A Study of $\gamma p \rightarrow K^{+}\Lambda^{*}$ reaction

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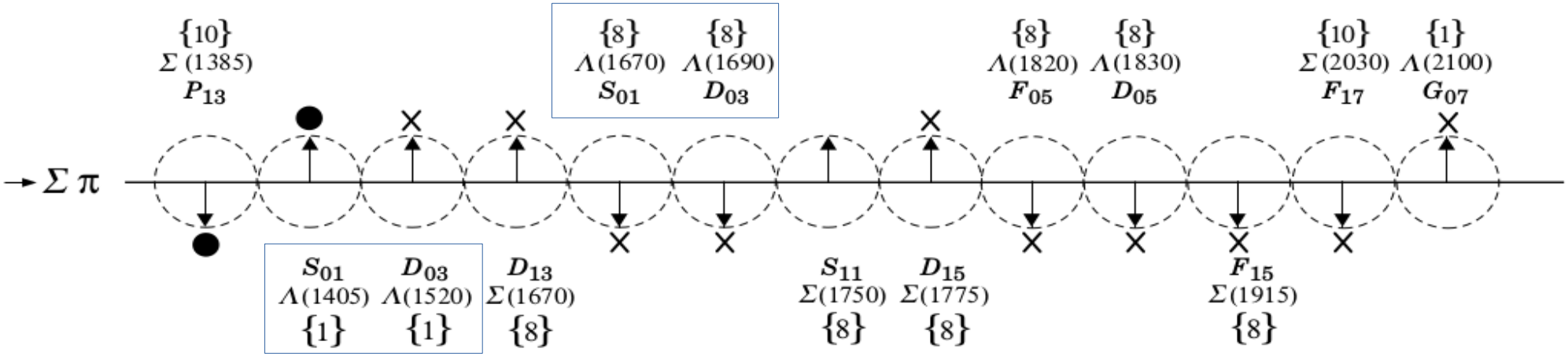
Motivation



Particle	J^P	Overall status	$N\overline{K}$	$\Lambda\pi$	$\Sigma\pi$	Other channels
$\Lambda(1116)$	$1/2+$	****		F		$N\pi$(weakly)
$\Lambda(1405)$	$1/2-$	****	****	o	****	
$\Lambda(1520)$	$3/2-$	****	****	r	****	$\Lambda\pi\pi, \Lambda\gamma$
$\Lambda(1600)$	$1/2+$	***	***	b	**	
$\Lambda(1670)$	$1/2-$	****	****	i	****	$\Lambda\eta$
$\Lambda(1690)$	$3/2-$	****	****	d	****	$\Lambda\pi\pi, \Sigma\pi\pi$

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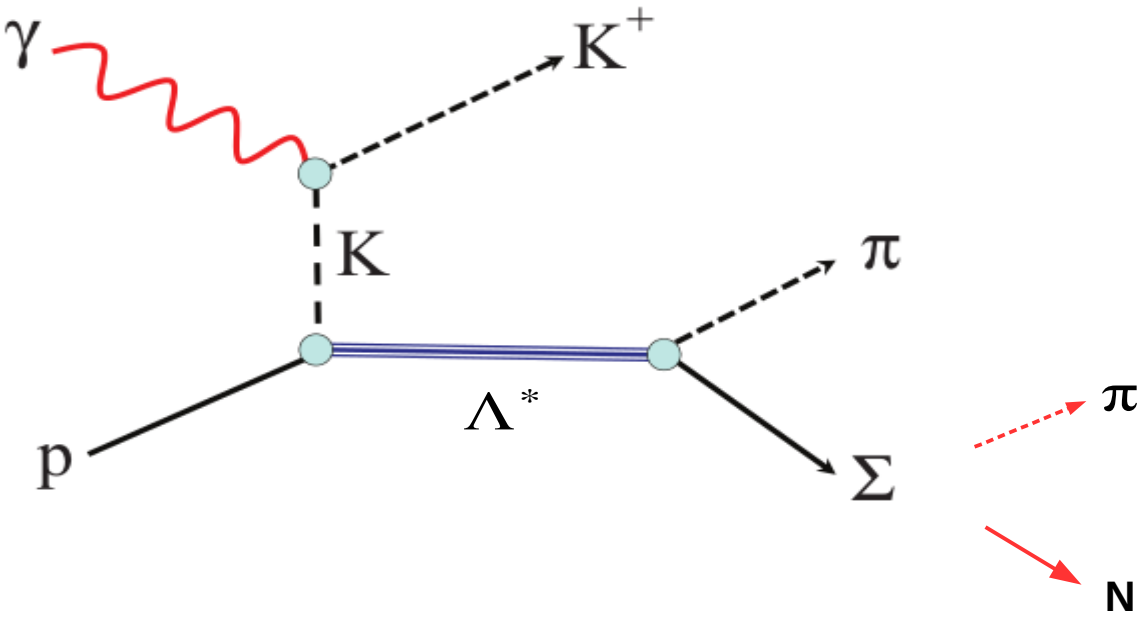
Motivation



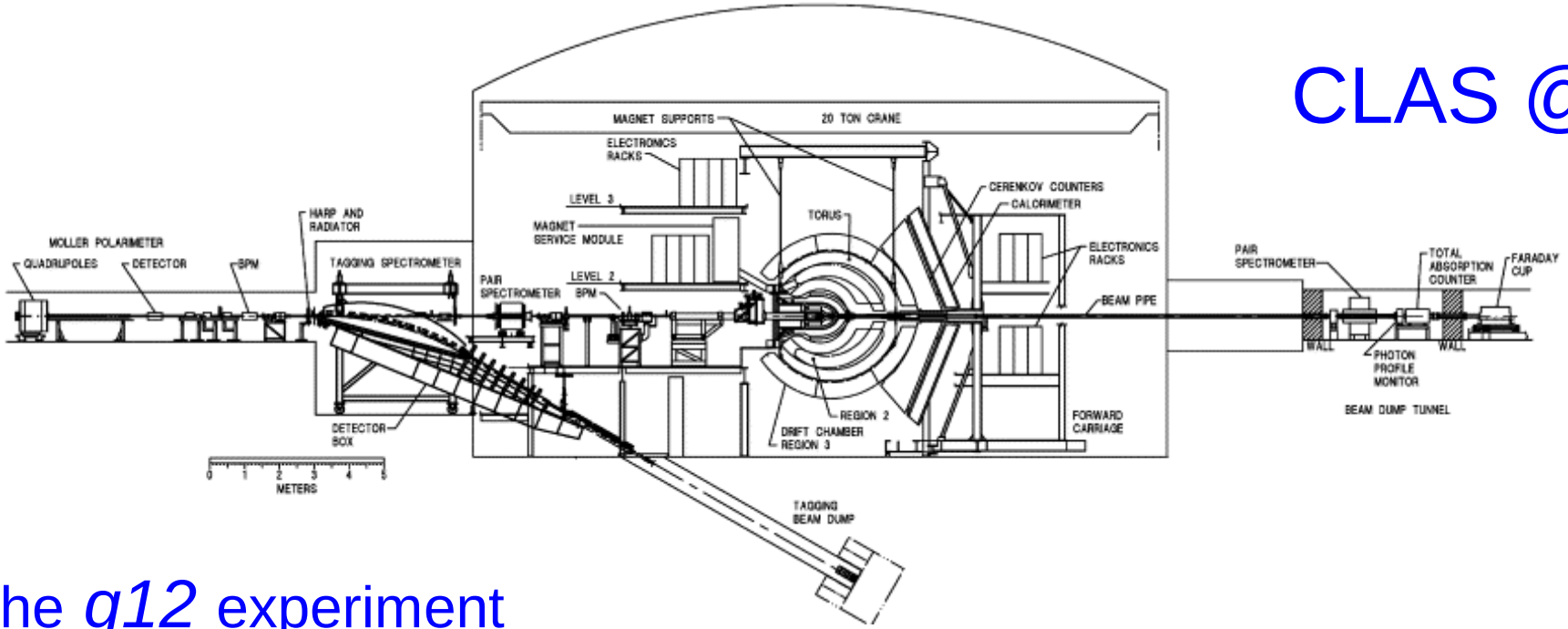
$$\gamma + p \rightarrow K^{+} + \Lambda^{*}$$

