

Status of tests with the MPI-TPC Prototype by European, Asian, Canadian Groups

by Ron Settles MPI/Desy

(groups listed on next slide)

- Steps leading up to tests at KEK
- Beam tests
- Status of data analysis
- Next steps

Asia/Europe TPC Prototype

MPI, Desy, Asia, Orsay/Saclay, Carleton groups

MPI

Tscharlie Ackermann, Helmut Schendzielorz, Heinrich Keppeler, et al
Volker Eckardt, Peter Maierbeck, Ron Settles

Desy/HH

Markus Ball, Ties Behnke, Markus Hamann, Rolf Heuer, Matthias Janssen, Thorsten Kuhl, Thorsten Lux, Peter Wienemann, et al

Orsay/Saclay

Paul Colas, Bernard Genolini, Joel Pouthas, Philippe Rosier, Vincent Lepeltier et al
Carleton/Montreal

Alain Bellerive, Madhu Dixit, Ernie Neuheimer, Jun Miyamoto, Jean-Pierre Martin

Asia

Keisuke Fujii, Tomohiro Kijima, Makoto Kobayashi, Takeshi Matsuda, Tak Matsui, Osamu Nito, Tohru Takahashi, Akira Sugiyama, Nobutomo Sakamoto, Takashi Watanabe, Rose Reserva,

Jun Goo, Yamaguchi-san et al from the CDC groups:

Dept. of Physics, Mindanae State University, Ilagan City, Philippines

Department of Physics, Saga University

Department of Quantum Matter, Hiroshima University

Venture Business Laboratory, Hiroshima University

Department of Mathematics and Physics, Kinki University

Department of Applied Physics, Tokyo University of Agriculture and
Technology

Kogakuin University

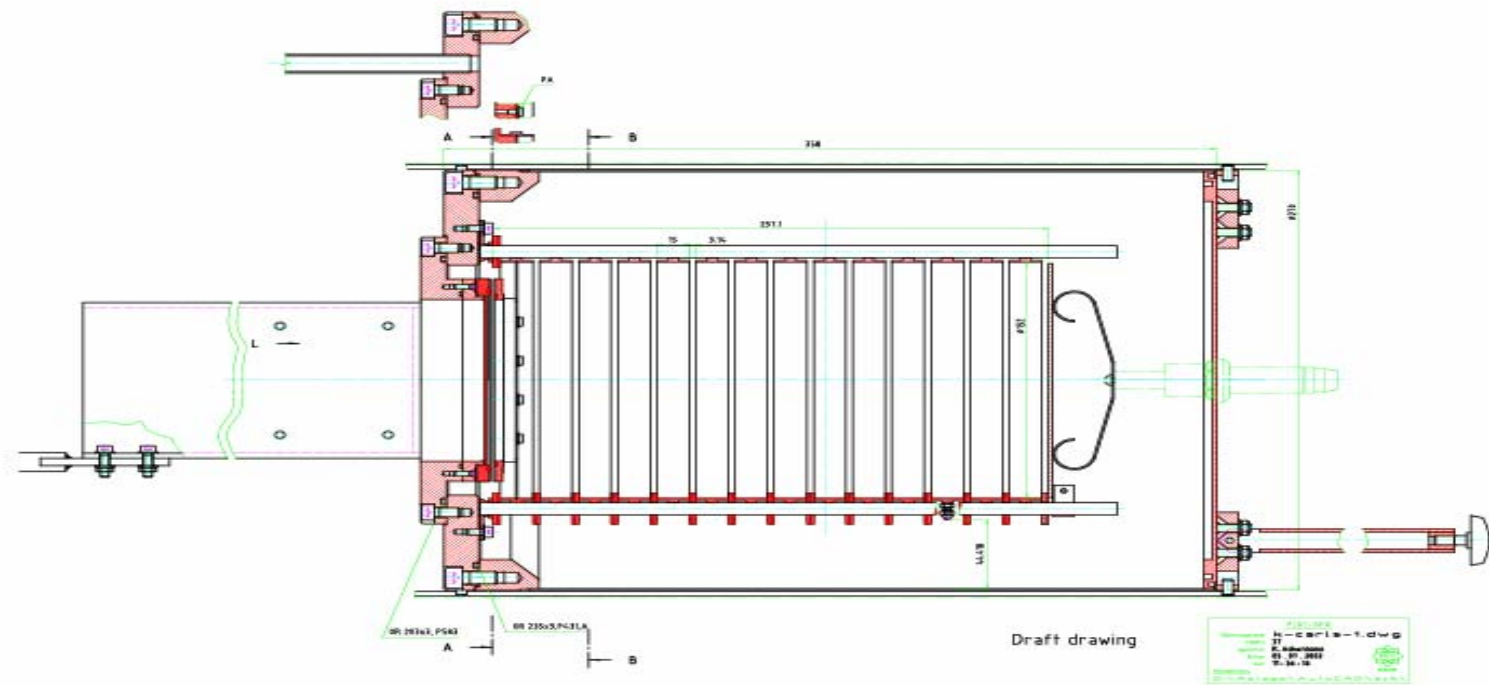
Department of Physics, University of Tokyo

International Center for Elementary Particle Physics, University of
Tokyo

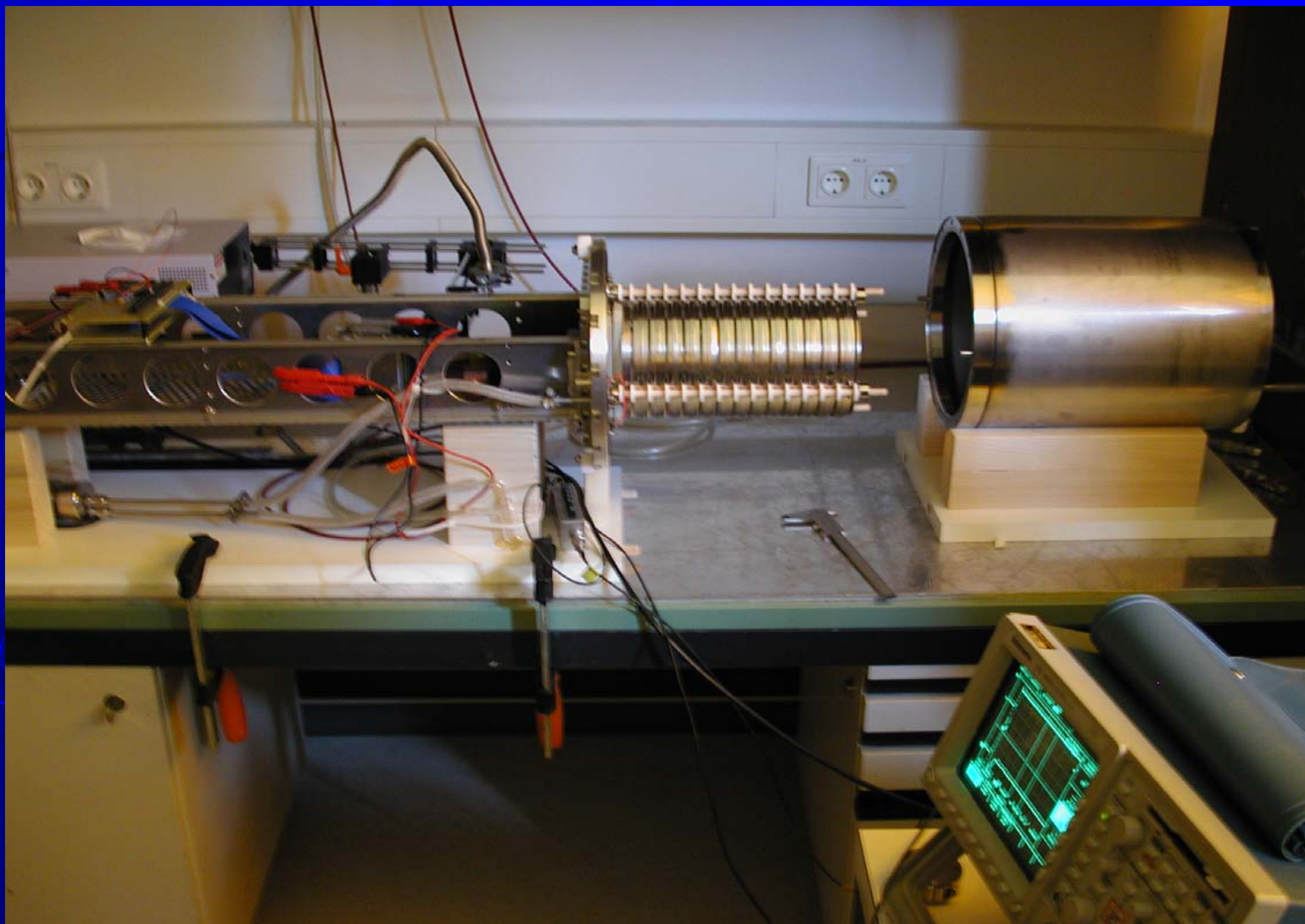
Institute of Applied Physics, University of Tsukuba, and

Institute of Particle and Nuclear Studies KEK Tsukuba

Prototype built at MPI for comparing Wires, Gem, Micromegas technologies in one chamber. Wire data taken in Desy 5T magnet (cosmics) and in $\pi 2$ beam at Kek. Gems now installed/ taking cosmics, beam test to follow next month. Micromegas version in preparation.



