DHCAL studies with Pandora

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Special notice :
In my personal opinion, French research ministry law project concerning university staffs is threatening the future ability of university teachers to do researches and will degrade the quality of lectures given to students.

Today is a national day to protest against this law project.

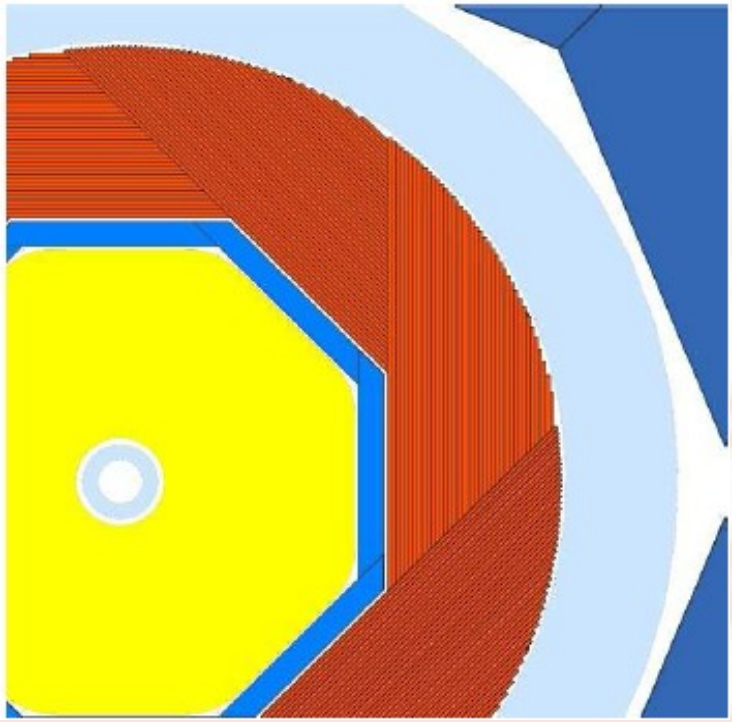
I'm talking at this meeting today but my heart is with the demonstrators.

The tools.

The studies are done with :
- Mokka HEAD version as of December 15th 2008.
- Marlin HEAD version as of December 12th 2008
- PandoraPFA HEAD version as of December 12th 2008.

Mokka is run using ILD_00 detector model with SHcalSc02 (AHCAL) replaced by SHcal04 (DHCAL à la Videau).

Note : HCAL outer edge is circular rather than octogonal. The PandoraPFA version used here not necessarily designed to handle this.



Important : In this simulation, the endcap has different (wrong) absorber thickness than the Barrel.

The simulations.

Simulation have been done for single K_long at 4 energies :
- 35 GeV
- 50 GeV
- 70 GeV
- 100 GeV

Each simulation has been done at η=0 and ϕ varying and has 10000 events.

Other simulations are done from PYTHIA uds STDHEP files for 4 sqrt(s) :
- 91 GeV
- 200 GeV
- 300 GeV
- 500 GeV

STDHEP files are taken from http://www.hep.phy.cam.ac.uk/~thomson/stdhep/
Each sqrt(s) has 10000 events.

Marlin setup.

Configuration taken from **StandardConfig v00-06-00** file mc2008/stdreco_IN.xml with few changes :

- No Durham jets nor flavor reconstruction.
- Extra Pandora processors.
- LDCCaloDigi changed to NewLDCCaloDigi.

NewLDCCaloDigi parameters changes :

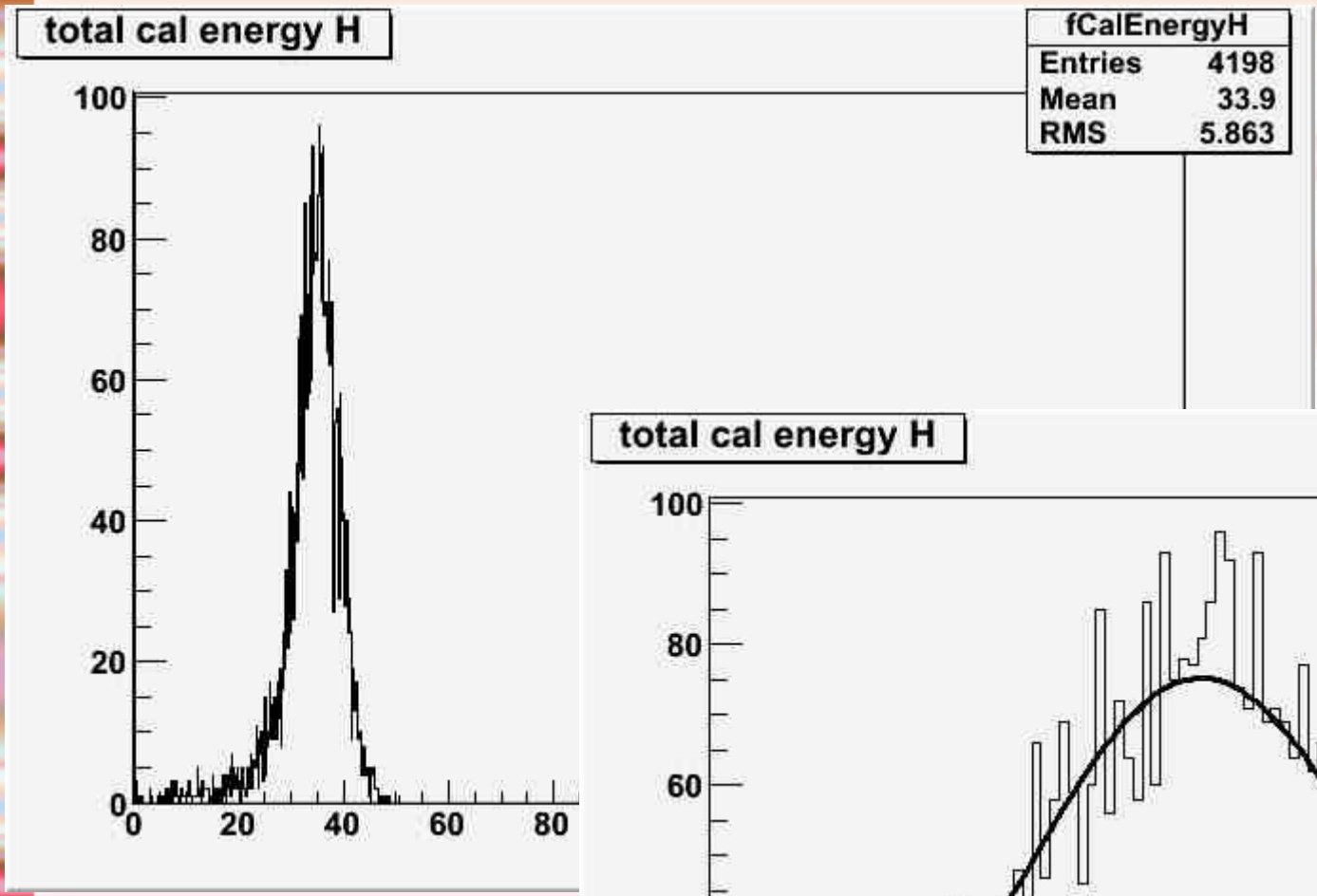
- **CalibrHCal 34.8 → 0.121**
- **HCALThreshold 2.5e- 4 → 1.25e- 7 (this simulates the Digital Hit Threshold)**
- **IfDigitalHcal 0 → 1**

