THE GEORGE WASHINGTON UNIVERSITY
WASHINGTON, DC

$K_L + p \rightarrow \pi^+ + \Lambda$

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K LONG FACILITY

Jefferson Lab

KL4 RXN and Generating Steps

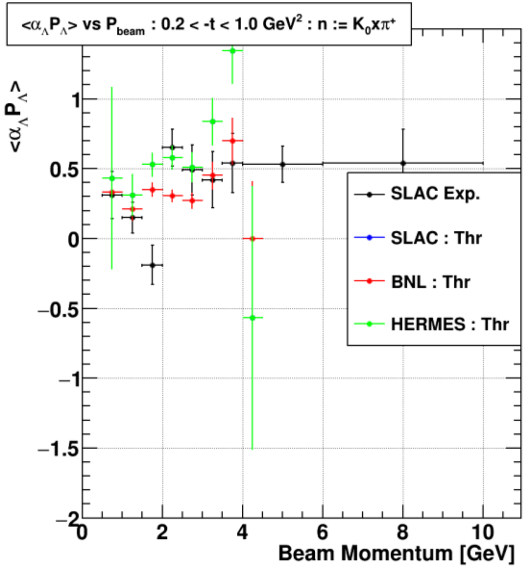
- Kl4 : $K^0{}_L + p \rightarrow \pi^+ + \Lambda$
  - $\Lambda \rightarrow p + \pi^-$ (63.9%) ; Current priority
  - $\Lambda \rightarrow n + \pi^0$ (35.8%)
- Backgrounds : (Primary) $K^0{}_L + p \rightarrow \pi^+ + \Sigma^0$, (Secondary) $K^0{}_L + p \rightarrow K^+ + \Xi^0$
- Generated histograms/root files (Monitoring Histograms, ReactionFilter, mcthrown_tree)
  - hd_root --nthreads=8 -PPLUGINS=PEVENTRFBUNCH:USE_TAG=KLong -PVERTEX:USEWEIGHTEDAVERAGE=1 -PPLUGINS=monitoring_hists foo_smeared.hddm
  - hd_root --nthreads=8 -PPLUGINS=PEVENTRFBUNCH:USE_TAG=KLong -PVERTEX:USEWEIGHTEDAVERAGE=1 -PPLUGINS=ReactionFilter –PReaction1=10_14__8_18 foo_smeared.hddm
  - hd_root --nthreads=8 -PPLUGINS=PEVENTRFBUNCH:USE_TAG=KLong -PVERTEX:USEWEIGHTEDAVERAGE=1 -PPLUGINS=mcthrown_tree foo_smeared.hddm

