# Update on Micromegas TB analysis

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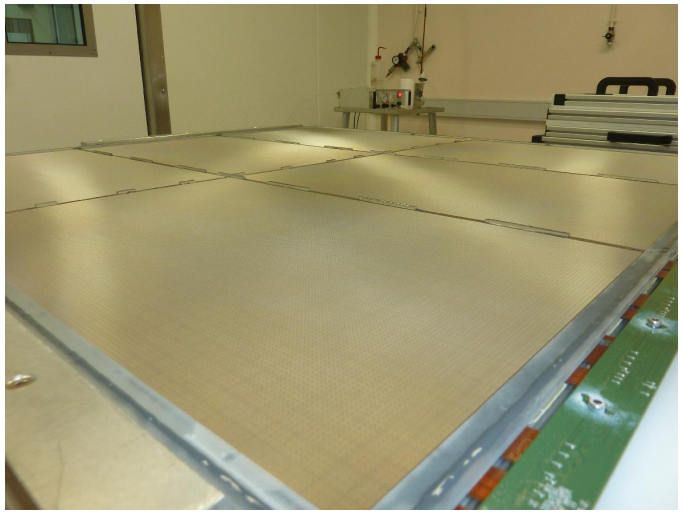
## Overview

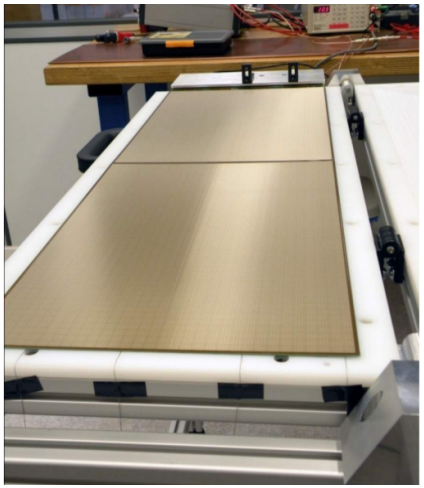
1. The Micromegas 1 $m^2$ prototype
2. Test beam results in 2011
3. Test beam plans for 2012

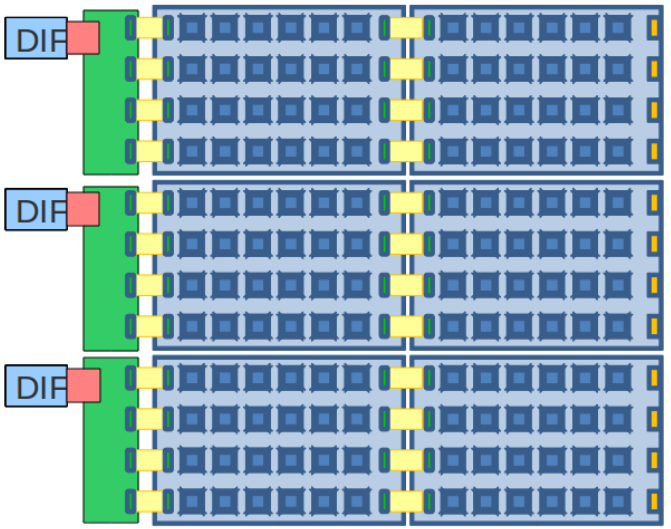


# The Micromegas 1 $m^2$ prototype (1/2)

- Mechanics: 6 ASU with flexible interconnections
  - 96x96 = 9216 pads of 1 $cm^2$, 2% dead areas, 1 cm thick chamber (incl. 2 mm Fe)

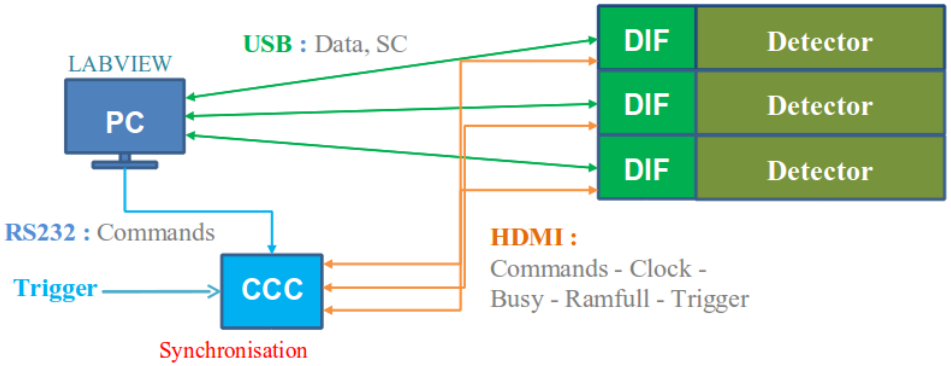
- Electronics: 144 MICROROC ASIC
  - Noise RMS of 0.25 fC, 50-200 ns shaping, integrated spark protections



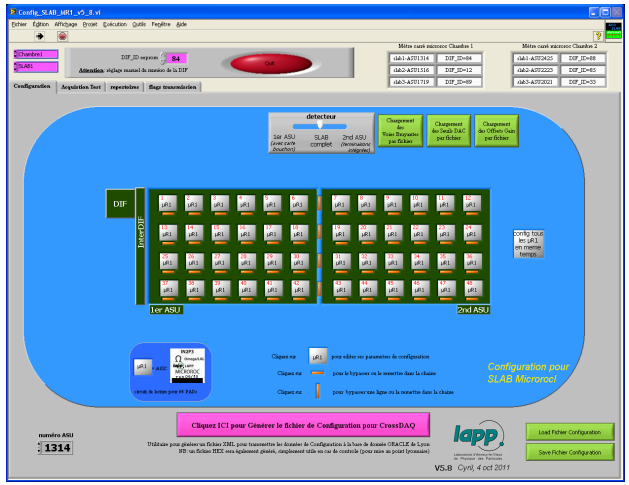


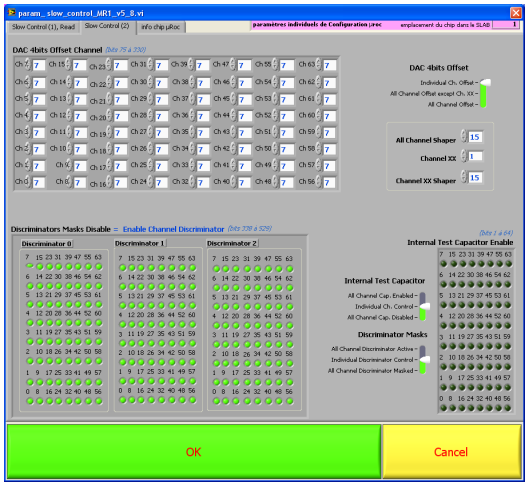
# The Micromegas 1 m$^2$ prototype (2/2)

