3000ch Asian GEM module test without Gate

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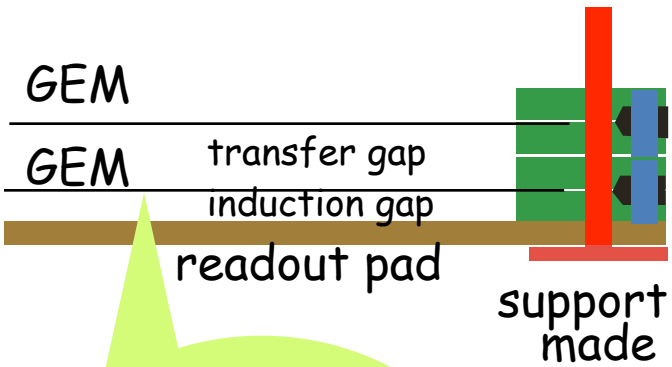
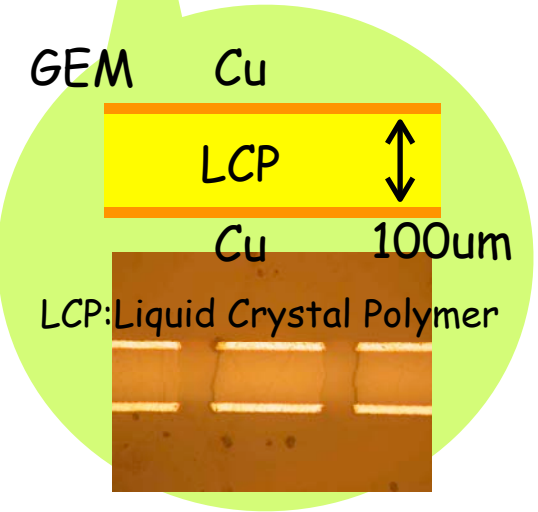
What is Asian GEM module
How data look like
dead channel and unknown
Charge
drift velocity
residual and distortion correction
pad response
position resolution
momentum resolution
problem?
next

Asian GEM module

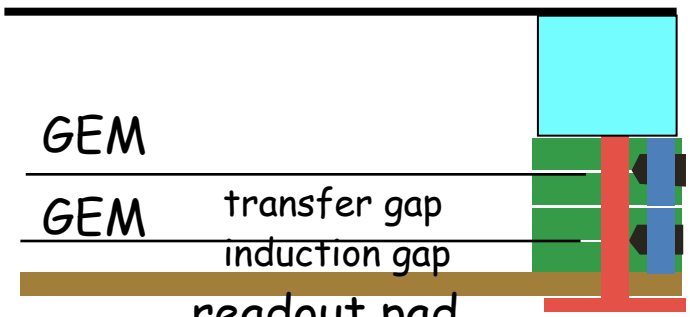
we have used

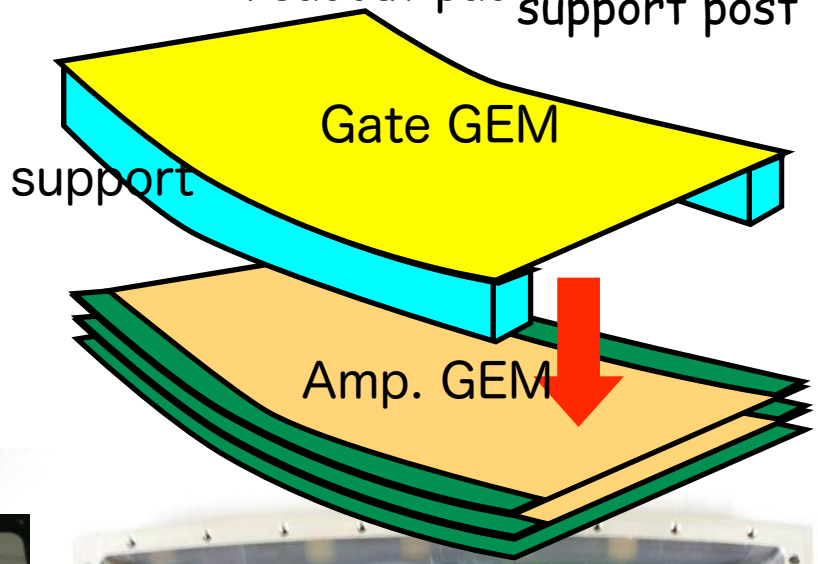
we will use at next



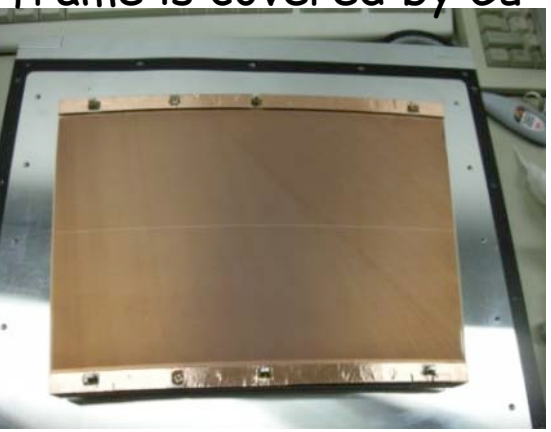


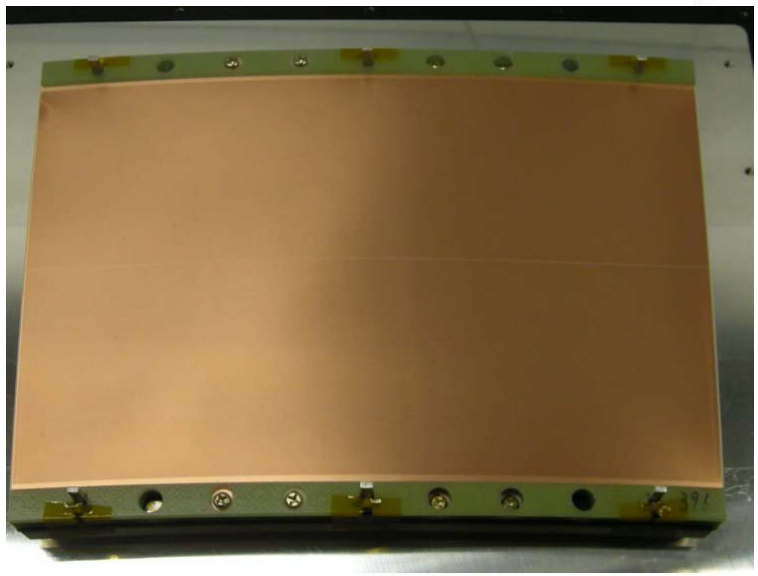
14um Gate GEM

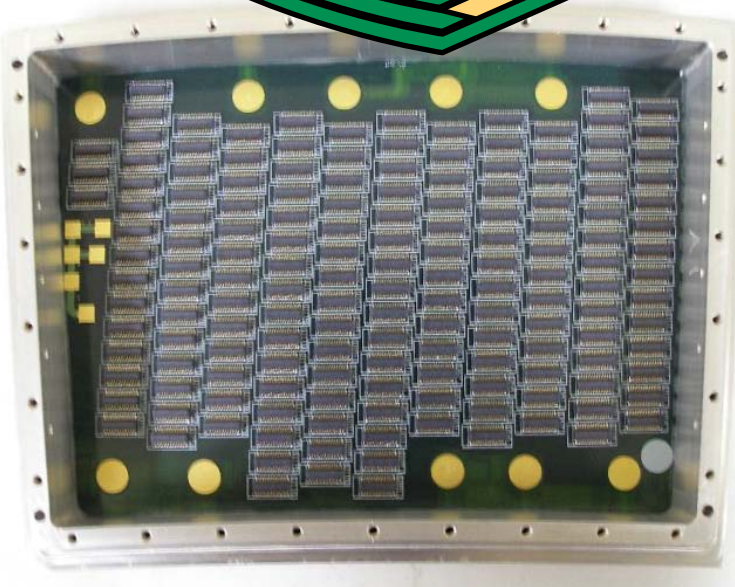




frame is covered by Cu







Test of Asian GEM-module

Note: GEM is not flat on the module.

