CALICE ECal data analysis

May 2007

Kobe, CALICE meeting, May 11, 2007

Michal Marcisovsky, IoP ASCR

Structural overview

- Perform muon calibration for each pad individually
  - Do event selection for muon data

- Usign the above calibration, analyze the electron data
  - Apply electron event selection

- SW used: raw2calohit 0402

Caveat emptor: This is first approximation to a complex problem.

Calibration

- Using muon runs :

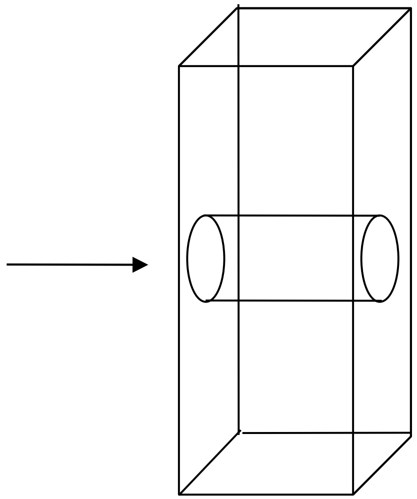
300919 - 300941
300949
300951
300956 - 300962

Each run has ~ 250 k evt

32 runs;

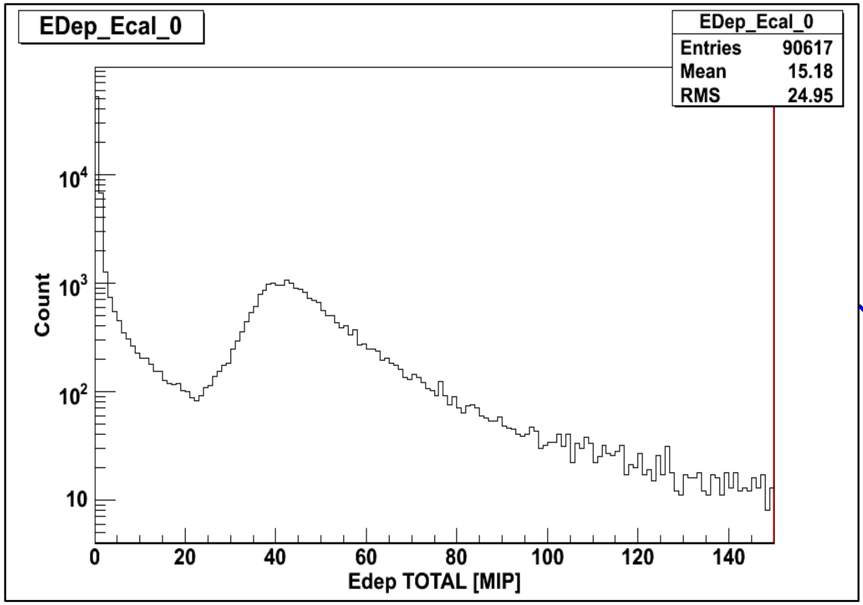
Total about ~ 8 M evt

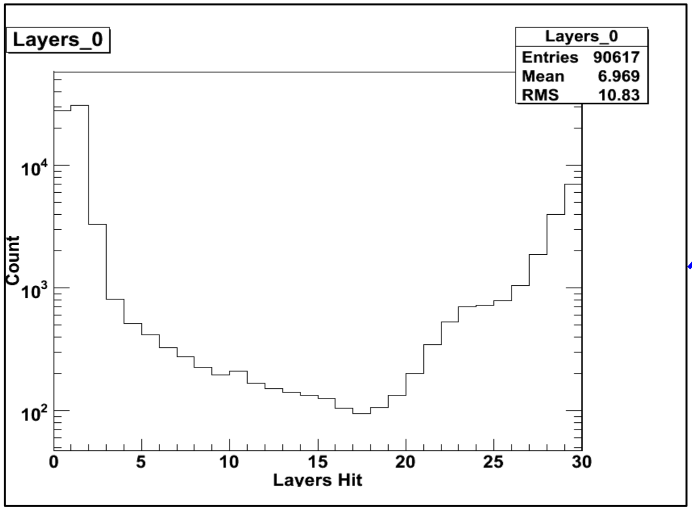
- Virtual cylinder around muon

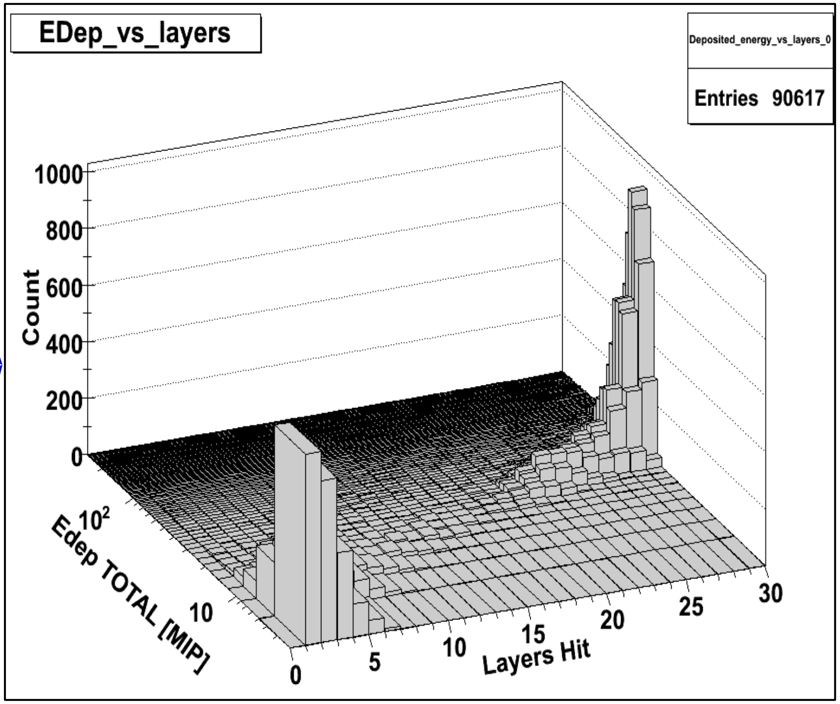


Calibration

Run 300919








```
if (E_hit > 0.75 MIP)  {
 Layers[z]=1;
}
 h->Fill( Sum(Layers[z]) );
```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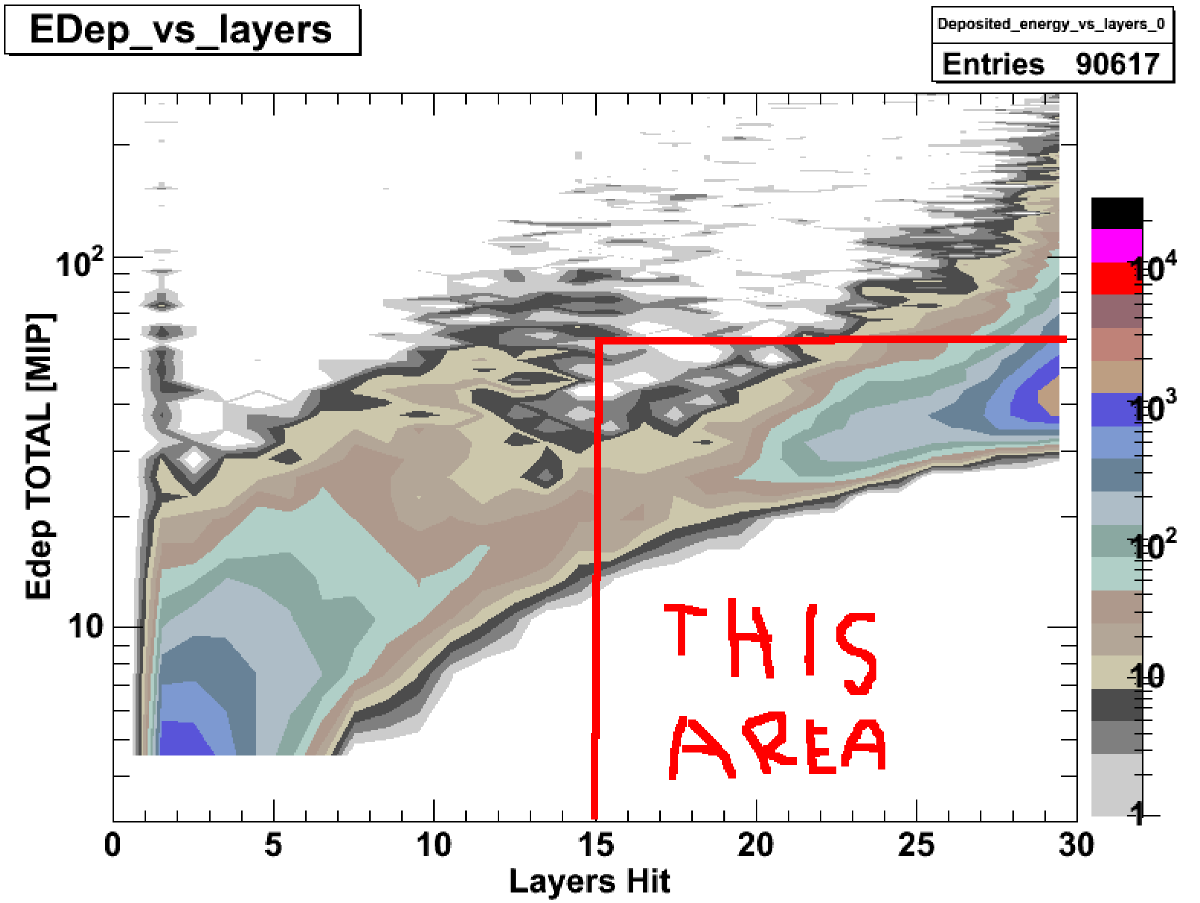
Calibration

- Apply selection:

