AHCAL Muon Paper Update

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Calorimeter for ILC

Excellence Cluster Universe

Credits

- This paper builds on the work of many people, on various levels of analysis, detector understanding and problem solving:
  - Andrea Vargas Trevino
  - Nils Feege
  - Erika Garutti
  - Clemens Guenther
  - Katja Seidel
  - Lars Weuste
  - ...

The AHCAL Muon Paper

- Details on the muon calibration and related studies of detector performance
  - Bridging the gap between the technical paper and the "physics" papers

- Current working title:

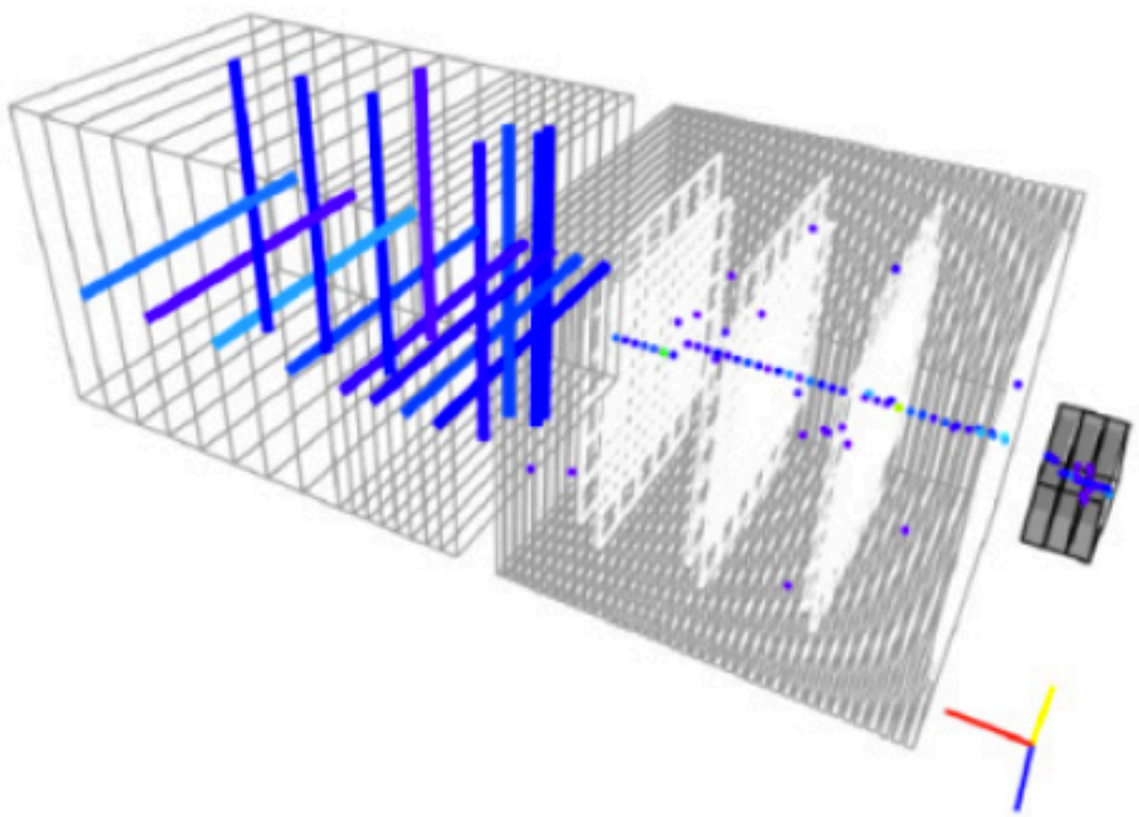
> Muon Calibration and Portability of Calibration Constants in a highly granular Hadron Calorimeter

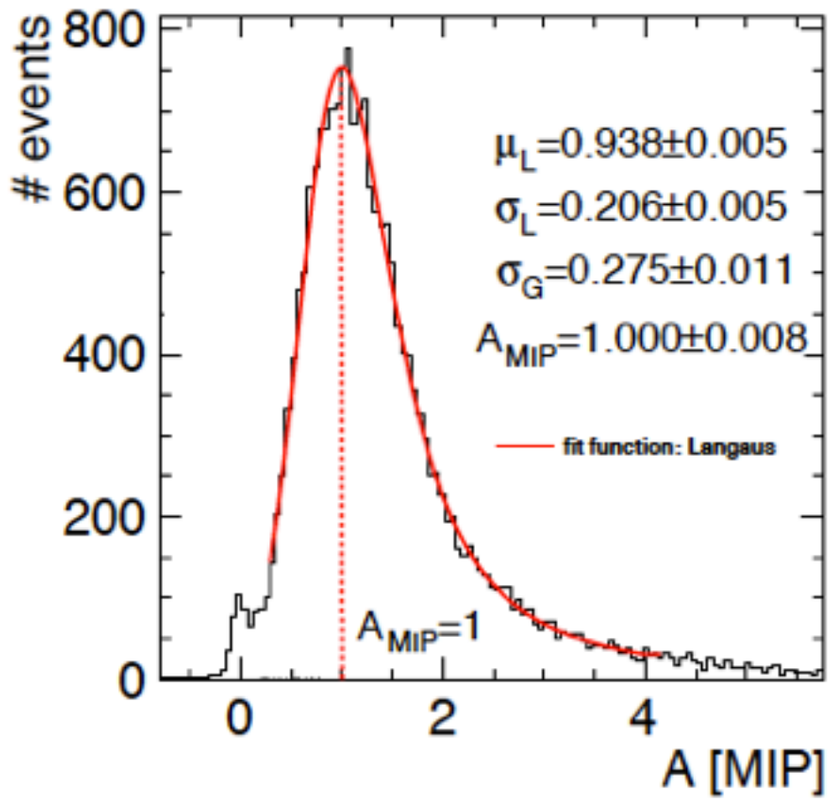
Main topics:

- Muon calibration procedure
- Detector performance: Noise, Light yield of cells
- Response stability: Voltage, temperature
- Portability of calibration constants: Test with muons

