

# Kinematic Fitting Studies in GlueX using HDFast

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(Draft Version 1)

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## Abstract

This document reports on studies carried out using kinematic fitting to do particle identification in the GlueX experiment.

## 1 Introduction

The purpose of this study is to examine the possibility of using kinematic fitting alone to carry out particle identification in the GlueX experiment. In order to do this, we have taken kinematic fitting software that we wrote for the CLAS experiment [1], and written wrappers to enable us to access the output data from the HDFast Monte Carlo.

## 2 Implementation of the Kinematic Fit

In order to verify that the kinematic fitting software was correctly working, we produced a sample of 10000

$$\gamma p \rightarrow \pi^+ \pi^- \pi^+ \pi^- p \quad (1)$$

events, and put then reconstructed momenta with their covariance matrices from HDFast. Figure 1 shows the confidence level from the 4-constraint (4C)

fit to this data. It also shows the *pulls* for each of the measured quantities. These plots indicate that the information coming out of HDFast is all consistent. We then followed this up with a check where instead of  $\pi$ , we called pairs of particles  $K$ s, and then looked at the probability of that hypothesis being satisfied. The plots of the confidence level for these fits are shown in Figure 2. The only one that shows anything resembling a good fit is the upper left-hand plot which is a fit to the true  $4\pi$  hypothesis. From this study, it does not look like it is possible to accidentally identify a  $4\pi$  event as a  $KK\pi\pi$  event.

### 3 The Kaon Samples

We next examined a sample of events of the form  $\gamma p \rightarrow K^+K^-\pi^+\pi^-p$ . We varied the intermediate states a bit using the following reactions:

$$\gamma p \rightarrow X(1800)p \rightarrow K^{*0}\bar{K}^{*0}p \rightarrow K^+K^-\pi^+\pi^-p \quad (2)$$

$$\gamma p \rightarrow X(2400)p \rightarrow K^{*0}\bar{K}^{*0}p \rightarrow K^+K^-\pi^+\pi^-p \quad (3)$$

We generated 10000 events for each of these samples, and then performed kinematic fits to all possible  $K$  and  $\pi$  assignments. Table 1 summarizes the results to this fitting. Those tagged as correct have only the correct assignment of  $K$ s and  $\pi$ s more probably than the confidence level cut off. Those labeled Incorrect have only a wrong assignment of  $K$ s and  $\pi$ s more probably than the confidence level cut off. Those labeled ambiguous have more than one solution more probable than the confidence level cut off, while None tags those in which no combinations satisfied the confidence level cuts.

### 4 Summary

Using only a kinematic fit to resolve particle identification issues indicates that we can unambiguously identify the event about 40% of the time, and that we are wrong about 4% of the time. Of more interest is that a four-pion final state will be confused with a kaon state about 1% of the time.

This study needs to be extended to allow for information from both time-of-flight detectors and possible  $dE/dx$  information in the drift chambers.

Reaction	Conf. Level.	Events	Correct	Incorrect	Ambiguous	None
1	1%	9764	8570	1060	45	89
	5%	9764	7940	1731	29	64
	10%	9764	7478	2258	17	61
2	1%	9973	3905	561	5043	284
	5%	9973	4264	1020	4152	347
	10%	9973	4285	1483	3651	374
3	1%	9844	4781	472	4333	258
	5%	9844	5113	919	3486	326
	10%	9844	5120	1353	3002	369

Table 1: The fraction of events that have been identified correctly and incorrectly from the various reactions.

