Micromegas DHCAL

W-DHCAL workshop, Annecy

C. Adloff for A. Espargilière

LAPP

September 24, 2009

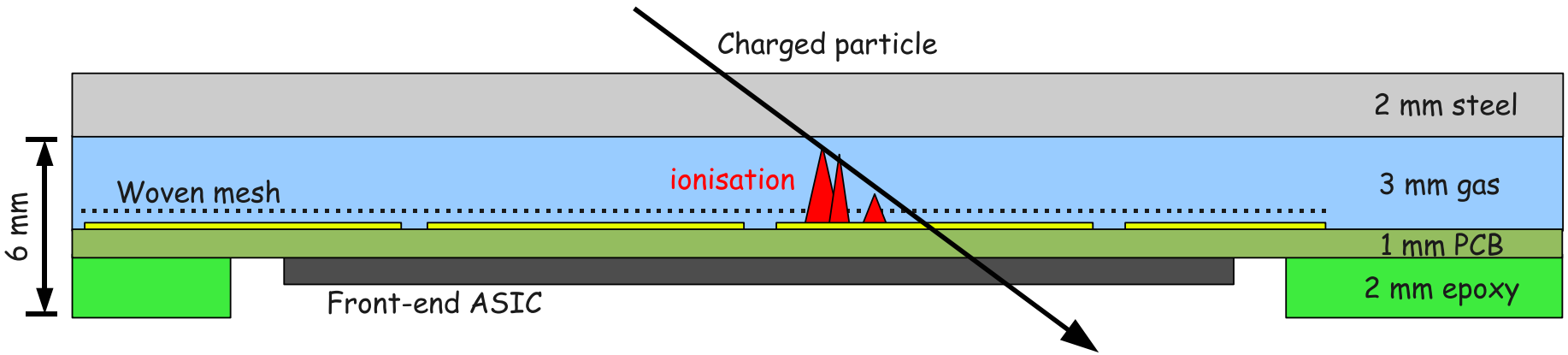
Outline

Simulation Activities

Simulation Activities

- Cubic Meter Simulation (Jan Blaha):
  - Better understanding of DHCAL generally
  - The first qualitative view on DHCAL global performance
  - Study performed:
    - Study of the main calorimeter characteristics
    - Comparison of various absorber materials: Fe, W, Pb
    - Comparison of analog and digital readout
    - Dependency on the readout threshold
- High Energy Physics Simulation (J. J. Blaising)

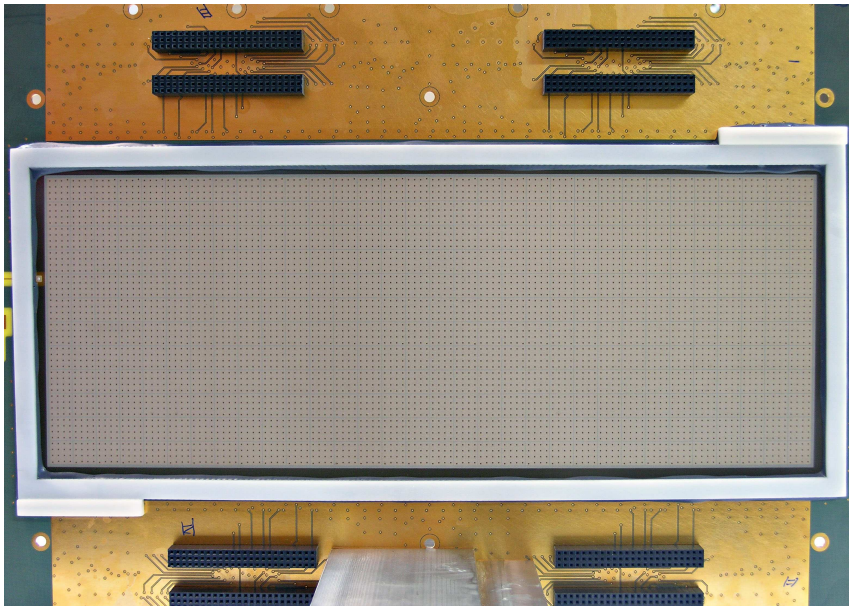
Micromegas Developments for DHCAL Active Layer



Bulk MICROMEGAS Prototypes

General Features

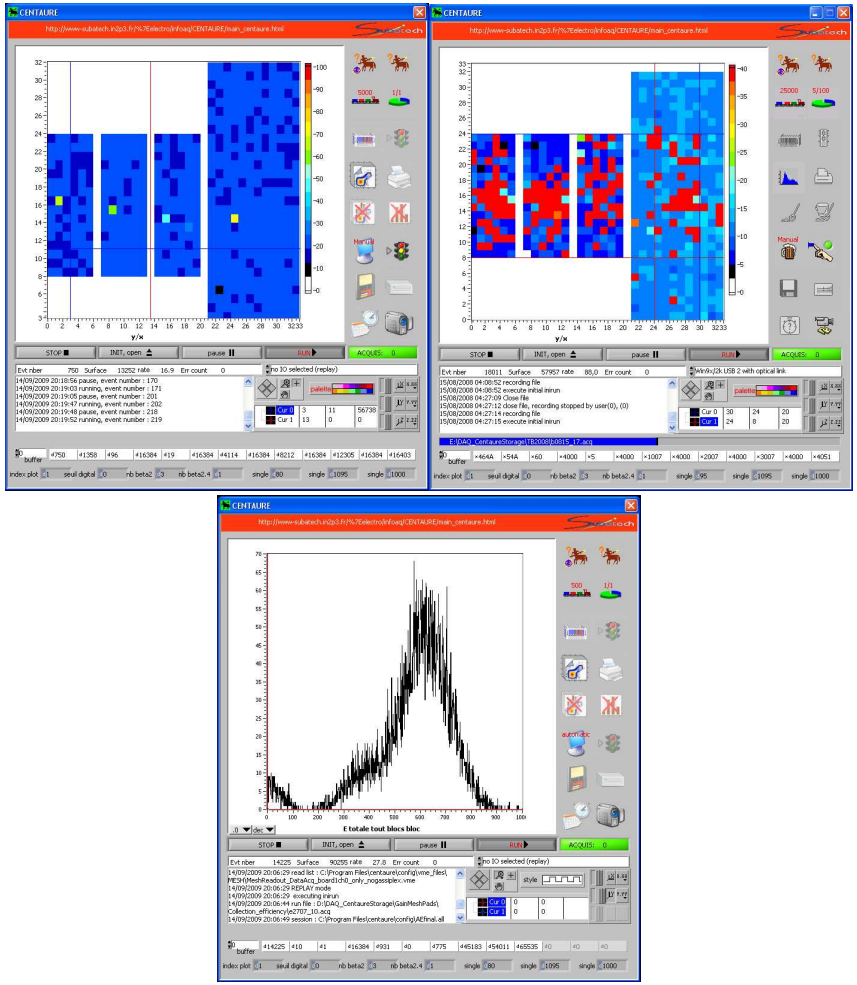
- Robustness, industry process
- Low voltage (V_{mesh} & $V_{\mathrm{drift}} < 500\,\mathrm{V}$)
- 120μm amplification gap
- 1 cm^2 pads readout
- Needs for low noise electronics
- Needs for reliable sparks protection



Centaure for analog readout

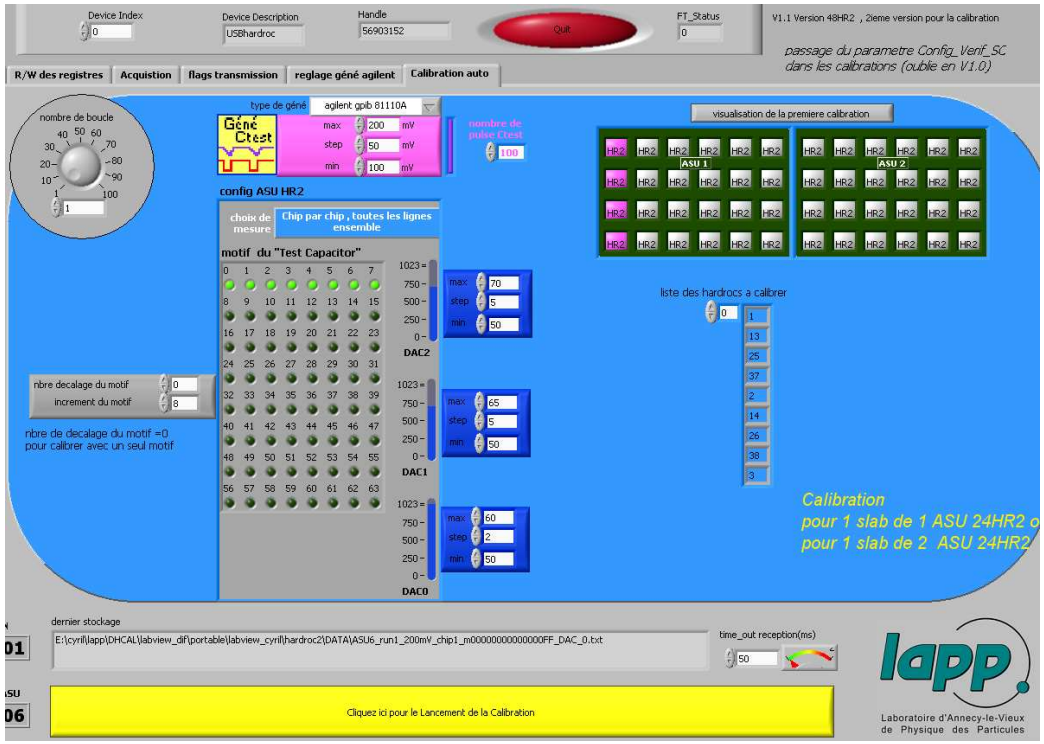
Centaure used for analog data acquisition and online monitoring

