CALICE
Summary of 2006 testbeam for the ECAL

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On behalf of the CALICE-ECAL Collaboration

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   - Briefly, what does the ECAL look like ??
   - The three 2006 test beam periods and their objectives
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   - 1, 10 or 100 TBytes on disk ?
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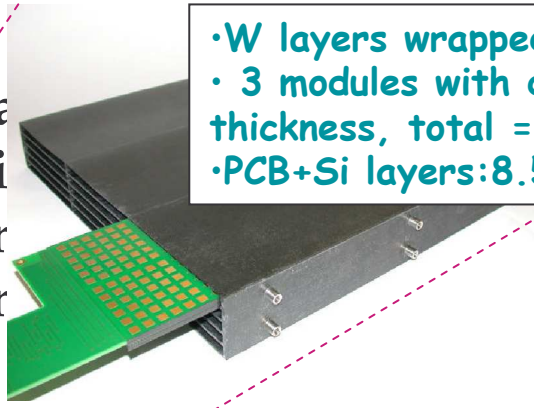
   - A few event displays.
4. Noise issues
   - A perfect detector would be amazing !
5. Conclusion
   - A successful experience

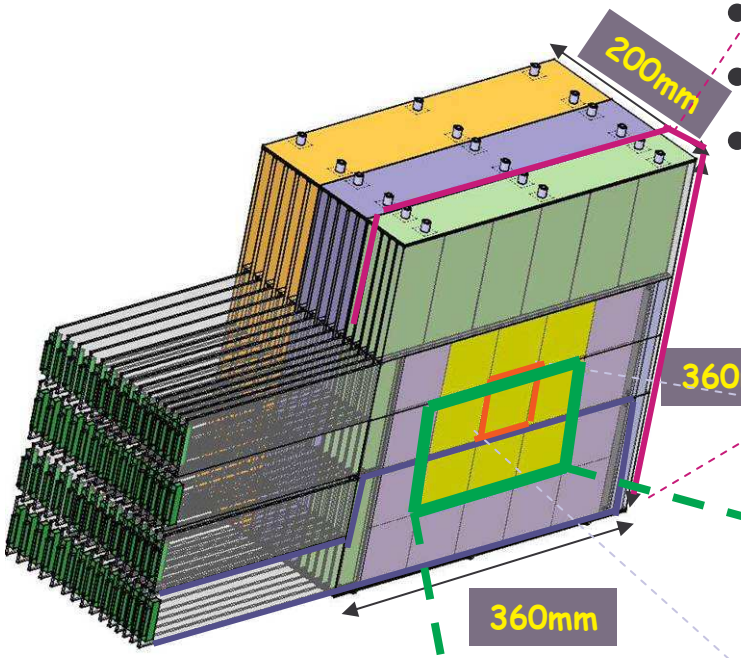
The Electromagnetic Calorimeter prototype

- ECAL prototype:
  - 30 la
  - Acti
  - Fror
  - Sigr

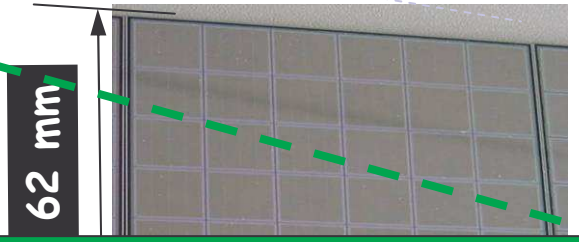


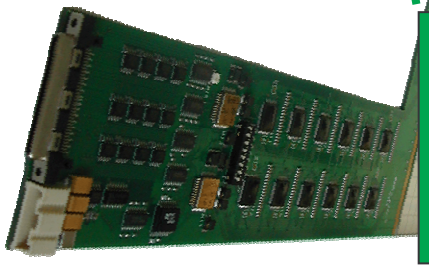
·W layers wrapped in carbon fibre
· 3 modules with different tungstene thickness, total = 24 X_0.
·PCB+Si layers:8.5 mm

it on PCB board



·6x6 1x1cm^2 Si pads
·Conductively glued to PCB





Area now completed for 30 layers
Last year : only 14 layers
Last 1/3rd expected in May 2007.

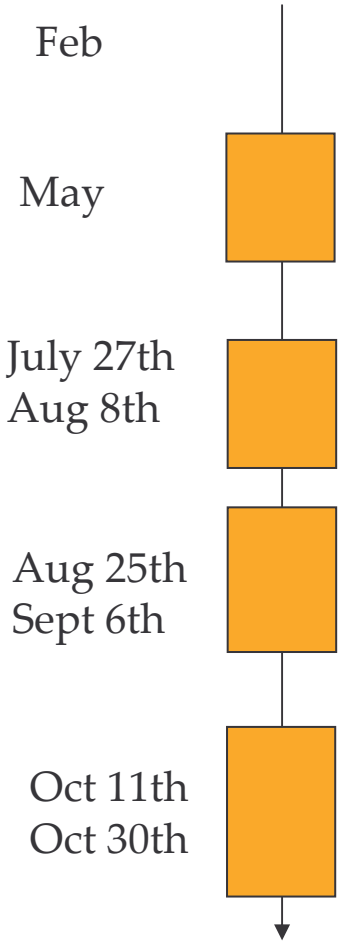
Overall objective of 2006 beam test for ECAL

- Characterize detector performances
- Test and tune the simulation. Once we trust the simulation Ł optimisation of the detector

- Identify hardware problems to correct them before building the whole so-called EUDET module.

- Test particle flow algorithm.

2006 beam test period



Feb — Installation @ DESY . First cosmic events in the “tent”.

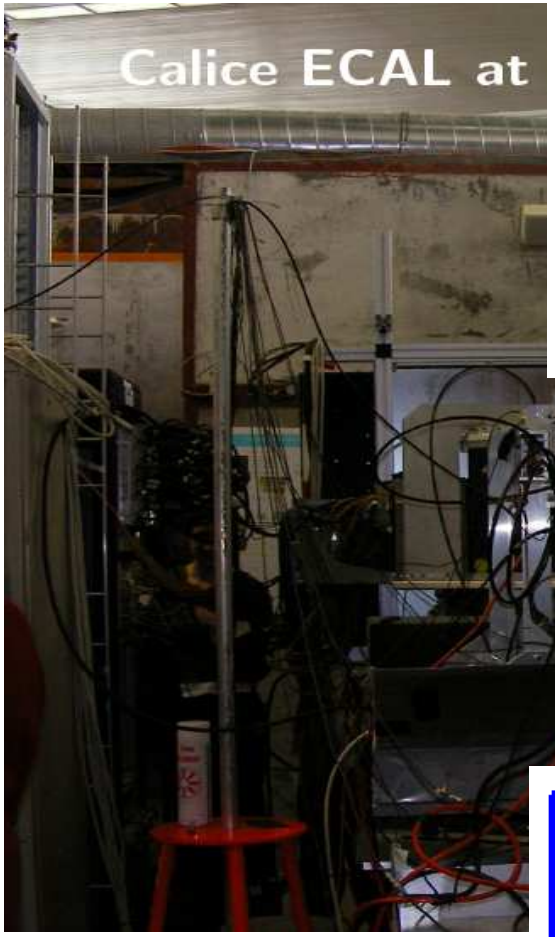
May — DESY TB area, 1-6 GeV electron beams, with only 24 layers .
14 days in total.

