Study of a Correction to the Leakage: *Update*.

Ivan Marchesini, HCAL Analysis Meeting, 2011-03-07

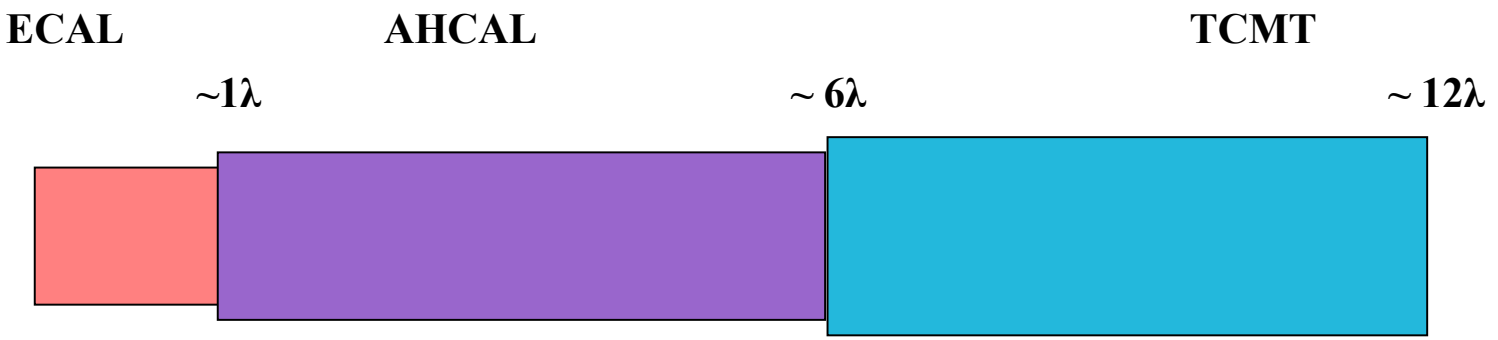
Outlook

- Reminder: purpose of the study.
- Reminder: correction structure.
- Results: Monte Carlo and data.
- Next steps.

Introduction

Cern 2007 Prototype

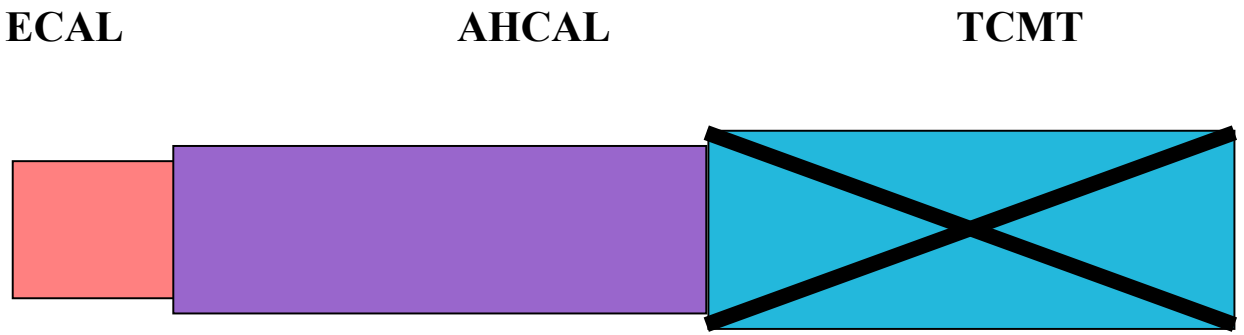
- This study uses **pion** data collected in 2007 at CERN using the CALICE prototypes.



- ECAL+AHCAL+TMCT: leakage from the complete set-up negligible.

Tasks of the Study...

- Study a correction to the leakage from the AHCAL, using the **AHCAL alone**, without TCMT information.



- In an ILD/Particle Flow perspective a correction to the leakage essentially matters for the **neutrals** (study on the pions easily transferable).

- We do not consider the **punchthrough** pions, that start showering in the TCMT (~1%).

