BigBite Tracking and Analysis for G_n^E

Seamus Riordan
Carnegie Mellon University
riordan@jlab.org

June 22, 2006

Abstract

The G_n^E experiment completed running in May 2006. Crucial aspects of the analysis in the BigBite spectrometer for this experiment include precise and efficient tracking and accurate momentum reconstruction. While there have been successes on these fronts, there are still some issues before any final analysis can be made.

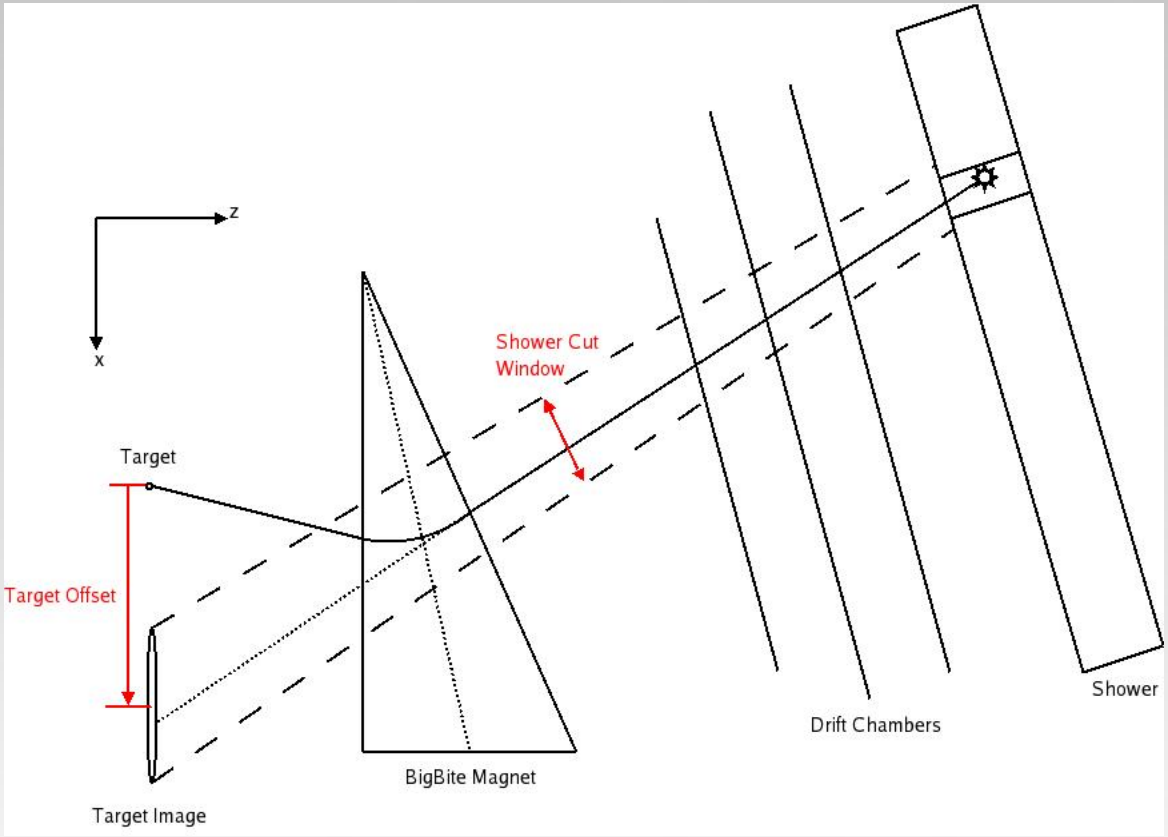
Outline

1. Introduction
2. Tracking
   (a) Algorithm
   (b) Fitting
   (c) Drift Time to Distance
   (d) Crosstalk
3. Momentum and Vertex
   (a) Track Reconstruction
   (b) Momentum Reconstruction
   (c) Additional Fitting
      i. Momentum and Vertex
      ii. Coefficient Stability
      iii. Out of Plane Angle
4. Summary

Tracking - Algorithm

Very general algorithm:

- Remove hits outside time window
- Identify shower cluster
- Find wires in path defined by shower
- Coarse tracking through all combinations of wires without drift times
- Fine tracking using drift times



