MPI/TPC prototype beamtest at KEK and future plan

by Akira Sugiyama (Saga Univ.)
for Europa/Asia TPC collaboration
(Not an official name yet !)

Collaboration

Goal of this this collab.

Facilities at KEK

Results

Future plan

Collaboration

Institute:

Europa/ MPI, DESY, Orsay

Asia/ KEK, Tsukuba, TUAT,Tokyo,
Kogakuin, Kinki, Hiroshima, Saga,
MSU(Mindanao State)

Aim of this collab.

define base line sensor for TPC using "ultimate" WMPC

(back up) 2mm spacing with 1mm gap to cathodes

- ExB effect should be smaller
- localize induced charge dist. on pads

typical width of PRF is 1~2 times of gap

-> ~1.5mm

Pad size is 2mm x 6 mm

max. Drift Distance ~ 27cm

understand this TPC w/ wires thoroughly using beam/cosmic

trans. resolution, z resolution, 2 track separation ...

reference data to evaluate MPGD/TPC performances

(and to be parameters for full sim. for LC/TPC study)

MPGD sensor must provide better performance than wires do

Which MPGD is the best for TPC ?

using the same TPC/readout/analysis except for the sensor

Ron's remark

"No work has been done for MPGD in Japan.

It is good place for unbiased MPGD tests."

.....mm

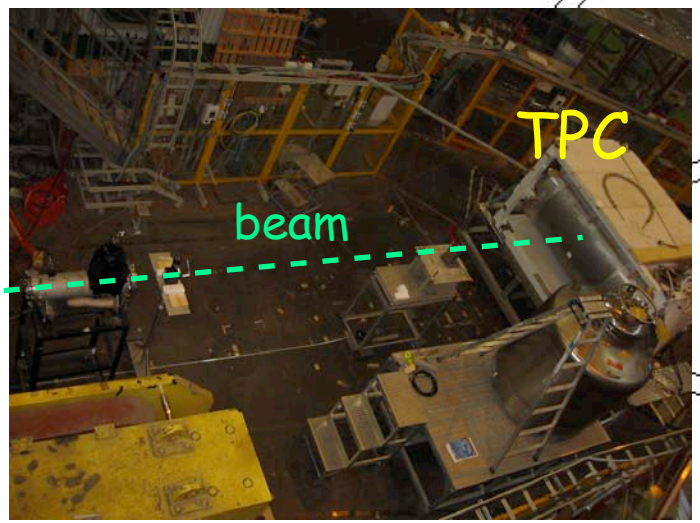
If you have a sensor for TPC, Please bring it to KEK and put it on TPC.

