DHCAL and MICROMEGAS at LAPP

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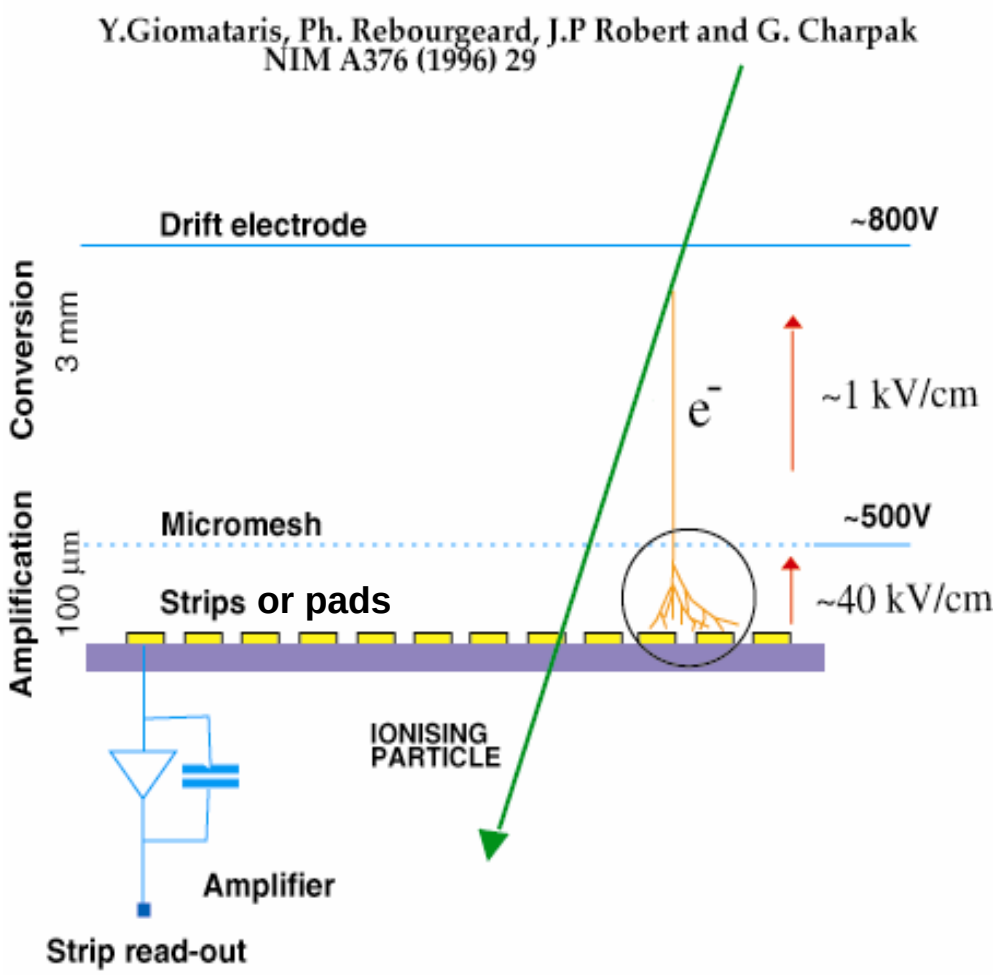
LAPP R&D axes

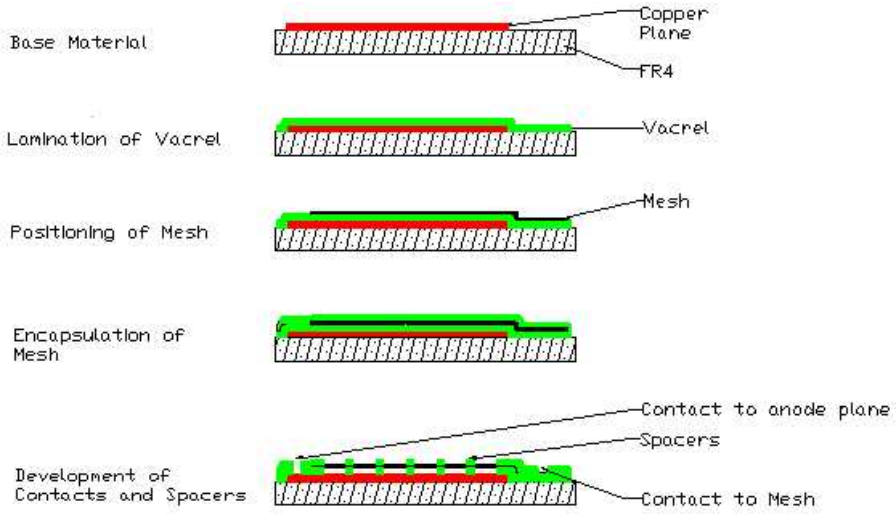
- MicroMegas studies with analogue readout
- Design and realisation of large surfaces MicroMegas with digital readout
- Design of the Digital InterFace (DIF)

Within the European DHCAL project

Micro Mesh gaseous structure

- Our choice : the bulk technology





mesh + PCB = 1 block: the bulk

robustness

large area

uniformity

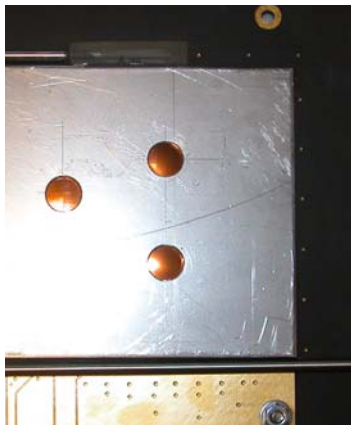
industrial process…

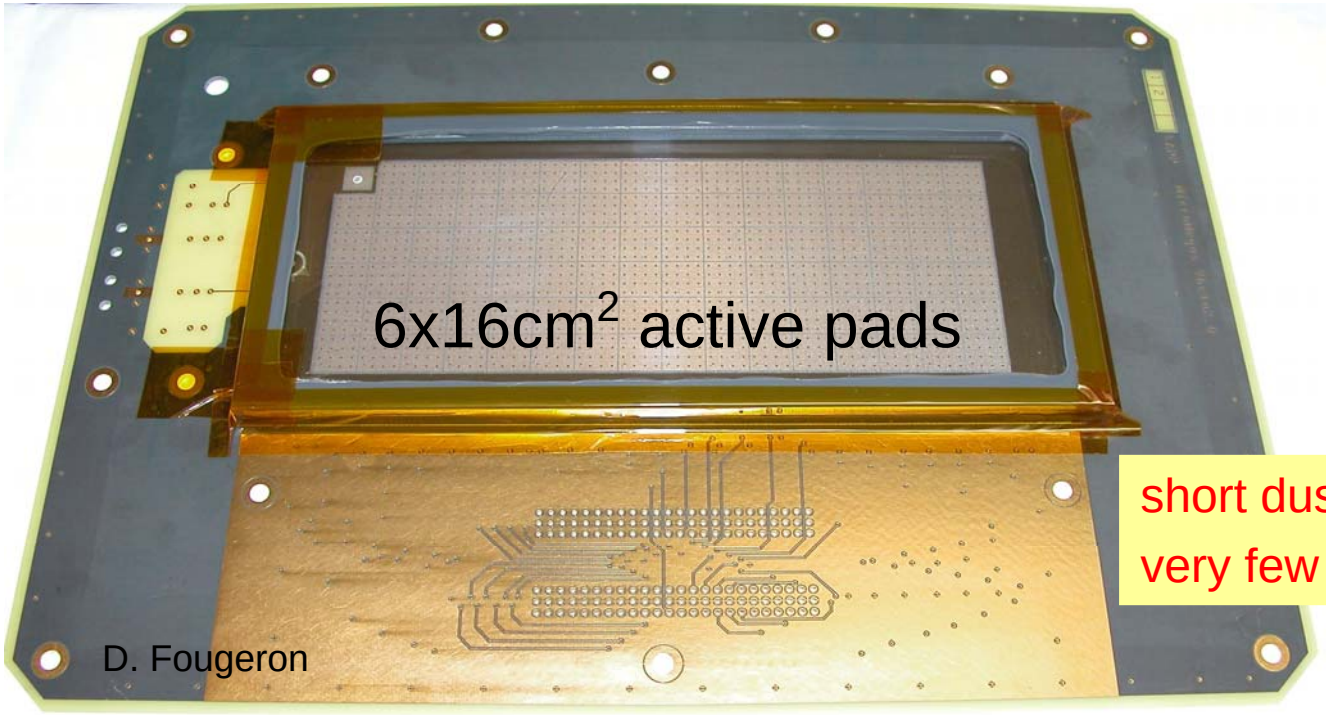
MicroMegas Prototypes

- PCB and bulk from CERN (*Rui de Oliveira*)
  - 325 LPI mesh
  - spacers : 120 μm height
    300 μm diameter
  - pads : 0.98x0.98 cm^2, 200μm between pads
- The chamber
  - 95% Argon, 5% Isobutane
  - conversion volume (3mm)
  - a top in Stainless Steel with a copper drift cathode
- The pad readout : analogue
  - Gassiplex board : 6 gassiplex chips - 96 channels
    Electronics card built for CAST by DAPNIA (P. Colas, Philippe Abbon)
  - VME sequencer and ADC from CAEN
  - CENTAURE acquisition (SUBATECH, Nantes, D.Roy)