Jig for GEM framing had incorrect geometry(1 mm longer in radial dir.)

So we cannot stretch GEM enough.

improper fabrication makes situation worse.

You may not believe, but GEM was stretched better at the pre-prototype.

Current situation is a kind of mistake at fabrication

not due to conceptual design

LP1 beamtest 2009

Jan. Start to use ALTRO RO electronics in Japan

Feb. Start setting up module+ALTRO at DESY

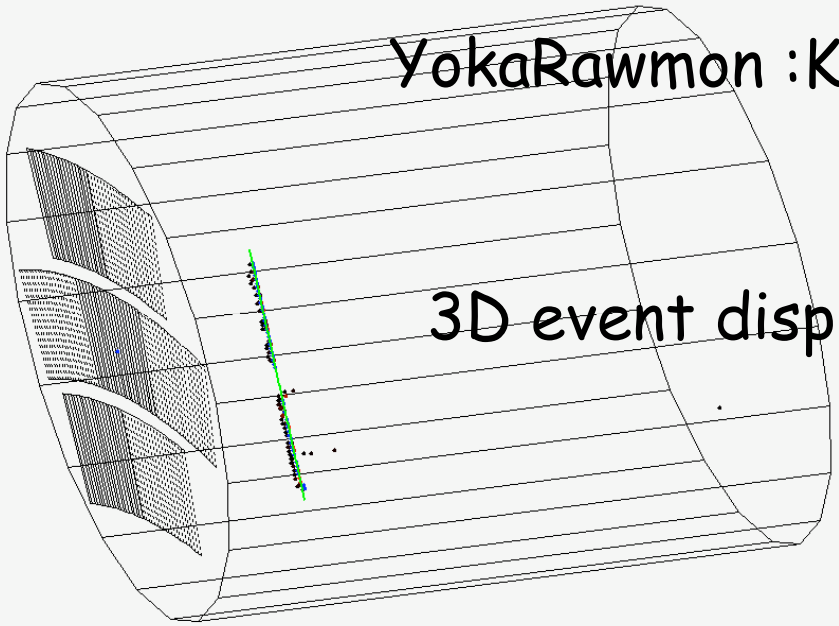
Mar. Beam on Central mod. was dead (HV connection)

Apr. Beam on module modified (module 6 was bad) ← today's talk

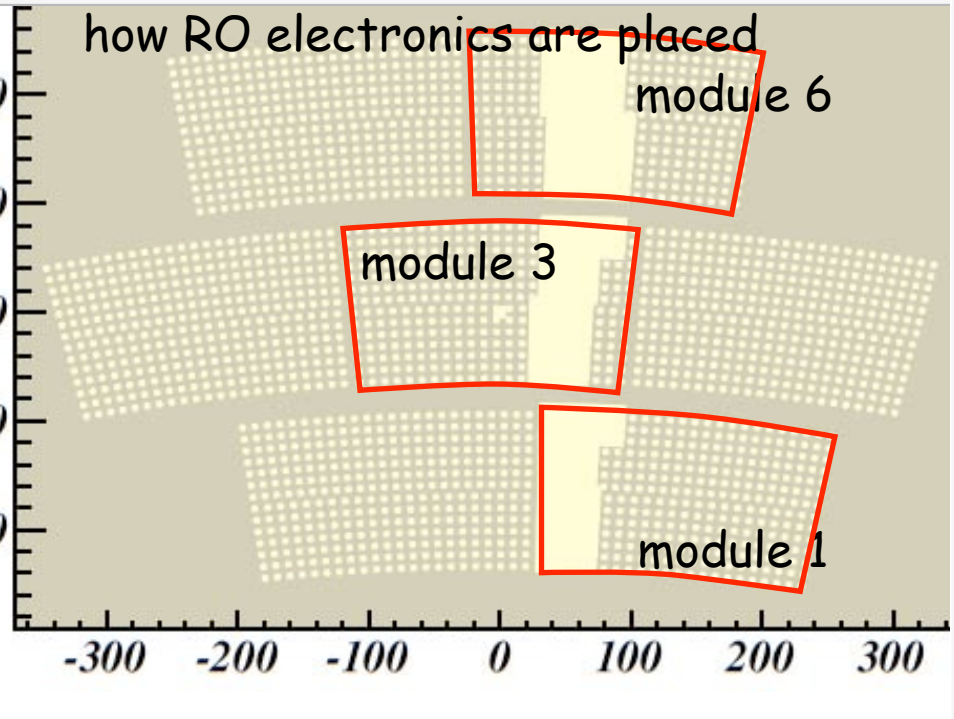
Jul. Lund group takes 1 module data with updated Altro system

