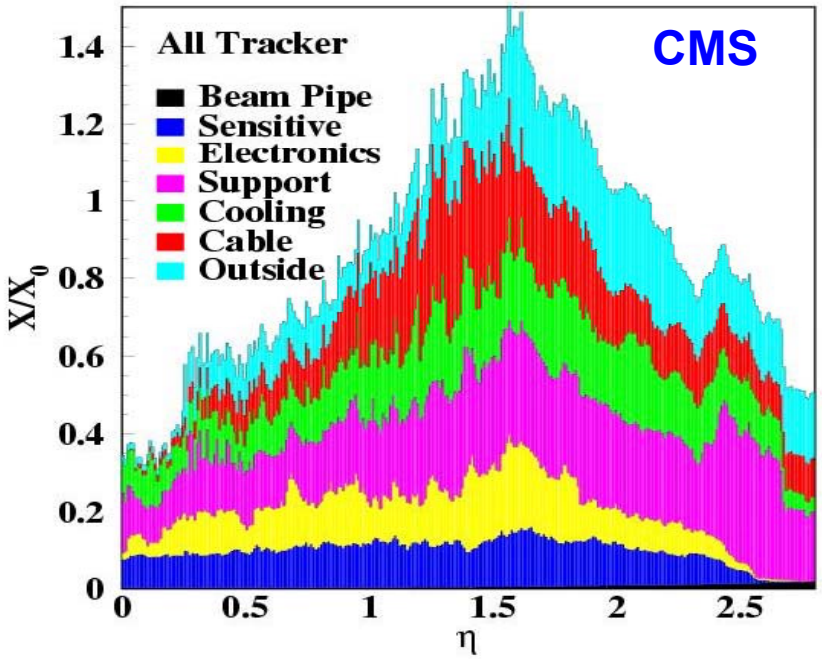
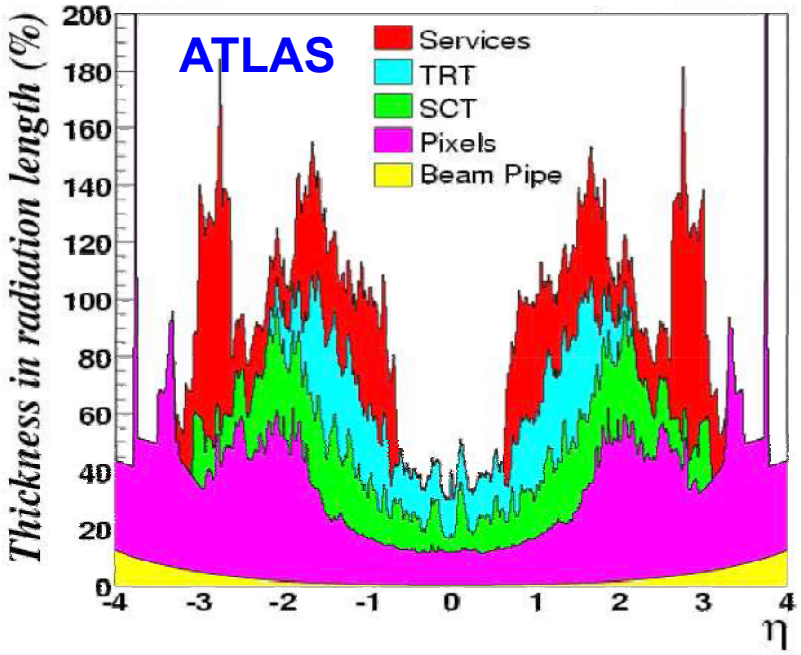
PREAMBLE

A VERY VERY URGENT MESSAGE

Precision physics at ILC is incompatible with this





20-40% of the photons are converted before the ECAL
40-80% of the electrons start showering before ECAL
5-20% of the pions start had. shower before calo.

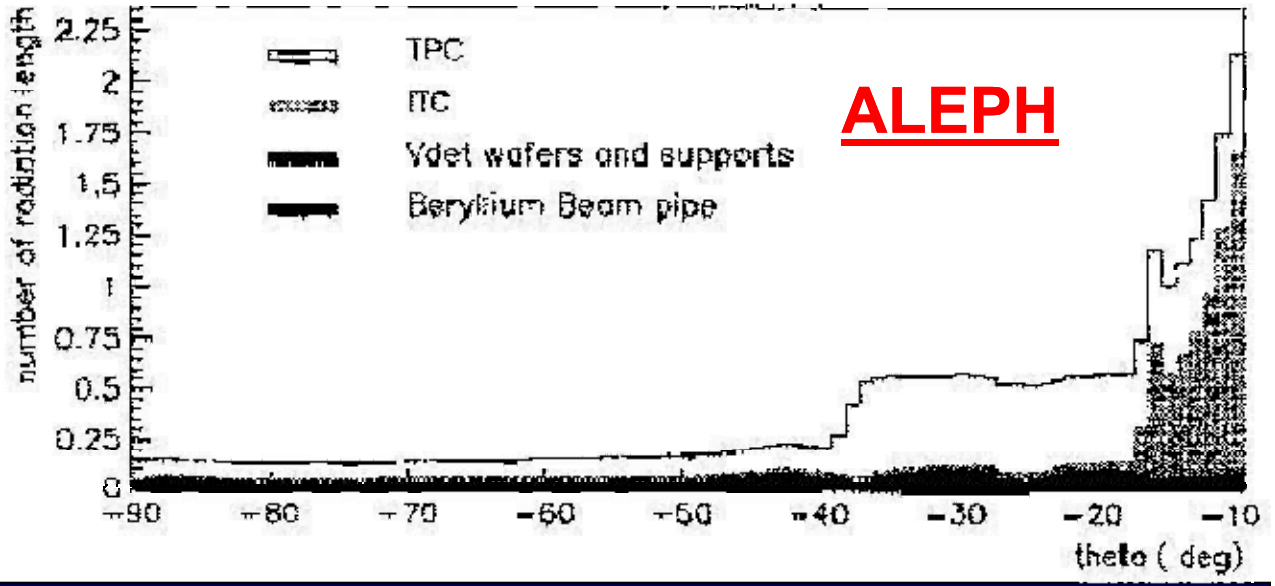
Totally inconsistent with PFA approach for jets

Reading about tracker in detector for ILC

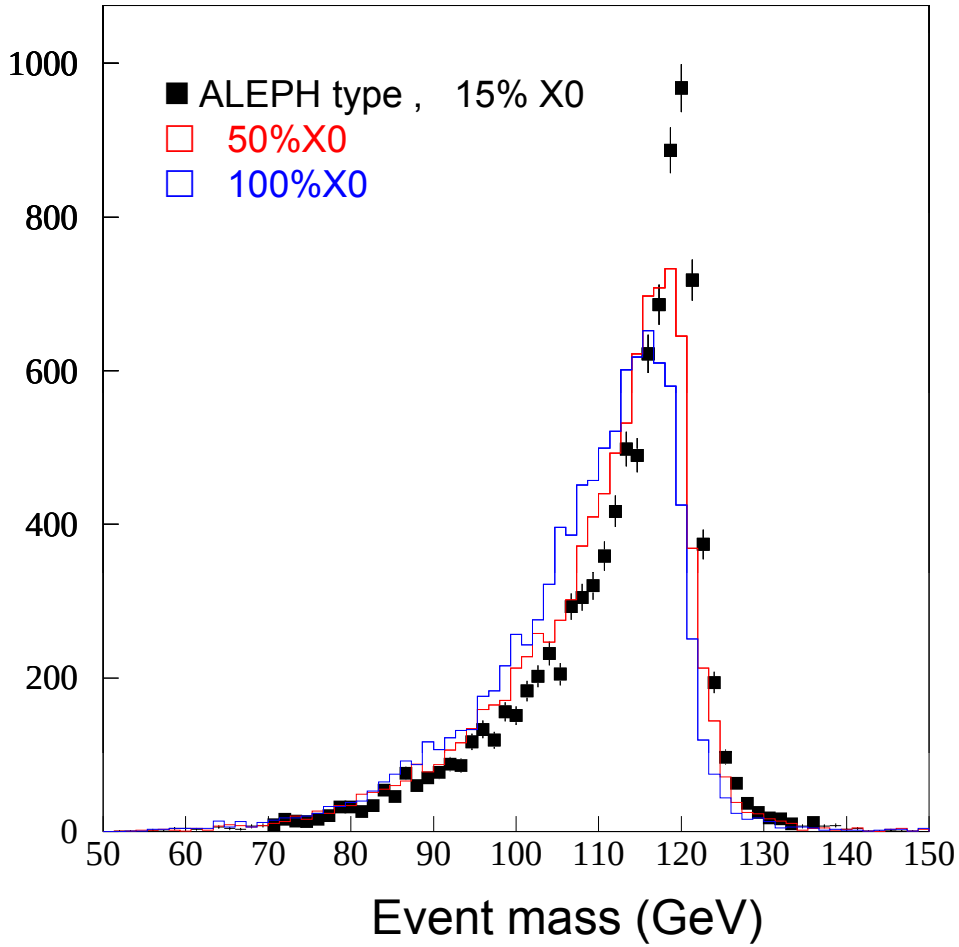
- The number(s) are ALWAYS related to $\delta p/p$ (single particle momentum resolution)
- NO quantitative report on material cost (auxiliary are more important than Si itself)
- NO quantitative report on separability of close tracks (mandatory for PFA)
- NO report on ghost in the tracker !!
- NO report on V0 (Ks,Λ) reconstruction capability
- Reconstruction of converted photons and pions interaction in the inner region

The best ECAL we can imagine depends on theses number !!!

Whatever the gain on momentum resolution, we must not goes too far away from that



e+e- to ZH at 500 GeV , Z to νν and H(120) to bbar



Hypothesis : Converted photon reconstruction has an efficiency of 75%
(eff(Trak1)*eff(Trak2)*eff(V0))

Going from $0.15X_0$ to $0.5X_0$

Mass Higgs = 119.8 ± 0.037 to 116.5 ± 0.065

S/B ↘ by 17% and ΔMHiggs ↗ 75%

To open discussion at the end of the talk

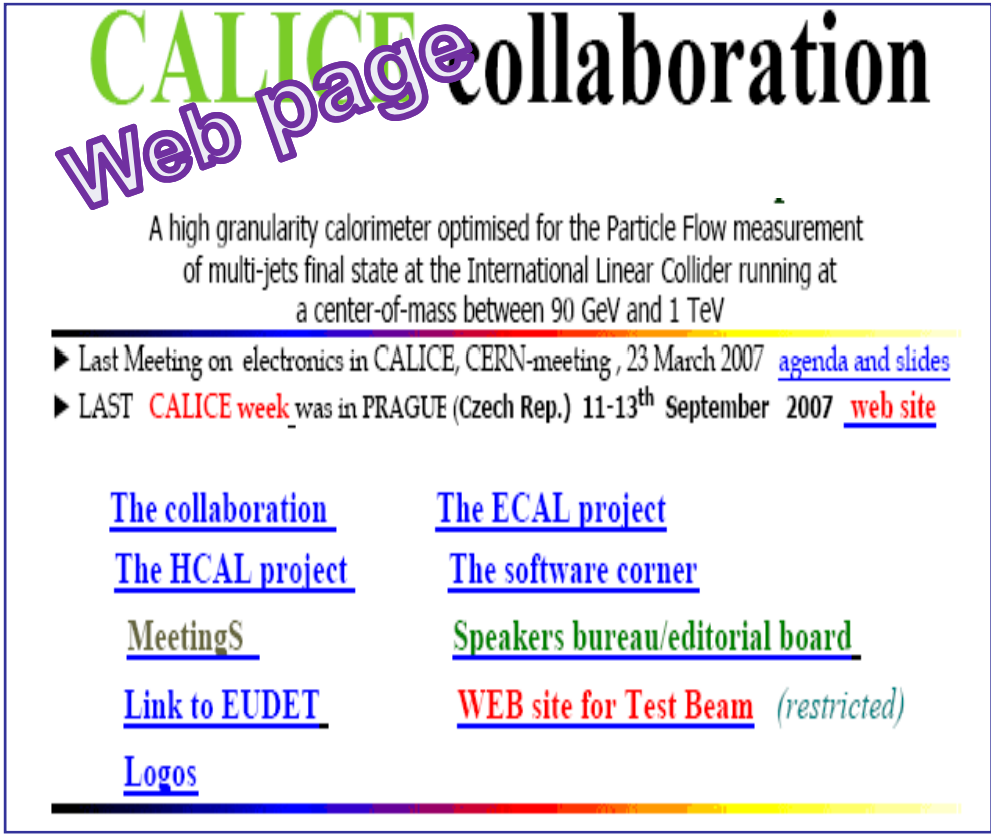
- 1 TPC starting at low radius
  (please work on endplate and electronics to minimize the material)
- 1 VDET 4layers , without internal active cooling
- 1 layer of SIT (strip perpendicular to Z) without cooling
- No SET (Yesterday Valeri write “help PFA” ????)
- ETD ?? if one , just hold on at the entrance of ECAL

