Status of Micromegas DHCAL

CALICE Collaboration Meeting - Lyon

Ambroise Espargilière

LAPP, Annecy

September 18, 2009

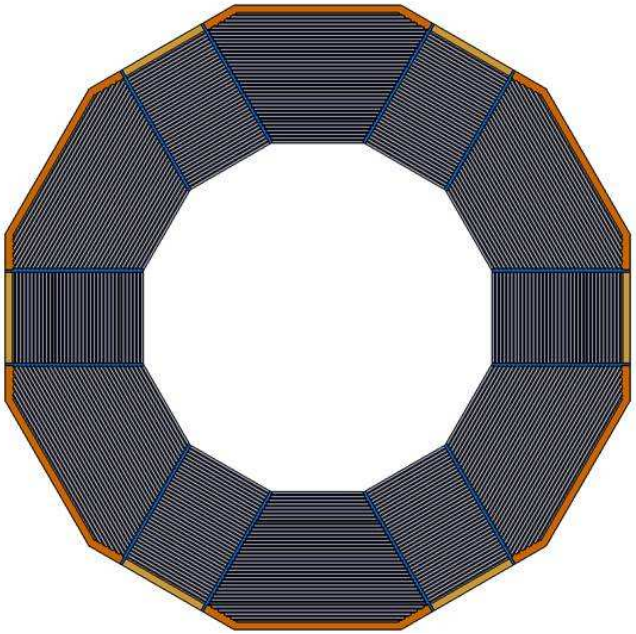
Outline

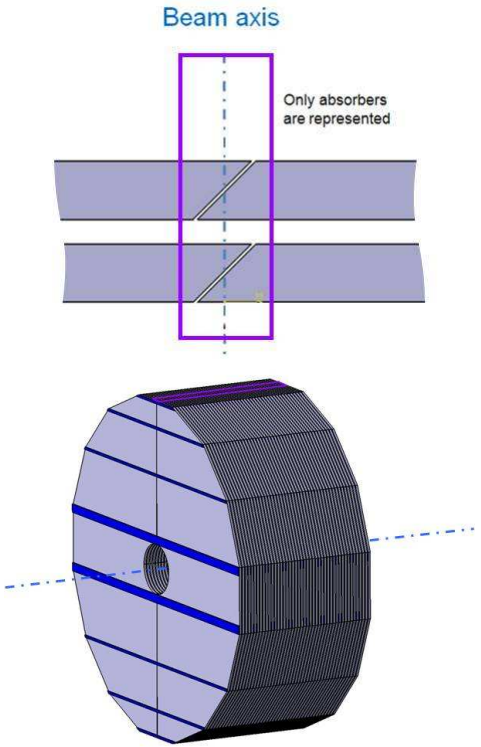
Engineering Developments

SID DHCAL Mechanical Design

SiD HCAL:

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

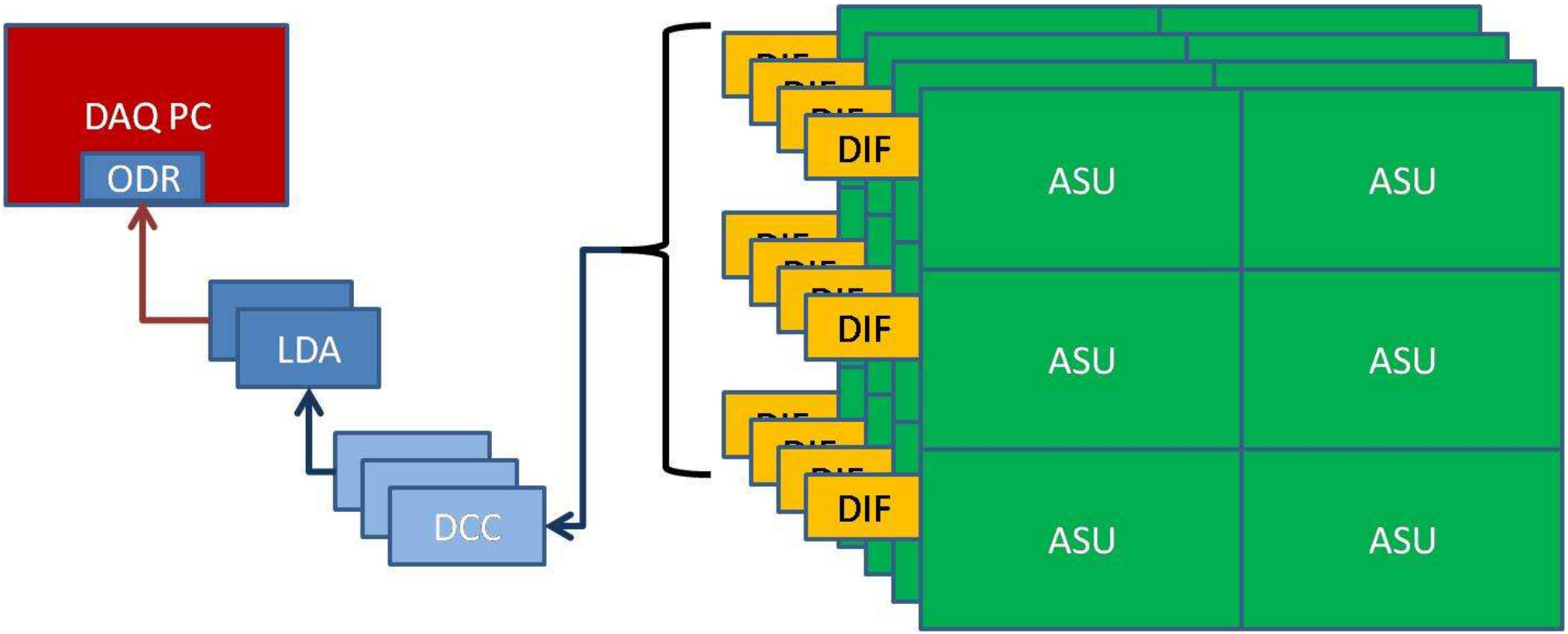




Electronics Developments

Detector InterFace (DIF)

Calice DAQ Scheme:



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

Detector InterFace (DIF)

- 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

See R. Gaglione's talk

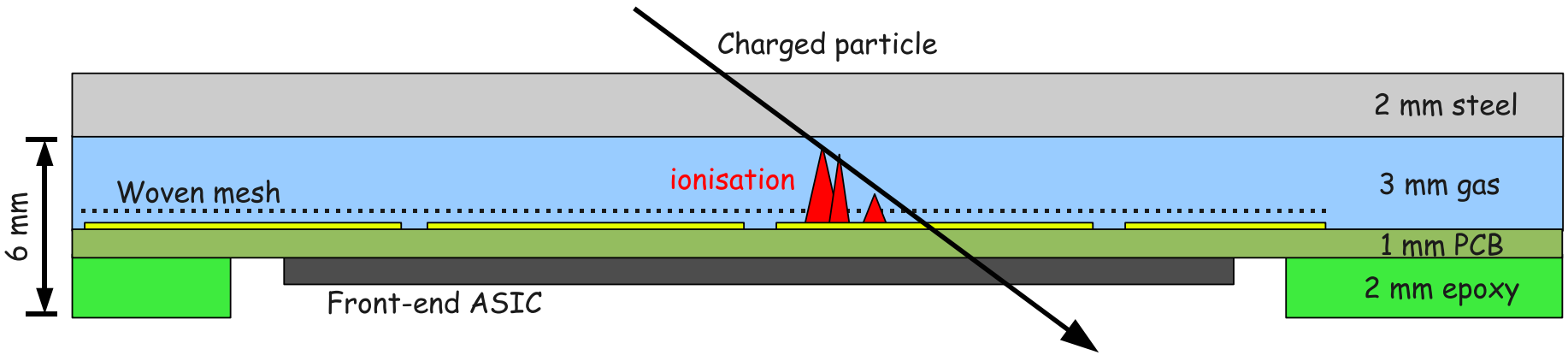
- DIRAC initially developed at IPNL
- Now in tight collaboration with LAPP
- DIRAC2 intensively tested at LAPP
- Best Power pulsing performance (stable at 2.7 μs power-on time)
- Very low threshold achievable ($<$10 fC?)
- First digital ASIC embedded on a bulk MICROMEGAS: tested successfully in 2008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