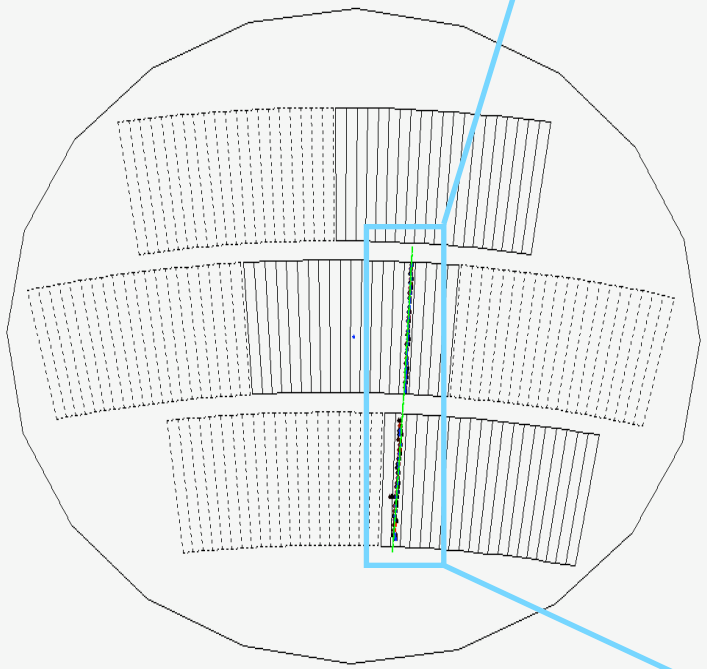
how data look like

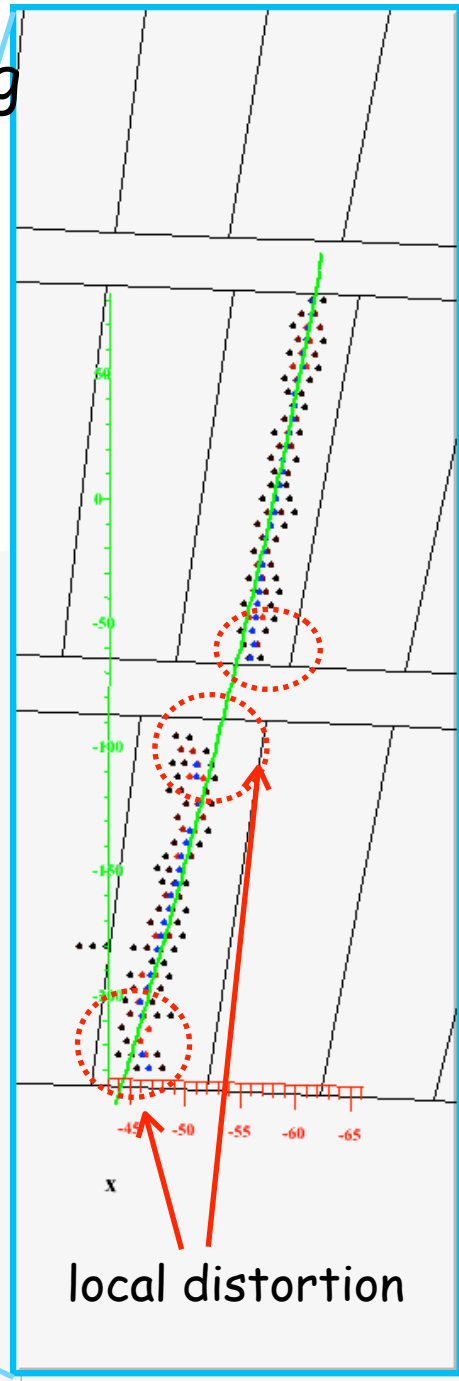
YokaRawmon :Kalman filter based tracking



3D event display







dead channel

We found 6 dead channels

module 1 L18-P16~18, L19-P16

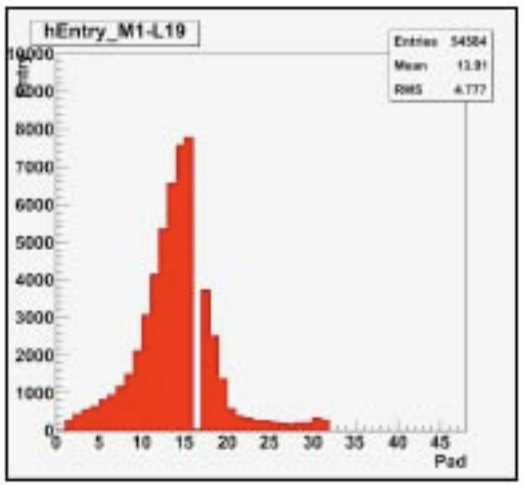
module 3 L01-P127, L11-P128~129

bad connection

module 1 L03 P-0~15, L09-P0~15

(signal exist but rate is very low)

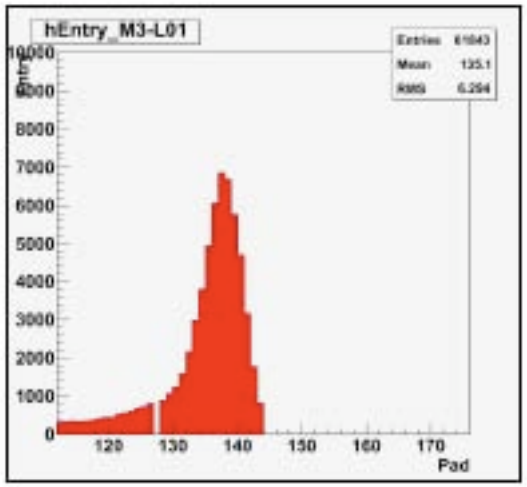
~0.2% dead



Module 1

Layer 19

Pad 16



Module 3

Layer 1

Pad 127

These layers are removed from analysis

Charge/layer

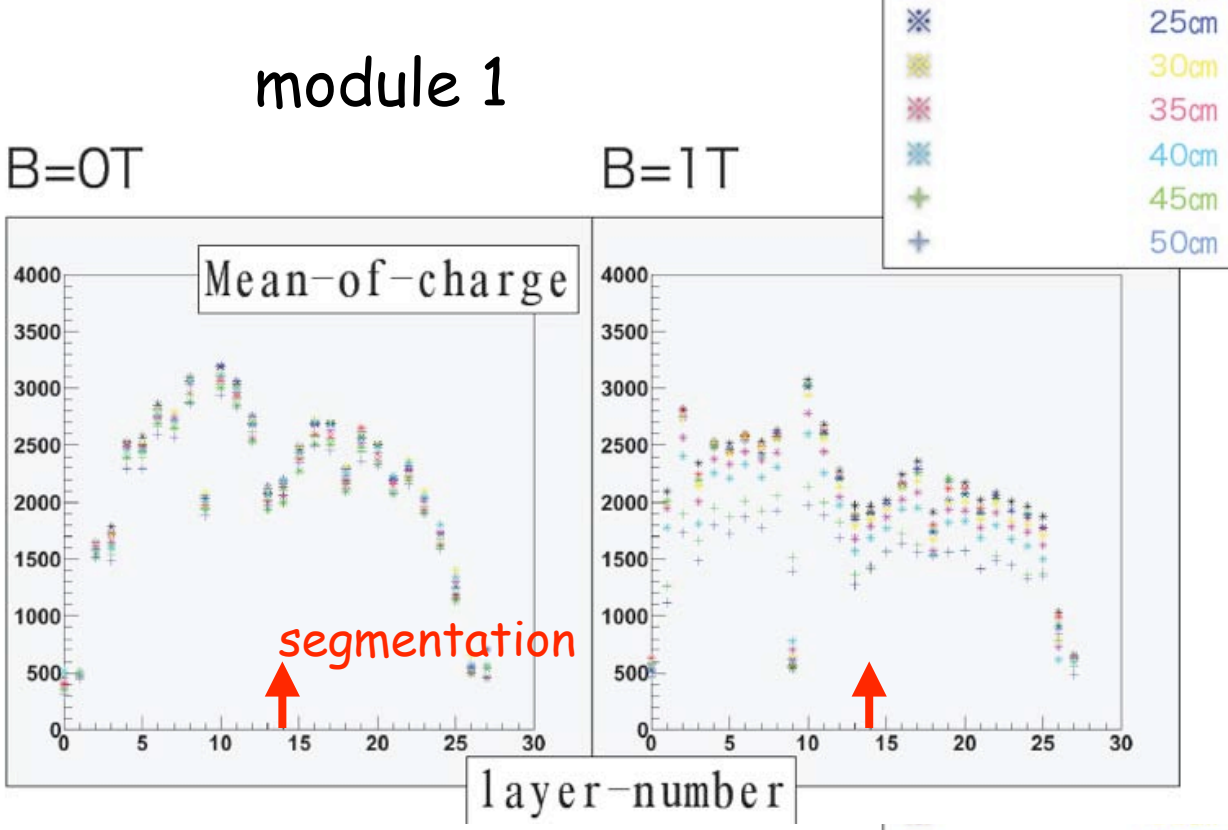
E-field distortion reduce charge near boundary for mod. 1 at B=0T

