GEM Module Tests at LP1

First test of GEM module at LP1
Electron transmission measurement
（14 μ m-thick GEM for next test）

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LC-TPC collaboration

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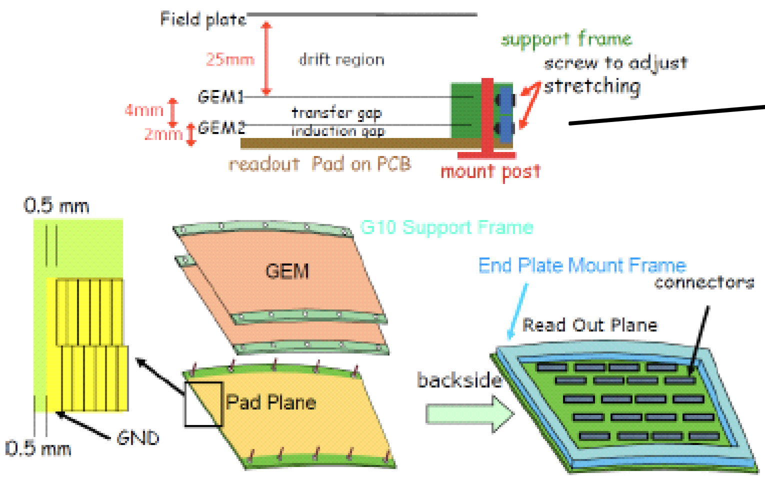
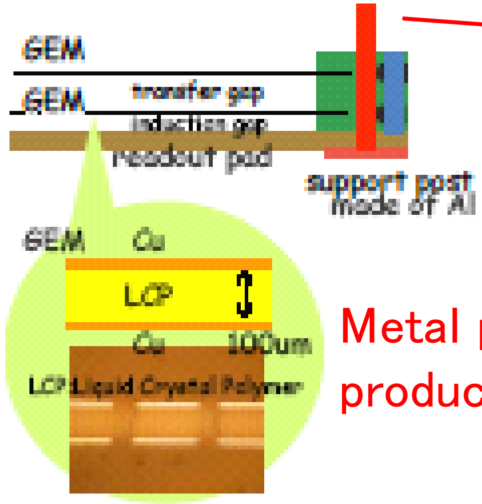
UNM（Albuquerque）

