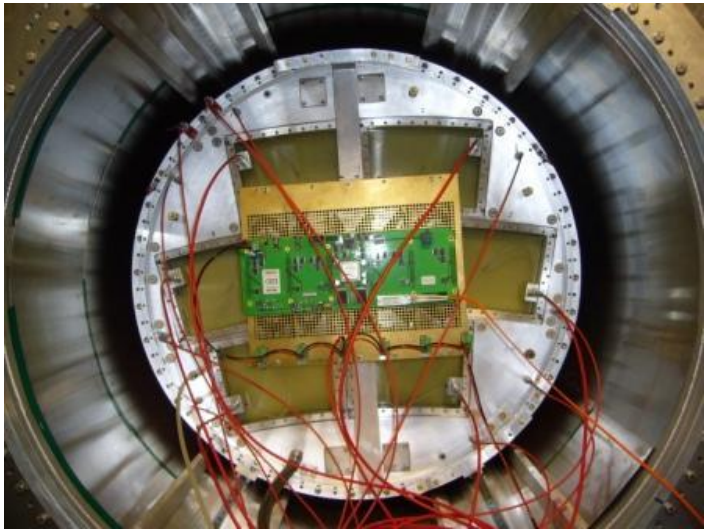
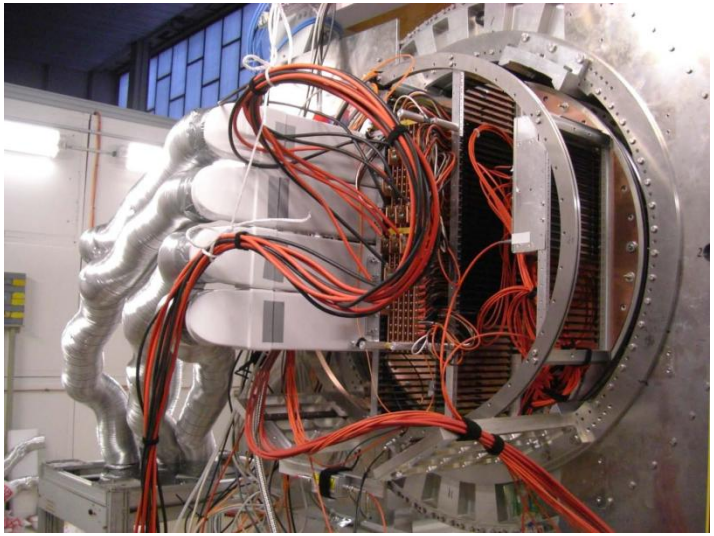
Large TPCs for HEP

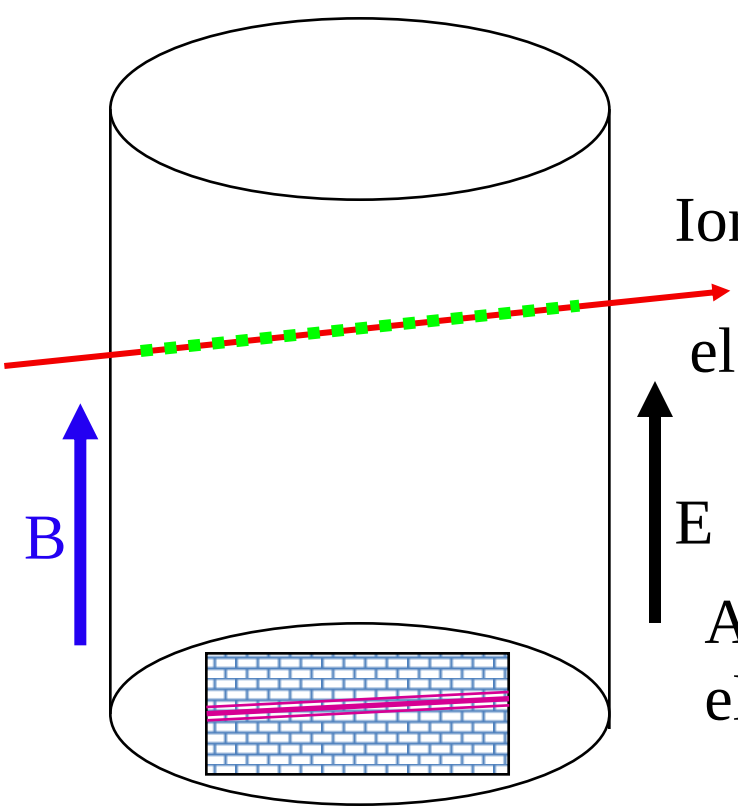
P. Colas

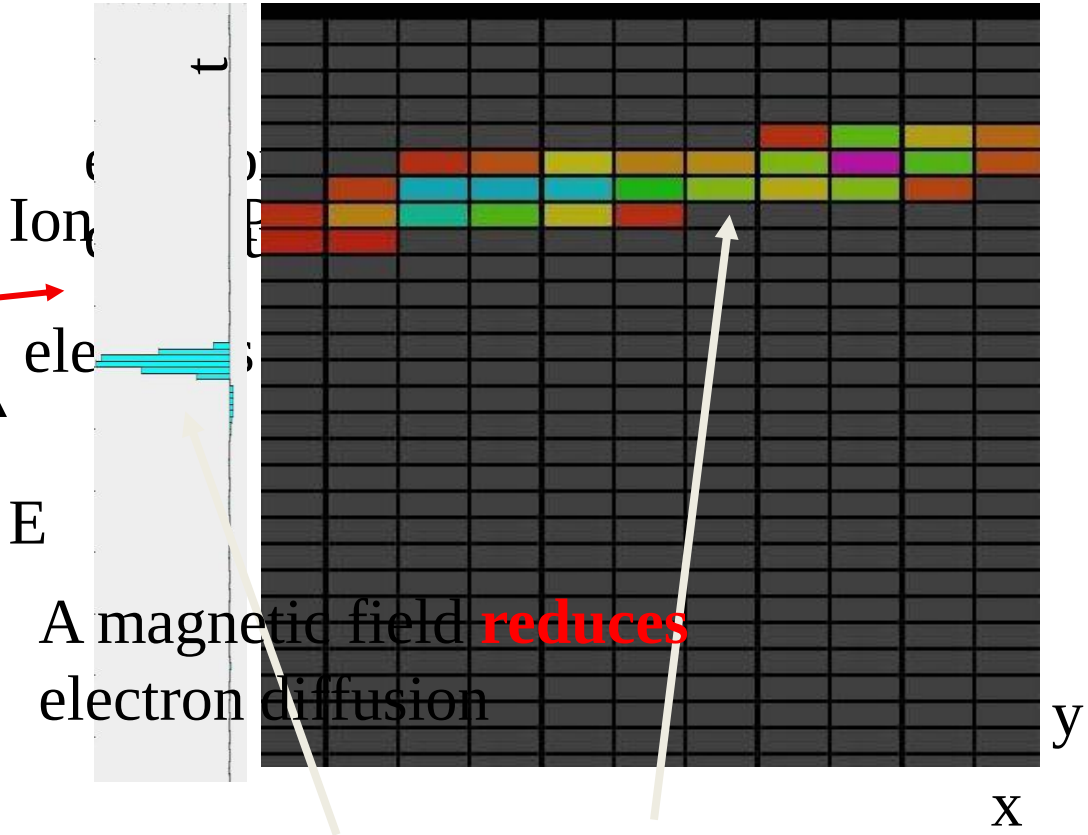




Lanzhou U., Saclay, Tsinghua U.

Time Projection Chamber





MPGD TPC : the amplification is made by a MPGD

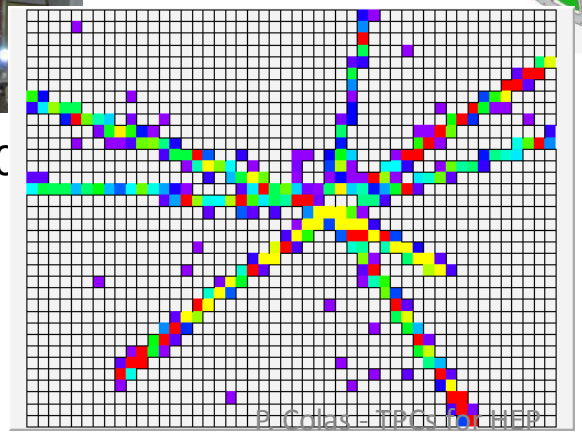
A magnetic field **reduces** electron diffusion

Localization in time and x-y

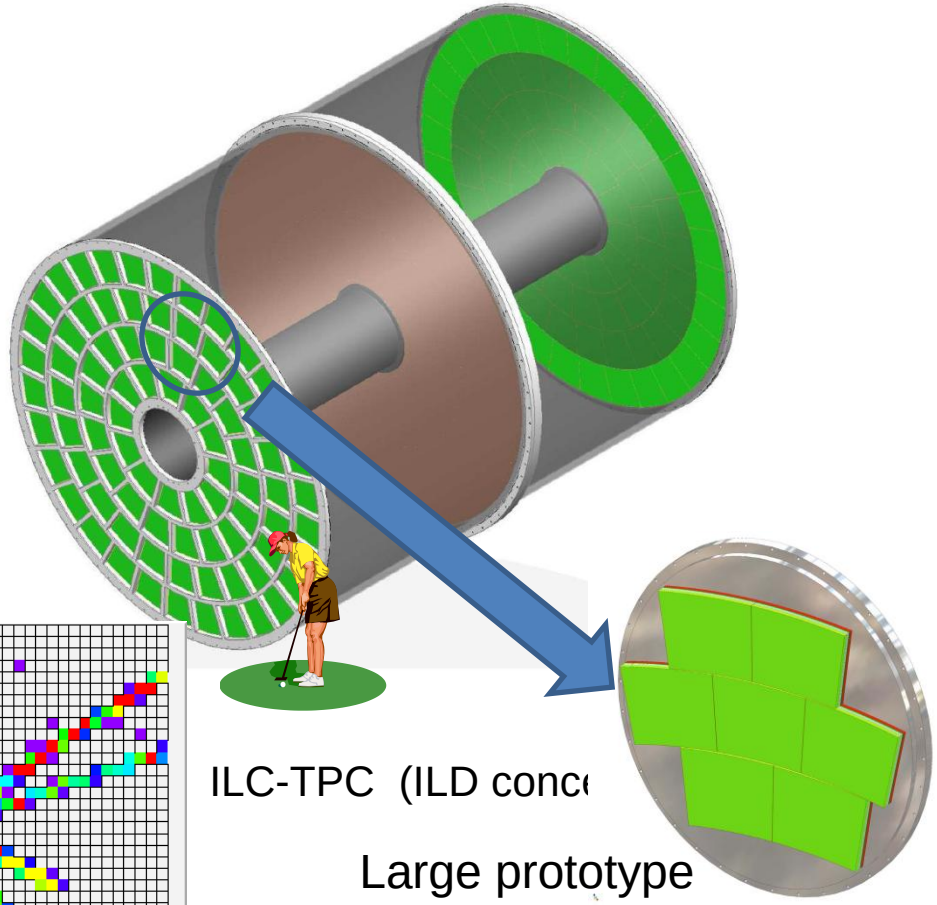
TPCs in HEP

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

T2K TPC for ND280
(M. Zito, F. Pierre)



