

Electrons in the AHCAL

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A First Look at FNAL 2009

Frank Simon, Philipp Klenze
MPI for Physics & Excellence Cluster 'Universe'
Munich, Germany

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Max-Planck-Institut für Physik
(Werner-Heisenberg-Institut)



Overview

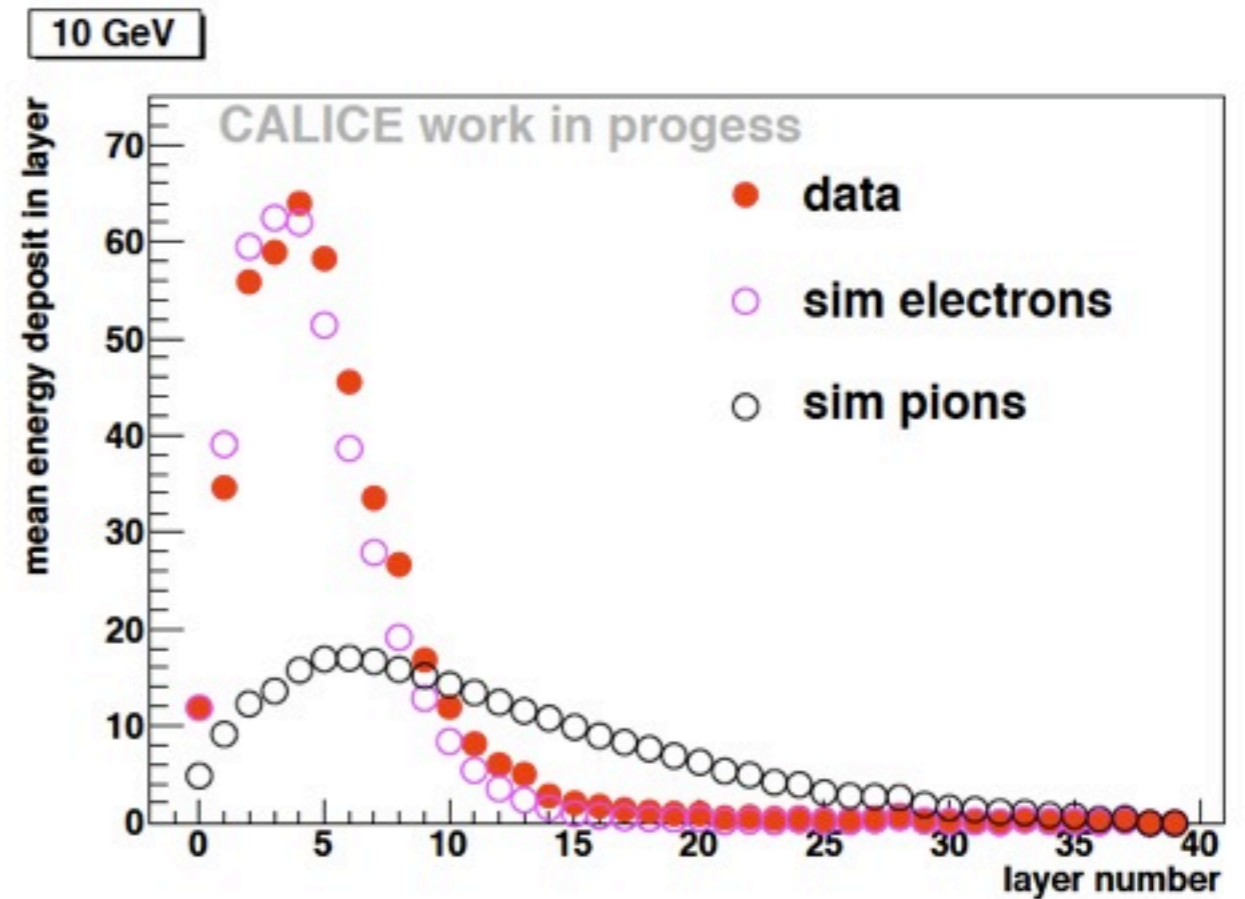
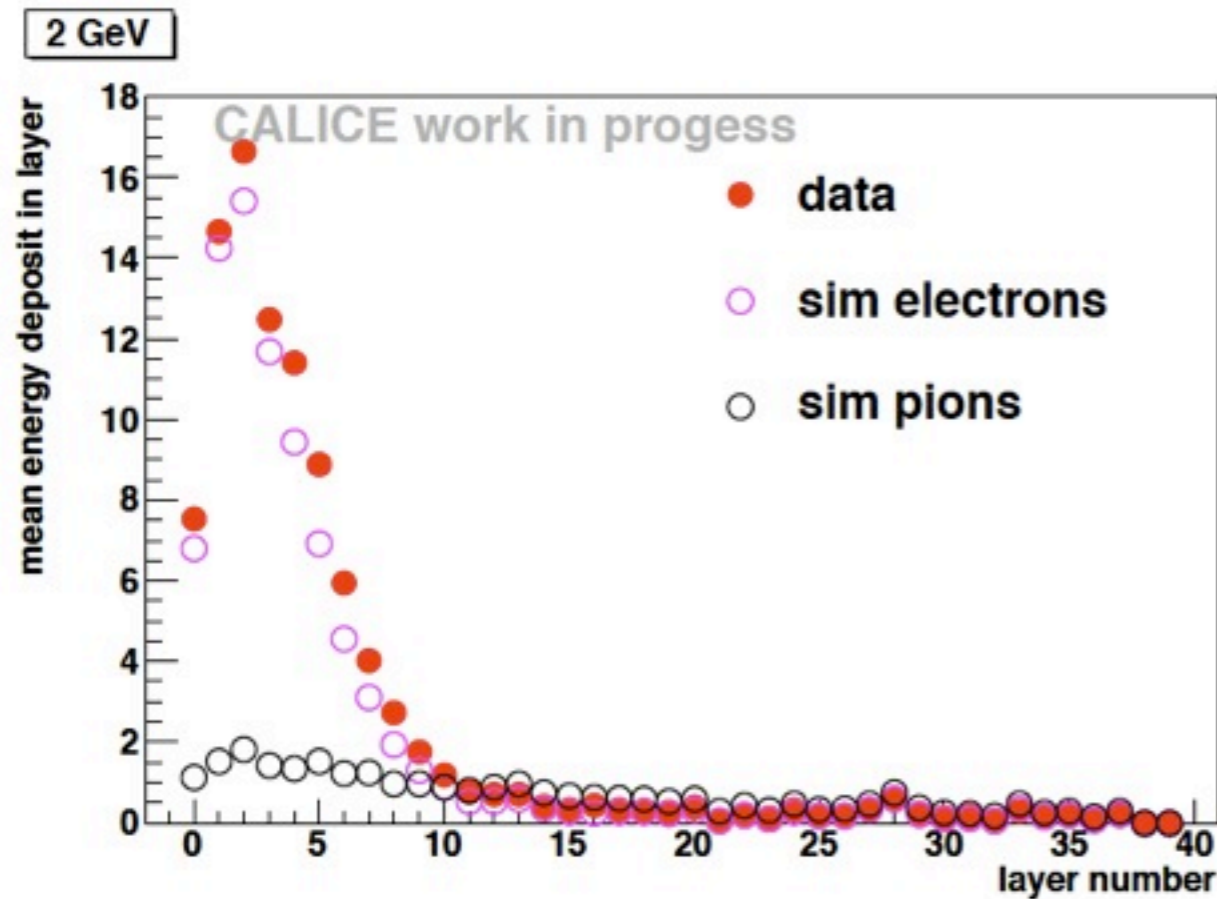
- Motivation and Analysis Technique
- First Results
 - Shower Profiles
 - Noise Issues
 - Linearity and Resolution
- Summary

Motivation

- Electromagnetic probes are our best tool to study the quality of our simulations, and our detector understanding!
- FNAL 2009 Data adds points at low energy
- In this talk: FNAL data from 2 GeV to 20 GeV, in addition CERN 2007 data from 10 GeV to 50 GeV as cross-check
- Analysis cuts:
 - Cherenkov not explicitly used, was in the trigger for some runs
 - Cuts on the TCMT to reject muons
 - some clearly noisy cells excluded (both in data and simulations)
- Disclaimer: No in-depth study of cuts yet, still at the beginning...

Shower Profiles

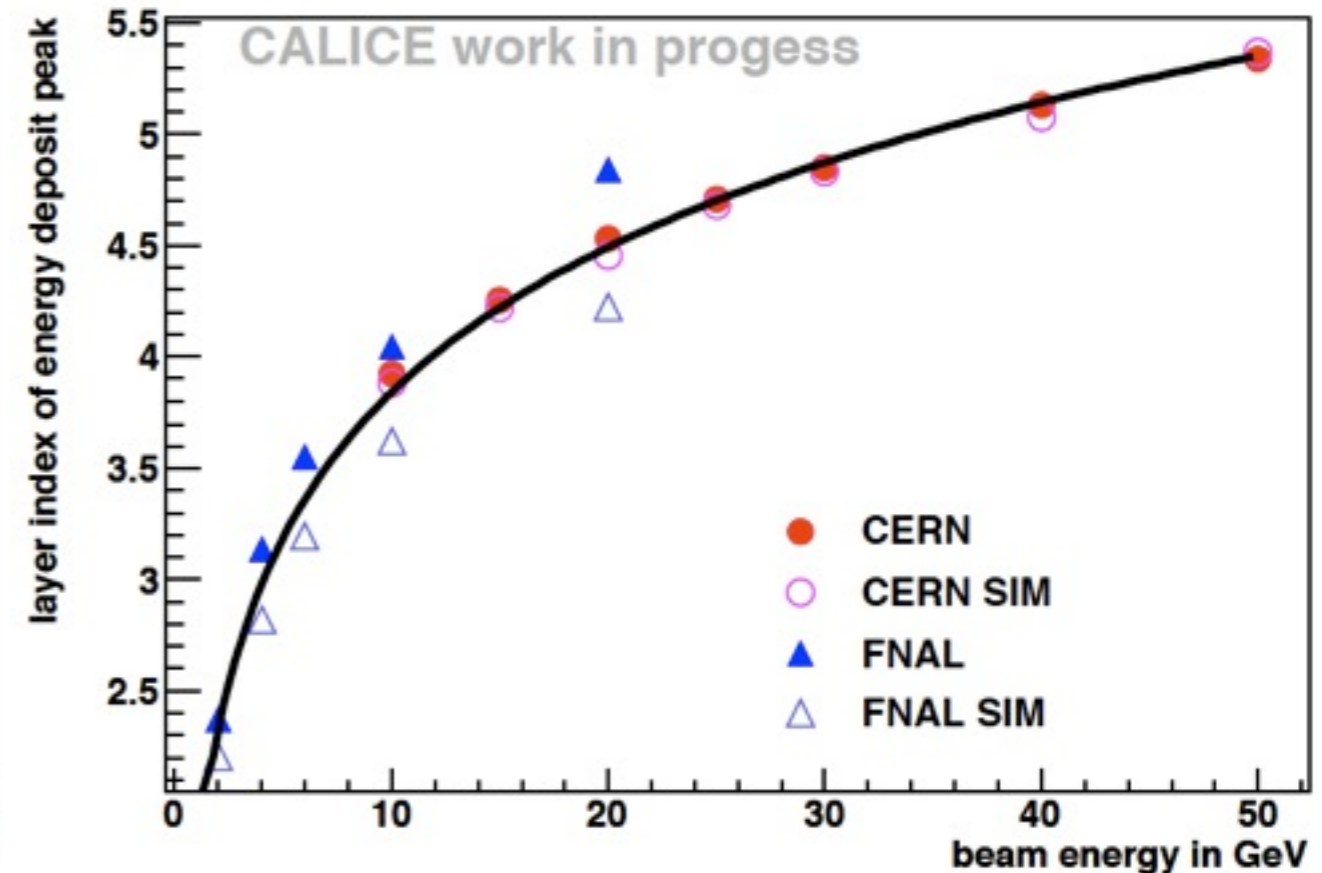
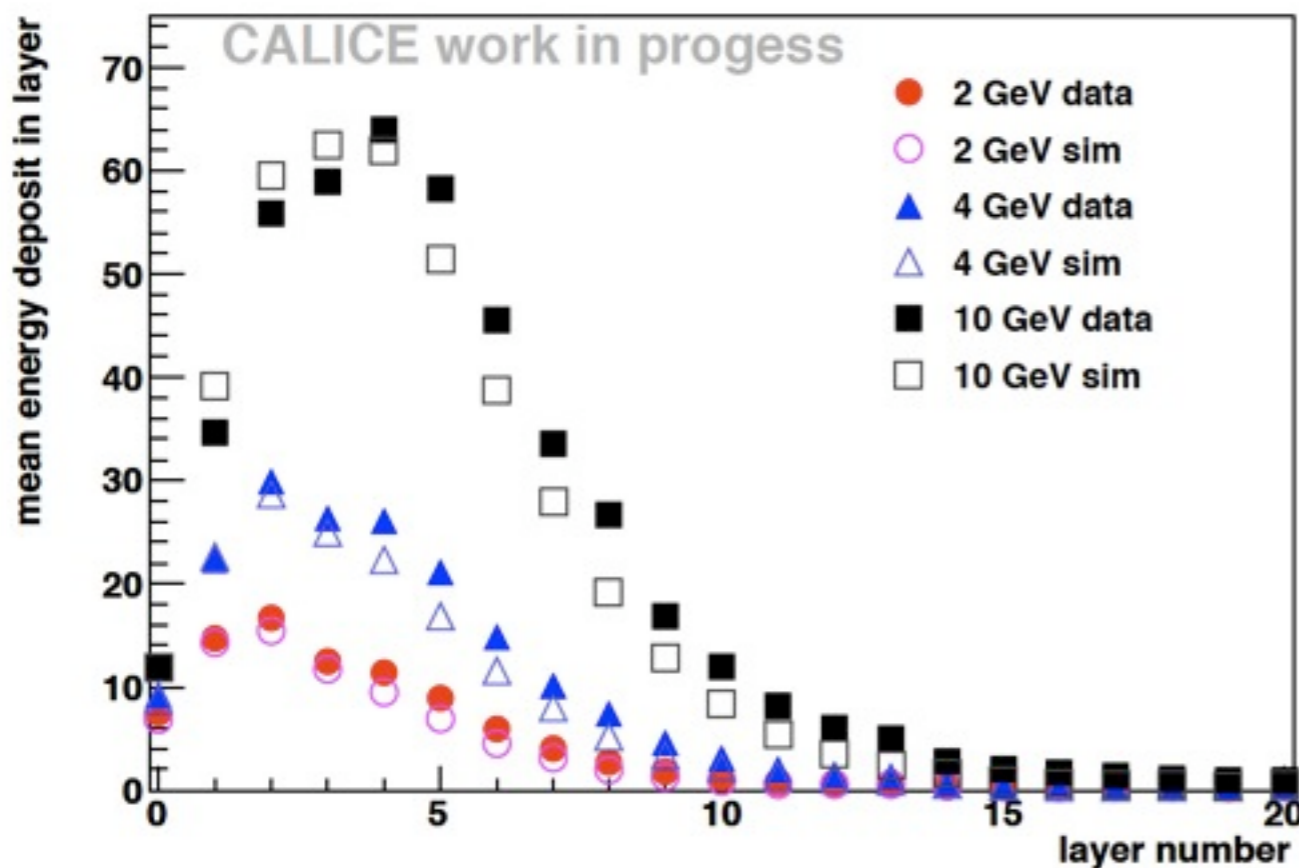
- Longitudinal profile, compared to simulated electrons and pions