MPI TPC Prototype at MPI



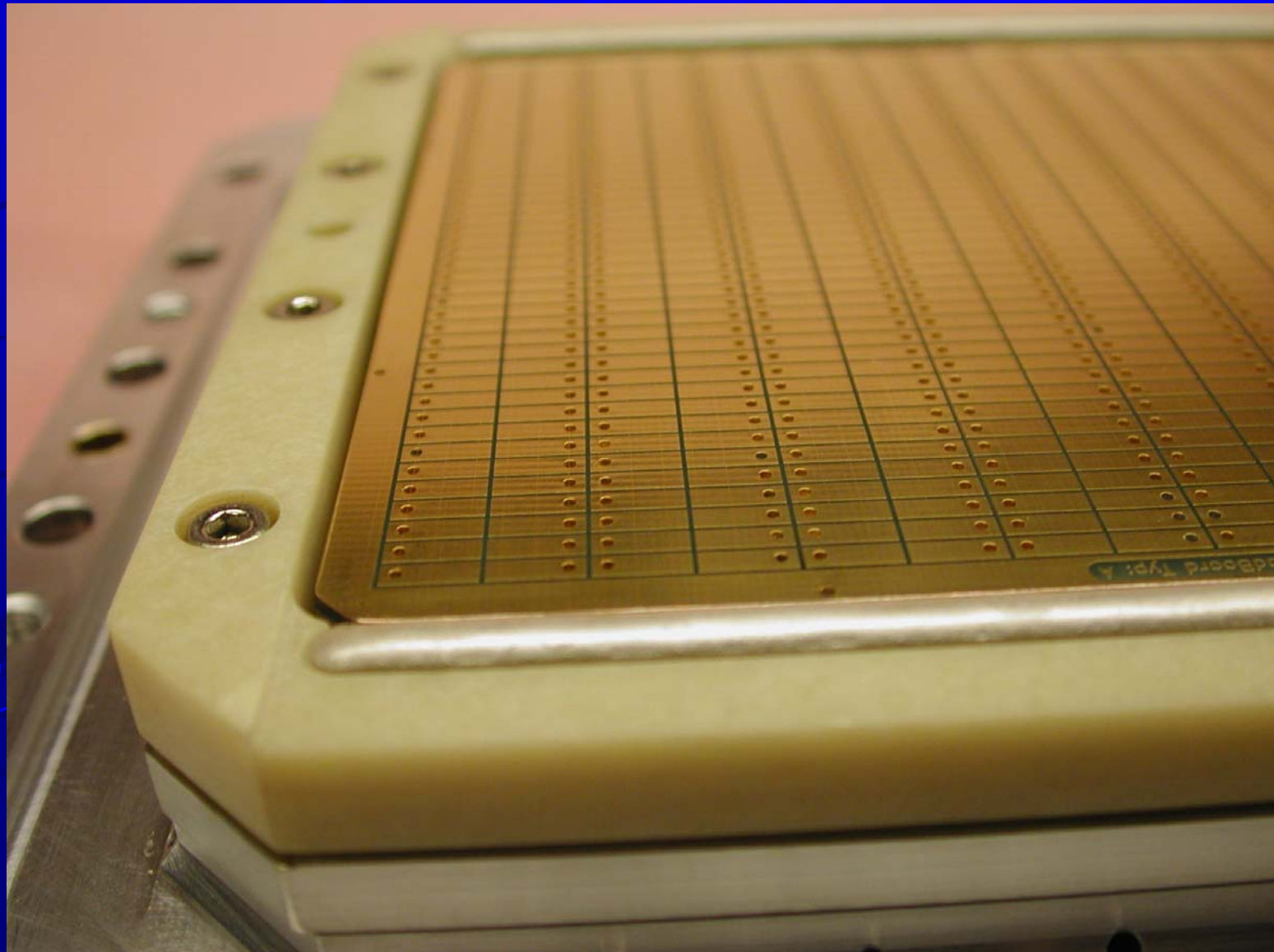
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- Pad plane 100mm x 100mm
 - Pad size 2mm x 6mm
 - Pad pitch 2.3x6.3mm
- 12 of 16 rows (384 pads) instrumentable
- Wire spacing 2mm (without fieldwires)
- Pad-wire distance 1mm ($\sigma_{PRF} \sim 1.4\text{mm}$, in principle -> to be measured)
- No gating plane for the moment

MPI TPC Prototype

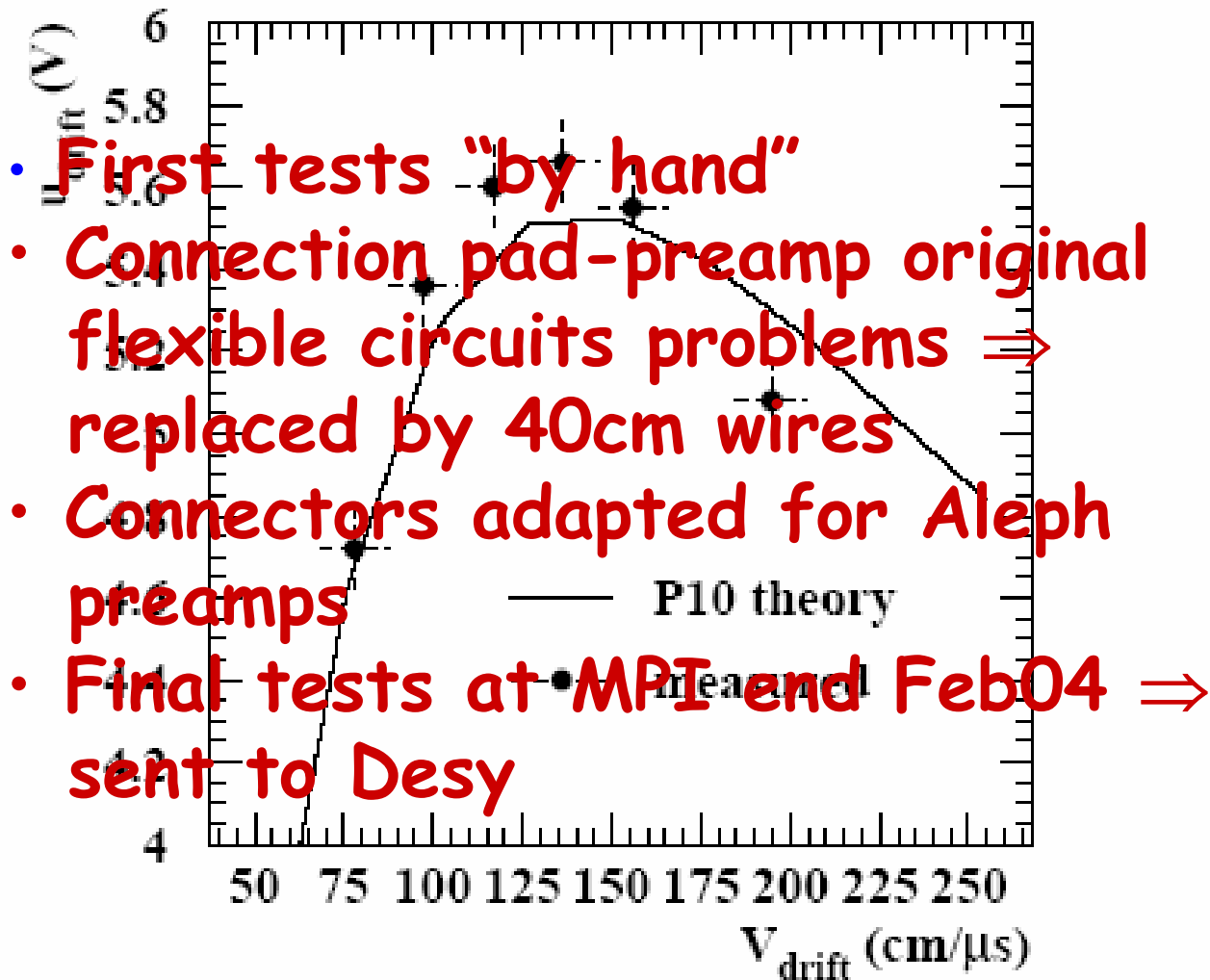


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MPI/Desy/KekTPC - first tests at MPI



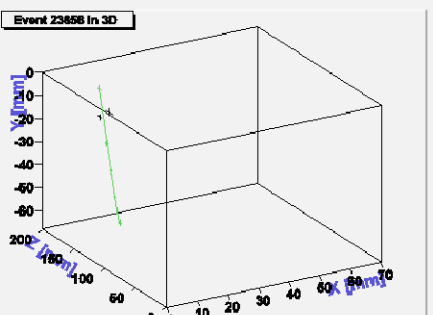
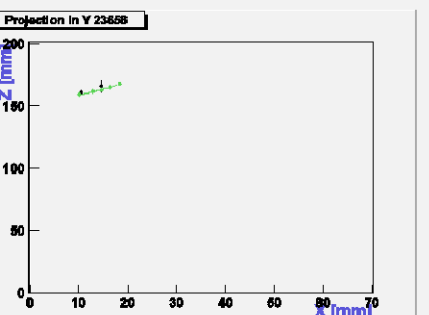
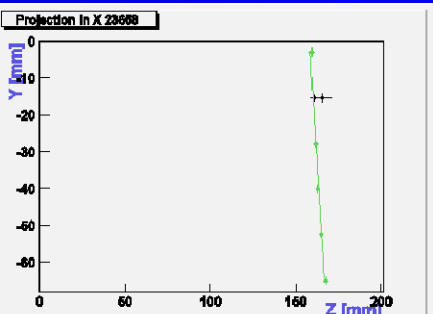
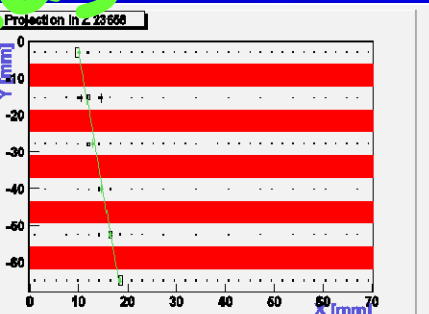
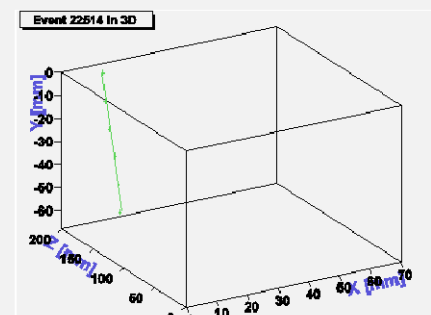
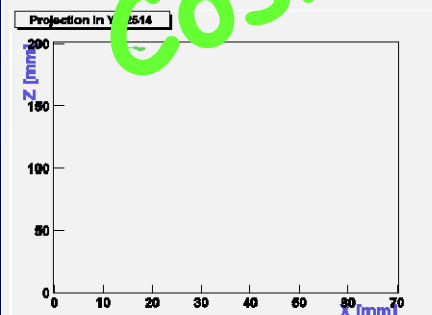
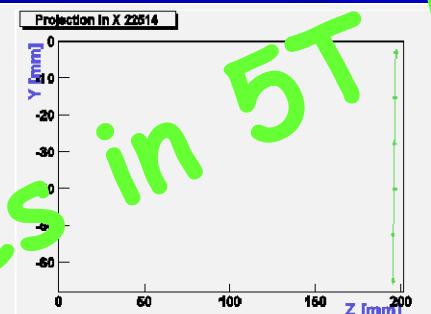
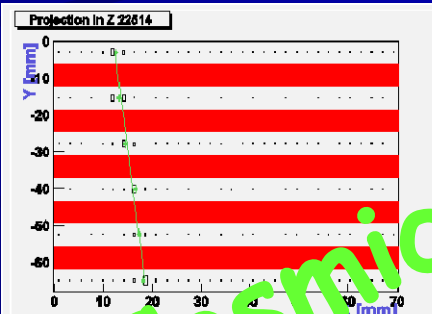
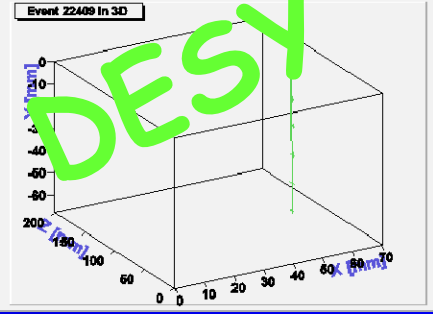
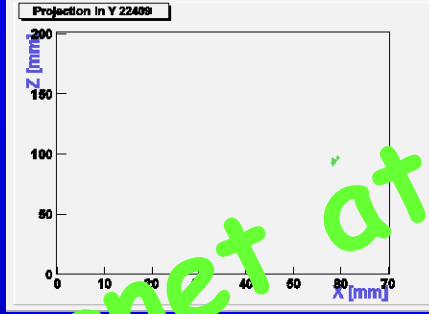
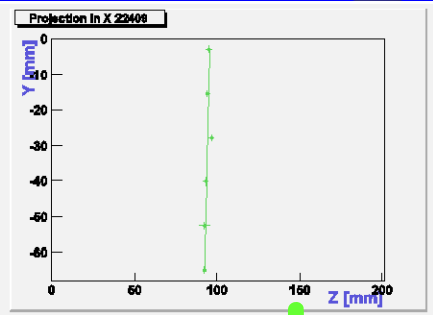
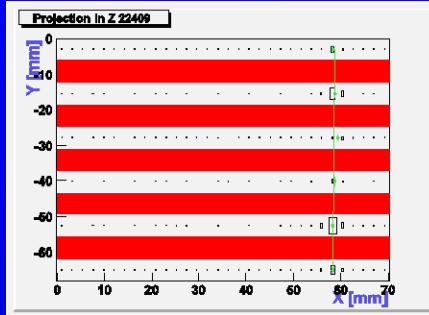
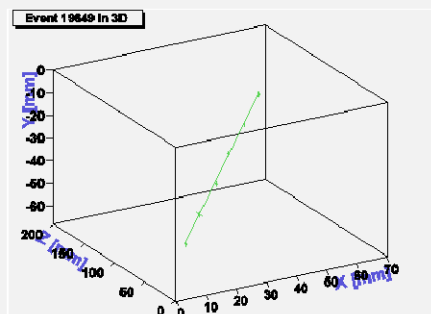
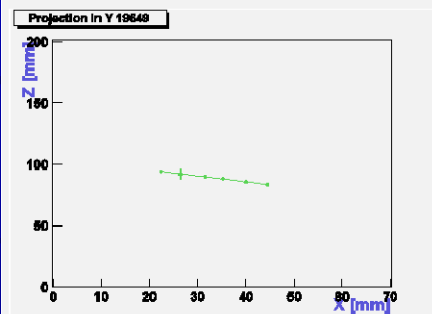
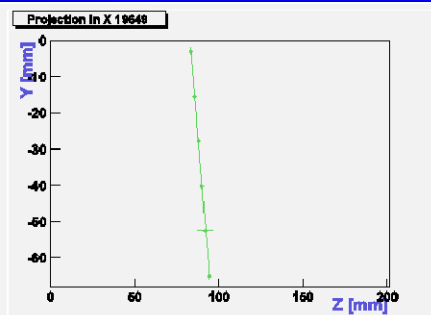
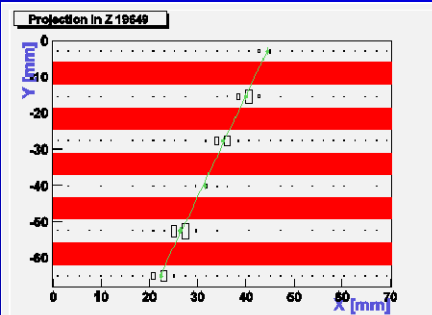
Steps leading to Desy

