# R&D advances on Micromegas for a semi-DHCAL



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# Overview



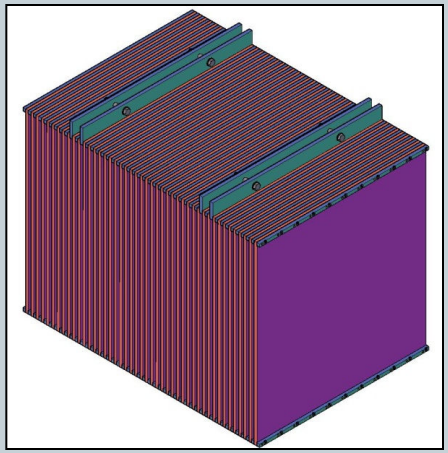
- Micromegas semi-DHCAL
- Basic performance (analog electronics)
- $m^2$ prototype (semi-digital electronics)
- Simulation

# Micromegas semi-DHCAL



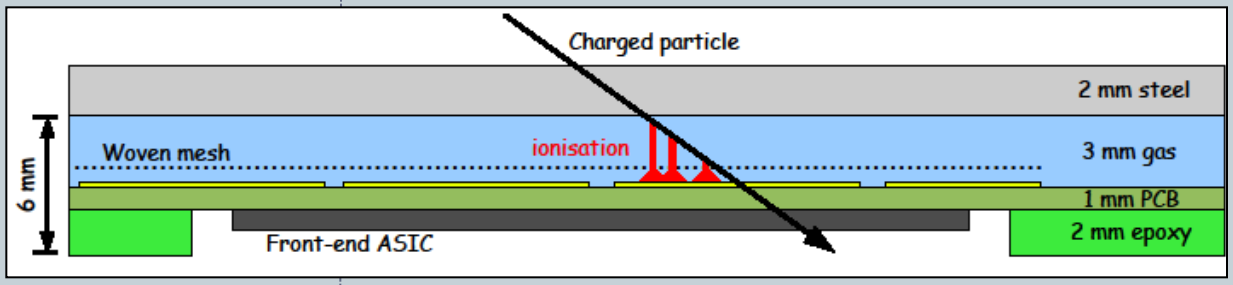
- Proportional mode
- Low working voltage
- Standard gas mixtures
- Robust (Bulk)
- High rate capability

1 m³ structure



- Sparking
  - Depends on gain & rate
  - Protection exist (RD51)
- Large area
  - Relatively new
  - RD51, MAMMA

