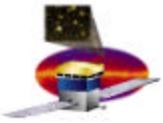


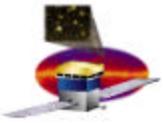
Gain and linearity correction

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General approach

- Charge injection calibration gives for each channel the map $dac[i]$, $adc[i]$, where
 - $dac[i]$ is DAC settings defining the calibration pulse height
 - $adc[i]$ is the average adc value for corresponding peak.
- Function $adc_to_dac(adc)$ is defined to convert ADC values to the DAC scale, supposed to be linear.
- From muon calibration run the average adc value of muon peak is determined for range 0 of each log end.
- Gain is defined as
 - $gain01 = MI P / adc_to_dac(mu_peak)$ for small diode (ranges 0 and 1)
 - $gain23 = 60 * gain01$ for big diode (ranges 2 and 3)
- To convert adc values to energy following formula is used:
$$Energy = gain * dac_to_adc(adc)$$



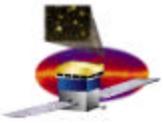
Linearity corrections-2000

- Quadratic-quadratic model used for conversion

$$adc_to_dac(adc) = f(adc - ped)$$

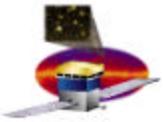
$$f(x) = \begin{cases} a_0 + a_1x + a_2x^2, & x < brkpt \\ b_0 + b_1x + b_2x^2, & x > brkpt \end{cases}$$

- parameters $a_0, a_1, a_2, b_0, b_1, b_2, brkpt$ - obtained by fitting charge injection peaks for each channel.

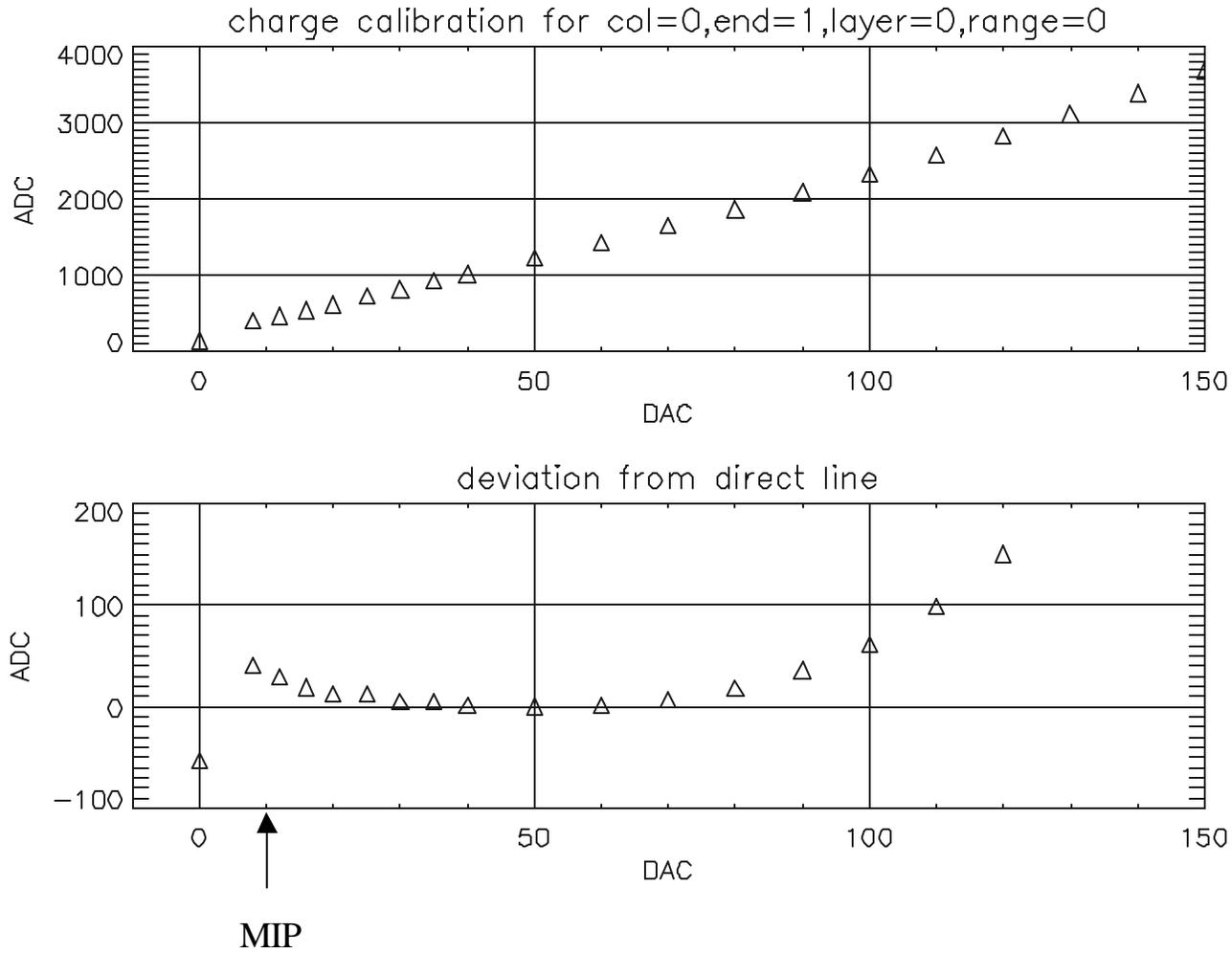


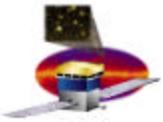
Main modifications in linearity correction

- Pedestals are unstable – they are not used for conversion any more.
- Adc=> dac conversion: quadratic-quadratic fit is replaced by lookup table with linear interpolation between adjacent points.



