



Laboratoire d'Anney-le-Vieux
de Physique des Particules



MicroMegas for DHCAL

Status and activities at LAPP

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Fabrice Peltier
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Jean Tassan
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In2p3

Outline

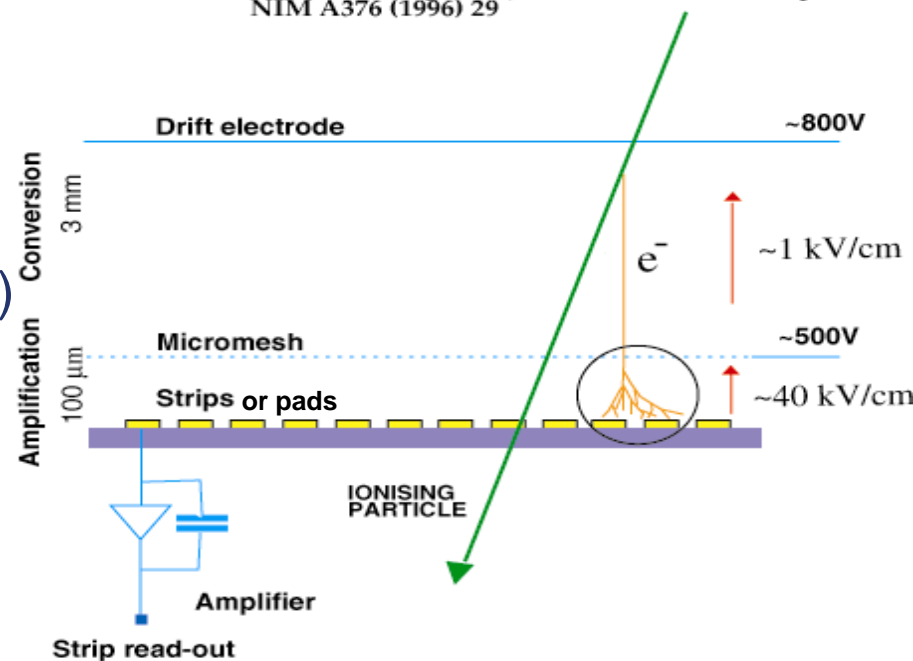
- MicroMegas R&D for DHCAL
 - MicroMegas specificities at lapp
 - X ray and Test Beam results
 - MicroMegas with Digital Readout
- Simulation
- Future m² Design
- Conclusion

MicroMegas

Micro Mesh gaseous structure

- Description:
 - Gas mix: Argon+Isobutane
 - Drift and Mesh HV < 500 V
 - High detection rate
 - Robust, cheap (industrial process)
 - Thickness: 3,2 mm
 - Delicate functioning: sparks
- Readout:
 - Analog for characterisation
GASSIPLEX + CENTAURE DAQ
 - Digital :
HARDROC or DIRAC +
Detector InterFace (DIF) board +
EUDET DAQ2 or CrossDAQ

Y.Giomataris, Ph. Rebourgeard, J.P Robert and G. Charpak
NIM A376 (1996) 29



lapp

LM

Irfu

IPNL
you

Omega

cea

saclay

MicroMegas

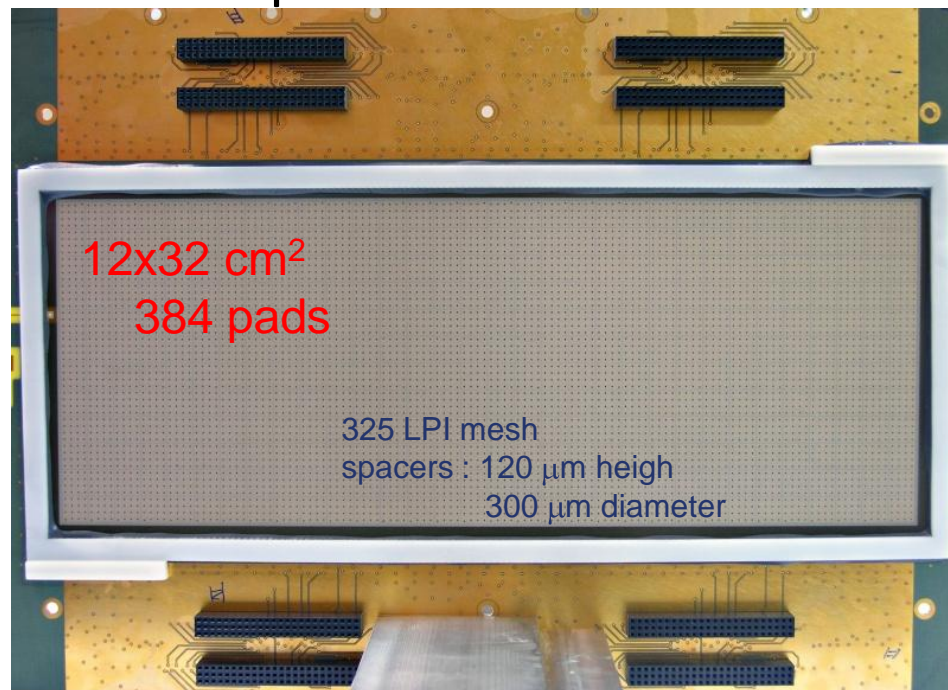
Bulk :

- Mesh laminated on the PCB with $1 \times 1 \text{ cm}^2$ pads
- Industrial process
- Cheap and robust



Steel top :

- Part of the absorber
- Holes for X Ray tests
- Holds a $55 \mu\text{m}$ thick cathode
- Glued on a plastic frame 3mm above mesh

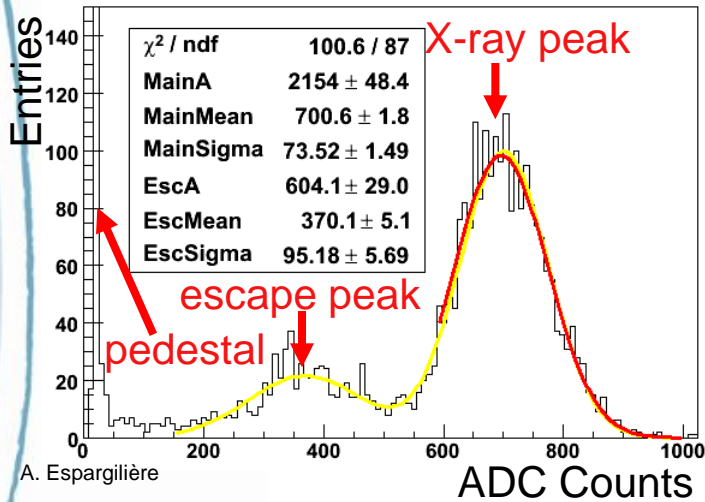
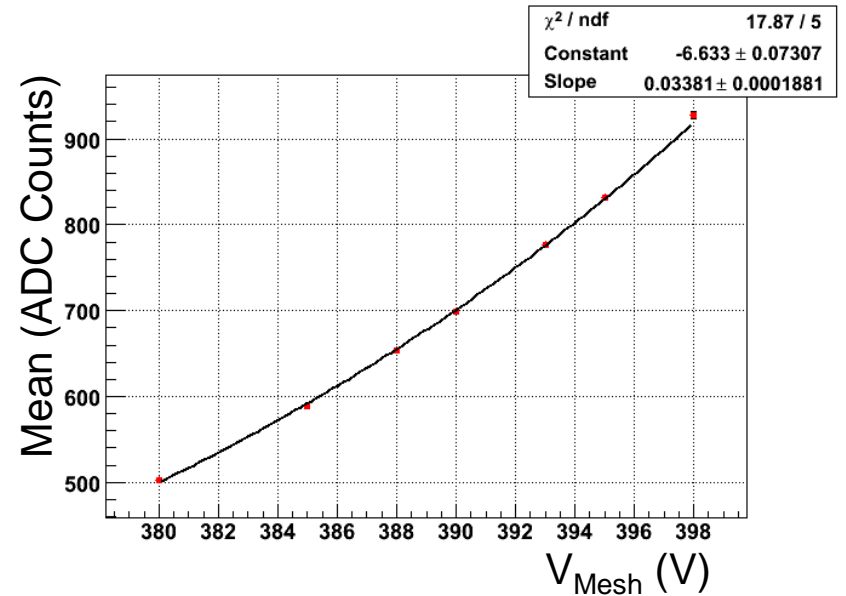