PandoraPFA parameters changes :

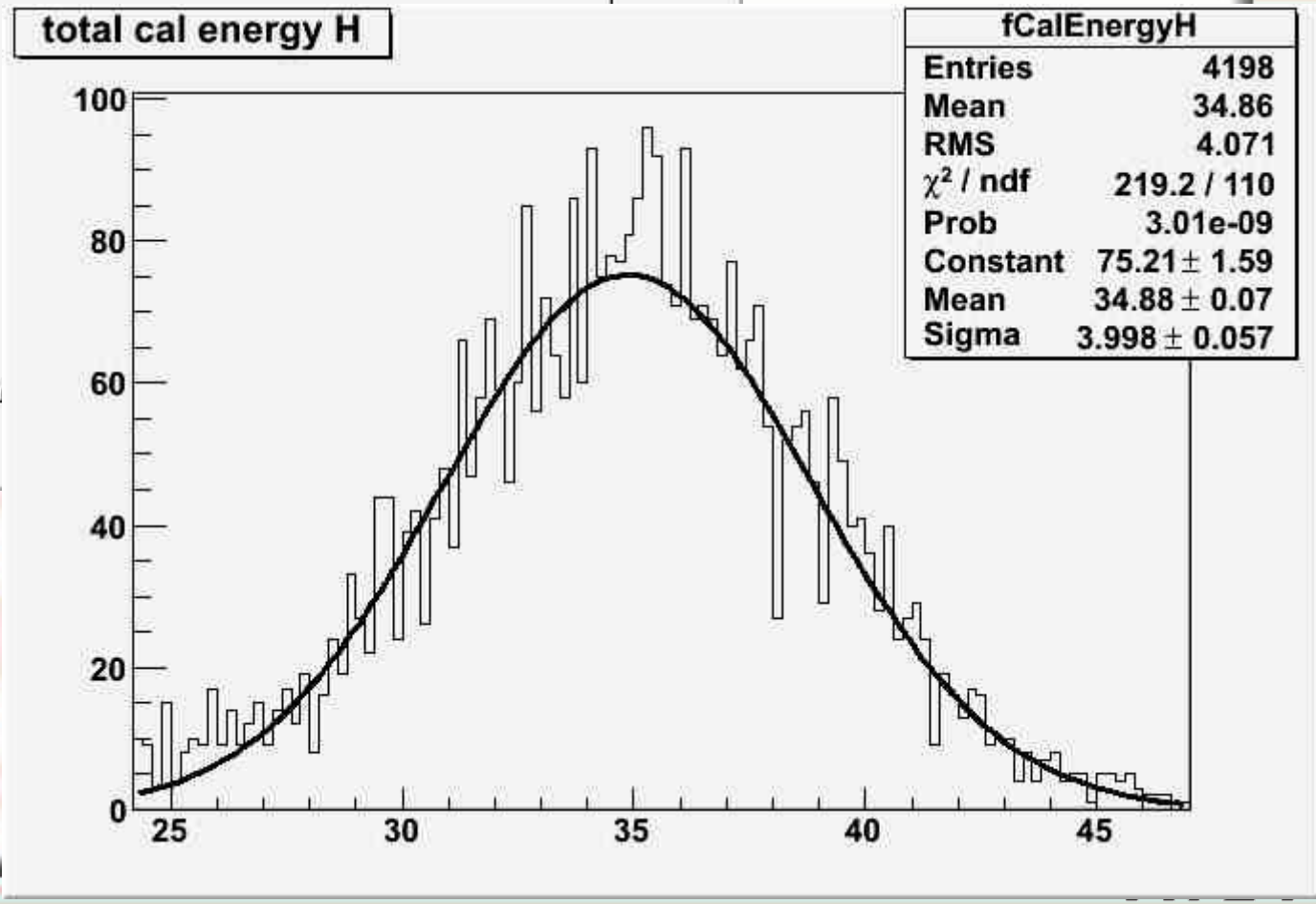
- **HCALMIPCalibration 34.8 → 8.1 (roughly 1 / CalibrHCal)**
- **HCALEMMIPToGeV 0.104 → 0.123 (roughly CalibrHCal)**
- **HCALHadMIPToGeV 0.104 → 0.123**
- **TypeOfOrderingInLayer 0 → 1**
  (0 = PseudoEnergy,
  1 = density within layer,
  2=local density over layers)

Values in red are correlated and have been tuned for 35 GeV single K_long.

CalibrHcal.

