

Far Detector PMT Linearity Update

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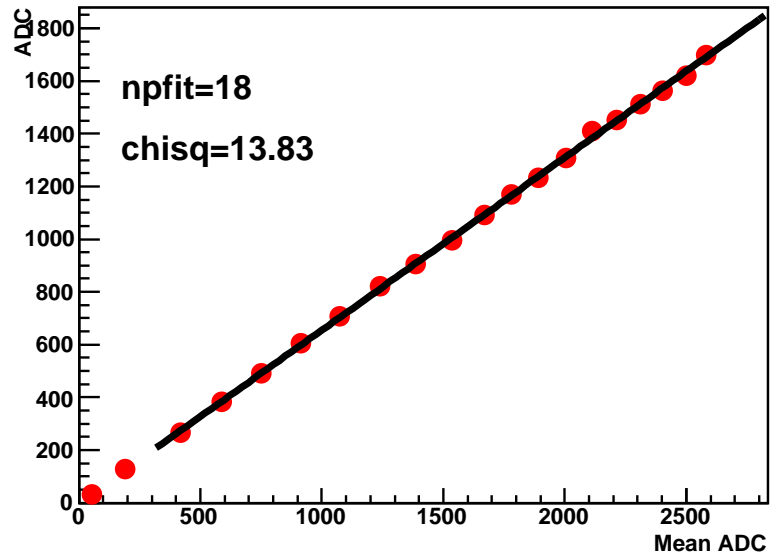
- At last meeting fitted each strip-end against all other strip-ends for the same LED using Far data (June 2005 gain curve)
 - ⇒ good fits for $\sim 98\%$ of strip-ends
 - ⇒ PMTs are linear in region $200 < ADC < 7000$
- But how linear?
- Could perform linearity correction by fitting Near v Far data for each strip, but 13% of strip-ends have < 3 Near points in linear region

Far-Far Linearity Plots

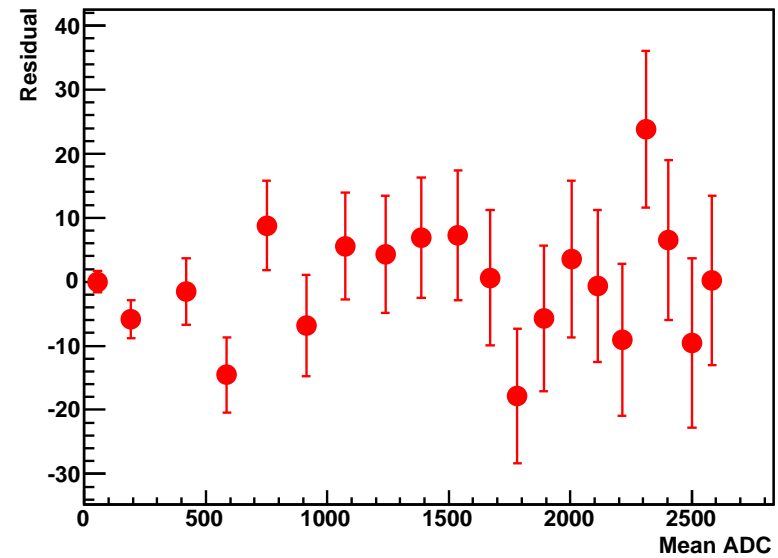
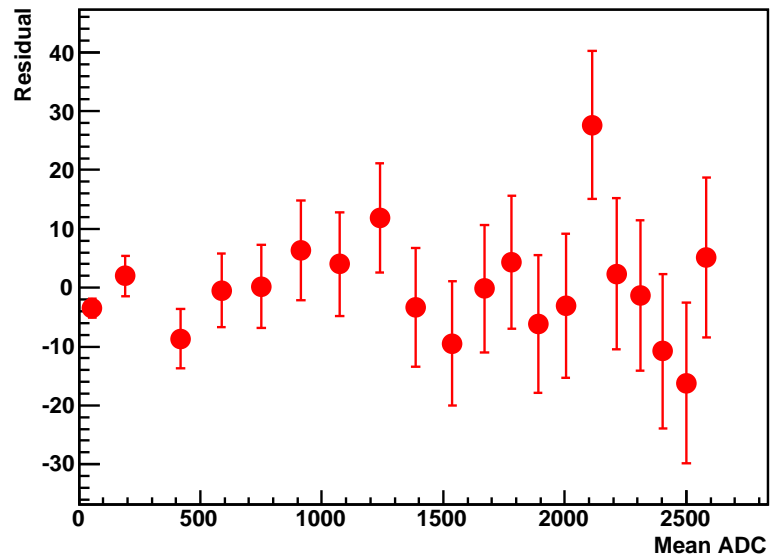
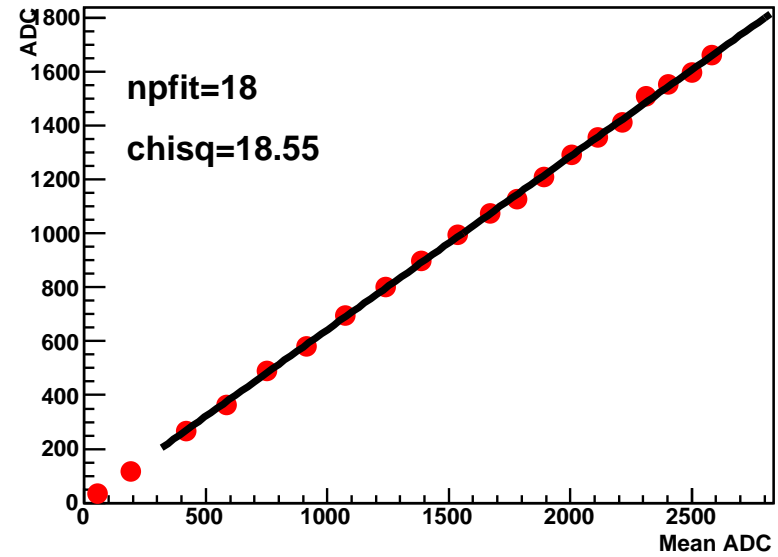
- Have redone fits to Far data, but fitted each strip-end against MEAN of all GOOD strip-ends for that LED
 - Average all strip-ends with $1000 < \max(ADC) < 6000$
 - Fit each strip-end against mean in range $200 < ADC < 7000$
 - Remove strip-ends with $npfit < 5$ or $\chi^2/dof > 2$
 - Make new averages and redo fits
 - Iterate 3 times
 - Approx. 80% of strips are included in averages
 - Mean number of good strips per LED = 474
 - Minimum number of good strips per LED = 52
- PulserBox 6 LED 2: 368 strip-ends have $\max(ADC) > 6000$

