GEM TPC Large Prototype Beam tests

A. Sugiyama
Asia LC-TPC group

on behalf of LC-TPC collaboration

Introduction

Tracker has to have

"good" momentum resolution

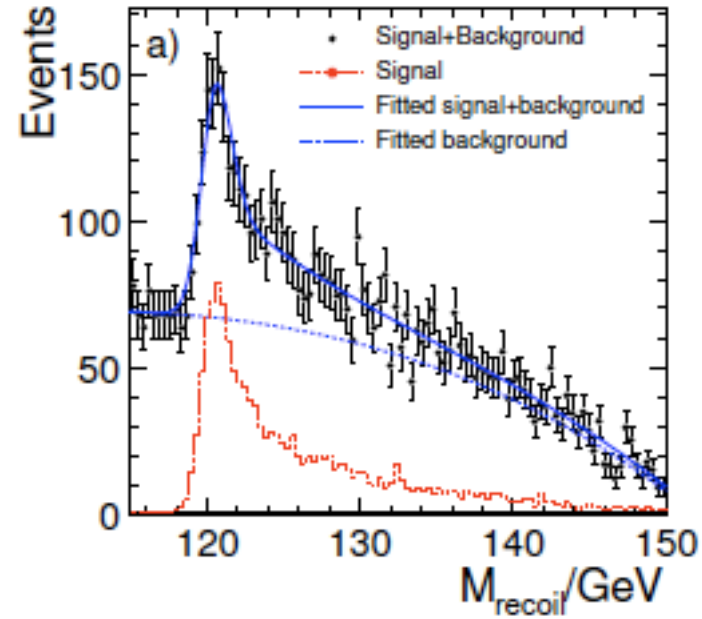
for good M_{recoil} resolution

"good" recon. efficiency

for PFA/F-tag

even for low P track

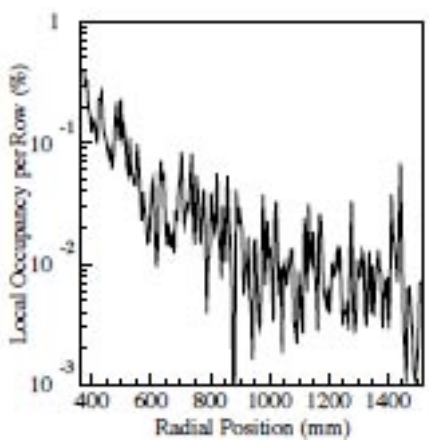
Low X_0



Tracker has to achieve the performance

even under high bkg. condition

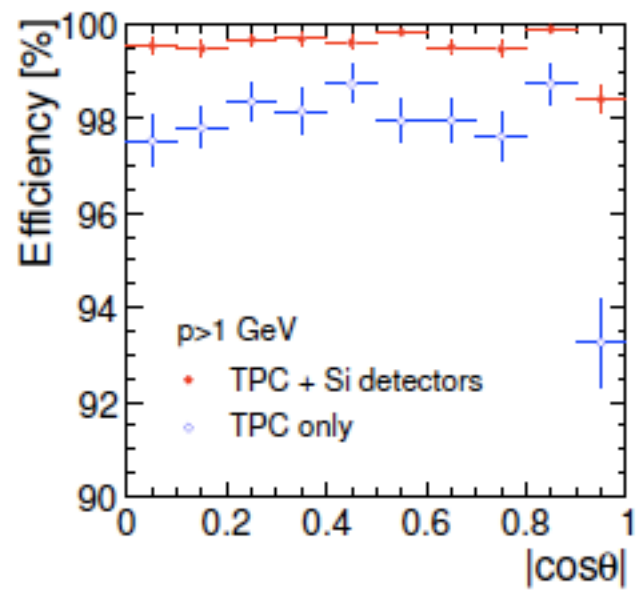
from beam-beam



TPC w/ high B field

GEM with narrow pad

w proper gas choice



In order to make sure TPC can achieve this goal

Small prototype test has been continued to

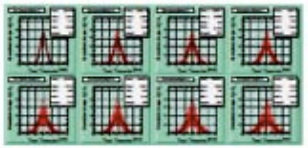
understand how the resolution behave

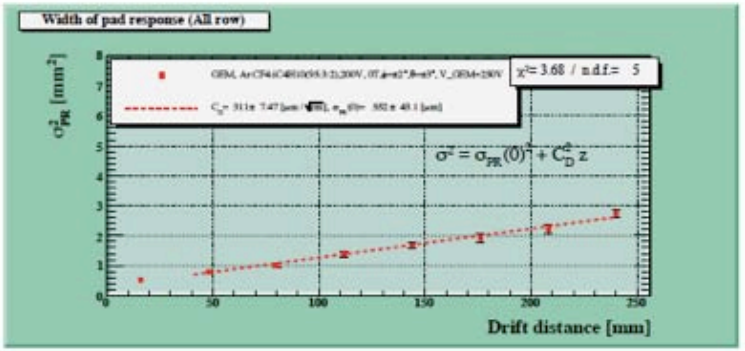
how gas choice affect to the performance

What we had achieved at small prototype (MP-TPC)

