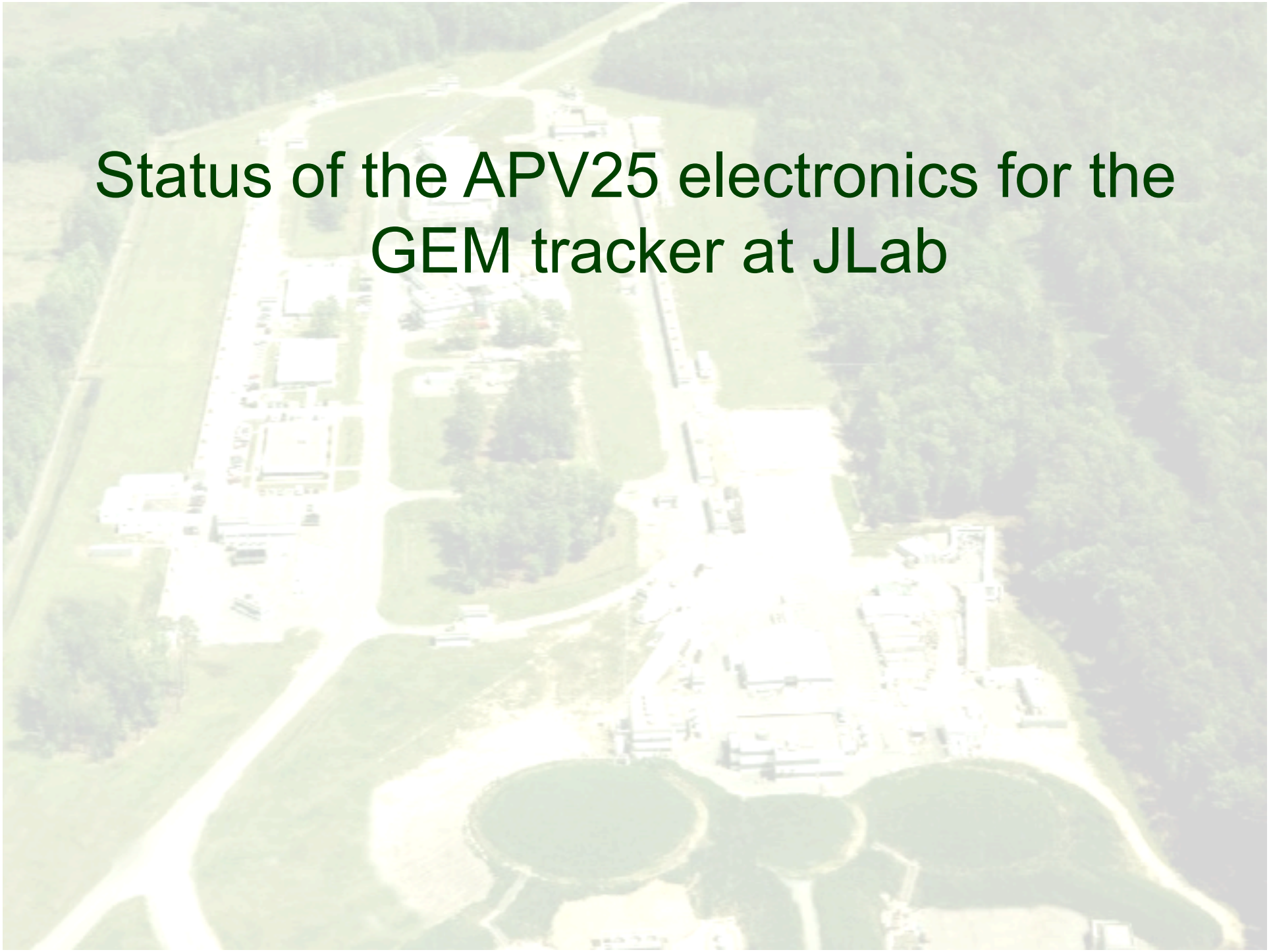
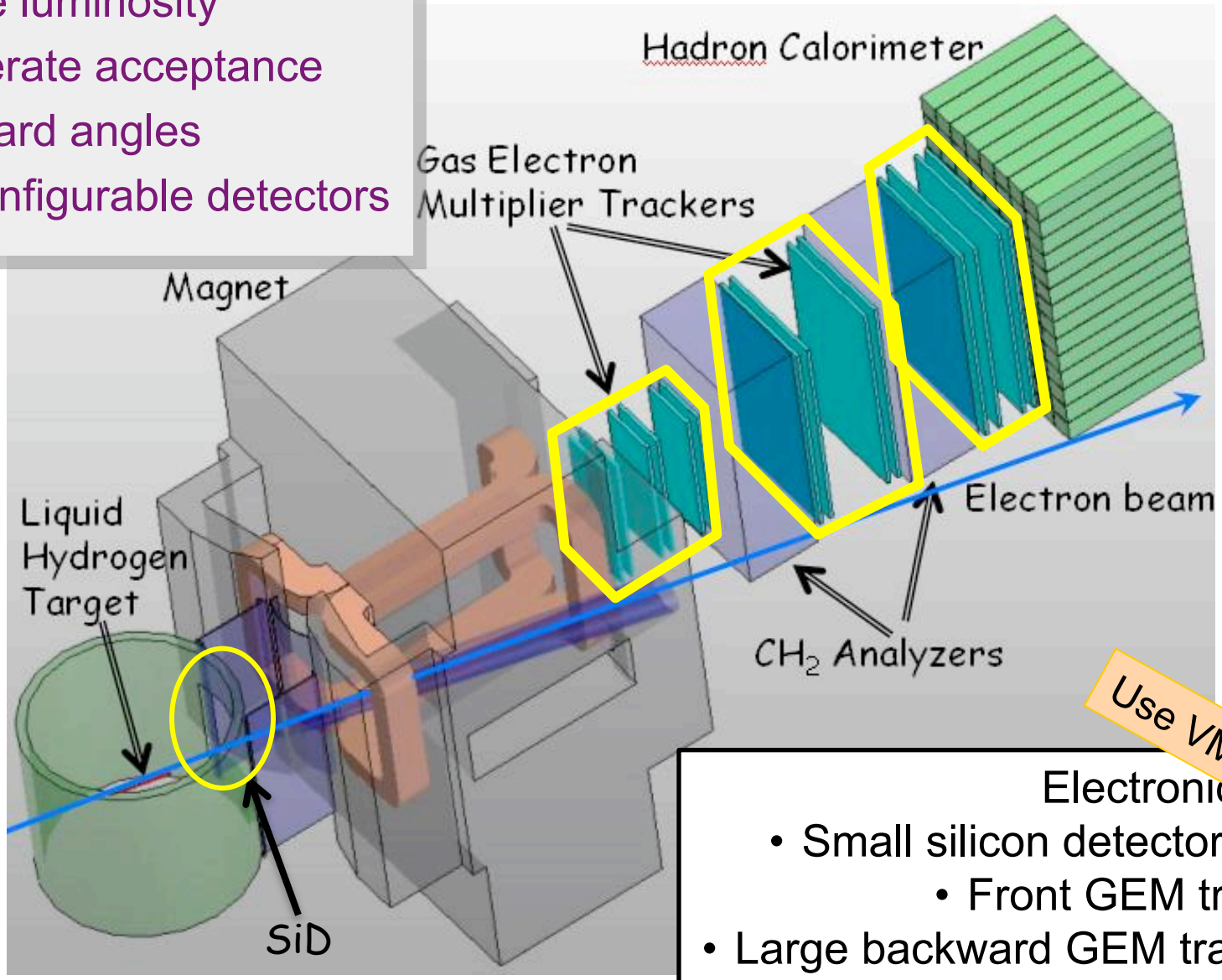
# Status of the APV25 electronics for the GEM tracker at JLab



# SBS Spectrometer in Hall A

- Large luminosity
- Moderate acceptance
- Forward angles
- Reconfigurable detectors




Use VME64x

Electronics
- Small silicon detector (SiD)
- Front GEM tracker
- Large backward GEM trackers

⇨ **>100k channels**

# Choice of the technology

| System Requirements | Tracking Technology | | |
|---|---|---|---|
| | Drift | **MPGD** | Silicon |
| High Background Rate (up to): (low energy $\gamma$ and e) **1 MHz/cm$^2$** | NO | **MHz/mm$^2$** | **MHz/mm$^2$** |
| High Resolution (down to): **70 $\mu$m** | Achievable | **50 $\mu$m** | 30 $\mu$m |
| Large Area: from 40×150 to 80×300 cm$^2$ | YES | **Doable** | Very Expensive |