Gain versus drawbacks (including of course full sim and rec) , on adequate list of Benchmarks

*(**not only** the ones related to b/ctag and momentum resolution, but also impact on Jet, on gamma conversion, etc…)*

CALorimeter for the LInear Collider Experiment

13 countries,
45 laboratories (+5 in discussion)
225 physicists/engineers ,



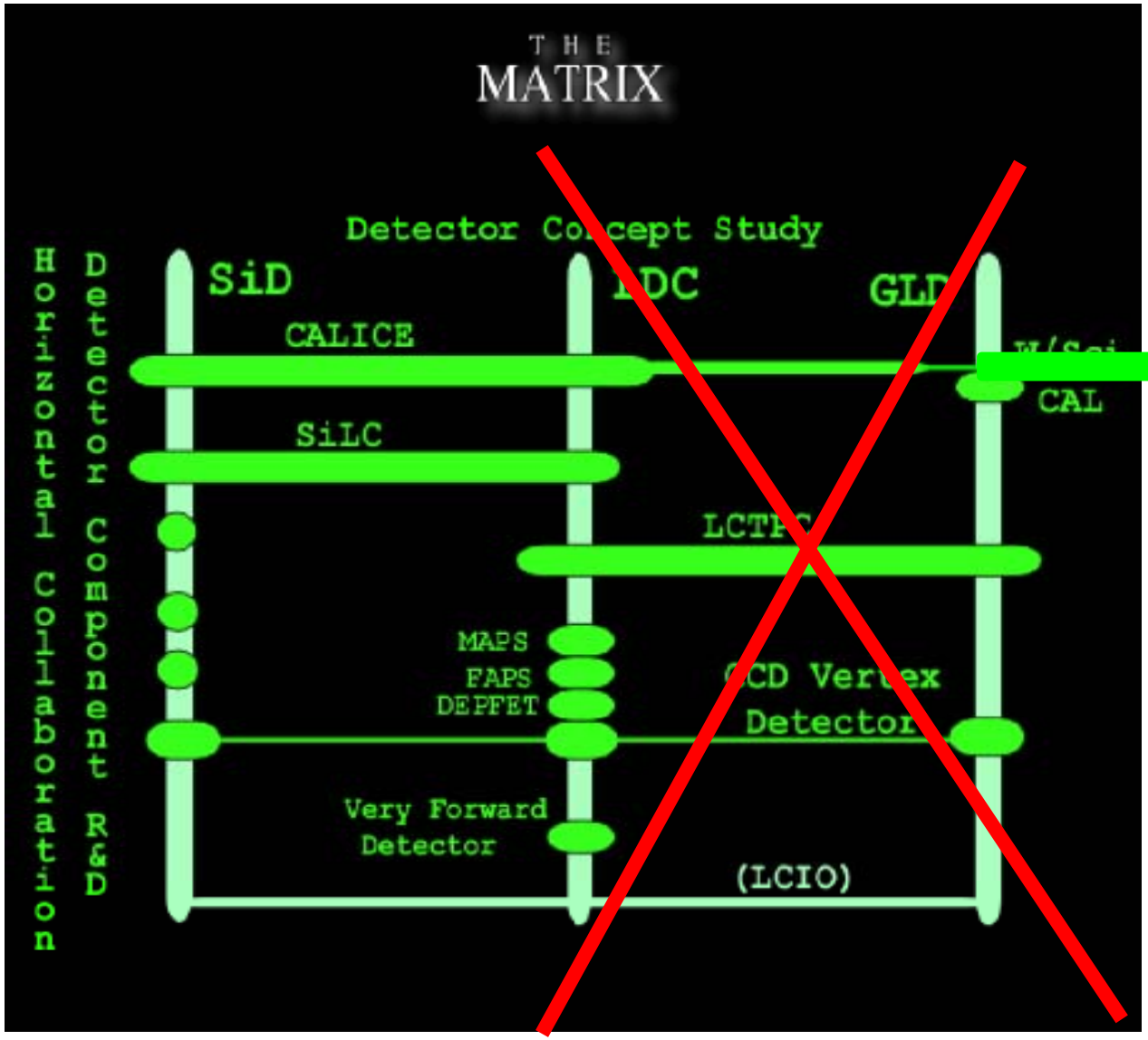
- High granularity calorimeters for precision physics
  - Study of particle flow for $\sigma_E/E \sim 30\%/\sqrt{E}$
    - Validation of hadronic interaction models in MC

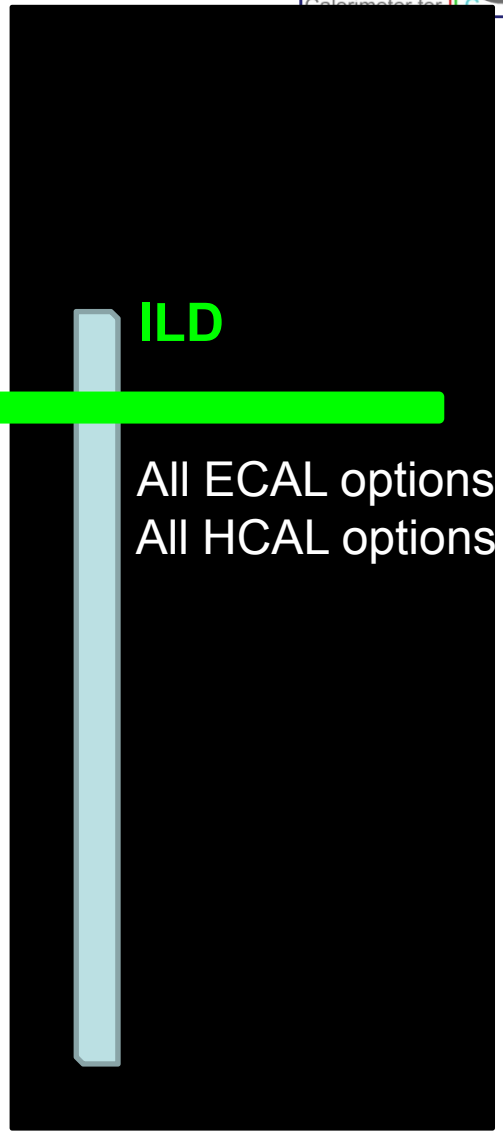
ECAL for PFA

> Tungsten – silicon (0.5x0.5 cm²)
> Tungsten – scintillator strip (4x1 cm²)
> Tungsten - MAPS (50x50 μm² , digital readout)

HCAL for PFA

> Stainless steel – scintillator tile read by SiPM (3x3 up to 20x20 cm²)
> Stainless steel - Scintillator strip (size ?) read by MPPC
> Stainless steel – gas device (RPC,GEM or Micromegas, with digital (or semi digital) readout with 1x1 cm²


THE MATRIX
Detector Concept Study
SiD
LDC
GLD
Horizontal Collaboration
Detector Component R&D
CALICE
SiLC
LCTPC
MAPS
FAPS
DEPFET
CCD Vertex Detector
Very Forward Detector
(LCIO)


ILD
CAL
All ECAL options
All HCAL options

Belarus
University of Minsk

Canada
University of Regina, McGill Univ. Montreal

Czech Republic
Charles University Prague, Academy of Science-Inst. of Physics

ECAL Silicon

France
LAPP-Annecy, LPC-Clermont, LPSC-Grenoble, IPNL-Lyon, LAL- Orsay, LLR-Palaiseau

Germany
DESY , Hamburg Univ., Univ. of Heidelberg , MPI-Munich

India
Bhabha Atomic Research Centre- Mumbai

Japan
University of Kobe , Shinshu University

ECAL Scintillator MPPC

Korea
EWHA Seoul Univ. , Kangnung Nat. Univ. , Yonsei Univ. - Seoul , Sungkyunkwan Univ. - Suwon

Morocco
CNESTEN-Rabat , Univ. of Casablanca

Russia
JINR-Dubna, ITEP Moscow, LPI-Moscow, MEPhI Moscow, Moscow State Univ. , IHEP-Protvino