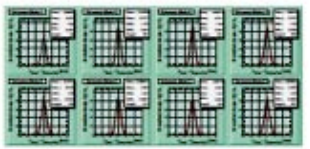
0T

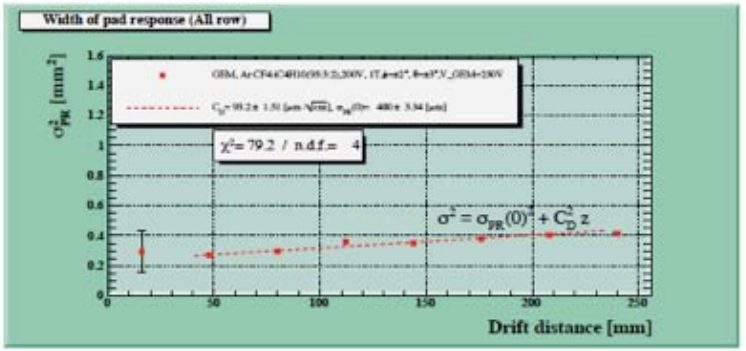
Pad Response





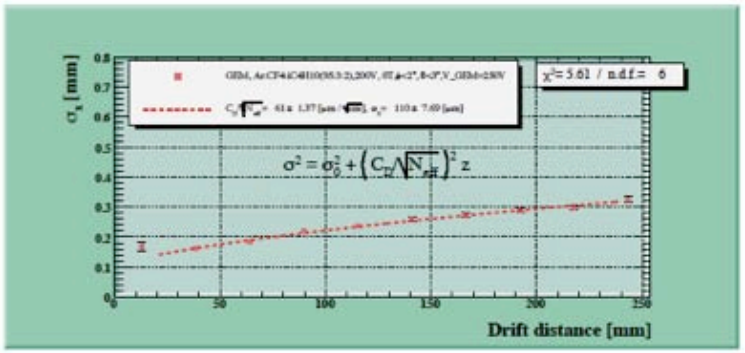
1T

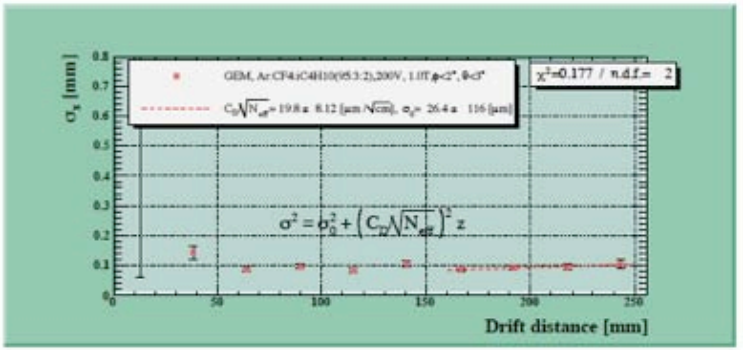


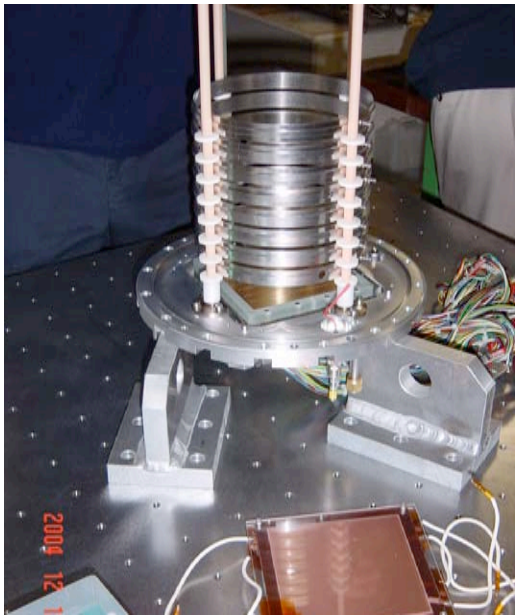


Resolution

E=200[V/cm], T2K gas V_{GEM}=250[V]







What we did learn from the small prototype test

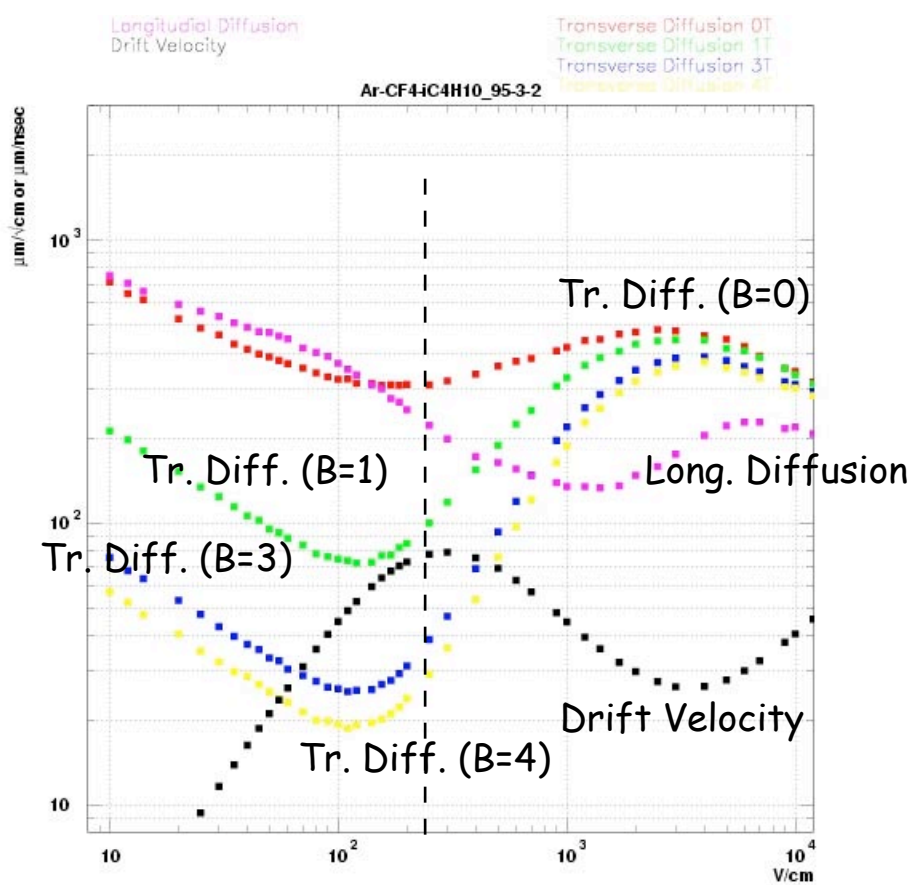
position resolution

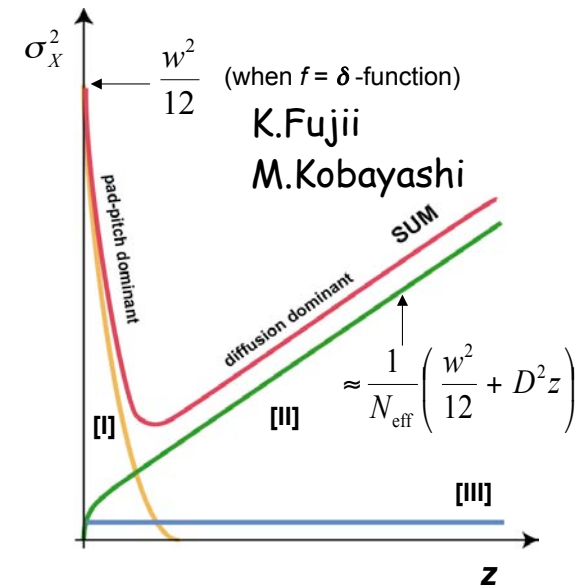
the relation between pad pitch and charge spread(p.r.f.)

pad pitch < 3 x diffusion@MPGD

Gas property under B field

is explained by MagBoltz





1mm pitch pad with GEM

2 GEM for gas amplification

1 thin GEM for ion gate

Large Prototype test (based on EUDET facility)

Concept

Modules(GEM, MM, +TimePix)