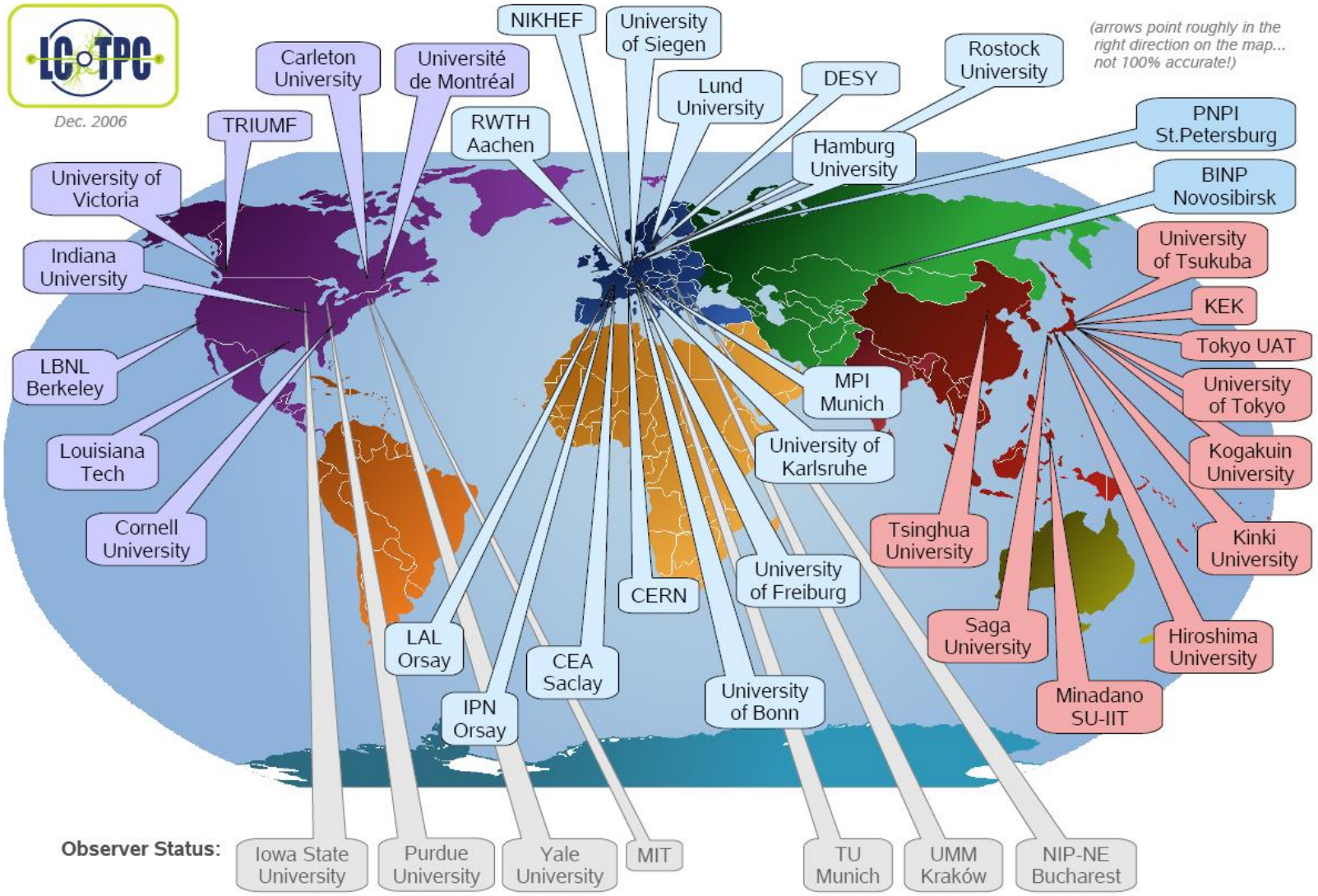
Tests at TRIUMF
Installation at JPARC
Startup end 2009



ILC-TPC (ILD conc

Large prototype
being tested at
DESY

LCTPC Collaboration

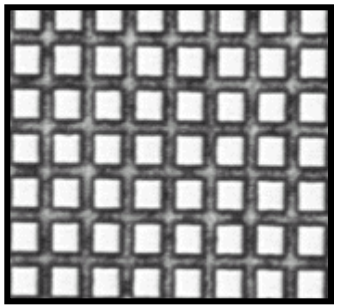


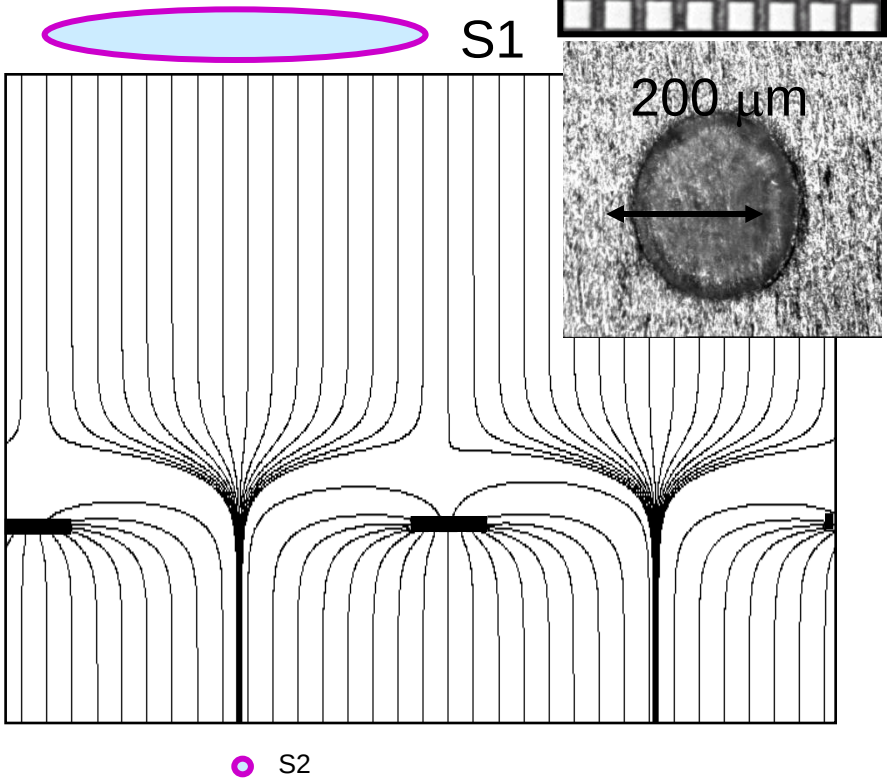
DETECTION TECHNOLOGIES

Micromegas and GEM

Micromegas

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

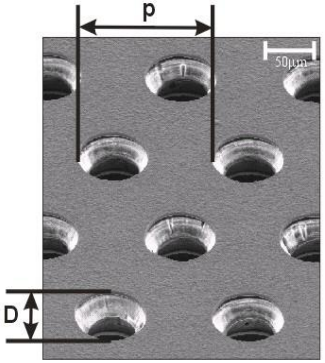


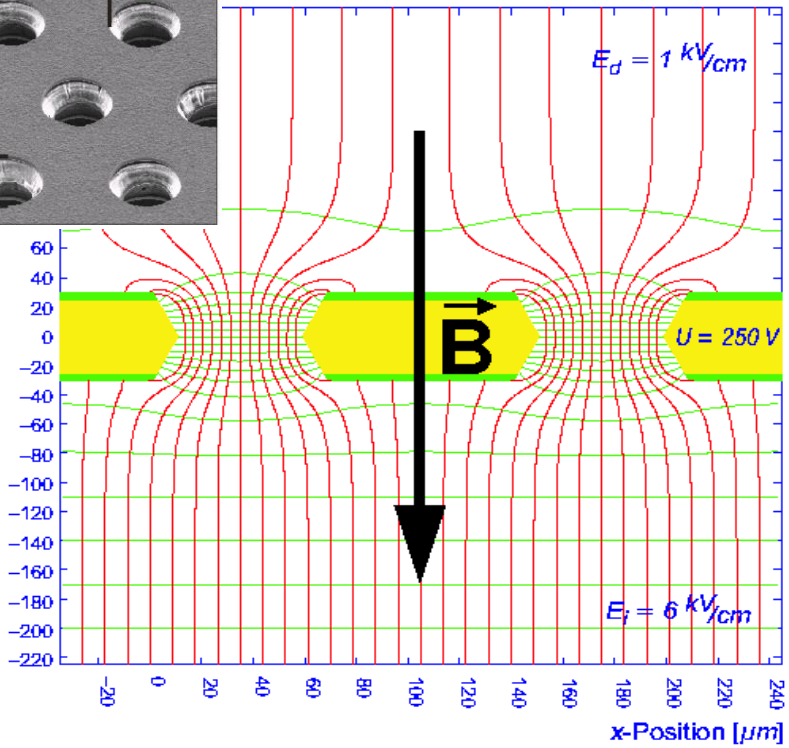


GEM

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

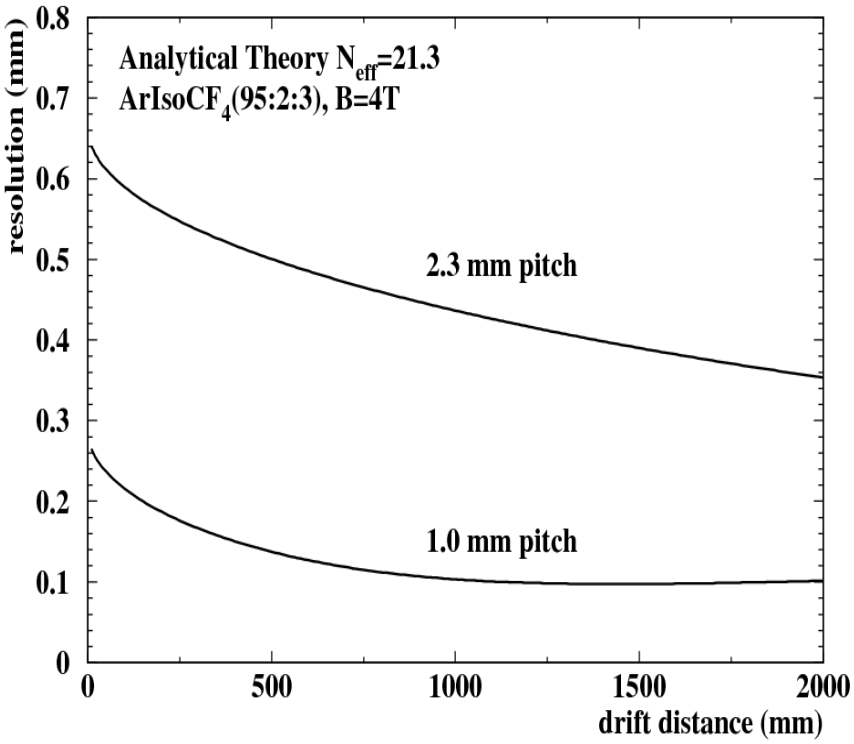
LC-TPC goal is 200 measurement points on a track, with <130 micron resolution

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.

