Muon Calibration Issues

MINOS Collaboration Meeting

Fermilab
April 2002

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Introdction

- Working towards producing a set of numbers for Far Detector strip-to-strip normalisation
- Obtain histograms for each strip-end as follows:
  - Use hits from CandTrackSR
  - Veto planes also in CandShowerSR
  - Correct for path length
  - Correct for attenuation
- Then, characterise energy deposits for a MIP for each strip-end... How?
  - Three possiblities:
    * Mean
    * Truncated Mean
    * Fit

Simple Fit

Approximate:

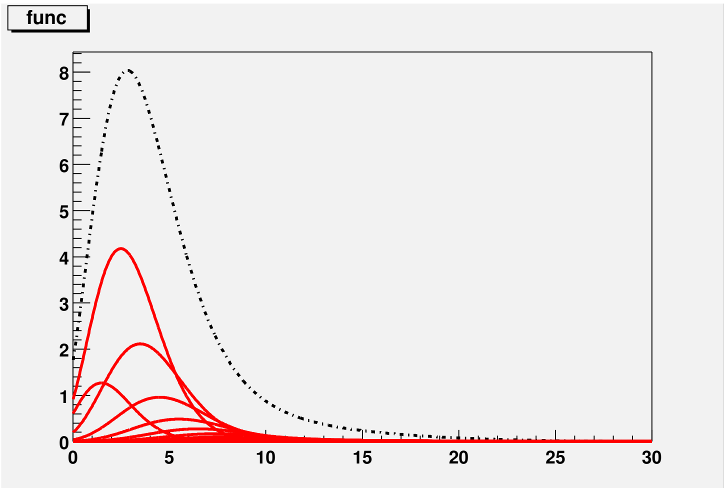
$$Prob(n) = L \otimes P = \int L(\lambda, \mu, \sigma).P(n, \lambda)d\lambda$$

With:

$$Prob(n) \approx N \sum_{\lambda=1}^{20} L(\lambda.s, \mu, \sigma).P(n, \lambda.s)$$

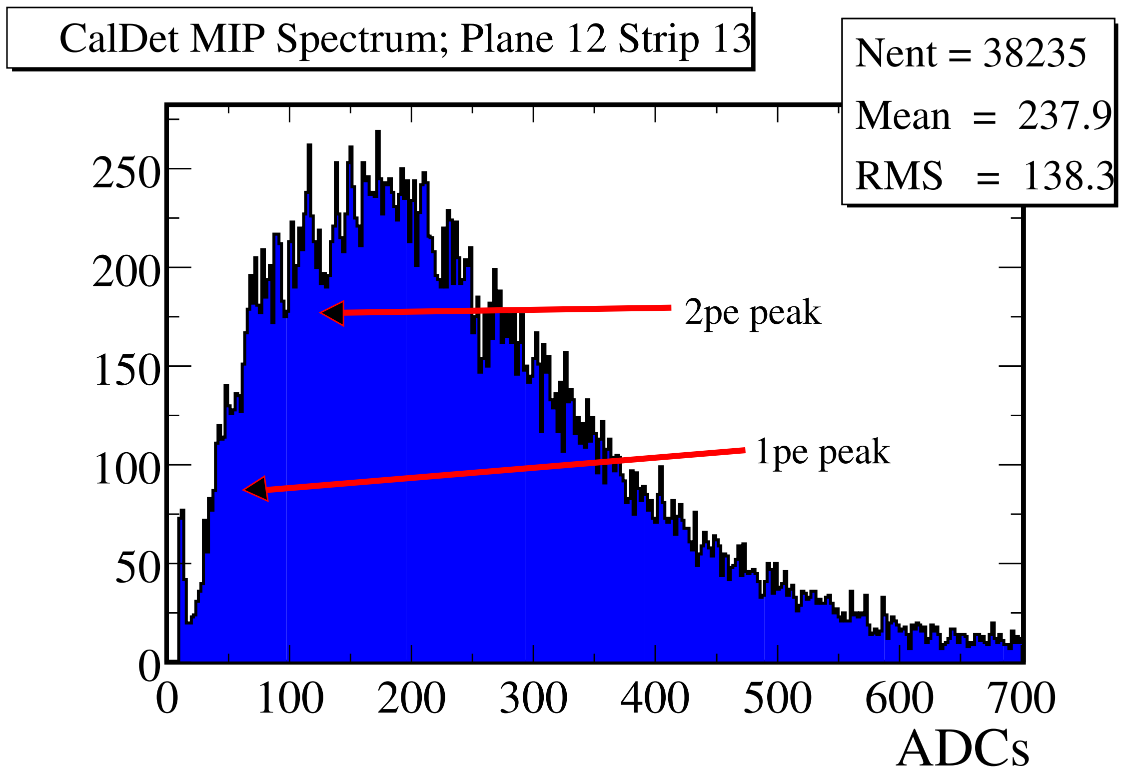
n in NPEs; N = normalisation factor; s = range of spectrum (upper limit of integration)

