Cascade Simulations Update

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GlueX Collaboration Meeting
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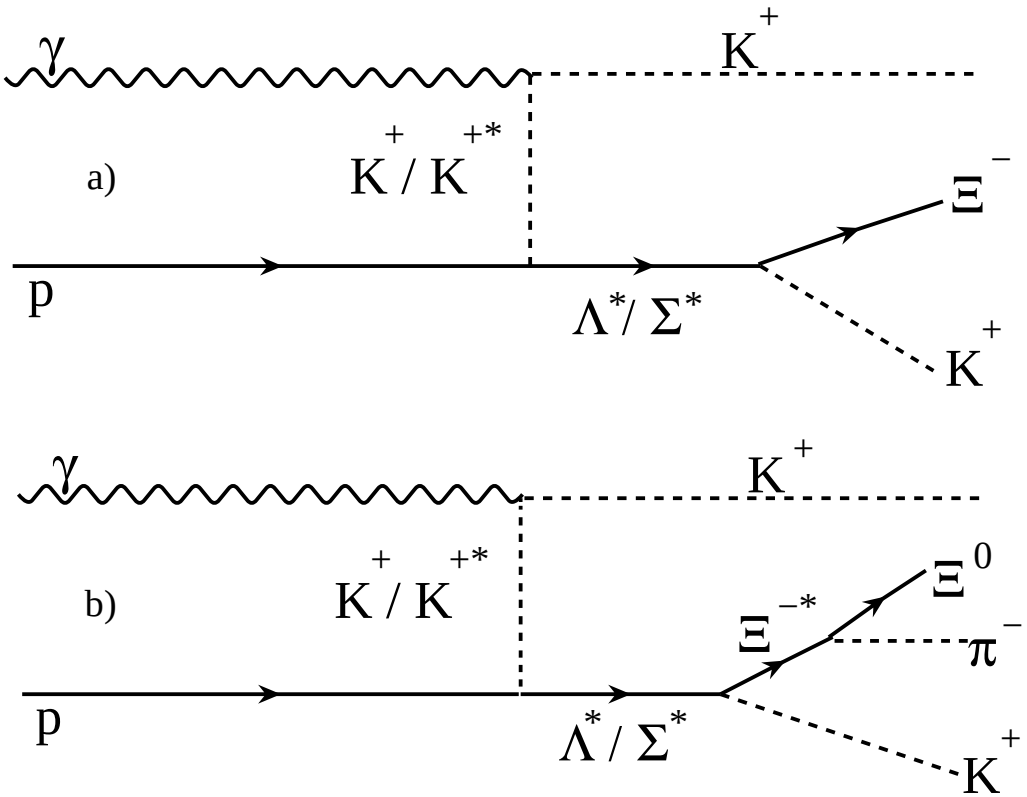
Outline

Possible Production Mechanism



$K^+(\Xi^- K^+)$, $K^+(\Xi^0 K^0)$, $K^0(\Xi^0 K^+)$

Production of excited states via a

1. forward-going K^0 meson
   ➜ $K^0\,(\,\Xi^-\,\pi^+\,)\,K^+$, etc.
2. forward-going K^+ meson
   ➜ $K^+\,(\,\Xi^-\,\pi^+\,)\,K^0$,
   $K^+\,(\,\Xi^0\,\pi^-\,)\,K^+$, etc.

Procedure

Photoproduction of $\Xi^-(1320)$ and $\Xi^0(1315)$ using 9 GeV photons

- t-channel production using the genr8 program
- Reactions and decay chains
  - $\gamma p \to K^+ Y^*$ with $Y^* \to K^+ \Xi^-$, $\Xi^- \to \Lambda\pi^-$, $\Lambda \to \pi^- p$
  - $\gamma p \to K^+ Y^*$ with $Y^* \to K_s \Xi^0$, $\Xi^0 \to \Lambda\pi^0$, $\Lambda \to \pi^- p$, $K_s \to \pi^+\pi^-$, $\pi^0 \to \gamma\gamma$
  - $\gamma p \to K_s Y^{*+}$ with $Y^* \to K^+ \Xi^0$, $\Xi^0 \to \Lambda\pi^0$, $\Lambda \to \pi^- p$, $K_s \to \pi^+\pi^-$, $\pi^0 \to \gamma\gamma$
- Excited hyperon parameters:
  m(Y*) = 1960 MeV and Γ(Y*) = 220 MeV
  from (Guo *et al.*, PRC **76**, 025208 (2007))
- t-channel slope parameter: 1.4 $(\text{GeV})^{-2}$
- Swim particles through GlueX detectors using HDGeant (minimal control.in file with HADR==0)

Procedure cont. and Status

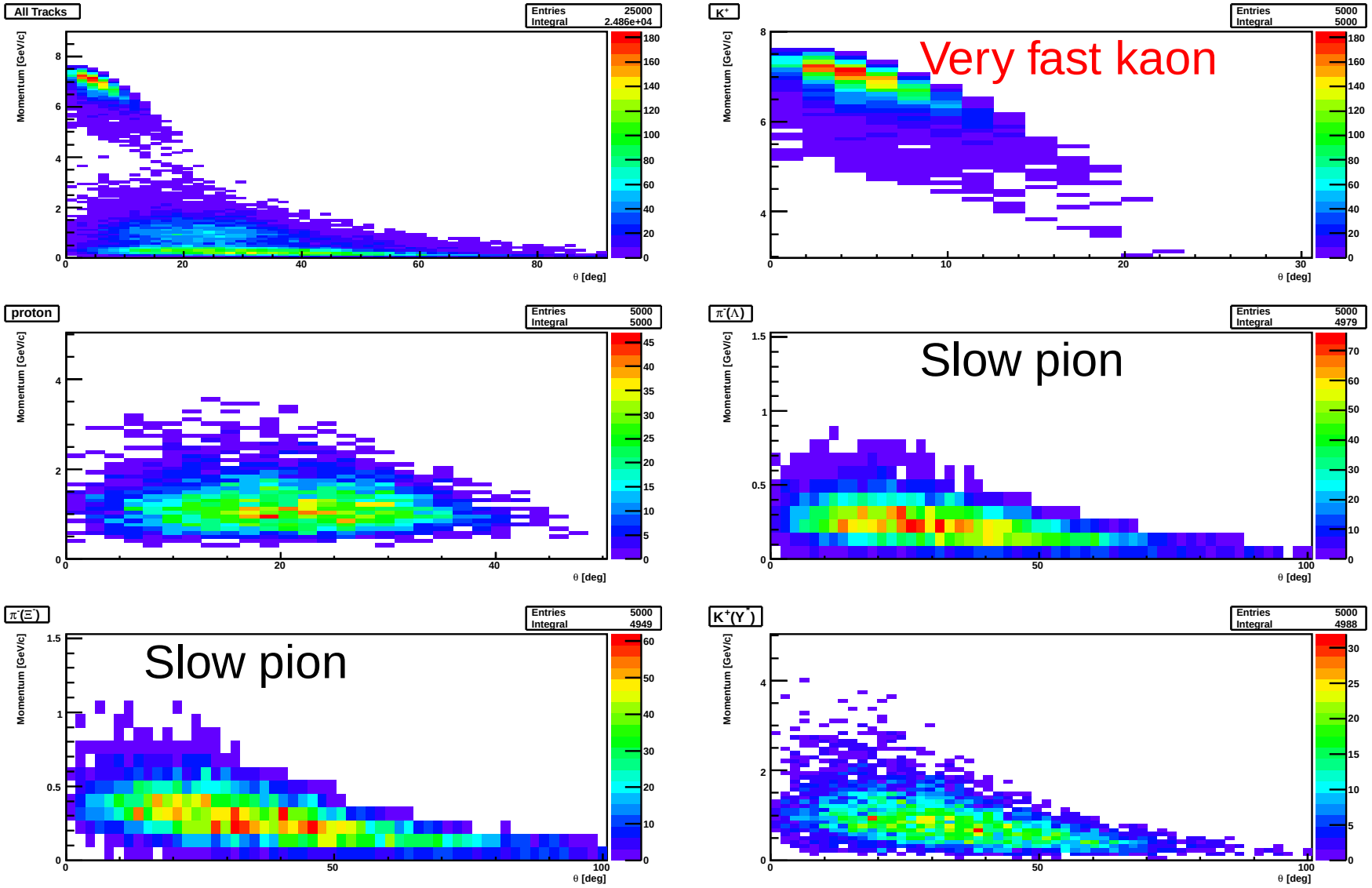
- Standard reconstruction and PID from OFFLINE software
- Determine best final state particle combination kinematically
- First find $\pi^-\pi^-$p combination giving best Ξ^- mass
- Pick π^-p from this list giving best Λ mass
- Form best Y* from $\Xi^- K^+$
- All final state particles not required in this analysis