Muon Calibration

- By now a well-known technique: Find track, fit MIP





Muon Calibration

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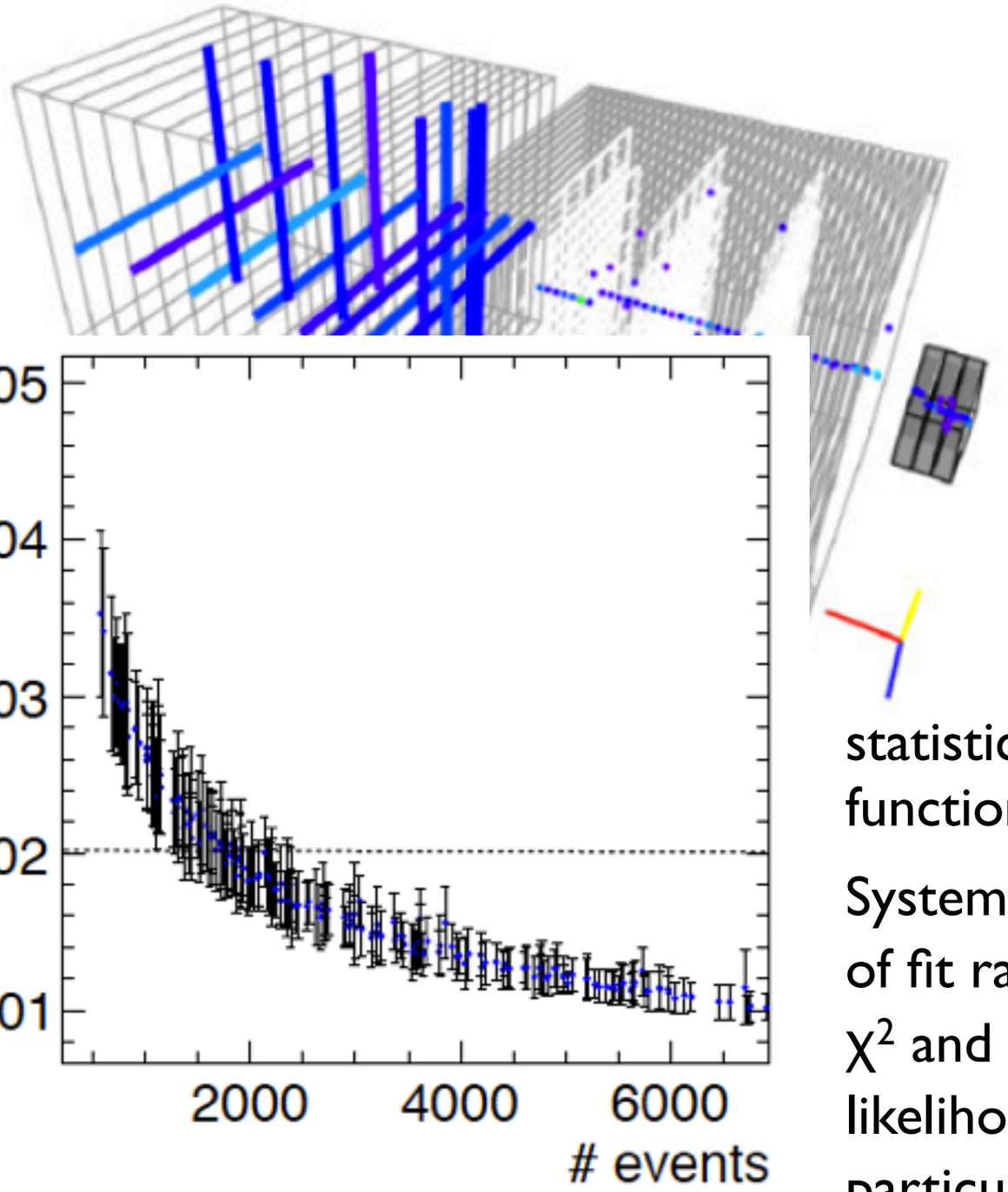
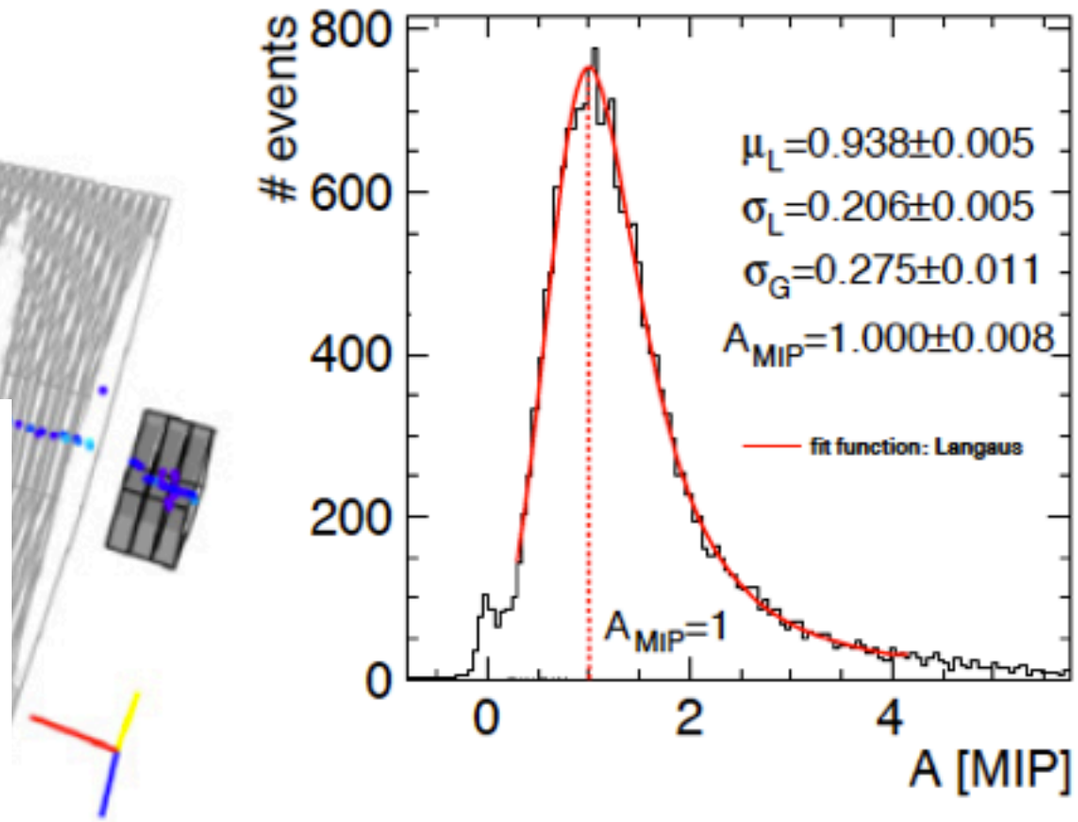