$$\Lambda^{*} \rightarrow \Sigma^{+} + \pi^{-}$$

$$\Lambda^{*} \rightarrow \Sigma^{-} + \pi^{+}$$

- $\Lambda(1405)1/2^{-}$ and $\Lambda(1520)3/2^{-}$ are rated 4-star by Particle Data Group
- Insight into higher resonances $\Lambda(1670)1/2^{-}$ and $\Lambda(1690)3/2^{-}$

CLAS @ Jlab



The *g12* experiment

E_{beam} of photon	5.715 GeV
Beam Polarization	Circular
e^- Current	60–65 nA
Tagger Range	5% - 95% of e^- energy
Tagger Trigger Range	3.6–5.441 GeV
Torus Magnet	$\frac{1}{2}B_{\max}$ (1930 A)

Target Length	40 cm
Target Center (z location)	–90 cm
Target Material	ℓH_2
Target Polarization	None
Start Counter Offset	0 cm
Radiator Thickness	10^{-4} radiation lengths
Collimator Radius	6.4 mm

PID

$$\gamma + p \rightarrow K^{+} + \Lambda\,(1520)$$

~14% → $\Sigma^{+} + \pi^{-}$

~14% → $\Sigma^{-} + \pi^{+}$

~48% → $n + \pi^{+}$

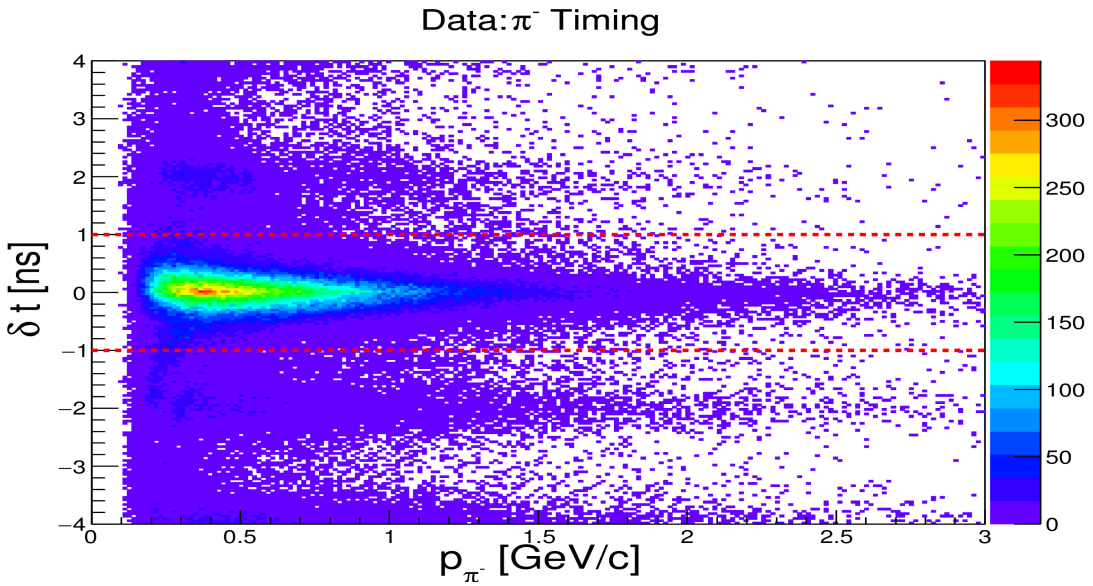
~100% → $n + \pi^{-}$

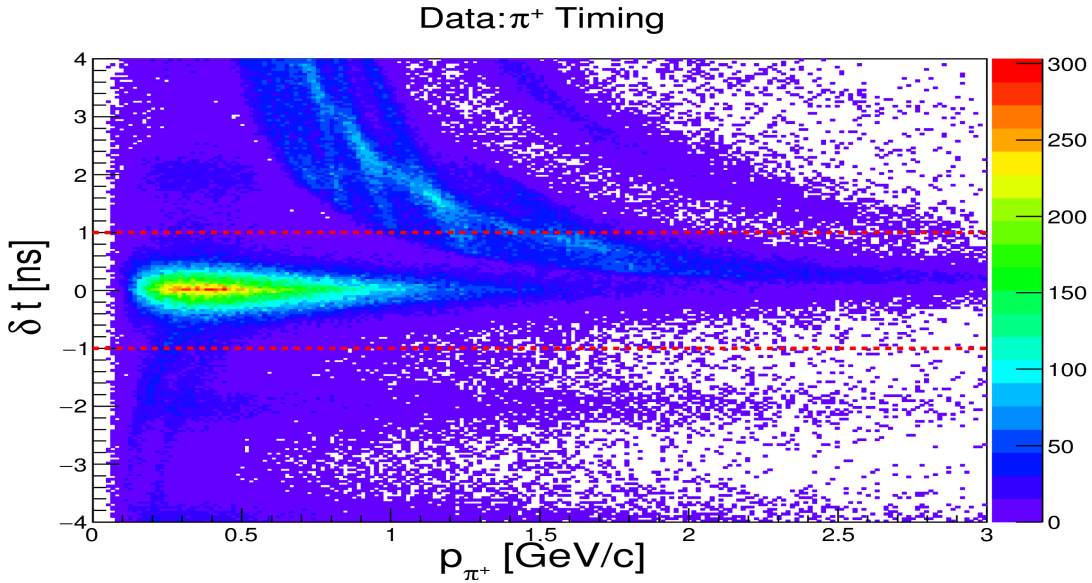
$$\delta t = t_{meas} - t_{calc}$$

$$t_{meas} = t_{SC} - t_{\gamma}$$

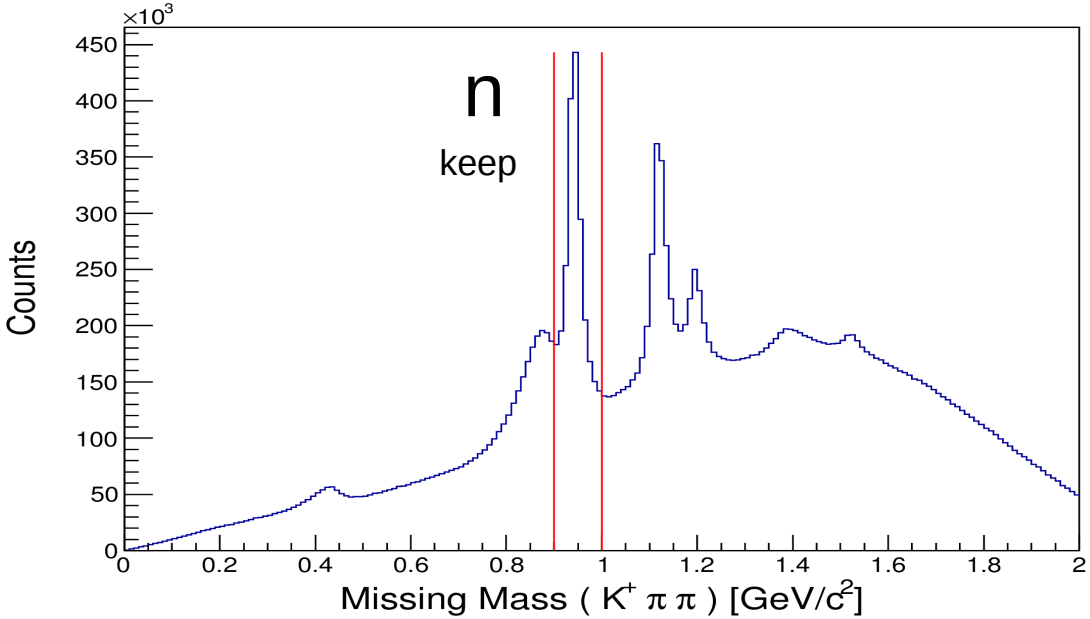
$$t_{calc} = \frac{d_{path}}{c}\frac{E_i}{p_i}$$

Similar |δt| < 1 [ns] for K^{+} was done

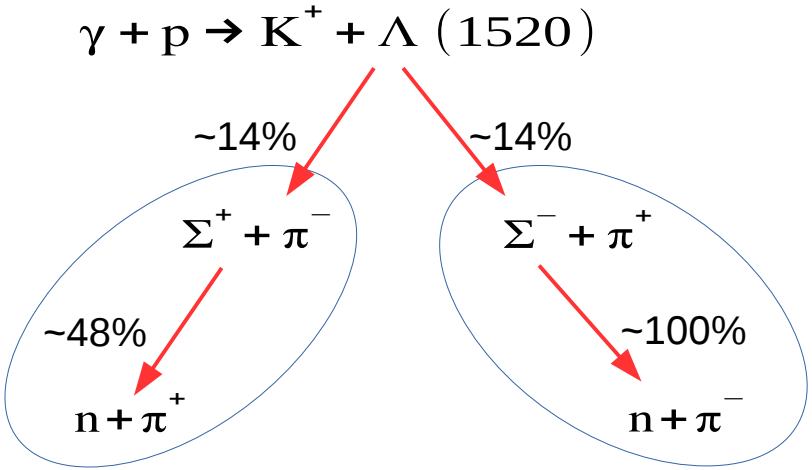


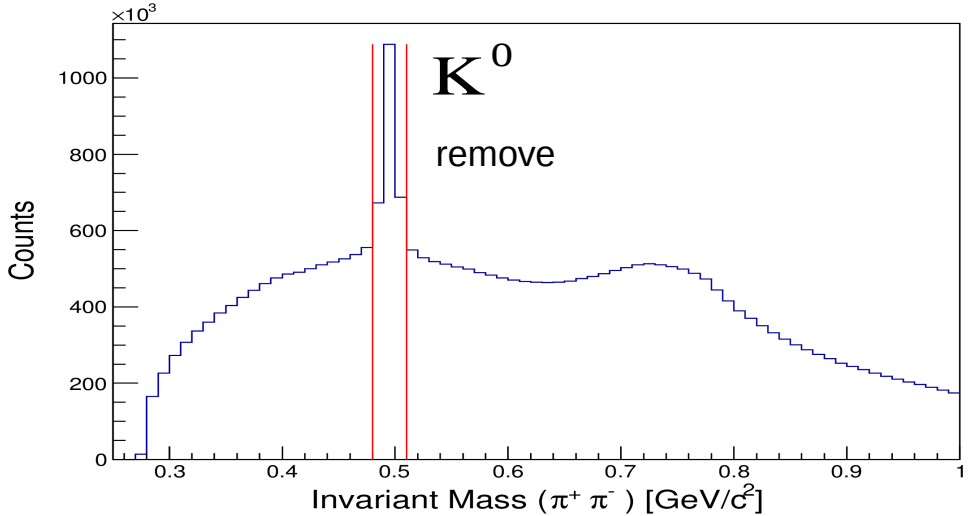


Cuts



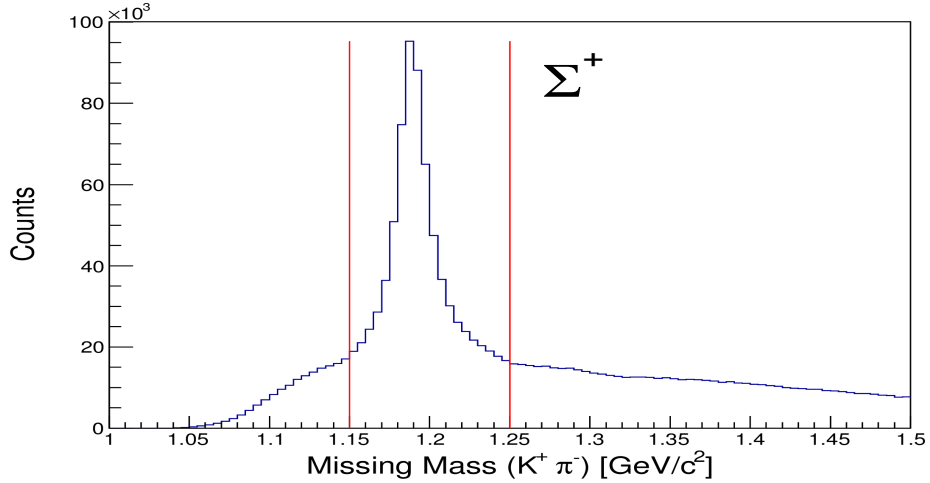
$0.9 < MM(K^{+}\pi\pi) < 1.0$ [GeV]



