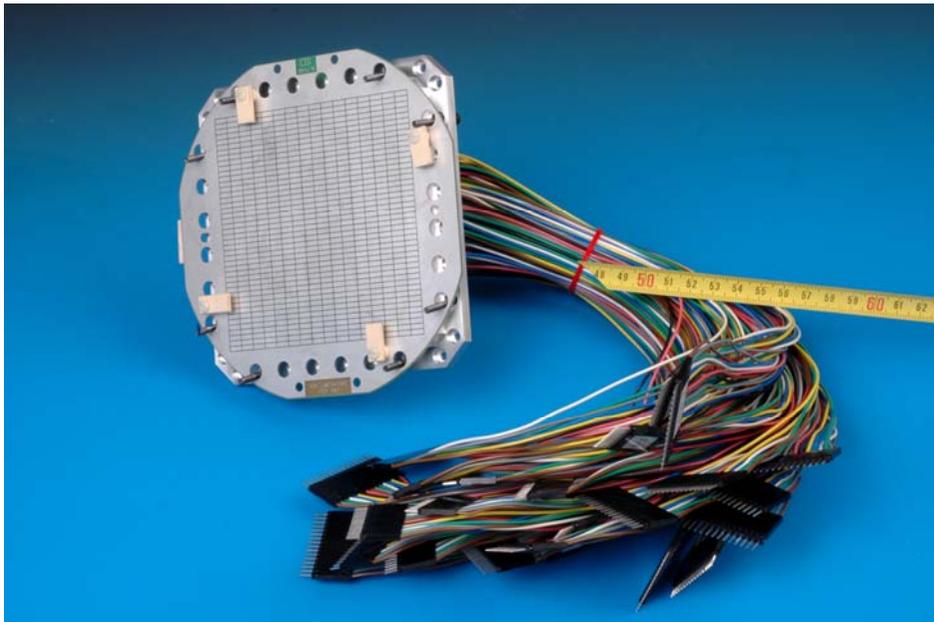


Micromegas TPC beam tests at KEK

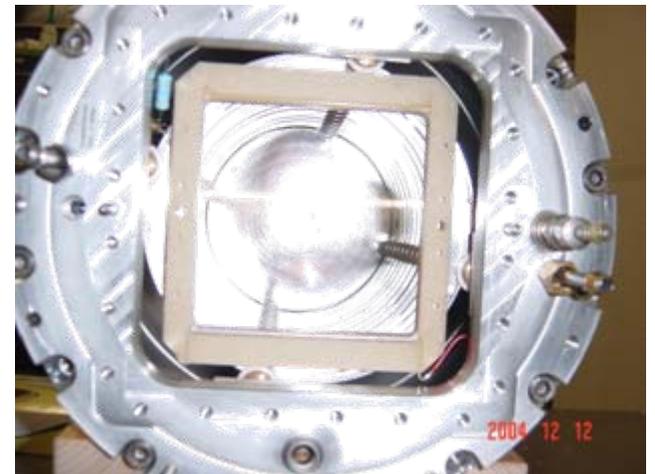
A.M. Bacala, A. Bellerive, K. Boudjemline, P. Colas, M. Dixit, K. Fujii, A. Giganon, I. Giomataris, H. C. Gooch, Y. Kato, M. Kobayashi, H. Kuroiwa, V. Lepeltier, T. Matsuda, O. Nitoh, R. L. Reserva, Ph. Rosier, R. Settles, A. Sugiyama, T. Takahashi, T. Watanabe, H. Yamaoka, Th. Zerguerras

Students: D. C. Arogancia, Fujishima, M. Habu, T. Higashi, S. Matsushita, K. Nakamura, A. Yamaguchi



- 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)

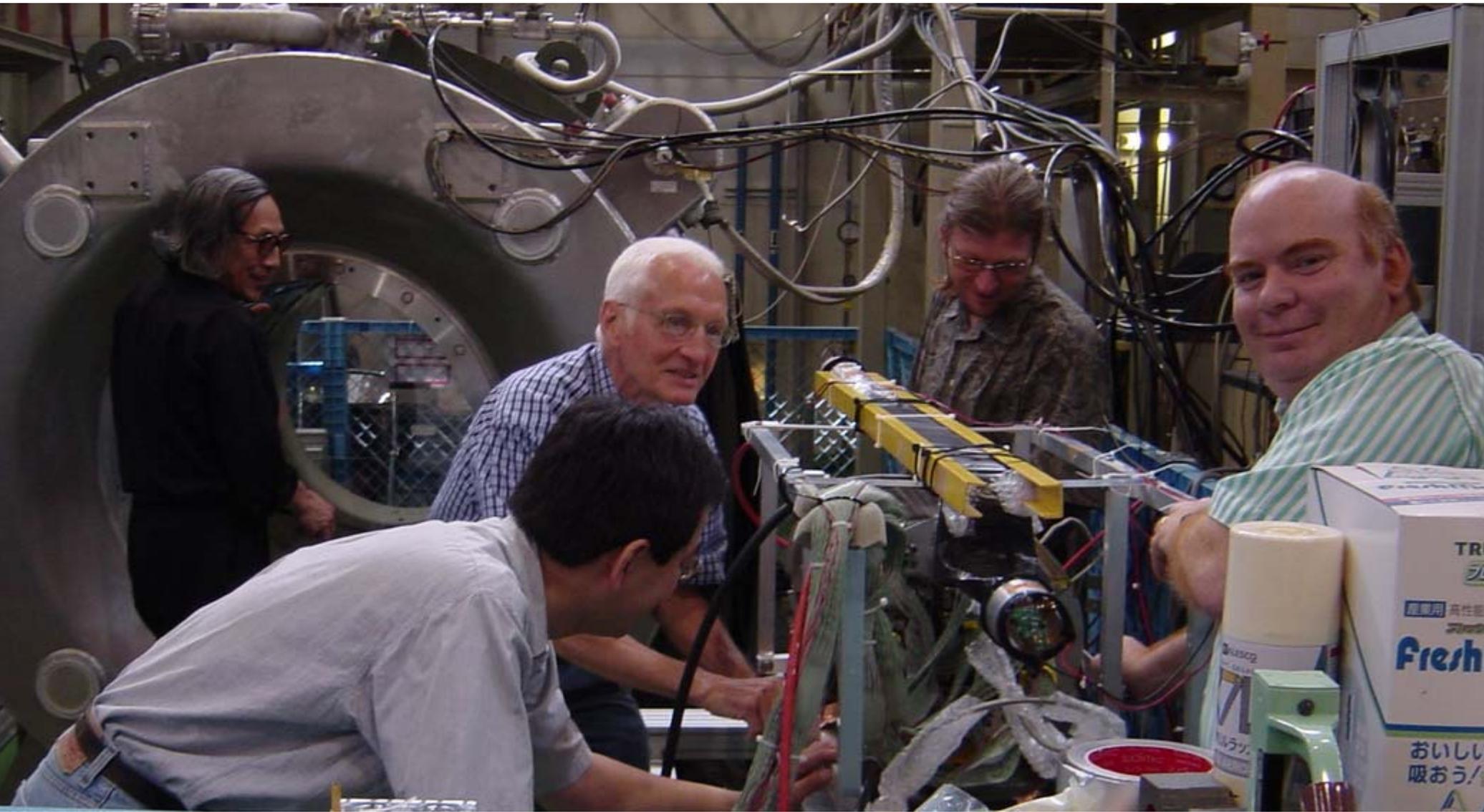


MPI TPC, Motivation

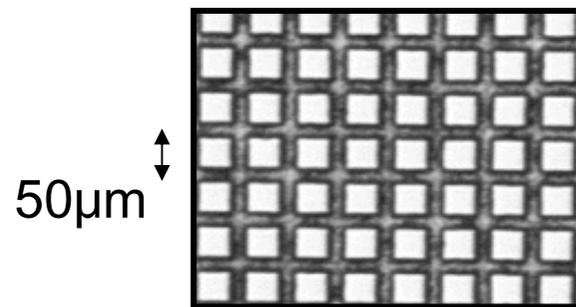
- Initiated by Ron Settles. Comparison of several gas amplifiers using same Field Cage, Electronics, analysis
 - MWPC : Beam test in Jun, 2004
 - GEM : Beam test in Apr, 2005
 - **Micromegas**