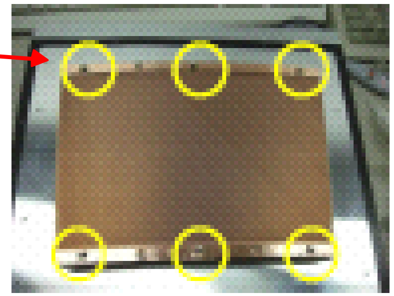
First Test of GEM Module at LP1

GEM Module

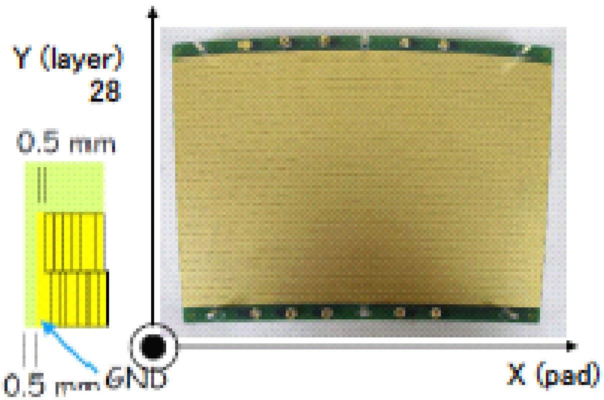
- 100um thick Double GEM





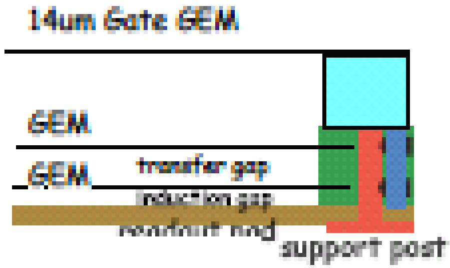


Metal posts facing drift volume produce local distortion

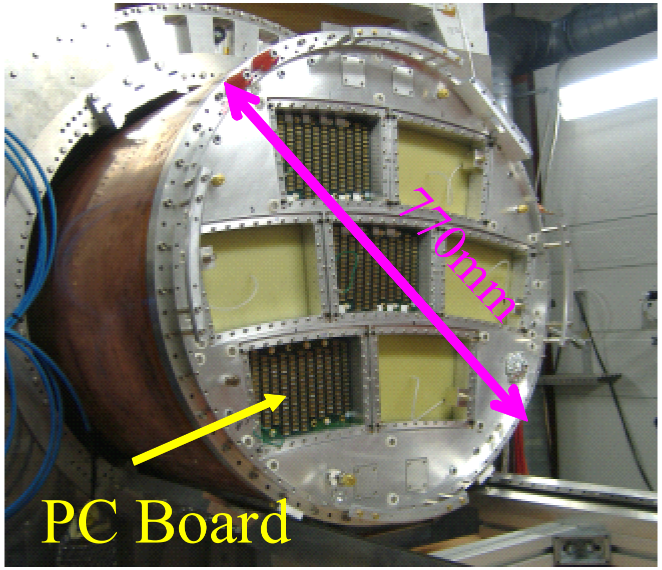


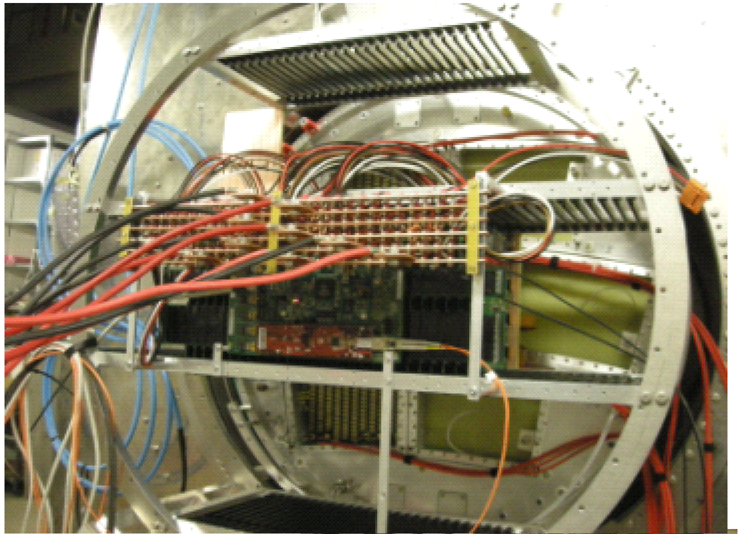
28 pad rows
192 pads at outer
176 pads at inner
(1.15–1.25)mm W
5.26mm H

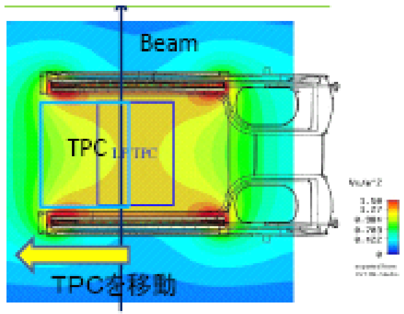
next tine--------------------------------



Test of GEM Module







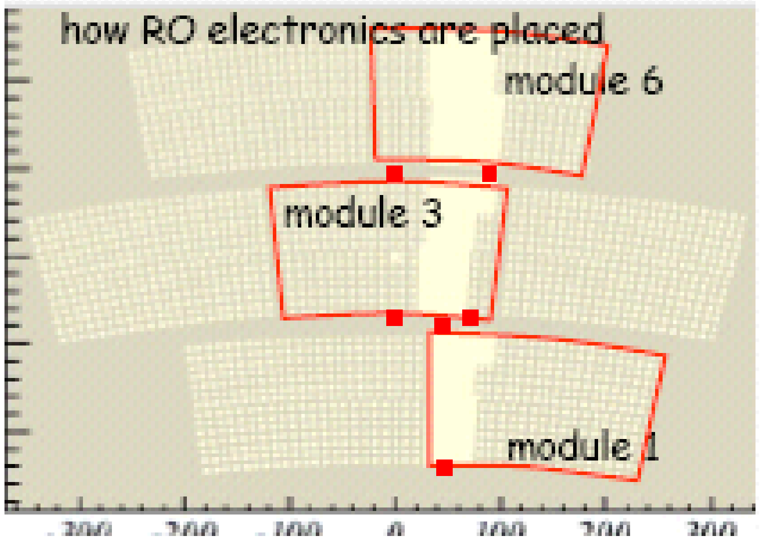
Displacing TPC in magnet for drift distnce dependence introduce different B for each drift as moving stage was not available

