# Status of the Front Tracker GEM and MAROC readout for PMTs

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SBS Weekly Meeting

INFN – Catania, Genova, Bari and Rome/Sanità

Started assembling with new GEM foil revision

Electronics test for final production

MAROC readout for PMTs...

# Summary of activities

Last few weeks mainly devoted to:

- Going to finalize the cosmic test infrastructure for the GEM modules in Rome

- Move to the assembling of the new GEM foil (with external protective resistors) ... Needs some changes in the HV testing tools and assembling procedures

- Starting test of the final MPDs

- Tested latest (different APV25 bonding) Front End cards for starting final production

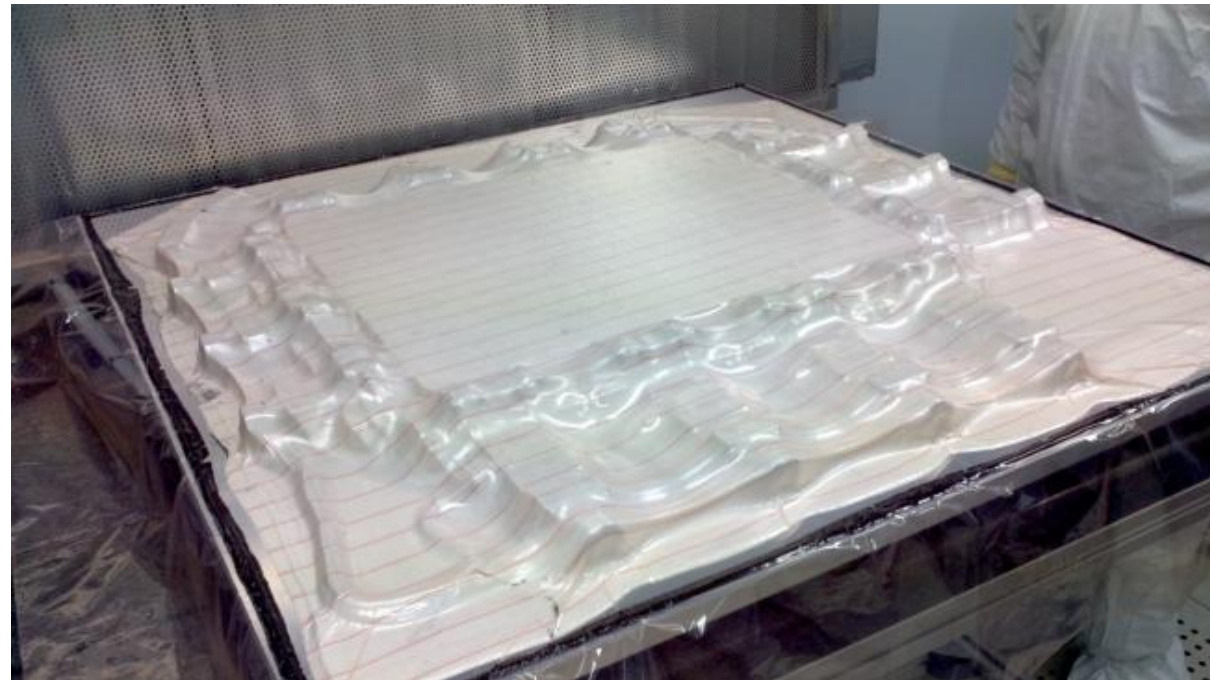- Finalizing the testing procedures (and related software)
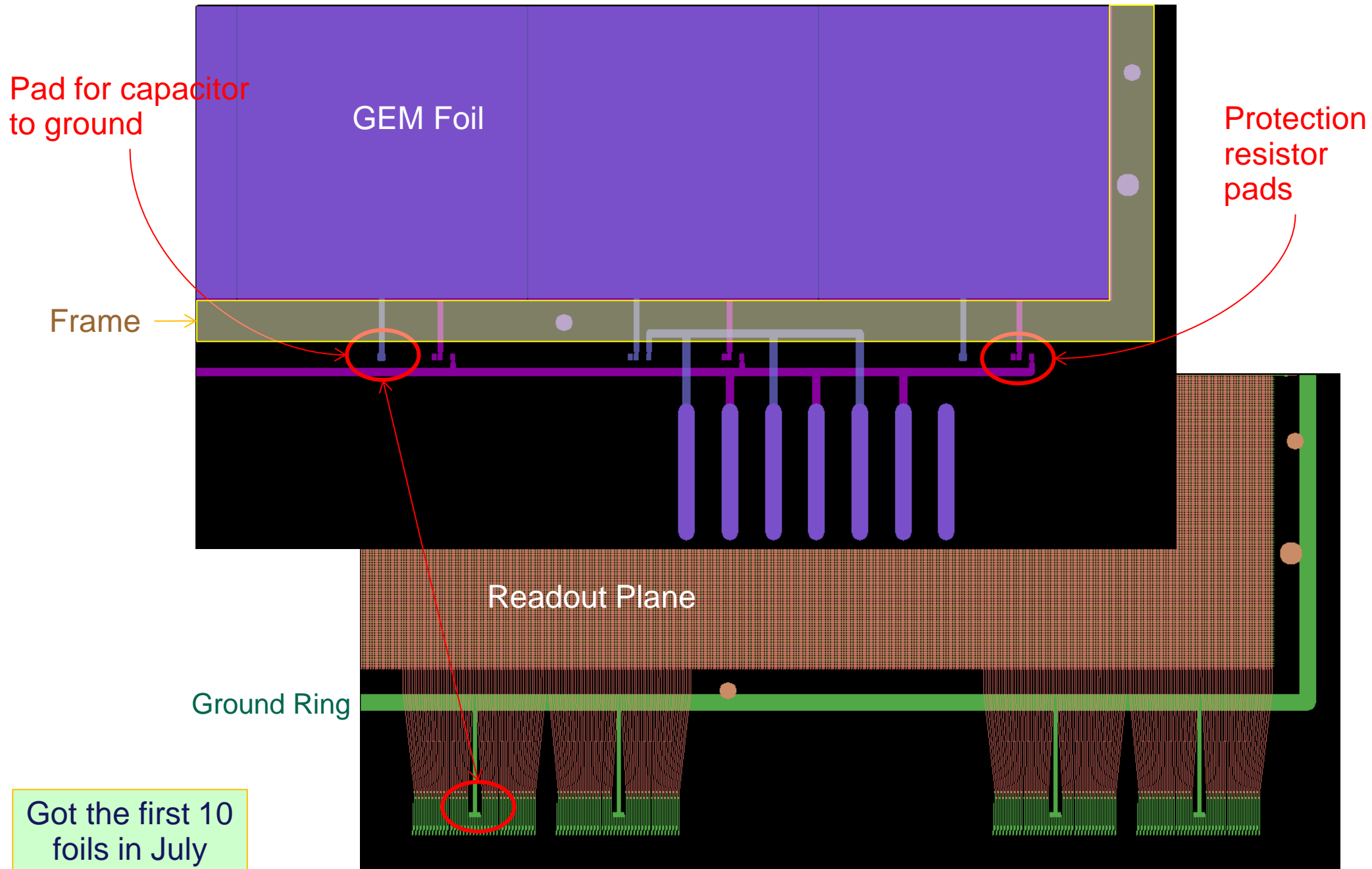
# Improved GEM gluing procedure
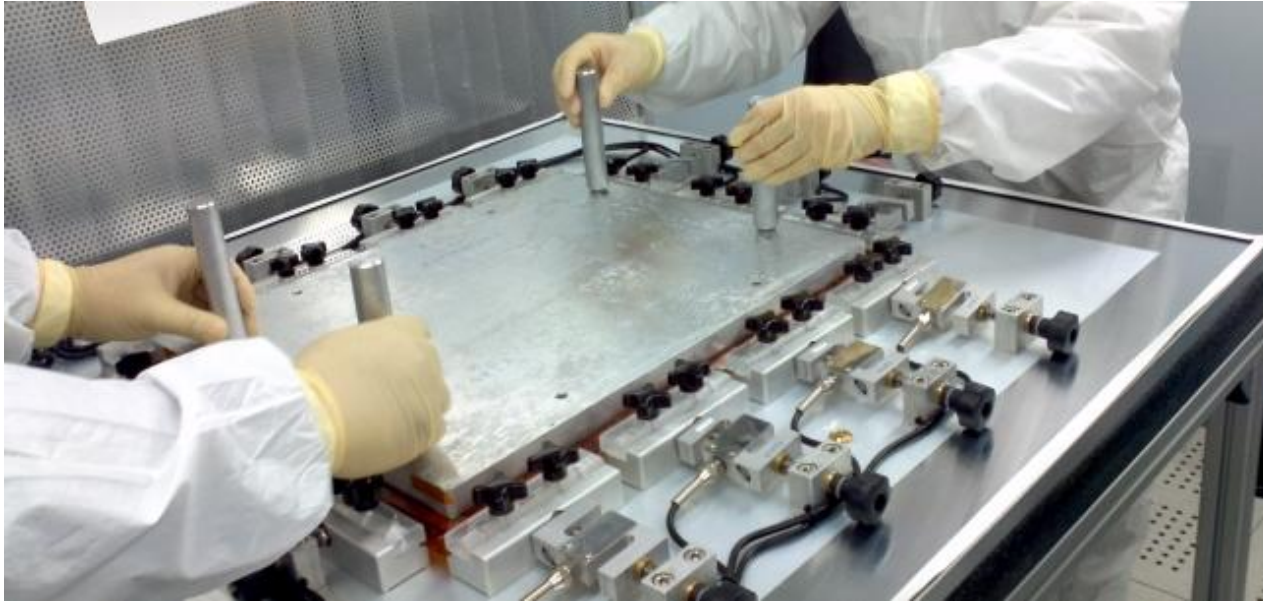