- Developed by D. Roy (SUBATECH, Nantes)
- GASSIPLEX chips on external boards
- Mesh readout



LabVIEW for digital readout

- Home made software for chips characterisation
- Hardroc1, Hardroc2 (input for calibration) and Dirac chips
- Development for cosmic data acquisition ongoing



X-DAQ

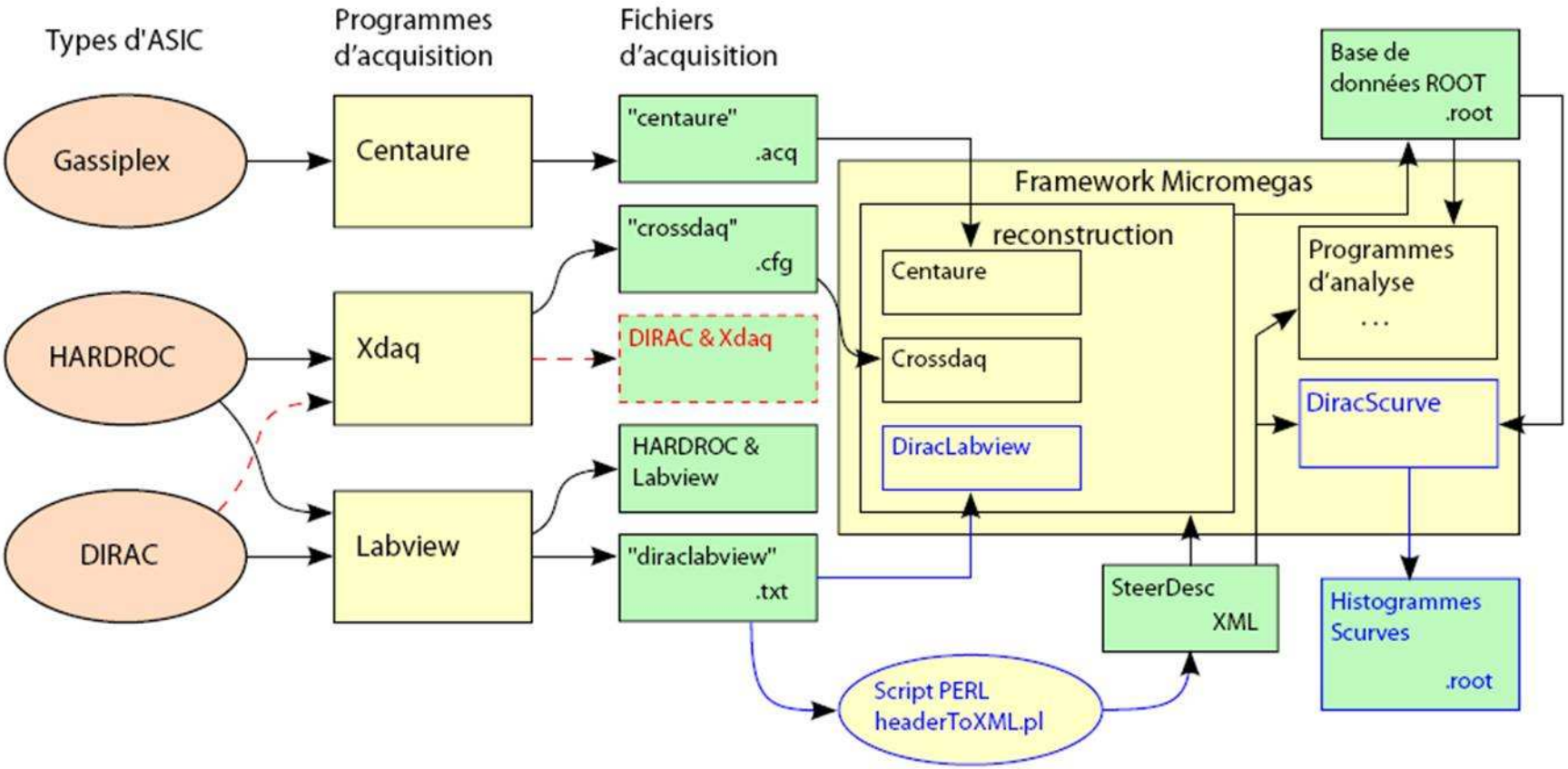
- Developed at IPNL
- Used for fast data acquisition
- Works for Hardroc1 and 2
- Development for Dirac ongoing

Aspects

- Fast running
- html control interface
- need expert on site

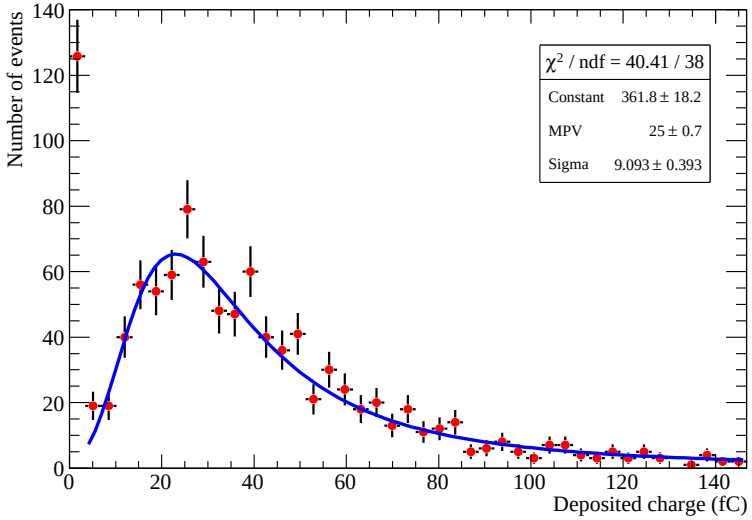
Analysis Framework

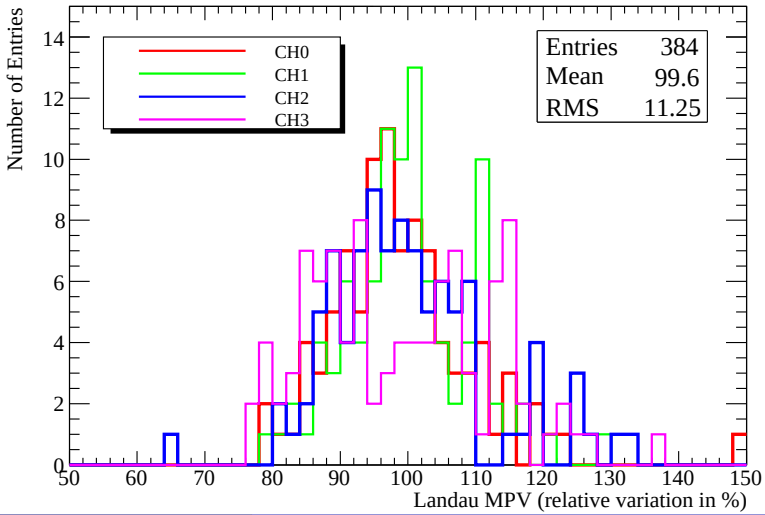
(J. Jacquemier)



Beam test 2008 Results

- Overall gain disparity $\approx 11\%$ $(384\,\mathrm{cm}^2)$
- Efficiency $= 97\%$ at $1.5\,\mathrm{fC}$
- Maximum Multiplicity < 1.1 at $1.5\,\mathrm{fC}$





MICROMEGAS analog prototypes performances

Characteristics (A. Espargilière)

