

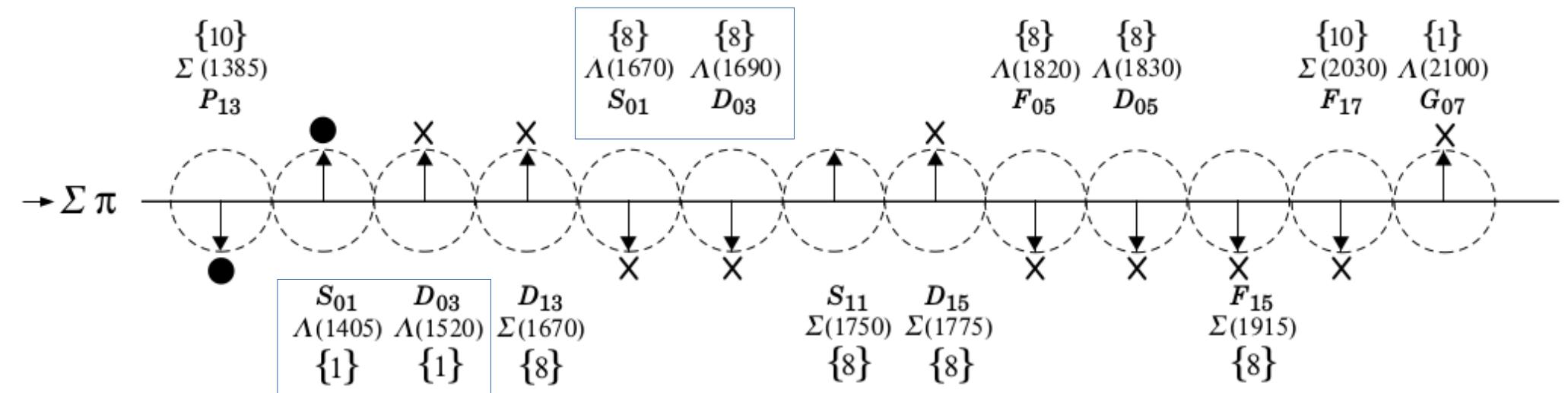
A Study of $\gamma p \rightarrow K^+ \Lambda^*$ reaction

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Ohio University

CLAS Collaboration Meeting
July, 2018

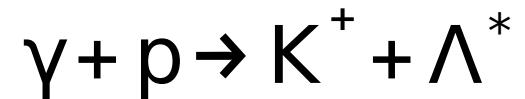
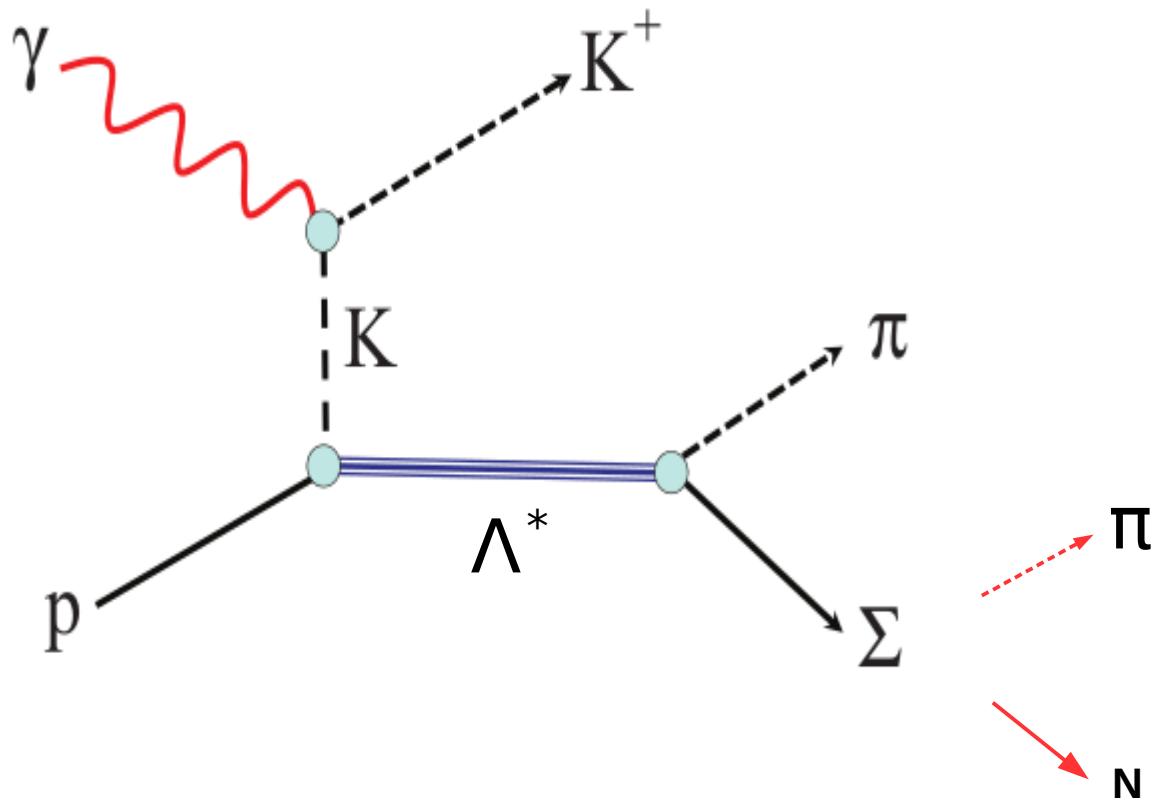


Motivation



Particle	J^P	Overall status	$N\bar{K}$	$\Lambda\pi$	$\Sigma\pi$	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	****	$\Lambda\pi\pi, \Sigma\pi\pi$

Reaction



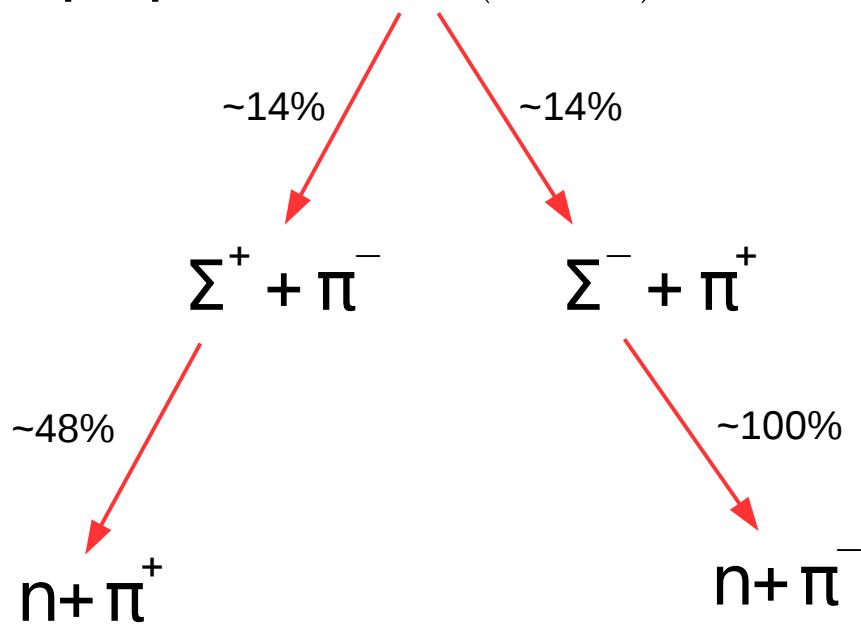
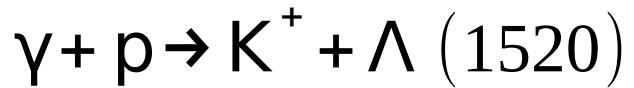
- $\Lambda(1405)1/2^-$ and $\Lambda(1520)3/2^-$ are rated 4-star by Particle Data Group
- Insight into higher resonances $\Lambda(1670)1/2^-$ and $\Lambda(1690)3/2^-$

Outline (Cuts)

- Photon selection → 1 and 2 photon case
- Particles Identification → K^+ , π^+ , π^-
- Trigger → 3 particles detected in 3 different sectors
- Fiducial cut → nominal
- Paddle Cut
- Momentum Cut
- Missing mass cut
- $2.05 \leq W \leq 2.45$ ($1.77 \leq E_\gamma \leq 2.75$)
- $-0.9 \leq \cos\theta_{cm}^{K+} \leq 0.9$