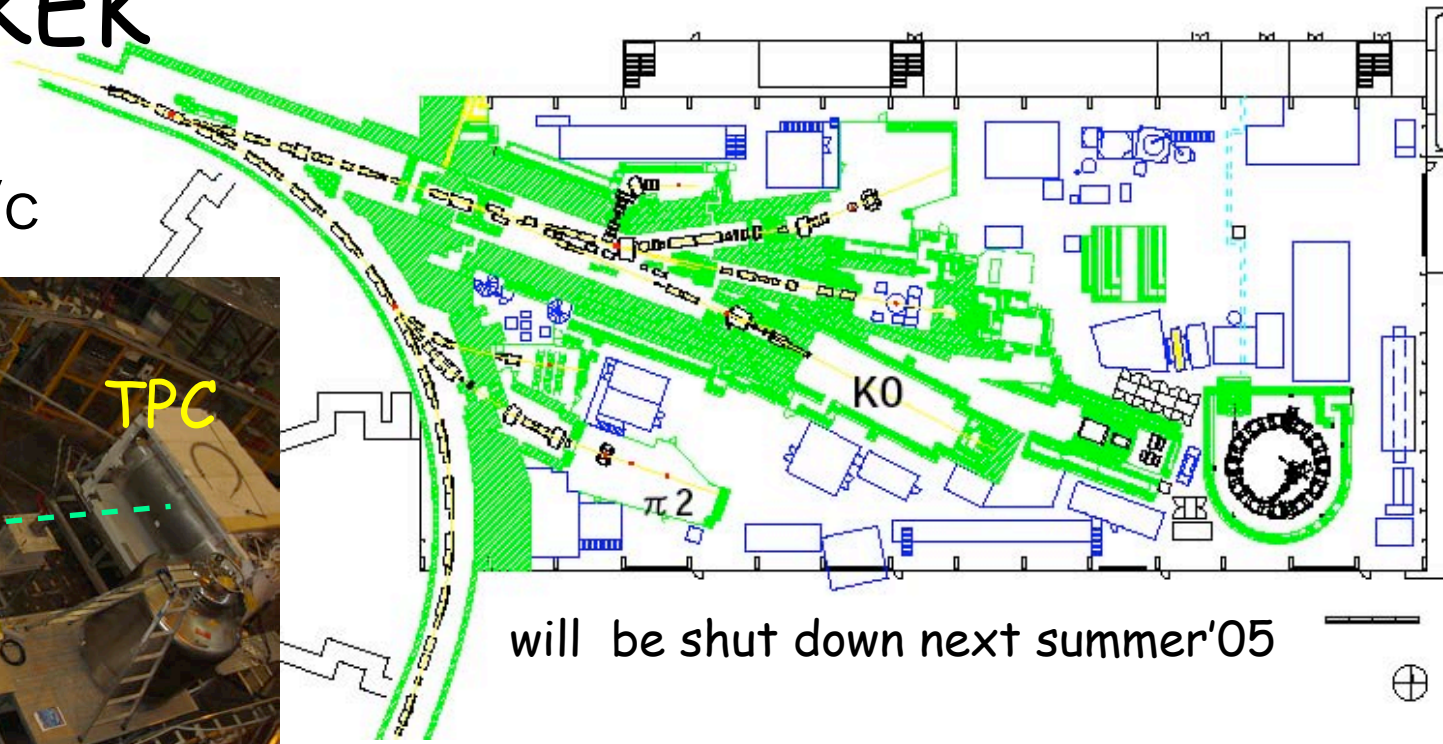
Facilities at KEK

test beam "π2" line

π^- 0.6->4GeV/c

π^+,p





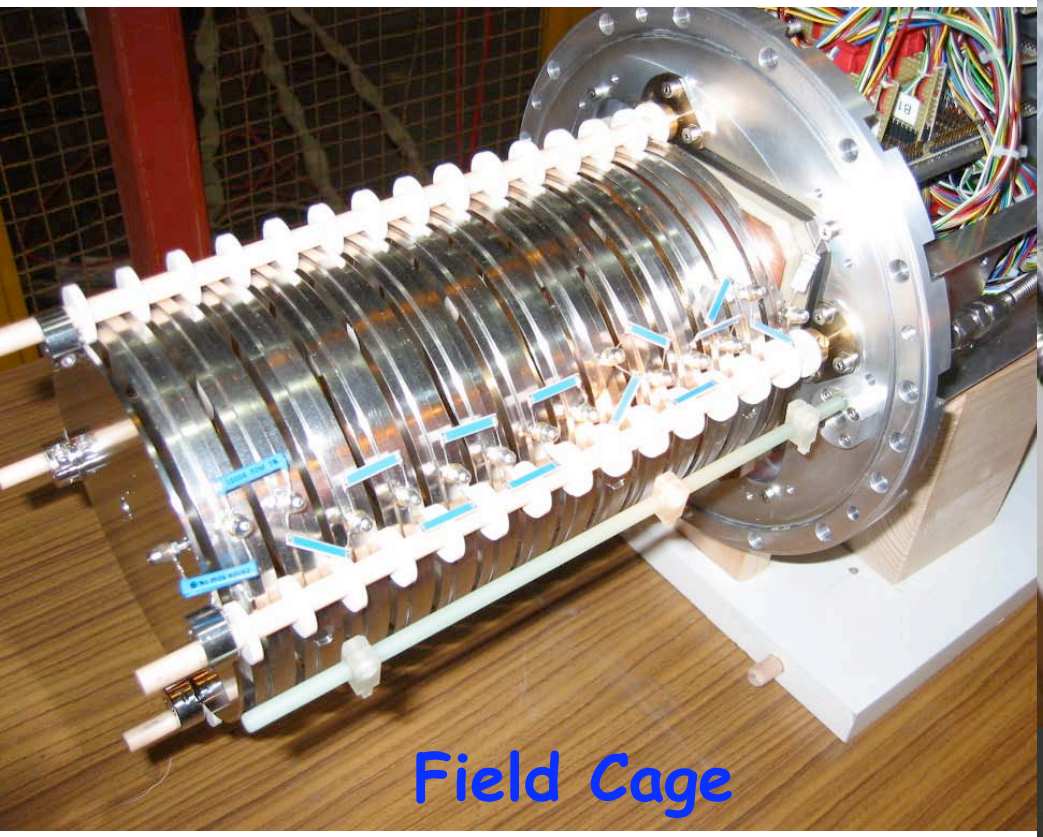
will be shut down next summer'05

SuperConducting Magnets

portable "JACCEE" on bema line

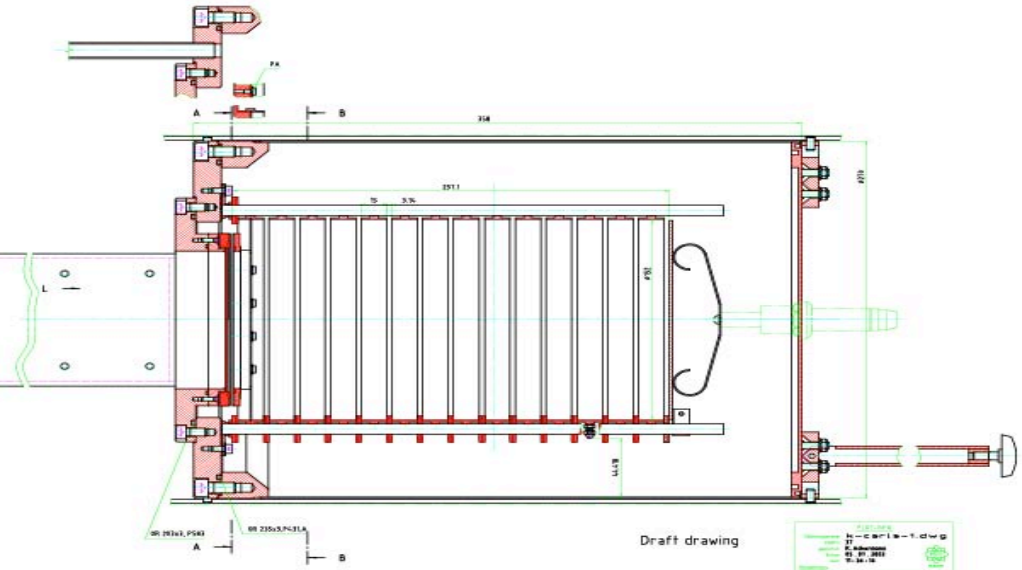
Magnet w/ return yoke at cryo. Center

MPI TPC

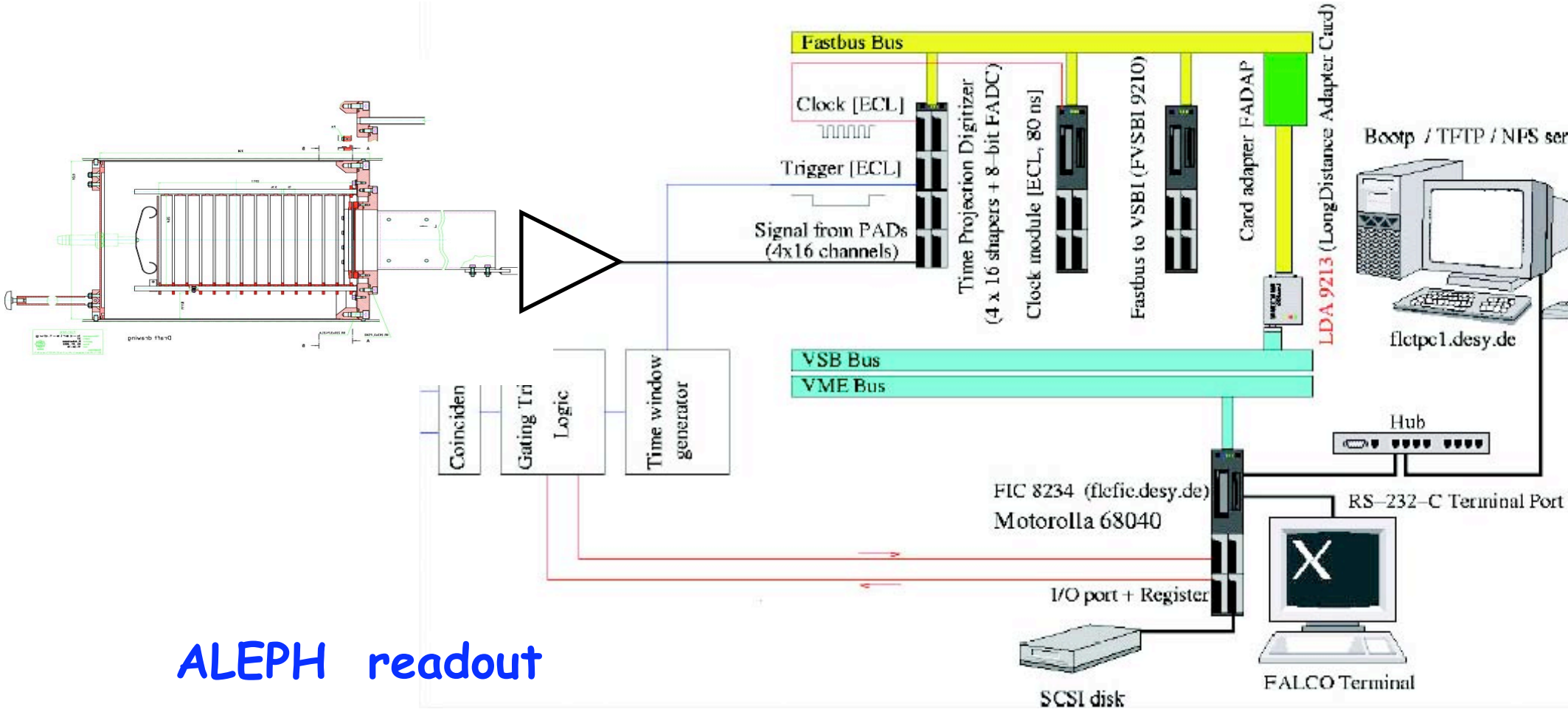


Field Cage

Readout Pad w/ broken wire



"aged" readout electronics



ALEPH readout

80nsec time slots

preamp. shaping time 500nsec

TDR Gas Ar:CH_4:CO_2=93:5:2% used

