DHCAL with MICROMEGAS

Catherine Adloff

Overview

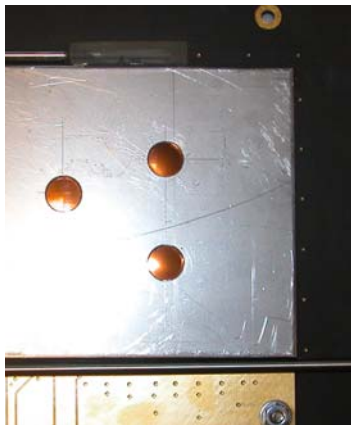
- MicroMegas with Analog Readout
- MicroMegas with Digital Readout
  - HARDROC
  - New ASIC from IPNL
- Near future
  - Mini calorimeter prototype
  - ASU
  - DIF
  - Design of a $1m^2$ MicroMegas

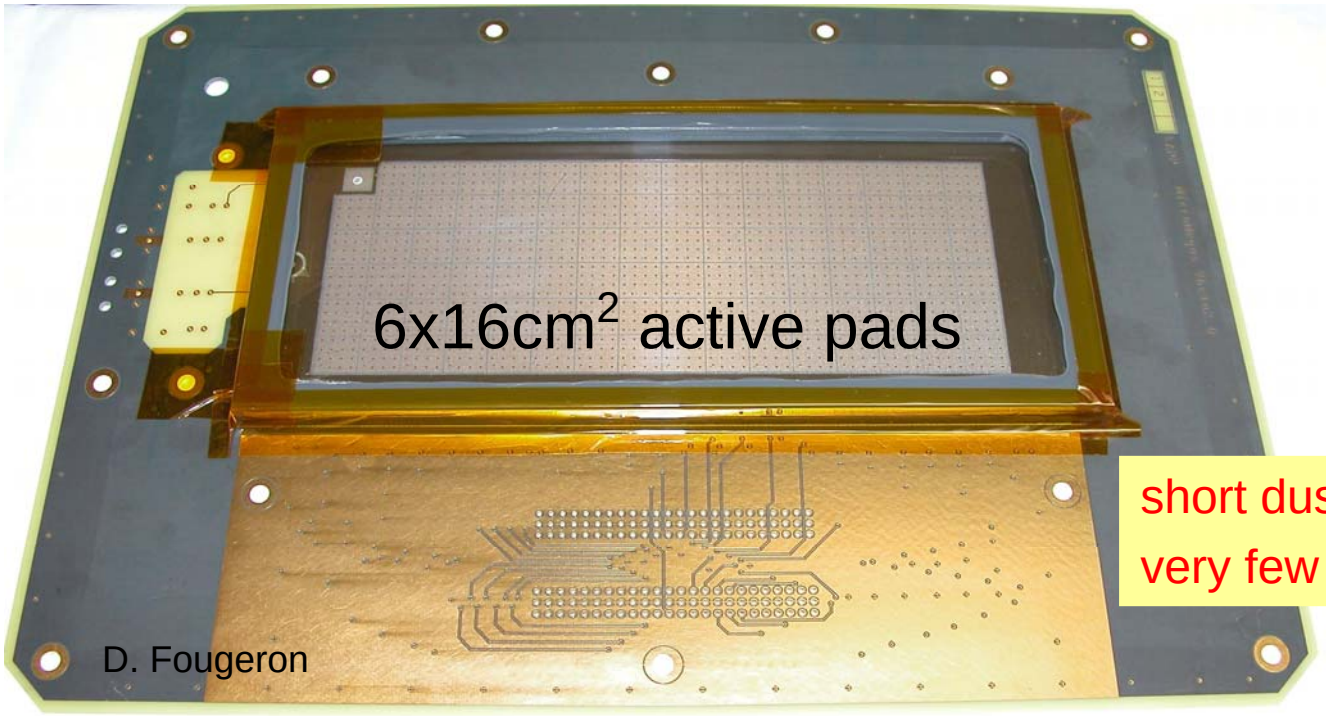
MicroMegas Prototypes

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

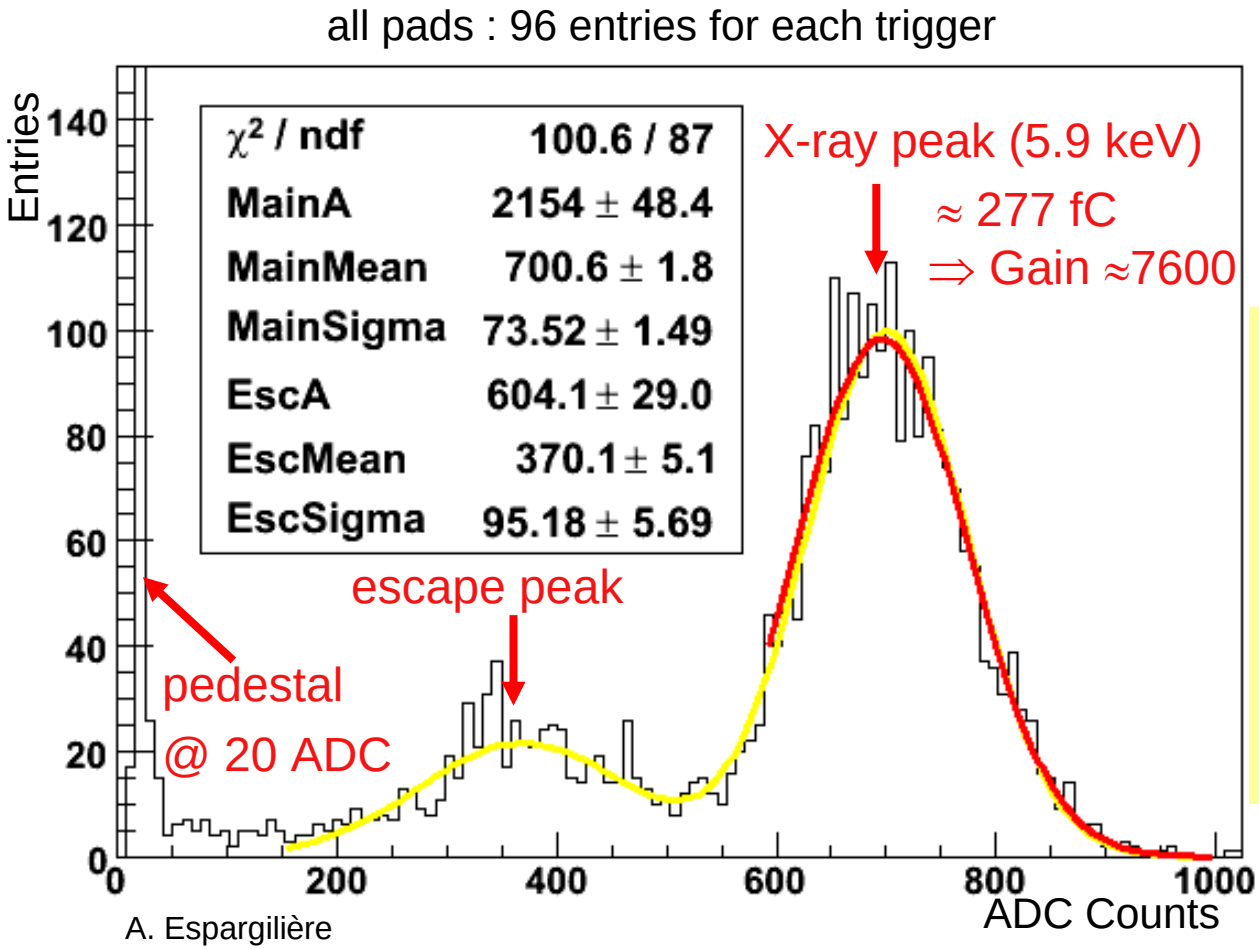




short dust burning time !
very few sparks during functioning

X-ray Results

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



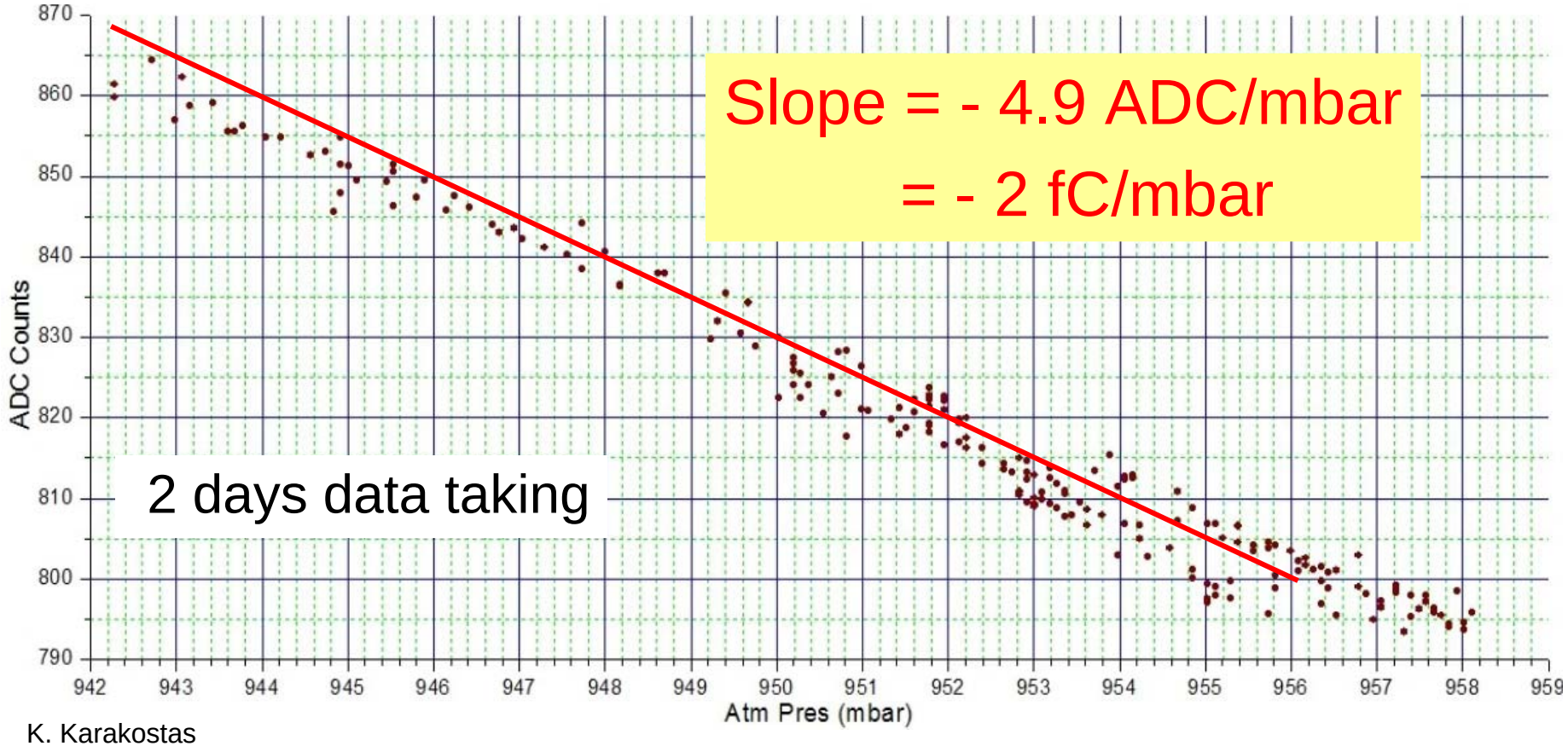
V_{mesh} = 420 V
V_{drift} = 470 V
E_{mesh} = 35 kV/cm
E_{drift} = 167 V/cm

