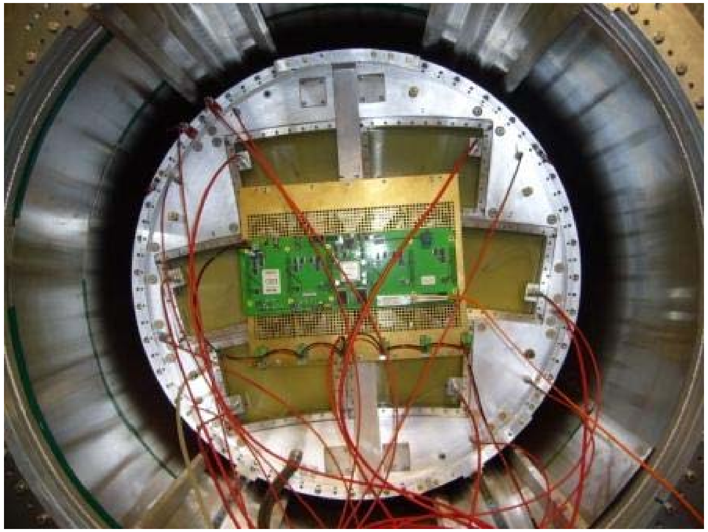
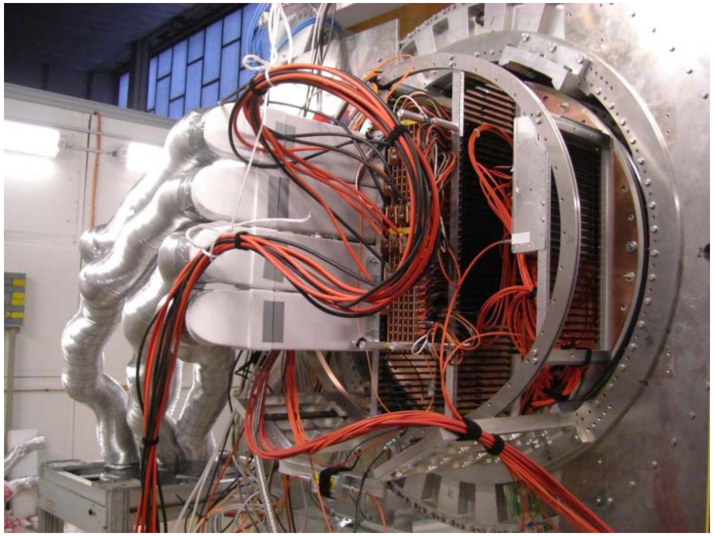
TPC for LC

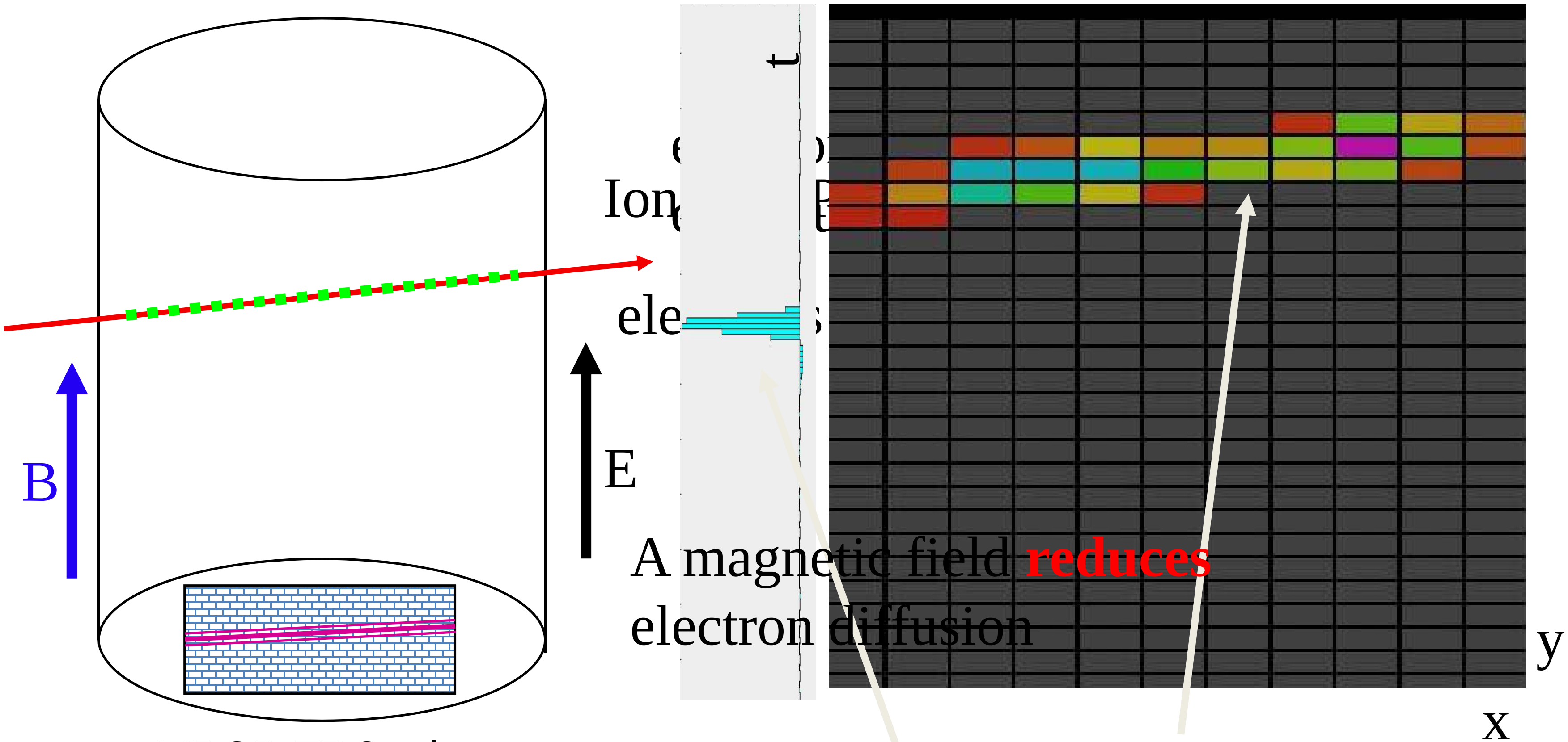
P. Colas





Lanzhou U., Saclay, Tsinghua U.

Time Projection Chamber

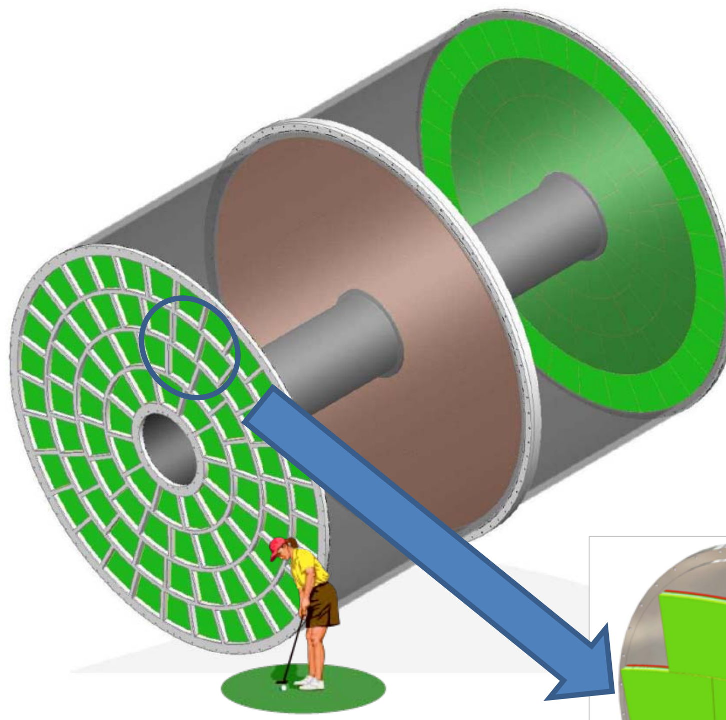


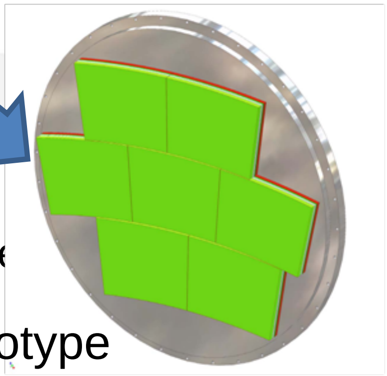
MPGD TPC : the amplification is made by a MPGD

Localization in time and x-y

TPC for ILC

Continuous 3D tracking in a large gaseous volume with O(100) space points.