Trigger	$\Sigma^+ \pi^-$	$\Sigma^- \pi^+$
Data	~ 78 %	~ 78 %
MC	~ 74 %	~ 77 %

PID



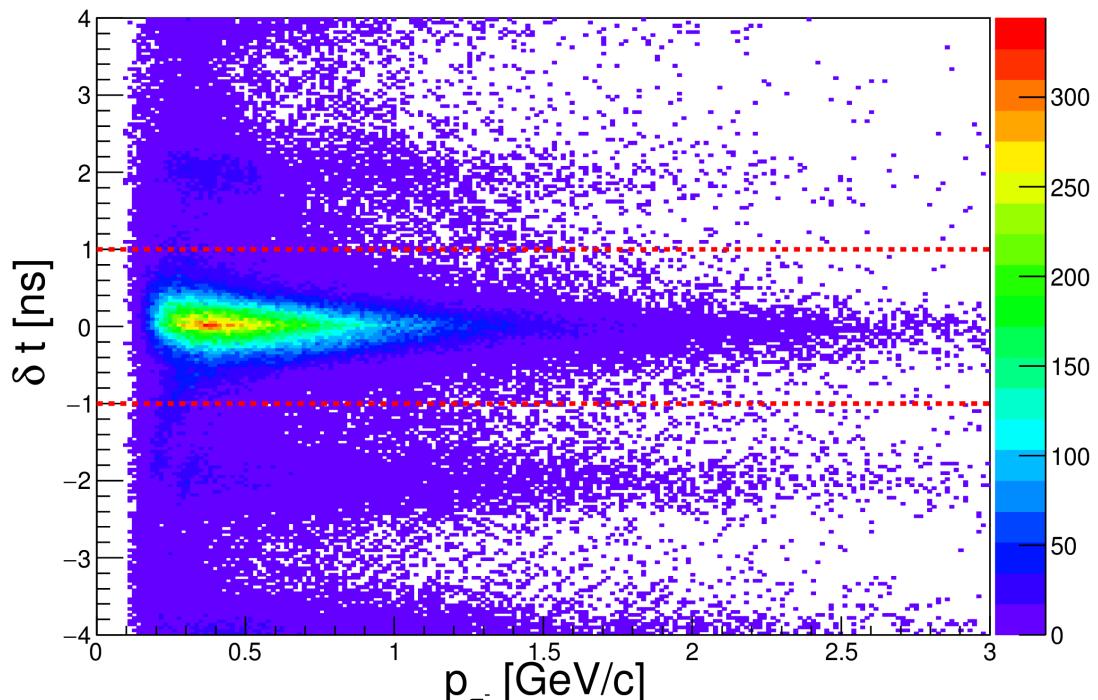
$$\delta t = t_{meas} - t_{calc}$$

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

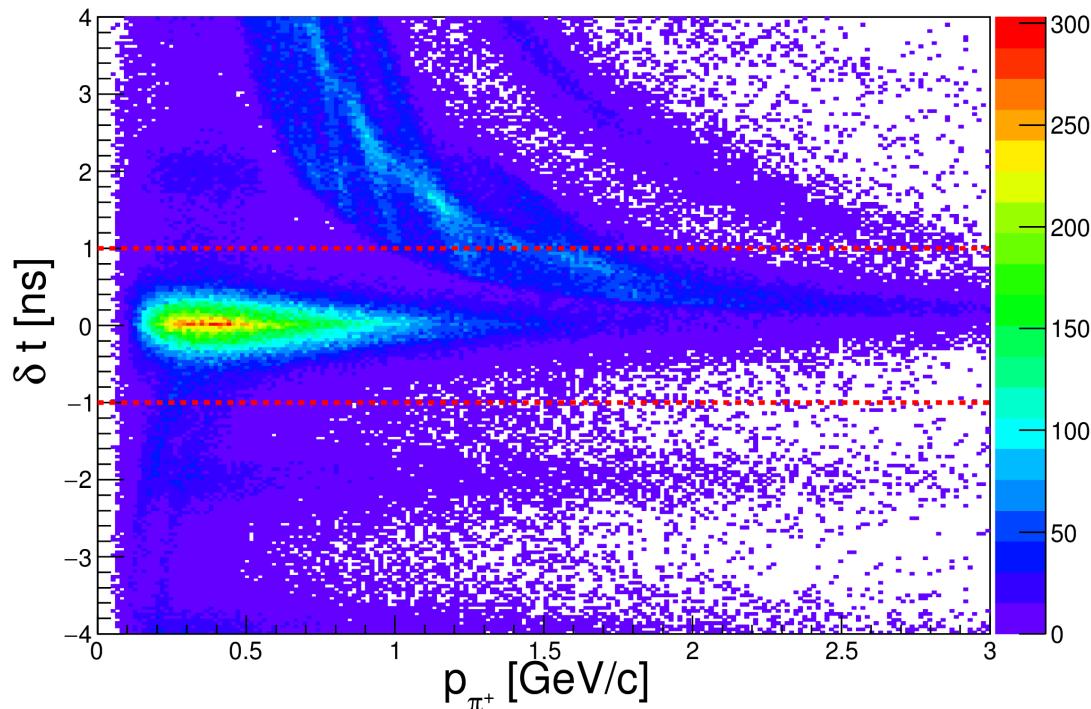
$$t_{calc} = \frac{d_{path}}{c} \frac{E_i}{p_i}$$

