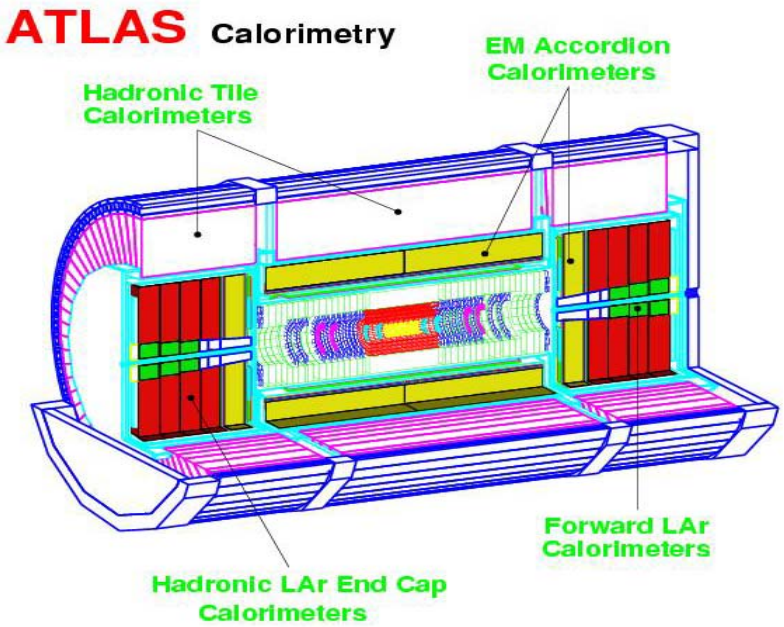

LHC
ATLAS
For 200?
CMS

# The ATLAS liquid argon detectors

Pascal Perrodo, LAPP-IN2P3 Annecy,
for the ATLAS LAR and L1 trigger Collaborations

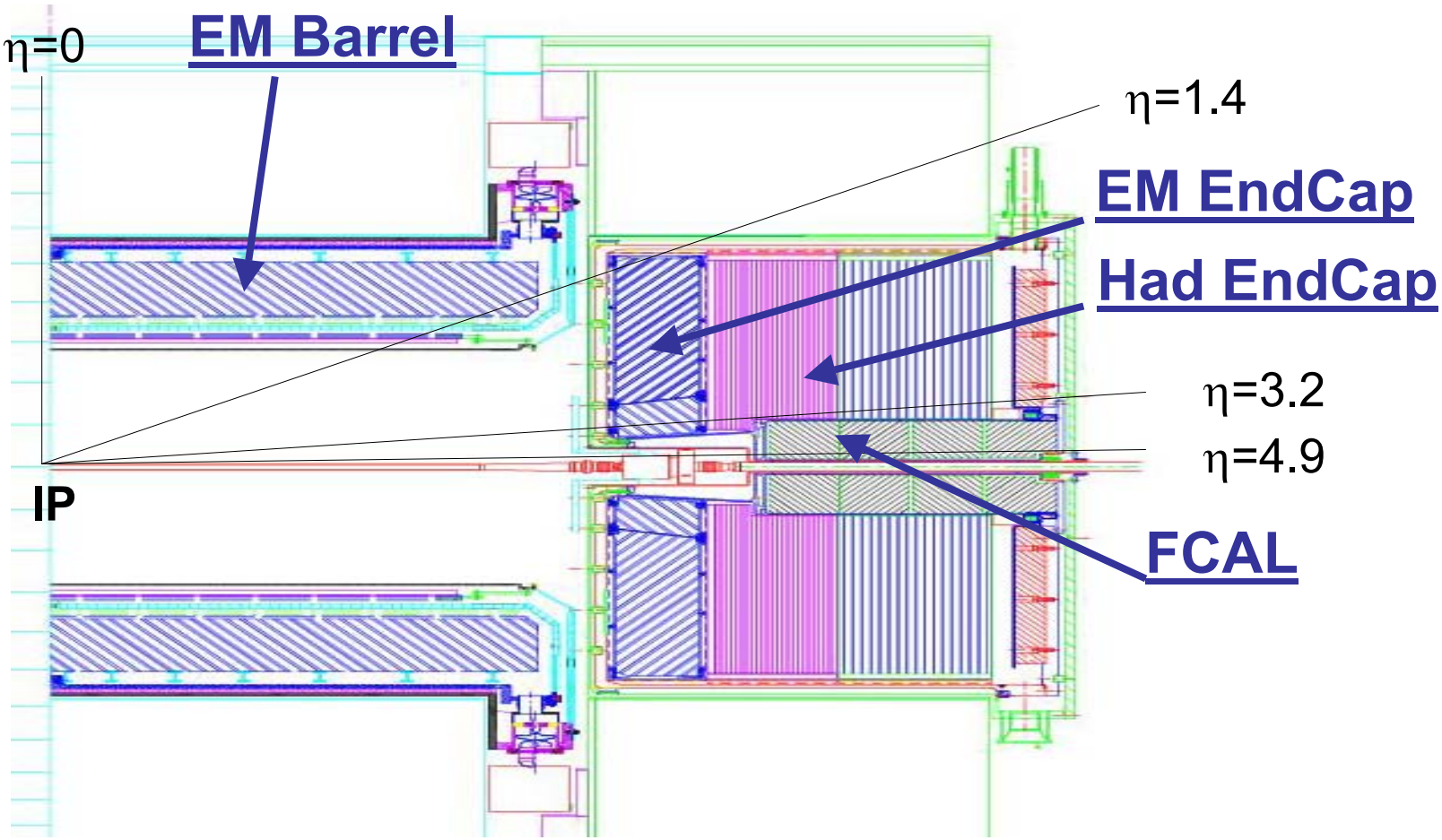



- Status and recent results of the liquid argon detectors :
  - Electromagnetic calorimeters
  - Hadronic endcap calorimeter
  - Forward calorimeters
- Developments on the e.m./isolated hadron L1 trigger

# The ATLAS liquid argon system

**Countries :**

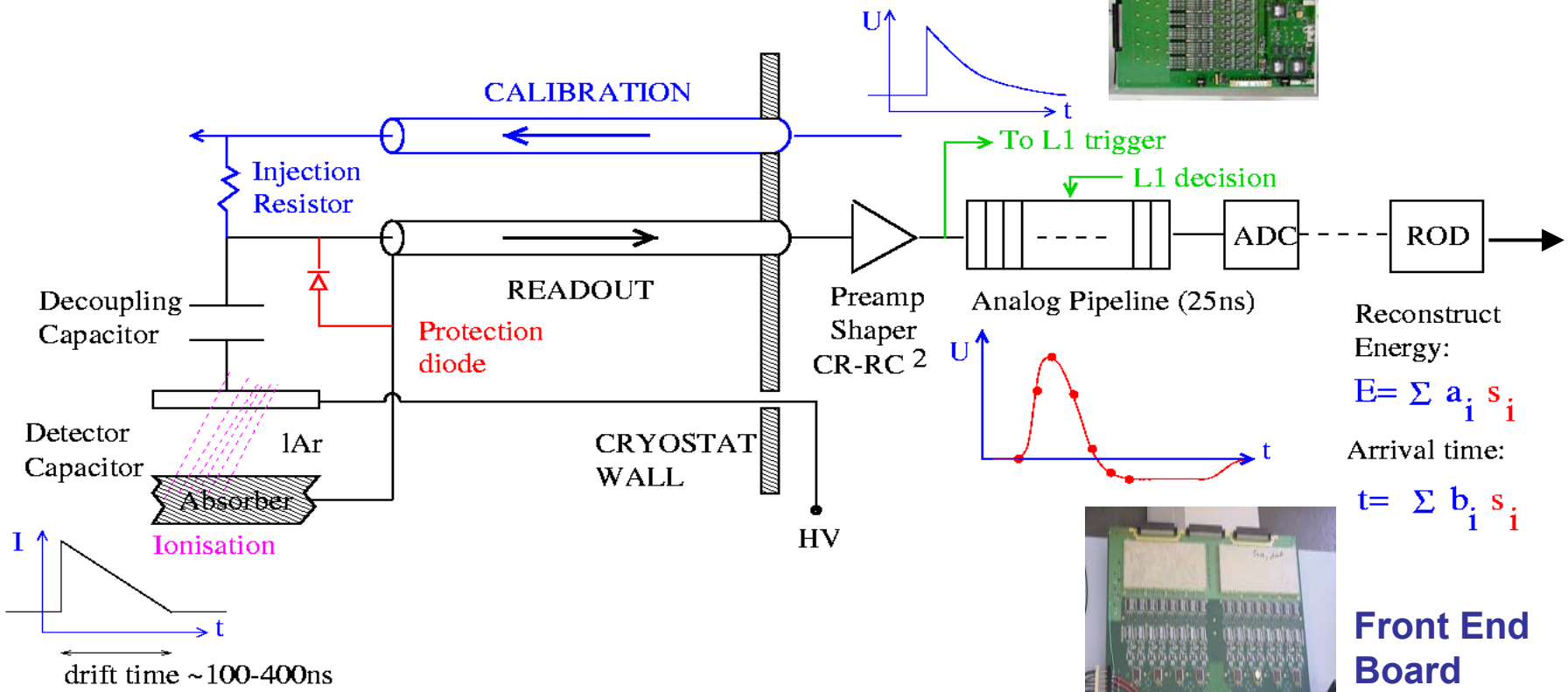
Canada
CERN
France
Germany
Italy
Morocco
Russia
Slovakia
Spain
Switzerland
USA