- Returns peak, μ and width, σ of Landau distribution
- Quick to fit
- Has been used at CalDet



Complex Fit

- This time, trying to account for the phototube features seen in many of the CalDet spectra:



- These features can cause problems for the simple fit

Complex Fit

- Instead, try to include the effects of the phototube

- Want to use the function:

$$Prob(n) = L \otimes P \otimes P_{scaled}$$

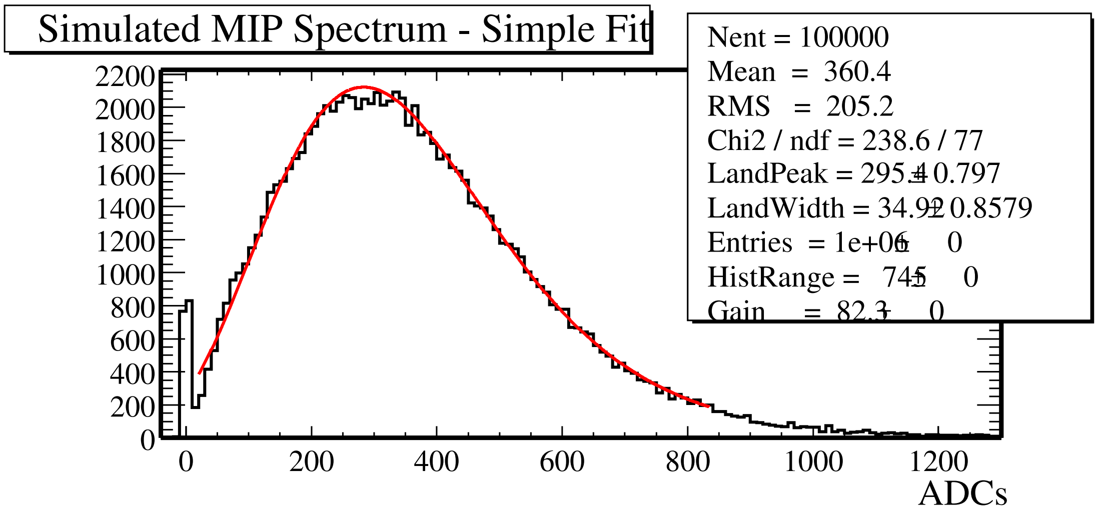
$$= \int \int L(\lambda_1, \mu, \sigma).P(\lambda_2, \lambda_1).P_{scaled}(n, \lambda_2) d\lambda_1 d\lambda_2$$

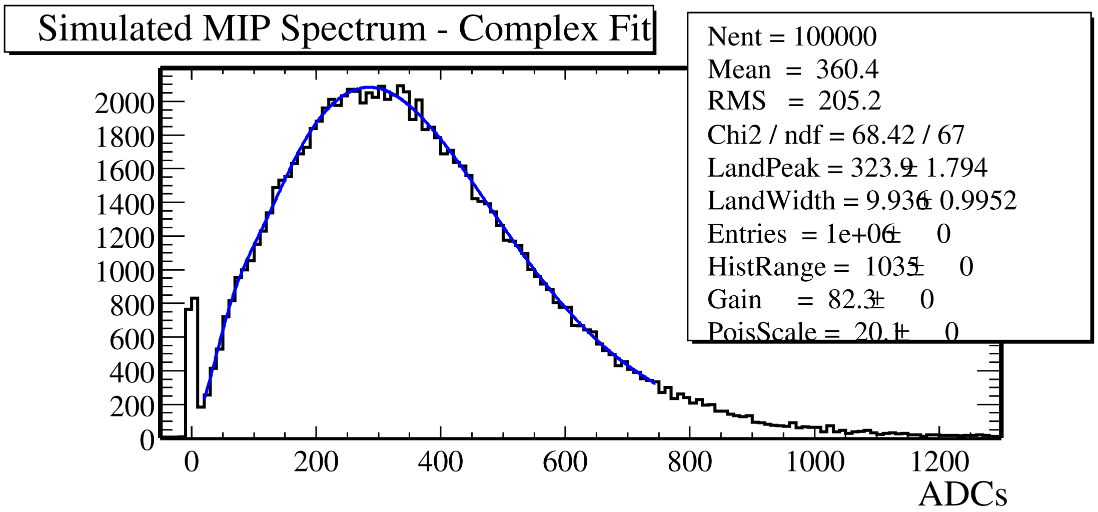
- $P_{scaled}(n, \lambda)$ represents the PDF for λ pes at the photocathode, after photomultiplication