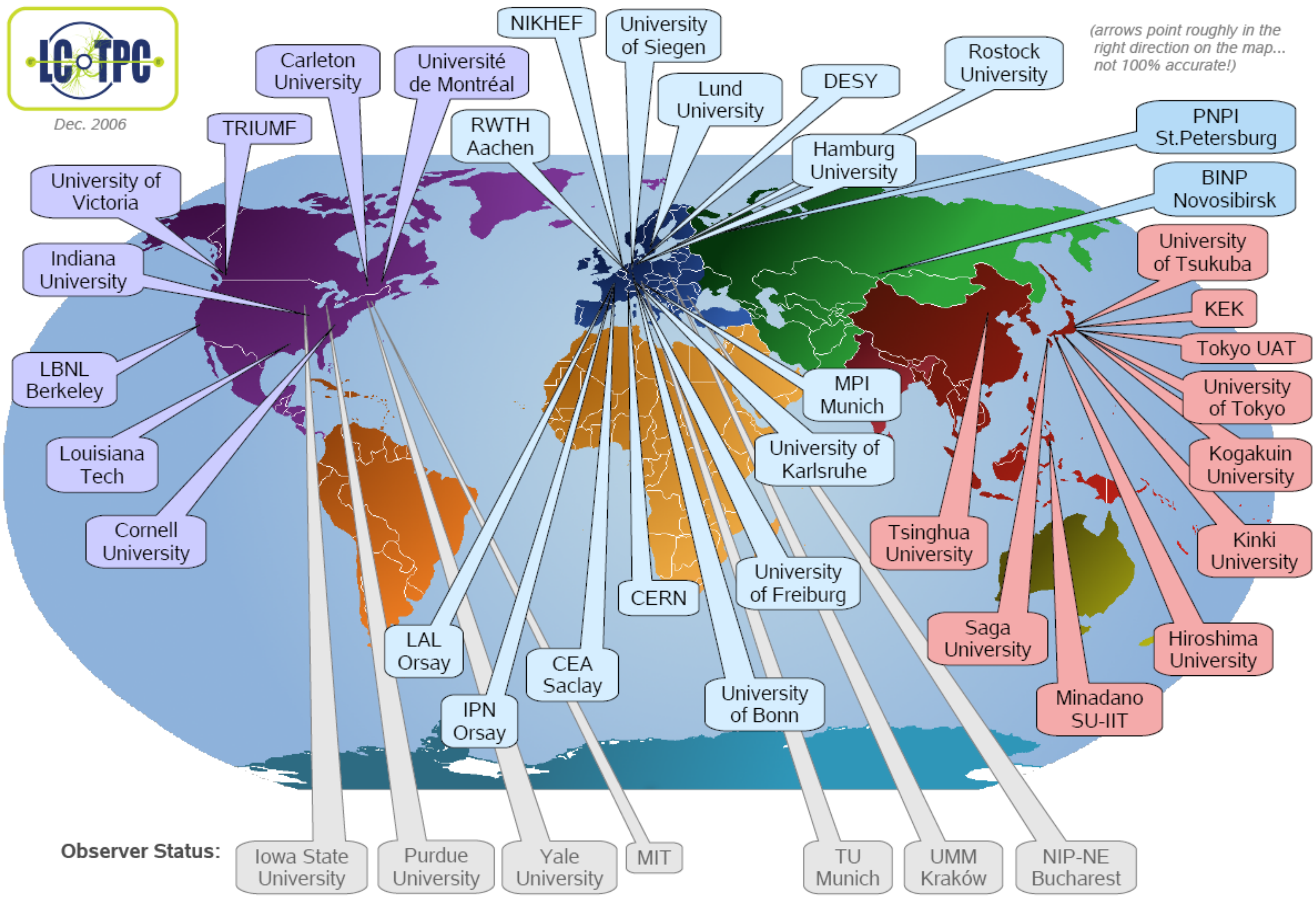




ILC-TPC (ILD conce

Large prototype being tested at DESY

LCTPC Collaboration

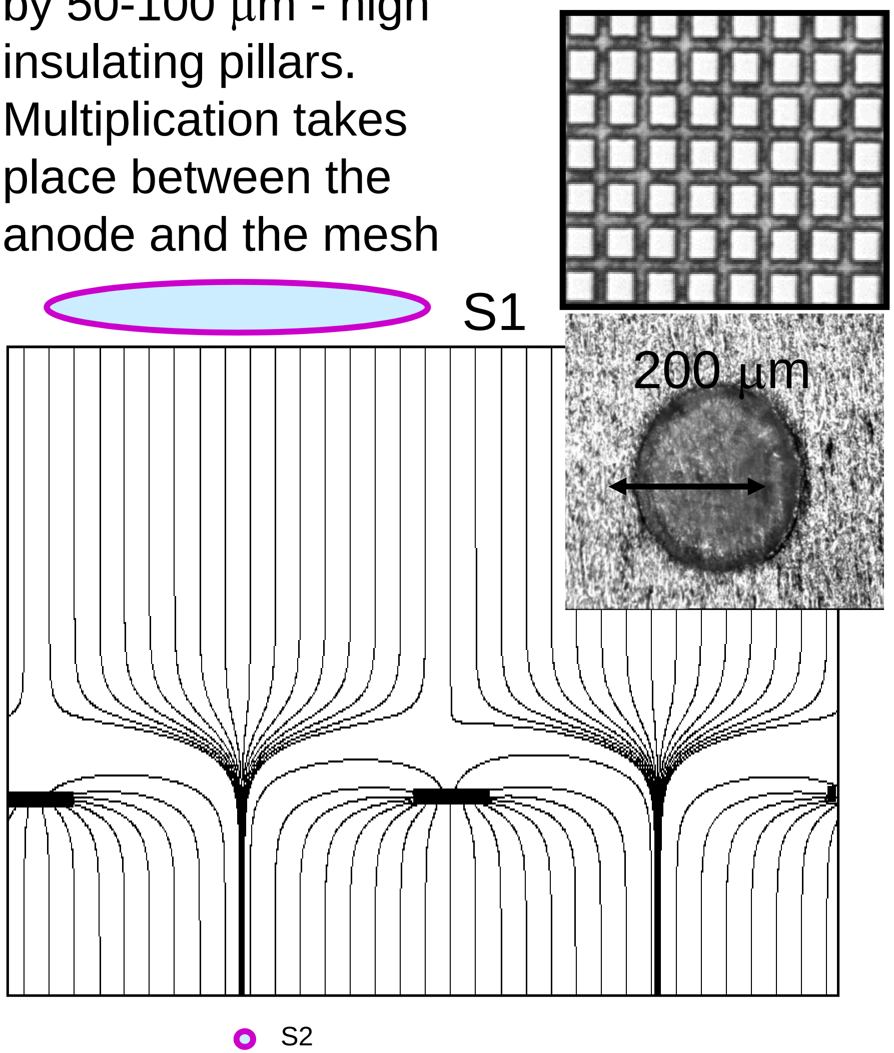


DETECTION TECHNOLOGIES

Micromegas and GEM

Micromegas

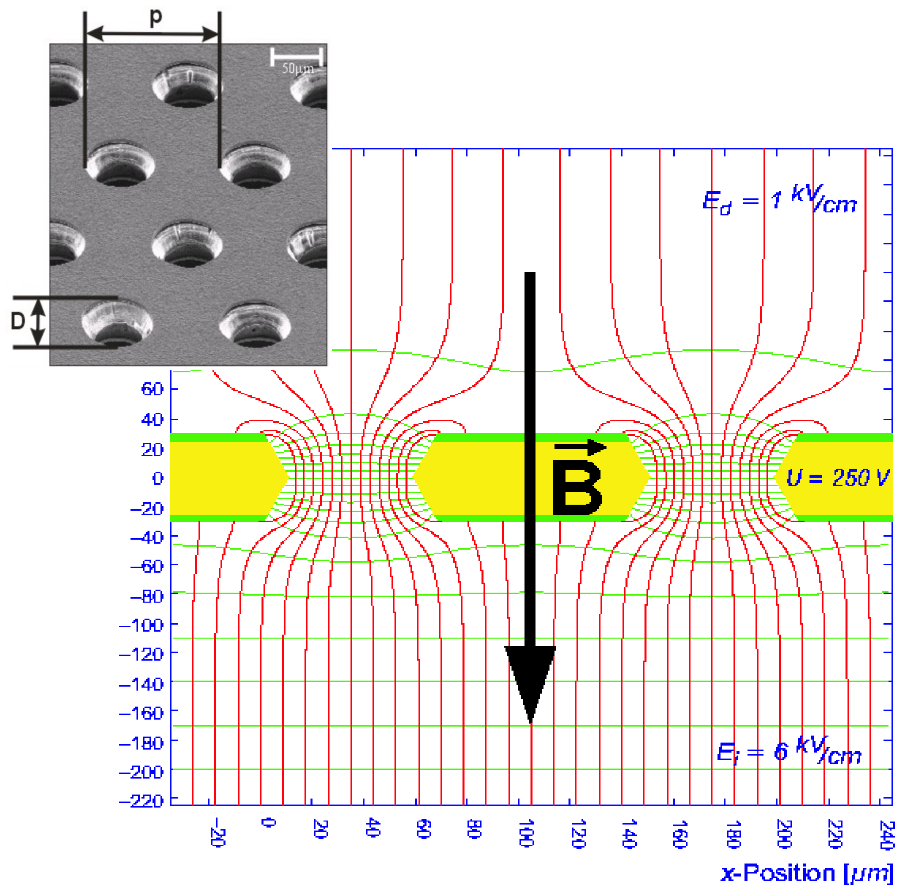
a micromesh supported by 50-100 μm - high insulating pillars. Multiplication takes place between the anode and the mesh



GEM

Two copper perforated foils separated by an insulator (50 μm). Multiplication takes place in the holes.

Usually used in 2 or 3 stages.



resistive anode

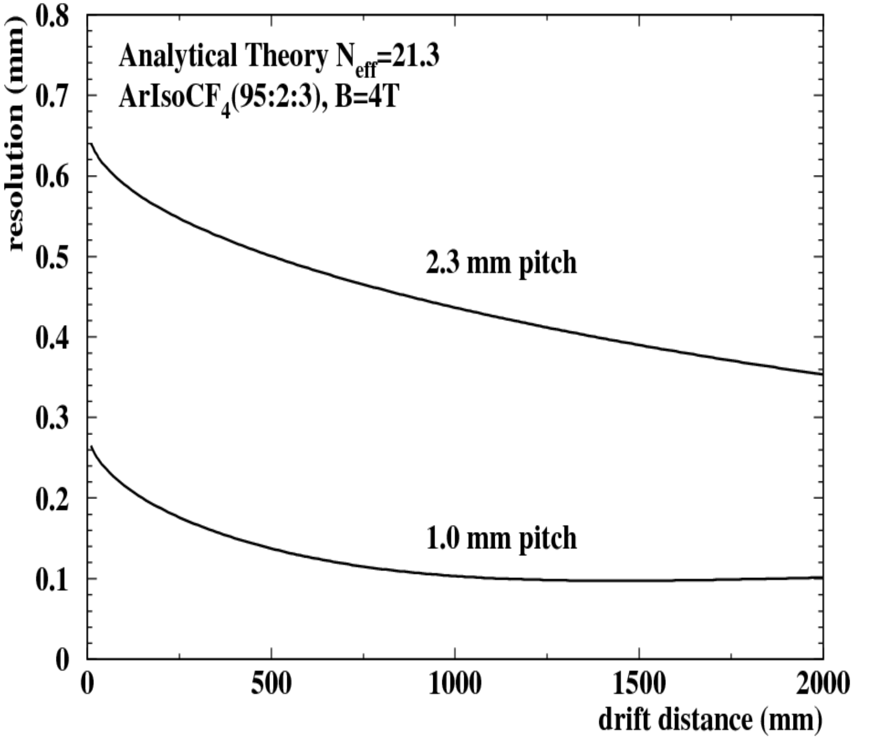
LC-TPC goal is 200 measurement points on a track, with <130 micron resolution

With Micromegas, signal spread is equal to the avalanche size, 12-14 microns : not enough charge sharing at low diffusion even with 1mm pads.
Need to share the charge between neighbouring pads to make a barycentre possible and improve resolution.

With GEMs, diffusion in the last transfert gap helps to spread the charge and good resolution is obtained with 1mm-wide pads.

Both solutions are studied in LC-TPC: Micromegas with resistive anode or GEMS with small standard pads.