# LHC liquid argon calorimetry

- **Beam Crossing 25 ns, drift time 400 ns**
- **Minimum bias events, noise**

**Calibration Board**

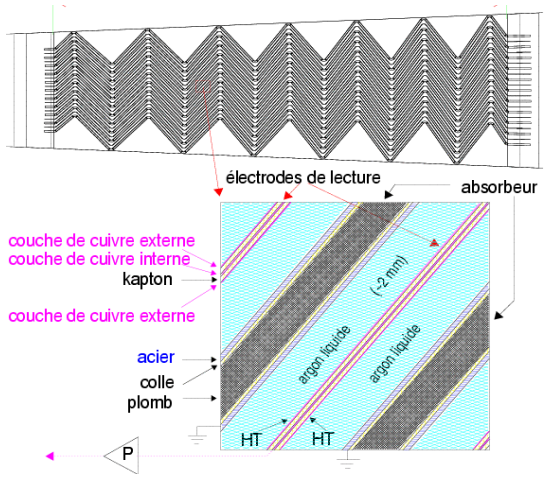




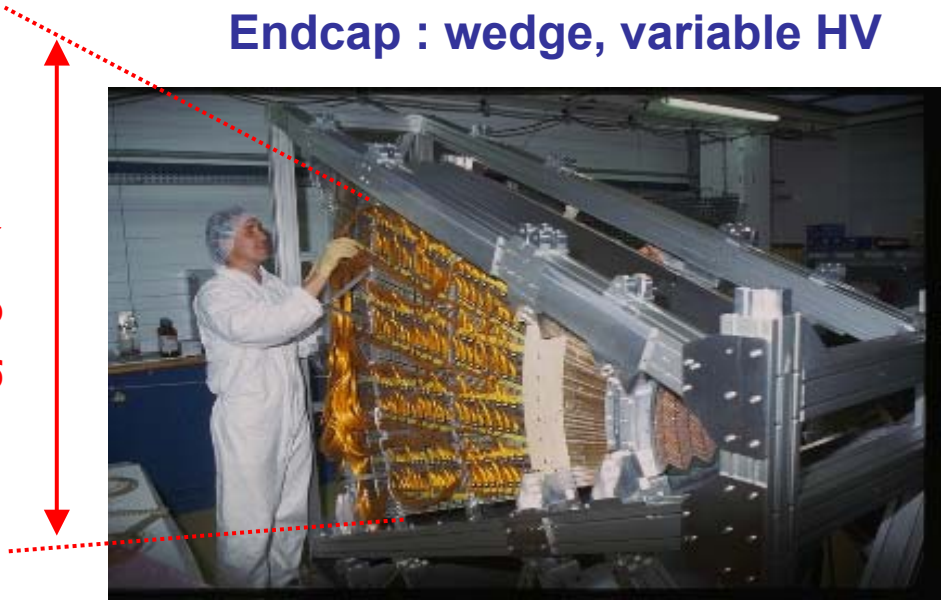

**Front End Board**

# The electromagnetic calorimeter

**Accordion geometry** : hermicity in φ, fast response, radiation hard, uniformity

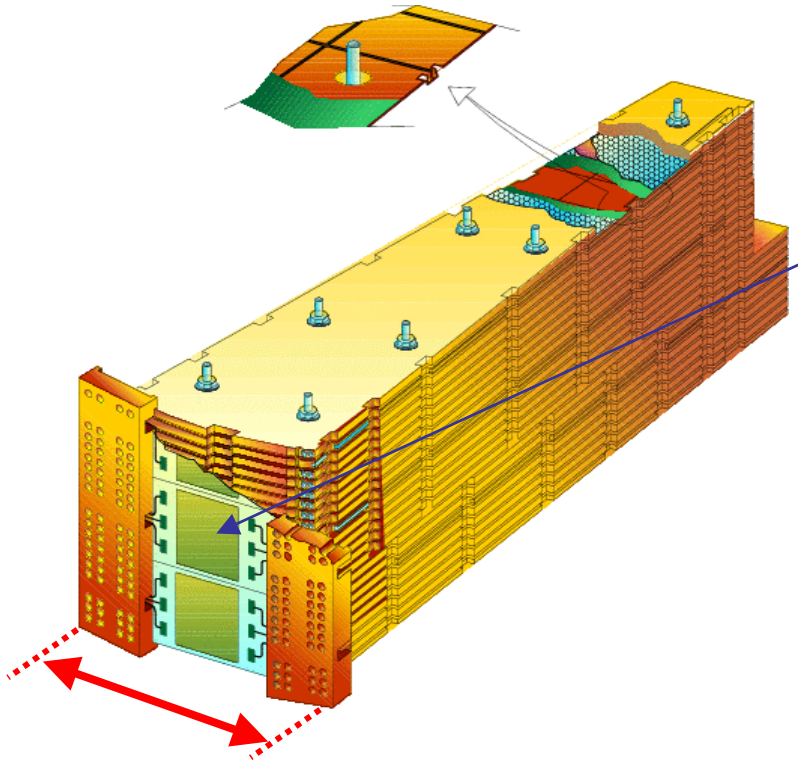




**Endcap : wedge, variable HV**



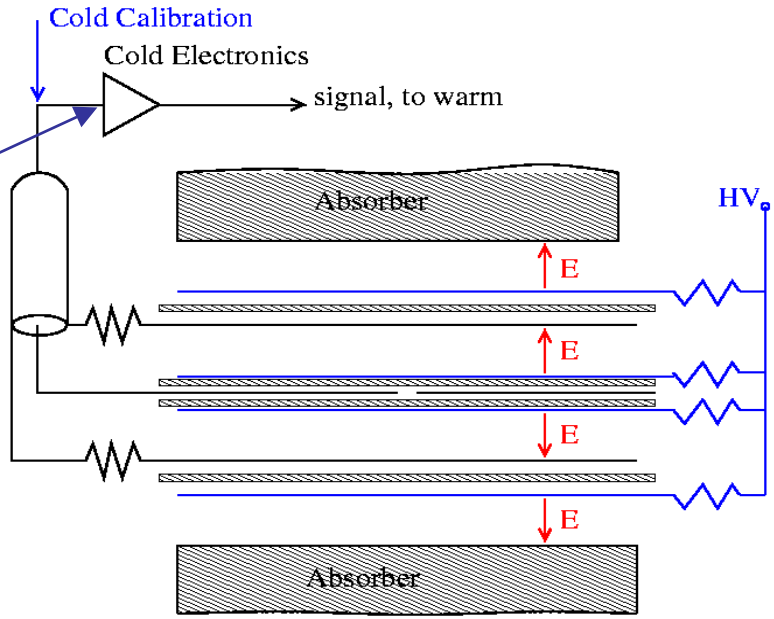
# The hadronic endcap calorimeter

**Schematics of a module:**



$\Delta\varphi = 2\pi/32$

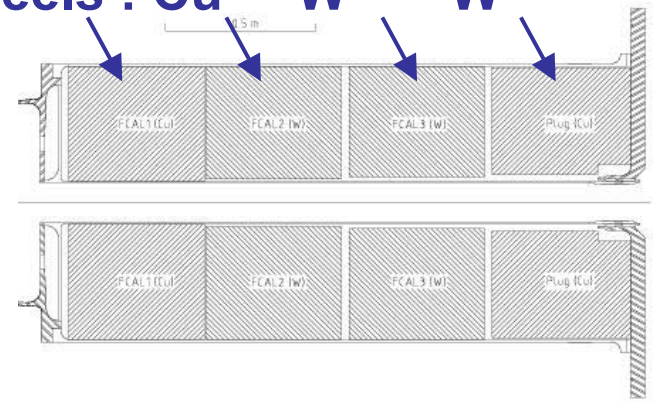
**Readout (ElectroStatic Transformer):**