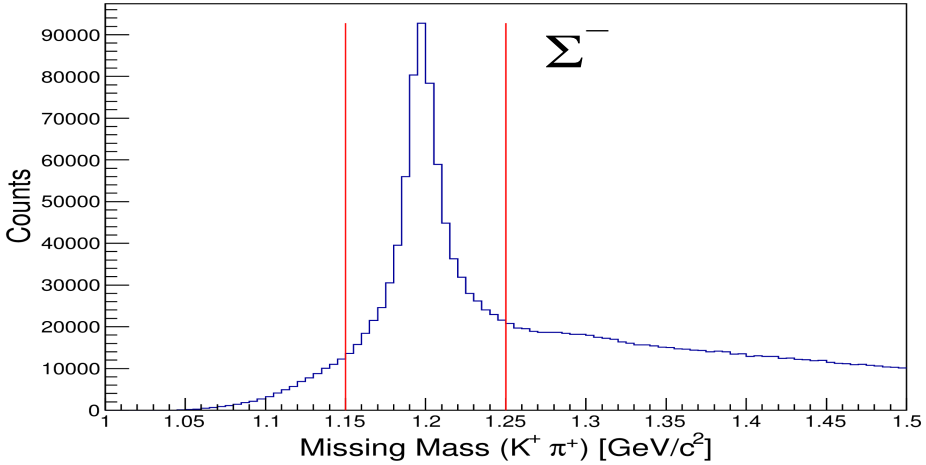


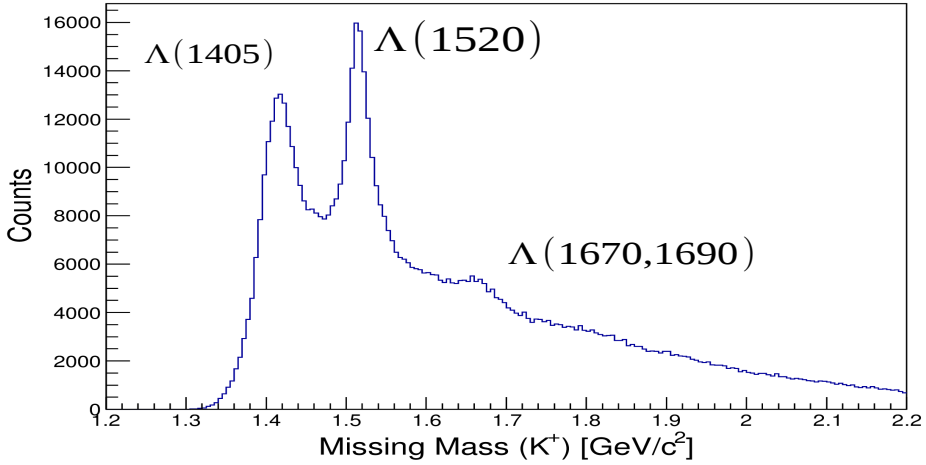
Cuts

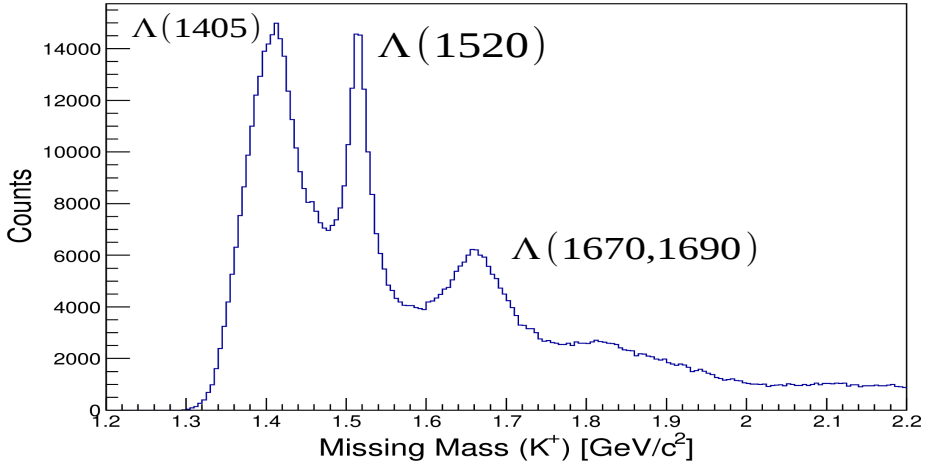
$\Lambda(1520) \rightarrow \Sigma^+ + \pi^-$