Documentation can be found in:

http://hallaweb.jlab.org/experiment/E02-013/offline/bbtracking.pdf

Tracking - Algorithm

Algorithm is still slow ($<$30Hz) and obvious improvements should be made

Possible improvements:

- New grouping algorithm (Clustering hits on invidiual chambers, etc.)
- Clean up noise
- Optimize for data

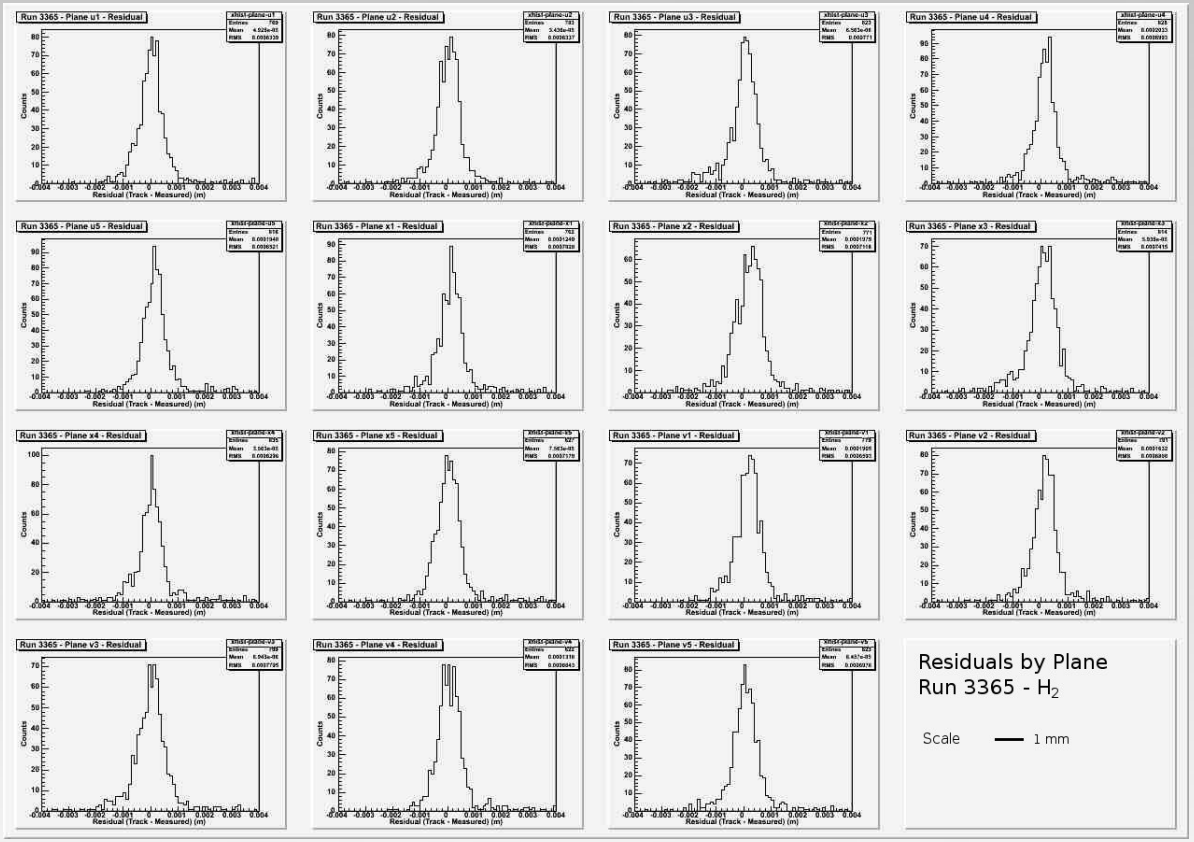
Tracking - Fitting

Tracking has been successful

Reconstruction efficiency estimated between

- 70% for production conditions
- 90% for low beam currents ($\sim$1μA)

Wire plane spatial resolution about 300$\sim$400μm.



