Calibration of An Electron Run in CLAS

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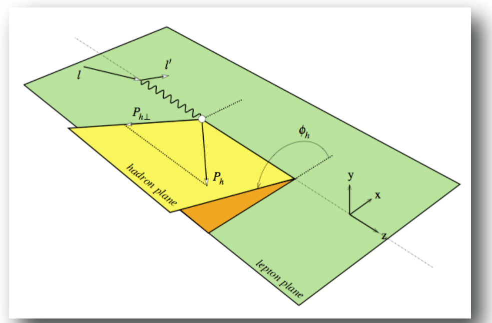
Work supported by DOE

The Experiment

- Semi-Inclusive Pion Production

$$ep \longrightarrow e\pi^{\pm}X$$

- Ability to measure both positive and negative pions greatly reduces systematic errors.

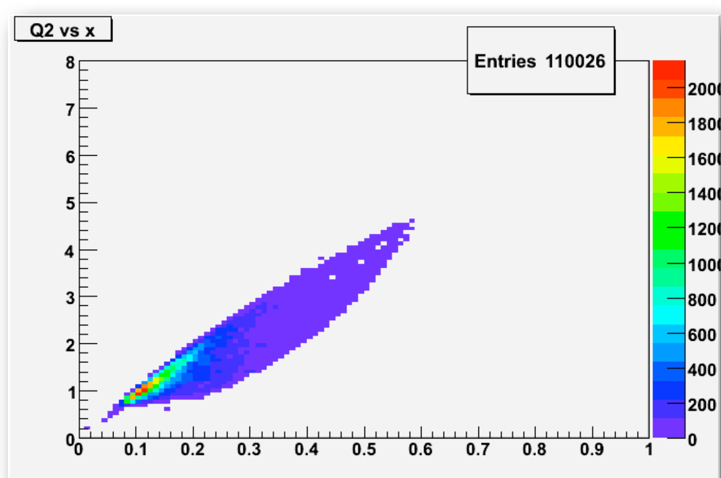


$$\sigma = \sigma_0 + \sigma_1 \cos\phi + \sigma_2 \cos 2\phi + \lambda_e \sigma_3 \sin\phi$$

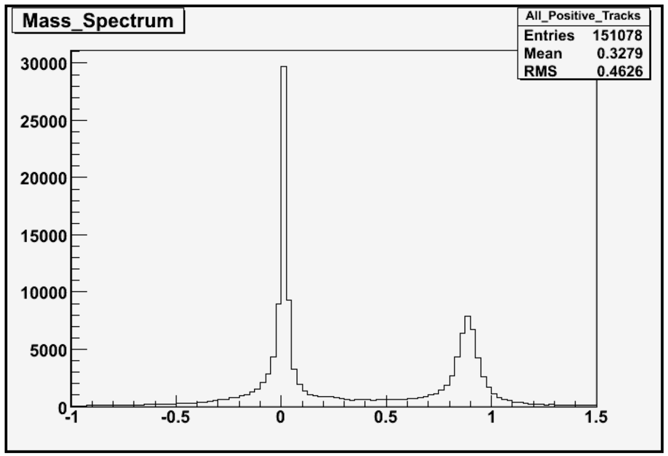
$$Asym. = \frac{\sigma^+ - \sigma^-}{\sigma^+ + \sigma^-} = \frac{\sigma_3 \sin\phi}{\sigma_0 + \sigma_1 \cos\phi + \sigma_2 \cos 2\phi}$$

- Measuring proton spin structure via SSA's and Phi Dependence of Cross-sections, giving access to PDF's and orbital angular momentum of quarks.

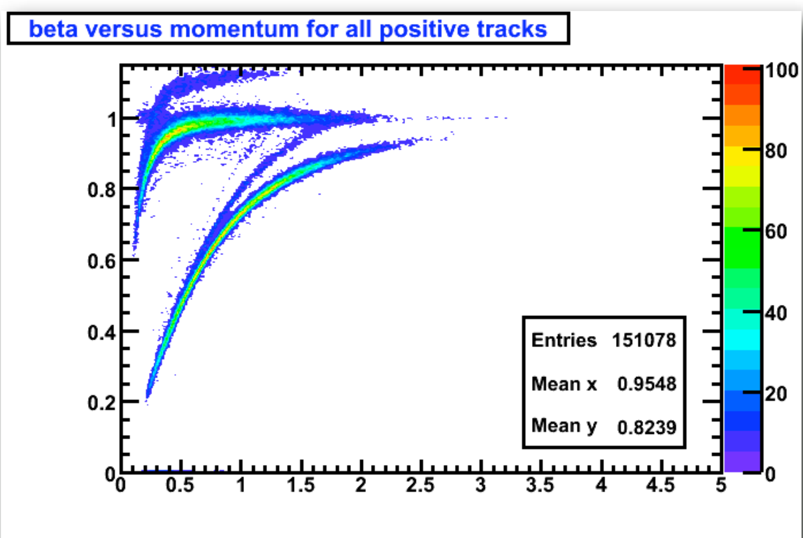
- Require W>2 for the deep inelastic region and high acceptance of pions.



