Charge Dispersion Studies in MPGDs with a Resistive Anode

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IEEE Workshop on Micro-Pattern Detectors for Time Projection Chambers
Portland, Oregon (20 October 2003)

Position sensing from charge dispersion in micro-pattern gas detectors with a resistive anode

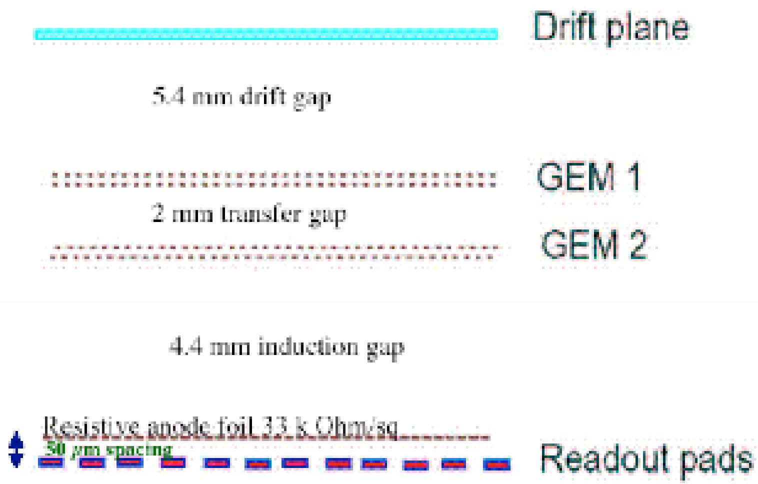
Double-GEM *spatial resolution ~ 70 μm* reported earlier *(Dixit et al, to be published in NIM)* consistent with x-ray spot size *for 1.5 mm wide long strip readout*

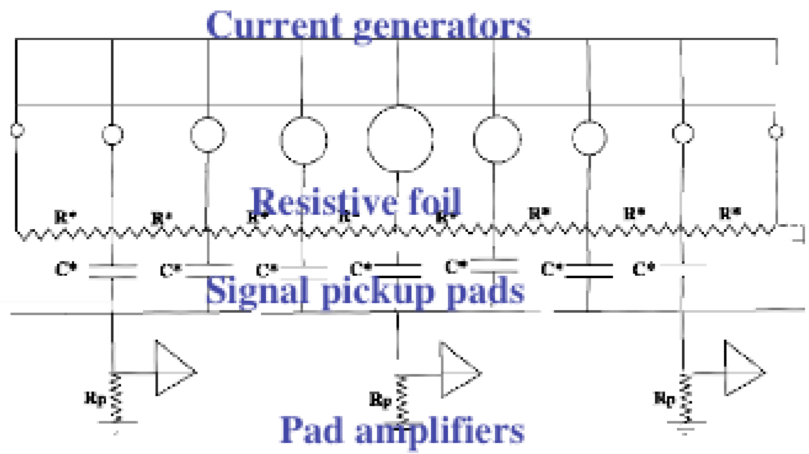
Here we report on:

Energy and gain tests in Micromegas

Resolution for rectangular (2 x 6 mm) pads in GEM and in Micromegas using a collimated x-ray source

Position sensing from charge dispersion in micro-pattern gas detectors with a resistive anode





