Developments on MicroMegas for DHCAL

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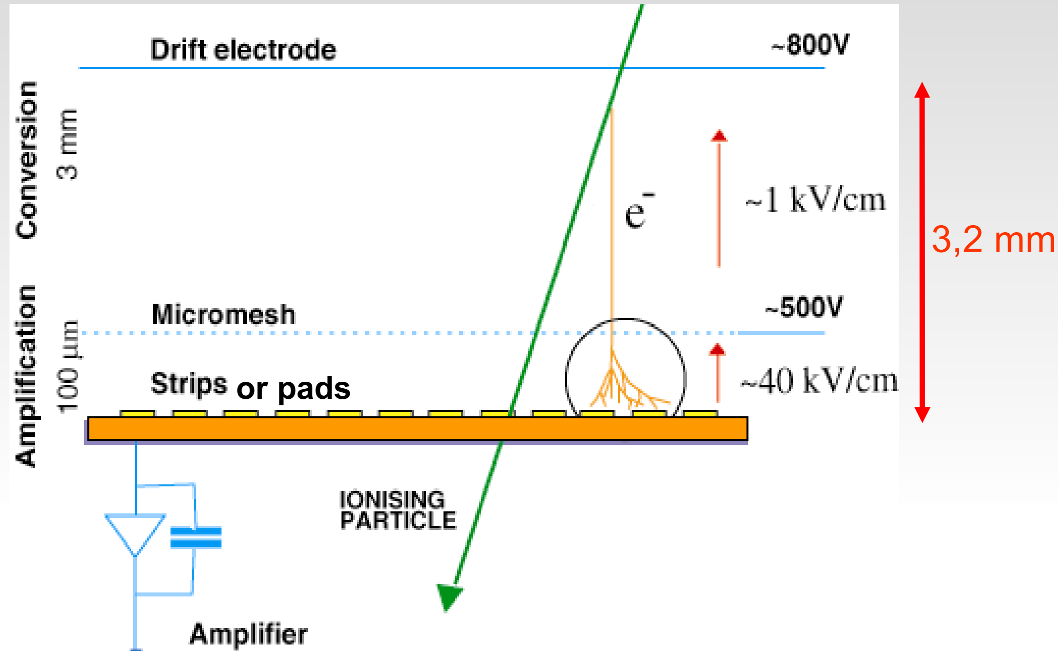
Outline

- μMegas
- Readout electronics
- X-ray response
- Test beam results
- Large scale prototype
- Conclusion

MicroMEsh GAseous Structure

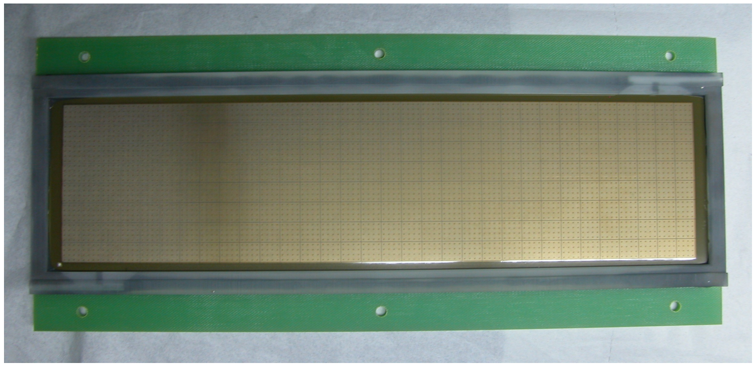
Description

- Gas (Argon + Isobutane)
- Hight voltage < 500 V
- High detection rates
- Robust, relatively low cost
- Thickness 3.2 mm
- Delicate functioning (sparks)



Readout

- Analog for characterization
  - GASSIPLEX + CENTAURE DAQ
- Digital
  - HARDROC or DIRAC + DIF + CrossDAQ or EUDET DAQ2

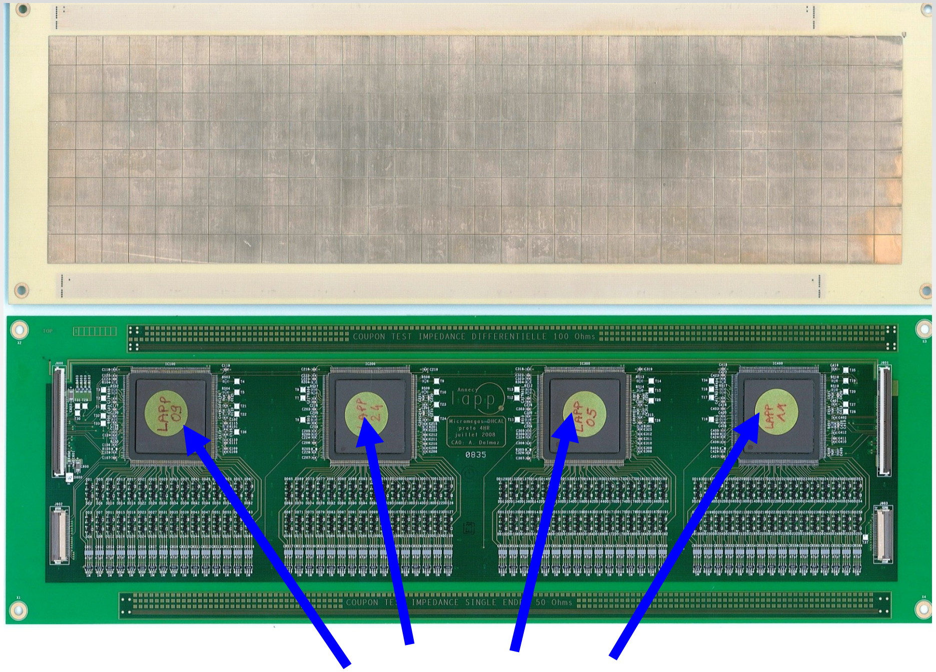


Bulk technology, 32x8 pads

HARDROC and DIRAC

HARDROC 1 (2) (LAL)

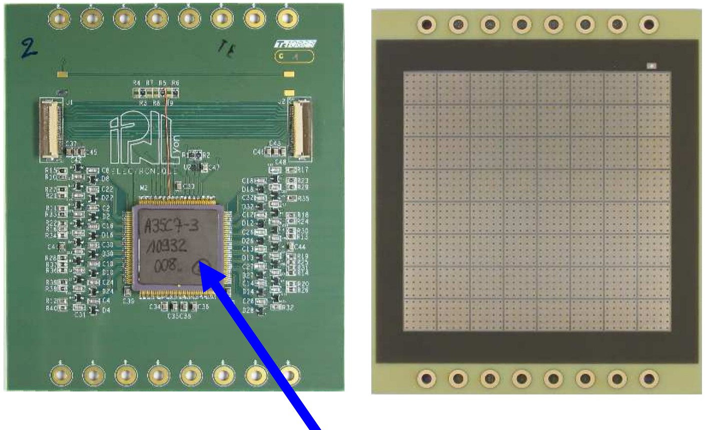
- Analog and digital readout
- 1 chip (16 mm^2, 19 mm^2) – 64 channels
- 2 (3) thresholds in 10 bit precision
- Digital memory for 128 events
- Gain – 10 fC to 1 pC (5 pC to 10 pC)
- Low consumption - < 10 μW/channel



4 HARDROC for 8x32 pads

DIRAC (IPNL)

- Digital readout
- 1 chip (7 mm^2) – 64 channels
- 3 thresholds in 8 bit precision
- Digital memory for 8 events
- 2 gains – 3 fC to 200 fC
  (100 fC to 10 pC)
- Low consumption - < 10 μW/channel