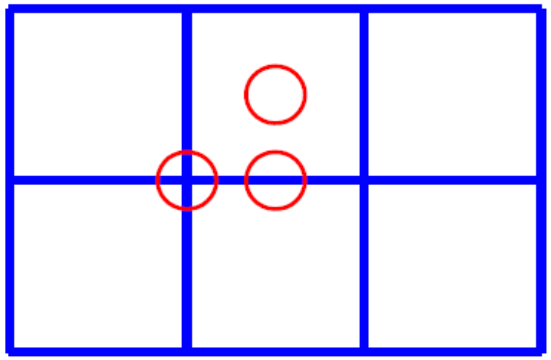
July 27th
Aug 8th — ECAL CERN period : cancelled !! No beam, SPS fault, not ours....

Aug 25th
Sept 6th — AHCAL+TCMT period : transformed into 5 days ECAL+5 days AHCAL stand alone
+ 3 days, courtesy of ATLAS, for ECAL stand alone.

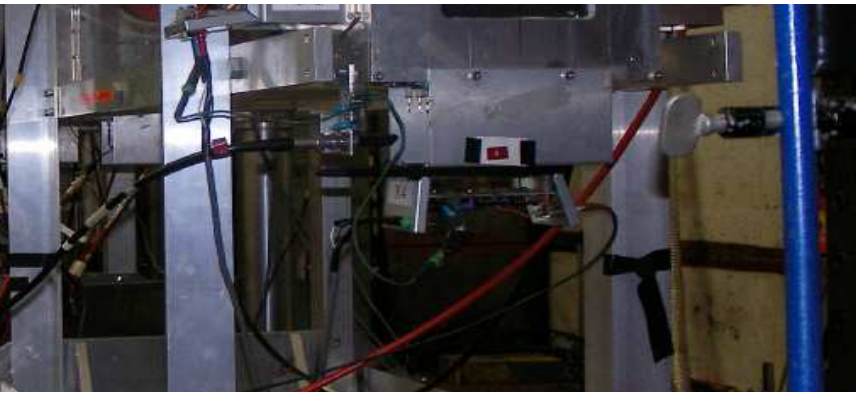
Oct 11th
Oct 30th — Combined ECAL+AHCAL + TCMT , with ECAL-AHCAL @ 6cm

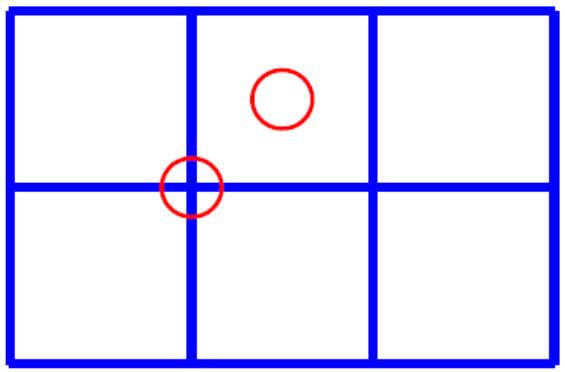
DESY TB setup





- ECAL at 0°
  three position points
- energy scan (1, 1.5, 2, 3, 4, 5, 6 GeV)
- 100k events per sample





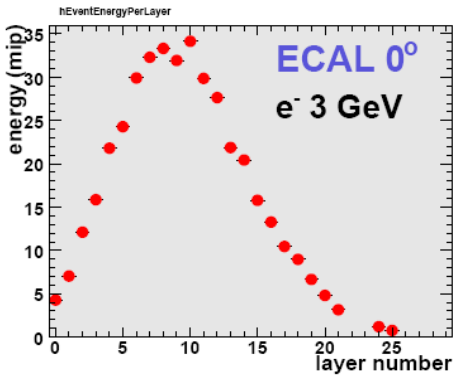
- angle scan (10°, 20°, 30°, 45°)
  two position points
- energy scan (1, 1.5, 2, 3, 4, 5, 6 GeV)
- 100k events per sample

Trac
ECAL:
First tests of EC

DESY Data Samples

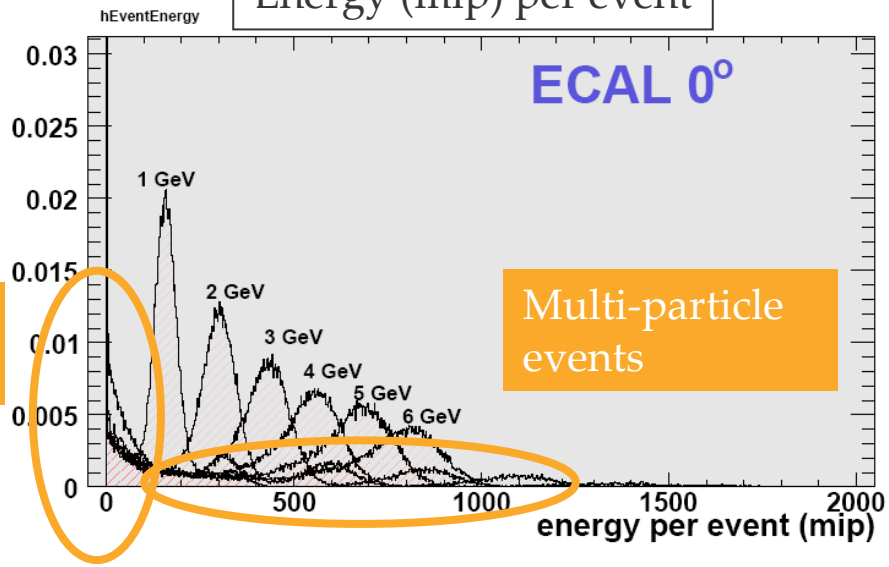
angles	0 deg (k Evt.)	10 deg (k Evt.)	20 deg (k Evt.)	30 deg (k Evt.)	45 deg (k Evt.)	GOAL per angle
total :	**2888**	**2112**	**1545**	**1934**	**1400**	
(GeV)						
6	594	688	200	185	200	100
5	304	300	200	325	200	100
4	400	224	200	300	200	100
3	304	200	200	324	200	100
2	400	200	200	300	200	100
1.5	486	200	200	300	200	100
1	400	300	345	200	200	100