Asia, Saclay/Canada, NIKHEF,Bonn,,,,,

+

Field cage

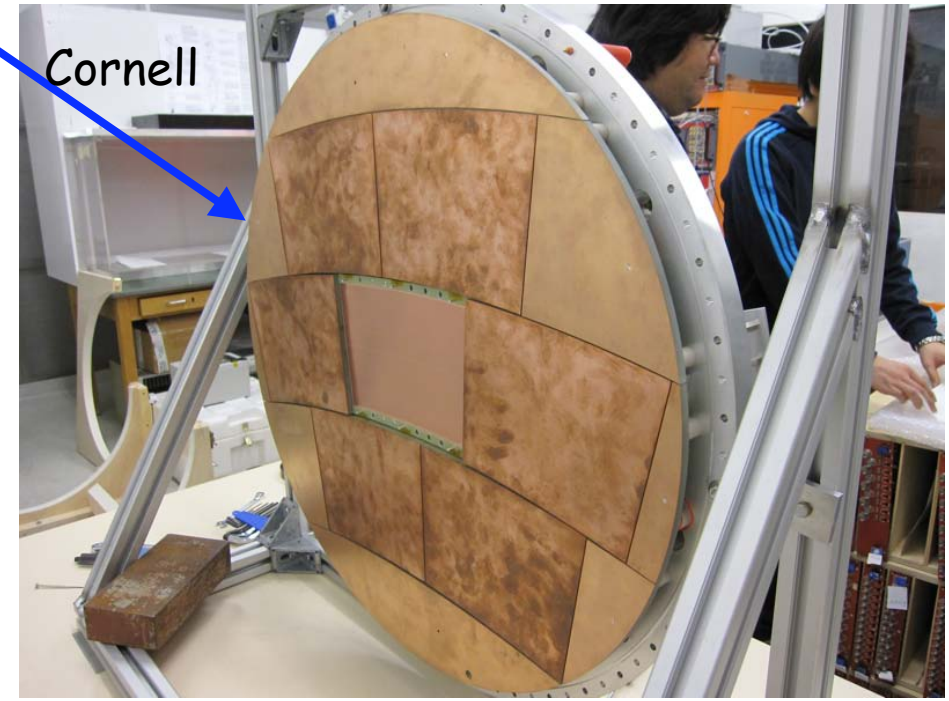
End Plate

Magnet

calibration

Victoria

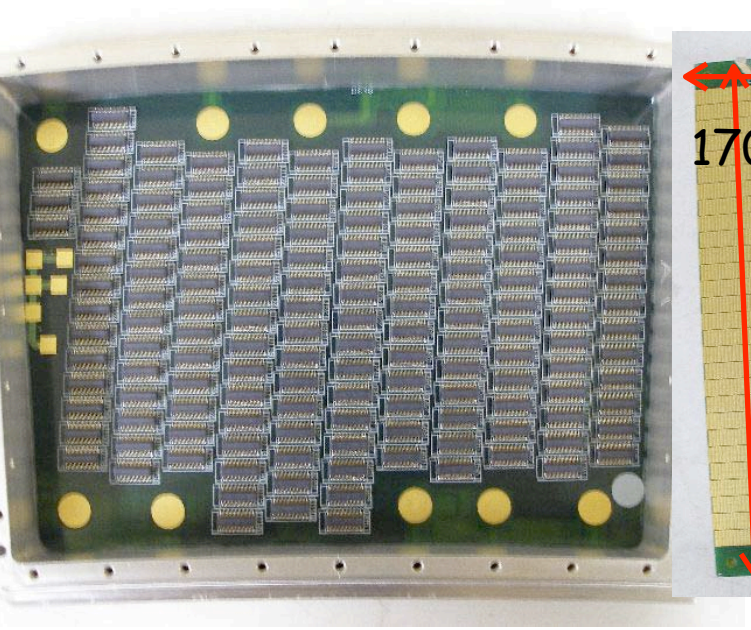
DESY II T24 area

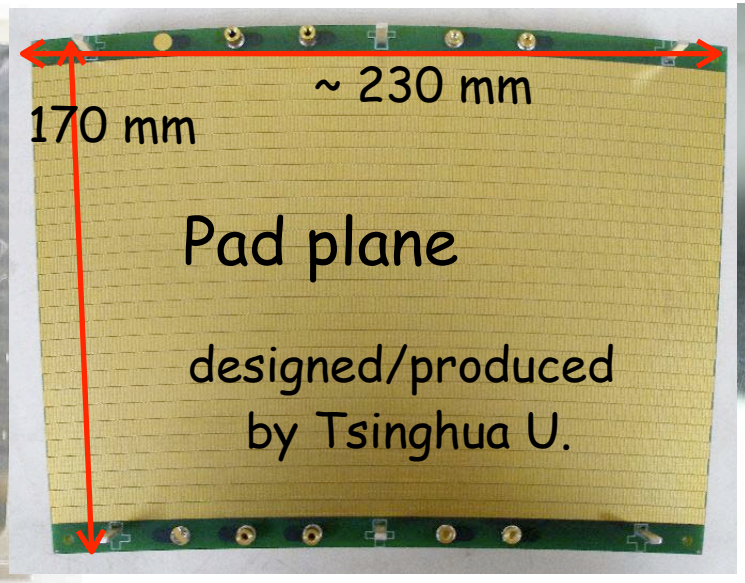


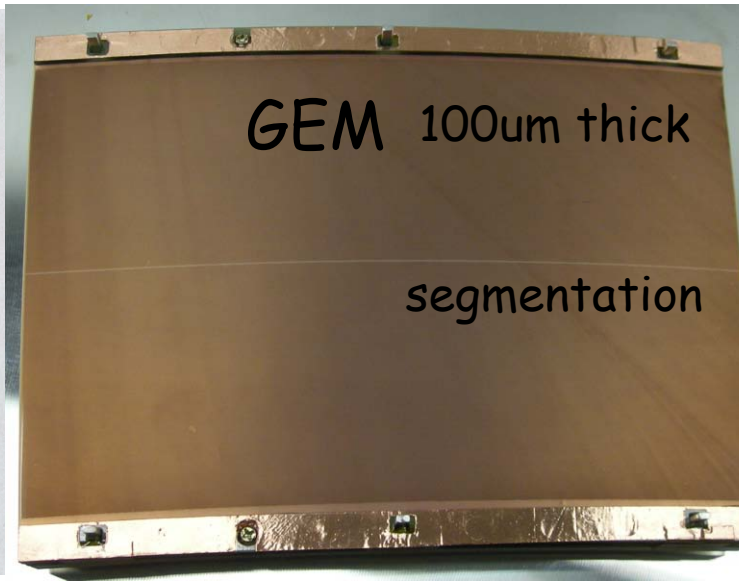
GEM module

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

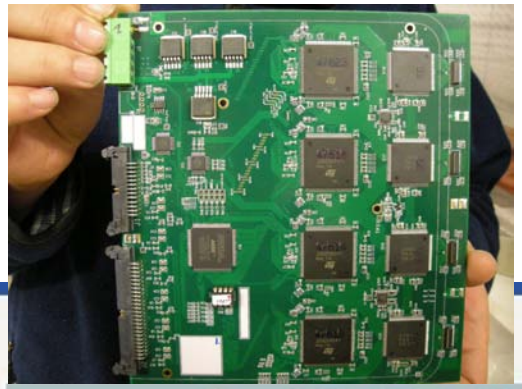
28 pad raws (176/192 pads/raw)
~1.2(w) x 5.4(h) mm^2
staggered every each layer

Total 5,152 ch/module

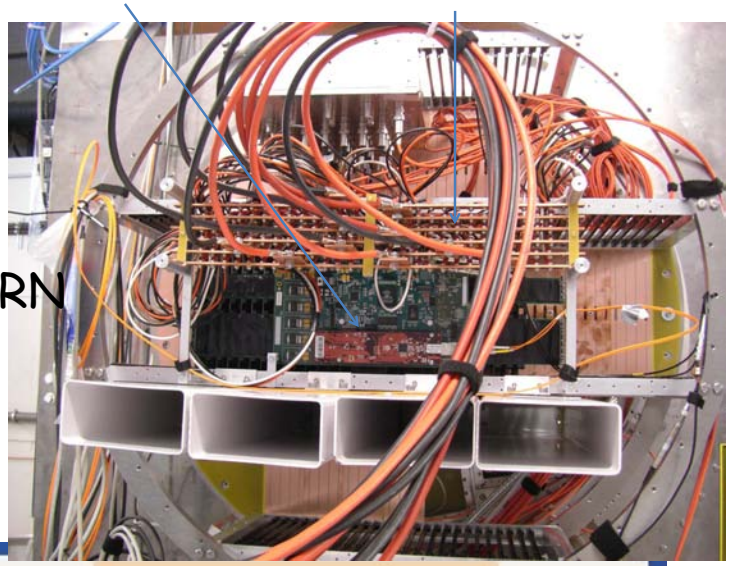
Gate GEM (14um thick) will be on top of the module

