A Study on Leakage and Energy Resolution

Ivan Marchesini , HCAL Analysis meeting, 2010-06-21

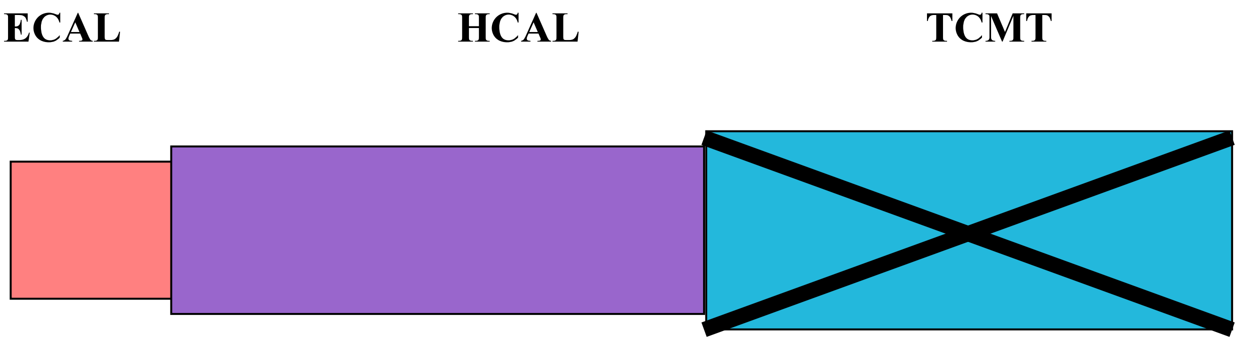
Outlook

- Introduction.
- Event selection.
- Variables sensitive to the leakage:
  - Shower Start;
  - End-fraction.
- An energy-independent correction to the Leakage.
- Comments and next steps.

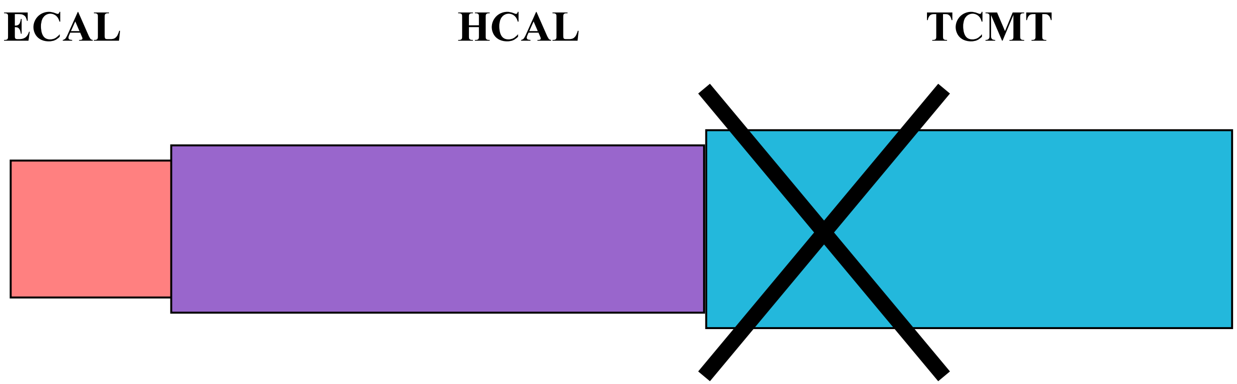
Introduction

Tasks of the Study

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



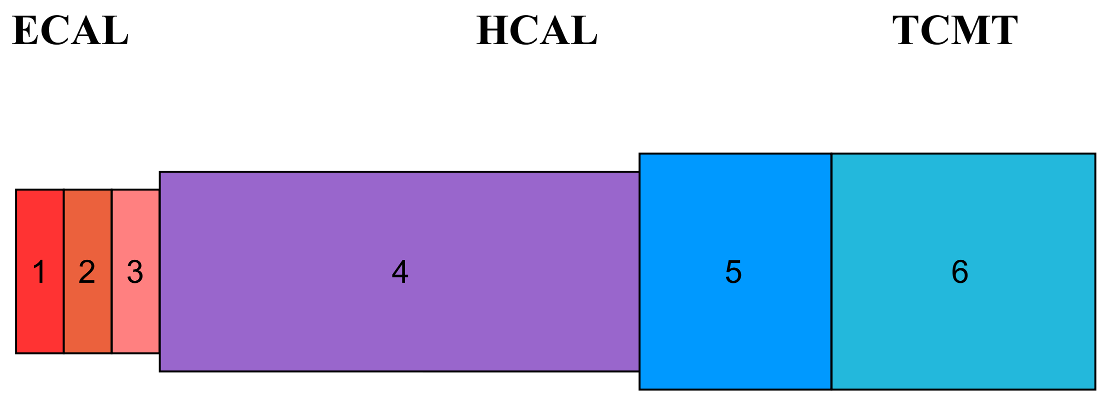
2) See the benefit of having additionally a **TCMT** in an ILD-like configuration:



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

Sampling Weights Optimization

- **6 sampling weights** for different sections.



- SW by a **χ^2 minimization** on the total energy:

$$\chi^2 = \sum_{events} \left(E_{beam} - \left(E_{ECAL1} \cdot w_1 + E_{ECAL2} \cdot w_2 + E_{ECAL3} \cdot w_3 + E_{HCAL} \cdot w_4 + E_{TCMT1} \cdot w_5 + E_{TCMT2} \cdot w_6\right)\right)$$

- We use pions starting in the HCAL, no sensitivity ECAL weights: w1, w2, w3 fixed to those given by the literature.

- Weights for a 30 GeV run used for all the energies: enough E to reach the TCMT, irrelevant leakage from the TCMT.

Event Selection

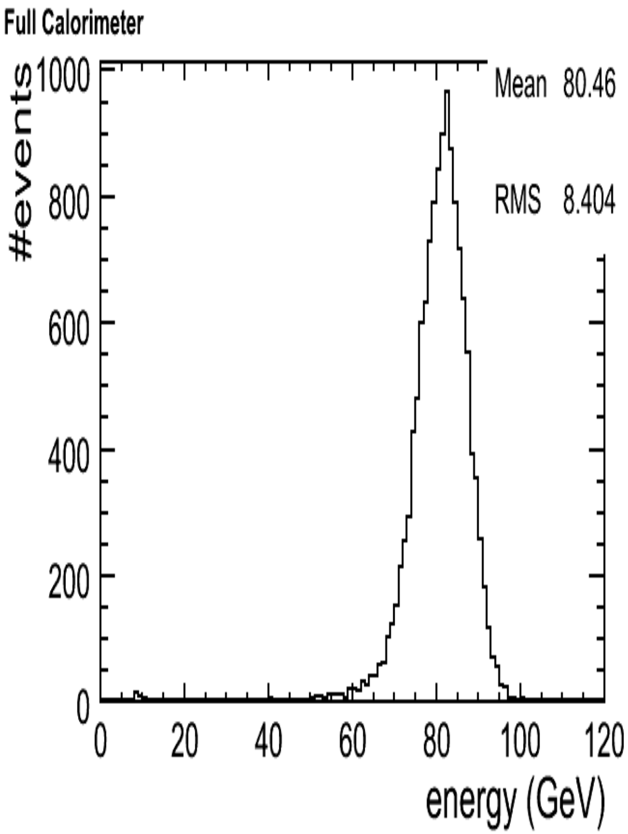
Event Selection

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

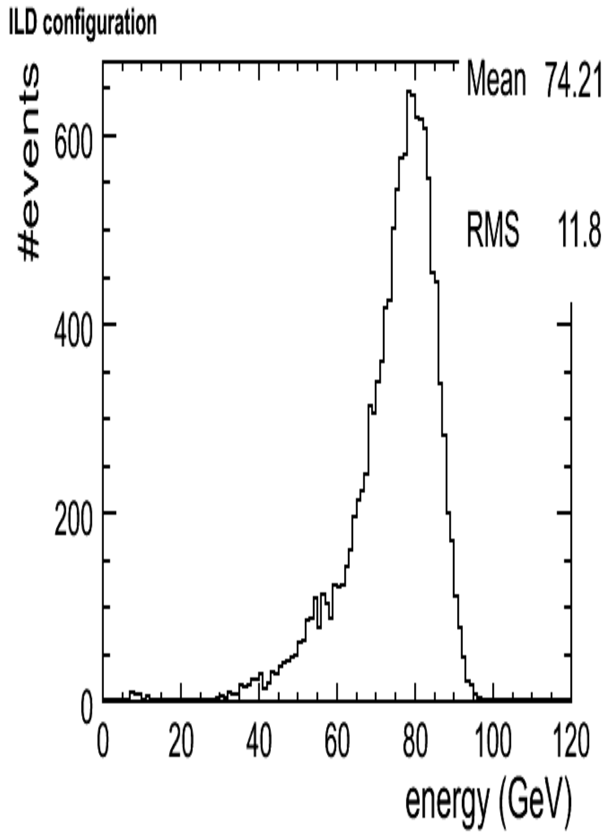
- Cuts:
  - 0.5 MIP threshold.
  - TRIGGER:
    - BeamBit==1;
    - b100x100Bit==0 no muons.
    - CherenkowBit==0 no electrons.
  - Shower start in the HCAL:
    - Marina processor: exclude shower start HCAL layers 1, 2.
  - Further MIP rejection:
    - Frac-10 cut: E hits > 10 MIPs / total E > 0.01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