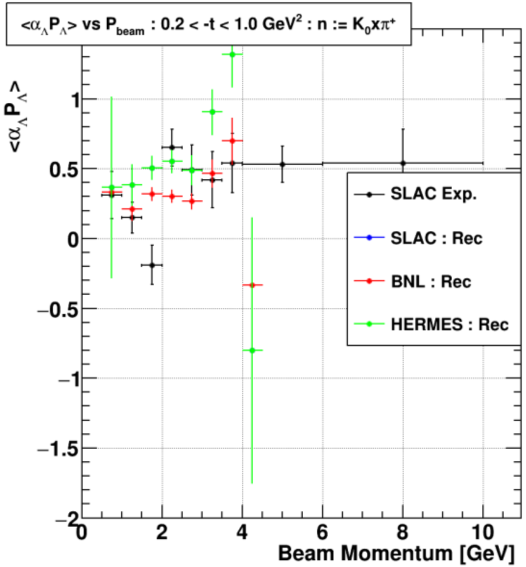
aP Refresher

- The Λ is polarized and its polarization can be induced from the angle the decay proton in the Λ center of mass makes with the beam-Λ normal.
  - SLAC defines its normal as : $K_L \times \pi^+$
  - HERMES defines its normal as : $K_L \times \Lambda$
- In the absence of an X hadronic remnant, the two normal unit vectors are opposite of each other, i.e., $K_L \times \pi^+ = - K_L \times \Lambda$.
  - $K_L = \Lambda - p_{rest} + \pi^+ + X_{remnant}$
    - $K_L \times \pi^+ \rightarrow (\Lambda - p_{rest} + \pi^+ + X_{remnant}) \times \pi^+ \rightarrow \Lambda \times \pi^+ + X_{remnant} \times \pi^+$
- $aP = 3\langle \hat{p}_{\Lambda cm} \cdot \hat{n} \rangle = 3\langle \cos\theta_{pn} \rangle$ (aP for a 4π detector)
  - aP for a detector that is not 4π is defined as $\langle \cos\theta_{pn} \rangle / \langle \cos\theta_{pn}^2 \rangle$
- BNL has another way of calculating aP : $aP = 2(N_+ - N_-)/(N_+ + N_-)$
  - +/- denotes events with $\cos\theta_{pn} > 0$ and $\cos\theta_{pn} < 0$, respectively.

MEAN aP
$n = K_L X \pi^+$ and $0.2 < -t < 1.0$ GeV^2

- The mean aP for the Thr. and Rec. are plotted using the SLAC, BNL, and HERMES definitions with the $n = K_L X \pi^+$.
- The aP measured by SLAC is also shown.
- Since HERMES and SLAC are the same using this normal, the HERMES overlaps the SLAC.
- The Rec. events matched with the Thr. events have the same aP.

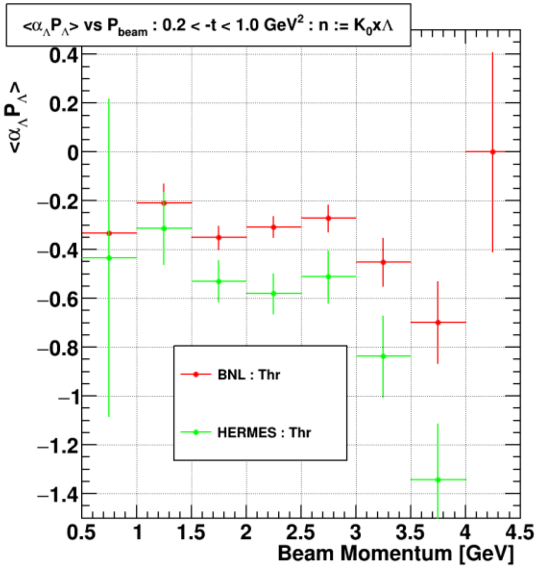


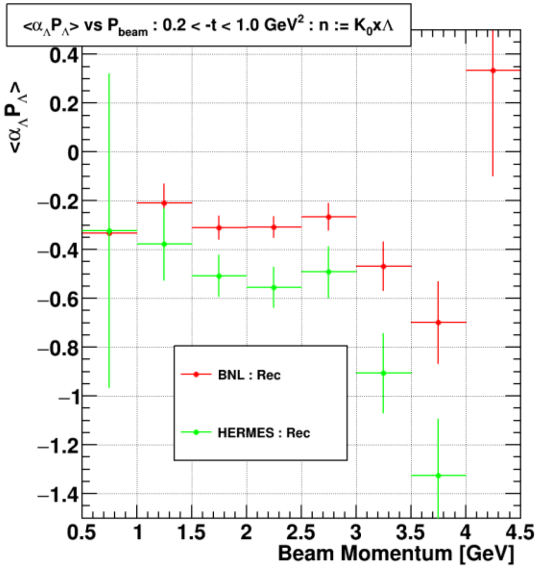


AP RESULTS 2

n = K_L X Λ and 0.2 < -t < 1.0 GeV^2

- The results for BNL and HERMES are plotted to the right for the Thr. and Rec.
- Here n = K_L X Λ.