… and modular: reuse in different geometrical configurations

**GEM** **$\mu$Ms**

Flexibility in readout geometry and lower spark rate

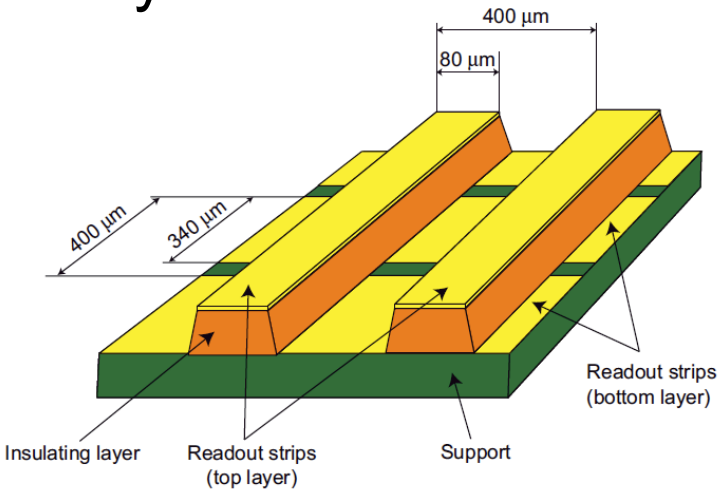
# Approach: 40x50 cm$^2$ 3xGEM Module

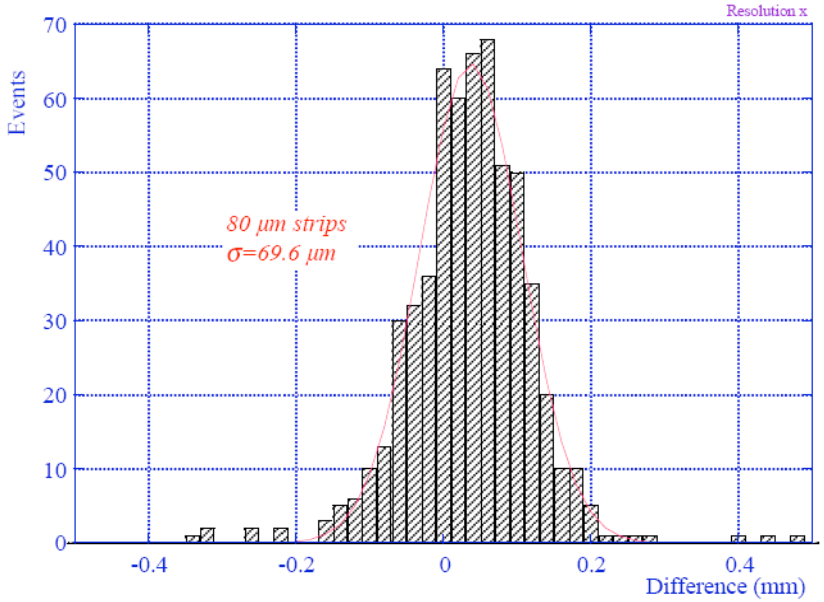
## Use the same "basic" module for all trackers types

- Size: 40x50 cm$^2$ active area + 8 mm frame width
  - FEM study:

| Frame width | (mm) | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|
| Maximum Sag | ($\mu$m) | 180 | 24 | 21 | 19 | 16 | 12 |

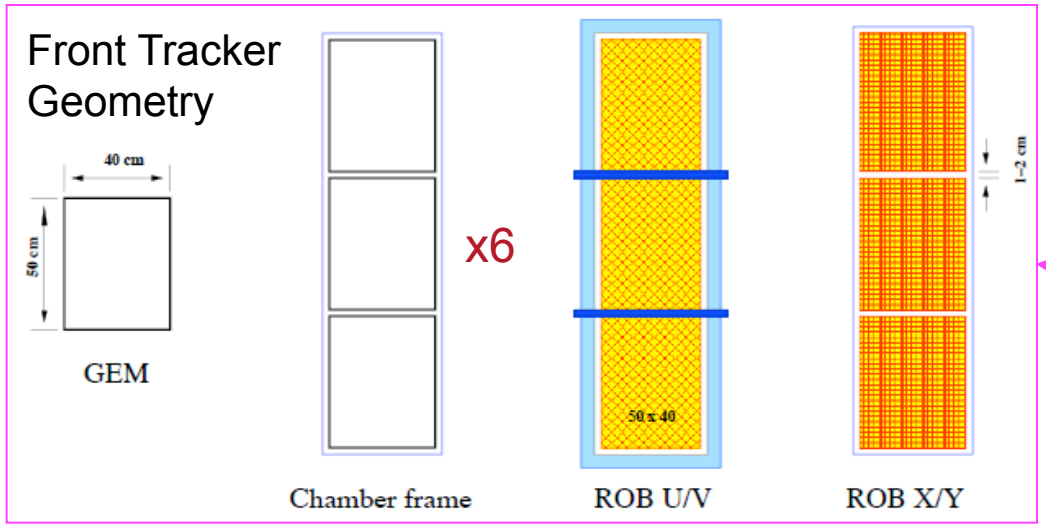
- 3 x GEM foils (double mask) technology
- 2D strip readout (a la COMPASS) - 0.4 mm pitch
- x/y and u/v coordinates

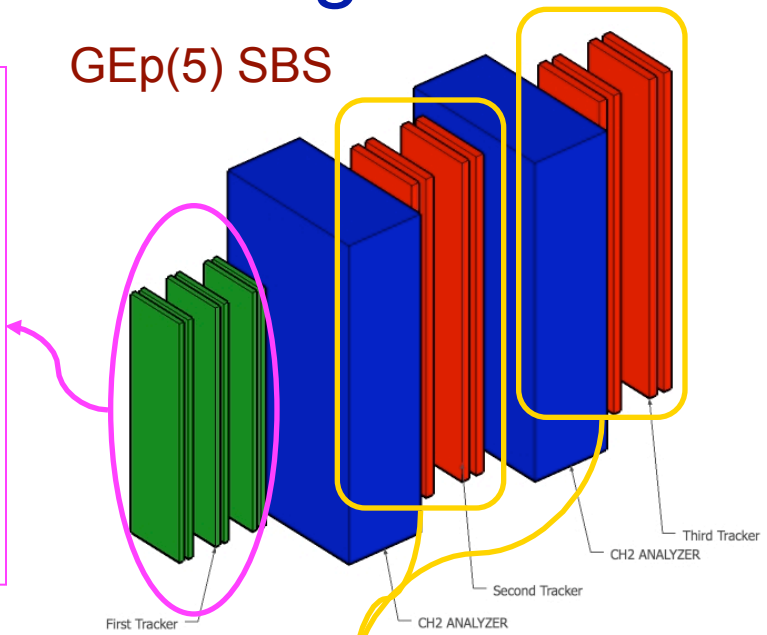


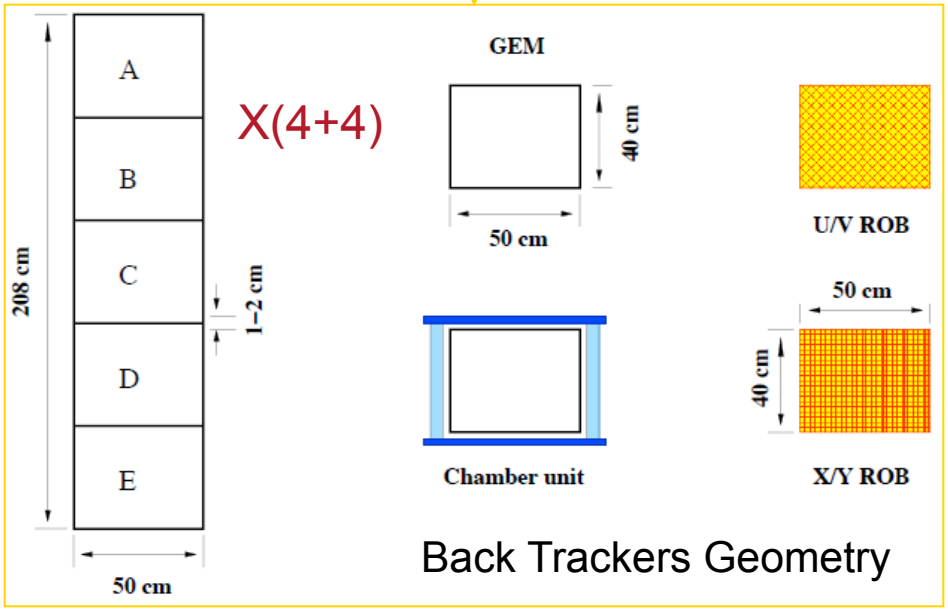

Performances proven in real experiment such as COMPASS and PREX!

