Corrections to the g1c Dataset

In advance of a study of the density matrix elements for $\gamma p \to p\omega$

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Outline

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2. Tagger Corrections
   - Method
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   - Method
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Outline

Introduction

- The g1c dataset was taken from October 2 to November 30, 1999
- 7.5 terrabytes of data were collected and there were 4.5 billion triggers
- The target was unpolarized liquid H_2
- The run period studied here had an electron beam at an energy of 2.445 GeV which produced a circularly polarized tagged photon beam
- The beam was circularly polarized, allowing for study of different spin density matrix elements than g11 or FROST
  - g11a did not have a polarized beam or a polarized target
  - FROST has runs with a circularly polarized as well as linearly polarized beam and a polarized target

Introduction

- There was a single charged track trigger giving us access to the reactions $\gamma p \to p\pi^0$ and $\gamma p \to \pi^+ n$
- There are approximately 800,000 ω events to study after fiducial cuts
- Though the dataset has been studied before, a good set of momentum corrections was not available to us, thus we had to create our own before we can study the dataset in great detail

CLAS Background

- CLAS has six sectors and two coordinate systems used in this analysis
- The lab system has z pointing in the direction of the beam, y straight up, and x to the center of sector 1
- θ_{lab} and ϕ_{lab} are the lab polar and azimuthal angles, binning is based on these variables
- The tracking system has x pointing in the direction of the beam, y passes through the center of the sector, and z is aligned with the average magnetic field in the sector.
- $\lambda_{tracking}$ is the dipolar angle and $\phi_{tracking}$ is the angle relative to the sector's plane, corrections are made to these variables
- The momentum tracking is done in terms of the ratio of charge to the magnitude of momentum q/p

Corrections Background

- Corrections
  - Energy loss corrections already existed and were written by Eugene Pasyuk
  - Tagger corrections are used to correct the misalignment of the tagger hodoscope first discovered by Mike Williams (CMU) in 2003
  - Momentum corrections fix inaccurate magnetic field maps or drift chamber survey information
  - Poor resolution for low momentum protons is solved with a simple cut
- Previous momentum and tagger corrections were more coarse than g11a and were not studied in as much detail
- The old corrections treated protons and $\pi^+ s$ as equivalent
- The new corrections here treat each particle separately and intend to be complete

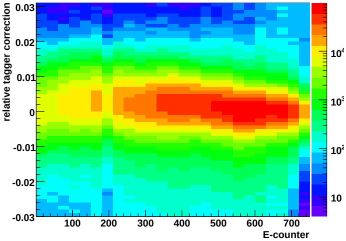
Outline

Generating Tagger Corrections

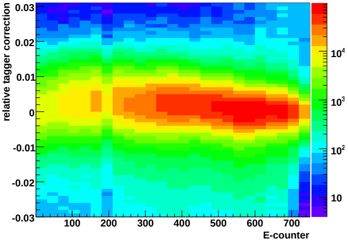
- First look at corrections to the tagged photon energy
- Start by choosing events of $\gamma p \rightarrow p\pi^+\pi^-$ with nothing missing
- Apply E-loss correction to the particles
- Get the measured energy of the photon $\rightarrow E_\gamma^{meas}$
- Do a 3-C kinematic fit ignoring the measured photon energy $\rightarrow E_\gamma^{kfit}$
- Cuts
    - Cut events with proton momentum less than 350 MeV/c
    - Cut events with a missing $p_\perp$ of greater than 25 MeV/c
    - Make a 10 percent confidence level cut

Generating Tagger Corrections

- Plot $(E_\gamma^{kfit} - E_\gamma^{meas})$/Electron Beam Energy vs energy counter
- Fitting
  - Take each energy counter and generate 1-D histogram of relative tagger correction
  - Fit histogram with a Gaussian plus linear background



Generating Tagger Corrections



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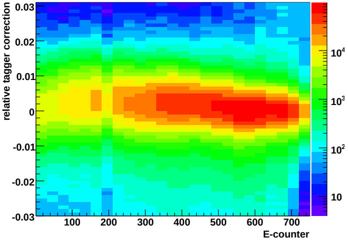

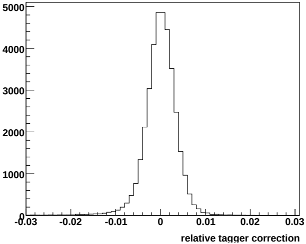

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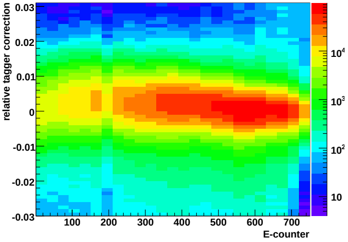

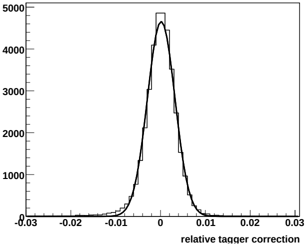

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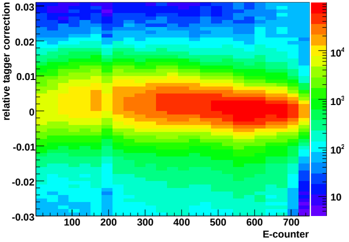

