# TPC R&D at ASIA/MPI

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summary of 2004 work
plan of 2005
WorldWide TPC study
MPGD R&D in Japan

# Work done in 2004

The first year of TPC study@ASIA

## Hardware

MPI/TPC MWPC

beam test in JACEE solenoid (June)

cosmic test (Nov.)

triple GEM test chamber

beam test(Jun., Dec.)

GEM CERN/Fuchigami

MPI/TPC( MWPC -> triple GEM ) (Dec.)

MPI/TPC

Comparison all kind of sensors in the same environment

MWPC, GEM, micromegas, ,,,

## Software

Developing JUPITER based tracking w/ TPC geometry

re-establish the real requirements to tracker

resolution, 2track separation, extra pol. ,,,,

# TPC with MWPC

Accumulated experiences
Stable operation

Cathode readout -- broad image
resolution (ExB, ,, )

2mm : small pitched anode wires
1mm : small gap between wires to cathode pads

Pad response @ 0 drift -> ~1.5 mm ( due to gap length )
Diffusion behavior is as expected

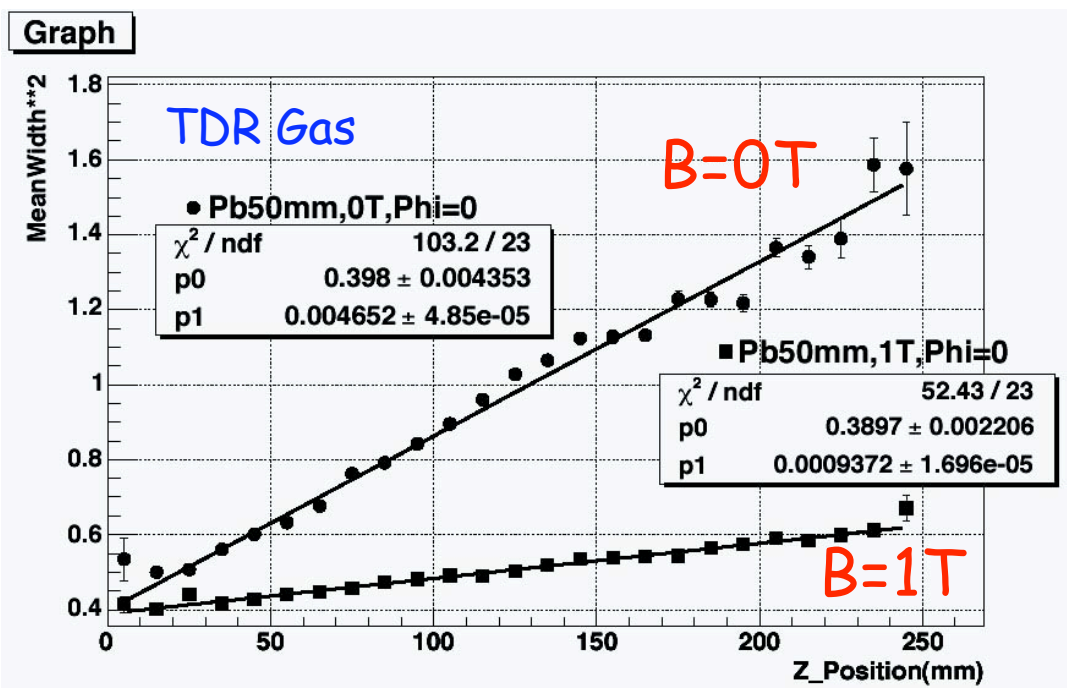
$$\sigma_{PRF} = \sqrt{(\sigma^0_{PRF})^2 + C_D^2 z}$$

0 drift PRF

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

Expected $C_D$ @B=3T ~0.1 mm/√cm

signal width ~2mm @ 2.3m drift
enough for 2 track separation??