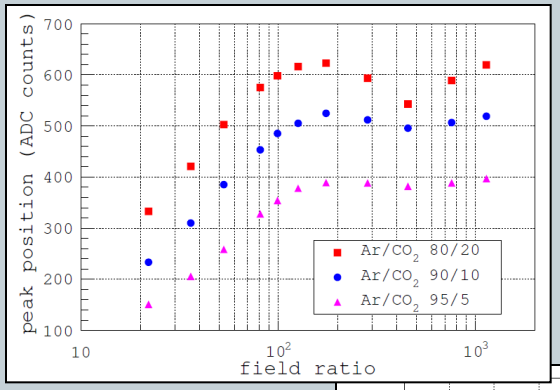
3 mm gas, 1 cm² pads, thick. < 8mm

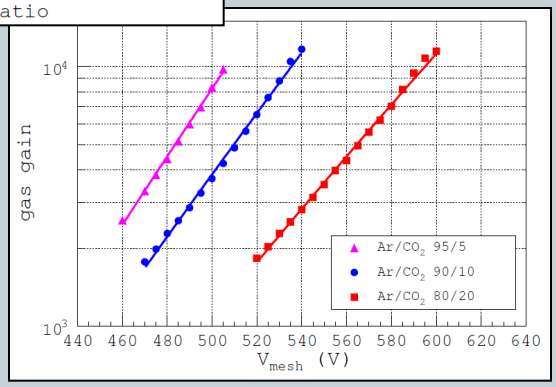


# Basic performance (X-rays)

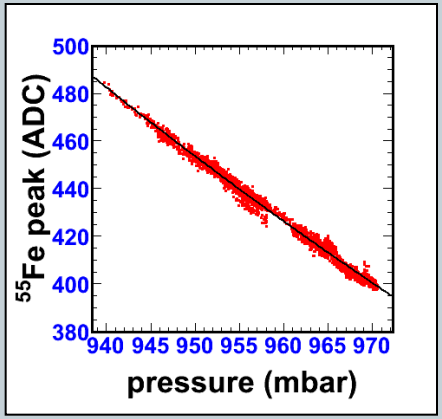


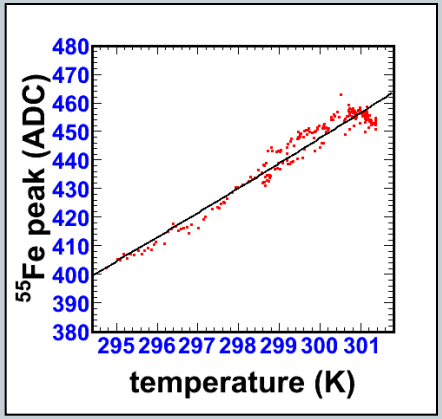
- Gas mixtures
  - Collection efficiency
  - Gas gain




- Ambient parameters
  - Pressure
  - Temperature

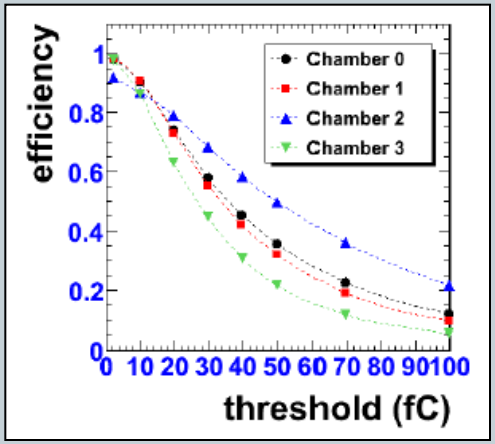


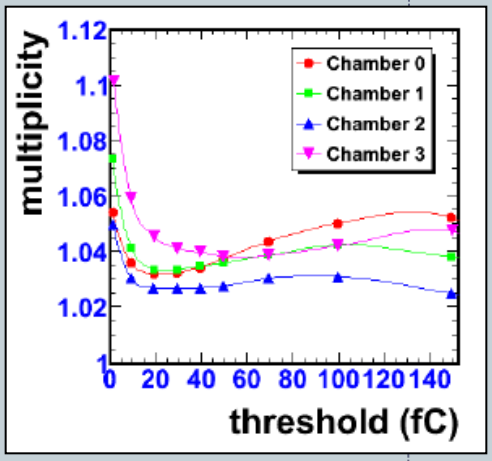



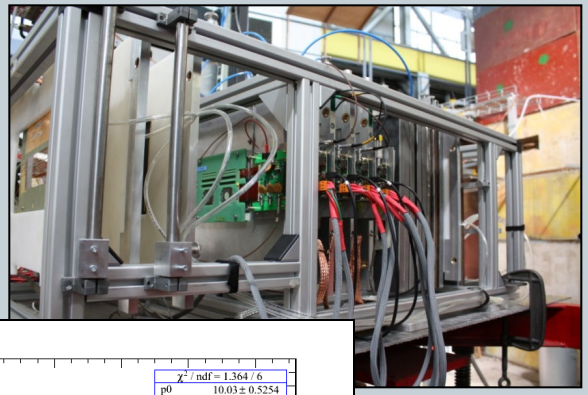
# Basic performance (TB)

