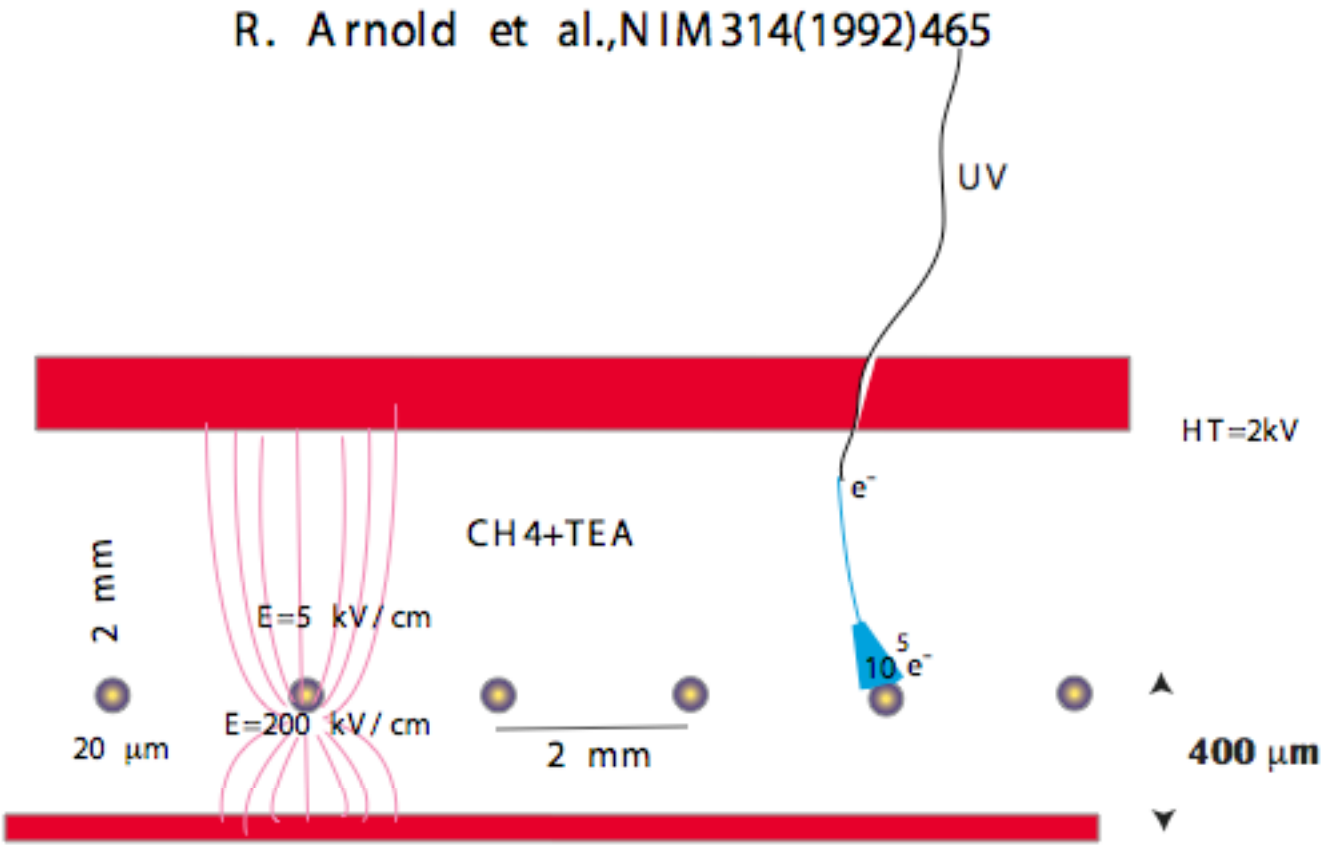
MicroMegas

I. Giomataris, DAPNIA-Saclay

- **History**
- **New developments**
- **New experiments**

Fast RICH project

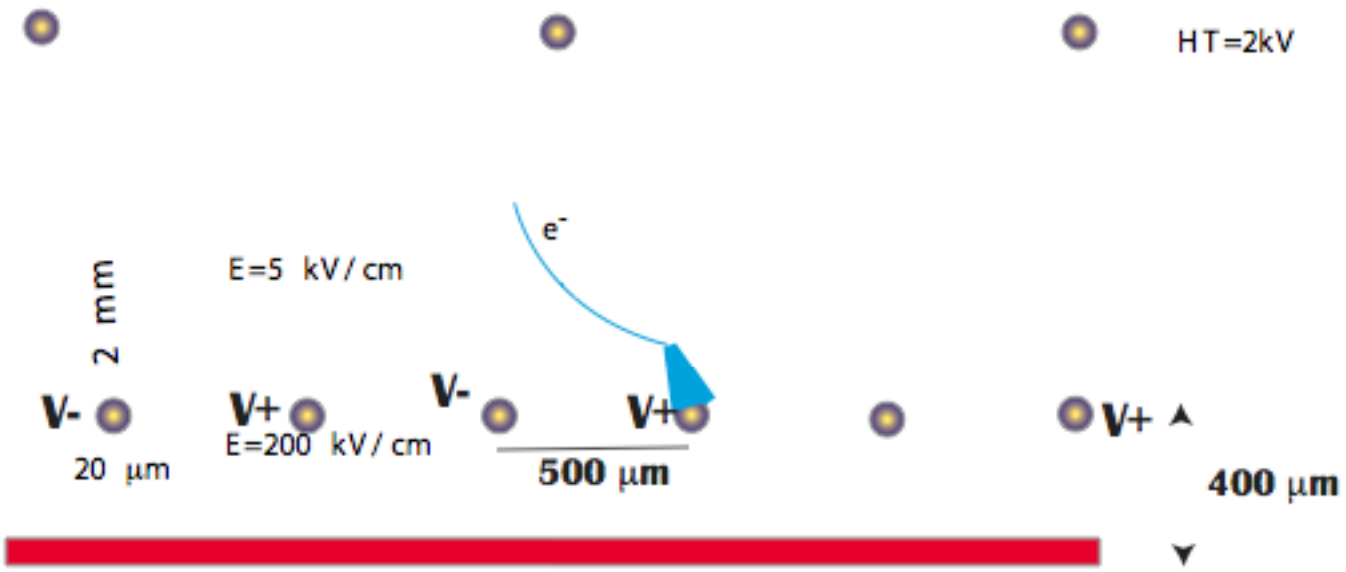
Fast-assymetric MWPC with pad read-out



Fishing line spacers have been used

Assymetric small gap MWPC

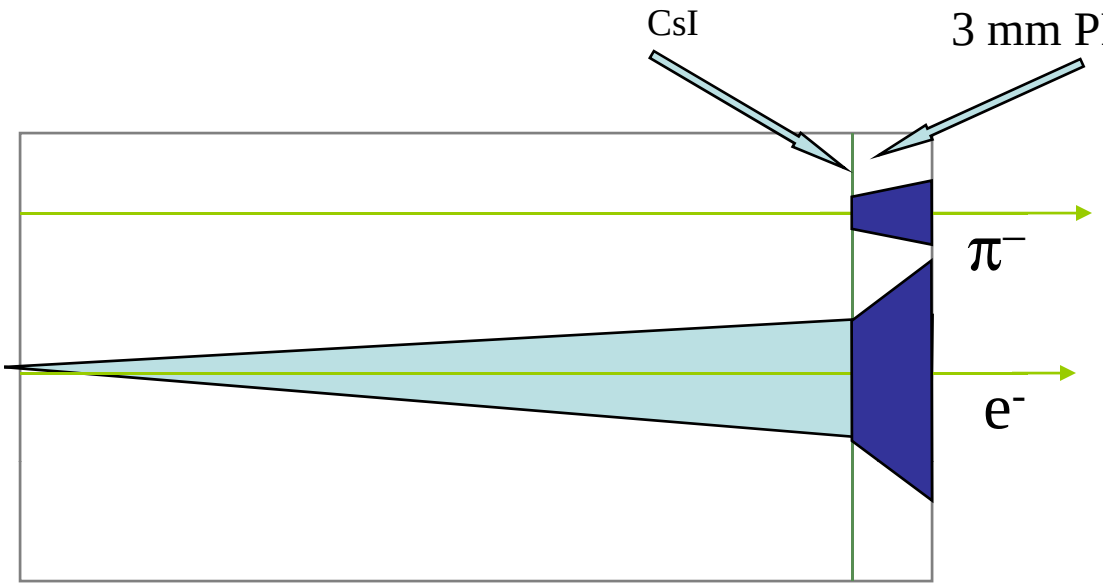
Georges Charpak, I. Crotty, Y. Giomataris, L. Ropelewski, M.C.S. Williams,
Nucl.Instrum.Meth.A346:506-509,1994.



High rate > 10^5/mm2/s

Scaling up?

Hadron Blind Detector(HBD) → Micromegas



Idea

I. Giomataris,G. Charpak, NIM A310(1991)589,
CF4 magic HBD gas
I.Giomataris,G.Charpak,V.Peskov,F.Sauli
Nucl.Instrum.Meth.A323:431-438,1992

HBD great result on 1992: N_0=500 and good signal to background ratio

M. Chen et al., Nucl.Instrum.Meth.A346:120-126,1994

HBD improvements

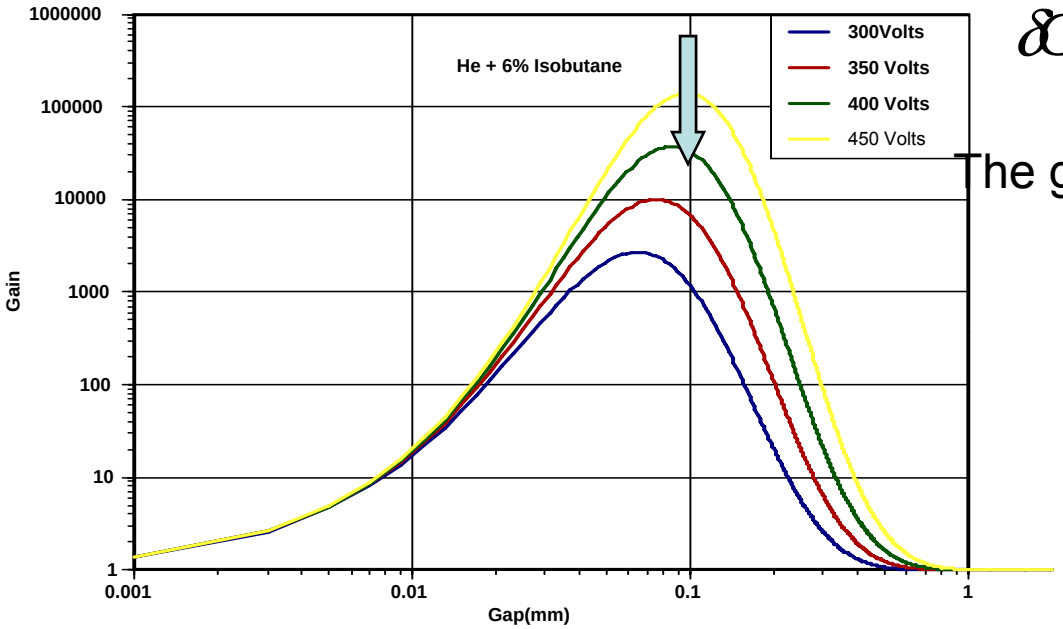
Very small PPAC gap:

1 mm gap sucessfully tested but no uniform gain

Micromegas is an ideal detector for HBD

Virtue of the small gap

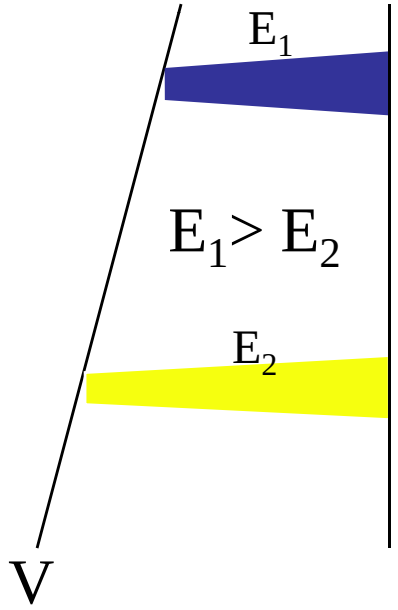
$$G = e^{\alpha d}$$



$$\delta G/G = apd(1 - Bpd/V) = apd(1 - Bp/E)$$

The gain variation exhibits a minimum for

d = V/Bp



Optimum gap : 30 - 100 microns

Ref: Y. Giomataris, NIM A419, p239 (1998)