Further plane position alignment must be done

Tracking - Time to Distance Conversion

Time to distance conversion can be done through several different methods:

- Constant drift velocity
- Empirical Function
- Conversion Table

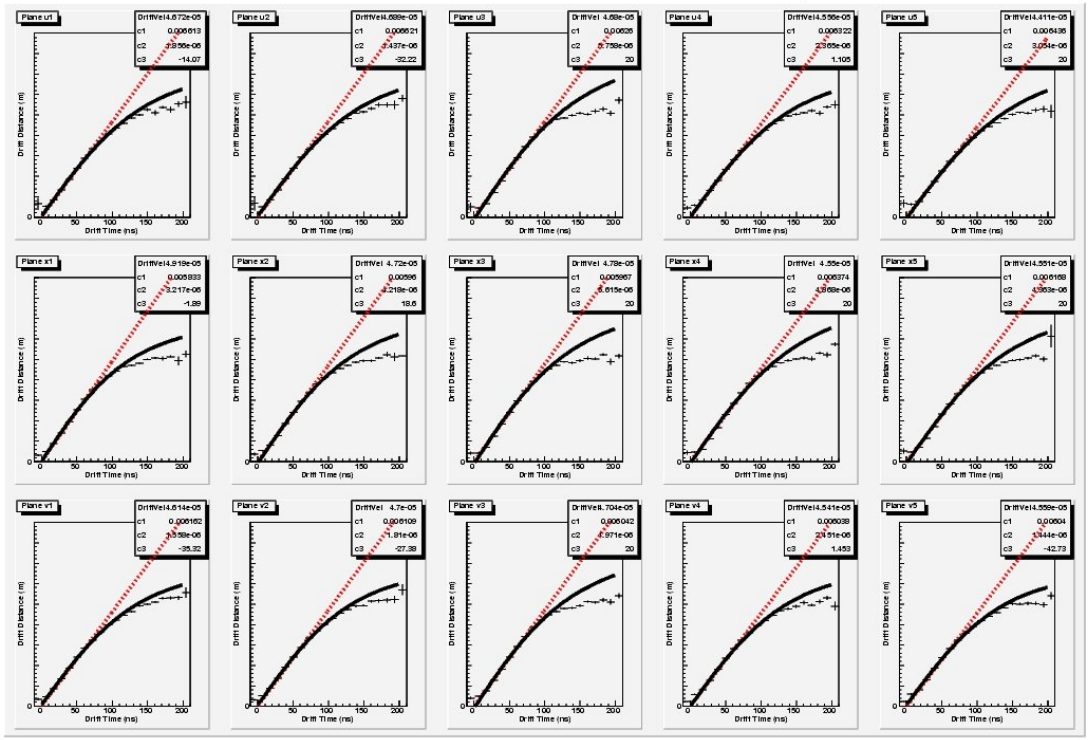
Time to distance can be done through the function:

$$d_{drift} = c_0 \tanh\left(\frac{v t_{drift}}{c_0}\right) + c_1(t - t_0) \tag{1}$$

v, c_0, c_1, and t_0 constants to be determined from available scripts.

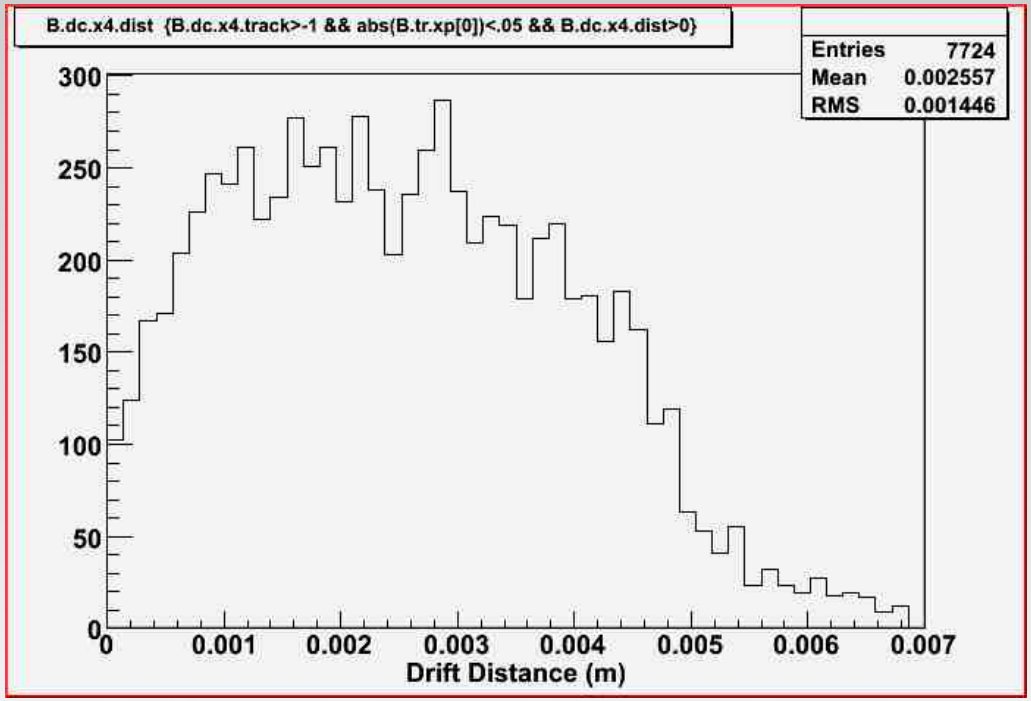
v is still kept as leading term in conversion