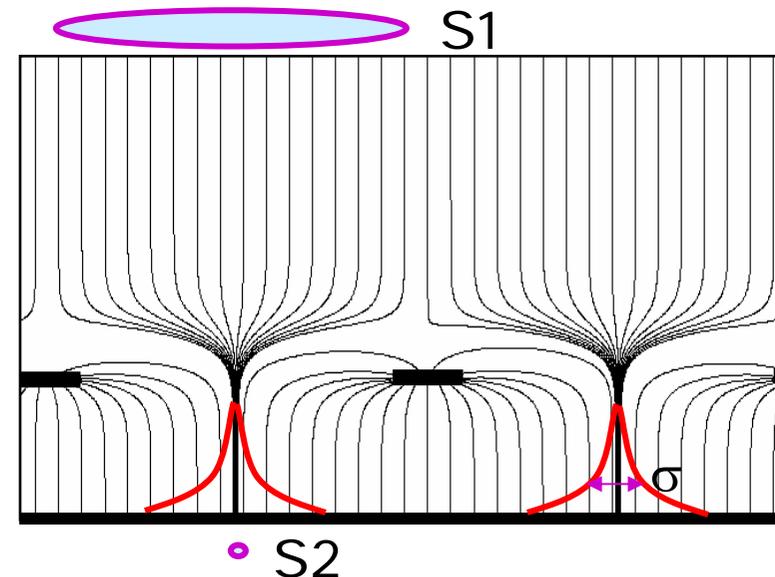
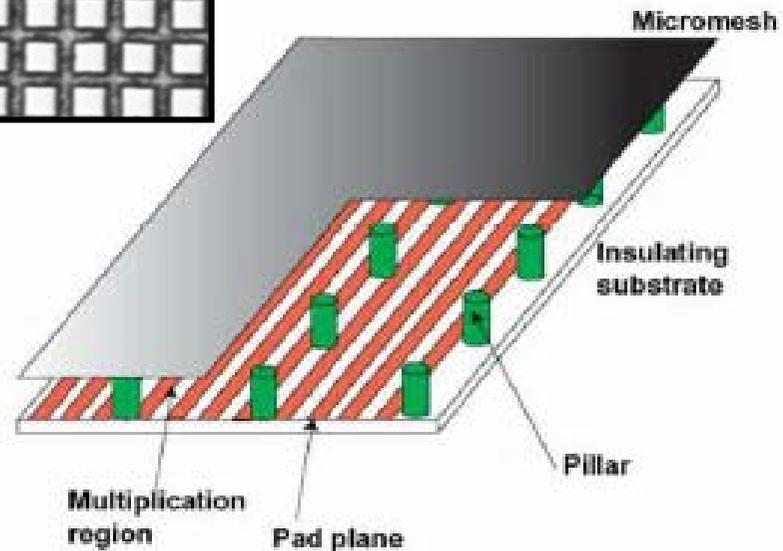
Beam test in Jun. 22 ~ Jul. 1, 2005



Micromegas

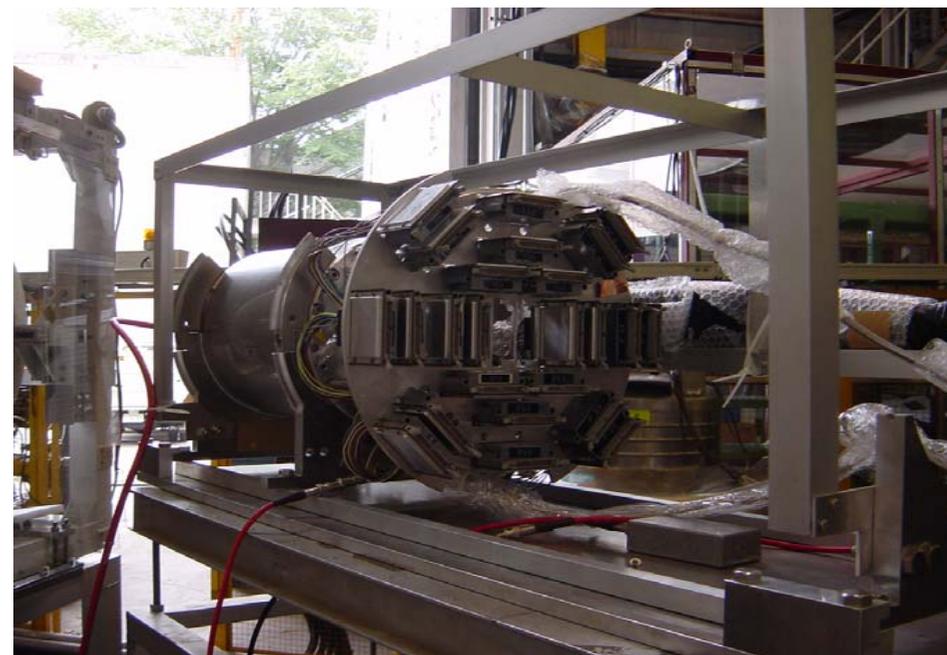
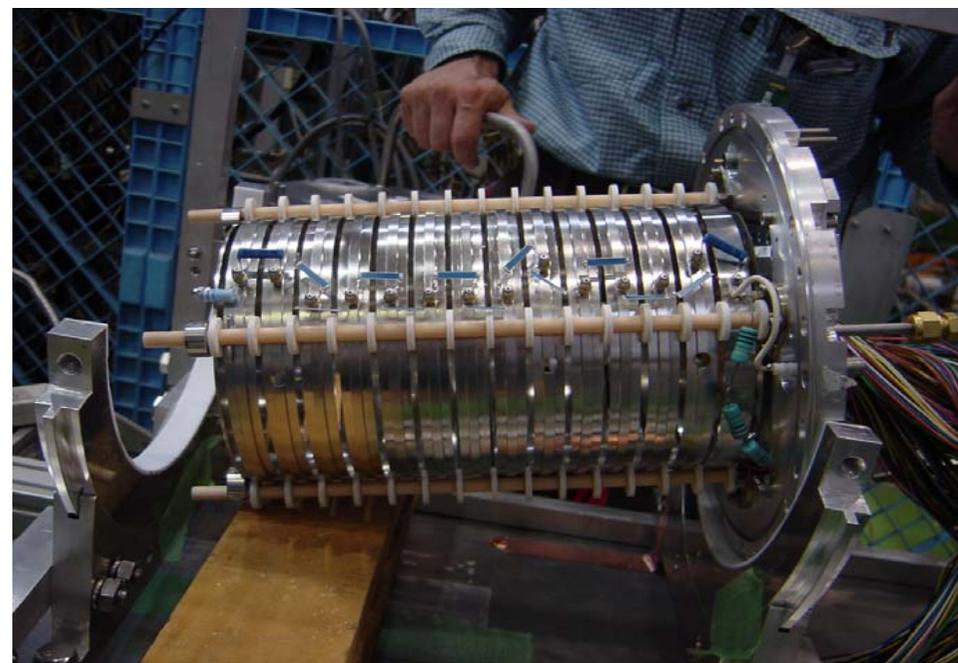


- Micromesh supported by 50-100µm - high insulating pillars
- Multiplication takes place between the anode and the mesh
- One stage
- Direct detection of avalanche electrons
 - Small $E \times B$ effect
 - Fast signals
 - Self-suppression of positive ion feedback
 - the ions return to the grid
 - Better potential spatial resolution
 - No wire angular effect



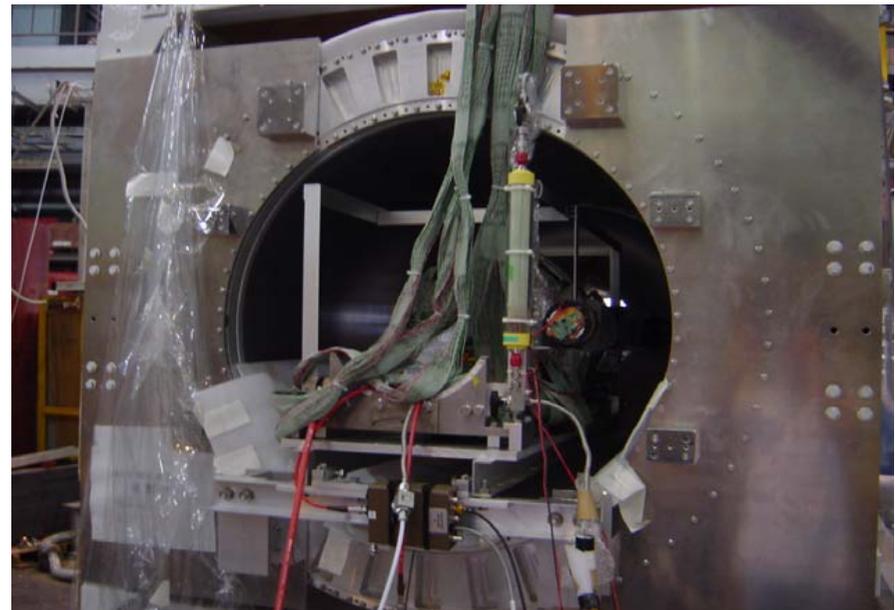
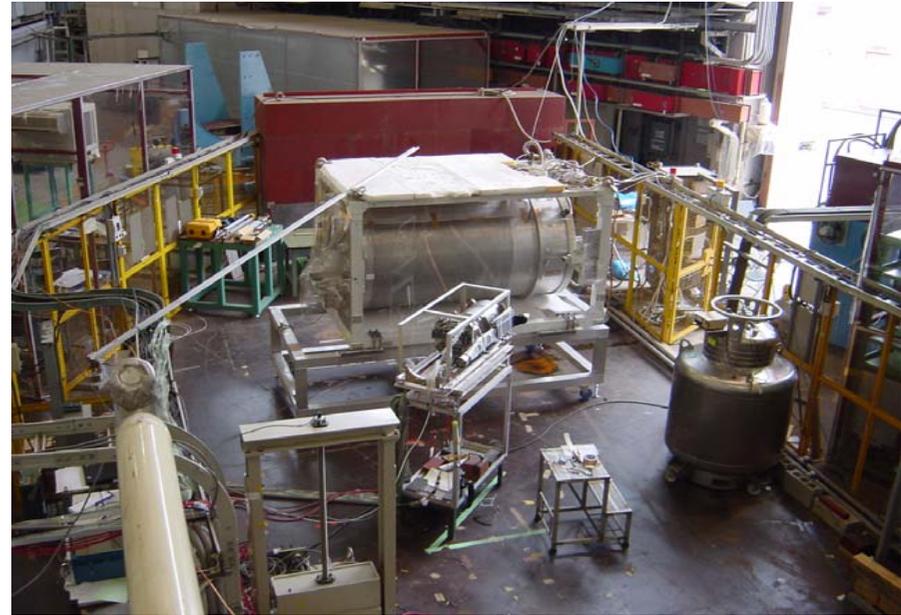
The MPI TPC at KEK