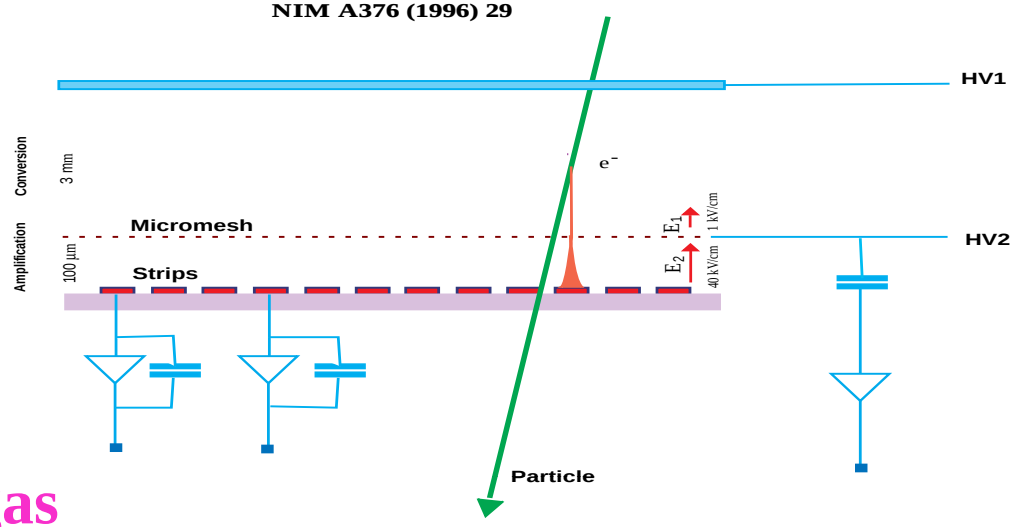
Stable gain and relative immunity to flatness defects or temperature and pressure variation

Good energy resolution

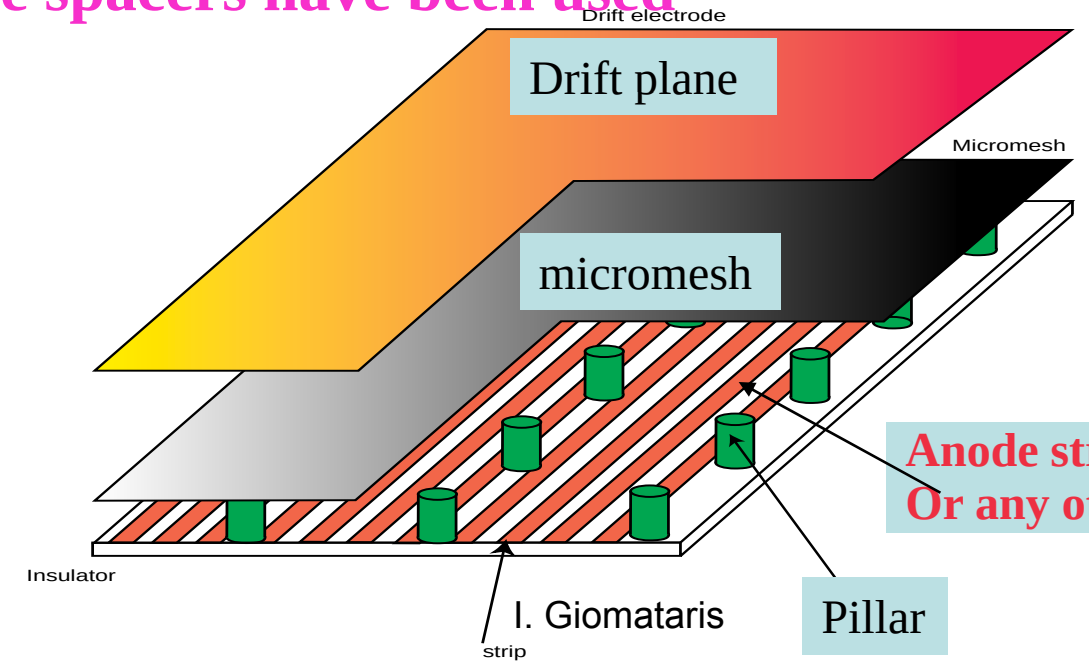
I. Giomataris

MICROMEGAS

Y.Giomataris, Ph. Rebourgeard, J.P Robert and G. Charpak
NIM A376 (1996) 29



In 1st Micromegas
Fishing line spacers have been used



Anode strips
Or any other readout structure

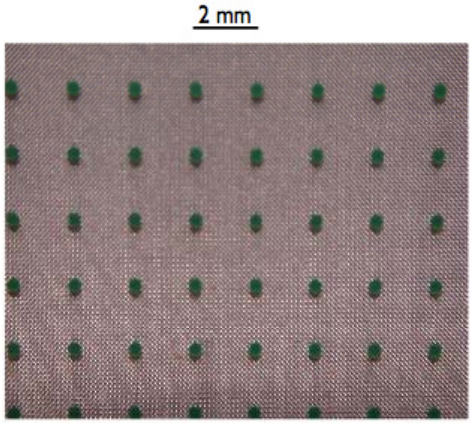
Bulk Micromegas

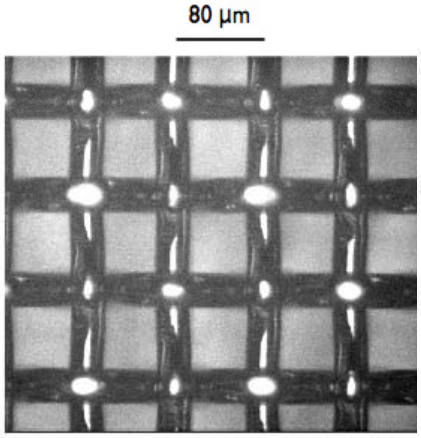
I. Giomataris et al., DAPNIA-2004
Nucl.Instrum.Meth.A560: 405-408,2006

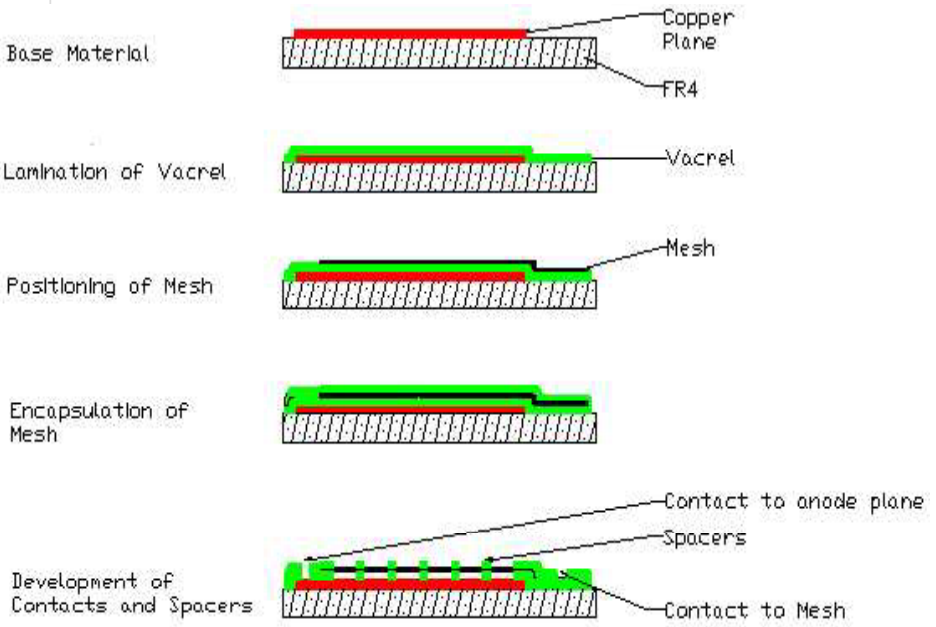
- **Large area and robustness**
- **Easy implementation**
- **Low cost**
- **Industrial process**

- Bulk Micromegas obtained by lamination of a woven grid on an anode with a photo-imageable film

« Bulk » : construction process





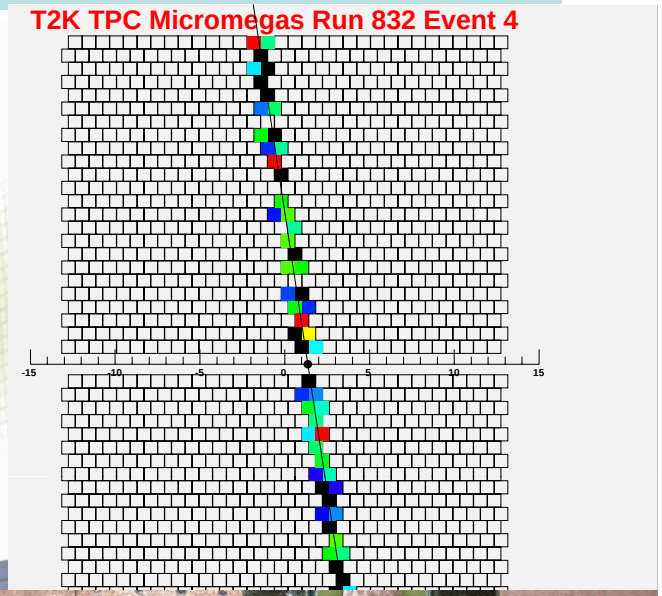


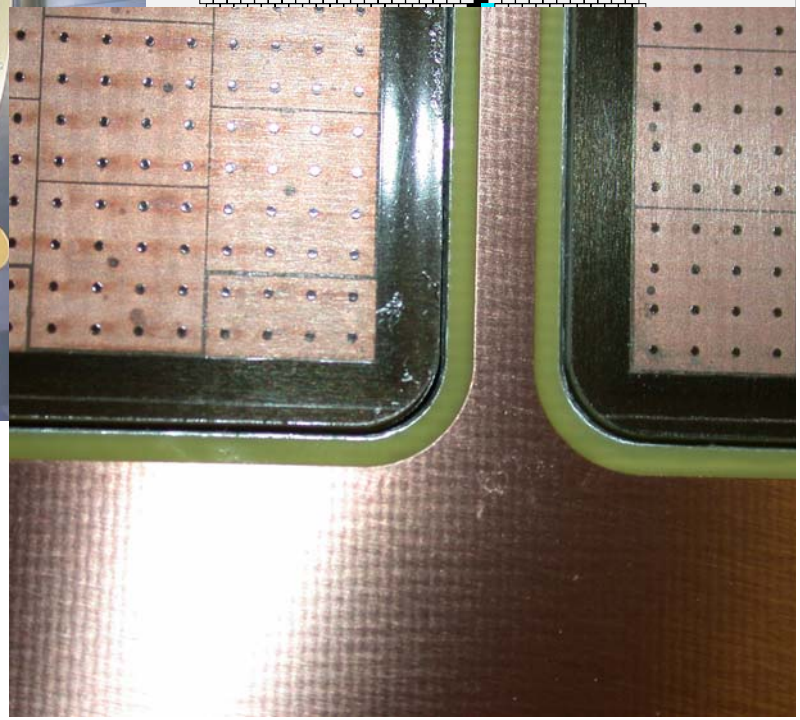
- **Low material detectors**
- **Goal : 5-10 lower of a standard silicon detector**