Use vacuum to make uniform pressure and improve glue degassing

Used for readout foil glued on honeycomb and GEM on frame ... 24 h each



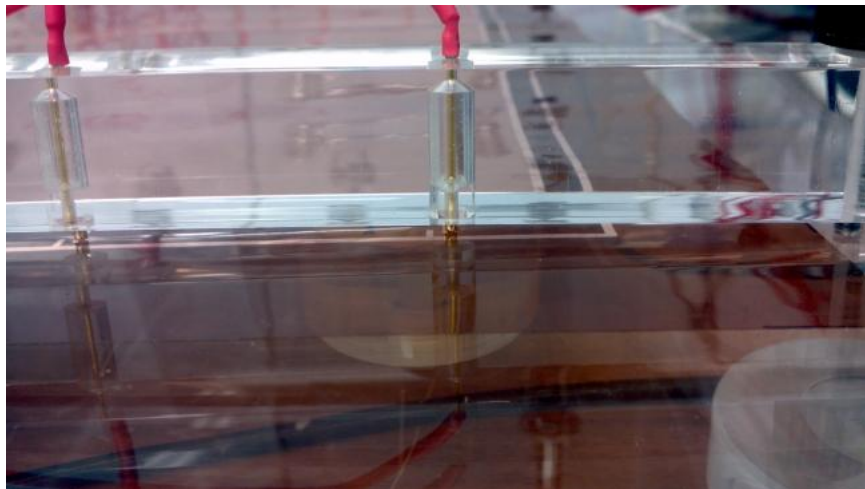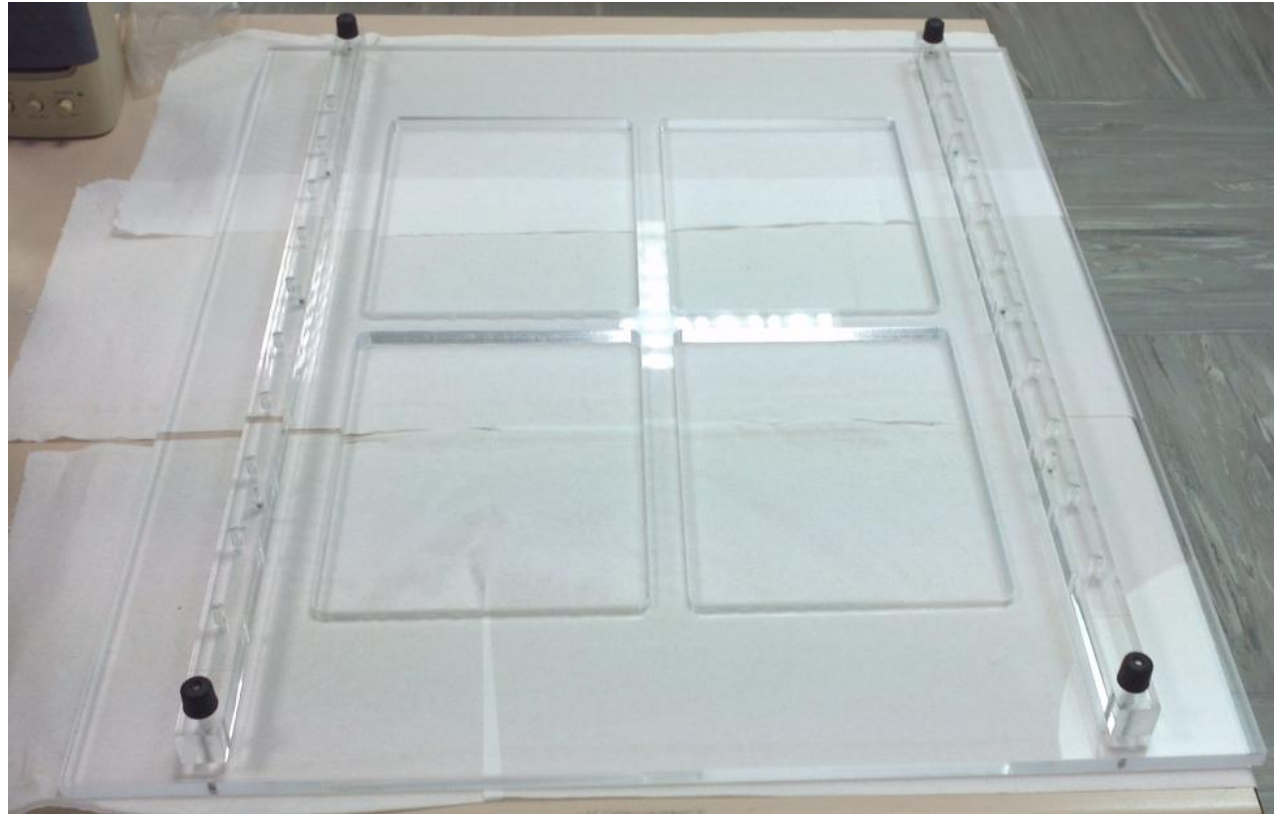Assembling procedures detailed document under finalization