Simulation Activities

Simulation Activities

- Cubic Meter Simulation (Jan Blaha's talk):
  - 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's talk)

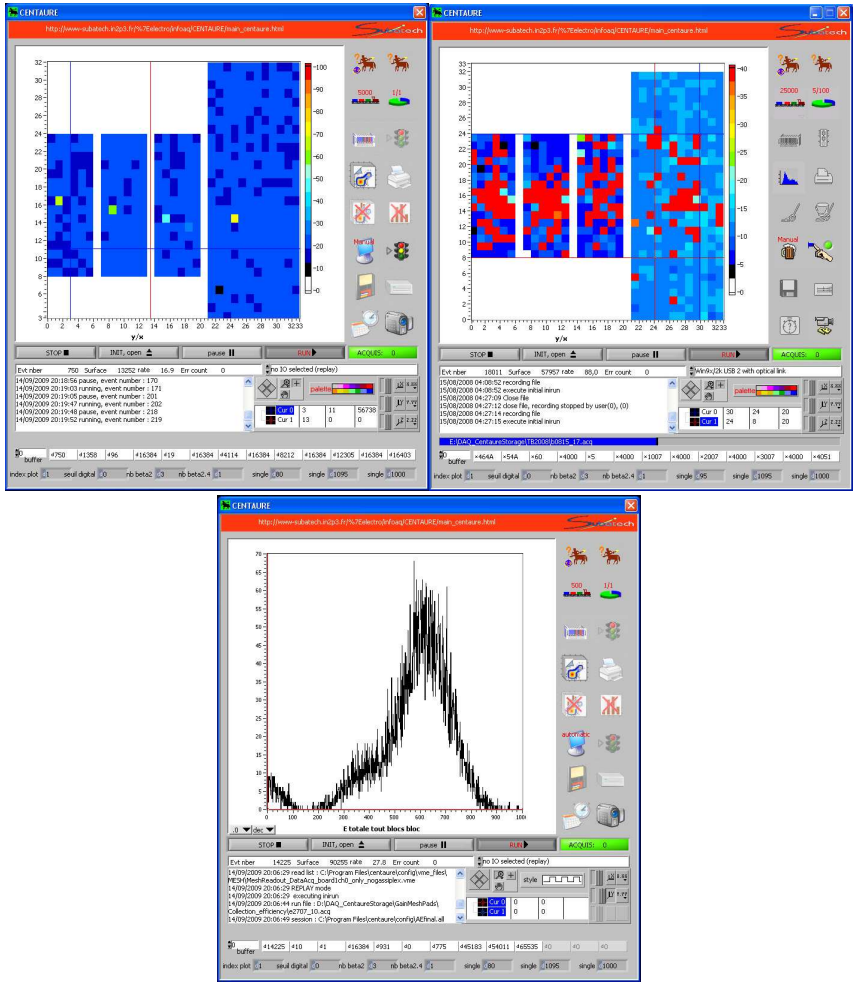
Micromegas Developments for DHCAL Active Layer



Centaure

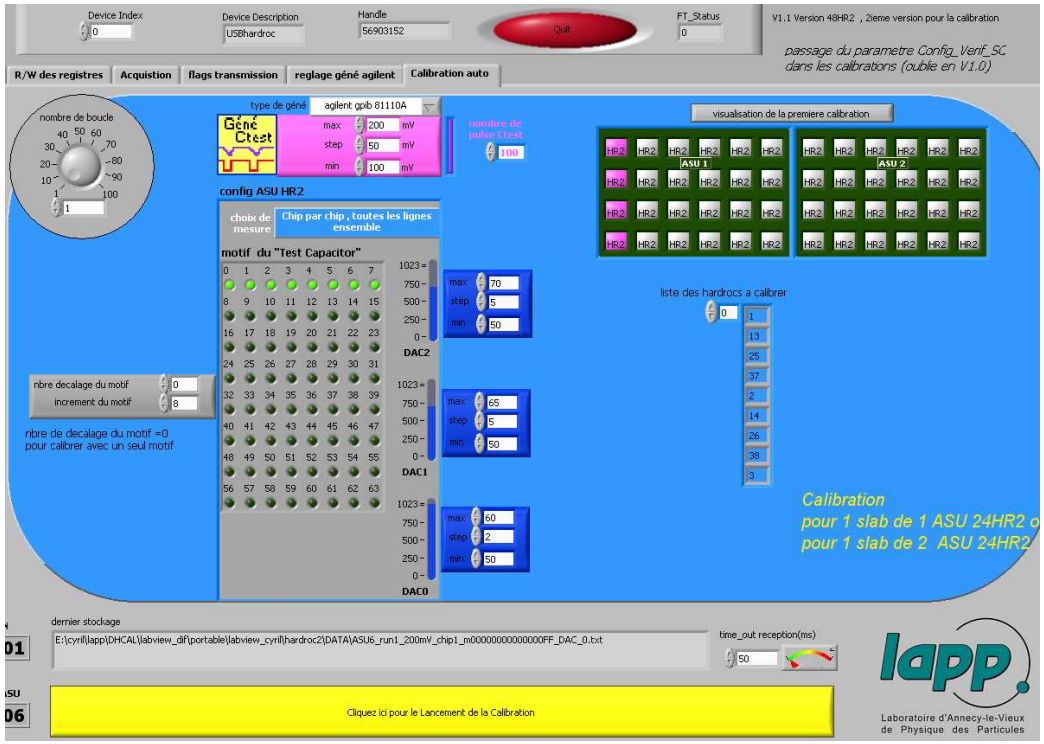
Centaure used for analog data acquisition and online monitoring

- Developed by D. Roy (SUBATECH, Nantes)
- GASSIPLEX readout (any number of boards)
- Mesh readout



Labview

- Home made software for calibration
- Works for Hardroc1, Hardroc2 and Dirac chips
- Development for cosmic data acquisition ongoing