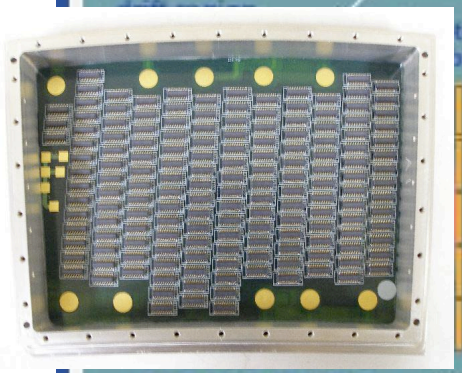
ReadOut Electronics

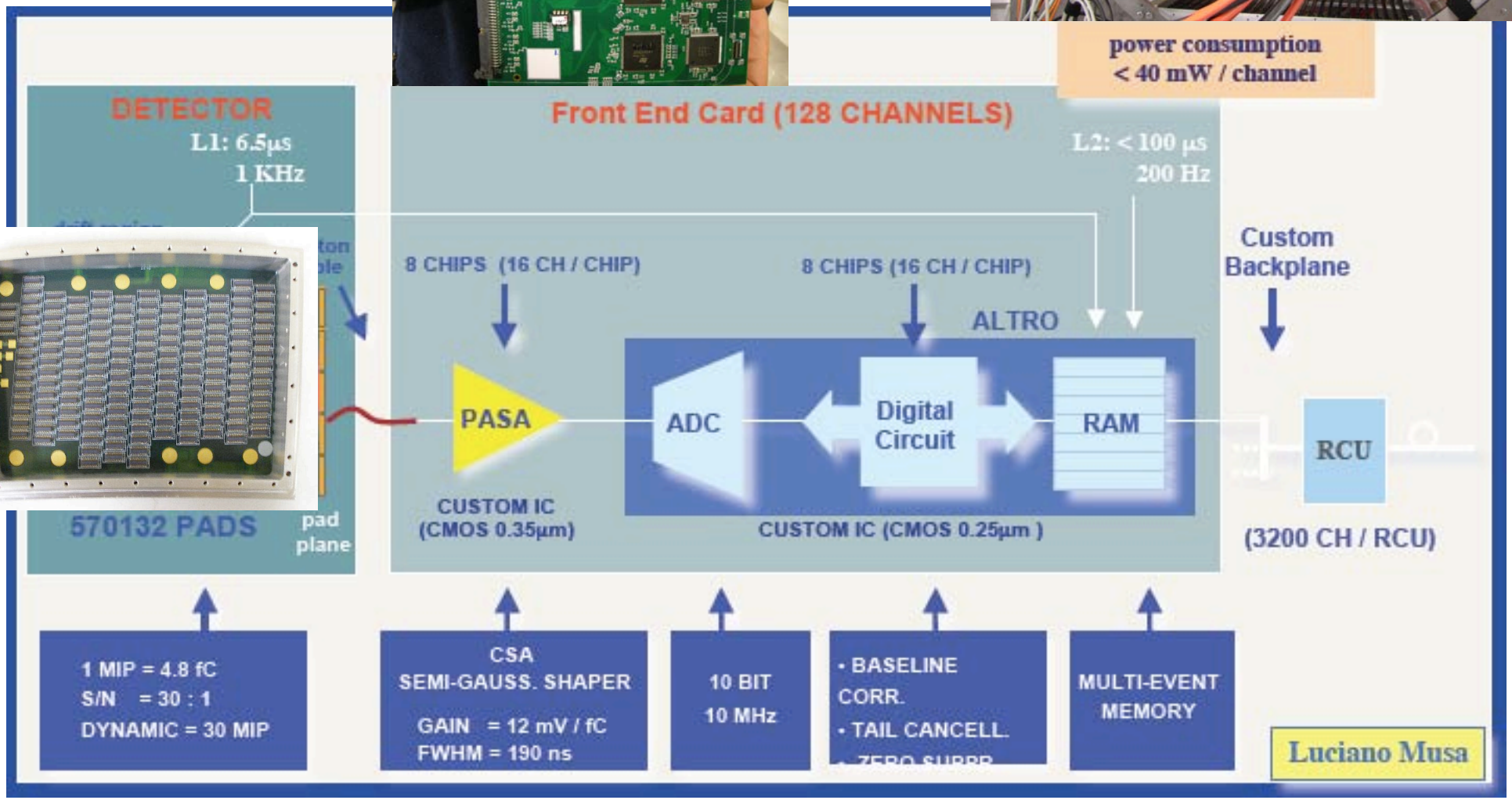
ALICE/ALTRO electronics +DAQ



LUND/CERN

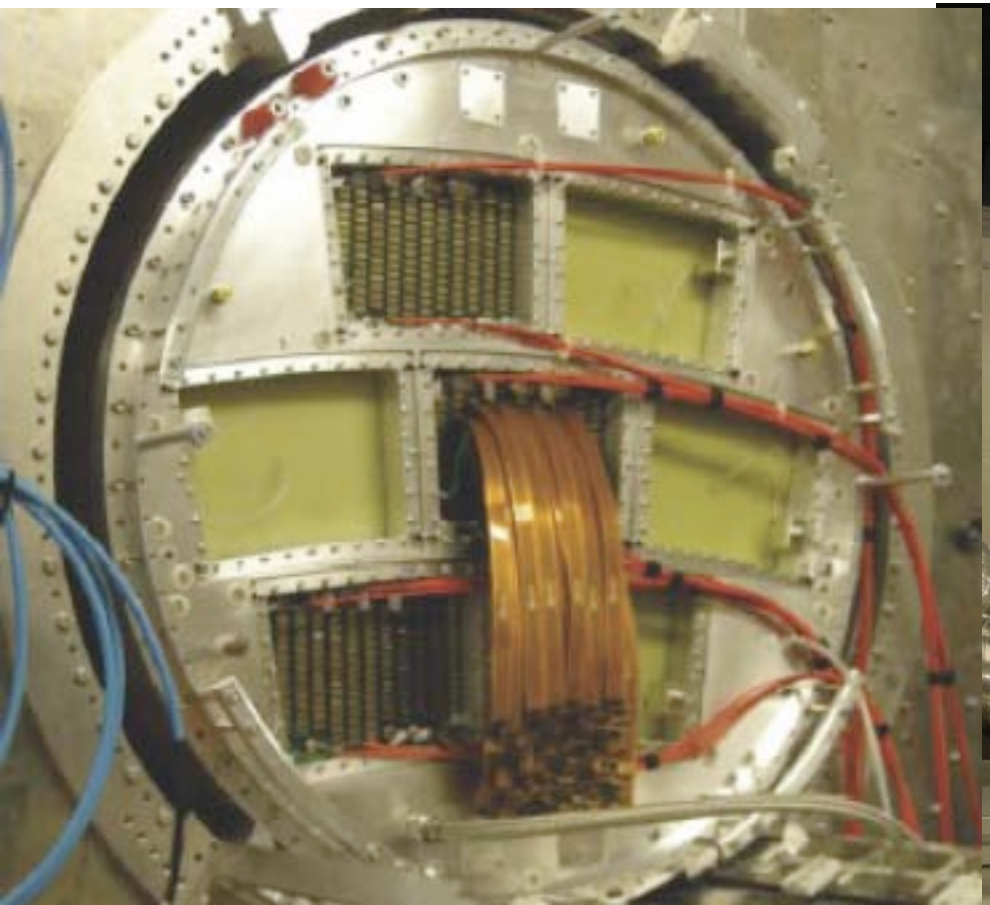


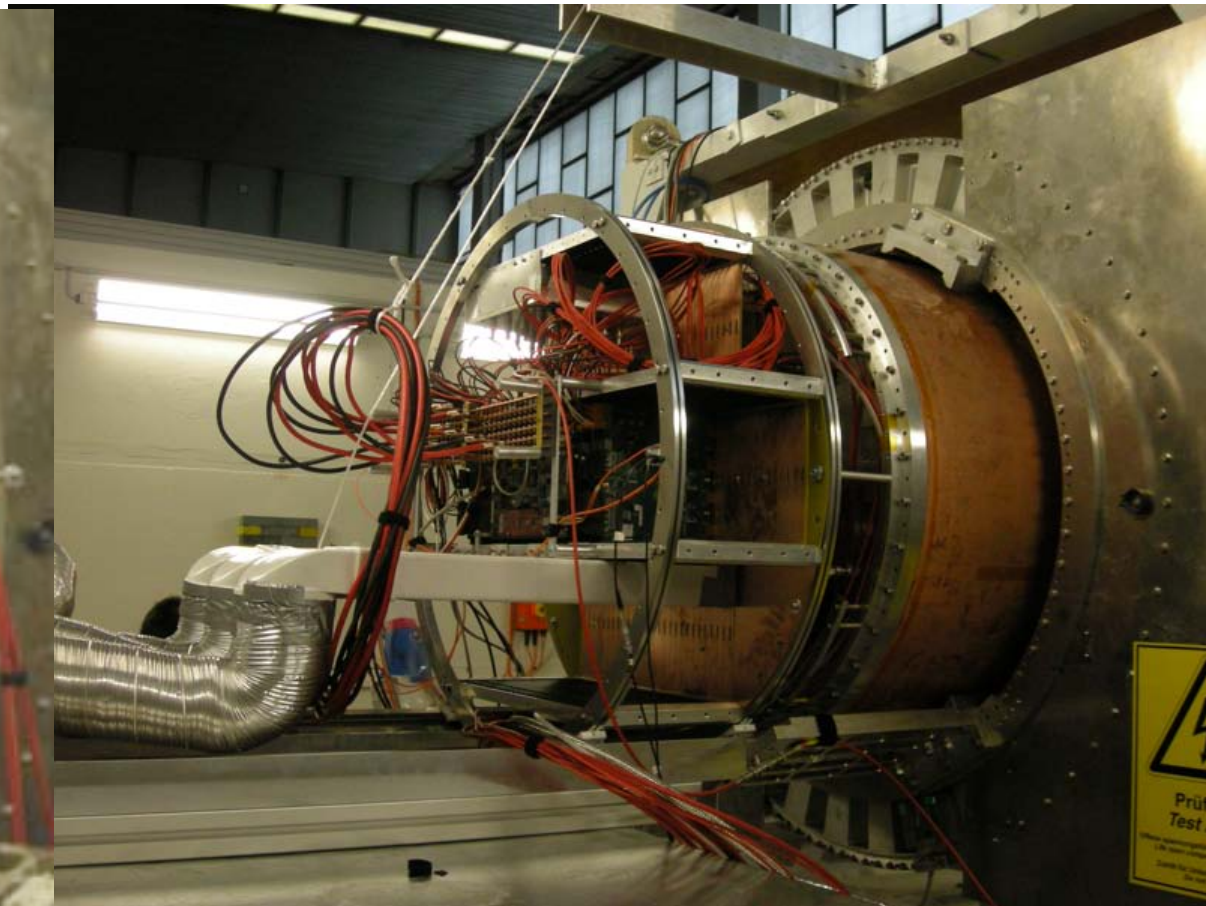




3,200 channels are available now

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,,,,,,