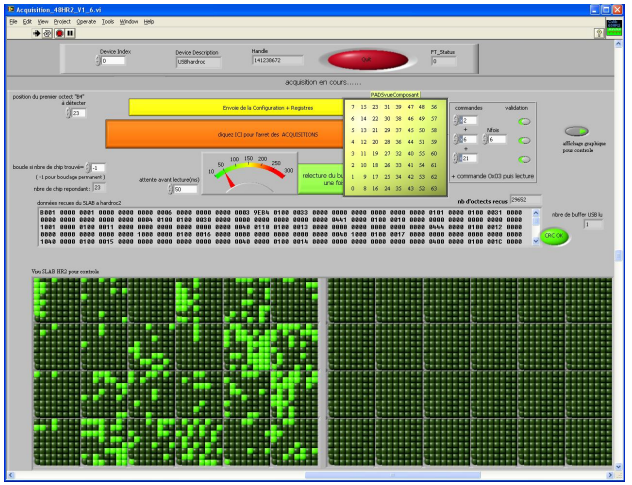
- Data acquisition:
  - 3 interDIF (HV) and DIF + 1 CCC
  - 1 computer (3 USB ports) running Labview




- Reconstruction and analysis
  - C++ framework with ROOT classes





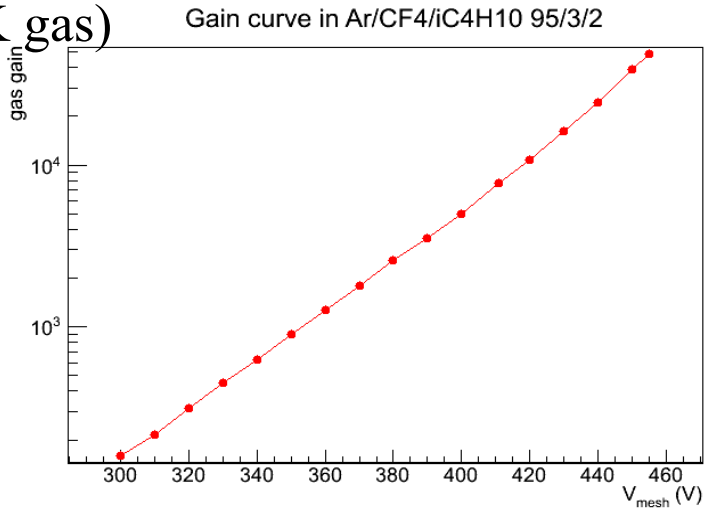


# Prototype settings

- New non-flammable mixture Ar/CF4/iC4H10 95/3/2 (T2K gas)
  - Gas gain up to 30000 → Vmesh < 450 V

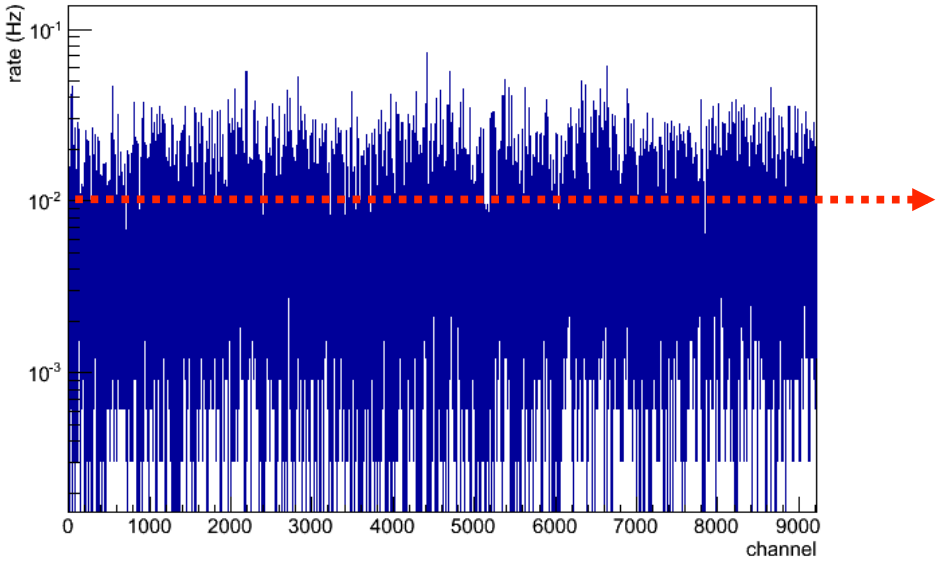
  Drift field of 300 V/cm (max. of drift velocity)

  → Vdrift = Vmesh + 90 V
  - Gas flow (as before): 1 volume per hour → 3 l/h




- Front-end ASIC features pedestals offset correction DAC

  Set thresholds and offsets so as to align noise hit rate over all 9216 channels




Target noise was 10 mHz/chanel in this case, can be lowered further by increasing the thresholds

# 2011 test beams

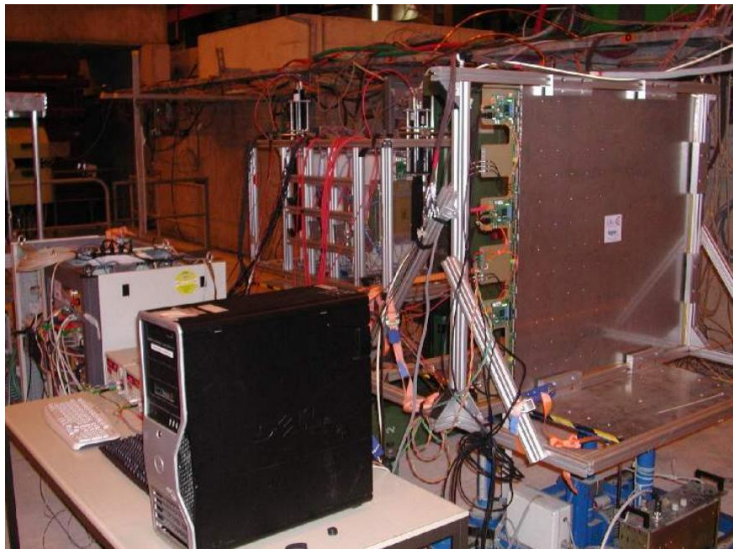
- 3/22 August, SPS/H4, Standalone CALICE (6 days) + multi-user RD51 (13)

