Analysis of $K^+ K^{+*} \Xi^-$

Connor Ouellette

Decay Sequence

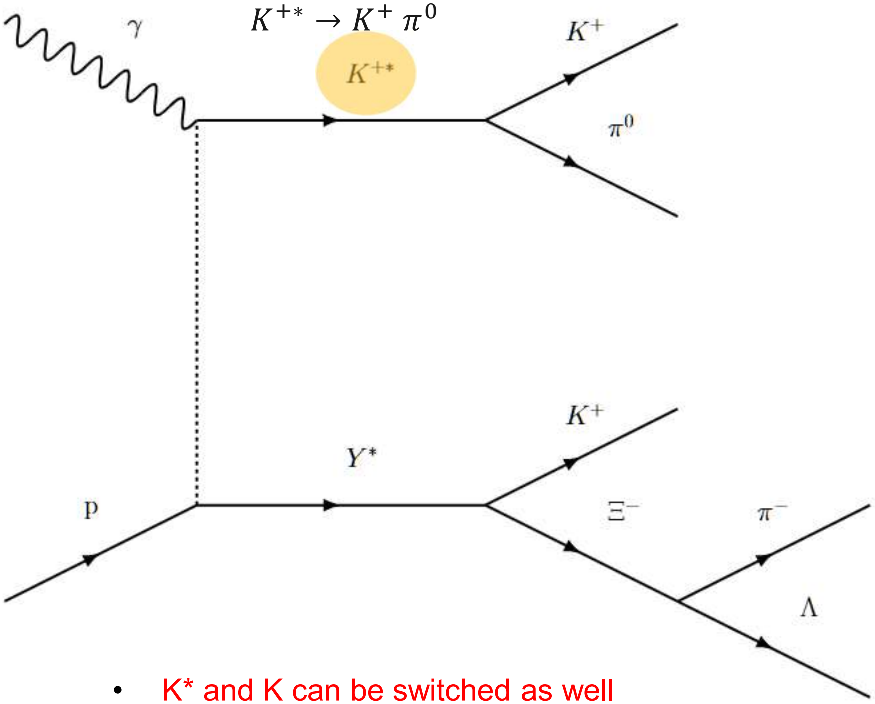
Diagrams

This reaction:

$\gamma\, p \rightarrow K^{+*}\, K^{+} \Xi^{-}$

$\Xi^{-} \rightarrow \pi^{-} \Lambda$

$K^{+*} \rightarrow K^{+}\, \pi^{0}$



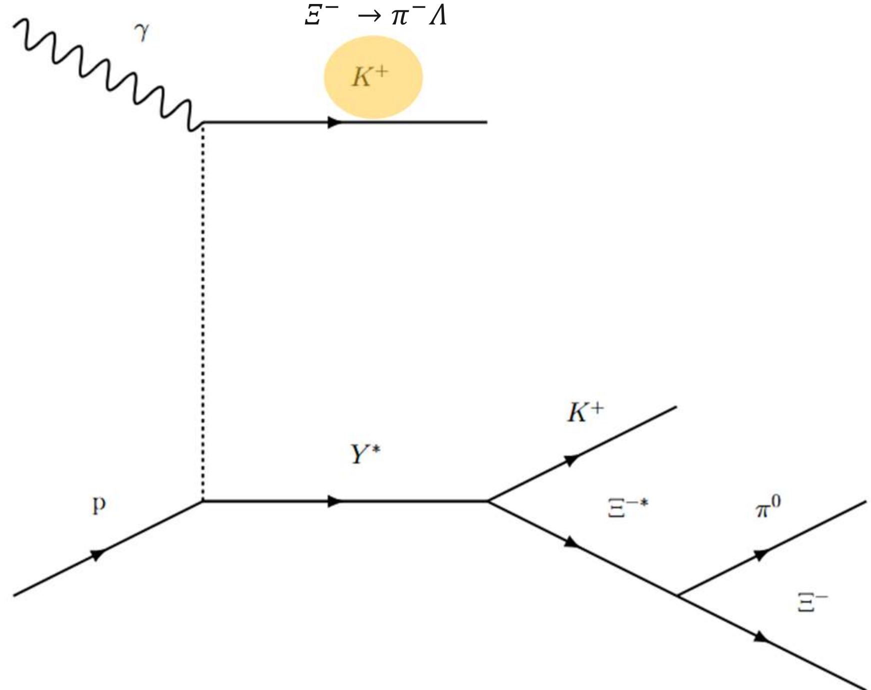
- K* and K can be switched as well

Background:

$\gamma\, p \rightarrow K^{+}\, K^{+} \Xi^{-*}$

$\Xi^{-*} \rightarrow \pi^{0} \Xi^{-}$

$\Xi^{-} \rightarrow \pi^{-} \Lambda$



Decay Sequence

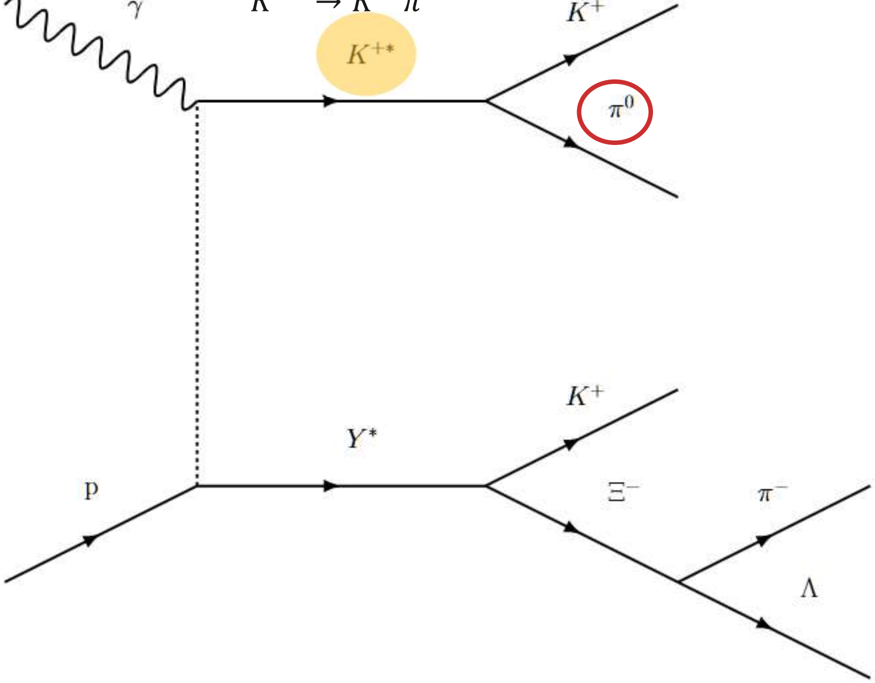
Diagrams

This reaction:

$\gamma\, p \rightarrow K^{+*} K^{+} \Xi^{-}$

$\Xi^{-} \rightarrow \pi^{-} \Lambda$

$K^{+*} \rightarrow K^{+} \pi^{0}$

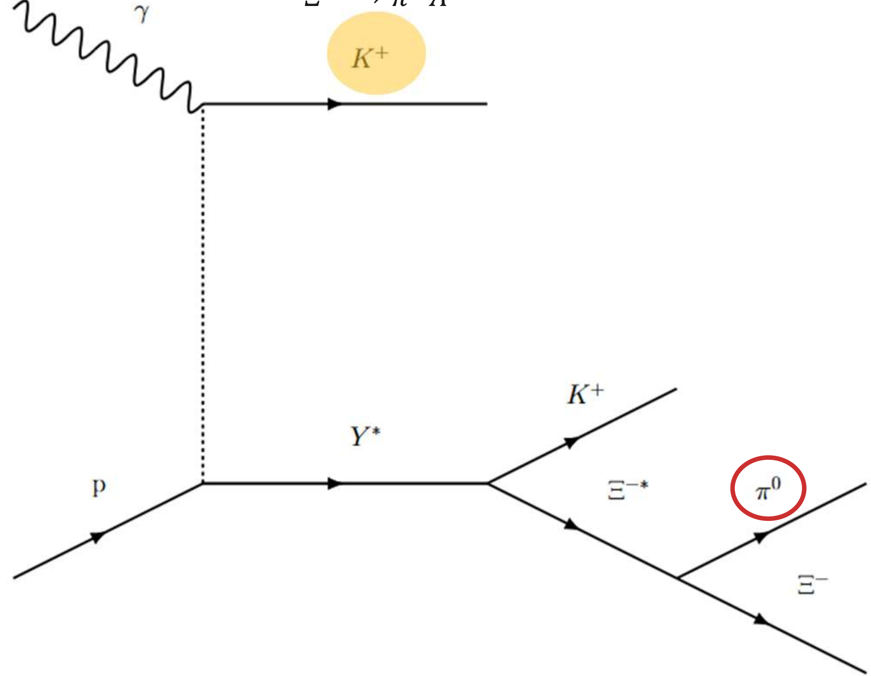


Background:

$\gamma\, p \rightarrow K^{+} K^{+} \Xi^{-*}$

$\Xi^{-*} \rightarrow \pi^{0} \Xi^{-}$

$\Xi^{-} \rightarrow \pi^{-} \Lambda$



Decay Sequence

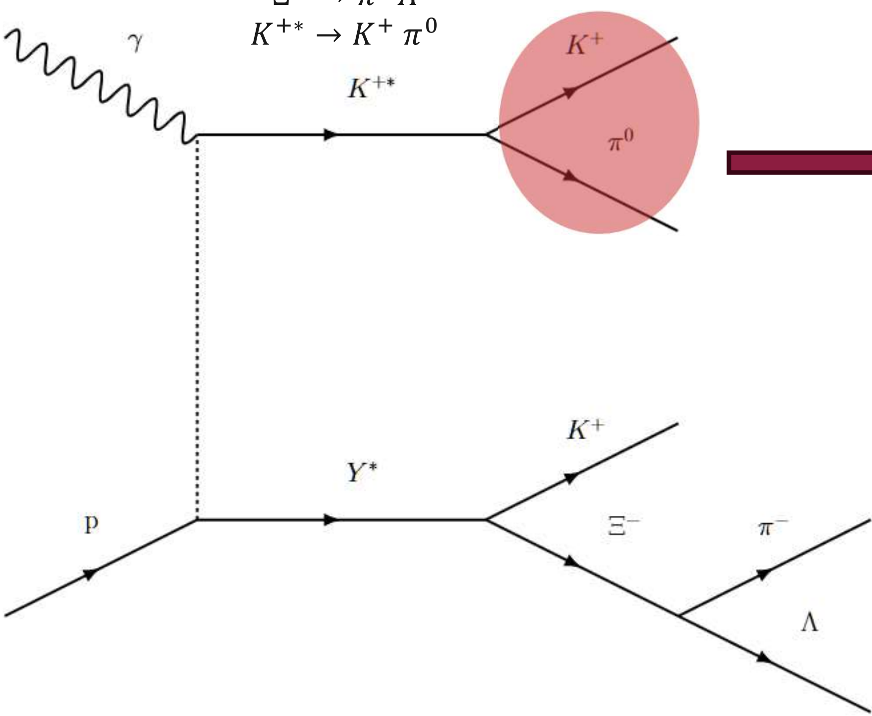
Histograms

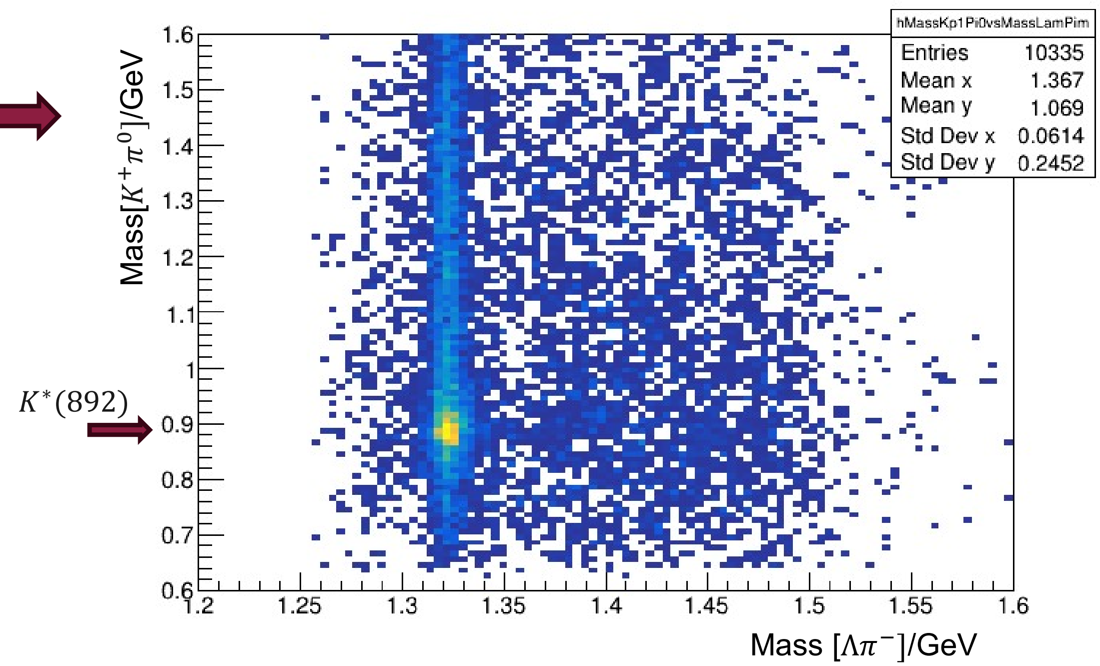
This reaction:

$\gamma\, p \rightarrow K^{+*}\, K^{+} \Xi^{-}$

$\Xi^{-} \rightarrow \pi^{-} \Lambda$

$K^{+*} \rightarrow K^{+}\, \pi^{0}$



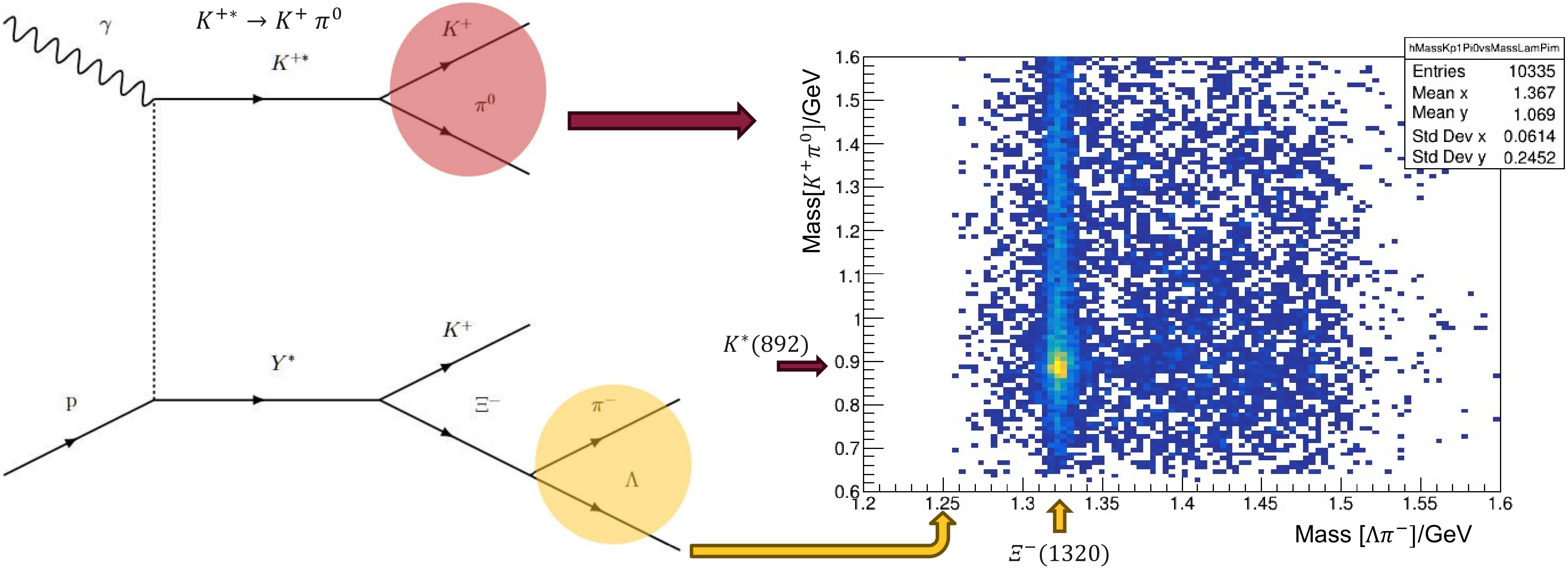


Decay Sequence

Histograms

