GEM TPC Large Prototype Beam tests

This talk is heavily dependent on Akira Sugiyama's presentation at TILC09 held about a month ago, but R.Y. is the one who is responsible for any error you might find in this talk.

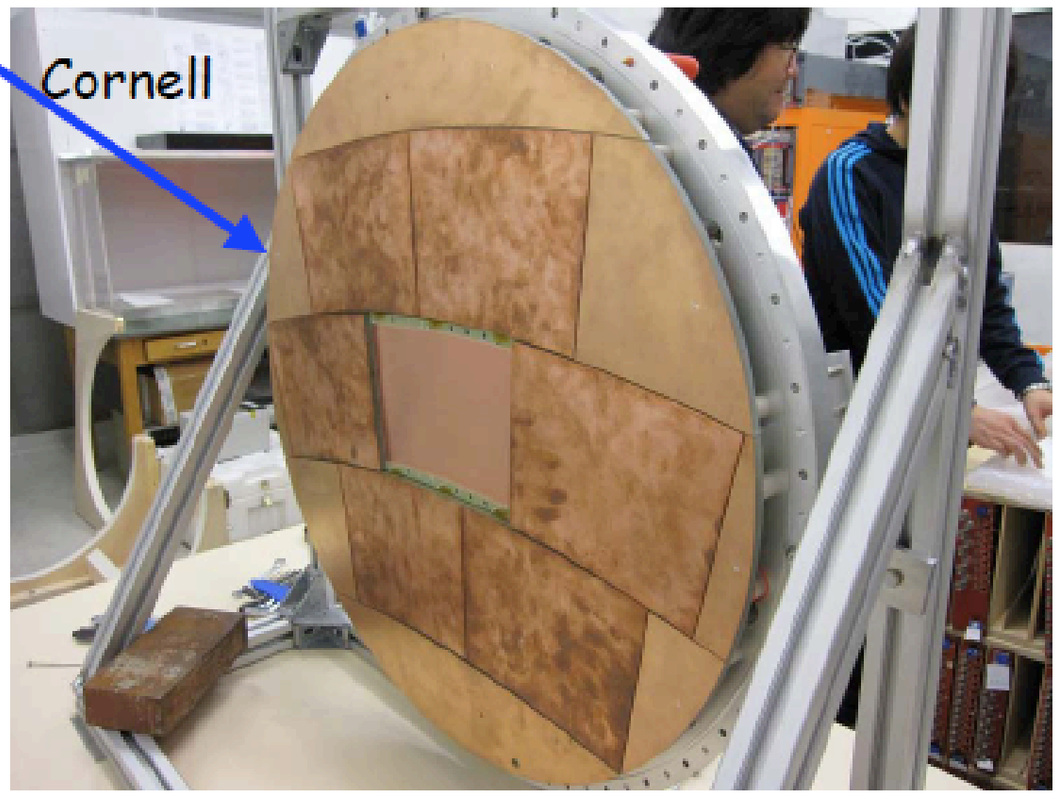
R. Yonamine
on behalf of part of LC-TPC collaboration

Large Prototype test (based on EUDET facility)

Concept

Modules(GEM, MM, +TimePix)
Asia, Saclay/Canada, NIKHEF,Bonn,,,,,
+
Field cage
End Plate
Magnet
calibration
Victoria

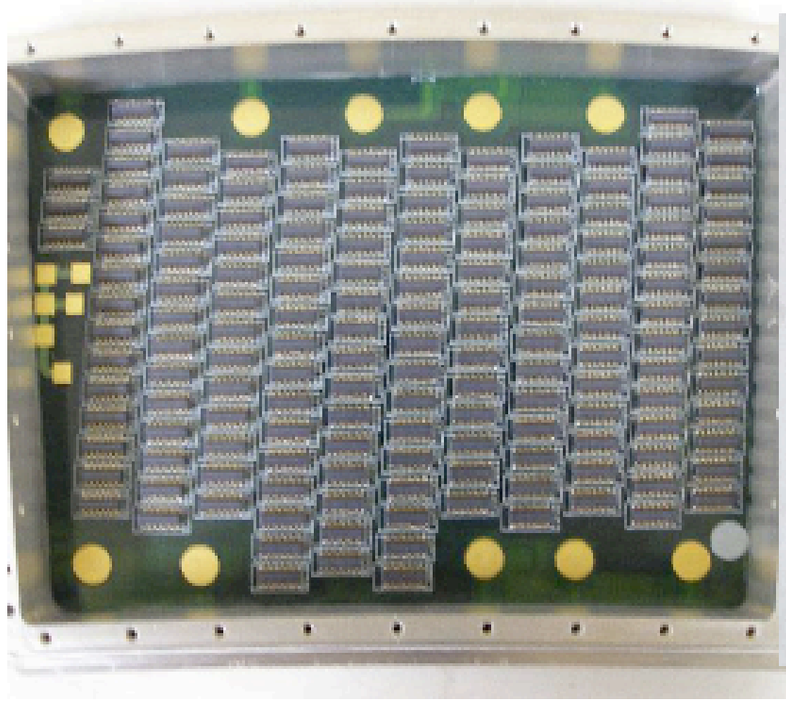
DESY II T24 area

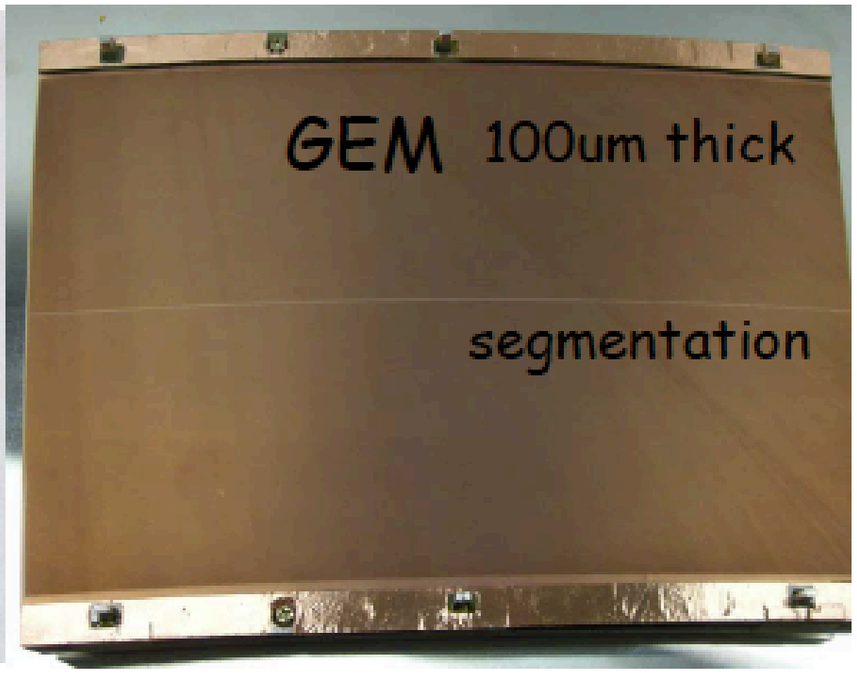


GEM module

conceptual design

minimize insensitive area pointing IP between modules (limited frame)