Bulk technology from R. De Oliveira & O. Pizzirusso

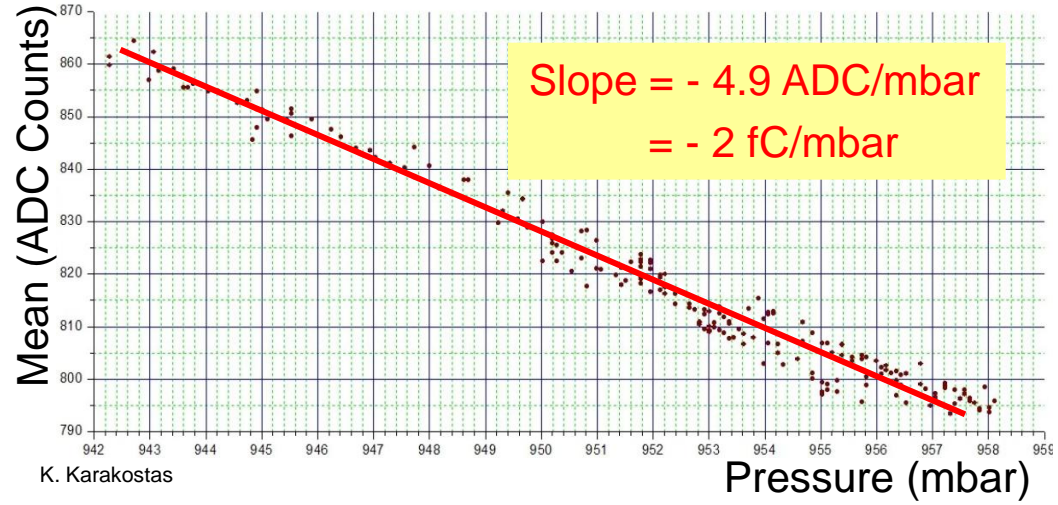
X-ray Response

- Set-up:
 - ^{55}Fe source (5.9 keV)
 - Trigger on mesh
 - analog readout

Gain : up to 10 000
 Energy resolution : down to 8.5 %
 (FWHM = 19.6)%



A. Espargilière

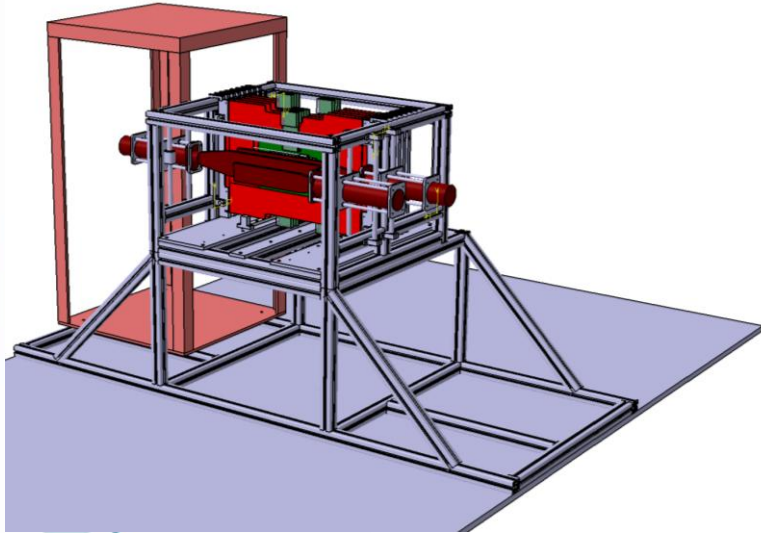


K. Karakostas

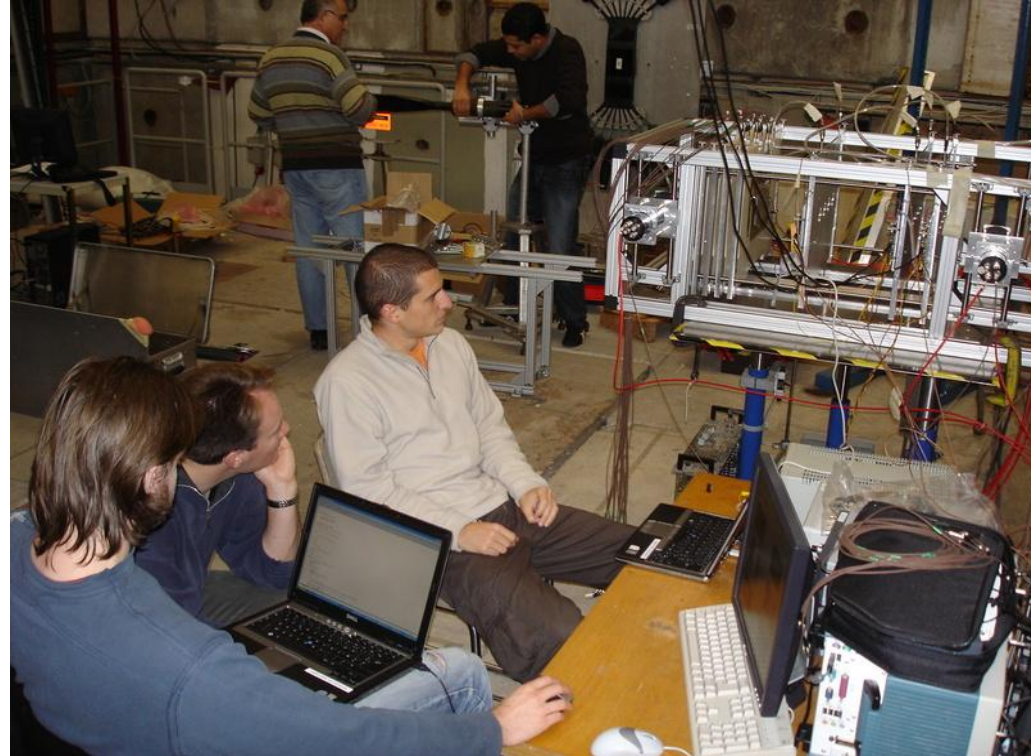


Test Beam 2008

- From dream to reality



T9 line at PS-CERN (November 2008 TB)



- Characterisation of the prototypes:
 - efficiency and multiplicity
 - pads / prototypes uniformity
 - X-talk studies
 - behaviour in hadronic shower

- The data

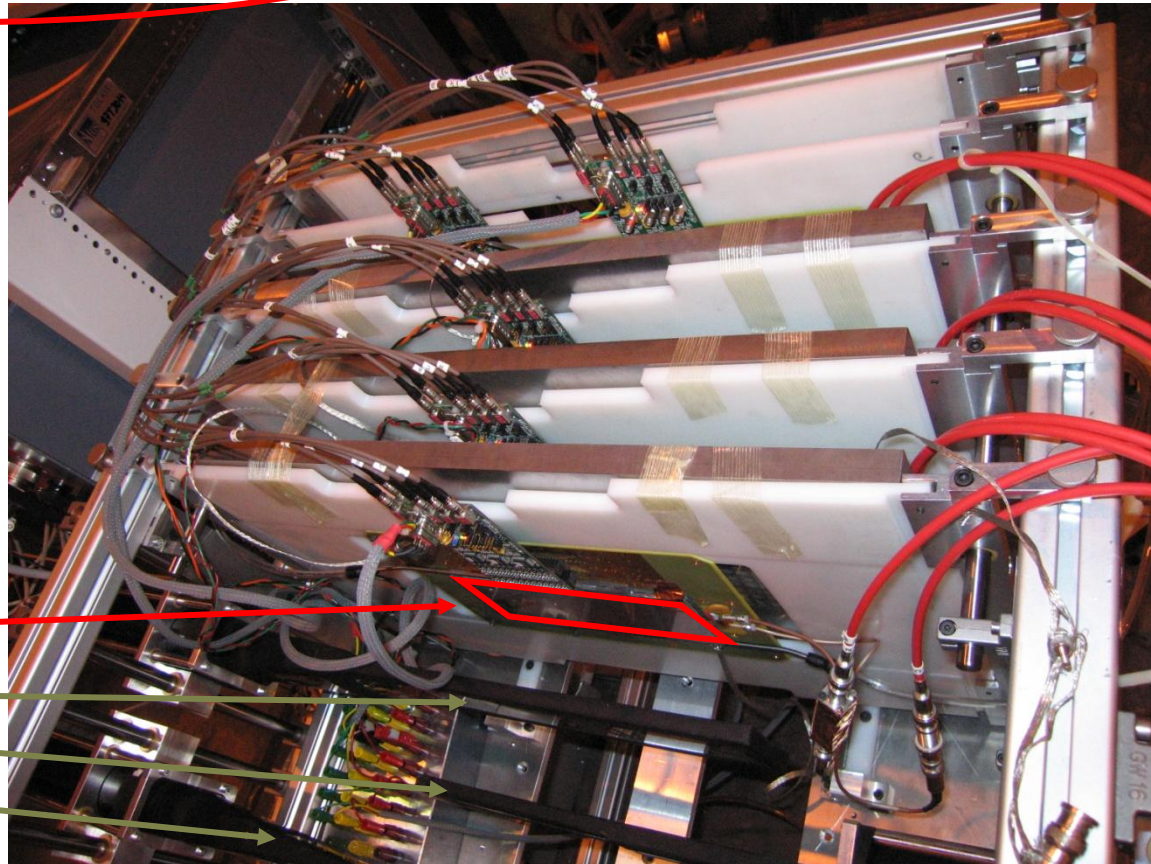
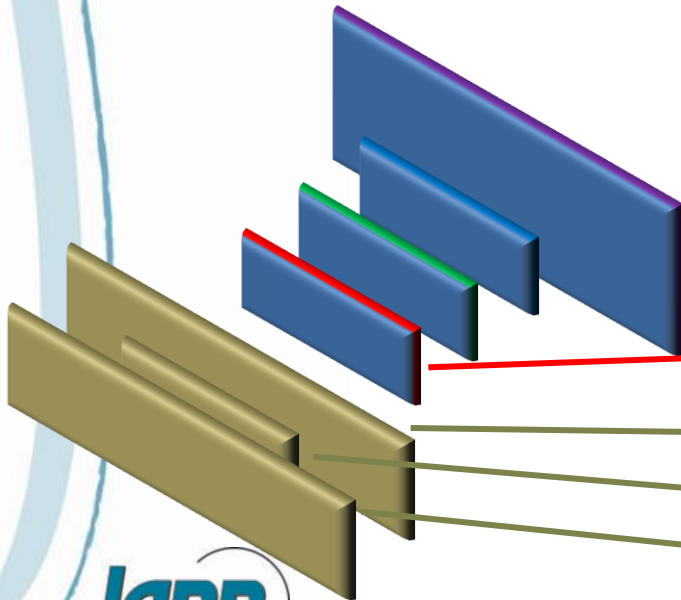
– 200k Pions @ ~7 GeV

A. Espargilière
Preliminary
Results

Test Beam Setup

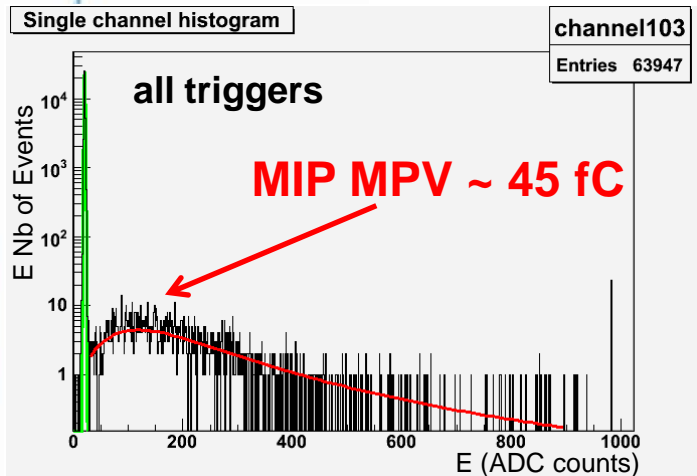
- Trigger: 3 scintillators in coincidence
- 3 MicroMegas 6x16 pads
- 1 MicroMegas 12x32 pads
- Steel absorber option

