Ground State Hyperon Studies - $K^+ \Lambda$, $K^+ \Sigma^0$

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GlueX Physics Meeting
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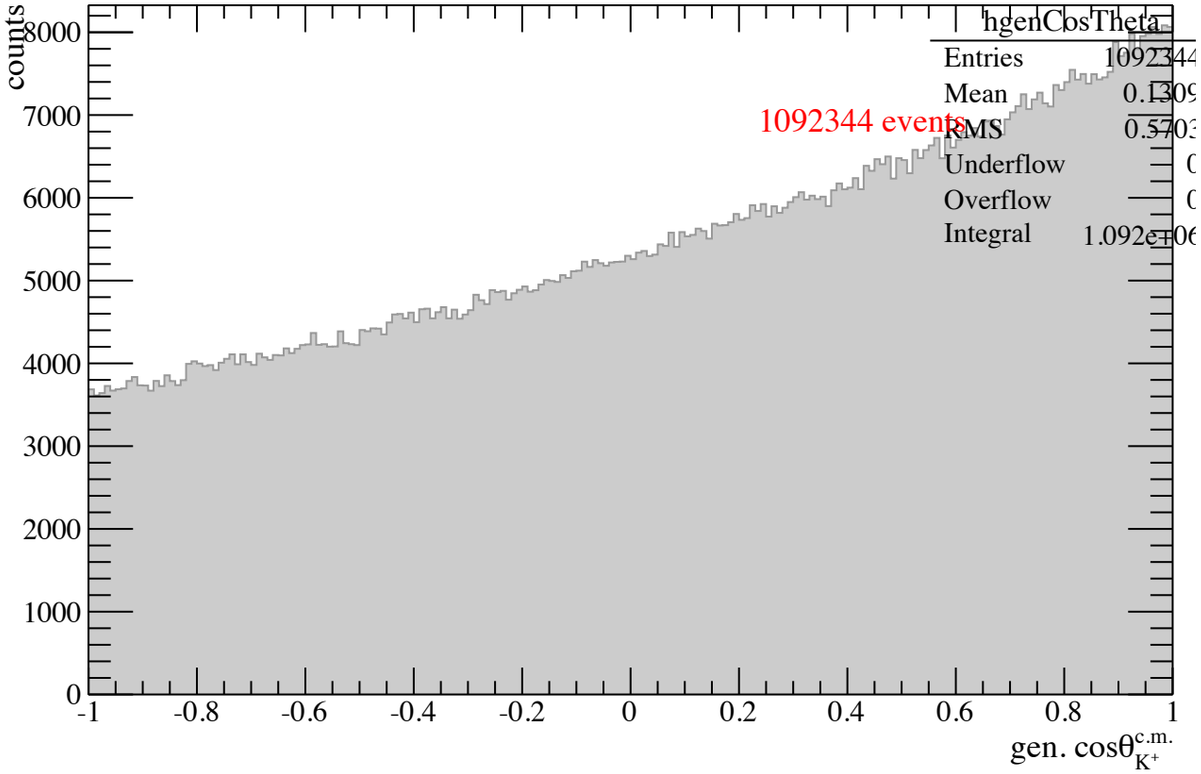
Motivation

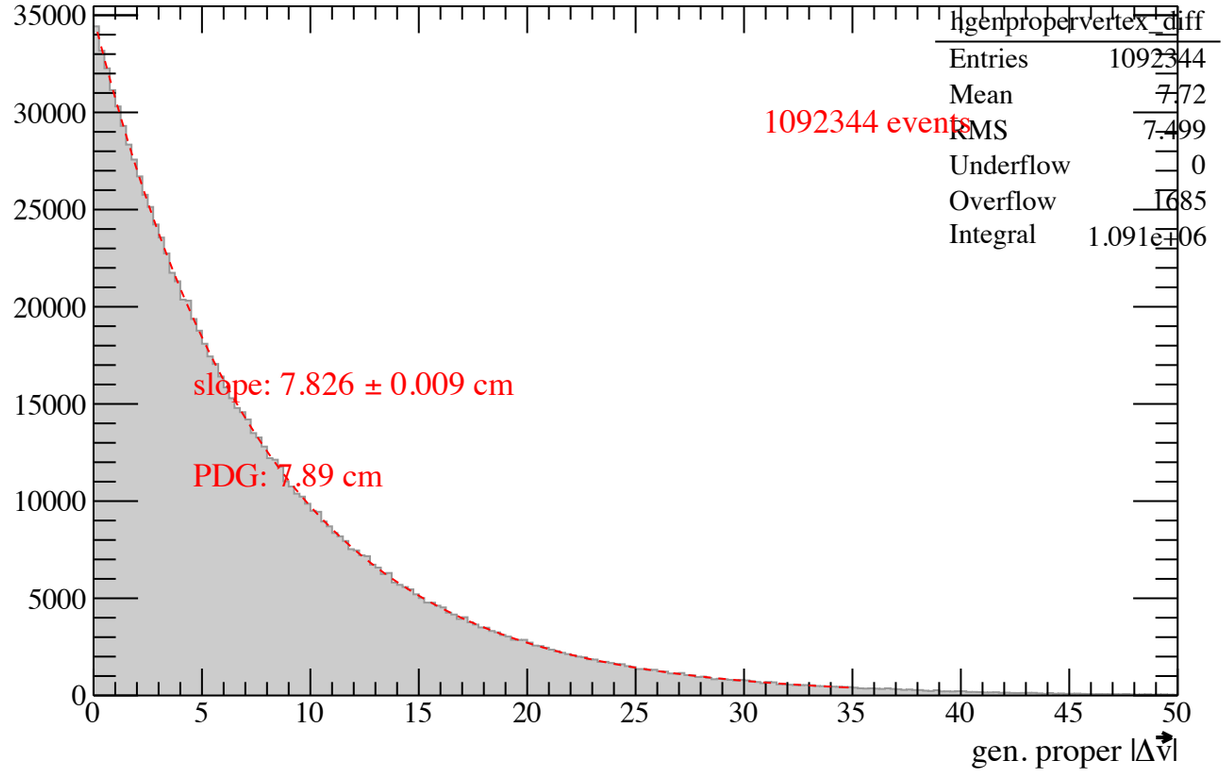
- One of the simplest event topologies (3 charged tracks (+ 1 γ)), so a good initial channel at startup
- Detector-wise, it would be a good channel to test how well we reconstruct the Λ decay vertex
- K^+ Λ events have been studied at lower energies by CLAS and other collaborations, we should at least be able to compare to extrapolations
- Theory interests?
- We can measure differential cross sections, Λ polarization variables

Generate Events

- Use genr8 to generate events flat in phase space (no decay of Λ specified - use $p\pi^-$ decays only)
- Use t-slope of 0.05, populate detector
- Study GlueX detector's ability to reconstruct events
- E_γ = 9 GeV, primary vertex (0,0,65)