- 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

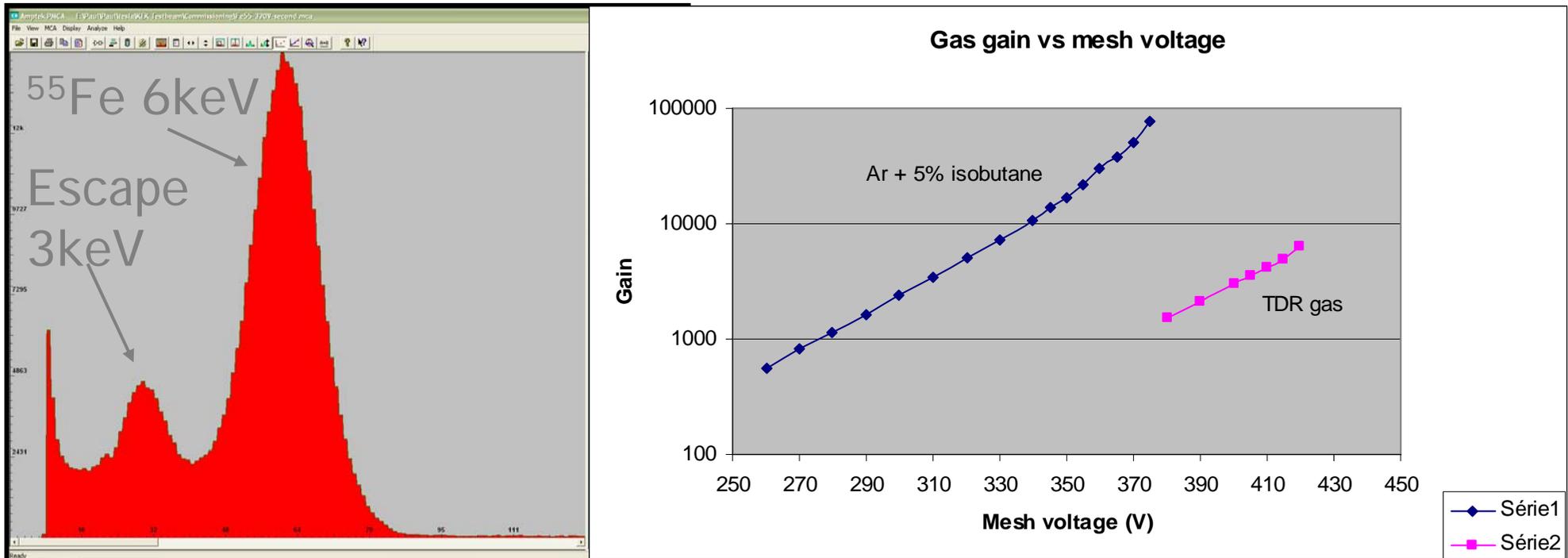
- KEK-PS π^2 beam line
 - mainly 4 GeV π^-
- Superconducting magnet (JACEE)
 - $B = 0, 0.5$ and 1T
- Gas
 - Ar + isobutane (95:5)
- Drift field :
 - mainly 220 V/cm



Mesh readout

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

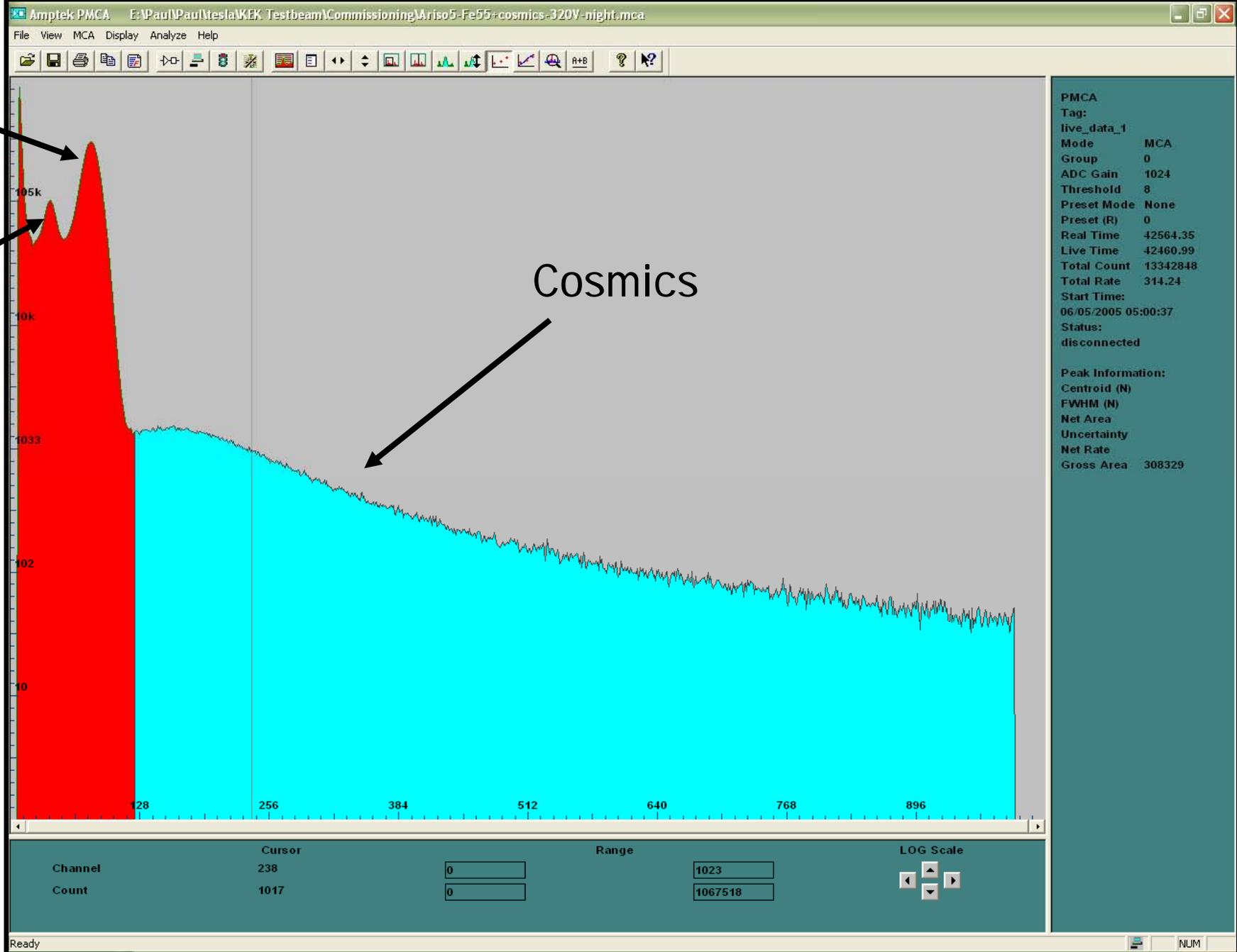
Mesh readout by a Multichannel Analyser. Used for monitoring the gain