Far-Far Fit: example 1

Plane1Strip66

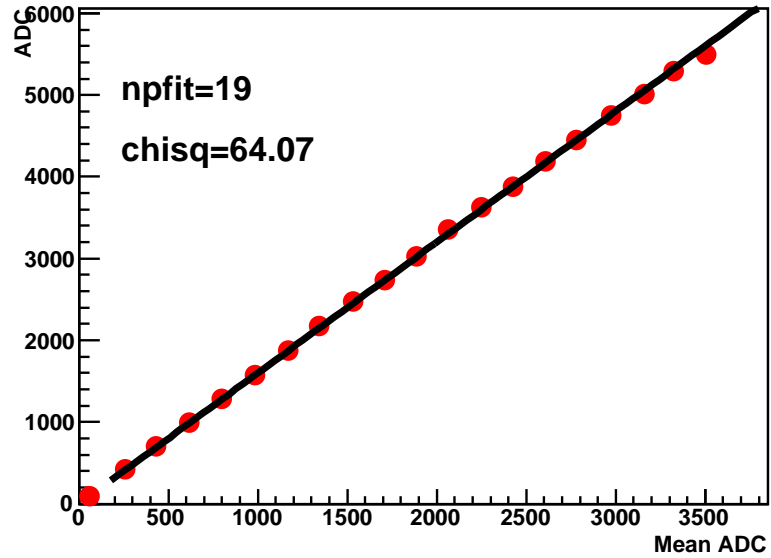


Plane1Strip67

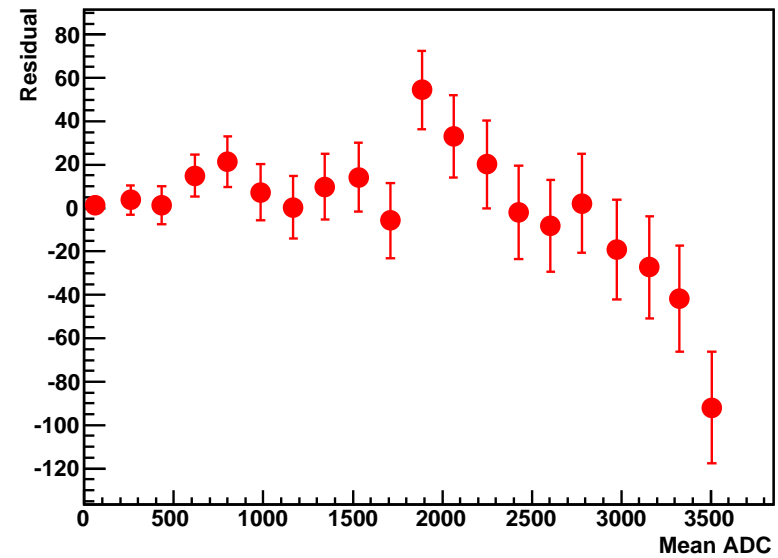
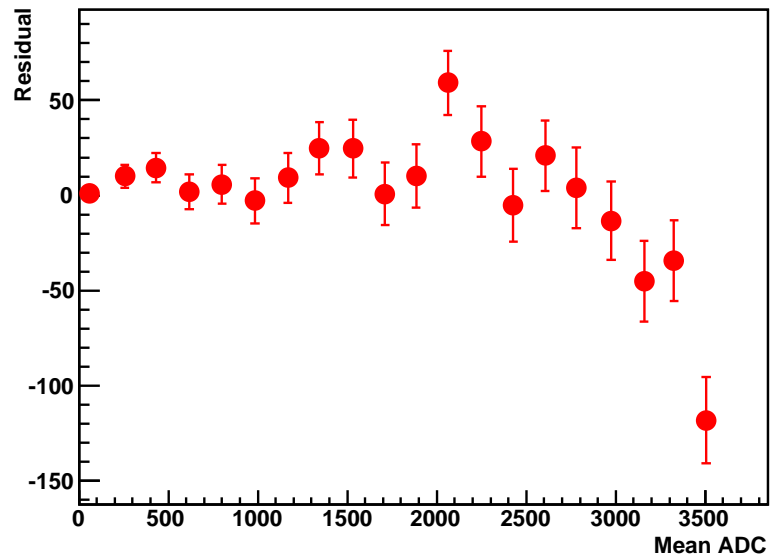
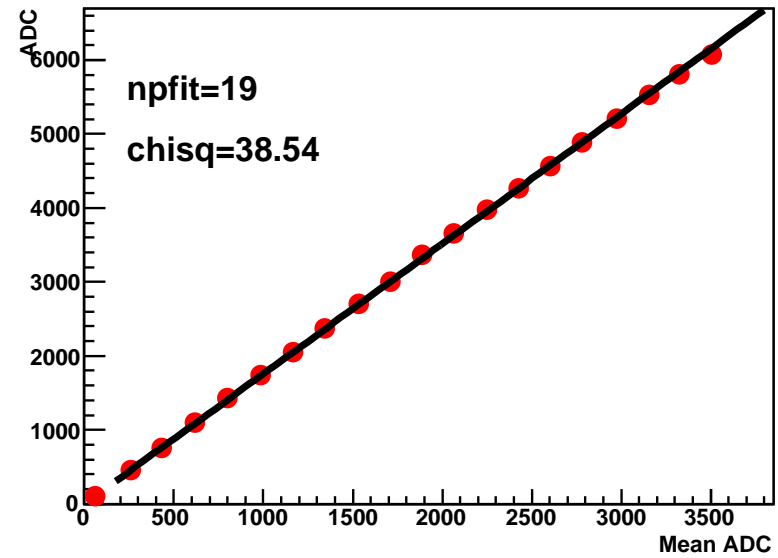


Far-Far Fit: example 2

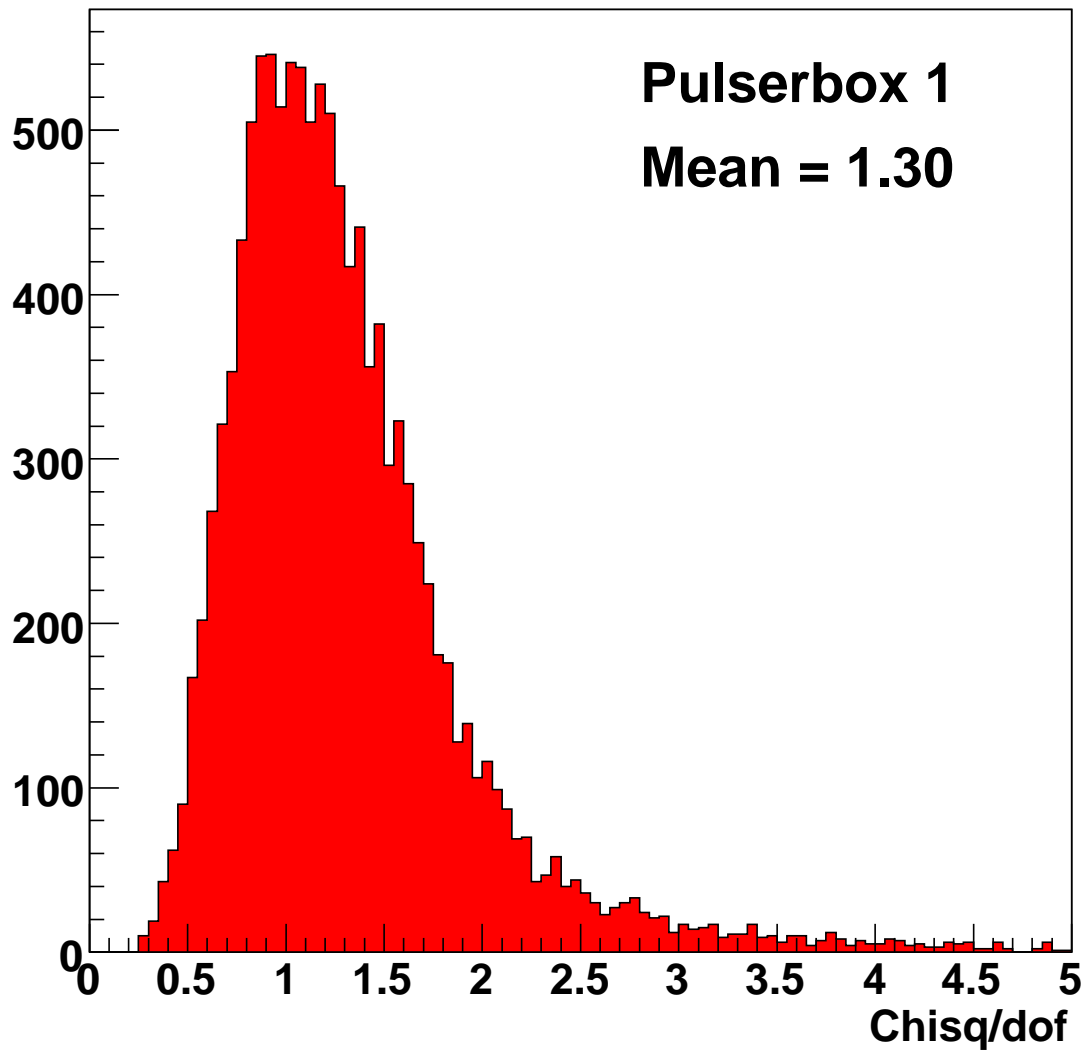
Plane2Strip176



Plane2Strip177



Far-Far: Fit χ^2 Values



- Fits generally reasonable
- 98% of strip-ends have $\chi^2/dof < 10$
- 96% of strip-ends have $\chi^2/dof < 3$
- $\langle \chi^2/dof \rangle = 1.35$
(excluding values > 10)