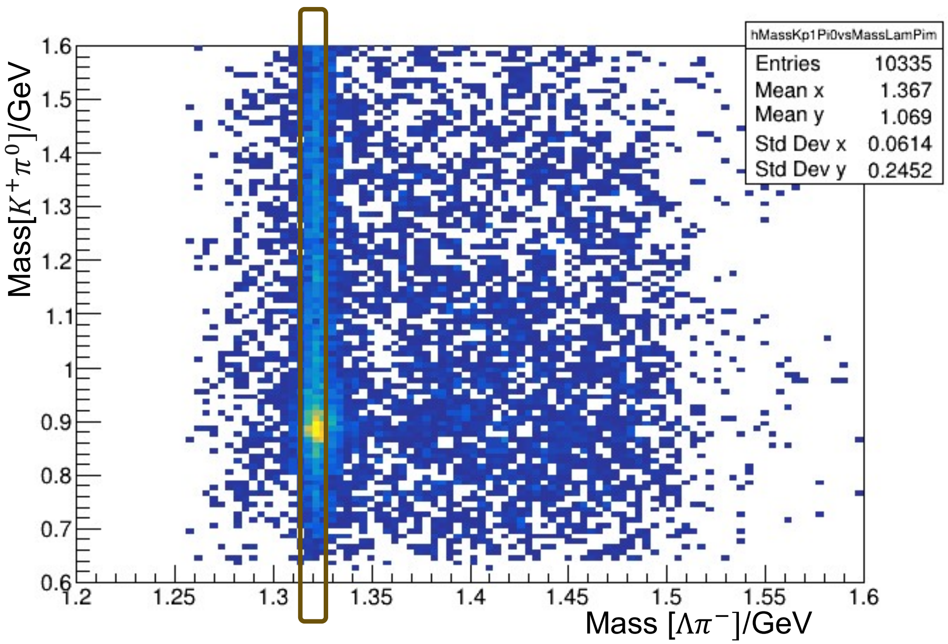
This reaction:

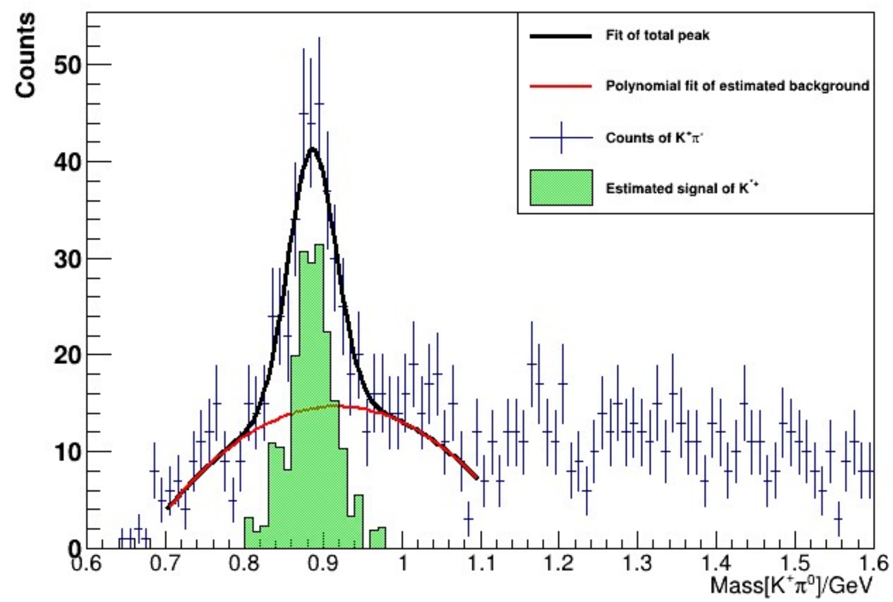
$$\gamma\, p \rightarrow K^{+*}\, K^{+} \Xi^{-}$$
$$\Xi^{-} \rightarrow \pi^{-} \Lambda$$
$$K^{+*} \rightarrow K^{+}\, \pi^{0}$$