MicroMegas Prototypes

- PCB rooting with great care (4 layers)
- Stainless Steel top with holes for X-rays
- 5μm thick copper drift cathode
- Chamber assembly in clean environment





short dust burning time !
very few sparks during functioning

MicroMegas Studies

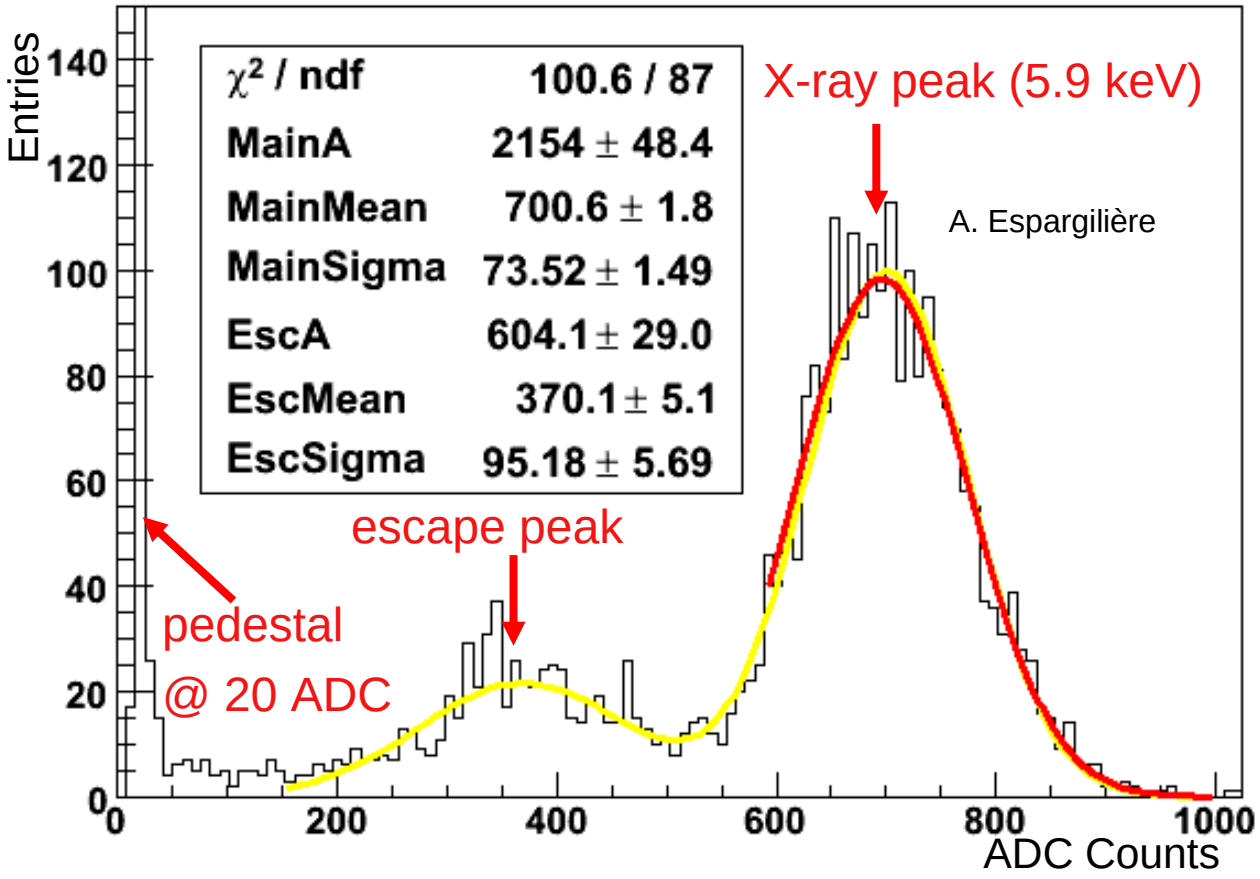
- X-ray studies (5.9 keV)
  - Gain
  - Response versus V_{mesh}
  - Response versus V_{drift}
  - Gas flow dependencies
  - Time stability
  - HV supply dependencies
- Cosmics
  - MIP value measurement
  - First glance on X-talk

X-ray Results

- ^{55}Fe source (5.9 keV → 228e^- in drift volume)
- Trigger on mesh : preamp (T output) + fast ampli

V_{mesh} = 420 V
V_{drift} = 470 V
E_{mesh} = 35 kV/cm
E_{drift} = 167 V/cm

all pads : 96 entries for each trigger

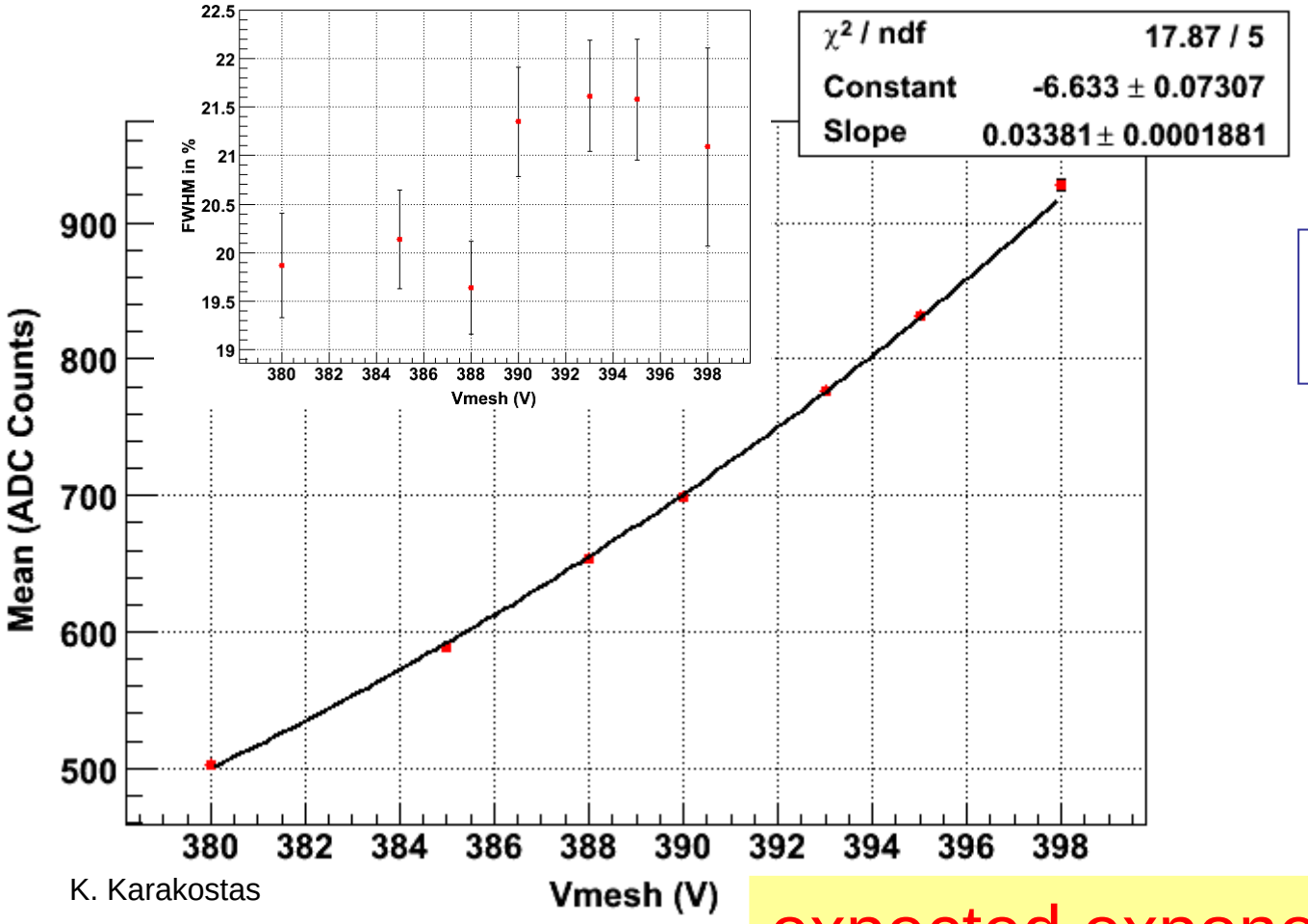


Gassiplex Readout :
Peak = 680 ADC cnts
= 996 mV
≈ 277 fC
⇒ Gain ≈7600
FWHM = 25.5%