# Resolution

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

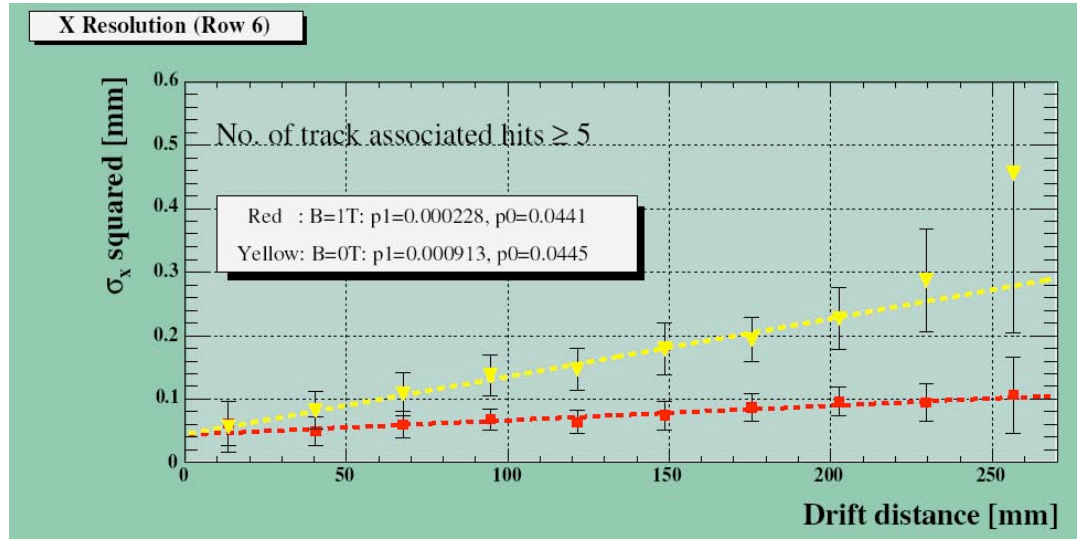
From fit

$\sigma_0 = 0.21\ mm$

$C_D/\sqrt{N_e} = 0.048\ mm/\sqrt{cm}\ \ (B = 1T)$

$= 0.096\ mm/\sqrt{cm}\ \ (B = 0T)$

preliminary




obtained "Ne" is ~ 40% of real Ne !!

wire screening effect?
gain fluctuation?
due to tracking error?

eee
e

## "Huge" detector TPC

Max. drift length ~ 2.3m@B=3T

$C_D$= 0.1 mm/√cm TDR@B=3T

Ne 100% $\sigma_x$ ~ 190 um

Ne 40% $\sigma_x$ ~ 300 um

+ $\sigma_0$ $\sigma_x$ ~ 370 um

need better gas having smaller $C_D$

improve "Ne" or MPGD

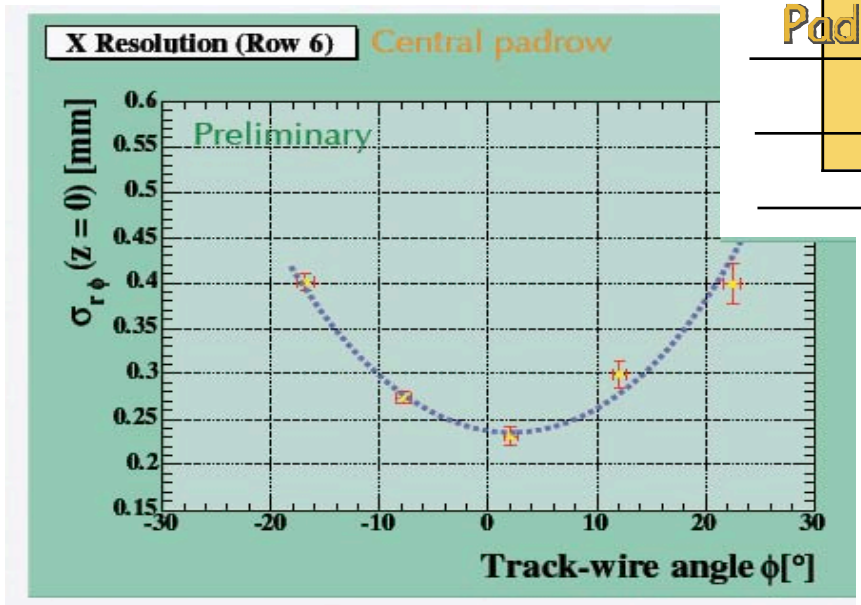
improve resolution ( S/N, corrections)

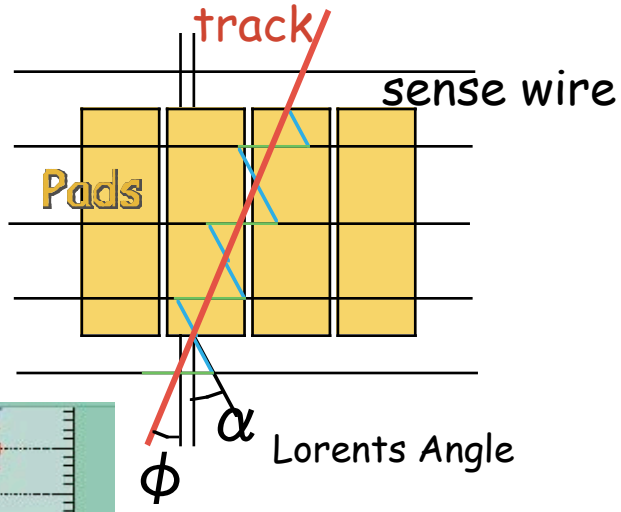
210 um is a little bit too large!

to achieve 150um : $C_D$ < 0.07 mm/√cm w/ 100% Ne

$\sigma_0$ < 0.1 mm

# Wire Angular effect(EXB) is not so bad for 2mm pitch sense wire




## We will finish analysis for MWPC-TPC data ASAP -->LCWS05

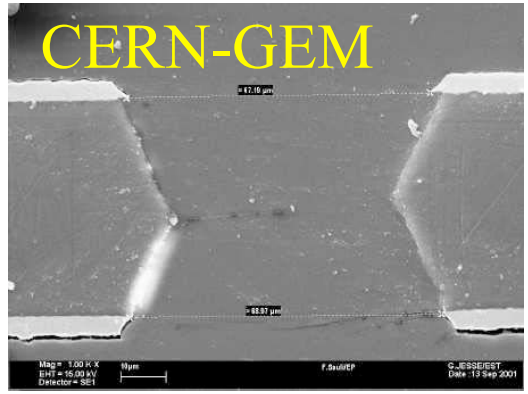
Using obtained parameters : Simulation study w/ MWPC-TPC