Similar $|\delta t| < 1 \text{ [ns]}$ for K^+ was done

Data: π^- Timing

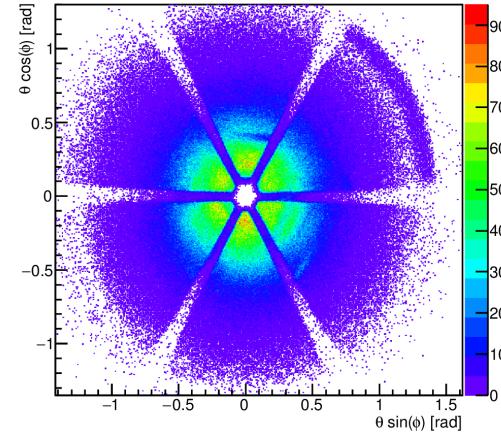


Data: π^+ Timing

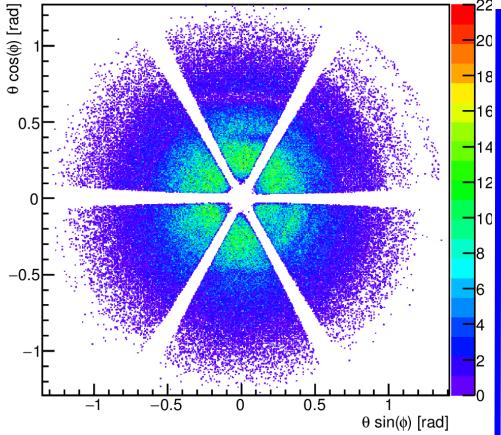


Fiducial plots

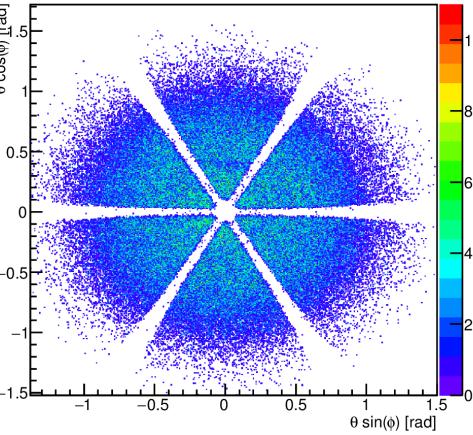
Data: K^+



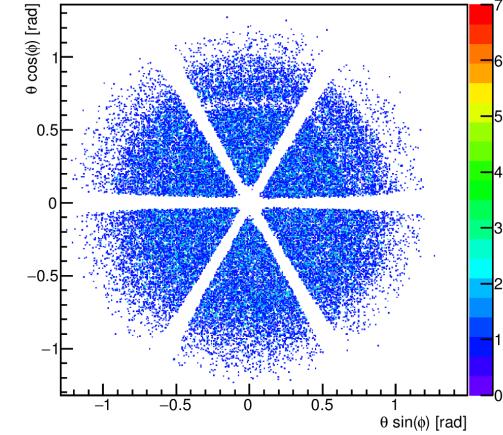
Data: K^+



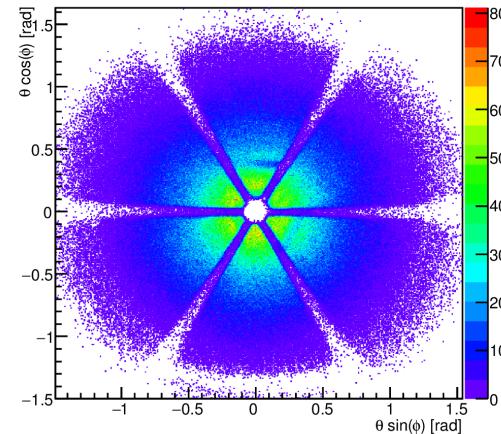
MC: K^+



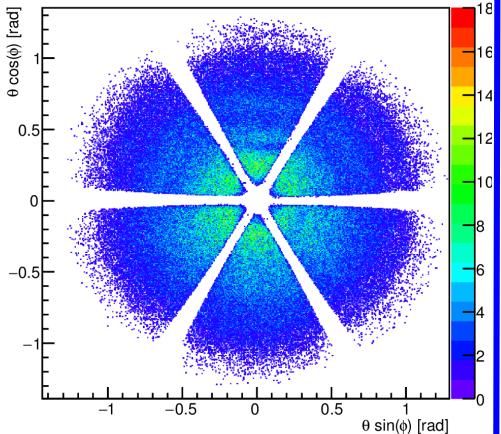
MC: K^+



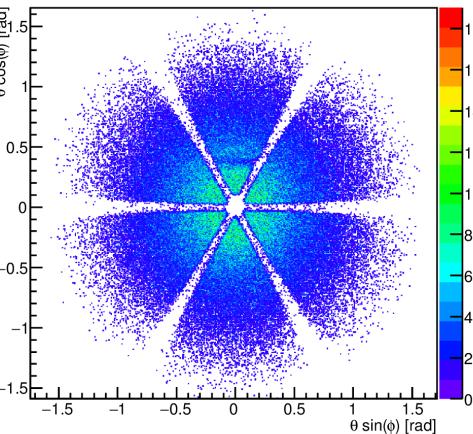
Data: π^+



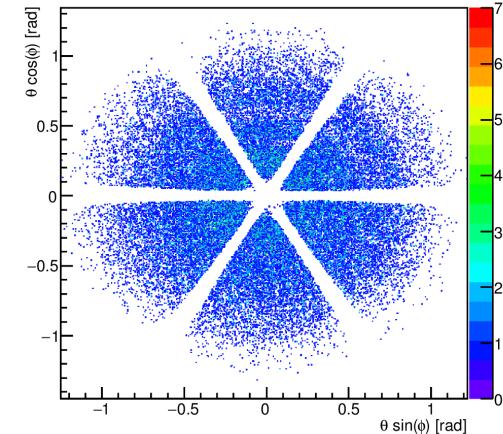
Data: π^+



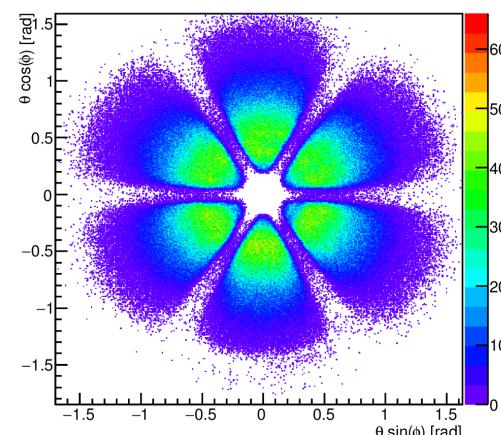
MC: π^+



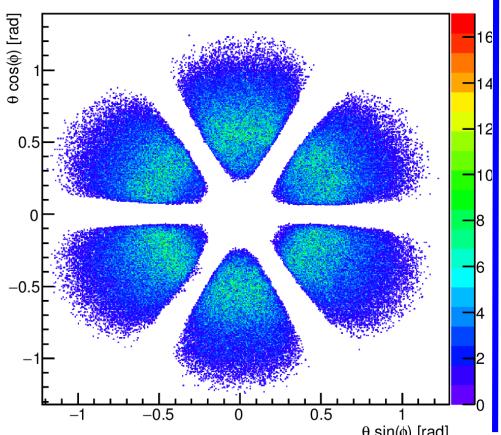
MC: π^+



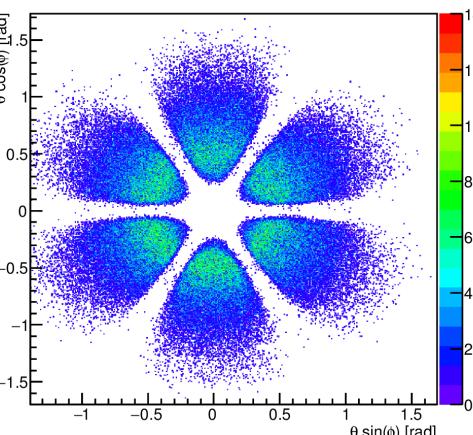
Data: π^-



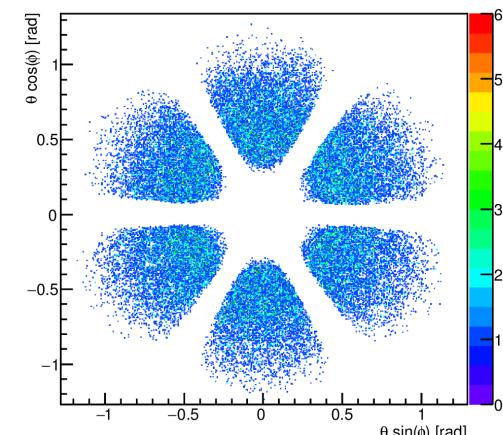
Data: π^-

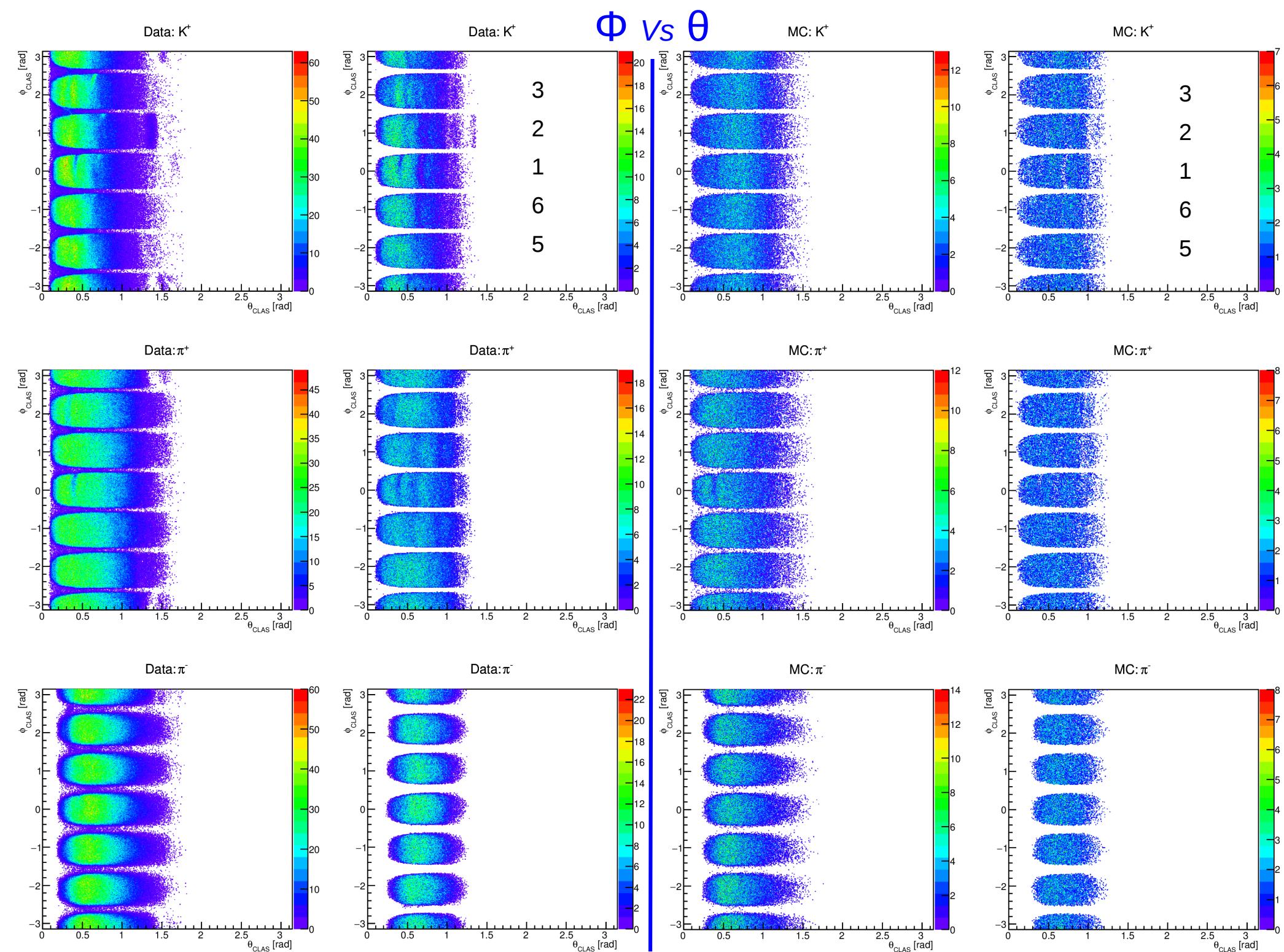


MC: π^-

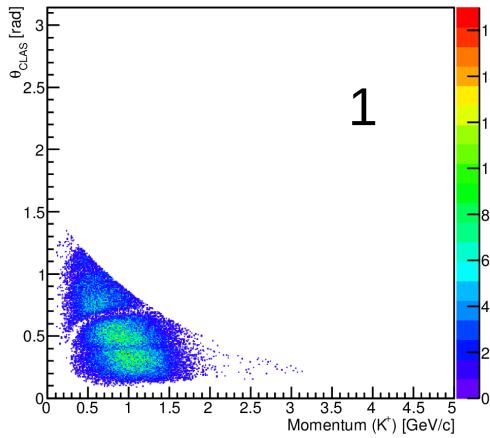
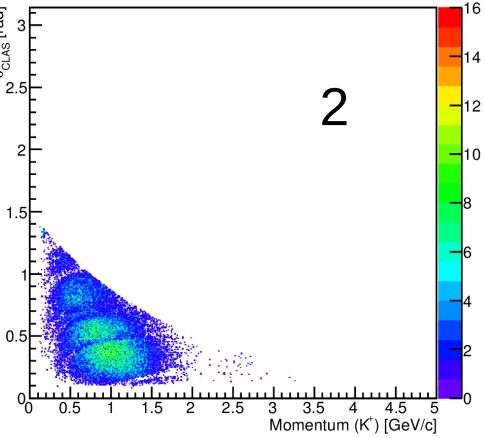
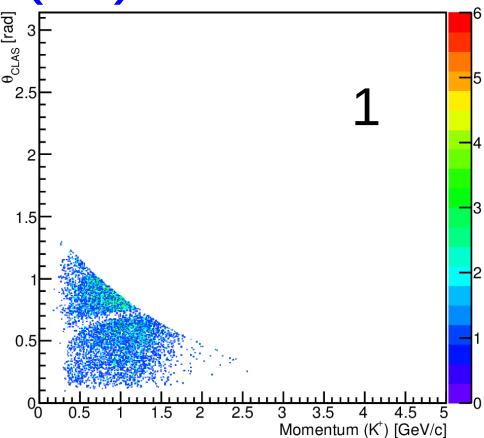
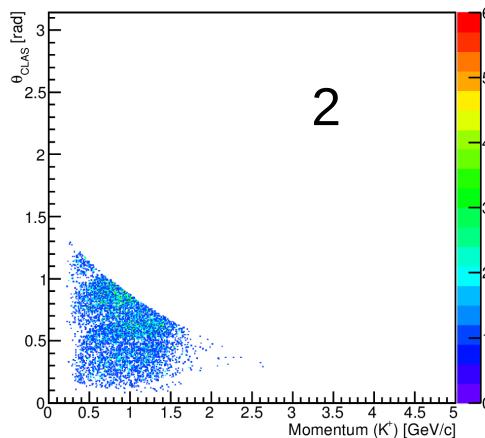
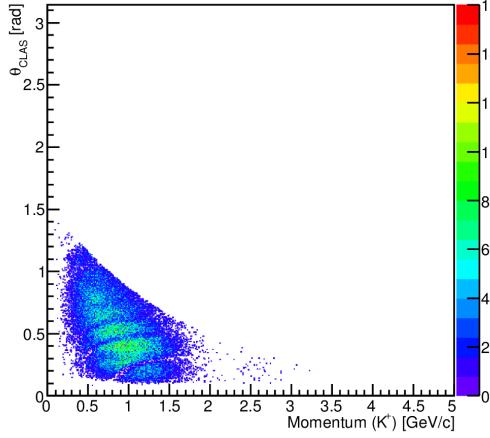
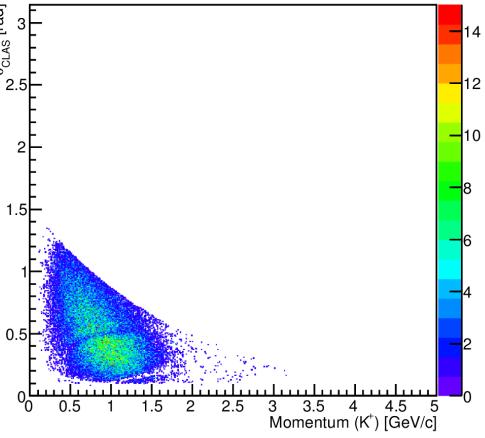
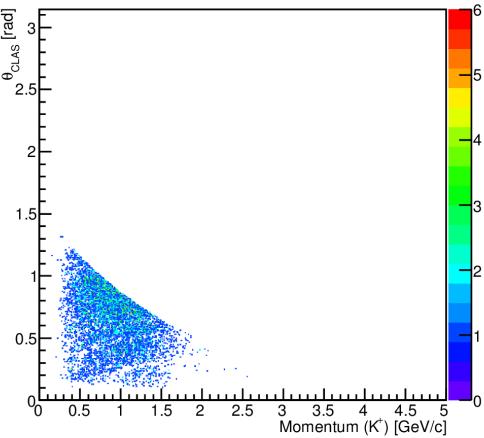
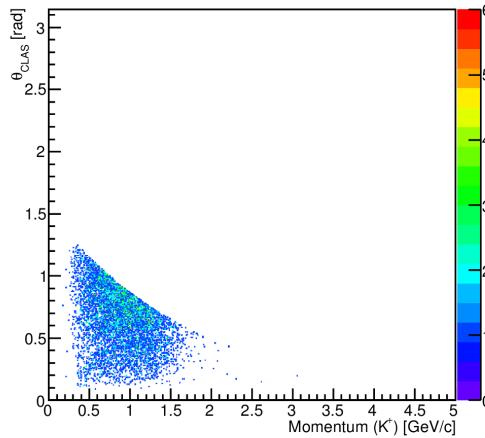
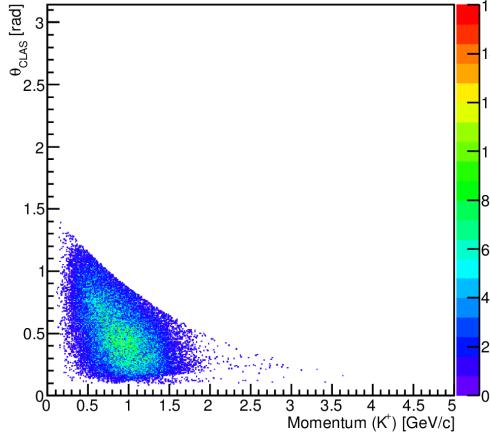
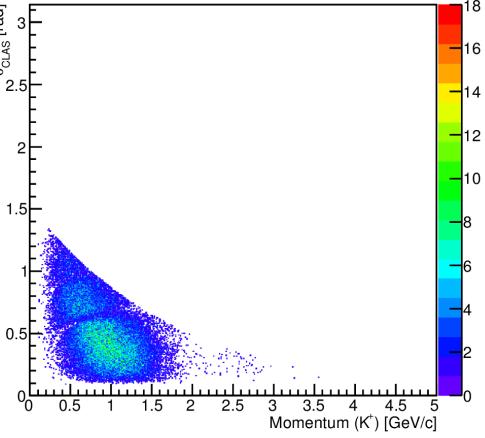
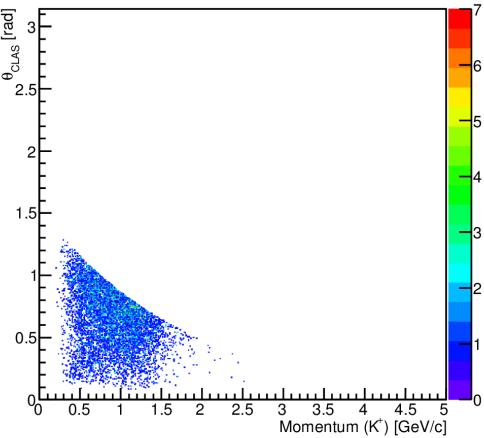
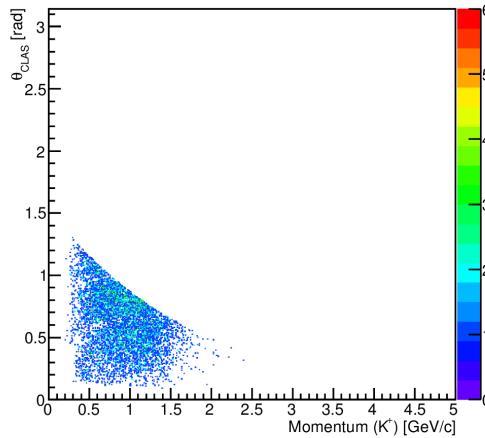