Decay Sequence

Fitting Routine

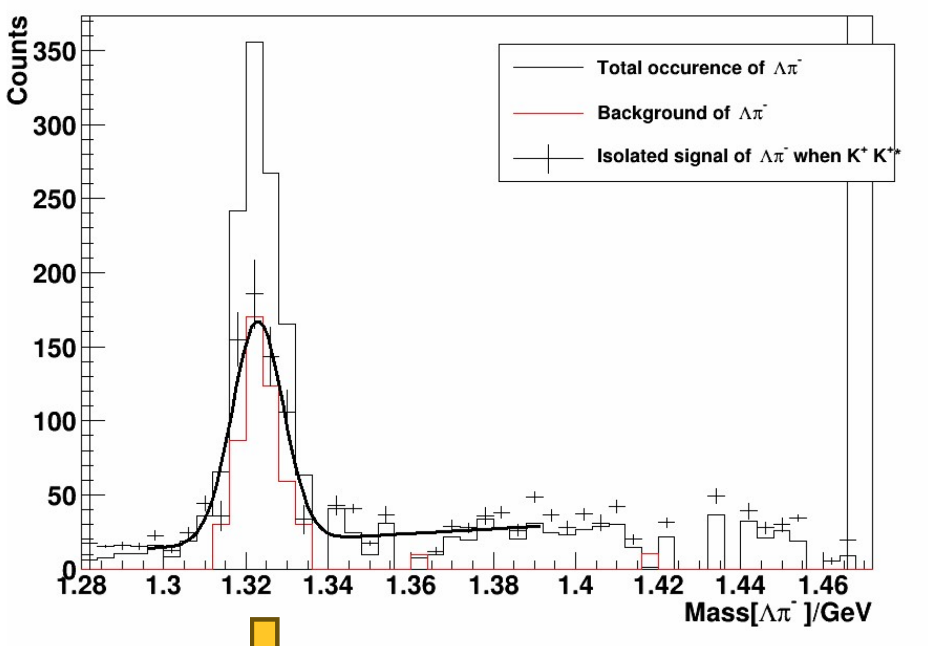




**Repeat for each Mass$[\Lambda\pi^-]$ bin

Decay Sequence

Fitting Routine, contd.



Average Mass[$\Lambda\pi^-$] : 1322.9 ± 0.47 MeV

- PDG value: 1321.71 ± 0.07 MeV

Width[$\Lambda\pi^-$] : 5.648 ± 0.4 MeV

Cross Section

Methodology

$$\sigma = \frac{Y}{Nt\epsilon}$$

- Y = Yield from fitting routine
  - Accidental subtraction (Hybrid with out of time weighted by $-\frac{1}{6}$)
- t = Scattering centers (protons per barn of target)
- N = Incident photons
- ϵ = Detector efficiency (= $\frac{Y_{\text{seen}}}{Y_{\text{thrown}}}$)

Cross Section

Yield Data & Cuts

- From 2018-1, 2019-11 runs
- Cuts:
    - Confidence level > 10^{-6}
    - Path length significance > 4

Cross Section

Monte Carlo for Y_{seen}

- Monte Carlo generated Breit-Wigner with PDG mean and width for Ξ^- and K^{+*}
- Fixed t-slope
- Incident photon distribution from experiment
- All other decays phase space
- Passed through simulations for detector resolution and geometry
- No other generator refinement (currently)

