# Micromegas DHCAL

## Status Report and Future Plans

CALICE Meeting
UT Arlington, Texas
12th March 2010

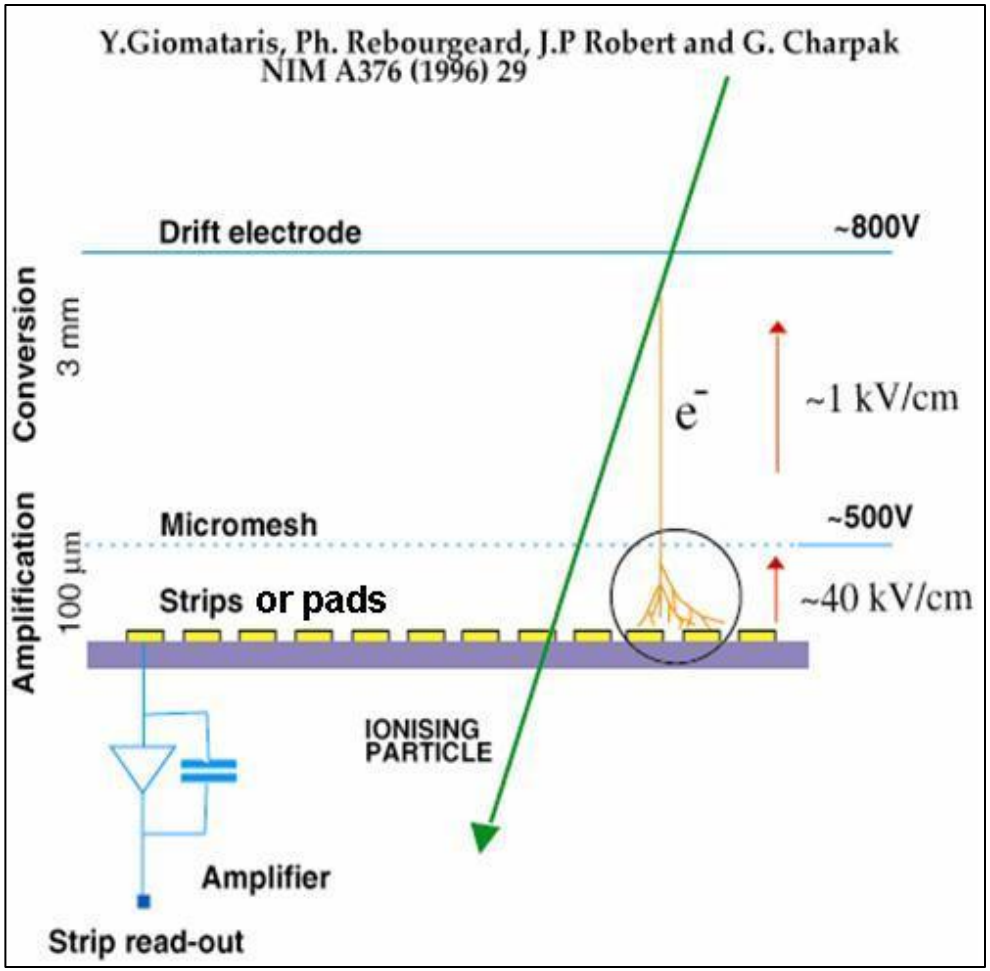
*Ambroise Espargilière on behalf of the LAPP group*

# Outline

- Brief reminder
  - Prototype caracteristics
  - Electronic realisations
  - Bulk Micromegas with embedded readout electronics
- Beam tests results
  - Analog readout
  - HARDROC 1-2
  - DIRAC2
- 2010 plans
  - VFE Electronics developments (readout ASIC, spark protection)
  - First $m^2$ technological prototype status
  - Beam tests
  - Simulation activities
- Conclusion

