CALICE SiW Electromagnetic Calorimeter: Test beam performance

Laurent MORIN, on behalf of the CALICE Collaboration

Laboratoire de Physique Subatomique et de Cosmologie de Grenoble
CNRS/IN2P3
UJF
INPG
Grenoble

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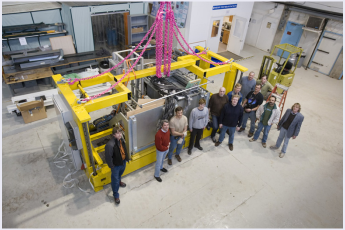
Outline

- The calice collaboration
- Description of the calorimeter
- Results from the 2006 test beam
  - Energy response of the calorimeter
  - Space development of the shower
- Conclusion

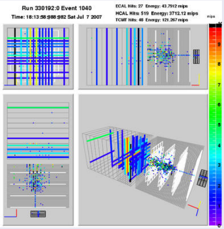
The CALICE collaboration

CAlorimetry for LInear Colider Experiment

281 physicists/engineers from 47 institutes and 12 countries



CALICE
Calorimeter for ILC



The goal of this collaboration is to test different calorimeter prototypes for PFA calorimetry at ILC, and to share:

- Beam-test facilities
- Data acquisition
- Analysis environment

CALICE a nomadic collaboration

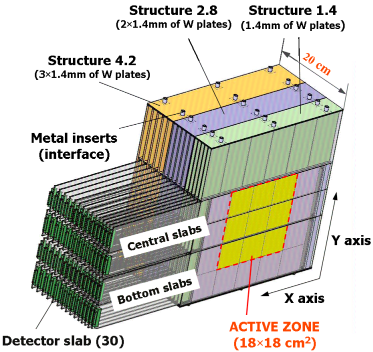
Our prototype has been tested all around the world:

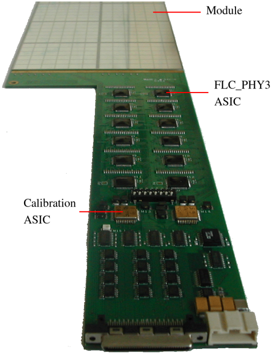
- DESY (2006)
- CERN (2006, 2007)
- FNAL (2008)

The calice collaboration uses the grid tools to share and analyse the data

During 2008 test beam the concept of a "remote control room" at Desy has been successfully tested. The DESY people have participated to the last test beam period from their remote control room.

Prototype of electromagnetic calorimeter



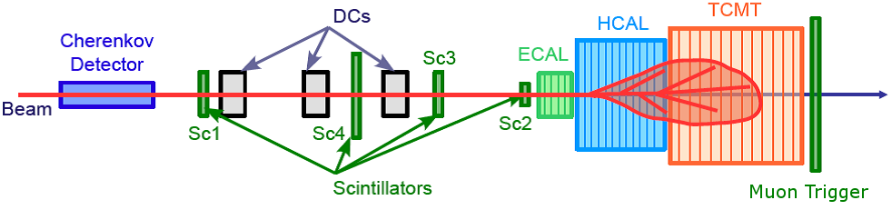


A high granularity calorimeter

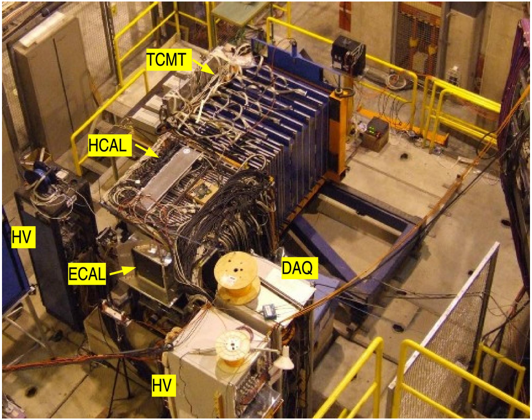
The SiW calorimeter is composed of:

- *Absorber*: 30 layers of 1.4, 2.8 and 4.2 mm plate of W ($= 24X_0$)
- *Active element*: 30 layers of Si diodes (1*x*1 cm^2, 6480 channels available)

The experimental display



The CALICE collaboration at CERN in 2006



- The H6 line of SPS at CERN was used
- This line provides *e*, π and μ
- Electrons and positrons have been taken from 6 GeV up to 45 GeV

The CERN 2006 DATA

The statistics is performed after event selection

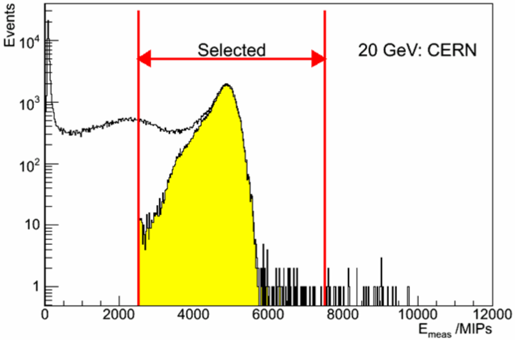
Energy (GeV)	particle	date	statistics (kevts)
6	e^-, e^+	Oct	10.6
10	e^-, e^+	Aug, Oct	55.9
12	e^-, e^+	Oct	32.1
15	e^-, e^+	Aug, Oct	60.4
20	e^-, e^+	Aug, Oct	76.9
30	e^-, e^+	Aug, Oct	43
40	e^-	Aug	27
45	e^-	Aug	129.3

Electron selection

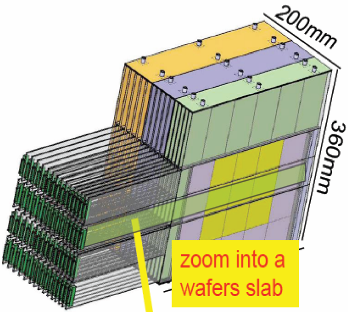
- E_i is the energy measured in the layer i

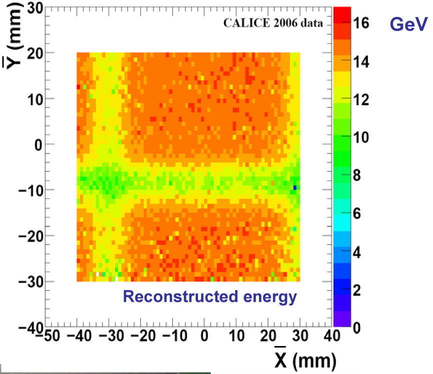
$$E_{meas} = \sum_{i=0}^{i=9} E_i + 2\sum_{i=10}^{i=19} E_i + 3\sum_{i=20}^{i=29} E_i$$

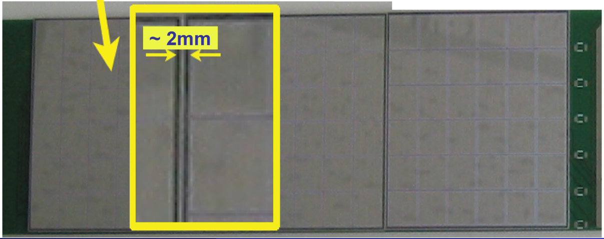
- Use Cherenkov signal to reject π and μ



