

Activités R&D du groupe LC Détecteur au LAPP

R. GAGLIONE pour C. ADLOFF
7 Décembre 2011

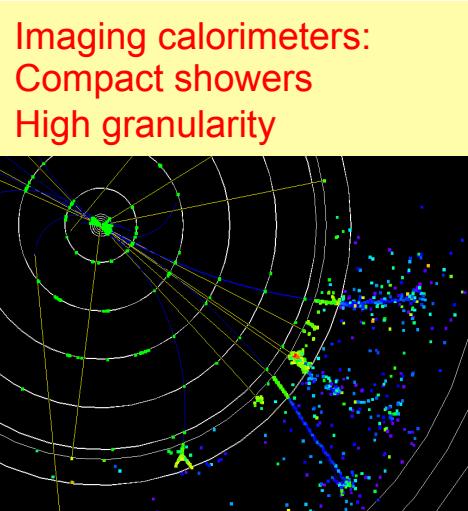


In2p3



Hadronic Calorimeter for LC

- Particle Flow Algorithms :
jet resolution $s_{E_j}/E_j = 0.3/\sqrt{E_j}(\text{GeV})$ depends on
 - cluster separation
 - track-cluster matching
- HCAL
 - Absorber: Steel (ILC) or Tungsten (CLIC)
 - Barrel thickness (SiD@ILC): $4.5 \lambda_l$, 40 layers
 - Large area : $\sim 3000 \text{ m}^2$
 - Active medium developed at LAPP:
 - bulk-MICROMEGAS
 - Threshold readout : 2 bits “Semi-Digital” HCAL
 - High segmentation : 1 cm^2
 - Reduced thickness : down to 6 mm



Evolution des activités R&D

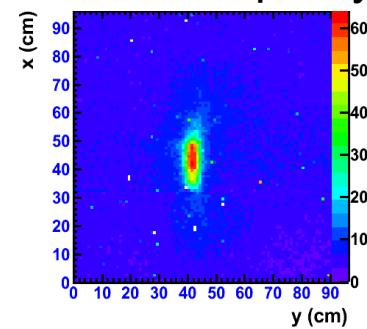
- New 1m² chamber
 - Improved mechanical design
 - New readout electronics
- August 2011 beam tests
- Preliminary results
- October 2011 beam tests

2011

MICROROC

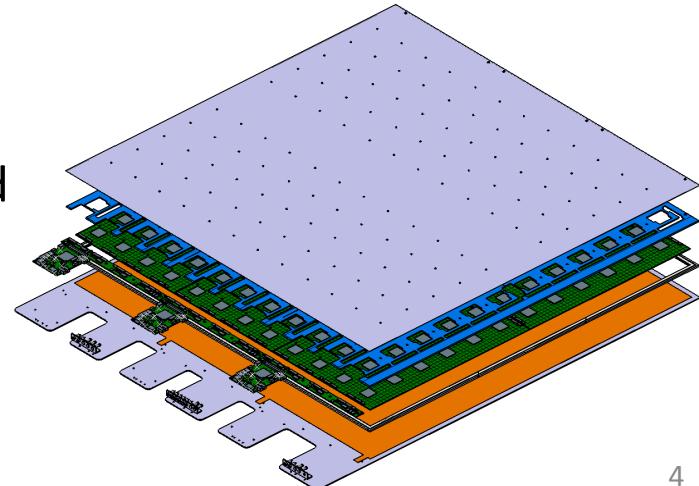
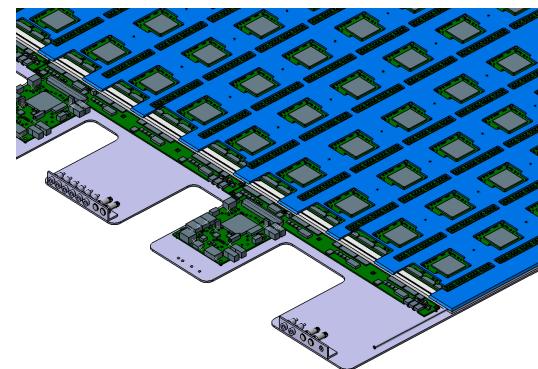
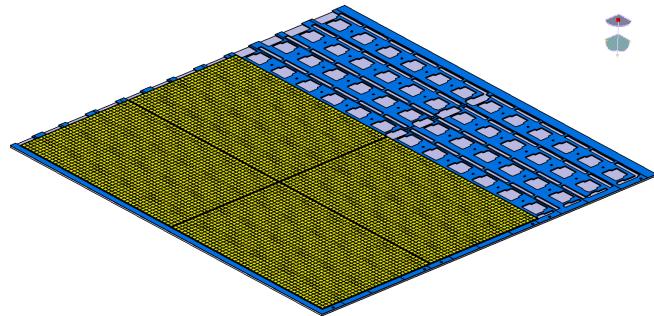
32x48 cm²
1x1 m²

Shaping 75-200 ns
98 % efficiency
< 1.1 multiplicity



Improved Mechanical Design

- Gas tightness made by ASU and mask one side, drift plate on top side
- Base plate screwed instead of glued
 - [Access to ASIC side of ASUs](#)
 - Eventually get rid of Fe baseplate
 - For WHCAL prototype: less steel
 - For ILC steel HCAL : improve absorber stiffness (+2mm for the absorber plate)
- ASU mask thickness reduced from 3 to 2 mm
→ [Thinner chamber](#) (7mm instead of 8 mm active thickness)
- Easier access to DIF connectors and LV & HV patch panel when chambers are inserted inside structures

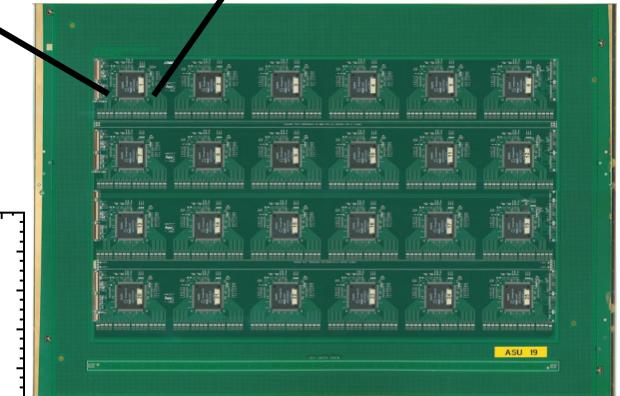
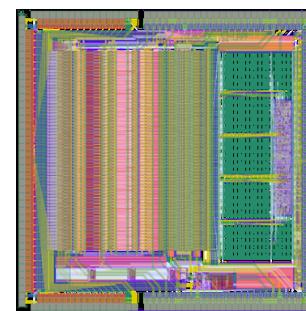
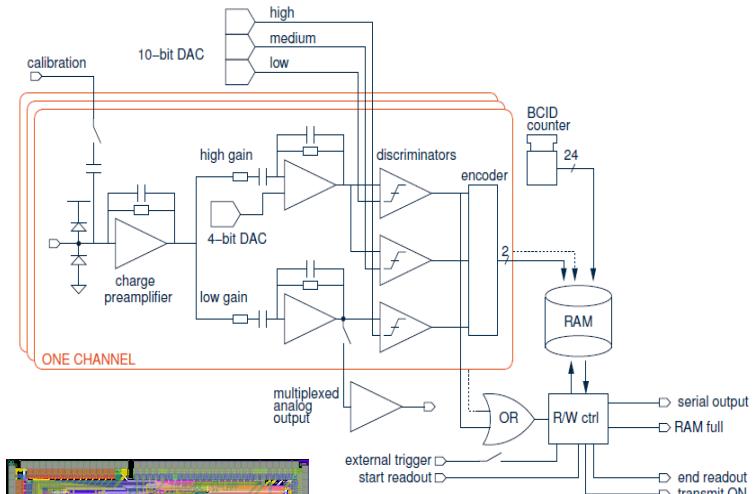


