Universität Hamburg

DESY

AHCAL Calibration Status

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CALICE Collaboration Meeting
Arlington (Texas), March 10-12, 2010

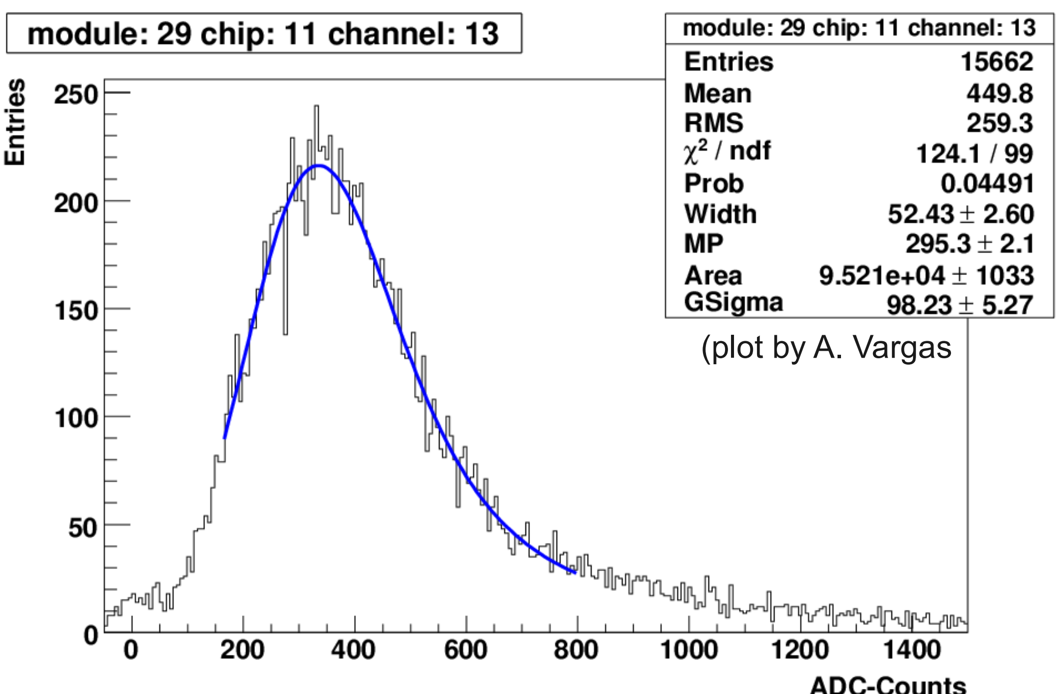
CALICE
Calorimeter for ILC

Outline

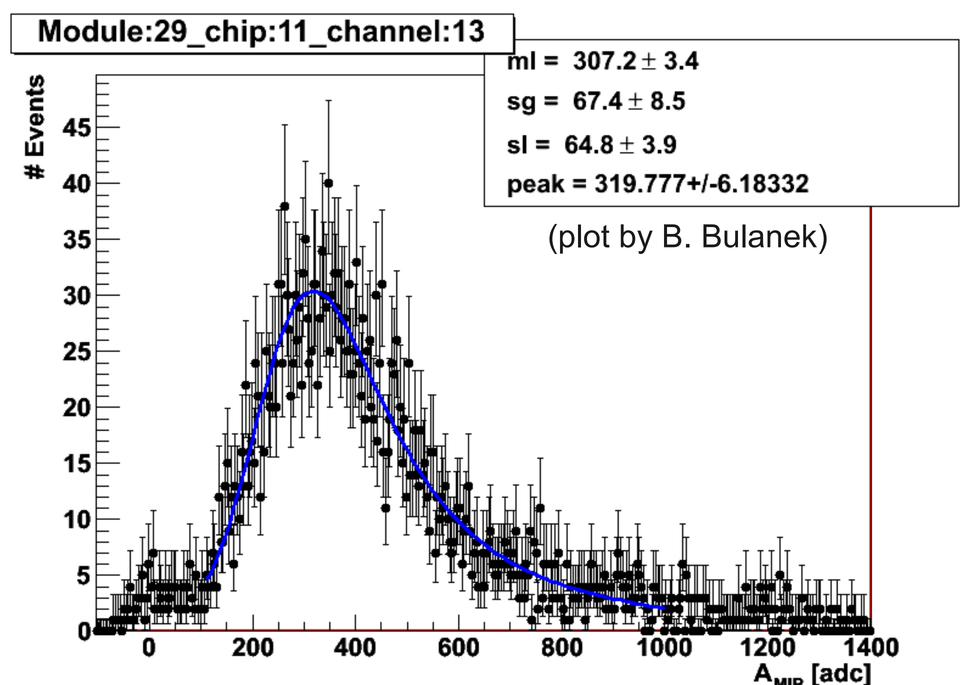
- MIP Calibration 2007
  + Temperature Correction
- Gain Calibration 2007
  + Temperature Correction
- Saturation Correction

MIP: Measuring Coefficients

- MIP coefficient for each cell: MPV of gauss $\ast$ landau fit to muon response
- established method: χ^2 fit
- new approach: maximum likelihood fit $\rightarrow$ more stable
  $\rightarrow$ only small number of events required (results for **each** muon run)

