Analysis of Micromegas Large Prototype data

D. Attié, P. Colas, M. Dixit, Yun-Ha Shin
(Carleton and Saclay)

3rd analysis meeting - June 22, 2009

Outline

- Comparison between two resistive modules
- Resolution measurements
- Distortions
- Momentum resolution

Bulk Micromegas panels tested at DESY

- Three panels were successively mounted and tested in the Large Prototype and 1T magnet:
  - standard anode
  - resistive anode (carbon loaded kapton) with a resistivity ~ 2.8 MΩ/□
  - resistive ink (~1-2 MΩ/□) ready for next beam tests

November 2008

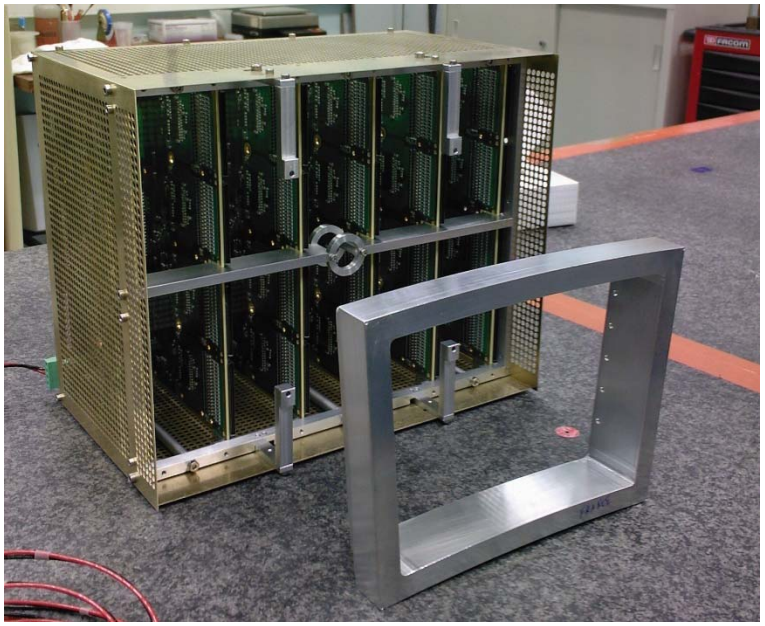
May-June 2009

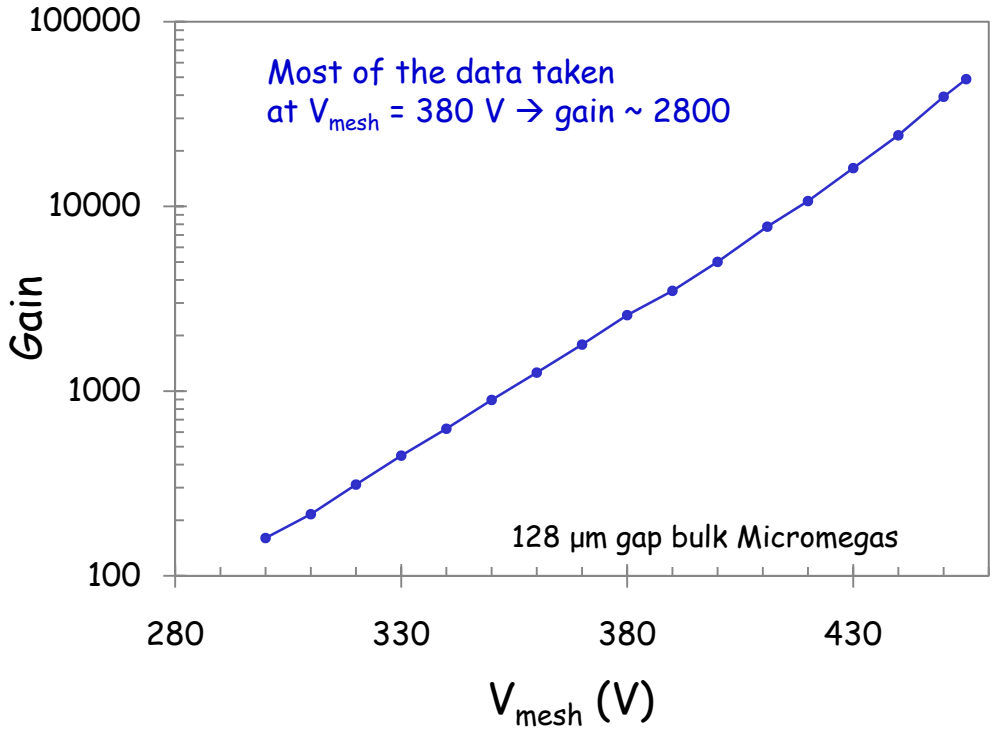
Standard bulk Micromegas module

Carbon loaded kapton Micromegas module

Beam test conditions at B=1T

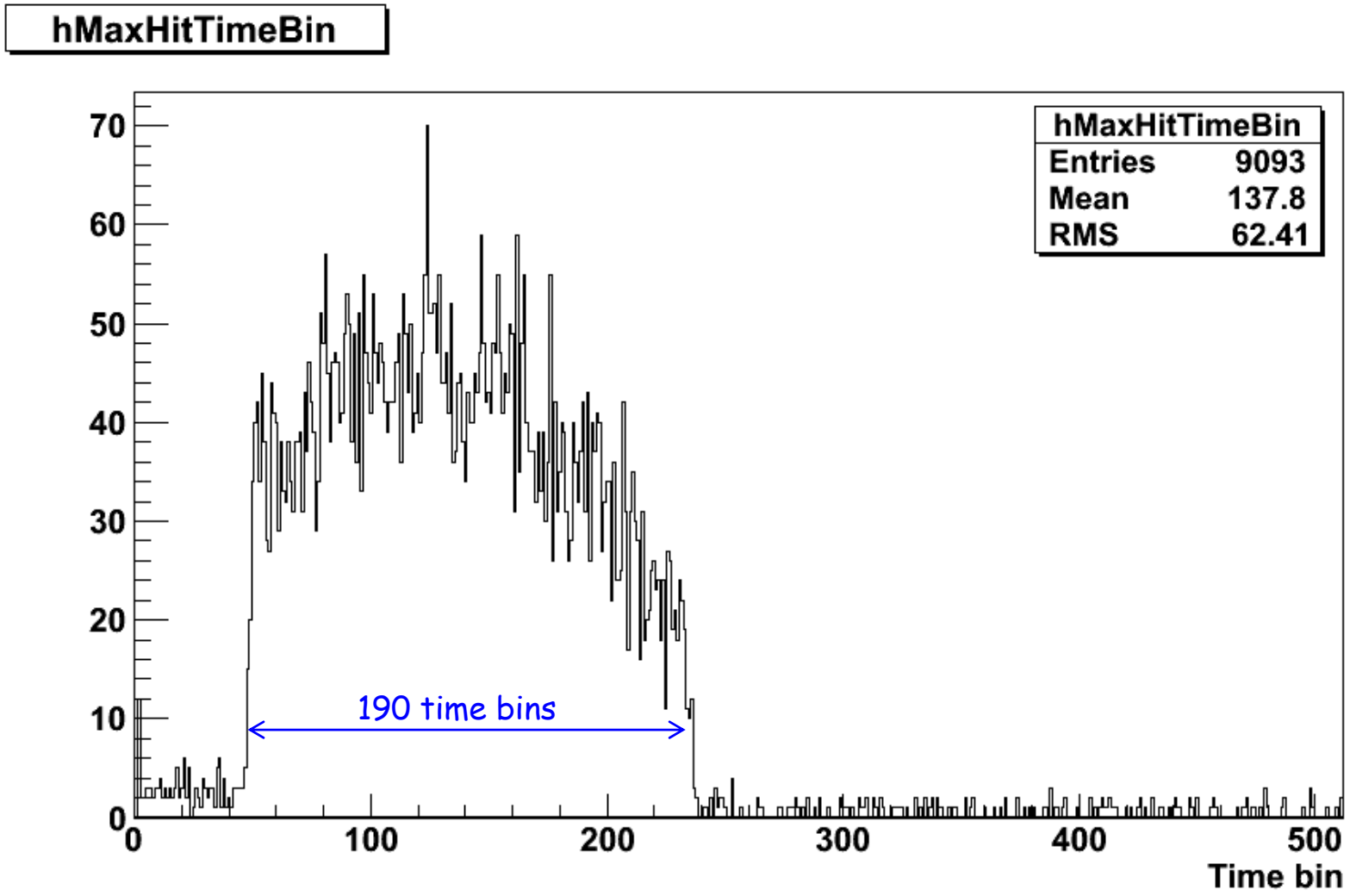
- Bulk Micromegas detector: 1726 (24x72) pads of ~3x7 mm^2
- AFTER-based electronics (72 channels/chip):
  - low-noise (700 e-) pre-amplifier-shaper
  - 100 ns to 2 µs tunable peaking time
  - full wave sampling by SCA
  - frequency tunable from 1 to 100 MHz (most data at 25 MHz)
  - 12 bit ADC (rms pedestals 4 to 6 channels)
- Beam data (5 GeV electrons) were taken at several z values by sliding the TPC in the magnet. Beam size was 4 mm rms.