New Readout Electronics

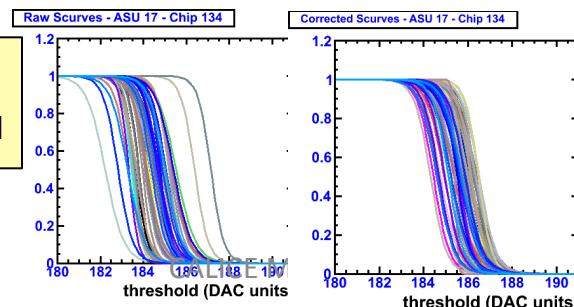
- New readout ASIC : MICROROC
- New PCB routing
 - Improved EMC :
minimize detector/digital signals X-talk
 - Chip bypass correctly routed
 - Analog readout
- Improved PCB spark protection network
 - Faster
 - More compact

New Readout ASIC

- MICROROC:
 - developed in collaboration between LAPP & LAL/Omega
 - Details in R. Gaglione talks [Feb](#), [May](#)
- From HARDROC2 to MICROROC:
 - Same digital part : pin-to-pin compatibility
 - Current preamp replaced by charge preamp
 - Additional spark protections inside silicon
 - Fast shaper (~20ns) replaced by 2 tunable shapers (30-200 ns)
 - 8 bit preamp gain corrections replaced by 4-bits pedestal (offset) corrections

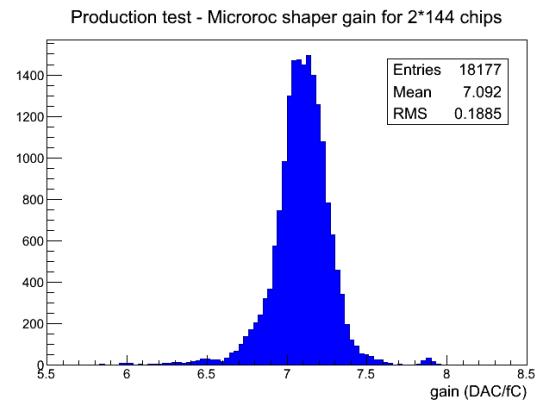
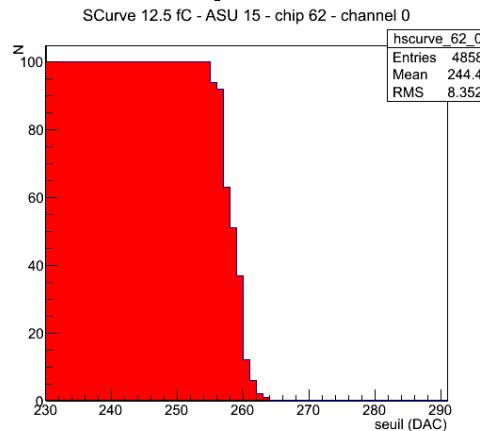
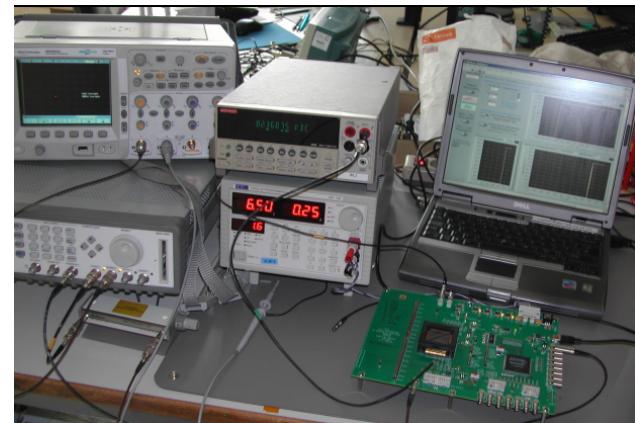


Chip threshold + channel offset
→ virtually 1 threshold / channel



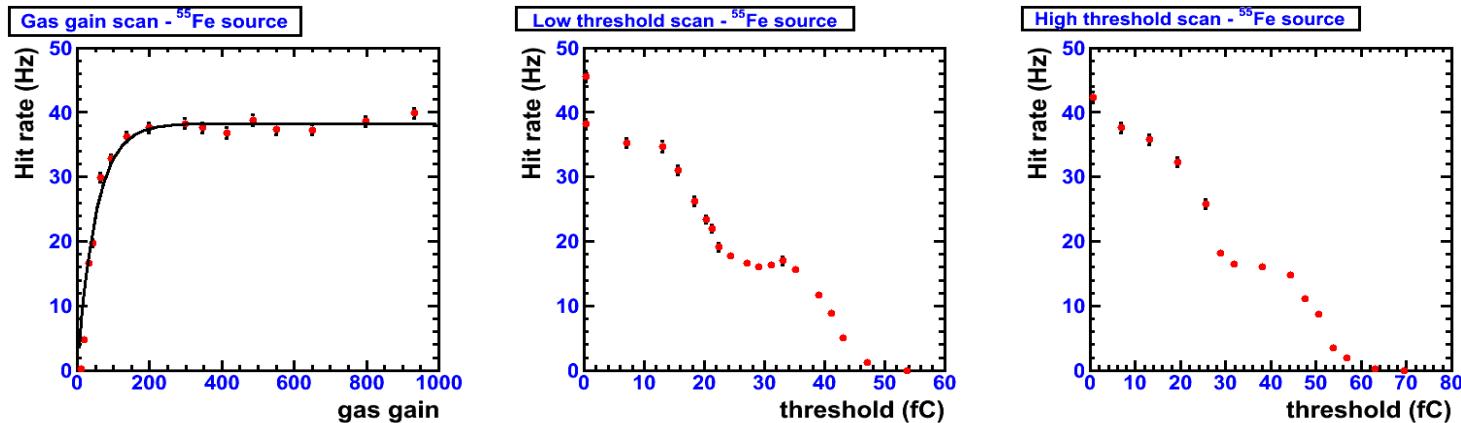
New Readout ASIC

- Production tests
 - 341 chips produced
 - 339 Tested on test board at LAPP
 - Gain of high gain shaper : Pedestal Scurve + 1 test charge (50 fC)
 - Average gain of 7.09 DAC/fC
 - Yield of 91.5 %
 - 13 ASUs equipped and calibrated 2 m² plus one laboratory test ASU.