March 2004	Transport MPI TPC to Desy Set up and test
April 2004	Chamber working—cosmics taken Measurements with cosmics in 5T magnet

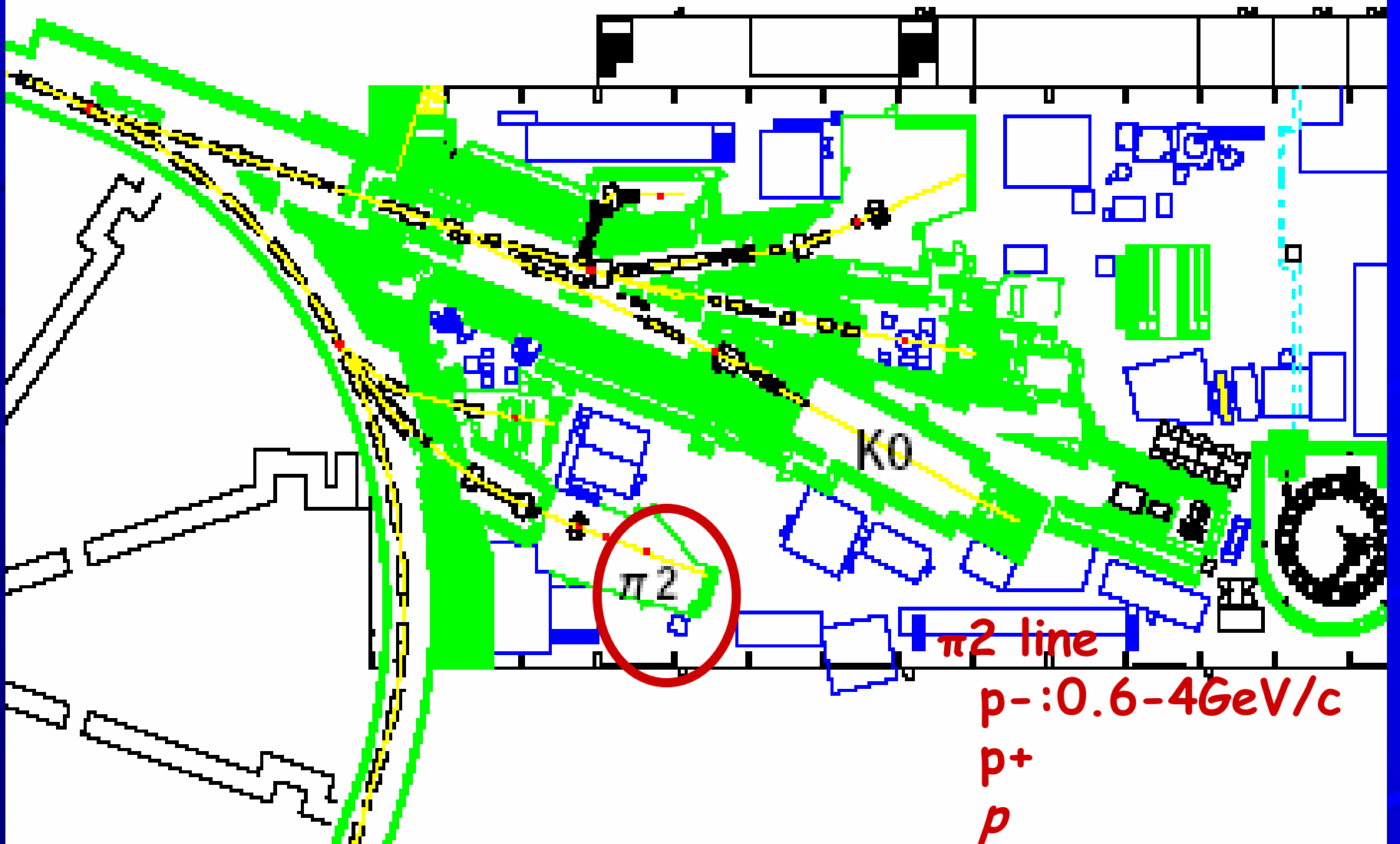
Steps after that to KEK

Early May	Ship MPI TPC + electronics to KEK
May-June	Set up at KEK for test in beam
June 16-July 1	Beam tests

Video meetings every 2 weeks



Cosmics in 5T Magnet at DESY



One of the World's Laboratories for ILC



KEK Facilities
using MPI-TPC



$\pi 2$ Hall,

JACEE magnet at KEK



We would like to thank the IPNS cryogenic group lead by Prof. T. Haruyama KEK for their support for the JACEE magnet operation, Prof. A. Yamamoto the director of the cryogenic center, Dr. Y. Makida IPNS KEK for having made the JACEE magnet available to us.

Magnet installation,



TPC mounting fixture



Broken wire
had to be fixed



Chamber +
electronics prepared



A lot of work went into tuning the beam & the p.i.d.



Tests in $\pi 2$ Beam Experiment T558

- 1-4 GeV/c e, μ, π, K, p with Č, Aerogel, TOF
- 7 pad rows equipped = $7 \times 32 = 224$ pads
- Diffusion, resolution, ect measured as function of drift distance, B field, pad-crossing angle.
- dE/dx data taken with p.i.d.

Measurements in π^2 Beam

- ~1000 triggers/setting
- Chamber moved precise distance and measured $V_{\text{drift}} = 4.5\text{cm}/\mu\text{s} \pm 1\text{-}2\%$ for "TDR" gas (93%Ar 5%CH₄ 2%CO₂)
- Spread beam to illuminate full chamber with mult scatt in few-mm-thick Pb plate
- Data taken with $B = 0\&1\text{T}$; $\varphi = 0, 10\&20^\circ$
- 0.6, 1.4, 2.0, 4.0 GeV/c proton (+polarity)
- 1.0, 2.0, 4.0 GeV/c π (-polarity)
- As function of beam intensity
- Analyses in progress, results preliminary

...and a lot of meetings to understand the data...

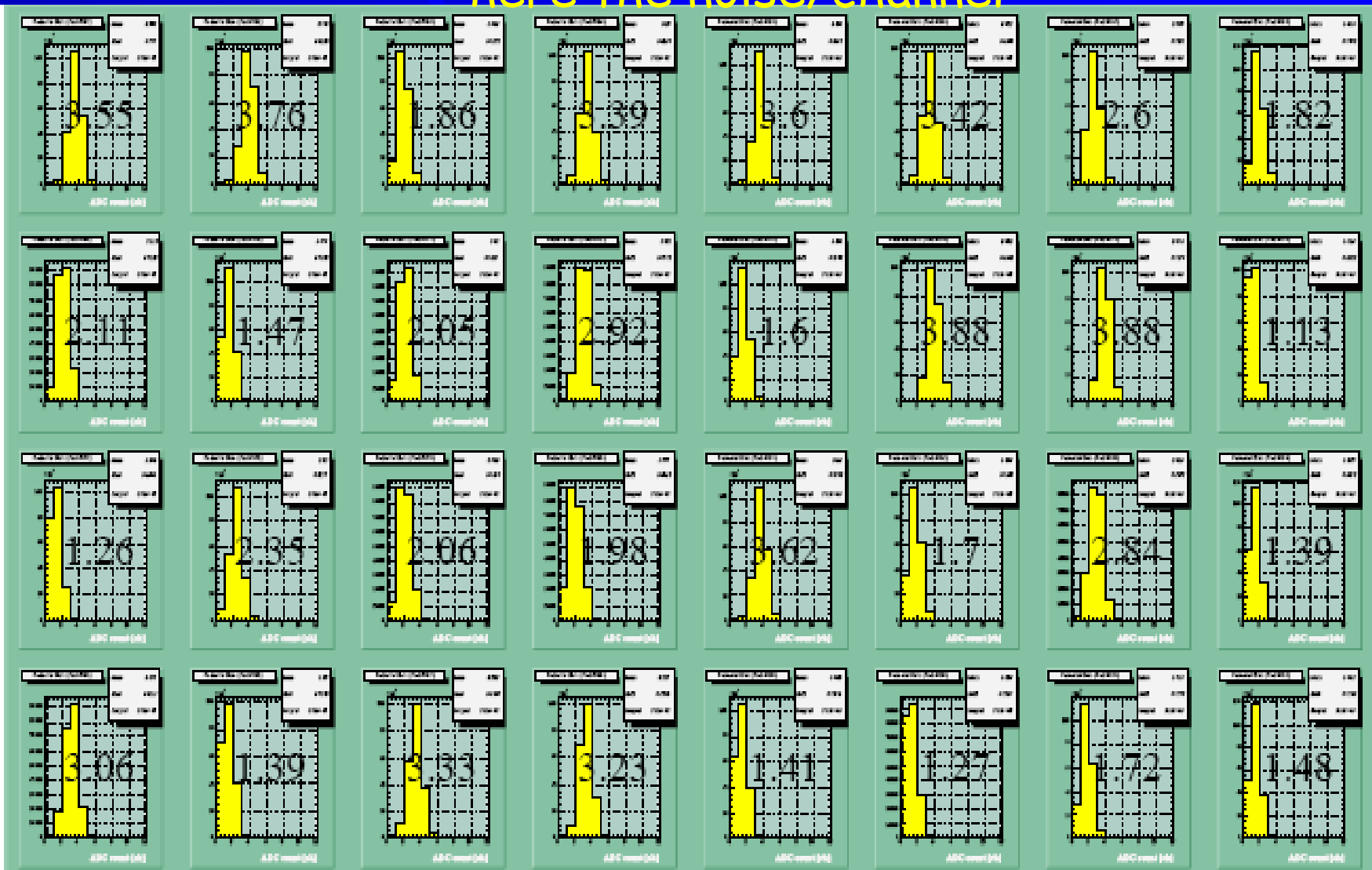


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Some plots by Katsumsa Ikematsu, here the noise/channel



