Snowmass ILC meeting

Micromegas TPC beam tests at KEK

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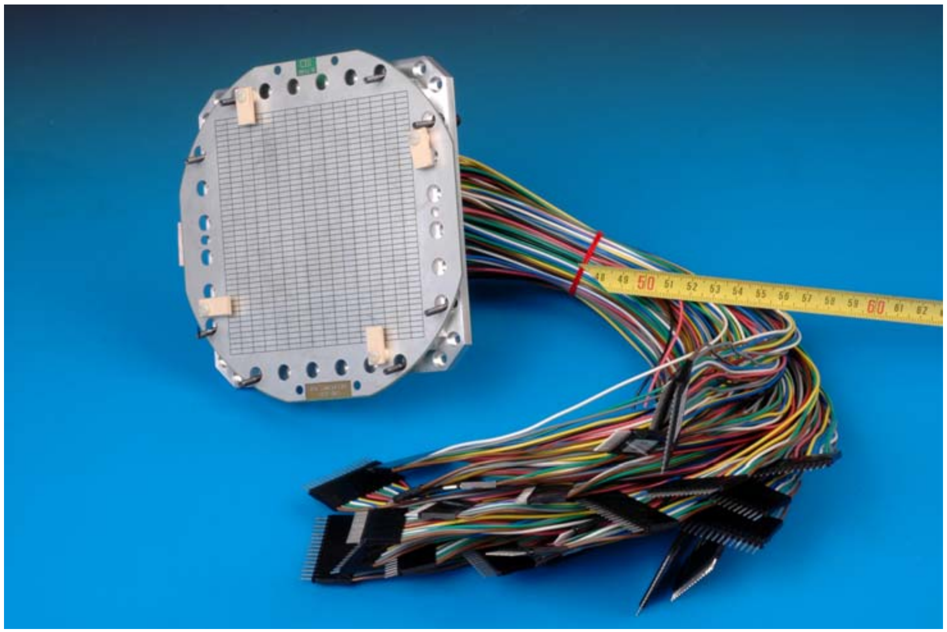
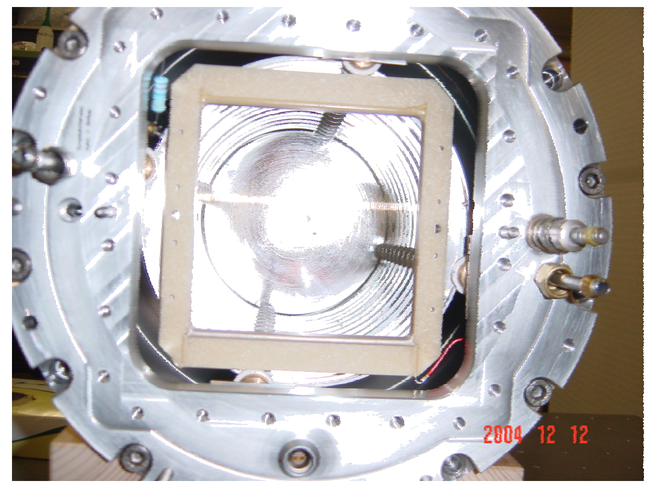


- MPI TPC, Micromegas option
- Beam test data taking
- Preliminary results
- Future

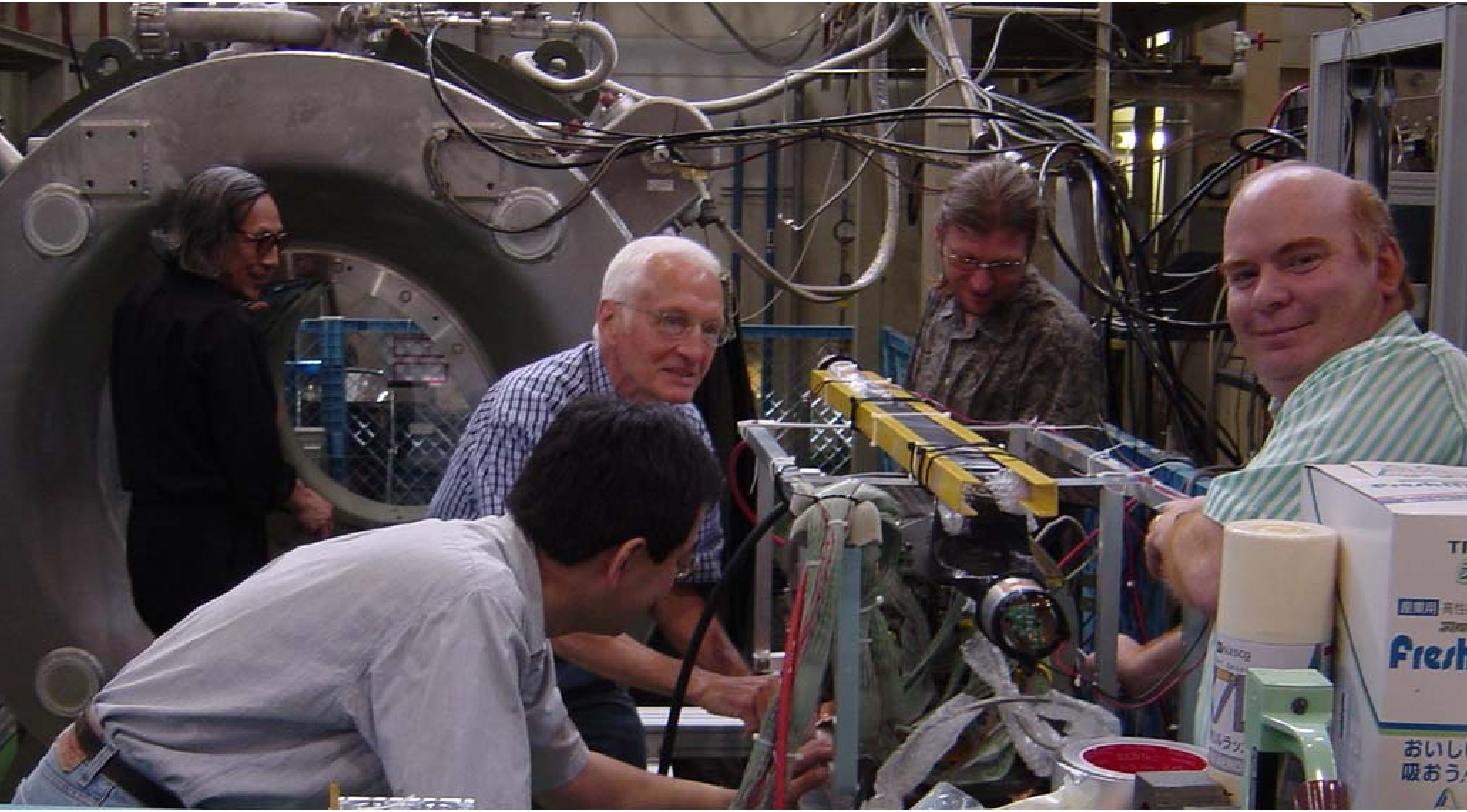


Saclay, Orsay, Carleton, MPI, DESY, MSU, KEK, Tsukuba U, TUAT, Kogakuin U, Kinki U, Saga U (Canada, France, Germany, Japan, Philippines)

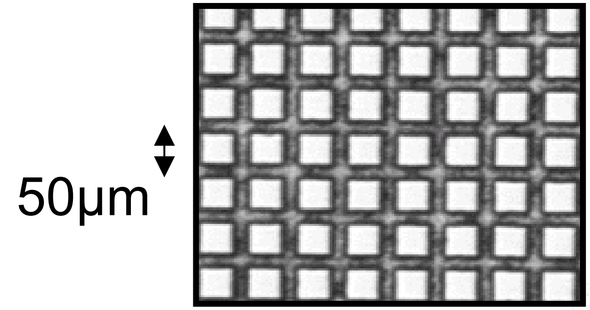
MPI TPC, Motivation

- Initiated by Ron Settles. Comparison of several gas amplifiers using same Field Cage, Electronics, analysis
  - MWPC : Beam test in Jun, 2004
  - GEM : Beam test in Apr, 2005
  - **Micromegas**

Beam test in Jun. 22□Jul. 1, 2005

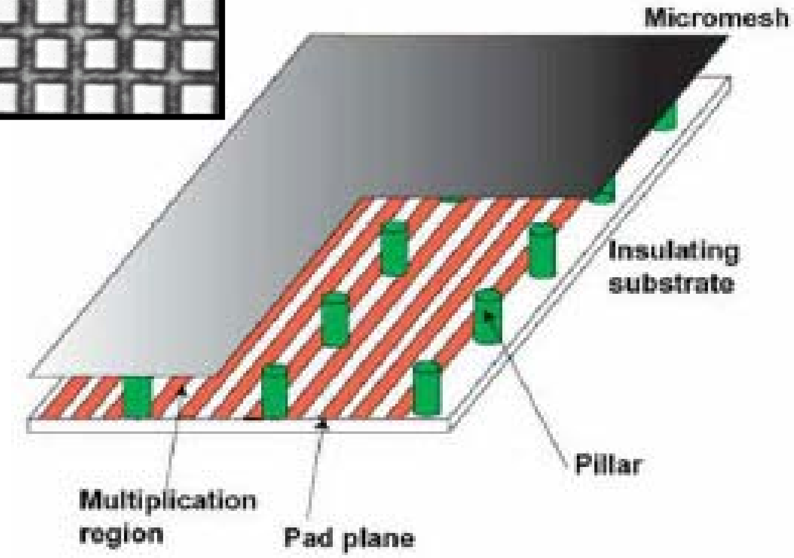

Fresh
おいしい
吸おう!