# SBS Tracker Chambers configuration



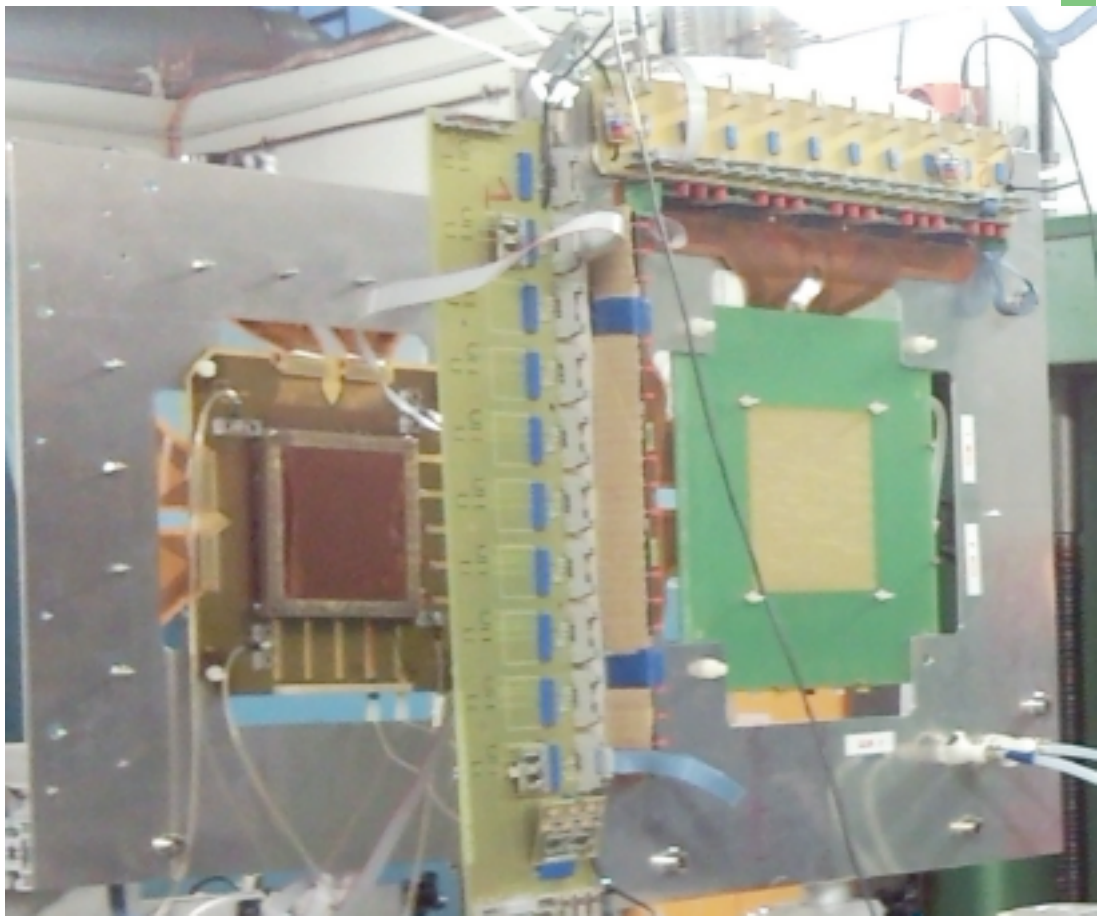

- ✓ Modules are composed to form larger chambers with different sizes
- ✓ **Electronics along the borders and behind the frame (at 90°) – cyan and blue in drawing**
- ✓ **Carbon fiber support frame around the chamber (cyan in drawing); dedicated to each chamber configuration**



# SBS GEM chamber prototyping

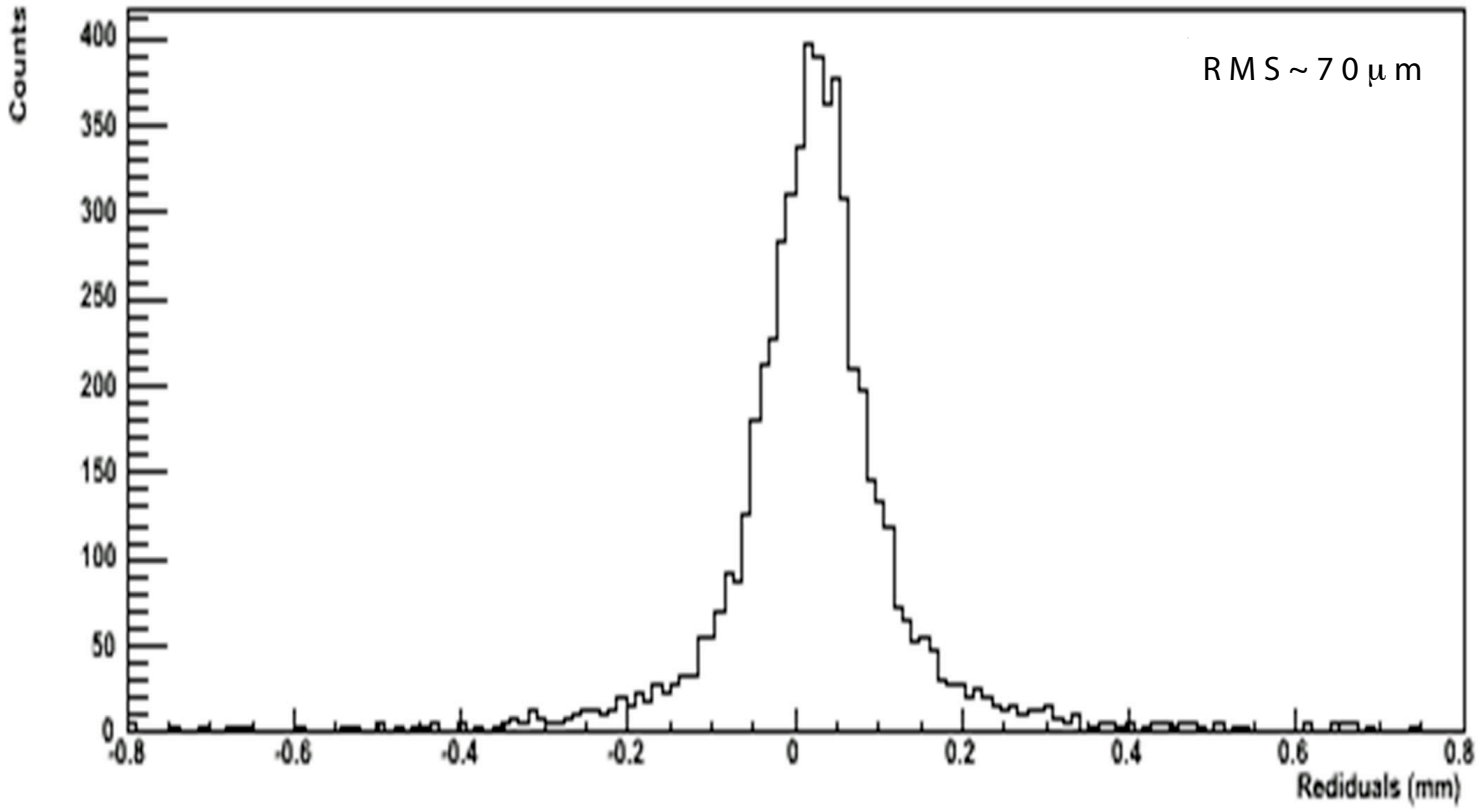
- Prototype GEM tracker consisting of five 10 cm x 10 cm chambers built.
- Already tested in high rate conditions during hall A PREX experiment. Data being analyzed now
- More extensive test with APV-25 electronics and under high background rates planed for this Autumn.

- A 40 cm x 40 cm prototype and APV-25 electronics under construction at INFN.