x resolution

What do we expect? *Guess:*

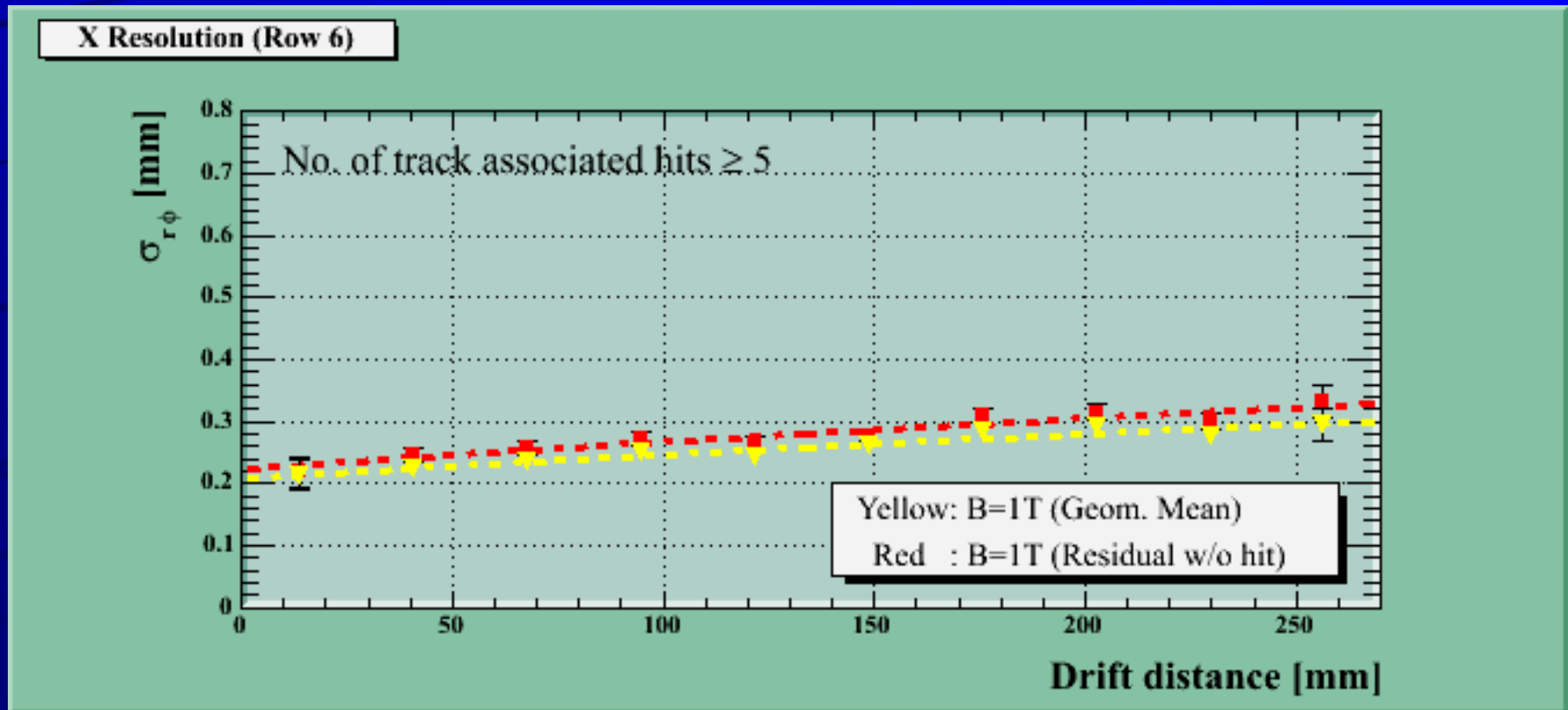
- Compare with Aleph (same electronics)
- Going through the arithmetic you find for for the best case:

$$\sigma_x \sim 0.074 \{(\delta P/P)_{\text{mpi}} / (\delta P/P)_{\text{Aleph}}\} \text{ mm}$$

- If $\delta P/P$ goes as $1/\sqrt{\text{Pad-length}}$, mult. by $\sqrt{30/6}$:
 $\Rightarrow \sigma_x \sim 0.17 \text{ mm}$, i.e. about the same as Aleph

x resolution as function of B, drift distance.

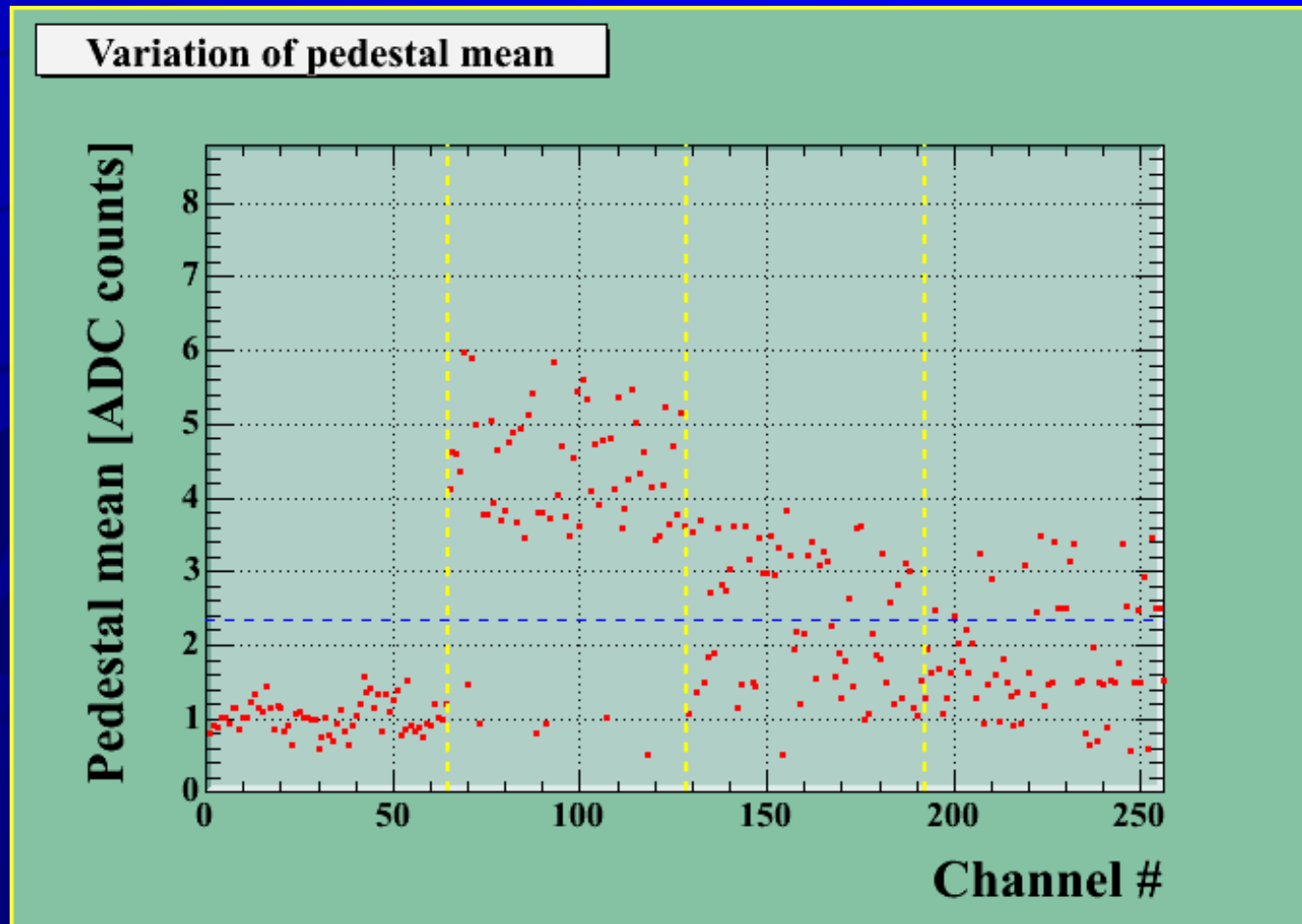
Method: fit track with and without row in question (row#6). Geometric mean of the two results gives the correct resolution.