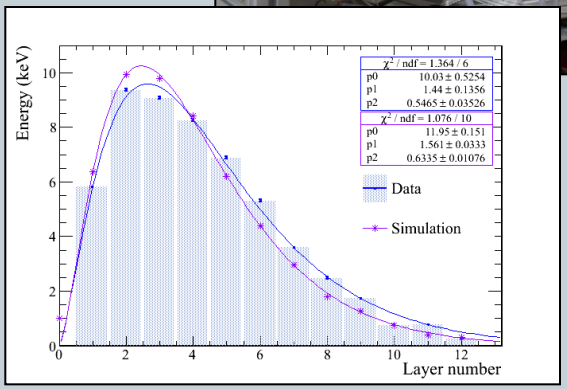


- Study with MIPs
  - Efficiency, multiplicity
  - Uniformity
    better than 1 % (100 cm²)
  - Threshold effect understood
- Shower profiles
  - 2 GeV/c electrons
  - Hadrons analysis on-going



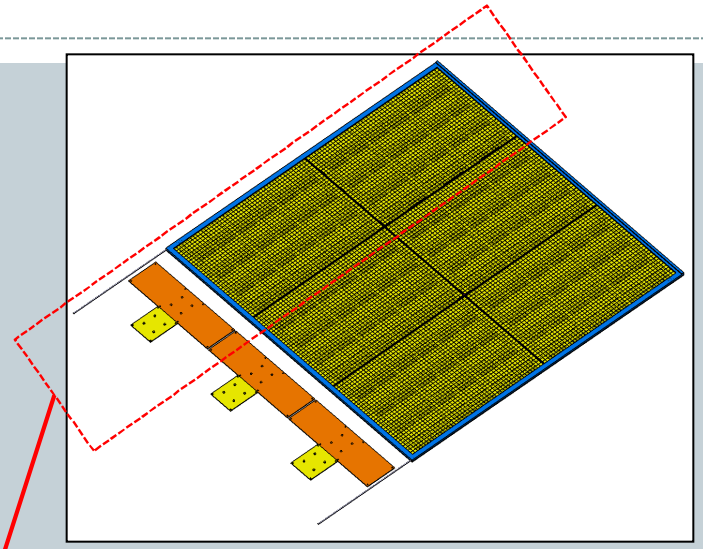



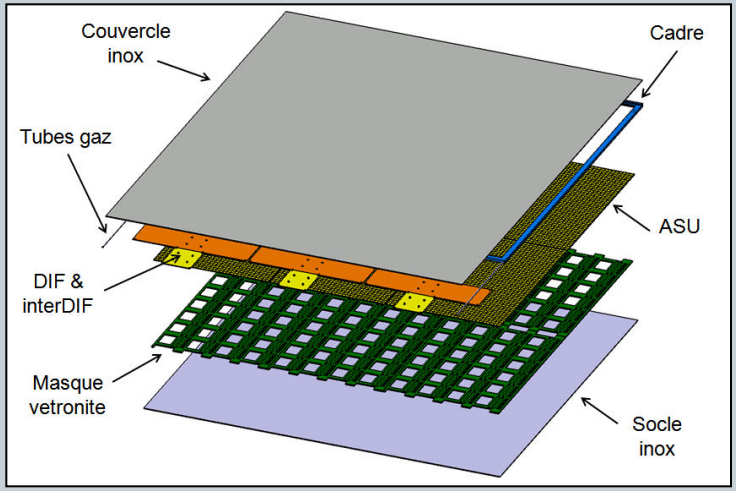


# 1 m² prototype



- Active Sensor Unit (ASU)
  - Front-end electronics embedded on 1 side of PCB
  - Pads and mesh on the over side
- Prototype
  - 6 ASU of 48x32 cm²
- Before that:
  - Tests with smaller prototypes and different chips



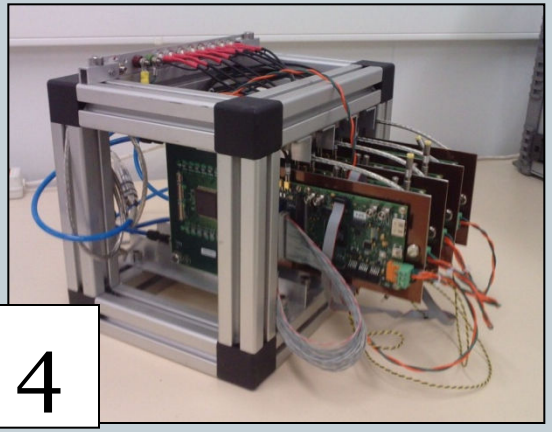



2x48x32 cm²

# Active Sensor Units



1. DIRAC chip, 8x8 cm², 2008
2. HARDROC1 chip, 32x8 cm², 2008
3. HARDROC2 chip, 48x32 cm², 2009
4. DIRAC2 chip, 8x8 cm², 2009