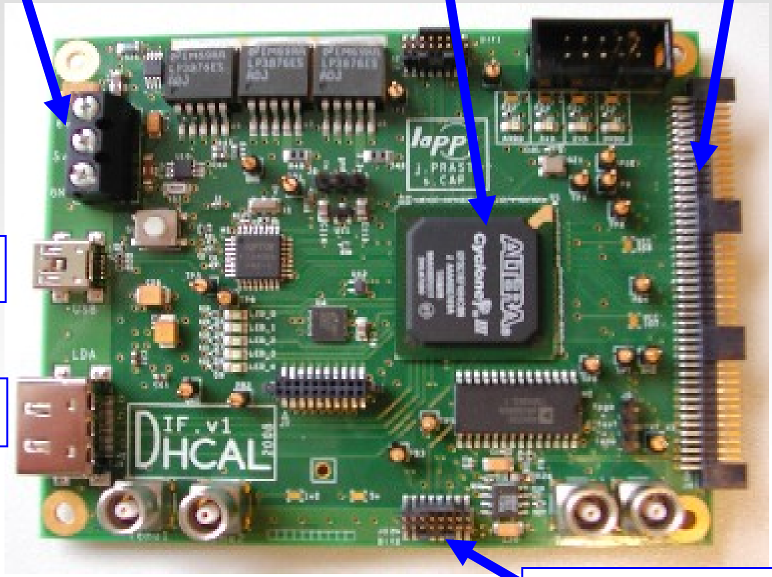


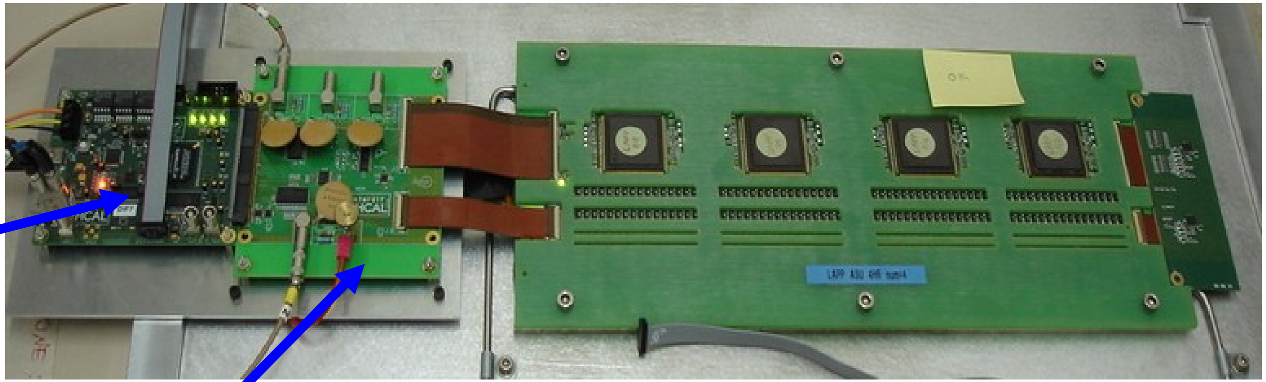
DIRAC

Digital InterFace

DIF board (LAPP):

- Independent board to have more flexibility
- It provides the communication with PCs and HARDROCs (DIRACs) through the intermediate board (InterDIF)
- It allows ASICs configuration and performs analog and digital readout
- Also compatible with SPIROC and SKYROC



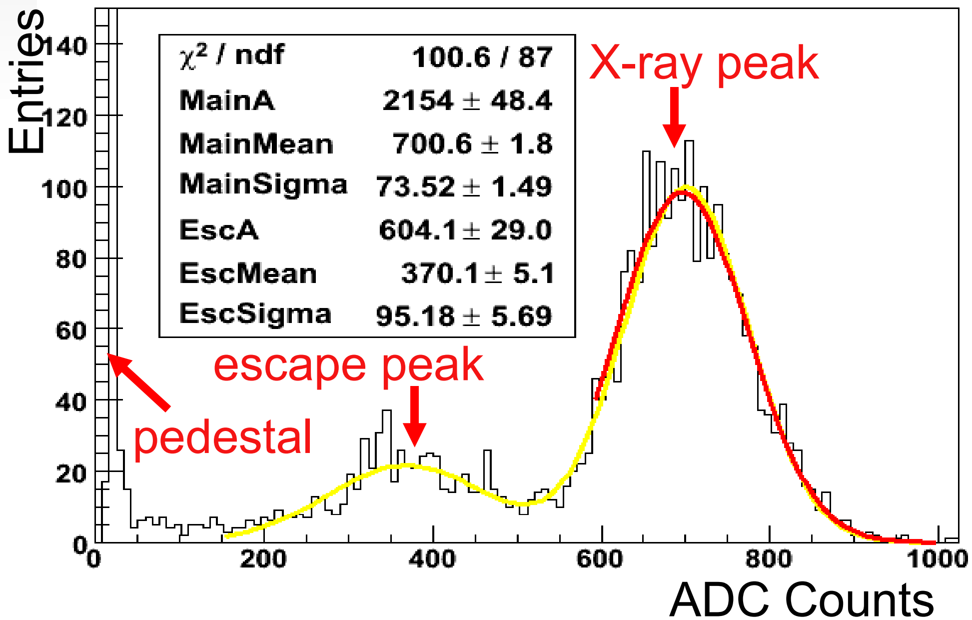


X-ray response

Set-up:

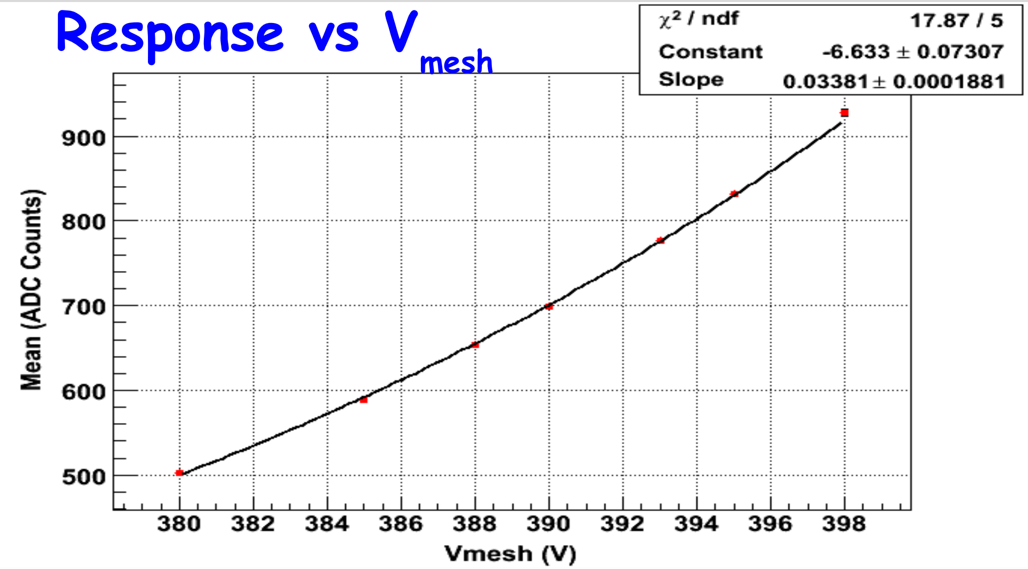
- ^{55}Fe source (5.9 keV)
- Trigger on mesh
- Analog readout

Energy resolution FWHM = 25.5%

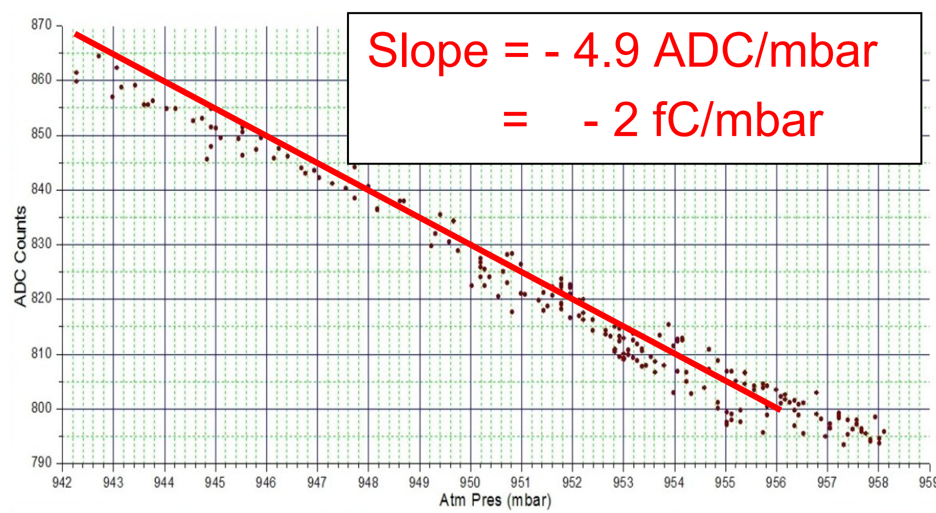


Gain ≈ 7600

Response vs V_{mesh}



Response vs pressure



Test beam (August 08)