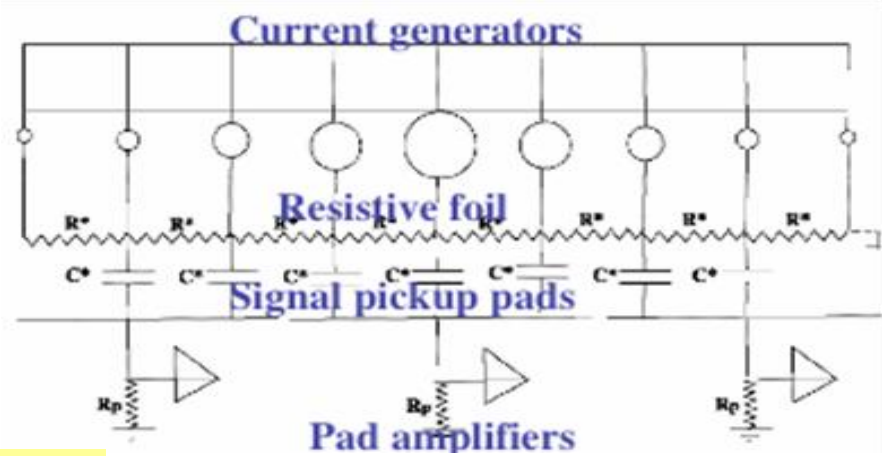
Note that charge sharing saves number of channels ($, W, X°).



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

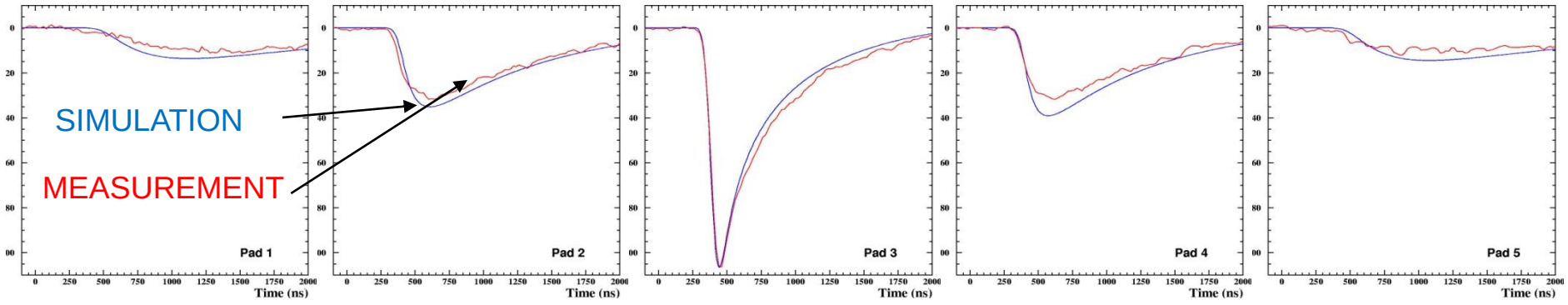
resistive anode (2)

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



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

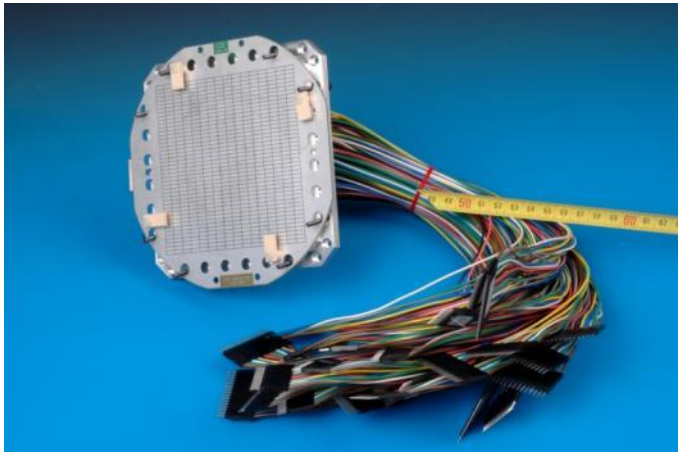
M.S.Dixit and A. Rankin NIM A566 (2006) 281



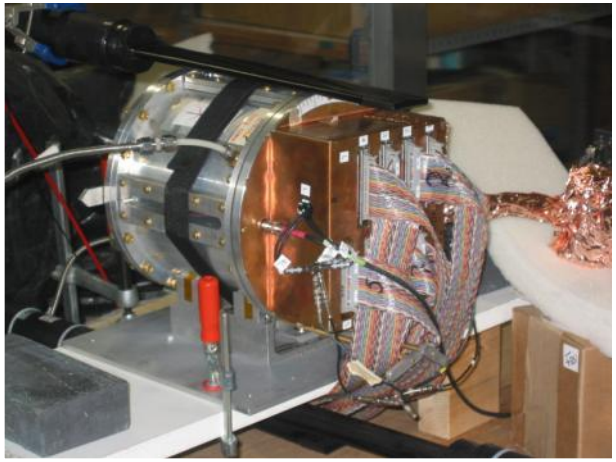
Res. foil also provides anti-spark protection

Small prototypes

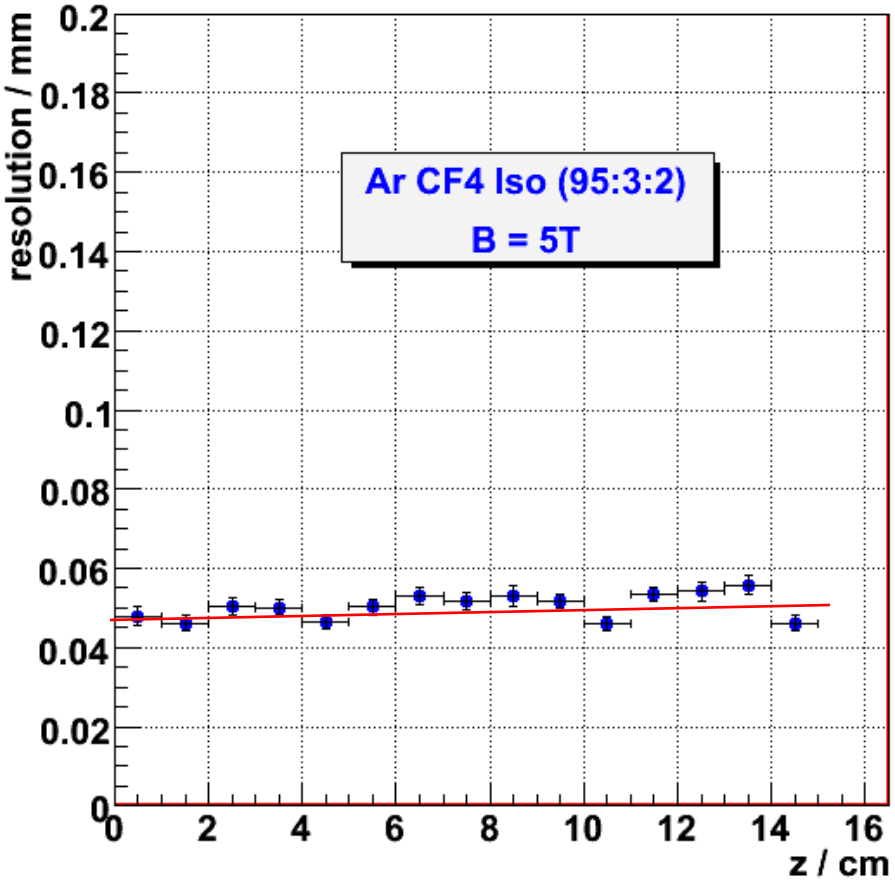
Micromegas



KEK beam test, MP-TPC (2005)



Carleton TPC with res. anode

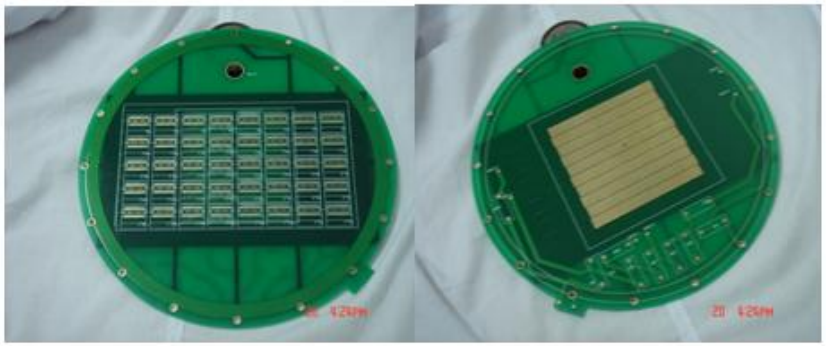


DESY 5T cosmic test, 2007

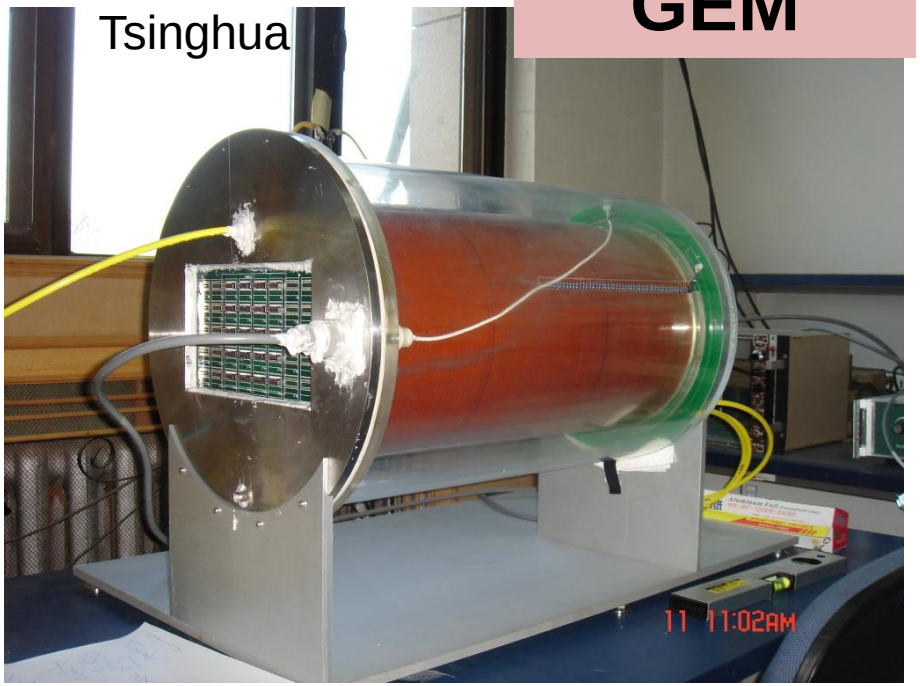
50 µm resolution with 2mm pads

Small prototypes

GEM



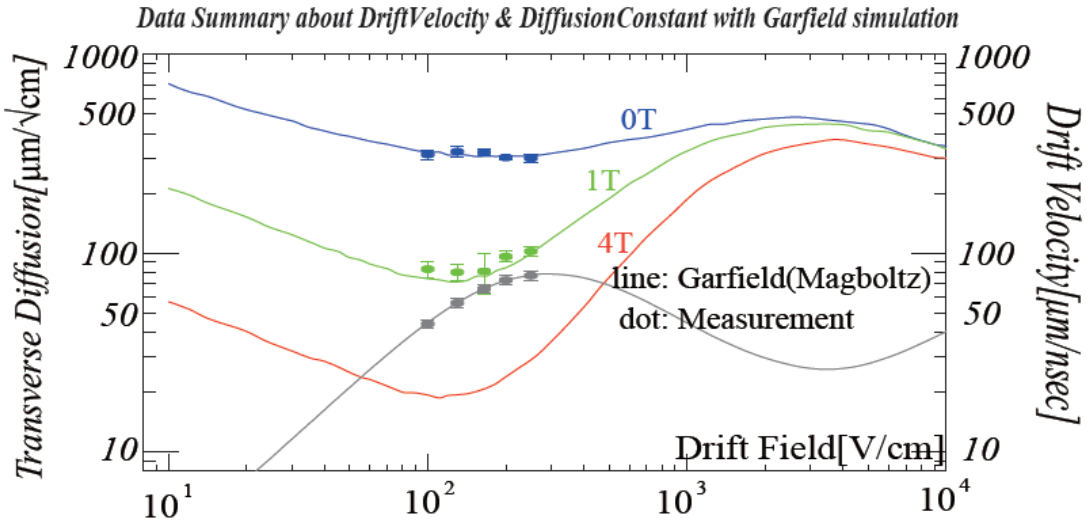
Tsinghua



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.