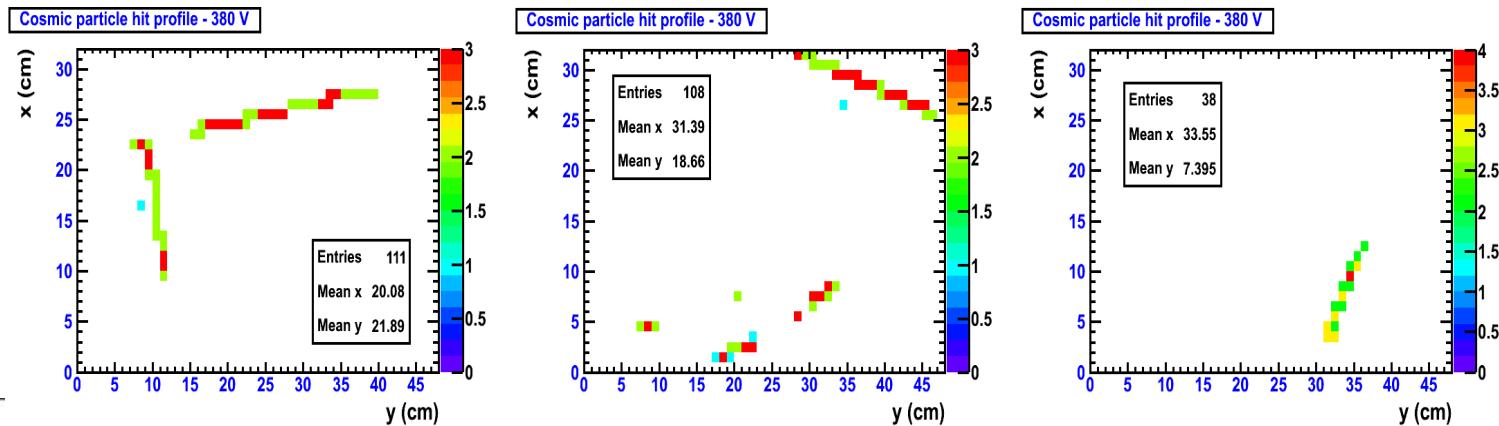


MICROROC ASU tests in test box

- Study of chamber properties with an ^{55}Fe X-ray source



- Cosmics :event display for the vertical chamber position



MICROROC 1m² assembly

June 2011



2011 Beam Tests

- Preliminary tests
 - Pedestal alignments
(cf Maximilien previous [talk](#))
 - Cosmics at LAPP in July
- Beam tests
 - 3rd to 22nd August 2011 at CERN SPS H4
 - 3rd to 9th August : CALICE
 - 9th to 22nd August : RD51 with 3 other users
 - 3rd to 12th October 2011 at CERN SPS H8