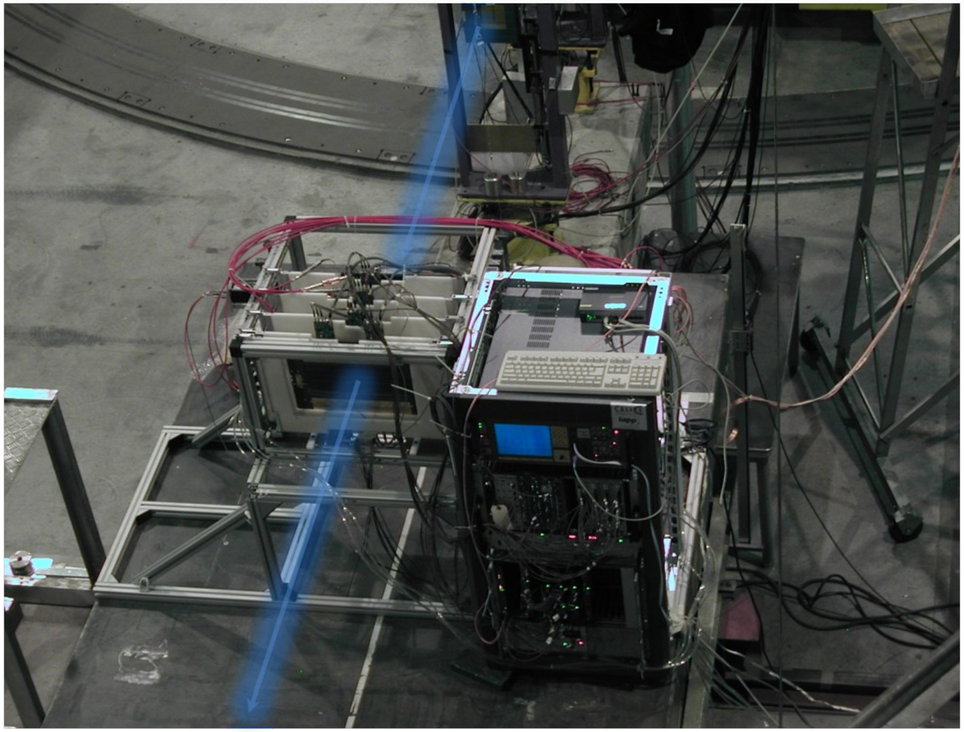
Main objectives

- Prototypes diversity
- Pad homogeneity
- Efficiency and multiplicity
- Crosstalk study
- Behavior in hadronic showers

Collected data

- 50 and 200 GeV pions
- 200 GeV muons
- 200 GeV pions with and without iron absorber in front of the system

Set-up at H2 line SPS-CERN



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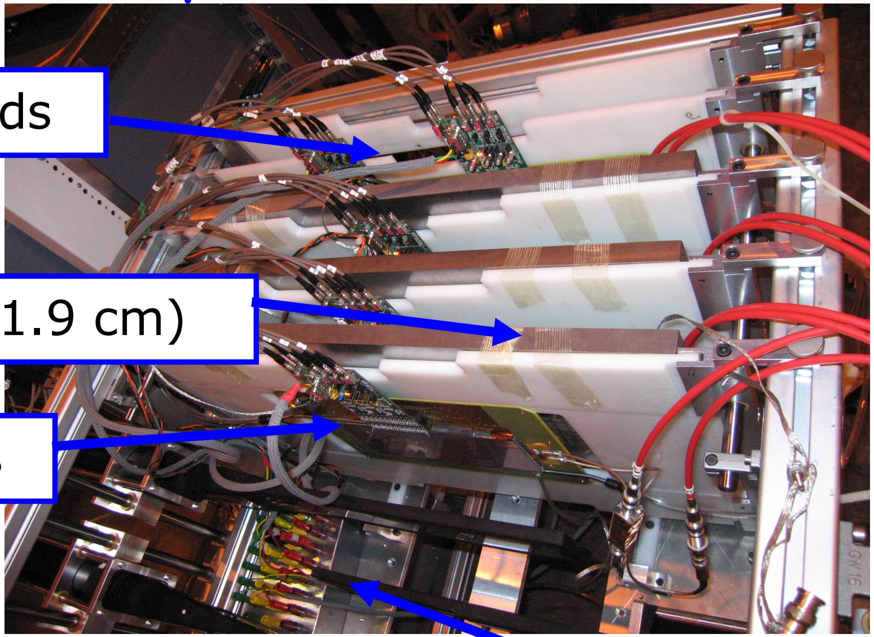
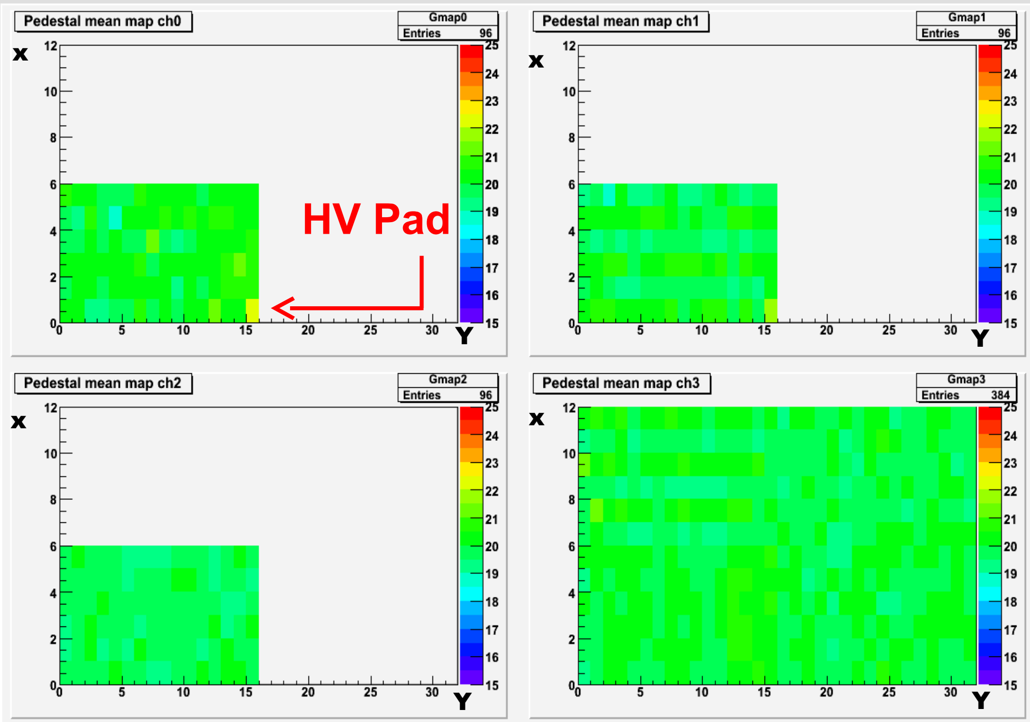
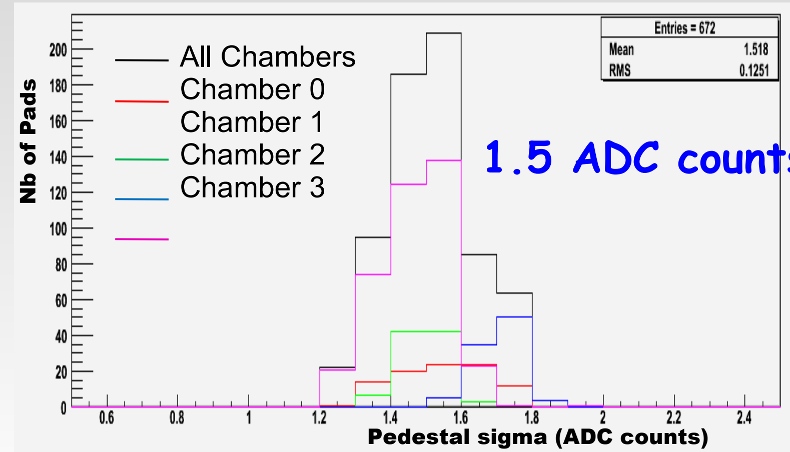