...Tasks of the Study

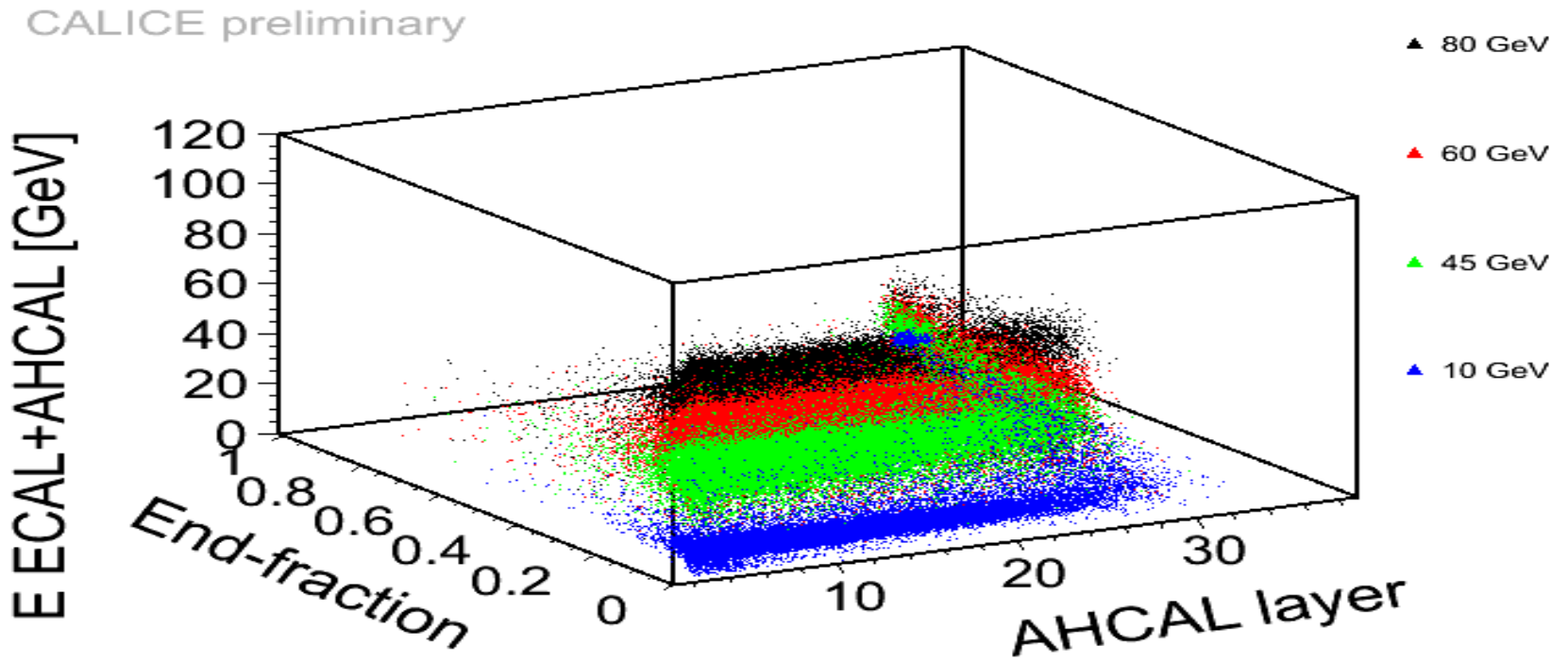
- Studies of corrections to the leakage:
  - so far developed in the "**idealistic**" case: tuned according to the a-priori knowledge of the beam energy.
  - power: **14%** $\sigma^{2\backslash 3}$ **relative** improvement at 80 GeV (B.Lutz PhD Thesis).
  - **intrinsic limitations** in the sigma improvement from event-to-event fluctuations.
  - mean improvement = average effect, more powerful.

- Main task of the study is to develop a "**realistic**" correction: correction factors do not depend on the beam energy.

Correction to the Leakage

3 Observables

- X: layer first hard interaction;
- Y: end-fraction (% measured energy in last 4 AHCAL layers);
- Z: measured energy (ECAL+AHCAL).



Correction Structure

- Different energies cover different regions of the 3D space, though with overlaps.

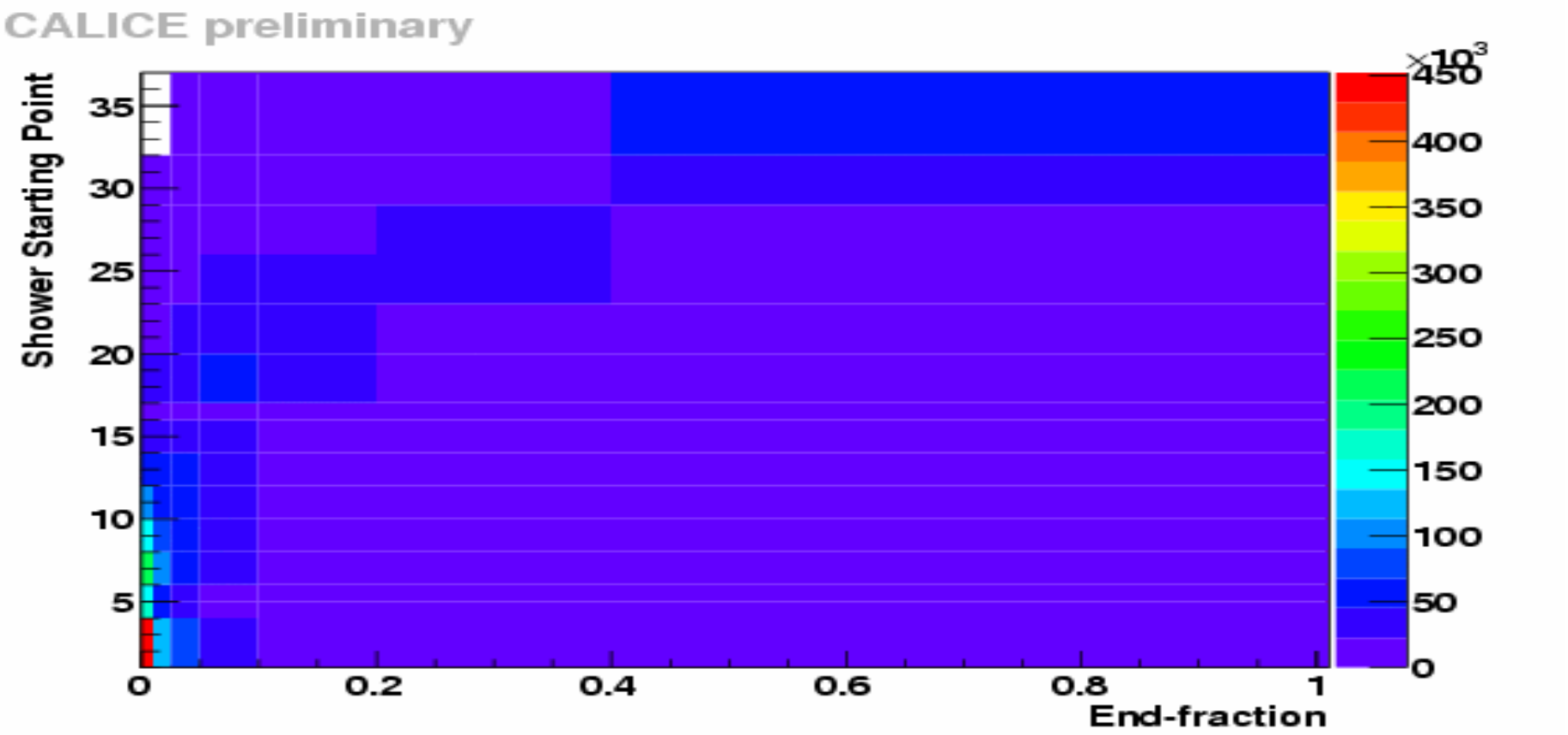
- Idea: use the **position in the 3D space** to replace the beam energy information.