T2K(same techno) :
FWHM = 26%

X-ray Results

- Response versus V_{mesh}



K. Karakostas

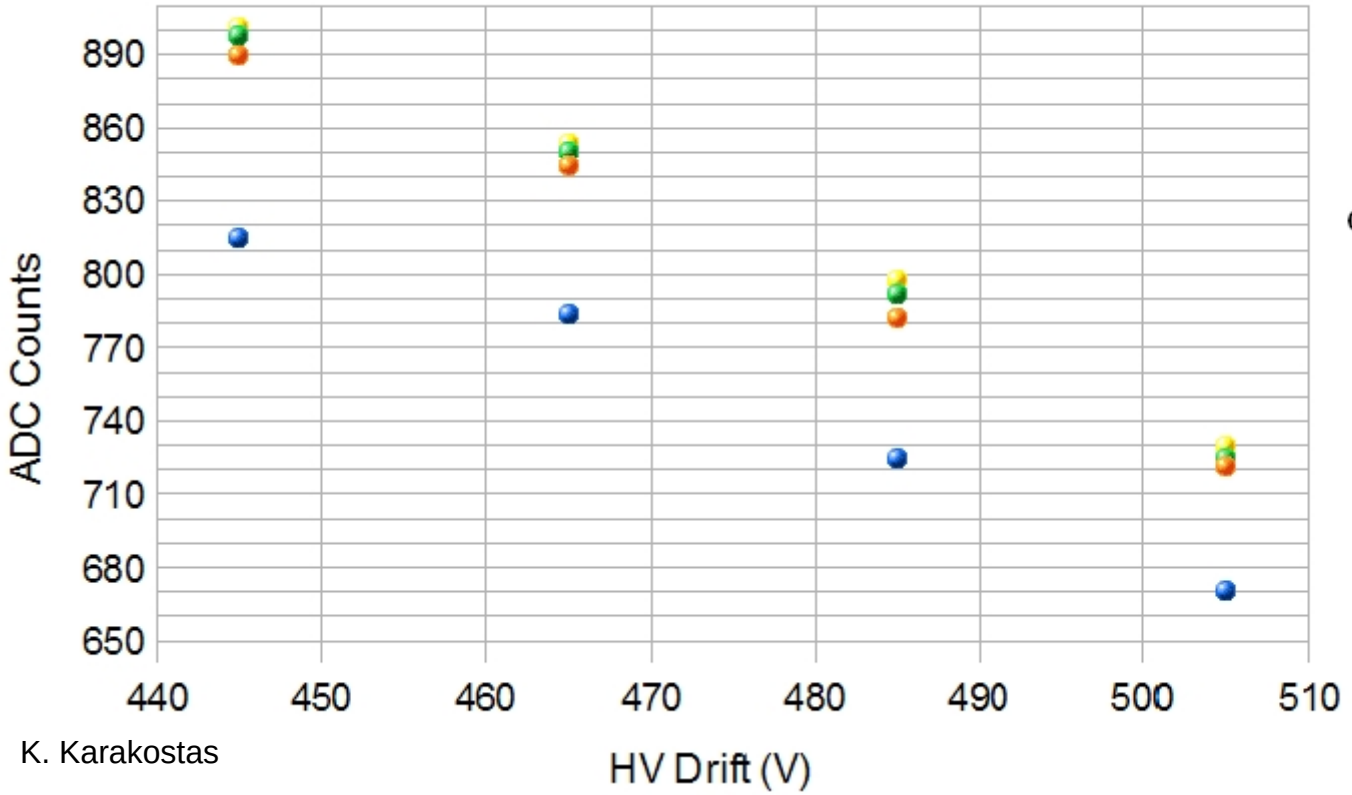
$V_{drift} = V_{mesh} + 70$ V

$E_{drift} = 233$ V/cm

expected exponential behaviour

X-ray Results

- Response versus V_{drift} and Gas flow dependencies



K. Karakostas

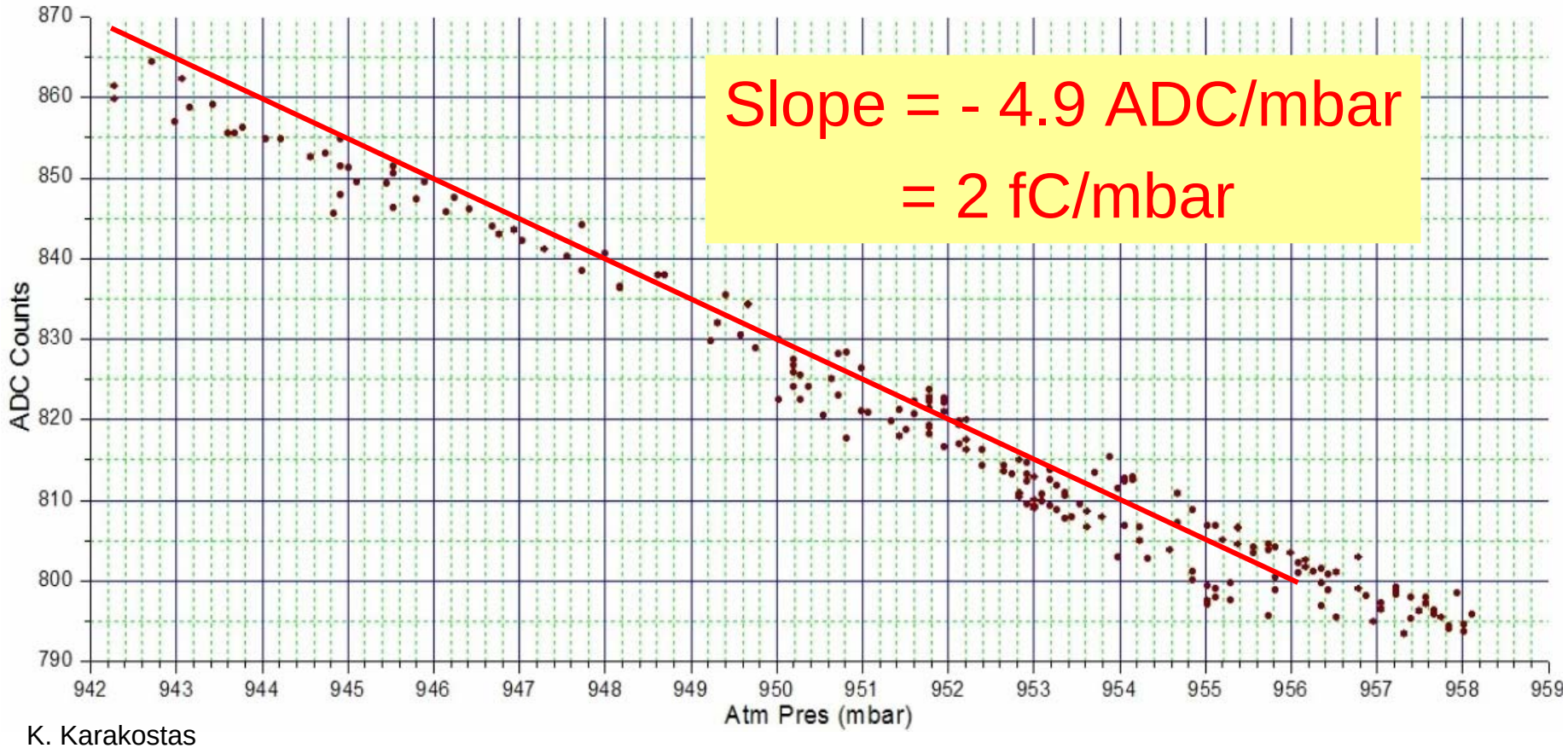
V_{mesh} = 395 V
E_{mesh} = 33 kV/cm
E_{drift} = 167-367 V/cm