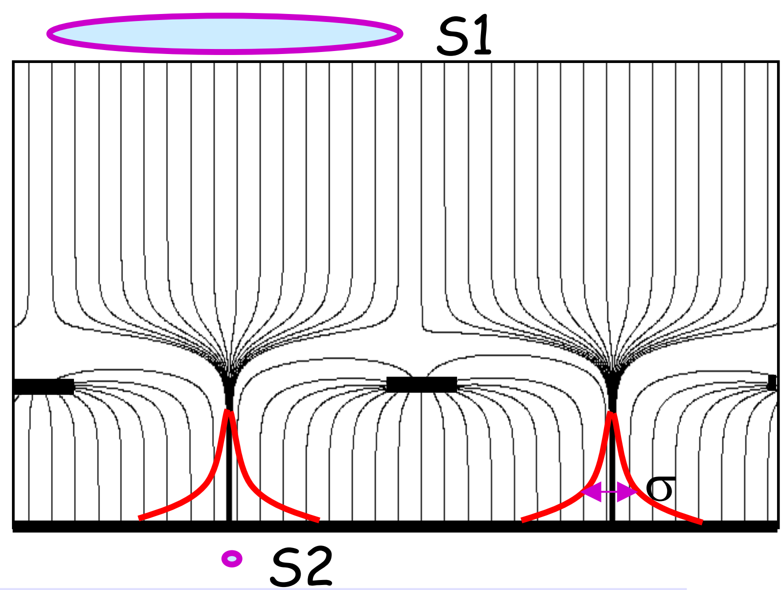
Micromegas



- Micromesh supported by 50-100µm - high insulating pillars
- Multiplication takes place between the anode and the mesh
- One stage
- Direct detection of avalanche electrons
  - Small E×B effect
  - Fast signals
  - Self-suppression of positive ion feedback

    the ions return to the grid
  - Better potential spatial resolution
  - No wire angular effect





The MPI TPC at KEK

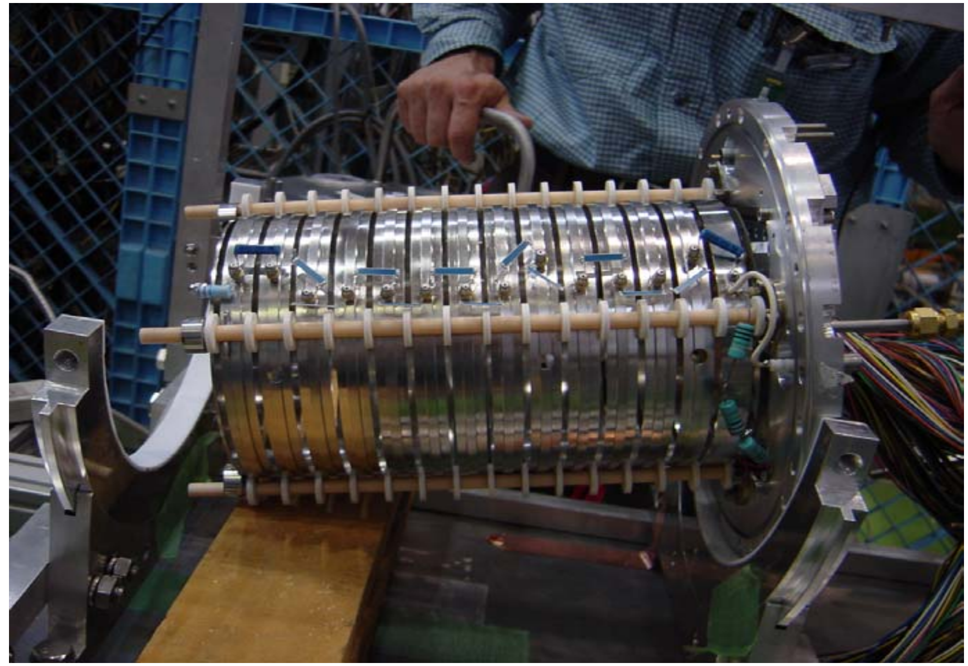
- Drift length : 26 cm
- Pads
  - 2,3×6,3 mm pitches
  - 32 pads×12 pad rows
    □ 384 readout channels
  - pad plane : 10×10 cm
- Readout
  - ALEPH TPC electronics

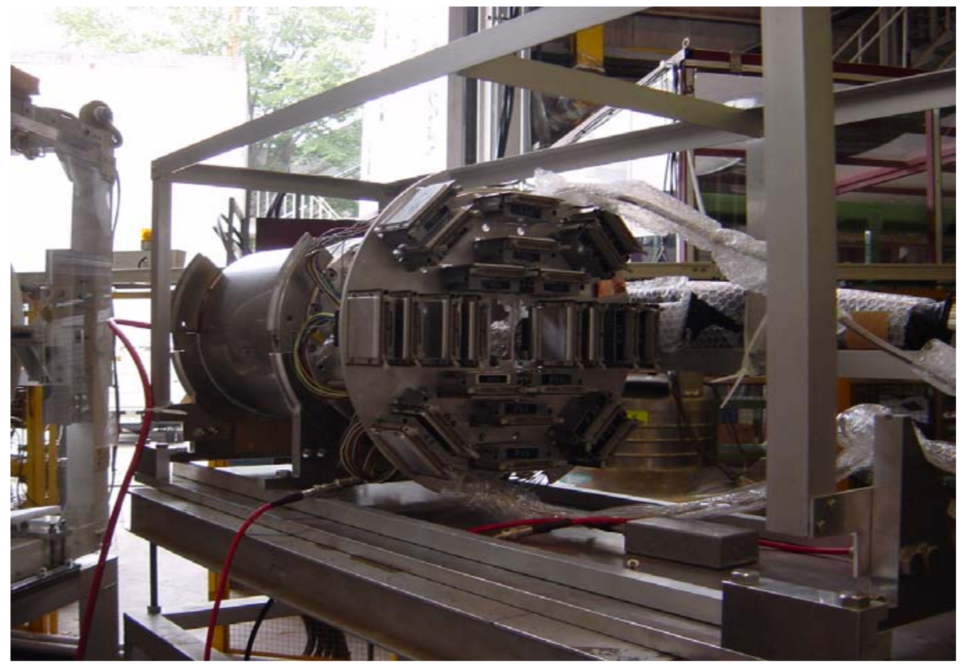
    24 amplifiers, 16 channels each

    500ns shaping time, charge sensitive

    sampled every 80 ns

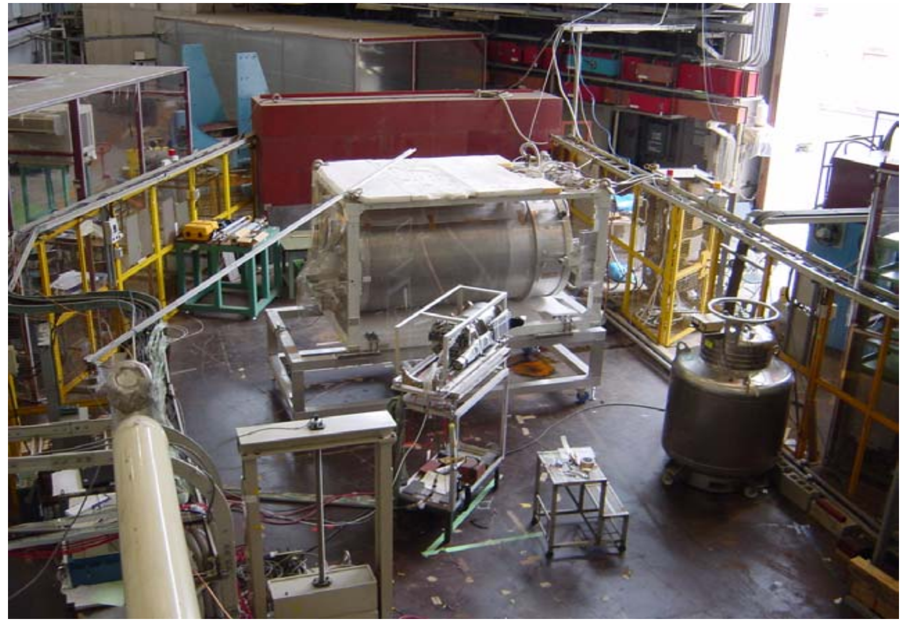
    digitized by 6 TPDs

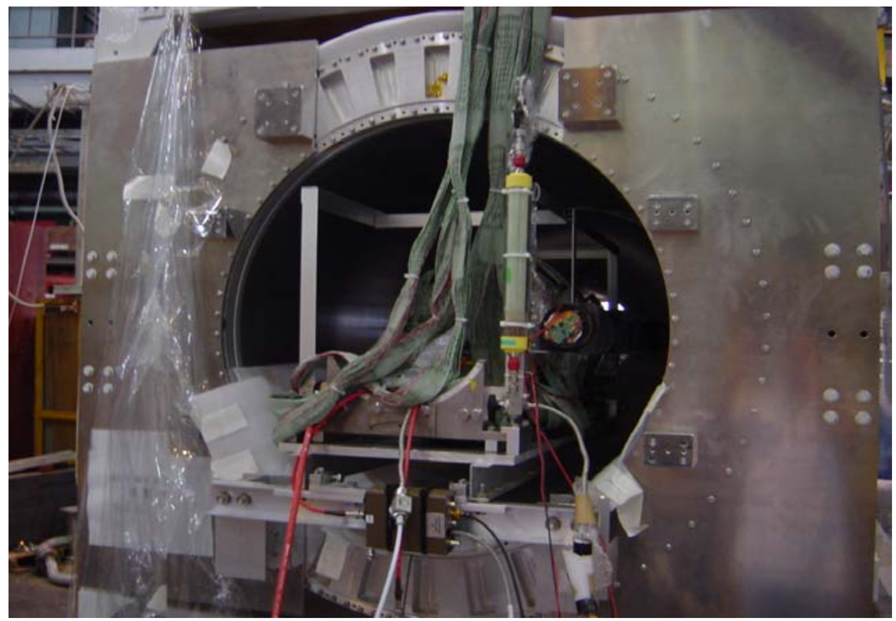




Experimental Setup

- KEK-PS π2 beam line
  - mainly 4 GeV π^-
- Superconducting magnet (JACEE)
  - B = 0, 0.5 and 1T
- Gas
  - Ar + isobutane (95:5)
- Drift field :
  - mainly 220 V/cm

