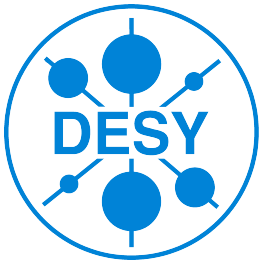
Universität Hamburg



Update on the AHCAL Calibrations

Nils Feege

On Behalf of the Calibration Task Force

HCAL Main Meeting, DESY, 10 December 2009

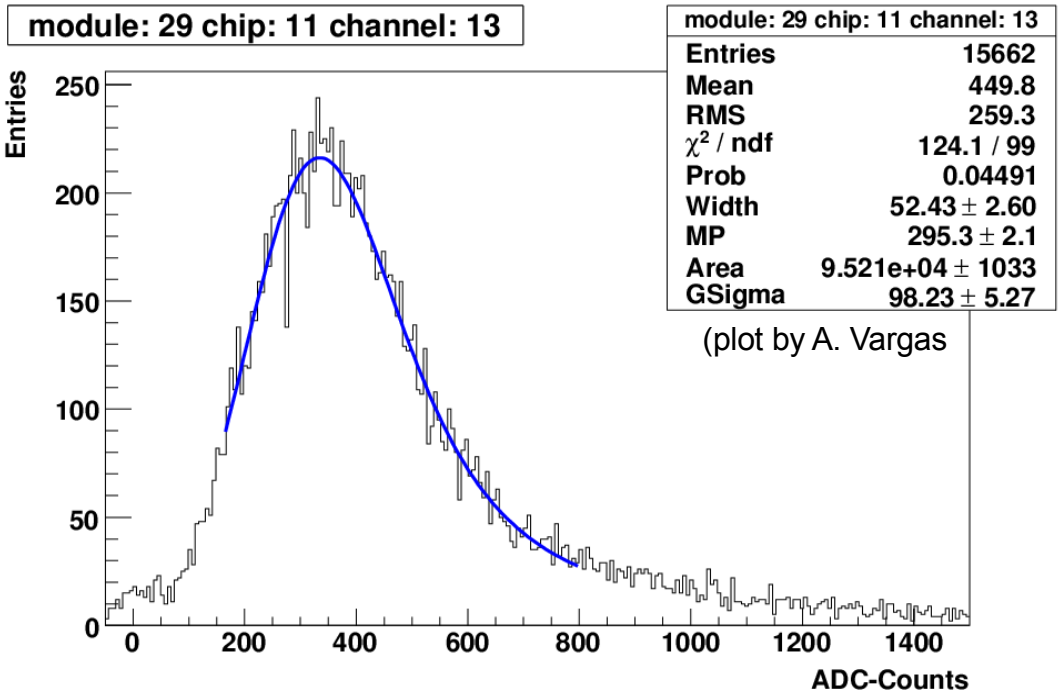
Outline

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

MIP: Measuring Coefficients

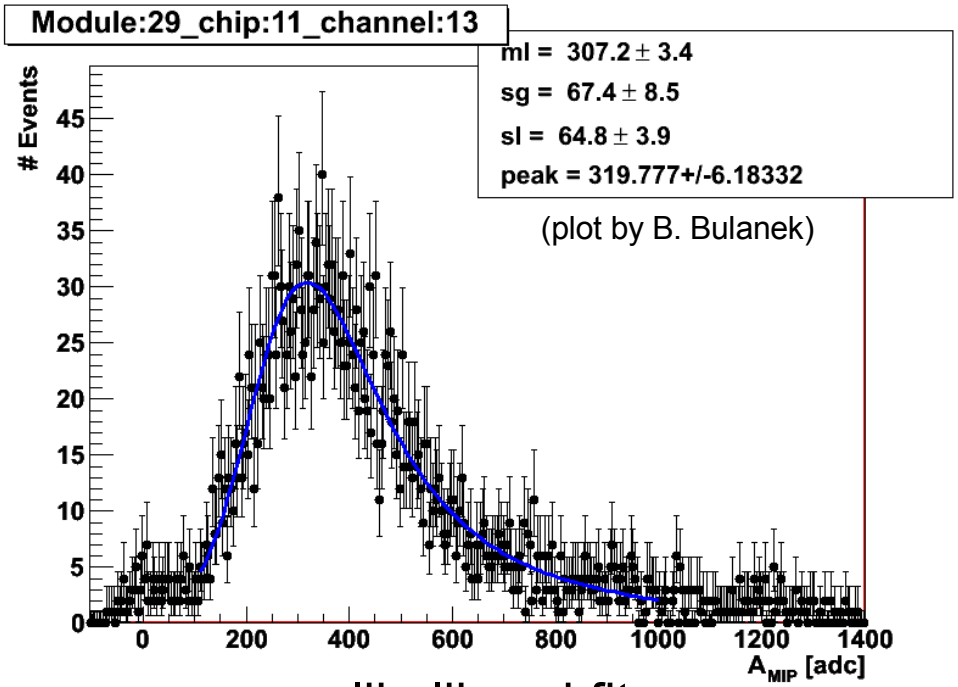
- established method: χ^2 fit
- new approach: maximum likelihood fit

→ more stable
→ handling of empty bins
→ only low statistics required
(results for **each** muon run)