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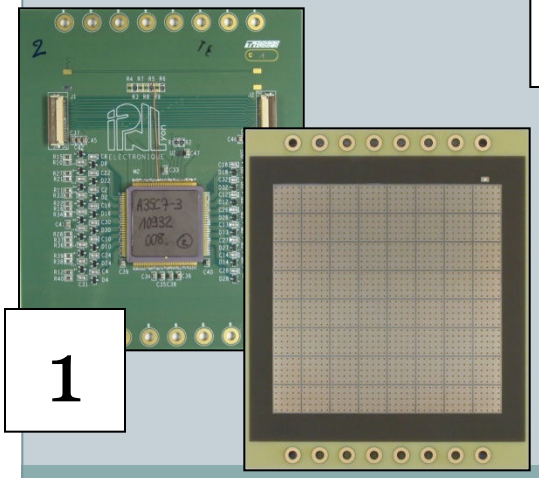
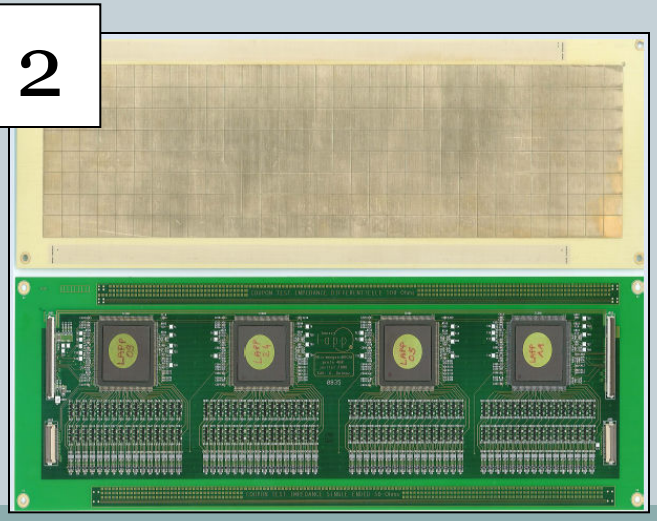


1



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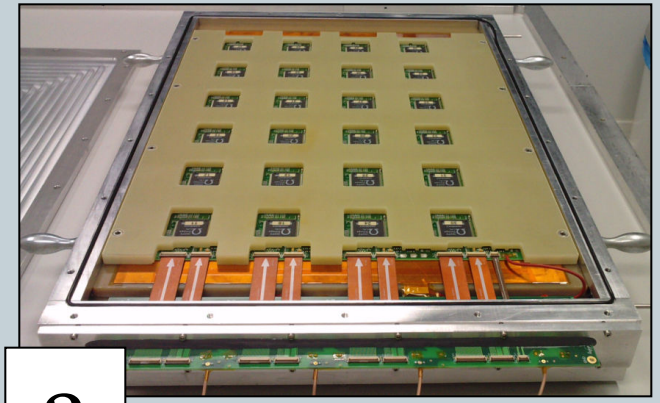