E per layer



Ł Shower fully contained

Energy (mip) per event

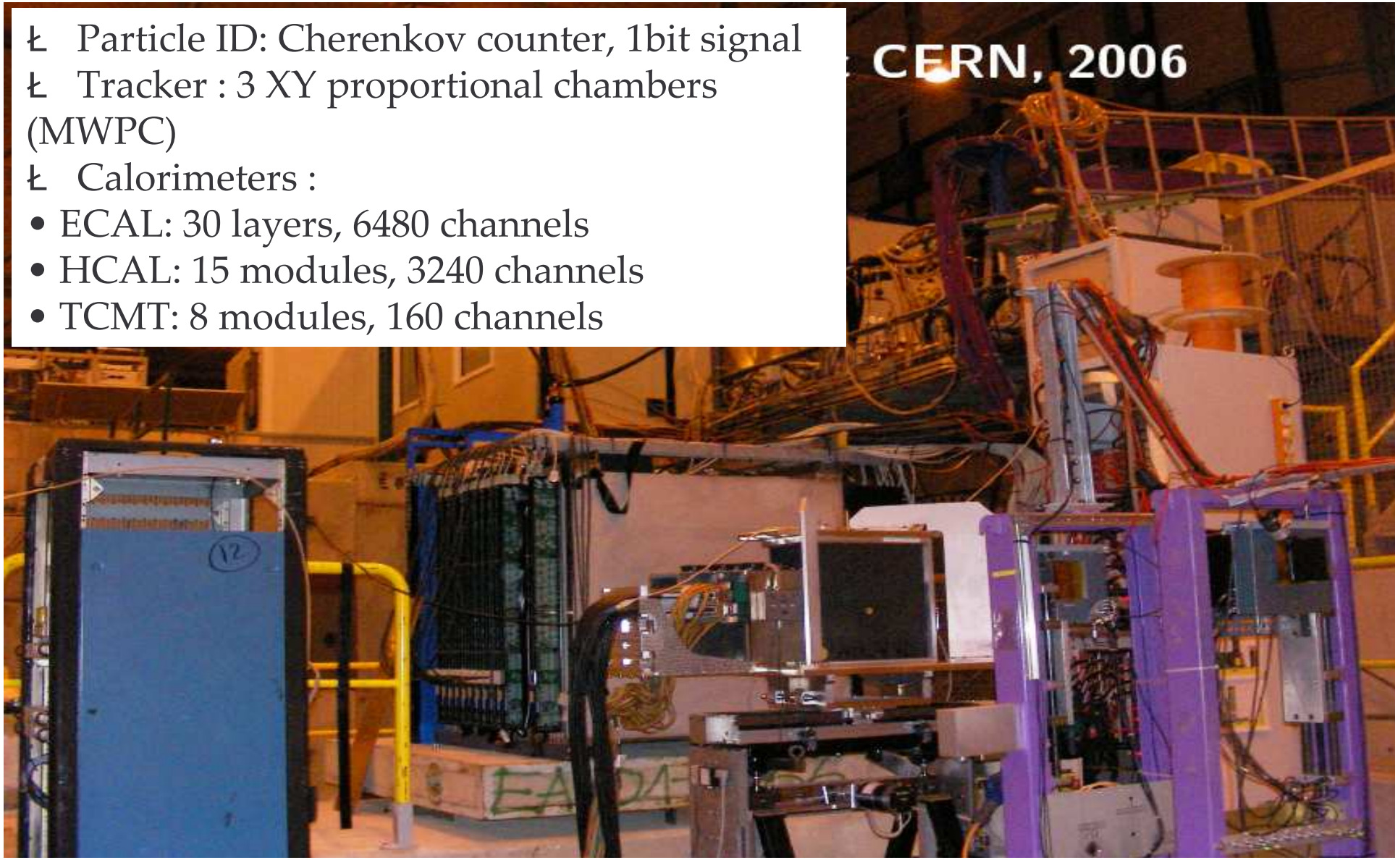


Garbage and empty events

Multi-particle events

CERN installation

- Particle ID: Cherenkov counter, 1bit signal
- Tracker : 3 XY proportional chambers (MWPC)
- Calorimeters :
  - ECAL: 30 layers, 6480 channels
  - HCAL: 15 modules, 3240 channels
  - TCMT: 8 modules, 160 channels



CERN- August period in figures

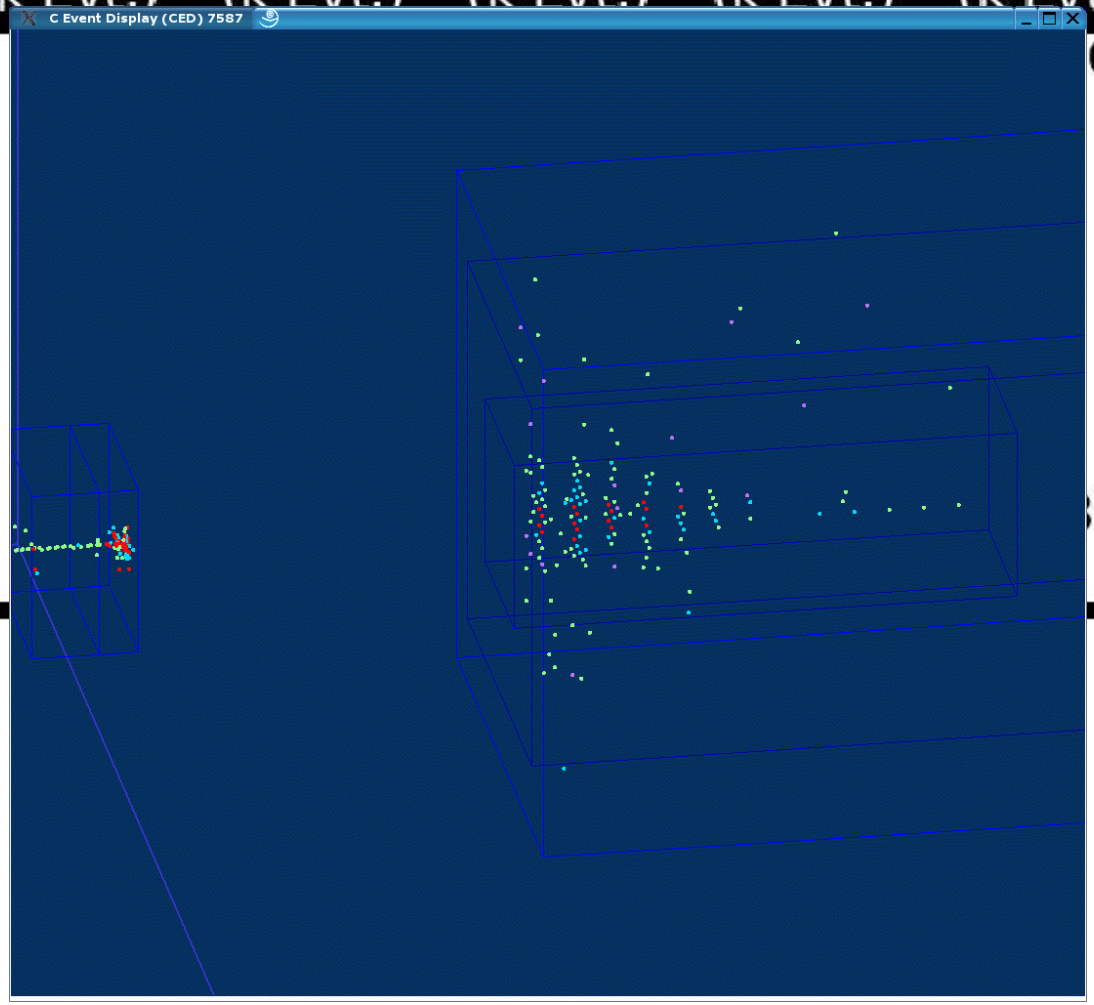
- **run plan**
  - : ECAL testbeam with electrons at higher energy
  - : HCAL+TCMT commissioning
  - : beam tuning

angles	0 deg (k Evt.)	10 deg (k Evt.)	20 deg (k Evt.)	30 deg (k Evt.)	45 deg (k Evt.)	GOAL per angle
total :	**2843**		**742**	**2688**	**2375**	**900**
energy (GeV)						
45	933		250	753	551	250
40	347			280	311	150
30	685		270	550	531	250
20	380		110	330	208	100
15	201			181	244	50
10	297		112	594	530	100

