Cascade Update $\Xi^{-}(1530)$
Cross Section Update

Brandon Sumner

Outline

- Review of Cuts
- Confidence Level Study
- *t*-slope matching
- Cross Section

Cuts on Data

- Exclude events where both Kaons come from start timer or NULL events

- Above a confidence level of .0001

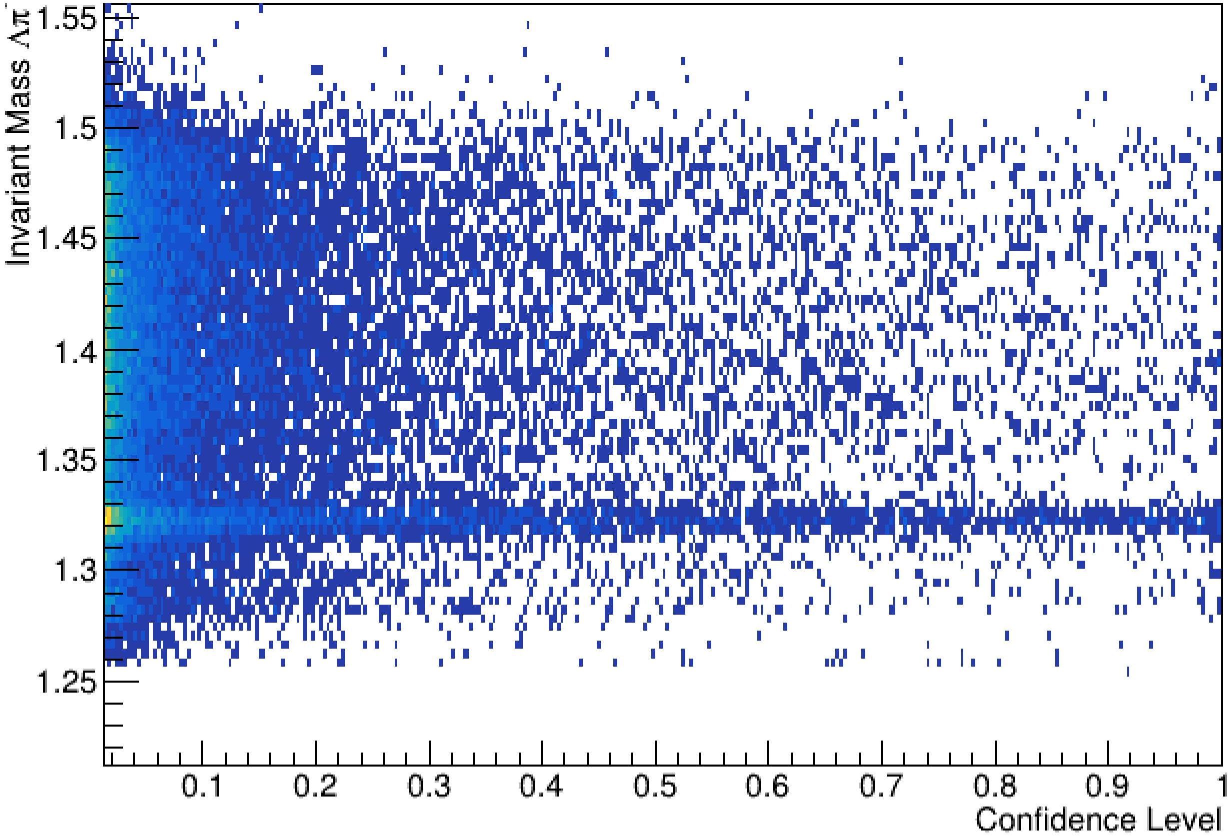
- Invariant mass of $\Lambda\pi^-$ (note $\Xi^- \rightarrow \Lambda\pi^-$) between 1.31-1.34 GeV/c^2

Decay Chain

$$\gamma p \rightarrow K^+ K^+ \Xi^{-*}(1530)$$
$$\Xi^{-*}(1530) \rightarrow \Xi^- \pi^0$$
$$\Xi^- \rightarrow \Lambda \pi^-$$

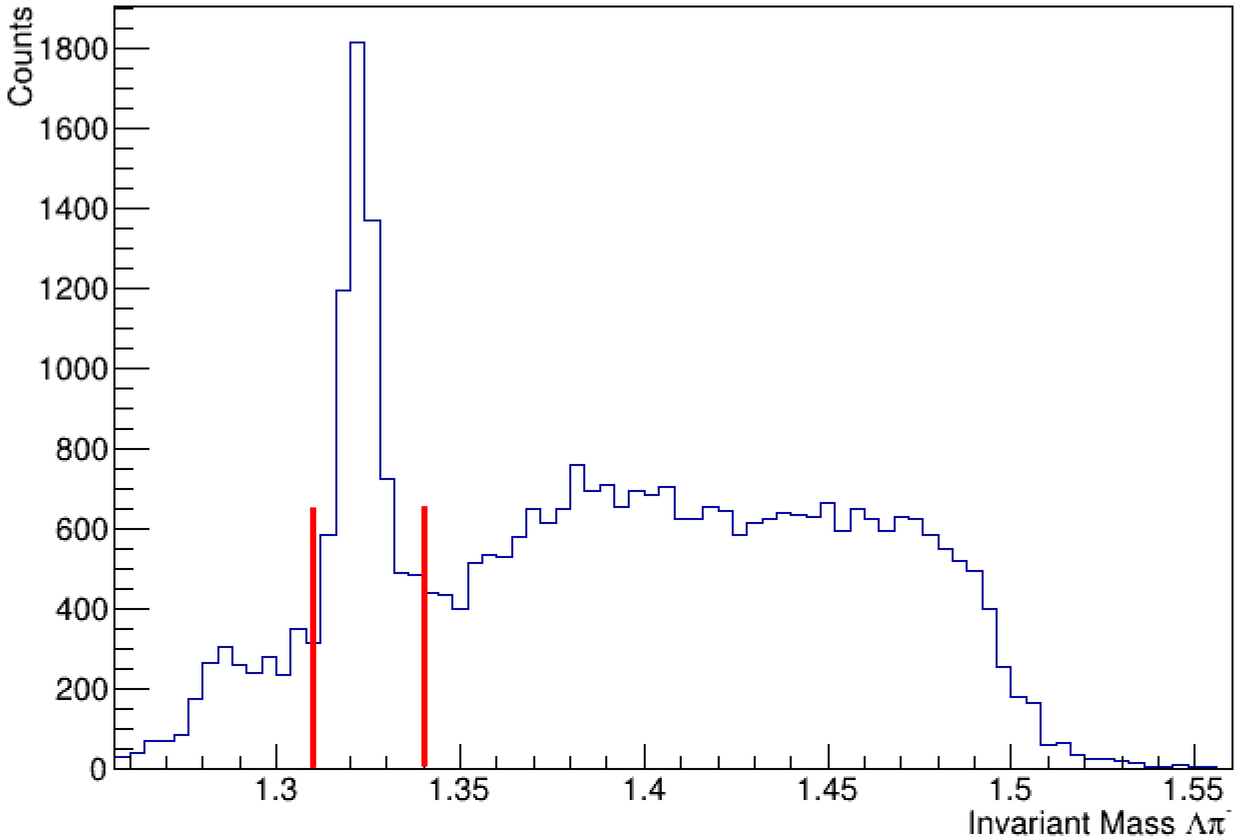
- The Λ and π^0 are Kinfit
- Data comes from Spring 18