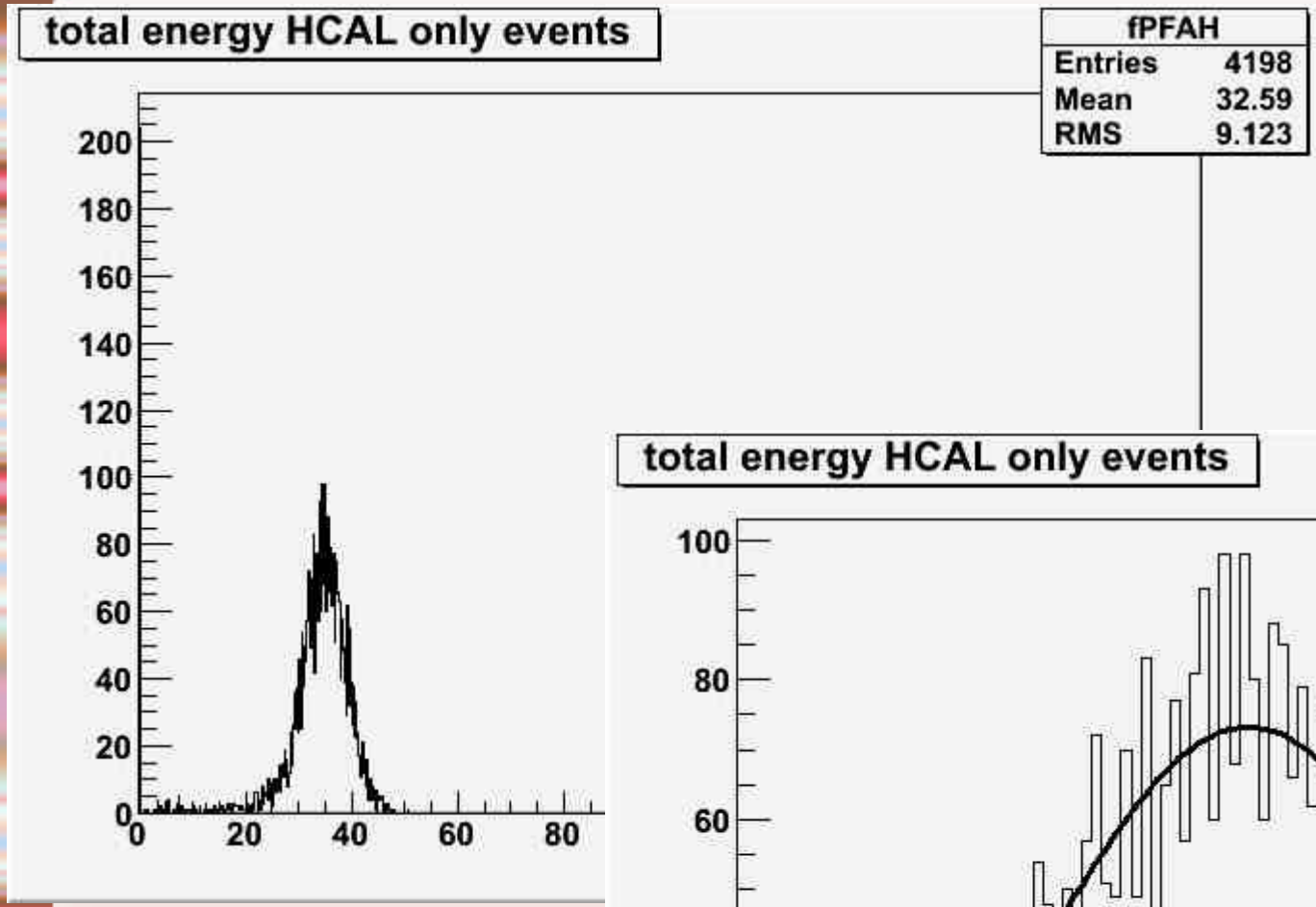


Total calorimetric energy for HCAL only events.

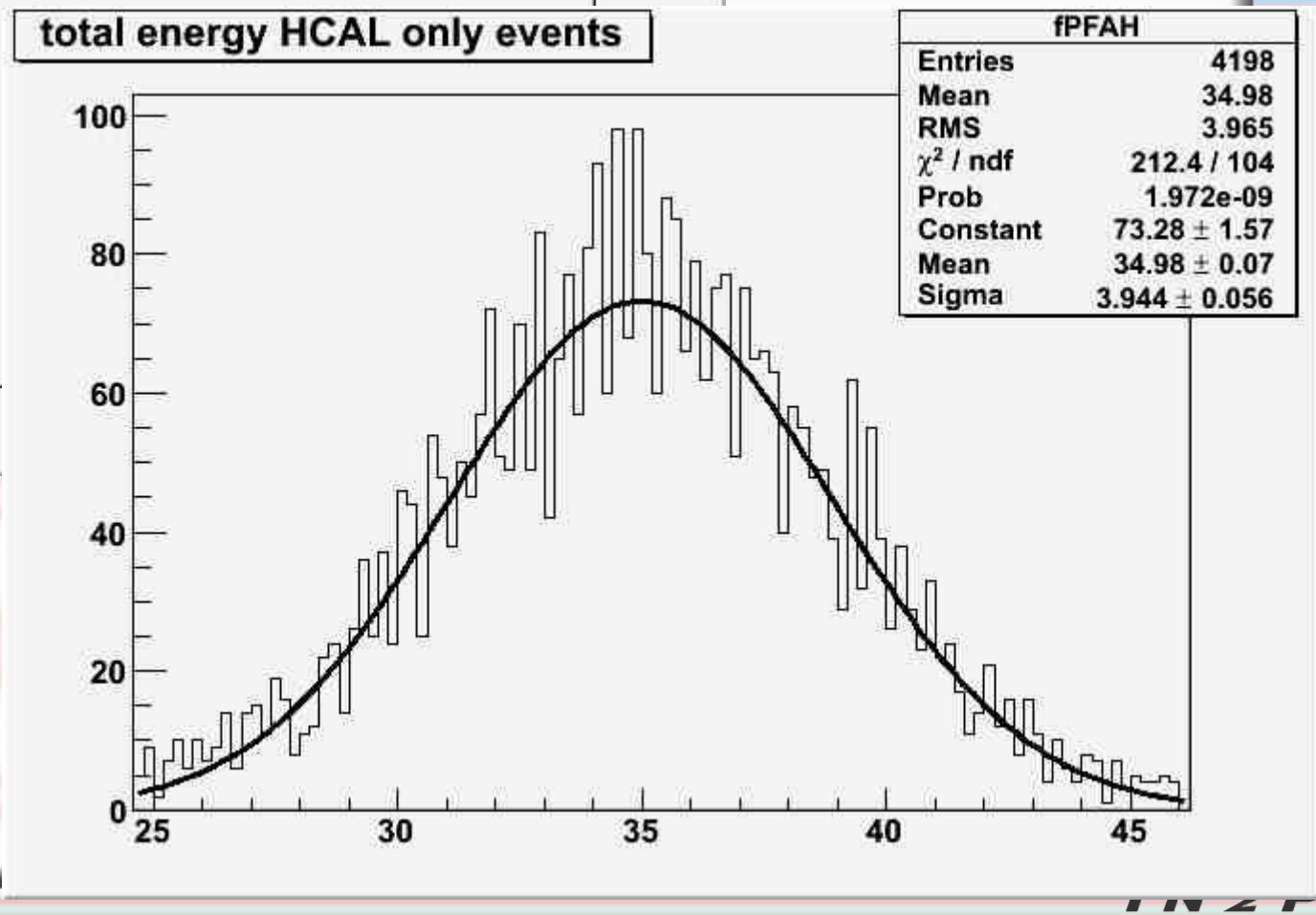


Mean is controlled by CalibrHcal

PFA calibration (HCAL only).