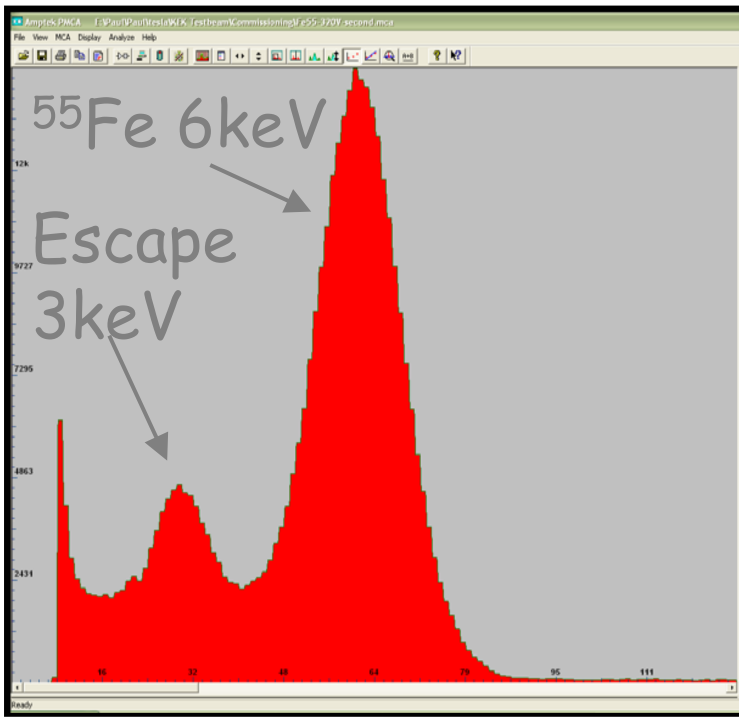


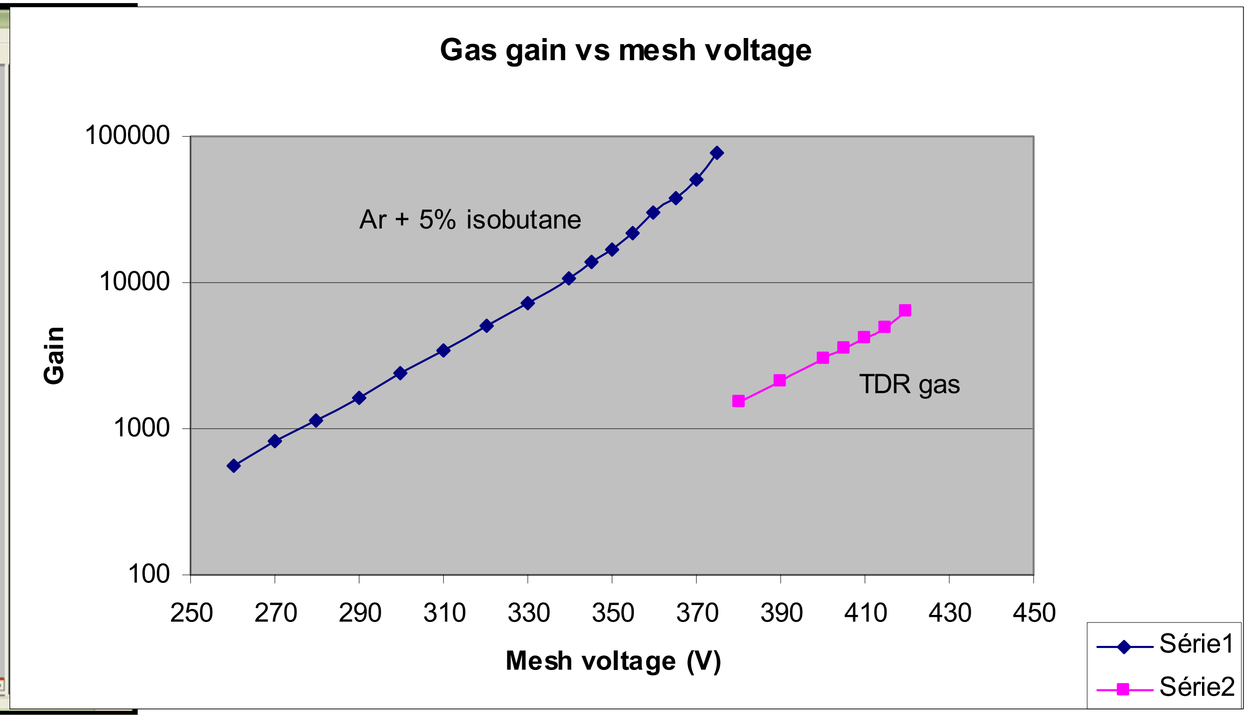


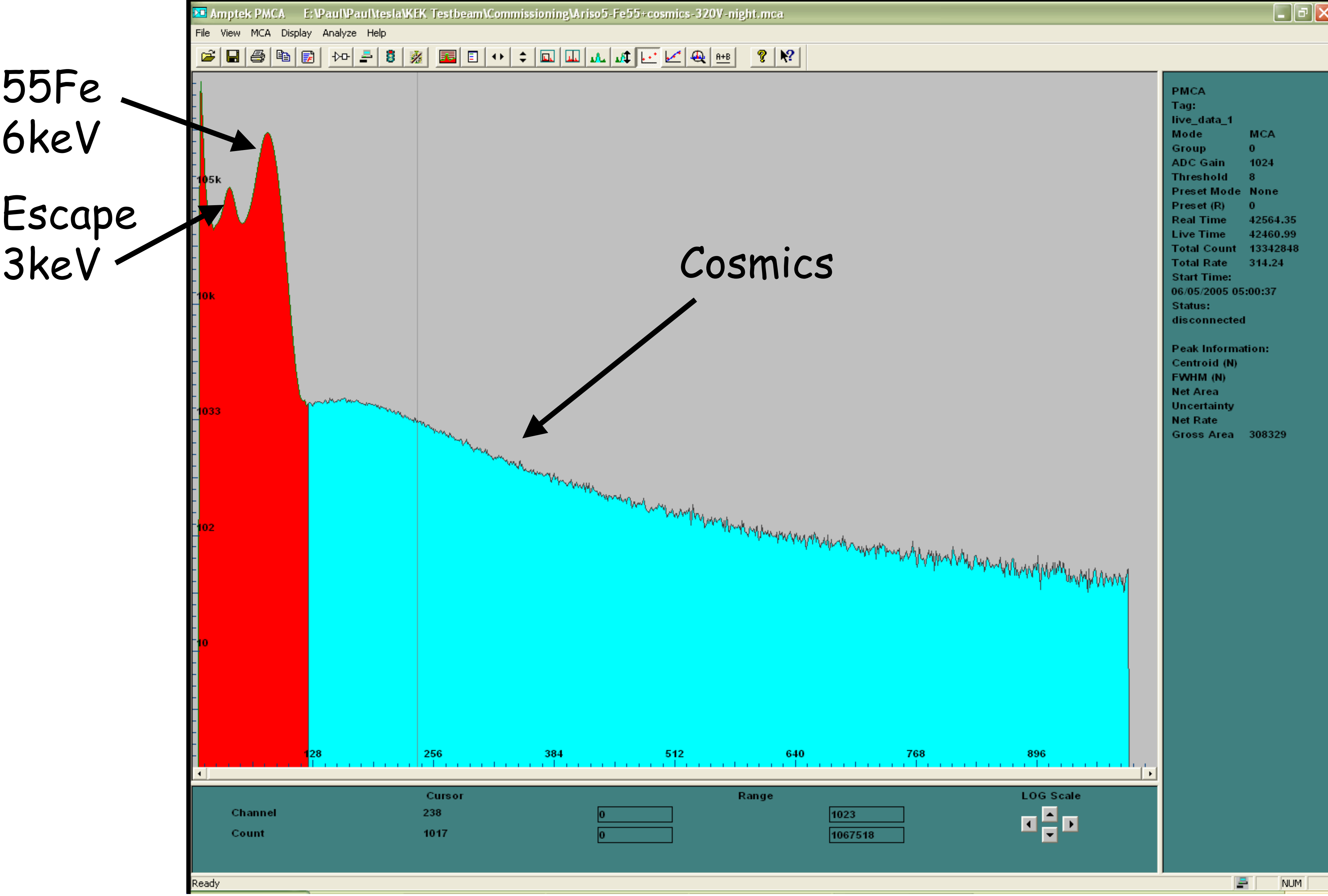
Mesh readout

Calibration with a ^{55}Fe source installed inside the chamber.