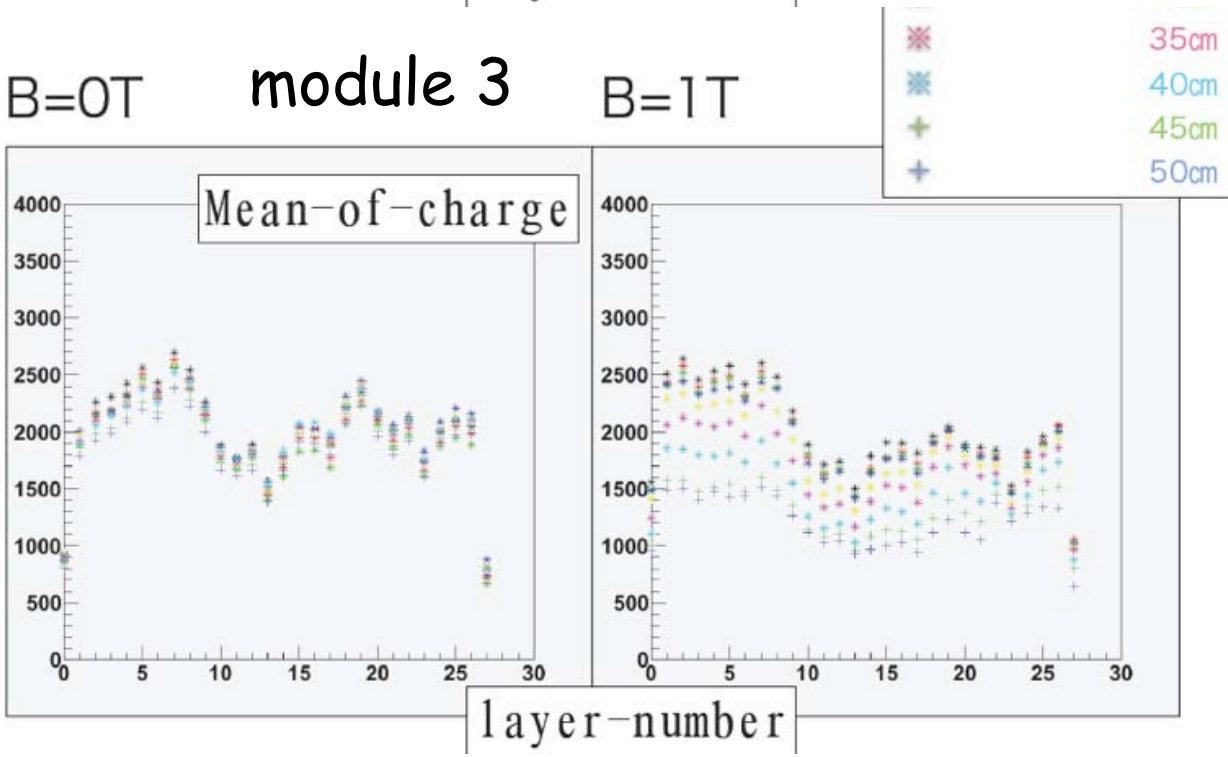
No clear dependence on drift distance.

Reduced charge might be recovered by B=1T (due to ExB ?)

Clear dependence on drift distance.
Why ??

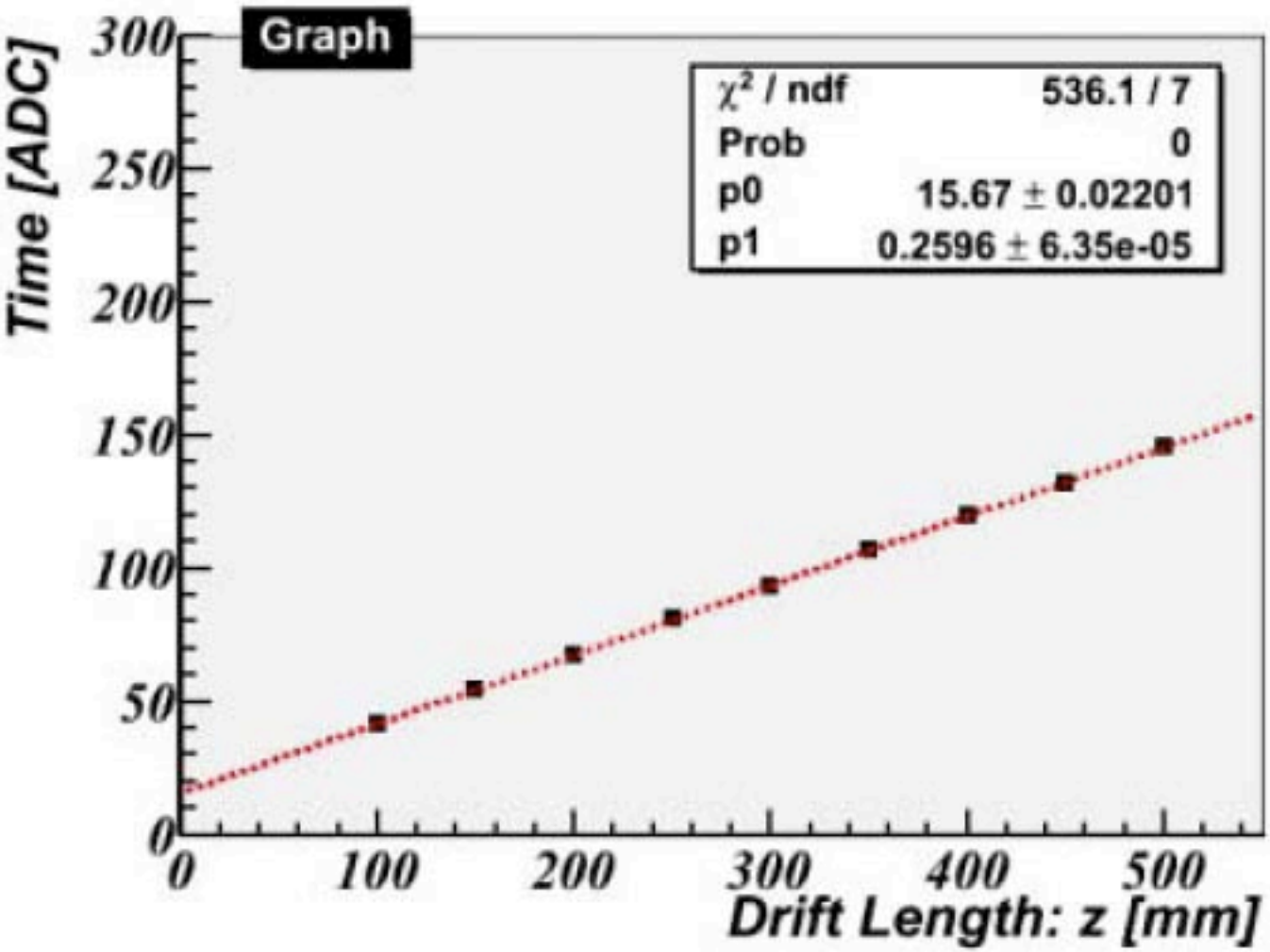
No tracking information
track may bend away to insensitive area !?