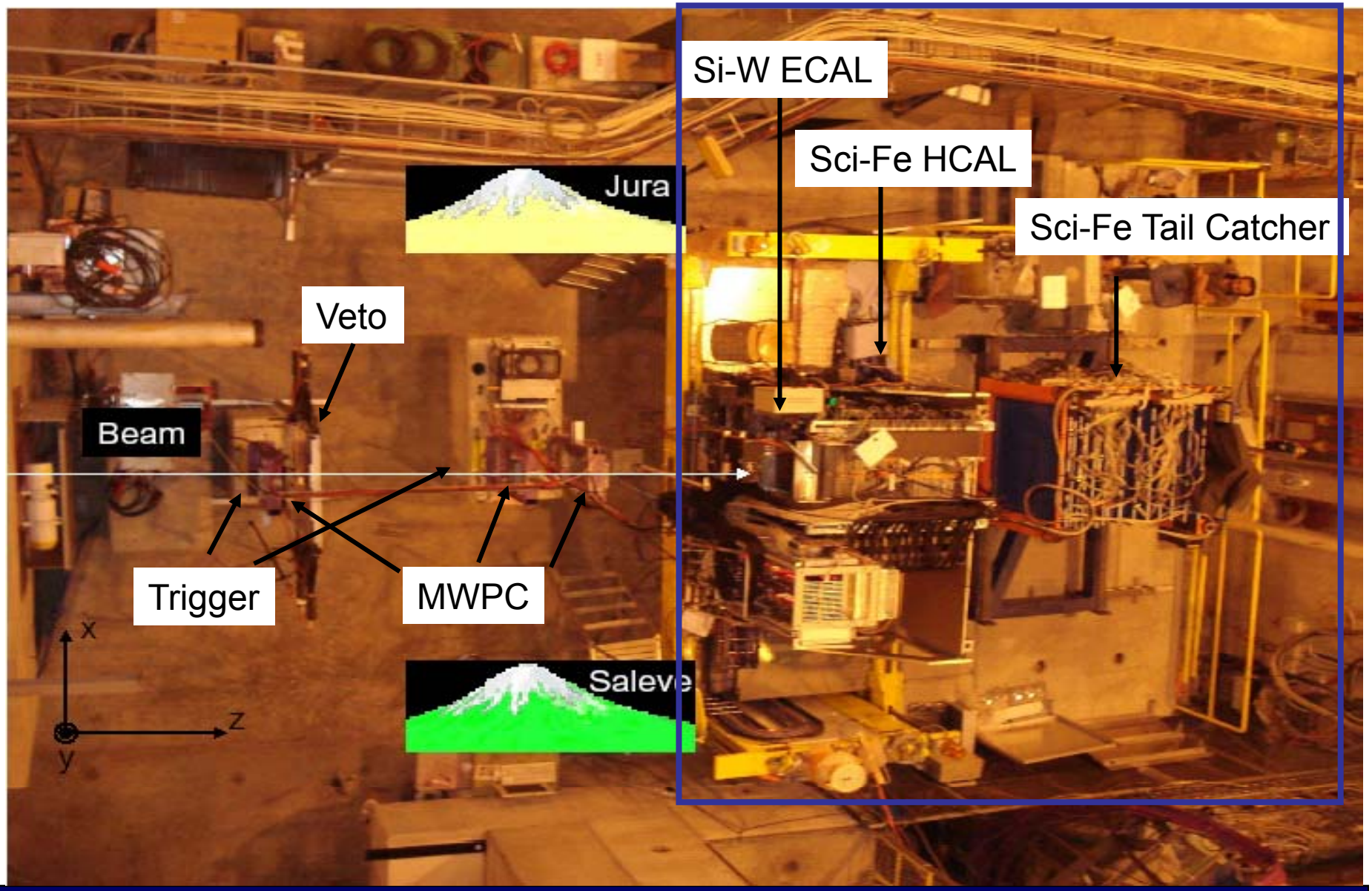
Spain
CIEMAT-Madrid

United Kingdom
Univ. of Birmingham, Cambridge Univ., Imp.Coll. London, UC London, RHUL London, Univ.of Manchester, RAL-didcot

United State of America
ANL Argonne, Univ. Texas Arlington, Boston Univ., Univ. of Chicago, North Illinois U. DeKalb, Univ. of Iowa

Test beam @

CALICE calorimeters

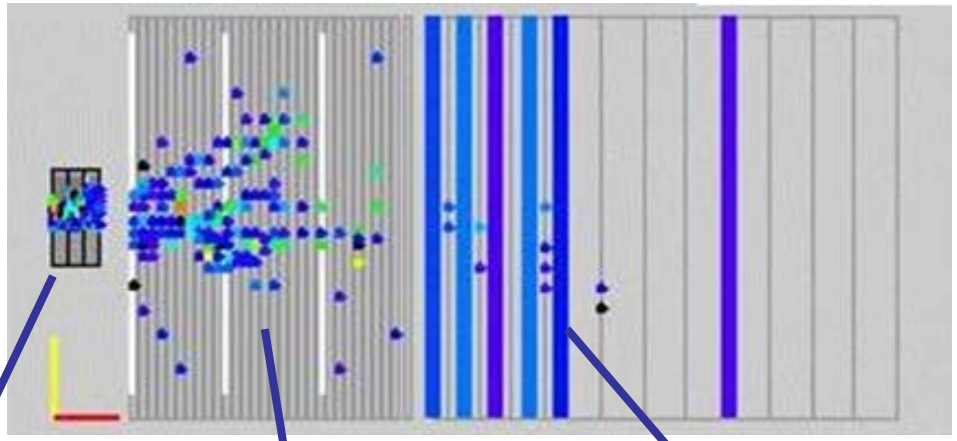


Test beam @ CERN

2006 et 2007

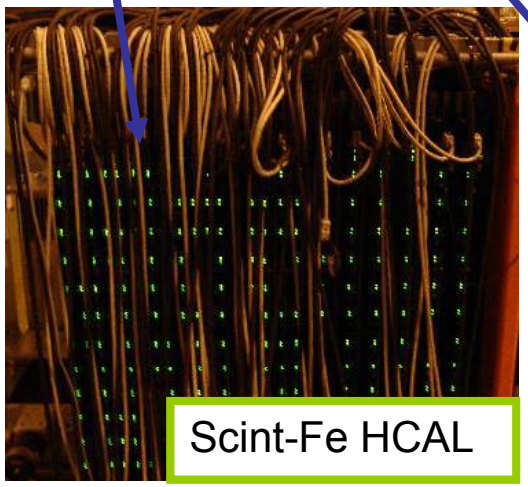
10 GeV pion shower
@ CERN test beam

beam



SiW ECAL

1x1cm^2 lateral segmentation
0.4-3.0 X_0 longitudinal segment.
~1λ total material, ~24 X_0