Mesh readout by a Multichannel Analyser. Used for monitoring the gain



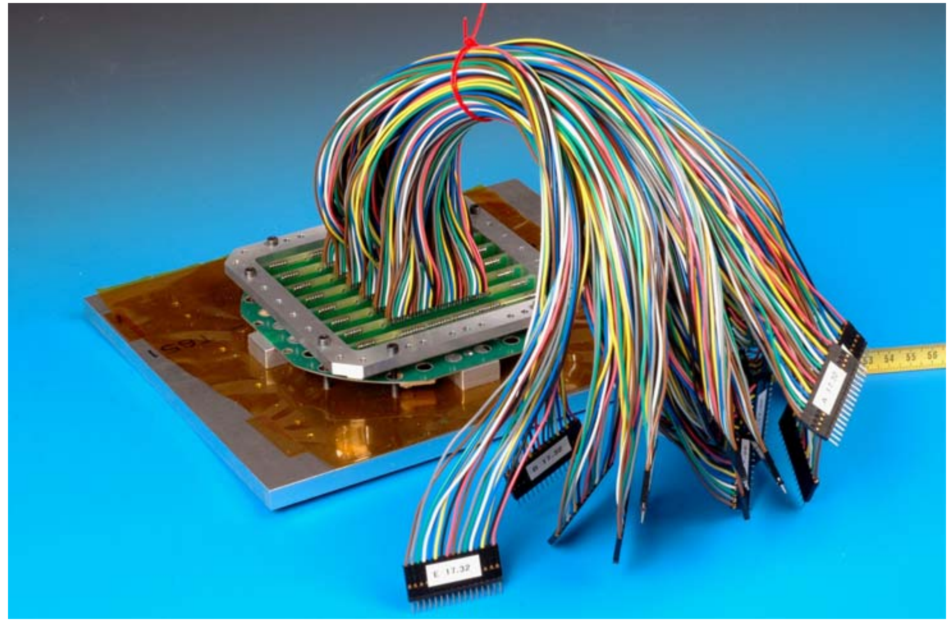



55Fe
6keV
Escape
3keV
Cosmics
Amptek PMCA E:\Paul\Paul\tesla\KEK Testbeam\Commissioning\Ariso5-Fe55+cosmics-320V-night.mca
File View MCA Display Analyze Help
105k
10k
1033
102
10
128
256
384
512
640
768
896
PMCA
Tag:
live_data_1
Mode MCA
Group 0
ADC Gain 1024
Threshold 8
Preset Mode None
Preset (R) 0
Real Time 42564.35
Live Time 42460.99
Total Count 13342848
Total Rate 314.24
Start Time:
06/05/2005 05:00:37
Status:
disconnected
Peak Information:
Centroid (N)
FWHM (N)
Net Area
Uncertainty
Net Rate
Gross Area 308329
Cursor
Range
LOG Scale
Channel 238
Count 1017
0
0
1023
1067518
Ready
NUM

June 2005 tests in KEK

December to May : design and build the Micromegas endplate, all from drawings and photographs of the GEM endplate.

June 4th,5th : assemble, test, install in Cryo-hall. Detect a leak. Re-glue the pad plane



June 6th : Re-assemble, test with ^{55}Fe in Ar+5%isobutane, OK, connect pad electronics. **See tracks!** Take data overnight

June 7th-10th : Take cosmic data

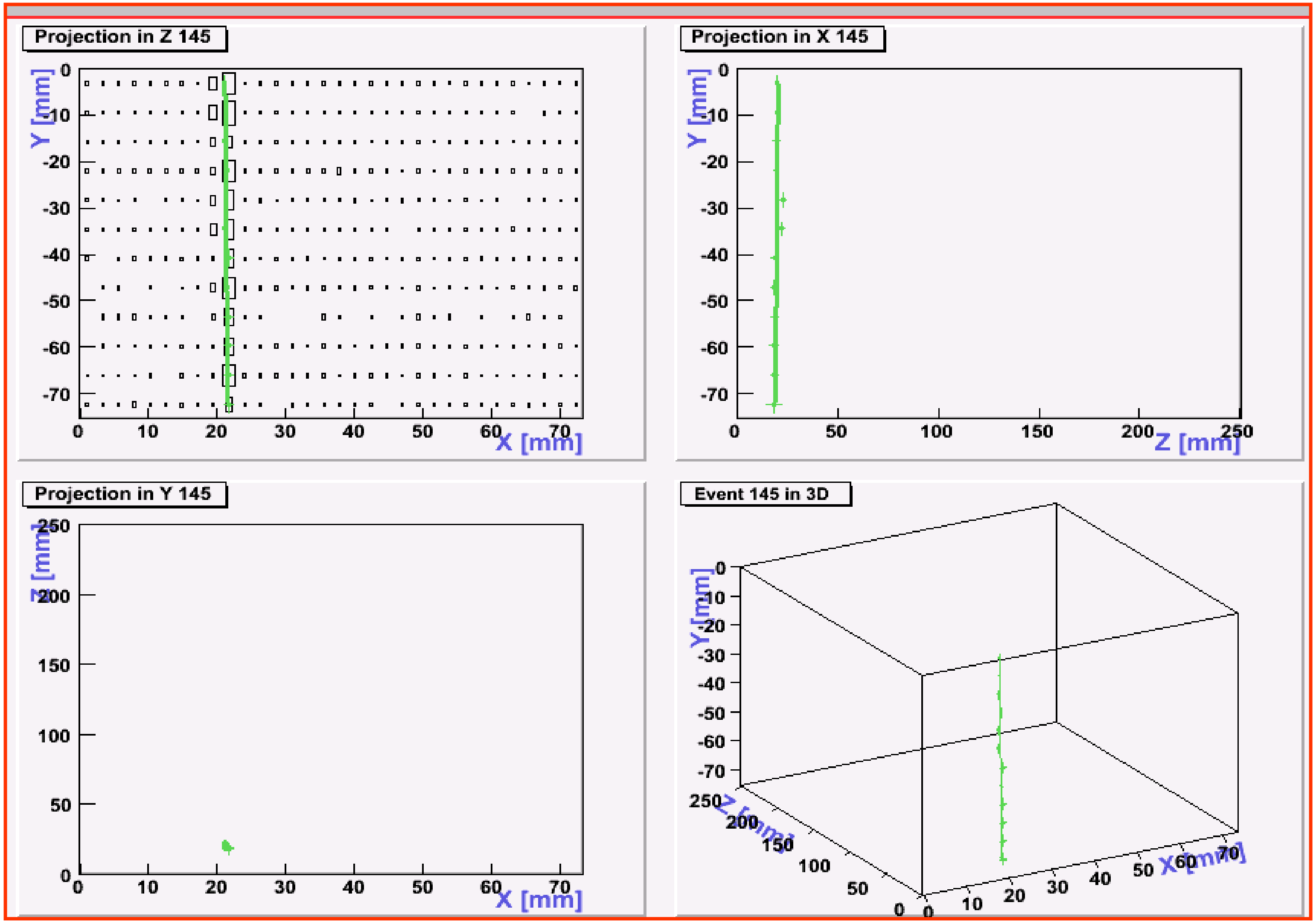
June 21st : Set last resistor value for E field continuity. Move to beam hall

June 22nd to 25th : setup DAQ (with 380 channels) during machine studies

June 26th, 0:00 : start beam DAQ.

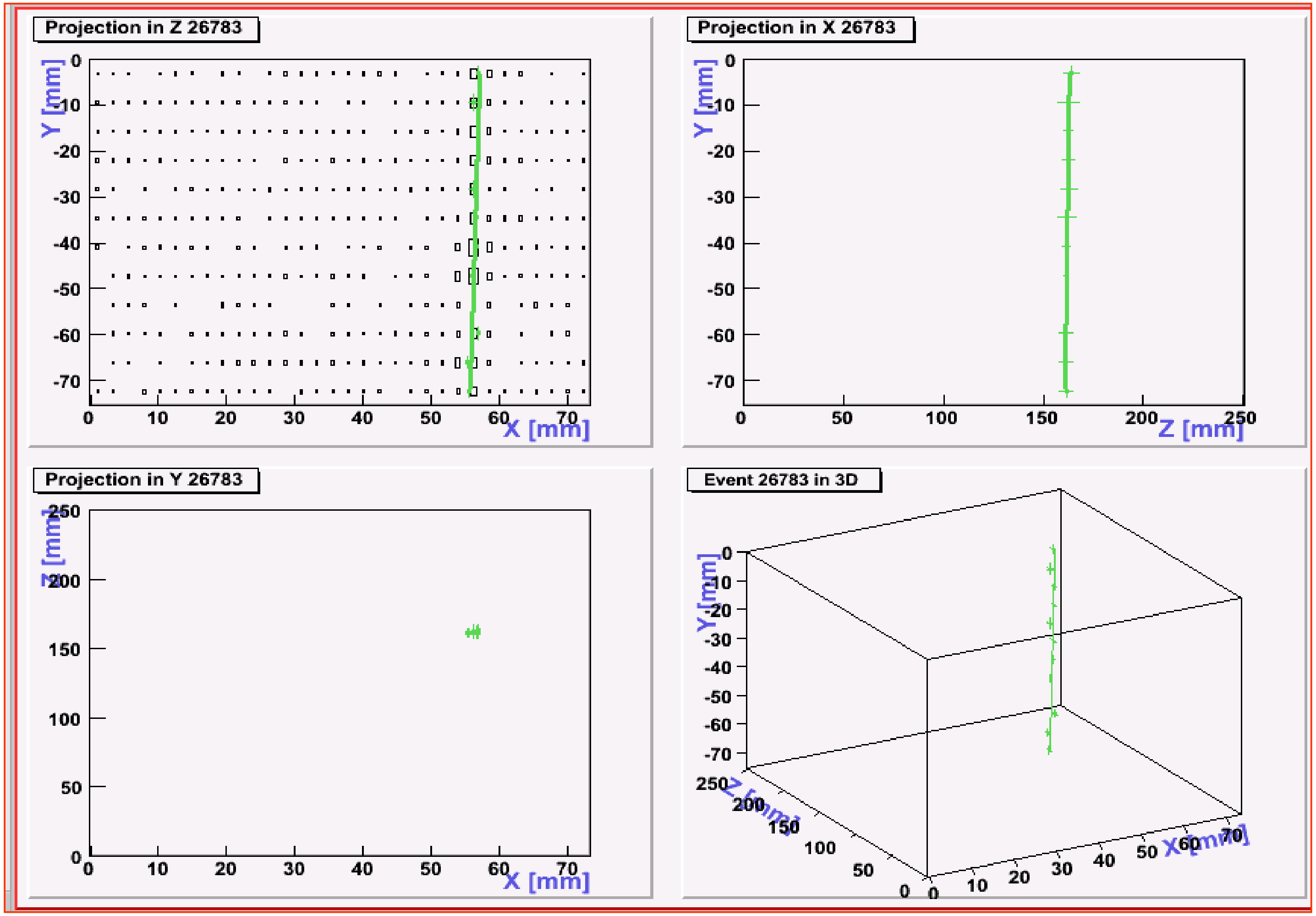
July 1st : end of beam, end-of-run party and analysis meeting…

