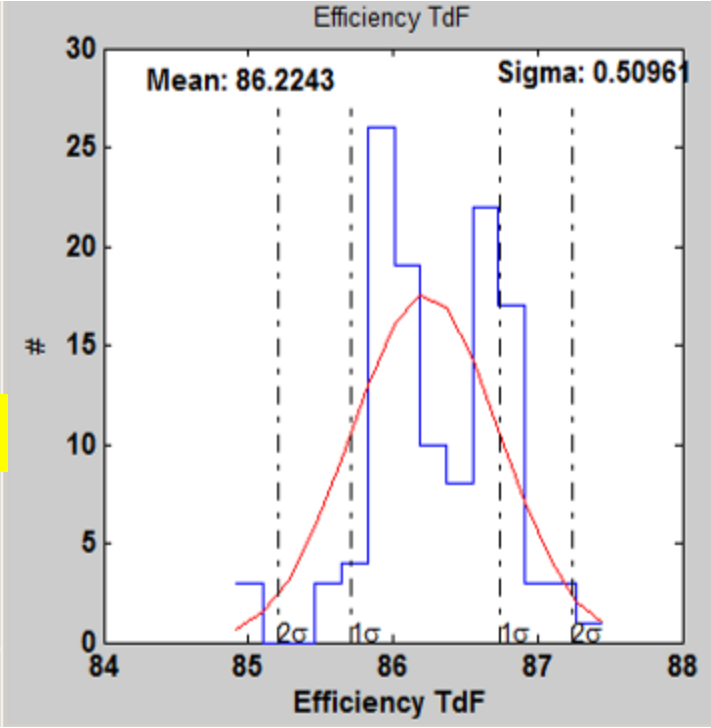
200 V/gap (1 mm gap)
ΔP=150 mbar
"same" temperature