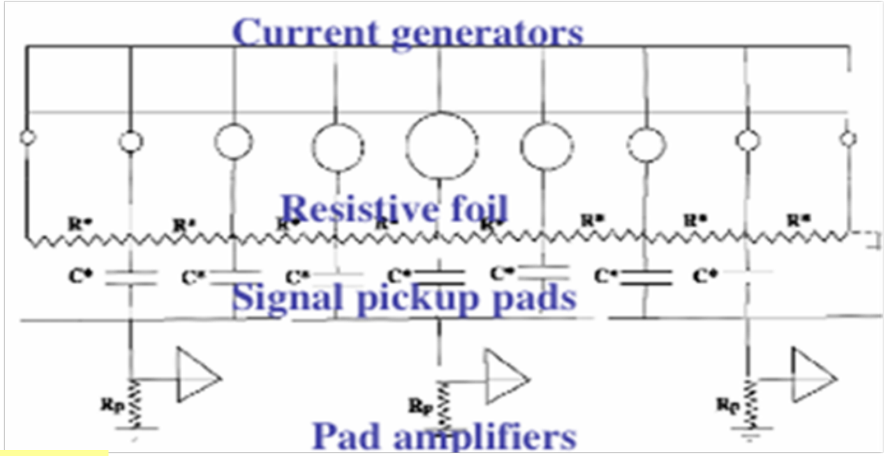
Note that charge sharing saves number of channels ($, W, X°).



D. Arogancia, K. Fujii et al., to appear in NIM A

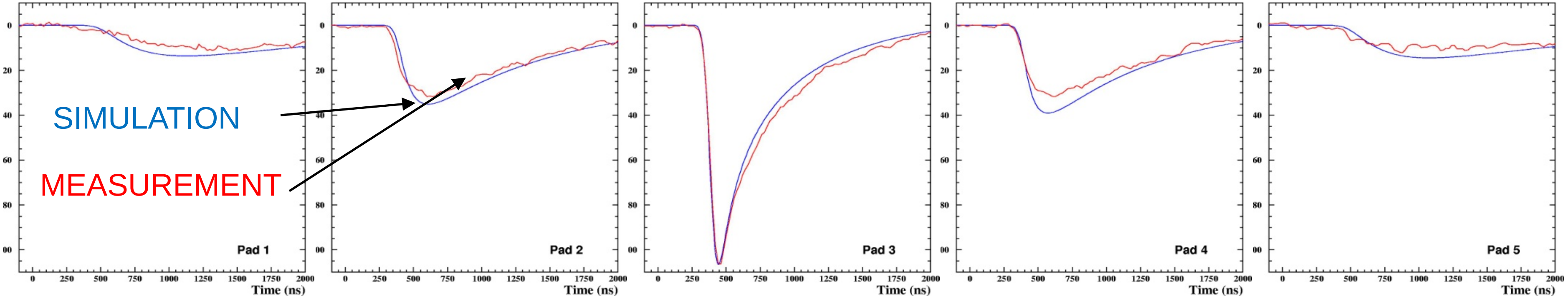
resistive anode (2)

One way to make charge sharing is to make a **resistive anode**
(M.S.Dixit et.al., NIM A518 (2004) 721.)
This corresponds to adding a continuous RC circuit on top of the pad plane. Charge density obeys 2D telegraph equation



$$\frac{\partial \rho}{\partial t} = \frac{1}{RC}\left[\frac{\partial^2 \rho}{\partial r^2} + \frac{1}{r}\frac{\partial \rho}{\partial r}\right] \Rightarrow \rho(r,t) = \frac{RC}{2t} e^{\frac{-r^2 RC}{4t}}$$

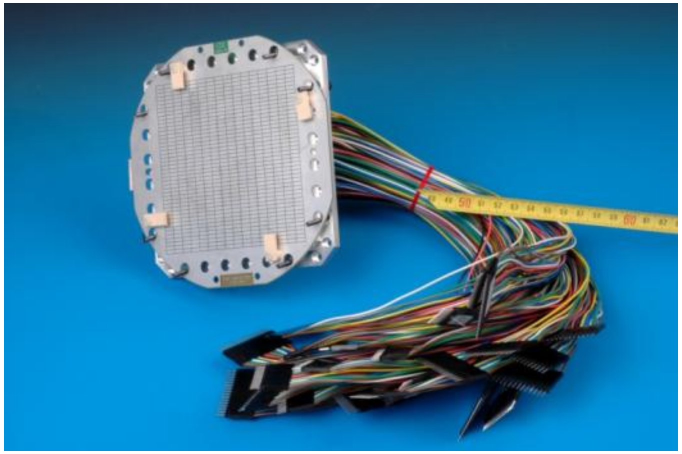
M.S.Dixit and A. Rankin NIM A566 (2006) 281



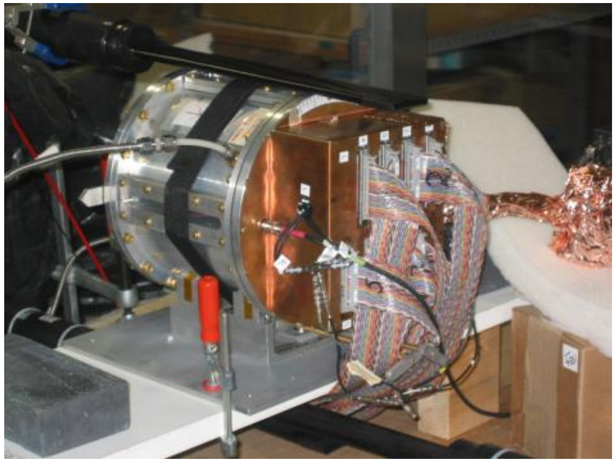
Res. foil also provides anti-spark protection

Small prototypes

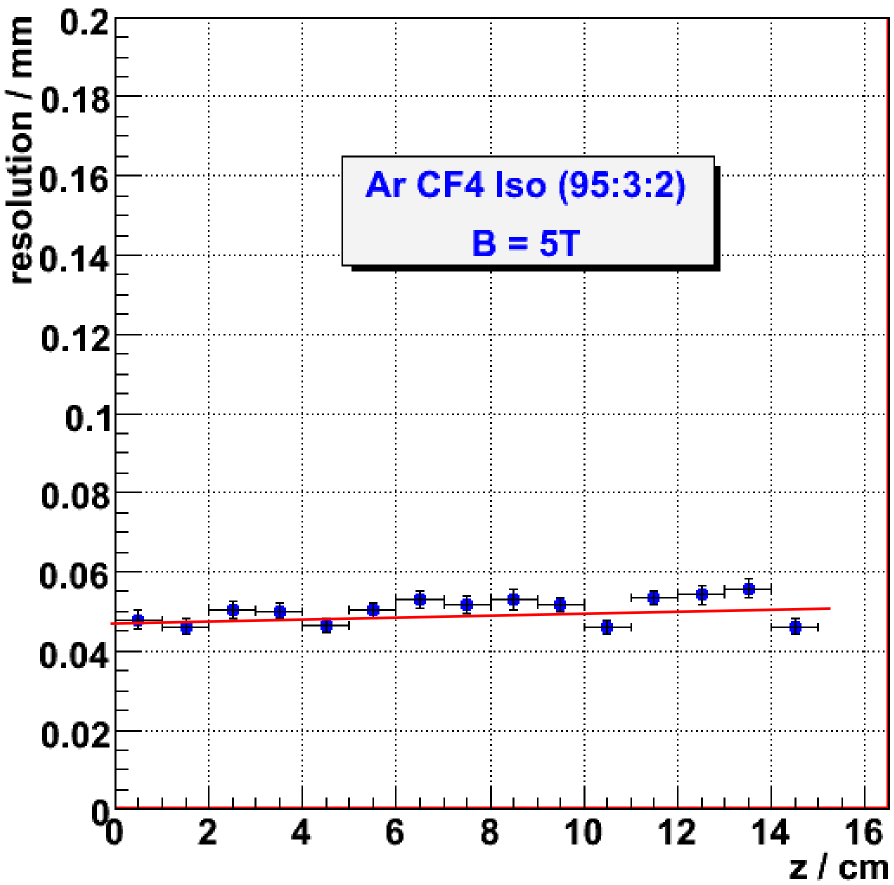
Micromegas



KEK beam test, MP-TPC (2005)