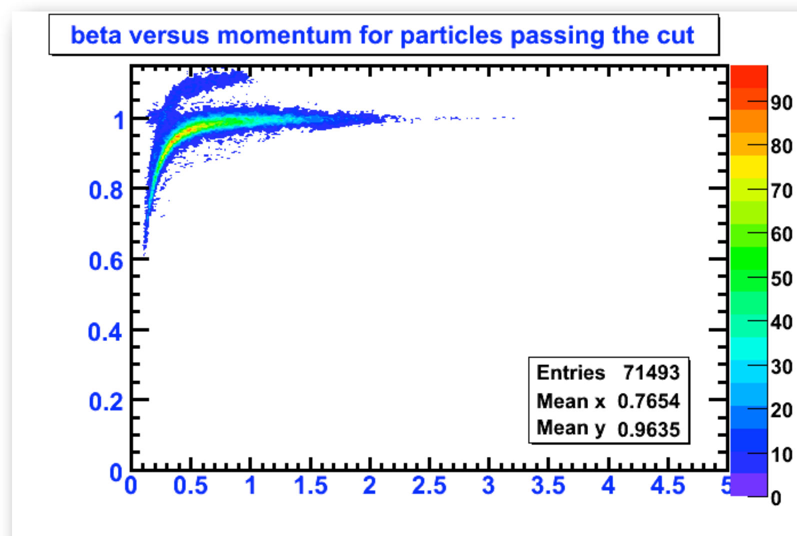
Pion Identification



The histogram on the left was generated by selecting all positive tracks from a set of data and binning the particles by mass. The taller peak represents pions (0.1396 GeV).