analog readout



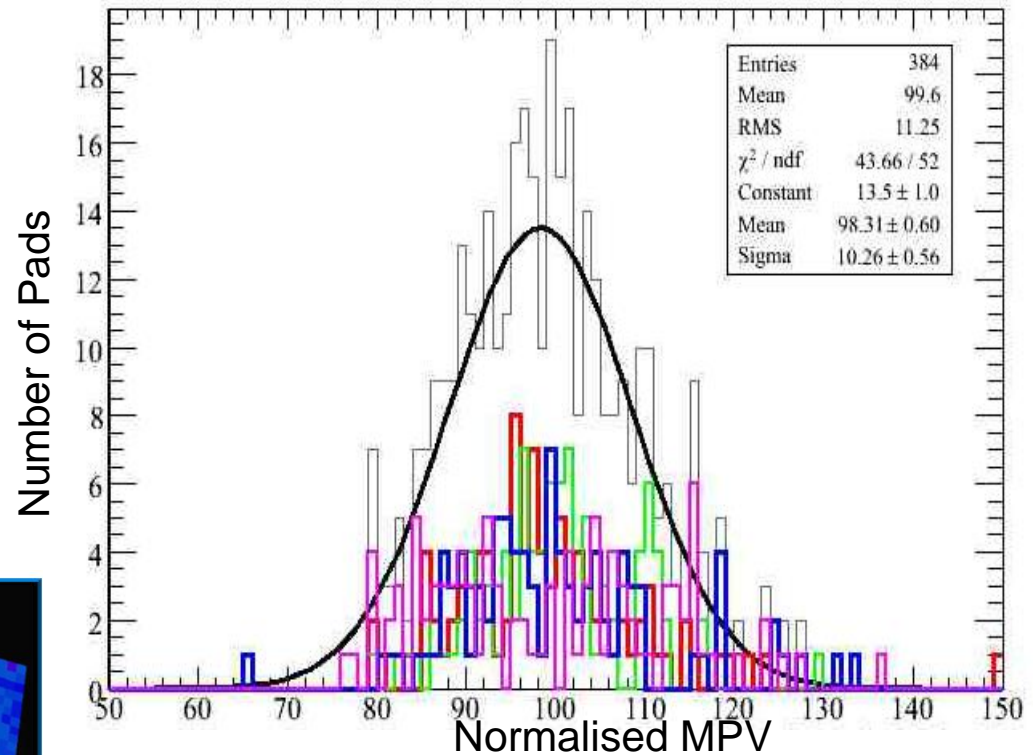
Results

- MIP Signal observed on every Single Channel



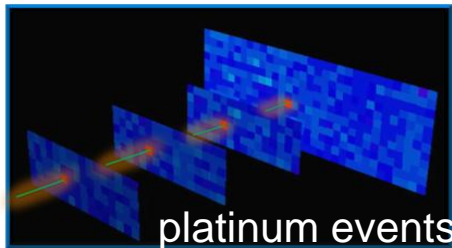
MPV variation under study:

- Electronics channels disparity
- Gain homogeneity



Pedestal:

- aligned online (0.2 fC RMS)
- constant over time
- average sigma = 0.6 fC
- ⇒ Good noise conditions!



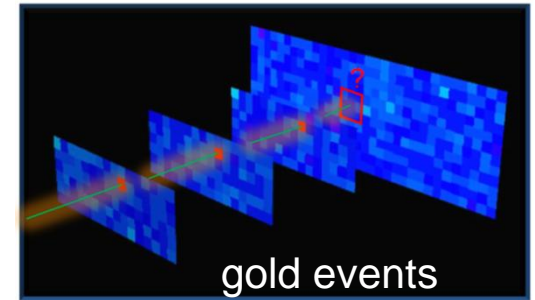
Results

- Efficiency Measurements:

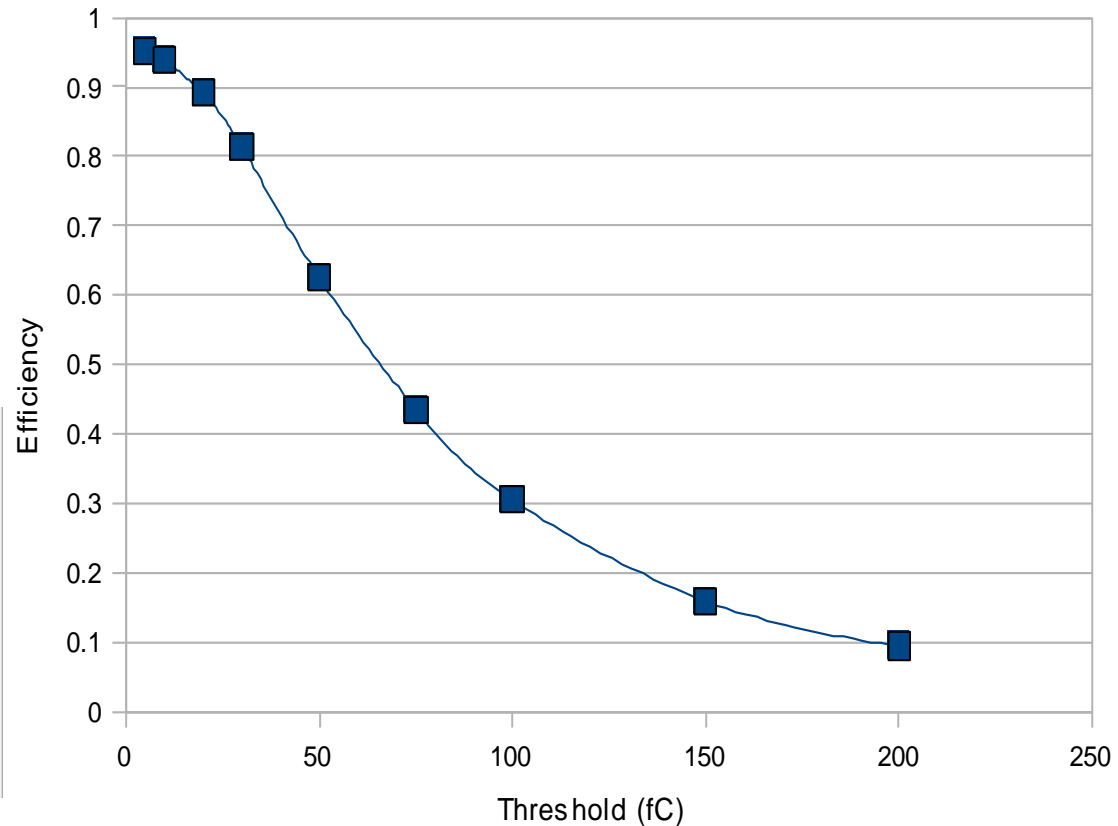
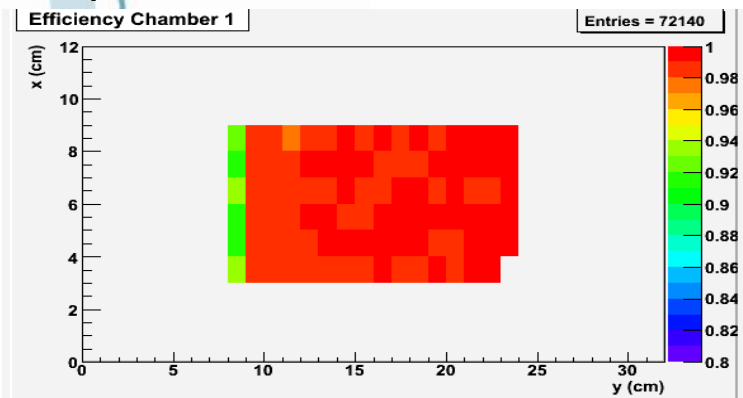
| | Efficiency |
|-----------|--------------------|
| Chamber 0 | $97,05 \pm 0,07\%$ |
| Chamber 1 | $98,54 \pm 0,05\%$ |
| Chamber 2 | $92,99 \pm 0,10\%$ |
| Chamber 3 | $96,17 \pm 0,07\%$ |

Threshold :

$2.8 \text{ fC} = 0.06 \text{ MIP MPV}$

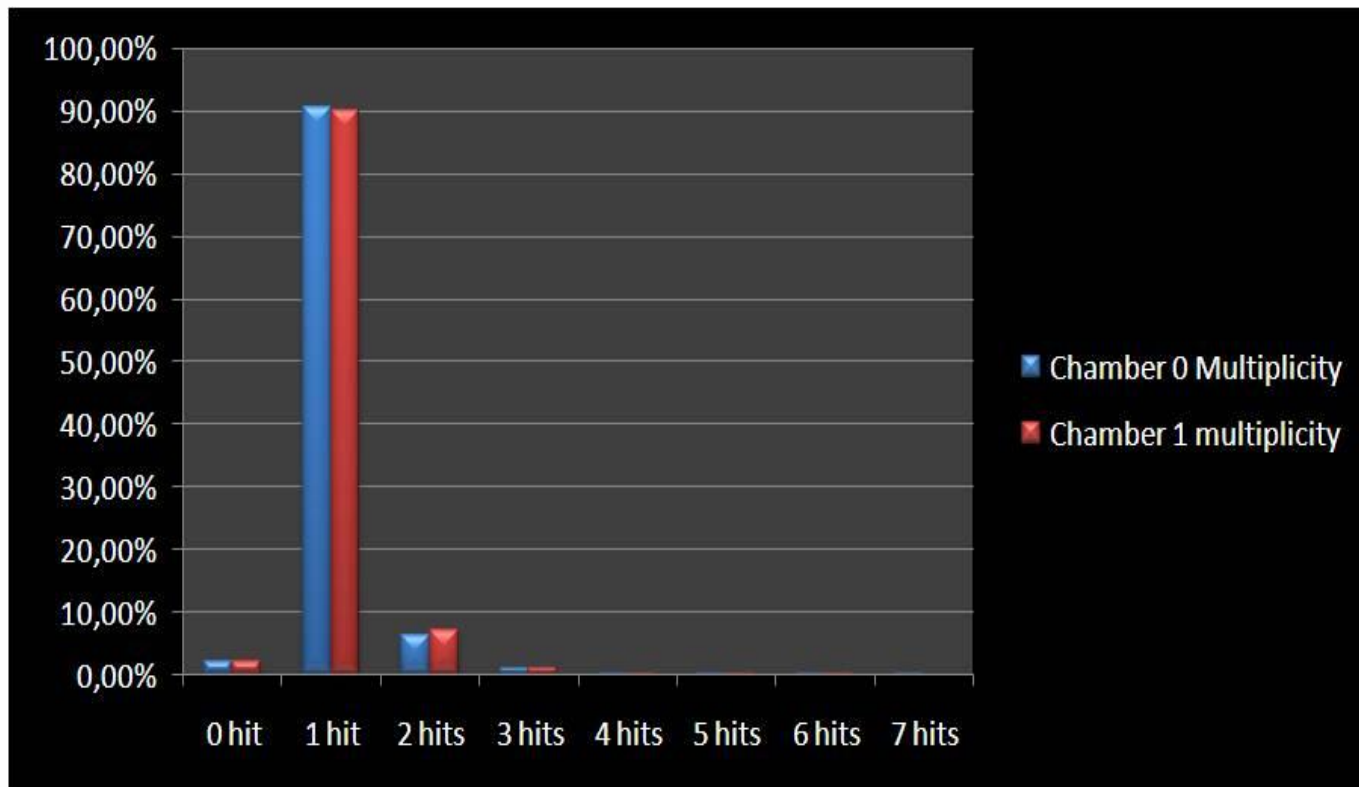
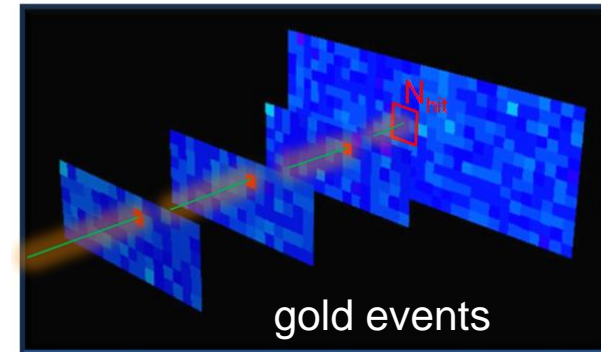