Example of charge calibration data



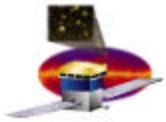


New correction algorithm

- For ADC value find $i > 0$ such that $adc[i] < ADC < adc[i+1]$, or set $i=1$ ($i=0$ corresponds to pedestal value)
- Conversion $ADC \Rightarrow DAC$:

$$DAC = \frac{dac [i + 1] - dac [i]}{adc [i + 1] - adc [i]} \cdot (ADC - adc [i])$$

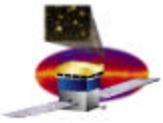
- if $DAC < 3$ energy is set to 0 (to avoid nonlinear behavior of peak finder below certain threshold)
- Conversion to MeV for each range: $Energy = gain * DAC$



New calibration files

The names of two new calibration files are defined by parameters of CalRecLogsAlg:

- **MuPeaksFile** – contains average adc value of muon peak for each channel;
- **ChargePeaksFile** – contains dac and adc values for all charge calibration peaks of each channel.



Test of longitudinal coordinate measurement

Measurement of coordinate along CsI log is very sensitive to linearity and gain correction, thus it could be used to verify that calorimeter is correctly calibrated in MIP energy region.

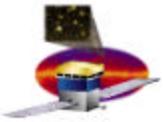
Longitudinal coordinate is calculated from asymmetry of response from two ends of each CsI log:

$$X = \text{Slope} * (E_p - E_m) / (E_p + E_m)$$

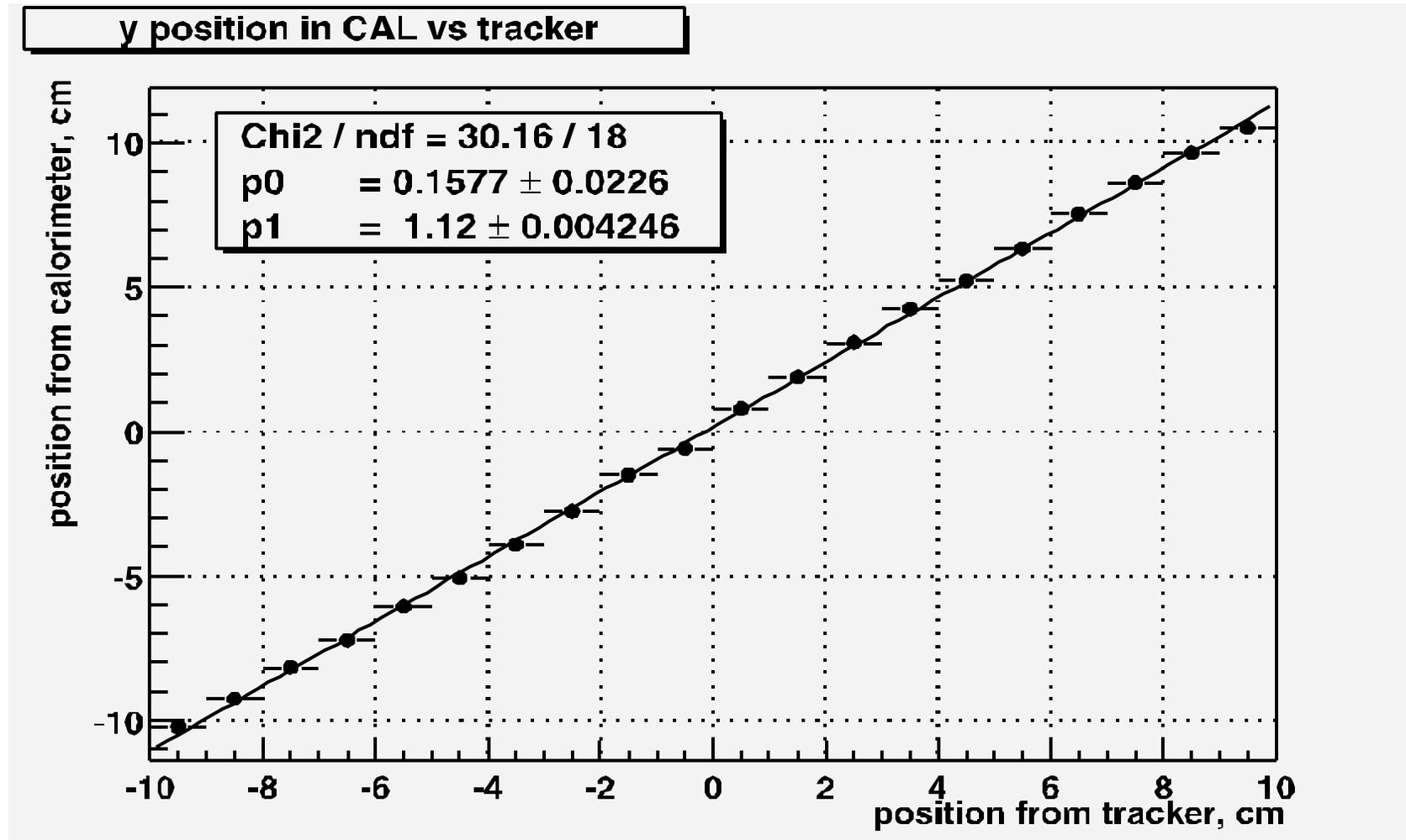
Slope for each log was determined from muon run by finding correlation between the response asymmetry and the coordinate in certain log calculated from tracker information.

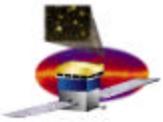
Comparison of coordinates measured by tracker and calorimeter for cosmic muons didn't show any deviations of linear behavior (see next slide).

Difference of tracker and calorimeter measurement has gaussian distribution with sigma~2.5 cm and rather small tails.



Linearity of longitudinal coordinate measurement (all Y logs superimposed)





Precision of longitudinal coordinate measurement