$\Lambda(1520) \rightarrow \Sigma^- + \pi^+$

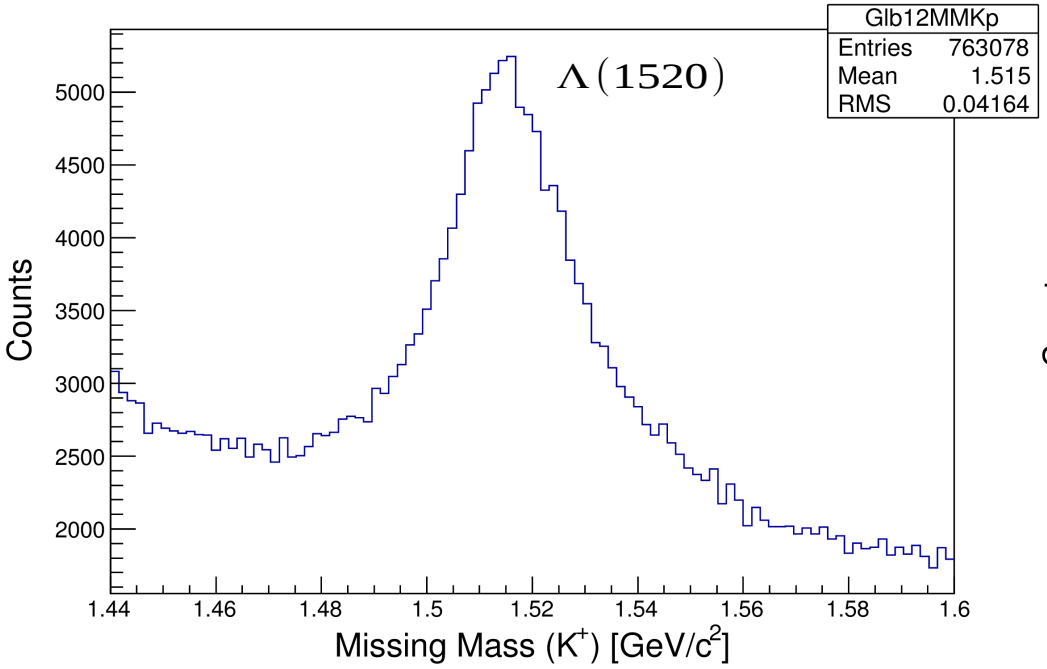




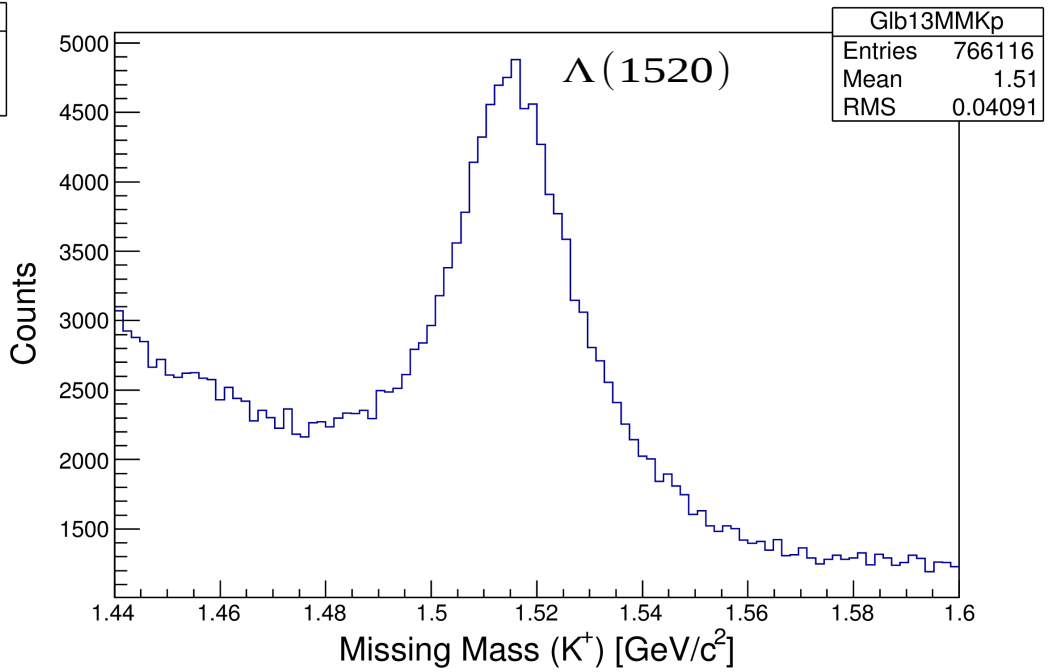


Global Spectrum

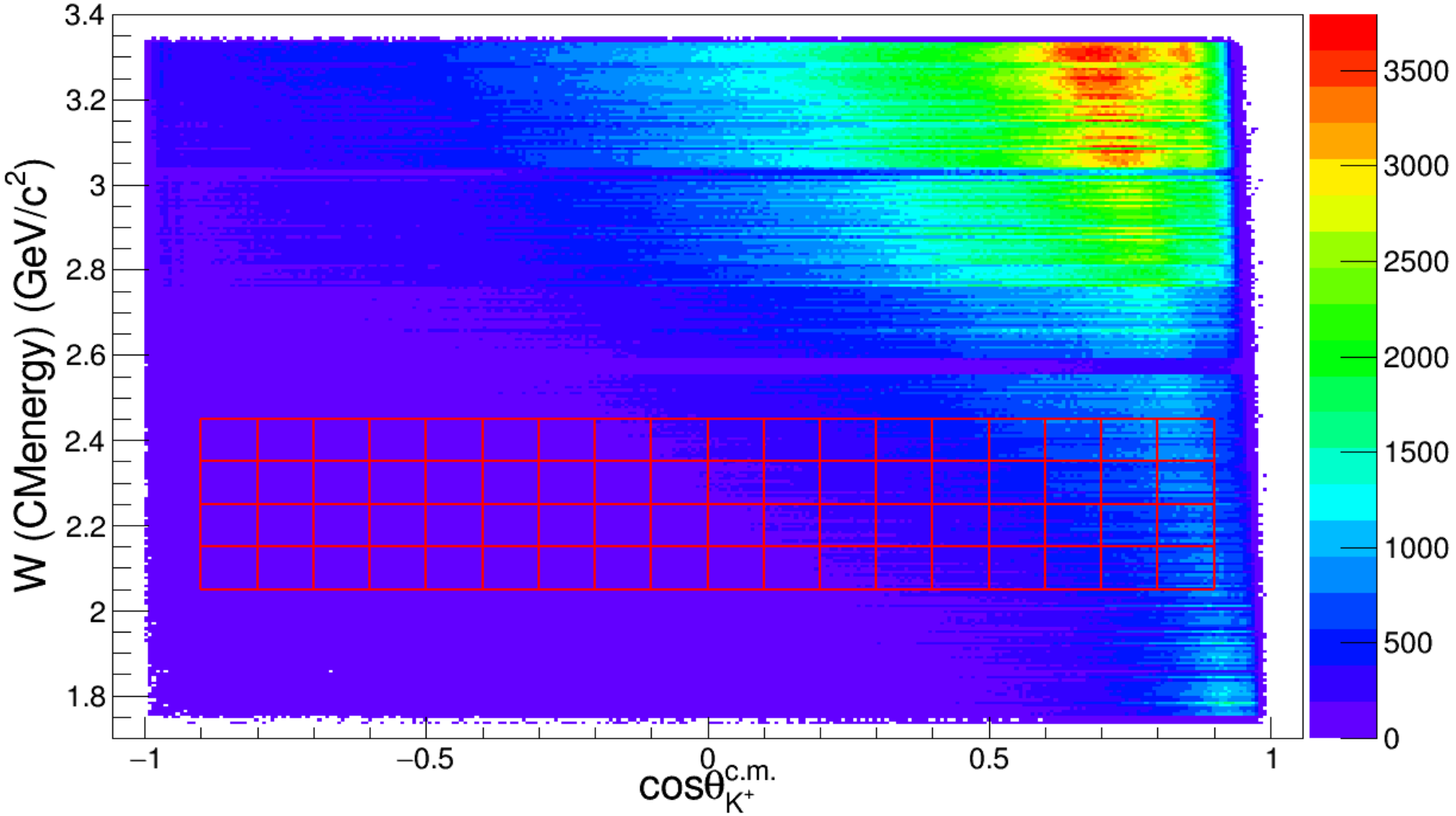
$\Lambda(1520) \rightarrow \Sigma^{+} + \pi^{-}$



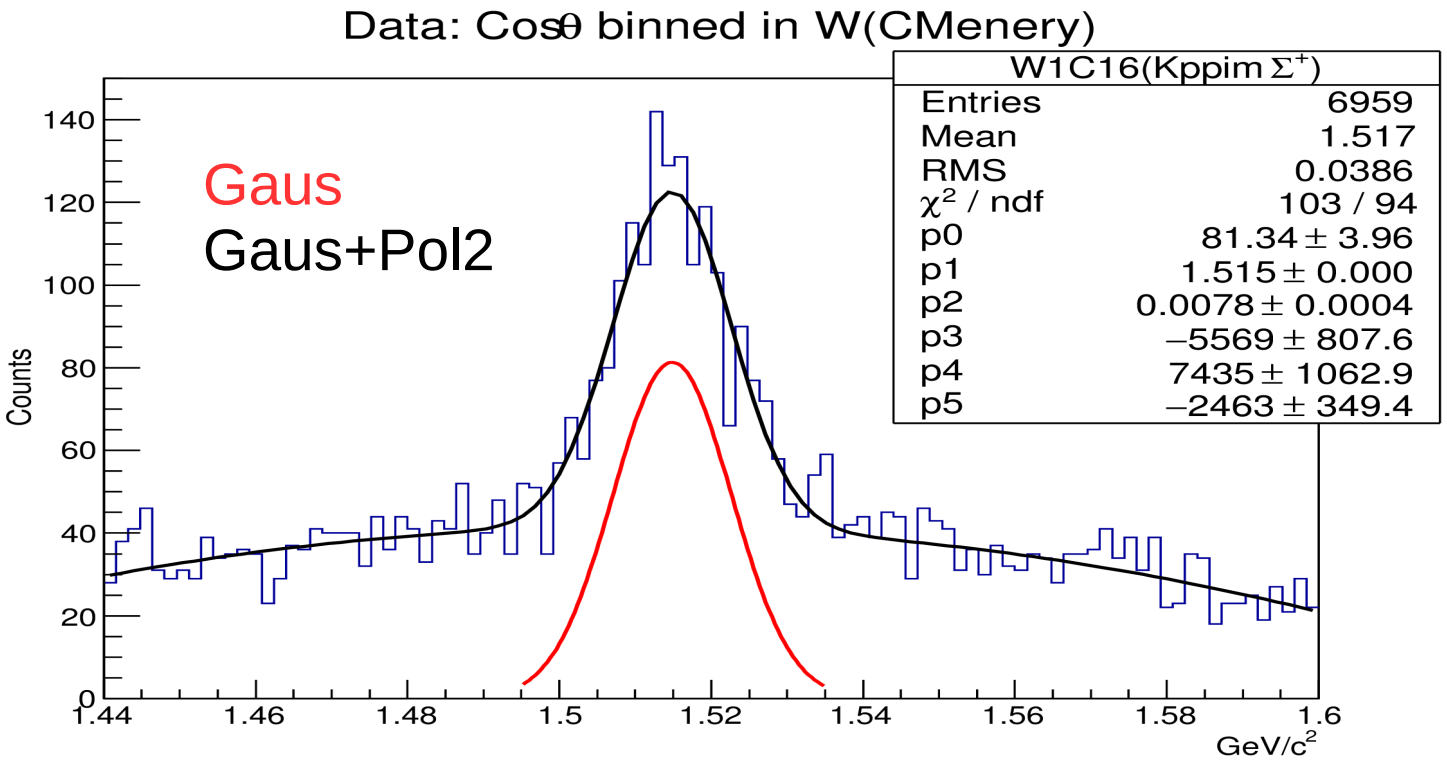
$\Lambda(1520) \rightarrow \Sigma^{-} + \pi^{+}$