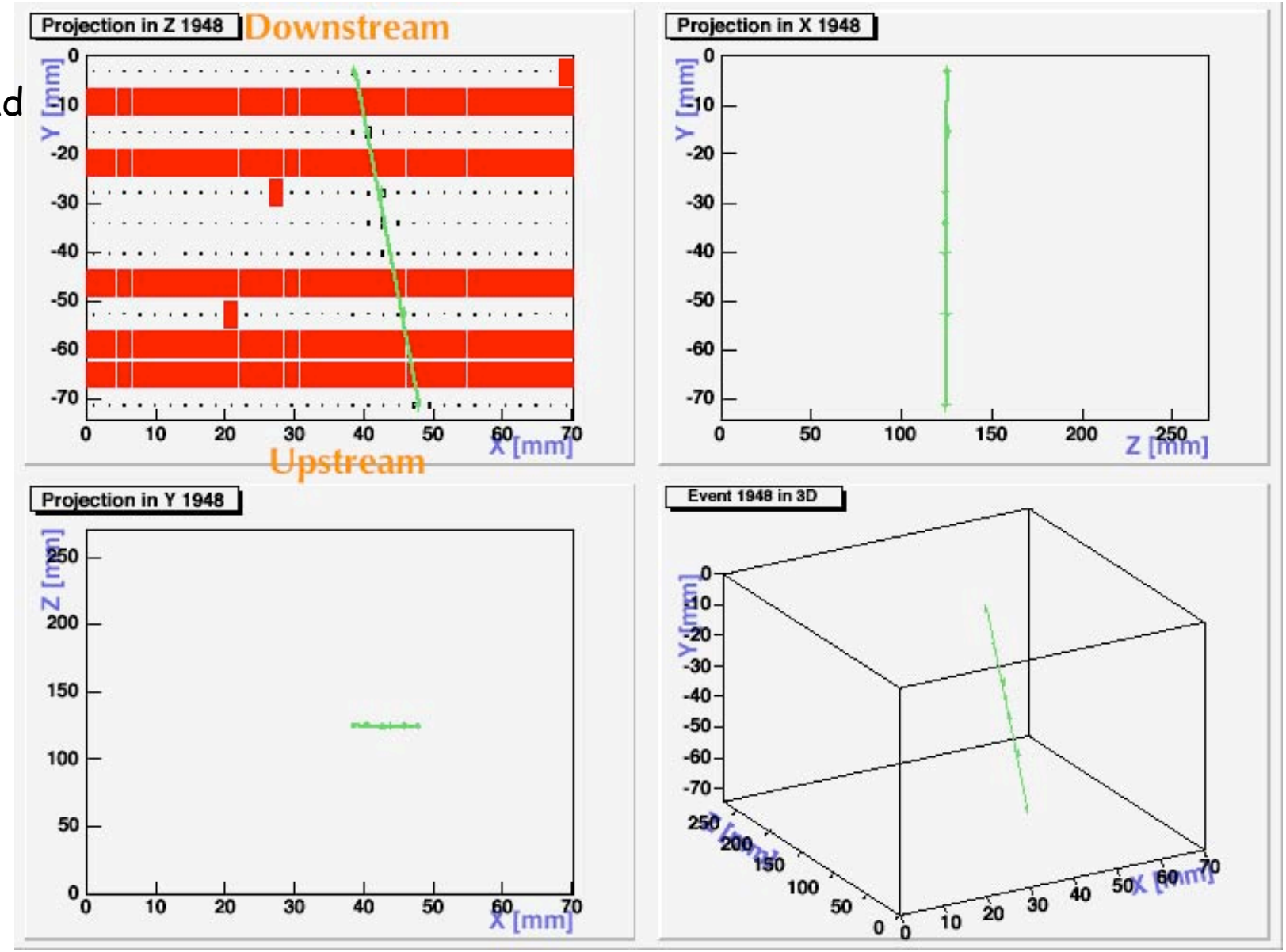
Beam test was done 6/15/04 -6/30/04

Beam Test Results

Typical Event in B = 1T, 1 GeV/c pi-

7 pad-raws are read

3 dead chan.



All results are very preliminary(no correction is applied yet!)

PRF(pad response function) as a function of z,B,phi

resolution(σx, σz) as a function of z(drift distance),B,phi

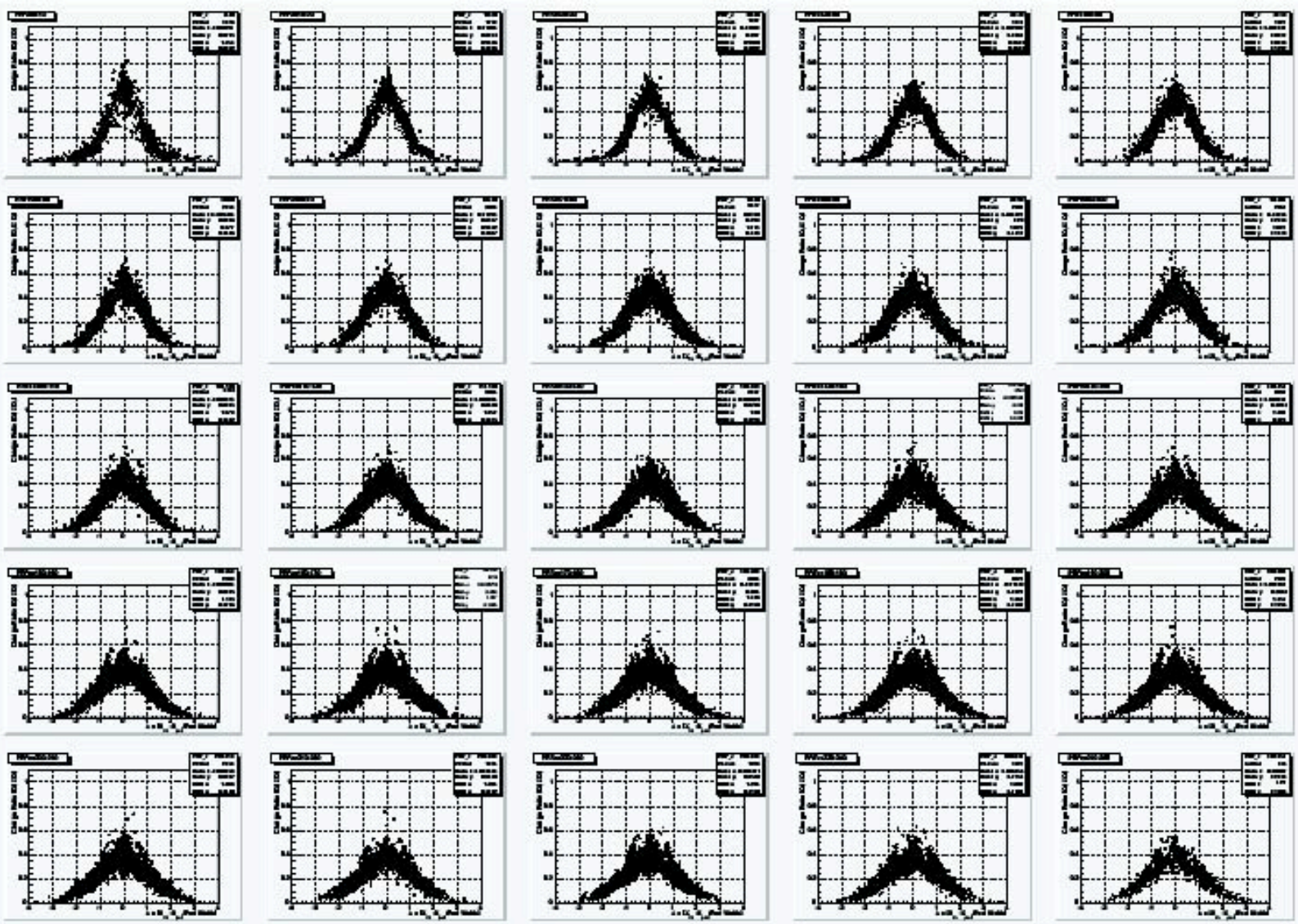
dE/dx

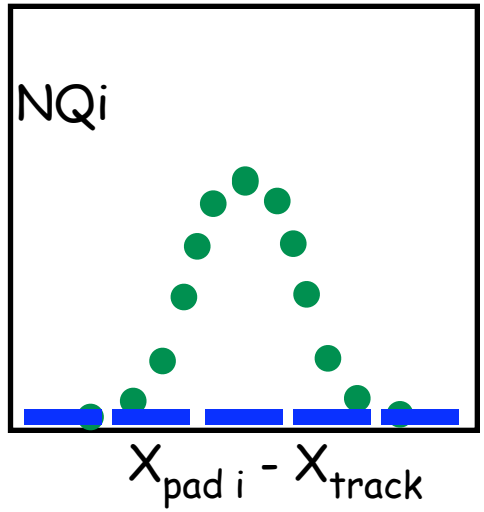
Pad Response function

is evaluated by a normalized charge (NQi = Qi/ Σ Qj) on pad i.
as a function of $(X_{pad} - X_{track})$