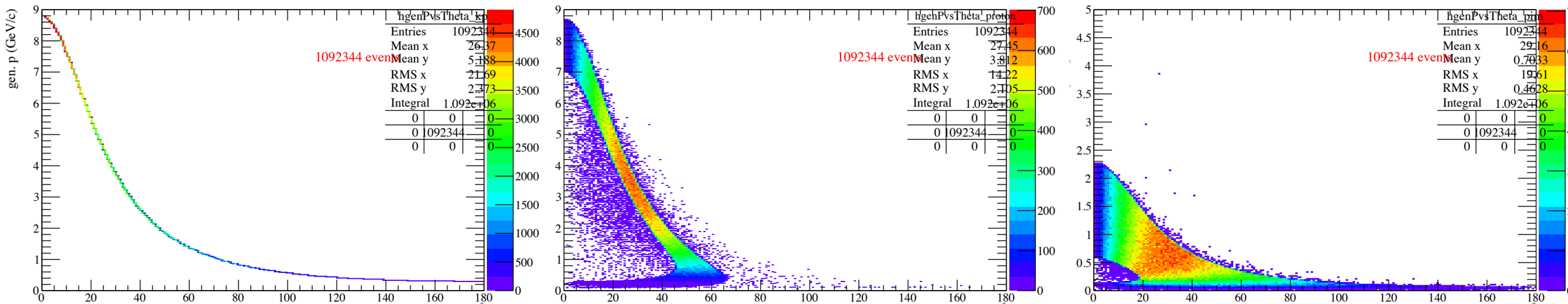
generated $\cos\theta_K^{c.m.}$



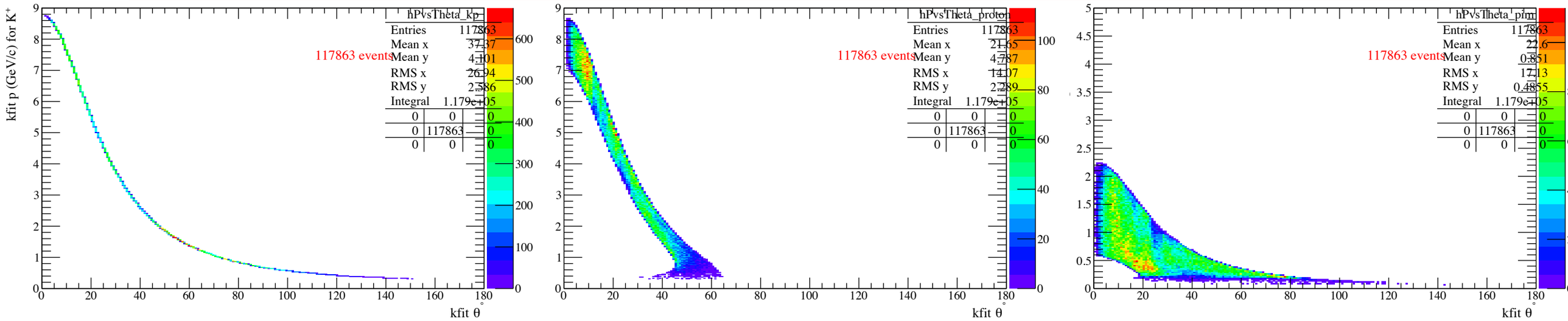
generated Λ proper decay length

Generated vs Reconstructed
p vs θ

thrown

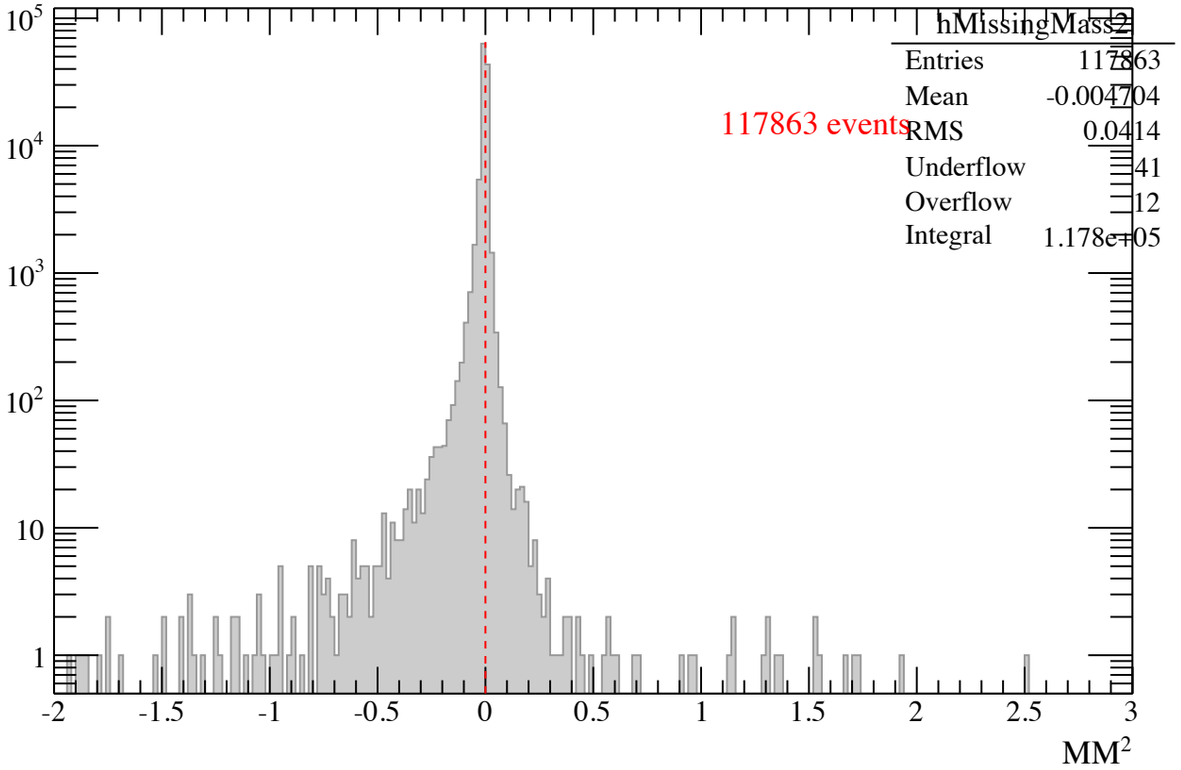


K⁺ p π⁻

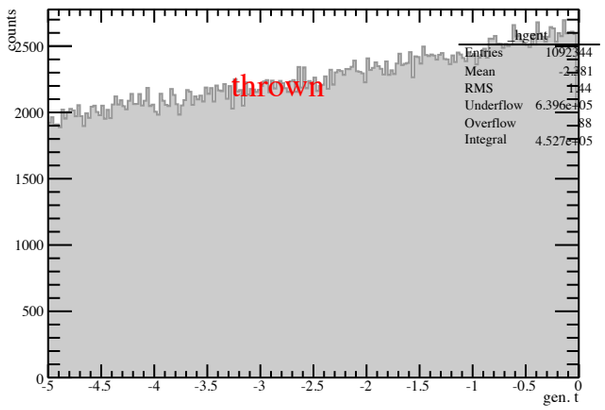


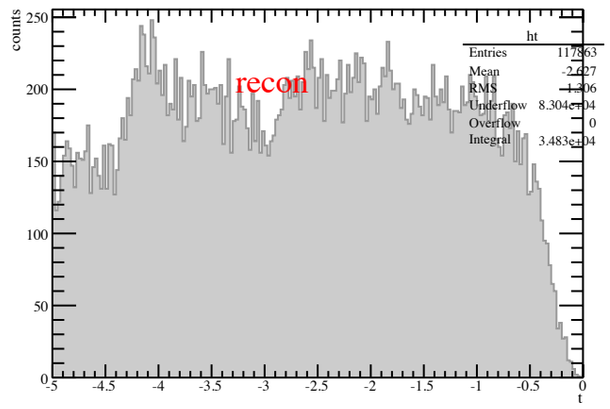
reconstructed

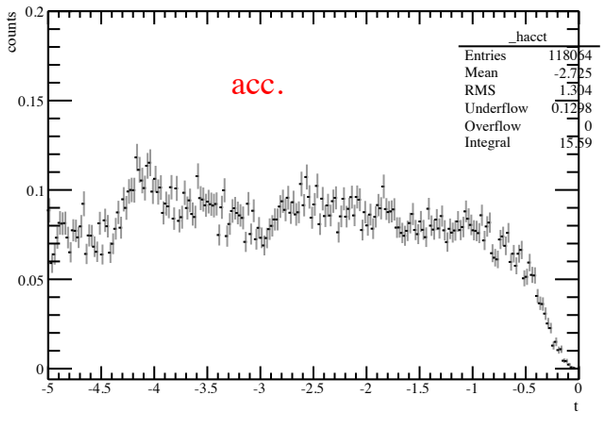