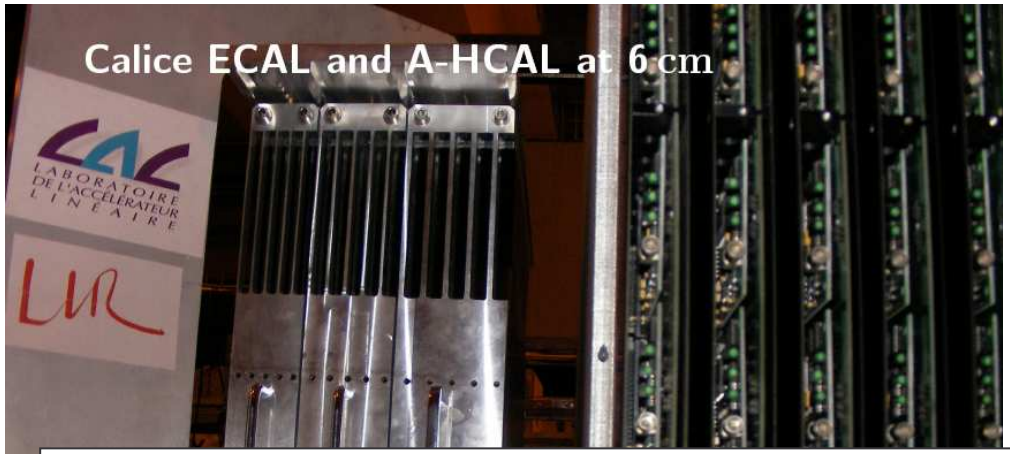
+ 30 Millions of Muon events for calibration.

A few hadron runs combined with AHCAL and TCMT

angles	0 deg (k Evt.)	10 deg (k Evt.)	20 deg (k Evt.)	30 deg (k Evt.)	45 deg (k Evt.)	GOAL per angle
total :					03	0
energy (GeV)						
80						
60						
50						
40					03	
30						



October 2006 period



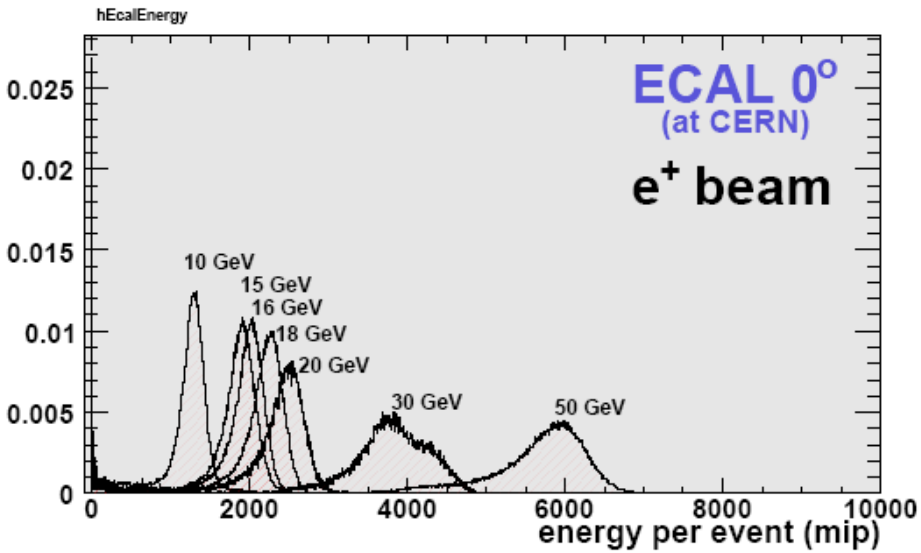
- Calorimeters
  - : **ECAL:** 30 layers, 6480 channels
  - : **HCAL:** 23 modules, 4968 channels
  - : **TCMT:** completed, 16 modules, 320 channels

- Add another **70 Million physics events** !
  - **+ 14M** only for HCAL calibration
  - **+ 3.5** M of HCAL only runs

- Detail of the 70 M:
  - 42M of muons for calibration
  - Another 3.8 M dedicated to electron studies between 6 and 50 GeV
  - And 23 M of hadronic events between 6 and 80 GeV
  - Dedicated to beam tuning : "only" 1.2M

Electron runs

Electron combined runs		
E (GeV)	e+ (kEvts)	e- (kEvts)
6	208	128
8		218
10	152	172
12		211
15	476	124
16	310	
18	303	231
20	390	210
30	409	
50	305	



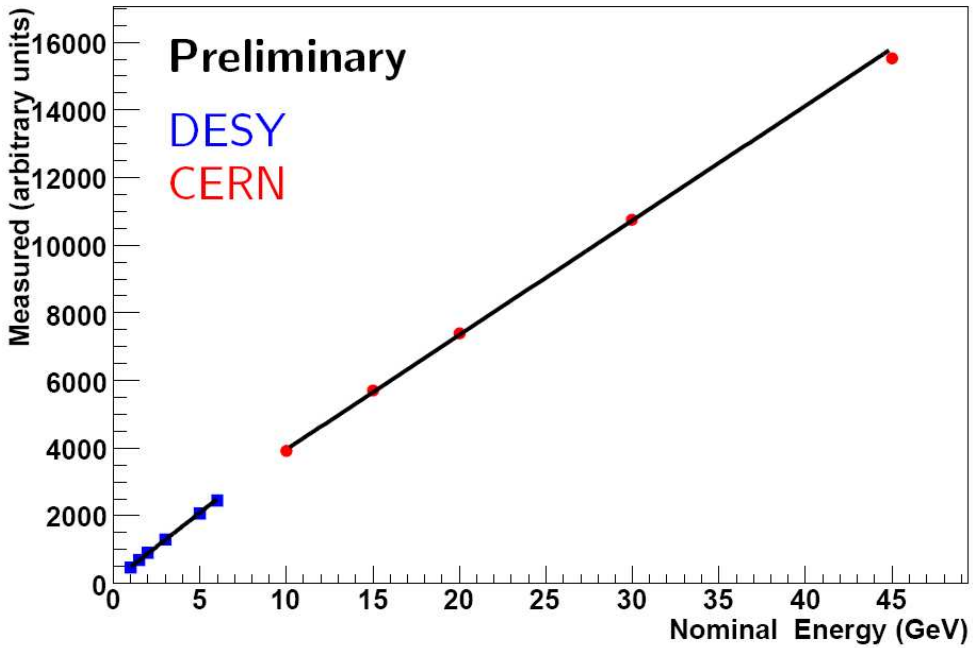
- most runs with nice and typical behaviour
- at 30 GeV run response spoiled by noisy/unstable layers