Confidence Level Cut



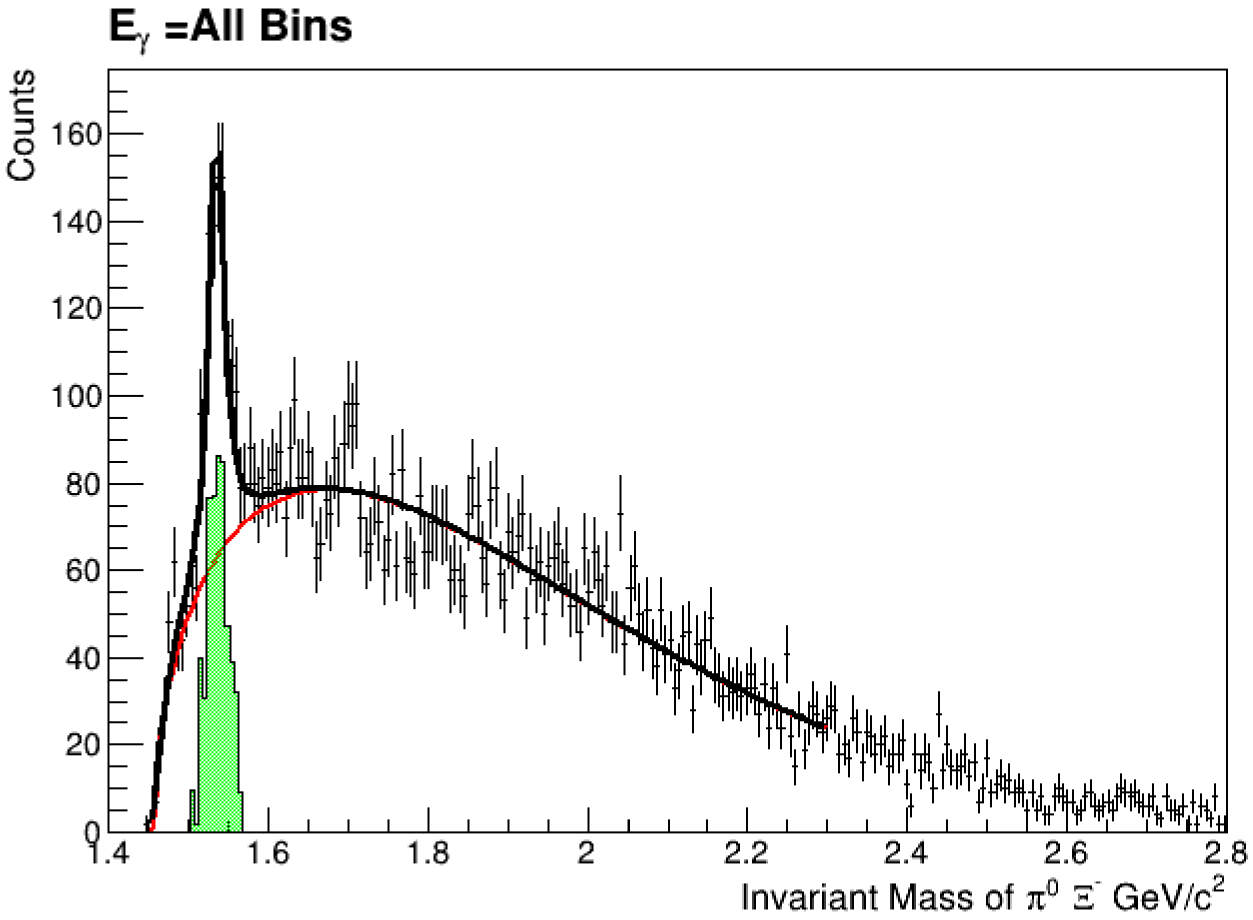
- There is a bound state signal around the mass of the cascade
- I selected events with a CL cut above 10^{-4}

Cascade Mass Cut



- The cascade mass, with a detector cut and confidence level cut produced the following plot.
- I made a mass cut from 1.31-1.34 GeV/c^2

Invariant Mass of Excited Cascade



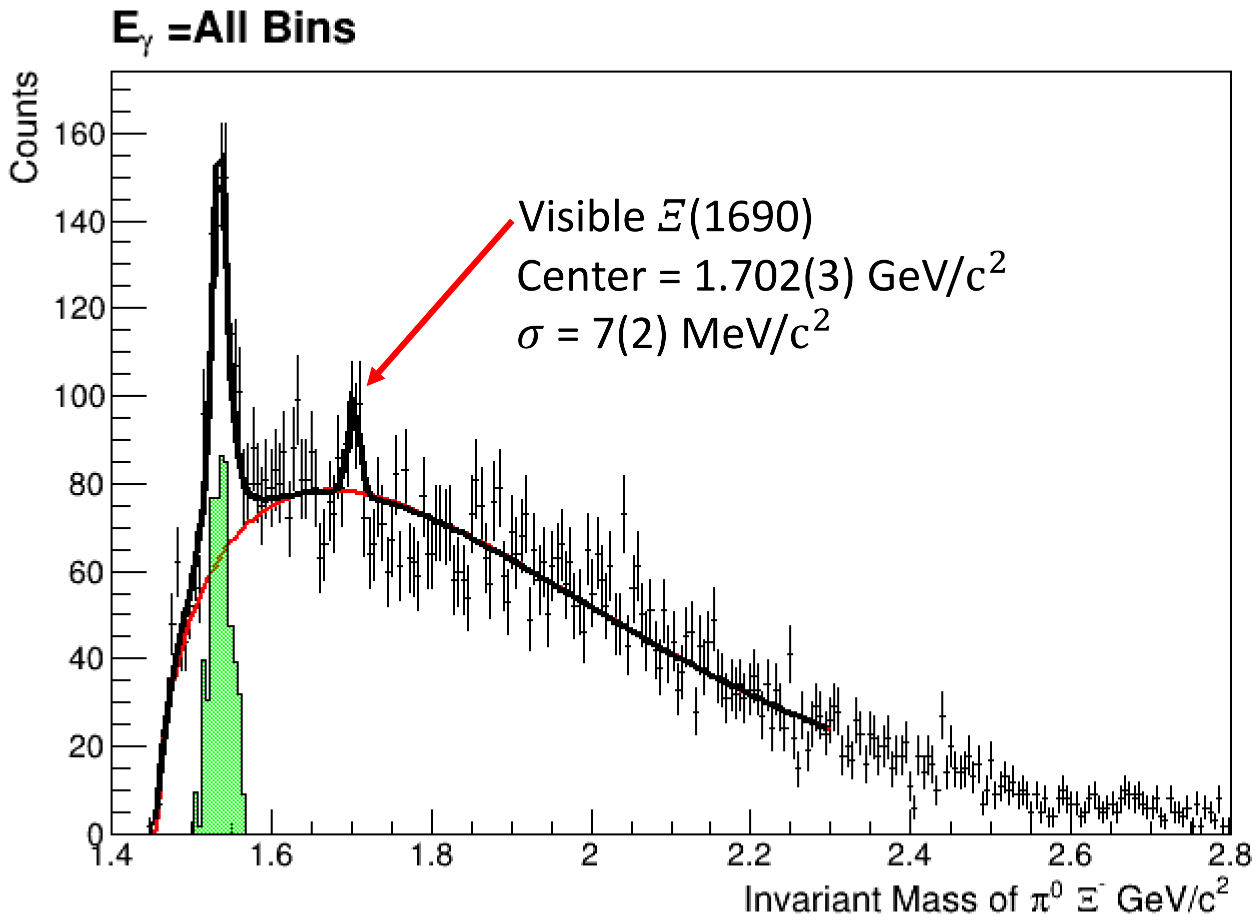
Yield = 556.9 +/-44.7
Center = 1.536(1) GeV/c^2
Width = 13(1) MeV/c^2