Carleton TPC with res. anode

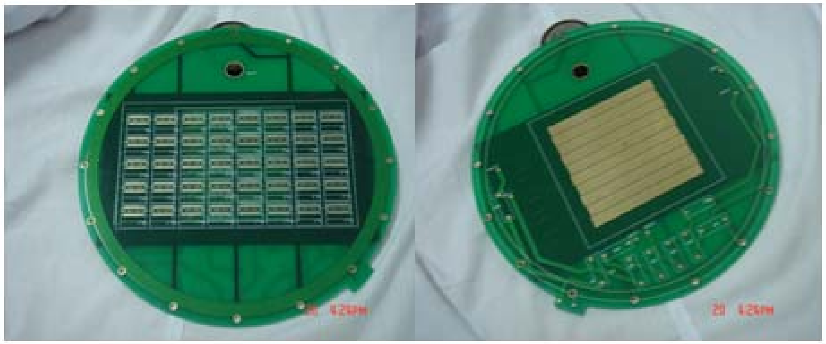


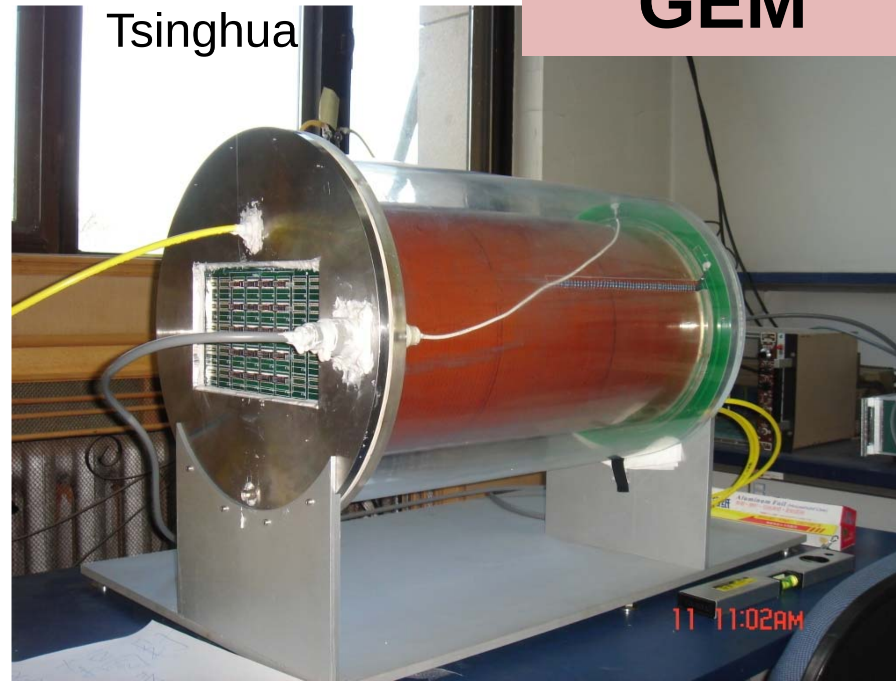
DESY 5T cosmic test, 2007

50 µm resolution with 2mm pads

Small prototypes

GEM

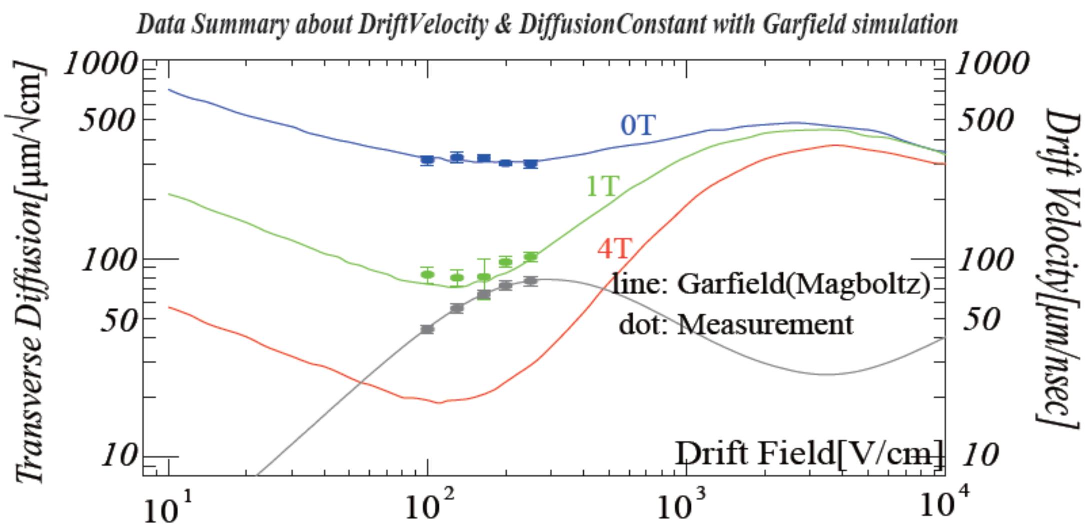




GEM prototype built at Tsinghua to train and measure gas properties, with help from Japan.

Also work on MP-TPC cosmic-ray test at KEK.

Good operation with Ar-CF4-isobutane.

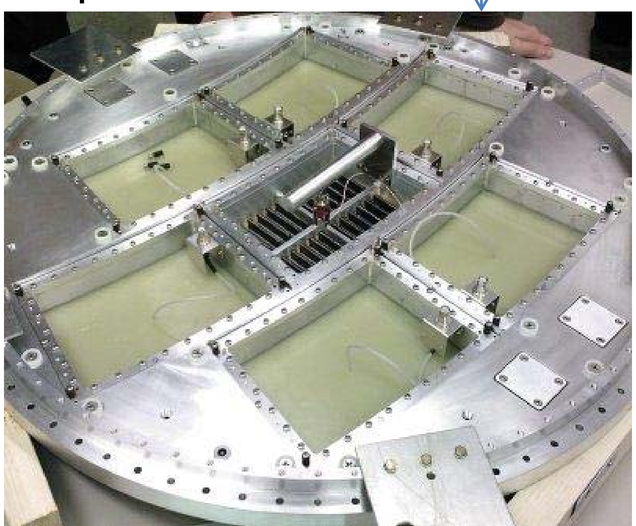


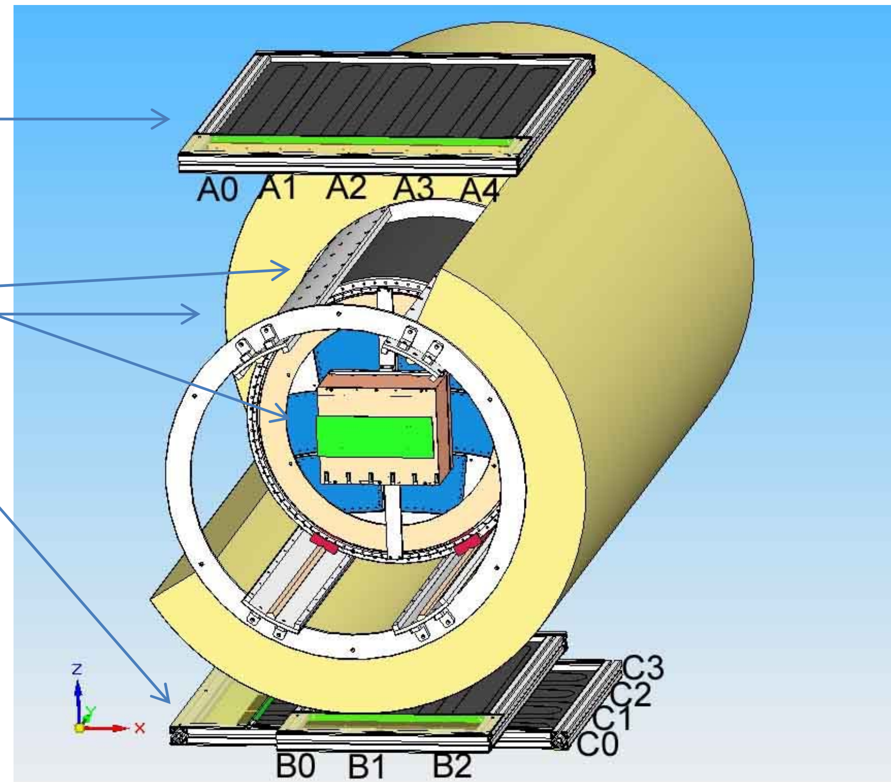
THE LARGE PROTOTYPE

LC-TPC project using the
EUDET test facility at DESY

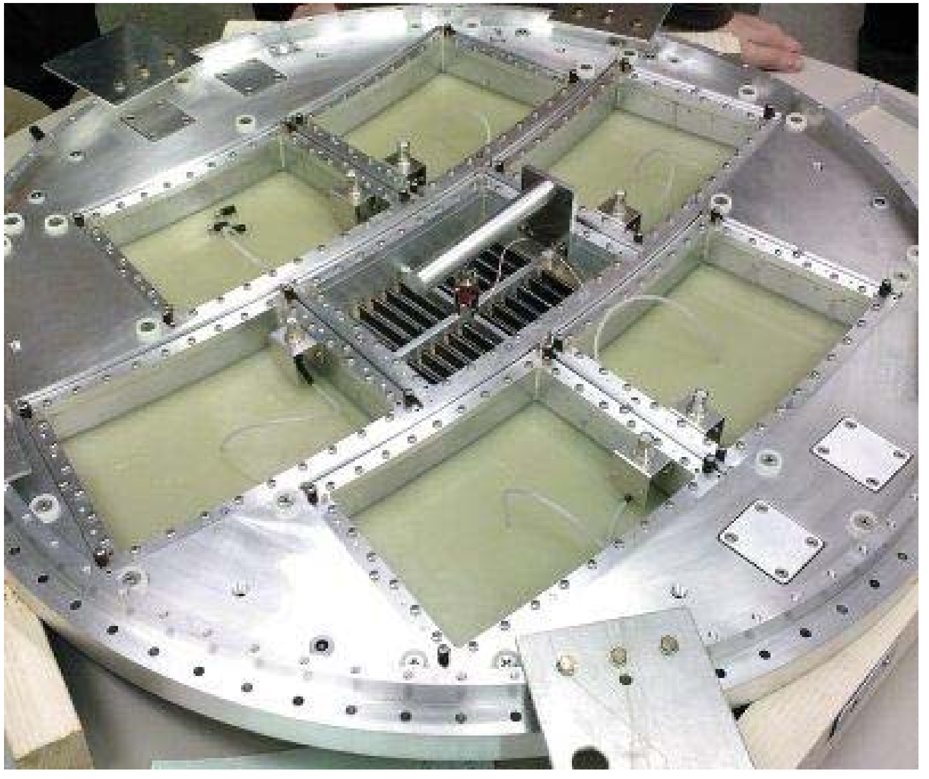
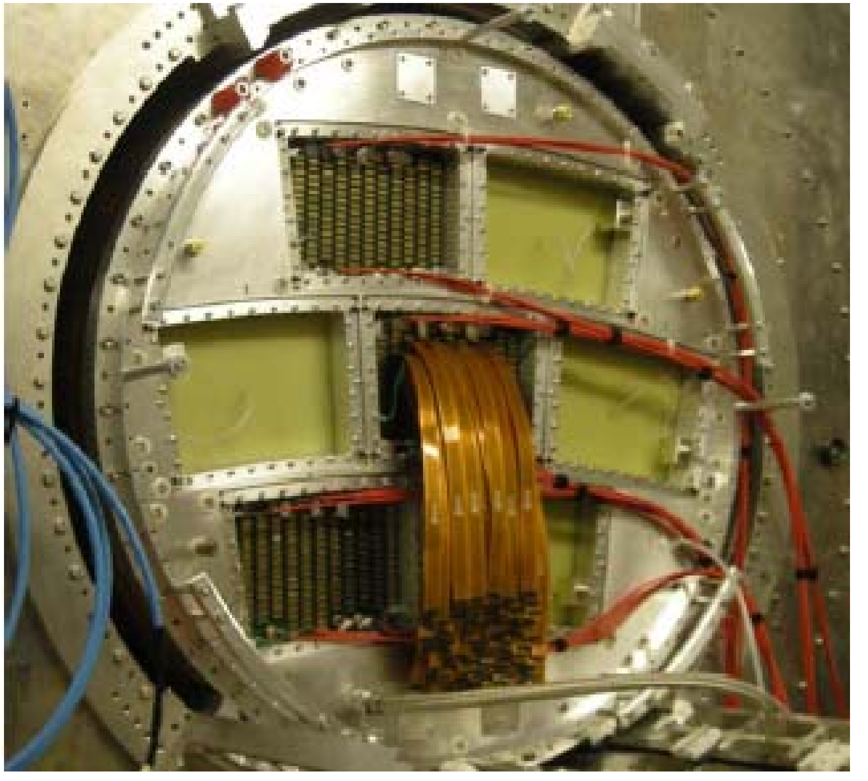
The EUDET setup at DESY

PCMag magnet from KEK
Cosmic trigger hodoscope from Saclay-KEK-INR
Beam trigger from Nikhef
Dummy modules from Bonn
Field cage, gas from DESY
Endplate from Cornell