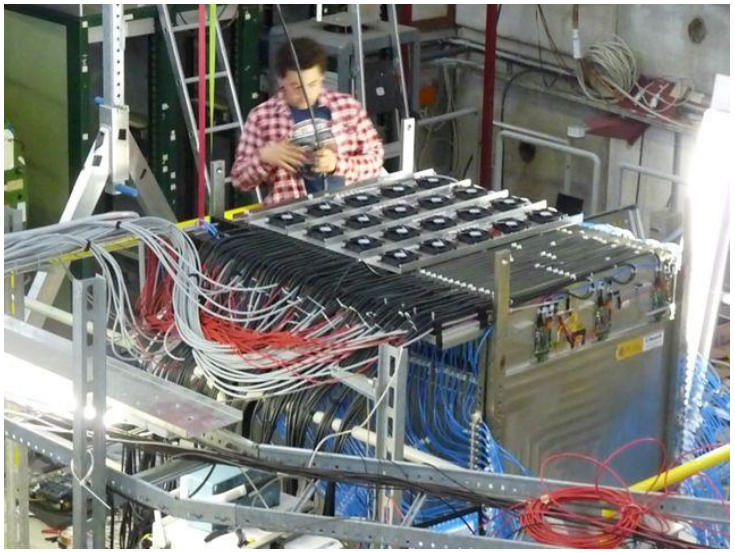
  ~ 6 millions of recorded triggers (150 GeV/c muons and pions in the ratio 85/15)

- 3/12 October, SPS/H8, Parasitic in steel $m^3$ structure with Lyon GRPC

  At the back of the calorimeter (position 47/50)

  ~ 1 millions of recorded hadron triggers
  at various beam energies from 60 to 180 GeV/c



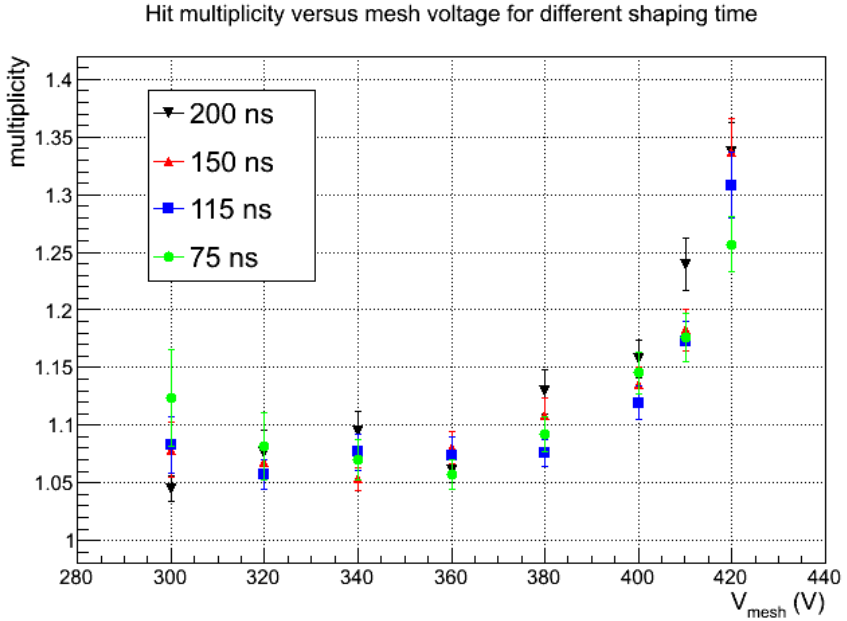


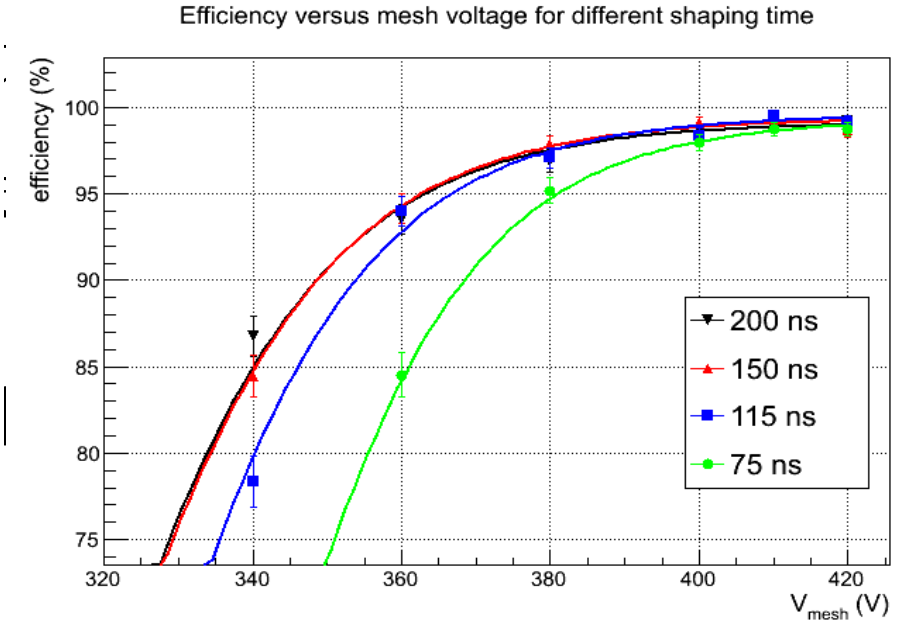
# Summer results – 150 GeV/c muons

- First chip threshold from 1 to 2 fC

  → Efficiency larger than 95 % for gas gain larger than 1000 only (365 V) !