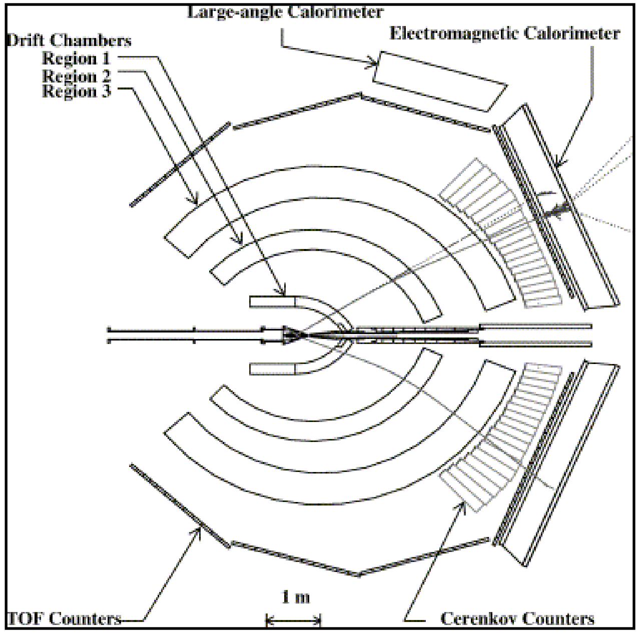
Before cut



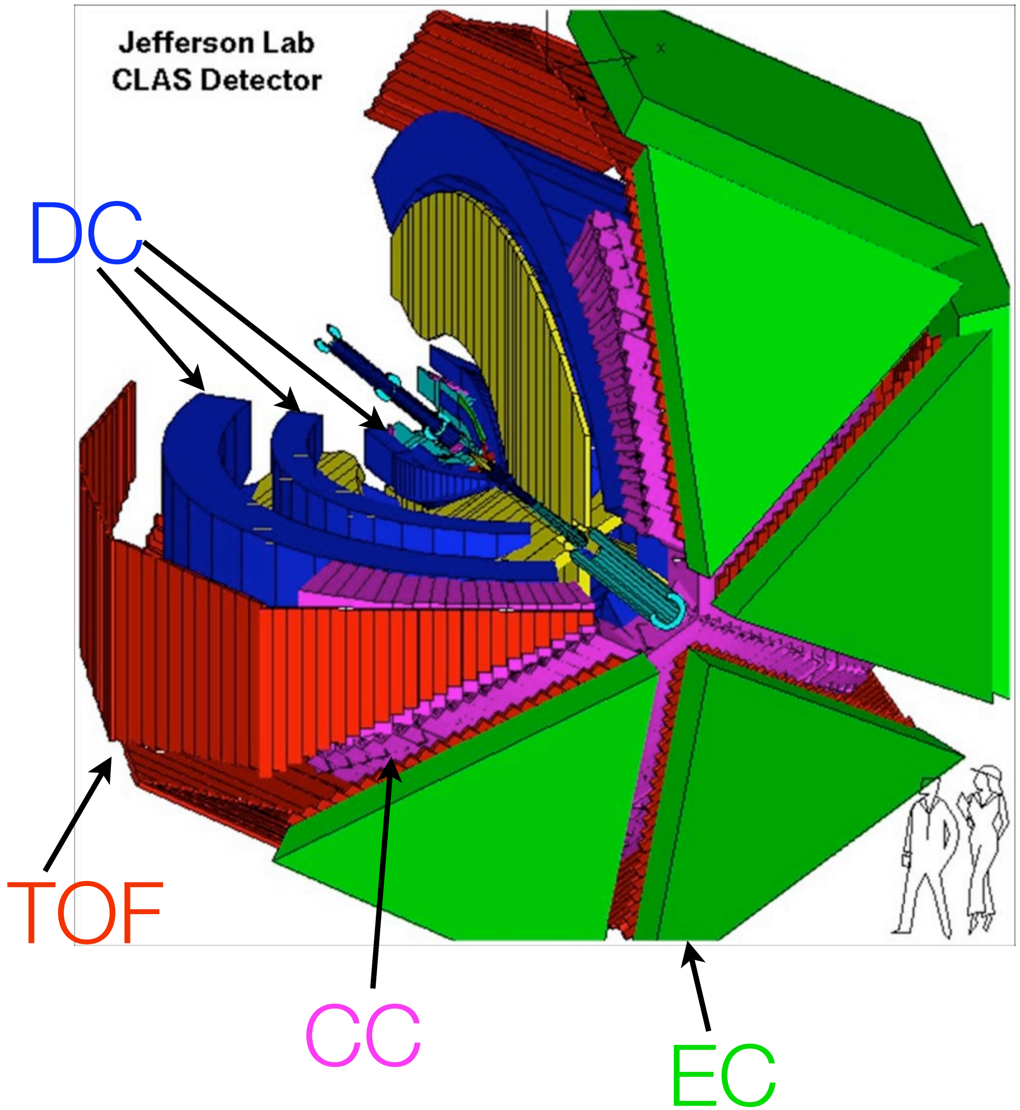
After cut

E1F Run Period

- Data taken between April and July of 2003.
- Torus magnet lowered to 2250 A to maximize pion acceptance.
- Polarized electron beam at 5.496 GeV.
- Unpolarized Liquid Hydrogen Target
- ~50 billion Triggers in Run Period



CEBAF Large Acceptance Spectrometer



- Six superconducting coils produce toroidal magnetic field
- 34 layer drift chambers provide tracking information such as momentum and polarity
- Electron identification by electromagnetic calorimeter and Cerenkov counter
- Timing information from time of flight detector combined with polarity and momentum information from drift chambers provide track's particle identification

Calibration

- EC timing
  - Important to achieve timing resolution of better than 350 ps.
  - Used in electron identification.
  - Iterative procedure.
- Time of Flight
  - Important to have good timing resolution for particle identification.
  - Particles identified by measuring beta vs. momentum.
- RF
  - Must account for rf signal in electron beam.
- Cerenkov Counters
  - Used in electron identification.
- Drift Chambers
  - Provide tracking information.
  - Determine momentum for particle identification

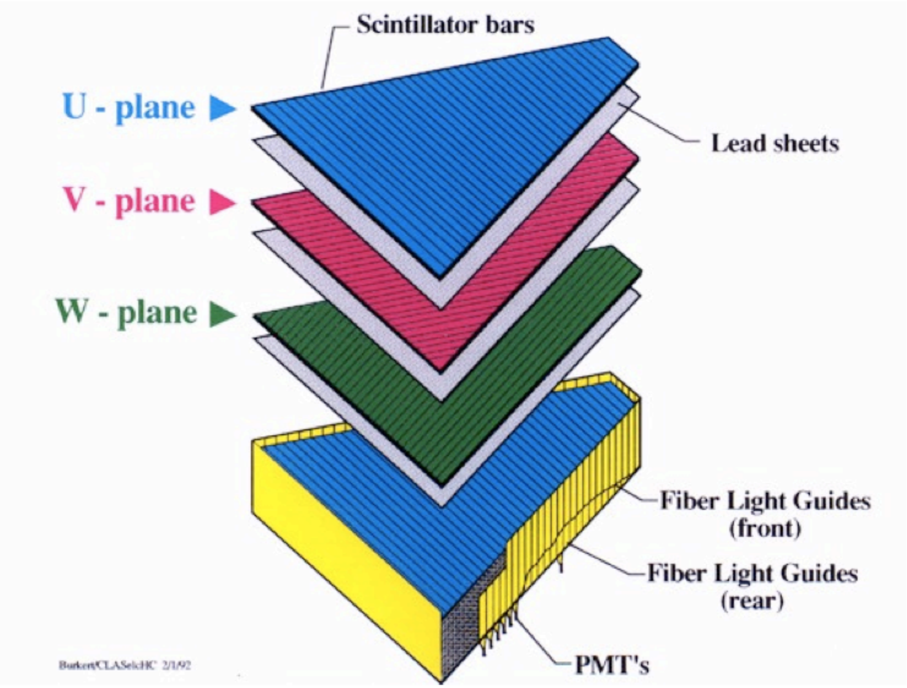
Electromagnetic Calorimeter (EC)