- Pion contribution estimated to be small (as expected)
- Some discrepancy in the details of the profiles, but overall not so bad agreement: After all, this is a very first try!

Shower Profile and Shower Maximum

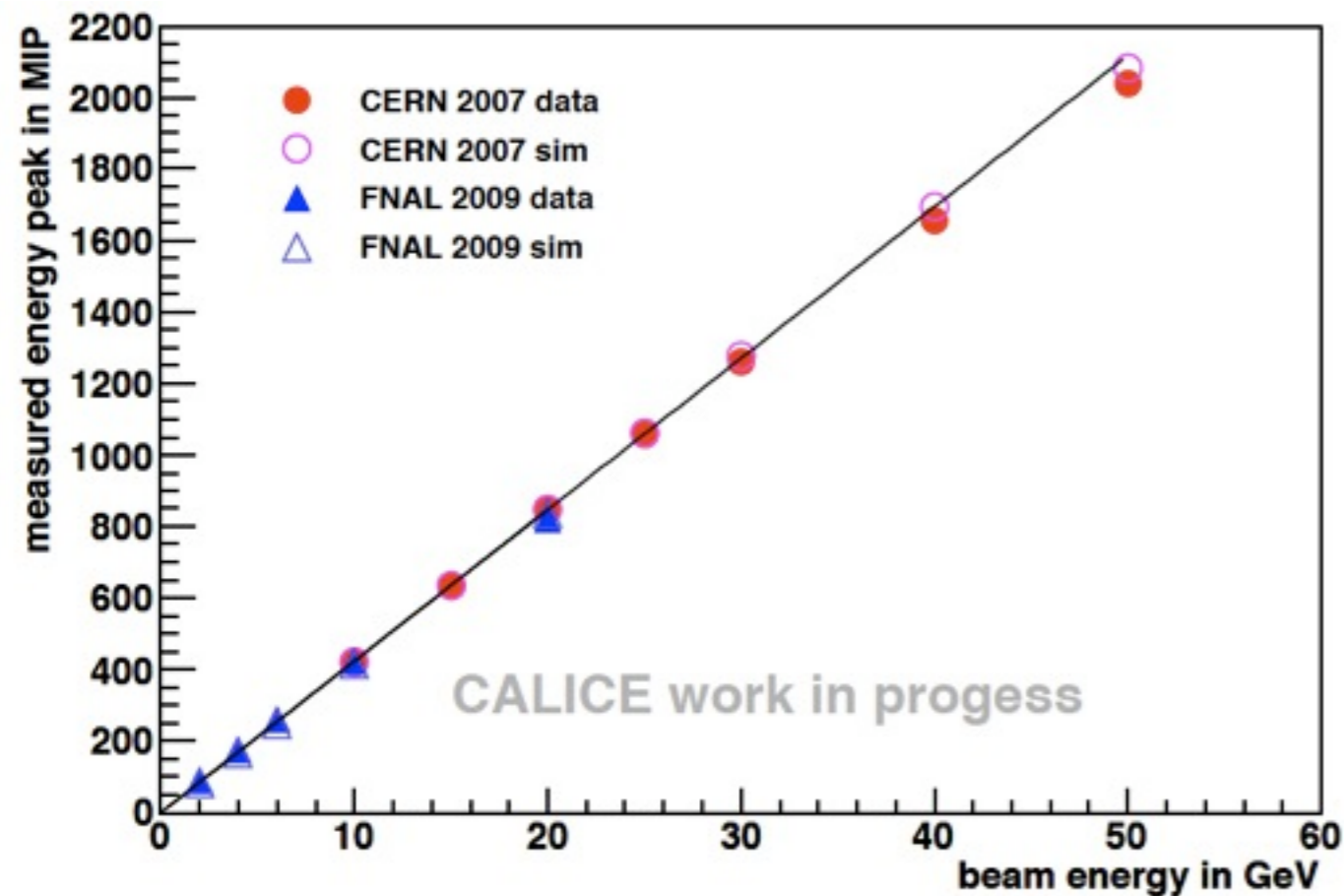
- Shower maximum extracted from a Gaussian fit around the peak of the longitudinal profile



- expected logarithmic behavior
- slight discrepancy between FNAL data and simulations: simulated showers seem to peak and fall off earlier than those in data

Linearity: First Shot

- Reconstructed energy: Complete energy in the HCAL



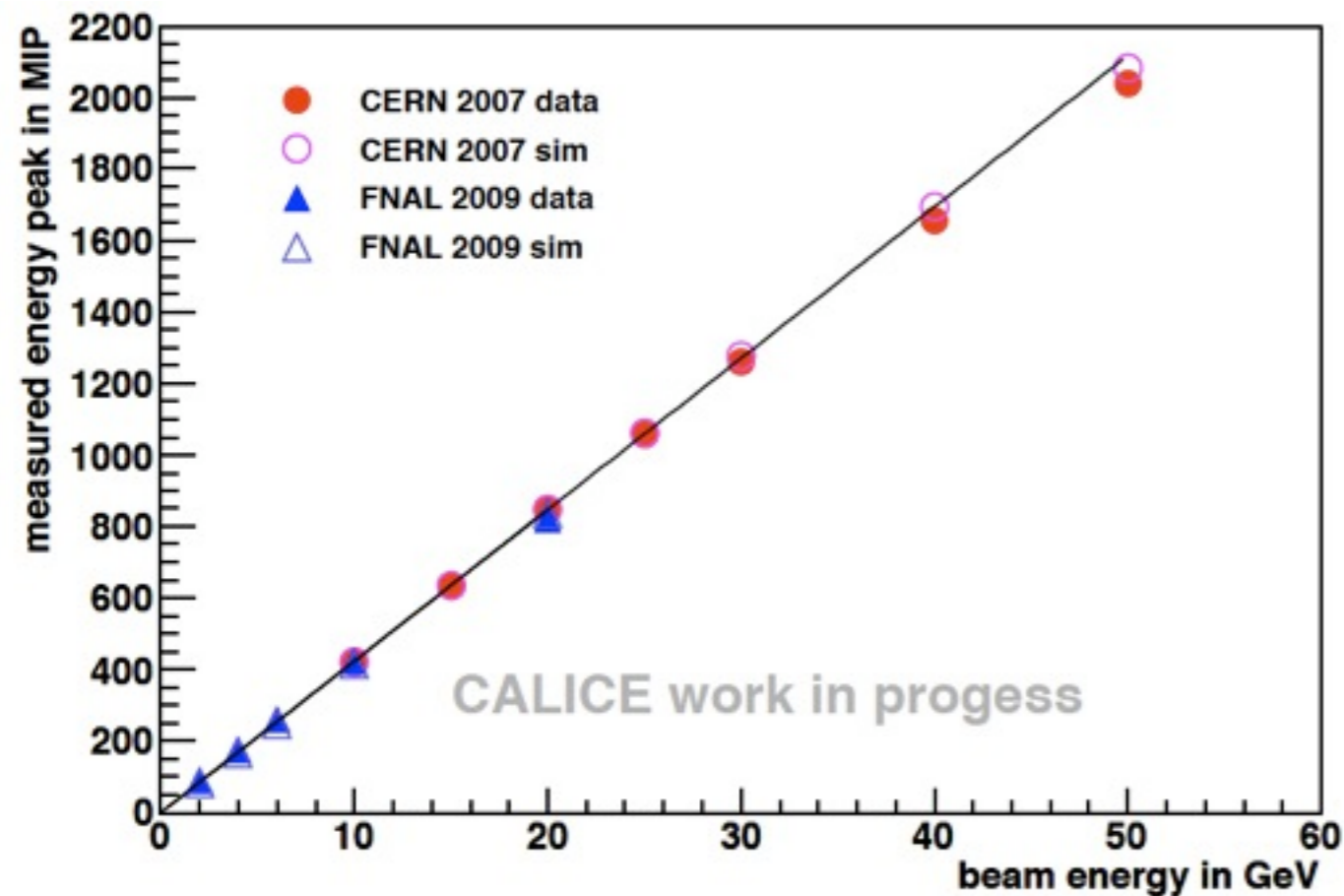
Fit: Straight line through all data points