- For MC: build a template using energies from [7.5,100] GeV (FTFP_BERT). Apply the correction to independent runs and also to energies not used to build the template.

- For data: build template either from independent data runs or from MC (using specific sampling weights to recover the energy scale).

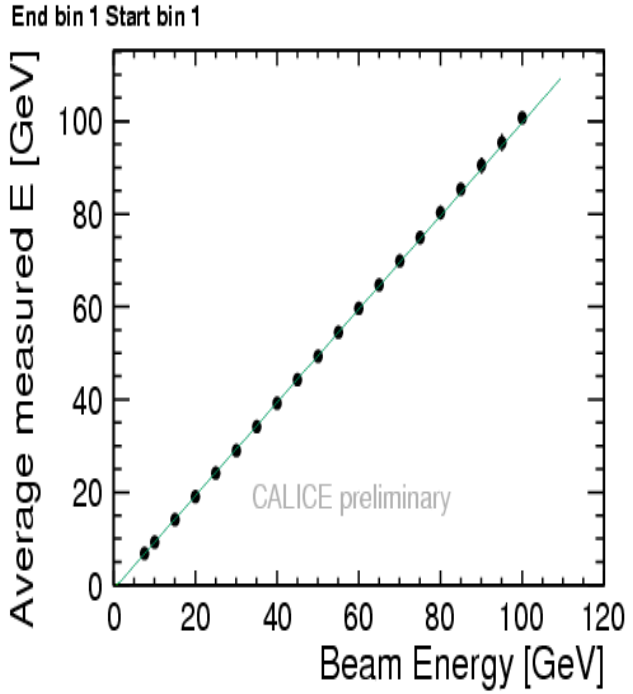
Fit: Step 1

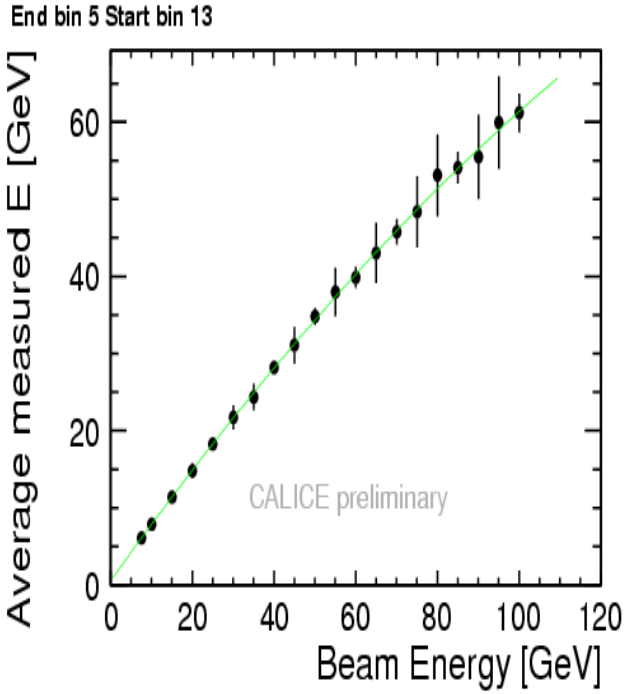
- Shower start/ End-fraction 2D distribution. Binning **under optimization**.



Fit: Step 2

- For each bin Shower start/ End-fraction 2D distribution correction derived from the plot: average measured energy vs true beam energy.