along z every 1 cm

B=0T



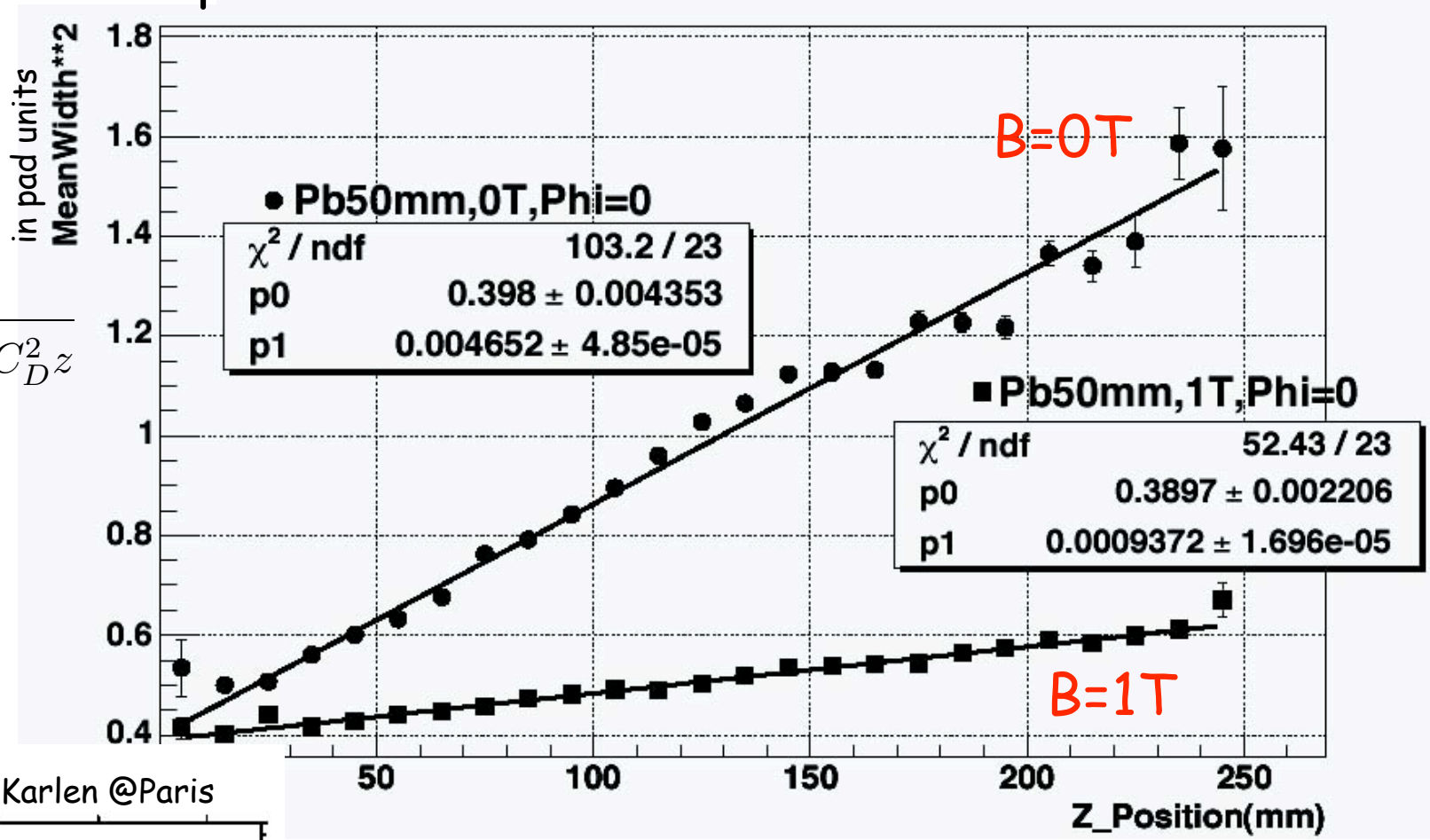


slice on X axis
obtain the mean
fit them w/ gaussian
to get width

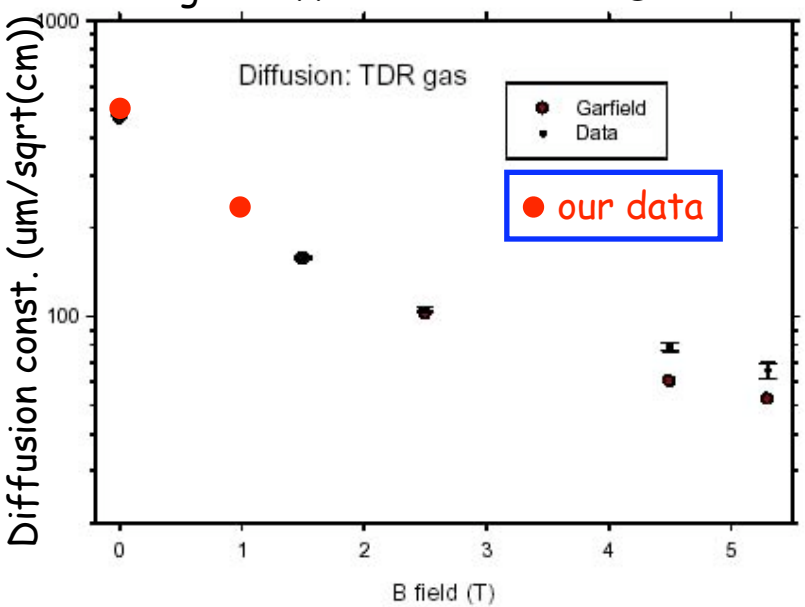
Width of PRF can be parameterized

$$\sigma_{PRF} = \sqrt{(\sigma^0_{PRF})^2 + C_D^2 z}$$

0 drift PRF



TDR gas diffusion : D.Karlen @Paris



convert param. to normal unit

	$B = 0\ T$	$B = 1\ T$
$\sigma^0_{PRF}\ (mm)$	1.44	1.45
$C_D\ (mm/\sqrt{cm})$	0.50	0.22

Diffusion is consistent with each other

0 drift σ_{PRF} = 1.45 mm (as expected)