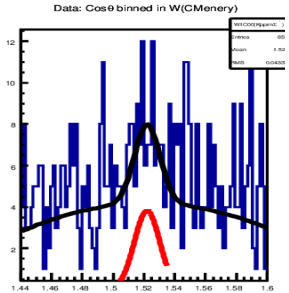


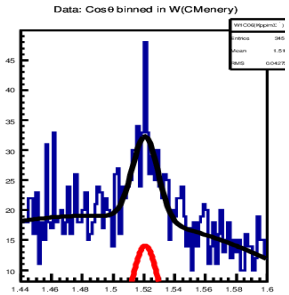
Bin Scheme

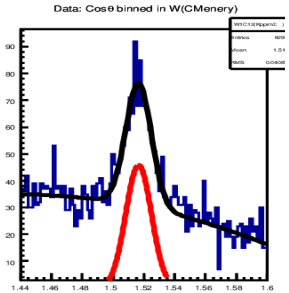

W (CMenergy) (GeV/c^2)
3.4
3.2
3
2.8
2.6
2.4
2.2
2
1.8
−1
−0.5
0
0.5
1
$\cos\theta^{c.m.}_{K^+}$
3500
3000
2500
2000
1500
1000
500
0

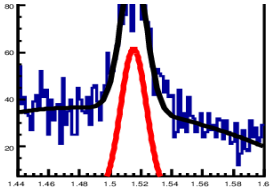
Yield Extraction & Fit

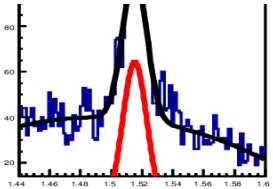


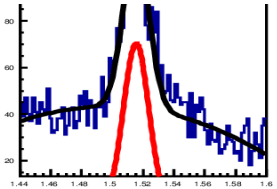


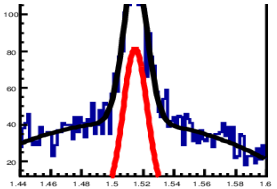


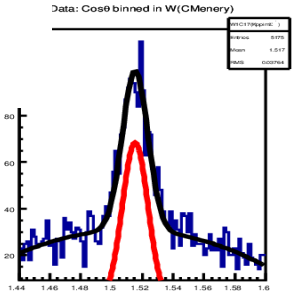


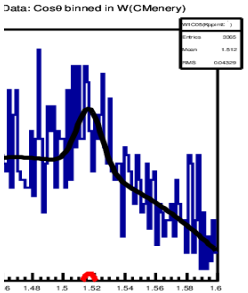


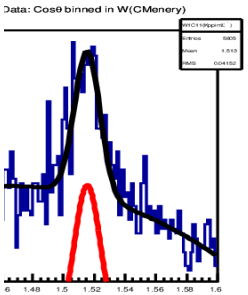








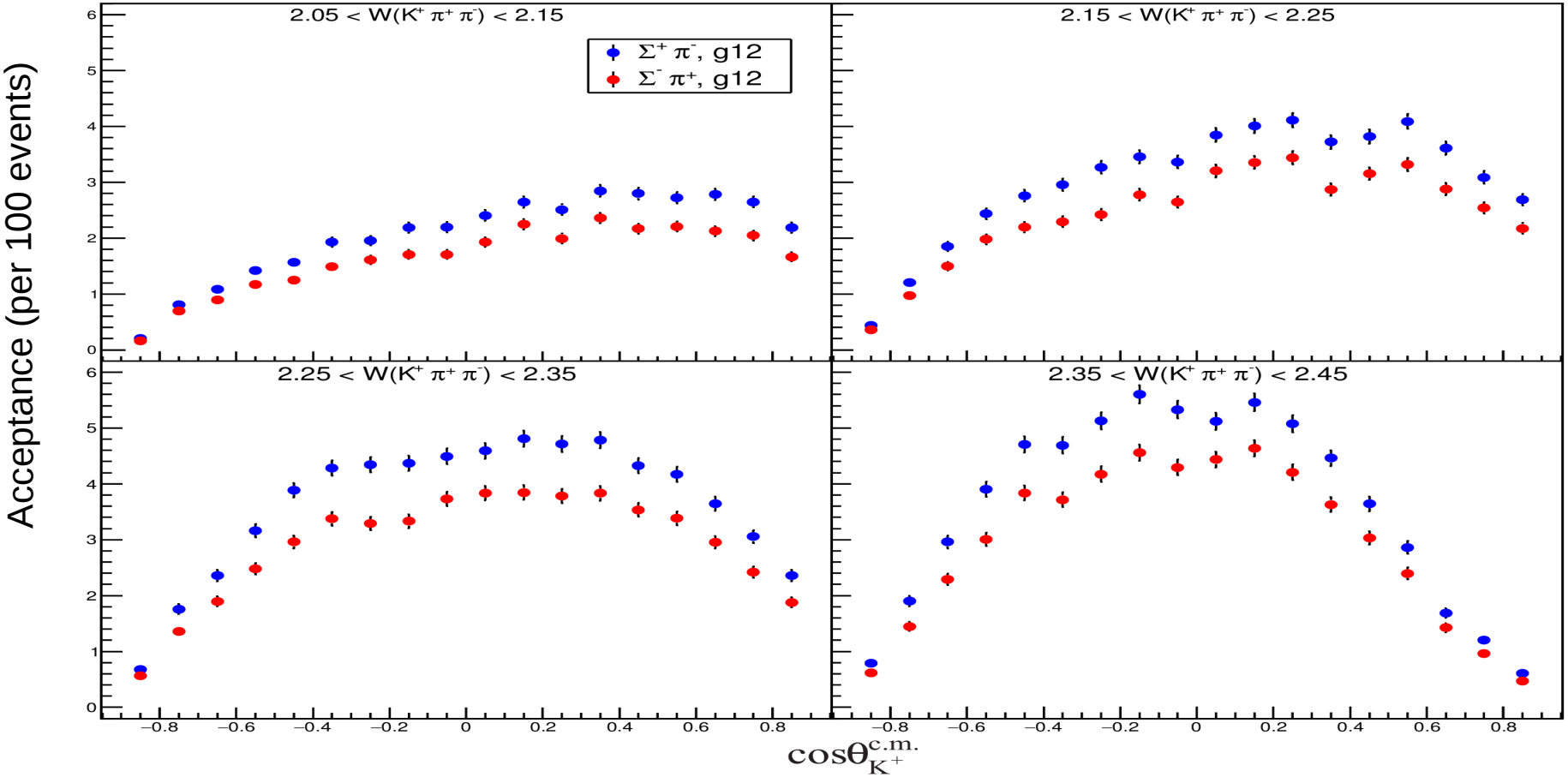




Detector Efficiency

GEANT Based MC Simulation

$$Acceptance = \frac{Accepted\ Events}{Generated\ Events}$$

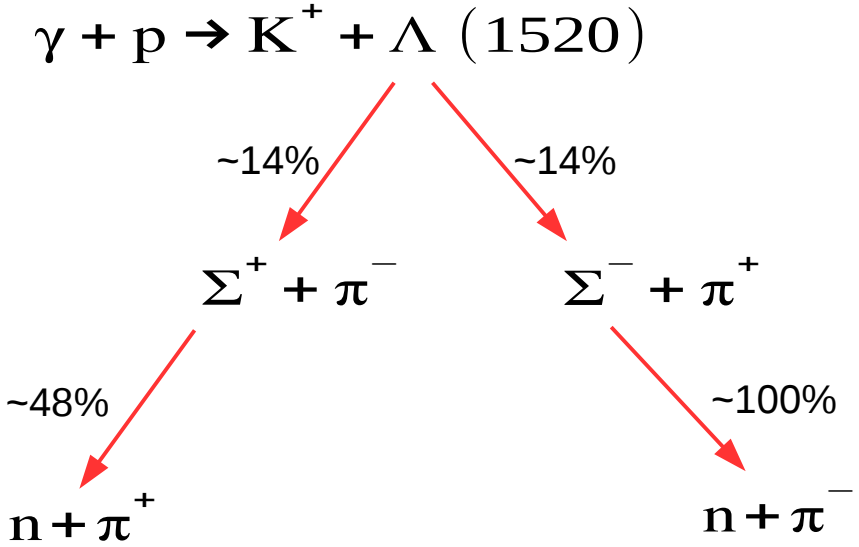


Luminosity Calculation

$$L\ (W) = \frac{\rho_p\ N_A\ l_T}{A_p}\ N_\gamma\ (W) \sim 10^{36}\ cm^{-2}\ (per\ \ Wbin)$$

$\rho_p = 0.0711\ g\ cm^{-3}$
$l_T = 40\ cm\ (g\ 12)$
$N_\gamma = Photon\ Flux$
$A_p = 1.00794\ gm\ mol^{-1}$

Differential Cross-section



Differential Cross-section

$$\frac{d\sigma}{dCos\theta^{c.m.}_{K^+}} = \frac{Y_d}{\tau\,\Delta\,cos\theta^{c.m.}_{K^+}\,A\,L(W)}$$