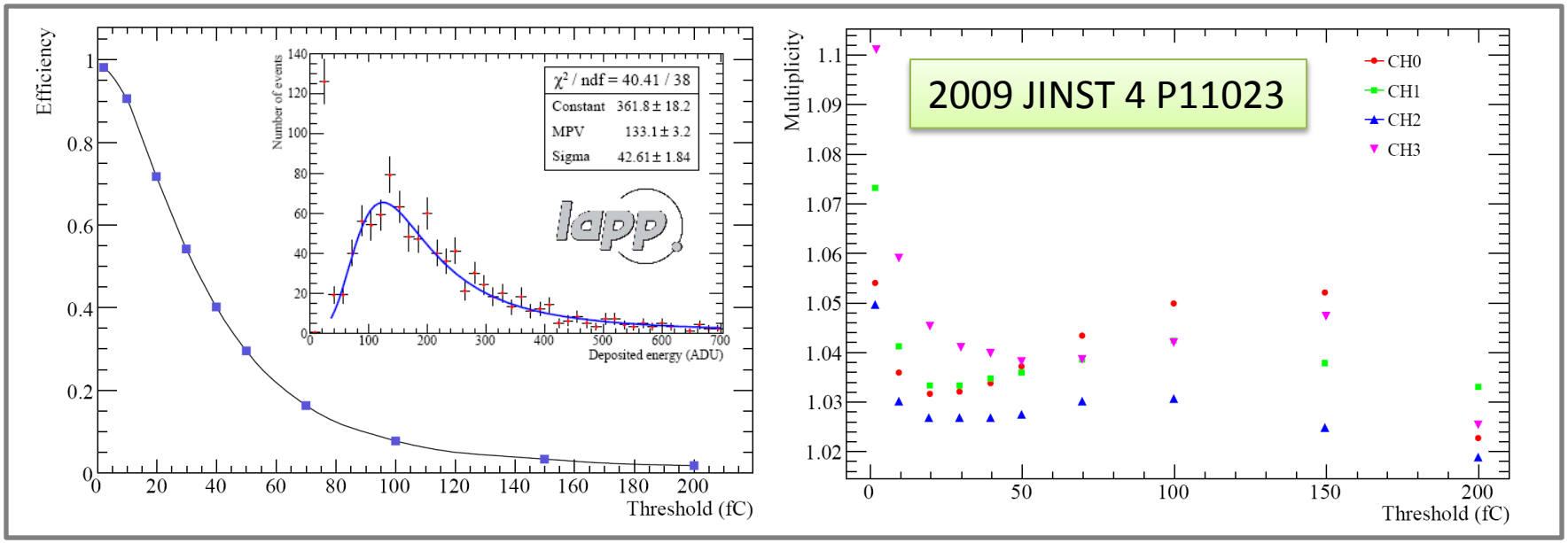
# Reminder: MICROMEGAS

- MICROMEGAS detector
  - MICRO MEsh GAseous Structure
  - High detection rate
  - Low voltage (all < 600V)
  - Bulk technology
    →Robust, cheap
- Prototype layout
  - 128µm bulk
  - 3 mm conversion gap
  - 2 mm absorber as chamber cover



# Reminder: basic performance

- Prototype basic performances (test beam 2008)
  - MIP most probable value : ~20fC (11% r.m.s.)
  - Efficiency > 97%, channel non-uniformity < 1% (1.5fC threshold)
  - Multiplicity < 1.1 , chamber non-uniformity < 1.5%

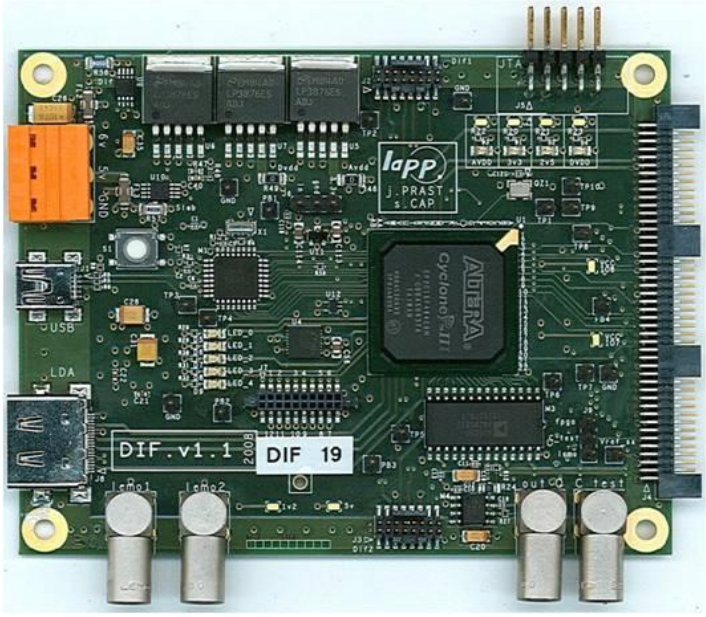


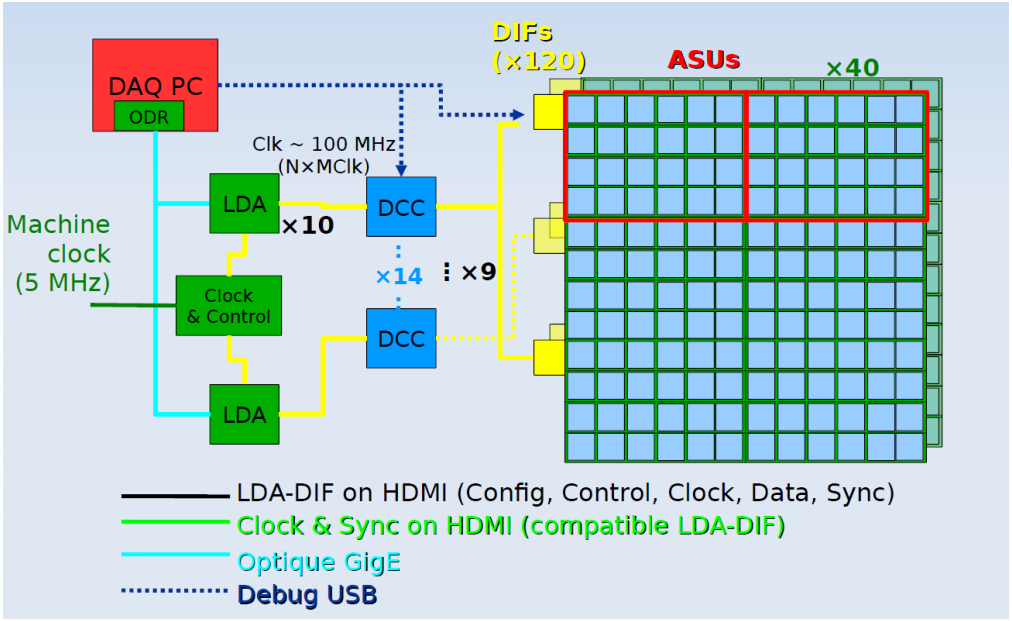
# Reminder: Electronics (see C. de la Taille's talk)

- DIF (Detector Interface) developed at LAPP and ready for mass production
- Recent developments for the new CALICE DAQ:

→ 8B/10B Communication protocols validated (LAPP/LLR)