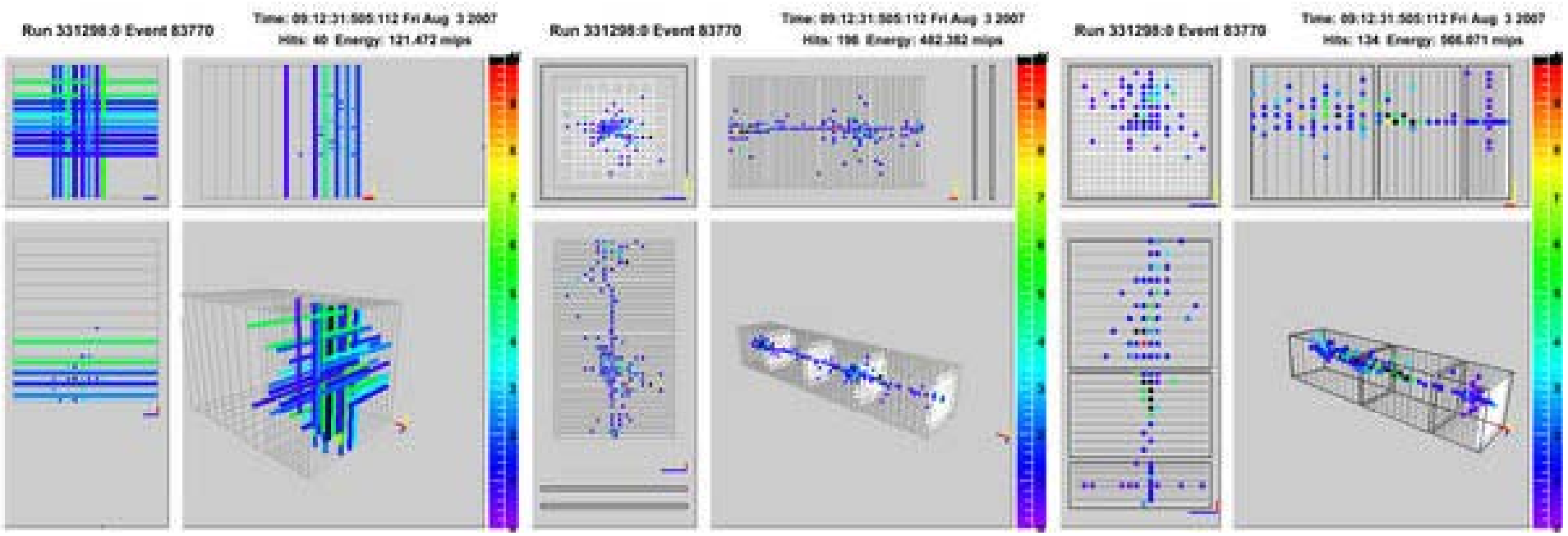
Scint-Fe HCAL

3x3cm^2 tiles lateral segmentation
~4.5 λ in 38 layers

Scint-Fe tail catcher/ muon tracker

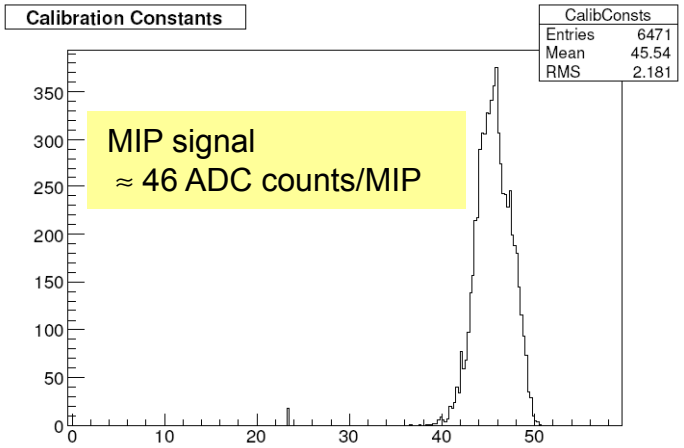
5x100cm^2 strips
~5 λ in 16 layer

Test beam @

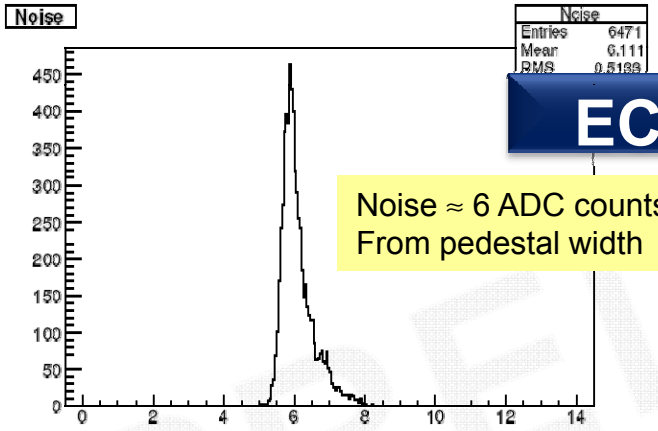


TCMT AHCAL ECAL

Analysis of e.m. showers

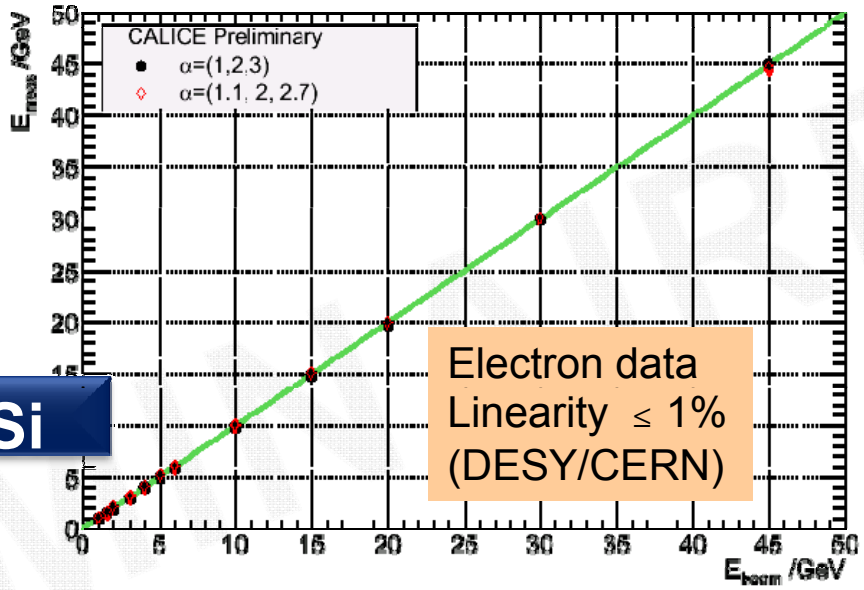


MIP signal
≈ 46 ADC counts/MIP

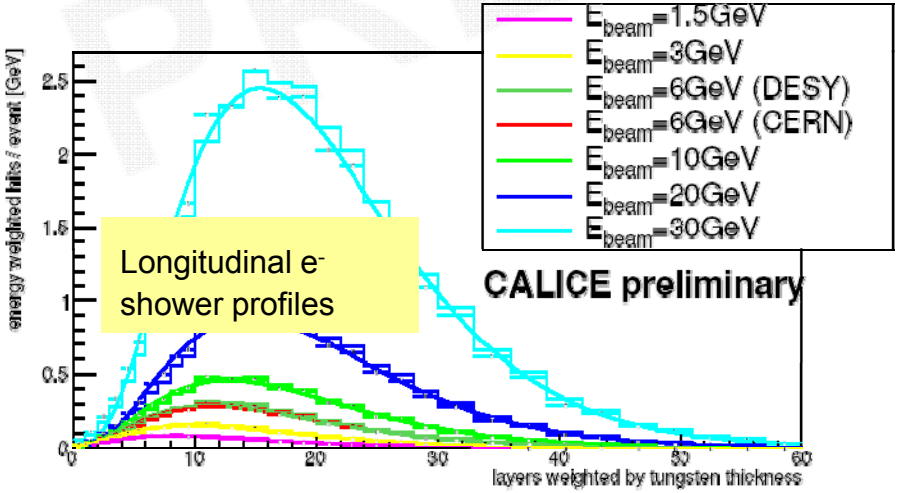


Noise ≈ 6 ADC counts
From pedestal width

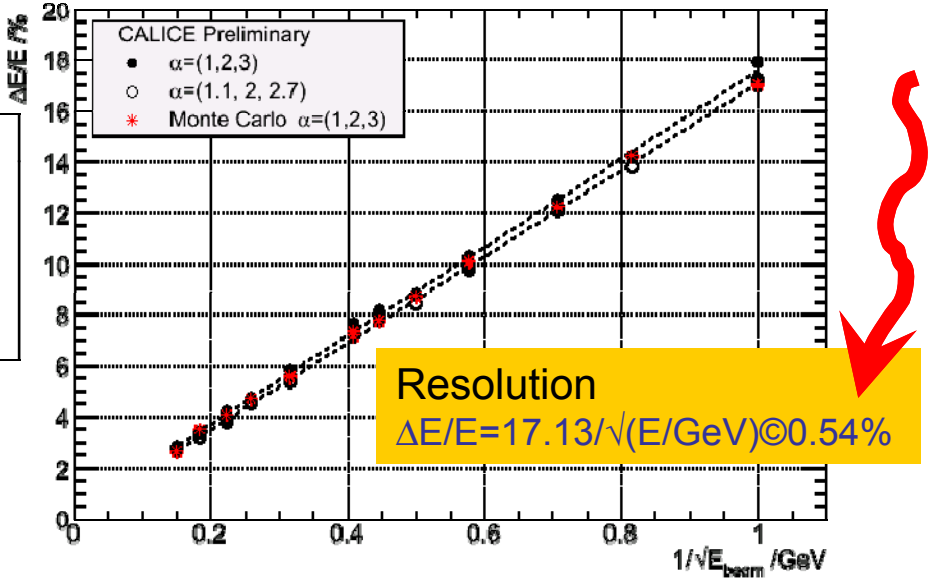
ECAL W-Si



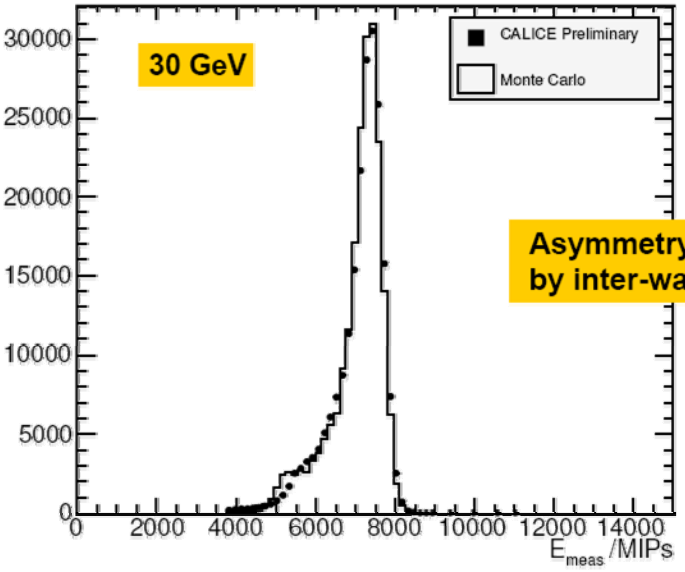
Electron data
Linearity ≤ 1%
(DESY/CERN)



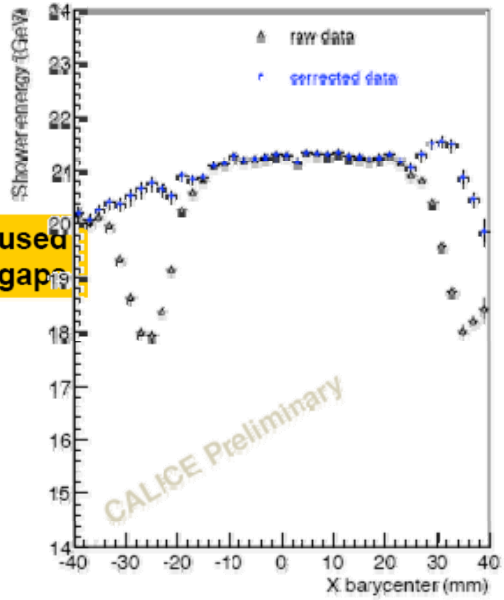
Longitudinal e⁻
shower profiles

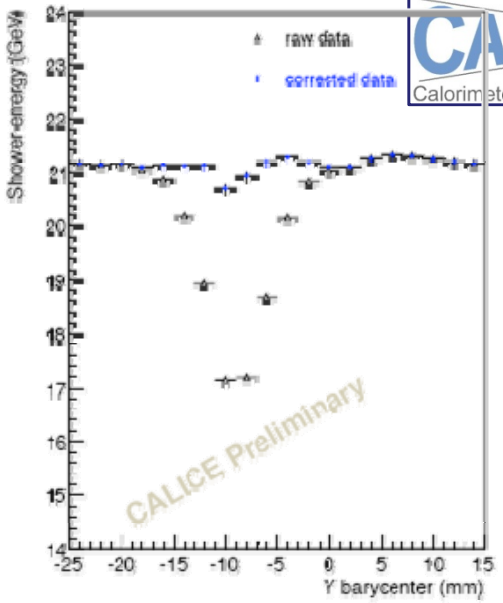


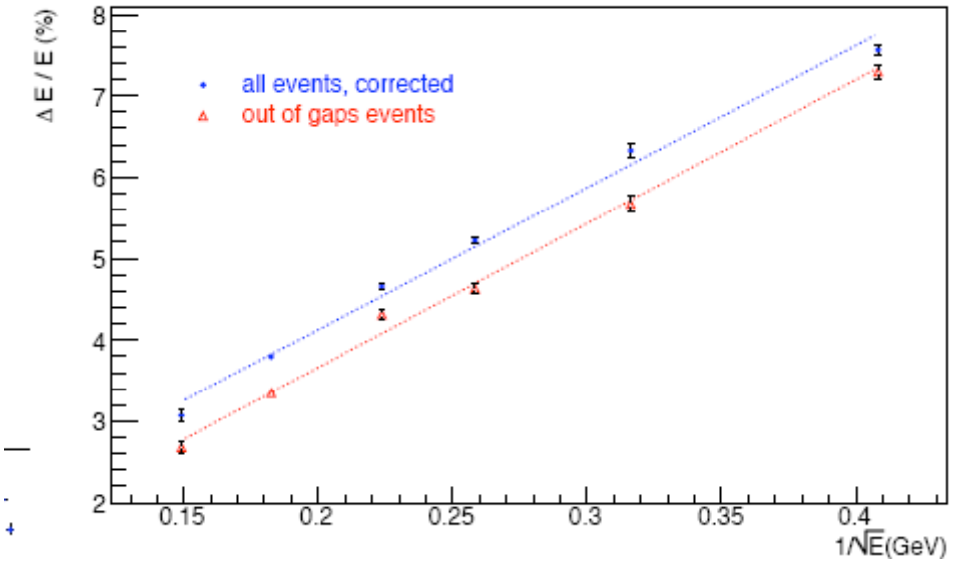
Resolution
ΔE/E=17.13/√(E/GeV)©0.54%



Asymmetry caused by inter-wafer gaps







LARGER WAFERS

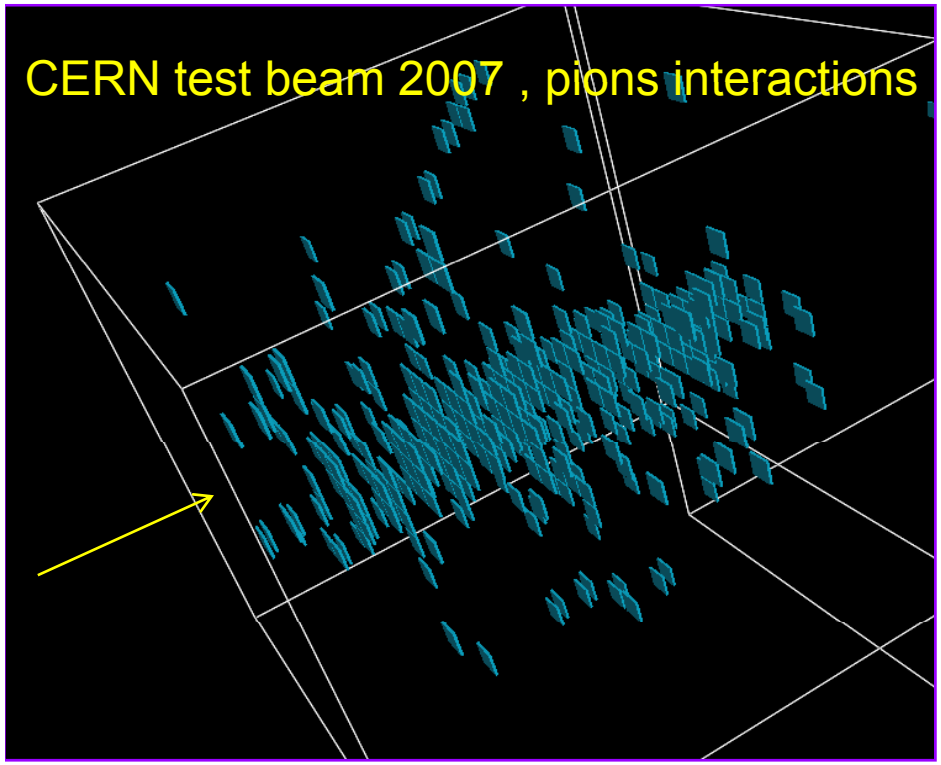
- 6” wafers ,
- 9x9 cm matrices
- New size for alveoli : 18 cm