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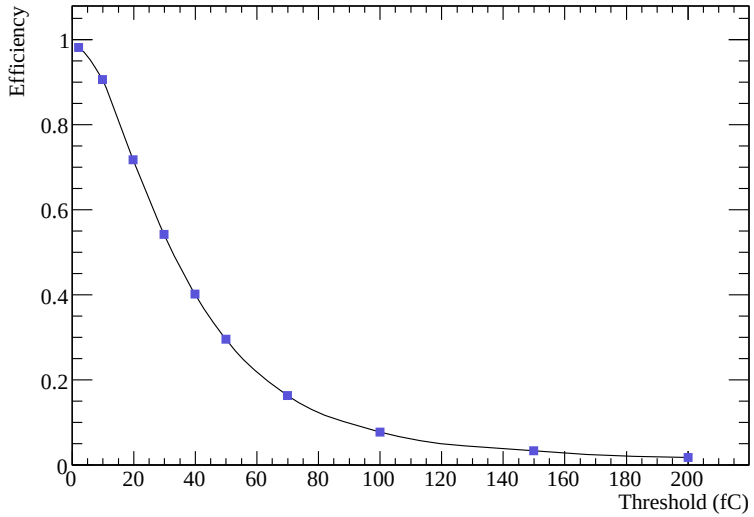
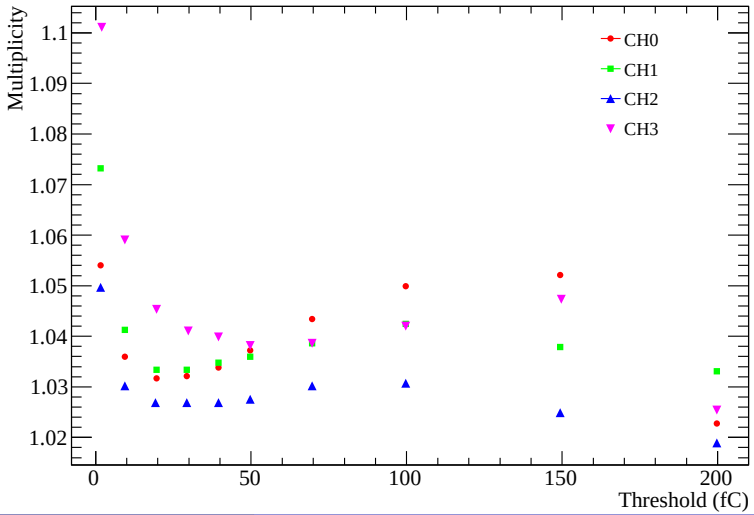
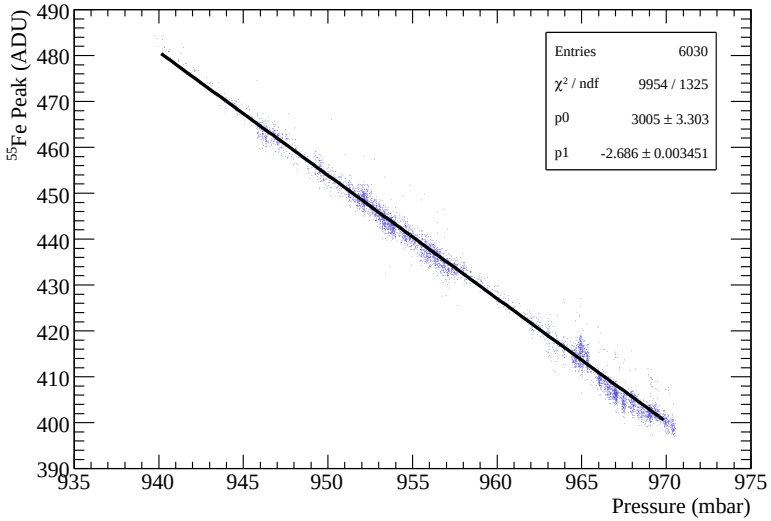




X-Ray Study

- Two-week long data acquisition
- $5.9\,\mathrm{keV}$ photons from $^{55}\mathrm{Fe}$
- Dependency of response versus P and T
- Method for gain correction established:

$$f_x = 1 - C_x \cdot \Delta(x)$$



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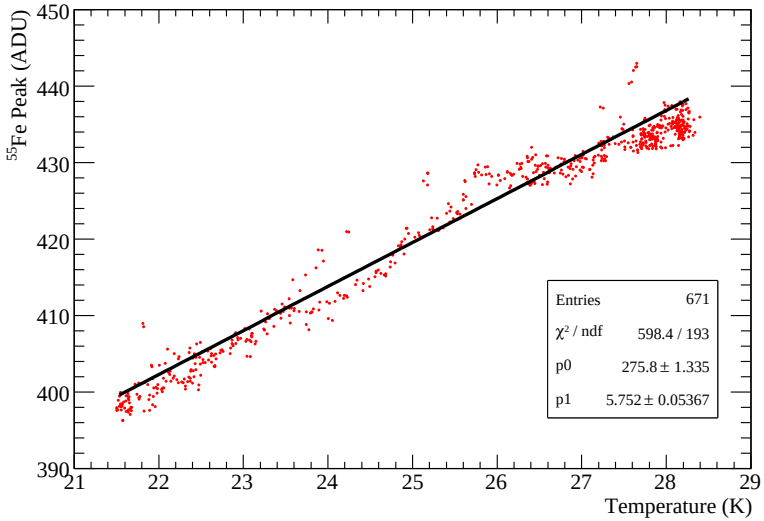

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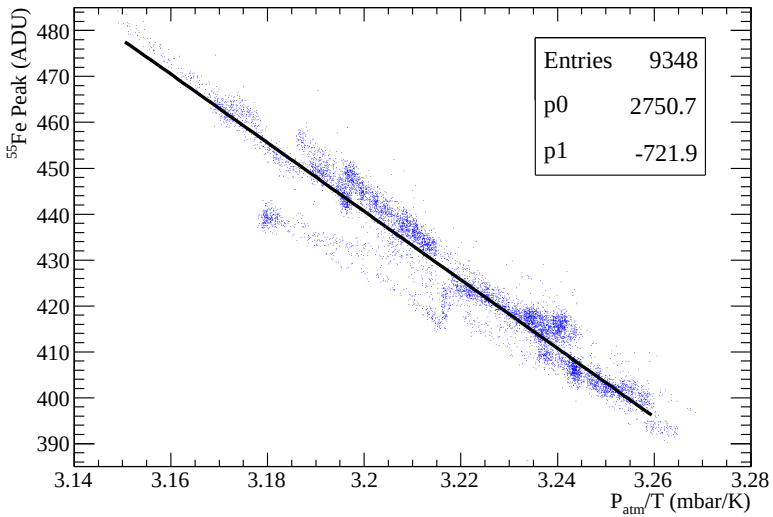

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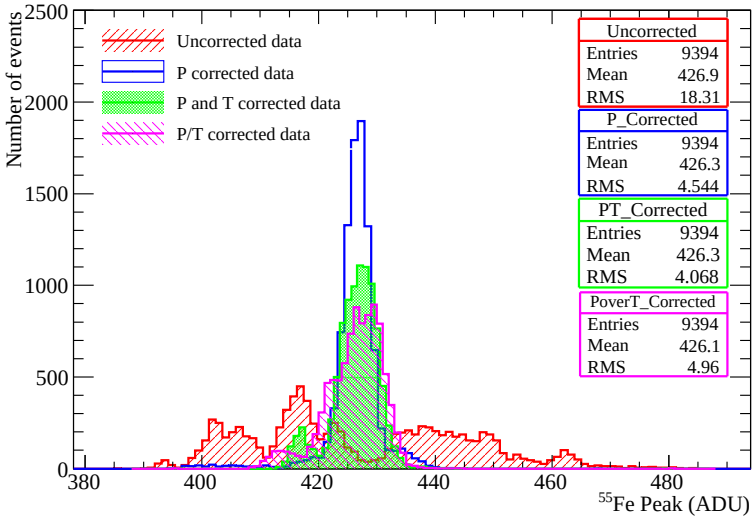
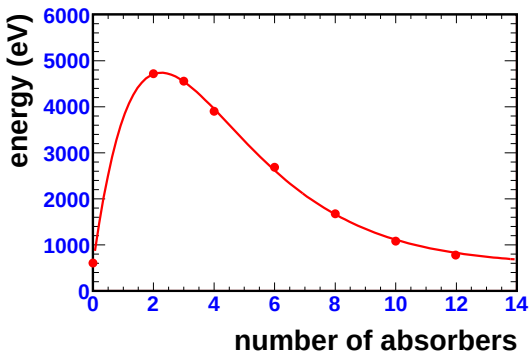
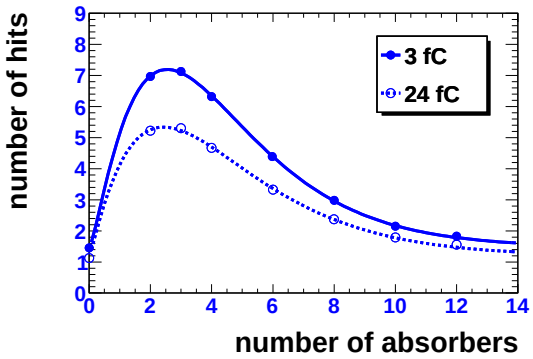


MICROMEGAS analog prototypes performances

Shower Measurements (M. Chefdeville)

- Micromegas behaviour in 2 GeV electron:
  - Stable and high gain during test period (a few HV trips over 12 days)
  - correction for P, T variations, pads intercalibration
- Energy and number of hit distributions:
  - Show a similar trend with the number of absorber
  - Longitudinal hit distribution maximum reached slightly deeper
  - Transverse hit distribution shows larger RMS at first shower stages
- Future plans
  - Comparison with simulation
  - Take data at different energies at next beam test (next week)





Tests with digital electronics

First embedded electronics on a MICROMEGAS

- Single DIRAC chip 8×8 pad MICROMEGAS chamber
- 10,7 mm thickness

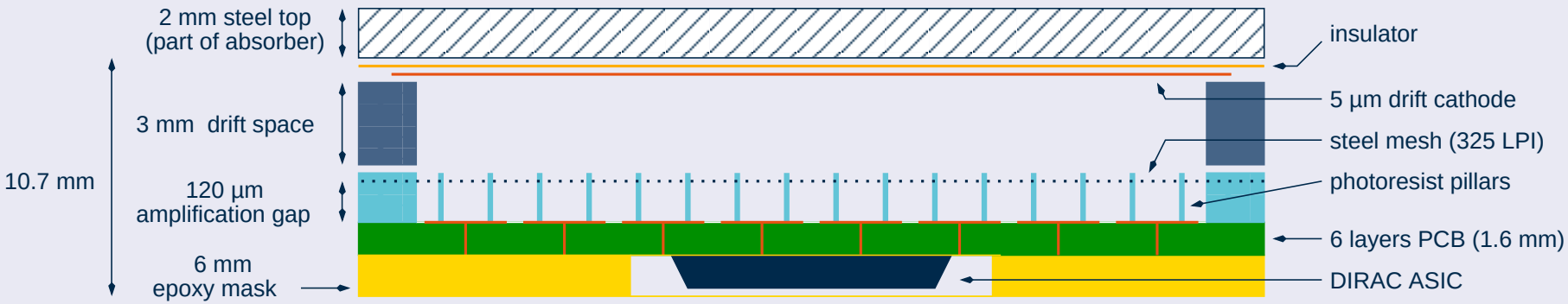


Figure: design of a bulk MICROMEGAS with embedded electronics

Tests with digital electronics

First DIRAC operative test (Beam test 2008, August)