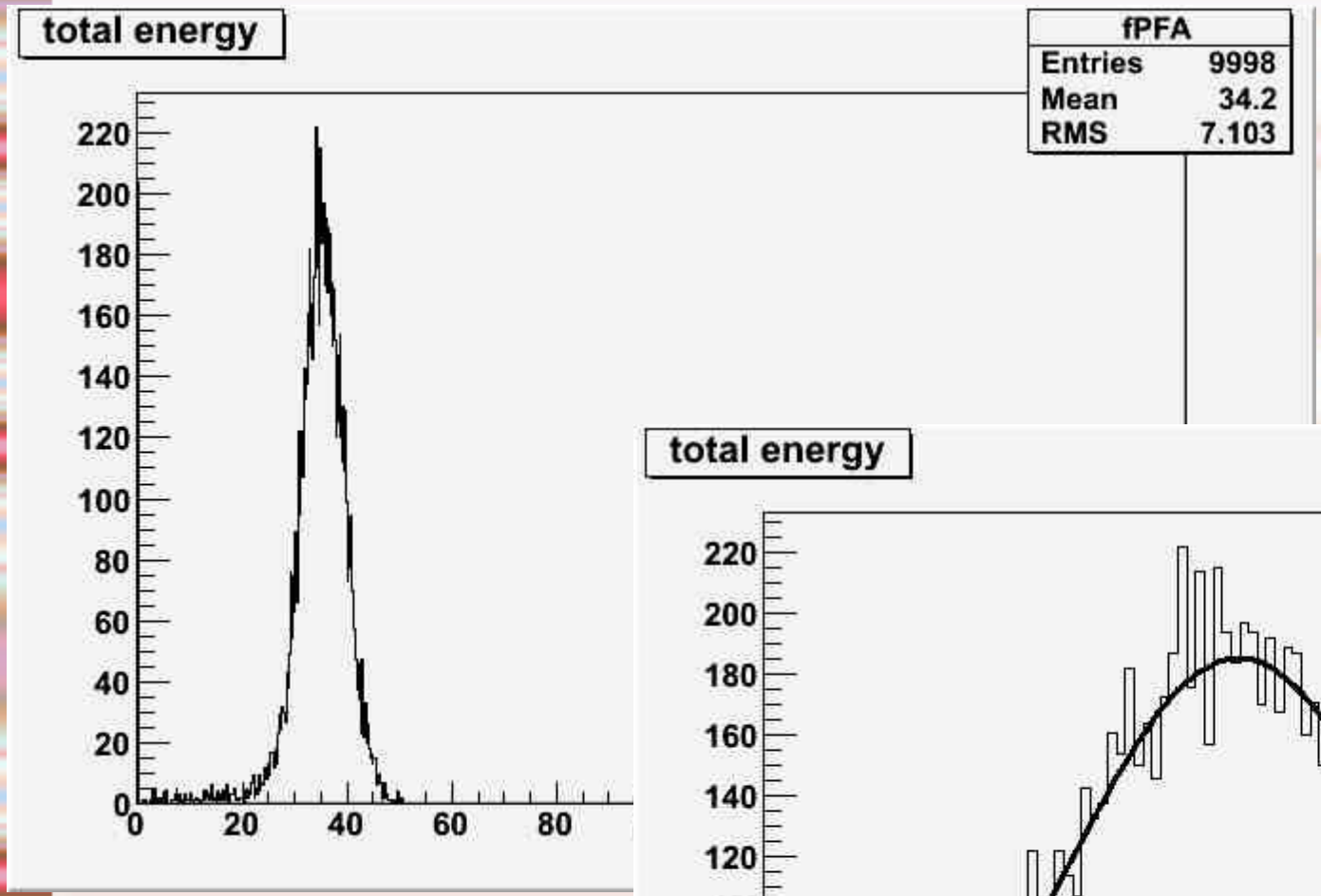


Total Pandora energy for HCAL only events.