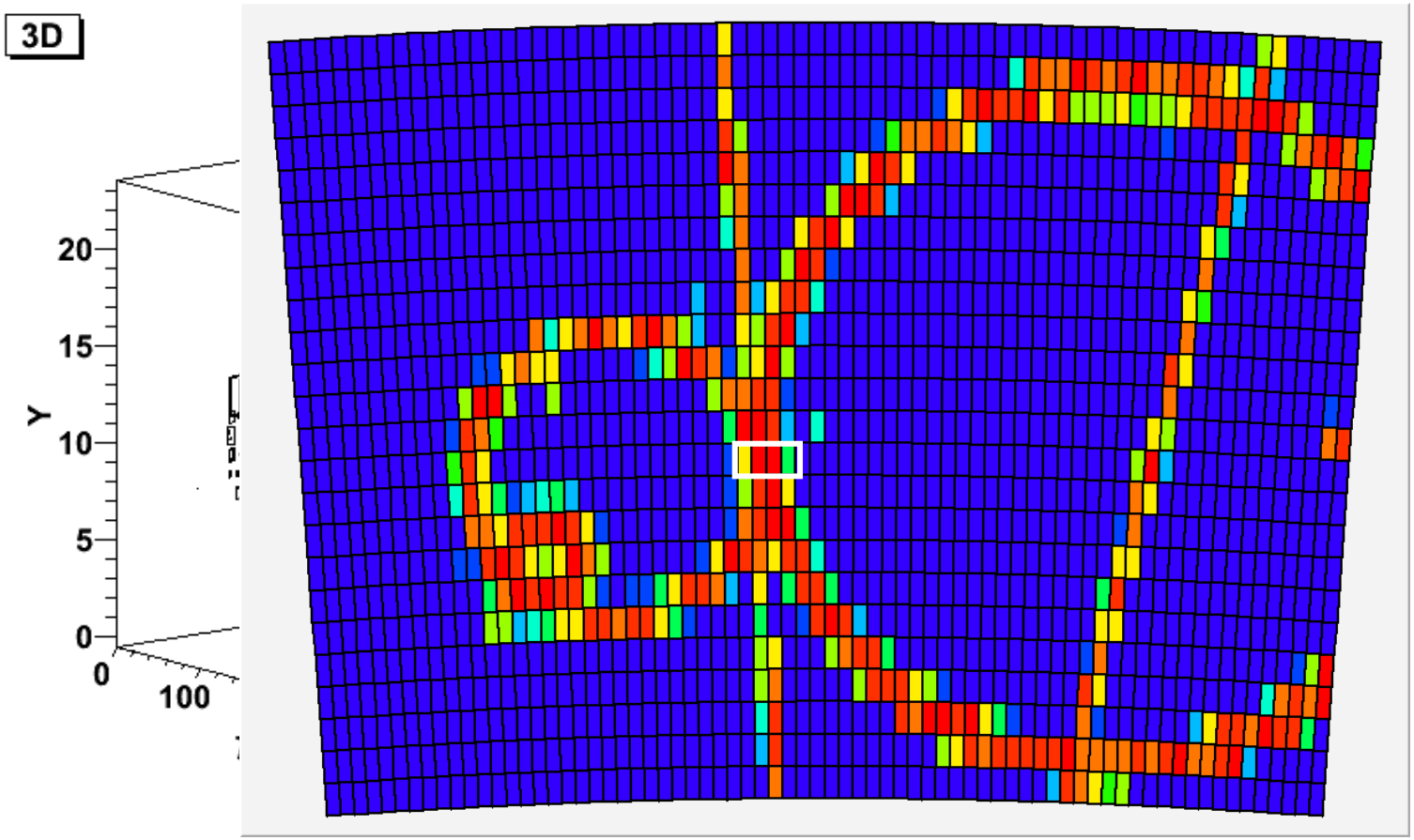


Determination of z range

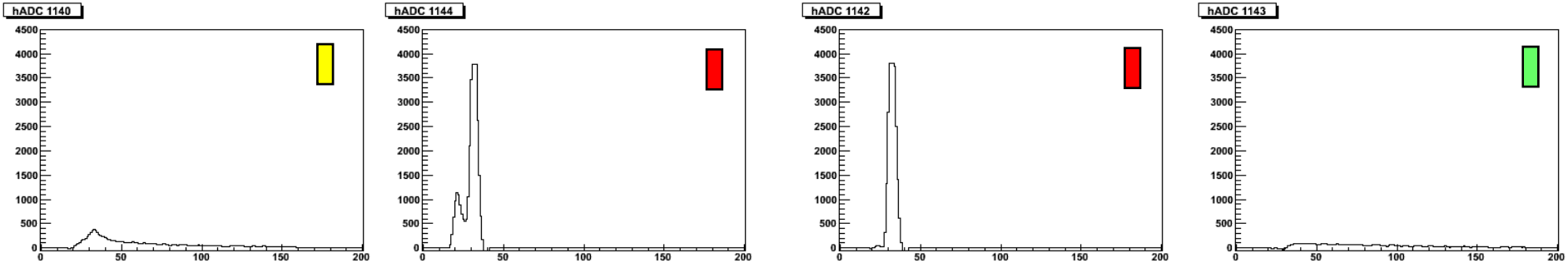
- cosmic run at 25 MHz of sampling frequency → time bin = 40 ns
- TPC length = 56.85 cm in agreement with survey