B=0T



Projection in Z 145
Y [mm]
X [mm]
Projection in X 145
Y [mm]
Z [mm]
Projection in Y 145
Z [mm]
X [mm]
Event 145 in 3D
Y [mm]
Z [mm]
X [mm]

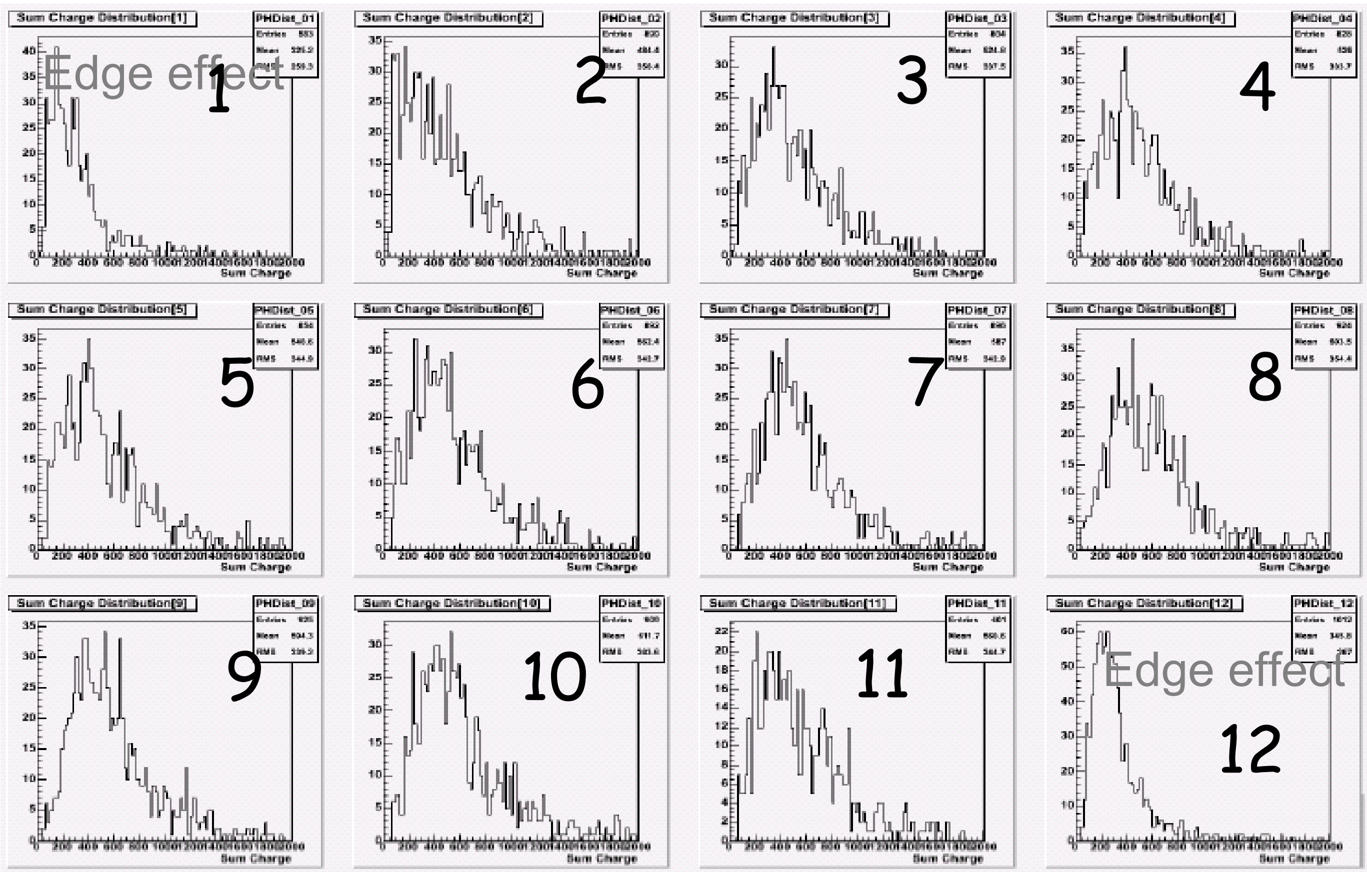
B=0.5 T



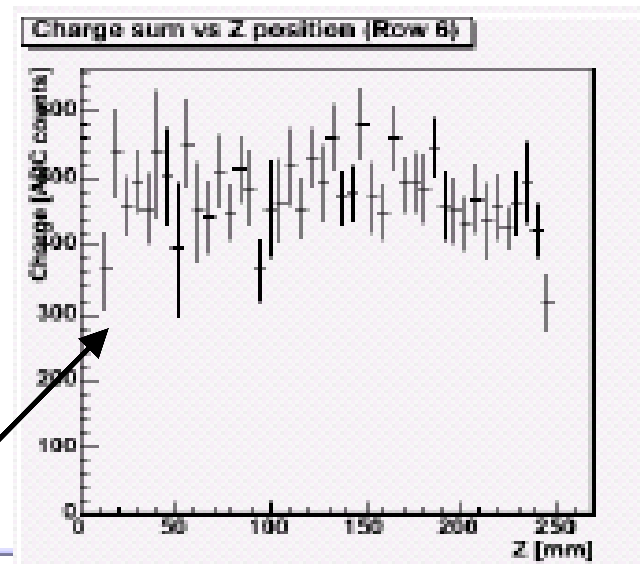
Projection in Z 26783
Y [mm]
X [mm]
Projection in X 26783
Y [mm]
Z [mm]
Projection in Y 26783
Z [mm]
X [mm]
Event 26783 in 3D
Y [mm]
Z [mm]
X [mm]