Bunch of tiny connectors
(40 pins) 161 connectors

all other space for HV supply
+ Back Frame

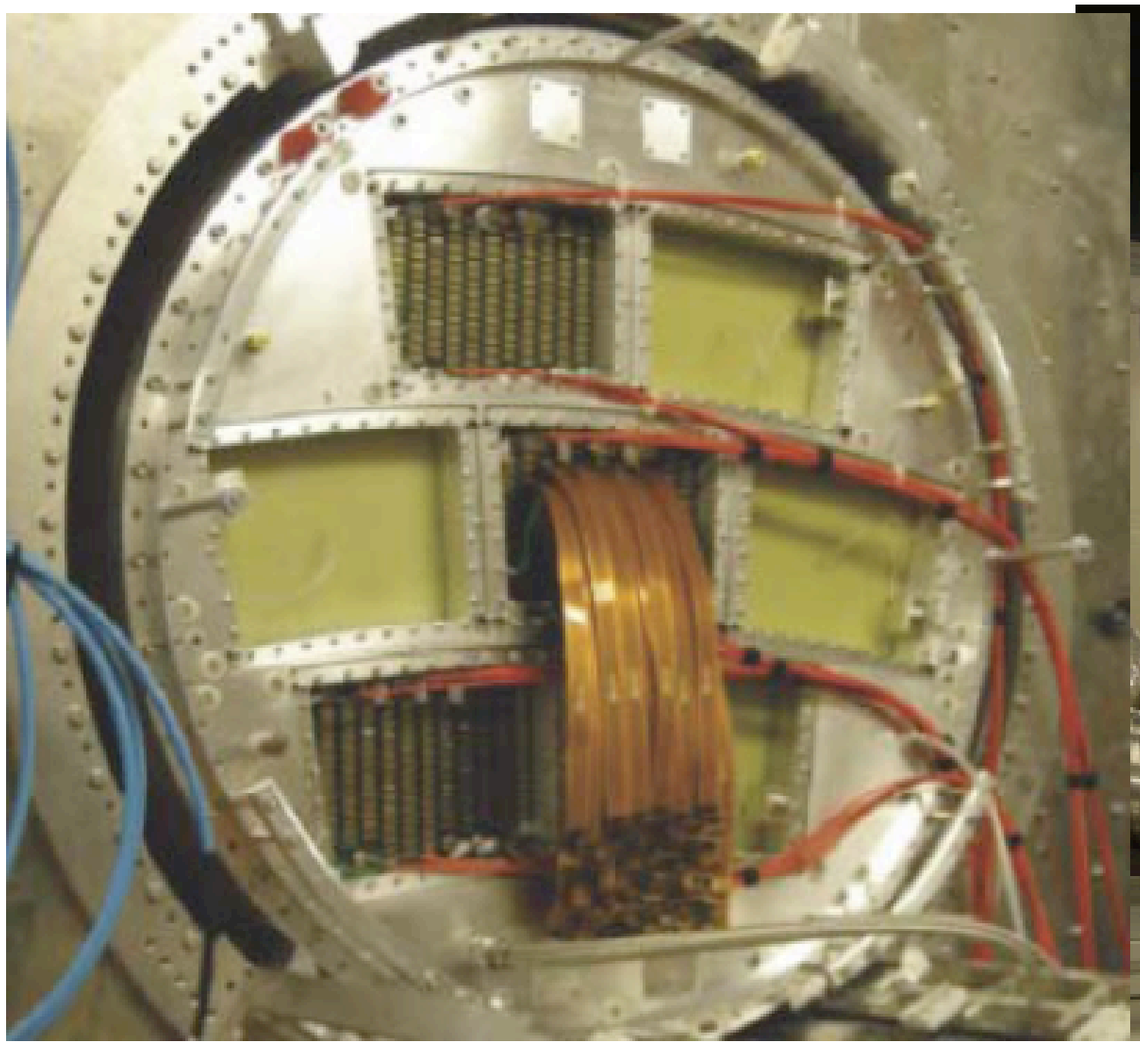
28 pad raws (176/192 pads/raw)
~1.2(w) x 5.4(h) mm^2
staggered every each layer

