LI Gain Curves

Phone meeting 10th November

Peter Litchfield

- The Idea: Fit all the information for one strip together->gives constraints on the model and parameters.
- Each end of the strip is flashed by a different led and read out by;
  - The near end pmt
  - The far end pmt
  - A high gain pin
  - A low gain pin
- Eight sets of measurements at different led intensity

The model

- I assume that each pmt and pin has a correction function which is up to quadratic in the read out adc value.
- Denote the two sides as side A and side B

$$Pmt_t^A = Pmt_m^A(1.0 + a_1 Pmt_m^A + a_2 \left(Pmt_m^A\right)^2)$$

$$Pmt_t^B = Pmt_m^B(1.0 + b_1 Pmt_m^B + b_2 \left(Pmt_m^B\right)^2)$$

$$LPin_t^A = LPin_m^A(1.0 + c_1 LPin_m^A + c_2 \left(LPin_m^A\right)^2)$$

$$HPin_t^A = HPin_m^A(1.0 + d_1 HPin_m^A + d_2 \left(HPin_m^A\right)^2)$$

$$LPin_t^B = LPin_m^B(1.0 + e_1 LPin_m^B + e_2 \left(LPin_m^B\right)^2)$$

$$HPin_t^B = HPin_m^B(1.0 + f_1 HPin_m^B + f_2 \left(HPin_m^B\right)^2)$$

- Subscript $_t$ values are the true values, subscript $_m$ the measured values

The model

- Each true value is assumed to be associated with the others by a constant

$$Pmt_t^{An} = x_0 Pmt_t^{Af} \qquad Pmt_t^{Bn} = x_5 Pmt_t^{Bf}$$

$$Pmt_t^{An} = x_1 LPin_t^{A} \qquad Pmt_t^{Bn} = x_6 LPin_t^{B}$$

$$Pmt_t^{An} = x_2 HPin_t^{A} \qquad Pmt_t^{Bn} = x_7 HPin_t^{B}$$

$$Pmt_t^{Af} = x_3 LPin_t^{A} \qquad Pmt_t^{Bf} = x_8 Lpin_t^{B}$$

$$Pmt_t^{Af} = x_4 HPin_t^{A} \qquad Pmt_t^{Bf} = x_9 HPin_t^{B}$$

$$LPin_t^{A} = x_{10} HPin_t^{A} \qquad LPin_t^{B} = x_{11} HPin_t^{B}$$

- The superscripts n and f refer to the near and far readout of the led side A or B. Thus $Pmt_t^{Af} = Pmt_t^{Bn}$
- For a quadratic fit we have 12 measurements at up to 20 led intensities and 24 unknowns

A typical strip

- The data for two fairly typical strips is given in the next four slides. There is a lot of data and it may be difficult to read on the slide. The ps files are also on the web at www.hep.umn.edu/~pjl/li/phone_meeting_10nov/ I suggest that you print them if you want to follow the arguments.
- The slides plot the difference between the fitted true value and the predicted true value e.g

