EXCITED HYPERON SPECTROSCOPY AT THE PROPOSED K-LONG FACILITY

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04/19/2020 | Kevin Luckas, James Ritman | Institut für Kernphysik - FZ Jülich

Motivation

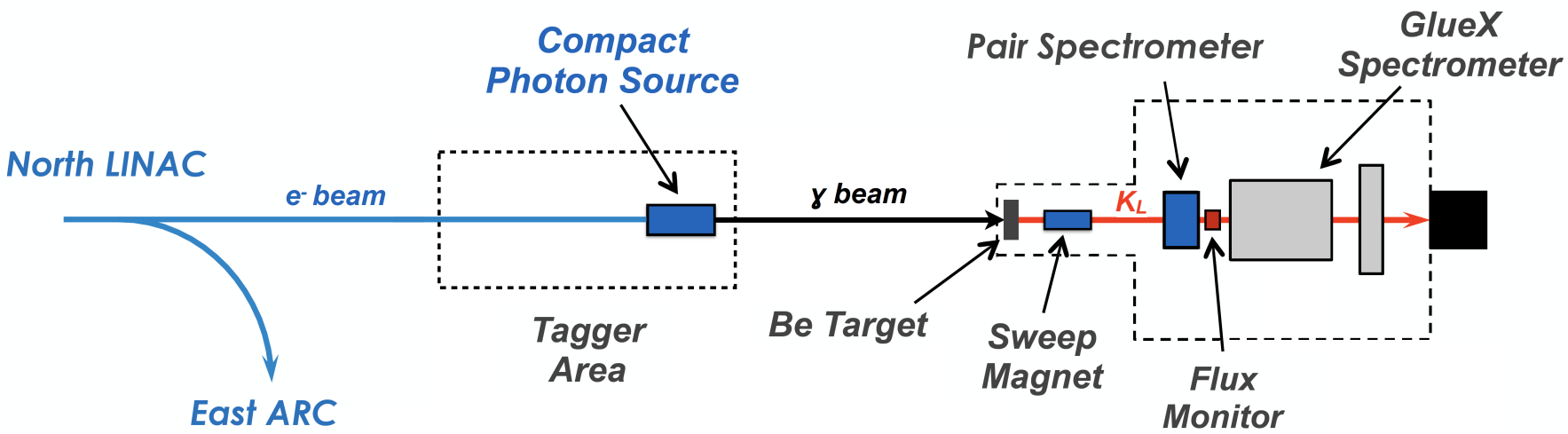
- Goal: Analysis of radiative decays of excited hyperons
- K-Long Facility will provide high-statistics and high-quality data
- In this talk $\Sigma(1670)^+ \rightarrow \Lambda\pi^+$ as a first step

Outline

- K-Long Facility Beamline
- Simulation and Reconstruction
- Results
- Summary and Outlook