Charge Distribution

B = 1T, row by row



Aver. charge distribution, Row6, as a function of z

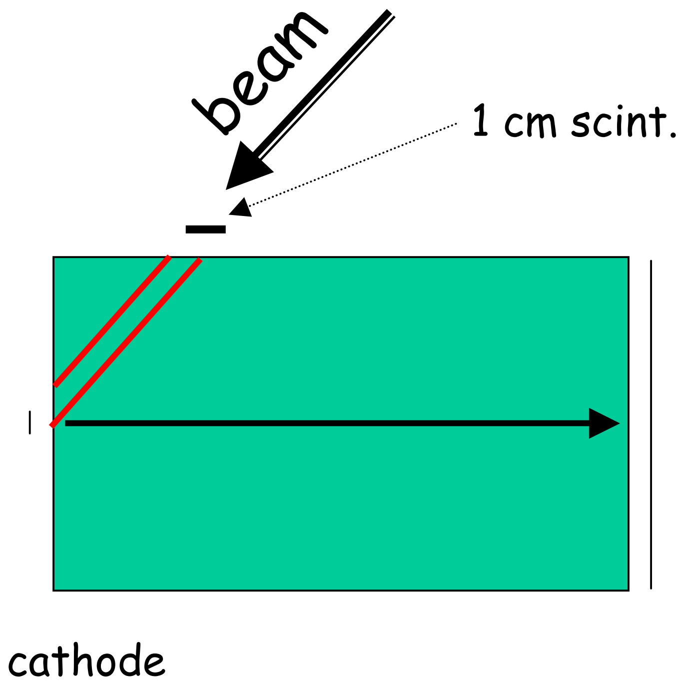


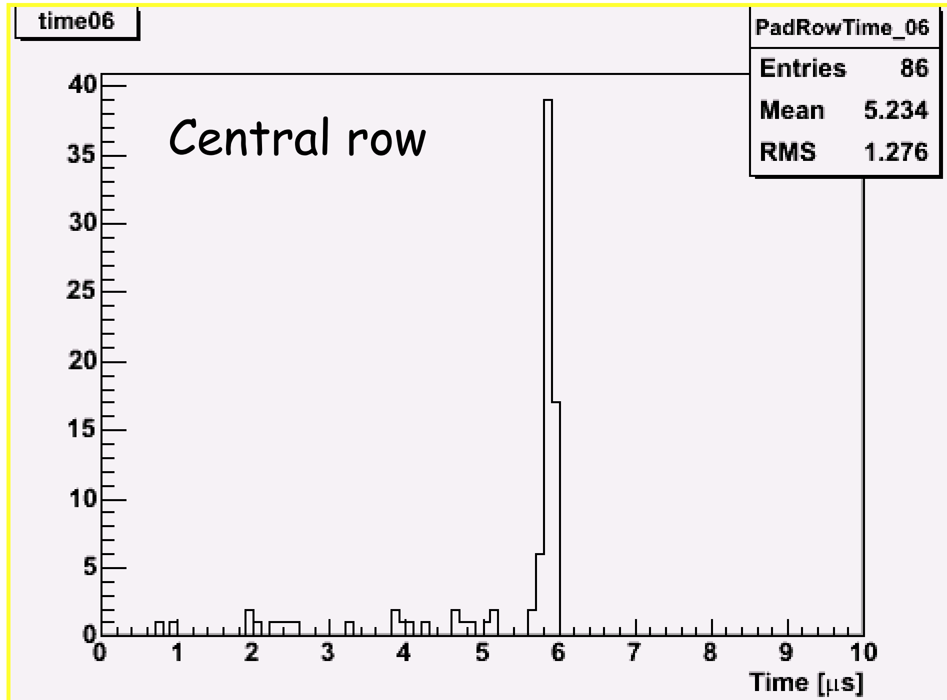
no significant attenuation

Drift velocity measurement

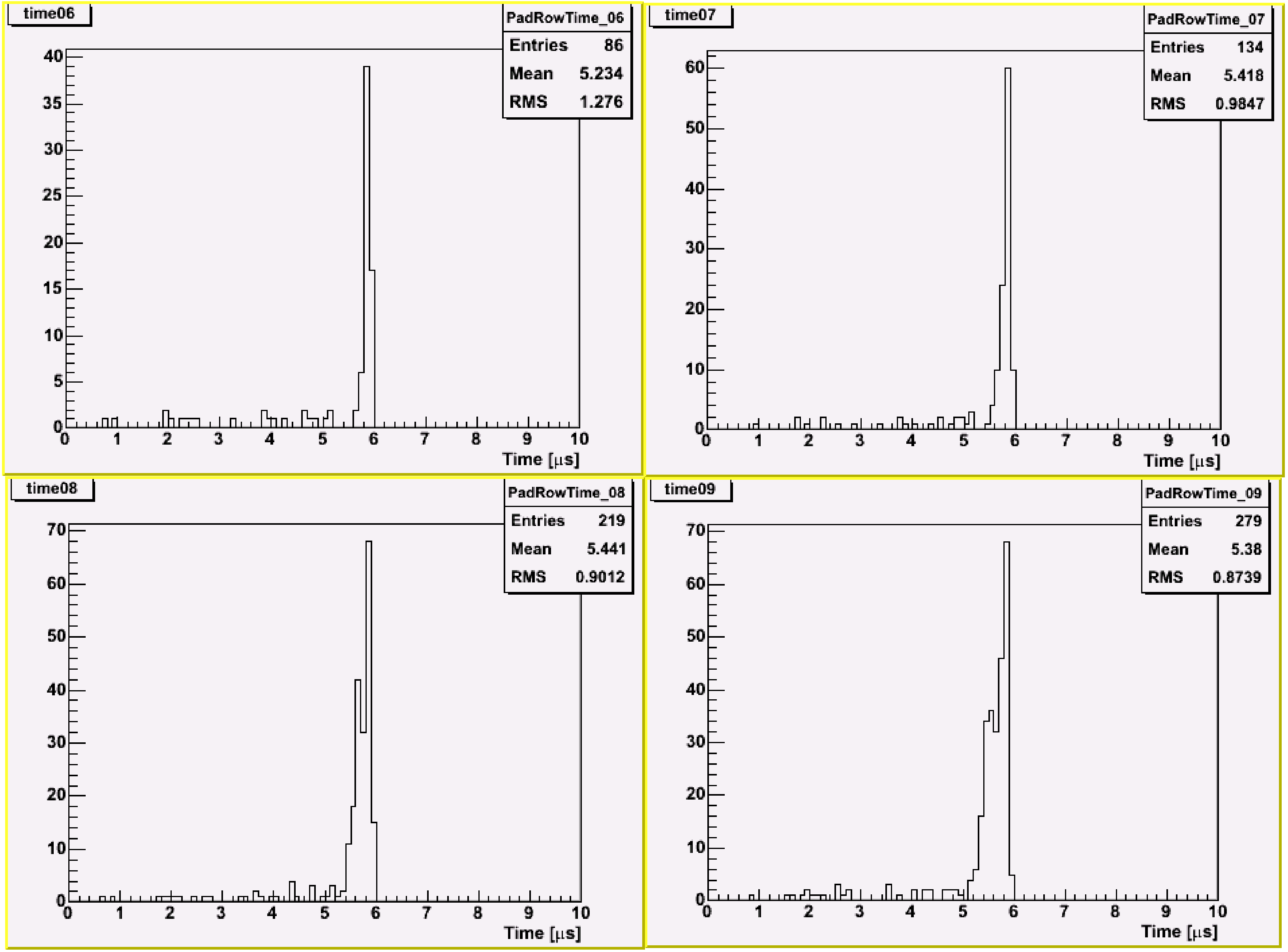
Method

Using a beam at 45 deg. Look at time distribution on one pad. Max time gives drift time over 26.08+-0.02 cm





Time distributions



Result

Avoid side pads where the field might not be nominal.

Padrow 6: 5.907 μs
Padrow 7: 5.911 μs
Padrow 8: 5.911 μs
Padrow 9: 5.901 μs

Average 5.907 +-30 ns
Trigger cable delay (measured): 310+-5 ns
Trig. Logic and start TPD (guess) : 20+-20 ns