Lower pressure implies lower gas density and lower ionization density

Tierra del Fuego setup @ BATATA site, AUGER

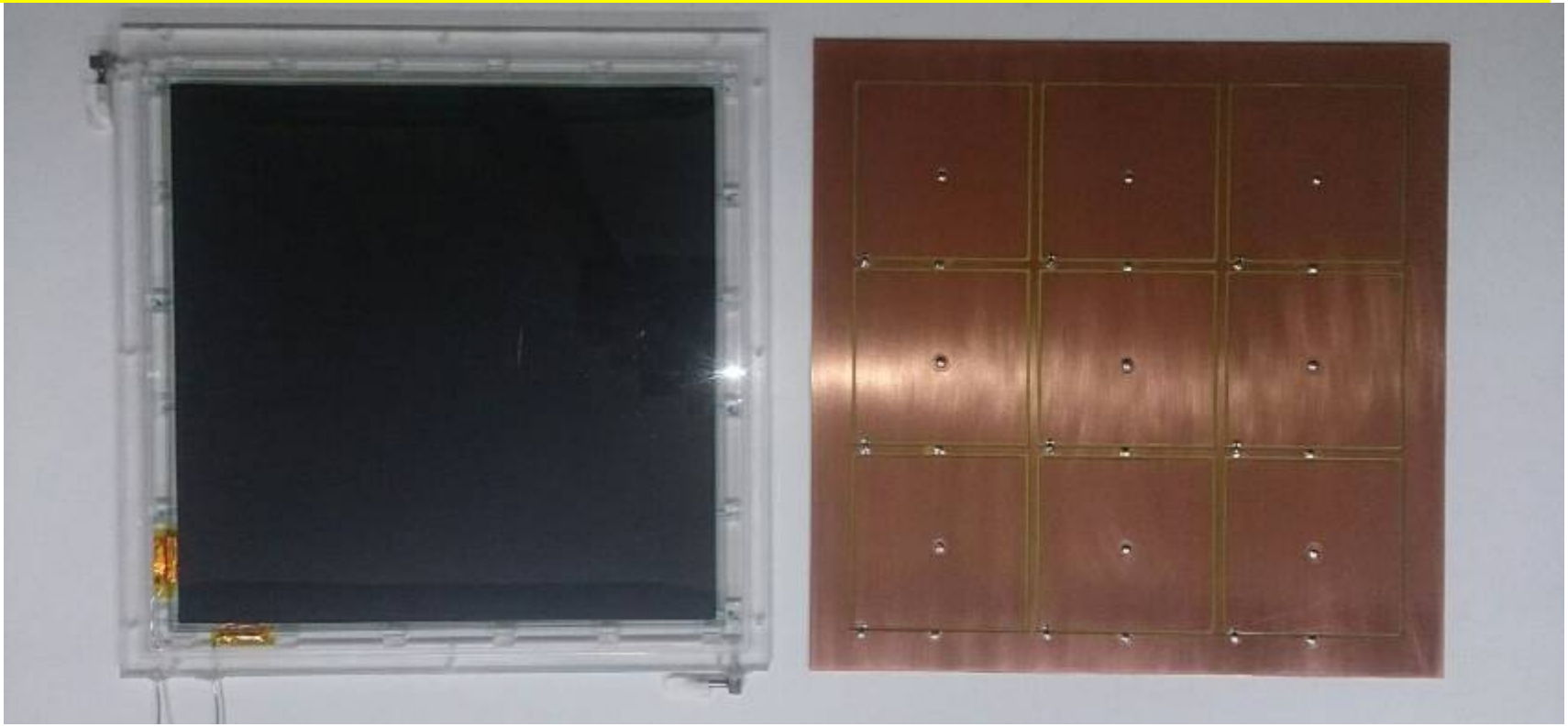






Test @ lower pressure/density in the lab

Small chamber 30x30 cm^2, same design as MARTA. To be placed inside pressure box and tested until 500 mbar (LATTES site ambient pressure)



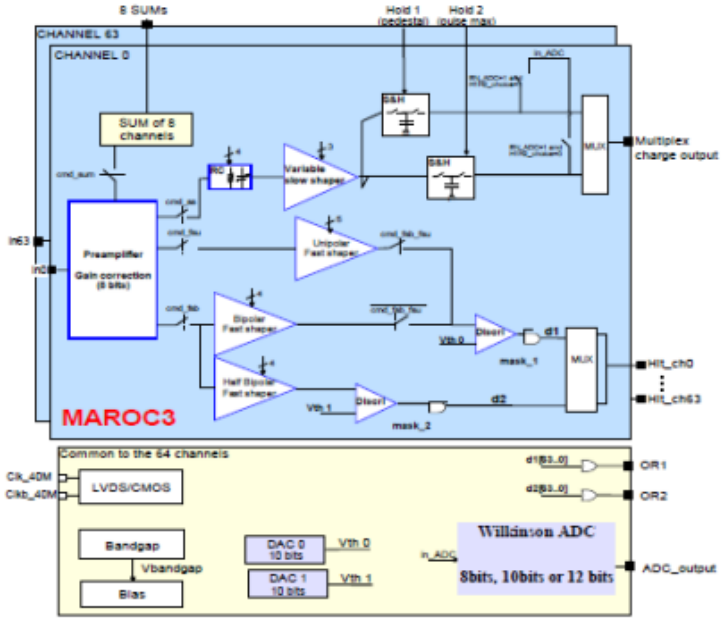
To be done soon….