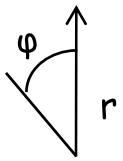
Pad signals: beam data sample

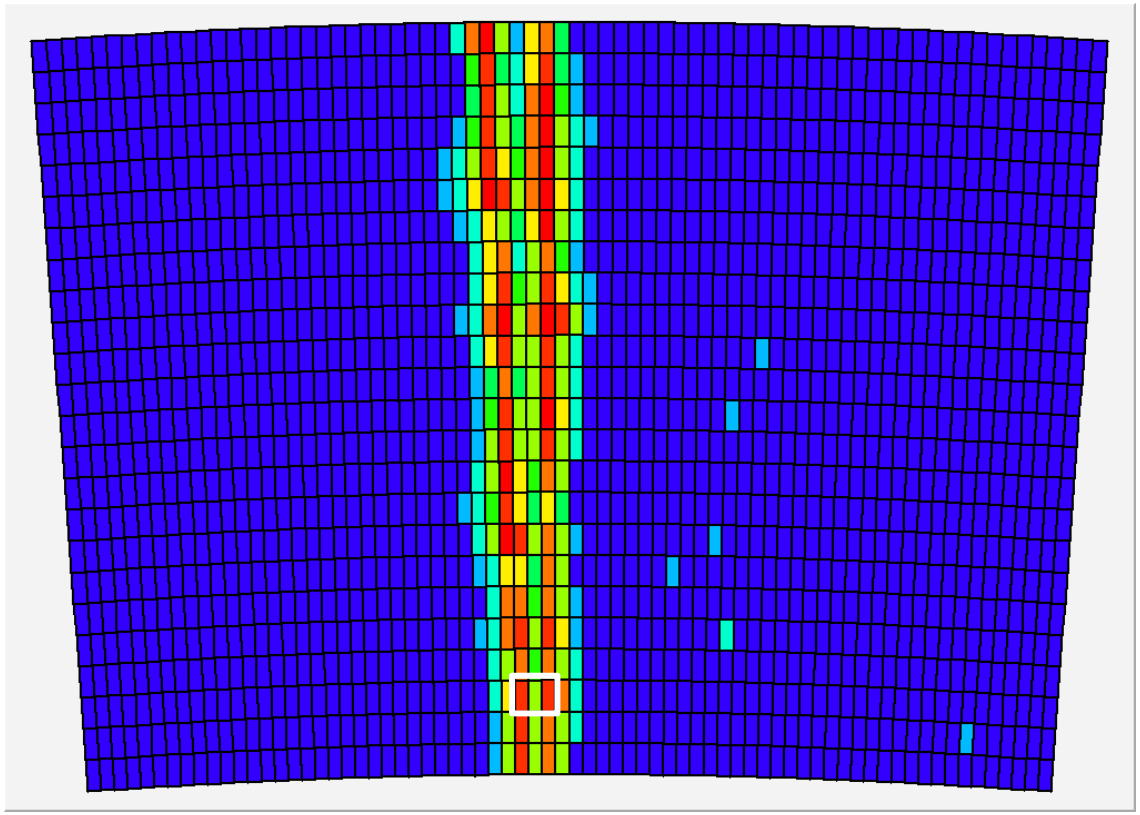


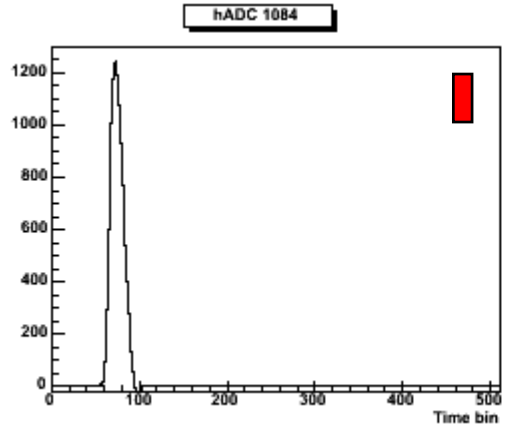
- RUN 284
- B = 1T
- T2K gas
- Peaking time: 100 ns
- Frequency: 25 MHz

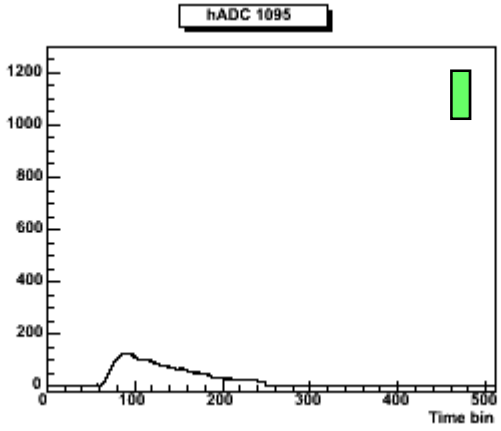


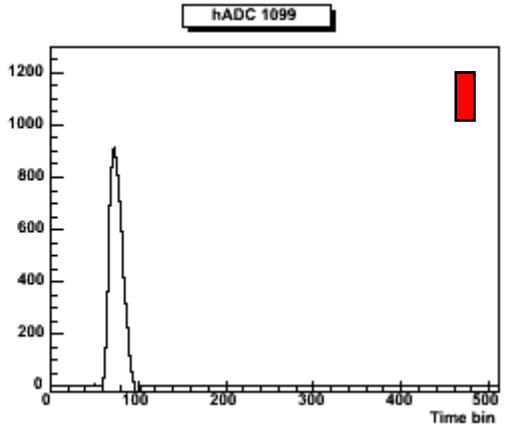
Two-track separation









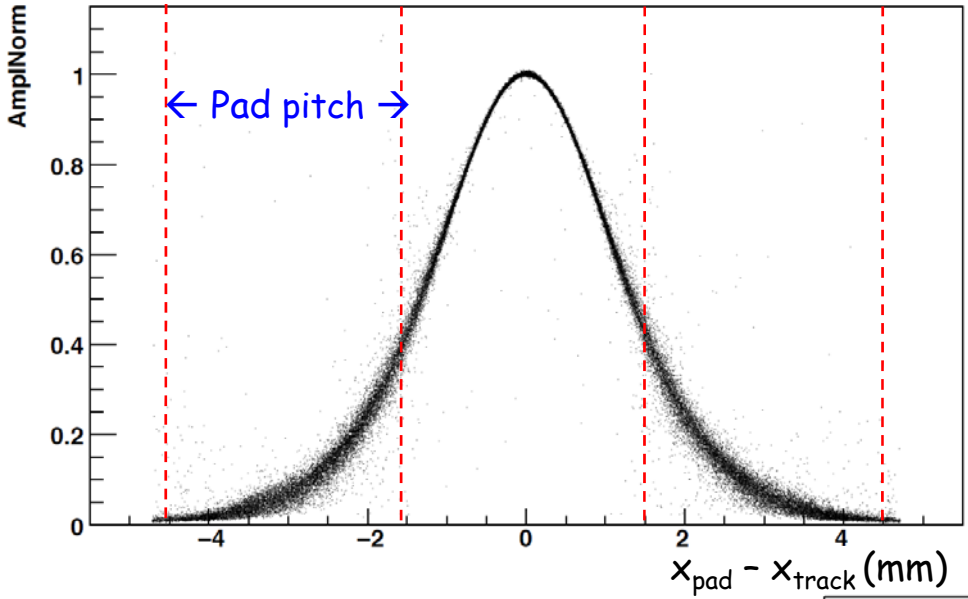


z

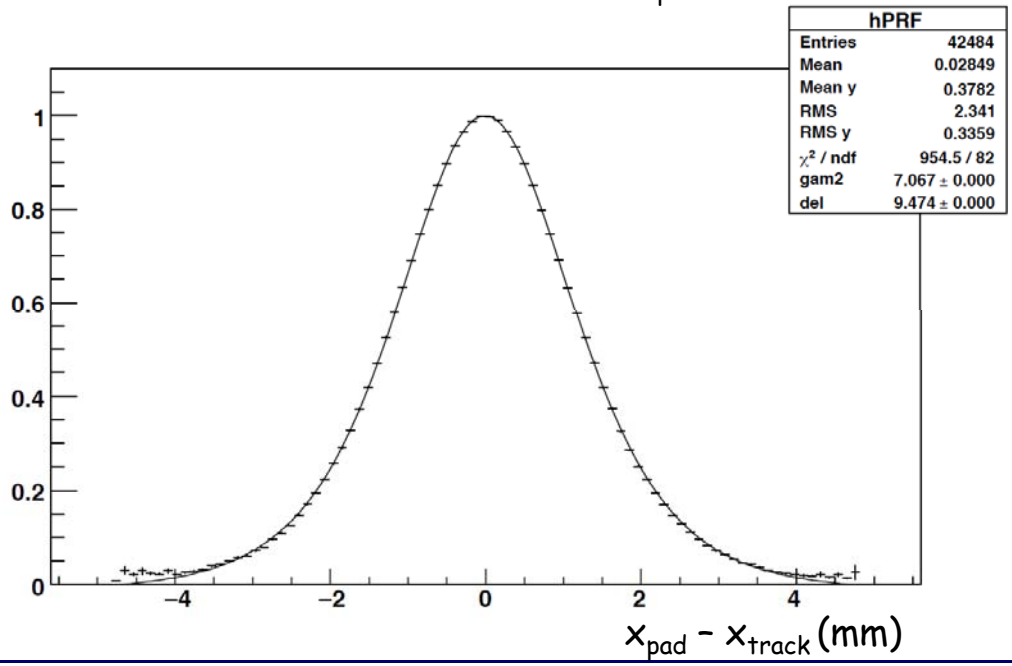
Determination of the Pad Response Function

- Fraction of the row charge on a pad vs $x_{pad} - x_{track}$ (normalized to central pad charge)

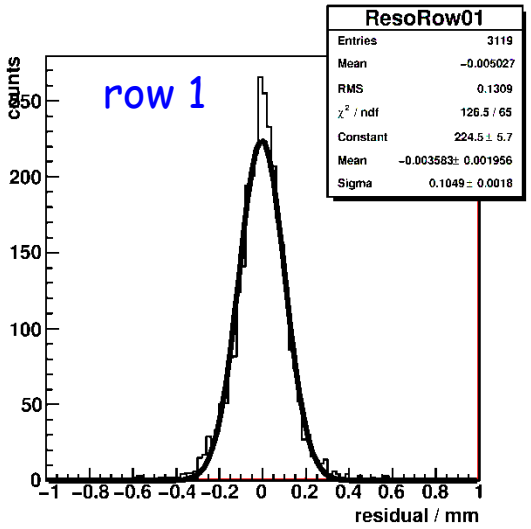
→Clearly shows charge spreading over 2-3 pads (data with 500 ns shaping)

