SIMULATION $\Sigma(1670)^+ \rightarrow \Lambda\pi^+$

KLF collaboration meeting - Spring 2020

02/12/2020 | Kevin Luckas | Institut für Kernphysik

Motivation

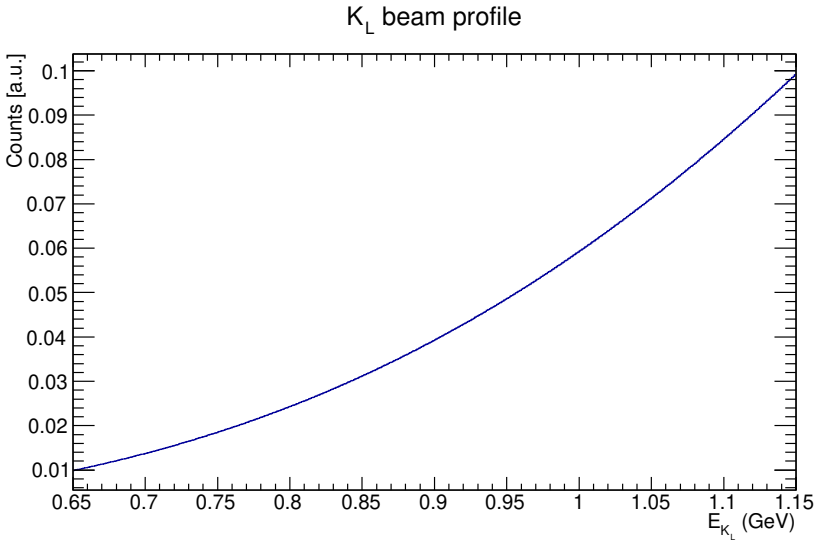
- Final Goal: Analysis of radiative decays of excited hyperons
- Start with $\Sigma(1670)^+ \rightarrow \Lambda\pi^+$ to familiarise with KLF software

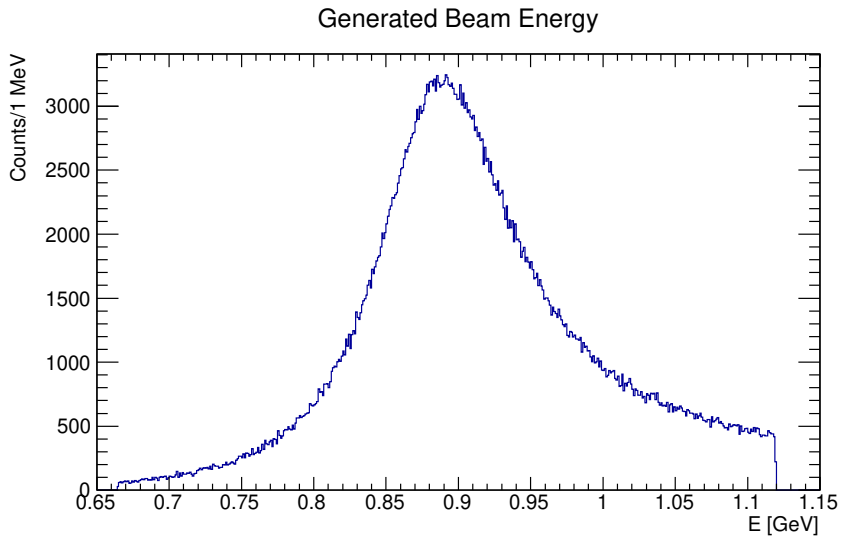
Outline

- Event Generator
- Particle Identifiaction
- Reconstruction
- Individual Particle Efficiency
- Summary

Event Generator

- Reaction $K_L^0 p \rightarrow \Sigma(1670)^+ \rightarrow \Lambda\pi^+ \rightarrow \pi^-\pi^+ p$
- Custom generator for phasespace distributions
- Momentum distribution of K_L^0
- Breit-Wigner resonance for $\Sigma(1670)^+$
  ($M = 1670\,\text{MeV}, \quad \Gamma = 60\,\text{MeV}$)