(plot by A. Vargas

χ^2 fit

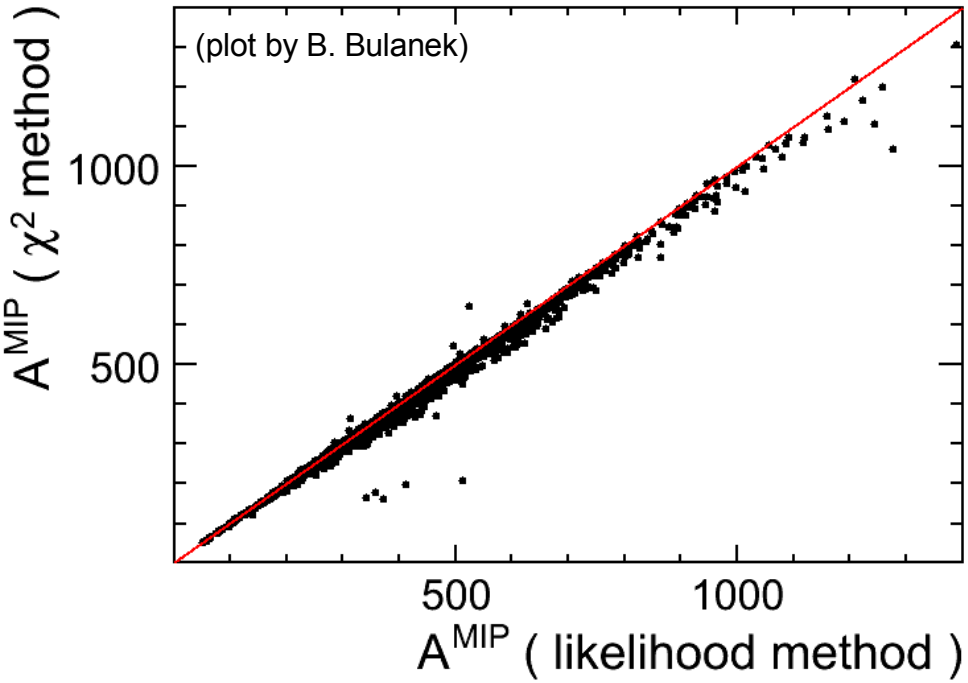


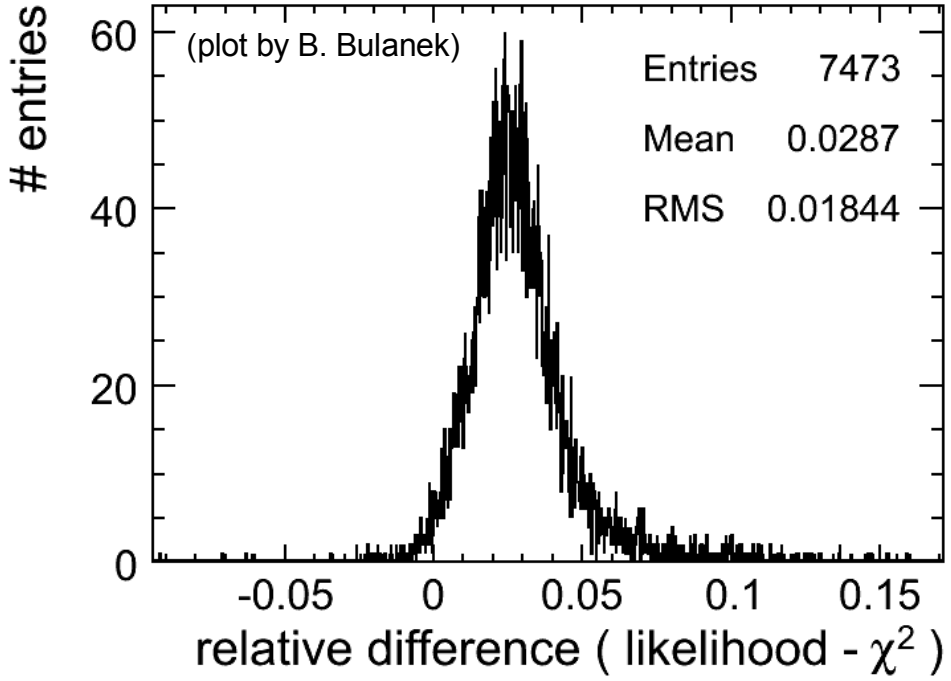
(plot by B. Bulanek)

likelihood fit

example: merging 5 runs

MIP: Comparing χ^2 And Likelihood Fit





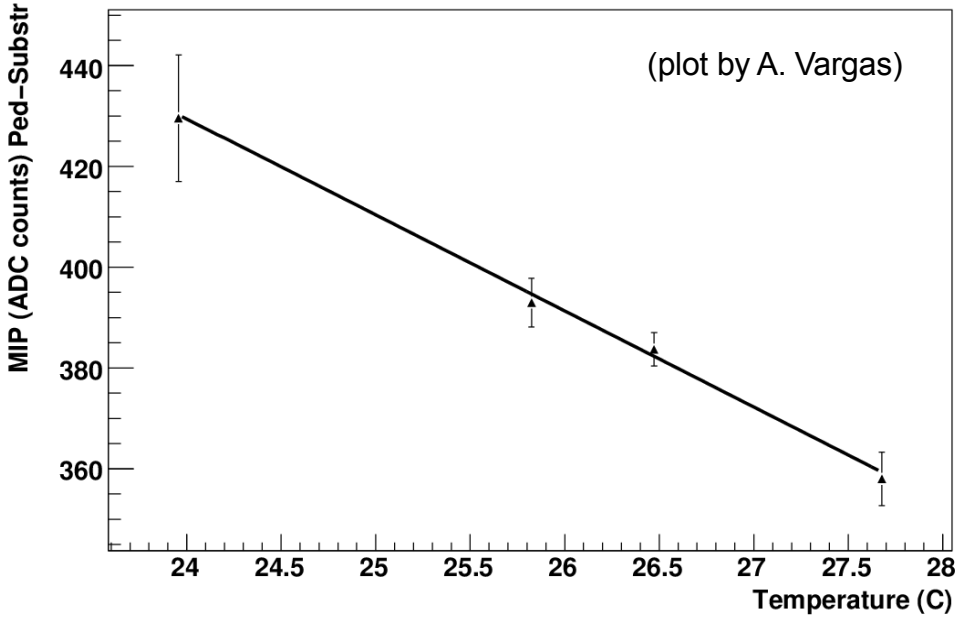
- same data used for both fit methods
- 99.4 % correlation
- shift: results from likelihood fit 3% larger than from χ^2 fit