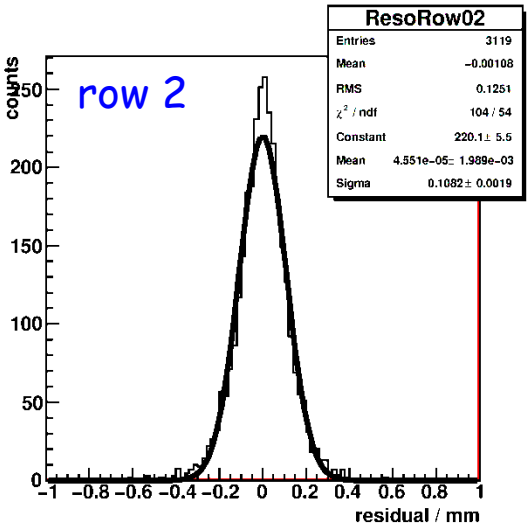


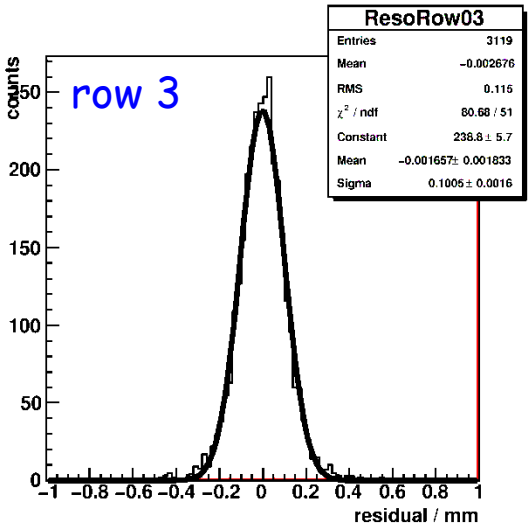
- Then fit x(cluster) using this shape with a χ^2 fit, and fit simultaneously all lines

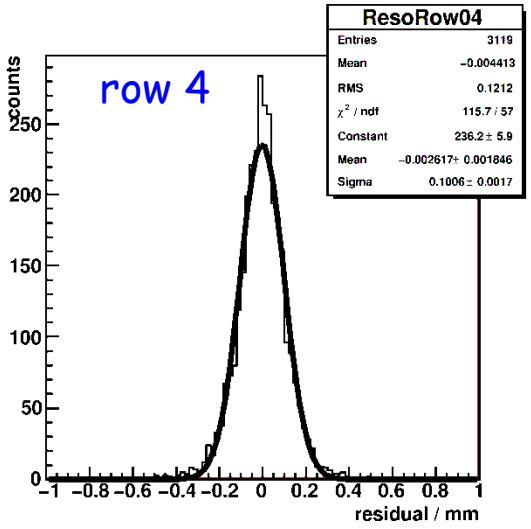


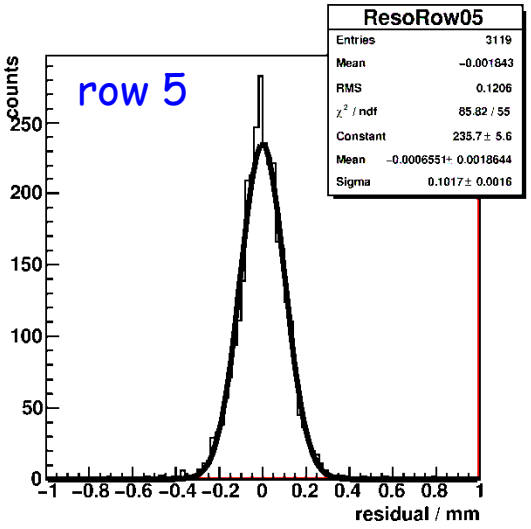
Residuals (z=25 cm)

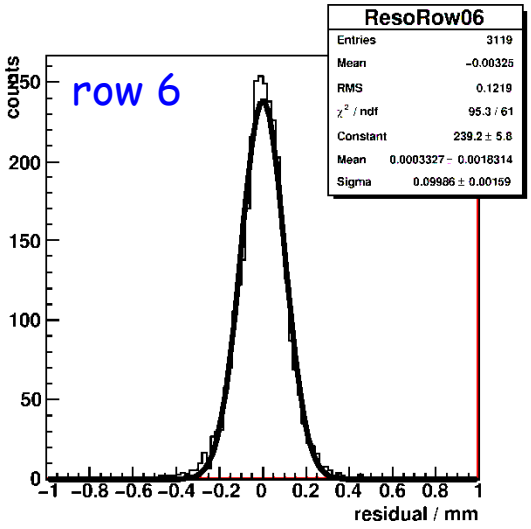






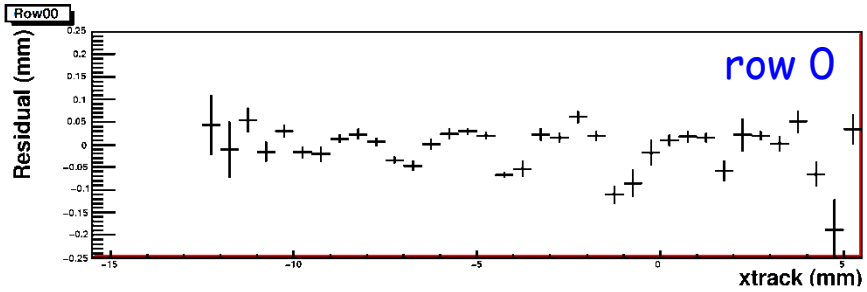


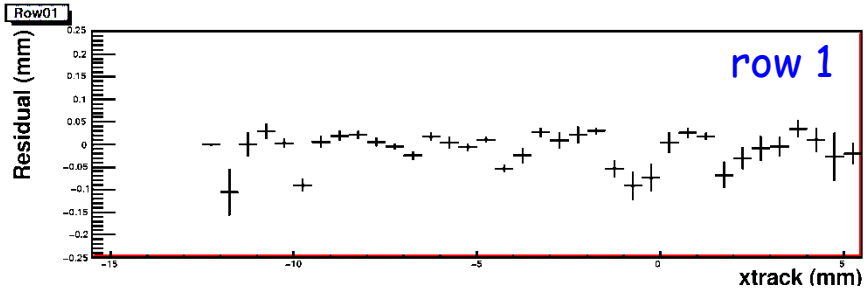


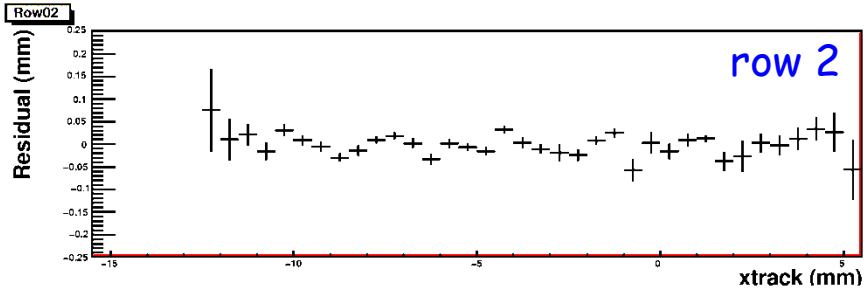


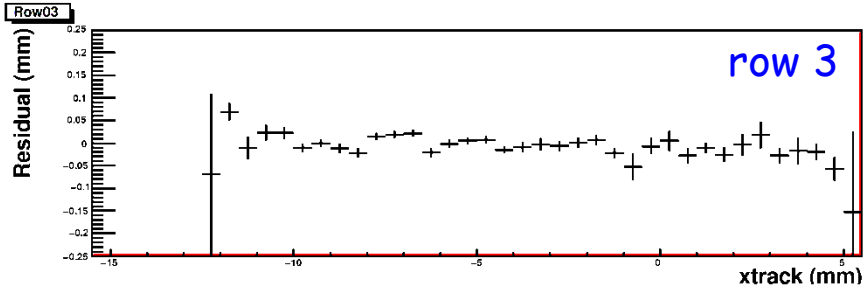
Residuals (x_{row}-x_{track}) are gaussians

