THE GEORGE WASHINGTON UNIVERSITY
WASHINGTON, DC

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

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K LONG FACILITY

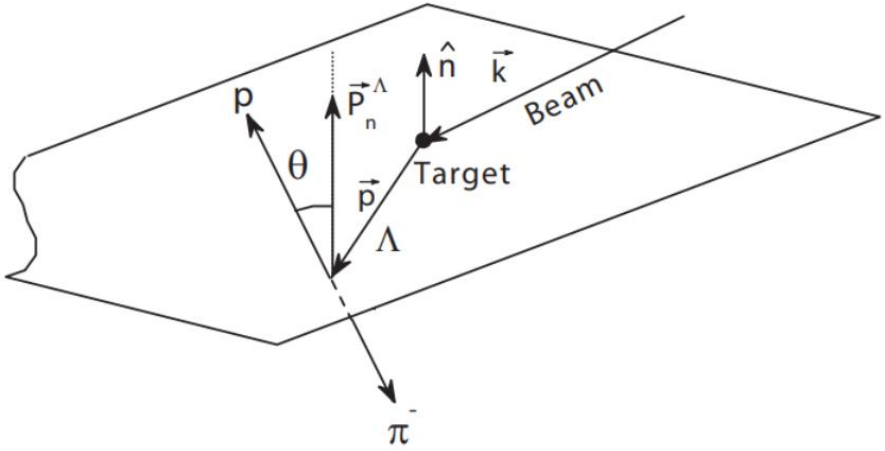
Jefferson Lab

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

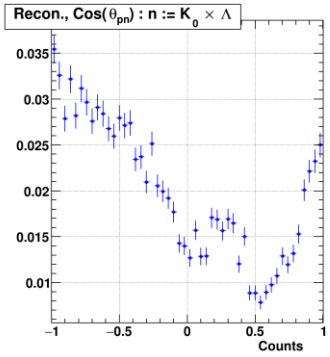
Working on Polarization Extraction

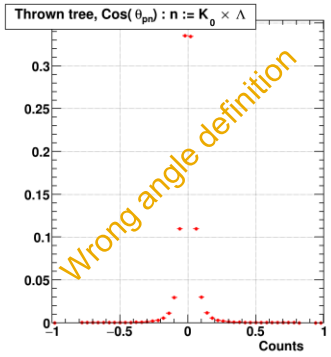
- The Λ is polarized and its polarization can be induced from the angle the decay proton in the Λ center of mass makes with the beam-Λ normal.
- The normal for this analysis is defined as : $n = K_L \times \Lambda$
- $\alpha P = 3\langle \hat{p}_{\Lambda cm} \cdot \hat{n} \rangle = 3\langle \cos\theta_{pn} \rangle$
  - Decay parameter α = 0.732, older data has it at 0.642.

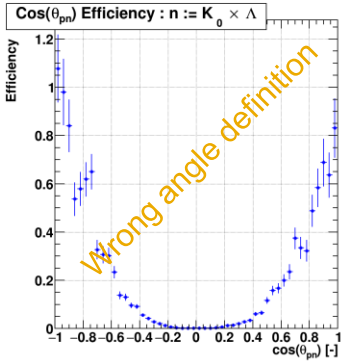


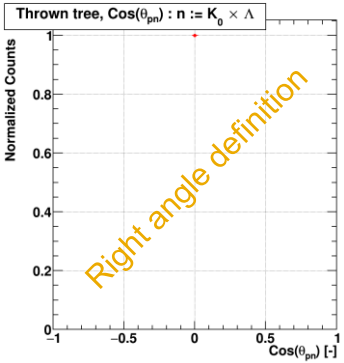
Error in Last KLF presentation

- The plots on the right show the $\cos\theta_{pn}$ distributions.
- The plots show a large distortion that the reconstruction causes in the cosine distributions.
- It was suggested that I should double check my angle definitions, and it turns out that in the Thrown Tree distributions I did **not** boost the proton to the Λ center of mass frame.
- The bottom plot shows the distribution with the correct definition, which is identically zero.



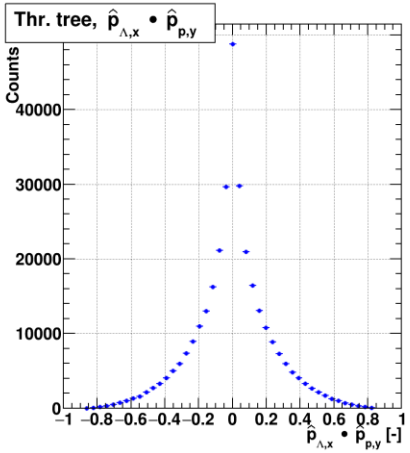


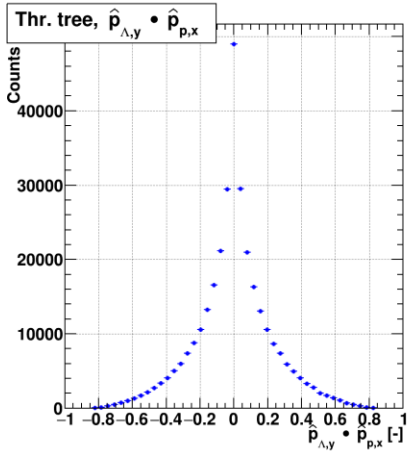


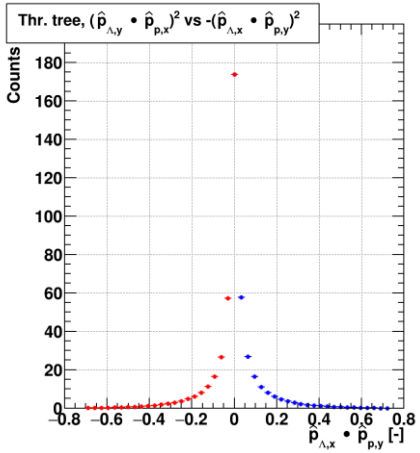


CURRENT HYPOTHESIS

- The components of the dot product are equal in magnitude and opposite in sign.
- K_L = (E, 0, 0, p_z), so rearranging the terms in the cosine
  – $Cos(\theta_{pn}) = p_{z,K}(p_{x,\Lambda}p_{cm,y,p} - p_{y,\Lambda}p_{cm,x,p})$; so the term in parentheses is zero.
- Plot on the bottom shows that the distributions of the two terms and the distributions are equal in magnitude and opposite in sign.

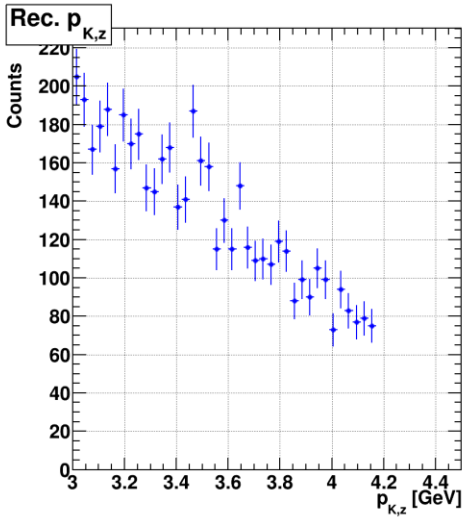


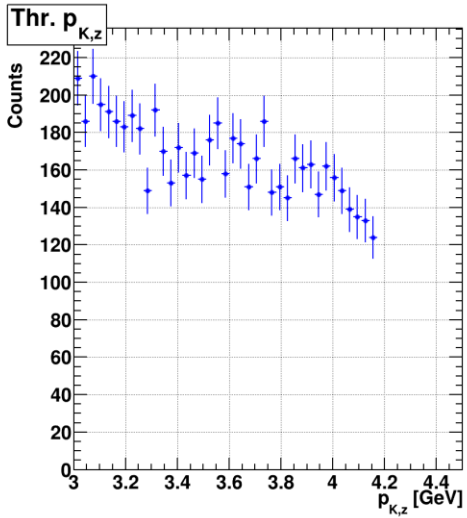


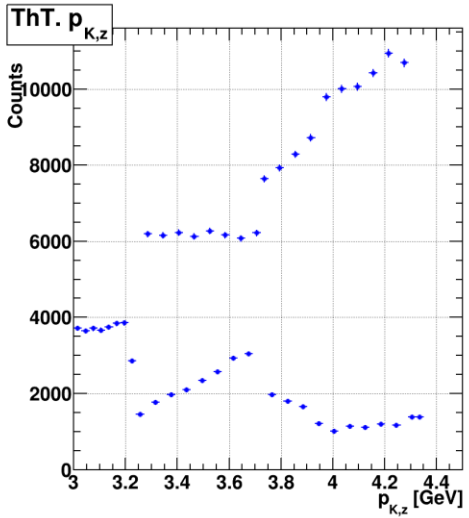


Beam Momentum issues

- From the plots below, it shows that the Thrown Tree Beam p_z oscillates after 3.2 GeV.
- This is not found in the Rec. and the Thr. Distributions.