DAQ for LATTES

- DAQ will be inspired in the development of MARTA DAQ
- MAROC ASIC
- Adding PMT readout: Amp + ADC
- Care in the clock tree to achieve ns synchronism
  (Dense array allows optical fibre)
- Local “aggregation units”

MARTA DAQ

- Readout system based on the MAROC ASIC by OMEGA:
  - Built to be used with photomultipliers for the ATLAS detector
  - Low power ASIC
  - Able to do both charge and count measurements
  - 64 input channels
  - Complex with more than 800 parameters and it has a complicated trigger system



MAROC 3 schematic view

MAROC ASIC

Marta V4 DAQ Summary

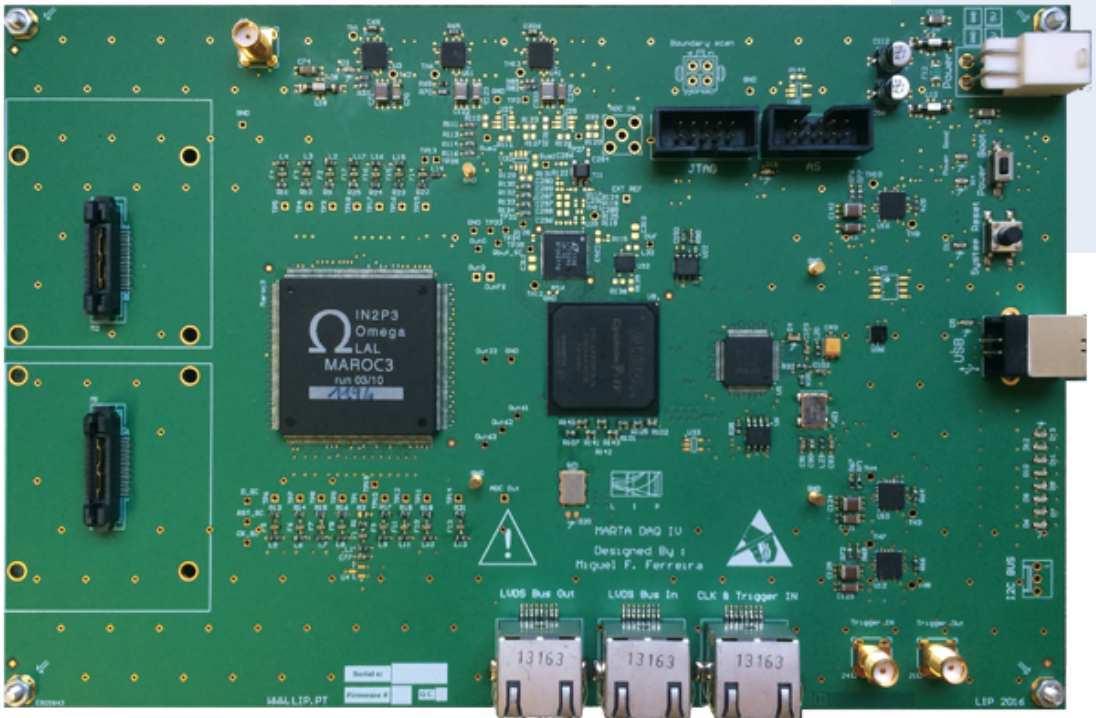
Main changes :

- A more Recent FPGA.
  - Cyclone IV.
  - Low Power.
  - BGA Package.
- LVDS Links communication – trigger and central unit interface.
- ADC for Sums.
  - Buffer and analog adder.
  - Shaper.
  - ADC:
    - 200 MSPS.
    - 10 bit resolution.
    - LGA package.

For event total charge measurement.

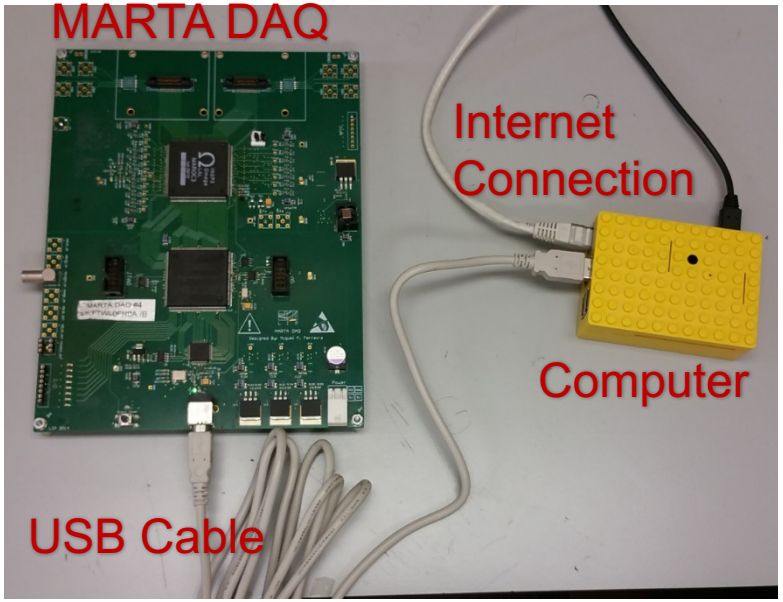
For calibration using RPC charge spectra.