$\tau = Branching\ ratio$

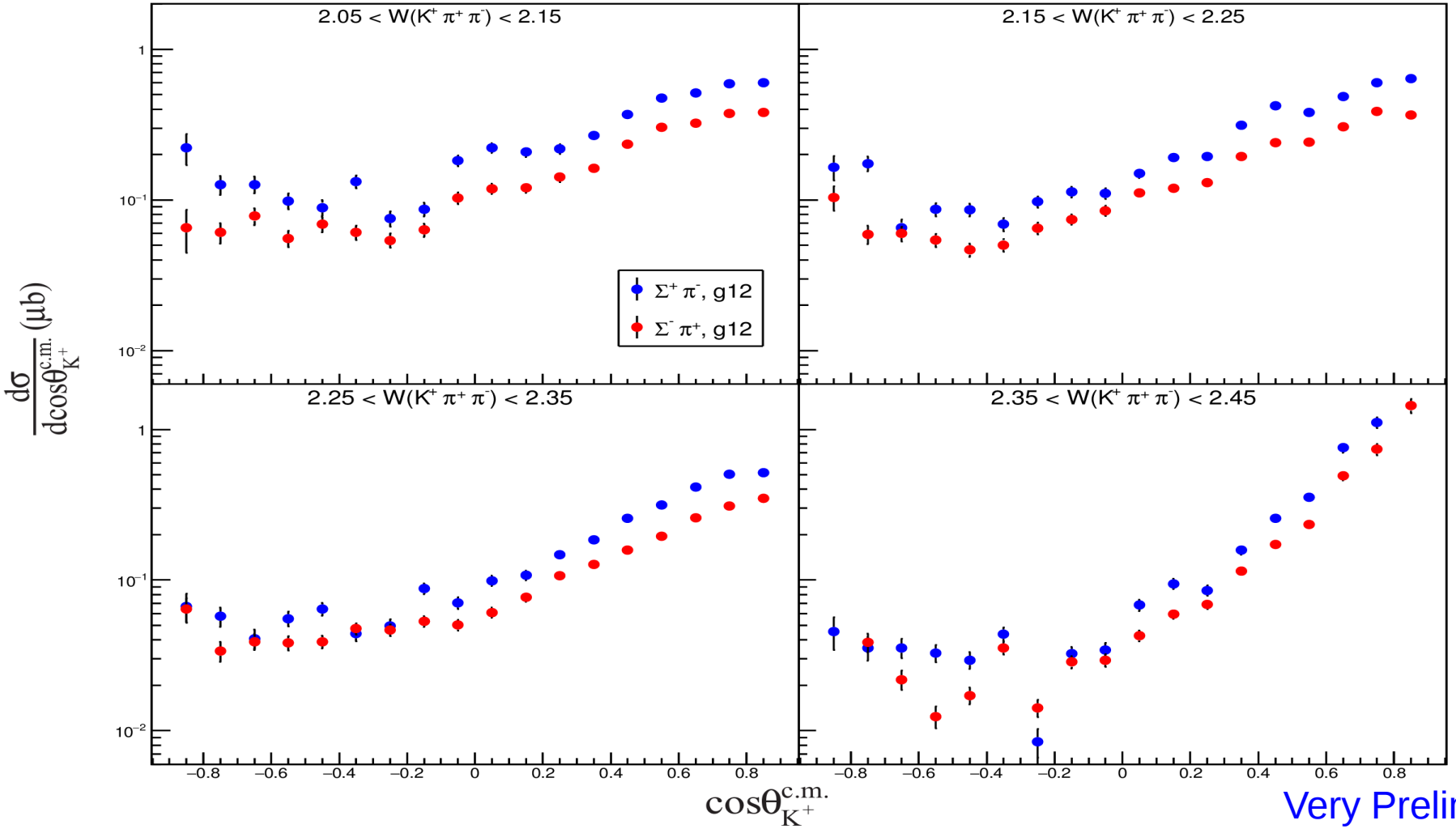
$Y_d = Signal\ Yield$

$A = Acceptance$

$\Delta\,cos\theta^{c.m.}_{K^+} = Width\ of\ cos\theta\ bin$

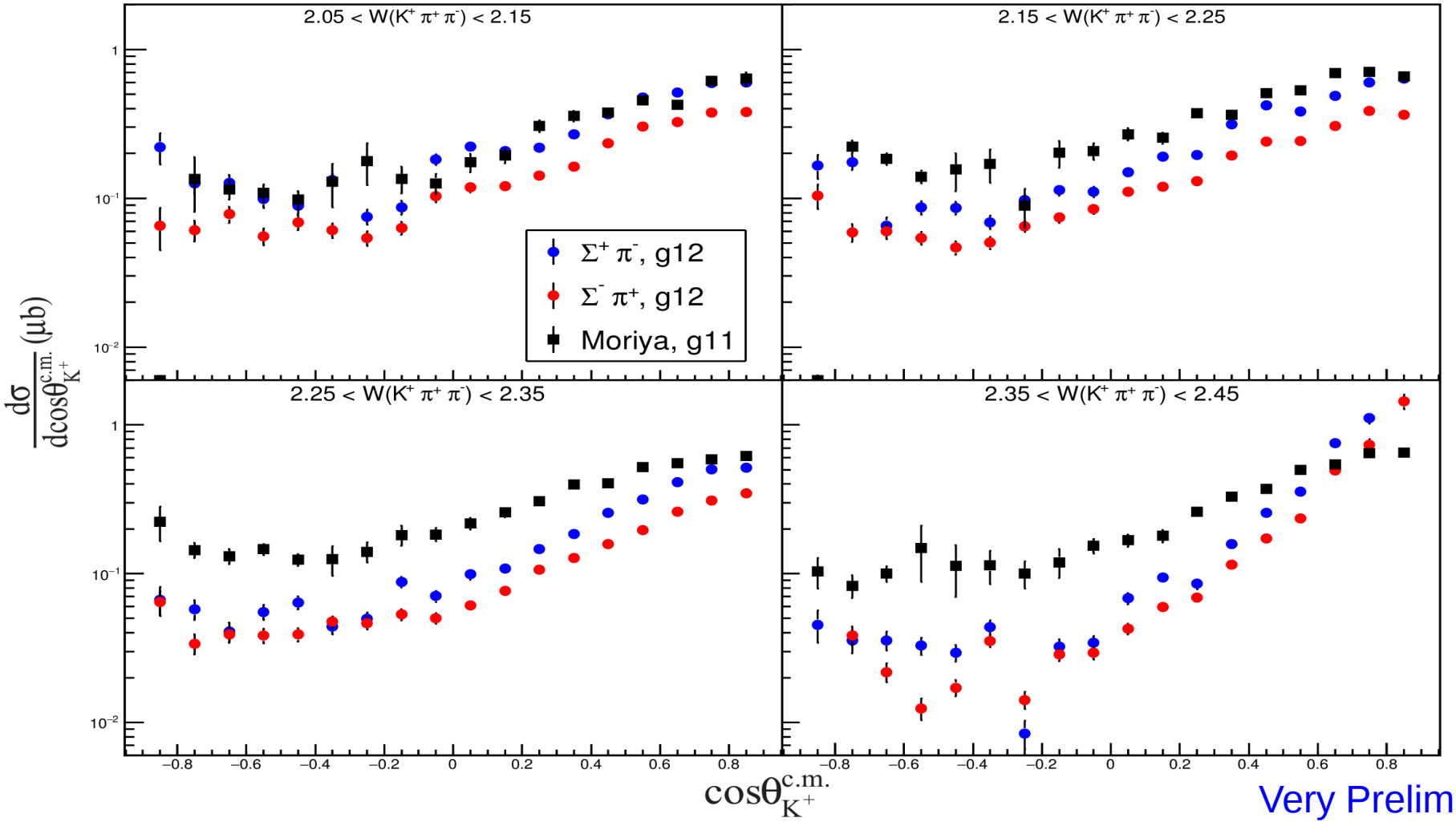
$L(W) = Luminosity$

Differential Cross-section g(12)



Very Preliminary!!!

Differential Cross-section (Comparison)

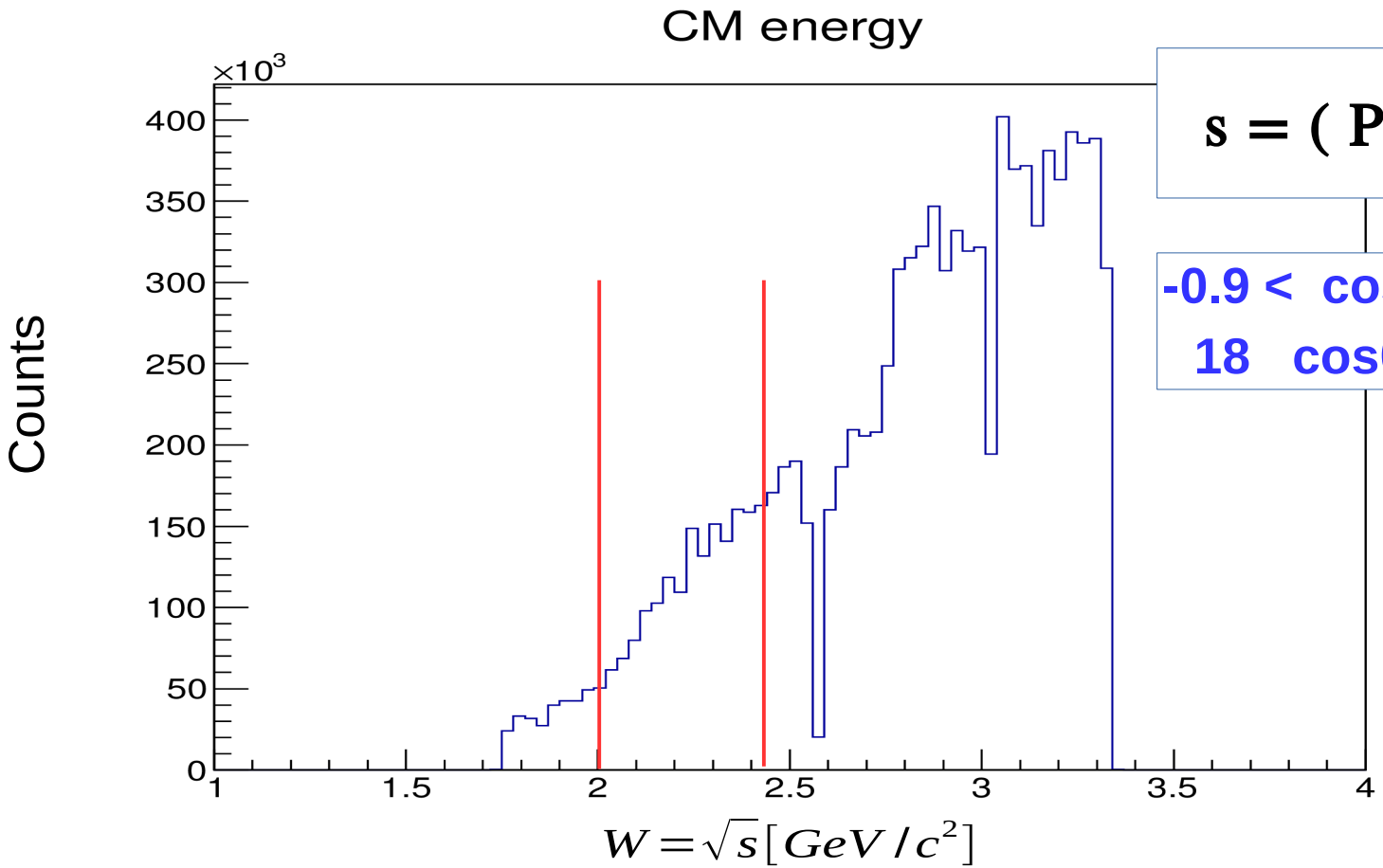


Very Preliminary!!!

Summary & Future Work

- This work presents preliminary look at the Λ(1520) cross-section using CLAS g12
- In-detail analysis to follow for g12
- For now, the results show consistent shape for cross-section
- Works on normalization will lead us closer to our goal
- In Future,preliminary analysis for higher mass resonances, i.e., Λ(1670) & Λ(1690) will be done

Analysis W



$$s = (P_\gamma + P_p)^2$$

$-0.9 < \cos\theta_{k+}^{c.m.} < 0.9$

18 $\cos\theta_{k+}^{c.m.}$ bins