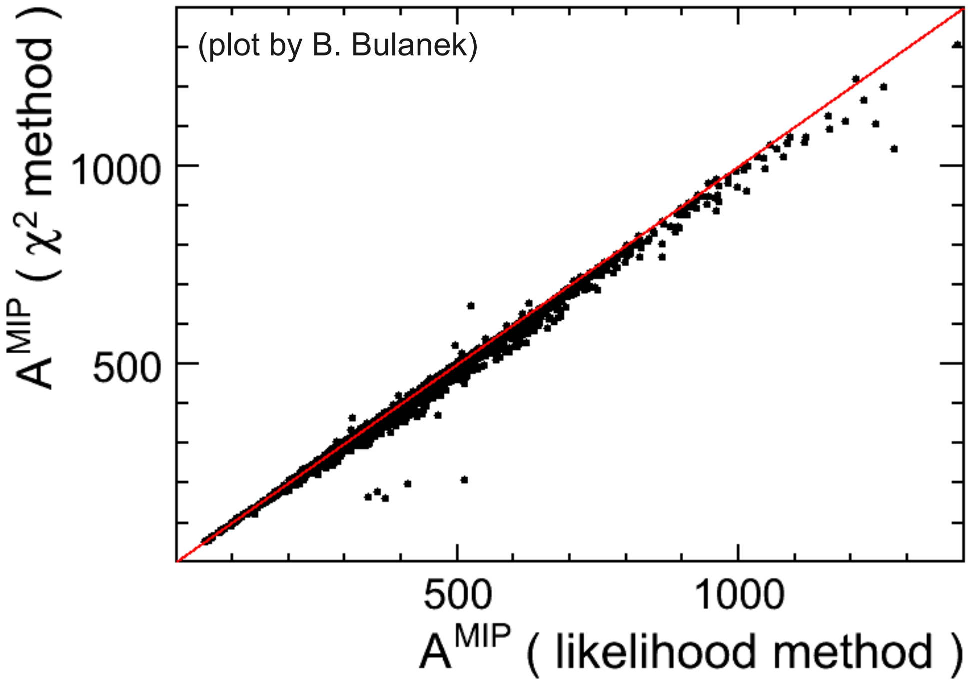


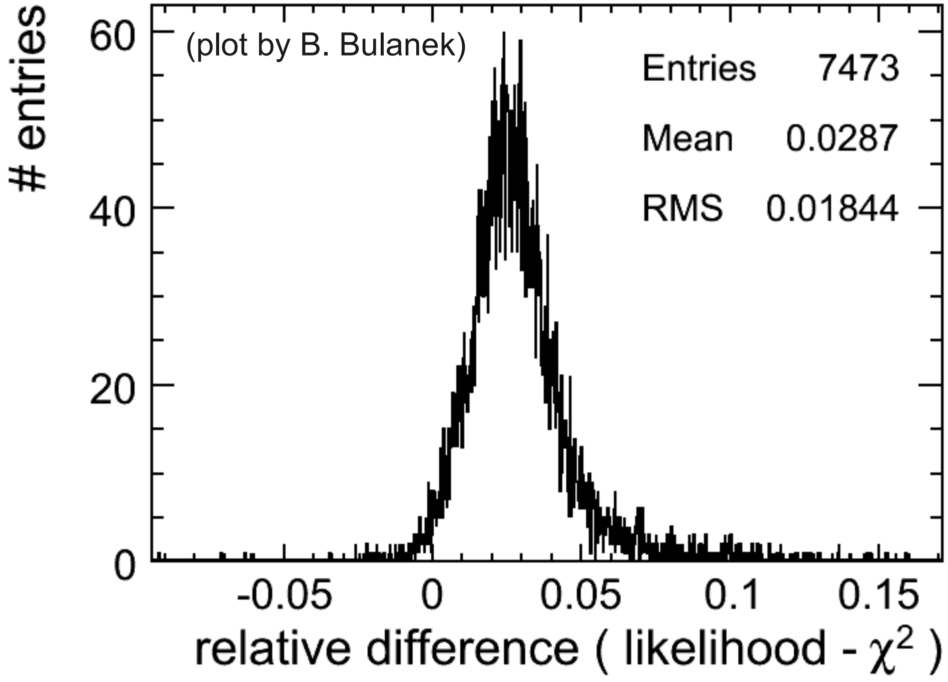
χ^2 fit



likelihood fit

MIP: Comparing χ^2 And Likelihood Fit





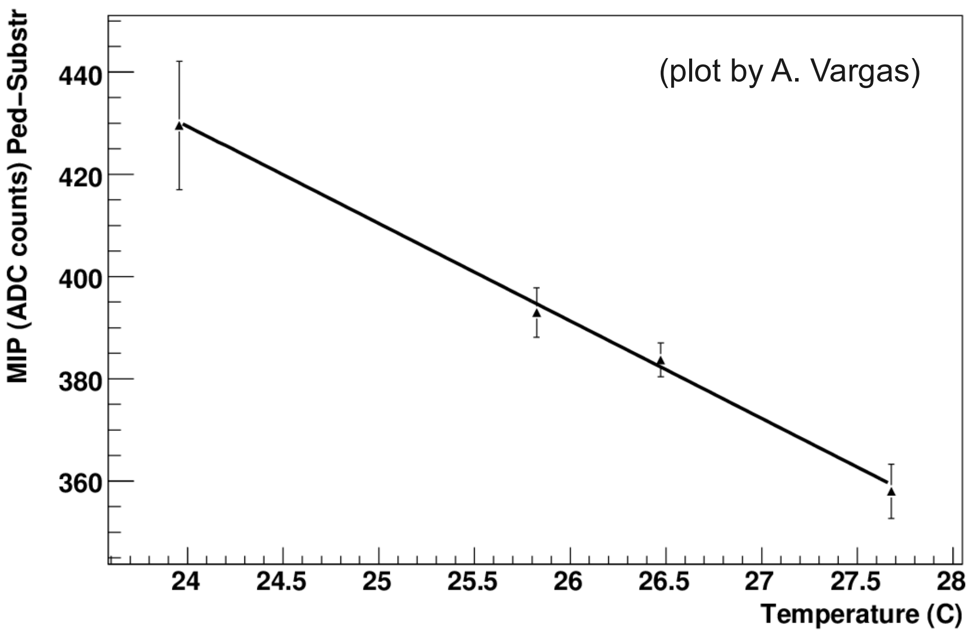
- same data set used for both fit methods
- 99.4 % correlation
- shift: results obtained from likelihood fit 3% larger than from χ^2 fit

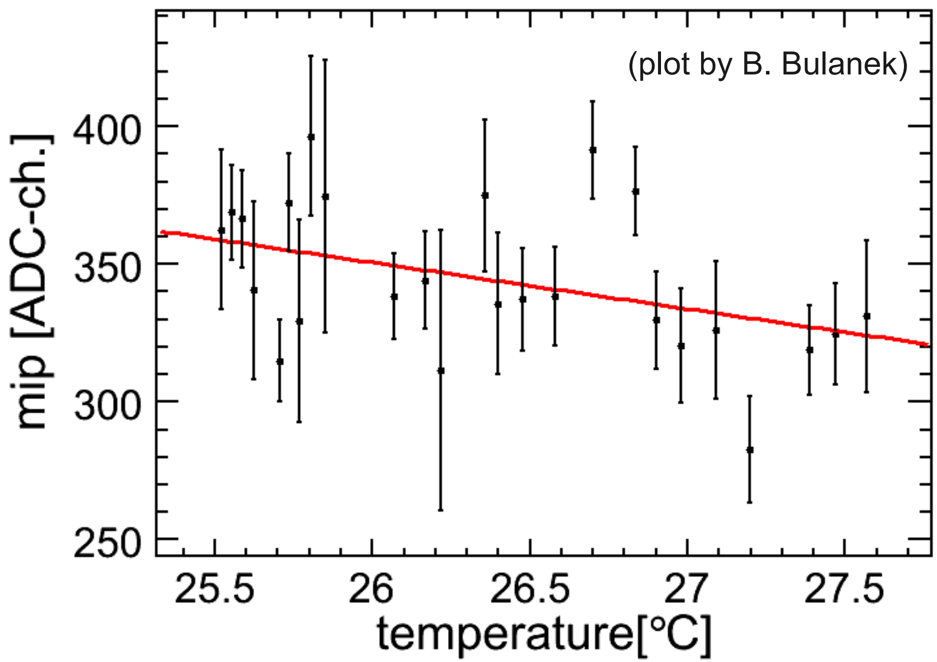
MIP: Temperature Dependence

Different methods to determine dA^{MP} / dT:

1) use average 1 / A^{MP} dA^{MP} / dT = -3.8 %/K (at 27 °C)

2) linear fit for each channel





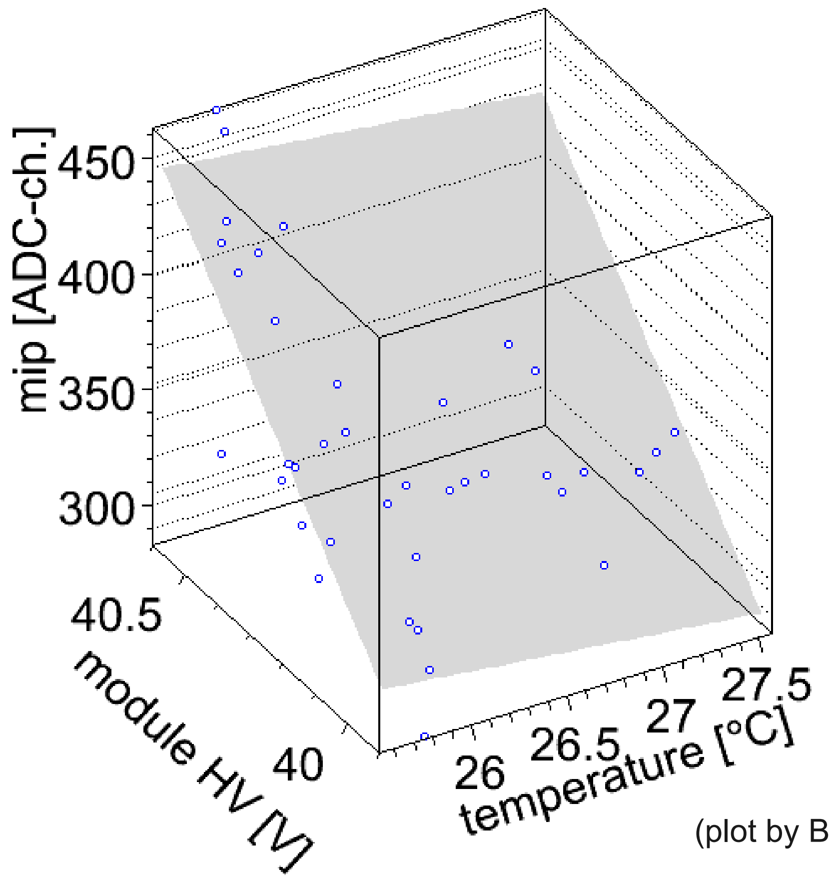
MIP coefficients from χ^2 fit:
need **set** of muon runs for each value

MIP coefficients from likelihood fit:
one value **for each** muon run

MIP: Temperature Dependence

Different methods to determine dA^{MP} / dT:

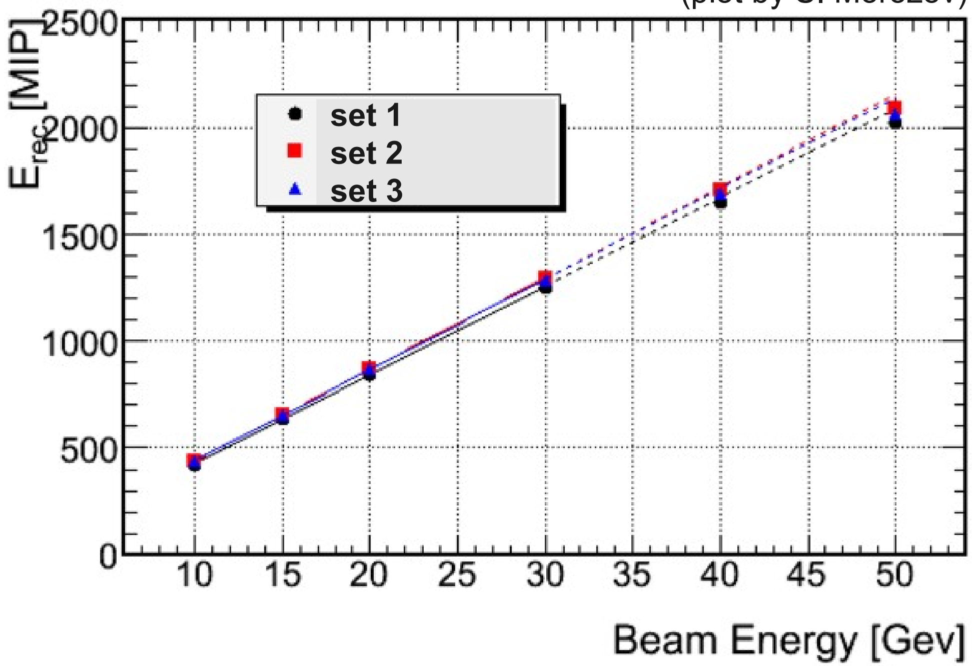
3) planar fit for each channel
  - include runs taken with different SiPM bias voltage settings
  - only likelihood approach yields enough values



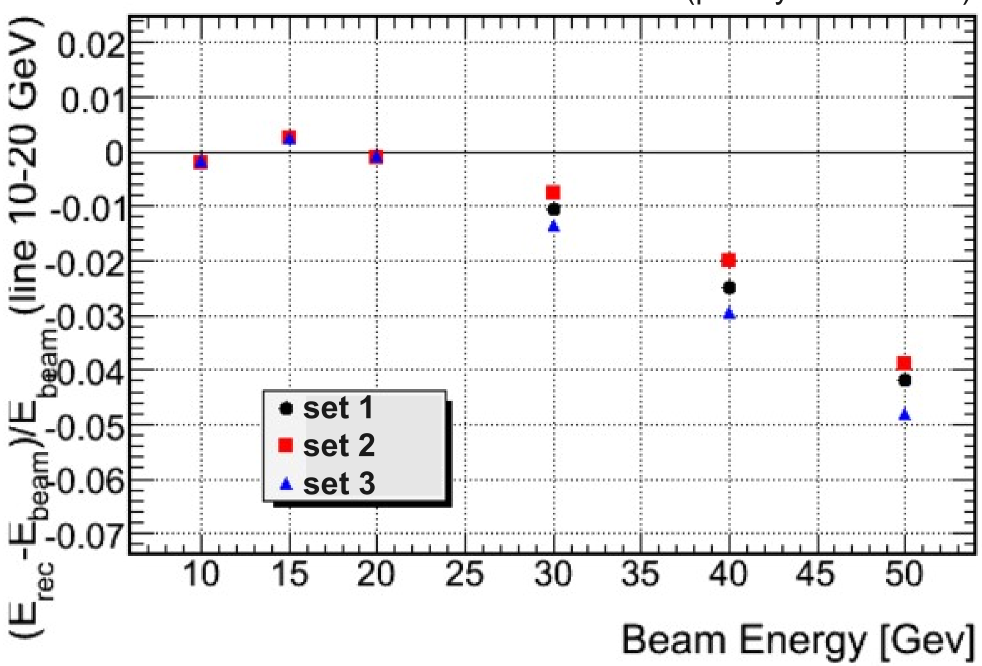
(plot by B. Bulanek)