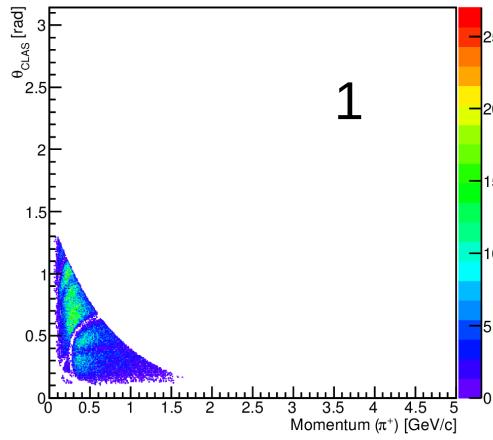
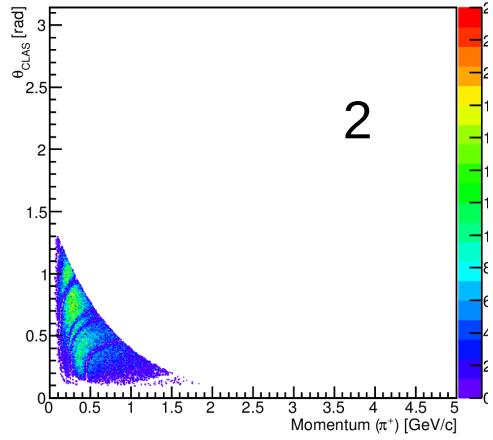
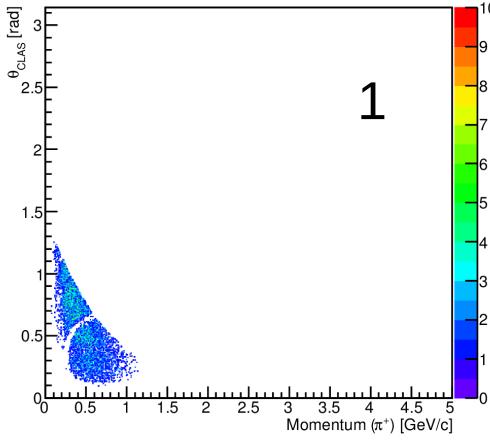
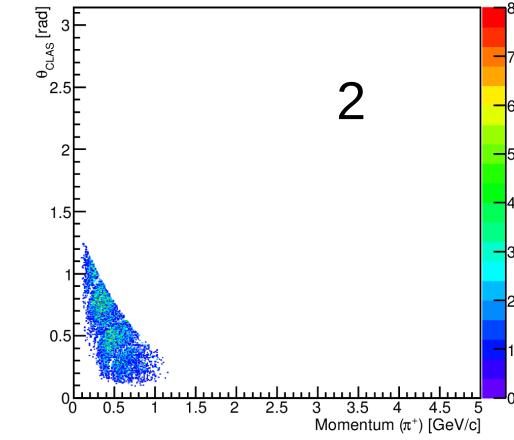
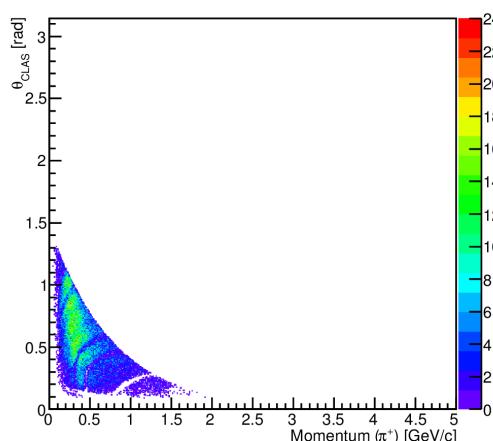
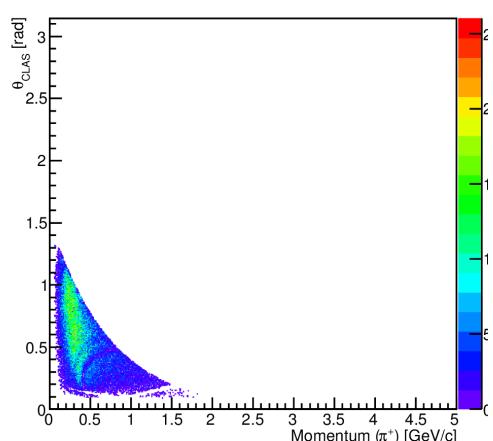
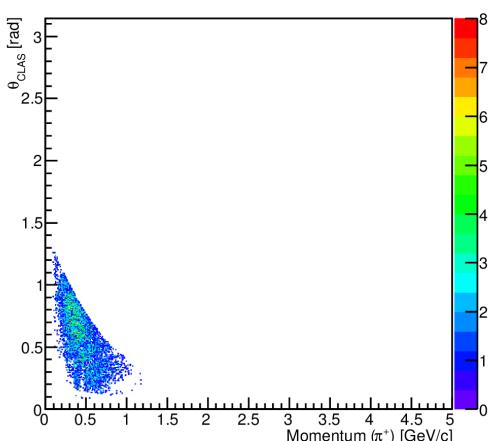
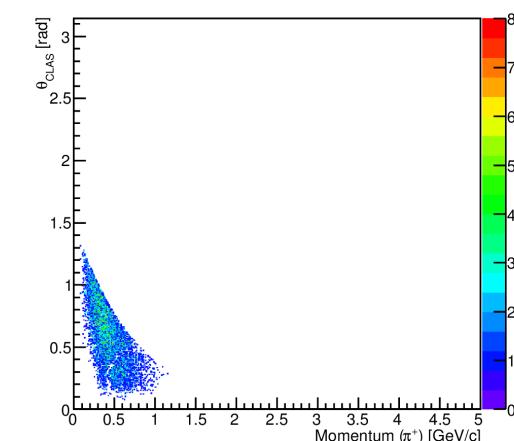
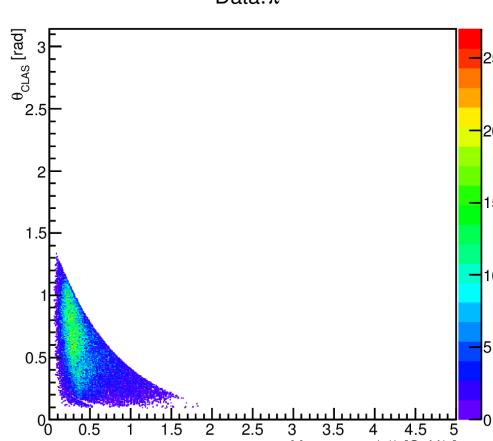
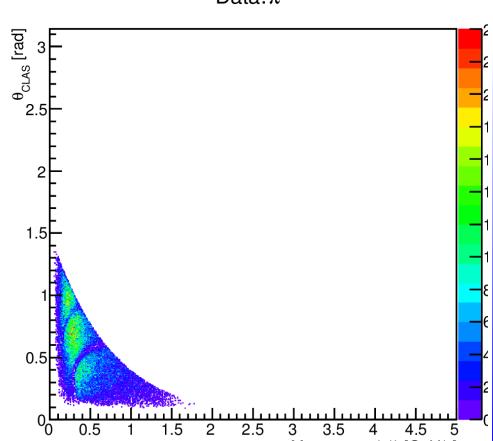
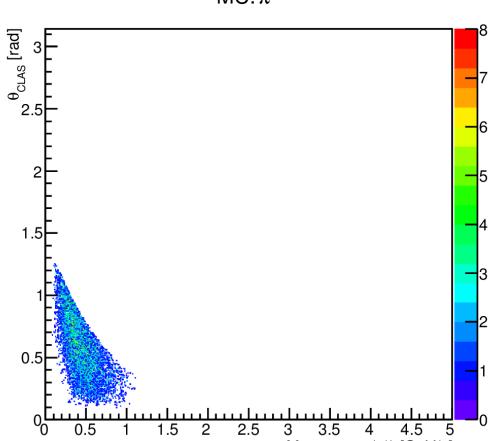
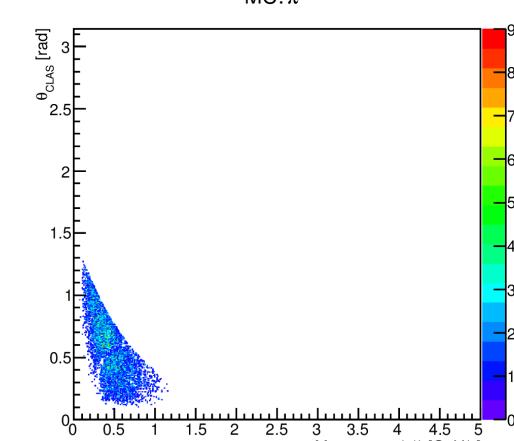
MC: π^-



