

Cosmic Ray Test of GEM-MPI/TPC in Magnetic Field

Akira Sugiyama (Saga U.)

Asia + MPI, DESY

KEK

U. Tsukuba

Kogakuin U.

TUAT

U. Tokyo

Kinki U.

Hiroshima U.

Saga U.

Mindanao SU

(from North to South)

Motivation

MWPC->GEM

magnet, setup

cosmic ray data

Plan of Beam Test

R&D of GEM

Motivation

***Unbiased comparison of several sensors
using same Field Cage, Electronics, Analysis,,***

MWPC (original) : Beam test @ Jun. '04 Ron's talk

GEM : this talk

***MicromEGAS : Beam test is scheduled @Jun.'05
in collab. with Saclay,O'rsay,Carlton,,***

***How much resolution/2 track separation
can we achieve?***

***we try to understand TPC performance
enough to design "the real TPC"***

Accumulate experience of various sensors

from MWPC to GEM

*MPI-TPC had an ultimate MWPC
as a sensor*

*2mm wire spacing
1mm wire-cathode gap*

Modification for GEM-TPC

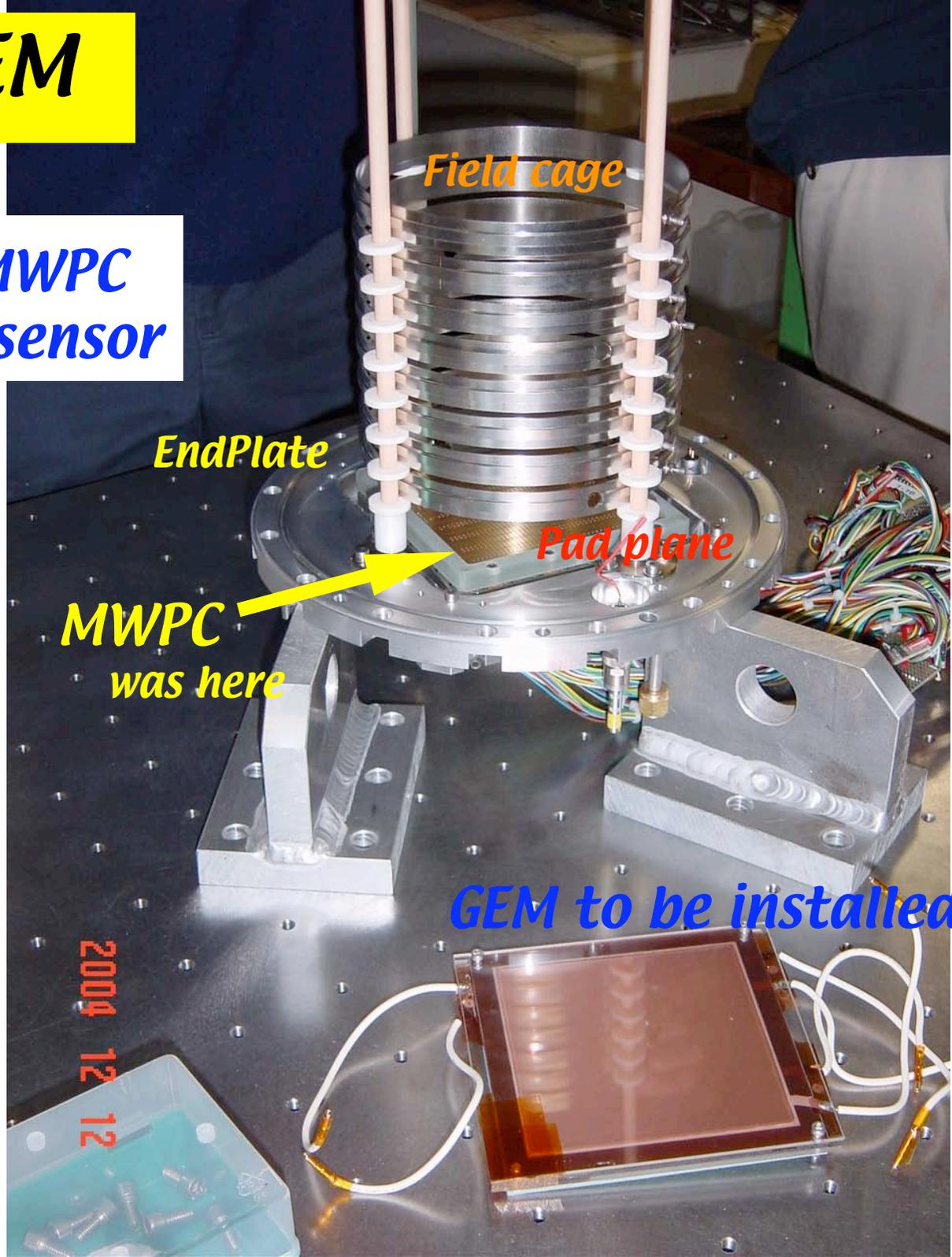
*remove cathode wire plane
rebuild Field cage*

to avoid interference

*guard ring to adjust E field
near GEM*

Many HV connectors for GEM

triple GEM was installed



Magnet

Cryogenic Center @KEK

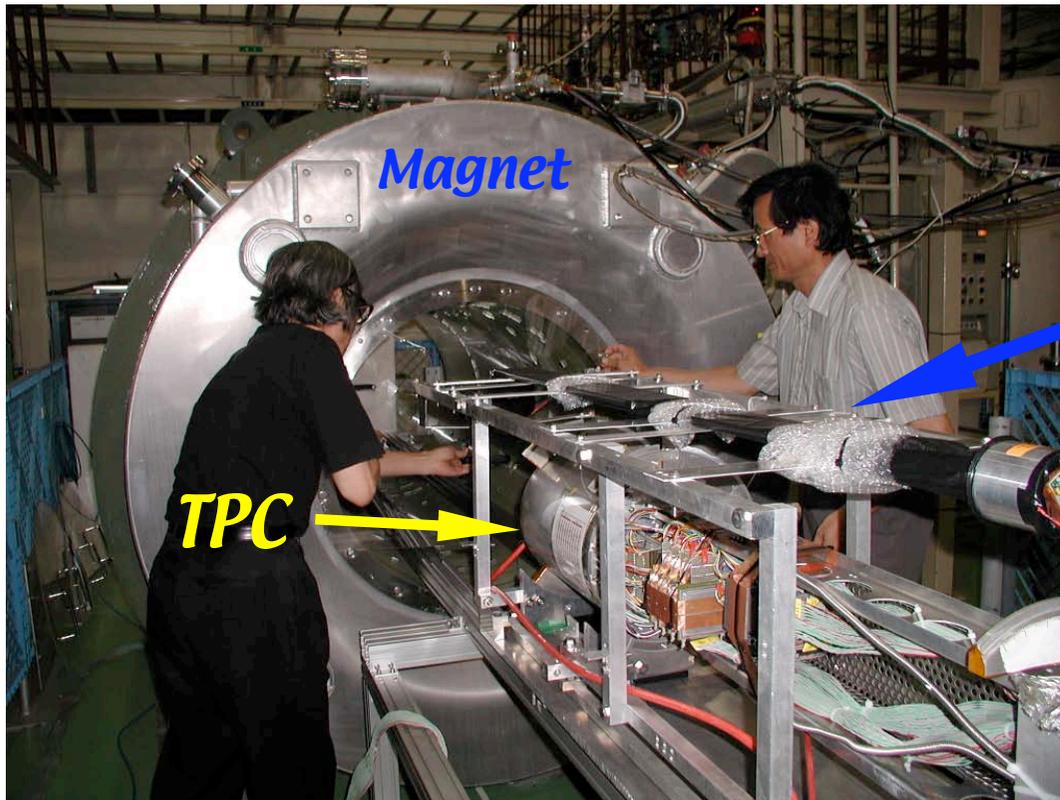
Superconducting magnet with yoke cylinder