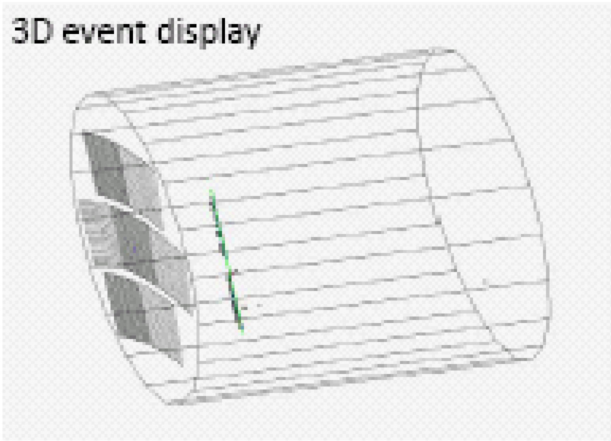
DAQ is based on ALICE TPC system

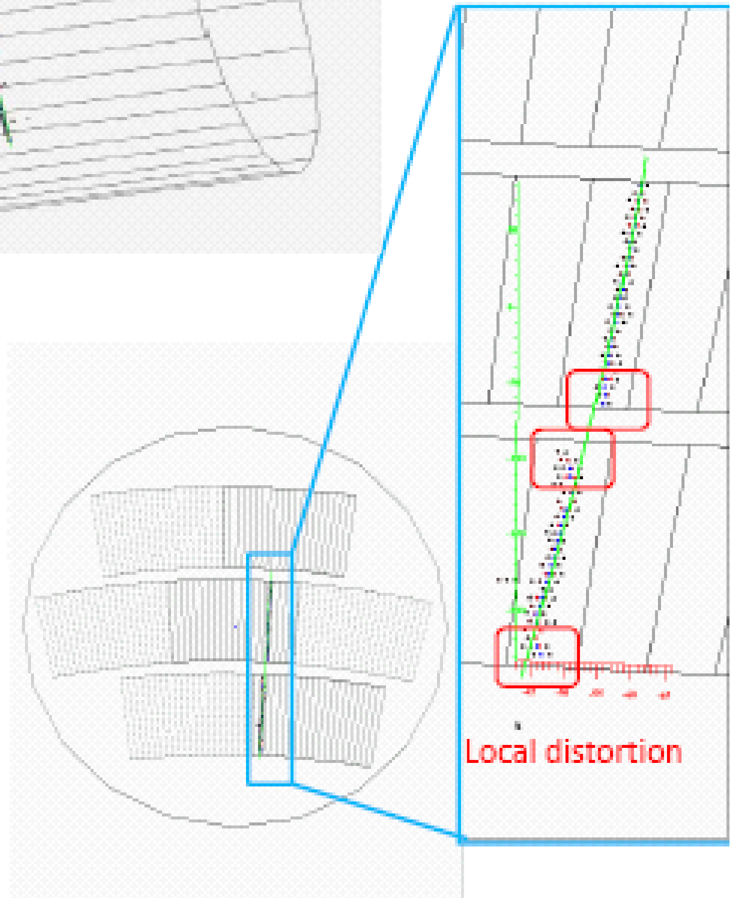
the Front End Cards (FEC) with ALTRO

20MHz 10bits digitization chip

Event Display







Metal posts facing drift volume produce local distortion.

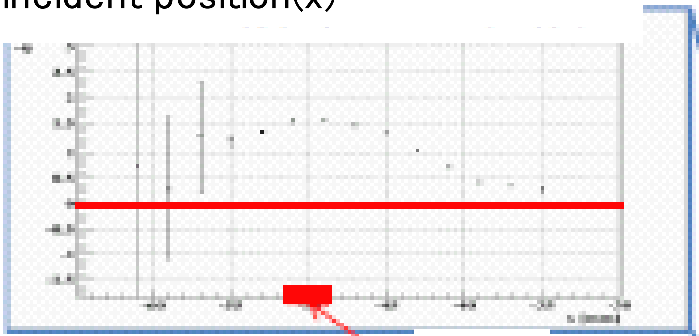
Displacing TPC in PCMAG for drift distance dep.
introduce different B field for each drift.
as moving stage was not available