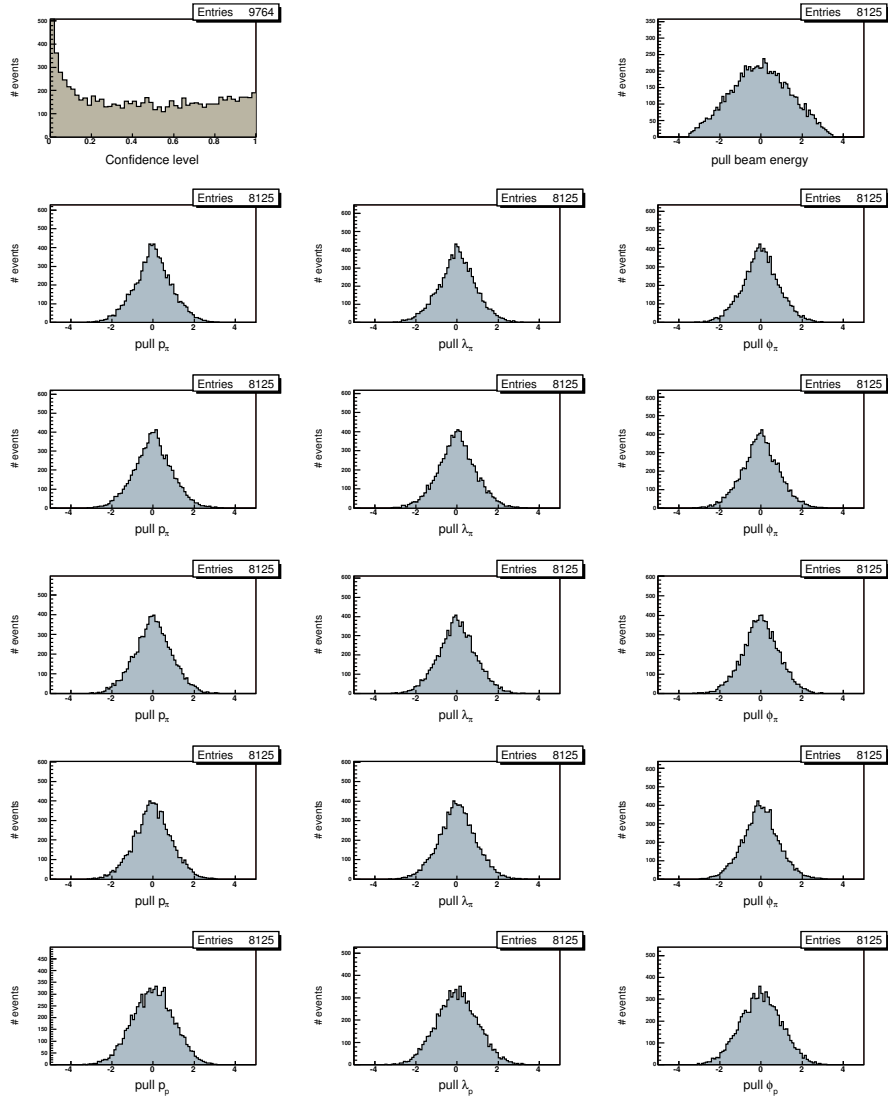


Figure 1: The confidence level and pulls to a fit to the reaction  $\gamma p \rightarrow \pi^+ \pi^- \pi^+ \pi^- p$ . The first row is the confidence level and the pull on the photon energy. The second through fifth rows are the pulls for the pions, while the sixth row is the pulls for the proton momentum.

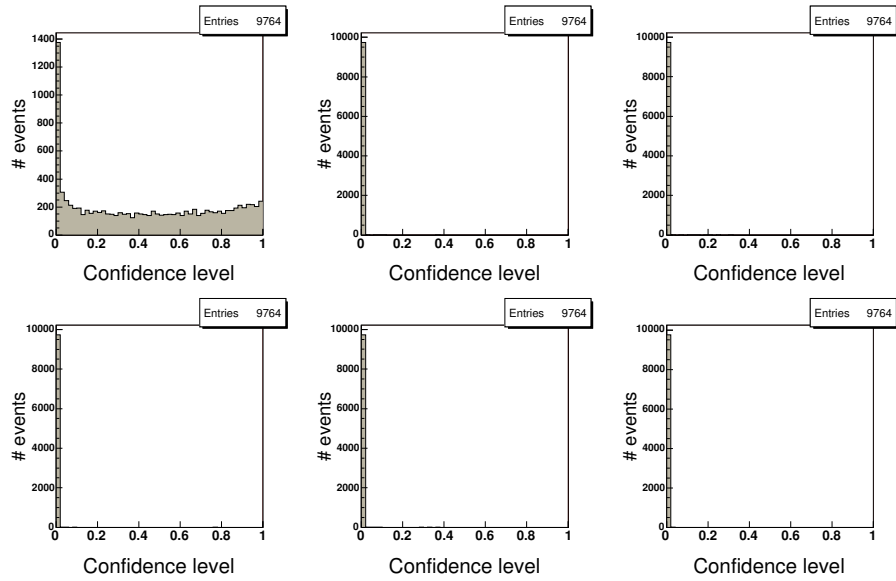


Figure 2: The confidence level of various fits to the reaction  $\gamma p \rightarrow \pi^+ \pi^- \pi^+ \pi^- p$ . The upper left-hand figure is the confidence level for the  $4\pi$  hypothesis, while the remaining five figures are the confidence level for various combinations of replacing pions with kaons.