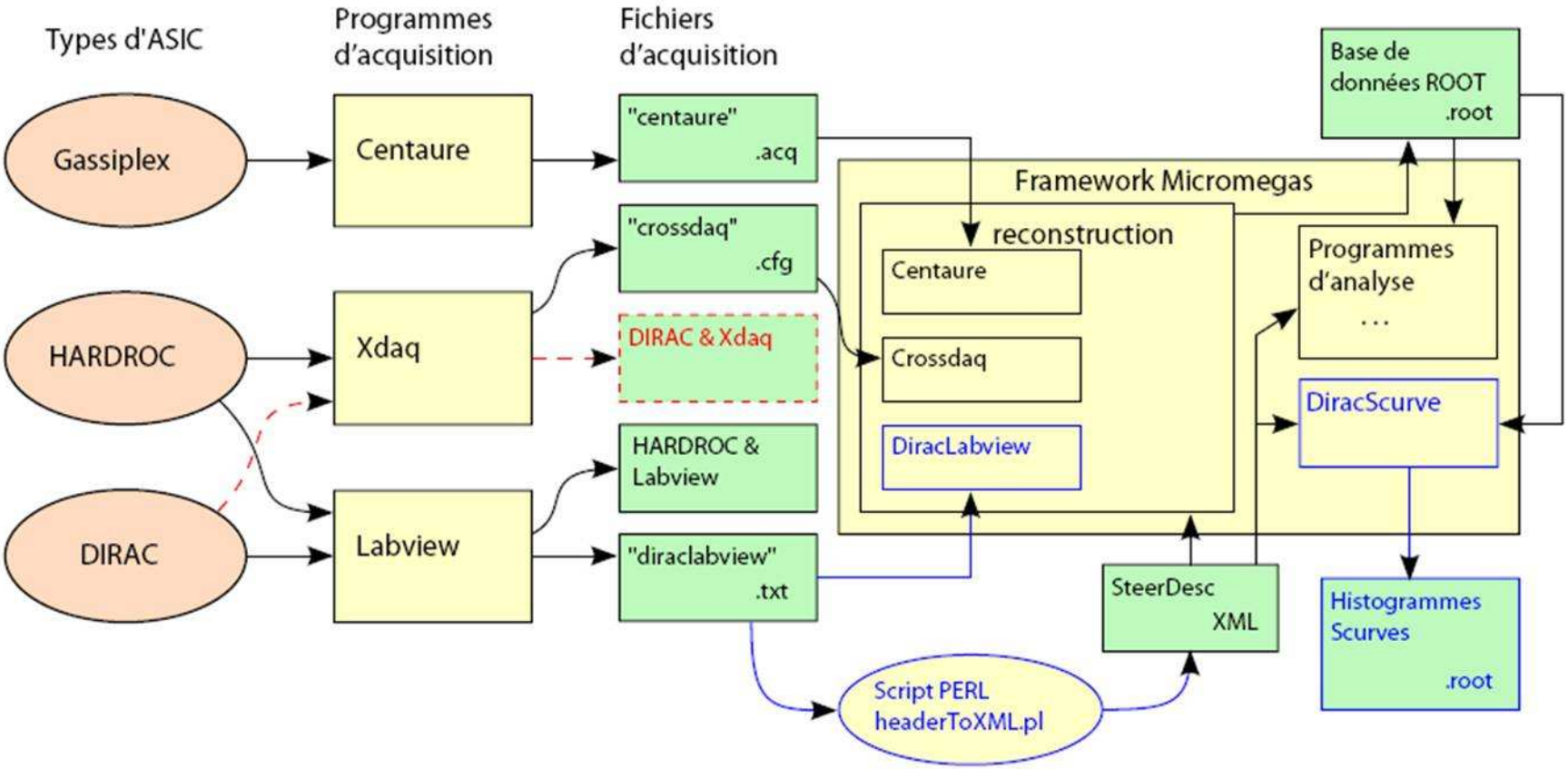
X-DAQ

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

Aspects

- Fast running
- html control interface
- Many annex files (xml, cfg)
- Not user friendly

Analysis Framework

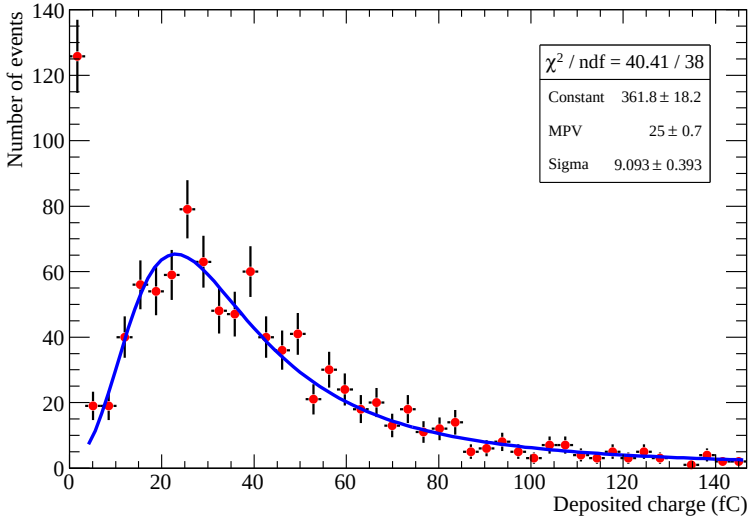


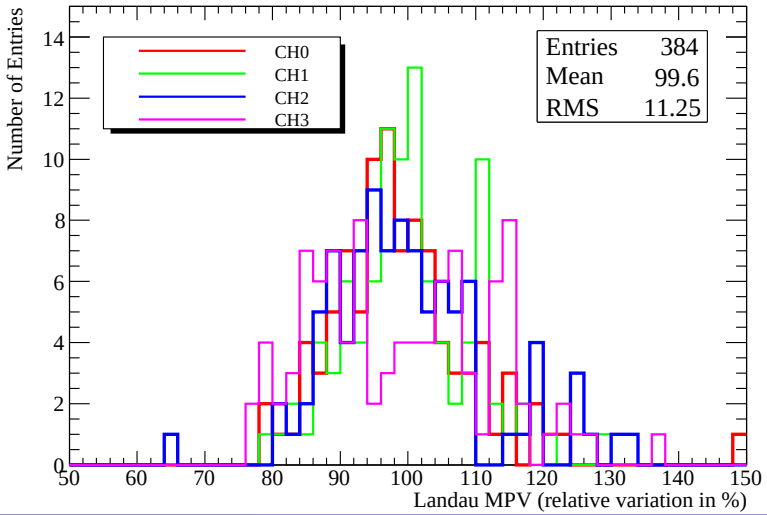
Beam test 2008 Results

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

General Features

- Robustness, industry process
- Low voltage (V_{mesh} & $V_{\mathrm{drift}} < 500\,\mathrm{V}$)
- Needs for low noise electronics
- Needs for reliable sparks protection





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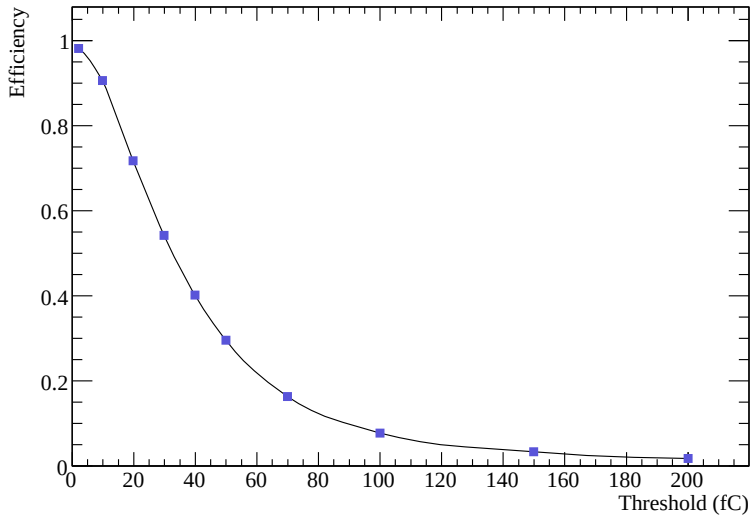
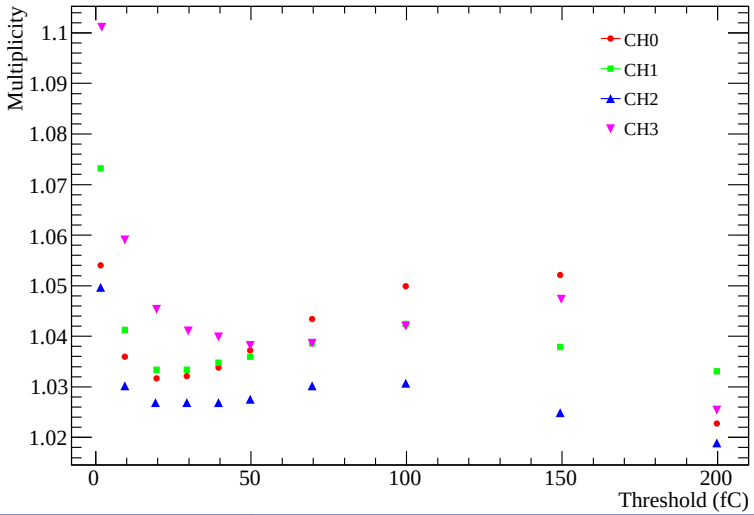
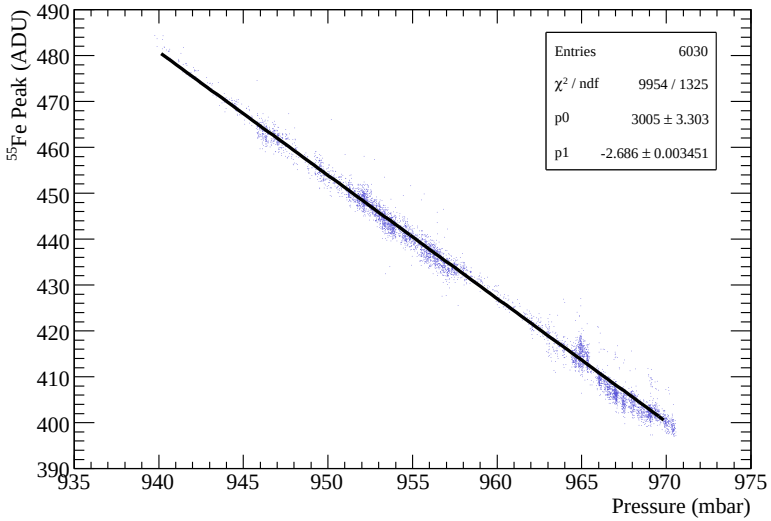