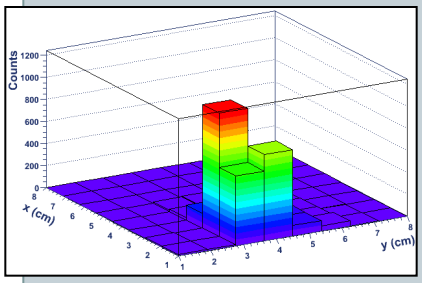
3

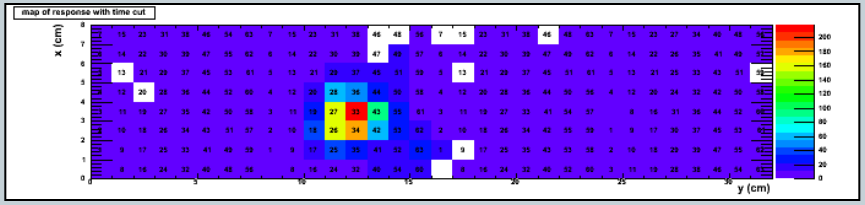
# ASU test in CERN particle beams

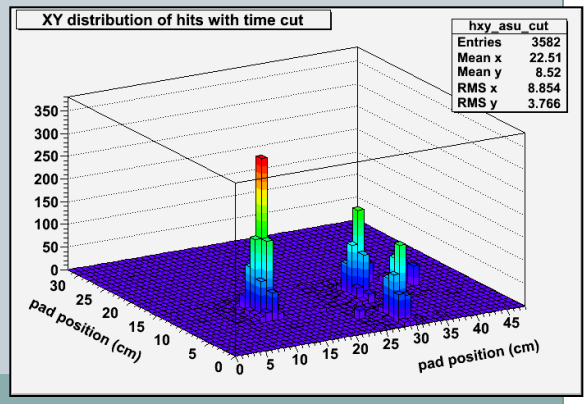


- DIRAC chip
  - Promising results on efficiency
  - Not spark-proof yet, protection tests @ LAPP just started
- HARDROC 1 & 2
  - Too short shaping time w.r.t. Micromegas signals
  - Very low efficiency
- Work on a new chip in collaboration with LAL/Omega

*For more details, see Micromegas talk in calo/muon session*

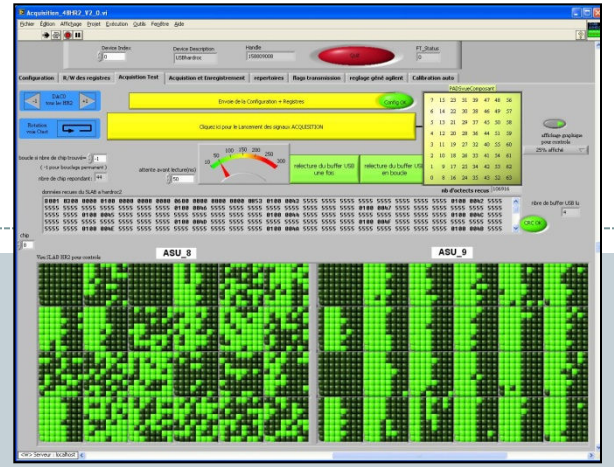


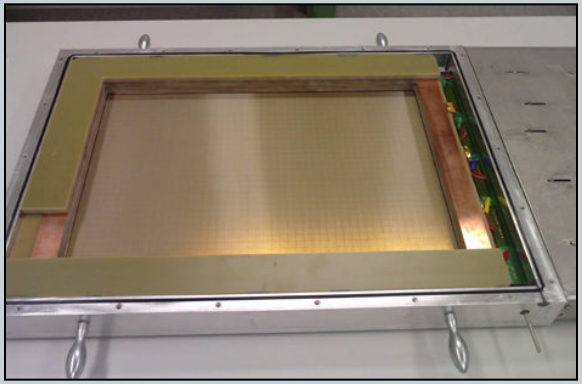



# Status and future plans



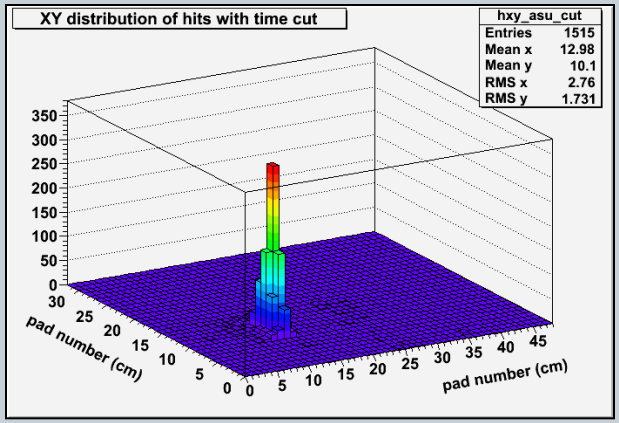



- ASU test on-going
  - Measurement of ASIC performance
  - Response to $^{55}$Fe X-rays and cosmics