  # of layers hit >14

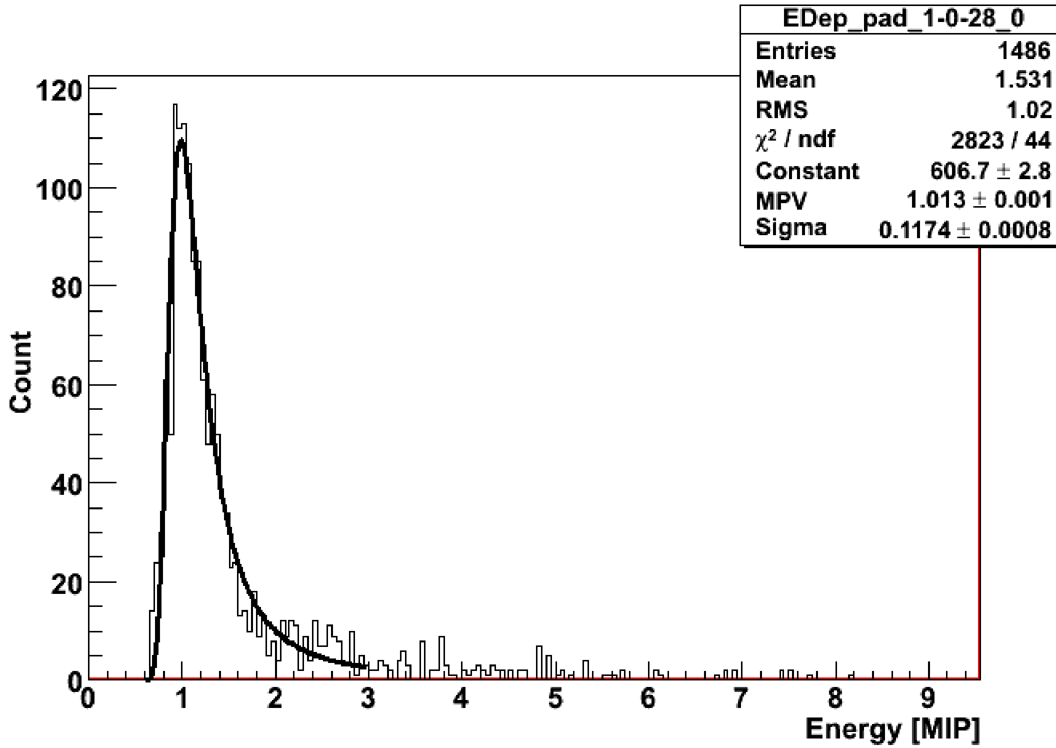
  Edep TOTAL MAX < 60 MIP



- This cut should help suppress the noise

Calibration II.

- Using data from all above mentioned muon runs to have sufficient statistics
- Fit each channel with Landau



- Average # of hits per pad ~1000

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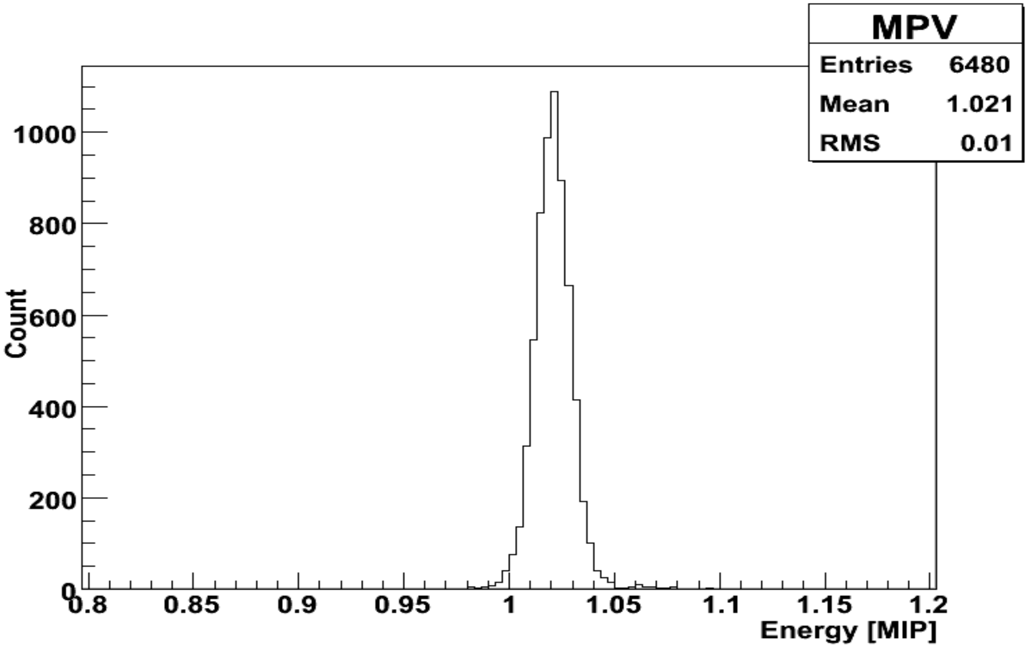
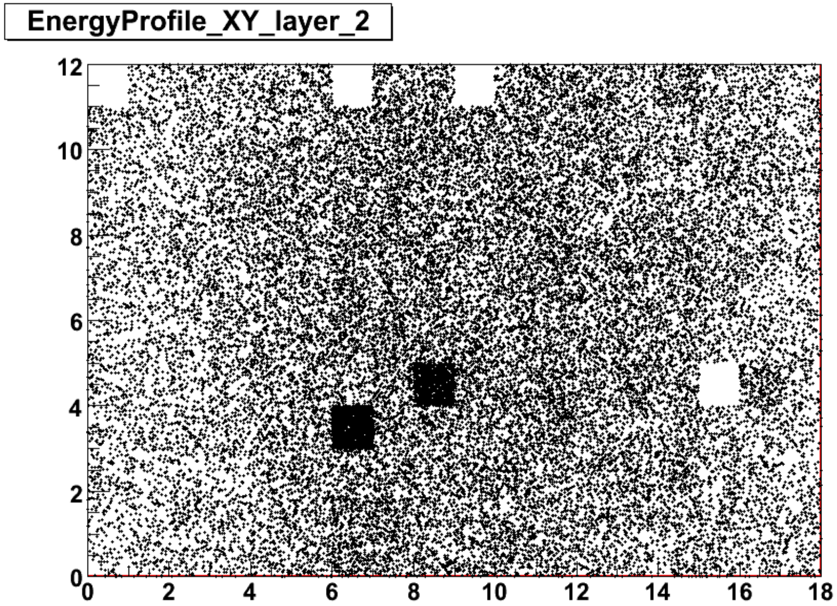
Calibration III.