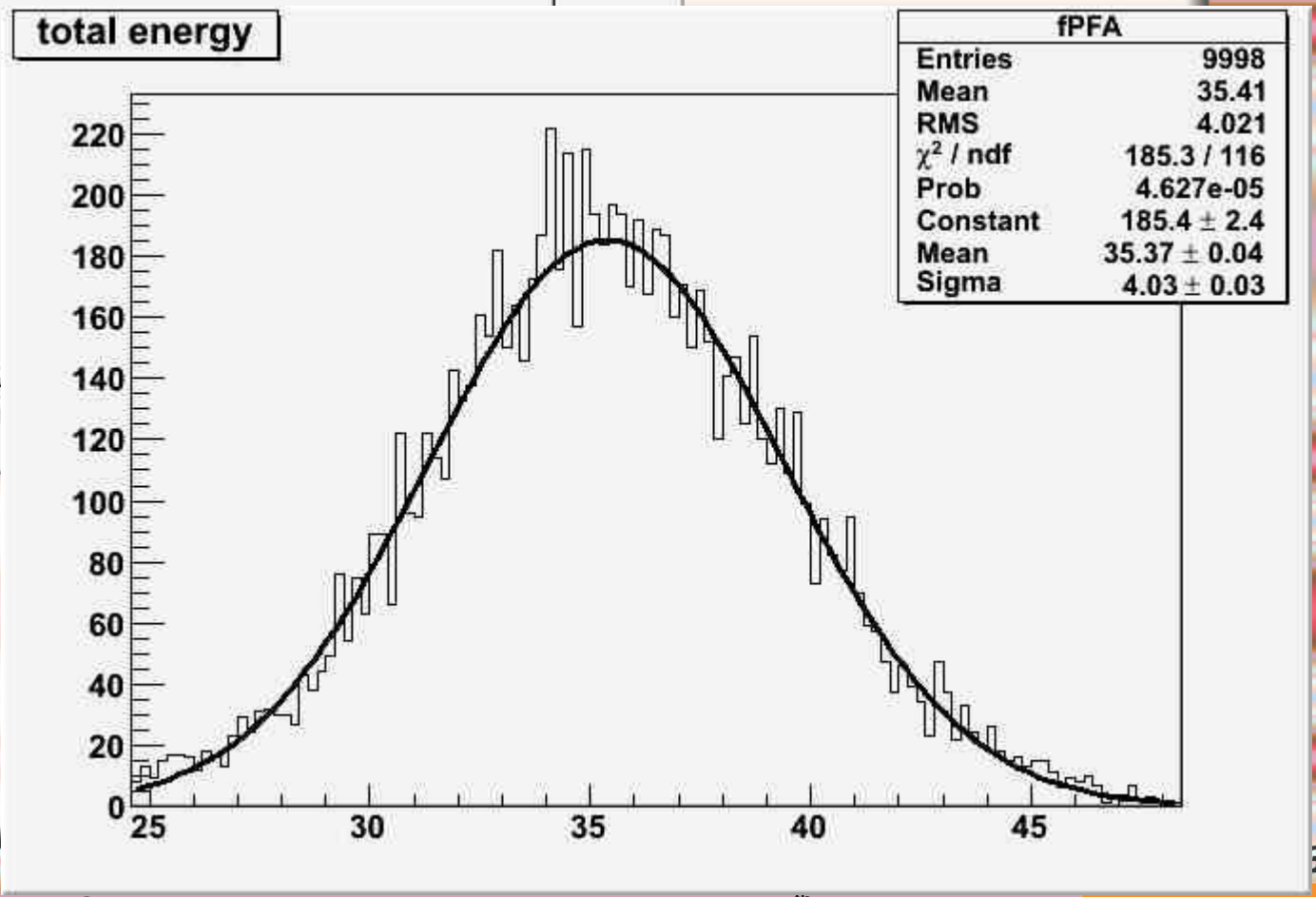


Mean changed by HCALEMMIPToGeV and HCALHadMIPToGeV

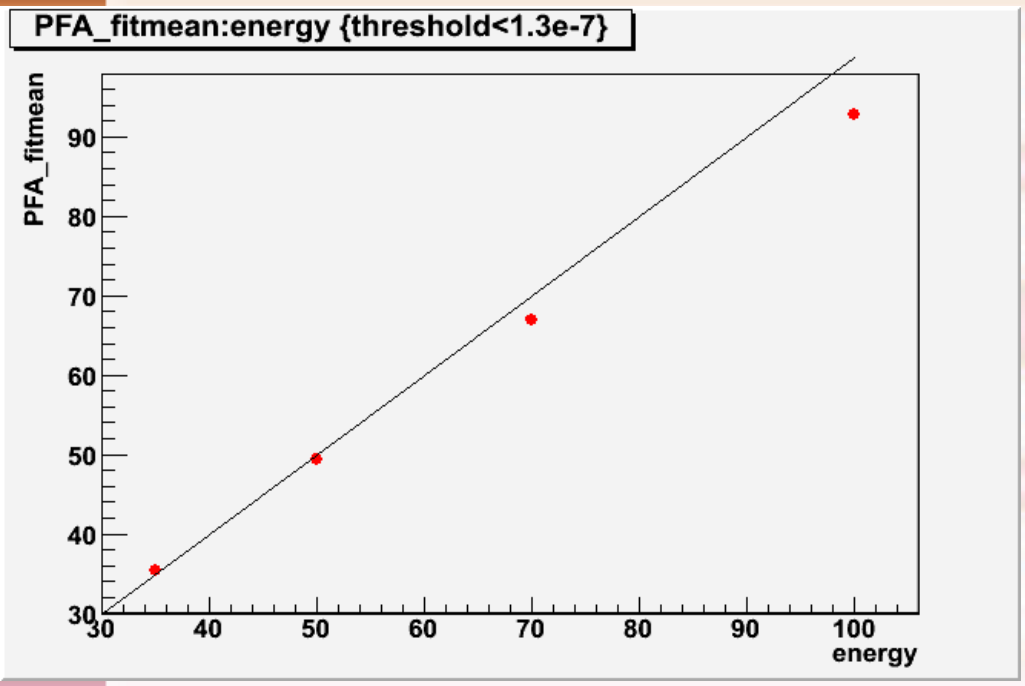
PFA calibration.

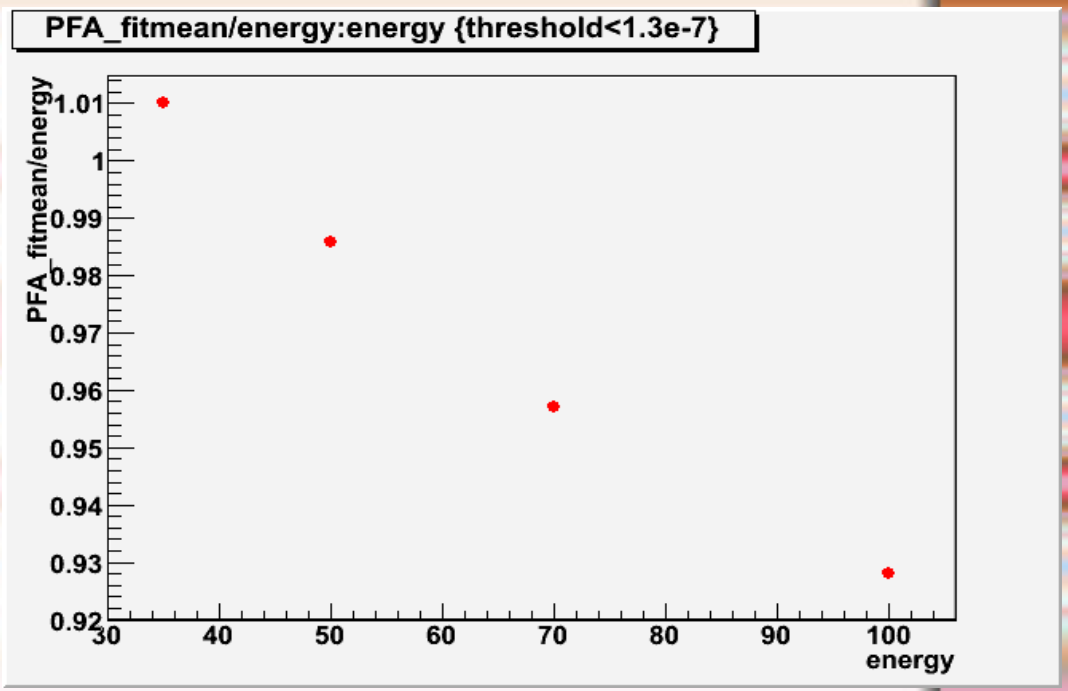


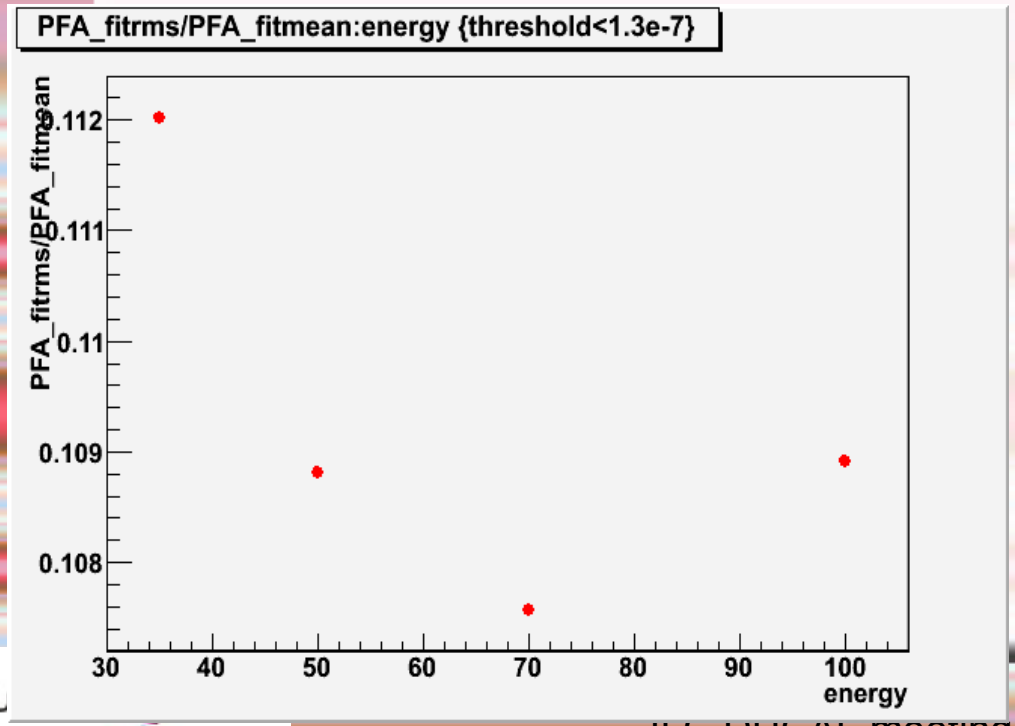
Total Pandora energy for all events.