Drift Distance vs Drift Time

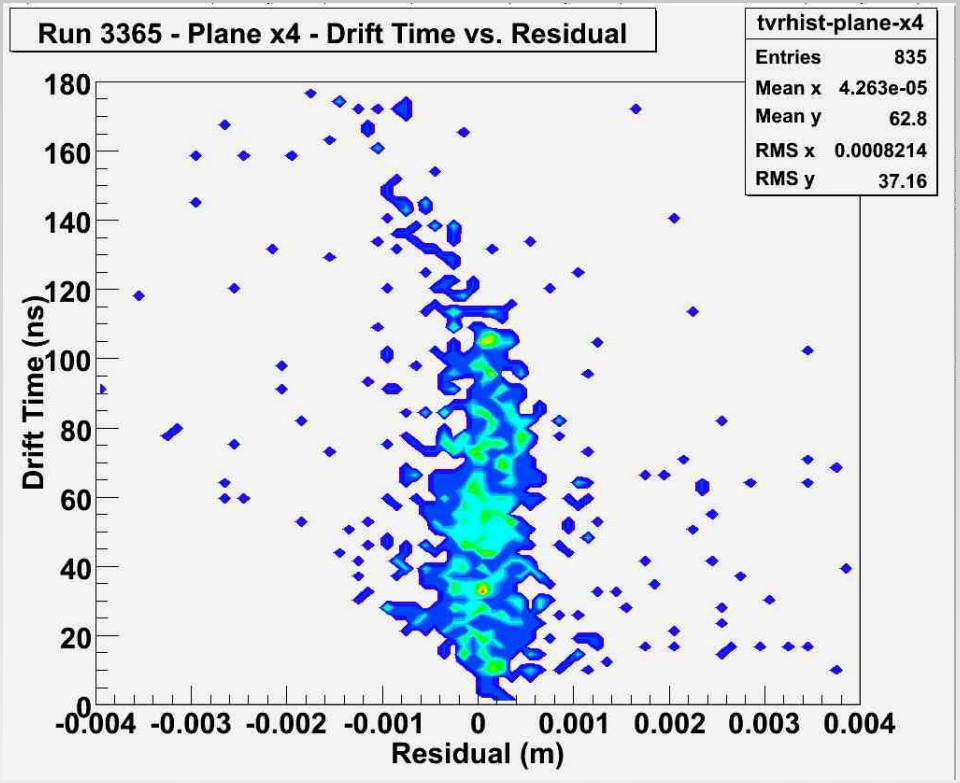


Fit is very good for lowest times

Drift distances for narrow angle range ($\pm 3^\circ$):



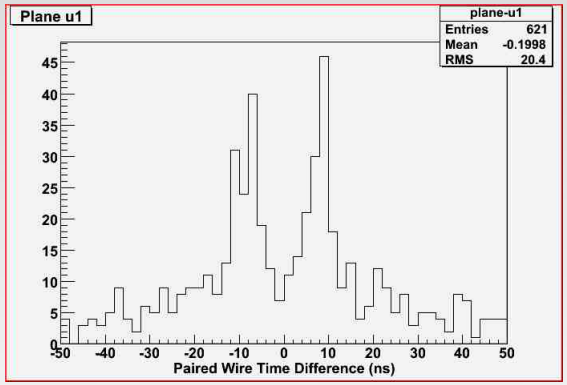
Missing reconstruction at higher distances?