# Study GEM using test chamber

GEM

CERN/Fuchigami show almost same performance

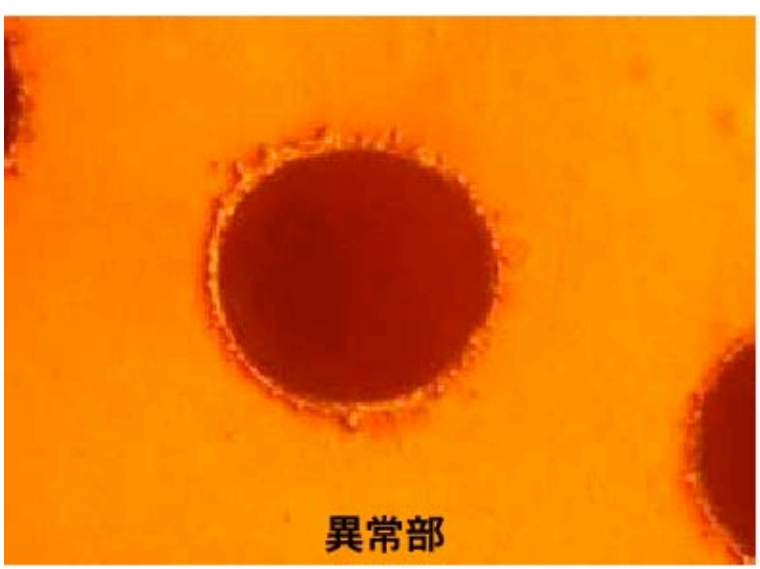
wet / dry(plasma) etching

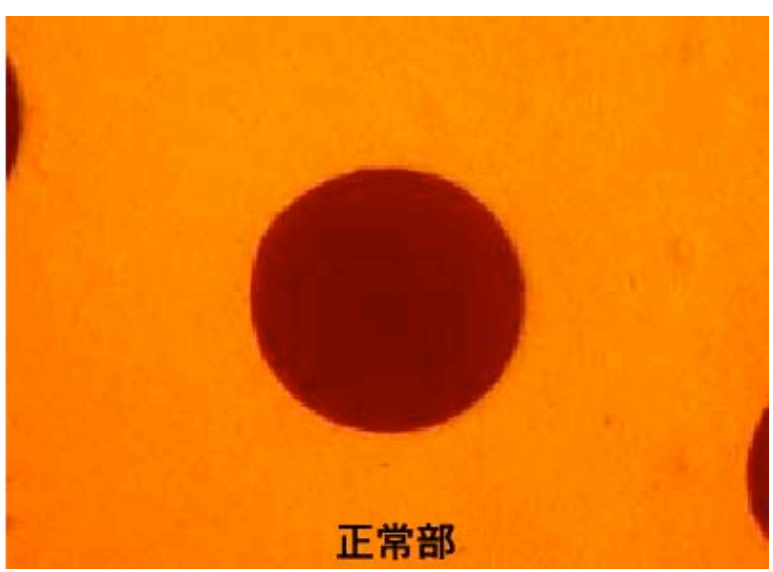




Overdose test (accidental) @ Hiroshima

dose > 1 MHz/mm2 for 10usec every 100msec
current draw when beam come
( not constant drawing )
same thing happen both CERN/Fuchigami

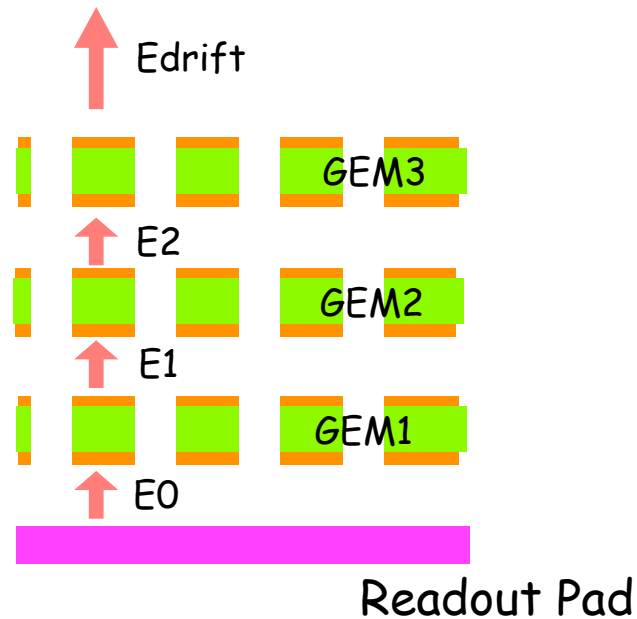


Systematic study of resolution ( defocusing effect )

- $V_{GEM}$
- induction gap field
- transfer gap field

Max. drift length ~3cm




Analysis on going.