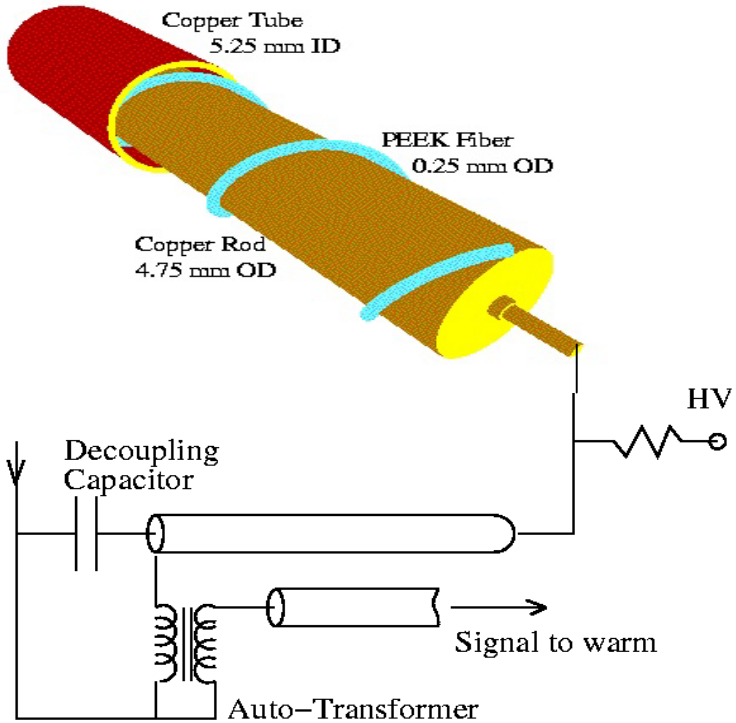

**Radiation hardness, Jet reconstruction,**
**50%/√E, $E_T$ and missing $E_T$ measurements**

# The forward calorimeter

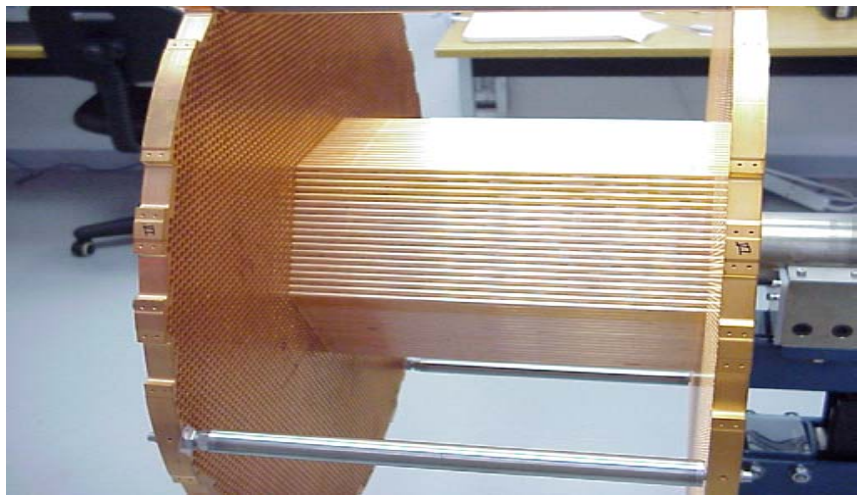
**Three successive wheels : Cu W W**
**Plug**