Hadron runs

Combined pion runs		
E (GeV)	π+ (kEvts)	π- (kEvts)
6	481	1804
8		1872
10	968	1878
12		1568
15	722	1616
18		1728
20	769	1559
30	3298	
40	1457	
50	1533	
80	1860	

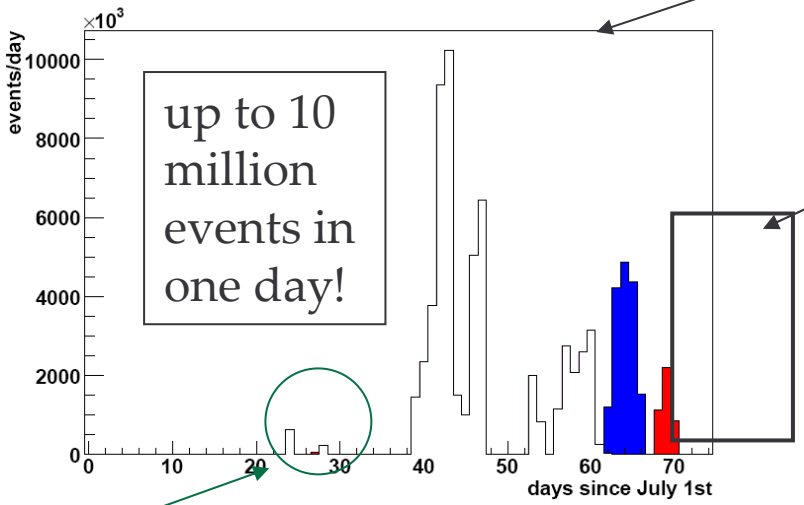
Summary of events

- Add the final plot showing nb of events per day over the whole CERN period, separating tuning/calib/physics ???



The data taken

CERF period: parasitic muon
high intensity, wide distribution
Ł Very important for calibration !!!



Combined run, goal: ECAL EM program
- e 10-45 GeV, from 50 GeV beam, with 0,10,20,30 deg
- small samples of π 30-80 GeV
too large distance ECAL-AHCAL

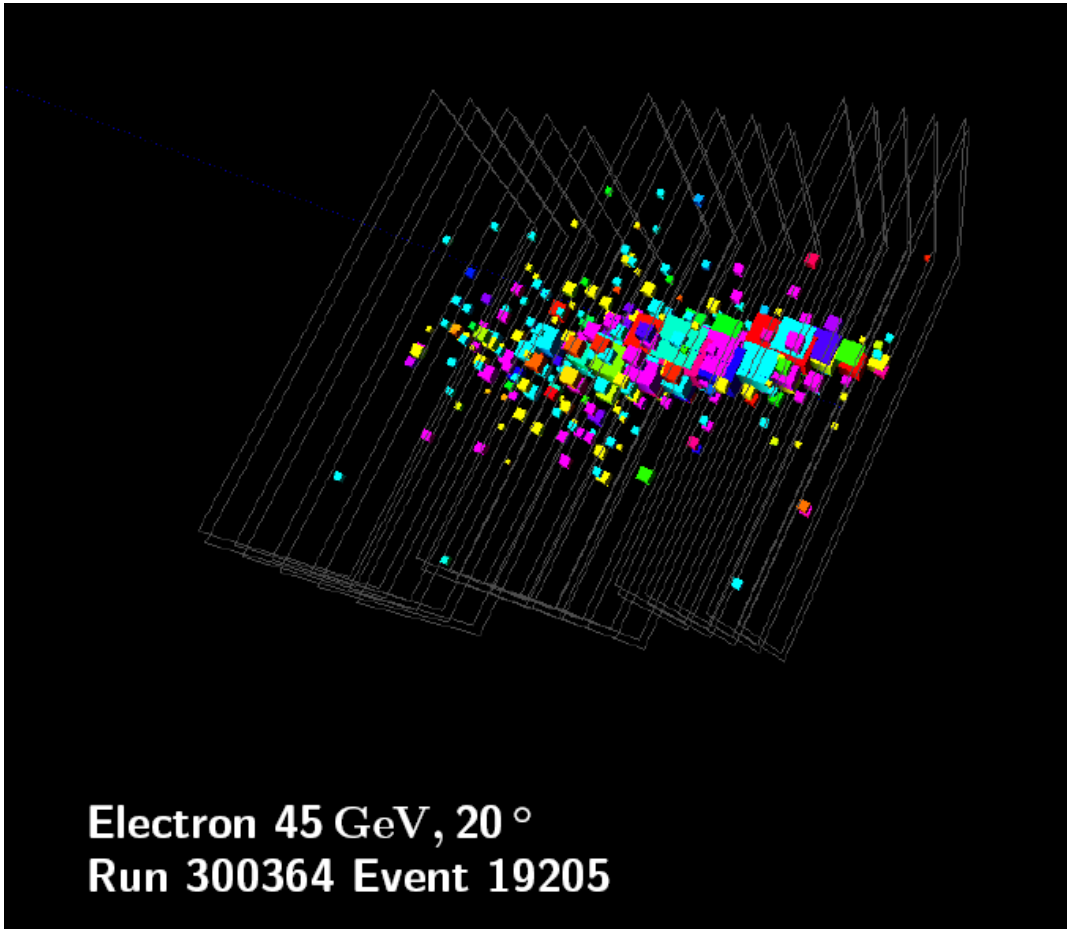
AHCAL stand alone, ECAL removed
- 1 day @ 10 GeV secondary beam
tested π / e 6,10,15,20 GeV
- 3 days @ 50 GeV secondary beam
e 10-45 GeV and p 30-80 GeV