Reconstructed $K^+ \Lambda$



pre-kinfit MM^2

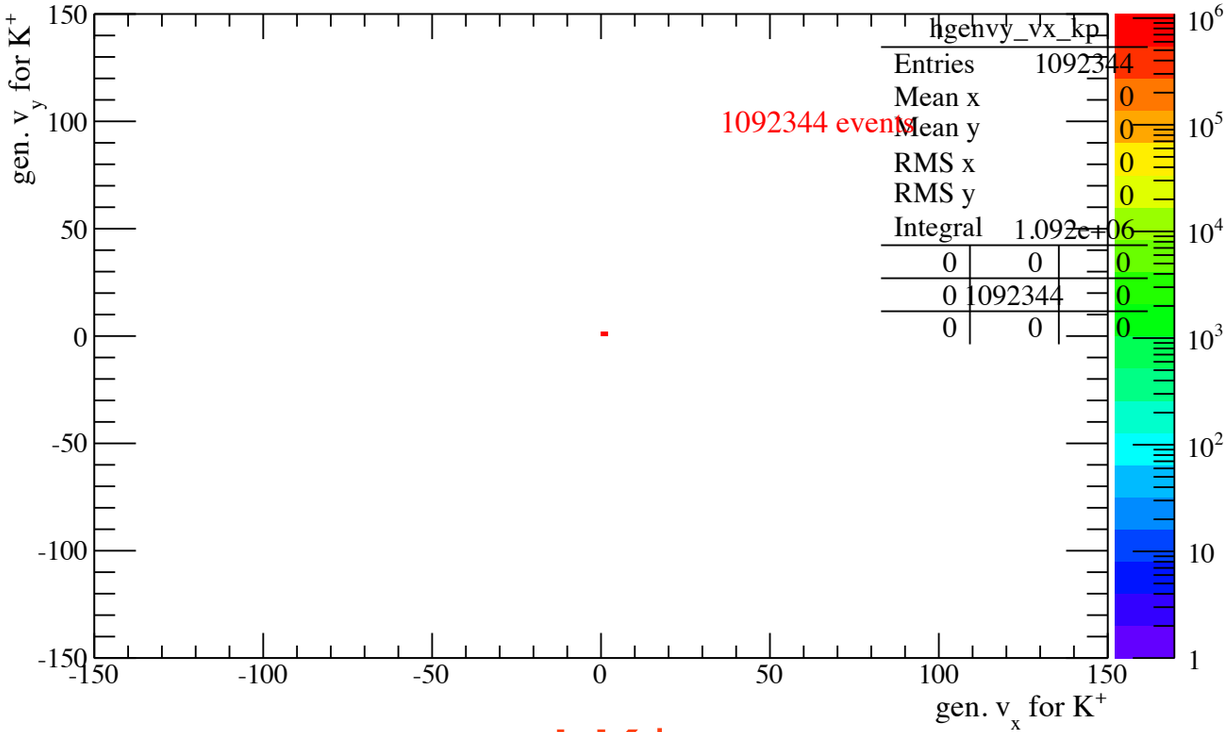




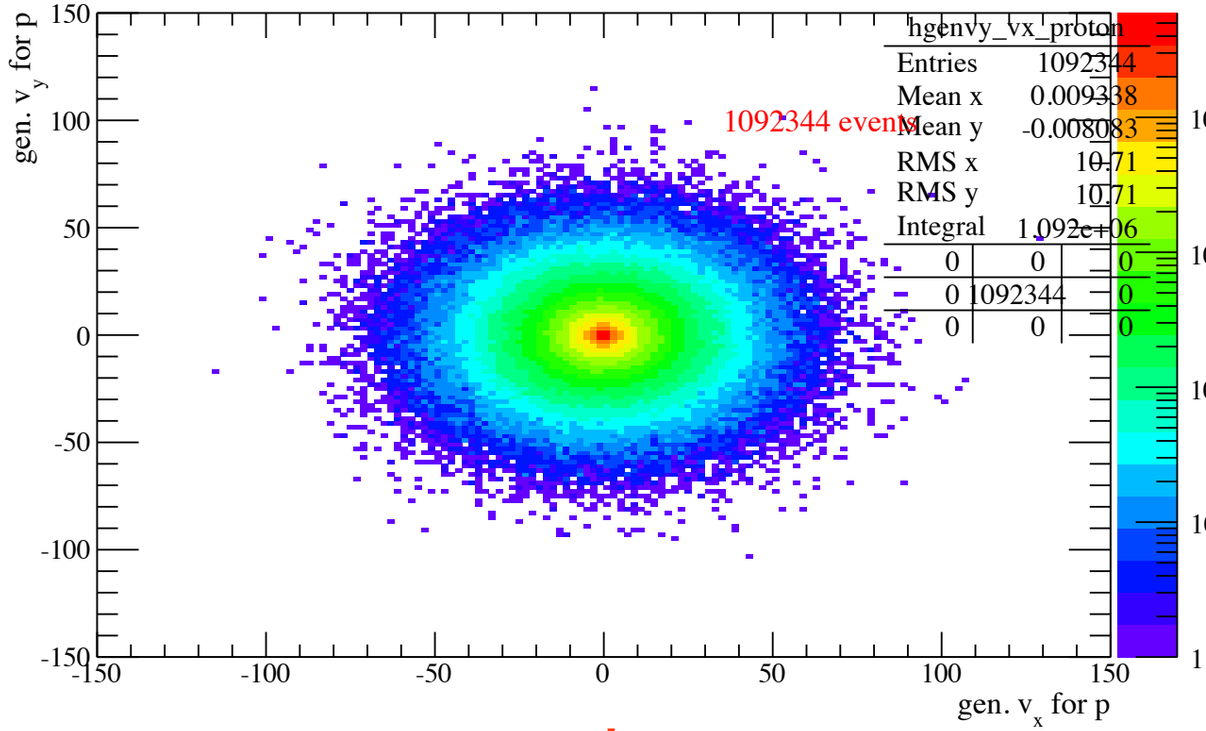


acceptance against $\cos\theta_K^{c.m.}$

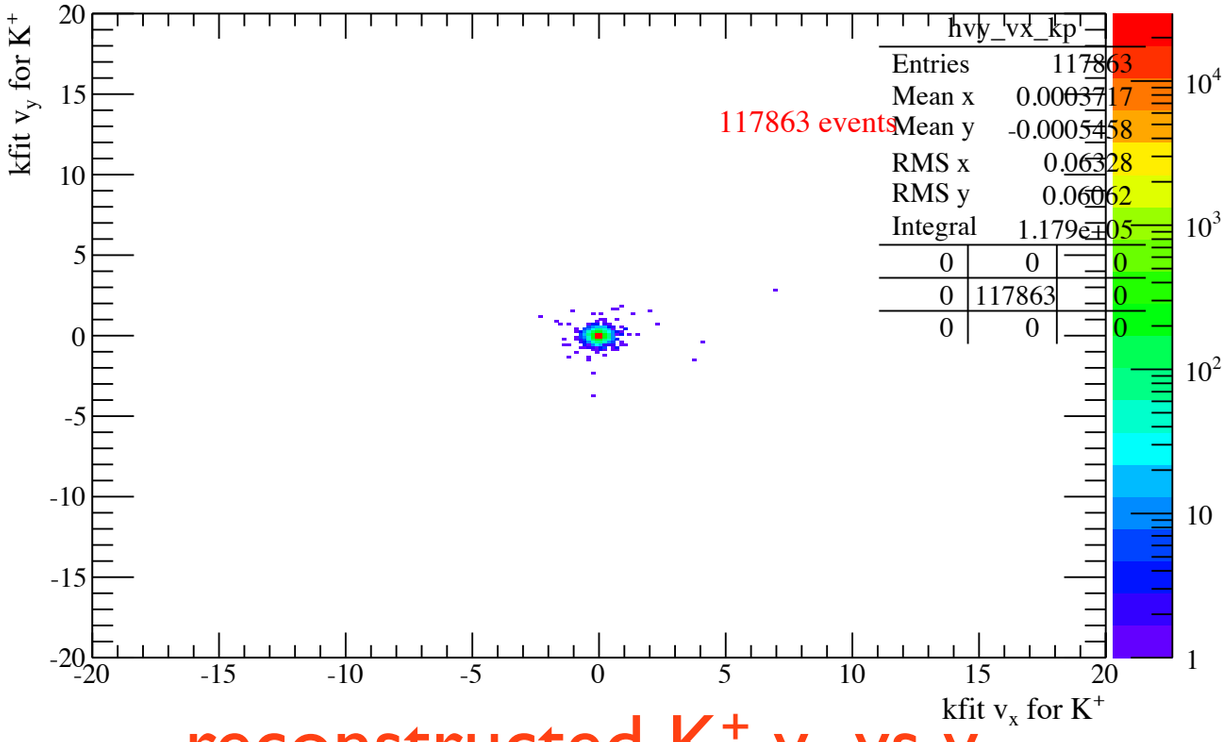
Vertex Information



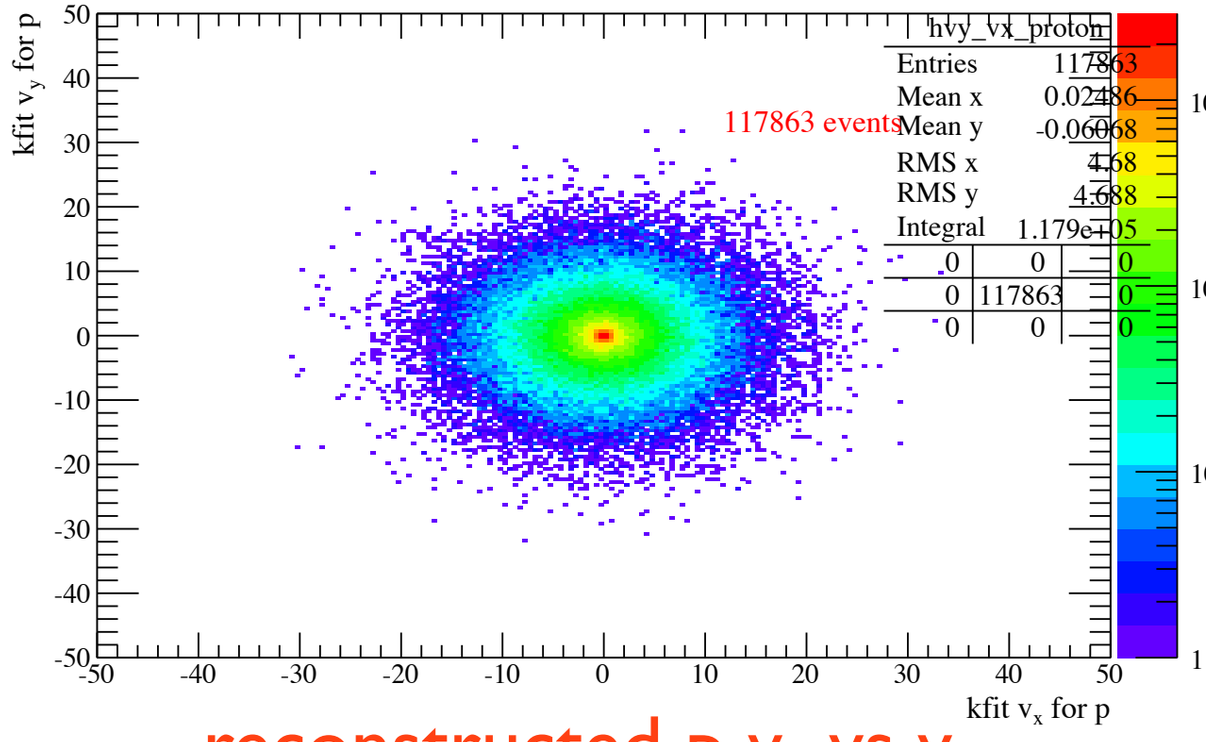
generated K^+ v_y vs v_x



generated p v_y vs v_x

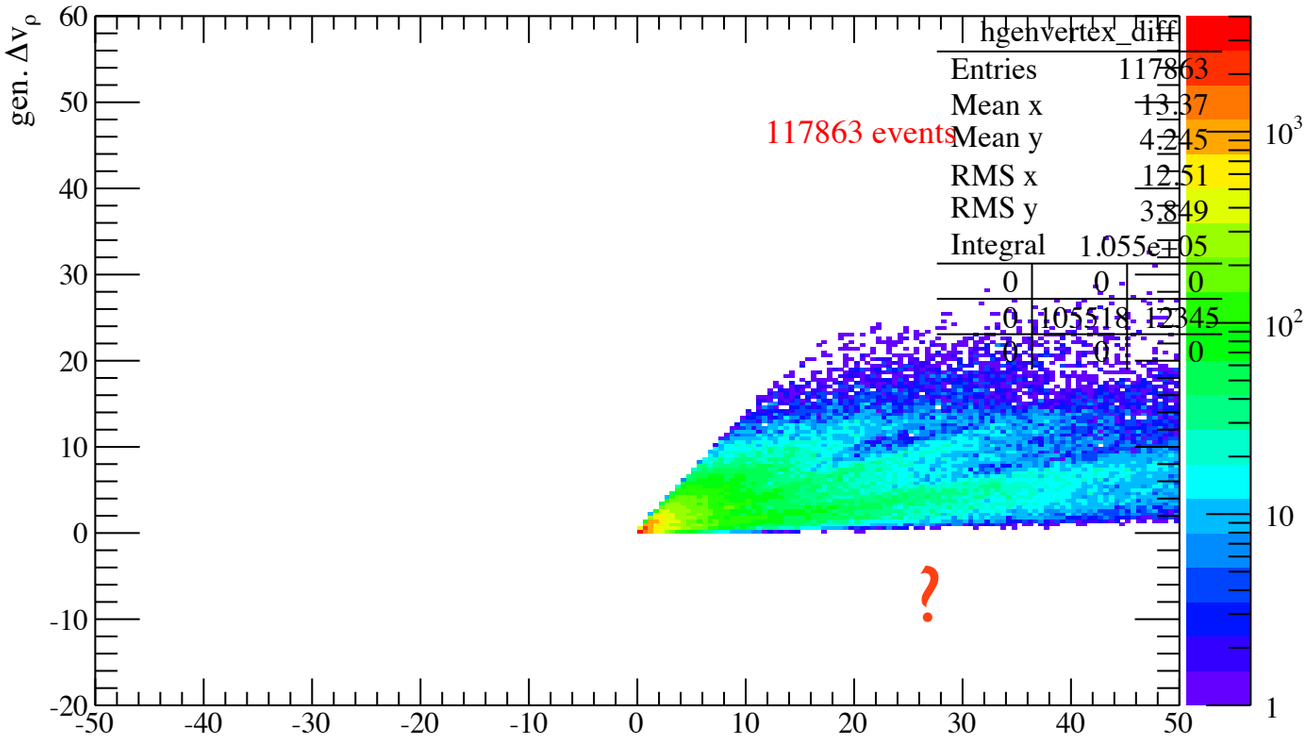


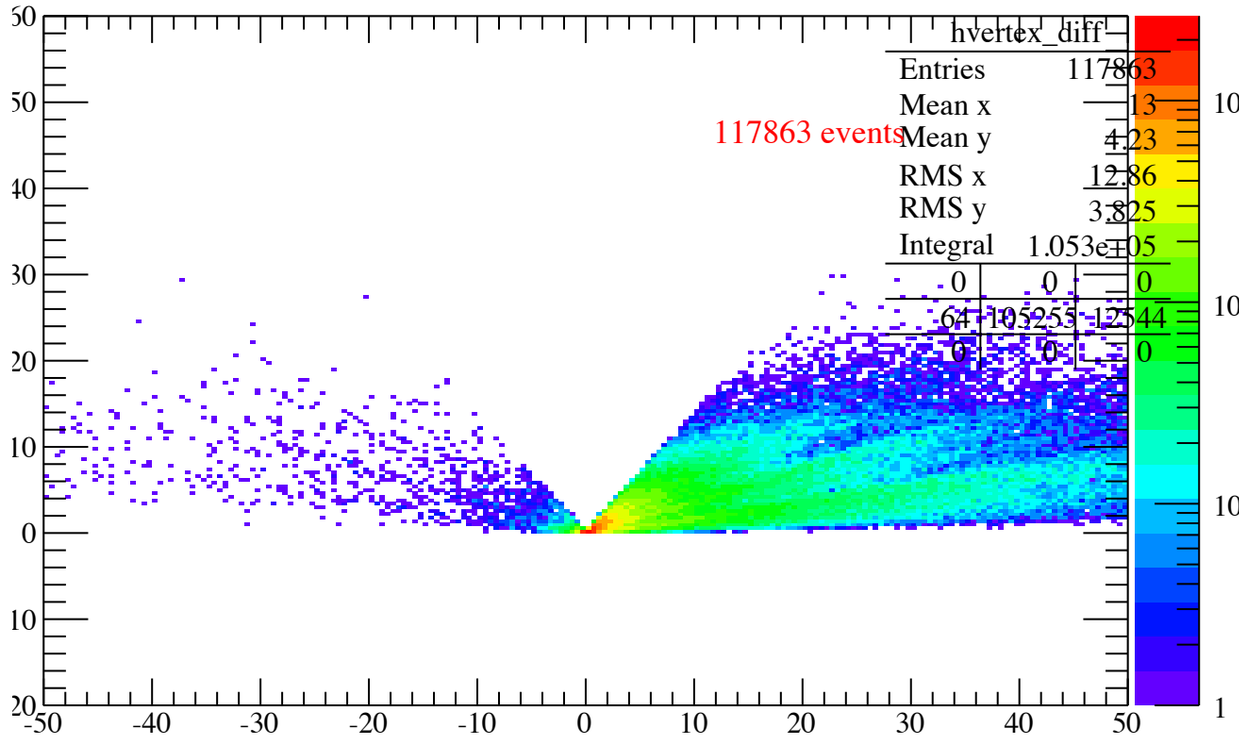