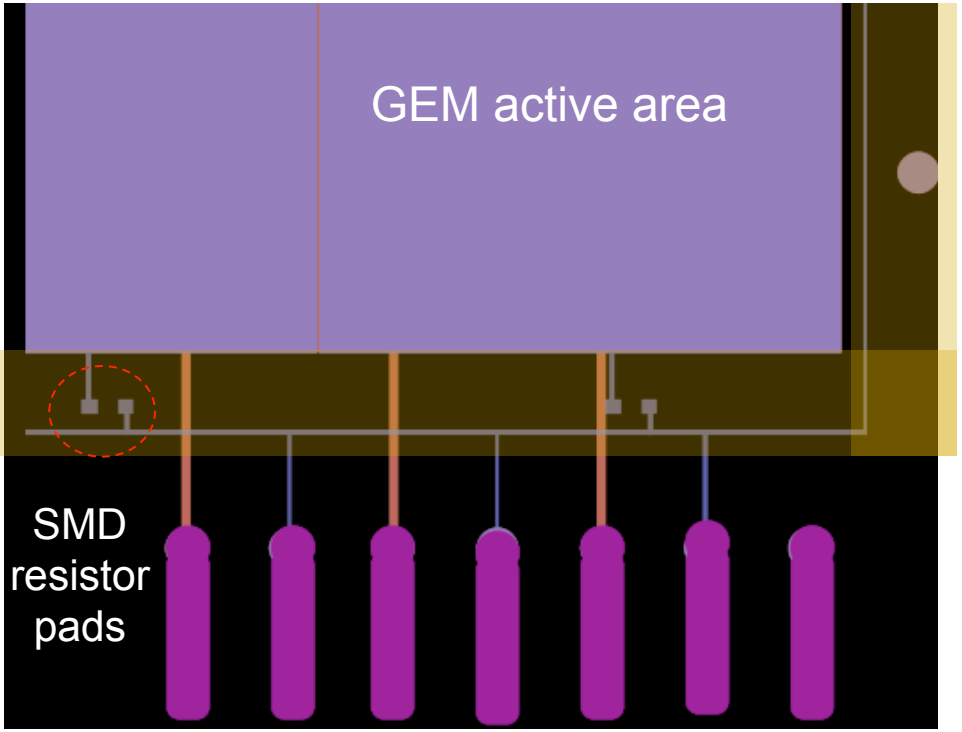
Topics to study

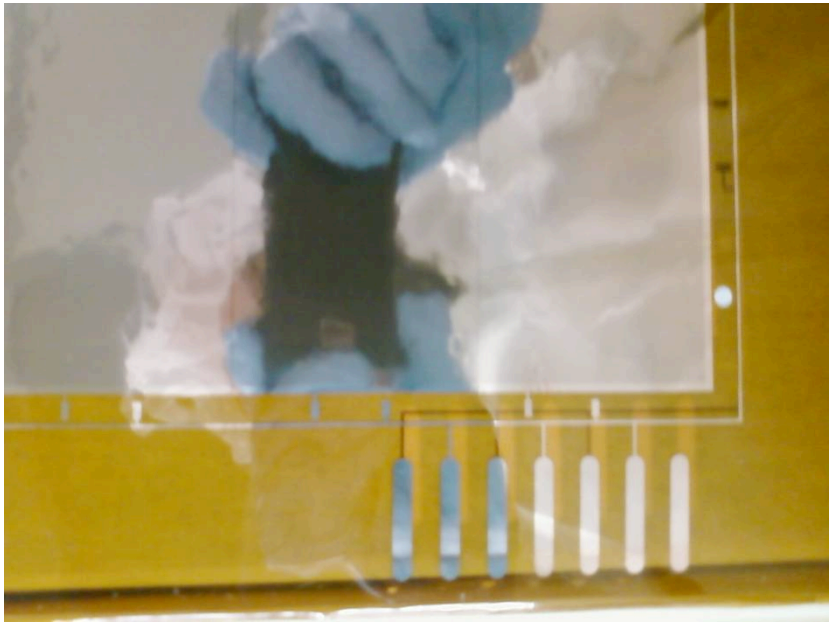
- Tracking under high rates
- Response to low energy photons
- Readout plane size limitations (noise pickup, capacitance etc.)
- Combining readout strips


Counts
400
350
300
250
200
150
100
50
0
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
Rediduals (mm)
RMS ~ 70 μm

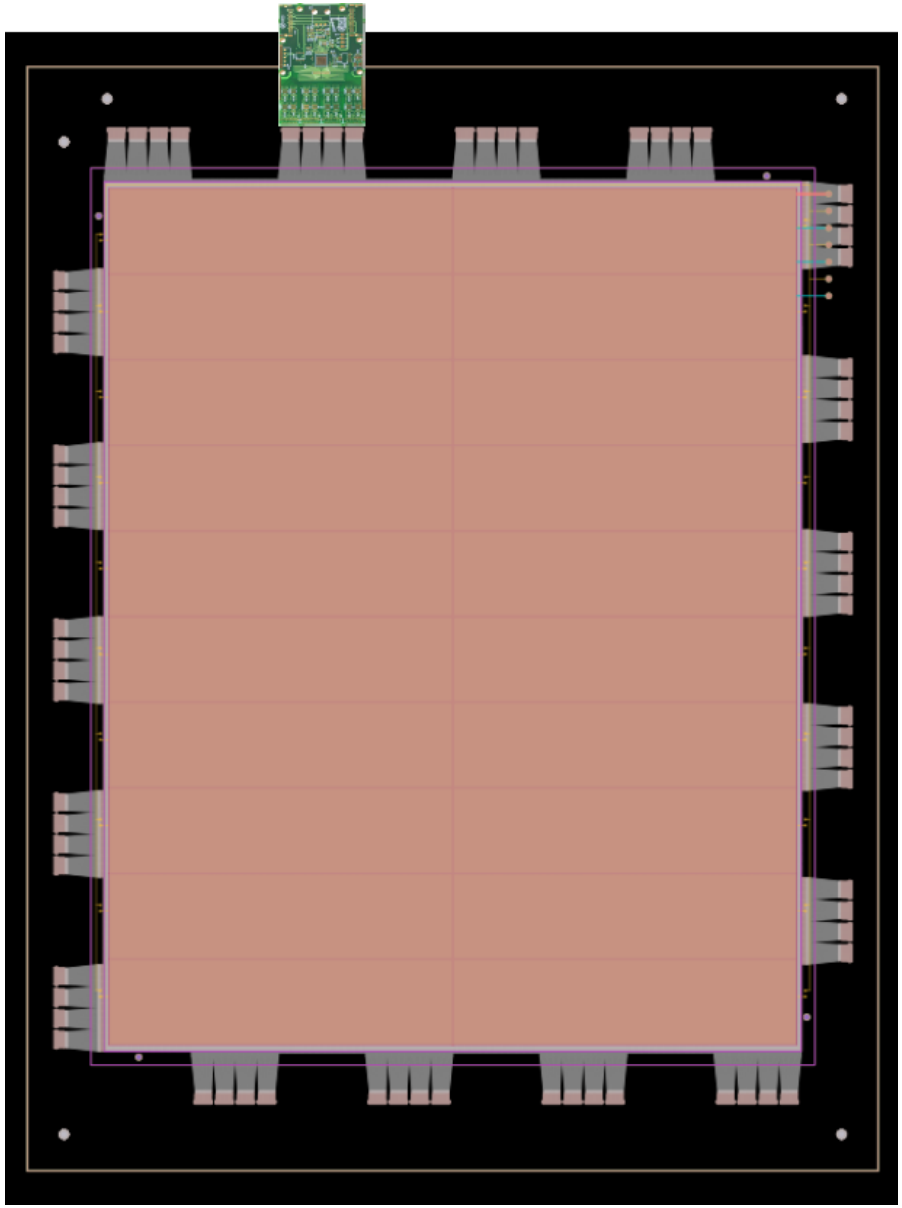
# GEM foil (first 40x50 cm$^2$ / double mask technique)

- **7 independent HV channels** for each chamber (TBC)
- 3 HV identical doublets + 1 for drift (same on all GEM foils); each doublet serves one GEM foil, unused will be cut.
- SMD protection resistors, under the thin frame