Maps Available for each chamber



Results

- Multiplicity < 1.1
 - 2 chambers
 - $\sim 75\text{k}$ gold events / chamber
 - threshold : $2.8 \text{ fC} = 0.06 \text{ MIP MPV}$



MicroMegas with Digital Readout

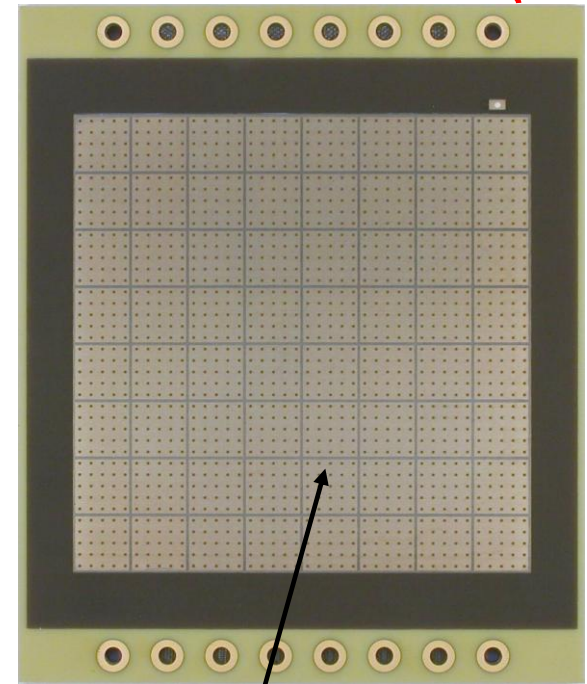
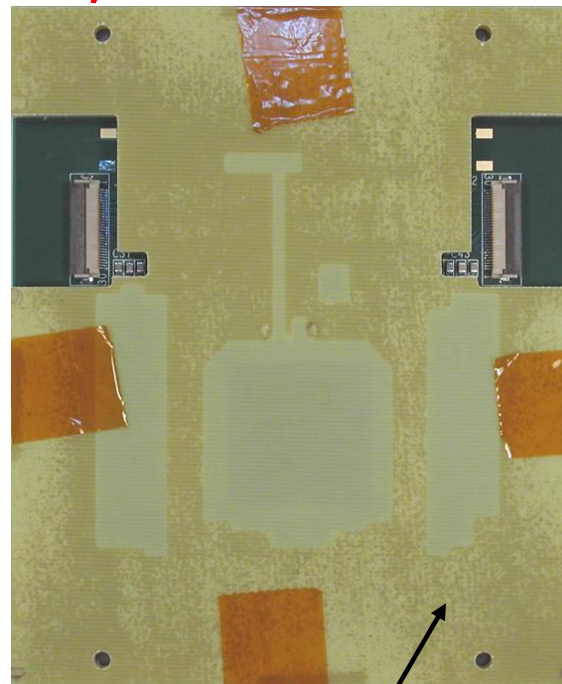
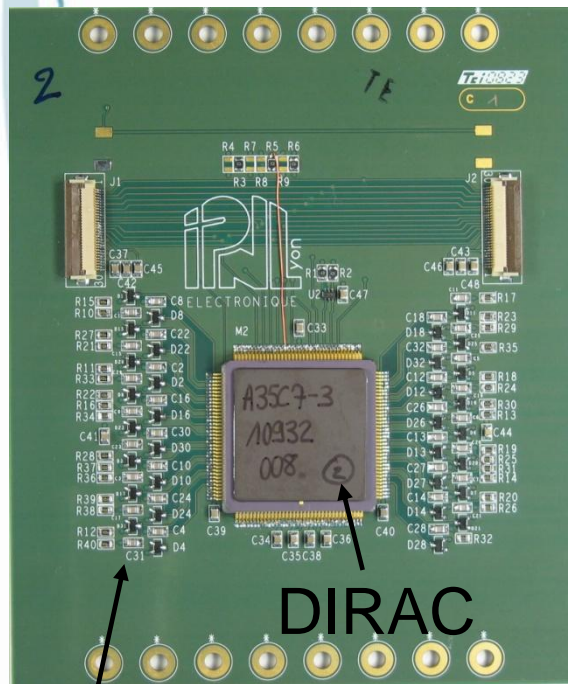
- PCB with DIRAC1 64 channels ASIC (R. Gaglione, IPNL)

First operational Bulk MicroMegas with embedded readout electronics !

Digital link to DAQ

(possibility to chain detectors)

Bulk from R. De Oliveira & O. Pizzirusso



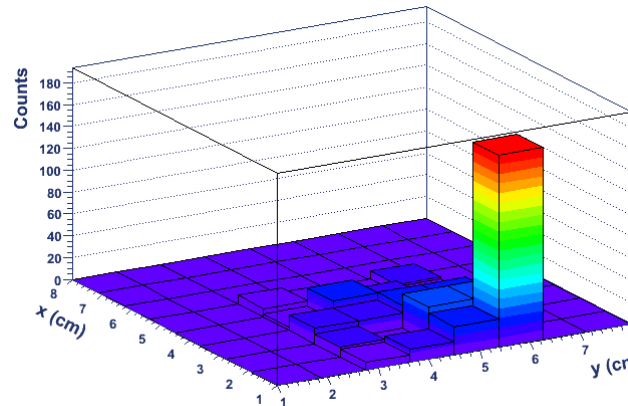
Sparks protections

mask for bulk laying

8x8 pads with bulk

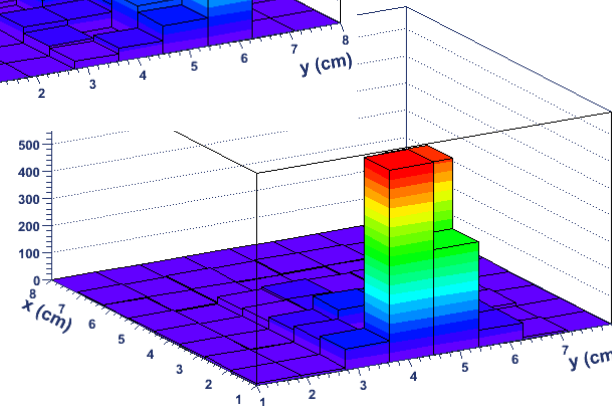
MicroMegas with Digital Readout

- Tested during the August 2008 TB

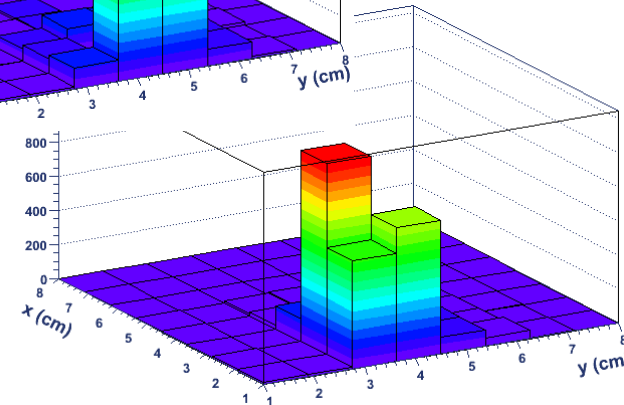


Beam Profile
when moving
the X-Y table

Lower Threshold = 19 fC



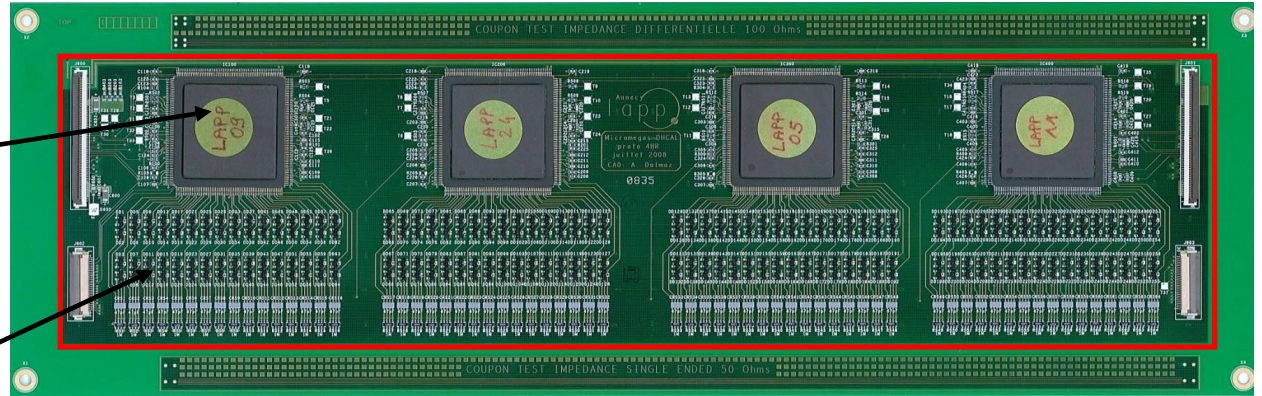
- Future test beam:
Need a stack
of chambers
to check efficiencies