$\Xi(1530)$ 3/2$^+$ $I(J^P) = \frac{1}{2}(\frac{3}{2}^+)$

$\Xi(1530)^0$ mass $m = 1531.80 \pm 0.32$ MeV   (S = 1.3)
$\Xi(1530)^-$ mass $m = 1535.0 \pm 0.6$ MeV
$\Xi(1530)^0$ full width $\Gamma = 9.1 \pm 0.5$ MeV
$\Xi(1530)^-$ full width $\Gamma = 9.9^{+1.7}_{-1.9}$ MeV

$\Xi(1530)$ DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
$\Xi\pi$	100 %		158
$\Xi\gamma$	<4 %	90%	202

Invariant Mass of Excited Cascade



$\Xi(1690)$ $I(J^P) = \frac{1}{2}(?^?)$

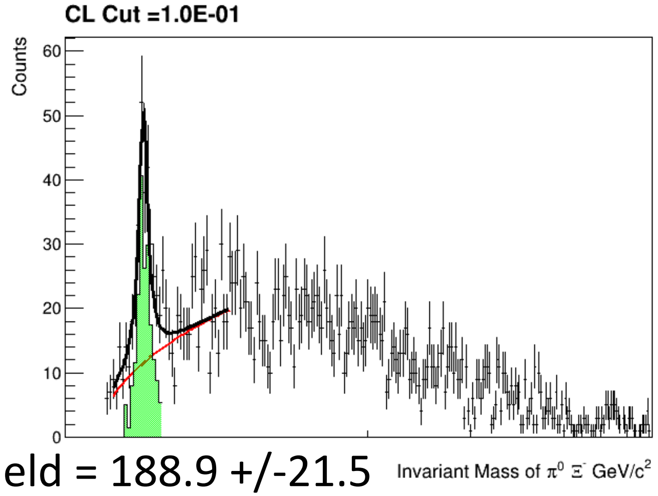
Mass $m = 1690 \pm 10$ MeV [c]
Full width $\Gamma < 30$ MeV

$\Xi(1690)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Lambda \overline{K}$	seen	240
$\Sigma \overline{K}$	seen	70
$\Xi \pi$	seen	311
$\Xi^- \pi^+ \pi^-$	possibly seen	213

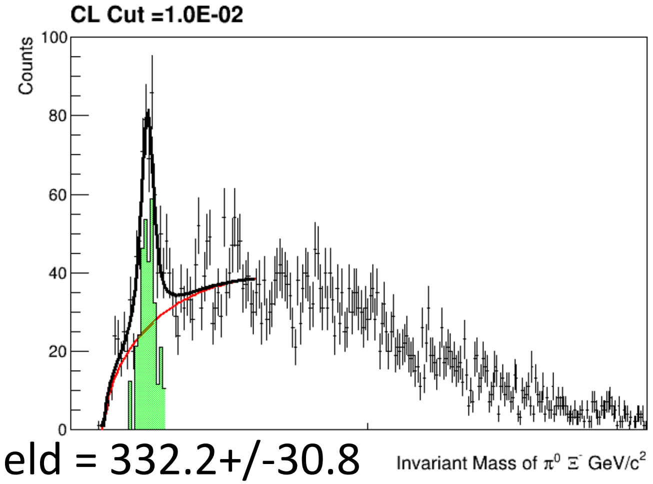
CL Study

- The CL cut needs to minimize the error in the yield improving the error in my final cross section measurement. Therefore I defined a figure of merit (FOM) as the ratio of error in the signal yield over the signal yield: σ_Y/Y
- The CL cut used in the analysis is determined by CL interval that minimizes the FOM

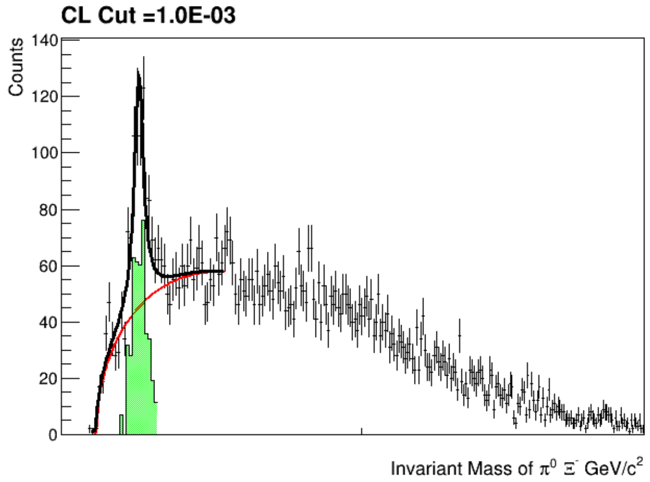
Excited Cascade Mass Spectrum (Slide 1 of 2)