- Single ASIC 8×8 pad MICROMEGAS chamber
- Very first test of bulk MICROMEGAS with embedded digital readout
- fully successful
- Raw multiplicity of 1.1

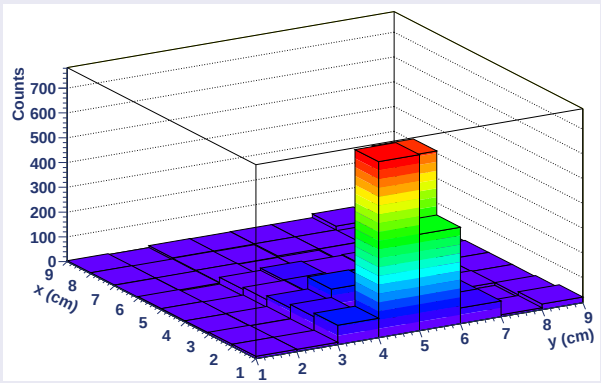
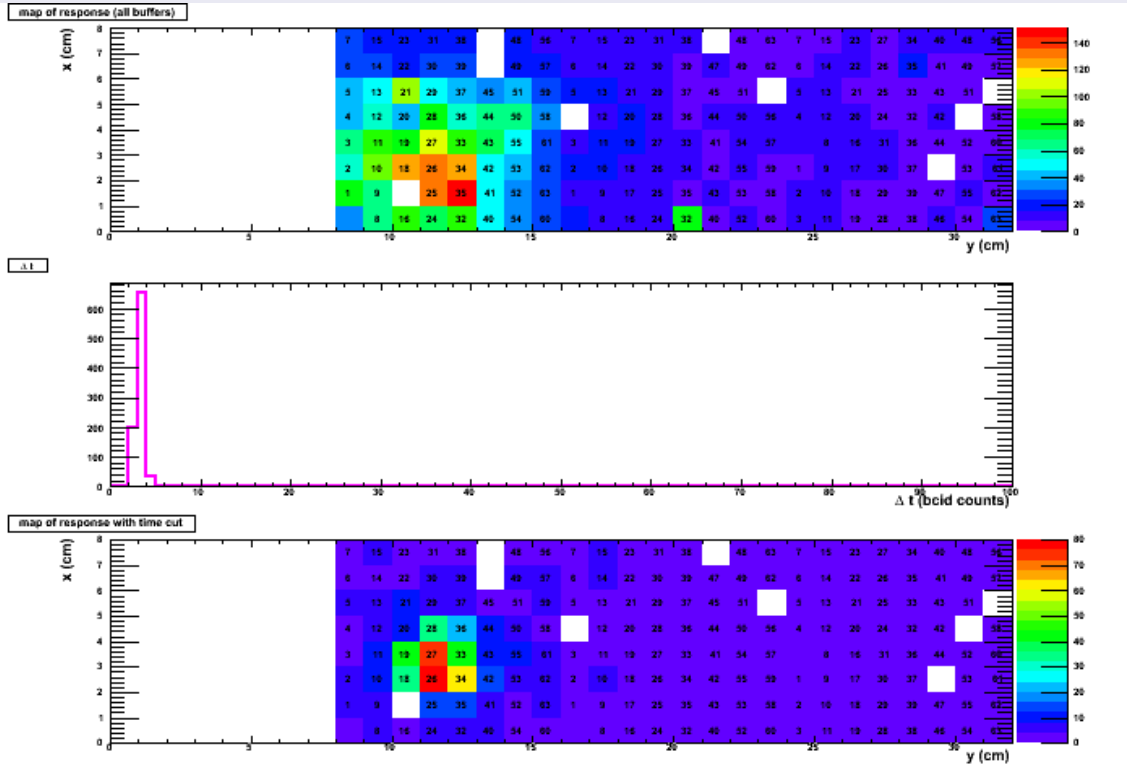


Figure: Beam profile obtained with digital readout using the DIRAC ASIC.

Tests with digital electronics

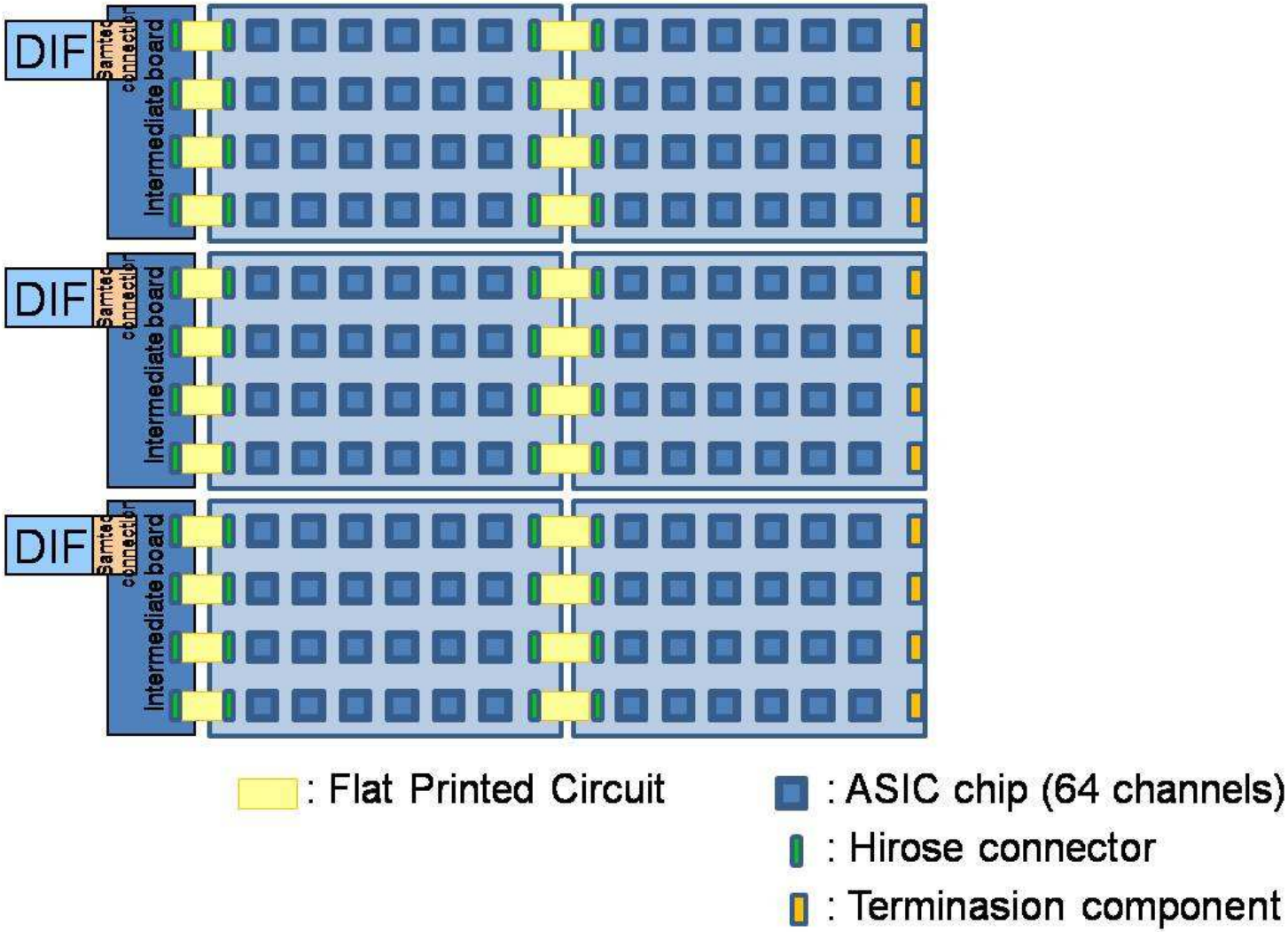
First HARDROC1 operative test on MICROMEGAS (Beam test 2009, May)

- Beam profile observed w and w/o scintillator coincidence
- bad chip configuration $\Longrightarrow$ data mostly corrupted
- Raw efficiency estimated around 60%



Square Meter Project

Layout (N.Geffroy)