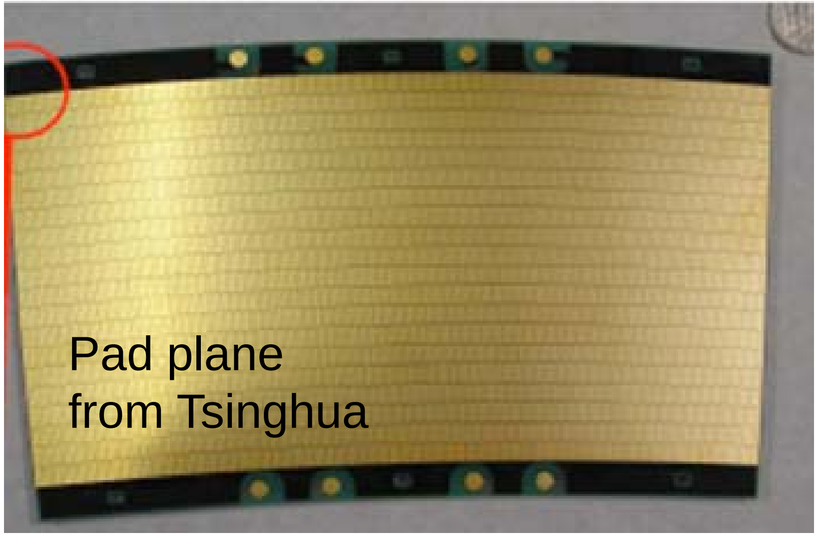


Test one Micromegas module at a time

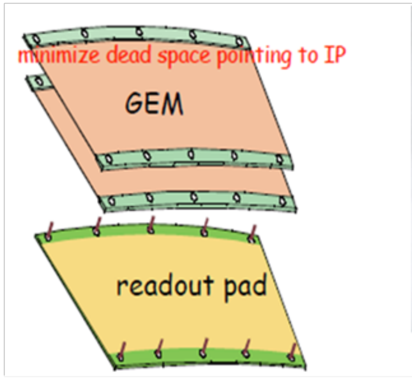
Micromegas	GEM
	
About 2000 readout channels AFTER-based electronics (made in Saclay)	About 3200 readout channels ALTRO-based electronics (made at CERN)

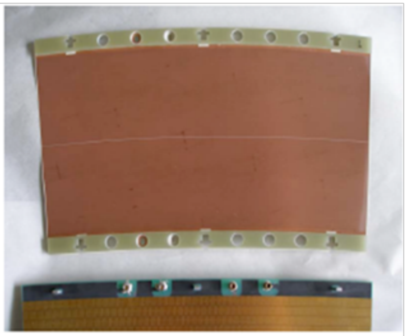
Micromegas

DOUBLE GEM



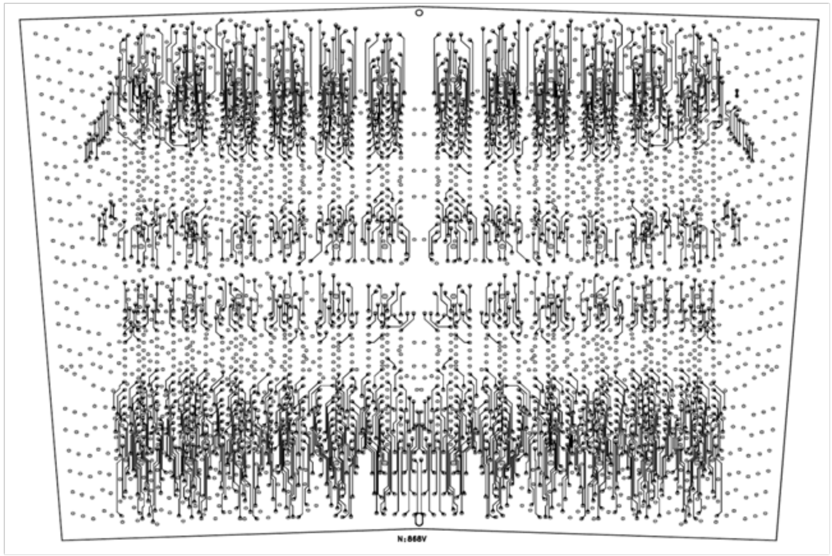
‘Bulk’ technology (CERN-Saclay) with resistive anode (Carleton)





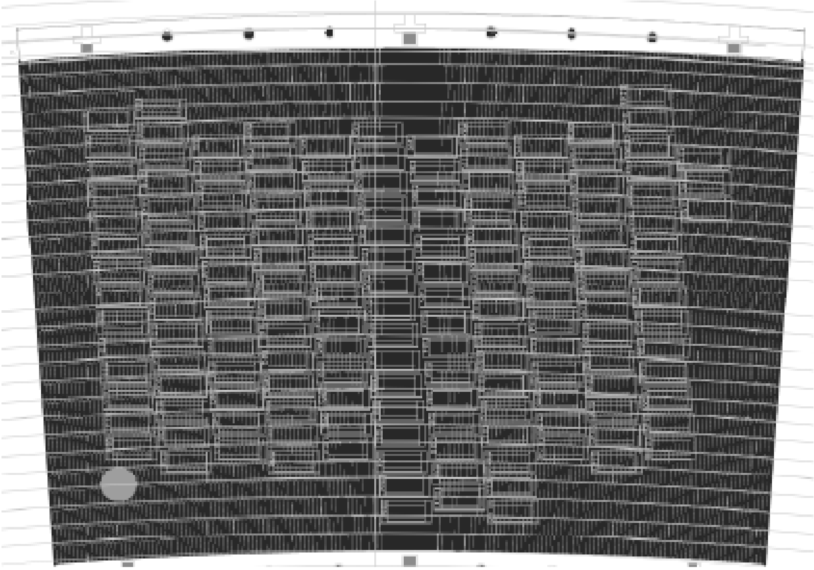
New 100 micron GEM (plasma-etched in Japan) stretched from 2 sides.

Micromegas

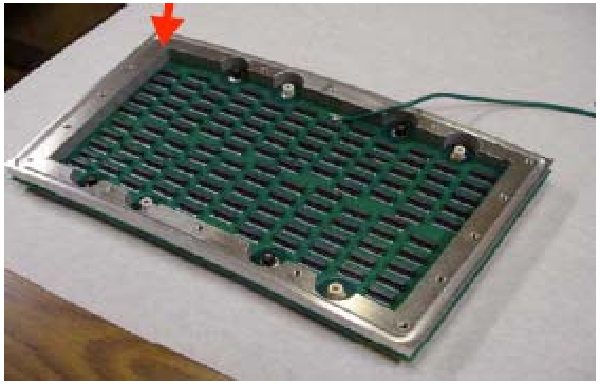


4-layer routing (CERN) and 6-layer routing (Saclay)
24x72 pads, 2.7-3.2 mm x 7 mm

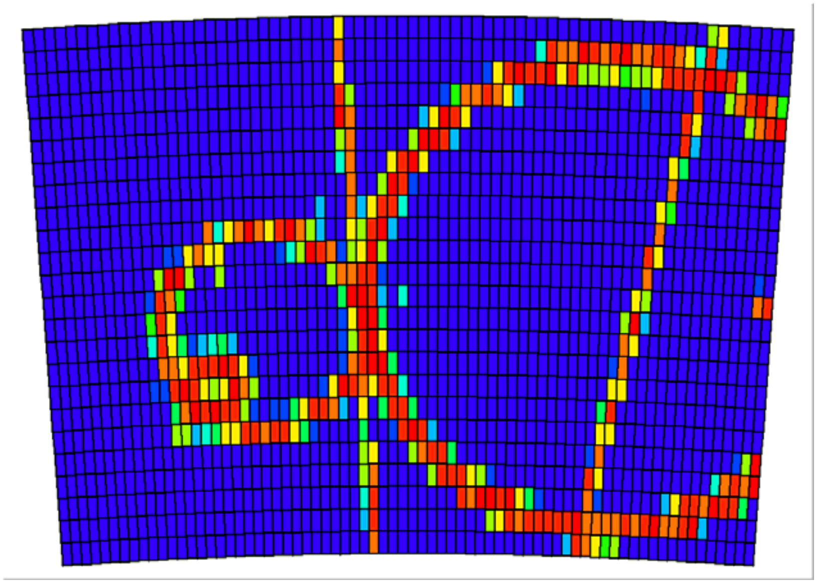
DOUBLE GEM

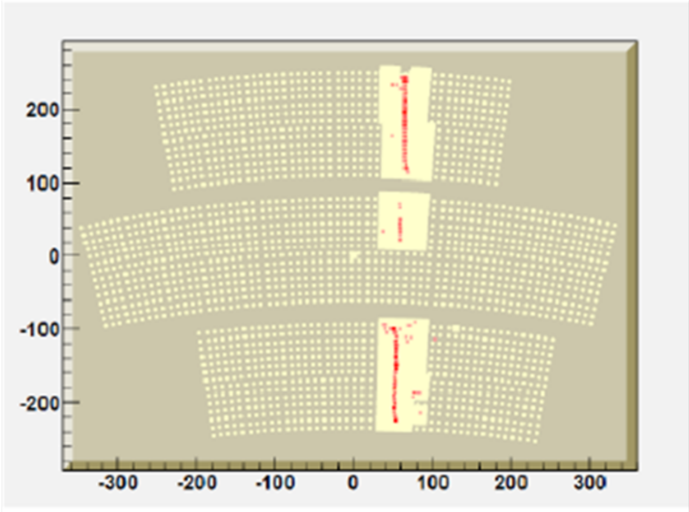


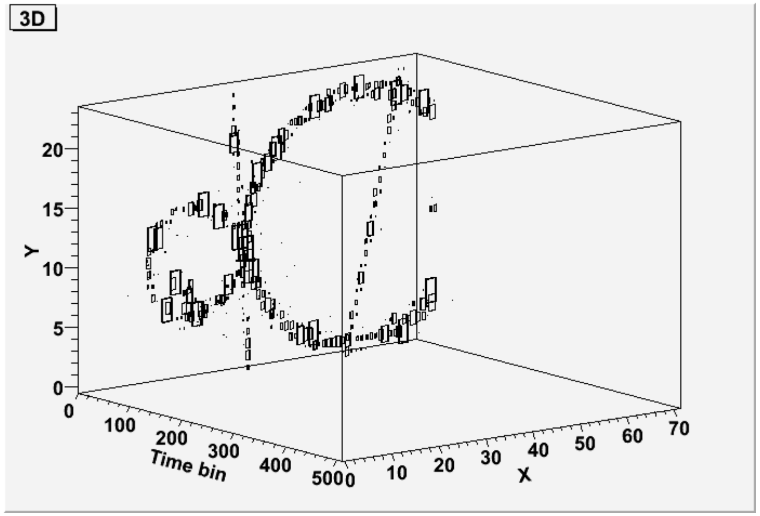
8-layer routing done at Tsinghua
28x176-192 pads, 1.1 mm x 5.6 mm