Total time 6.237+- 0.050 μs

→Velocity = 4.181+-0.034 (t meas)+-0.003 (length) cm/μs

V_{drift} (Ar+5%iso) = 4.181 +- 0.034 cm/μs

In agreement with Magboltz : 4.173 +- 0.016

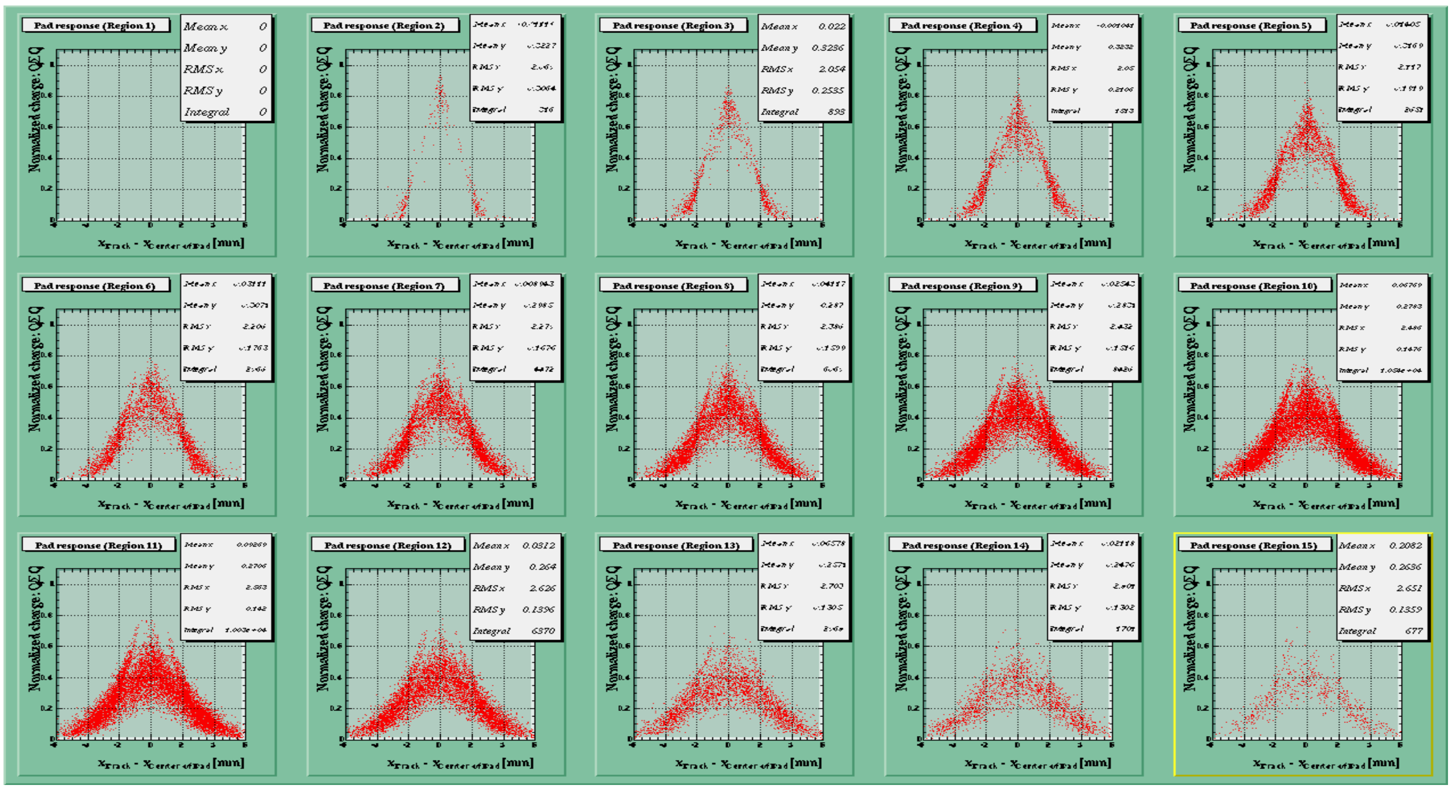
Gas composition

Pad Response Function

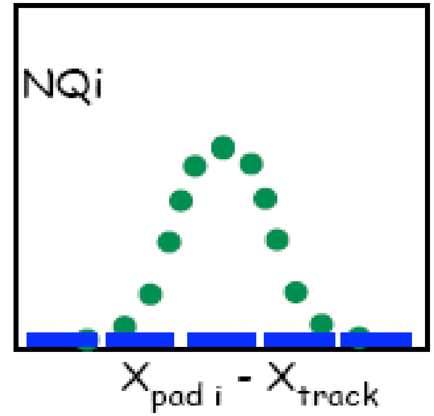
evaluated by the charge fraction ($NQ_i = Q_i/\sum Q$) on pad i, as a function of ($X_{pad} - X_{track}$)

Charge width for different z drift regions (B = 0T)

anode Z →



cathode



Width increases with drift distance (diffusion)

Width of Pad Response Function as a function of z

B = 0T

$$C_D = 480. \pm 4. [\mu m]$$
$$= 469 (\text{Magboltz})$$

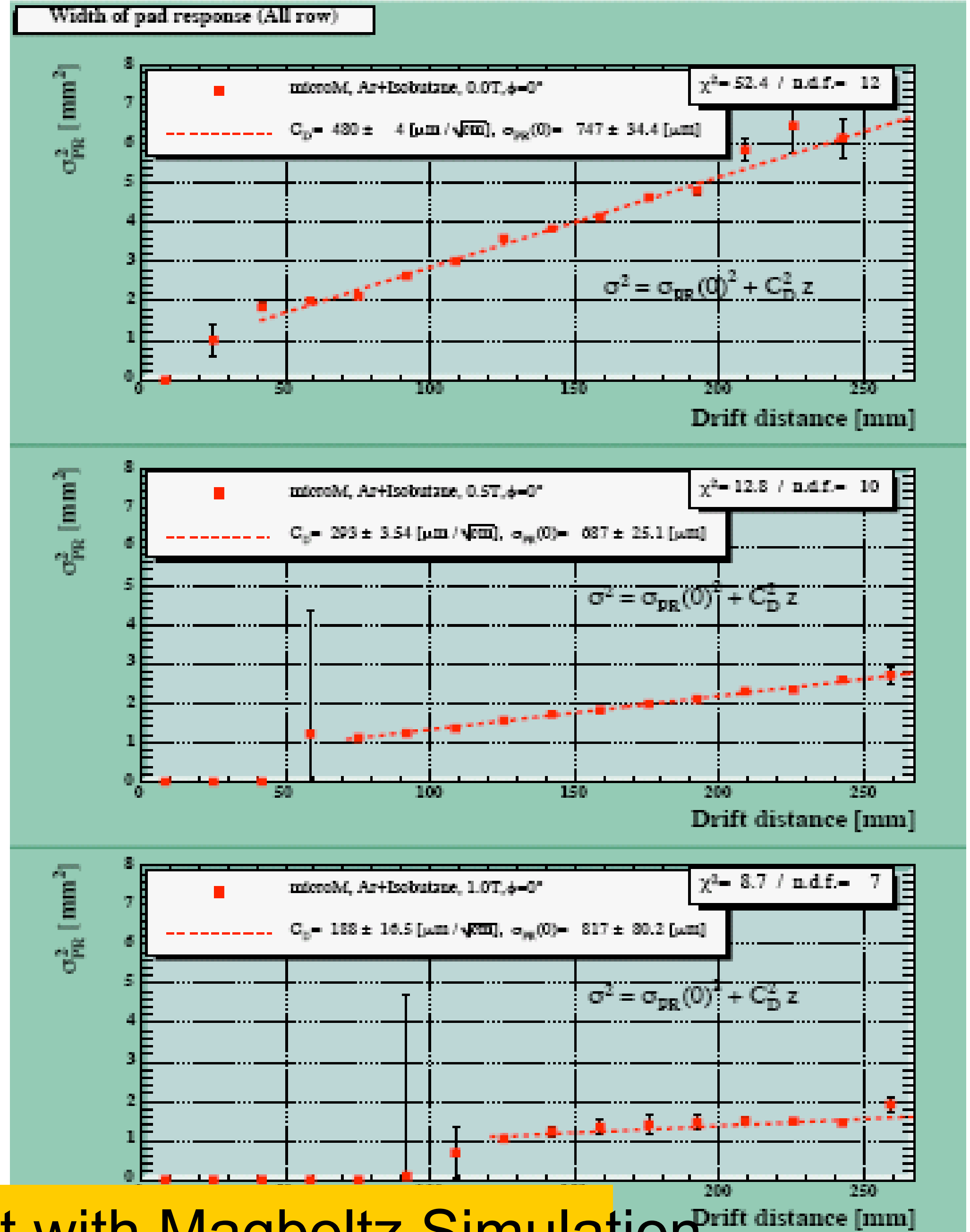
Preliminary results

B = 0.5T

$$C_D = 293. \pm 4. [\mu m]$$
$$= 285 (\text{Magboltz})$$

B = 1T

$$C_D = 188. \pm 17. [\mu m]$$
$$= 193 (\text{Magboltz})$$



Measured C_D in good agreement with Magboltz Simulation

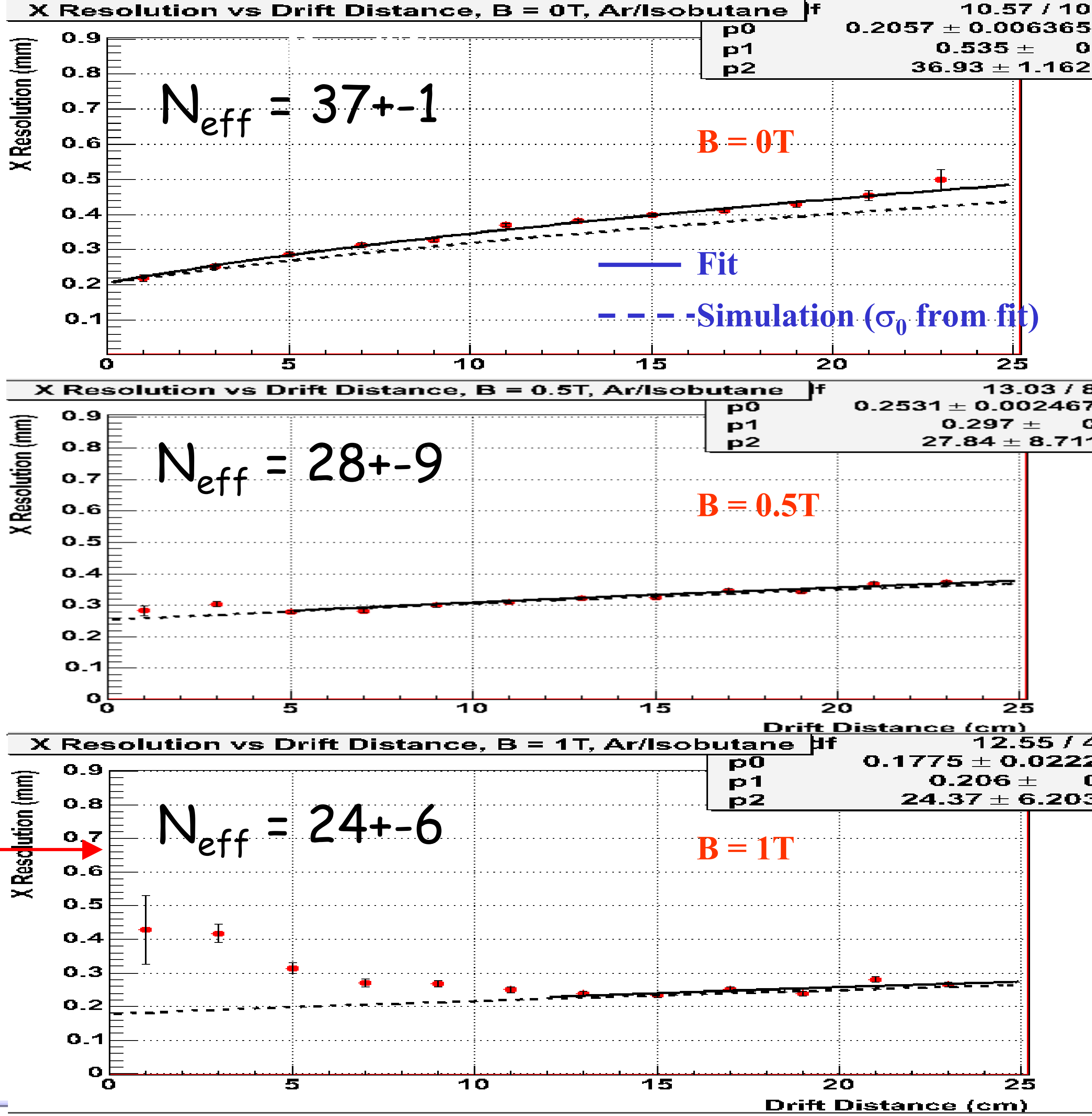
X Resolution vs Z

Use 8 rows, fix C_d, and fit:

$$\sigma_x^2 = \sigma_0^2 + \frac{Cd^2 \cdot z}{N_{eff}}$$

N_{eff} ~ 35, much smaller than the average number of electrons (63 for 6.3 mm)