55Fe
6keV

Escape
3keV

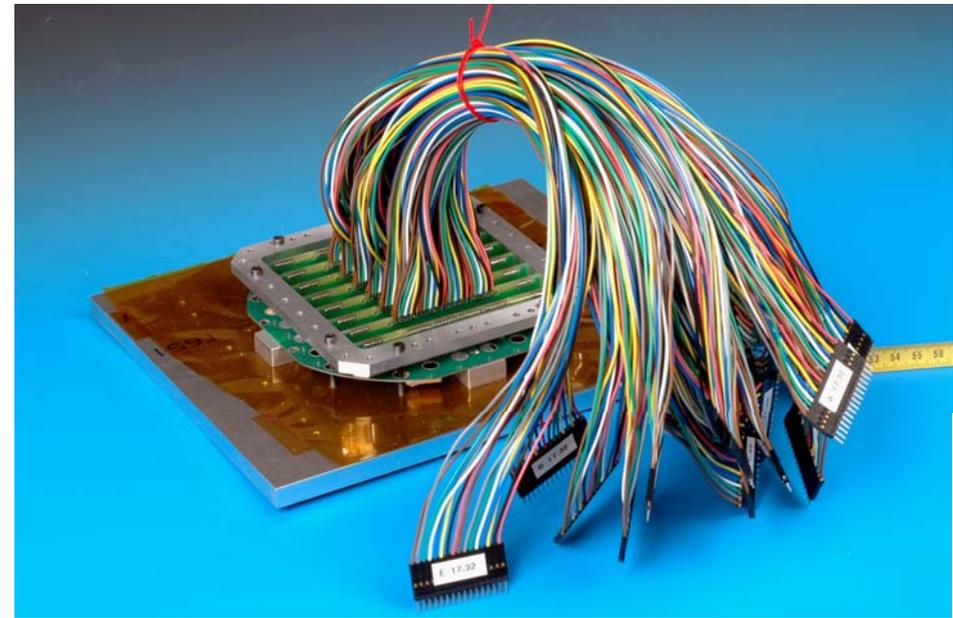
Cosmics



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

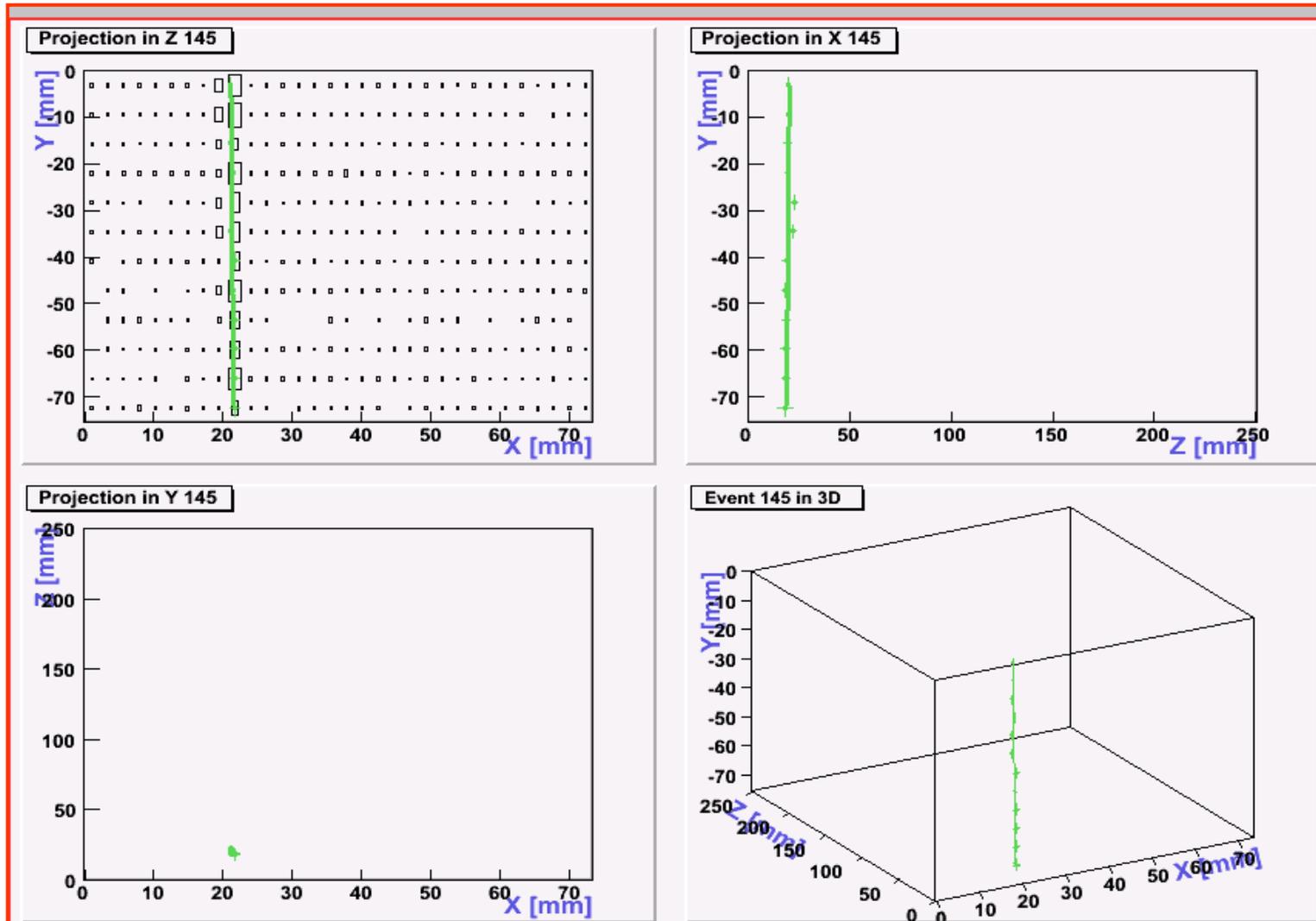
June 21st : Set last resistor value for E field continuity. Move to beam hall

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

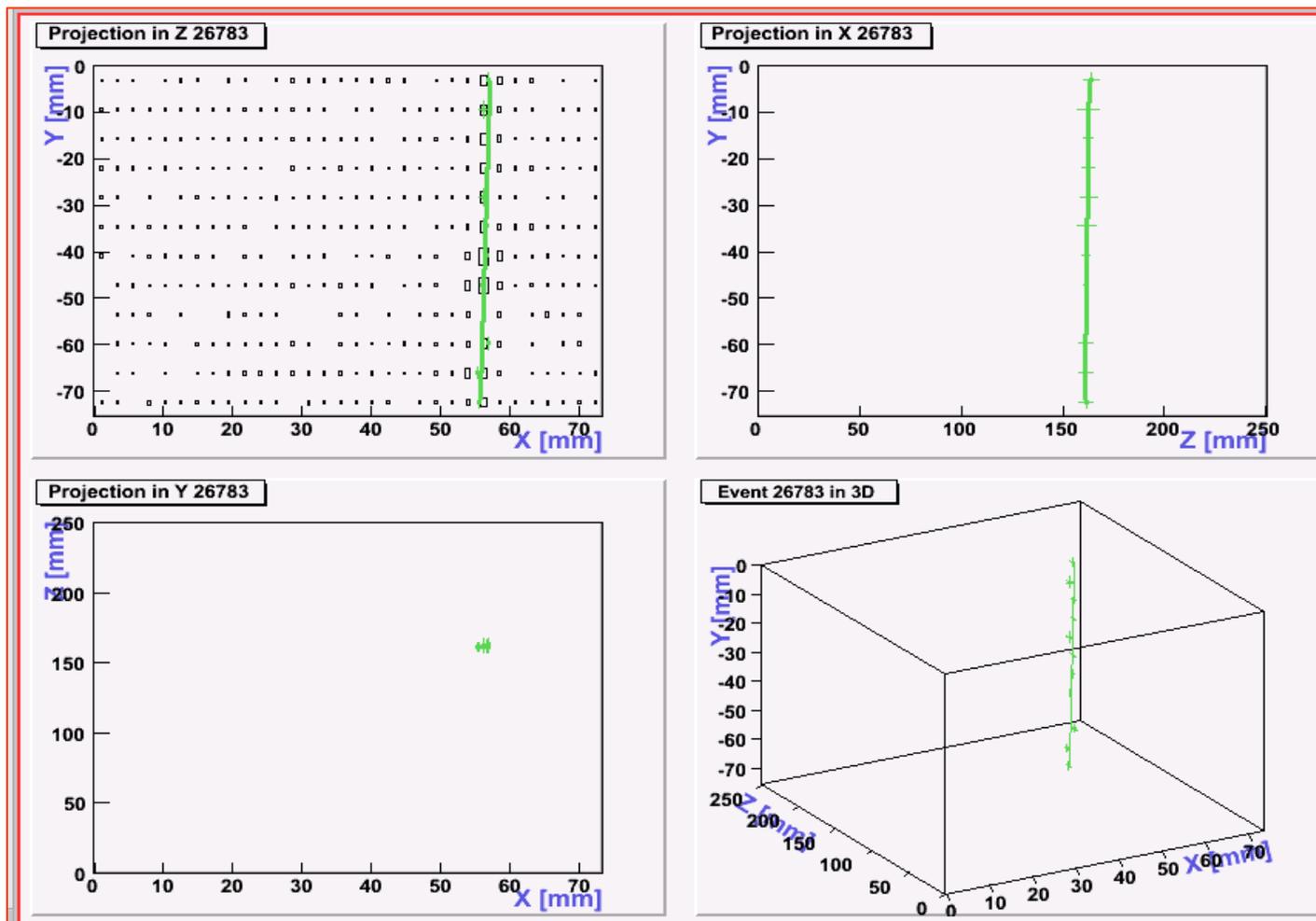
June 26th, 0:00 : start beam DAQ.