MicroMegas with Digital Readout

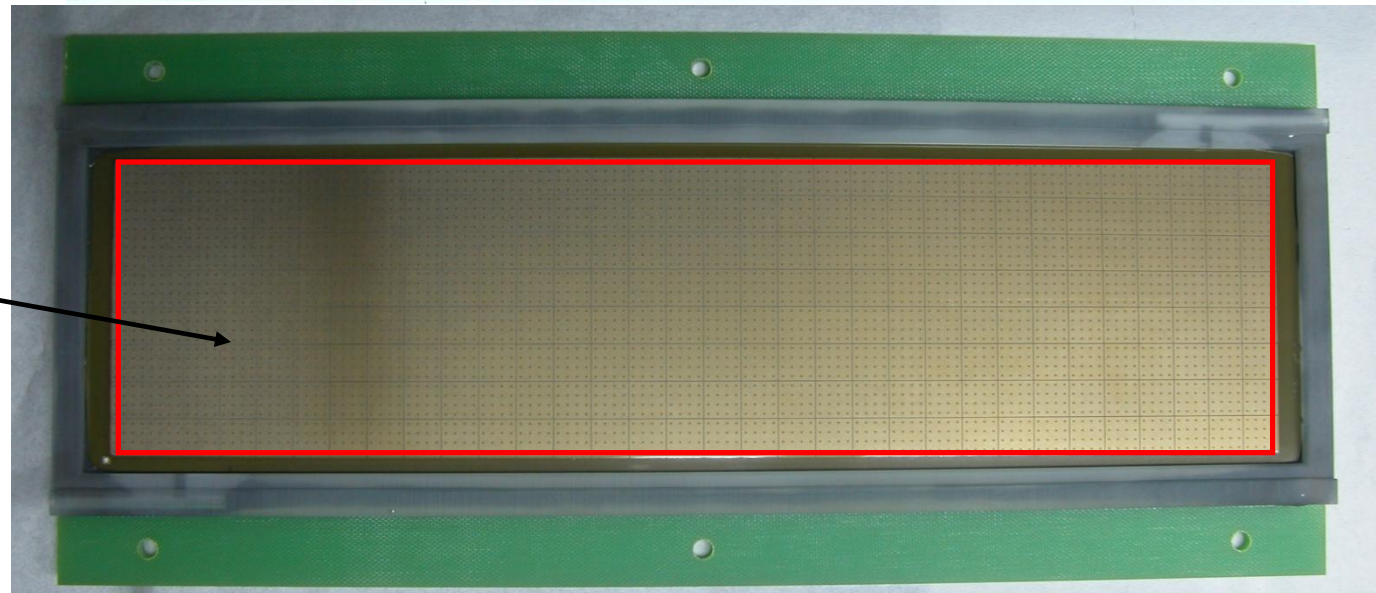
- PCB with 4 HARDROC1 64 channels ASIC
3 layers of 8x32 cm²

HARDROC1



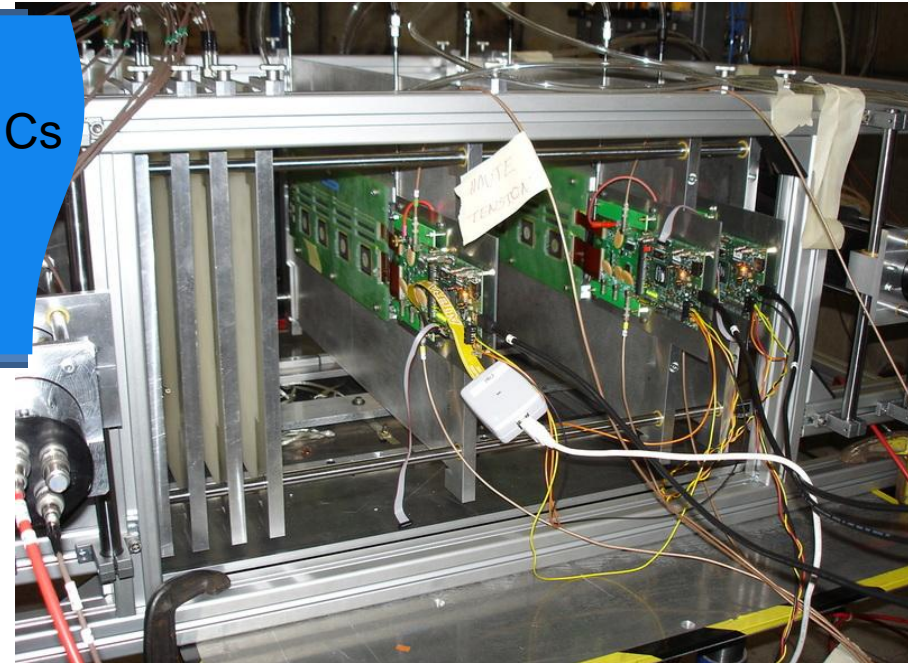
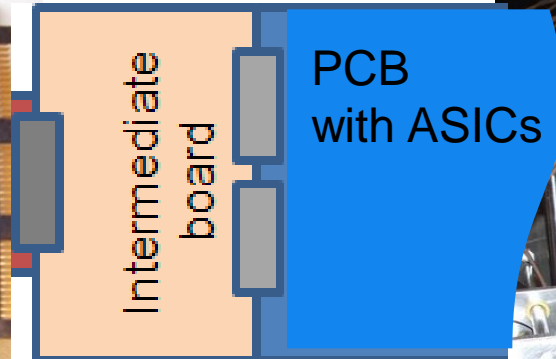
sparks protections

bulk



MicroMegas with Digital Readout

- Tested during the November 2008 TB



- Readout : DIF board
 - Separated from the SLAB
 - For large number of ASICs HARDROC, DIRAC and also SPIROC and SKYROC
 - DIF task force interface : USB or EUDET DAQ
- Excellent work from Guillaume Vouters (DIF) and Christophe Combaret (CrossDaQ)
- Difficulties to get the bulk stable
- Data currently under study

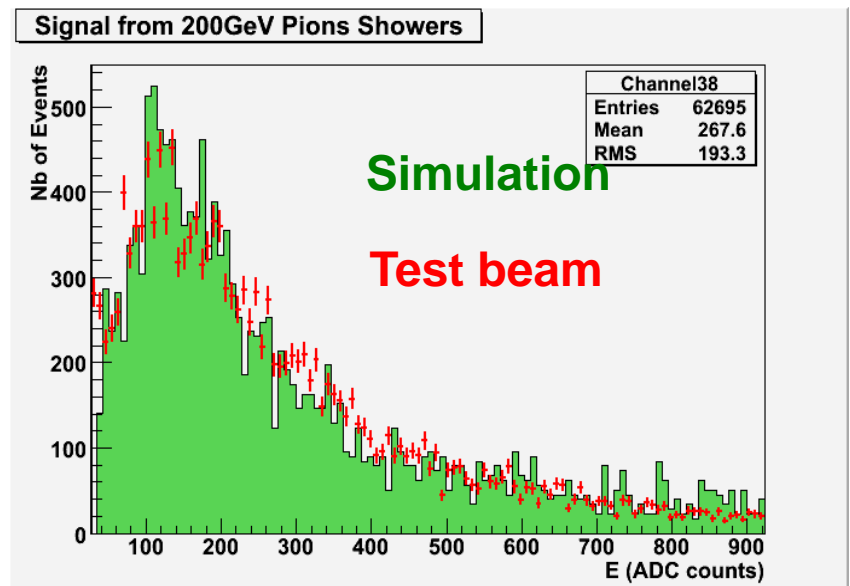
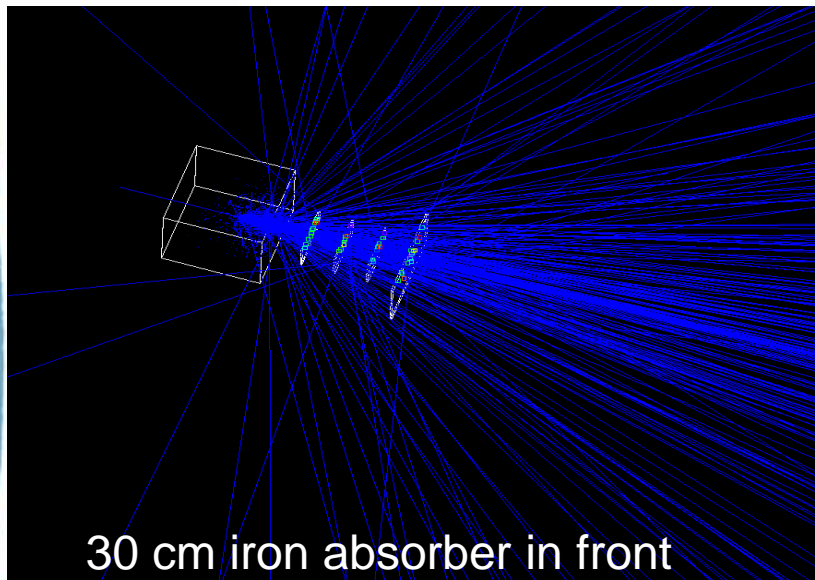
Simulation

- Simulation tools
 - SLIC full simulation of SiD concept (Geant 4)
 - Analysis using JAS3
- 2008 Test beam setup (A. Espargilière)
- DHCAL with μ Megas (J. Blaha)
 - Comparison between analog and digital
 - Thresholds & absorber studies