Cross section

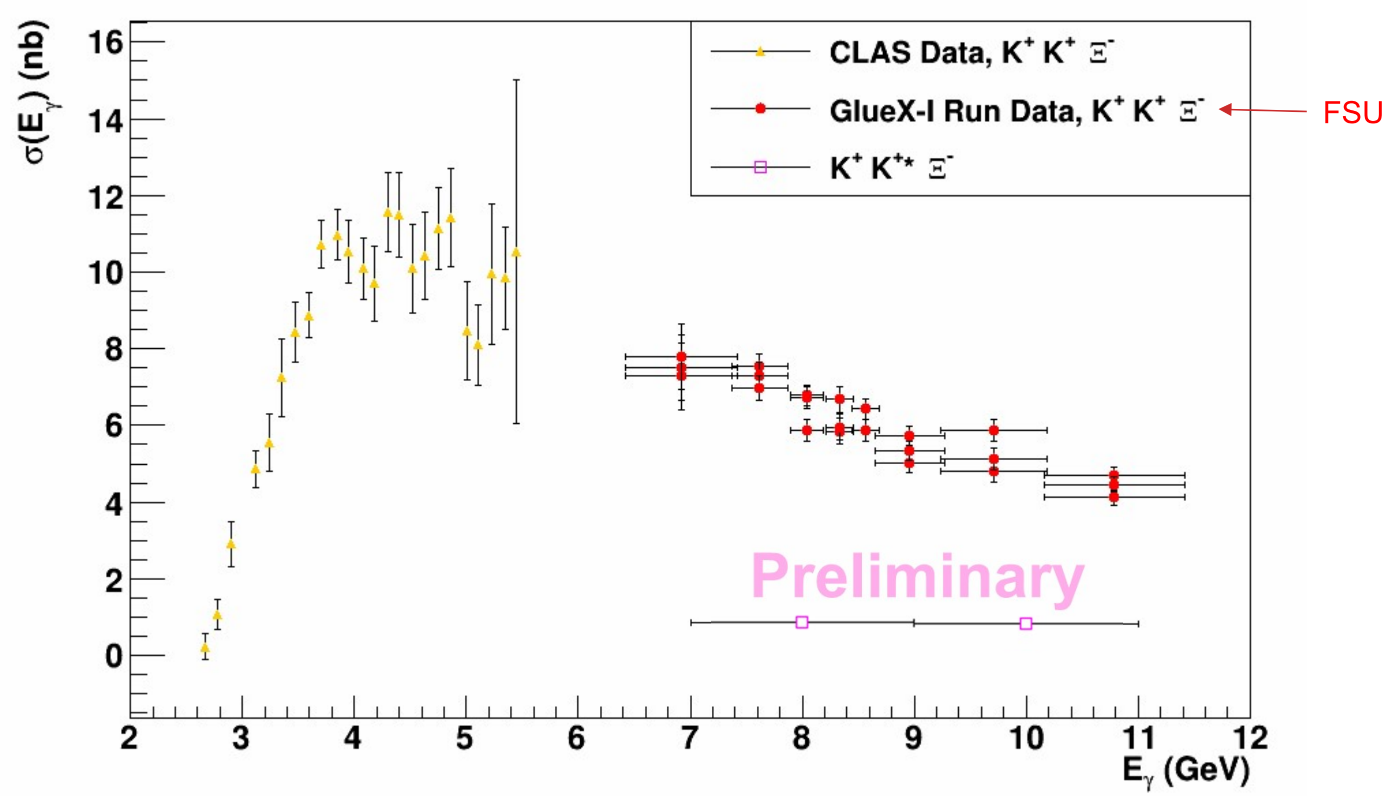
Results

- $$\sigma(8\text{ GeV}) = \frac{(862.096\ \Xi^{-}\text{ particles})}{(2.1711\times10^{14}\text{ photo}\quad)(1.3156\text{ protons/barn})(1.0345\times10^{-9})} = 0.8510\text{ nbarns}$$

- $$\sigma(10\text{ GeV}) = \frac{(616.475\ \Xi^{-}\text{ particles})}{(1.5595\times10^{14}\text{ photons})(1.3156\text{ protons/barn})(1.0345\times10^{-9})} = 0.8352\text{ nbarns}$$

Cross section

Results



Future Work

- Exploration of which K^+ is associated with the K^{+*}
- Generator refinement
- How this ($K^+ K^{+*} \Xi^-$) serves as a background to $K^+ K^+ \Xi^{-*}$

Cross Section Backup

Scattering Centers

- Protons per volume $= 4.3854 \times 10^{22}\ \frac{\text{protons}}{\text{cm}^3}$

- Number of scattering centers per area $= 4.3854 \times 10^{22}\ \frac{1}{\text{cm}^3} \times 30\ cm\ = 1.3156 \times 10^{24}\ \frac{1}{\text{cm}^2}\ =\ 1.3156\ \frac{1}{\text{barn}}$

Hall D LH2 Cryotarget
Values listed below are nominal. Final dimensions will be determined on an as-built basis.
CD Keith, Jan 28, 2014

Item	Material	Z position (cm)	Density (g/cm^3)	Dimensions (cm)
Target entrance window	Kapton, 75um	0	1.42[1]	1.56 id, 75 um thick
Target fluid, conical ~18 K, 16 psiA	Liquid hydrogen, 30 cm	0-30	0.0734[2]	2.42 dia. at entrance 1.56 dia. at exit
Target Exit window	Kapton, 75 um	30	1.42	1.56 id
Super-insulation	Aluminized-mylar+cerex (5 layers)	30	2.9 mg/cm^2 per layer[3]	--
Scattering chamber exit window[4]	Aluminum, 25 um	TBD	2.70	2.54 dia.
Target cell, conical (not in beam path)	Aluminized kapton, 127 um	--	1.42	2.42 id at ent. window 1.56 id at exit window
Super-insulation (not in beam path)	Aluminized-mylar+cerex (5 layers)	--	2.9 mg/cm^2 per layer[5]	--
Scattering chamber[6] (not in beam path)	Aluminum-lined Rohacell	--	~110 mg/cm^3	11.1 OD, 1 thick

https://halldweb.jlab.org/wiki/images/b/b8/HallD_Target_Table.pdf