Size is same as JACEE (used at beam test)

excited 24 hrs/everyday

$$B = 1 T$$

JACEE Magnet



*trigger
counter
(top, bottom)*

Cosmic Ray test

middle Dec. `04 GEM installation / 1st cosmic track

Jan. `05 no track observed

Feb. `05 investigation

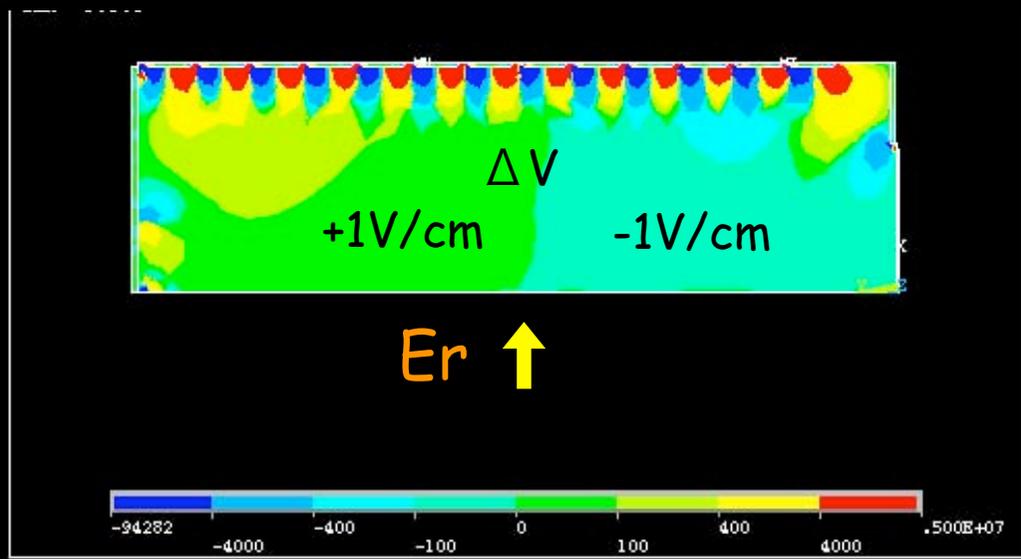
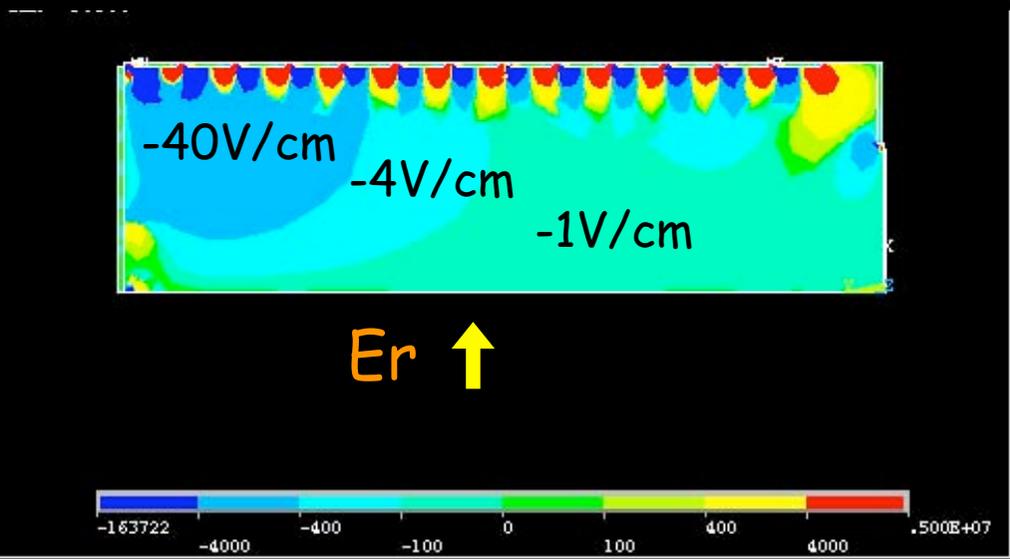
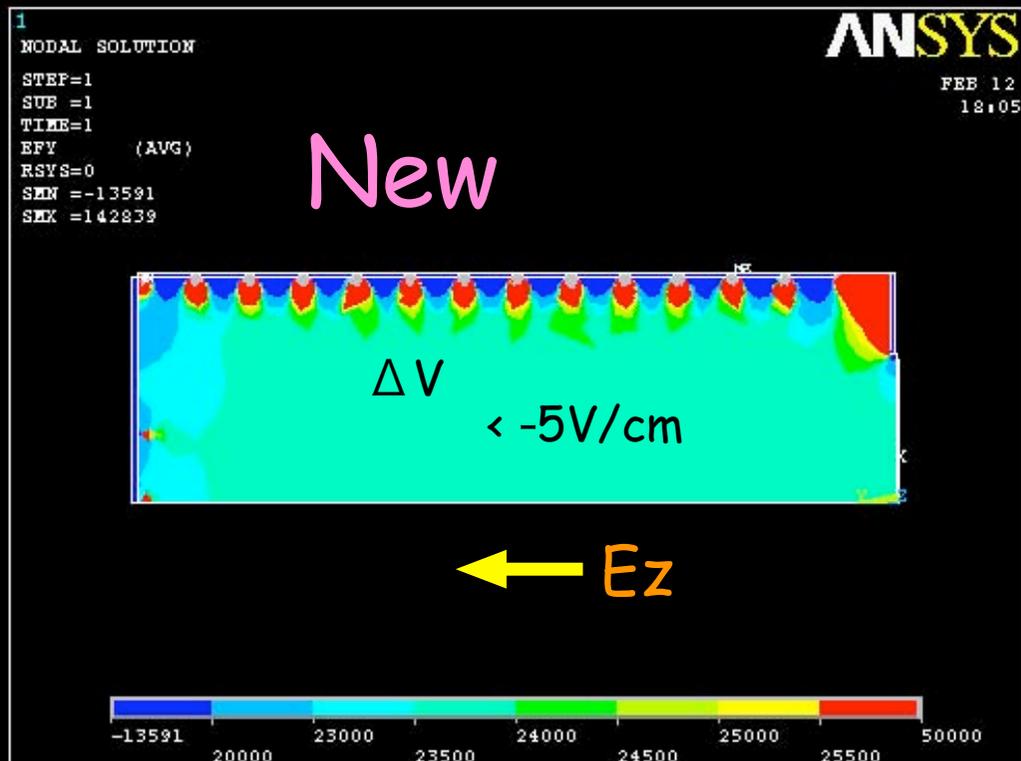
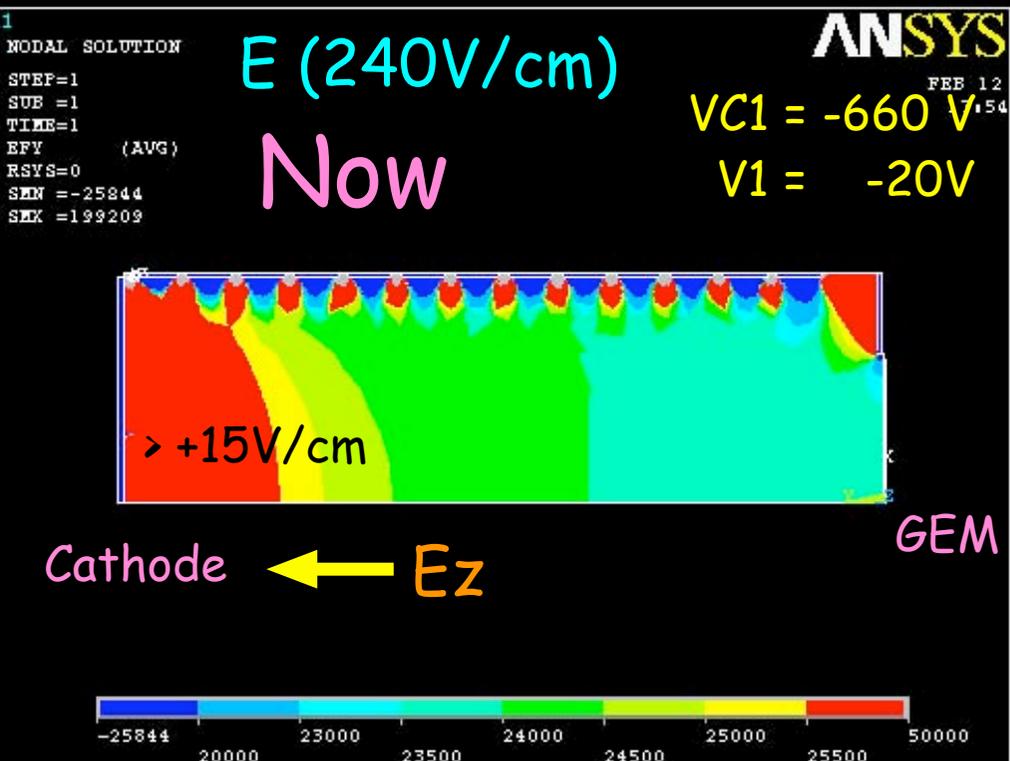
connector HV leak