Saturates for Flow > 0.20 l/h ≈ 7 volume/h

Gain ↘ when Drift field ↗

X-ray Results

- Time Stability

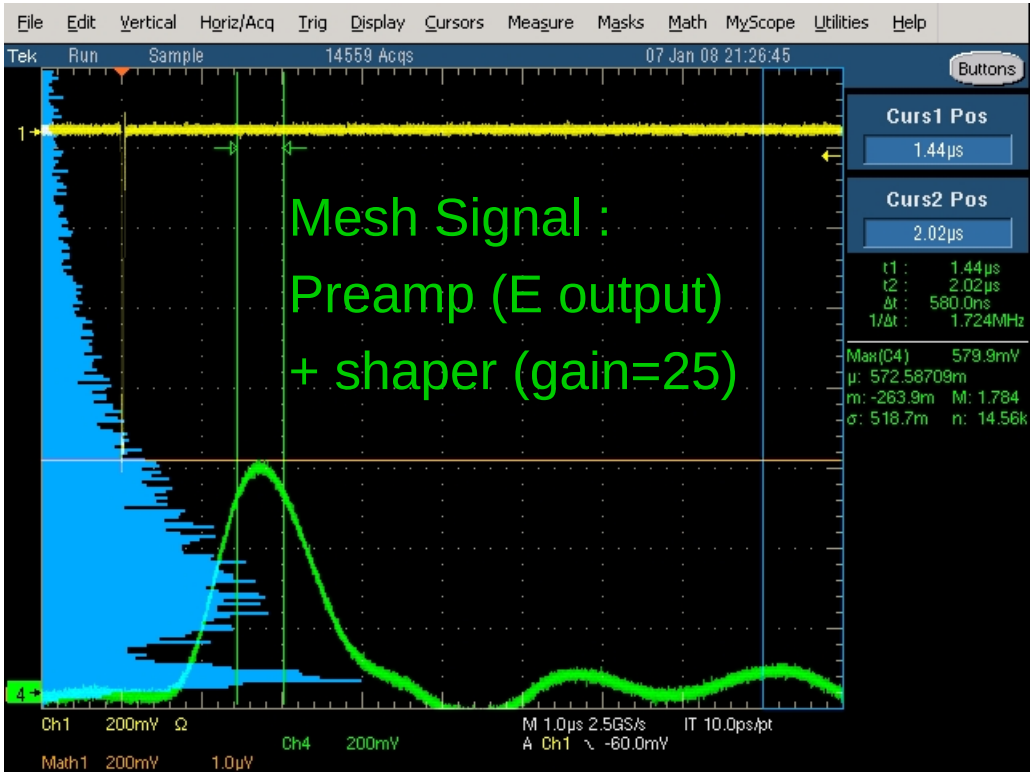


K. Karakostas

Gain ↘ when Atmospheric Pressure ↗

Cosmics

- Trigger on 3 scintillators coincidence

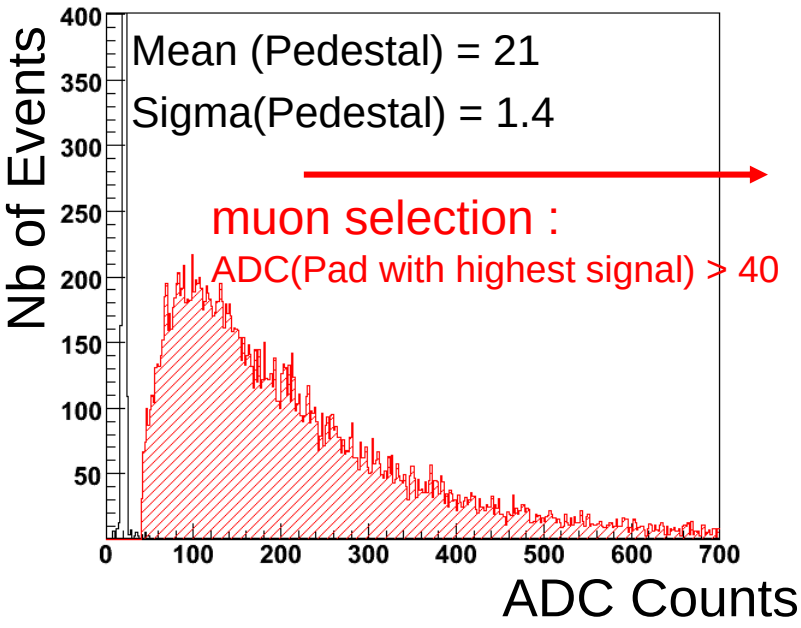


Charge ≈ 210(mV)/25/0.312(mV/fC) = 27 fC

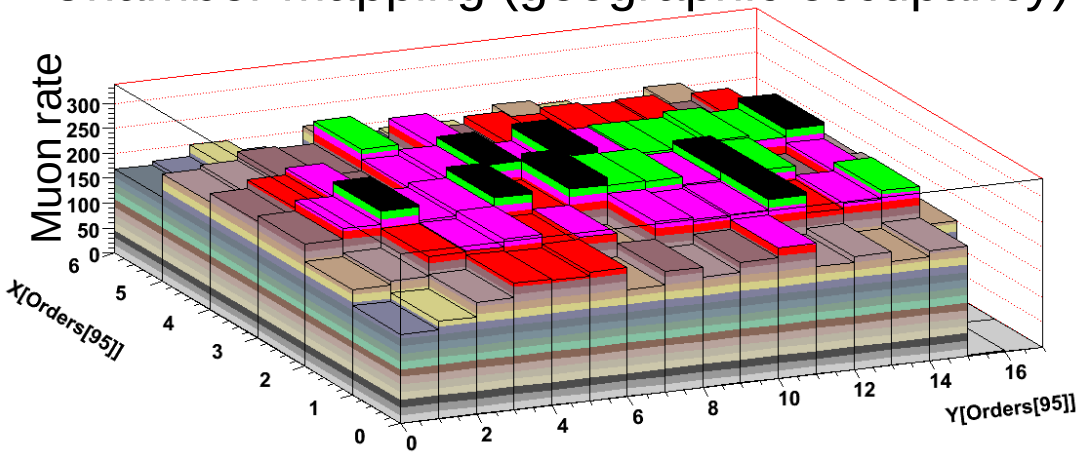
Cosmics

- Muon in 3mm drift volume = 29e$^-$
- Gassiplex Readout :

V_{mesh} = 410 V
V_{drift} = 470 V
E_{mesh} = 34 kV/cm
E_{drift} = 167 V/cm



Chamber mapping (geographic occupancy)



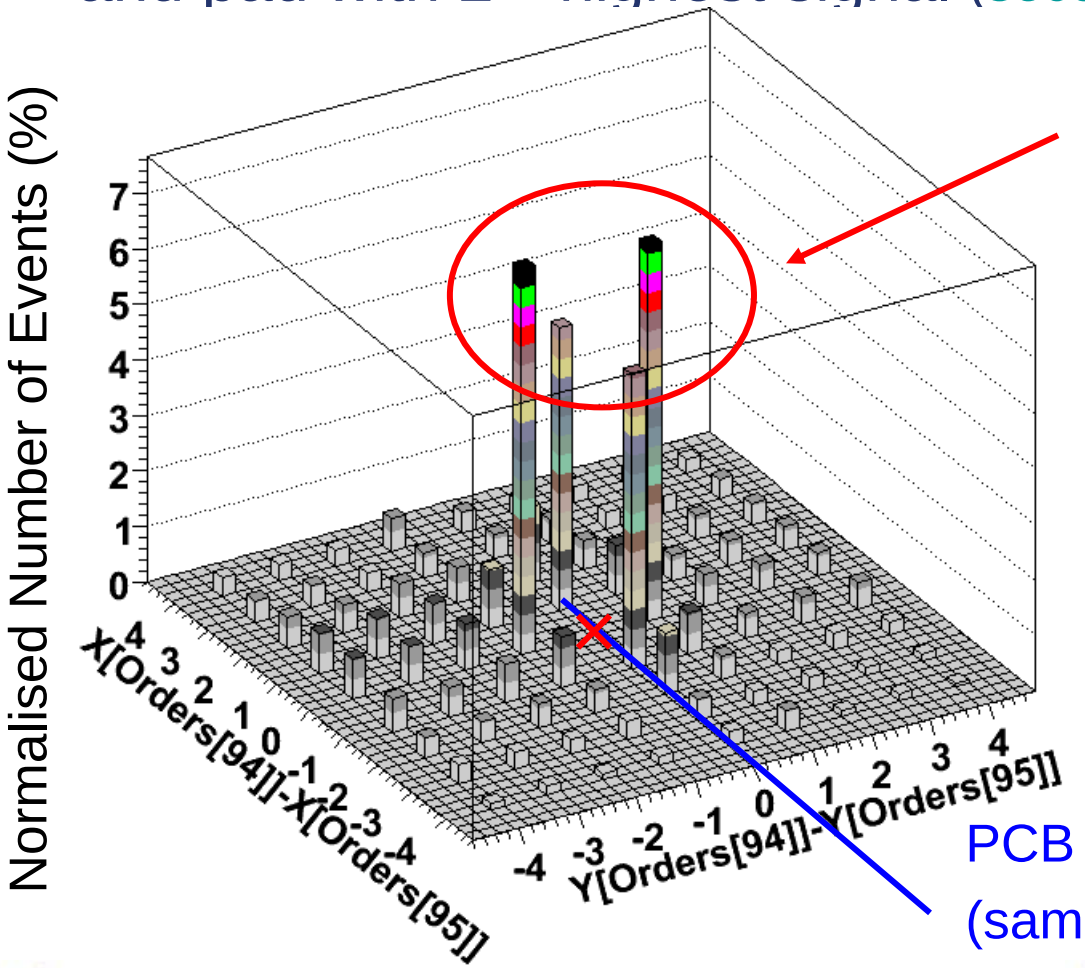
reflects scintillators geometry

Charge ≈ 80(1500mV)/1024/3.6(mV/fC) = 32 fC

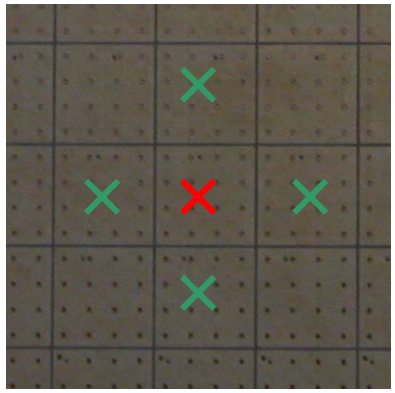
Gain ≈ 6900

Cosmics

- After muon selection :
  distance between pad with highest signal (muon pad)
  and pad with 2nd highest signal (second pad)



20% of the events with a muon have the second highest signal close to the muon pad



