IDAG studies: portability of calibration coefficients

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5th/6th July 2010
DESY - Hamburg

The question(s) from the IDAG board

How can you create and maintain the calibration for 8 million channels?

- Answer: (see CAN-018 for details)
  1. calibrate module before installing
  2. transport constants to new conditions
  3. use MIP-tracks to maintain calibration
- Now: „IDAG reloaded“ - redo presented solution
  - ☑ with new calibration
  - ☐ without time pressure

IDAG reloaded:

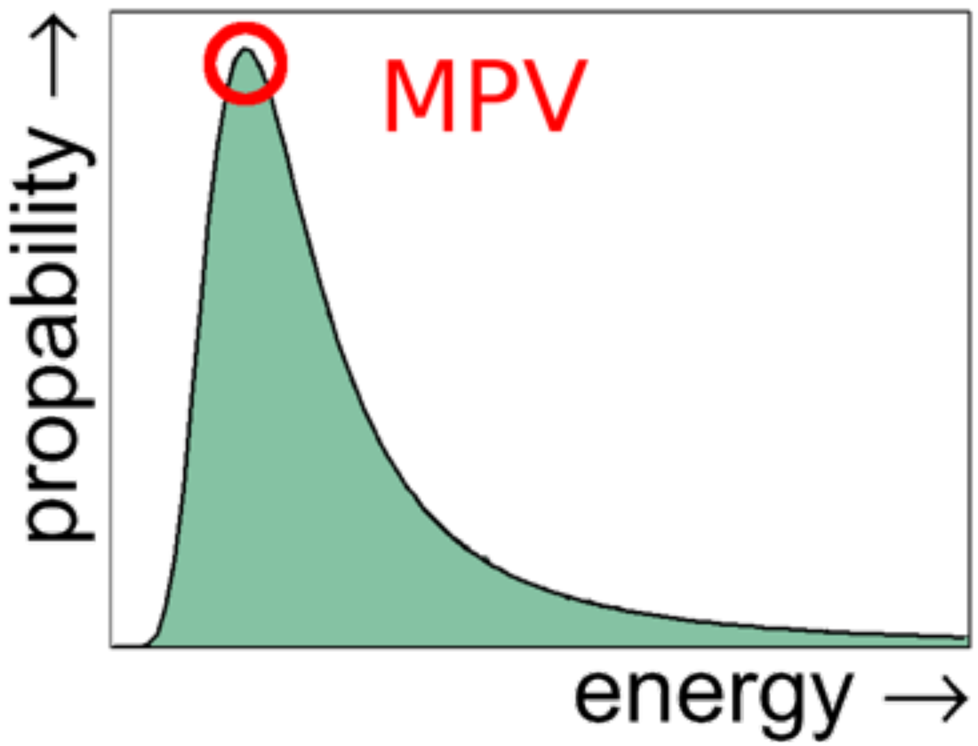
- CERN 2007 Data
- 3 Calibration Sets:
  1. Cern 2007: „001“: reference
  2. FNAL 2008: „002“
  3. FNAL 2008: „004“: large ΔU to Cern
- Transport calibration constants FNAL → Cern
  ⇒ see talk by Nils Feege
- Check resolution of reconstructed energy
- Use MIP Tracker on data (see CAN-022)
  ⇒ module wise energy correction/calibration factors (per run)
  ⇒ Use correction factors on reconstructed energy (per run)

MIP energy deposition: Langau

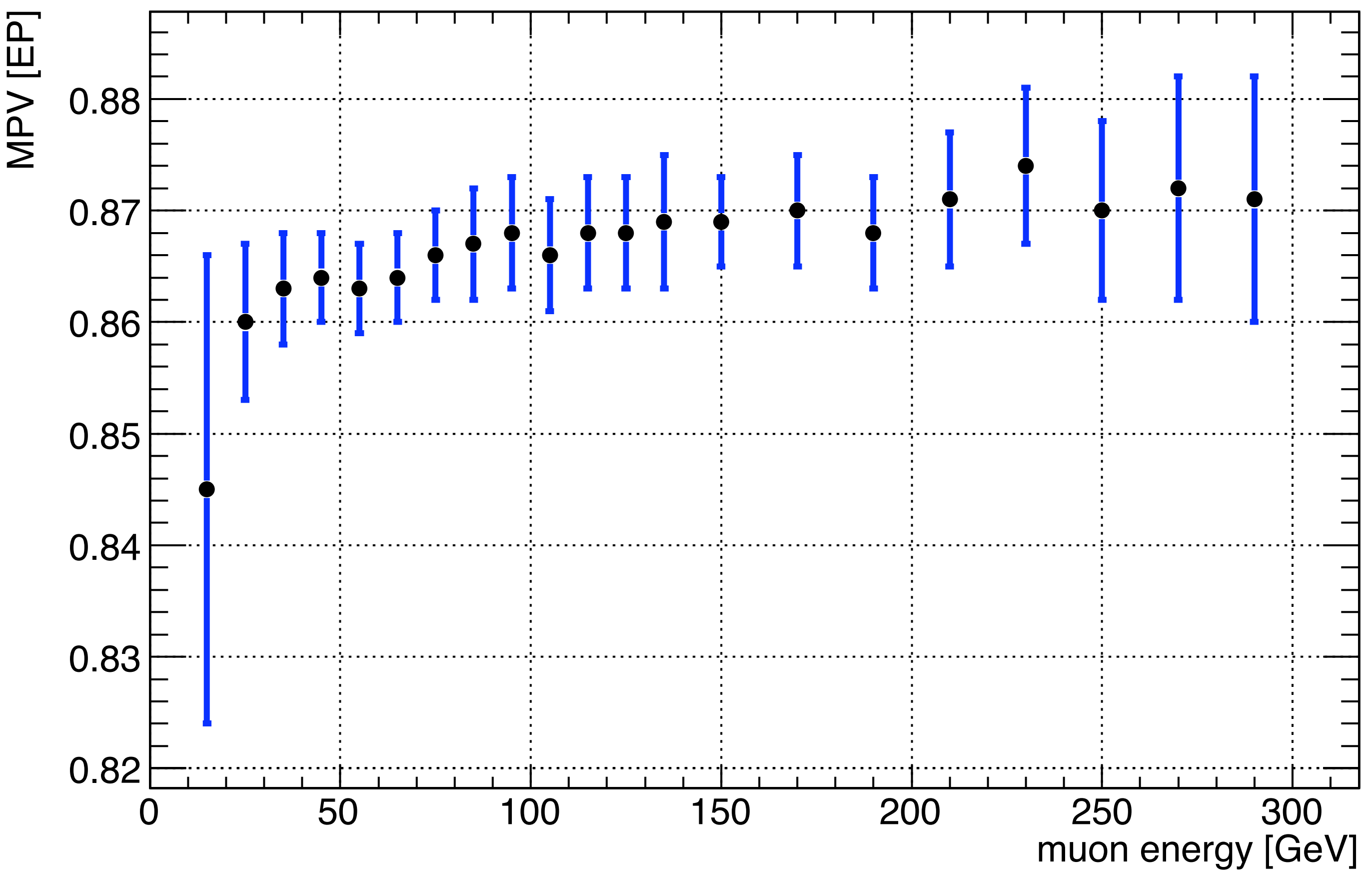
- Energy deposition of MIP according to Landau convoluted Gauss distribution („Langau“)
- MPV used for original calibration

➡ use for correction/calibration after transport too

- Mean/MPV dependent on angle



The Landau-MPV energy dependance



1 EP = truncated mean of 77GeV µ

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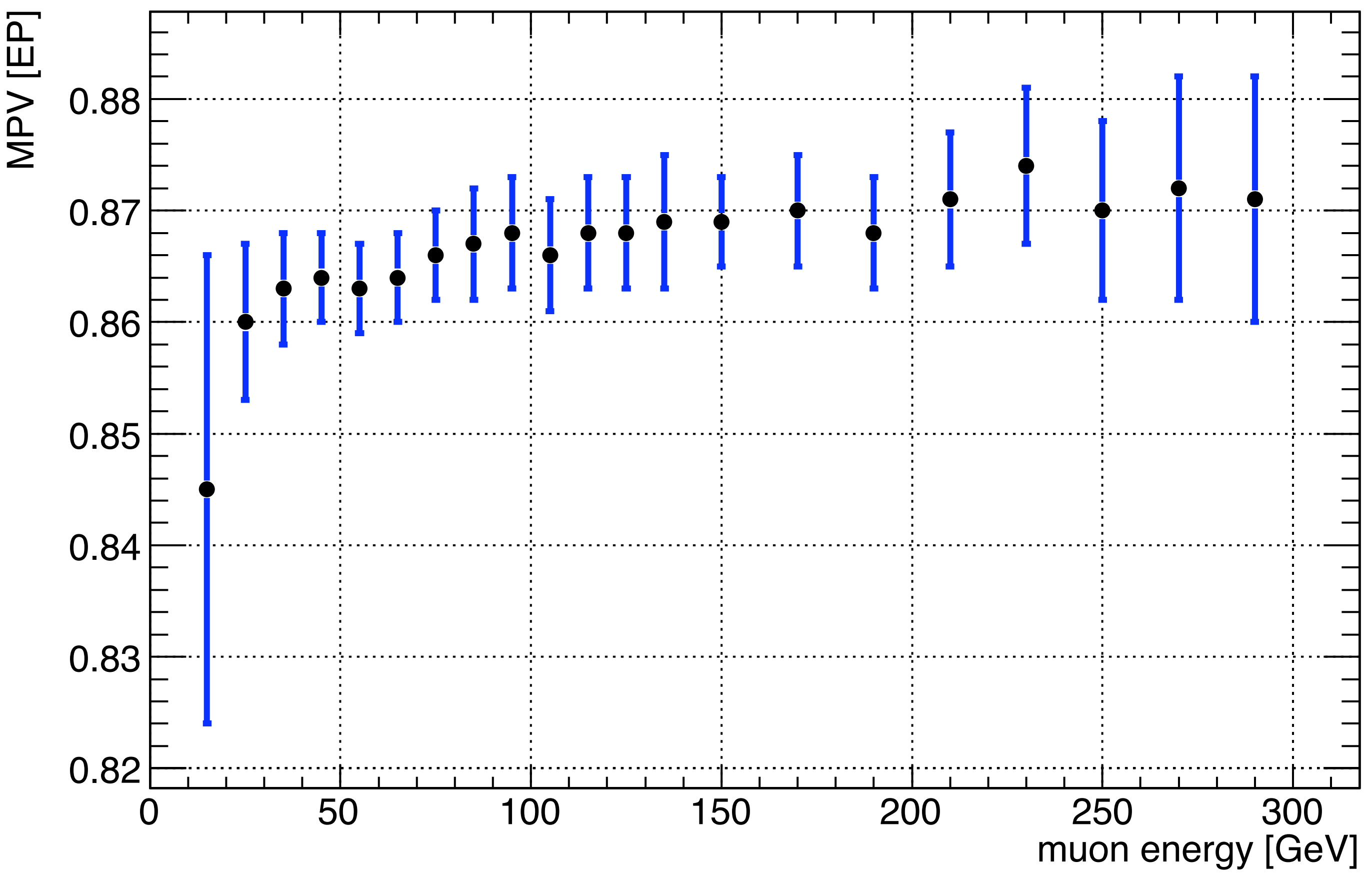

- Source:
  Nuclear Instruments and Methods in Physics Research A 343 (1994), p. 463-469, table 2, 1CTR

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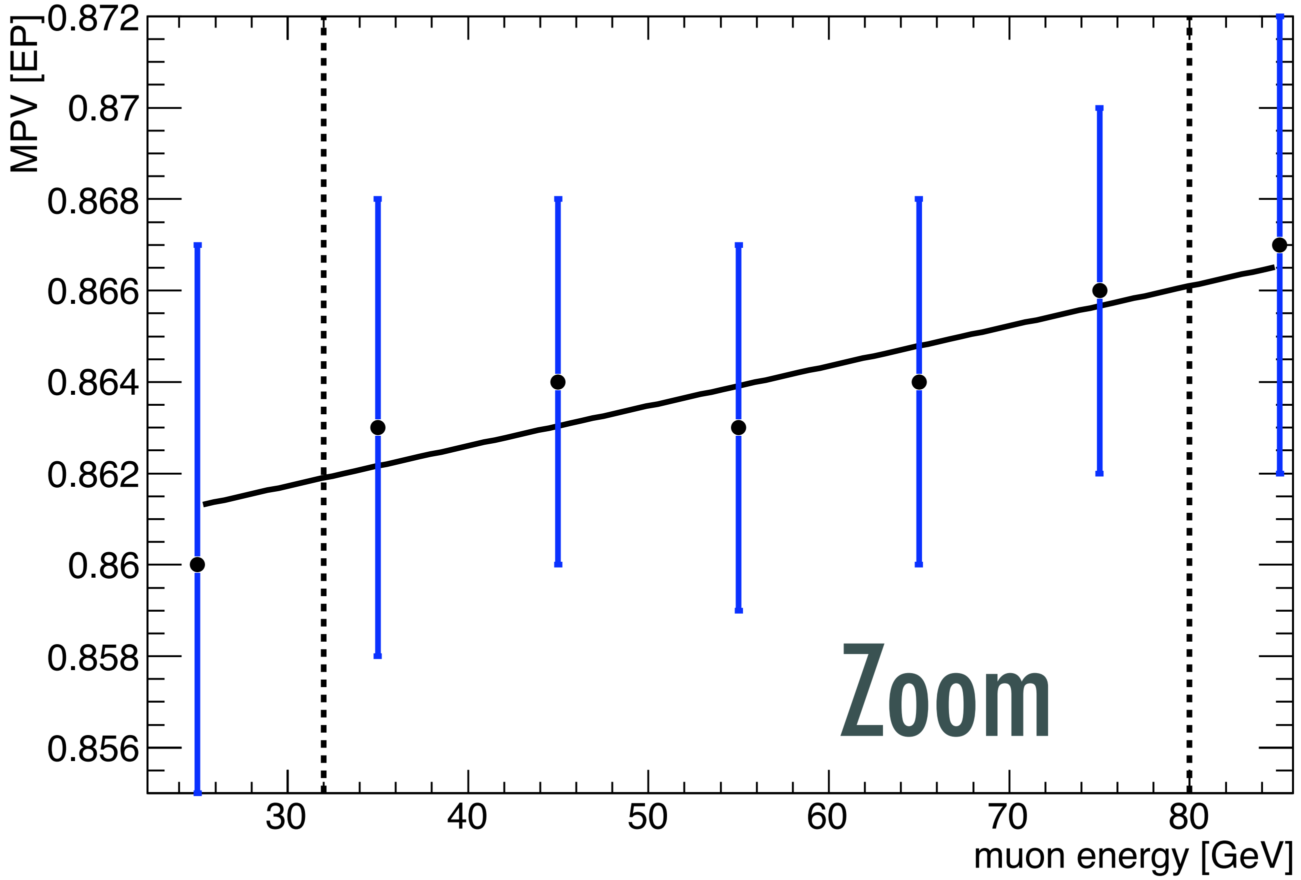