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

B=0T

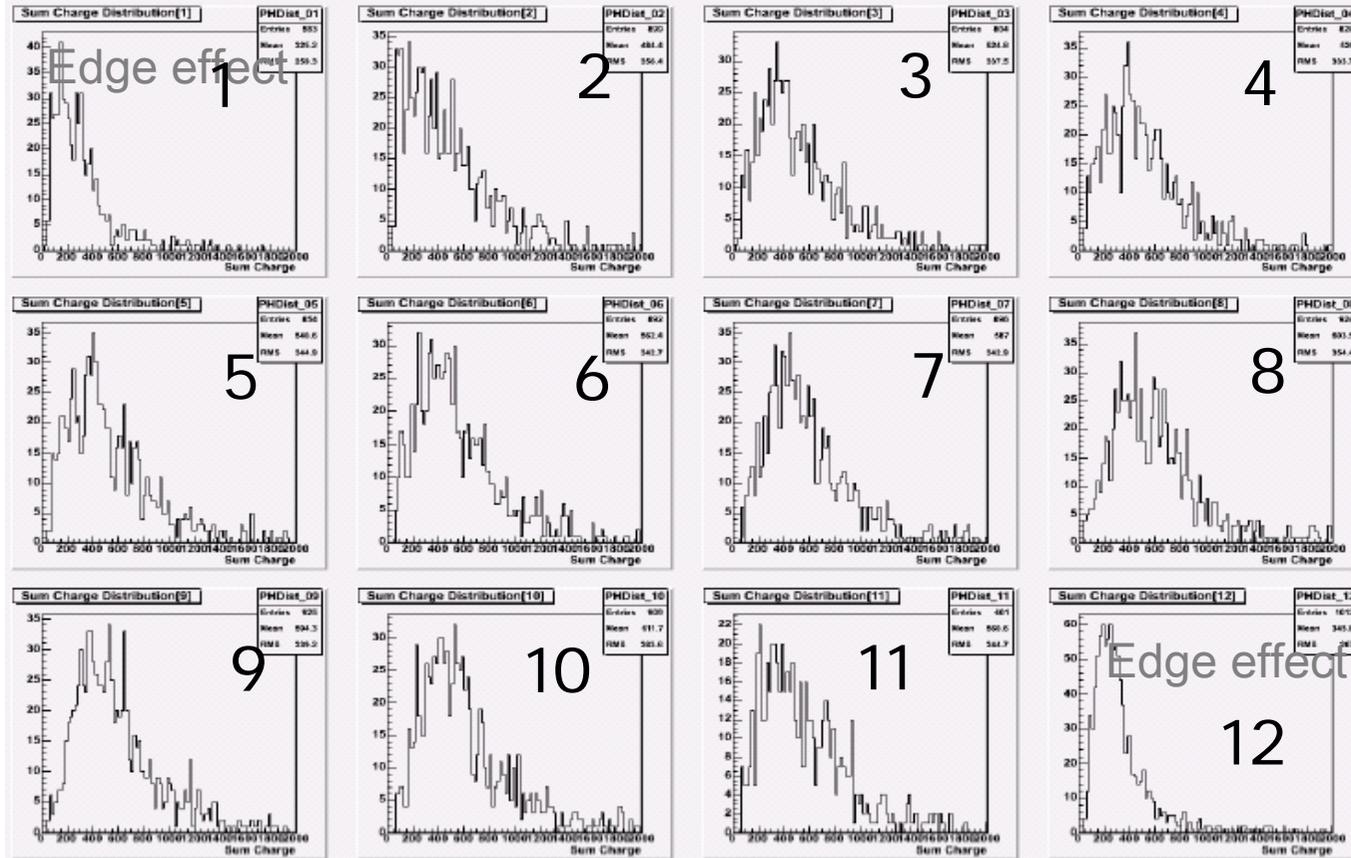


B=0.5 T

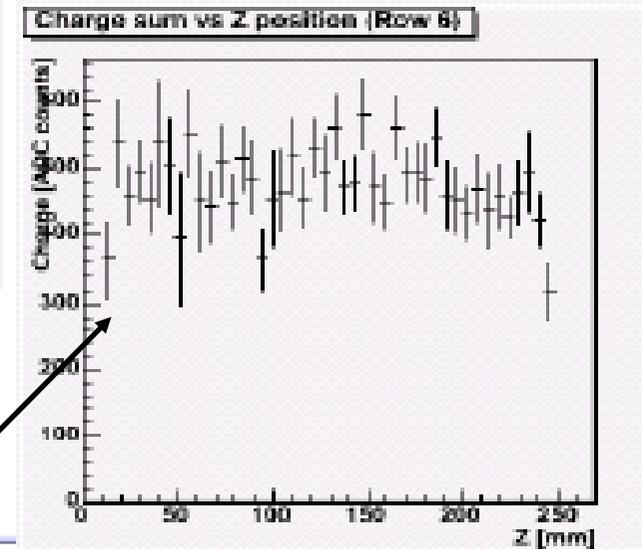


Charge Distribution

$B = 1T$, row by row



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

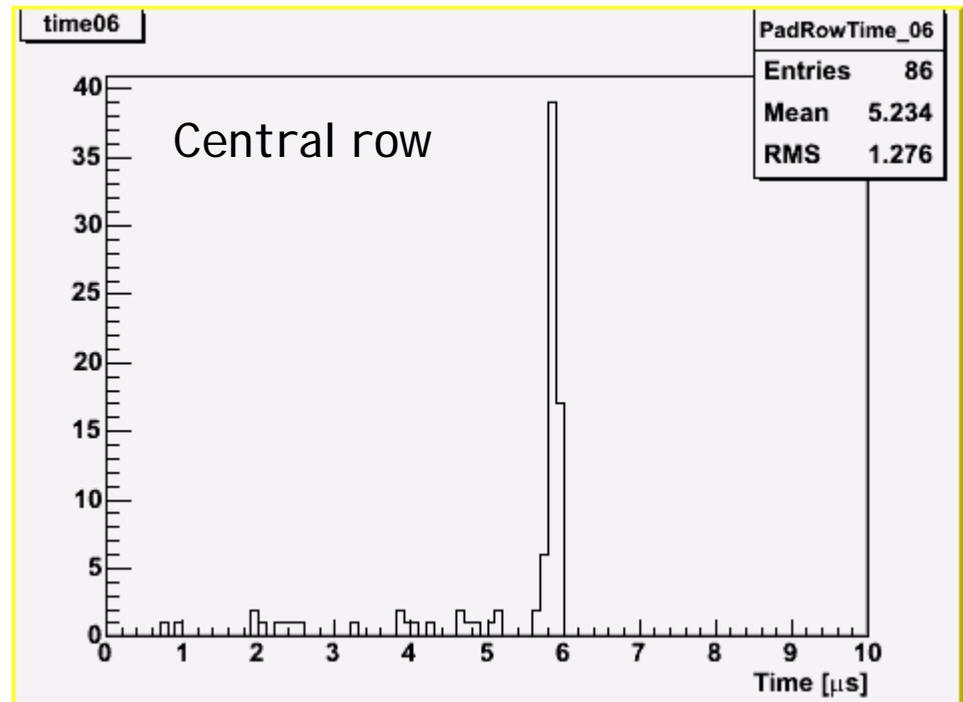
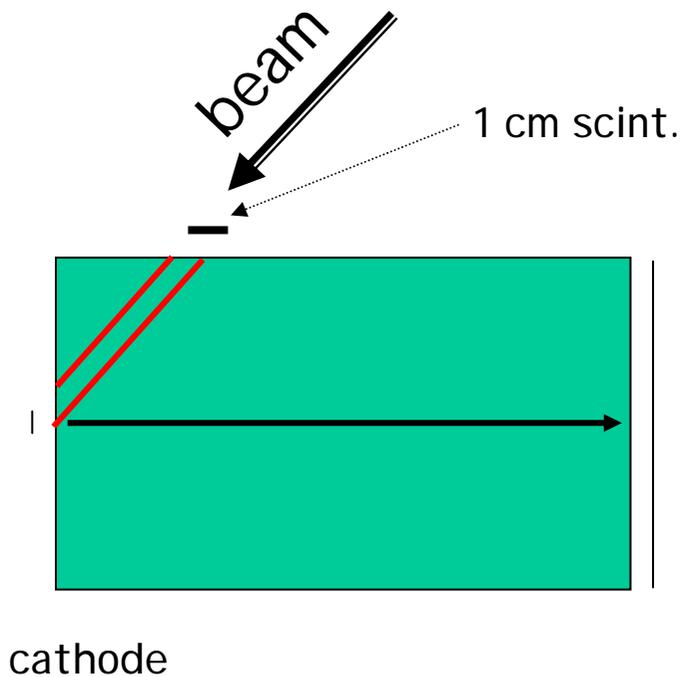


no significant attenuation

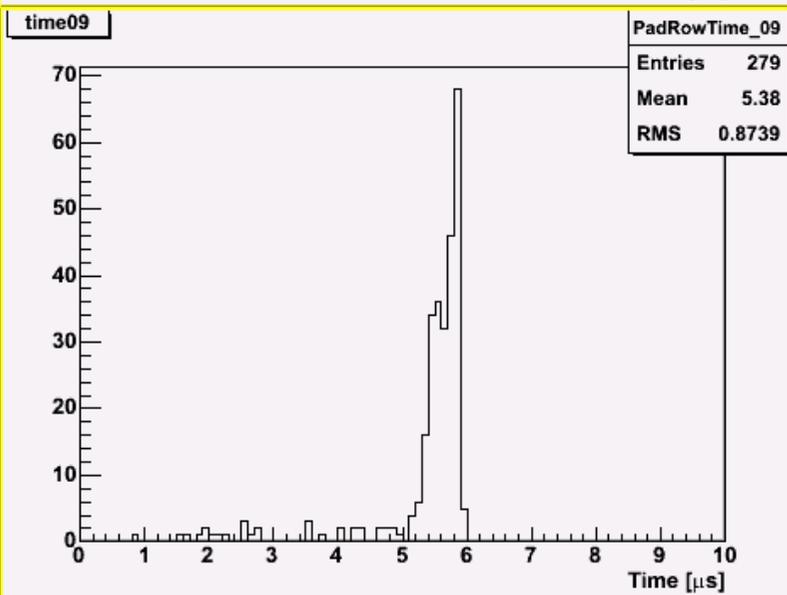
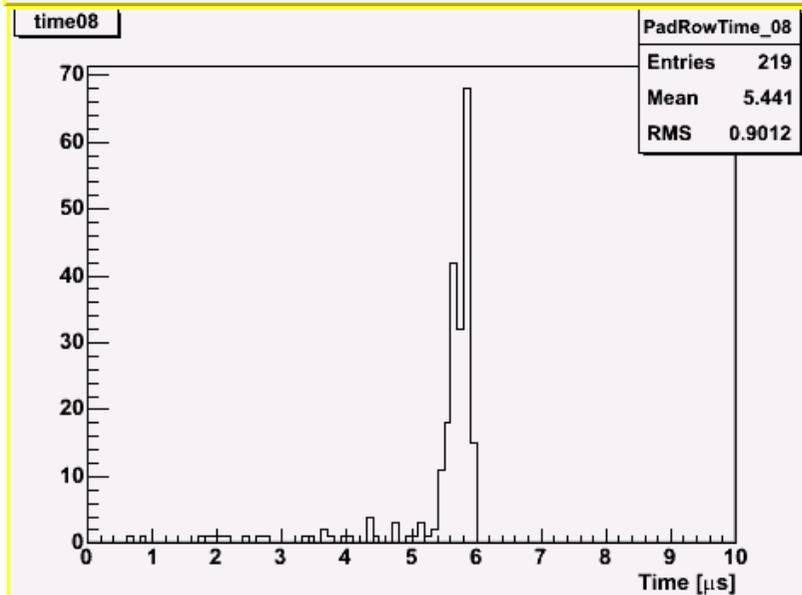
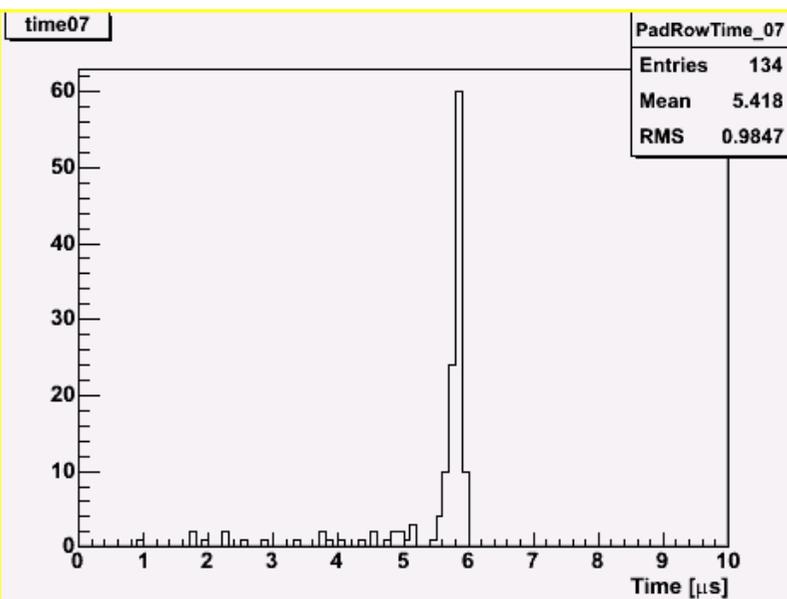
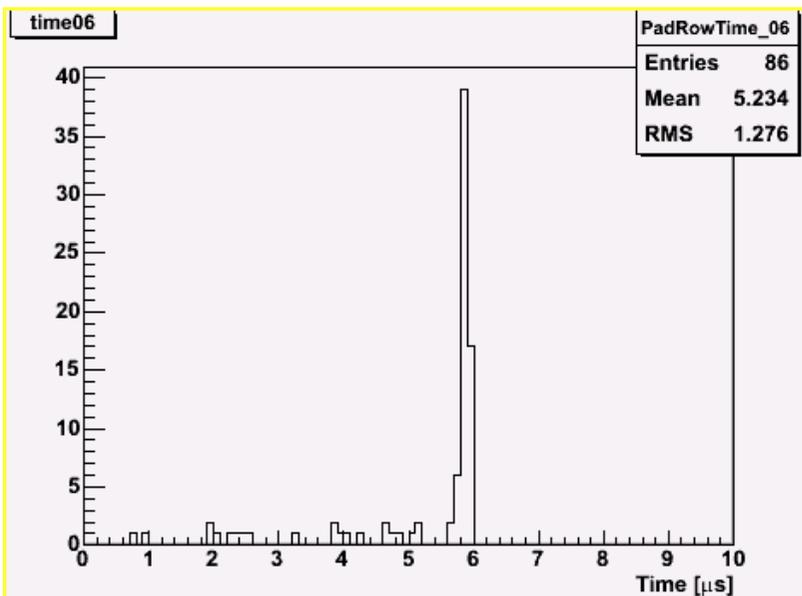
Drift velocity measurement