Dean's suggestion: geometric mean

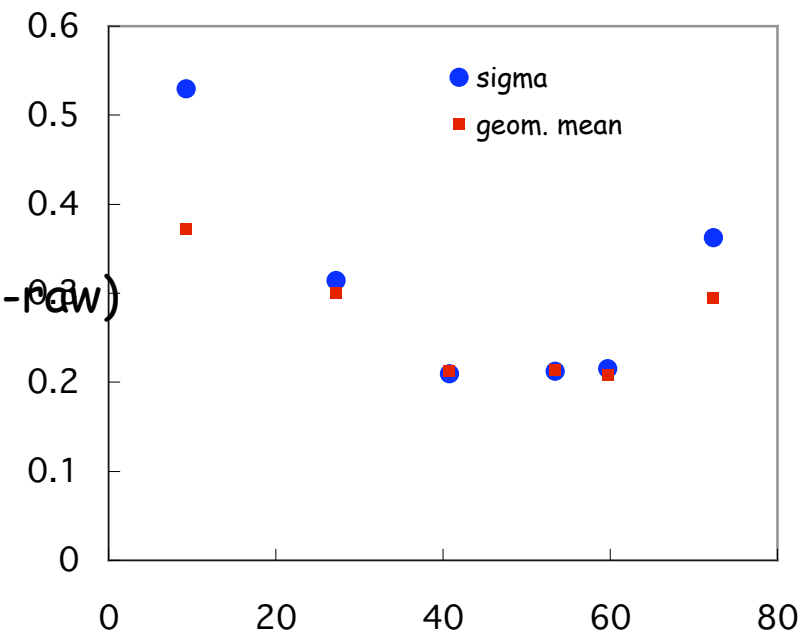
check of "geometric mean" for resolution
use 6 pad-raws

$\sigma_6$ residual using 6 pad-raws

$\sigma_5$ residual using 5 pad-raws (w/o target pad-raw)