**High rate and ionisation,**
**Drift time ≈50 ns**
**Readout principle:**




**Assembly of a tungsten wheel:**

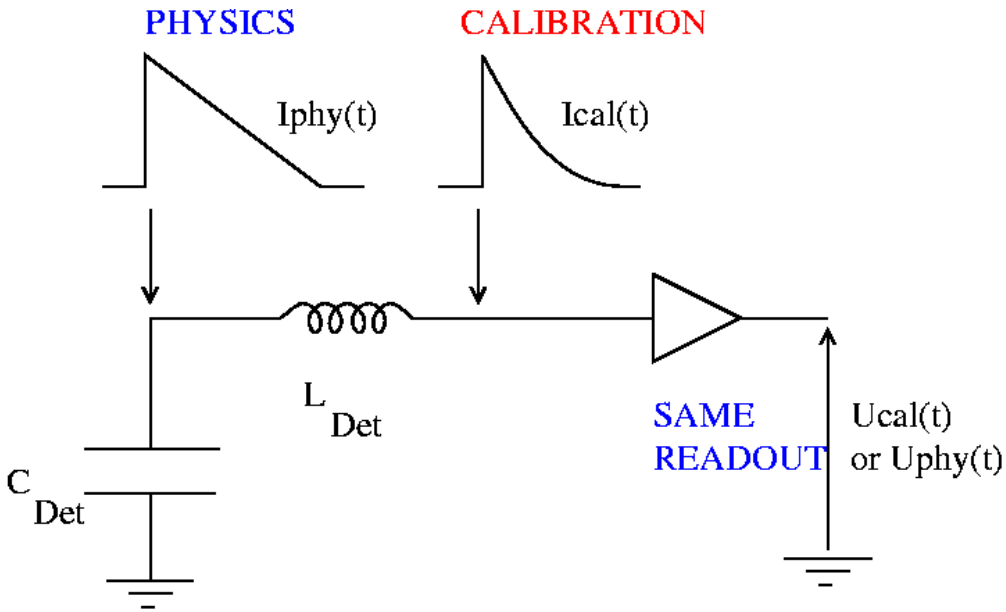


# Signal and energy reconstruction

**Uniformity at 0.7 %**

**Energy $E = \Sigma a_i s_i$ , $a_i$ in GeV/ADC**

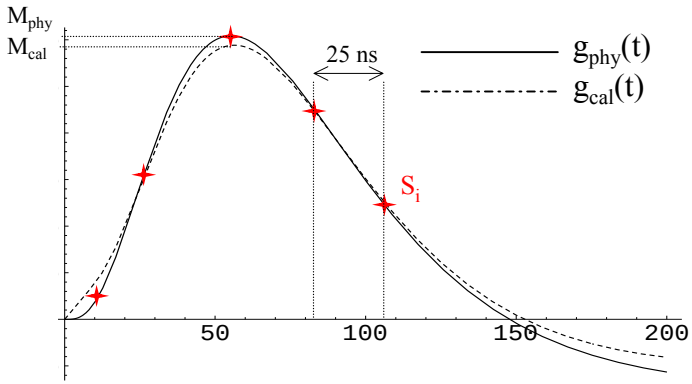
**Simple electrical model :**



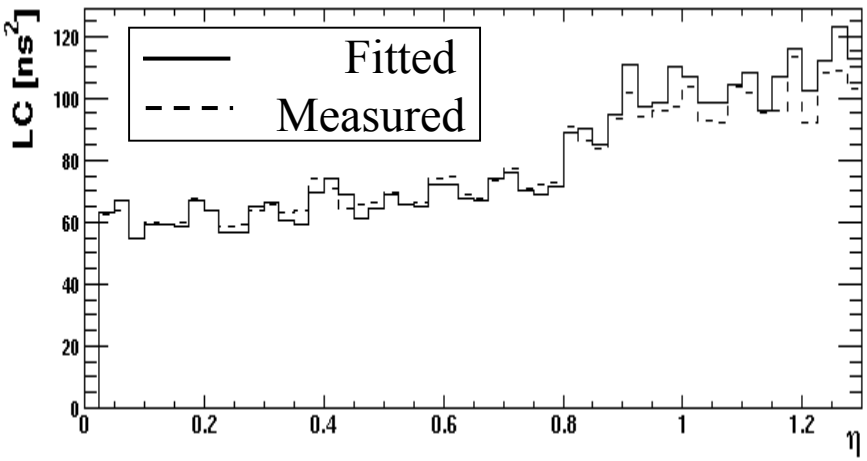

**Validite the modelisation**

**Provide an absolute electronic calibration**

**Shape in Calibration and Physics :**



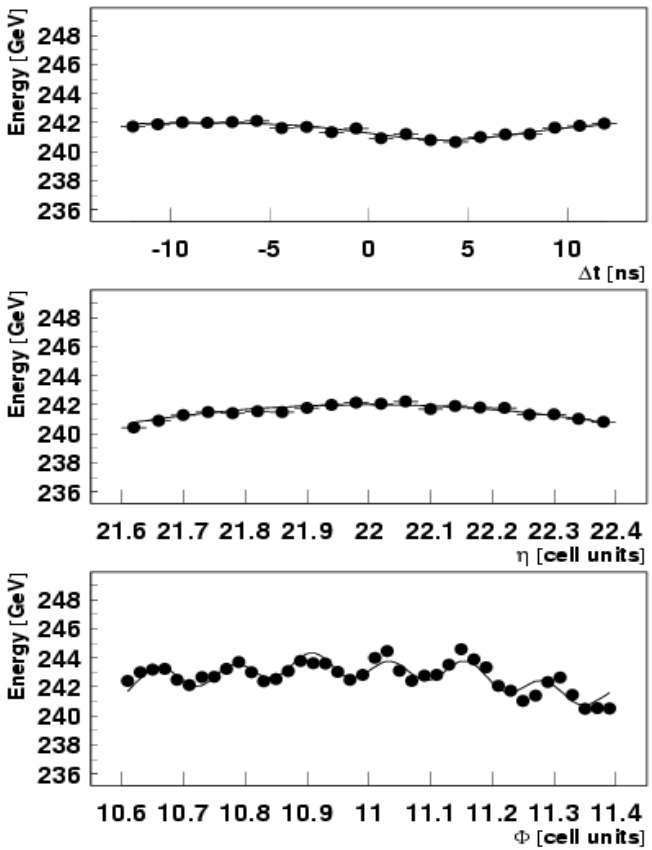

**Validity of the modelisation :**

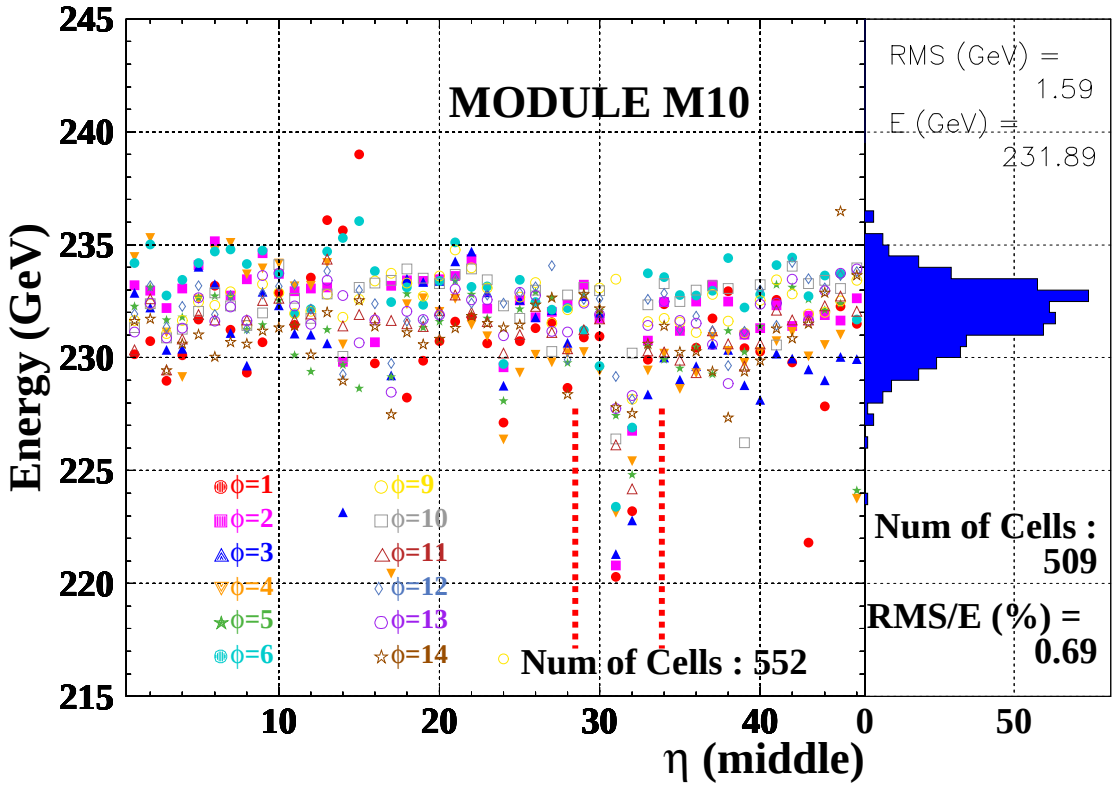


# EM barrel uniformity

**4/32 EMB, 3/16 EMEC tested.**

**Corrections :**

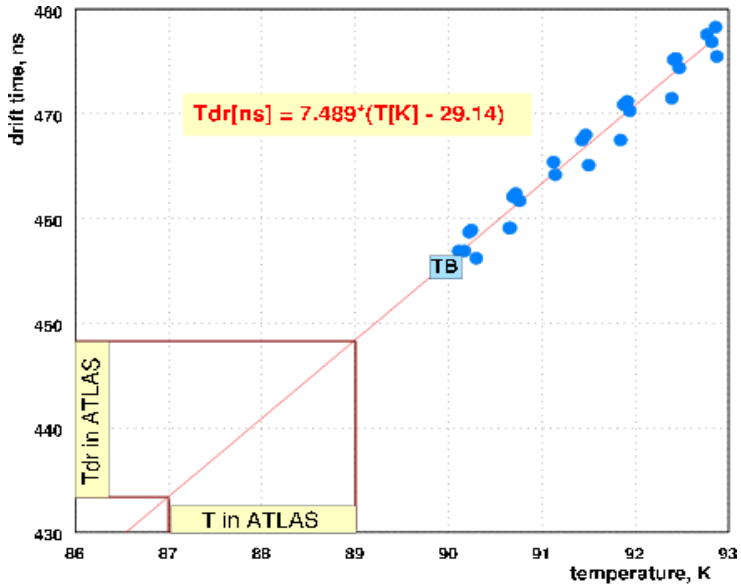


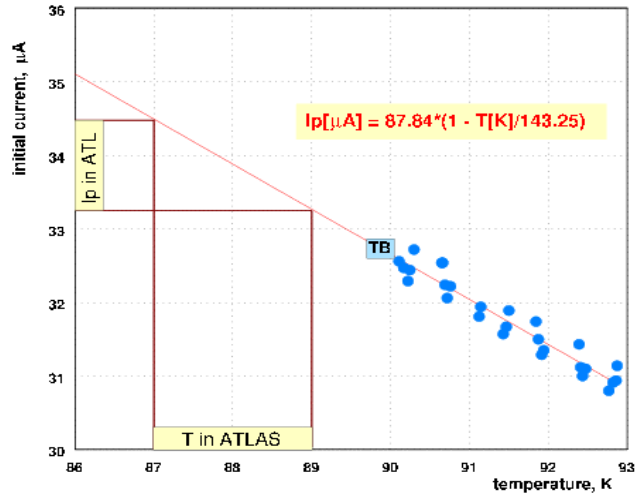

**Expected : 0.7% over the EM detector**

# Drift time and temperature effect

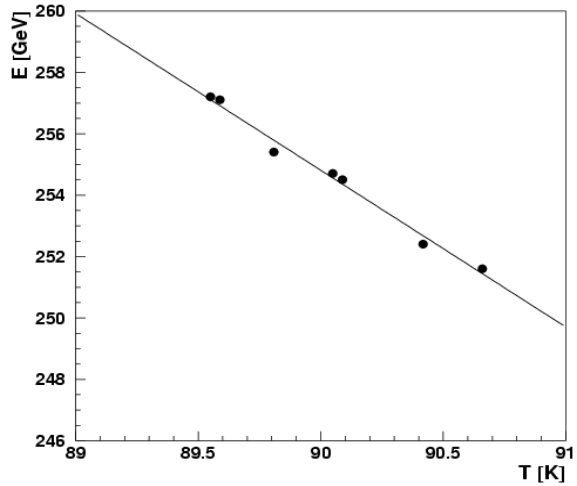
**Drift time measured from the physics shape in the HEC :**