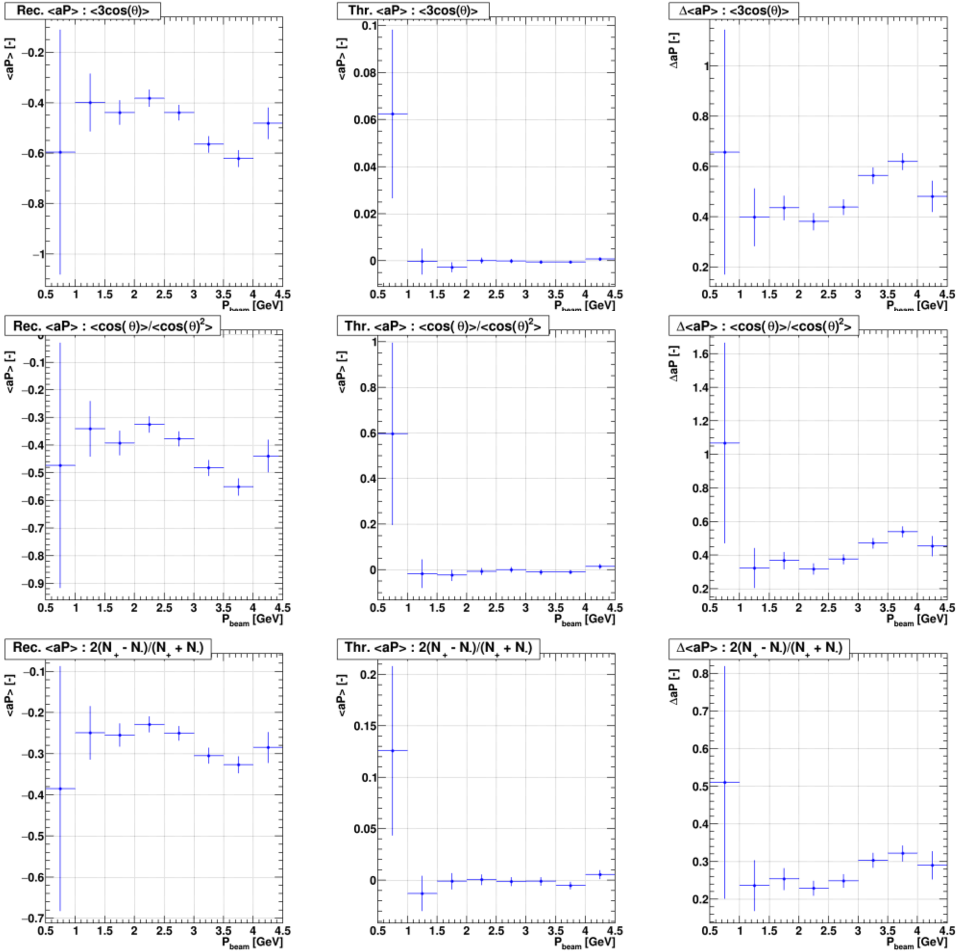




aP : Thr. Tree vs. Reconstructed

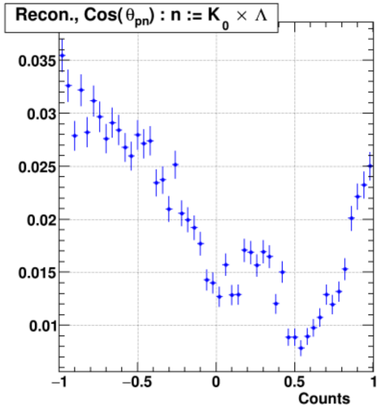
Thrown tree != Reconstructed

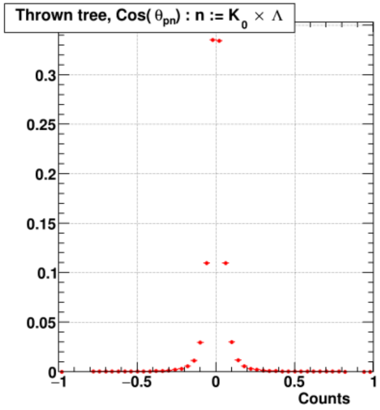
- Plots to the left show the mean aP in each thrown beam momentum bin for the Thrown tree and Reconstructed distributions.
- The BNL and HERMES aP definitions are depicted.
- The last column shows the differences between the Thrown and Reconstructed distributions.
- From the results, it is clear that the reconstruction process induces a strong polarization.
- All following plots use $n = K_L \times \Lambda$, have no t cut, and have $W < 3$.