Far-Far Fits

- Fits generally reasonable, but χ^2 values tend to be larger than for fits to a single strip-end

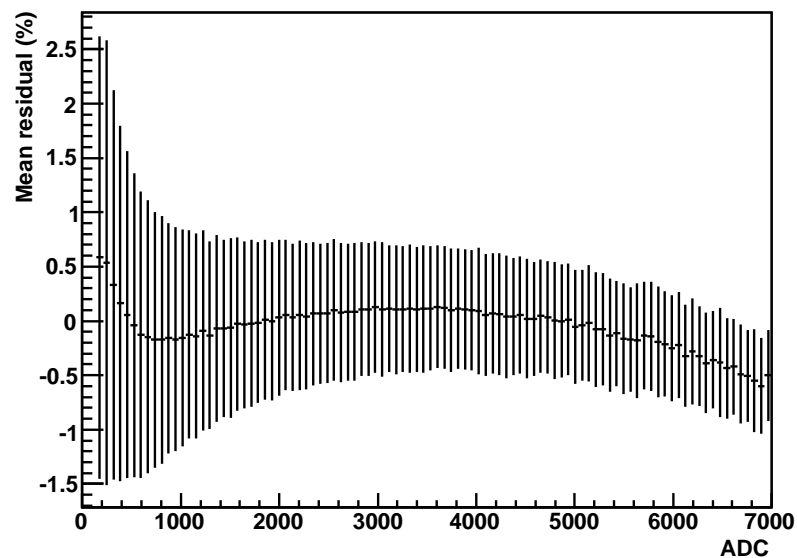
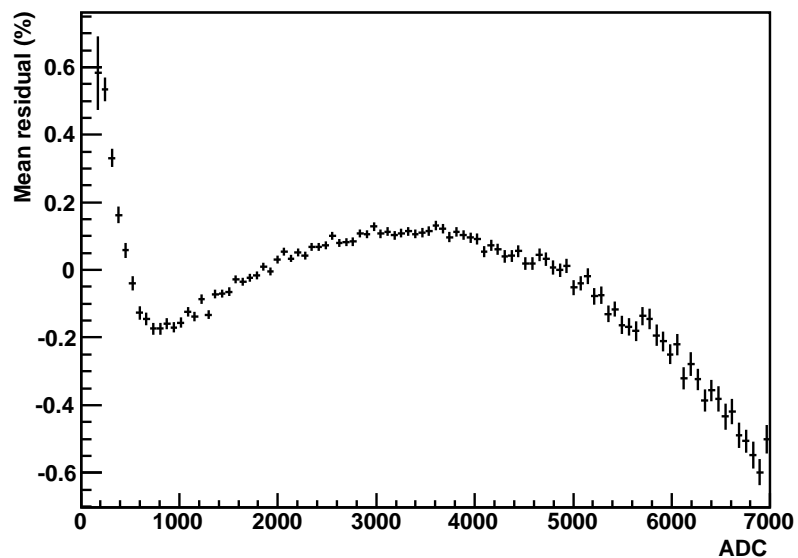
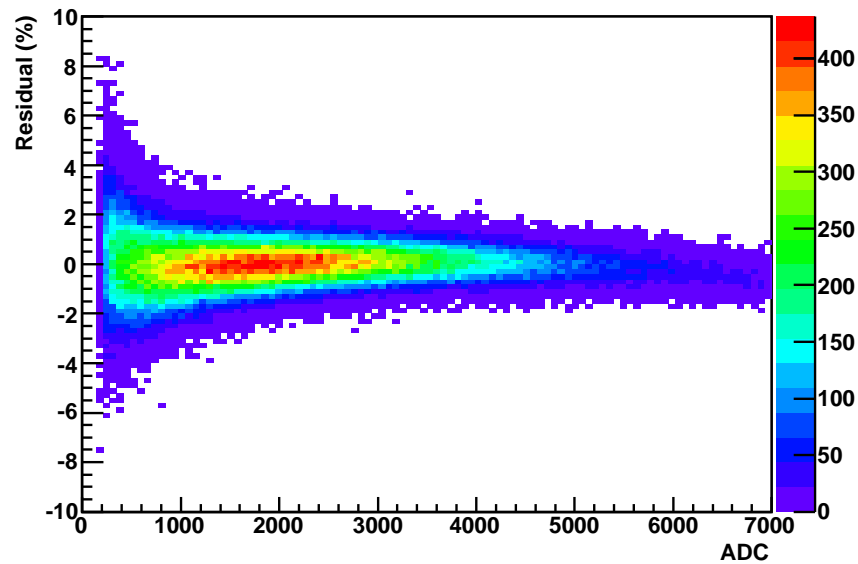
Errors on mean values smaller

- Several channels show signs of saturation at ADC values of ~ 5000 (e.g. example 2)
- Try to quantify linearity by calculating residuals from fitted line
- Plot mean residual v. strip-end ADC value for good strips ($\chi^2/dof < 2$)
- Find distinct systematic deviations from linearity