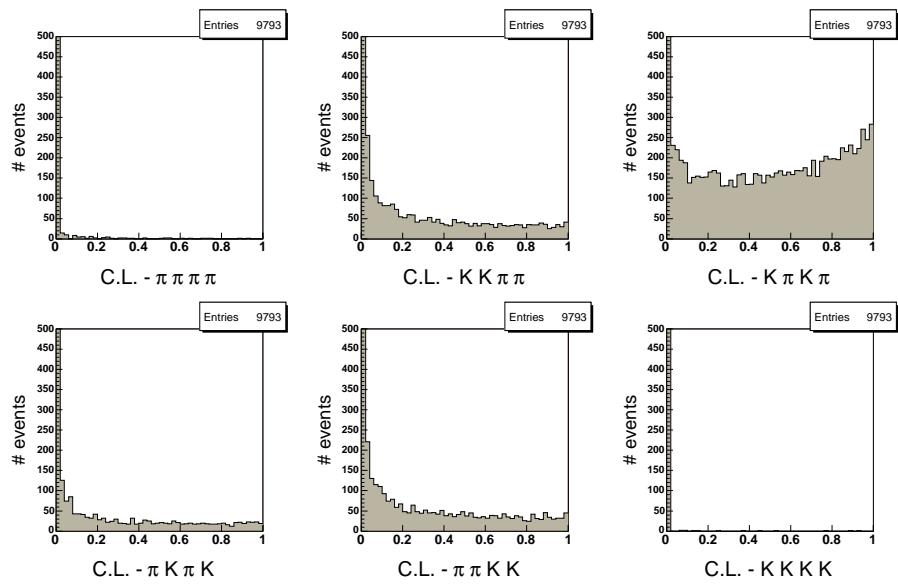


Figure 3: Confidence level plots for reaction 2.

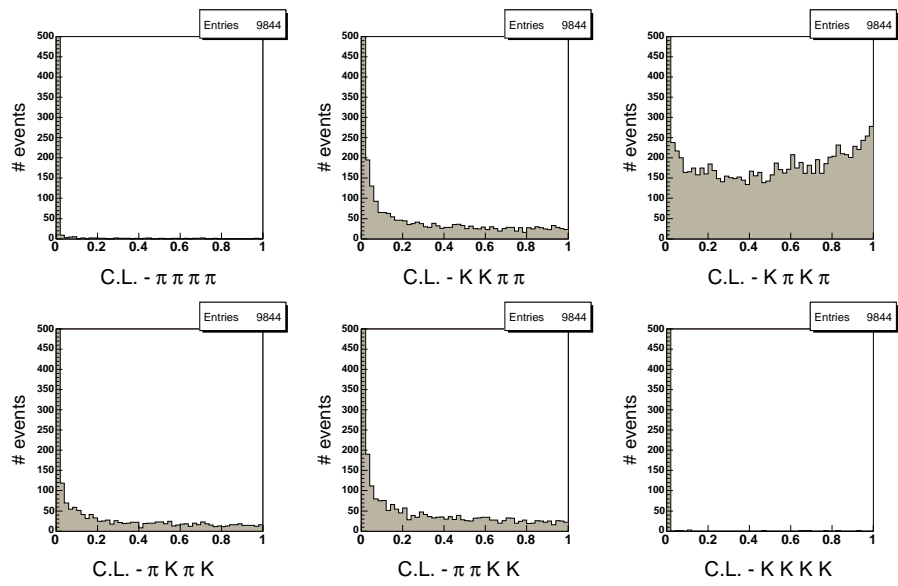


Figure 4: Confidence level plots for reaction 3.

## References

- [1] Mike Williams and Curtis A. Meyer, **Kinematic Fitting in CLAS**, CLAS-NOTE 2003-017, (2003), [http://www.jlab.org/Hall-B/notes/clas\\_notes03/03-017.pdf](http://www.jlab.org/Hall-B/notes/clas_notes03/03-017.pdf).