



# Recent progress towards a Pixel-TPC

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K. Desch • Bonn University • 19/10/2006



1. Objectives
2. New Structures (Ingrid, Twingrid,...) + Discharge Protection
3. Gas Studies
4. Testbeam at DESY (Medipix+3GEM)
5. Simulations
6. Summary and Plans

Participating Institutes:

BONN BUCHAREST CERN DAPNIA-CEA FREIBURG NIKHEF

(this talk: everything except Timepix)



# 1. Objectives

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**Idea:** use a Pixel readout chip (w/o Si sensor) as integrated device hosting pads + readout electronics for a TPC

## Potential Advantages:

- very small ( $50 \times 50 \mu\text{m}^2$ ) Pads
- potentially very good point+momentum resolution
- $dE/dx$  via cluster counting
- frontend electronics automatically integrated ('active endplate')

## SiTPC goals in EUDET:

- construction and test of the Timepix chip (CERN  $\mu$ -Electronics team)
  - ⇒ X.Llopart's talk
- construction of module(s) for LP endplate(s) for diagnostic purposes

both Micromegas and GEMs as gas amplification systems are being pursued



## 2. New Structures

NIKHEF

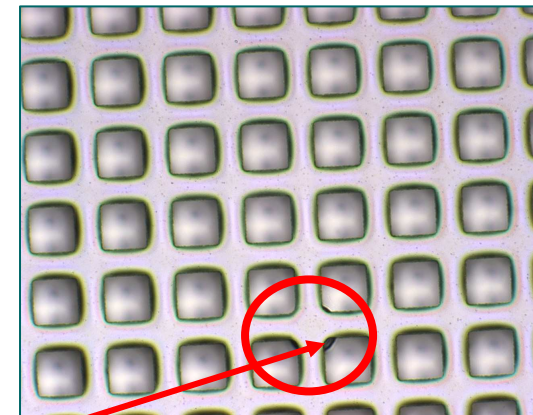
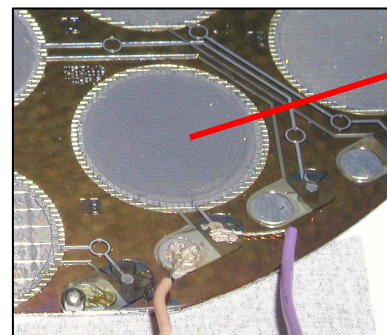
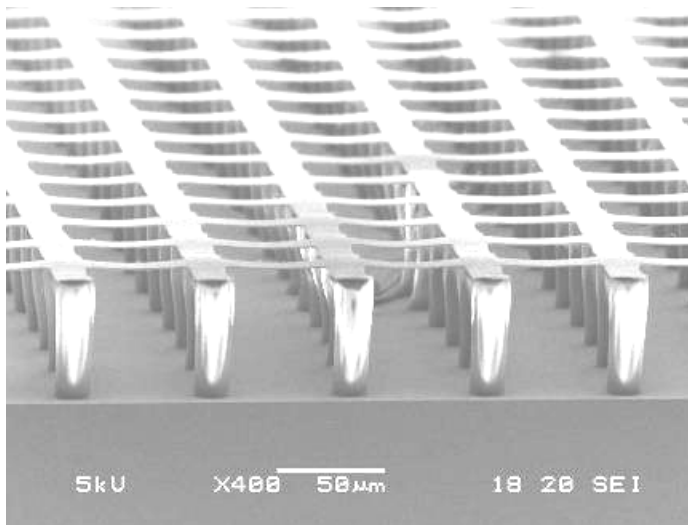
InGrid, an integrated Micromegas

Integrate grid by wafer post processing

Low temperature process (spin coating, wet etching)

Perfect alignment between grid holes and pixel pads

No pillars dead areas - Flexible design



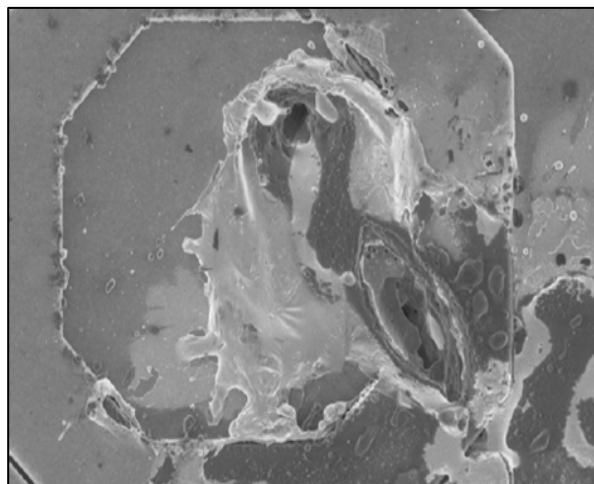


## 2. Discharge protection

NIKHEF

- Discharges
- melt pixel pad
  - damage Grid

1  $\mu\text{m}$  thin grid  
Aluminum Tf  $\sim 660\text{ }^\circ\text{C}$



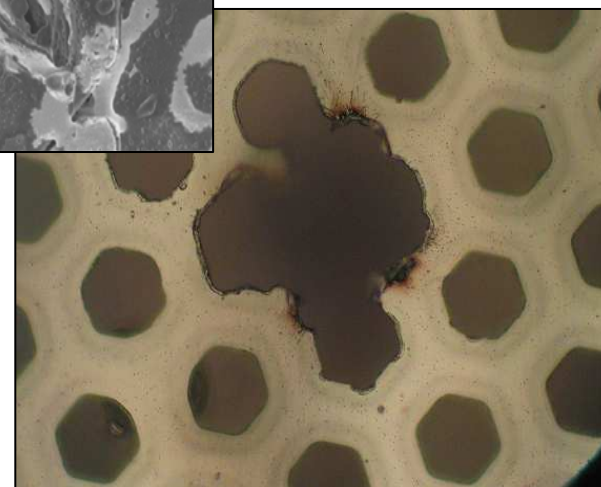
Proposals:

Resistive layer, RPC principle

**SiProt**

Multi-stage amplification

**TwinGrid**

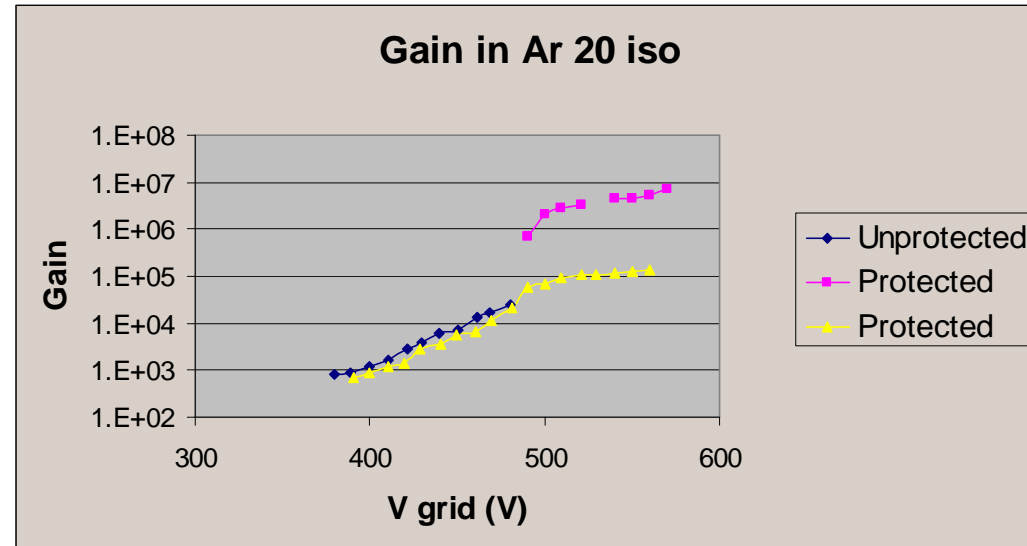




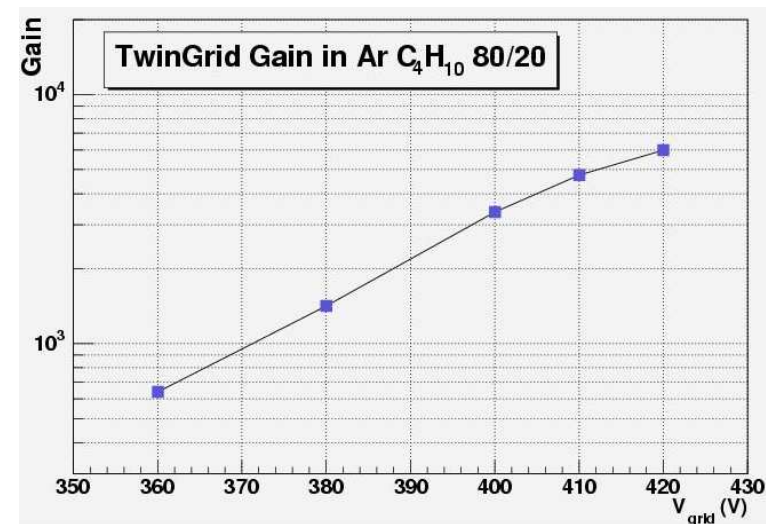
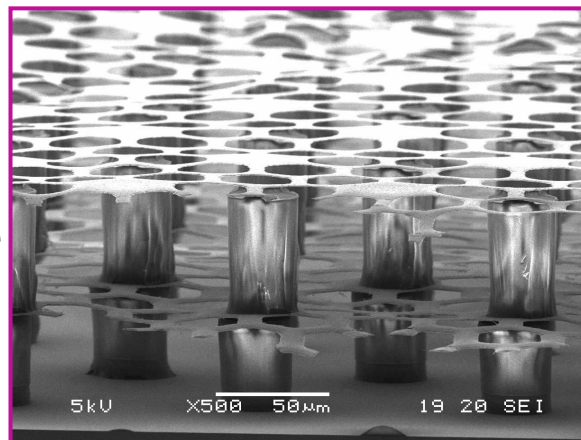
## 2. Discharge protection

NIKHEF

First results with resistive layer:



First result from 2-stage amplification (Twingrid)





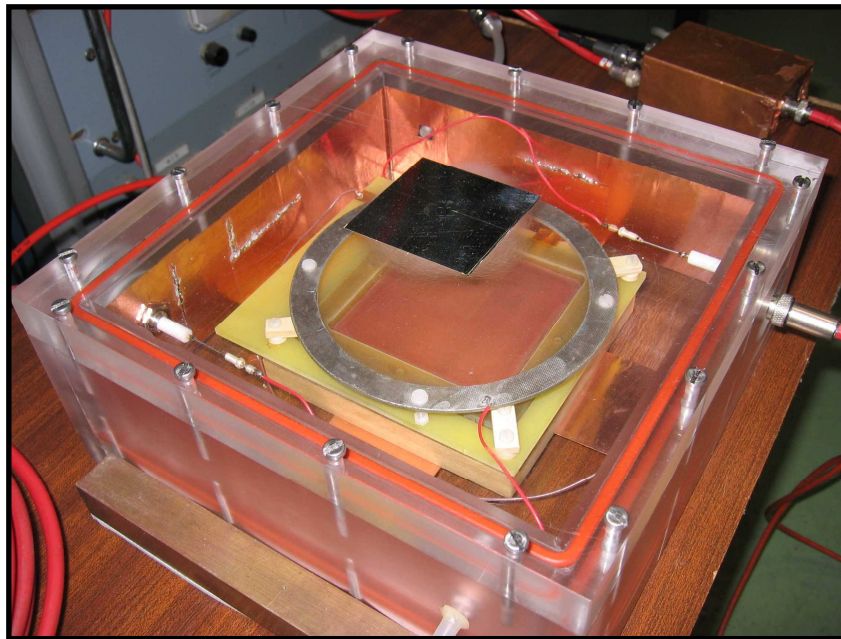
## 3. Gas Studies

Saclay

Complementary approach to fight the sparks in Micromegas structures:

- finding a gas mixture for optimal stability
  - damping the sparks (specific supply circuit)

Comprehensive study started



- Standard" 50  $\mu\text{m}$  mesh of 10 cm x 10 cm size
- Sources:
  - Fe 55 (5.9 keV)
  - COOL-X (8.1 keV)
- Monitoring of:
  - pressure
  - $\text{H}_2\text{O}$



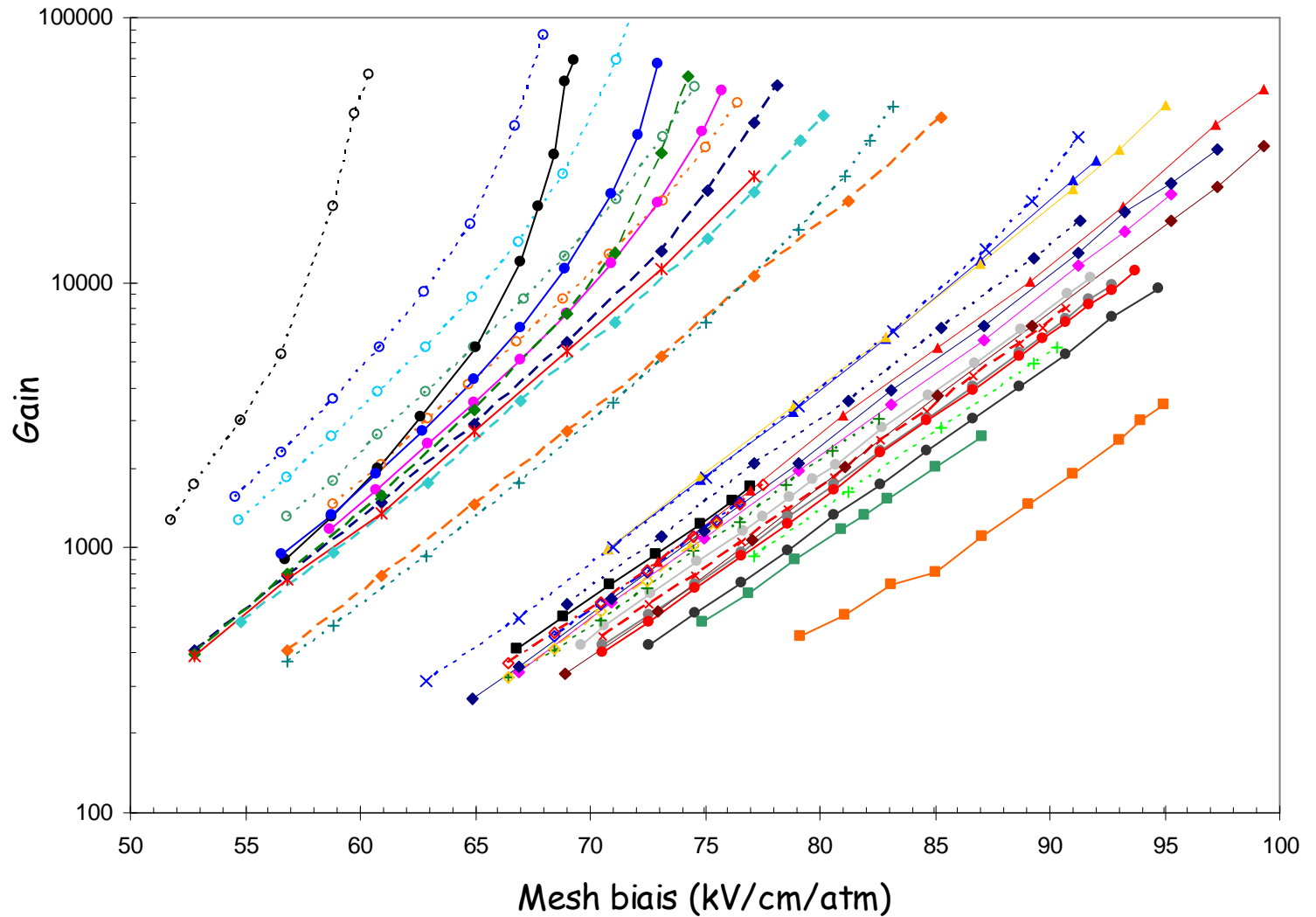
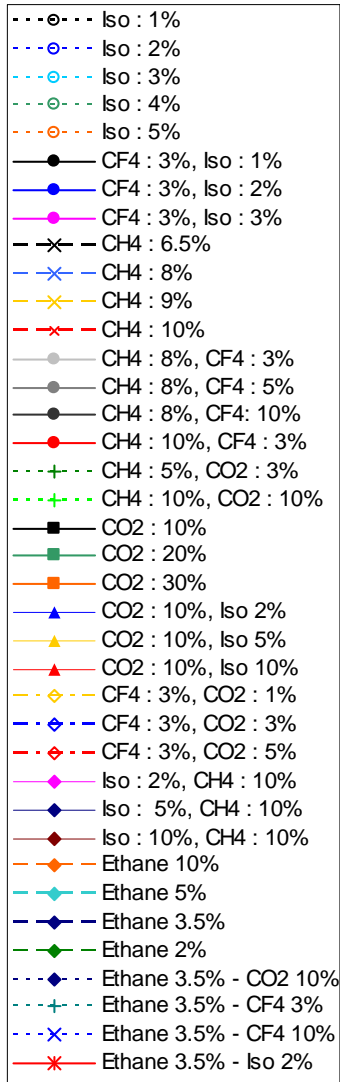
# 3. Gas Studies