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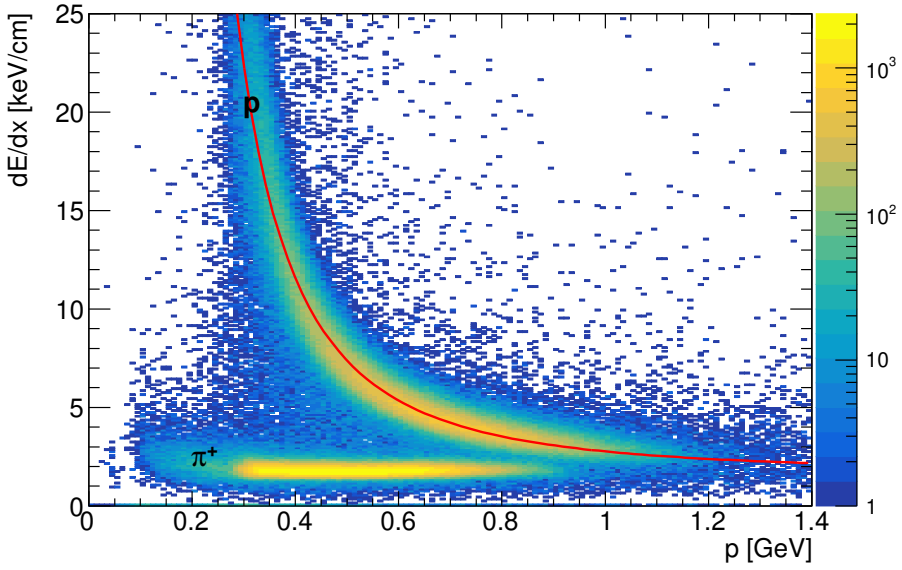
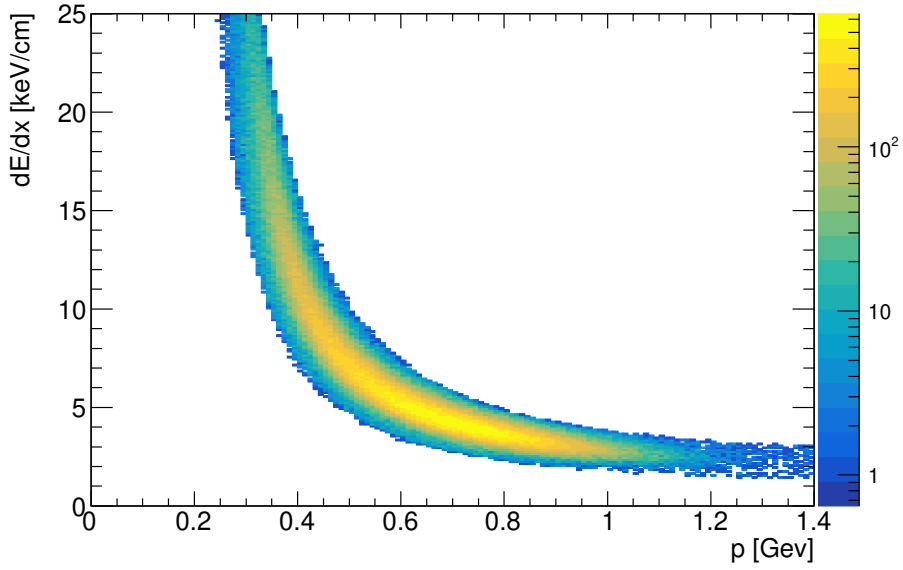
Particle Identification