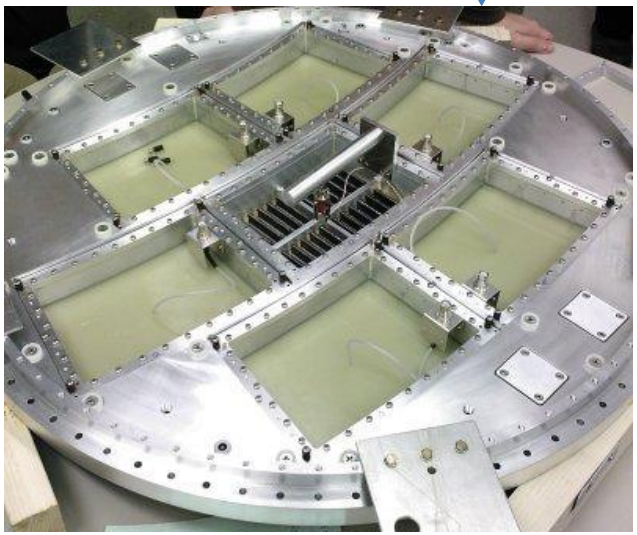


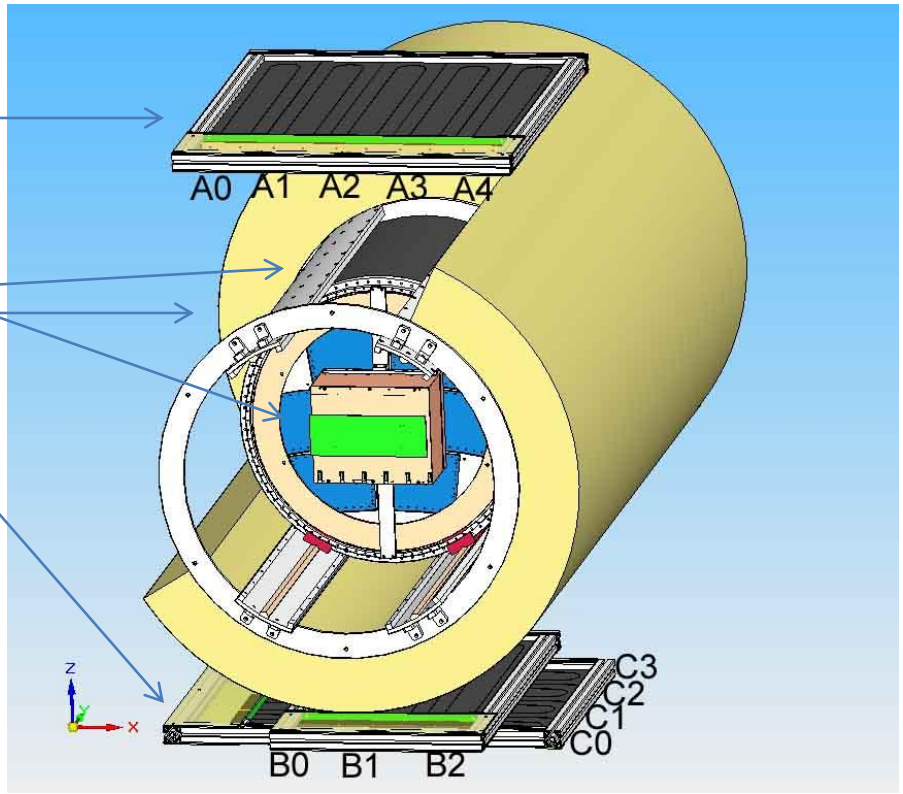
THE LARGE PROTOTYPE

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



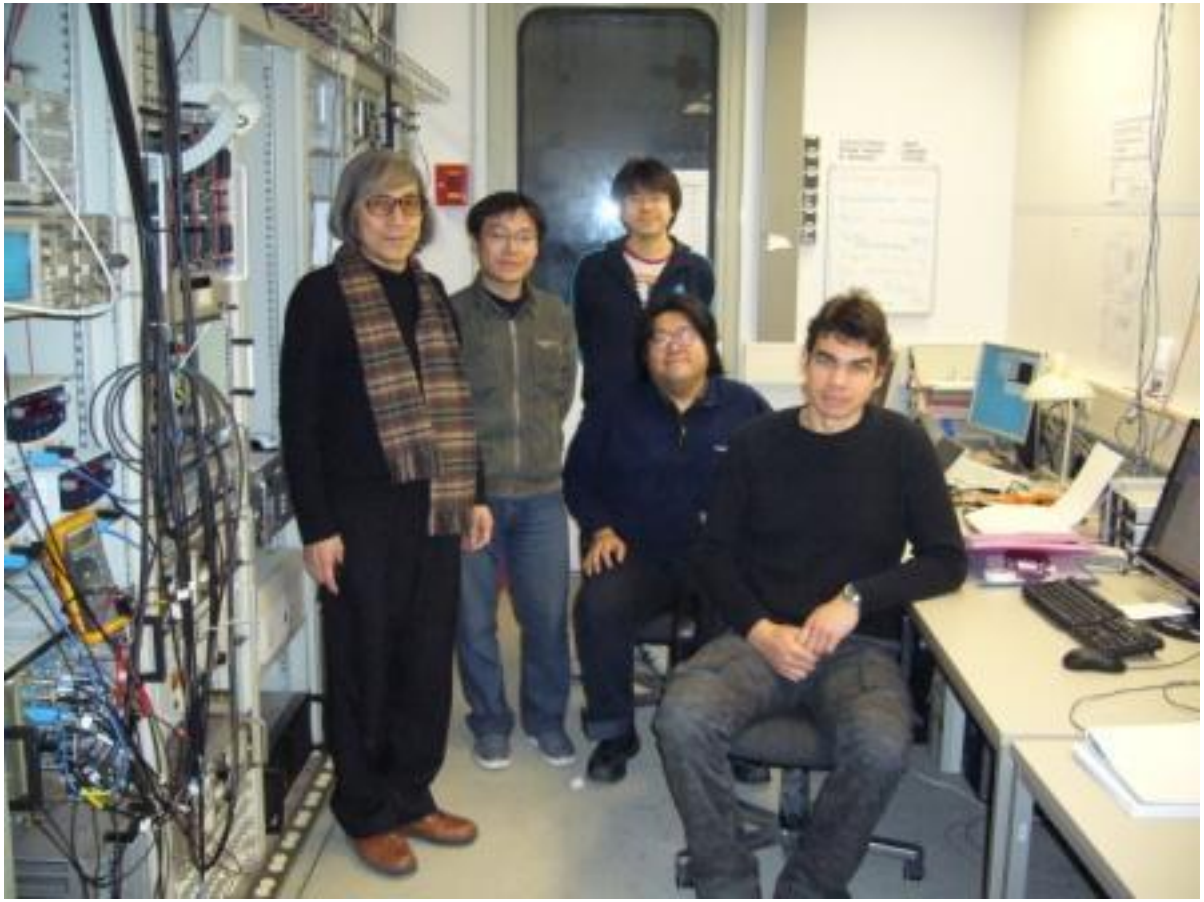


Test one Micromegas module at a time

Common data taking at DESY

FCPPL

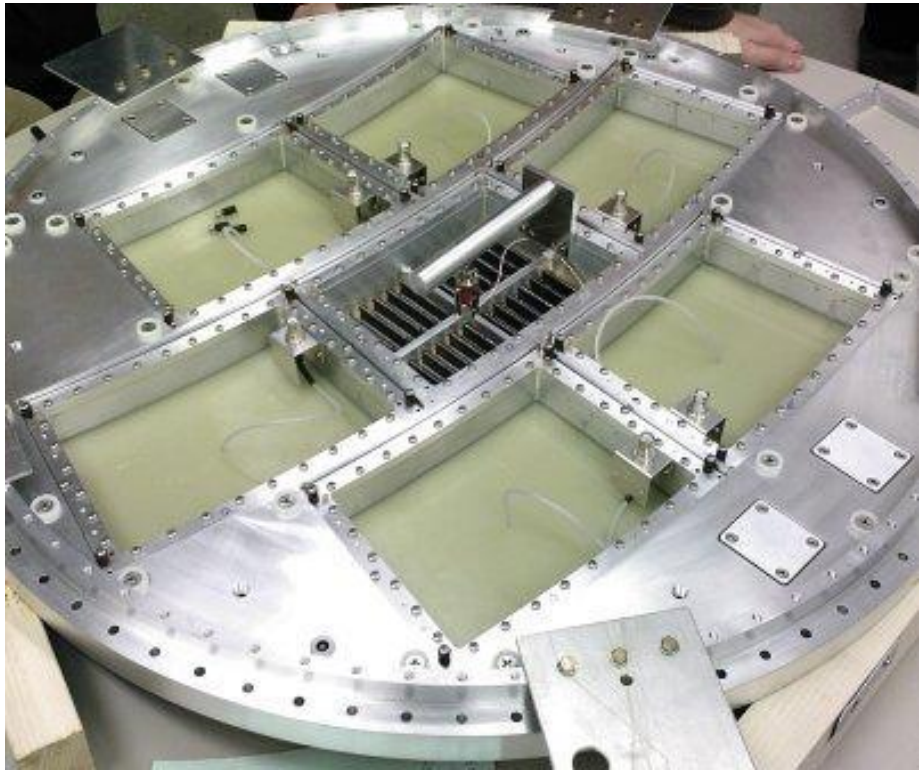
Li Bo David Attié



FJPPL

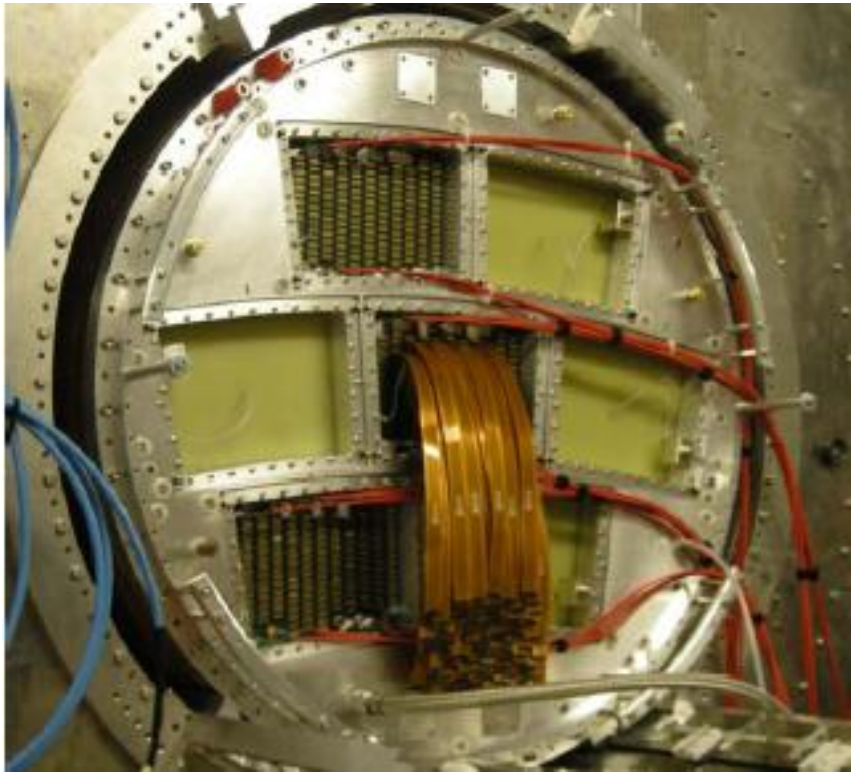
T. Matsuda R. Yonamine H. Kuroiwa

Micromegas



About 2000 readout channels
AFTER-based electronics
(made in Saclay)

GEM

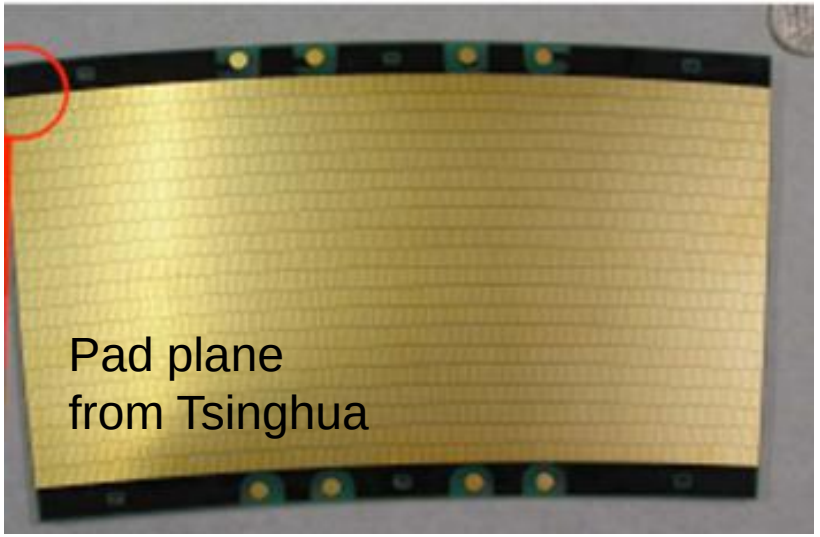