Status of analysis

- Efficiencies of reconstructing baryons have improved
- This is due to improvements in the tracking efficiencies, resulting from Simon's work
- Still need to study impact of forward Cherenkov PID on this final state

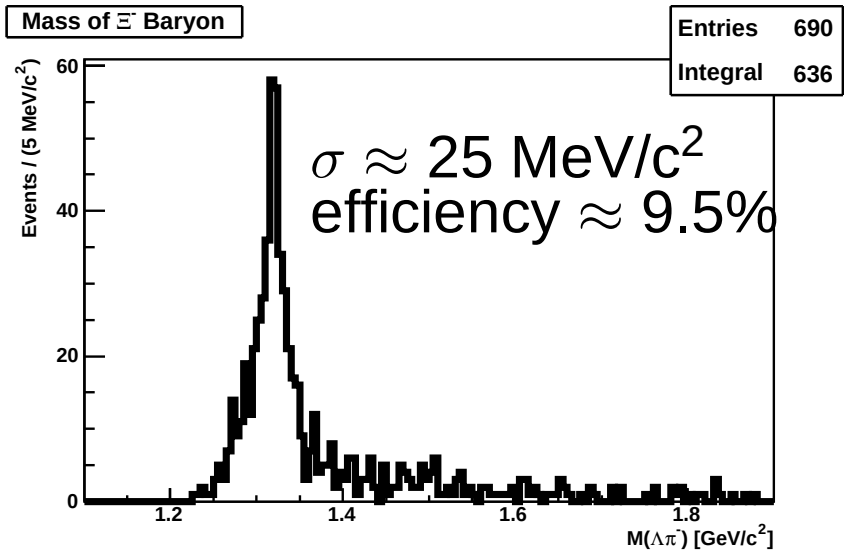
Status

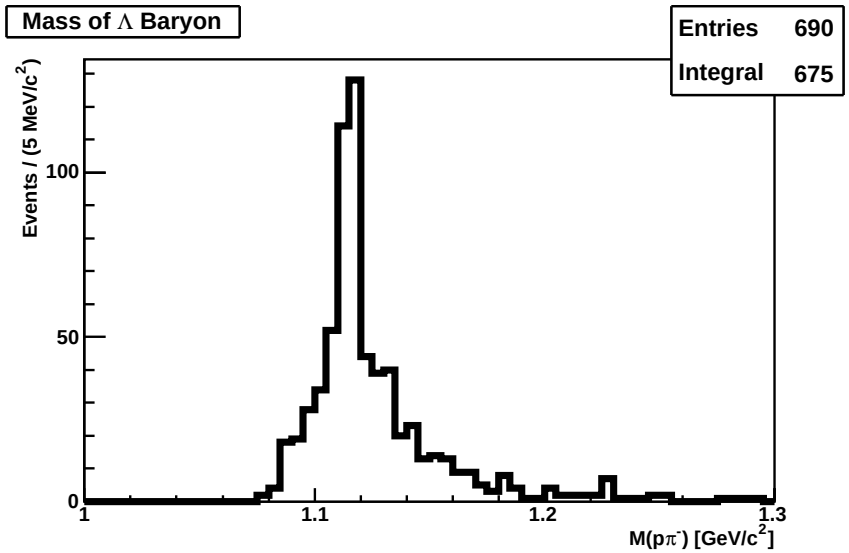
Generated Momentum versus θ Distributions