*Mar. `05 Electric field calculation/adjust
continuous Data taking*

very low rate ~1000 trig./day

14th Apr. `05 Beam test

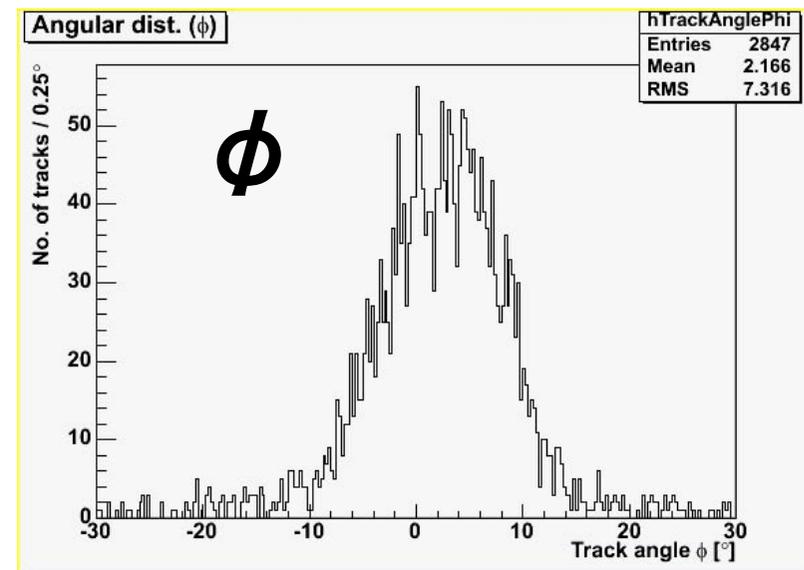
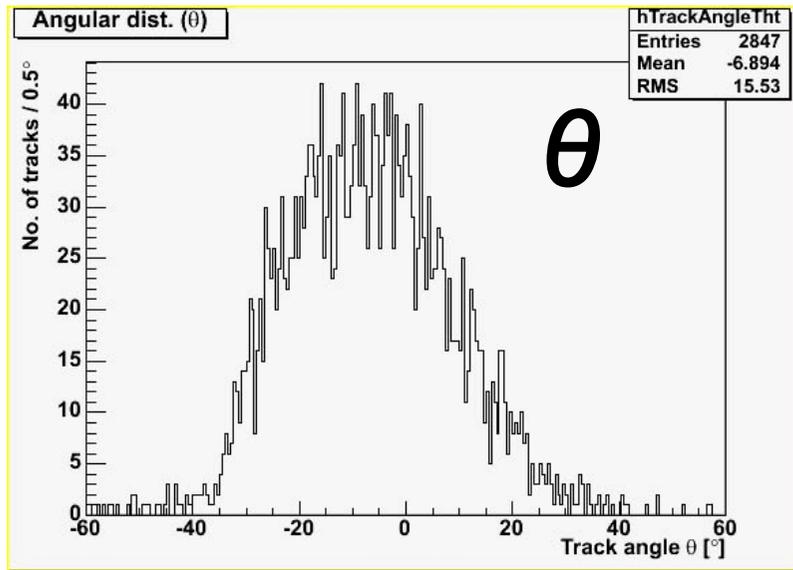
Electric Field Adjustment (be done before Beam)