Combination of 2 problems make the situation very complicated

Local Distortion Correction

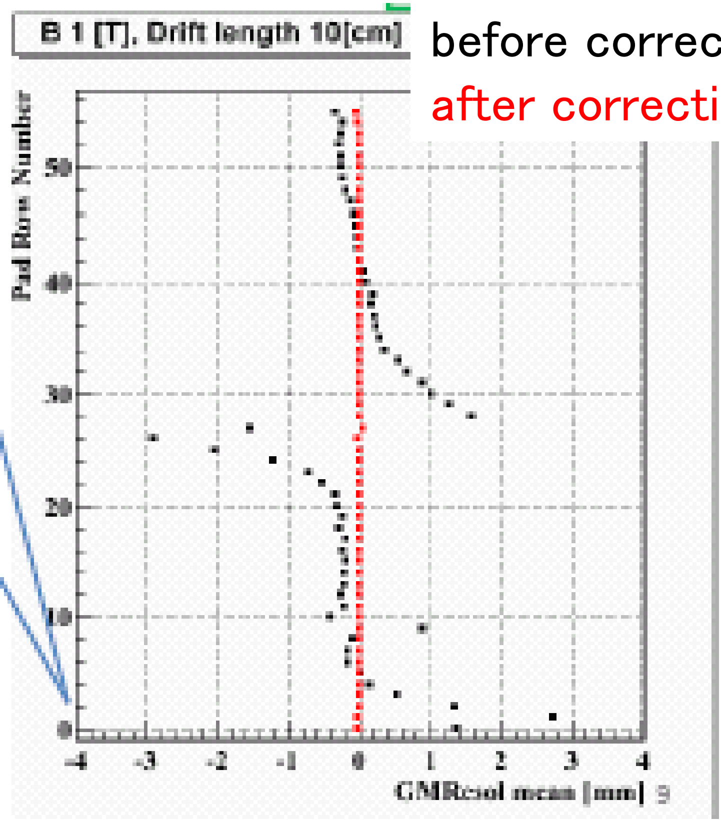
Local distortion (supposed to be same for any drift distance) is corrected as a function of incident position(x) by using 10cm drift data as it largely depend on metal post

residual mean as a function of incident position(x)



post

This correction includes relative module alignment.