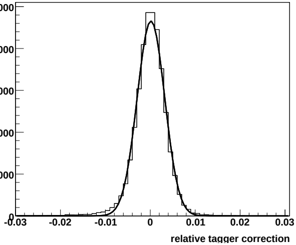

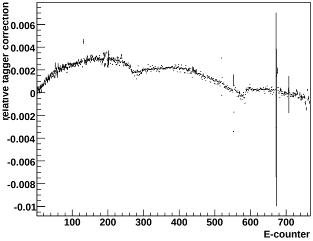

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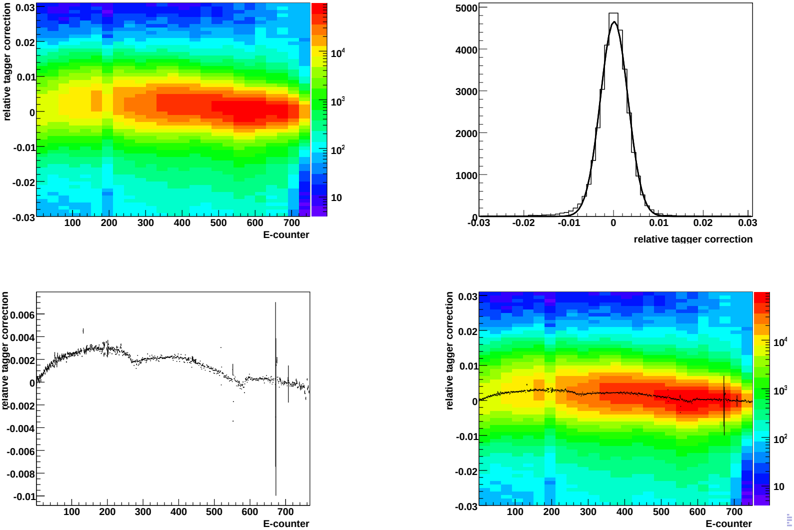
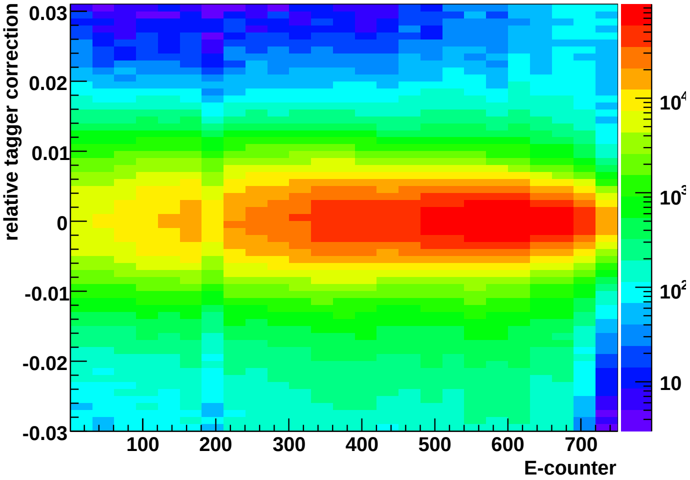


Corrected Tagger



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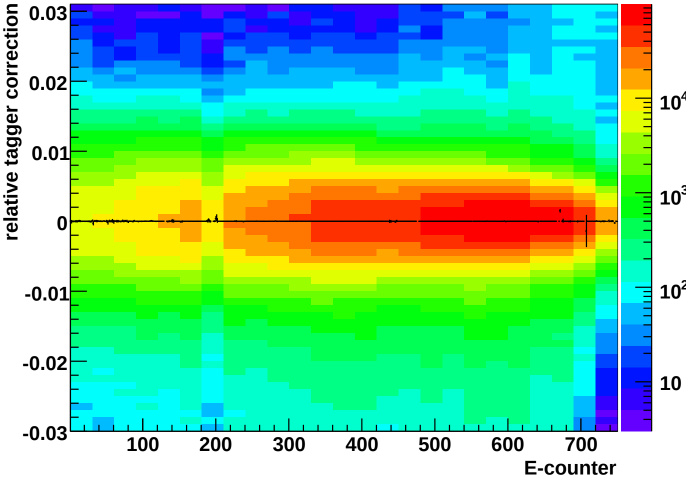


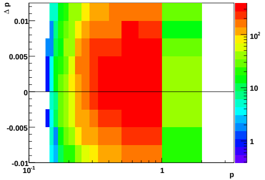
Outline

Generating Momentum Corrections

- Start by choosing events of $\gamma p \to p\pi^+\pi^-$ with nothing missing
- Apply E-loss to the particles and tagger corrections to the photon
- Apply momentum corrections to the particles if they have been generated
- Keep events with $|MM| < 100$ MeV$/c^2$
- Kinematic Fit
  - Do a 1C kinematic fit ignoring the momentum of one particle
  - Record difference between fit and original p, $\lambda_{tracking}$ and $\phi_{tracking}$
  - $\Delta x = x^{kfit} - x^{meas}$
- Repeat for all 3 particles, p, π^+ and π^-
- Cuts
  - Cut events with proton momentum less than 350 MeV/c
  - Cut events with a missing $p_\perp$ of greater than 25 MeV/c
  - Make a 10% confidence level cut (i.e. all three particles below 10%)

