Pion Asymmetry Analysis

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Abstract

A new method of target polarization monitoring is attempted, using a measured pion asymmetry. The statistical uncertainty of this asymmetry is too large for an absolute measurement. However, the relative change in target polarization could be observed throught this asymmetry. For E02-013, there were insufficient events for even this analysis, but the results are very promising for upcoming polarized experiments.

1 Introduction

The target polarization can be monitored by observing the asymmetry in the pion yeild. The size of this pion asymmetry is directly related to the product of the beam and target polarizations. For a period of running with nearly constant beam polarization, variations in the pion asymmetry can be assummed to result from variations in the target polarization.

Traditional ^{3}He target polarimetry techniques can measure the target polarization to within 4%. However, each of these measurements destroys polarization, and cannot be made during a data-taking run. Previous experiments have agumented these traditional polarimetry methods by observing the elastic electron asymetry, through dedicated data-taking runs.

A successful electron scattering experiment must have a very good method of separating the scattered electrons from the produced pions (specifically, π^-). These same techniques can be used to positively identify the pions. Since each electron scattering run produces a nearly overwhelming quantity of pions, this is a good possibility for tracking pions

2 Method

This method was tested on a sub-set of well understood data, kin.4. For each production run in kin. 4, the cuts from Table 1

These results were normalized to a target measurement. Specifically, the asymmetry measurement closest in time to one of the traditional measurements was normalized to the that target polarization. Then, that scale factor was

Variable	Cut	Reason
B.ts.ps.e	$100 < x < 400$	Use BB preshower to select pions
B.tr.vz	$-0.18 < x < 0.18$	Use BB tracking to select target cell pions
Ndata.D.bit2	true	Select T2s (BB singles)
D.ctimeL1A	$2690 < x < 2700$	Select out of time T3s

Table 1: **Pion Cuts.** The cuts were used to select Big Bite singles events or mis-identified coincidence events that were identified as pions originating from within the target.

applied to all asymmetry measurements. The scaled asymmetry measurements were plotted against the target polarization measurements.

3 Results

The cuts from Table 1 were applied and plotted as described in Section 2. The results are presents as Fig. 1. From this figure, it is clear that a larger sample is needed.

Several methods were proposed to create a larger sample. First, it was suggested that all coincidence events be included. For an electron asymmetry, taking all coincidence events would bias the sample. For pions, it is not clear that it would, as a pion in true coincidence with a neutron would be very rare. The results of including all coincidence pions (and all singles events) is plotted in Fig. 2.

Many of our singles events were lost due to a lack of tracking information. The restriction to include only event orginating within the target cell was relaxed and the results are plotted in Fig. 3.

Finally, both restrictions (timing and tracking) were relaxed and the results are plotted in Fig. 4.

In the preceeding plots, it is the absolute value of the asymmetry plotted with the polarization. This is becuase the target polarization measurements do not give a sign. However, the asymmetry has a sign. The beam half-wave plate and the target polarization direction were changed throughout the experiment. To check for consistency, the signed asymmetries are plotted together in Fig. 5. The sign changes are consistent. Measurements without tracking information had a smaller asymmetry. This is to be expected, as those pions may have come from unpolarized material along the beamline.