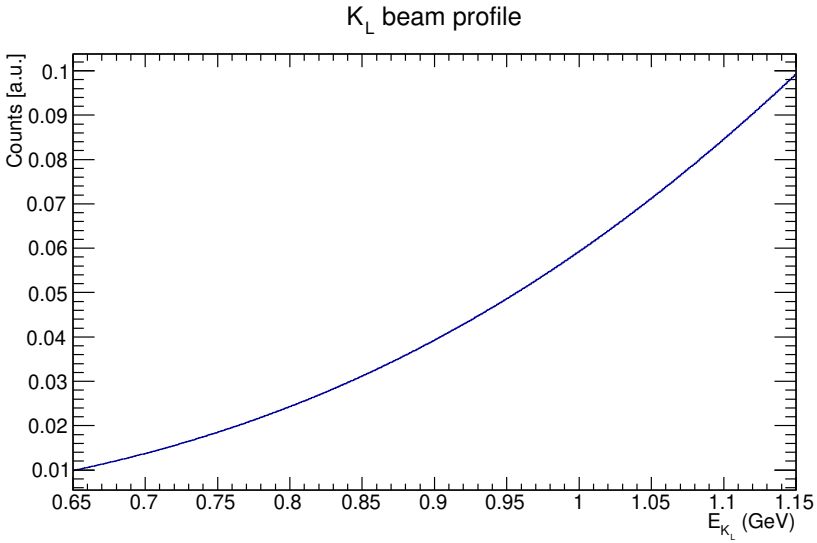
KLF Beamline

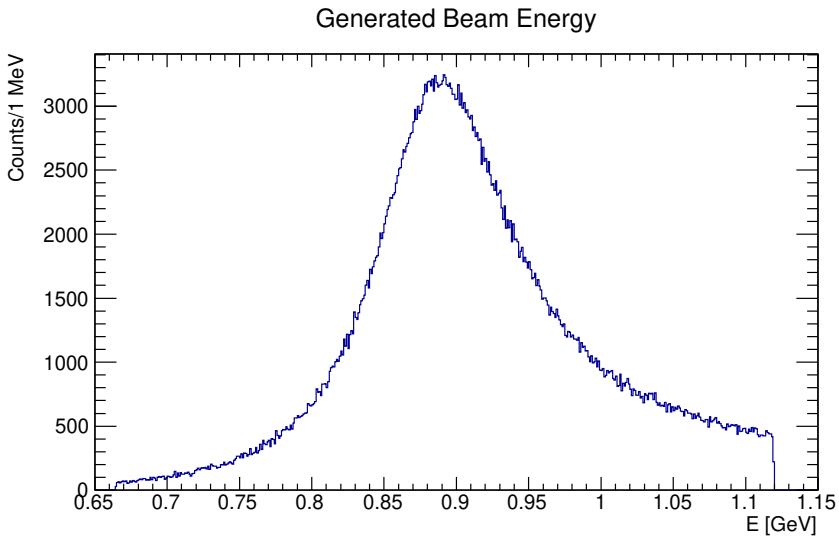
- Compact Photon Source $\rightarrow$ Untagged photon beam
- Beryllium target $\rightarrow$ production of K_L^0 via decay of forward emitted ϕ
- LH_2/LD_2 target $\rightarrow$ Secondary target