Total Energy

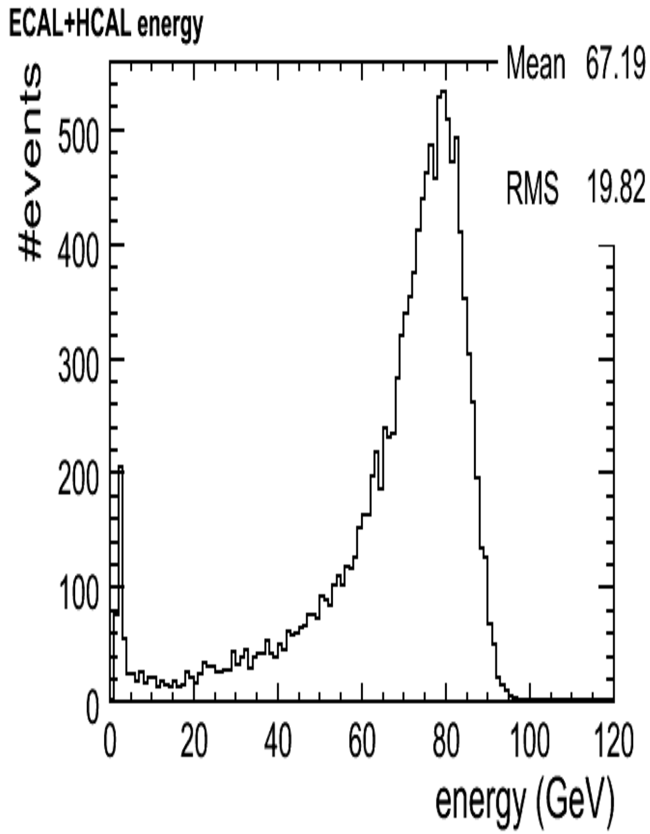
All



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

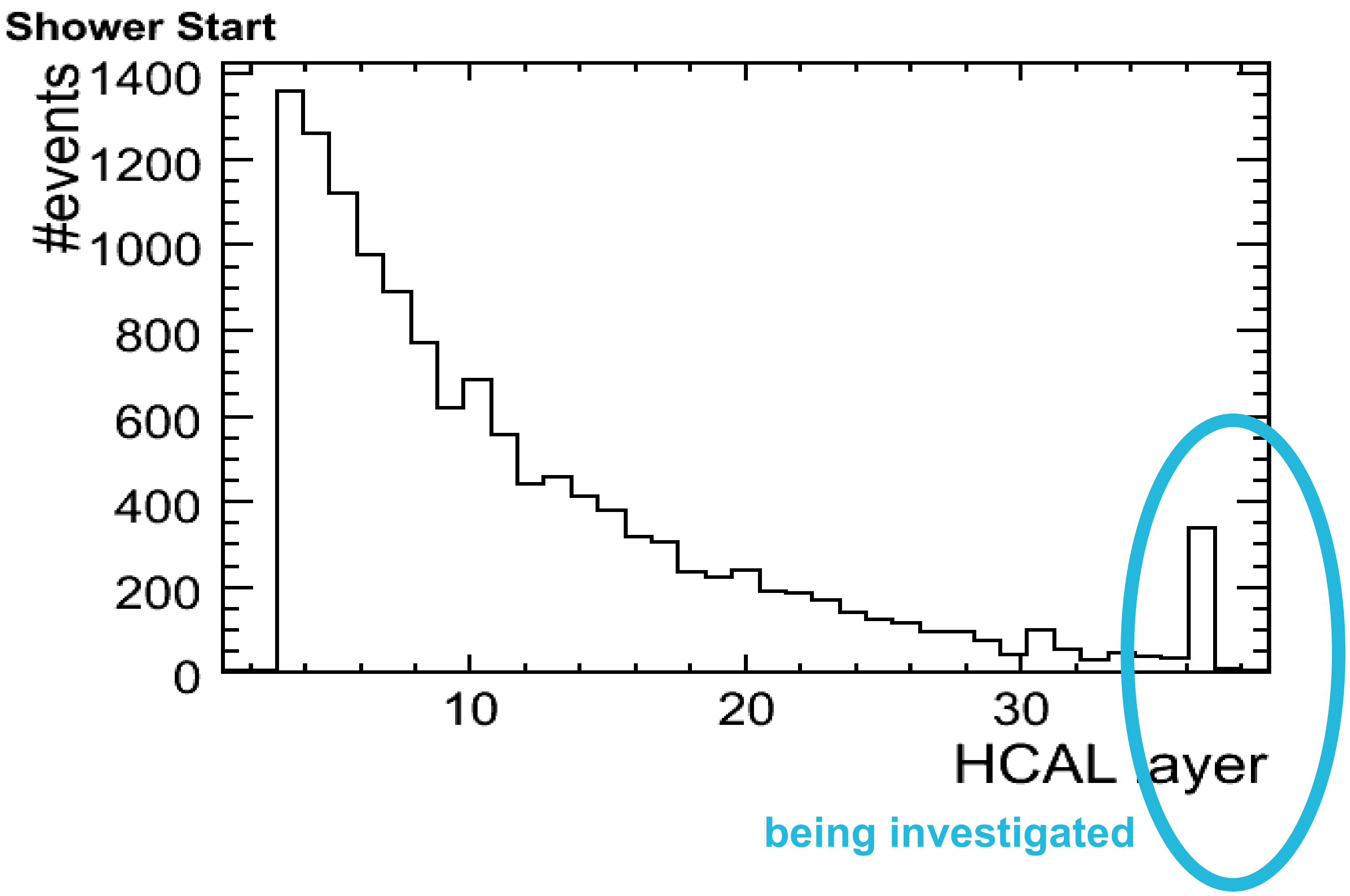


ECAL+HCAL



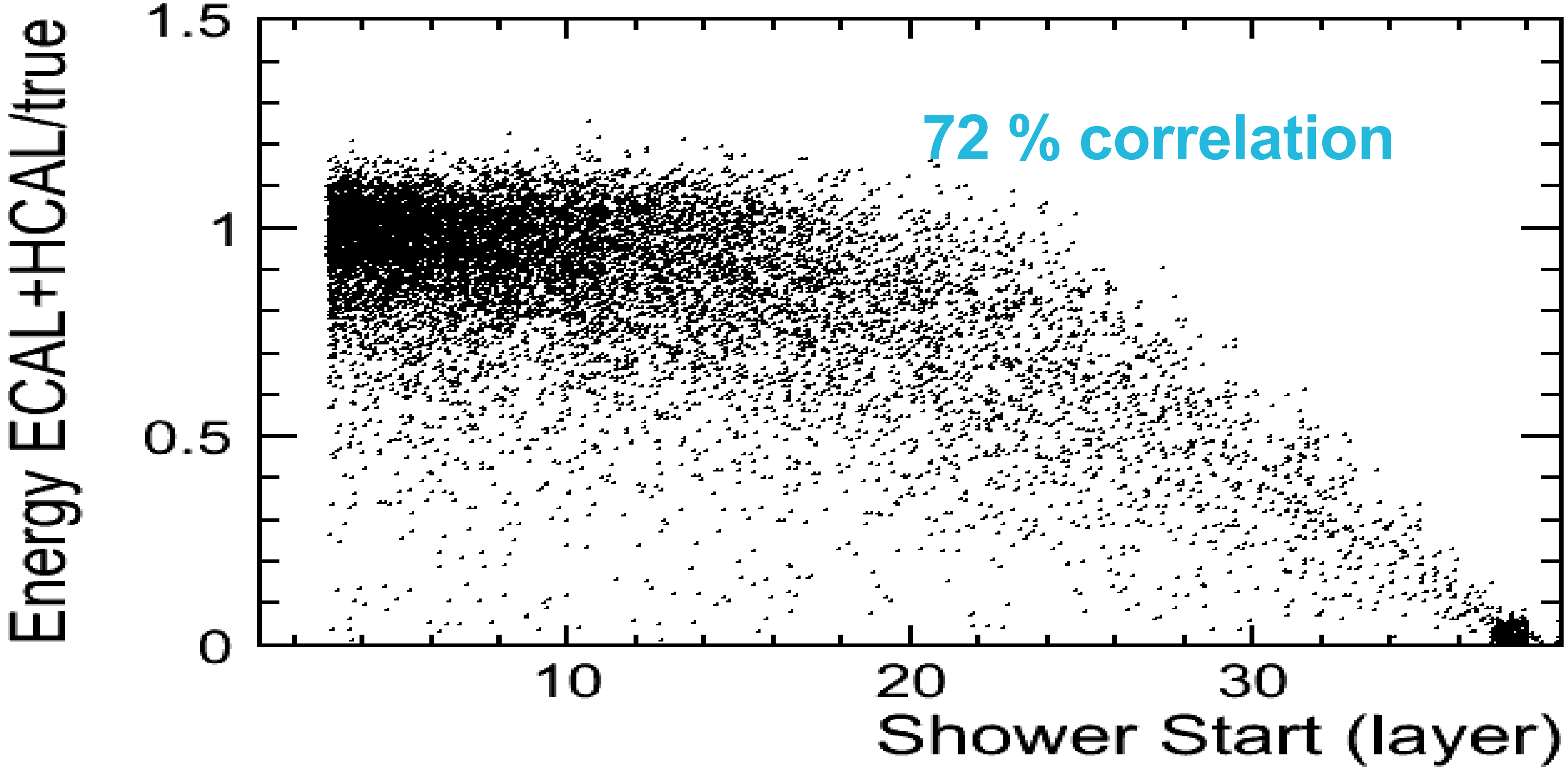
Variables Sensitive to Leakage: 1 – Shower Start