up to 20 GeV, no offset at 0

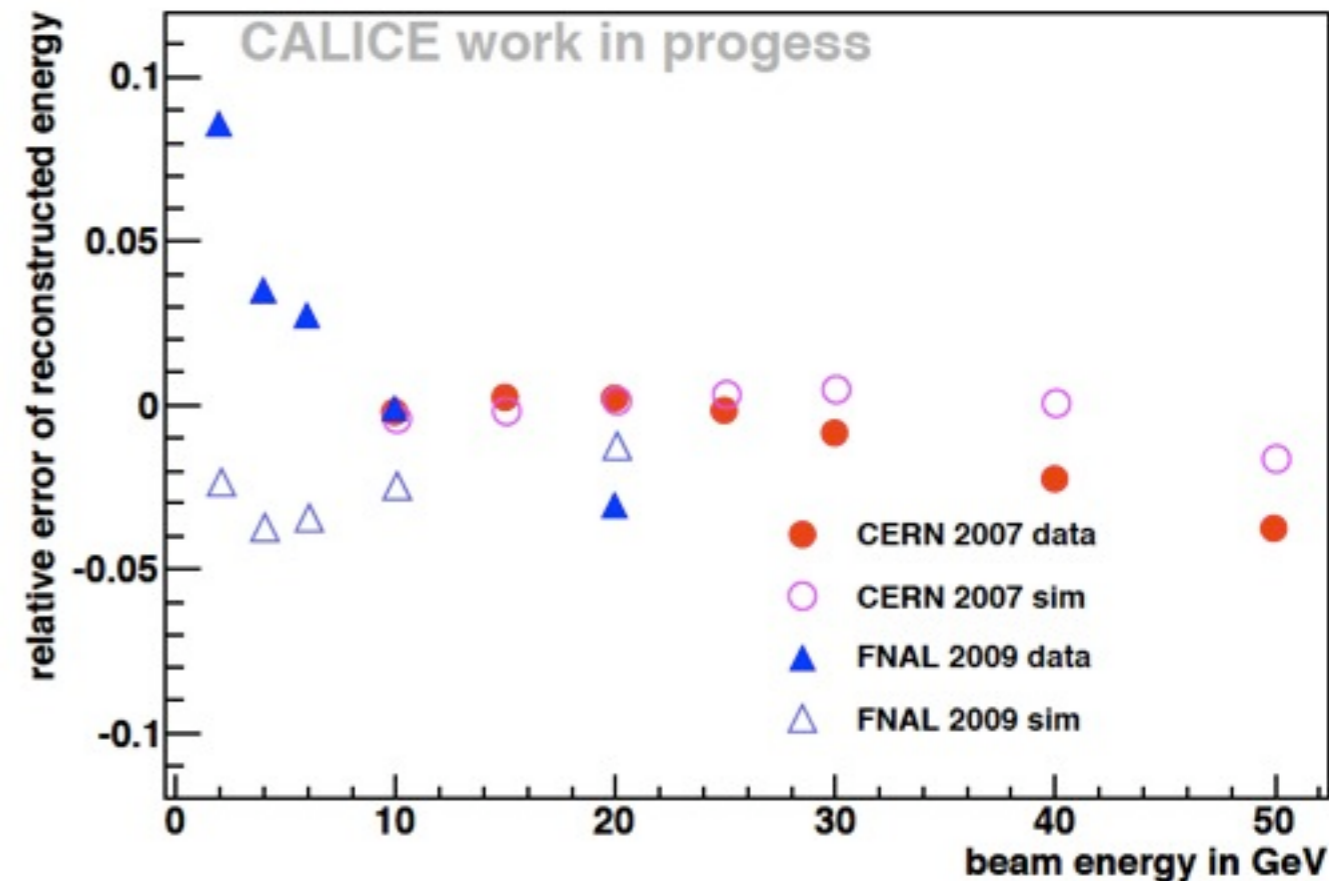
Slope: 42.3 MIP/GeV

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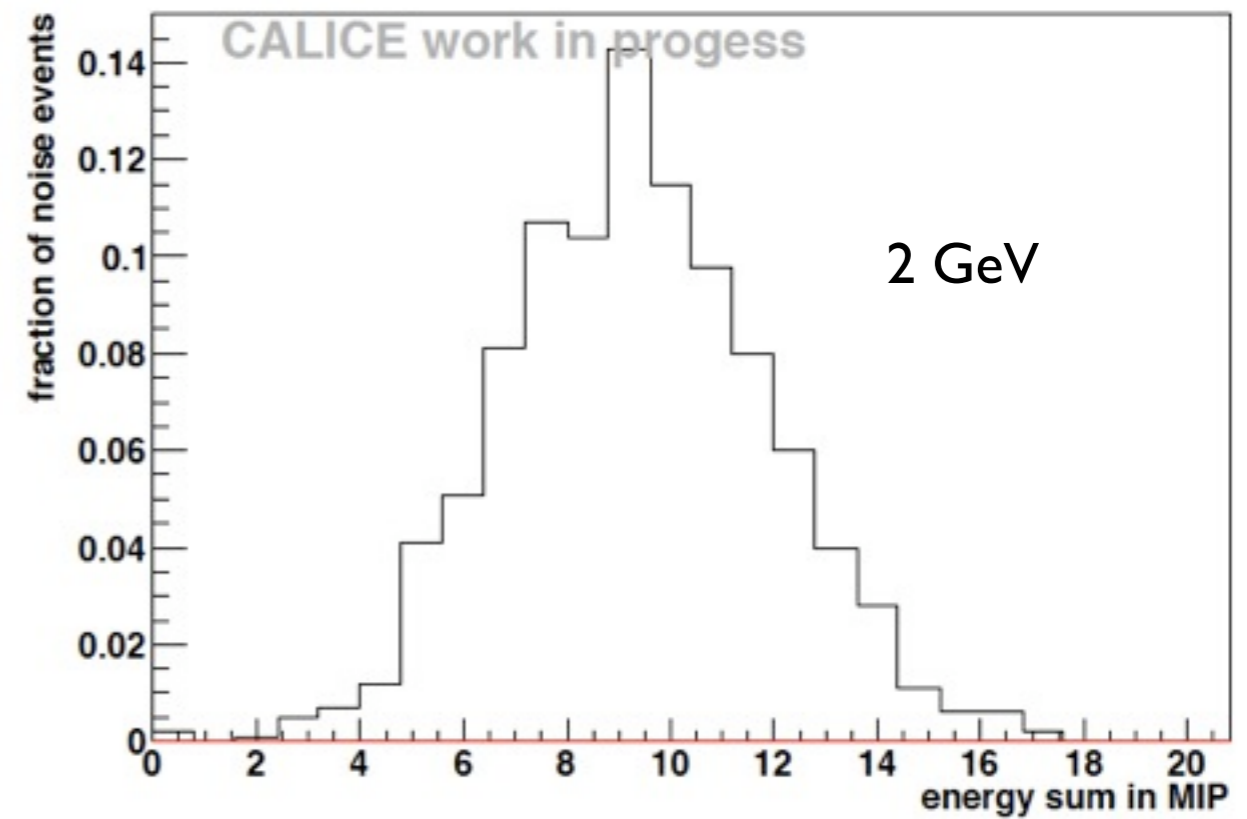
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- High energy shows expected saturation
- Problems at low energy: Reconstructed energy in data is too high

Noise in Electron Runs

- Measured from random trigger events
 - ~ 9 MIP mean noise contribution, corresponds to 200 MeV

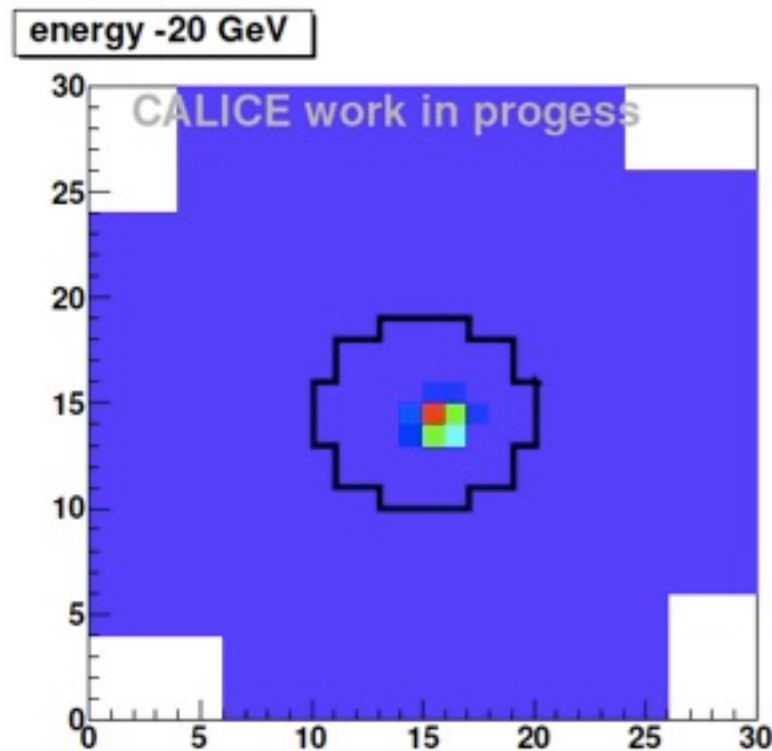


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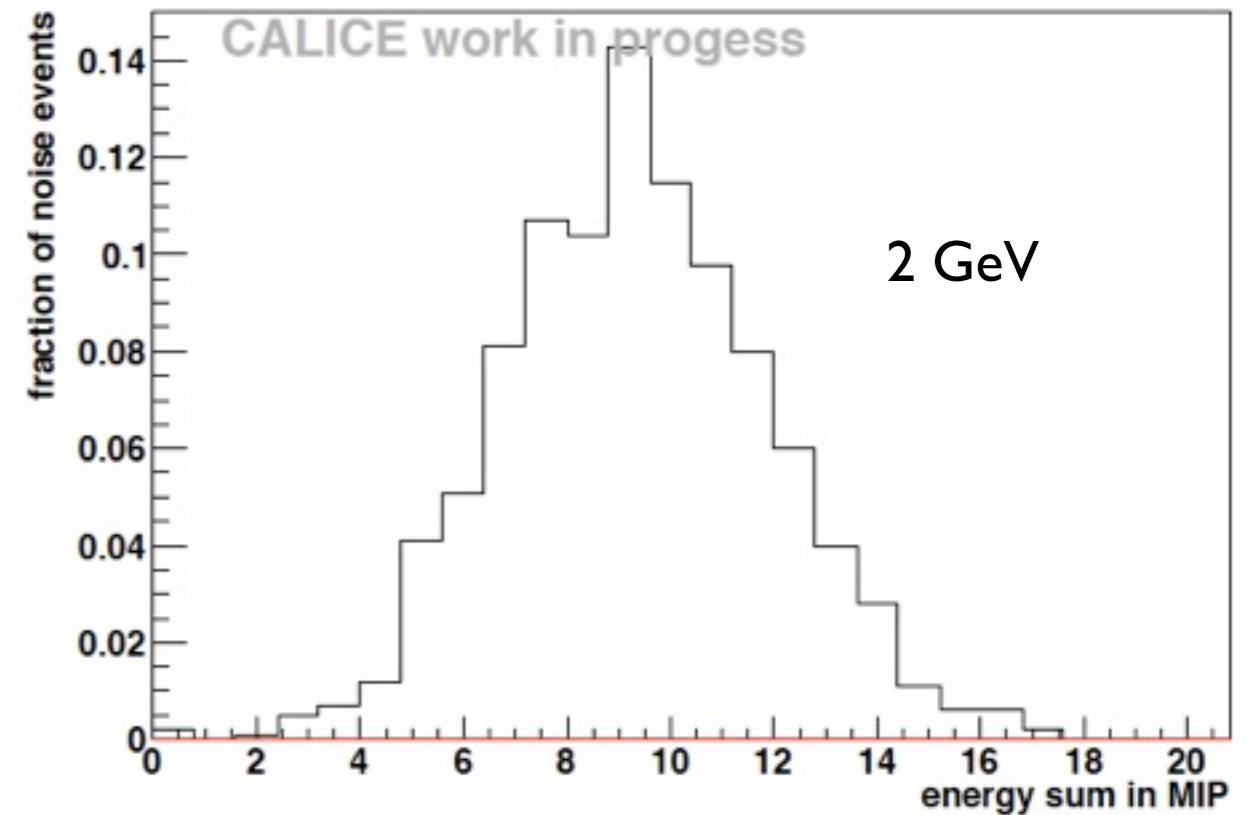
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Reducing noise:

- ▶ Introduce a smaller fiducial volume (em-showers are compact!)
- ▶ Use only first 19 layers, reduced lateral integration volume



New integration volume:
1400 cells
(20% of full detector)