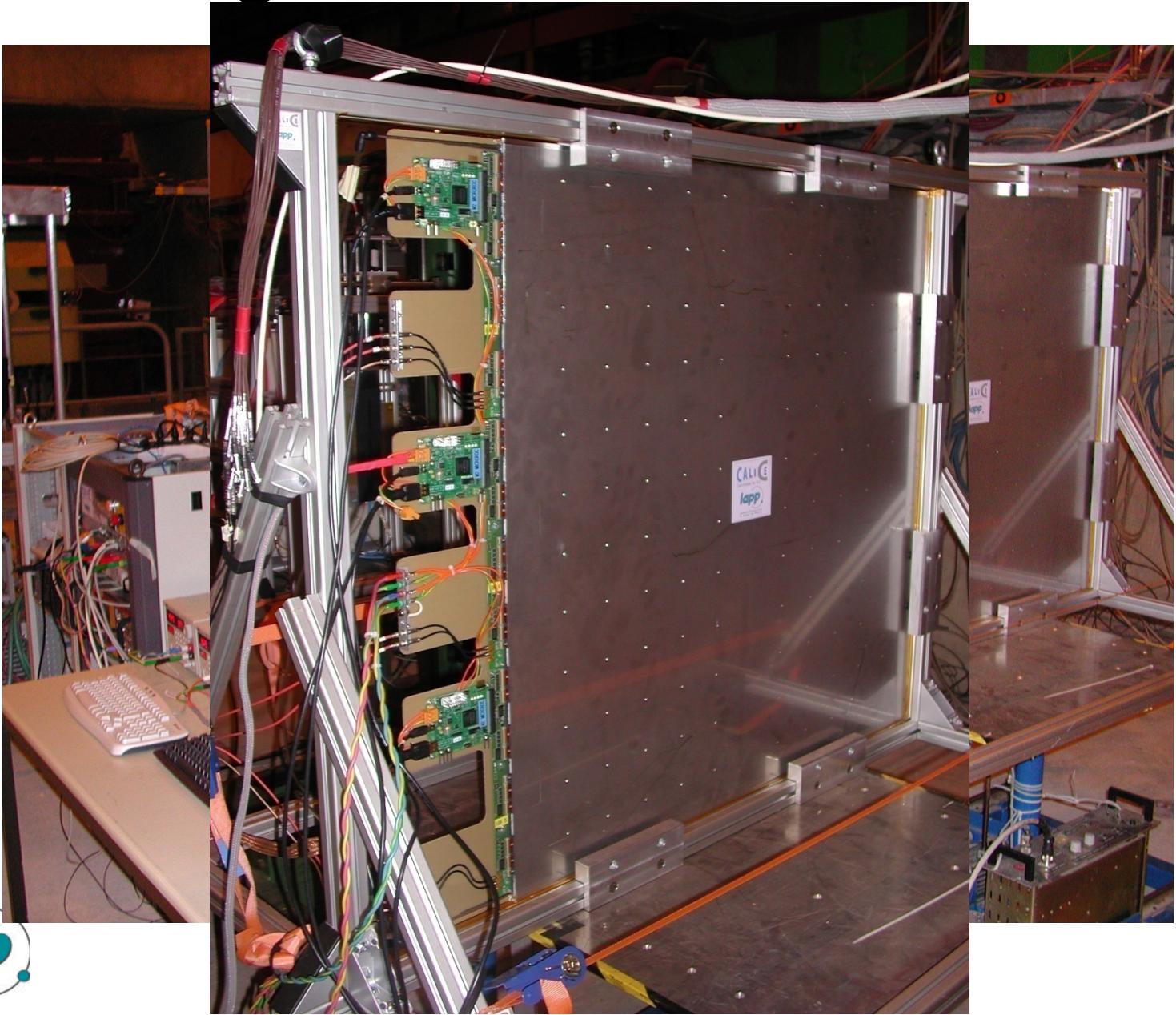
August 2011 Beam Tests

- Setup
 - 3 Scintillators: for triggering
 - Pad telescope
 - LAPP
 - 3 analog readout MICROMEGAS $6 \times 16 \text{ cm}^2$
 - Pads size: 1cm^2
 - Conversion gap: 3 mm
 - Strip telescope
 - NCSR Demokritos,
National Technical University of Athens
 - 3 analog readout MICROMEGAS $2.4 \times 2.4 \text{ cm}^2$
 - Strips length: 10 cm
 - Strip pitch: $250 \mu\text{m}$
 - Conversion gap: 7 mm
 - 1m^2 MICROMEGAS Chamber with 144 MICROROCs
 - Gas used :
95% Ar, 2% isobutane and 3% CF4 : not flammable.

August 2011 Beam Tests

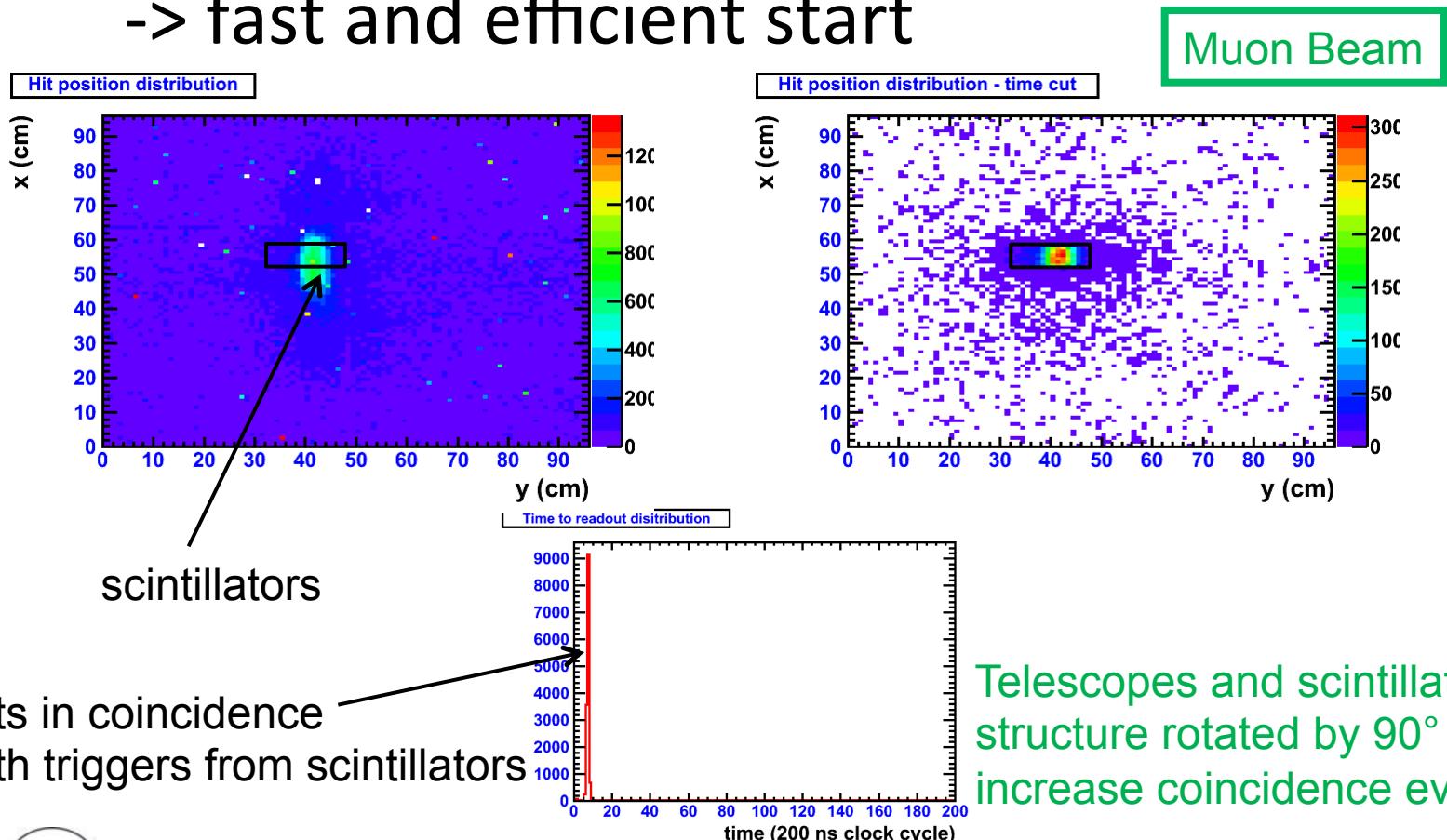
- Acquisition
 - telescopes
 - VME ADC + Sequencer
 - CENTAURE DAQ
 - 1m² MICROMEGAS:
 - 3 (interDIF + DIF)
 - LAPP LabView DAQ
 - Hardware Synchronization with busy handshake between VME sequencer and CCC : **acquisition rate up to 200 Hz**