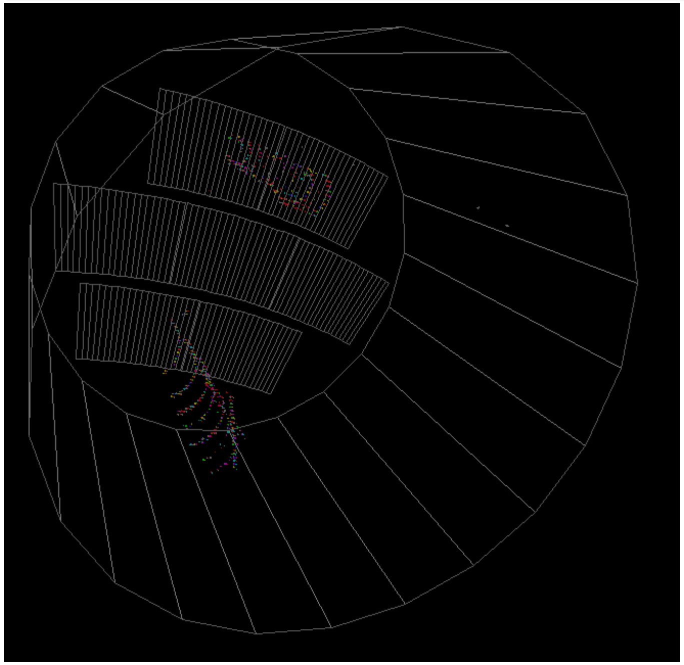


Micromegas	Double GEM







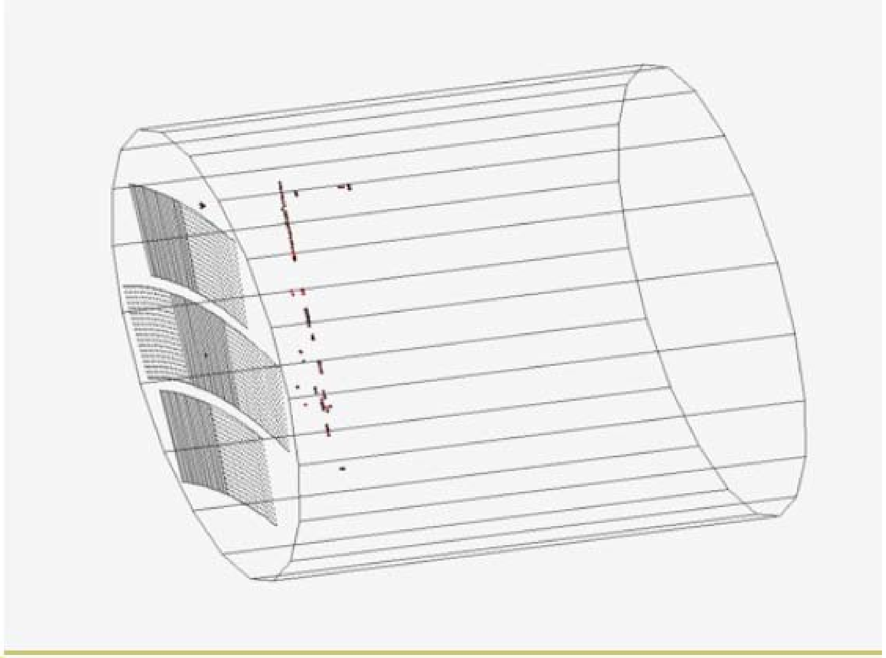


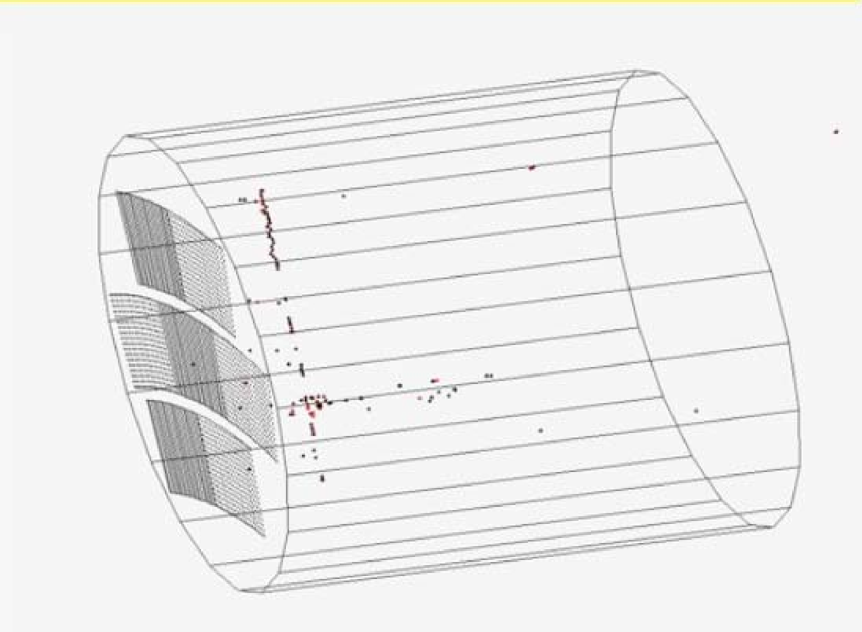
Shaper 30ns

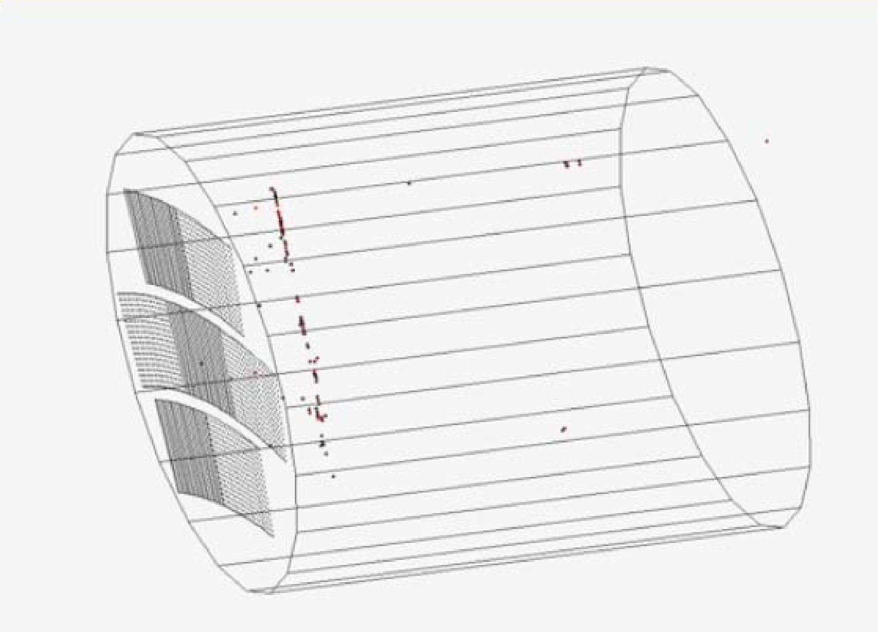
(Raw data: readout-6848_0.dat)

Not yet performed clustering
(Just picked up high pulses)

ADC count > 80





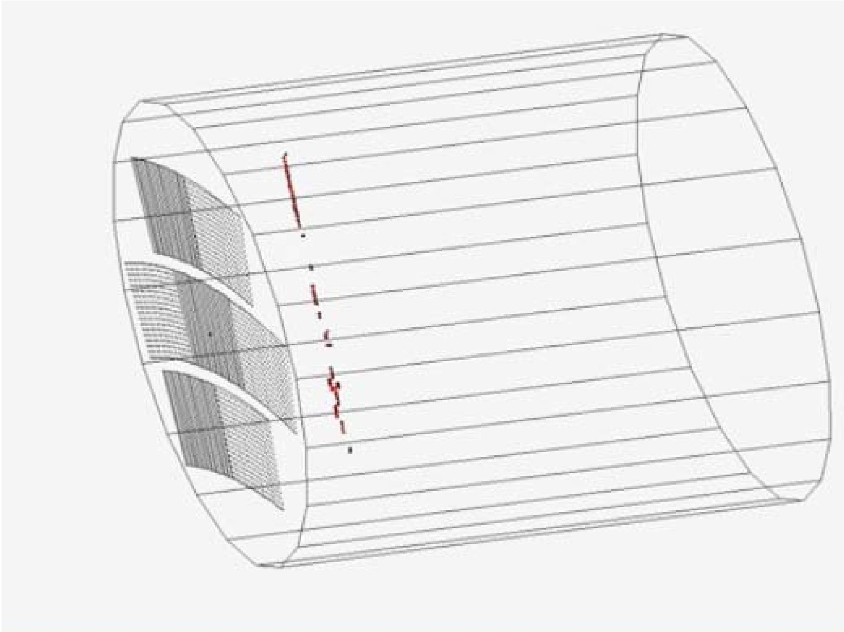


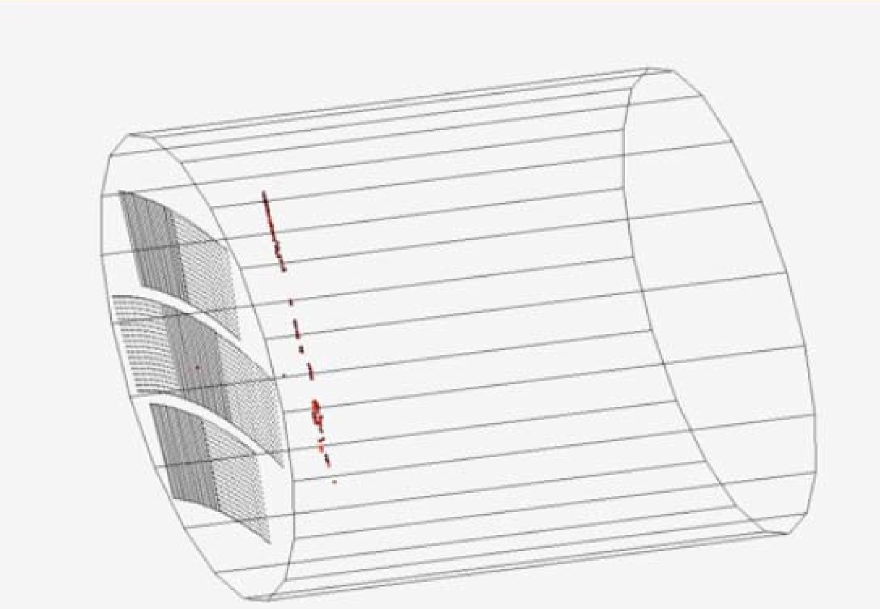
nearly same condition but ...