Saclay

Mesh : 50  $\mu\text{m}$  gap of 10x10 size

Mixtures of gases containing argon

K. Desch News from the SiTPC Project p. 7

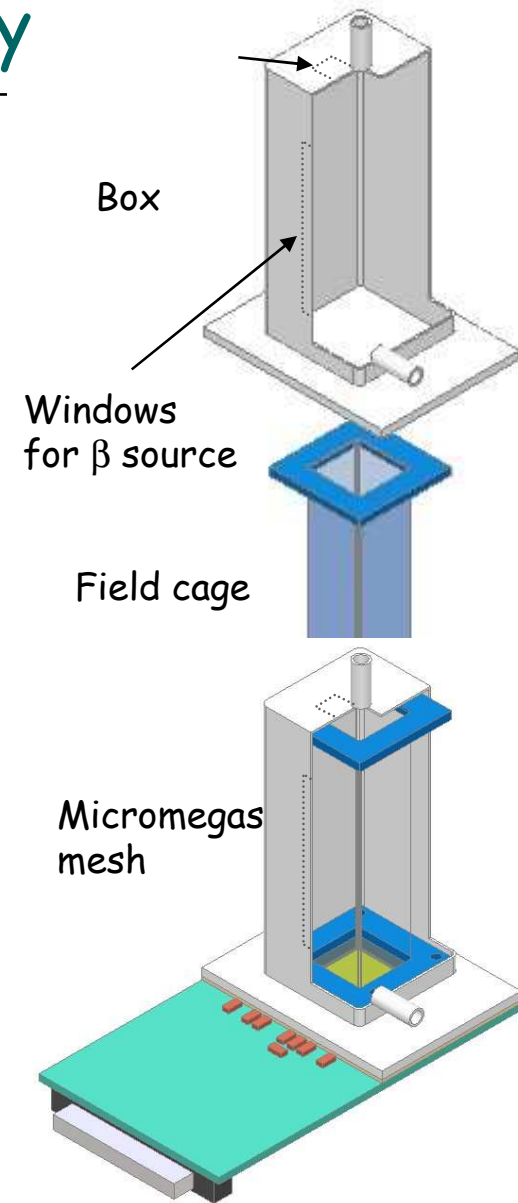




### 3. Further activities at Saclay

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- Study of detector-to-detector gain homogeneity
- Measurement of ions backflow using various InGrid geometries
- We are ready to test TimePix in gas
- Future activities and development in Saclay  
design for a Mini-chamber using Medipix2 readout chip  
SiTPC endplate for the Large Prototype







## 4. Testbeam at DESY: 3-GEM+Medipix

Freiburg  
Bonn

4 weeks of beam test in September/October

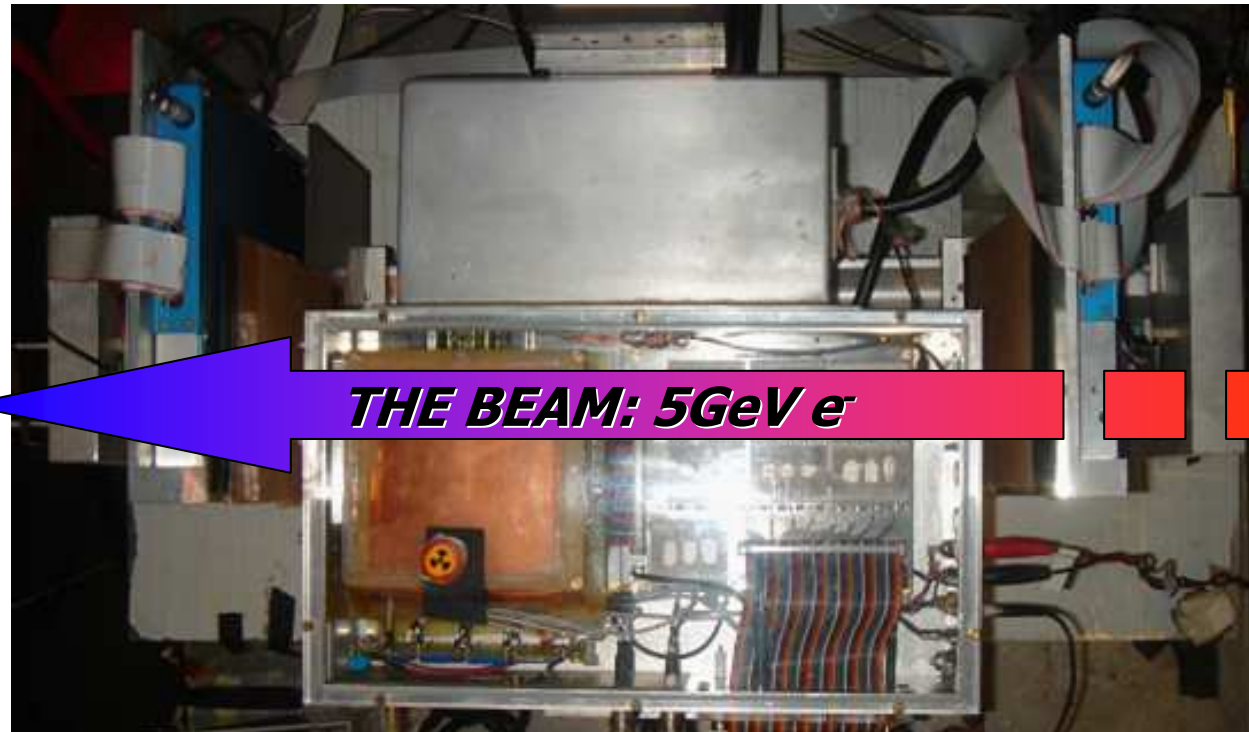
Very good support from DESY testbeam support : thanks to N.Meyners et al!

Use ZEUS Silicon telescope: thanks to U.Kötz,I.Gregor,J.Stzuk!

Support of DESY FLC group : thanks to M.Janssen et al!

(NB: a pity that we were all German - would have been a nice TA1 usage, will organize at the European level next time...)