# New GEM foil revision / detail



Pad for capacitor to ground

Protection resistor pads

GEM Foil

Frame

Readout Plane

Ground Ring
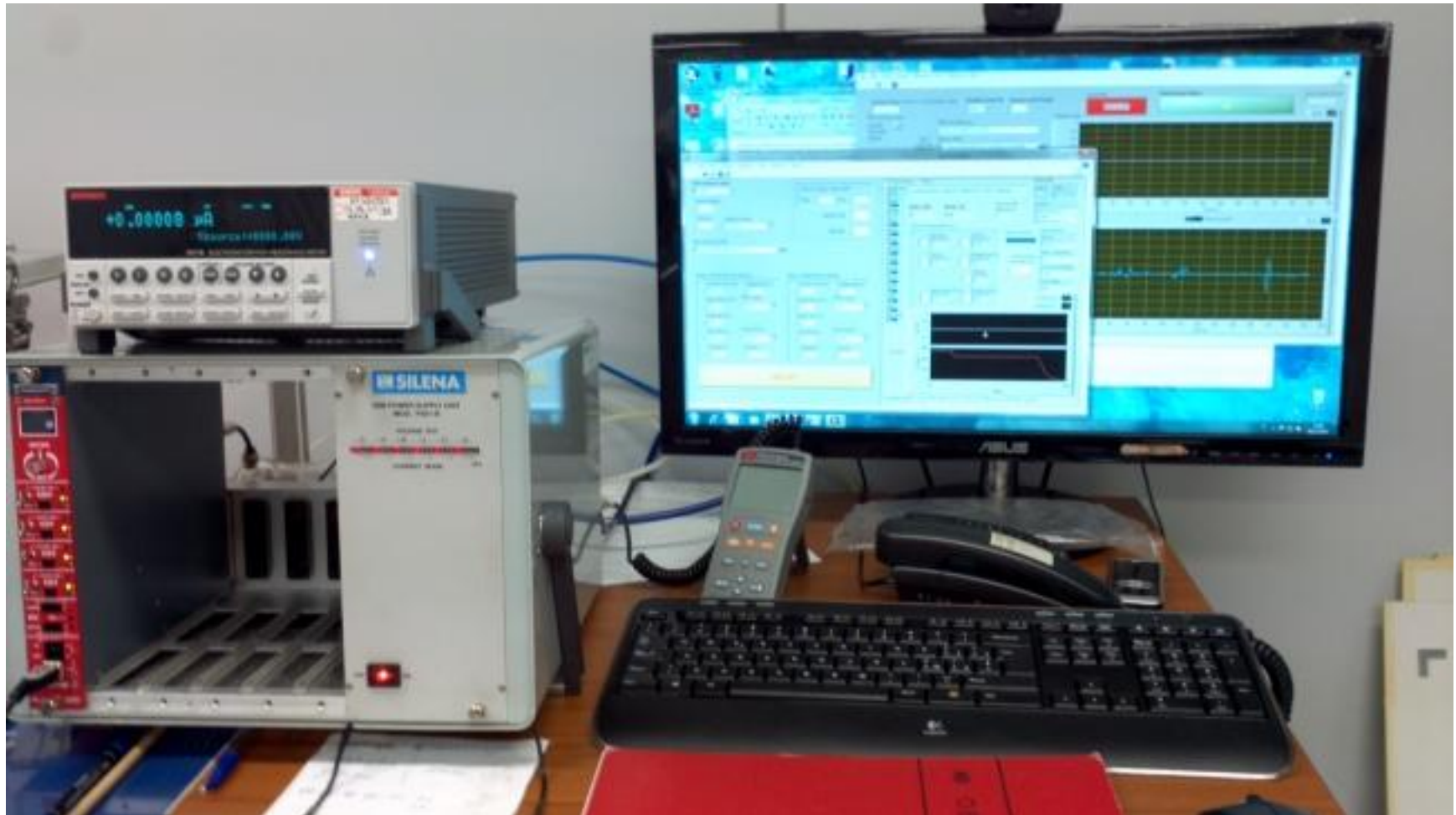
Got the first 10 foils in July