Pedestal and noise performance

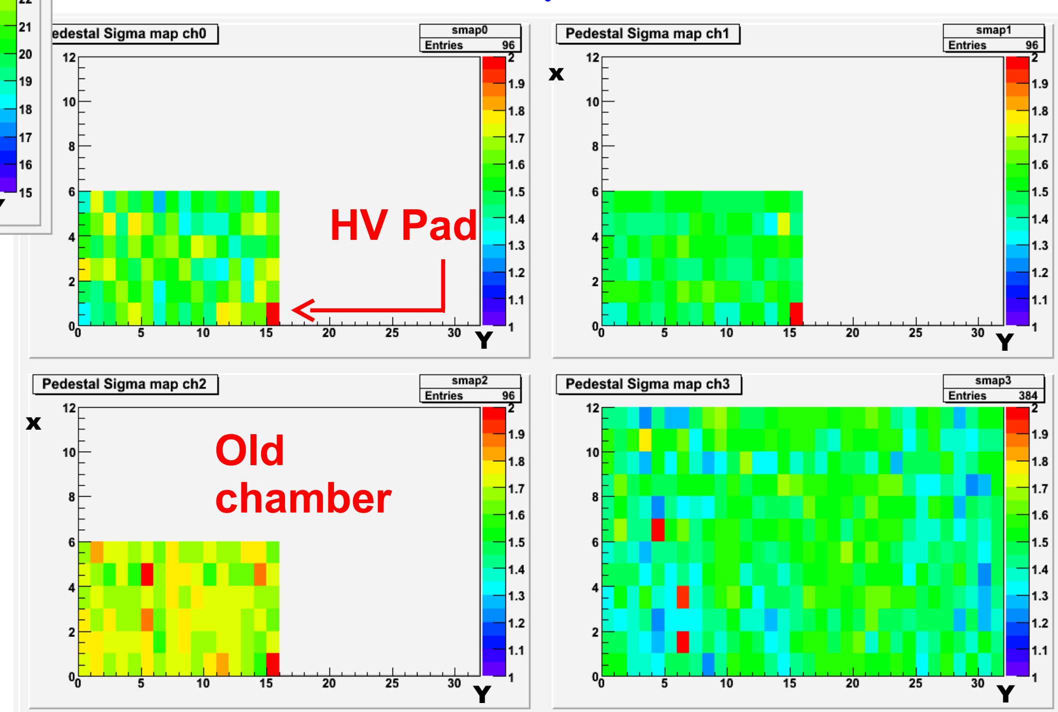
Pedestal vs pad



Mean electronic noise



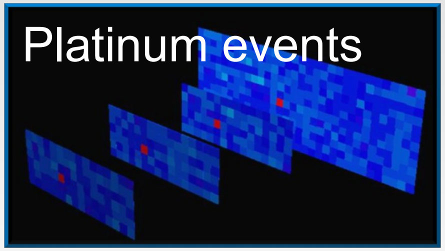
Electronics noise vs pad



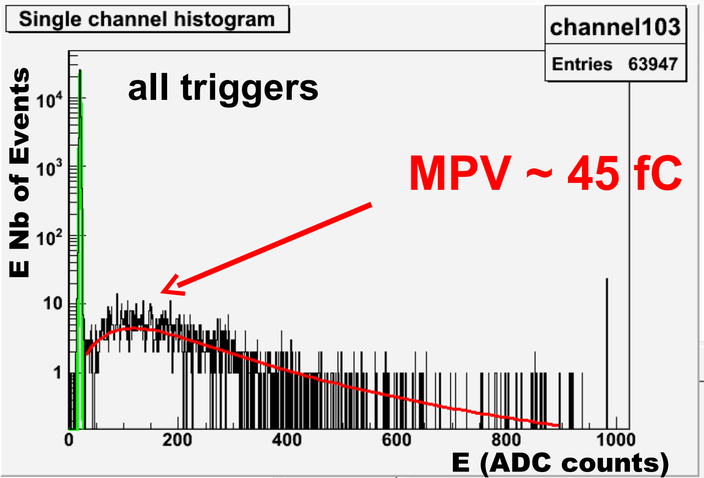
- Pedestal was set correctly for all the pads
- Pedestal and noise were stable over all the test beam period

MIP signal

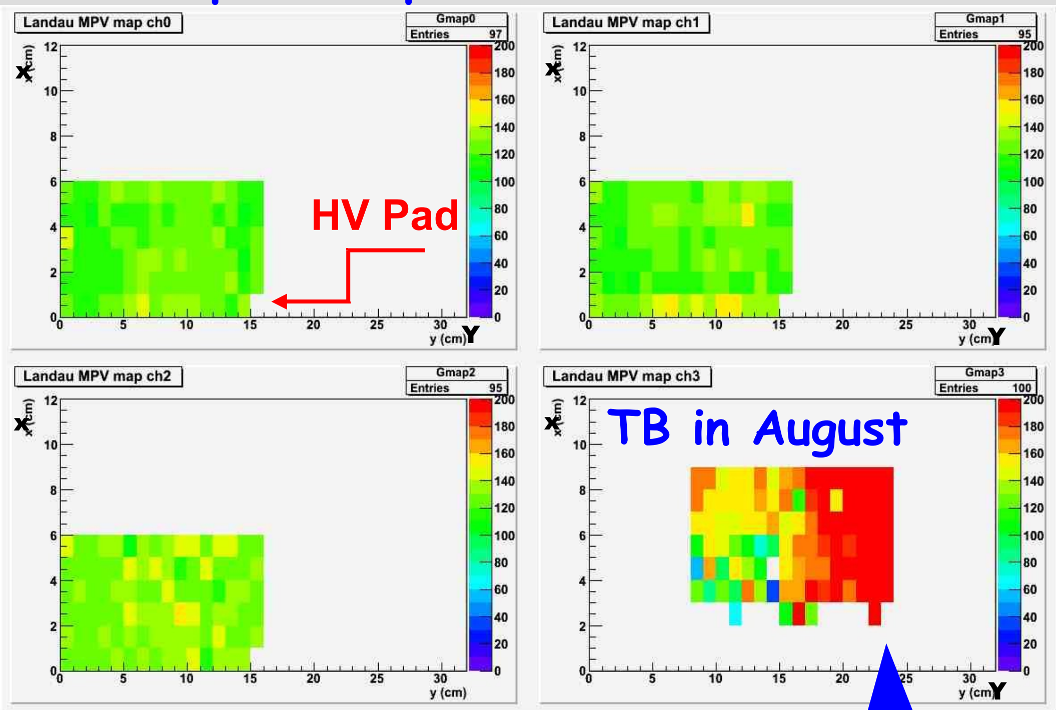
Only events with single hit in 4 chambers are considered