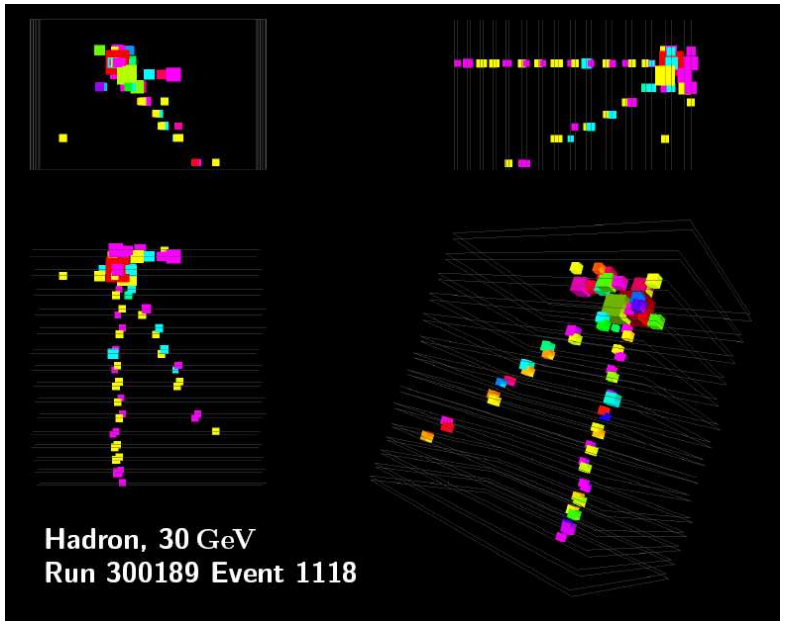
All what was collected in the ECAL run:
60 GeV secondary beam, tested e 10-45 GeV and π 30-80 GeV.

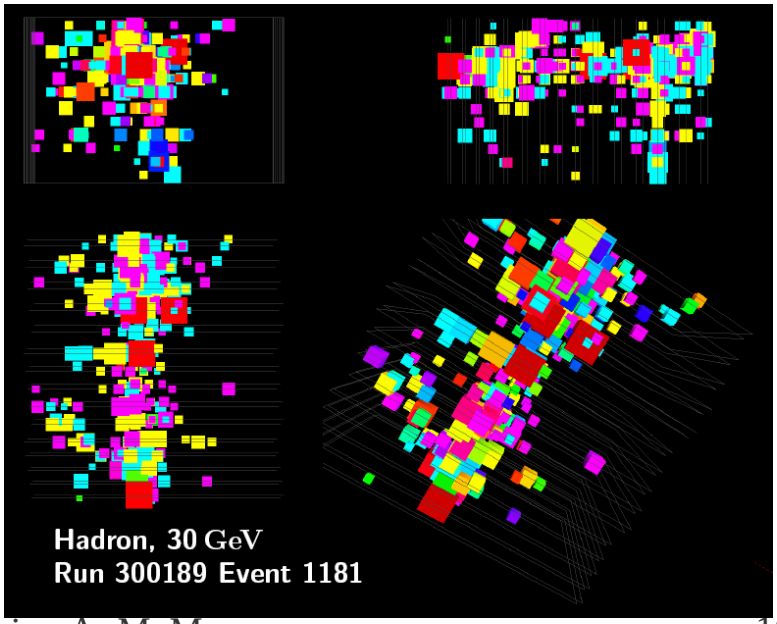
!!! large fraction of time invested in beam tuning !!!

Ł 3 additional days "courtesy" of ATLAS: AHCAL and TCMT out of beam line, ECAL re-installed for high statistics low energy runs (thanks to all voluntary shifters)

Electron and π showers in the ECAL







A few more displays

- For the October runs...

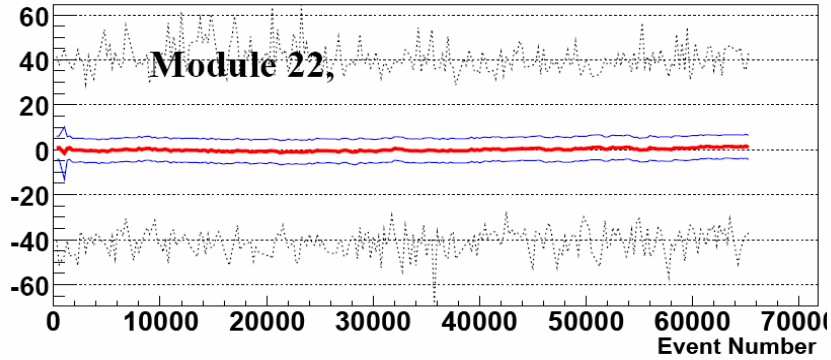
A few problems, “of course”

1. Pedestal instabilities : results in “noisy” layers, with a correlated noise over a whole PCB of up to 50% of a MIP !!!
   - Not understood yet ! Currently investigating on an hardware point of view !!
   - A preliminary procedure to correct this effect event by event is applied in the data reconstruction, but need further studies.
2. “Square events” : appearence of hits around some wafers, in the guard ring zone.

Pedestal instabilities ...