- GlueX spectrometer $\rightarrow$ Measuring final state



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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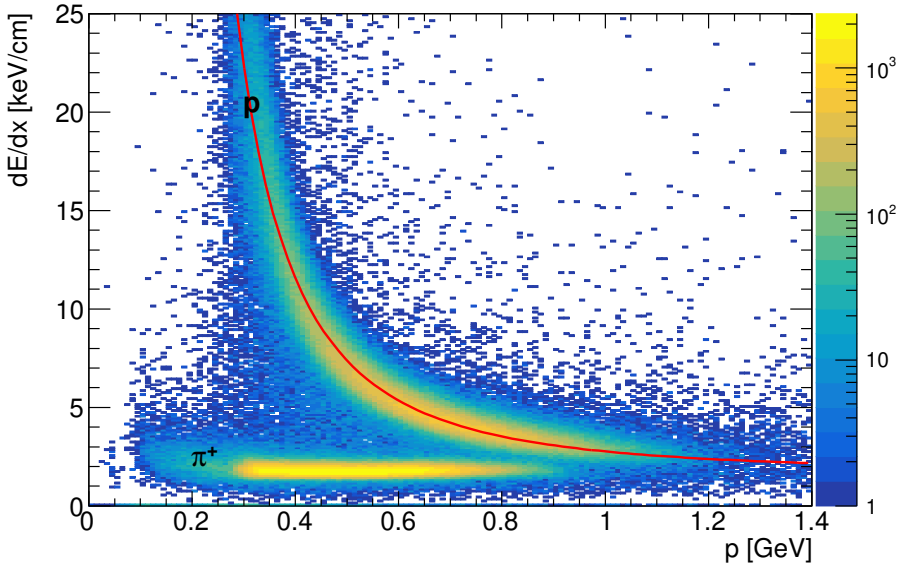
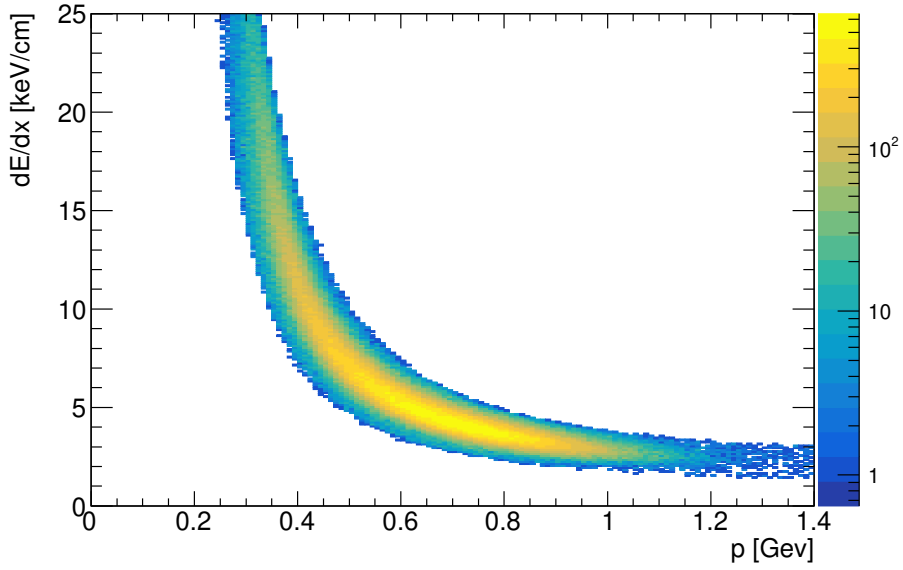
Particle Identification