MIP: Temperature Dependence

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

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

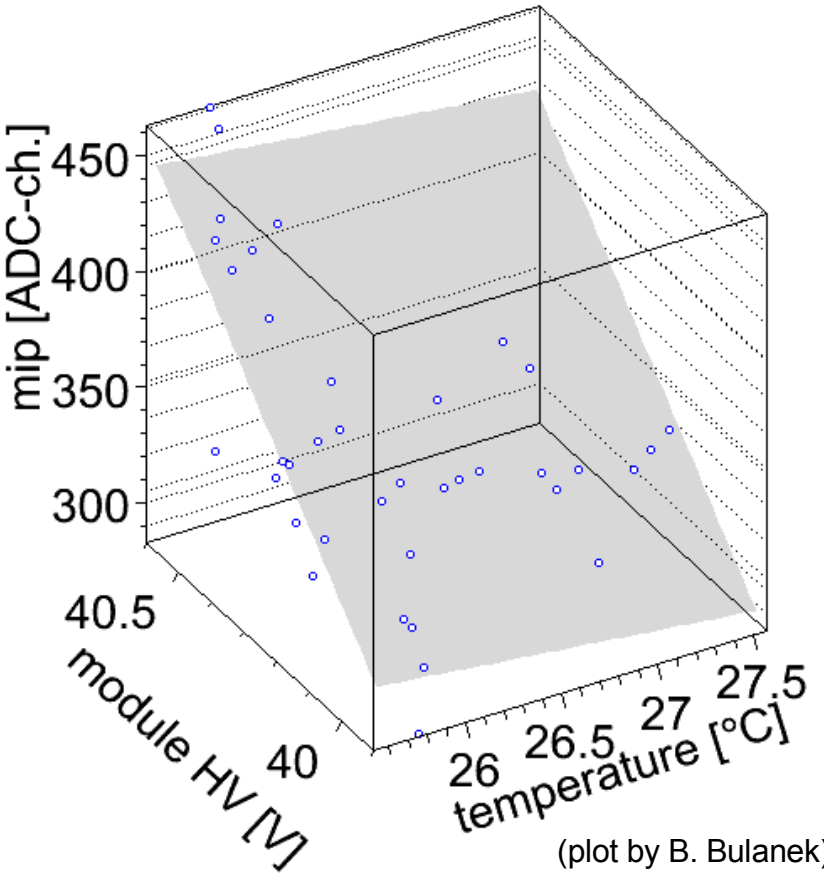
2) linear fit for each channel (χ^2 approach):
need set of mip runs for each point, only few points



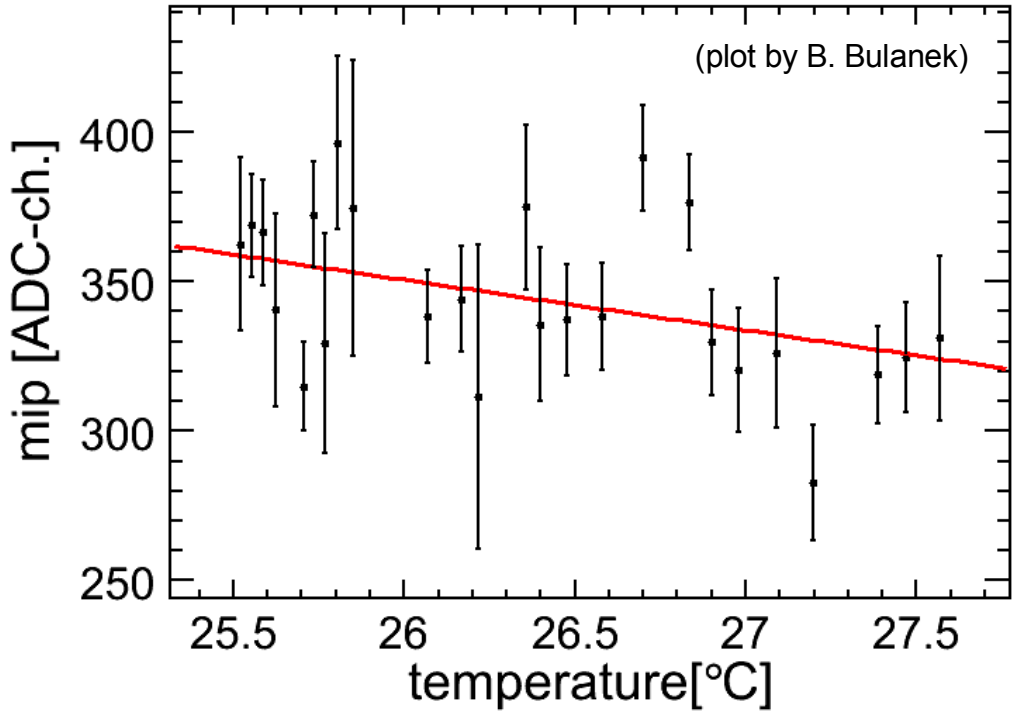
MIP: Temperature Dependence

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

3) planar fit for each channel (include different HV, likelihood approach):
one measurement point per muon run



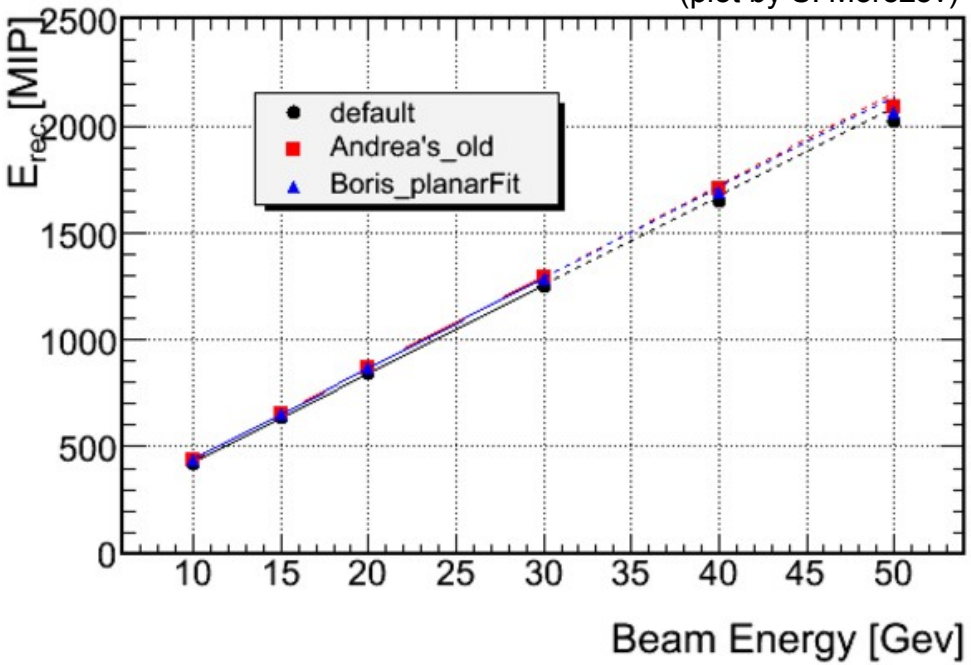
(plot by B. Bulanek)