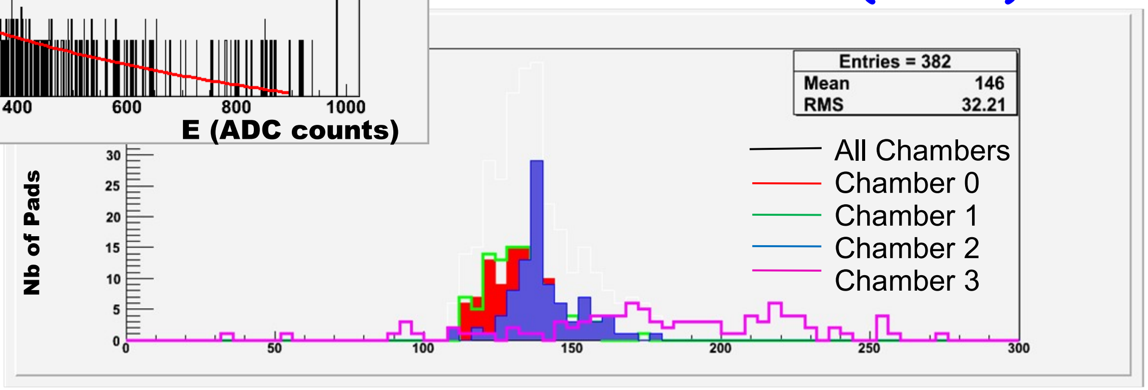
MIP signal in single channel



Landau peak vs pad

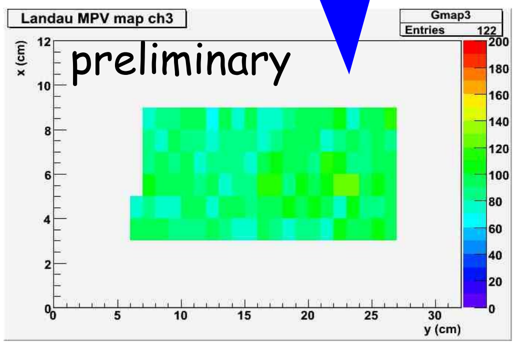


Landau variation (~12%)



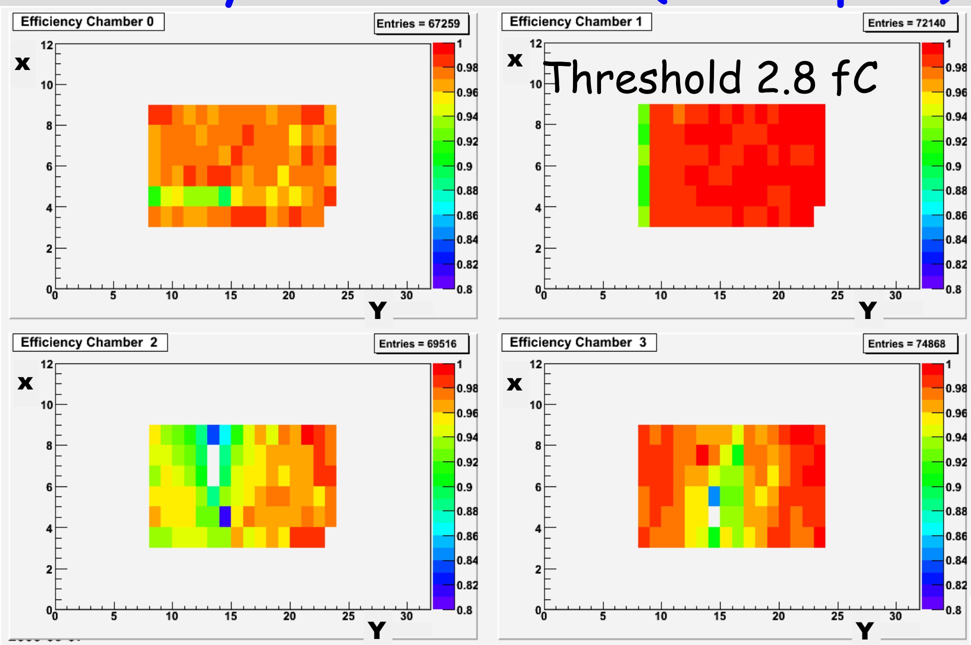
Landau MPV (ADC counts)

TB in November

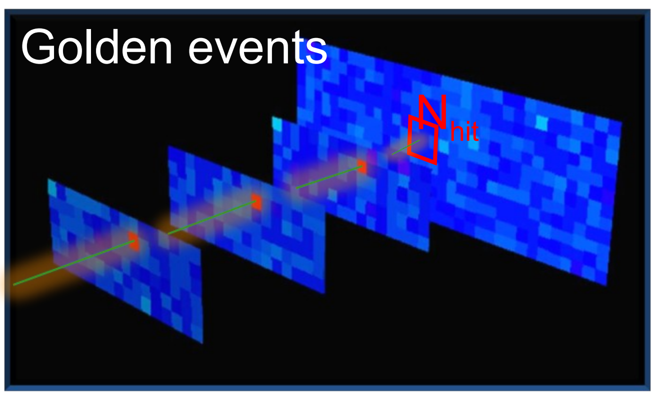


Efficiency

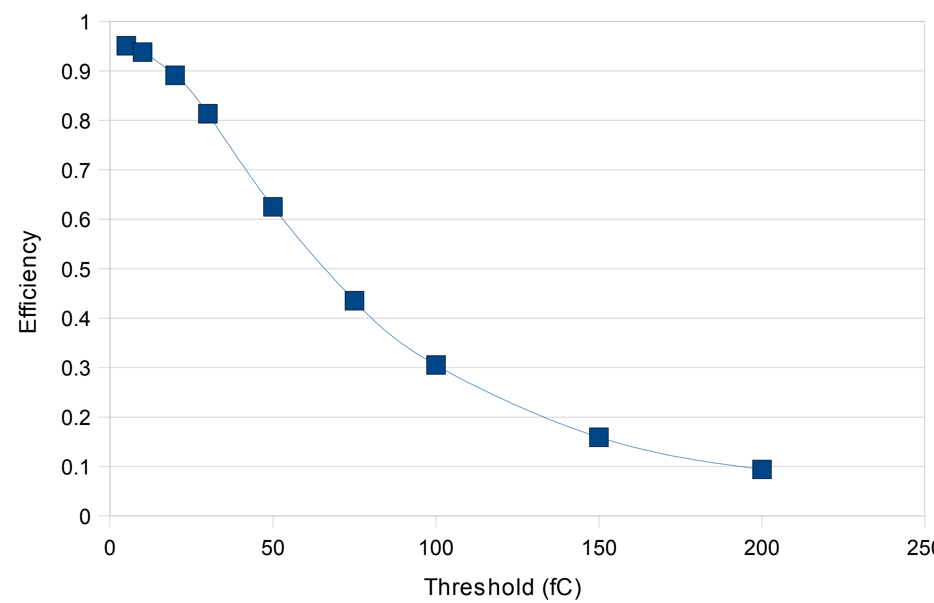
Efficiency for 4 chambers (for all pads)



	Efficiency
Chamber 0	97,05 ± 0,07%
Chamber 1	98,54 ± 0,05%
Chamber 2	92,99 ± 0,10%
Chamber 3	96,17 ± 0,07%