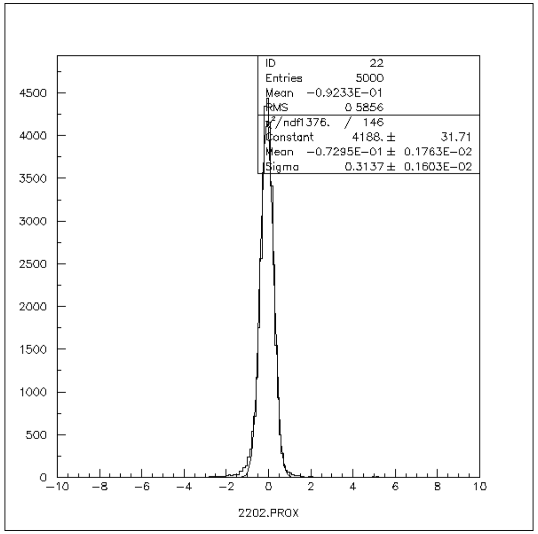
i. Compute five calibration constants for each strip (36) in each view (3) and layer (2), and sector (6); giving 6480 constants to be uploaded to database.

ii. Program uses MINUIT to perform a five-parameter chi-squared minimization on the equation for ectime.

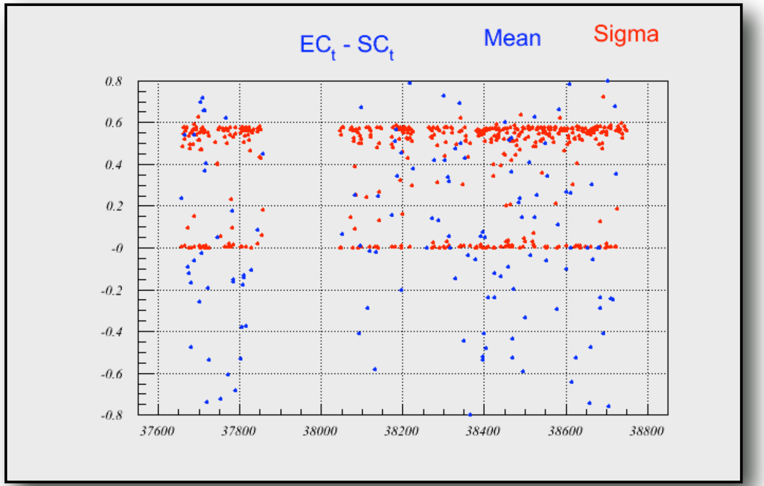
iii. Cook data with new calibration constants.

iv. Repeat procedure iteratively until means are ~100 ps and sigmas are ~350 ps.