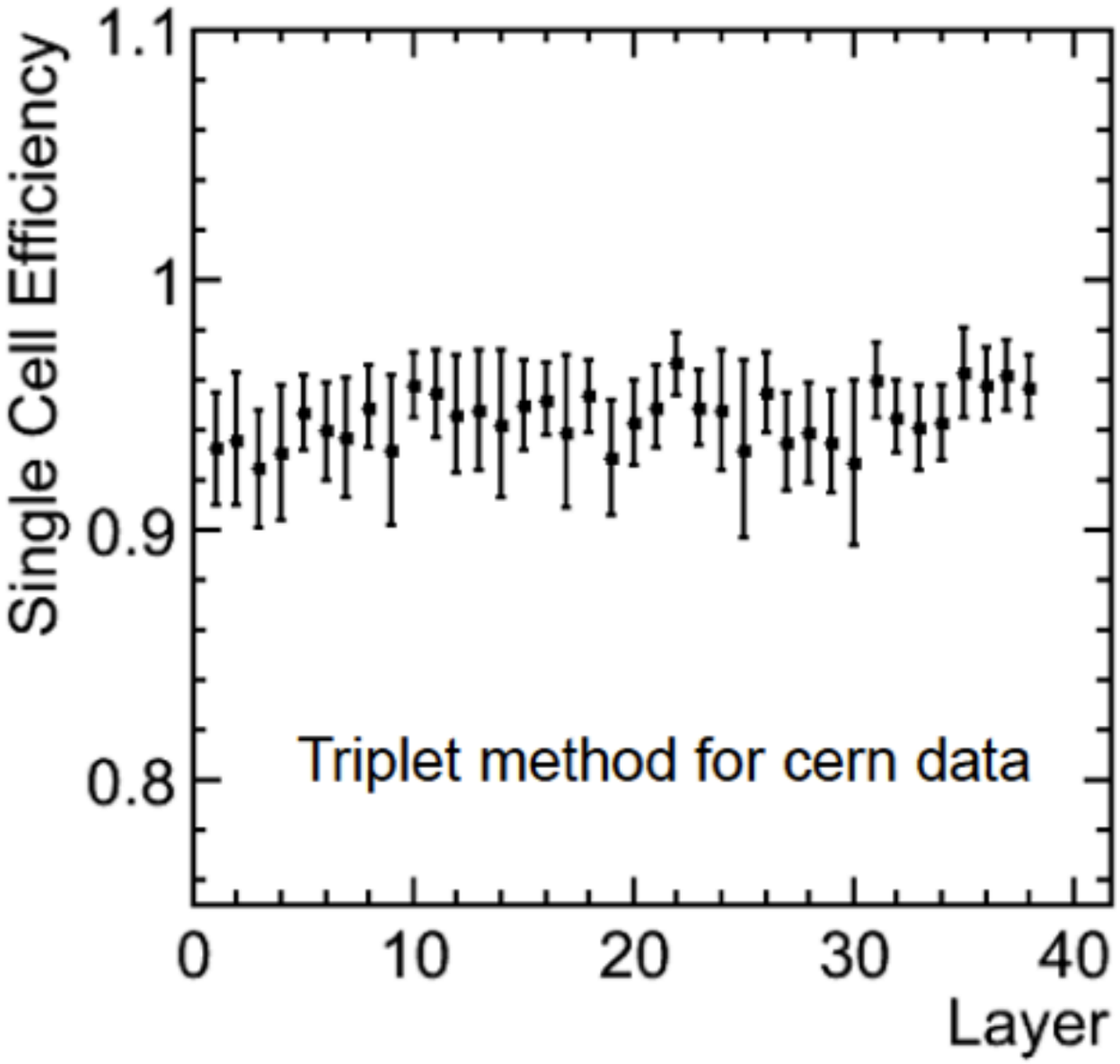


statistical error of LanGau fit as a function of entries

Systematic error of 2% obtained from a study of fit ranges

χ^2 and likelihood fits have been studied, likelihood provides best performance, in particular in terms of stability