Preliminary results of Cosmic Data

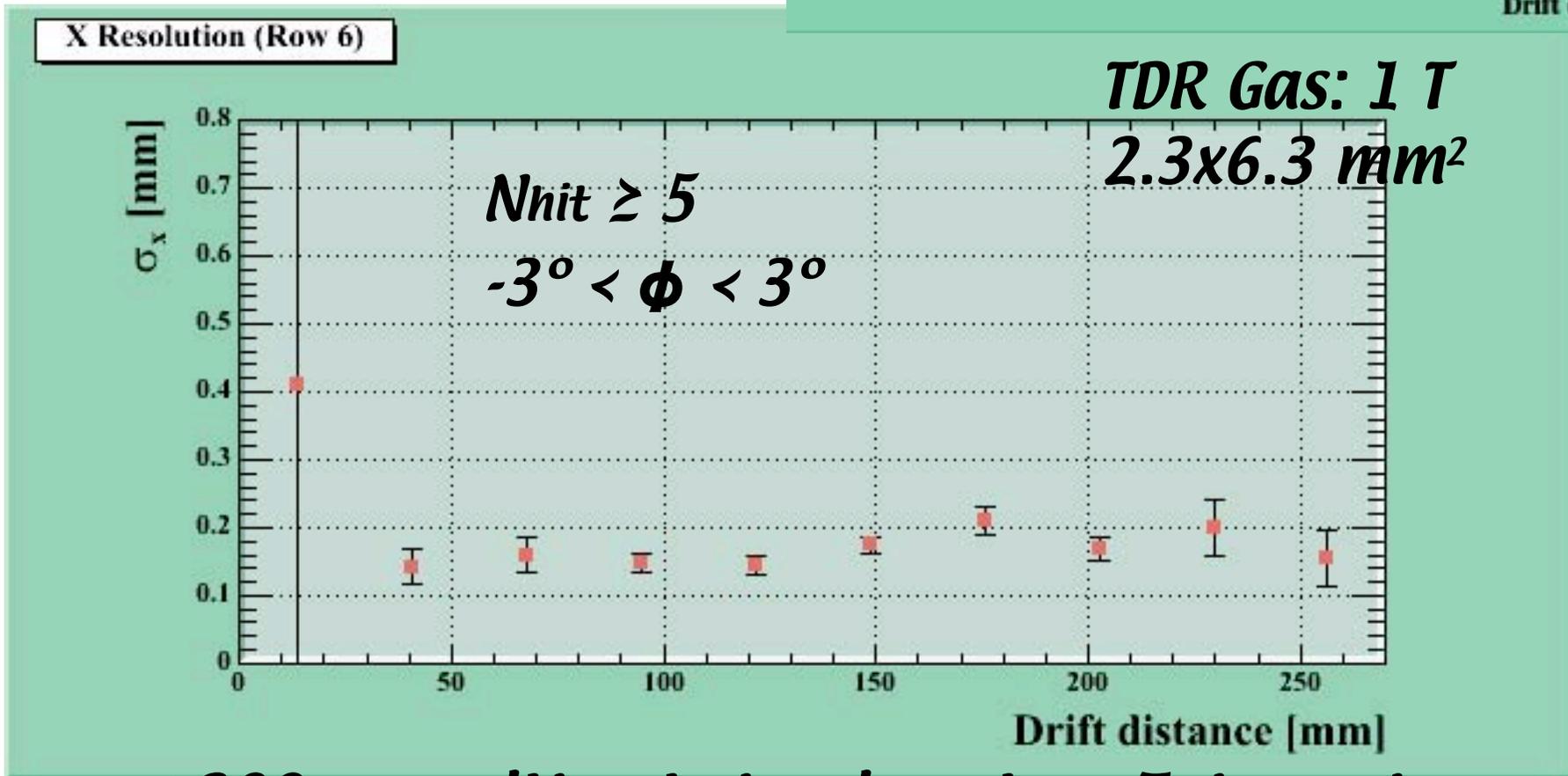
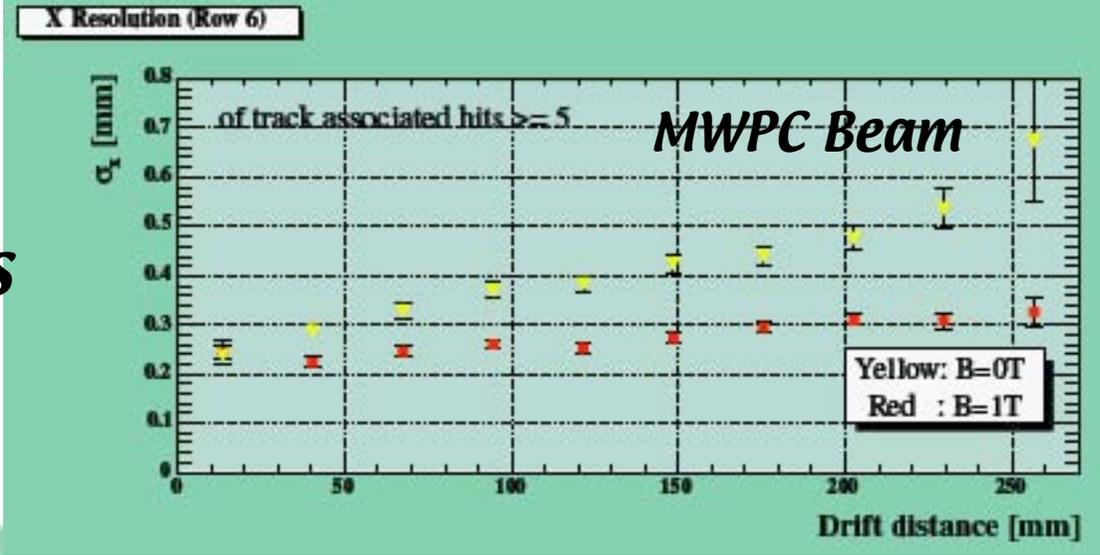
Analysis : double fit (developed @DESY)

Theta, Phi distribution (from line fit)