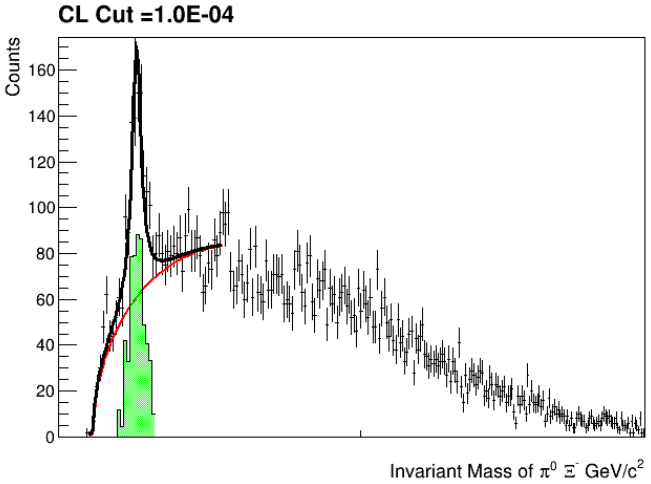
Yield = 188.9 +/-21.5



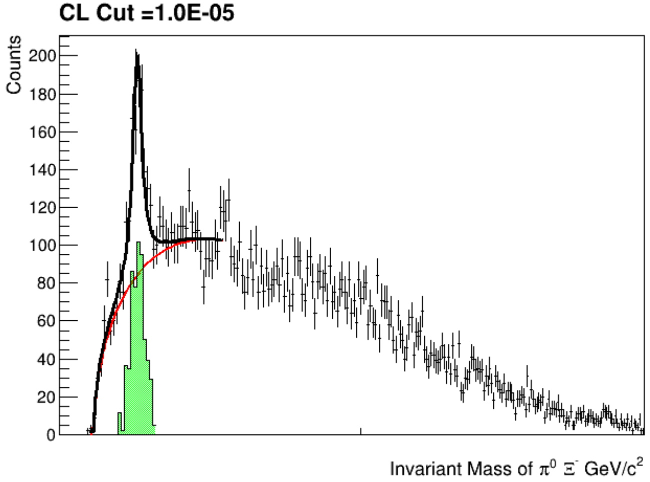
Yield = 332.2+/-30.8



Yield = 422.9 +/-38.7



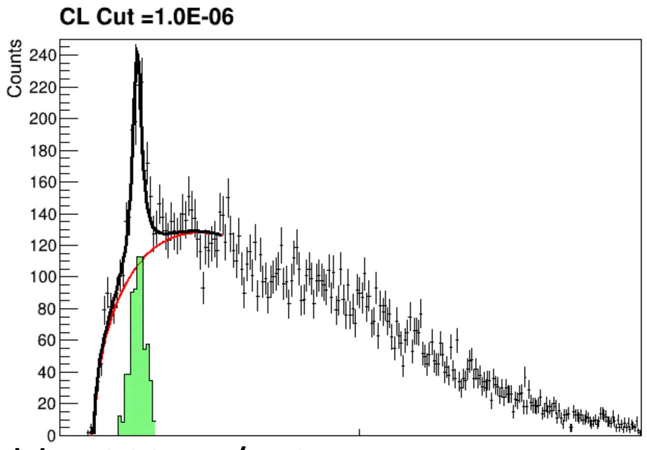
Yield = 556.9 +/-44.7



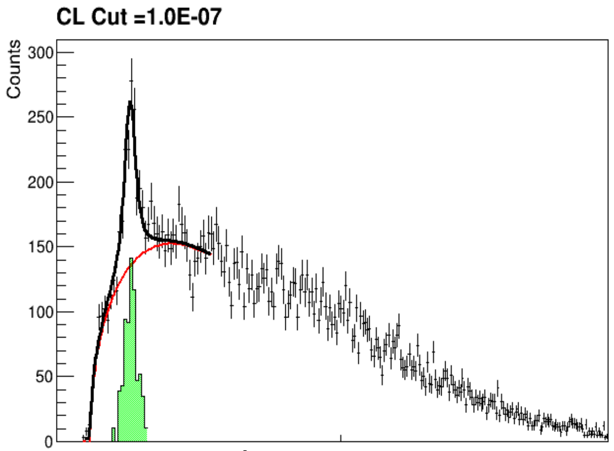
Yield = 569.2 +/-50.6

ASU

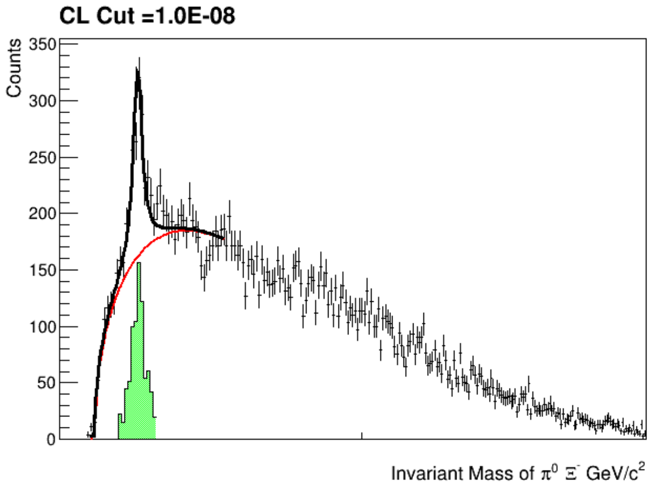
Excited Cascade Mass Spectrum (Slide 2 of 2)



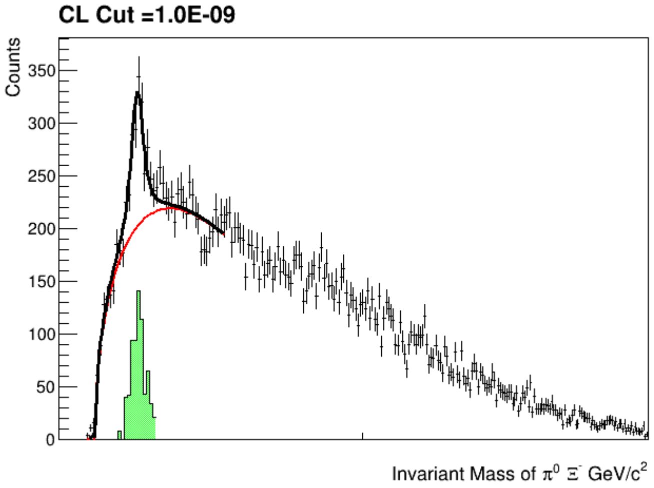
Yield = 662.4+/-56.5



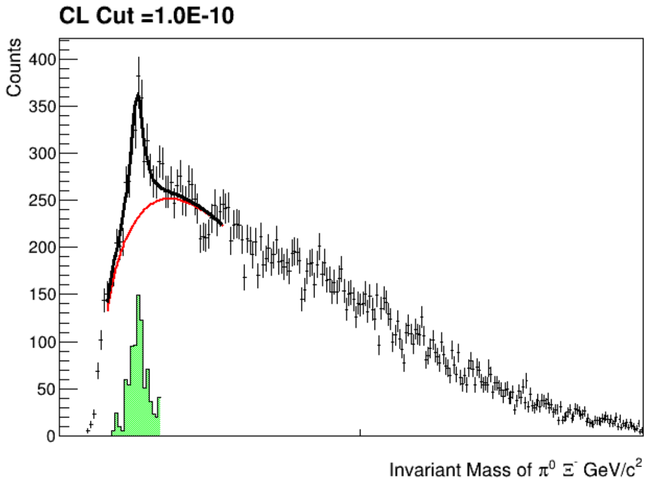
Yield = 679.2+/-62.2



Yield = 789.9+/-67.9

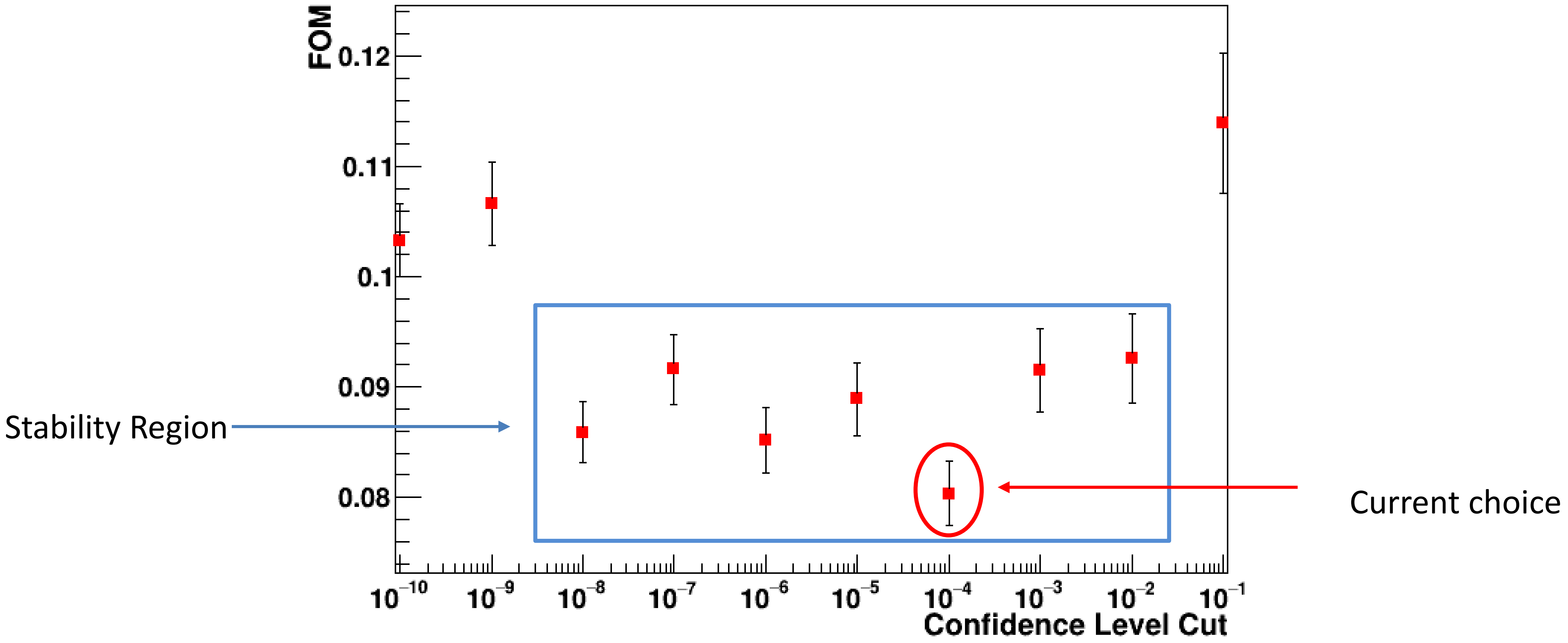


Yield = 692.1+/-73.8



Yield = 864.8+/-89.32

CL Study



FOM
0.12
0.11
0.1
0.09
0.08
10^{-10} 10^{-9} 10^{-8} 10^{-7} 10^{-6} 10^{-5} 10^{-4} 10^{-3} 10^{-2} 10^{-1}
Confidence Level Cut
Stability Region
Current choice

t-slope generation

- Theoretical Calculations done by Nakayama, Oh and Haberzettl proposed the cascade/excited cascade are produced by a two-step process:

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

- Direct production of the Ξ^{-*} would be OZI suppressed with two strange- antistrange pairs at the production vertex. Therefore, I defined t as:

$$t = \left(P_{\gamma} - P_{K^{+}}\right)^{2}$$

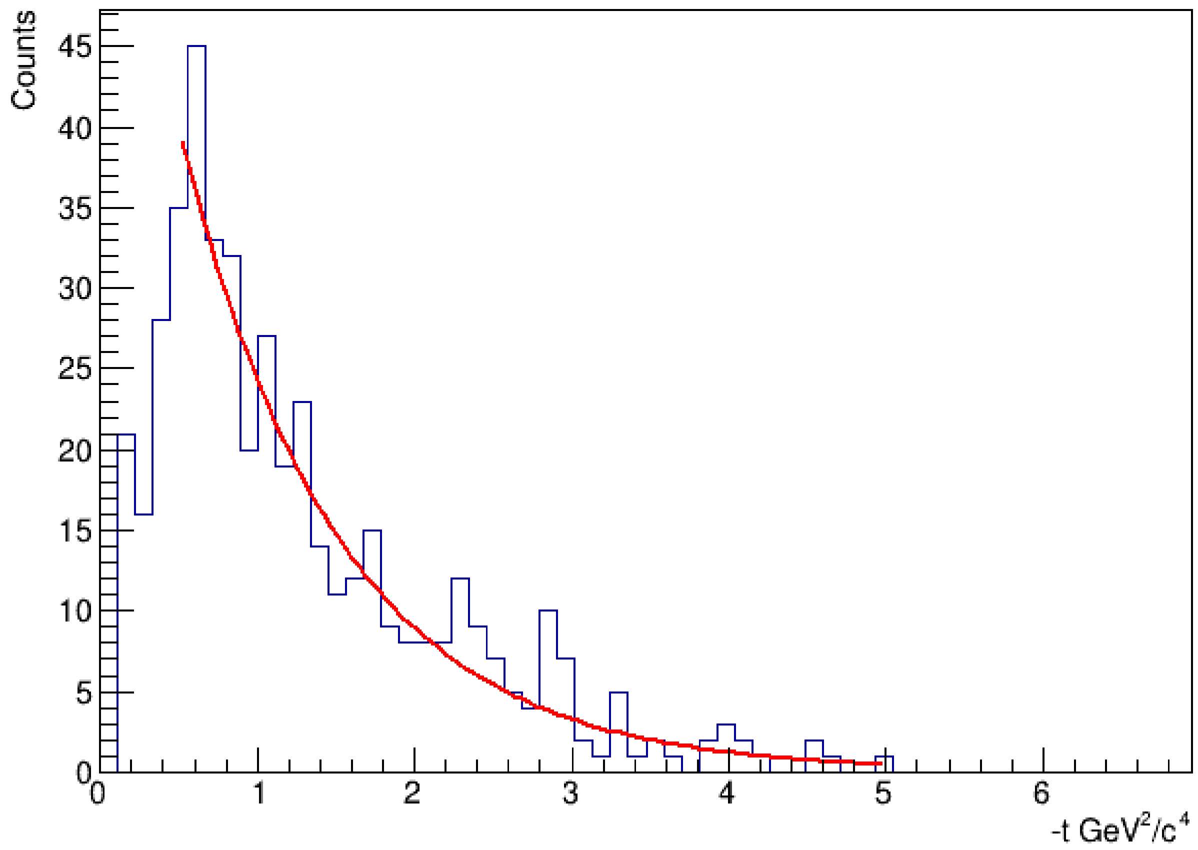
ASU

MC Generation

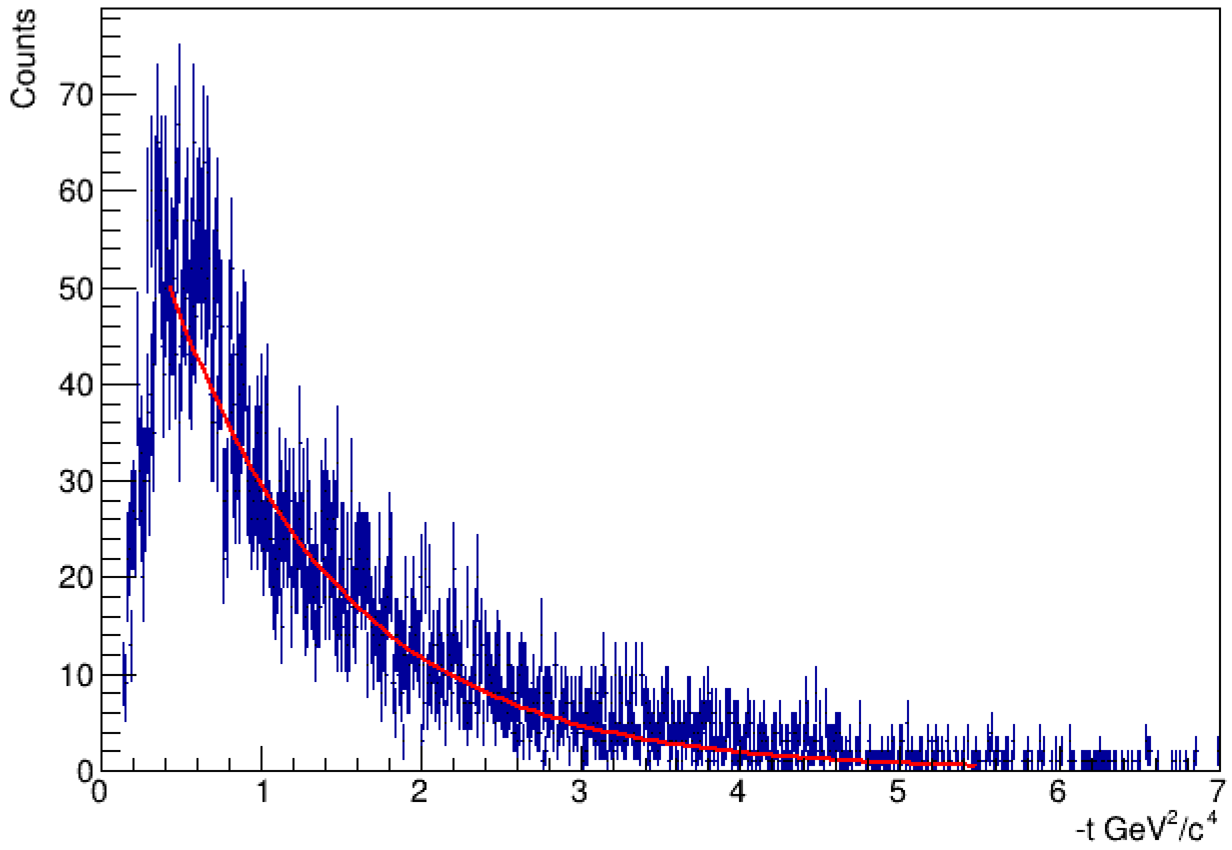
Assuming : $\frac{d\sigma}{dt} \propto e^{-bt}$