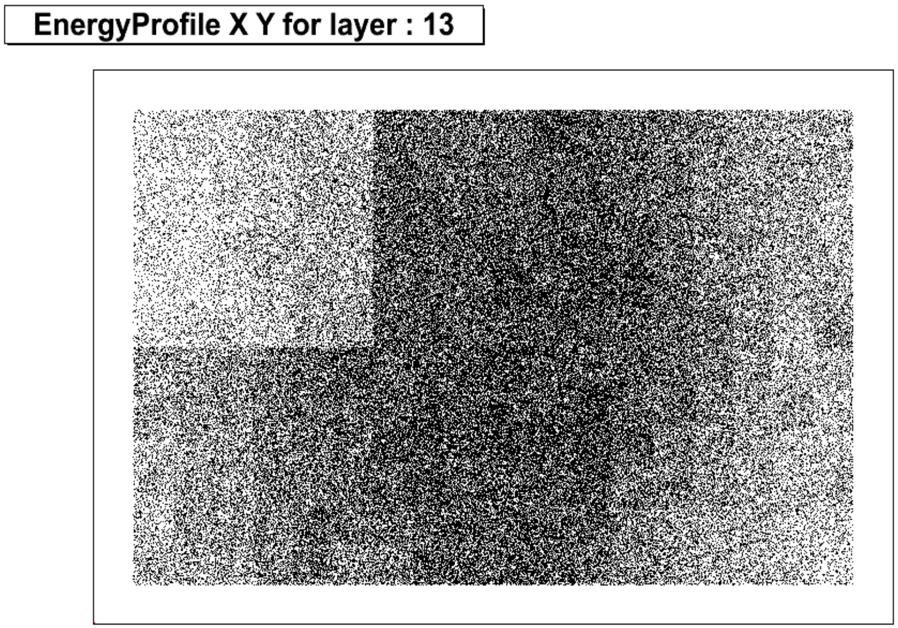
- About 2% off
- Each pad is corrected individually
- Since in database we have different calibration constants for different runs, this correction is averaged

~ 20 dead/noisy pads.

White and black holes in the ECAL



Third layer, run 300919:
4 DEAD (?) pads
2 Noisy (?) pads



Layer 13, run 300135:

One wafer in upper left corner is less efficient than the others.

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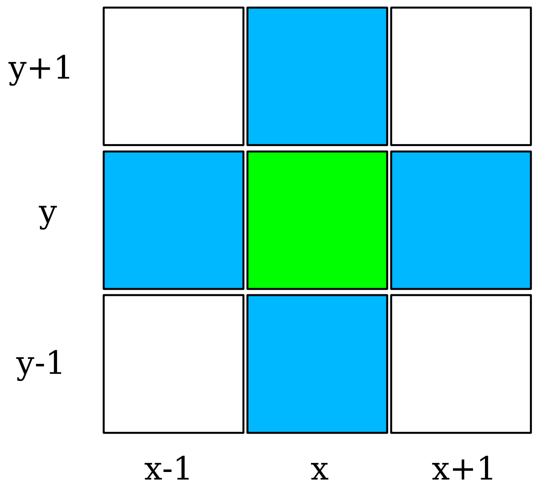
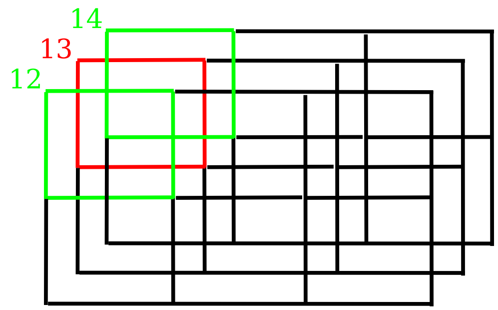
Sewing the ECAL

$$E_{dep}(x,y)=\frac{1}{4}\left(E_{dep}(x+1,y)+E_{dep}(x-1,y)+E_{dep}(x,y+1)+E_{dep}(x,y-1)\right)$$