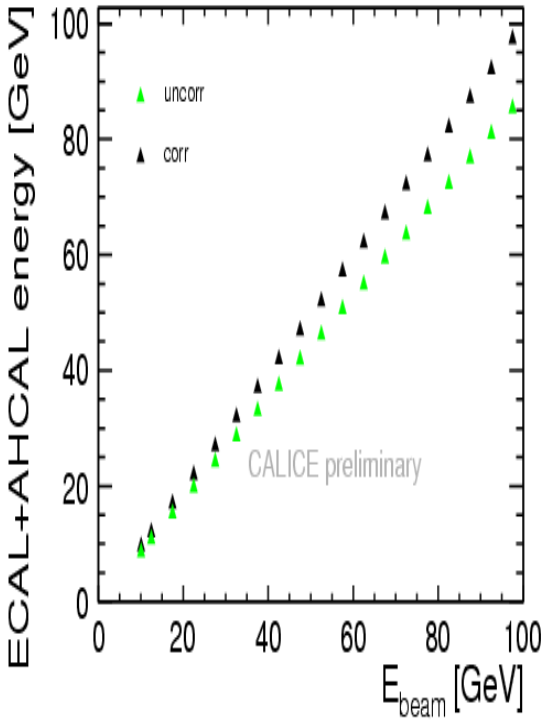


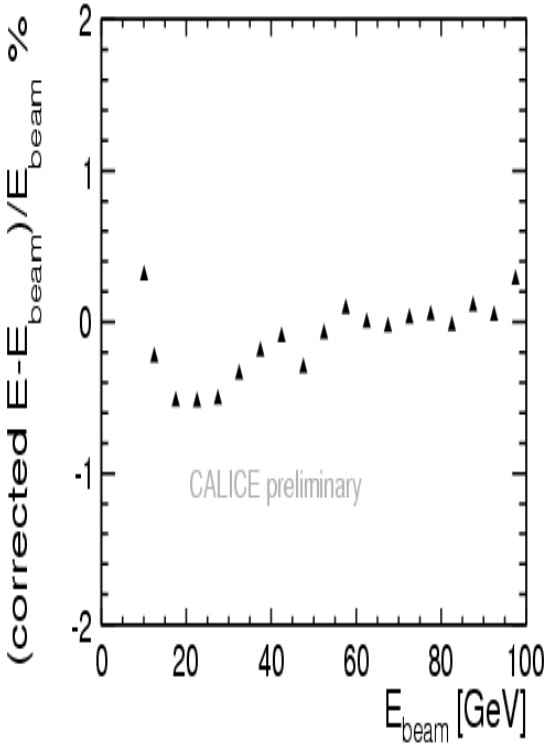


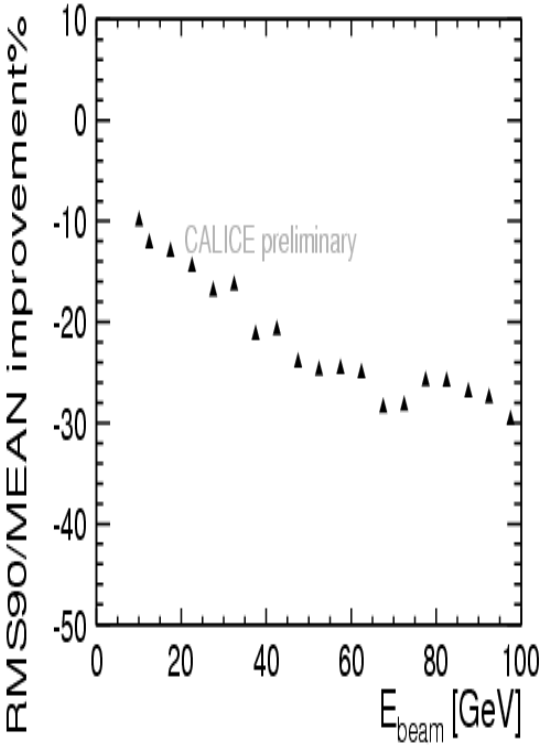
Bin : early start/low End-fraction => no leakage