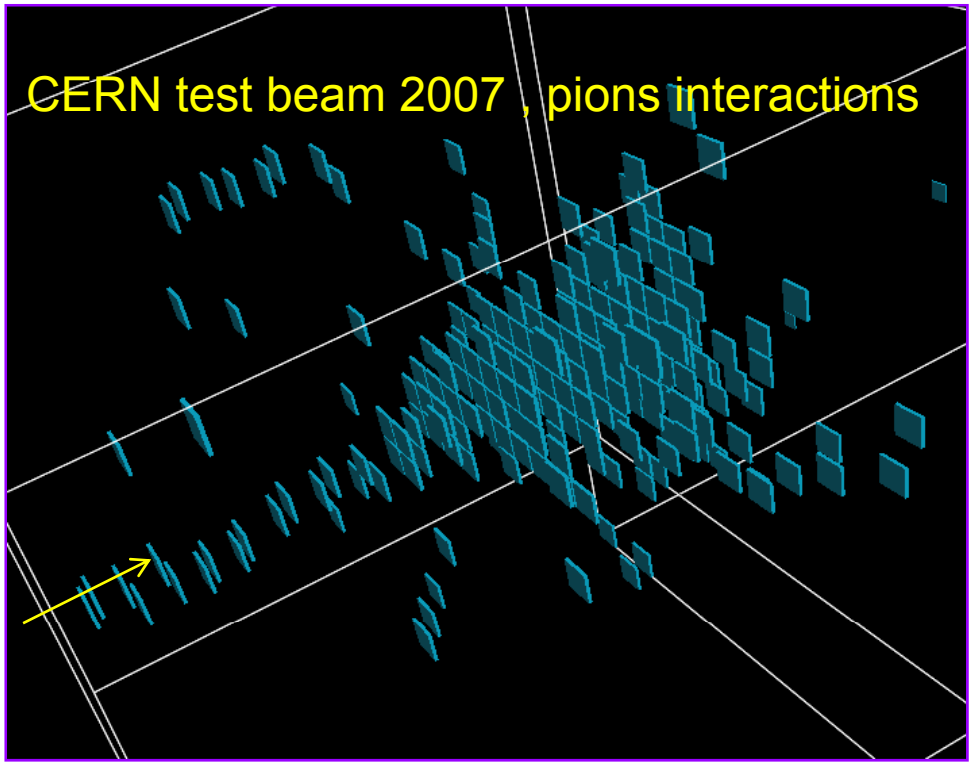
It change the ECAL barrel dimension

Analysis of hadronic showers

About 60% of the hadrons will interact in the ECAL

The pattern of hadronic showers has to be efficient also in the ECAL Not only in the HCAL. Therefore the choice of technology for the ECAL has also to be based on PFA performances on jet (not only photons)



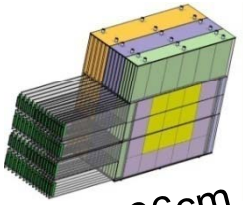


The design of the ECAL must also allows a good pattern of the hadronic shower

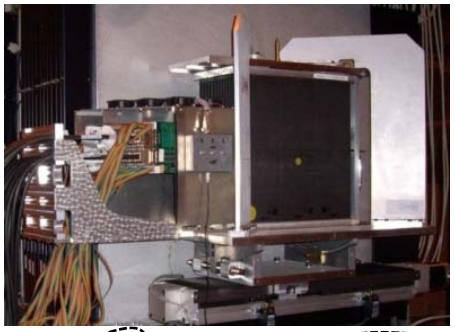
CALICE R&D directly impacting on design

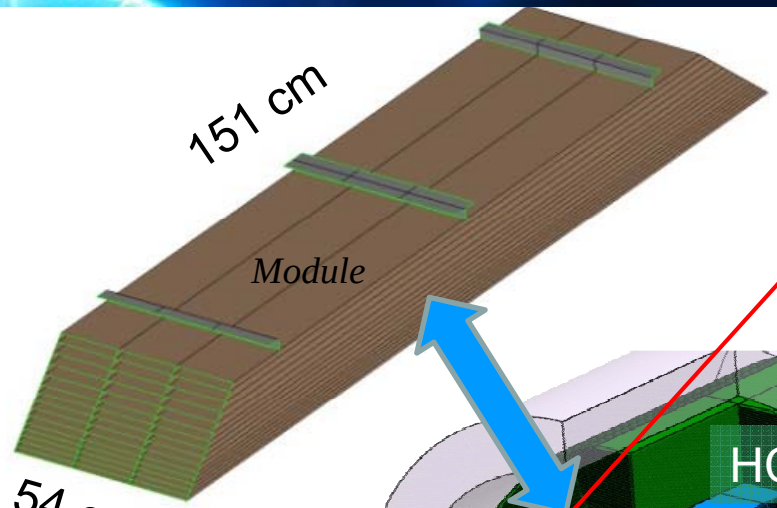
EUDET Detector R&D towards the International Linear Collider

ECAL Prototype



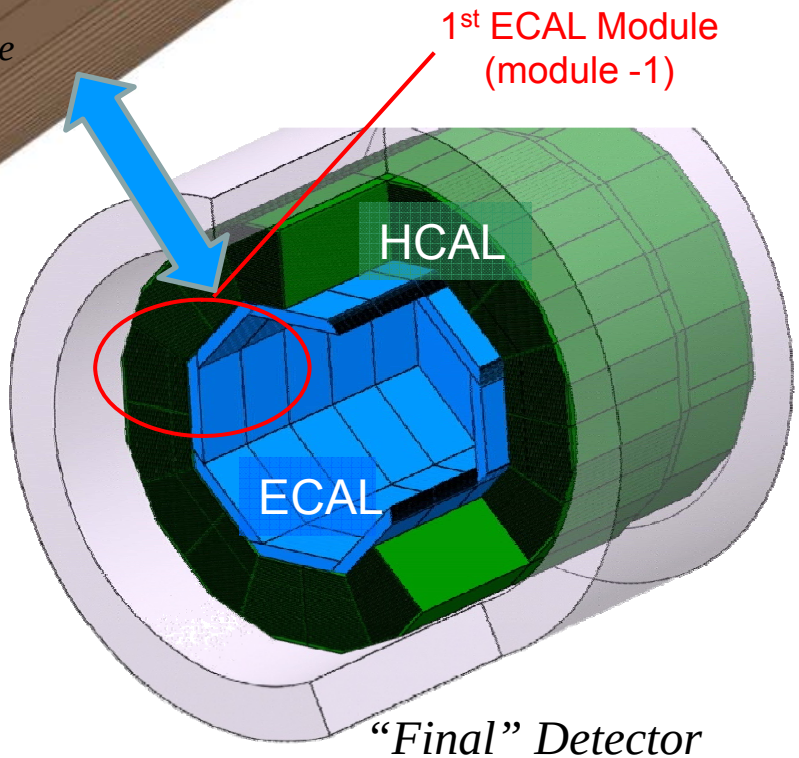
36cm



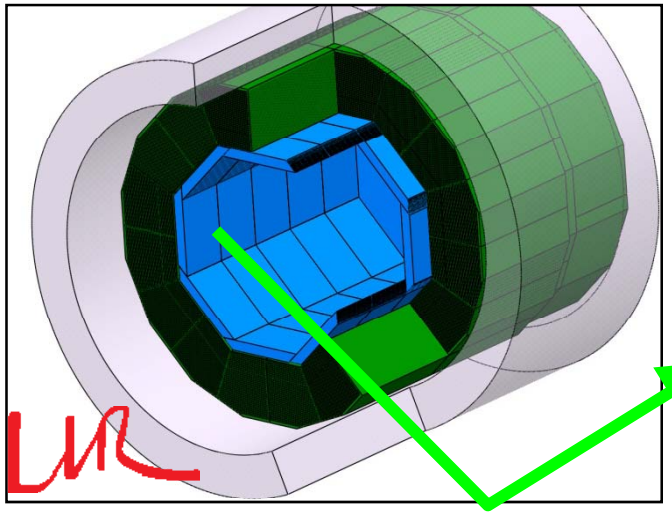


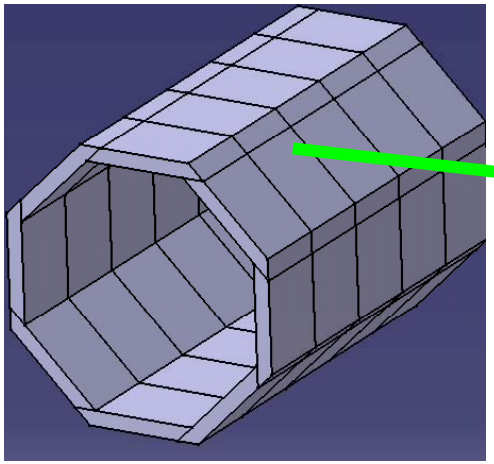
5/8 of CMS –ECAL

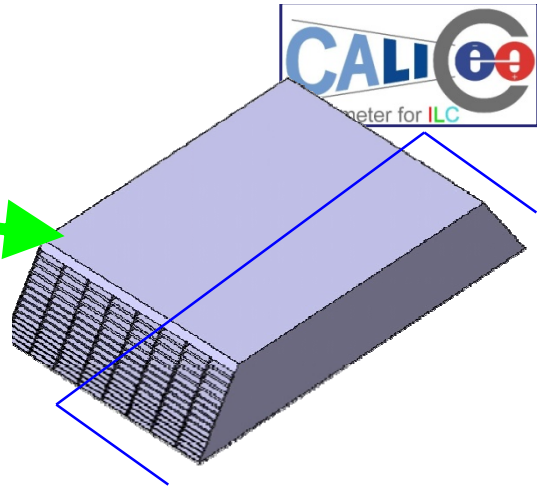
ECAL		
	1er proto.	EUDET
number of channels	9720	45 360
Size (cm)	36 x 36	154 x 54
Tungsten (kg)	200	700
chip VFE	external	internal



"Final" Detector



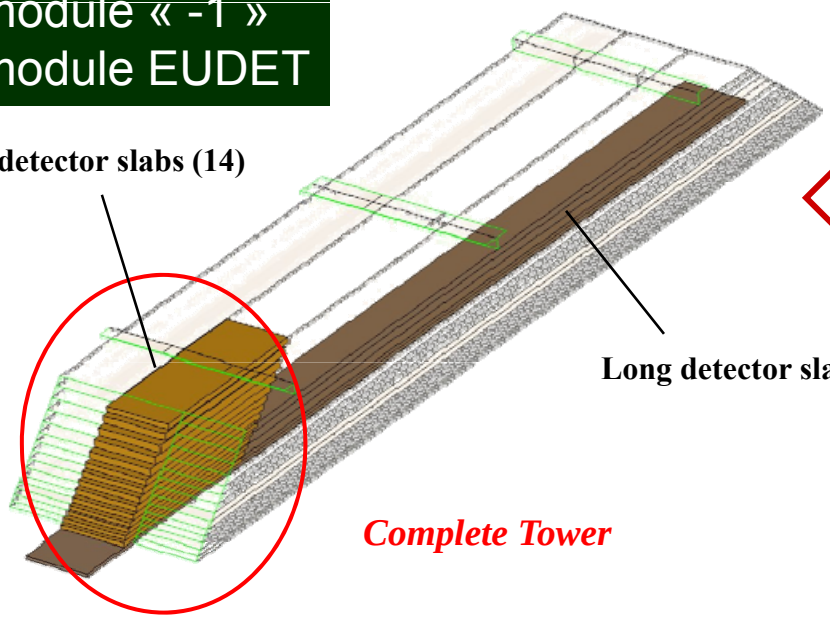




Demi module
en prototype

module « -1 »
module EUDET

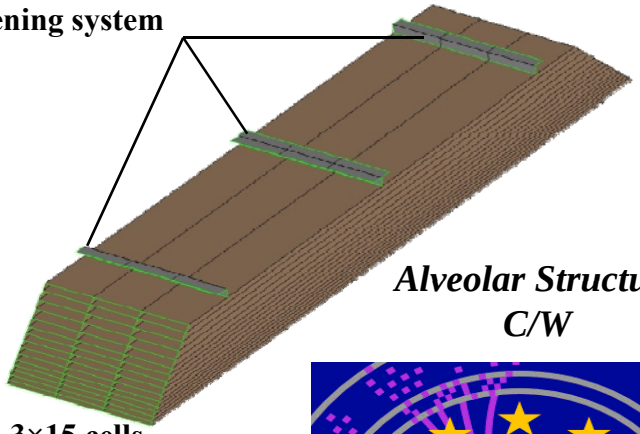
Short detector slabs (14)