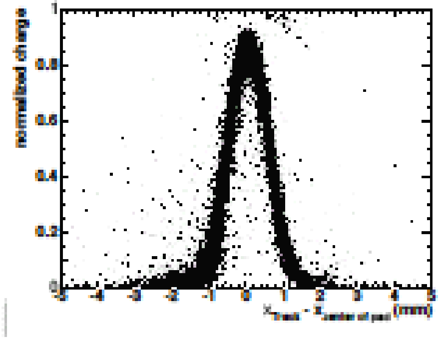


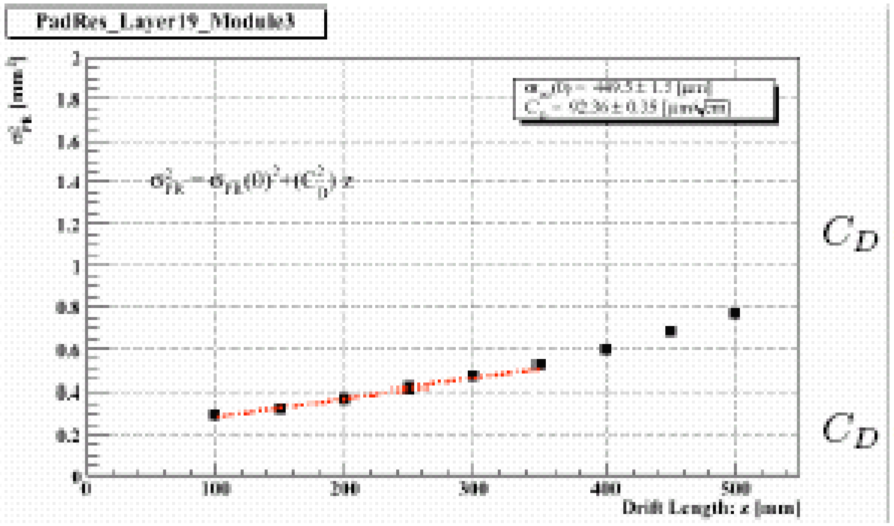
before correction

after correction

Pad Response

$$\sigma_{PR} = \sqrt{\sigma_0^2 + C_D^2 z}$$





Data(<35 cm) provides

$$C_D = 92.7 \pm 0.4 \quad [\mu m/\sqrt{cm}]$$

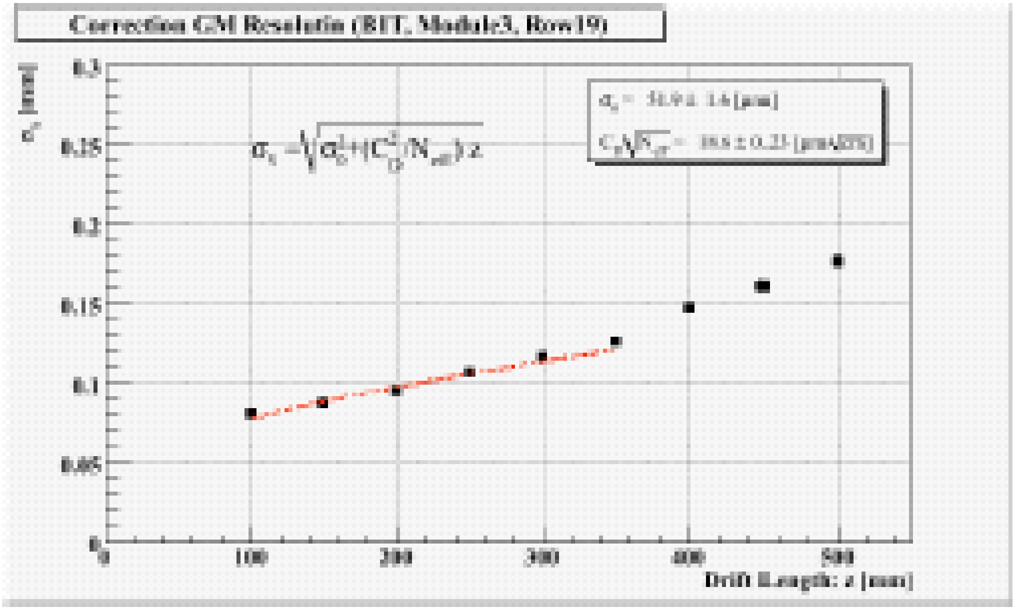
Garfield provides

$$C_D = 93.7 \pm 2.4 \quad [\mu m/\sqrt{cm}]$$

consistent

Long drift distance (>35cm) may suffer large non-uniform B effect
Discard these region from fit

Position Resolution



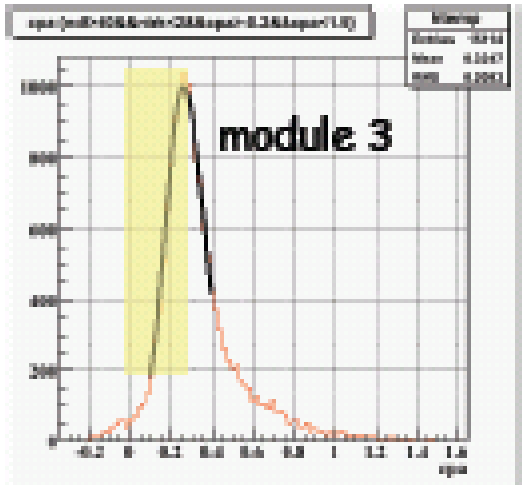
$$\sigma_x = \sqrt{\sigma_0^2 + \frac{C_D^2}{N_{eff}} z}$$

C_D = 92.4 ± 0.4 [μm/√cm]
$C_D/\sqrt{N_{eff}}$ = 18.6 ± 0.23 [μm/√cm]

→ N_{eff} = 24.6 ± 0.5 consistent with small prototype TPC

Momentum Resolution (single module)

κ (1/Pt) distribution at 10cm drift



σ_κ = 0.083 [GeV^{-1}]

$$\sigma_\kappa = \delta\left(\frac{1}{P_T}\right) = \frac{\sigma_x}{0.3BL^2}\sqrt{\frac{720}{n+4}}$$