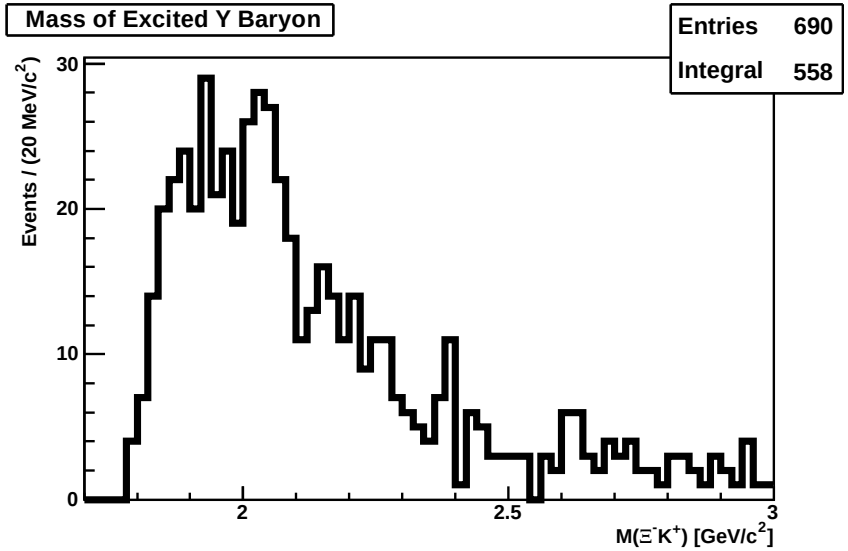


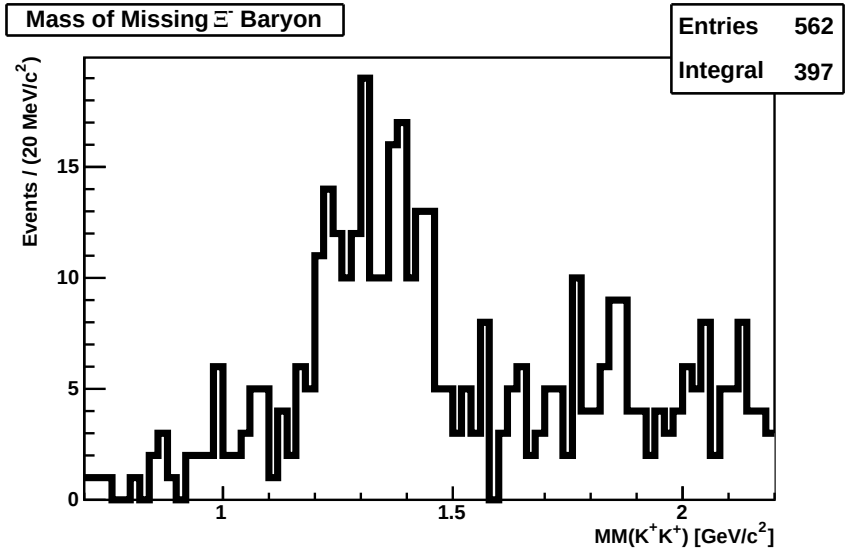
Status

Mass Distributions









Strategy

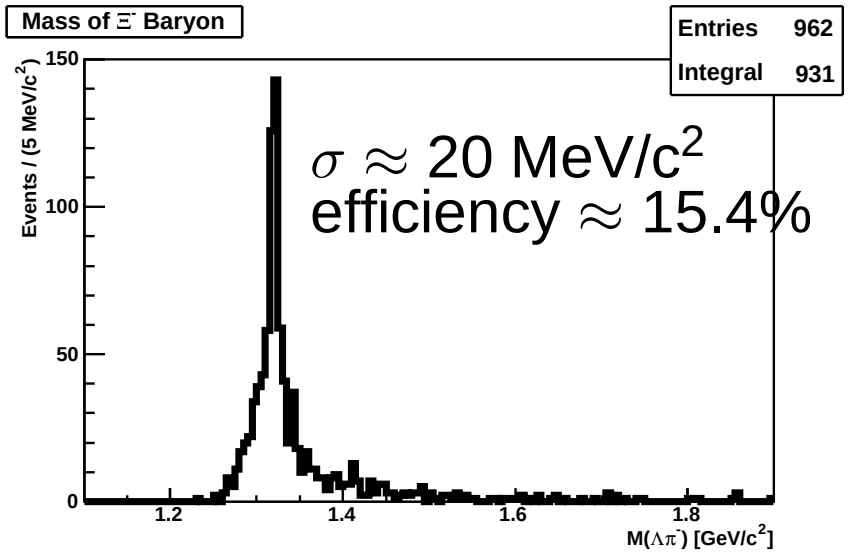
- Use MC truth information to better understand quality of tracking and PID
- Match reconstructed tracks to thrown (generated) tracks by comparing hits and also parameter values
- Hits and parameter values are required to point to the same thrown track
- Define a track parameter quality cut value χ_r^2
- $3\chi_r^2 = (\Delta P_T/P_T(\text{thrown})/\delta f(P_T))^2 + (\Delta\theta/\delta\theta)^2 + (\Delta\phi/\delta\phi)^2$, where $\Delta\theta = \theta(\text{reconstructed}) - \theta(\text{thrown})$, etc.
- $\delta f(P_T)$=10%, $\delta\theta$=25 mrad, $\delta\phi$=50 mrad
- Study the dependence of certain quantities on this cut

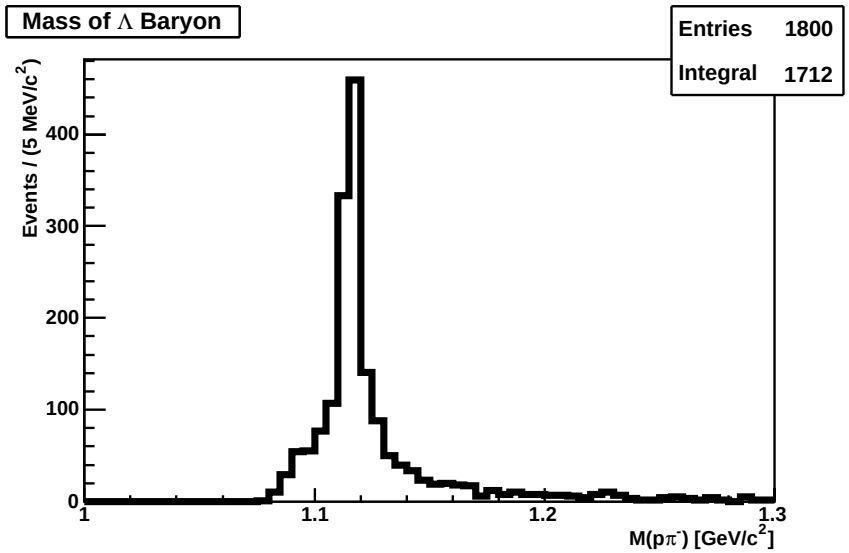
Tracking Resolutions (σ)

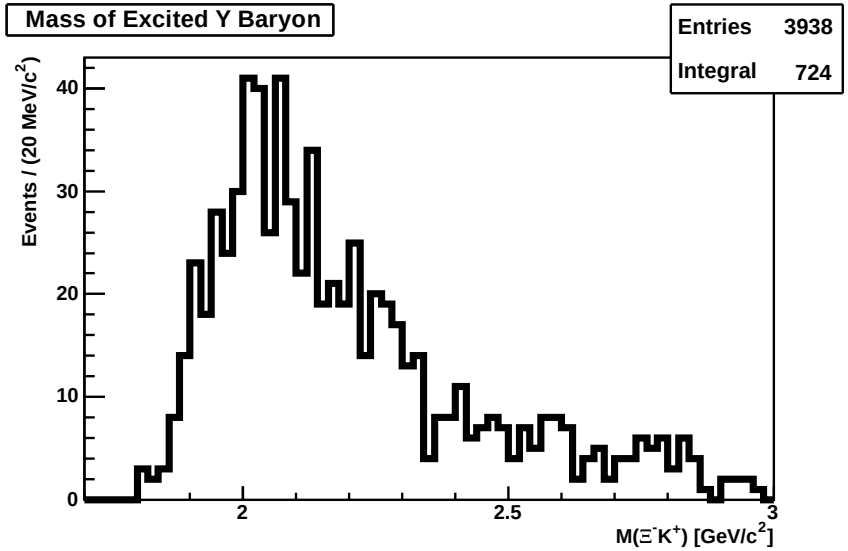
Track	σ(f(P_T)) %	$\sigma(\theta)$ mrad	$\sigma(\phi)$ mrad
K^+	3.8	0.5	8.6
proton	3.3	4.9	11.0
$\pi^-(\Lambda)$	5.5	14.4	32.2
$\pi^-(\Xi)$	4.4	11.2	27.1
$K^+(Y^*)$	2.6	5.0	9.1

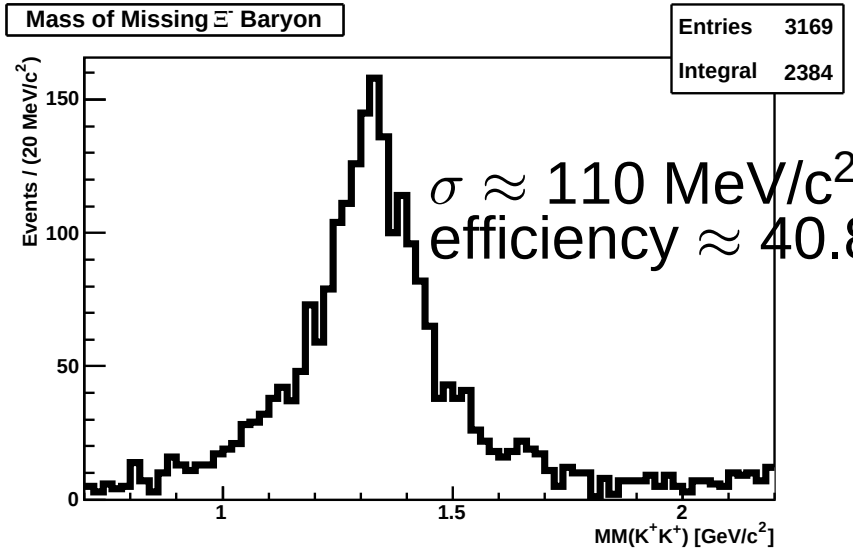
- The proton and K^+'s have better resolutions than the π^-'s because of the generated kinematics
- π^- momentum distribution peaks at about 250 MeV/c, whereas the other particles peak at much higher momenta
- π^- angular resolutions are up to 3 times worse than the others
- See backup slides for fits