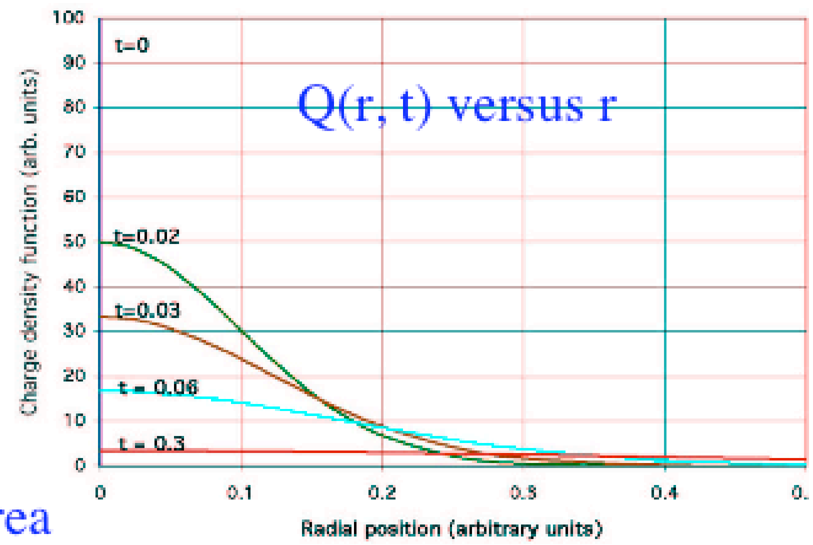
Deposit charge cluster at r=0 at t=0

Telegraph equation in 2-D

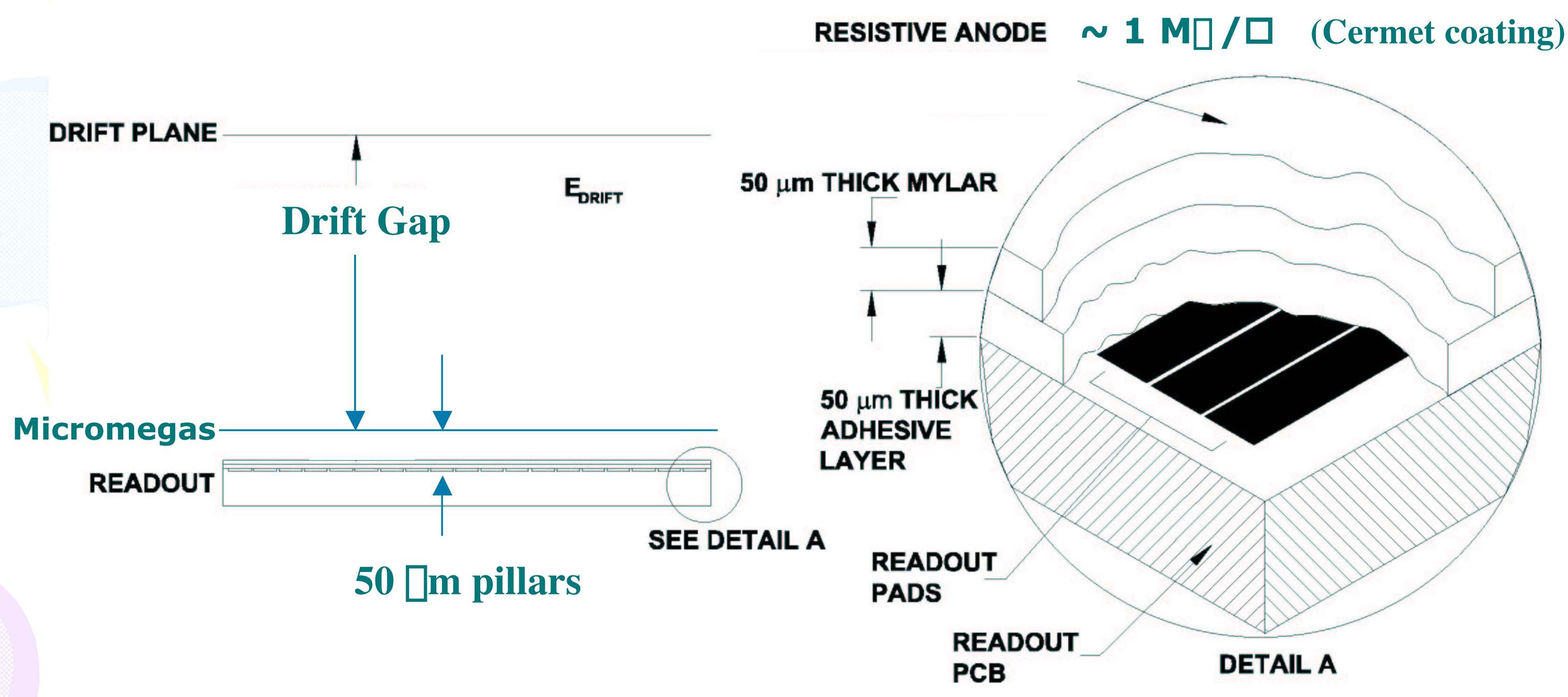
$$\frac{\partial Q}{\partial t} = \frac{1}{RC}\left[\frac{\partial^2 Q}{\partial r^2} + \frac{1}{r}\frac{\partial Q}{\partial r}\right]$$