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fit to guide the eye

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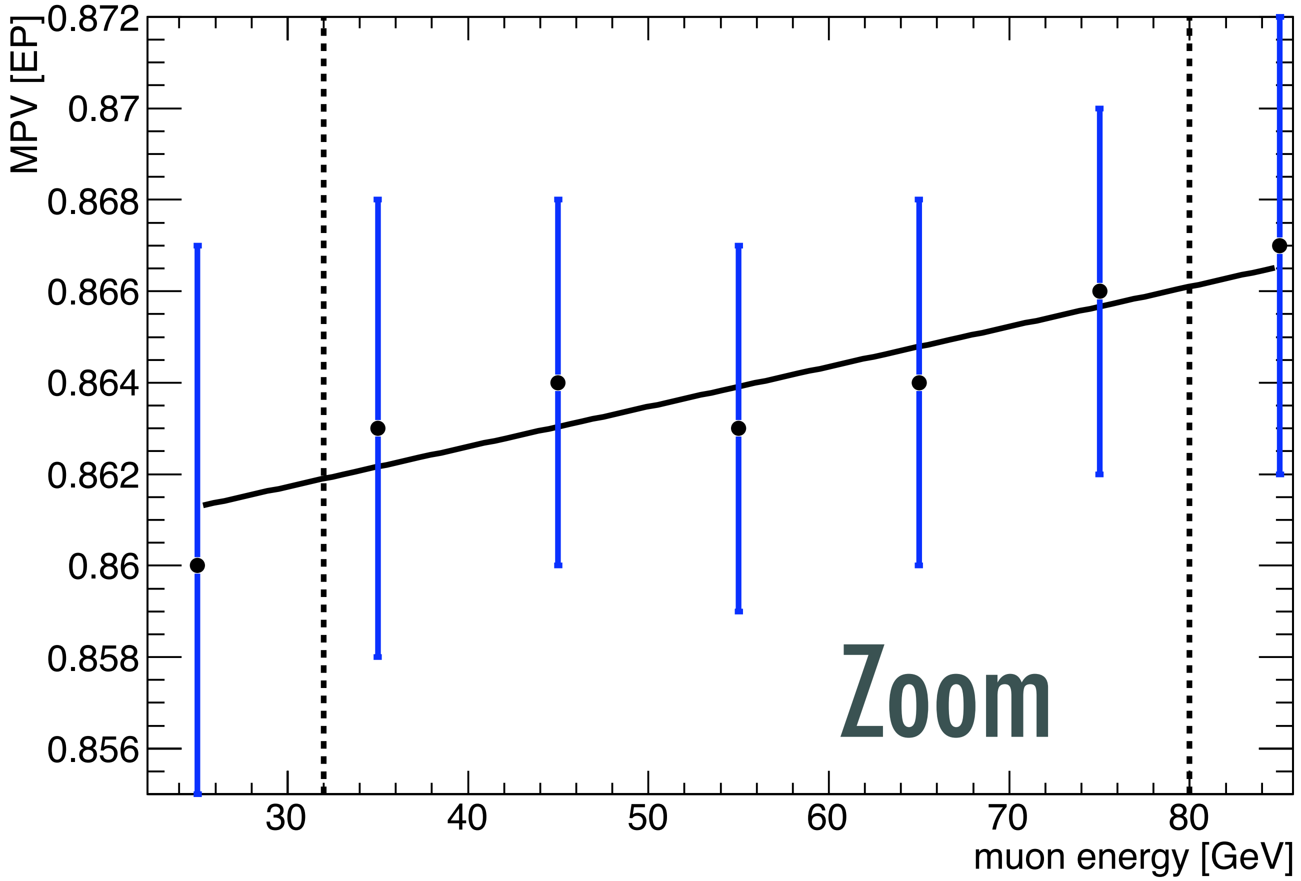

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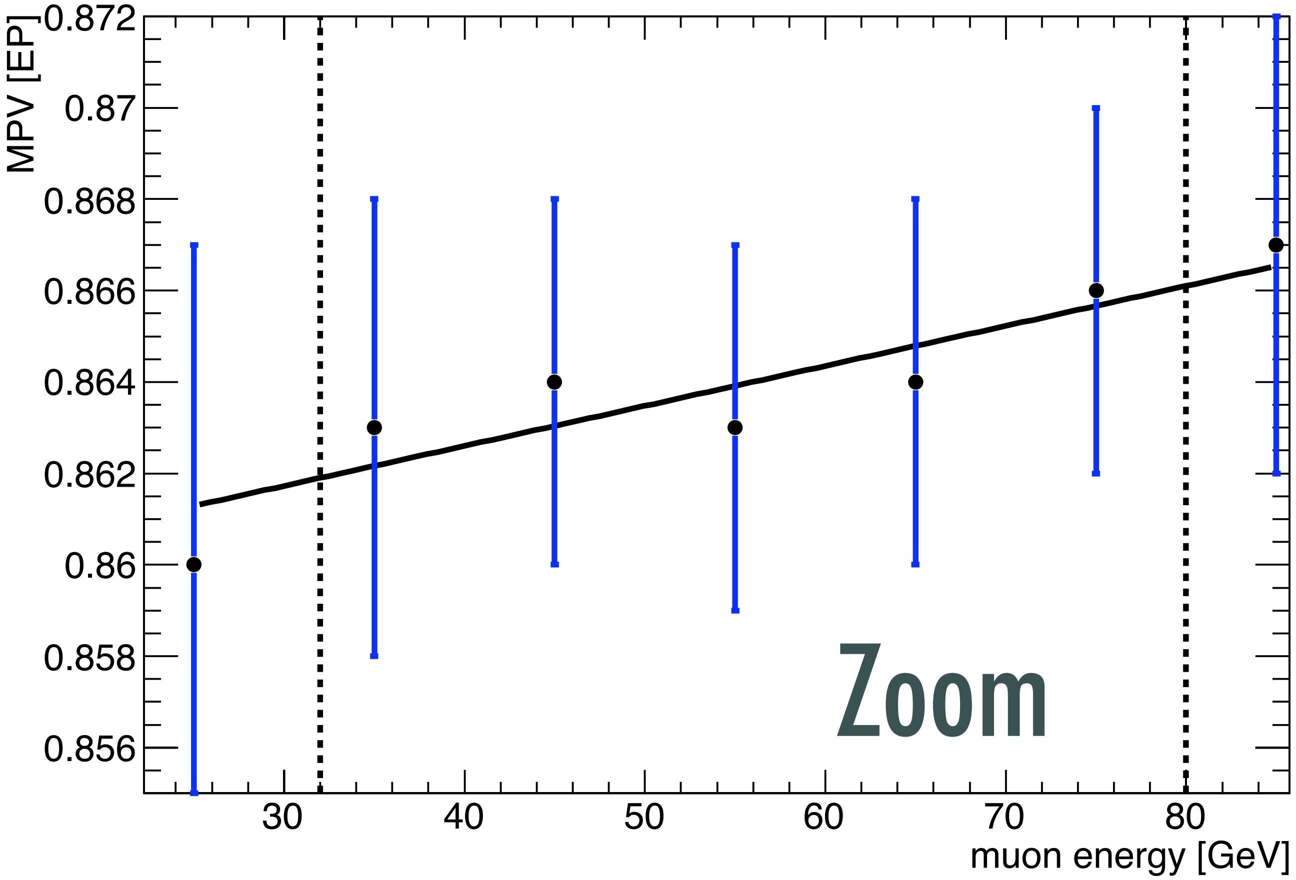

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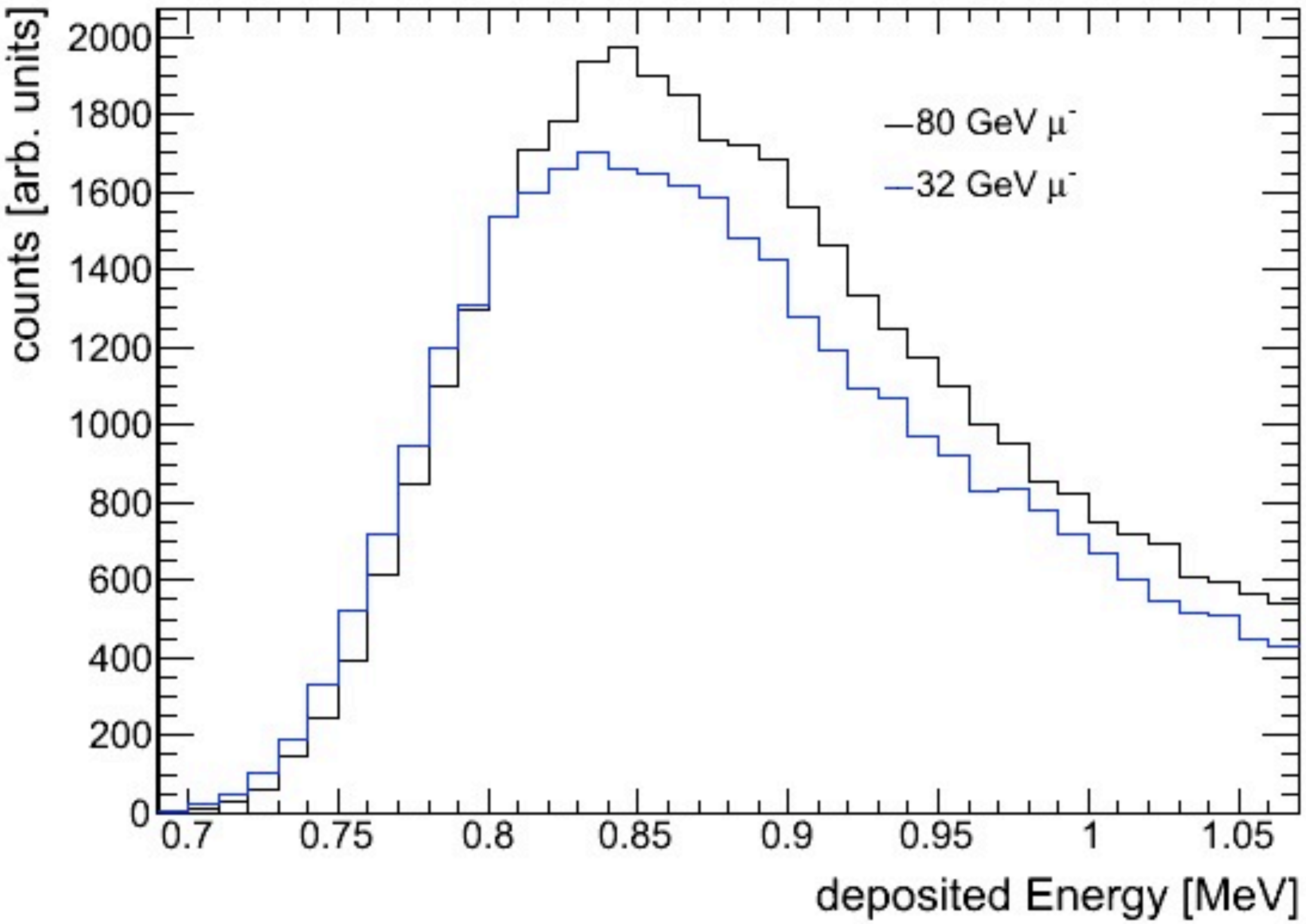