Drift velocity

is consistent



Garfield

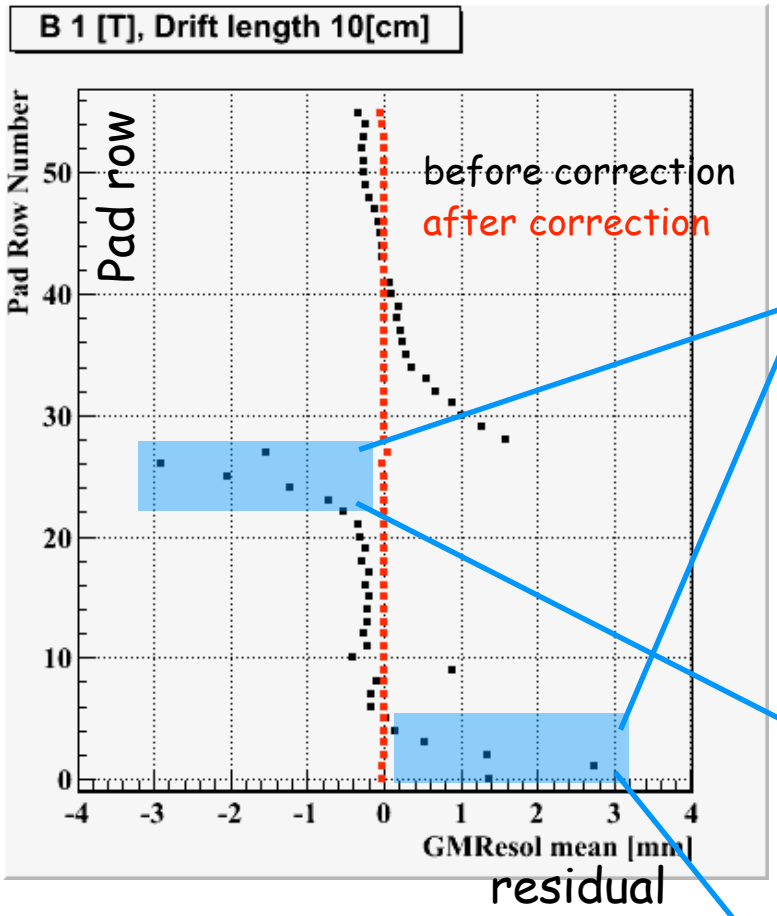
Vd = 0.076[mm/ns]

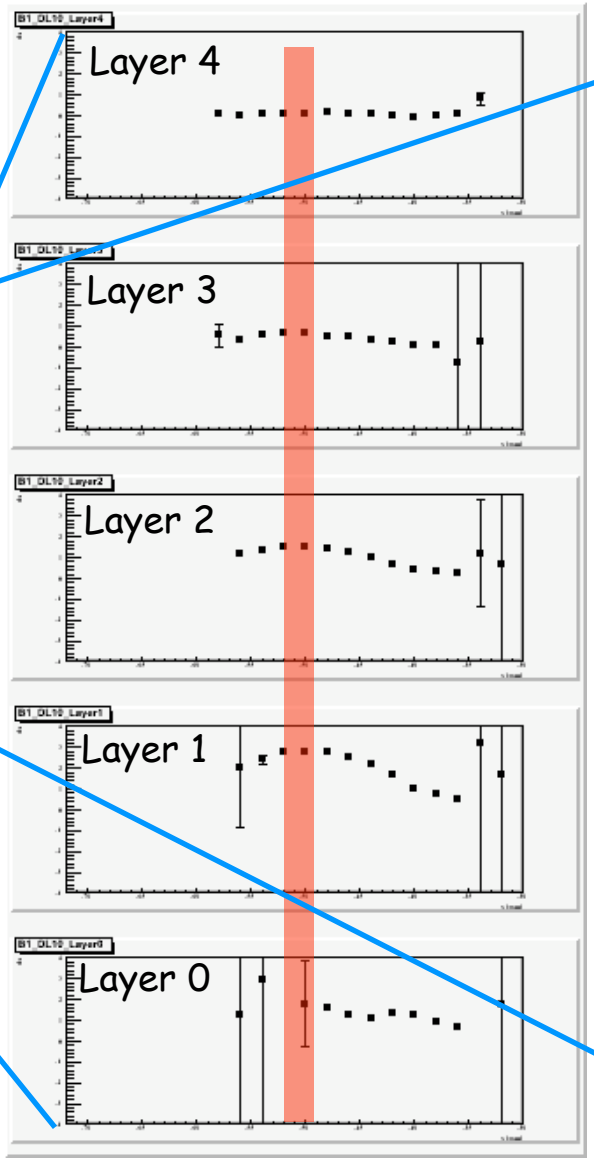
Measurement

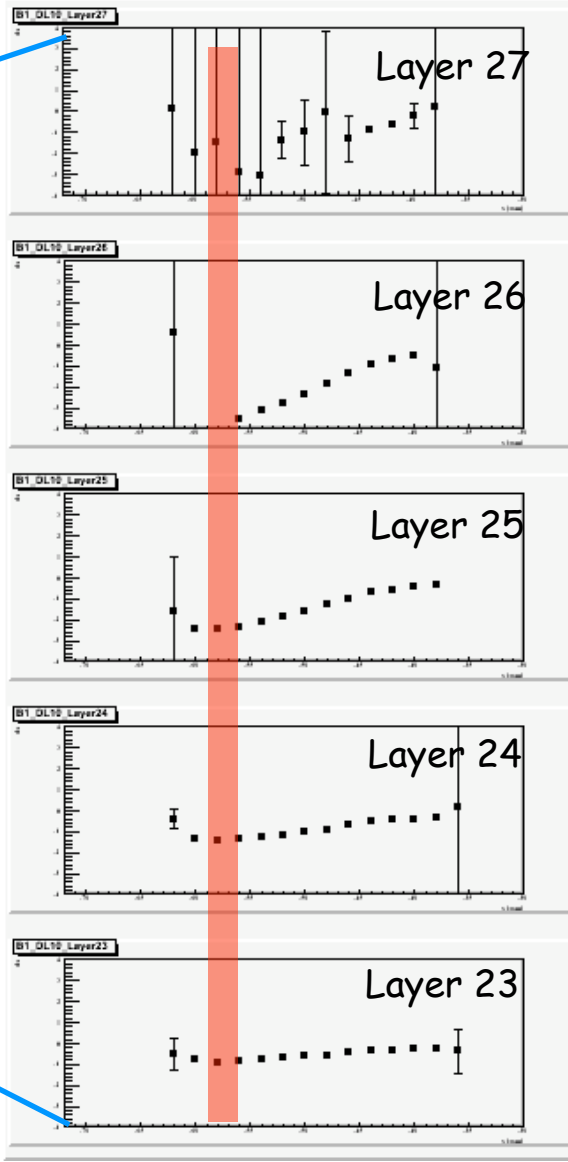
Vd = 0.077[mm/ns]