Varying Klong energy.

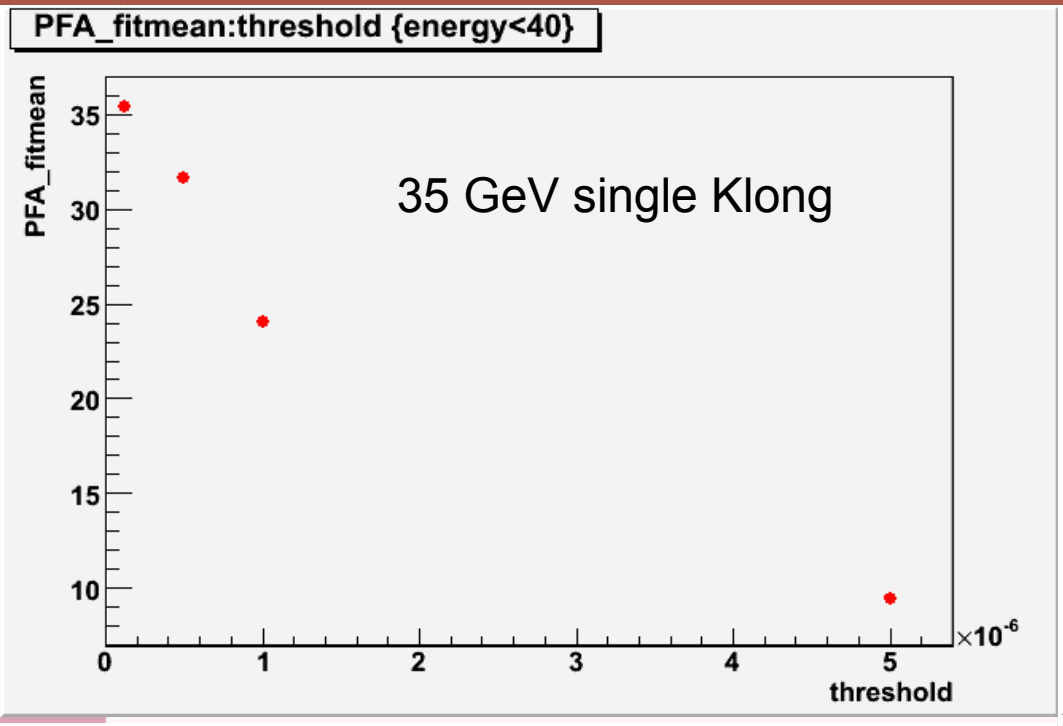


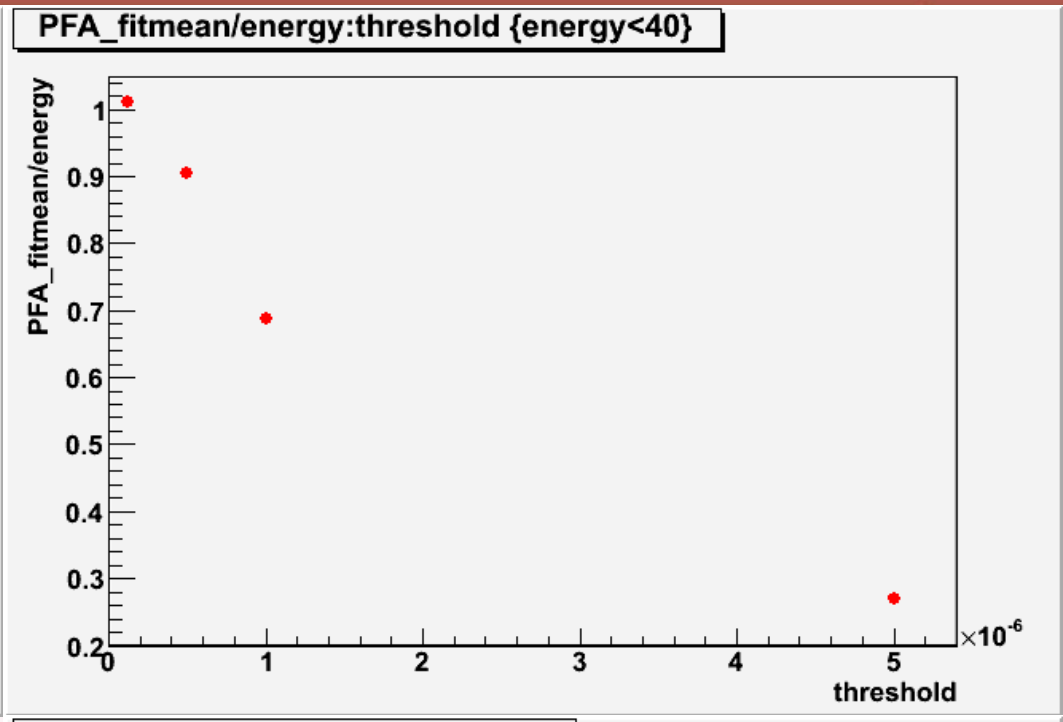


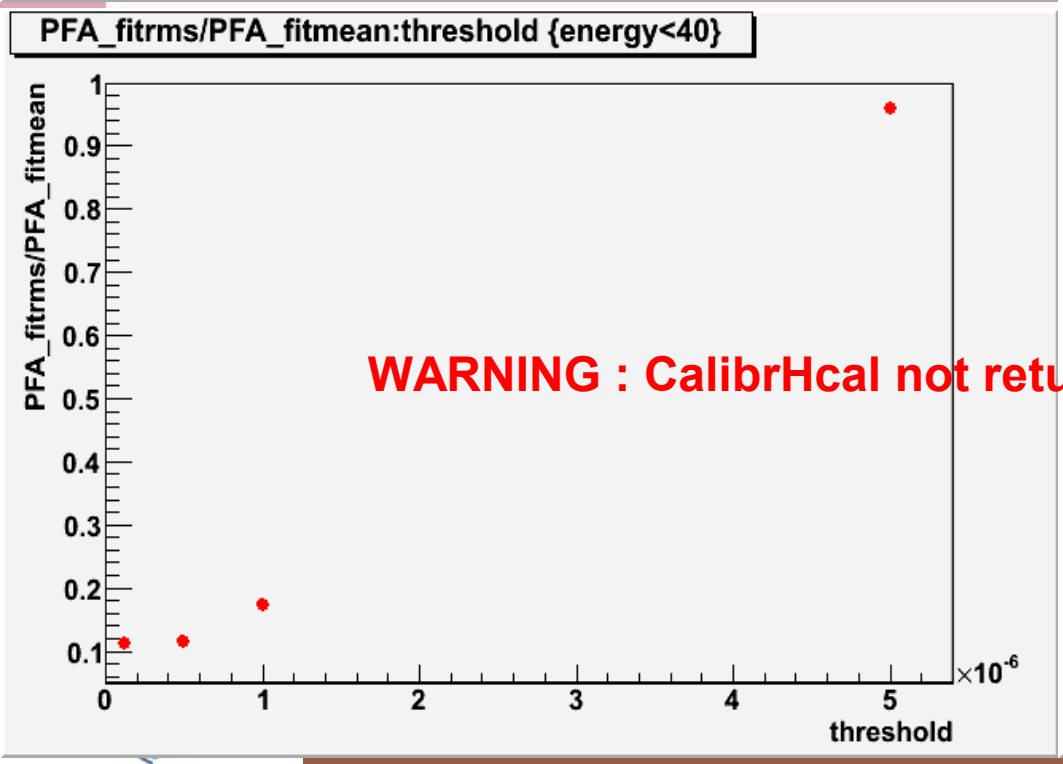


Energy is in GeV.

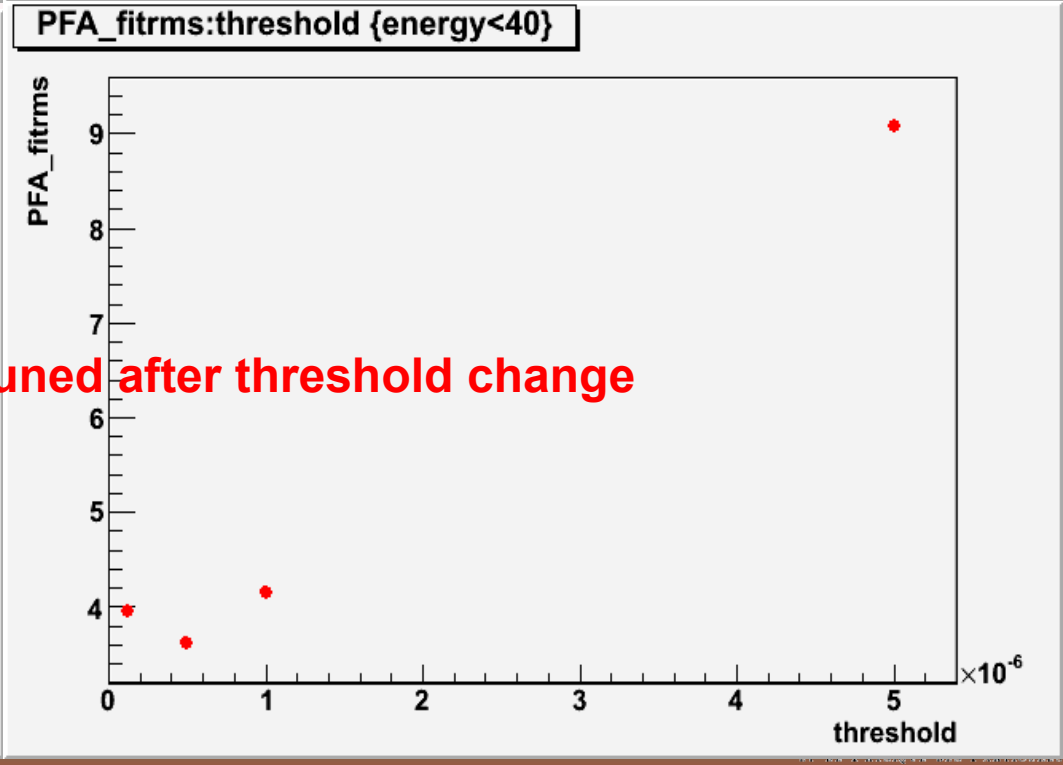
Varying DHCAL threshold.







WARNING : CalibrHcal not retuned after threshold change



Status at LCWS08

❷ PandoraPFA and ILD

★ Results obtained with the very new Mokka model of the ILD concept

Performance (ILD) $Z \to d\bar{d}, Z \to u\bar{u}, Z \to s\bar{s}$

rms90 PandoraPFA v03-β

E_{JET}	$\sigma_E/E = \alpha/\sqrt{E_{jj}}$ $\lvert\cos\theta\rvert<0.7$	σ_E/E_j
45 GeV	24.5 %	3.6 %
100 GeV	29.2 %	2.9 %
180 GeV	39.7 %	2.9 %
250 GeV	49.6 %	3.2 %

- Full G4 simulation