- Assign Particle Id based on probability from dE/dX and timing info



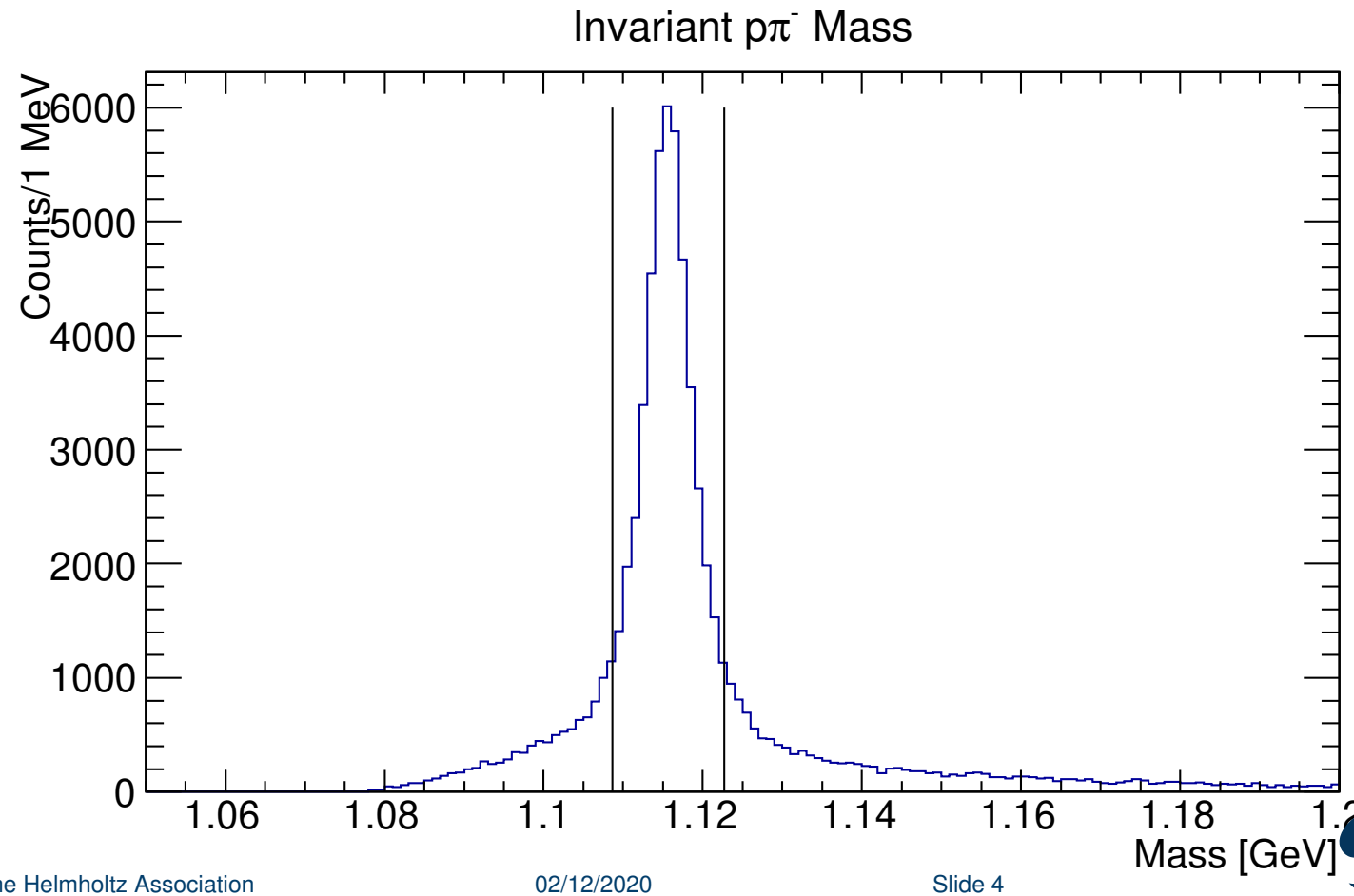


PID criterion

- Determine the probability for all hypotheses
- Keep all PIDs where rel. probability is above 40 %

Reconstruction of the Λ $(M = 1115\,\mathrm{MeV})$

- Combine all π^- and p
- Apply a mass cut with total width 14 MeV
- Λ signal can clearly be selected