The setup:  
(top view)



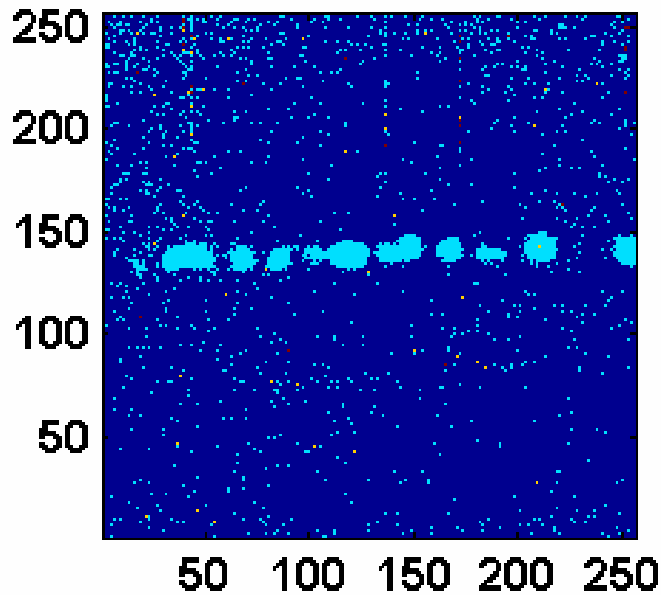


# 4. Testbeam at DESY: 3-GEM+Medipix

Freiburg  
Bonn

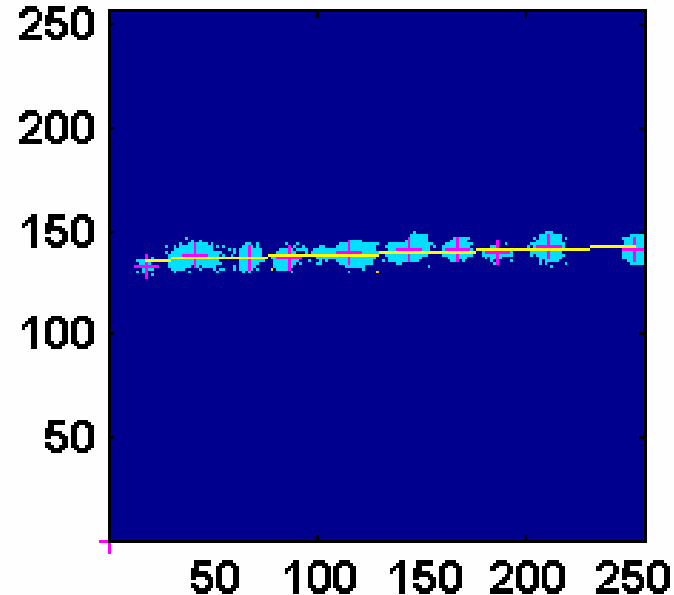
Typical events (have ~100.000 tracks on tape)

H28.09.2006\_16-14-35-843\_311ms.dat



raw events

ArCO<sub>2</sub>,  
 $\Delta V_{GEM}=404V$



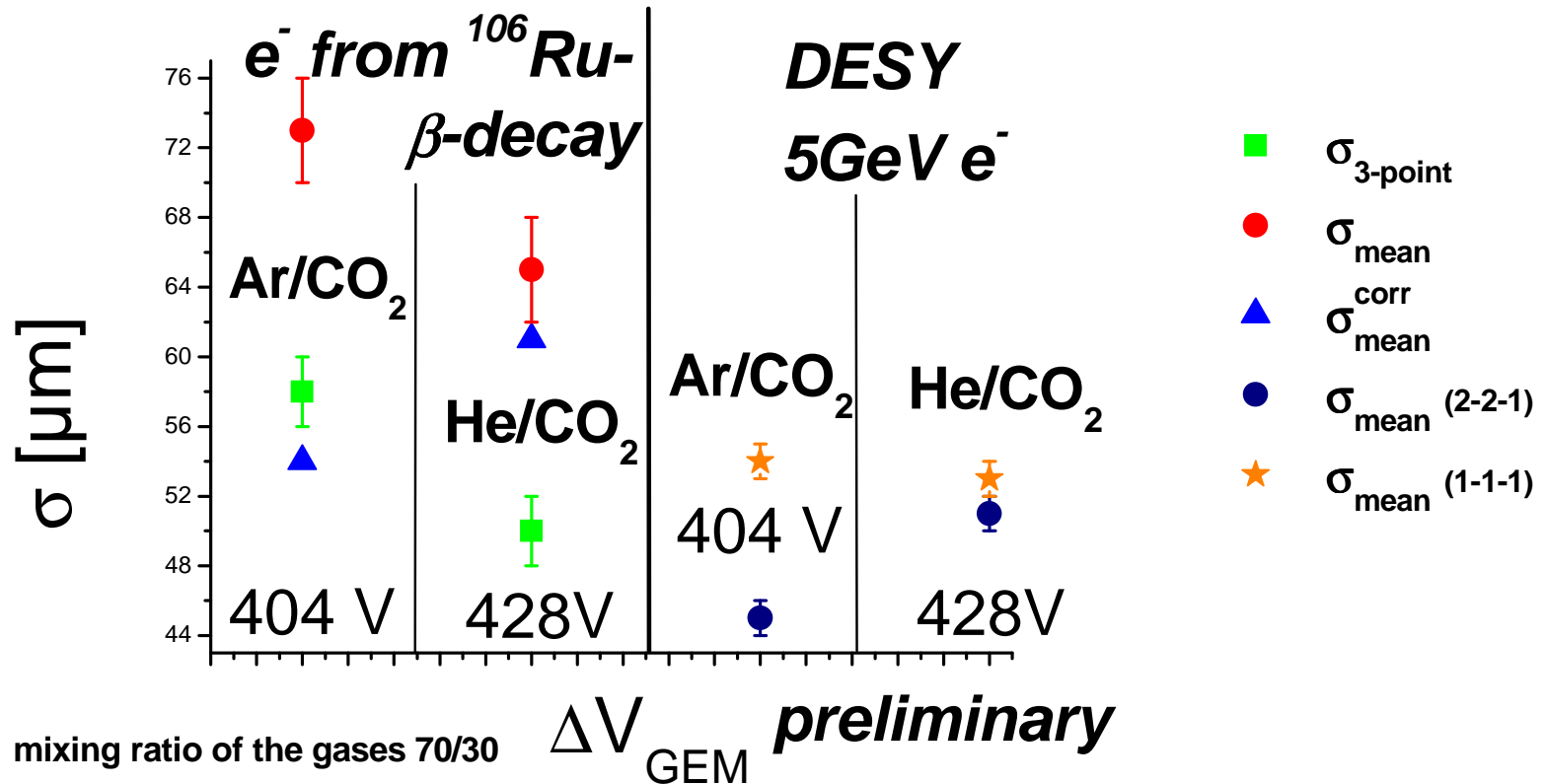
after some cleaning and  
cluster finding  
(remove isolated pixels)



