A Study on Leakage and Energy Resolution

Ivan Marchesini , CALICE meeting, 2010-07-05

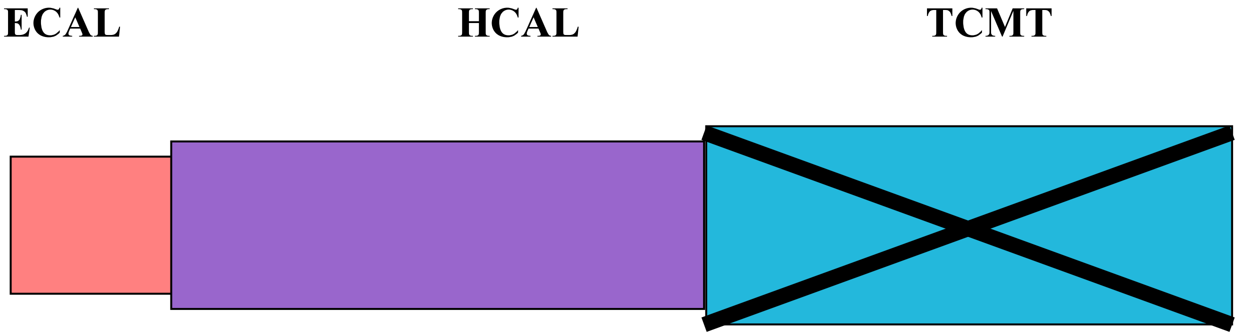
Outlook

- Introduction.
- Event selection.
- Quick reminder. Variables sensitive to the leakage used:
  - → Shower Start;
  - → End-fraction.
- An energy-independent correction to the Leakage.
- First data/MC comparisons.
- Comments and next steps.

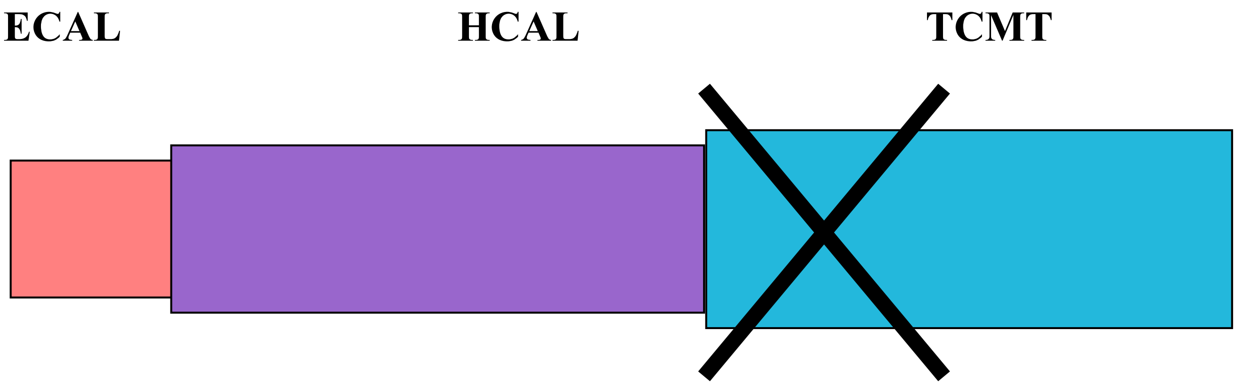
Introduction

Tasks of the Study

1) Study a correction to the leakage from the HCAL, using the **HCAL alone**.



2) See the benefit of having additionally a **TCMT** in an ILD-like configuration:



Information of the first TCMT layers removed, to simulate coil.

Event Selection

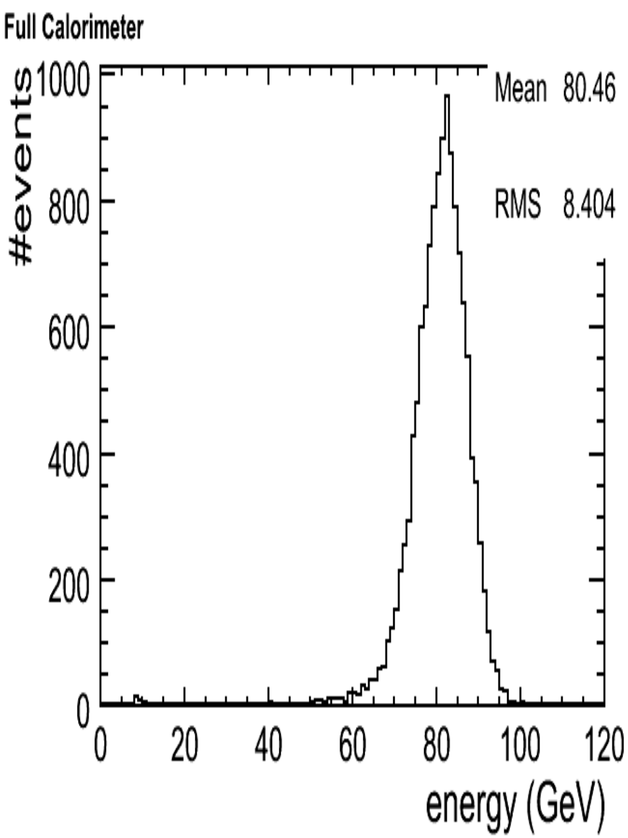
Event Selection

- CERN 2007 pion runs. Examples for 80 GeV run 330962.

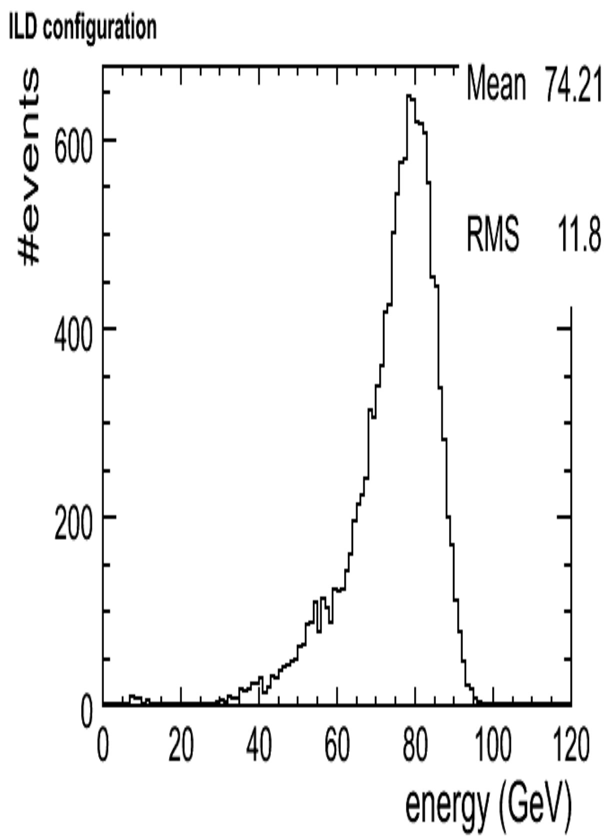
- Cuts:
  - 0.5 MIP threshold.
  - TRIGGER:
    - BeamBit==1;
    - b100x100Bit==0 no muons.
    - CherenkowBit==0 no electrons.
  - Shower start in the HCAL:
    - Marina processor: exclude shower start HCAL layers 1, 2.
  - Further MIP rejection:
    - Frac-10 cut: E hits > 10 MIPs / total E > 0.01 (for HCAL + TCMT).
    - Triangle cut: E TCMT vs E HCAL+ECAL.