Bin : advanced start/higher End-fraction => leakage for high energies

MC Results

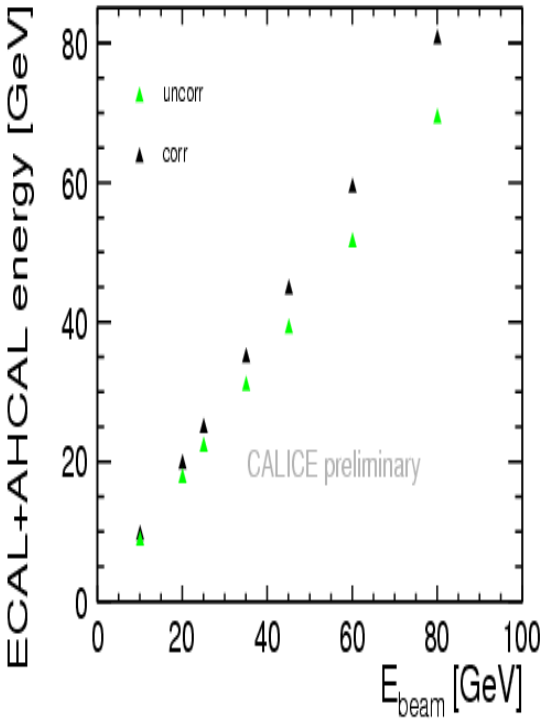


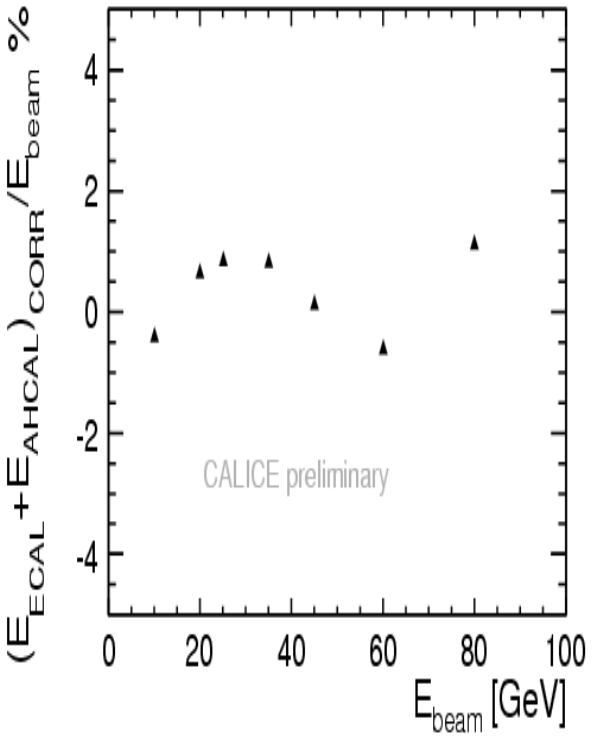


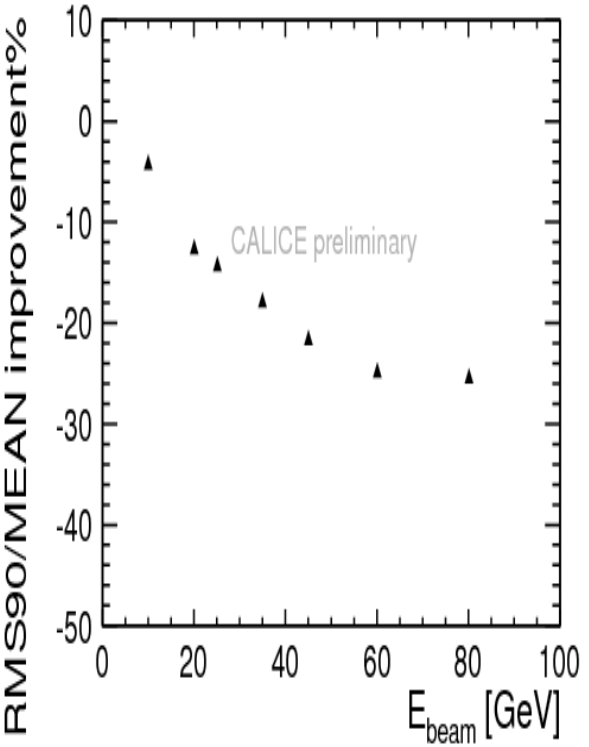


- Good recovery of the leakage.
- Mean recovery better than 0.5% over the full energy range.
- RMS90/Mean % improvement up to 30% at high energies.
- Effect decreasing at lower energies together with leakage.