reconstructed K^+ v_y vs v_x



reconstructed p v_y vs v_x

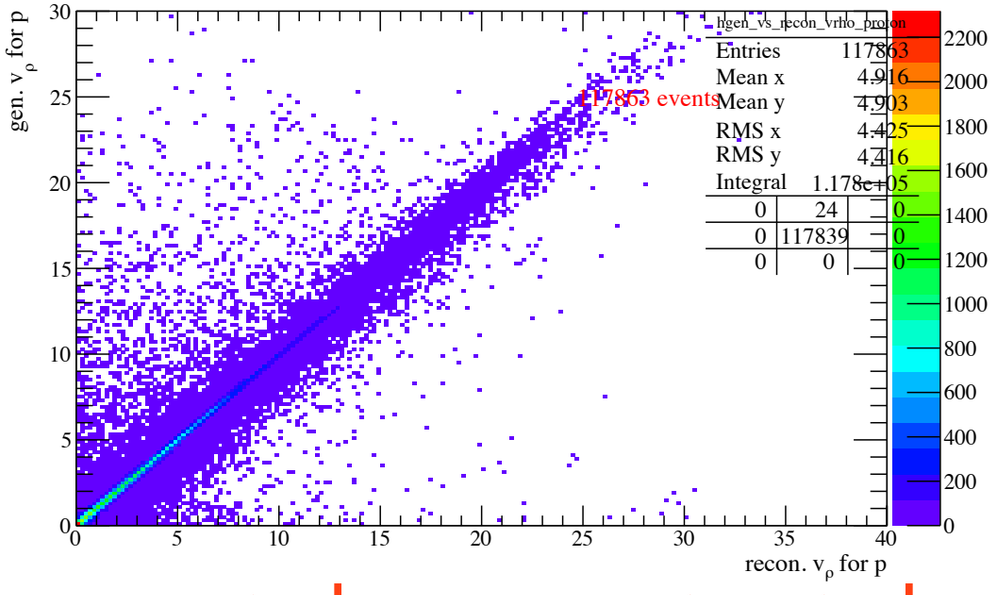
Vertex Resolution

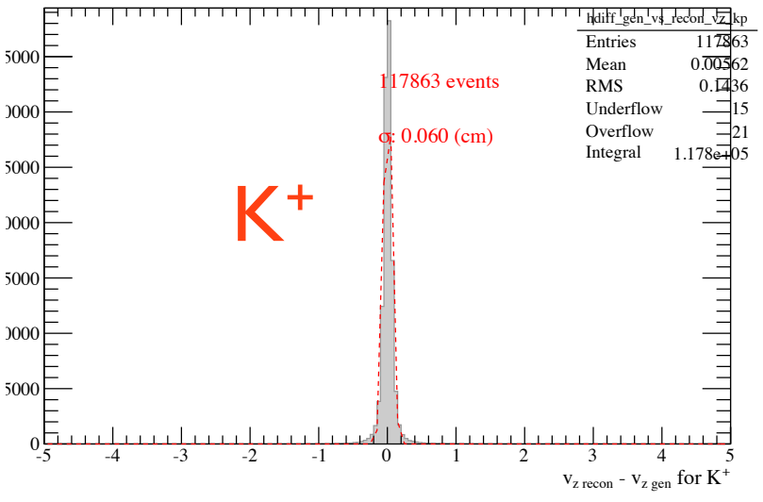


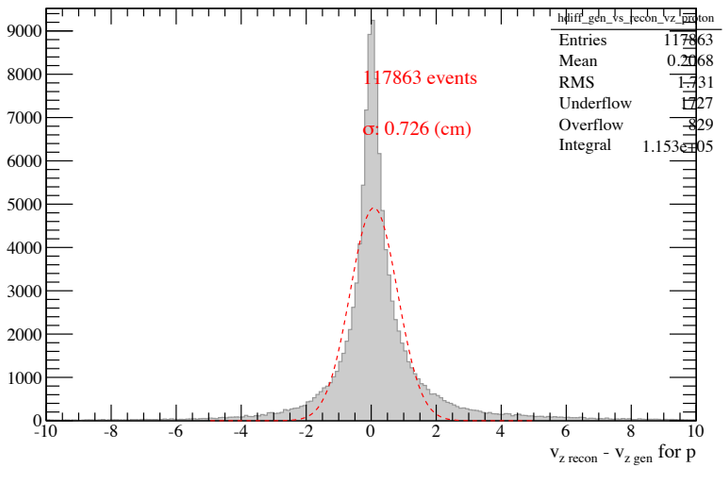


generated K^+, p vertex difference

reconstructed K^+, p vertex difference



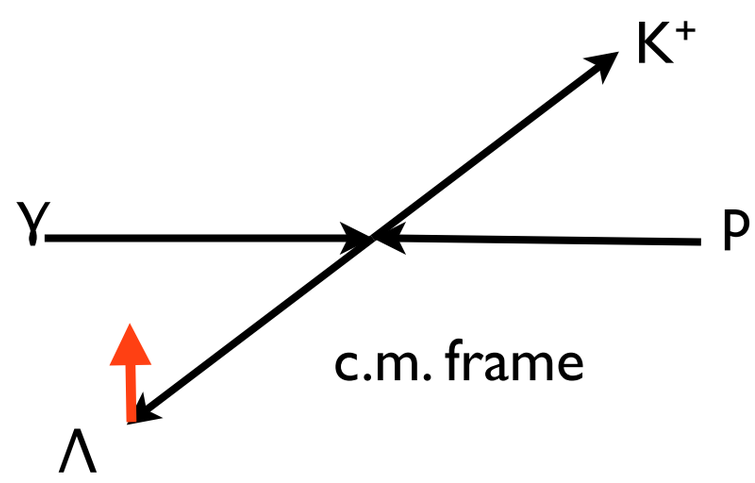




generated vs reconstructed p v_ρ