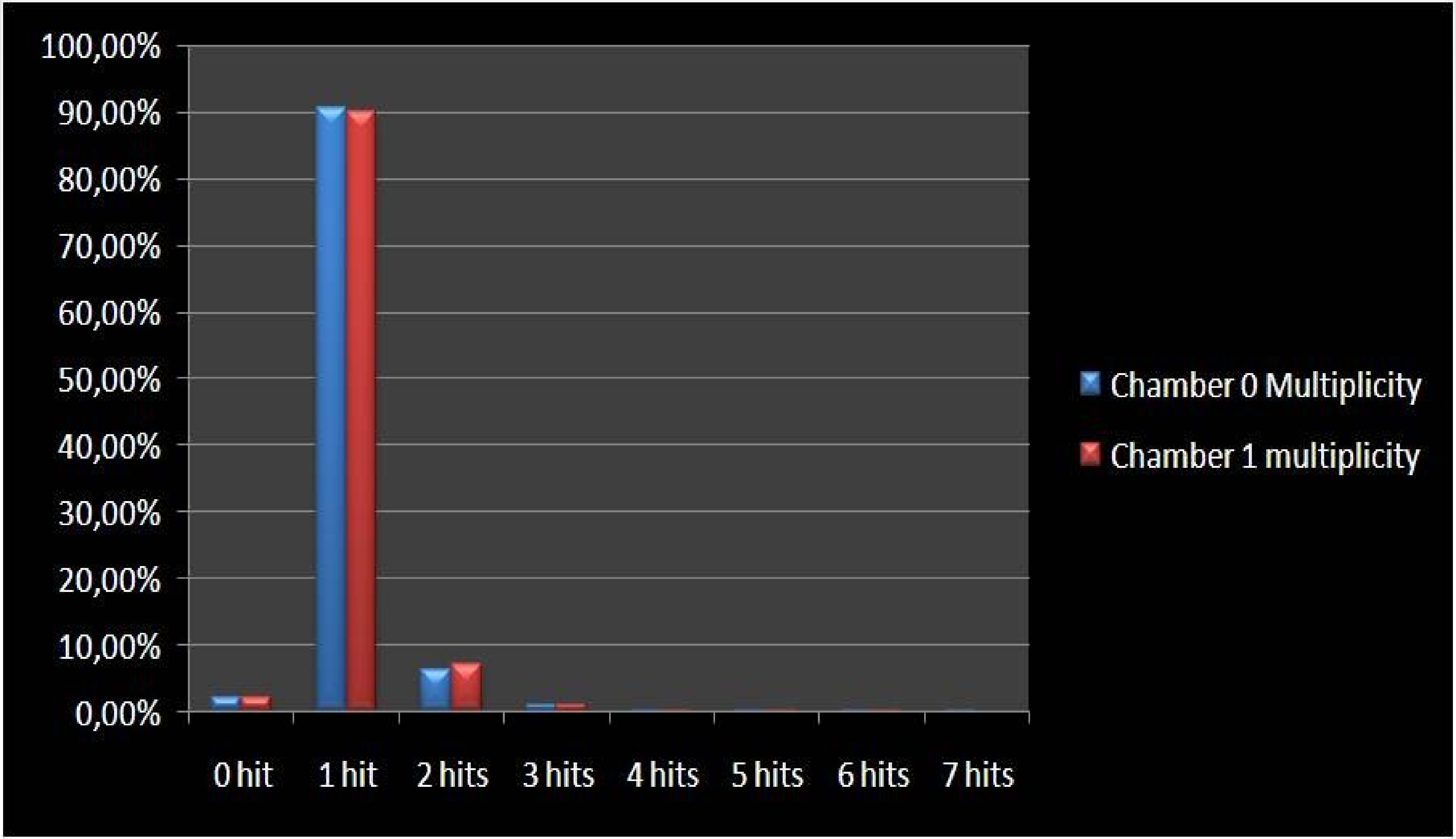
Efficiency vs threshold



Count the Number of hit(s) in a 3x3 array around the expected hit

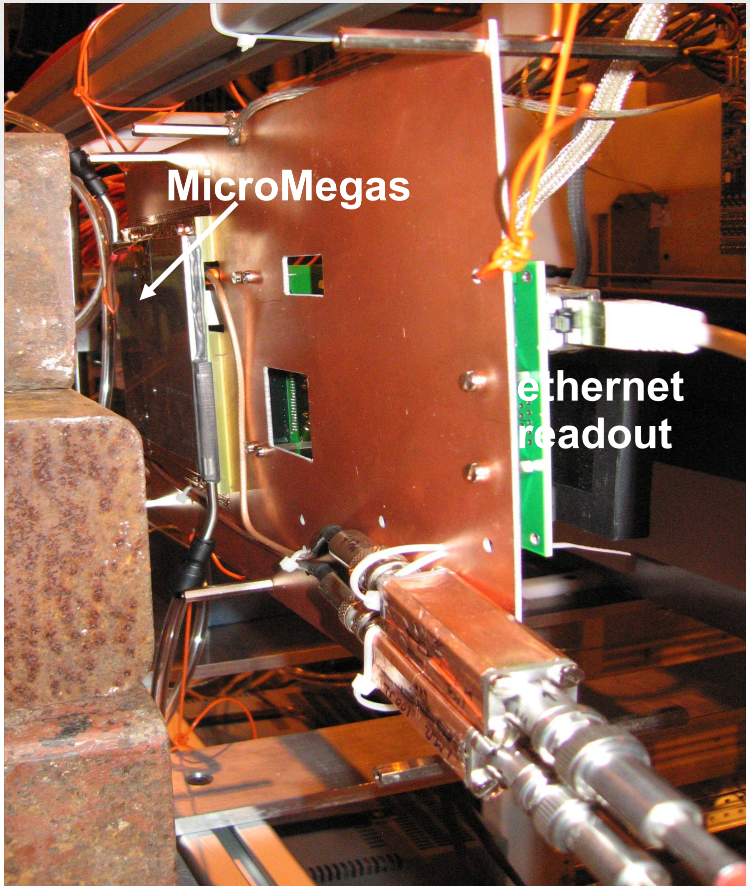
Multiplicity

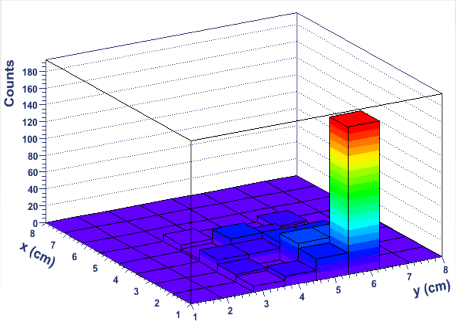
Pad multiplicity for two chambers (~ 80,000 events each) < 1.1



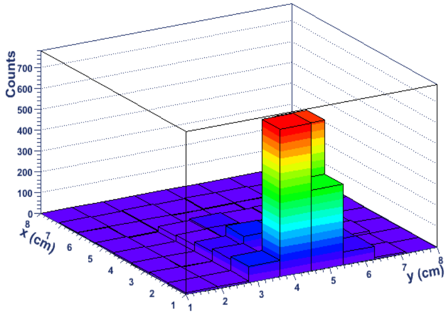
MicroMegas with digital readout

The first operational bulk µMegas with embedded readout electronics (TB in August 08):