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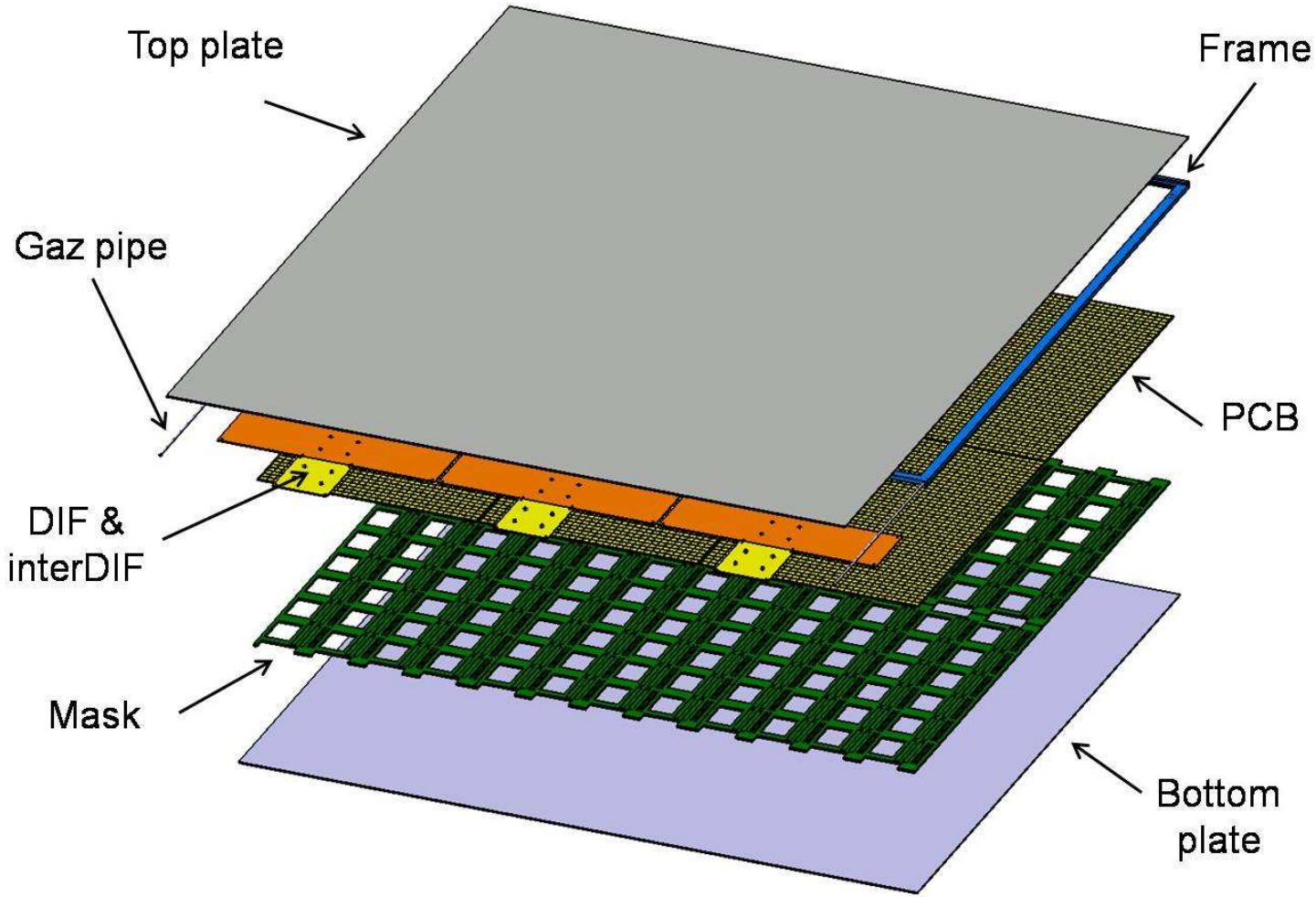

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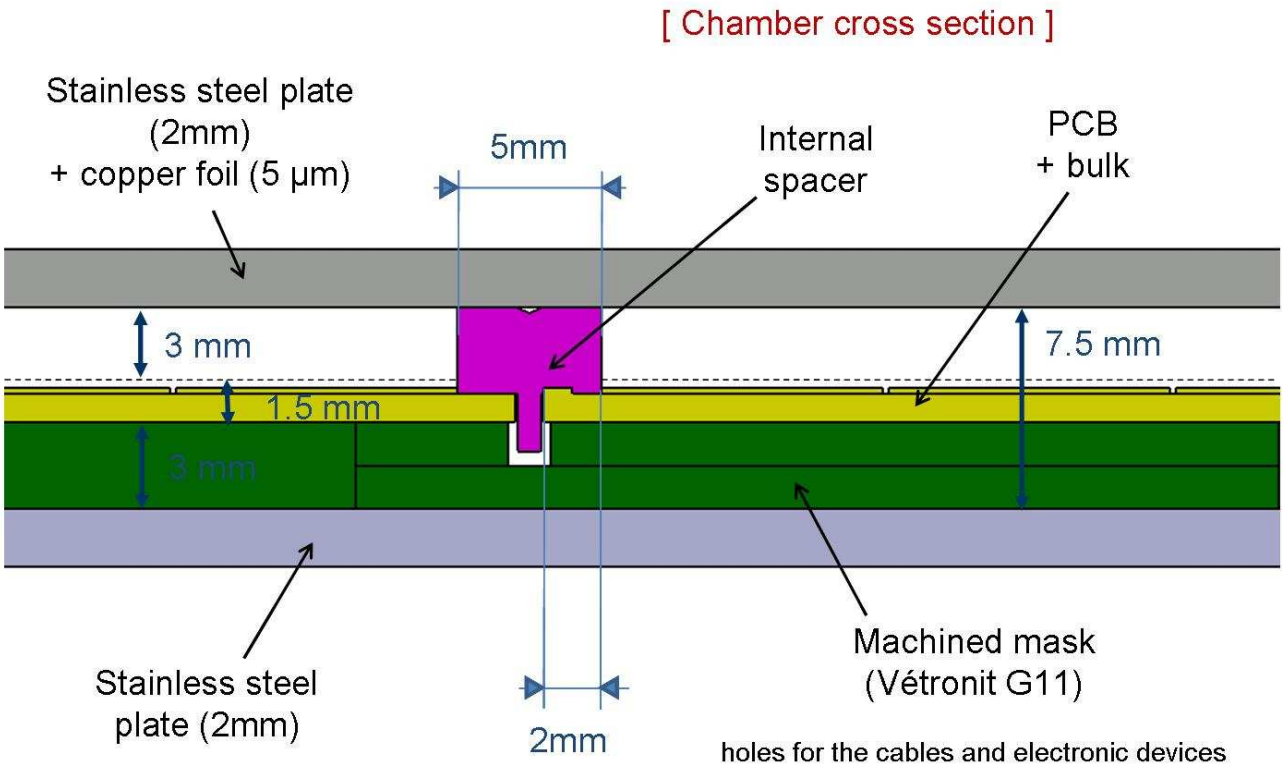
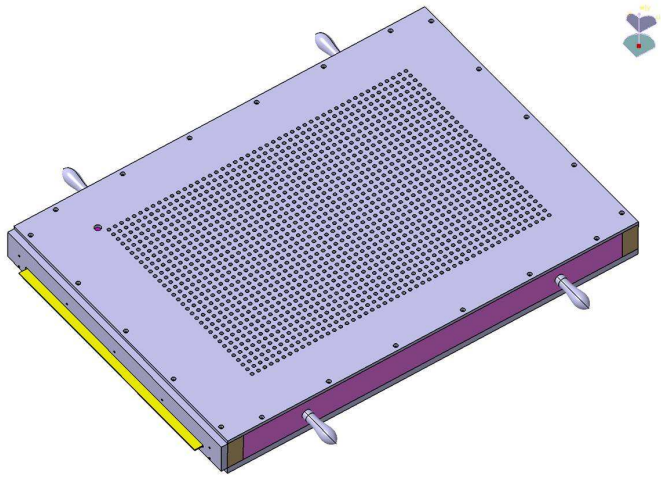
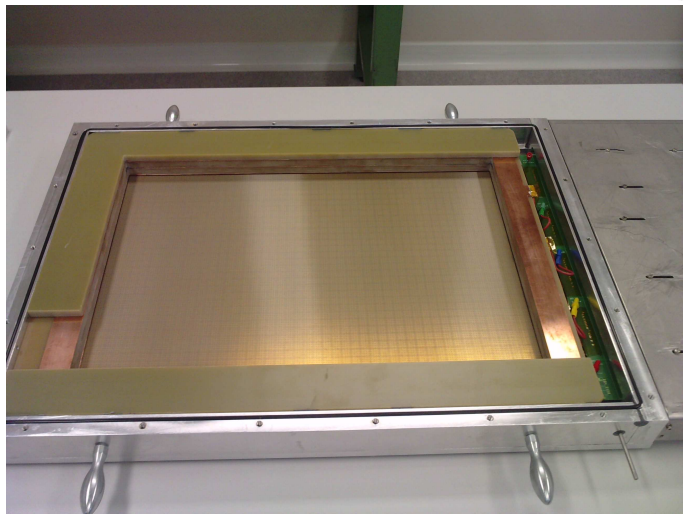


Square Meter Project

Test Box (N.Geffroy, F. Peltier)

- Every ASU has to be tested individually:
  - Electronics verifications
  - Mesh cooking
  - Get physical signal from the pads (^{55}Fe source and/or cosmics)
- Clean room available for handling naked mesh ASU
- A test box has been built:
  - ASU easily inserted and removed
  - Plexiglass lid for mesh cooking
  - Aluminum lid, drilled above every pad for X-rays injection
  - Drift cathode on the aluminum lid $\Rightarrow 3\,\mathrm{cm}$ drift gap
  - A fully functional MICROMEGAS test chamber





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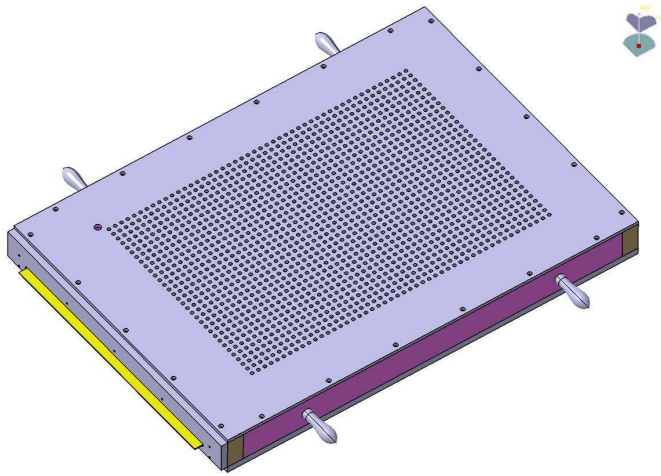