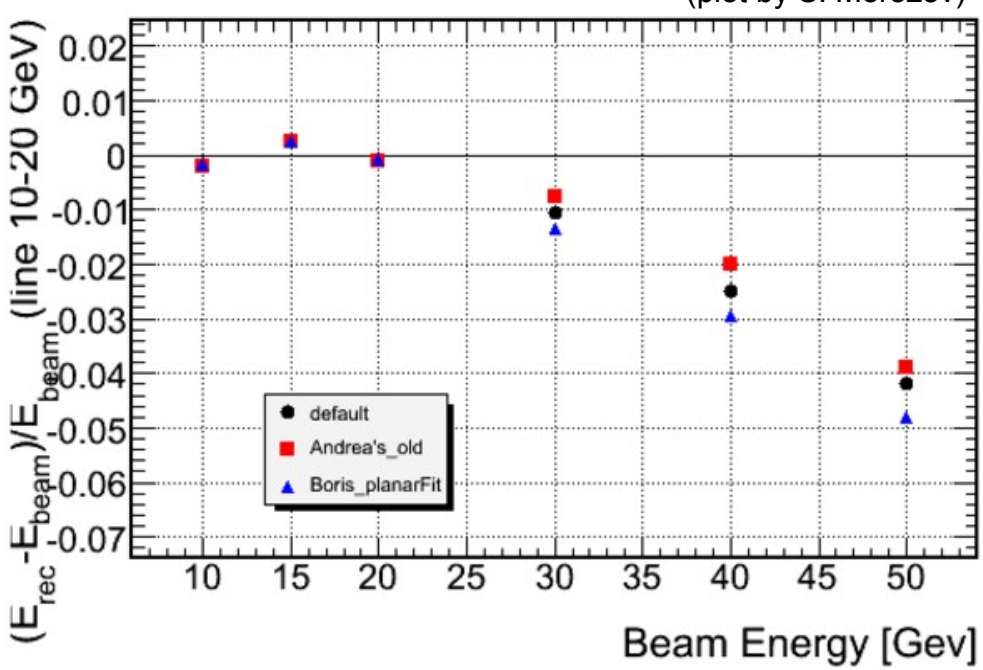
temperature dependence at fixed HV

MIP: Compare Calibration Sets

(plot by S. Morozov)



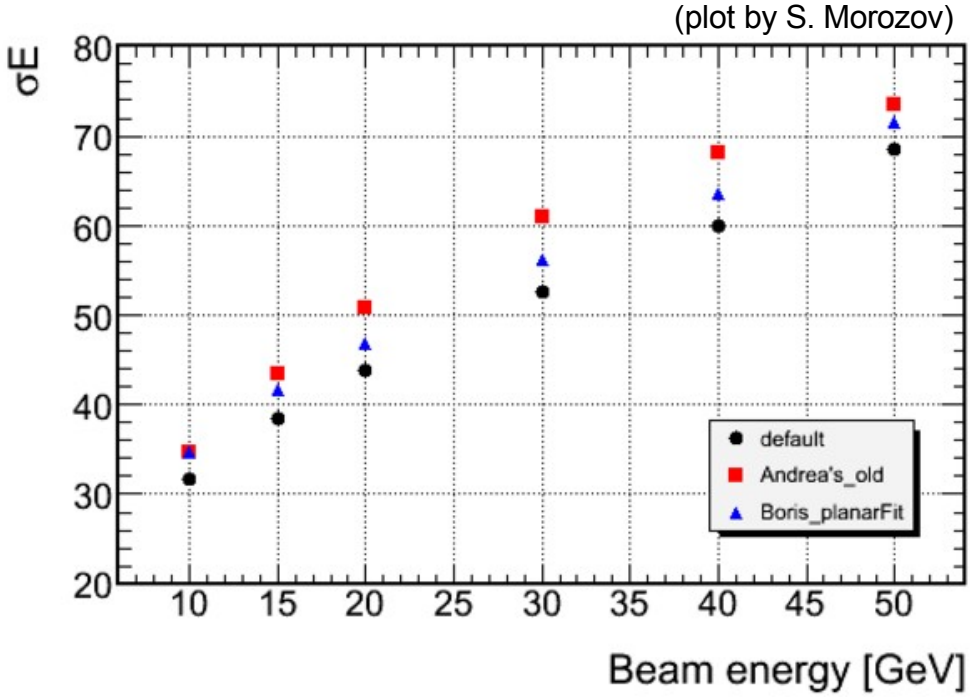
(plot by S. Morozov)



- CERN 2007 electron data
- Different sets of mip constants and mip slopes:
  1) χ^2 fit, $1 / A^{MIP}$ dA^{MIP} / dT = -3.8 %/K for all channels
  2) χ^2 fit, linear fit for each channel
  3) likelihood fit, planar fit for each channel
- excluded: all cells for which any calibration coefficient is missing in any set (FilterBadChannels processor)

MIP: Compare Calibration Sets

(plot by S. Morozov)

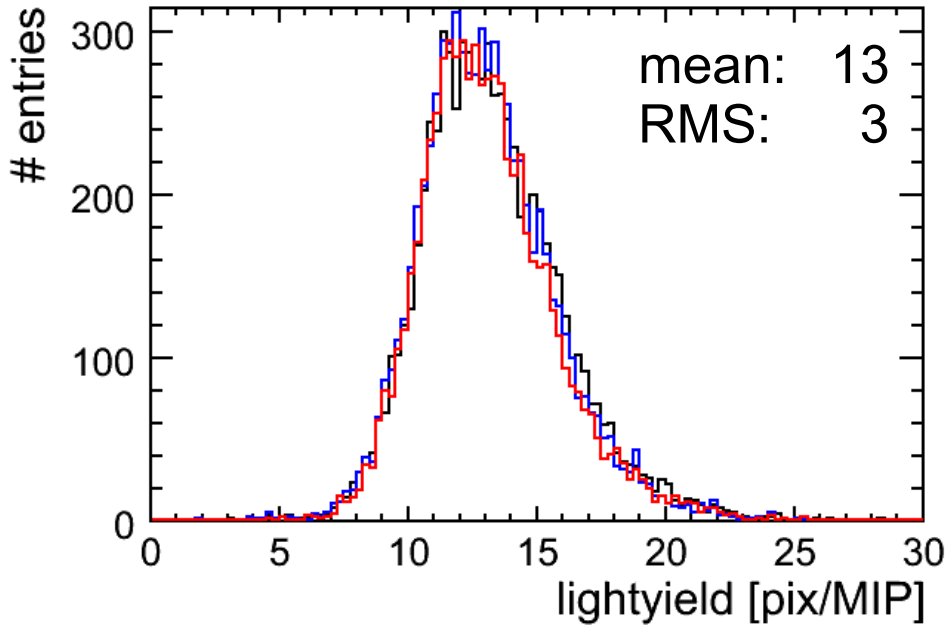


- CERN 2007 electron data
- Different sets of mip constants and mip slopes:
  1) χ^2 fit, $1 / A^{MIP}$ dA^{MIP} / dT = -3.8 %/K for all channels
  2) χ^2 fit, linear fit for each channel
  3) likelihood fit, planar fit for each channel
- excluded: all cells for which any calibration coefficient is missing in any set (FilterBadChannels processor)