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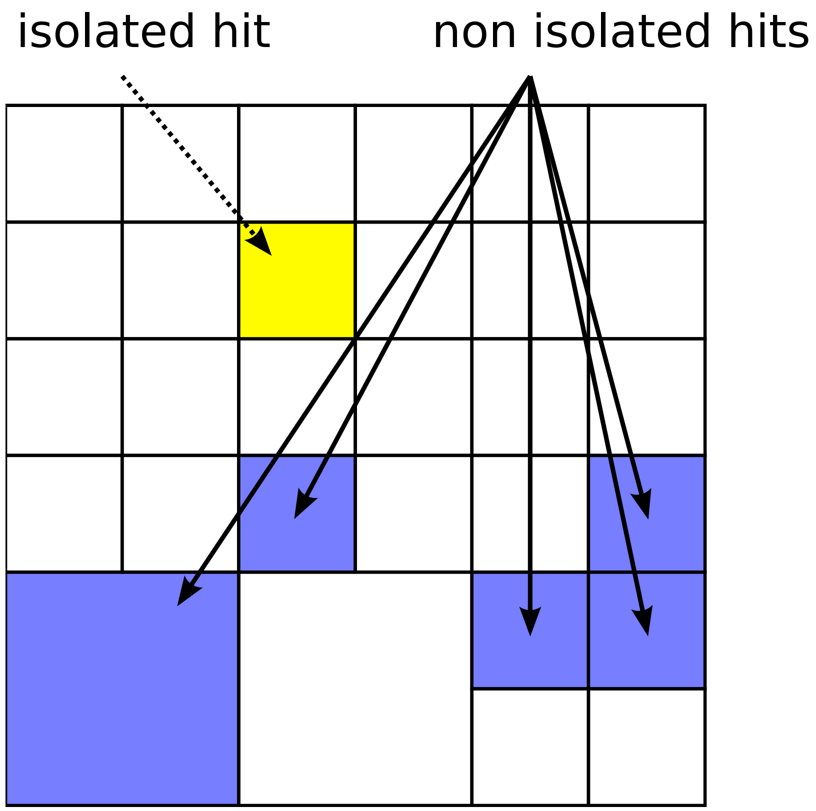

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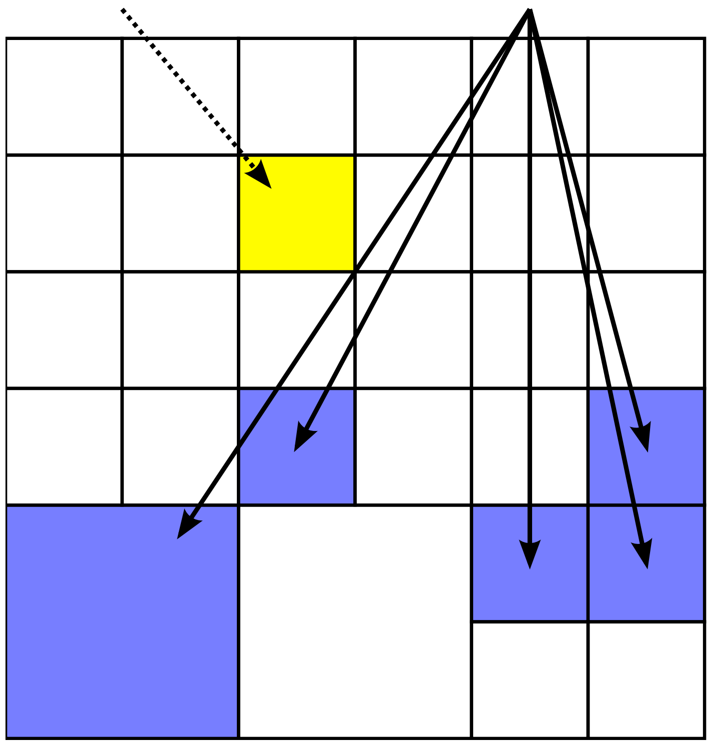

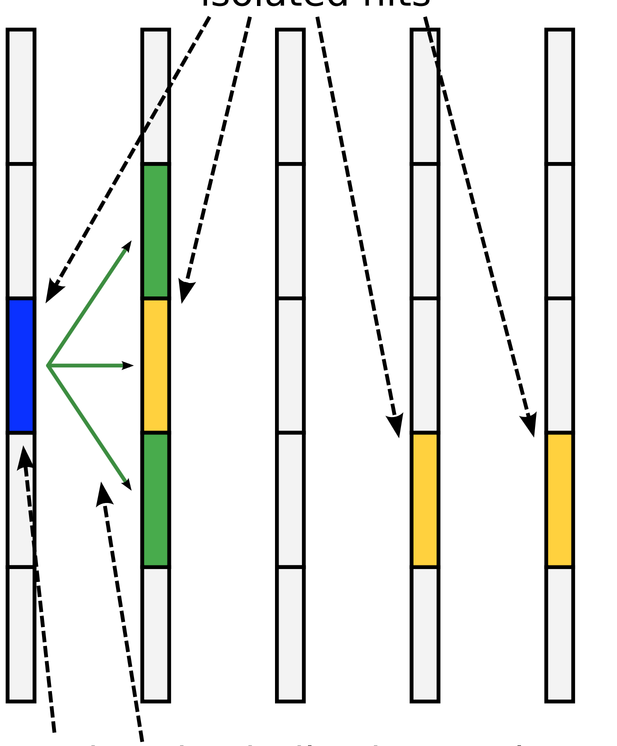

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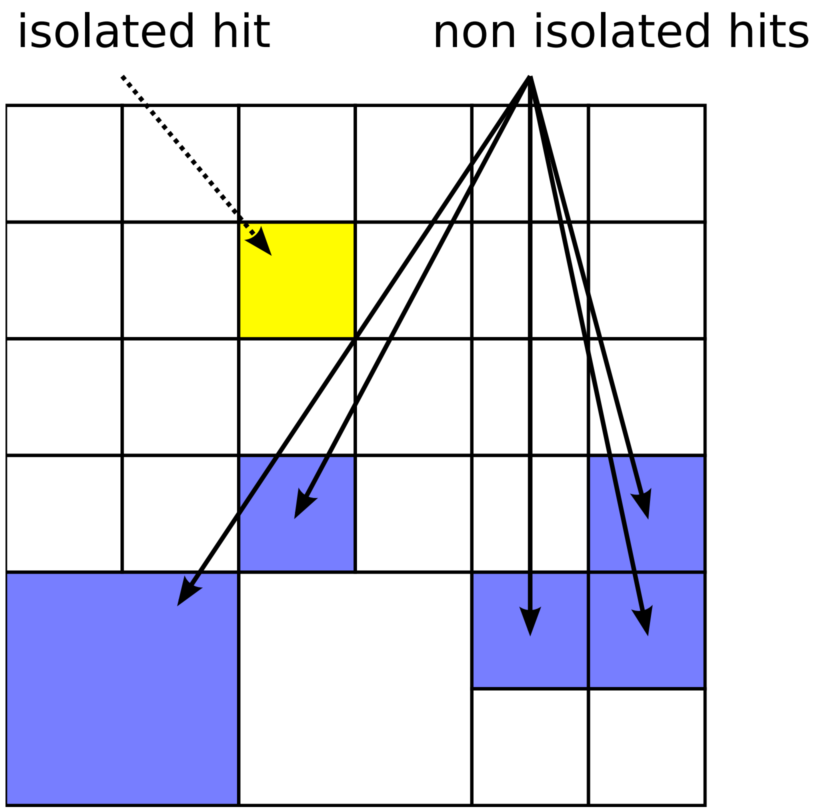

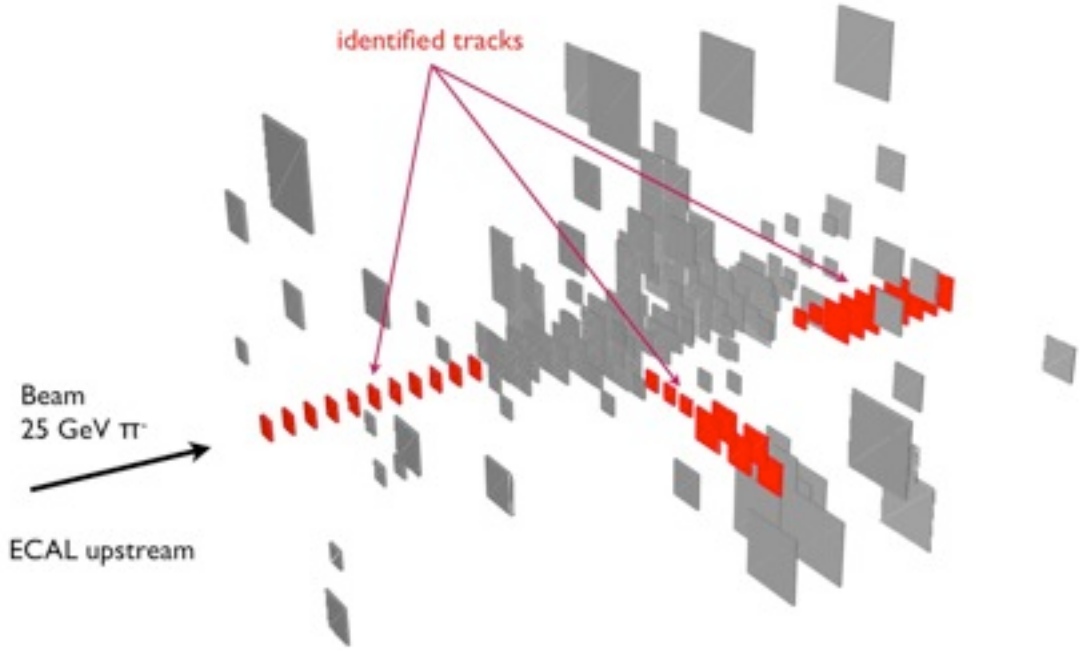

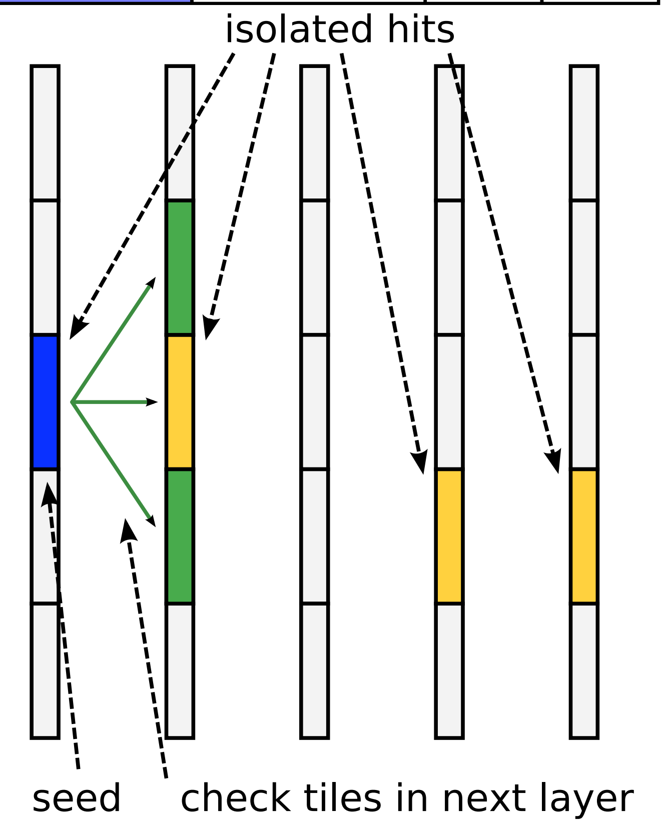

Obtaining layerwise calibration factors

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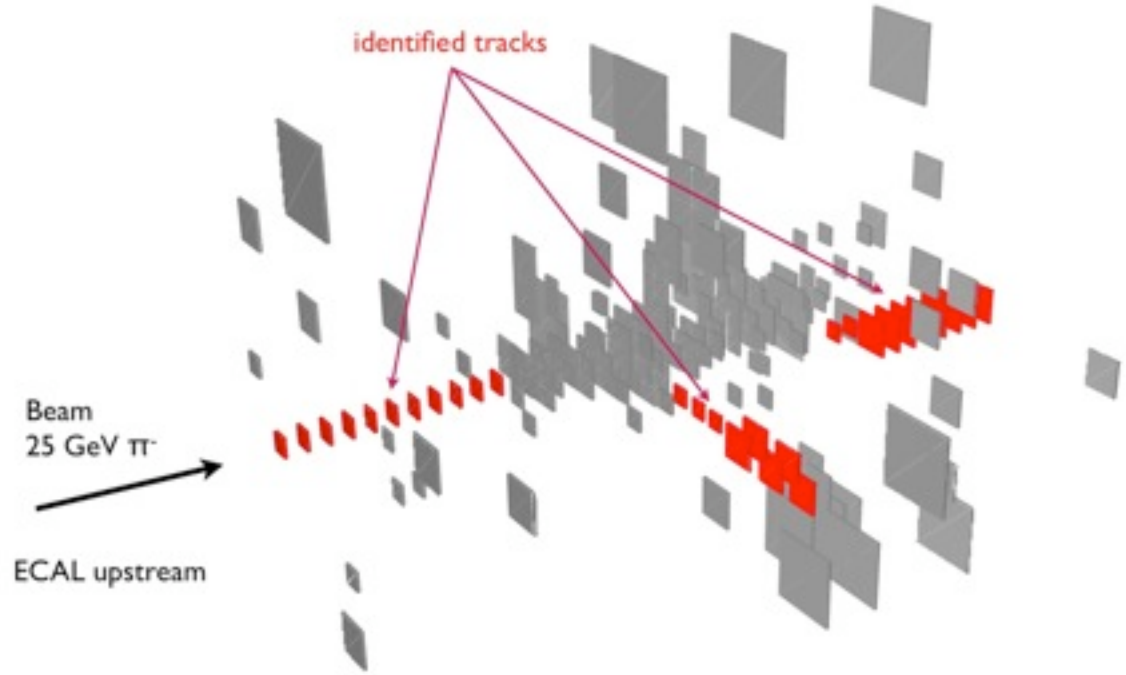