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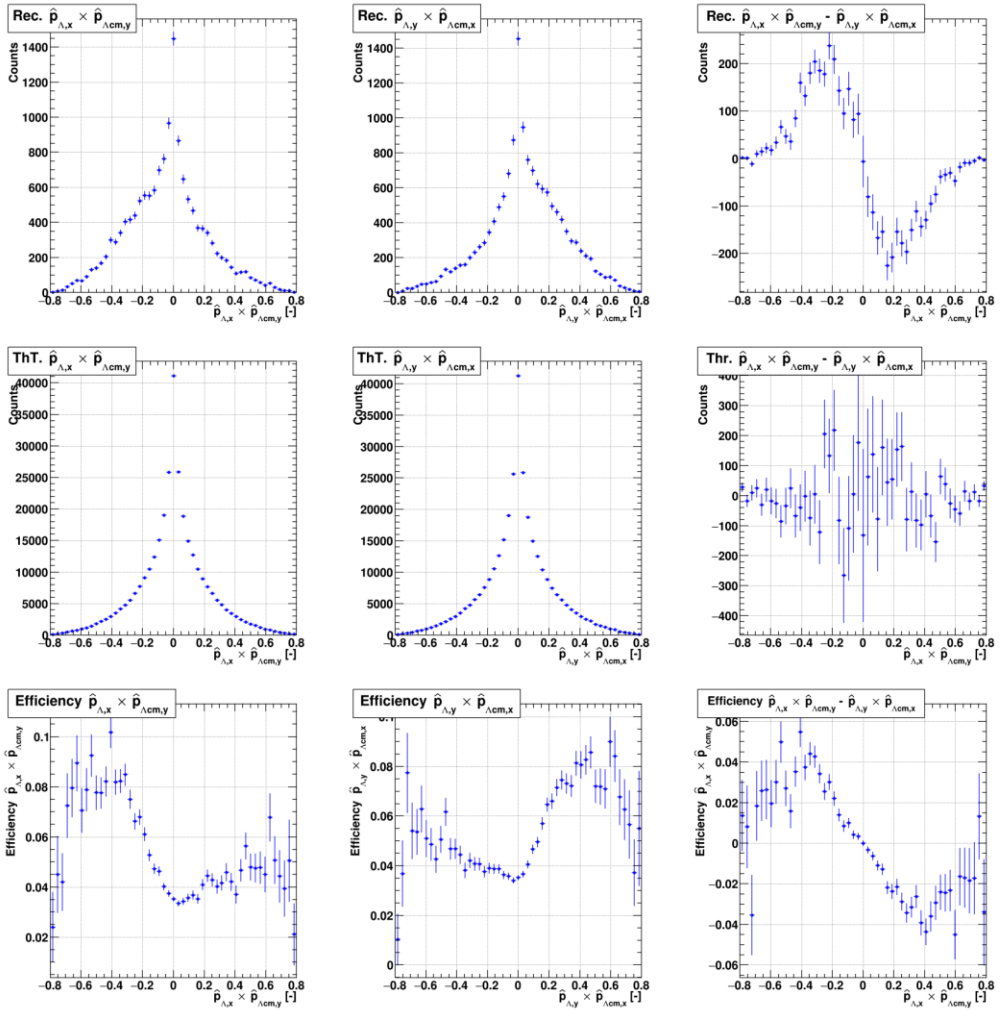
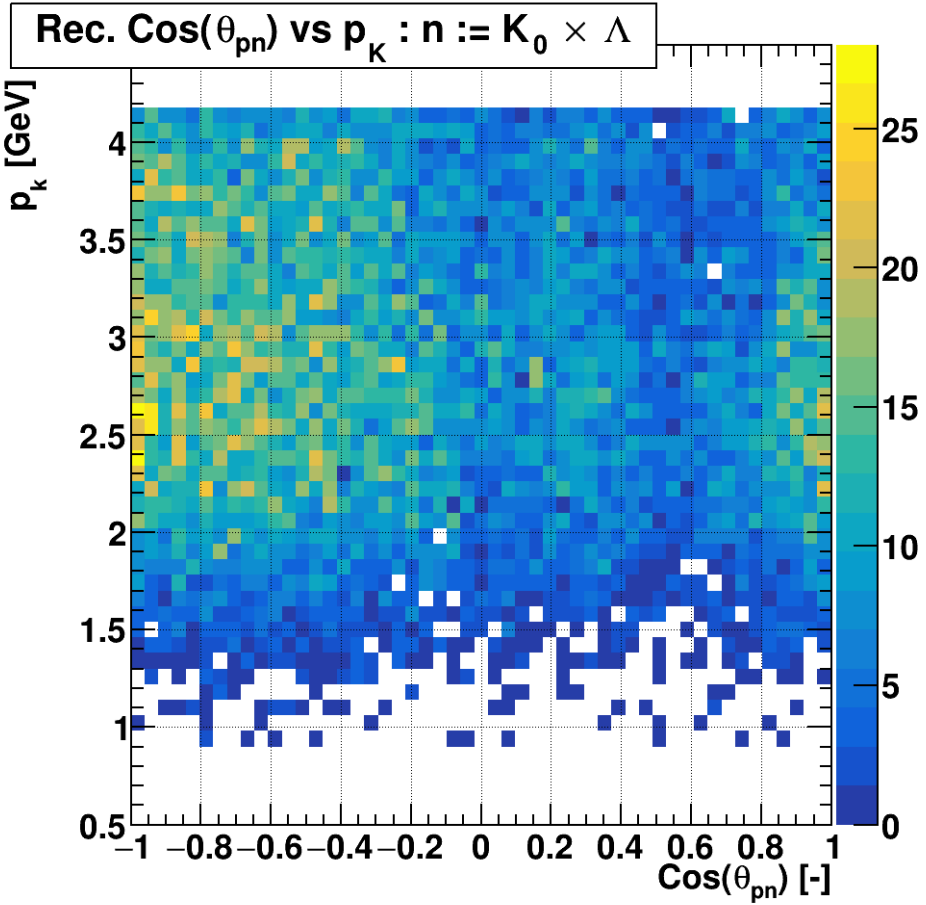
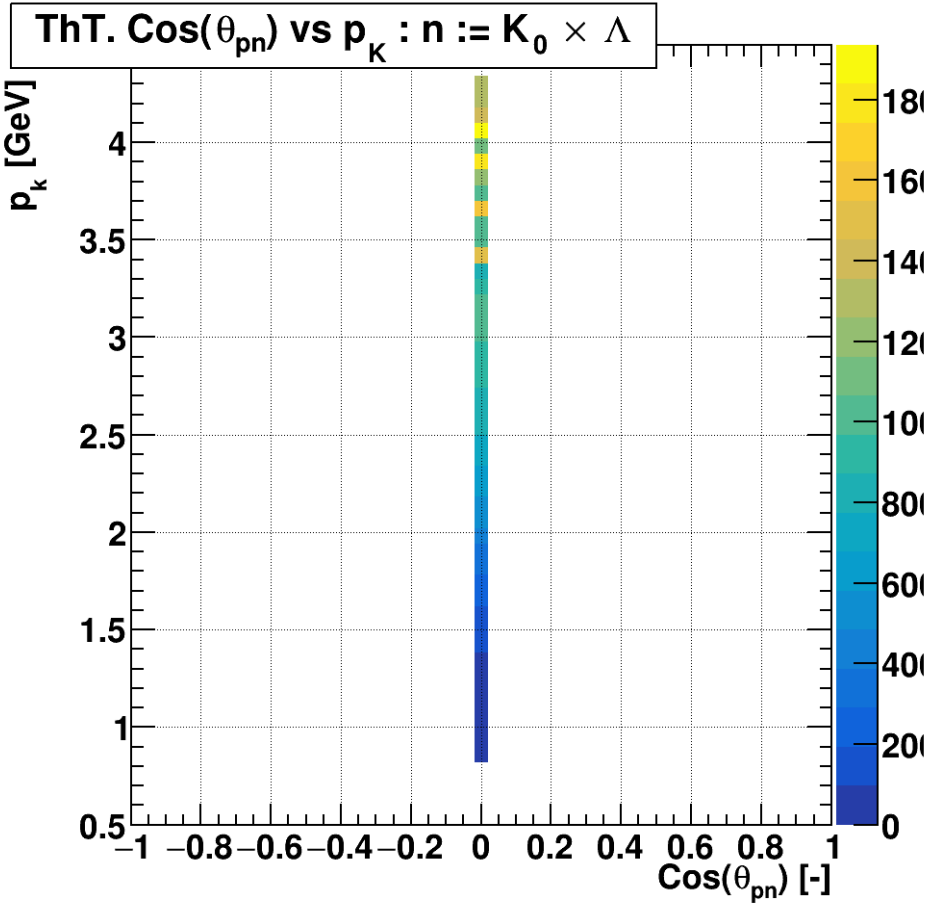
Backup Slides