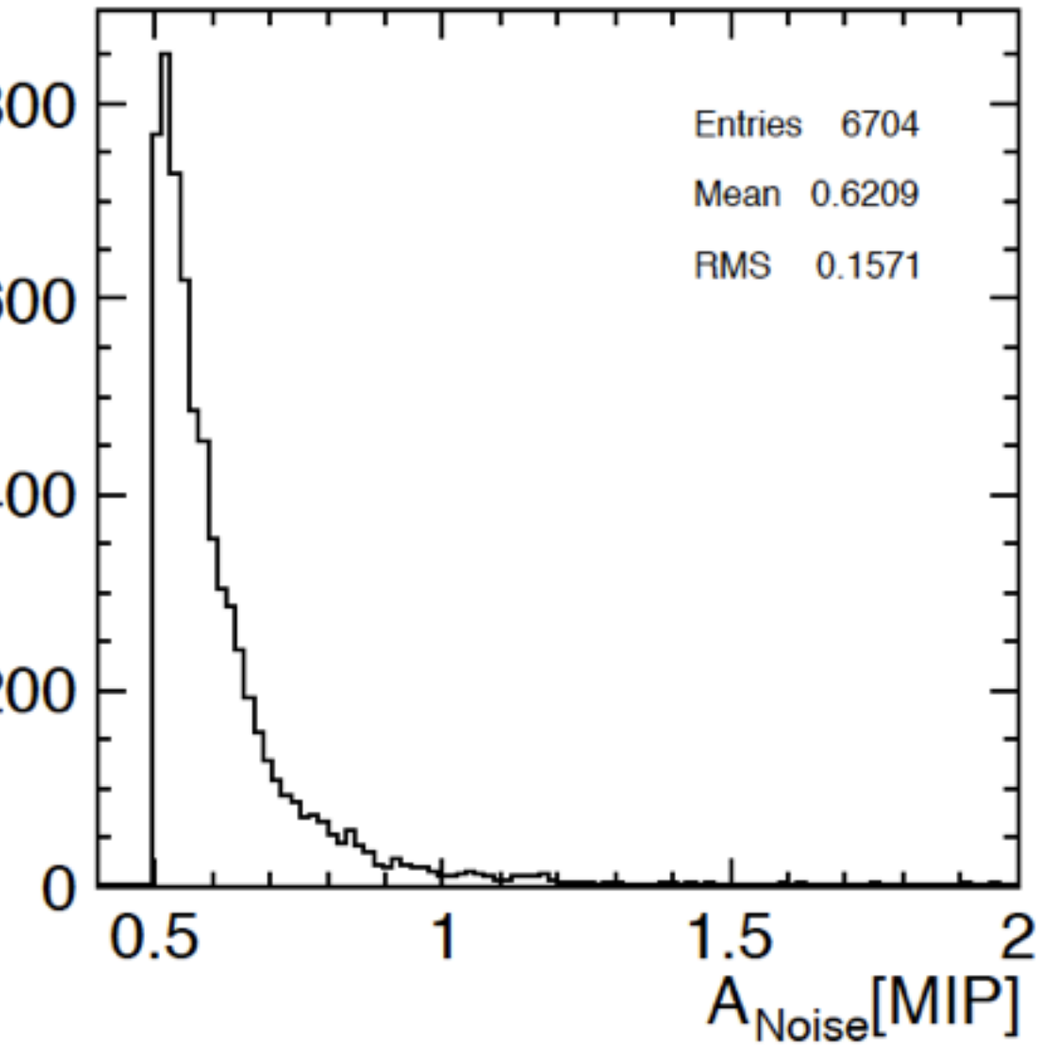
Performance: Muon Efficiency

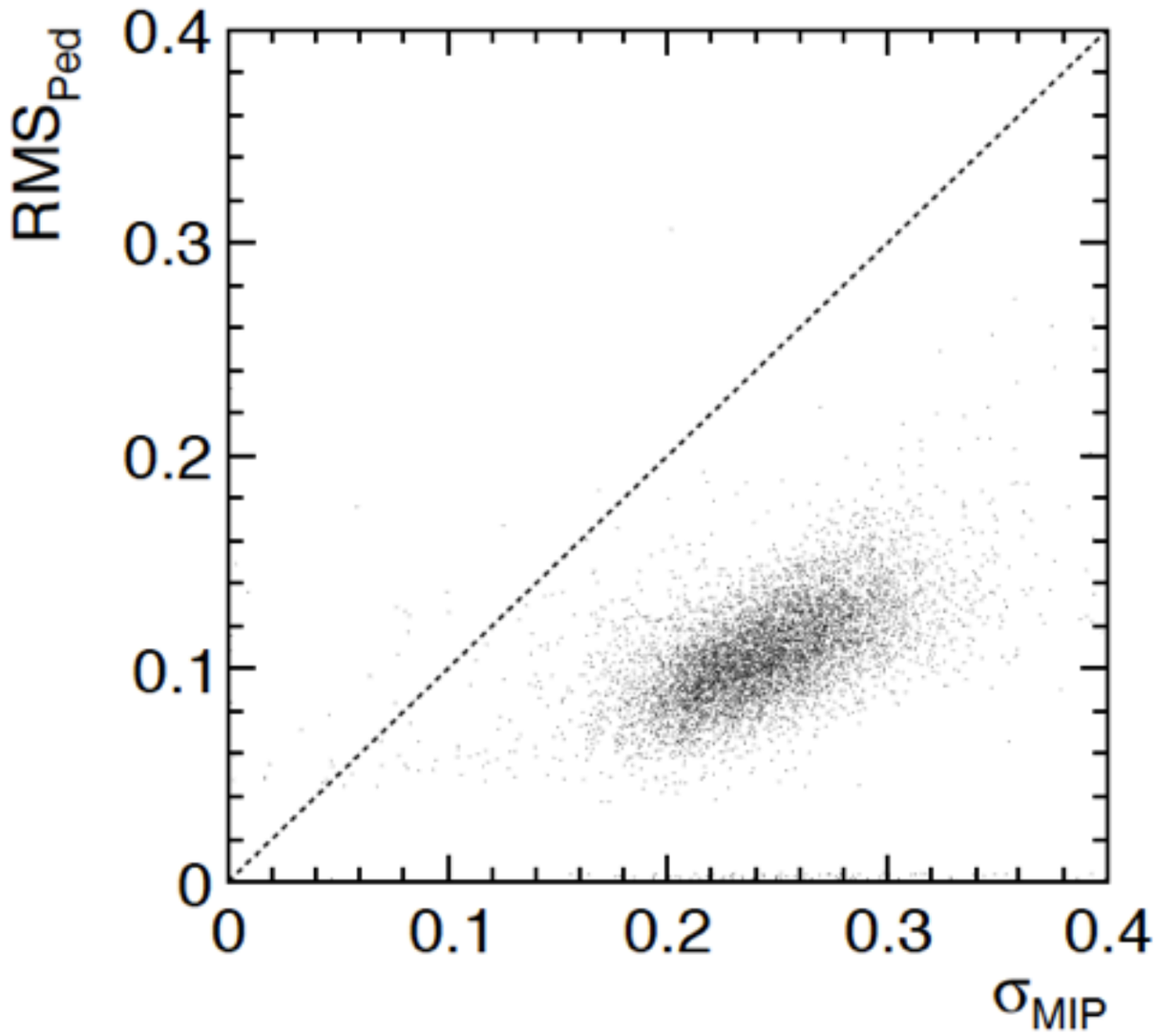


- Different techniques to extract efficiency have been studied, most reliable:
  - Triplet method - require hits in next neighbors
    - Minimizes bias of track finding in region going from fine to coarse section
- Average efficiency for CERN 2007: 93% (0.5 MIP threshold)