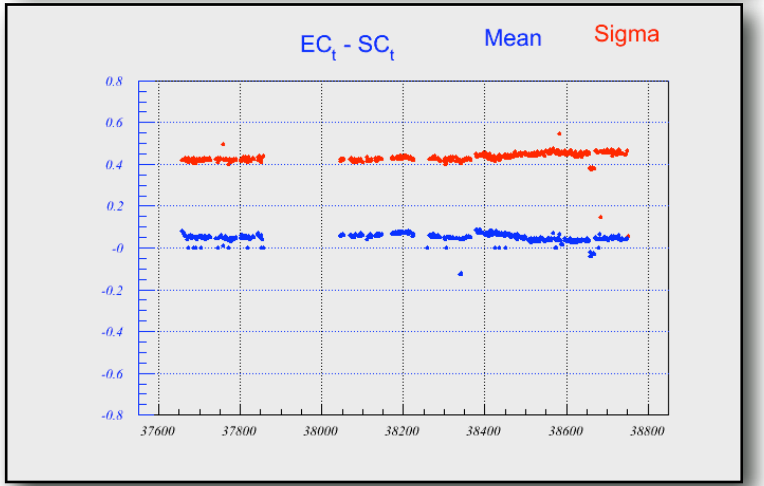




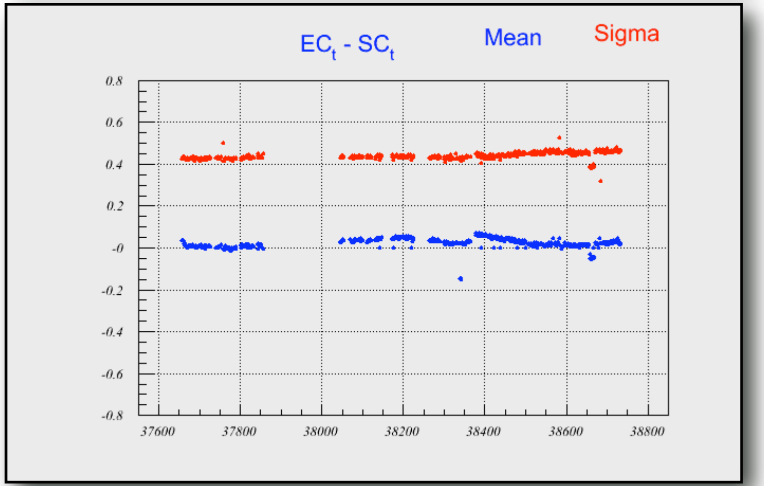
$$ectime = a * tdc + b + \frac{c}{\sqrt{|adc|}} + d|dist|^2 + e|dist|^3 - \frac{dist}{velocity}$$



Before Calibration



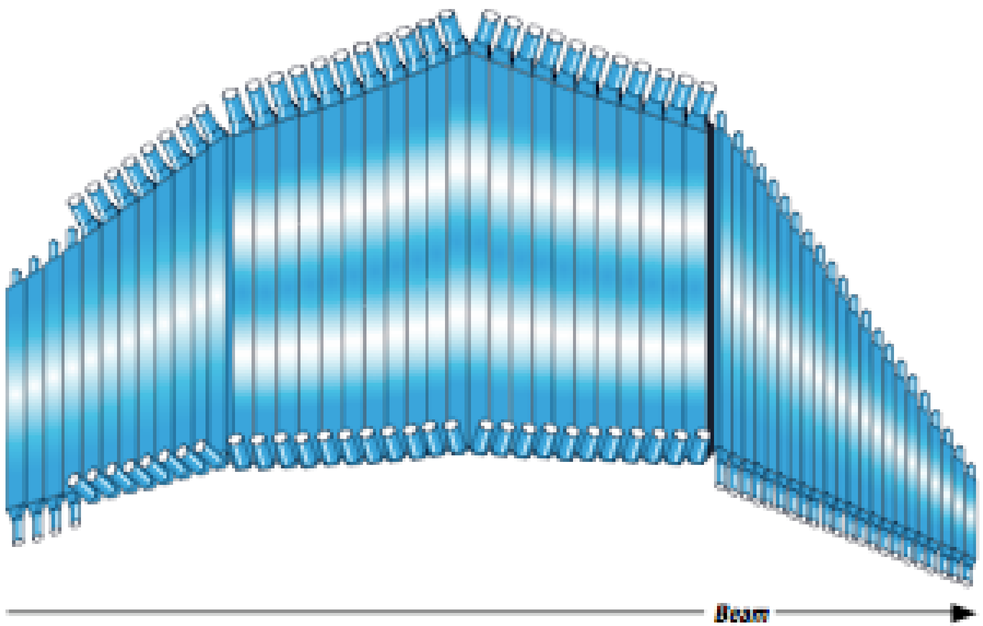
After One Iteration



Final Values

Time-of-Flight

- Status
- Pedestals
- TDC Calibration
- Attenuation Length
- RF parameters
- Paddle to Paddle



The status calibration tags bad PMT's. The pedestal refers to the ADC when no signal is present.