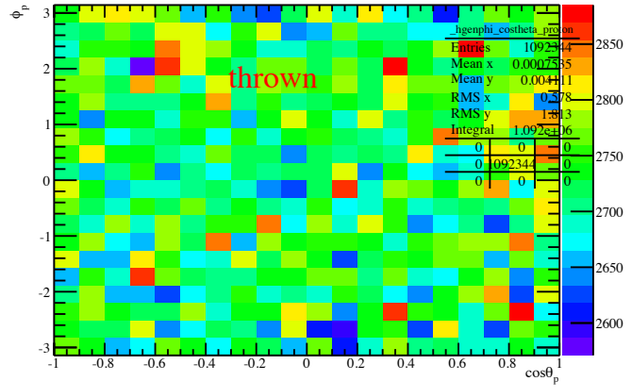
v_z resolution is < 1cm (too good?)

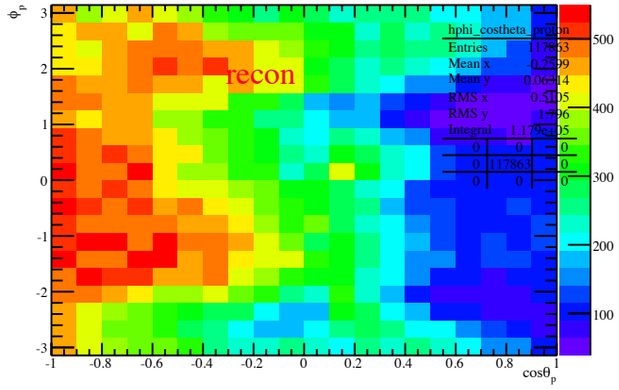
Polarization

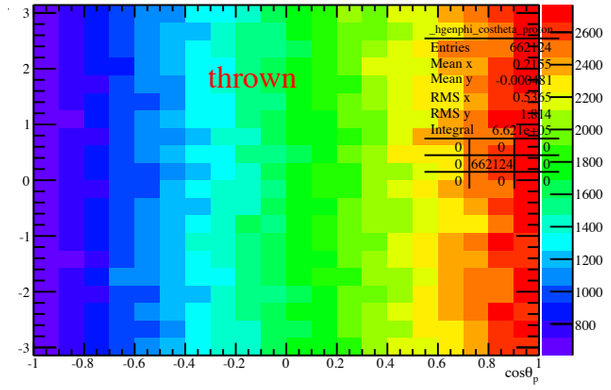


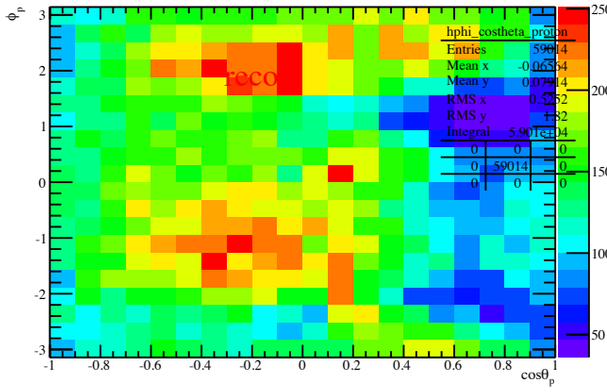
- Use hddm_select_events to select events after hdgeant -- select $\Lambda \rightarrow p\ \pi^-$ events, also set Λ decay distribution to be
  $I(\theta_p) = 1 + \alpha \cos\theta_p$