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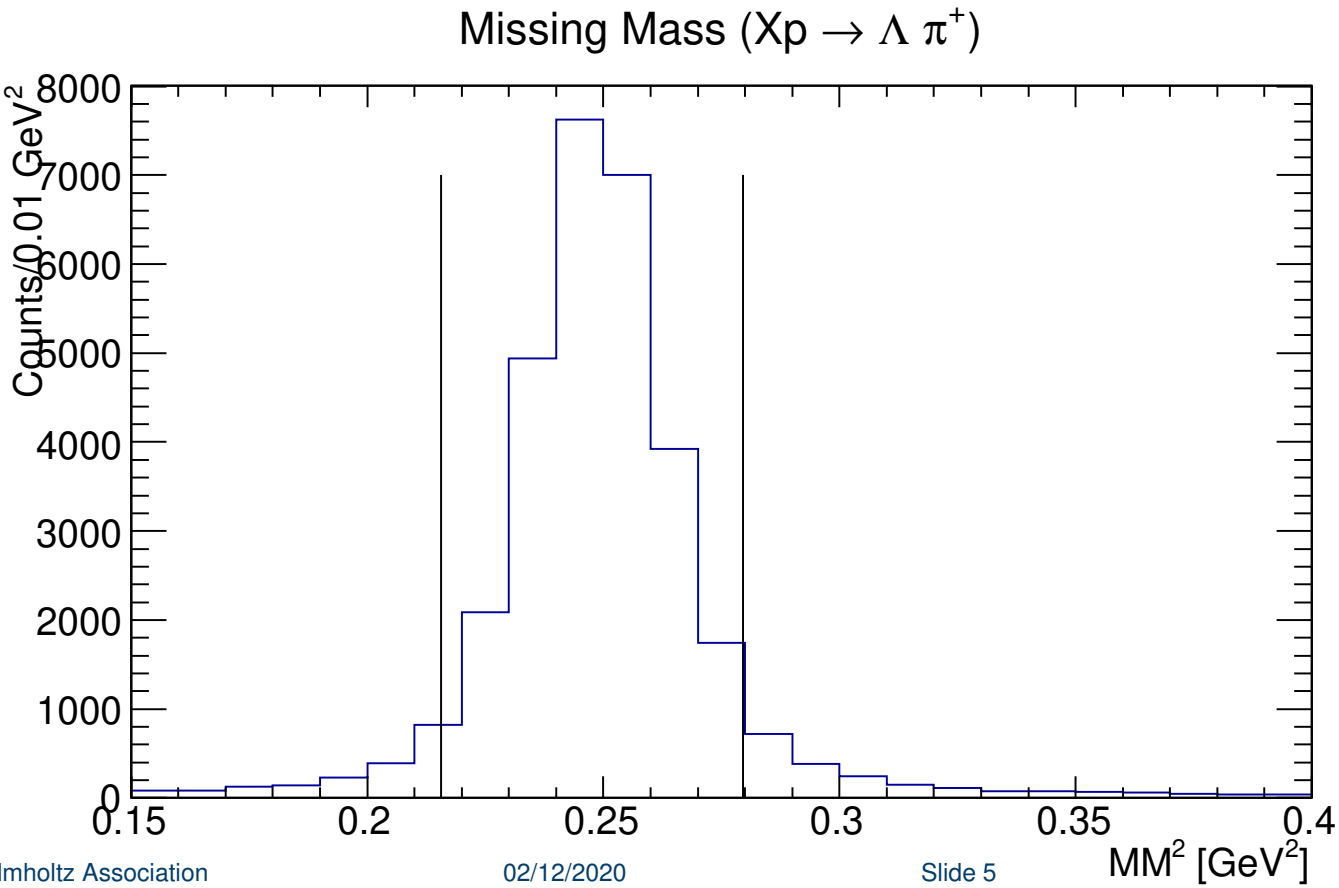
Missing Mass

- Need to distinguish Kaon and γ beam $\Rightarrow$ Missing Mass
- Combine Λ with π^+, determine $\mathrm{MM}^2(Xp \rightarrow \Lambda\pi^+)$
- Cut with total width of $0.064\,\mathrm{GeV}^2$ centered around squared Kaon mass