MIP: Compare Calibration Sets

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

- lightyield at 27 °C:

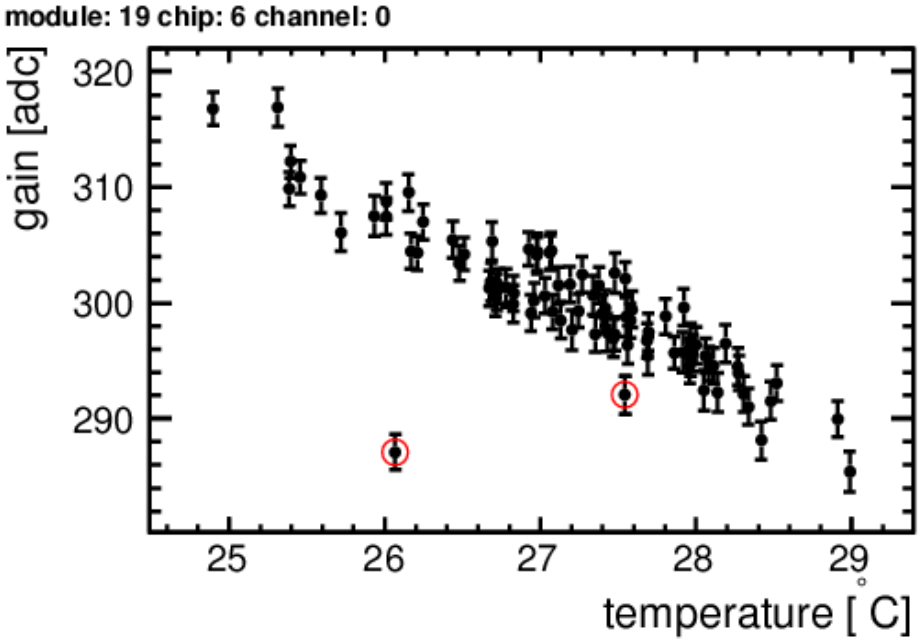


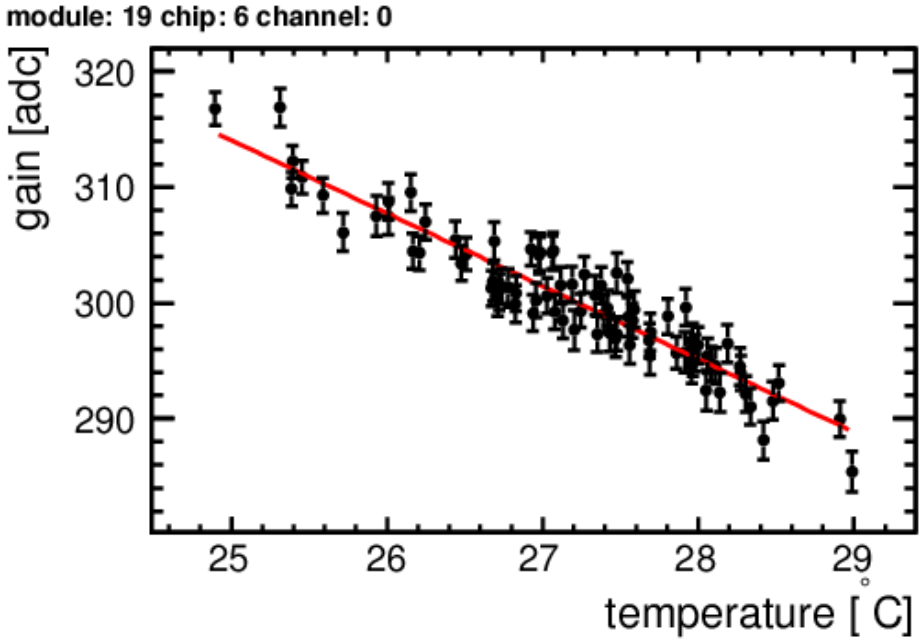
- calibration for reconstruction: **set 1)**

Gain Temperature Dependence

Different methods to determine dG / dT:

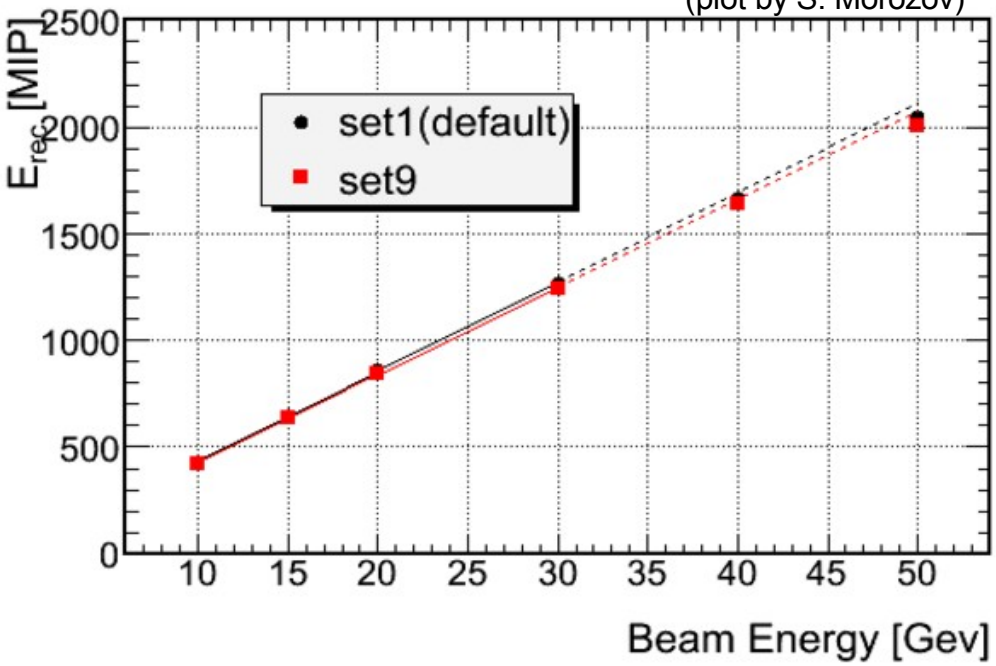
1) use average 1 / G dG / dT = -1.7 %/K (at 27 °C)
2) linear fit for each channel → need cleanup of data set:
   - Step 1: all gain measurements G_i with σ_i / G_i > 1% → bad
   - Step 2: - do linear fit
     - calculate χ^2 for each data point
     - largest χ^2 && χ^2 > 9 → bad
     - repeat this step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



