Energy Reconstruction - ECAL+AHCAL+TCMT

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CALICE meeting

Annecy

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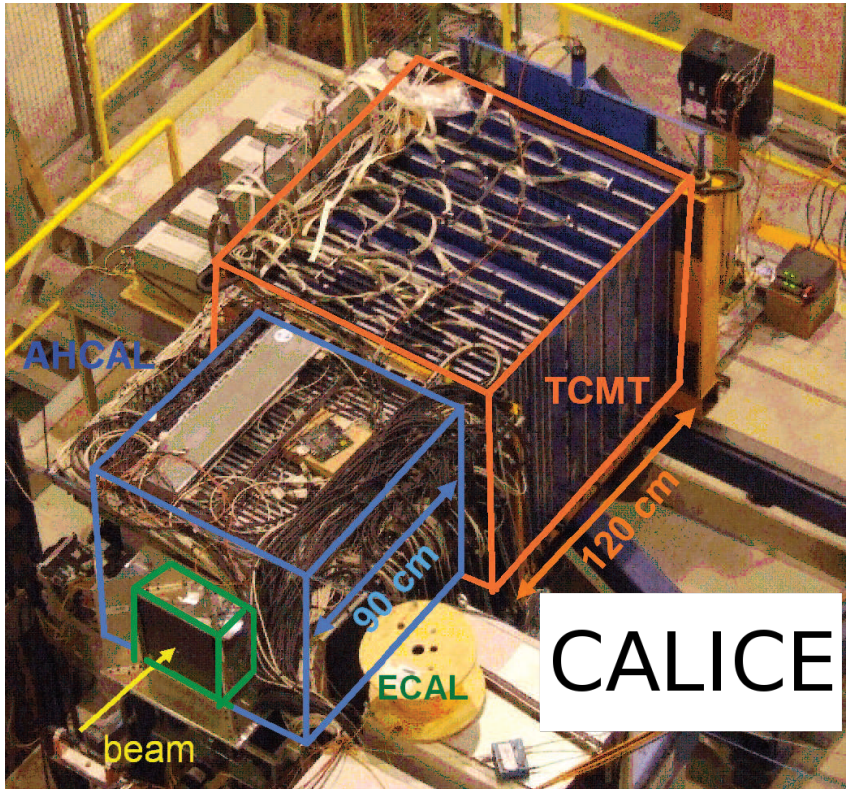
Outline:



Motivation:

- Precise energy resolution mandatory for calorimeter
- Work started in CAN-15, CAN-35 and the software compensation paper, but discontinued
- CAN-35/software compensation paper focus on the AHCal
- Calibration in CAN-15 outdated (e.g. no temp correction)
- Expand analysis to complete setup

Up to date analysis for the whole ’07 prototype needed!

The idea:

- W ECal + Fe AHCal + Fe TCMT:
  three detectors that need to be treated independently
- Different absorber thickness:
  - ECal: 1.4mm, 2.8mm and 4.2mm
  - AHCal: 20mm
  - TCMT: 19mm and 105mm
- Introduce weighting factors ω_i
- Advantage of the prototype:
  energy is known!

So sum up the energy and use TMinuit for minimization:

$$\chi^2 = \sum_{events} \left(\sum_i E_i \omega_i - E_{beam} \right)^2$$

Techniques:

layer dependent weights:

- Multiply every hit by layer thickness
- Convert MIP→GeV giving ECal, AHCal and TCMT each one ω_i