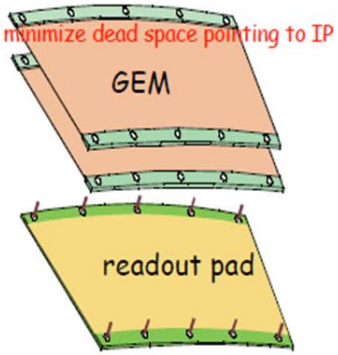
About 3200 readout channels
ALTRO-based electronics
(made at CERN)

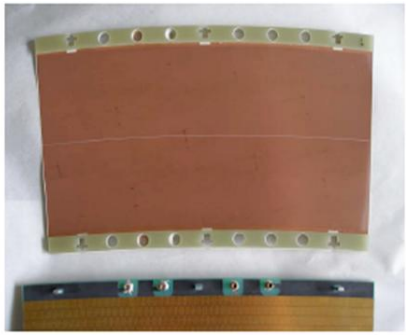
Micromegas

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

DOUBLE GEM

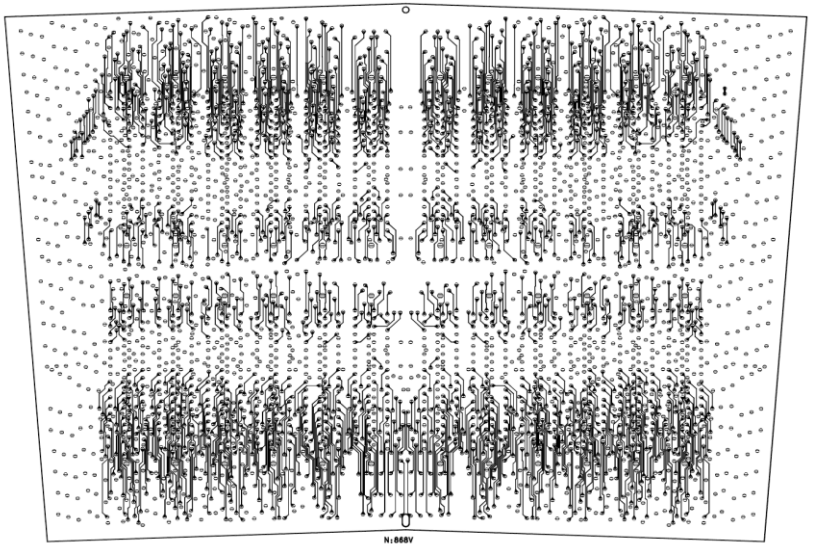






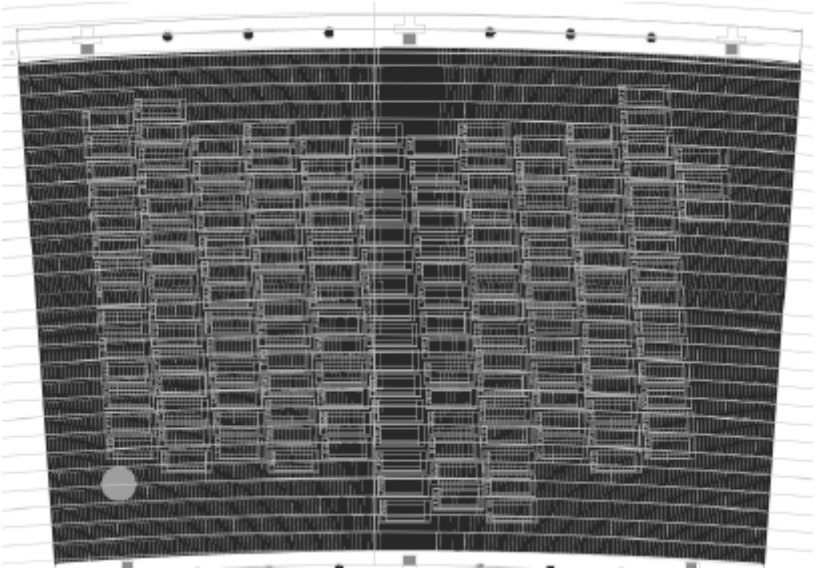
New 100 micron GEM (plasma-etched in Japan) stretched from 2 sides.

Micromegas

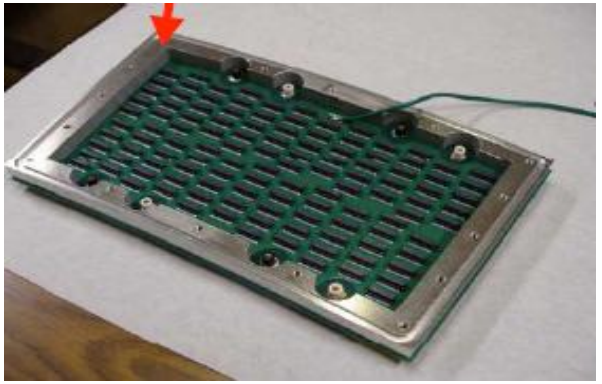


4-layer routing (CERN) and 6-layer routing (Saclay)
24x72 pads, 2.7-3.2 mm x 7 mm