$$\sigma_{geom.} = \sqrt{\sigma_5 \sigma_6}$$

$$\sigma_{sigma} = \sqrt{\sigma_5^2 - \sigma_{track}^2}$$

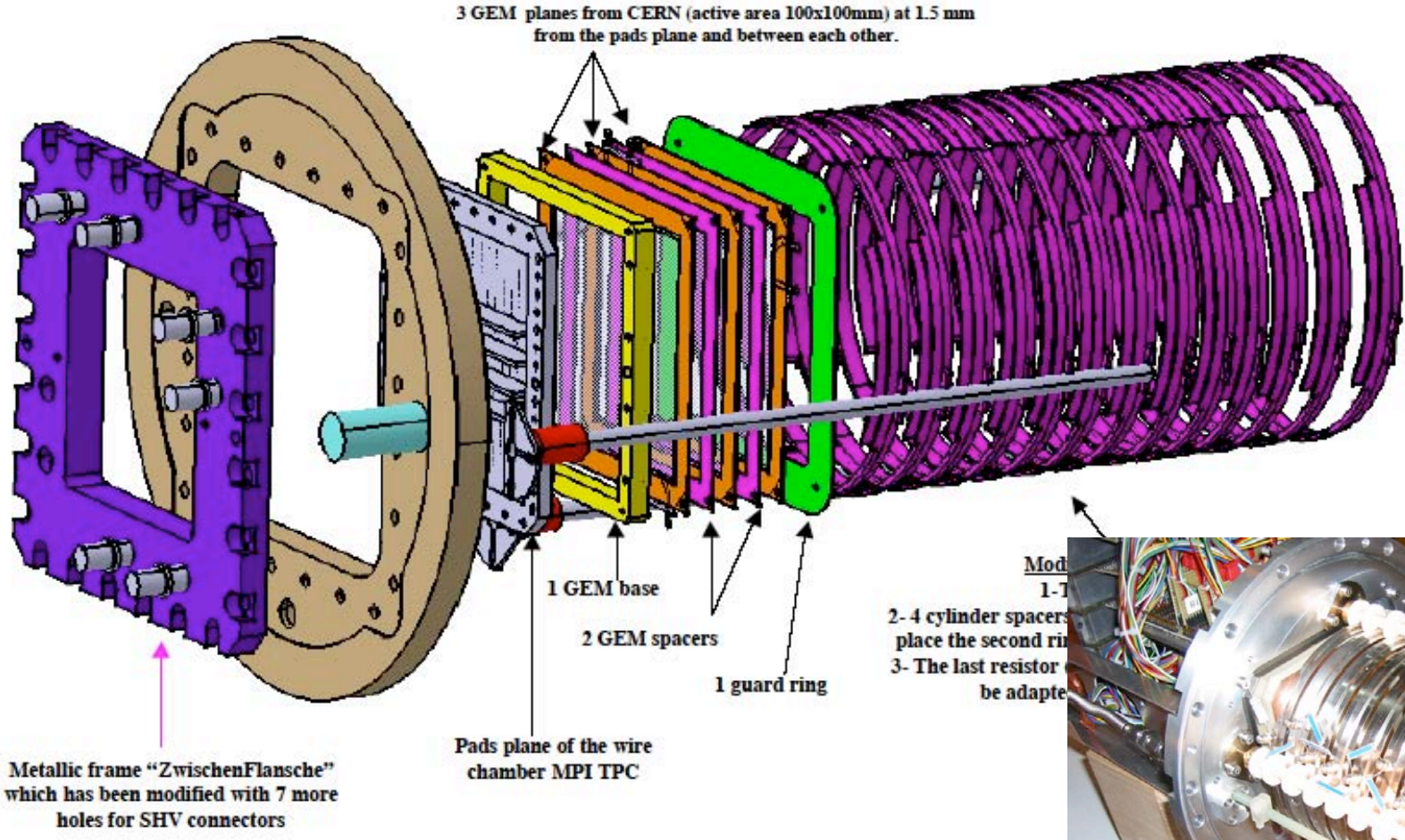


# GEM installation into MPI/TPC

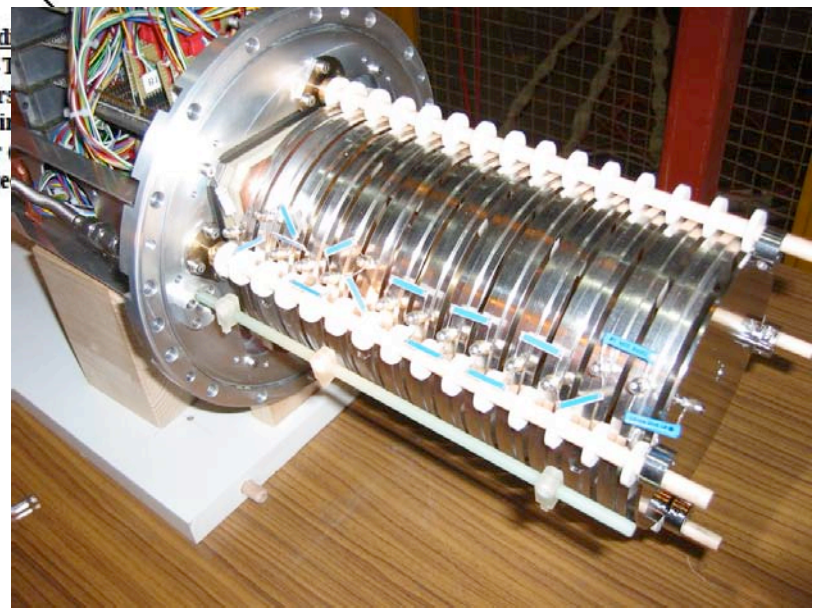
**Exploded view of the modified MPI TPC equipped with 3 GEM planes**