MIP: Compare Calibration Sets

(plot by S. Morozov)



(plot by S. Morozov)



- CERN 2007 electron data
- Different sets of mip constants and mip slopes:

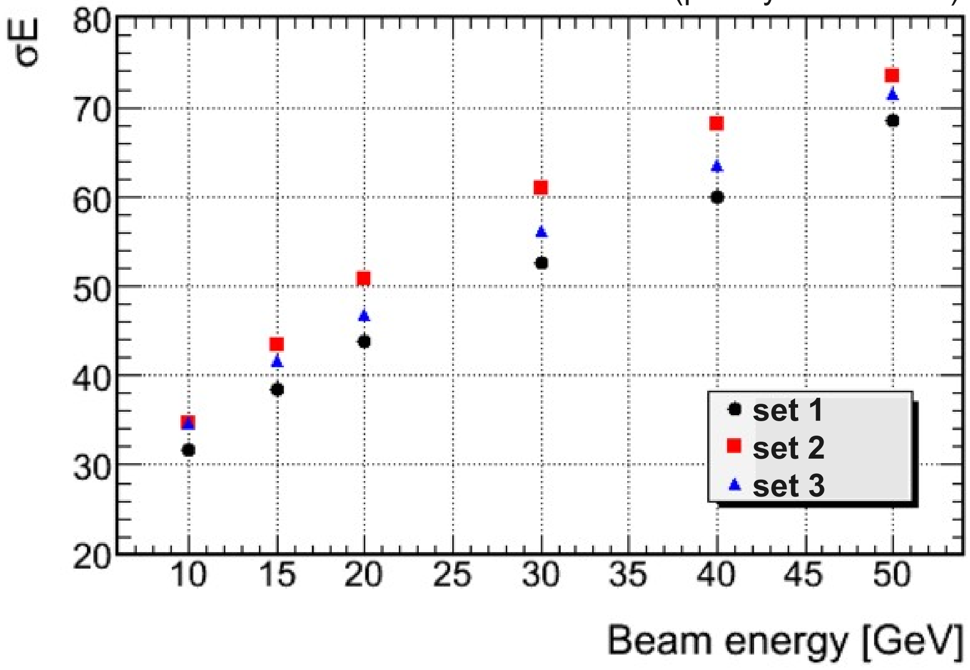
  set 1) χ^2 fit, 1 / A^{MP} dA^{MP} / dT = -3.8 %/K for all channels

  set 2) χ^2 fit, linear fit for each channel

  set 3) likelihood fit, planar fit for each channel
- Include only cells for which all calibration coefficients are available for all sets

MIP: Compare Calibration Sets

(plot by S. Morozov)



- CERN 2007 electron data
- Different sets of mip constants and mip slopes:

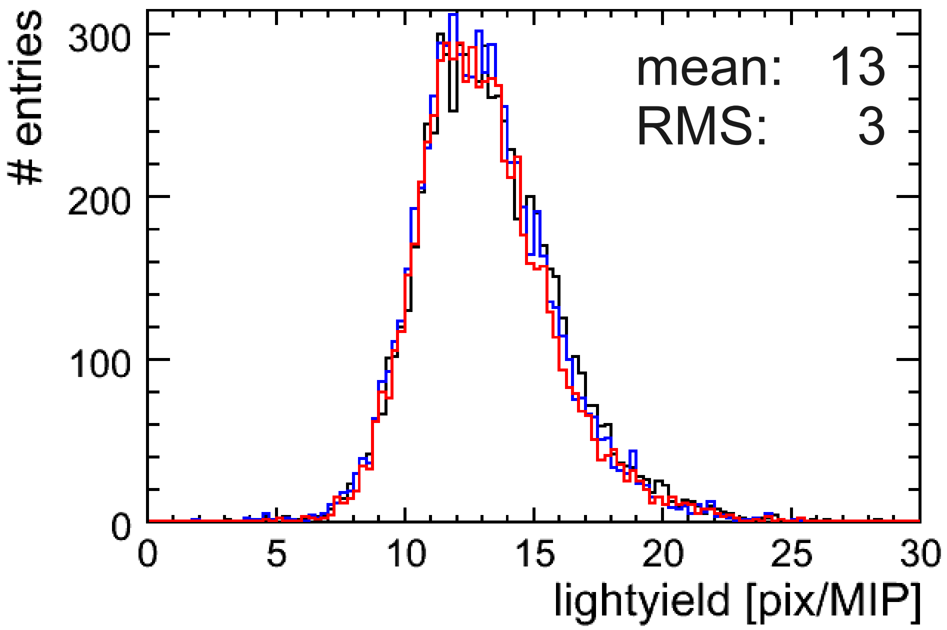
  set 1) χ^2 fit, 1 / A^{MP} dA^{MP} / dT = -3.8 %/K for all channels

  set 2) χ^2 fit, linear fit for each channel

  set 3) likelihood fit, planar fit for each channel
- Include only cells for which all calibration coefficients are available for all sets

MIP: Compare Calibration Sets

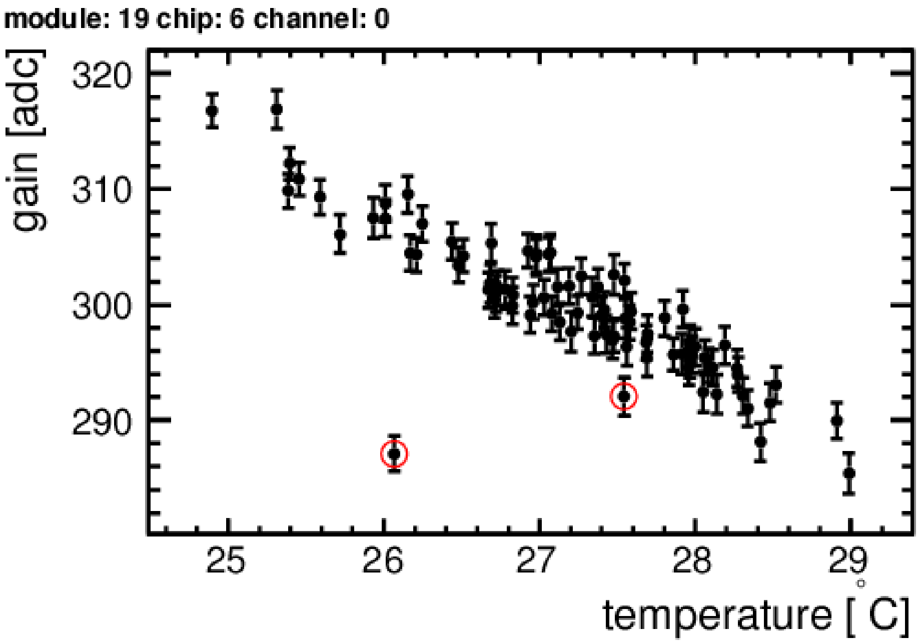
- # channels, for which mip constant and mip slope are available:
  - set 1) χ^2 fit, $1 / A^{MP} \; dA^{MP} / dT$ = -3.8 %/K for all channels → 7474
  - set 2) χ^2 fit, linear fit for each channel → 7470
  - set 3) likelihood fit, planar fit for each channel → 7028
- lightyield at 27 °C:

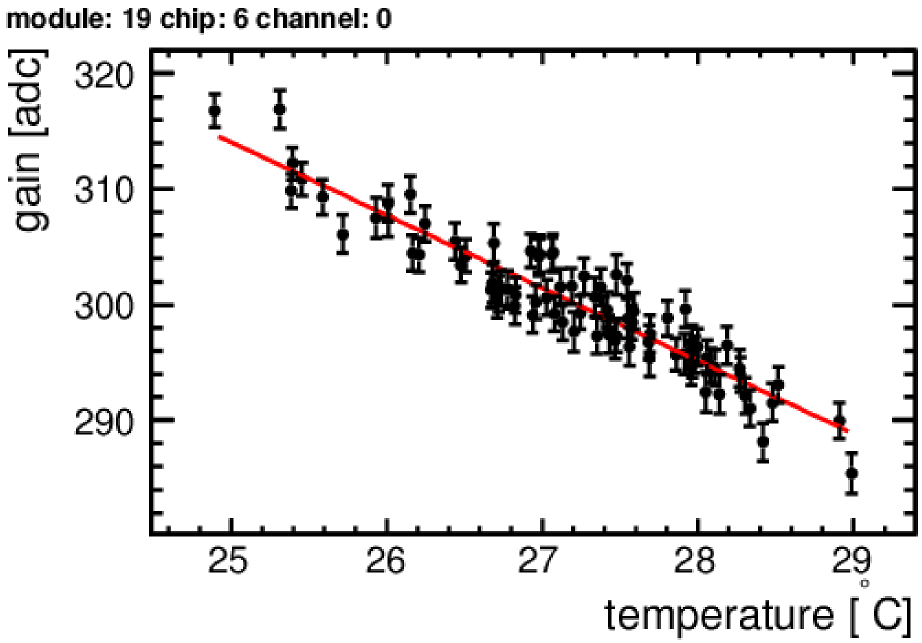


- calibration for reconstruction: **set 1)**
  → issues with application to FNAL data to be investigated

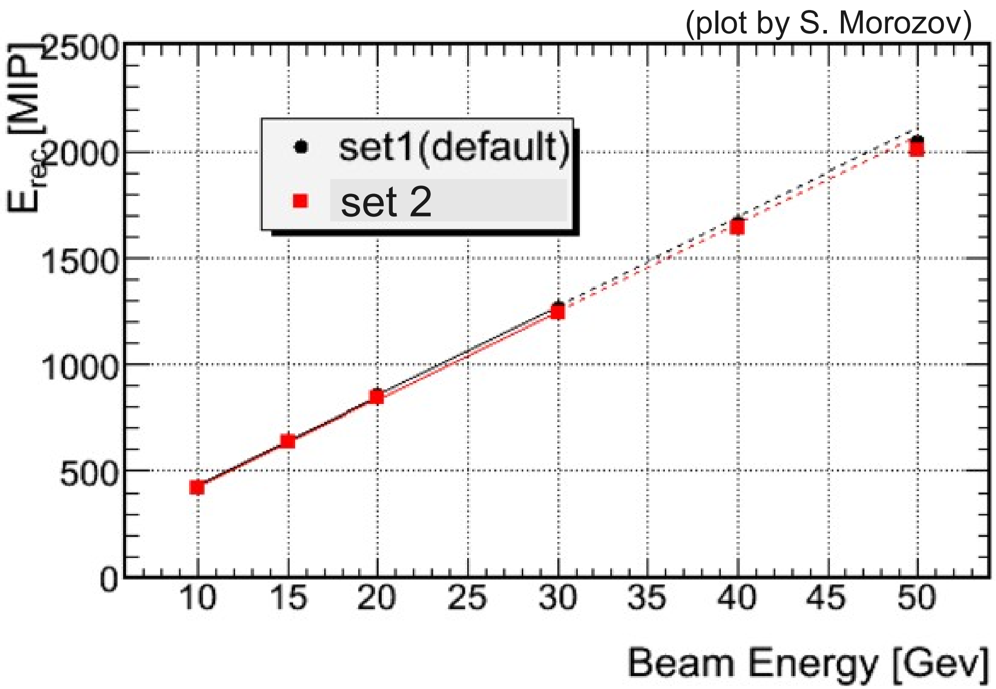
Gain Temperature Dependence

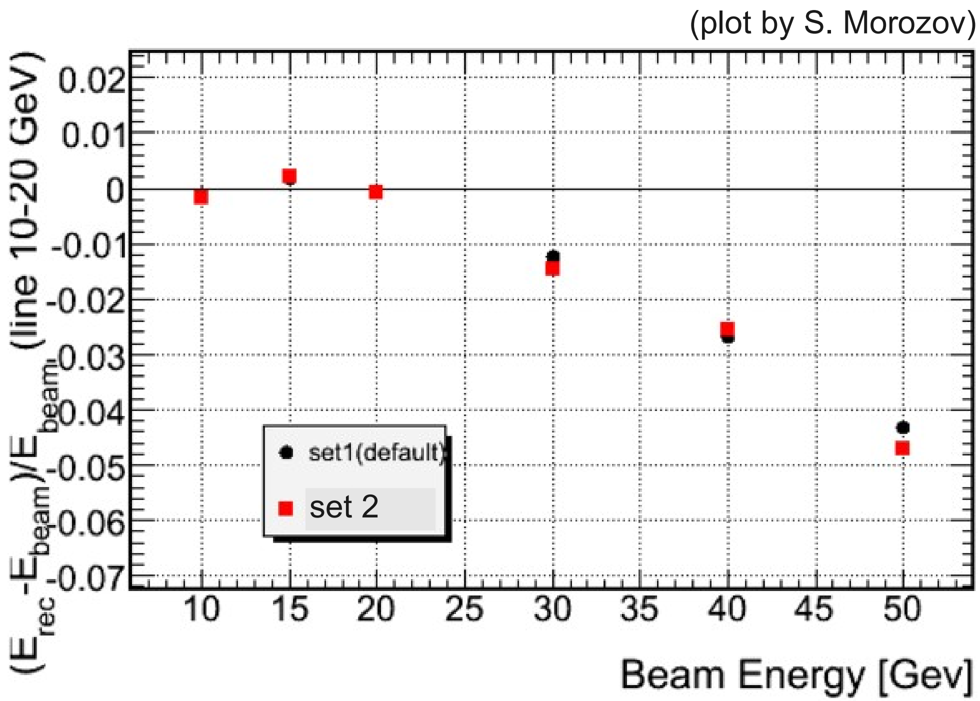
- Gain extraction procedure established and unchanged
- Different methods to determine dG / dT:
  1) use average 1 / G dG / dT = -1.7 %/K (at 27 °C)
  2) linear fit for each channel → need cleanup of data set:
     - Step 1: all gain measurements G_i with σ_i / G_i > 1% → bad
     - Step 2: - do linear fit
       - calculate χ^2 for each data point
       - largest χ^2 && $\chi^2 > 9$ → bad
       - repeat this step until no bad measurement found