Time-of-Flight

- Status
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- **TDC Calibration**
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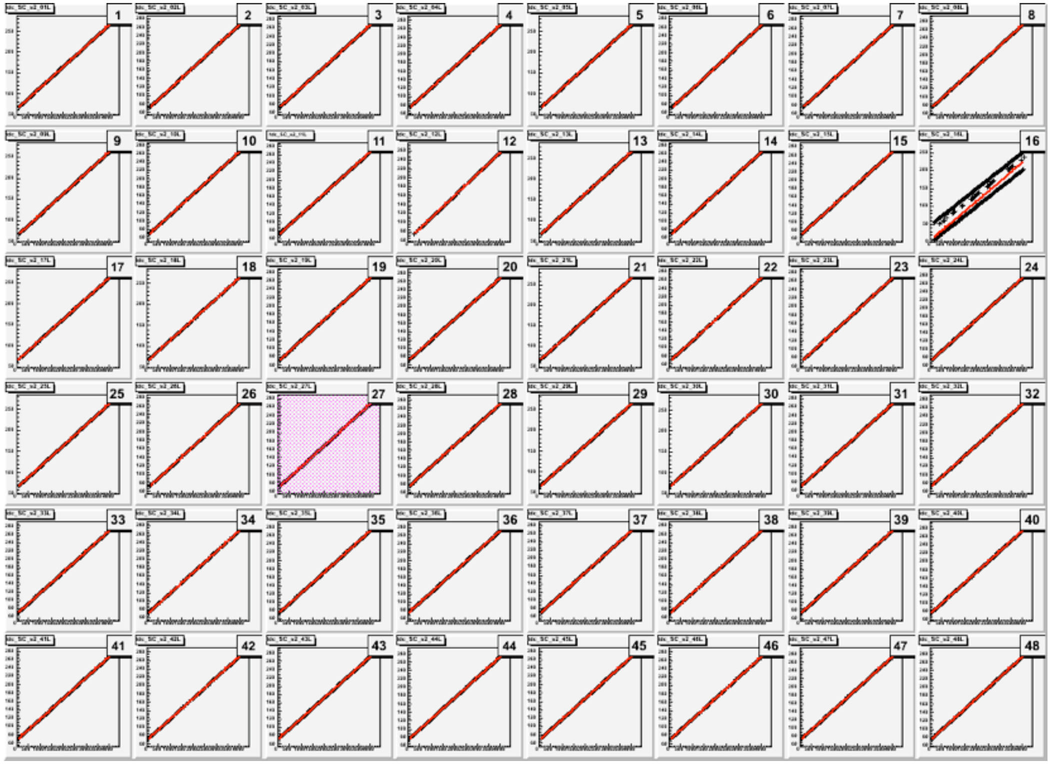
- RF parameters
- Paddle to Paddle



$$t = c_0 + c_1 T + c_2 T^2$$

Here t is the real time in ns and T is the raw time in TDC units.

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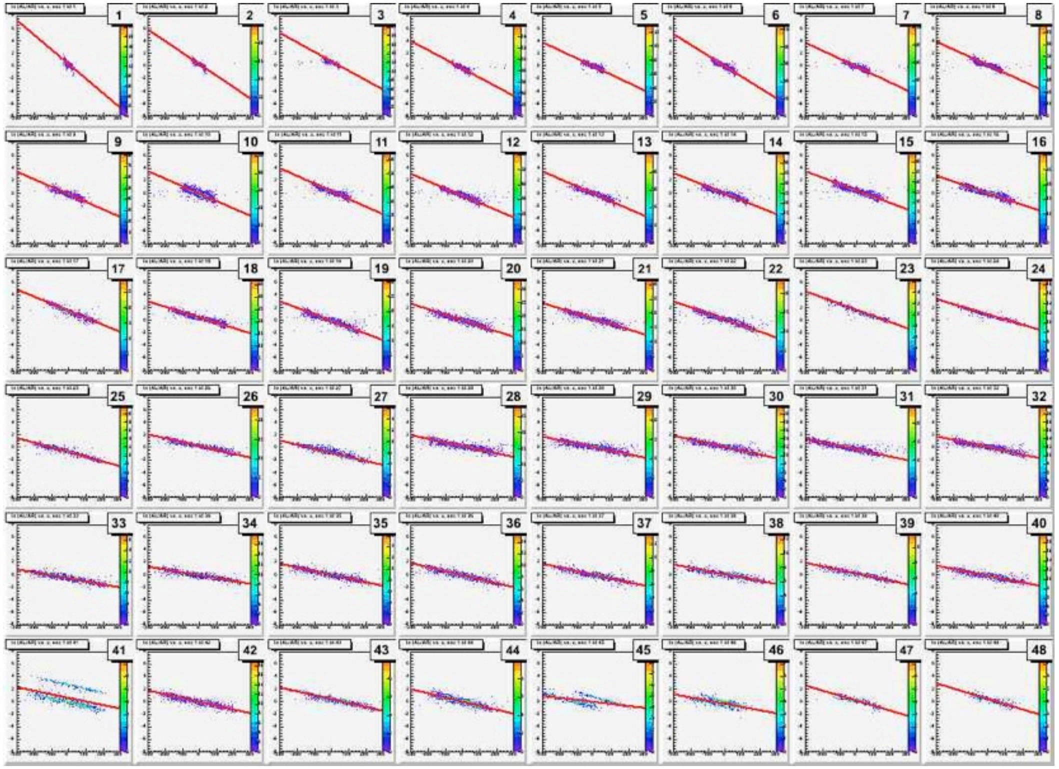
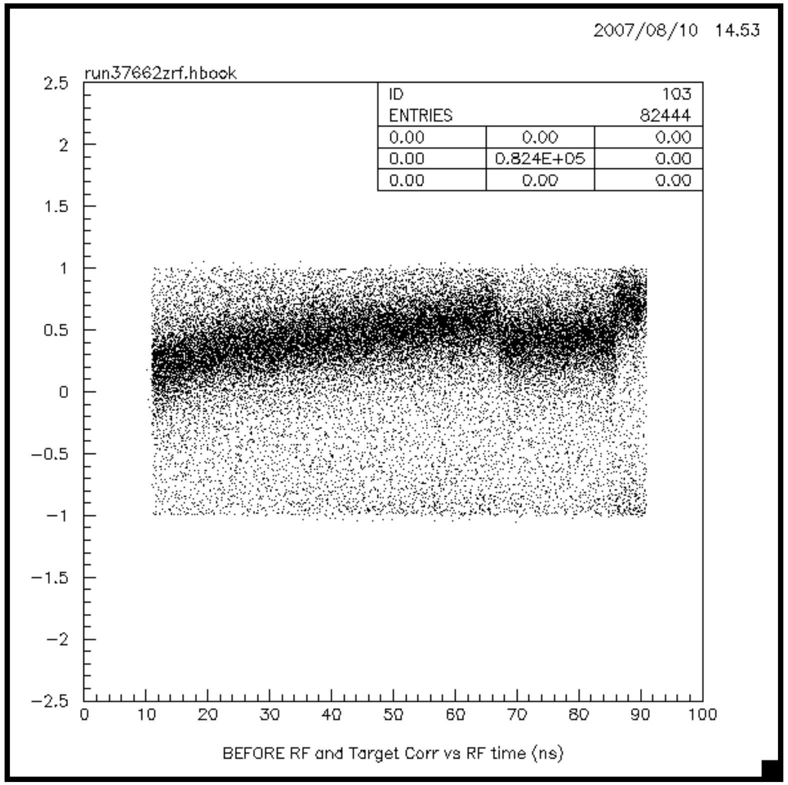