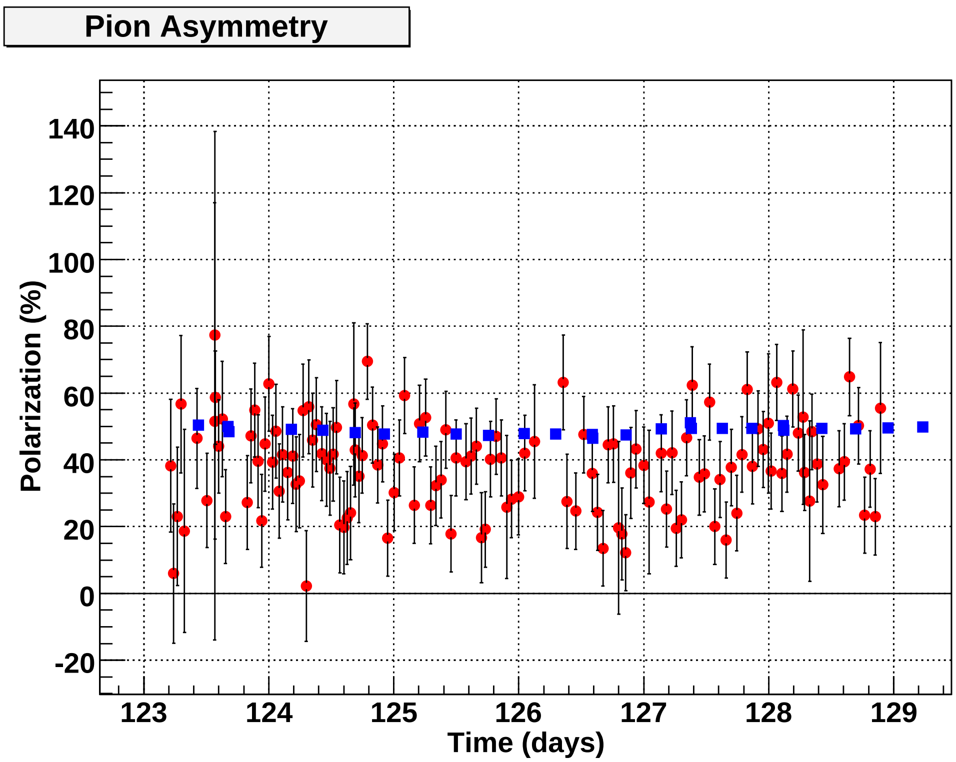

Figure 1: **Pion Asymmetry.** The asymmetry from the cleanest pion sample, target polarization measurements (blue squares) have systematic uncertainty included.

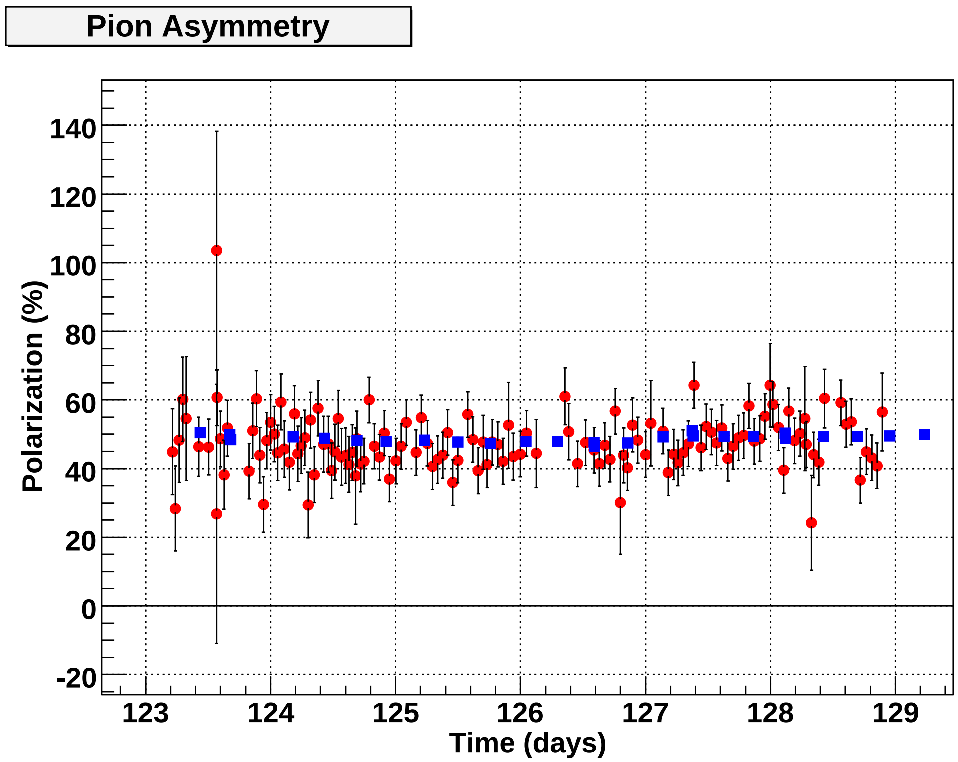

Figure 2: **Pion Asymmetry – Coincidence.** The cut restricting coincidence triggers to those without meaningful timing is relaxed to increase the sample size.