Total Energy

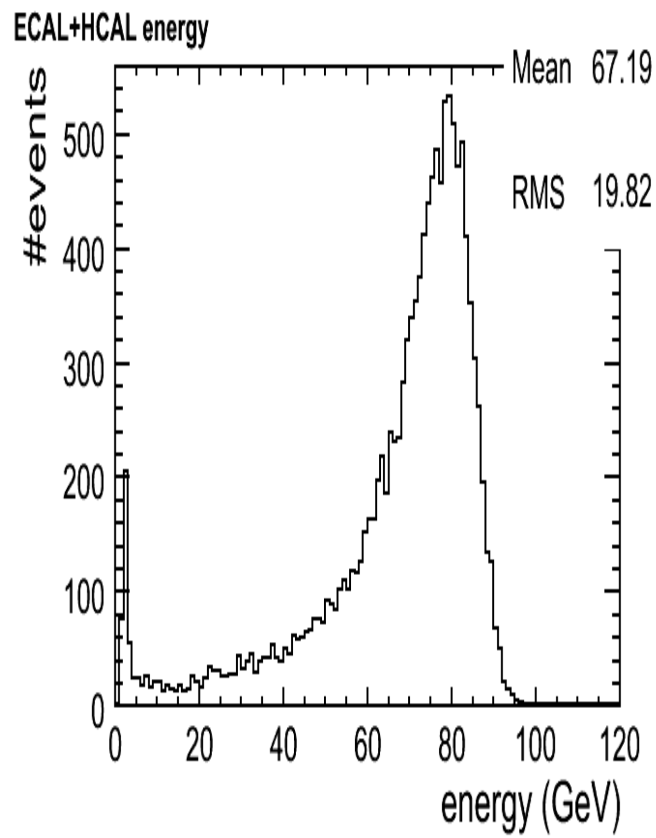
All



ECAL+HCAL+~~COIL~~ +TCMT = ILD



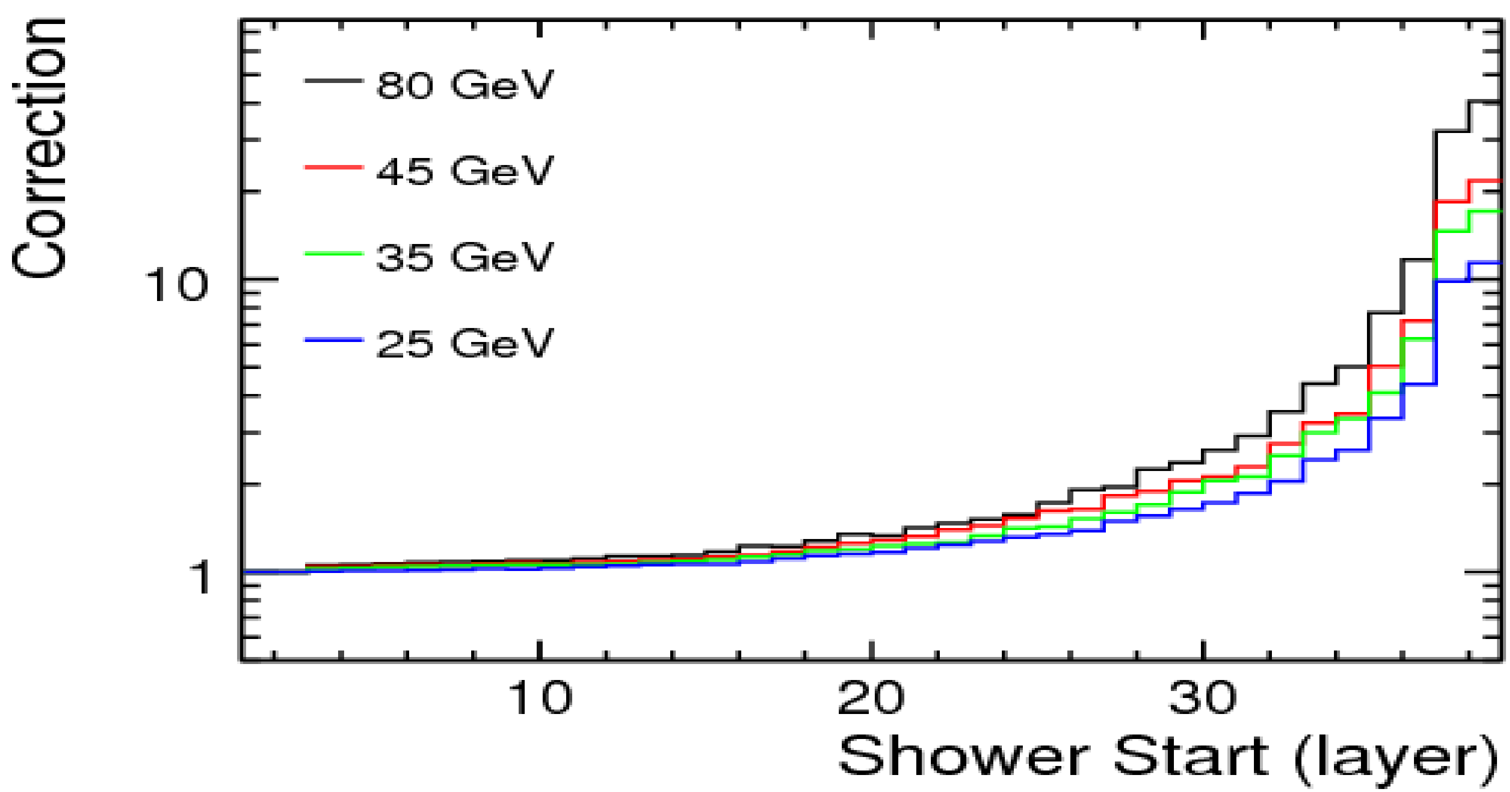
ECAL+HCAL



Variables Sensitive to Leakage:
1 – Shower Start

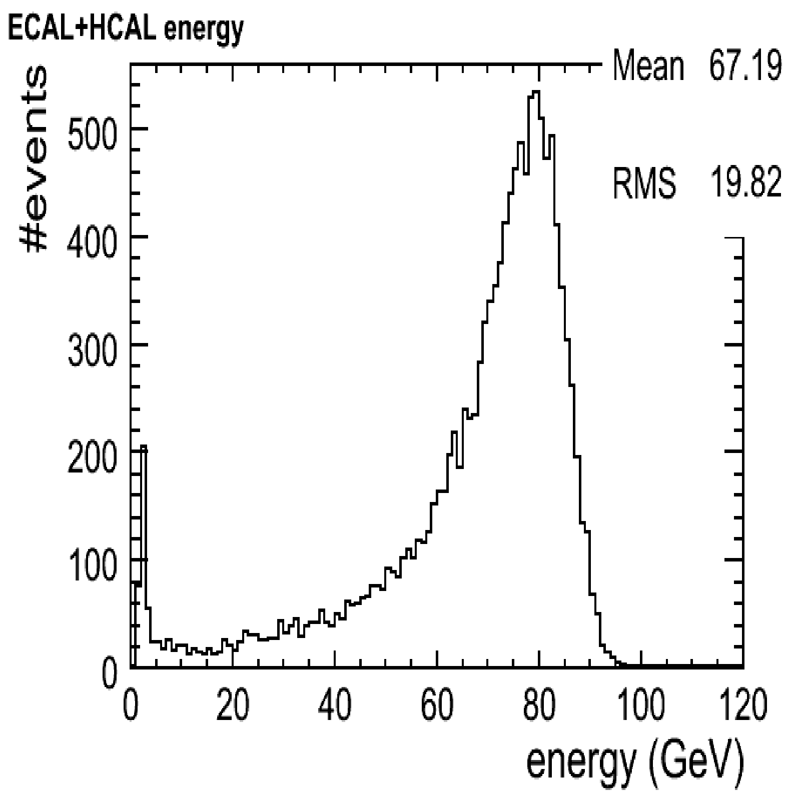
Correction vs Energy

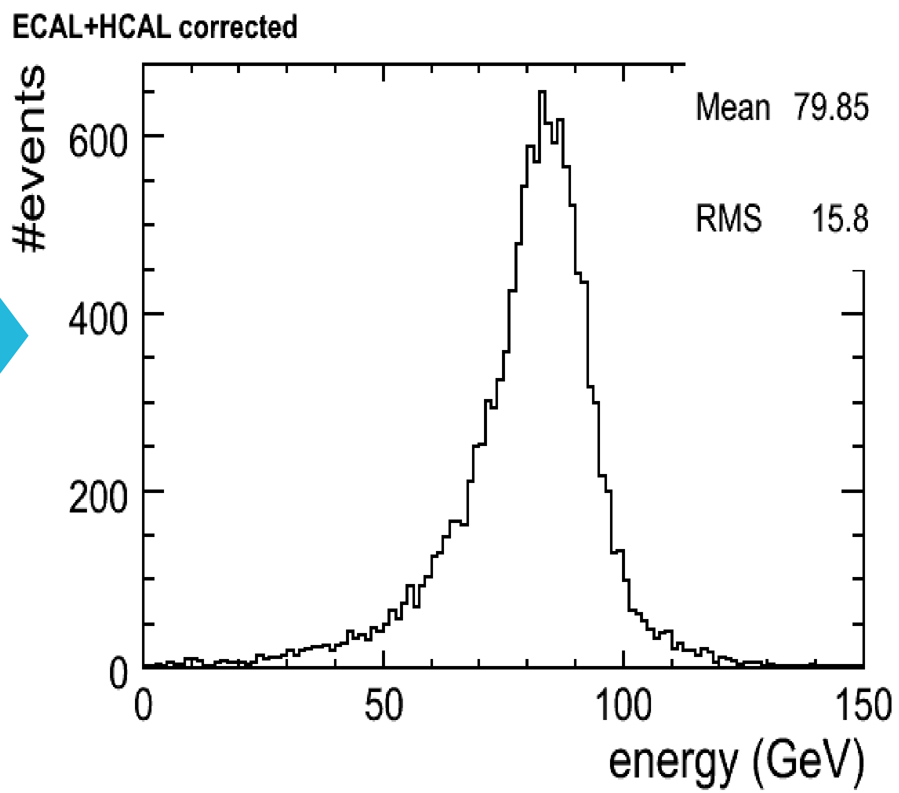
- Correction to the leakage depending on the shower start layer.
- Correction strongly **energy dependent**.



Result

- Mean value of the total energy distribution well recovered.
- RMS reduced but still large.

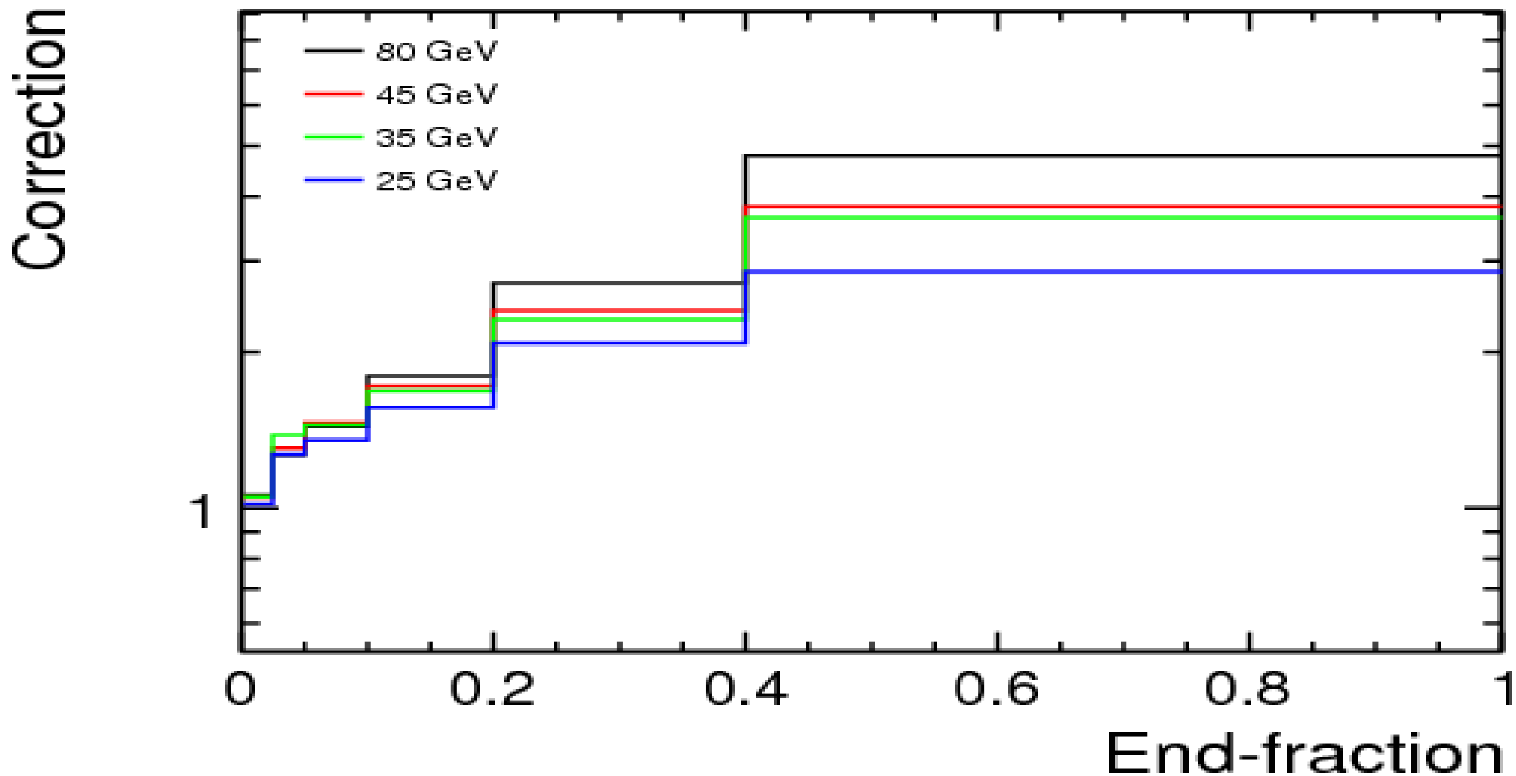




Variables Sensitive to Leakage: 2 – End-fraction

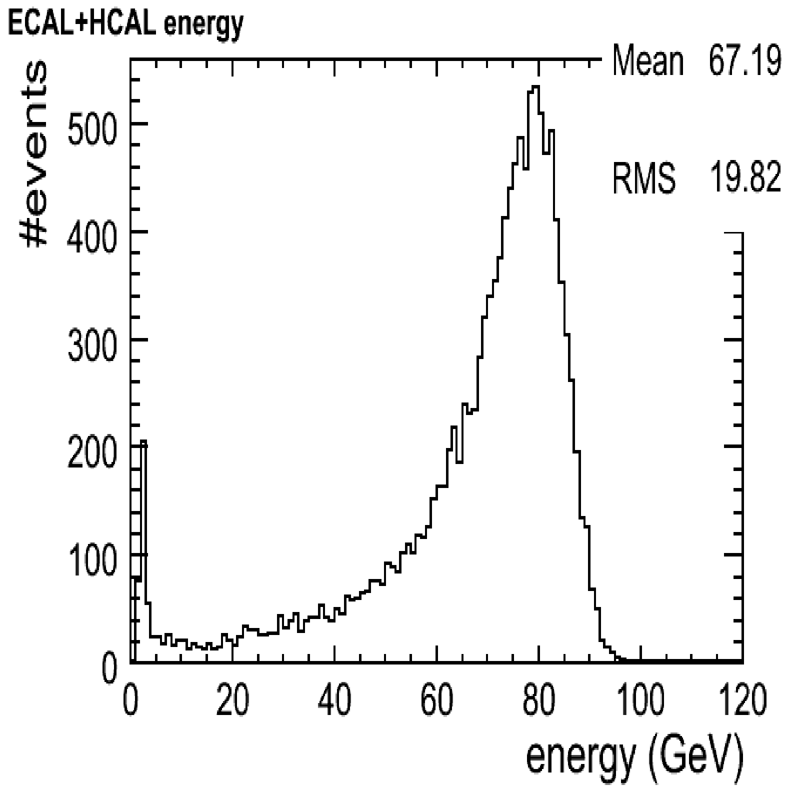
Correction vs Energy

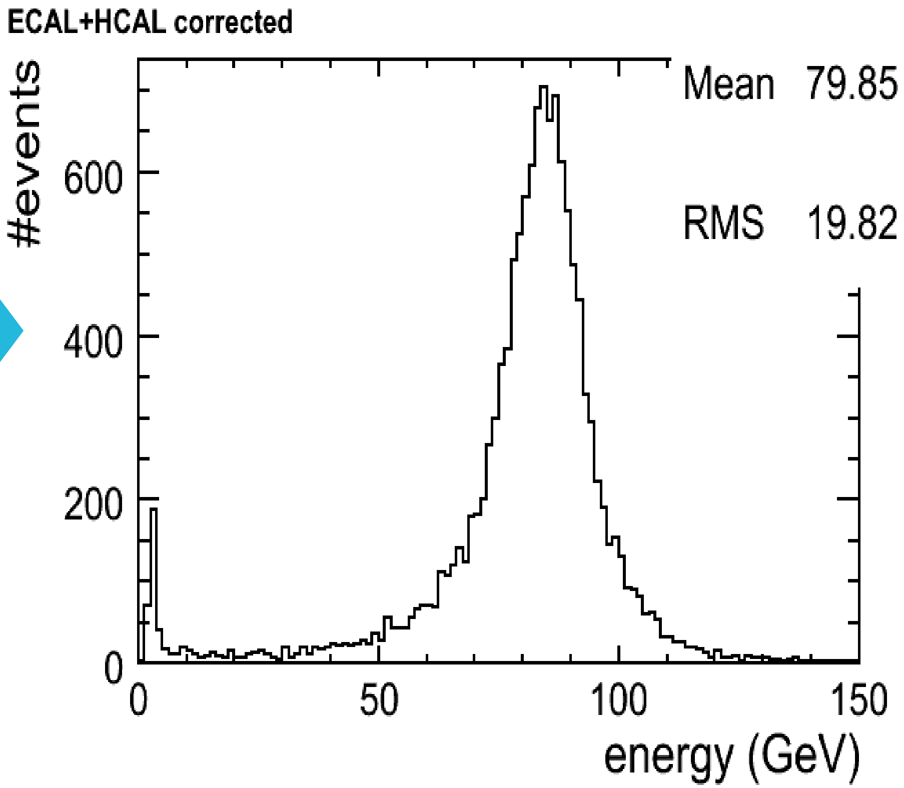
- End-fraction: fraction of energy in the last 2 layers of the HCAL/ measured energy ECAL+HCAL.
- Correction to the leakage depending on the end-fraction bin.
- Correction strongly **energy dependent**.



Result

- Mean value of the total energy distribution well recovered.
- Some events on the left tail not recovered: RMS still large.





Correction to the Leakage

Content

- Shower start and End-fraction: powerful but energy dependent.

- Idea: add **measured energy** observable to gain energy independence.

- I present here a **Monte Carlo study**.