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COMBINATORICS

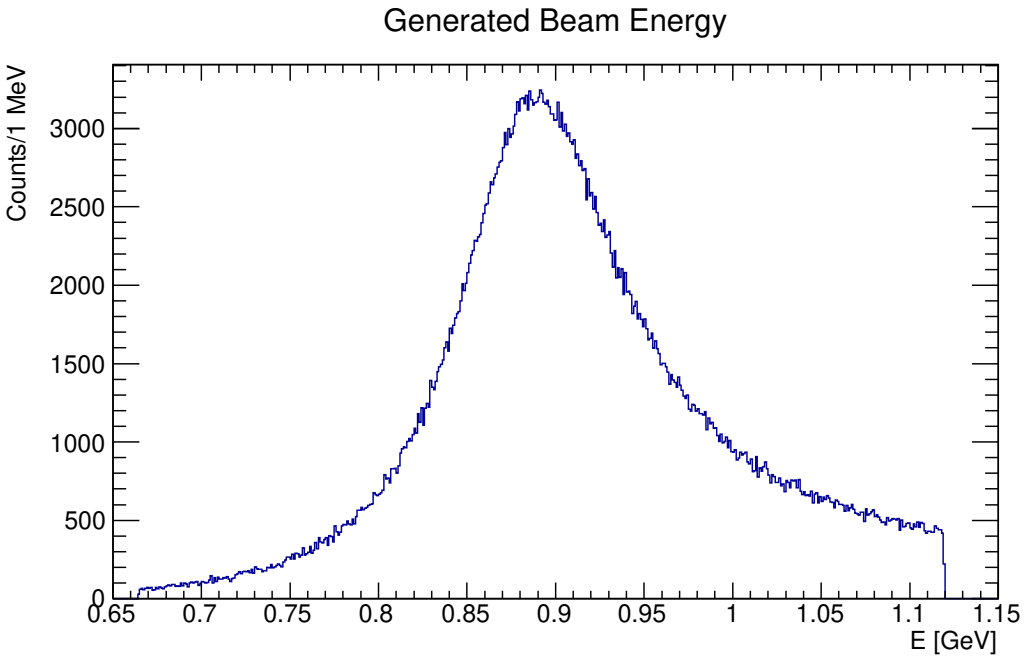
Target Volume

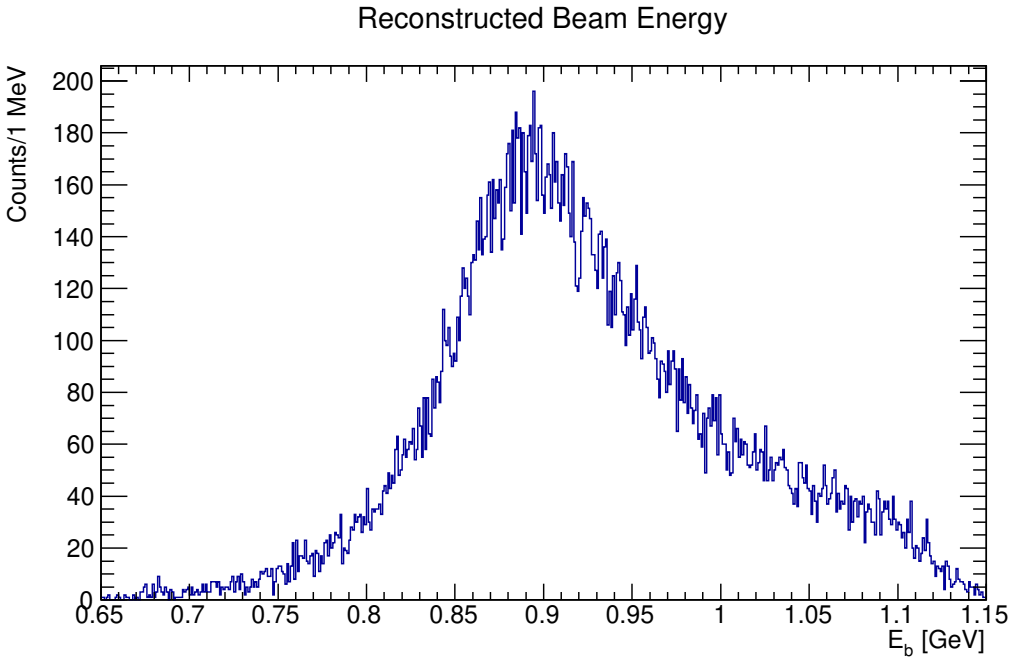
- Determine POCA between π^- and p: o_Λ
- Determine POCA between π^+ and o_Λ : o_Σ
- Cut on the z-Coordinate of o_Σ^z