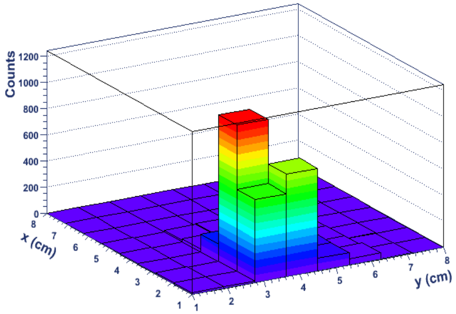




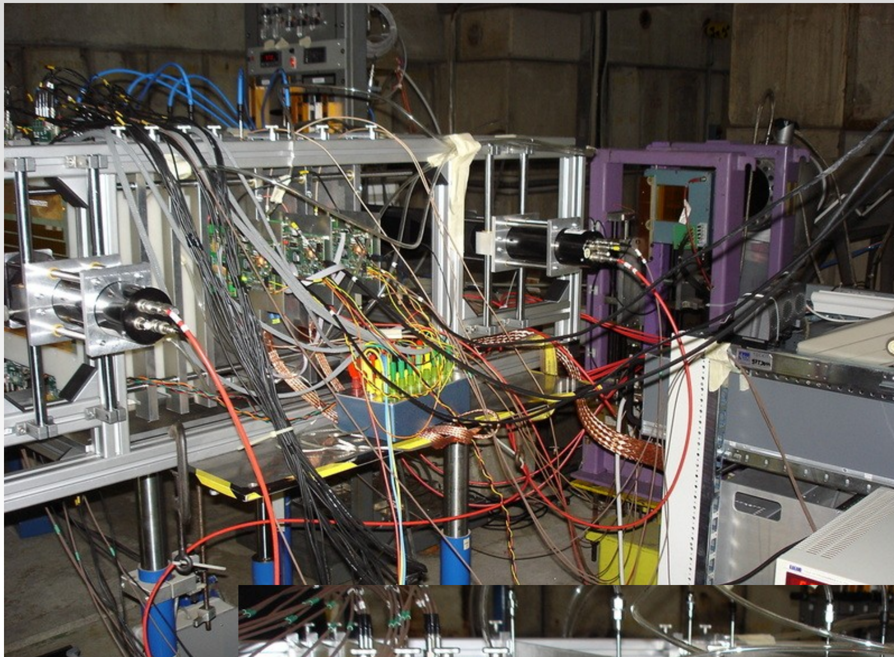
Beam Profile when moving the X-Y table

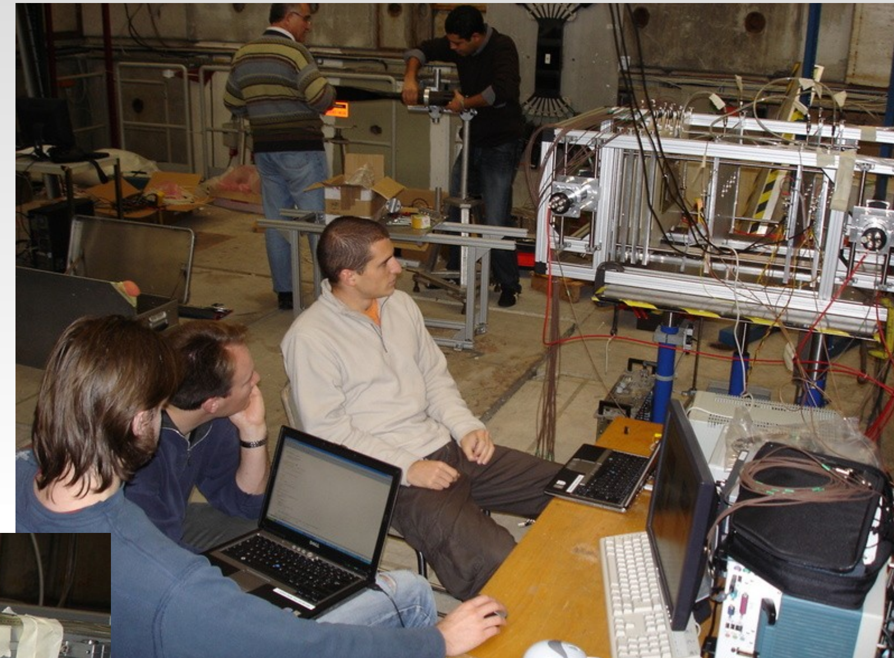


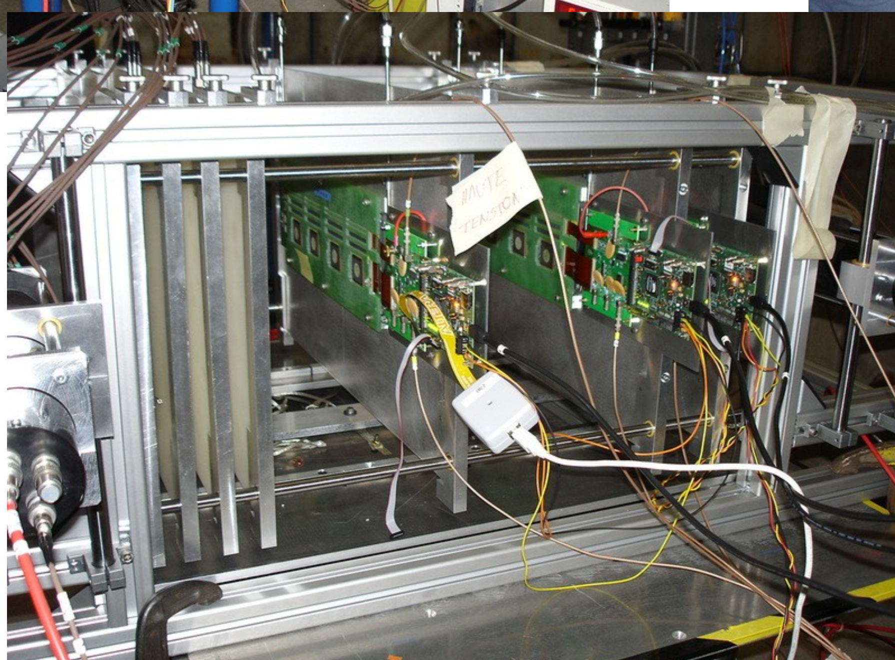
Very promising results!



Test beam (November 08)







T9 line (PS-CERN)

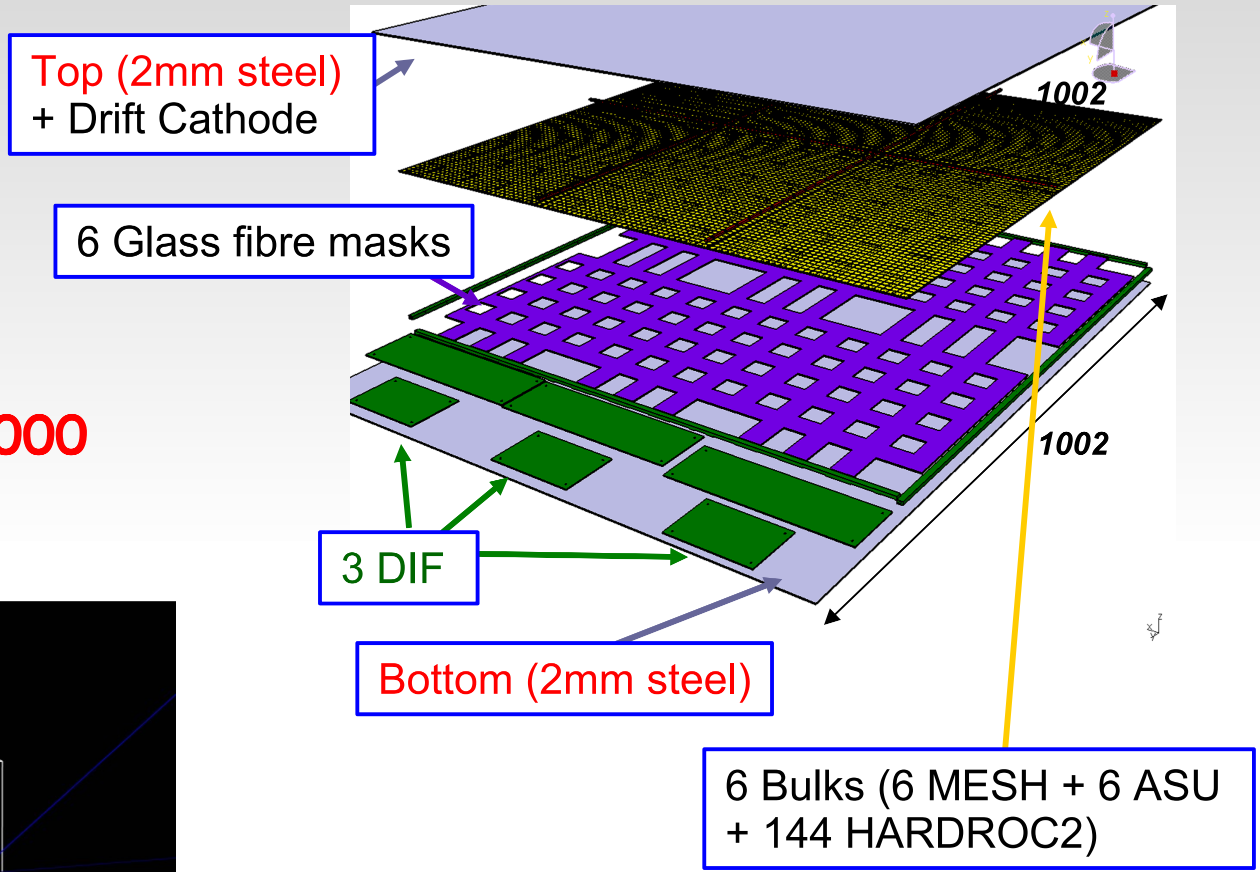
- 7 GeV Pions
- Old and new prototypes
- Data currently under study