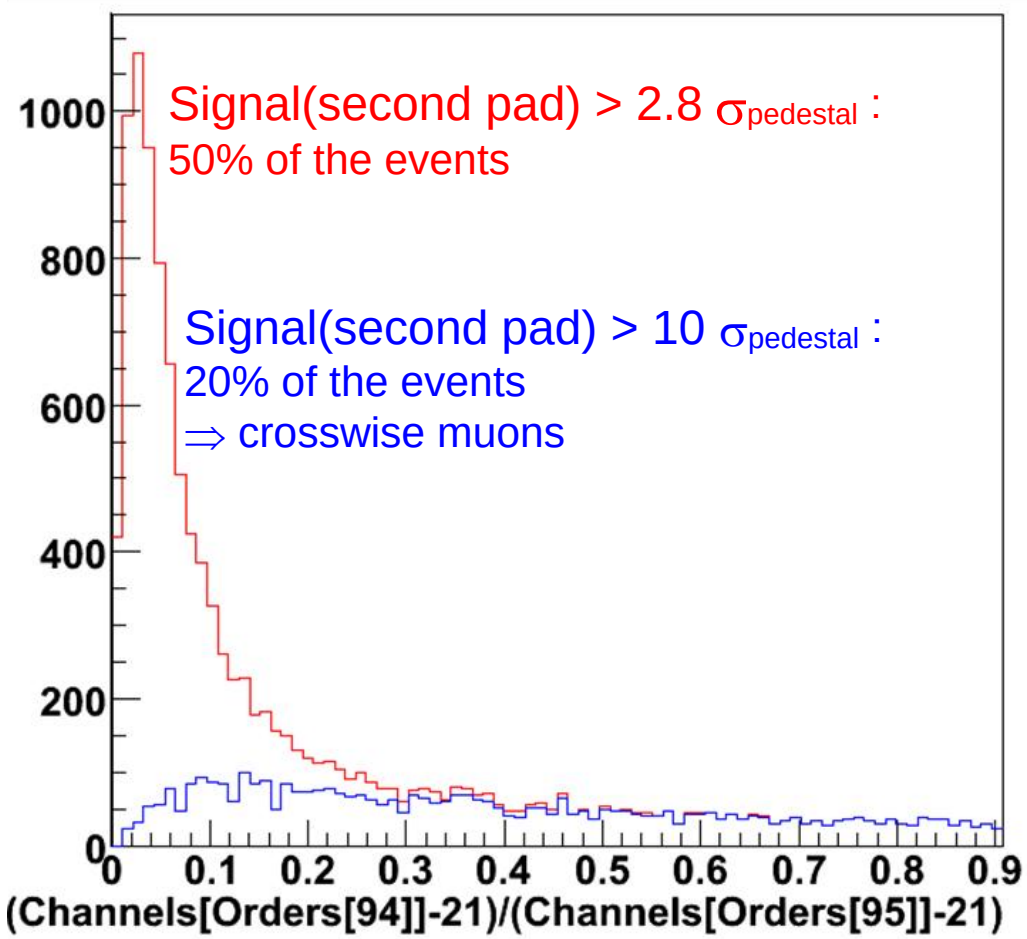
Dominant Crosstalk?

PCB routing along X

(same Y than muon pad)

Cosmics

- Signal(second pad) / Signal(muon pad)

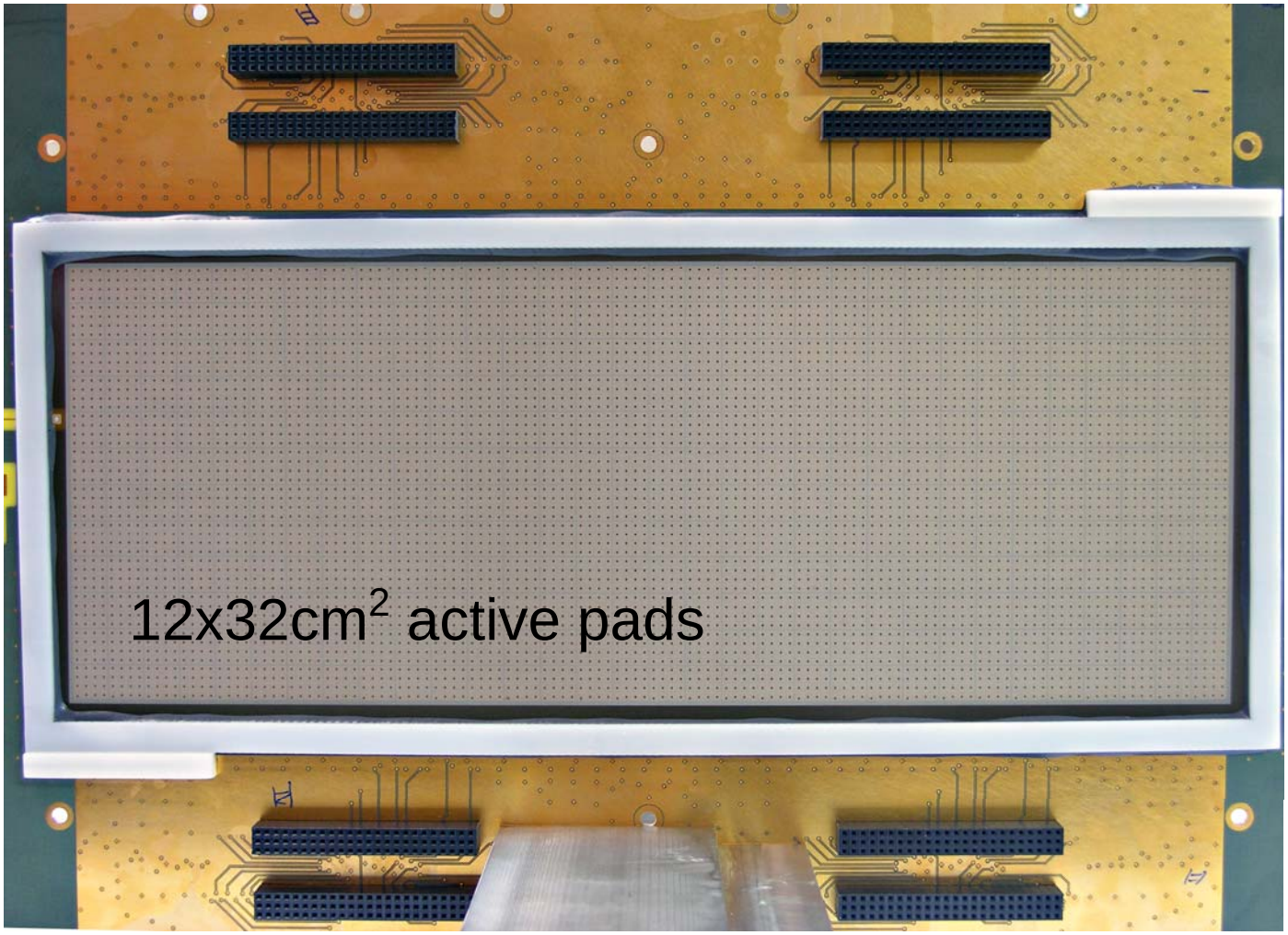


Future

- X-ray source, Cosmics, Test Beam
  - **pad homogeneity**
  - **prototypes disparity**
  - **more detailed X-talk studies**
  - **different gas mixture**
  - **efficiency measurements**
- Bulk with digital readout
- Mini calorimeter prototype (exposure in 2008)
- Design of a $1m^2$ MicroMegas