Long detector slab (1)

Complete Tower

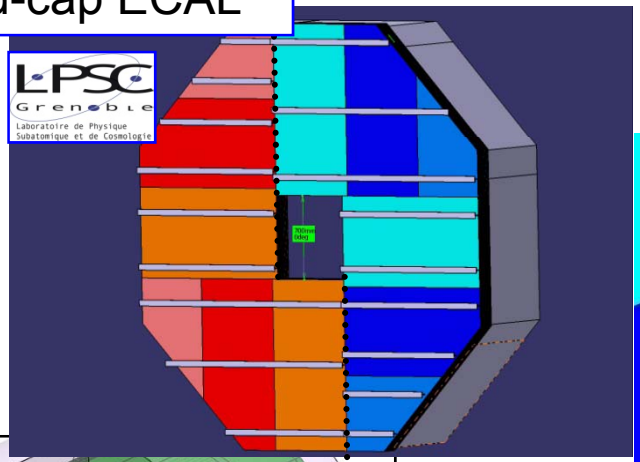
Fastening system

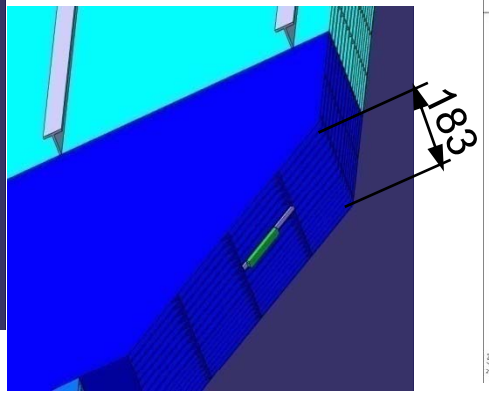


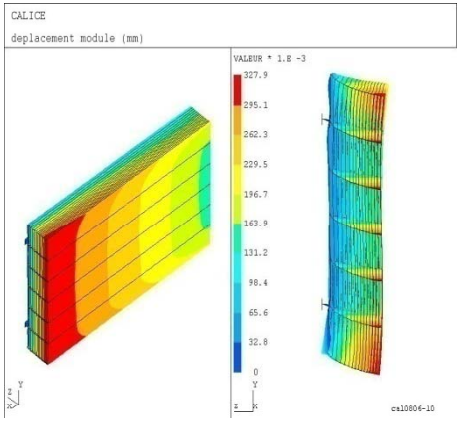
Alveolar Structure
C/W

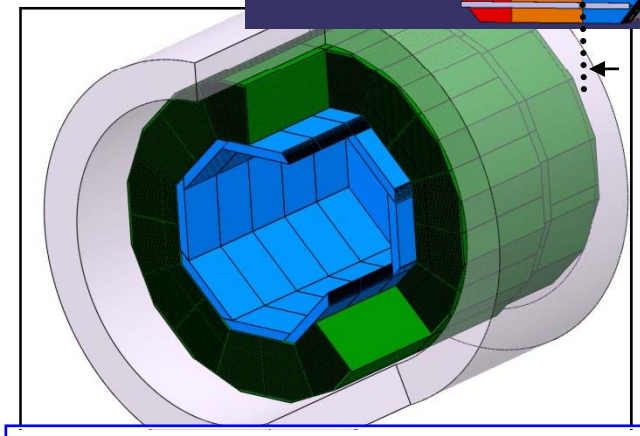
3×15 cells

Study of the end-cap ECAL

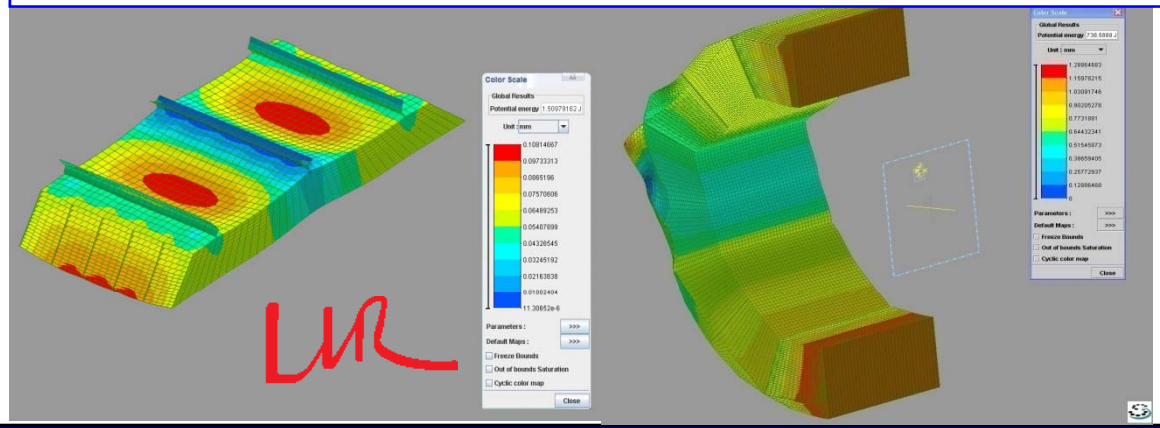




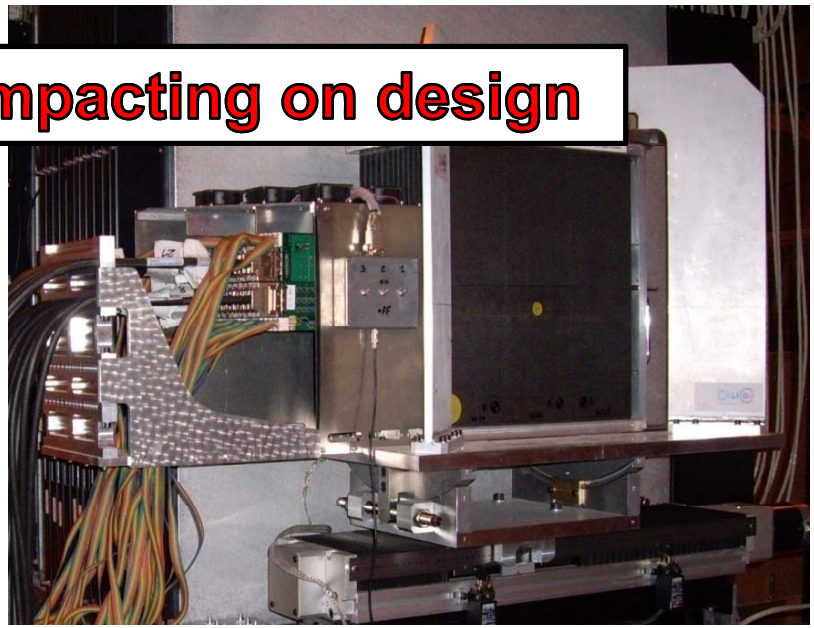




But also , study of the deformation with an ECAL hang up to the HCAL



CALICE R&D directly impacting on design



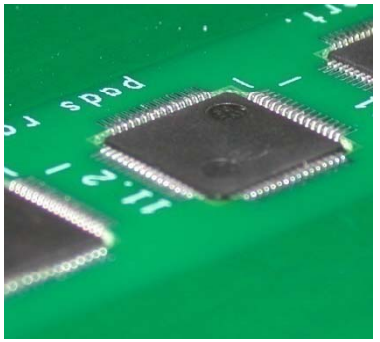
Of course, it is not useable for ILD !!

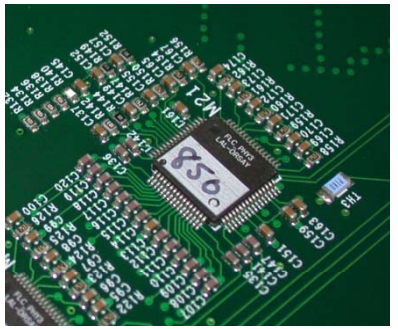
VFE and Mux inside

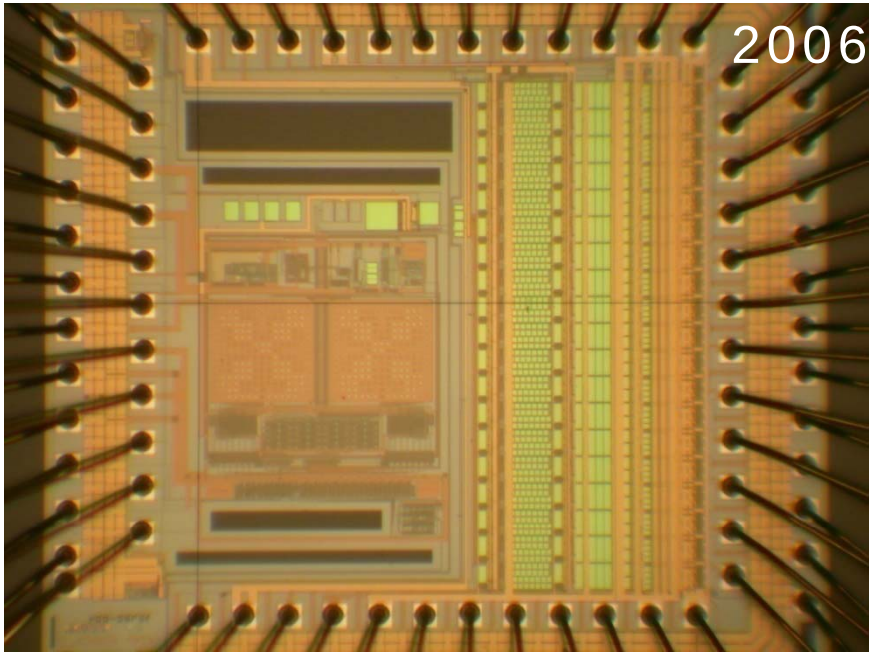
- power cycling for low power dissipation
- ADC included in chip
- local zero suppress (in chip)
- control of the common modes
- test of impact of high energy em shower passing through

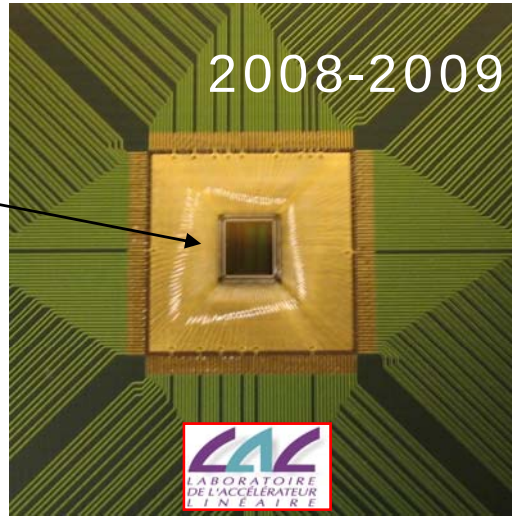
Readout system of the MODULE -1

- Module “-1” ECAL pour 2009
  - 40k voies d’électronique
  - Chip 72 ou 144 voies
  - Zero suppress
  - Mémoire RAM interne
  - Démonstrateur techno
  - PCBs ultra fins interconnectables
  - Chip on board