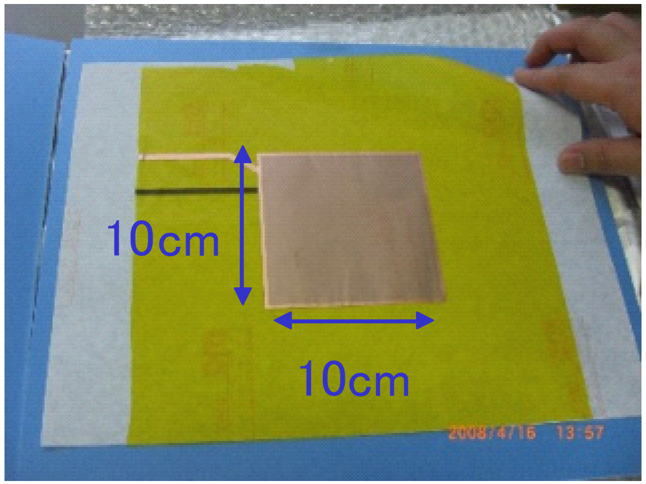
would expect 0.081 [GeV^{-1}] as σ_κ

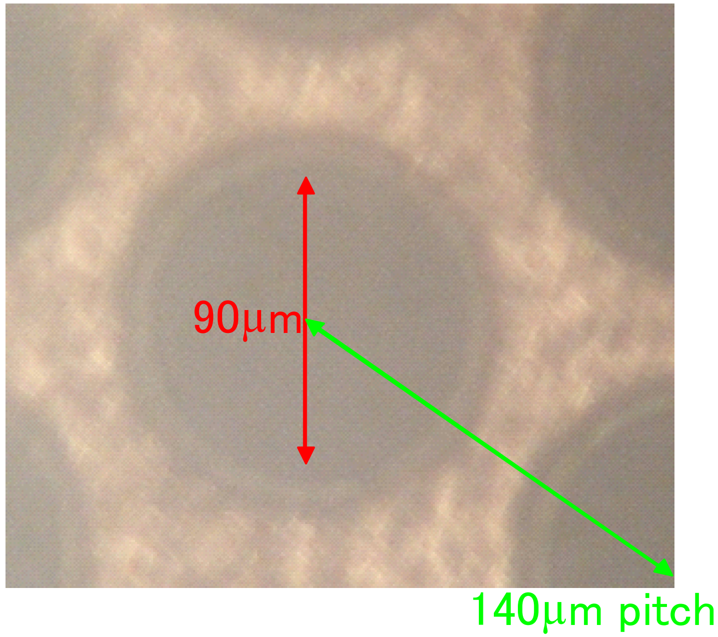
high P side was used to obtain σ

Electron Transmission Measurement

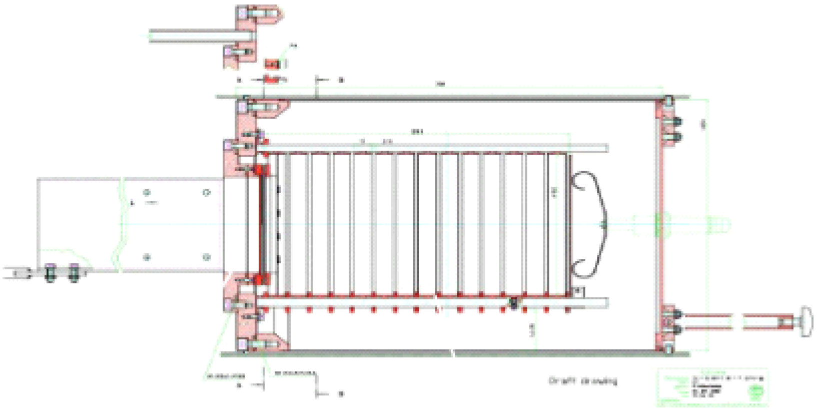
Gate GEM

- 14μm-thick GEM
  - with small prototype TPC and cosmic-ray

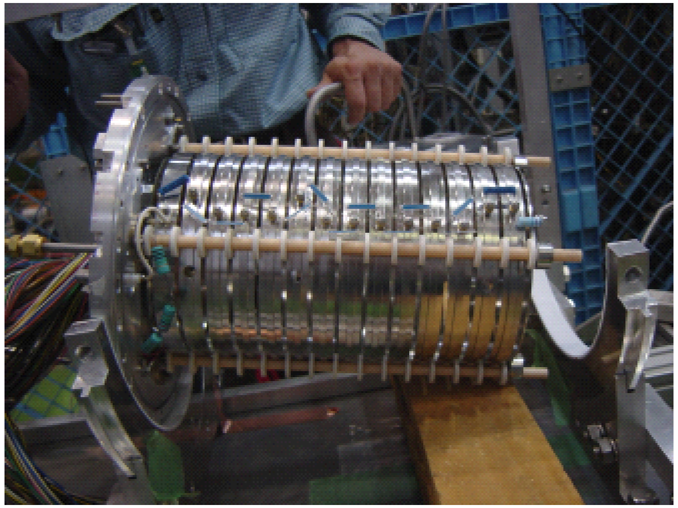


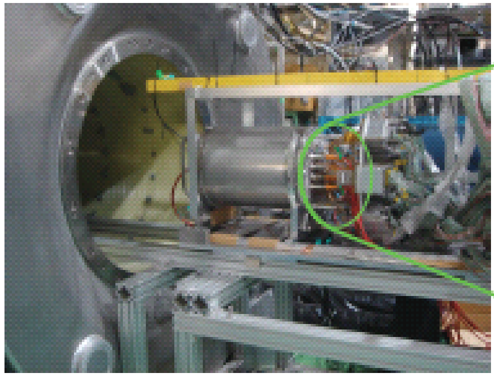


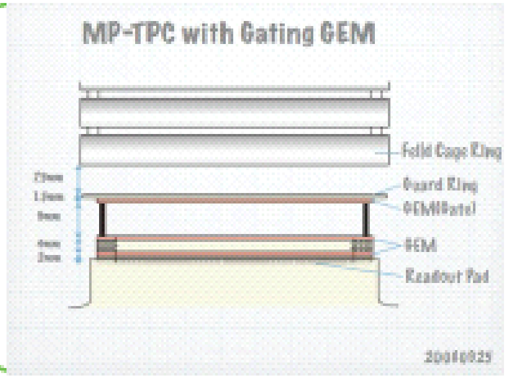
Experimental Setup



- Max. drift length = 254mm
- Pad
  - 1.17×6mm pad (0.1mm gap)
  - 12 pad rows×32pads
- Ar−CF_4−isoC_4H_{10} (95:3:2)
- B = 1T (at KEK C.C.)