This is a measure of the light attenuation by each paddle

RF

- The electron beam carried a radio-frequency that must be taken into account in the RF calibration.
- Each 2D histogram show rf offset vs rf time.
- Each histogram is sliced into slices, each of which is fit with a gaussian.
- The mean's of each gaussian fit is then fit in four regions with a third degree polynomial.



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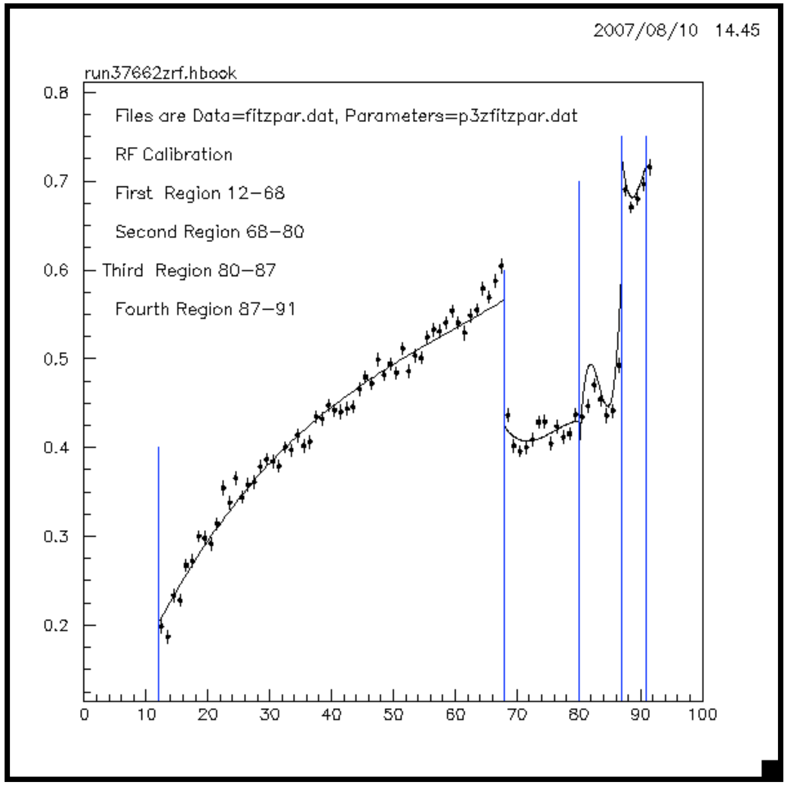