- "Realistic" detector, gaps etc.
- Full reconstruction inc. tracking
- Not yet optimised for ILD
- Calibration not final

★ Comfortably achieve ILC "goal" of $\sigma_E/E_j < 3.8$ % over full range of jet energies of interest at a TeV collider
★ For lower energy jets (< 100 GeV) calorimetric resolution more important than confusion – PFA is doing its job
★ Current PFA code is not perfect – lower limit on performance
★ Believe moderate improvements will be obtained soon for higher energy jets, "work in progress"

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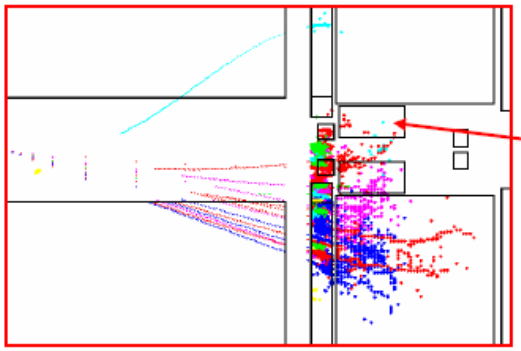
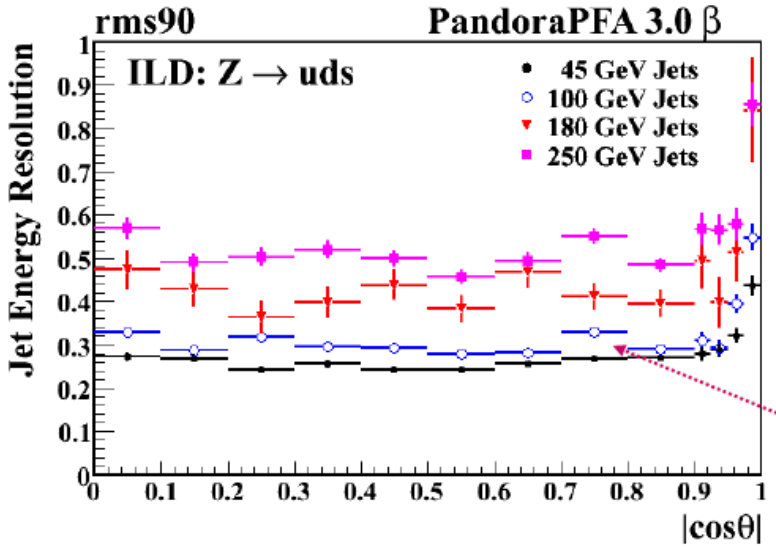
Status at LCWS08