- Particle ID based on dE/dX and timing



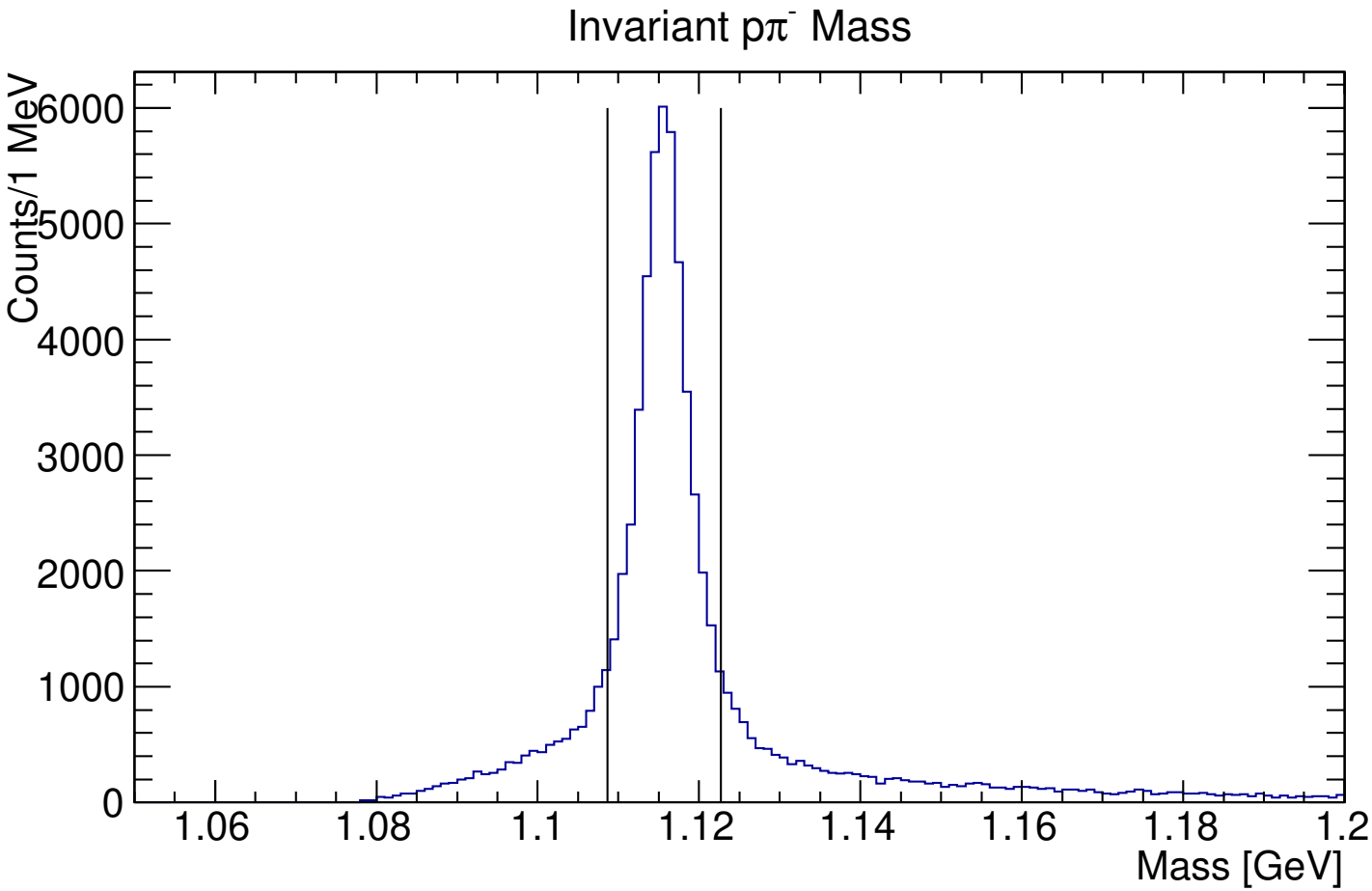


PID criterion

- Determine the probability for all charged hypotheses