→ CCC (Clock and Control Card) integration in work at LAPP



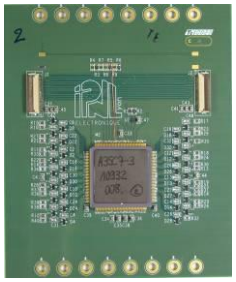



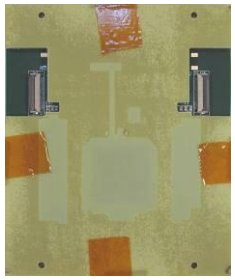
# Digital Readout

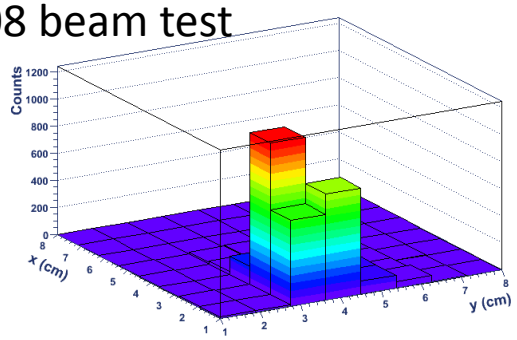
- Bulk MICROMEGAS with embedded Readout electronics
  - HCAL compactness ⇒ embedded VFE
  - Install bulk or VFE first ? ASICs won't survive being laminated
    Bulk won't behave well in the soldering oven
  - →Solution: VFE first with protection mask for the ASICs

2 types of ASICs concidered
- HARDROC , 2 versions (LAL)
- DIRAC2 (LAPP/IPNL)

First MICROMEGAS bulk with embedded VFE successfully tested in 2008 beam test



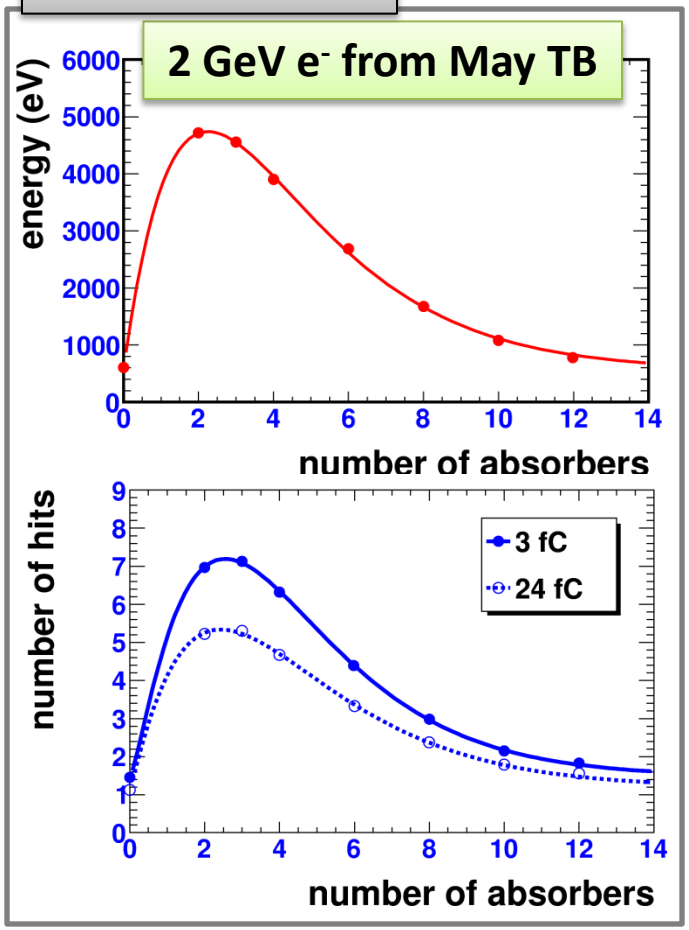




# 2009 Beam tests results summary
# SEPT 2009: GASSIPLEX

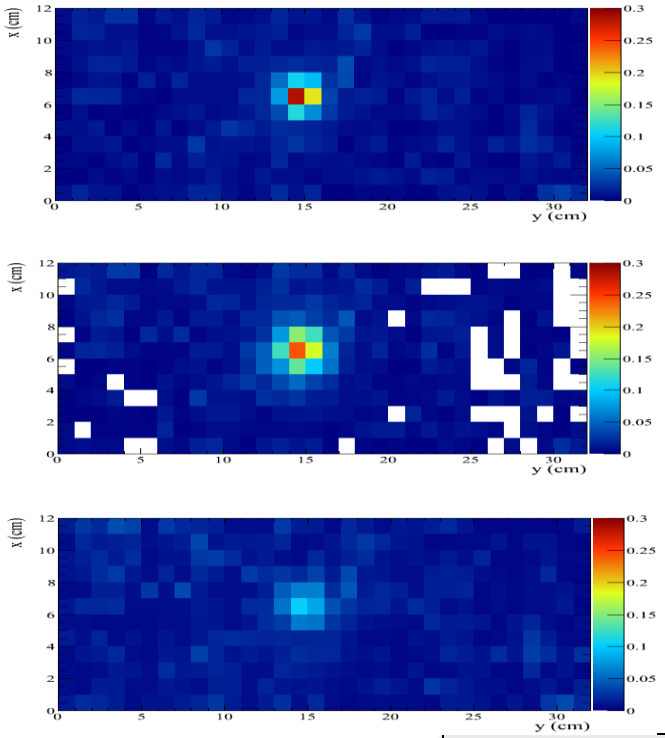
- hadron showers (1-6 GeV, 6 Abs.)