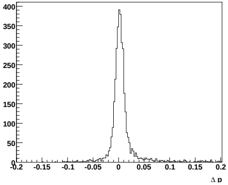
Generating Momentum Corrections

- The data is binned in the same way as g11
  - There are six sets of bins due to the six CLAS sectors
  - θ_{lab} has 15 bins
    - Nine 5° bins from $[5^\circ, 50^\circ)$
    - Four 10° bins from $[50^\circ, 90^\circ)$
    - Two 25° bins from $[90^\circ, 140^\circ)$
  - ϕ_{lab} has twelve 5° bins
  - Magnitude of momentum is binned in equal sized 1/p bins because of tracking
- Each bin has nine plots: Δp, $\Delta\lambda_{tracking}$ and $\Delta\phi_{tracking}$ vs p for all three particles



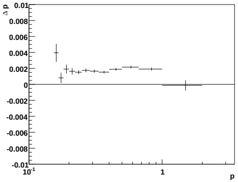
Generating Momentum Corrections

- Fitting
  - Take each 1/p bin in and generate a 1-D histogram of Δx
  - Check that there are at least 100 events and a peak of at least 10 (due to binning)
  - Fit histogram with a Gaussian plus linear background



Generating Momentum Corrections

- The results of these fits are plotted vs p and then those points are fit with a polynomial
  - If there are no entries the bin is ignored
  - If there is one entry the fit takes its value
  - If there are two entries the bin is fit with a line
  - If there are three entries the bin is fit with a quadratic
  - If there are four or more entires the bin is fit with a third order polynomial



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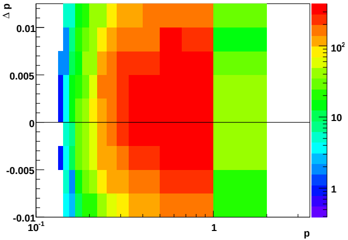

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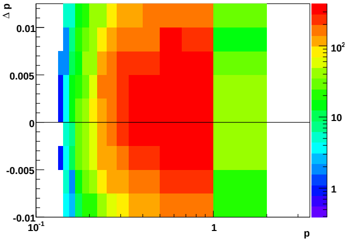

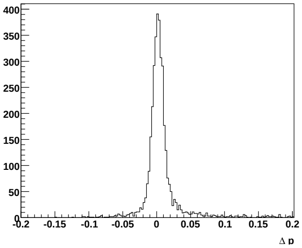

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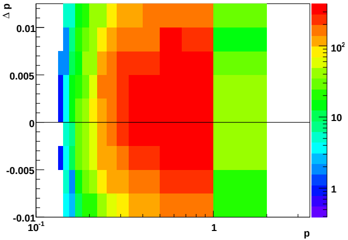

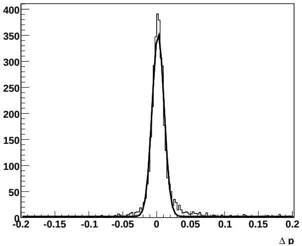

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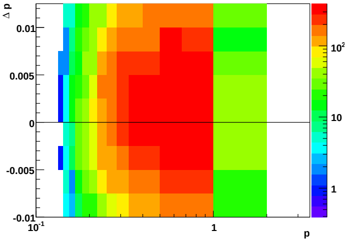

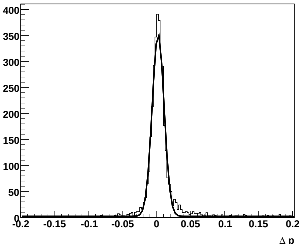

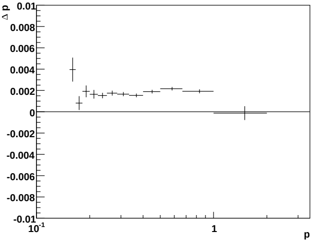

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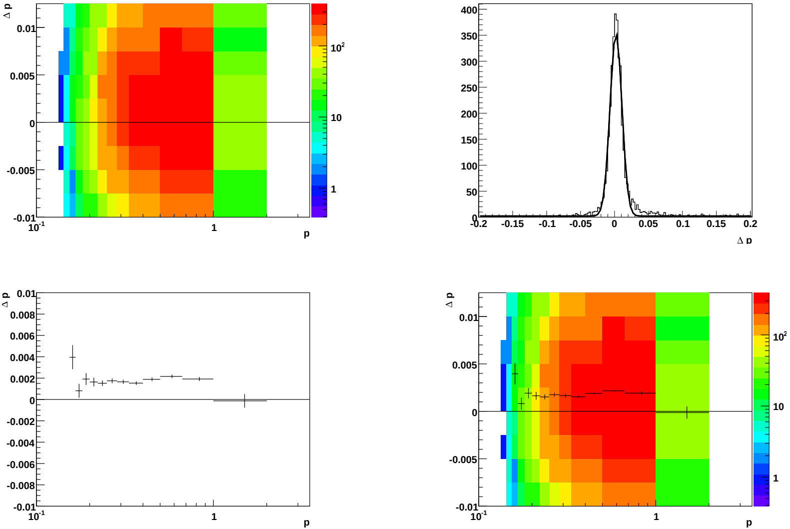