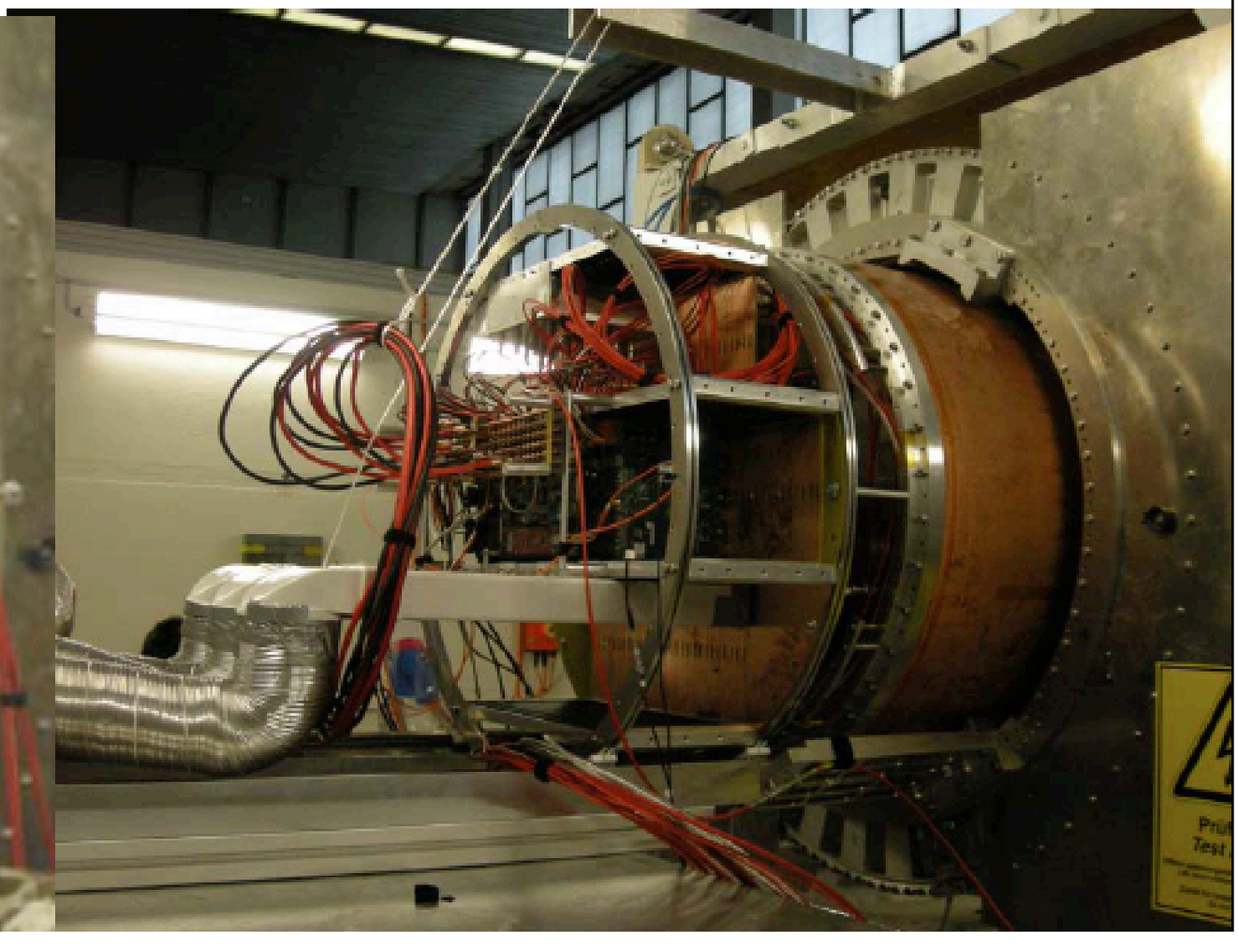
Total 5,152 ch/module

Gate GEM (14um thick) will be on top of the module

3,200 channels are available now

summer 2009 10,000 channels ready





BeamTest

Feb.1st ~ Mar.6, 2009
Mar. 23 ~ Apr. 8, 2009

shift @ Apr.1st,2009

GEM module　without GATE

4 modules made

3 modules are installed to LP1/EP

RO electronics are equipped to 2/3 connectors/raw on 84 raws

lever arm　~50 cm

5 GeV/c beam

T2K gas ($Ar:CF_4:isoC_4H_{10}/95:3:2$)

E_{drift} ~ 230V/cm

establish (good) local resolution at LP1

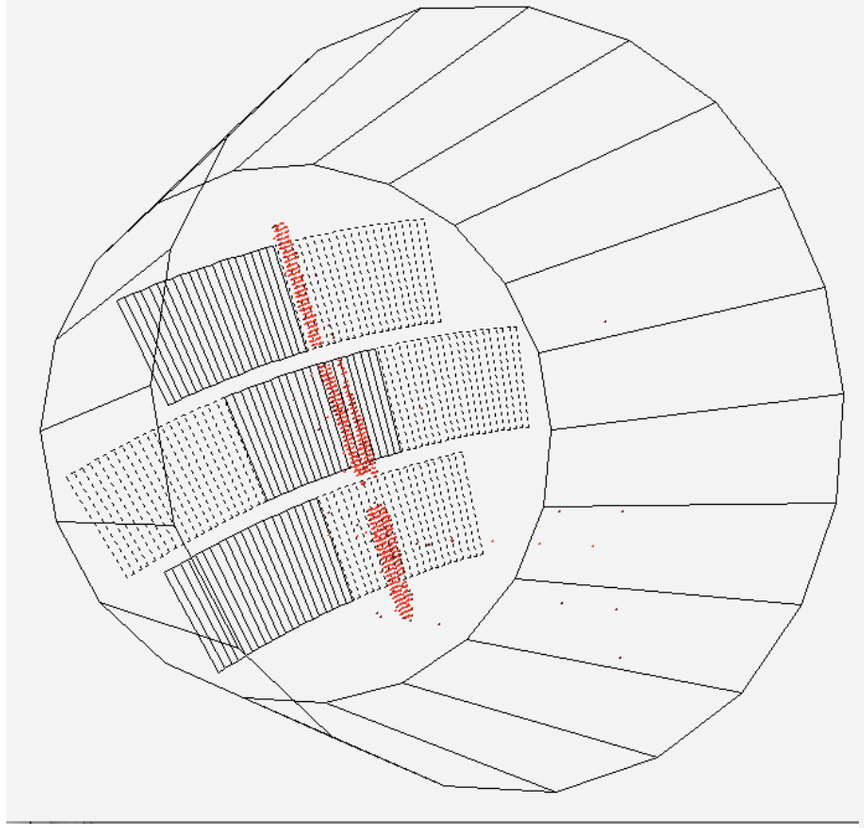
extend this performance to all over the whole module