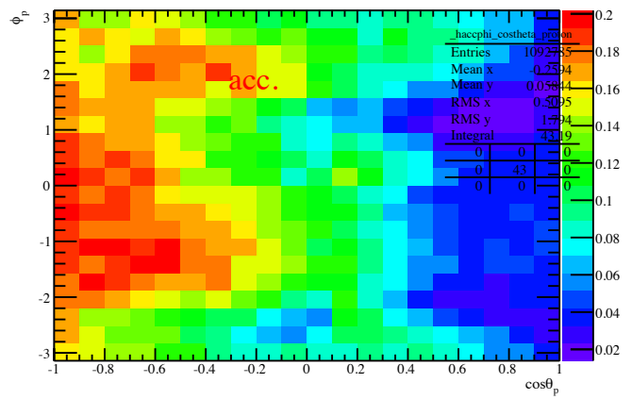
- This corresponds to a Λ that is completely polarized in the out of production plane

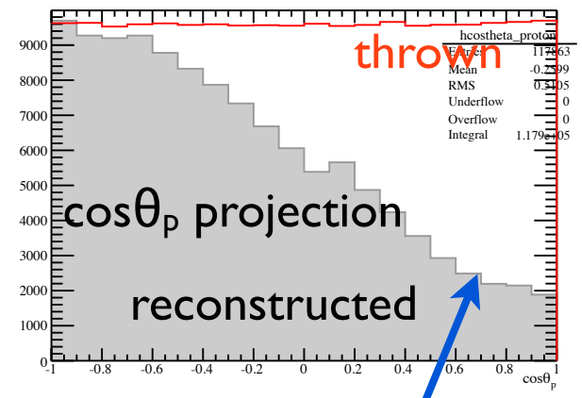


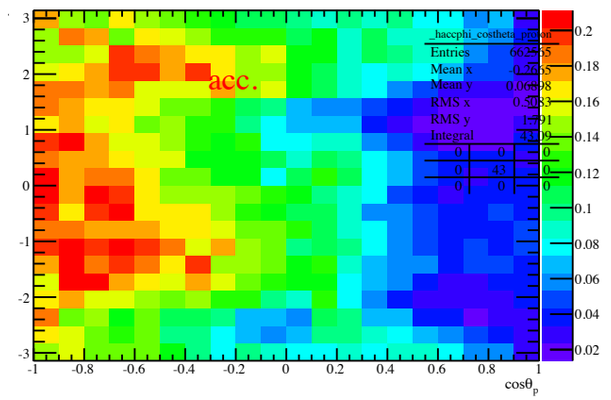


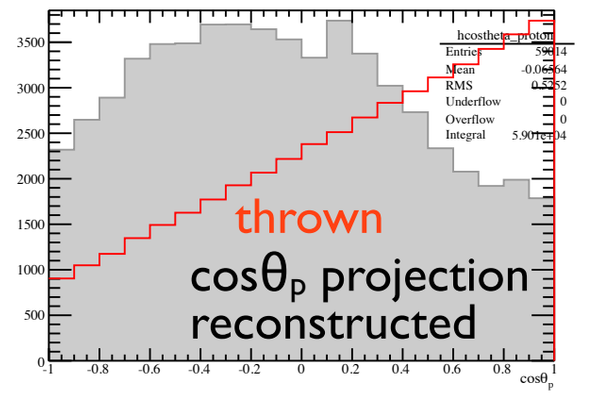












no selection

GlueX detector effeciency

"polarized"

Run on bggen Events

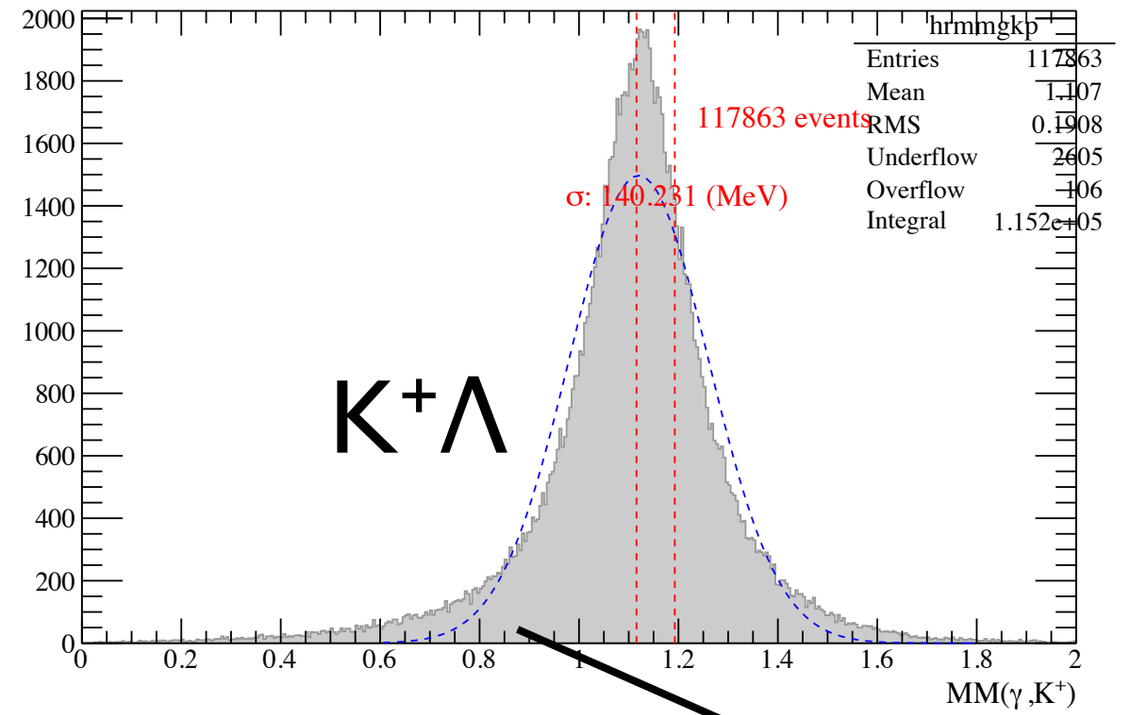
- Ran over 2.1 M bggen events (small sample)
- After imposing kfit CL > 0.01, only two events survive
  - $K^+ \Lambda$ event
  - $p K^+ K^- \pi^+ \pi^-$ event
- Note that bggen probably underestimates $K^+ \Lambda$ cross section, also tends to create hyperons in pairs, and not through t-channel exchange