Shower Start

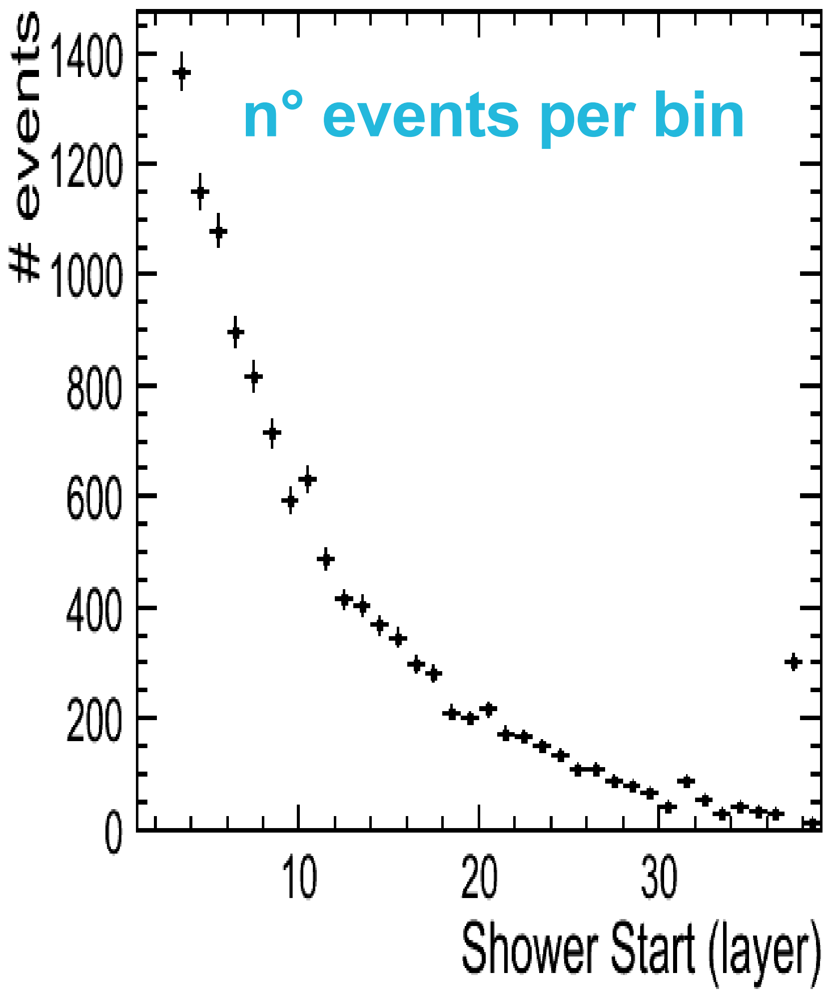


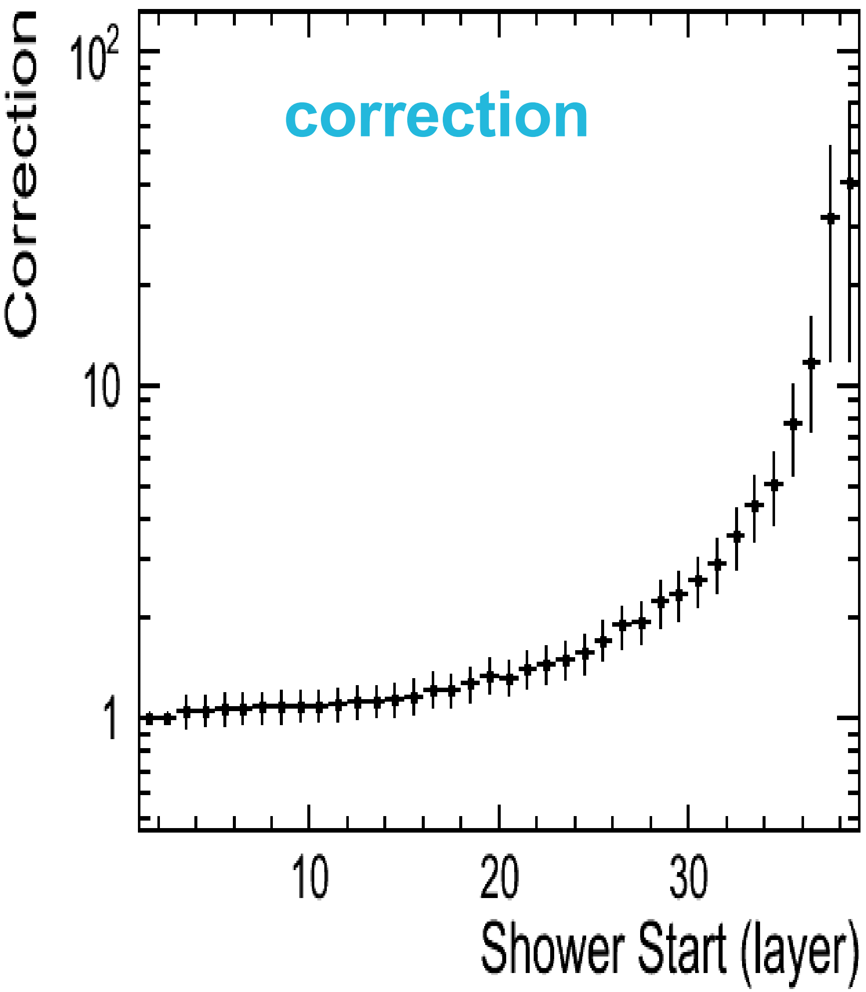
Shower Start vs Leakage

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



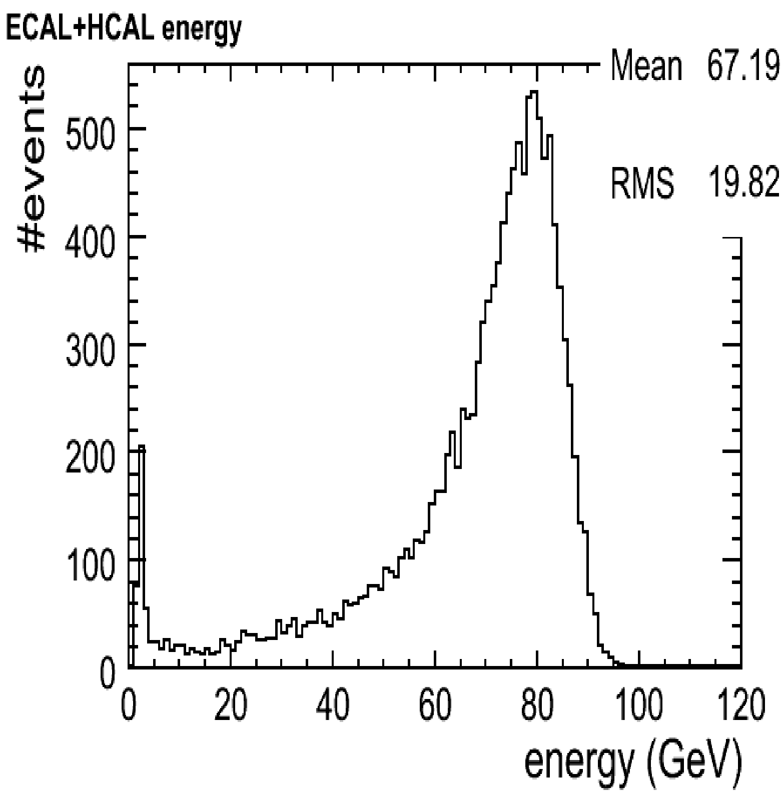
Correction

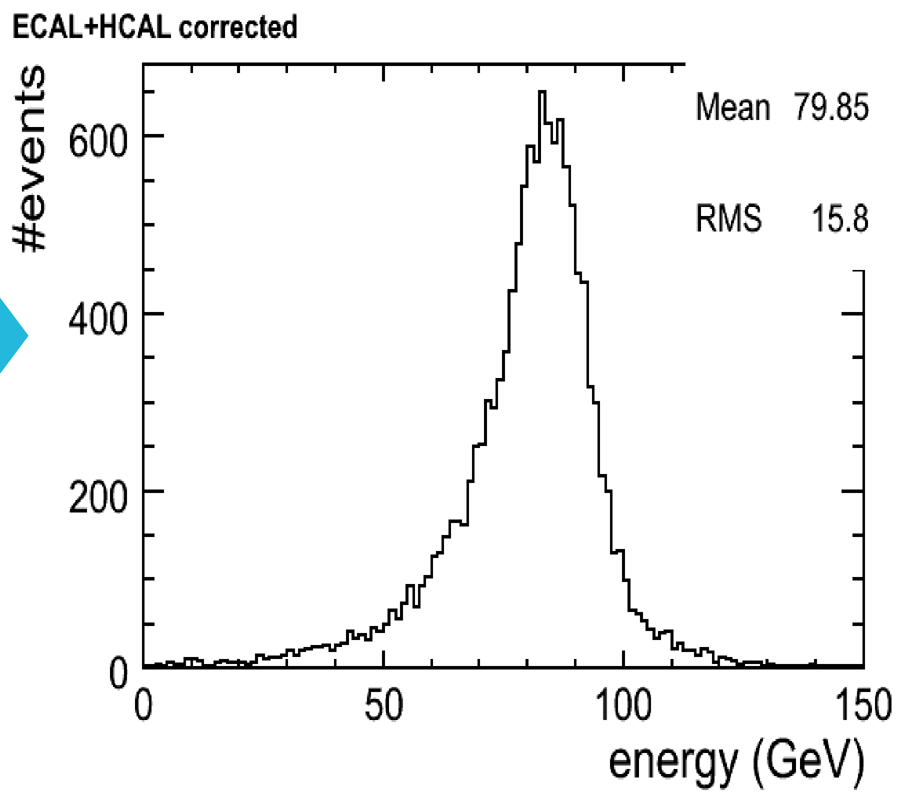

n° events per bin
events
1400
1200
1000
800
600
400
200
0
10
20
30
Shower Start (layer)