- 3.6 million events generated
- Using Genr8
- Initially setting the t-slope to be b = 1.1 $\mathrm{c}^4/\mathrm{GeV}^2$

t-slope: MC and real

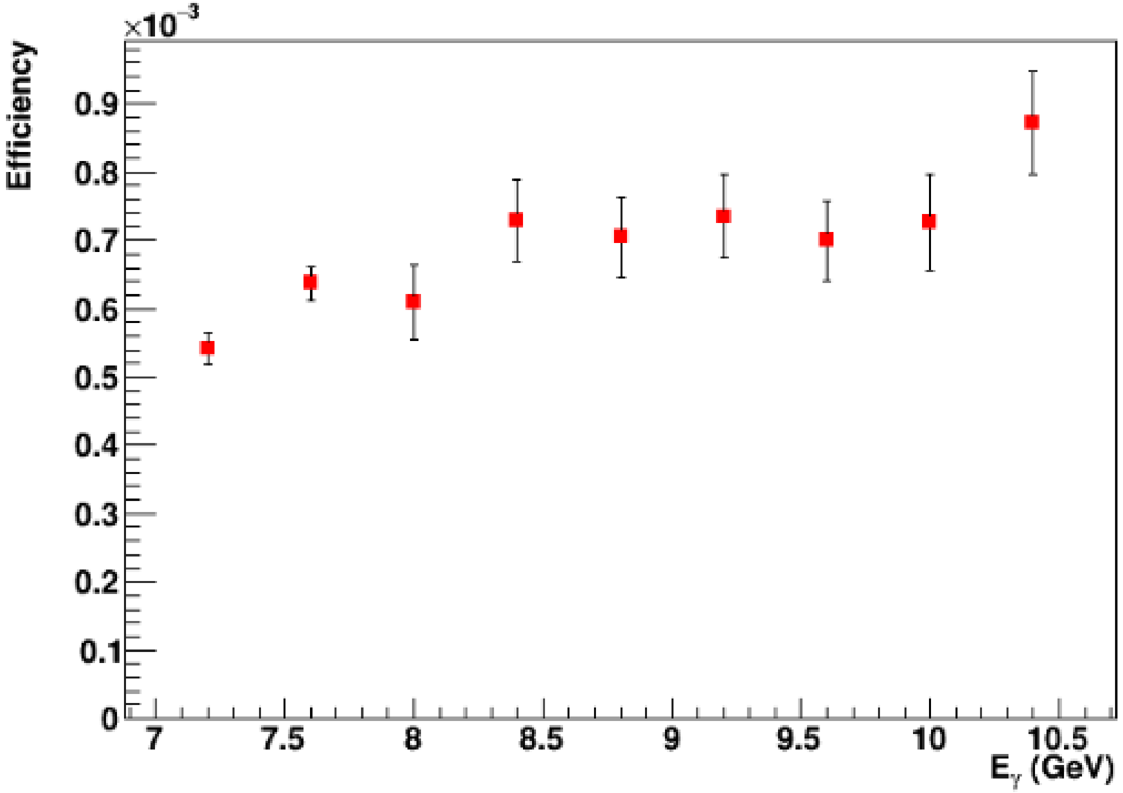


Seen MC *t*-slope = .99 $\mathrm{GeV}^2/\mathrm{c}^4$



Real *t*-slope = .92 $\mathrm{GeV}^2/\mathrm{c}^4$

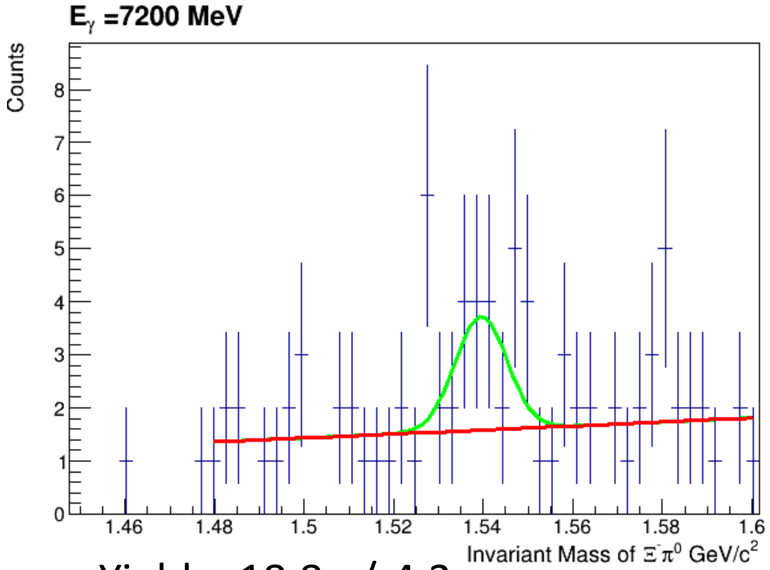
Efficiency vs Beam energy



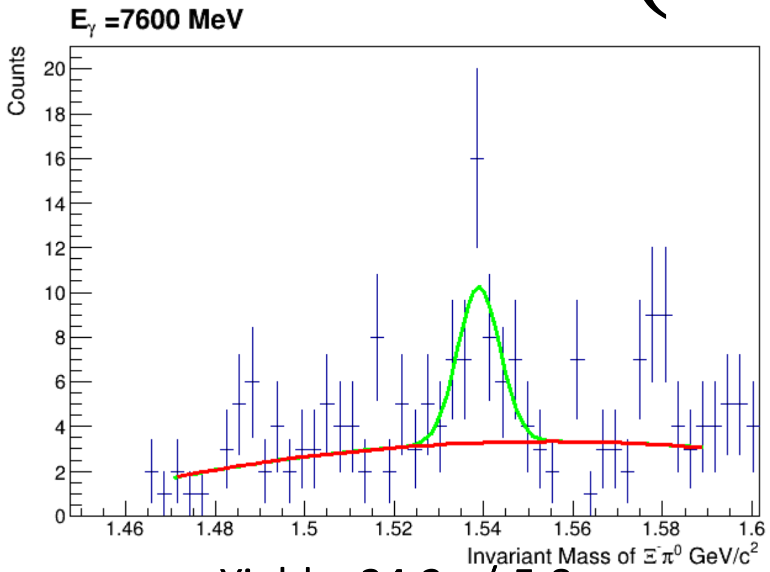
- The next step is to extract yields in 400 MeV wide beam energy bins from 7.0 – 11.0 GeV for a cross section measurement.
- Fits use a Gaussian for the signal and second order polynomial for the background.