T2K Micromegas TPC project : about 12 m^2 detector surface

First test in CERN

J. Bouchez et al., Nucl.Instrum.Meth.A574:425-432,2007

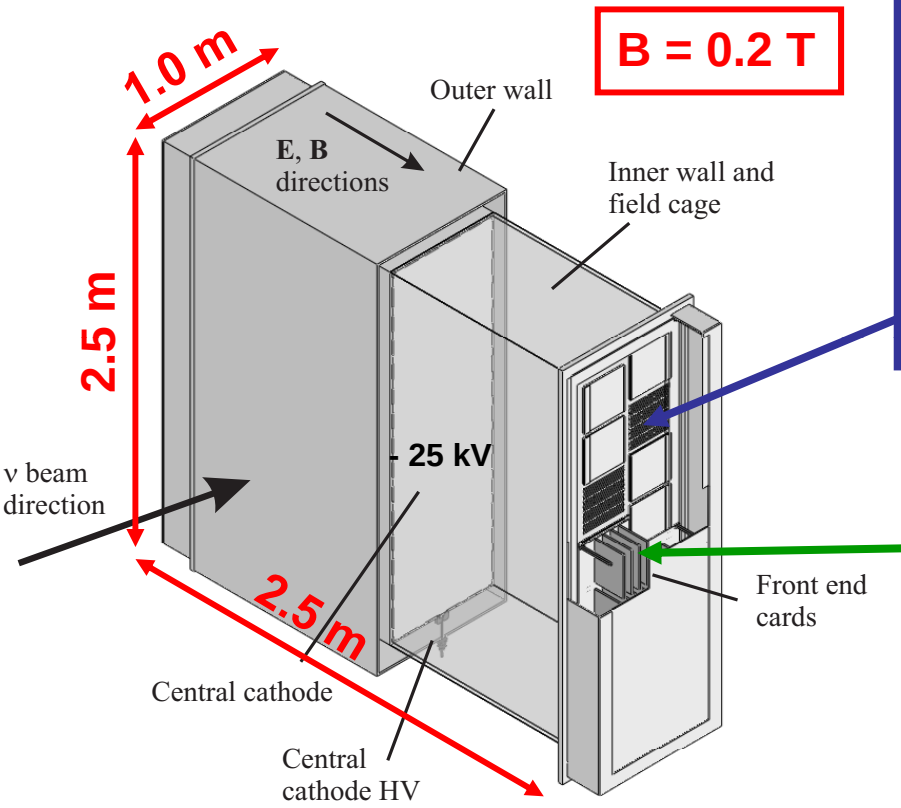




Inner surface covered by PCB for E-field termination

I. Giomataris

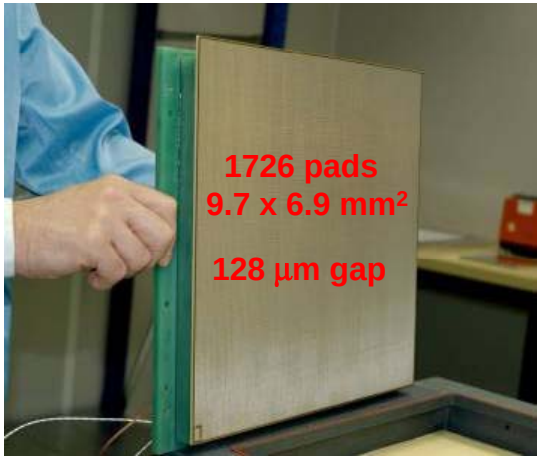
The T2K TPC



T2K requirements:

- σ(dE/dx) ≤ 10% for e,μ ID
- σ(p) / p < 10% @ 1GeV/c

36 x 34 cm² « Bulk » MicroMegas



2 x 6 modules per readout plane

Total of 72 modules

FEE based on the AFTER ASIC

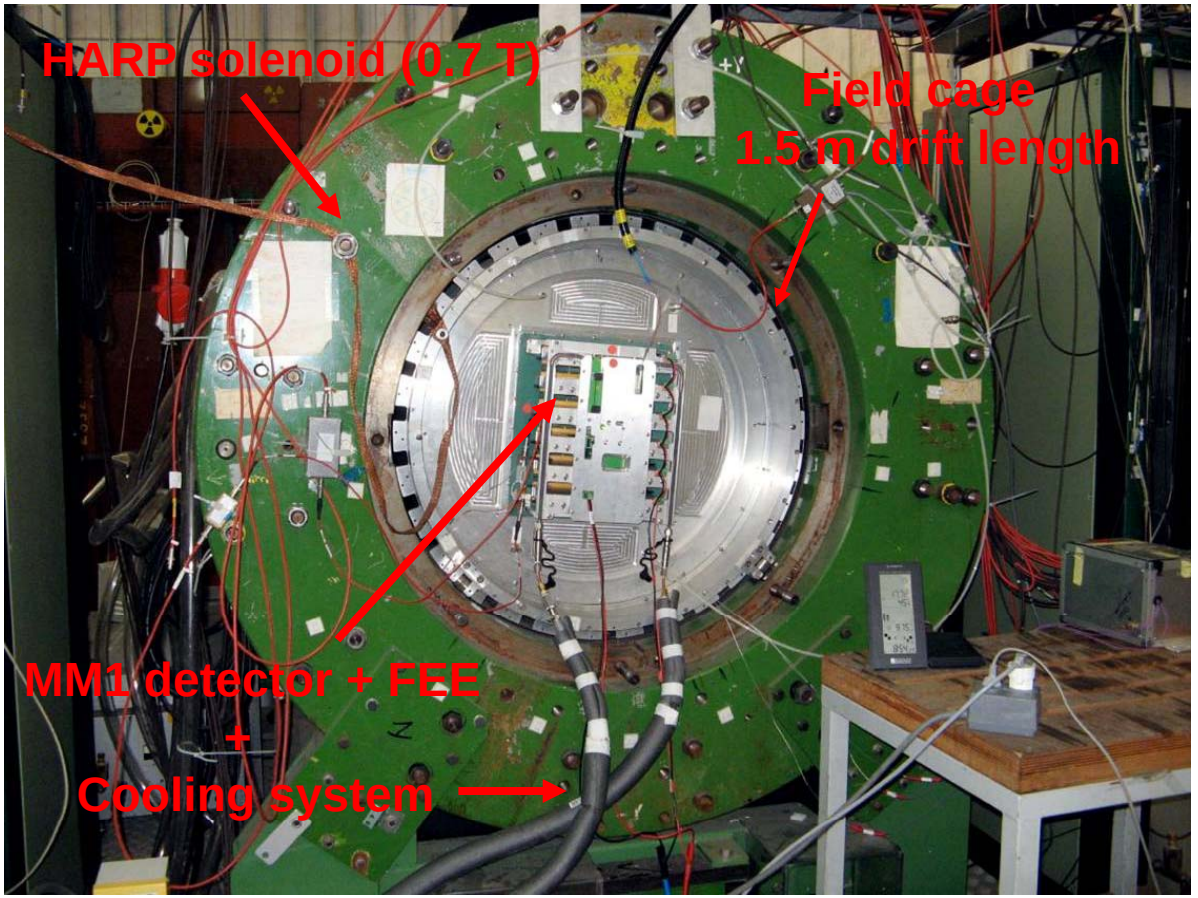
6 FECs + 1 FEM card per module
Total of 1728 ASICs

Successful test at CERN of a fully instrumented bulk-MicroMegas module

By T2K/TPC-Europe

Sep. 19th – Oct. 3rd 2007

Former HARP Field Cage

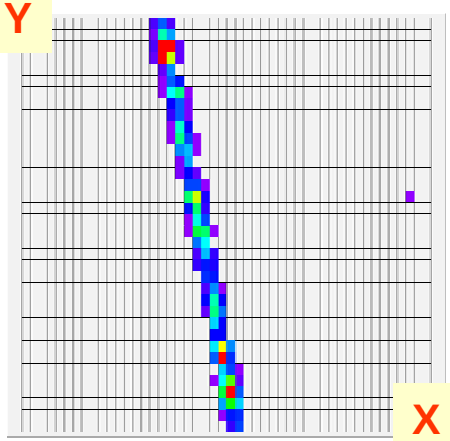


Bulk-MicroMegas prototype tests

Cosmic ray track

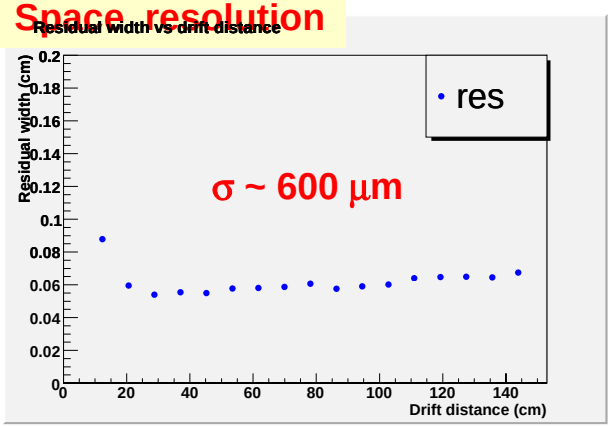
B=0.2 T

Y

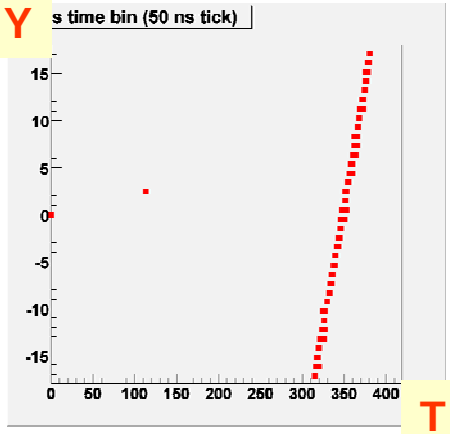


X

Space resolution

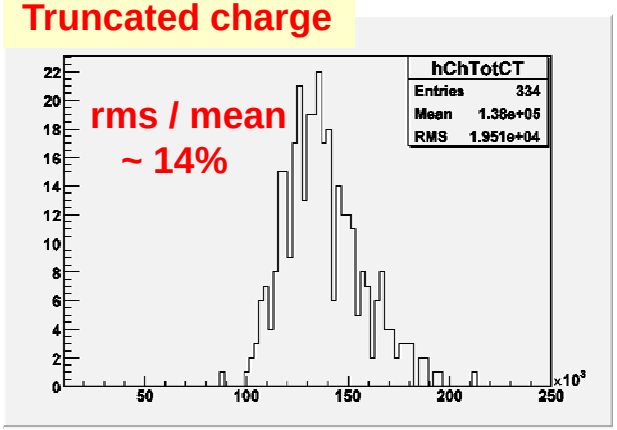


Y



T

Truncated charge



Expected resolutions for a 70 cm track in the T2K TPC for B=0.2T:

σ(p) / p < 8% @ 1GeV/c

σ(dE/dx) < 9%

⇒ TPC requirements are fulfilled

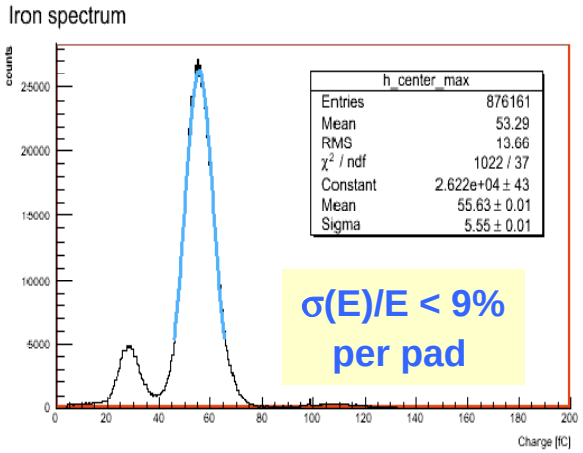
Bulk-MM

UniGe Test Bench

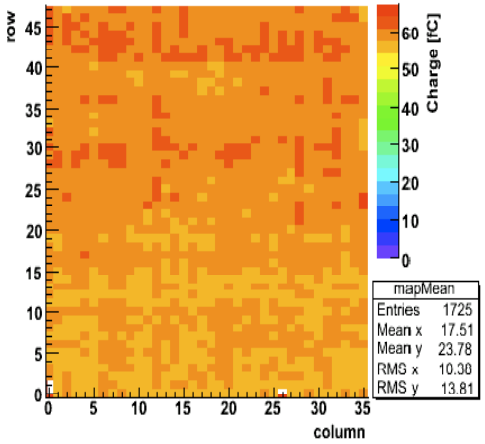
^{55}Fe source scan

M. Ravonel

Gain variation < 3%



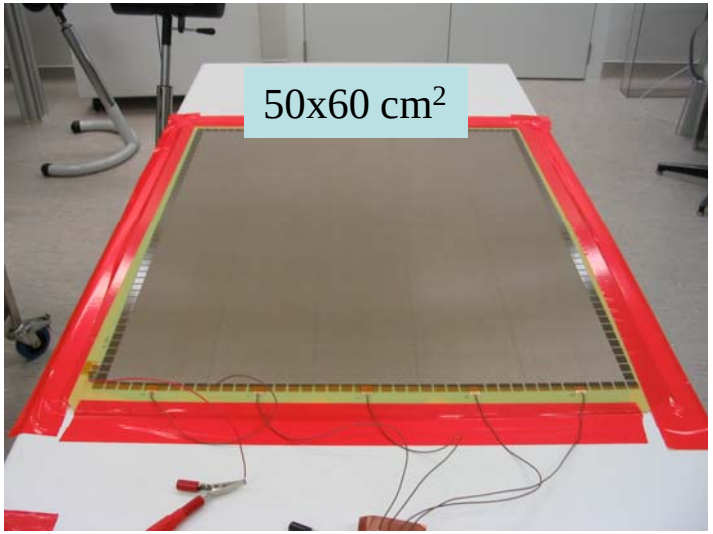
σ(E)/E < 9% per pad



- **Pre-production of MM modules satisfactory**
- **Production of final modules (8/month) is starting**
- **FEE production (AFTER ASICs) in course**
- **Test of 1st TPC (Module 0) at TRIUMF (Canada) this summer**

I. Giomataris

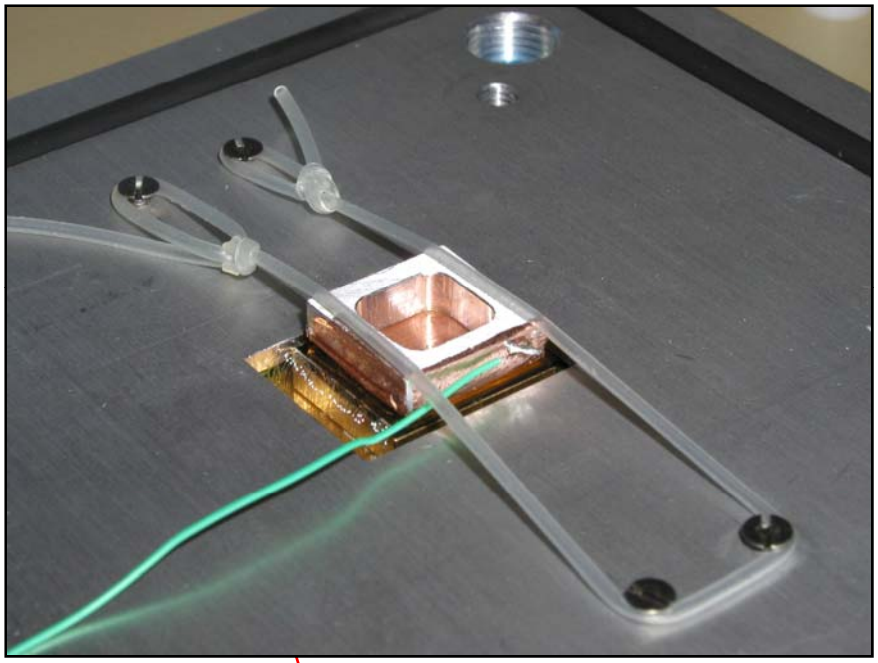
Towards Larger Micromegas

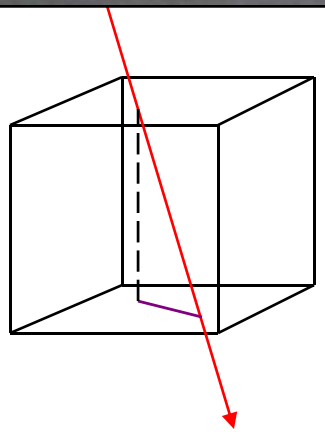


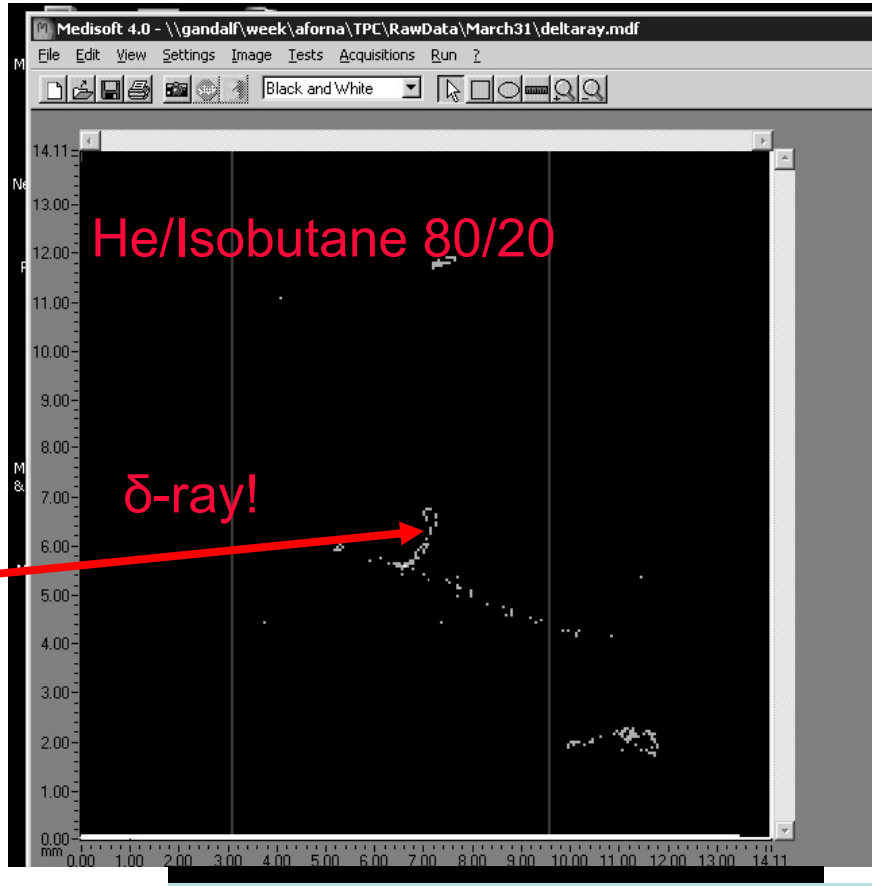
ATLAS-SPLC muon system,
V. Polychronakos, J., Wotschack et al.,
Goal : 2mx1m detectors
Details in P. Iengo talk

50x50 cm² under study for ILC-HCAL by Annecy-Lyon

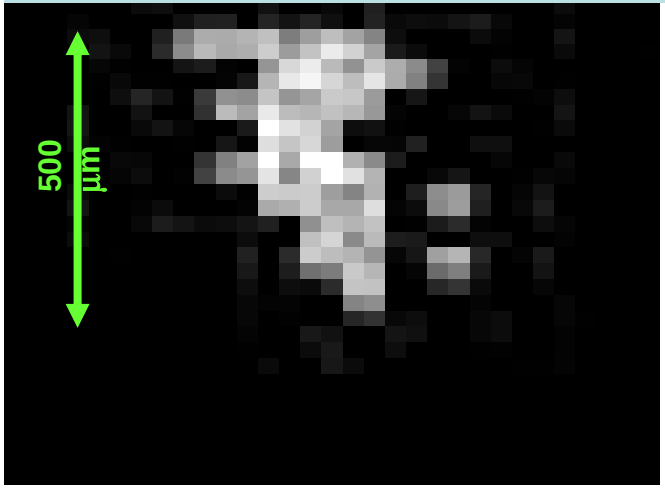
Medipix2 & Micromegas







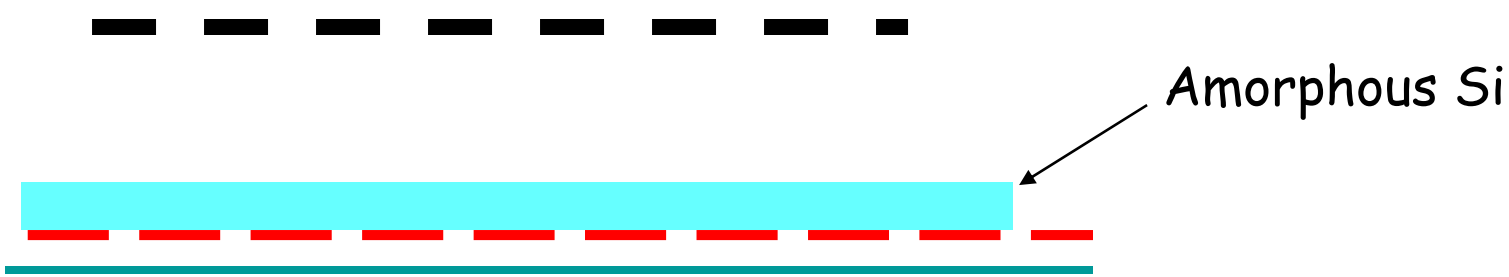
5.9 keV photoelectron in Argon



Efficiency for detecting single electrons:
> 90 %

I. Giomataris

Silicon Protection: SiProt



Empirical method:
Try RPC principle

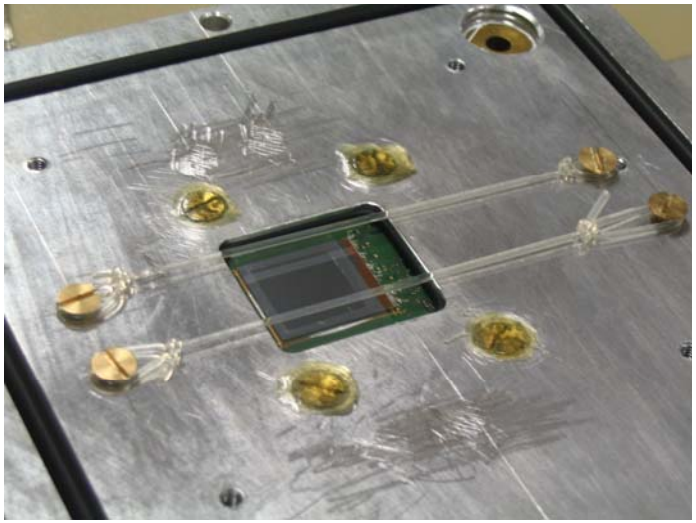
- prevents melting by plasma
- quenches discharge: reduced discharge current

Technology

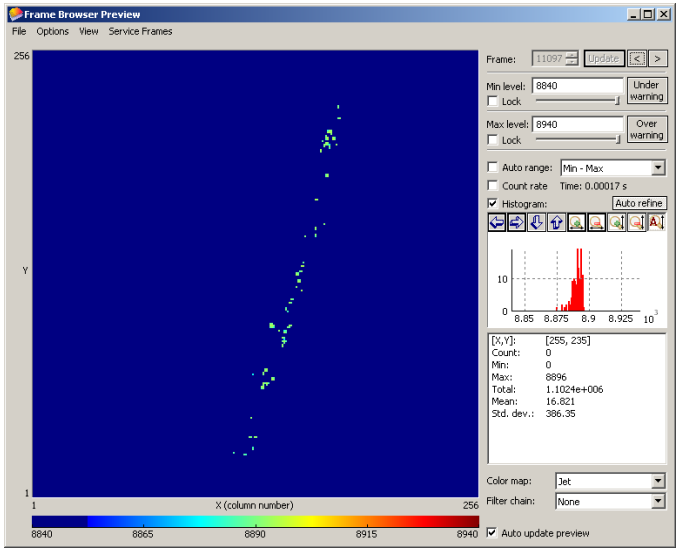
A-Si deposit: standard wafer post processing, but wafers may get too hot