August 2011 Beam Tests



August 2011 Beam Tests

- The first beam profile: 4/8/11 at 8pm
-> fast and efficient start



August 2011 Beam Tests

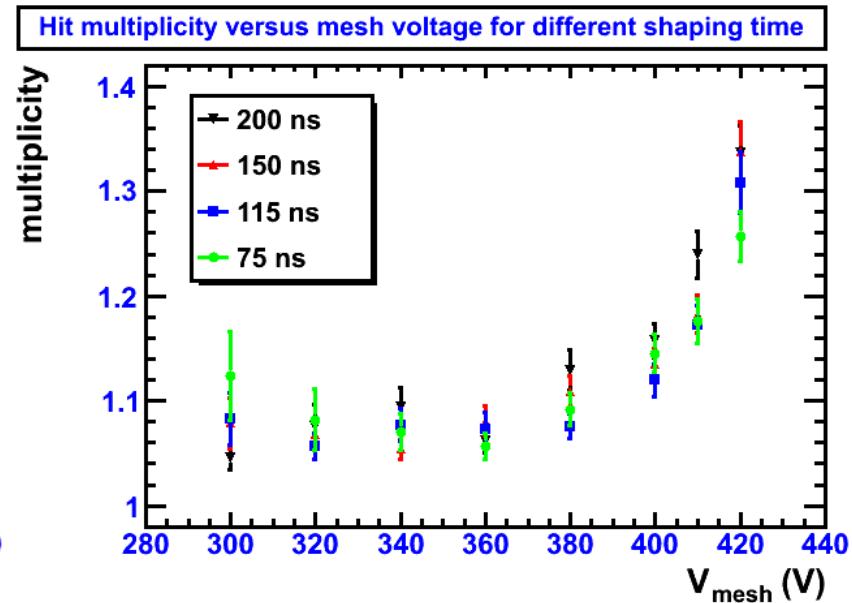
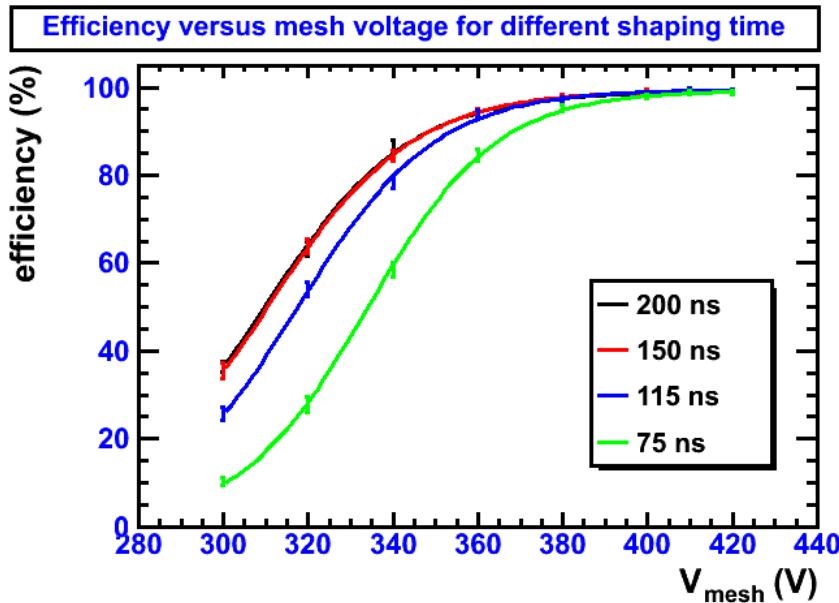
- Beams
 - Muons: beam core on 3x9 pads
 - Pions: high intensity beam and focused on 2 pads (RD51 users)
- During more than 2 weeks:
 - Less than 10 HV trips on the m² even in high intensity pion beam
 - No MICROROC damage due to sparks
- Data on disk
 - Drift voltage scan (405V to 570V)
 - Mesh voltage scan (300V to 420V)
for different shaping time (75ns, 115ns, 150ns 200ns)
 - Position scan: ≈ 20 positions
 - Threshold scan
 - Analog readout (after hold adjustment)
 - Different angle of beam incidence (0°, 30°, 60°)
 - Pion showers for different mesh voltage and thresholds.
 - MICROROC tests:
 - Ramfull mode
 - With/without one stage of the preamplifier.

Very preliminary results

- Mesh voltage scan (300V to 420V) for different shaping time (75ns, 115ns, 150ns, 200ns)

DAC0 threshold ~ 0.7 fC

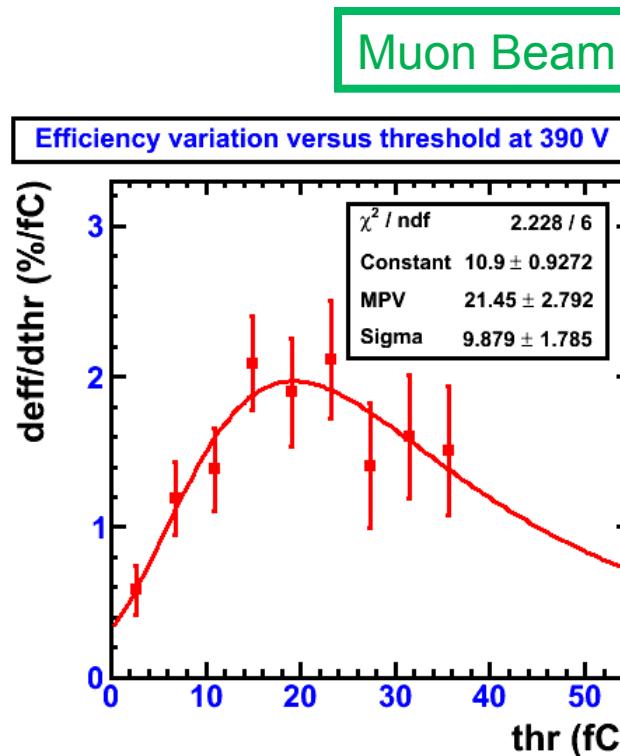
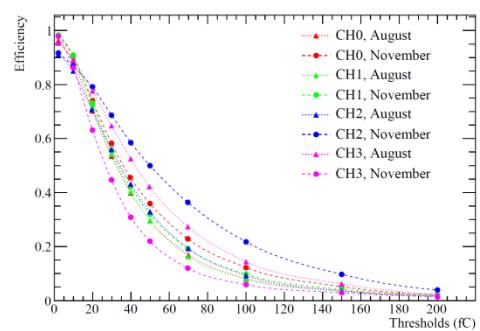
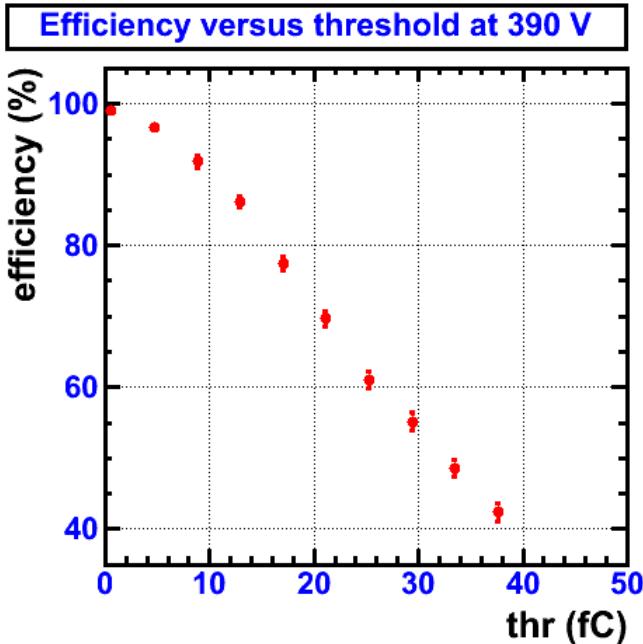
Muon Beam



Standard settings : $V_{\text{mesh}} = 390\text{V}$ $V_{\text{drift}} = 480\text{V}$