Mass Distributions Using Truth Information

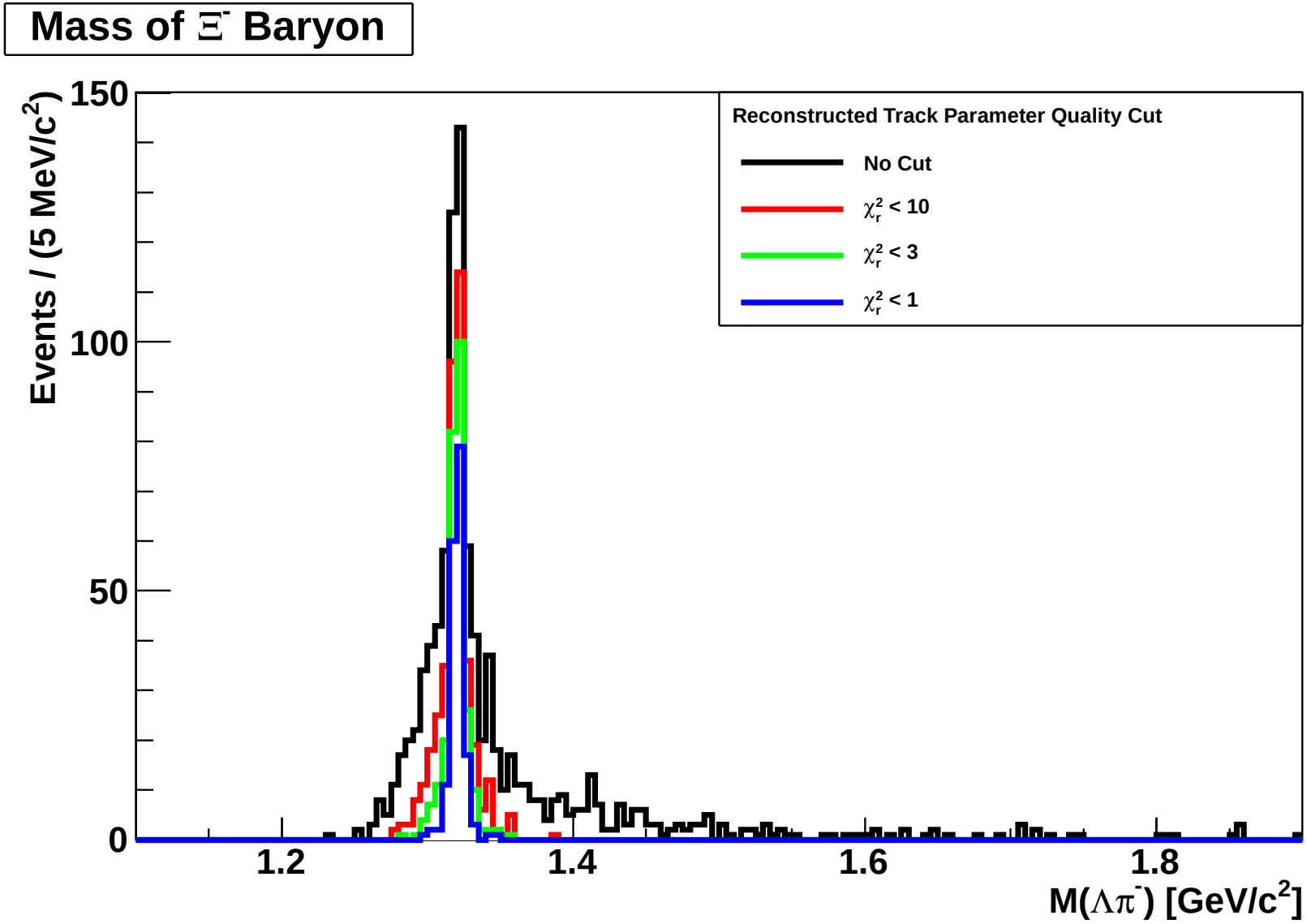




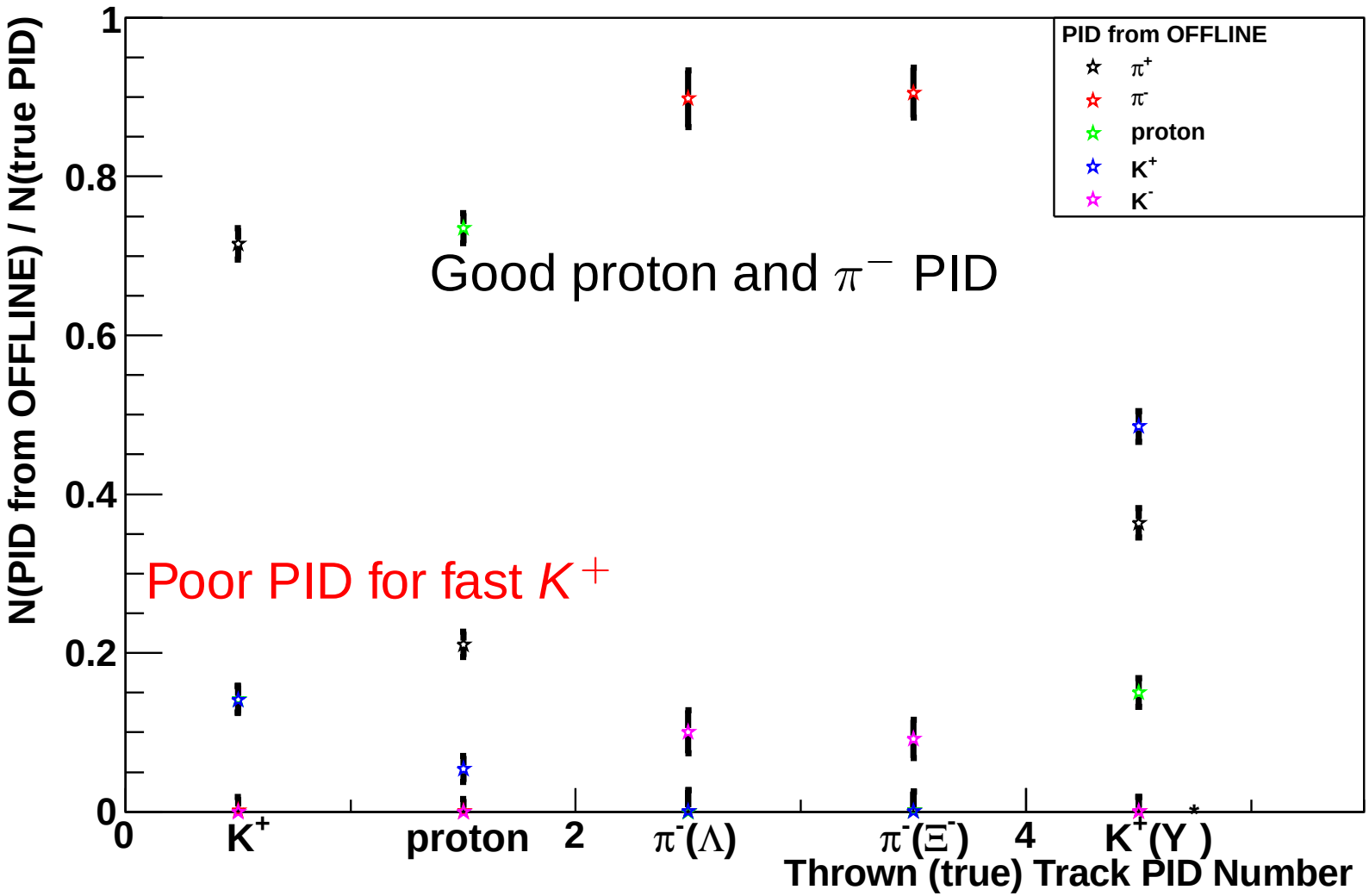




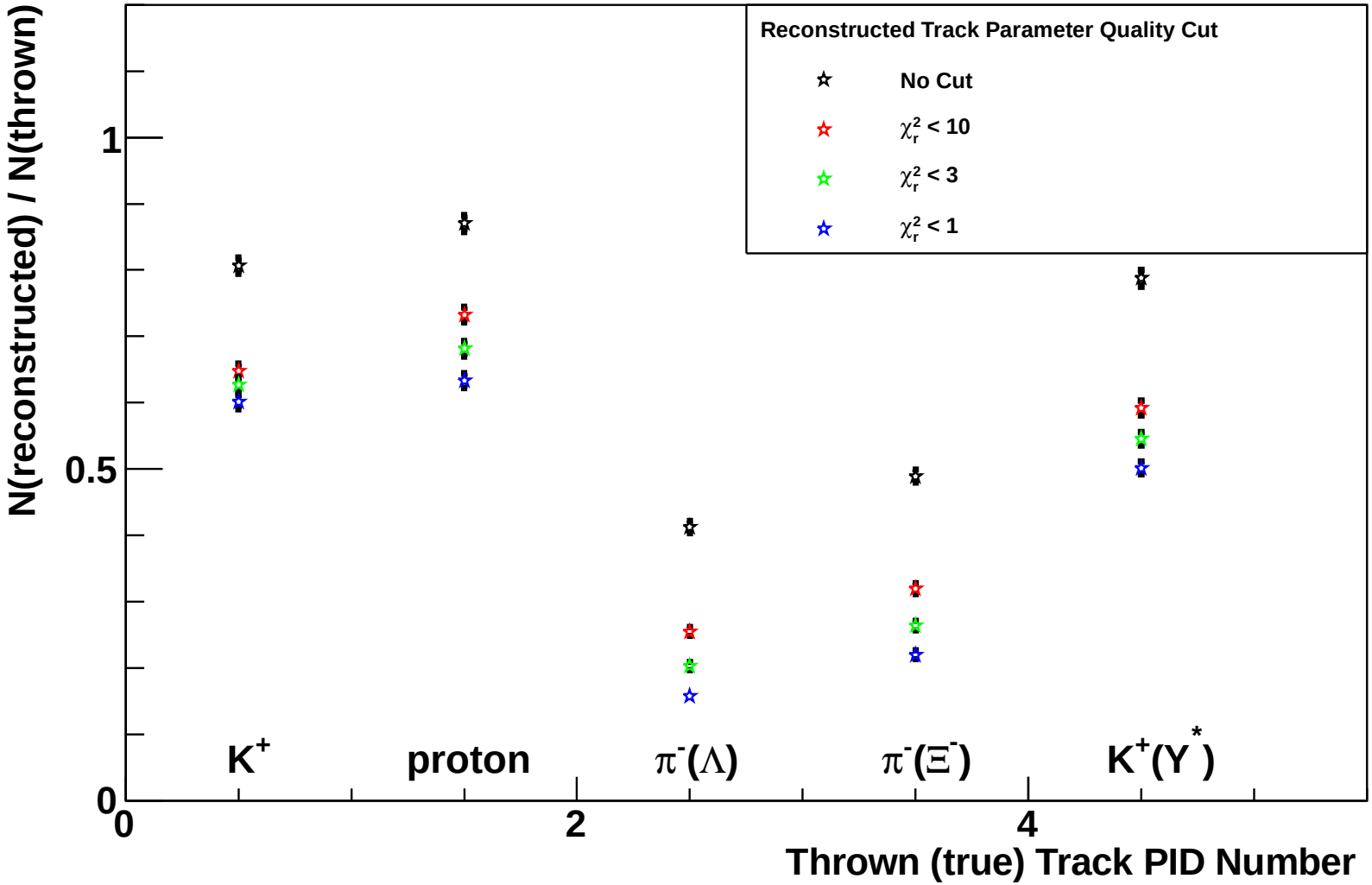
Cascade Mass Distribution with Track Parameter Cuts