Data Corrected from Data: Results



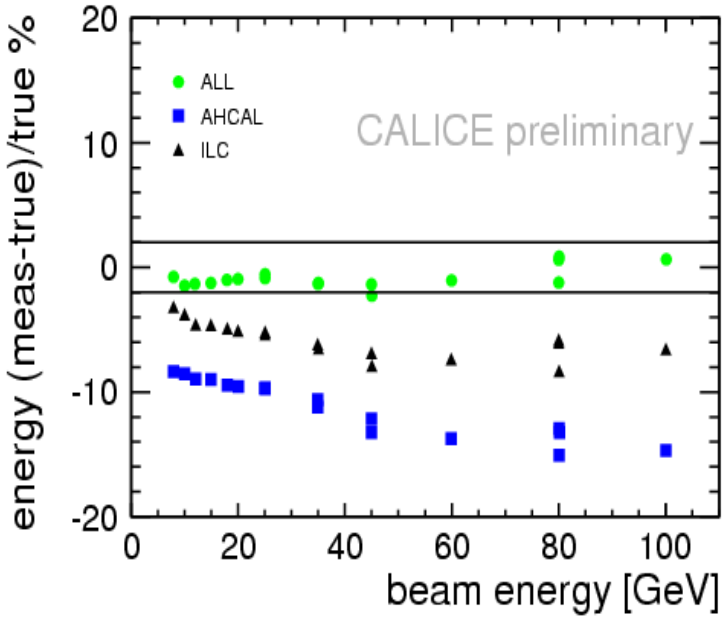


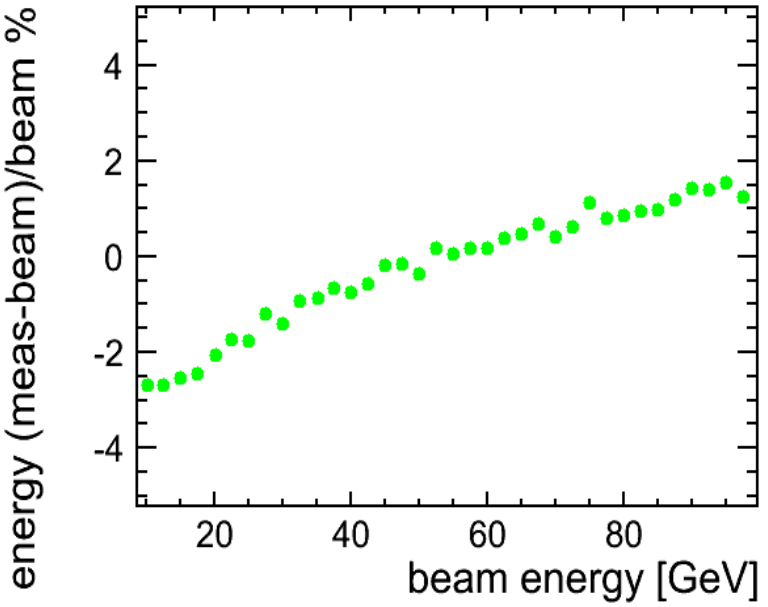


- Good recovery of the leakage.
- Mean recovery better than 1% over the full energy range.
- RMS90/Mean % improvement up to 25% at high energies.

“Linearity” - DATA vs MC

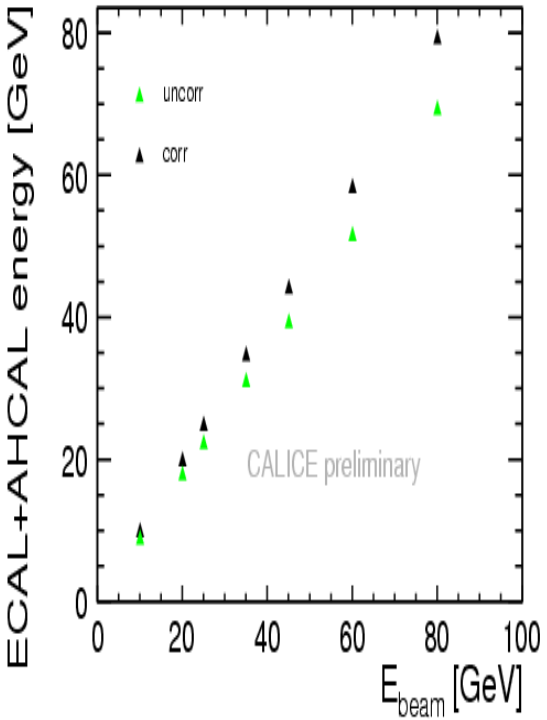
- Response using the full ECAL+AHCAL+TCMT (i.e. no leakage):

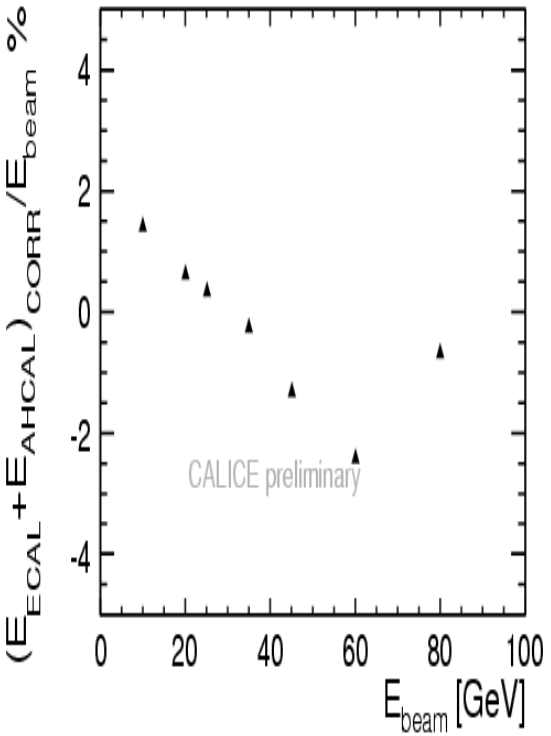


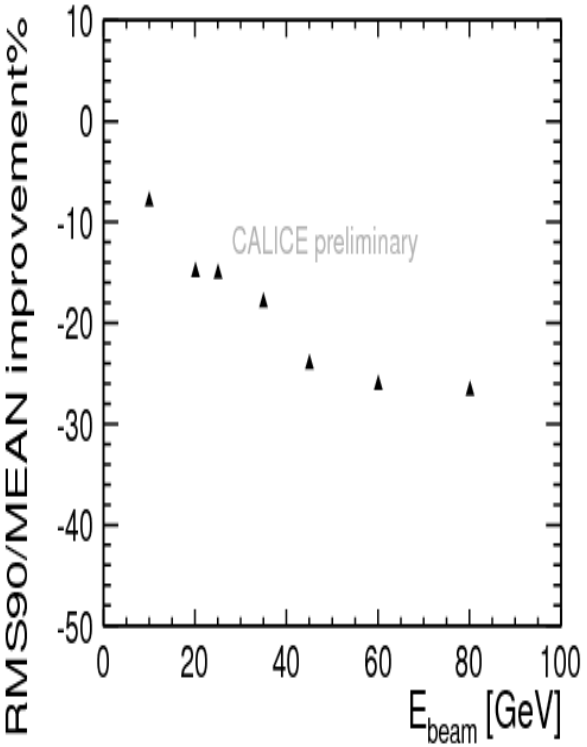


- Data (**ALL**) good at the 2%: non-linear response compensated by saturation effects.
- Non-compensating response more visible in MC: effect known!
- Eventually introduce correction factors to MC to reproduce energy scale data (CAN 21).