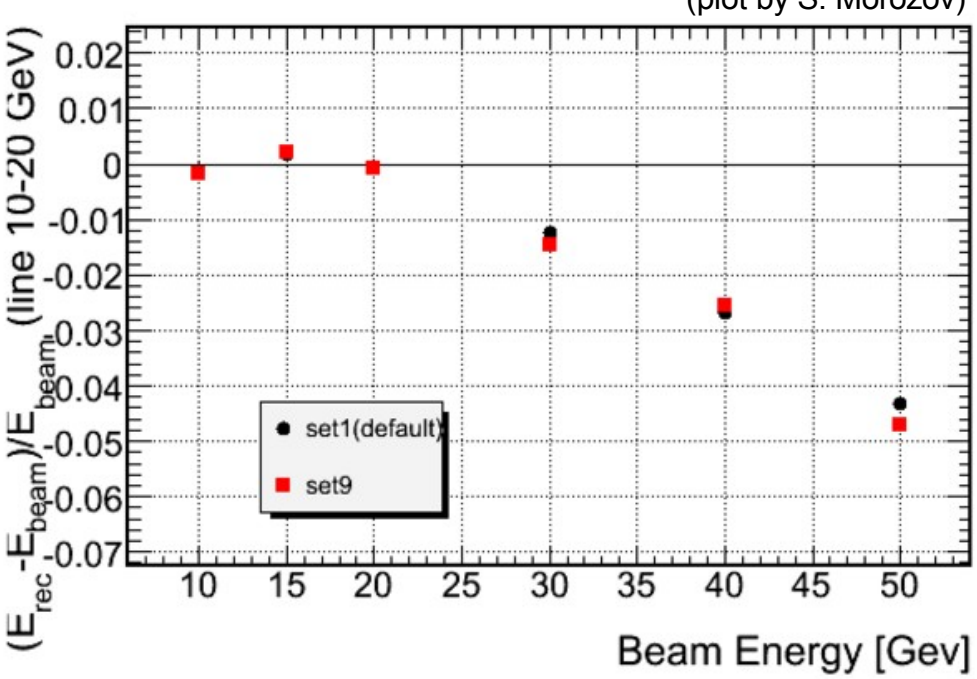


Gain: Compare Calibration Sets

(plot by S. Morozov)



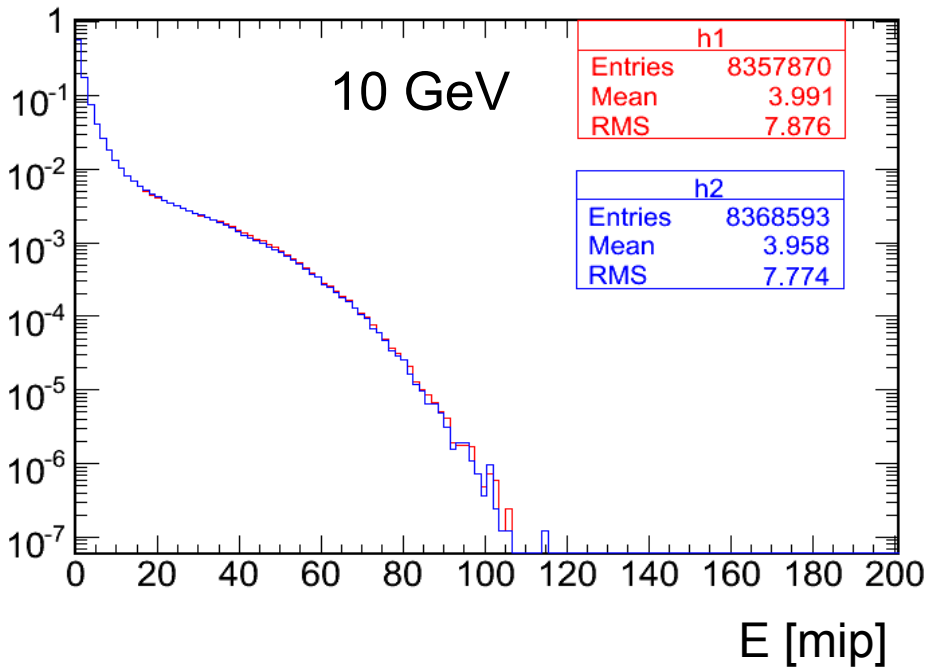
(plot by S. Morozov)



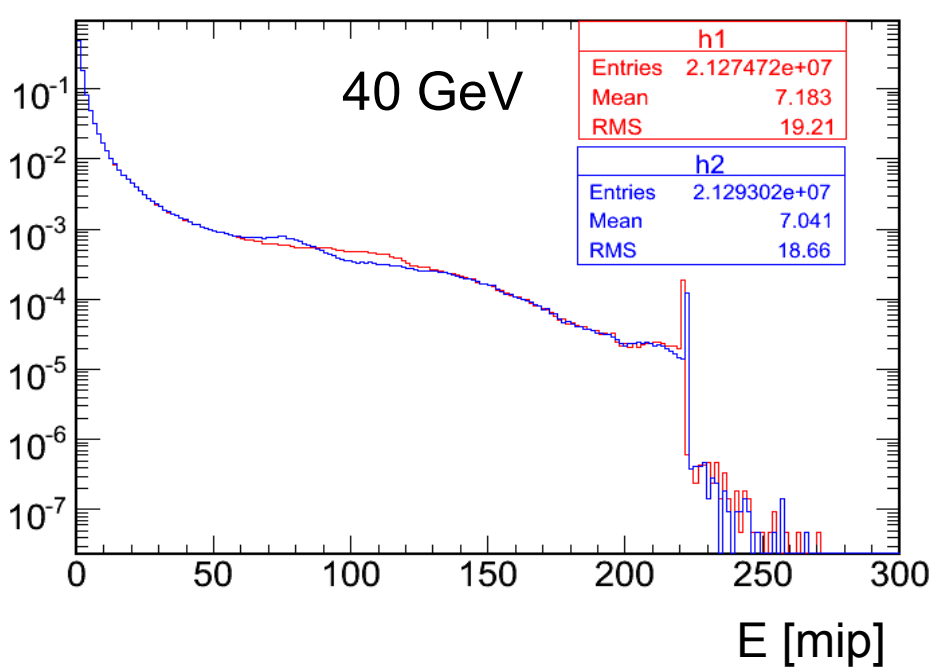
- CERN 2007 electron data
- Different sets of gain constants and gain slopes:
  1) 1 / G dG / dT = -1.7 %/K for all channels
  2) linear fit for each channel