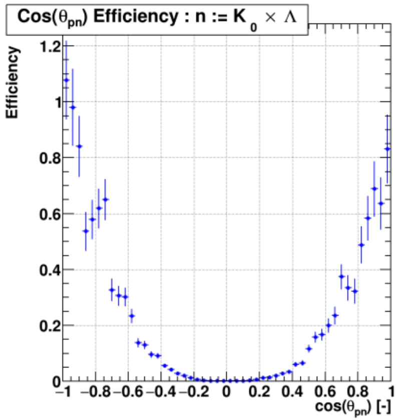


Cosine Distributions

- The plots on the right show the cosine of the angle between the proton in the lambda center of mass and the normal.
- This is also the aP in the HERMES definition.
- The plots show that the distortion the reconstruction has and the efficiency decreases as |cos(θ)| decreases.

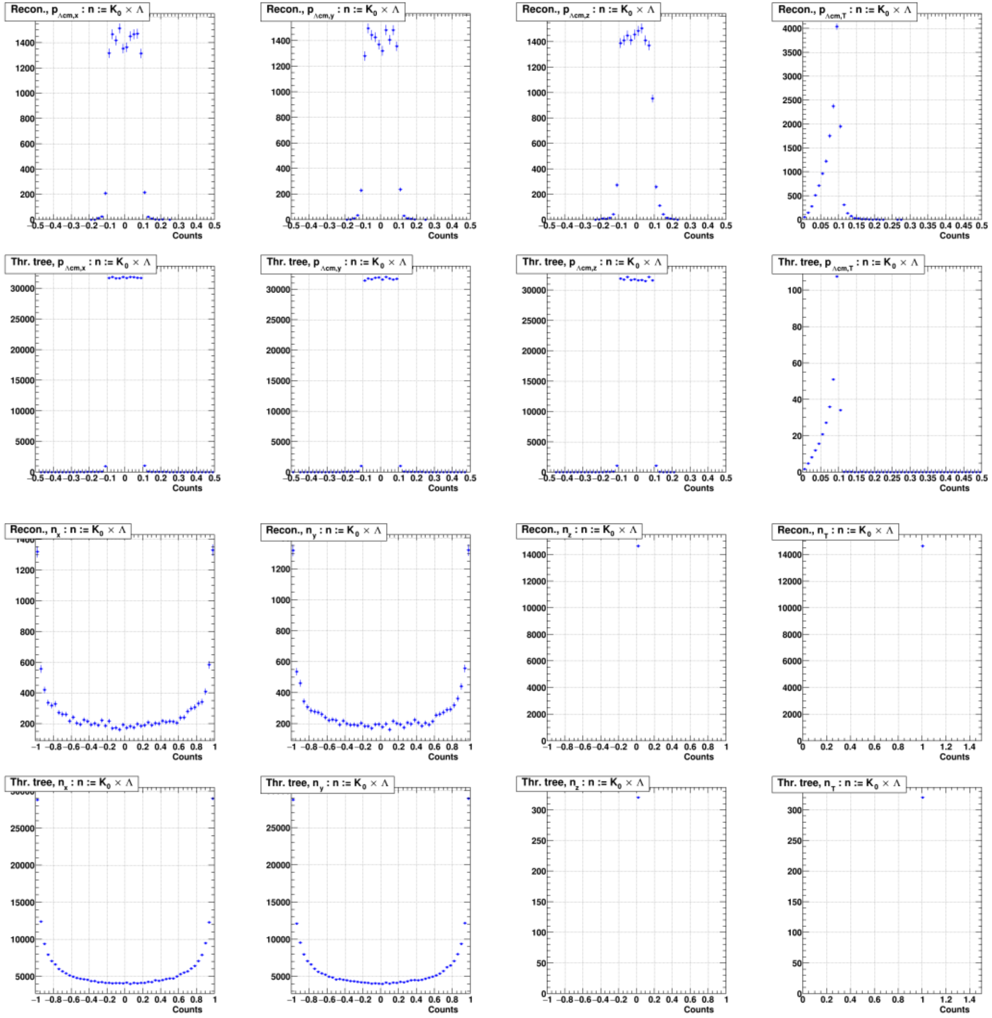






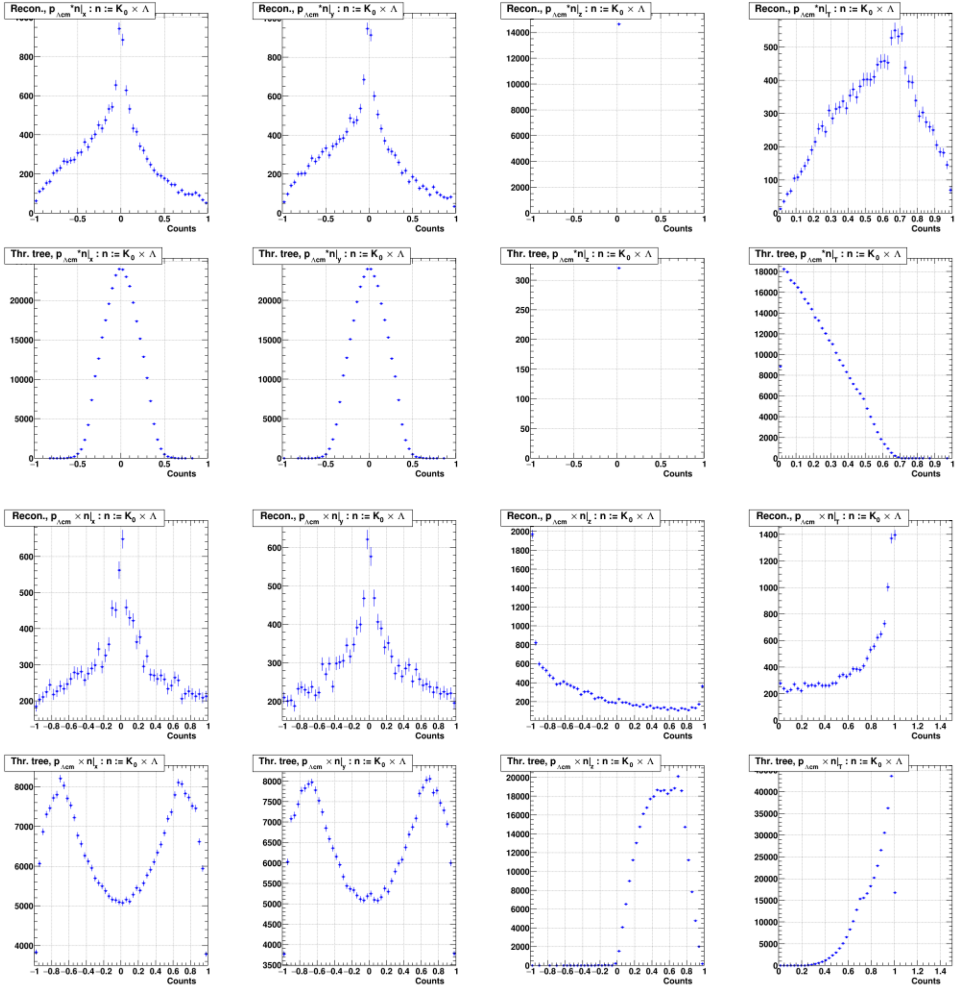
N and P_{Λ}

- The top two plots show the components of the normal for the Recon. and Thrown Tree.
- The top two plots show the components of the proton in the lambda center of mass for the Recon. and Thrown Tree.
- Both sets of plots illustrate that the reconstructed and thrown have similar shapes.



Sources of Difference

- The top two plots show the components of $p_{\Lambda cm} \bullet n$ for Recon. and Thrown Tree.
- The top two plots show the components of $p_{\Lambda cm} \times n$ for Recon. and Thrown Tree.
- Every comparison plot shows a stark difference between the Rec. and Thrown tree, save for the z component of $p_{\Lambda cm} \bullet n$.



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