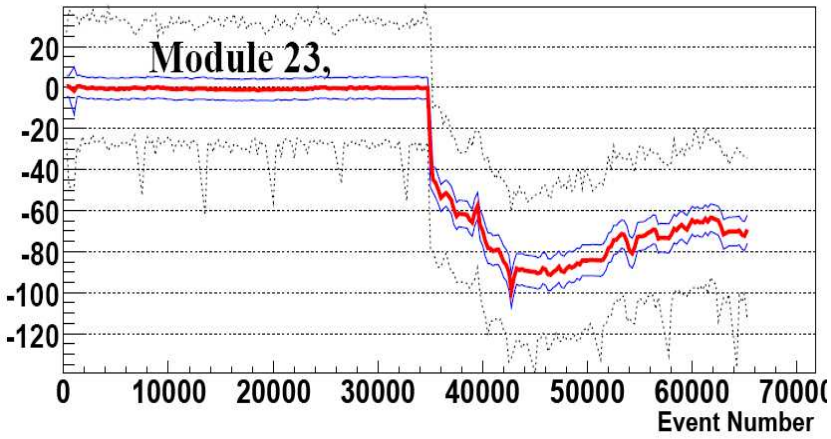
A Good PCB

Noise

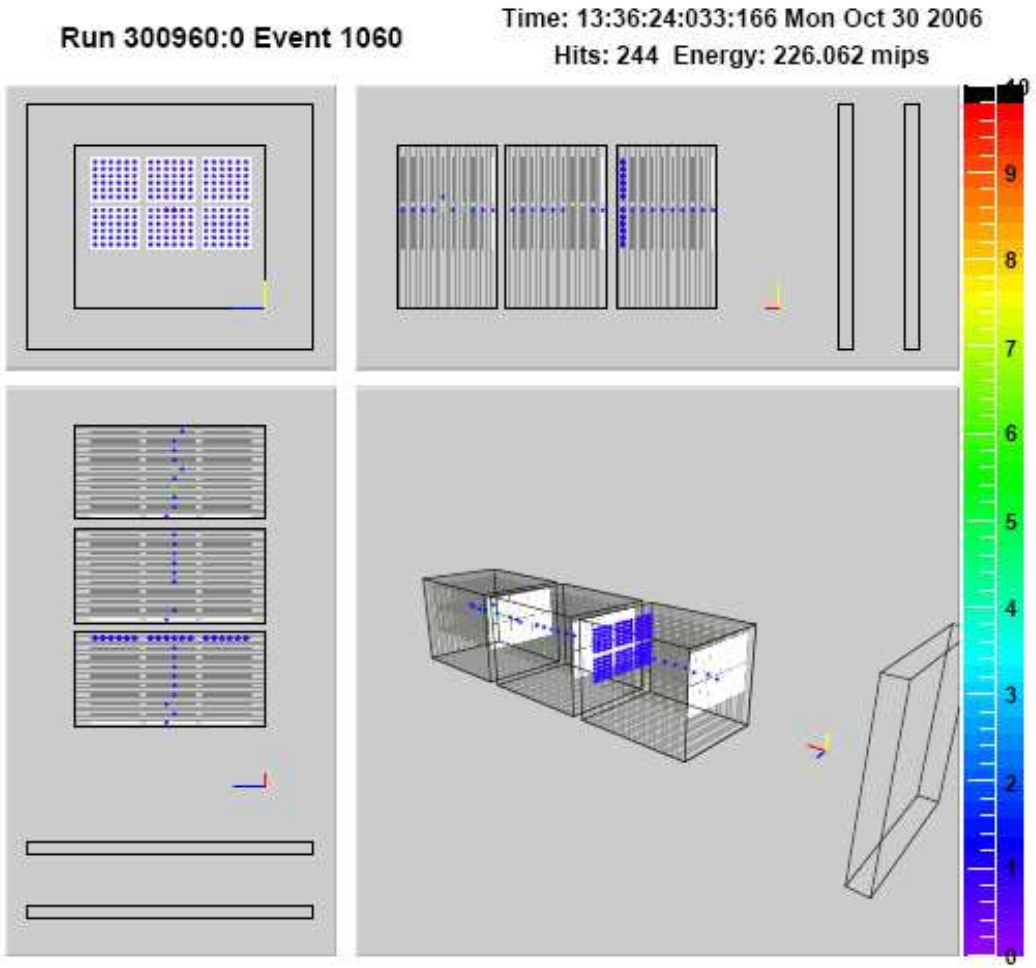


A PCB with unstable pedestals

Noise



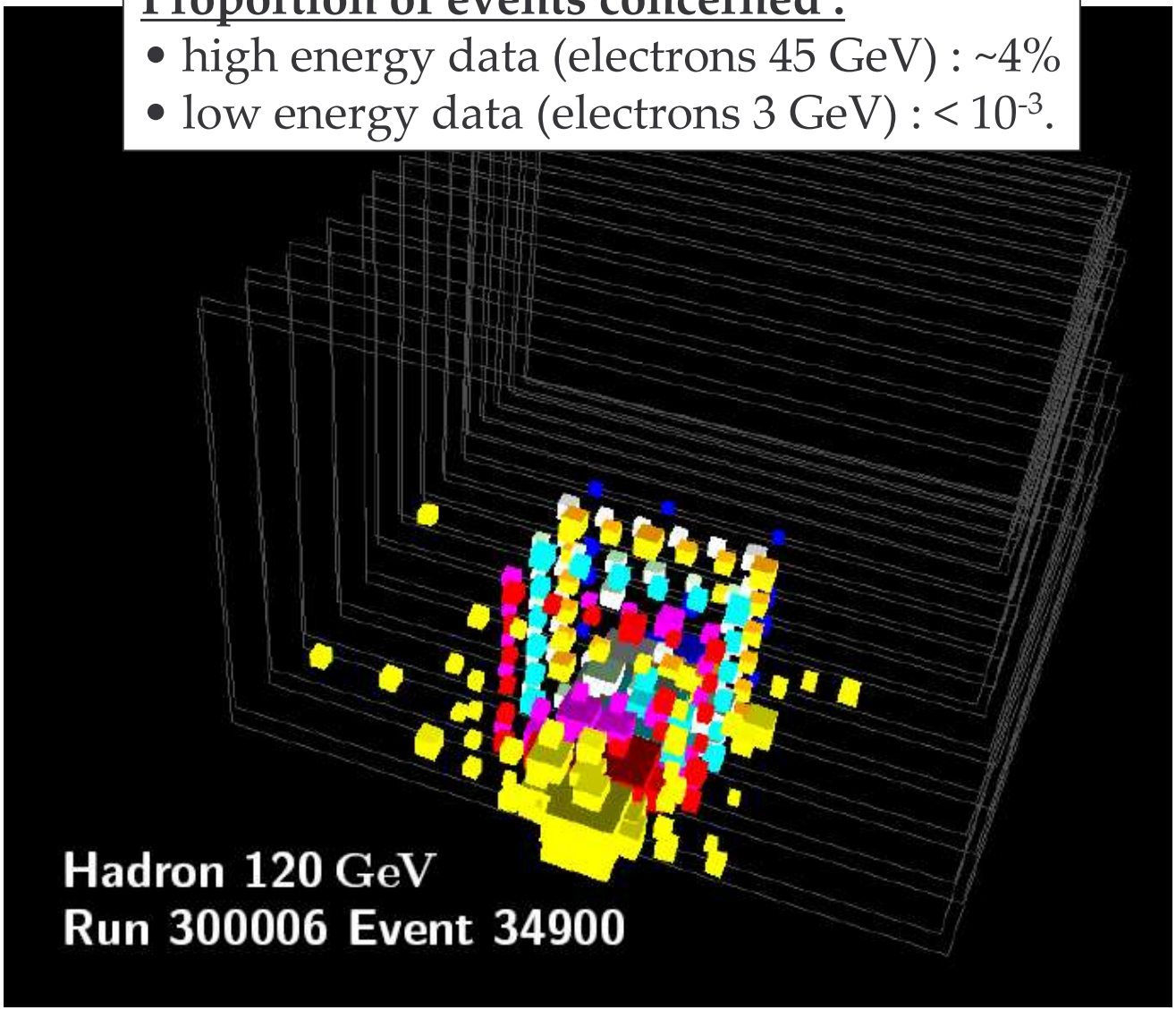
Muon run (ECAL threshold : 0.5 MIP)



“Square” events ...

Proportion of events concerned :

- high energy data (electrons 45 GeV) : ~4%
- low energy data (electrons 3 GeV) : < 10^{-3}.



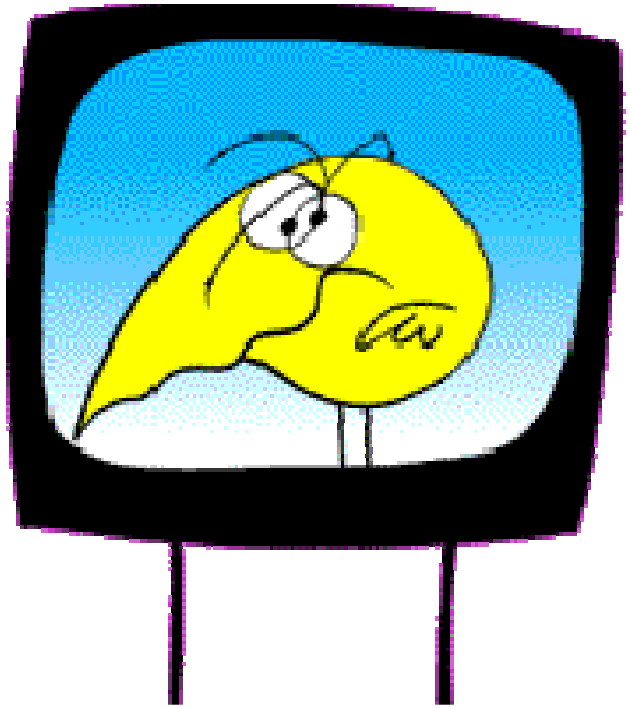
Conclusion

- A successful experience !!
- Lots of data taken, stable detector running, people on-site to solve the problems as soon as they appear...