Gain: Compare Calibration Sets

(plot by S. Morozov)



(plot by S. Morozov)

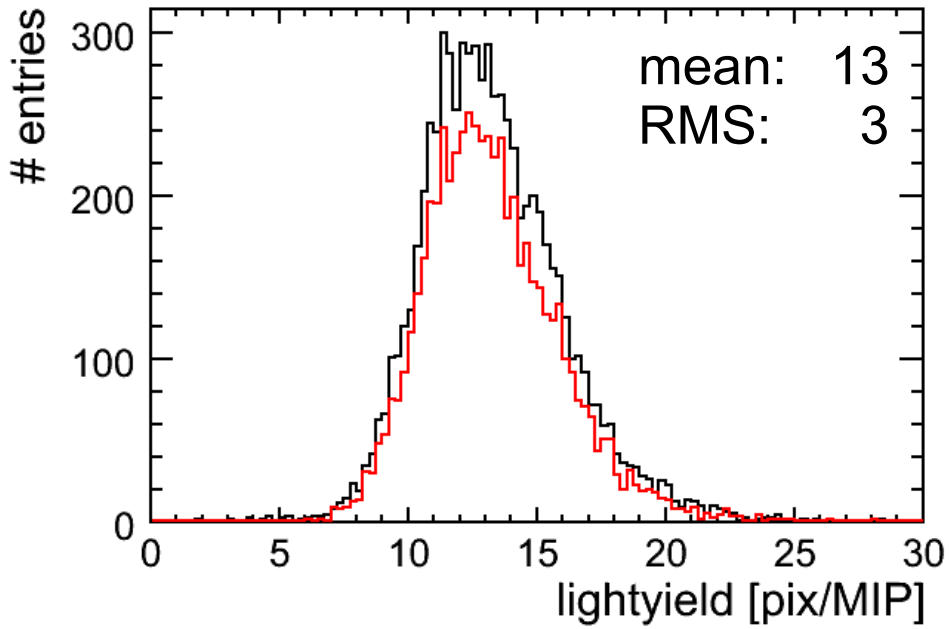


- CERN 2007 electron data
- Different sets of gain constants and gain slopes:
  1) 1 / G dG / dT = -1.7 %/K for all channels
  2) linear fit for each channel

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: Latest Developments

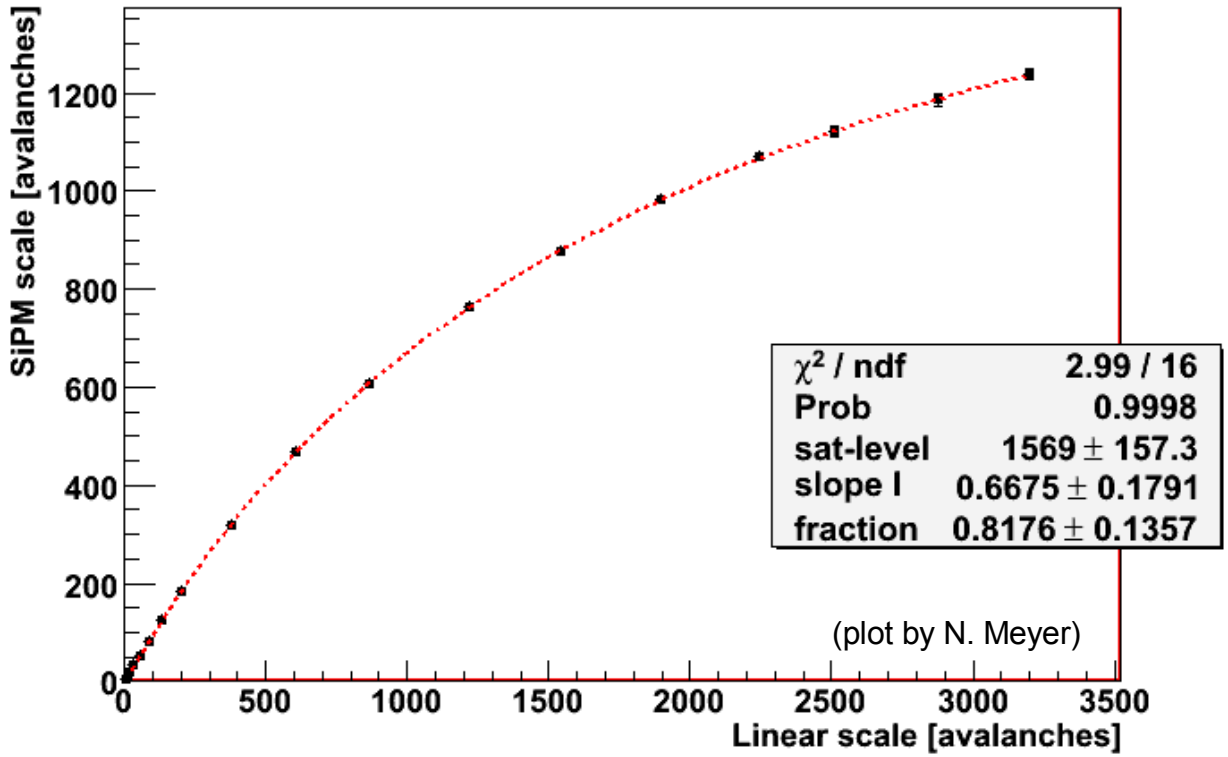
- treatment of raw ITEP curves (force initial slope = 1):
  - old procedure:
    - remove 1st point at (0,0)
    - fit line to 1st 3 points
    - scale linear scale by slope
  - new procedure:
    - remove 1st point at (0,0)
    - fit function to 1st 10 points: $f(x) = a \cdot \left(1 - \exp\left(\frac{-b}{a}(x-c)\right)\right)$
    - shift linear scale by c
    - scale linear scale by b

- new software implementation (currently only in CVS, calice_pro_test uses old)