Charge density: $Q(r,t) = \frac{RC}{2t} e^{\frac{-r^2 RC}{4t}}$

Signal = Integral of Q(r, t) over pad area

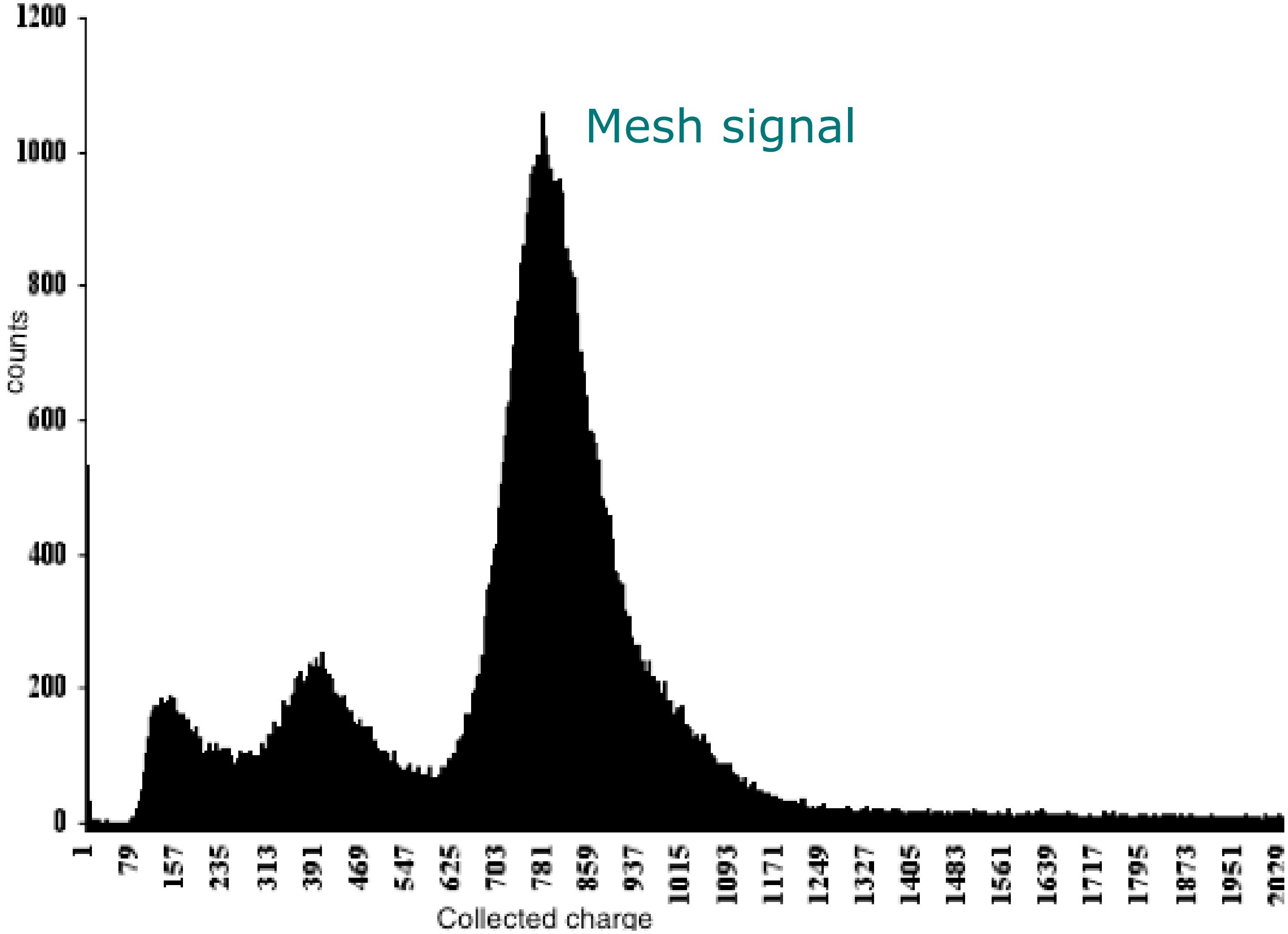


Resistive anode Micromegas gain tests at Saclay



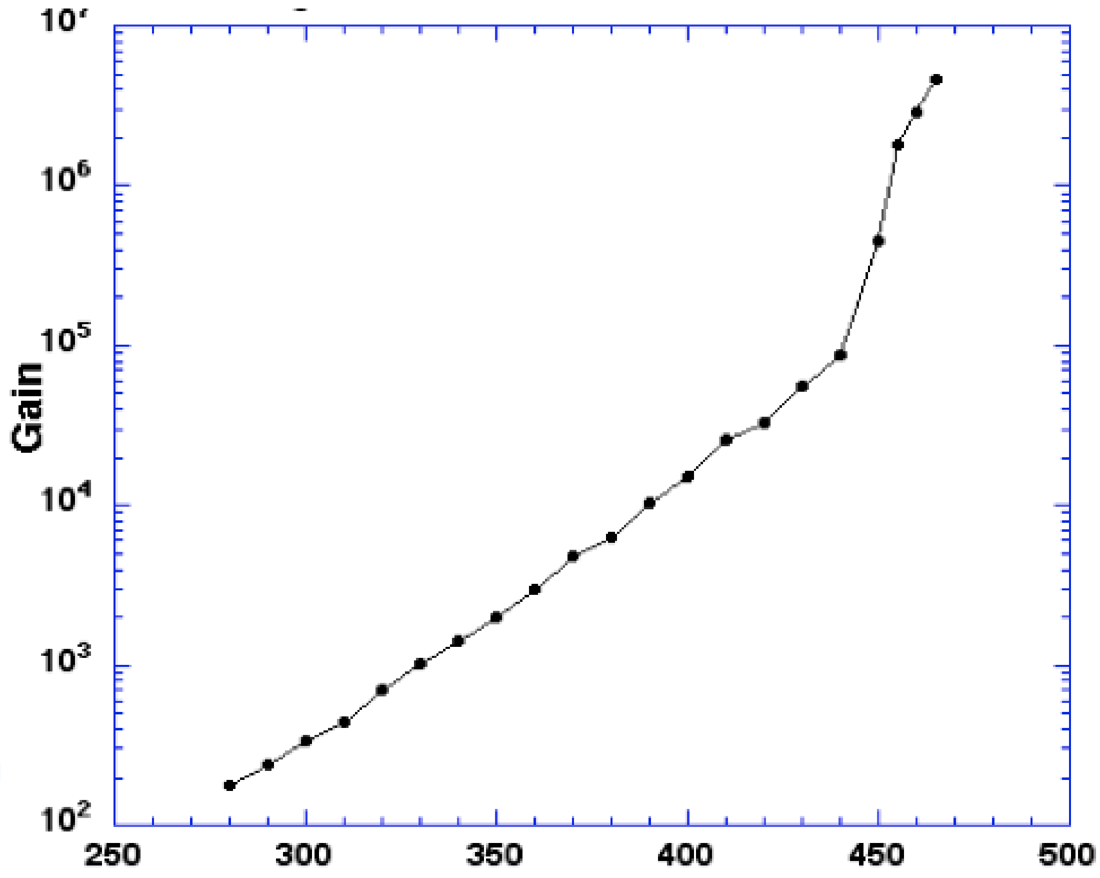
Micromegas ^{55}Fe energy resolution

Argon/Isobutane 90/10 (Gain ~ 6000)