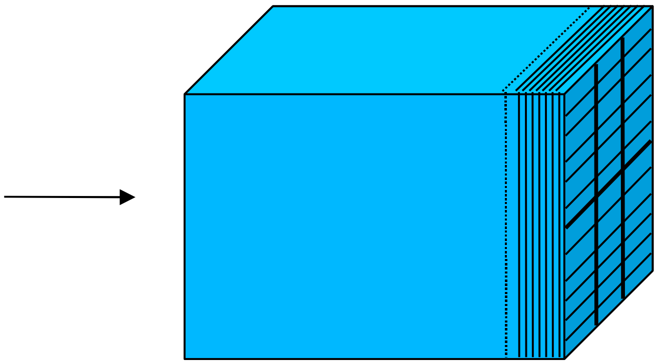
First approximation to the holes.

$$E_{dep}(x,y,13)=\frac{1}{2}\left(E_{dep}(x,y,12)+E_{dep}(x,y,14)\right)$$

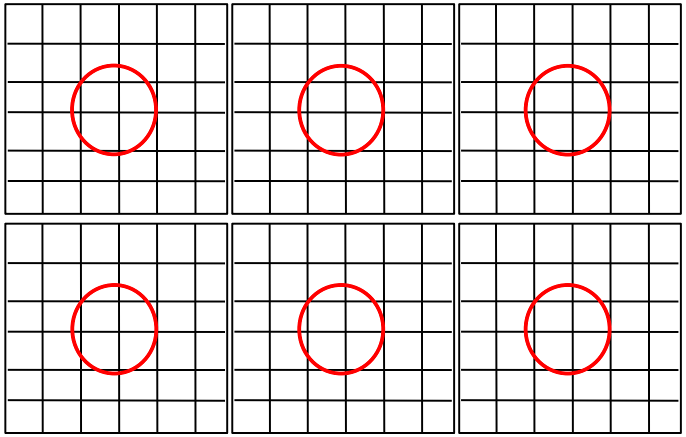


Corrections for the problematic wafer

Event selection



- Energy leaks outside < 1%



$$\langle x_E \rangle = \frac{\sum E_{hit} * x}{\sum E_{hit}}$$

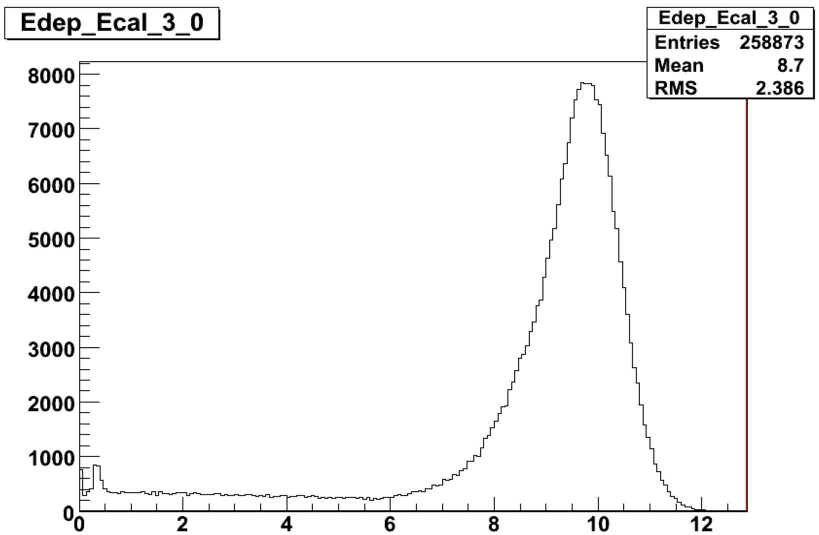
Energy weighted average for the first three layers – centre of gravity
= impact point estimate