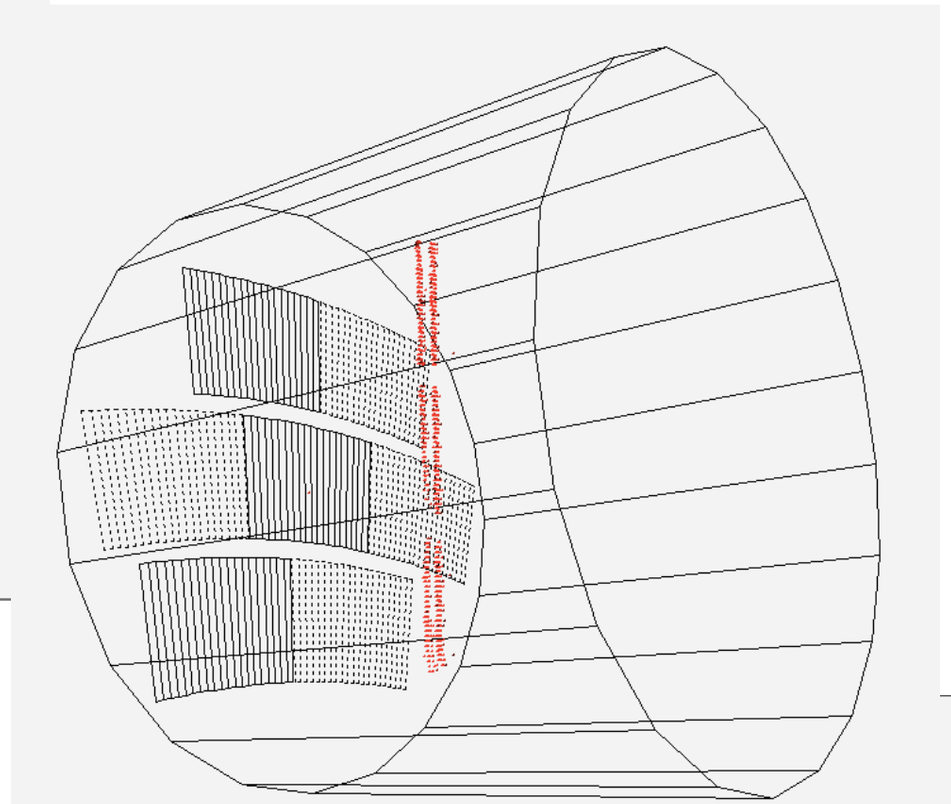
inter module correction/alignment

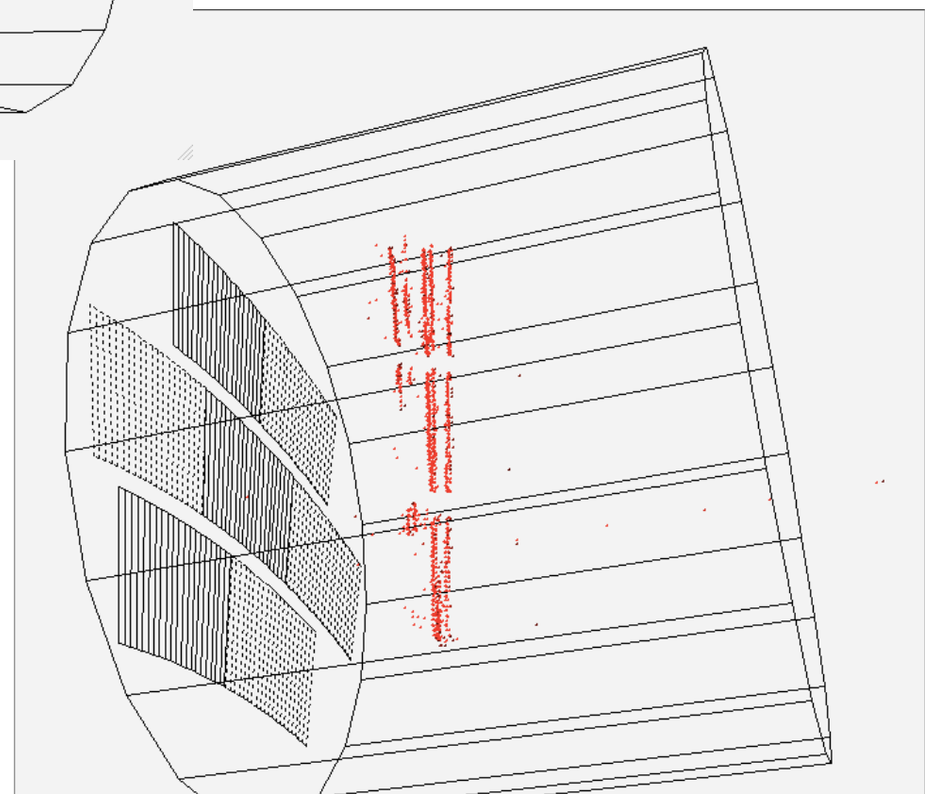
-----> momentum resolution/efficiency,,,,,,