# 4. Testbeam at DESY: 3-GEM+Medipix

Freiburg  
Bonn

Preliminary point resolutions (averaged over all drift distances)



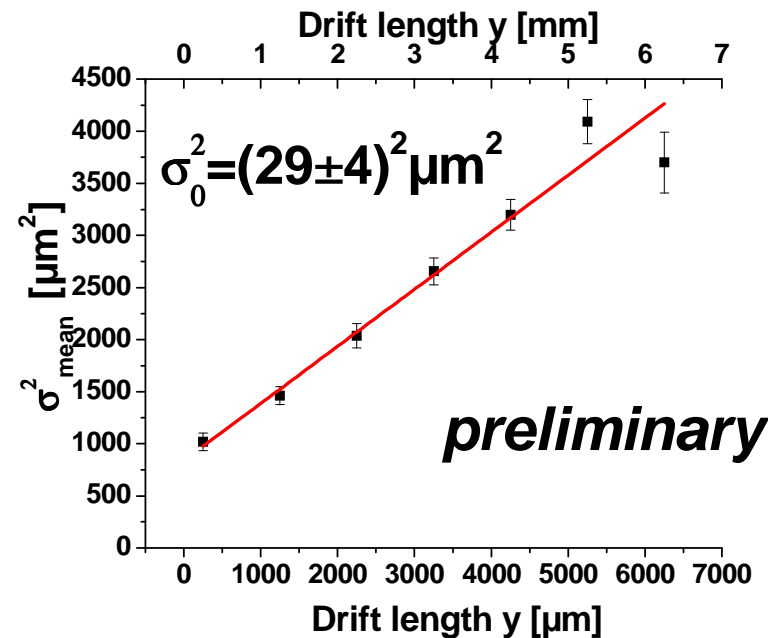
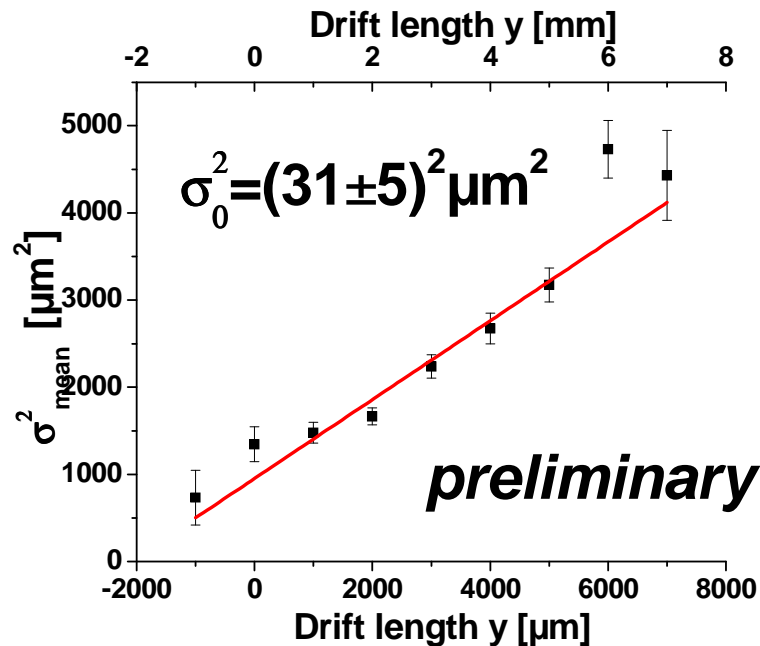
Resolutions in testbeam consistent with mult.-scatt. corrected resolutions from  $^{106}\text{Ru}$  (2 MeV  $e^-$ )



# 4. Testbeam at DESY: 3-GEM+Medipix

Freiburg  
Bonn

Preliminary point resolutions: as a function of drift distance:



$$\sigma_0(\text{ArCO}_2, 2-2-1) = 37 \pm 5 \mu\text{m}^2$$

Lots of data to be analyzed

Still the same Medipix chip as 1.5 years ago

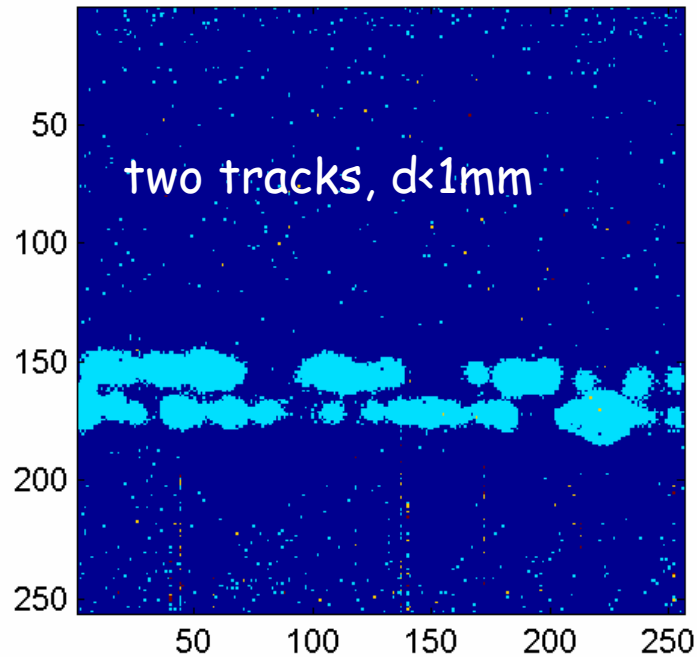
Prepare for Testbeam with Timepix in same setup a.s.a.p.