- To use as a fitting function, approximate using summations, as for the simple fit

Complex Fit

Example of fits with simulated data:

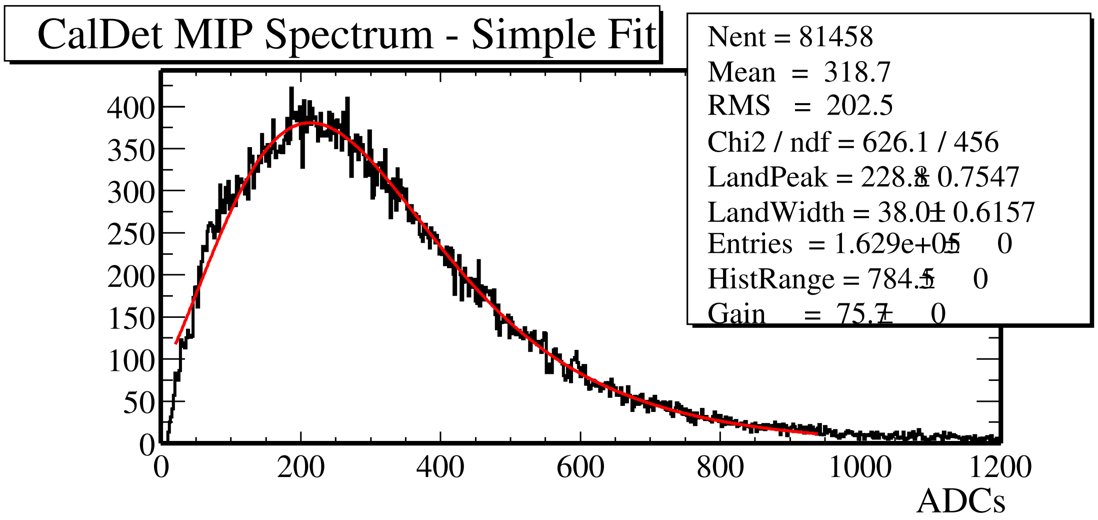


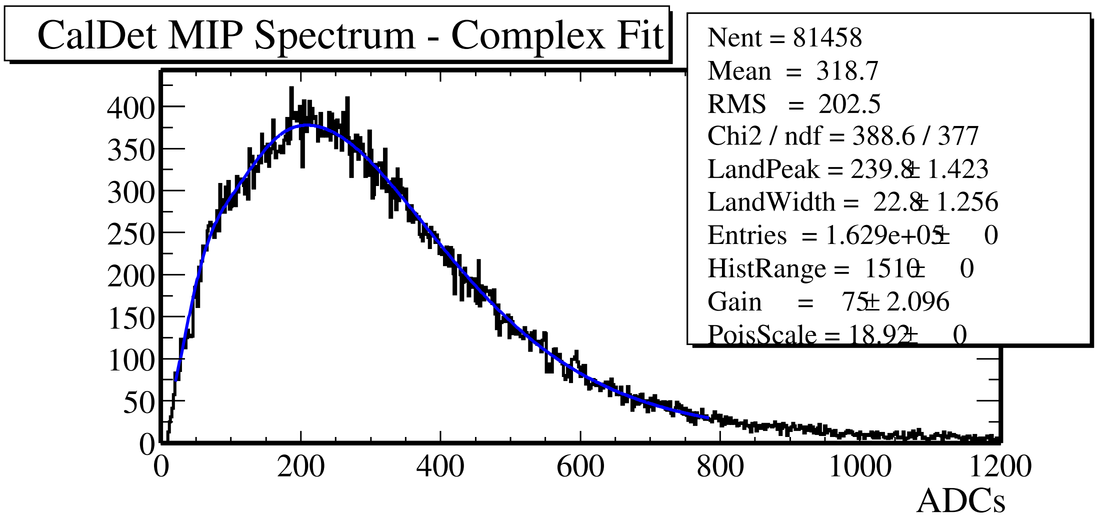


- Complex fit much better
- Slower
- Has difficulty when shape not well defined (low stats)