- 4 ASU with HR2, 1 ASU HR2b + 1 dummy
  Assembly foreseen in April
  Cosmics tests @ LAPP until June

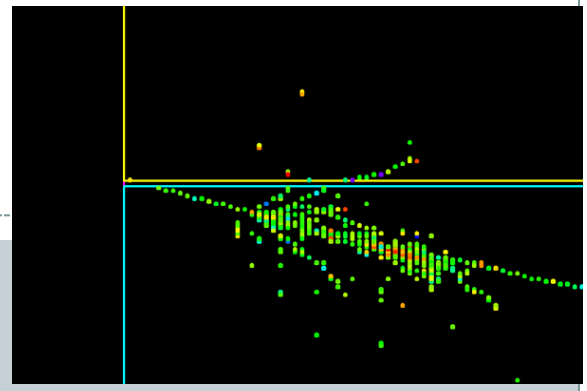
- 2-3 weeks of beam in SPS/H4 end of June
  - Efficiency, multiplicity, uniformity
  - Spark study (beam intensity)

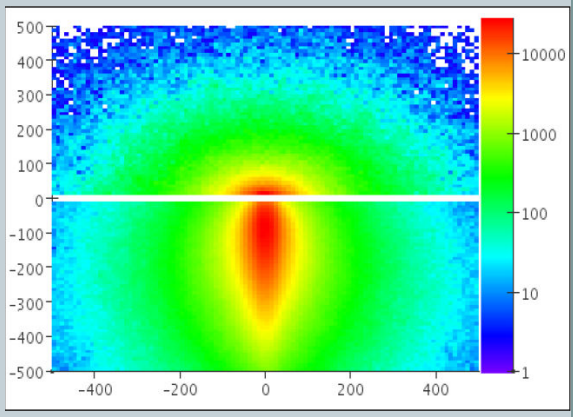


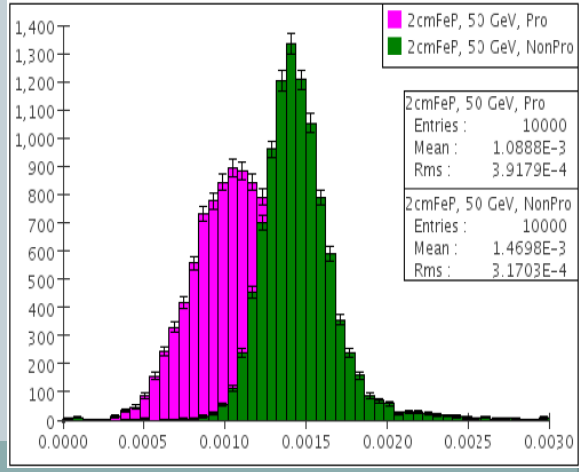
# Simulation



- Comparison analogue/digital readout for 1 m³ steel
- Digitization, from GEANT4 energy deposits in gas layers to hits
- Simulation for CLIC: definition of HCAL and small prototype for TB
- TB setup simulation and comparison with data
- Implementation of MICROMEGAS DHCAL in CLIC and SiD detector geometry
- Study of crack effects on HCAL performance





# Conclusions



- Very good basic performance for a DHCAL but strongly depends on electronics
  - HARDROC input stage not optimized for MICROMEGAS signals
    Work on a new ASIC on-going
  - Several options for spark protection are being investigated

- First 1 m² MICROMEGAS prototype available end of April 2010 and ready for beam test at the end of June
  - Equipped with HR2, so limited performance expected
    However, a lot to learn for next 1 m² prototypes
  - Next prototypes should be equipped with a different chip
    - One plane with DIRAC if spark protection issue solved
    - Next planes with a new chip, probably resulting from the collaboration between LAL and LAPP

# Acknowledgments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