- Keep all PIDs for which probability is above 40 %

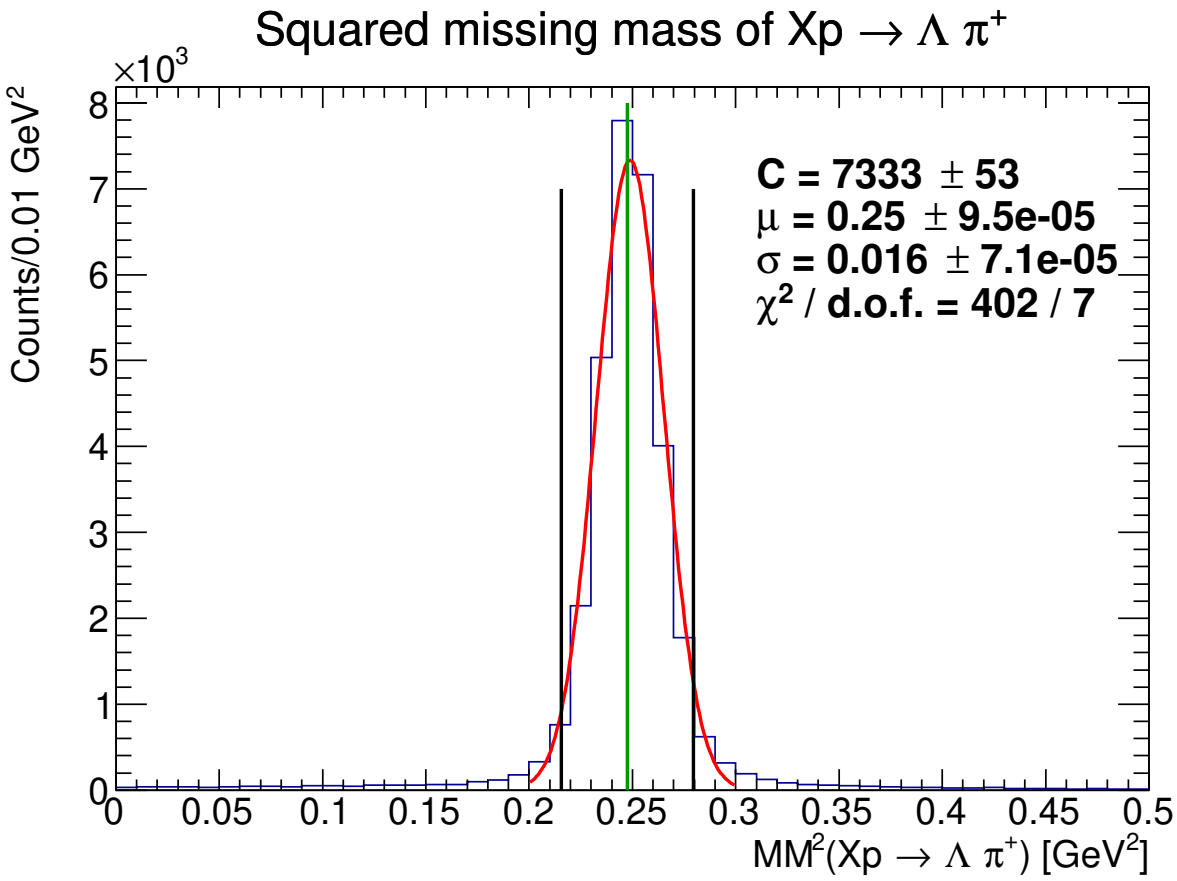
Reconstruction of the Λ ($M = 1115\,\mathrm{MeV}$)