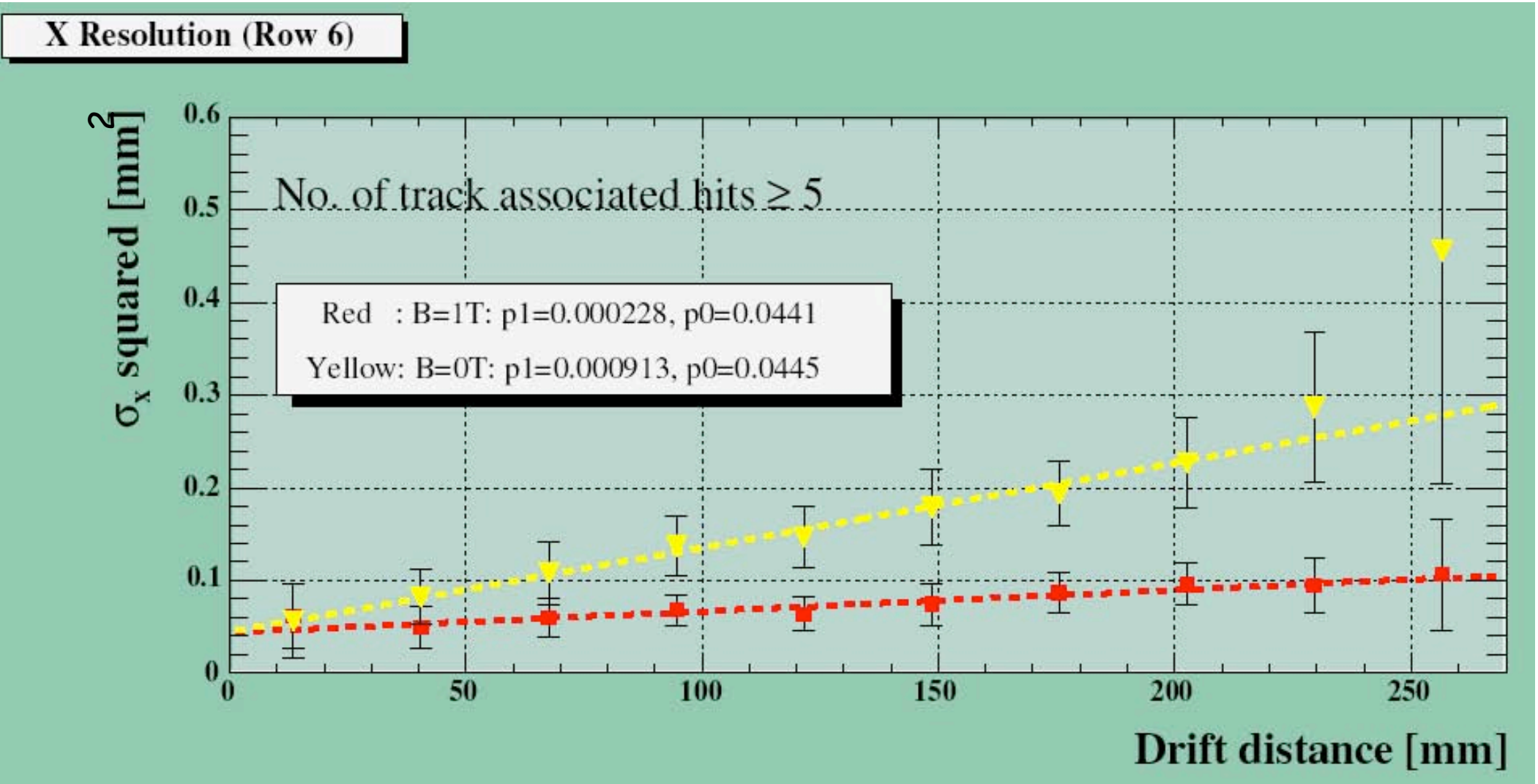
σ x resolution

can be parameterized

$$\sigma_x \sim \sqrt{\sigma_0^2 + \frac{C_D^2}{N_e} z}$$

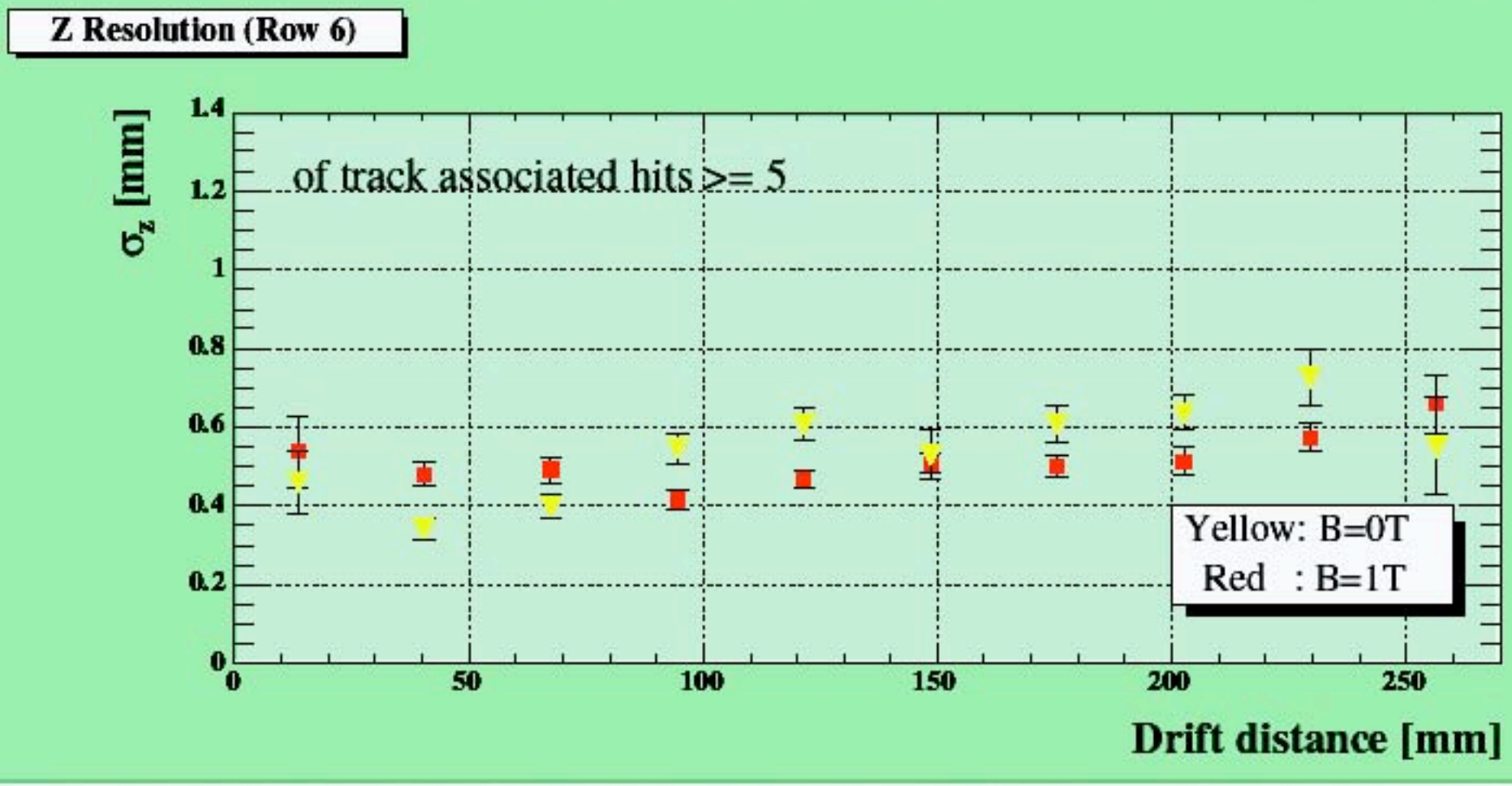
$$\begin{aligned} \sigma_0 &= 0.21 \ mm \\ C_D/\sqrt{N_e} &= 0.048 \ mm/\sqrt{cm} \ (B = 1T) \\ &= 0.096 \ mm/\sqrt{cm} \ (B = 0T) \end{aligned}$$

if Ne=60 Cd is ~8times larger than above number
if Cd is assumed, Neff= ~0.4*Ne
parametrization is too simple!? do more study