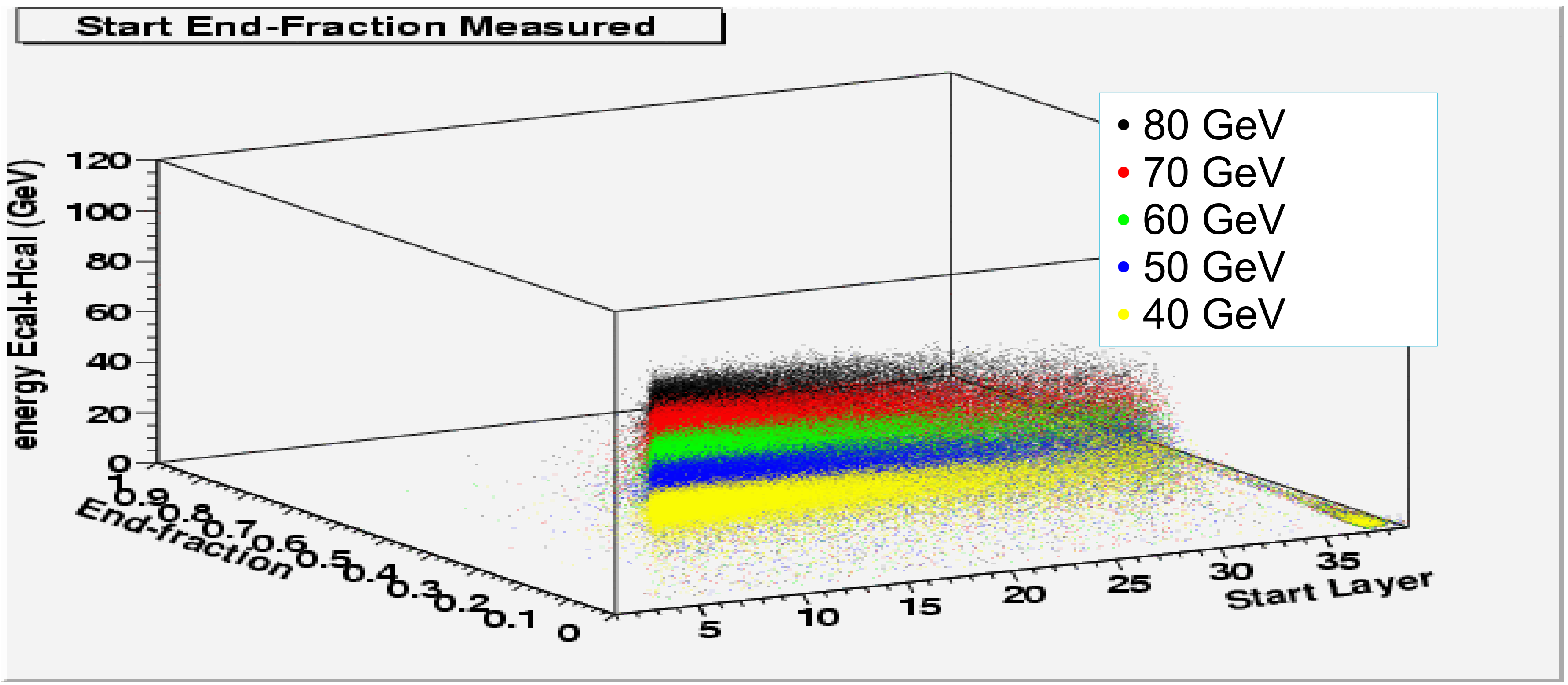
- Monte Carlo files:
  - physics list: FTFP_BERT;
  - detector model: TBCern0707_p0709.

- Monte Carlo template: [10,15,20,25,...,100] GeV.

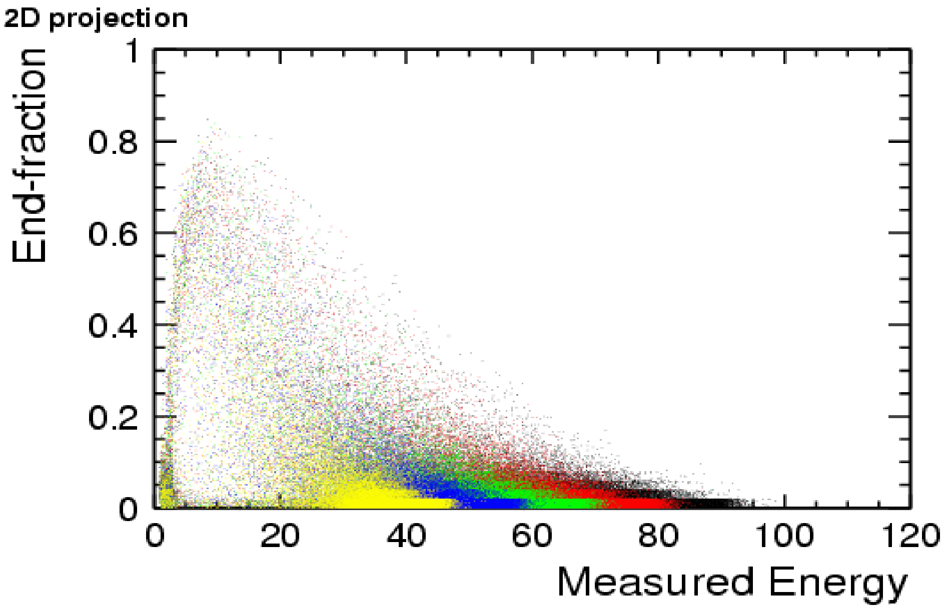
- Data fitted to the template: [32.5,37.5,42.5,...,77.5] GeV.

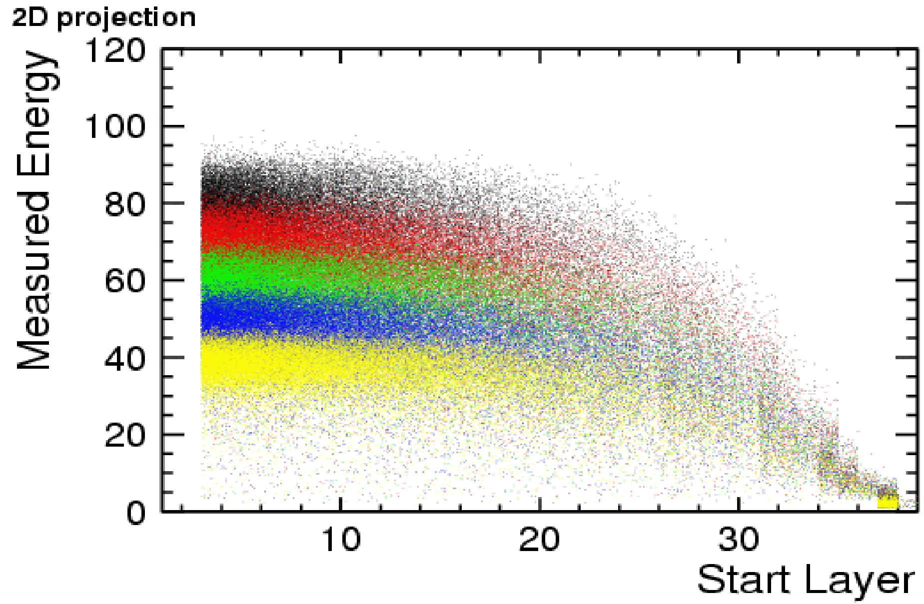
3D Distribution

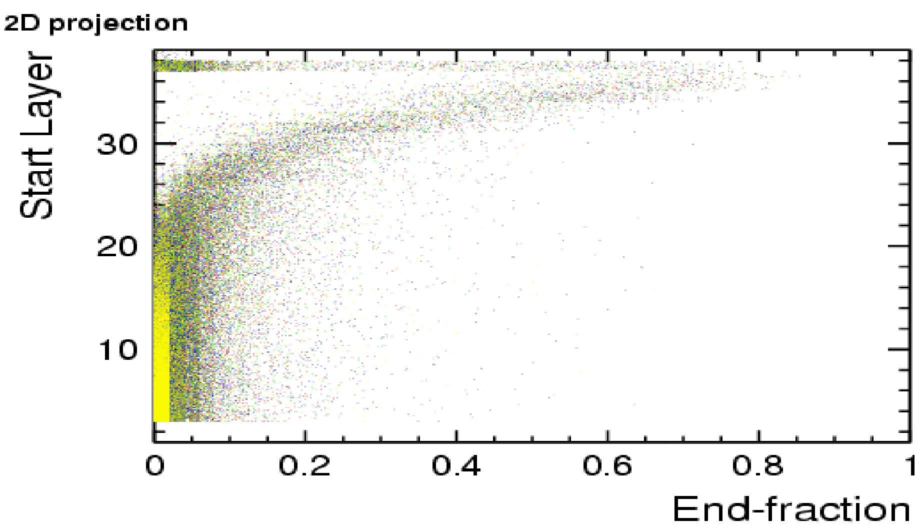
- X: shower start layer;
- Y: fraction of energy in the last 2 layers of the HCAL with respect to the measured energy (Ecal+Hcal);
- Z: measured energy (Ecal+Hcal).



2D Projections







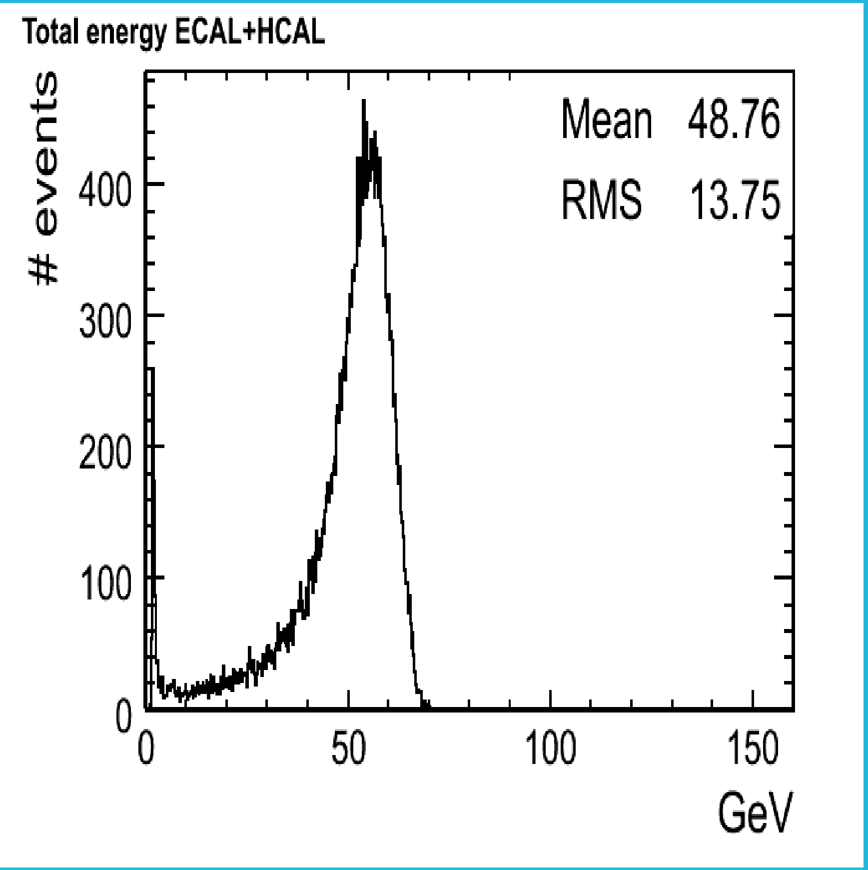
- 80 GeV
- 70 GeV
- 60 GeV
- 50 GeV
- 40 GeV

Fit Structure

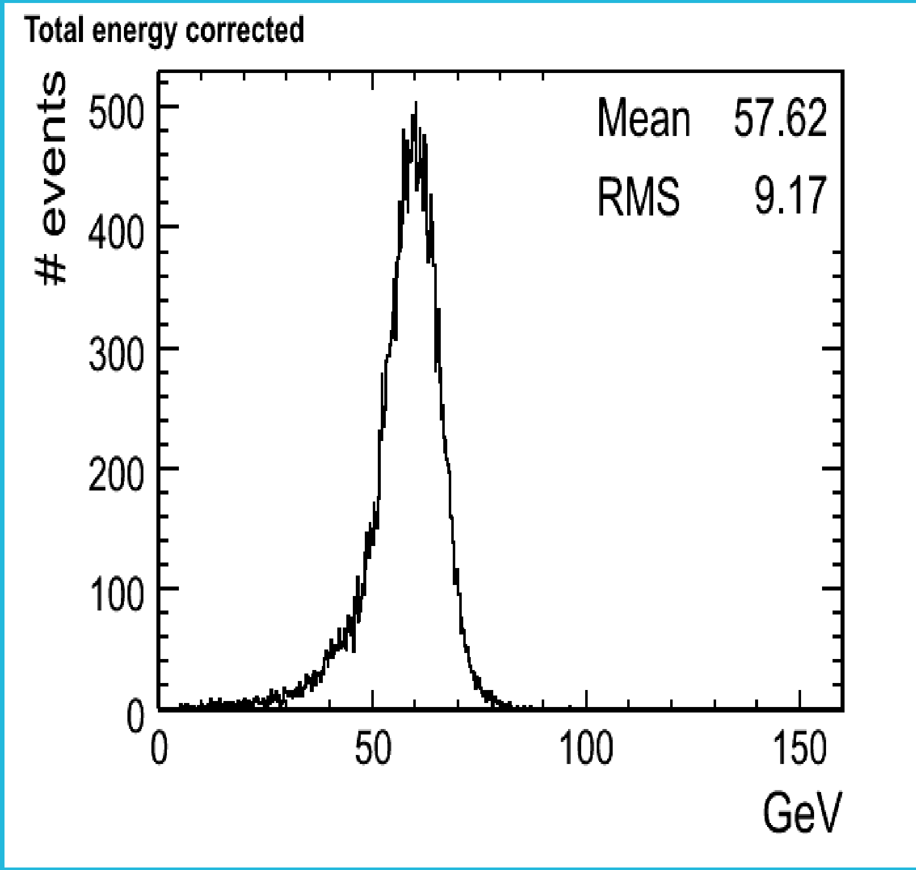
- Different energies cover different regions of 3D space.
- Fill the 3D space with the average leakage correction.
- **Averaging over energies** where they overlap.
- Apply a **bin-wise correction** to independent runs.
- Correction depends on the 3D bin where the event is located. **No beam energy information used**.
- Note: the shower start finder uses the beam energy information, but this is not strictly necessary (could use measured energy).

Application

- Run to be corrected: **57.5 GeV**.