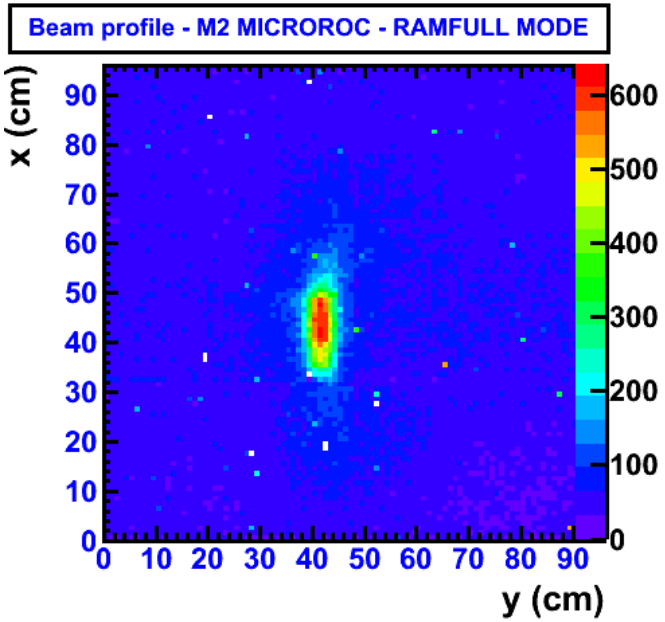
- Choose working voltage of 390 V, gas gain of ~3000

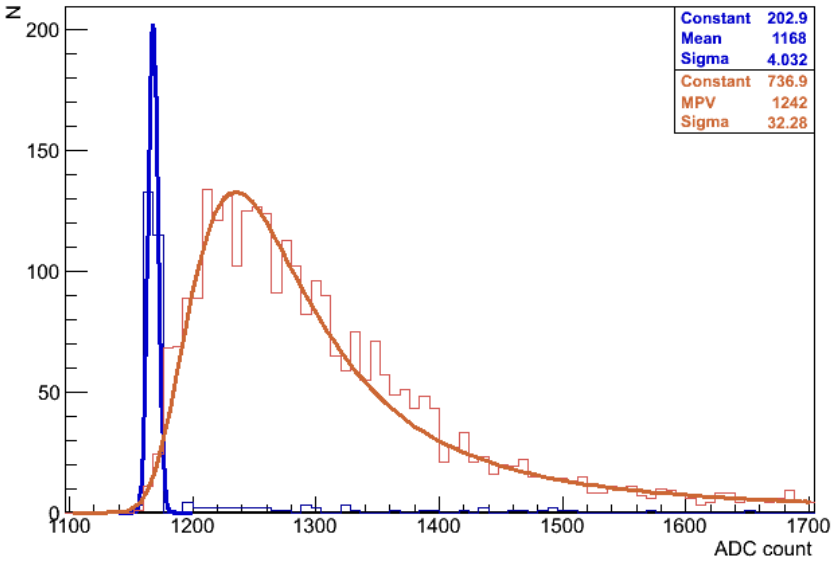


# Summer results – MICROROC ASIC

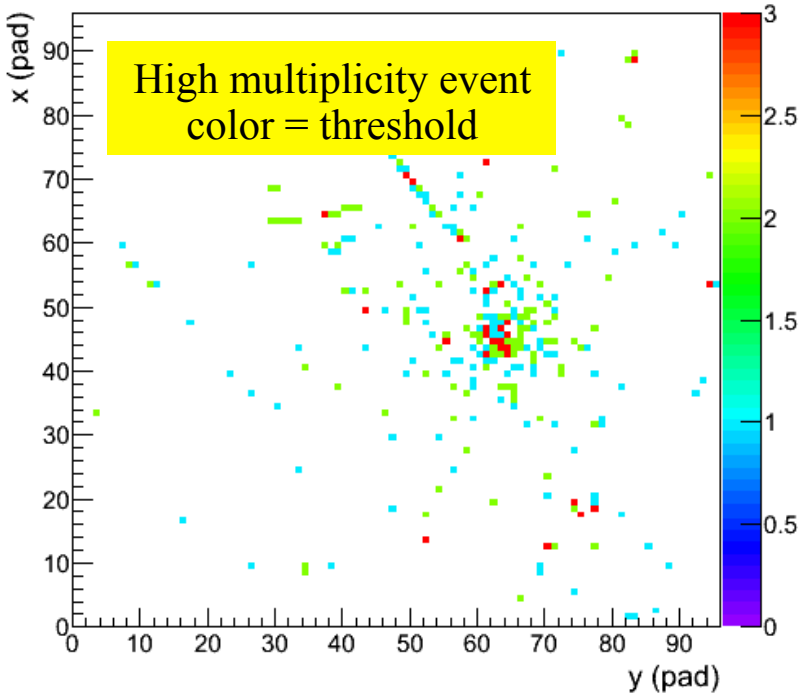
- Triggerless mode
  - Readout when at least one ASIC memory is full (128 events)
  - Possible thanks to a very quiet detector
- Analogue readout
  - Shaper signals converted on DIFs
  - Landau distribution on a few pads
  - Energy conversion still being worked out