Data has an asymmetry

- The Rec., Thrown Tree, and efficiencies for $p_{x,\Lambda}p_{cm,y,p}$ and $p_{y,\Lambda}p_{cm,x,p}$ are shown to the right.
- The Rec. distributions are have an asymmetry

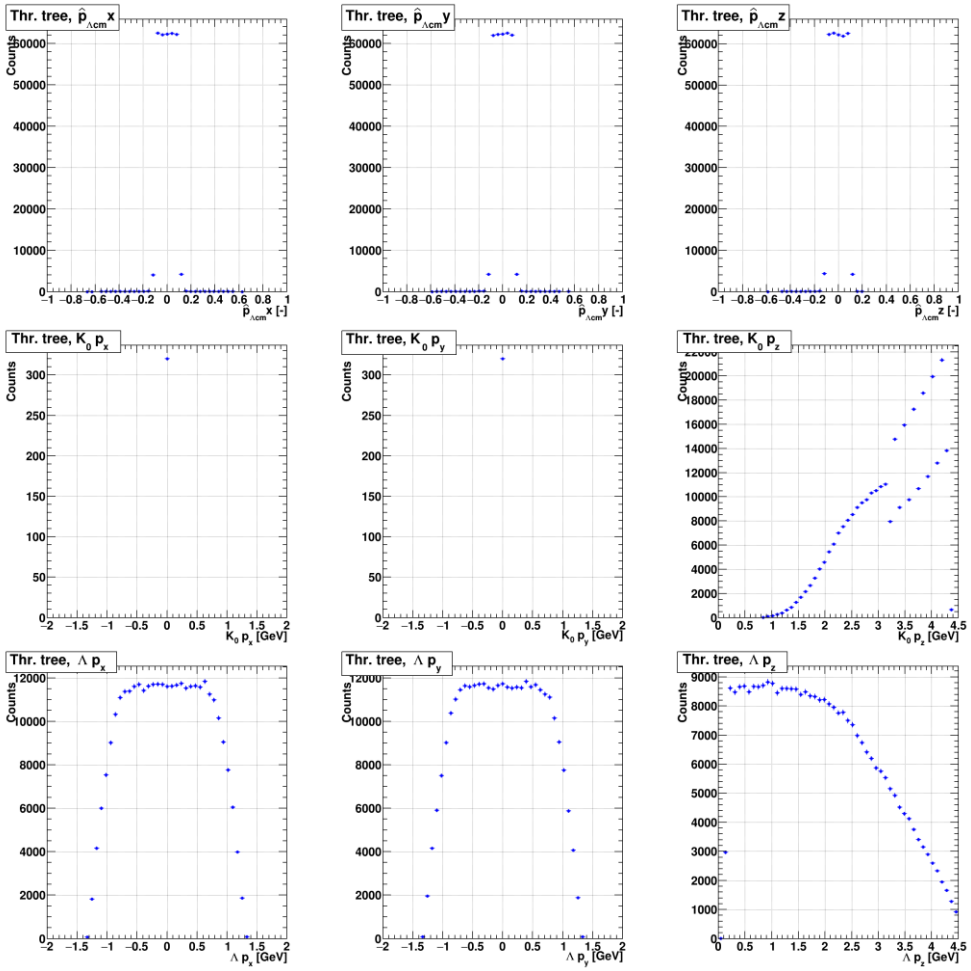



Rec. Cos(θpn) vs pK : n := K0 × Λ
pk [GeV]
Cos(θpn) [-]


ThT. Cos(θpn) vs pK : n := K0 × Λ
pk [GeV]
Cos(θpn) [-]

Thrown Tree Distributions

- Plots to the right show the thrown tree proton momentum in the lambda center of mass frame, the beam momenta, and the lambda momenta.



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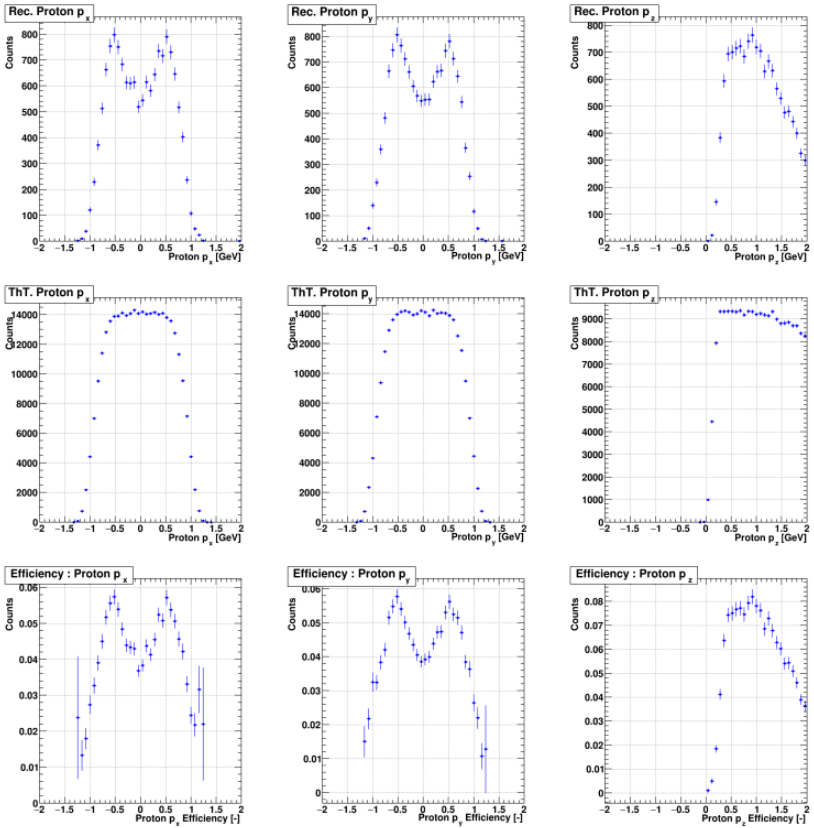
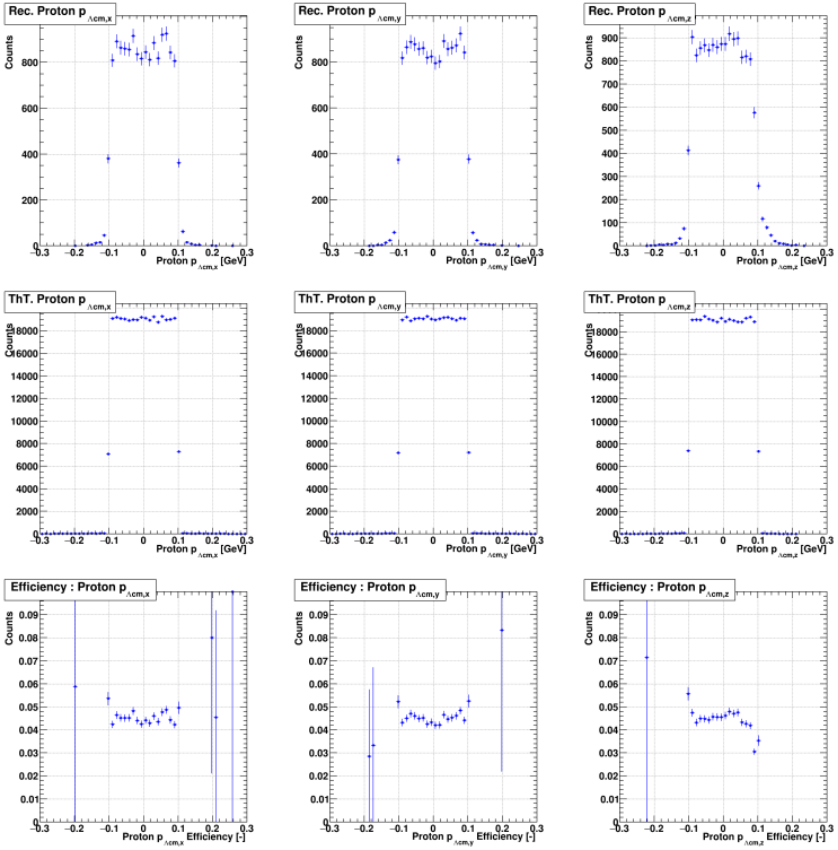
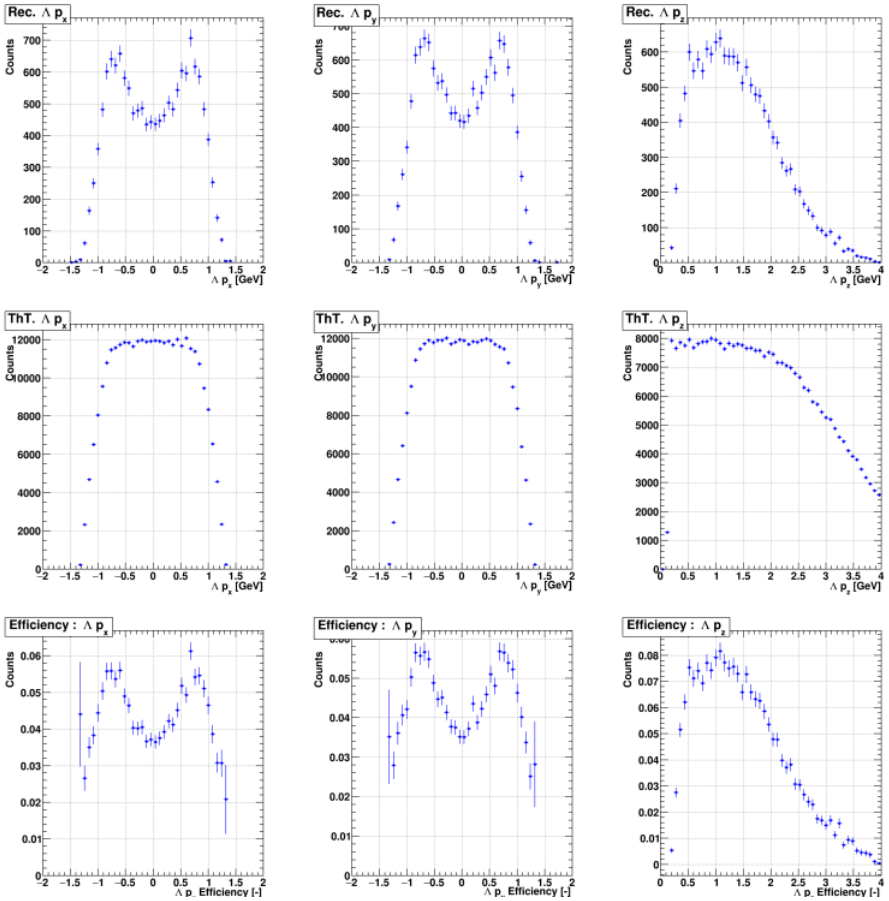
Rec. vs. Thrown Tree : Proton Momenta