# New HV GEM Testbed

Test bed open to permit dust falling



Precise pins fixed locations to avoid misaligment and bad contact (use the reference holes in GEM)
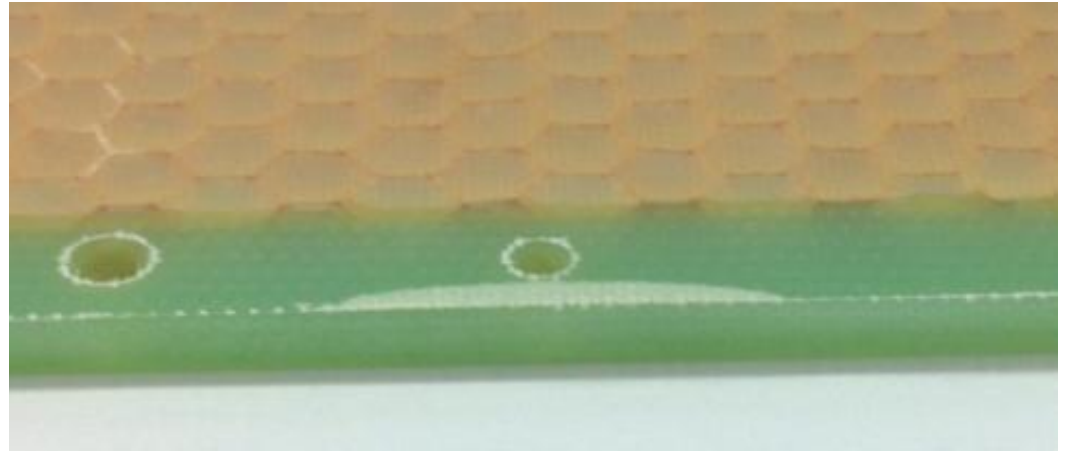
# Improved LabView Control

All settings and readings during HV test are now stored on files automatically

# Some production issues

Honeycomb plane:

Upper layer tends to un-glue in few points on last 2 planes inspected



Readout cutting quality on last bunch of production:

Moved from laser cutting to «standard» cutting

Seems to be minor or no issue -> to be checked after assembling with electronics

# Electronics Test and Production

<u>MPD VME Modules</u>

All produced and delivered; first 4 tested succesfully (testing procedure basically completed: test report for each MPD)

<u>Front-End</u>

Latest tuning before final production: modified bonding procedure and bonding pads to improve quality (?) and speed up production.

New 5 cards received; two of them tested successfully, additional three show problem likely related to heating temperature during bonding ... confirmation underway

Testing procedure under finalization: test report for each of approx. 400 cards

# Front End Test Procedure

Test procedure

1. Absorbed current

2. ADC levels

3. Pedestal and noise level disconnected and after connection to test board (via flat adapter)

4. Internal calibration pulse estimate gain ch by ch

5. External calibration pulse estimate gain and quality of bonding contacts ch by ch

External pulse on 2 pF capacitor connected to software selectable group of 8 adjacent channels
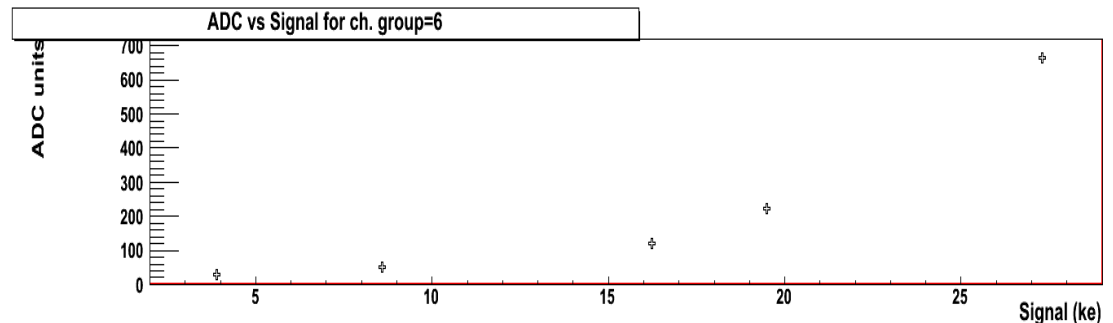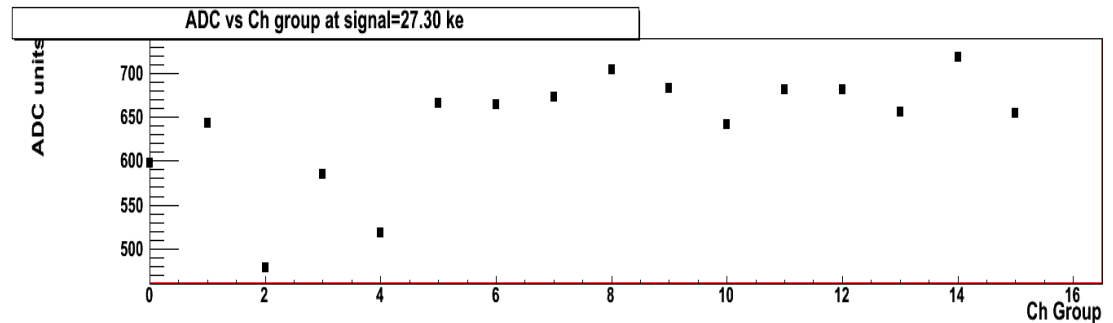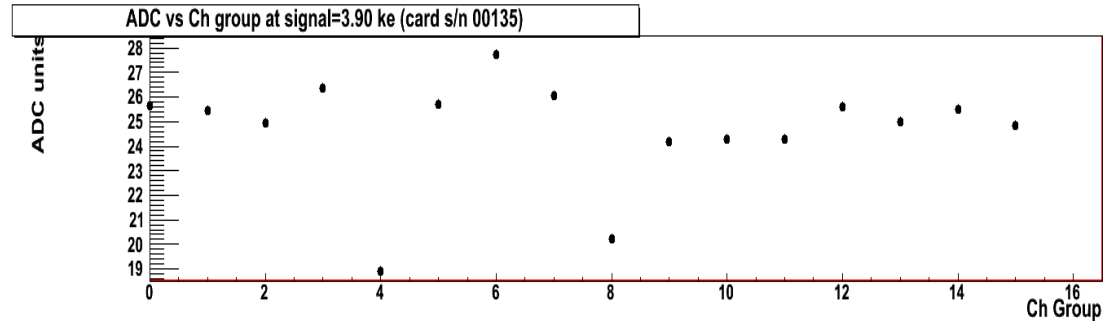
# MAROC electronics for PMTs