Residual bias (z=25 cm)

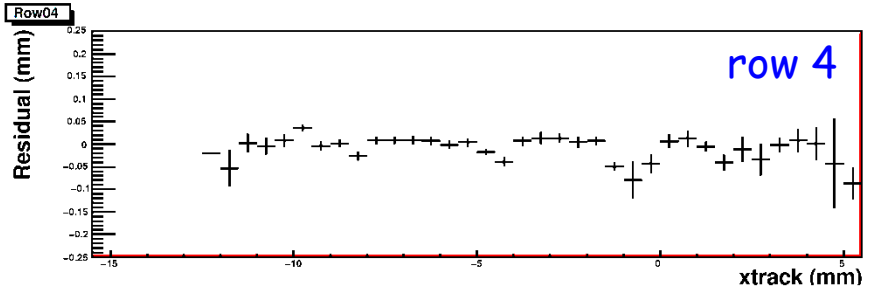


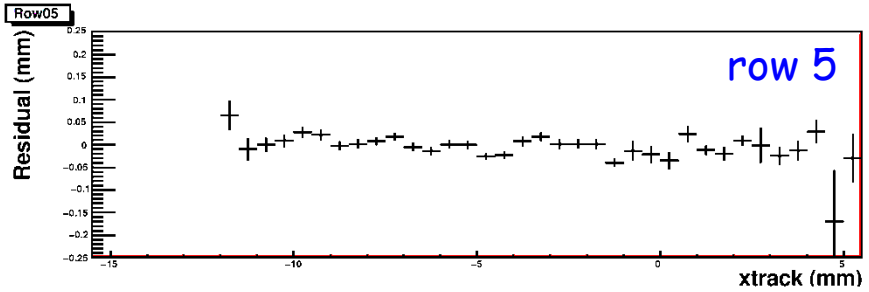






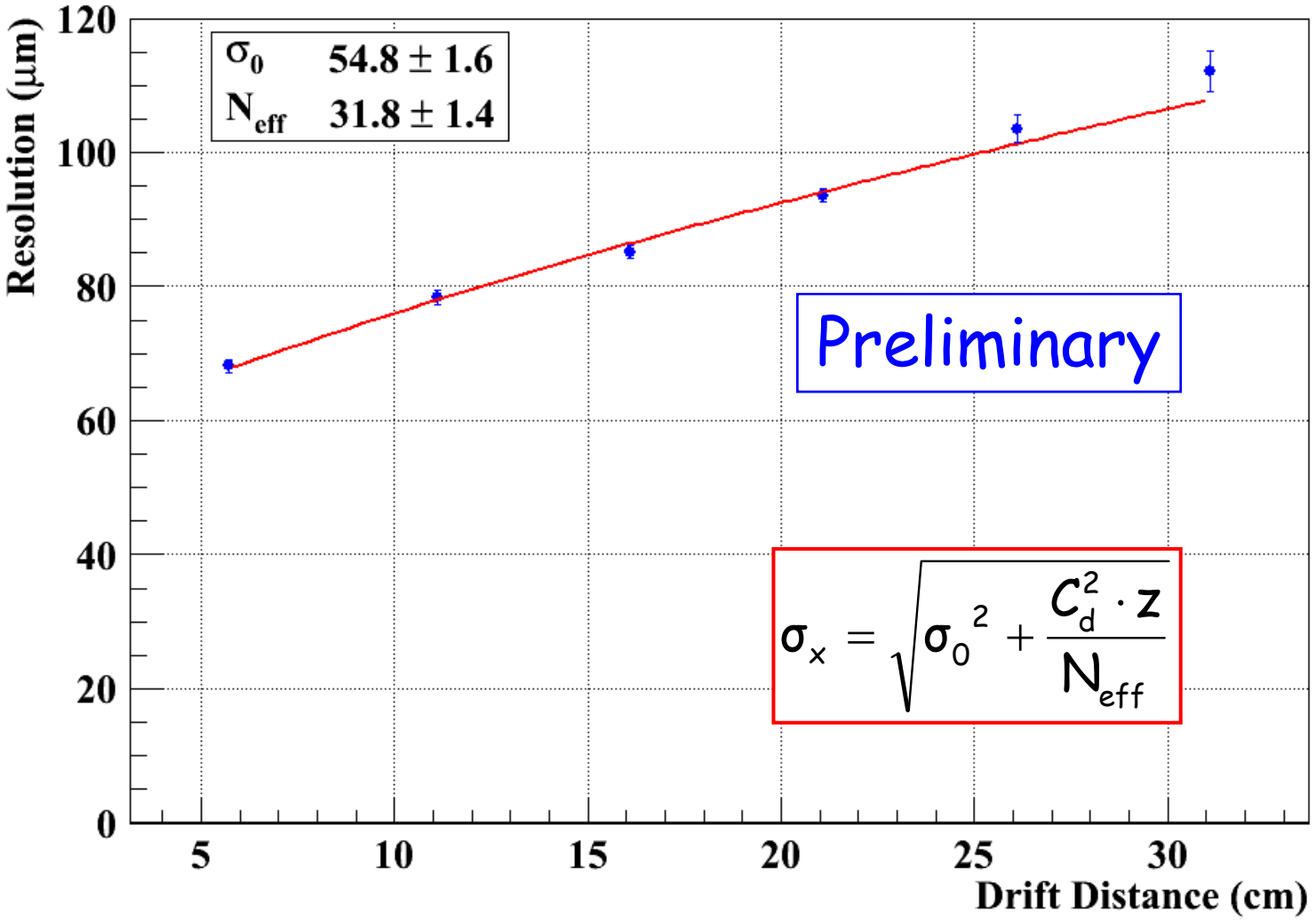
- Bias remaining after correction: mean of residual x_{row}-x_{track} = f(x_{track})
- Variation of up to 50 µm
- with a periodicity of about 3mm (pad width)





Spatial resolution

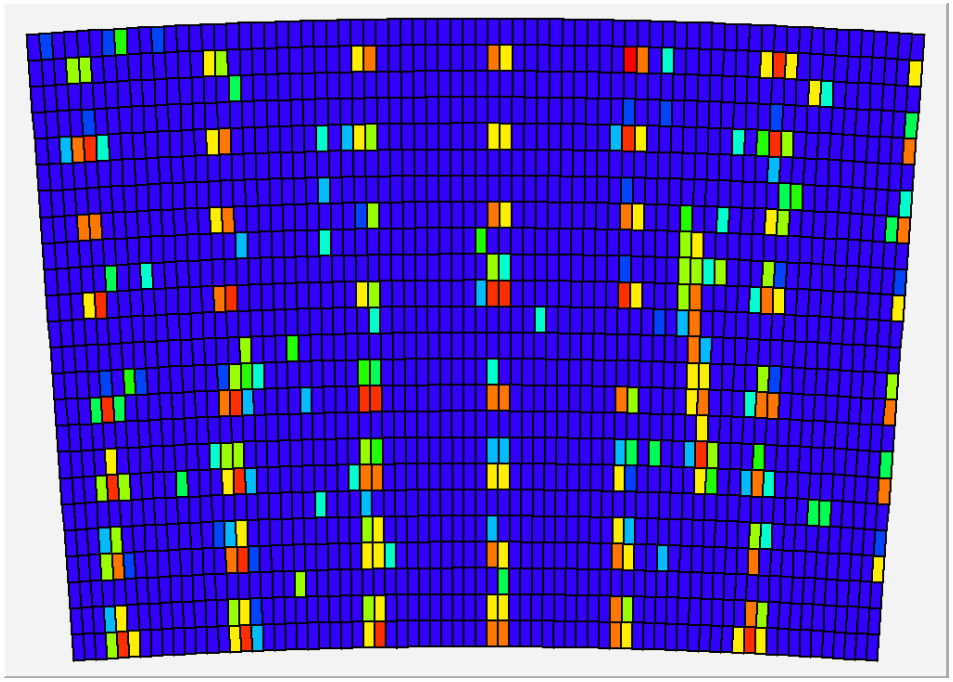
- Resolution at z=0: σ_0 = 54.8±1.6 µm with 2.7-3.2 mm pads (w_{pad}/55)
- Effective number of electrons: N_{eff} = 31.8±1.4 consistent with expectations