Performance: Noise

correct normalization still to do

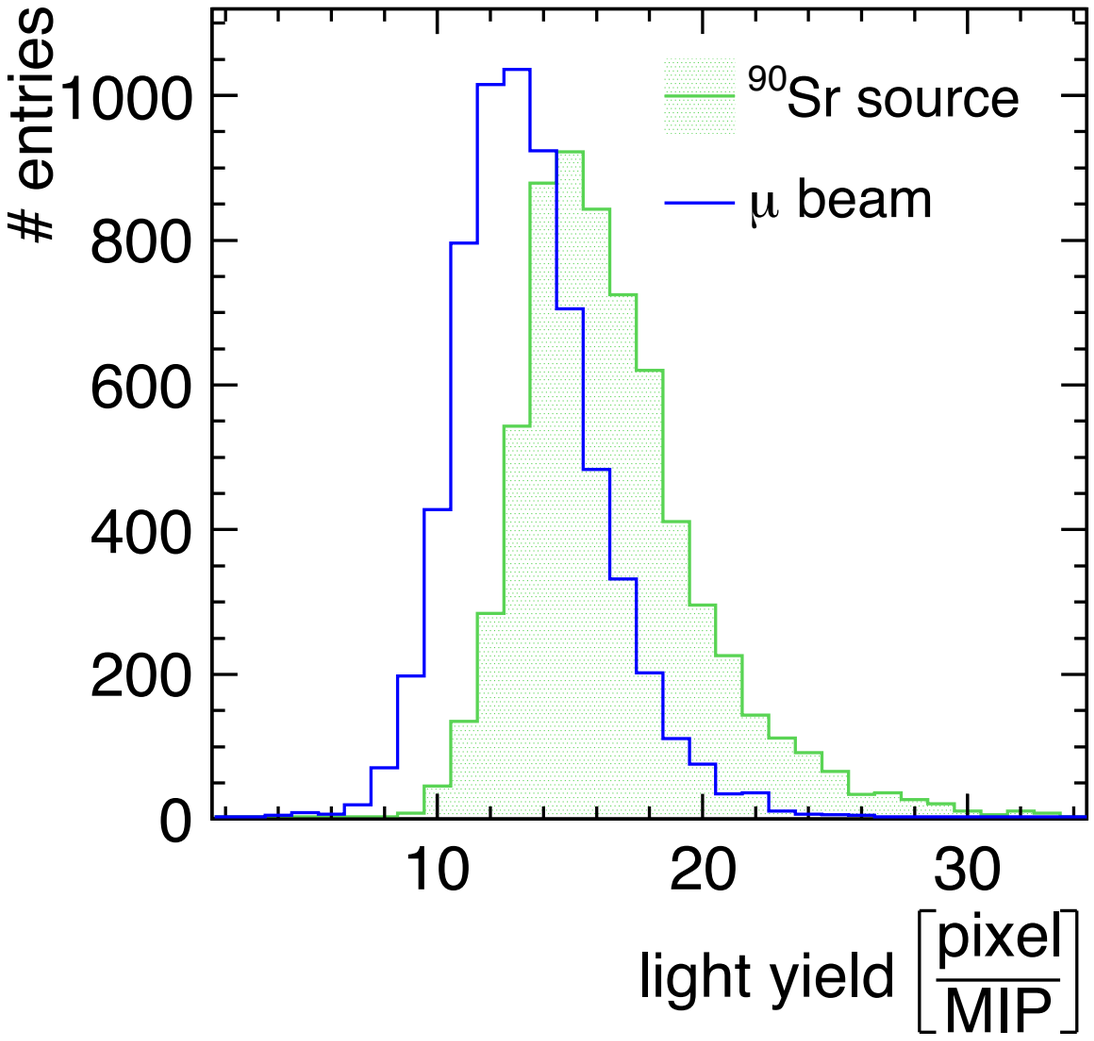


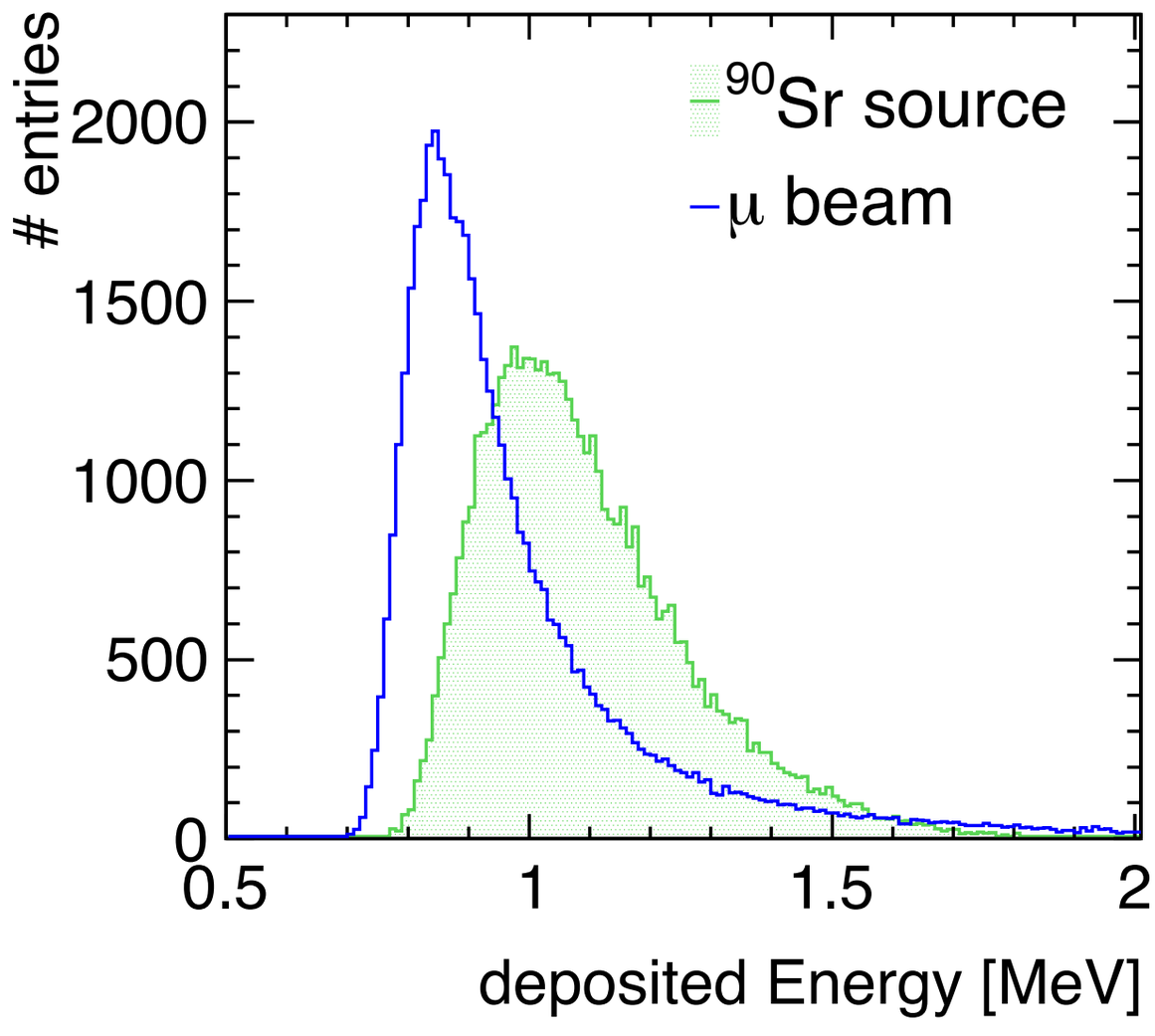


- Noise amplitude: Steeply falling beyond 0.5 MIP threshold
- RMS of pedestal distribution of each channel (above 0.5 MIP) is correlated with the width of the Gaussian component of the MIP fit