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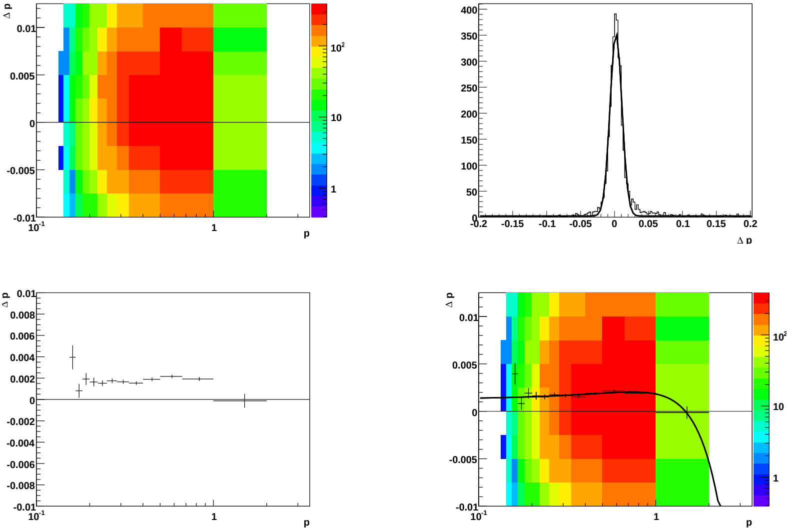
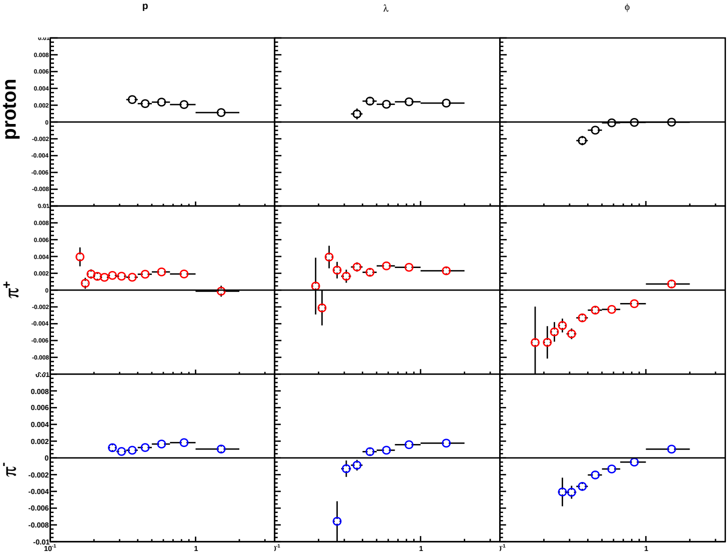


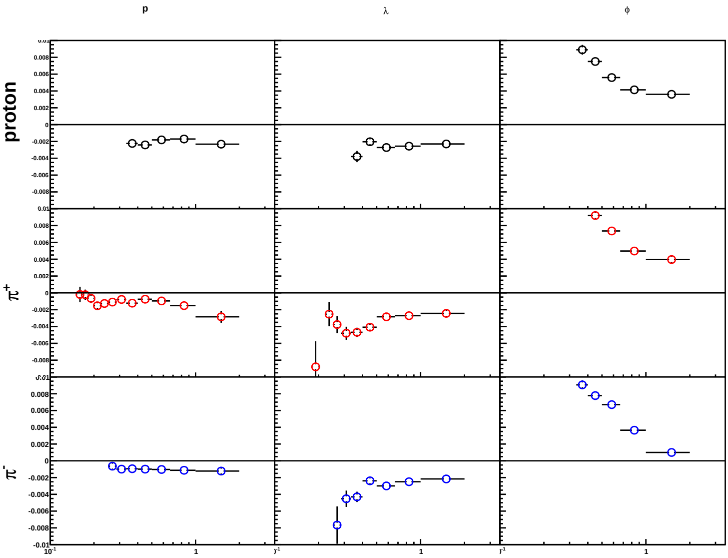
Generating Momentum Corrections

- Once the Tagger and Momentum corrections are generated repeat process
  - Redo tagger correction with momentum and tagger corrections applied
  - Combine last iteration with the new correction
  - Redo momentum correction with previous iteration's momentum correction applied
  - Combine last iteration with the new correction
- Each iteration should get you closer to zero
- The 9 variables are correlated
  - Proton p tied closely to π^+ and π^- $\phi_{tracking}$
  - π^+ p tied closely to proton and π^- $\phi_{tracking}$, etc.
- Varying one variable changes others as well
- So change only one variable at a time