Very preliminary results

- Threshold scan

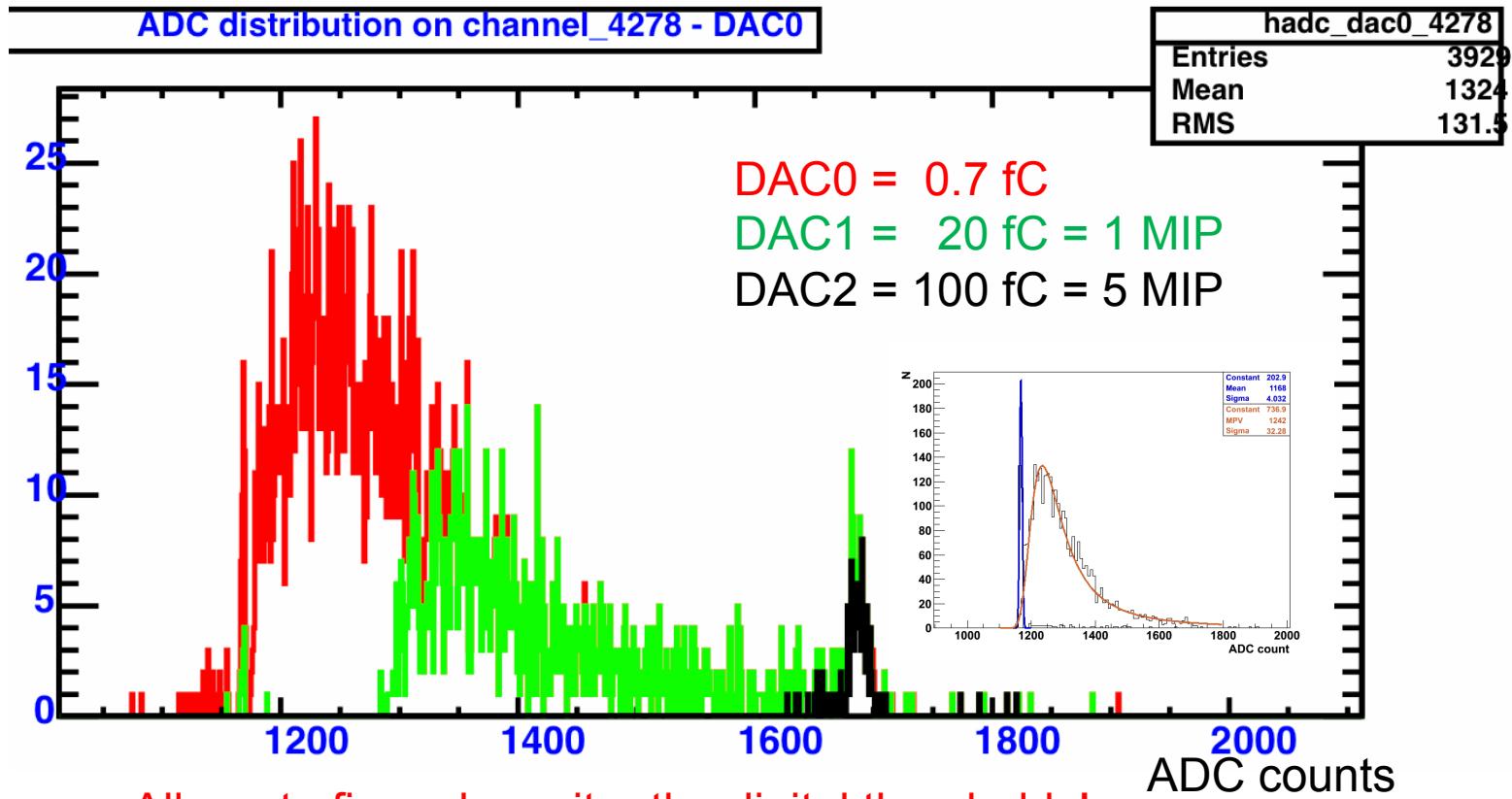


2008 beam tests
(analog readout, threshold cut offline)

Very preliminary results

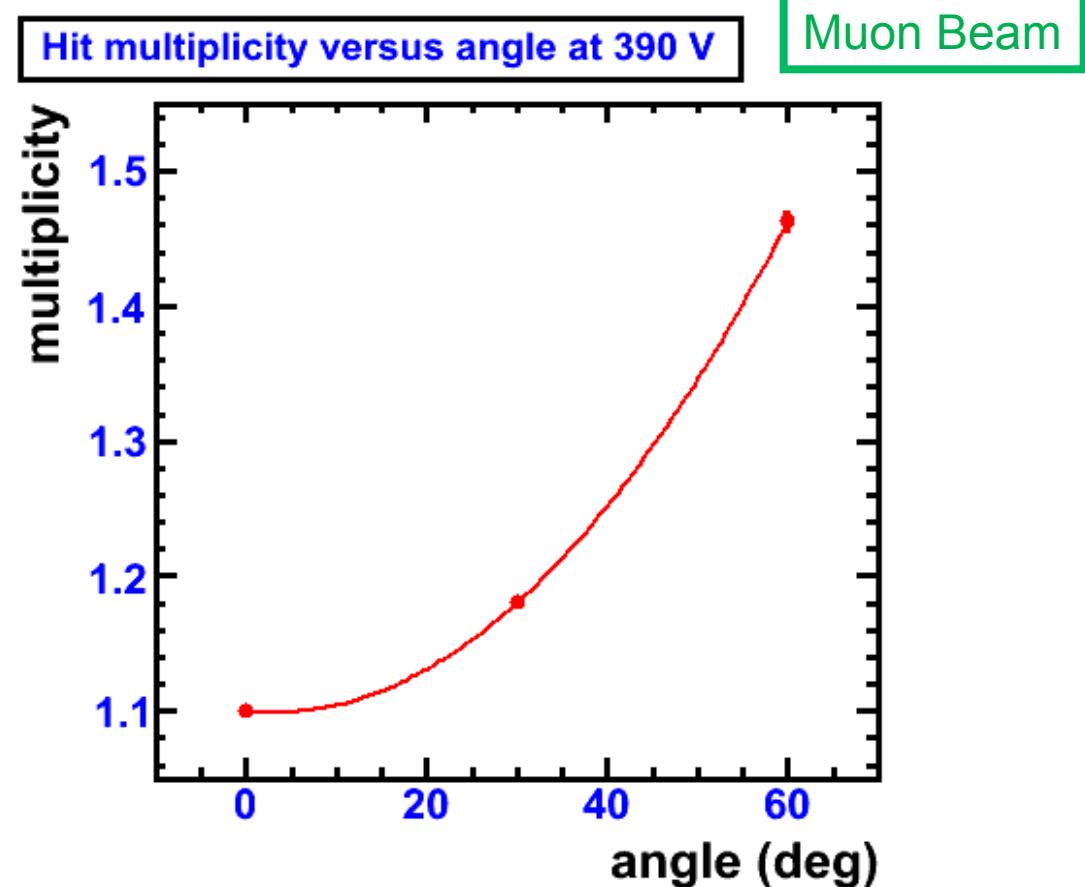
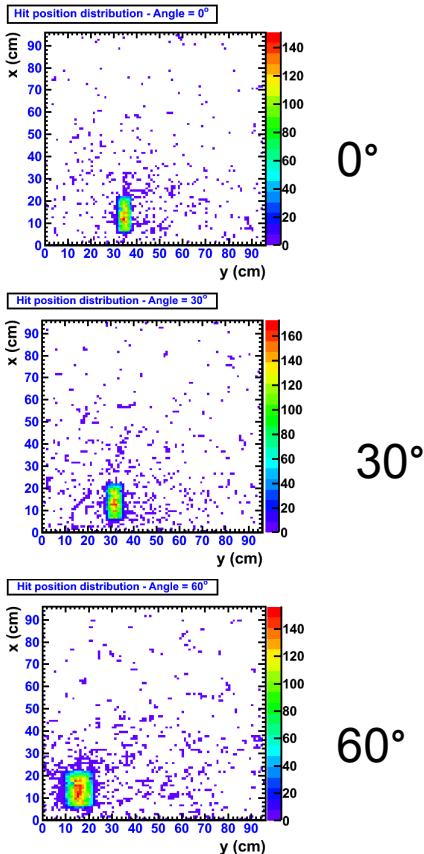
- Analog readout