3 ω_i total

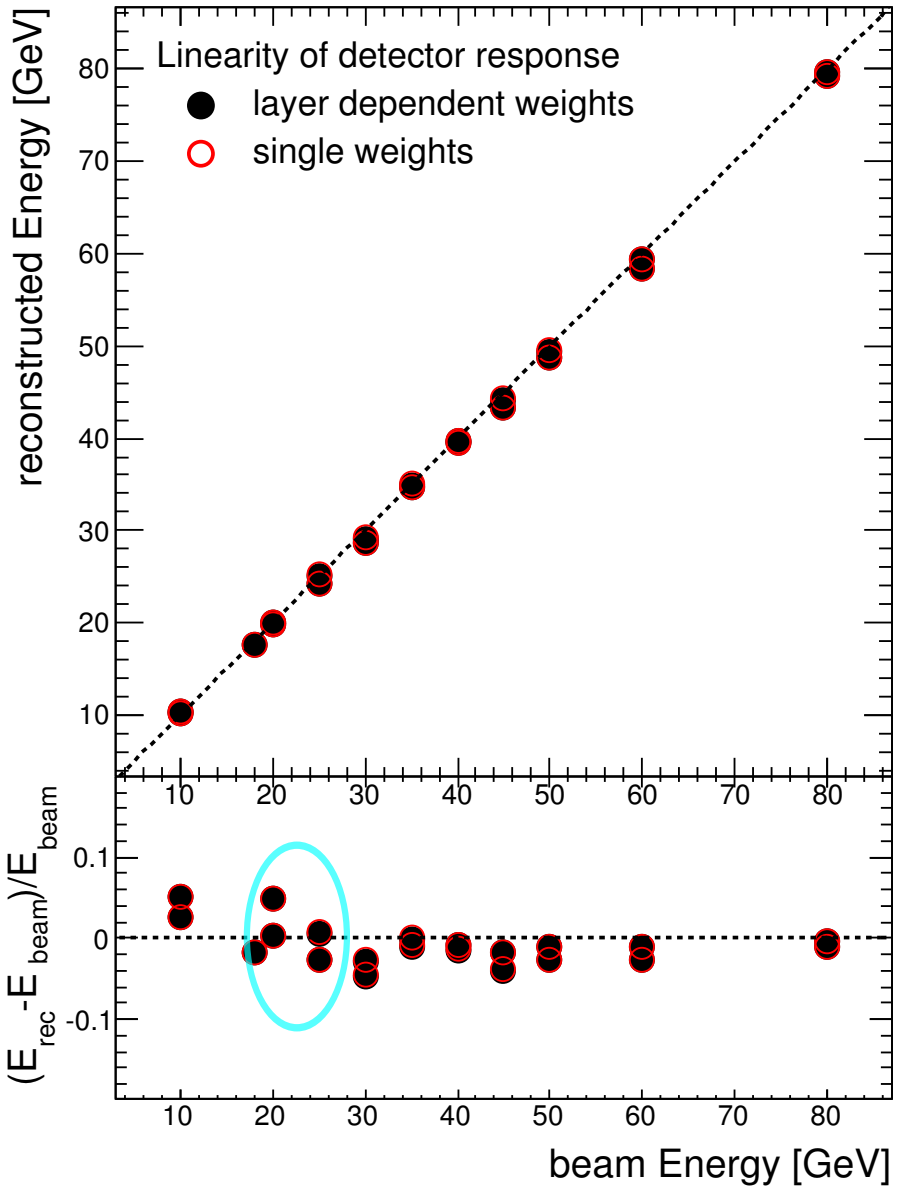
single weights:

- Divide detectors in sub detectors
- 3xECal, 1xAHCal and 2xTCMT
- MIP→GeV with ω_i for each

6 ω_i total

Reconstructed energy:

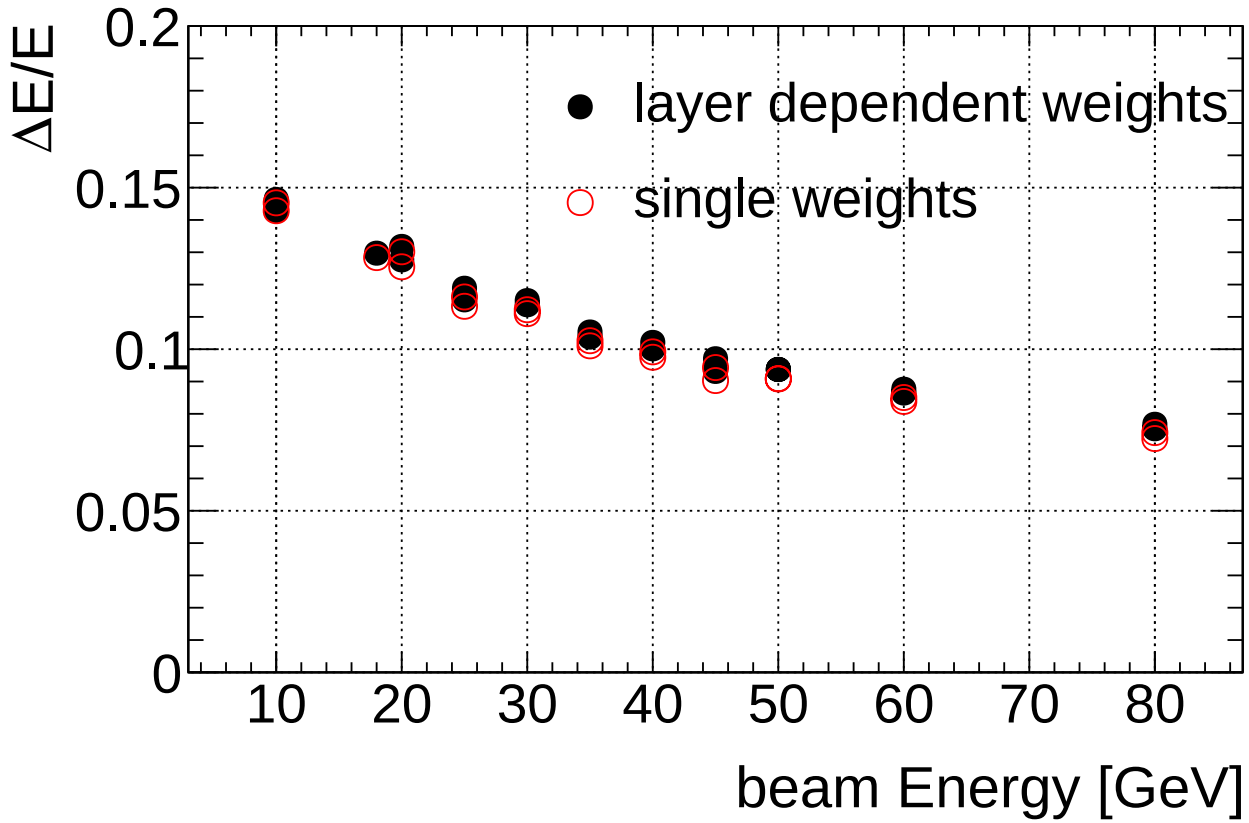
- 2 runs for each energy (except 18 GeV)
- **Reconstructed energy fairly linear**
- **Insignificant difference between the two techniques**
- Considerable difference of the runs for 20 and 25 GeV



Energy resolution:

- Results favor single weights
- But very similar outcome

Ideas for further improvement?



Software compensation:

- $\frac{e}{h} > 1 \Rightarrow$ non-linearity in the detector response
- em sub showers have higher energy density
- MIP amplitude normalized to cell volume

Total:

- 3x6 ECal bins(1.4mm, 2.8mm, 4.2mm)
- 1x10 AHCal bins
- 1x5(19mm) + 1x3(105mm) TCMT bins
- 36 ω_i weights

- AHCal for example:
  - Discriminate using energy density
  - Give each density bin own ω_i