**HEC : I= f(T)**




**EM barrel: E= f(T)**

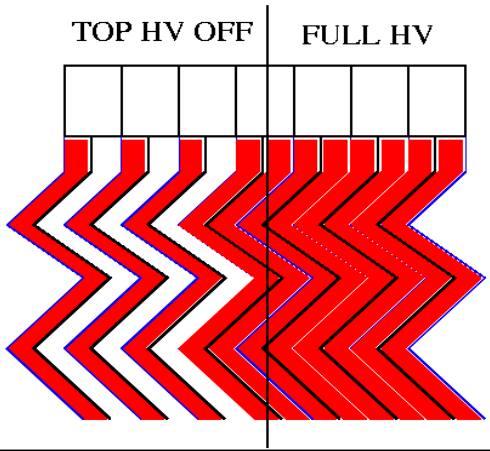



**In agreement with expectation :**
**2% / K on the energy**

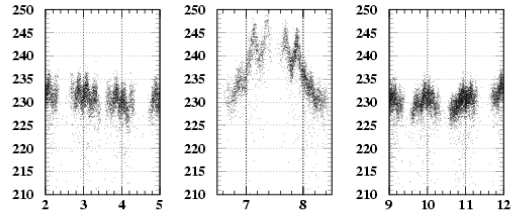
# HV corrections in EM modules

**If one HV line is missing, E = E x 2 in a sector**

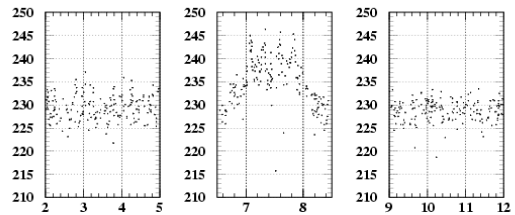
**At the transition, the effect is understood and reproducible by MC**