Pion Beam



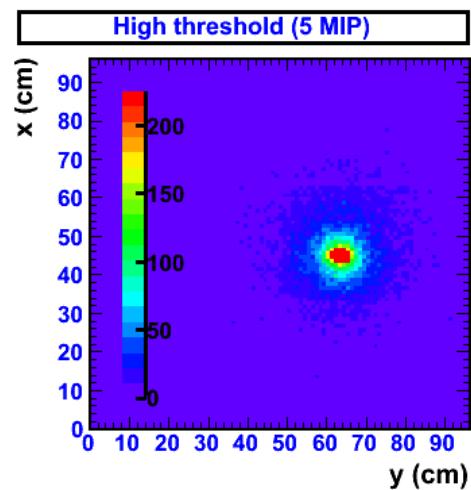
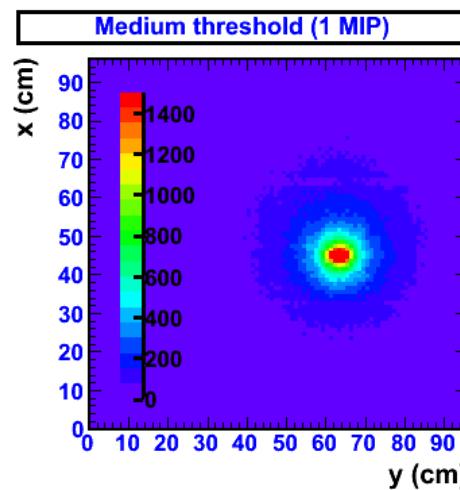
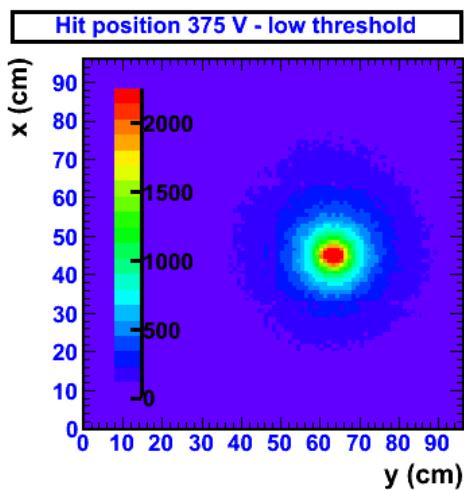
Very preliminary results

- Different angle of beam incidence (0° , 30° , 60°)



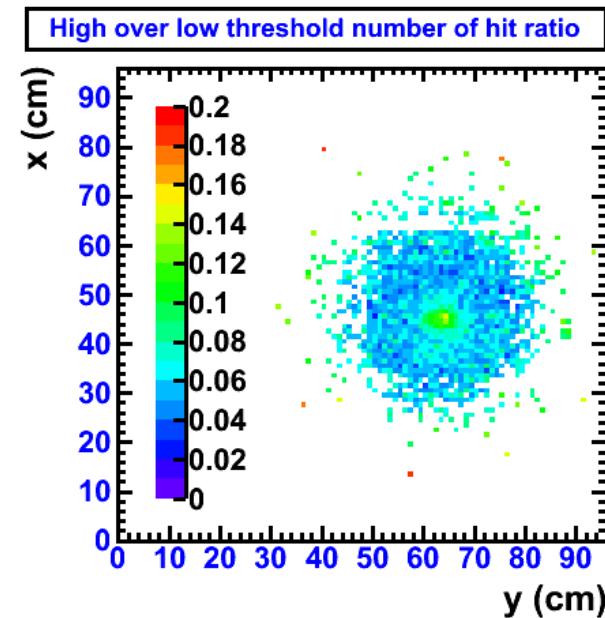
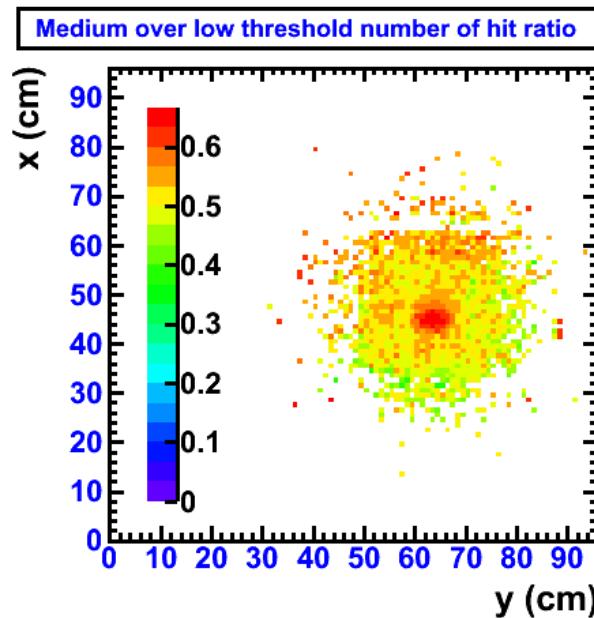
Very preliminary results

- Pion showers for different mesh voltages and thresholds.
 - 20 cm iron block
 - Medium and high thresholds adjusted for the different V_{mesh} voltages.