X-Ray Study

- 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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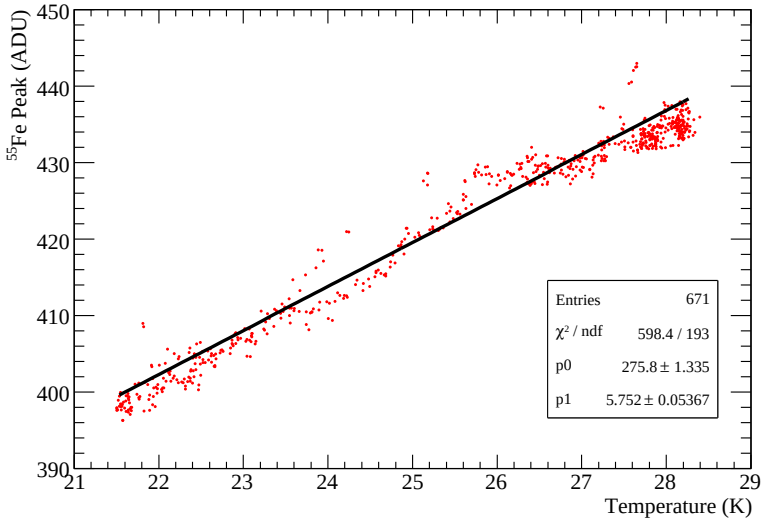

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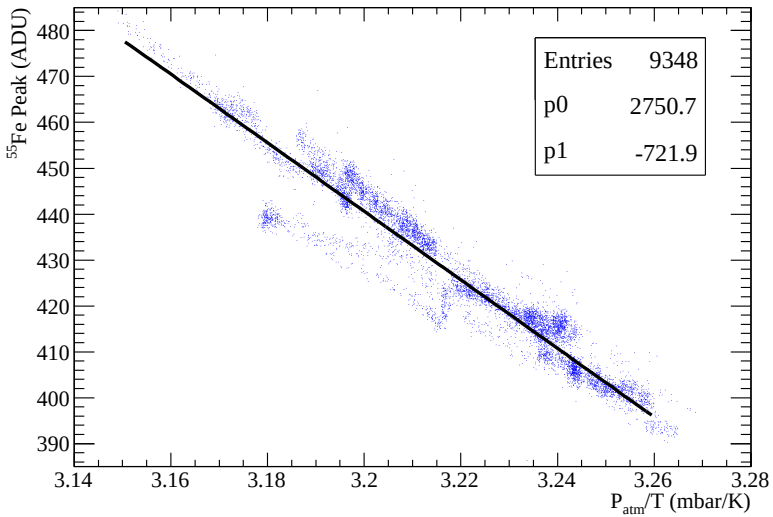

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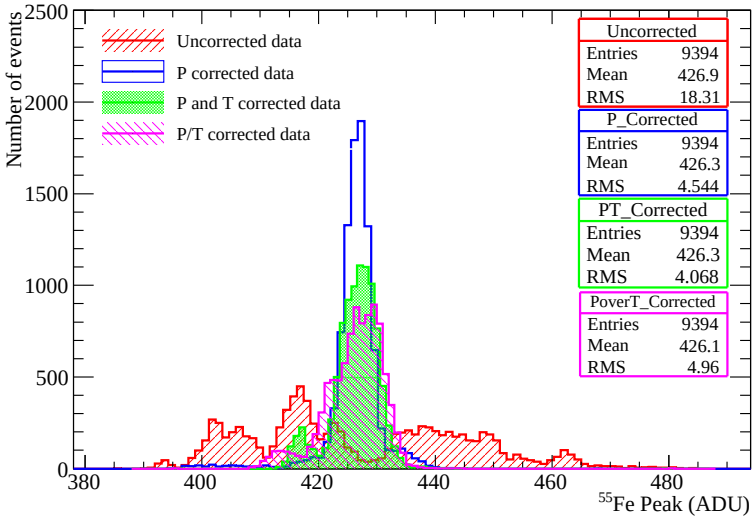
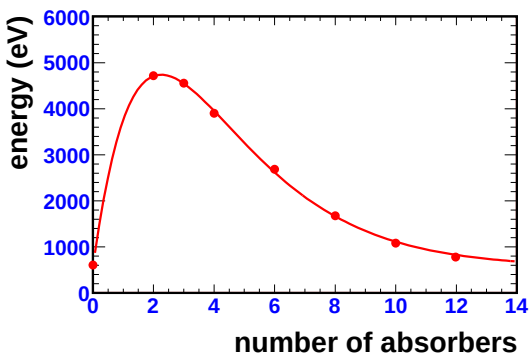
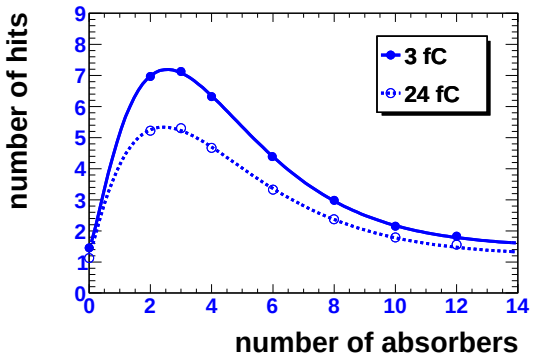


Shower measurements

(see M. Chefdeville's talk...)

- Micromegas behaviour in 2 GeV electron:
  - Stable and high gain during test period (a few HV trips over 12 days)
  - P, T variations can be corrected for, or HV adjusted accordingly
- 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 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