Thrown Tree Lambda Distributions

- To the right are plots of the thrown tree and recon. lambda momenta distributions.



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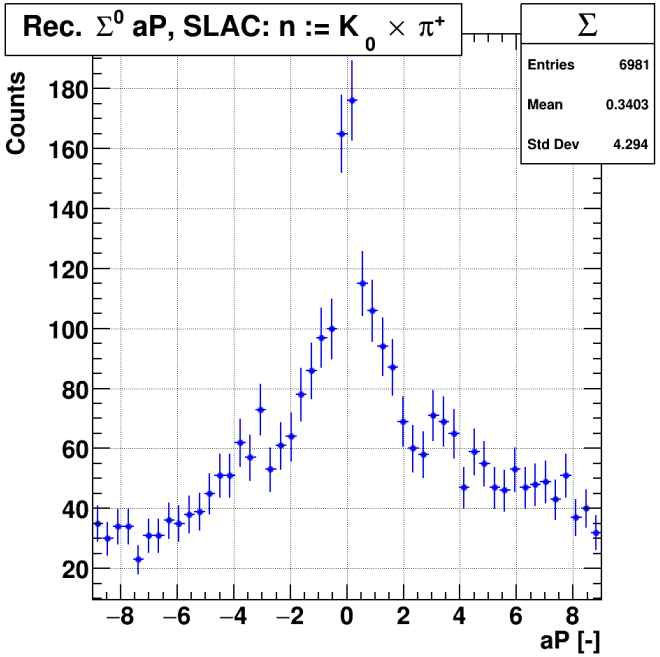
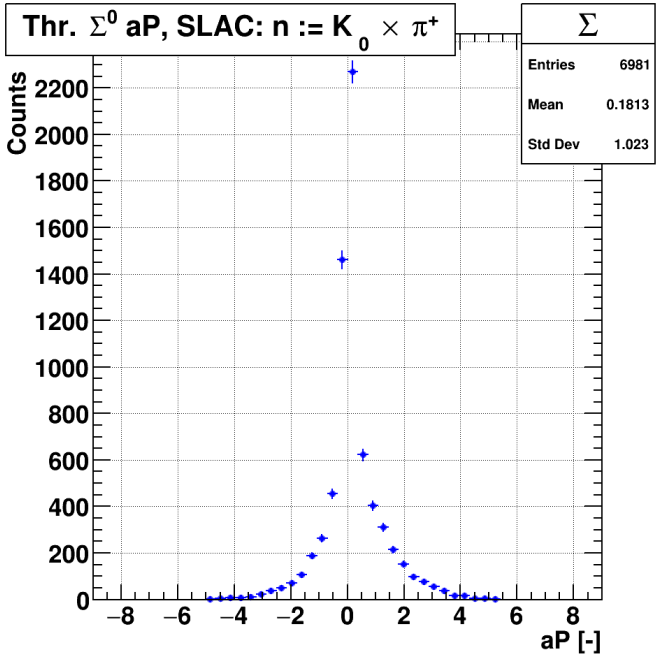
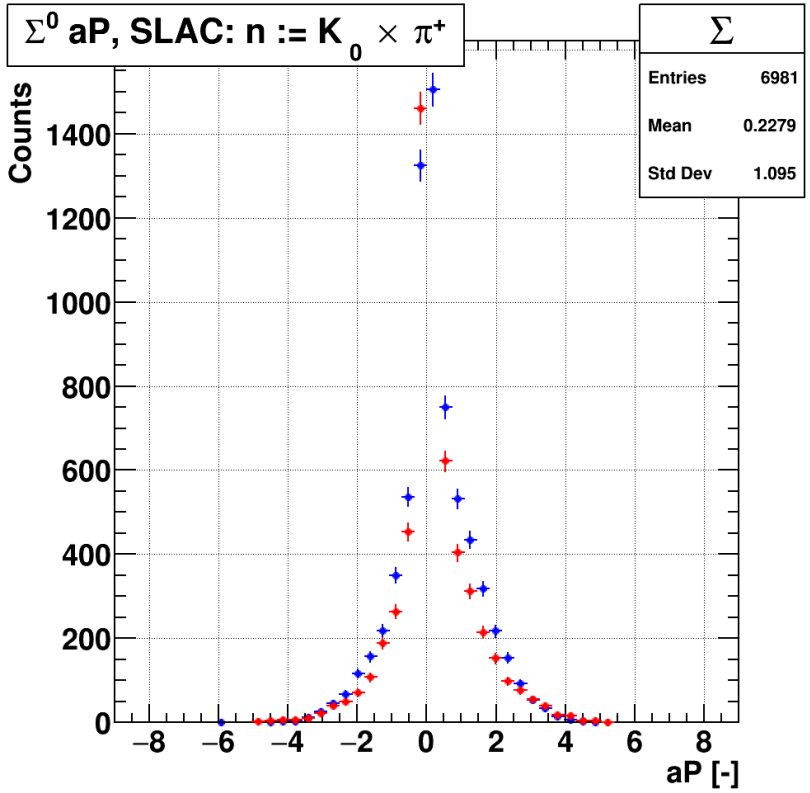
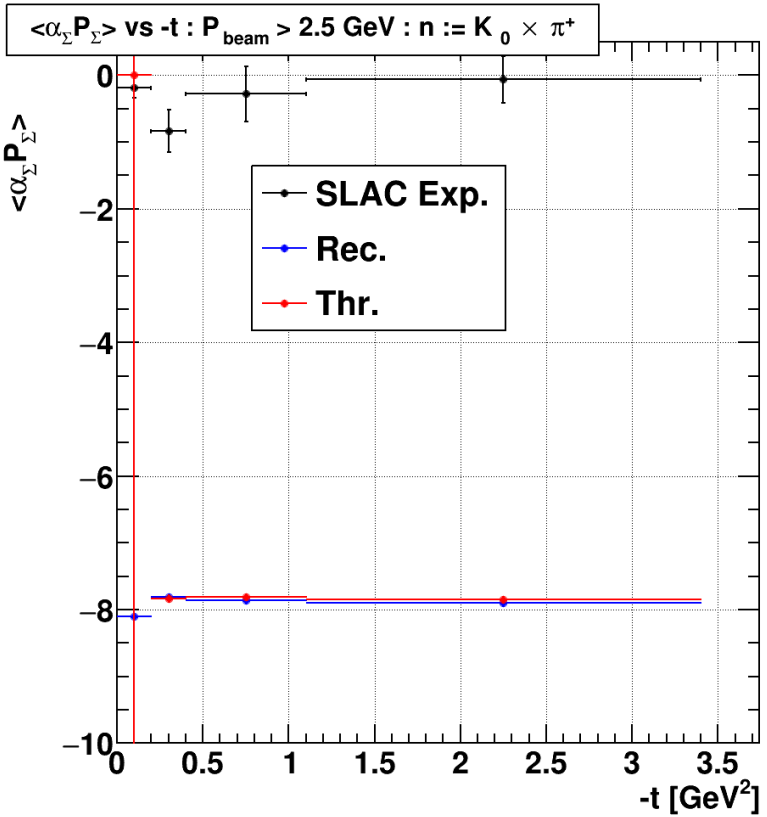
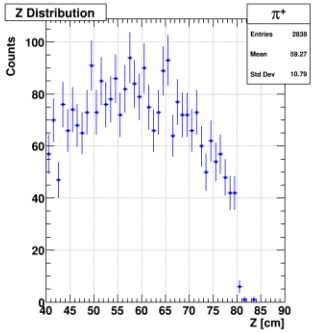
Deeper Backup Slides