- R_M ~9 mm

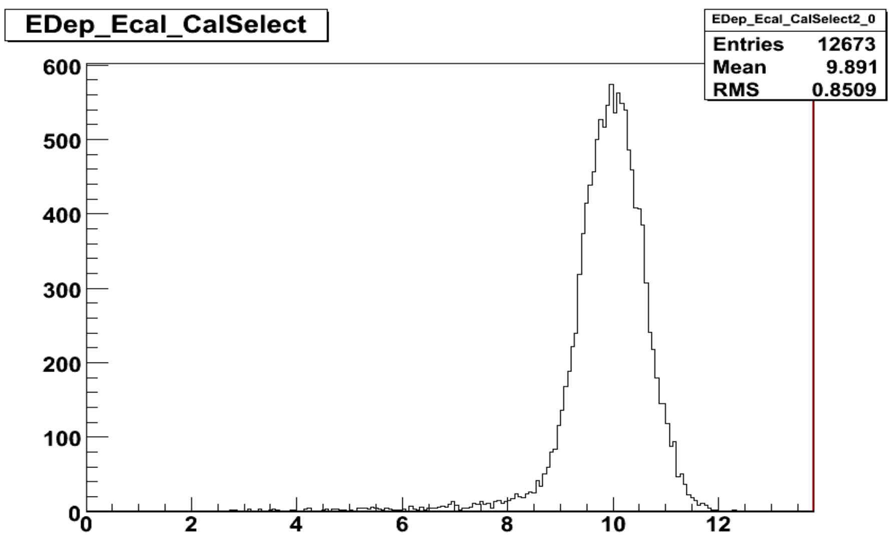
Now ready for electrons …

Fitting

Run 300731, recalibrated to 10 GeV



without event selection



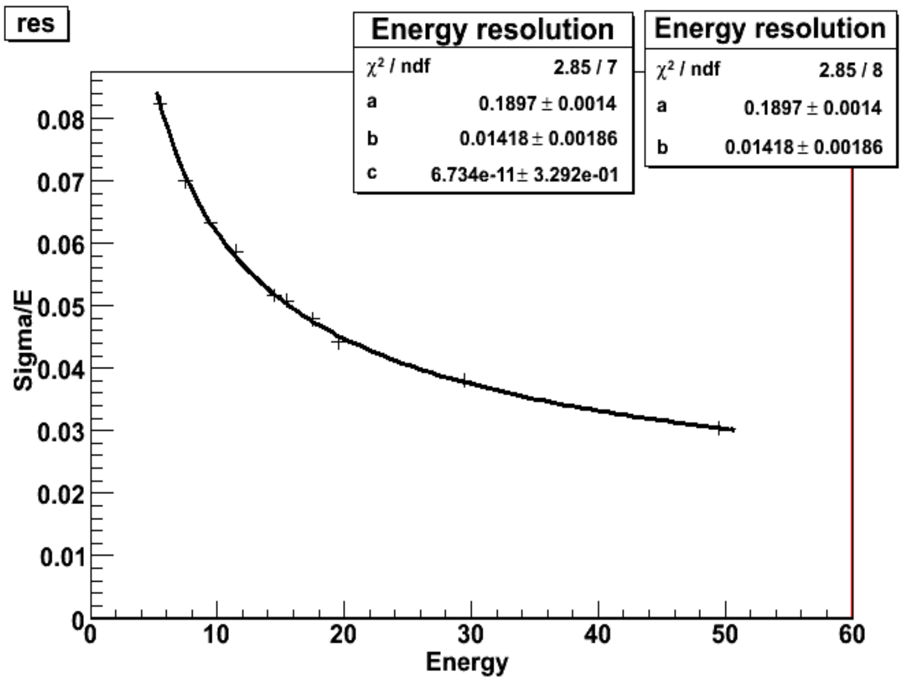
with event selection

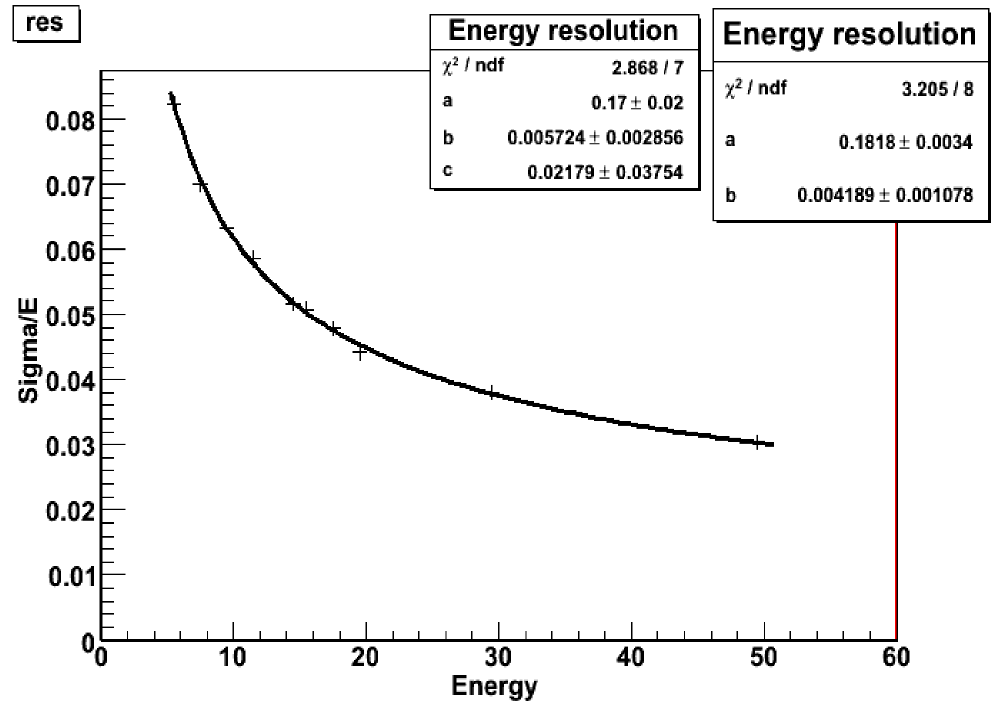
Used runs:

6 GeV	300670	18 GeV	300734	
8 GeV	300671	20 GeV	300741	
10 GeV	300731	30 GeV	300742	
12 GeV	300673	50 GeV	300744	(40 GeV in logbook)
15 GeV	300735			
16 GeV	300733			

Resolution without selection

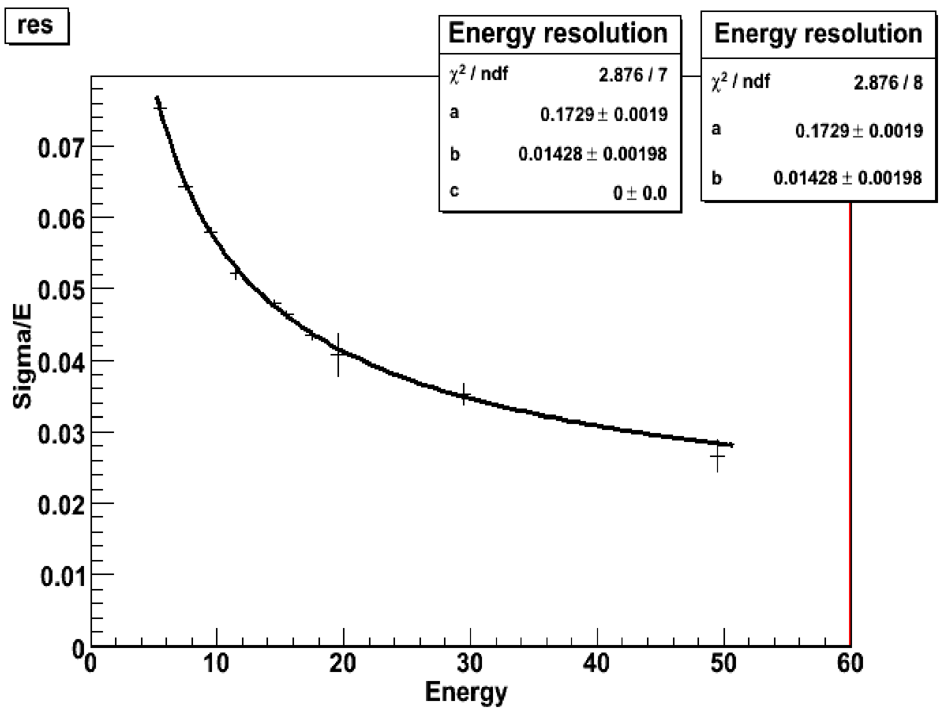
$$\frac{\sigma}{E}=\sqrt{\left(\frac{a}{\sqrt{E}}\right)^2+b^2+\left(\frac{c}{E}\right)^2} \quad \text{vs.} \quad \frac{\sigma}{E}=\frac{a}{\sqrt{E}}+b+\frac{c}{E}$$