MARTA DAQ IV PCB



Test benches setups and results

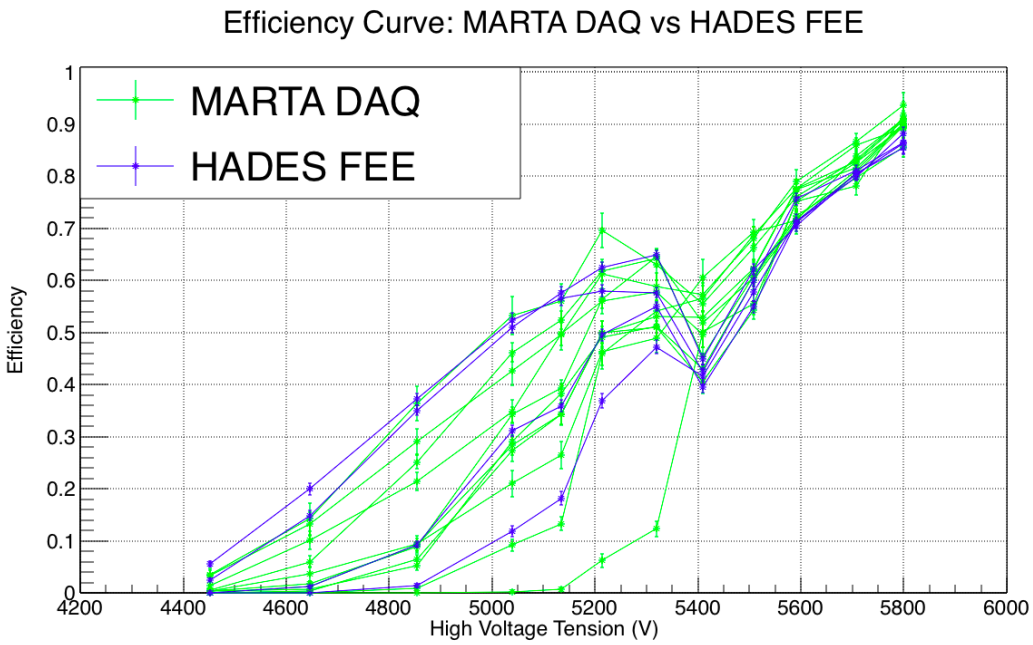
- Lisbon setup:
  - Mainly used for firmware and software development
  - A RPC will be at the new LIP Lisbon
- Coimbra setups:
  - Performance studies of the MARTA unit (RPC + MARTA DAQ)
  - Setup 1: An RPC hodoscope is used to trigger the MARTA unit
  - Setup 2: Two RPCs instrumented with MARTA DAQ boards in coincidence
- Rio de Janeiro setup:
  - Similar setup to Coimbra 2
  - Central Unit development



Efficiency studies

- Using an RPC hodoscope to trigger the RPC being studied.