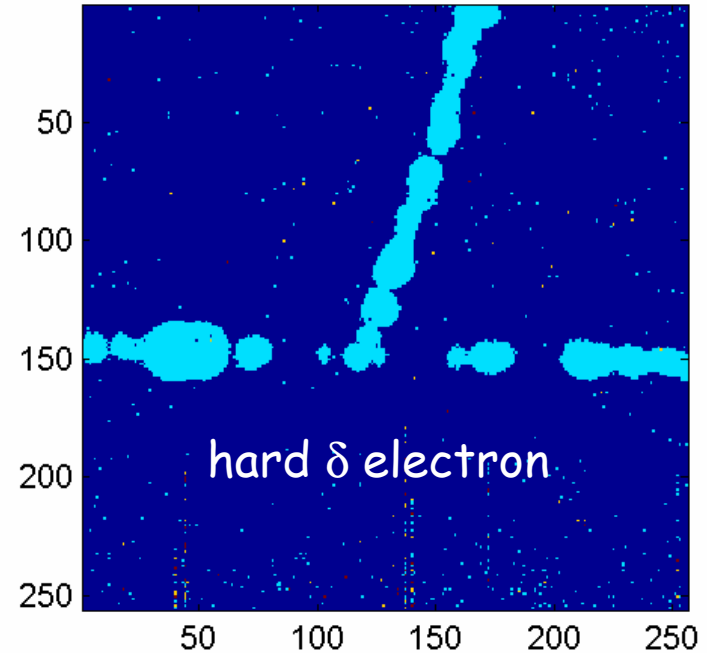
## 4. Testbeam at DESY: 3-GEM+Medipix

Freiburg  
Bonn

A28.09.2006\_16-07-17-156\_648ms.dat



B03.10.2006\_13-20-01-796\_348ms.dat



Lots of data to be analyzed  
Still the same Medipix chip as 1.5 years ago  
Prepare for Testbeam with Timepix in same setup a.s.a.p.



## 5. Simulations for Testbeam

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CERN

### CLUSCO (M. Hauschild)

- Generates ionization clusters/electrons along tracks and drifts electrons towards GEMs/MicroMegas structures
  - HEED (I. Smirnov) for cluster generation (incl.  $\delta$ -electrons, mult. scat.)
  - MAGBOLTZ (S. Biagi) for gas properties (diffusion, drift velocity)
- "Squeeze" electrons through GEM/MicroMegas holes and perform gas amplification
  - use simple geometric transformations, no detailed E-field simulation
  - exponential gas gain distribution
- Drift ALL electrons created in gas amplification to next GEM or MediPix (can be several Millions in total)
- Count electrons collected on MediPix, noise + apply detection thresholds (digitization step)



# 5. Simulations for Testbeam

CERN

## Cluster densities:

- Very different primary cluster density

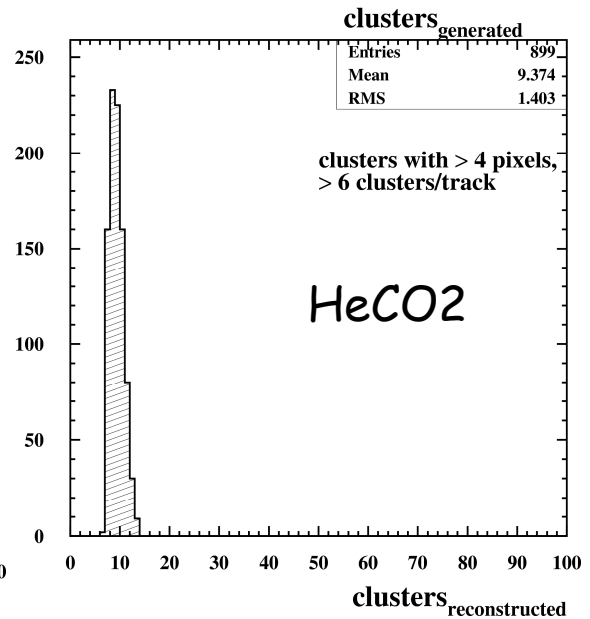
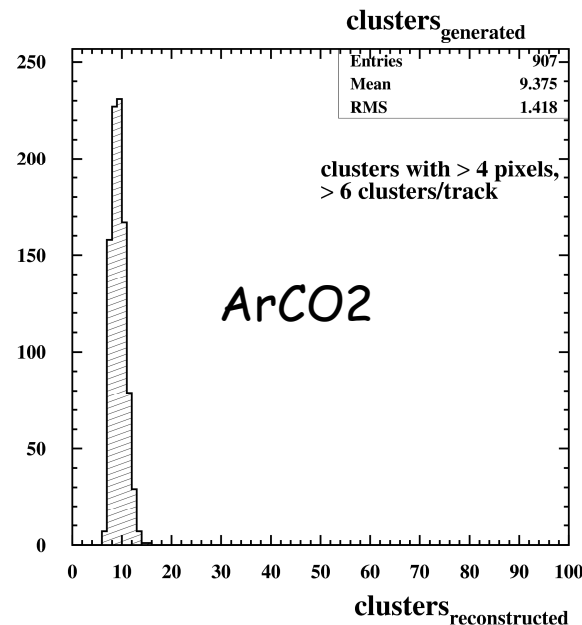
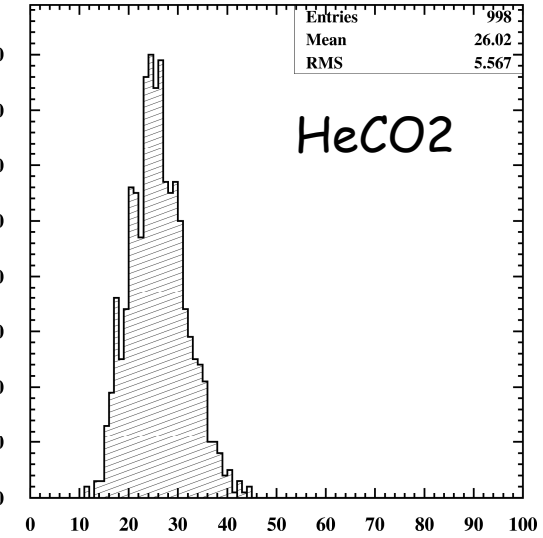
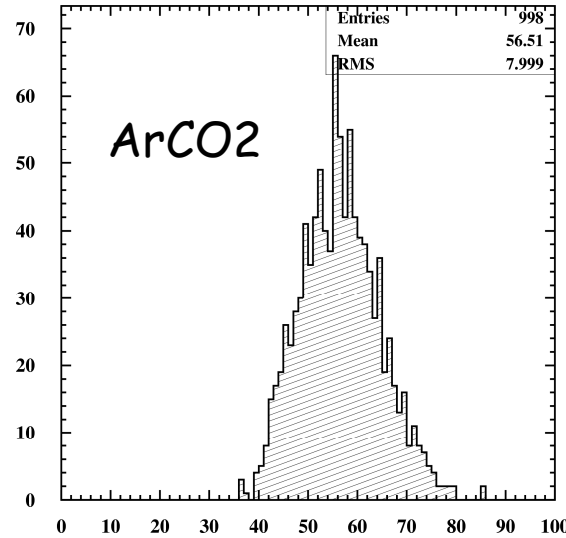
Ar/CO<sub>2</sub> (70/30):  
40.0 cl./cm