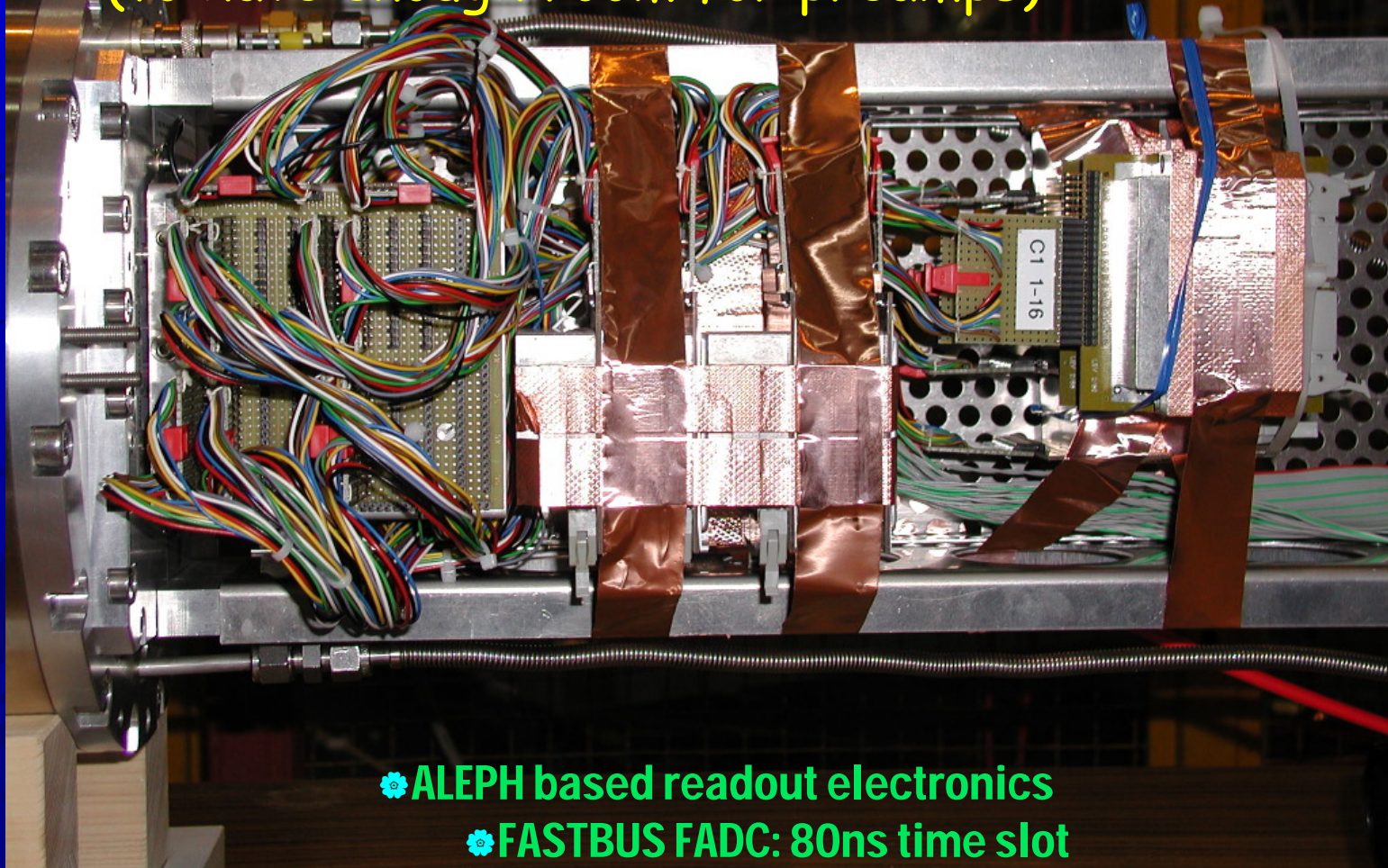
x resolution

So we find for the best case $\sigma_x \sim 0.22$ mm

Why? One reason:

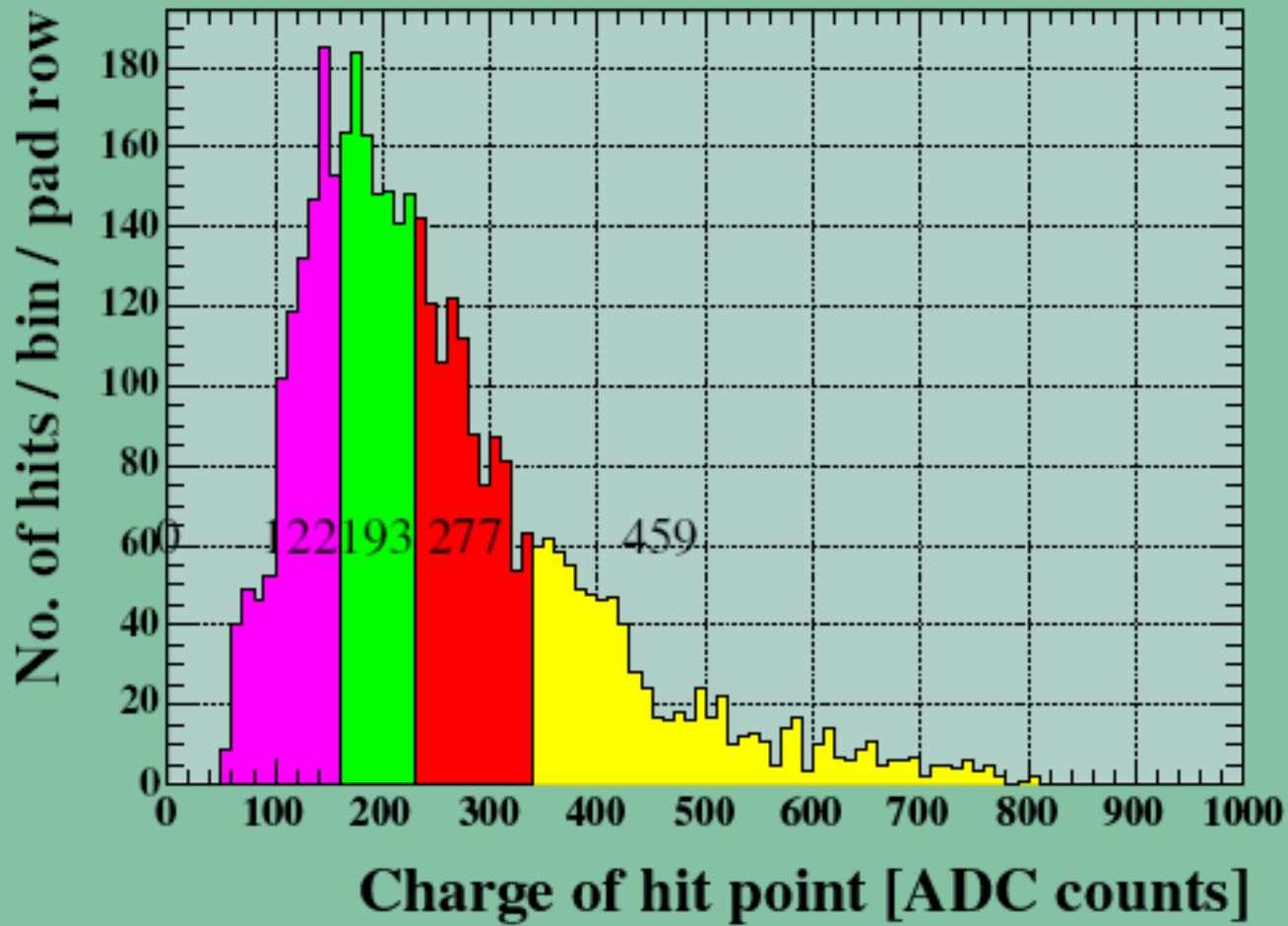


pad -> 40cm wire -> preamp
(to have enough room for preamps)

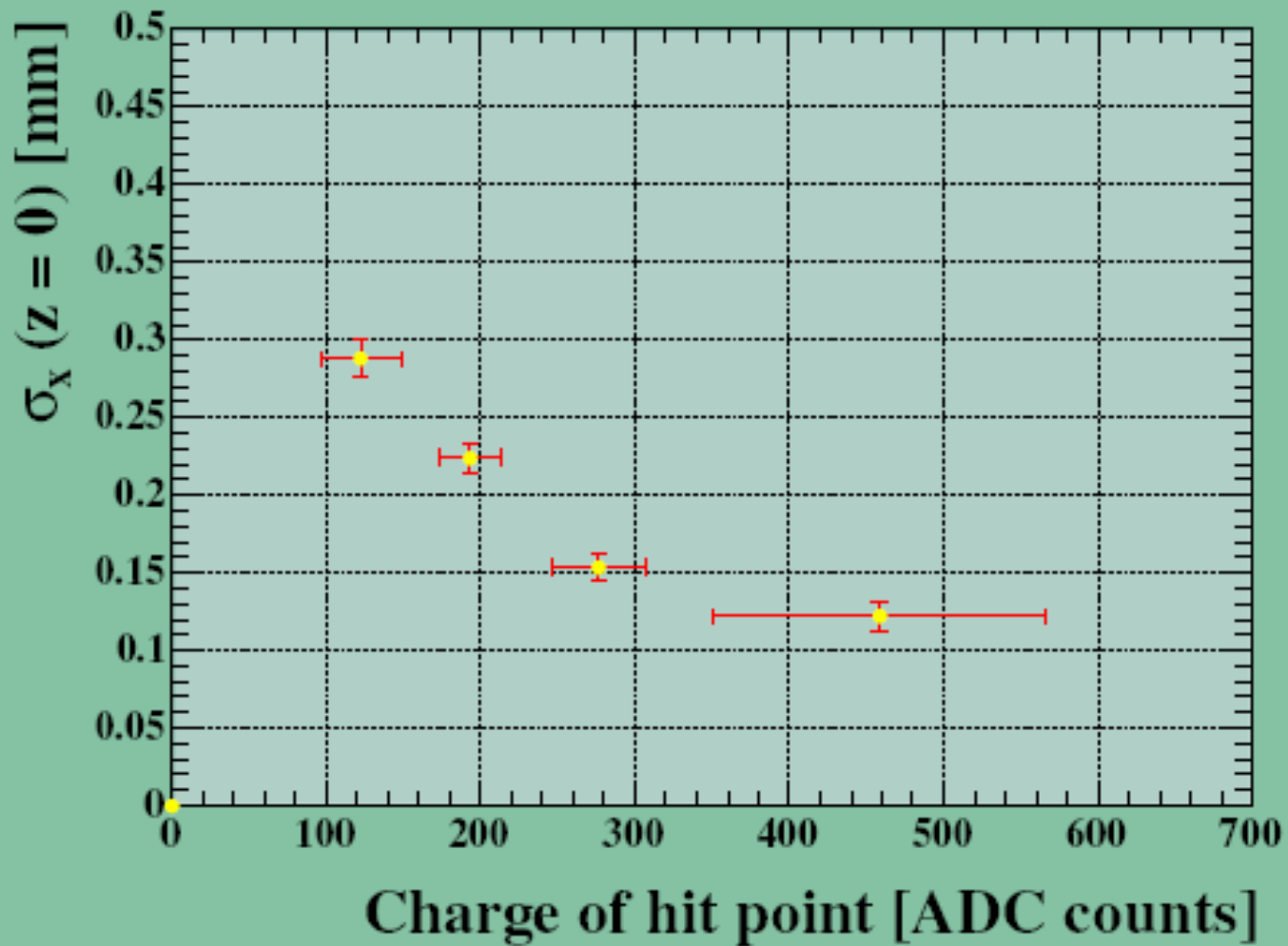


- ⚙️ ALEPH based readout electronics
- ⚙️ FASTBUS FADC: 80ns time slot
- ⚙️ Pre-amplifier: 500ns shaping time

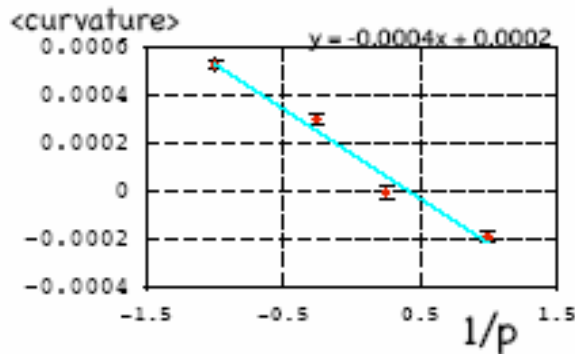
Charge of hit point (Row 6)