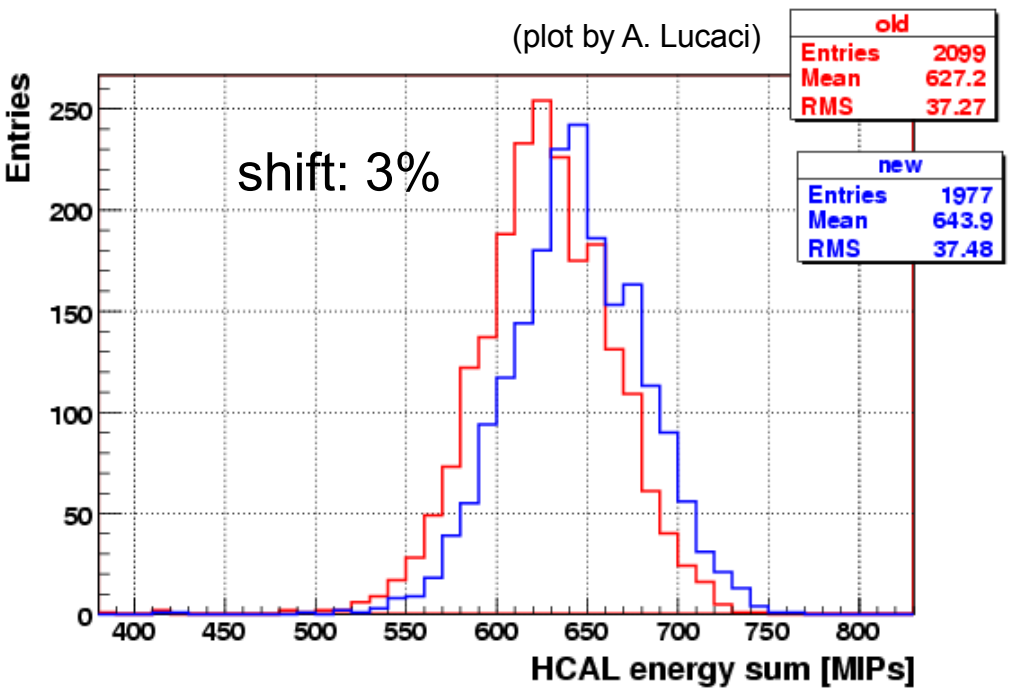
Saturation: A New Parametrisation

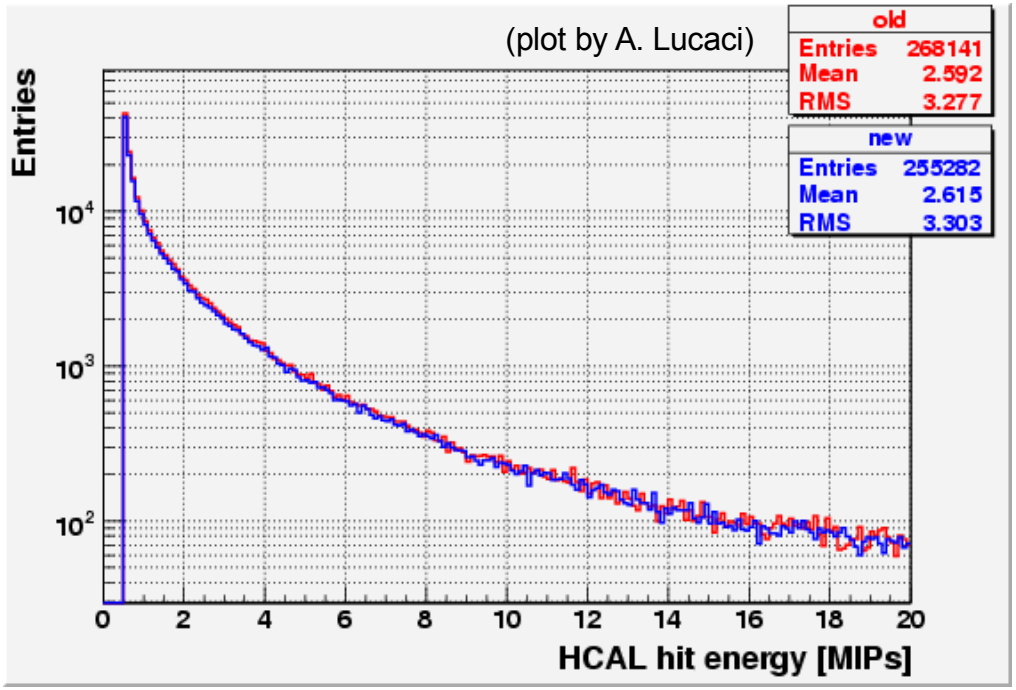
- assume two pixel types (use sum of two exponentials)
- Parametrisation: $$A_{SiPM} = A_{max} \cdot \left(r_1 \cdot \left(1 - \exp\left(\frac{-A_{lin} \cdot s_1}{r_1 A_{max}} \right) \right) + r_2 \cdot \left(1 - \exp\left(\frac{-A_{lin} \cdot s_2}{r_2 A_{max}} \right) \right) \right)$$
  - $1 = r_1 + r_2$
  - $s_2 = \frac{1 - r_1 \cdot s_1}{1 - s_1}$

→ fit works good for > 95% of channels, the others need to be checked



Saturation: Effects of Changes





CERN 2007, 15 GeV positrons

- old saturation correction:
  - latest calice_pro_test software implementation
  - old treatment of raw ITEP curves (linear fit)
- new saturation correction:
  - new software implementation (CVS only)
  - use parametrised saturation curves

Conclusions

The calibration for the 'official' reconstruction:

- **MIP**: $1 / A^{MIP}\ \ dA^{MIP} / dT$ = -3.8 %/K for all channels
  - constants: /cd_calice/Hcal/mip_constants (ahc_mip_constants_002)
  - slopes: /cd_calice/Hcal/mip_slope (ahc_mip_slopes_002)
- **Gain**: $1 / G\ \ dG / dT$ = -1.7 %/K for all channels
  - constants: /cd_calice/Hcal/gain_constants (ahc_gain_constants_002)
  - slopes: /cd_calice/Hcal/gain_slopes (ahc_gain_slopes_002)
- **Intercalibration:**
  - constants: /cd_calice/Hcal/ic_constants (ahc_ic_constants_002)
- **Saturation Correction:**
  new implementation and parametrisation of raw curves
  - /cd_calice/Ahc/ResponseCurve (ahc_response_curve_002)

Next Steps

- improve validation procedure
- validate calibration for FNAL
- saturation curves: investigate individual re-scaling factors for each cell
- continue studies of temperature correction