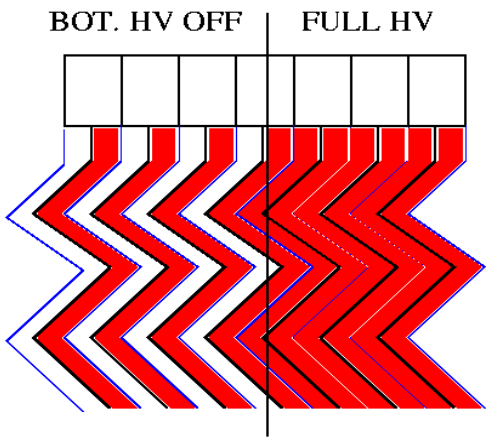



DATA

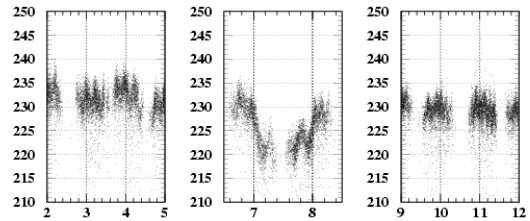


MC

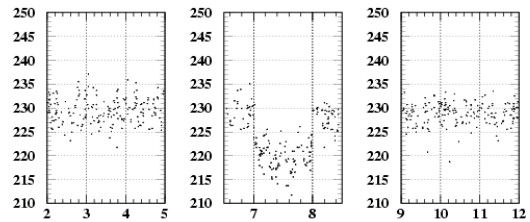




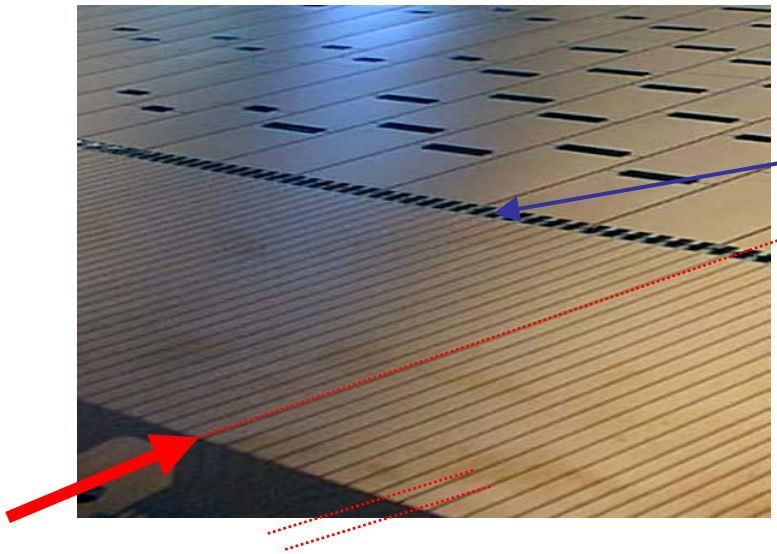

DATA



MC

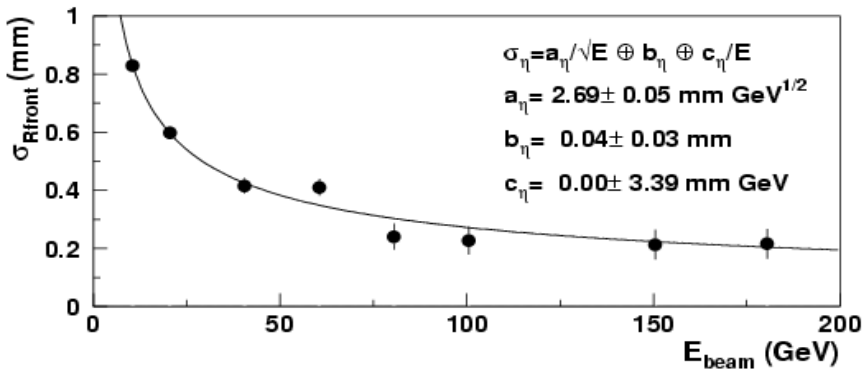


# EM endcap position resolution

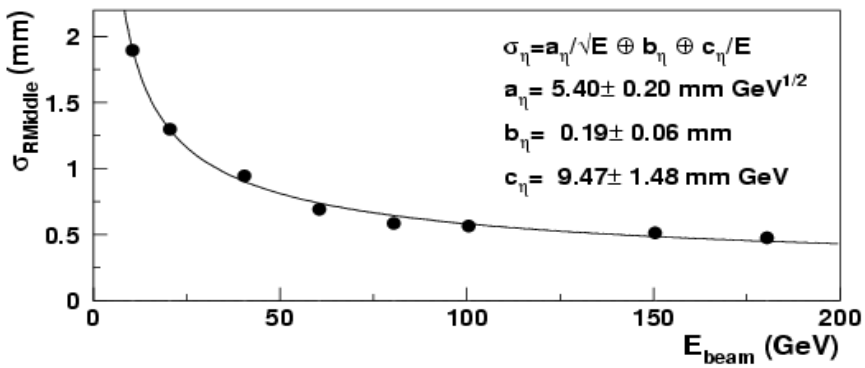


**Endcap electrode :**
**Strips in front layer**

$\Delta\eta$(strips)=0.025/6



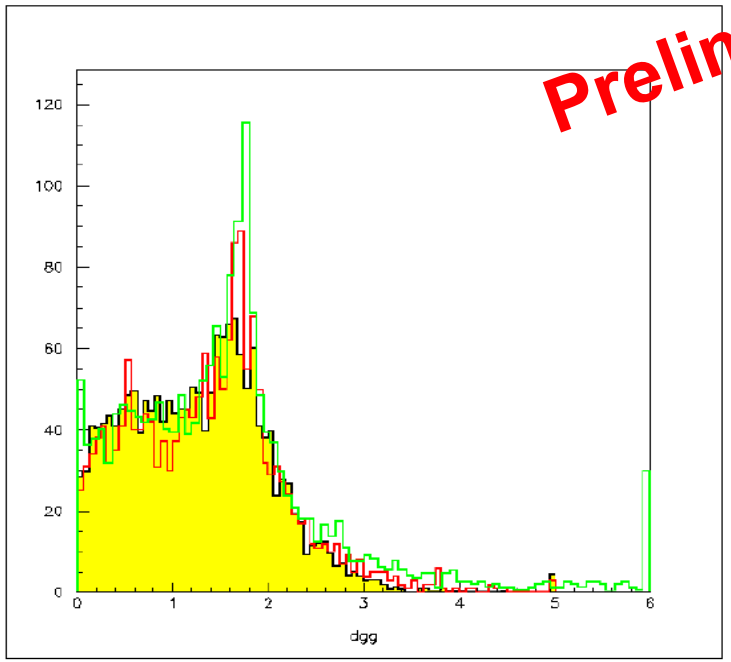

**S-shape correction,**
**Beam chambers resolution 0.35mm**
**->angular resolution 50 mrad/√E**



# $\gamma$ / $\pi^{\circ}$ separation

$\gamma$ beam, kinematical association of $2\gamma$

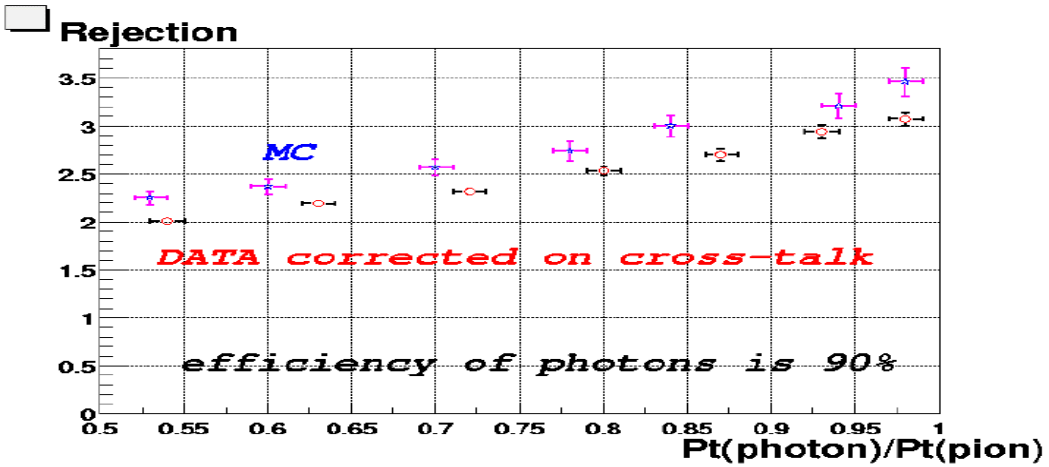
Distance($\gamma 1$, $\gamma 2$):




DATA, MC, Kin. study

For H->$\gamma\gamma$

90% photon's efficiency
<R>(Expected)=3.0

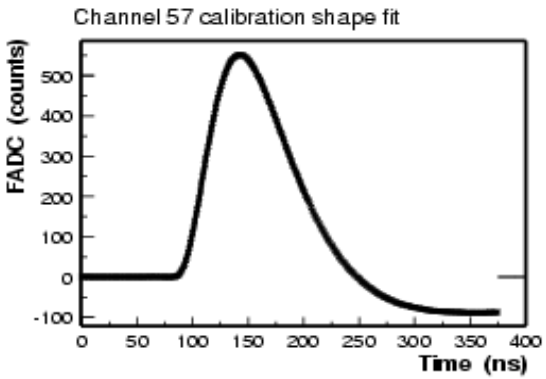


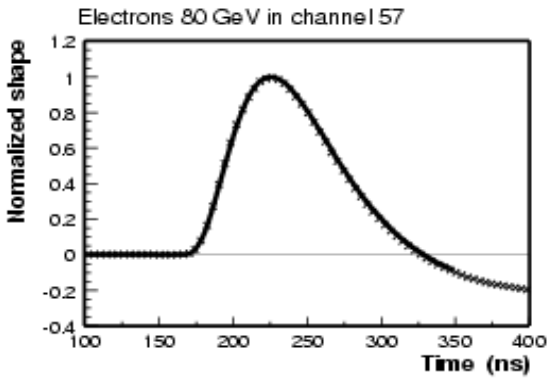

<R>(DATA)=2.60±0.05
<R>(MC)=2.82± 0.1
Looks promising

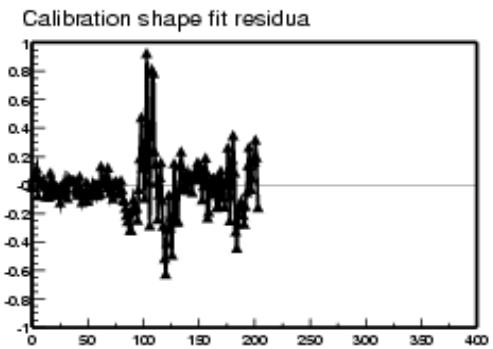
# HEC results

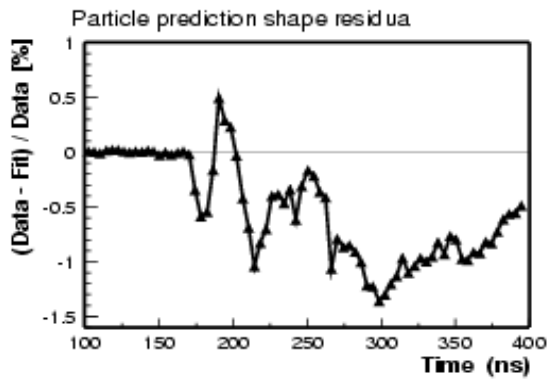
- 24/134 modules to Test Beam
- Linearity and resolution for e and π