Data Corrected from MC: Results



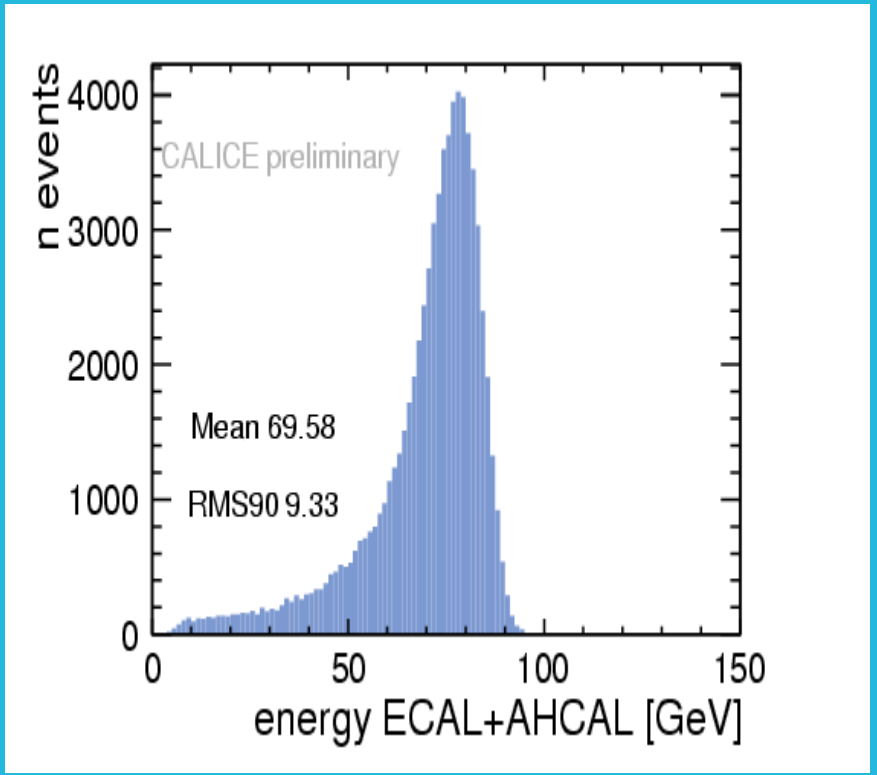




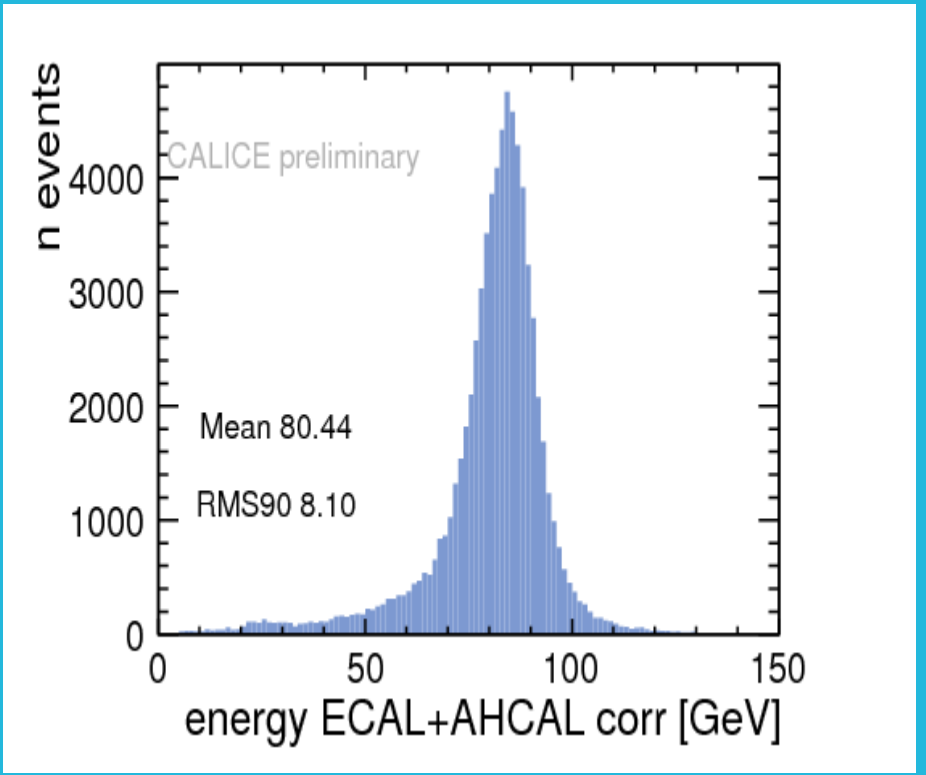
- Good recovery of the leakage.
- Mean recovery better than 2% over the full energy range, but slope (reflects the MC slope, absent in the data).
- RMS90/Mean % improvement up to 25% at high energies.