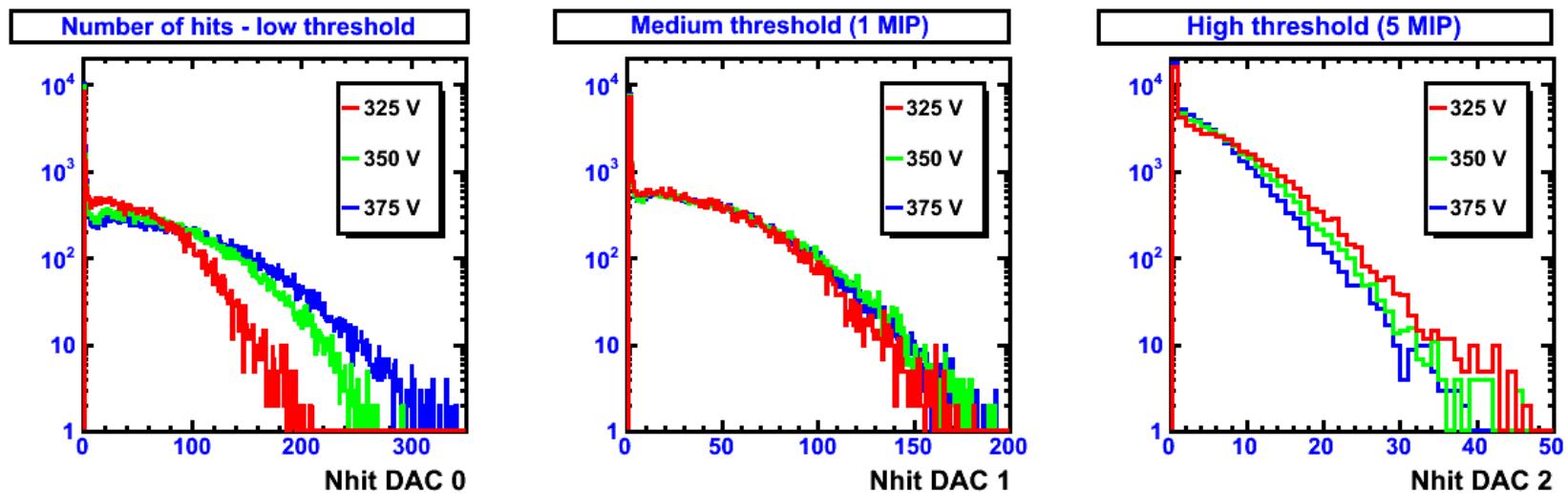
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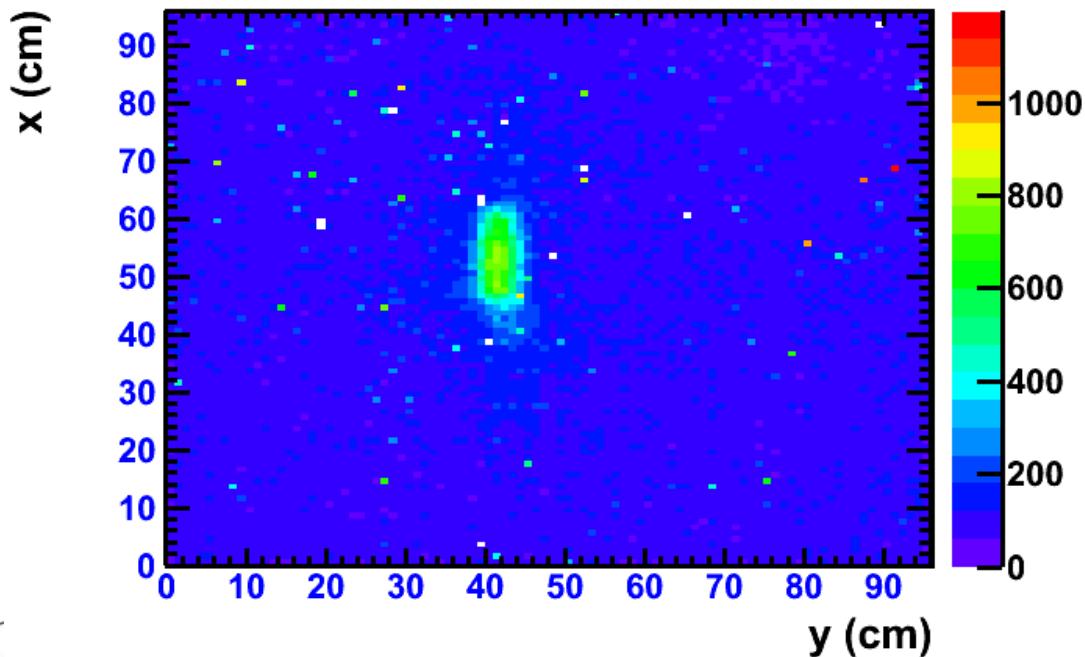
Very preliminary results

- MICROROC tests in Ramfull mode

- Data taken also outside the spill
- 10 noisy channels out of 9216
(6 are cut in hardware, 4 in software)
- Threshold about 0.7 fC from pedestal

Muon Beam

Hit position distribution



Ramfull mode ok
All data from detector.
No time cut applied.
-> Very quiet Detector!

October 2011 Beam Tests

- Improve setup
- First test with CALICE DAQv2 at LAPP on September the 28th !
 - Succeed to configure MICROROC chip and get data from MICROROC and HR boards simultaneously on the September 30
- Beam tests
3rd to 12th October 2011 at CERN SPS H8

October 2011 Beam Tests

- Ready for insertion in CALICE-DAQv2 on the 6th
- Very unstable DAQv2 until 10th late night
- First insertion in CALICE-DAQv2 on the 11th
-> no time to debug, no data taken
- Waiting for insertion in the DAQv2:
 - Improve our knowledge on noisy channels
 - HV SCAN
 - 80 GeV/c pions ~ 50k evts
 - 60 GeV/c pions ~600k evts
 - 100 GeV/c pions ~130k evts
 - 120 GeV/c pions ~120k evts
 - 150 GeV/c pions ~ 70k evts
 - 180 GeV/c pions ~ 60k evts

Conclusion pour 2011

- MICROMEGAS m²
 - Bulk process with embedded chips: ok
 - Mechanics : ok
 - Tests beam results
 - Electronic Readout: ok
 - Nearly no V_{mesh} trips. Very quiet detector
 - Performances compatible with HCAL requirements
- MICROMEGAS Framework : great tool for analysis
- A second chamber is constructed
- Group is also involved in
 - SiD HCAL Mechanical design
 - Physics simulation
 - Detector simulation and studies
 - CLIC CDR and summary document

R&D Future

- Larger production could be launched in 2012
- Funding for studies of bulk-MICROMEGAS with resistive layer : ANR SPLAM
 - 1 postdoc + test prototypes
- Continue DAQv2 developments for CALICE

Acknowledgments

- LAPP LC Detector group • Collaborators

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Enrique Calvo Alamillo

Khaled Belkadhi

Vincent Boudry

Paul Colas

Christophe Combaret

Rémi Cornat

Paul Dauncey

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Mary-Cruz Fouz Iglesias

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