Arizona State University

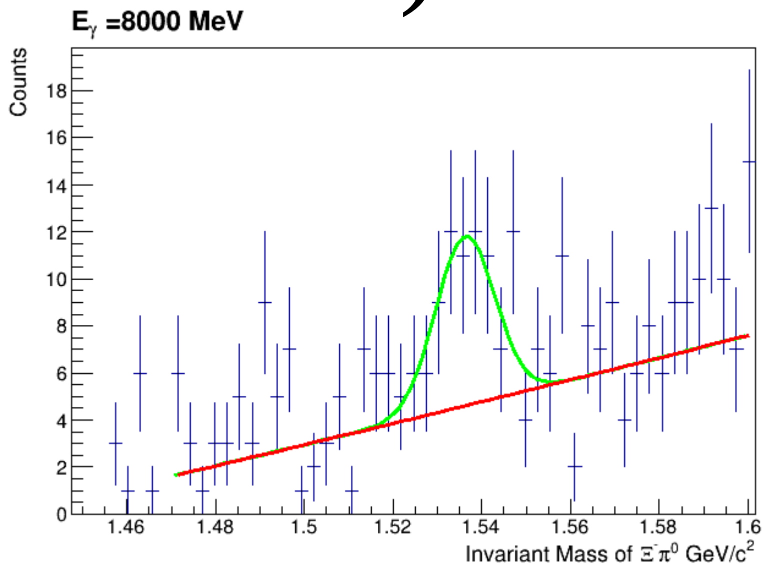
Cross Section Yields (Slide 1 of 2)



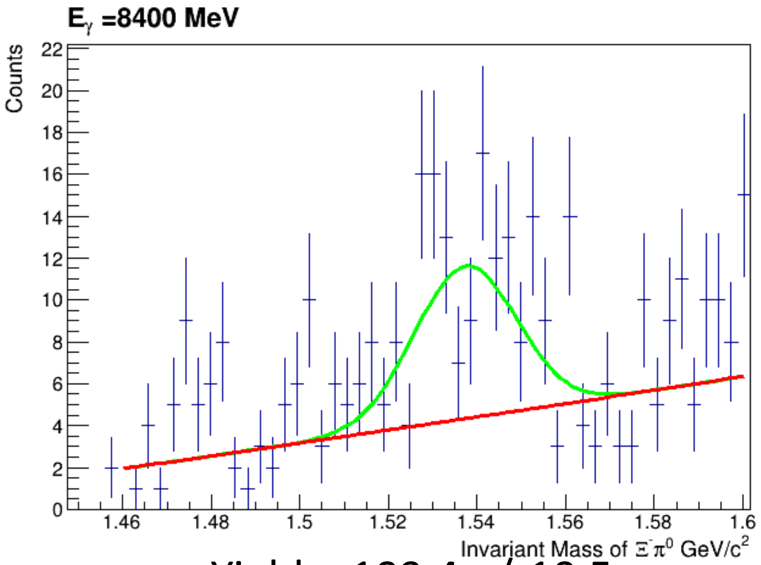
Yield = 18.8 +/-4.3



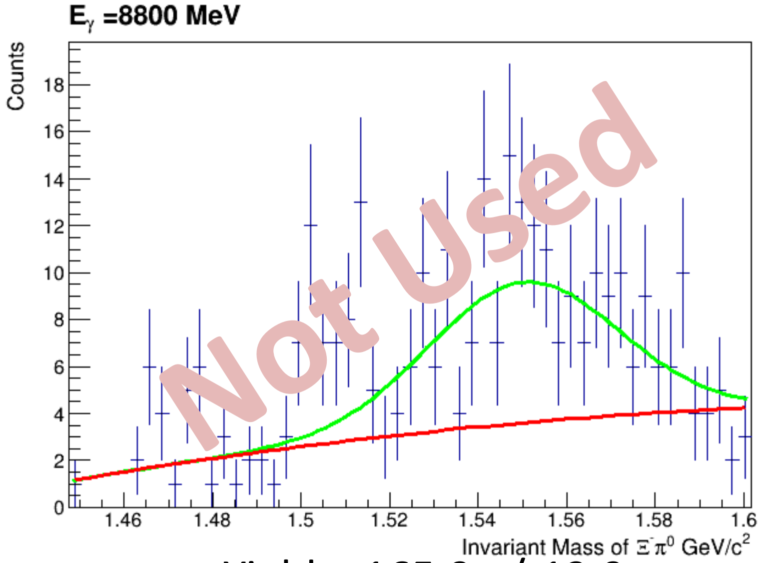
Yield = 34.2 +/-5.8



Yield = 51.2 +/-7.2

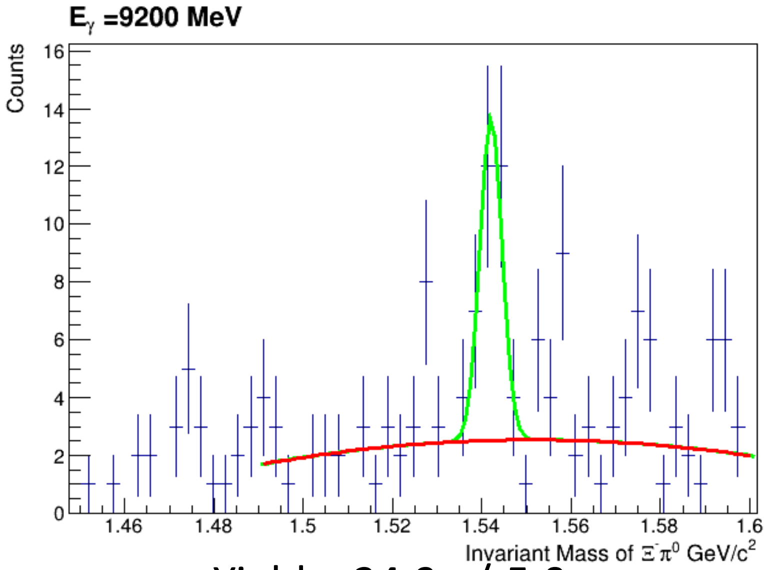


Yield = 109.4 +/-10.5

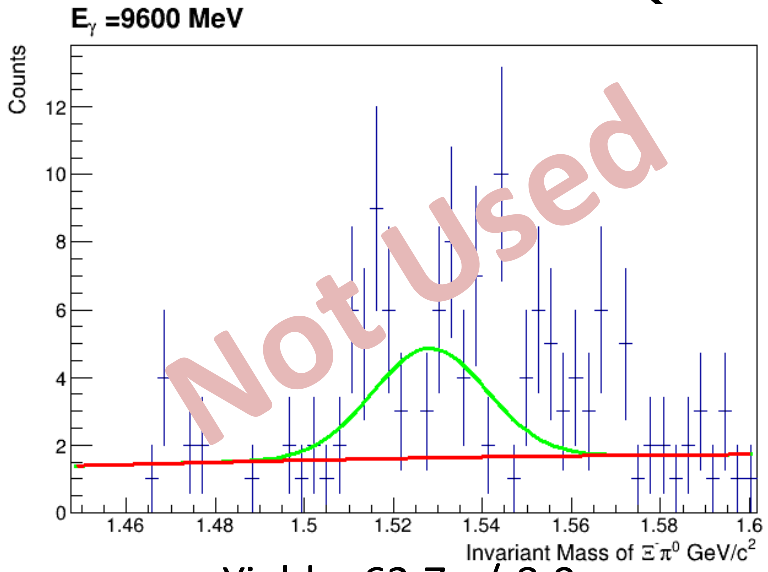


Yield = 165.9 +/-12.9

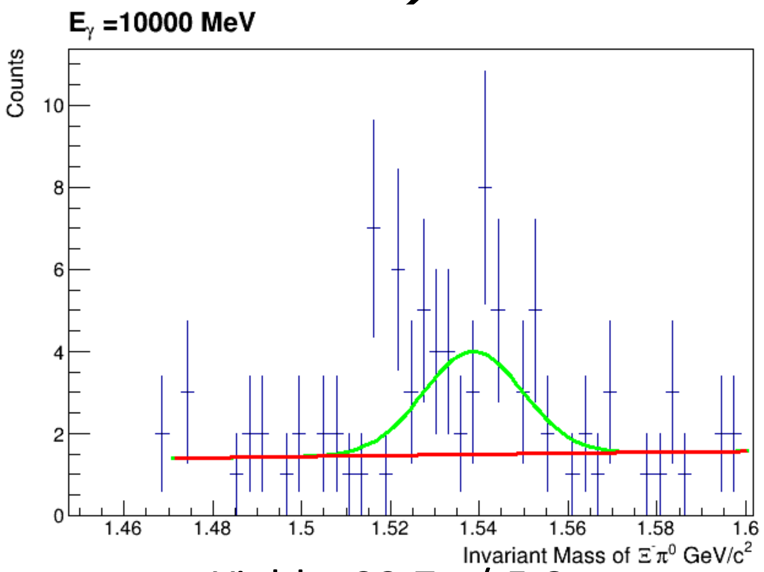
Cross Section Yields (Slide 1 of 2)