Simulation

2008 Test beam setup is being simulated

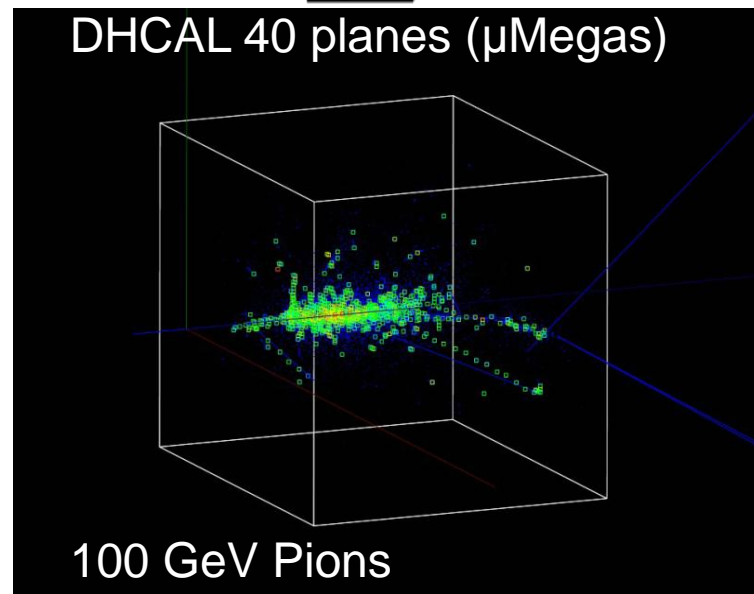
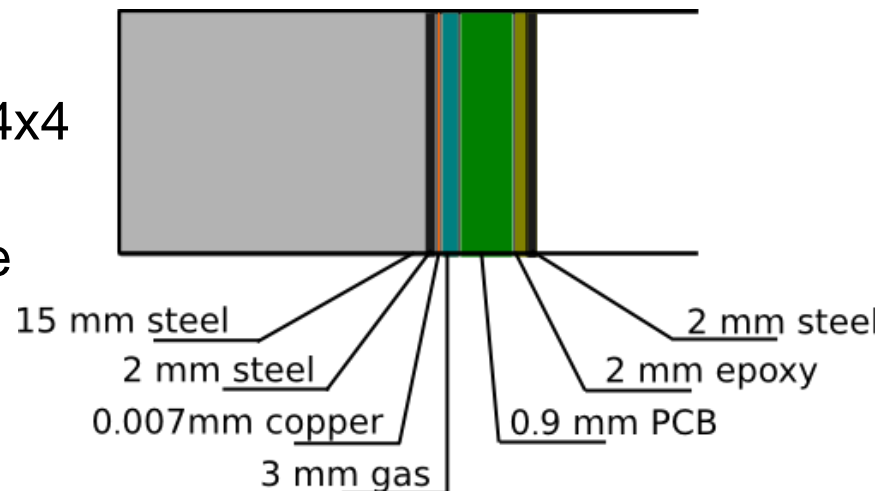
- Comparison with real data
- Better understanding of our detector
- Preparation for next test beam



Simulation

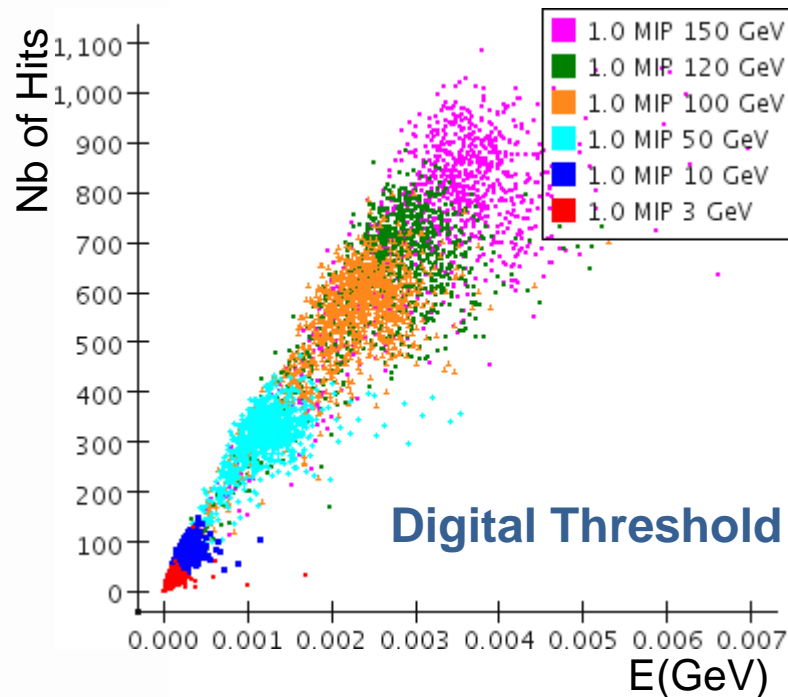
DHCAL with μ Megas

- Full m^2 geometry implemented
- Readout: from $0.5 \times 0.5 \text{ cm}^2$ to $4 \times 4 \text{ cm}^2$ pads
- 3mm active volume: Gas mixture (95 % Argon + 5 % Isobutane)
- 1.9 cm thick absorber
- Different absorber materials
- **40 or 80 layers** ($\sim 4, 5$ or $\sim 9 \lambda$)
- Thickness of active layer: 6 mm
- Ideal MicroMegas, digitization not yet fully implemented



Simulation

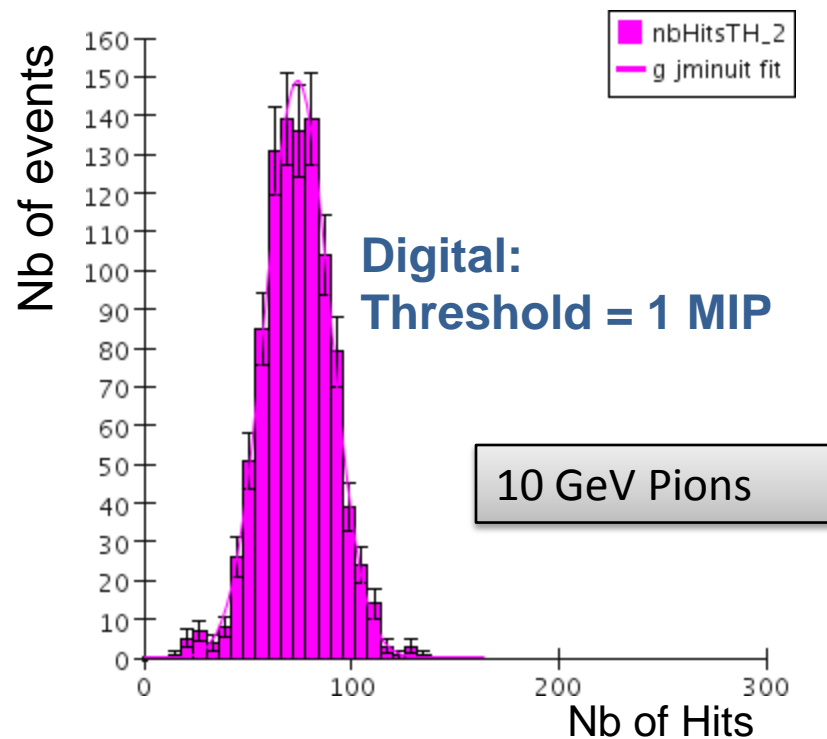
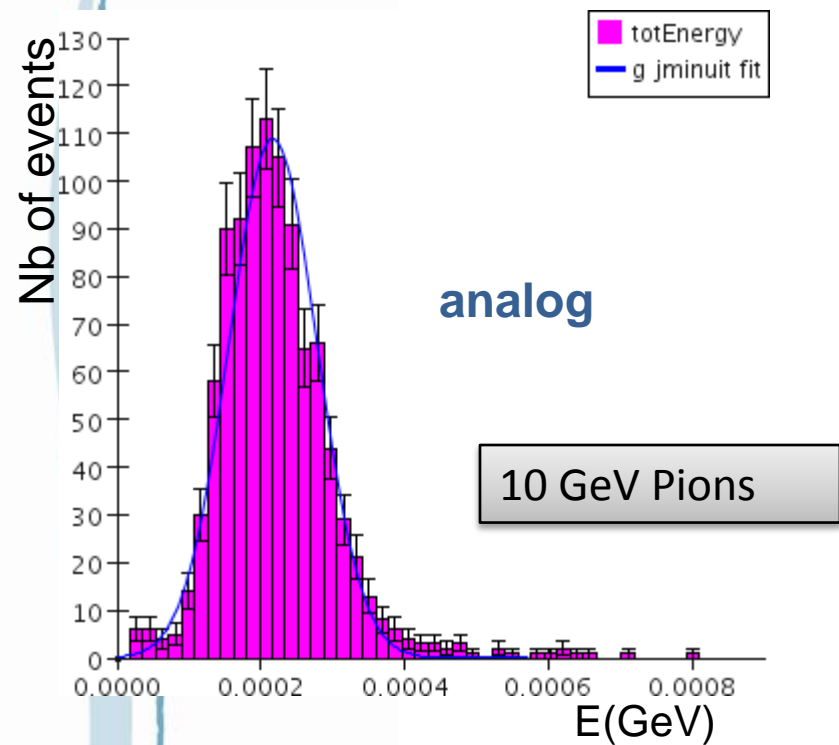
Number of hits in calorimeter vs total deposited energy