Gain: Compare Calibration Sets



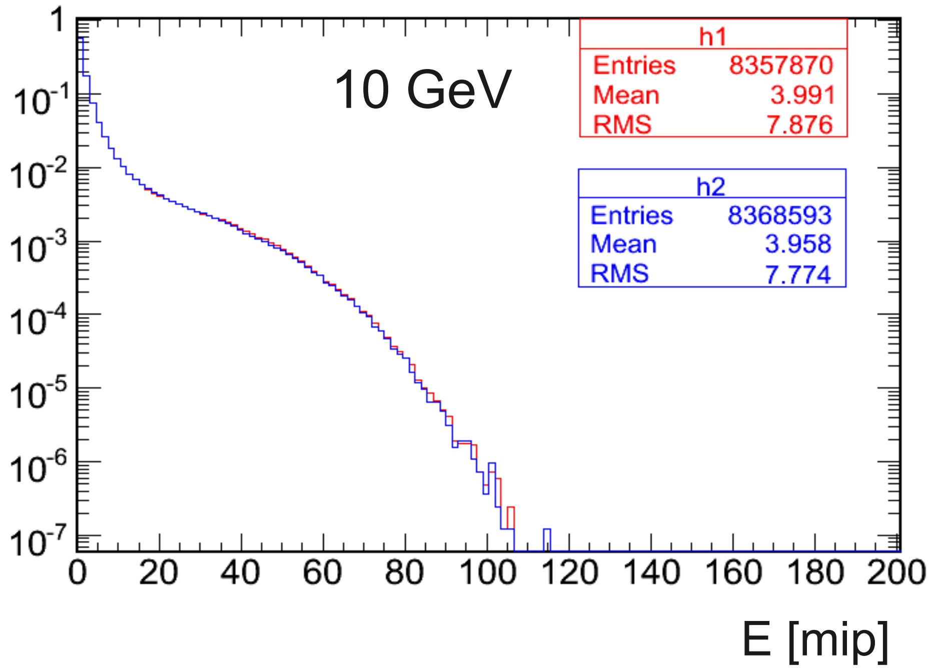


- CERN 2007 electron data

- Different sets of gain constants and gain slopes:
  set 1) 1 / G dG / dT = -1.7 %/K for all channels
  set 2) linear fit for each channel

Gain: Compare Calibration Sets

(plot by S. Morozov)



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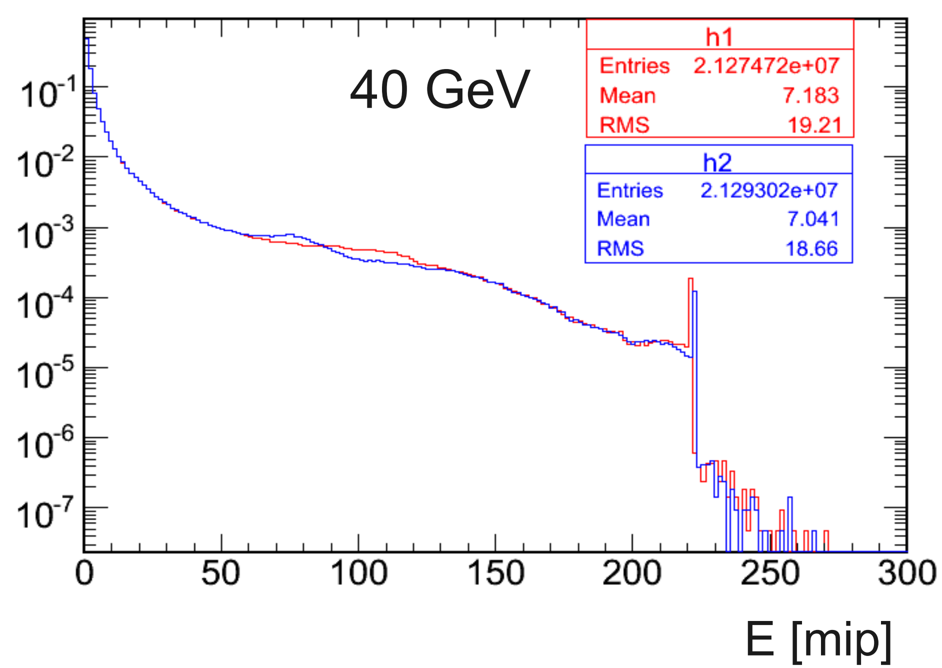
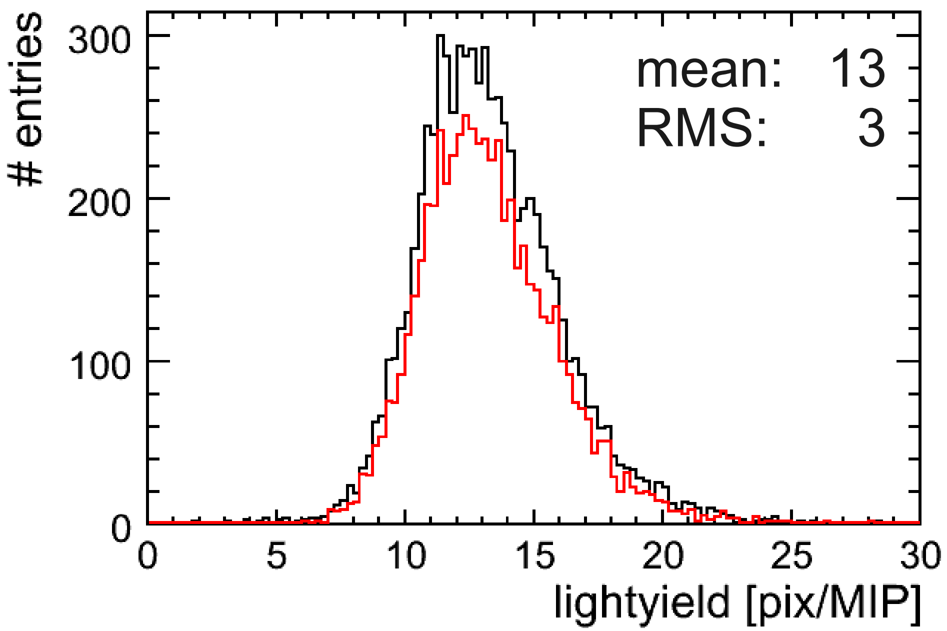