Still need to find coefficients for various configurations

Tracking - Crosstalk

Crosstalk introduces extra noise into data through induction of signals in neighboring wires

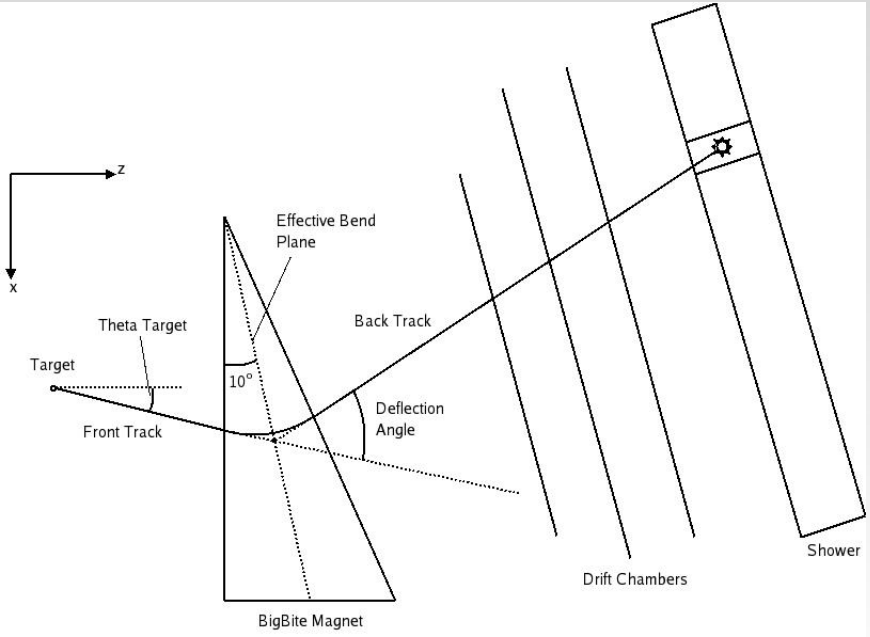


Second signal appears to be about 7ns$\pm$3ns after first signal

Removal reduces hits by 12% in chamber 1 and 5% in others

Track Reconstruction

Track reconstruction done by effective bend plane model



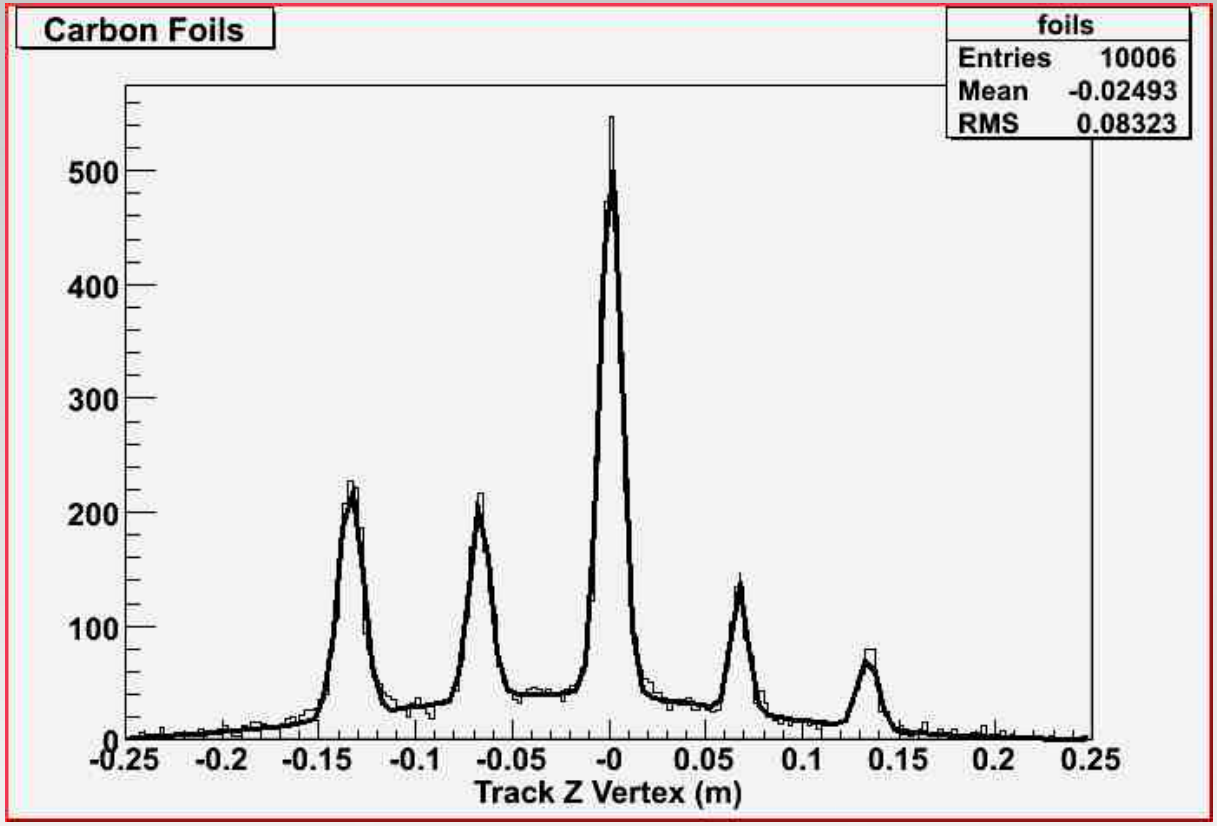
Vertex along beam reconstructed by:

$$v_{z,LAB} = c_0 z_0 + c_x x_{det} + c_{x'} x'_{det} + c_y y_{det} + c_{y'} y'_{det} \qquad (2)$$