Already done :

- Response versus V_{mesh}
- Response versus V_{drift}
- Gas flow dependencies
- Time stability
- HV supply dependencies

X-ray Results

- Time Stability



K. Karakostas

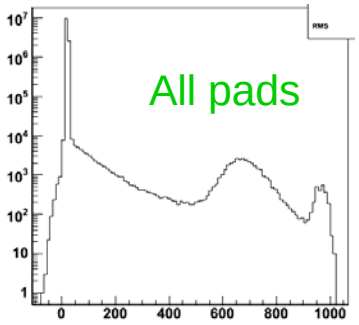
Gain ↘ when Atmospheric Pressure ↗

X-ray + Cosmics

- ^{55}Fe source (5.9 keV $\rightarrow$ 228e^- in drift volume) on top of one pad for gain monitoring
- Trigger on mesh : preamp (T output) + fast ampli
  or
  Trigger on 3 scintillators coincidence

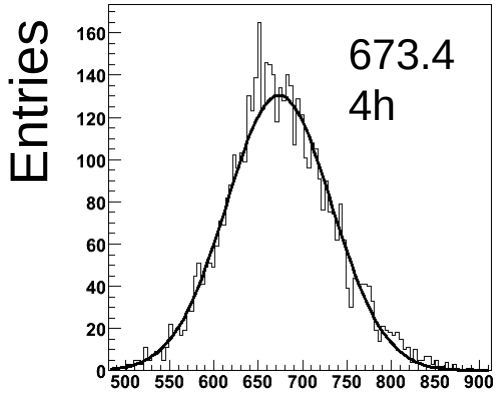
V_{mesh} = 400 V
V_{drift} = 450 V
E_{mesh} = 33 kV/cm
E_{drift} = 167 V/cm

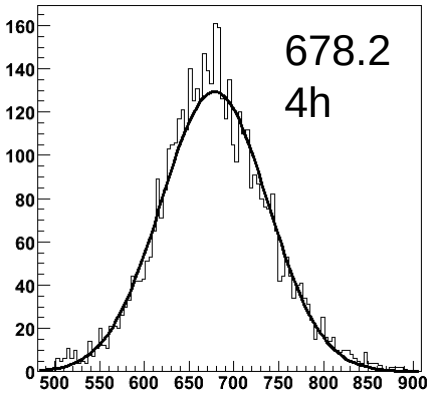
Example : 1 night data taking
2 chambers



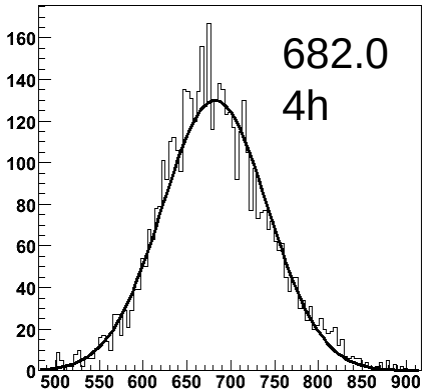
Pad with source only:

P = 967mbar





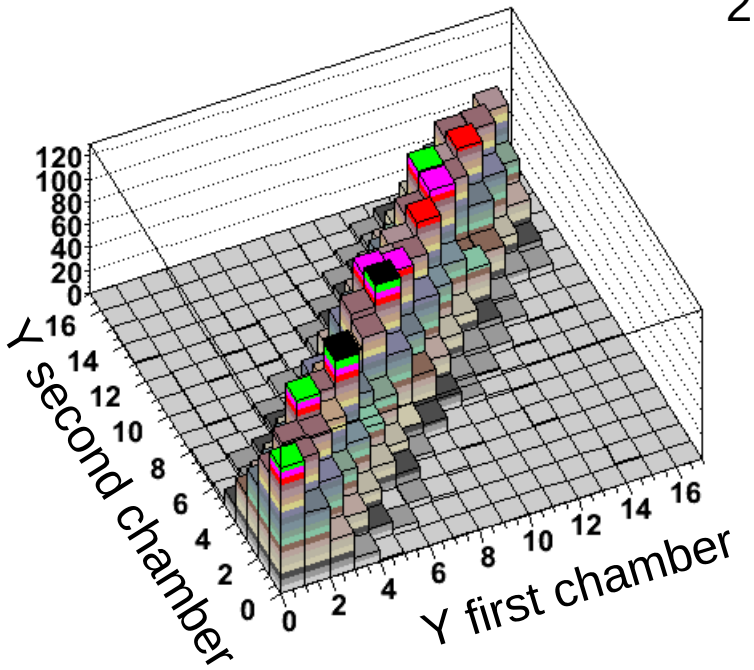
P = 966mbar

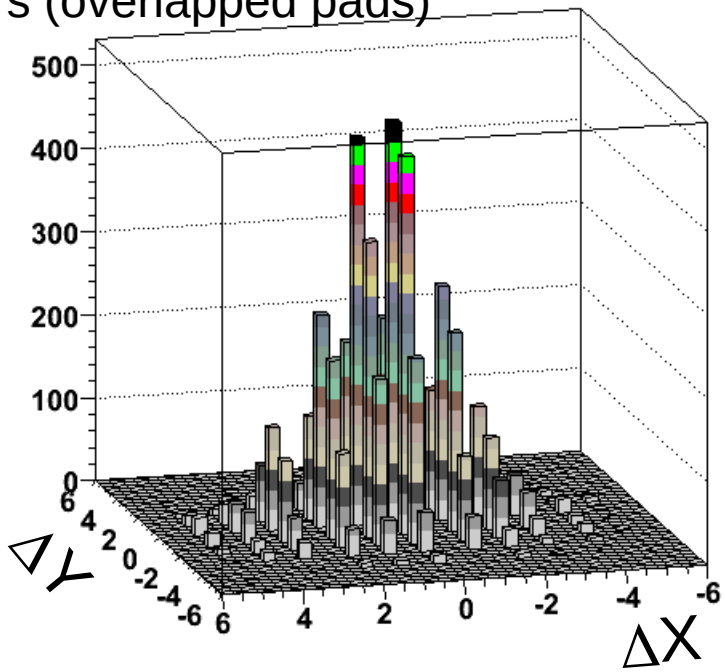


X-ray + Cosmics

- Pad with source cut out
- Muon selection : ADC > 40 (see January slides)

Example : 1 night data taking
2 chambers (overlapped pads)



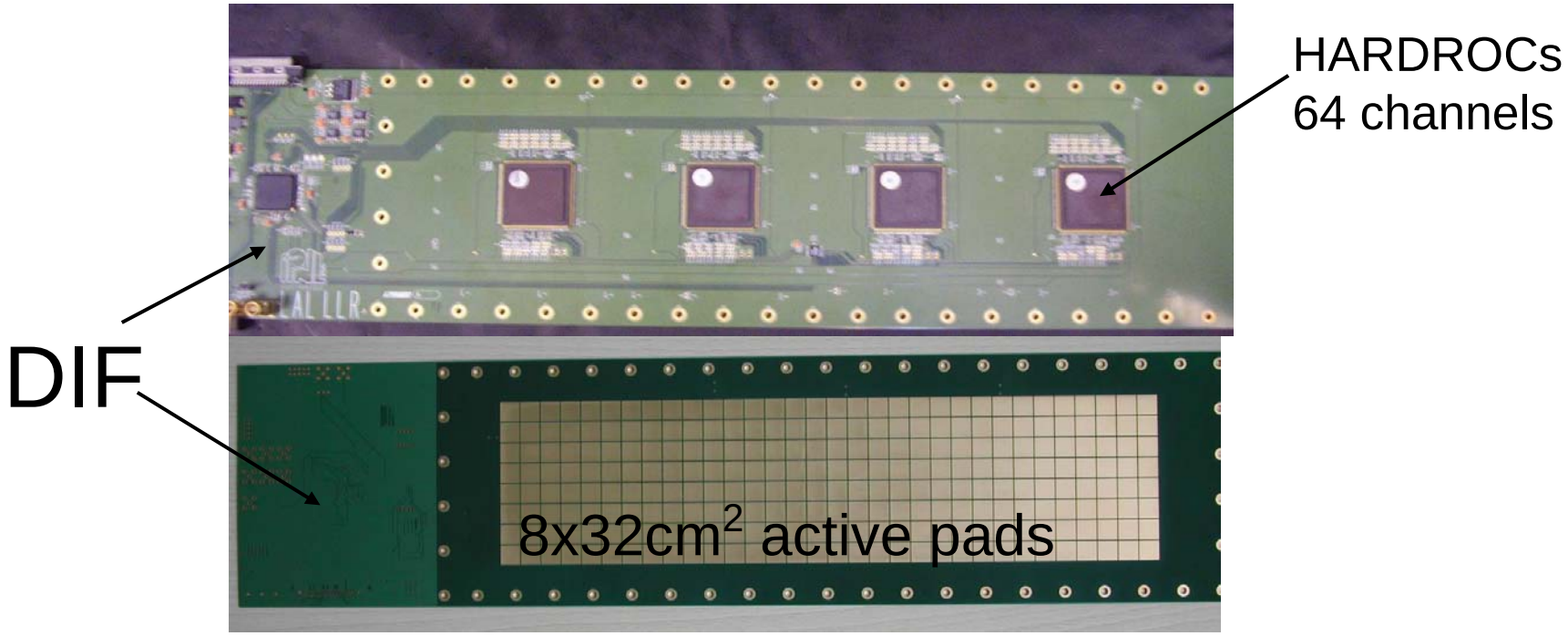


Ready for cosmics acquisitions for days with 4 prototypes!