*MPI TPC – GEM study*

**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)***

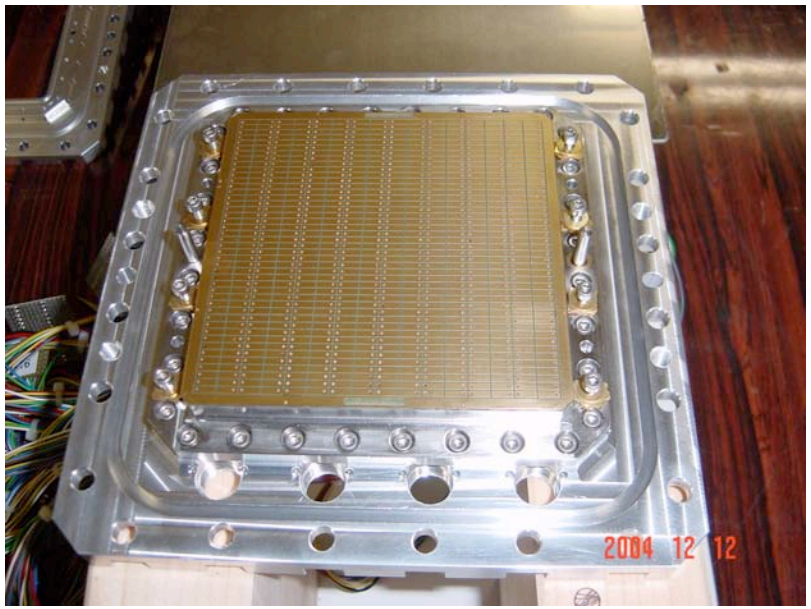



Mod
1-T
2- 4 cylinder spacers
place the second ri
3- The last resistor
be adapte

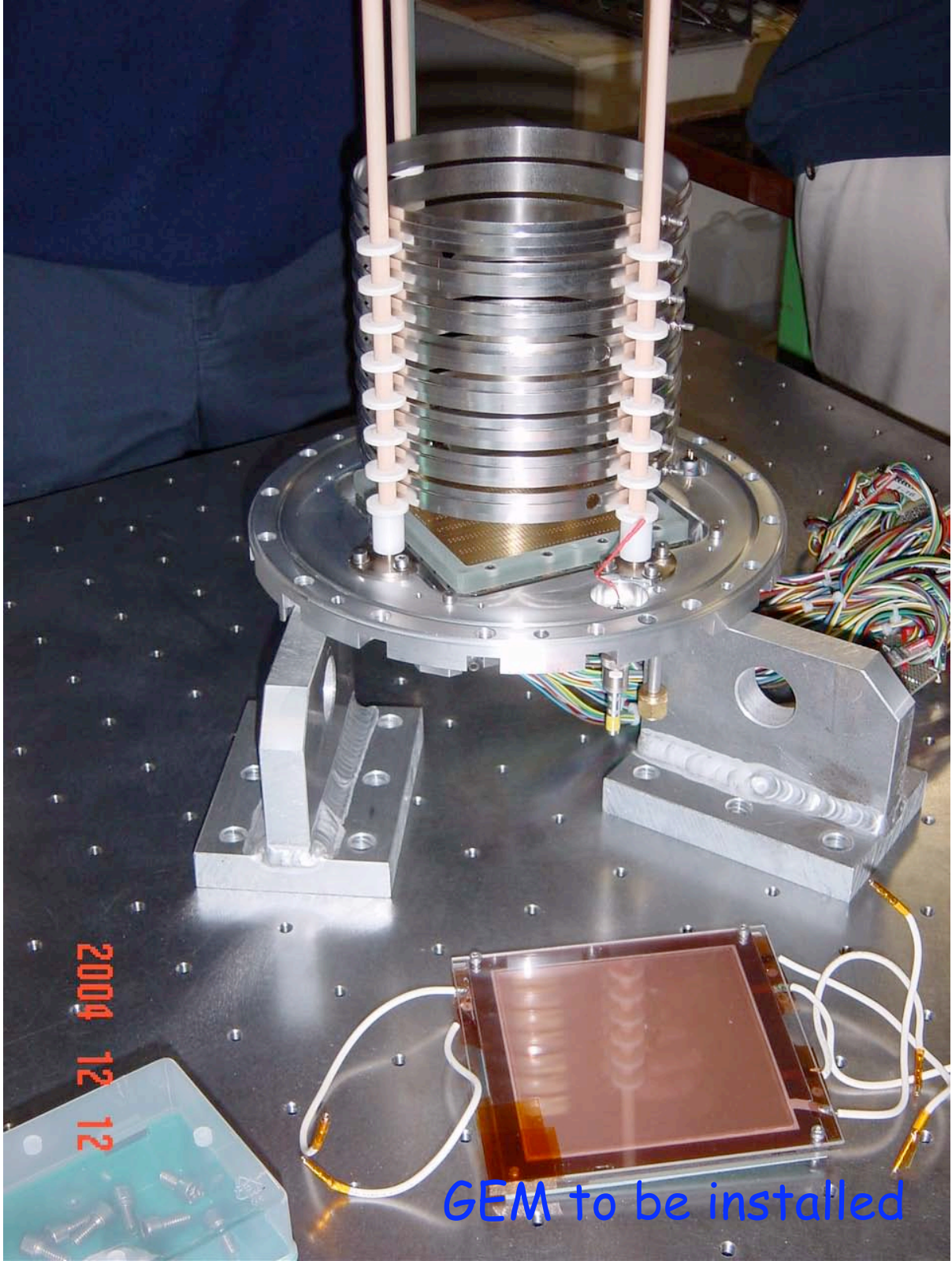


Field Cage modification

Remove 1-st ring of FC




New "ZwischenFlansche"
having extra HV connectors for GEM



# 1st track observed from MPI/GEM-TPC

triple CERN GEM
$V_{GEM}$ = 320V
$E_{trans./ind.}$ = 2kV/cm

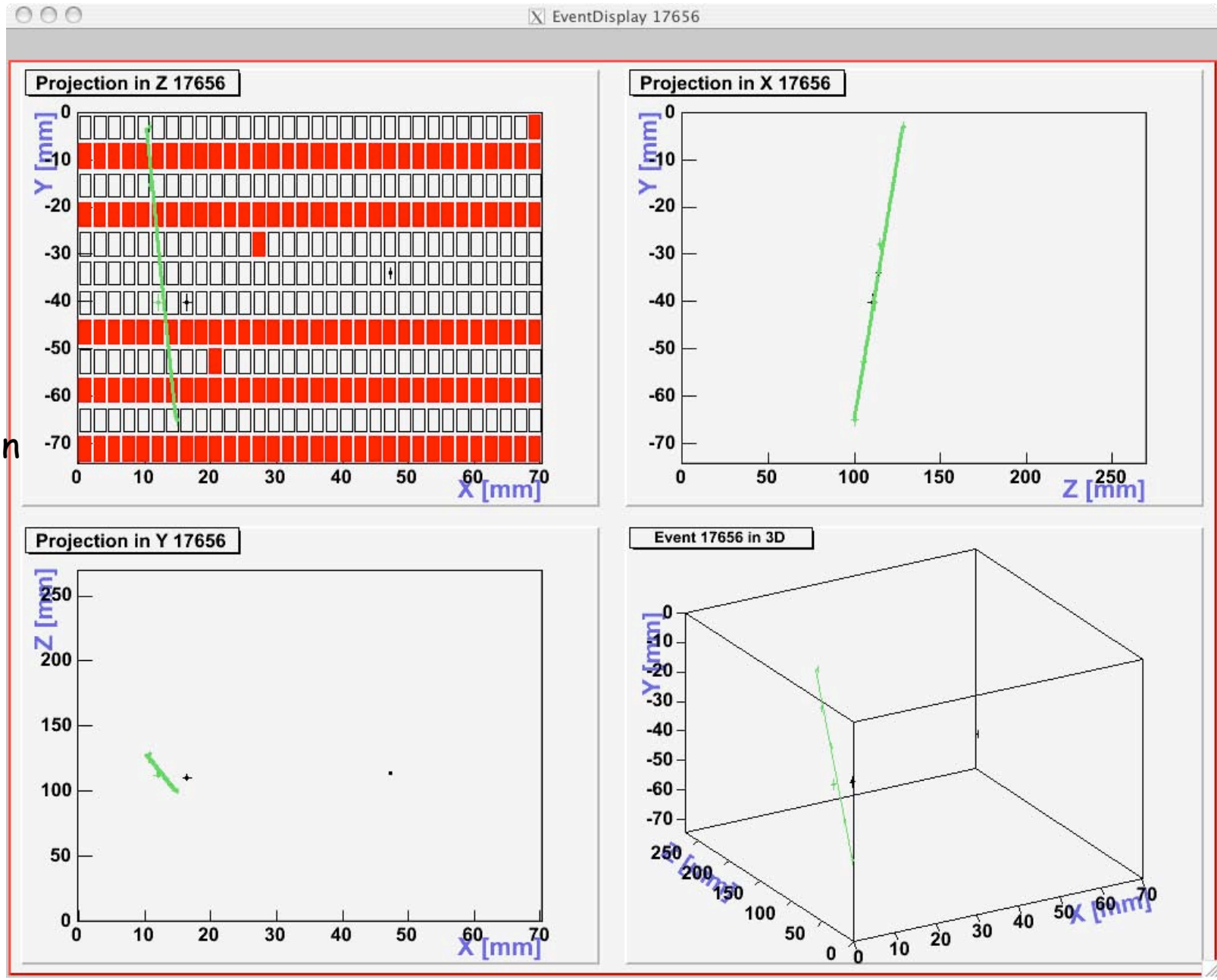
No Mag. Field

GAS : TRD

Trying to take
cosmic data.

but DAQ trouble &
New year's vacation

....



# Plan for 2005

MPI/TPC w/ MPGD beam test( Direct comparison of sensors)

We are proposing beam tests for GEM-TPC and Micromegas-TPC
in spring of 2005 ( Apr.~ ? )
JACEE magnet

GEM-TPC : installed in TPC and test by cosmic
* Pad(2x6mm) is too wide !?
we may build new pad plane ( 1x6? mm)
CERN/Fuchigami, small pitch GEM(50/30)?

Micromegas : under preparation by Orsay,Saclay,Carlton
w/ resistive foil

Cosmic Ray test @Cryogenic center

## General issue

Pad size optimization
Gas study
realistic MPGD /readout pad (sector) design
Simulations

# Effort to WW TPC study

Preparation for WW large/middle prototype TPC

submit several proposals to JSPS, US-Japan

not sure we have money

The basic plan

Build TPC within JACEE type super-conducting Solenoid Magnet

Magnet ( existing JACEE/ new one )

Size of Magnet

Field Strength

merit

Field Cage

Readout electronics

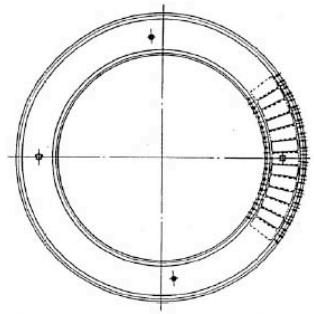
replaceable endplate( MPGD & readout pad) prepared by each group