realistic performance

Sample Event Display

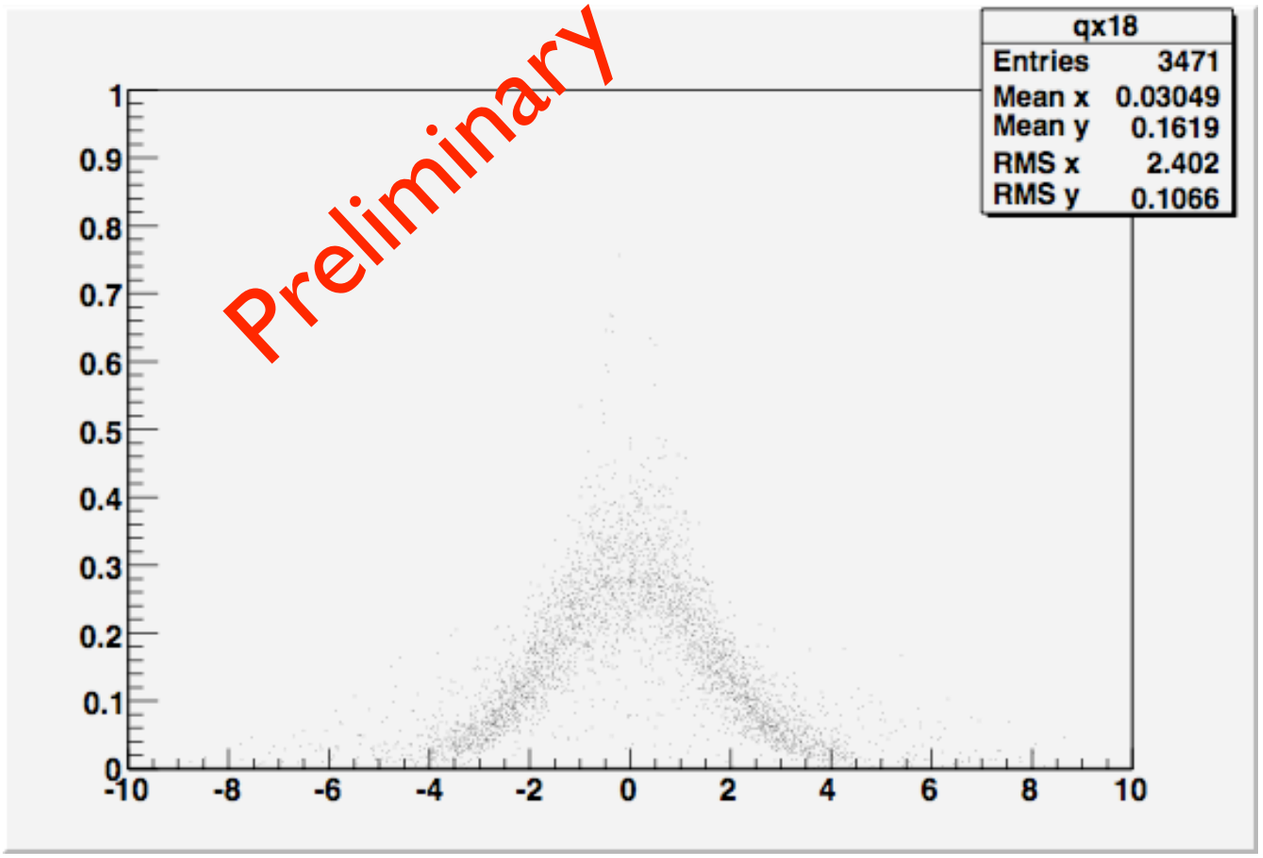


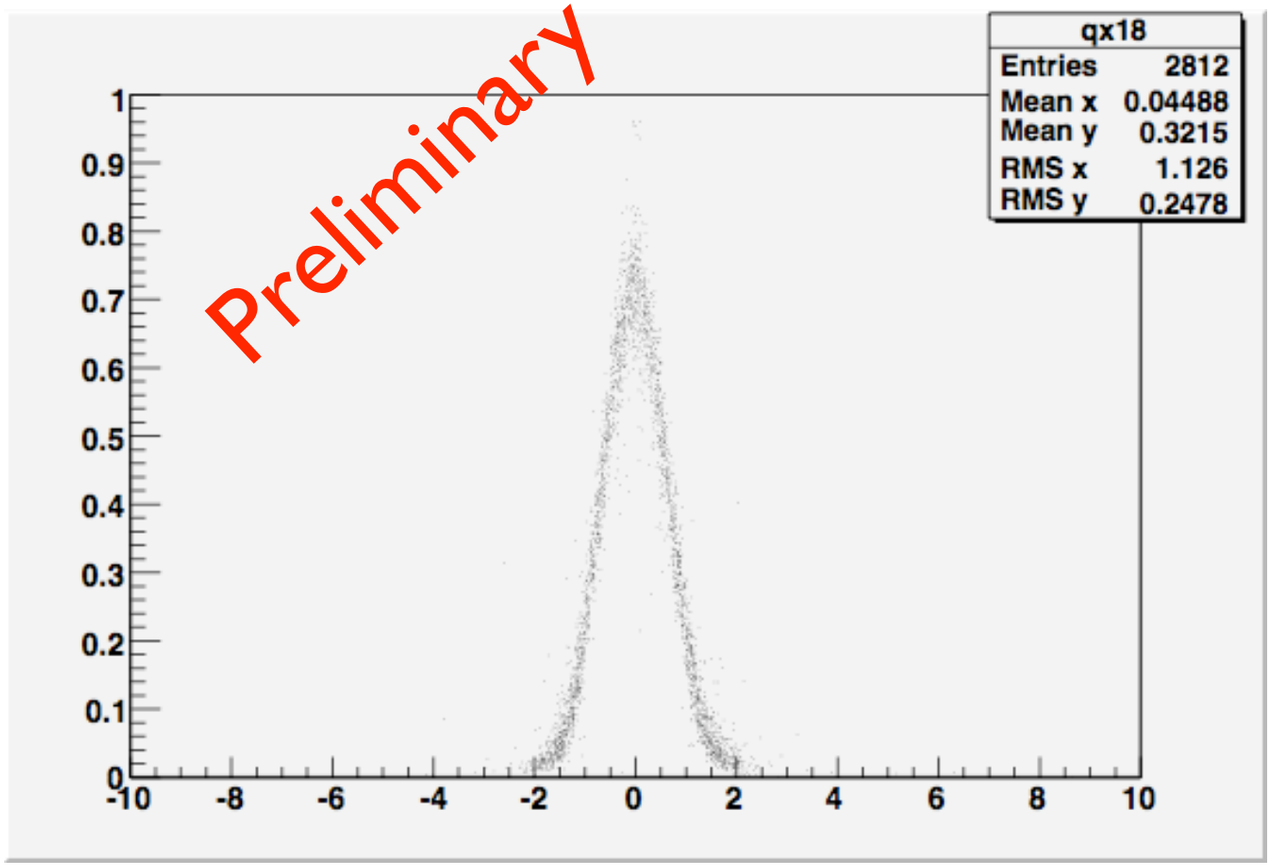




Pad Response Z=250mm, Row18

Normalized Charge



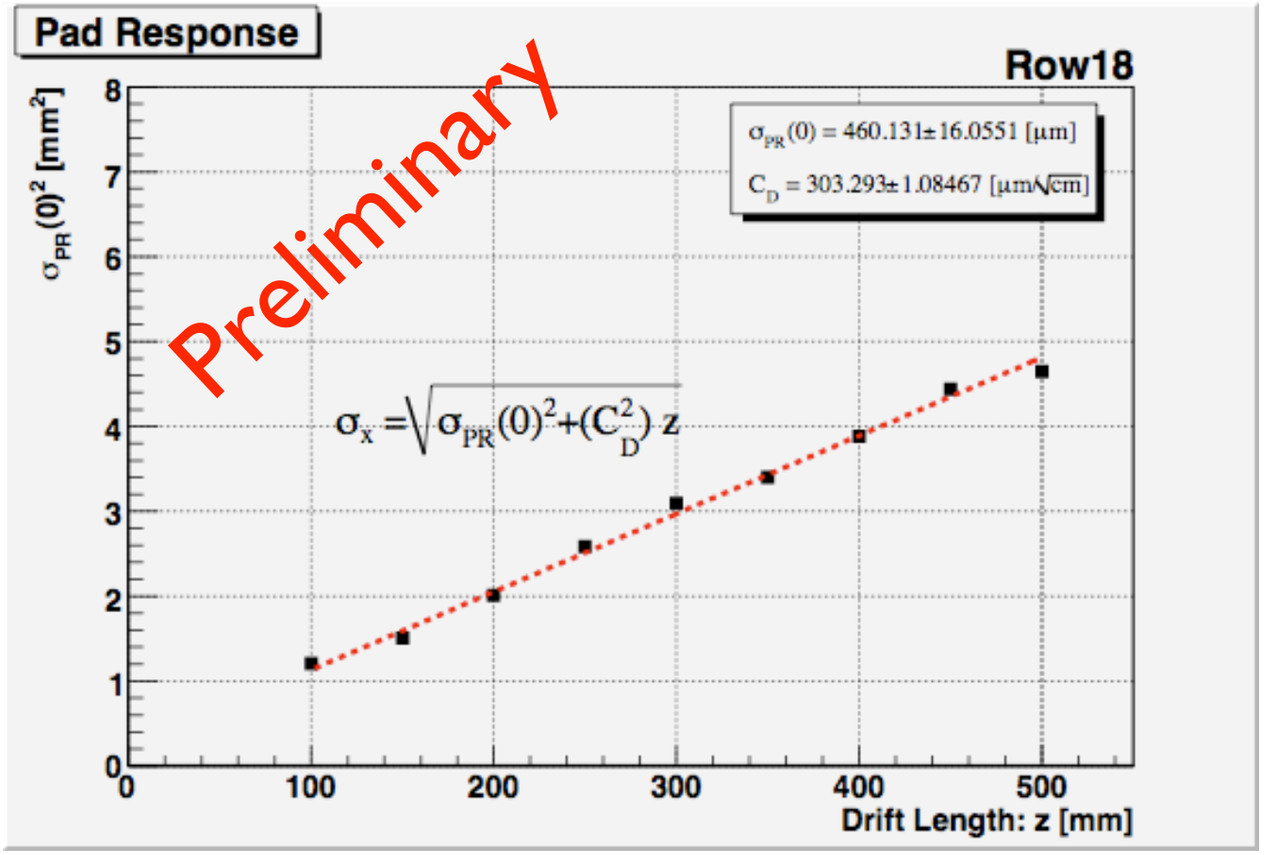


x[mm]