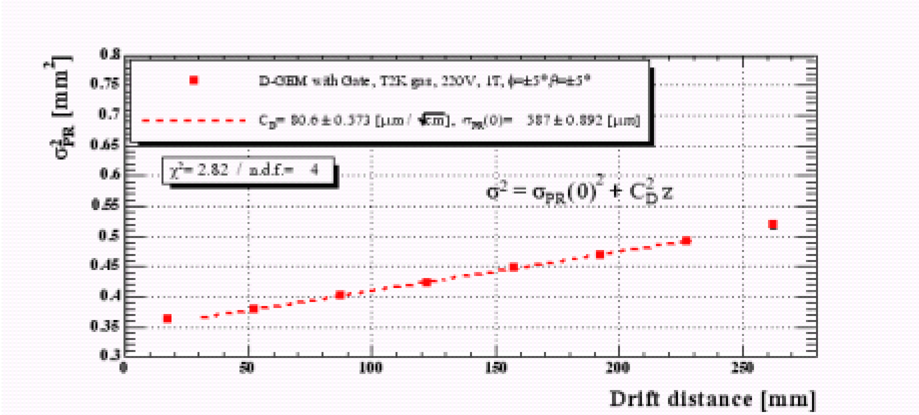


Method of Calculating N_{eff}

Pad respnse

$$\sigma_{PR}{}^2 = \sigma_{PR}(0)^2 + C_D{}^2 z$$

obtain C_D

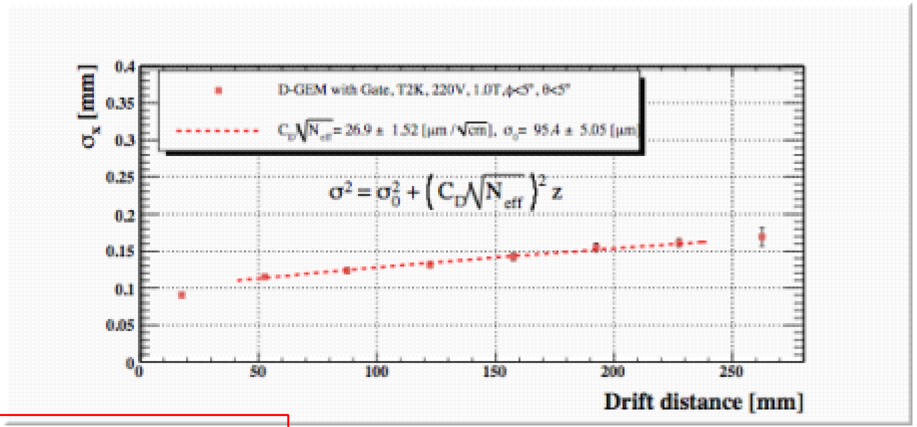


Position resolution

$$\sigma^2 = \sigma_0^2 + \left(C_D / \sqrt{N_{eff}}\right)^2 z$$

Resolution without diffusion

obtain N_{eff} from C_D and inclination

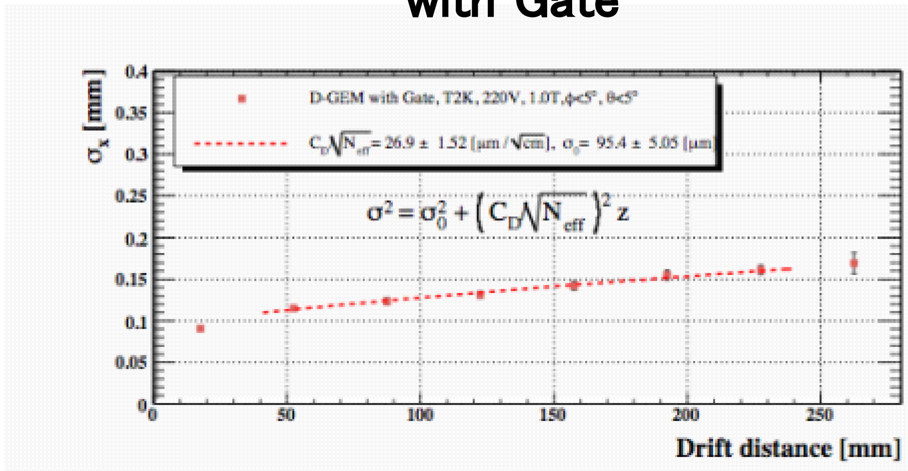


Transmission

E_D = 220 [V/cm]
Vgate = 5 [V]
B = 1 [T]