Vertex coefficients determined by optics foils data

Need to include BPMs and raster more effectively

Stability of coefficients between runs must be examined



0.5cm sigma resolution along beamline achieved

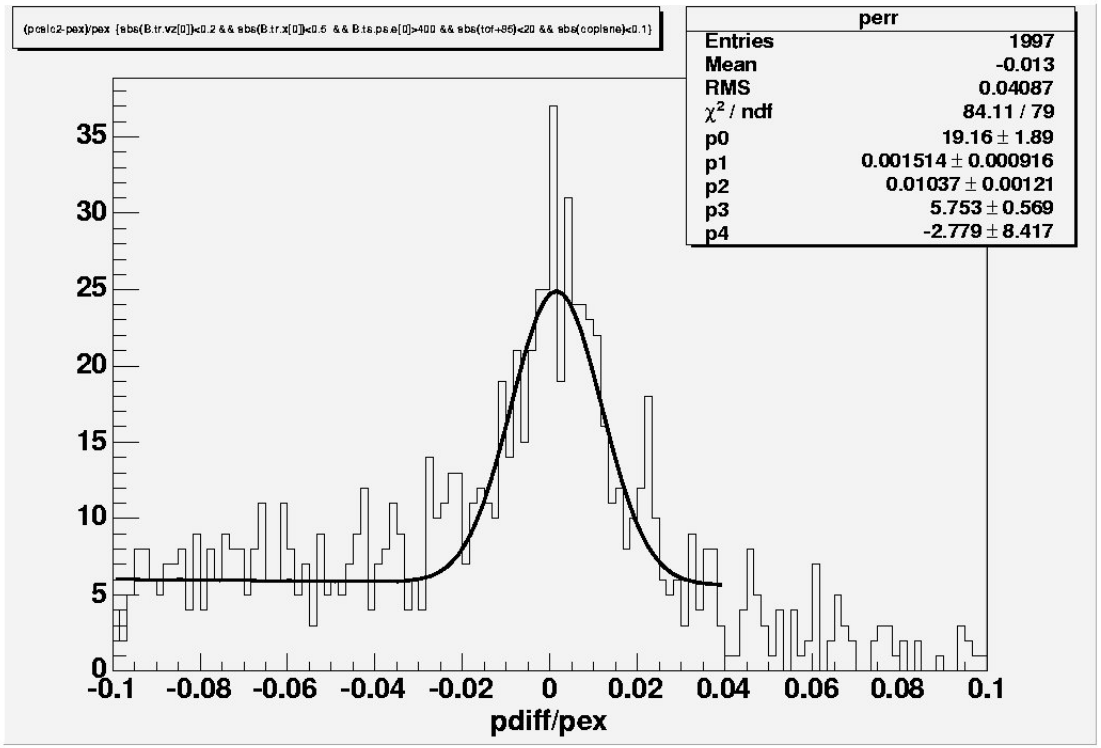
Momentum Reconstruction

Momentum represented by:

$$p = \frac{c_0 + c_x x_{bend}}{\vartheta_{def}} + c_\vartheta \vartheta_{targ} + c_y y_{det} + c_\varphi y'_{det} \tag{3}$$

$$\vartheta_{def} = \cos^{-1}\left(\frac{\vec{x}_{front} \cdot \vec{x}_{back}}{|\vec{x}_{front}||\vec{x}_{back}|}\right) \tag{4}$$