Magnet

portable

stand alone operation

## Existing JACEE



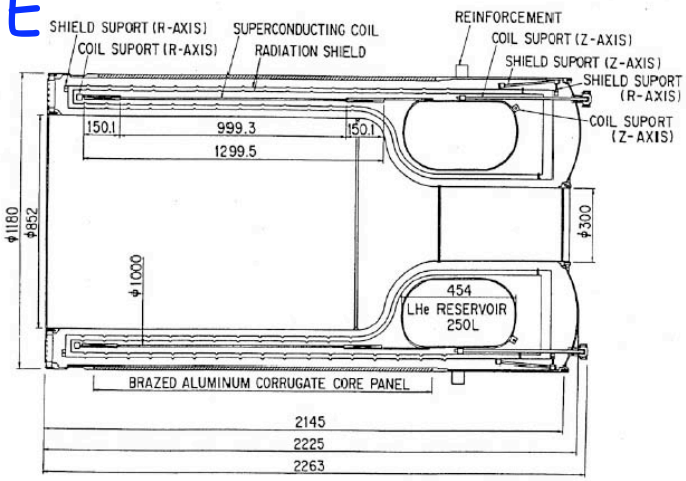
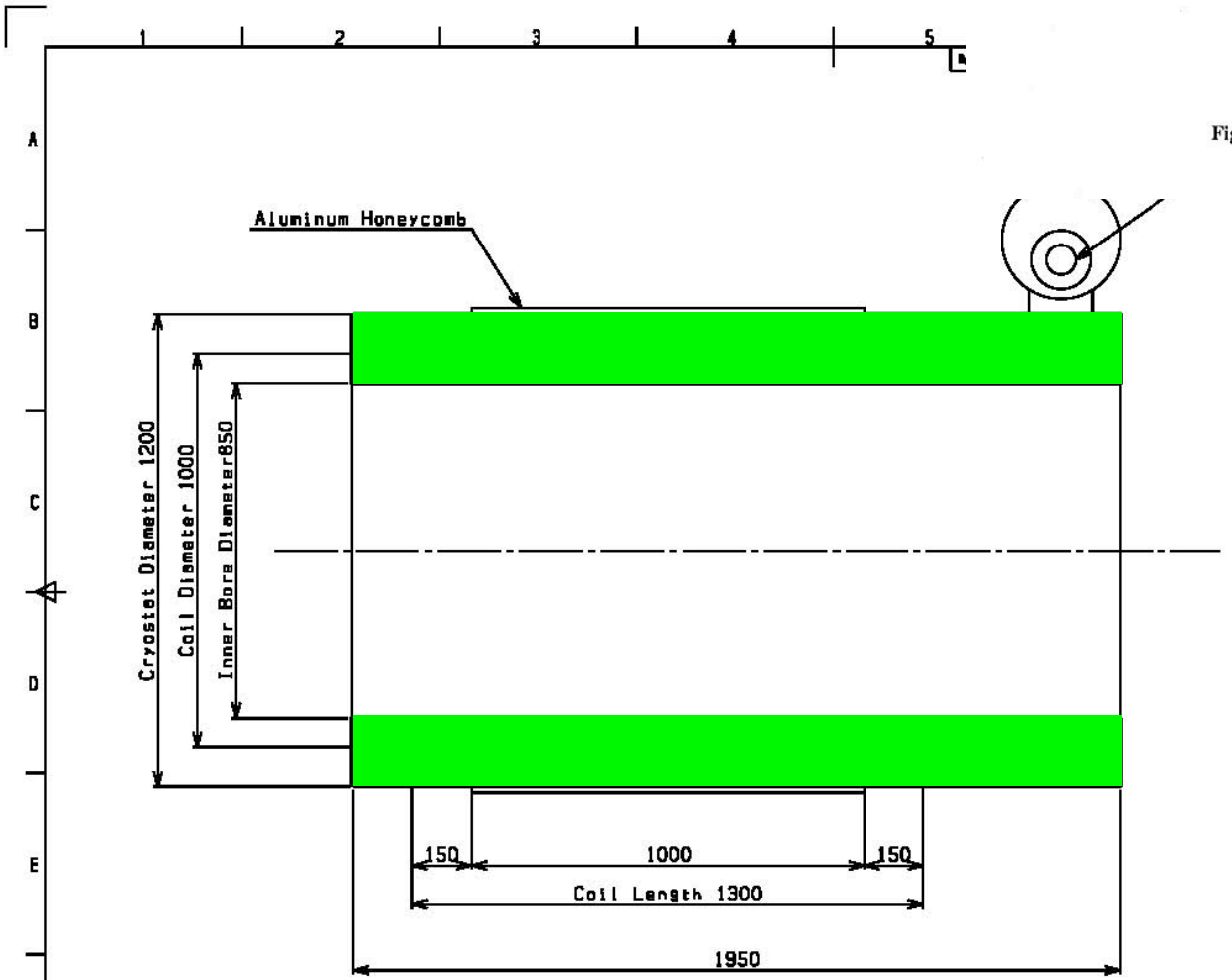



Fig. 1 Cross sectional view of the Super Jacee Magnet.




Inner diameter 85cm

Max. B 1.2T

0.2 rad. length

non-uniformity of B

Coil exist

but nothing else

Money!!

# MPGD R&D in Japan

A lot of work by CNS(Tokyo U.) and RIKEN w/ Fuchigami Micro co.

Processing method

Plasma etching

easy to make large area

but minimum pitch is ~90 um

Laser

50(pitch)/30(hole) possible

may improve defocusing effect

limit of gas gain

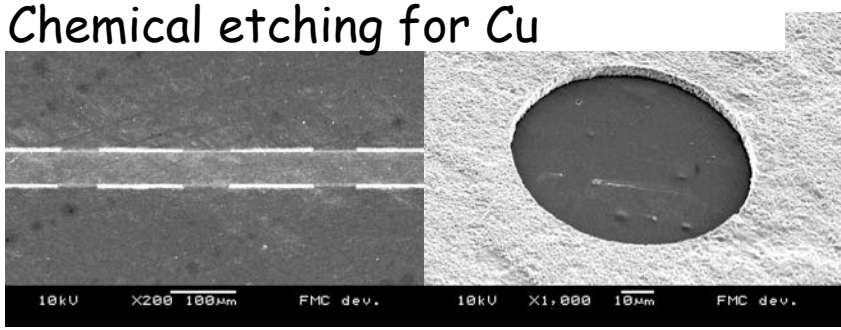
( reduce #of layer?)

Ni plating on Cu

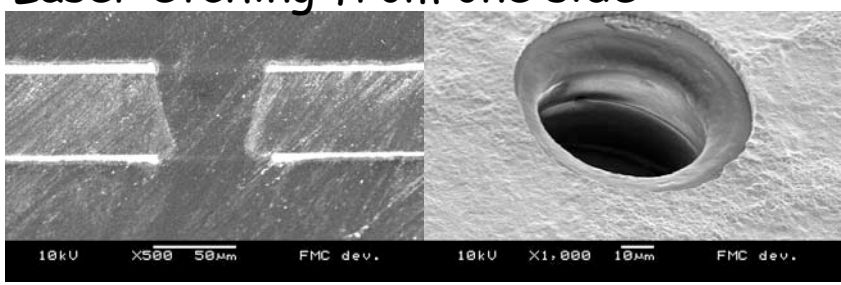
harden the edge of hole

$CO_2$ Laser etching by RIKEN

Chemical etching for Cu




Laser etching from one side




Laser etching from the other side