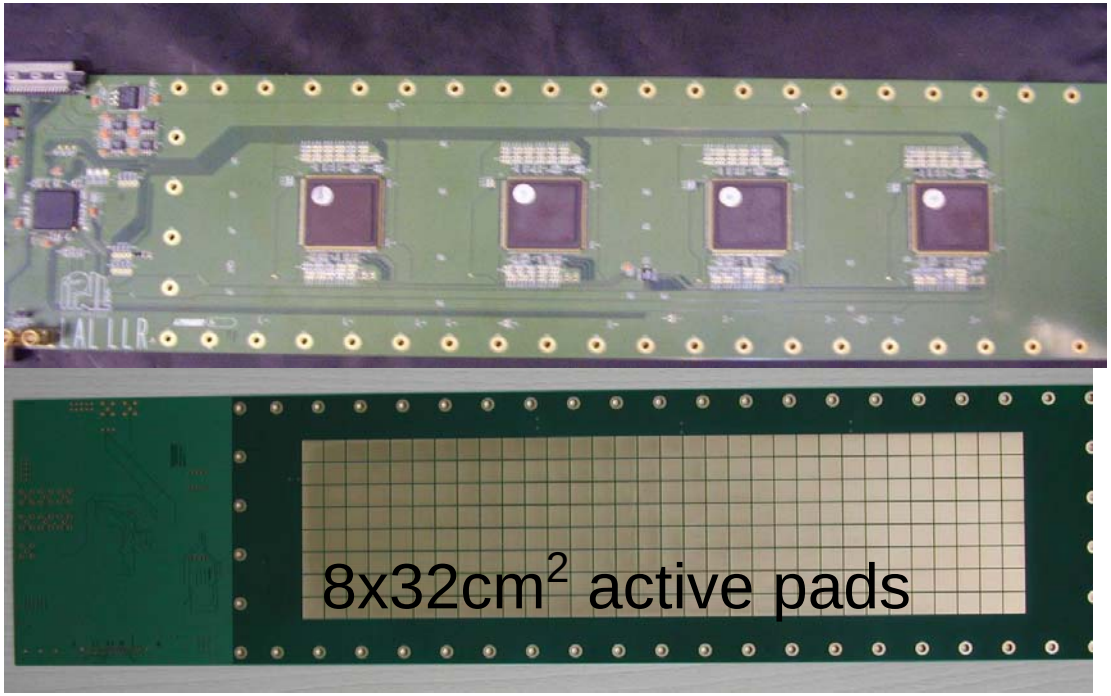
MicroMegas 12cmx32cm

- With Analogue Readout



MicroMegas 8cmx32cm

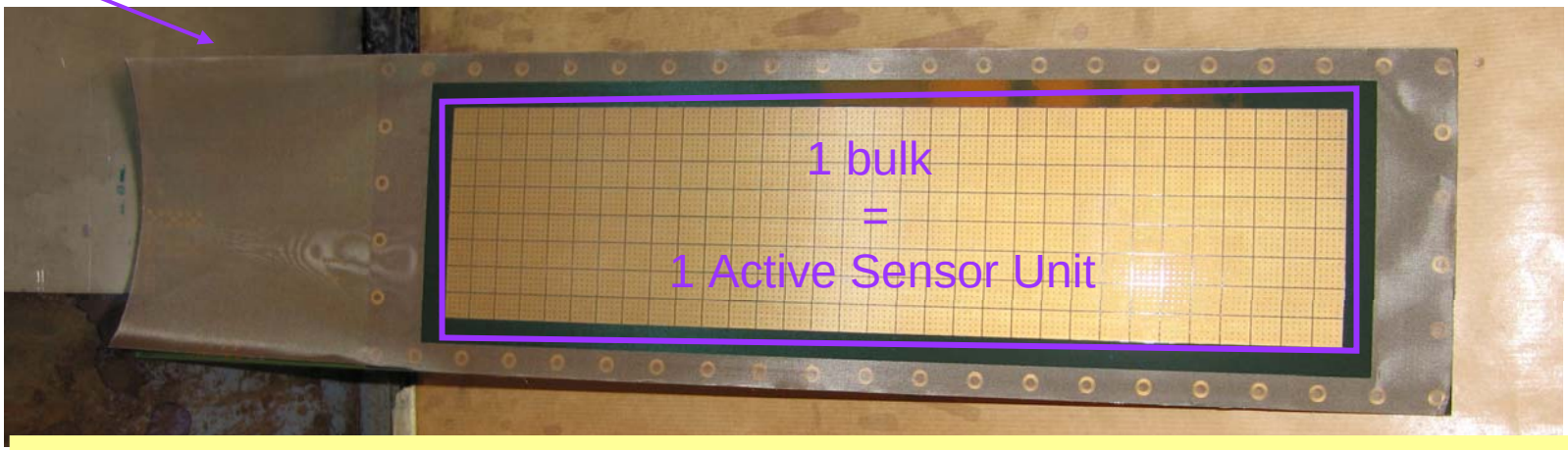
- With digital readout (4 HARDROC chips)
  IPNL-LLR PCB (500 μm interpad)



MicroMegas 8cmx32cm

- The first bulk with chips on PCB active part !

DIF

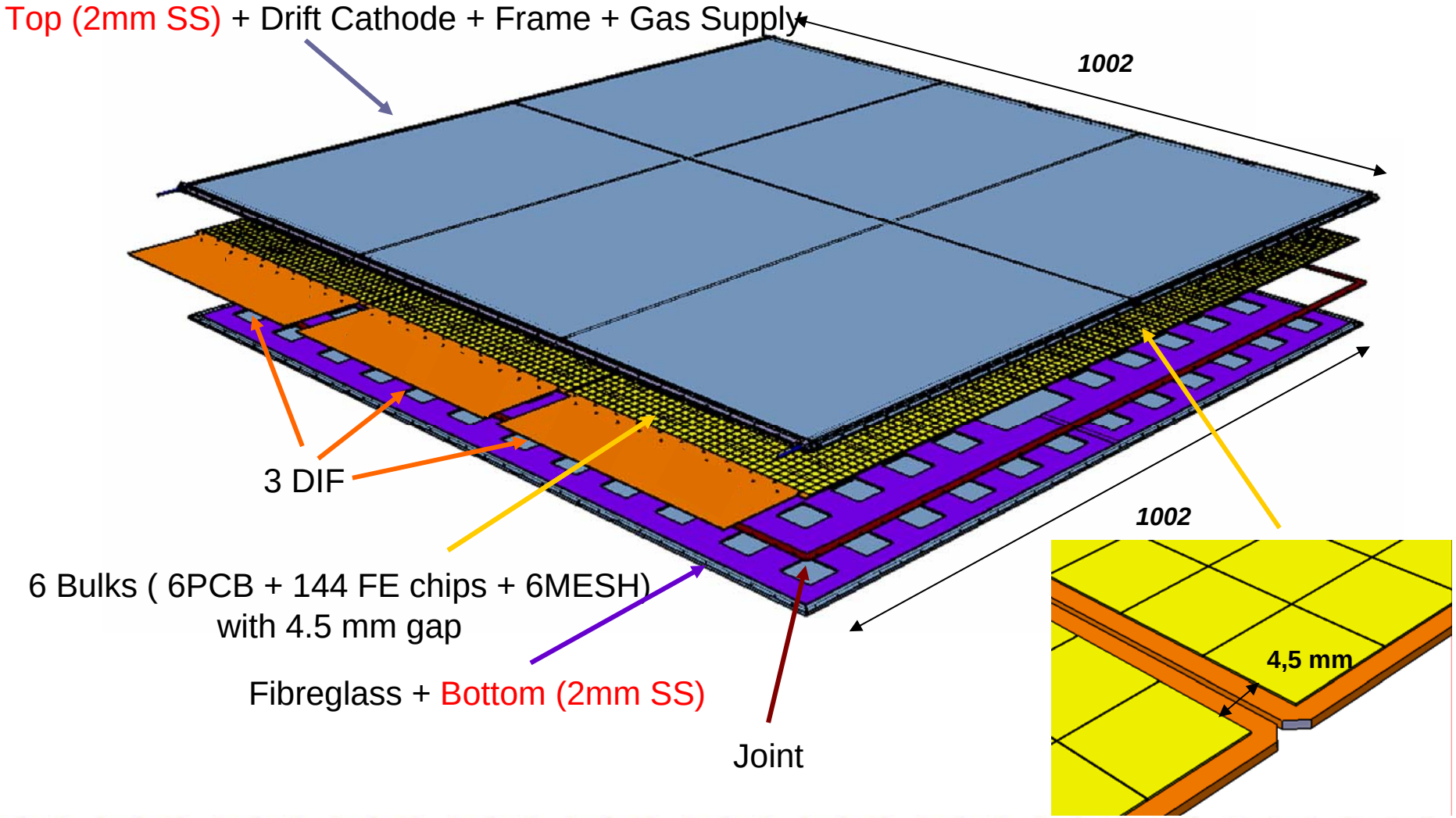


To be tested!

(New prototypes to come: ASU and DIF separated)