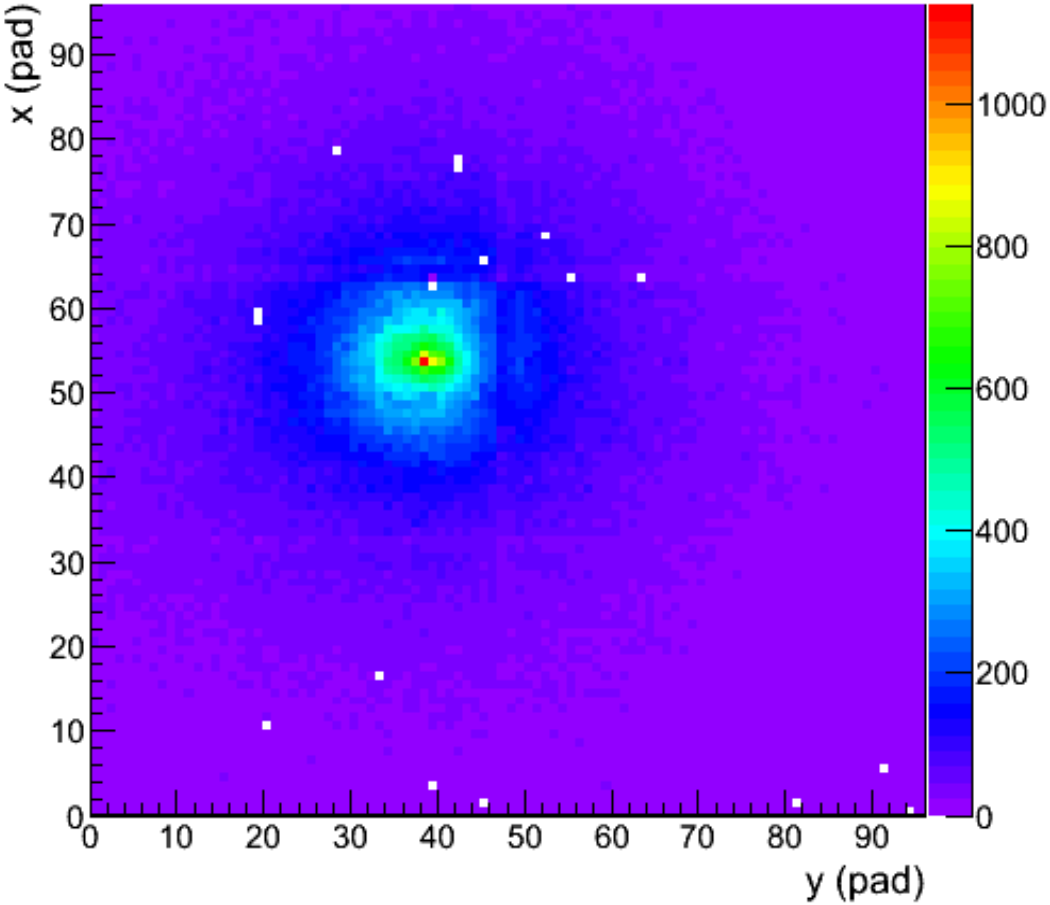


# Summer results – 150 GeV/c pions

- One interaction length of steel upstream (80 cm) of the prototype
  - Up to 300 hits in the chamber!
  - Nice symmetry
  - 3 thresholds work
  - Dead areas seen

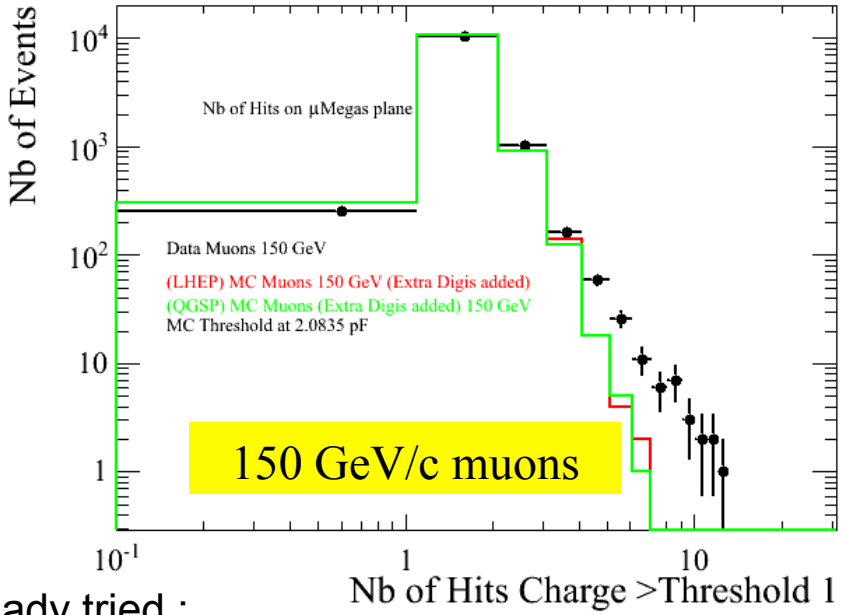


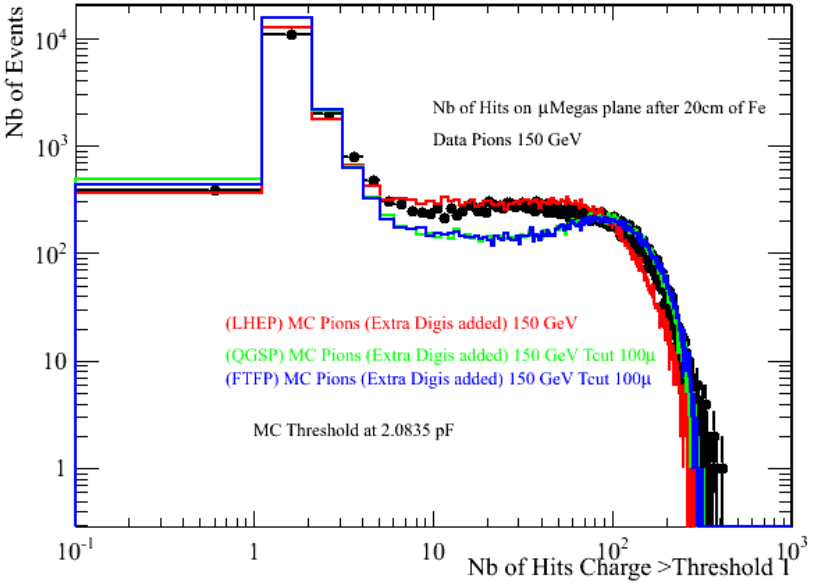



# Summer results – Monte Carlo

- Hit distributions:
  → Start Monte Carlo comparison
- Detector digitisation:
  - Energy / $cm^2$ from Geant4
  - Apply gas gain fluctuations and thresholds
    + simple diffusion model for multiplicity

On-going work,
very preliminary results!