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

Result

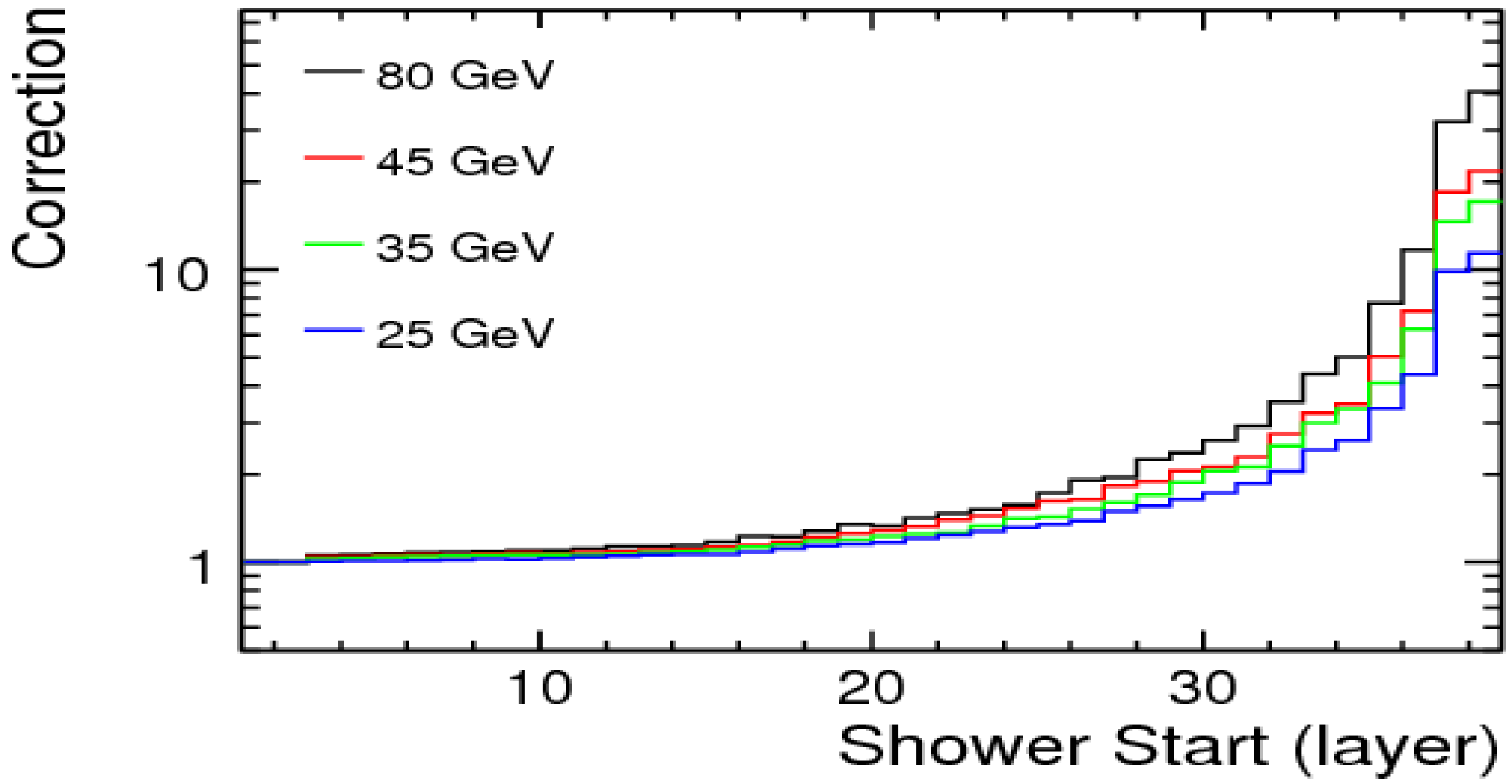
- Mean value of the total energy distribution well recovered.
- RMS reduced but still large.





Correction vs Energy

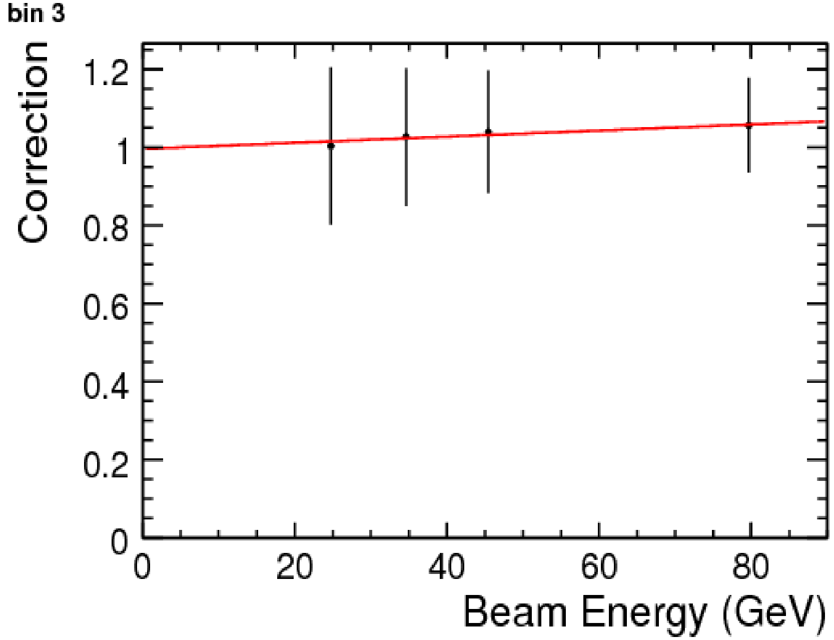
- Correction strongly **energy dependent**.