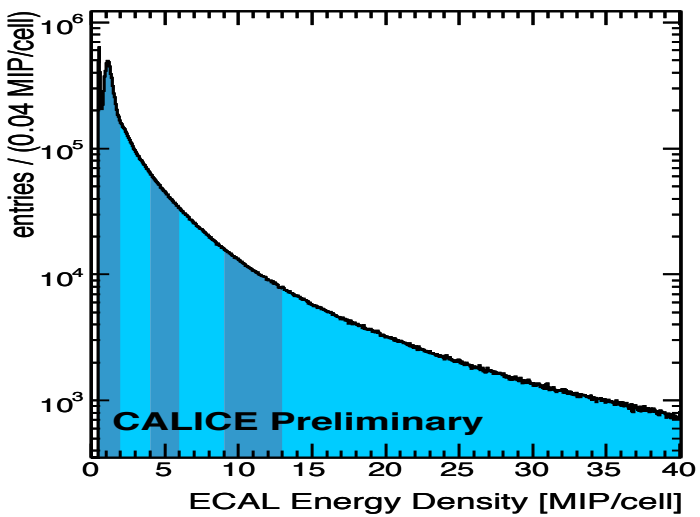
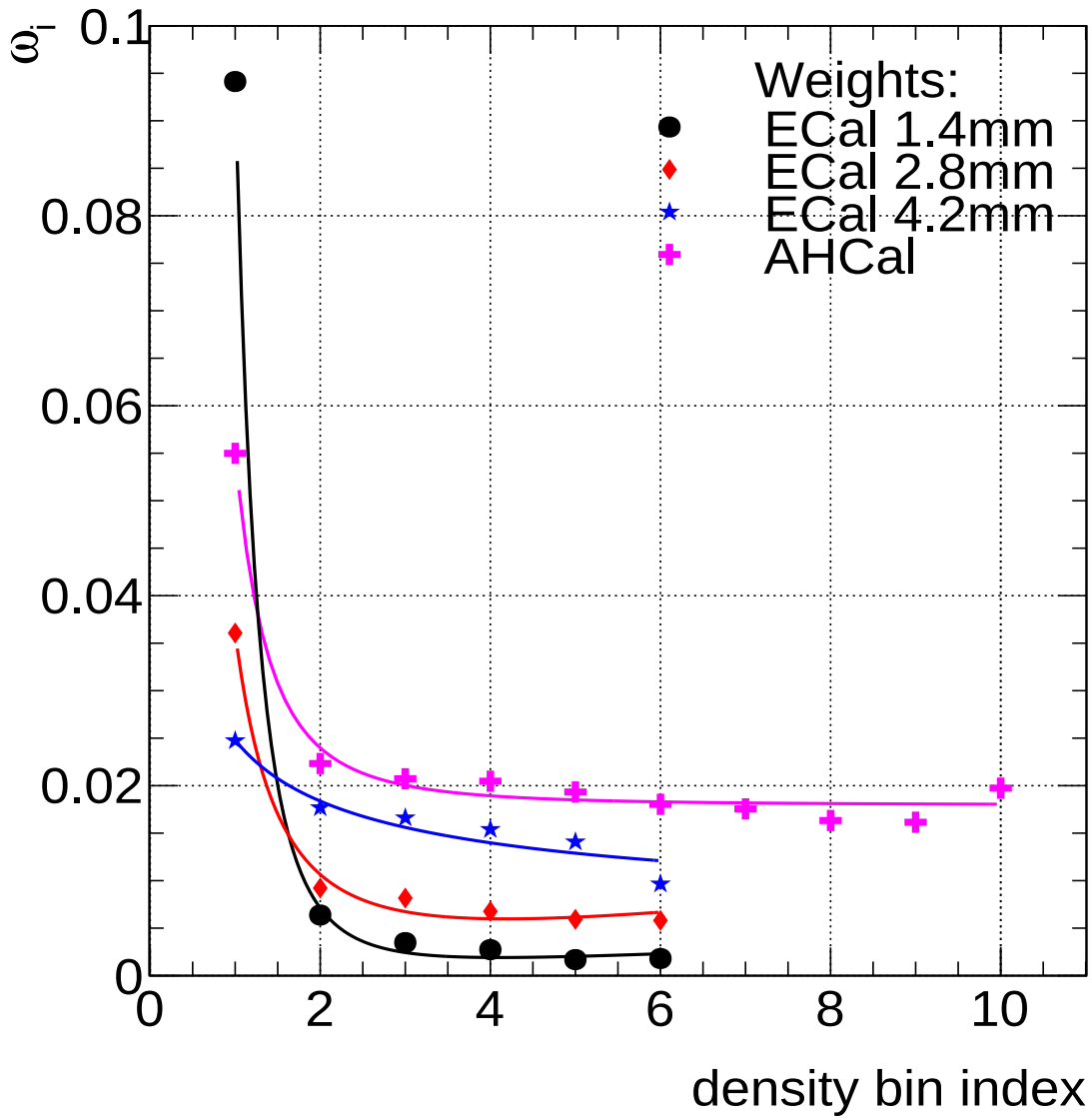