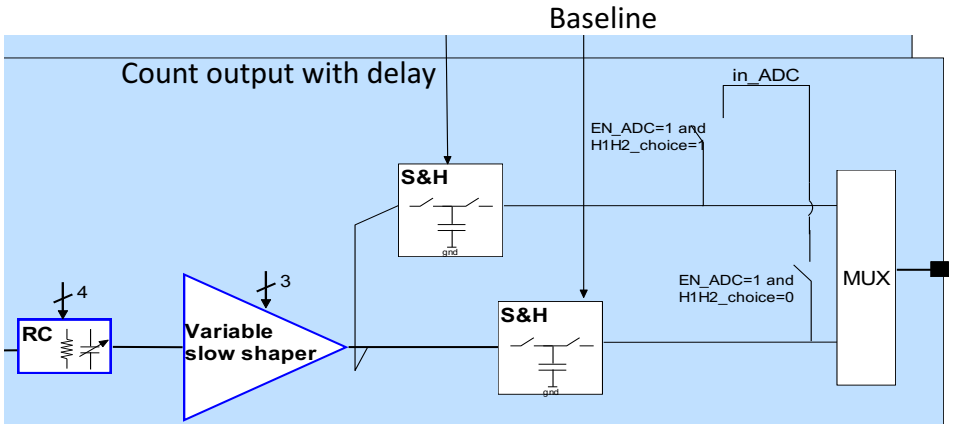
- A establish RPC DAQ (HADES FEE) and MARTA DAQ were connected to the RPC being tested.
- The efficiency was studied for different HV Tensions. Both DAQs follow the same patterns.

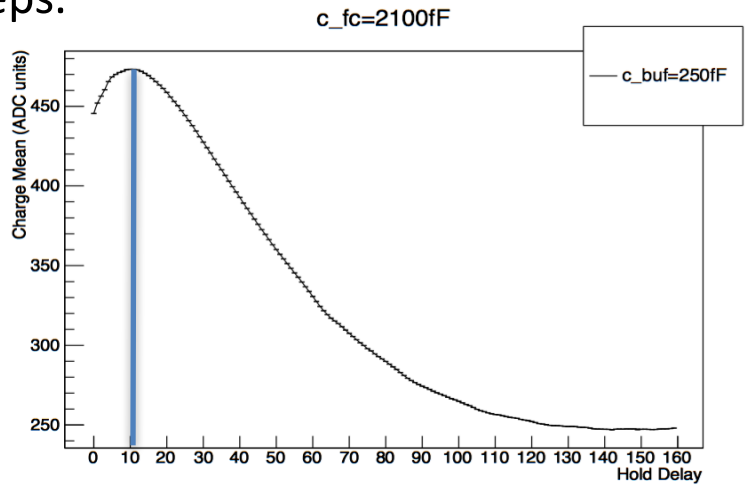


RPC efficiency using MARTA DAQ and an established RPC DAQ

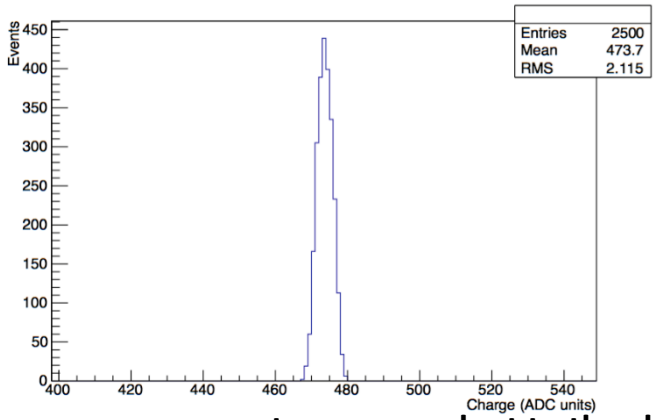
Charge studies with self trigger

- The slow shaper outputs was studied using a signal generator and changing the hold delay using 3.125 ns steps.