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

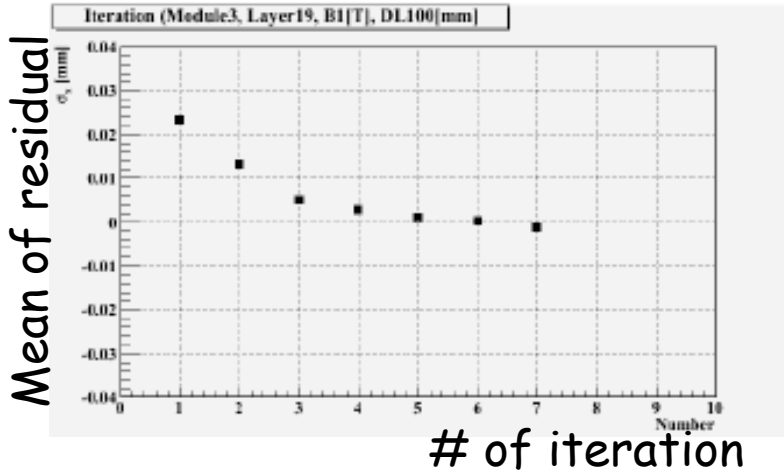




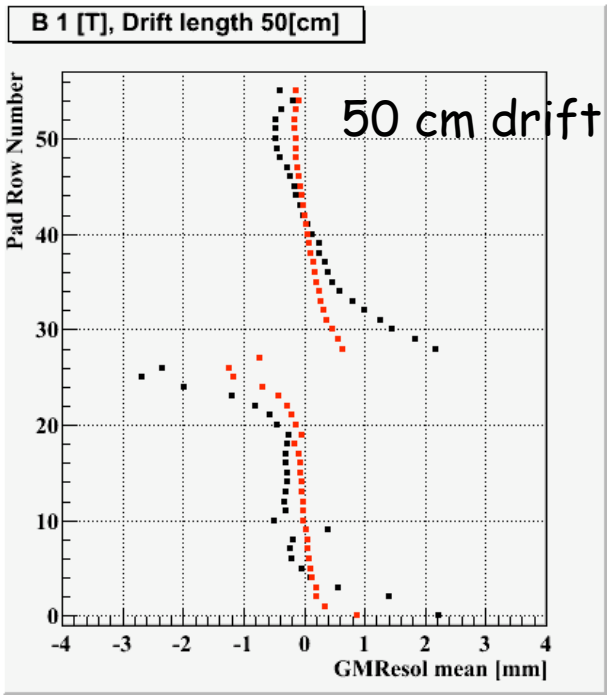


This correction includes
relative module alignment.

No constraint on curvature is applied in fitting.
The same procedure is repeated 5 times for each data.
(5 seems to be get stable result)



Correction obtained at 10cm drift



is applied to all data for following analysis

This correction includes relative module alignment.

Data at 50 cm drift shows clear deviations even after correction
(we could recognize deviation for drift > 35 cm)
due to variation of magnetic field at long drift.

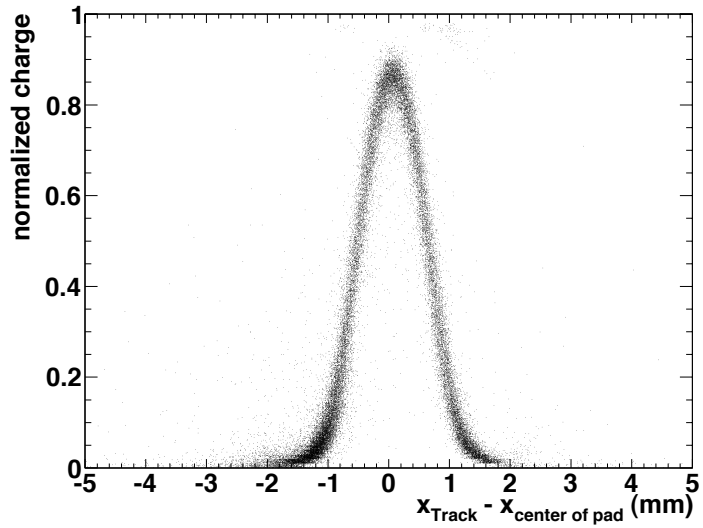
Metal posts facing drift volume produce local distortion.

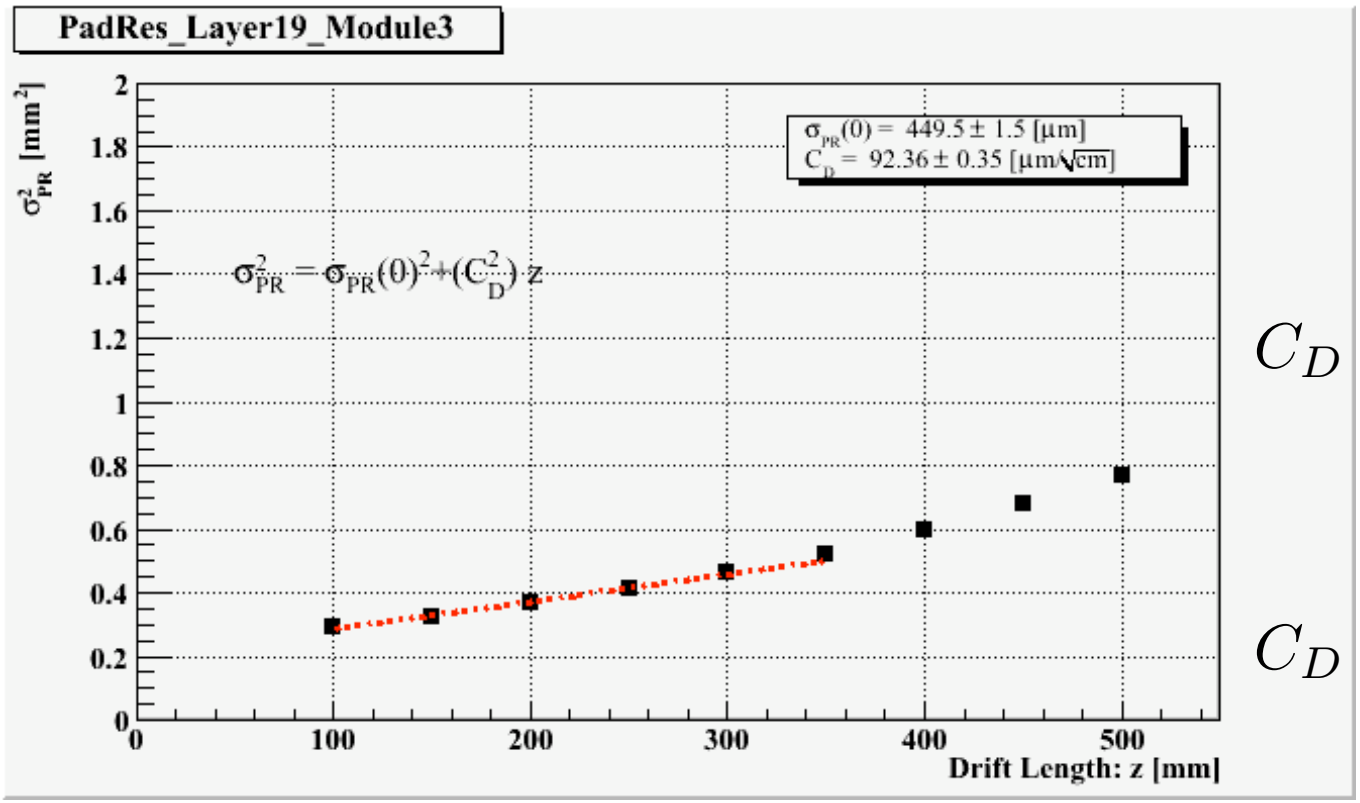
Displacing TPC in PCMAG for drift distance dep.
introduce different B field for each drift.
as moving stage was not available