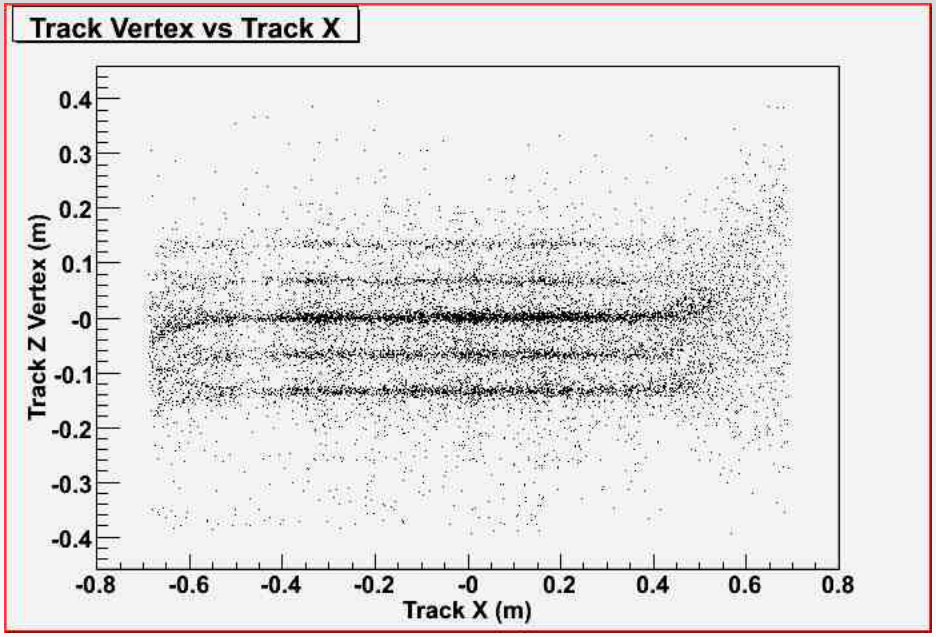
Coefficients determined by H_2 data

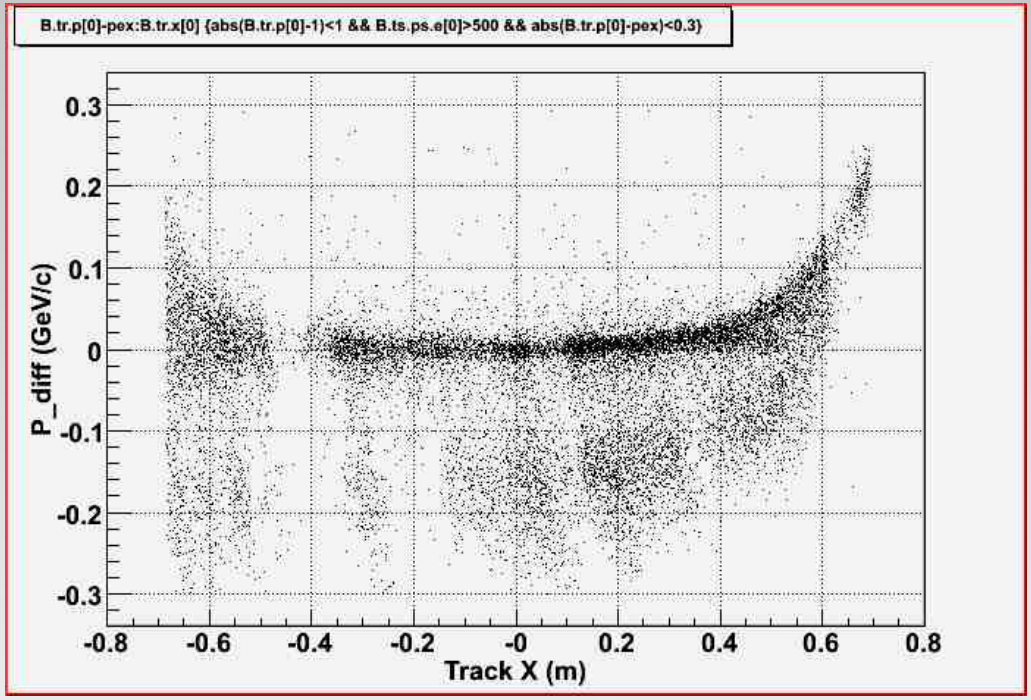


Achieved 1%∼1.5% $\frac{\delta p}{p}$ sigma resolution

Additional Fitting - Momentum and Vertex

Problematic physical areas in fitting: $|x_{det}|$ >0.5m





Vertex must be fixed first

Vertex problem cannot fully explain momentum fit problem

Additional Fitting - Coefficient Stability

More investigation must be done on coefficients

Small ($<$50 MeV) peak shifts between kinematics

Small shifts in beam height ($<$1mm) can cause peak shifts

Dependent on:

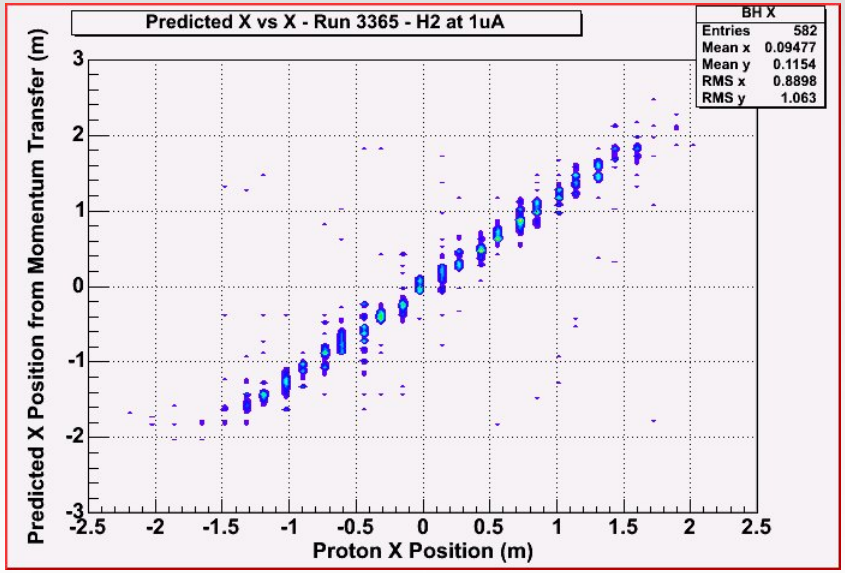
- Geometric configuration parameters
- BPM and raster information

Vertex coefficients preliminarily seem stable

Additional Fitting - Out of Plane Angle

Out of plane angle does not agree with neutron arm

Correction appears to be dependent on x_{det}



Need to investigate:

- BigBite Geometry Dependence
- Neutron Arm Bar Positions
- Effective Bend Plane Model Problem

Summary

While the tracking and momentum reconstruction are functioning at a usable and useful level, improvements still must be made for final analysis. The most important areas to be focused on with the spectrometer are reduction in noise and fitting to extremal vertical areas of the magnet.