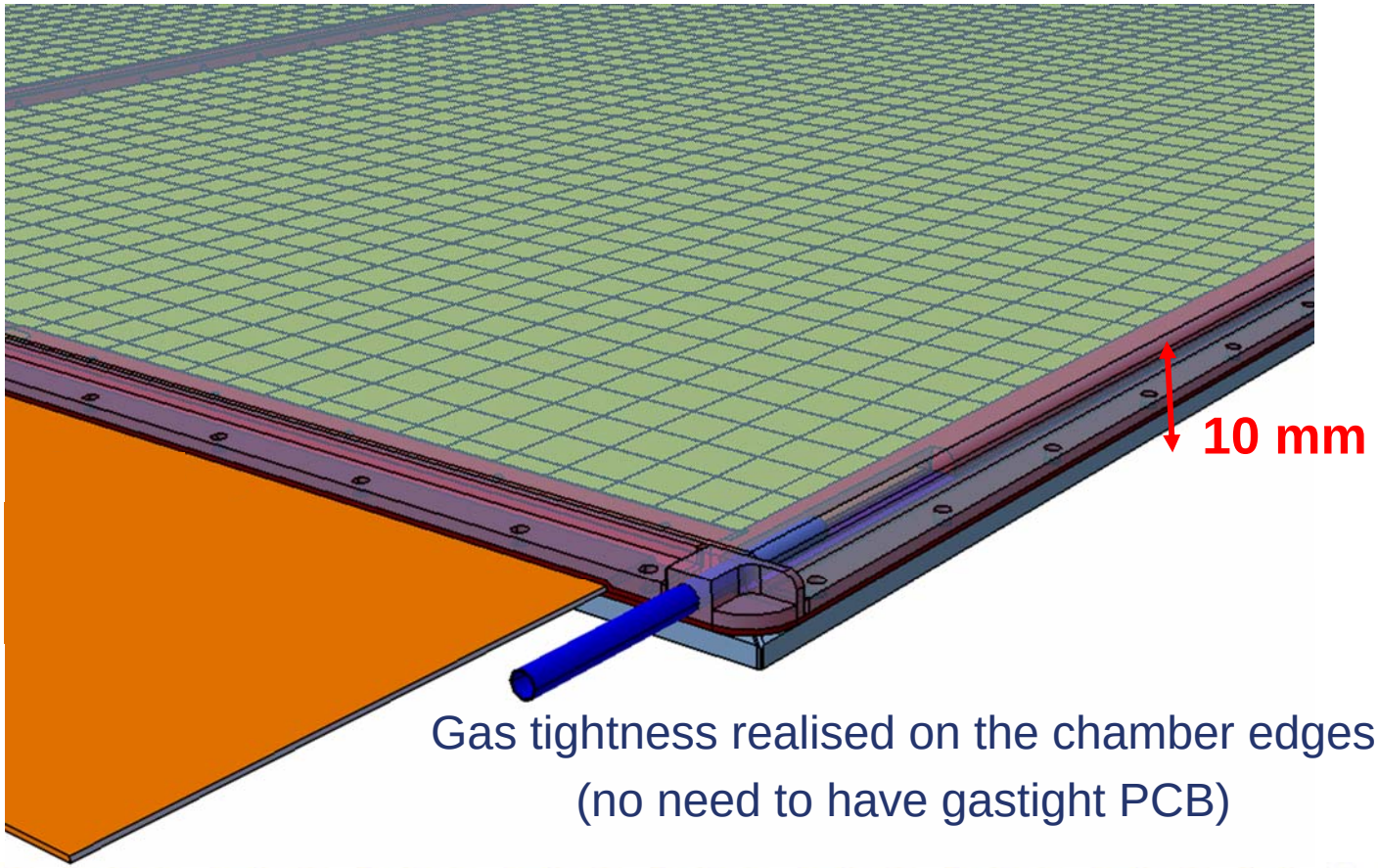
Design of a 1m^2 MicroMegas

- Case with 3 DIF (Digital InterFace)



Design of a 1m^2 MicroMegas

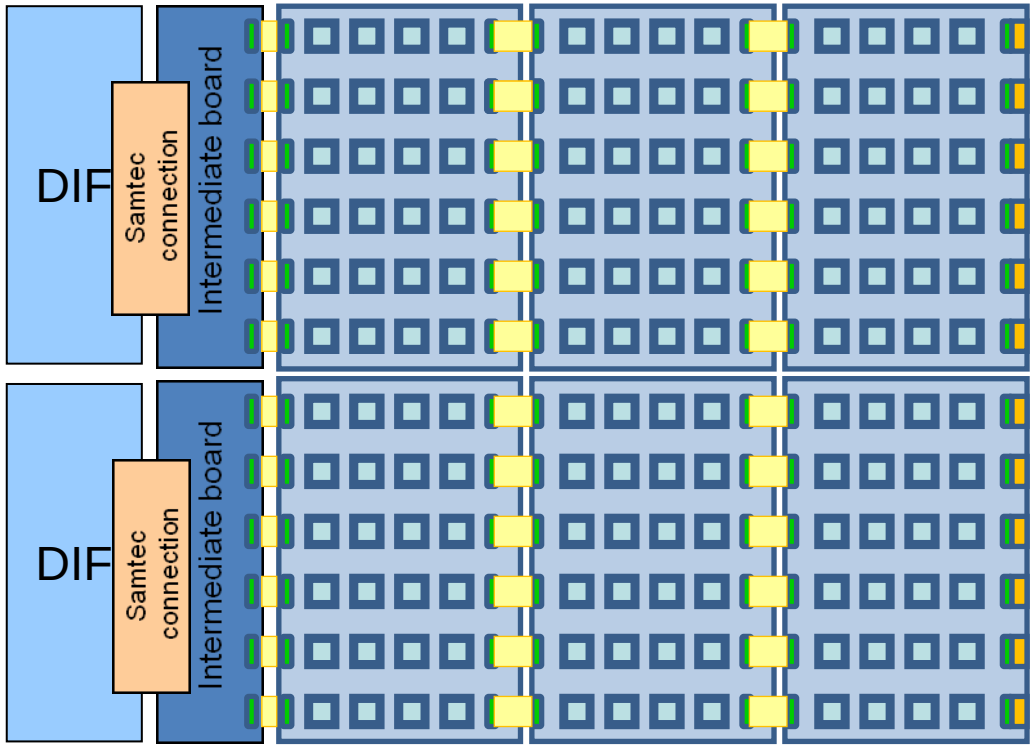
- 10 mm total thickness including
  - **4 mm SS (absorber)**
  - **6 mm active volume**



Gas tightness realised on the chamber edges
(no need to have gastight PCB)

Different designs

- 2 DIF case



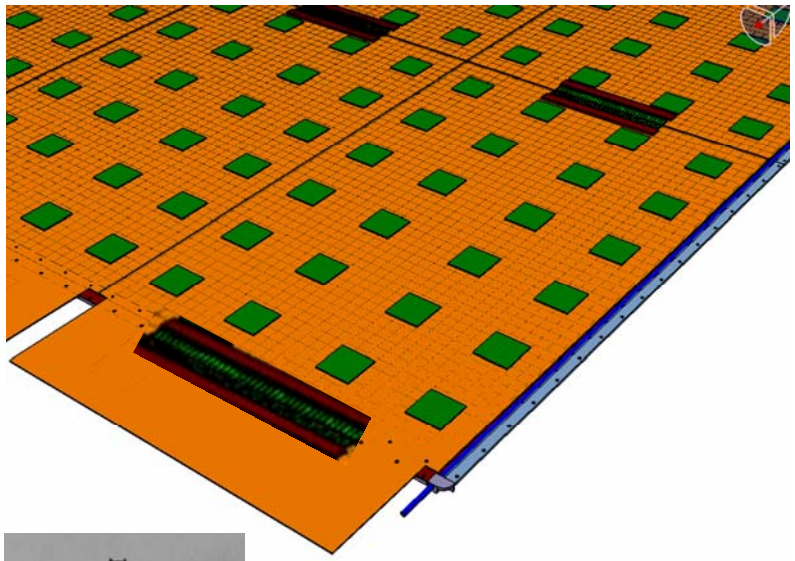
, : Flat Printed Circuit (kapton)

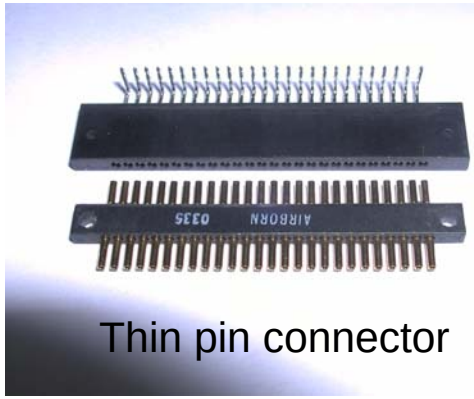
: FE chip

: Hirose connector

: Terminaison board

- 3 DIF case



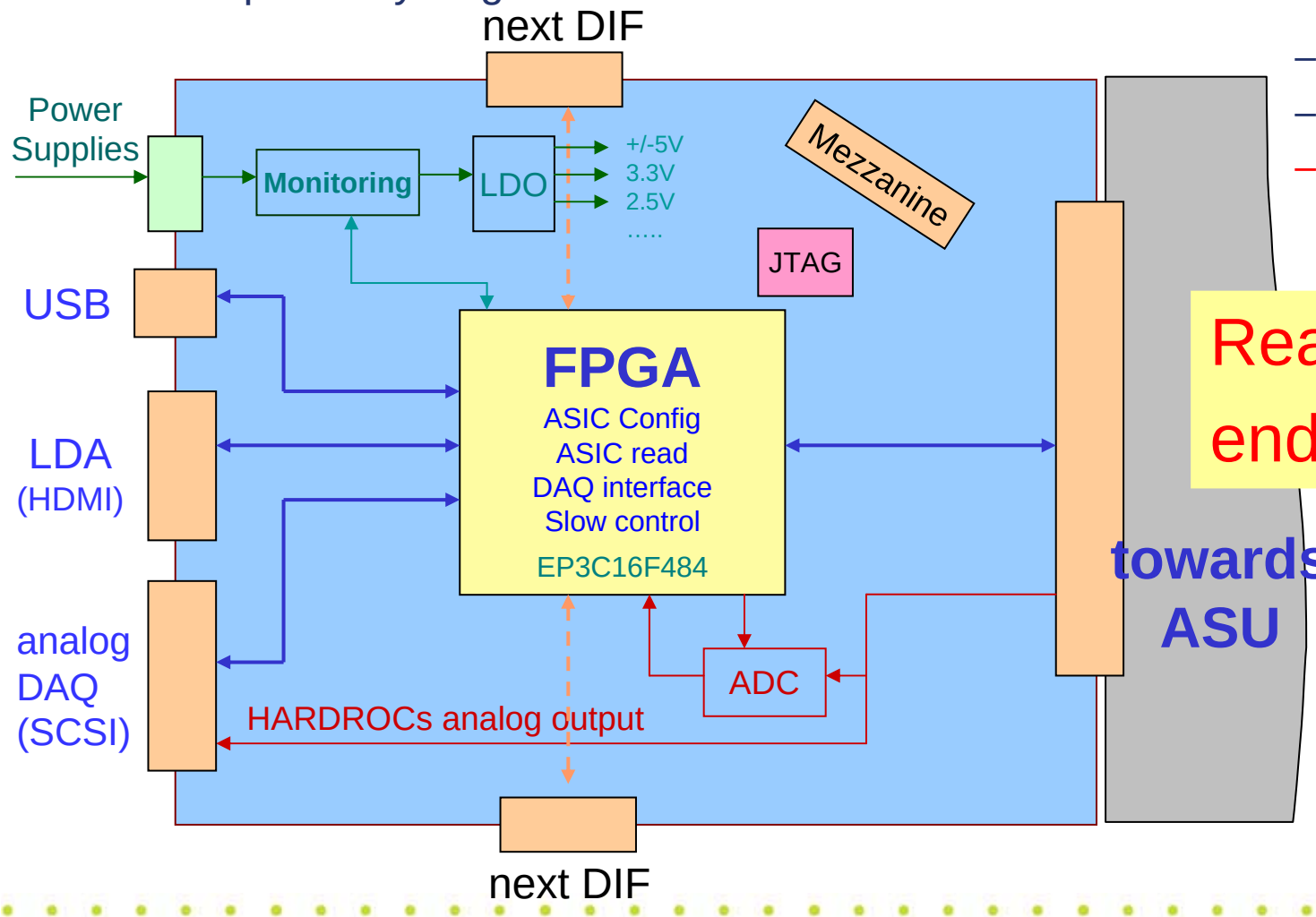


Thin pin connector

Design of the Digital InterFace (DIF)