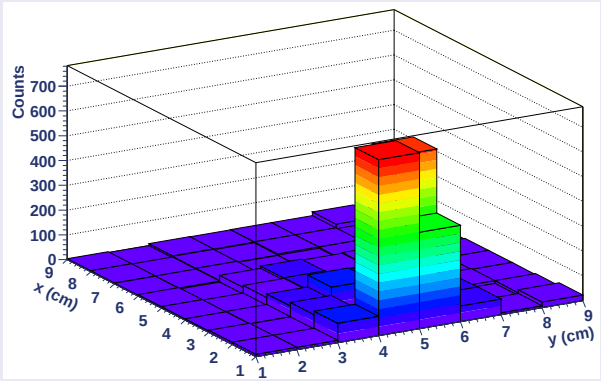
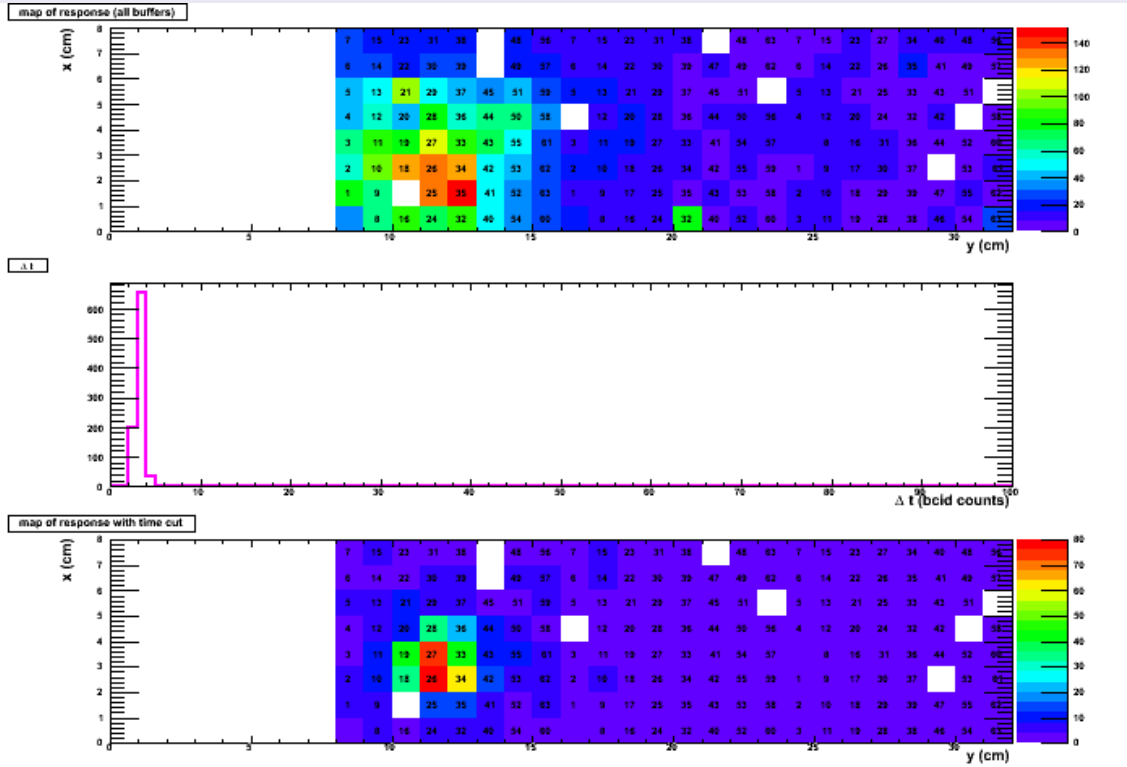


Figure: Beam profile obtained with digital readout using the DIRAC ASIC.

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
- Lack of support for X-DAQ before beam test
- Raw efficiency estimated above 60%



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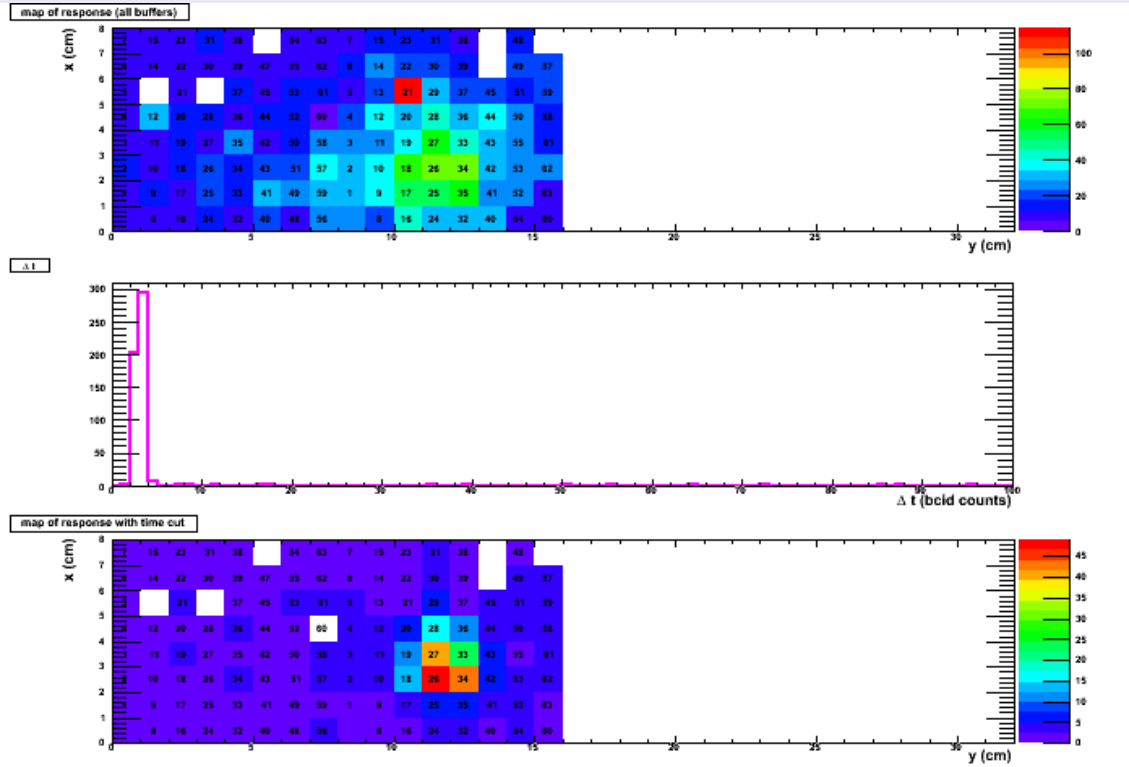


Tests with digital electronics

Ongoing tests of MICROMEGAS HARDROC1 at LAPP

Calibration

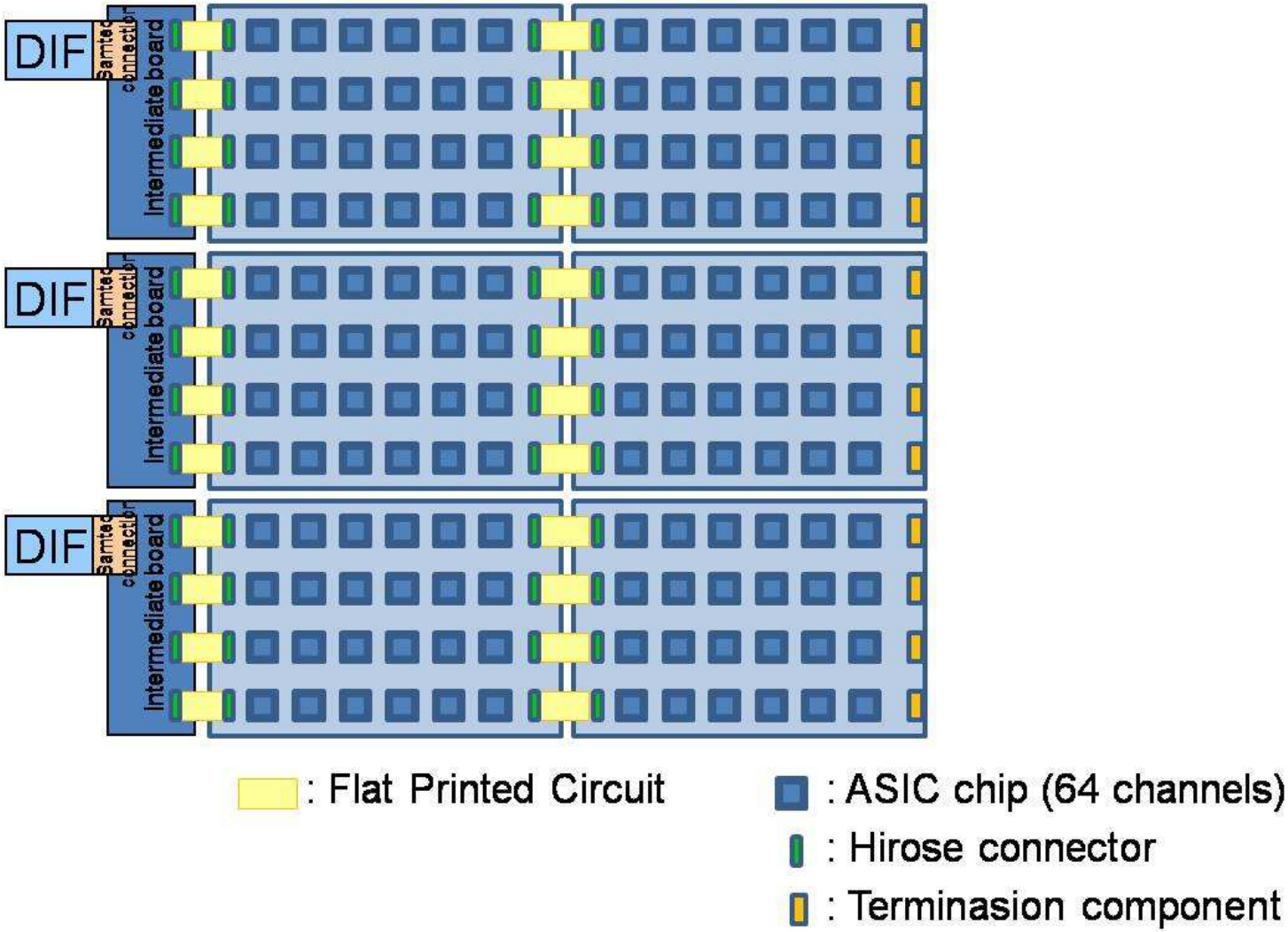
- LabVIEW software
- All S-curves processed (calibration constants almost ready)
- HARDROC1 with optimum configuration should be ready for next week beam test