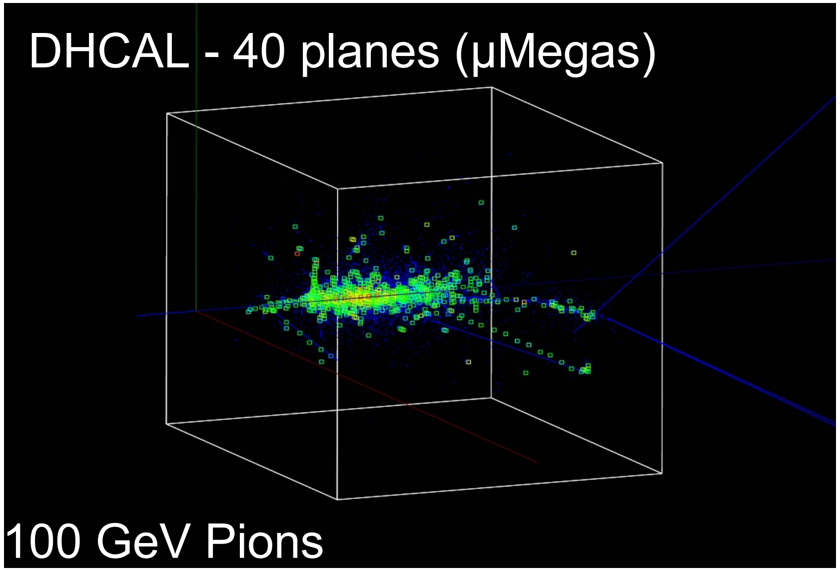
m² µMegas prototype

m² prototype:

- ~10 000 channels
- Prototype to be ready for test beam 2009

Next step: m³ with ~ 400 000 readout channels





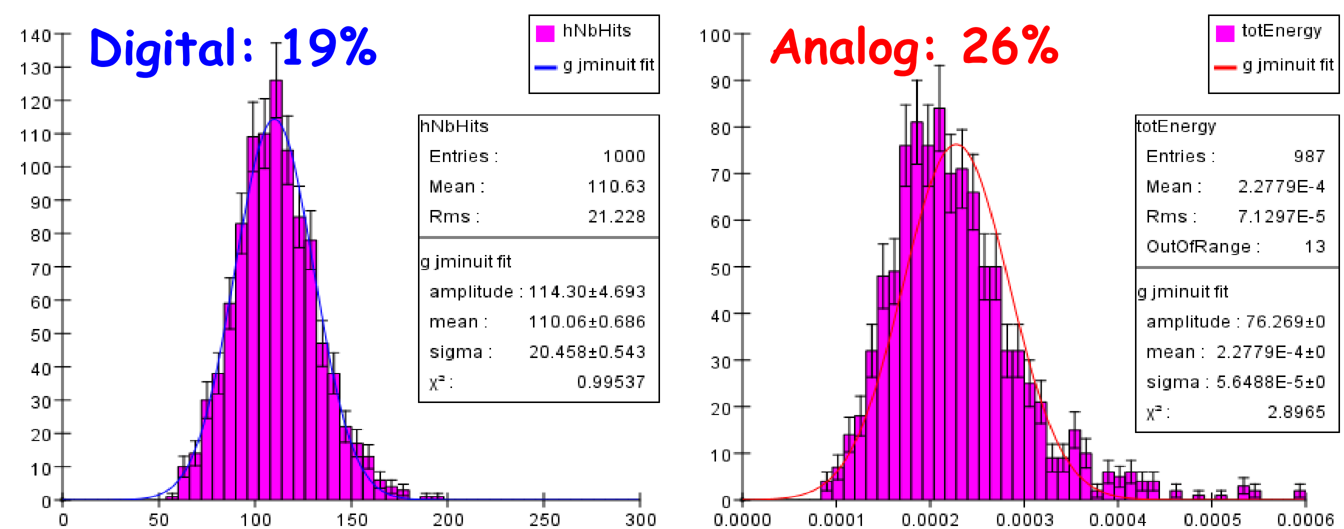
Ongoing simulation study for design optimization

m³ µMegas simulation

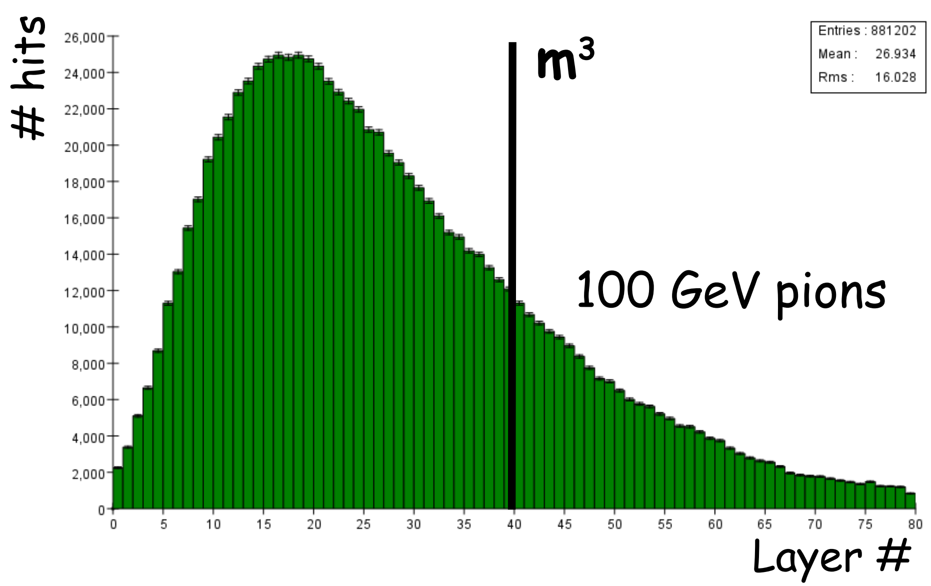
Optimization:

- Material and dimension
- Readout cell size:
  - 0.5 x 0.5 cm^2
  - 1 x 1 cm^2
  - 2 x 2 cm^2
  - 4 x 4 cm^2

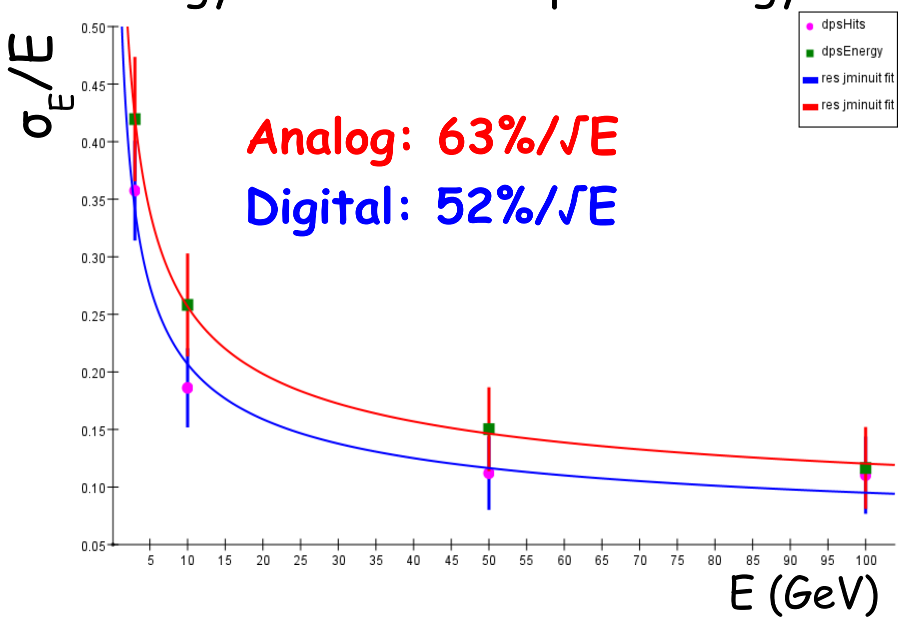
Energy resolution for 10 GeV pions (no threshold)



Longitudinal shower profile



Energy resolution vs pion energy



Conclusions

- Several μMegas prototypes have been successfully built and extensively tested

- The first μMegas test beam results have showed very good performance complying with DHCAL needs

- Development of large scale prototypes is well underway and is going to be ready for a test beam 2009