X Resolution

Line fit using 6 out of 7 rows
-> geometric mean

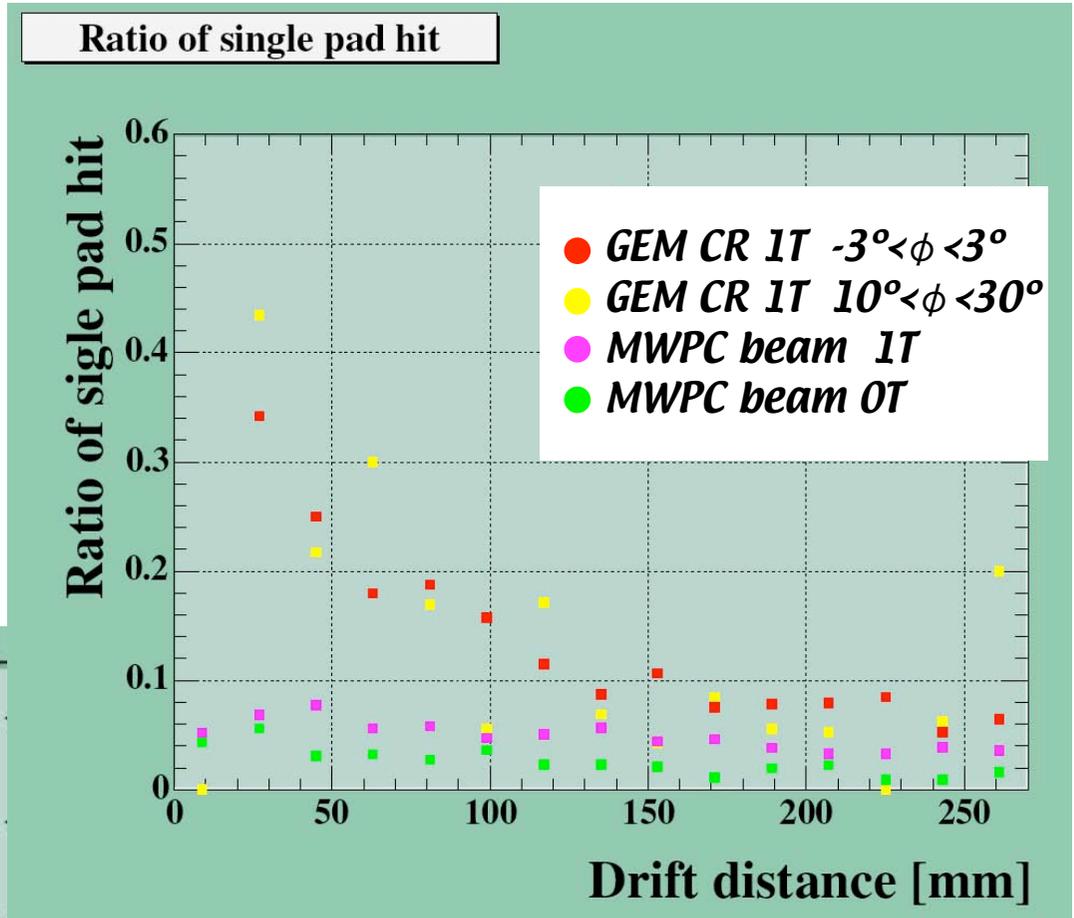


$\sigma_x \leq 200 \mu\text{m}$ without showing clear Z dependence
limited by geom. pad size ??