Following some discussions on the possibility to use the MAROC electronics for the PMTs in SBS

Few years ago we developed a MAROC2/3 based electronics for medical application (many optical photons regime)
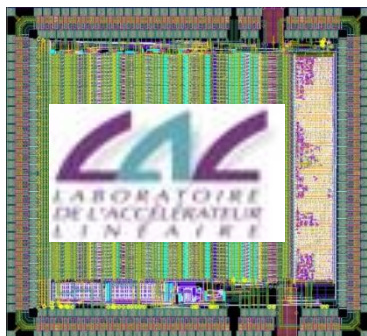
We made several tests in the last few months to study the Single PhotoElectron response

We are going to modify the above electronics for the new CLAS12 RICH detectors (single optical photon regime)

# MAROC (Multi Anode Read Out Chip)

**Originally designed for ATLAS**



- 240-pin
- 16 mm$^2$

**Single Channel (x64)**

- Preamplifier, configurable (gain 8 bit)

★ Fast line: 25 ns shaper + discriminator ⇨ Binary datum

★ Slow line: 100 ns shaper + mem. cell + ADC ⇨ Analog charge

★ Prompt Sum line: send to one of 8 embedded sum output

channels

PROs: 64 chs, designed for MAPMT, existing expertise, low power

CONs: Analog limited latency, single channel time resolution few ns (not true, see next)

Outputs: 1 Analog (MUX), 1 digitalized charge, 64 Binary, 8 prompt analog sums
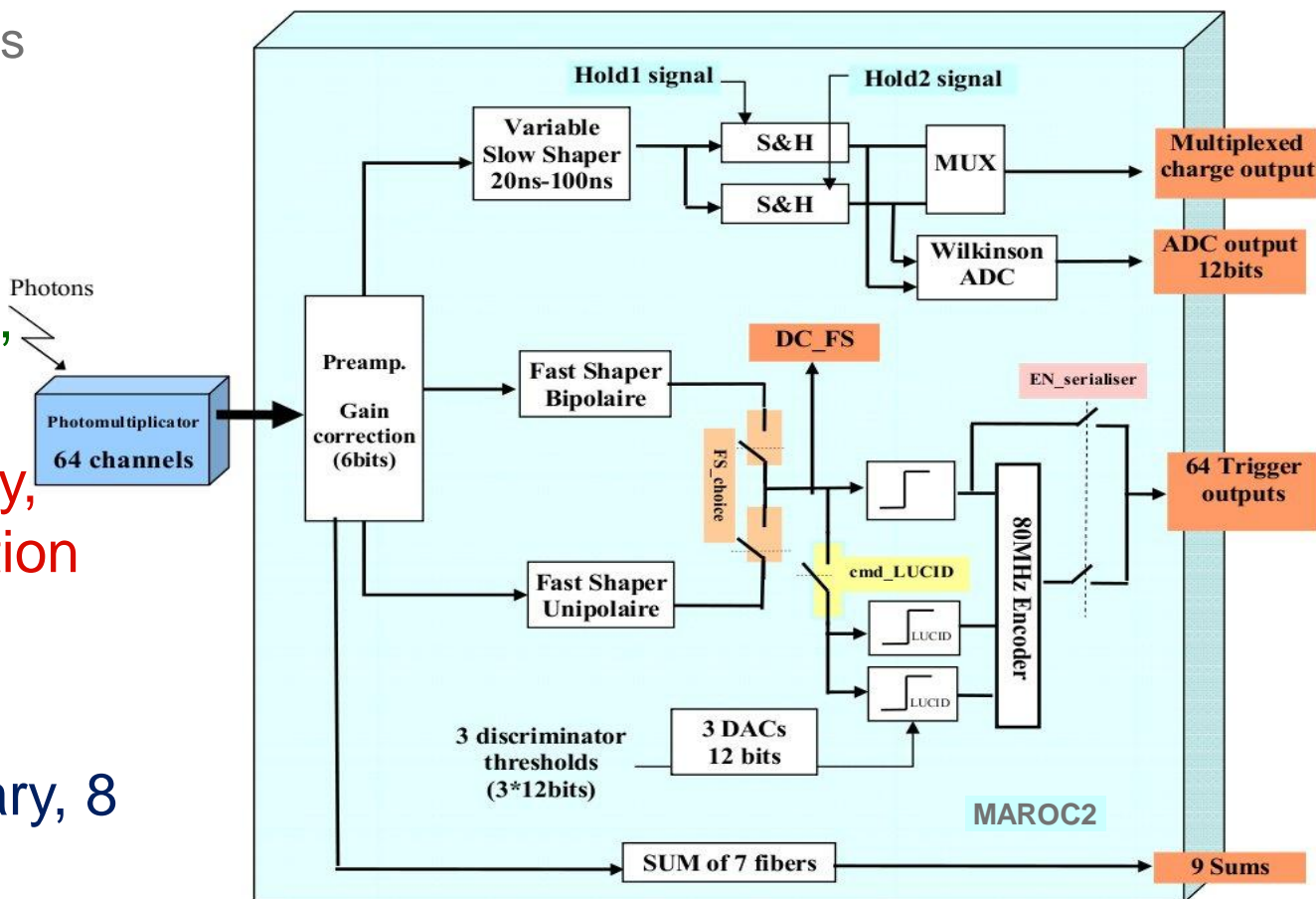
# In House MAROC based DAQ

Original system developed for Medical Imaging with radionuclides
Many optical photons applications
Designed for H9500/H8500 PMTs
4096 channels, USB2.0 readout
Binary outputs for self-trigger