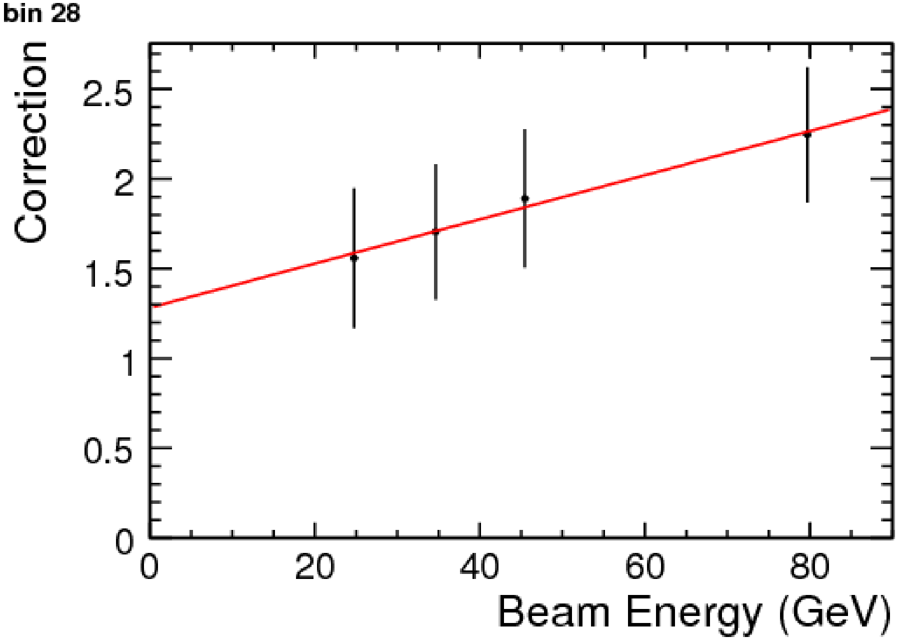
Energy Dependence

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

Correction vs energy



Shower start layer 3



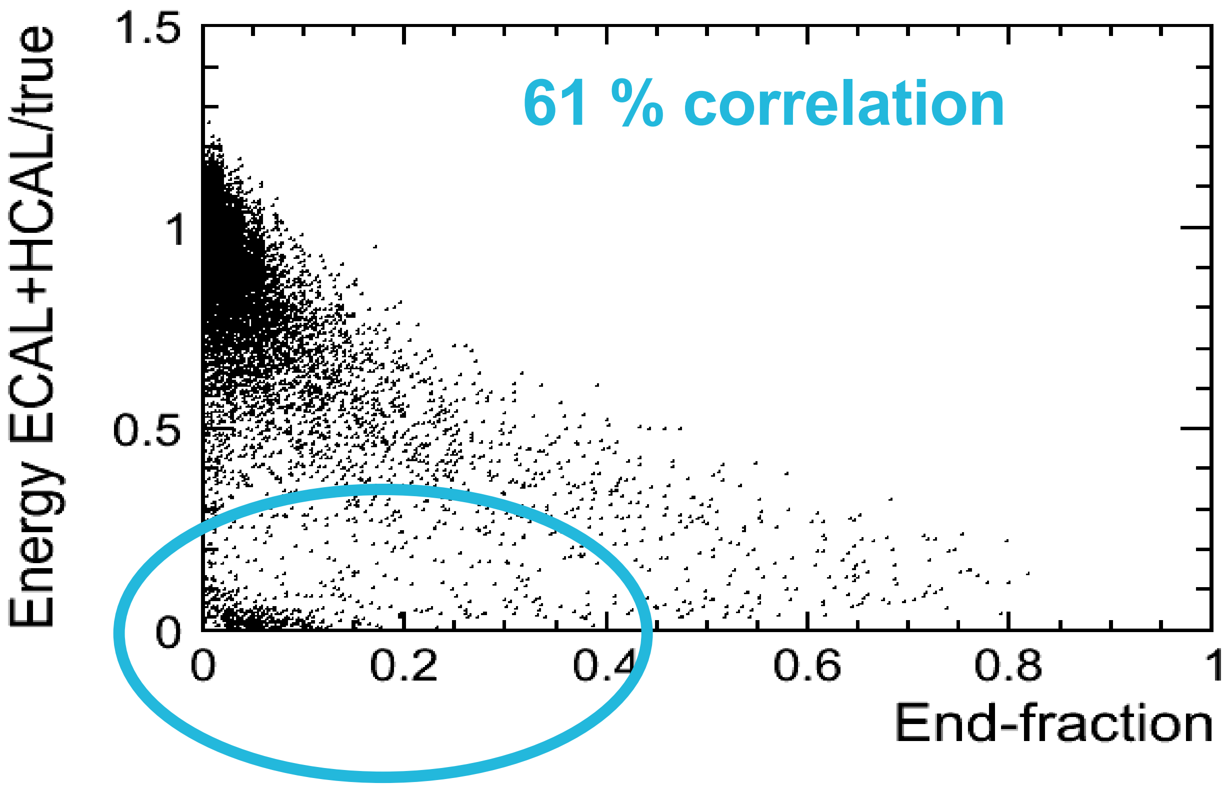
Shower start layer 28

Variables Sensitive to Leakage: 2 – End-fraction

End-fraction vs Leakage

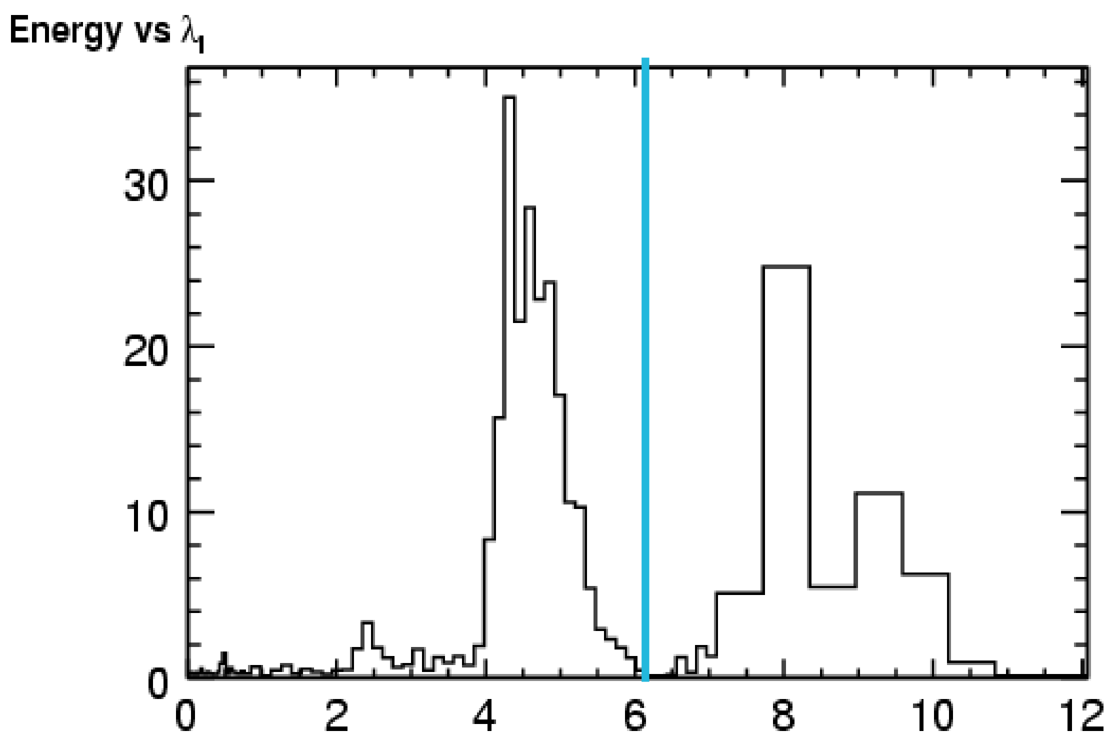
- End-fraction: fraction of HCAL hits in the last 2 layers.
- Ex.: 80 GeV run 330962.
- Note: variable **to be optimized** (binning, hits or energy?, ...).

Events spoiling the correlation



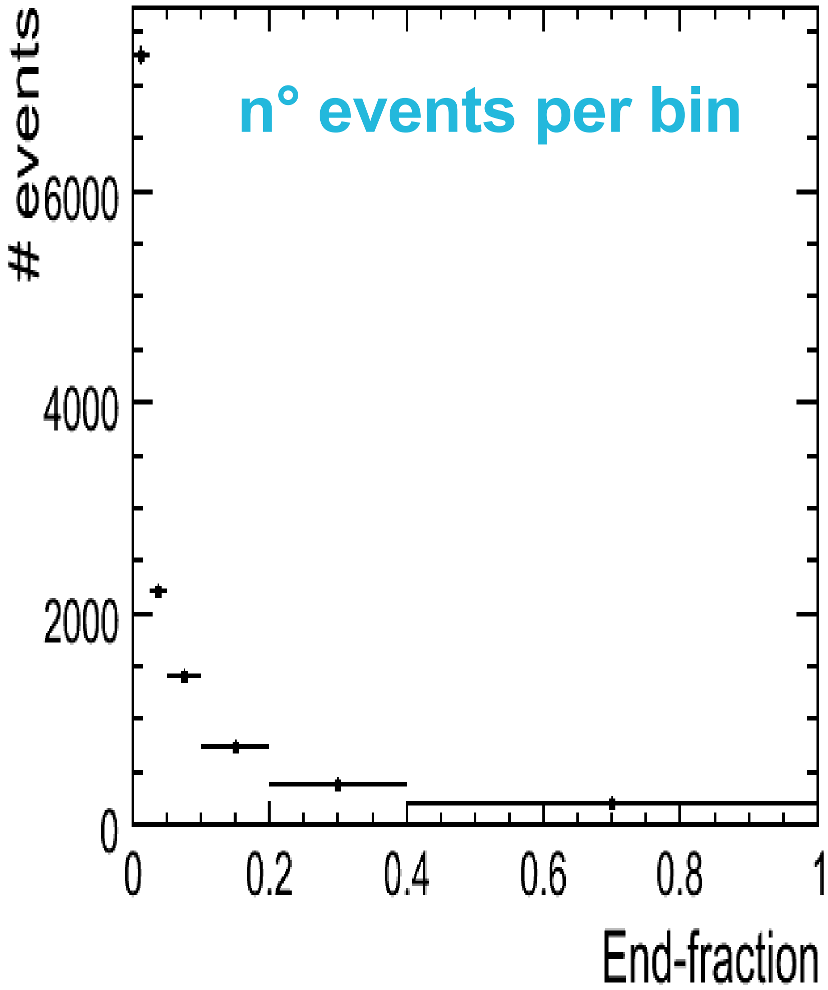
Events Spoiling the Correlation

- 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.

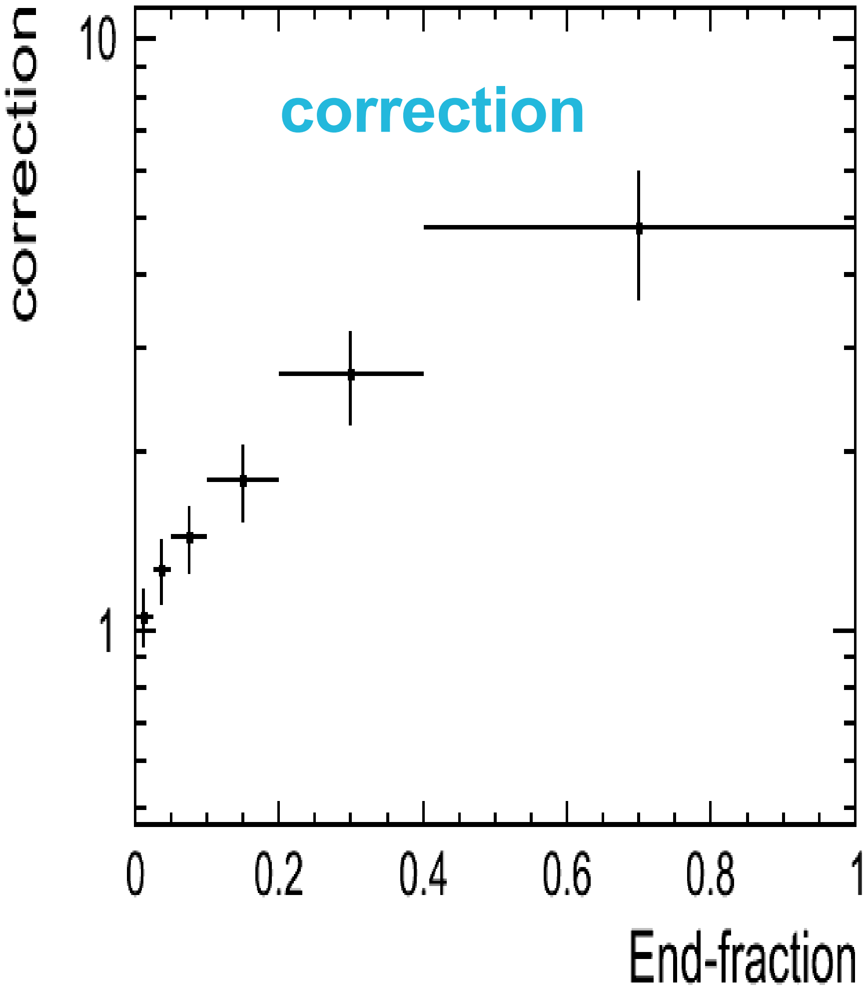


Ex.: neutral fractions the shower development

Correction



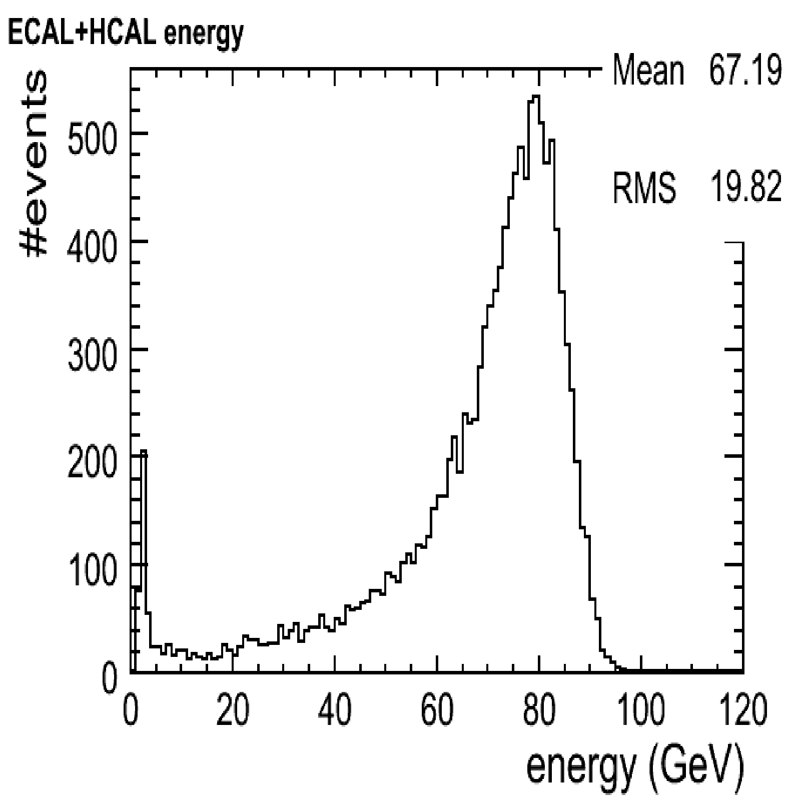
n° events per bin
events
6000
4000
2000
0
0
0.2
0.4
0.6
0.8
1
End-fraction