Previous Results




Ongoing analysis

Hadrons 1 GeV




0 absorber

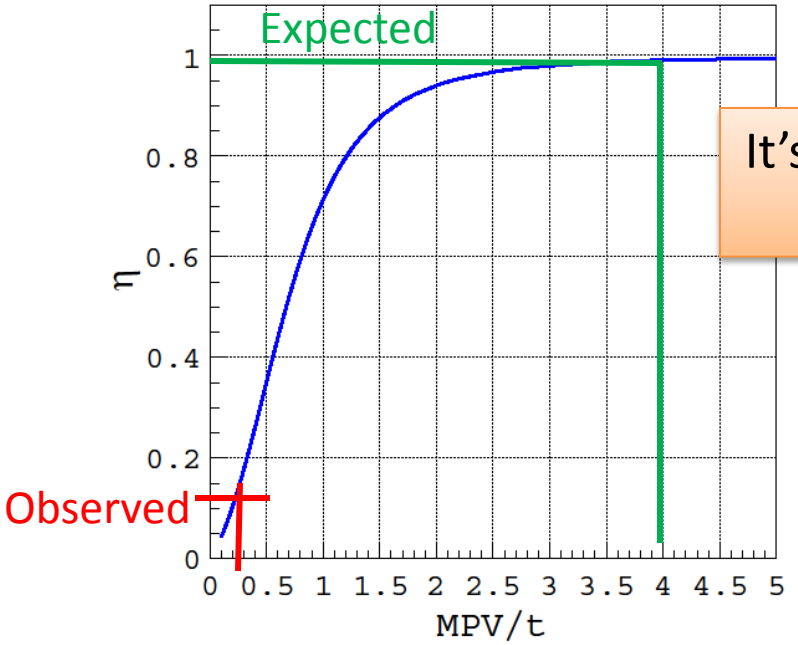
3 absorber

6 absorber

12x32 cm$^2$ chamber

# 2009 Beam tests results summary
# SEPT 2009 : HARDROC 1

- Threshold ~5fC → expect ~90% efficiency or more
- Measurement → 8 – 14 % (extremely low !!)




It's like if the MPV were only ~1fC (MPV/t = 0.25) instead of ~20fC

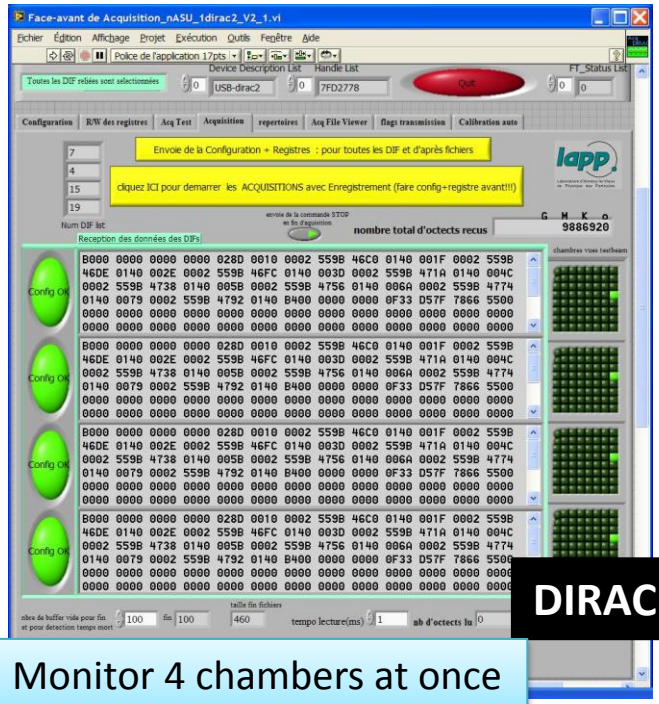
# 2009 Beam tests results summary
# SEPT 2009 : HARDROC 1

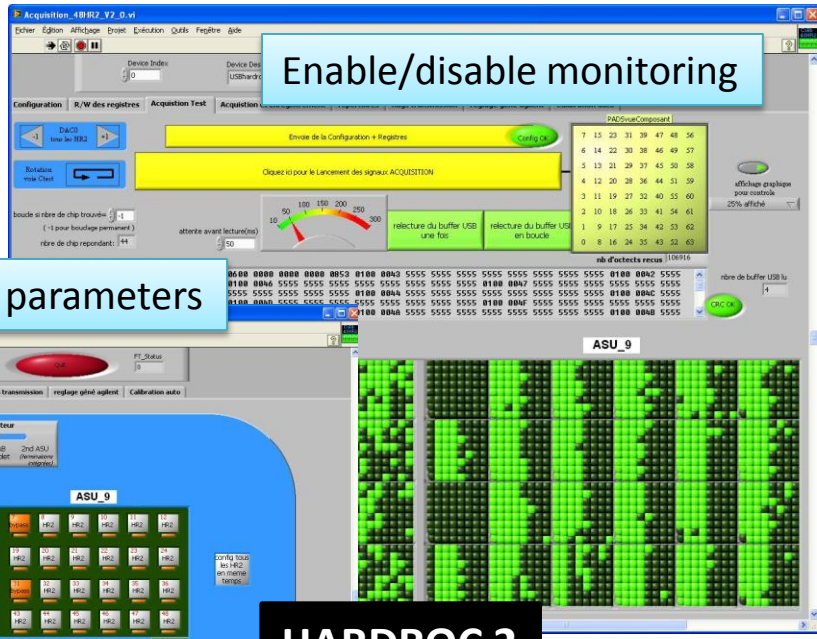
- MICROMEGAS signal
  - Fast electron signal (~1 ns)
  - Slow ion signal (~100 ns)
  - ~90% signal due to ions (e-/ions = 1/ln(Gain) ≈ 0.1 )

- HARDROC shaping time very short (10-20 ns)
  - electron drift velocity (~50 µm/ns)
    → only one mm of gas is seen (2/3 signal lost)
    → the ion tails can't be seen (~90% of signal lost)
  - HARDROC sees only 0.1 x 1/3 x 20fC ≈ 1fC as signal MPV