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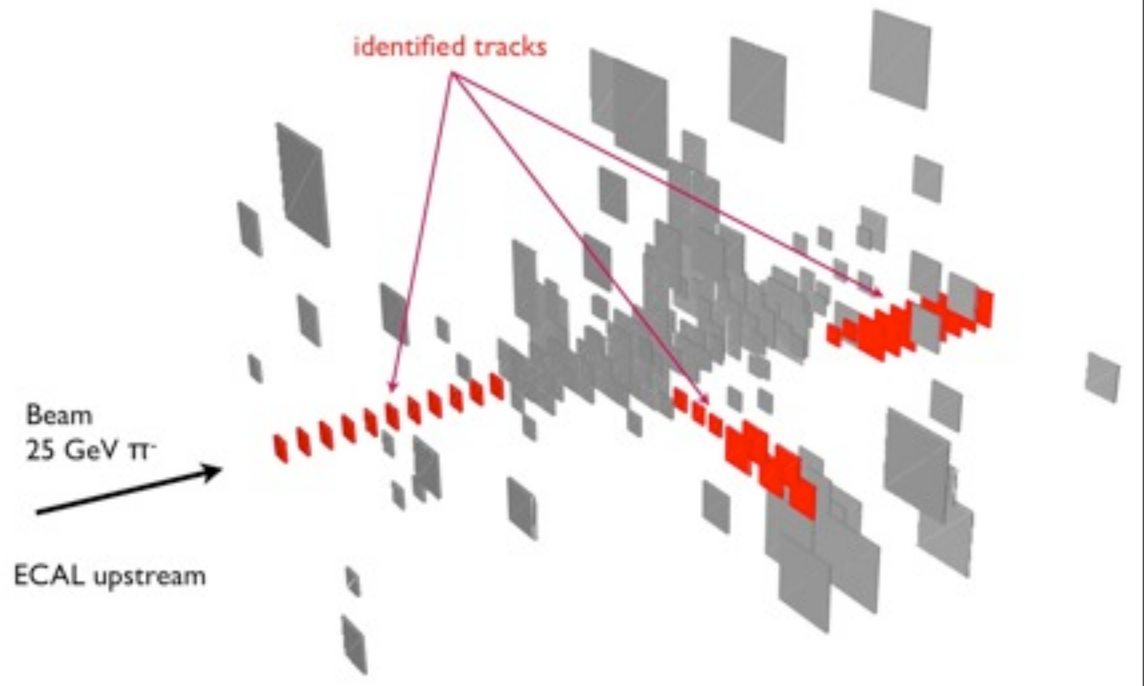

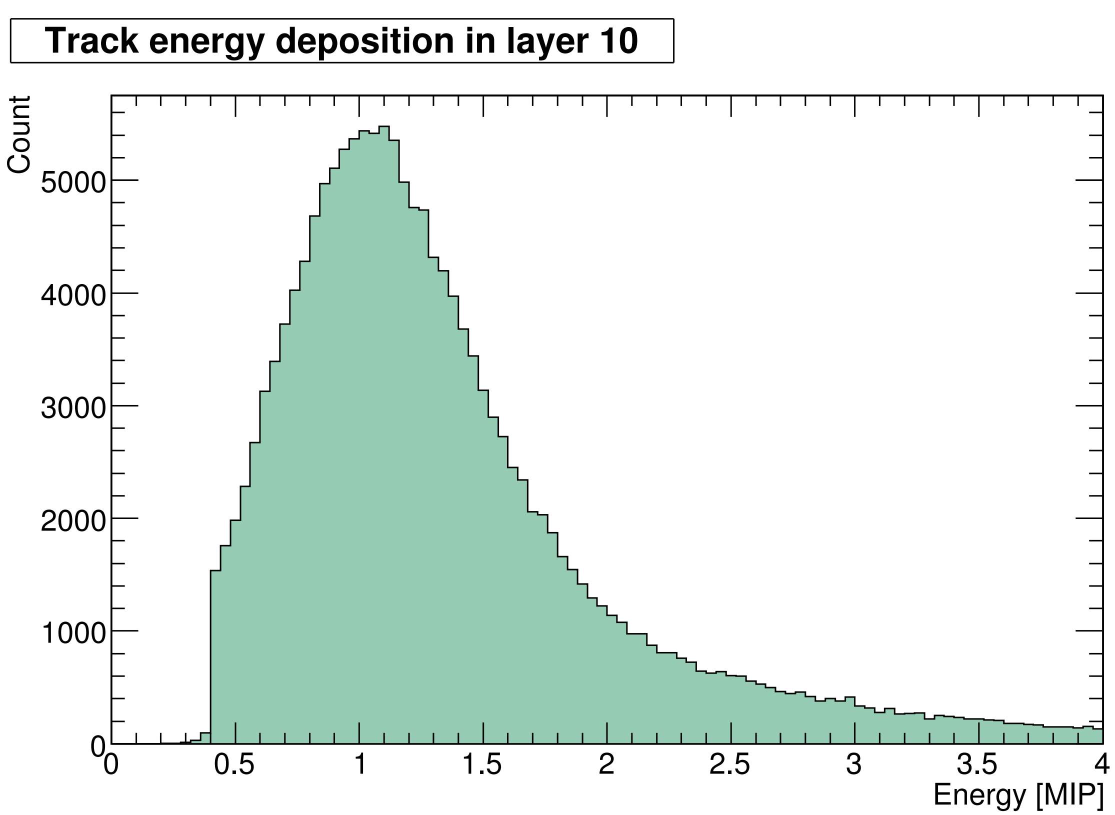

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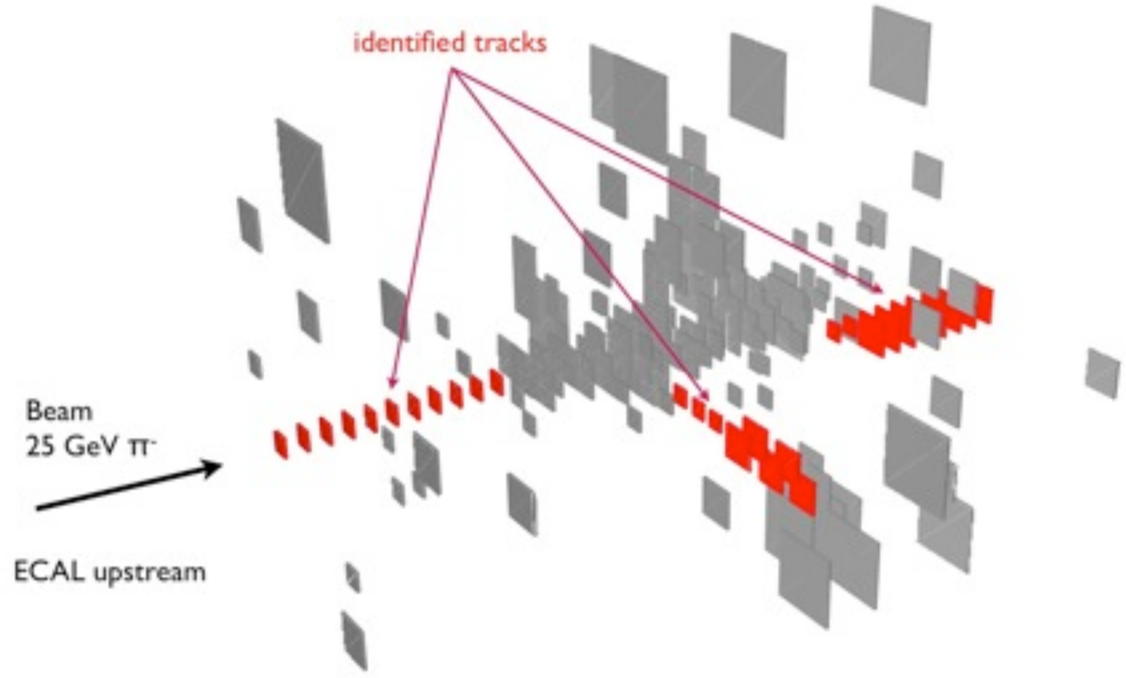