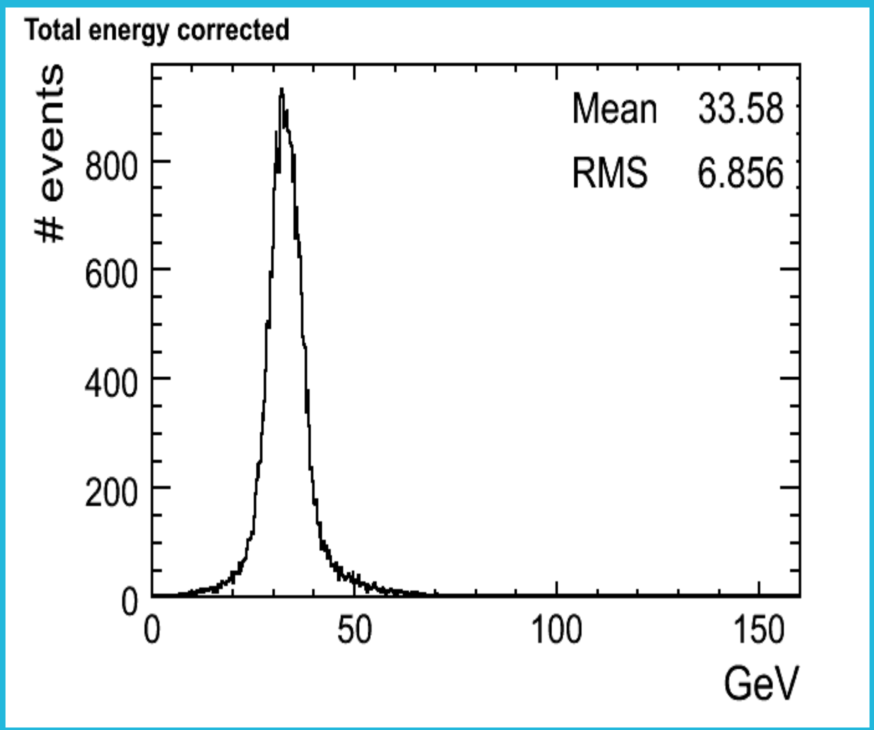
Uncorrected



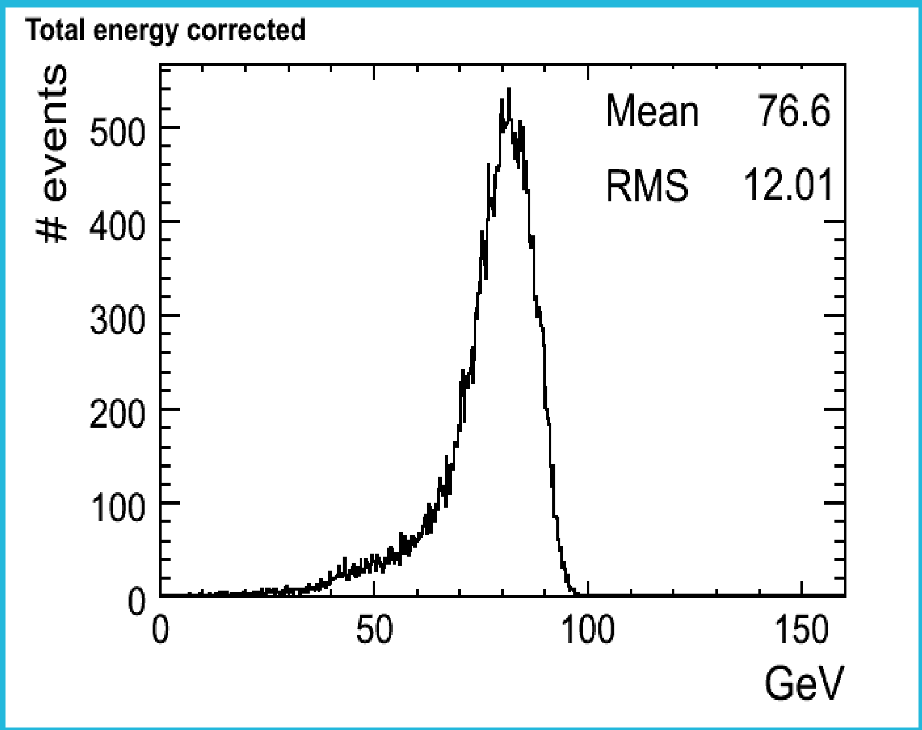
Corrected

Remaining Issues

- Low energies slightly over-corrected, high energies slightly under-corrected.
- Thinking of an improvement. Probably further energy steps in the template would help.

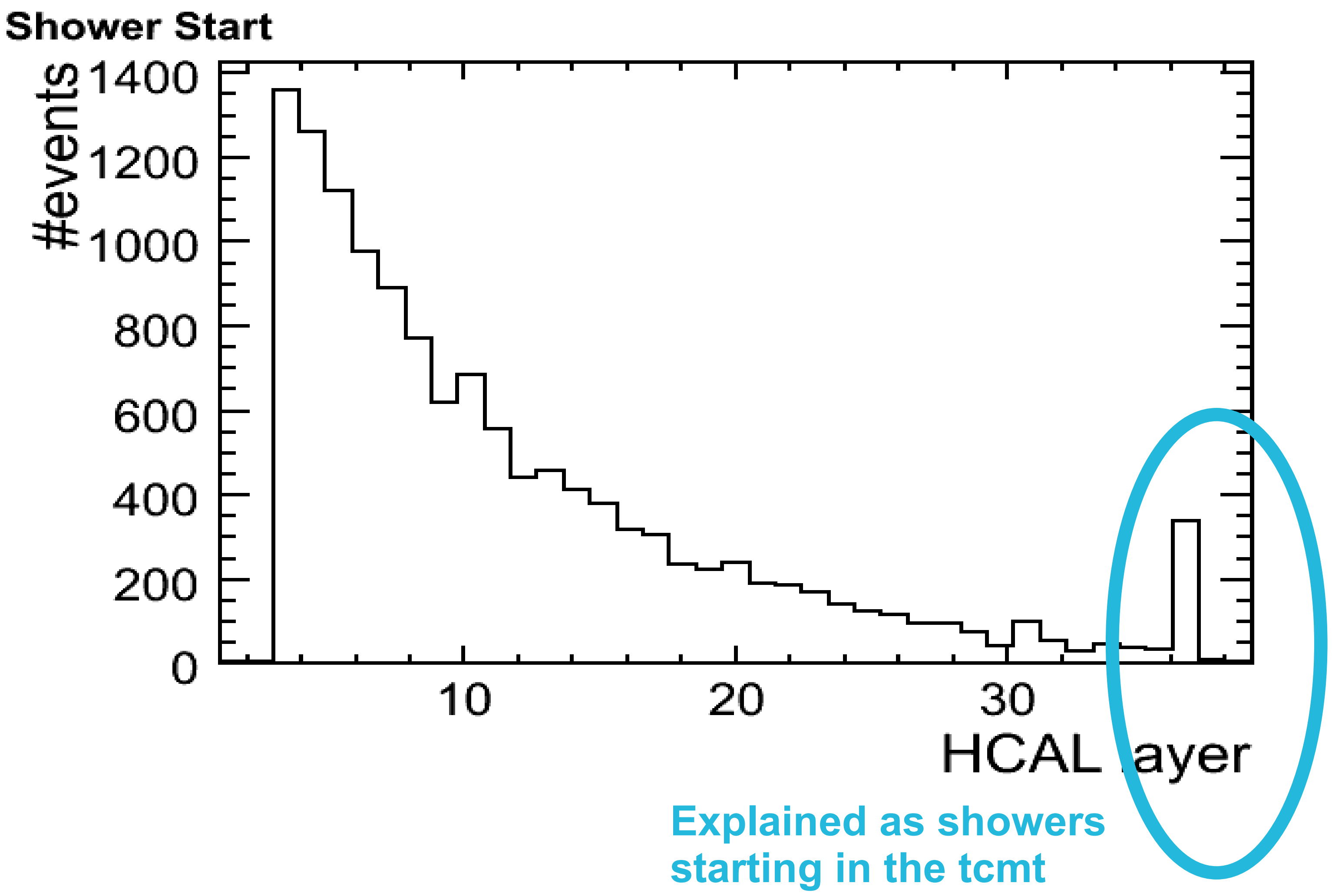


Corrected 32.5 GeV run



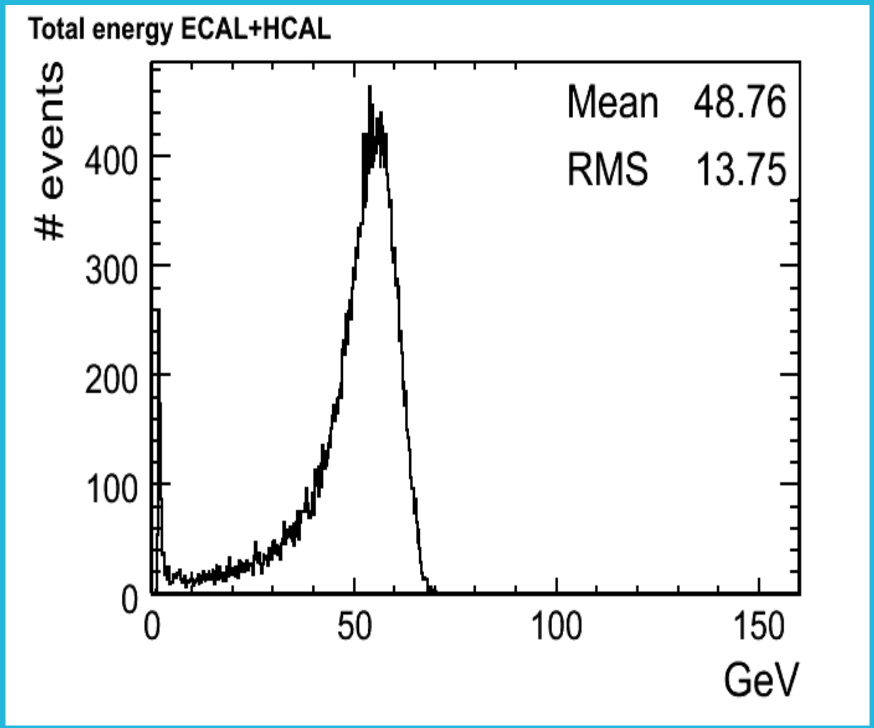
Corrected 77.5 GeV run

Showers Starting in the Tcmt

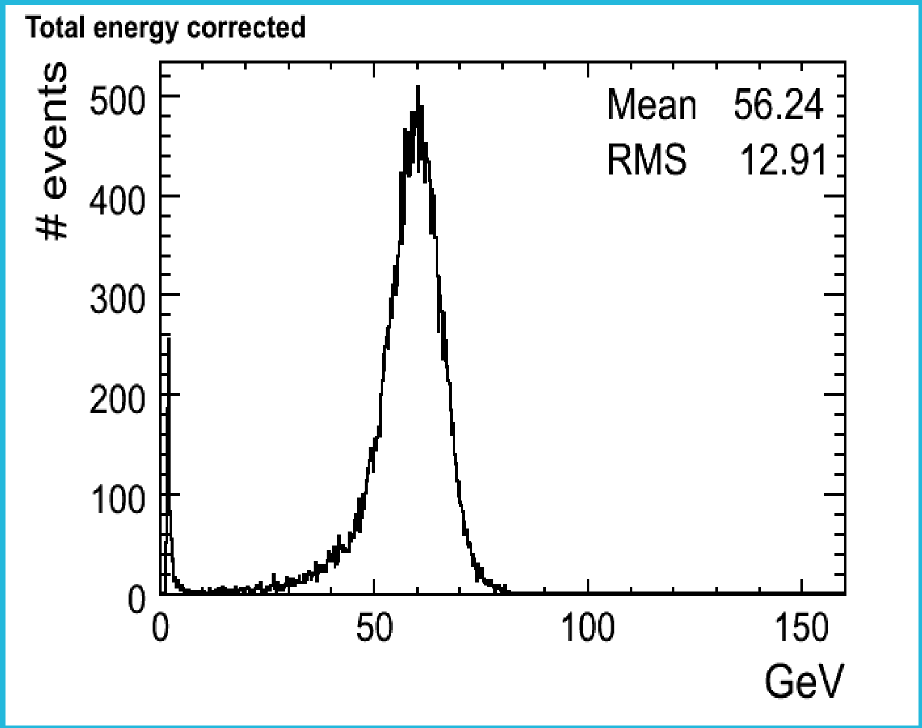


Relevance of a Post-Coil Sampling

- Showers starting in the tcmt would not be seen, and not corrected for, in a hcal-only option.
- Run to be corrected: **57.5 GeV**.



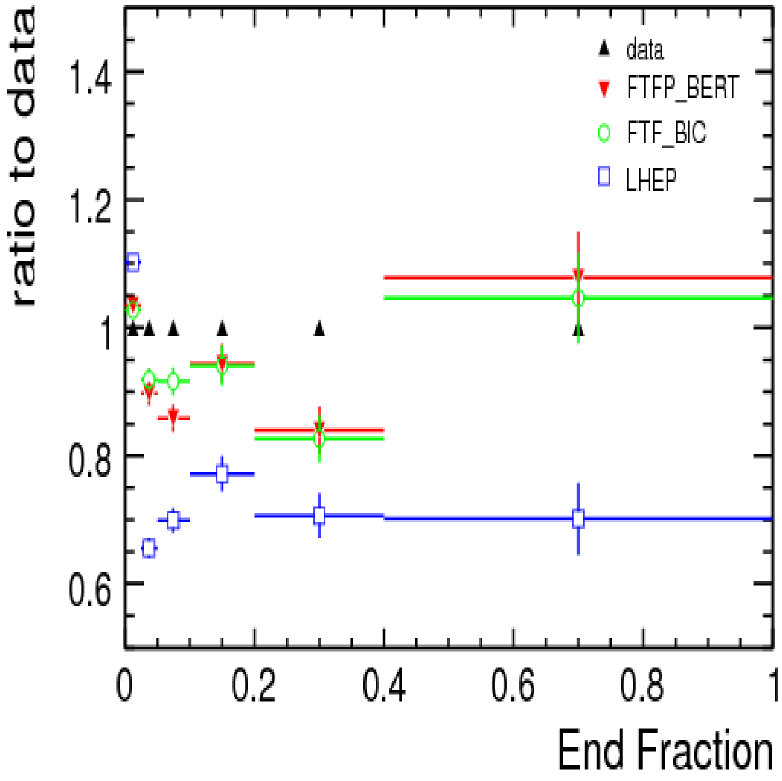
Uncorrected

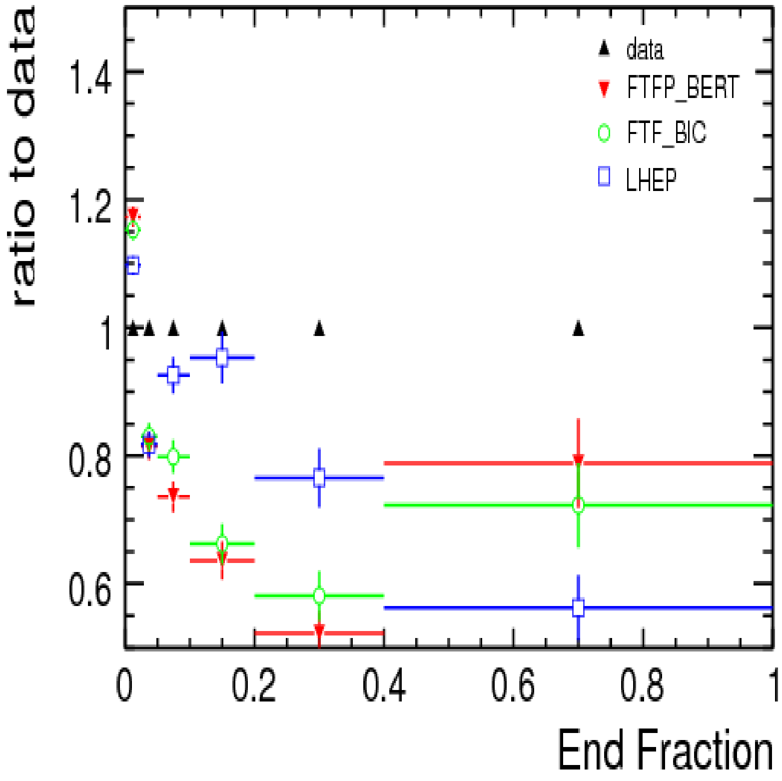


Corrected

First Data/MC Comparisons

End-fraction (ratio)