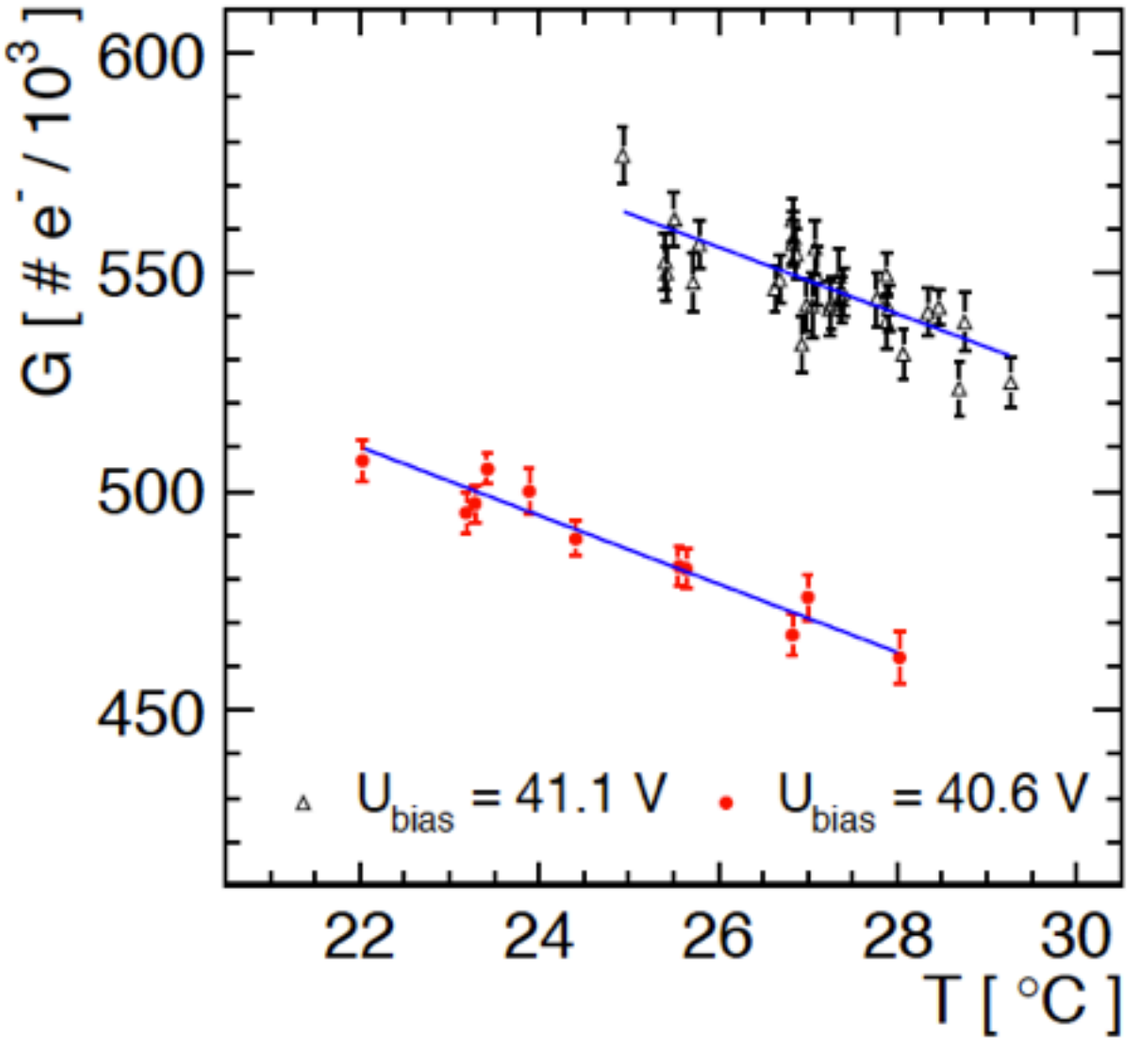
Performance: Light Yield

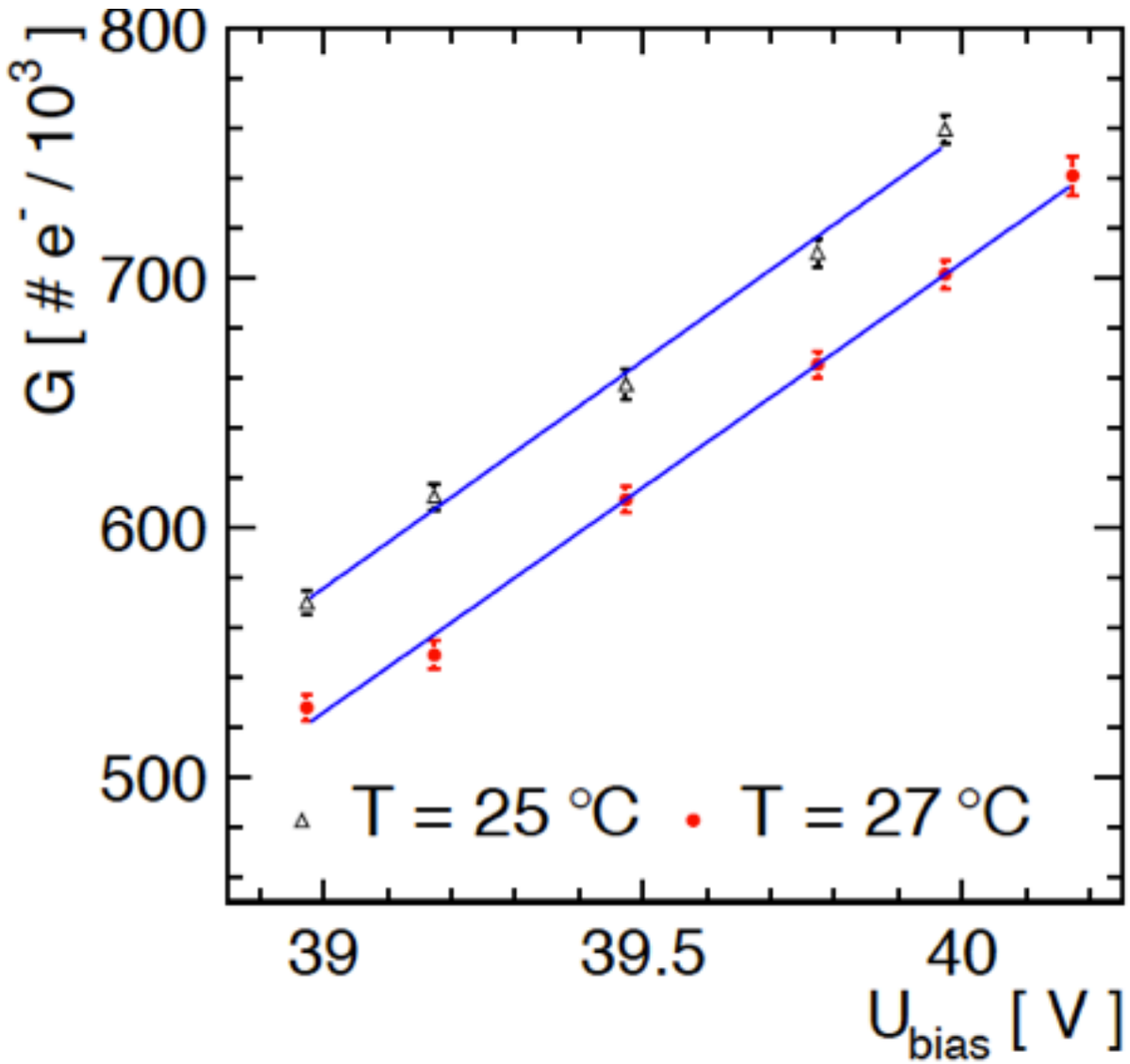
- Light yield measured in situ is consistently lower than test bench measurements: By now well-known effect of difference in energy deposit between source and muons





Response Stability: Gain



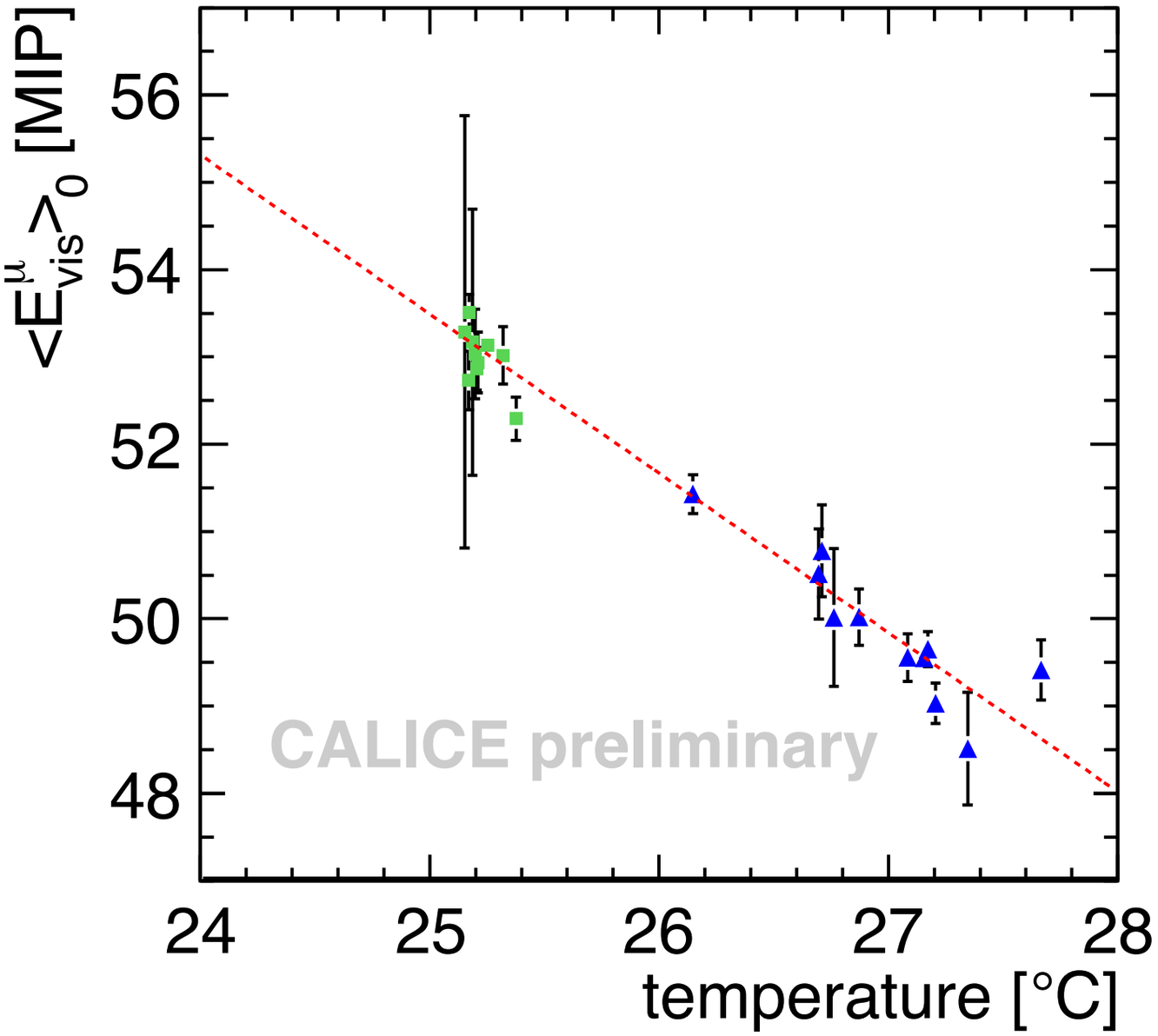


- SiPM gain depends on voltage and temperature: Measurements over a large sample of sensors at various voltages and temperatures

$$\frac{1}{G}\frac{dG}{dT} = (-1.7 \pm 0.3)\,\frac{\%}{\mathrm{K}} \qquad \frac{1}{G}\frac{dG}{dU} = (2.6 \pm 0.3)\,\frac{\%}{100\,\mathrm{mV}}$$