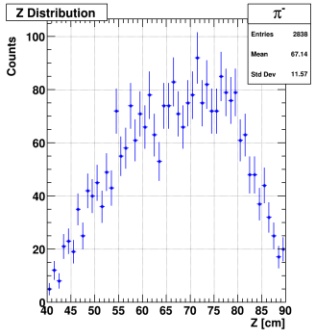

Rec. Σ^0 aP, SLAC: n := K_0 × π^+
Σ
Entries 6981
Mean 0.3403
Std Dev 4.294
Counts
aP [-]

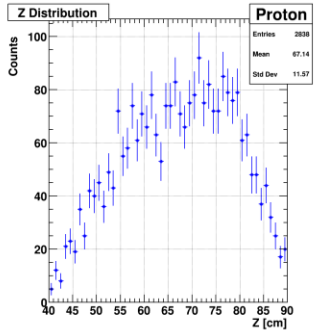

Thr. Σ^0 aP, SLAC: n := K_0 × π^+
Σ
Entries 6981
Mean 0.1813
Std Dev 1.023
Counts
aP [-]

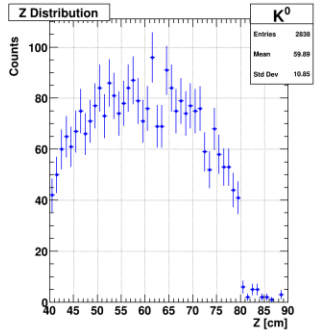

Σ^0 aP, SLAC: n := $K_0 \times \pi^+$
Σ
Entries 6981
Mean 0.2279
Std Dev 1.095
Counts
aP [-]

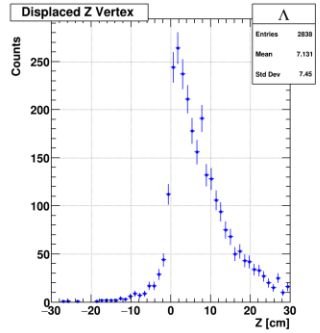

<$\alpha_\Sigma P_\Sigma$> vs -t : P_{beam} > 2.5 GeV : n := $K_0 \times \pi^+$
SLAC Exp.
Rec.
Thr.
<$\alpha_\Sigma P_\Sigma$>
-t [GeV^2]

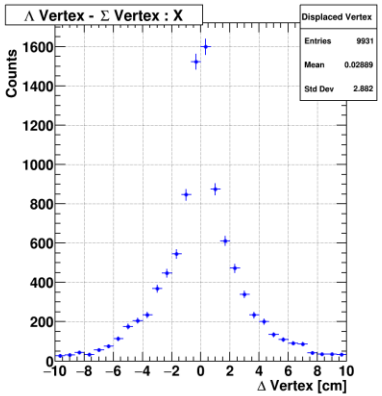

Z Distribution
π+
Entries 2838
Mean 59.27
Std Dev 10.79
Counts
Z [cm]

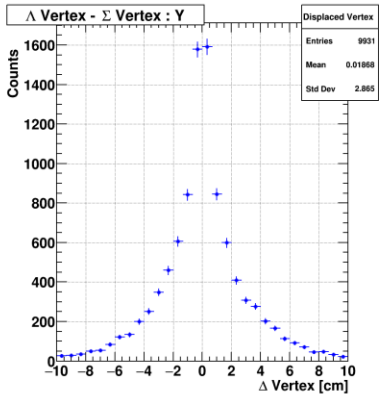

Z Distribution
π-
Entries 2838
Mean 67.14
Std Dev 11.57
Counts
Z [cm]

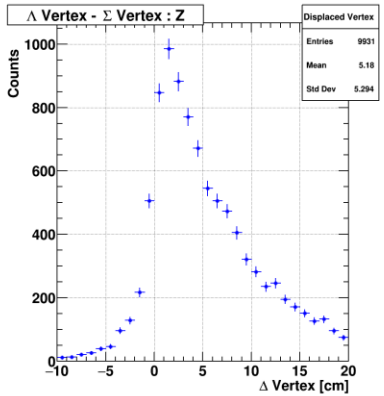

Z Distribution
Proton
Entries 2838
Mean 67.14
Std Dev 11.57
Counts
Z [cm]

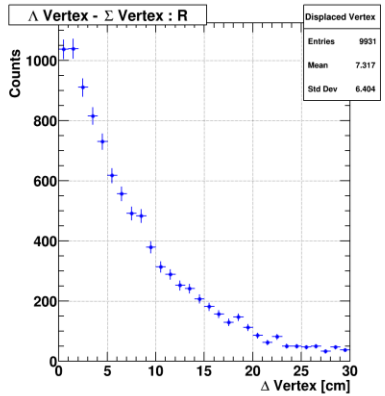

Z Distribution
K0
Entries 2838
Mean 59.89
Std Dev 10.85
Counts
Z [cm]