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 \pm 30 ns

Trigger cable delay (measured): 310 \pm 5 ns

Trig. Logic and start TPD (guess) : 20 \pm 20 ns

Total time 6.237 \pm 0.050 μs

→Velocity = 4.181 \pm 0.034 (t meas) \pm 0.003 (length) cm/ μs

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

In agreement with Magboltz : 4.173 \pm 0.016

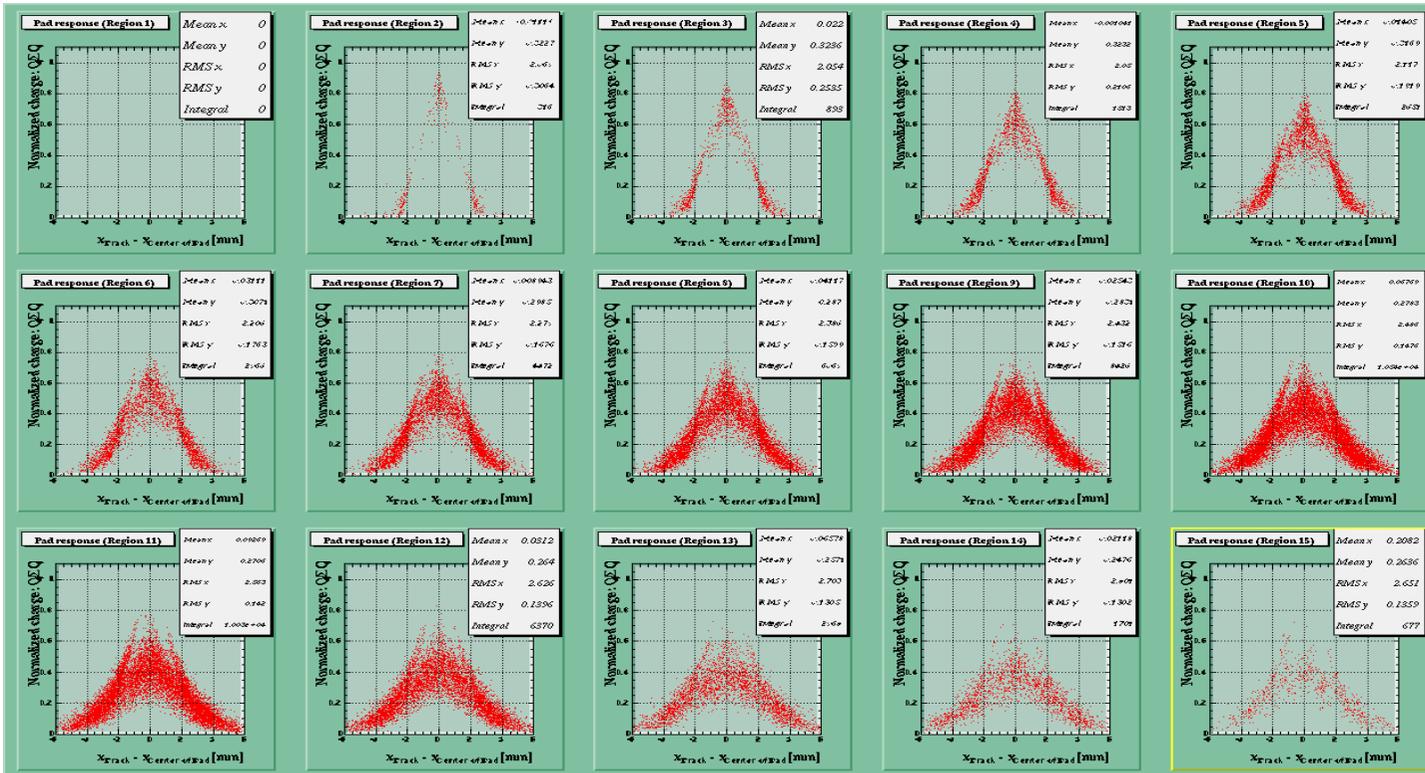
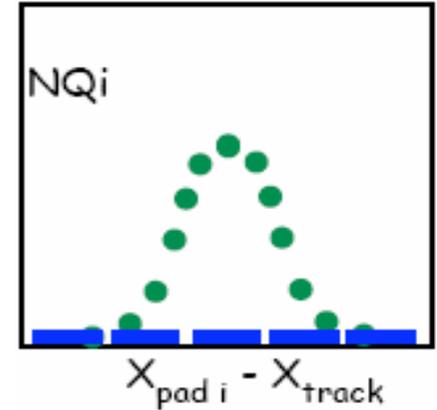
Gas composition 

Pad Response Function

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

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

anode $Z \rightarrow$



Width increases with drift distance (diffusion)

cathode

Width of Pad Response Function as a function of z

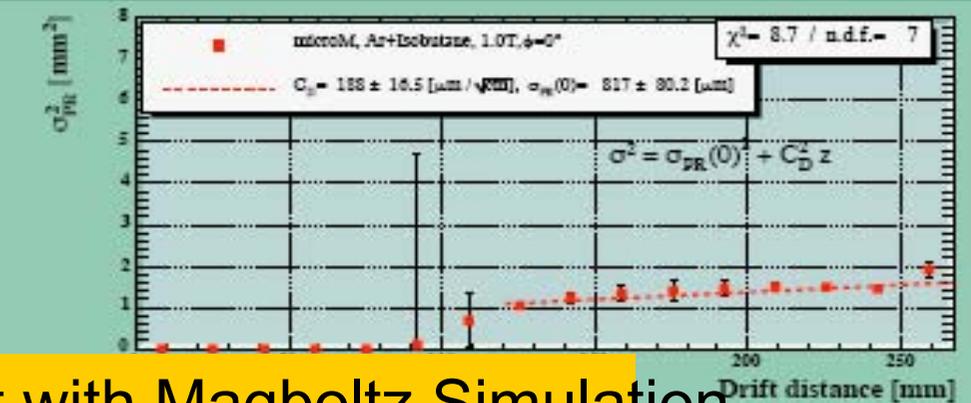
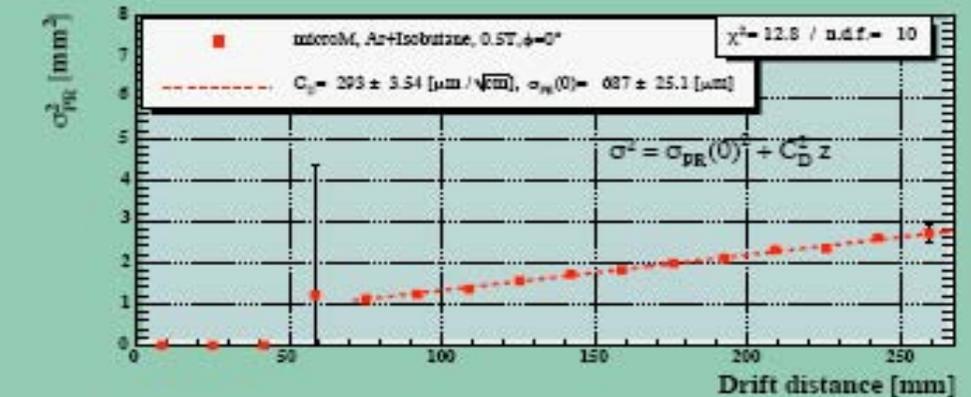
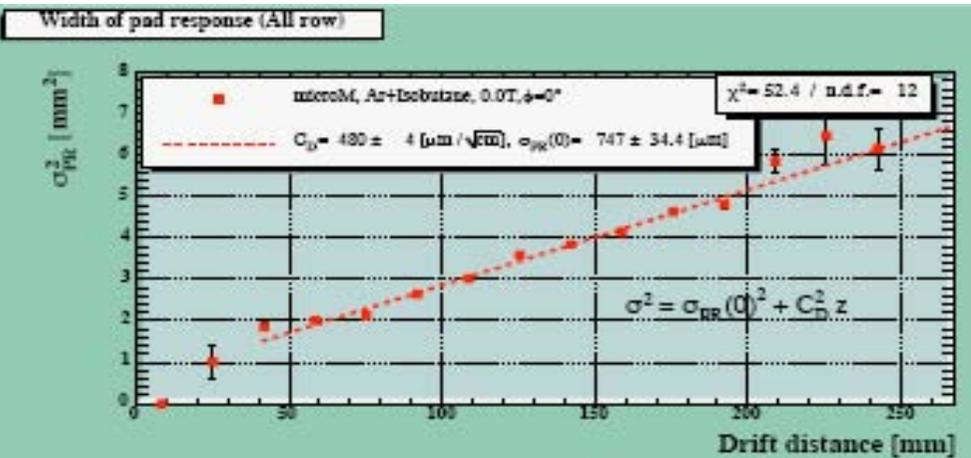
$B = 0T$ $C_D = 480. \pm 4. [\mu m]$
 $= 469(\text{Magboltz})$