Fitted X Resolution ($z = 0$, Row 6)



more about mom. resolution



$$\langle \text{curv} \rangle = -0.000372/p + 0.000161$$

result of gauss fit

P	1/p	<curvature>	error	sigma	
pi-	-4	-0.25	0.000303	0.000021	0.000607
	-1	-1	0.000529	0.0000196	0.000547
proton	1	1	-0.000186	0.000018	0.000523
	4	0.25	-0.00000143	0.000023	0.000642

$$p = 0.3B\rho \quad c = \frac{1}{\rho} = 0.3B\frac{1}{p}$$

$$\delta c = \delta\left(\frac{1}{\rho}\right) = 0.3B\delta\left(\frac{1}{p}\right)$$

$$\delta\left(\frac{1}{p}\right) = \frac{\delta p}{p^2}$$

$$\delta c = \frac{\sigma_{r\phi}}{L^2} \sqrt{\frac{720}{n+4}}$$

$$\left(\frac{\delta p_T}{p_T}\right)_{meas.} = \frac{3.3\sigma_{r\phi}p_T}{BL^2} \sqrt{\frac{720}{n+4}}$$

we are using 6(n) out of 11rows
(10 gap -> 63mm) for L

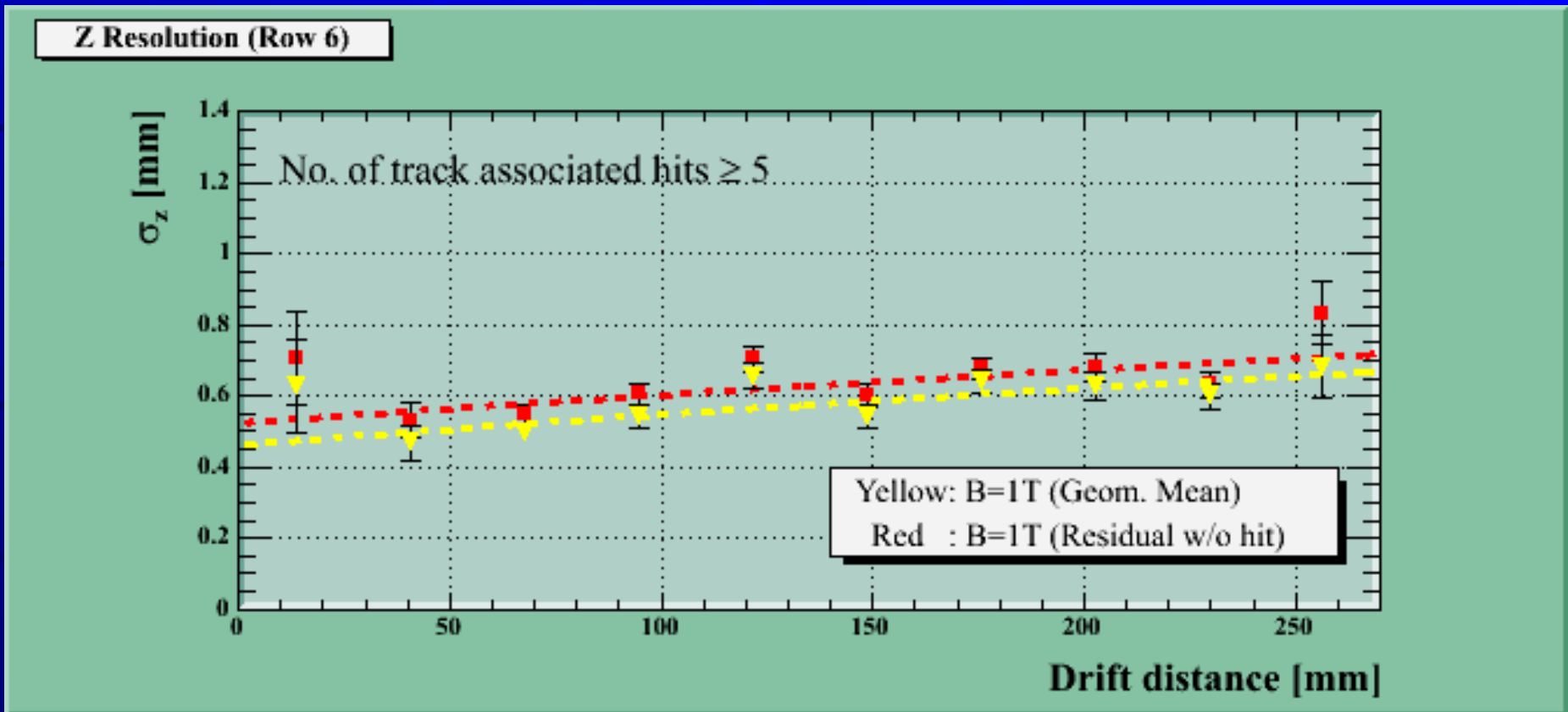
if we take 250um for sigma,

$$\delta c = 0.000534$$

this is quite consistent with

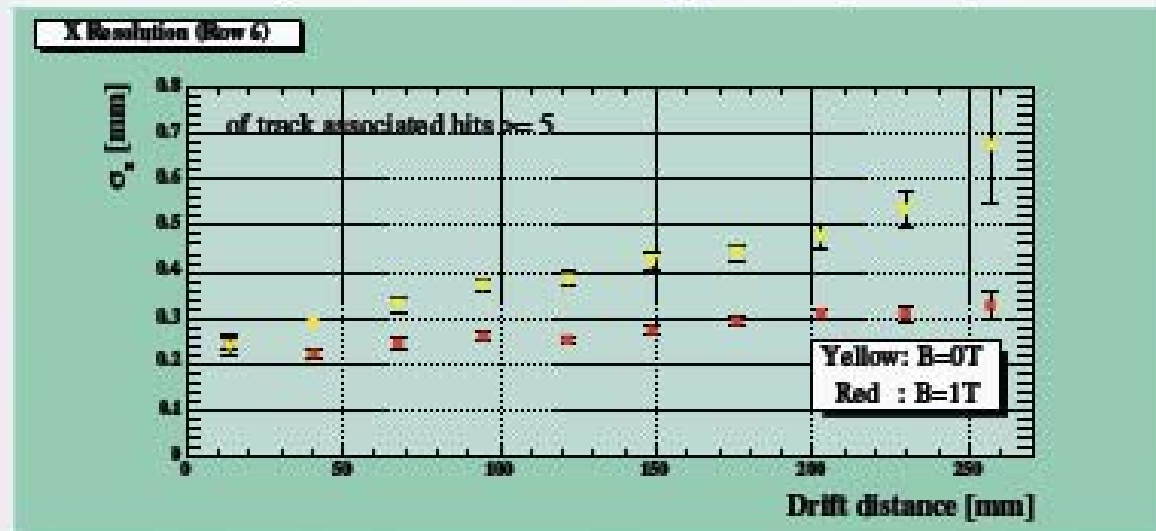
Curved fit working but still have some distortion to correct for...

z resolution



X Resolution (B-dep)

B-field dependence for central padrow (Row 6)



- Gas-diffusion suppression by B-field was clearly seen
- ★ X Resolution = 250-300 micron in B=1T (& No calibration)

PadResponseFunction

Tomohiro Kijima

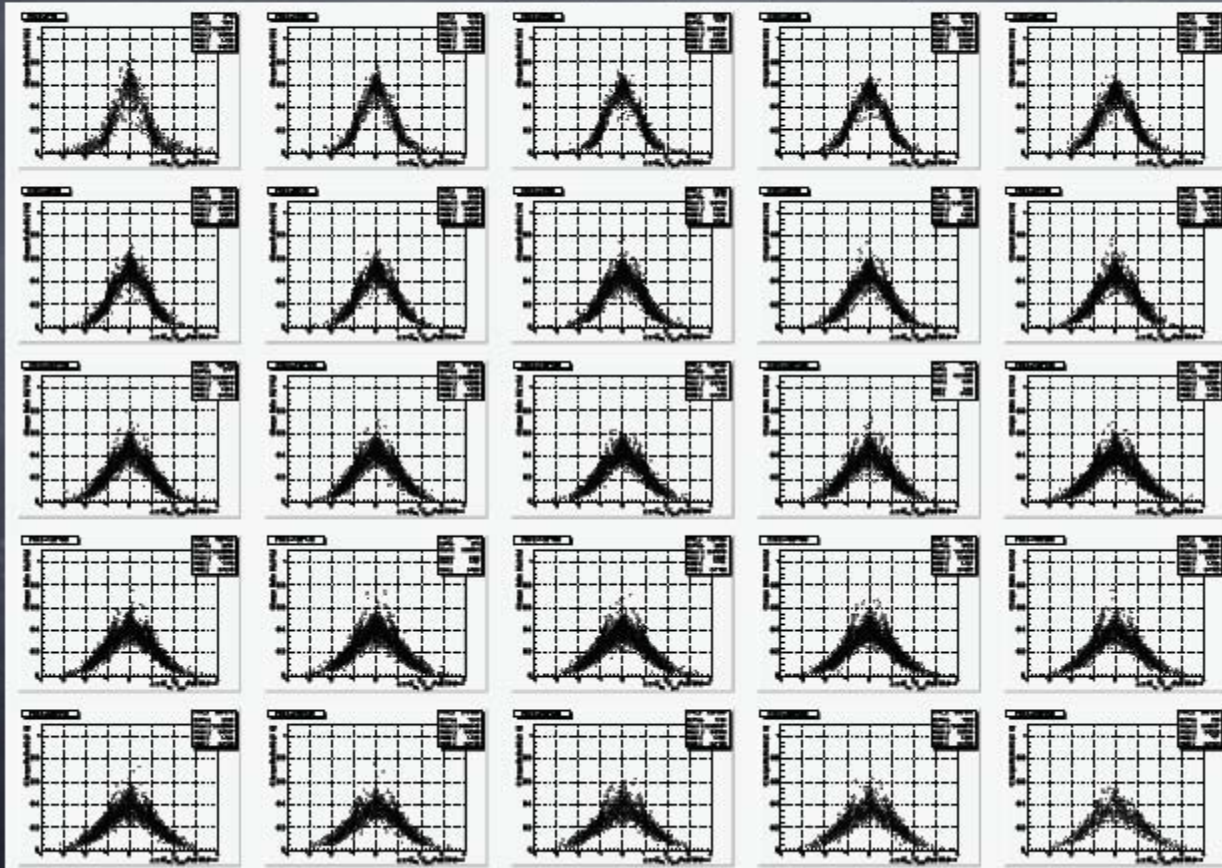
2004/07/22

Method

- Select track - associated hit points with 3 or more pads hit
- Plot Q_i/Q_{tot} against $(X_{track} - X_{padi})/w$ for different Z bins ($w=2.2\text{mm}$)
- Divide the plot into different X-slices and fit each slice with a gaussian
- Plot the sigma as a function of Z