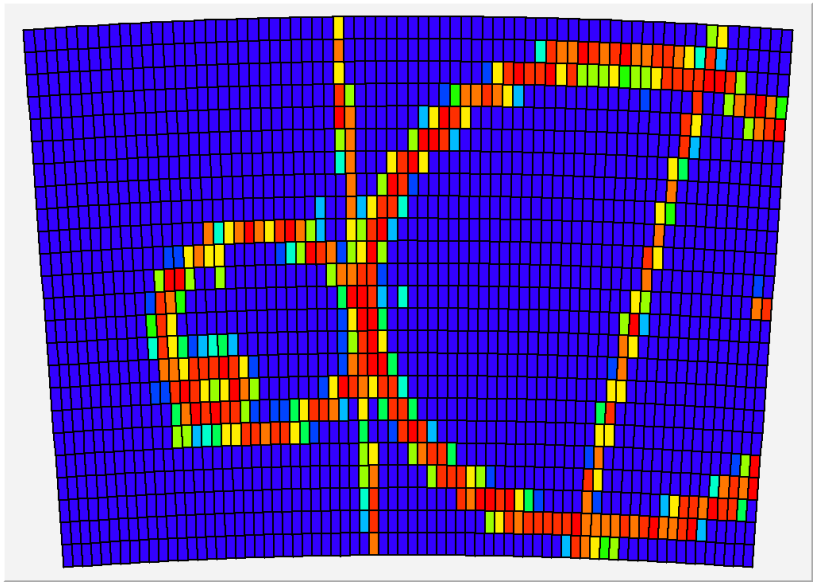
DOUBLE GEM

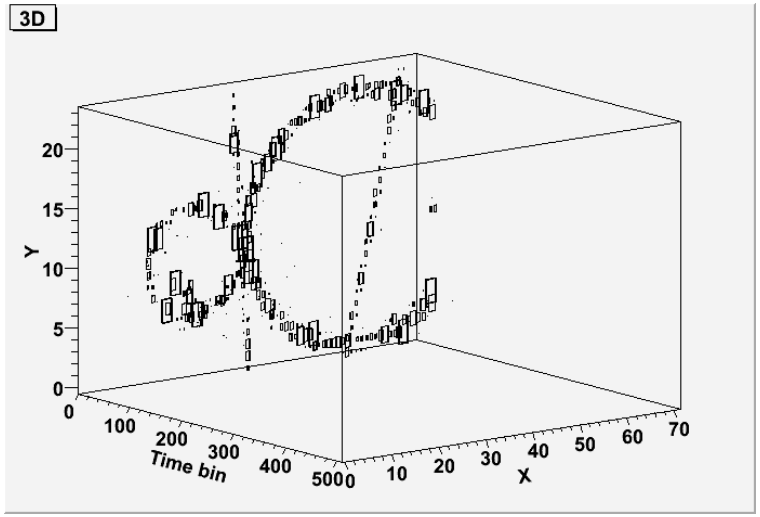


8-layer routing done at Tsinghua
28x176-192 pads, 1.1 mm x 5.6 mm

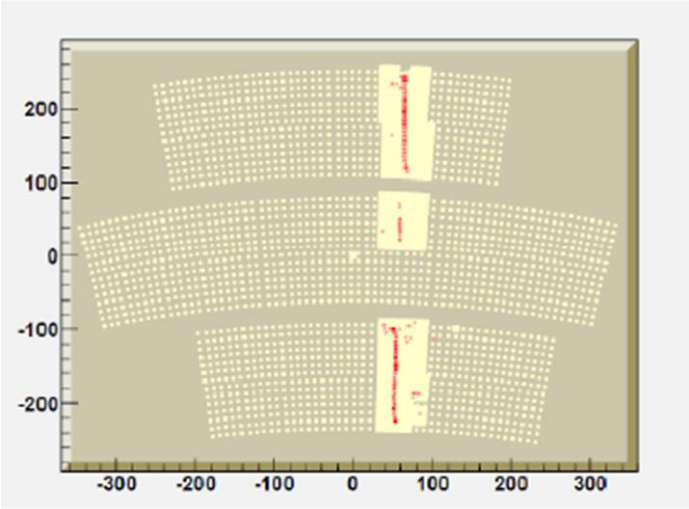


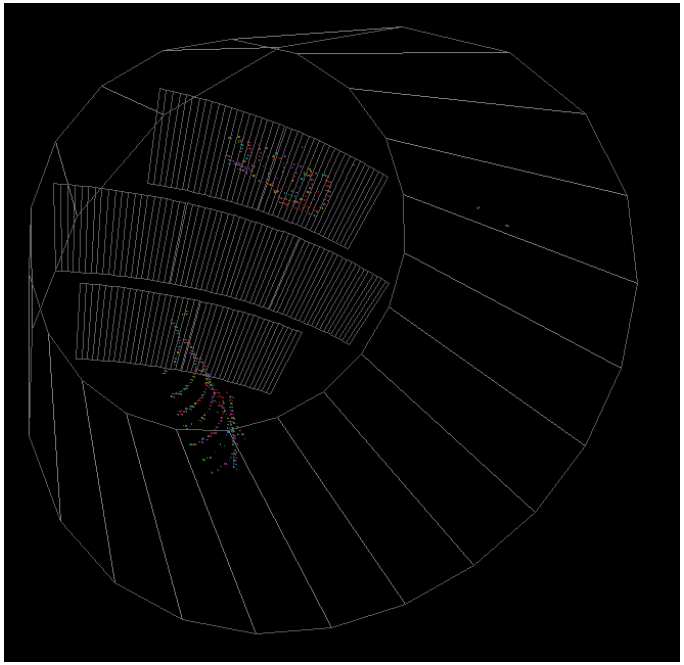
Micromegas





Double GEM

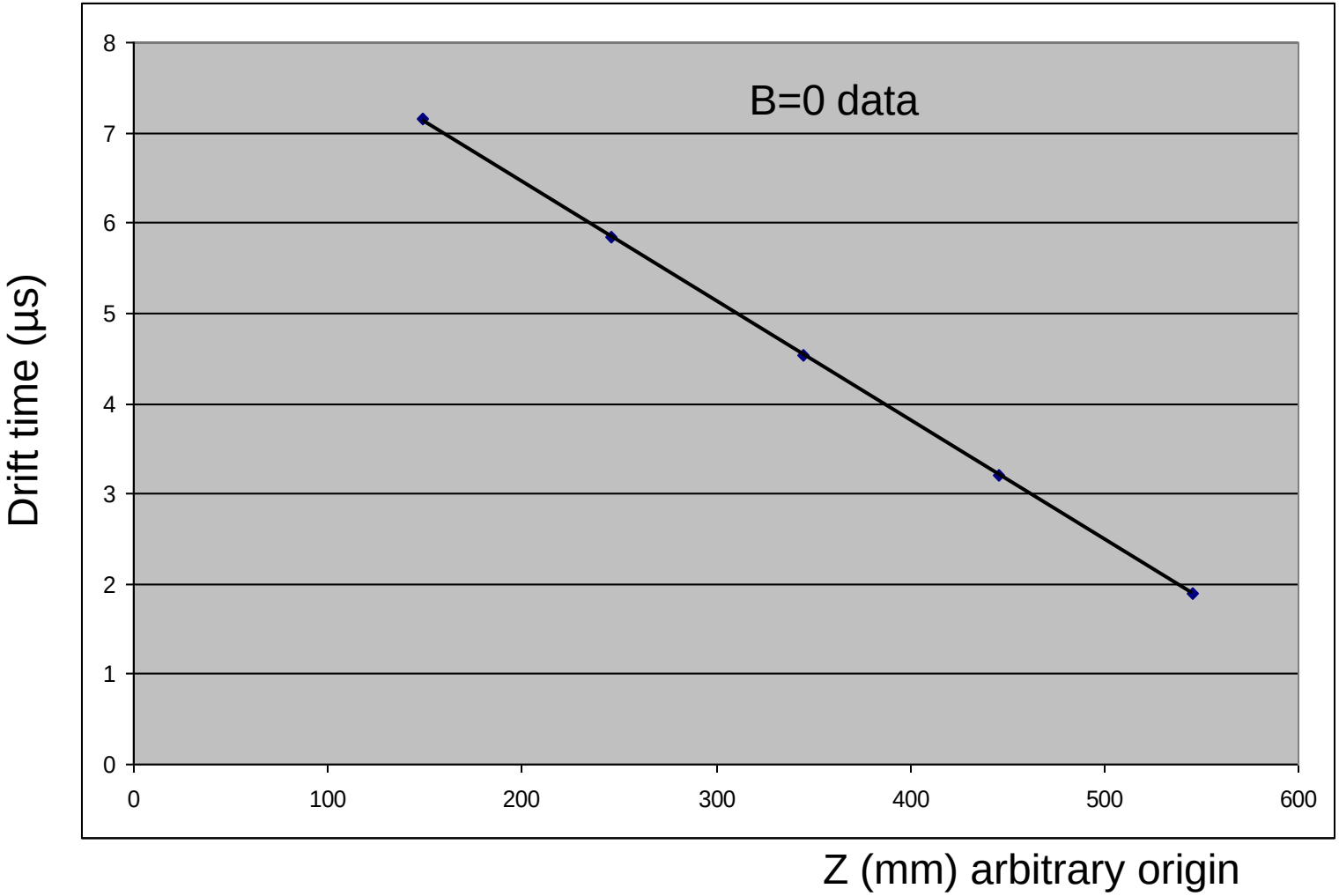


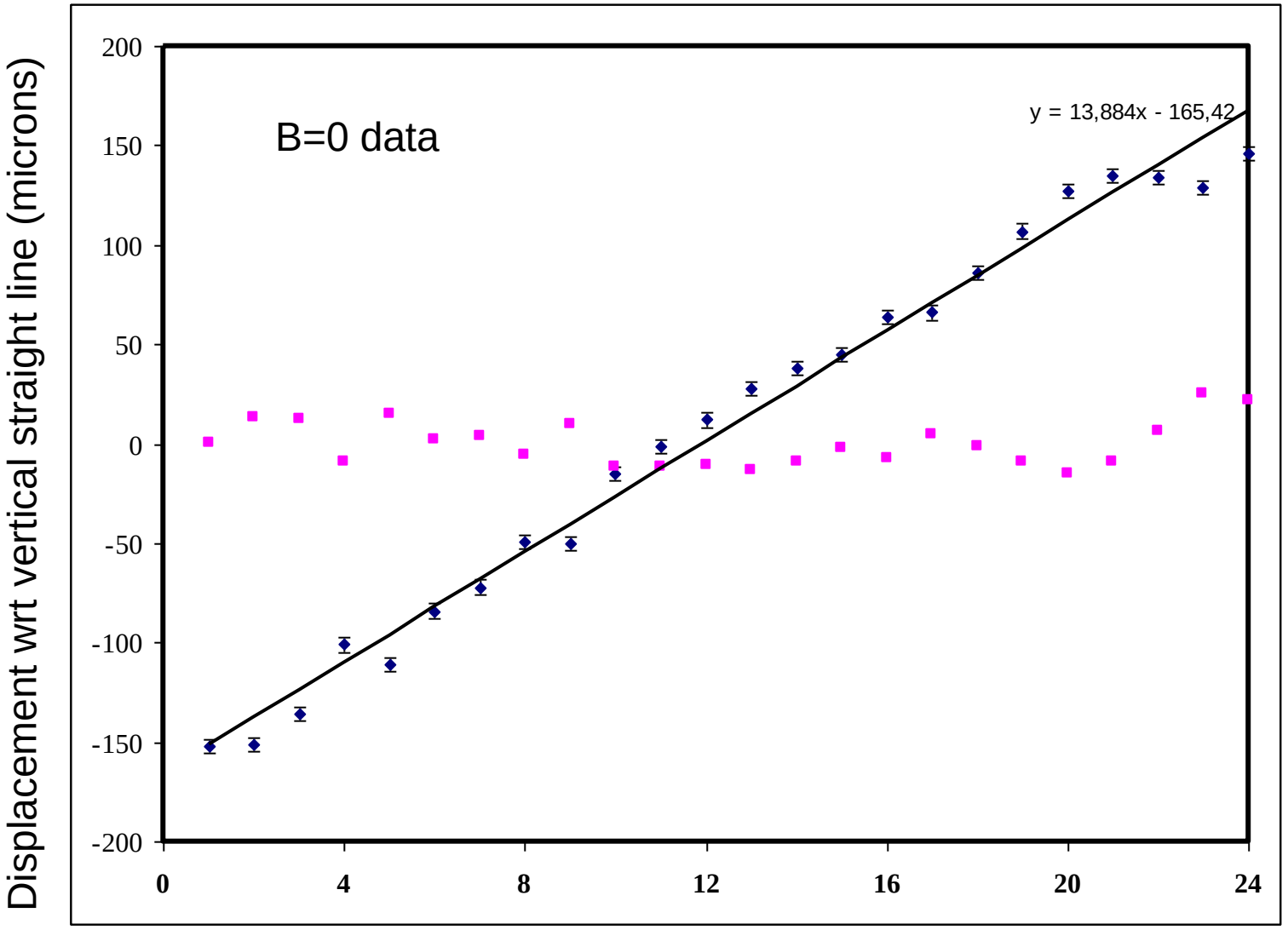


FIRST MICROMEGAS RESULTS

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