- pad homogeneity
- X-talk studies
- prototypes disparity
- efficiency measurements

MicroMegas 8cmx32cm

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



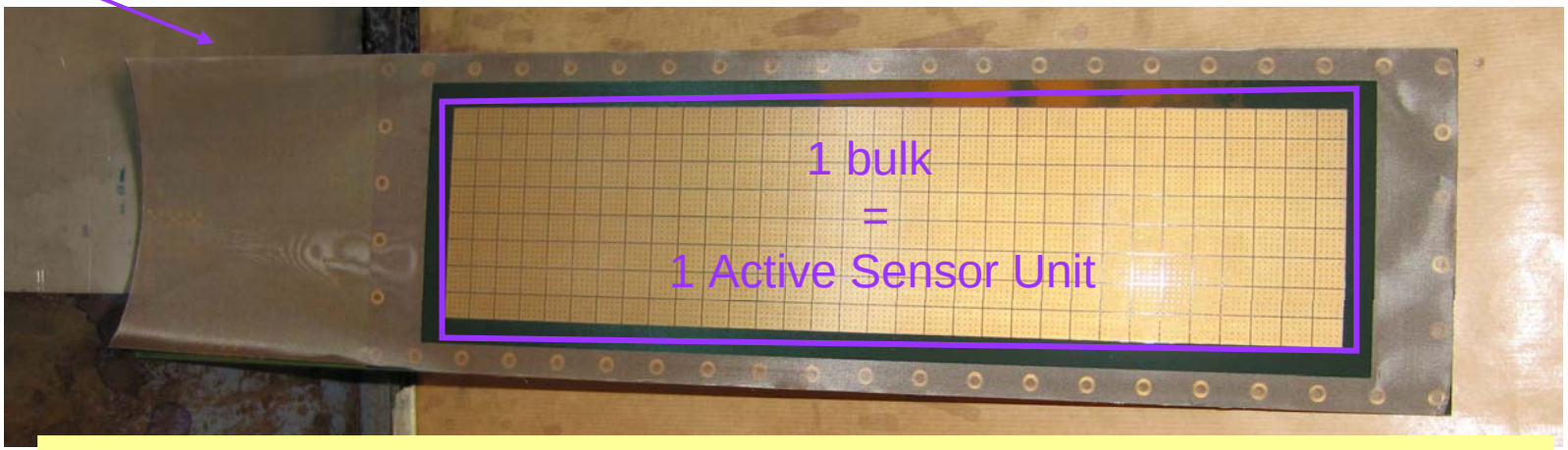
Toward a DHCAL!

(also equipped with RPC : IPNL)

MicroMegas 8cmx32cm

- The first bulk with ASICs on PCB active part !

DIF

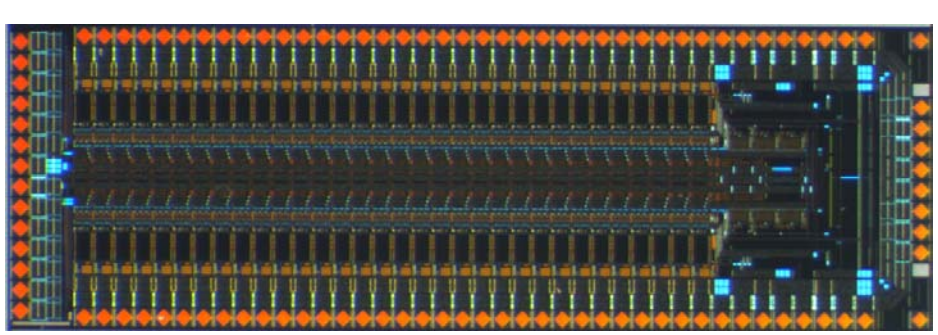


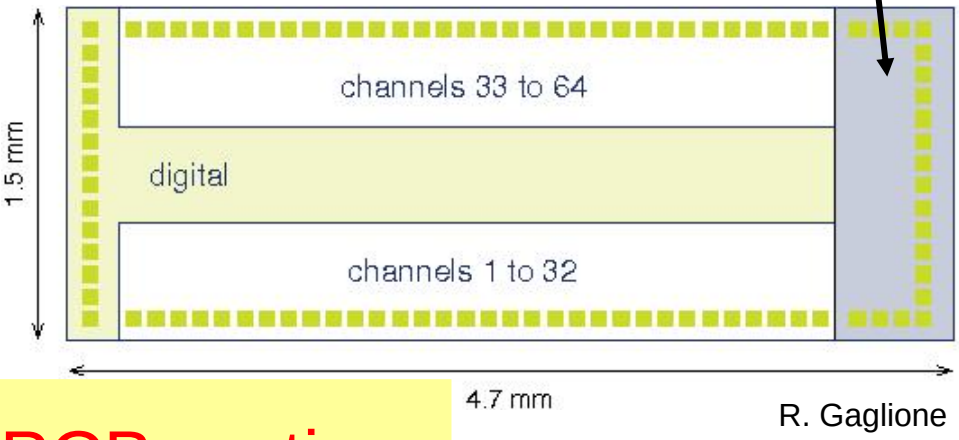
under test right now at IPNL (H. Mathez):

Power Supply ✓ USB Interface ✓

New ASIC from IPNL

- 0.35 μm CMOS technology
- 64 Analog Inputs
- 3 thresholds (DAC 8 bits)
- Covers a large dynamic range
  - RPC : 100 fC to 10 pC (gain= 0.1mV/fC)
  - MicroMegas : 10 fC to 200fC (gain= 5mV/fC)
- Power pulsing