Micromegas gain with a resistive anode

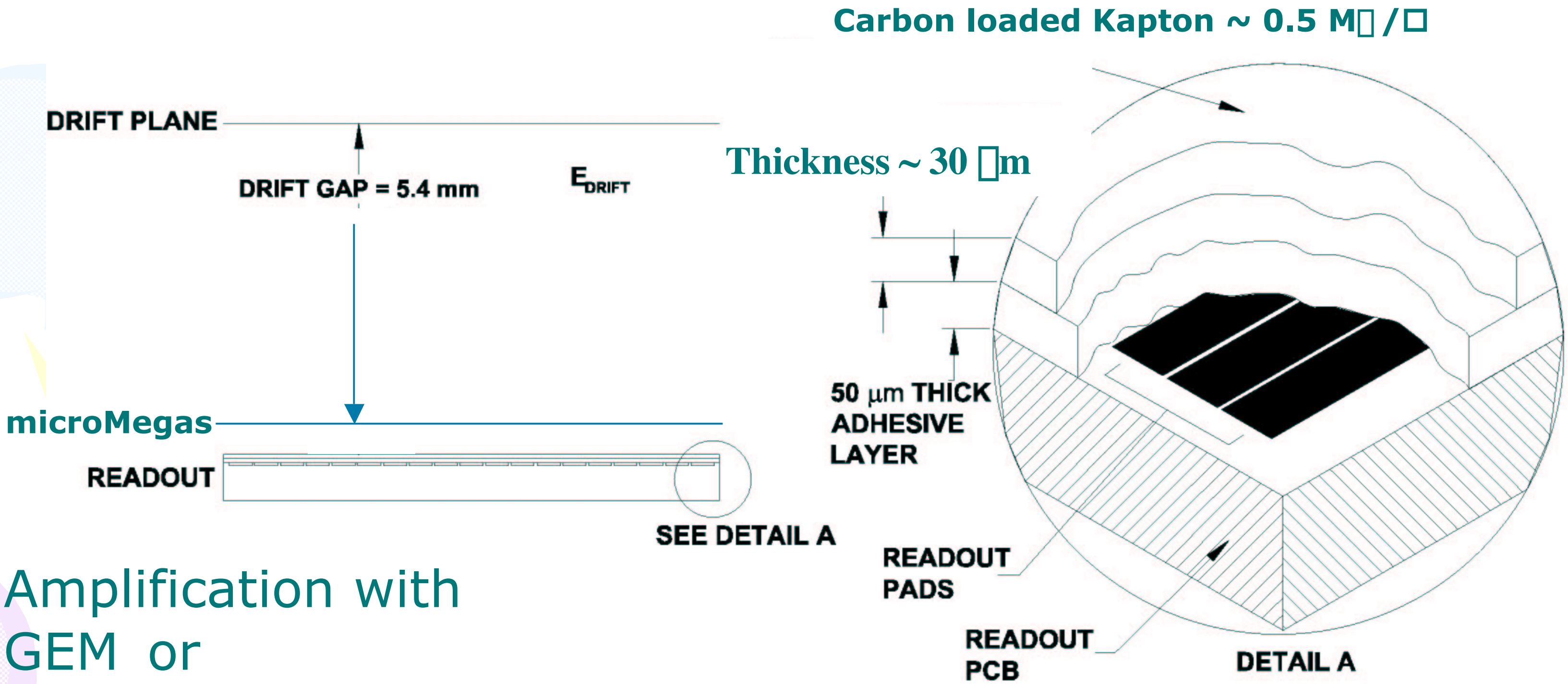
Argon/Isobutane 90/10



Resistive anode suppresses sparking stabilizing Micromegas

GEM & Micromegas Tests at Carleton

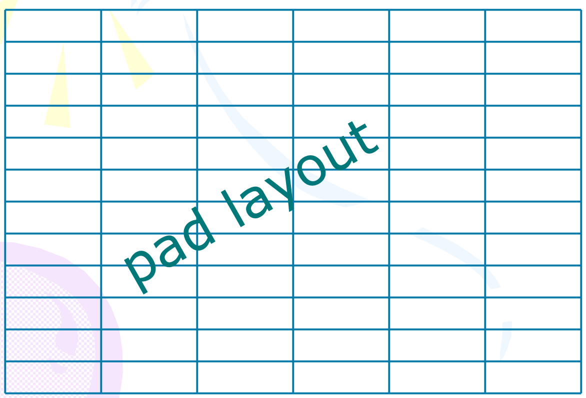
Resistive anode disperses avalanche cluster charge
Position from centroid of dispersed charge sampled by several pads
In contrast to the GEM, in Micromegas there is little transverse diffusion after gain which makes centroid determination difficult
Cermet-Mylar resistive foil replaced by C-loaded Kapton

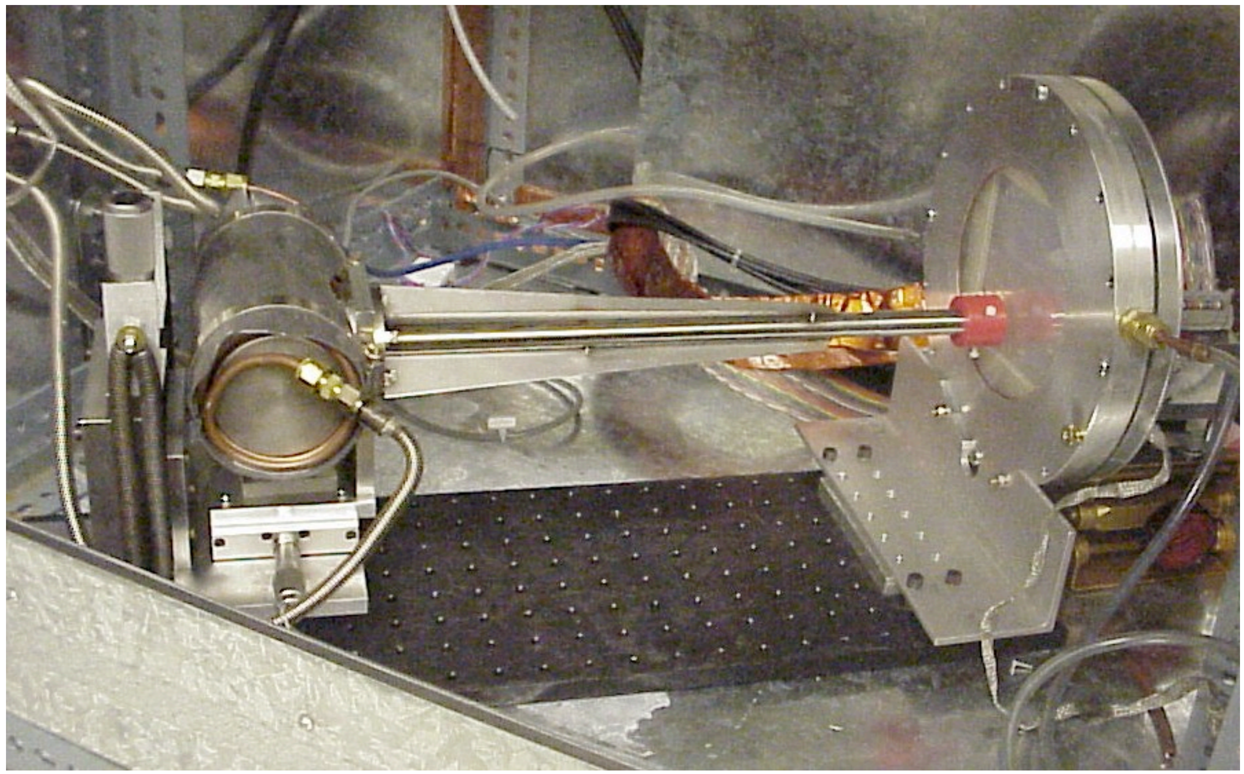


Amplification with GEM or MicroMegas

Space Point Resolution with Resistive Readout

- Test cells with double GEM & Micromegas
- 6 kV brehmstralung x-ray source
- ~ 40 μm pinhole camera produces ~ 70 μm focal spot
- Ar:CO_2 (90:10)
- 2 x 6 mm pads