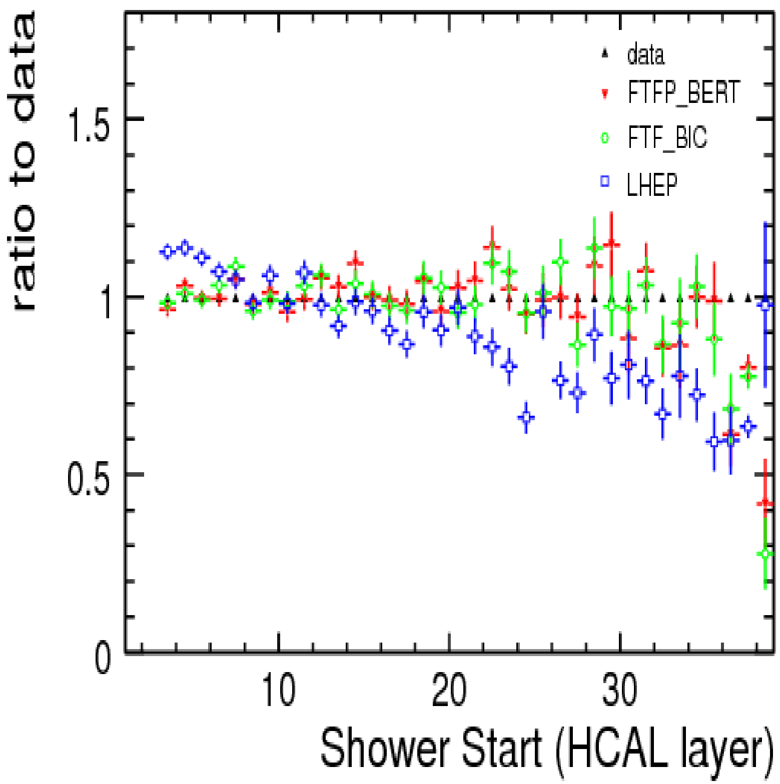


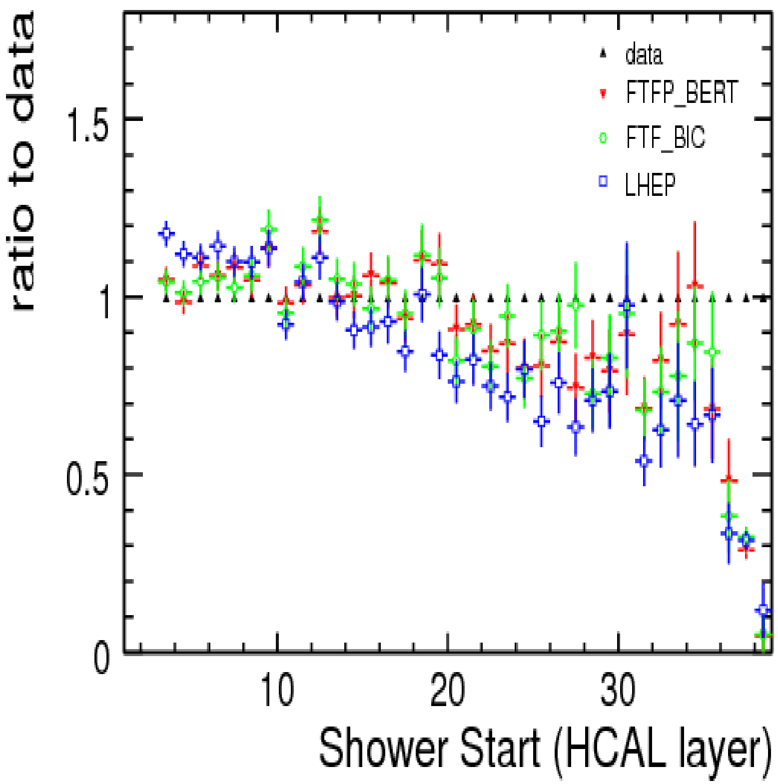


25 GeV

80 Gev

Shower Start (ratio)

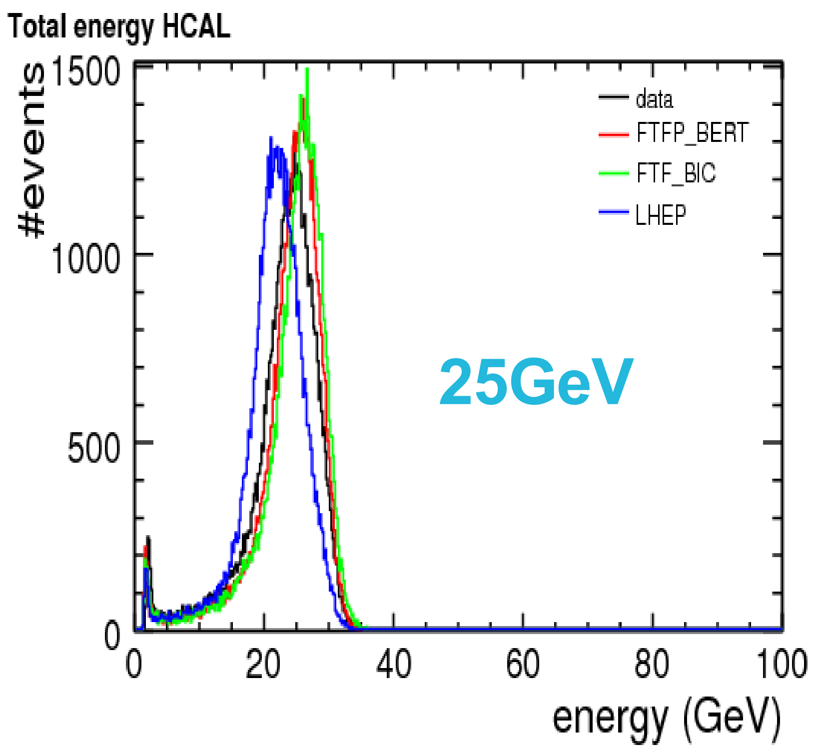


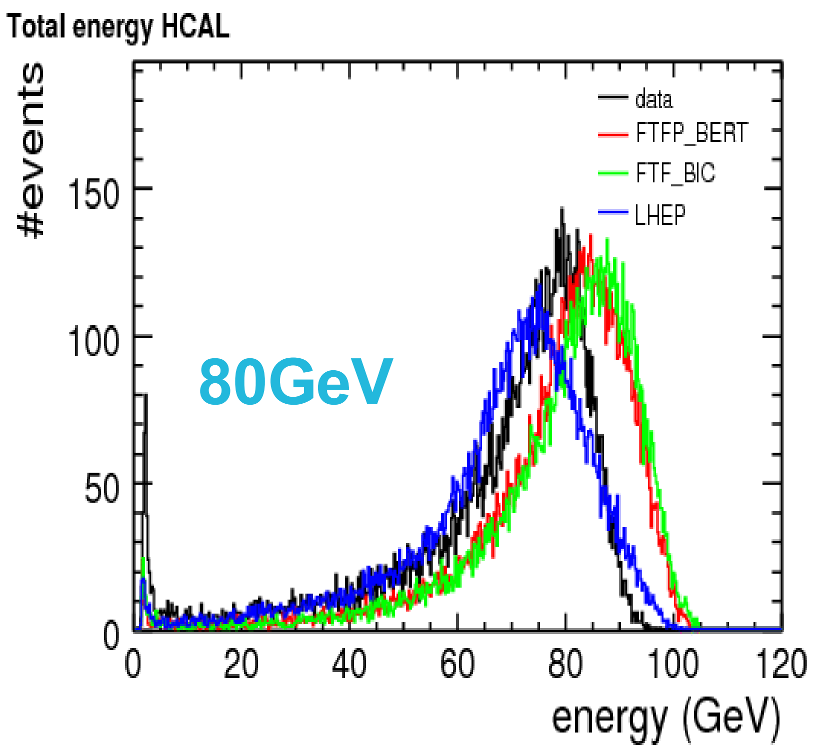


25 GeV

80 Gev

Measured Energy HCAL



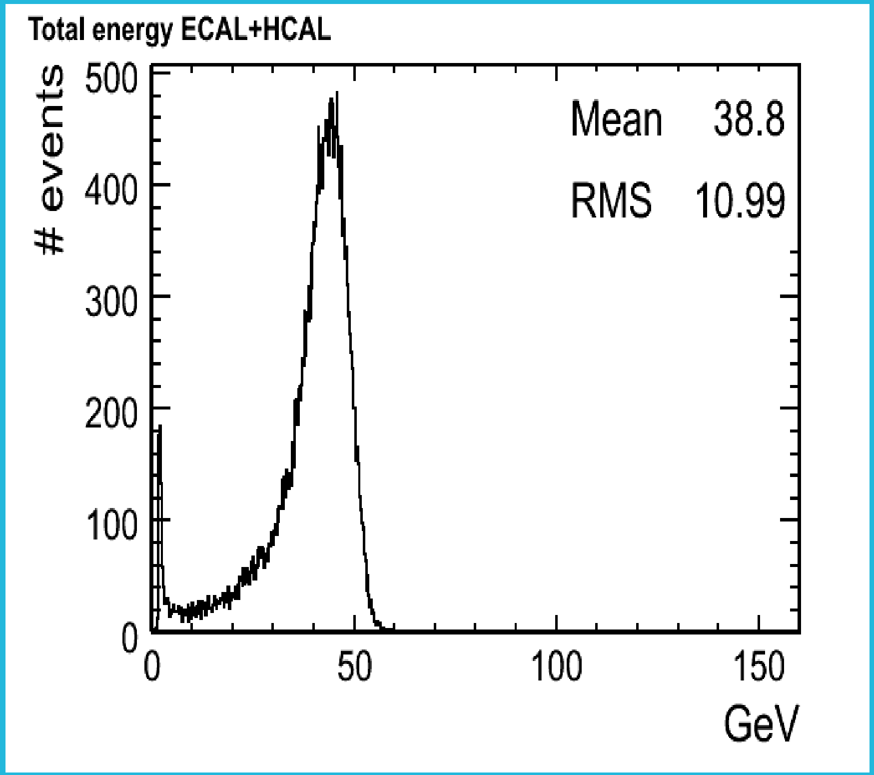


Mean 22.9 RMS 5.7
Mean 23.9 RMS 5.4
Mean 24.4 RMS 5.6
Mean 21.5 RMS 5.0

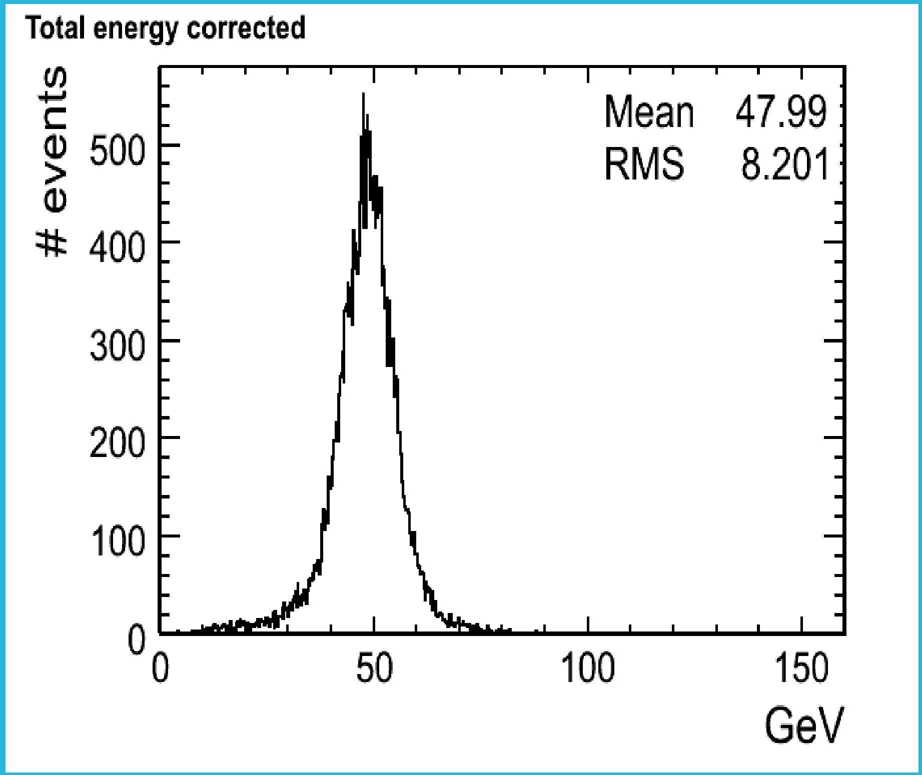
Mean 67.2 RMS 19.8
Mean 77.5 RMS 16.6
Mean 78.5 RMS 17.0
Mean 68.1 RMS 17.4

Correcting Data with Monte Carlo template

- Run to be corrected: **45 GeV**.
- Different sampling weights to Monte Carlo to recover energy scale.