- CERN 2007 electron data
- Different sets of gain constants and gain slopes:
  set 1) 1 / G dG / dT = -1.7 %/K for all channels
  set 2) linear fit for each channel

Gain: Compare Calibration Sets

- # channels, for which gain constant and gain slope are available:
  1) 1 / G dG / dT = -1.7 %/K for all channels → 7339
  2) linear fit for each channel → 5901

- lightyield at 27 °C:



- calibration for reconstruction: **set 1)**

Saturation: Treatment of ITEP Curves

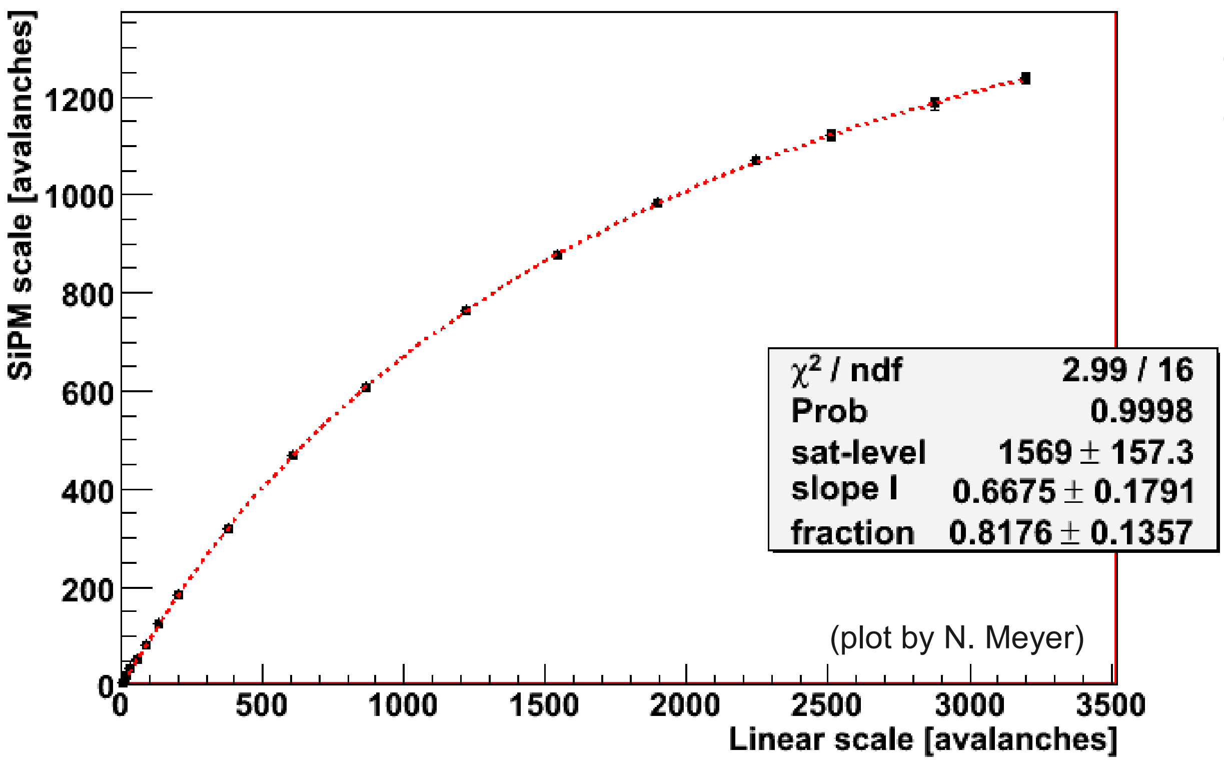
- Basis for saturation correction: Test bench measurements from ITEP

- old procedure:
  - remove 1st point at (0,0)
  - fit line to 1st 3 points
  - scale linear scale to get slope 1

- new procedure:
  - remove 1st point at (0,0)
  - fit function to 1st 10 points:

$$f(x) = a \cdot \left(1 - \exp\left(\frac{-b}{a}(x - c)\right)\right)$$

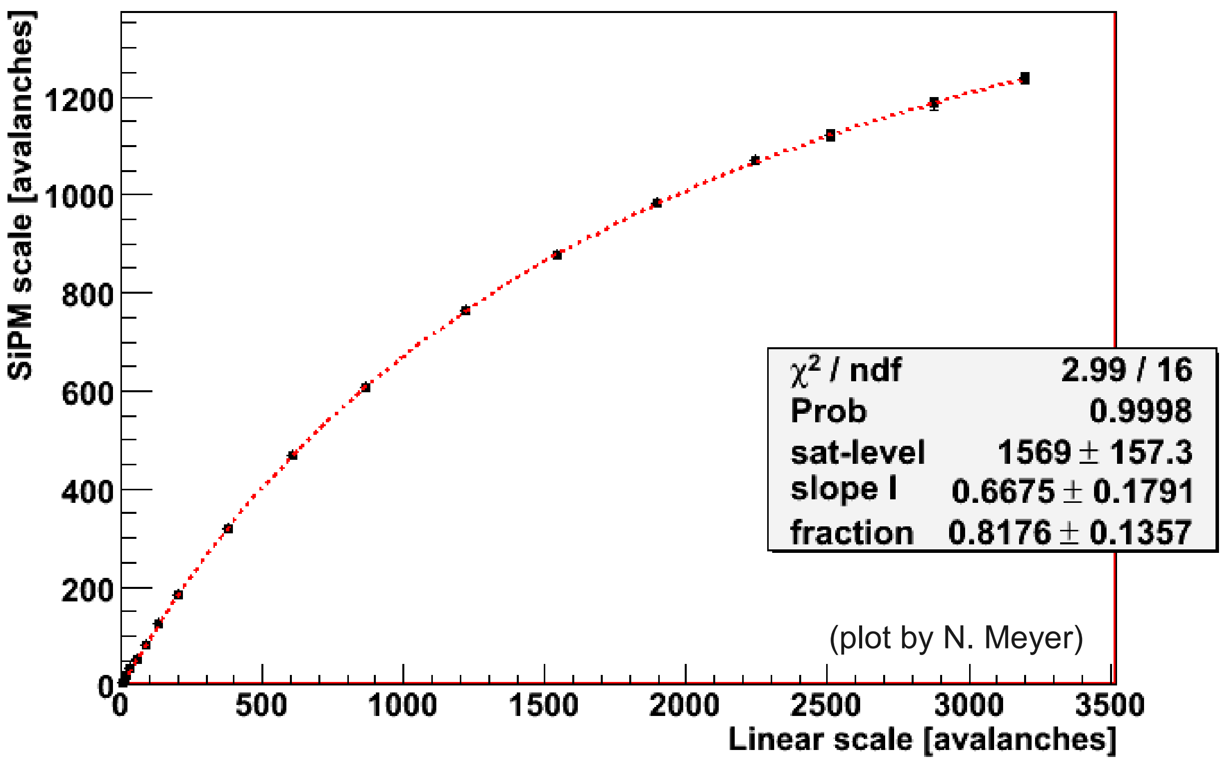
  - shift linear scale by c
  - scale linear scale by b