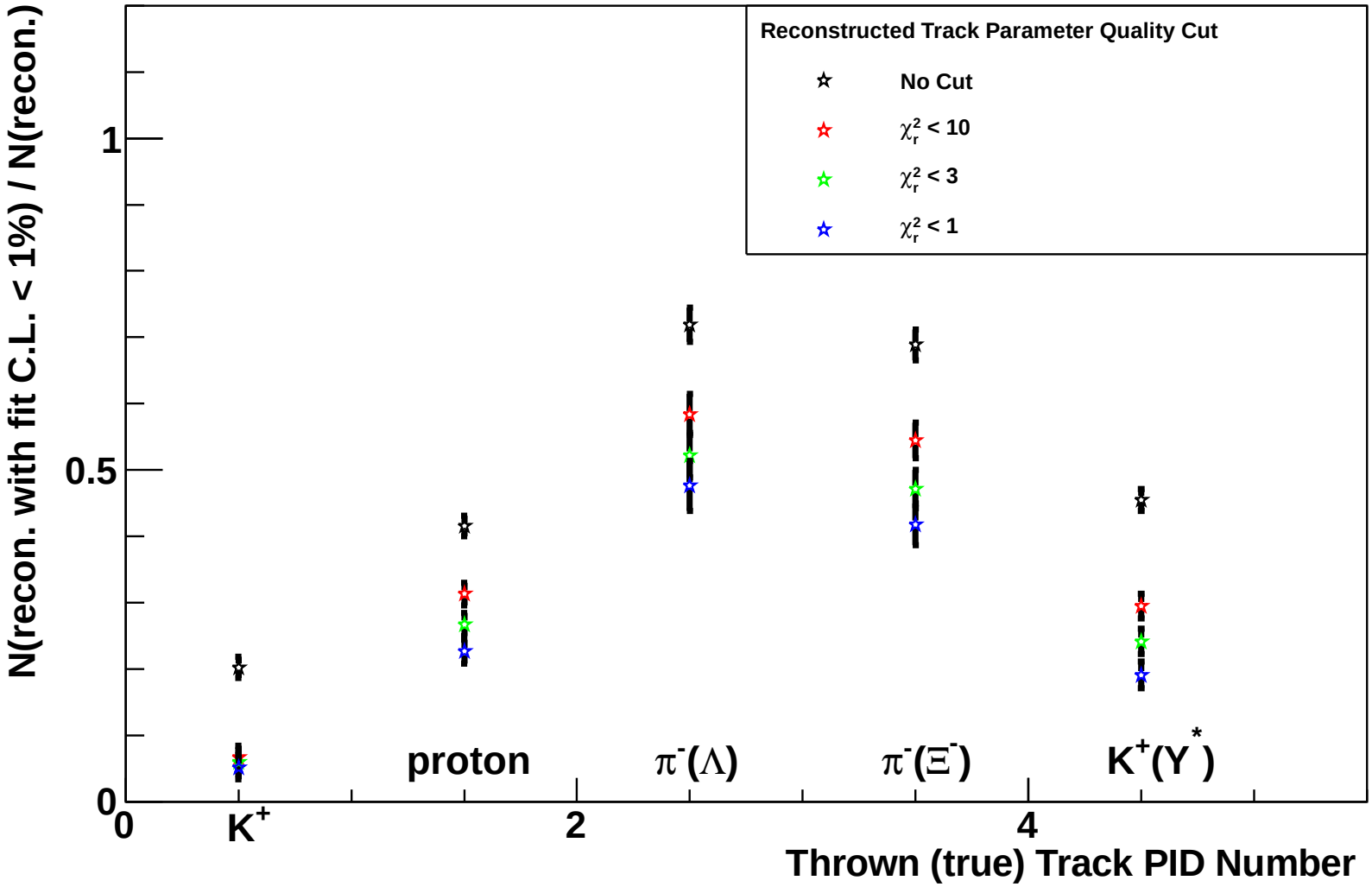
PID Efficiency with $\chi_r^2 < 10$



Track Reconstruction Efficiencies



Fraction of Low Confidence Level (C.L.) Tracks in C.L. Distribution



Summary and Outlook

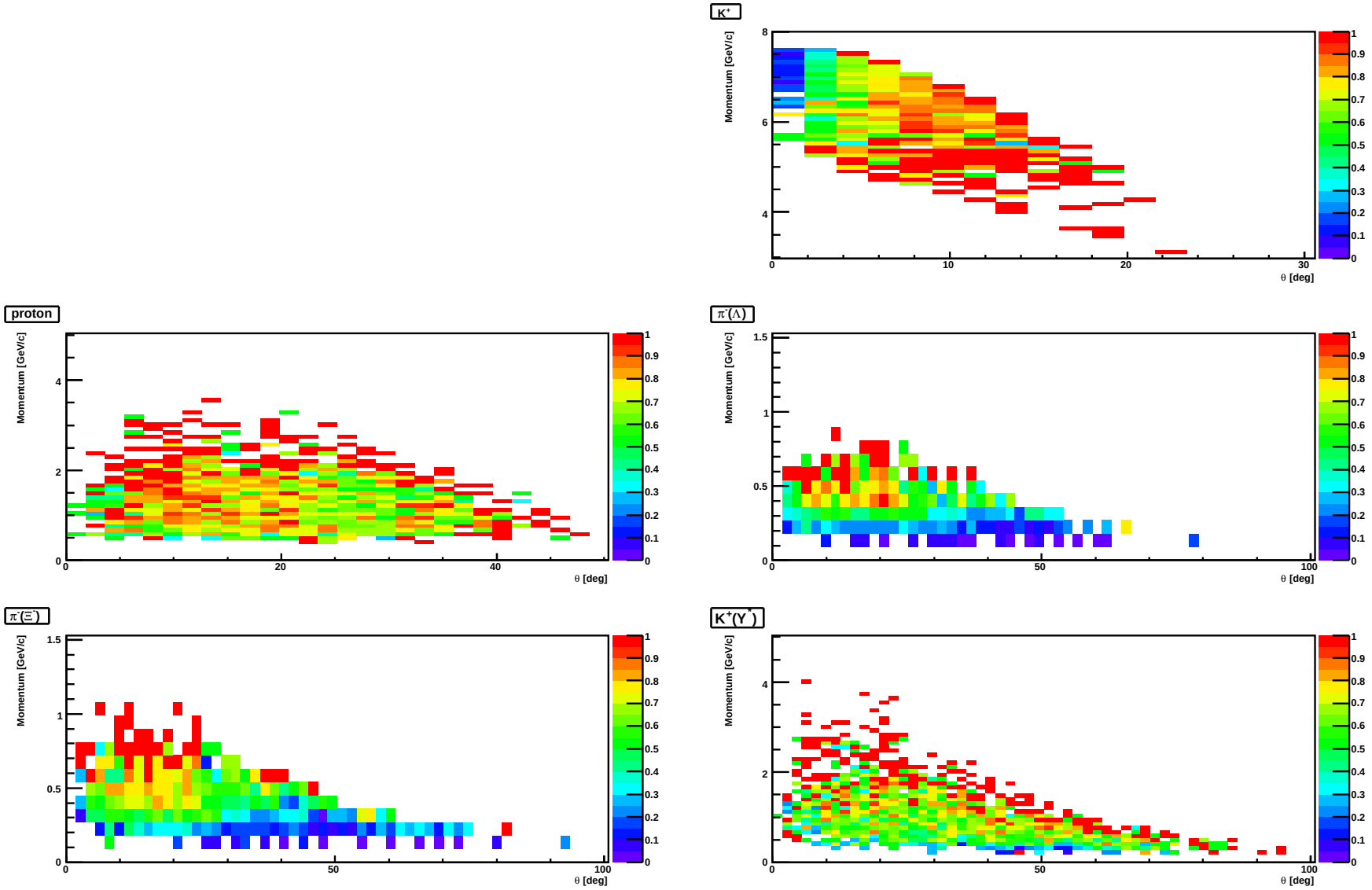
Simulations of Cascades at GlueX

- Tracking/Analysis
  - Noticeable improvements in tracking efficiency and C.L. distributions (see Simon's talk)
  - As a result, Cascade reconstruction efficiency has increased
  - Still too many low C.L. tracks for most generated particles in this simulation
  - Tracking C.L. cannot be fully trusted yet

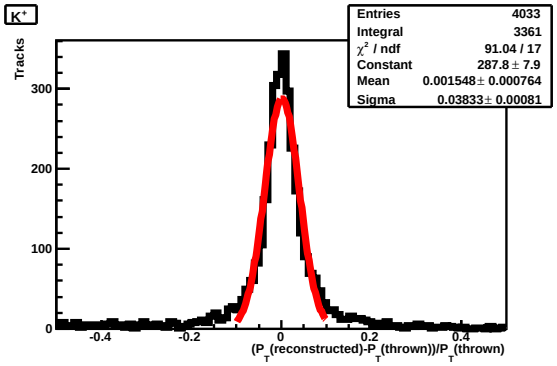
Outlook

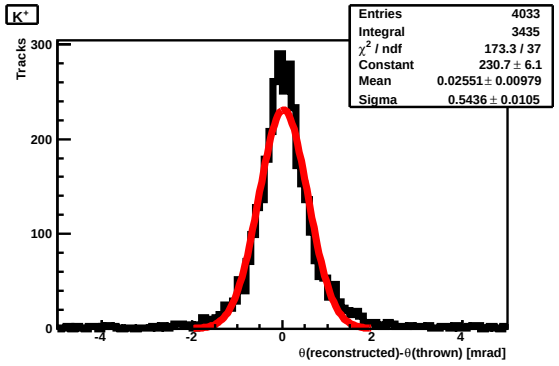
- Tracking studies
- Forward Cherenkov PID studies
- Study other cascade reactions (e.g. some with photons)