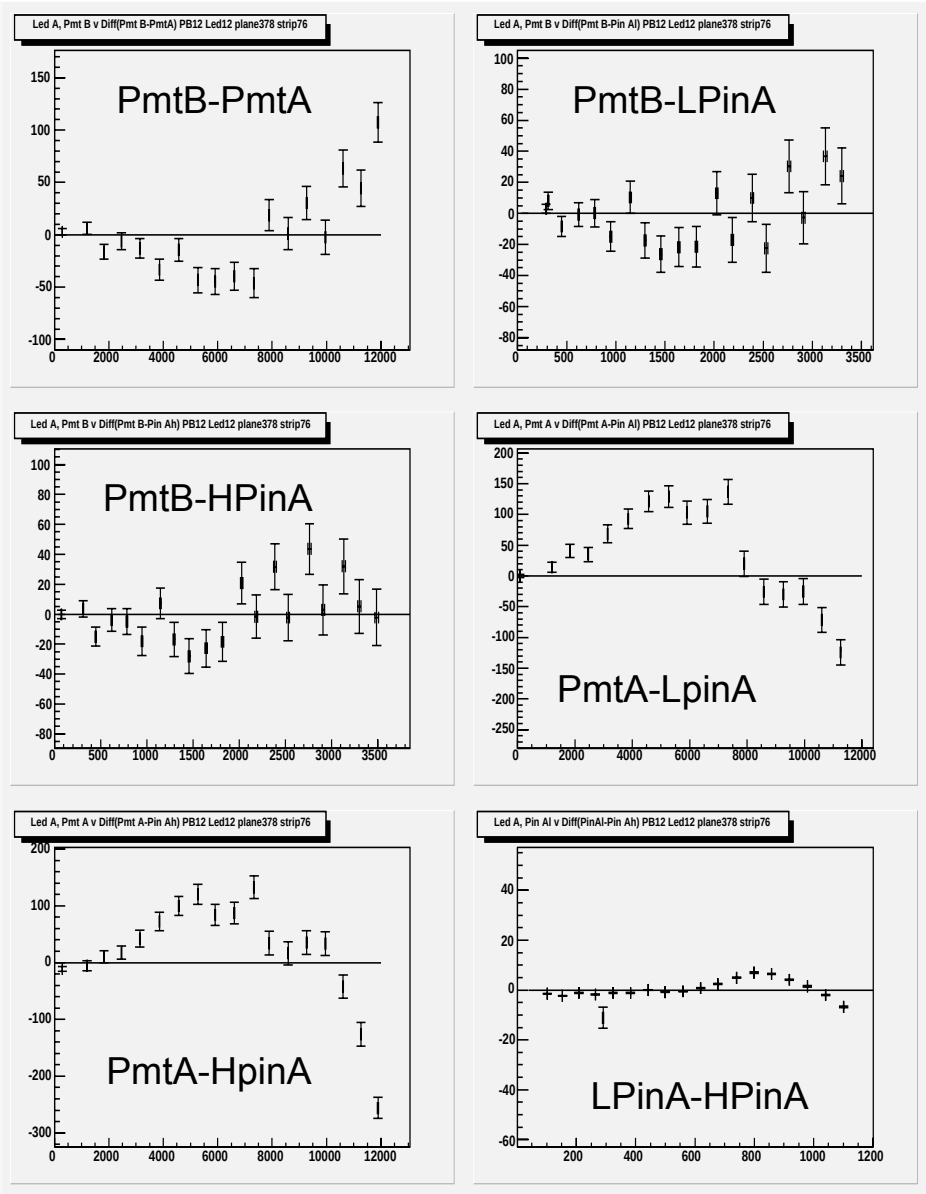
$$Pmt_t^{An} - x_0 Pmt_t^{Bf}$$

- The 6 left hand plots are for side A and the 6 right hand plots for side B
- The first slide (with _0_ in the web plot name) is for no correction, the second slide (with _2_) for a quadratic correction.

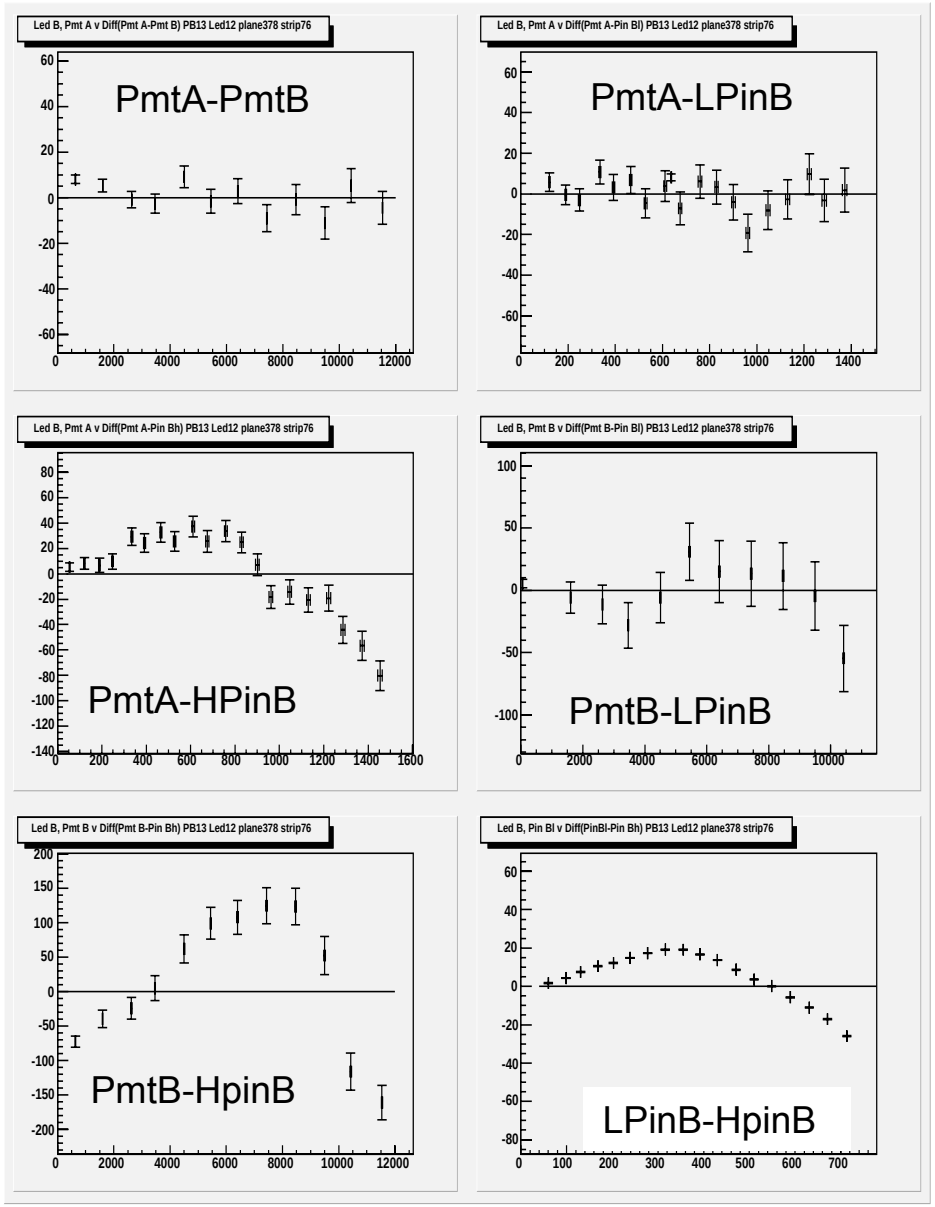
What does it show?