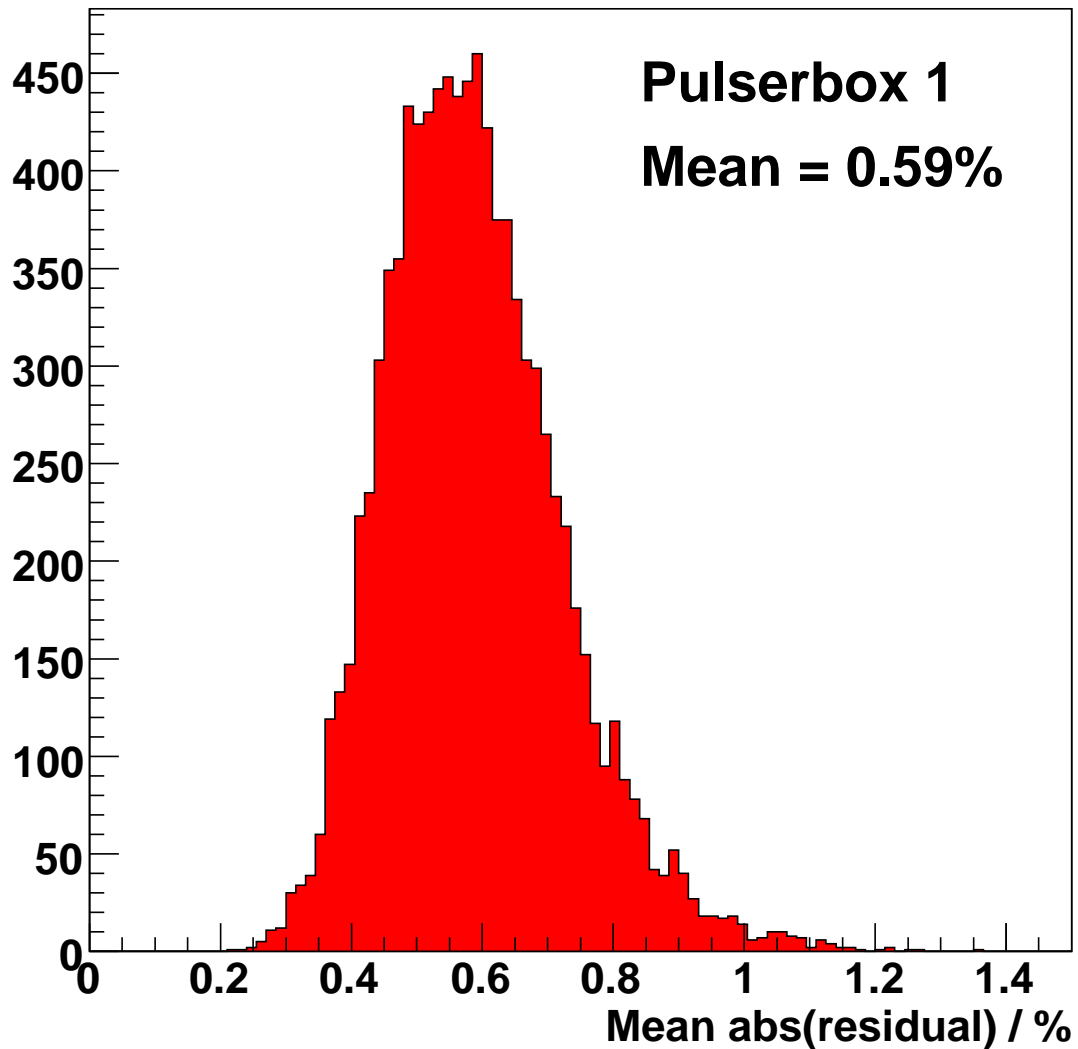
Far-Far Fit Residuals

Plots for Pulserbox 1

Others similar



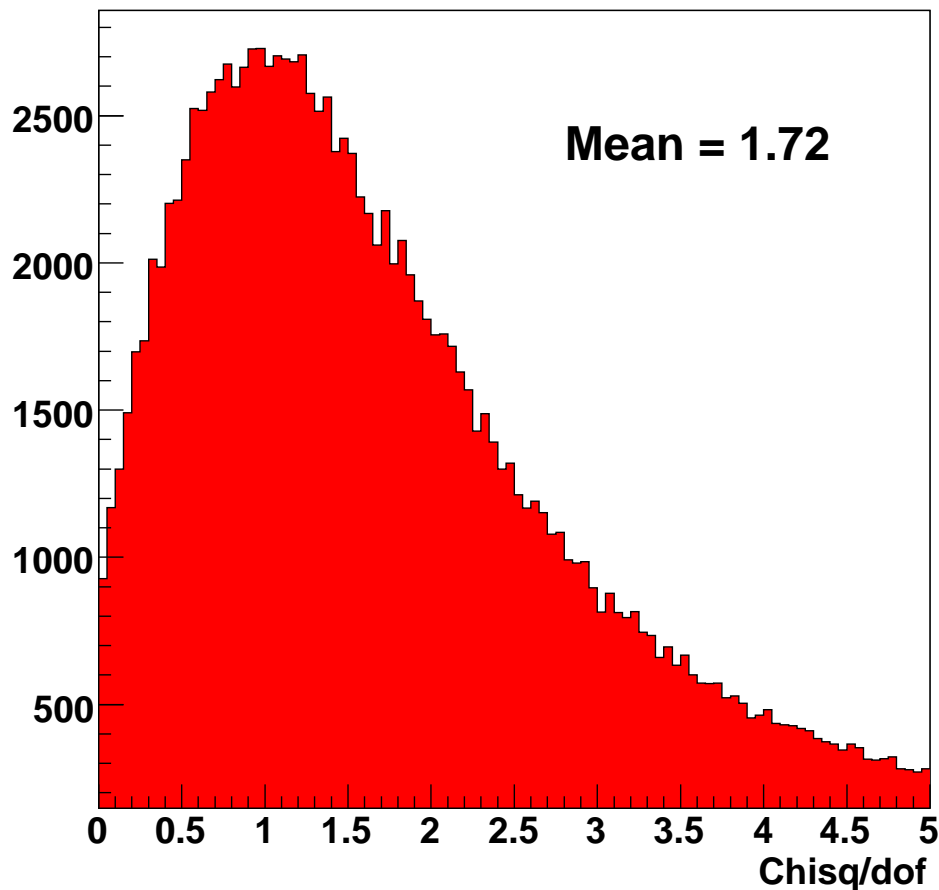
Far-Far Fit Residuals



- For good strip-ends, mean absolute value of residuals in fit range = 0.61%
- 99% of good strip-ends have value $< 1\%$
- Linearity good enough?

Near-Far Linearity Plots

- Have also fitted Near data to MEAN of all GOOD Far strip-ends for that LED
Straight line in $200 < ADC < 7000$



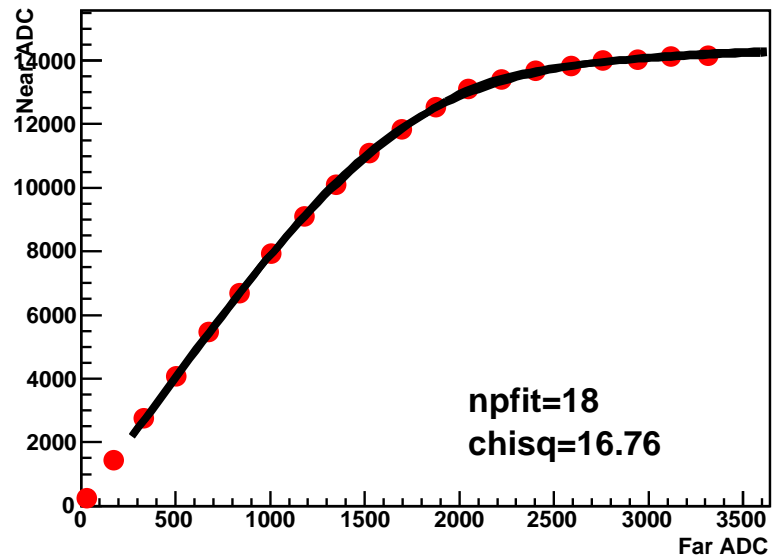
- Again see effect of smaller errors on means
- While many strip-ends give good χ^2 , a significant fraction which do not
- For the 82% of strip-ends with at least 3 points in fit range, $< \chi^2/dof > = 2.11$ (excluding those > 10)