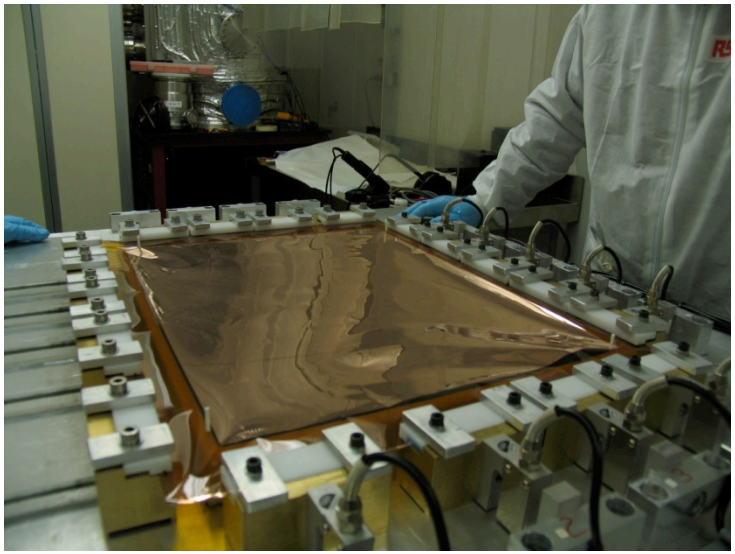



# Readout Foil

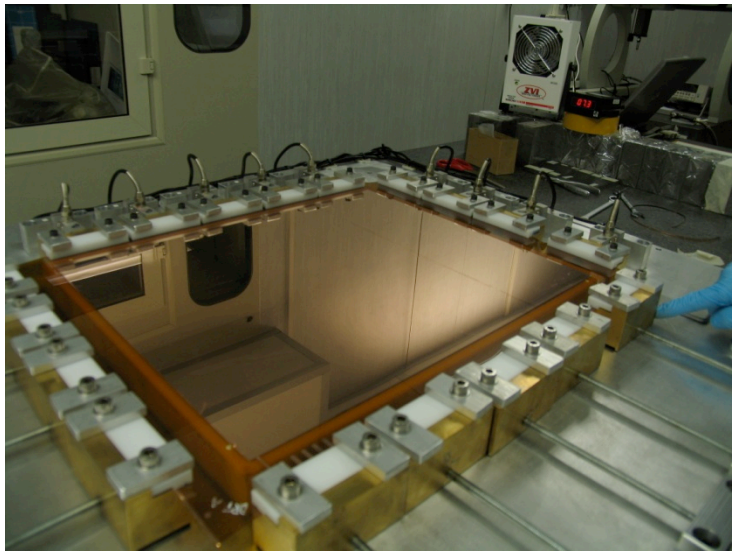


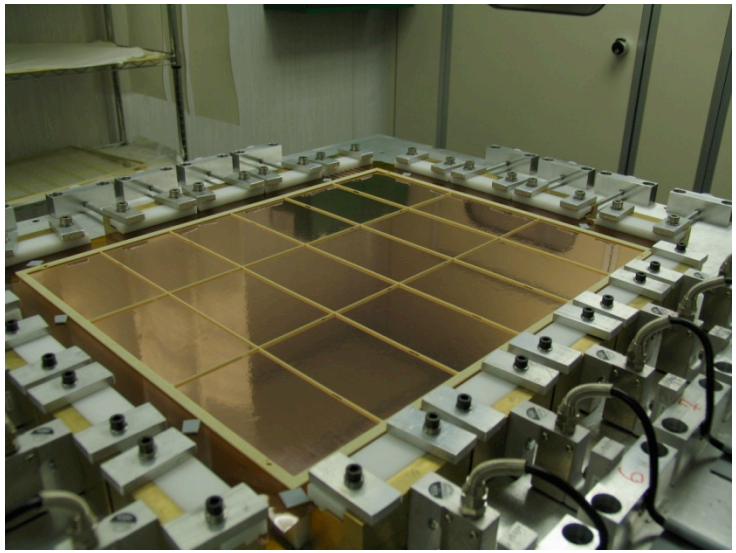
No soldering, very thin connections
Laser cutting required

# Assembling the first 40x50 cm2 module



Stretching

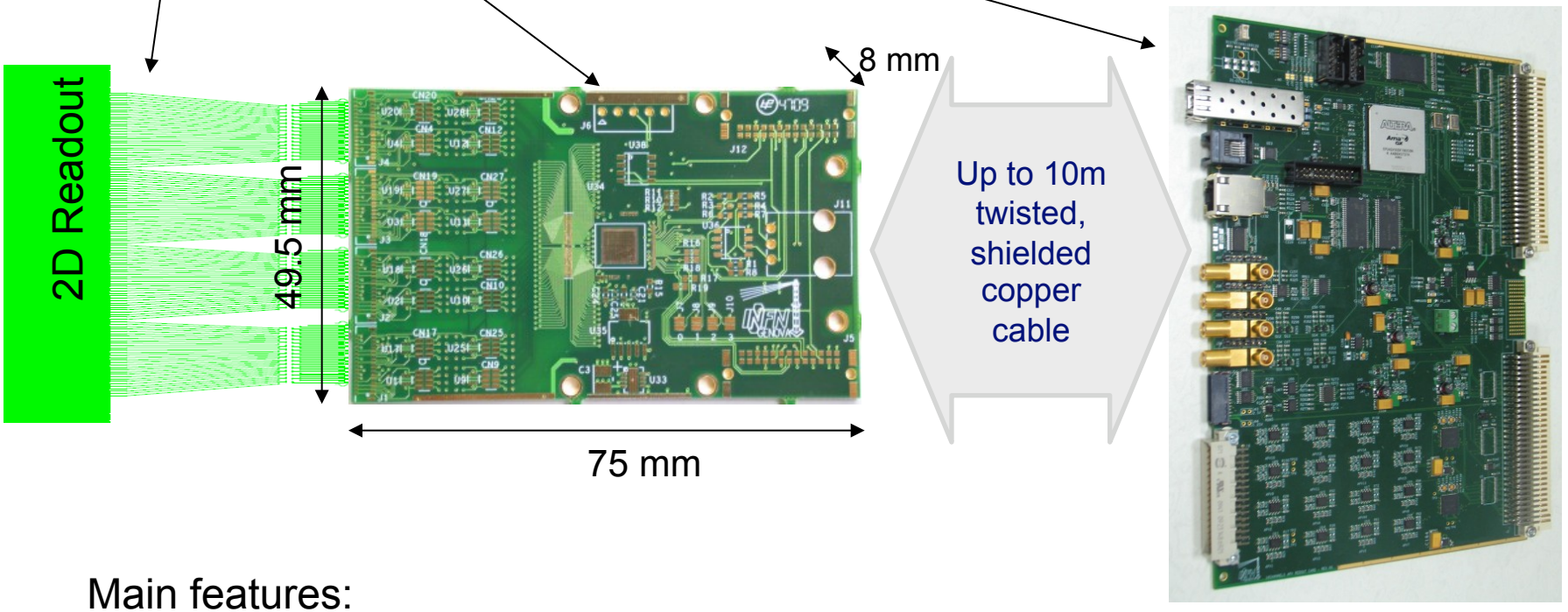




Gluing the next frame with spacers

# Electronics Components

GEM ⇒ **FEC** ⇒ **ADC+VME Controller** ⇒ DAQ

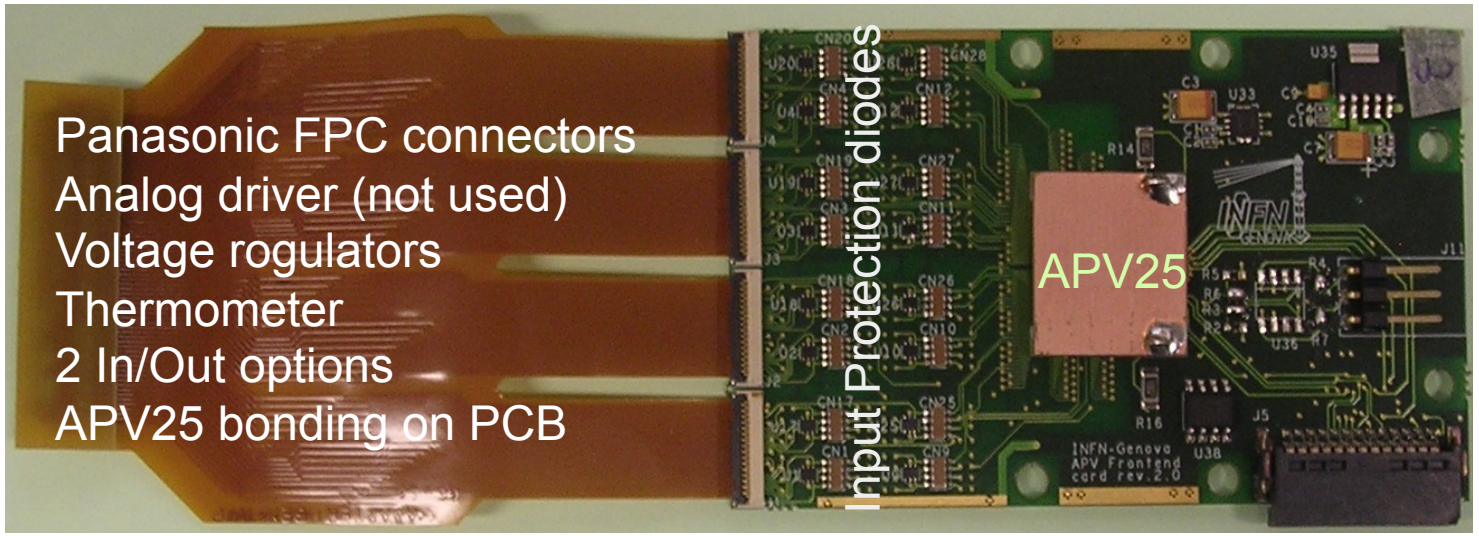



Main features:

- Use analog readout APV25 chips
- 2 active components: Front-End card and VME64x custom module
- Copper cables between front-end and VME

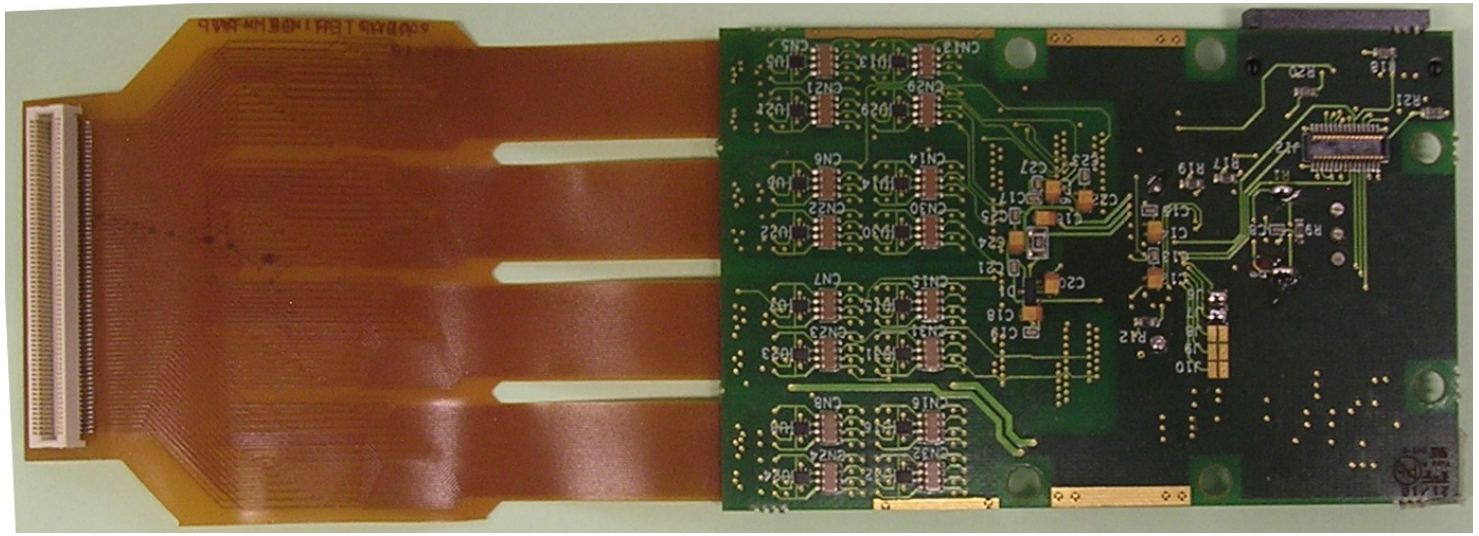
# Front End Card (Proto 1)

GEM ⇒ **FEC** ⇒ **ADC+VME Controller** ⇒ DAQ




Analog Output

Digital Input + Power supply

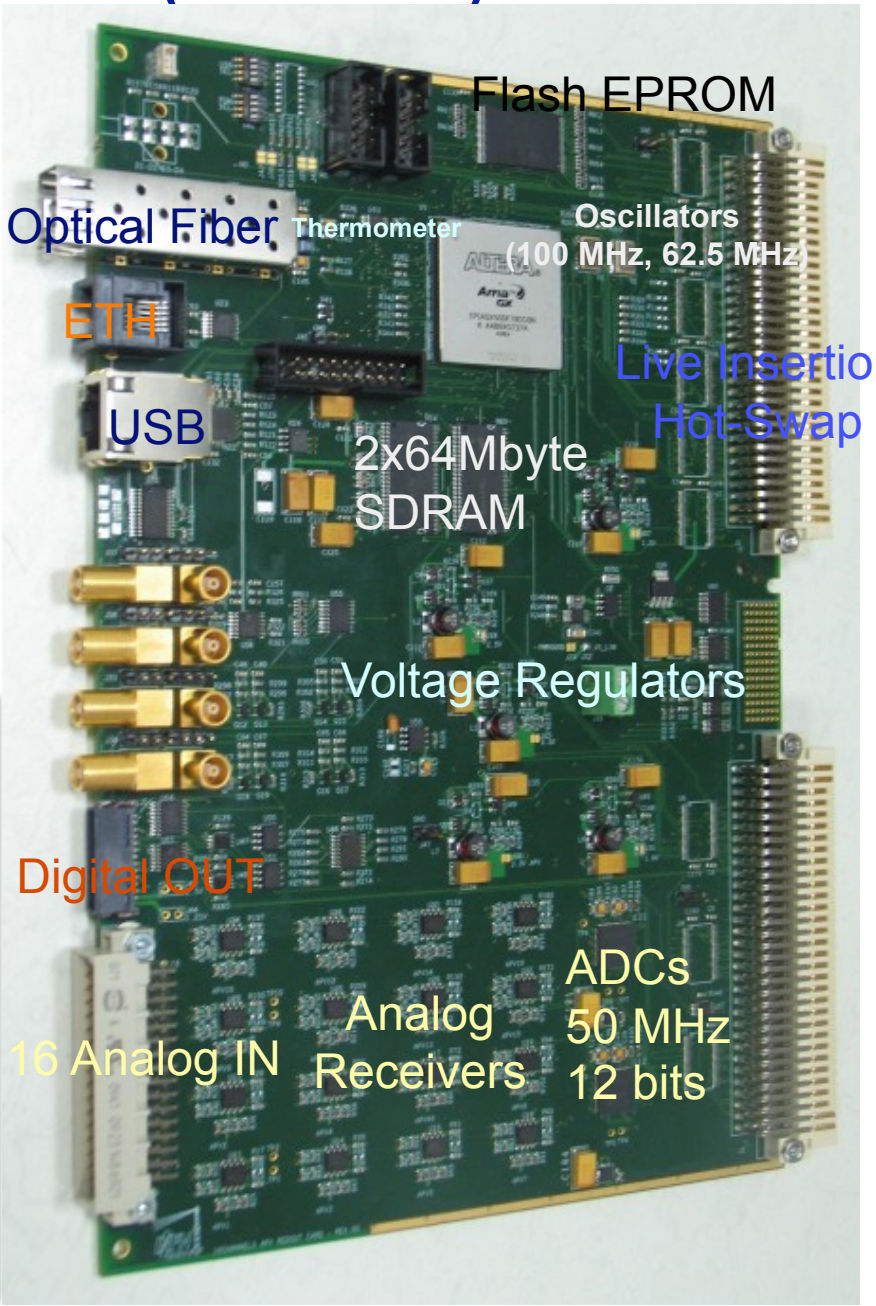


Analog out + Digital Input + Power supply

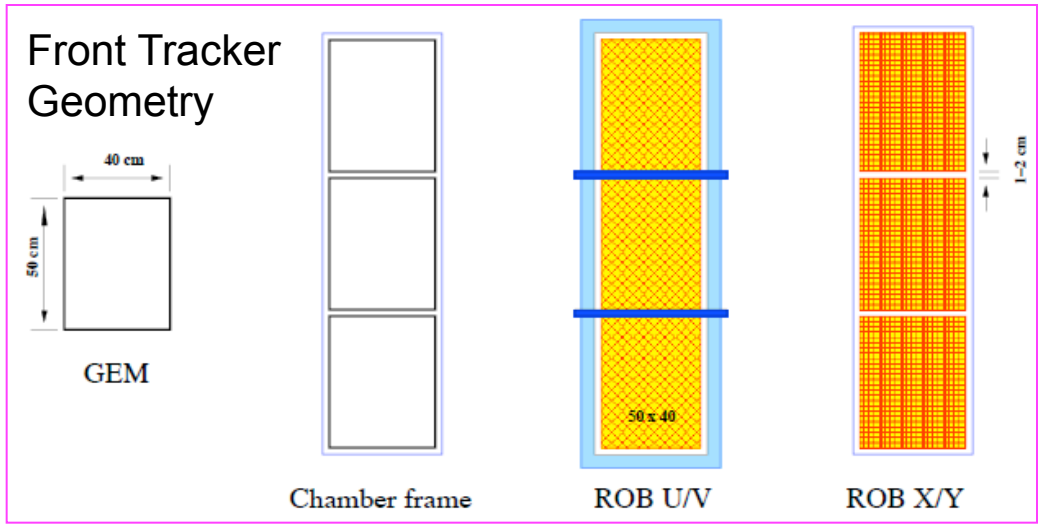
# VME64x Controller (Proto 0)