- **The no correction plots**
  1. The high and low gain pins are not linear with each other (bottom right plot).
  2. The PmtA-PmtB and PmtB-PmtA plots are different (top left). If the effect was just a correction to the measured values they would have to be the same?
  3. There are big effects in the Pmt v Pin plots, bigger than in either Pmt v Pmt or Pin v Pin. There must be some cancellation in the these plots.
  4. The biggest effects are in the Near Pmt v Pin in both the A and B sides.
- **The quadratic correction plots**
  1. The fit is improved but there does not seem to be a solution that removes all the discrepancies
  2. The best correction functions are shown in the third slide

Pb 12 Led 12 Plane 378 Strip 76

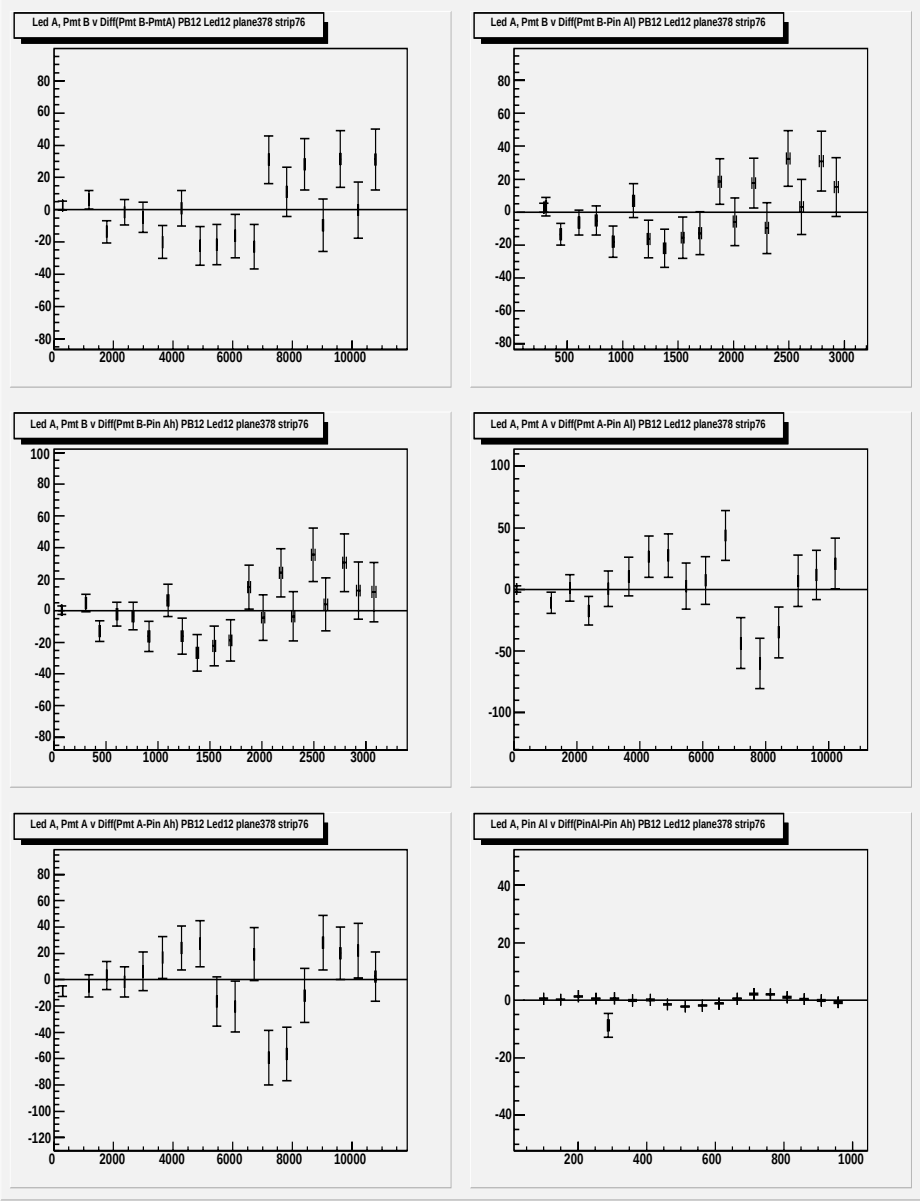


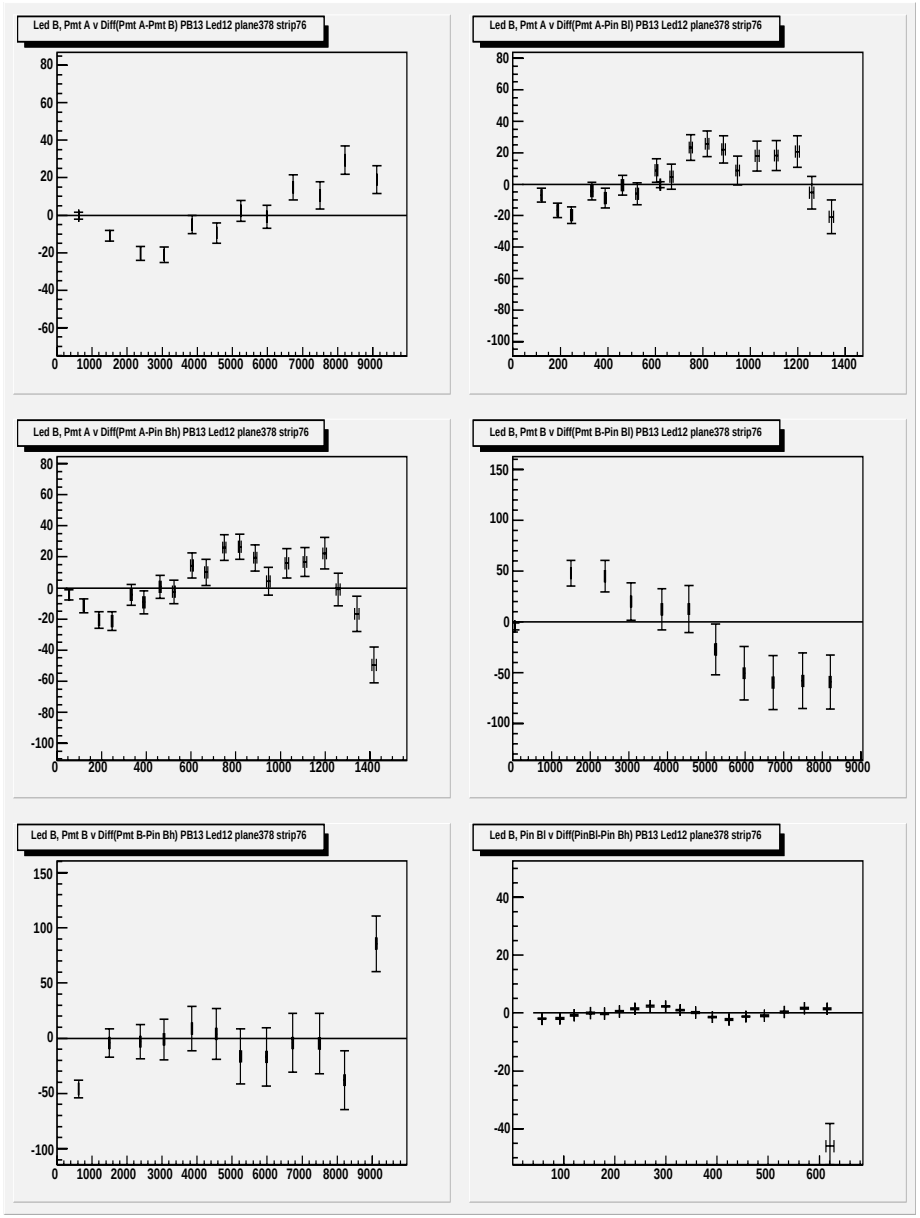
A side



B side

Pb 12 Led 12 Plane 378 Strip 76

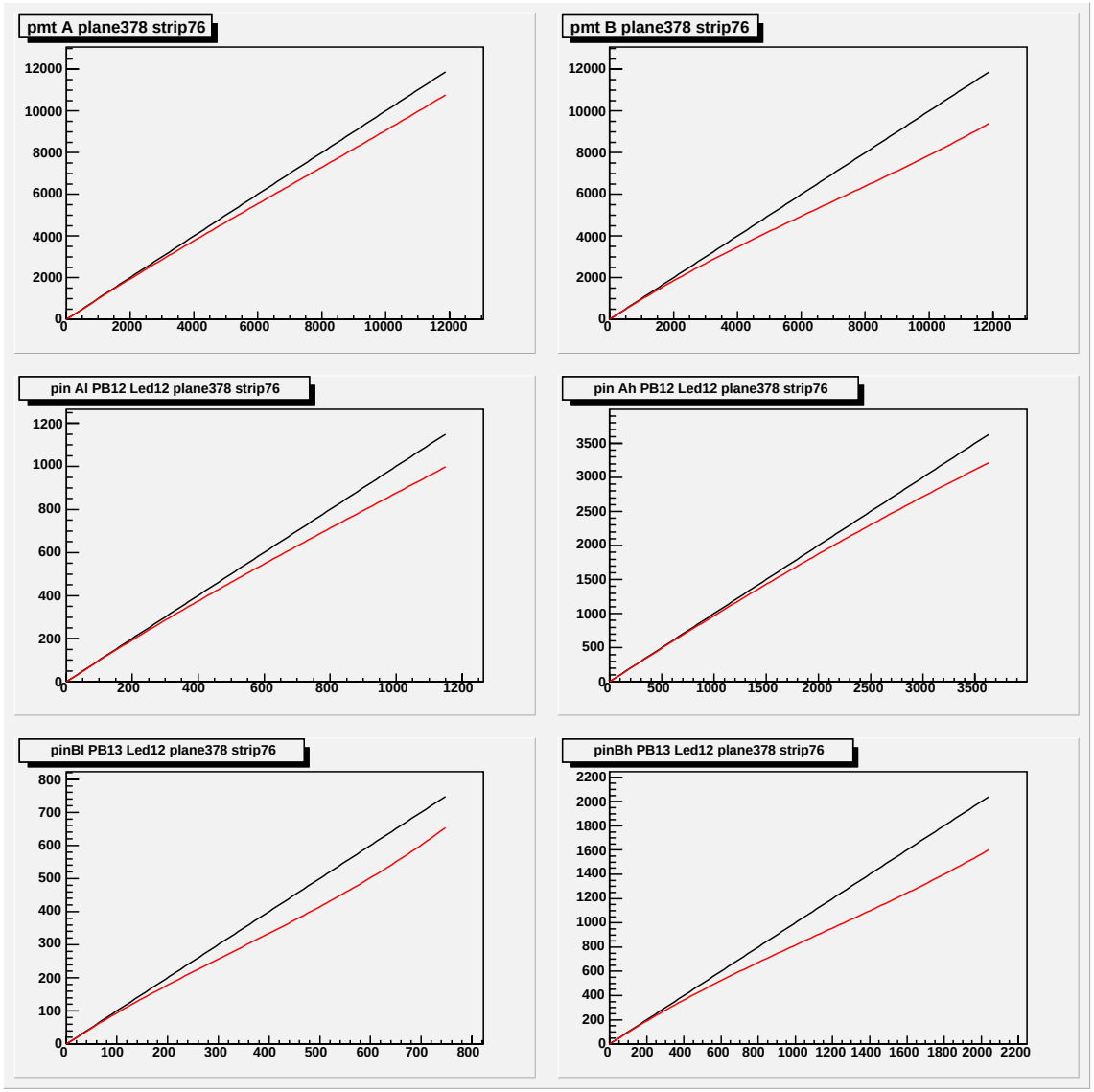




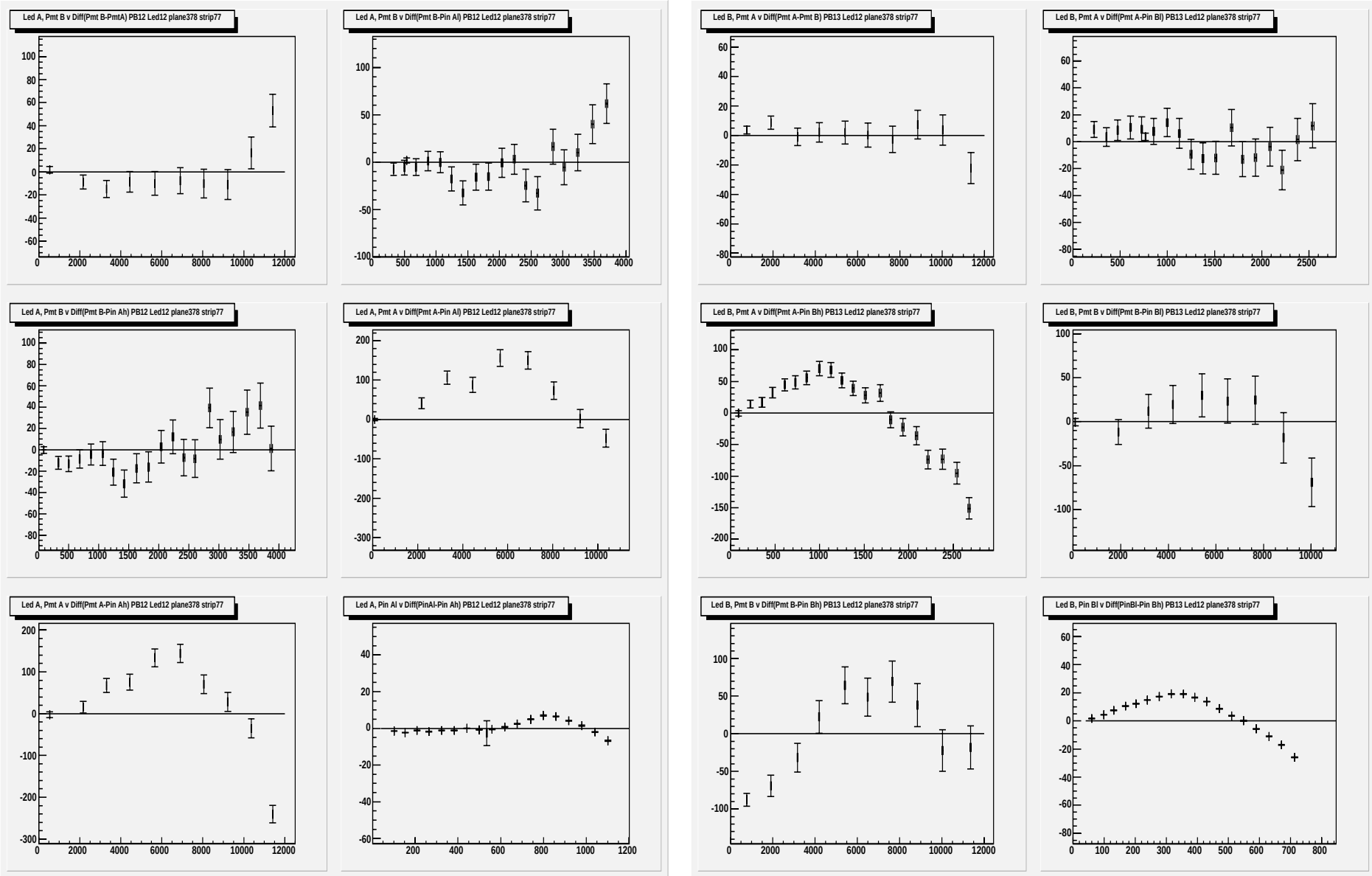
Plots with quadratic correction

Correction plots

- Substantial correction
- Seems to want to deviate at low adc but reduce the slope at higher adc.