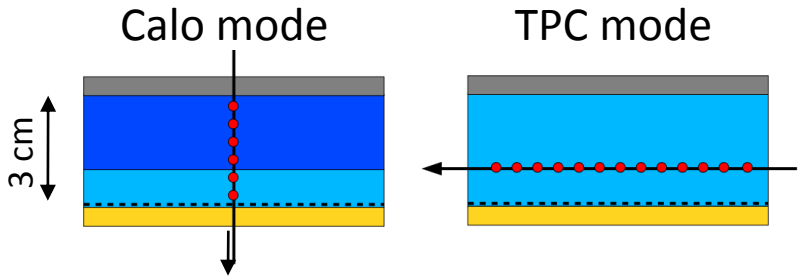
# New acquisition software

- X-DAQ left out
- Labview software for calibration, monitoring and data acquisition
- Version for HR1, HR2, DIRAC2
- Version for hybrid readout foreseen
- ~ 100Hz acquisition rate (24 HR2)

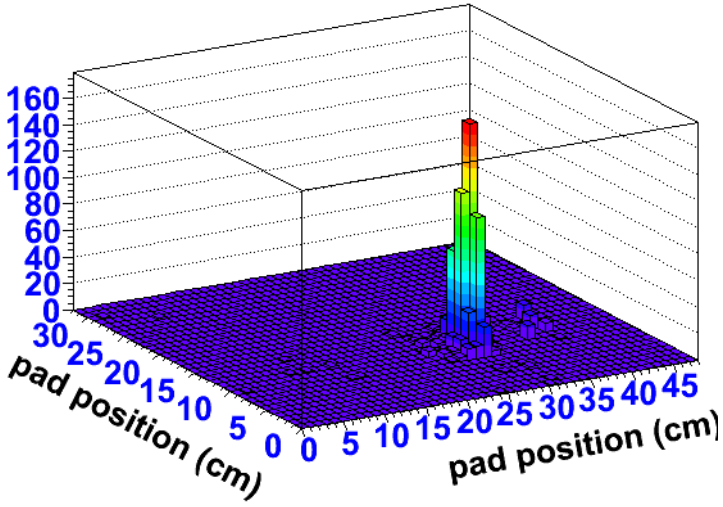


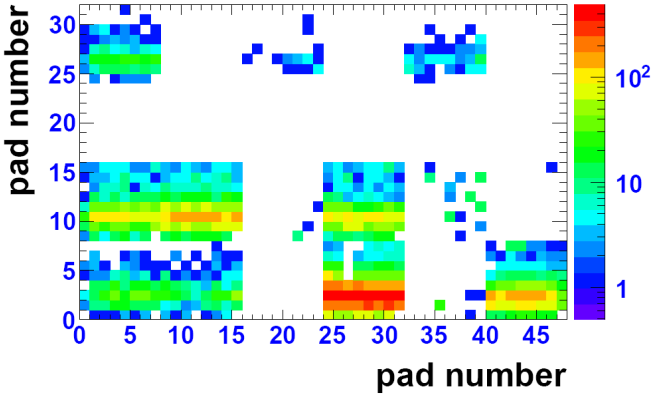



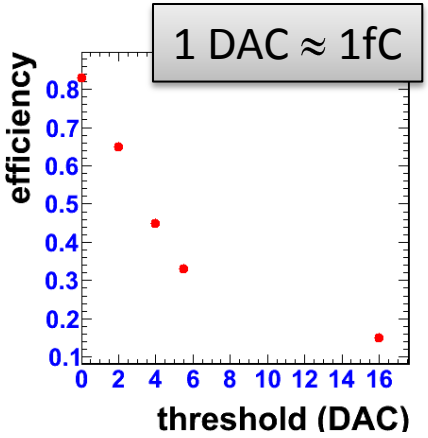

# 2009 Beam tests results summary
# NOV 2009: HARDROC 2




- One 32x48 ASU in test box
- Beam profile
- Efficiency very low (as expected with HARDROC)
  → measurements via« self tracker » or « TPC » mode (1cm gas)
- Many chips were dead (reason not obvious)

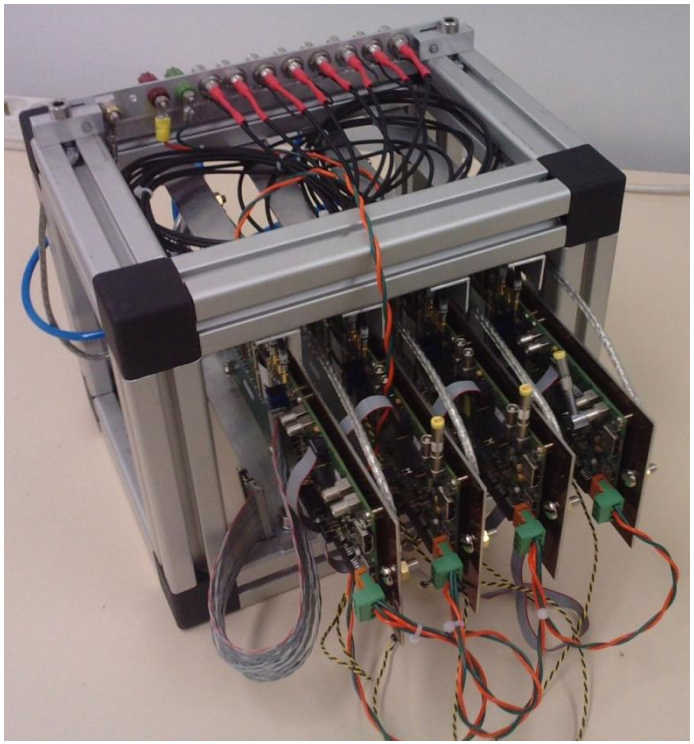


# 2009 Beam tests results summary
# NOV 2009: DIRAC 2

- Stack of 4 8x8 MICROMEGAS chambers equiped with DIRAC 2
- Only 3 hours commissioning
- 4-fold coincidences immediately observed
- Destructive sparks killed channels one by one after few hours functionning
  - Few data available
  - No time for threshold optimisation



