Replies to Round One Feedback

Referee 1:

Chapter 2

2.2) E1-F

The torus field polarity used for this run period was in-bending for negatively charged particles. The current used (2250 A) corresponds to 60% of maximum field.

2.3) Determination of Good Run List

The E1-F data has been analyzed previously, and there are several different good run lists. While there is no good run list that is standard between analysts, we find more than 88% of runs in common with Wes Gohn (the analysis of pion asymmetries from this dataset). For our analysis of a different channel we calculated the Faraday cup charge for the first time, and in doing so constructed a new good run list based on this information. We are revisiting the procedures used in that calculation to address the concerns over the lack of rigor used in our previous procedure.

Actions: Review my procedure, discuss with others, assess the possibility of repeating the study.

2.6) Timing Corrections

Paddles excluded from this analysis due to having too few events to correctly calibrate them were mostly in the backward angles (paddle number greater than 40).

2.7) Kinematic Corrections

In the text I state that DC misalignments should impact particles of both charges in the same way, as you correctly point out this is not the case when one considers also the magnetic field. I will clarify the text to reflect this. Several referees asked why the W resolution depicted for sector 6 is significantly worse than the other sectors, I am looking into this.

Actions: Revise this section to be clear. Investigate why sector 6 has bad W resolution.

Chapter 3

3.2) Electron Identification

Removing negatively charged pions using energy deposition cuts on the inner layer of the ECAL has proven very effective, and has been quite standard in CLAS. I am adding a figure that demonstrates this to the document.

Actions: Add figure that shows energy deposition cut on EC

3.3) Hadron Identification

When I added a cut based on the vertex difference, I expected the distribution to be Gaussian centered at zero, but it turns out that it is not; for that reason I have not included a Gaussian fit. This implies that the distribution doesn't arise from random differences in the reconstructed vertex position, but there is some physical mechanism driving the shape. The width of the cut

5cm was chosen to match the size of the target used in the experiment, where the electron originates from based on our vertex cut.

As you correctly assert, the separation of pions and kaons at higher momentum is simply not possible. Additionally, the abundance of pions means that our identification in that momentum region should be quite accurate, or we should simply avoid that momentum range. In order to address these concerns (which were raised by all referees) we are planning to add a Bayesian term to the likelihood which represents the probability of observing a pion, kaon, or proton as a function of momentum. Additionally, we will test these procedures on simulation of SIDIS events in the CLAS detector and provide a report on our findings.

Actions: Undertake study of particle identification at higher momentum

Chapter 4

4.2) Event Selection

In our analysis we use the common working assumption that the DIS region can be accessed at Q > 1. Our results for the extracted asymmetry as a function of Q are quite flat, indicating that we're not so sensitive to possible scaling.

There is a prominent feature in the electron-kaon missing mass spectrum, it is the lambda 1520 MeV resonance.

Empty target runs were taken during the E1-F run period, and the contribution from the target walls is at this time unknown.

Actions: Find out how to include the term from the target walls, find out why this was left out of Wes Gohn's study.

4.3) Phi Distributions

The explanation of systematic uncertainties in this document was not clear, I have re-worded this section and added a lot of detail. To answer your specific question, the EC-U coordinate cut makes a large difference on the final answer because moving the lower cut boundary varies the statistics used in the analysis widely. Additionally, the contribution from this is not the same for all bins, as it is correlated (not perfectly) with the polar angle away from the beam line in the lab frame.

We appreciate your comments on the kaon/pion separation issue and are looking into that.

At this time we have not looked at the asymmetry per sector.

At this time is is possible to extract the asymmetries for positively charged pions, if the sample size is limited to be close to that of the kaon sample used.

We understand and appreciate the comment that our analysis procedures should be similar to those used previously for this dataset. Ideally, one would use the same methods and classes to perform the analysis. Unfortunately, there is no common analysis package for the E1-F run period, consequently an exact match is difficult. Our electron selection closely follows that used for the SIDIS multiplicity analysis performed by Nathan Harrison using E1-F data (the methods are identical to his, and the majority of the parameters are as well). Nathan's identification was a slight improvement over those methods used by Wes Gohn.

Referee 2

Delayed helicity reporting was used for approximately half of the E1-F run period. Wes Gohn produced a package that can be used to insert the correct helicity information into the ntuples, and he wrote a CLAS note about this software package. This package was also used for his analysis, which published results for pions.

We apologize for our misstatement of the experiment to measure the g1 g2 product, and will update the motivation section accordingly. The motivations for this work may be updated completely after reviewing the publication which you have provided, thank you.

Actions: Read the publications provided regarding the spin crisis.

As you correctly observe, the beam position likely varies continuously over time and over the dataset. This correction however has proved to be effective, and that result is demonstrated in figure 2.3. It may be possible to return to this issue and create a new procedure for vertex correction if we could calculate the beam position on a run-by-run or event-by-event basis, but I am not sure if the time investment would justify the improvement (the correction works). Additionally, the observation that the correction works seems to imply that while it is possible and likely the beam spot drifts over the experiment, in this case it did not.

It appears to me that you are correct in asserting that our vertex cut treats the target windows differently and I am going to look into this to see what I can find.

Actions: Move vertex cut unless there is a reason for cutting through one window.