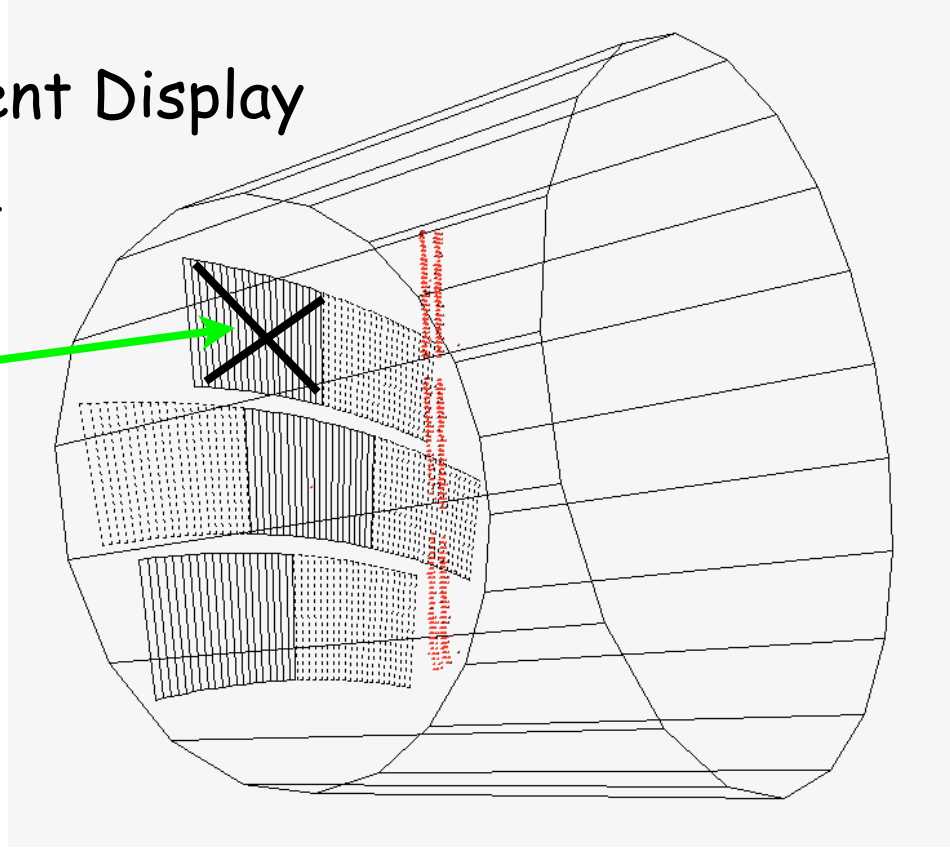
realistic performance

Event Display

At the beginning of 2nd period of beamtest
we could see hits over 3 modules

We have to give up module 6
after problem of drawing current

Data taken at 2nd. 2 modules alive



Rawdata -> LCIO data on GRID

LC-TPC

Analysis tools