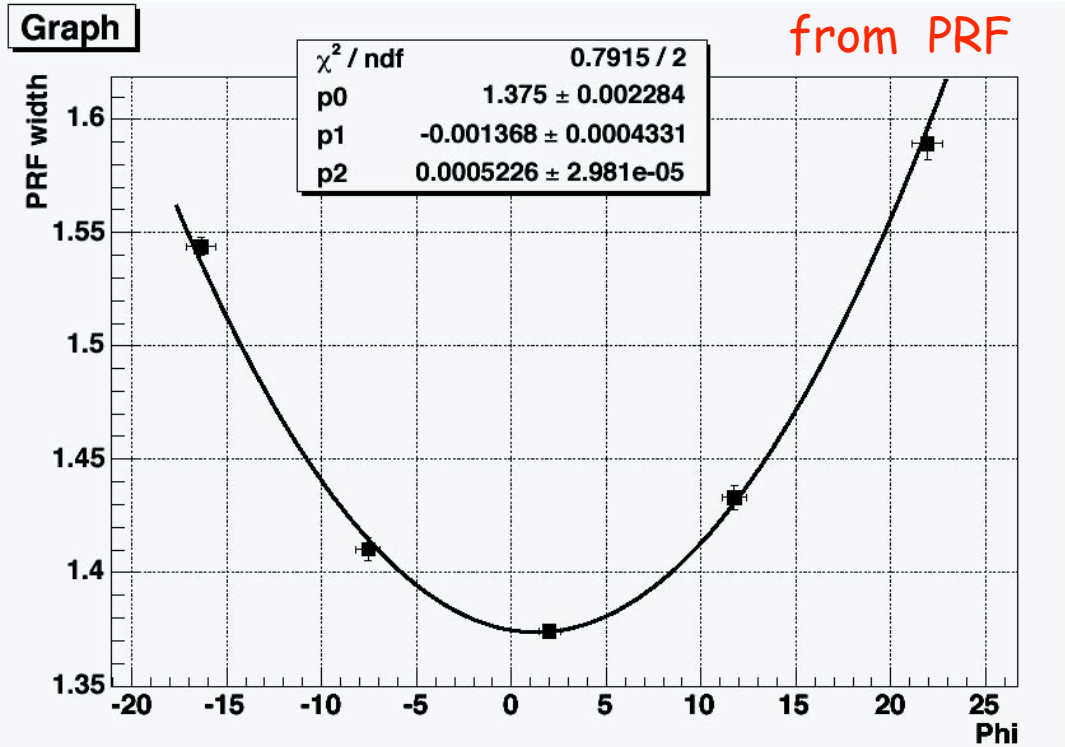
σ_z resolution

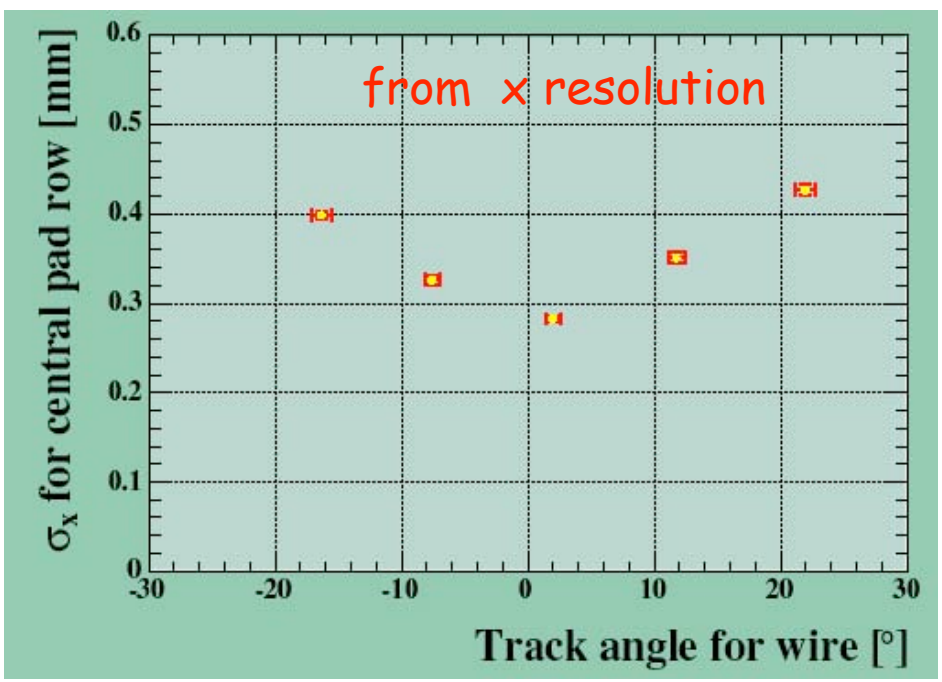
B-field dependence for central padrow (Row 6)

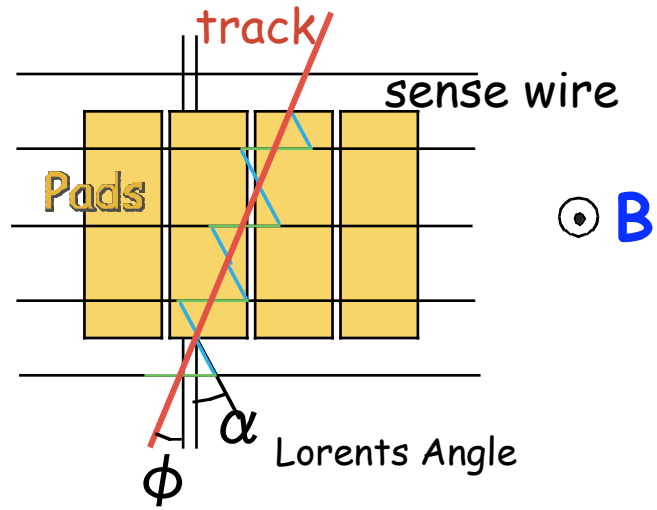


- No B-field dependencies for drift direction
- Z Resolution = 400-600 micron in B=1T (& No calibration)

Wire Angular Effect (ExB)







for a single wire

$$< x_w^2 > - < x_w >^2 = \frac{\sigma^2}{\cos^2\phi} + \frac{b^2}{12}(\tan\phi - \tan\alpha)^2$$

for 3 wires

convolute chg. dist.

from 3 line charge

need simulation to undestand detail and to get α

Similar behaviour for both PRF and X resol.

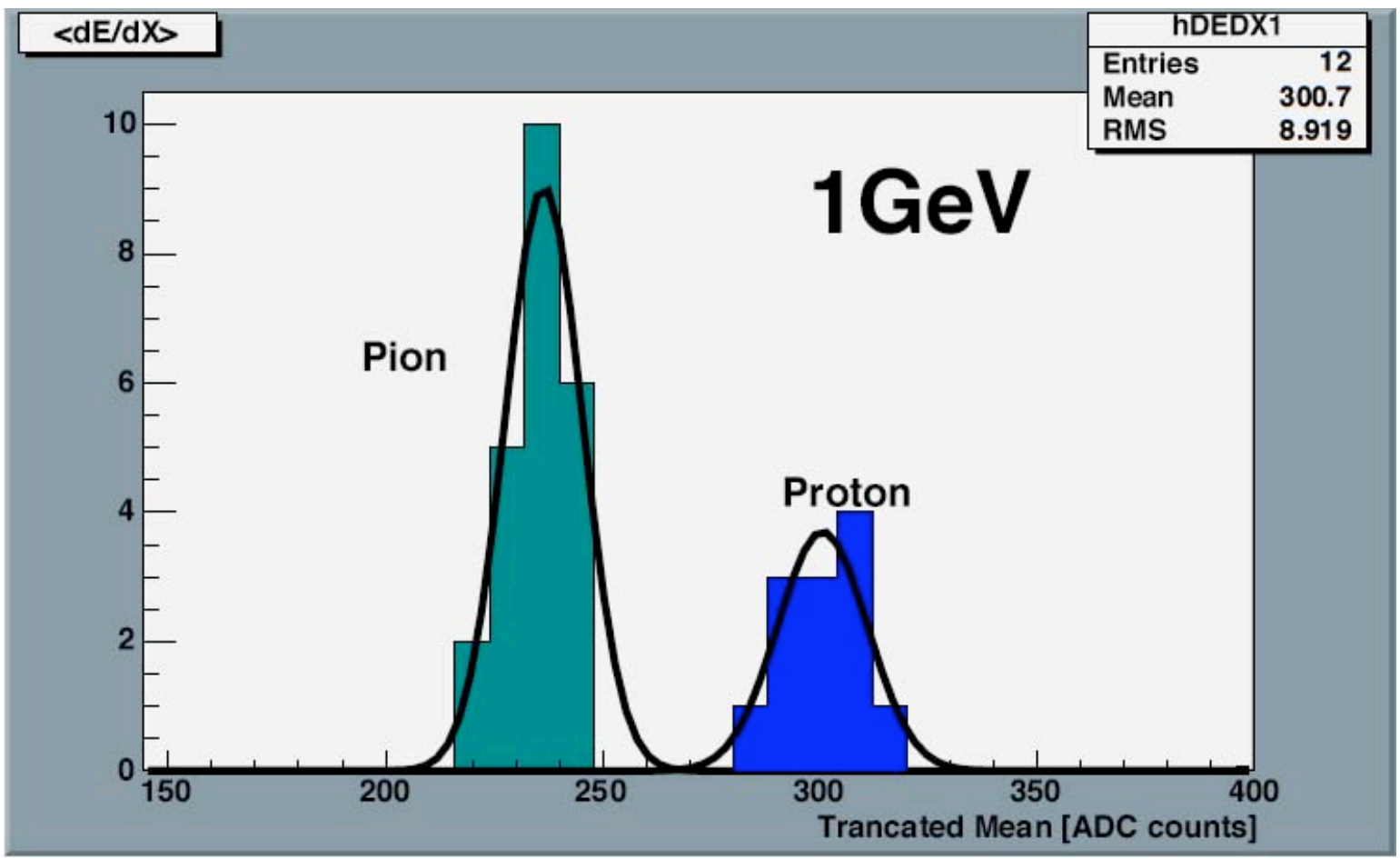
dE/dx in TDR gas

7 pad-raw /event x 30 events -> 210 sampling

$\sigma_{dE/dx}$ ~ 3.4% (-> 7.9% w/ 40 samples)

not a correct truncated mean.

good w/o calib., any corrections



proton @1GeV/c
<dE/dx> 300.6
sigma 10.3

pi @1GeV/c
<dE/dx> 236.4
sigma 8.9

Summary for TPC w/ MWPC

We start MPI/TPC operation at KEK using beam and CR

Analysis is on going.

some basic parameters are observed, but very preliminary

σ_x ~ 200(@0 drift) - 300um(@20cm drift w/1T),

σ_z ~ 400-600um small diff. w/ w/o B

We need to study more detail w/ calib., corr.

comparison to Simulation is necessary.