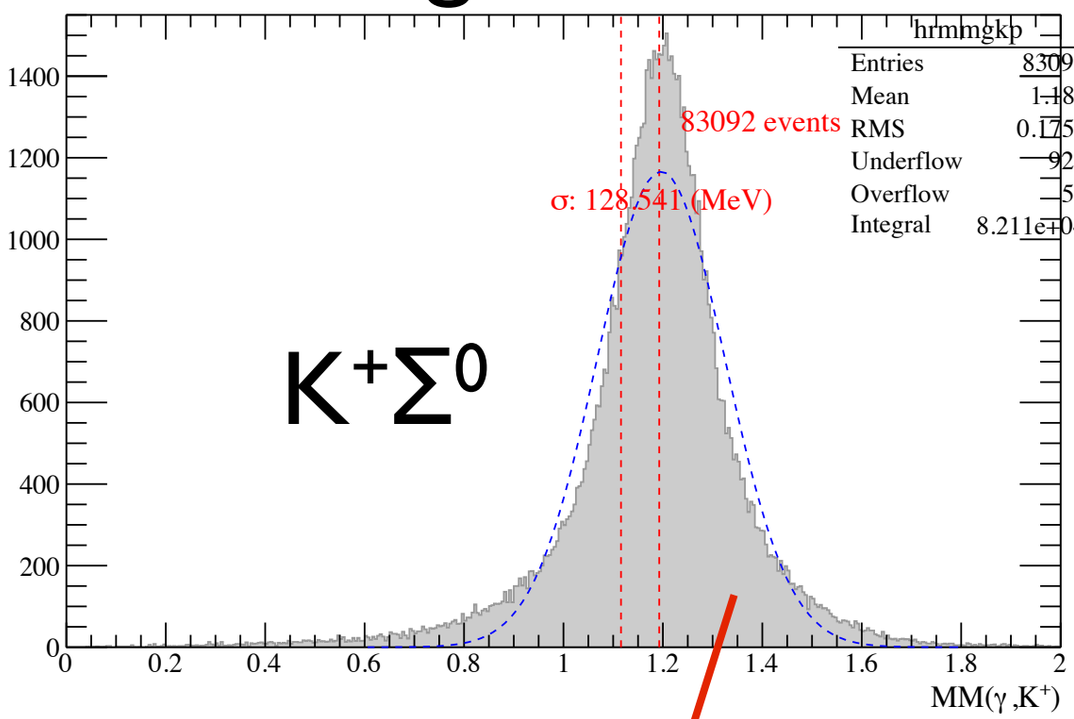
$K^+ \Sigma^0$ Events

- Generated similarly to $K^+ \Lambda$ events
- $\Sigma^0 \rightarrow \gamma \Lambda$ (100%), γ is 77 MeV in Σ^0 rest frame
- Depending on resolution of Λ/Σ^0 and EM bg, the two channels become difficult to distinguish
- Check for cross-feed into each channel

Distinction of $K^+\Lambda$ and $K^+\Sigma^0$

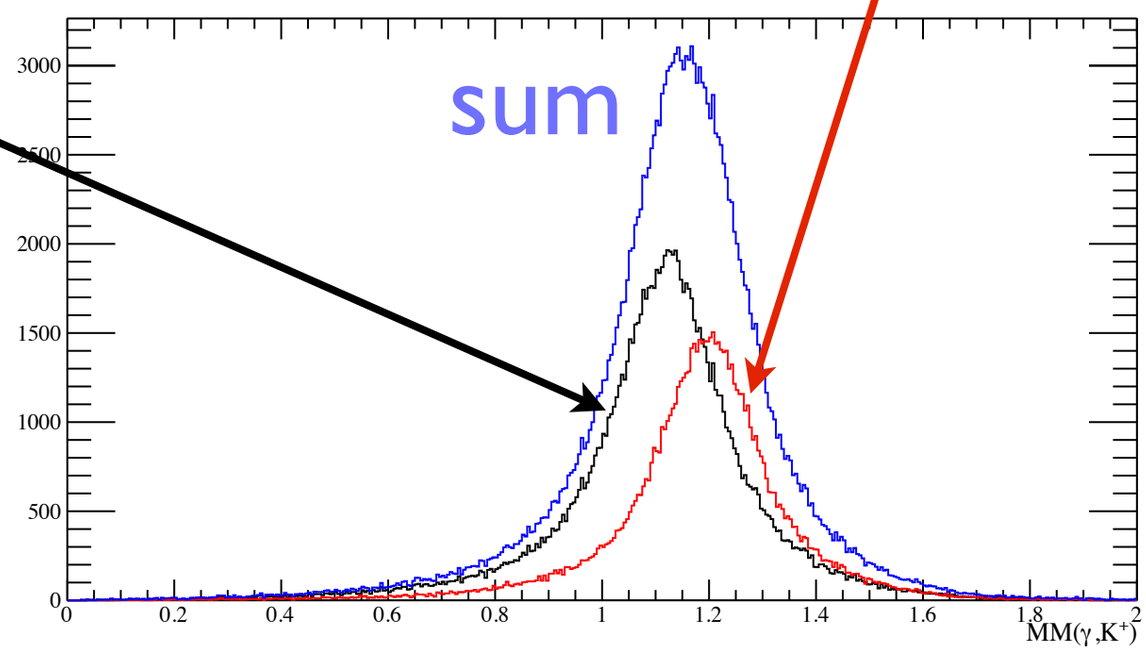
- Only 77 MeV difference in mass
- Σ^0 has one additional low-energy photon
- "Easiest" distinction is missing mass from K^+