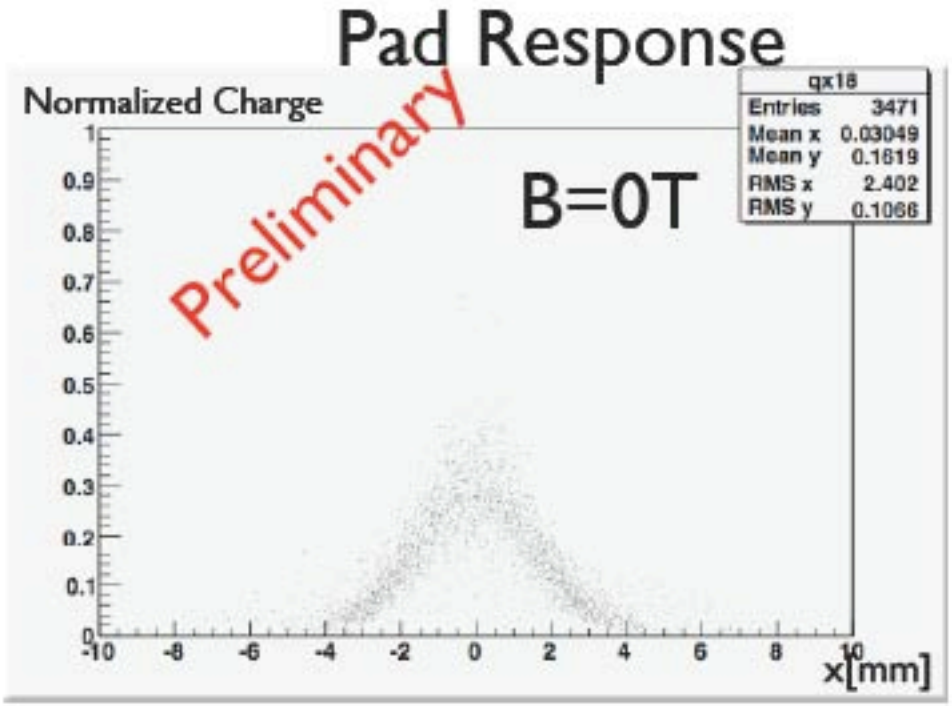
Marlin-TPC

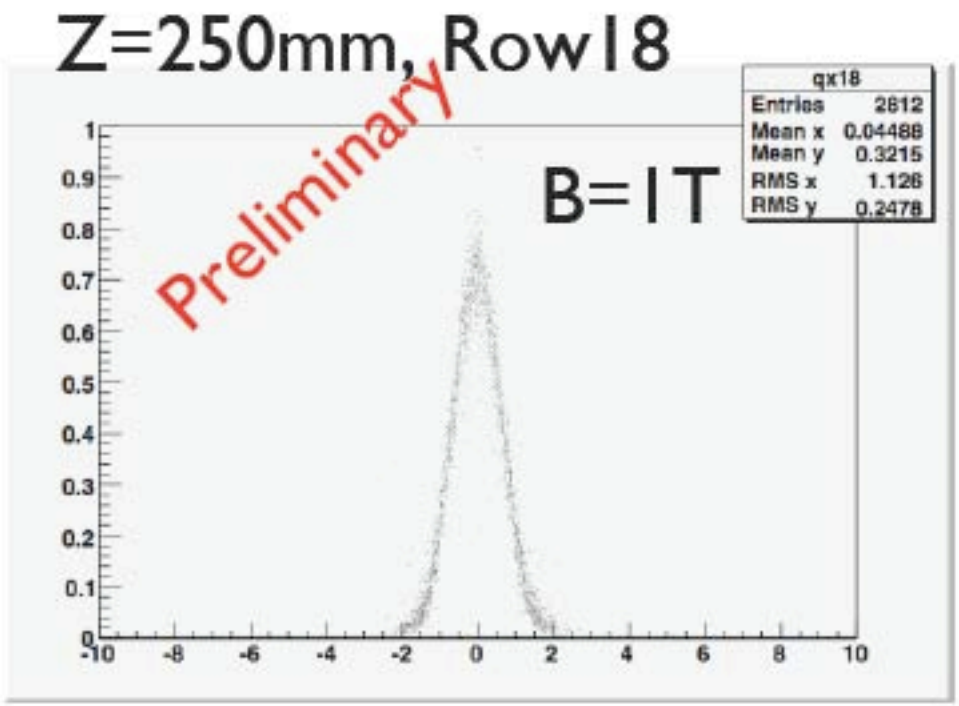
going to be implemented soon

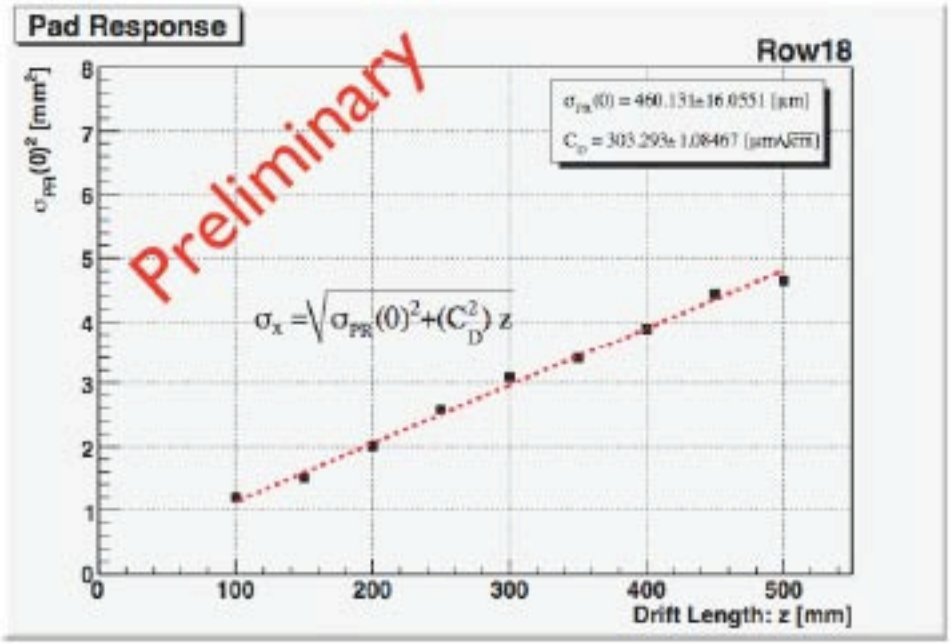
own analysis program (Kalman filter) is used for this

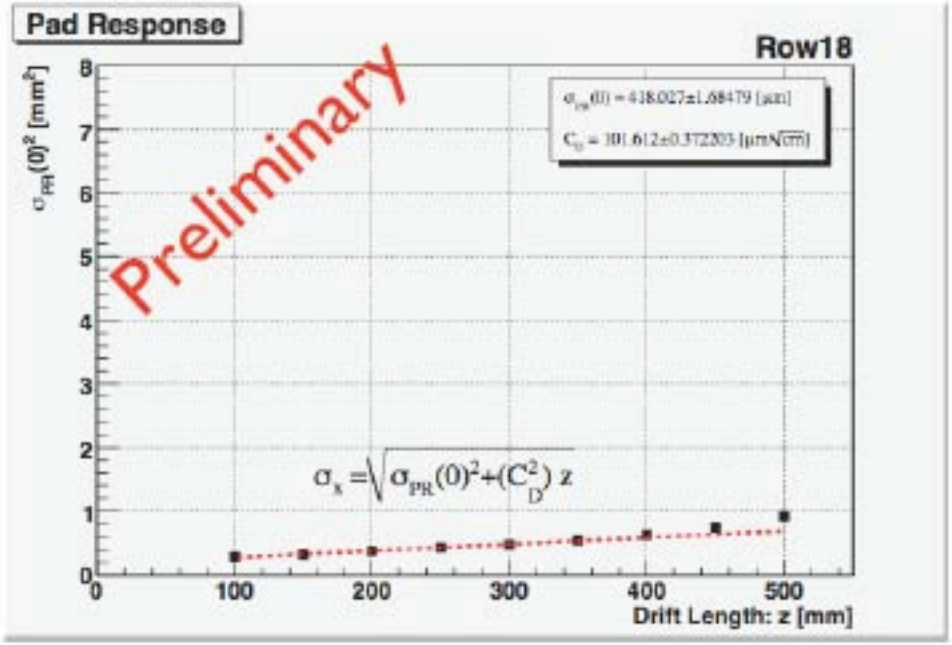
All plots shown today is preliminary

Charge spread (pad response function)