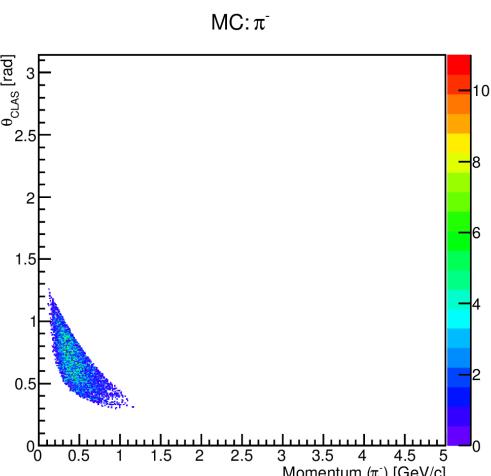
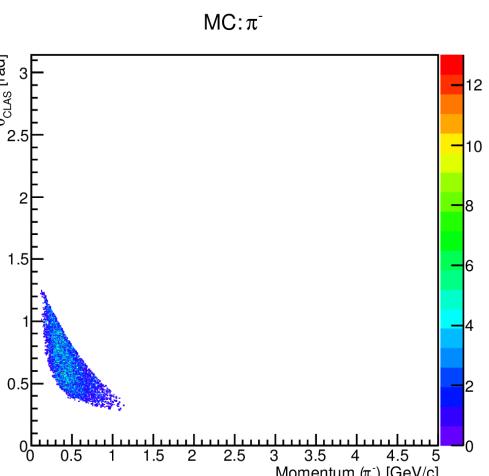
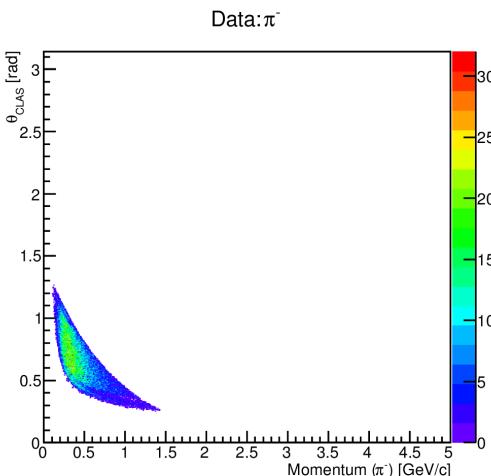
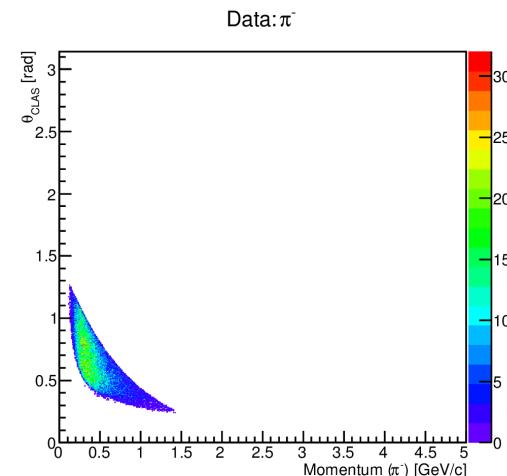
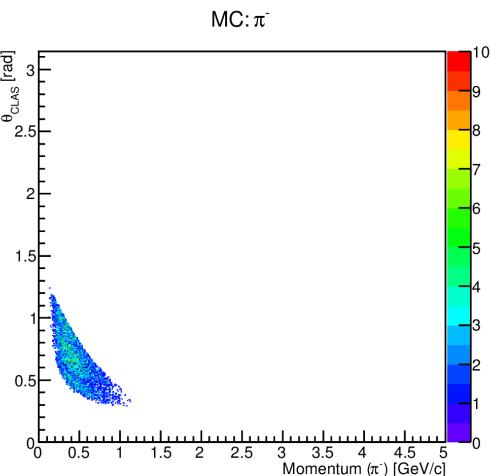
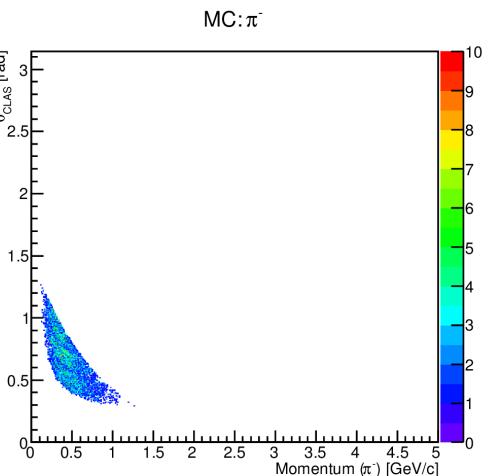
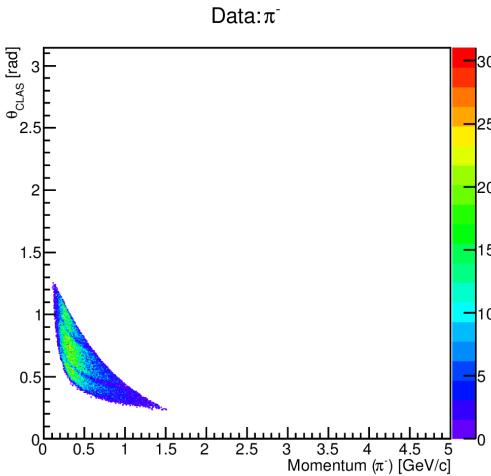
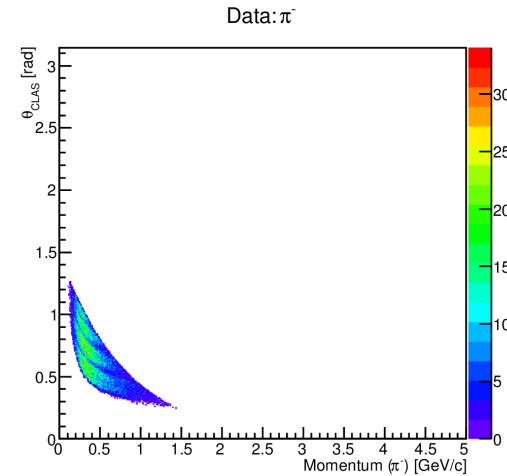
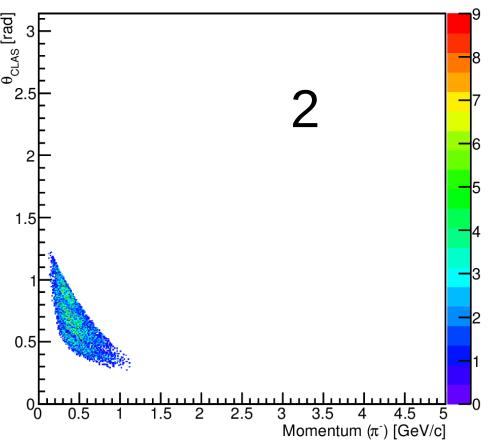
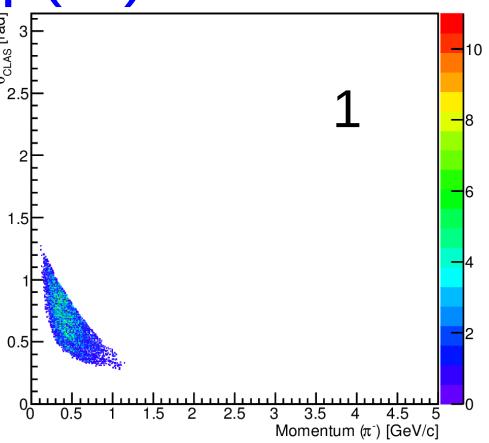
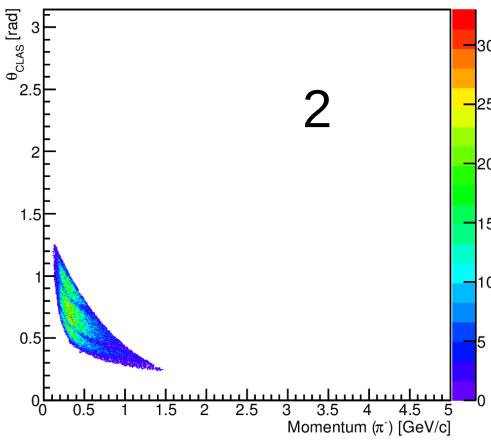
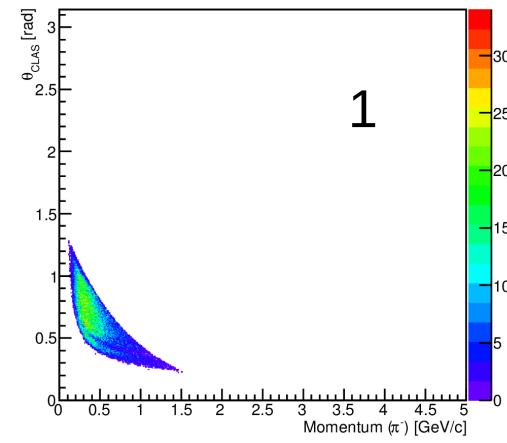
Φ Vs θ