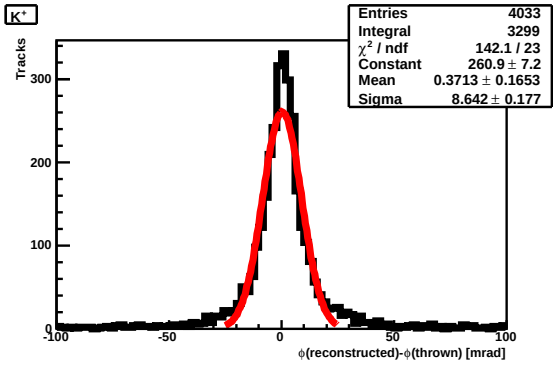
Track Recon. Efficiency Distributions w/ $\chi_r^2 < 10$

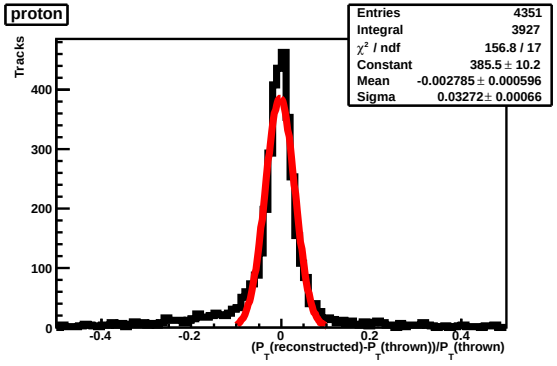


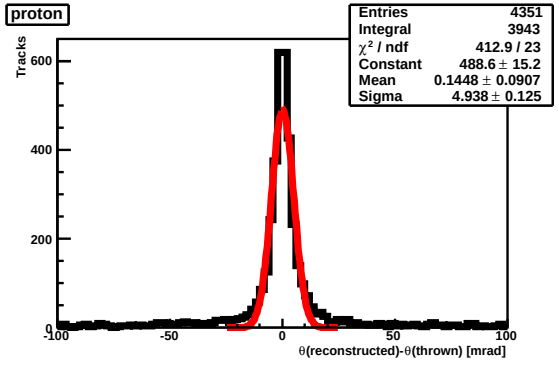
Gaussian Fits for Tracking Resolutions I