Combinations from different PIDs

- Allowed different PIDs for a single particle
- Cut combinations by chosing event, where o_Σ closest to beam axis

- With these cuts a single combination is chosen





Overal efficiency

- Reconstructed and generated beam energy are in good agreement
- Overall reconstruction efficiency of approximately 6 %

Next step

- Study individual particle eff. to determine source of losses

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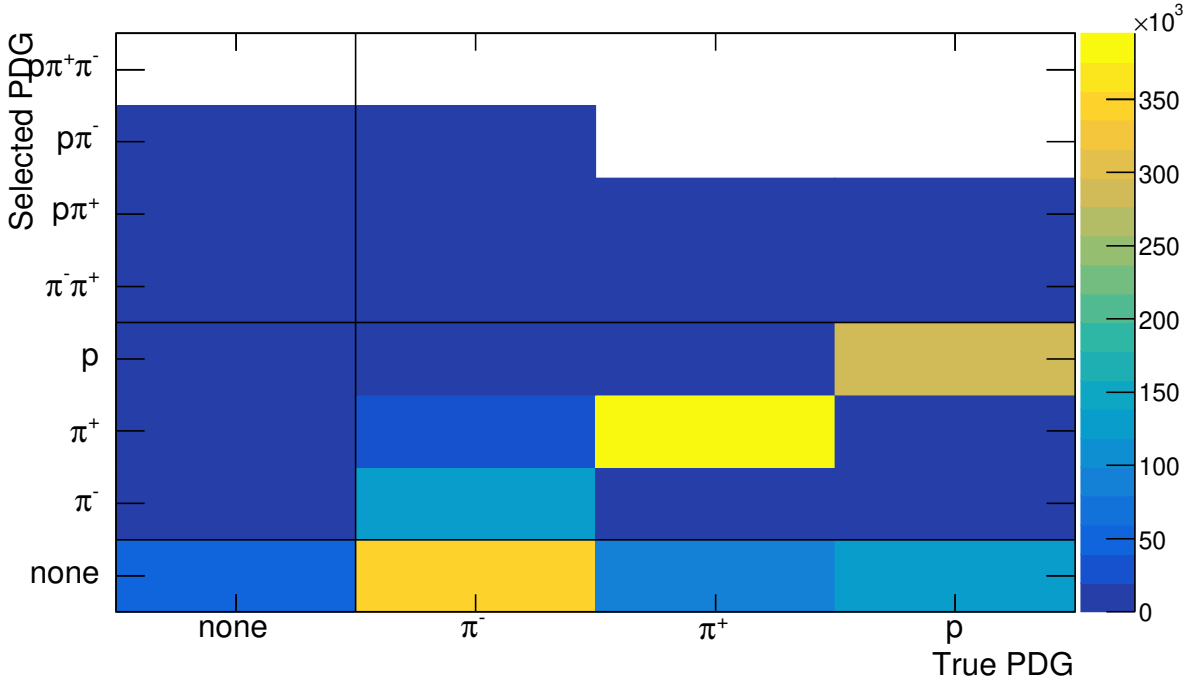
EFFICIENCIES

- Efficiency determined from “confusion matrix”
- Optimal case: Only Diagonal filled