# 2009 Beam tests results summary
# NOV 2009: DIRAC 2

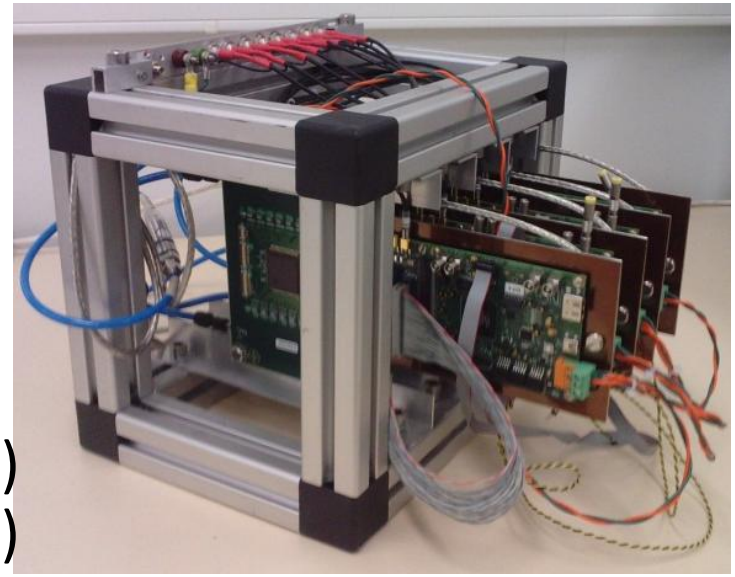
Very Preliminary

- DIRAC performances
  (no threshold optimisation)

**Compatible with previous measurements**

Multiplicity
- Chamber 1: 1.13 (6fC)
- Chamber 2: 1.11 (6fC)
- Chamber 3: 1.07 (14fC)
- Chamber 4: 1.06 (14fC)

Efficiency
- Chamber 1: 12 / 27 = 0.4±0.1 (6fC)
- Chamber 2: 14 / 29 = 0.5±0.1 (6fC)
- Chamber 3: 14 / 30 = 0.5±0.1 (14fC)
- Chamber 4: 14 / 30 = 0.5±0.1 (14fC)



**Not corrected for synchronous functionning**

# Digital readout
# Conclusions and outlook

- HARDROC 1 and 2 input stage not adapted to MICROMEGAS signal
- DIRAC 2 showed fragility to sparks
- HARDROC showed fragility not fully explained (sparks ? Commissioning ? … )
- New chip is needed
  - Optipmized for MICROMEGAS signal
  - Hardened design against sparks
- Improved external spark protection needed

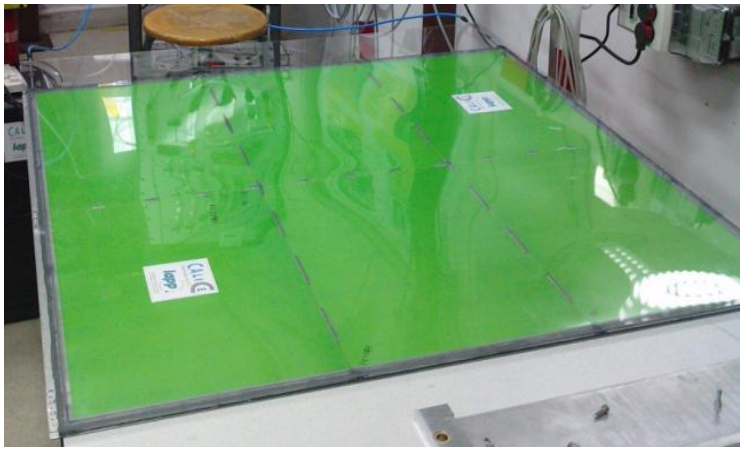
# 2010 plans : VFE Electronics developments

- New input stage developped for the next generation ASIC
  - Optimized for MICROMEGAS
  - Simulations give S/N=10 @ 1fC, noise r.m.s. 0.1fC @80pF
  - Integrable to HARDROC or DIRAC design
- Spark protections
  - PCB to test various protection schemes
  - Spark generator (large capacitance discharging in the PCB)
  - Test of burried components undergoing and promissing

Preliminary

# 2010 plans: First technological $m^2$ prototype (1)

- Mechanical Prototype validated the assembly procedure (6 dummy ASUs)
- Available ASU for technological prototype
  - 4 ASU with HARDROC2 chips
    (under tests, almost all ready)
  - 1 ASU with HARDROC2b chips
    (PCB in cabling)
  - 1 dummy ASU (6 ASU 32x48 are necessary)