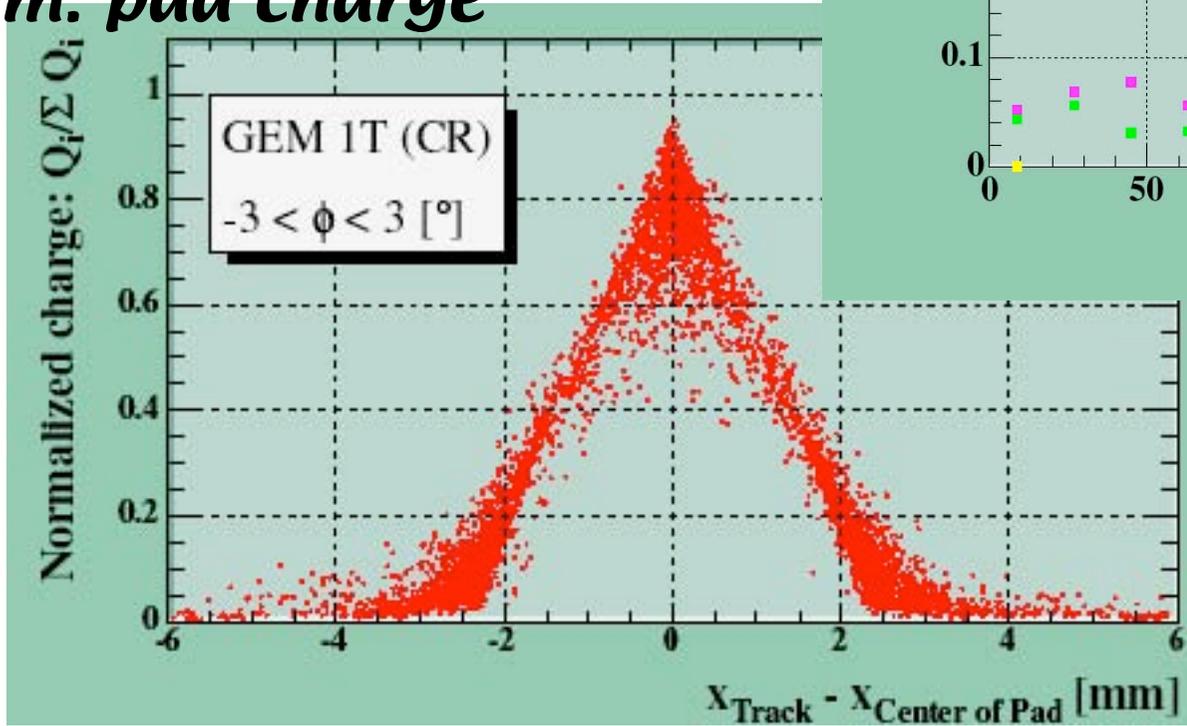
single(two) pad hit

Below 15cm in z, a ratio of single pad hit increase as Z \rightarrow small

Ratio of single pad hit



Norm. pad charge

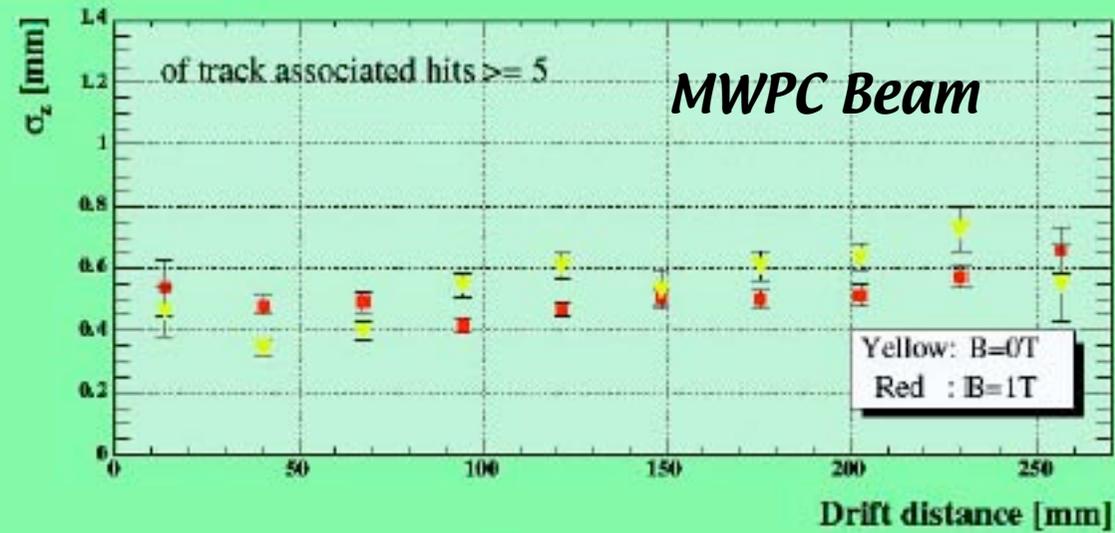


This is the sign We cannot obtain charge width from this method

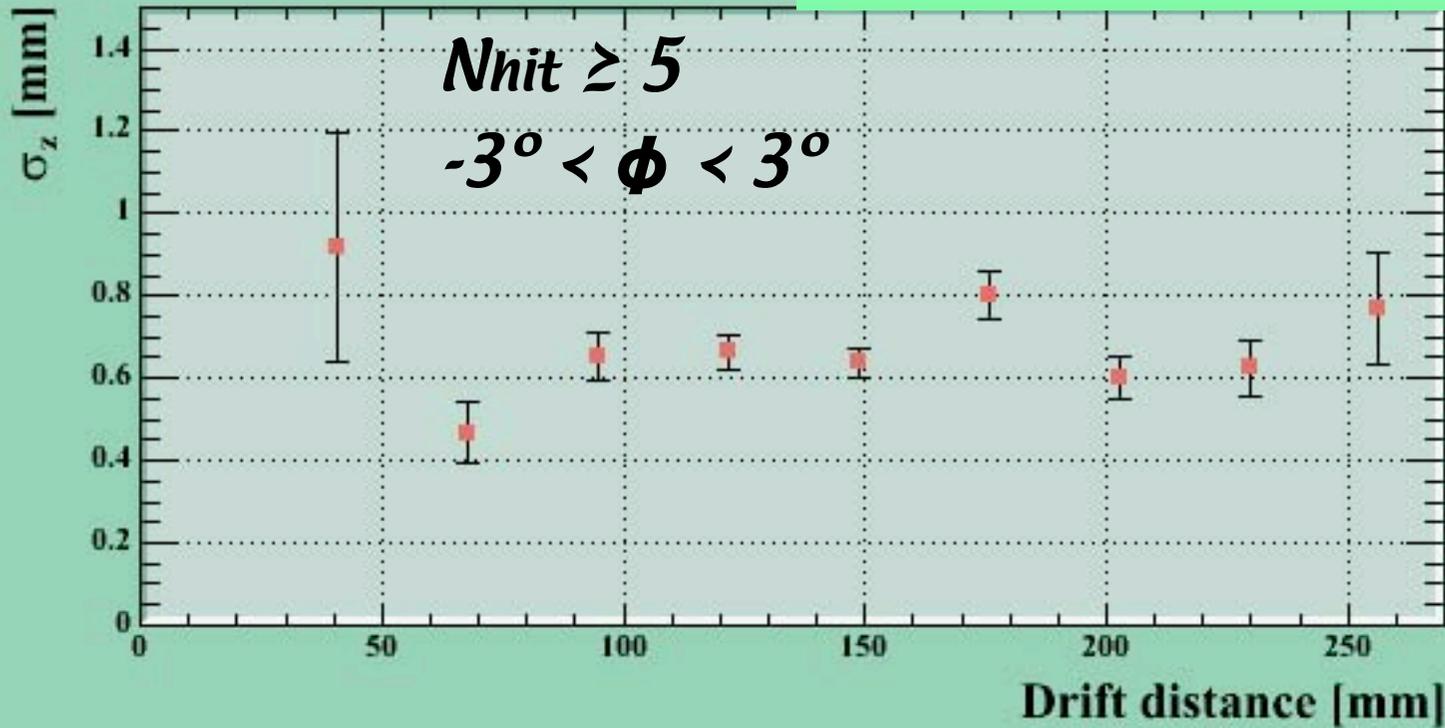
narrower pad size is necessary !

Z Resolution

Z Resolution (Row 6)



Z Resolution (Row 6)