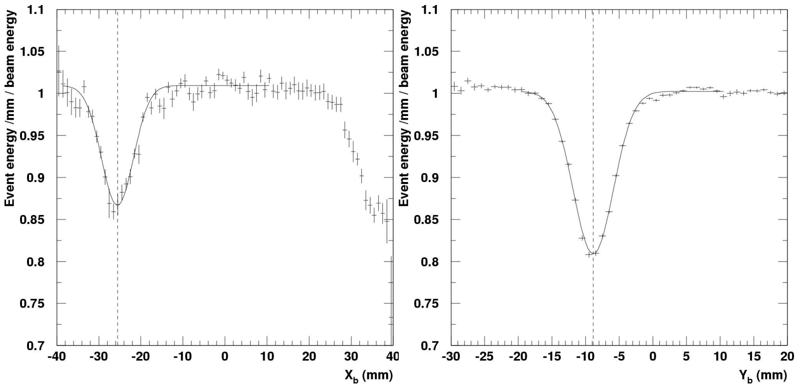
Control of the uniformity response







The guard ring effects

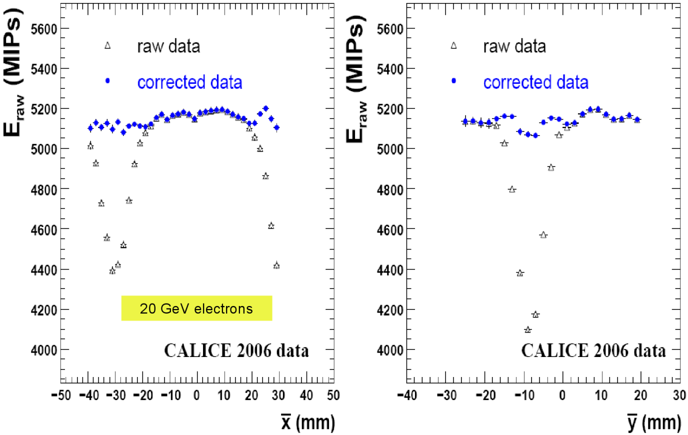


- Fit as a function of the shower barycenter:

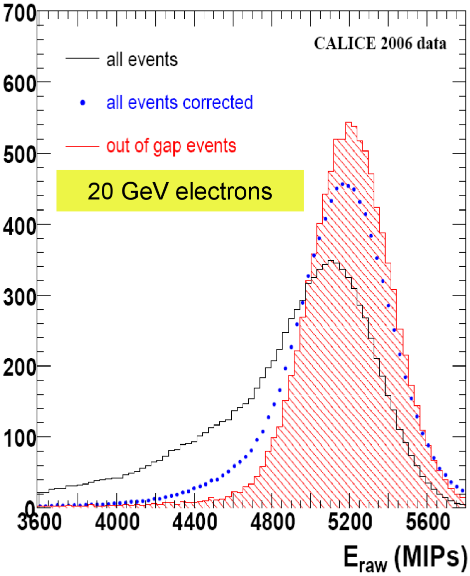
$$f(\bar{x}, \bar{y}) = \left(1 - a_x e^{-\frac{(\bar{x} - x_{gap})^2}{2\sigma_x^2}}\right) \bullet \left(1 - a_y e^{-\frac{(\bar{y} - y_{gap})^2}{2\sigma_y^2}}\right)$$

Correction of the guard ring effects

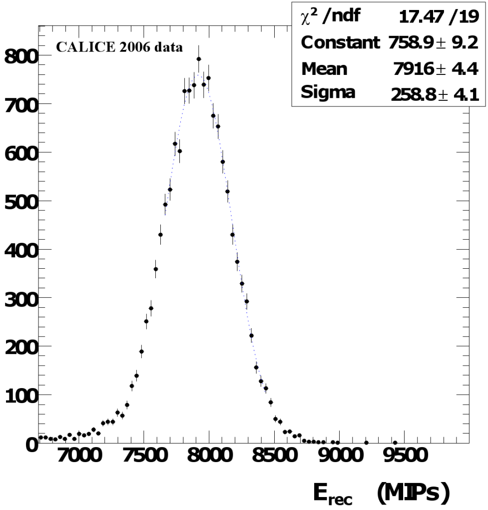
The energy response as a function of the shower barycenter is now flat