Status/Plan MPGD readout for TPC

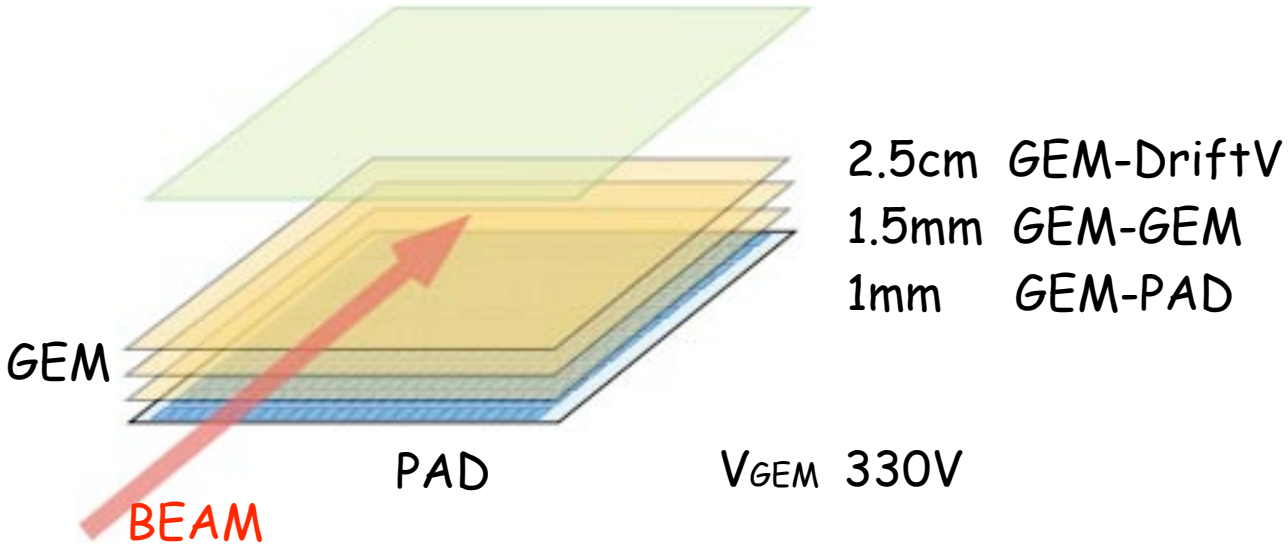
GEM readout is tested using beam

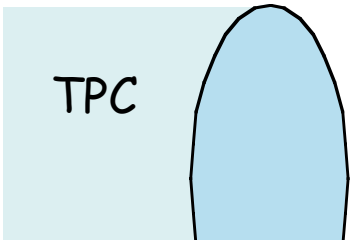
Preparation to install it into TPC is on going.

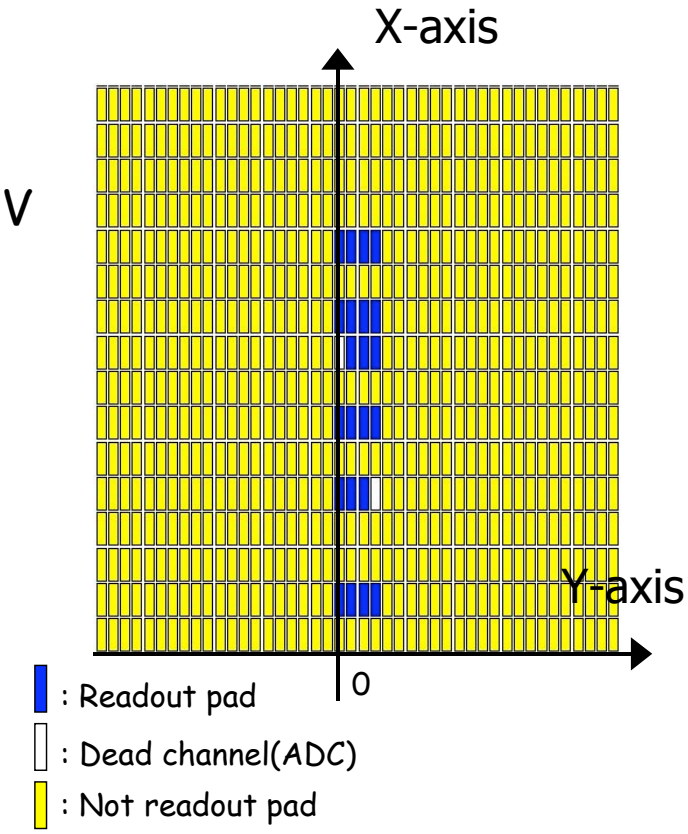
MPGD R&D for LC/TPC will be started

Beam Test of GEM sensor w/ short drift (preparation to install this into TPC)

tripple GEM
using the same readout pad plane (2mmx6mm /pad)
placed behind TPC
Gas P10
readout electronics -> wire chamber Pre/Post amp. from Belle
read ADC only







x Resolution

Using 5 pad-raws for tracking

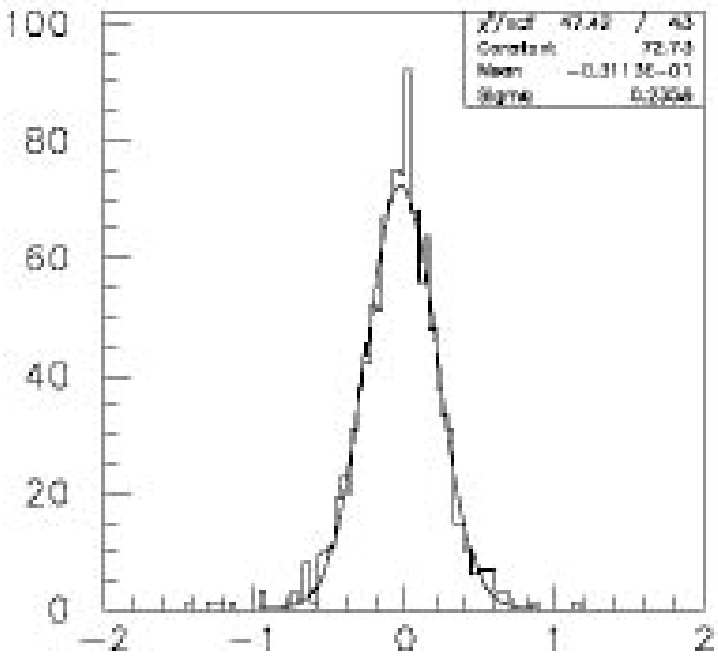
normal incidence -> many single pad hit -> track fit BAD!

cahmber is rotated about 2 degrees to make charges share on pads

≥2 hit pads are required in each pad-raw for tracking

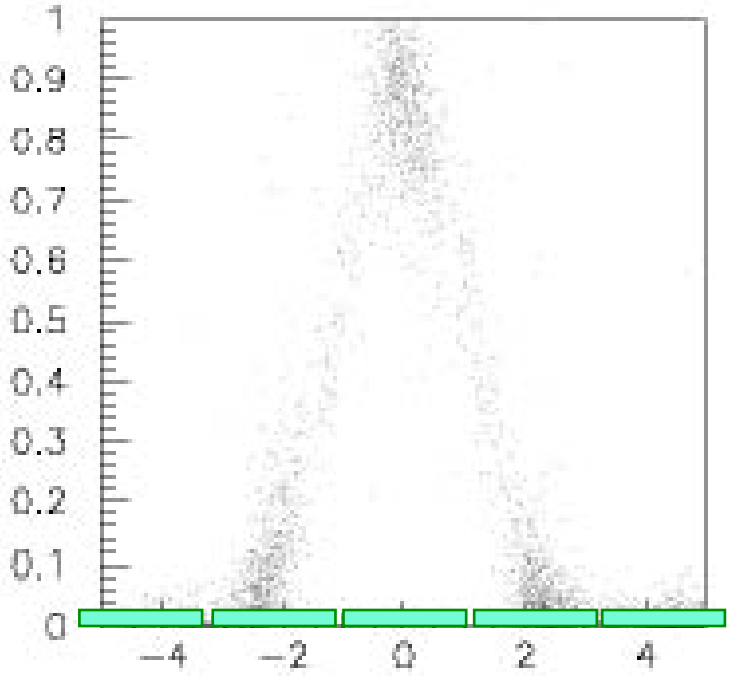
hit postion is calculated by *COG* method

σ = 235 μm



$X_{COG} - X_{track}$ mm

Q_i/Q_{tot}



$X_{pad\ i} - X_{track}$ mm

NOT great! charge sharing is not enough in short drift !

S/N needs to be improved.