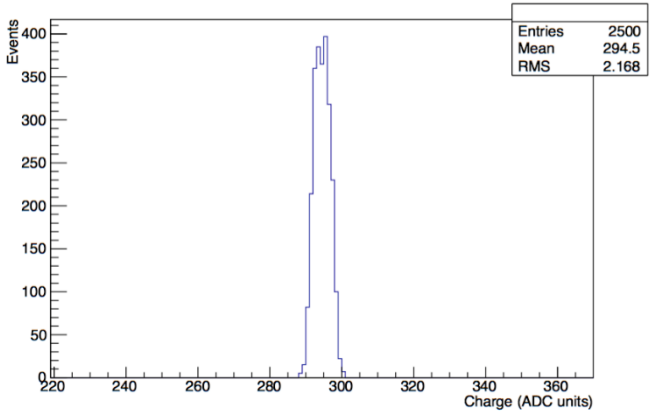




- The slow shaper peak is proportional to the RPCs induced charge.
- For this particular configuration that happens at hold delay = 10.

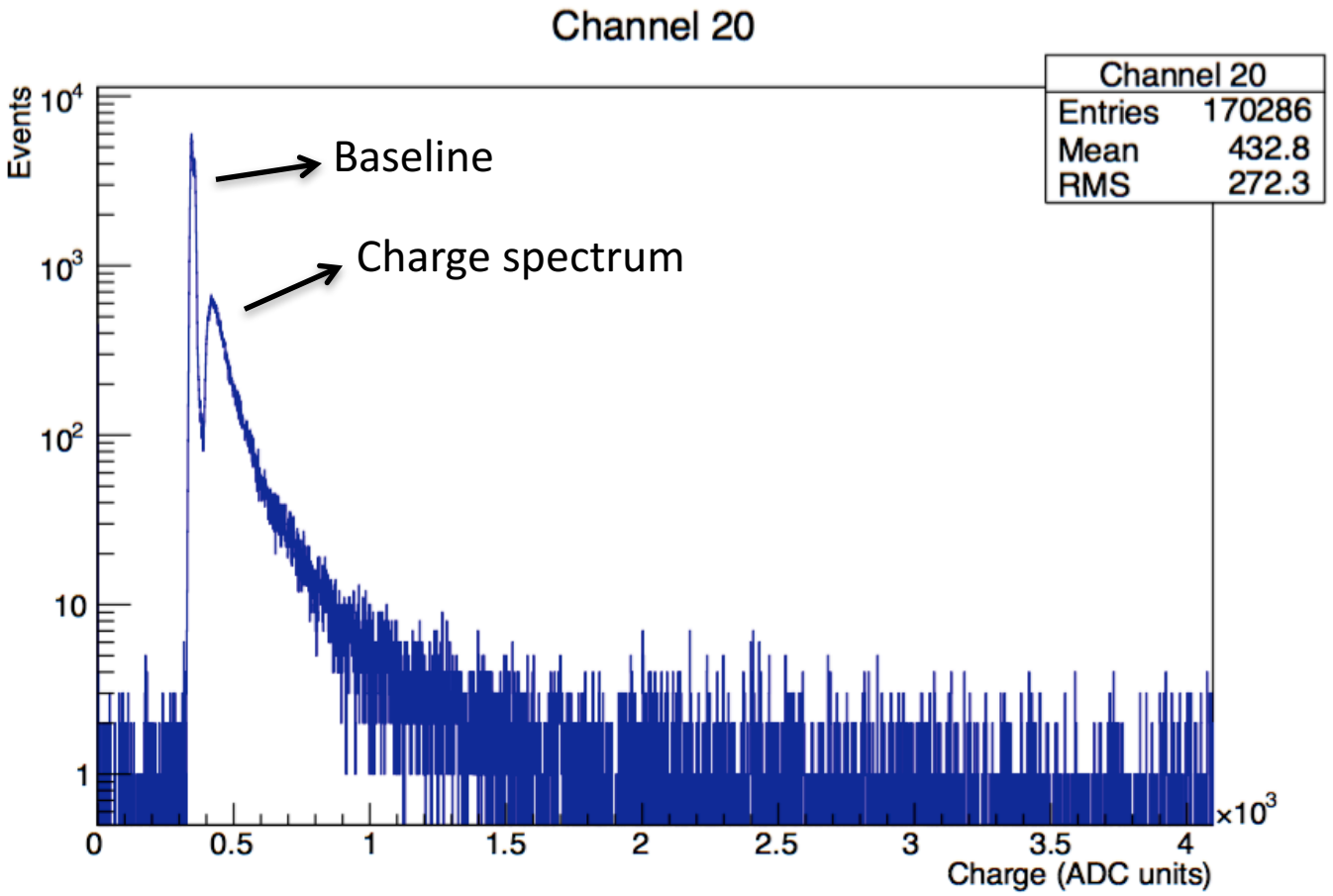


Charge measurement correspondent to the slow shaper peak

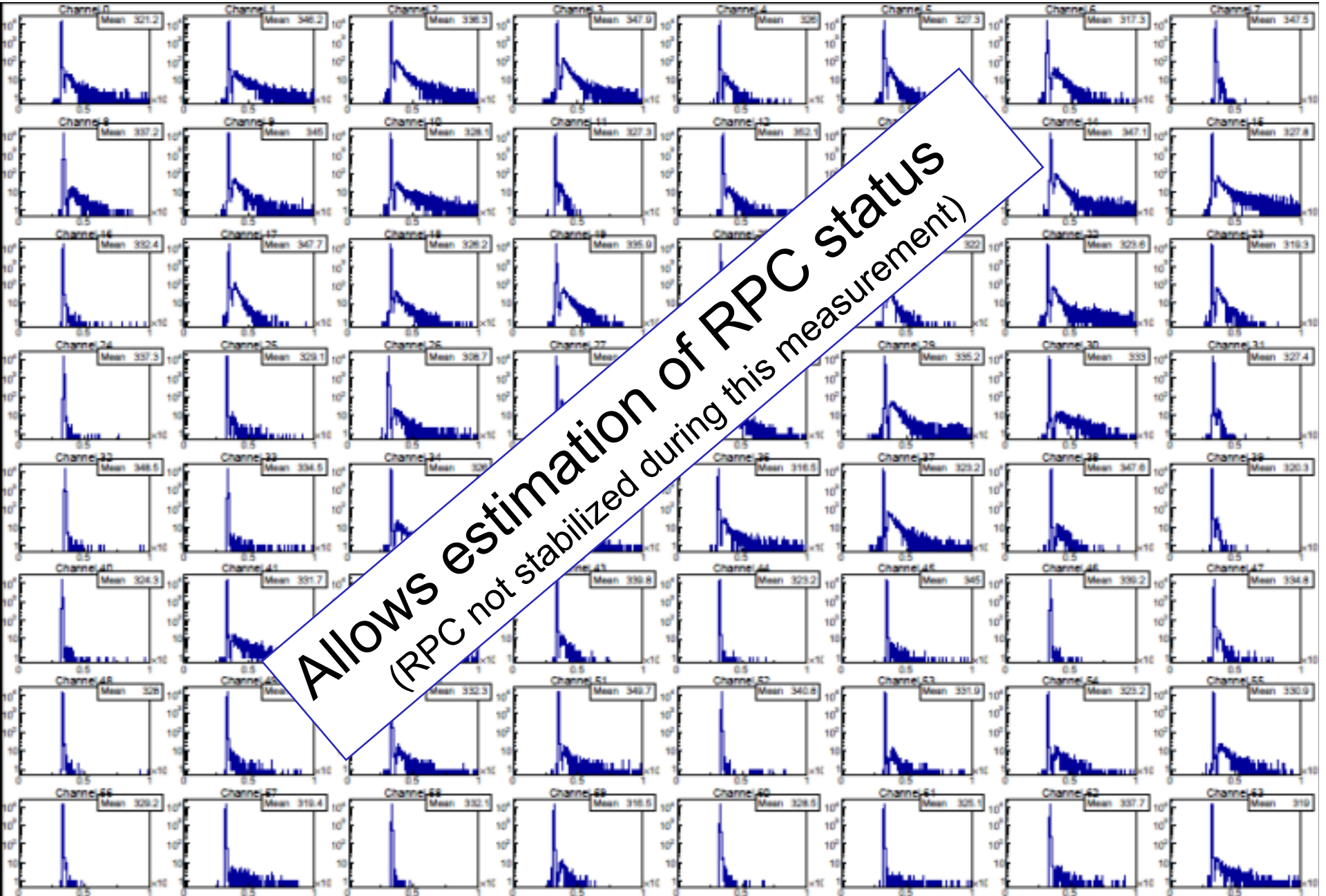


Charge measurement for a baseline

- A charge spectrum of an RPC was obtained using self trigger.

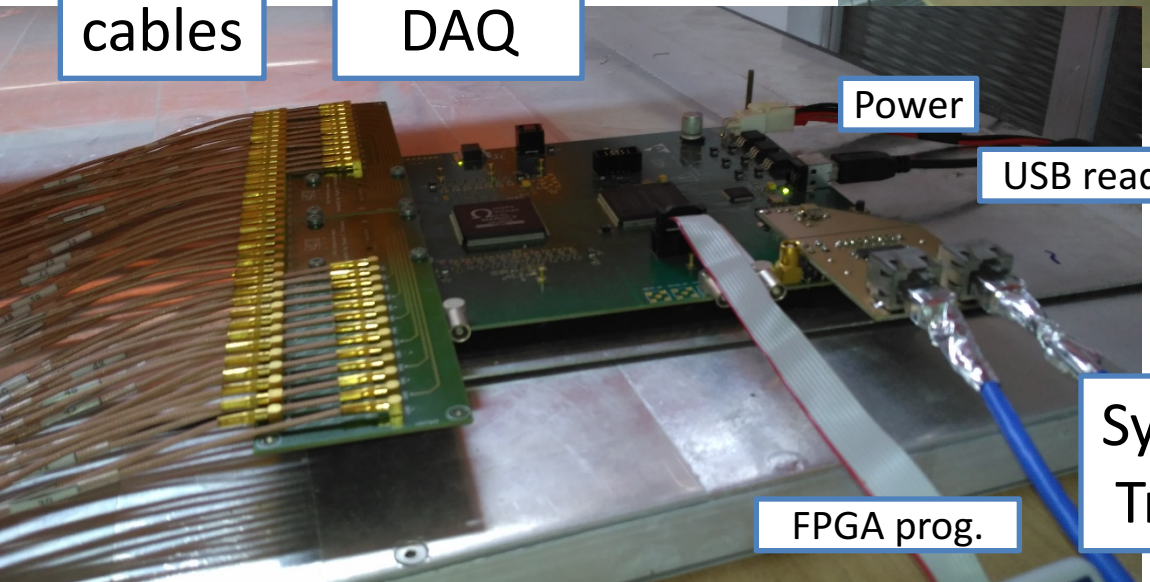


Charge for all channels @ São Carlos



MARTA setups @

Hodoscope: 2 x RPC with new DAQ



Rio Setups

- MASTER
  - High Precision Hodoscope
  - Produced and tested @ Coimbra
  - Being shipped to Rio de Janeiro
  - Support frame being built @ Rio workshop
    - Possibility to move and incline
- Enclosures
  - Being built @ Rio workshop
    - To install sensitive modules already @ Rio
- Hodoscope for Malargüe
  - Development of SSD test system
  - Hodoscope: Trigger; Osciloscope: acquire scintillator
  - Possibility of developing a new hodoscope for Malargüe
    - With MAROCs
    - Develop / replace / upgrade Gianni hodoscope
    - Upgrade SSD hodoscope

Summary

The DAQ readout system for RPCs is in its production phase.

Simple adaptations allows to use MARTA boards for LATTES prototypes

The LATTES DAQ system will probable evolve from the work done with the MAROC ASIC

Synchronism between stations to be studied.