Uncorrected



Corrected

Next Steps

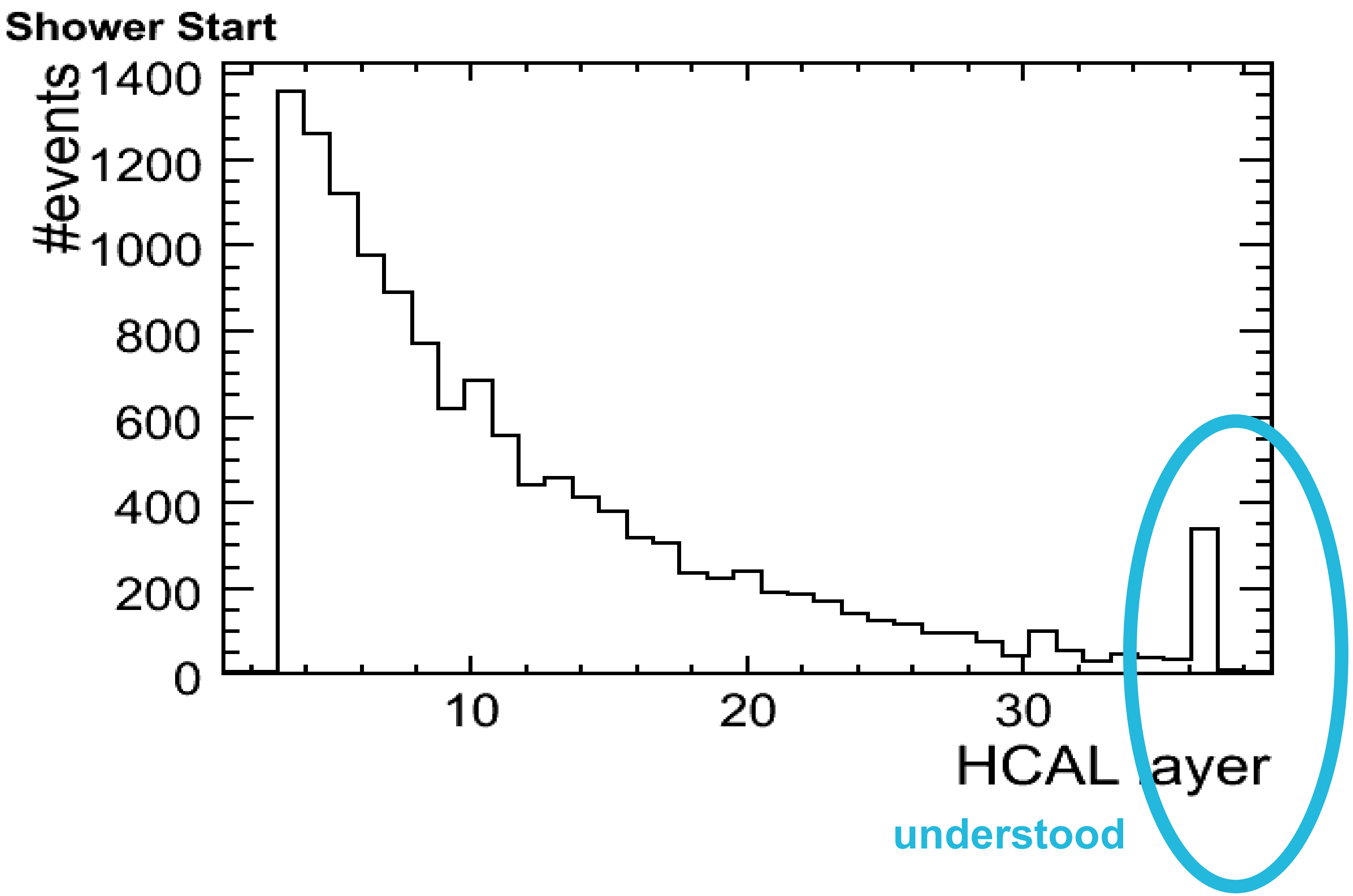
Next Steps

- Polish the analysis and study **smarter fit** to the template.
- Develop Monte Carlo / **data comparison.**
- Final aim is an **ILD-oriented** study:
  - Step 1: estimate detailed jet composition from ILD simulation.
  - Step 2: try to estimate impact on ILD physics events reconstruction of leakage correction for the neutrals.
  - Step 2b: study correction for overlayed/jets-like events in the HCAL.

End

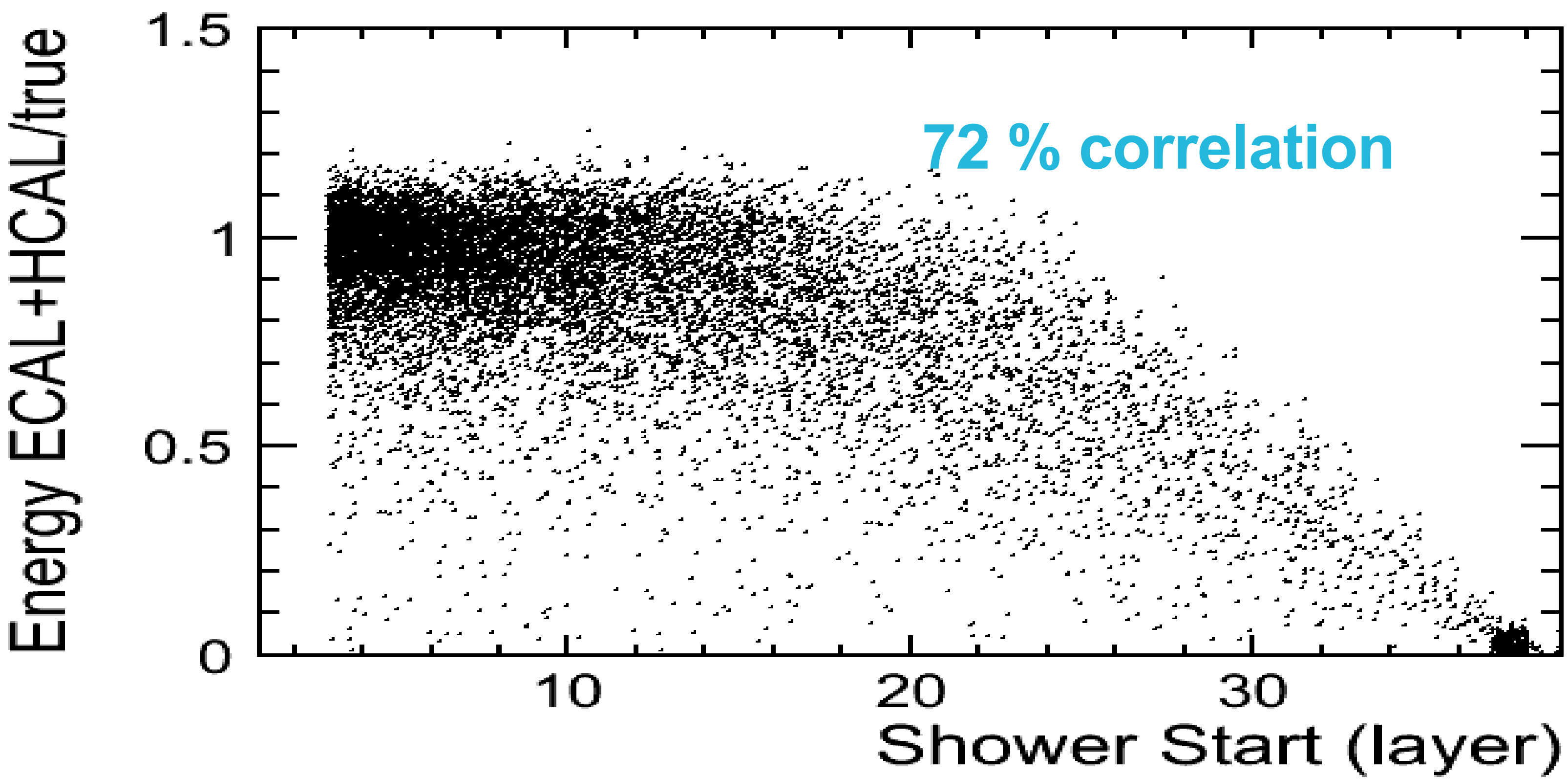
Additional Slides

Shower Start

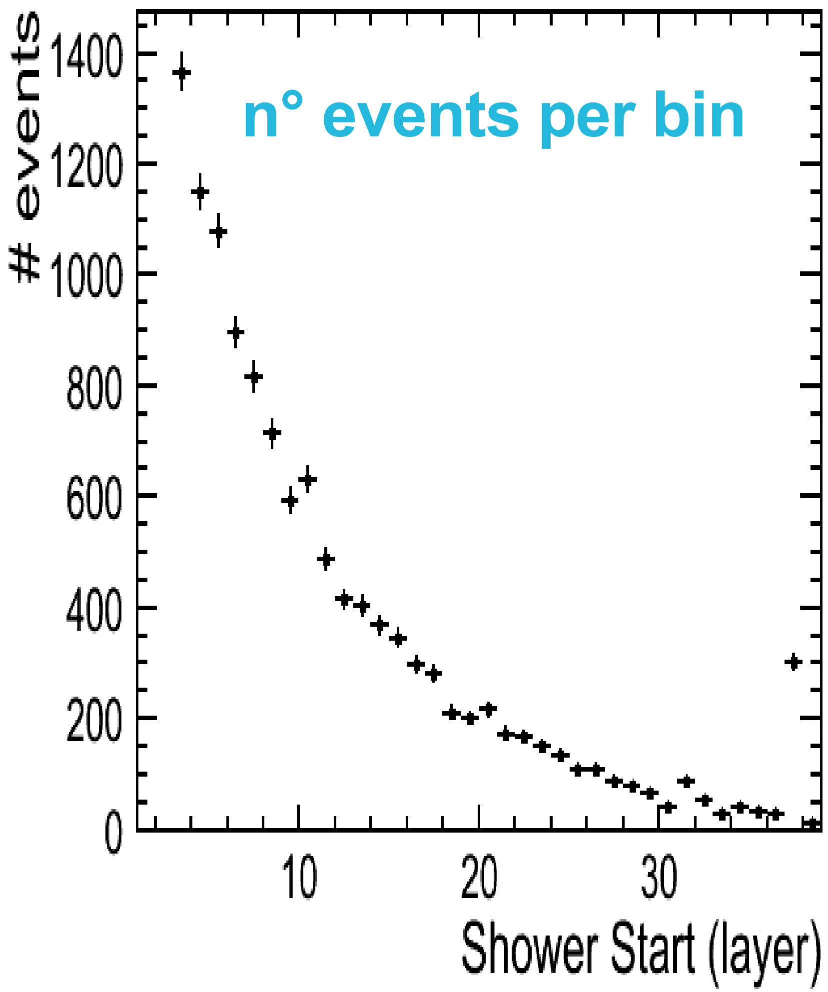


Shower Start vs Leakage

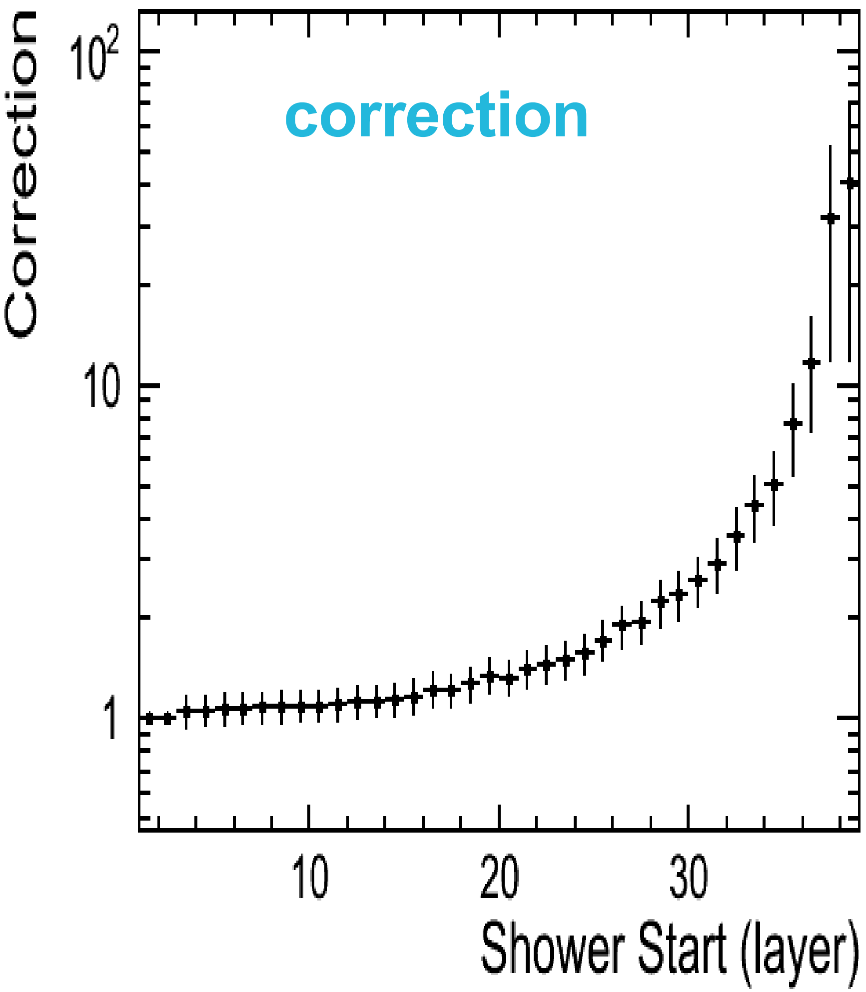
- Leakage expressed by: (energy ECAL+ HCAL) / (beam energy).
- Ex.: **80 GeV run 330962**.