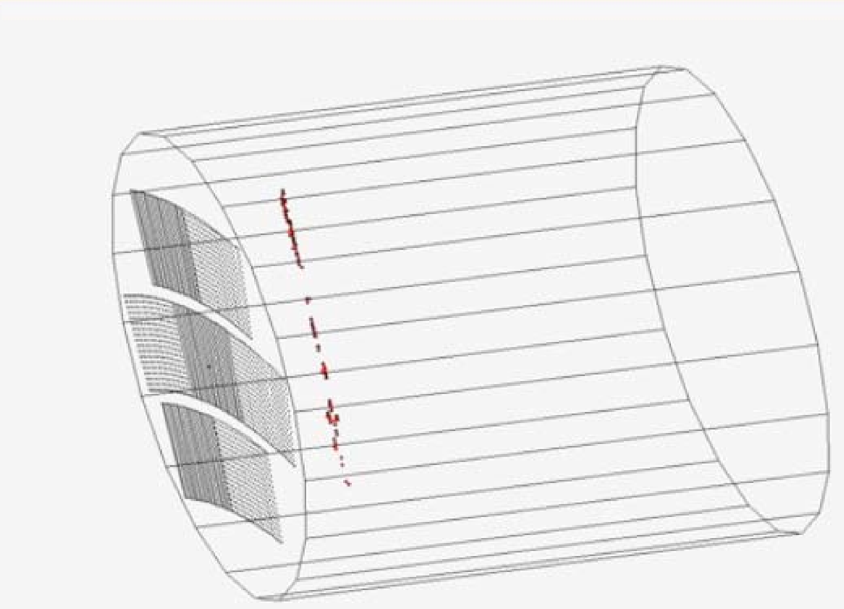
Shaper 120ns

(Raw data: readout-6864_0.dat)