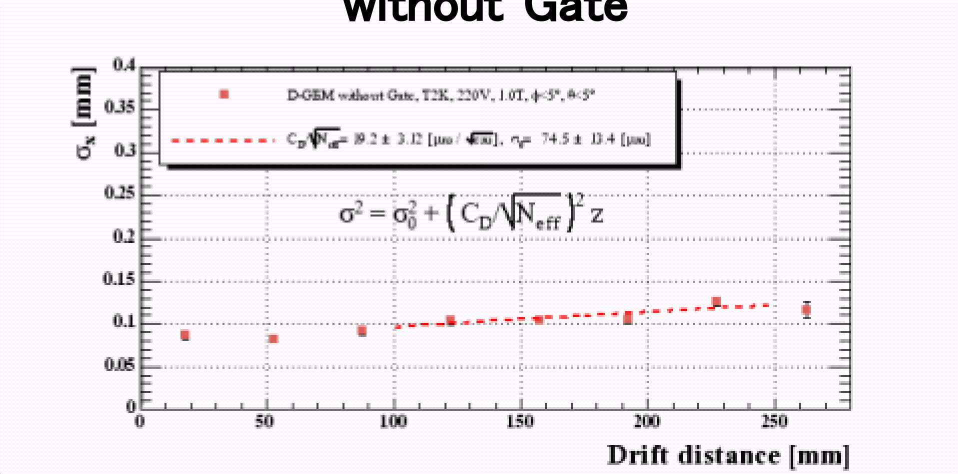
$$\sigma^2 = \sigma_0^2 + \left(C_D / \sqrt{N_{eff}}\right)^2 z$$

with Gate



N_{eff} = 9±1

without Gate



N_{eff} = 18±2

- electron transmissin eff. = 50%

Summary

Goal of the first test was

establish position resolution to be same as one provided from the small prototype

(Gate was skipped as it will provide different result)

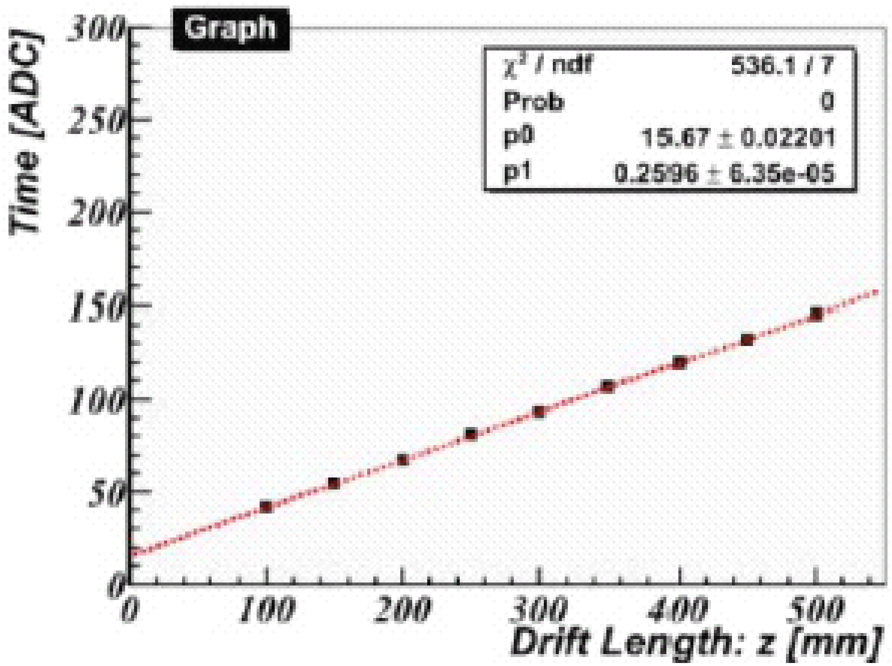
Hardware performance seems to be O.K.,

if local distortion is fixed by putting Gate

Gate is equipped for 4 modules

We have to prepare tracking tool taking non-uniform B field until the next beam test

Drift Velocity



Garfield

Vd = 0.076[mm/ns]

Measurement

Vd = 0.077[mm/ns]

velocity is consistent with garfield