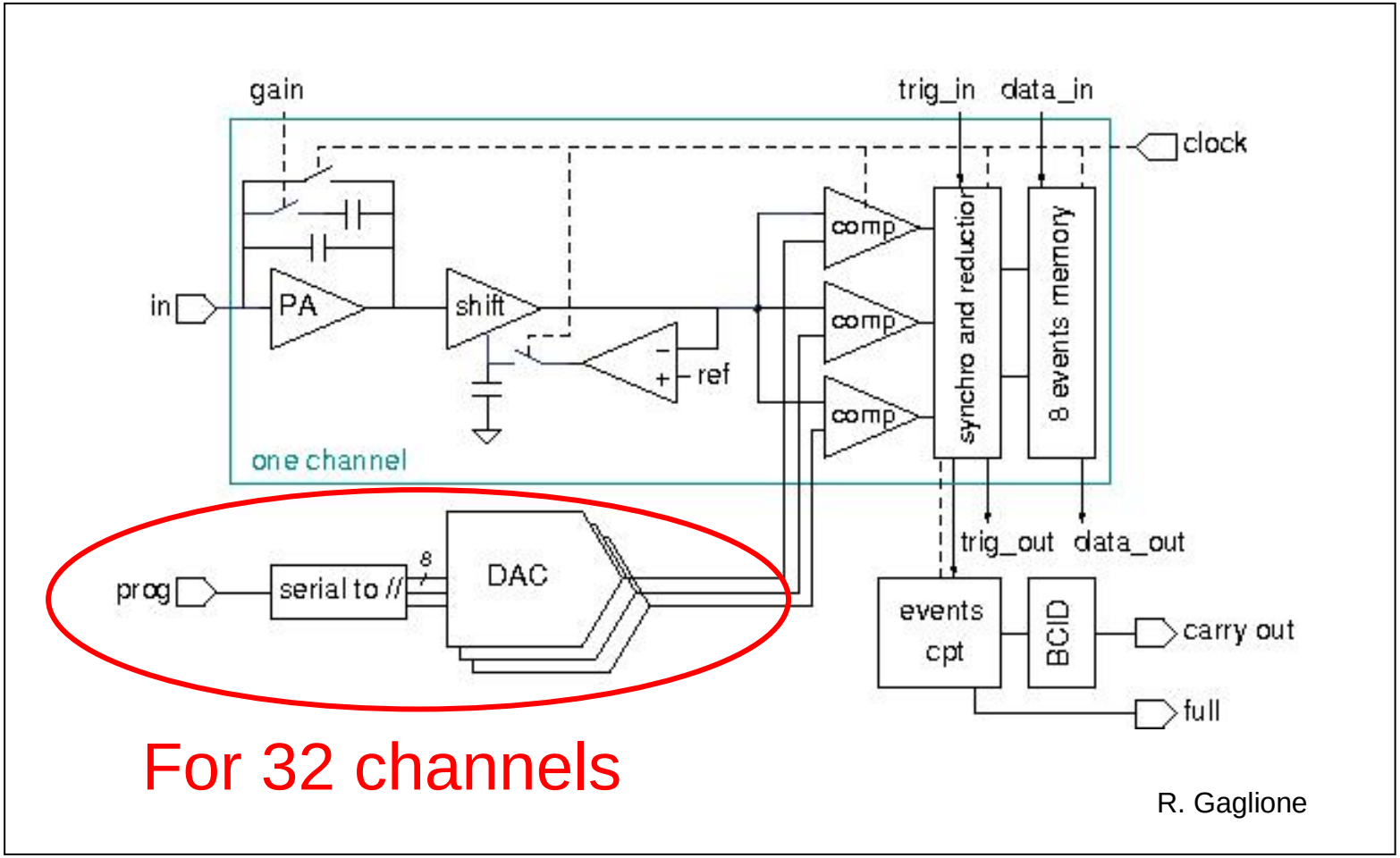


R. Gaglione

Cheap and Easy PCB routing

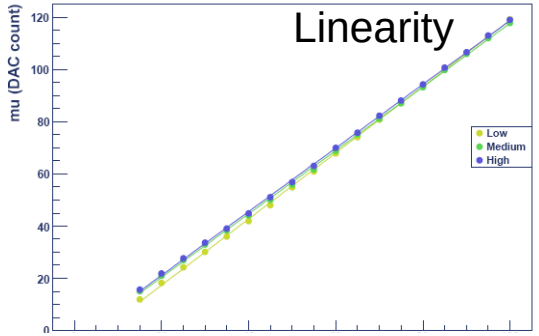
New ASIC from IPNL

- Schematic

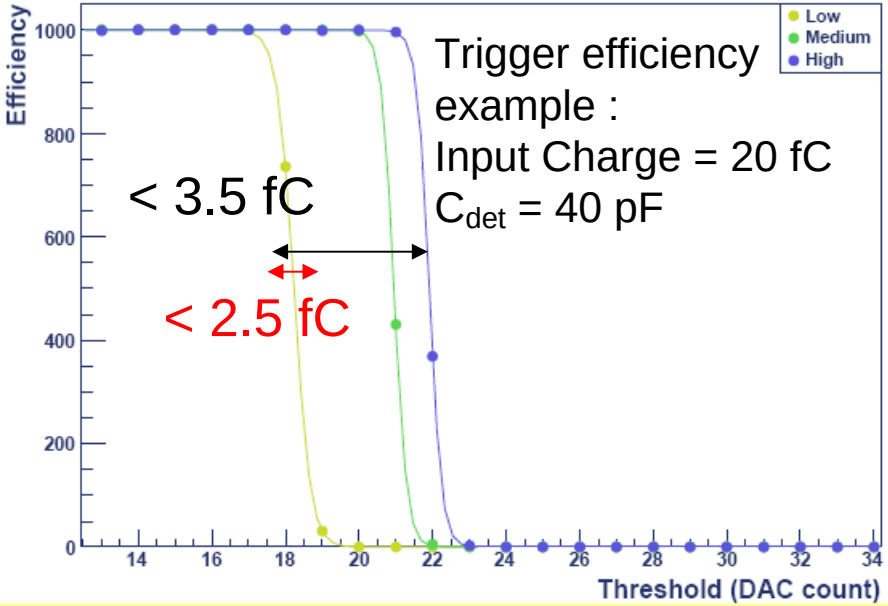


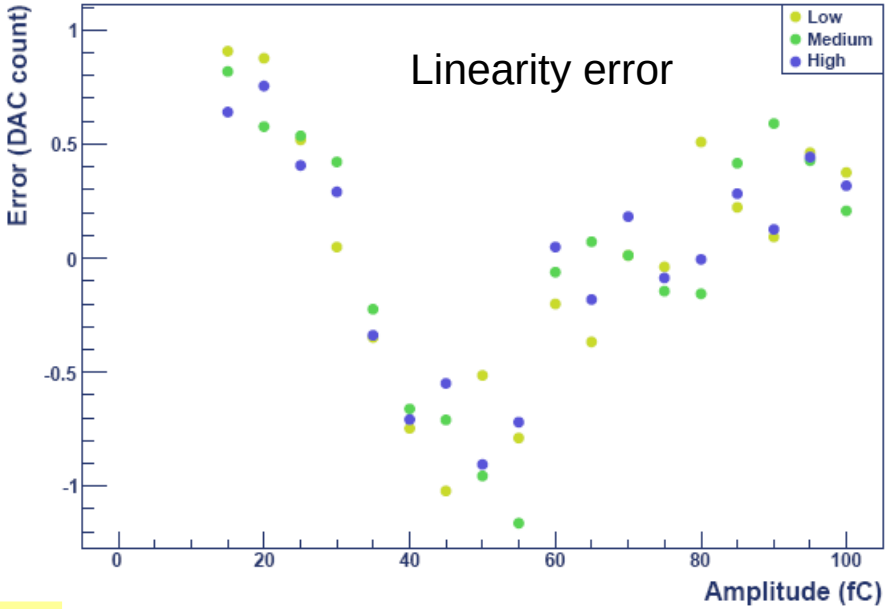
New ASIC from IPNL

- First Results (MIP @ 30 fC)



R. Gaglione





Noise for one comparator < 2.5 fC

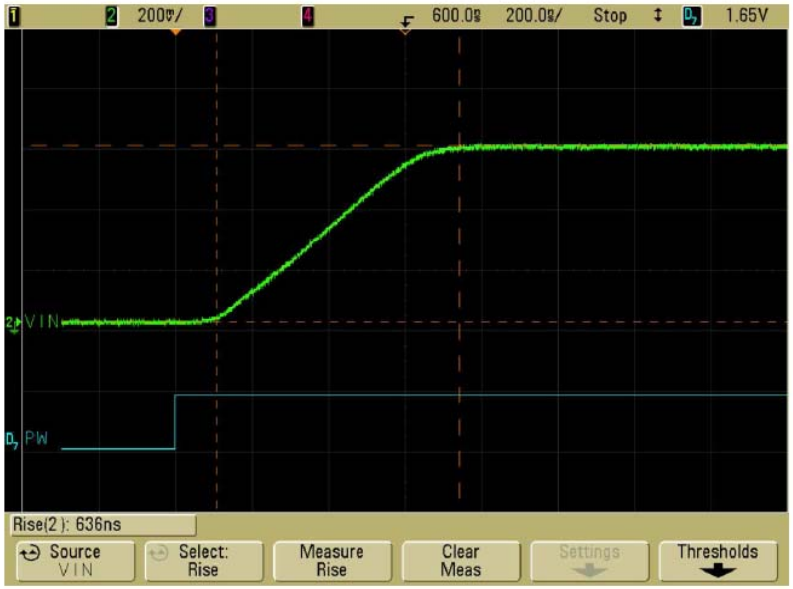
Total dispersion < 3.5 fC

Linearity error < 1.6 fC

(MIP @ 30 fC)

New ASIC from IPNL

- Power Pulsing



Preamp
Bias Voltage

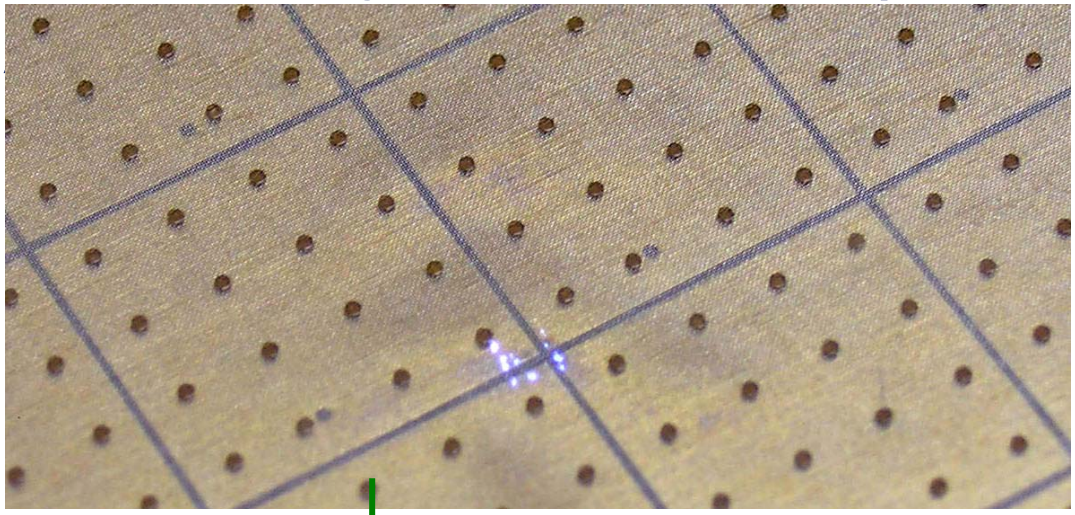
Wake up time < 800 ns

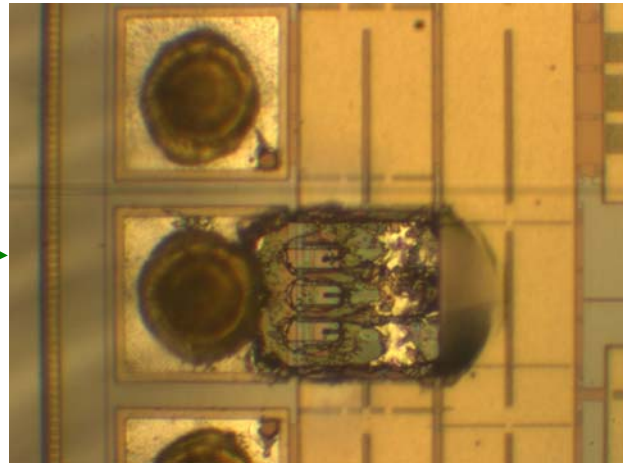
- Power Consumption :
  1 mW/channel

⇒ 10 μW/Channel with power pulsing
500 W for a 50 Million channels DHCAL

New ASIC from IPNL

- Some nasty tests with the previous 4 channels

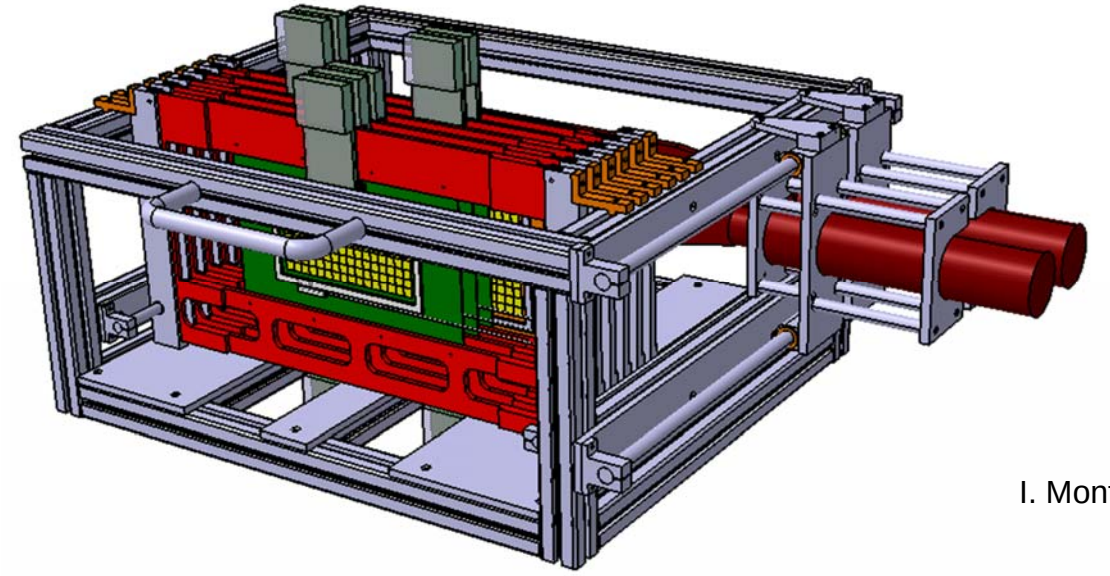




⇒ **strong** protection
for sparks
is compulsory
(see Gassiplex card)

Mini calorimeter prototype

- Test Beam : August 2008 at CERN
  - 3 MicroMegas-Gassiplex 6cmx16cm ✓
  - 2 MicroMegas-Gassiplex 12cmx32cm ✓
  - Stainless Steel Absorbers