Saturation: A New Parametrisation

- assume two pixel types (use sum of two exponentials)

- Parametrisation: $$A_{SiPM} = A_{max} \cdot \left(r_1 \cdot \left(1 - \exp\left(\frac{-A_{lin} \cdot s_1}{r_1 A_{max}} \right) \right) + r_2 \cdot \left(1 - \exp\left(\frac{-A_{lin} \cdot s_2}{r_2 A_{max}} \right) \right) \right)$$

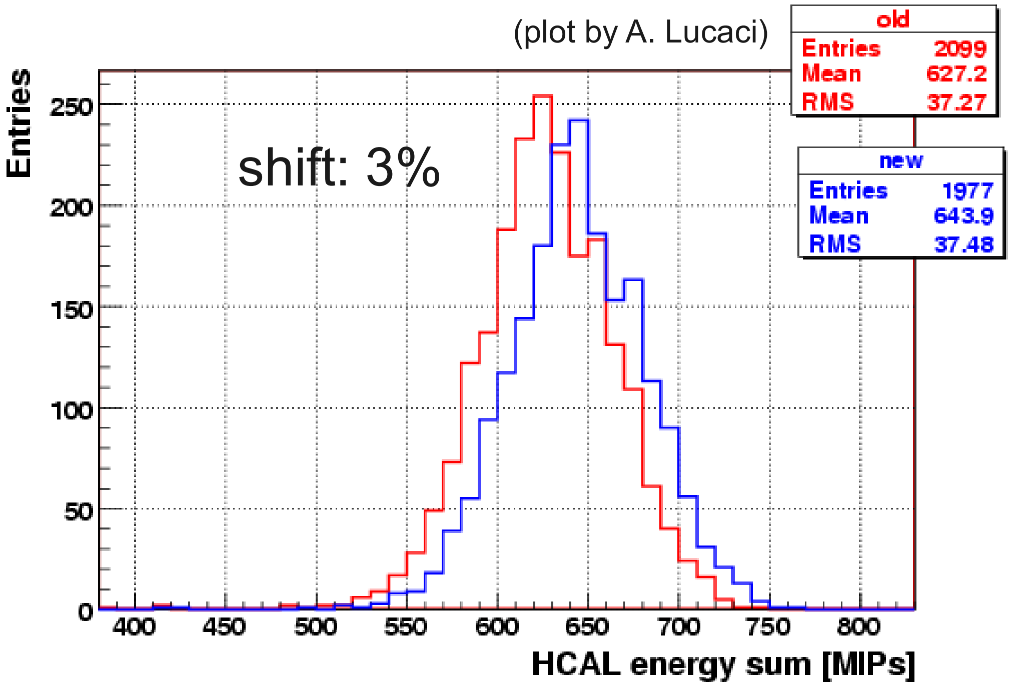


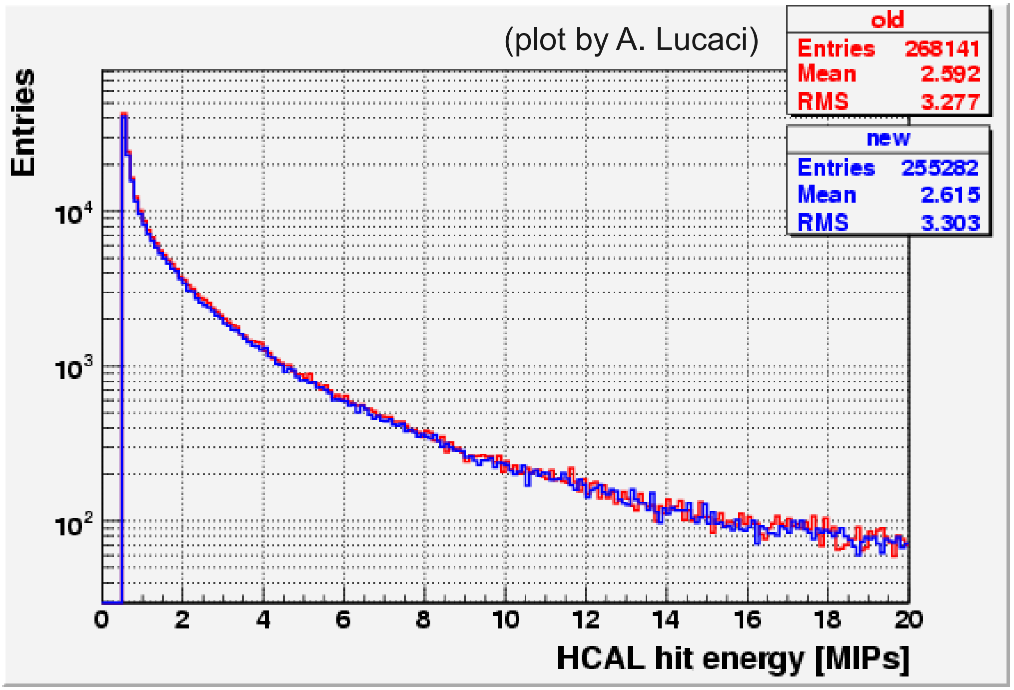
▶ $1 = r_1 + r_2$

▶ $s_2 = \frac{1 - r_1 \cdot s_1}{1 - s_1}$

→ fit fails for some channels, investigation ongoing

Saturation: Effects of Changes





CERN 2007, 15 GeV positrons

- old saturation correction:
    - old treatment of raw ITEP curves (linear fit)
- new saturation correction:
    - new treatment of raw ITEP curves (exponential fit)
    - use parametrised saturation curves
- still missing: individual re – scaling factors for each cell to account for different total number of effective pixels

Conclusions

- Chosen set of MIP constants: MPV from x^2 fit
- Temperature correction
  - slopes (MIP): $1 / A^{MP} \; dA^{MP} / dT$ = -3.8 %/K for all channels
  - slopes (gain): $1 / G \; dG / dT$ = -1.7 %/K for all channels
  - issues with application to FNAL data → to be investigated
- Saturation Correction:
  - new treatment of raw curves (exponential fit to first points)
  - use result from parametrisation
  - procedure / implementation under revision:
    - channels for which parametrisation fails
    - individual re – scaling factors for each cell to account for different total number of effective pixels