The index used on page 25 refers to the slice index, because the distribution is sliced into 40 momentum bins. This will be clarified. Below, I state that we used 2.5 standard deviations as the nominal cut value, this value is varied in our study of systematic uncertainties.

The cut used on the vertex difference between electron and kaon is applied to remove multiple scattering events, and cleans up the beta vs. momentum figure. I am open to removing this cut from the analysis, as it drew comments from all three referees.

Actions: Remove vertex difference cut from analysis.

Our definition of confidence level is in accordance with the traditional usage, as shown in equation 3.10. In our case, we apply a minimum acceptable confidence level cut of 0.05, which excludes the majority of the events which are very low confidence and clearly another hadronic species.

For each kinematic variable have 10 bins, in each of those there are 12 bins in phi, for a total of 10 * 12 = 120 bins. This is repeated for the 4 axes of interest.

A correction for the beam charge asymmetry was not applied, but will be.

Actions: Apply the beam charge correction to the systematic errors.

Referee 3

Chapter 1

You are correct, this equation is only valid for the unpolarized target case, and I will make this clear in the text.

Actions: Add that comment to the text

Chapter 2

Our good run list differs from others, please see my comment to referee 1.

Not all of the files shown in figure 2.1 are used as good files, I will re-make the figure and make this clear.

Actions: Add cut boundaries to figure 2.1, but first go back and study this in more details.

I have another plot where the wave-plate transitions are annotated, it is quite a busy figure but perhaps I can insert it here instead.

The vertex correction used is not run dependent, please see my comments to referee 2 regarding the vertex corrections used in this study.

The timing correction from paddle-to-paddle should not depend on what type of particle you look at, it is simply a timing offset. This section will be re-worded in order to avoid confusion, thank you for bringing this to our attention.

Figure 2.4 demonstrates the effectiveness of the timing corrections for one paddle. The reduction in number of bands after applying the correction demonstrates that those particles have been shifted into the band where the others are, and the correction has worked.

I apologize for the confusion in section 2.7, I have only corrected the electron momentum, and the text will be made clearer based on your recommendations. Thank you.

Actions: Update this section to be more specific and less theoretical.

Regarding figures 2.5-2.7, these should be labeled and explained more clearly. The momentum correction has been applied as a function of the azimuthal angle in the lab, so it makes sense to plot some corrected quantities as a function of this variable to show that the correction is indeed effective. We could also show the figures that you recommend for the resonances in the electron-kaon missing mass spectrum if needed. Even though these are trusted and standard for E1-F, we feel that they need to be shown in the spirit of completeness.

Actions: Add comments to figures 2.5 - 2.7

Chapter 3

At this time I don't know why we don't include fiducial cuts on the region 2 drift chambers. Slightly different values are used for positive and negative tracks.

The left and right boundary lines are both bottom boundaries, and therefore using y > left and y > right is the correct condition. In the right half of the sector, the left boundary line continues on down and is far below the physical sector. If it is more clear, one can just consider two conditions based on the half of the sector that the event is in. If you're in the left half you use y > left, if you're in the right have you use y > right. I will make this more clear in the text, thank you for your comments.

Actions: Make the text more clear in section 3.2.

We use no timing cuts on electrons, please see my comments to the first referee for a discussion of the ECAL energy deposition cut. A new figure will be added to the document to show this cut.

I am looking into this vertex cut position for all sectors, please see my comments to referee 2 for this issue.

Thank you for pointing out the fact that our code is not needed on page 28, it will be removed promptly. I will add some text that describes our determination of the cuts applied to the theta_cc variable, which follows the same procedure used to determine the electron sampling fraction cut boundaries. There are fiducial cuts applied to the Cherenkov Counter as well, I will ensure that these are described in the document.

Actions: Check into the document and make sure Cherenkov cuts are described in proper detail.

I appreciate your attention to detail on spotting my discussion of negative hadron identification and the fact that it does not belong here. I agree and will remove this discussion from the document. There are no fiducial cuts used on the regions 2 or 3 for hadrons, at the present time I don't have a reason why.

Actions: Remove discussion of negative hadrons. Find out why we don't use cuts on other regions for this study.

Please see my discussion regarding the vertex difference cuts in both sections for referees 1 and 2, while we consider removal of this cut entirely. We are planning to make our study of pion contamination more rigorous, and I have described that in some detail in the comments to referee 1.

Chapter 4

We do not use any cut on the variable y, however the values of z are restricted for all axes that are not z to be within 0.25 and 0.75. I will clarify this in the document.

The figure 4.2 is confusing, and I will update it so that it is clear exactly what is shown. I am showing the events which pass all other cuts before applying the cut on missing mass that is used in this analysis.

I claim that I have chosen bins to have equal statistics, which as you observe is false. I apologize for not making this clear, I choose the statistics equal in kinematic bins, but after I bin each of those into 12 phi bins, the statistics are not equal in each of those smaller and equal sized phi bins. I will clarify this in the text.

I will add figures to this document which display the replica fit results and the other kinematic dependencies.

The section on systematic uncertainties is currently confusing, I apologize for this and I am completely re-doing this section to be more clear.

For this extraction, I used chi-2 minimization that I implement using scipy.optimize. I use the replica method, and the magnitudes of the other terms (cos and cos2) are consistent with zero (large error). I can provide results using a simple sine fit, but I think that the form provided by the cross section is theoretically on strong grounds and wanted to use the full function.