Combination of 2 problems make the situation very complicated

Pad response

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





Data(<35 cm) provides

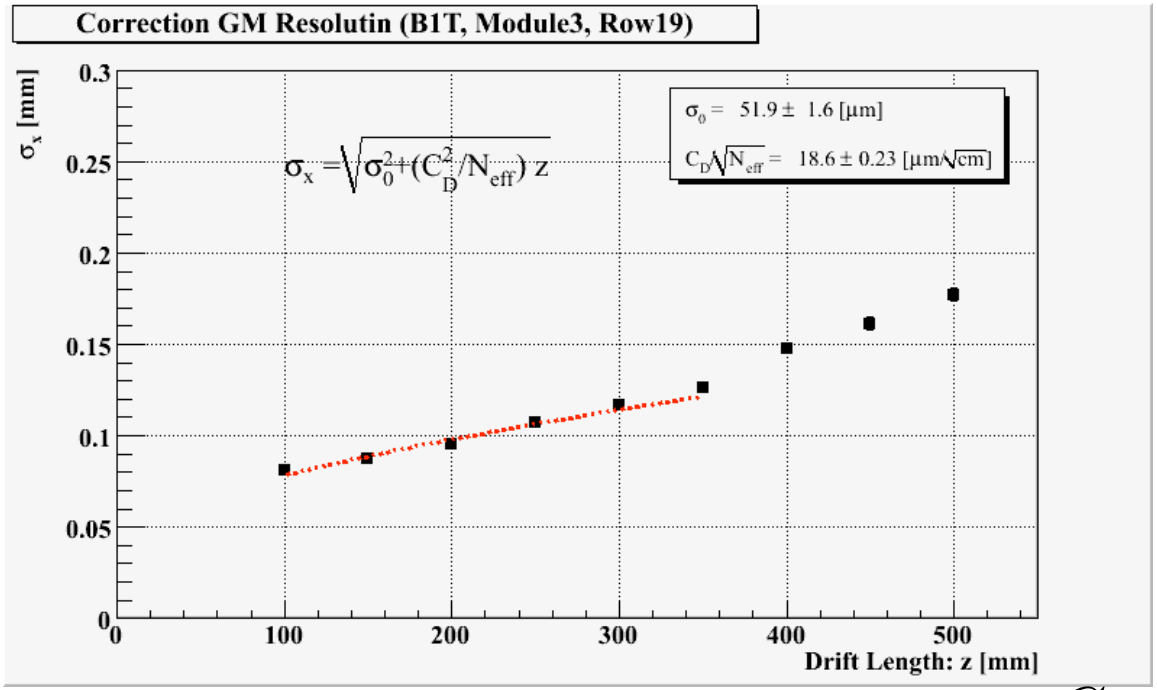
$$C_D = 92.7 \pm 0.4 \quad [\mu m/\sqrt{cm}]$$

Garfield provides

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

Drift distance >35cm may suffer large non-uniform B field effect.
Discard these region from fit

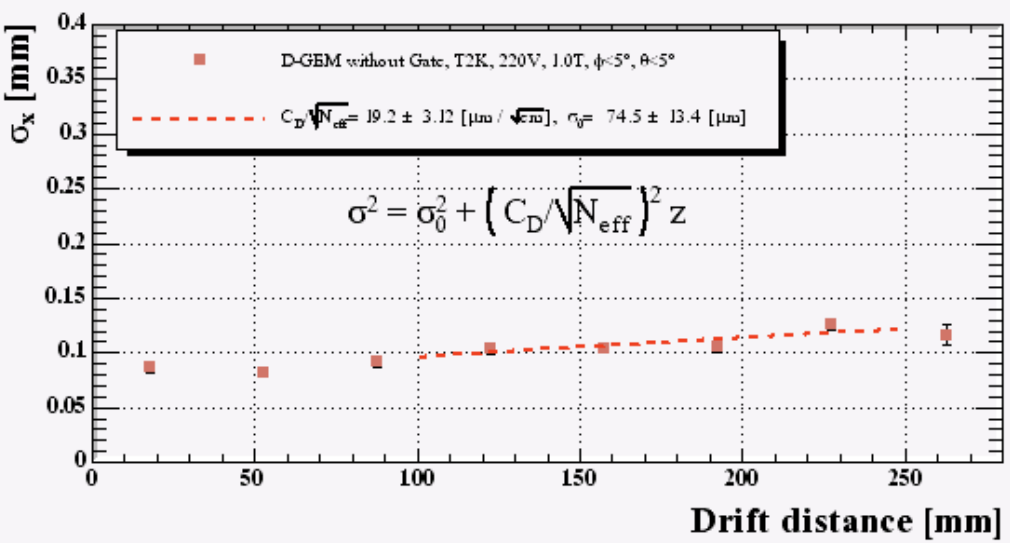
Position resolution



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

$$C_D/\sqrt{N_{eff}} = 18.6 \pm 0.23 \quad [\mu m/\sqrt{cm}]$$

$$N_{eff} = 24.6 \pm 0.5$$



Resut from small Prototype(MPTPC) with same condition except electronics

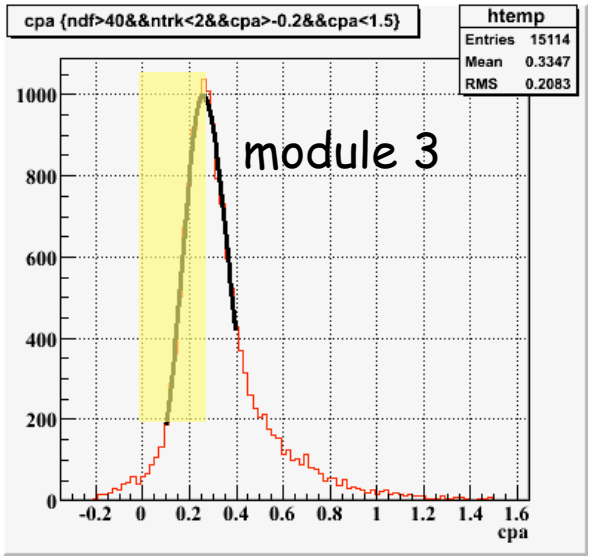
momentum resolution

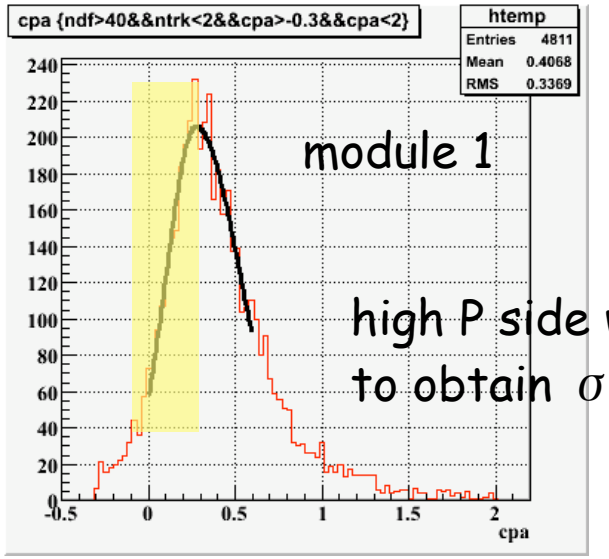
single module

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

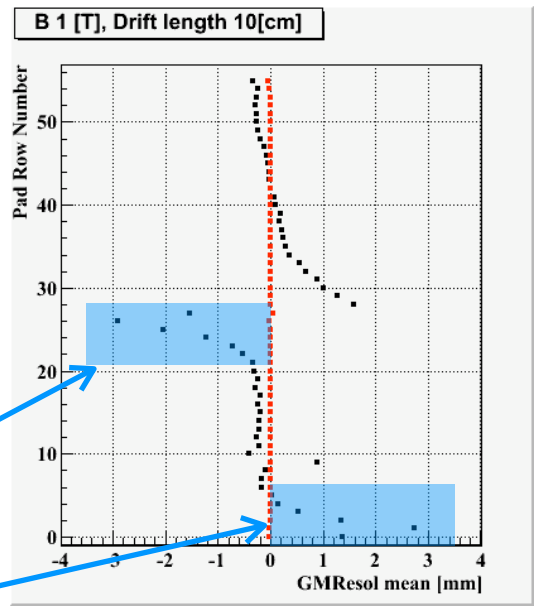
κ (1/Pt) distribution at 10cm drift

would expect 0.081 [GeV^{-1}] as σ_κ





high P side was used to obtain σ



σ_κ = 0.083 [GeV^{-1}]