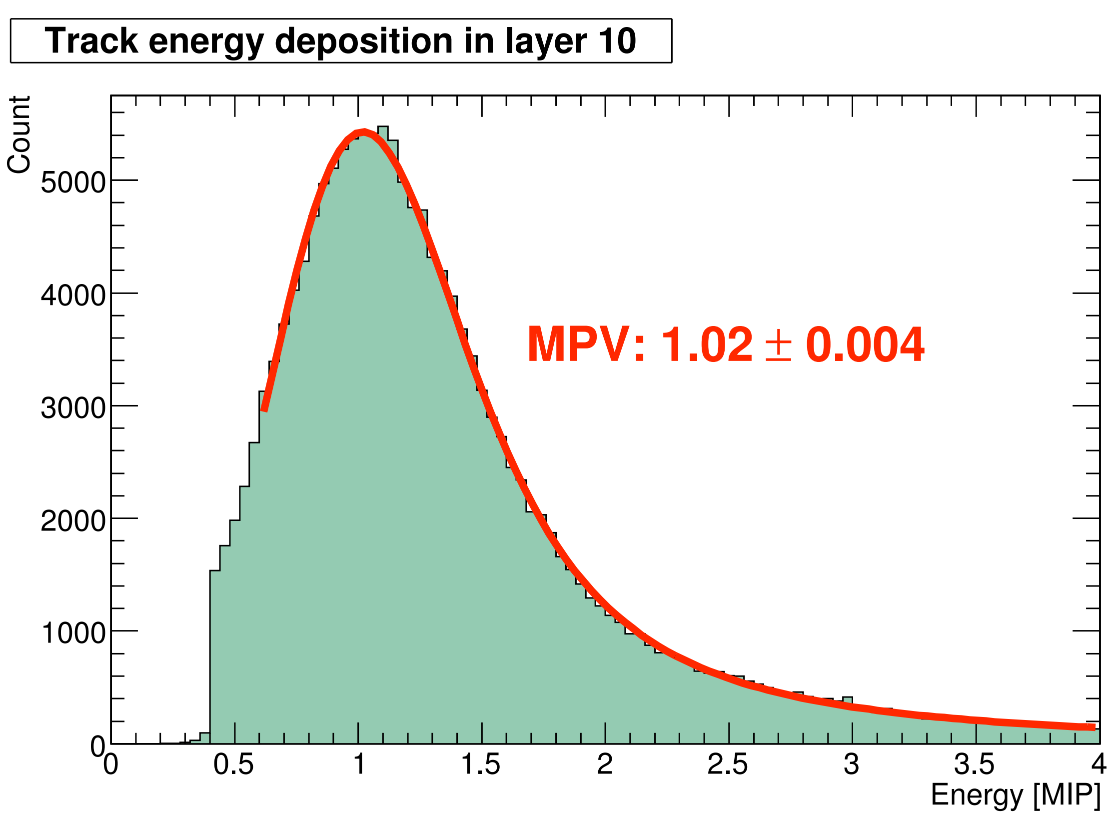

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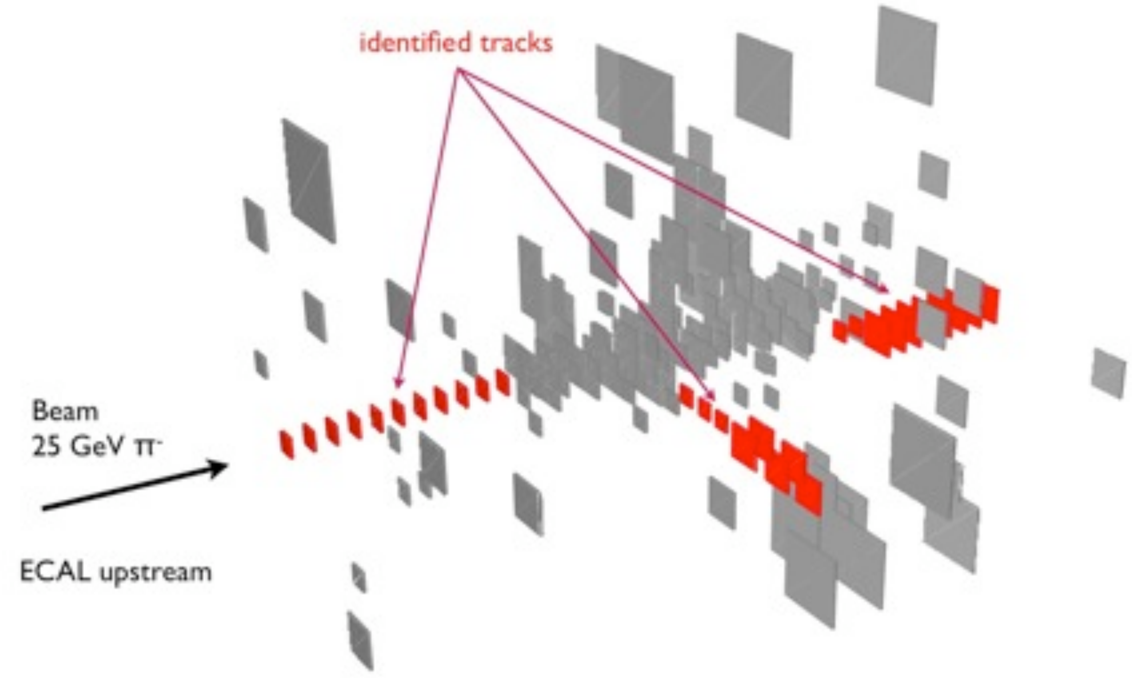
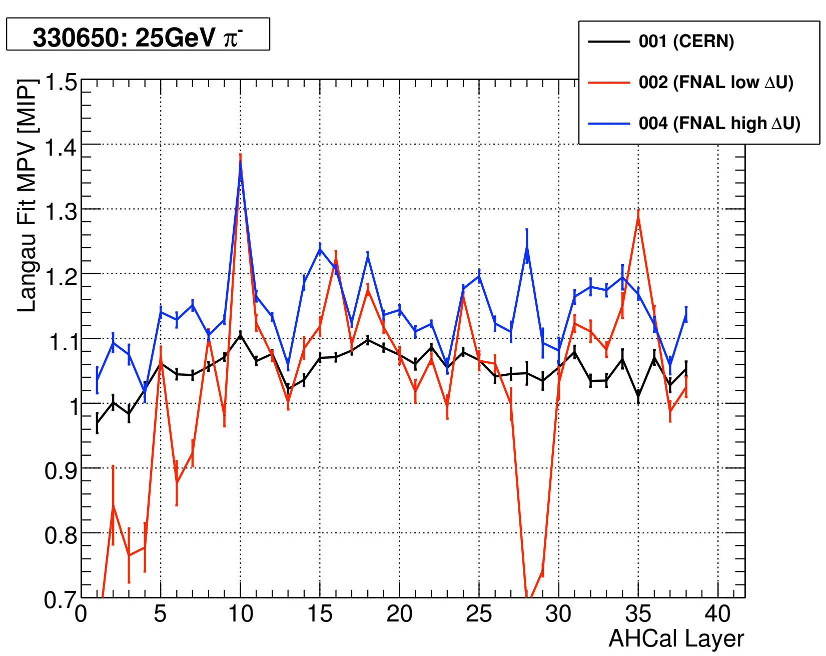
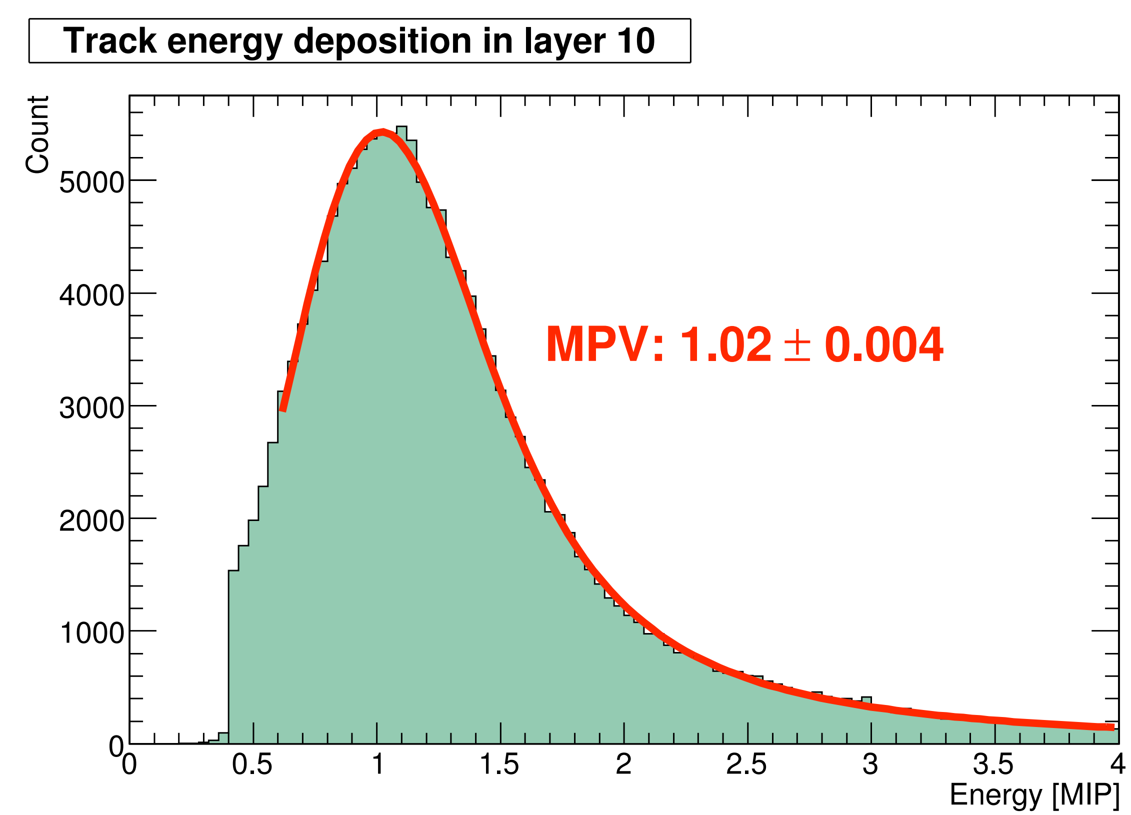
➡ Layerwise calibration factors

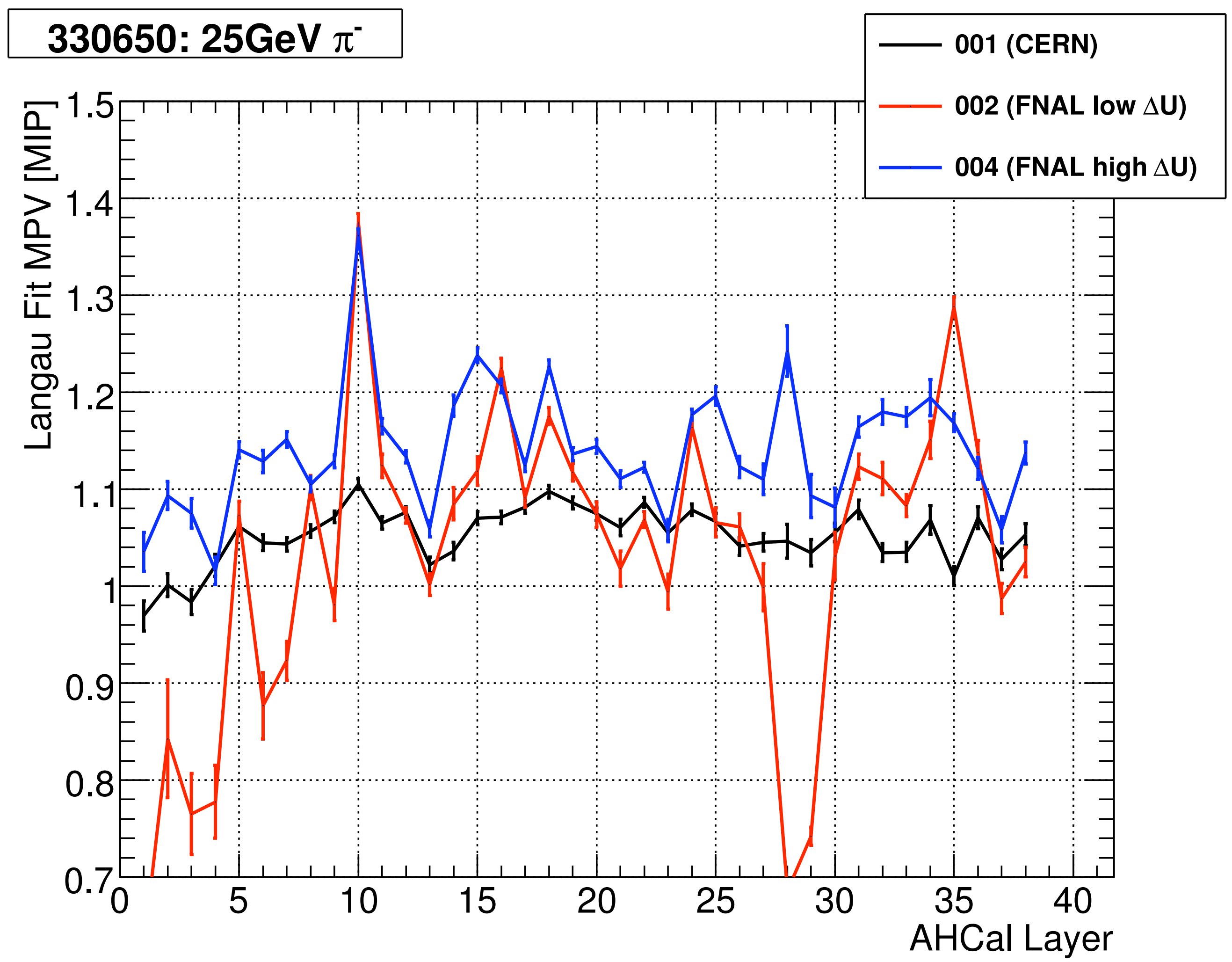






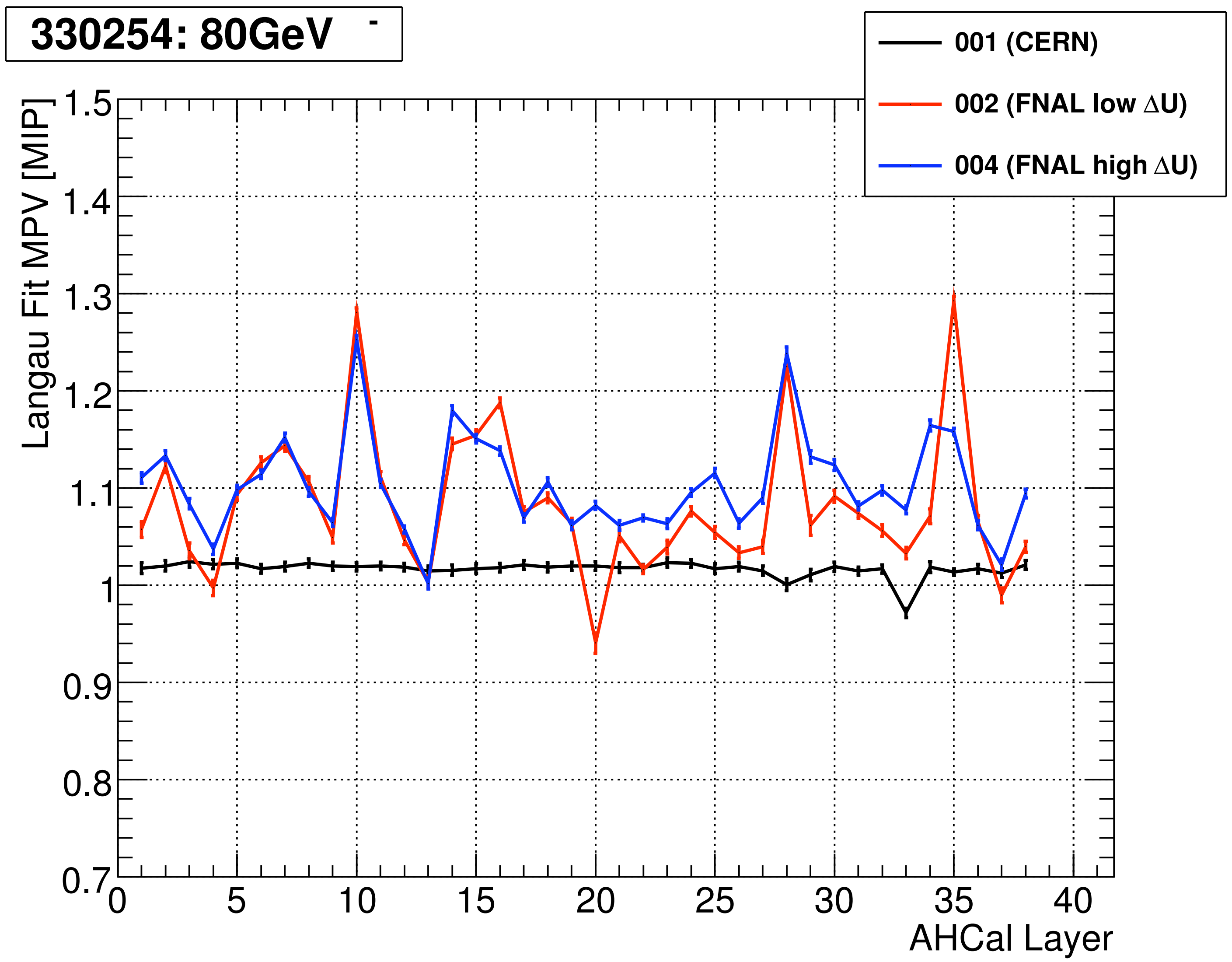
Layerwise calibration constants from π run

- CERN (001):
  - Should be flat
  - up to 10% overshoot
    - ➡ tracks inclined after shower
    - ➡ higher E_{dep}
- FNAL (002 & 004):
  - large variations
  - 002: largest variations