I. Monteiro

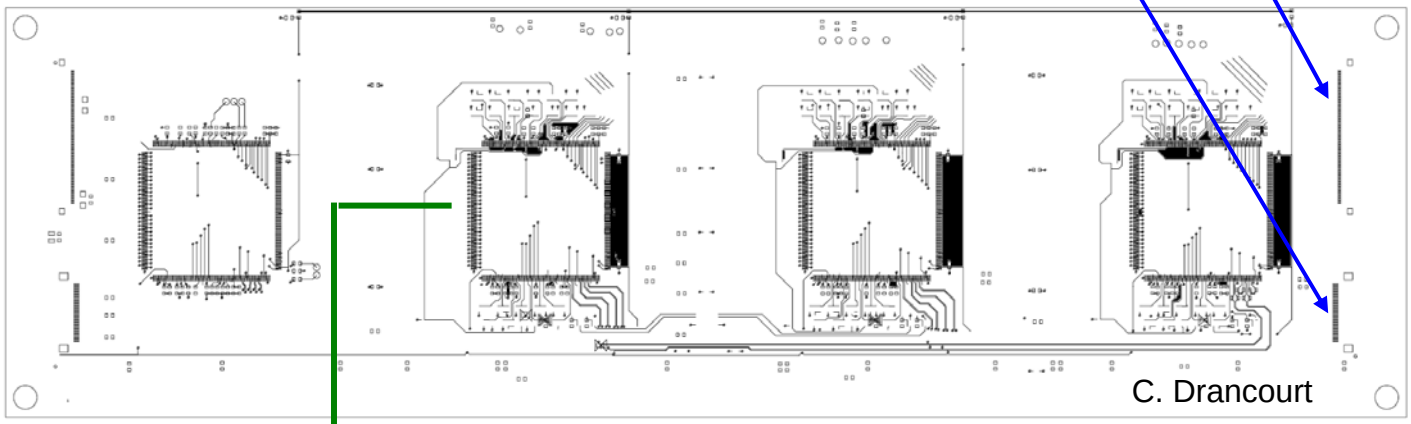
Mini calorimeter prototype

- Test Beam : November 2008 at CERN
  - 3 MicroMegas-Gassiplex 6cmx16cm ✓
  - 2 MicroMegas-Gassiplex 12cmx32cm ✓
  - 3 to 4 MicroMegas with digital Readout
    ASU and DIF separated
    - ASU with HARDROC 8cmx32cm
    - ASU with IPNL ASIC 8cmx8cm
  - Stainless Steel Absorbers

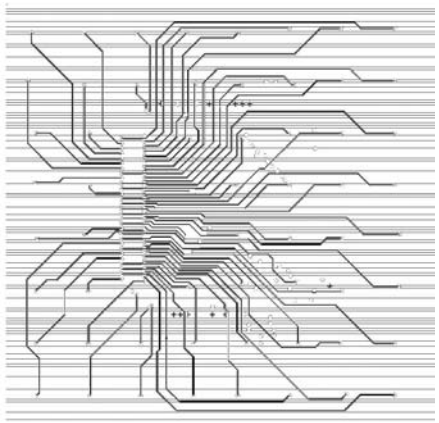
ASU with HARDROC

- Based on the IPNL 8 layers PCB with 4 HARDROCs
- No more lines or components outside the pads area (see ASU assembly)
- Analogue Input with sparks protections

Daisy chain In/Out (hirose connetors)