B=0T

B=1T

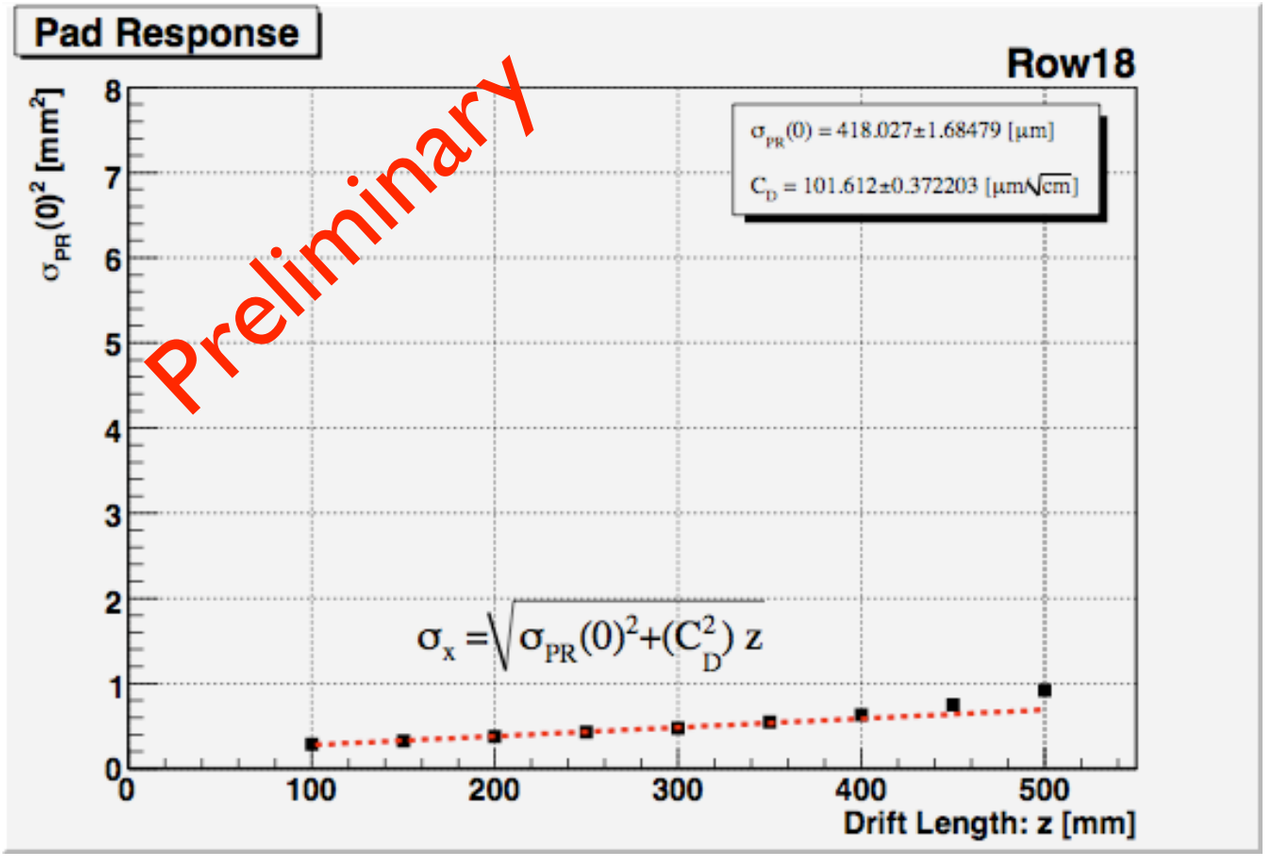
Width of Pad Response as a function of drift length



B=0T

fitting result

Diffusion Coefficient = 303±1[μm/√cm]