Figure: Illustration for density binning taken from CAN-15

Software compensation:

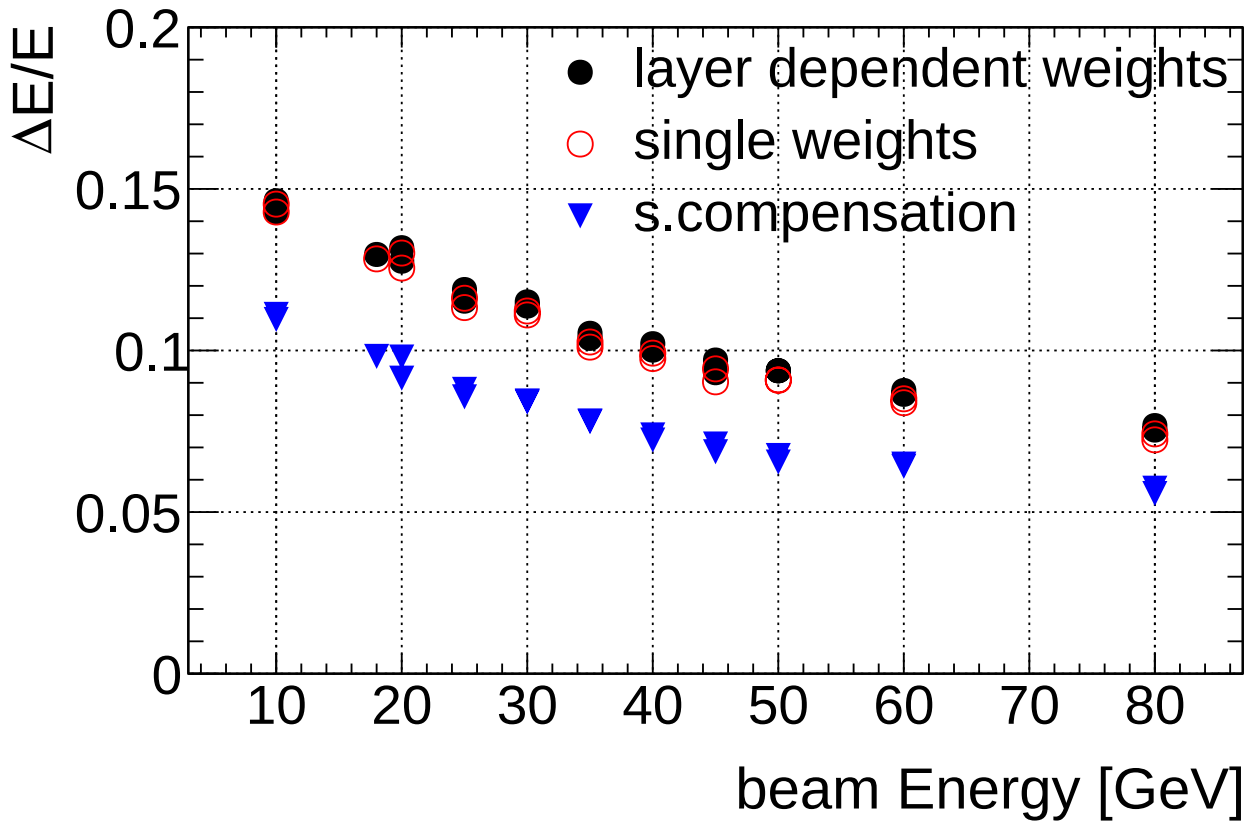
- Results still under investigation!
- **HEIGHER WEIGHTS for LOWER ENERGY**

But weights change strongly with energy! **Parametrization needed!**



Energy resolution:

- S.c. weights: every run calculated independently!
- Therefor not comparable



Software compensation as appetizer for what's possible!