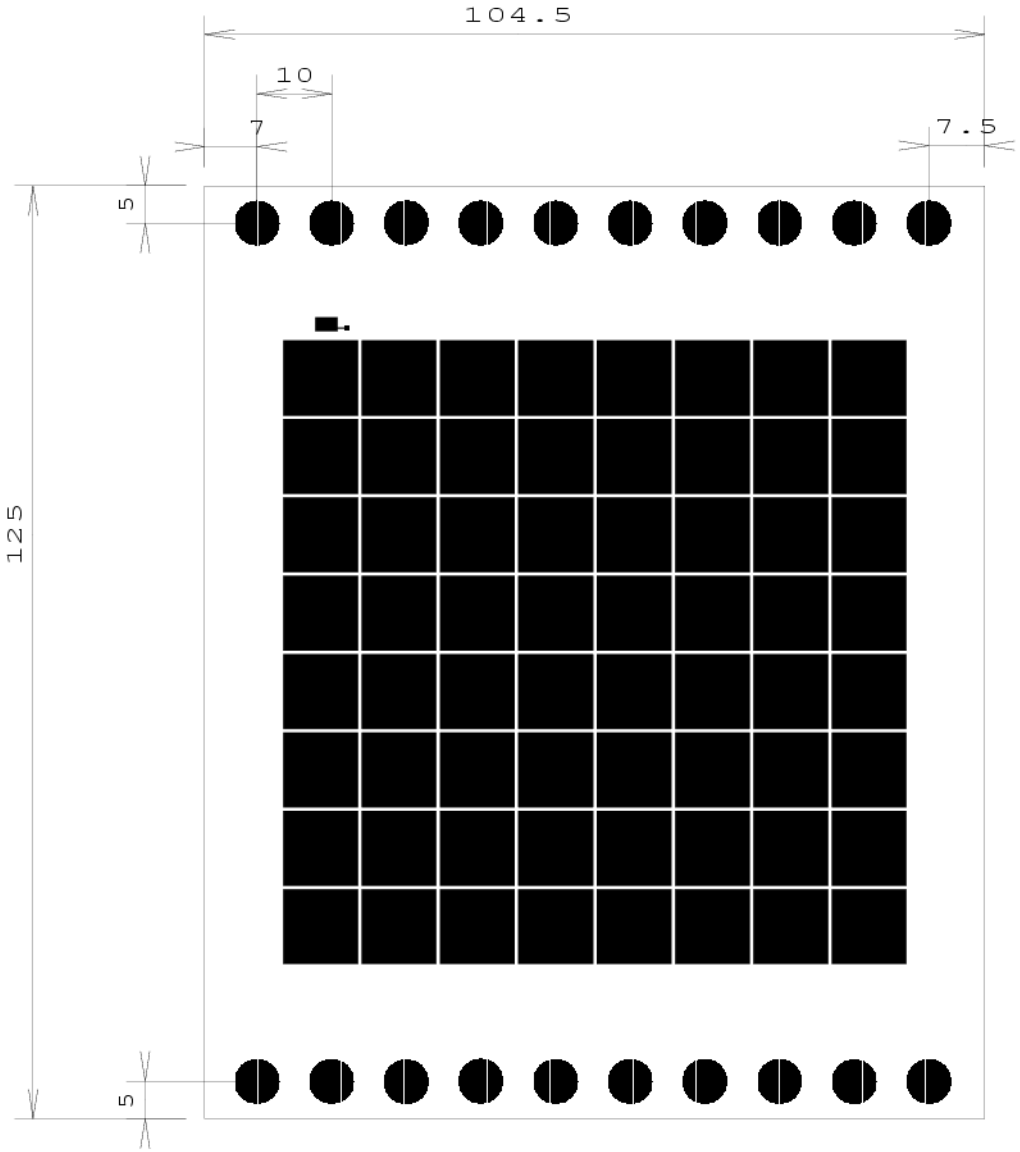


Analog Inputs

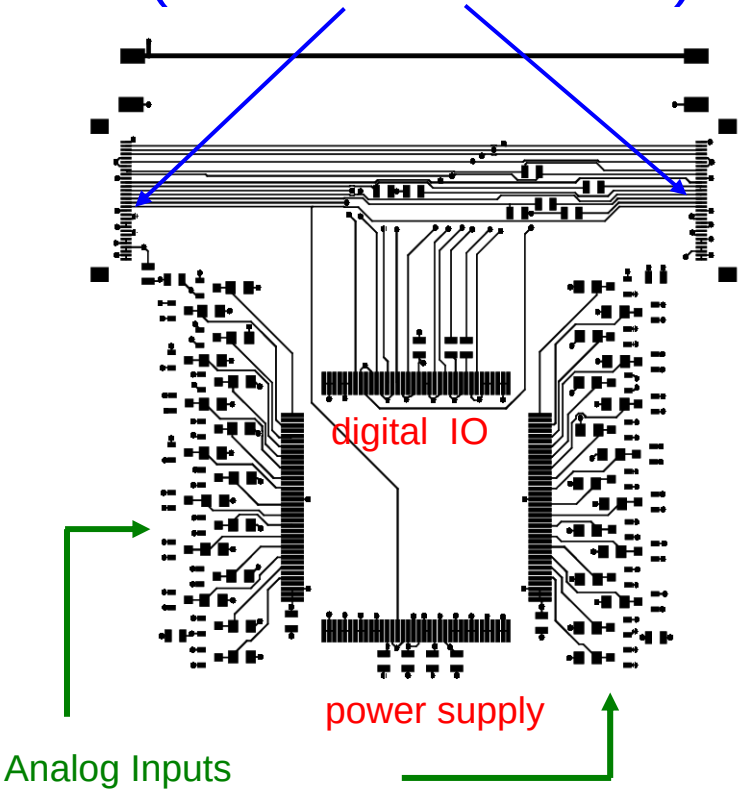


ongoing work

ASU with IPNL ASIC



- 6 layers PCB

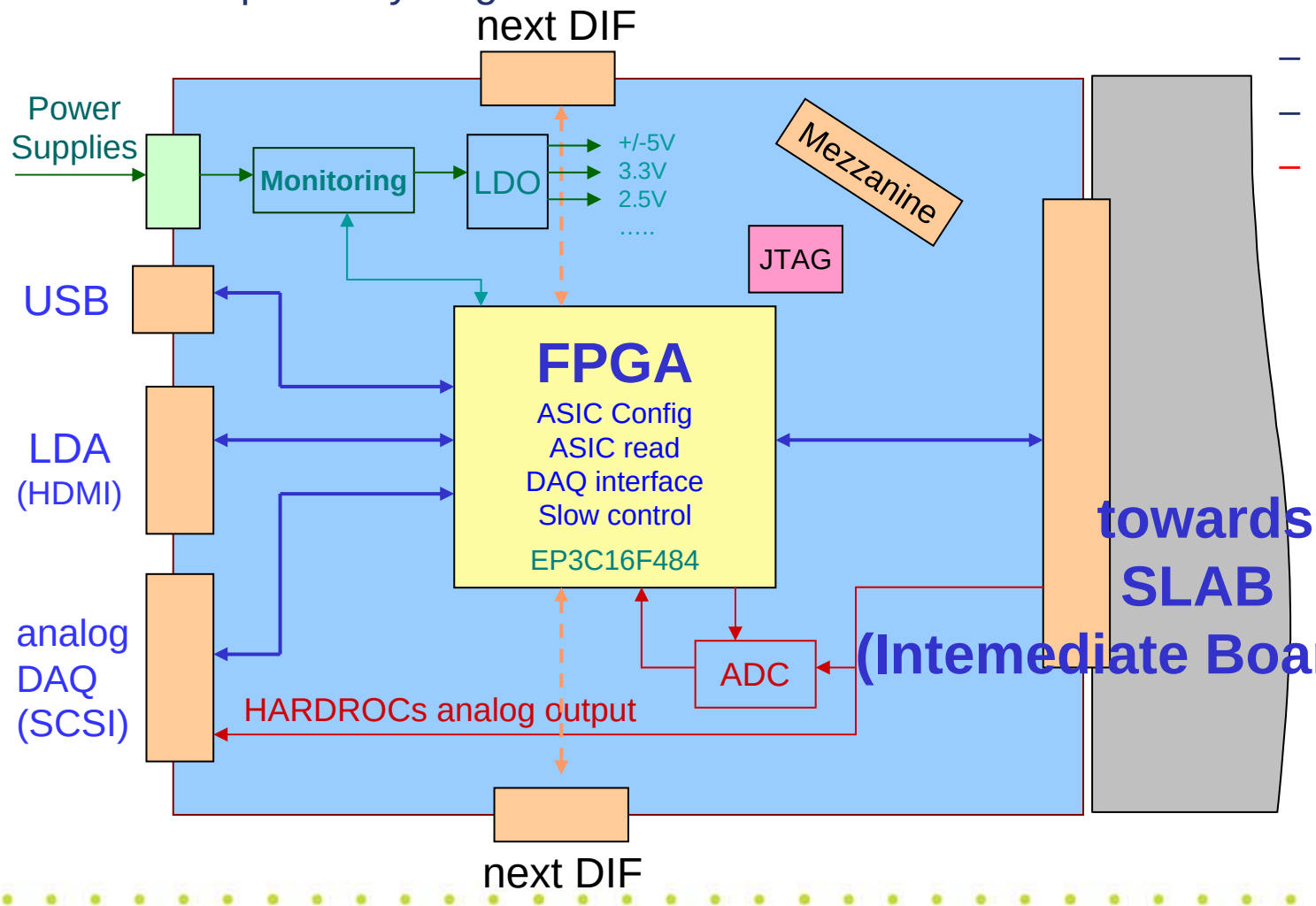


M. Miguet

Digital InterFace (DIF)

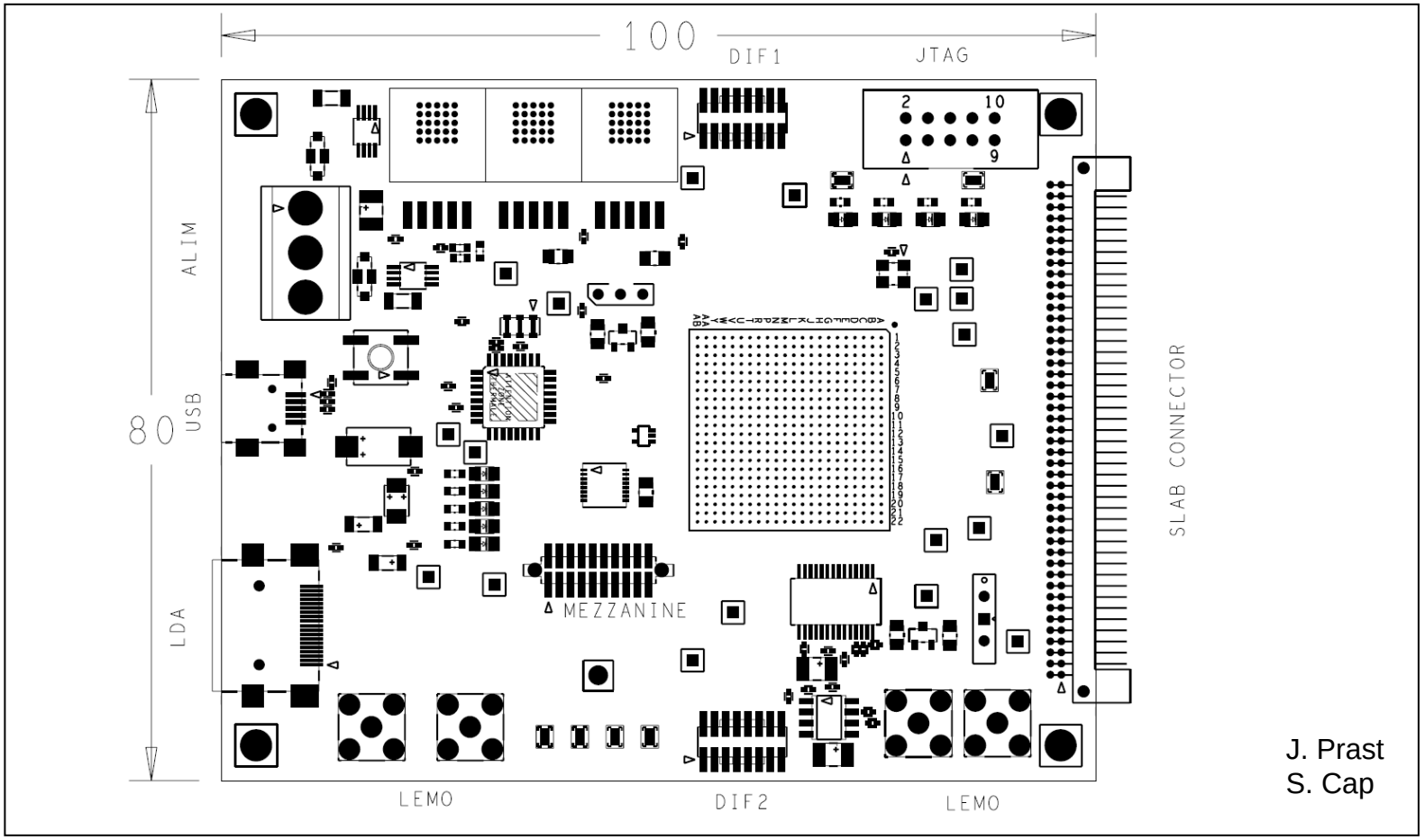
- Separated from the slab for more flexibility.
- up to 100 FE ASICs (HARDROC or IPNL ASIC) with power cycling

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



J. Prast
S. Cap

Digital InterFace (DIF)