Front End Cards

Backplane

Control Board

MAPMT H8500
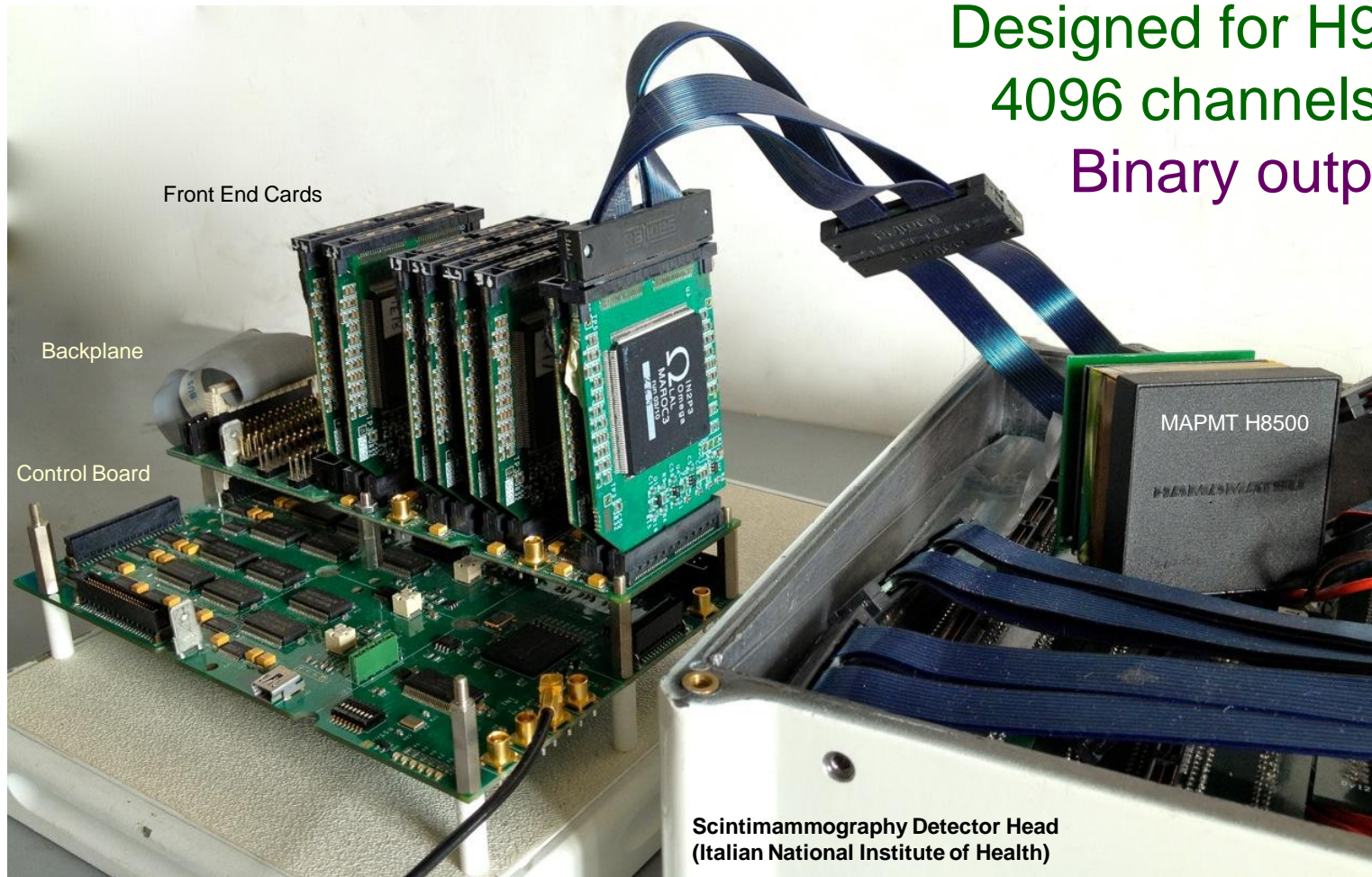
Not optimized for Single Photon and/or external trigger

Scintimammography Detector Head
(Italian National Institute of Health)

Modular design (FrontEnd + Bus + ControlBoard + USB int.)
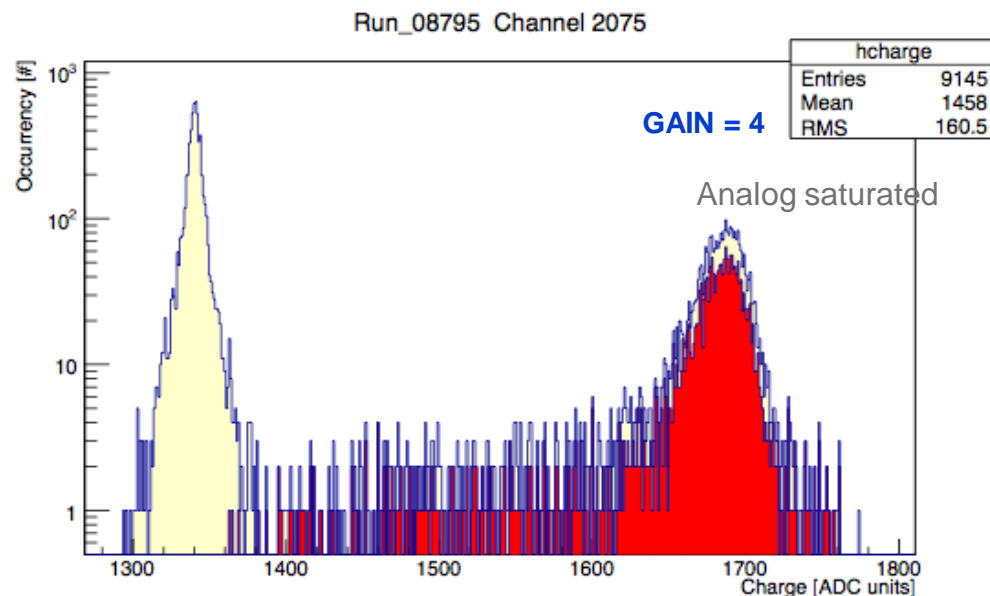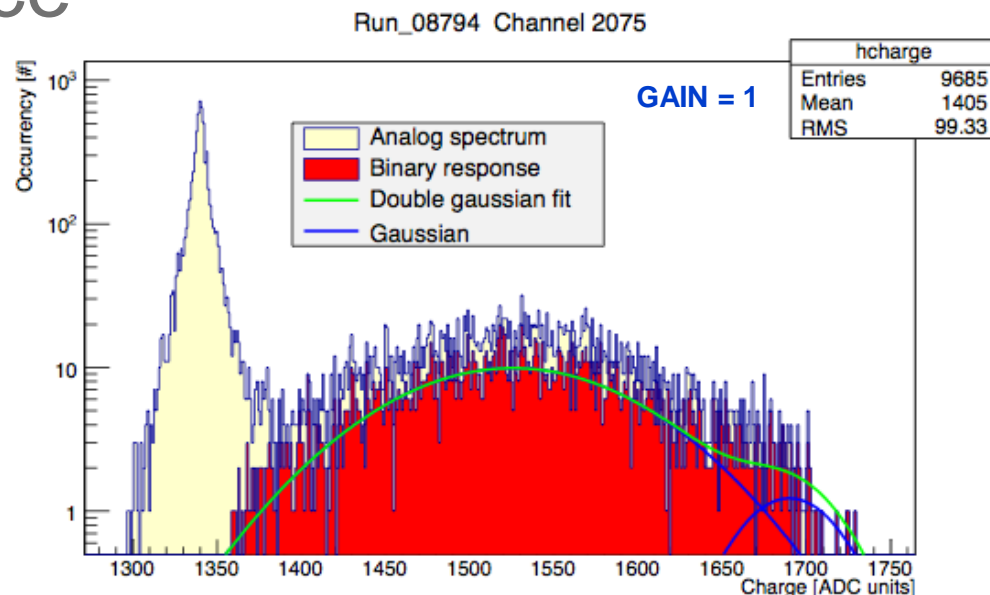
## External trigger / Light Source