Near-Far Fits

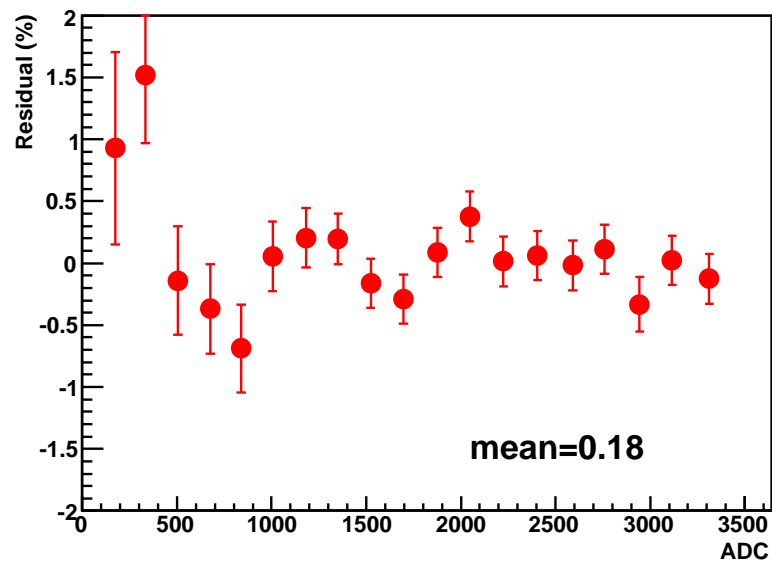
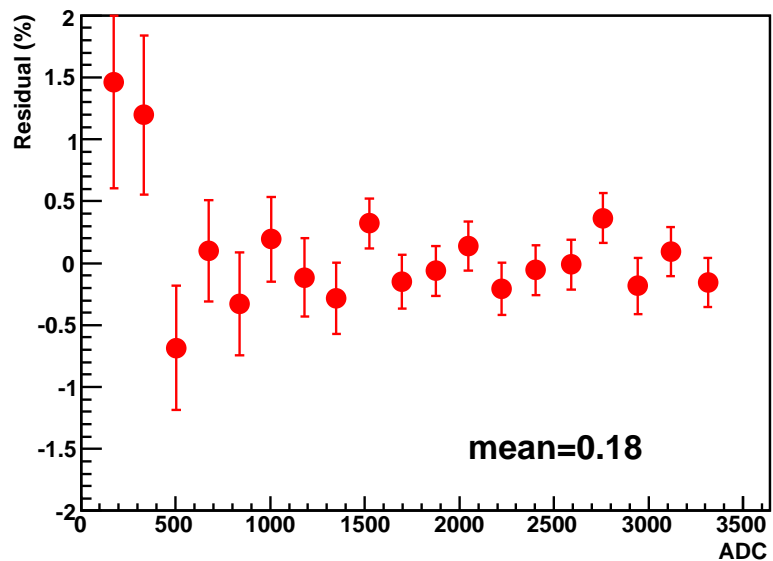
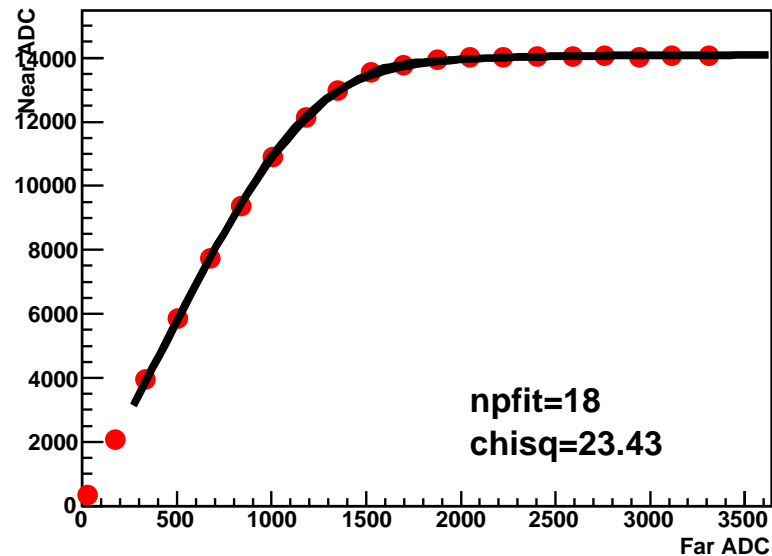
- Have tried fitting Near data to mean Far data for that led using Giles's 'Pole+Kicker' function:
 - Fit to straight line in range $200 < ADC < 7000$
 - Using slope from first fit to give starting value for that parameter, fit to Pole (3 parameters) function in range $ADC > 200$
 - Using results of second fit to give starting values, fit to Pole+Kicker (5 parameters) function in range $ADC > 200$
- Problem: points near saturation limit have very small errors:
⇒ set any error $< 0.2\%$ to 0.2%
- Second and third fits change slope from first fit by $\leq 0.7\%$
- Pole alone does not give good fits, pole+kicker gives reasonable fits
- Increasing lower limit on fit range to 500 gives small improvement in χ^2/dof

Near-Far Fit: example 1

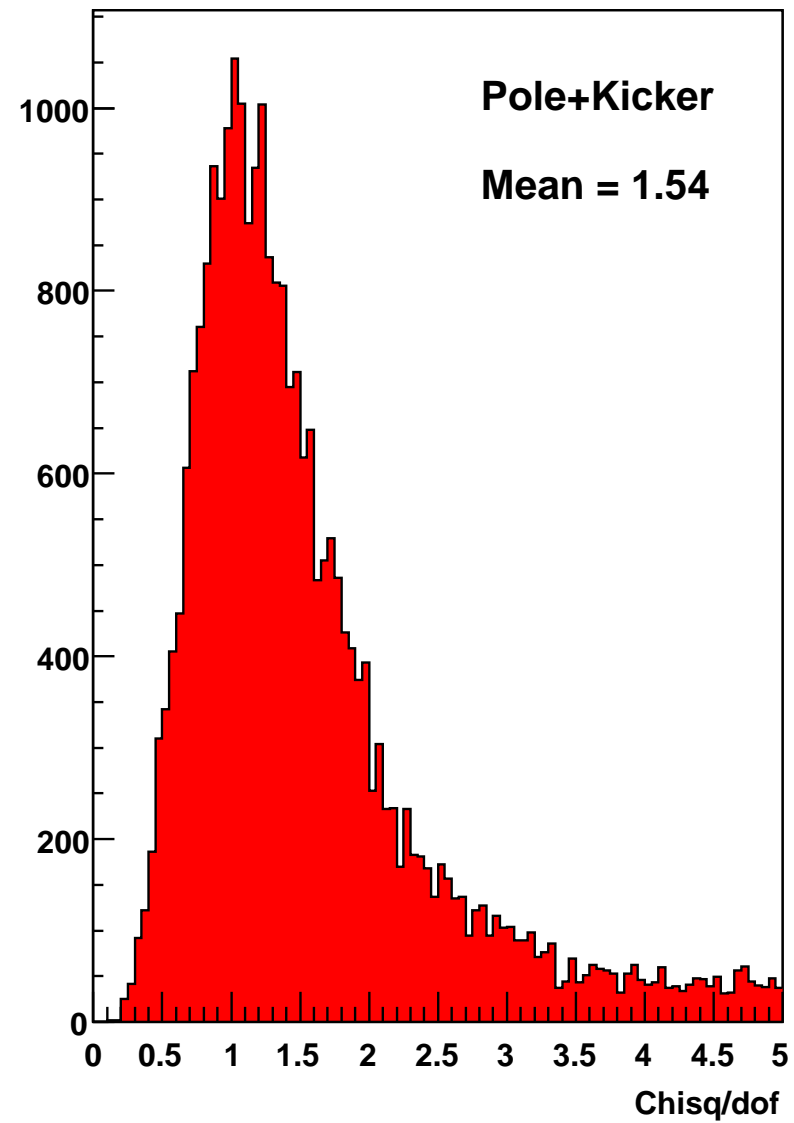
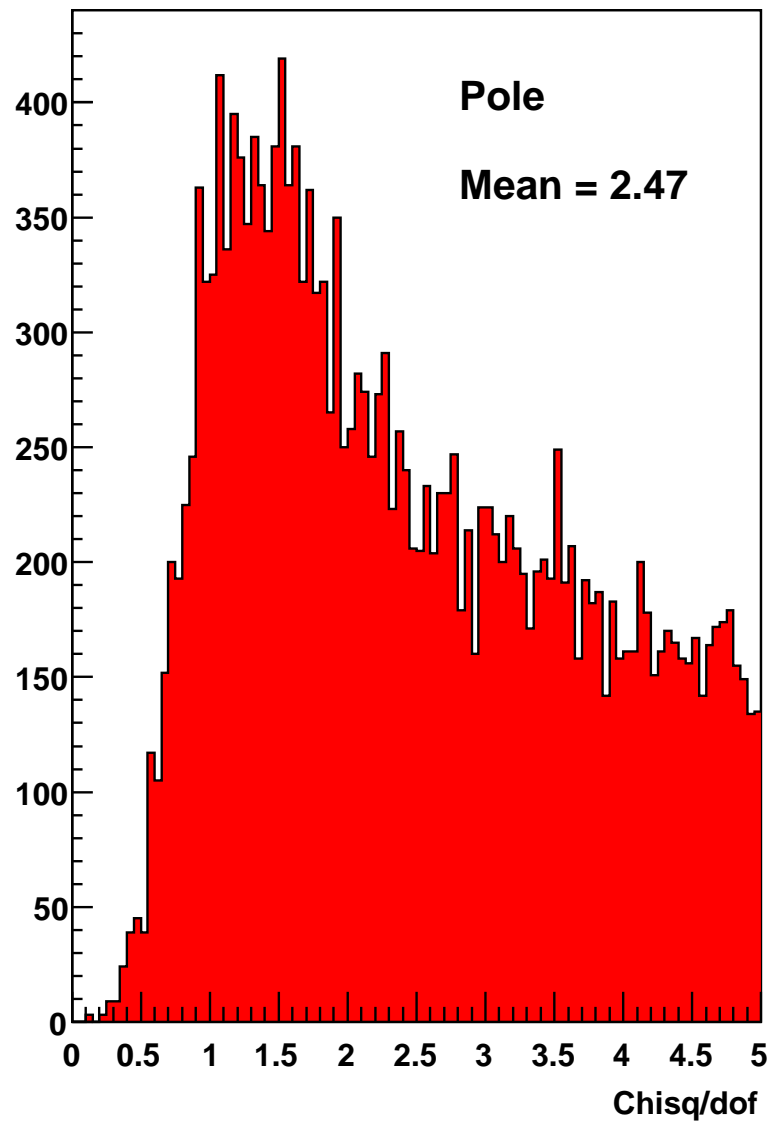
Plane16Strip164E