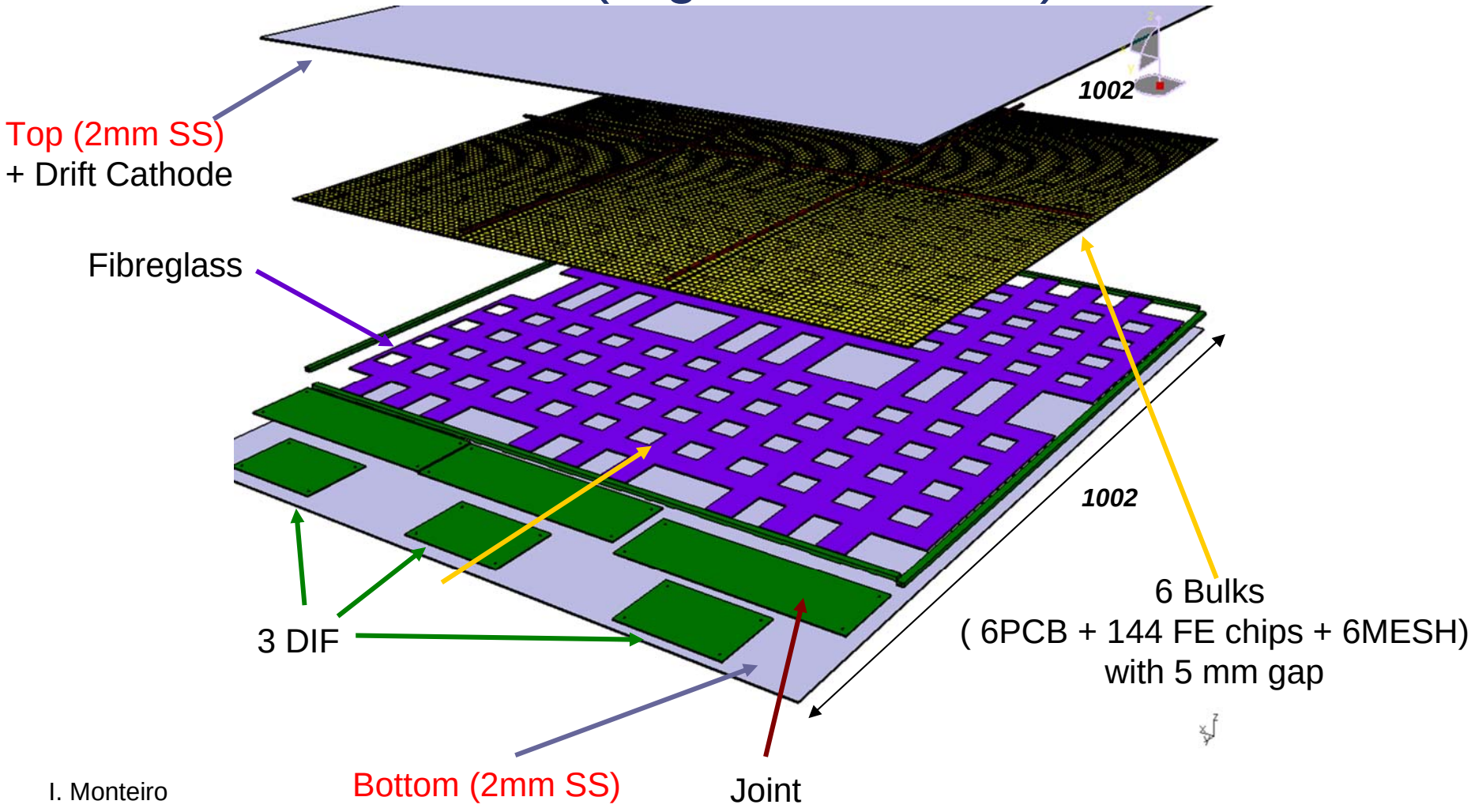


- 12 layers PCB

Ready for tests : end of May

Design of a 1m^2 MicroMegas

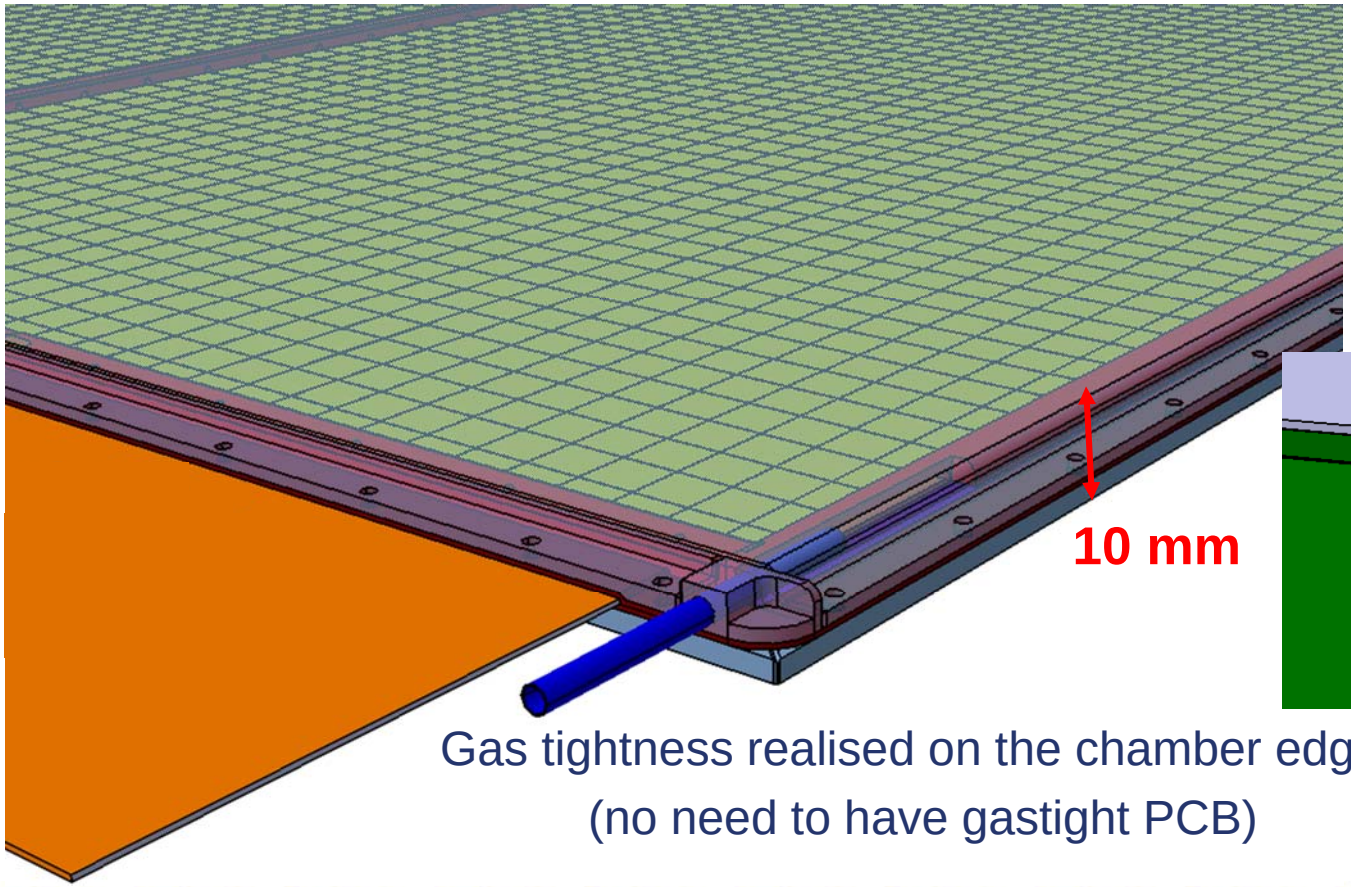
- Case with 3 DIF (Digital InterFace)



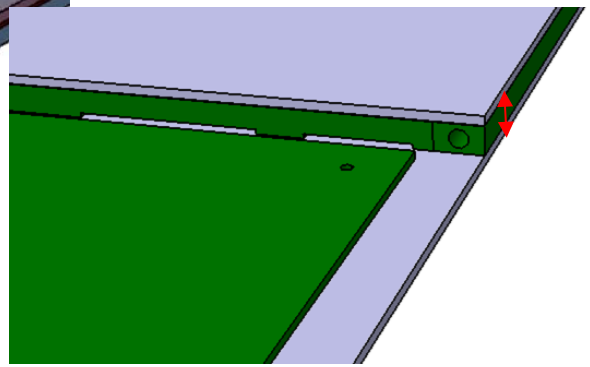
I. Monteiro

Design of a 1m^2 MicroMegas

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



Other design

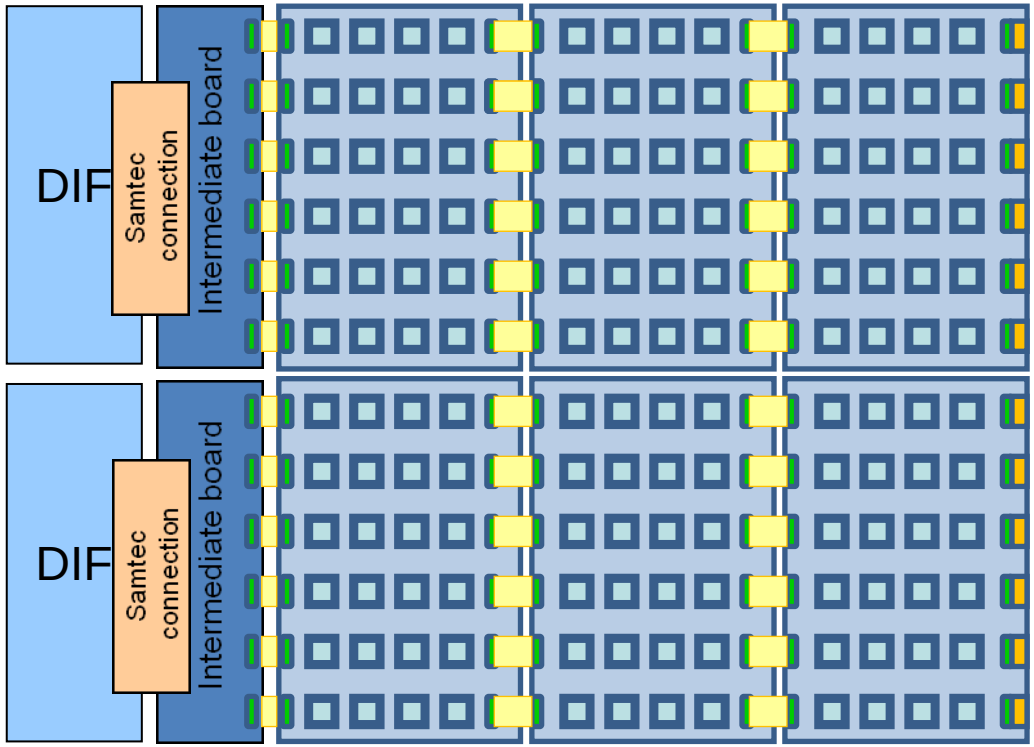


Gas tightness realised on the chamber edges
(no need to have gastight PCB)

I. Monteiro

Different designs

- 2 DIF case



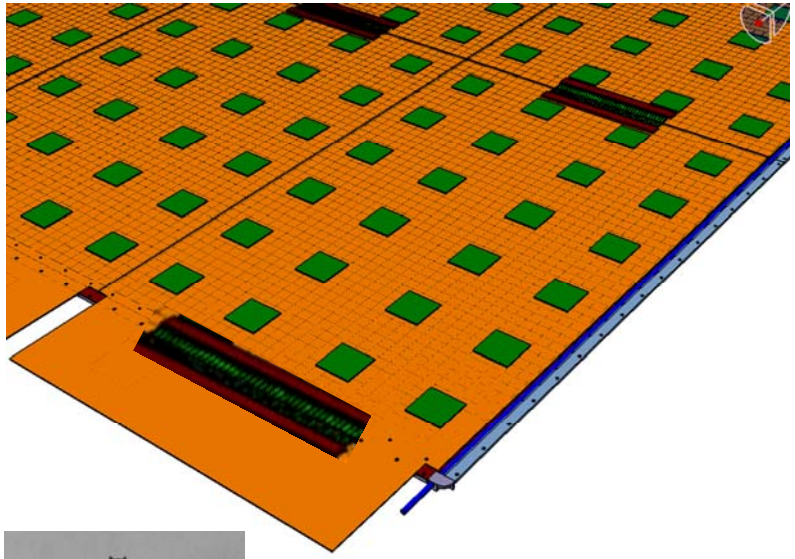
, : Flat Printed Circuit (kapton)