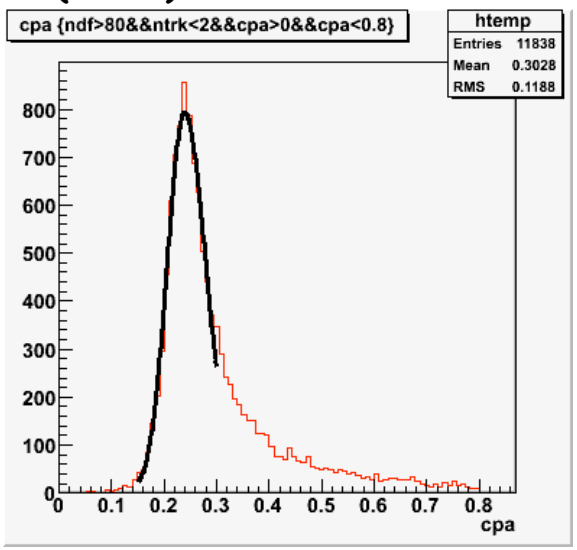
σ_κ = 0.17 [GeV^{-1}]

Poor resolution for module 1

- largely displaced layer by ExB would not contribute to momentum resolution as "track" pass through layer with angle effectively (angular pad effect)
- module 1 is away from PCMAG center, so non-uniform B effect may be large

Two module fit

κ (1/Pt) distribution at 10cm drift



$$\sigma_\kappa = 0.032[GeV^{-1}]$$

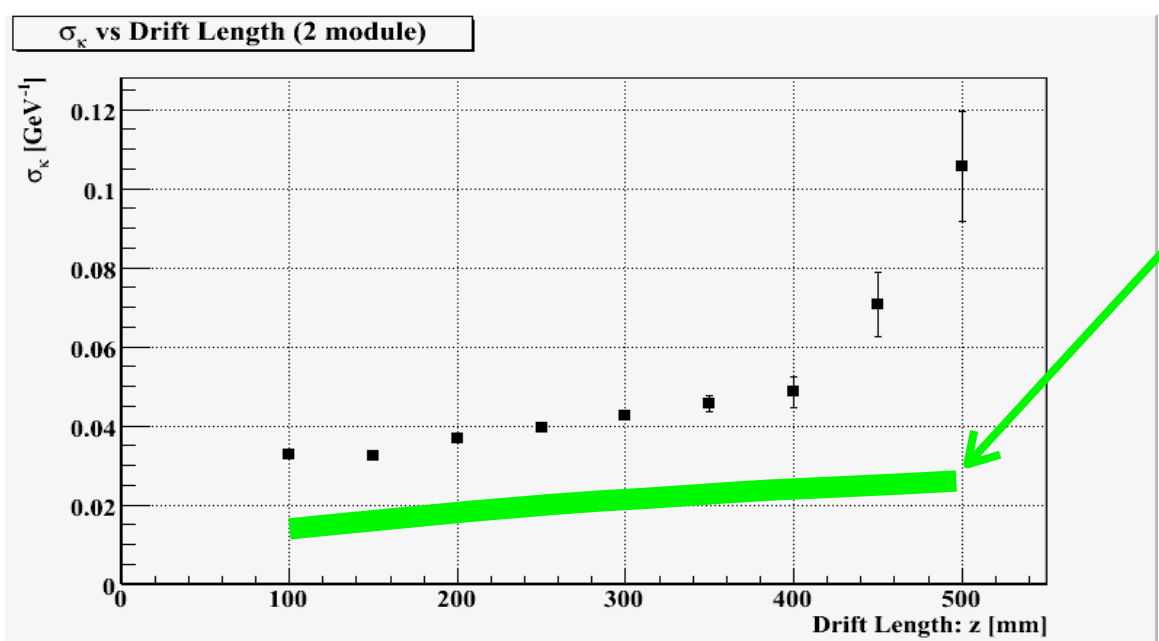
Naive formula expect to be 0.0128 [GeV^{-1}]

due to ExB distortion -> angular-pad effect

poor local resolution

non-uniform B field

momentum resolution as a fcn of drift distance



It must behave like this

same as position resolution

if B is uniform and

no distortion exist

Can we recover resolution

with a treatment of

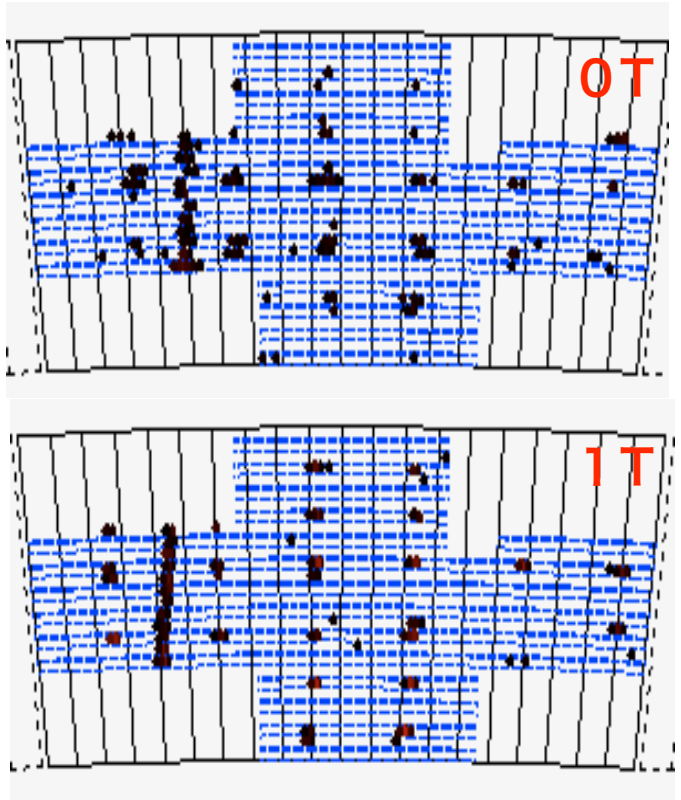
non uniform B field ??

Issue of LP1 study

What is this effect ?

July run contains data taken with Laser cal.

This is quick look by Ryo Yonamine.
(no detail analysis yet)



straight line is bended with B=1 T
event at middle region (away from post)
while it is somewhat being expected at B=0

Detail study is necessary!!

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)

make software tool, correction methods ready

for momentum resolution study

Hardware performance seems to be OK,

if local distortion is fixed by putting Gate

We have to prepare Tracking tool taking non-uniform B field

until the next beam test.

What will we do
at the next beam test ?

period

2010 Jan.~ Feb. set up and beam w/o B field

2010 Mar.~Apr. data with B field

a few weeks shift are expected from the prev. exp.

What will we do?

the final test(?) using 10K RO channels

full setup..... Gate is equipped for 4 module

momentum resolution using non-uniform B field map

YokaRawmon ? or Marlin-TPC ?

boundary effect