Response Stability: Amplitude

- Amplitude vs Temperature - New results for FNAL dataset

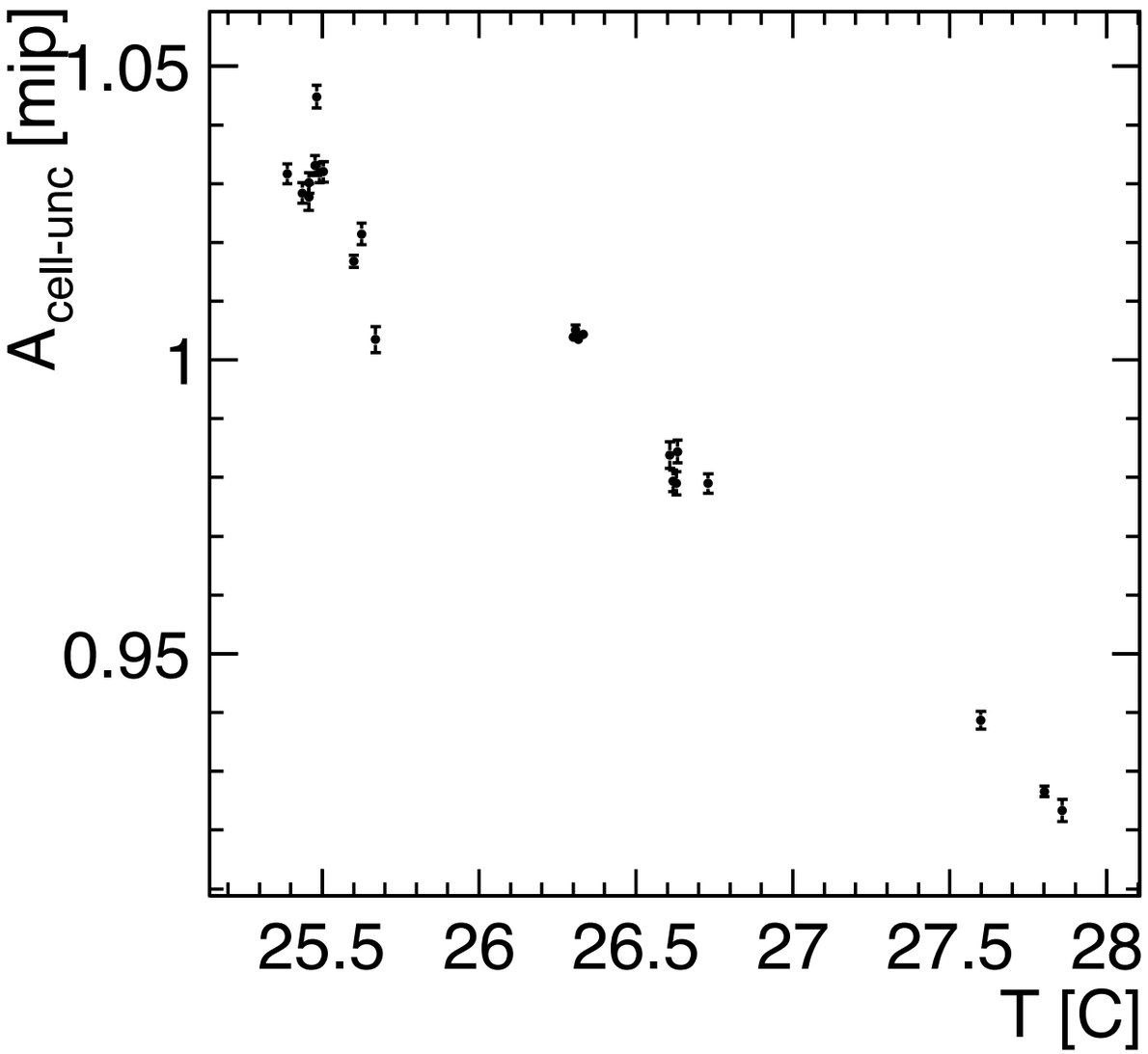


shown: complete energy in AHCAL for events with a good muon track, subtraction of mean noise level

slope: - 3.4%/K

Response Stability: Amplitude

- CERN data being reanalyzed - currently in progress
  - Present status of single cell MPV amplitude (sample of cells covered by trigger scintillators):