Correction



n° events per bin
events
1400
1200
1000
800
600
400
200
0
10
20
30
Shower Start (layer)

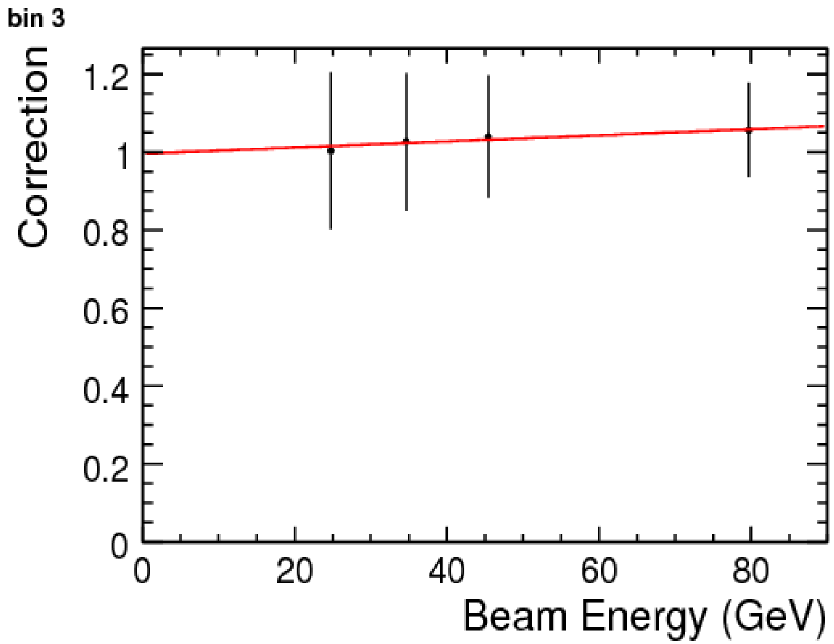


correction
Correction
10^2
10
1
10
20
30
Shower Start (layer)

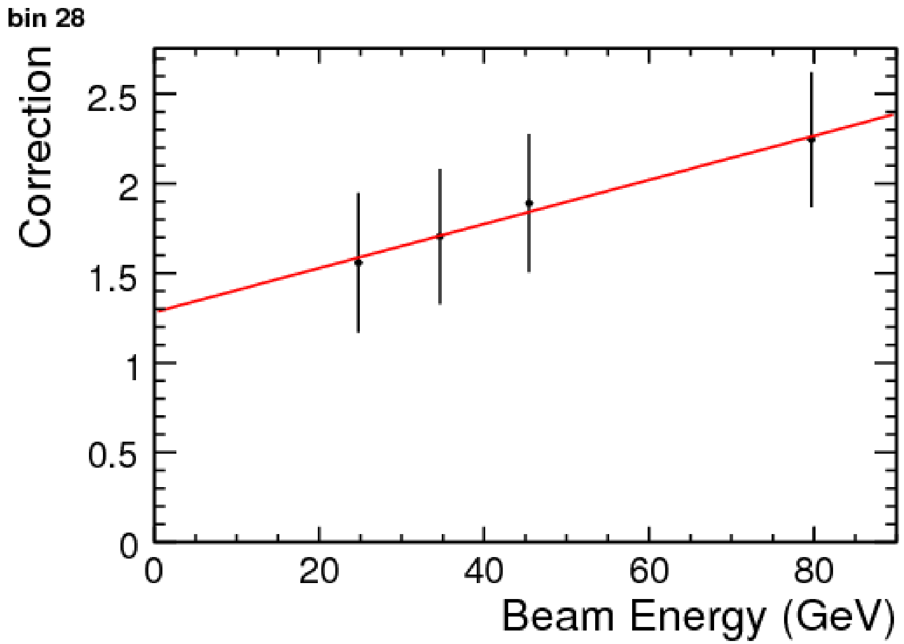
Energy Dependence

- Shower start advanced in the HCAL: steeper energy dependence.

Correction vs energy



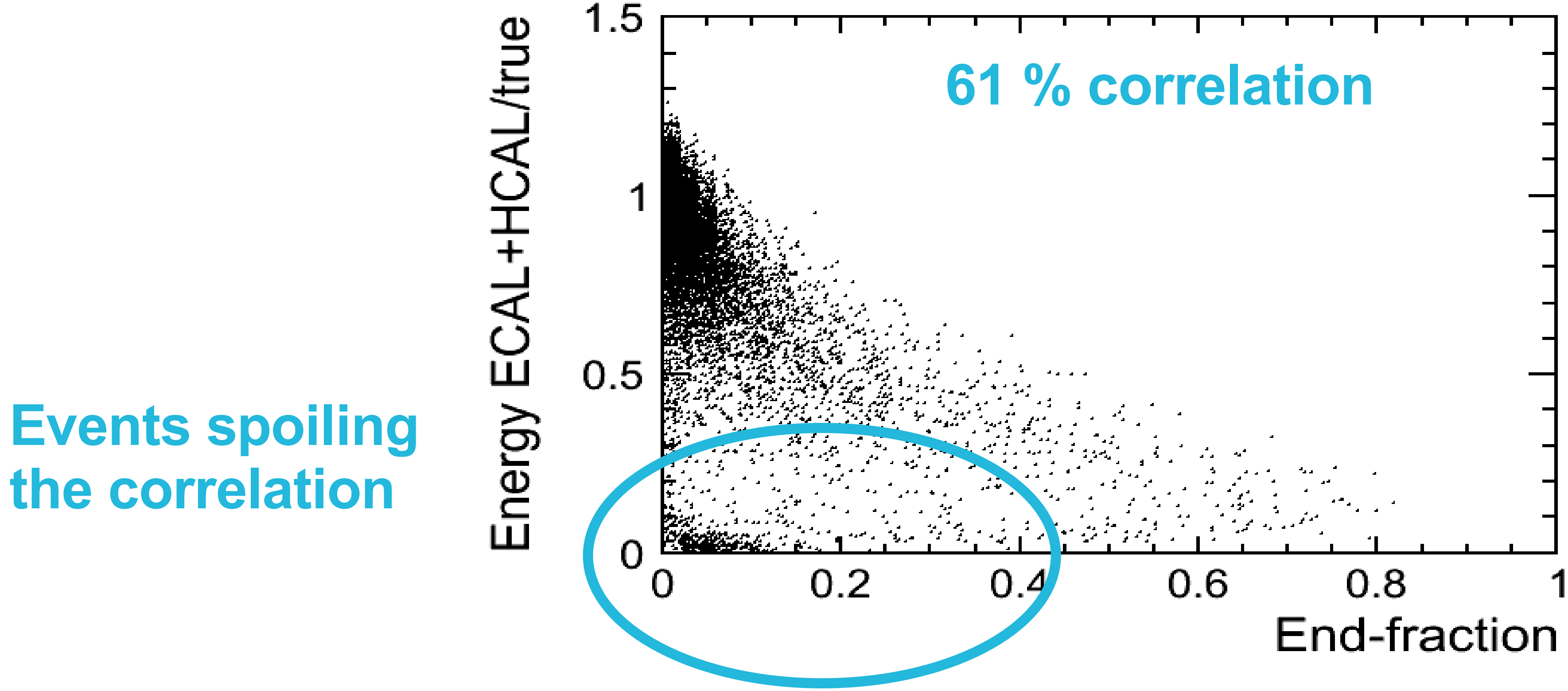
Shower start layer 3



Shower start layer 28

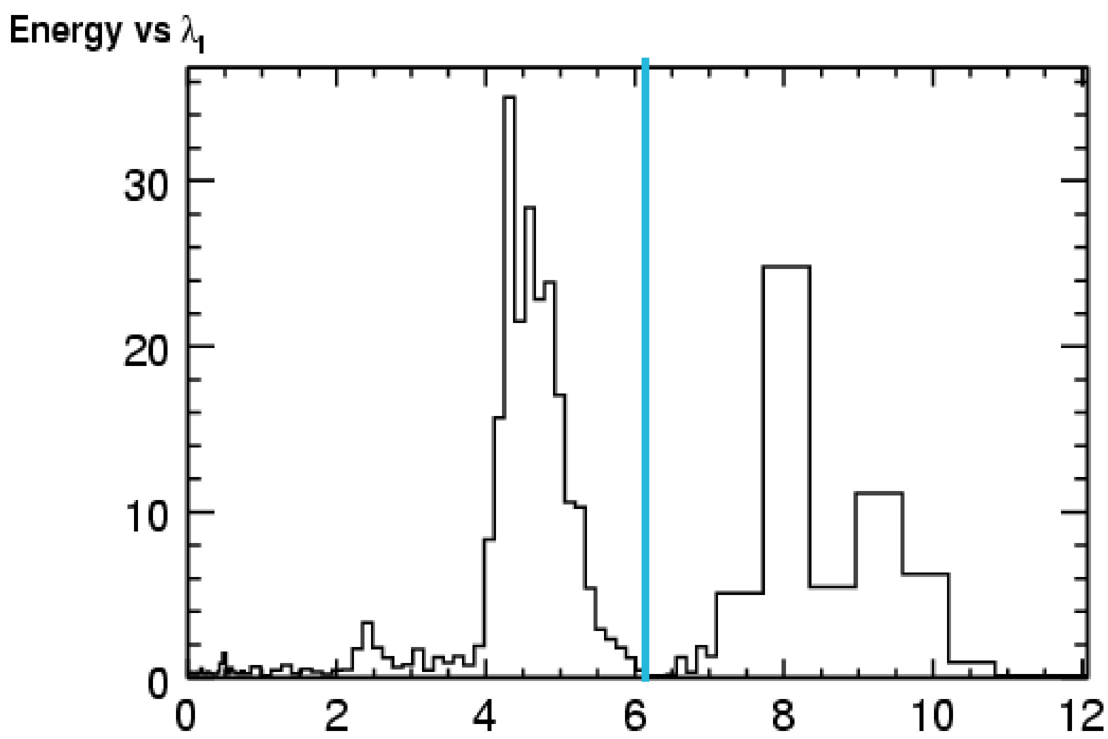
End-fraction vs Leakage

- End-fraction: fraction of HCAL energy in the last 2 layers.
- Ex.: 80 GeV run 330962.



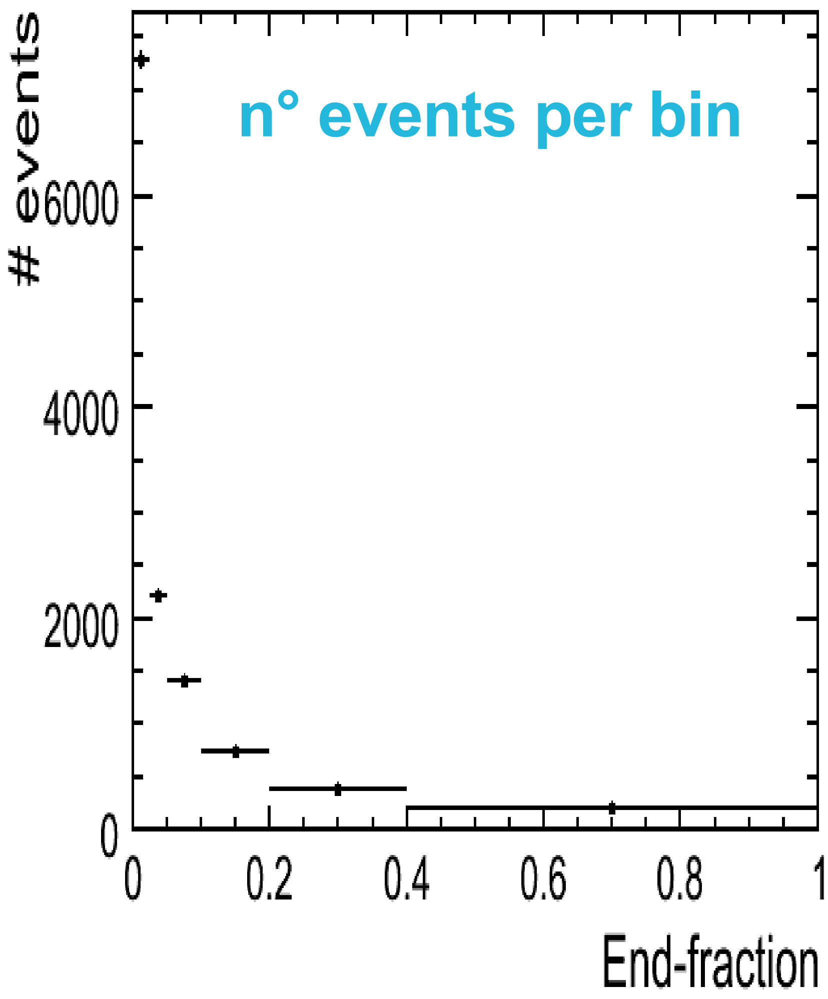
Events Spoiling the Correlation

- Events with a “bad” shower shape.
- (Few) events starting in the TCMT: for this one can do nothing anyway in a non-post-coil-sampling option.