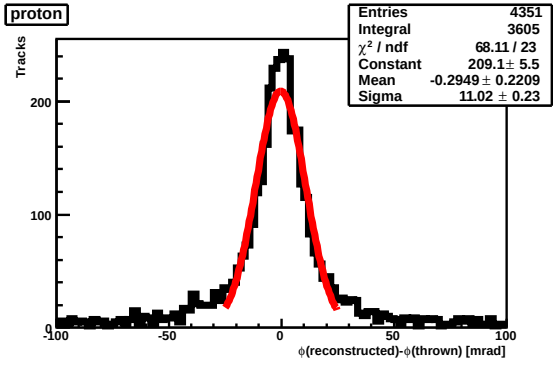


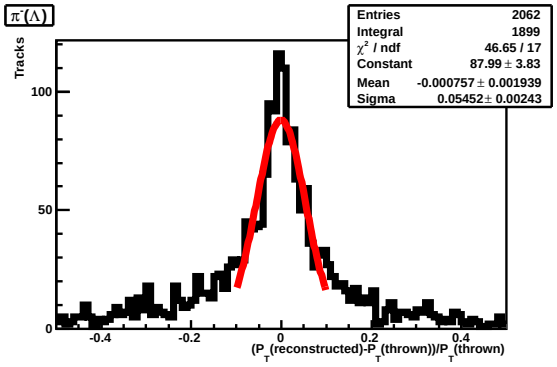


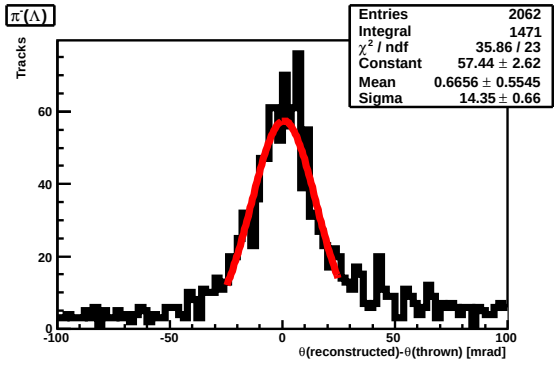


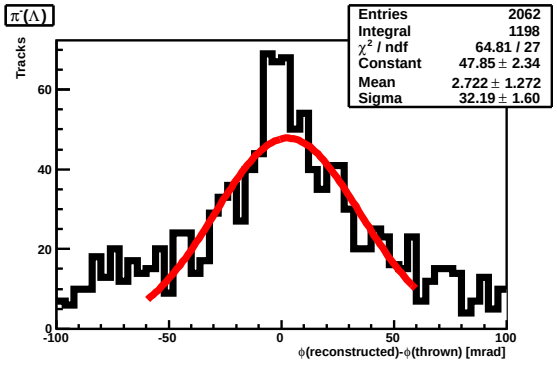




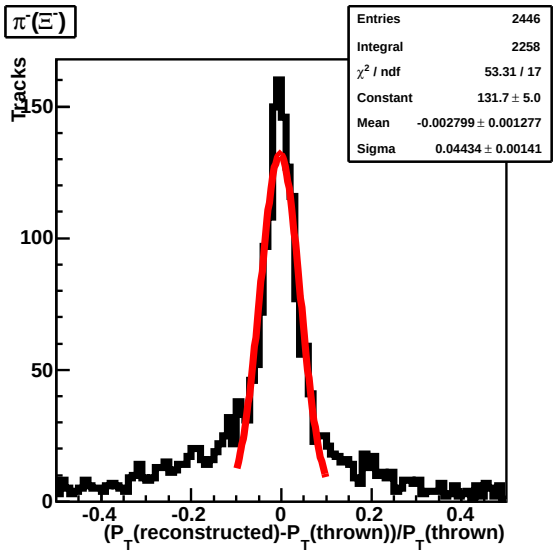


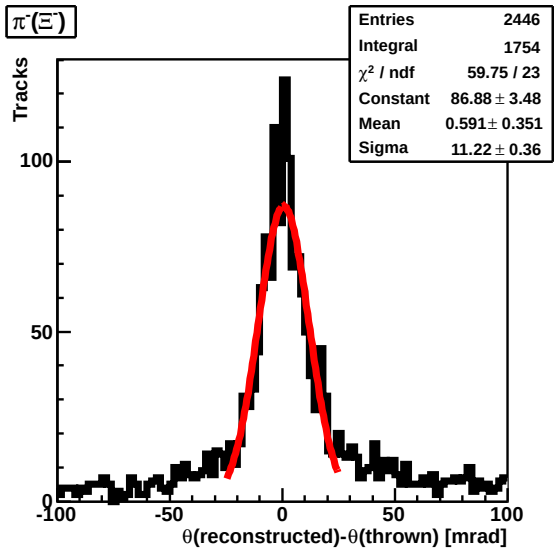


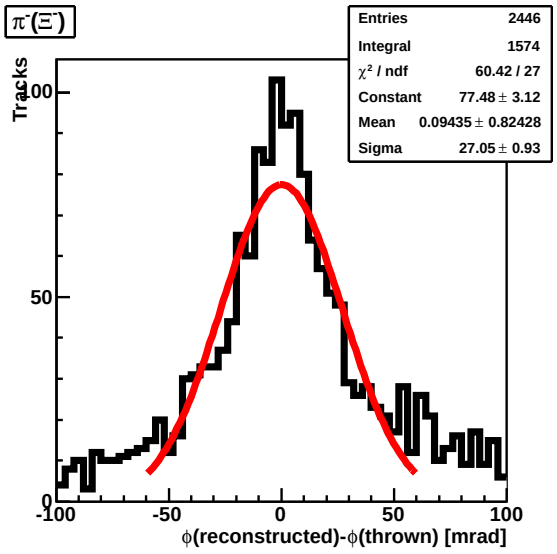