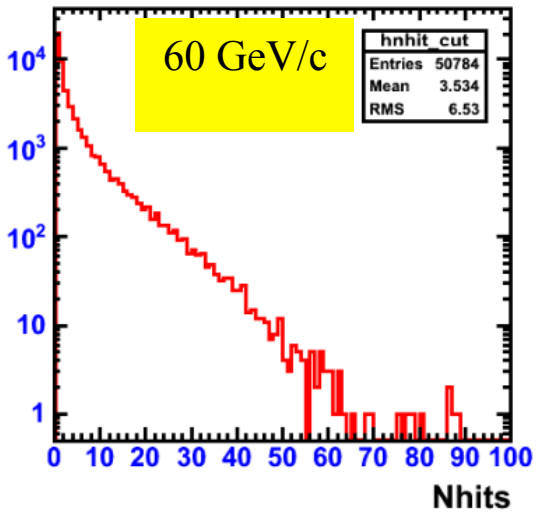

Already tried :
for muons : different pion contamination ratio
different Tcut (from 10um to 10km!)

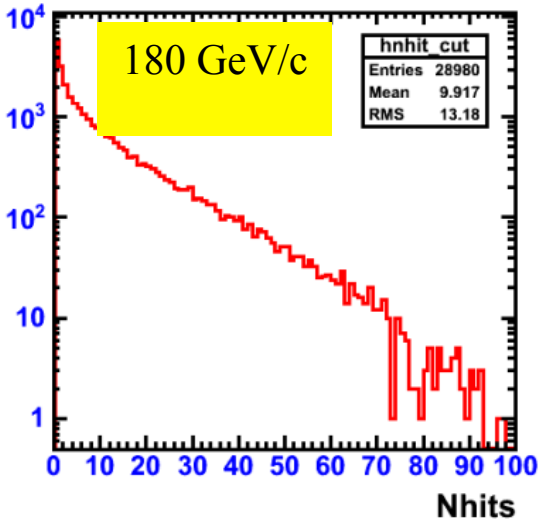
# Fall results – inside $m^3$ steel structure

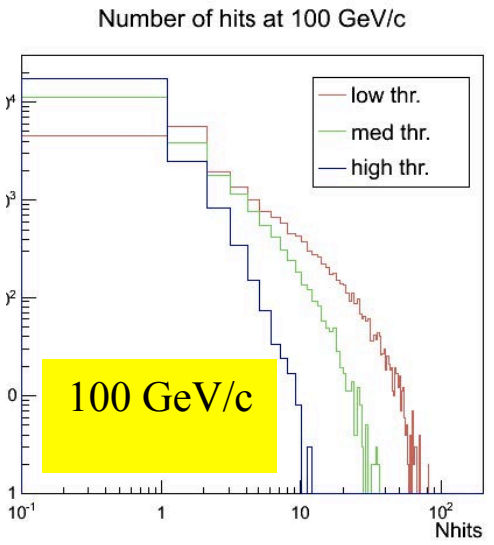
- Initial goal: measure showers in 3D with GRPCs

  → use of common CALICE DAQ
- But: DAQ too unstable at that time
  → standalone LAPP USB-DAQ (1 million triggers collected)
- Various energy points, data/simulation comparison soon

Pions after ~ 5 $\lambda_{int}$ of Fe (layer 47 in HCAL)




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

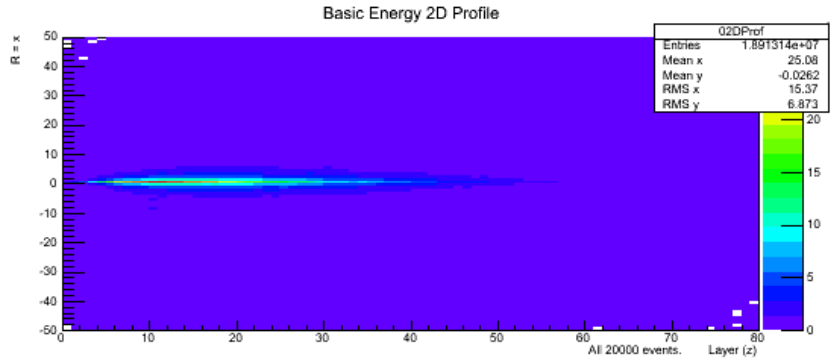
# Simulation studies for 2012 TB
# D. Girard

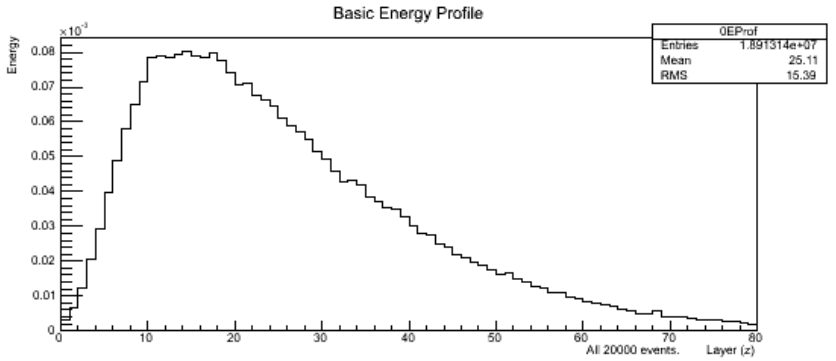
- Typical longitudinal profile:
  z = layer number inside structure
- Longitudinal profile asking shower start in the first structure layer:
  z = layer number inside structure
- Longitudinal profile with one single layer :
  z = number of layers from shower start to studied layer.
  (in test beam, shower start reconstructed with IPNL GRPCs)