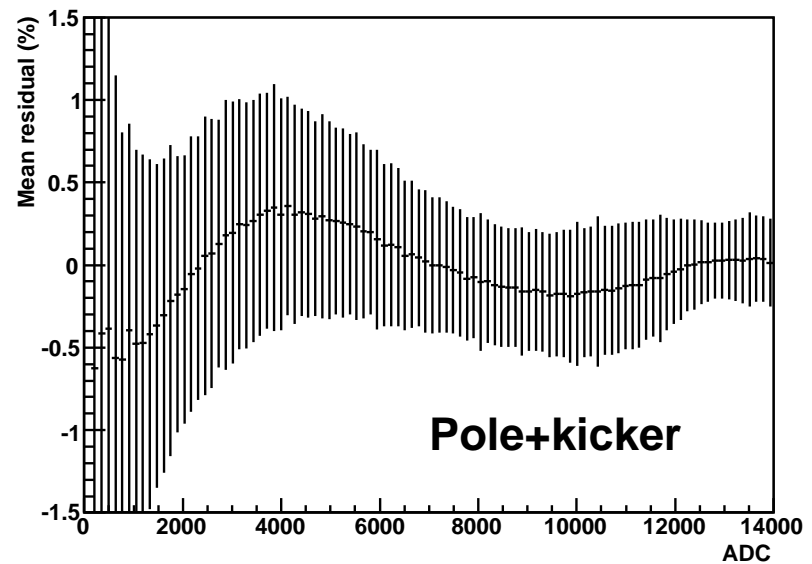
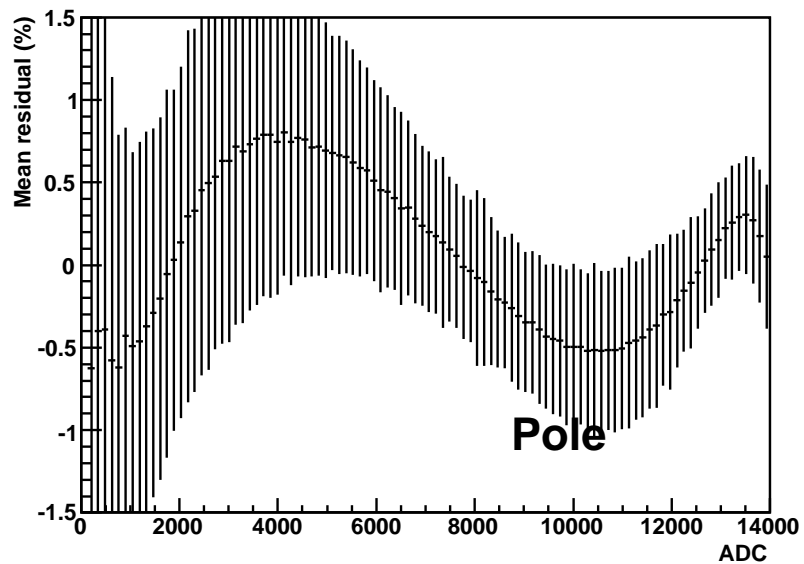
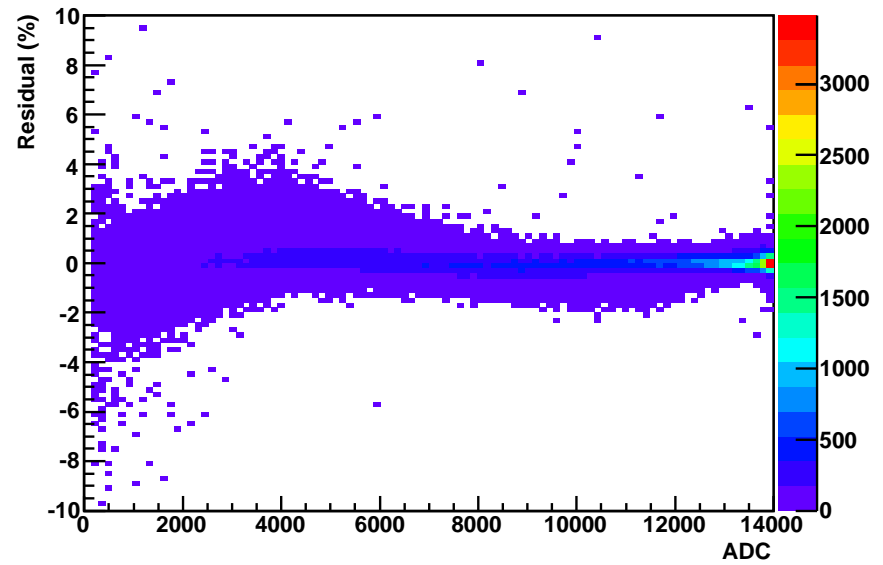
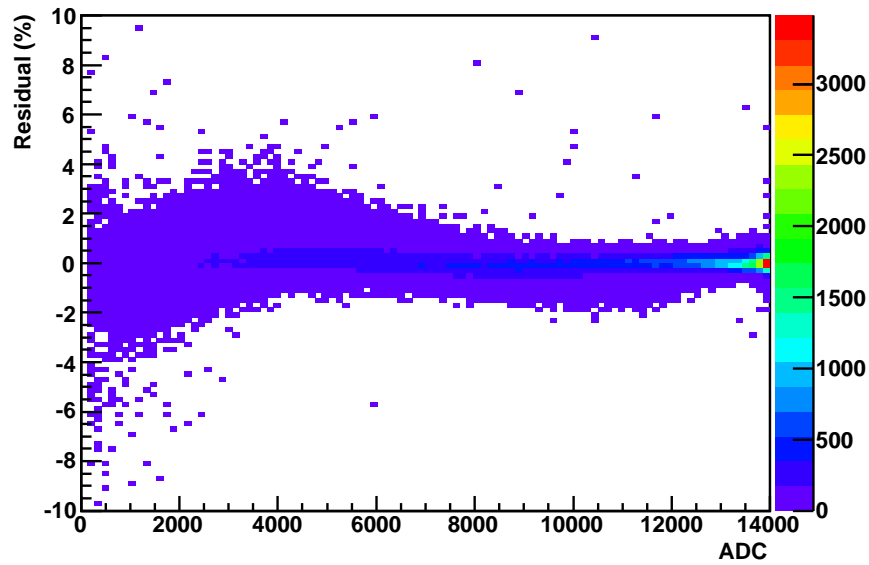
Plane16Strip165E