Complex Fit

Example of fits on CalDet data

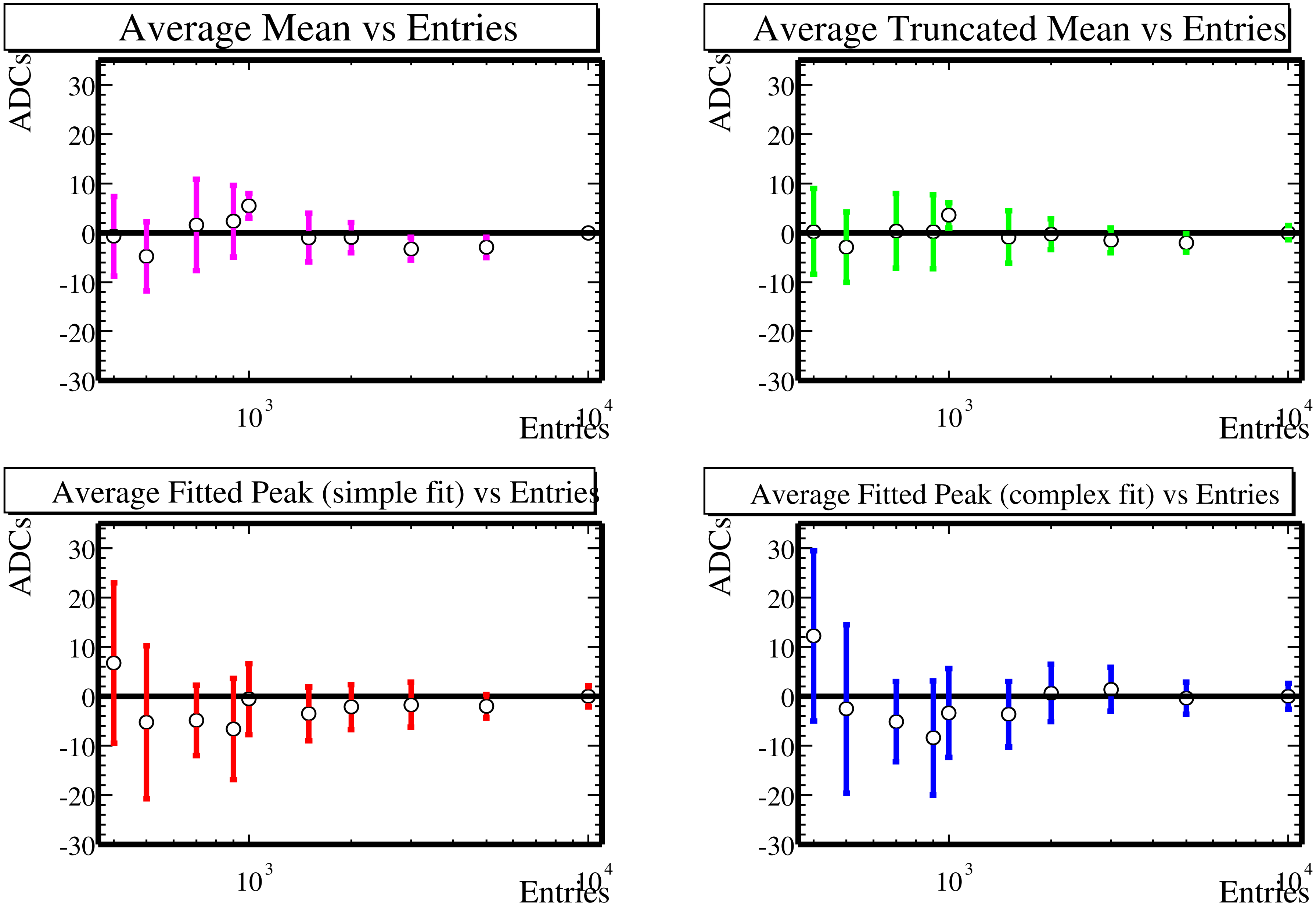


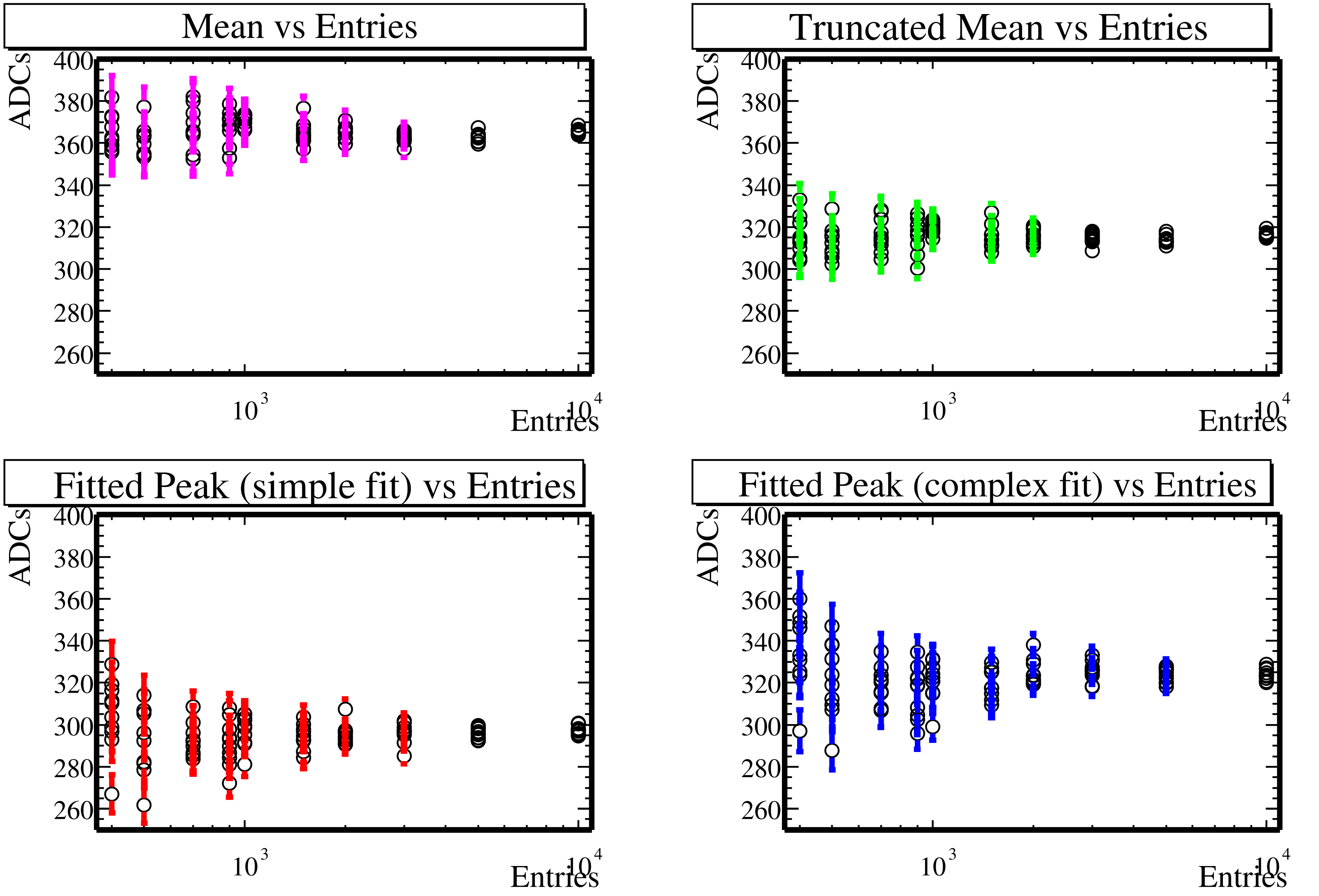


Can be applied to CalDet spectra too!

Comparison of Techniques

- Consider the following methods for obtaining MIP values:
  - Means
  - Truncated Means
    - Take mean of 90% of spectrum
  - Fits
    - Simple & Complex
- FarDet has ∼500 muon hits per strip-end per month.
- Check stability of MIP values with #entries
  - Considering 10 different #entries (between 400 and 10000)
  - Generated 10 independent spectra for each #entries
  - Obtain MIP values for all histos using each method


Average Mean vs Entries
ADCs
Entries
Average Truncated Mean vs Entries
ADCs
Entries
Average Fitted Peak (simple fit) vs Entries
ADCs
Entries
Average Fitted Peak (complex fit) vs Entries
ADCs
Entries


Mean vs Entries
Truncated Mean vs Entries
Fitted Peak (simple fit) vs Entries
Fitted Peak (complex fit) vs Entries
ADCs
400
380
360
340
320
300
280
260
10^3
10^4
Entries

MuCal Package

- Get track hits from CandTrackSR objects...
  Done
- Veto planes in CandShower objects...
  Done
- Path length correction...
  Done
- Attenuation correction (from mapper data)...
  Still to do
- Facility to get MIP values using any method...
  Almost done

Currently, all MIP values are written to a text file. Does this need to be changed?

Summary

- Realistic fit to MIP spectra developed
- However, truncated mean best choice for FarDet strip-to-strip calibration
- Want to try fitting all corrected MIP hits with complex fit
  - May be useful for detector-detector calibration
- MuCal package on the way