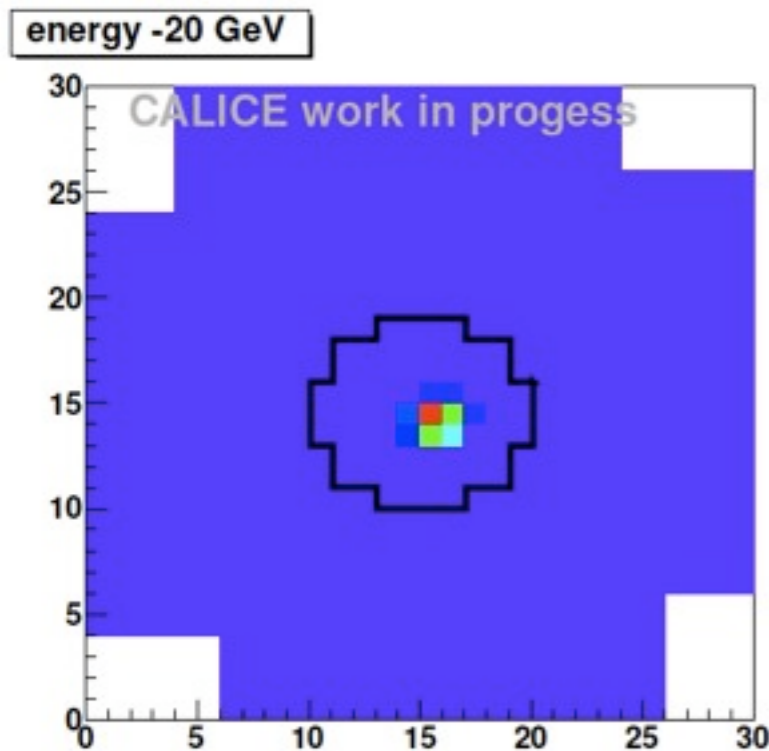


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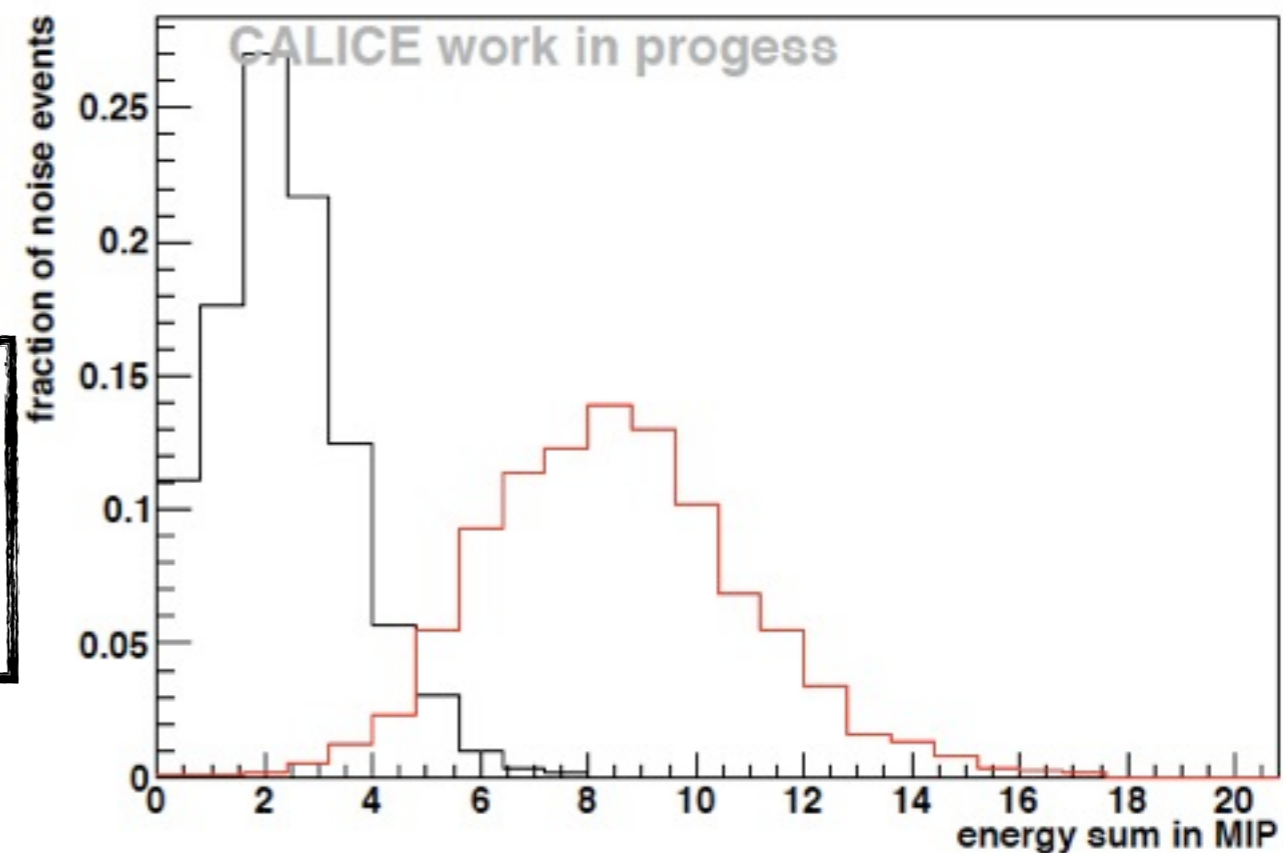
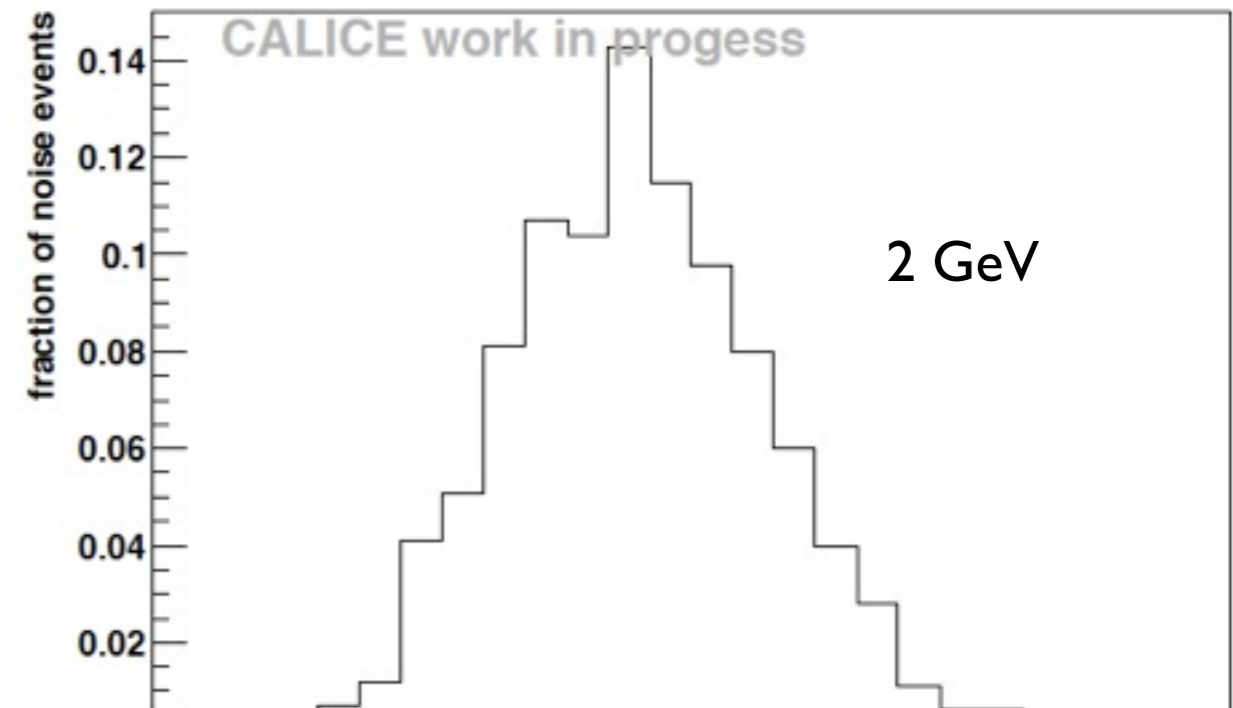
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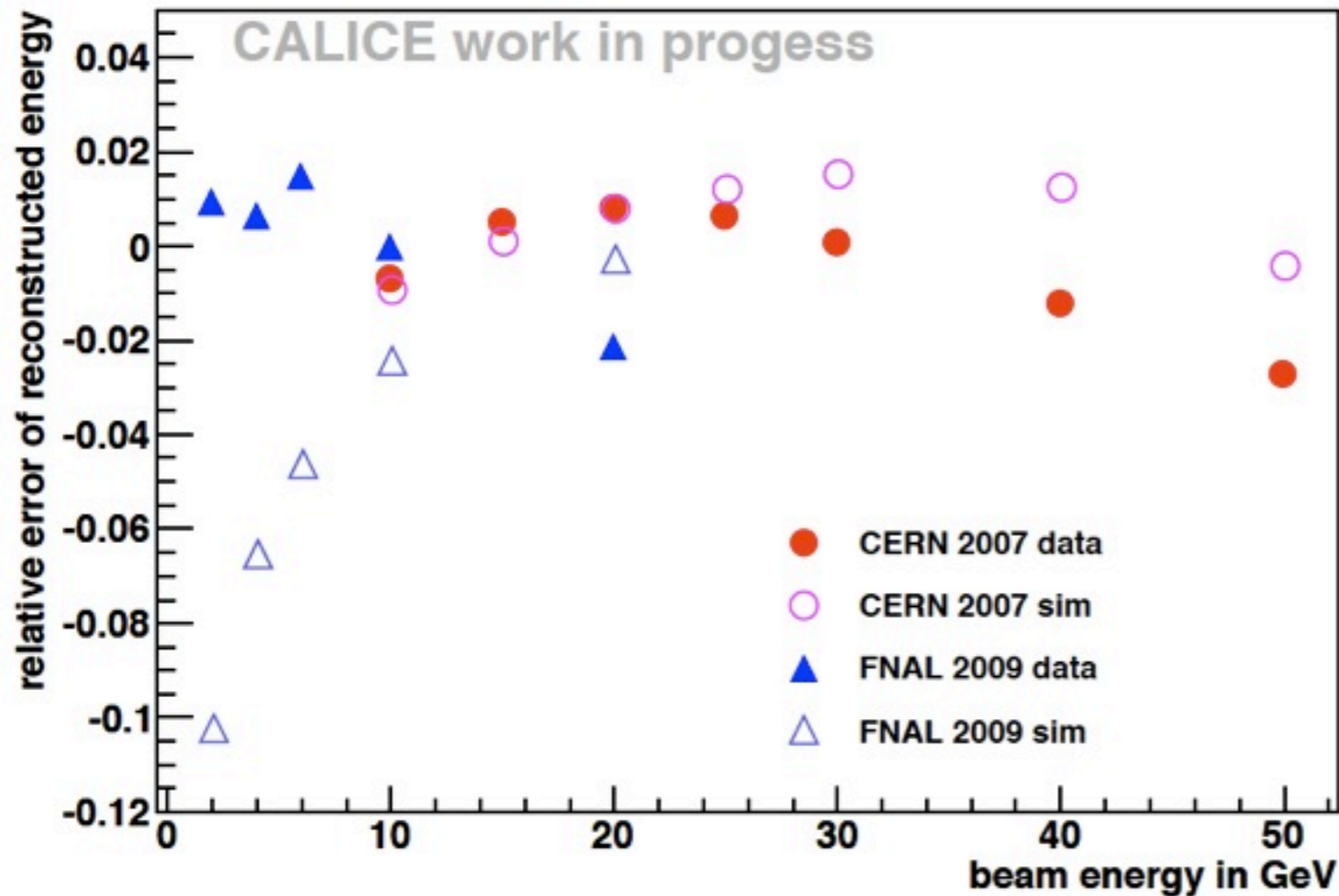


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Linearity with Noise Reduction

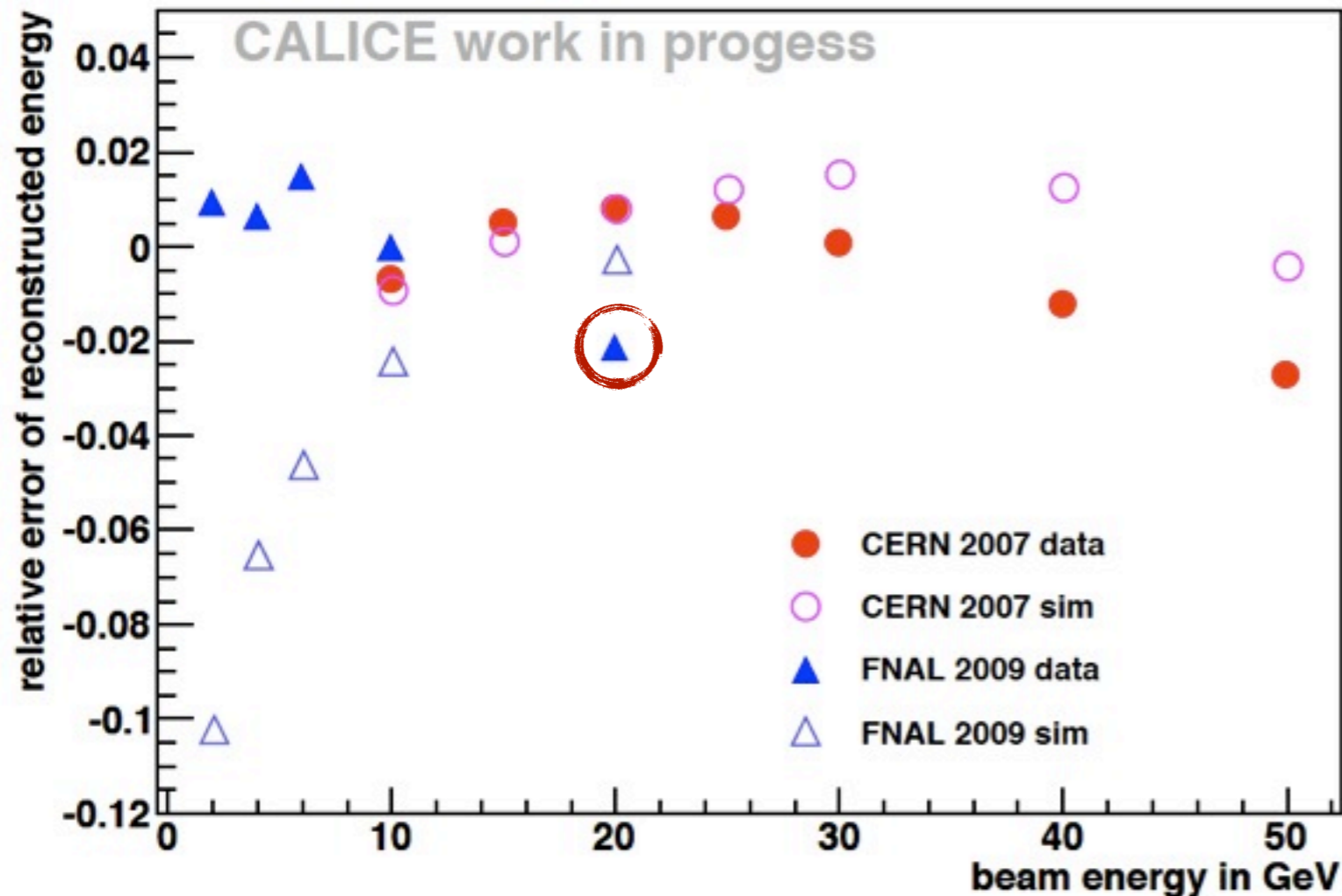
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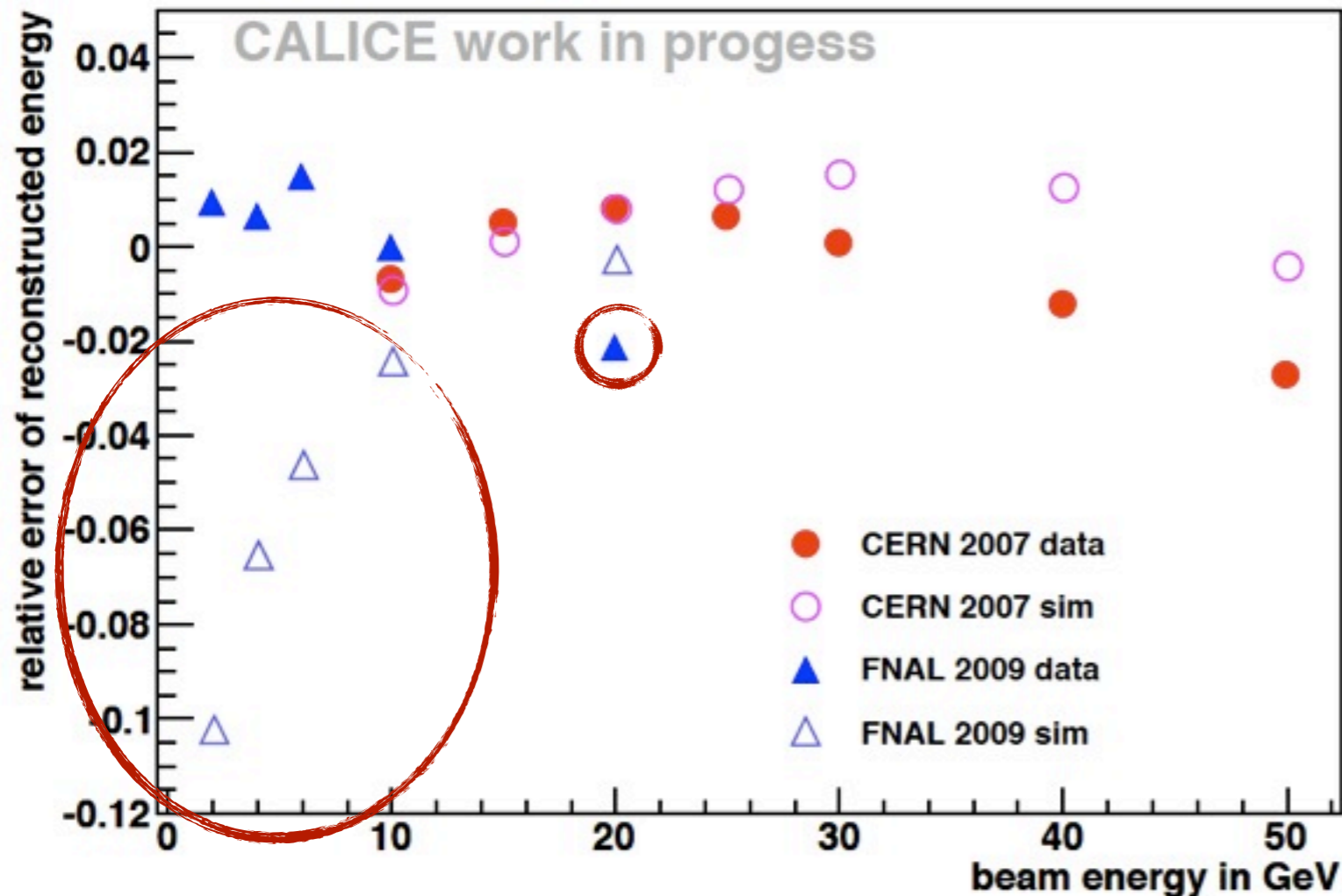
But:

downward trend at higher energies in FNAL:

could be a calibration issue - need a different MIP- \rightarrow GeV factor?

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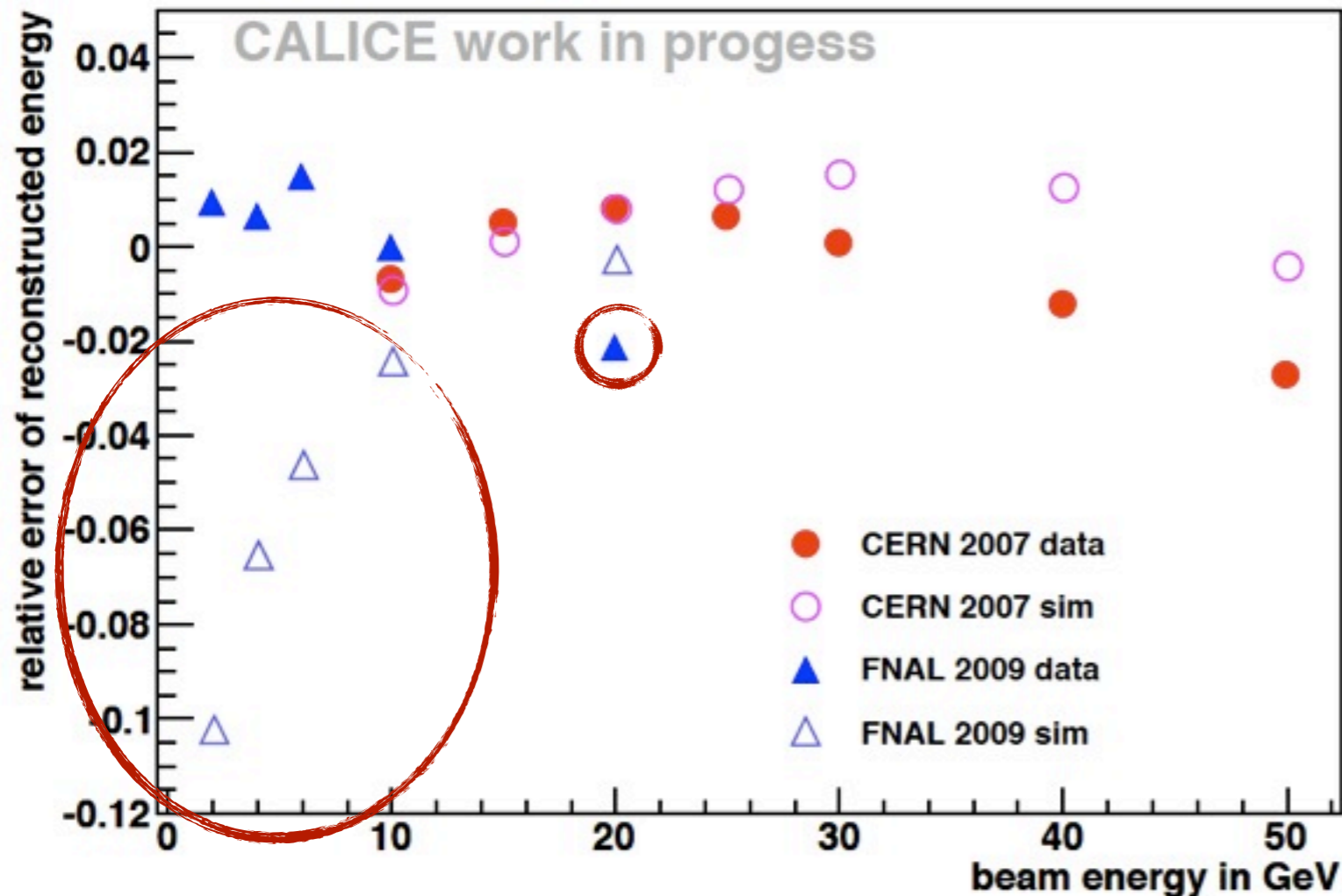
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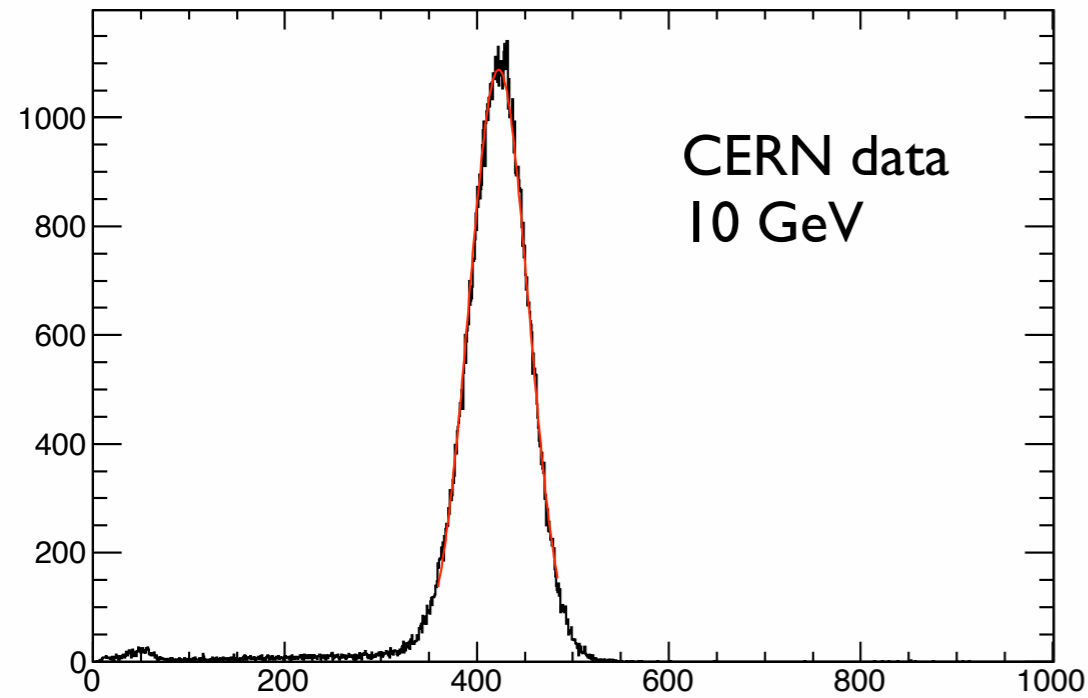
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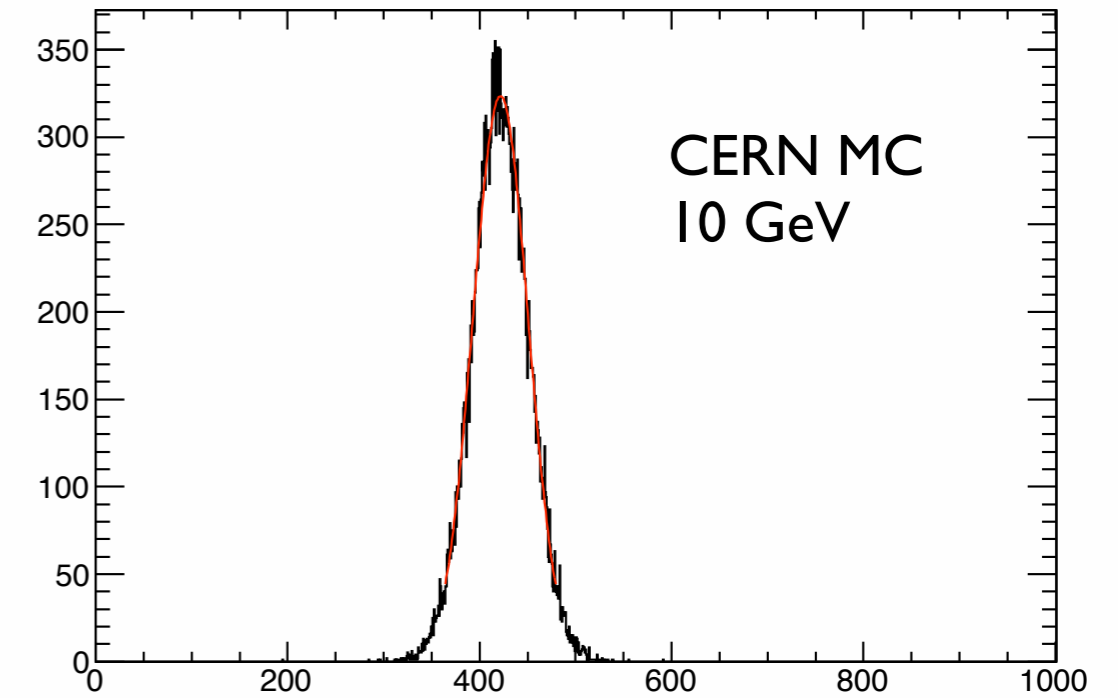
- Simulation clearly still needs a lot of work
 - Understanding the geometry? Link to discrepancy in shower maximum and profiles? MC showers seem to start a bit earlier than seen in the data...