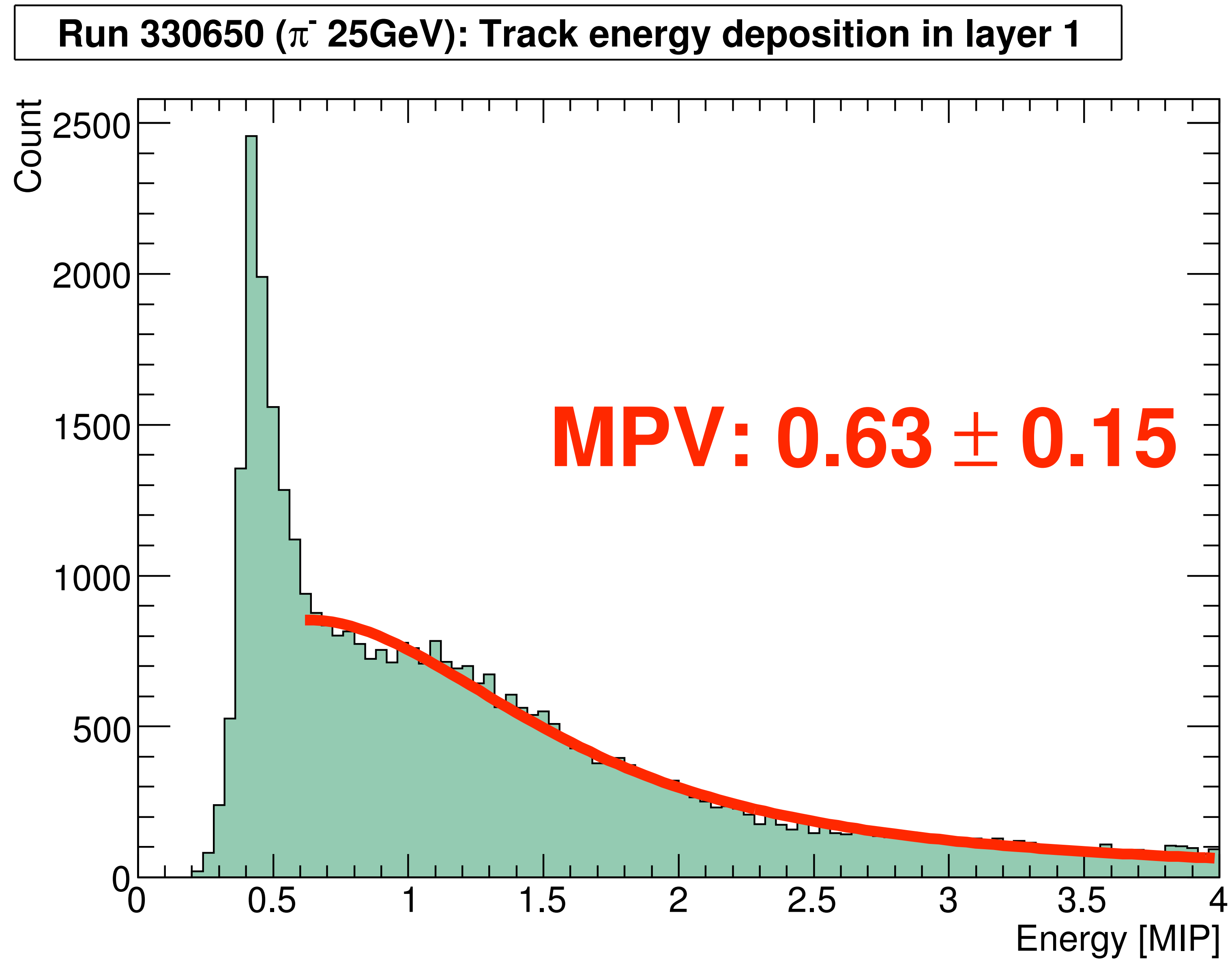
Layerwise calibration constants from μ run

- CERN (001):
  - Flat distribution
  - ca 2% offset
    ⇒ diff Langau-Fit?
- FNAL (002 & 004):
  - still large variations



Challenges for obtaining calibration factors

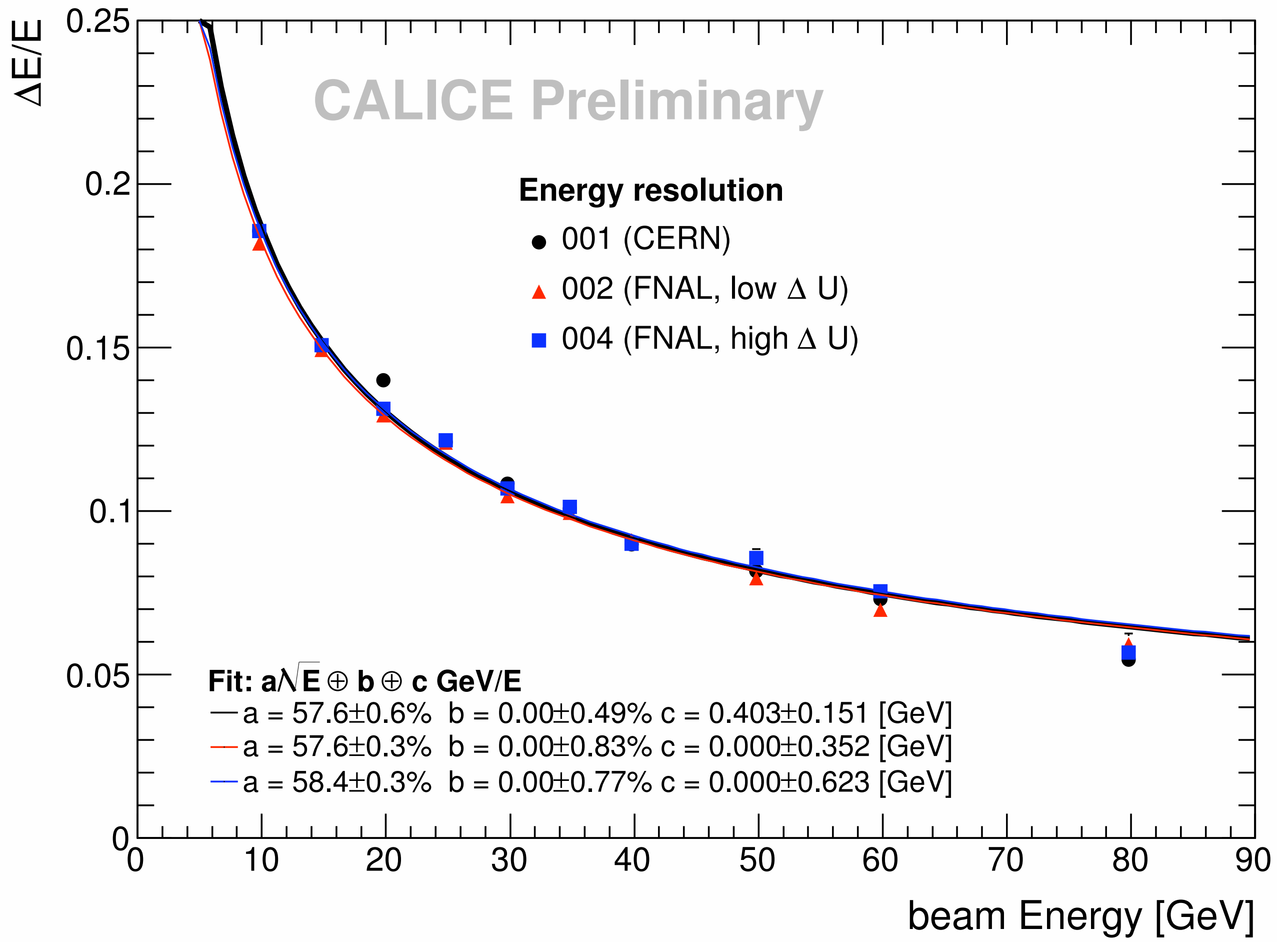
from set „002"

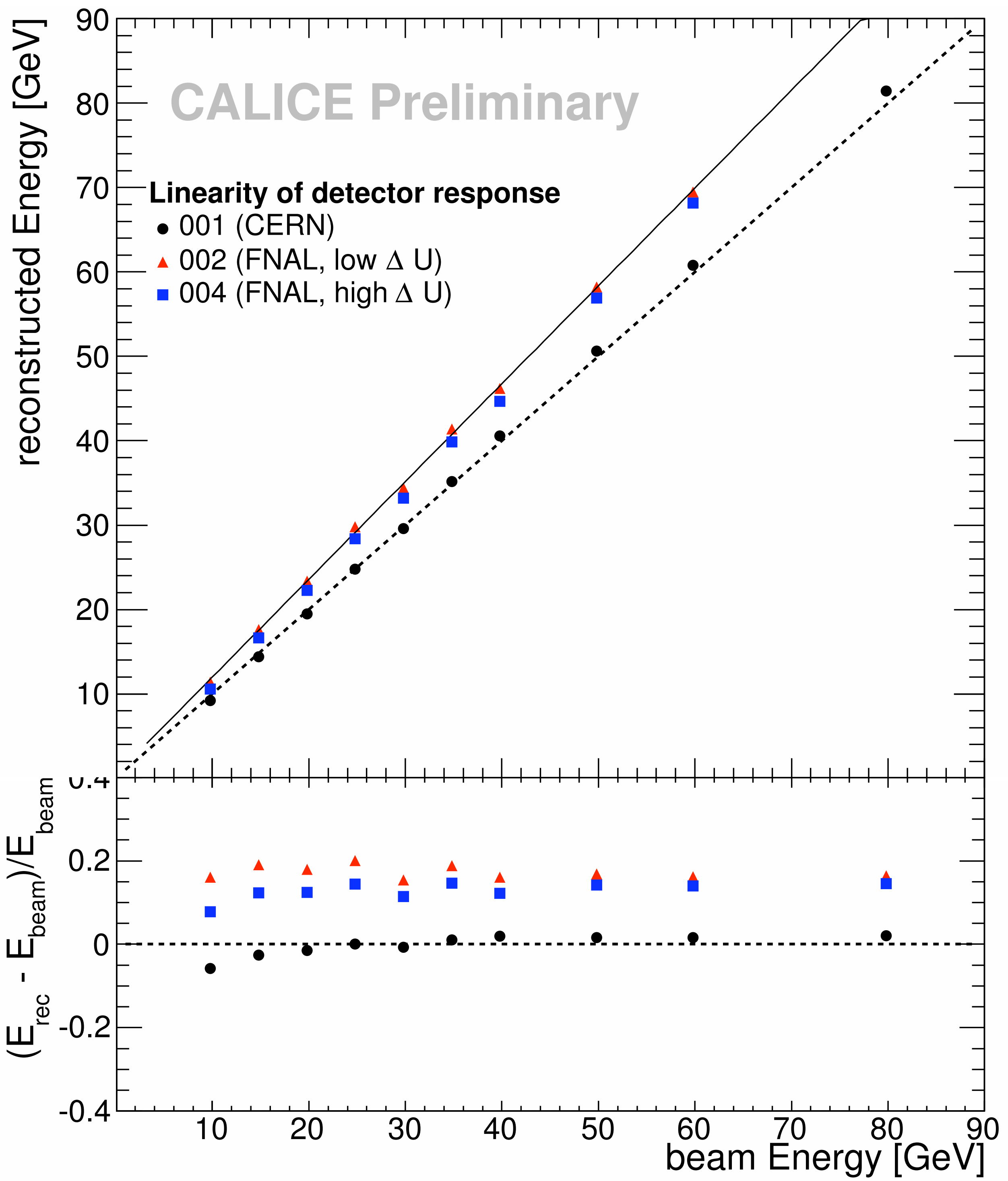


Large noise / shift into noise region will cause fit to fail!