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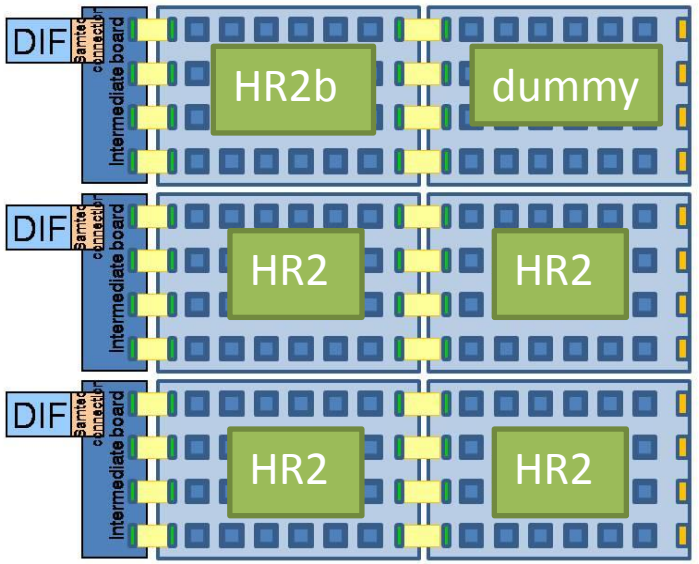
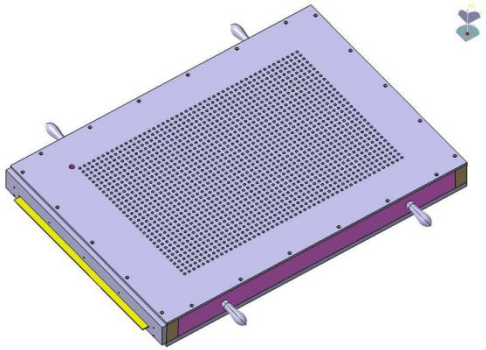
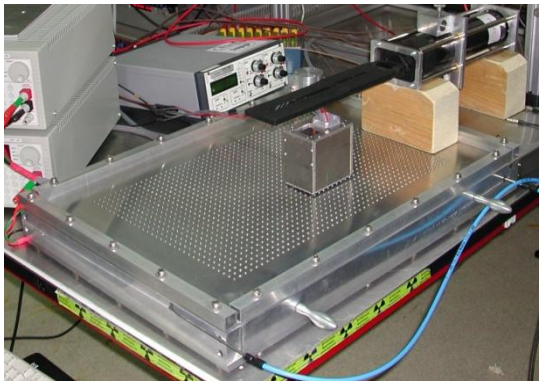
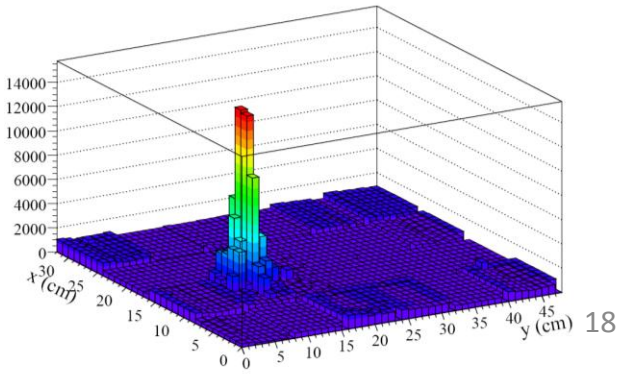


# 2010 plans: First technological $m^2$ prototype (2)

- All ASU tested between each step
  - Electronics:
    - Return from cabling
    - Return from bulk lamination
    - After bulk cooking
  - Full calibration
  - $^{55}Fe$ and/or cosmics with a test box
- Clean room $\rightarrow$ naked mesh ASU
  - Perform mesh cooking in air
  - Insert/remove ASU from test box
- $m^2$ completion
  $\rightarrow$ validate full design & processs