$\sigma_z \sim 600 \mu\text{m}$

low statistics, no selection in θ

Circle Fit

Peak is shifted

~ 0.000527

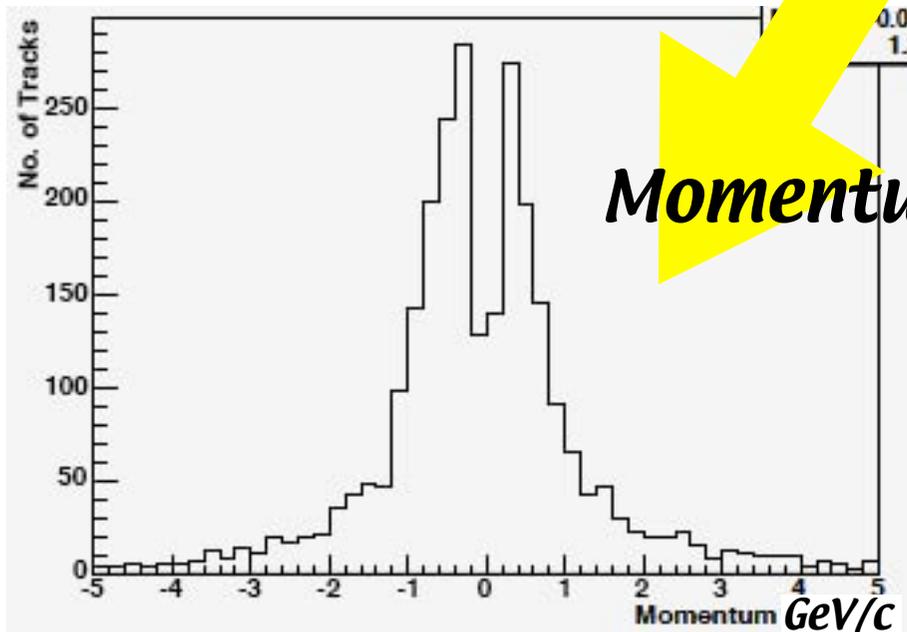
shift depend on Z

many systematic effect may exist

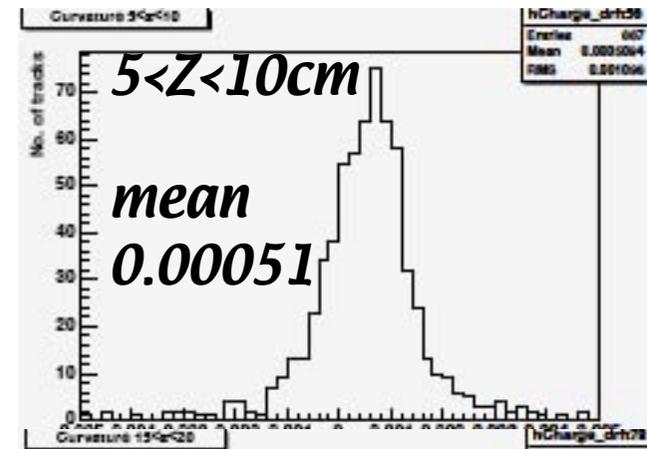
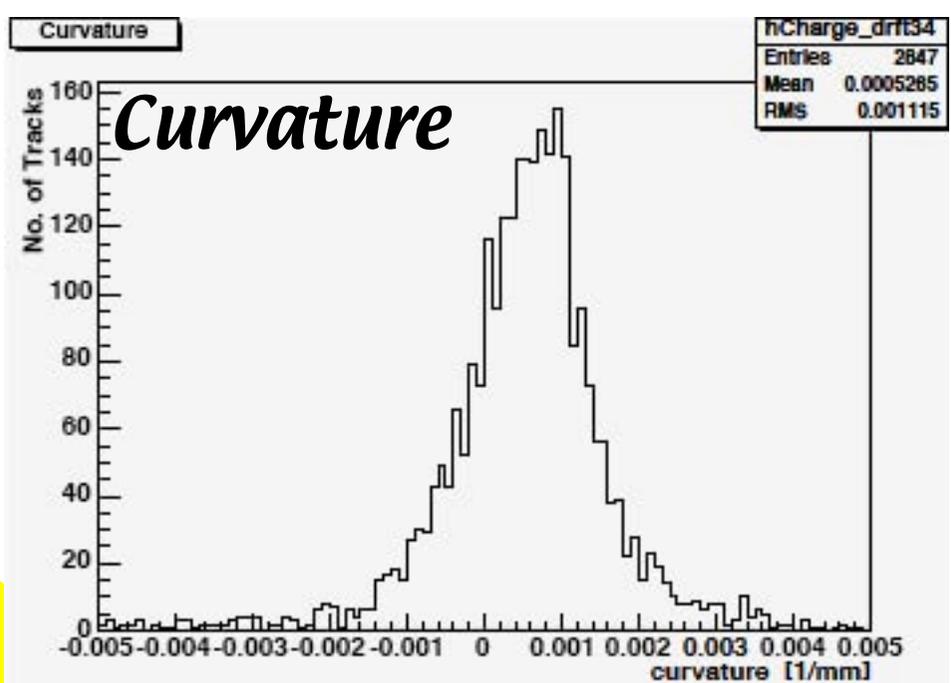
conversion formula

from prev. beam data + shift

$$P = 0.000372 / (\text{curv.} - 0.00052)$$

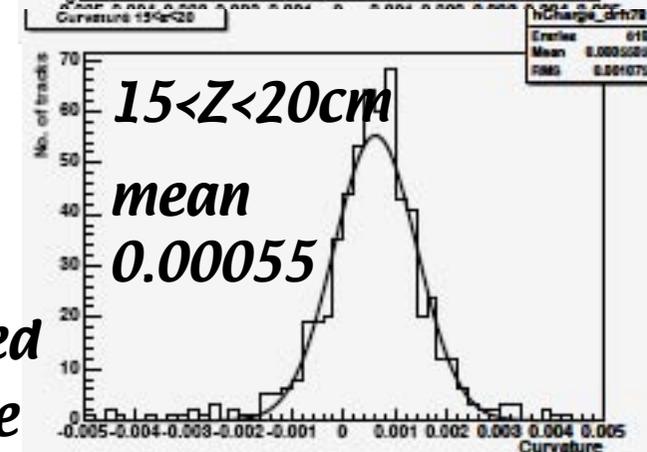


Momentum



$5 < Z < 10 \text{ cm}$

mean
 0.00051



$15 < Z < 20 \text{ cm}$

mean
 0.00055

Effect of distortion/non-uniform field must be considered
not to produce extra Z dependence

GEM R&D

*Plasma etched GEM works as well as CERN GEM
(same geom. as CERNs') at beam*

CERN GEM

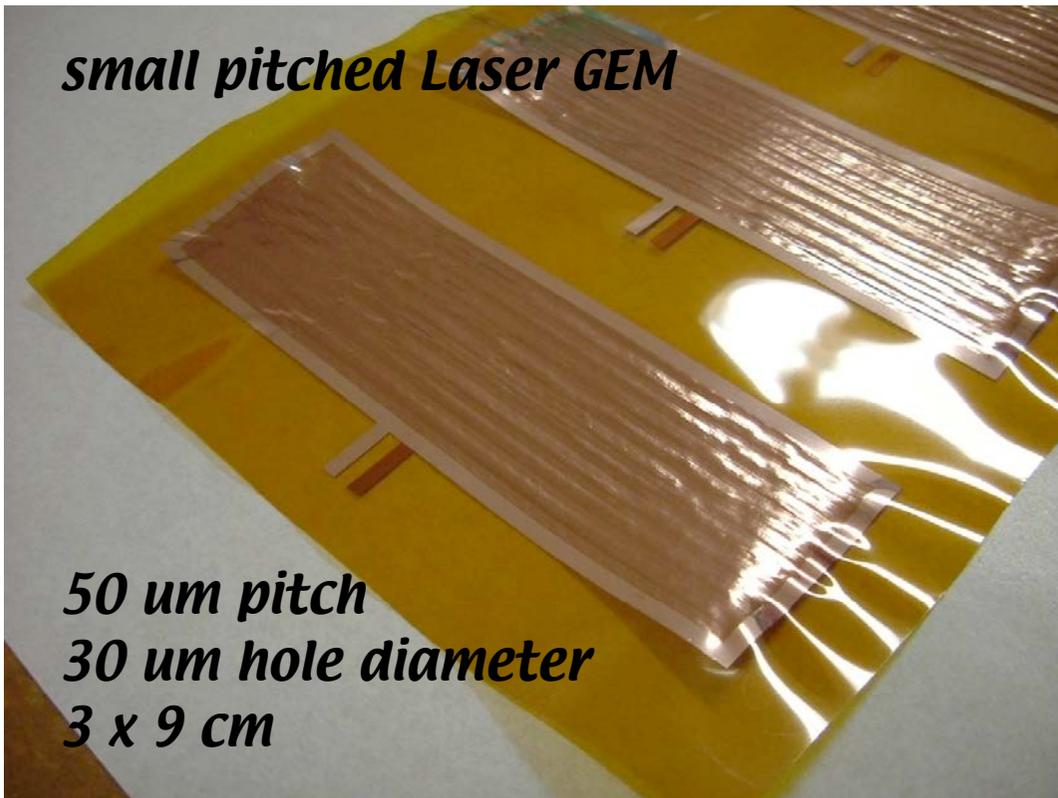


bi-conical

Fuchigami GEM



cylinder



small pitched Laser GEM

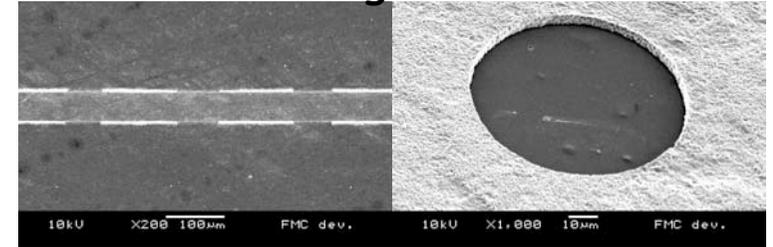
*50 um pitch
30 um hole diameter
3 x 9 cm*