Angular Dependence



- ★ILD model includes a more detailed simulation of forward region
- ★Including LHCAL
- ★Implemented a first (imperfect) attempt to include in reconstruction
- ★Also sensitive to forward tracking



Results

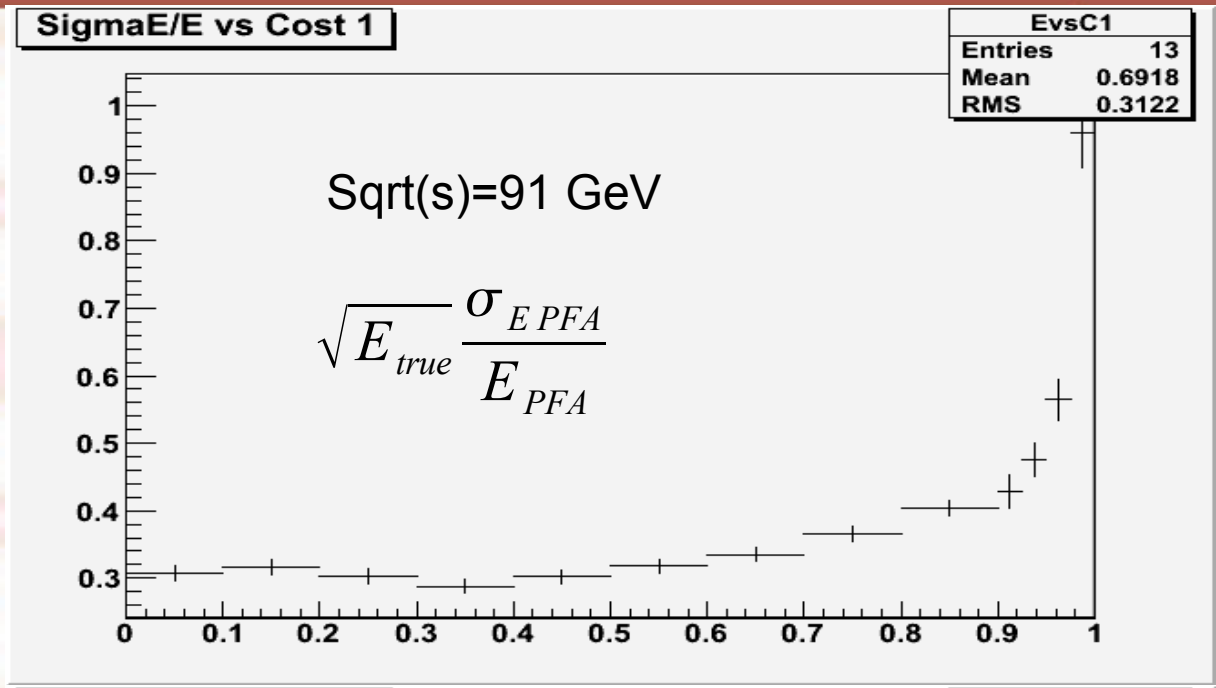
- PFA performance now almost flat out to $|\cos\theta| = 0.975$
- Performance worse for $|\cos\theta| > 0.975$, but not bad !
  (> factor 2 improvement wrt LDC)
- Some degradation in barrel/ endcap overlap

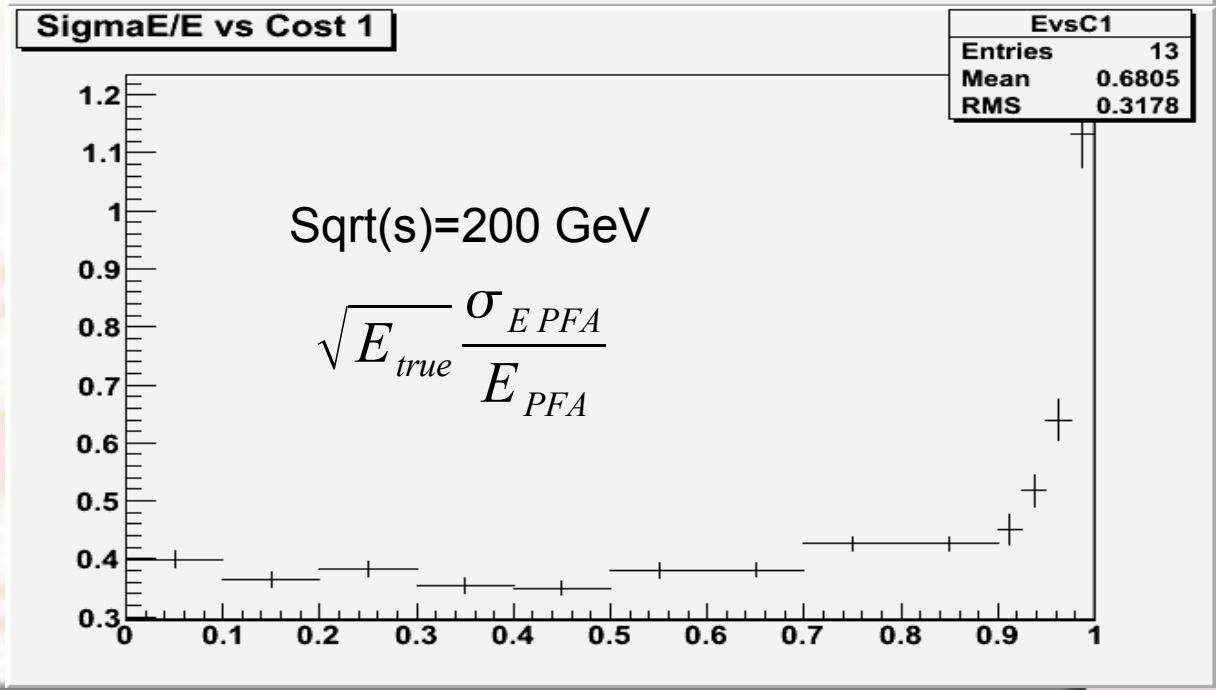
With PYTHIA dijets events.

In barrel :
30.8 % ± 0.4 % at 91 GeV
Jet resolution = 4.6 %

Using tools provided by
Mark Thomson

In barrel :
37.0 % ± 0.4 % at 200 GeV
Jet resolution = 3.7 %





Conclusion.

Very preliminary work on DHCAL resolution.
The main point up to now has been to **get basic tools working** in IPN Lyon.
Use of IPNL grid tier 3 is close to be setup.

Without any Pandora parameters tuning to DHCAL geometry,
Jet resolution is reasonable.
At 100 GeV, DHCAL already within ILD spec.

Next steps :
move towards semi-digital HCAL,
optimize reconstruction parameters in Pandora,
improve the tools.