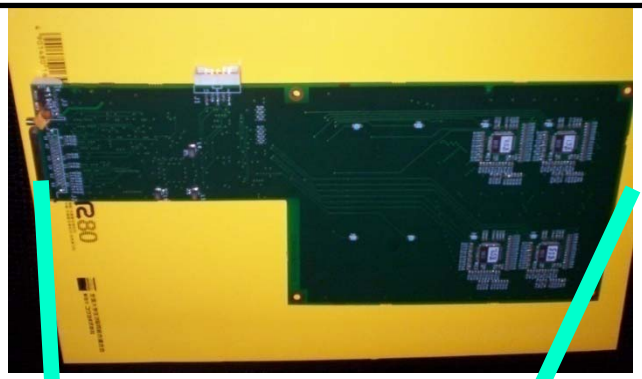


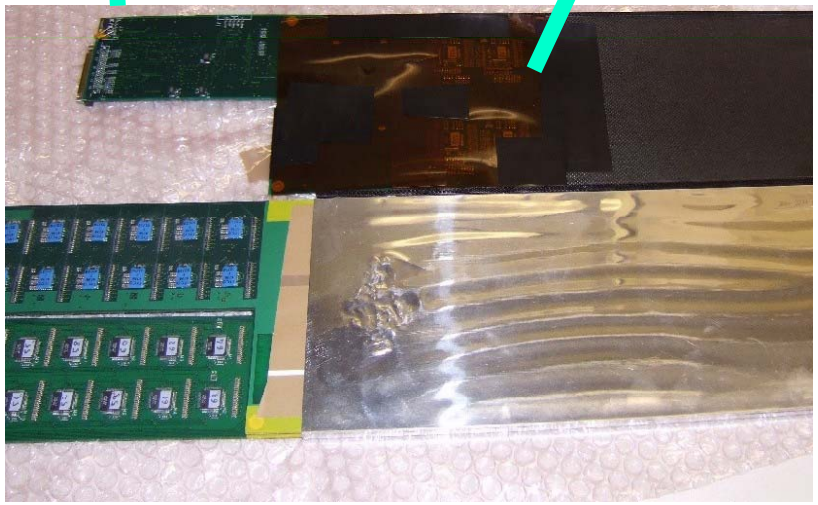




CALICE R&D directly impacting on design

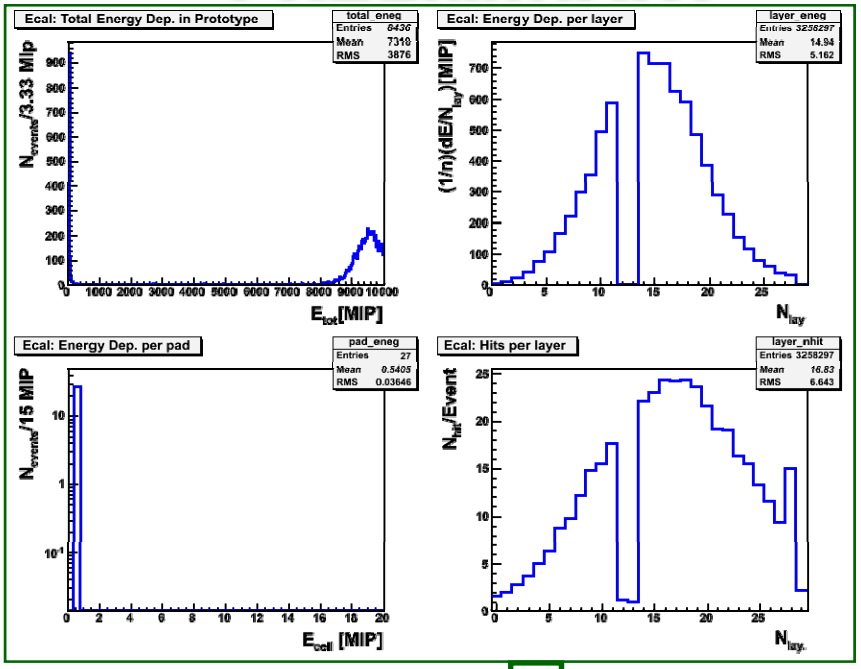
VFE chip embed in device





Replace a layer with a special PCB without silicon wafer (layer 12) .
Shoot on the VFE with HE electron (70,90GeV)

PRELIMINARY



Preliminary results seems to show that VFE chip can be put inside without trouble

CALICE R&D directly impacting on design

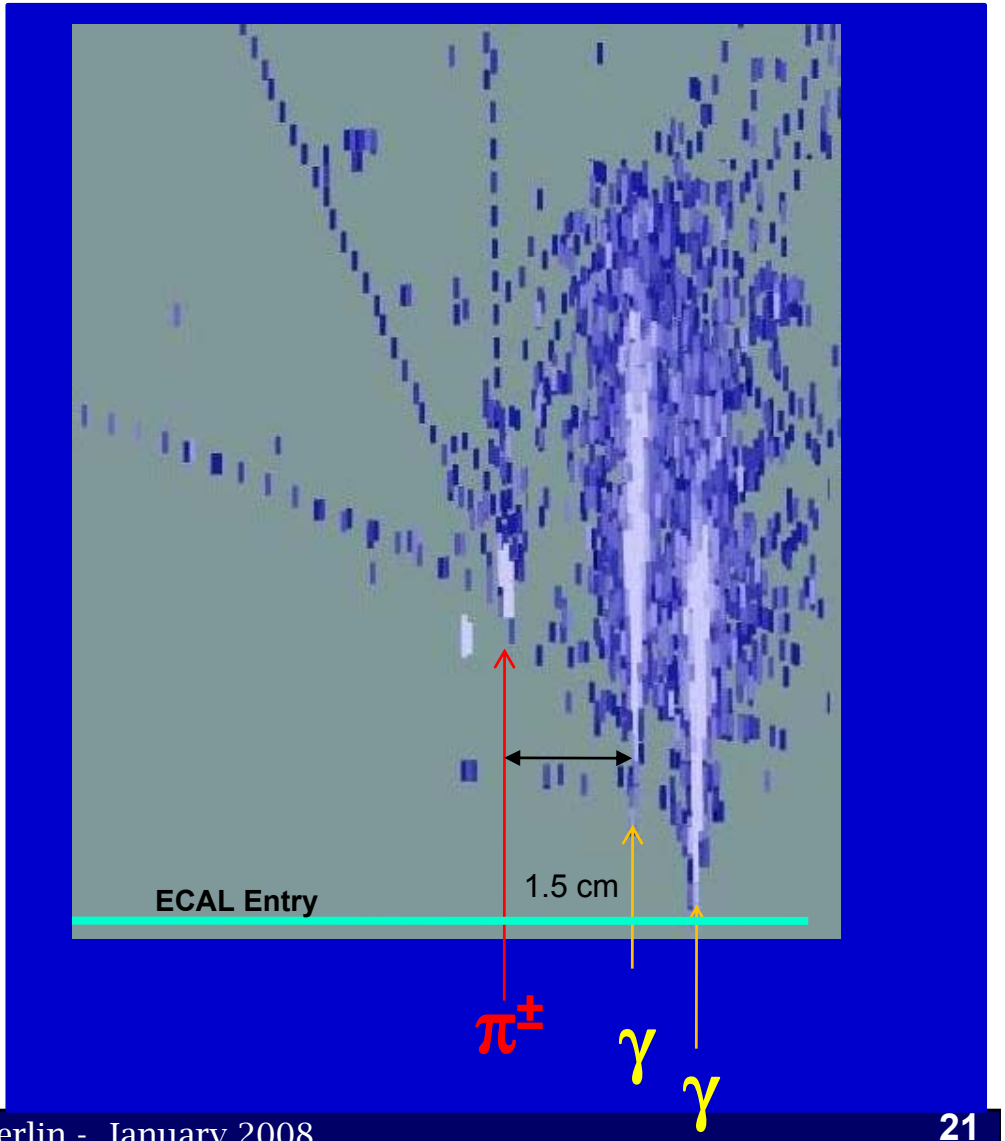
Our referee (from CMS) at IN2P3-France recent review, does not understand why it can be useful to have pixel size smaller than Molière radius…

Although , just a look is convincing

BUT

We have to make a compromise with electronics engineers (constraint due to the number of channels)

Pixel size at 0.5x0.5 cm² for the new prototype



"Un petit rappel" about optimizing the detector
the optimised variables must have impact on the performances and cost !!!

For the cost
- First order is silicon AREA
- First order is the choice of tungsten
- Number of channels (electronics) is second order
- …

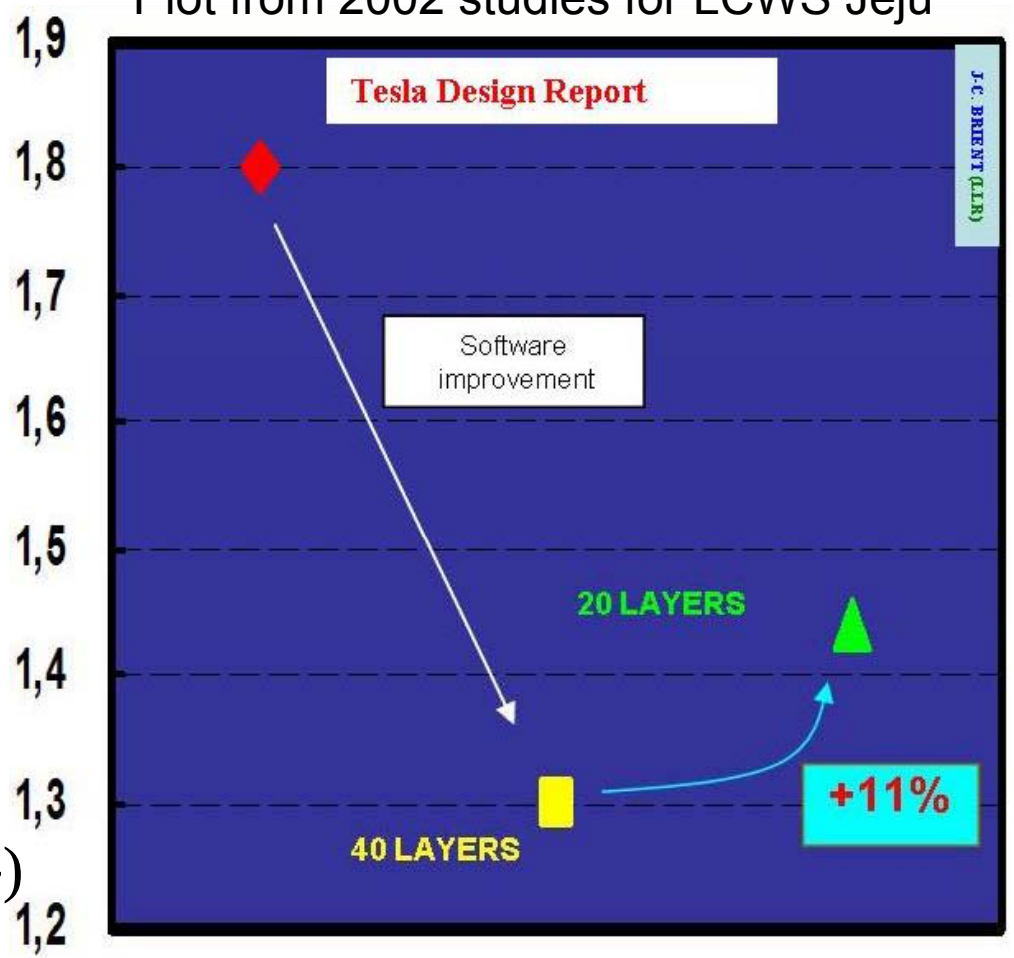
For the performances
- Radius impact on perf. (and indirectly on cost)
- Length of the Barrel (whatever the mag. Field)
- The pixel size
- …

Special warning
- The optimization through the PFA has to be taken

For what it is ….