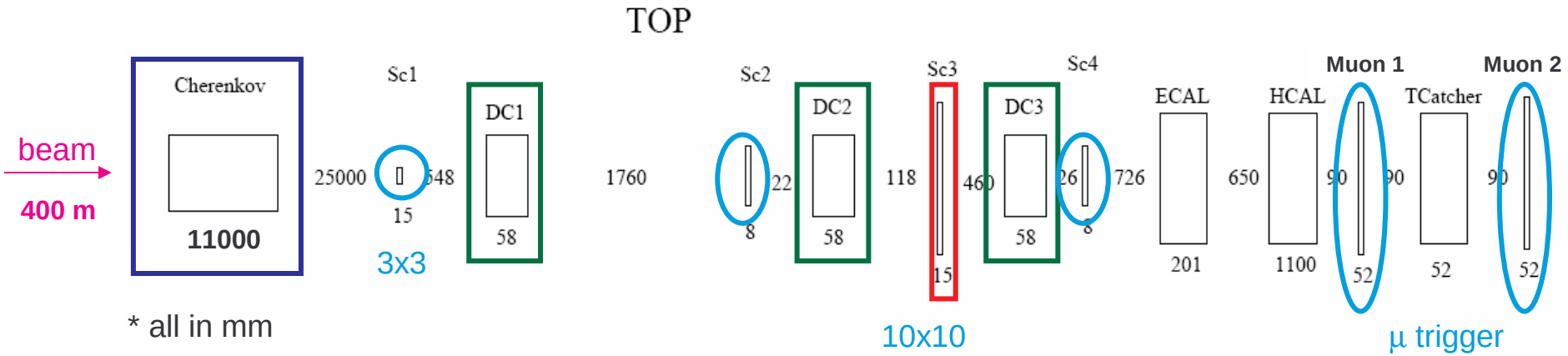
- ...

- Further plans : TB in May-June next year (currently in negociation with CERN)
- + Fermilab with DHCAL in fall 2007.

Chop, chop ! Happy analysing everybody !!



CERN installation



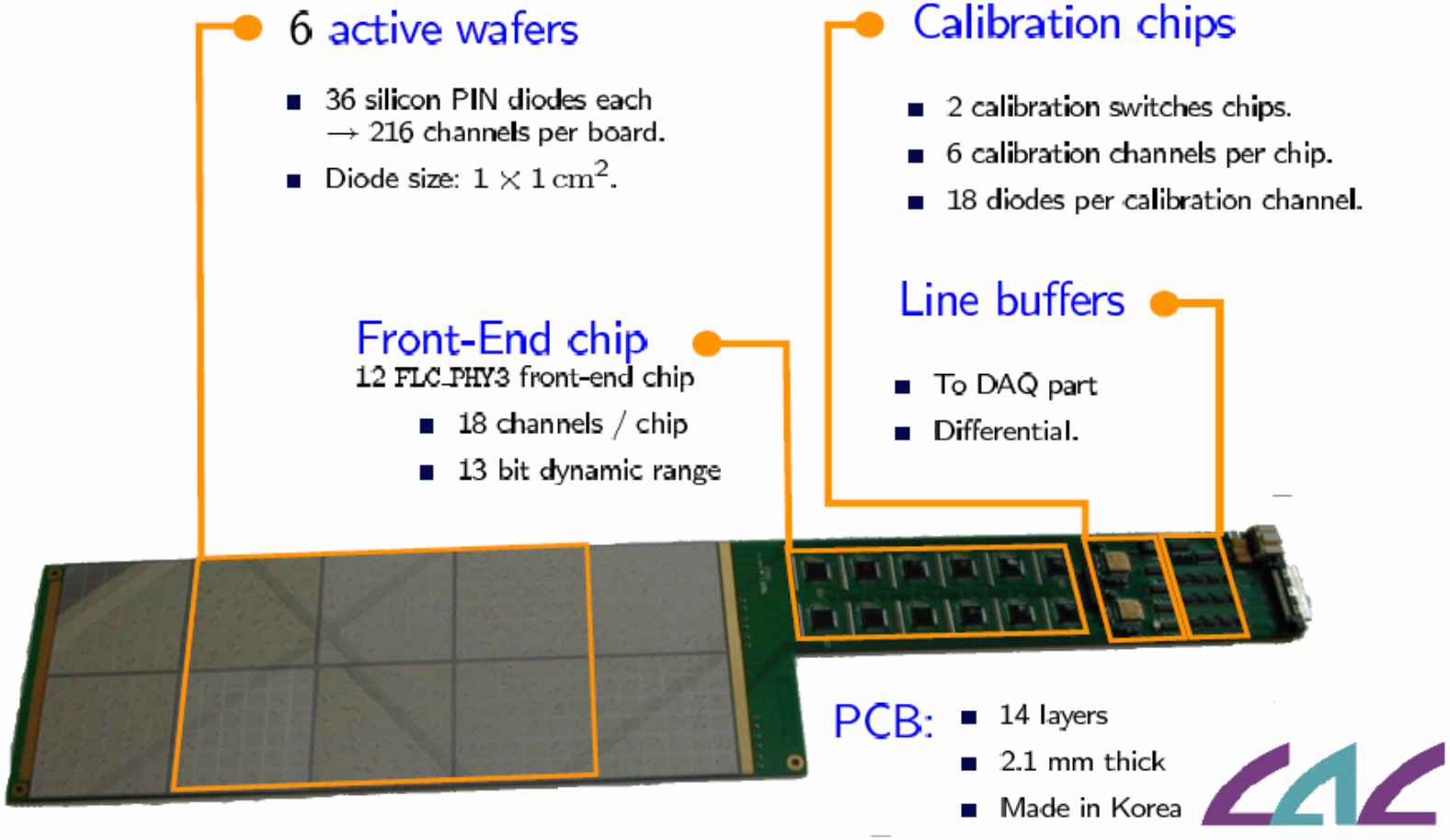
Beam instrumentation:

1) ~500 m beam line after Be trg = magnets, collimators, secondary trg, abs
2) Cherenkov detector for e/π separation < 40 GeV
3) 3 x/y pairs of Multi Wires Proportional Chambers (MWPC) with double readout, multi-hit capability
4) veto counter, r/o analog amplitude, to separate multi-particle events
5) trigger system

2) 3) 4) 5) are integrated in the DAQ and read out event by event

View of an ECAL board

ECAL board



Beam quality issues @ DESY