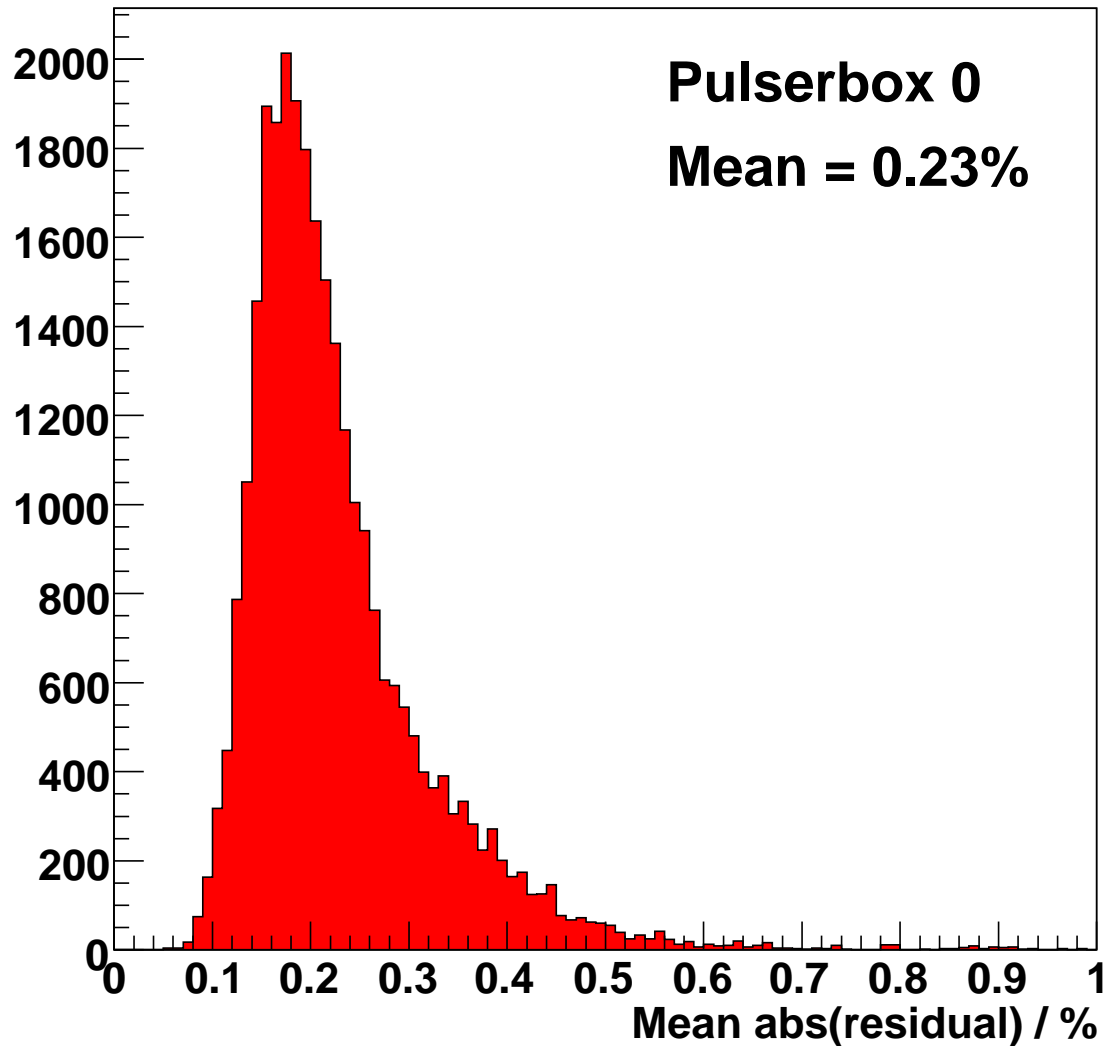
Near-Far Fit χ^2



Near-Far Fit Residuals



Near-Far Fit Residuals

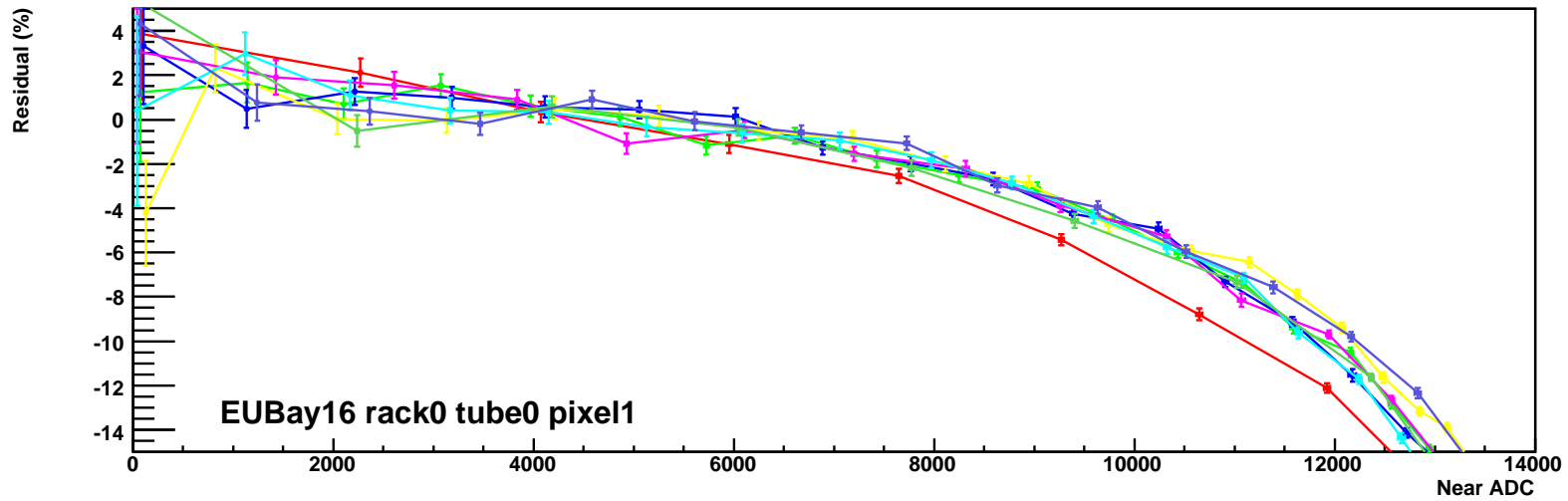
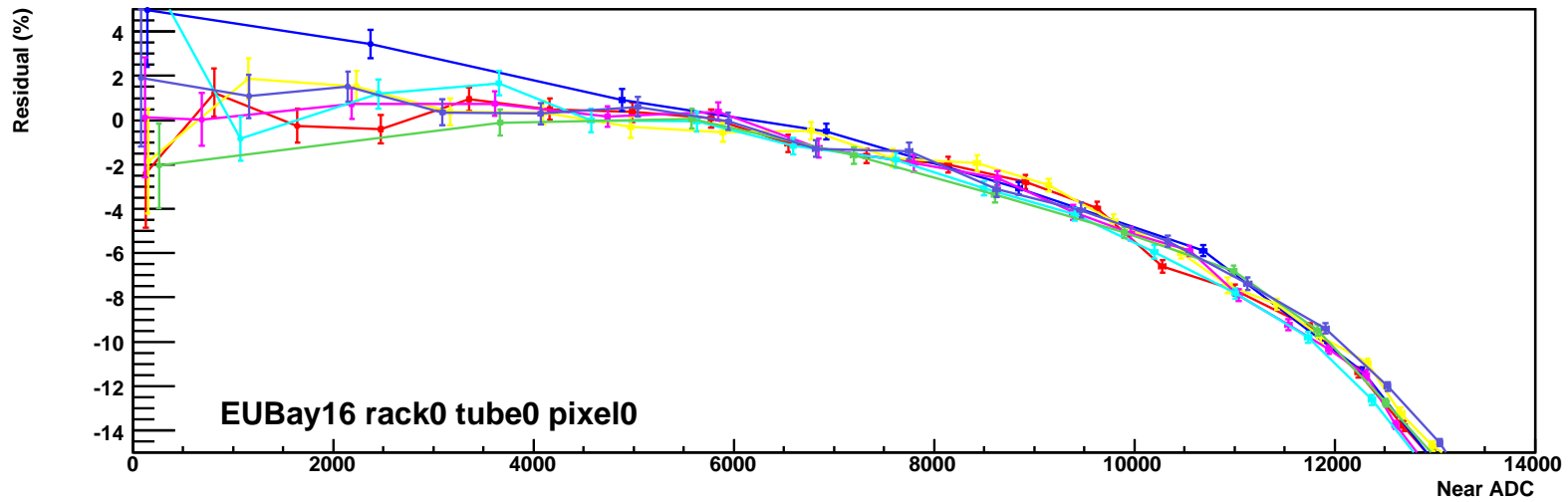