**Clean SPE identification with binary data (red)**

The smooth cut observed in the analog distributions can originate from:

- noise (both analog and binary combined)
- binary line provides better information on single photoelectron and «sees» good event below analog pedestal

Analog-binary amplitude mismatch due to not-optimal relative synchronization between analog and binary outputs (next slide)

Analog Timing: First local maximum



Run_08794 Channel 2075

| hcharge | |
|---------|------|
| Entries | 9685 |
| Mean | 1405 |
| RMS | 99.33 |

GAIN = 1

- Analog spectrum
- Binary response
- Double gaussian fit
- Gaussian



Run_08795 Channel 2075

| hcharge | |
|---------|------|
| Entries | 9145 |
| Mean | 1458 |
| RMS | 160.5 |

GAIN = 4

Analog saturated

**Binary output behaves as well as analog (or even better)**

13

**Self-trigger** capability can be exploited for effective calibration
(gain equalization, threshold selection, MAPMT gain compensation)
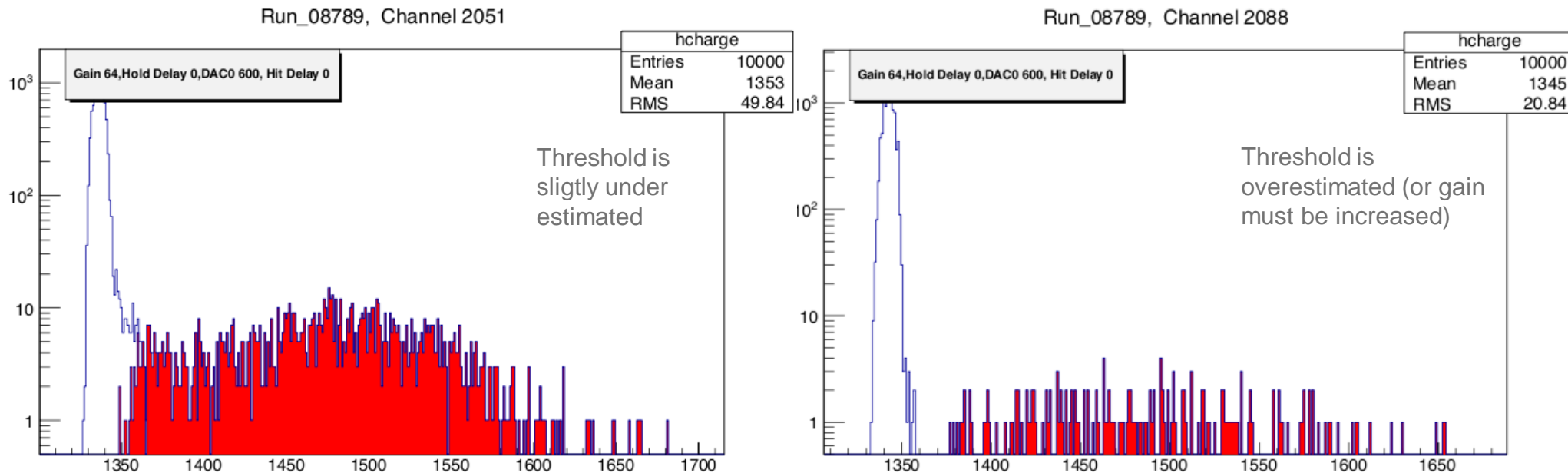