$2.3mm/\sqrt{12}$



Preliminary results

z Resolution as a function of z

Preliminary results

B = 0T

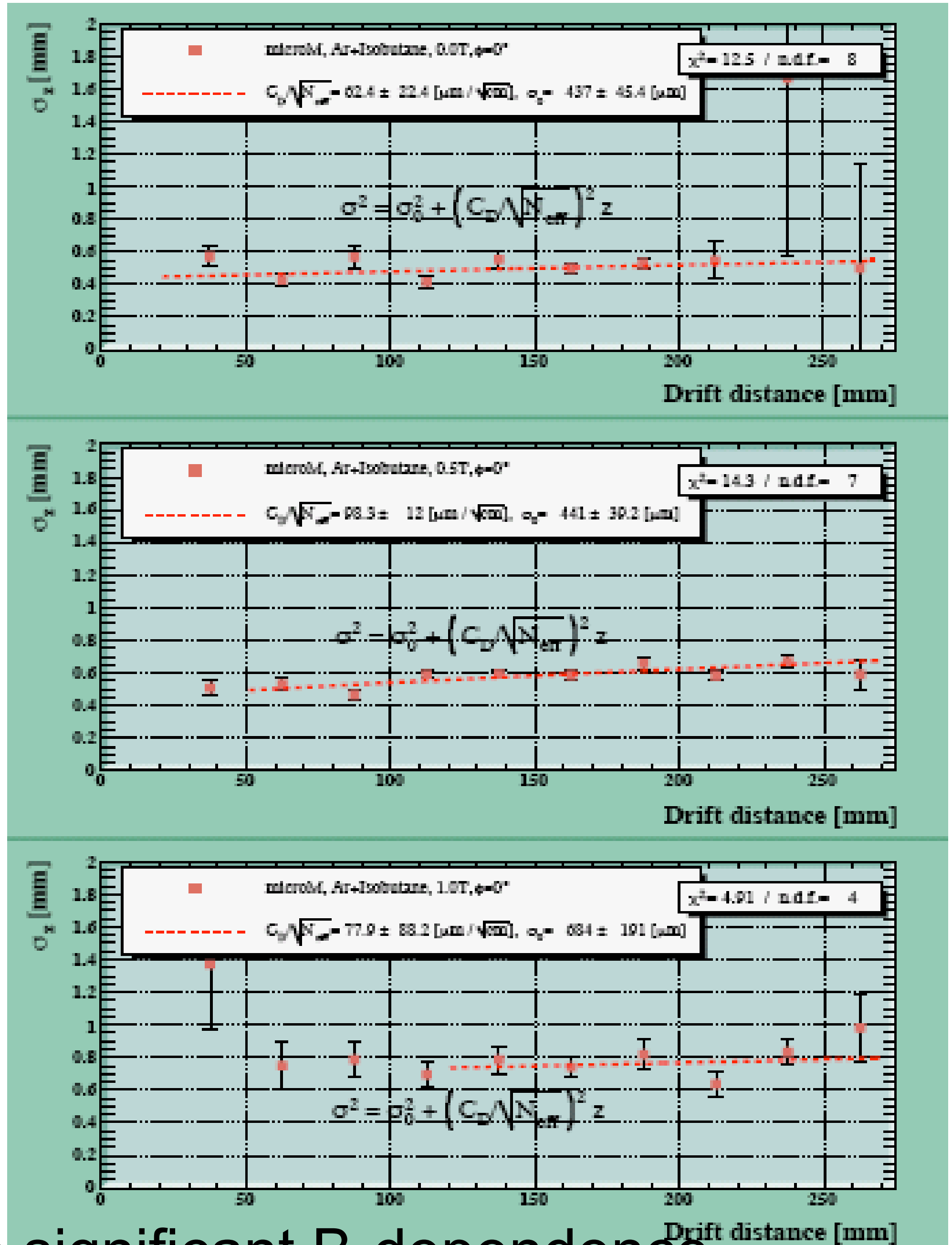
$$\sigma_0 = 437. \pm 45.[\mu m]$$

B = 0.5T

$$\sigma_0 = 441. \pm 39.[\mu m]$$

B = 1T

$$\sigma_0 = 684. \pm 191.[\mu m]$$

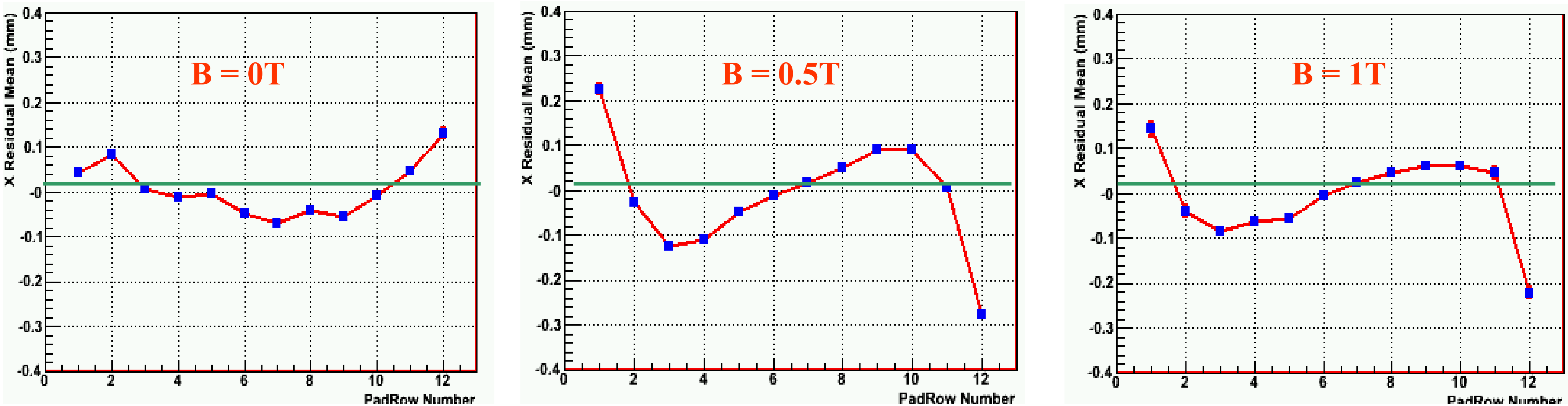


As expected, Unlike σ_X, σ_Z has no significant B-dependence

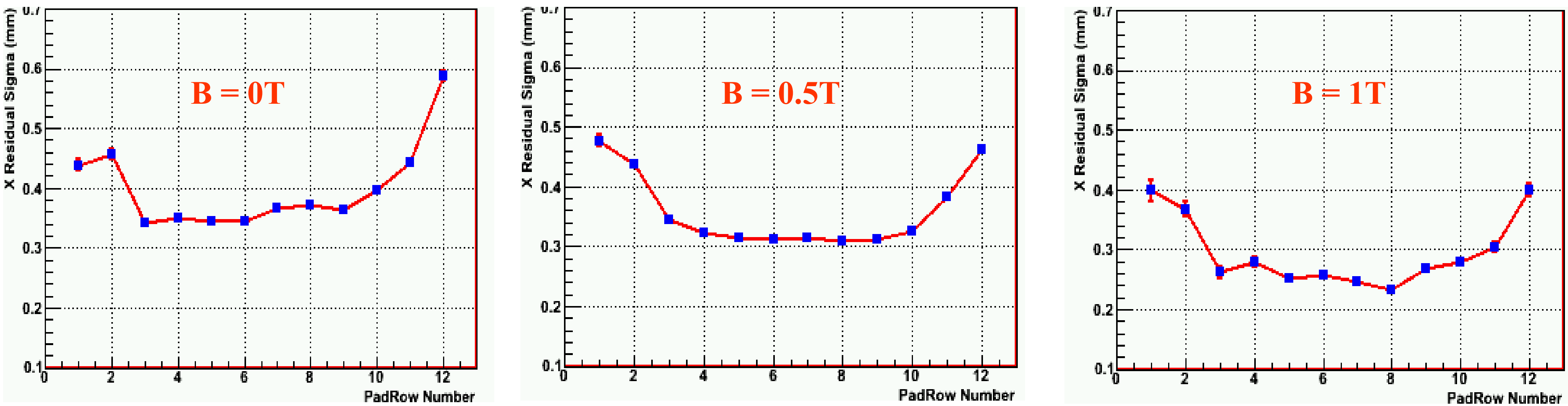
Distortions

X Residual Mean and r.m.s. vs PadRows

Mean



r.m.s.



Conclusions

- Micromegas tests went very smoothly (first 'pad partout' Micromegas TPC)
- Provided a lot of accurate and clean data on diffusion, resolution, etc...
- Much work remains for understanding σ_0, N_{eff}, etc
- Next step (October) : study the effect of a resistive foil on resolution, with 2 setups
  - The same, with a resistive foil added
  - The Carleton TPC, with a new 128 pad endplate and special electronics.
- Very nice beginning of a world-wide collaboration