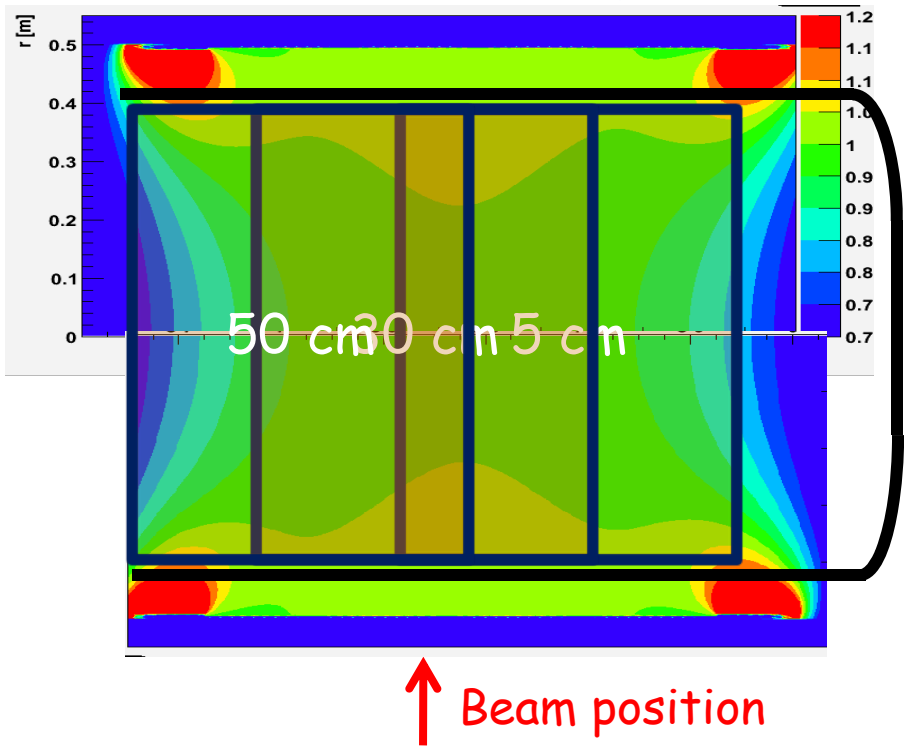
Field distortion measurement using laser

- two laser devices installed on the endplate to light up photosensitive pattern on the cathode (spots and line)
- deterioration of resolution at z > 40 cm : due to low field 0.9 to 0.7 T in the last 20 cm (significant increase of transverse diffusion)

Photoelectrons from the cathode pattern

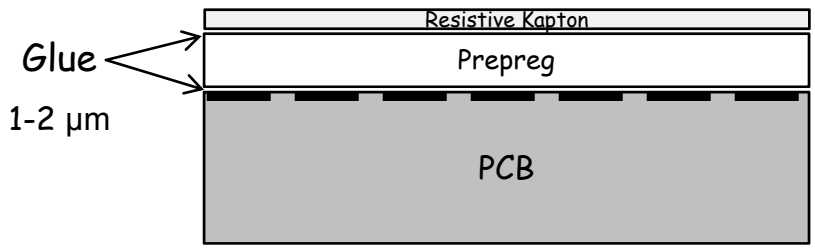


B field map of the magnet

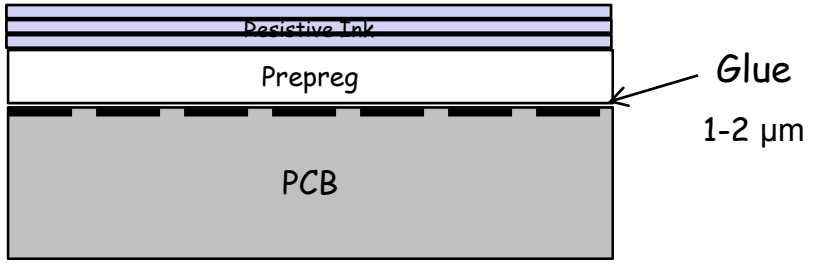


Description of the resistive anodes

Resistive Kapton



Resistive Ink

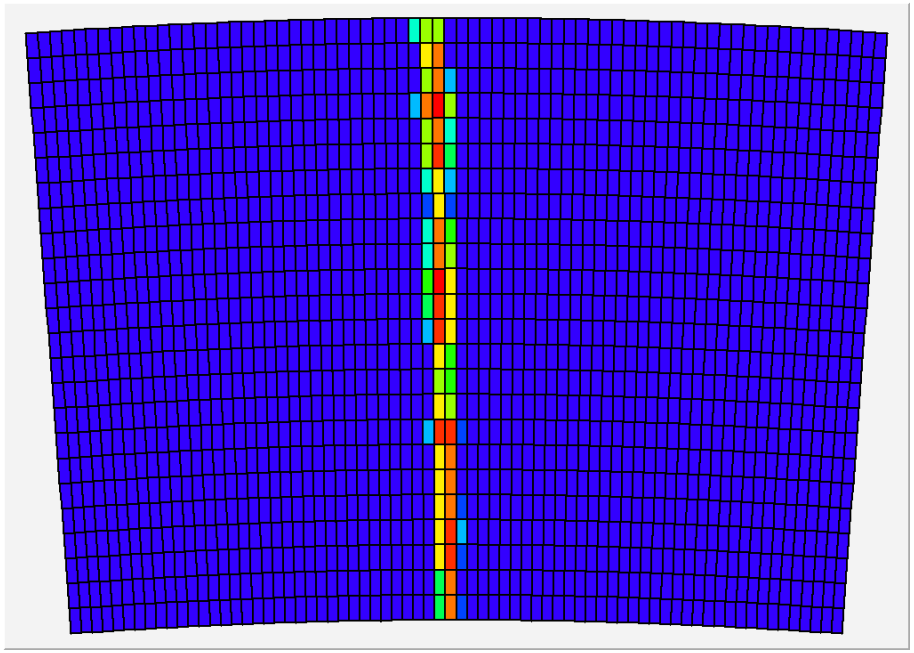


Detector	Dielectric layer	Resistive layer	Resistivity (MΩ/□)
Resistive Kapton	Epoxy-glass 75 µm	C-loaded Kapton 25 µm	~4-8
Resistive Ink	Epoxy-glass 75 µm	Ink (3 layers) ~50 µm	~1-2

Comparison at B=1T, z ~ 5 cm

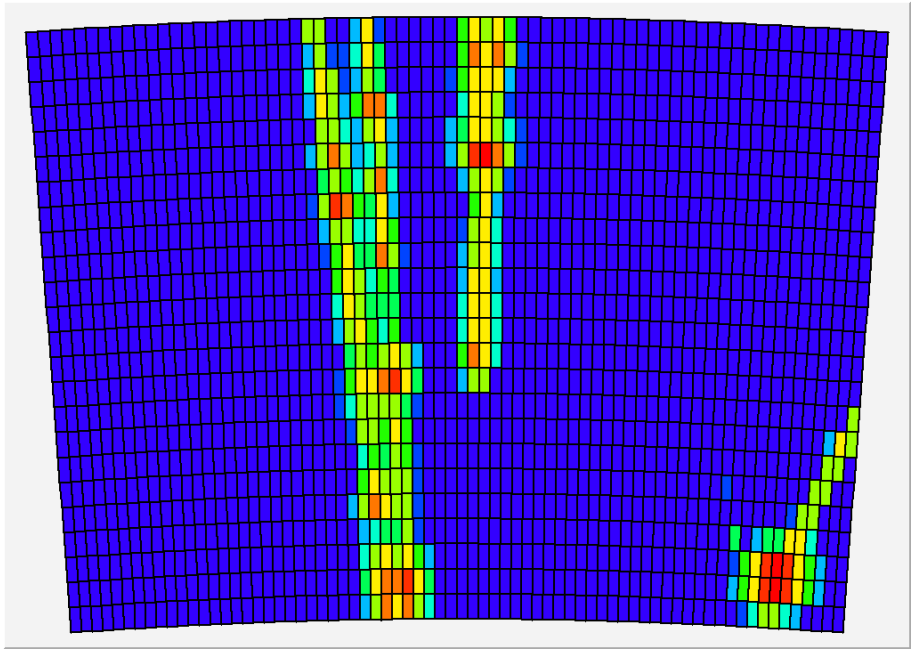
Resistive Kapton

- RUN 310
- v_{drift} = 230 cm/µs
- V_{mesh} = 380 V
- Peaking time: 500 ns
- Frequency Sampling: 25 MHz