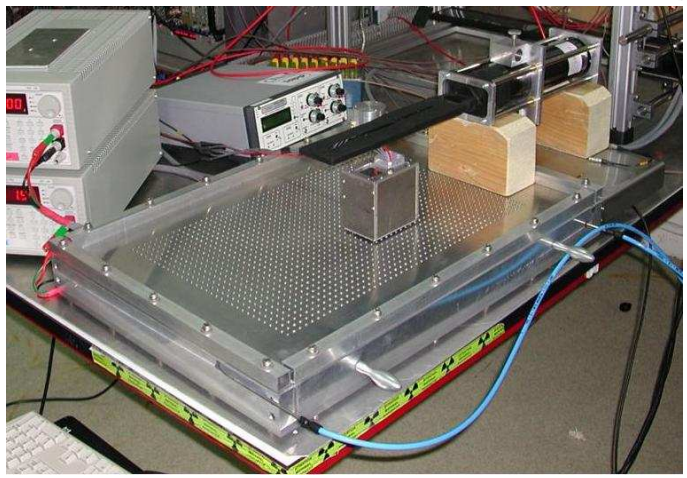

First tests of MICROMEGAS HARDROC2 at LAPP

- Two 32×48 pad ASU
- 24 HARDROC2 chip each
- Foreseen to equip the m^2 physics prototype

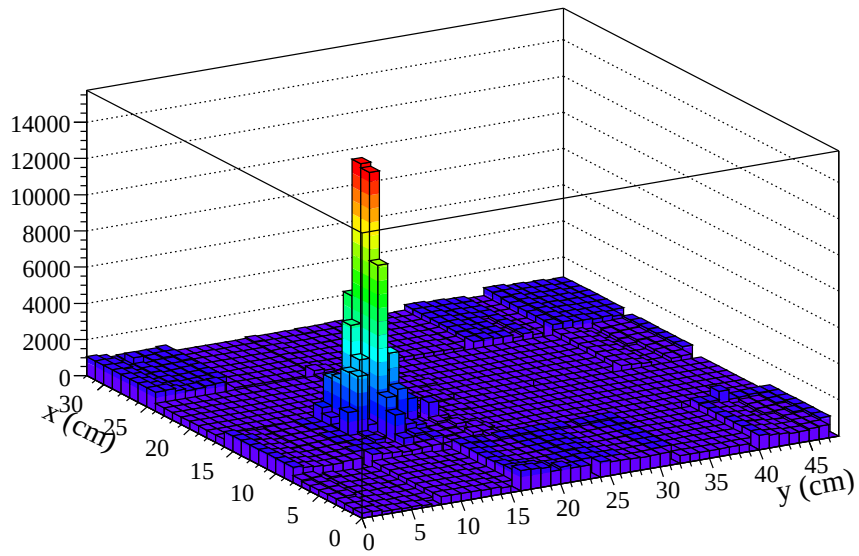

Figure: Response of a 32×48 pad ASU after irradiation with an ^{55}Fe source

Square meter project

Mechanical Prototype (N.Geffroy, F.Peltier)

A usefull model

- Test various assembly possibilities on small samples
- Establish an assembly process
- Train on building a prototype w/o real ASUs
- Perform mechanical tests
- Verify gas tightness

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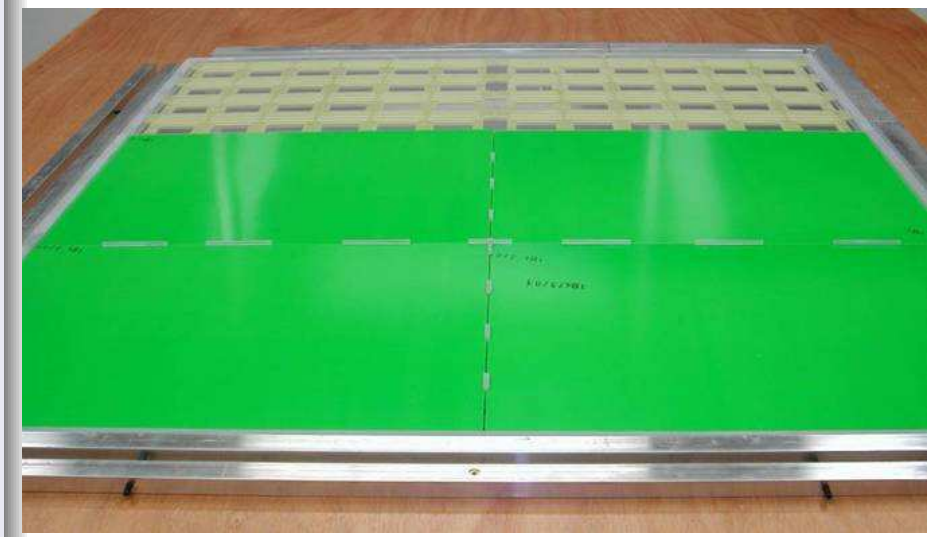

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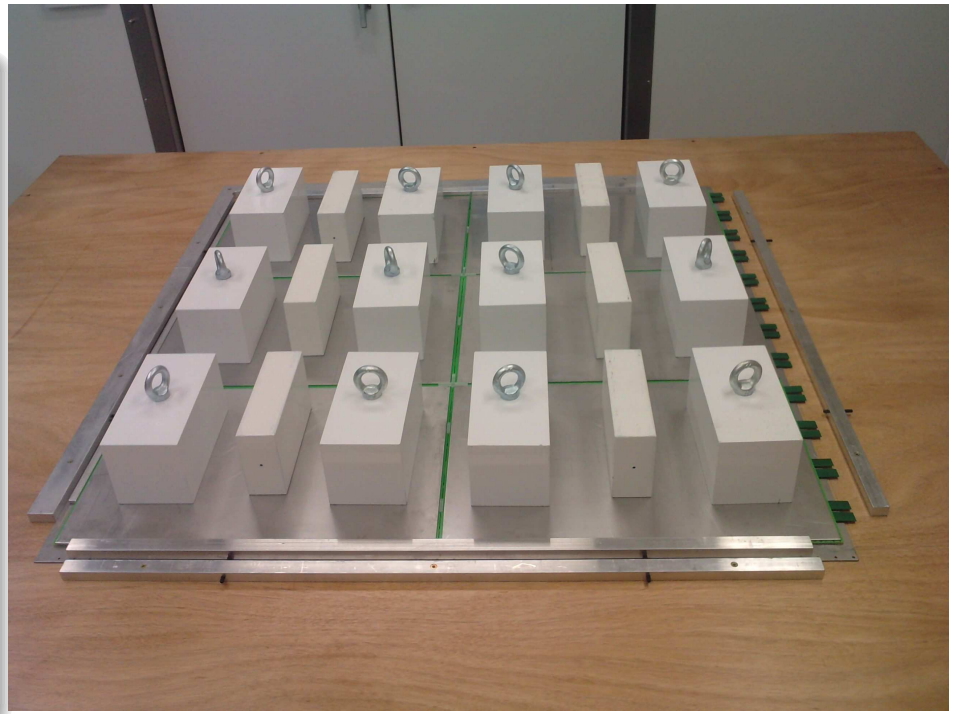

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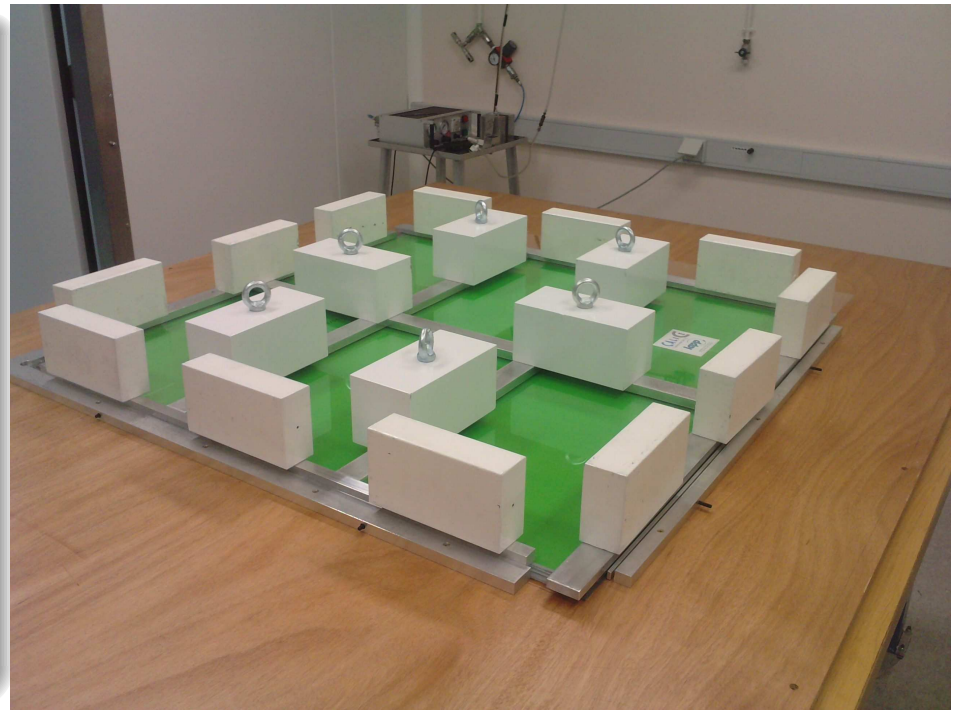