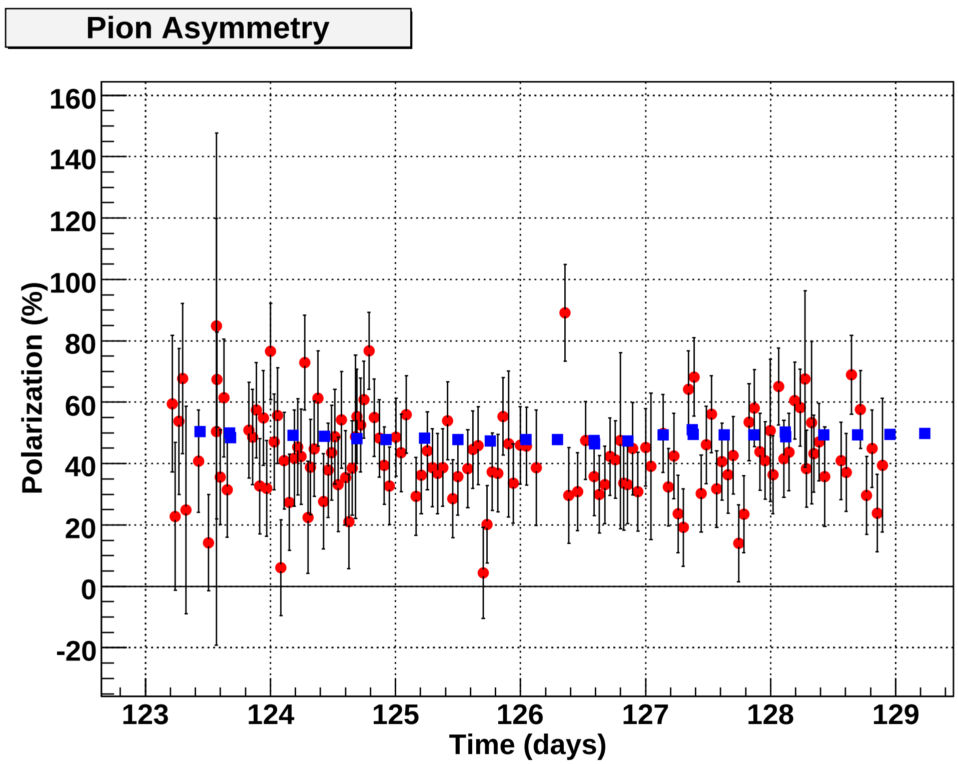

Figure 3: **Pion Asymmetry – No Tracking.** Tracking was not required for these events.