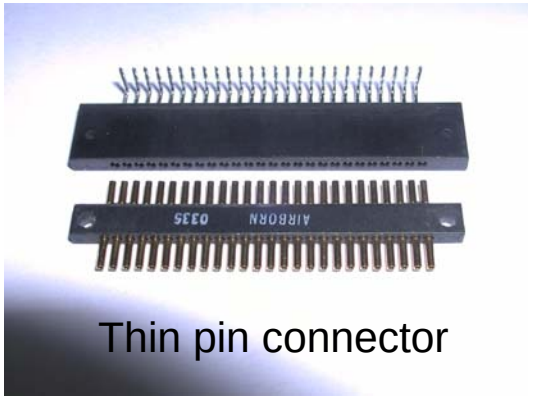
: FE chip

: Hirose connector

: Terminaison board

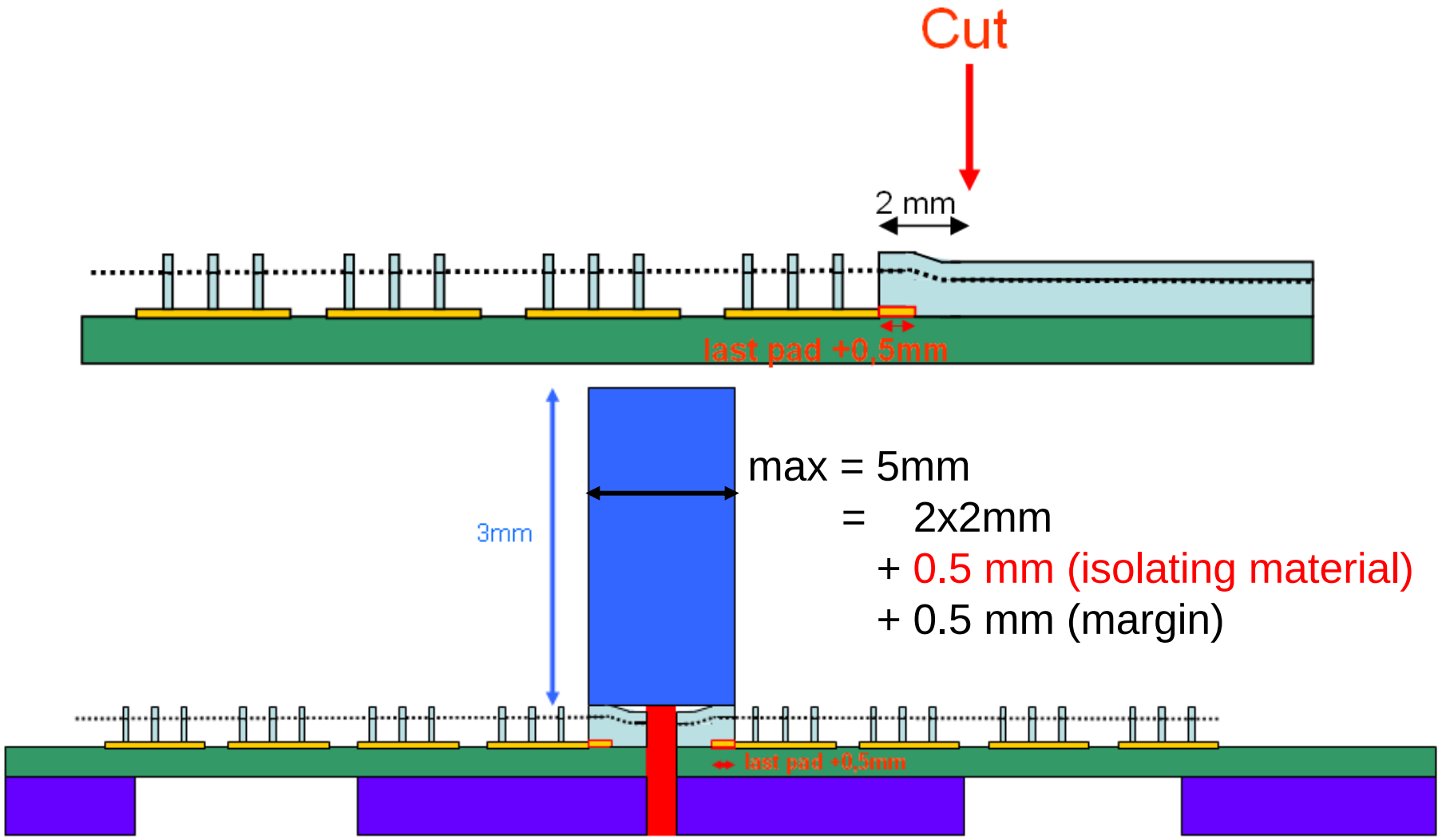
- 3 DIF case





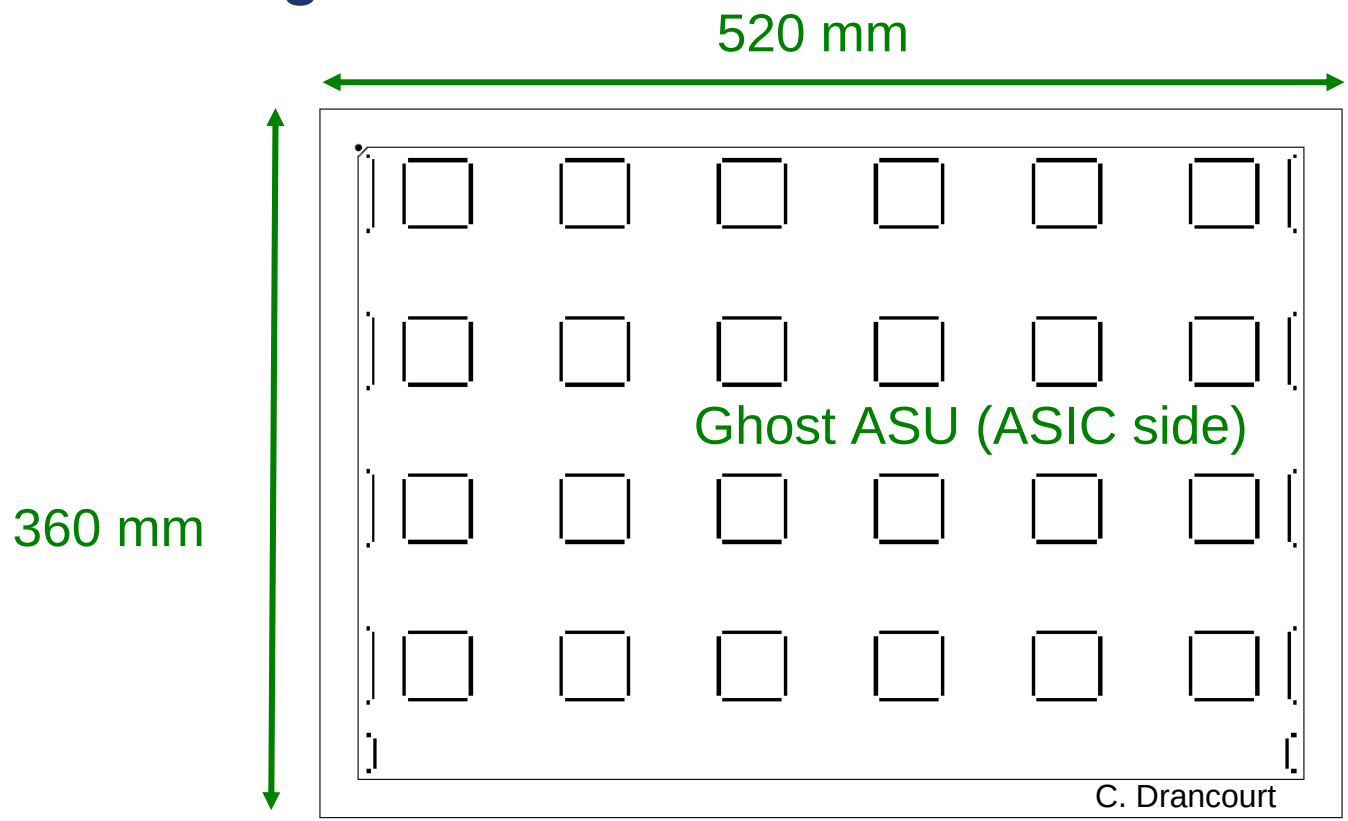
Thin pin connector

ASU Assembly

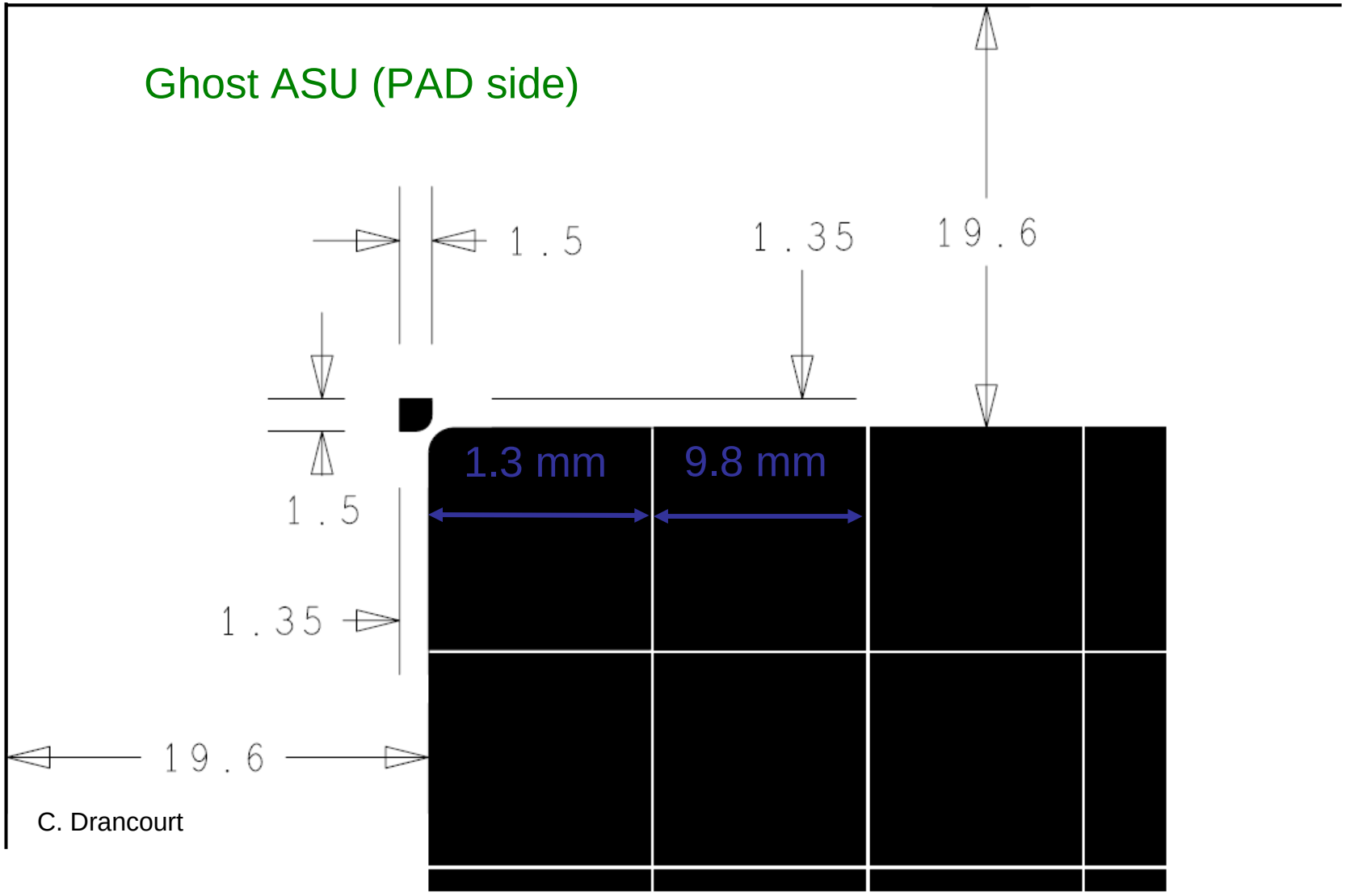


Mechanics Prototype

- $1m^2$ prototype :
  - **assembly tests with ghost ASU**
  - **Gastight tests**



Mechanics Prototype



Conclusion

- First results on small MicroMegas prototypes
- MicroMegas Techno looks promising and competitive with other gas detectors.
- Further tests are ongoing (Cosmics and TB)
- Large area prototype under way :
  towards $1m^3$ (project supported by ANR)