⇒ ignore calibration factors with deviation > 20%

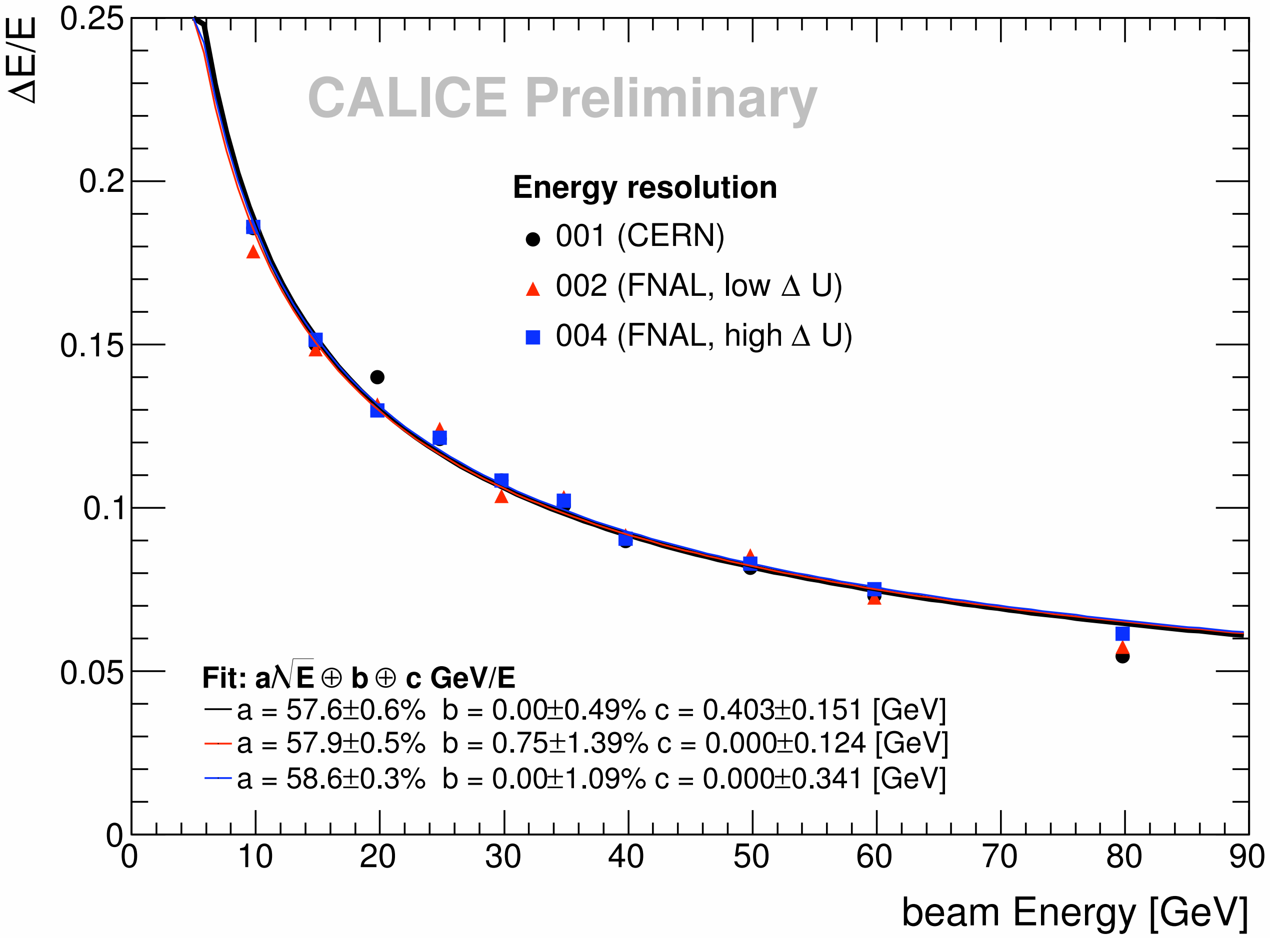
Resolution of reconstructed energy: w/o correction

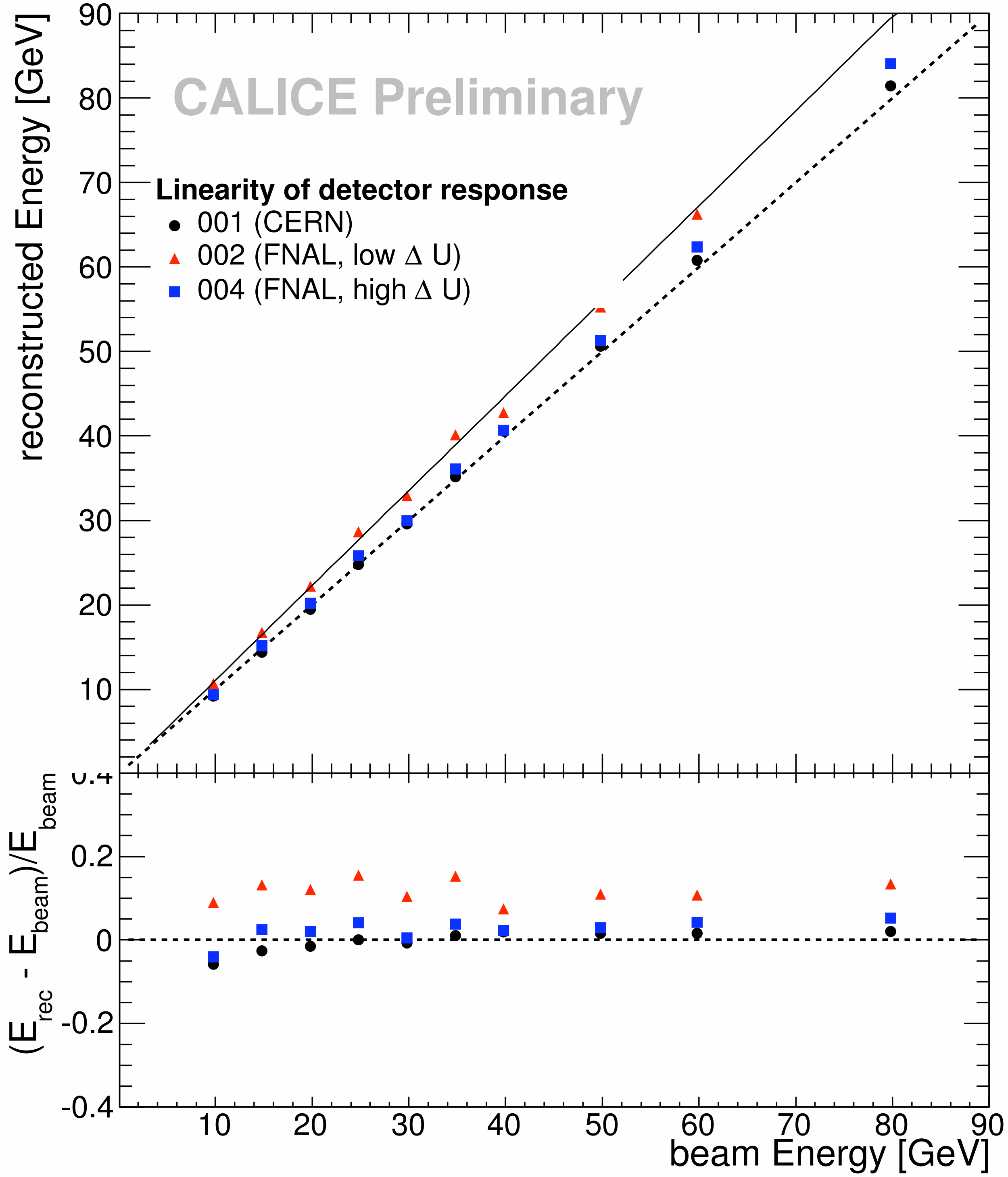




- CERN (001) as reference
- FNAL (002 & 004):
  - resolution: ≈ no change!
  - linearity: offset up to 20%

Resolution of reconstructed energy: w/ correction

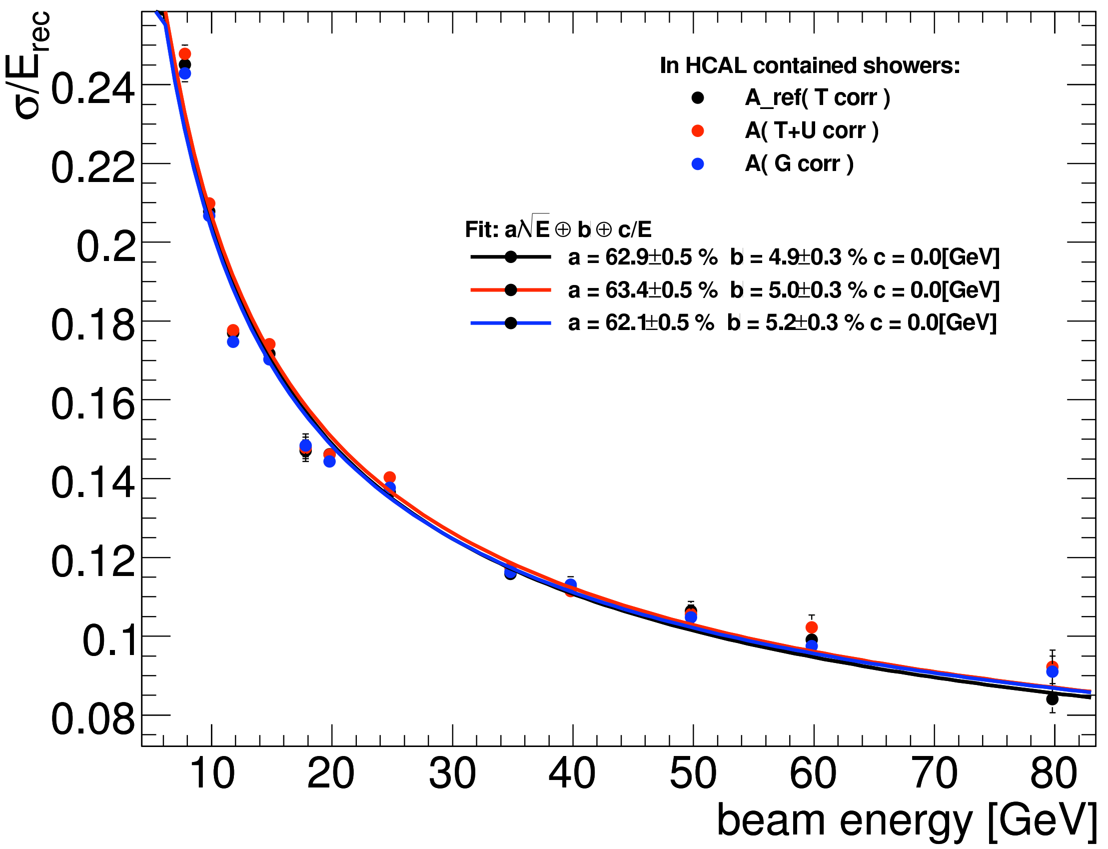




- correction improved linearity
  - 004: similar to 001 now
  - 002: offset only up to 15%

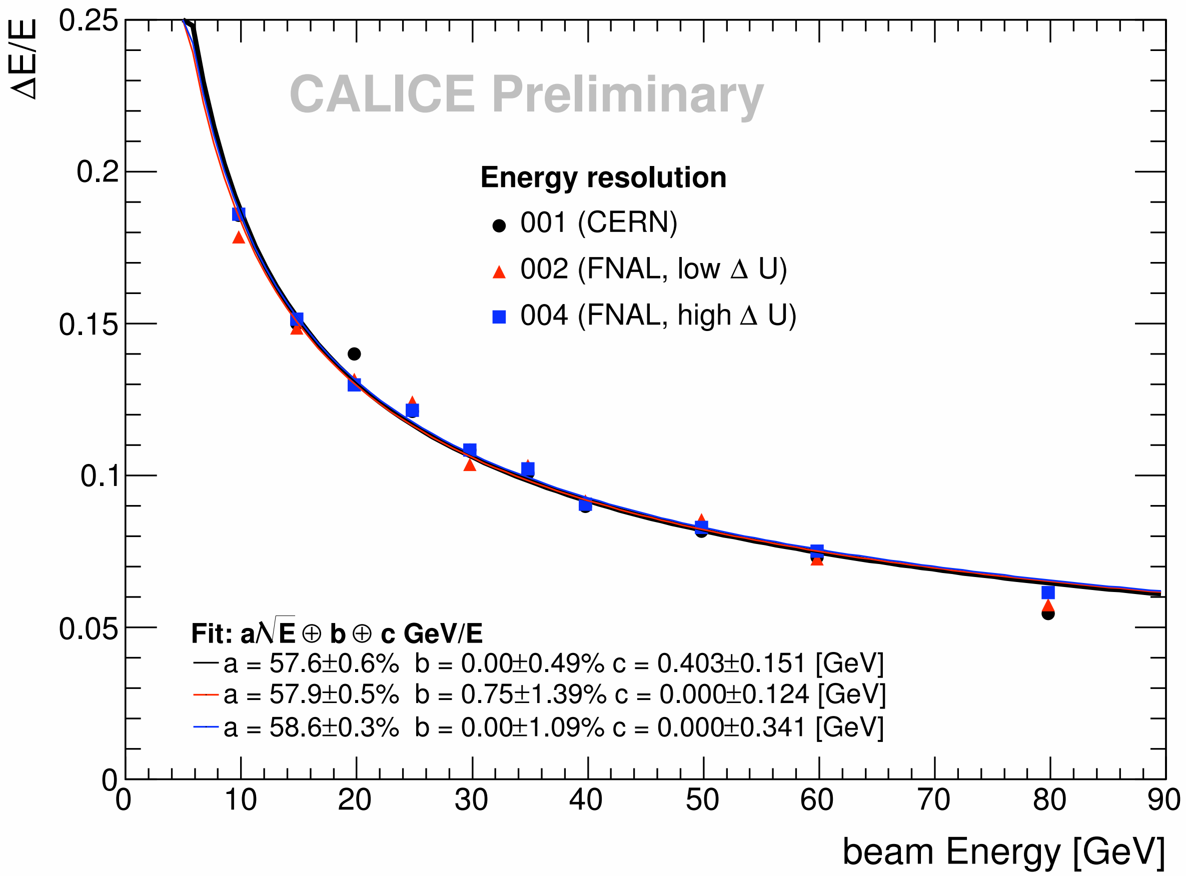
Comparison to IDAG (CAN-018)