ECal leakage:

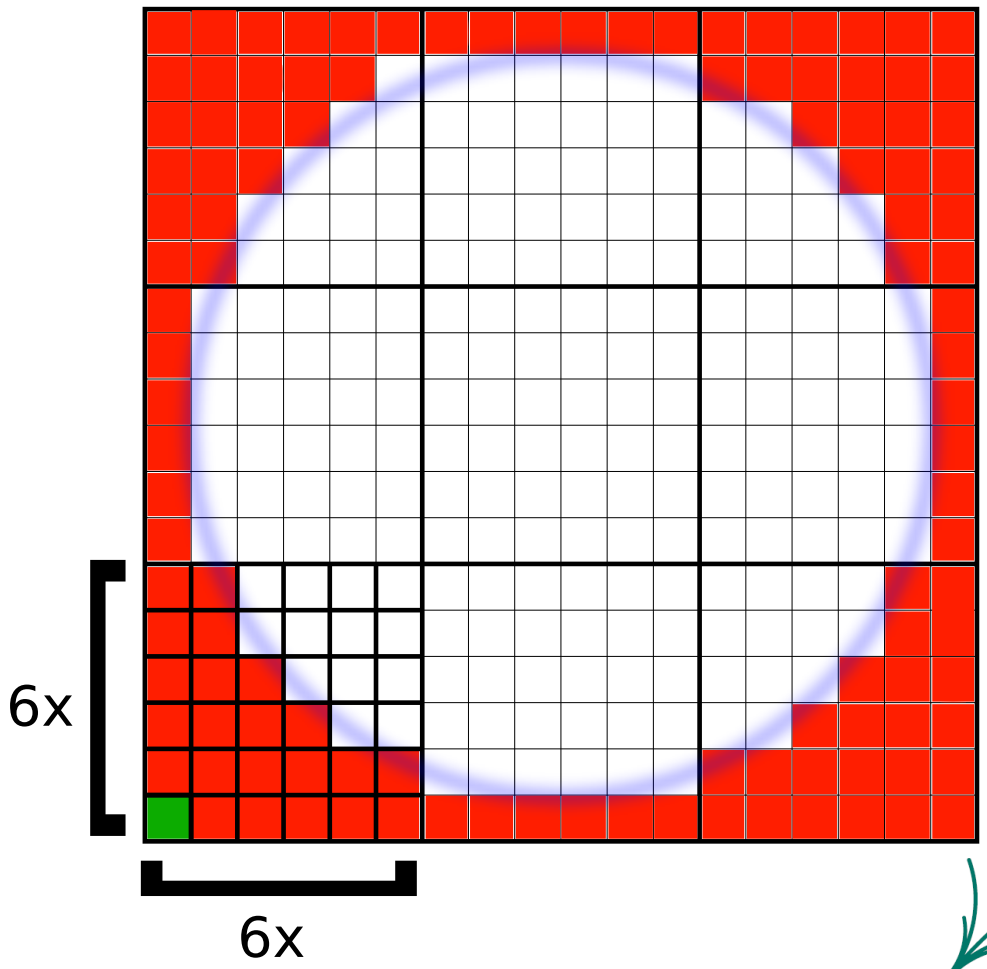
Why:

- Active ECal layers are only 18cm wide
- AHCal layer are 90cm
- **Absorber plates wider than 18cm!**

Filter:

$$\frac{E_{\text{deposited outside circle}}}{E_{\text{deposited inside circle}}} < 5\%$$

front view on an ECal layer



ECal leakage:

- Single weights /no s.c. calculated from 330412
- Applied on 331282
- Without filter small tail

indication for not detected energy loss!