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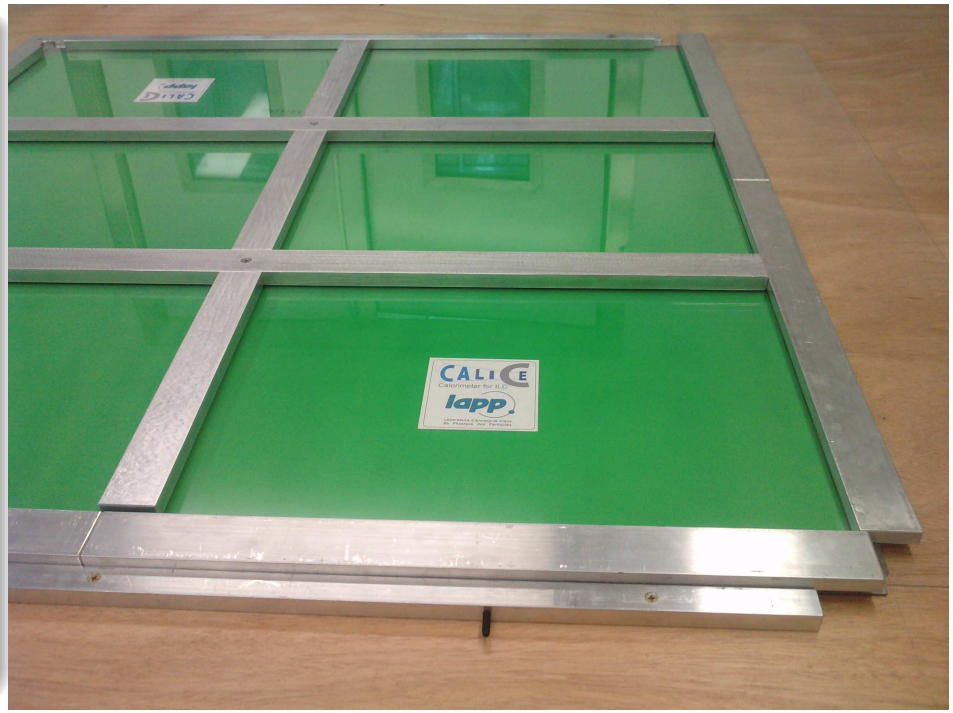
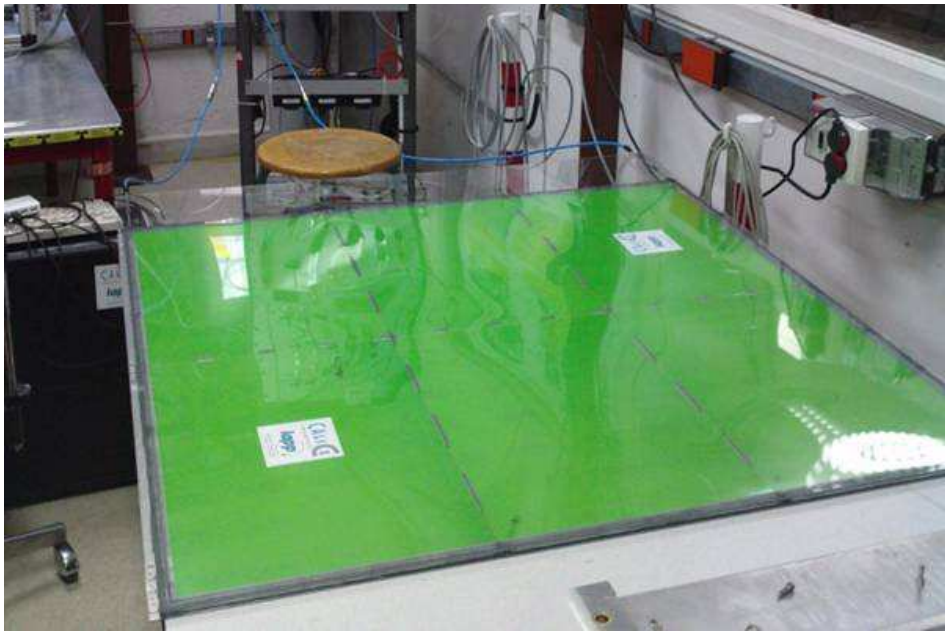


Square Meter Project

Physics Prototype (N.Geffroy, F.Peltier)

- 1 week needed for assembly



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- A third of the m^2 will be equipped (2 ASUs)

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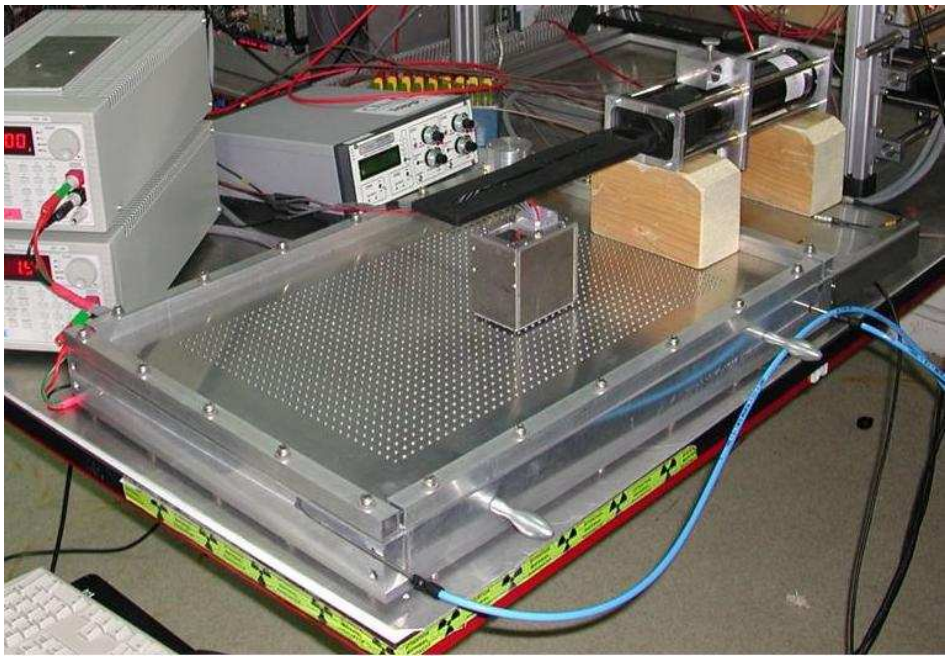
- Both ASUs are under intensive tests to prove their reliability before integration to the m^2



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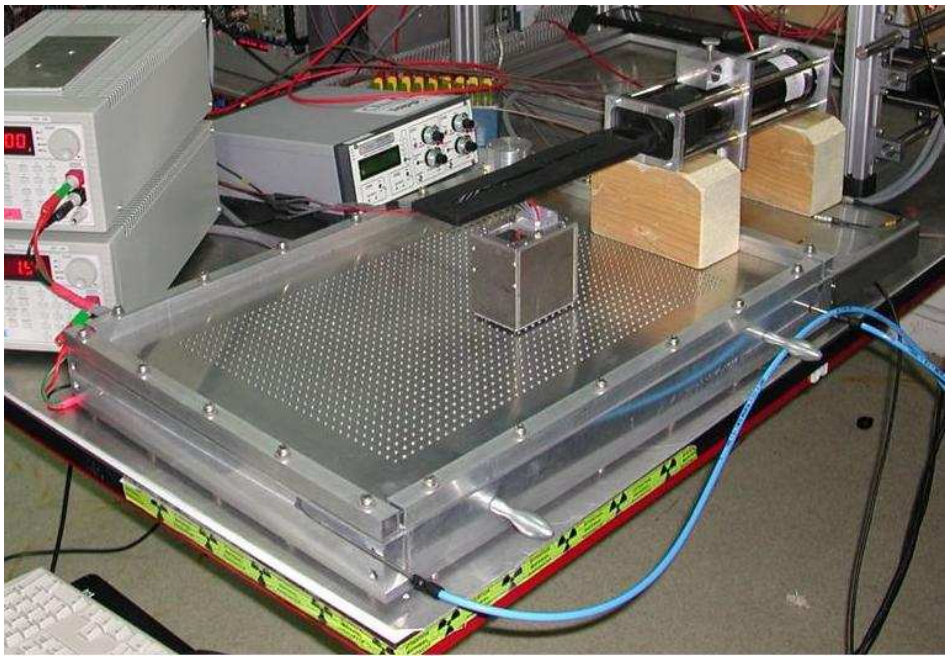
- next : Physics m^2 assembly