- Mean absolute value of residuals = 0.23%
- 99.5% of strip-ends have value $< 1\%$

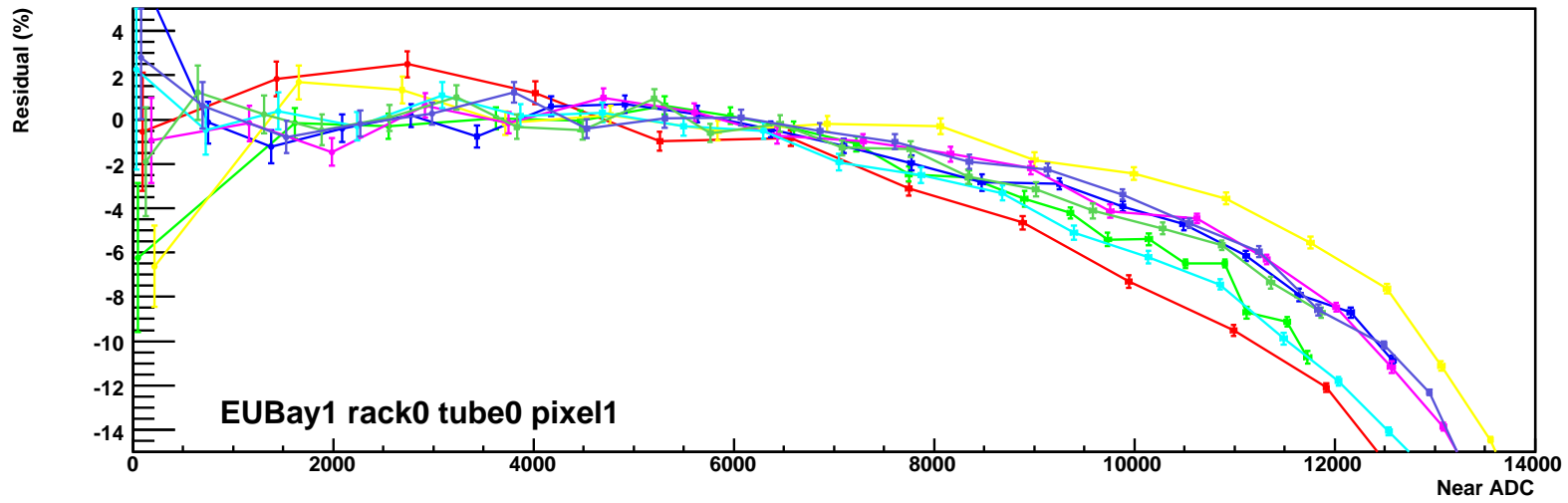
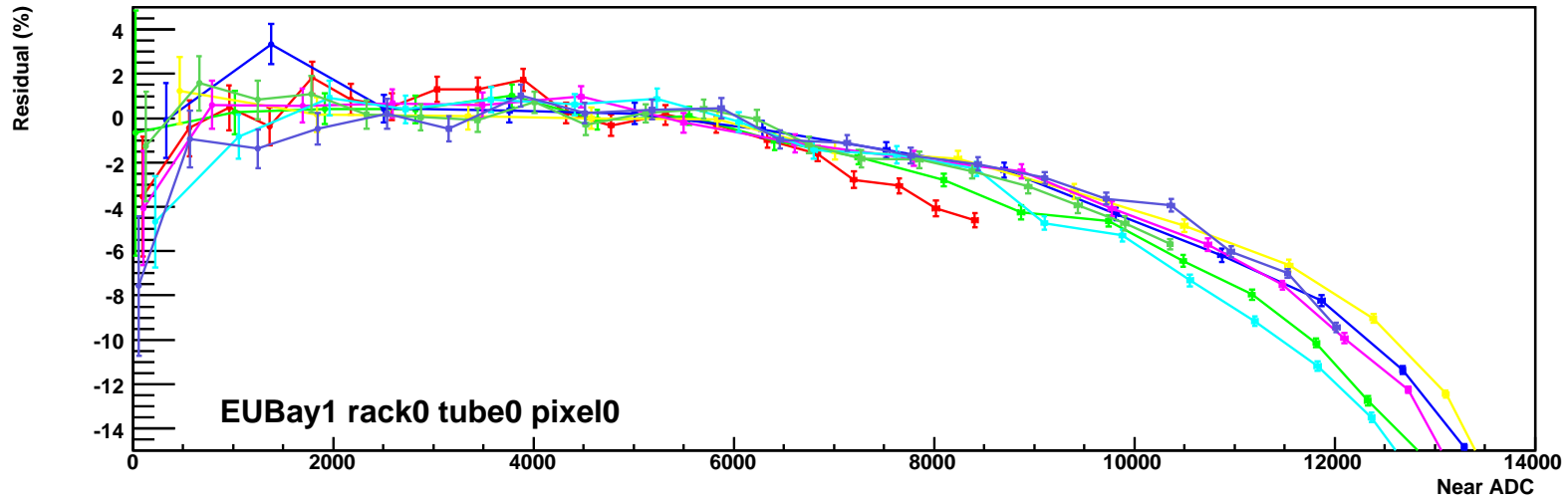
Near-Far Linearity Plots

- At last meeting it was suggested that all spots on same pixel should show similar behaviour, so could use another spot on same pixel for channels with too few points in linear region
- Have investigated using Near v. mean Far straight-line fits (in $200 < ADC < 7000$)
- Calculate fit residuals as function of Near ADC, and compare spots on same pixel
- See good correlation \Rightarrow should be possible to use neighbouring spot for channel with bad fit, but need to quantify agreement

Near-Far Fit Residuals



Near-Far Fit Residuals



Summary

- Have redone linear fits of Far data to mean of 'good' strip-ends for that LED
- The χ^2 values are larger than for fits to a single strip-end, but probably acceptable
- See systematic effects in the residuals, but these at a level $< 1\%$
- Near data can be fitted to Far means using 'Pole+kicker' function'
- Mean residuals typically $\sim 0.2\%$, and 99.5% of channels $< 1\%$
- Have compared straight-line fit residuals for spots on same pixel
- See good correlation \Rightarrow can probably use neighbouring spot for bad channels