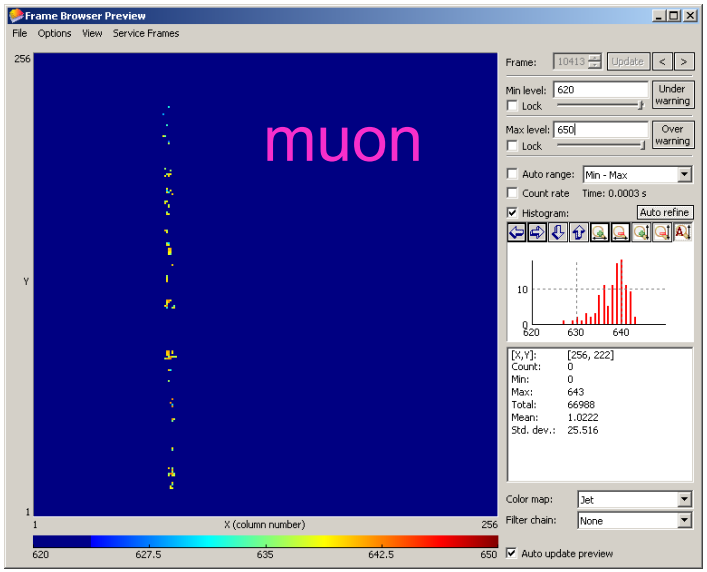
☺ Univ. of Neuchatel/IMT/P. Jarron (CERN) uses this for integrated X-ray sensor/convertor on MediPix 2

TIMEPIX + MICROMEGAS in Saclay, D. Attie, P. Colas et al.,



90Sr





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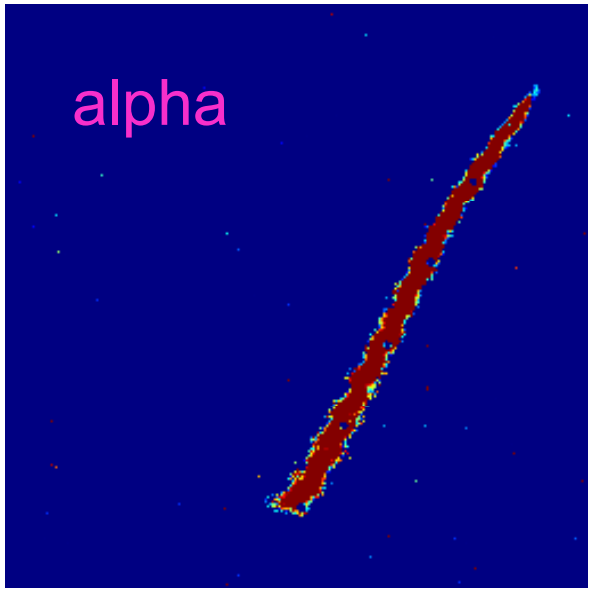
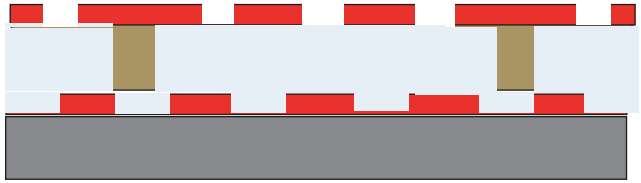
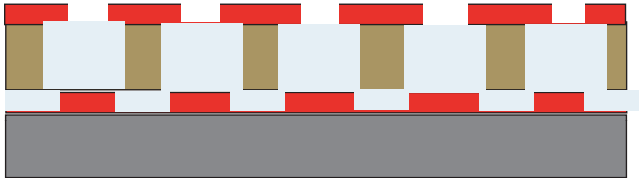
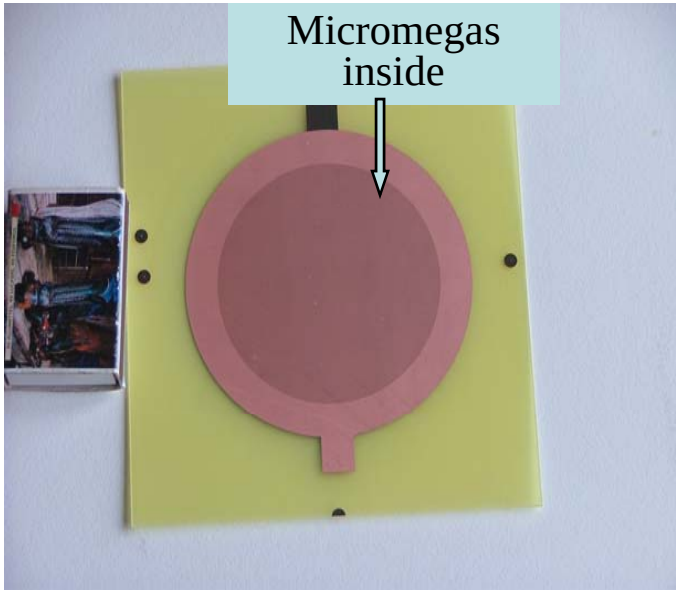


NEW Micro-Bulk,

I. Giomataris- R. De Oliveira idea

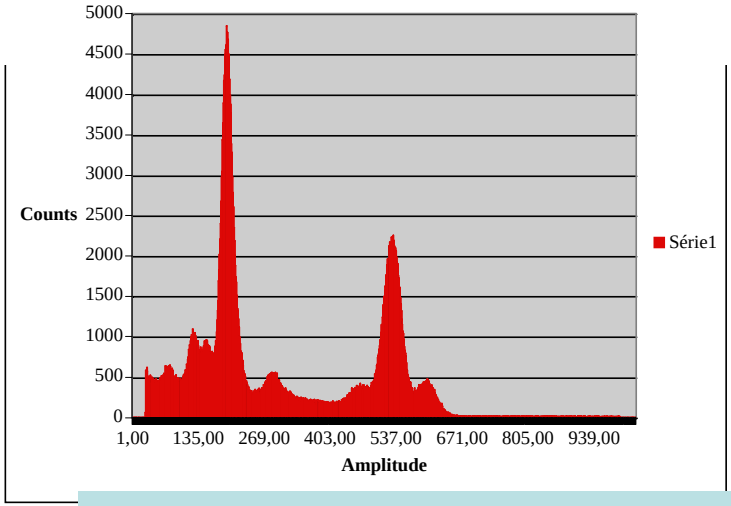






50 μm and 25 μm gaps fabricated

109Cd source



Very good energy resolution

-10.5% at 5.9 keV

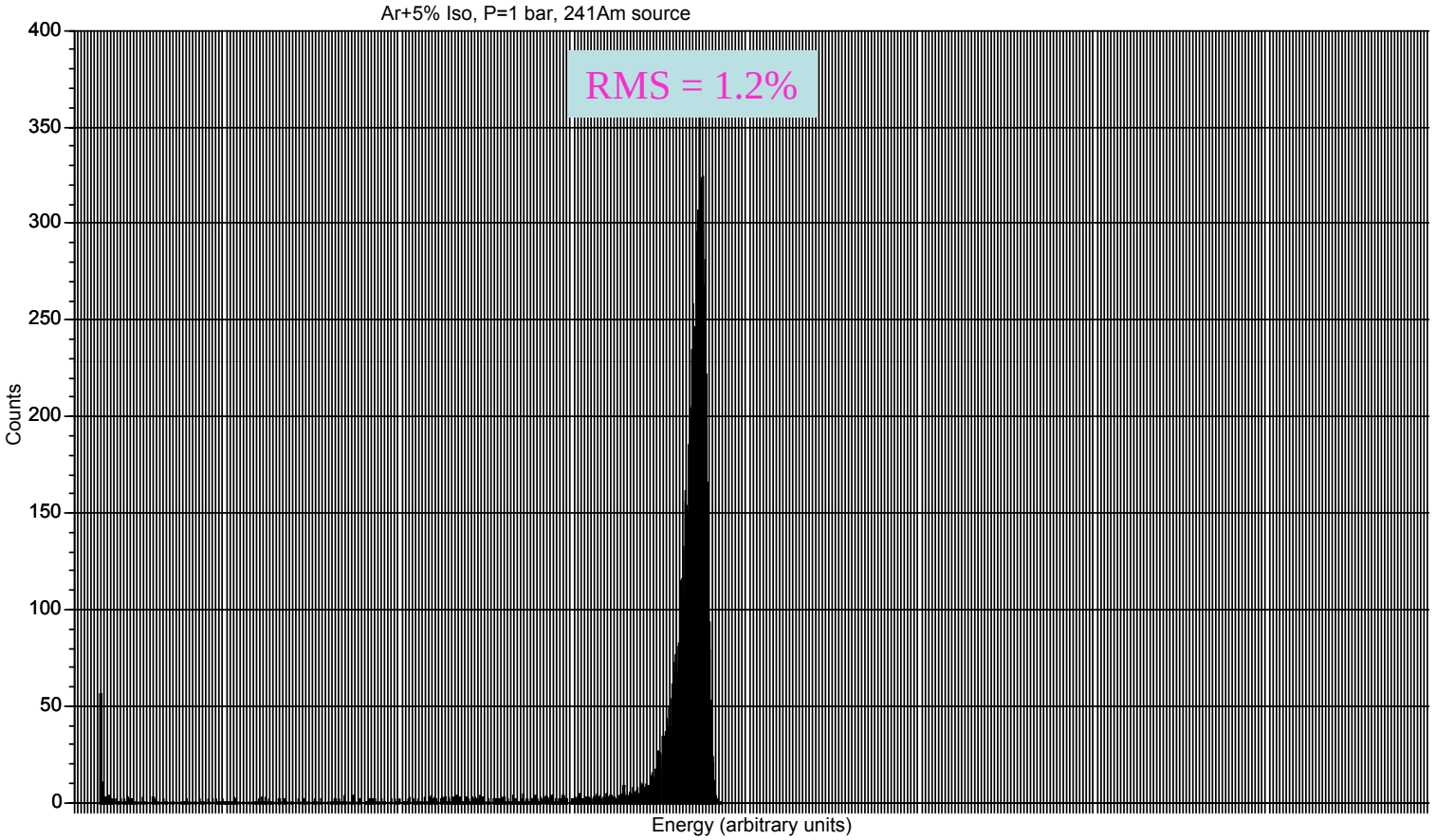
- 5.5% at 22 keV

- <1.5% with Am alpha source

We must measure resolution at higher pressure and Xenon mixtures

^{241}Am resolution in a small TPC with Micromegas read-out

Saclay, Saragoza,Ottawa collaboration

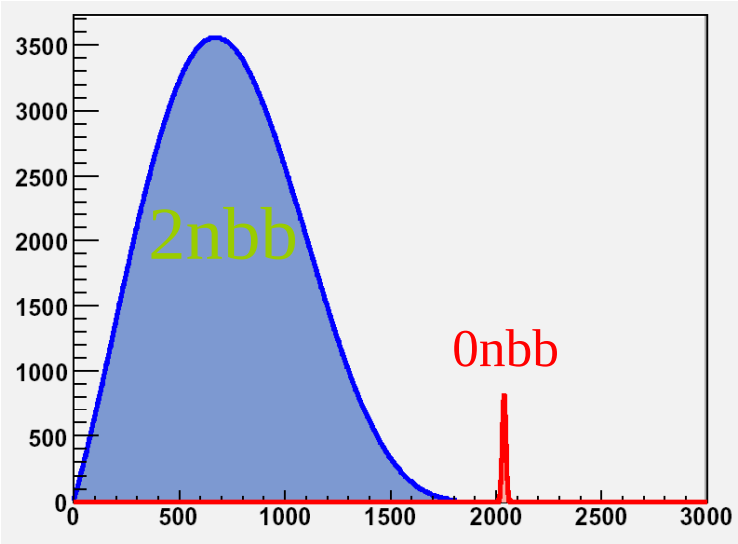


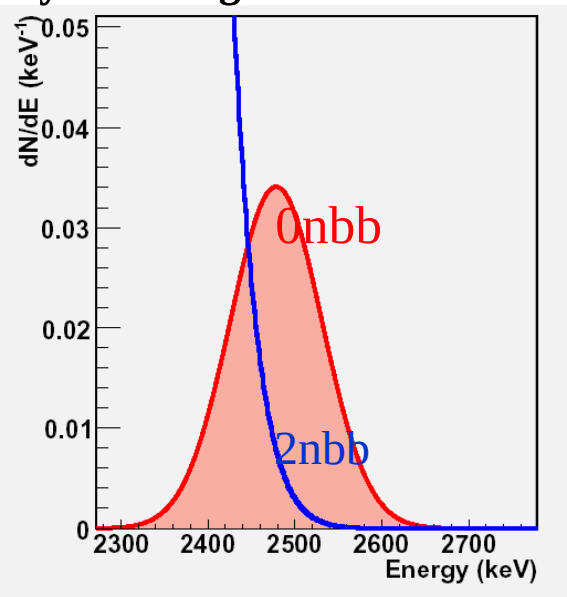
- **In Argon energy resolution was constant (RMS=1.2%) up to 4 bar**
- **We must measure it at higher pressure and in Xenon mixtures**