expecting higher gain@stability

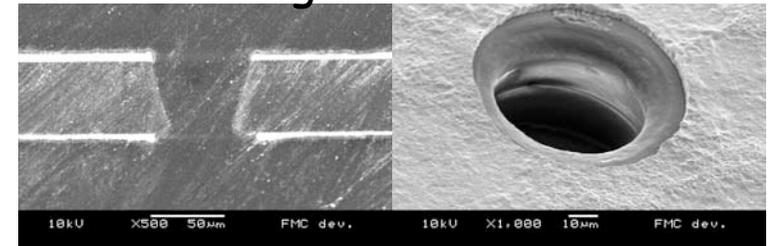
Laser GEM

*Laser etched GEM developed
by Tamagawa(RIKEN)*

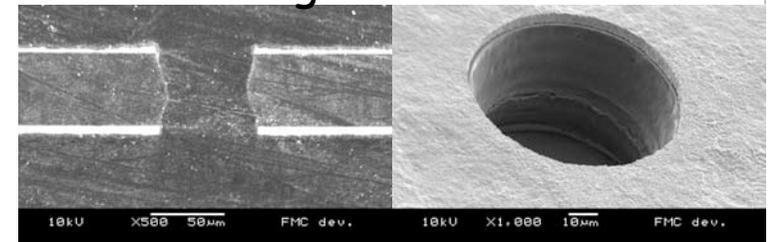
*3 x 3 cm CO₂ Laser etching by
RIKEN/Fuchigami
Chemical etching for Cu*



Laser etching from one side



Laser etching from the other side



Schedule of 2005 & Summary

*April
14~21*

*GEM TPC beam test
1.27 mm pad (hopefully)
parasite Fuchigami Laser GEM test*

*June 24
~ July 1*

MicromEGAS TPC beam test

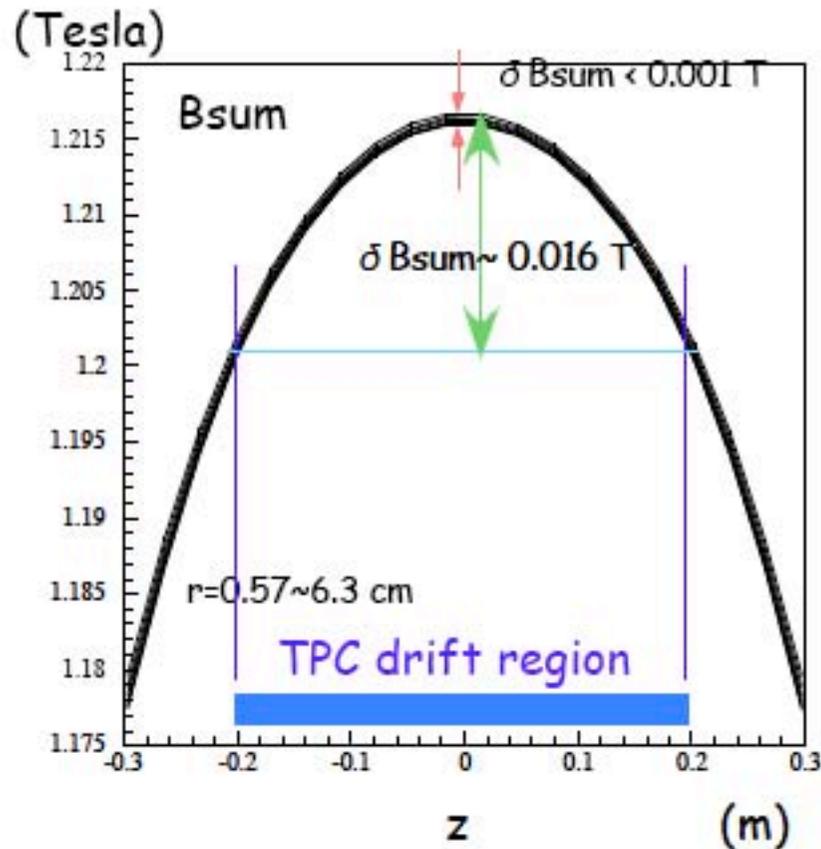
*not this time
w/ resistive foil (?)
with Carlton's readout elec(??).*

*Cosmic ray test/analysis continues ...
towards Outline design for ILC detector*

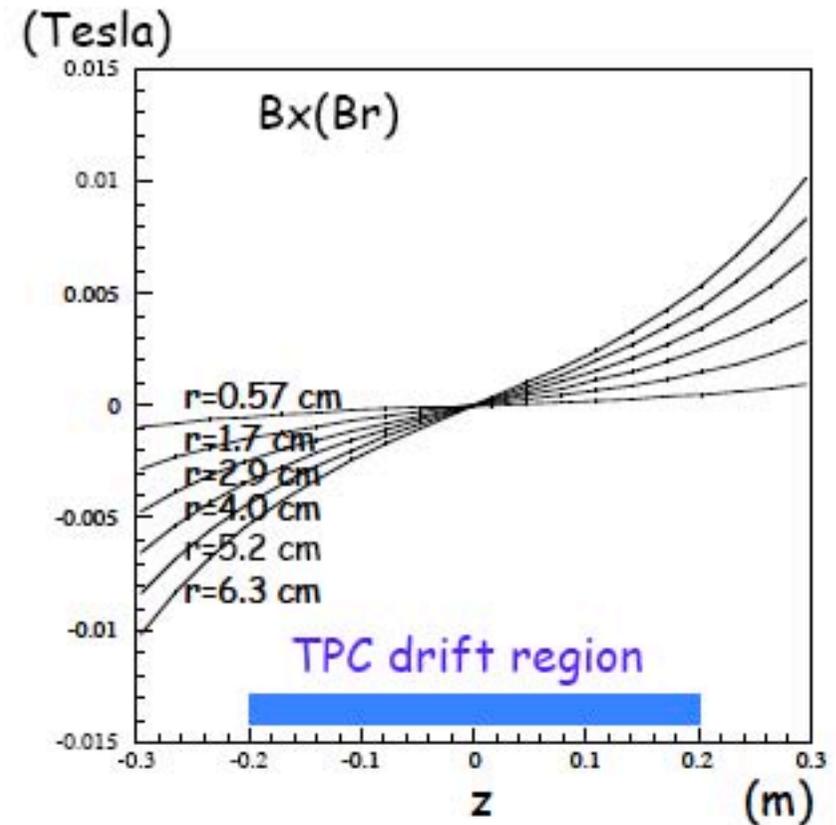
*We just began GEM-TPC study
Cosmic data looks reasonable
it's almost ready for beam test*

JACEE magnet field uniformity

Magnetic field around TPC region



$d|B| \sim 0.016$ T (1.3%)
if center is aligned



Max. $|B_r| < 0.005$ T (0.4%)
for TPC drift region
(40 cm)