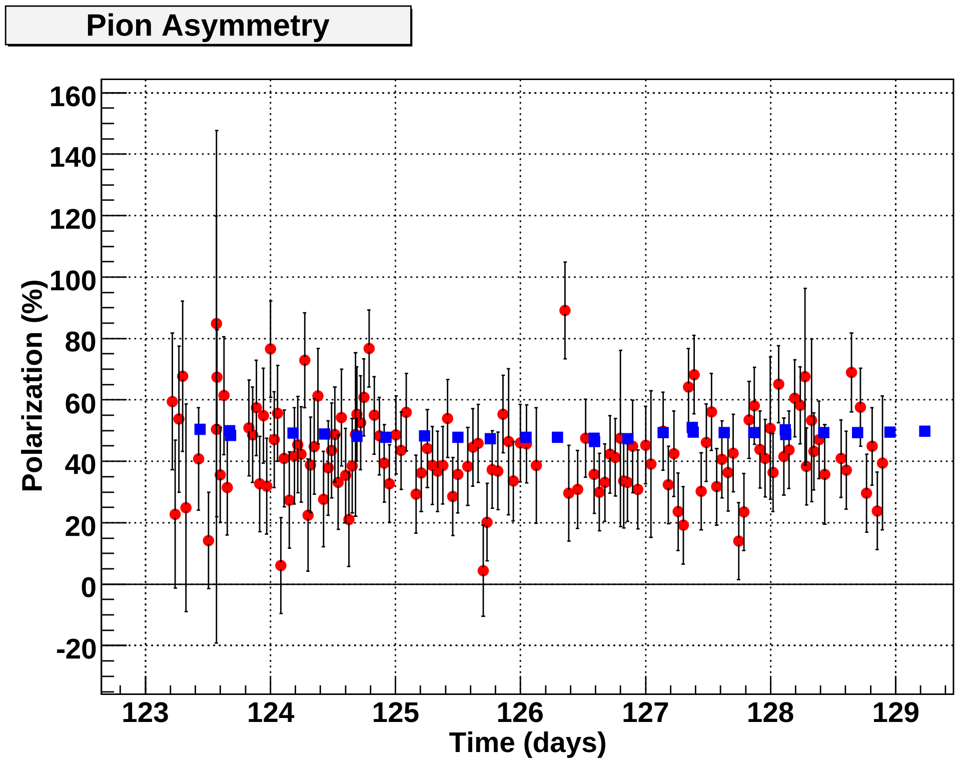

Figure 4: **Pion Asymmetry – No Timing.** Tracking was not required for these events, which included all coincidence triggers.

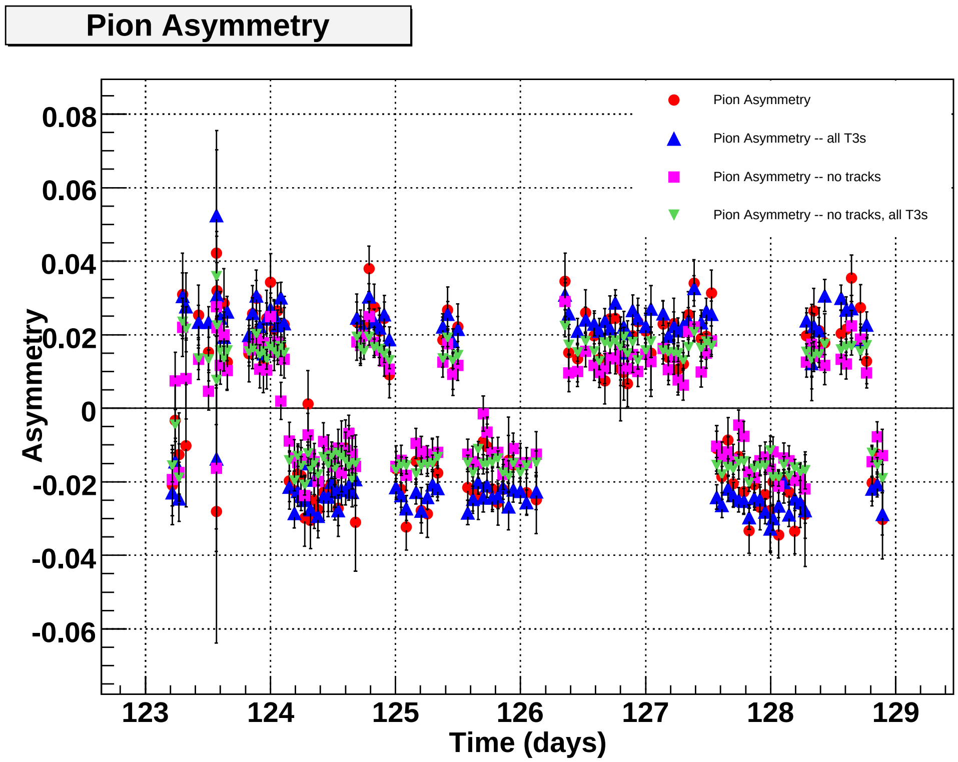

Figure 5: **Pion Asymmetry Cut Study.** Different samples are plotted together.