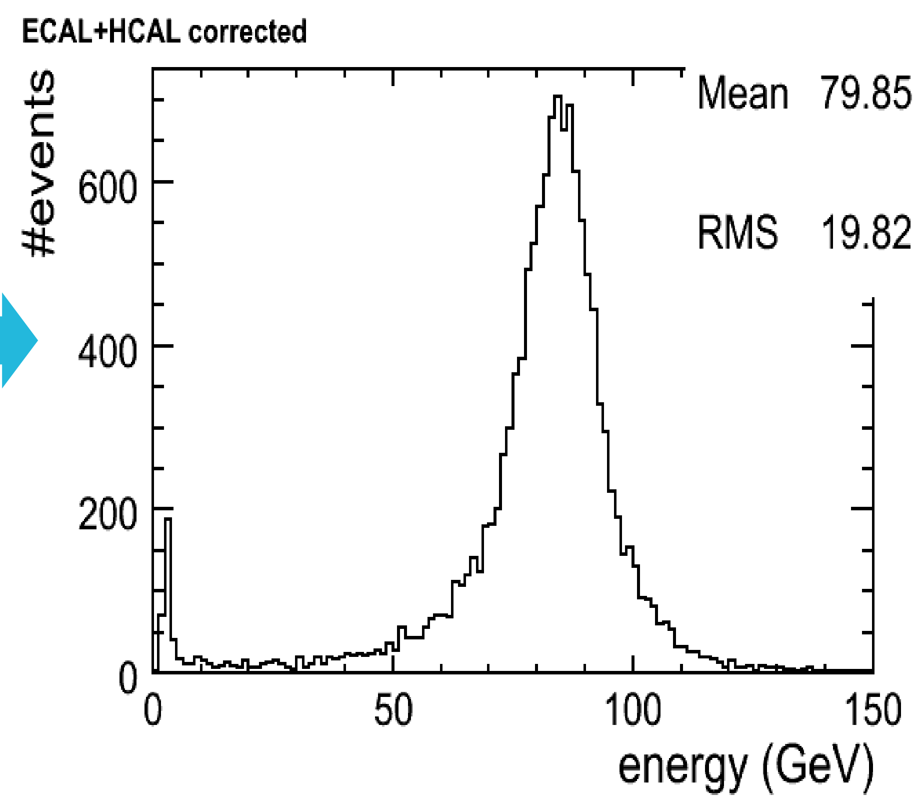


correction
correction
10
1
0
0.2
0.4
0.6
0.8
1
End-fraction

Result

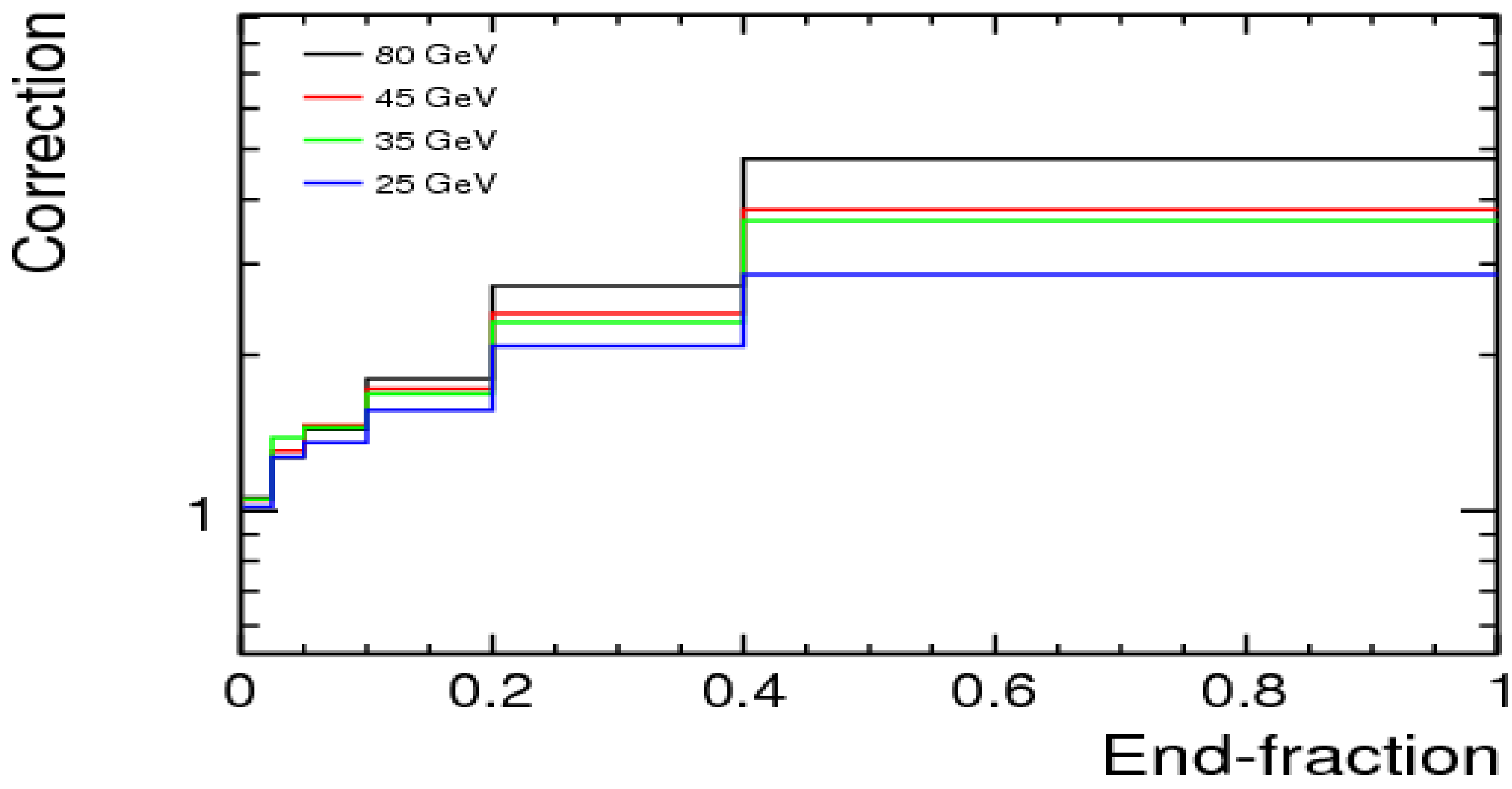
- Mean value of the total energy distribution well recovered.
- Some events on the left tail not recovered: RMS still large.





Correction vs Energy

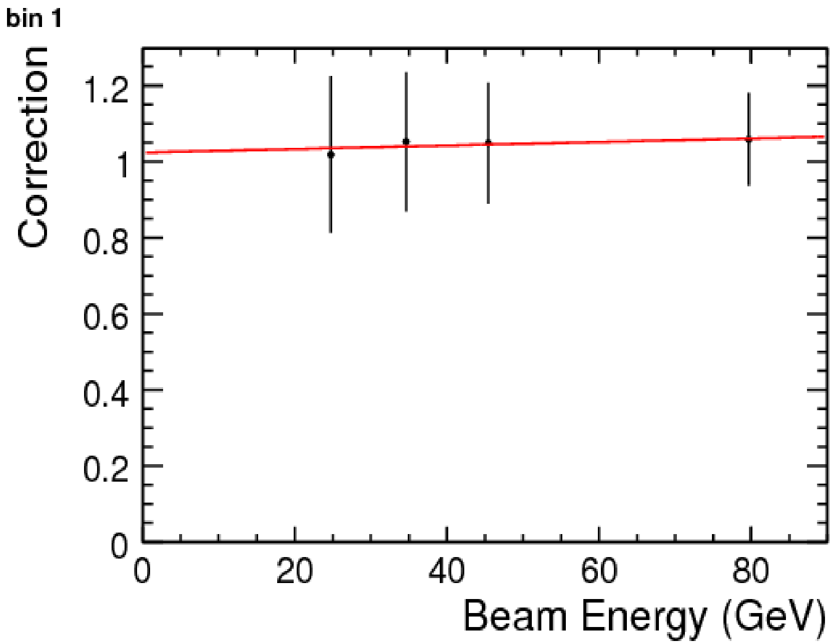
- Correction strongly **energy dependent**.



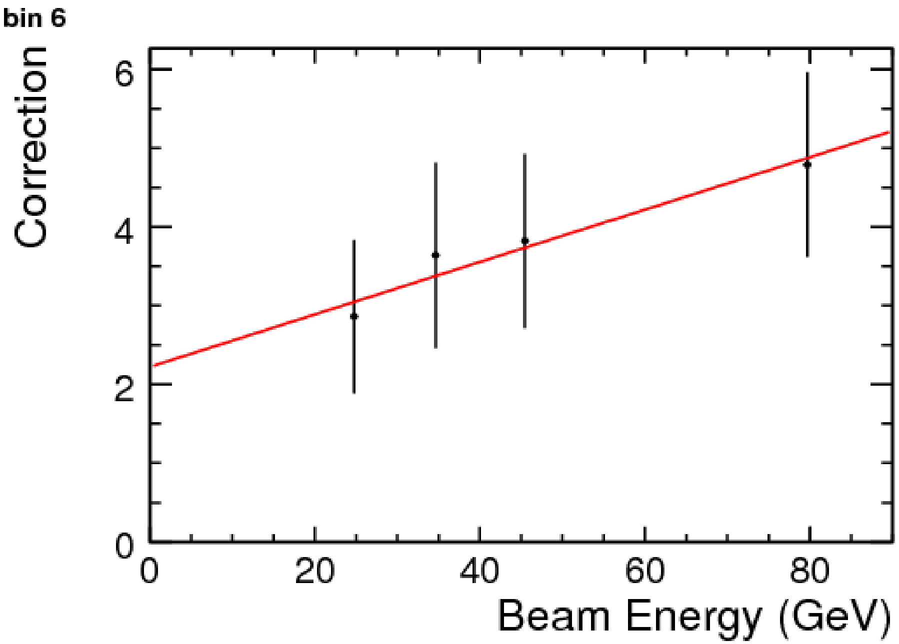
Energy Dependence

- Higher end-fraction: steeper energy dependence.