Overview

	p	π^+	π^-
ϵ	68 %	81 %	25 %

- π^- efficiency is significantly smaller
- Misidentification as π^+

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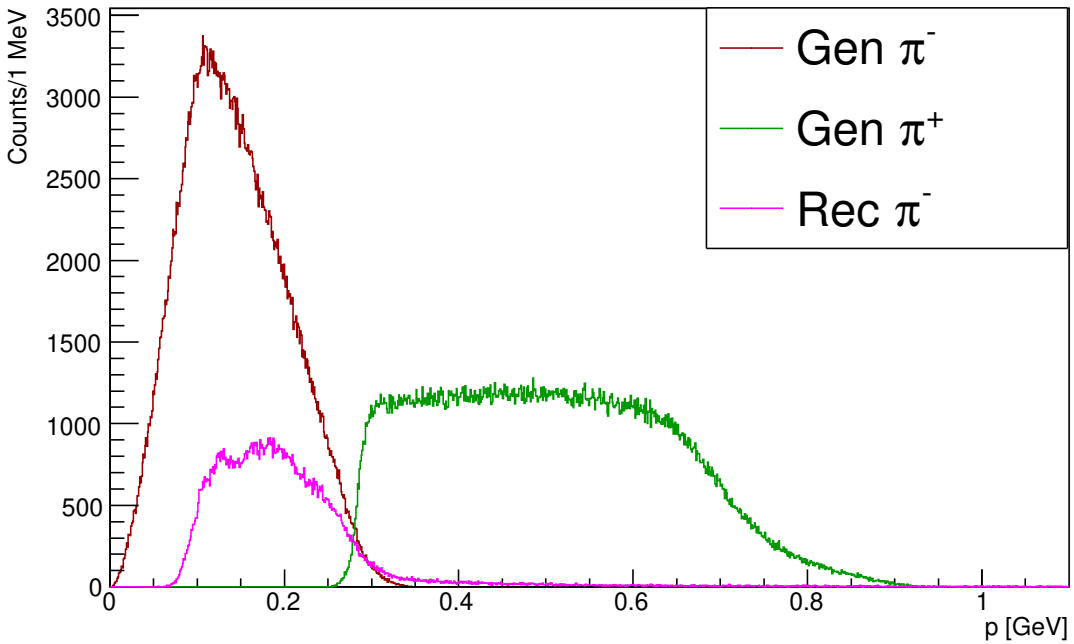
Issues in the π^- - Identification

- Significantly smaller efficiency than the other charged particles
- Misidentification, approx. 7 % assigned as π^+



- Low efficiency at low momenta consistent with other studies [1]
- Misidentification might come from spiralling tracks

[1] https://halldweb.jlab.org/DocDB/0038/003801/003/aschertz_piplustracking_oct2018.pdf

Summary

- Custom generator for $K_L^0 p \rightarrow \Sigma(1670)^+ \rightarrow \Lambda\pi^+ \rightarrow \pi^-\pi^+ p$
- Final state reconstruction
- Overall reconstruction efficiency of 6 %
- Losses due to low pion momentum (?)

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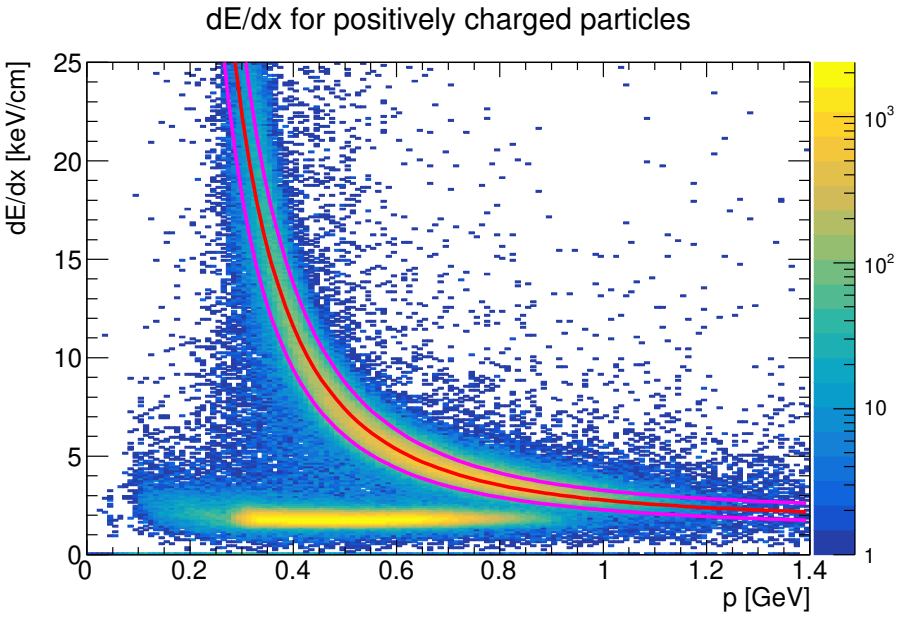
PARTICLE IDENTIFICATION