E.g.: 80 GeV Data Run

- Correction from data.



Uncorrected



Corrected

Next Steps & Conclusions

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- Correction powerful in restoring the mean of the total energy, and improves the resolution.

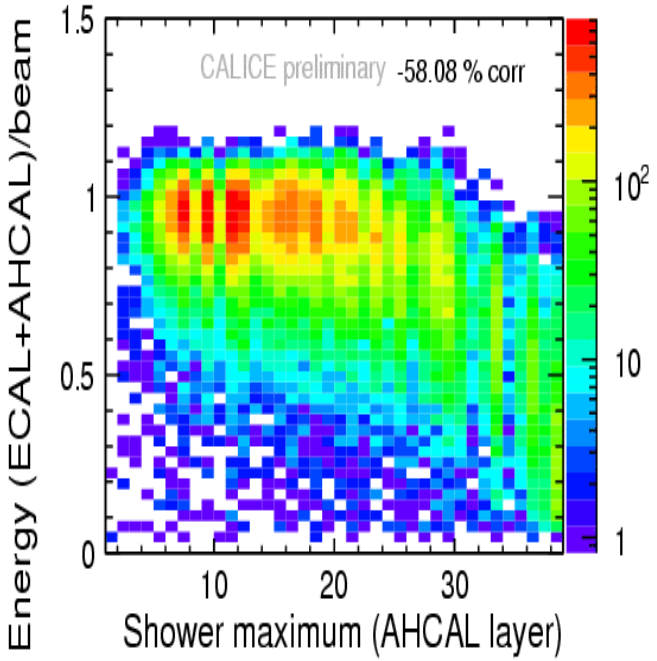
- Possible improvements: apply the correction on top a **software compensation**; better initial response linearity and reduced event-to-event fluctuations.

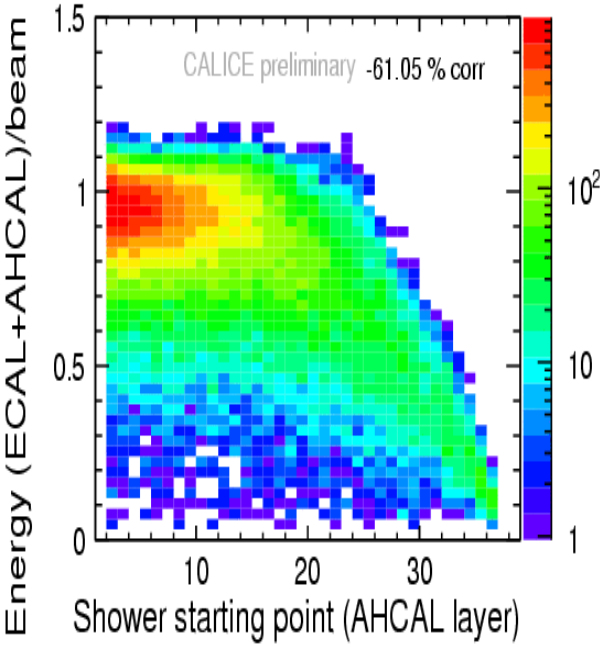
- New observables: **shower maximum**, to correct those cases where early shower starting point but main shower activity delayed.

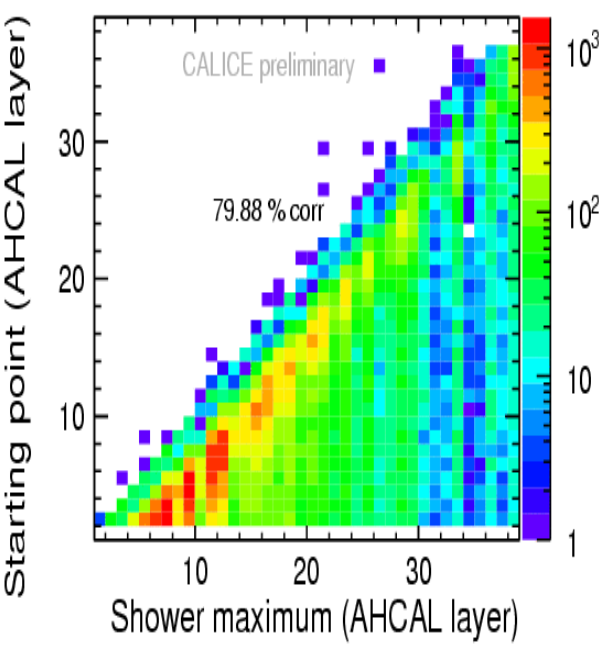
- CAN-29 under review.

Shower Maximum

- Shower maximum as a **complement** to the shower starting point, but not as a replacement, since sometimes "**lost**" in the TCMT ⇒ **redefinition** of the shower starting point, instead? Beginning of the main activity.







End