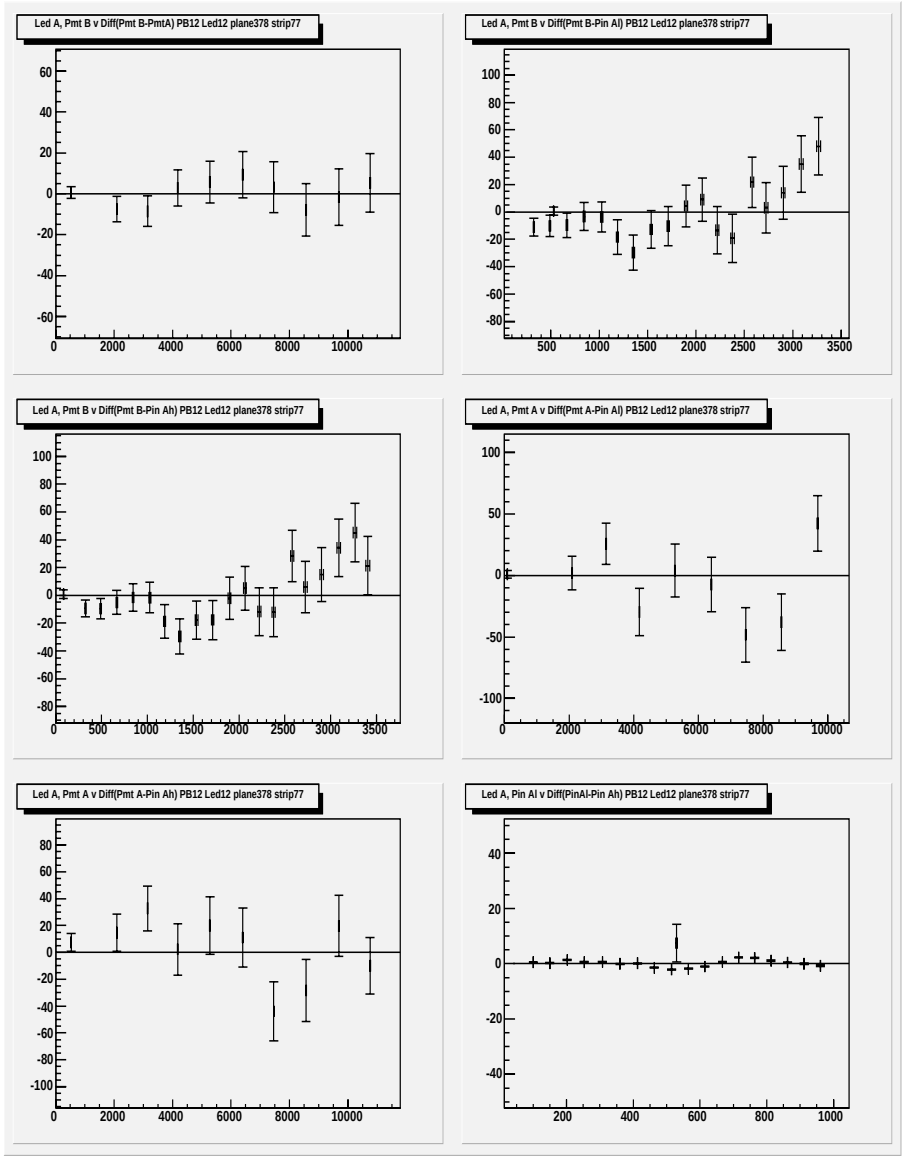


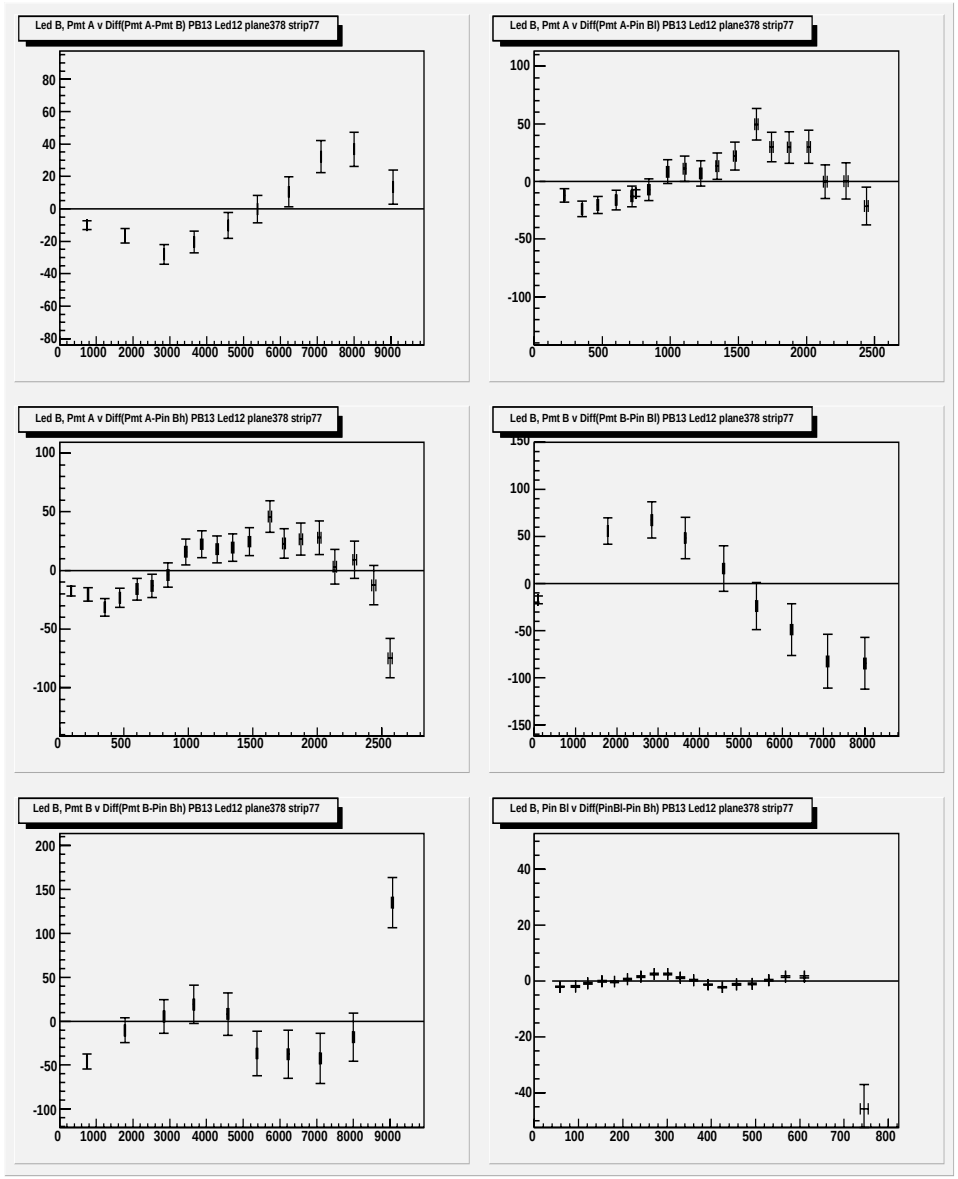
Pb 12 Led 12 Plane 378 Strip 77



No correction, another strip, same led

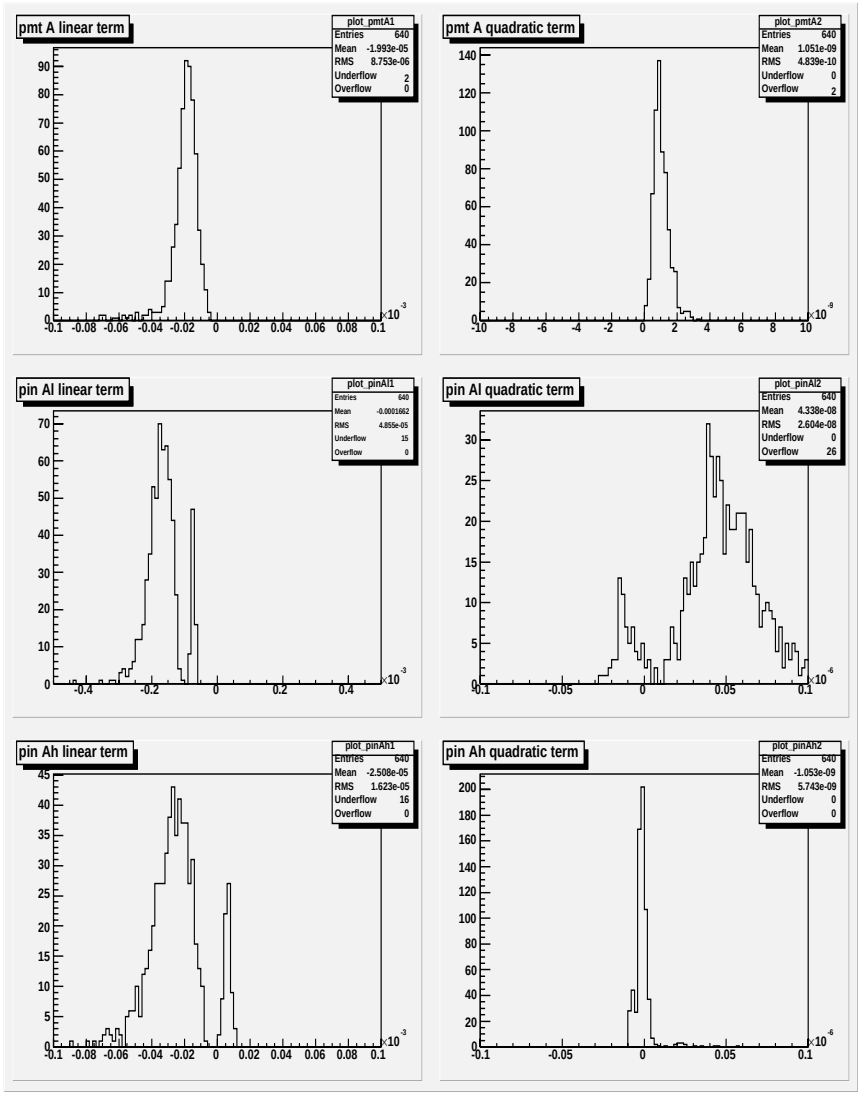
Pb 12 Led 12 Plane 378 Strip 76



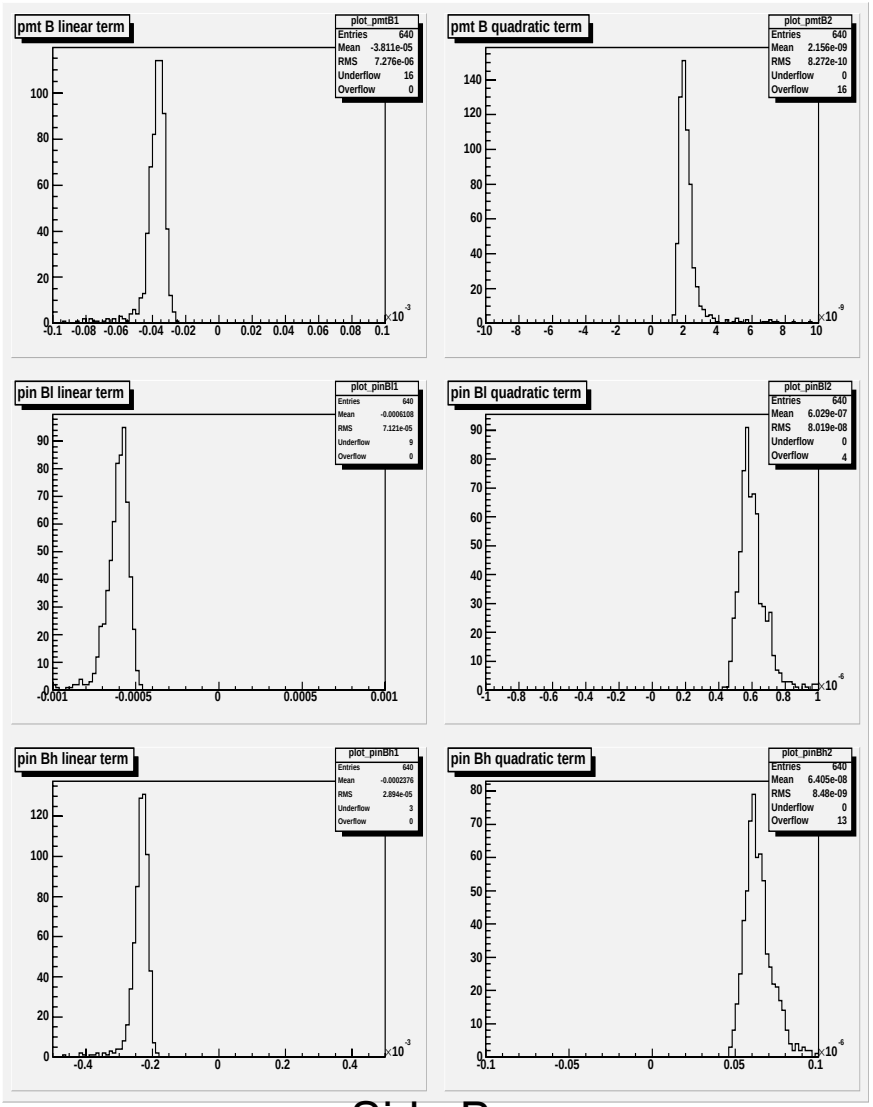


Quadratic correction, another strip, same led