- Combine all π^- and p candidates
- Apply a mass cut with total width 14 MeV



Missing Mass

- Need to distinguish Kaon and γ beam
- Combine Λ with π^+, determine $\mathrm{MM}^2(Xp \rightarrow \Lambda\pi^+)$
- Cut with total width of $0.064\,\mathrm{GeV}^2$ centered around $M^2_{K^0_L}$



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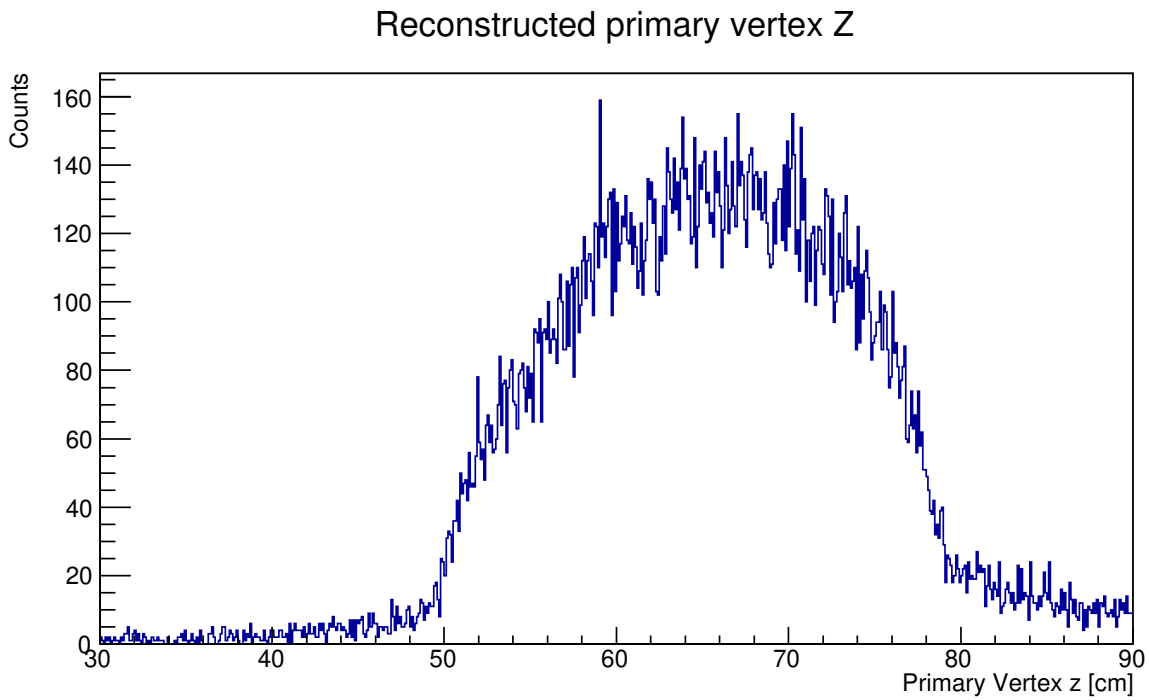
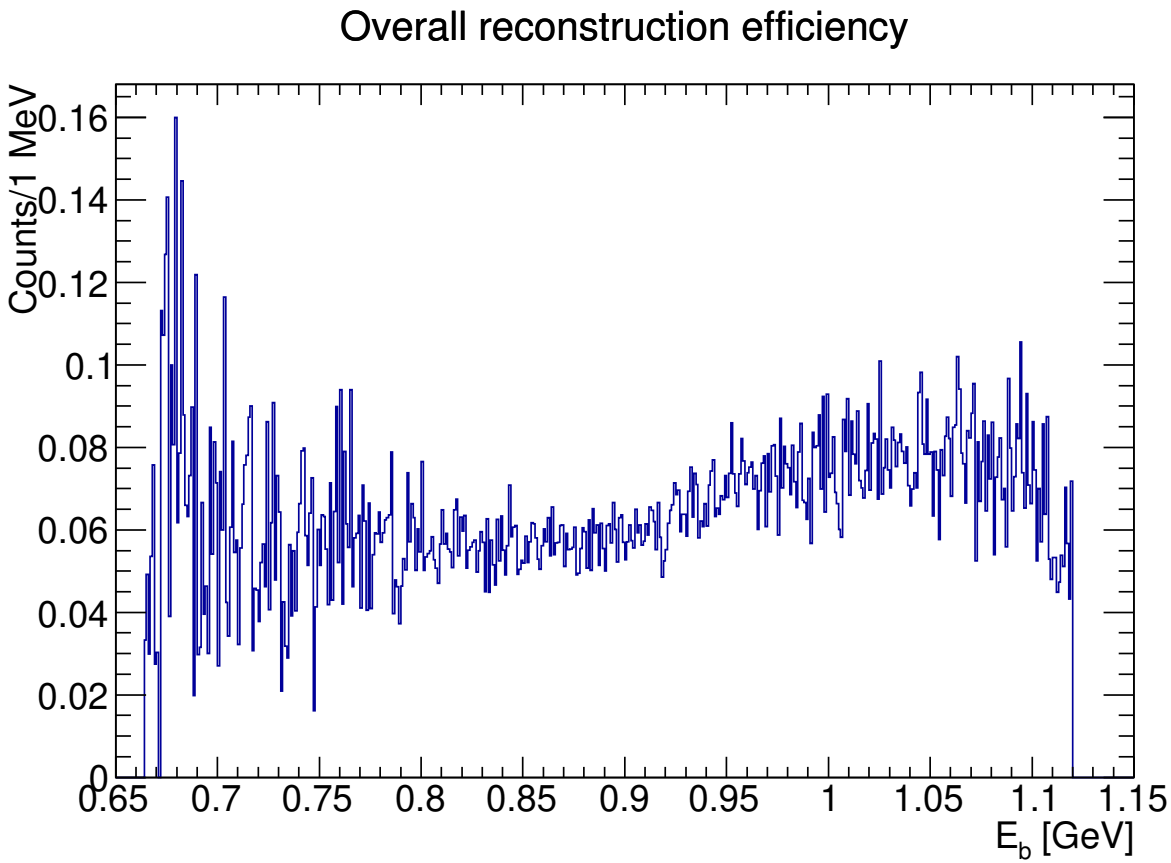
Target Volume