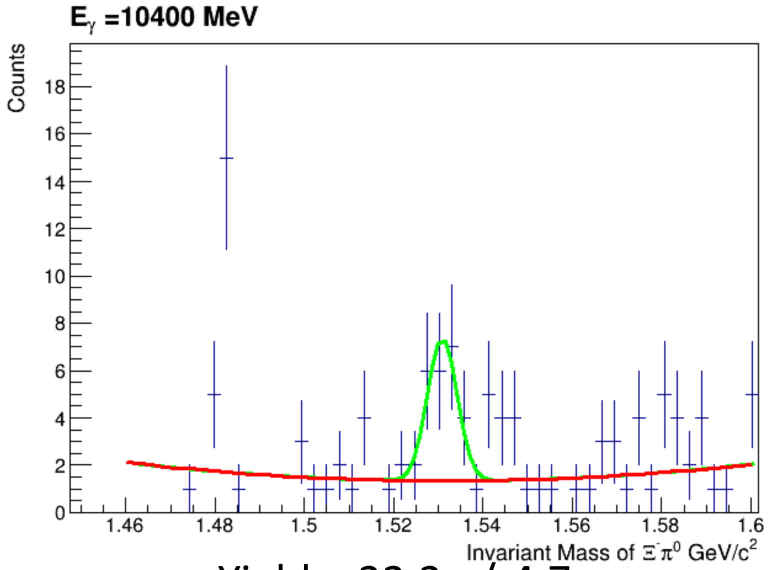
Yield = 24.9 +/-5.0



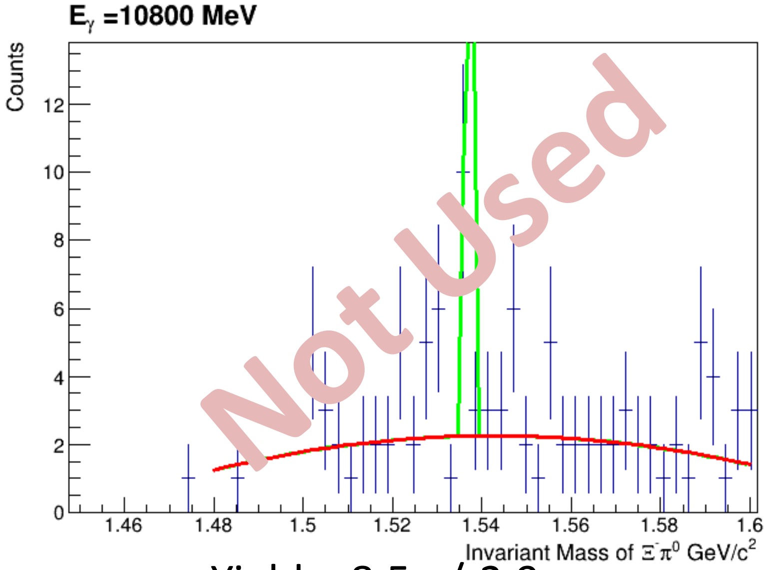
Yield = 63.7 +/-8.0



Yield = 33.7 +/-5.8

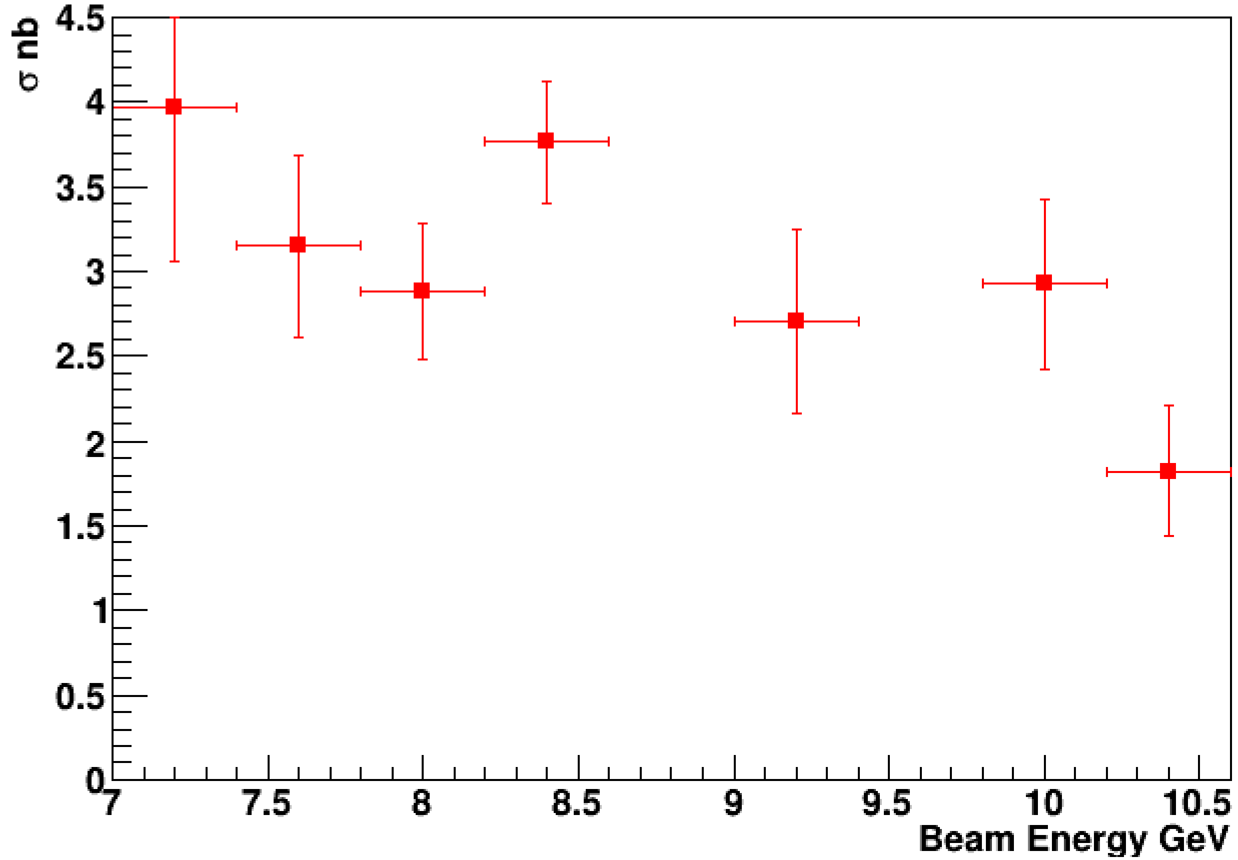


Yield = 22.2 +/-4.7



Yield = 8.5 +/-2.9

Cross Section



Next Steps

- Cross section in t

- Investigate efficiency corrected yields in terms of confidence level

- Look into other Decay Modes

- Increase Statistics

End