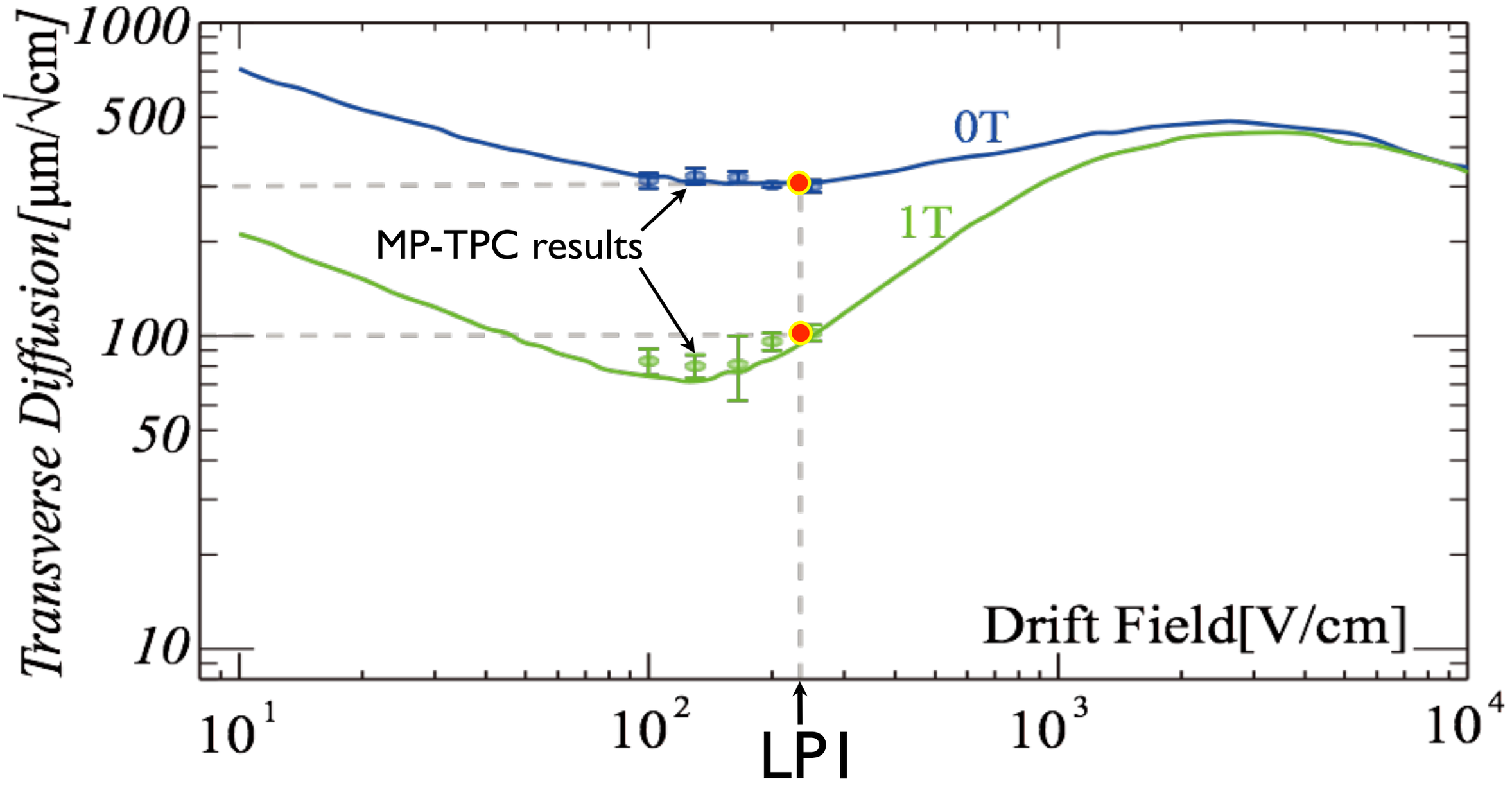


B=1T

fitting result

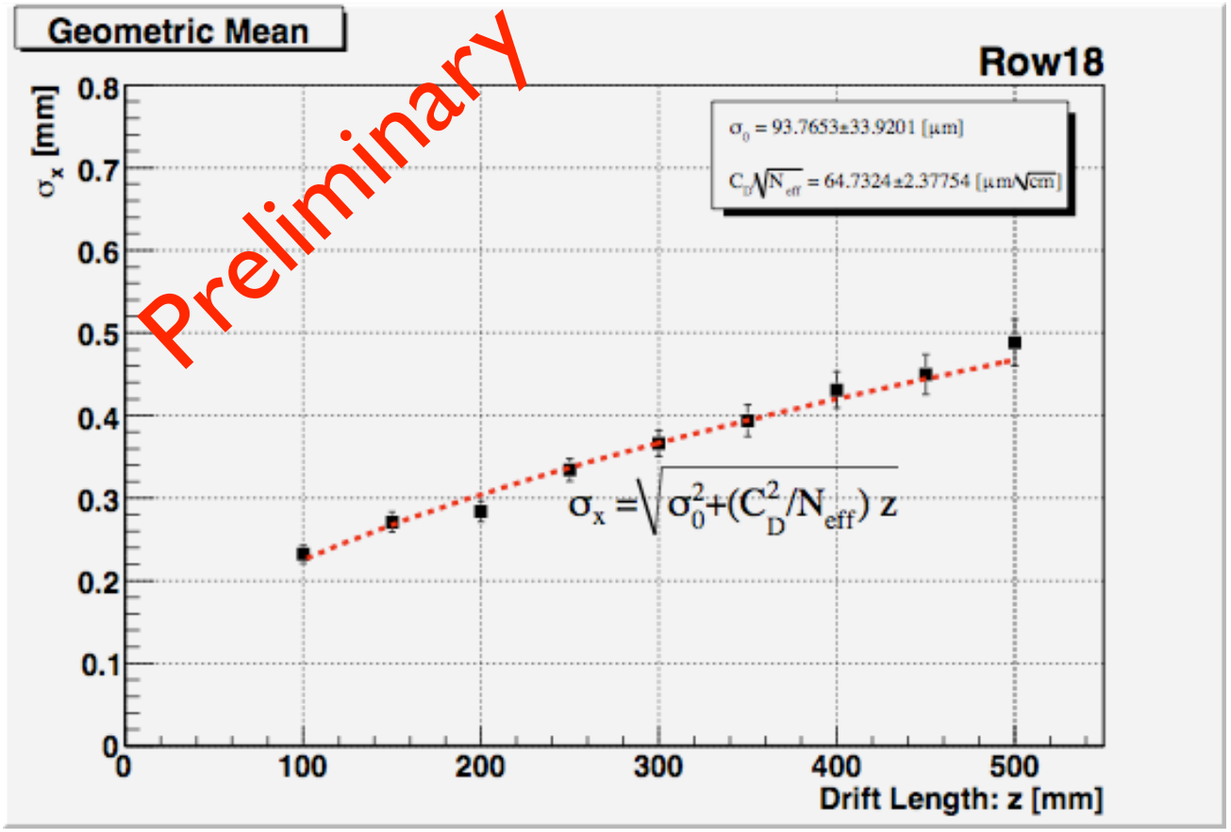
Diffusion Coefficient = 101.6±0.4[μm/√cm]

GARFIELD/Magboltz simulation



LP1 data are consistent with GARFIED/Maboltz simulation for diffusion coefficient.

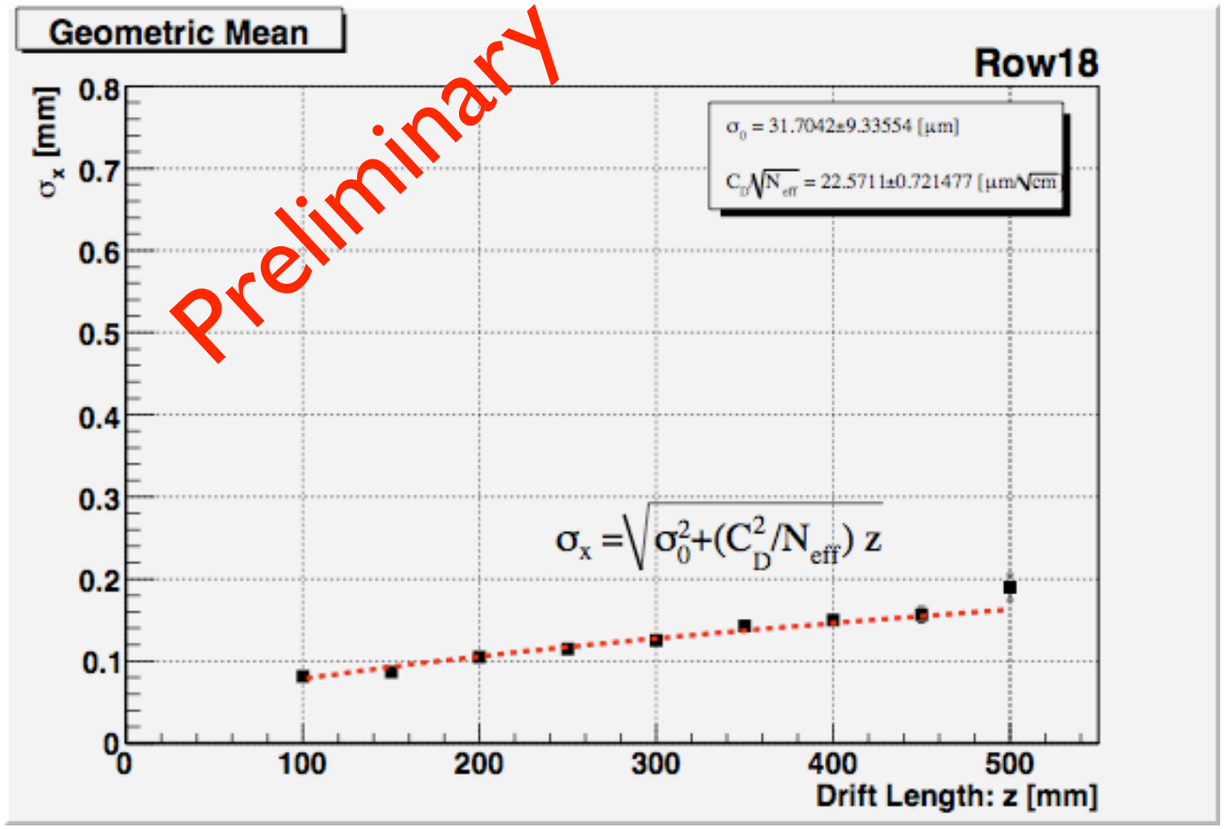
GM resolution as a function of drift length