$$\sigma^2 = \sigma_0^2 + C_D^2 z$$

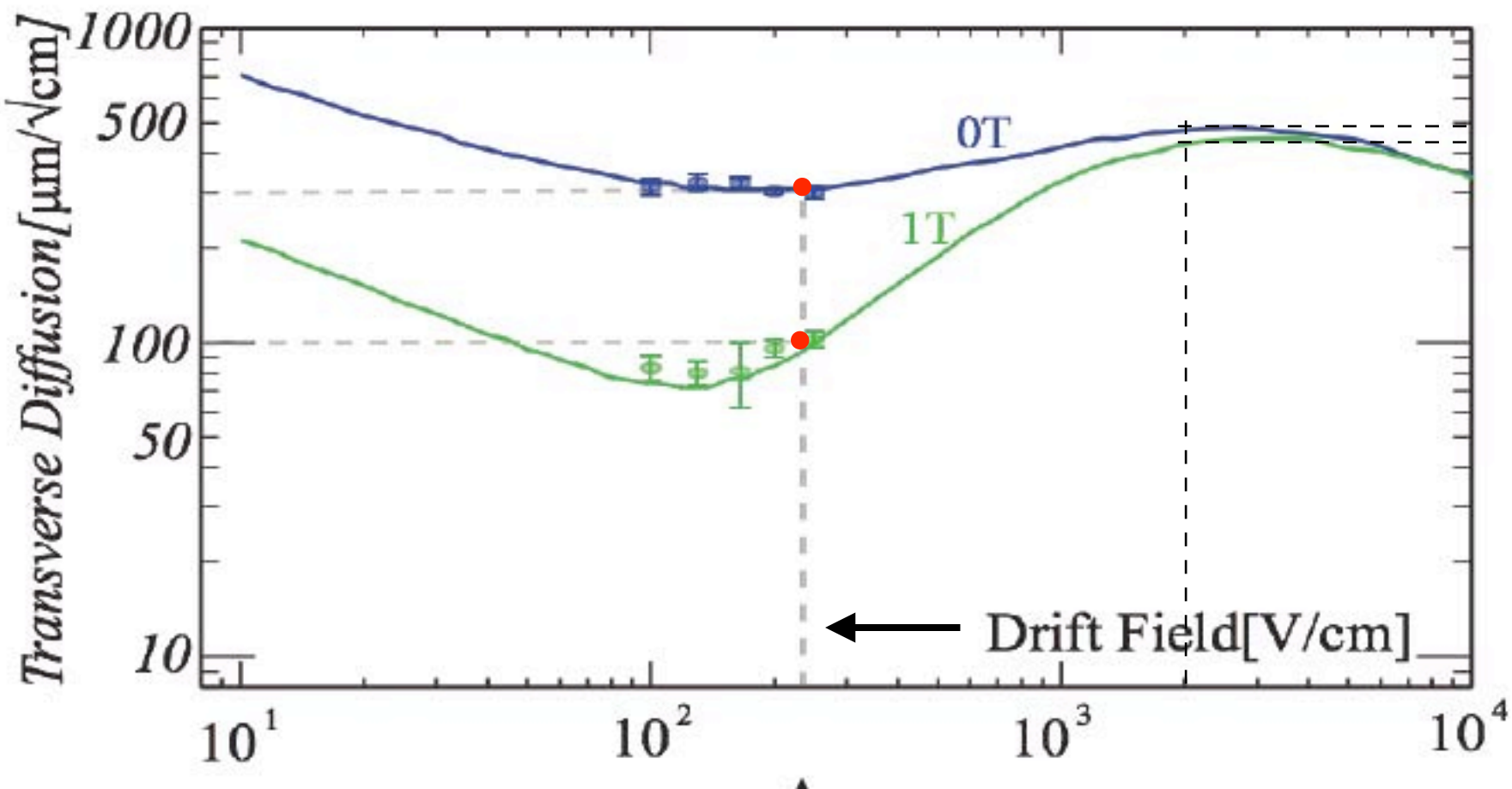
Diffusion constant

from Data

	B = 0 T	B = 1 T
C_D [um/√cm]	303	102
error	1	1

Comparison to MagBoltz and result of Small Prototype

Points means MP-TPC results.



Constant term σ_0

coming from

diffusion in gas amplification 370 um 480um for 0 T
310 um 410um for 1 T @1cm drift

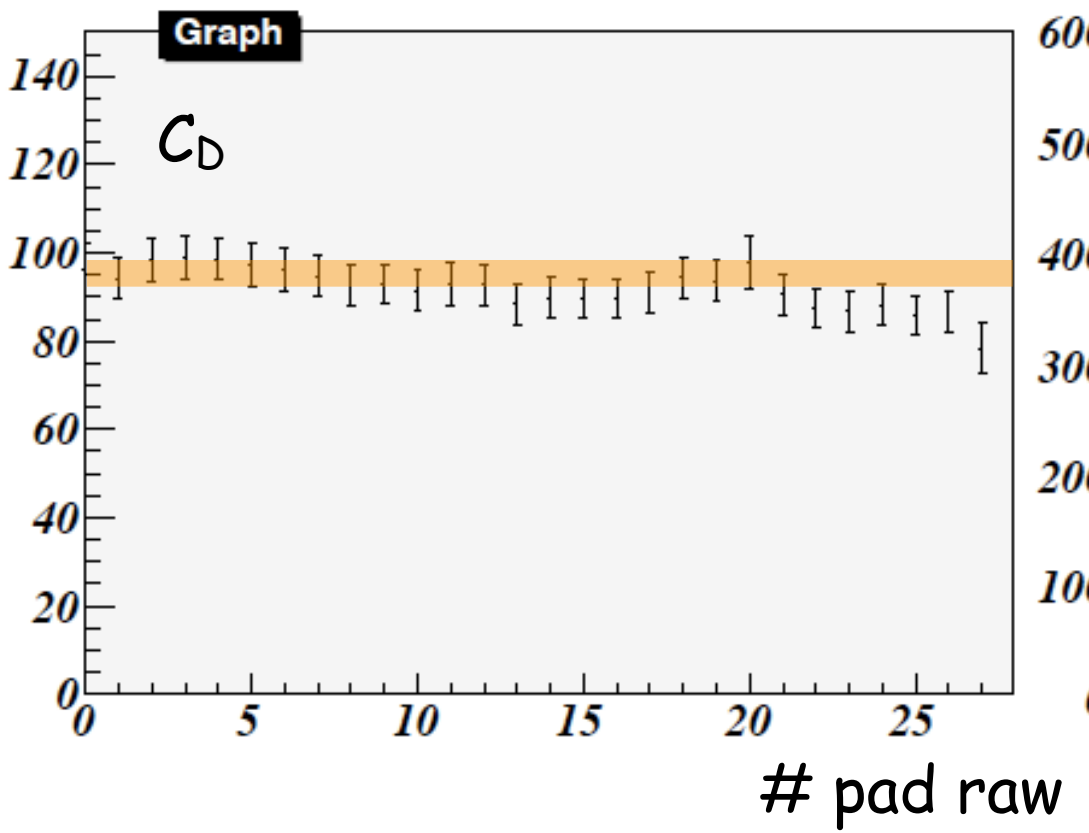
hodescope effect in pad ~ pad width /√12 =350um