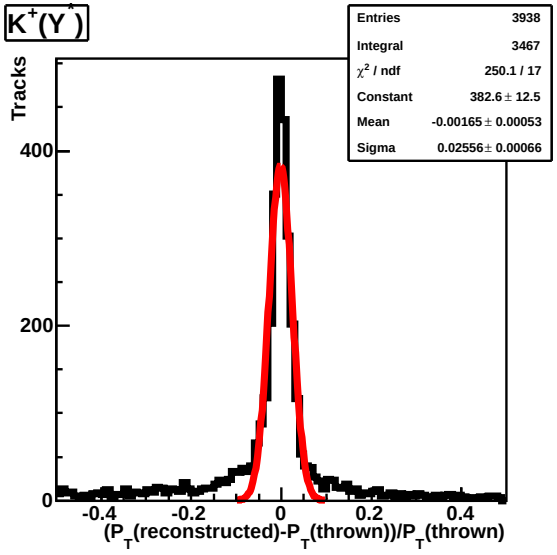


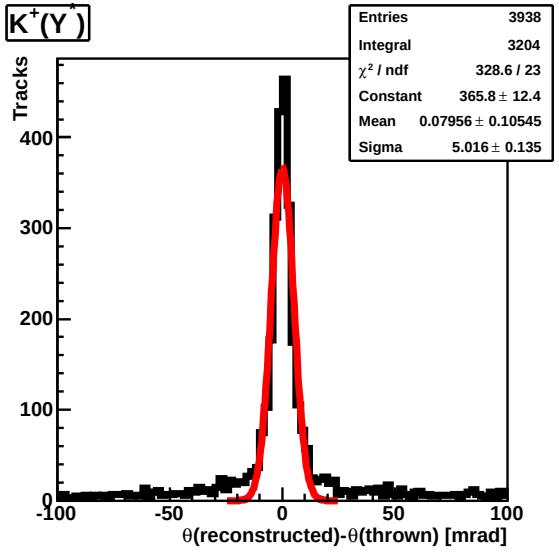
Gaussian Fits for Tracking Resolutions II

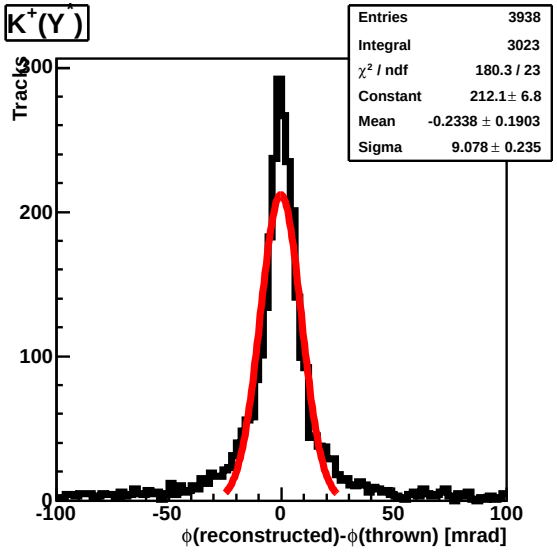




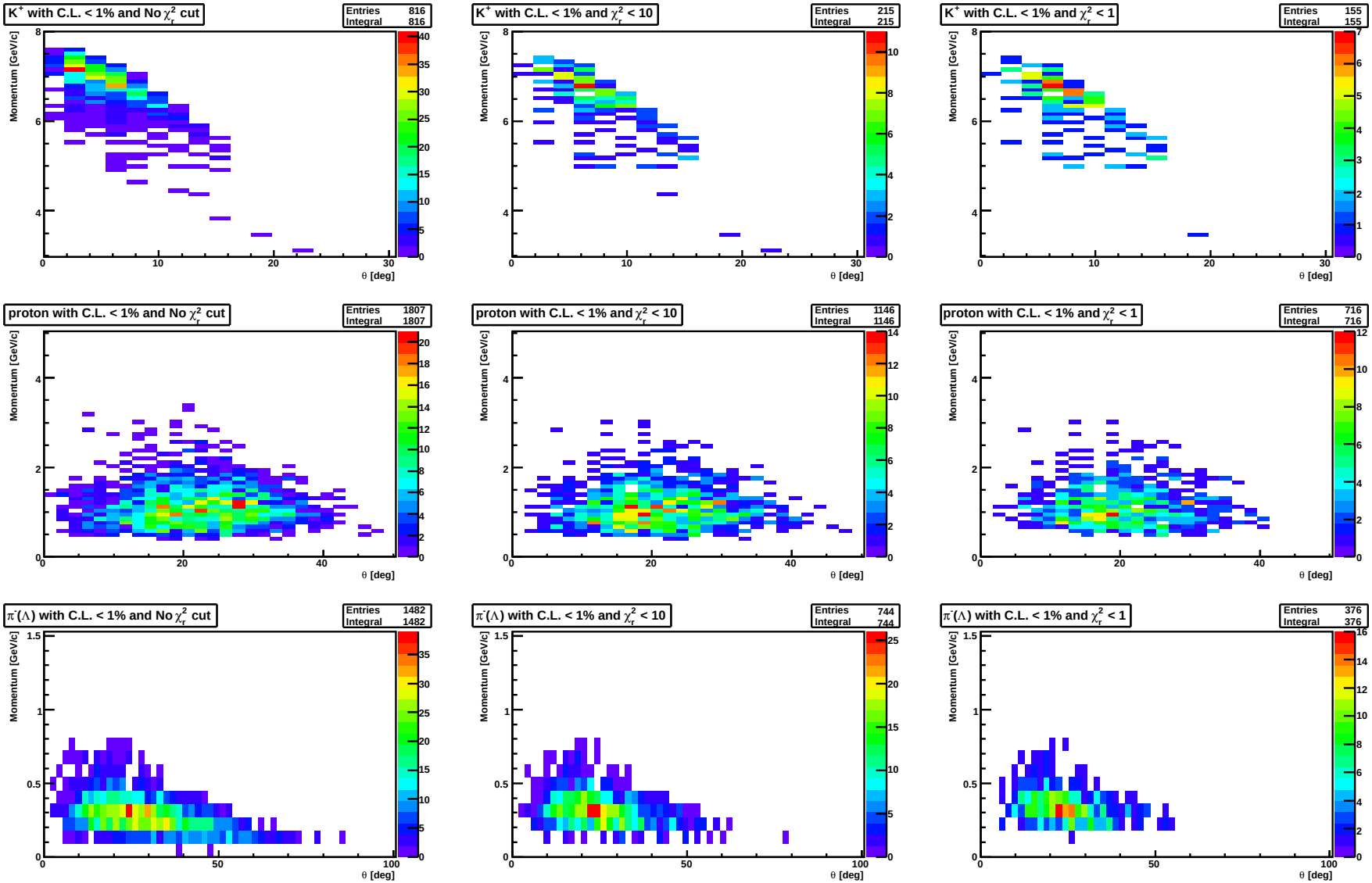








Momentum versus θ distributions of Low C.L. Tracks I



Momentum versus θ distributions of Low C.L. Tracks II