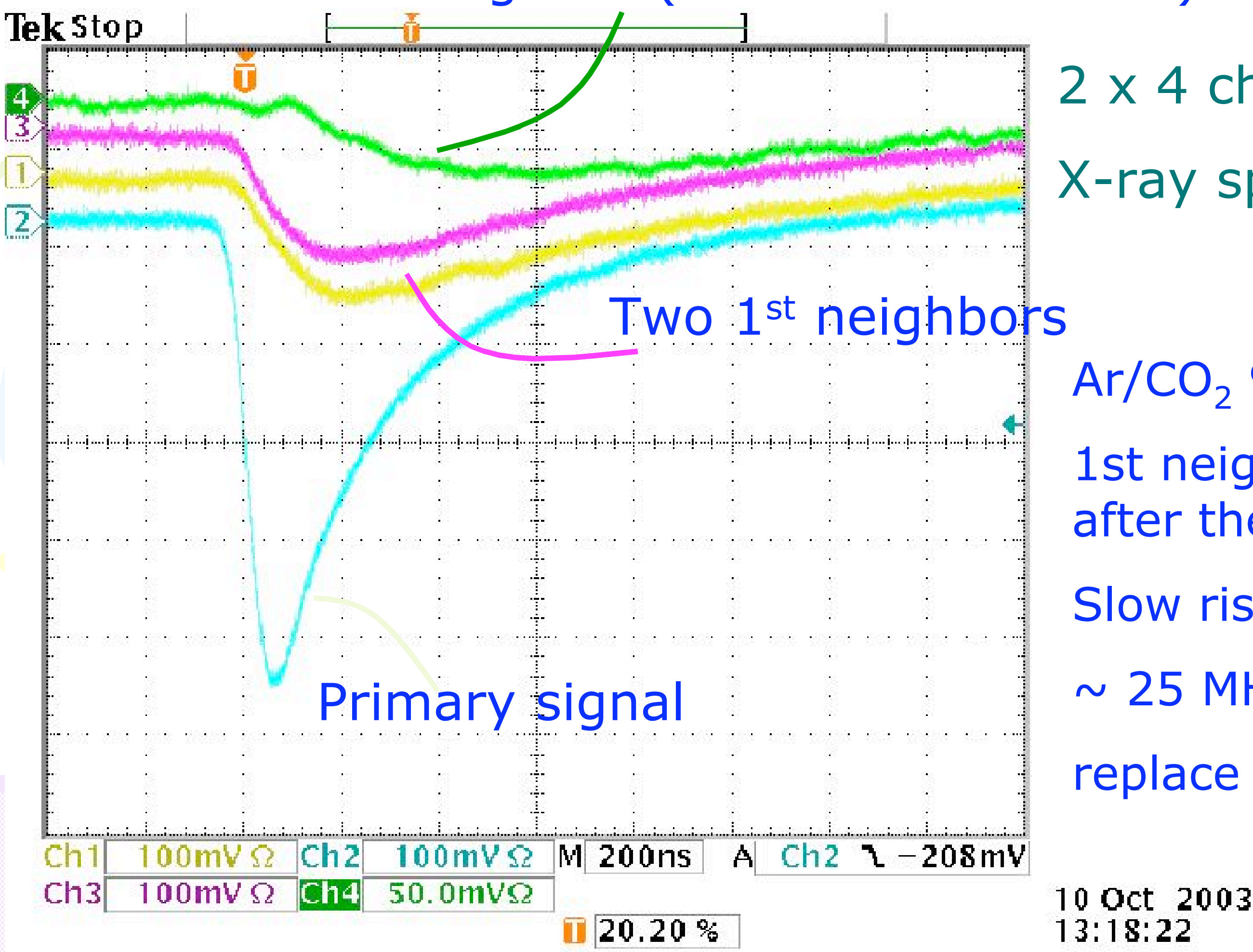




Charge dispersion signals in Micromegas

Single event (2 mm wide pads)

2nd neighbor (note different scale)



2 x 4 channel Tektronix

X-ray spot centred on pad 2

Ar/CO_2 90/10, Gain ~ 3000

1st neighbor peak ~ 100 ns after the primary pulse peak

Slow rising 2nd neighbor pulse

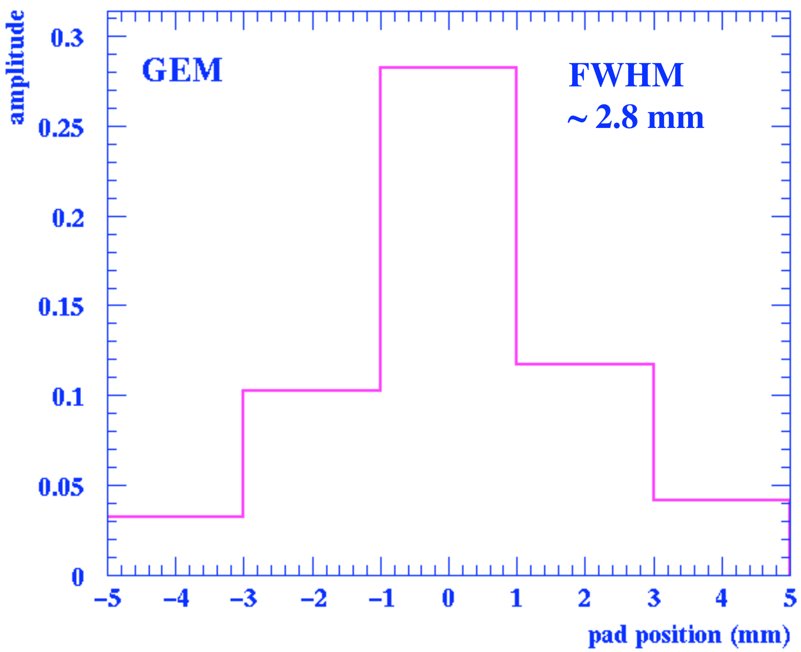
~ 25 MHz digitization could

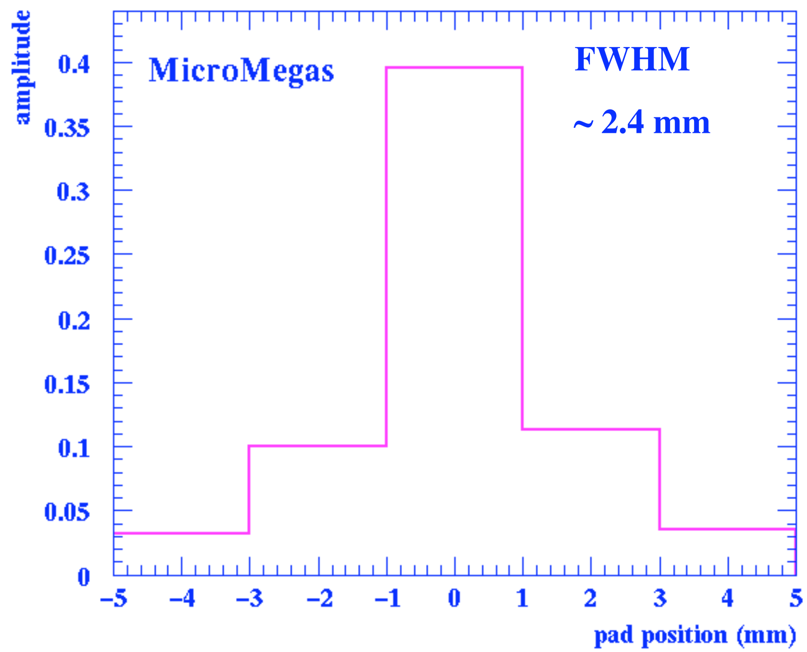
replace pulse shape sampling

Pad response function (PRF)