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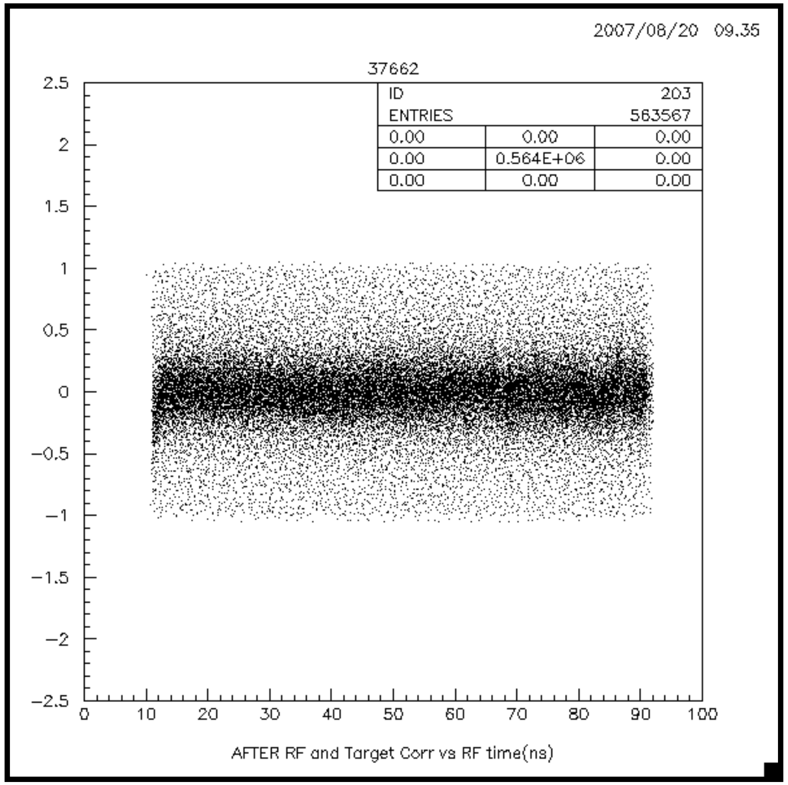

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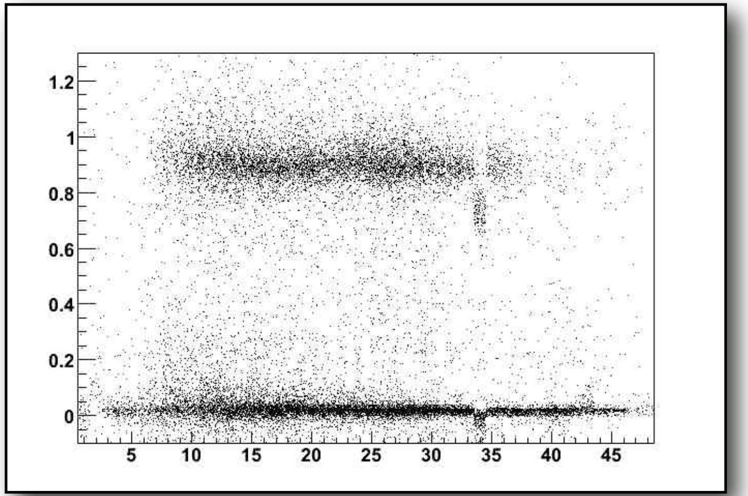
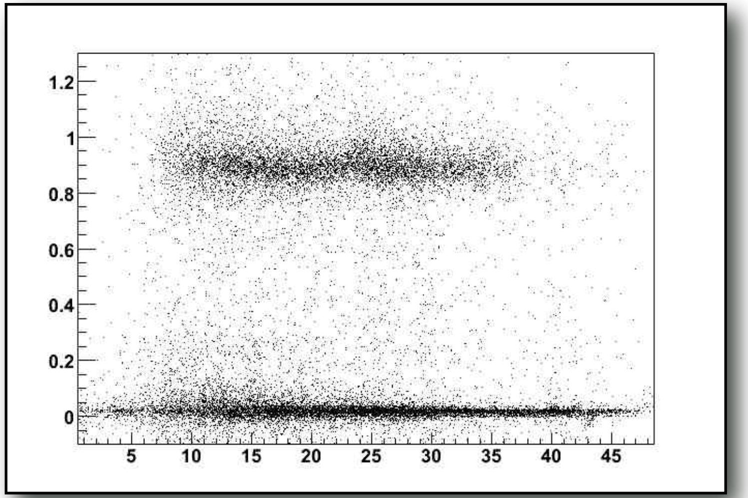


Before



After

Gives the relative time shifts between adjacent paddles.

Summary and Prospectus

- Calibration of E1F took more than one year, but it is now complete. The final cooking of the data is underway.
- Routines for particle identification, kinematic and geometric cuts, and momentum corrections are being perfected.
- Determination of CLAS acceptance using GEANT will be a large project.
- Within the next few months preliminary asymmetries will be measured.

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