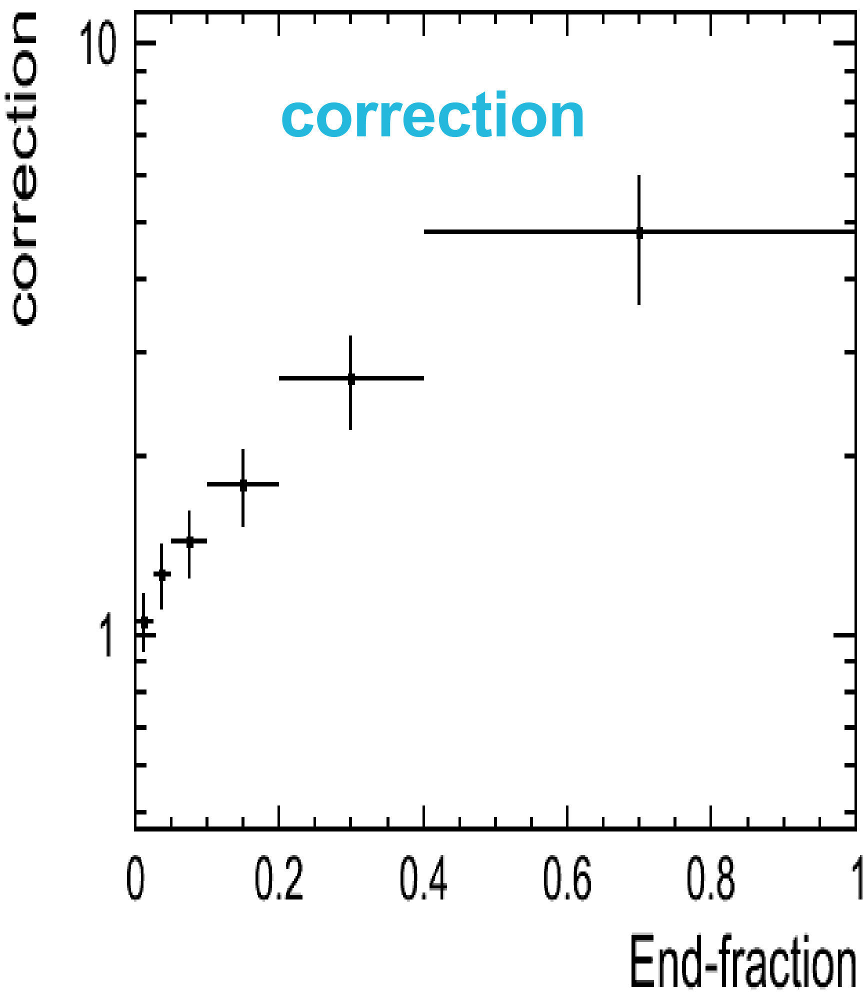


Ex.: neutral fractions the shower development

Correction



events
n° events per bin
6000
4000
2000
0
0
0.2
0.4
0.6
0.8
1
End-fraction

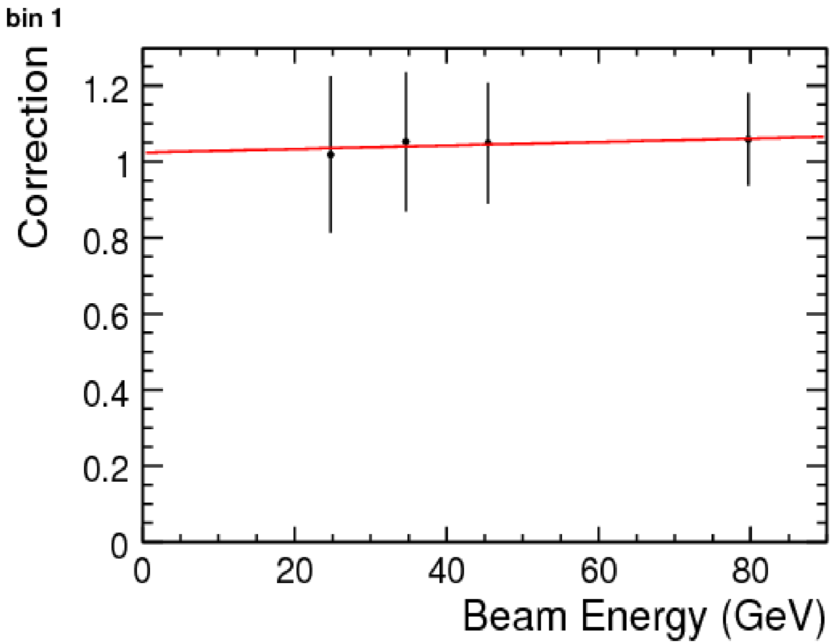


correction
correction
10
1
0
0.2
0.4
0.6
0.8
1
End-fraction

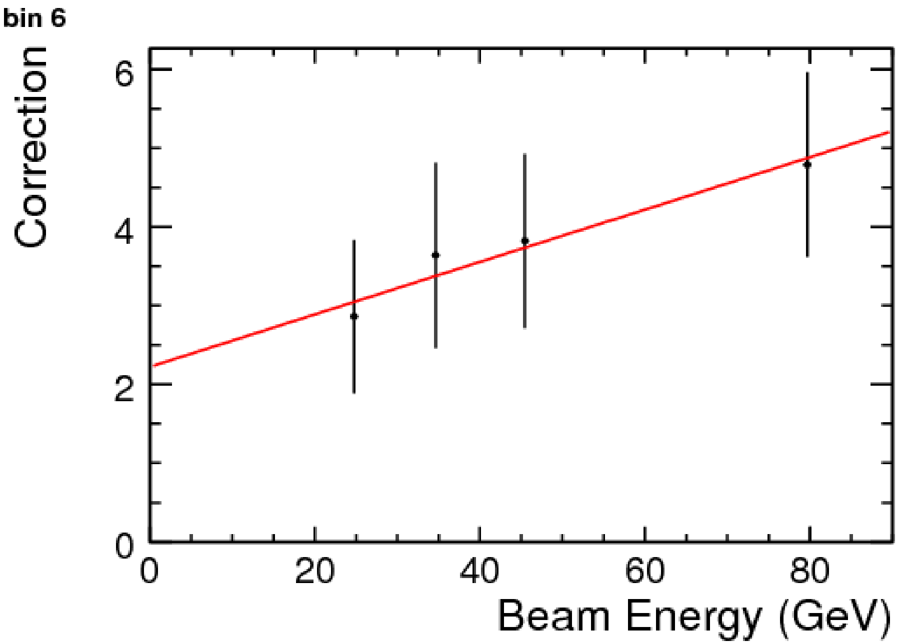
Energy Dependence

- Higher end-fraction: steeper energy dependence.

Correction vs energy

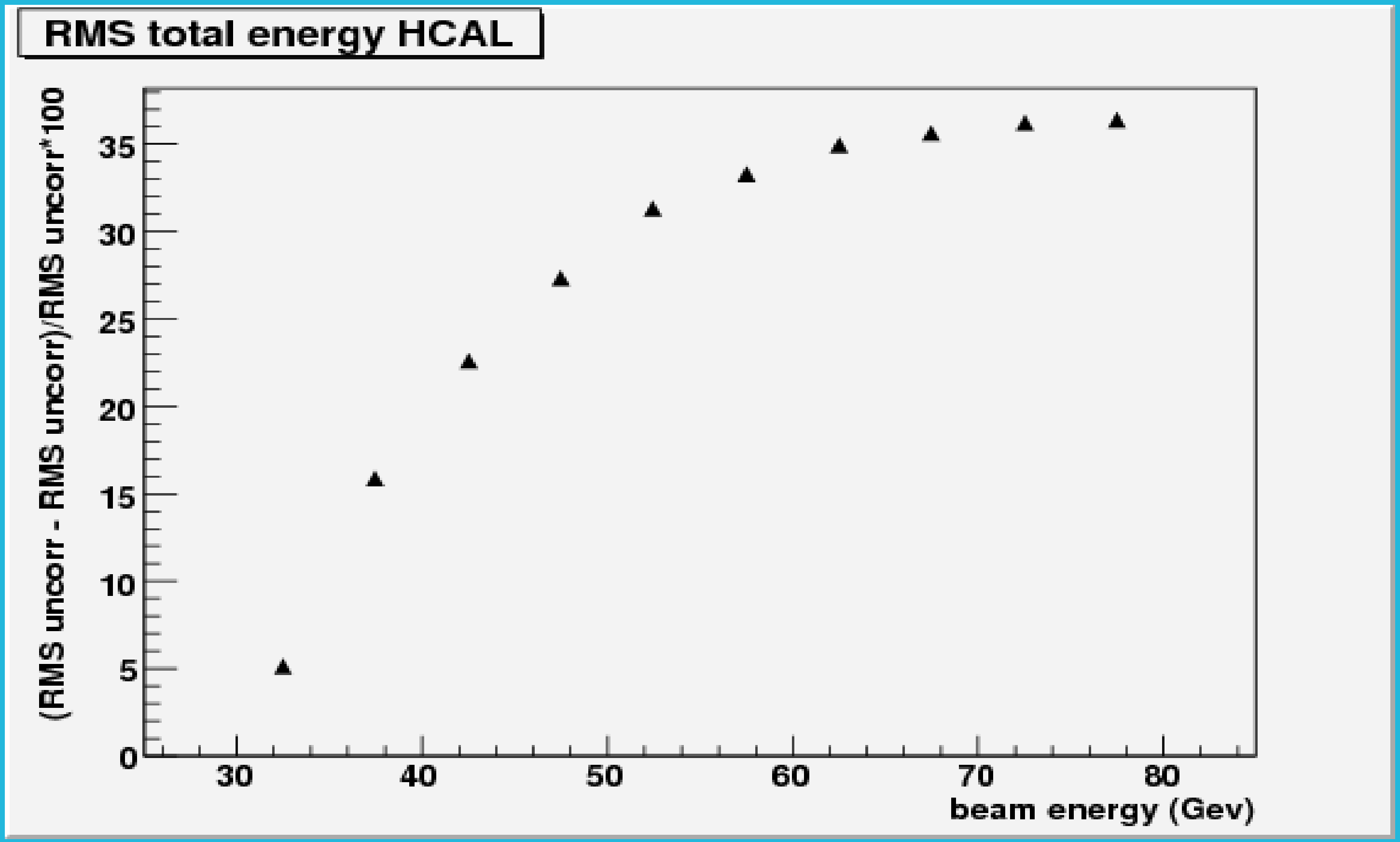


End-fraction bin 1



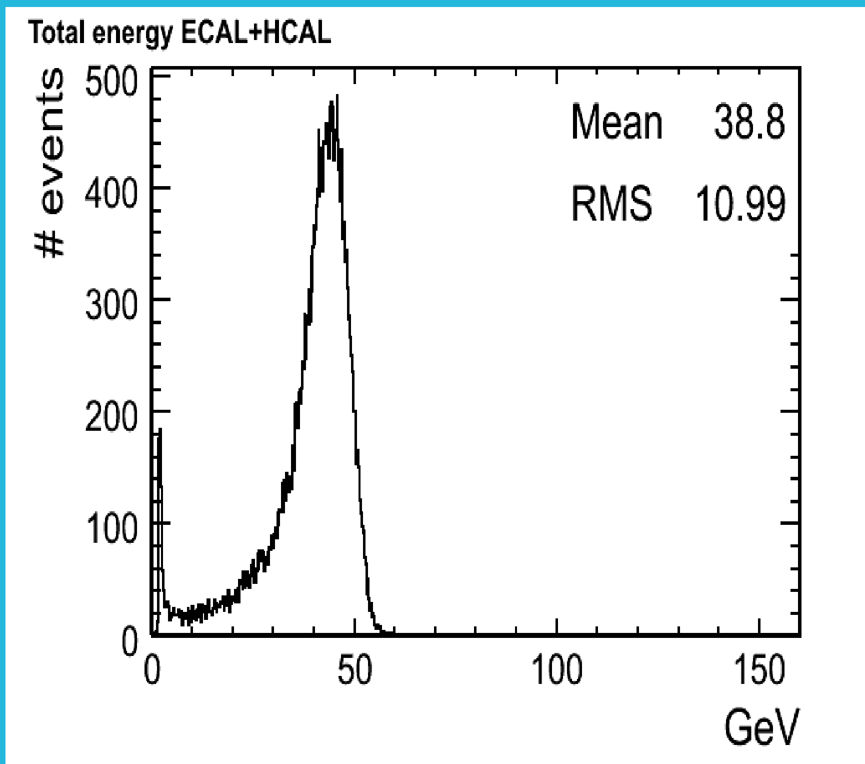
End-fraction bin 6

Preliminary RMS improvement estimate

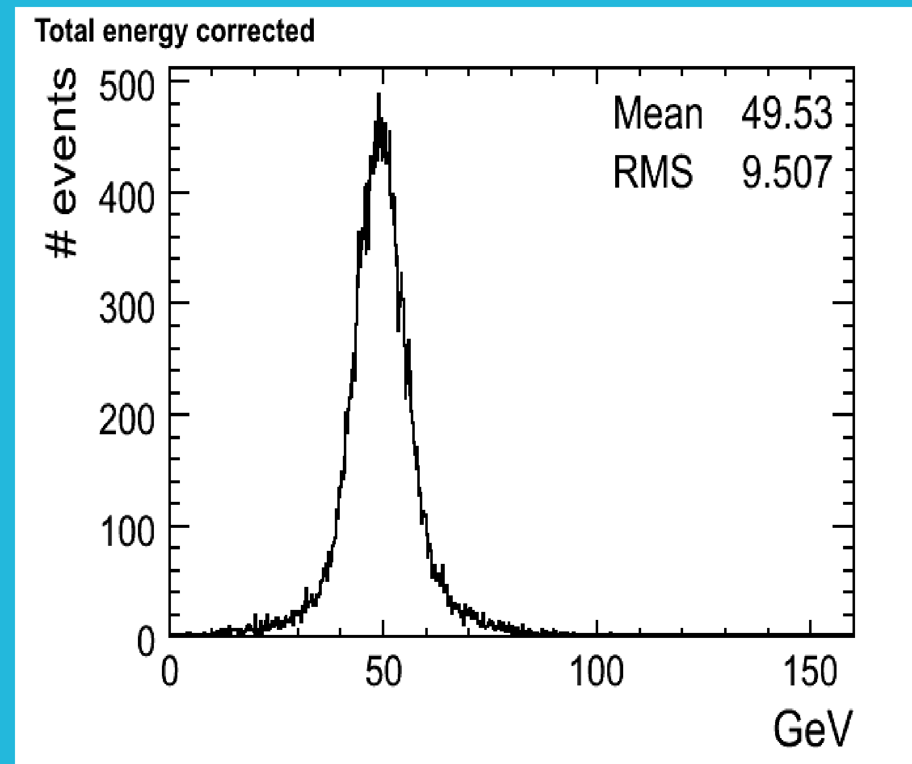


Correcting data with Monte Carlo template

- Run to be corrected: **45 GeV**.
- Same sampling weights data and Monte Carlo.



Uncorrected



Corrected