Intrinsic PRF width from charge dispersion on resistive anode

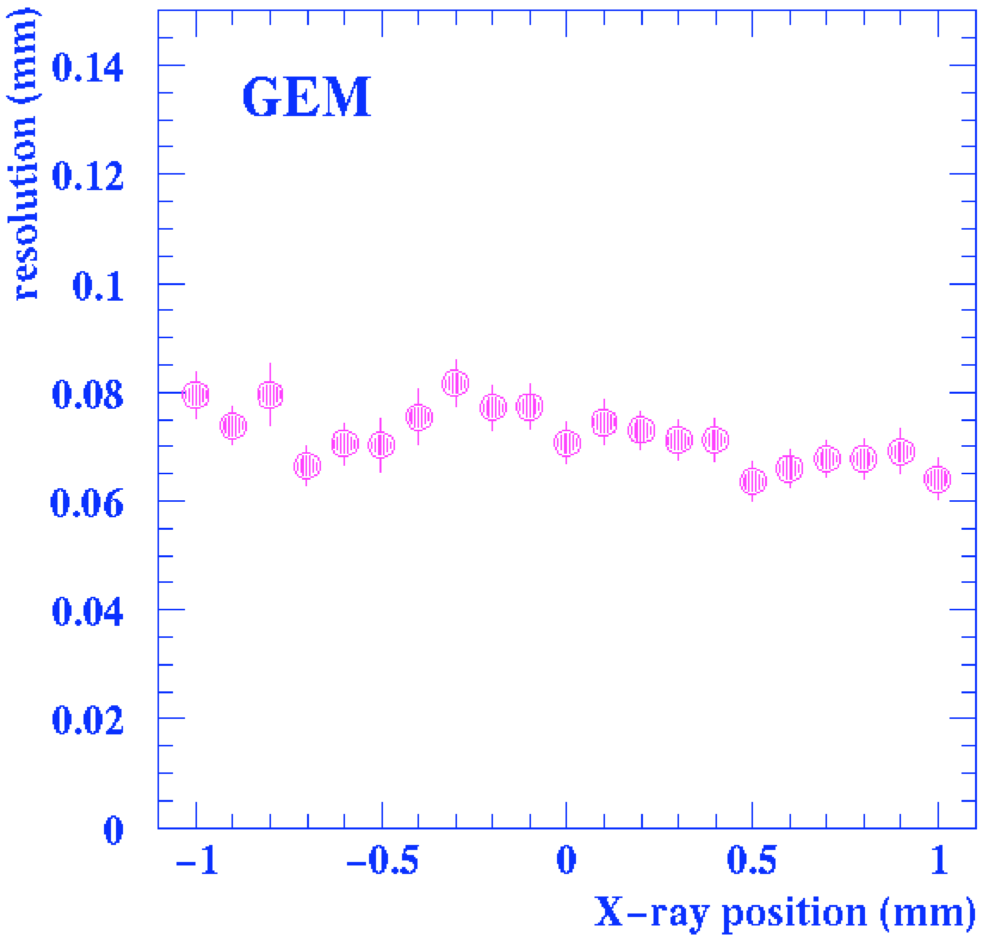
Transverse diffusion adds significantly to the GEM PRF width





Average amplitude on 5 consecutive pads

GEM resolution (rectangular pads)

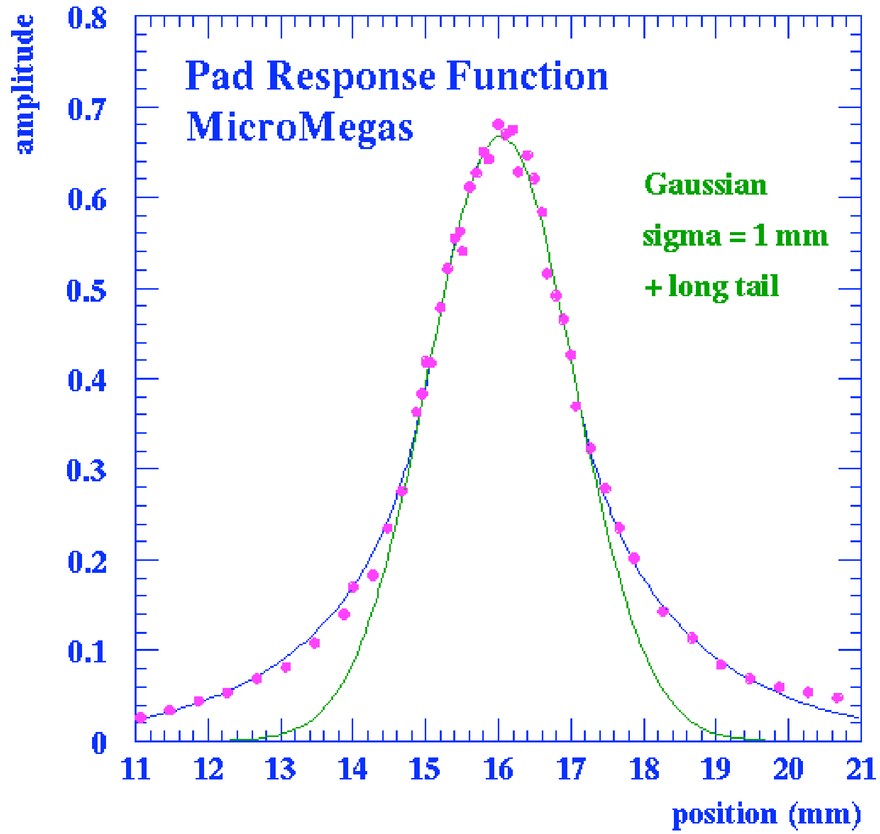


Resolution for 1.5 x 70 mm^2 strips for 2.5M□/☐ anode resistivity ~ 50-80 □m (to be published in NIM)