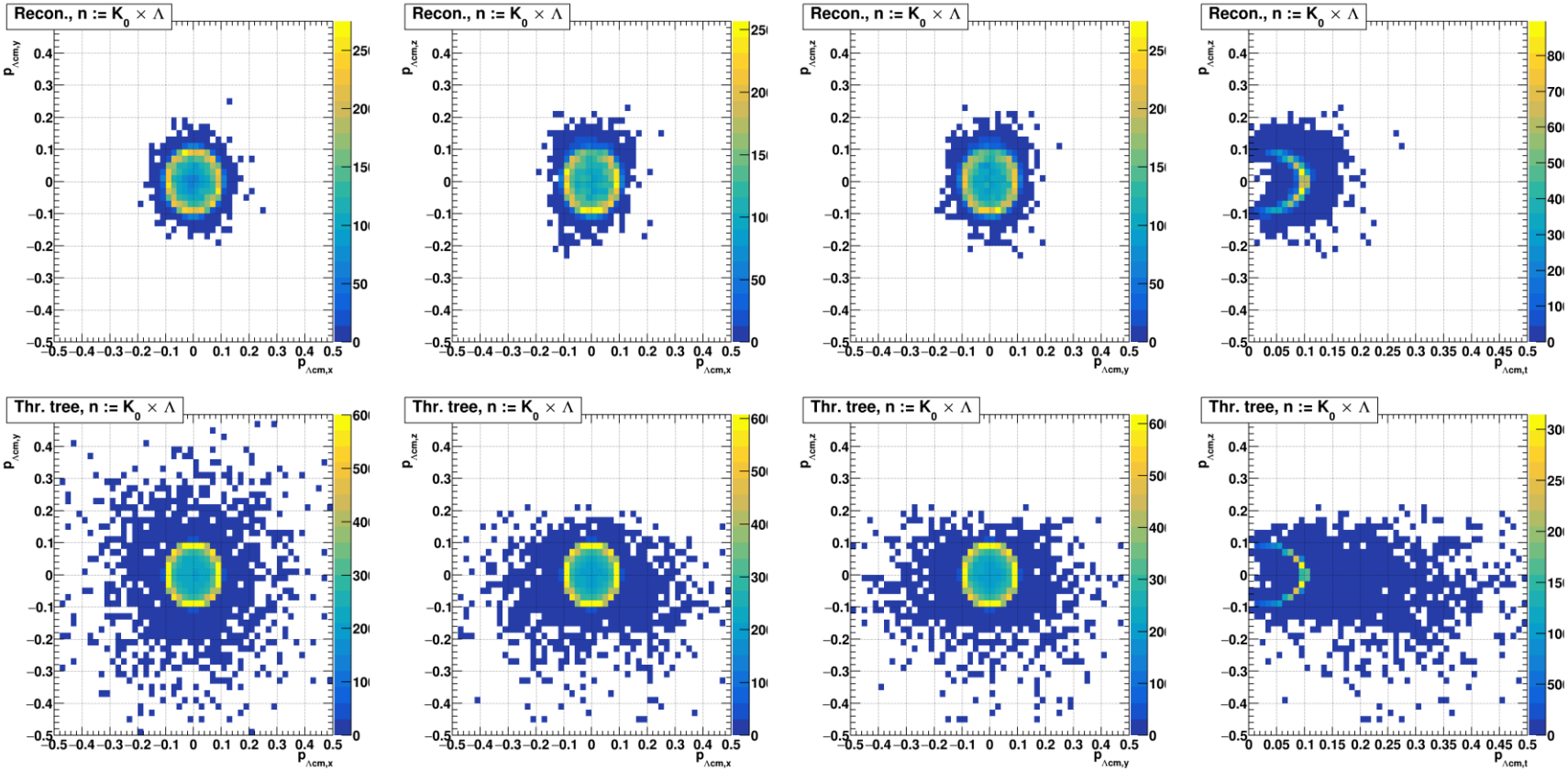

Displaced Z Vertex
Λ
Entries 2838
Mean 7.131
Std Dev 7.45
Counts
Z [cm]

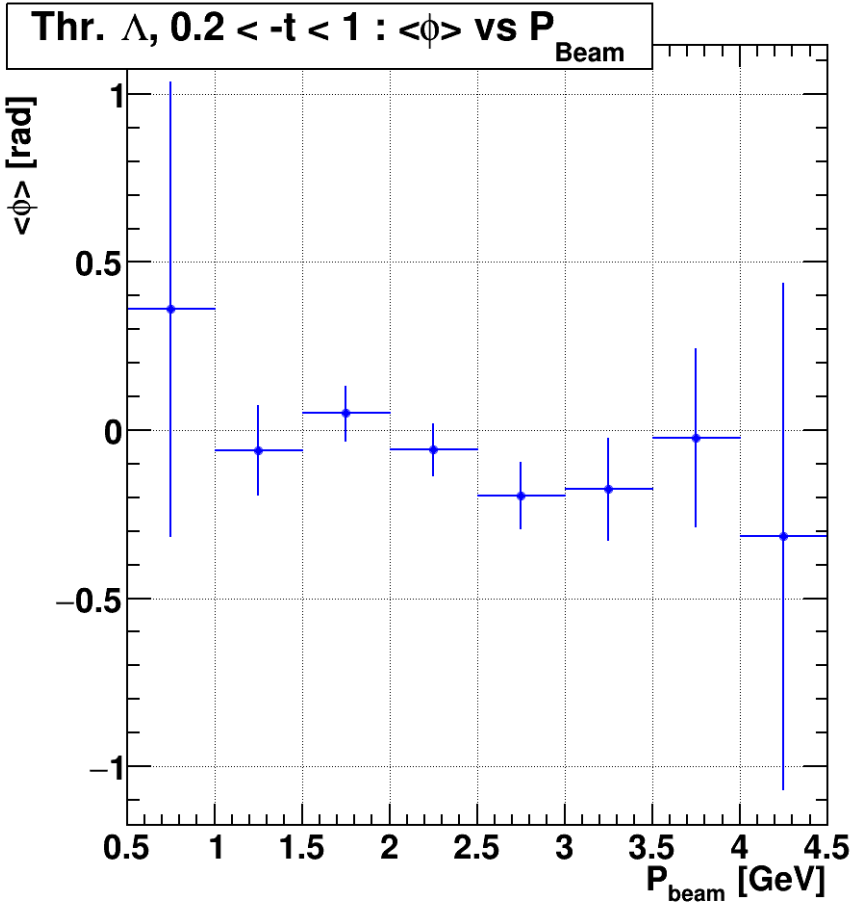

Λ Vertex - Σ Vertex : X
Displaced Vertex
Entries 9931
Mean 0.02889
Std Dev 2.882
Counts
Δ Vertex [cm]

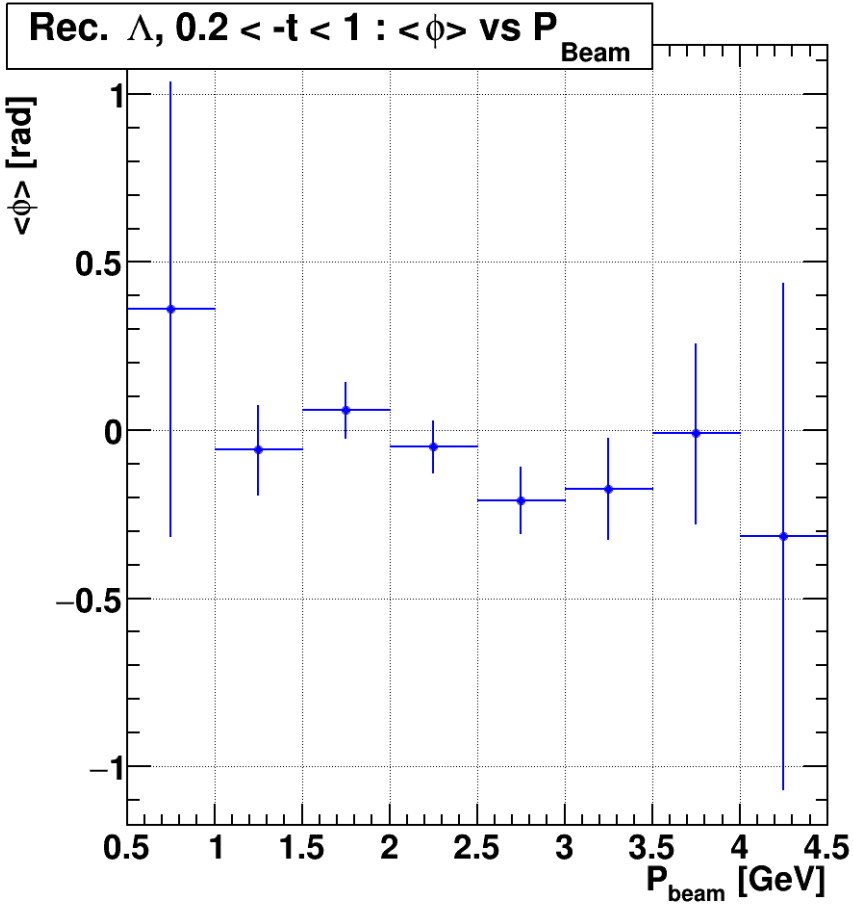

Λ Vertex - Σ Vertex : Y
Displaced Vertex
Entries 9931
Mean 0.01868
Std Dev 2.865
Counts
Δ Vertex [cm]