- Kinematic Fit not yet performed
- Primary Vertex is calculated from the measured charged tracks and reconstructed Λ
- Apply selection such that this vertex lies within the target volume
- If more than one valid combination, keep only the one closest to beamline



Overal efficiency

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



Main source of losses

- Study of individual particle efficiencies → losses due to soft pions from Λ decay

Summary

- Custom generator for $K_L^0 p \rightarrow \Sigma(1670)^+ \rightarrow \Lambda\pi^+ \rightarrow \pi^-\pi^+ p$
- Reconstructed the final and intermediate state particles with the GlueX spectrometer
- Achieved an overall reconstruction efficiency of 6 %
- Efficiency dominated by losses due to low momentum pion

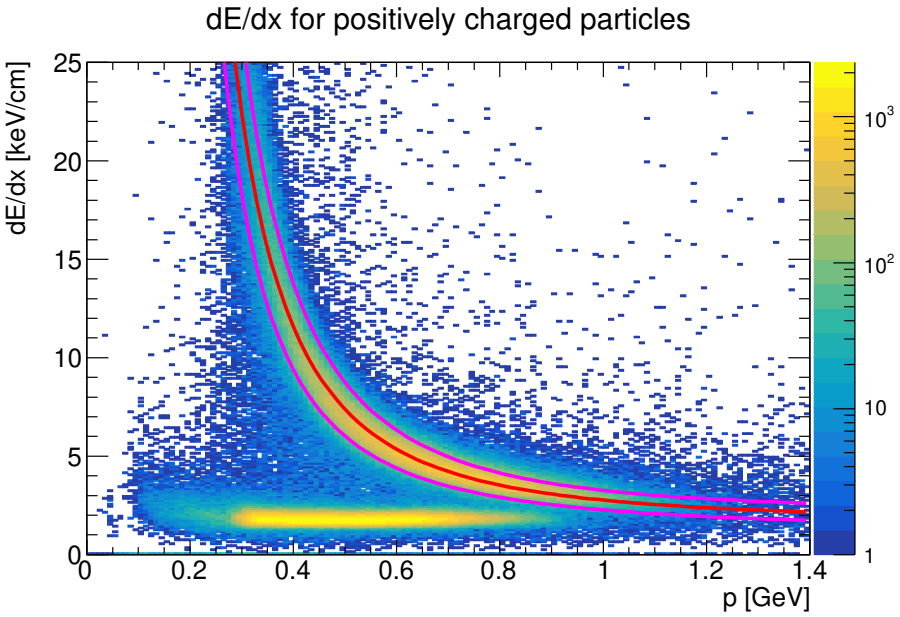
Outlook

- Analysis of radiative hyperon decays based on GlueX data
- Currently working on analyses of the final states $\Lambda\gamma$ and $\Lambda e^+ e^-$

Thank you for your attention and take care !

BACKUP

PARTICLE IDENTIFICATION



Definition of Probability

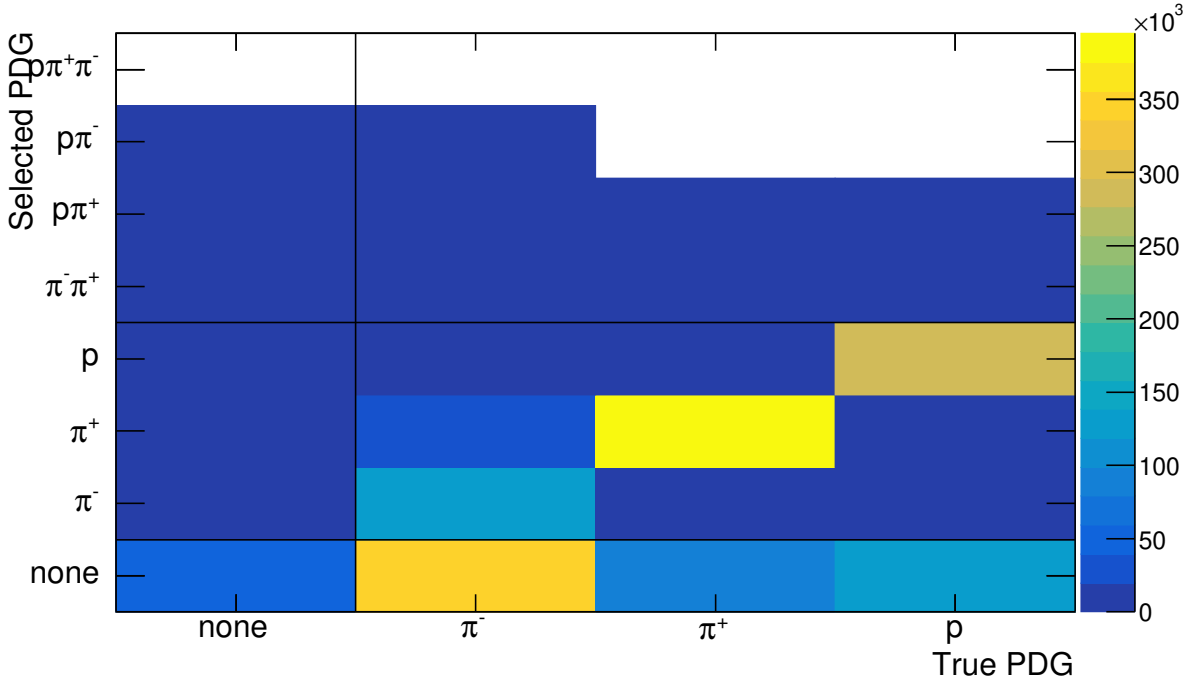
- $\left\langle \frac{dE}{dx} \right\rangle_\alpha$ and $\sigma_{\left\langle \frac{dE}{dx} \right\rangle_\alpha}$ predicted
- Define $\Gamma_\alpha = \frac{\frac{dE}{dx} - \left\langle \frac{dE}{dx} \right\rangle_\alpha}{\sigma_{\left\langle \frac{dE}{dx} \right\rangle_\alpha}}$
- $\mathbb{P}_\alpha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

PID criterion

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

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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π^+ - EFFICIENCY