## Signal reconstruction:

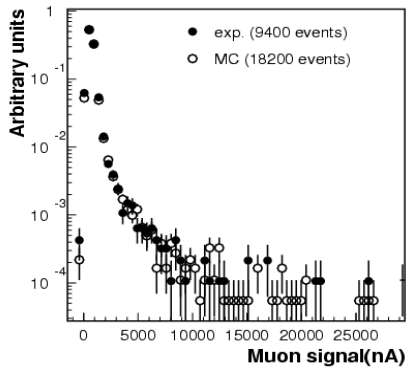


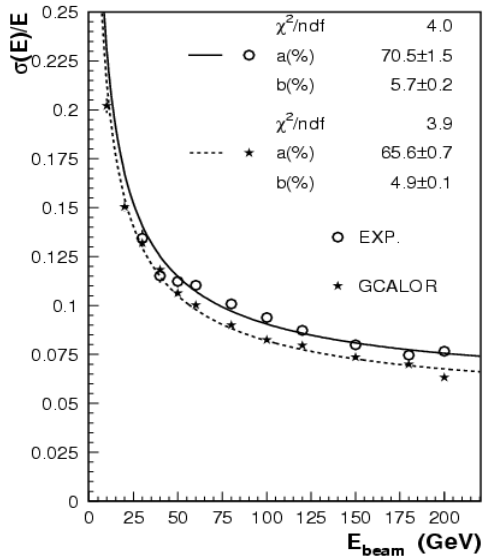

## Muons :




## Electron resol. =21.5%/√E

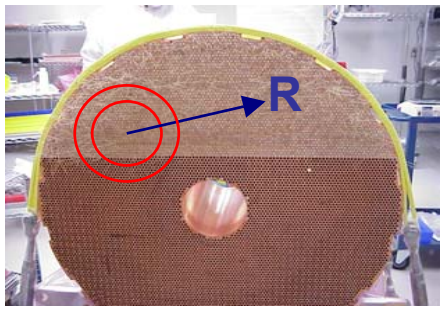
## Ratio e/h ≈ 1.5

## Pion resol. :



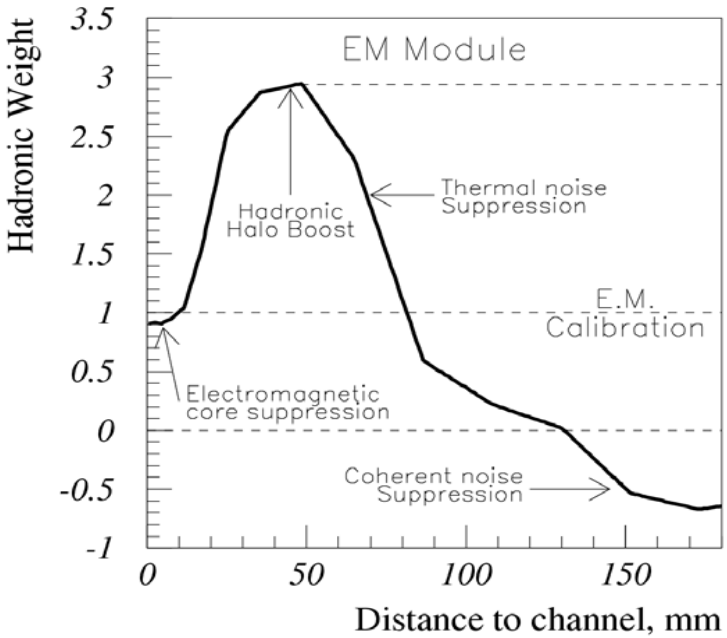
# FCAL results

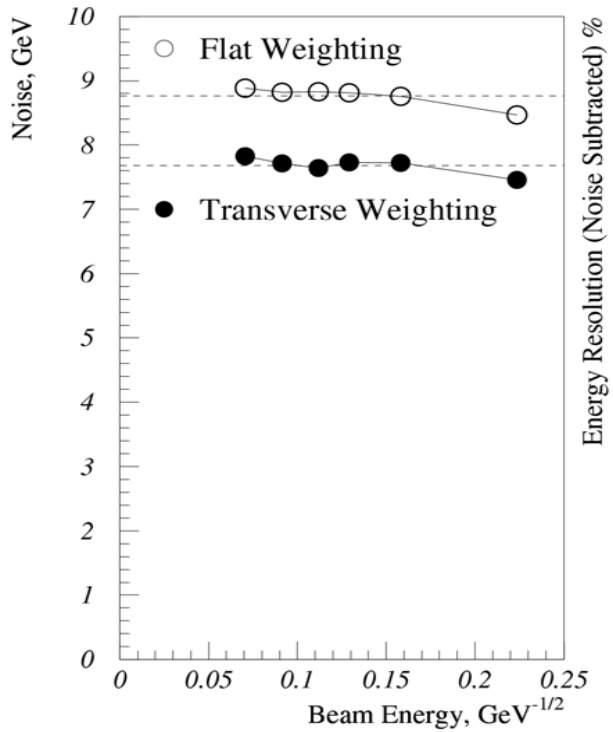
- **Radial weighting**
- **Narrow jets in FCAL**

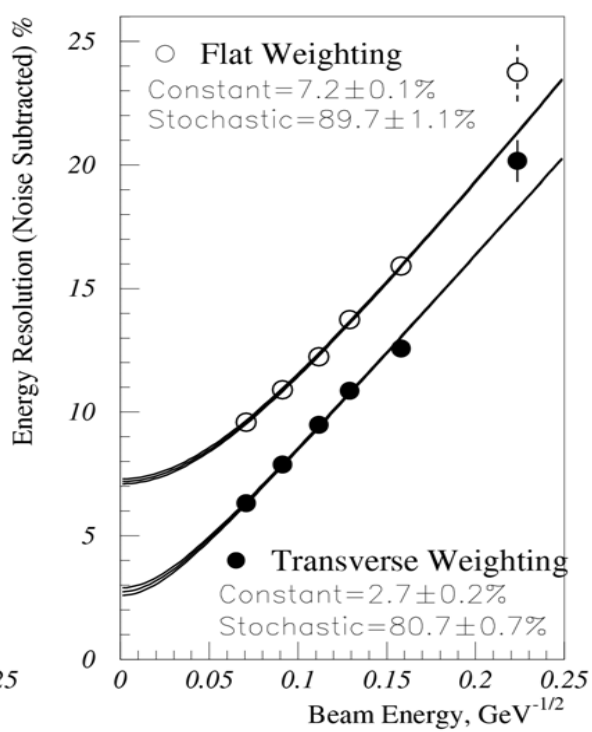



**Energy resolution**

**Expected 100%/E1/2 + 10 %**



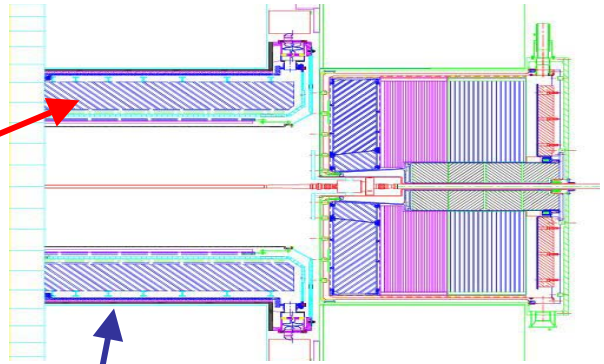



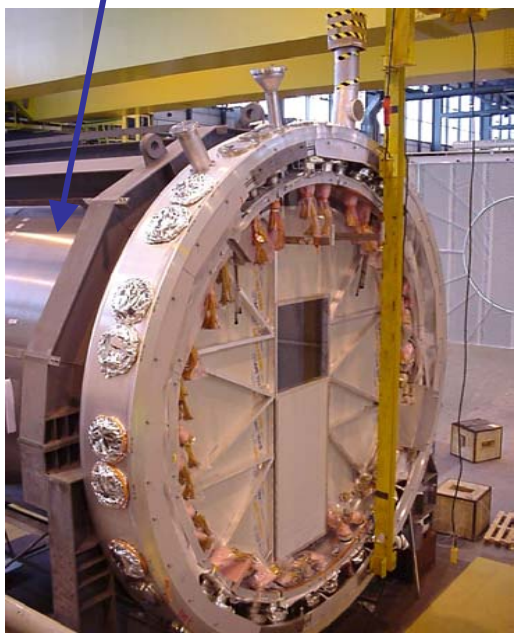
# EM barrel wheel assembly

## 3/4 of the 1st wheel already assembled

Accordion

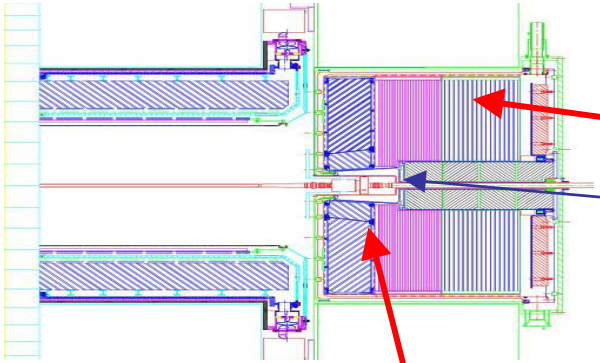
Structure



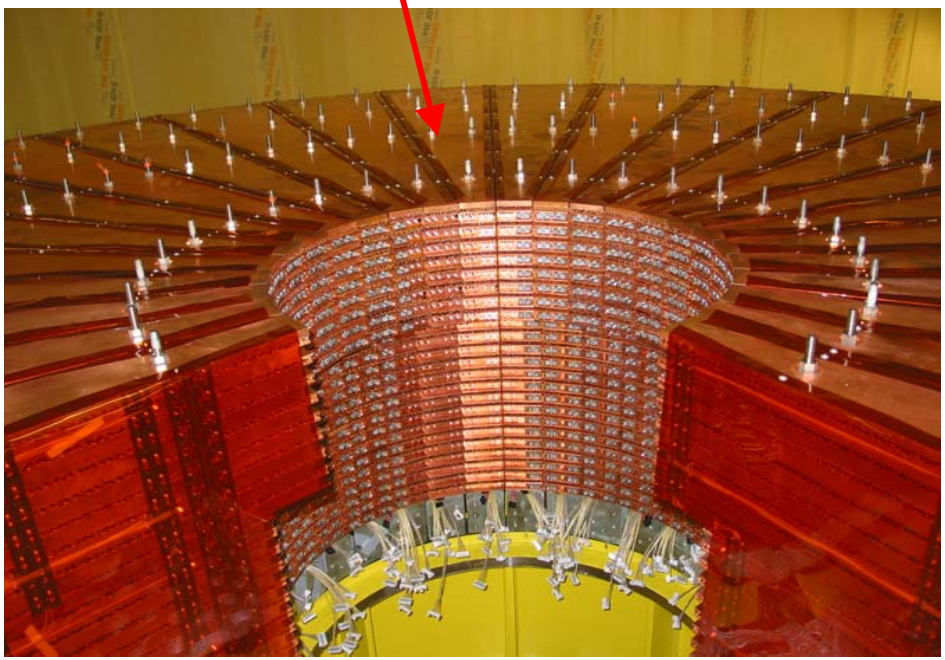


barrel cryostat

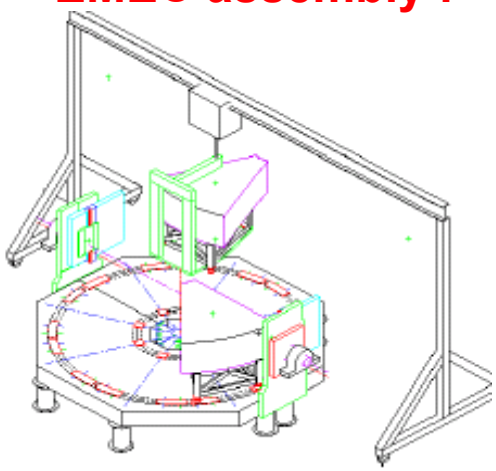
# Endcap EMEC and HEC assembly



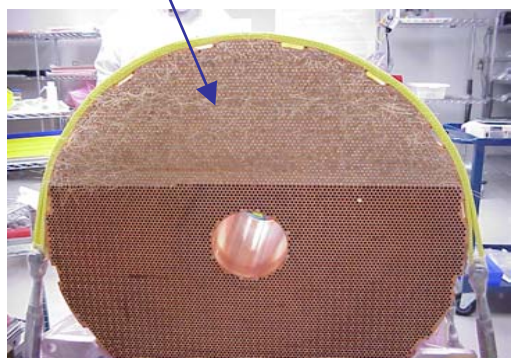
Endcap cryostat :