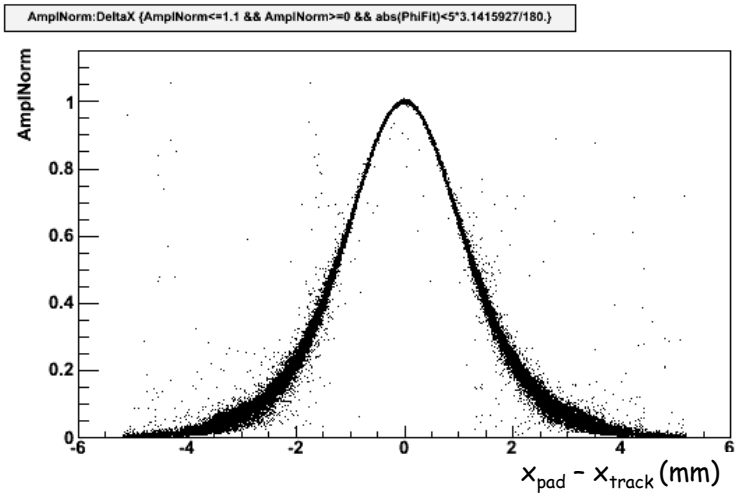
Resistive Ink

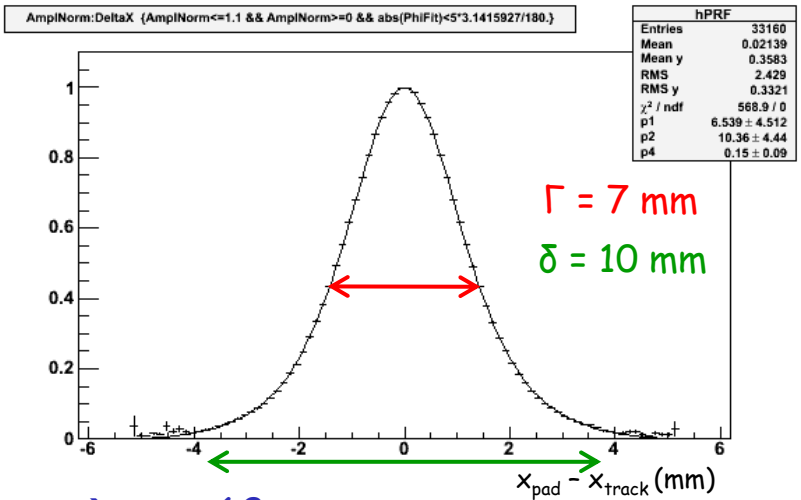
- RUN 549
- V_{drift} = 230 cm/µs
- V_{mesh} = 360 V
- Peaking time: 500 ns
- Frequency Sampling: 25 MHz