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

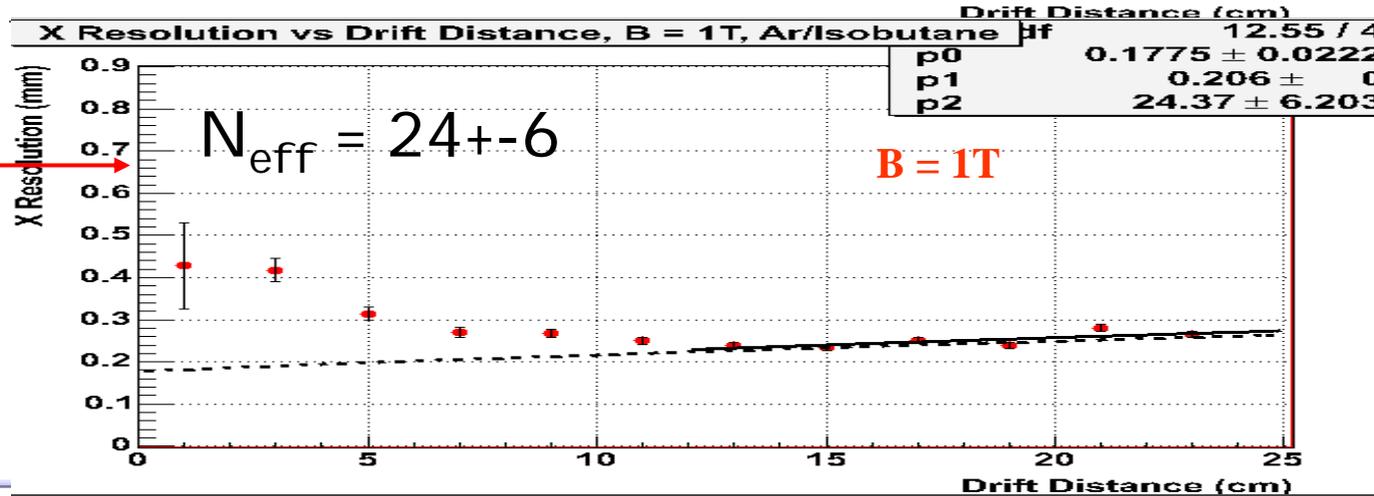
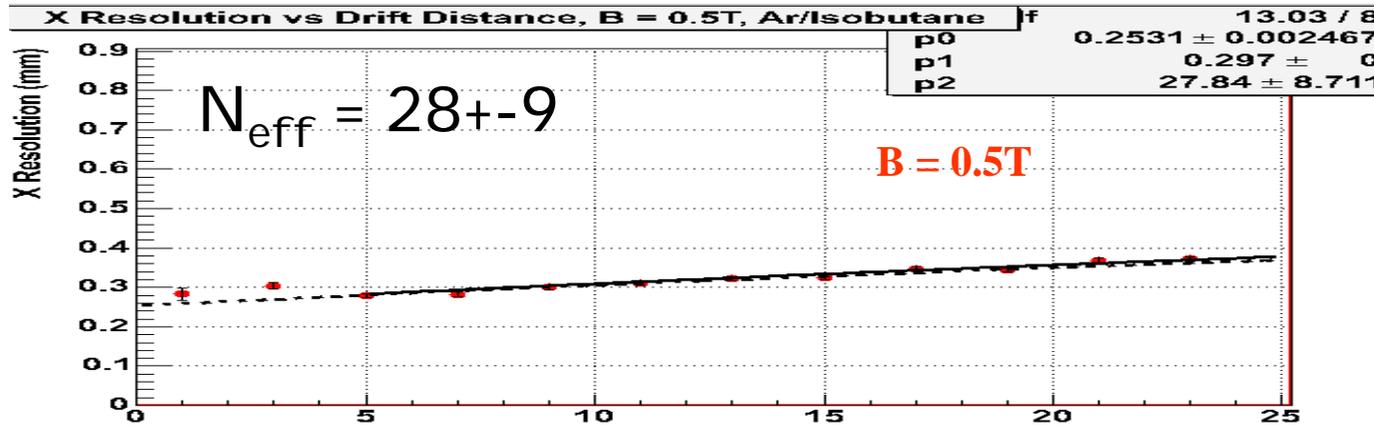
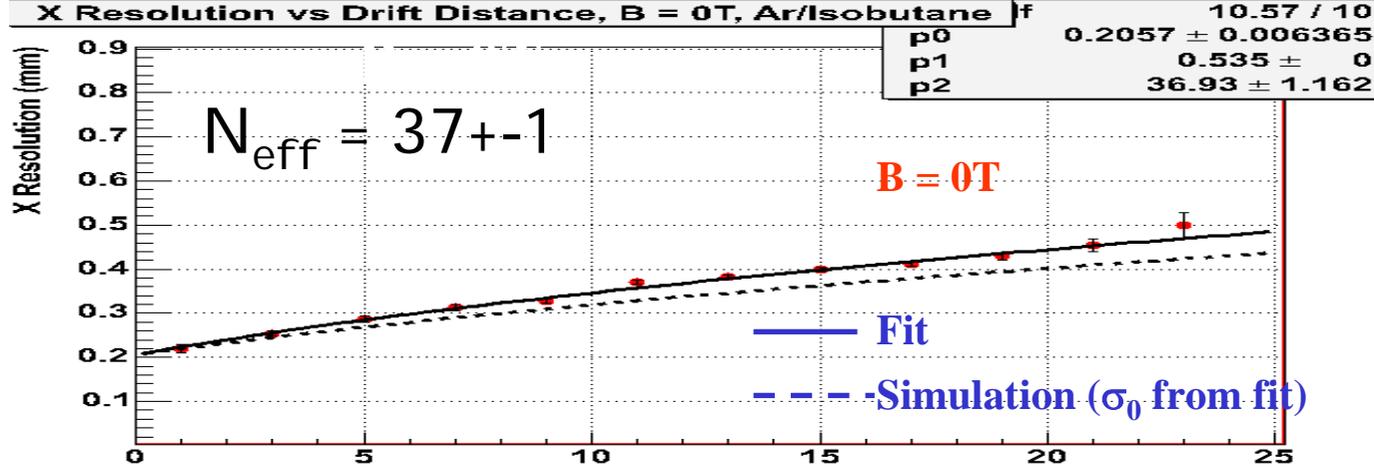
Use 8 rows, fix C_d , and fit:

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

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

$$2.3\text{mm} / \sqrt{12}$$

Preliminary results



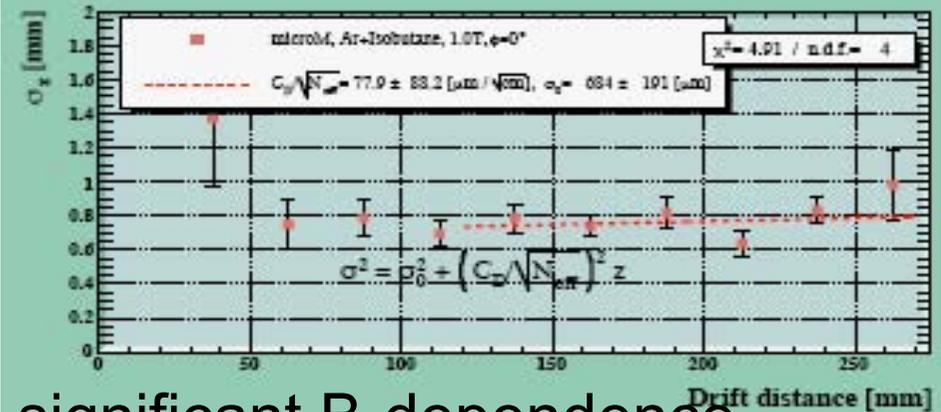
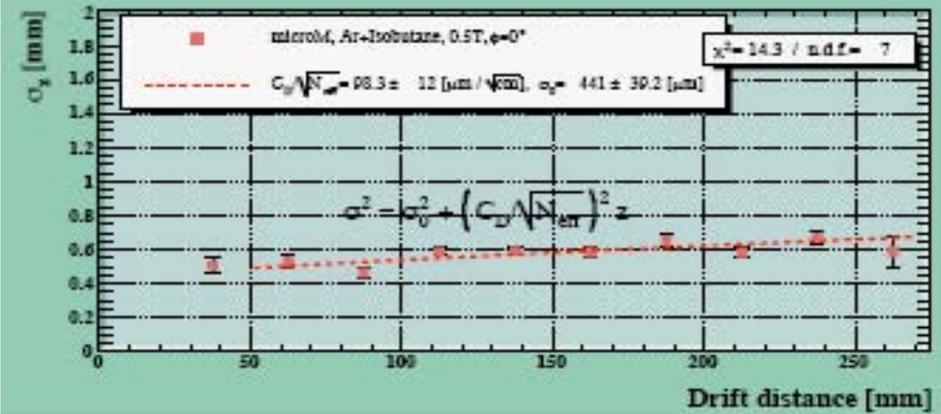
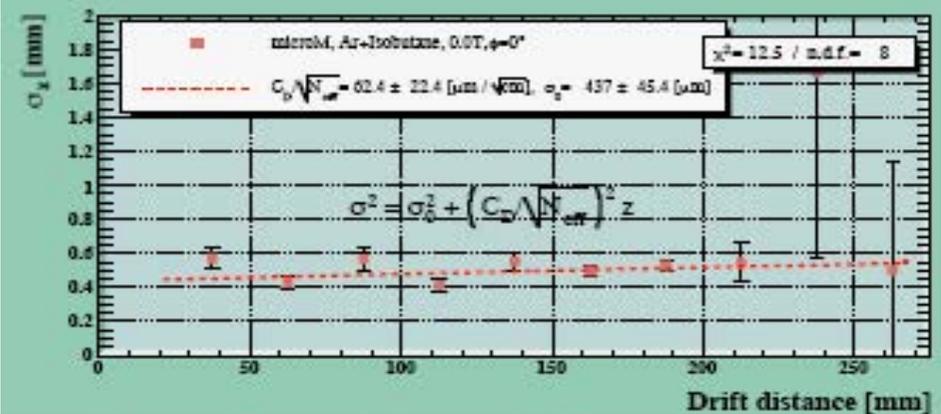
z Resolution as a function of z

$B = 0T$
 $\sigma_0 = 437. \pm 45. [\mu m]$

Preliminary results

$B = 0.5T$
 $\sigma_0 = 441. \pm 39. [\mu m]$

$B = 1T$
 $\sigma_0 = 684. \pm 191. [\mu m]$

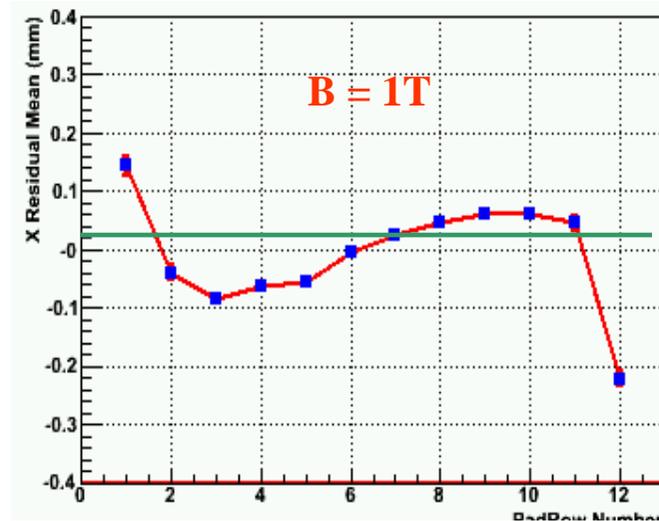
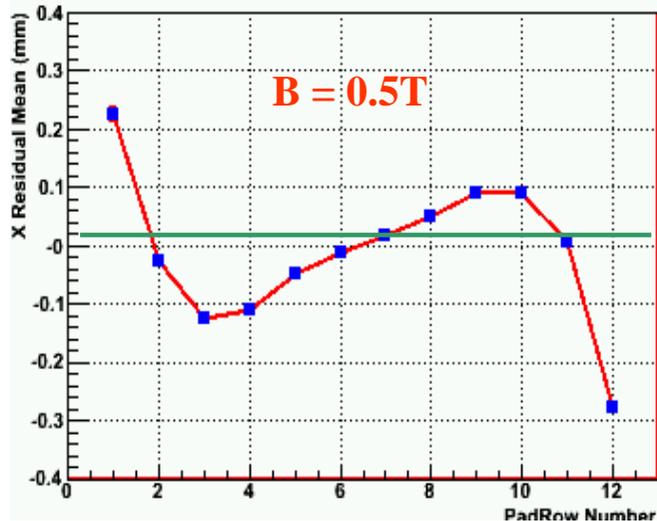
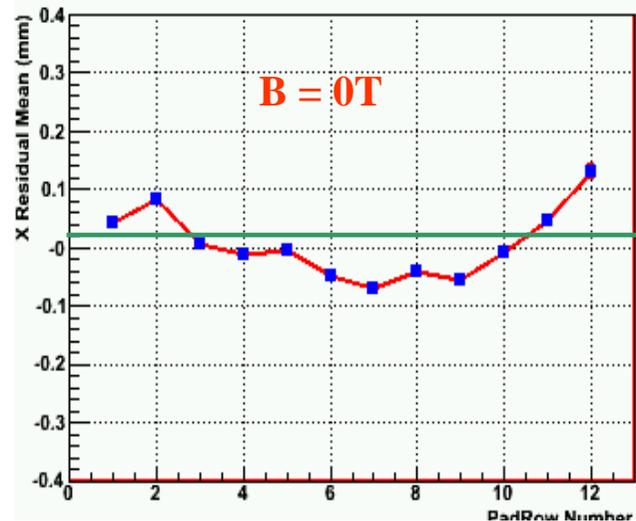


As expected, Unlike σ_x , σ_z has no significant B-dependence

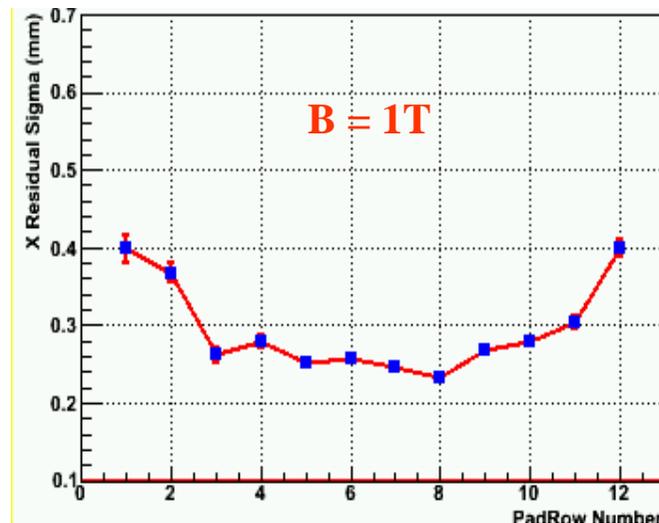
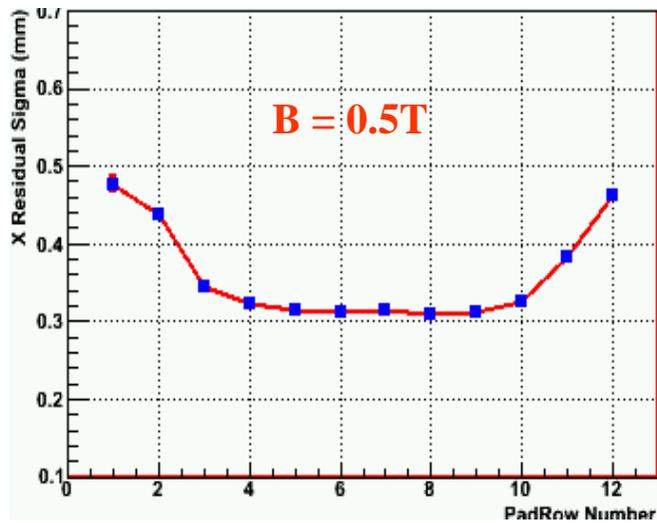
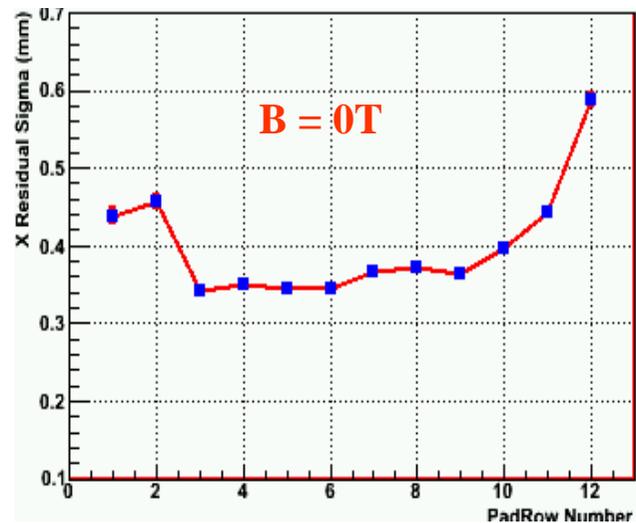
Distortions

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