Data and MC: Looking at Distributions

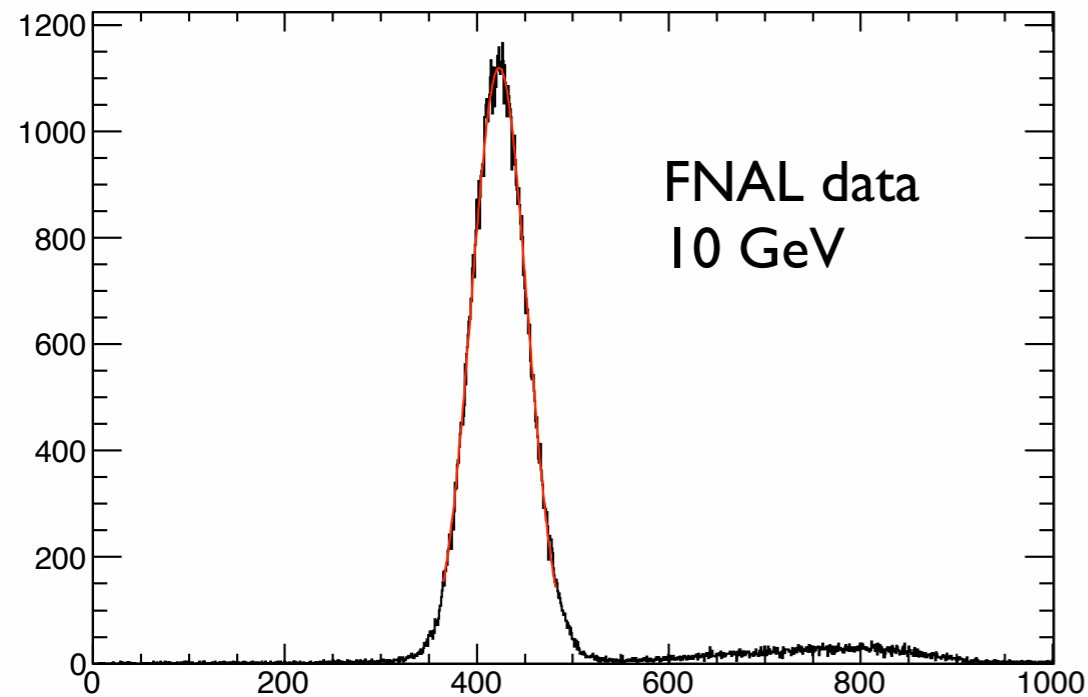
AHCLayerHistograms_MuonCut/energy_sum6_+10d



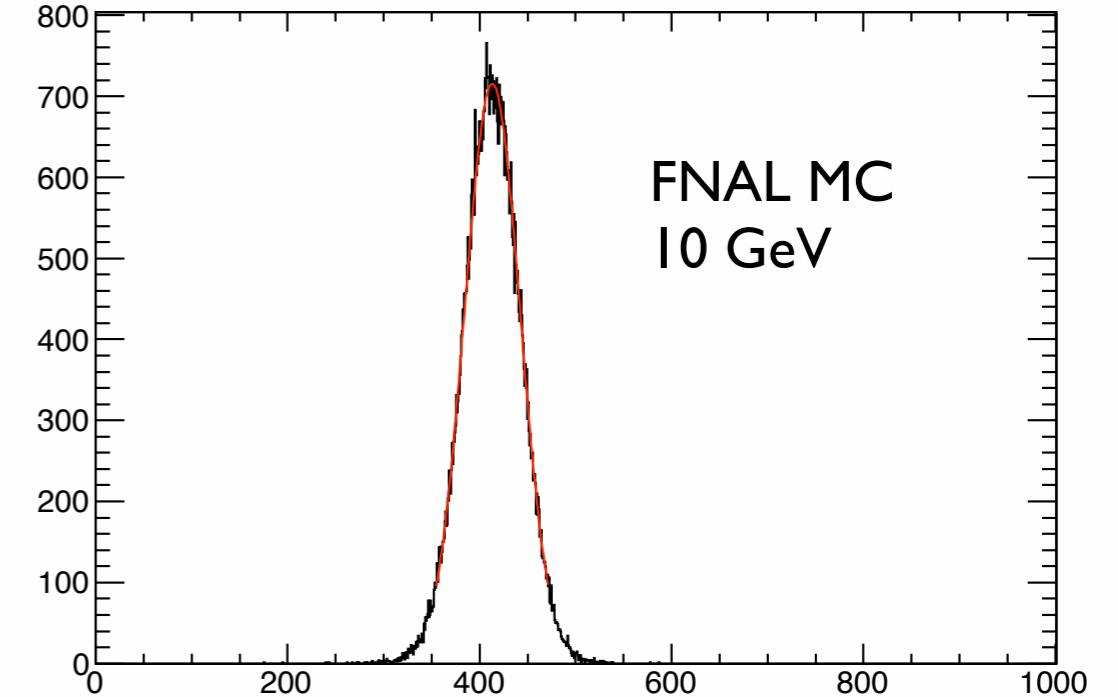
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AHCLayerHistograms_MuonCut/energy_sum1_-10d

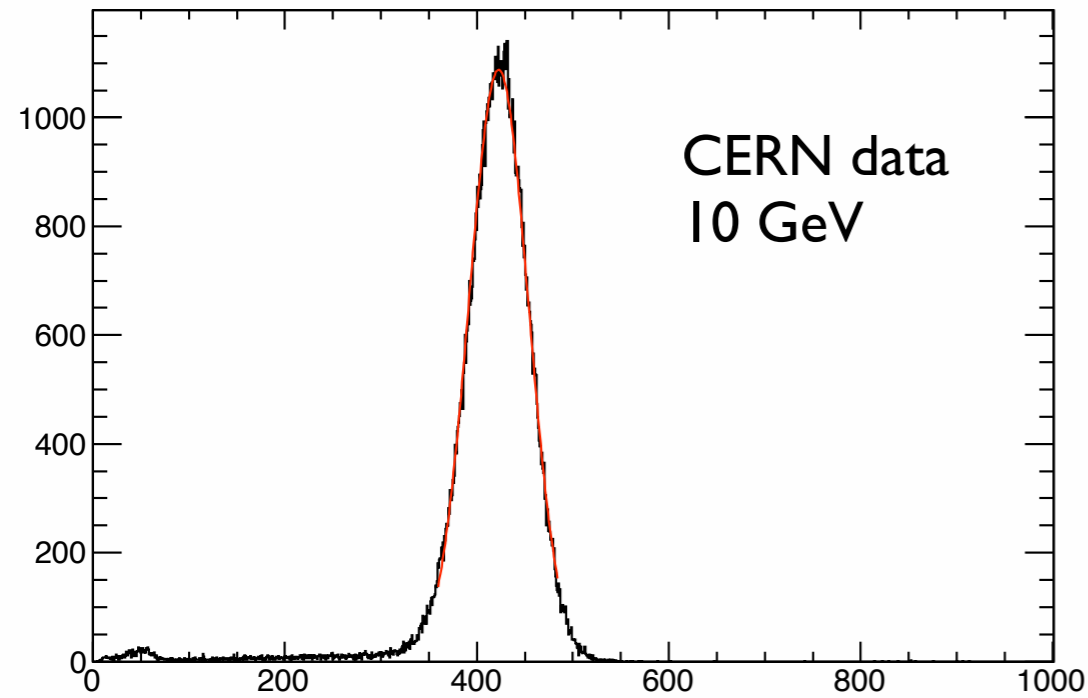


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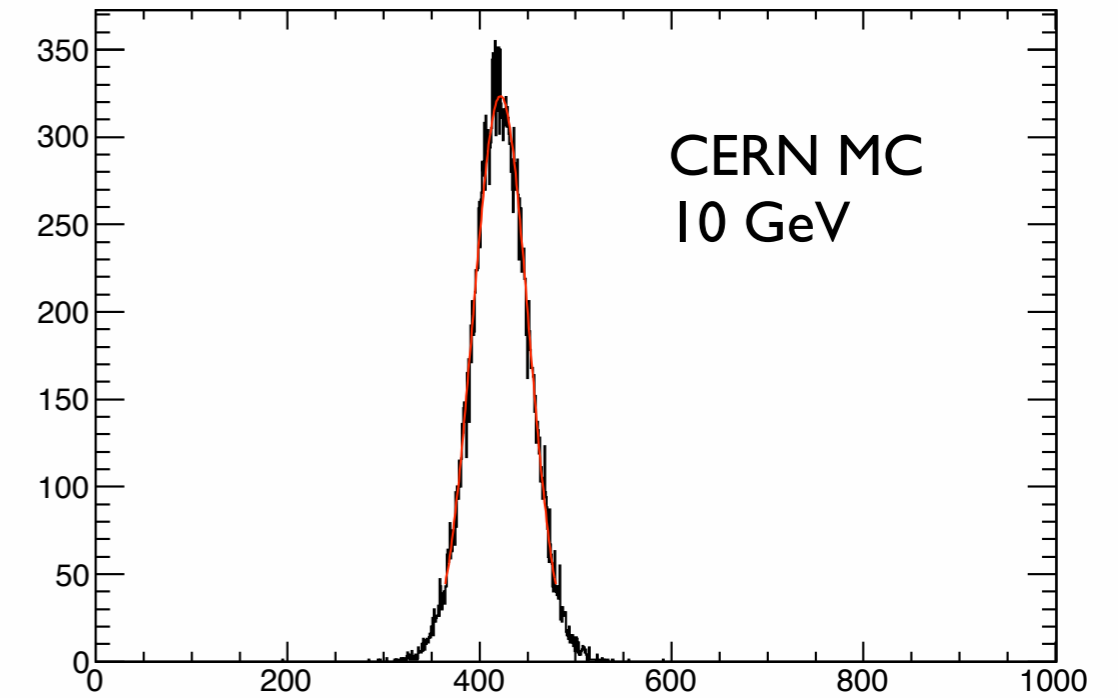