Improvement of the energy resolution

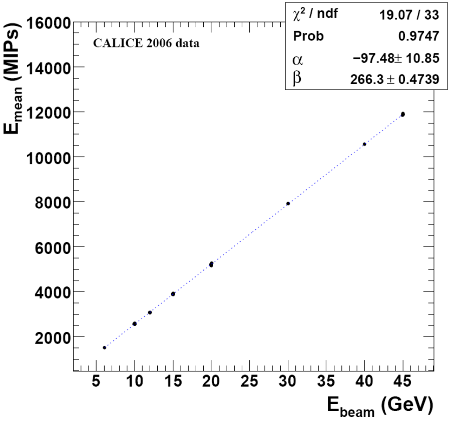


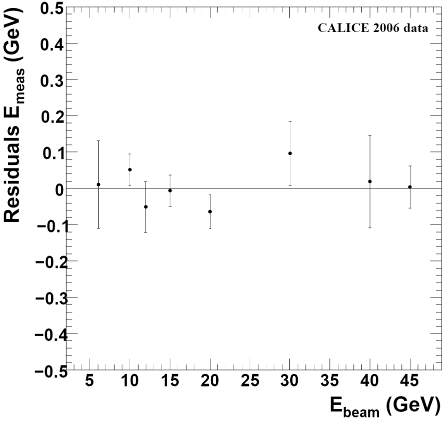
Energy resolution



- Selection of the events with the barycenter far away from the interwafer gap
- Gaussian fit in the interval $[-1\sigma, 2\sigma]$

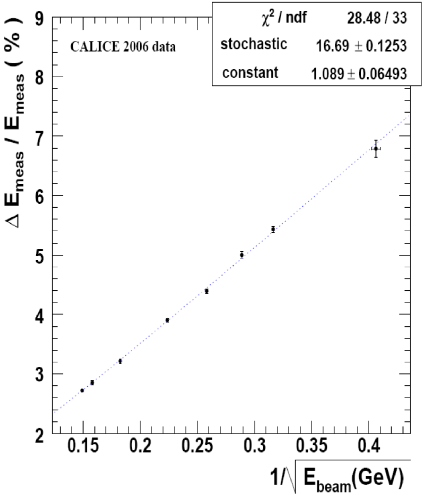
Linearity of the response





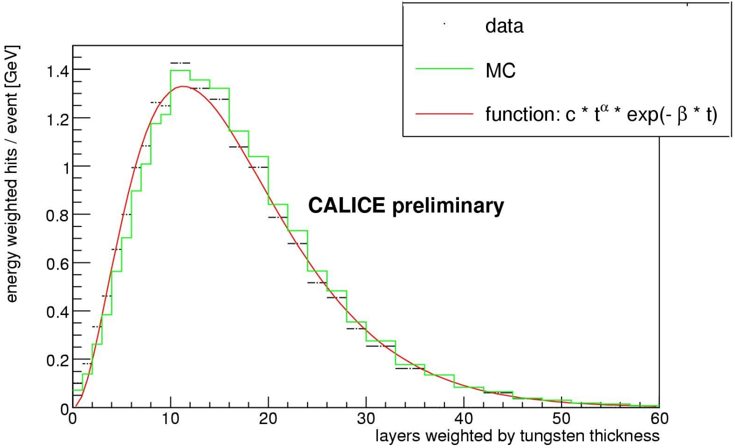
- The beam spread is measured to be: $\frac{\Delta E}{E} = \frac{0.12}{E} \oplus 0.1\%$
- After taking this into account, linearity better than 1%

Energy resolution



- The energy resolution is fitted by :
  $\frac{\Delta E}{E} = \frac{a}{\sqrt{E}} \oplus c$
  With
  $a = (16.69 \pm 0.13)\,\%$
  and
  $c = (1.09 \pm 0.07)\,\%$.

The shower development



- The shower profile is reasonably well reproduced by simulations

Conclusion

- Several millions of events were successfully recorded at CERN in 2006 with the SiW Ecal prototype
- The non-uniformity due to the guard-rings can be corrected
- The linearity is better than 1%
- The energy resolution leads to a sampling term of 16.7% and a constant term of 1.09%
- The 2007 CERN data study is ongoing
- More data are being taken at Fermilab (2008)