Hunting a high energy resolution in the MeV range is a must

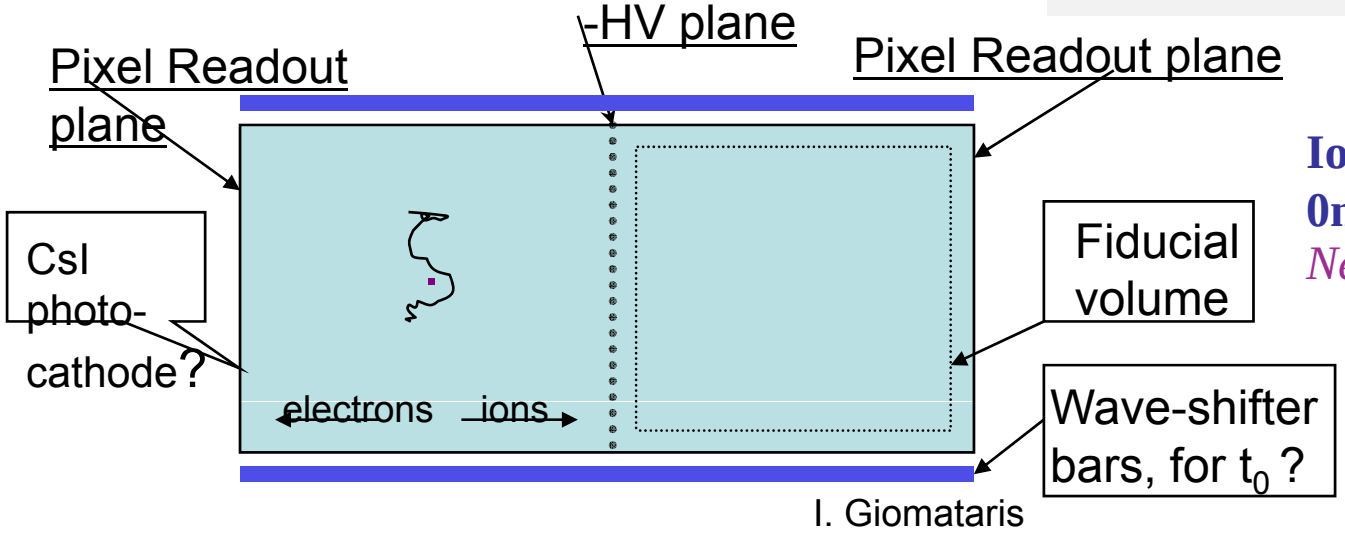
Neutrinoless Double Beta (0nbb) using ^{136}Xe target

- Energy resolution very important. **Only way to distinguish between both processes**





Q value



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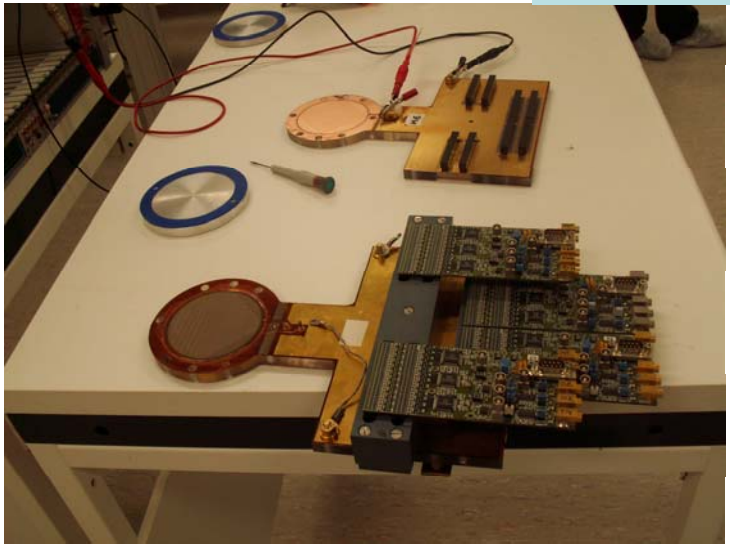
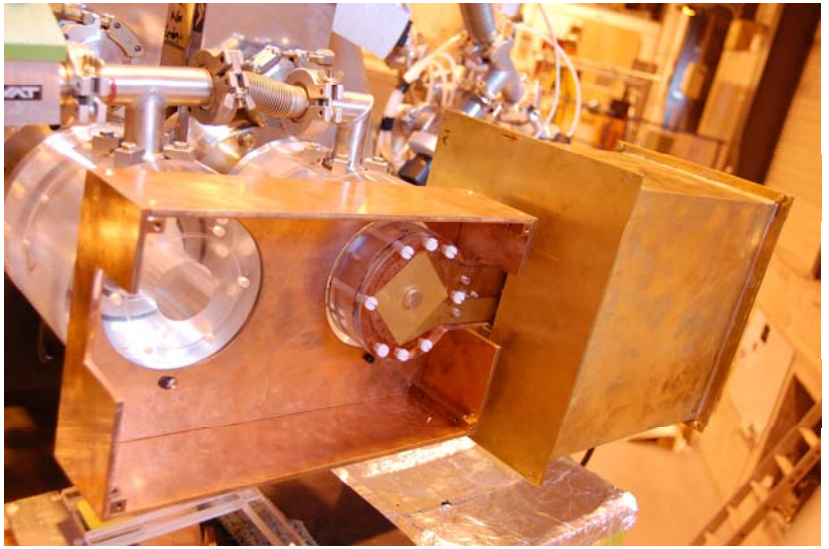
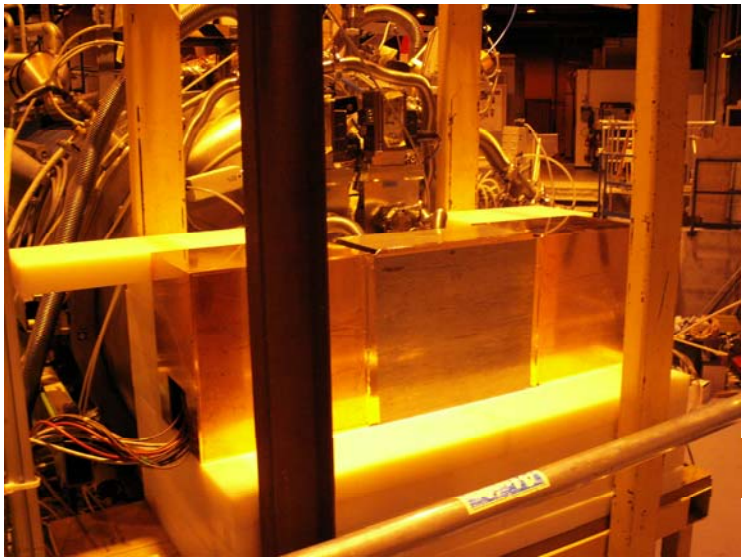
Ionisation chamber for 0nbb in ^{136}Xe,

New idea, by D. Nygren

Micro-bulk installed in CAST







I. Giomataris

NEW proposal

TPC-MICROMEGAS in BNL

Deuteron EDM at 10^{-29} e.cm

AGS Proposal: Search for a permanent electric dipole moment of the deuteron nucleus at the 10^{-29} e · cm level.
DRAFT 1

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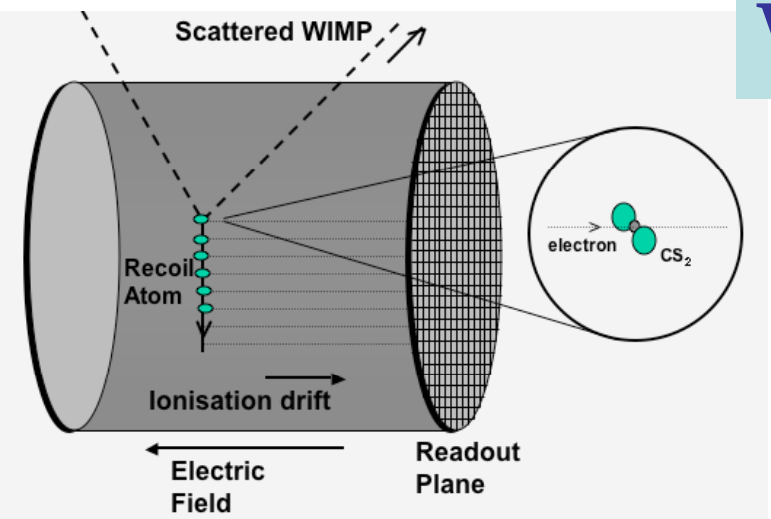
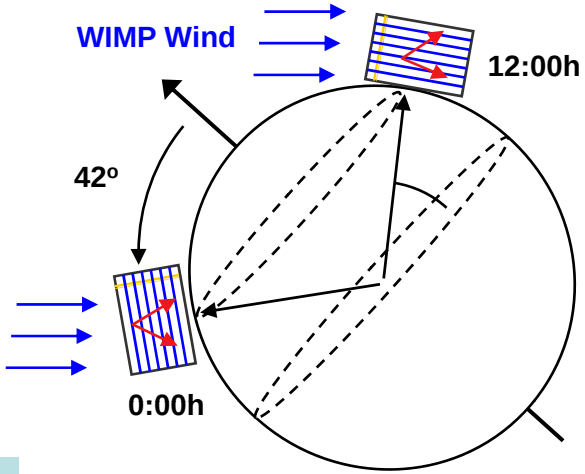
[16]Dipartimento di Fisica, Universita' "Tor Vergata" and Sezione INFN, Rome, Italy
[17]University and INFN Trieste, Italy [18]
[19]University and INFN Pisa, Italy
[20]Boston Medical School
[21]University of Patras, Greece
[22]Institute of Nuclear Physics Dimokritos, Greece
[23]Saclay/Paris, France

WIMP directional TPCs



DRIFT PROJECT, *N. Spooner et al.,*
GEM and Micromegas read-out studies



negative ion drift with CS_2 idea by Jeff Martoff

MIMAC-He3
MIcro-tpc Matrix of Chambers of He3

A new ^{3}He detector for non-baryonic dark matter search

Micromegas read-out

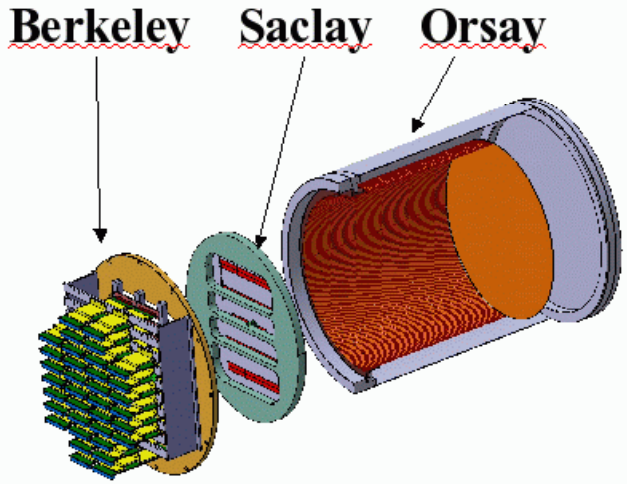
D. Santos et al.