Fit to all pb12 led 12 sample



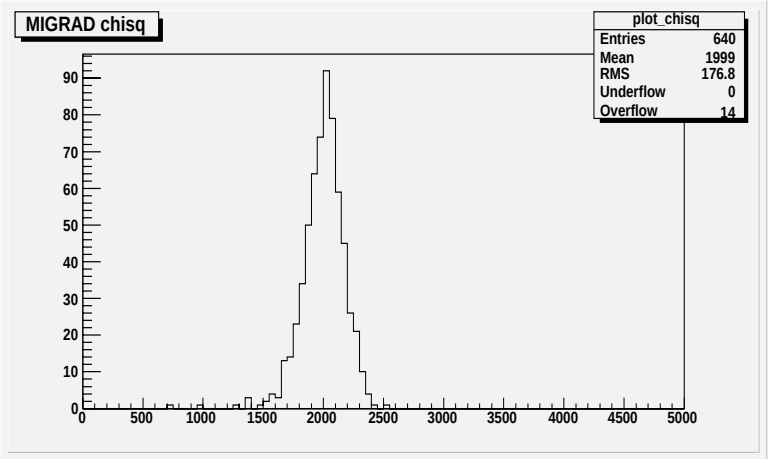
Side A



Side B

Fit to all pb12 led12 sample

- Expect::
  - All the pin values should be the same, within erros
  - Variations possible in the pmt values
- Find
  - Poor χ^2 (2000/~200 points)
  - Pin parameters vary more than the Pmt values



Conclusions

- Fits to an individual strip are possible, cpu time is reasonable
- Fits do not completely remove the discrepancies and have a bad χ^2
- The model is wrong?
- What can be the problem? Ideas?
  - Cross talk?
  - Variation of attenuation with pulse height?
- What parameterisation is appropriate? Ideas?