- VME controller hosts the digitization of the analog signals coming from the front-end card.
- It handles all control signals required by the front end cards (**up to 16 FE**)
- **Compliant to the JLab/12 VME64x VITA 41 (VXS) standard**
- We intend to make it accessible by standard VME/32 as well

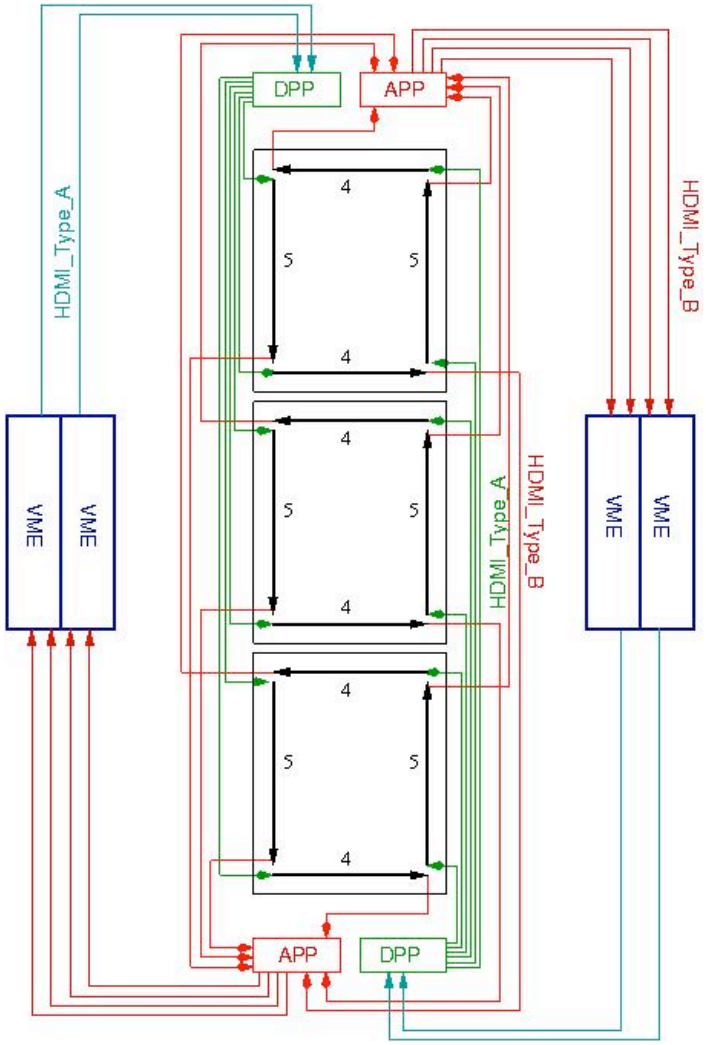
- **Version 1 submitted for production:**
  - **Minor bug fixed**
  - **2 HDMI-type A: digital lines + 2 analog lines (compatible with SRS hybrids connector)**
  - **2 HDMI-type B: 16 analog lines**
  - **Added delay line for clock-convert phase fine tuning (DELAY25 from CERN)**



# GEM Electronics Layout




1. Use high density, high quality, standard HDMI (A-type for digital signals, B-type for analogo output)
2. Analog and digital lines rus independently
3. Analog and Digital patch panels collect and reroute channels
4. Similar solution for the SiD planes




VME ⇨ Patch Panel ⇨ Backplane ⇨ Front End Cards

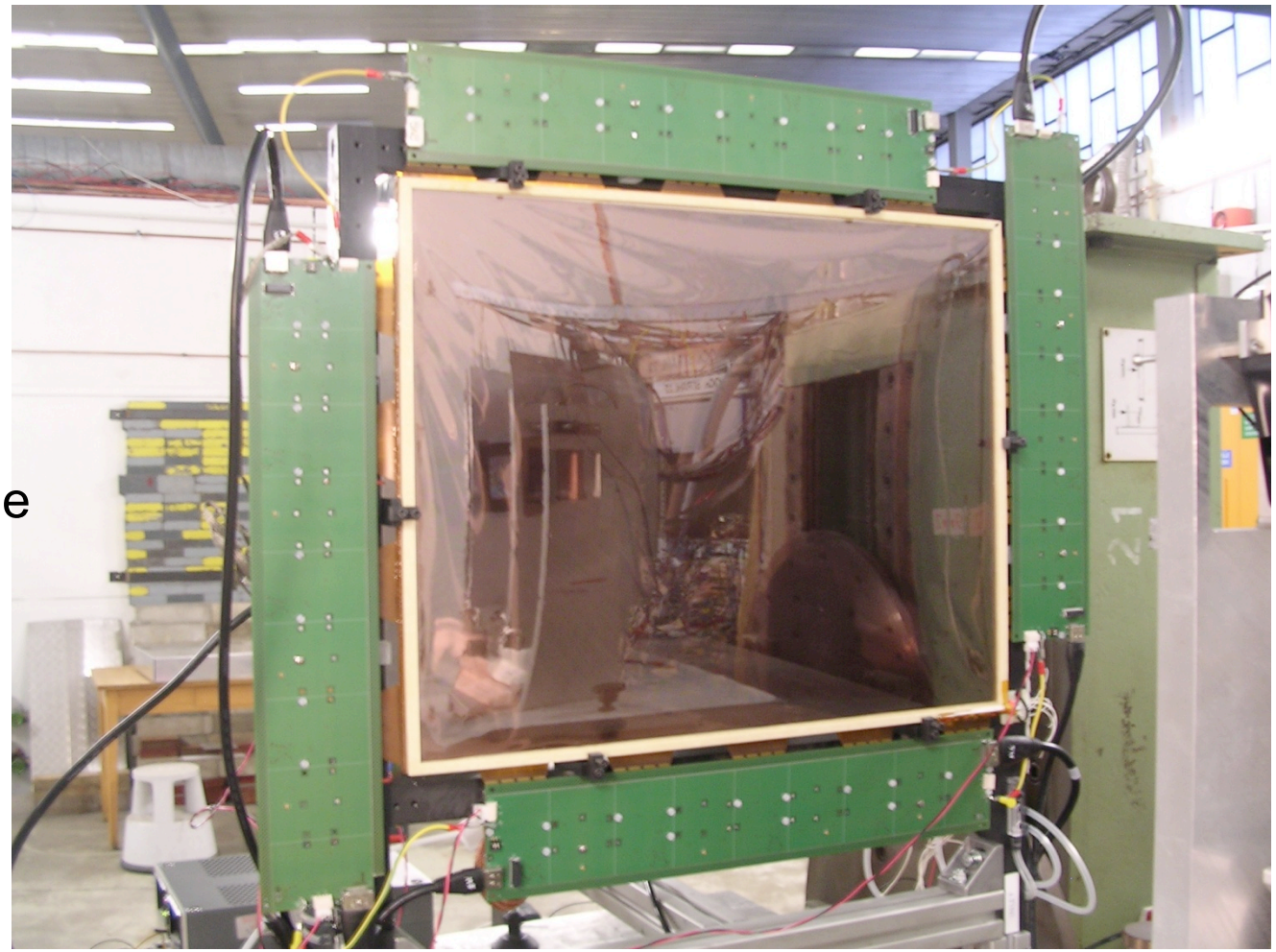
# Beam test @ DESY (EUDET support)

# Beam test @ DESY (EUDET support)

- Fully equiped GEM module
- 18 front-end cards
- 2304 channels

(front end cards on the other side)