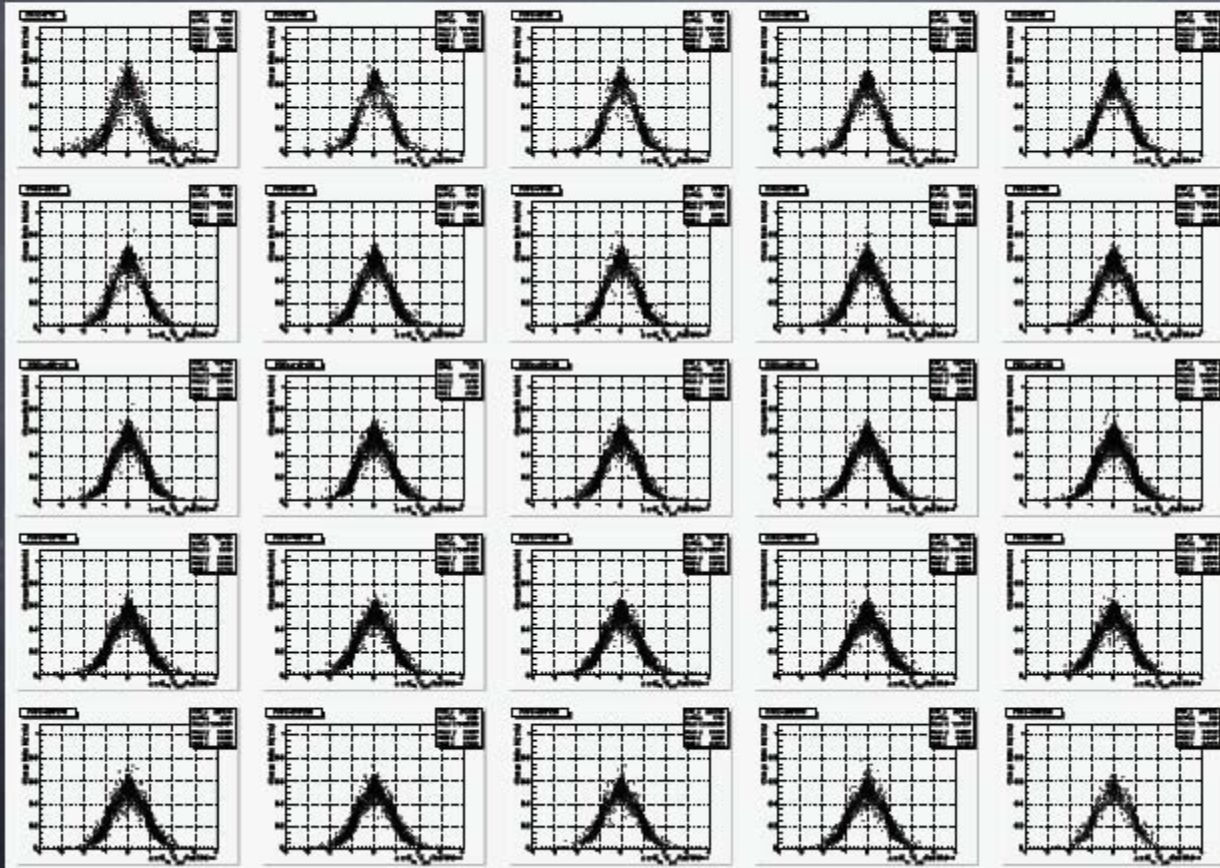
B=0T Results

Z-bins: 0-1,1-2,2-3, ..., 23-24,24-25cm

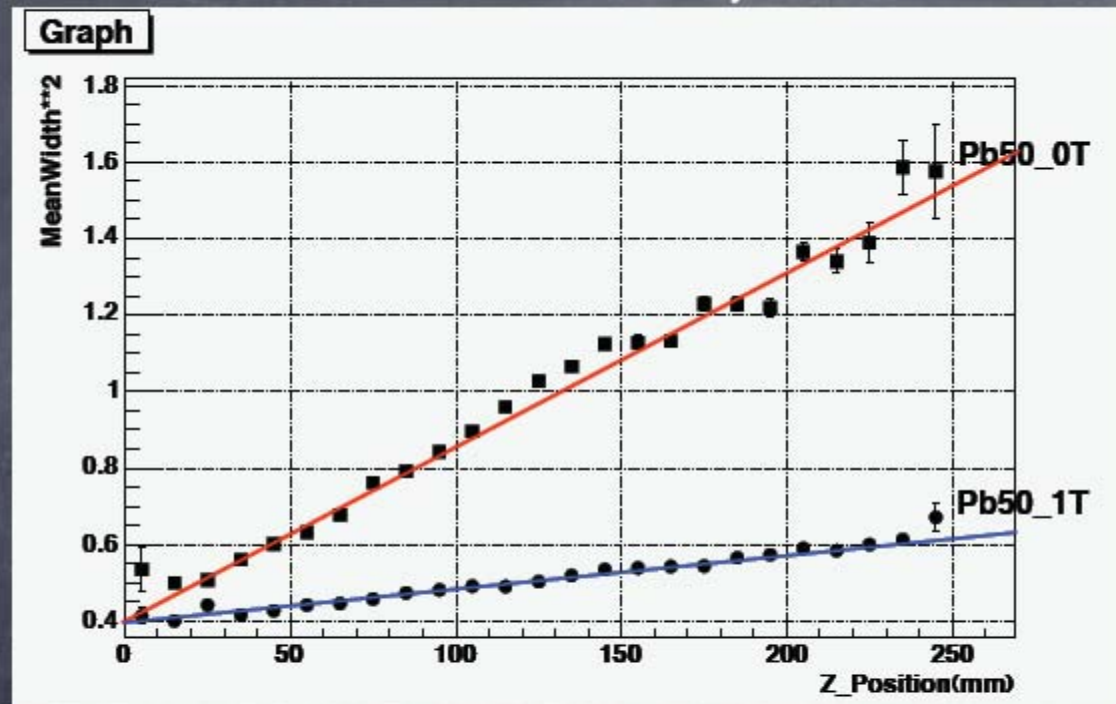


B=1T Results

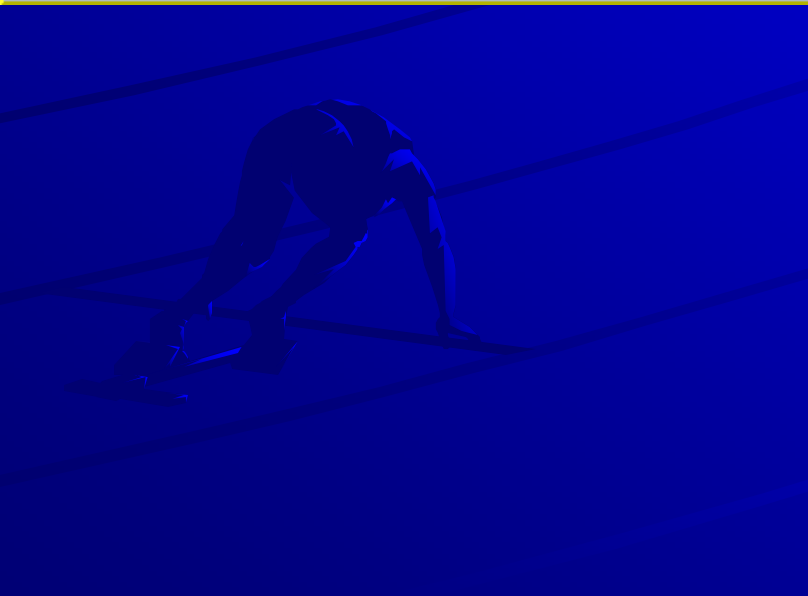
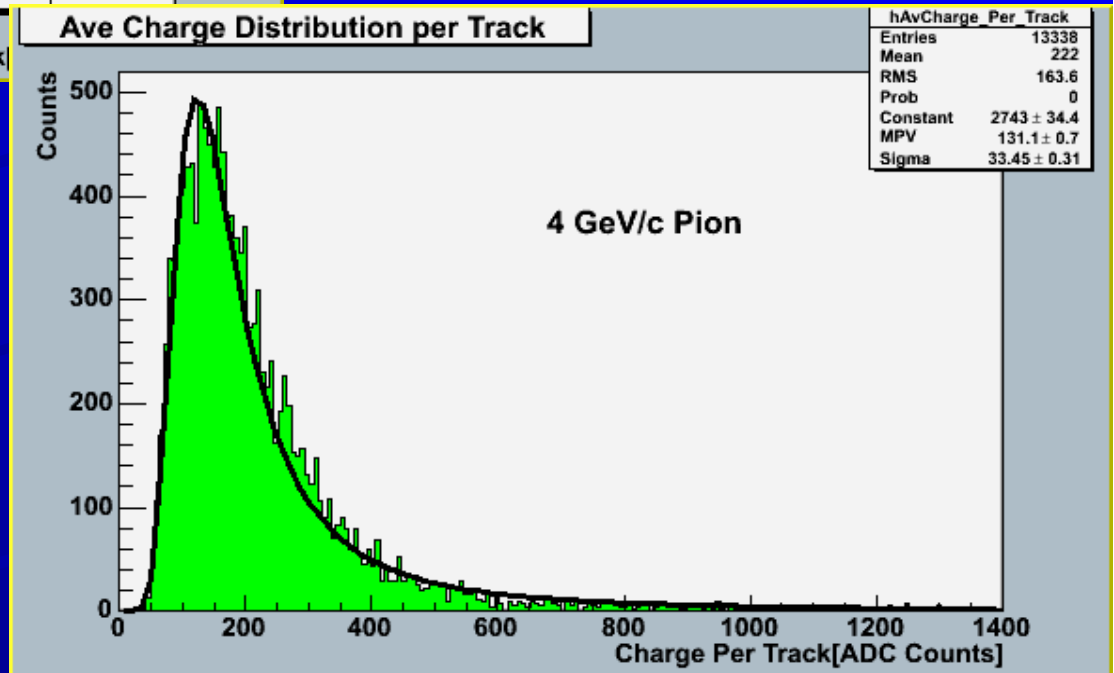
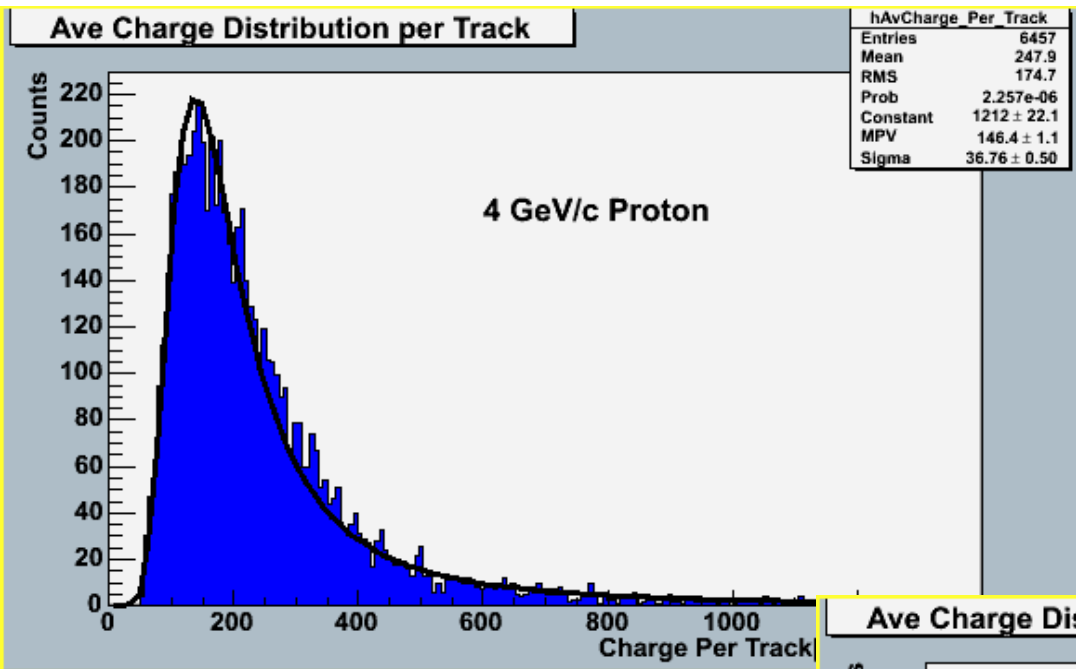
Z-bins: 0-1, 1-2, 2-3, ..., 23-24, 24-25cm



Summary



- B=0 & B=1T lines seem to meet at a single point for Z=0 which corresponds to PRF width of **1.39 mm**