Cosmic tests

- X-DAQ up to date
- Scintillator trigger
- low rate
- calibration constants not applied yet

Square Meter Project

Layout



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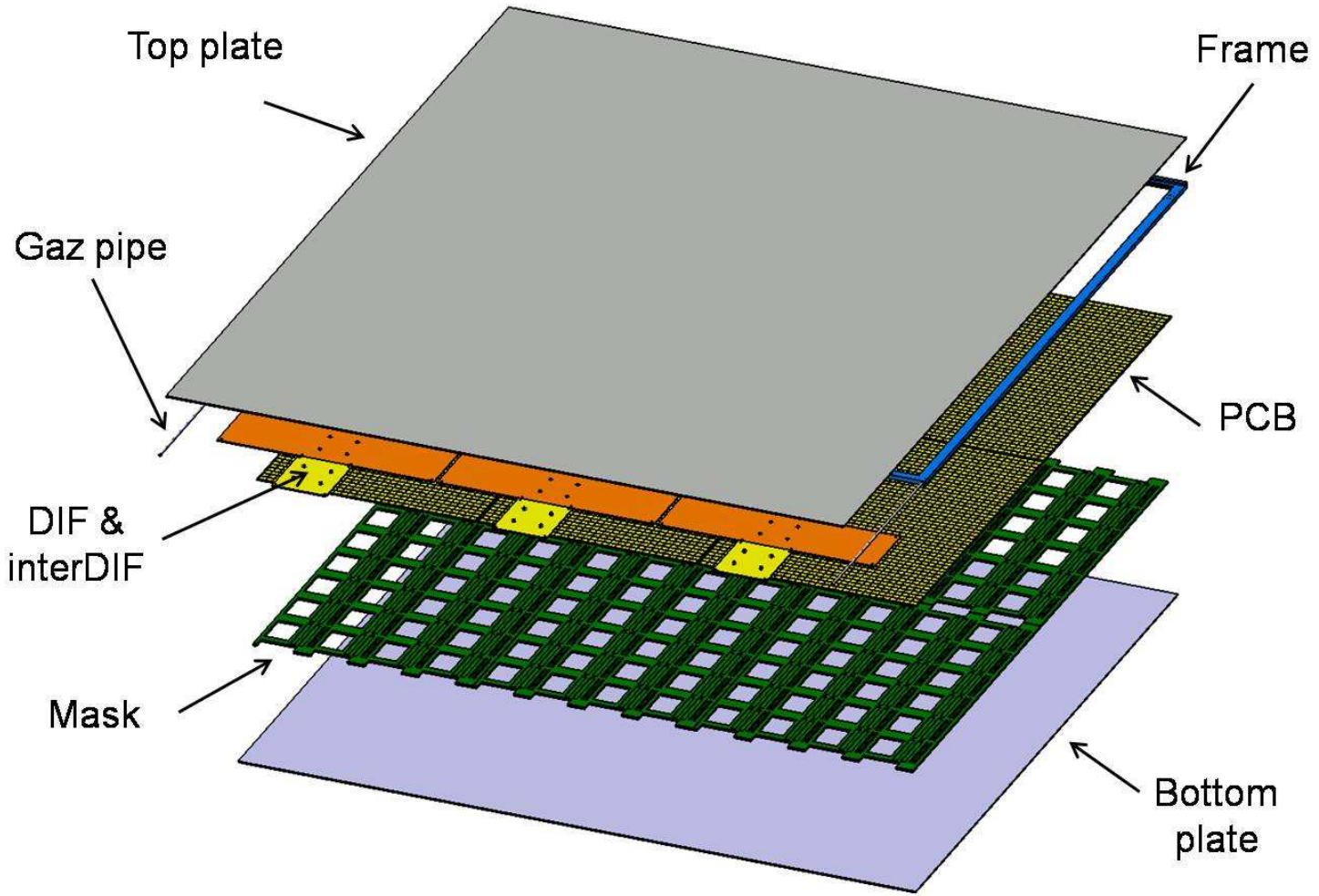
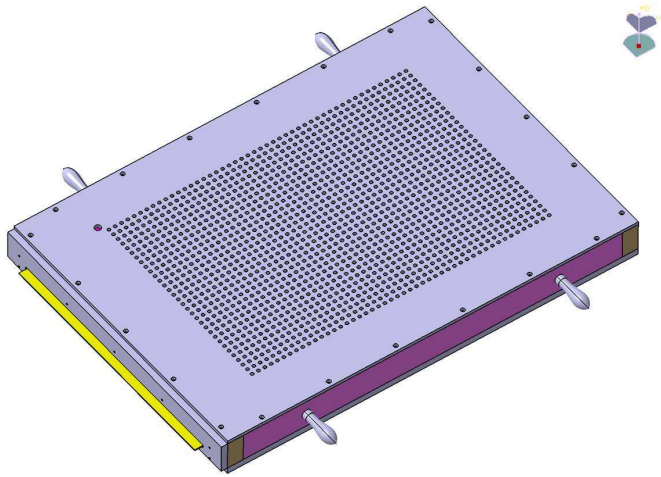
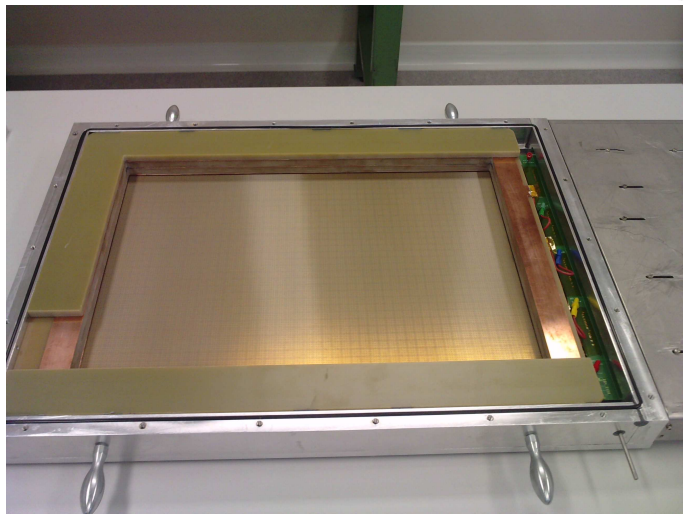