Dark spectra for two different channels

The small dark count rate (10Hz) is quickly acquired in self trigger mode, while in external trigger would require either a long acquisition time or an external light source.
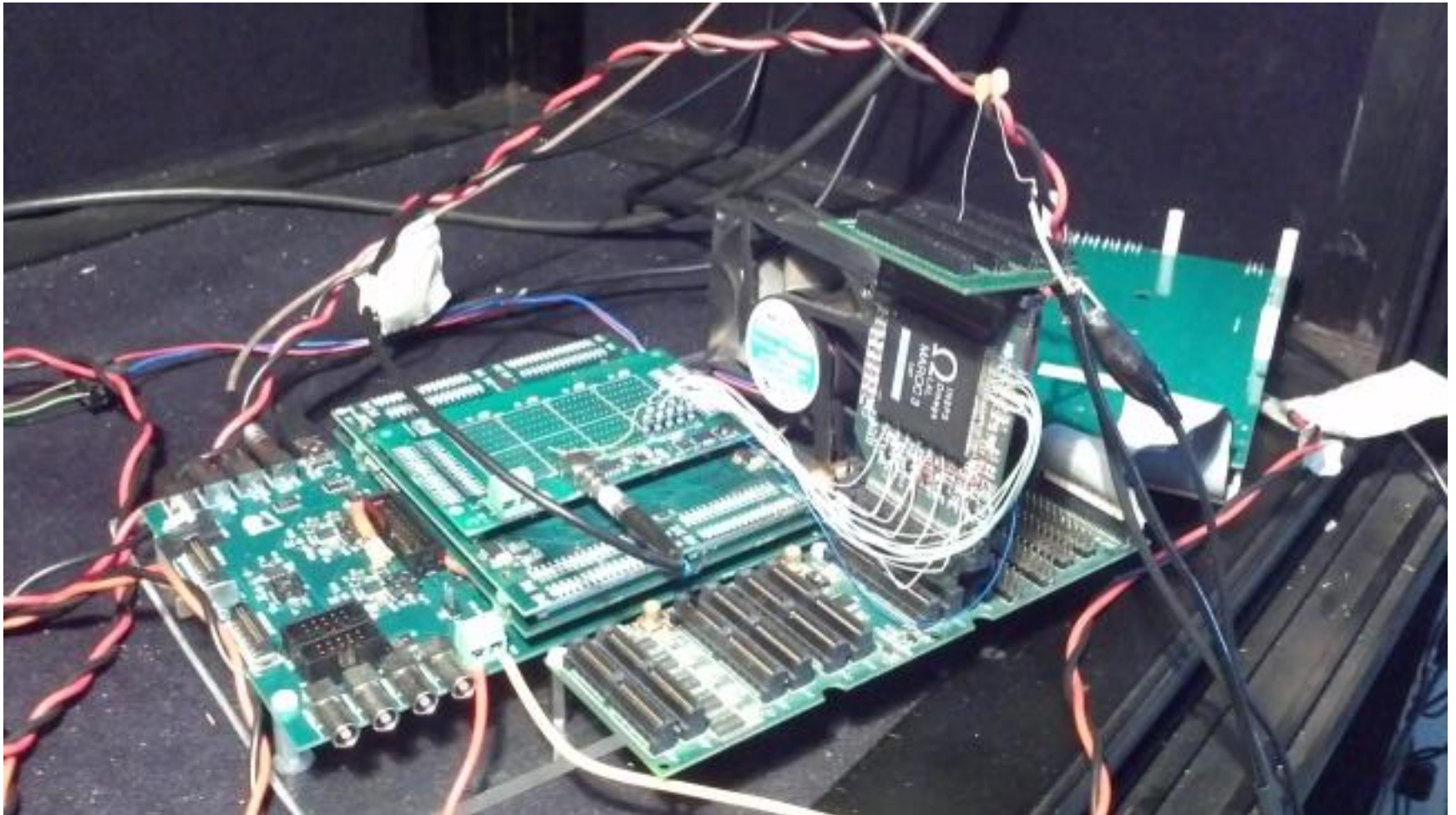
# CLAS12 RICH - DAQ electronics
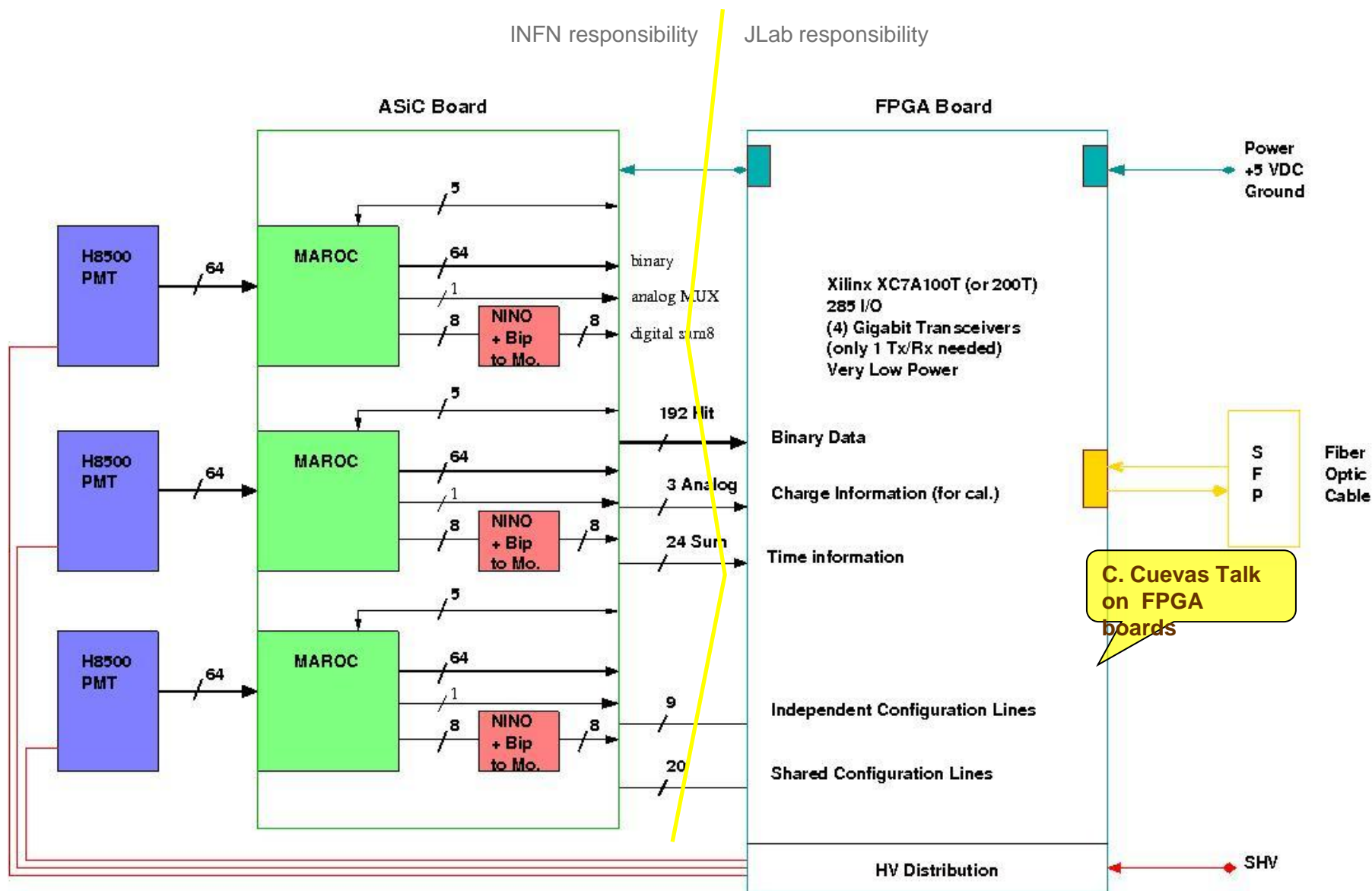


Modular design with 3 logic/physical layers
(similar approach of the existing electronics ⇨ straightforward porting)

# MAROC-NINO Interface

## Used to measure the time performance of the MAROC signals (analog and digital)

# SPE MAROC Timing Resolution

- External pulse on MAROC input at the single photoelectron level
- Measured time resolution of about **200 ps** (digital MAROC output)
- Get also some information on deposited charge (Time over threshold)



**(MAROC can be used in the online trigger)**