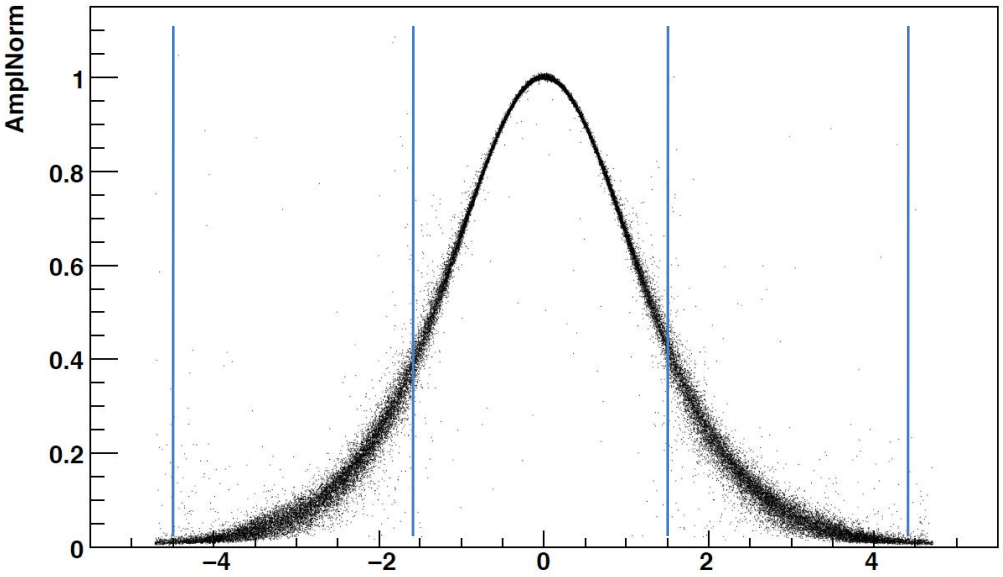
Rms displacement: 9 microns

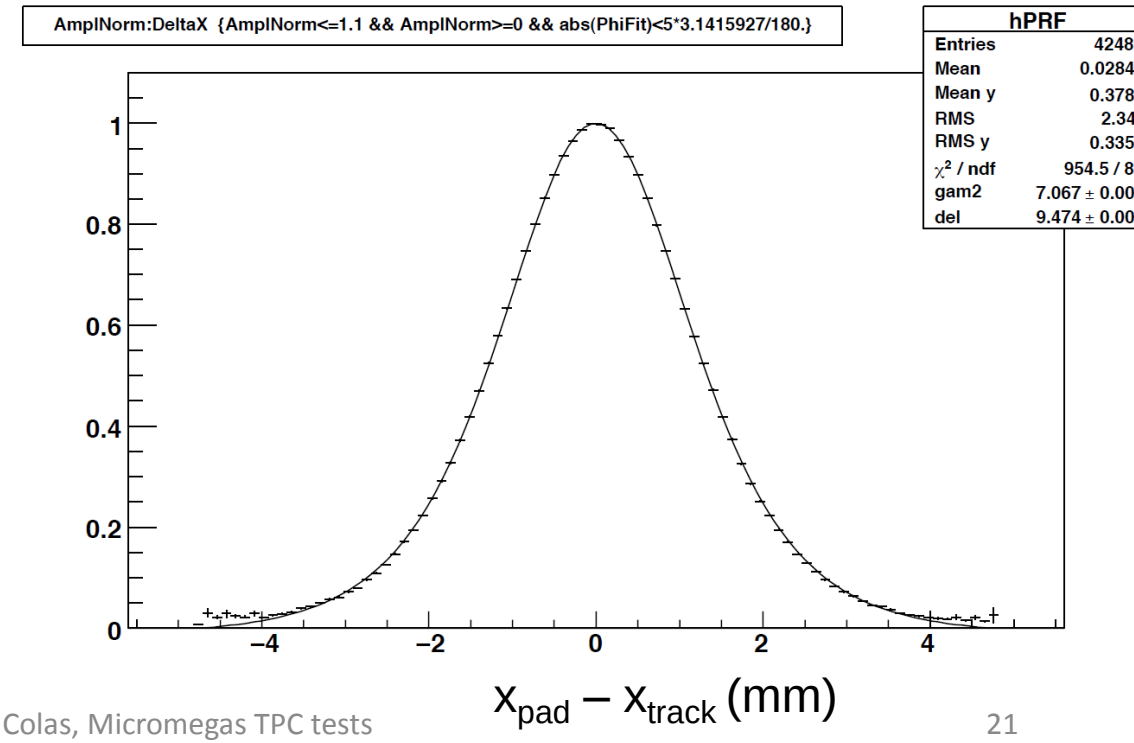
Determination of the Pad Response Function (B=1T beam data)

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

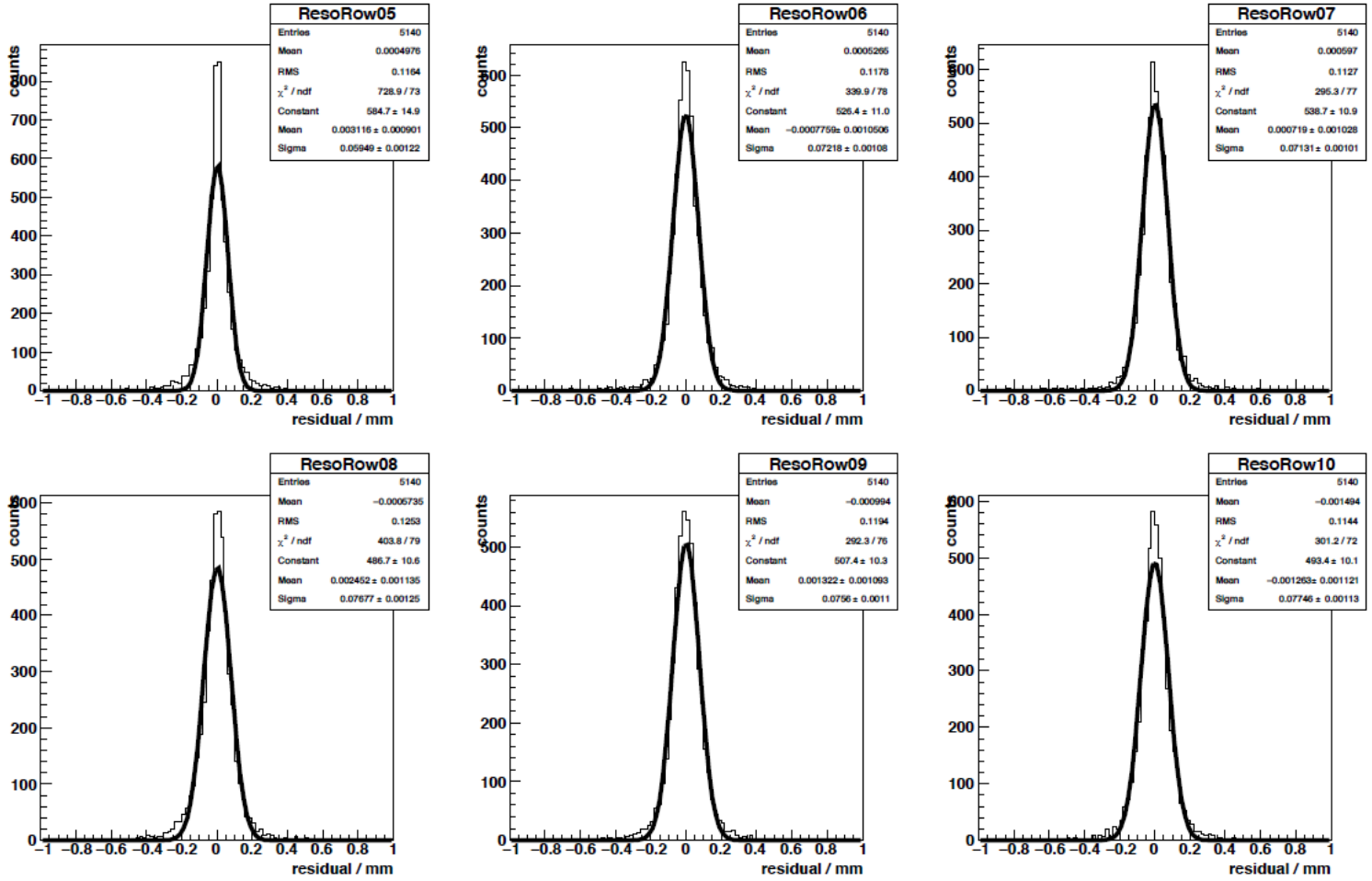
Clearly shows charge spreading over 2-3 pads (use data with 500 ns shaping)

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



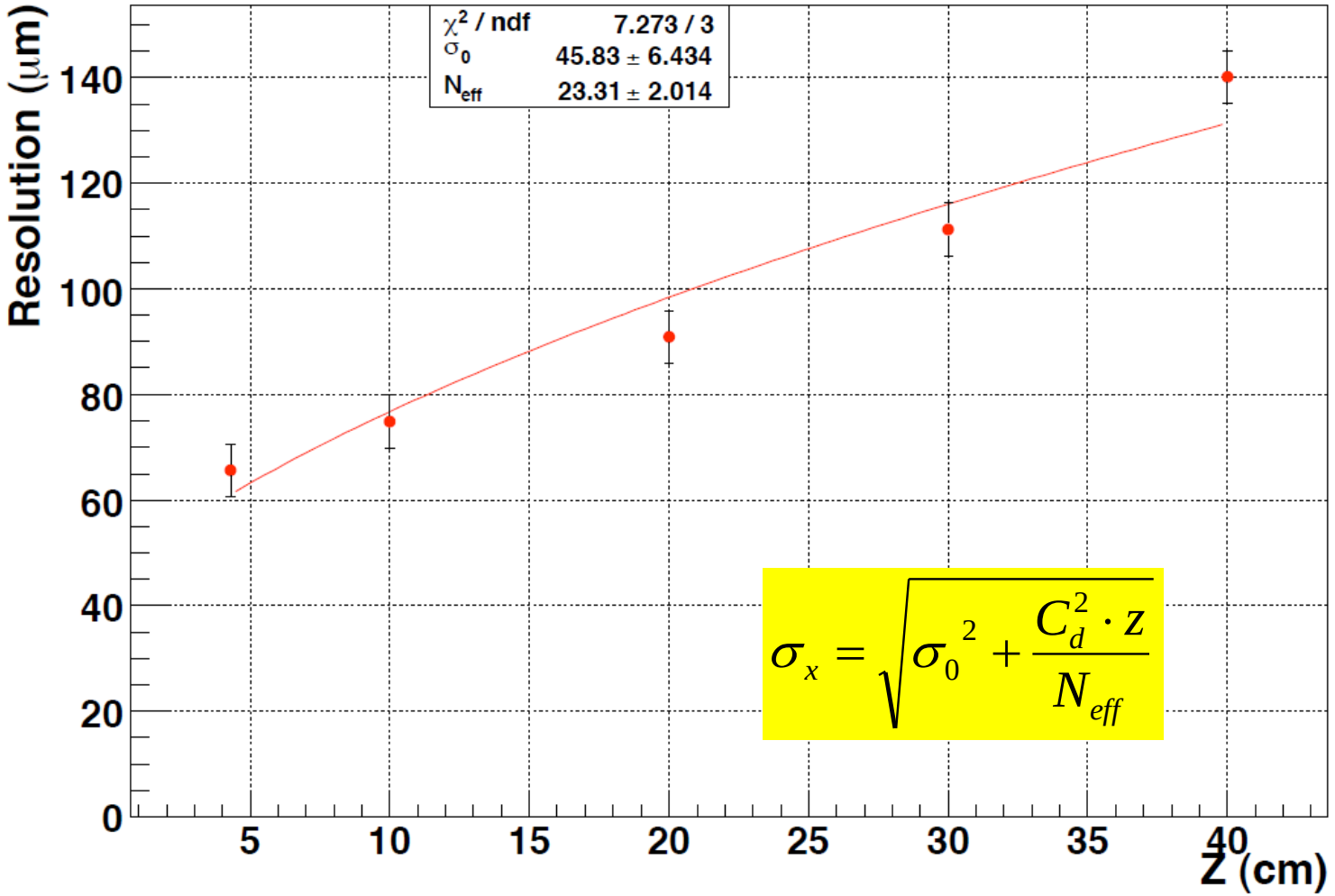


RESIDUALS (z=10 cm)