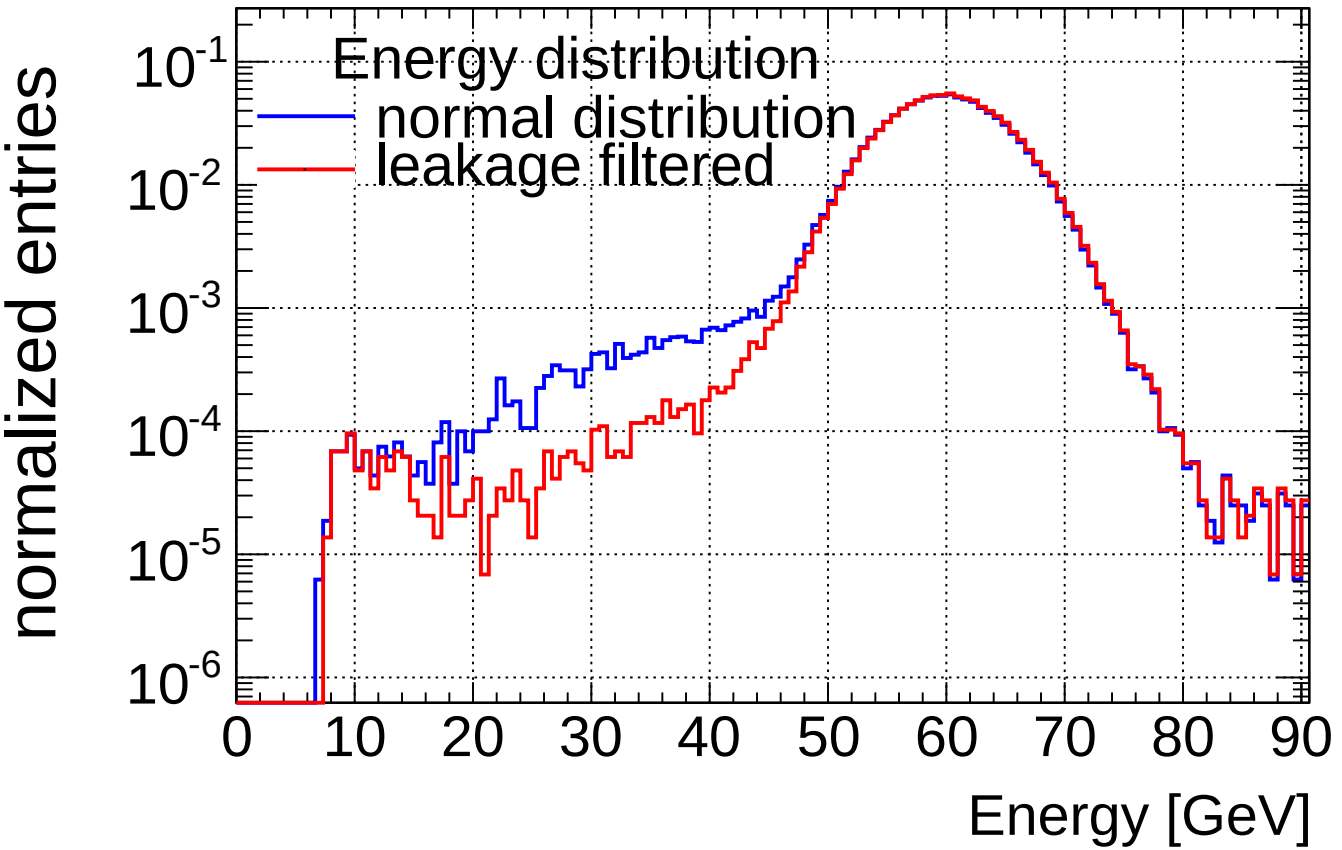


Figure: Energy distribution with and without leackage filter

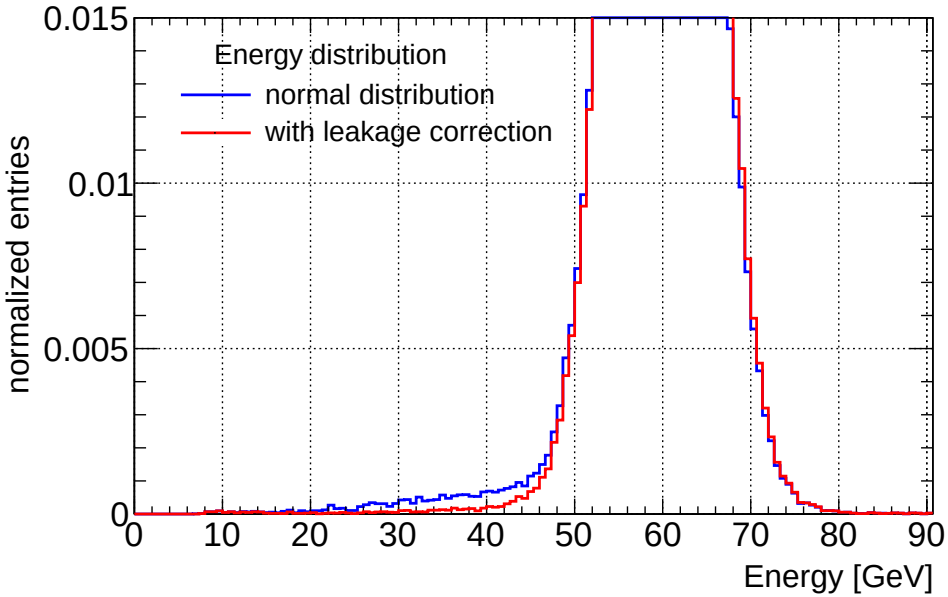
Outlook:

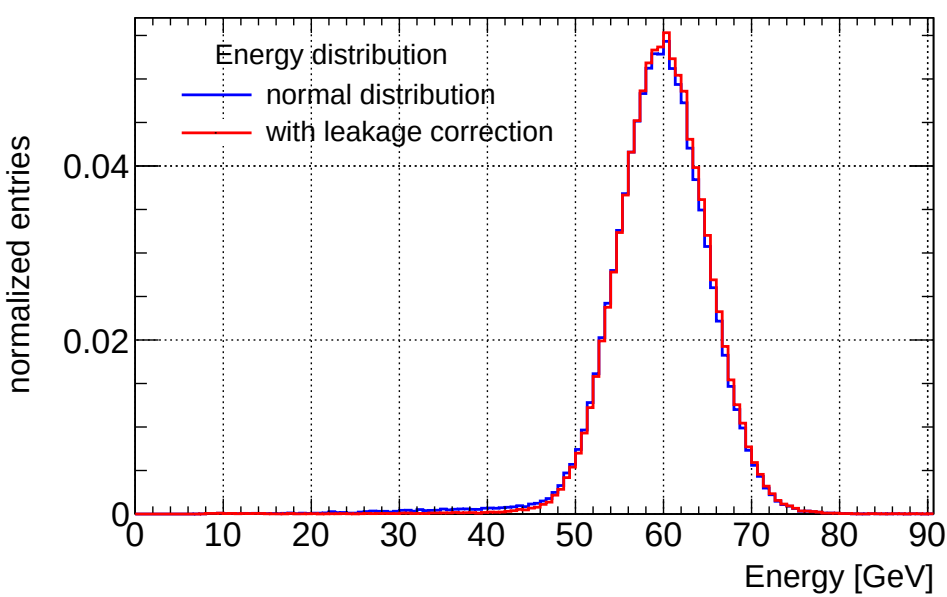
- Further study of the ECal leakage might enhance the resolution
- **Complete combined analysis of the software compensation paper!**
- **Goal CALICE analysis note, maybe more!**
- Find more pieces in the puzzle

Questions?

Backup

ECal leakage:





Run numbers:

run number	particle type	beam energy, GeV
330332	π^-	10
330643	π^-	10
330327	π^-	18
330649	π^-	20
330771	π^-	20
330325	π^-	25
330650	π^-	25
331298	π^+	30
331340	π^+	30
330551	π^-	35
330960	π^-	35

run number	particle type	beam energy, GeV
330412	π^-	40
330560	π^-	40
330559	π^-	45
330961	π^-	45
330558	π^-	50
331335	π^+	50
331282	π^+	60
331333	π^+	60
330962	π^-	80
331280	π^+	80