Square Meter Project

Test Box

- 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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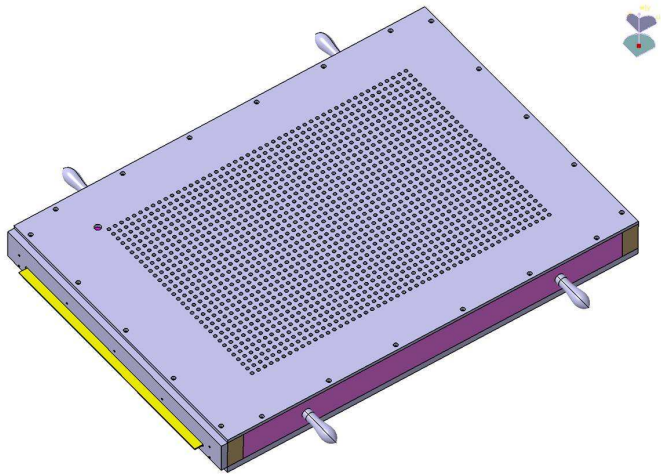

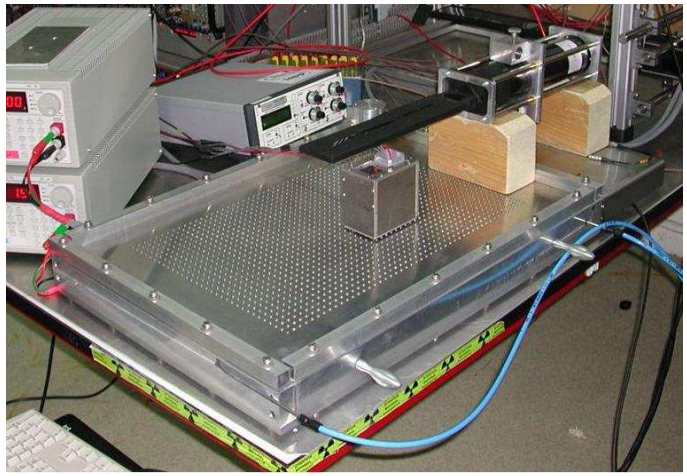

First tests of MICROMEGAS HARDROC2 at LAPP

- Two 32×48 pad ASU
- 24 HARDROC2 chip each
- To be mounted inside the m^2 physics prototype

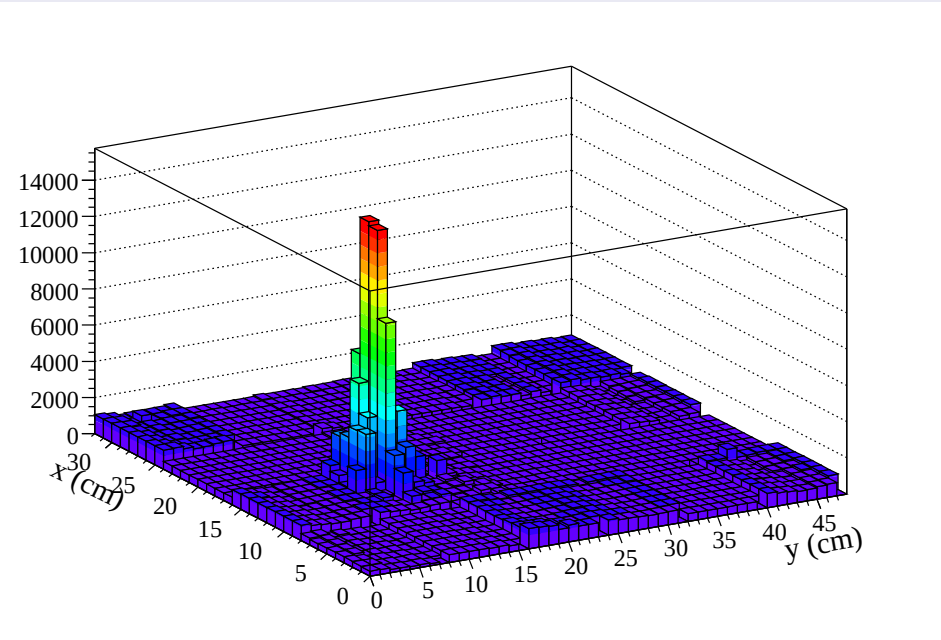

Figure: Response of a 32×48 pad ASU after irradiation with an ^{55}Fe source

Square Meter Project

Mechanical Prototype

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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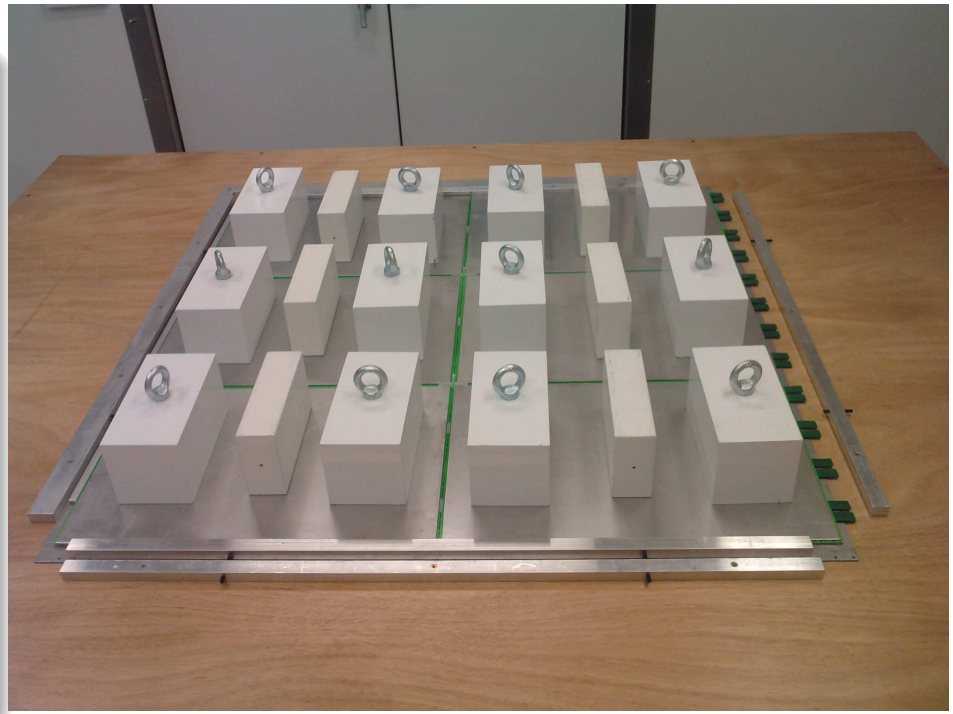

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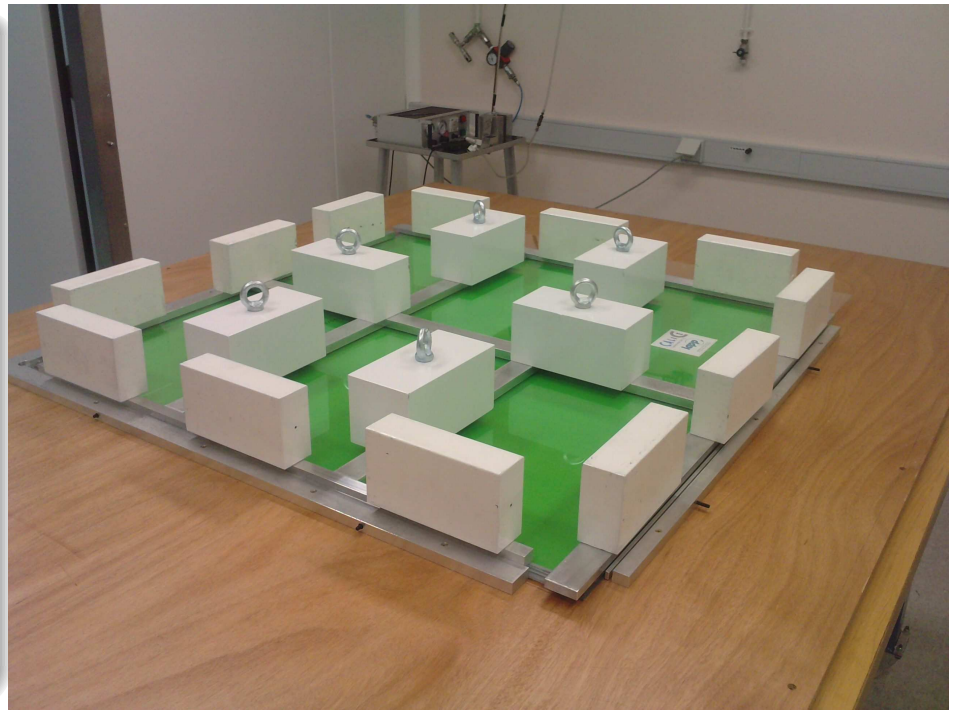