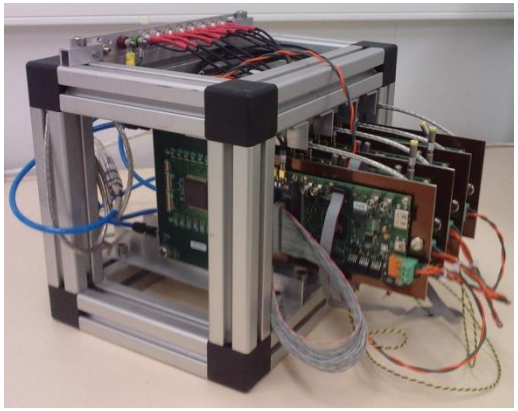






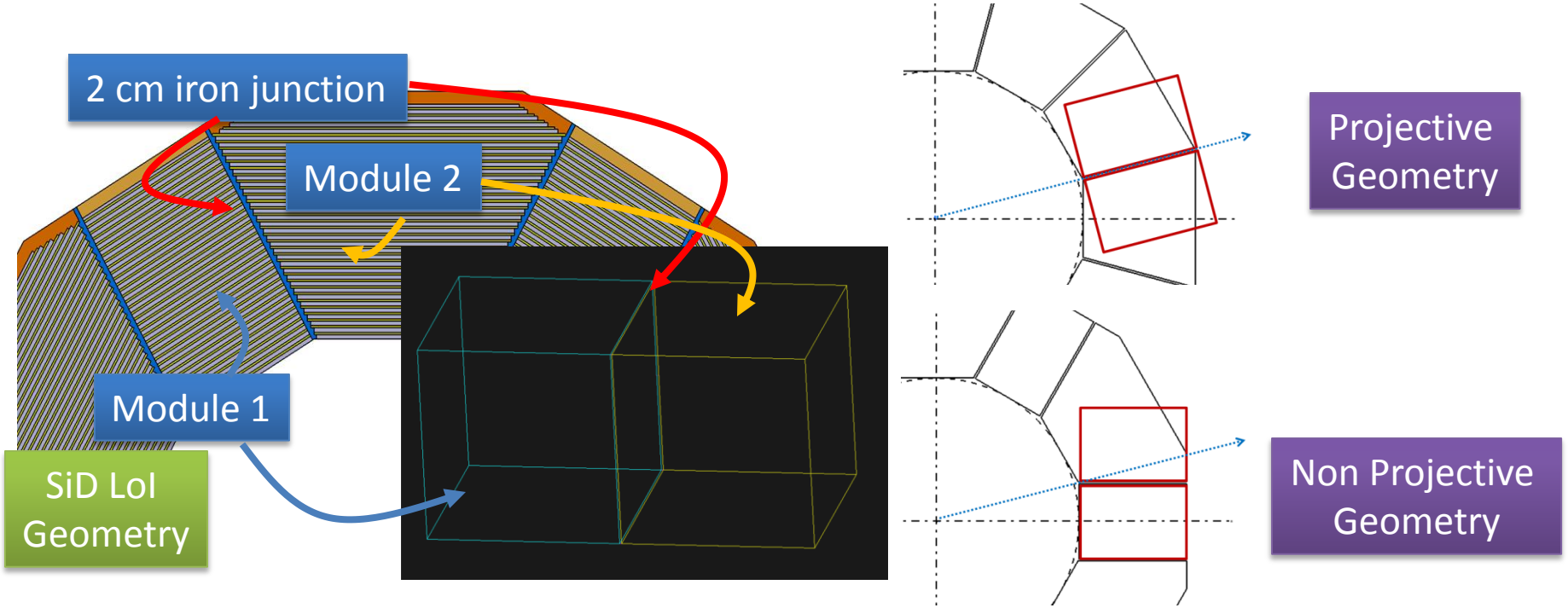
# 2010 plans: Beam tests

- Beam test second half of June 2010 at CERN/SPS/H4
  - $m^2$ tests
    - Test $m^2$ functionnality
    - Measure efficiency, multiplicity and uniformity
      $\rightarrow$ Use HR1 or DIRAC ministack stack as a telescope
  - DIRAC tests
    - Measure efficiency, multiplicity and uniformity
    - Test power pulsing in magnetic field
    - Spark study
- Beam test mid November 2010 at CERN/PS
  - $m^2$ tests in/behind W structure

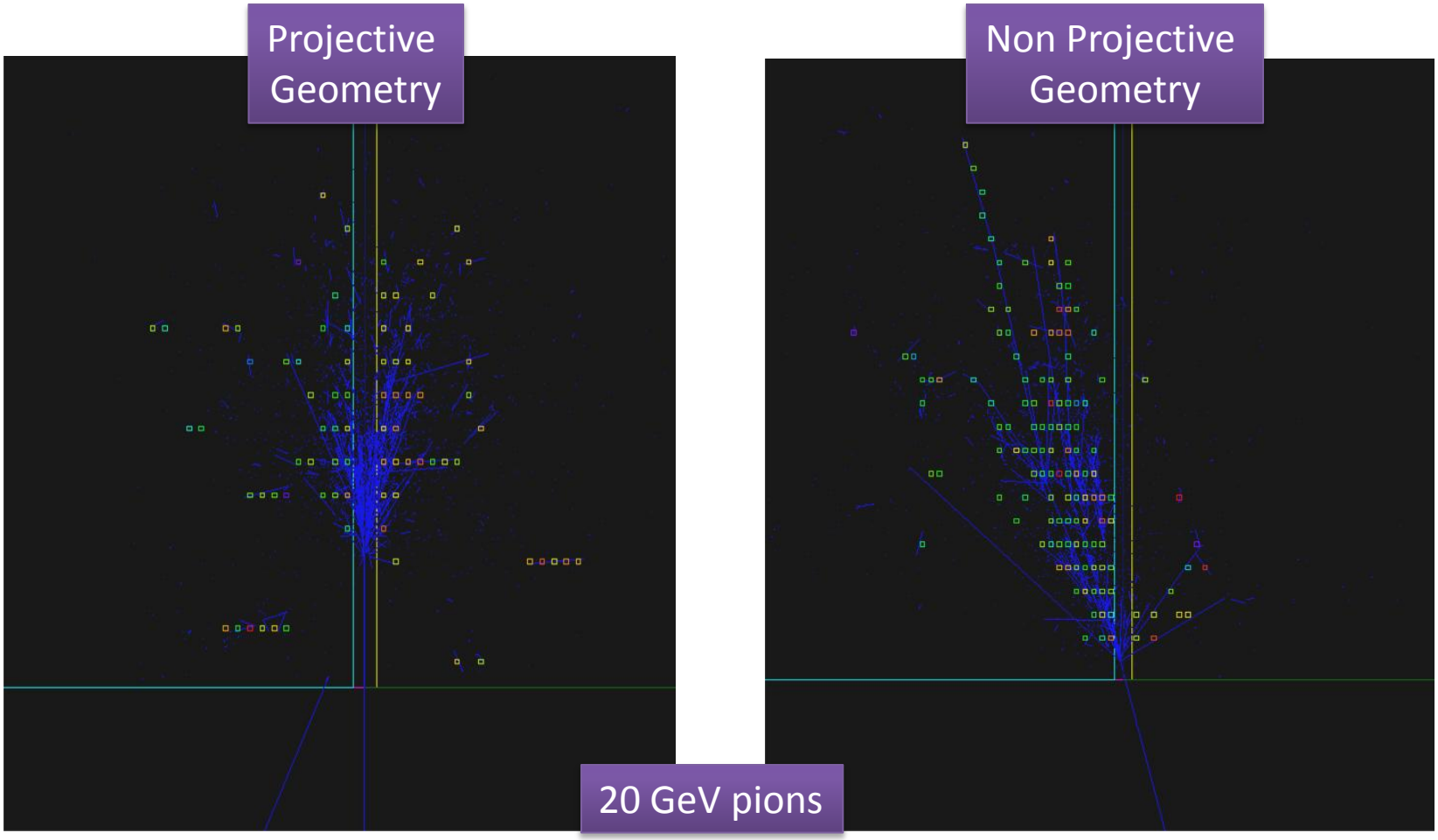


# 2010 plans: Simulation activities

- Study impact of supporting structure on the HCAL performance
- Projective and non-projective geometries are considered



# 2010 plans:
# Simulation activities



# Conclusion

- Project delayed
  - HARDROC 1 & 2 not applicable to MICROMEGAS
  - DIRAC 2 not spark proof
- Main benchmarks:
  - Commissioning of $m^2$ technological prototype
  - Optimized readout chip
  - Upgraded spark protections
- Intensive R&D activities
  - LAPP group is involved in several fields (DIF task force, Mechanical engineering, detector R&D, simulations)
  - Detector R&D highly supported by in2p3