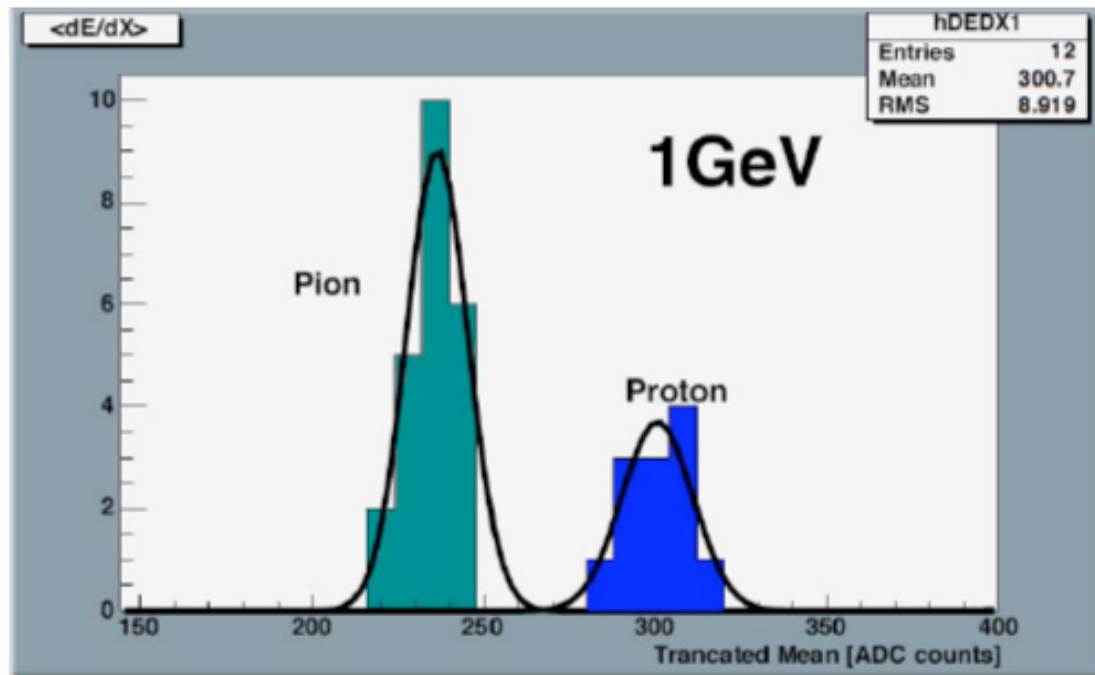
dE/dx in TDR gas

7 pad-row /event \times 30 events \rightarrow 210 sampling

$\sigma_{dE/dx} \sim 3.4\%$ ($\rightarrow 7.9\%$ w/ 40 samples)

not a correct truncated mean.

good w/o calib., any corrections



proton @1GeV/c

$\langle dE/dx \rangle$ 300.6

sigma 10.3

pi @1GeV/c

$\langle dE/dx \rangle$ 236.4

sigma 8.9

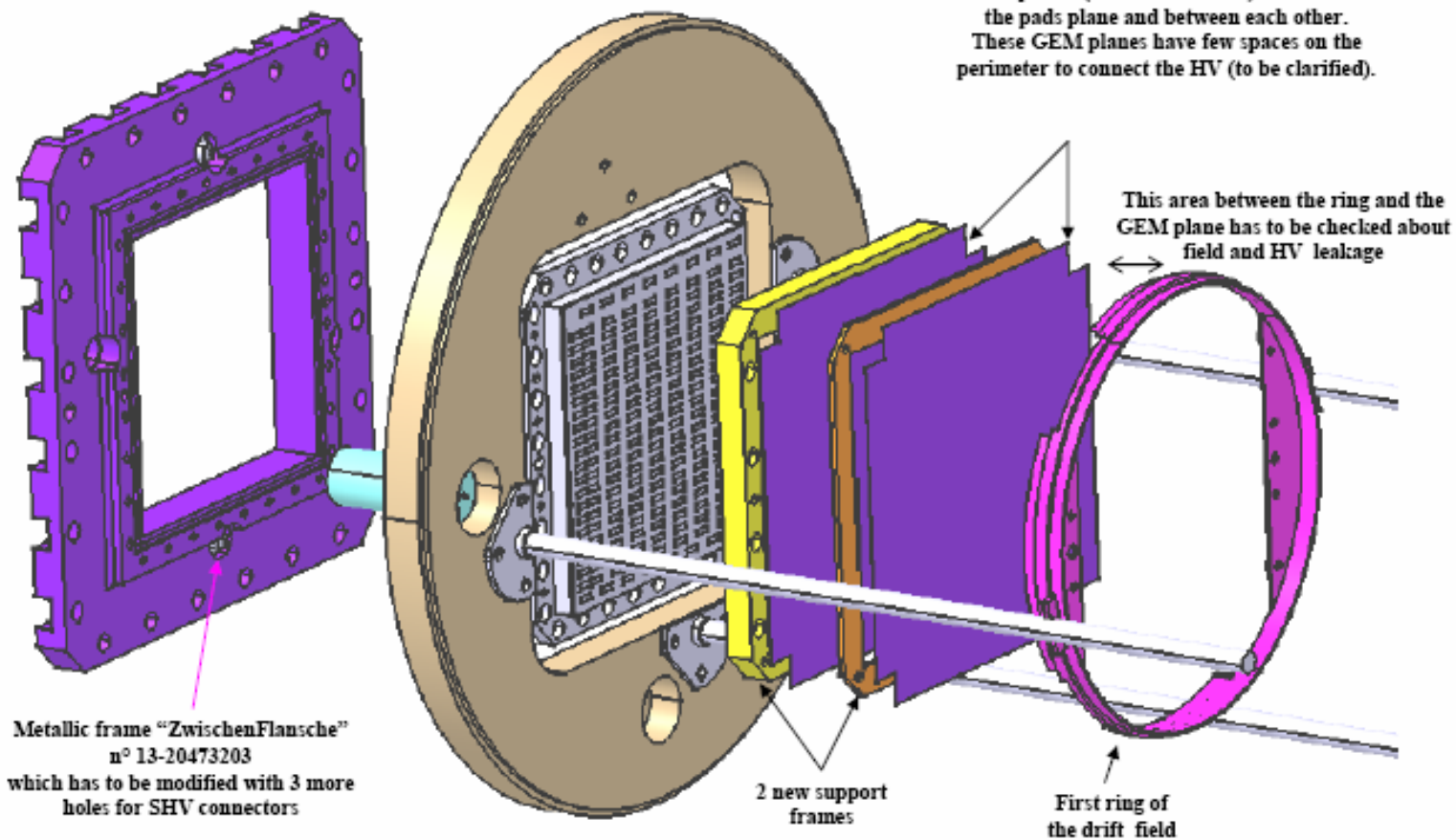
After beam test

- Move to Cryo Hall
- Continue testing with cosmics
- Prepare conversion to Gems, Micromegas
- Install Gems December04, Micromegas later
- Test with cosmics up to April'05
- Continue beam tests

Exploded view of the modified MPI TPC equipped with 2 GEM planes

- Some minor modifications seems already necessary: More holes for the SHV connectors.
- 2 support frames for GEM can be built.

2 GEM planes (130x130mm max) at 2 mm from the pads plane and between each other. These GEM planes have few spaces on the perimeter to connect the HV (to be clarified).

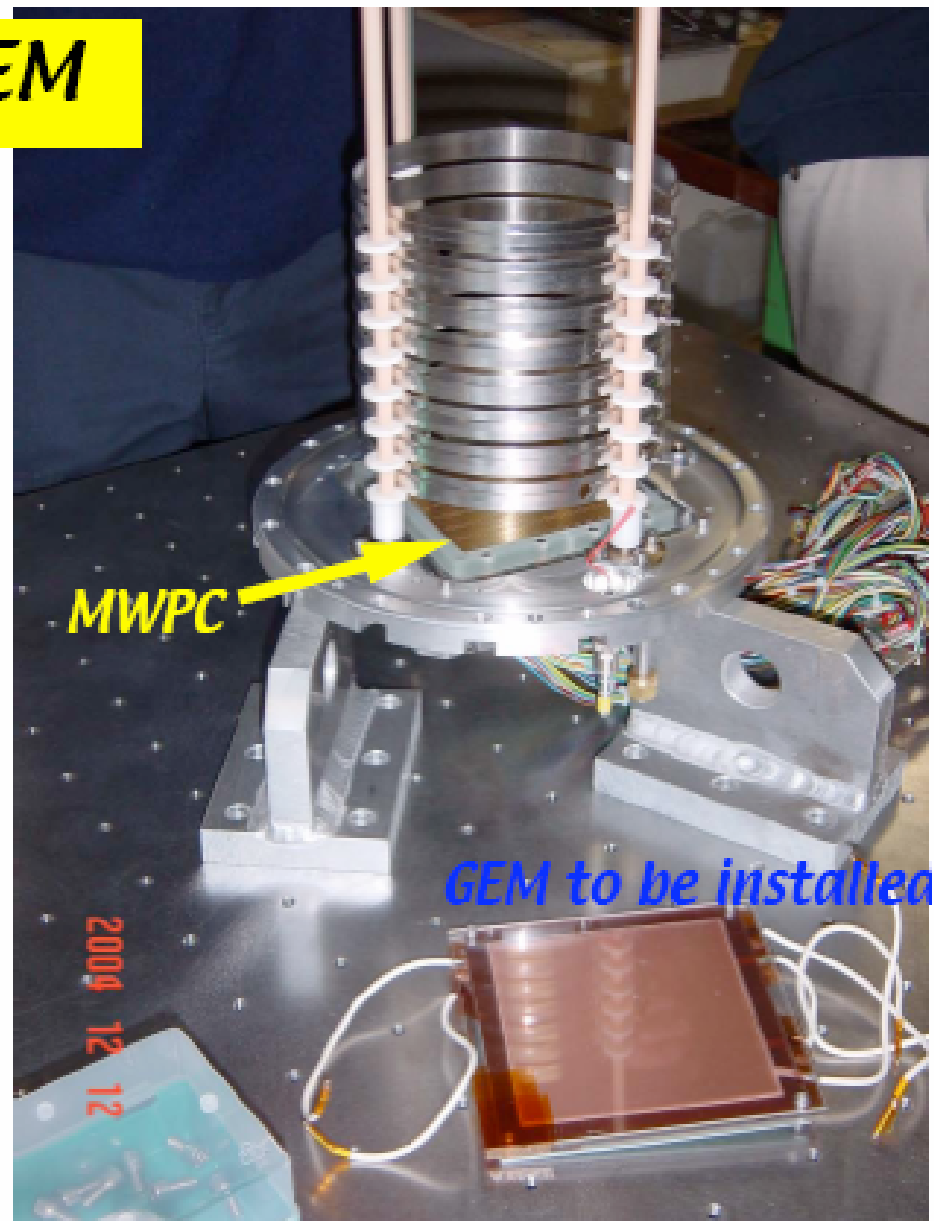


IPN Orsay: GEM for MPI prototype

from MWPC to GEM

*rebuild Field cage
without cathode wires*

Talk by Hirotoshi Kuroiwa/
Akira Sugiyama in previous
tracking session



Next steps

- Beam test with GEM 10-24 April
- Continue testing with cosmics in May
- Convert to MicroMegs beginning June
- Continue beam test 24 June