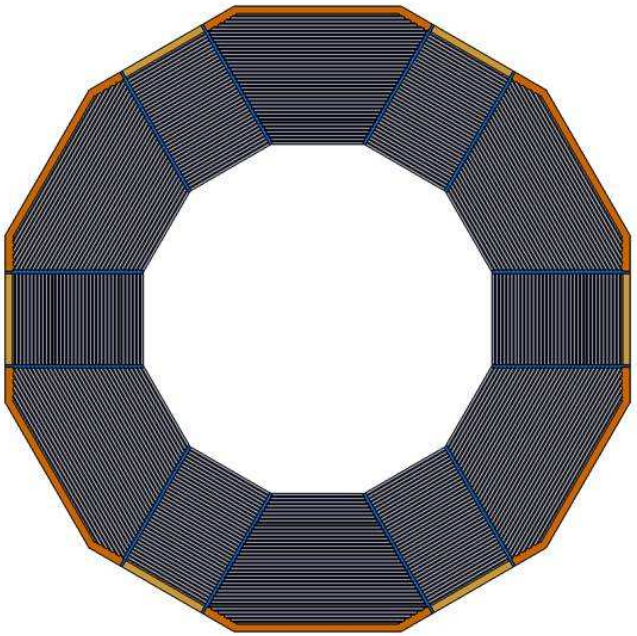
Engineering Developments

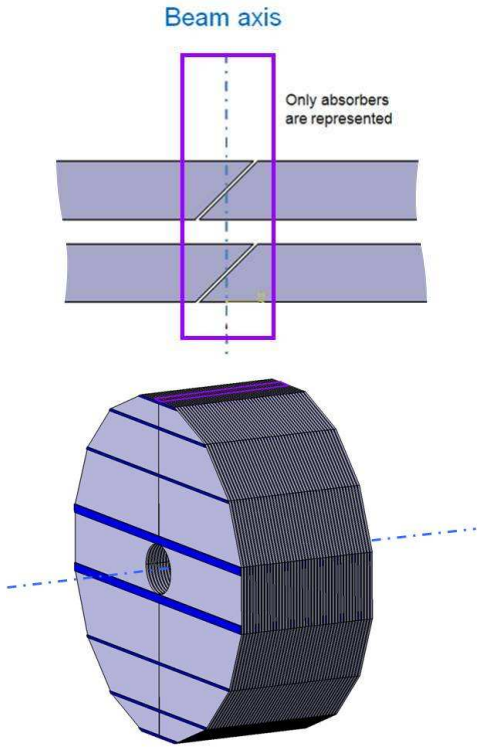
SID DHCAL Mechanical Design

(N.Geffroy)

SiD HCAL:

- Designed at LAPP
- Taken as a baseline in SiD LOI
- Detailed design needed
- Deeper study foreseen at LAPP (N. Geffroy)
- $\Rightarrow$ Construction of a module 0



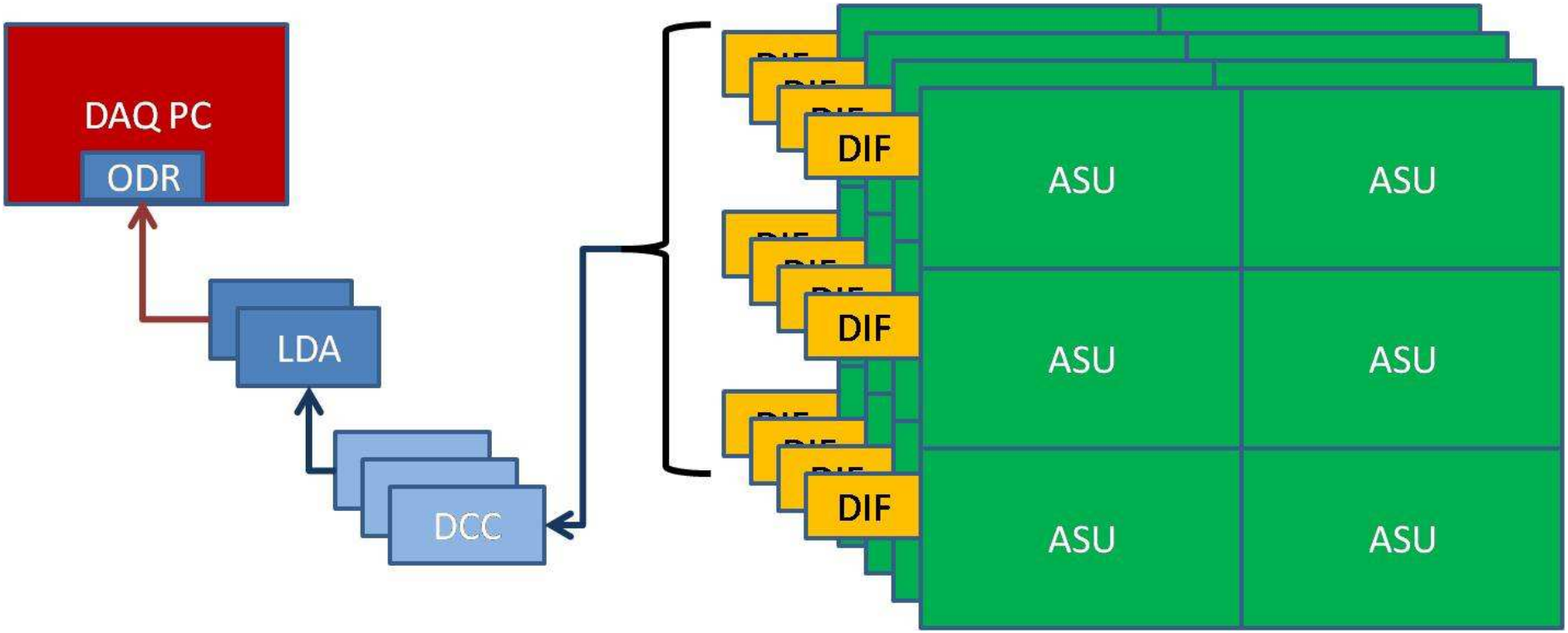


Electronics Developments

Detector InterFace (DIF)

(J. Prast, G. Vouters)

Calice DAQ Scheme:

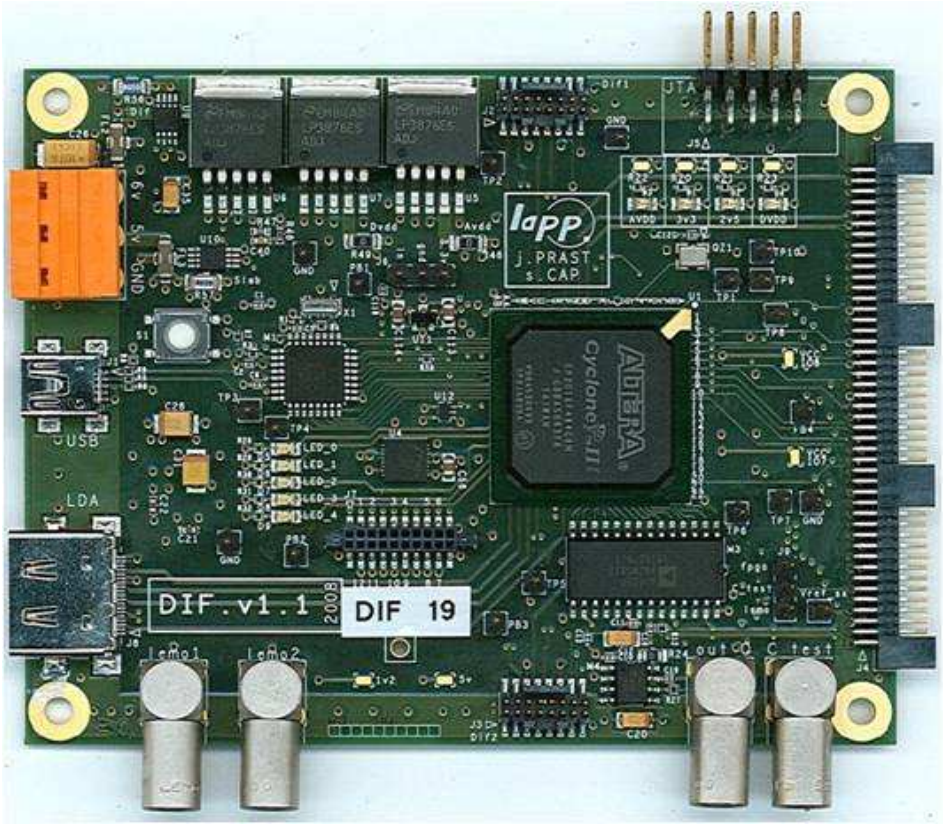


DIF $\Longleftrightarrow$ front-end electronics: data transfer, very front-end chip control

Detector InterFace (DIF)

(J. Prast, G. Vouters)

- Fully Designed at LAPP (J. Prast, S. Cap)
- First intermediate board between ASU and DAQ
- Programmable via VHDL code
- VHDL code implemented at LAPP (G. Vouters)
- Many firmwares available (see C. Drancourt's talk)
- Used in 2008 and 2009 Eu-DHCAL beam tests: MICROMEGAS and RPC



DIRAC ASICs Characterization and New Developments

(R. Gaglione)

- DIRAC initially developed at IPNL
- Now in tight collaboration with LAPP
- DIRAC2 intensively tested at LAPP
- Best Power pulsing performance (stable at 2.7 μs power-on time)
- Very low threshold achievable ($<$10 fC?)
- First digital ASIC embedded on a bulk MICROMEGAS: tested successfully in 2008 beam test
- DIRAC2 m^2 foreseen for 2010

Conclusion

Conclusion

- Developments of MICROMEGAS chamber as an active layer for DHCAL
  - MICROMEGAS performances in agreement with the DHCAL requirements
  - Digital front-end electronics ready
  - MICROMEGAS related collaborators: CERN (bulk MICROMEGAS) and Saclay (Beam tests ...)
  - Eu-DHCAL collaborators: CIEMAT, IPNL, LAL, LLR
  - Building thin and large area chambers
  - Very good progress toward a 1 m^3 technical prototype
- Other applications of MICROMEGAS now thinkable
  - MICROMEGAS W-HCAL (almost "copy and paste")
  - MICROMEGAS W-ECAL (segmentation and thickness)