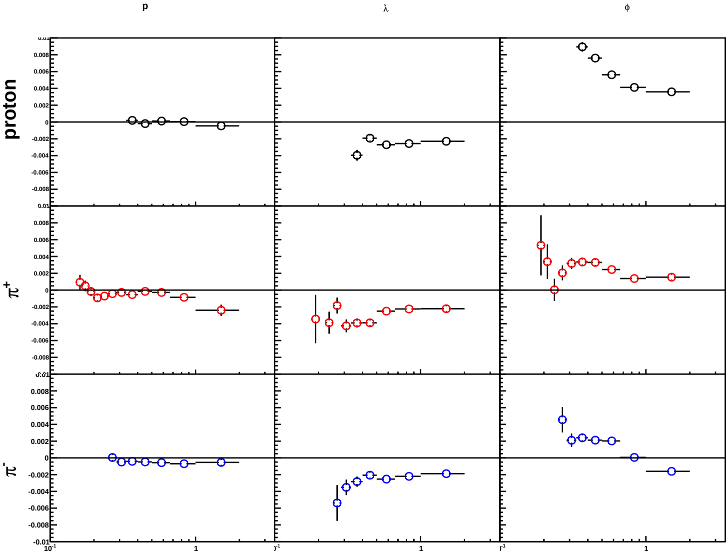
Initial Conditions



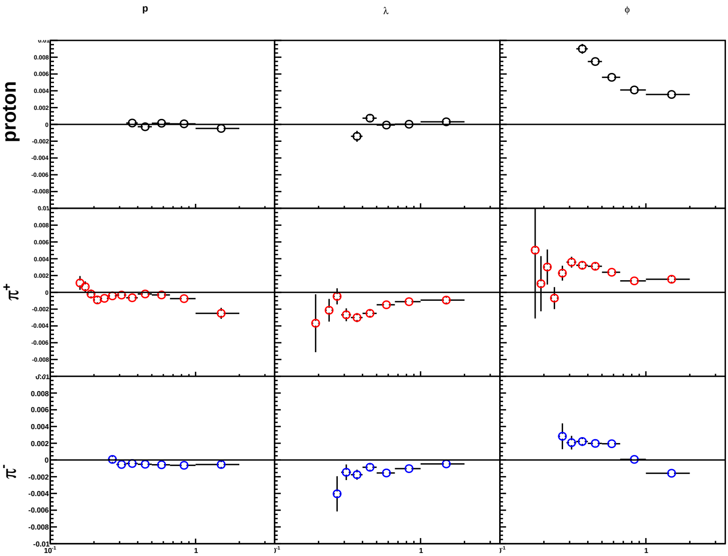
Modified all variables



Modified proton p



Modified proton $\lambda_{tracking}$



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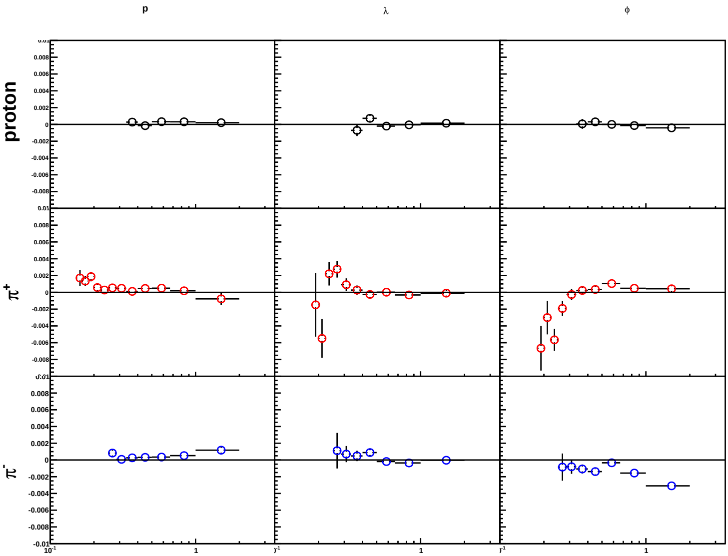
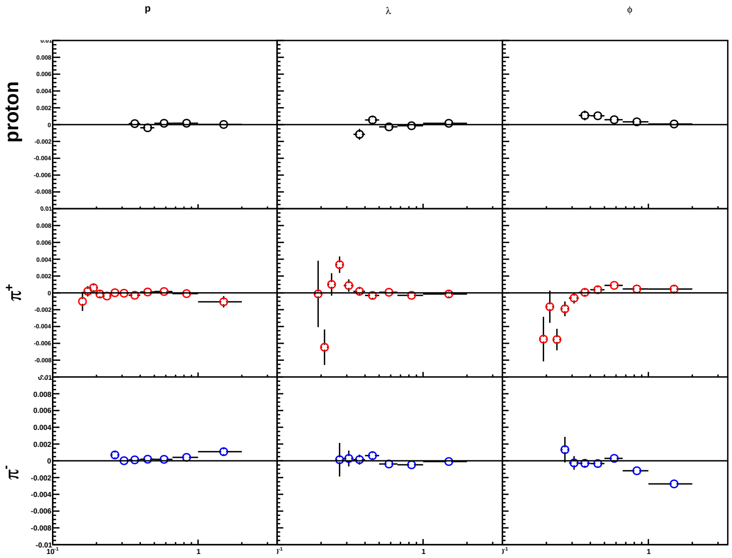
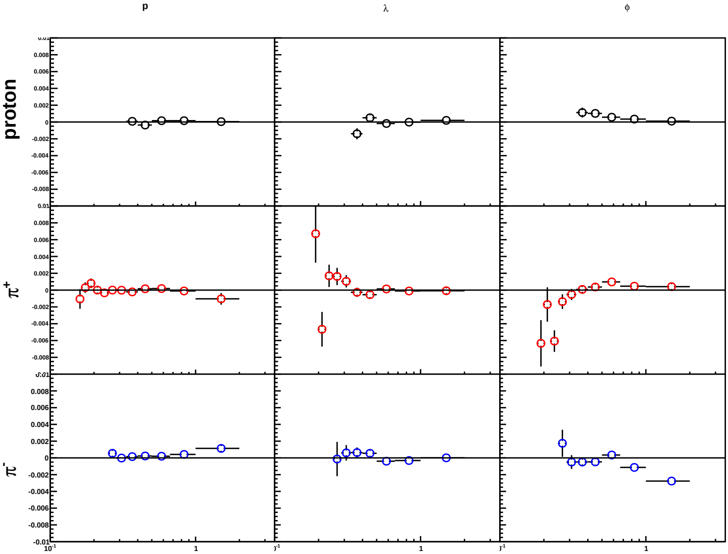