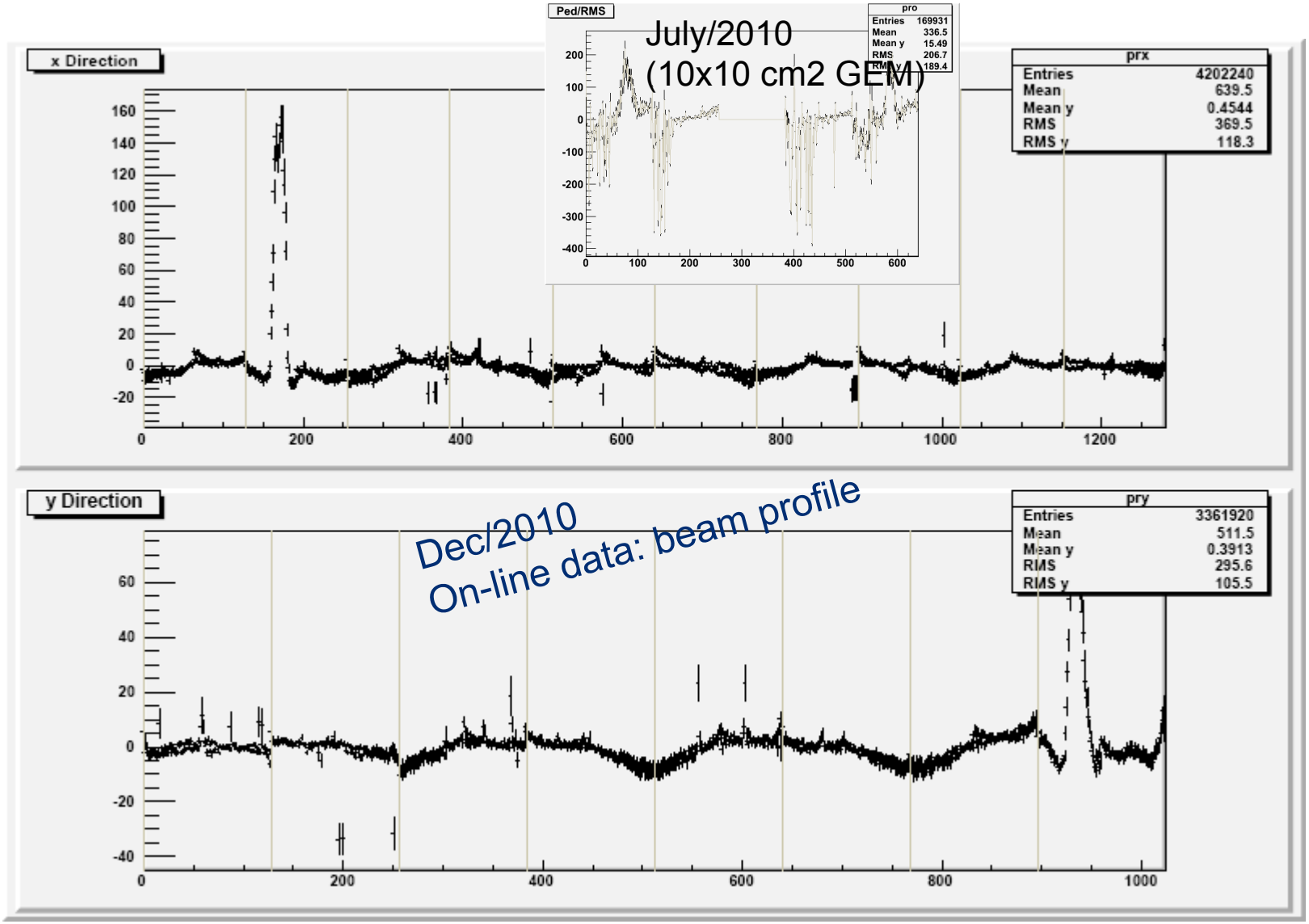
- 7 independente HV levels



2-6 GeV low intensity electron beam / silicon tracker available

**Data taking: 28/Nov-3/Dec 2010**

# Beam test @ DESY (EUDET support)

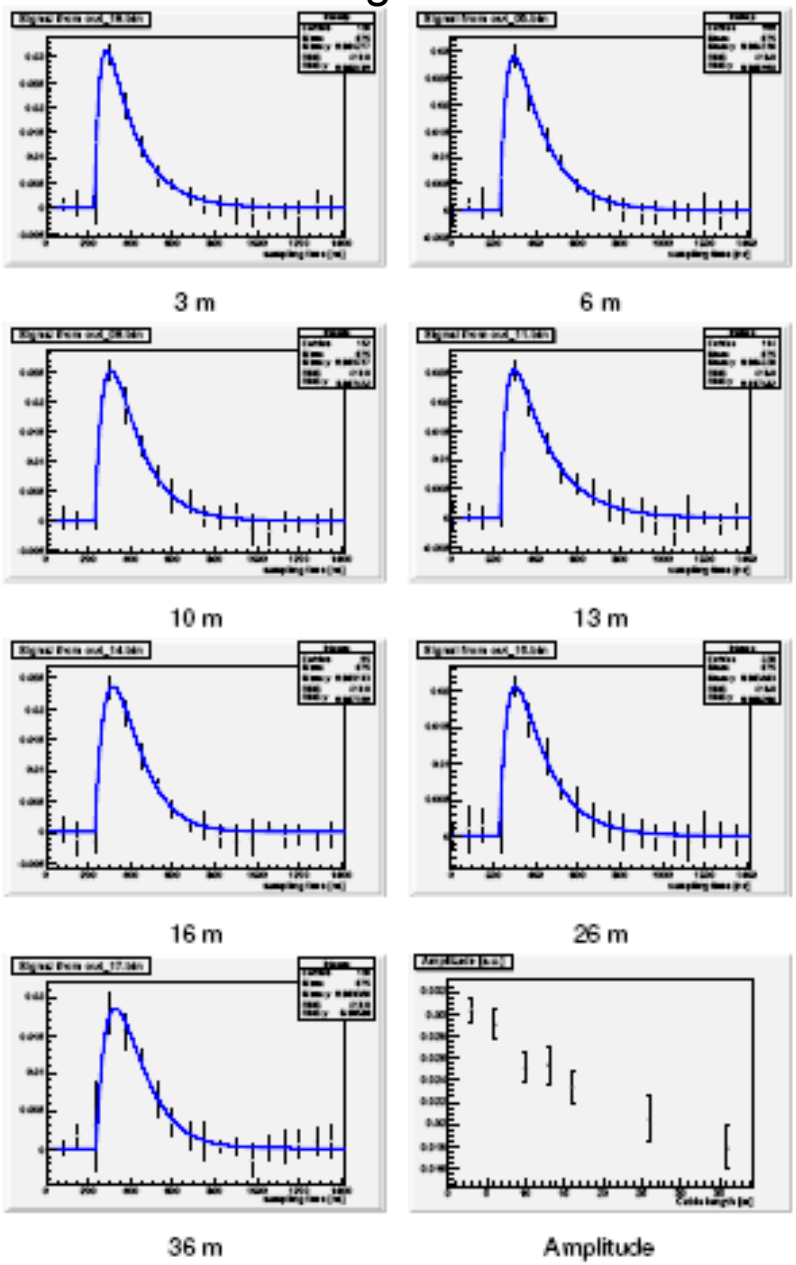



**Large improvement from July**

**Analysis has just started**

# Signal vs Cable length

Test signal




⇨ Long cables seems to work well: no distorsion, noise slighlty increase, amplitude attenuation as expected

Capacitance coupling to be optimized (in final size chamber)

APV25 parameters to be tuned!

# Conclusions

- GEM:
  - First full size module built and beam-tested
  - Analysis of the test data just started
  - Improvement of the assembling procedure ongoing
  - Pre-Production will start soon
- Electronics:
  - Second prototype tested, both front-end and VME controller - Can be considered final version
  - APV parameters tuning
  - Firmware under heavily development

- we finalize the first 40x50 cm2 and tested it in DESY (2-6 GeV electronbeam) last 2 weeks, together with the latest version of the electronics.There is still some noise but the situation is much better respect tothe test we performed in July with a small 10x10 cm2 GEM.Next weeks will be devoted to the analysis of the data, to theimprovement of the assembling procedure of the GEM module and to thefurther development of the firmware for the VME controller.The attached slides summarize the current status and present the veryfirst results. The analysis has just started.