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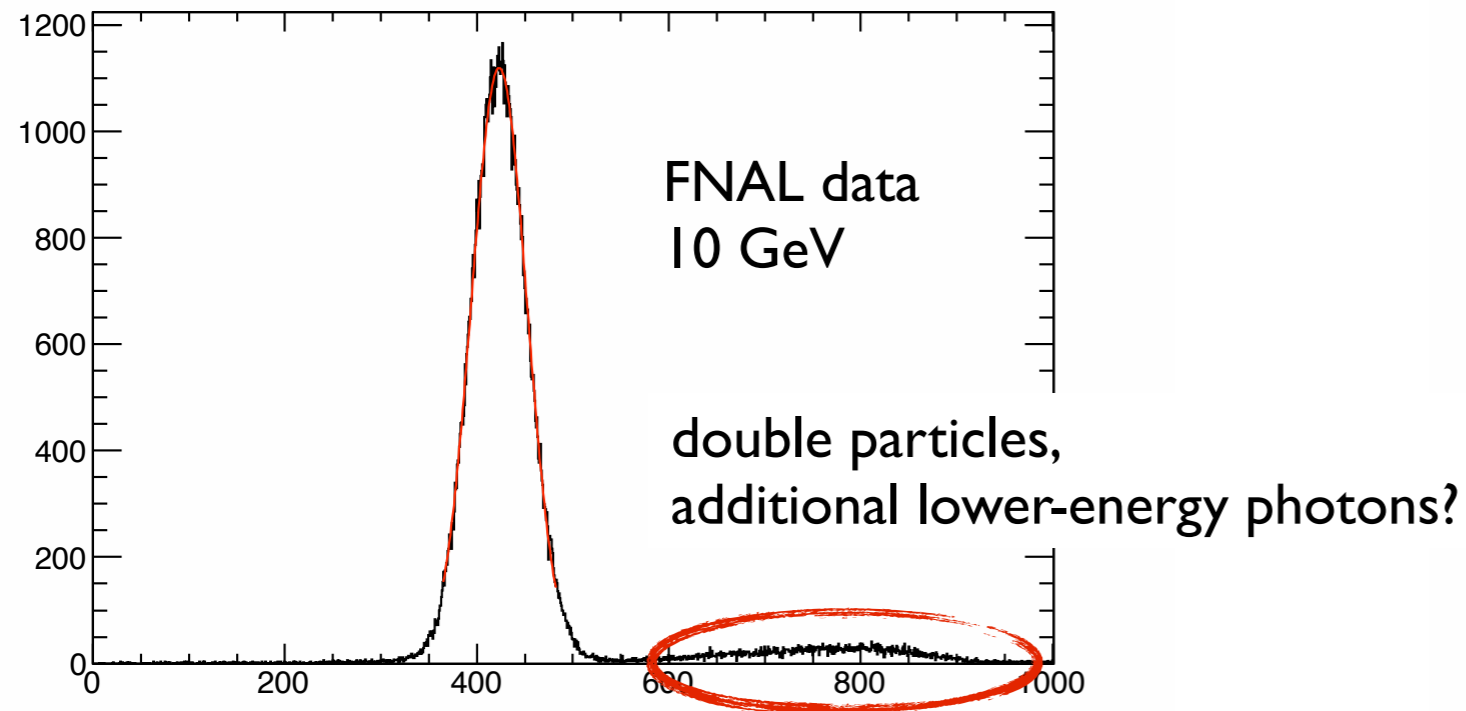
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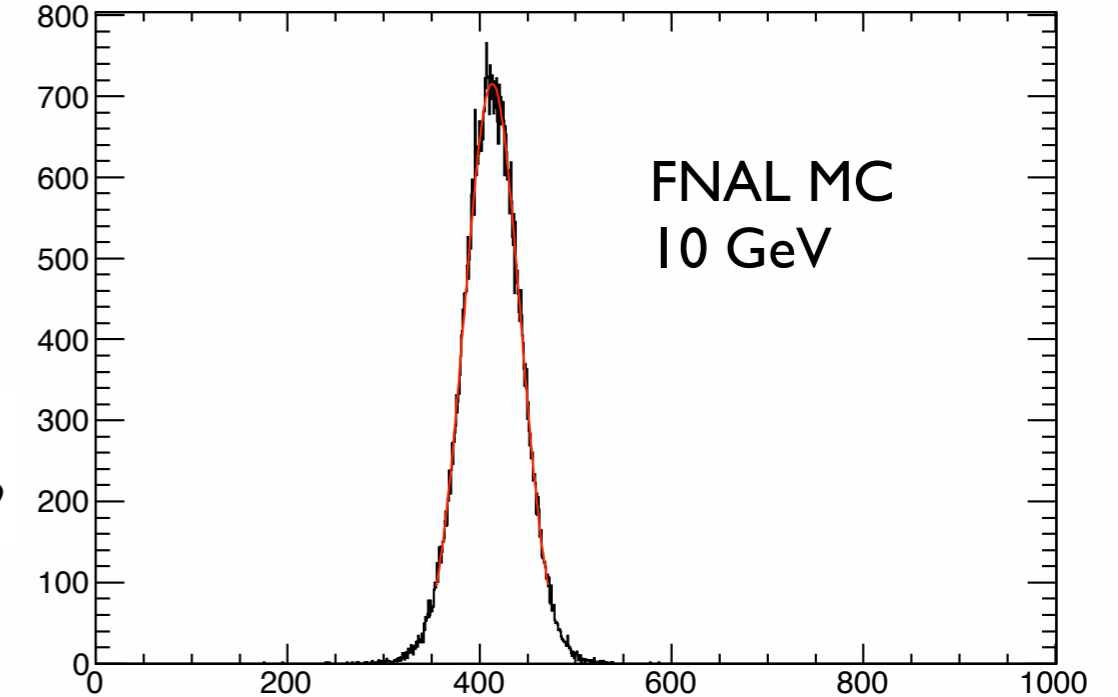
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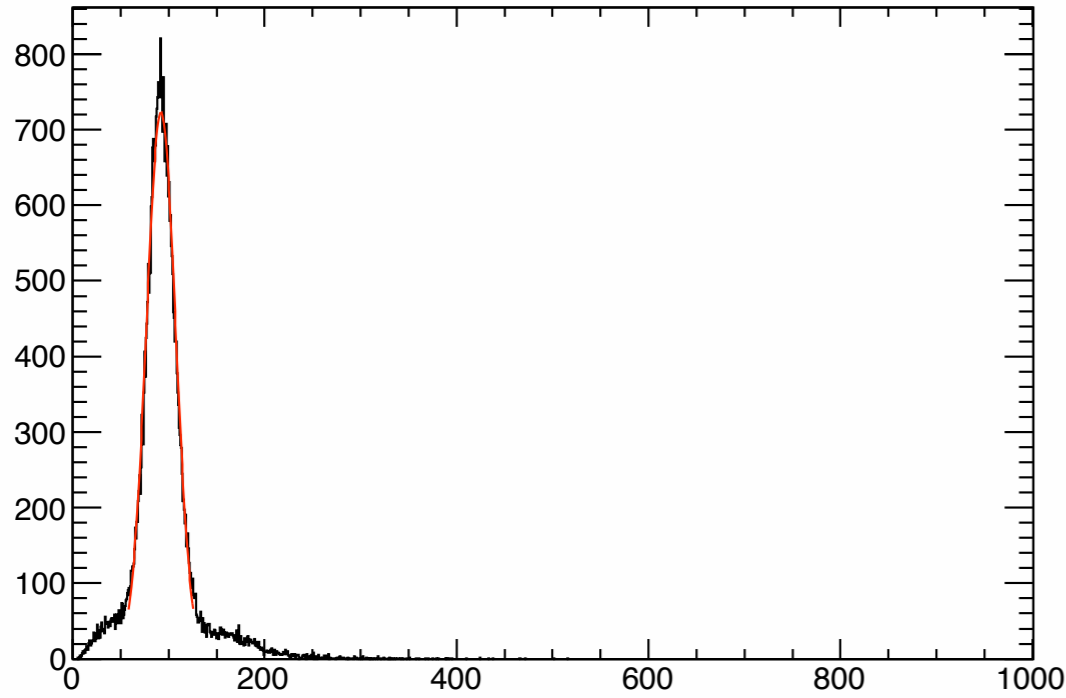


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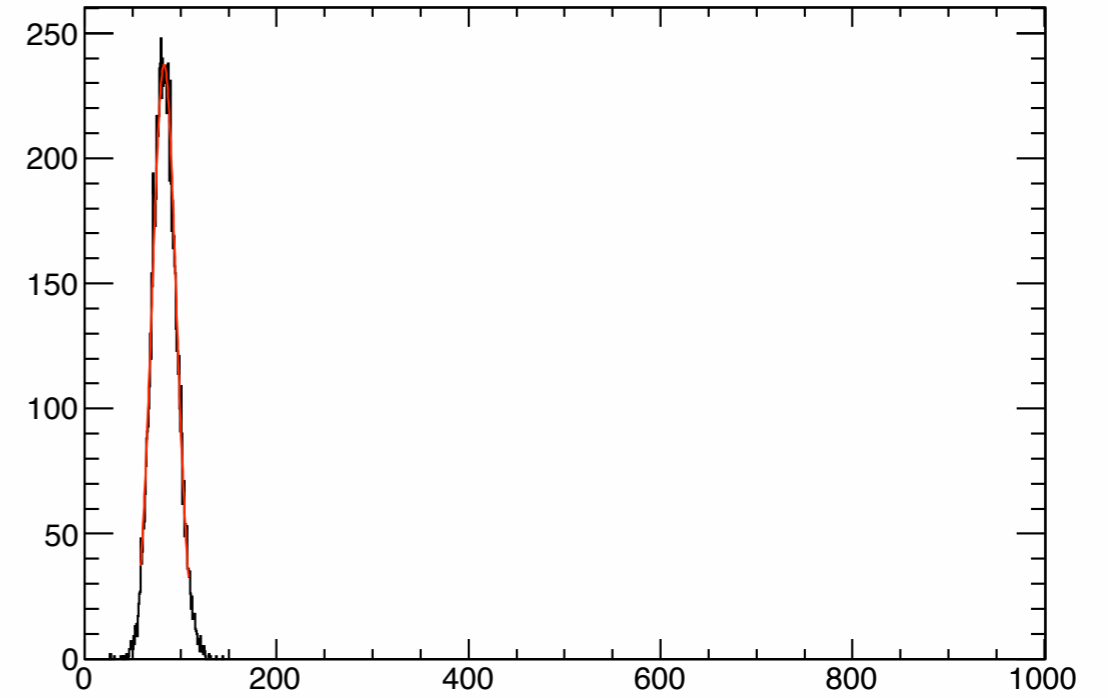


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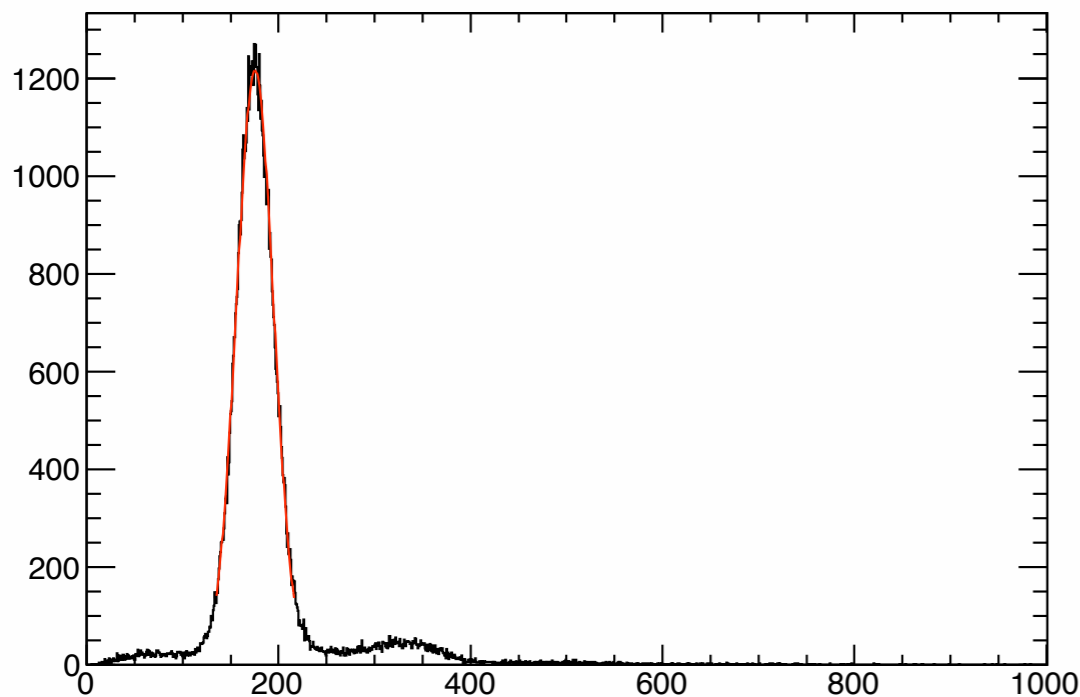
AHCLayerHistograms_MuonCut/energy_sum4_-02d



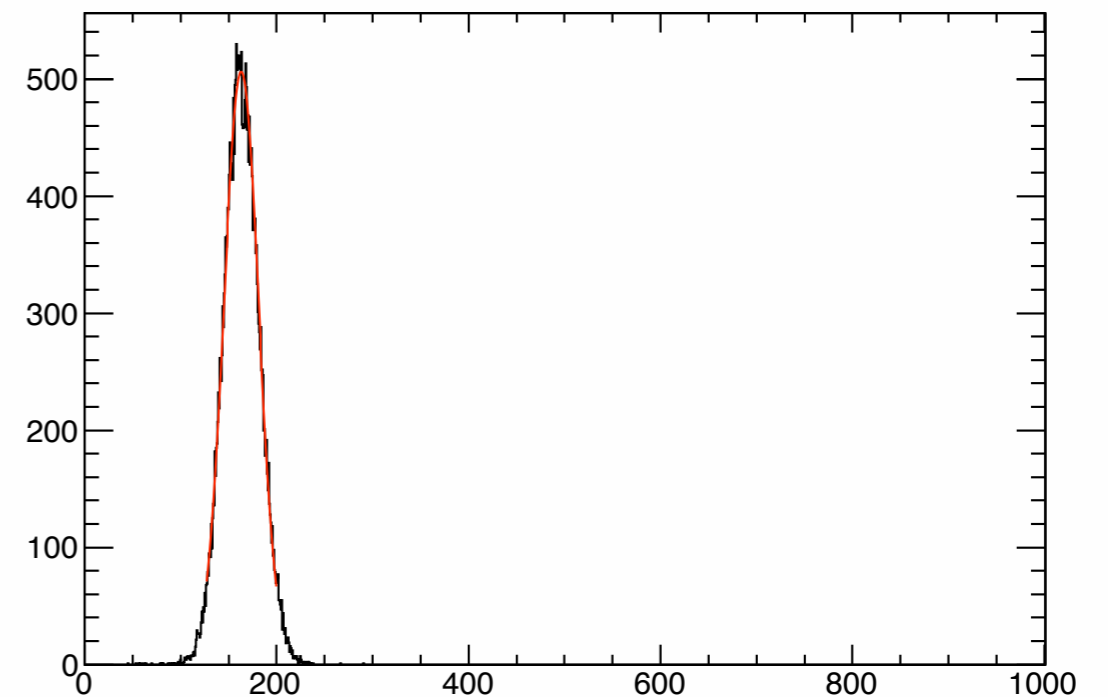
AHCLayerHistograms_MuonCut/energy_sum4_-02s