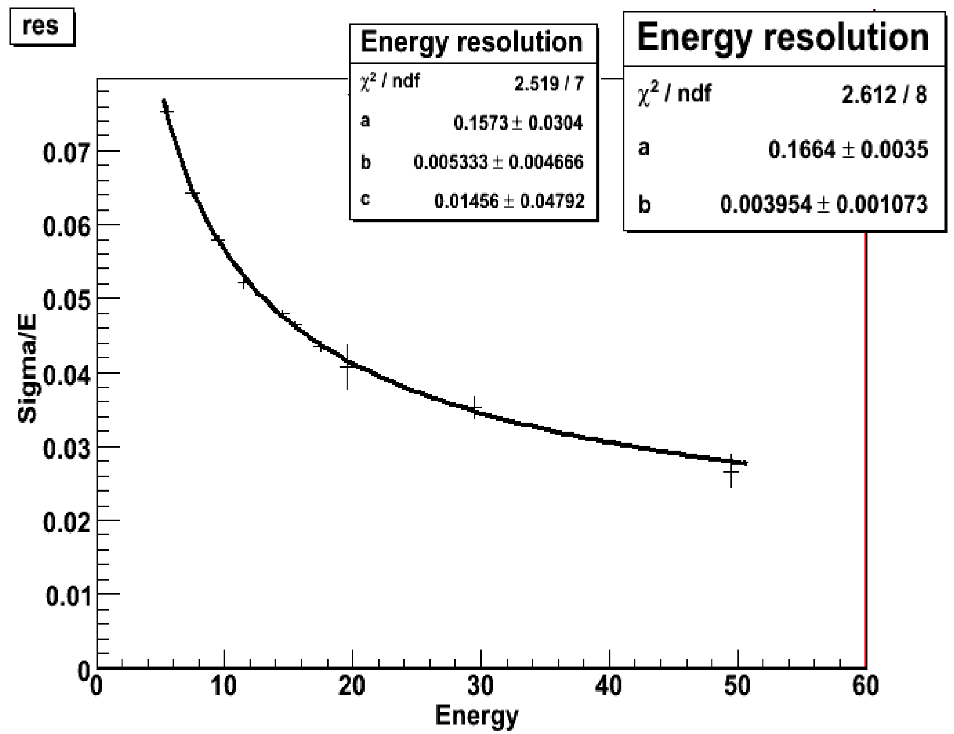




Resolution with selection

$$\frac{\sigma}{E}=\sqrt{\left(\frac{a}{\sqrt{E}}\right)^2+b^2+\left(\frac{c}{E}\right)^2} \quad \text{vs.} \quad \frac{\sigma}{E}=\frac{a}{\sqrt{E}}+b+\frac{c}{E}$$





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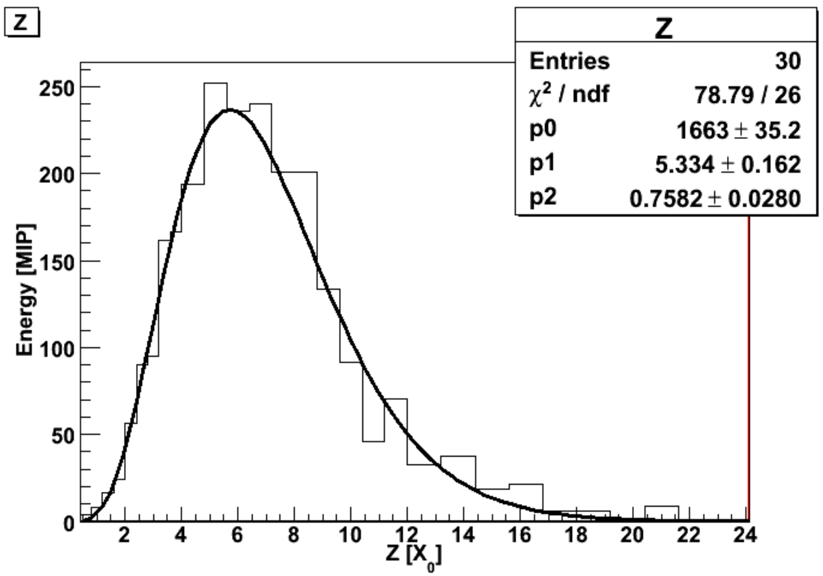
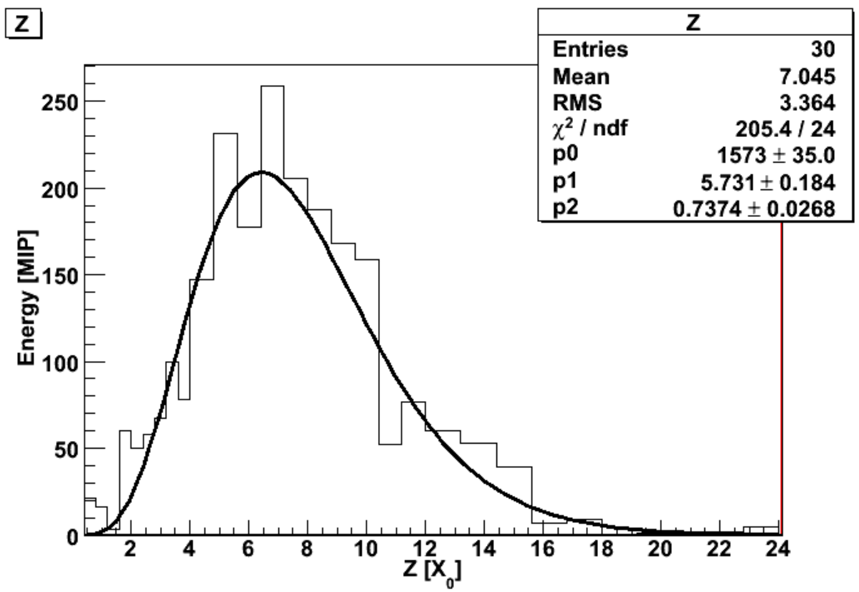
Fitting longitudinal profile

$$\frac{dE}{dt} = E_0 \frac{b\left(bt\right)^{a-1} e^{-bt}}{\Gamma\left(a\right)}$$

Fitting the shape with gamma distribution



Typical shower shape



... and sometimes like this

Seems to work for single showers.
Is it possible to estimate the leakage tail and correct for it?

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Conclusions

- The aim of the present analysis was to understand what we can expect from the full scale calorimeter and what improvements should be implemented in the next prototype.
- Ecal has energy resolution close to the expected.
- Dead space influence on the resolution is significant and deserves closer investigation. (Software and/or hardware revisions)
- Key issue is the calibration, the one in the database is more less OK, but needs improvements and constant focus.
- Some current problems and directions of future analysis have been indicated.