- Separated from the slab for more flexibility.
- up to 100 FE chips (HARDROC or IPNL chip) with power cycling

- Interfaces with :
  - **The final DAQ (via LDA, …)**
  - **The analog DAQ**
  - **Neighboring DIFs.**
  - **PC through USB for standalone tests and debugs.**



Ready for tests : end of May

Conclusion

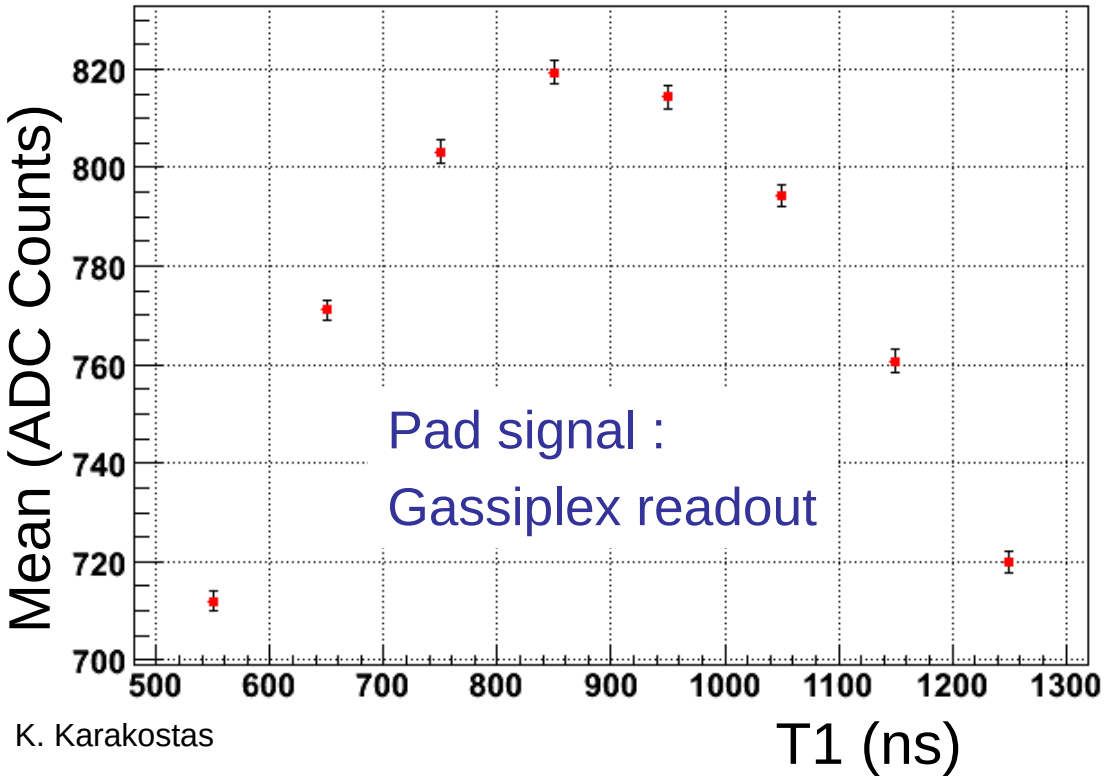
- First results on small MicroMegas prototypes
- MicroMegas Techno looks promising and competitive with other gas detectors.
- Large area prototype under way : towards $1m^3$ (project supported by ANR)
- Possibility to build a larger community

Backup slides

X-ray Results

- T1 Optimisation for Gassiplex readout

V_{mesh} = 390 V
V_{drift} = 440 V
E_{mesh} = 32.5 kV/cm
E_{drift} = 167 V/cm



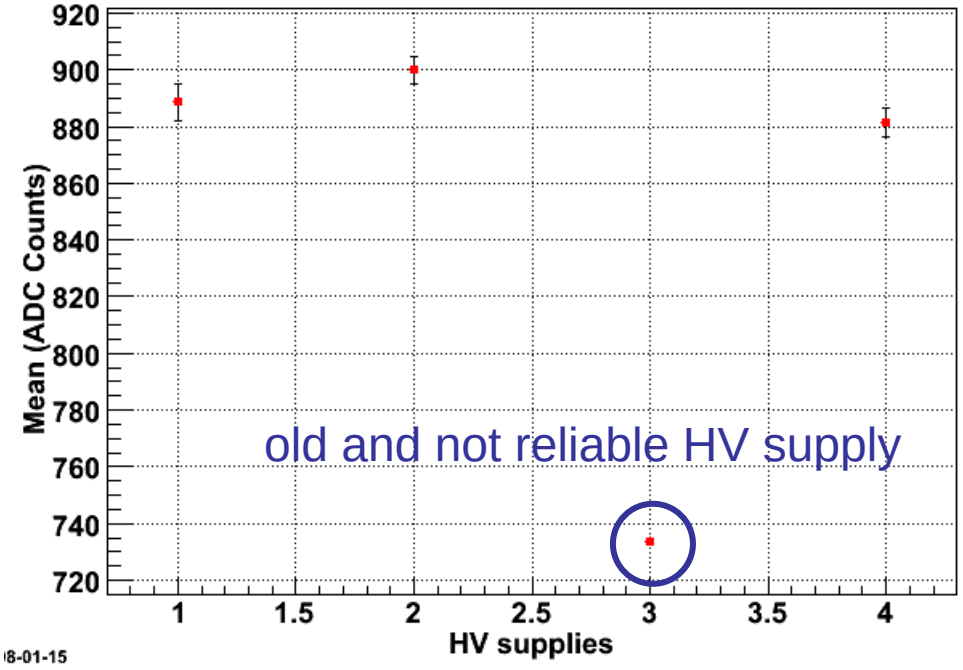
K. Karakostas

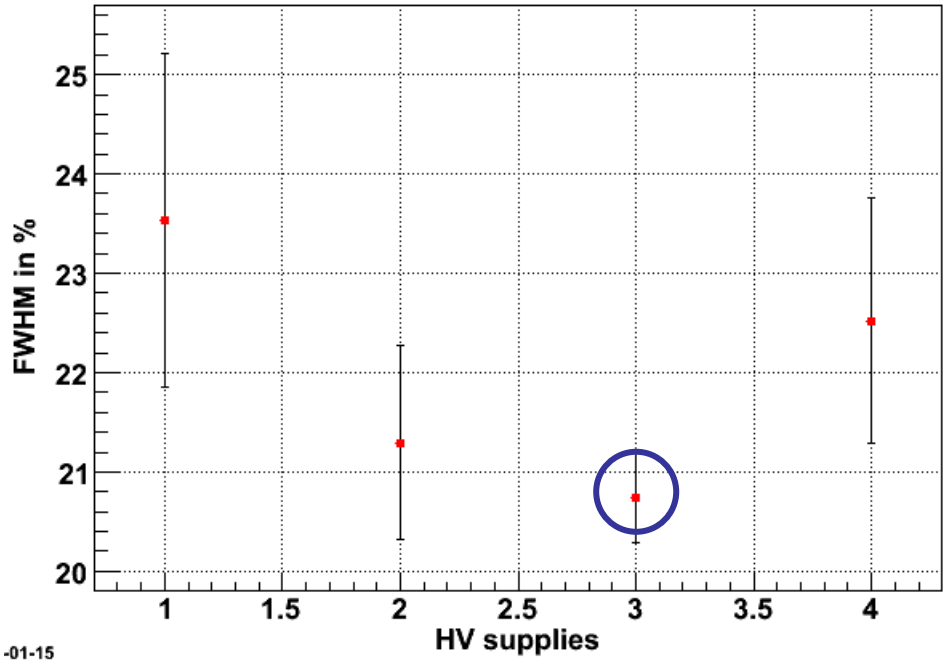
Charge = 820(1500mV)/1024/3.6(mV/fC) = 334 fC

X-ray Results

- HV supply dependencies

V_{mesh} = 390 V
V_{drift} = 450 V
E_{mesh} = 32.5 kV/cm
E_{drift} = 200 V/cm





No significant difference between HV supplies