θ vs $p(K^+)$

Data: K^+ Data: K^+ MC: K^+ MC: K^+ Data: K^+ Data: K^+ MC: K^+ MC: K^+ Data: K^+ Data: K^+ MC: K^+ MC: K^+ 

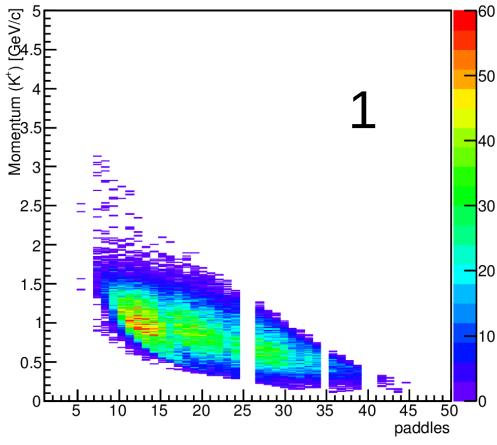
θ vs $p(\pi^+)$ Data: π^+ Data: π^+ MC: π^+ MC: π^+ Data: π^+ Data: π^+ MC: π^+ MC: π^+ Data: π^+ Data: π^+ MC: π^+ MC: π^+ 

θ vs $p(\pi^-)$

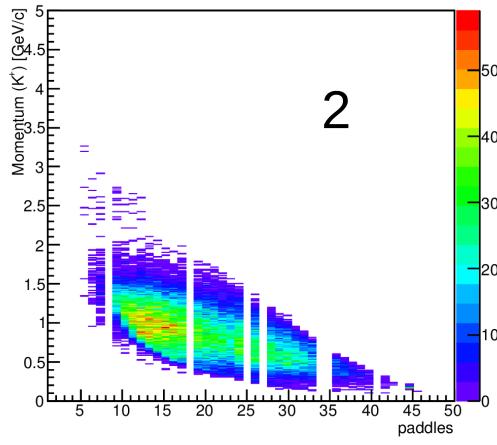


Paddle Cuts

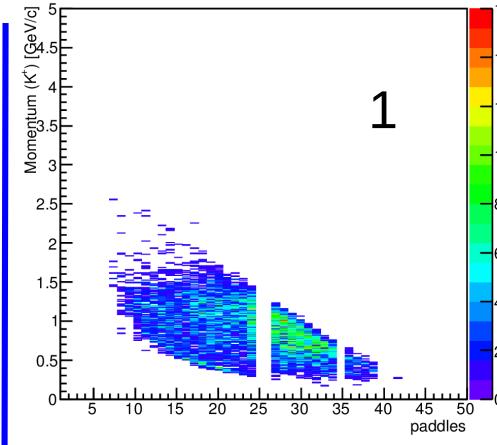
Data: K^+



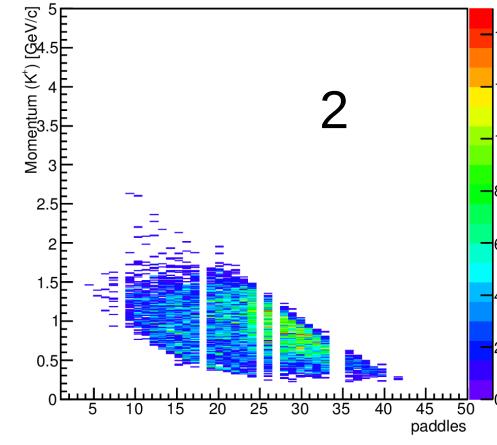
Data: K^+



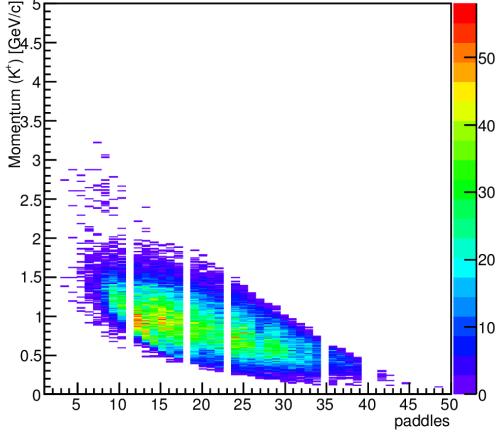
MC: K^+



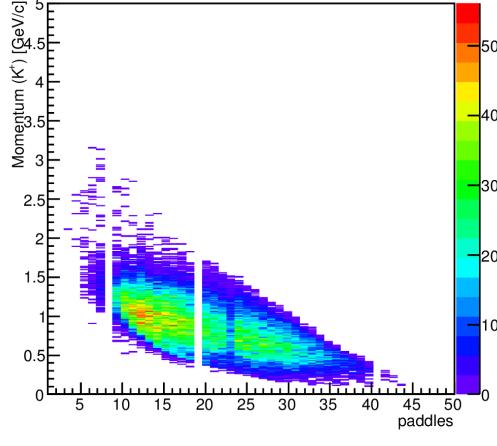
MC: K^+



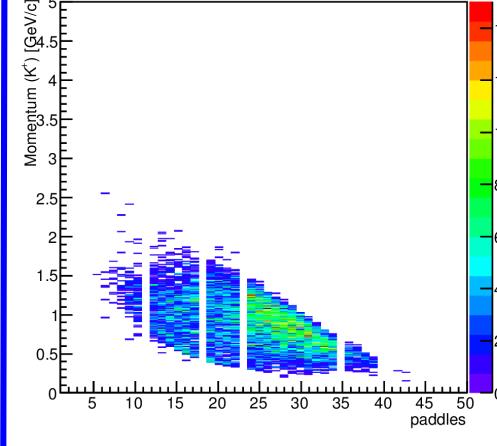
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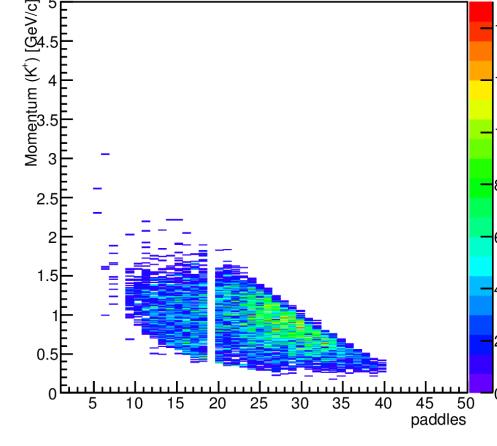
Data: K^+



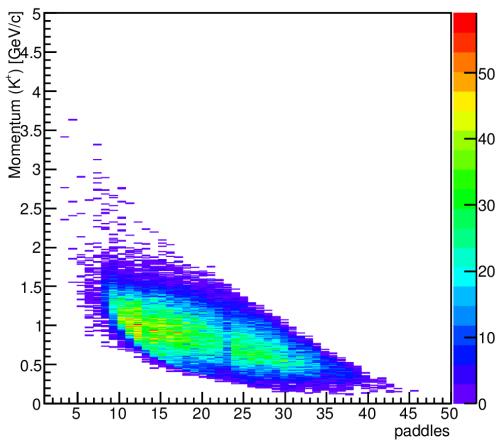
MC: K^+



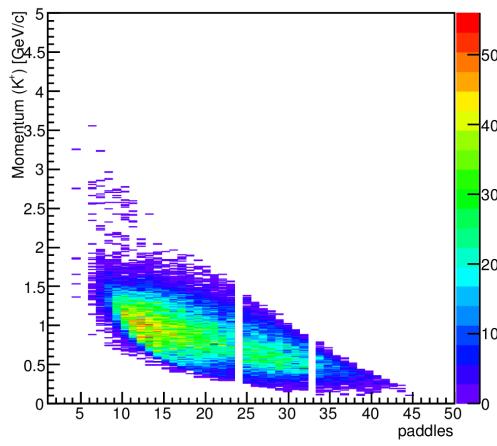
MC: K^+



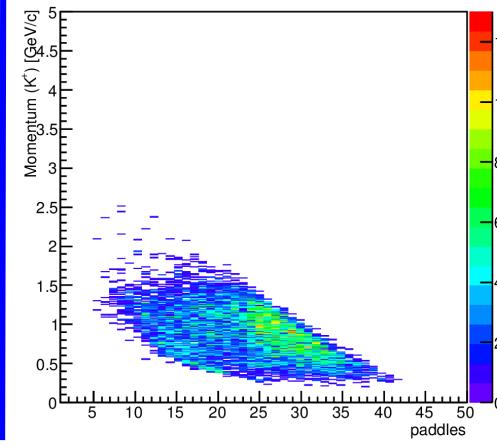
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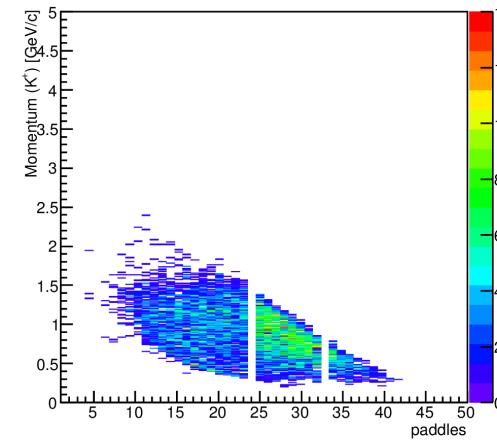
Data: K^+