Not yet performed clustering
(Just picked up high pulses)
ADC count > 60



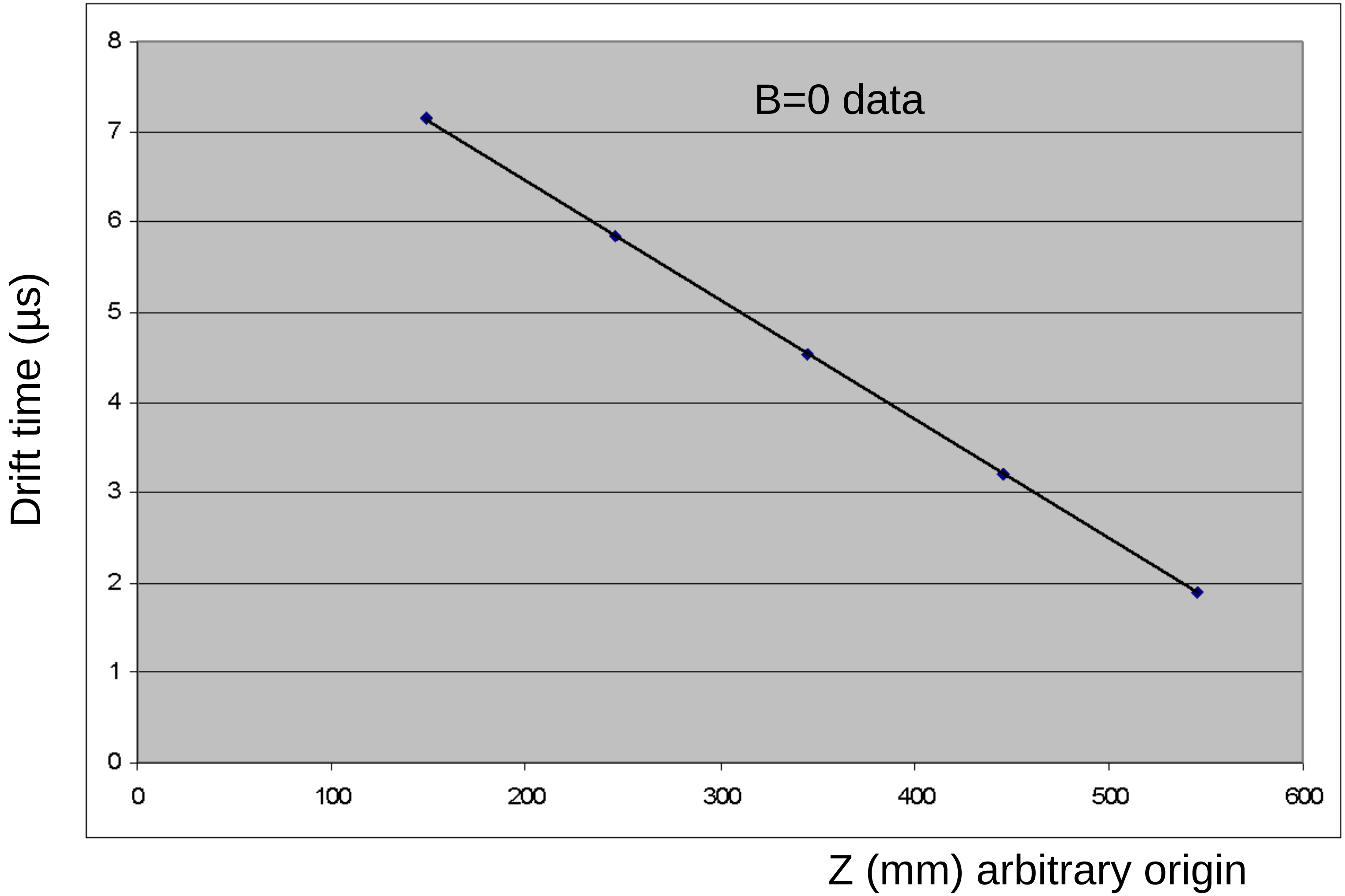


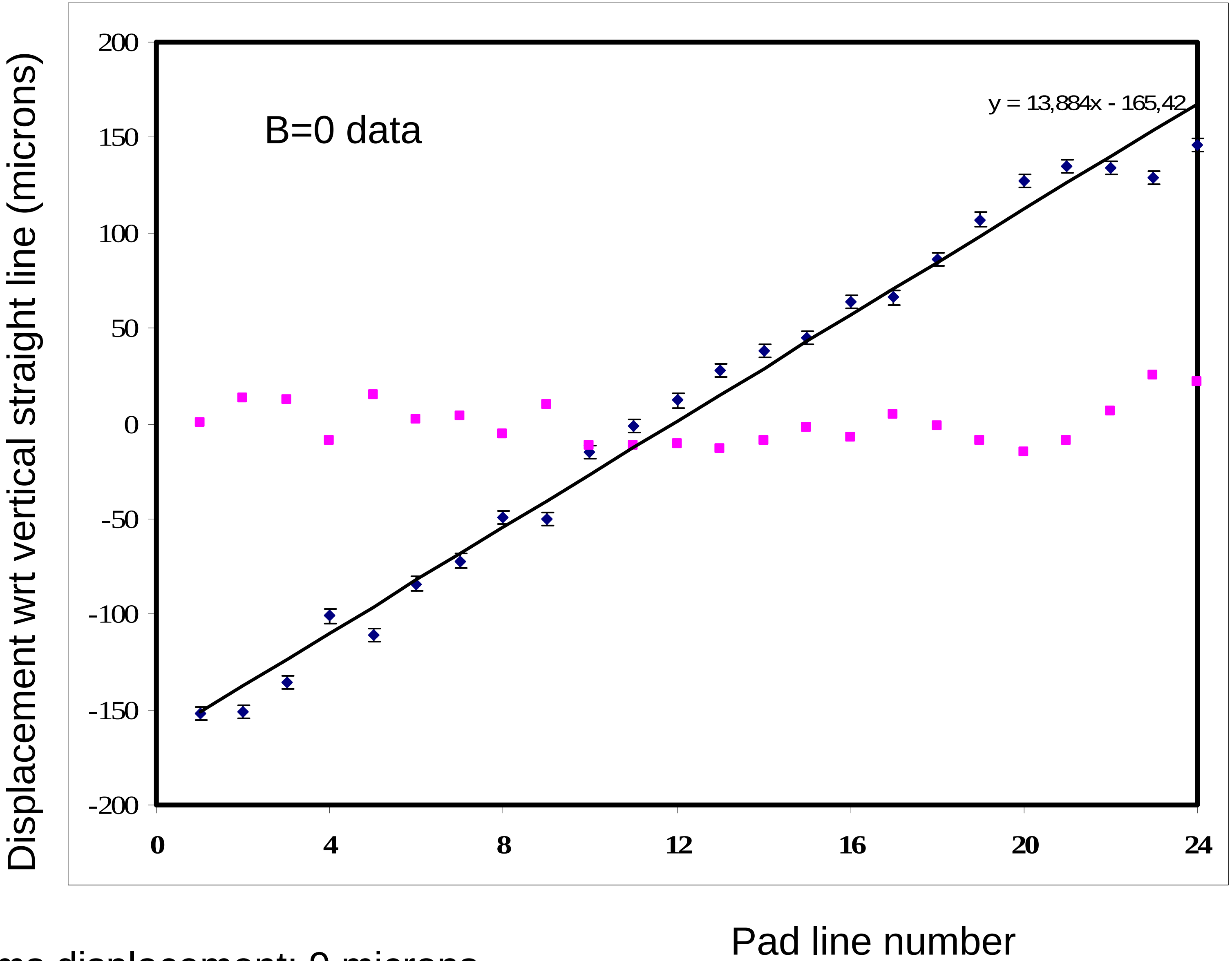


FIRST MICROMEGAS RESULTS

Measured drift velocity (Edrift = 230 V/cm, 1002 mbar) : 7.56 ± 0.02 cm/µs

Magboltz : 7.548 ± 0.003 pour Ar:CF4:isobutane:H2O/95:3:2:100ppm





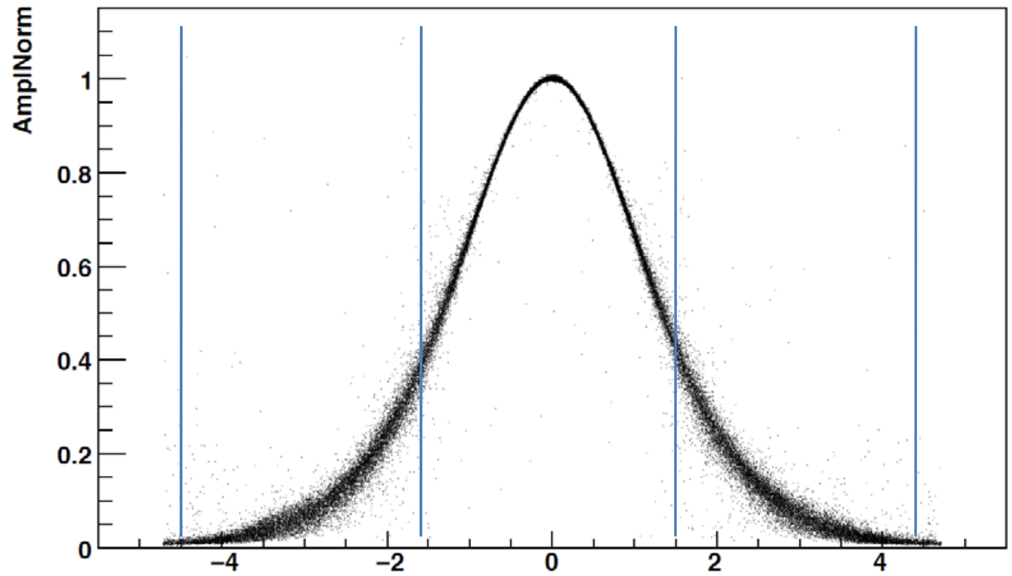
Rms displacement: 9 microns

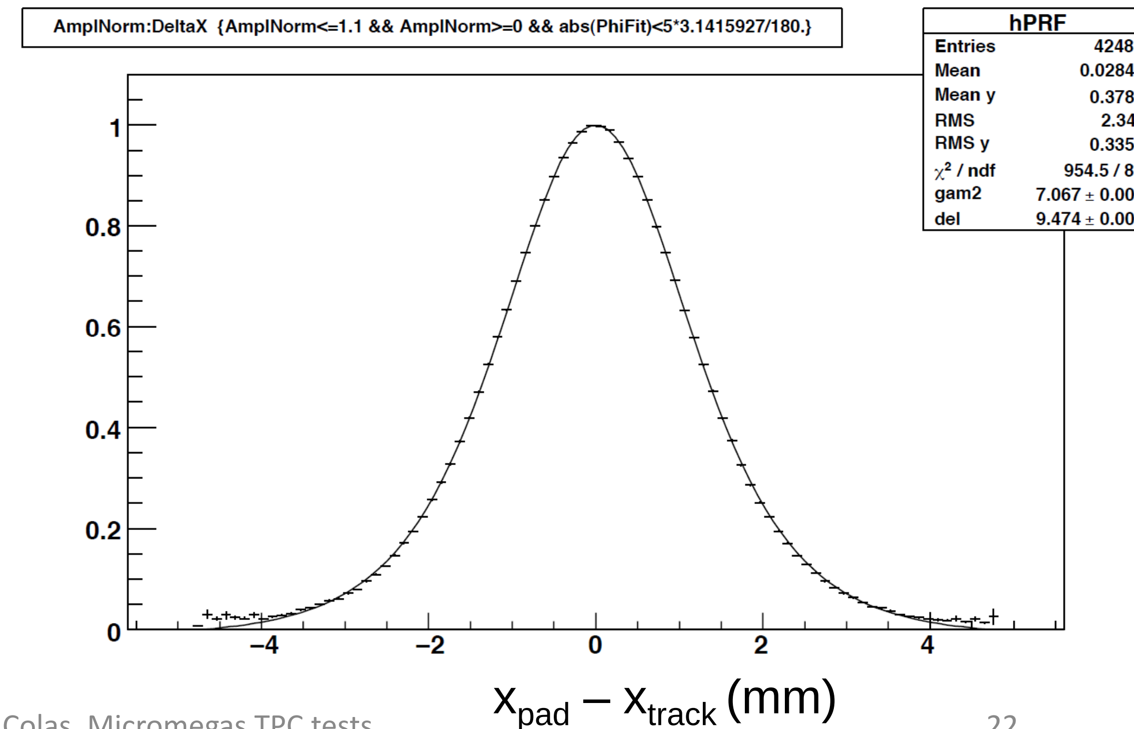
Determination of the Pad Response Function (B=1T beam data)

Fraction of the row charge on a pad vs $x_{pad} - x_{track}$ (normalized to central pad charge)

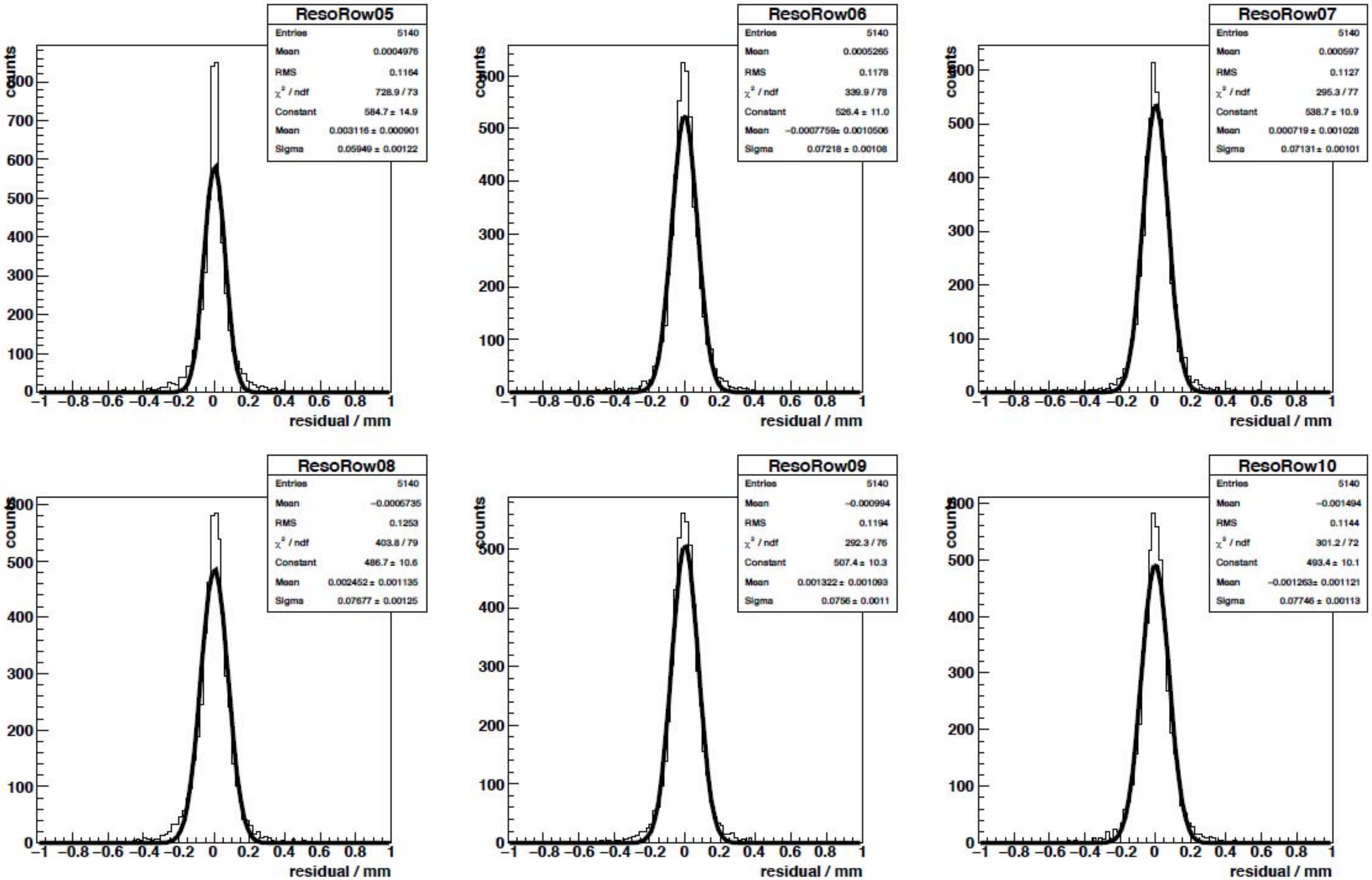
Clearly shows charge spreading over 2-3 pads (use data with 500 ns shaping)

Then fit x(cluster) using this shape with a χ^2 fit, and fit simultaneously all rows to a circle in the xy plane



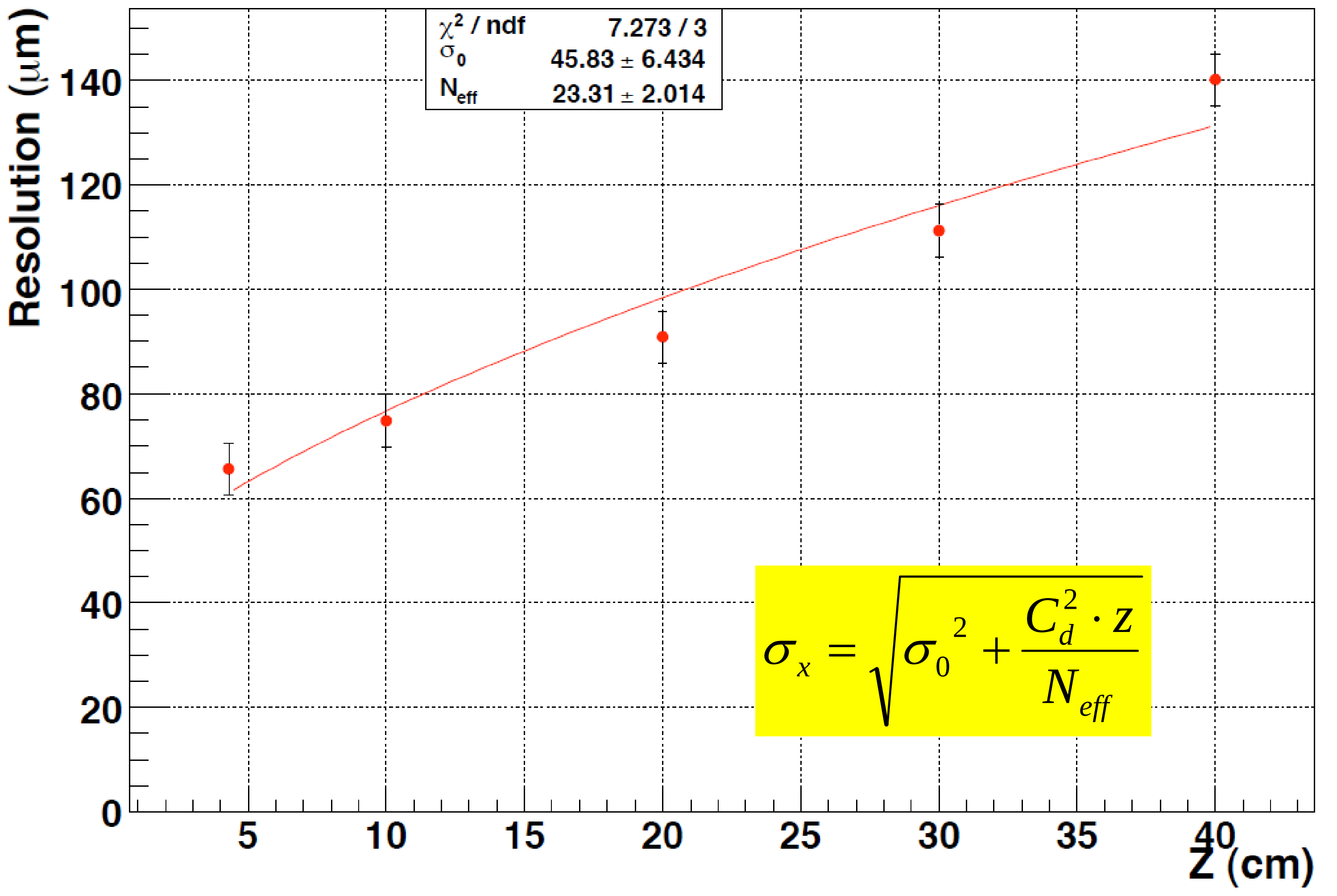


RESIDUALS (z=10 cm)



Do not use lines 0-4 and 19-23 for the time being (non gaussian residuals, magnetic field inhomogeneous for some z positions?)

Shaping 500 ns



Resolution 46±6 microns with 2.7-3.2 mm pads
Effective number of electrons 23.3±2.0 consistent with expectations