Correction vs energy



End-fraction bin 1



End-fraction bin 6

Correction to the Leakage

Content

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

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

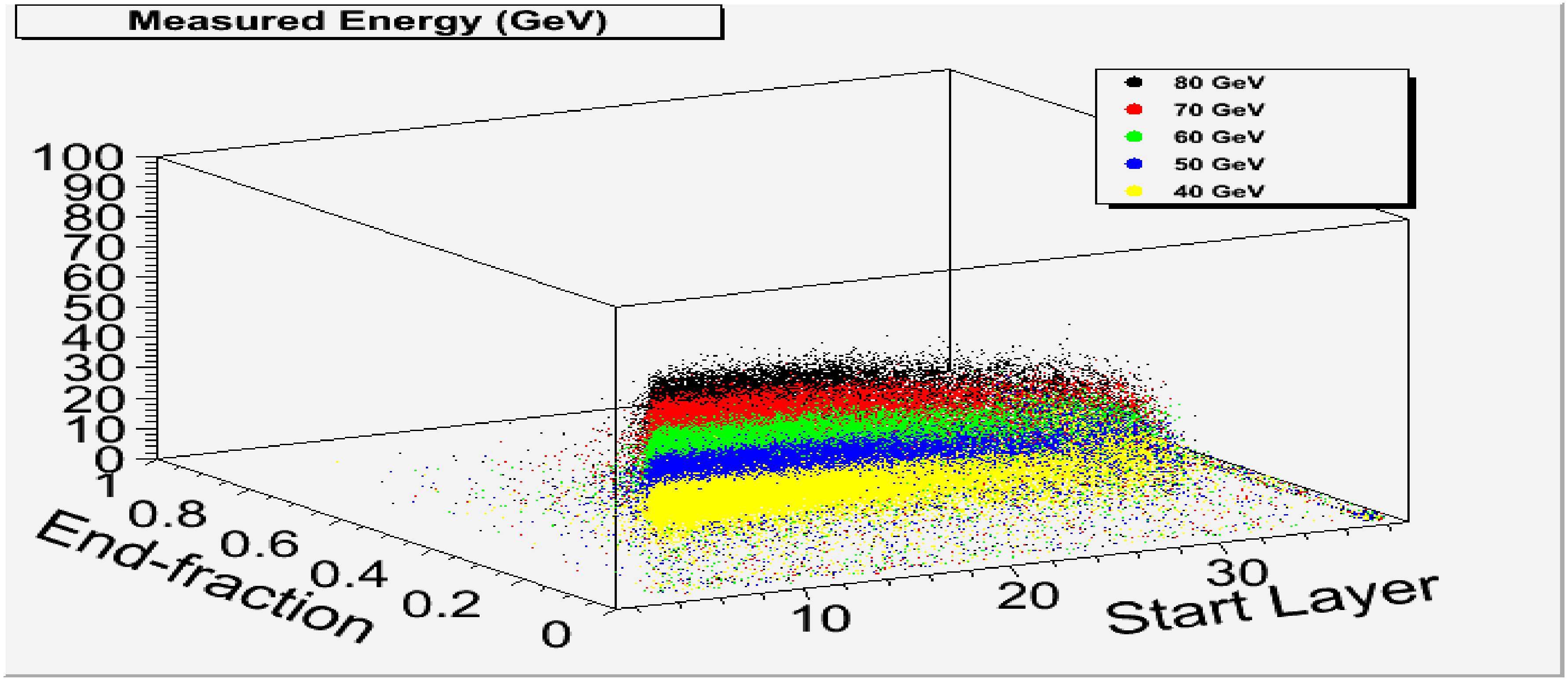
- I present here a first **Monte Carlo study**. Application to data ongoing (see my talk 06/05/2010 http://www-flc.desy.de/hcal/meetings/internal/minutes2010/meetings.php).

- Monte Carlo files:
  - physics list: FTFP_BERT;
  - detector model: TBCern0707_p0709;
  - produced by Lars with software version v02-00.

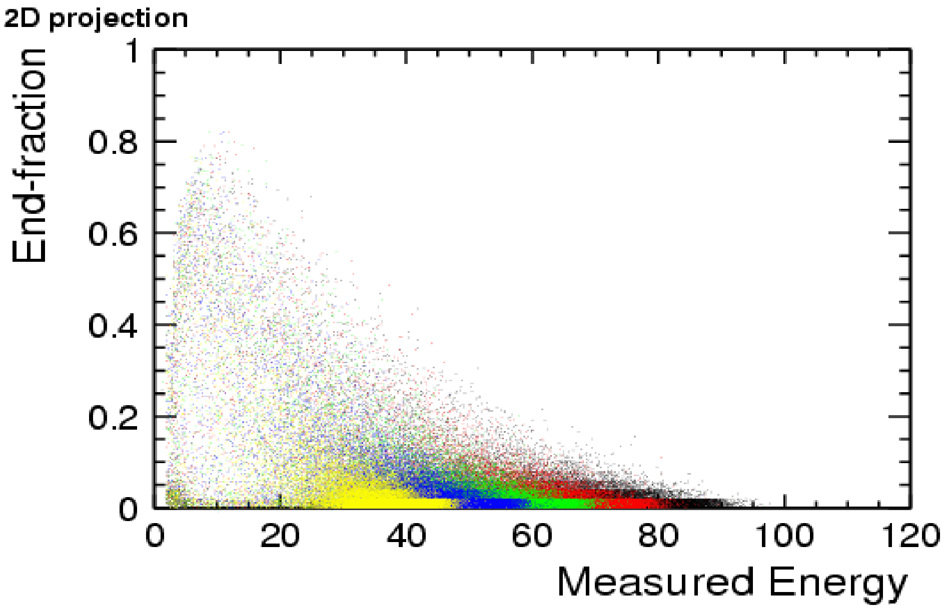
- Monte Carlo template: [40,80] GeV.

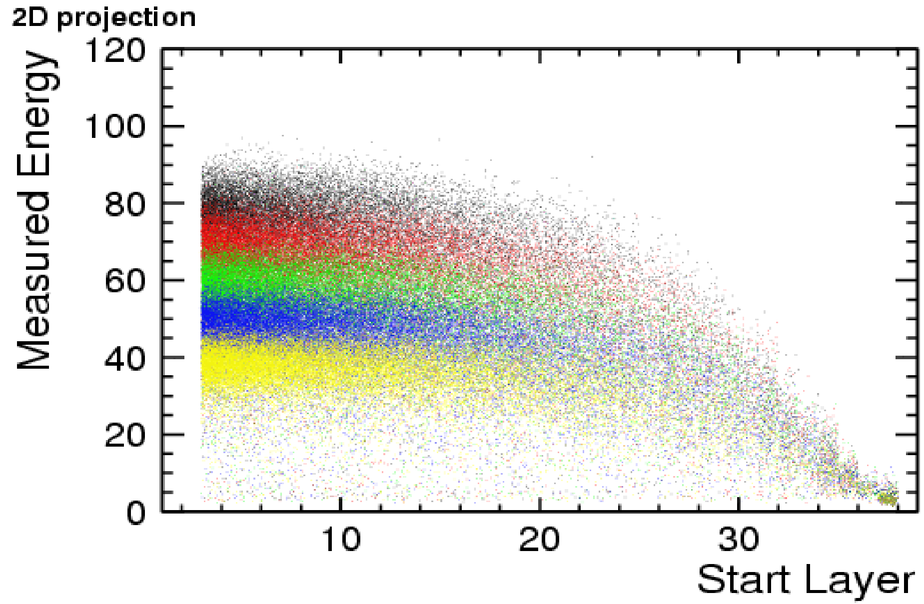
3D Template

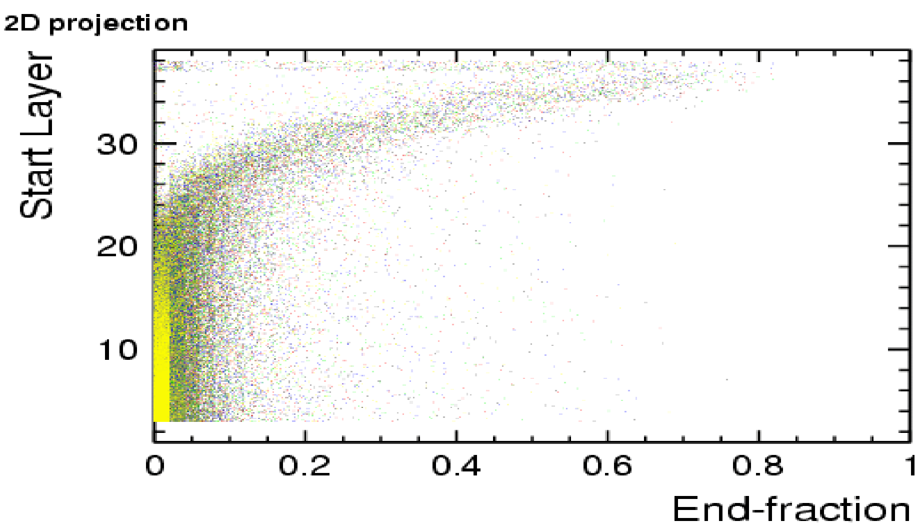
- X: shower start layer;
- Y: fraction of energy in the last 2 layers of the HCAL with respect to the measured energy (Ecal+Hcal);
- Z: measured energy (Ecal+Hcal).