B=0T

fitting result

$$\frac{C_D}{\sqrt{N_{eff}}} = 65 \pm 2[\mu m/\sqrt{cm}]$$



B=1T

fitting result

$$\frac{C_D}{\sqrt{N_{eff}}} = 22.6 \pm 0.7[\mu m/\sqrt{cm}]$$

Neff

B=0T

$$\begin{cases} C_D = 303 \pm 1[\mu/\sqrt{cm}] & \text{(P. 8)} \\ \dfrac{C_D}{\sqrt{N_{eff}}} = 65 \pm 2[\mu m/\sqrt{cm}] & \text{(P. 10)} \end{cases}$$

$$\longrightarrow N_{eff} \sim 22 \pm 1$$

B=1T

$$\begin{cases} C_D = 101.6 \pm 0.4[\mu/\sqrt{cm}] & \text{(P. 8)} \\ \dfrac{C_D}{\sqrt{N_{eff}}} = 22.6 \pm 0.7[\mu m/\sqrt{cm}] & \text{(P. 10)} \end{cases}$$

$$\longrightarrow N_{eff} \sim 20 \pm 1$$

Comparison with MP-TPC results

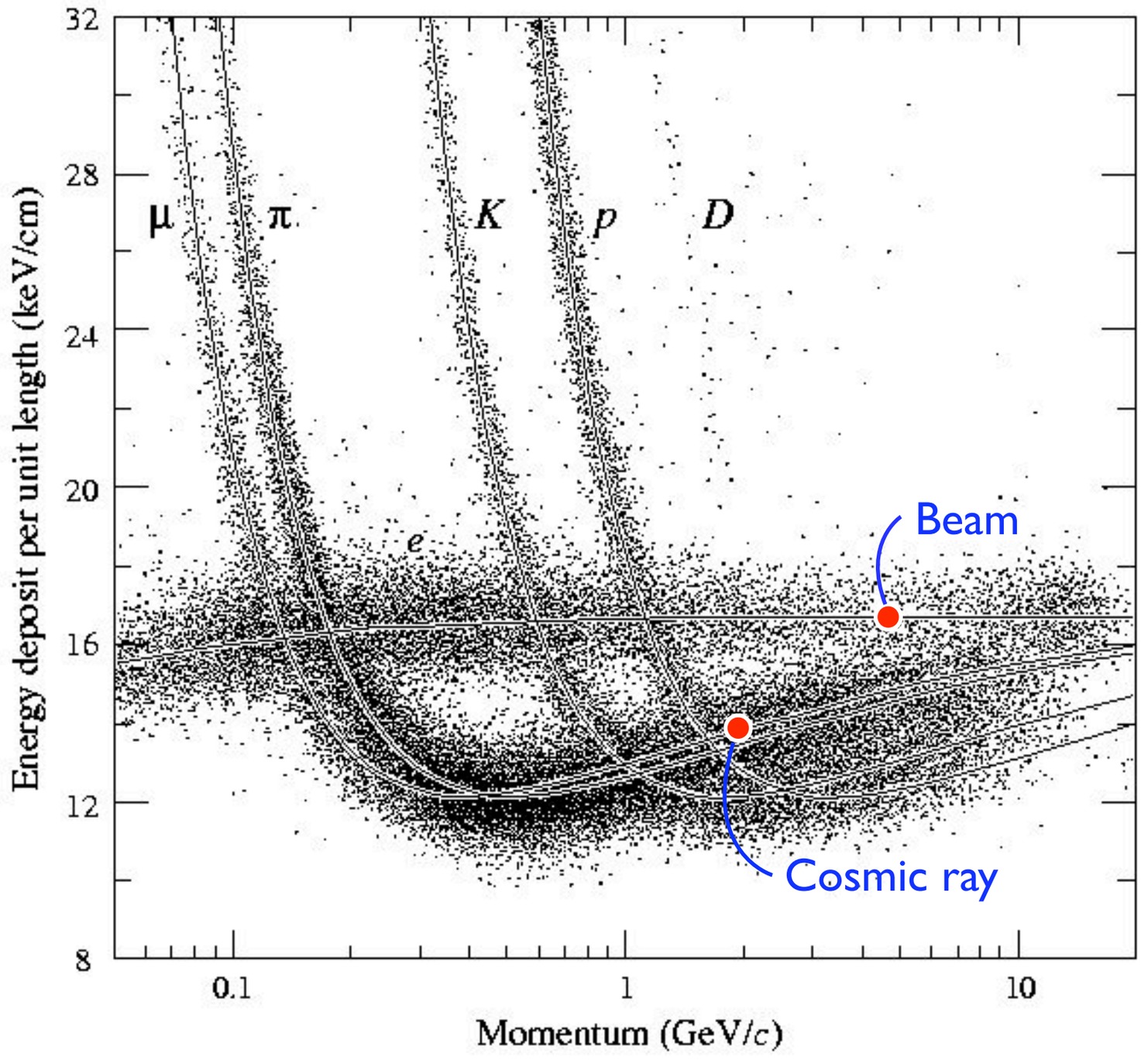
	LP1		MP-TPC
Pad height	5.6mm	Neff ×0.9	6.4mm
Source	Beam(5GeV)	$N_{ionization}$ ×1.2	Cosmic(MIP)

conversion from LP1 to MP-TPC

LP1 results ~ 20~22 $\xrightarrow{\times 0.9 \times 1.2}$ 22~24

Result of MP-TPC
Neff = 21±2

Our assumption



Though this is very preliminary result
it looks quite consistent with that of small prototype

Now we are at the starting point of LP1 study

systematic study of resolution

- z resolution
  - position dependence
  - PH dependence
  - drift distance dependence
  - angle dependence
- uniformity of gain
- cross talk

momentum resolution

2-track separation

tracking under non-uniform field

multi-module combined analysis

- effect of module boundary
- momentum resolution by multi-module

Summary

The first beam test under LP1 has been done

Preliminary results seem to be
quite consistent with these obtained w/ the small prototype

More will come (soon)
after software development and further analysis

Complete test with GATE is scheduled in winter