Point resolution for the 2 x 6 mm^2 rectangular pads with 0.5 M□/☐ anode foil similar

Use dispersed charge center-of-gravity with bias correction

Micromegas Pad Response Function



Average amplitude versus distance of the pad centre to the x-ray spot

Micromegas have little diffusion after gain in contrast to GEM

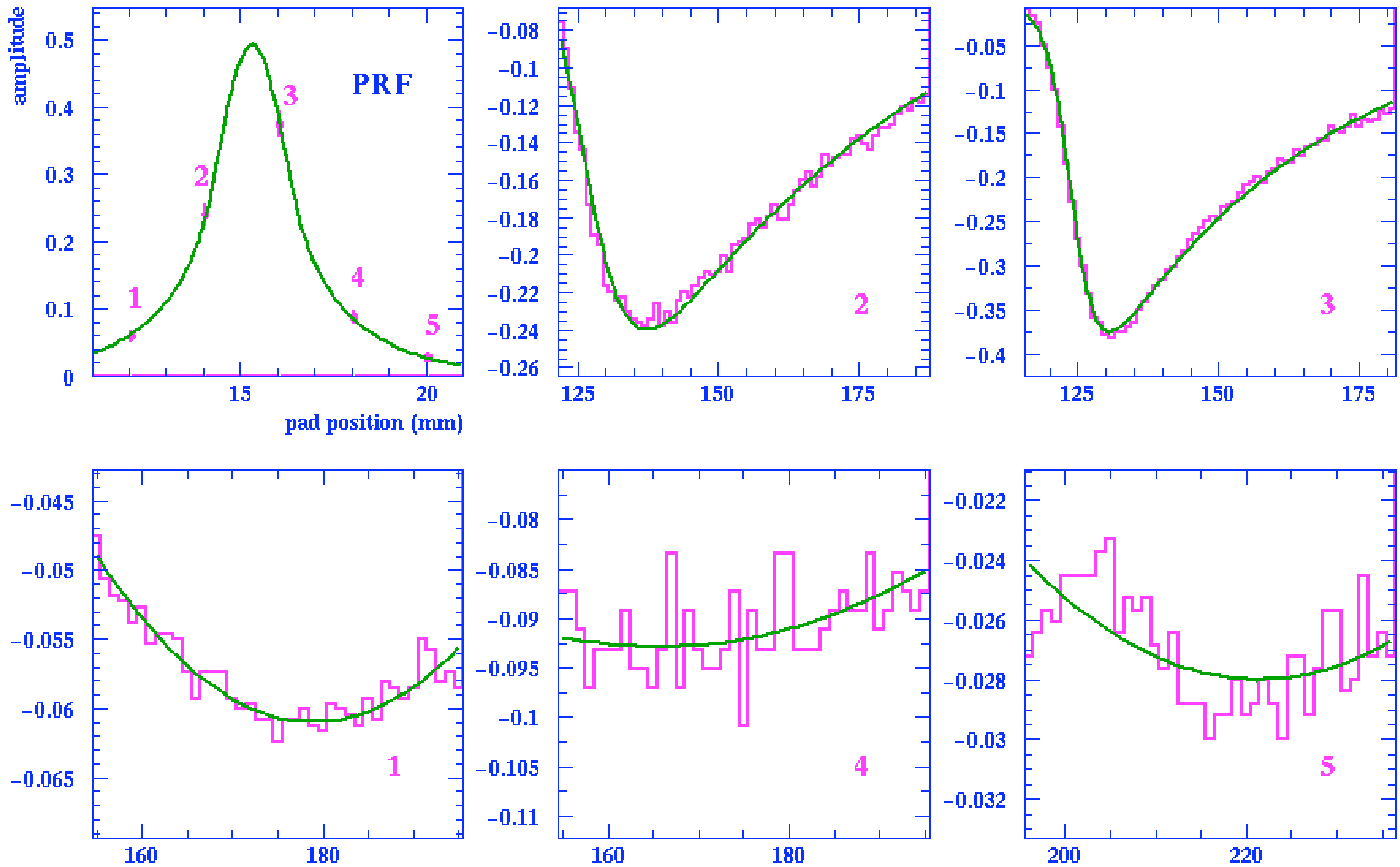
The centre of gravity method appears to be inadequate