A view through the filter of the limitation of the PFA program

Plot from 2002 studies for LCWS Jeju



Conclusion

ECAL in CALICE

> The needed R&D are going on

> No show stopper up to now

> We know where to go with the new quasi-module 0

Please, ILD designers , Remember,

If we do not stay around 20%X0 for the internal material budget ,
we can forget PFA !! (but also any good jet rec)

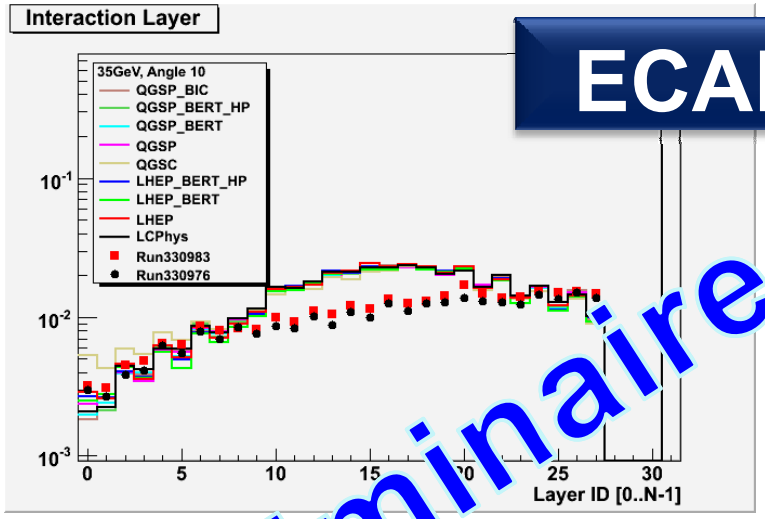

BACKUP

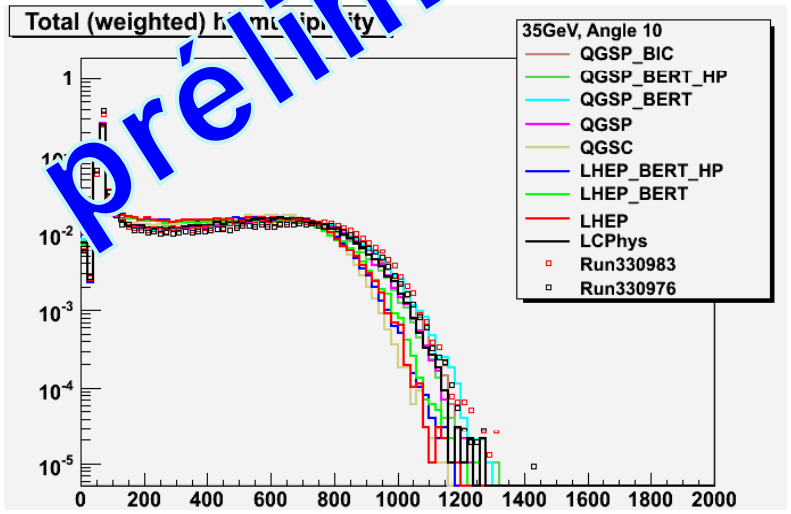
CALICE R&D directly impacting on design

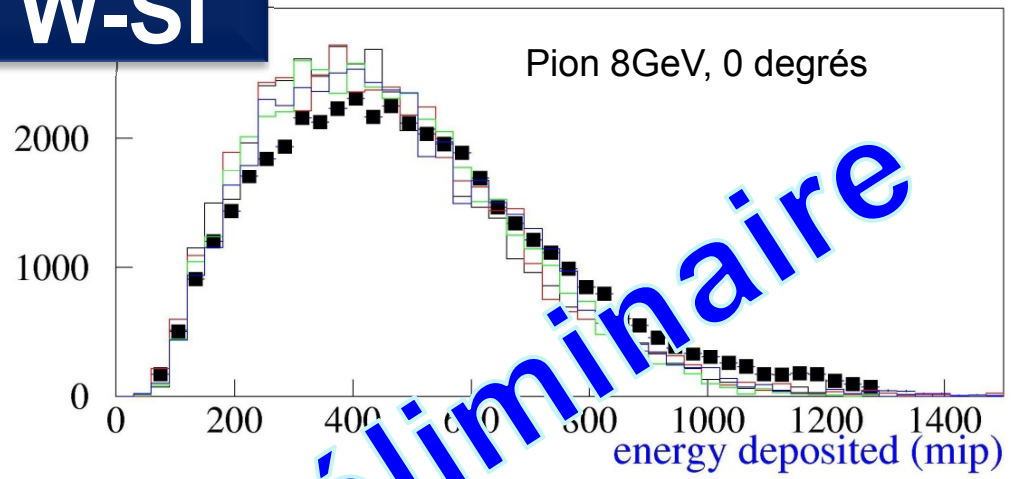
Analyse des gerbes hadroniques

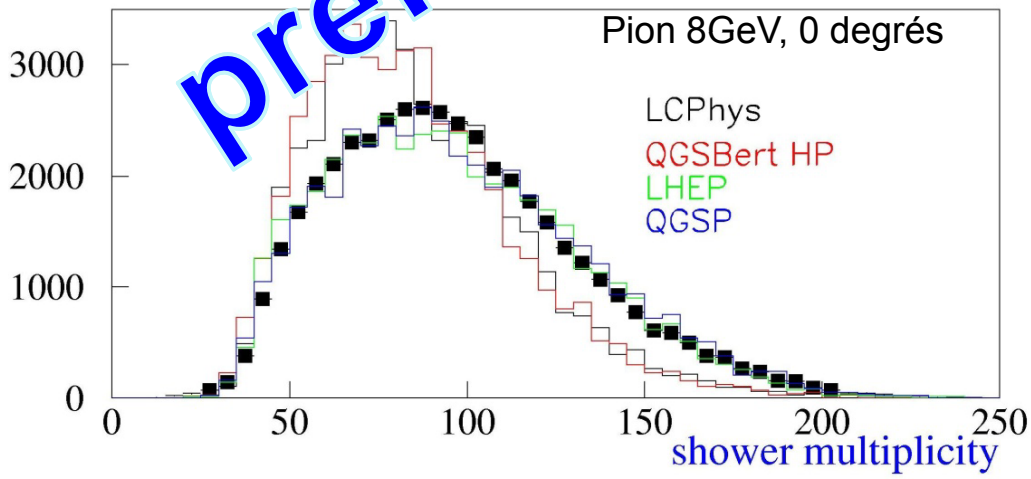
C'est en cours.
Les données de l'été 2007 sont les seules qui peuvent commencer à nous donner des informations;

ECAL W-Si

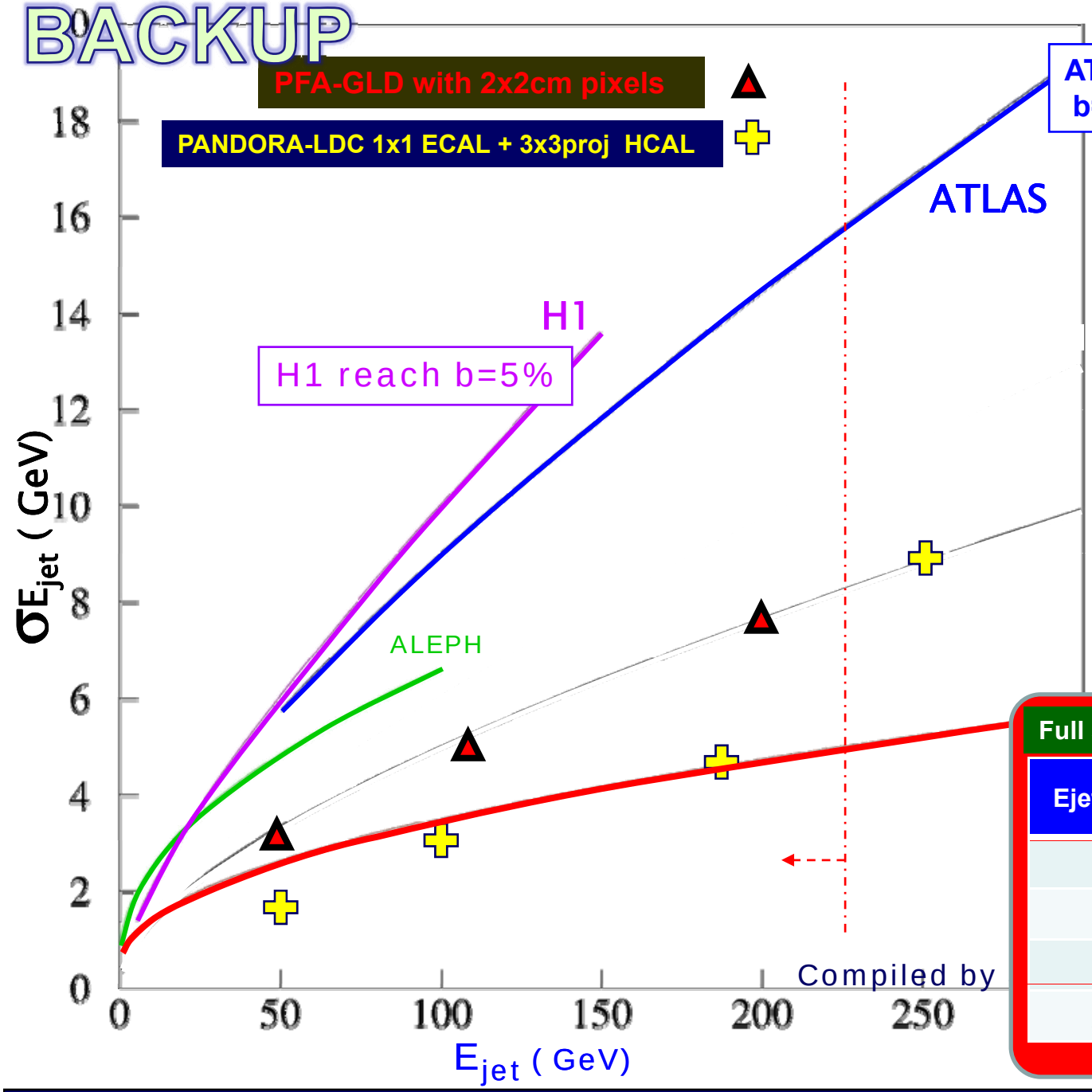






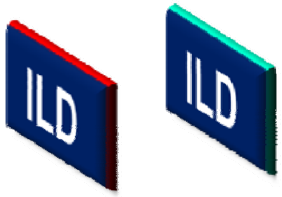


BACKUP



Full simulation and reconstruction

Ejet GeV	$\Delta E/E = \alpha \sqrt{E}$ $\lvert \Delta \cos \theta jet \rvert < 0.7$
45	0.227
100	0.287
180	0.395
250	0.532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