Combination of TimePIX + MPGD could improve detector performance in both Solar axion and WIMP search

ILC TPC project

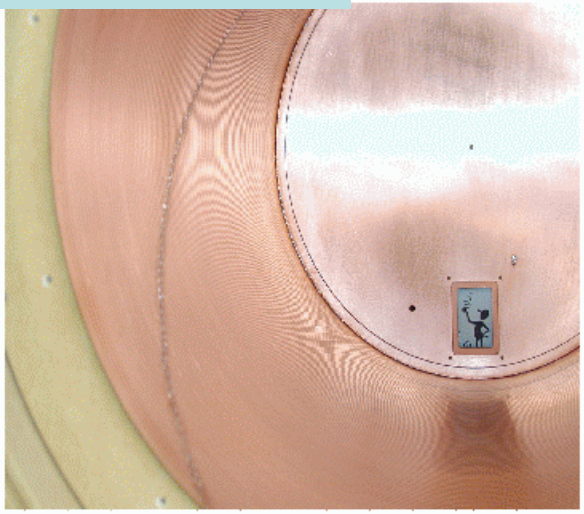
See P. Colas talk

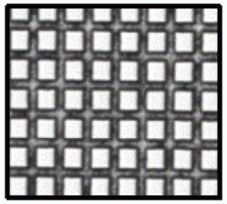
Chamber design and pad layout



Chamber

diameter 50 cm
length 50 cm

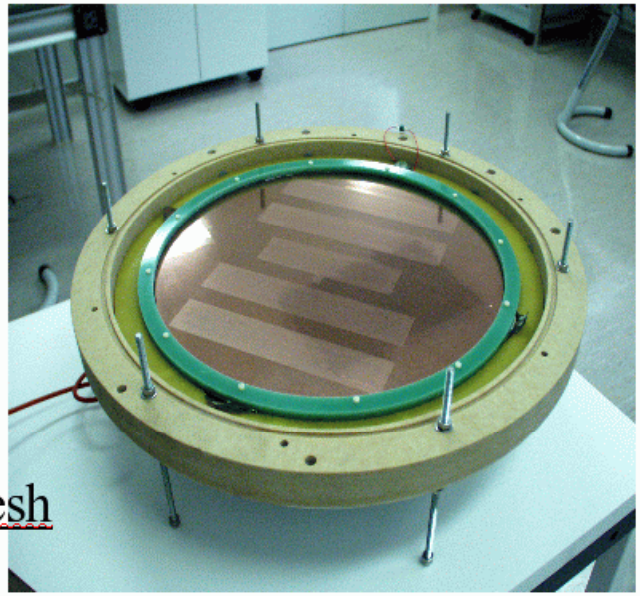




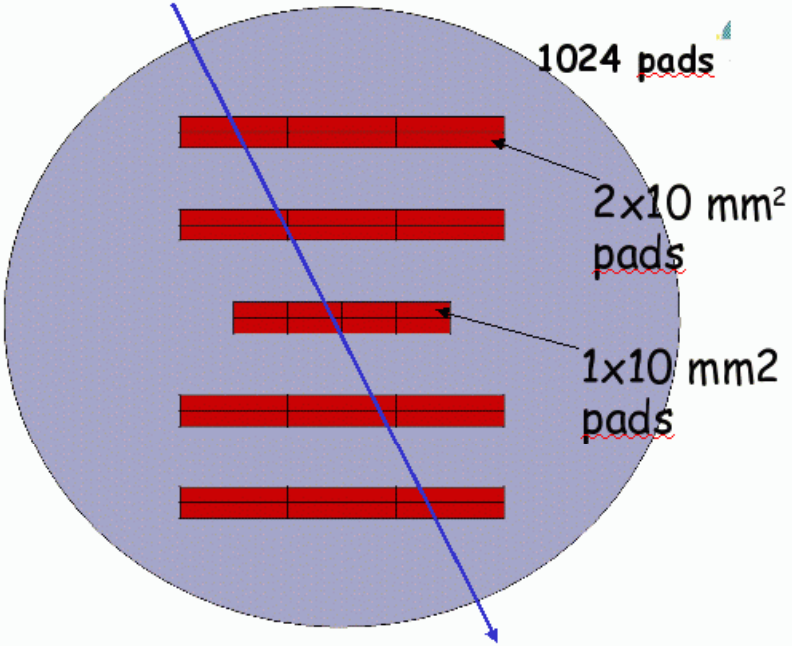
50 µm pitch

50 µm gap

Copper Mesh



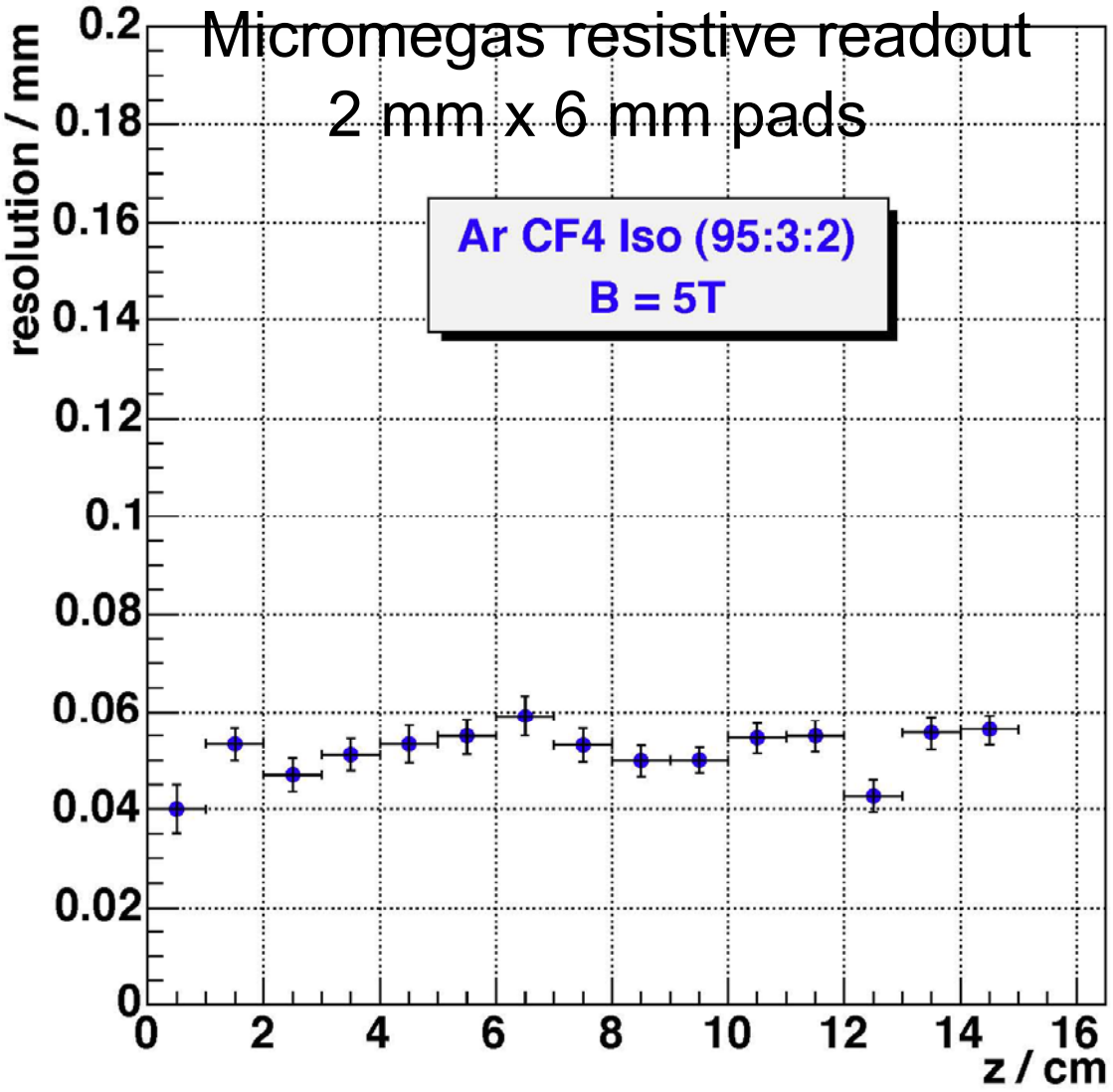
Readout anode pad plane



COSMo TPC - Transverse Resolution

B= 5 T D_T= 19 μm/√cm

M. Dixit et al., NIM581(2007)254-257



Cosmic ray tracks

~ 50 μm average

New

Micromegas for CERN n_TOF Ph2

Neutron beam monitor

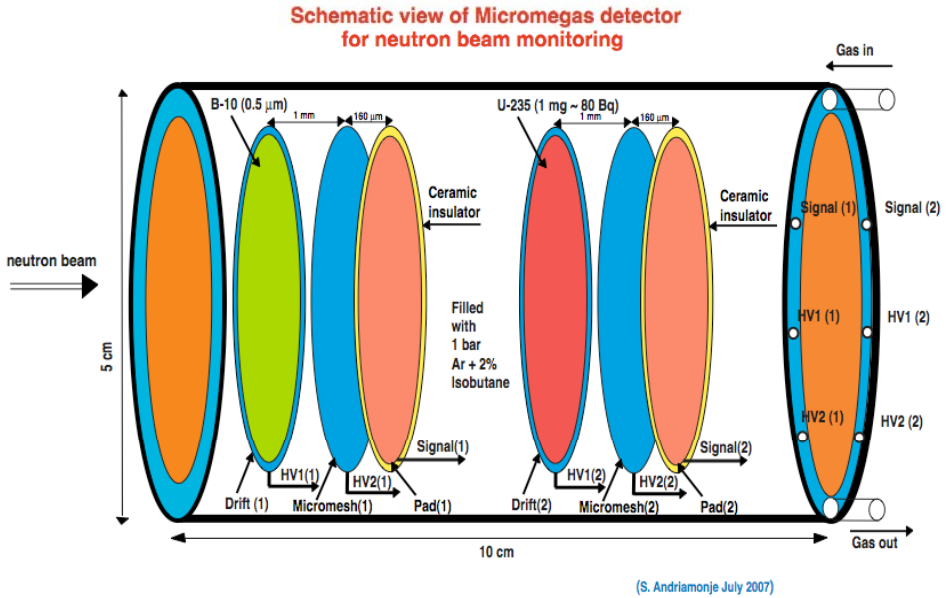
Two Micromegas detectors equipped with very thin material

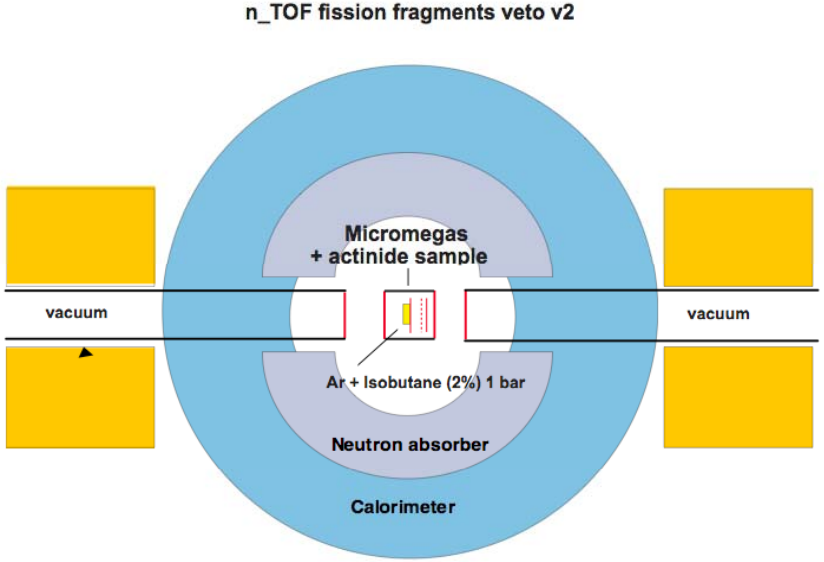
Neutron flux extracted from known cross sections (U-235(n,f) and B-10(n,alpha)):