Pad Response Functions, z ~ 5 cm

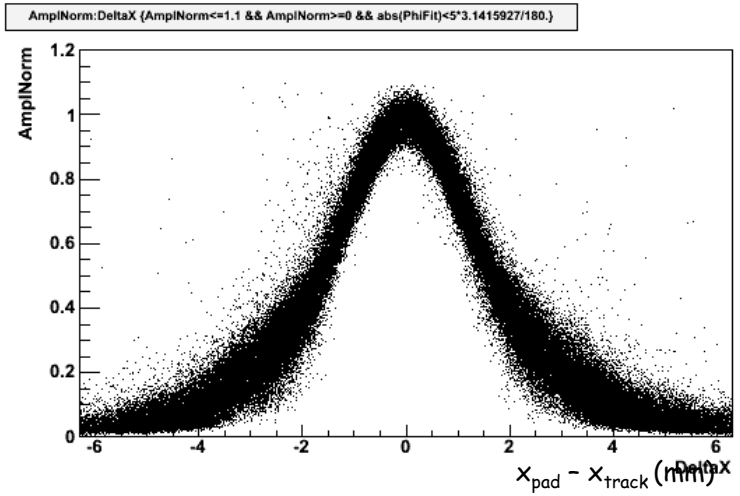
Resistive Kapton

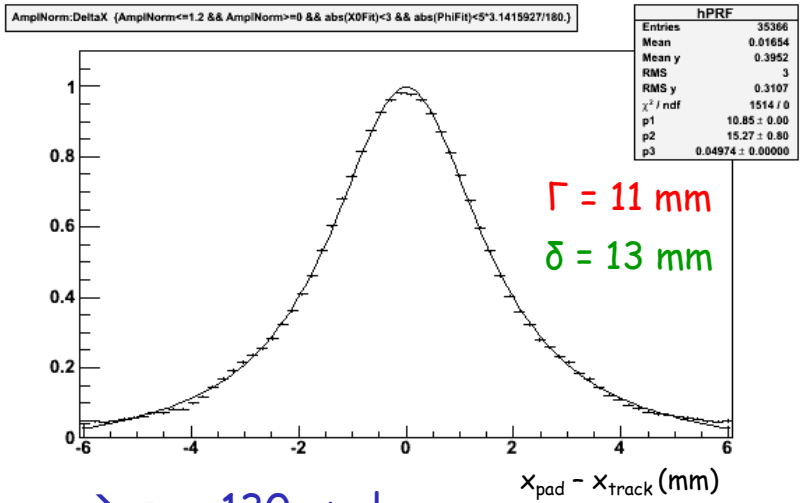




→ σ_0 = 68 µm

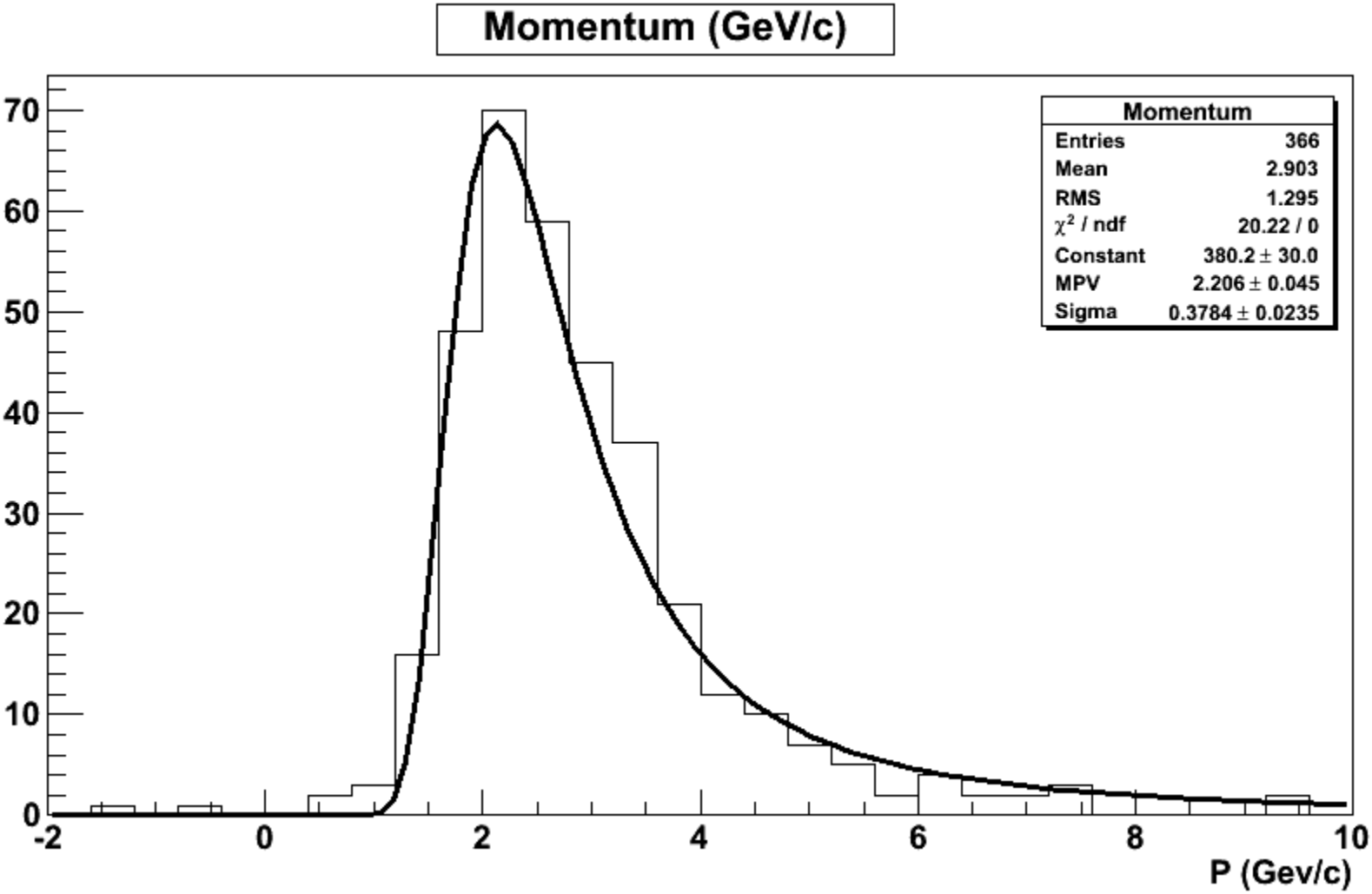
Resistive Ink



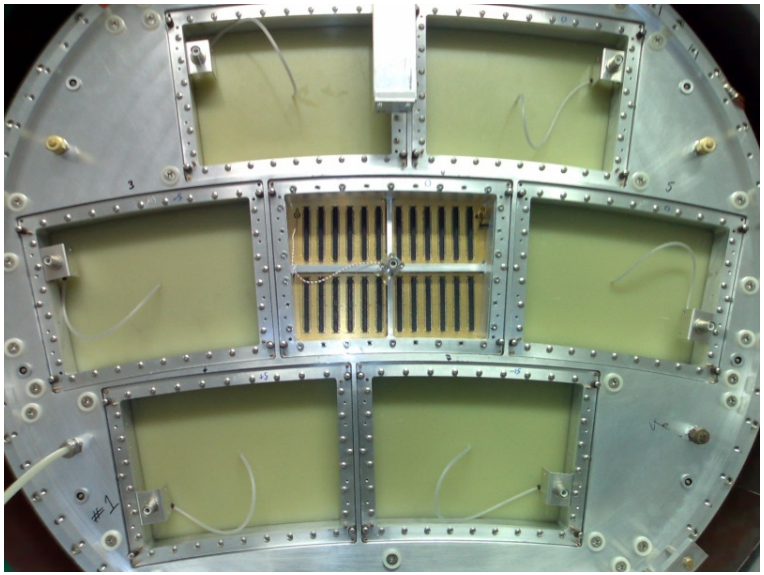


→ σ_0 = 130 µm !

2.2 GeV Momentum

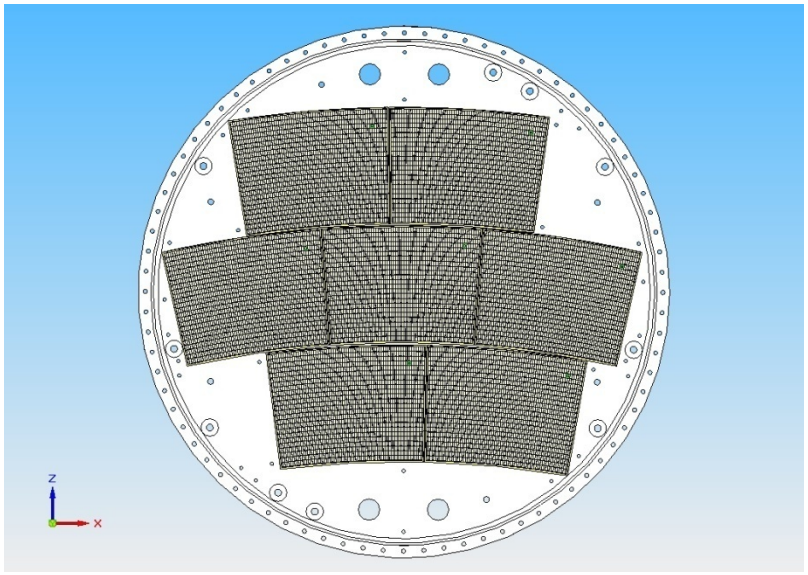


Further tests for Micromegas

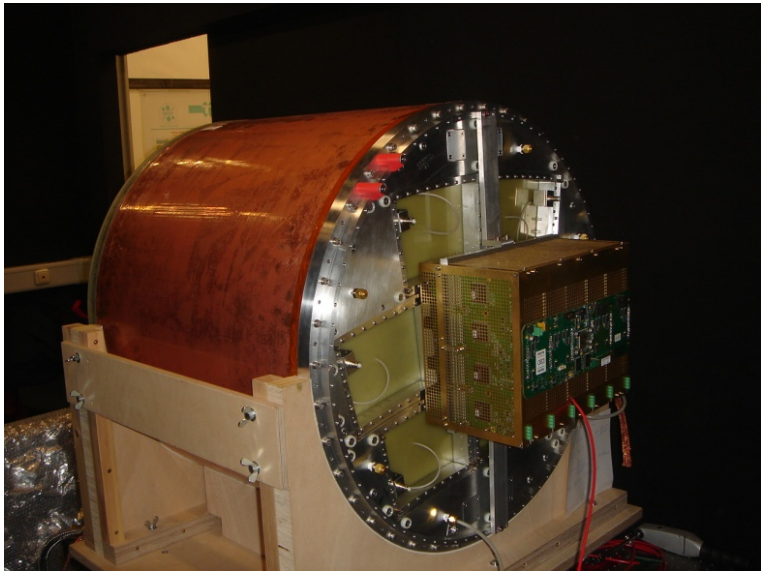


In 2008/2009 with one detector module

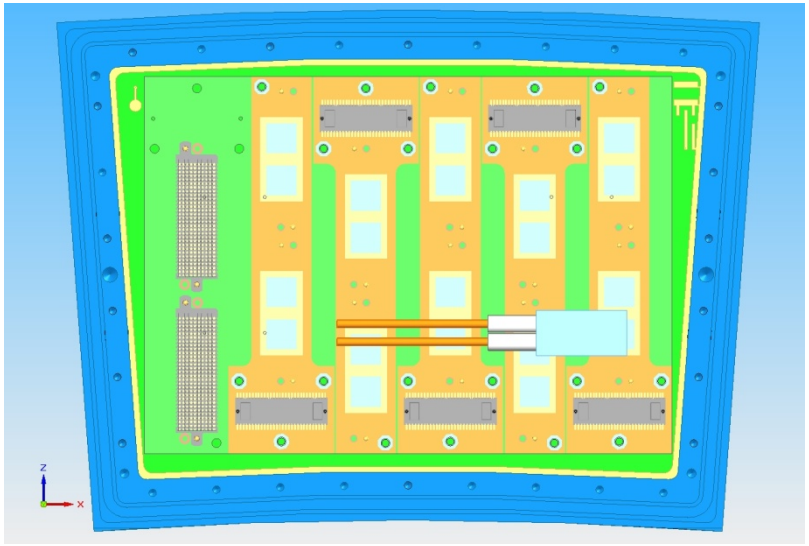
Resitive technology choice



In 2010 with 7 detector modules.



Reduce the electronic with possibility to bypass shaping



Conclusions

- Two Micromegas with resistive anode have been tested within the EUDET facility using 1T magnet to reduce the transverse diffusion
- C-loaded Katpon technology gives better result than resistive ink technology
- First analysis results confirm excellent resolution at small distance with the resistive C-loaded Kapton: **55 µm for 3 mm pads**
- The moving table is necessary to fix the inhomogeneous B field at high z
- Plans are to test several resistive layer manufacturing process and RC, then go to 7 modules with integrated electronics.
- Next step is making 2 new detectors, identical except the routing (we have 2 routings) both in CLP but a new, lower resistivity one. Should be close to ideal.

Acknowledgments

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  - D. A.
  - P. Colas
  - M. Riallot
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  - R. Woods
- DESY/EUDET