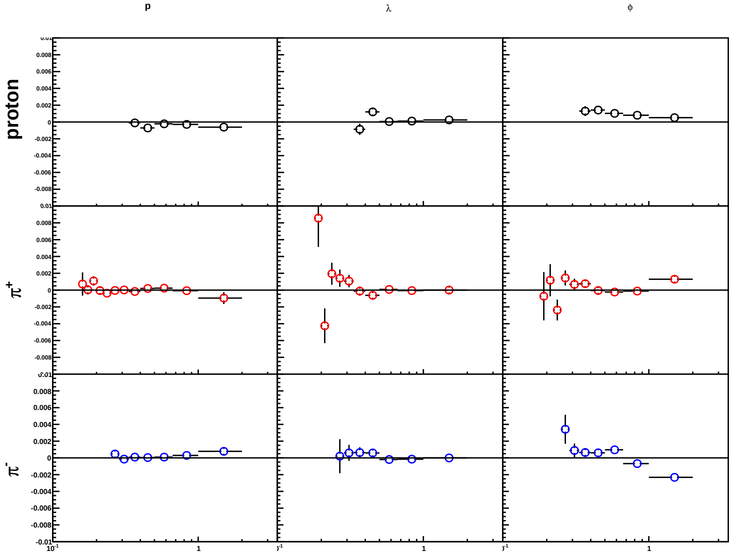
Modified π^+ p



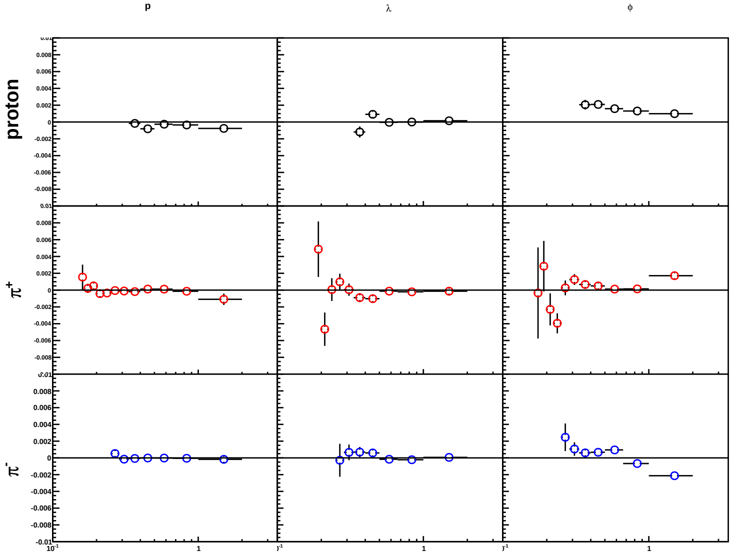
Modified π^+ $\lambda_{tracking}$



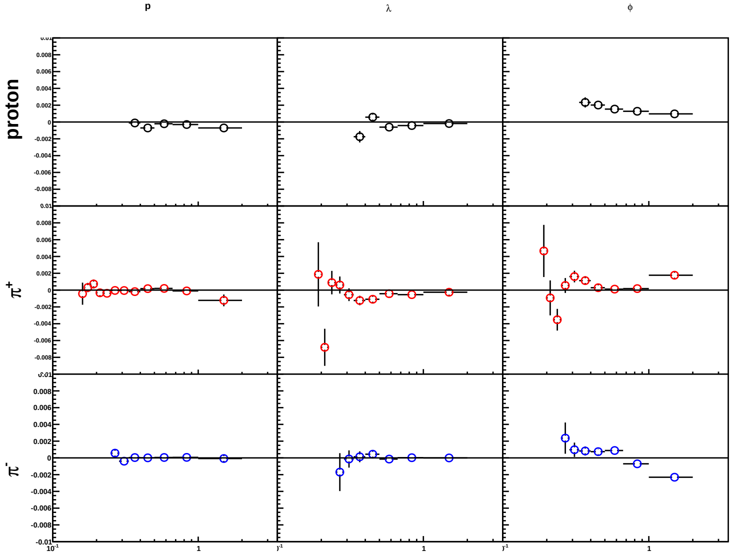
Modified π^+ $\phi_{tracking}$



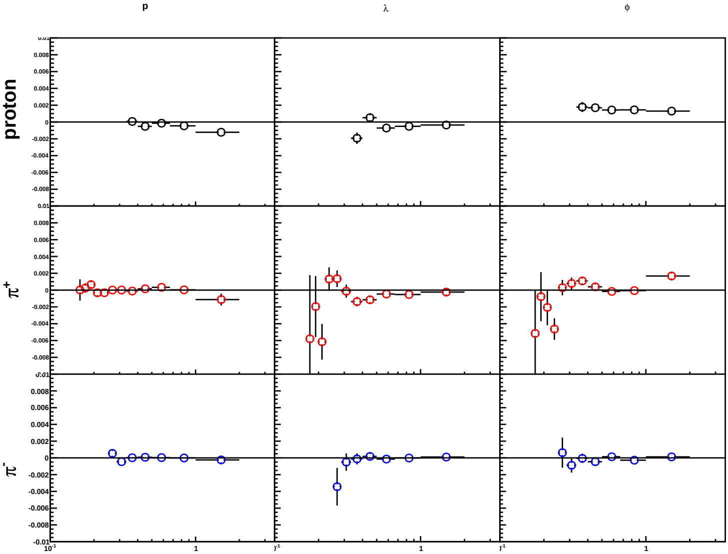
MODIFIED π^- p



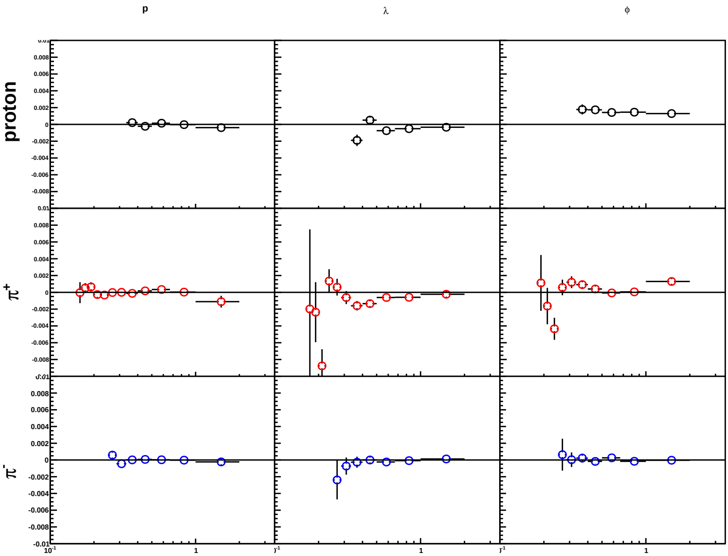
Modified π^- $\lambda_{tracking}$



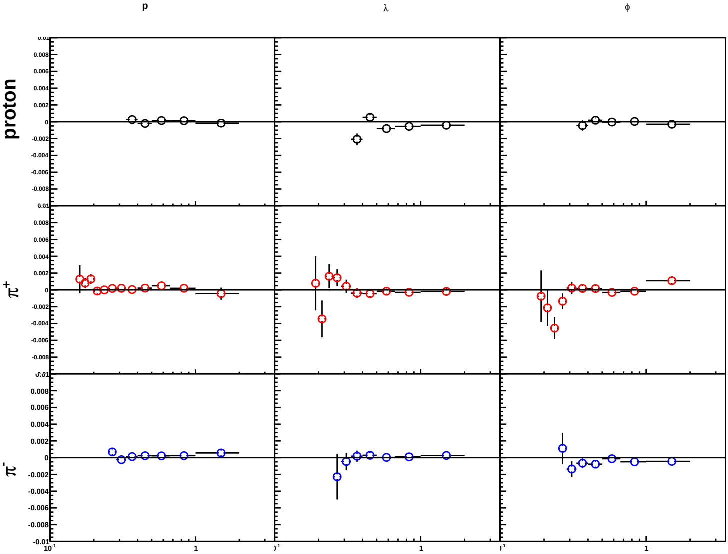
Modified π^- $\phi_{tracking}$



Modified proton p



Modified proton $\phi_{tracking}$



Outline

Tests of Momentum Corrections

- The corrections should yield proper masses for missing particles in a variety of reactions
- Since g1c had a one track trigger it is possible to check the reactions $\gamma p \rightarrow p\omega \rightarrow p\pi^+\pi^-(\pi^0)$, $\gamma p \rightarrow p(\pi^0)$, and $\gamma p \rightarrow \pi^+(n)$
- Method
  - Start by choosing a reaction to study and choose events of that type
  - Apply E-loss, tagger and momentum corrections
  - Cut events with proton momentum less than 350 MeV/c
  - Use COBRA to get the missing mass for the event
  - Plot all missing mass and missing mass vs. energy paddle id
  - Generate a histogram for each energy paddle and fit it with a Gaussian plus a linear background

π^0 MASS FROM ω

- The reaction $\gamma p \rightarrow p\omega \rightarrow p\pi^+\pi^-(\pi^0)$ should show a mass peak at 0.13498 GeV/c^2
- There is a problem when the missing mass is viewed vs photon energy