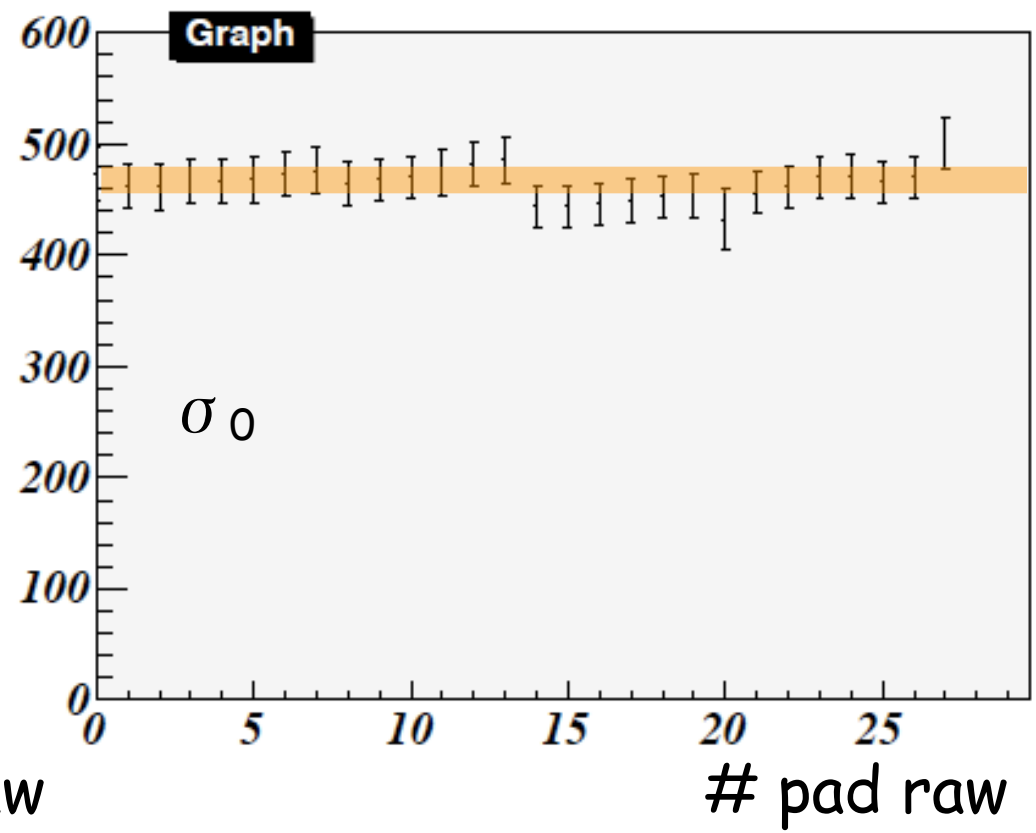
+ convolution with gain fluctuation

angular-pad effect 0

470 um @1T

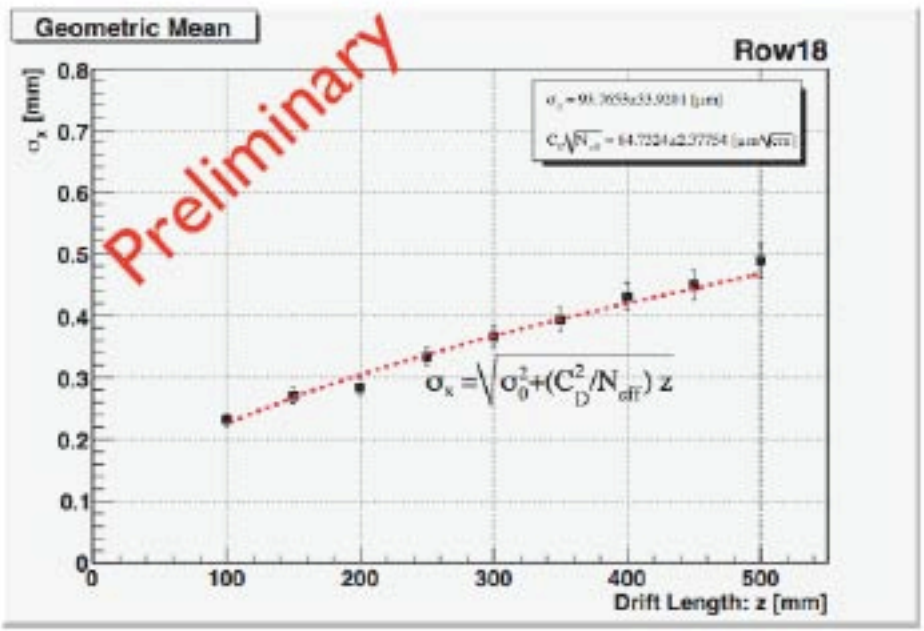
Pad response on each pad raw





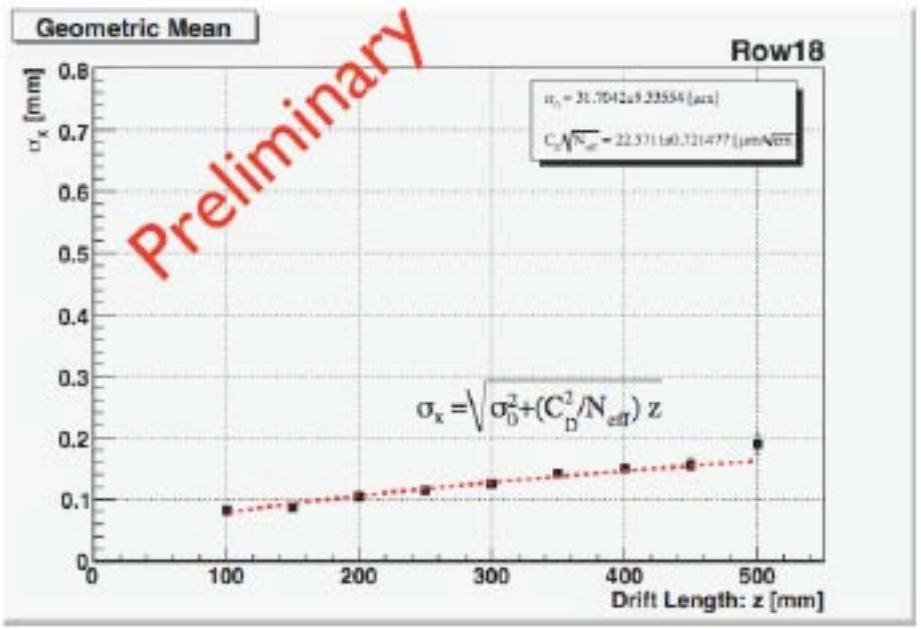
Residual

$$\sigma^2 = \sigma_0^2 + C_D^2\, z/N_{eff}$$



B=0T

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



B=1T

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

N_{eff} obtained from resolution plot

shows quality of data

N_{eff} is 20 ~ 22 in this exp.

but it needs correction when we compare that in small proto. results

	LP1	small proto.	correction
Pad height	5.4 mm	6.3 mm	0.93
dE/dx	1.5	1.2	

N_{eff} 19 ~ 21 (20~24 in small prototype)

a little bit fewer ??

Though this is very preliminary result

but it looks almost 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 done

Preliminary results seems to be
quite consistent with that obtained w/ small prototype

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

Complete test with GATE is scheduled in winter