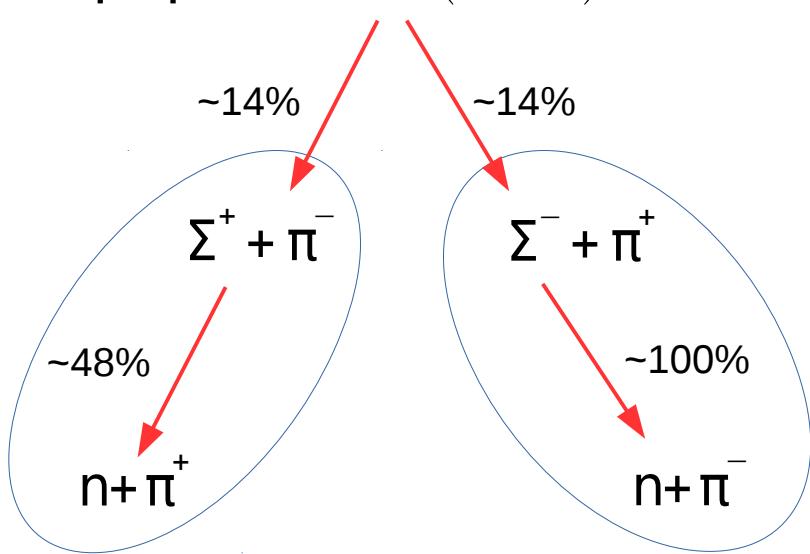
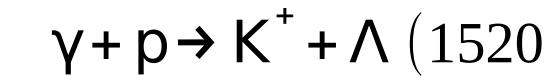
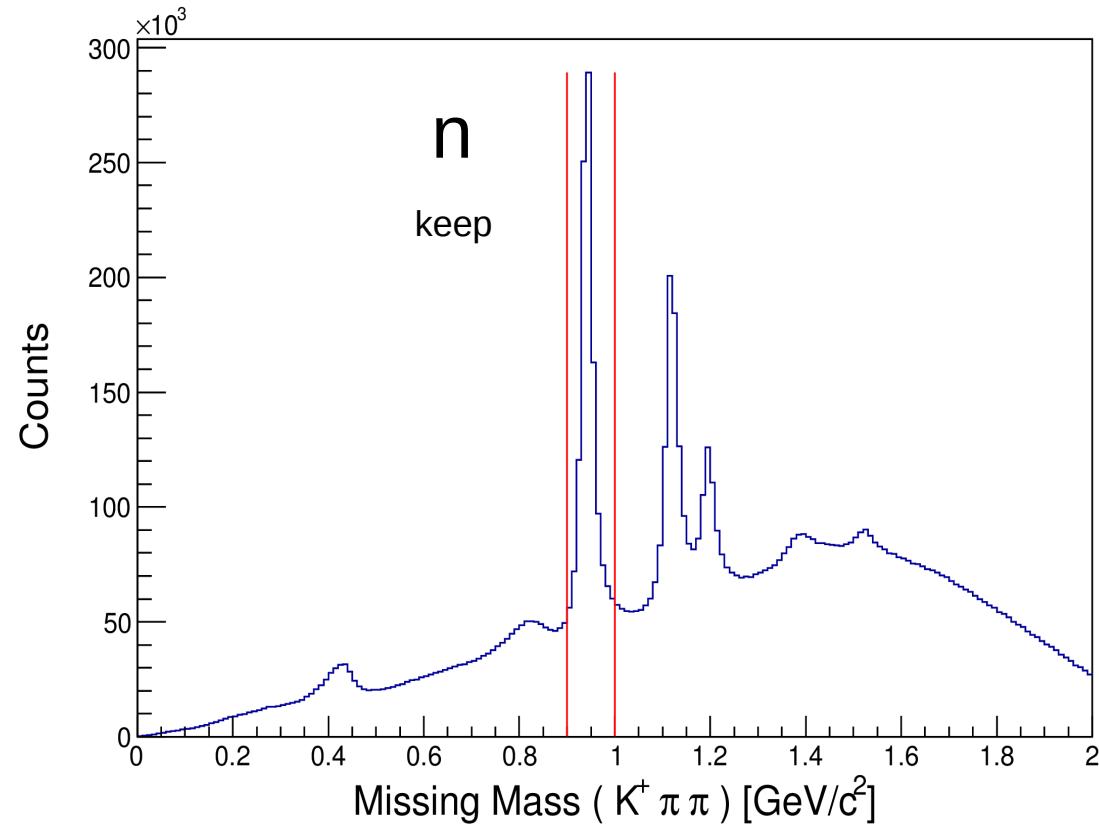