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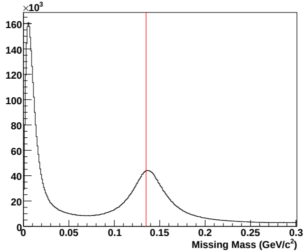

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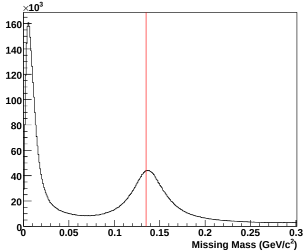

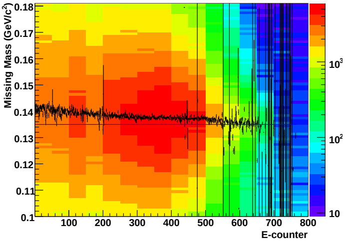

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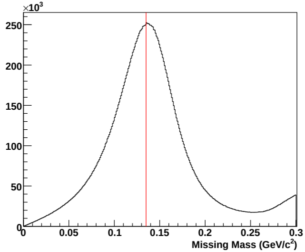

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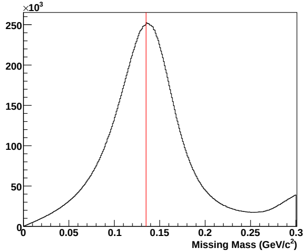

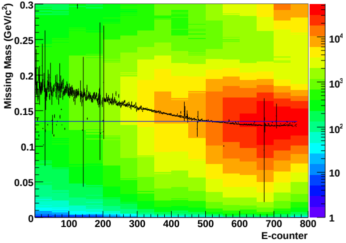

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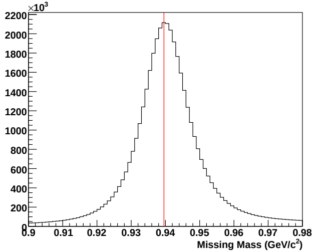

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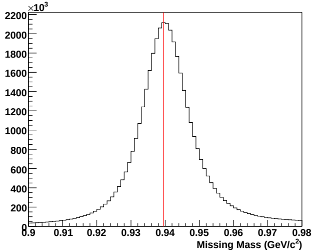
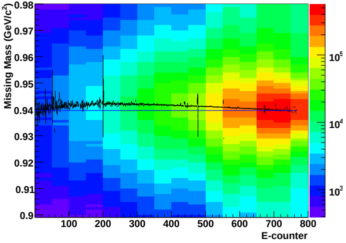
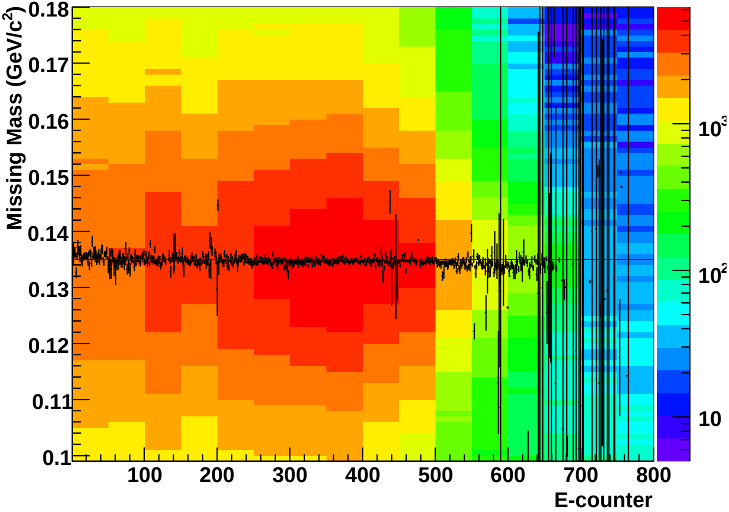




Checks, and a solution

- The masses are all a little high overall and some vary strongly with photon energy
- The π^0 mass from the reaction $\gamma p \rightarrow p\omega \rightarrow p\pi^+\pi^-(\pi^0)$ also increases as photon energy increases, to about 5 MeV high
- The π^0 mass from the reaction $\gamma p \rightarrow p(\pi^0)$ becomes about 25 MeV higher than it should at high photon energy
- The neutron mass increases for midrange photon energies but is close to expected at high and low energies
- A possible solution to this problem is to scale the photon energy
- Unfortunately the scale is different in each reaction, 99.85% works for ω reaction, but it is less in the other reactions

Corrected π^0 mass from ω



Checks, and a solution

- The fact that the scaling is reactions dependant suggests this may not be the final solution
- More work will probe whether it is the magnetic field that needs scaling and not the photon energy
- These corrections should be better than the corrections in any other channel and are sufficient for analysis

Summary

- Momentum and tagger corrections have been generated and satisfy their methods very well
- However, implementing these corrections leads to problems with the masses of missing particles
- Checks showed that this problem could be averted by scaling the photon energy, or perhaps the magnetic field
- Now that this is done work can continue towards getting the spin density matrix elements for $\gamma p \rightarrow p\omega$