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



$$\sigma_x = \sqrt{\sigma_0^{\,2} + \frac{C_d^2 \cdot z}{N_{eff}}}$$

Resolution 46±6 microns with 2.7-3.2 mm pads
Effective number of electrons 23.3±3.0 consistent with expectations

FCPPL ACHIEVEMENTS (2008) AND PROJECTS (2009)

FCPPL REPORT FOR 2008

ID: Title	*TPCHEP*: TPCs for High Energy Physics					
Project Leaders	French Group			X Group		
	Name	Title	Affiliation	Name	Title	Affiliation
	P. Colas	Dr	Irfu	Yulan Li	Prof	Tsinghua
				Zhang Xiaodong	Prof	Lanzhou

Funding from France				
Description	Euro/unit	Nb of units	Total (euros)	Provided by: *
Visit to Lanzhou P. Colas	700		700	CEA/Irfu
TPC school in Tsinghua P. Colas	1600		1600	CEA/Irfu
TPC school student Chefdeville	1600		1600	CEA/Irfu
Total			3900	

Funding from China				
Description	Yuan/Unit	Nb of units	Total (Yuan)	Provided by: **
Visit to EUDET test stand Oct 2008 Yulan Li	17000	1 travel	17000	Tsinghua
Visit to EUDET test stand Oct 2008 Jin Li	17000	1 travel	17000	Tsinghua
Visit to Paris RD51 Oct 2008 X. Zhang	520 Euro	1 travel	520 Euro	TU Munich
Total			34000	

TPC school at Tsinghua (January 2008)

+ meeting at Dresden and DESY
with Li Yulan and Li Jin

Yuanning Gao

Yulan Li

Max Chefdeville

Paul Colas

Micro-**P**attern **G**aseous **D**etectors

RD51

Consortium to share knowledge and resources for MPGD R&D

50 institutes (of which Lanzhou U. and USTC Hefei, **Tsinghua expected**).

2 collab. meetings per year, many collaborative activities:
- Beam tests at CERN (oct. 2009)
- Hands-on sessions for GEM and mM
- collaboration on gas and E-field simulation software
- development of user-ready electronics and DAQ
- bulk order of materials

Prof. Zhang Xiaodong from Lanzhou visiting Rui de Oliveira's MPGD workshop at CERN (Jan. 2009)

PLANS FOR 2009

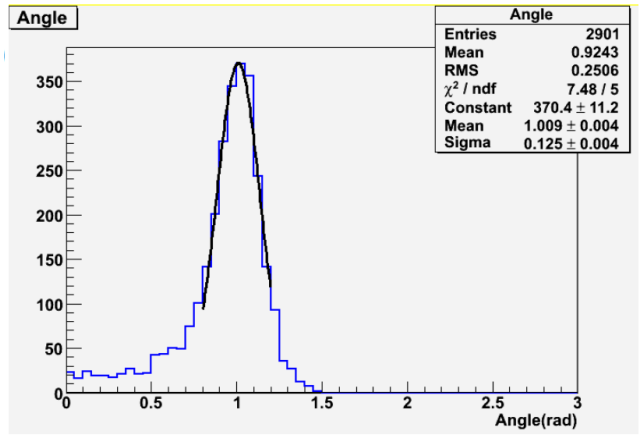
ID: Title	TPCHEP: TPCs for High Energy Physics					
Members	French Group			Chinese Group		
	Name	Title	Affiliation	Name	Title	Affiliation
	Leader P. Colas	Dr.	Irfu	Leader: Yulan. Li X. Zhang	Prof. Prof.	Tsinghua Lanzhou
	D. Attié	Dr	Irfu	Jin Li	Prof.	IHEP&Tsinghua
	M. Zito	Dr	Irfu	Bo Li Ting Li	Student	Tsinghua
	A. Giganon	Mr	Irfu	Hu Bitao	Prof.	Lanzhou
	I. Giomataris	Dr	Irfu	Zhang Yi	Prof.	Lanzhou
	F. Pierre	Dr	Irfu	Wang Wenxin	Student	Lanzhou

Funding from France				
Description	Euro/unit	Nb of units	Total (euros)	Requested to: *
3 visits to China	2000	3	6000	CEA/irfu
Total			6000	

Funding from China				
Description	Yuan/Unit	Nb of units	Total (Yuan)	Requested to: **
Travel	10000	3 travel	30000	Tsinghua
Visit to France	1200/day	45 days	54000	
Meeting	15000	1	15000	Lanzhou University
Visit to France	1200/day + travel	15 days + 1 travel	21000	Lanzhou University
Total			120000	

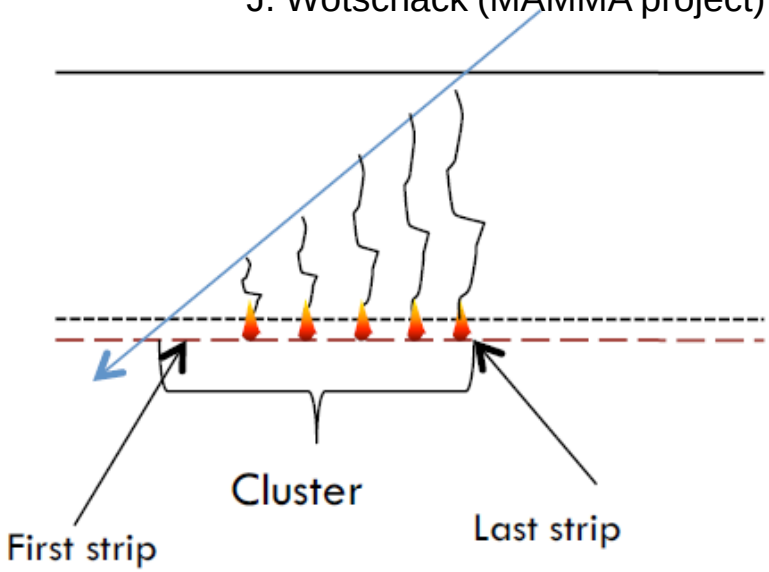
Continue data taking with Tsinghua at DESY and start soon collaborative analysis of beam test data (together with japanese and other LC-TPC members).

Welcome a Lanzhou student (Wenxin Wang) this summer for a PhD thesis in Saclay, at Orsay University, with a Chinese Governement grant, to work on '***Large-area Micromegas detectors for muon detection and calorimetry***' (i.e. forward muon chambers for ATLAS and DHCAL for ILC, with possible application in muon tomography).



ATLAS muon chambers as flat TPCs
Sensitivity to track angle for PT-dependent triggering

J. Wotschack (MAMMA project)



Prepare a proposal with Lanzhou, probably on fast-neutron radiography, using T2K 1728 channel electronics from Saclay and PCB by Lanzhou.
Simulations by Xiaodong Zhang have been presented at a RD51 meeting in January.

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Monte Carlo studies of micromegas as a neutron detector and its track reconstruction*

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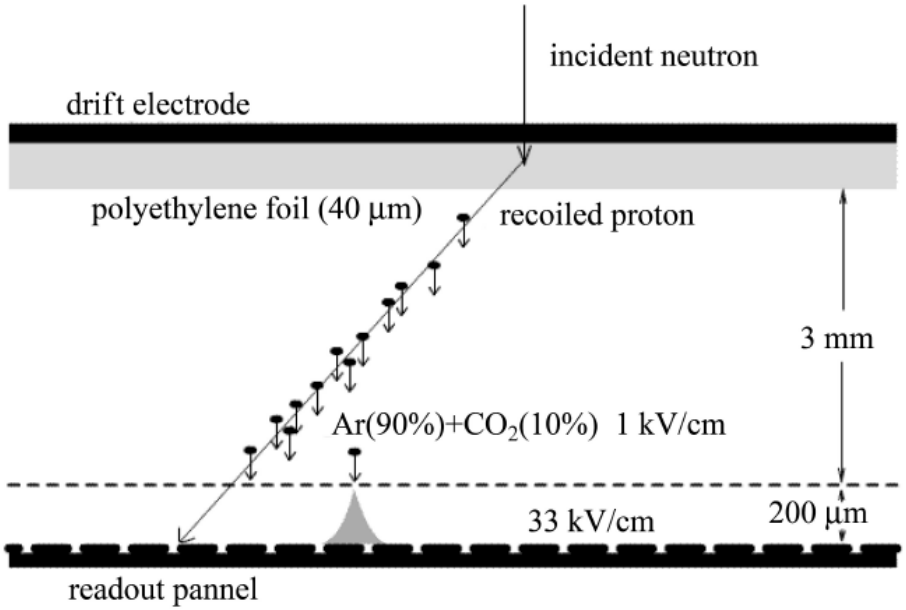
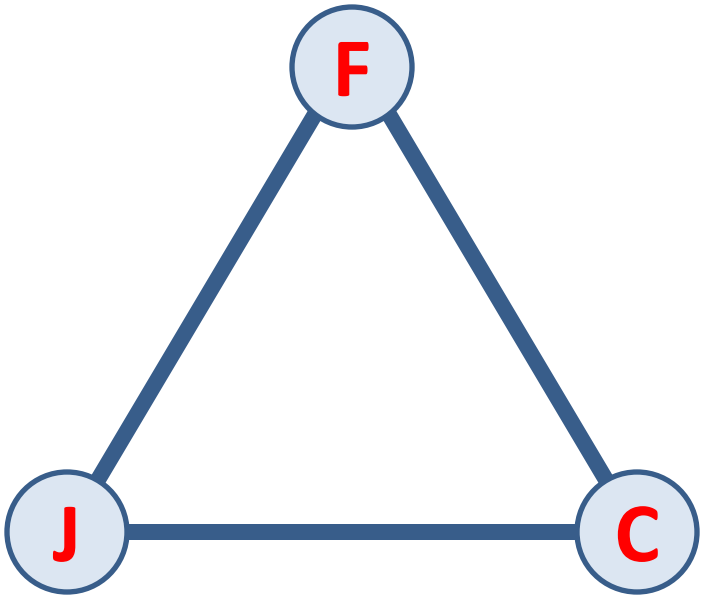
er a two dimensional readout micromegas detector with a polyethylene foil as converter .NT4 toolkit and GARFIELD for fast neutron detection. A new track reconstruction coincidence technology was developed in the simulation to obtain the incident neutron owed that with this reconstruction method higher spatial resolution was achieved.



Conclusions

- A lot has been done this year, even more is in view.
- FCJPPL and other bilateral agreements might be the building axes of a world laboratory



多谢