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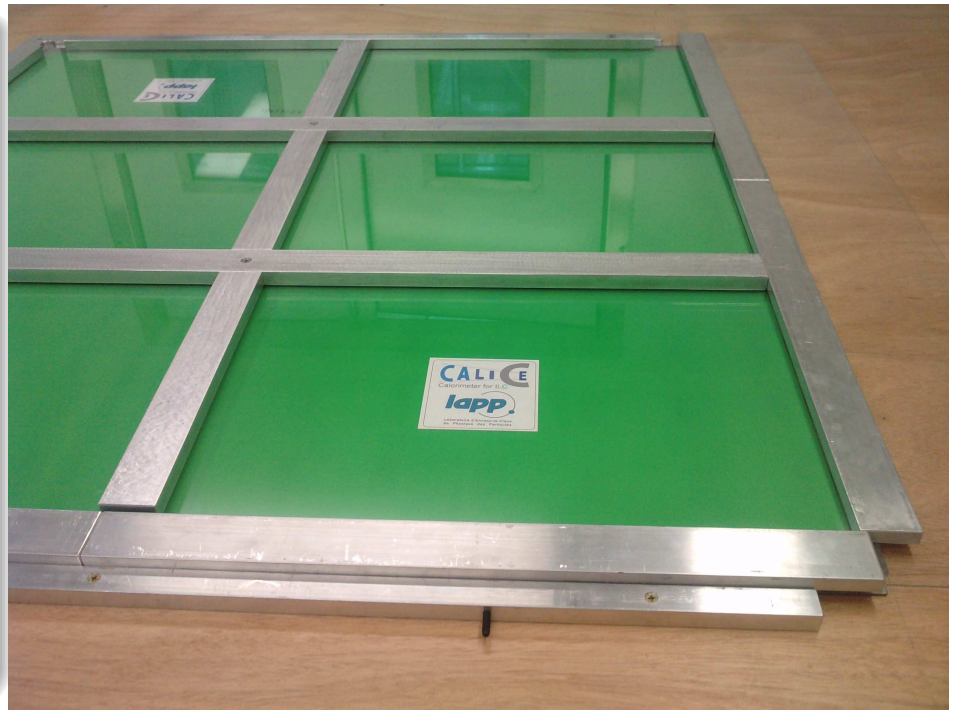

Square Meter Project

Physics Prototype

- 1 week needed for assembling a m^2

Square Meter Project

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- A third of the m^2 will be equipped at first
  $\Rightarrow$ will hold only two ASUs

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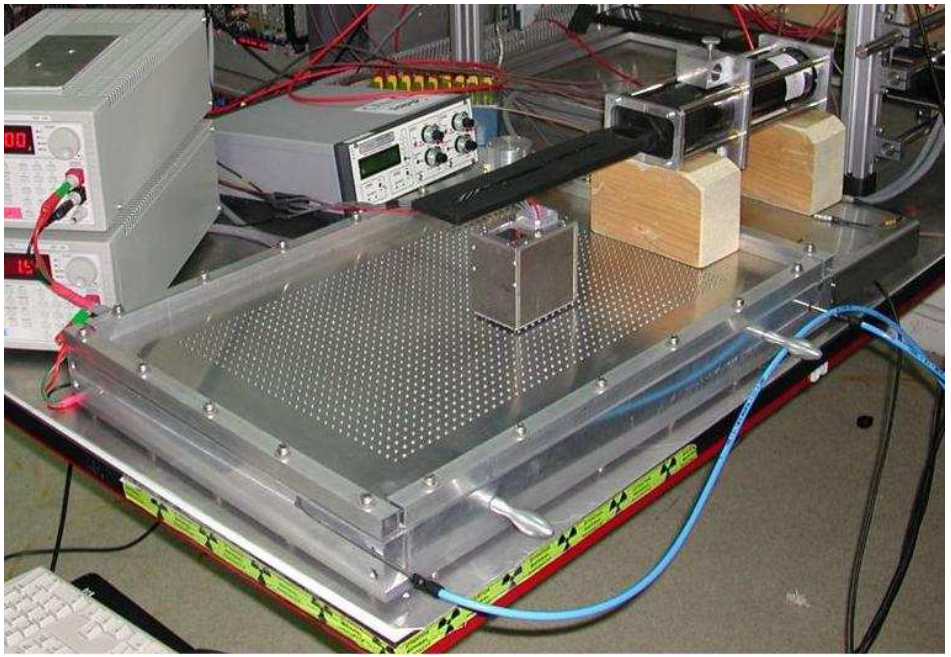

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- A third of the m^2 will be equipped at first
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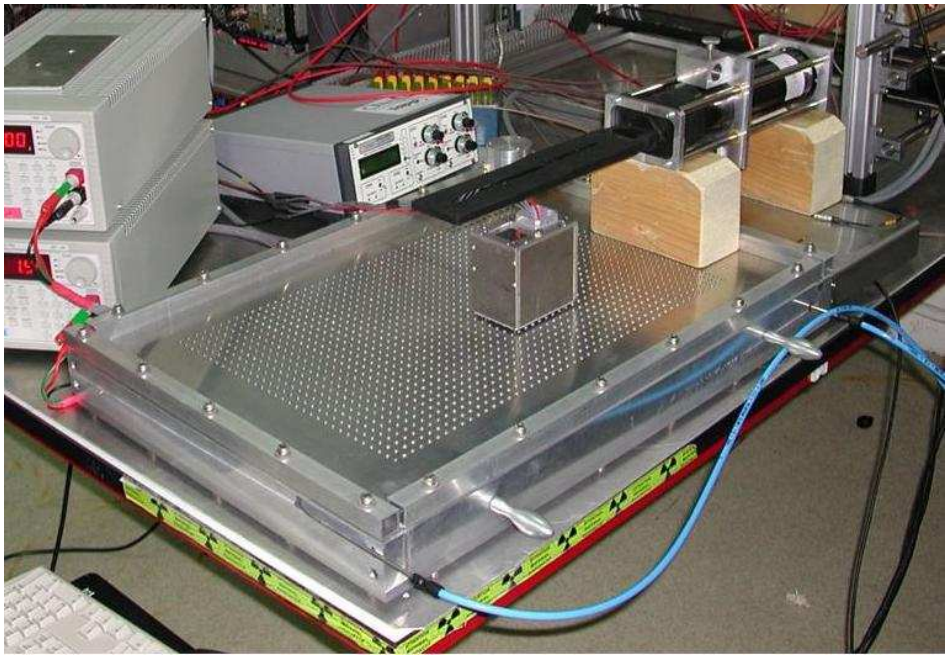
- Both ASUs are under intensive tests to prove their reliability before integration to the m^2
- Physics m^2 assembly to begin on next Monday



Conclusion

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- SiD DHCAL Architecture (LOI)
- DIF boards + VHDL firmware
- DIRAC promising developments
- Productive simulation activities
- Developments of MICROMEGAS chamber as an active layer for DHCAL
  - Collaboration with CERN (bulk MICROMEGAS) and Saclay (Beam tests ...)
  - Building thin and large area chambers
  - Test various readout chips (HARDROC, DIRAC)
  - Very good progress toward a technical prototype (m^2, Eu-DHCAL m^3)