AHCLayerHistograms_MuonCut/energy_sum3_-04d

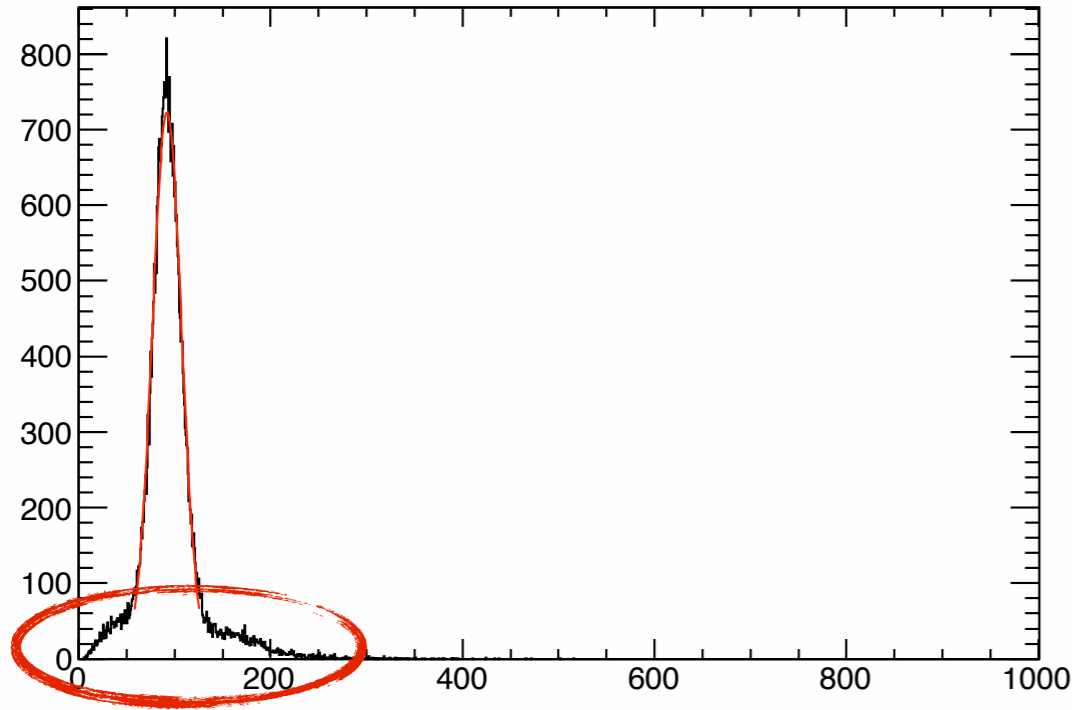


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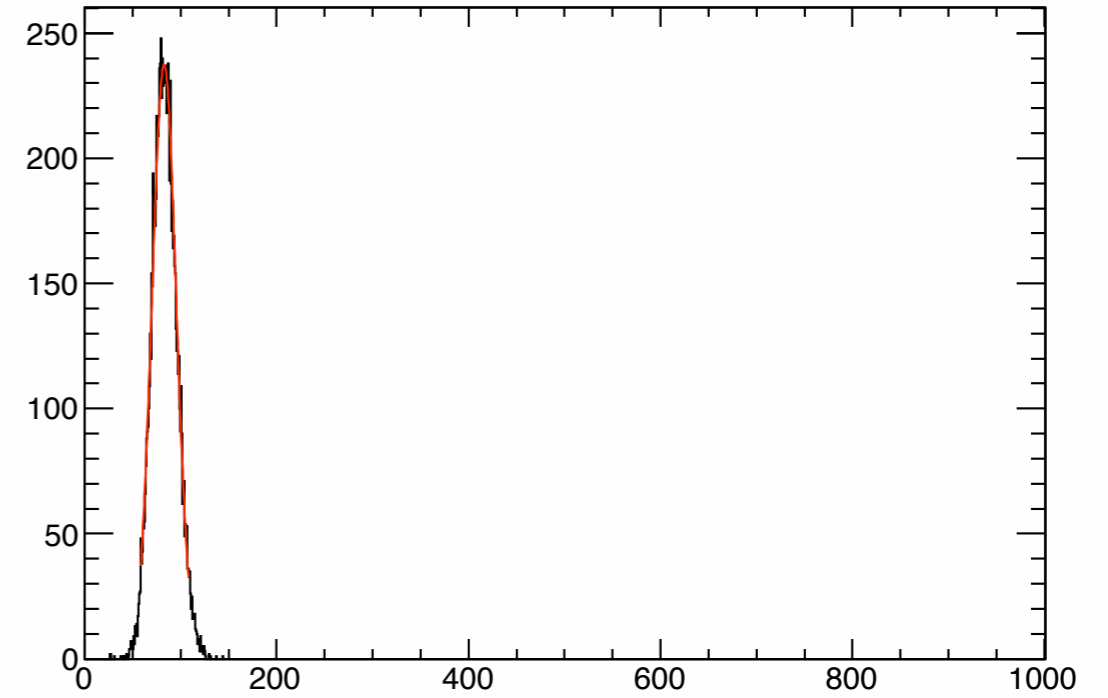


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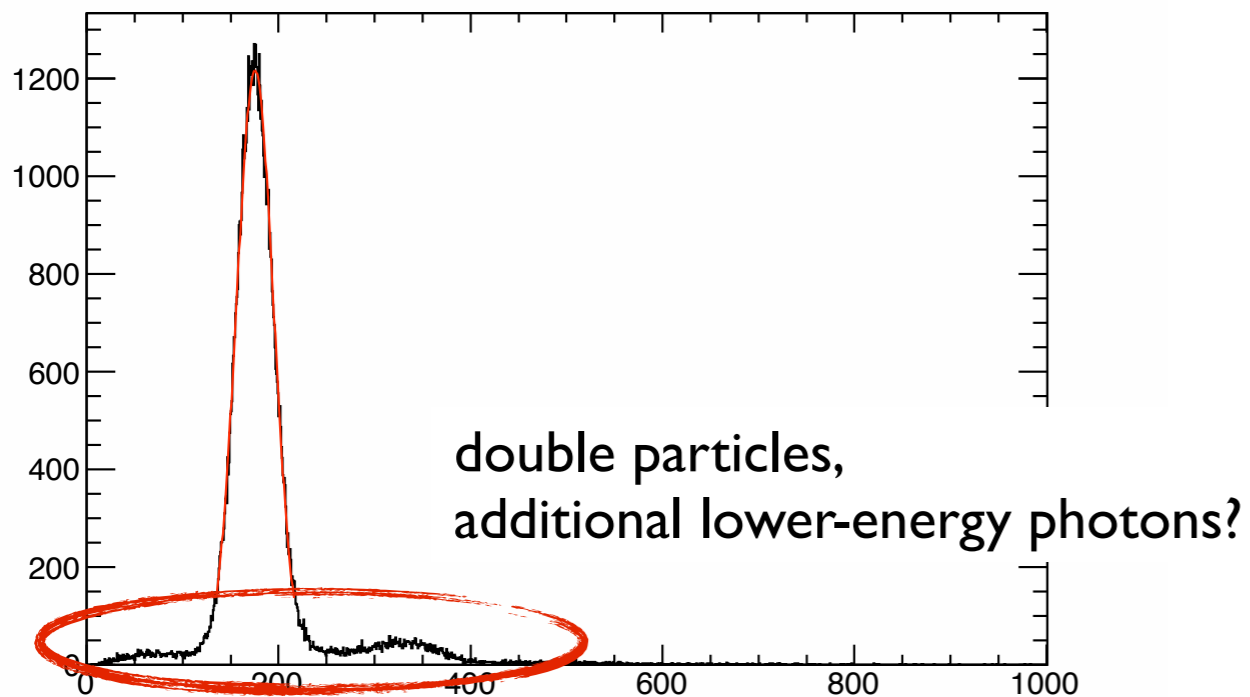
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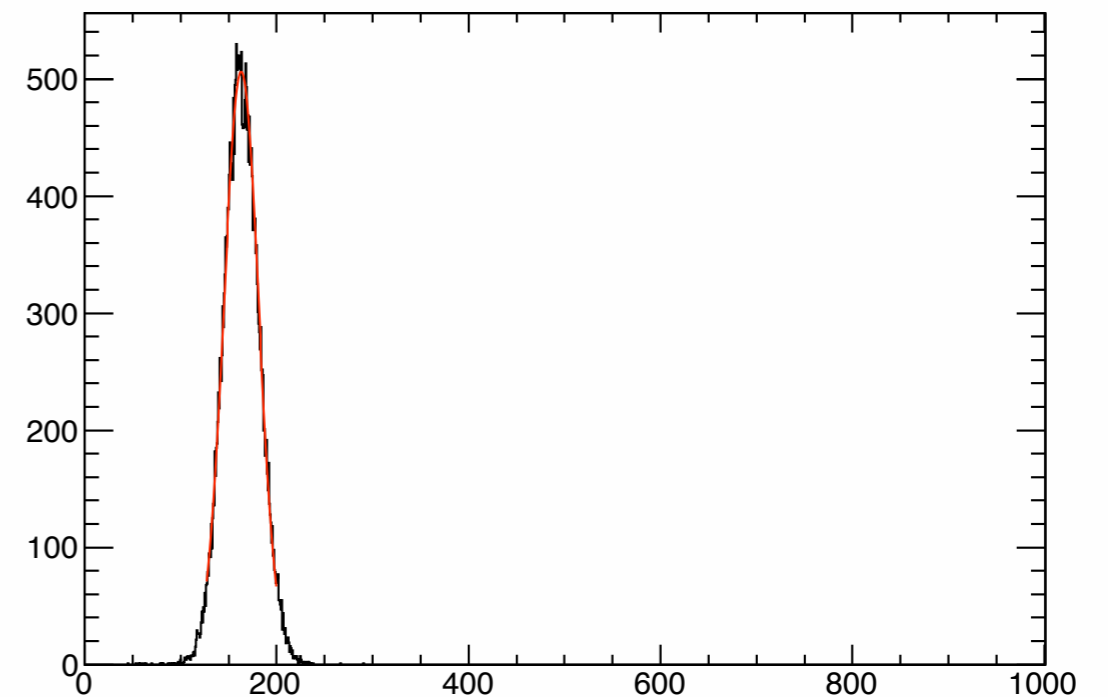
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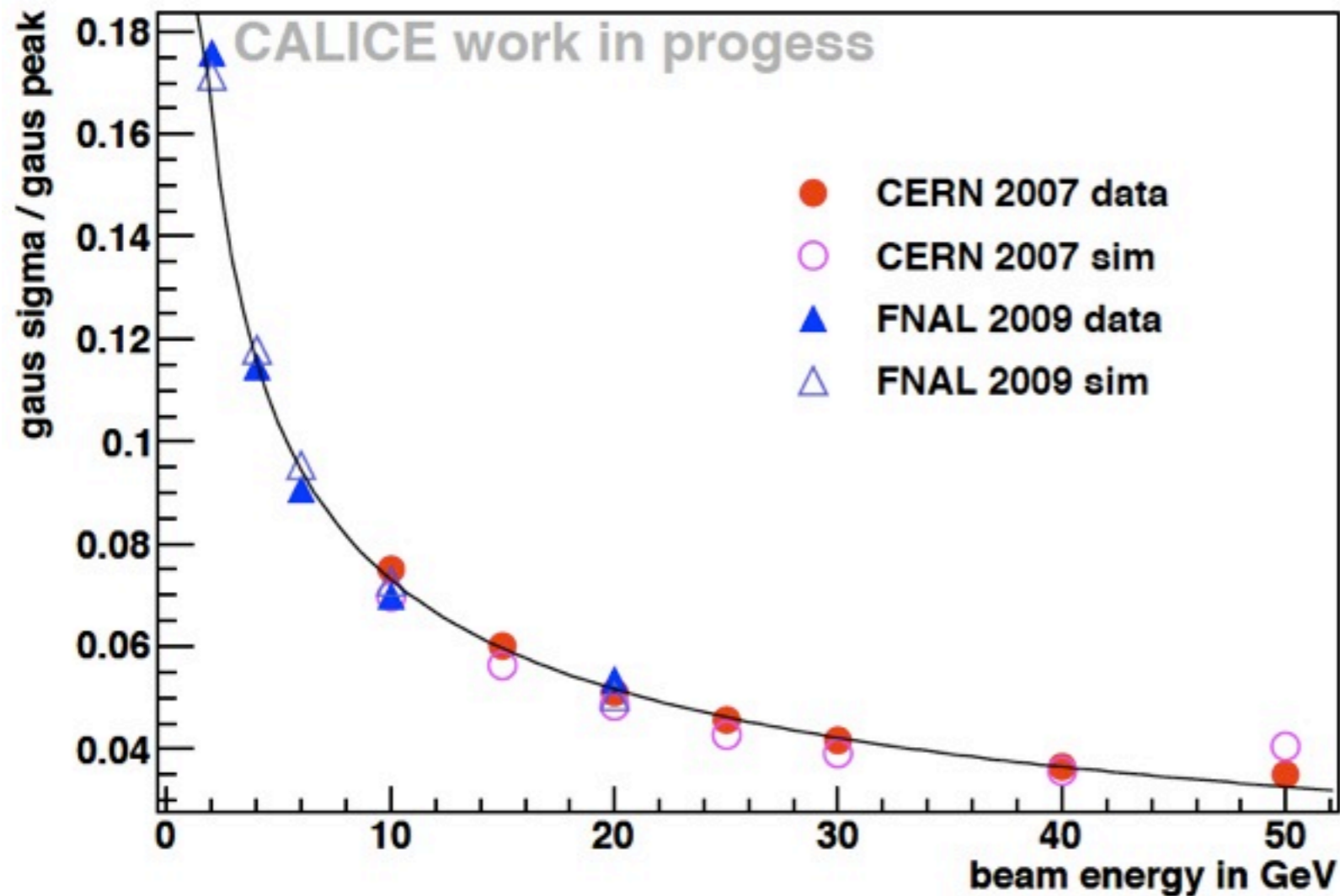


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Energy Resolution

- With noise reduction applied



Fit through data points:

$$\text{simple } \frac{1}{\sqrt{E}}$$

stochastic term: 23.1%

(compare to 22.5%
from CAN-014)

Summary

- First look at FNAL electromagnetic data (taken May 2009)
- Shower profile decent, but not perfect match with simulations
- Good linearity after introducing noise rejection by reducing the integration volume
 - But: Serious discrepancies between data and simulations
- Energy resolution encouraging: Already quite close to stochastic term obtained from CERN data

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Next:

Need to work on understanding of the data

and: understanding and potentially improving the simulation