2D Projections







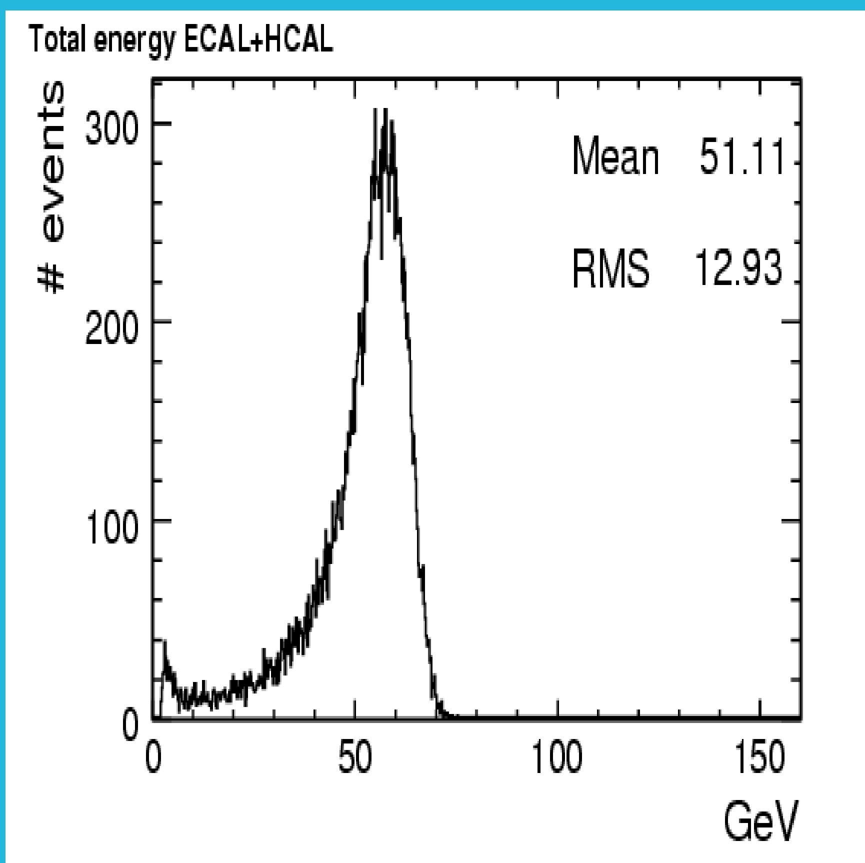
- 80 GeV (black)
- 70 GeV (red)
- 60 GeV (green)
- 50 GeV (blue)
- 40 GeV (yellow)

Fit Structure

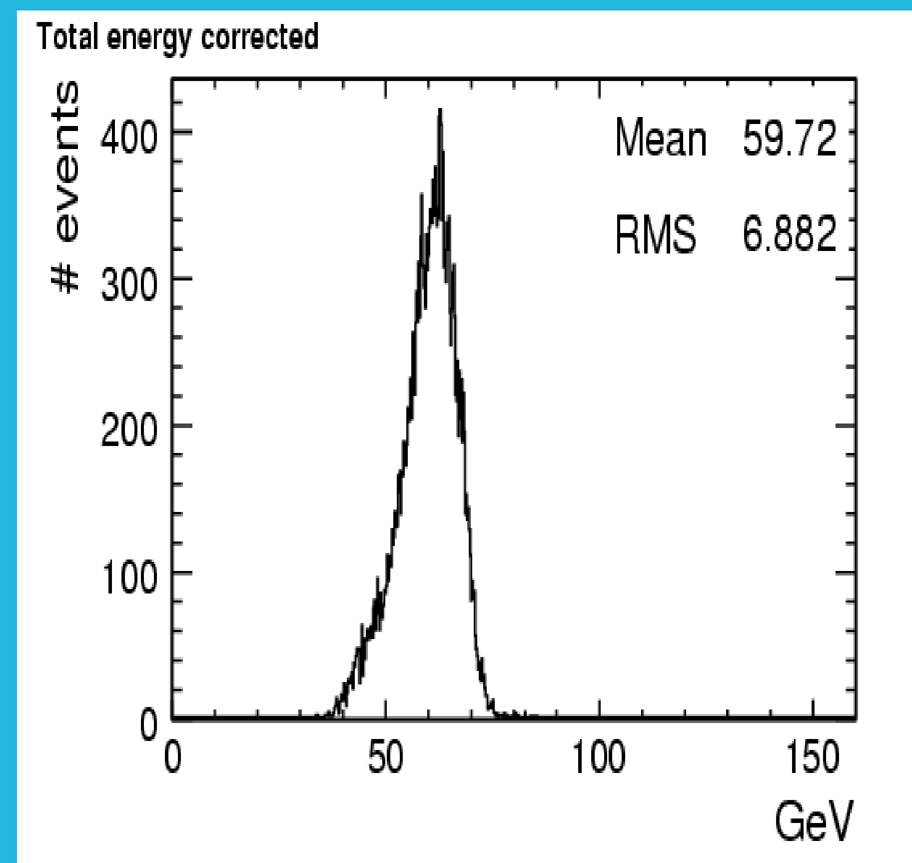
- Different energies cover different regions of 3D space.
- Fill the 3D space with the average leakage correction.
- **Averaging over energies** where they overlap.
- Apply a **bin-wise correction** to independent runs.
- Correction depends on the 3D bin where the event is located. **No beam energy information used**.
- Note: the shower start finder uses the beam energy information, but a version which uses the measured energy is already being studied by Alex.

Application - 1

- Run to be corrected: **60 GeV**.



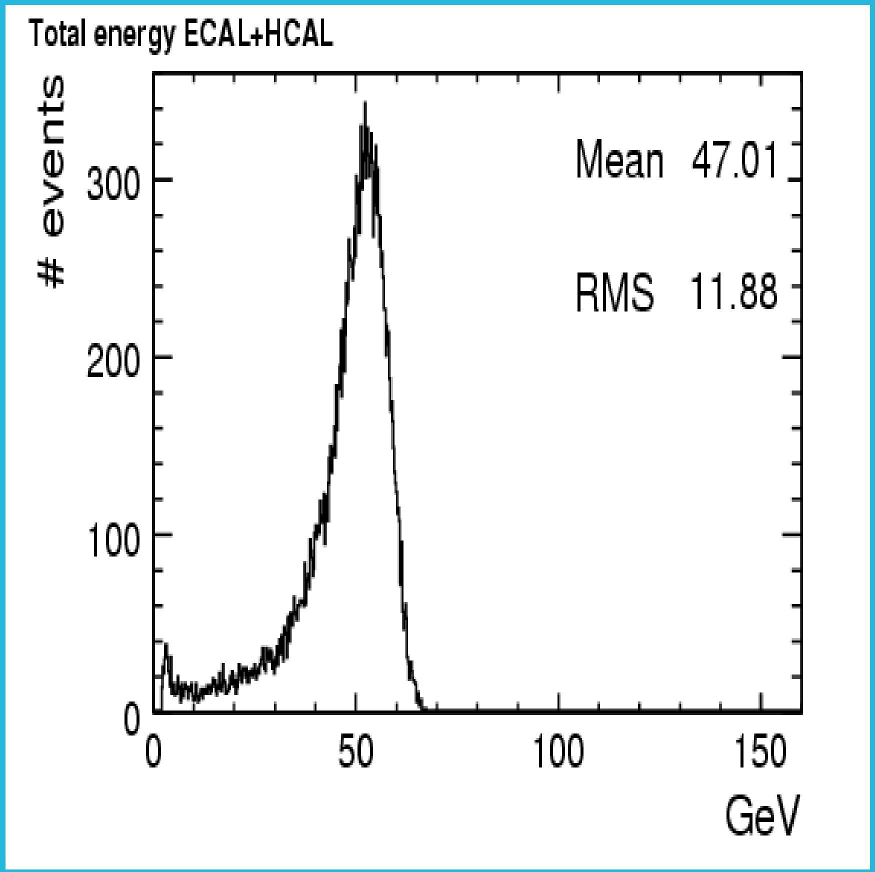
Uncorrected



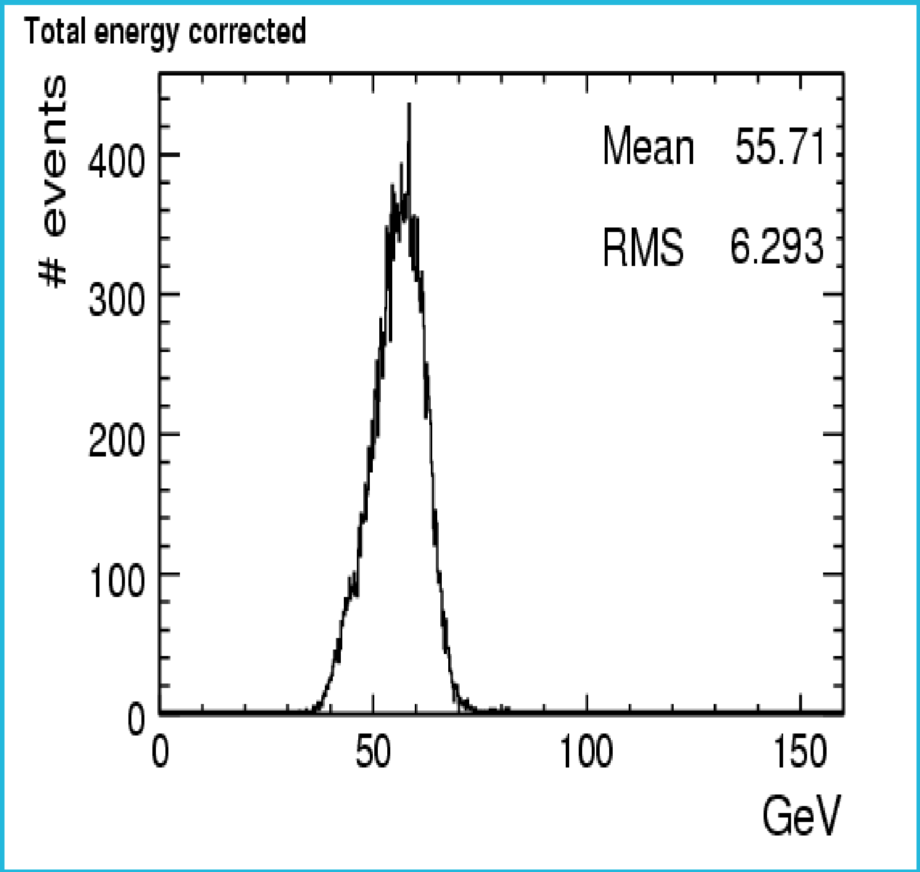
Corrected

Application - 2

- Run to be corrected: **55 GeV**.



Uncorrected



Corrected

Next Steps

Next Steps

- **Larger template** being produced (energy range+statistics).

- Monte Carlo / **data comparison**: can a Monte Carlo template be used for the data?

- Polish the analysis and eventually **smarter fit** to the template.

- 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

Frac-10 Cut from K. Francis

- Frac-10 cut: E(hits > 10 MIPs)/Total E > 0.01.