EMEC assembly :



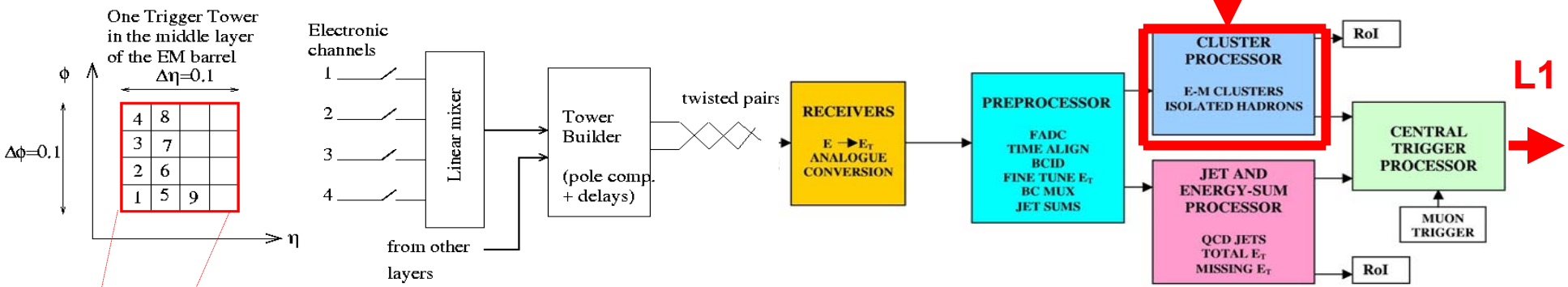
FCAL assembly :



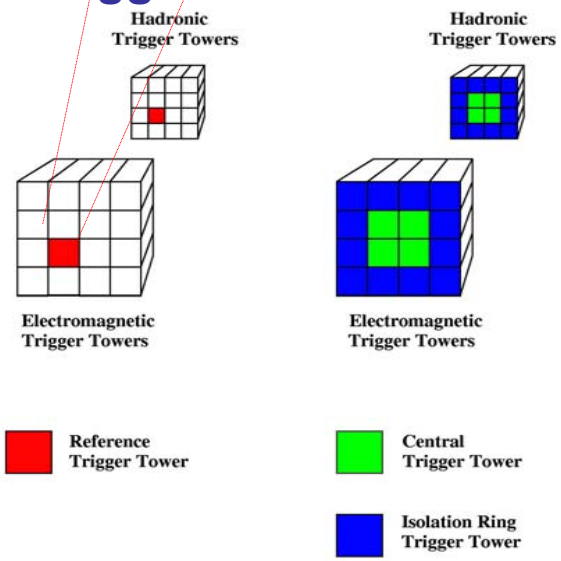
1st HEC wheel: 24/32 modules assembled

# e.m./isolated hadron Trigger

## •Generation of the L1 signal from the LAR calorimeters :




## •Trigger windows :



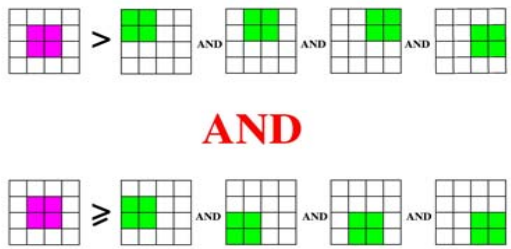

## •E.M. criteria :

- em cluster > Thr1
- em isolation < Thr2
- had isolation < Thr3
- local maximum

## •Isol. Had. criteria :

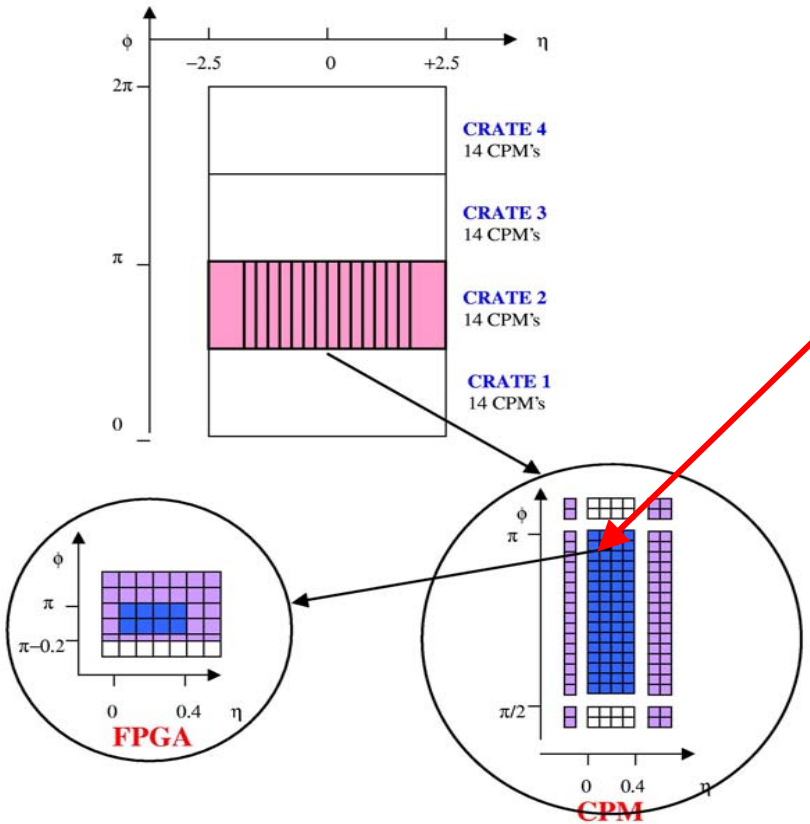
-had cluster > Thr4
-em isolation < Thr5
-had isolation > Thr6
-local maximum

## • Local Maximum for a RoI :



# Trigger Implementation

- Acceptance in four quadrants -> 4 crates
- 56 Cluster Processors Modules (CPM)
- Each FPGA processes 4x2 ($\eta$,$\varphi$) towers



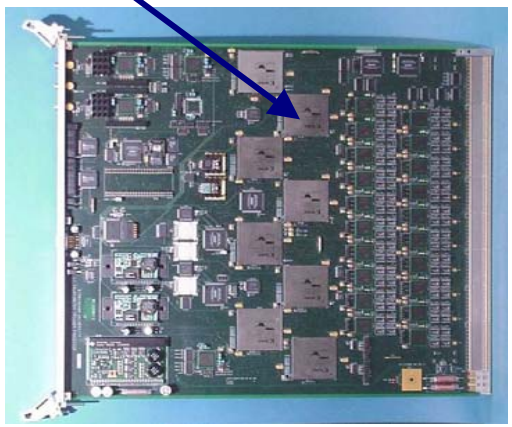

Communication between boards via the back plane

**Serialisation**

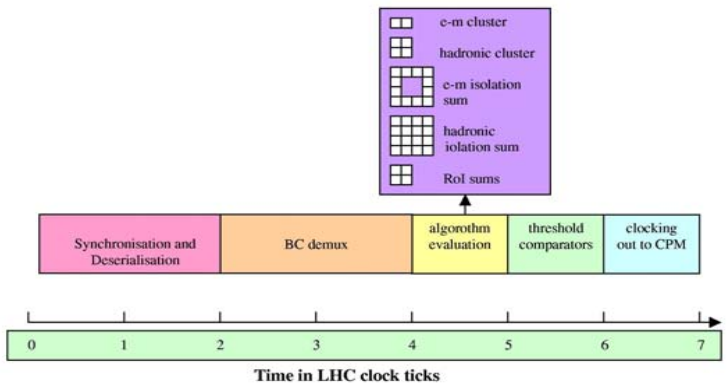
20 bits at 40MHz ->

5 bits at 160 MHz

A CPM board with 8 FPGA (Xilinx XCV1000E)



Time needed 175ns <600ns



# Conclusions

- Assembly of the ATLAS LAR system is going well, almost half is done
- Test beams for serie modules give good results (NIM)
- Next test beams :