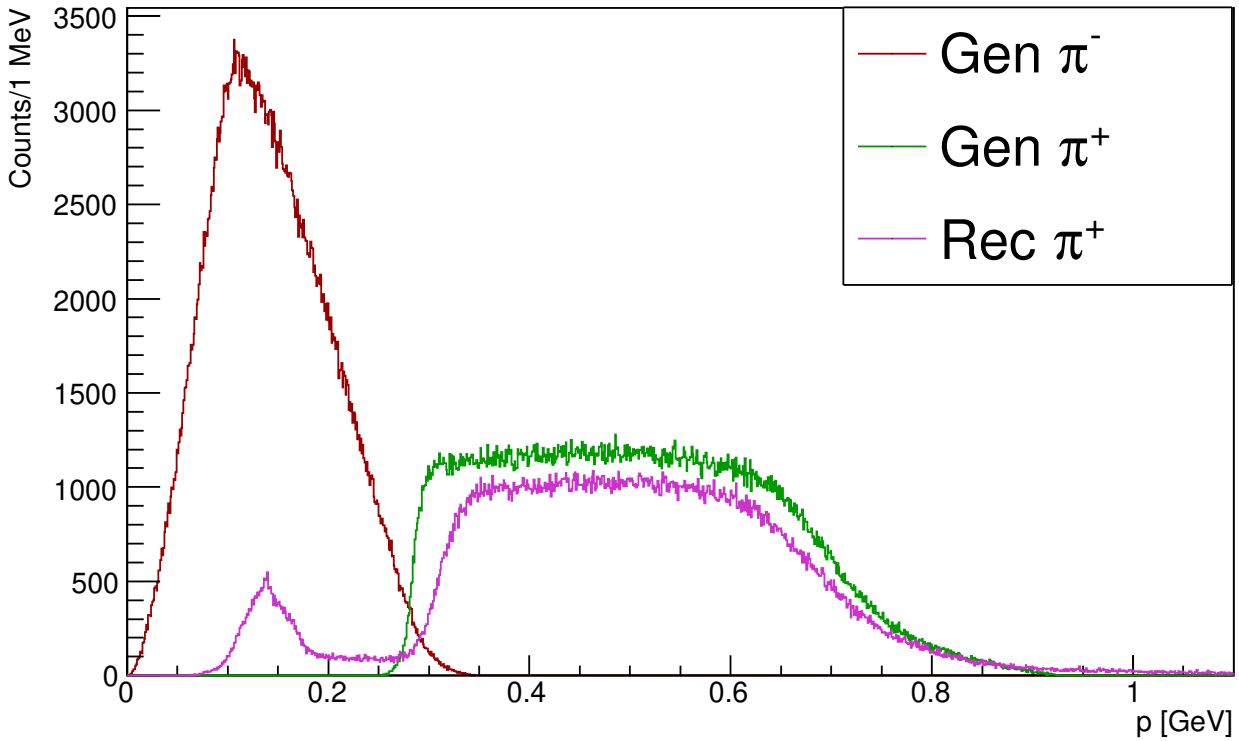
Definition of Probability

- $\left\langle \frac{dE}{dx} \right\rangle_\alpha$ and $\sigma_{\left\langle \frac{dE}{dx} \right\rangle_\alpha}$ predicted
- Define $\Gamma_\alpha = \frac{\frac{dE}{dx} - \left\langle \frac{dE}{dx} \right\rangle_\alpha}{\sigma_{\left\langle \frac{dE}{dx} \right\rangle_\alpha}}$
- $\mathbb{P}_\alpha = \mathbb{P}\left(\chi^2_{\text{real}} < \Gamma^2_\alpha\right)$
- Same is done for the BCAL and TOF time distributions

PID criterion

- Determine the probability for all hypothesis
- Keep all PIDs where rel. probability is above 40 %

π^+ - EFFICIENCY



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