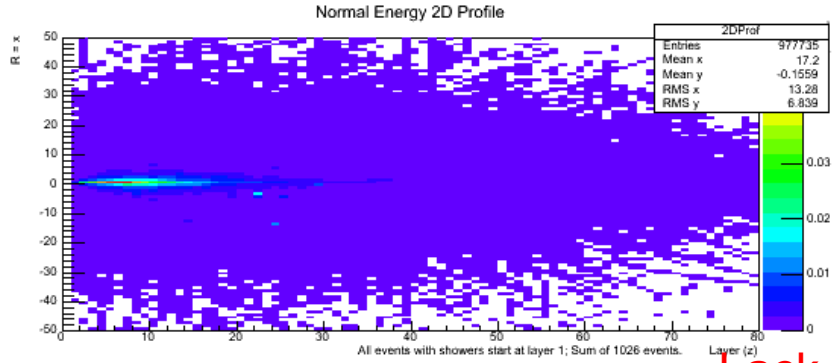
# Simulation studies for 2012 TB

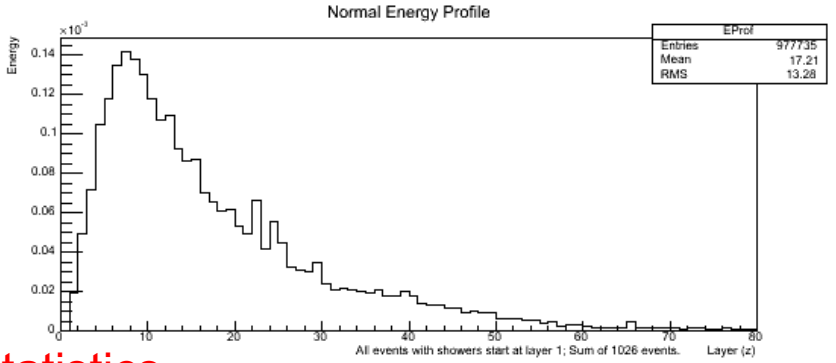
20 kevts

100 Gev/c Pions after ~ 5 $\lambda_{int}$ of Fe : studied layer is at position 47 in HCAL

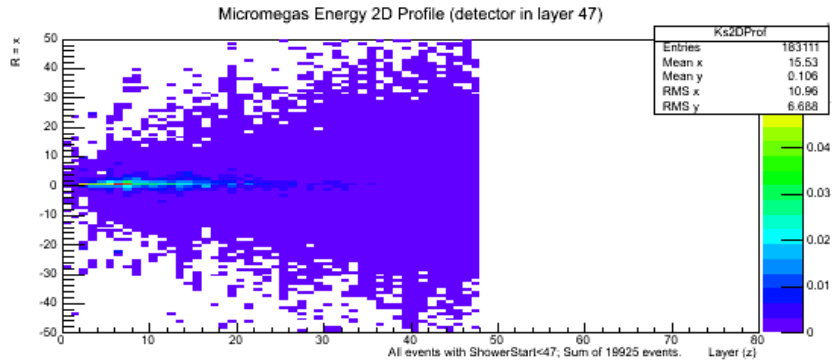


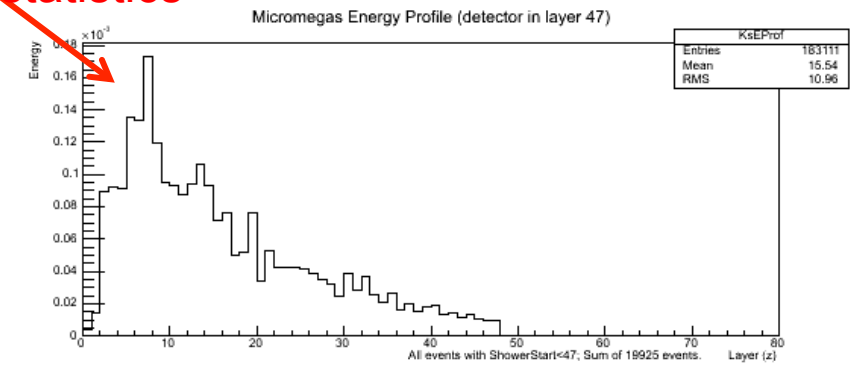




Lack of statistics

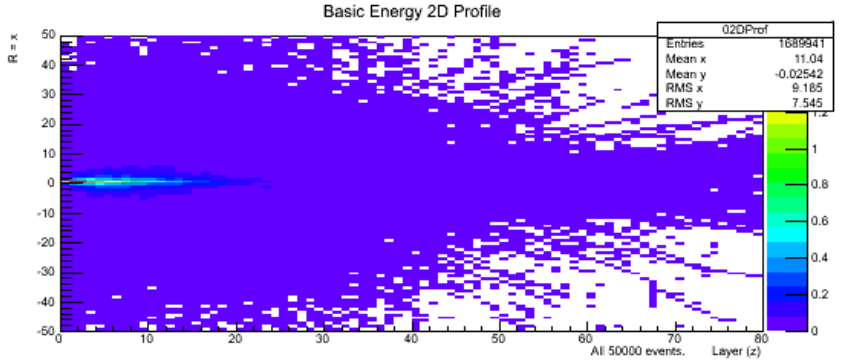


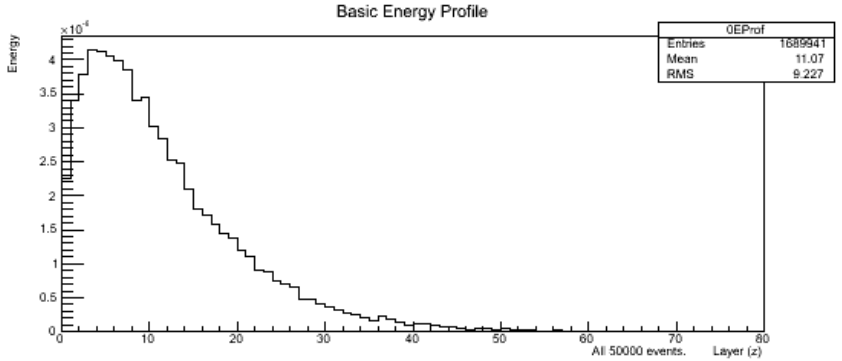



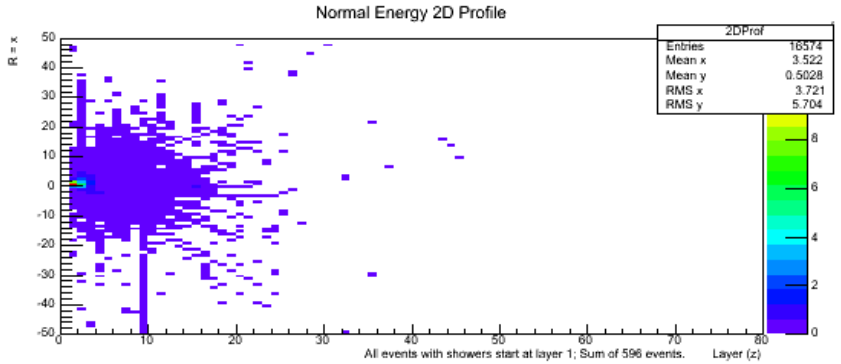
# Simulation studies for 2012 TB

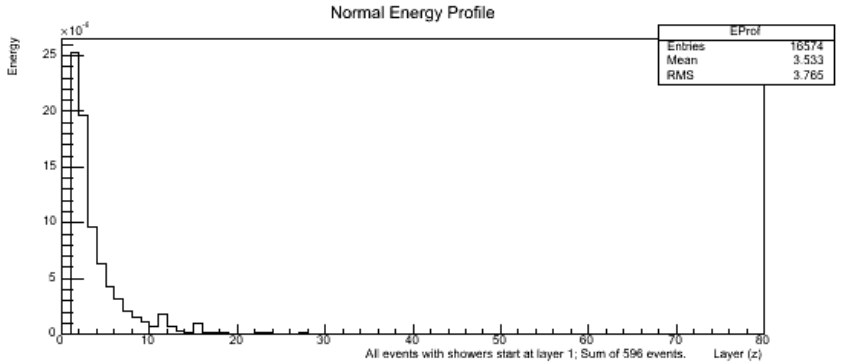
50 kevts

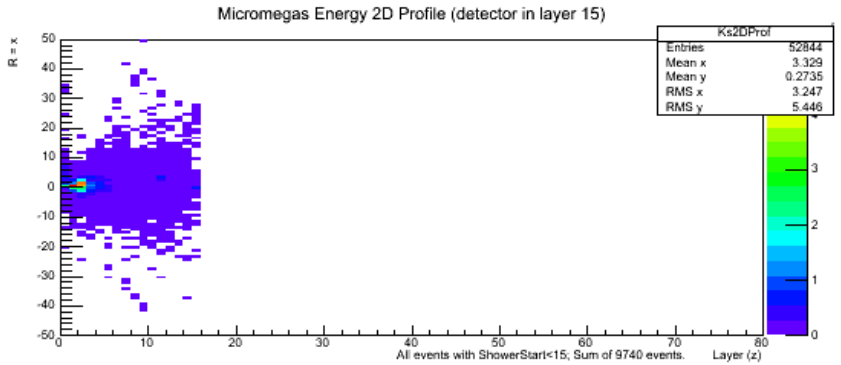
3 Gev/c Pions after ~ 5 $\lambda_{int}$ of Fe : studied layer is at position 15 in HCAL

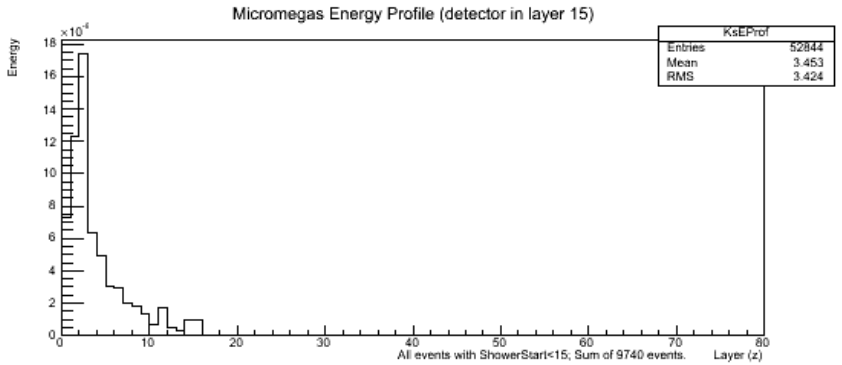


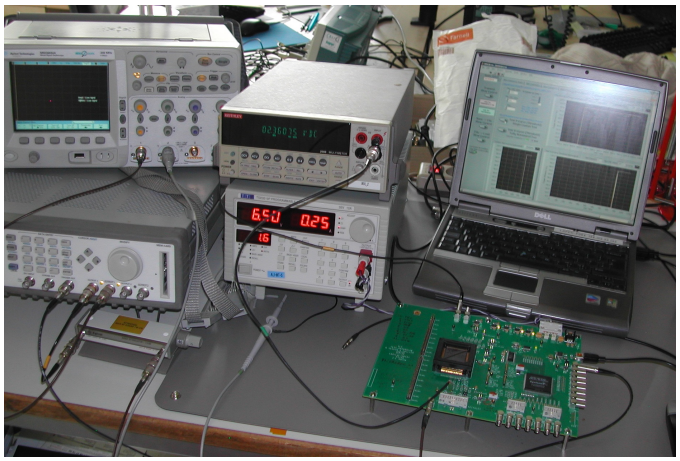



# Simulation studies for 2012 TB

- On-going analysis
- We can already deduced that
  - More than 100 kevts is needed per energy
  - Distribute the 4 Micromegas layers equally within GRPC structure.

# Status and future TB

- Today, at LAPP
  - 2 $m^2$ prototypes fabricated in 2011
  - 794 MICROROC chips received, being tested
    → 2 new prototypes to be built in 2012
  - resistive ASU under design



- 2012 test beams
  - Standalone RD51
    - understand analogue readout, power-pulsing …
    - study uniformity and resistance to sparks of standard and resistive prototypes
  - CALICE tests inside CIEMAT SDHCAL Fe structure with IPNL GRPCs
    - 2 Micromegas planes in April and May (parasitic)
    - 4 planes in November (parasitic + master)

    → Measure hadronic showers in great details thanks to common intermediate CALICE DAQ

# Conclusions

- Measured performance of large area Micromegas chambers suitable for a LC DHCAL
  Mechanics (Bulk + embedded FE) and electronics (MICROROC) validated

- 2011 TB analysis still on-going
  - Use all statistics, run quality selection…
  - Monte Carlo comparison (validate digitisation, physics list…)

- Looking forward to 2012 test beams
  - Intermediate CALICE DAQ (LAPP is heavily involved)
    → common reconstruction of Micromegas and GRPC data
    (see Guillaume Vouters talk)
  - Hopefully a lot of data to keep us busy during LHC shutdown!

# Acknowledgements


- LAPP
- CERN, TS/DM
- LAL/Omega
- IPNL
- CIEMAT