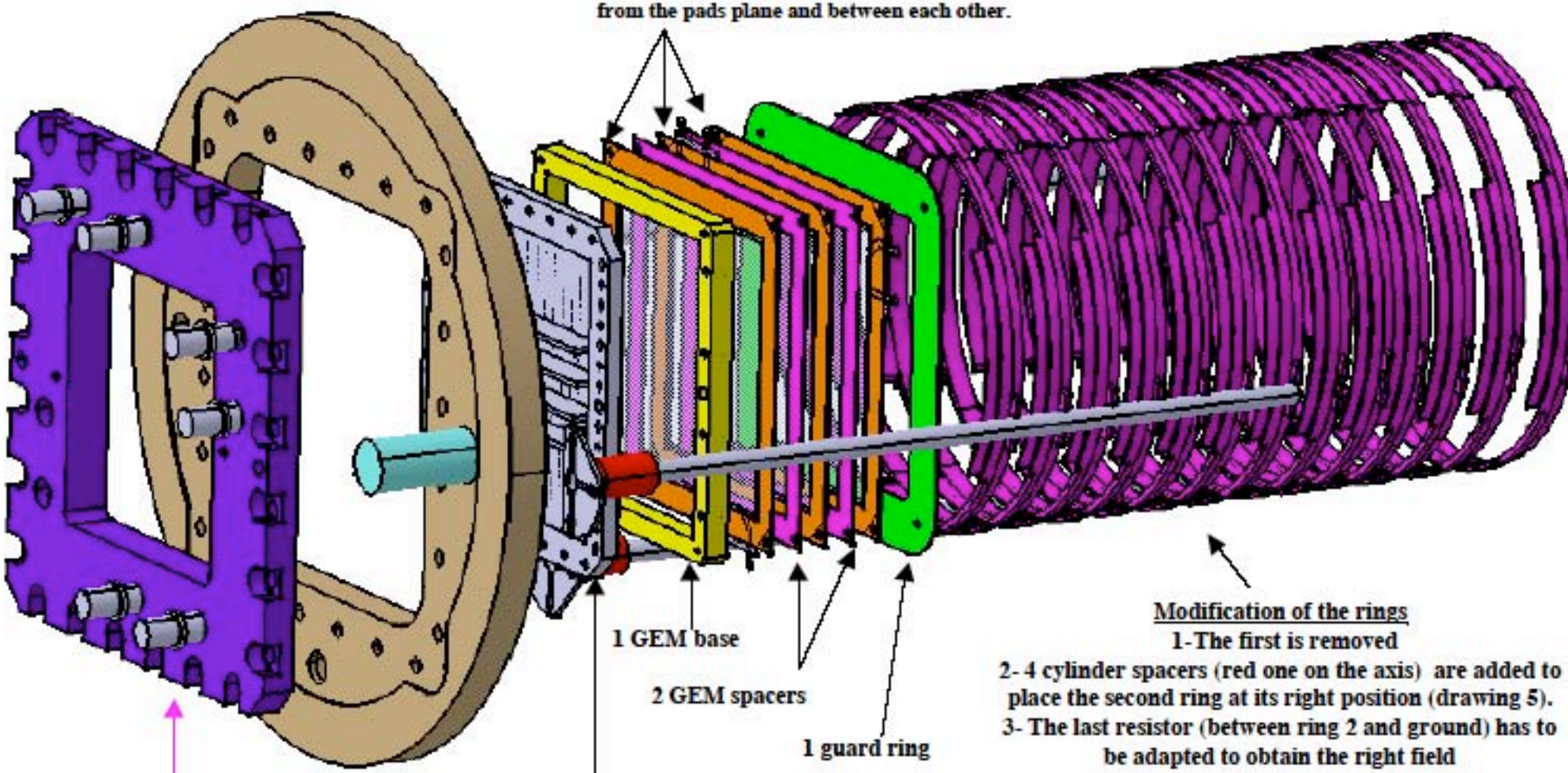
Exploded view of the modified MPI TPC equipped with 3 GEM planes

3 GEMs are mounted at a pitch of 1.5 mm. The metallic frame has to be modified (Drawing 1).
One epoxy GEM base 9 mm thick (yellow), 2 spacers 0.5 mm (purple) and a guard ring have to be machined (Drawing 2, 3 and 4).

Comments:

1- The pitch between GEM can be increased by introducing additionnal spacer

2- The reduction from 3 GEMs to 2 GEMs can be obtained by removing one plane and by adjusting the field (last resistor)



Future plans for MPI/TPC test

Cosmic ray test at Cryo. Center (to the end of Sept.)
install GEM readout into TPC (Oct.)
cosmic ray w/ GEM/TPC (Oct. ~ spring '05)
another sensor ?? micromegas?
beam test GEM/ readout (Apr./May '05 ?)
cosmic ray w/ new sensor (summer '05 ~)

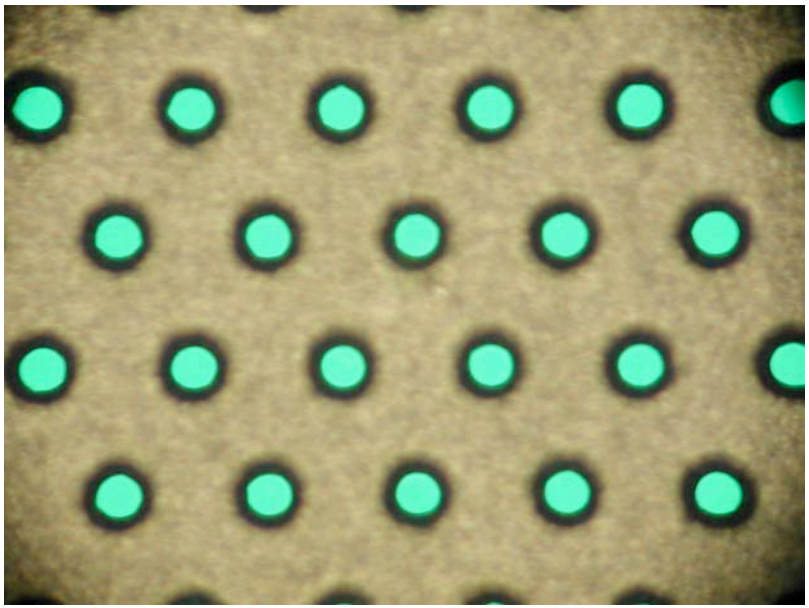
Biased work

MPGD developments in Japan

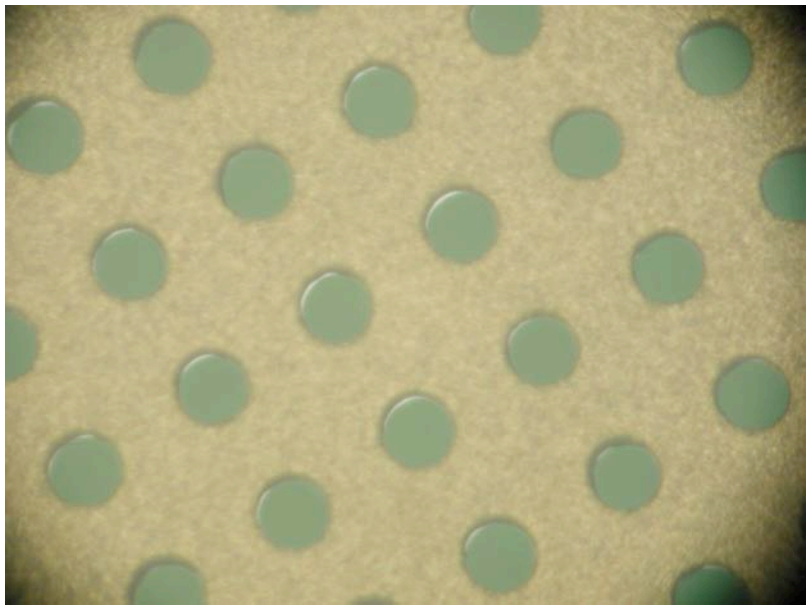
GEM : CNS(U. Tokyo) + Fuchigami Micro co.
plasma etching -> cylindrical hole instead of biconical.

μPIC : Kyoto univ. + Toshiba
pixel w/ PCB technology

CERN



Fuchigami



CERN GEM : dark ring around hole shows Kapton insulator

Fuchigami : straight hall

Gain is almost same as CERN GEM

need stability -> R&D

PIC

PCB technology
Pixel structure
2D readout

need modification for TPC
Pad readout
extra electrode for ion trap

from Nagayoshi @2004/2/9