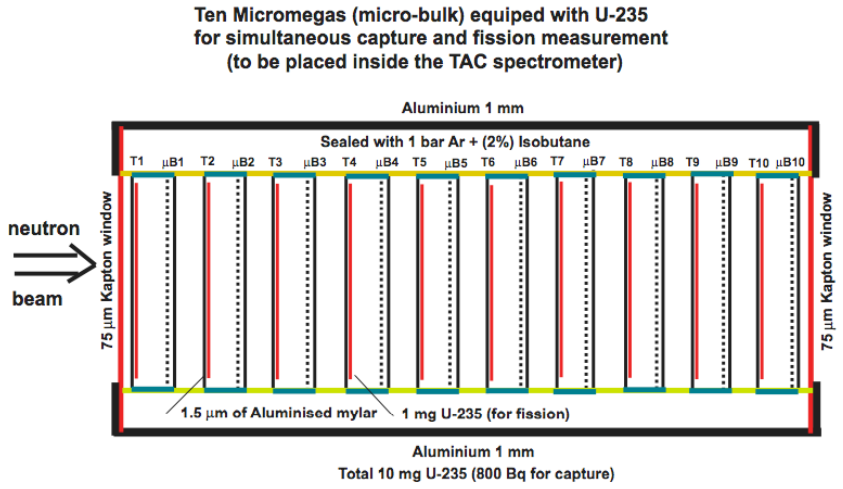
- U-235 lot of resonances between 0.1 eV and 10000 eV
- not the case for B-10

Combination of U-235 and B-10 very good neutron beam monitor

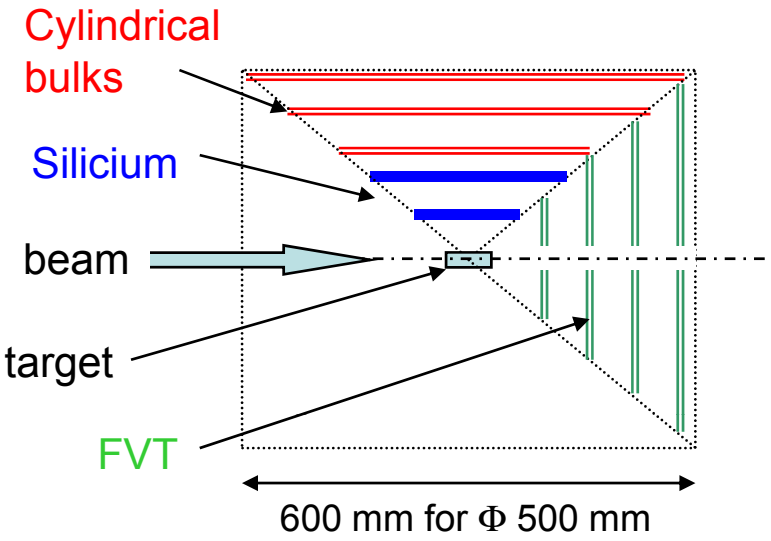
Fission veto for neutron capture measurement of fissile element

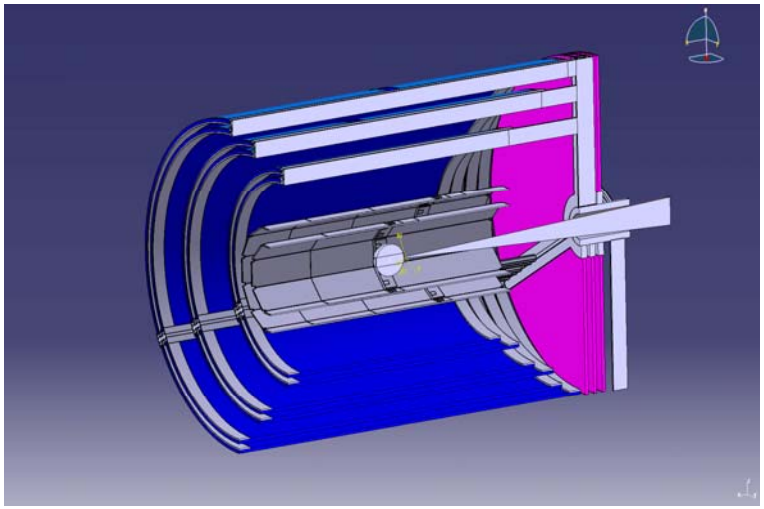


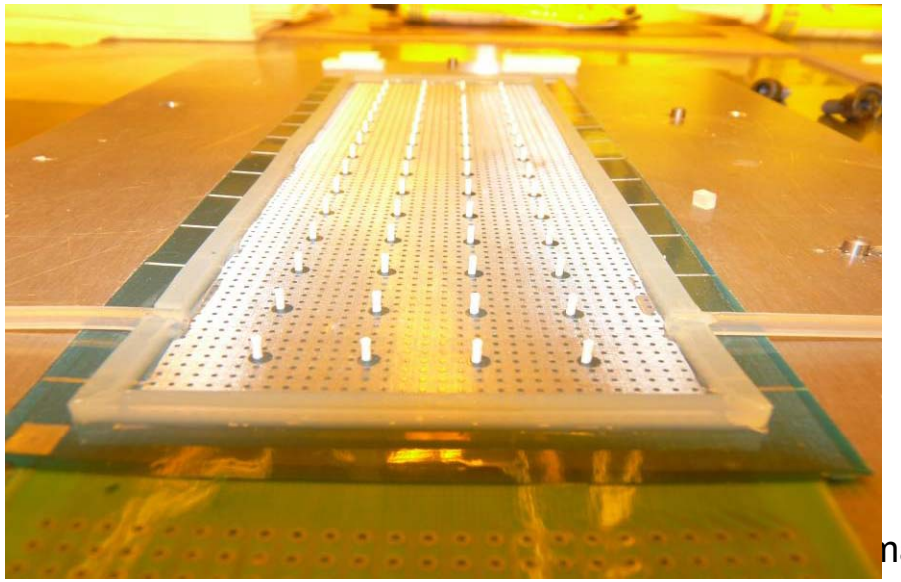


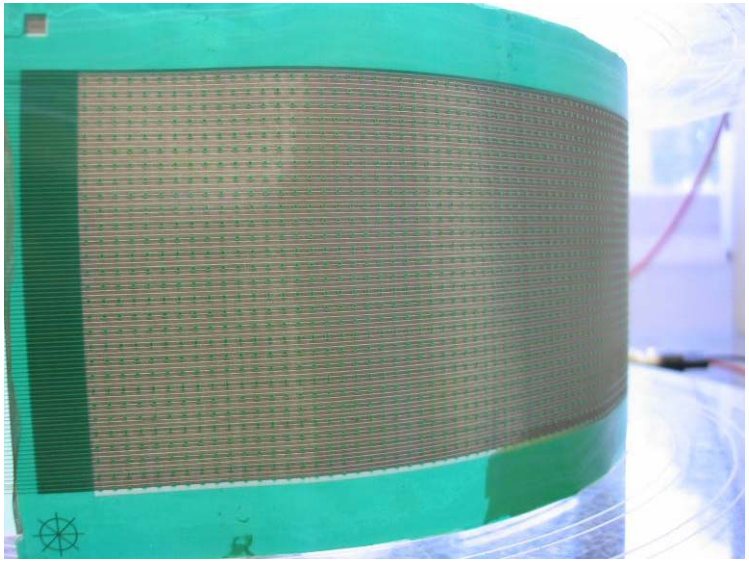


CLASS12 Micromegas in JLAB



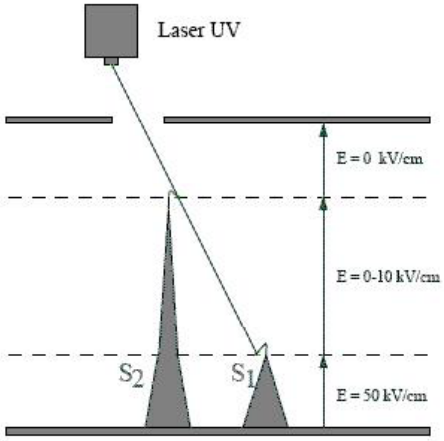




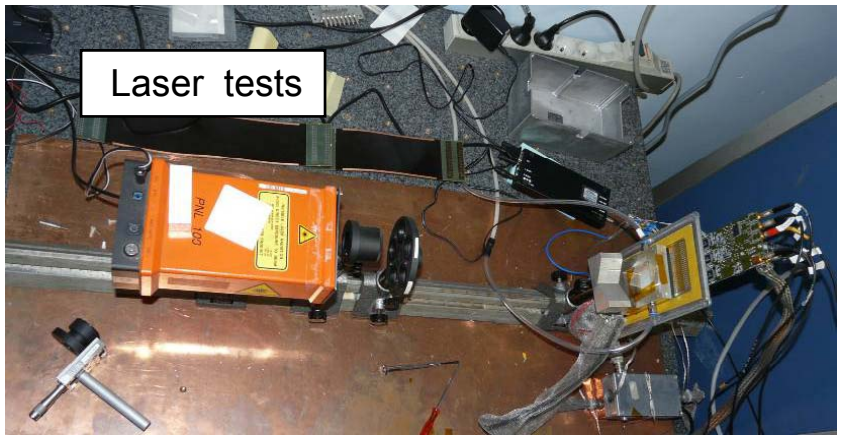


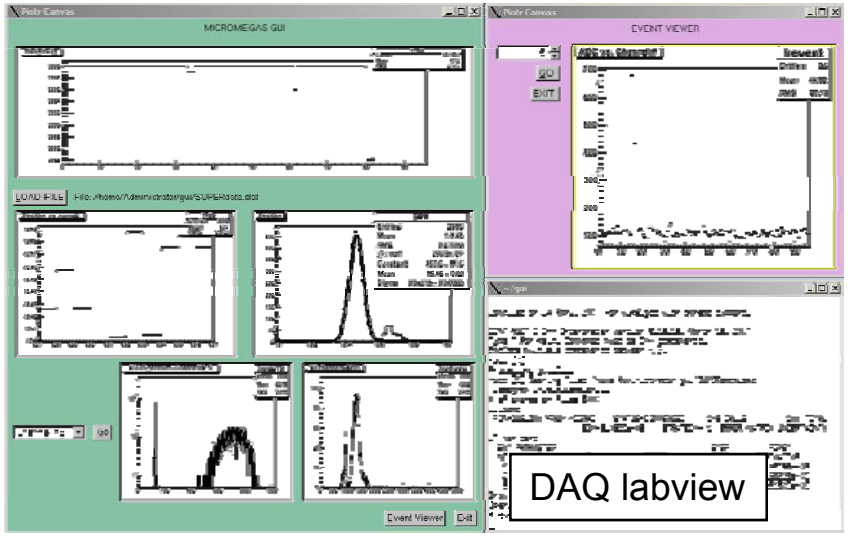
B: tests on 96 strips bulk MM

Promising first results



UV Laser on an optical bench is able to create ionising particles in the detector equipped with a Gassiplex board.





January - April 2008 :

- Tests with T2K electronics at Saclay and with magnetic field
- Designs of 2K channels prototype-build up the prototype
- Meeting at JLab,

May – June 2008 :

-Testing the prototype, packing and sending to JLab.

Summer 08 :

- Installation and tests at high field at JLab.