Significant correlation between Number of hits and deposited energy

Simulation

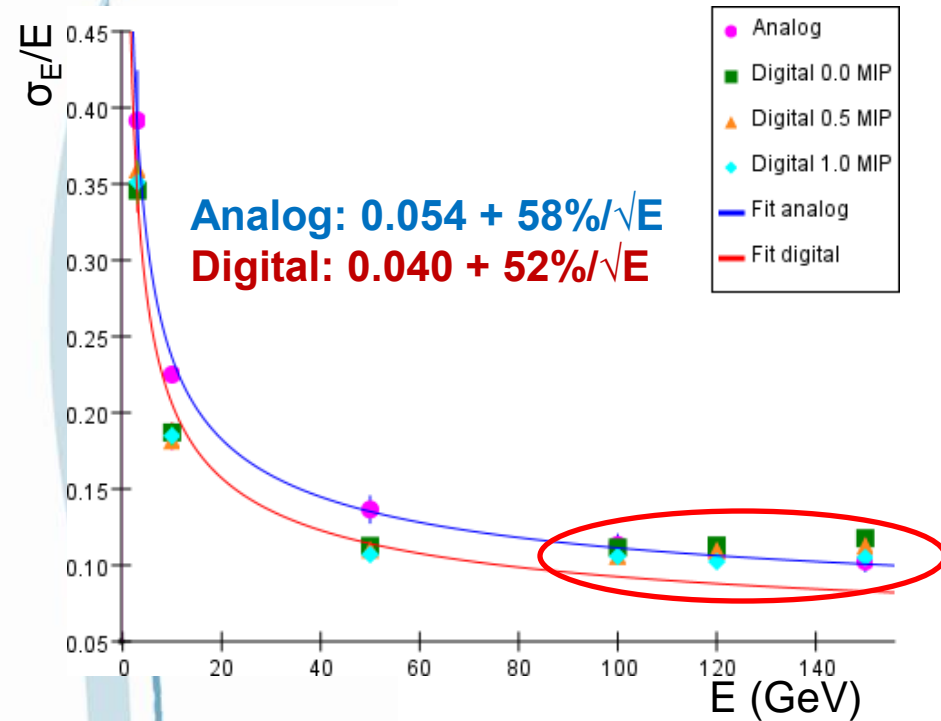
Comparison between analog and digital



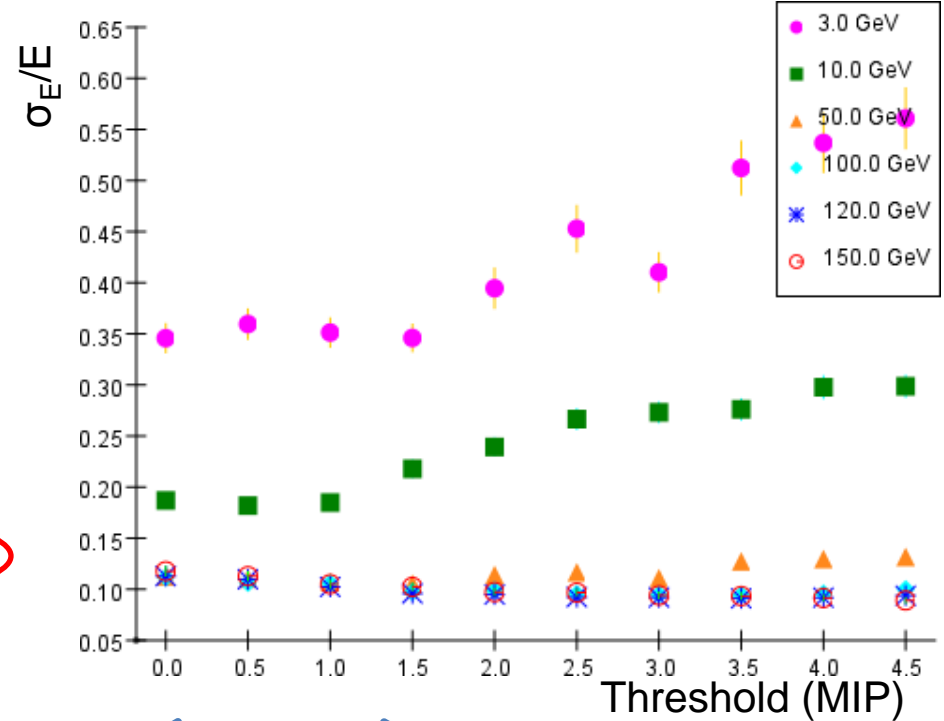
First glimpse : Digital signal seem more gaussian and more narrow

Simulation

Energy resolution vs pion energy



Energy resolution vs hit threshold



*Worse resolution at High energy
 \Rightarrow Need more than 1 threshold ?*

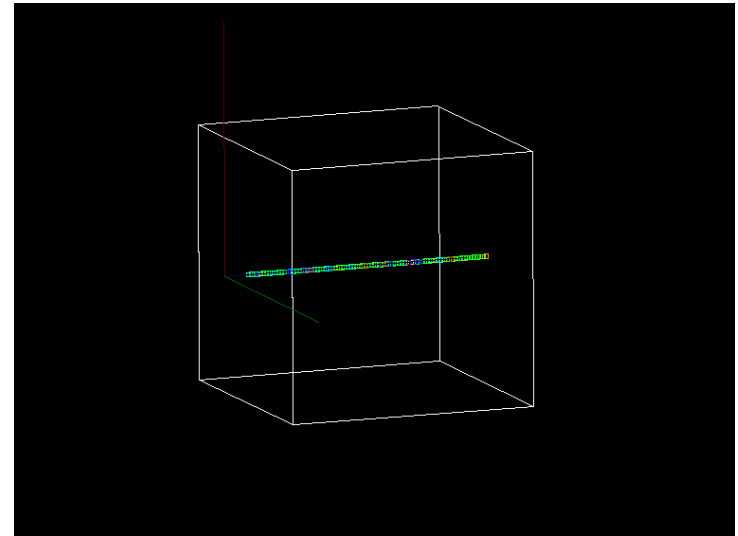
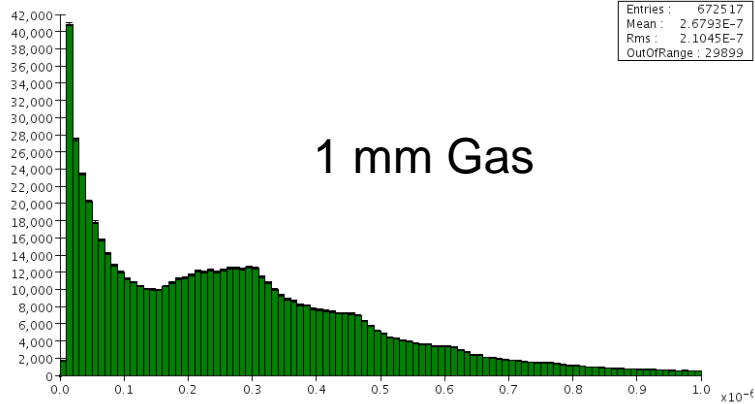
*Threshold range with
 constant energy resolution*

Simulation

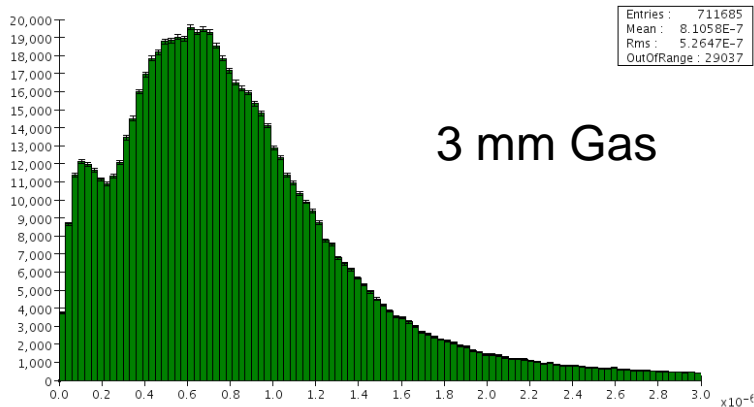
100 GeV muons

Deposited energy in all planes for different gas volume

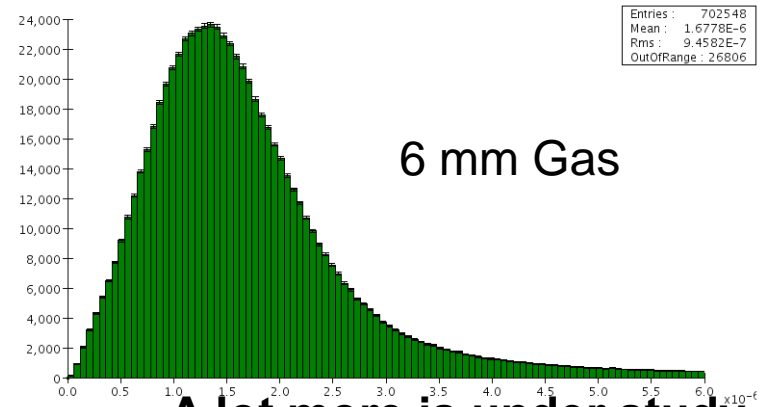
Energy deposited in a pad for all the layers (1 mm gas), muons 100 GeV



Energy deposited in a pad for all the layers (3 mm gas), muons 100 GeV



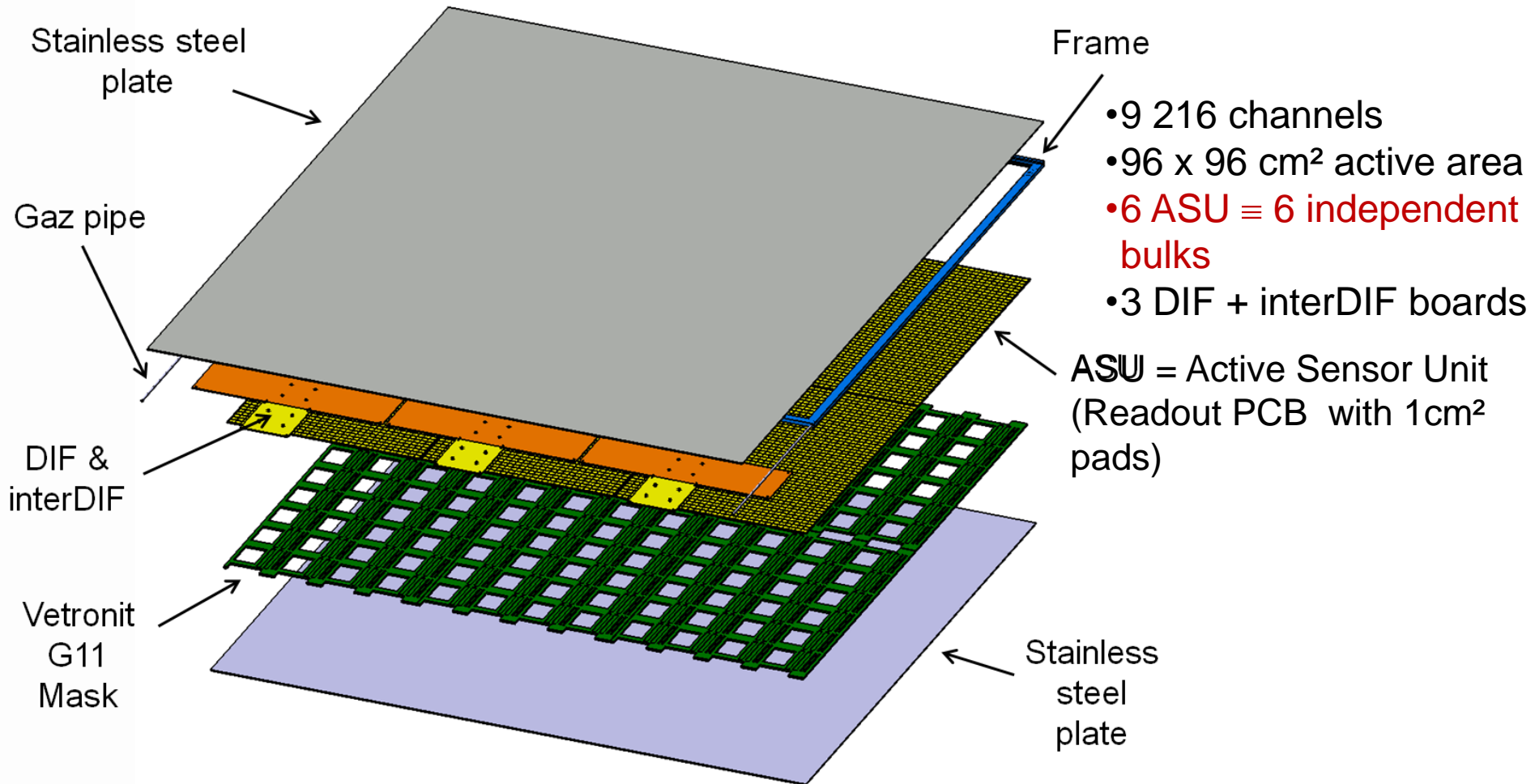
Energy deposited in a pad for all the layers (6 mm gas), muons 100 GeV



A lot more is under study ...