He/CO<sub>2</sub> (70/30):  
18.4 cl./cm

- Reconstructed cluster density very similar

Ar/CO<sub>2</sub> (70/30):  
6.3 cl./cm

He/CO<sub>2</sub> (70/30):  
6.2 cl./cm





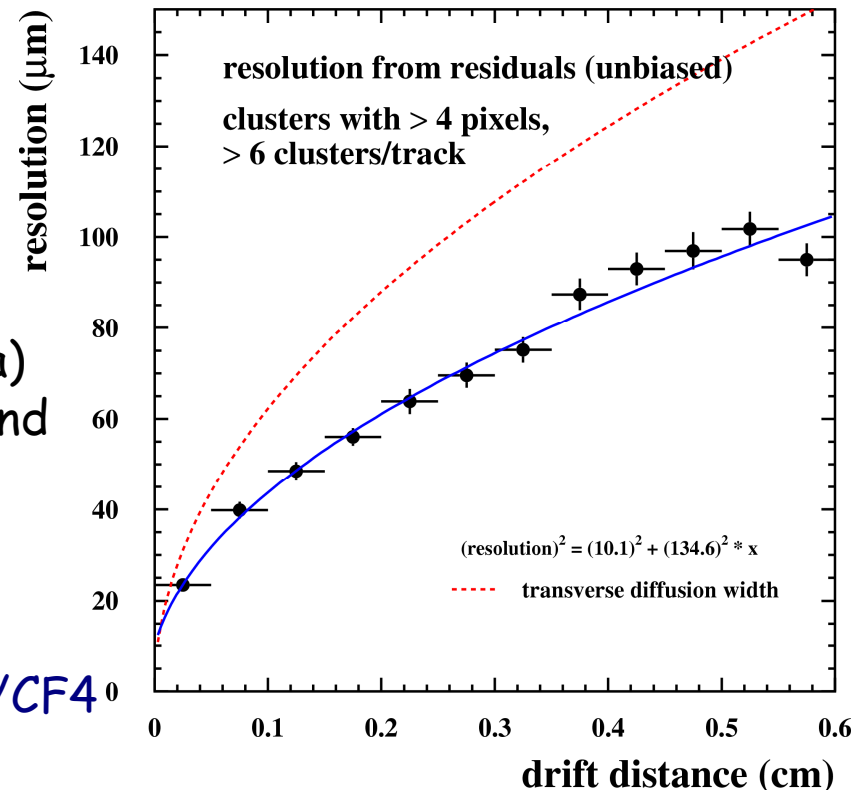
## 5. Simulations for Testbeam

CERN

### Single point resolutions:

- $\sigma_0$  quite similar to TB data
- resolution numbers for larger drift distances (still) somewhat larger
- no huge differences between ArCO<sub>2</sub> and HeCo<sub>2</sub> in resolution (~roughly in agreement with TB data)
- no huge difference between 1-2-2 and 1-1-1 setup (in agreement with TB data)

Ar/CH<sub>4</sub>/CO<sub>2</sub> (93/5/2) and Ar/CO<sub>2</sub>/CF<sub>4</sub> (90/5/5) mixtures have ~2x worse resolutions than Ar/CO<sub>2</sub> or He/CO<sub>2</sub>  
large diffusion in drift region and transfer region  
large blobs







## 6. Summary and Plans

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- Pixelized Readout of Micropattern Gas Detectors has been shown to be a quite attractive scheme to arrive at the BPLCTPC (=best possible linear collider TPC)
- Timepix appears to be operational! (=milestone)
- Good progress to understand the properties of this scheme
  - gas mixtures
  - integrated devices (INGrids)
  - simulation
  - first beamtest successful
- we are eagerly awaiting first Timepix samples for tests in detectors
- can start planning of a module for the EURECA infrastructure (in addition, small scale tests will of course continue)



## 7. Executive Summary

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