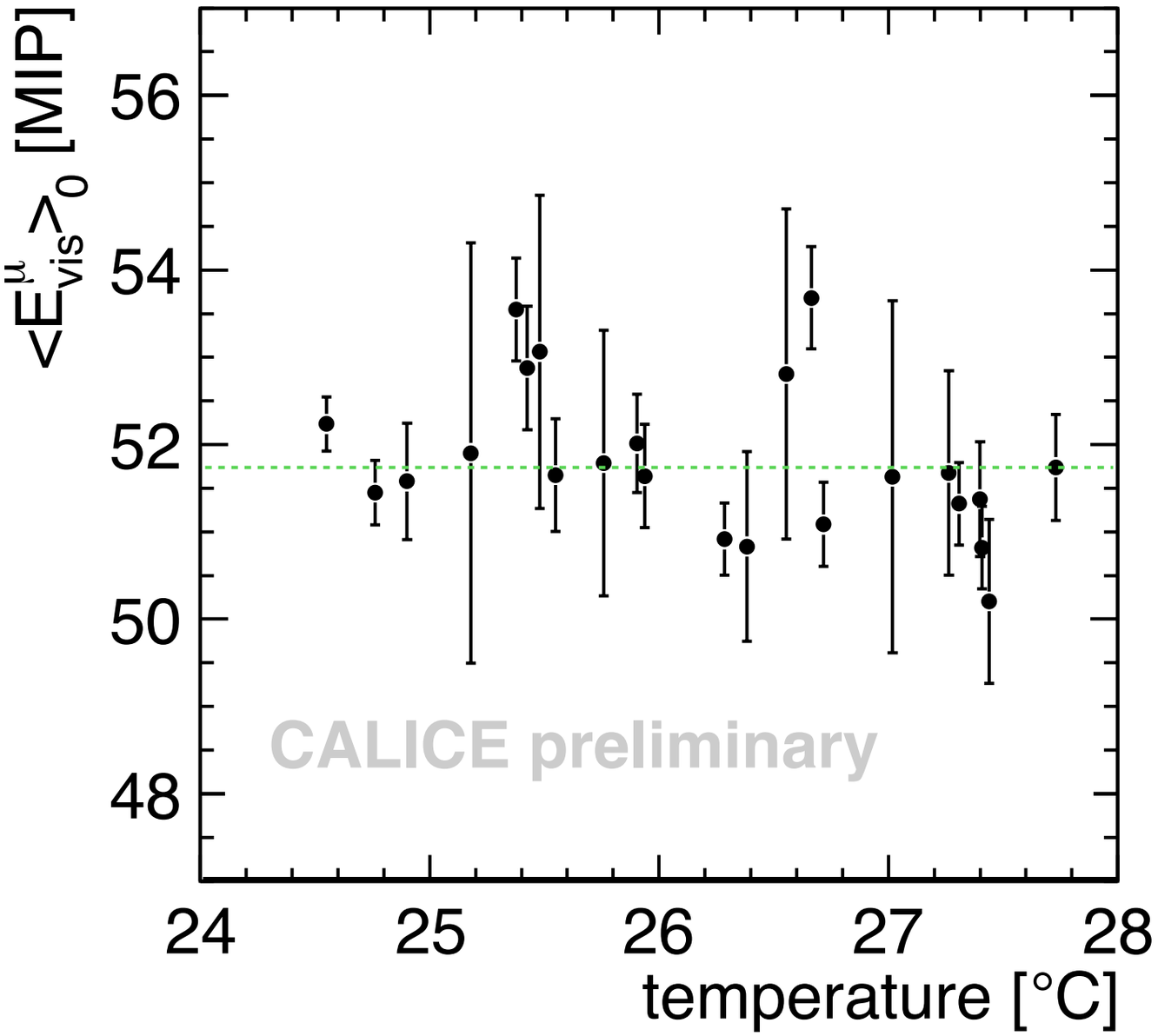


Sample still needs cleaning

First fit indicates a slope of ~ 4.3%/K

Effectivity of Temperature Correction

- Muon signal after temperature correction



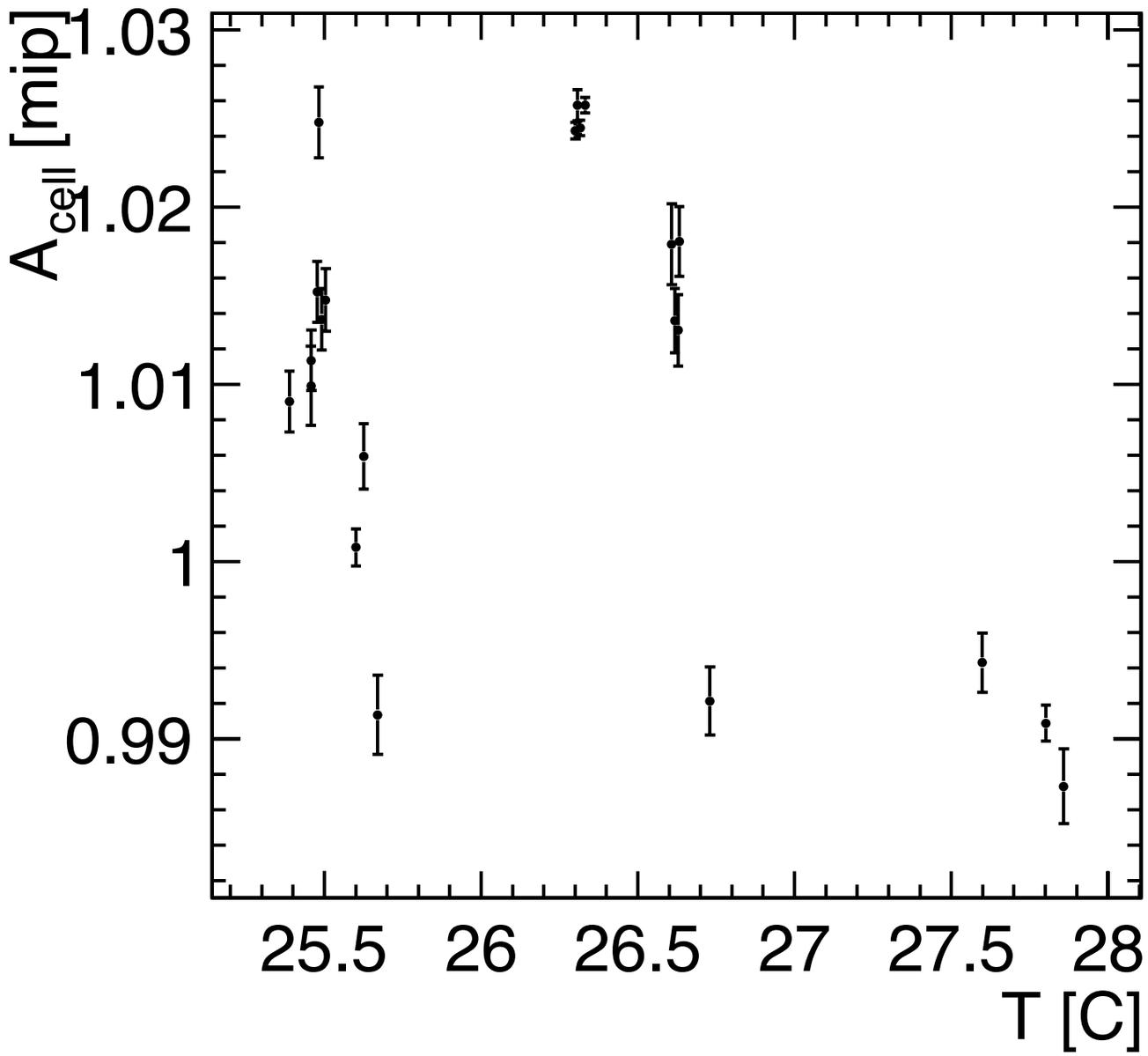
Spread of mean values after correction:
1.6% (RMS)
(not taking errors into account)

The same spread is obtained when the mean is calculated by weighting with the individual errors

Fit probability: 7×10^{-3}

Efficiency of Temperature Correction

- Temperature correction applied to CERN data

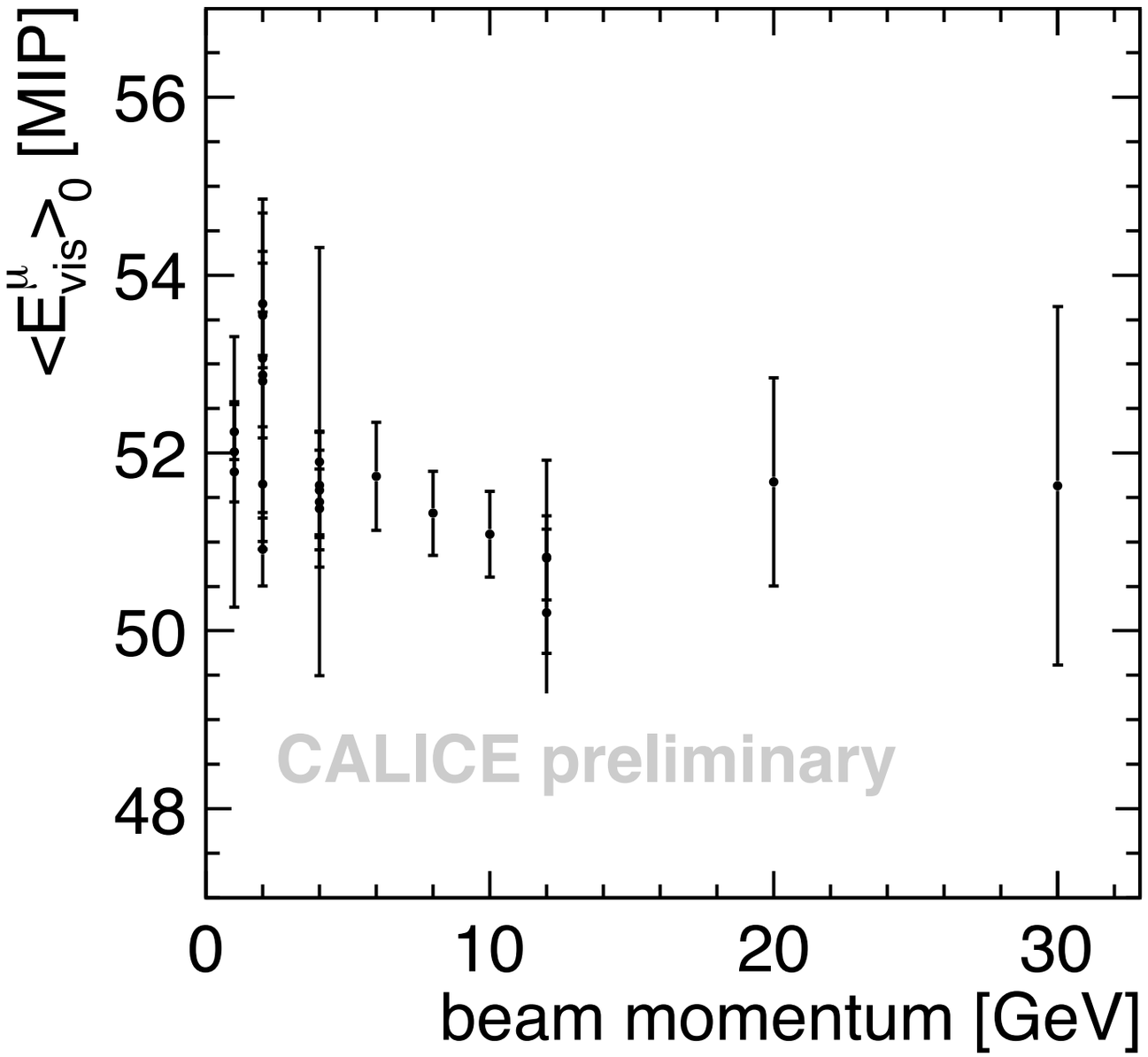


Mean: 1.01

RMS: 1.2%

Energy Dependence of Muon Peak

- Muons at FNAL, extracted from hadron data



For the mean energy deposition of towers, some energy dependence is expected, but that requires probably a larger leverarm

For the single cell MIP MPV, no significant energy dependence exists

Next Steps

- Study of portability of calibration constants: Apply transported CERN calibration to FNAL Muon runs
  Currently in preparation

- Finalize plots & discussions in the paper

- Circulate draft