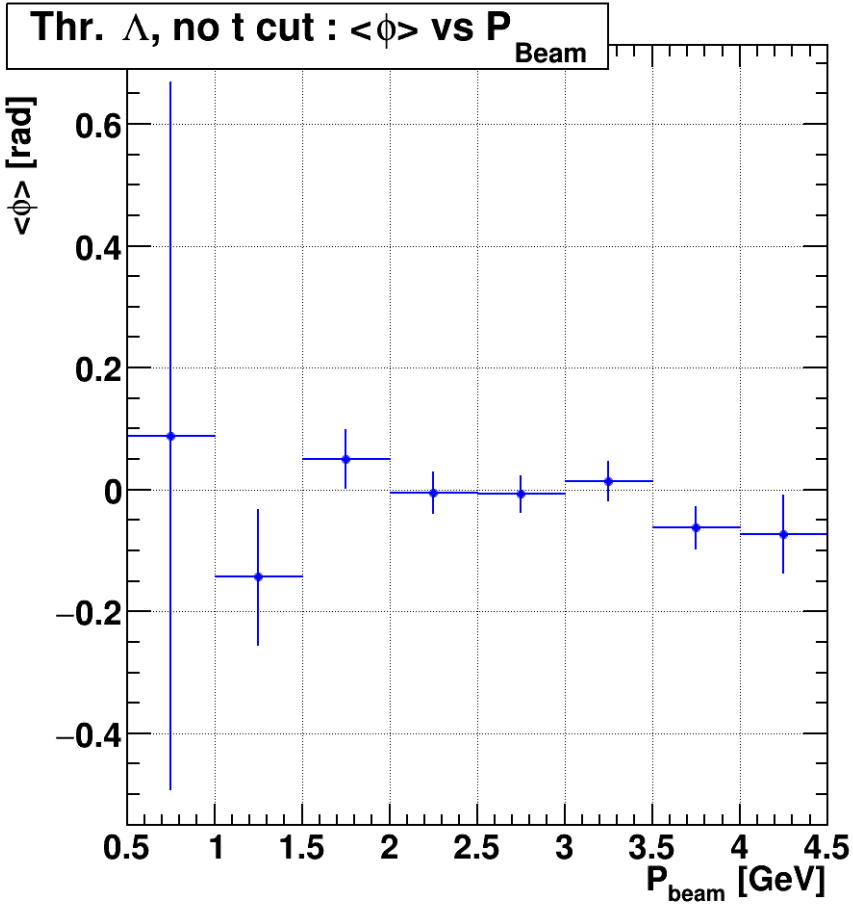

Λ Vertex - Σ Vertex : Z
Displaced Vertex
Entries 9931
Mean 5.18
Std Dev 5.294
Counts
Δ Vertex [cm]

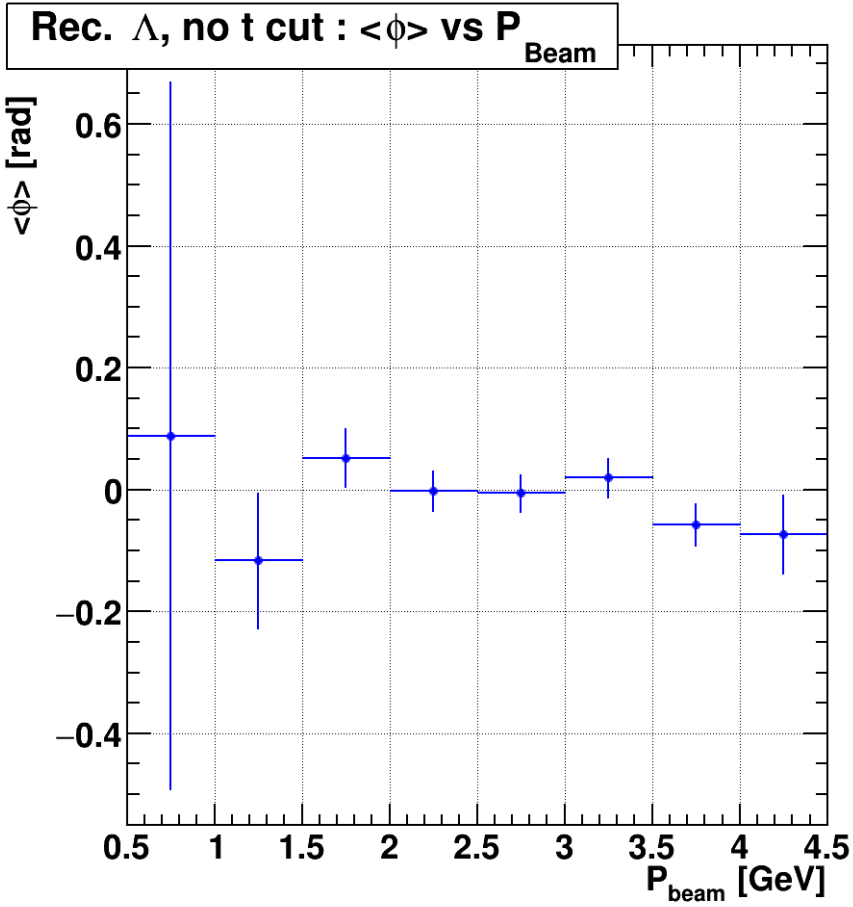

Λ Vertex - Σ Vertex : R
Displaced Vertex
Entries 9931
Mean 7.317
Std Dev 6.404
Counts
Δ Vertex [cm]

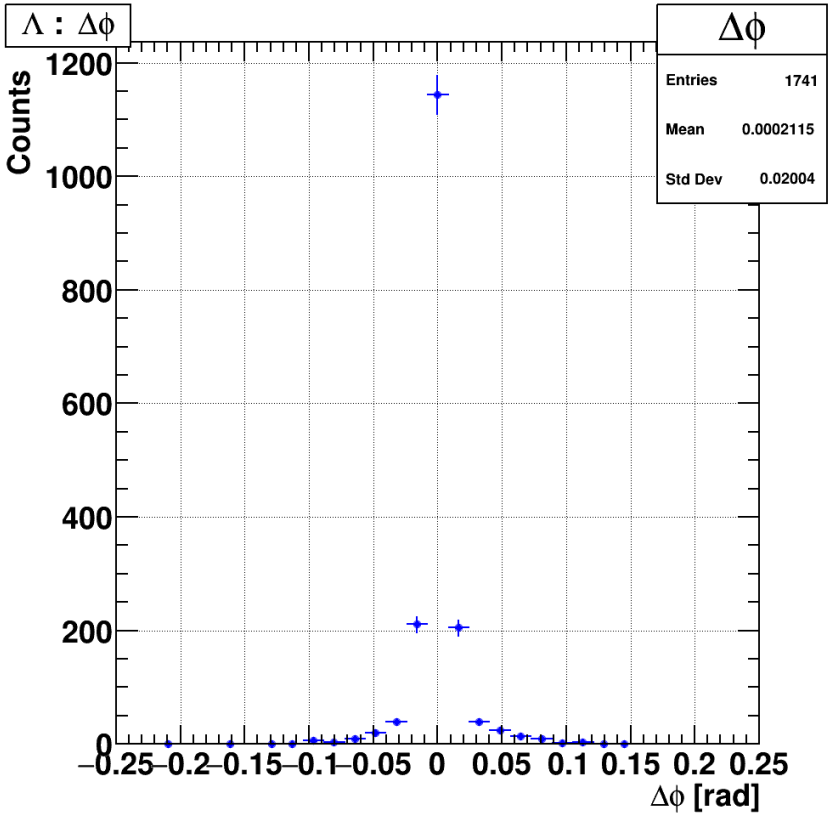

Recon., n := K0 × Λ
Recon., n := K0 × Λ
Recon., n := K0 × Λ
Recon., n := K0 × Λ
Thr. tree, n := K0 × Λ
Thr. tree, n := K0 × Λ
Thr. tree, n := K0 × Λ
Thr. tree, n := K0 × Λ
pΛcm,x
pΛcm,y
pΛcm,z
pΛcm,t


Thr. Λ, 0.2 < -t < 1 : <ϕ> vs P Beam
<ϕ> [rad]
1
0.5
0
−0.5
−1
0.5
1
1.5
2
2.5
3
3.5
4
4.5
P beam [GeV]


Rec. Λ, 0.2 < -t < 1 : <ϕ> vs P Beam
<ϕ> [rad]
1
0.5
0
−0.5
−1
0.5
1
1.5
2
2.5
3
3.5
4
4.5
P beam [GeV]


Thr. Λ, no t cut : <ϕ> vs P Beam
<ϕ> [rad]
0.6
0.4
0.2
0
−0.2
−0.4
0.5
1
1.5
2
2.5
3
3.5
4
4.5
P beam [GeV]


Rec. Λ, no t cut : <ϕ> vs P Beam
<ϕ> [rad]
0.6
0.4
0.2
0
−0.2
−0.4
0.5
1
1.5
2
2.5
3
3.5
4
4.5
P beam [GeV]