Detailed characterization of Micromegas pad response function

Normalize pad charge signals with mesh signal

Scan over 10 mm = 5 pads

A Micromegas Charge Dispersion Event

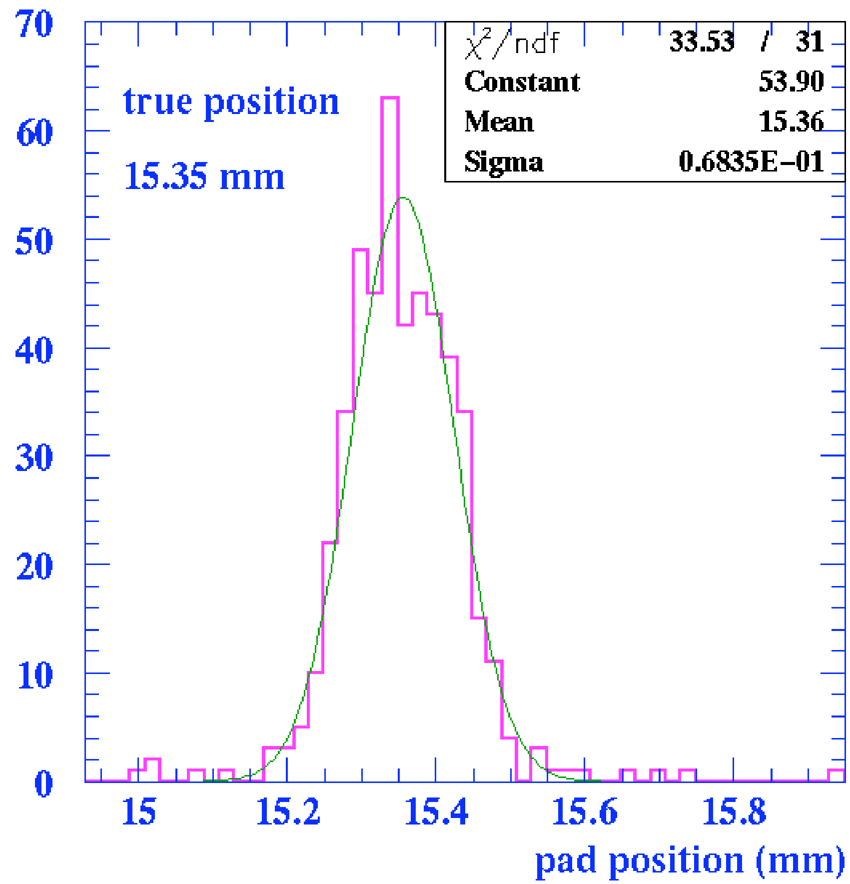


Micromegas Resolution

X-ray spot position 15.35 mm

Pad edge @ 15 mm
Centre @ 16 mm

Measured spatial resoluion 68 m

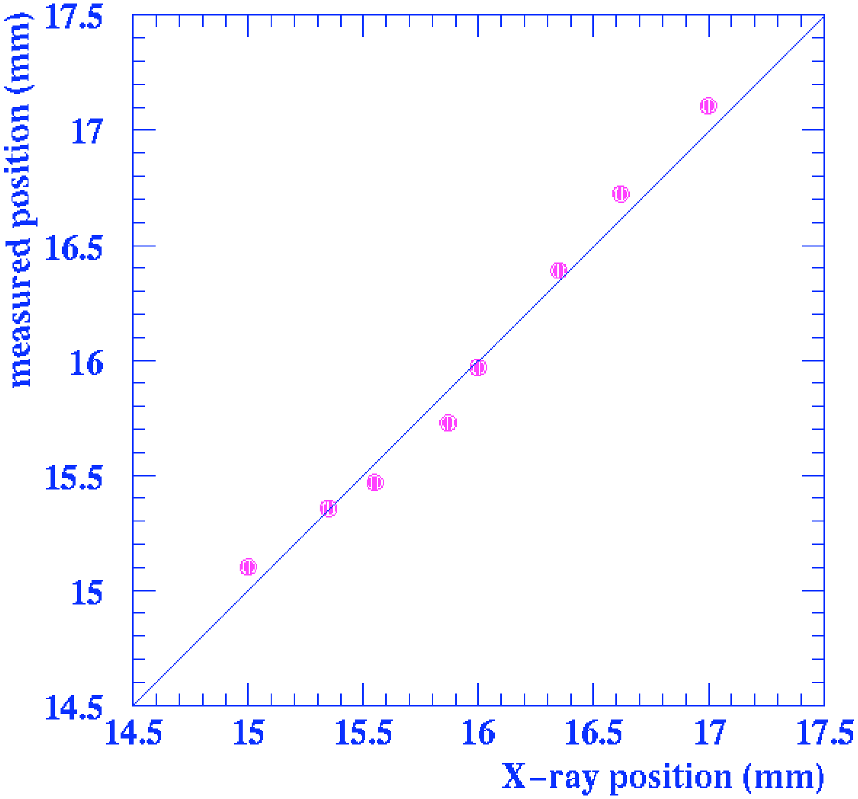


Micromegas Resolution

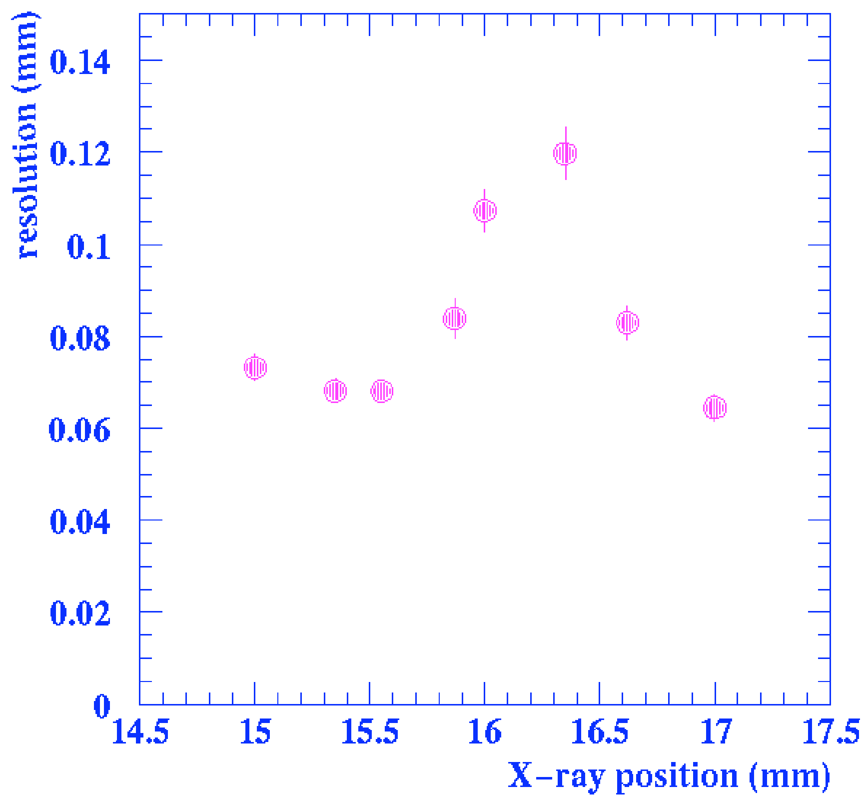
Scan across a 2 x 6 mm pad
Good resolution not uniform

Systematics not fully understood

Some points: bias of 100 μm



Some points: resolution of 120 μm



What's Wrong?

Possible reasons for poor resolution/bias in Micromegas

➢ Resistive foil not uniform - unlikely

➢ Quality/structural problems with our particular Micromegas setup

➢In the GEM, diffusion after gain makes PRF more Gaussian makes analysis easier

➢Still learning how to analyze the Micromegas data

➢More measurements under different conditions to understand the problem

Conclusion

- First charge dispersion resolution results for rectangular nominal TPC width pads in Micromegas & GEM very encouraging
- Spatial resolution ~ 70 μm consistent with x-ray spot size
- Systematics not fully understood for Micromegas
- Good energy resolution in Micromegas
- Sparking suppressed in Micromegas detector to high gains
- TPC cosmic ray tracking tests next