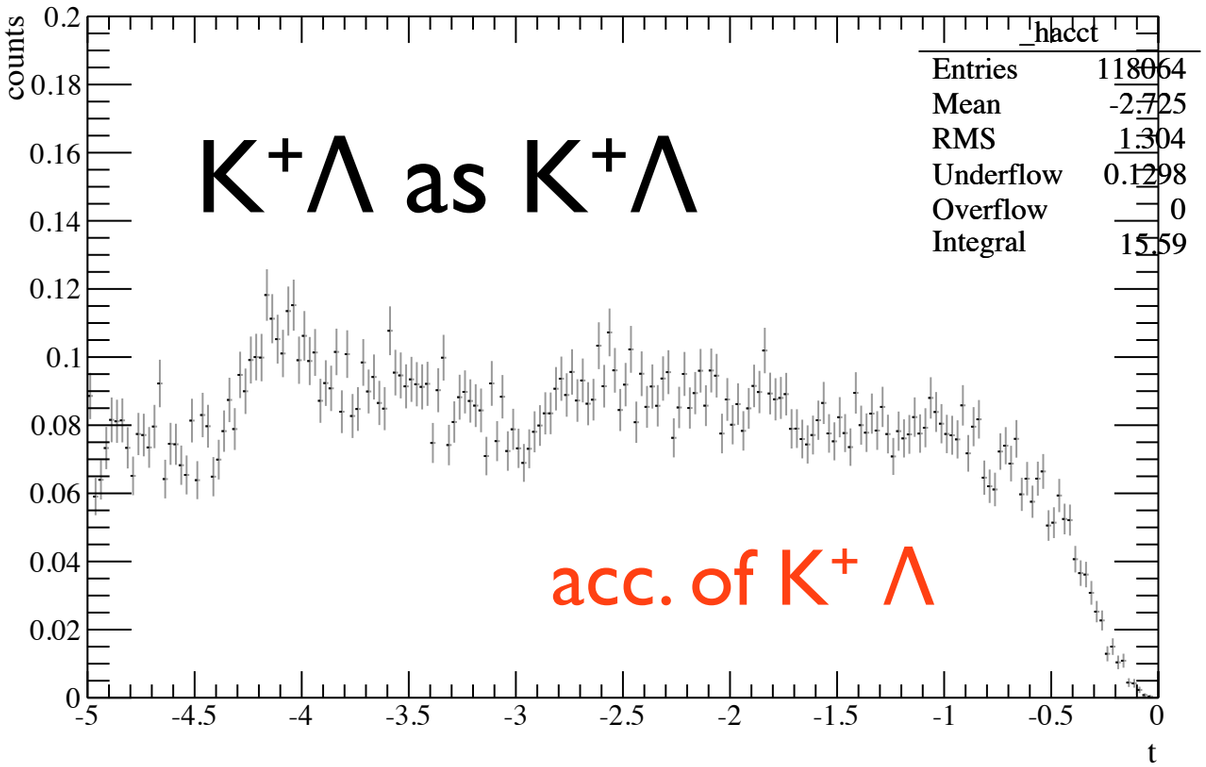


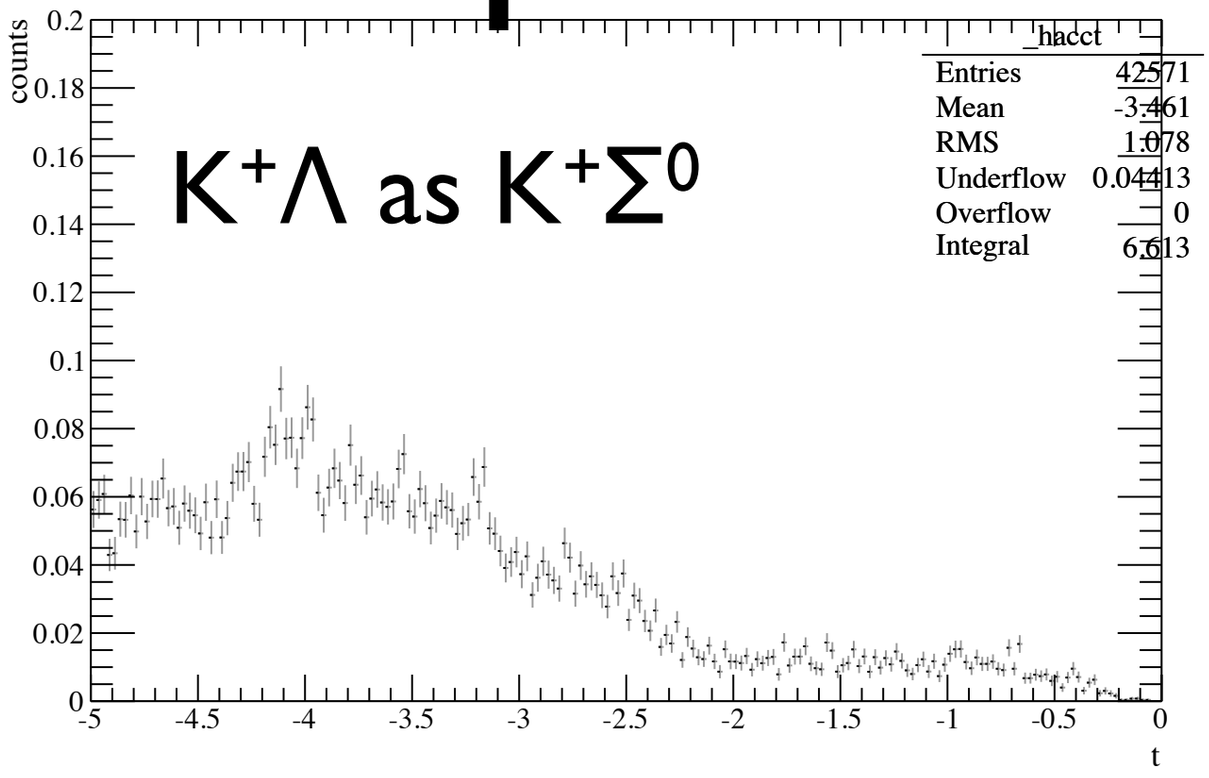
kfit CL > 0.01,
using non-kfit 4-mom.

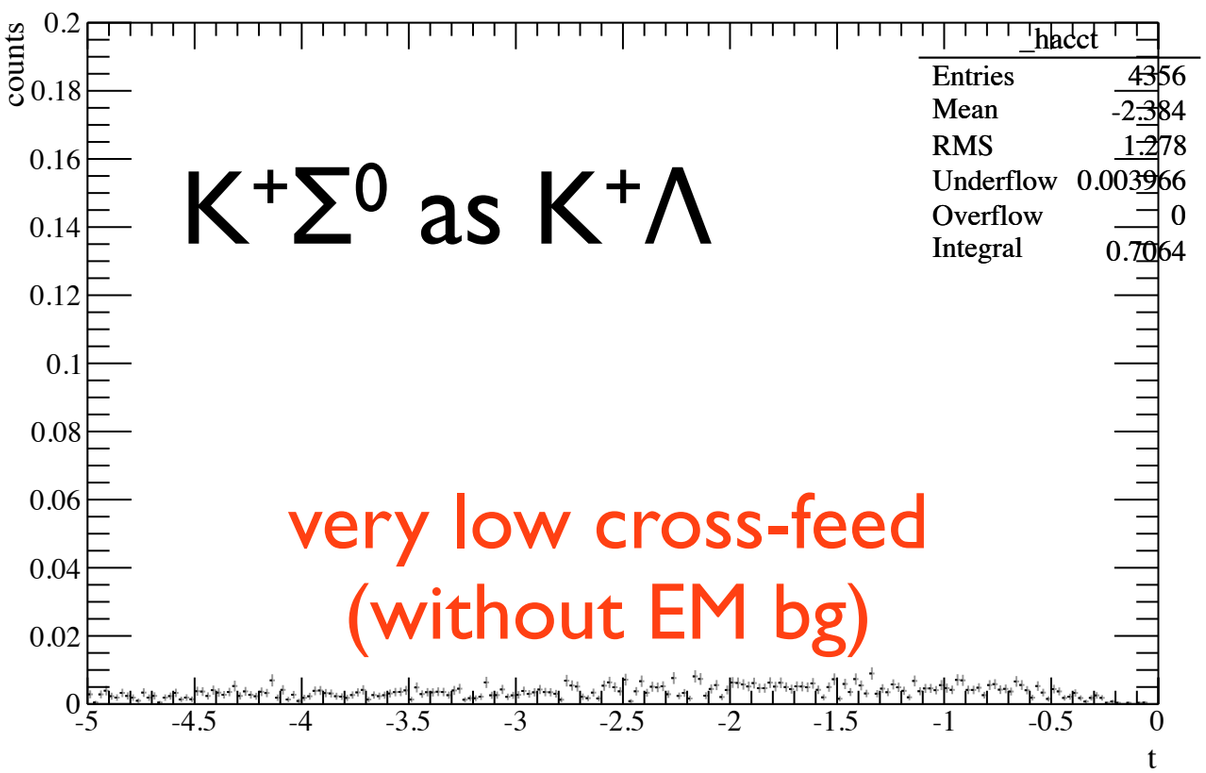
almost indistinguishable...

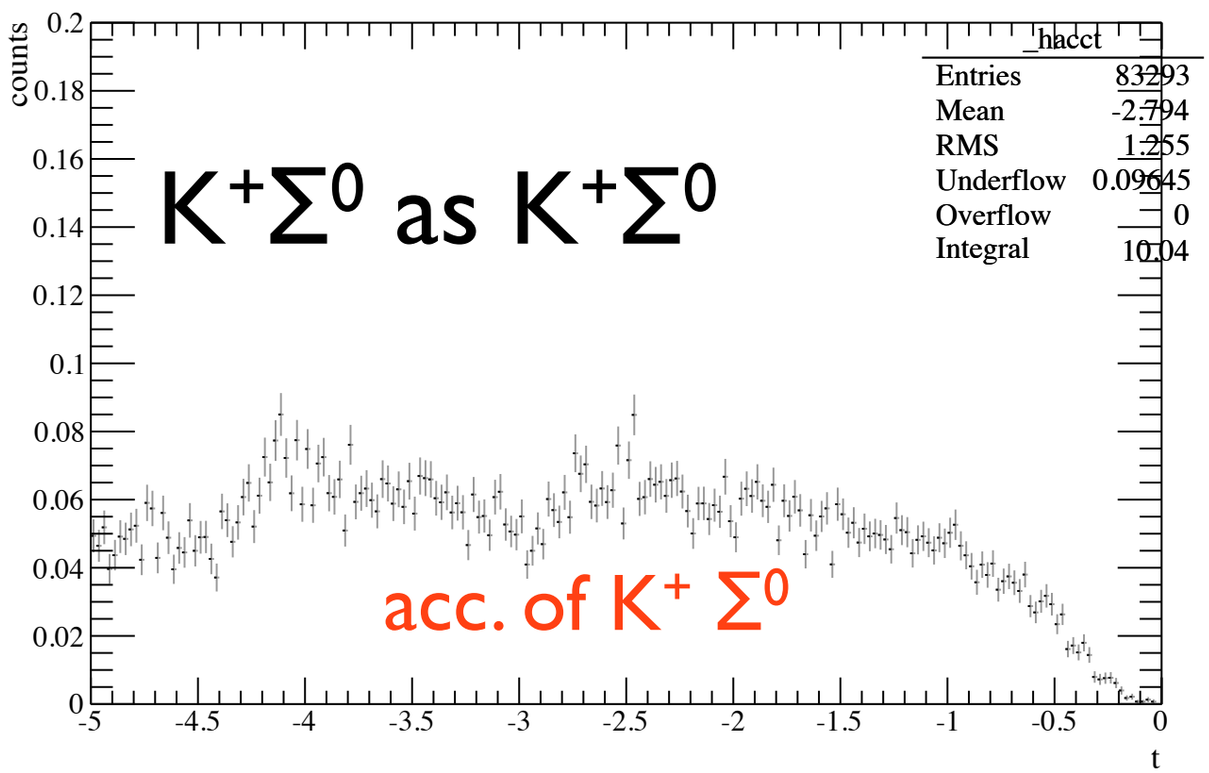


Cross-feeds in acceptance









assuming both channels are produced with similar strength,
it may be difficult to separate cross-feeds

Future Work

- K^+ Λ/Σ^0 studies are fairly simple, may be a good channel at initial startup to study detector characteristics, MC
- Need more physics motivation and potential connection to theory - What can we learn? Do we gain anything from the physics observables?
- Look at events in different production angles
- If EM background is added, will $K^+\Sigma^0$ channel still work? How would this affect cross-feed?
- Would BDT be able to separate the two channels?
- Measurement of Λ polarization will help in all analysis channels involving Λ's
- Work on other physics channels that will help in the initial startup phase of verifying that the GlueX detector works