(see Next Calice Analysis Meeting on 9 feb)

Future m² Design



Future m² Status

- DIF & DAQ almost ready
- ASU :
 - 24 HARDROC2
 - Design and routing done
 - **single ASU test box under conception**
- Clean room ready for m² assembly
- Mechanical prototype under construction

Conclusion

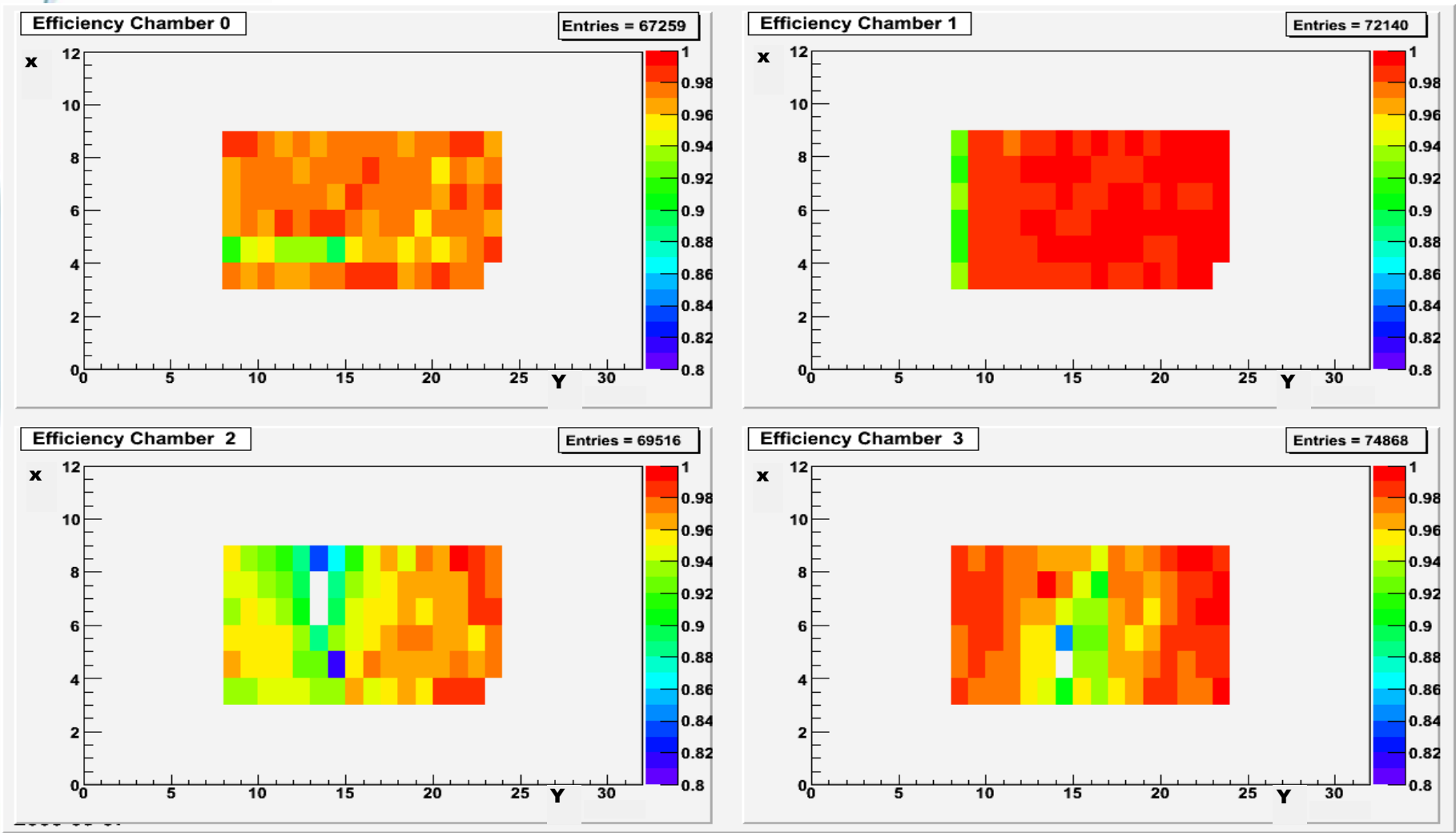
- MicroMegas R&D for DHCAL very active!
 - ASIC developments
 - Innovative prototypes, first μ Megas with embedded digital readout
 - Tests Beam: very promising results (still a lot to analyse)
 - Future Test Beam in 2009 ...
- Towards
 - 1m² prototype
 - Calorimeter of 1m³
- In parallel : work on simulation
 - 2008 TB prototypes, future 1m³ and leakageless 8m³
 - Different absorber material, active medium, pads size...



Thank you

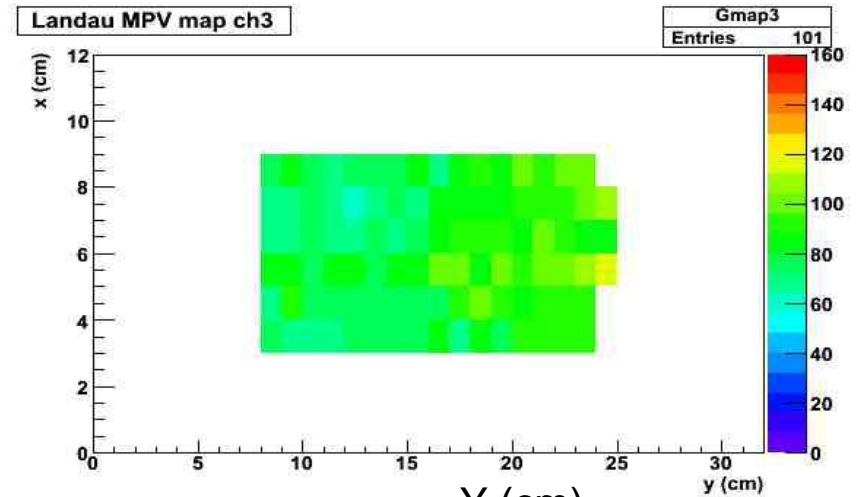
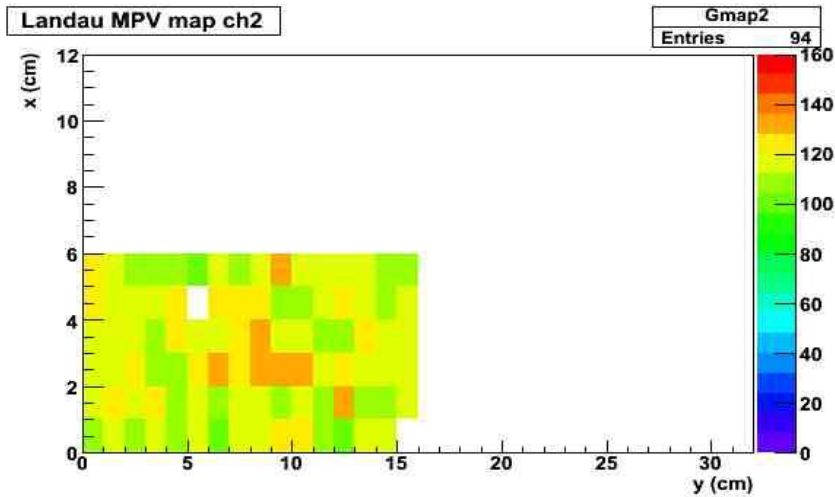
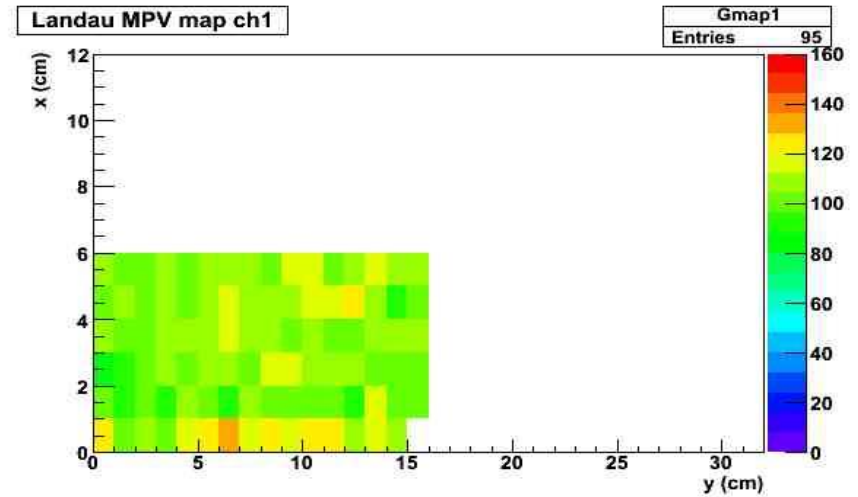
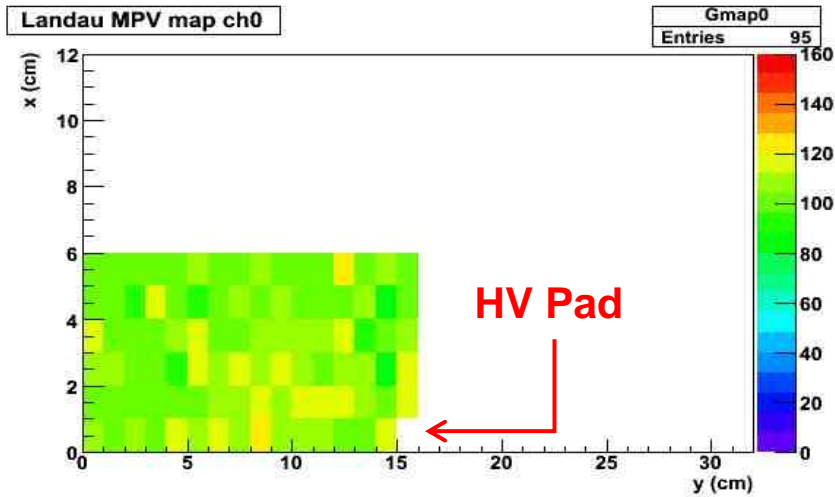
Bonus

Efficiency maps for All chambers



MPV Maps for all chambers

X (cm)



Y (cm)