Λ : Δϕ
Δϕ
Entries 1741
Mean 0.0002115
Std Dev 0.02004
Counts
1200
1000
800
600
400
200
0
–0.25 –0.2 –0.15 –0.1 –0.05 0 0.05 0.1 0.15 0.2 0.25
Δϕ [rad]

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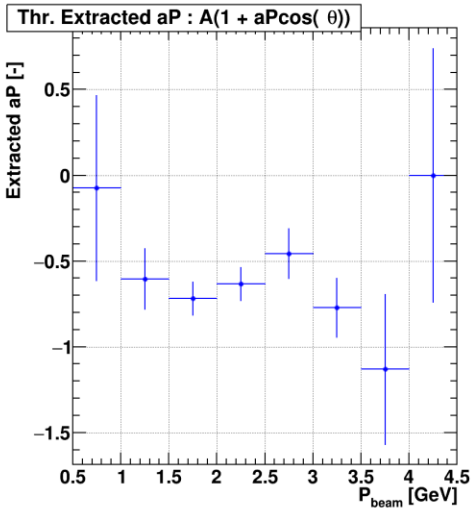
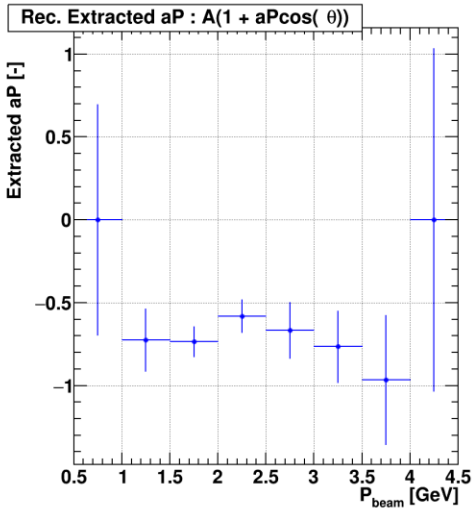
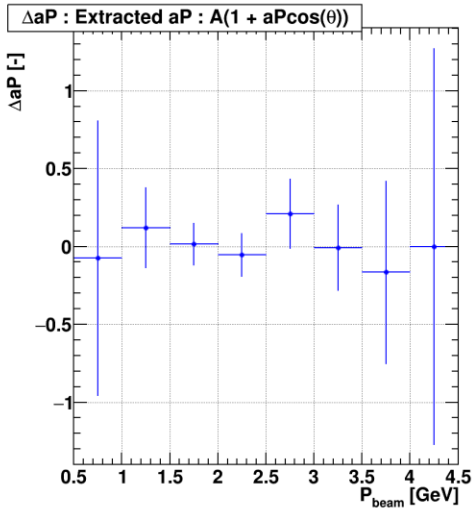
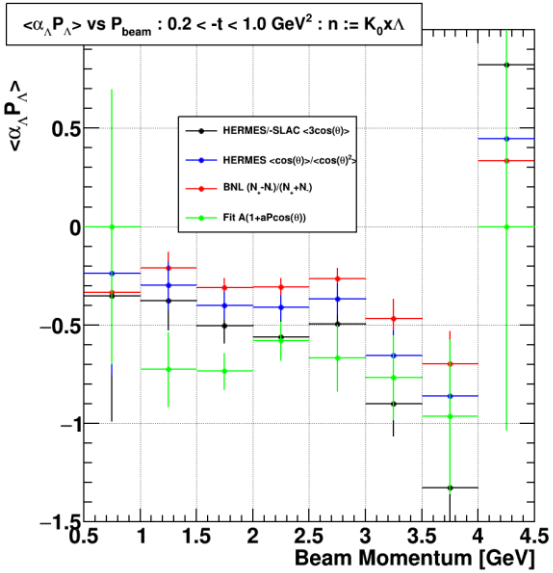

Thr. Extracted aP : A(1 + aPcos(θ))
Extracted aP [-]
0.5
0
−0.5
−1
−1.5
0.5 1 1.5 2 2.5 3 3.5 4 4.5
P_beam [GeV]

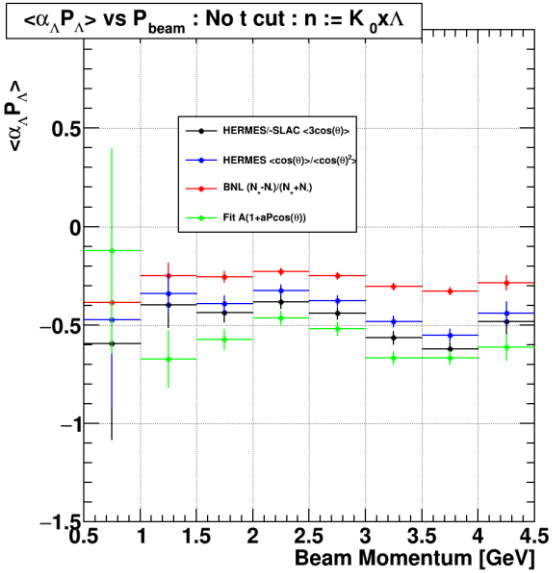

Rec. Extracted aP : A(1 + aPcos(θ))
Extracted aP [-]
1
0.5
0
−0.5
−1
0.5 1 1.5 2 2.5 3 3.5 4 4.5
P_beam [GeV]

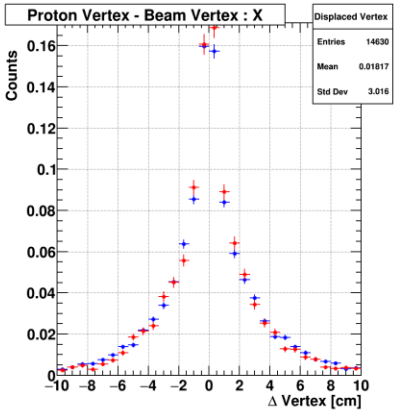

ΔaP : Extracted aP : A(1 + aPcos(θ))
ΔaP [-]
1
0.5
0
−0.5
−1
0.5 1 1.5 2 2.5 3 3.5 4 4.5
P_beam [GeV]

Full Results

- The plots to the let show the mea aP using the BNL, HERMES, and extracting the aP from the cosine distribution.
- The plots with ad without the t cut are shown.
- Here the n = K_L X Λ.



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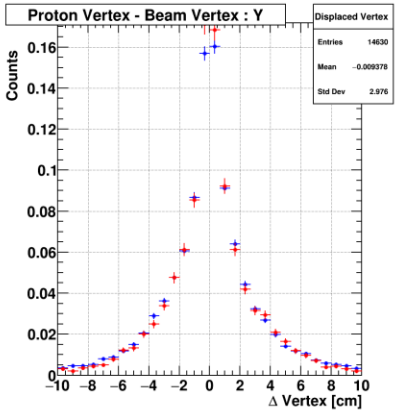
Displaced Vertex
Entries 14630
Mean 0.01817
Std Dev 3.016
Counts
Δ Vertex [cm]


Proton Vertex - Beam Vertex : Y
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Entries 14630
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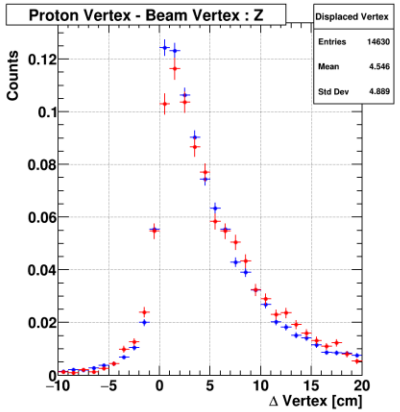
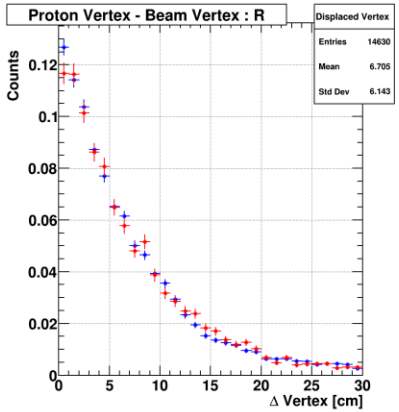
Std Dev 2.976
Counts
Δ Vertex [cm]


Proton Vertex - Beam Vertex : Z
Displaced Vertex
Entries 14630
Mean 4.546
Std Dev 4.889
Counts
Δ Vertex [cm]


Proton Vertex - Beam Vertex : R
Displaced Vertex
Entries 14630
Mean 6.705
Std Dev 6.143
Counts
Δ Vertex [cm]