IDAG



$$\frac{(63.4 \pm 0.5)\%}{\sqrt{E}} + (5 \pm 0.3)\%$$

IDAG reloaded



002: $$\frac{(57.9 \pm 0.5)\%}{\sqrt{E}} + (0.75 \pm 1.39)\%$$

004: $$\frac{(58.6 \pm 0.3)\%}{\sqrt{E}} + (0 \pm 0.3)\%$$

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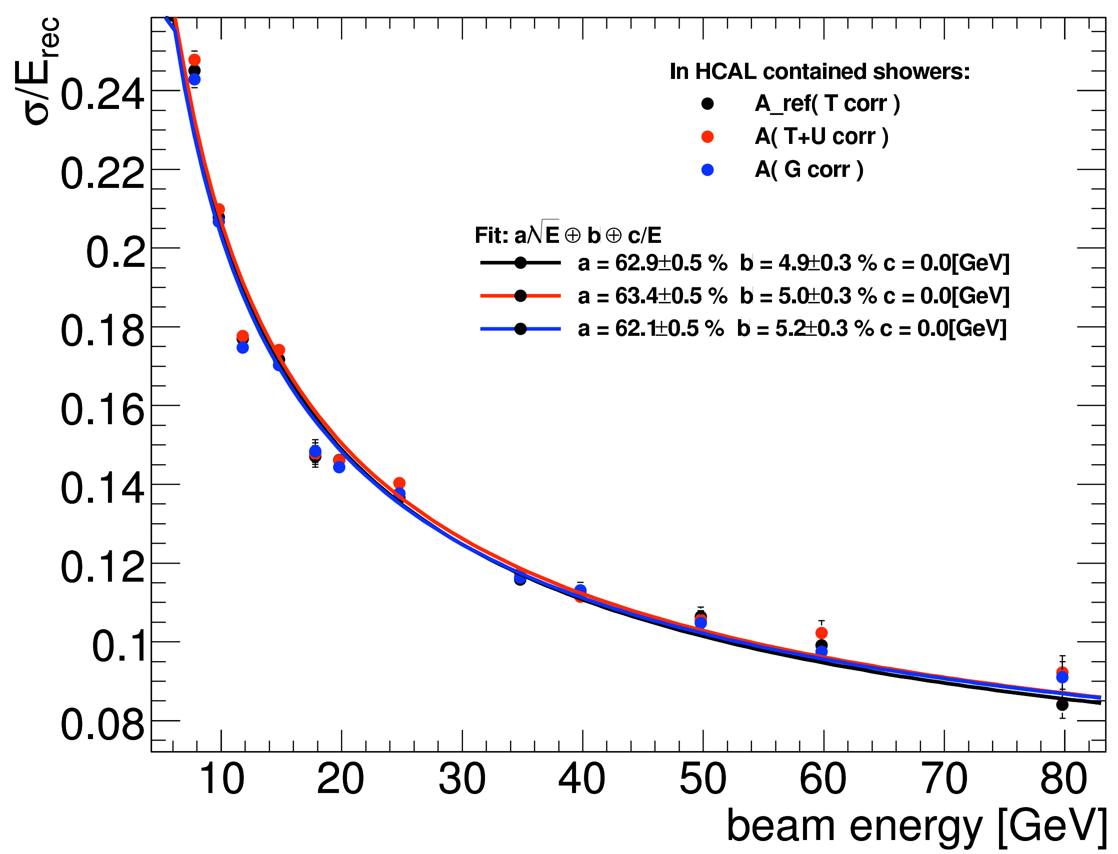

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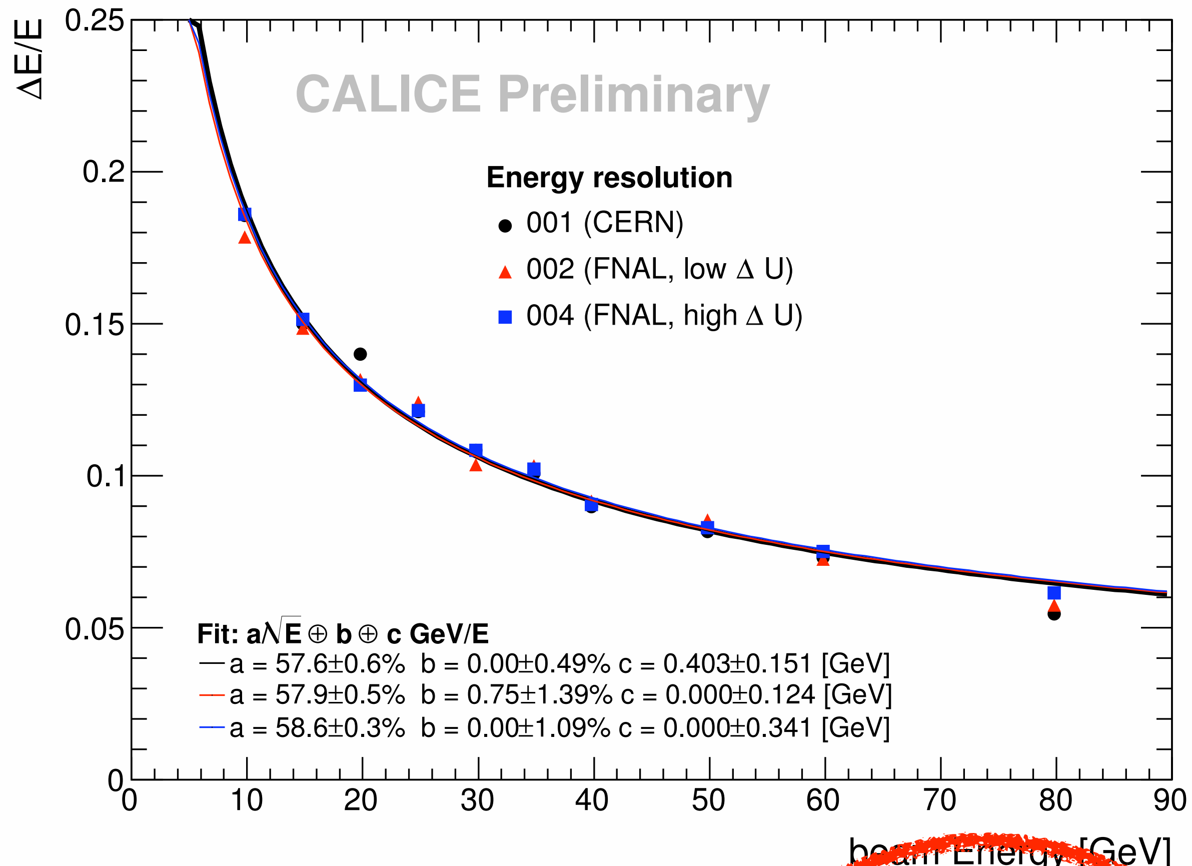

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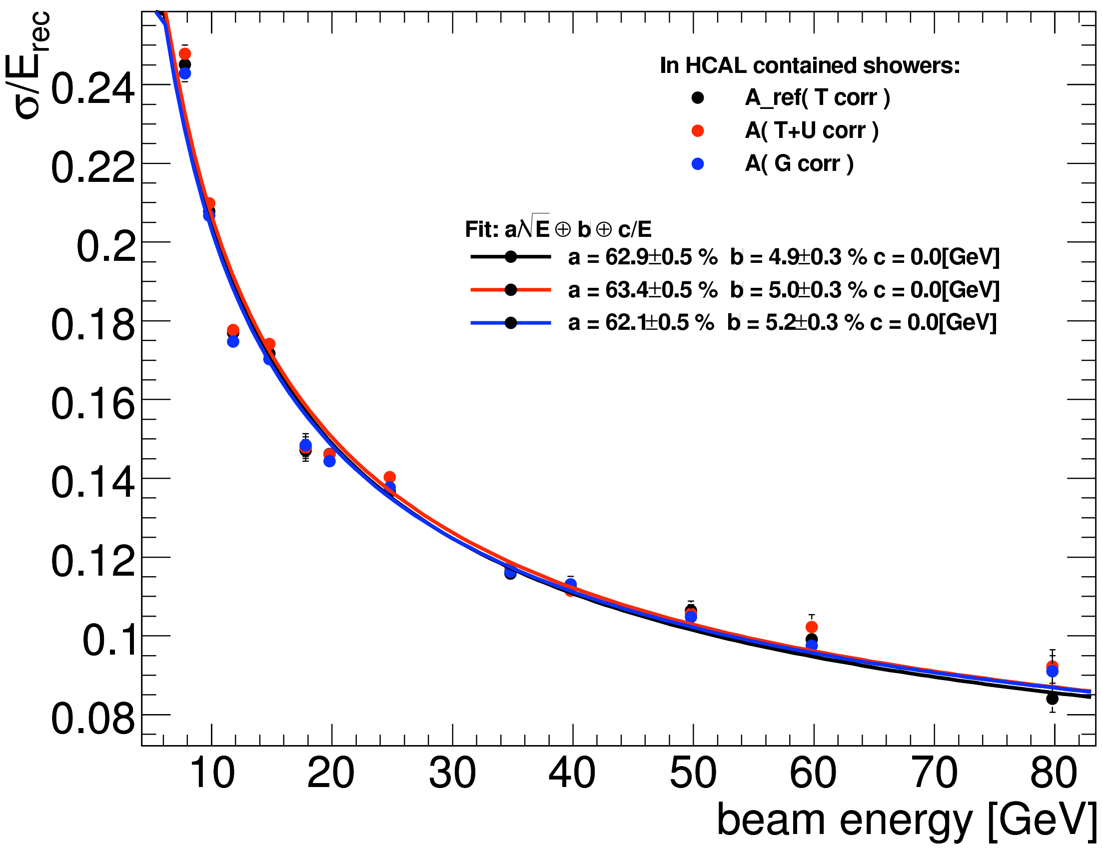

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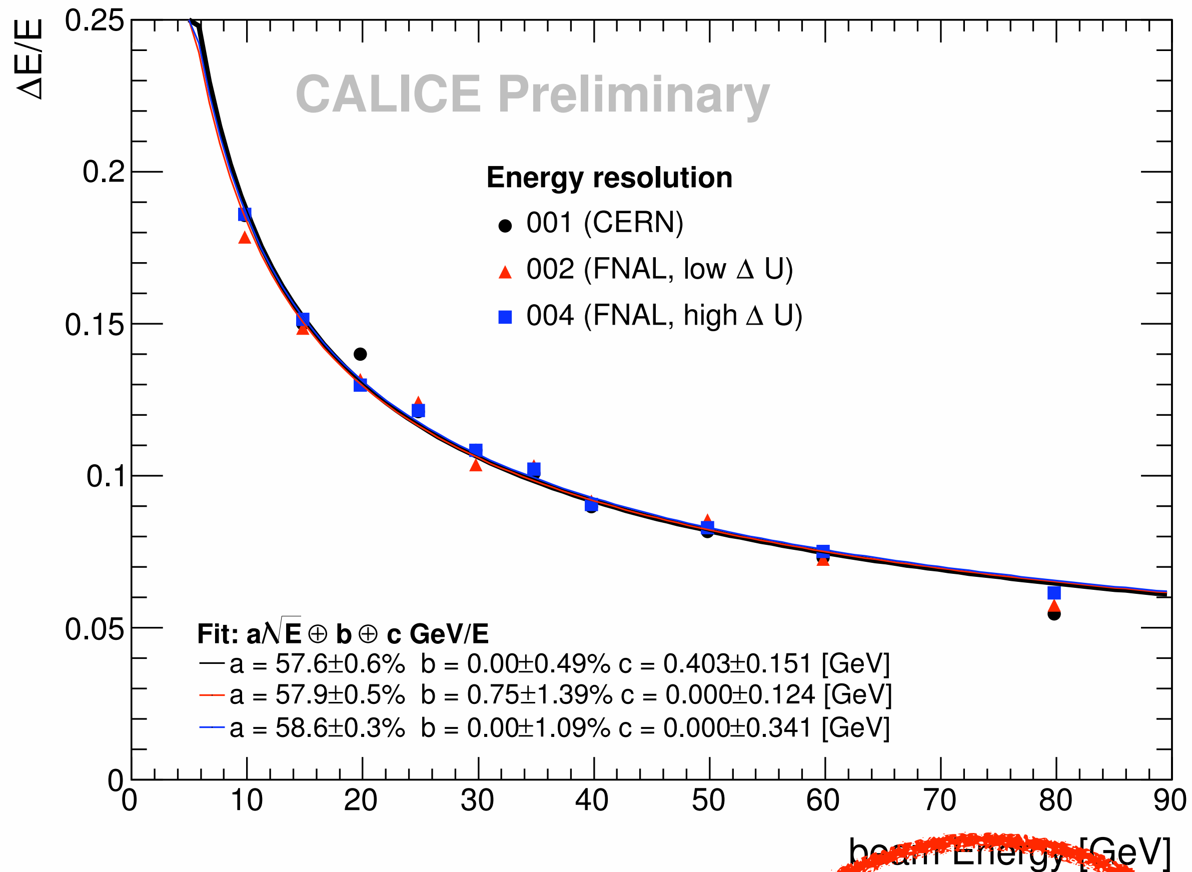

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reason: large no. of excluded cells

Conclusion

- Transport of calibration constants to new conditions possible, but not perfect
- Layerwise created correction/calibration set using MIP tracking possible
  - can correct constant shift in energy
    - improves linearity
    - better constant term in resolution than original IDAG
  - limited by correct langau fit
    - need to improve angle correction for MIP tracks
    - still need to understand what happend at FNAL 1 (002)

Langau angular dependence

- simulation of 5 mio μ
- angular spread
- start: center of AHCal
- expected: $1/\cos\theta$
- observed: $1.1/\cos\theta$
- not yet implemented! TODO