MC: K^+



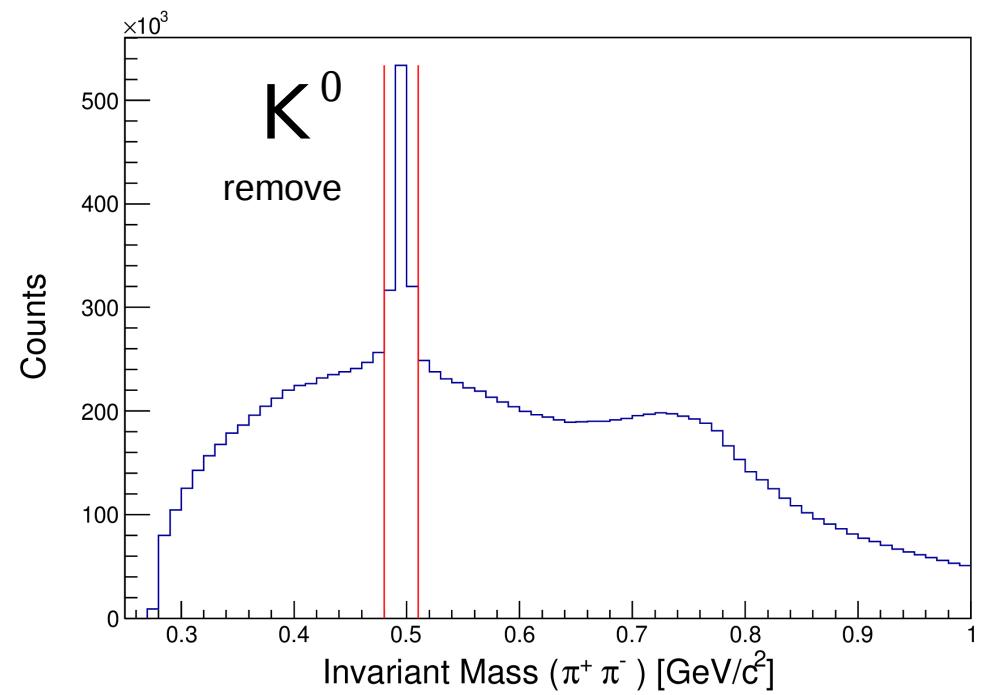
MC: K^+





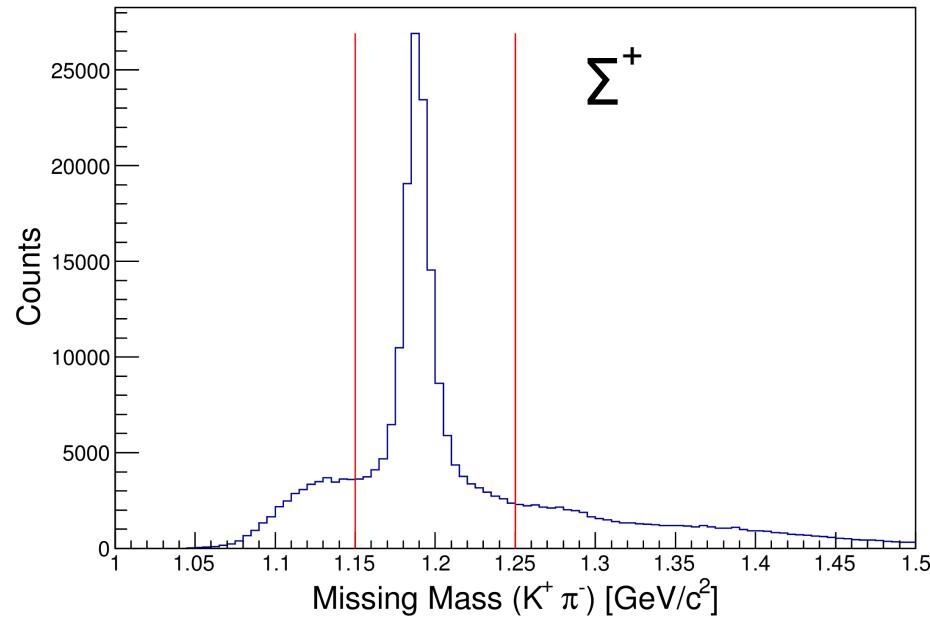
Cuts

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

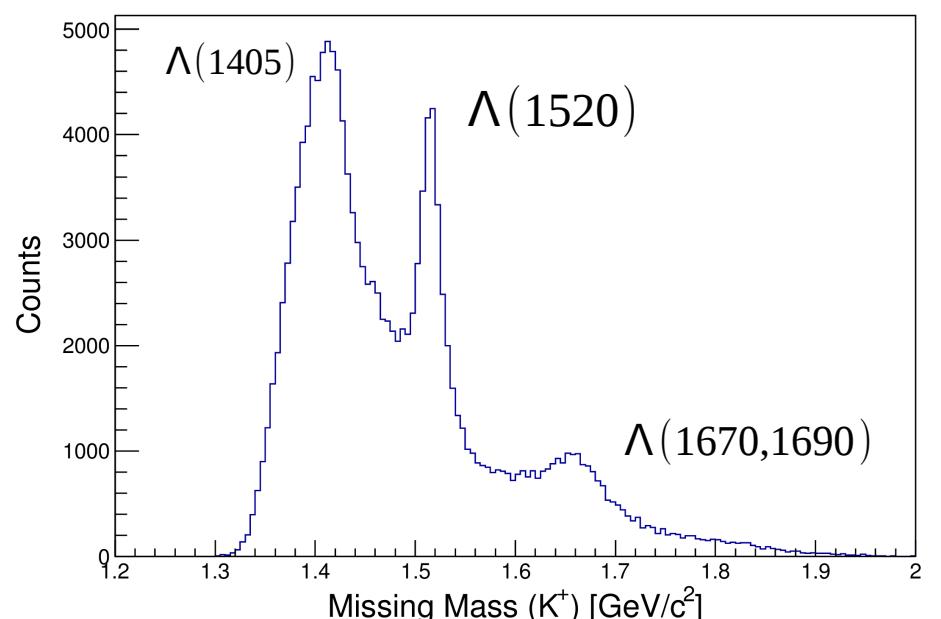
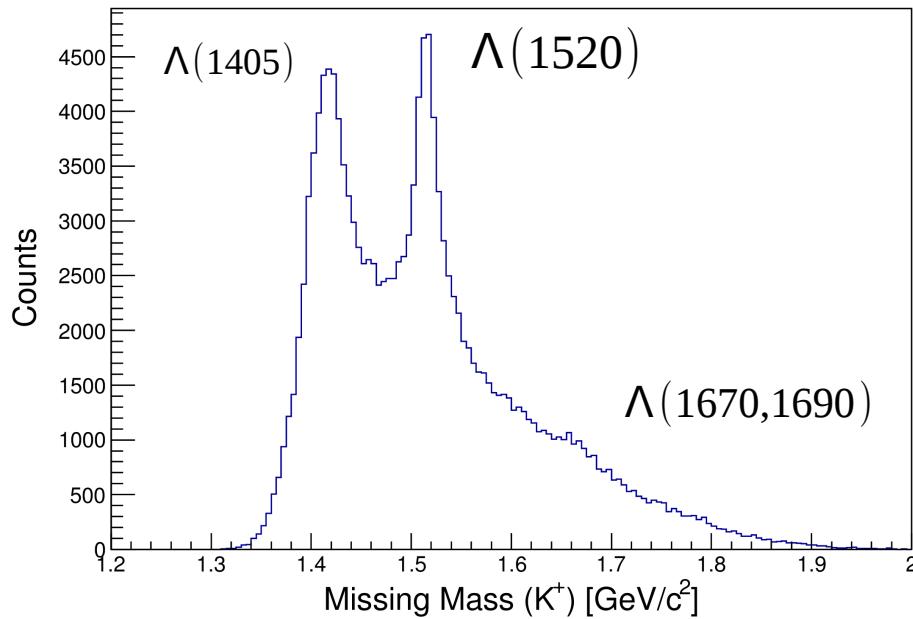
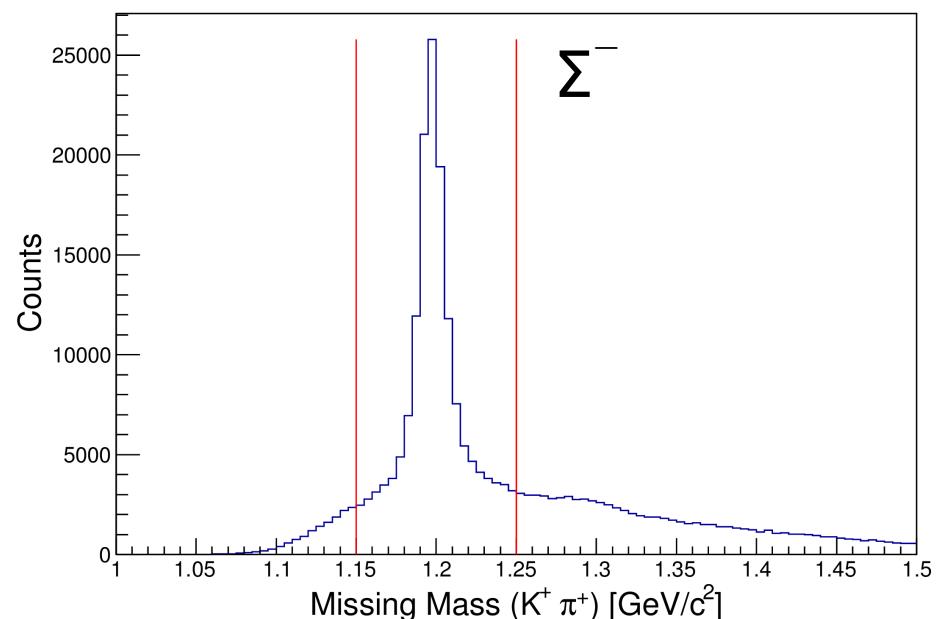


Cuts

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

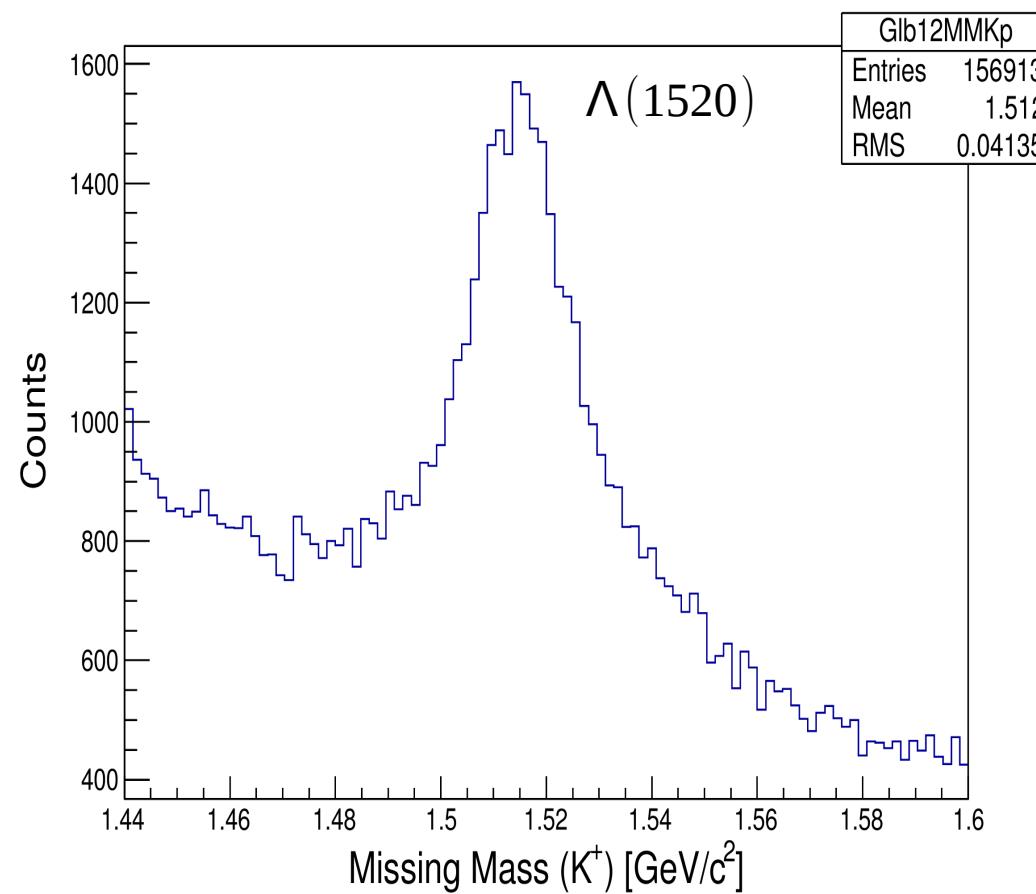


$\Lambda(1520) \rightarrow \Sigma^- + \pi^+$

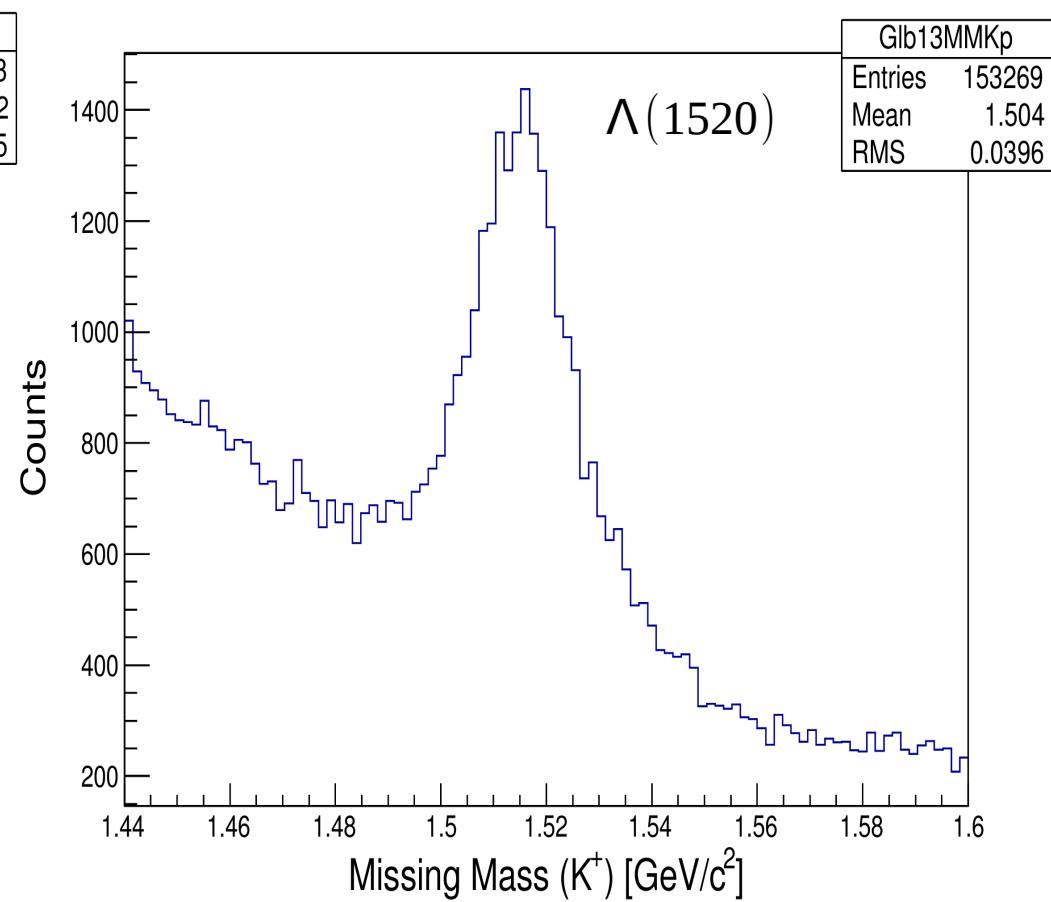


Global Spectrum

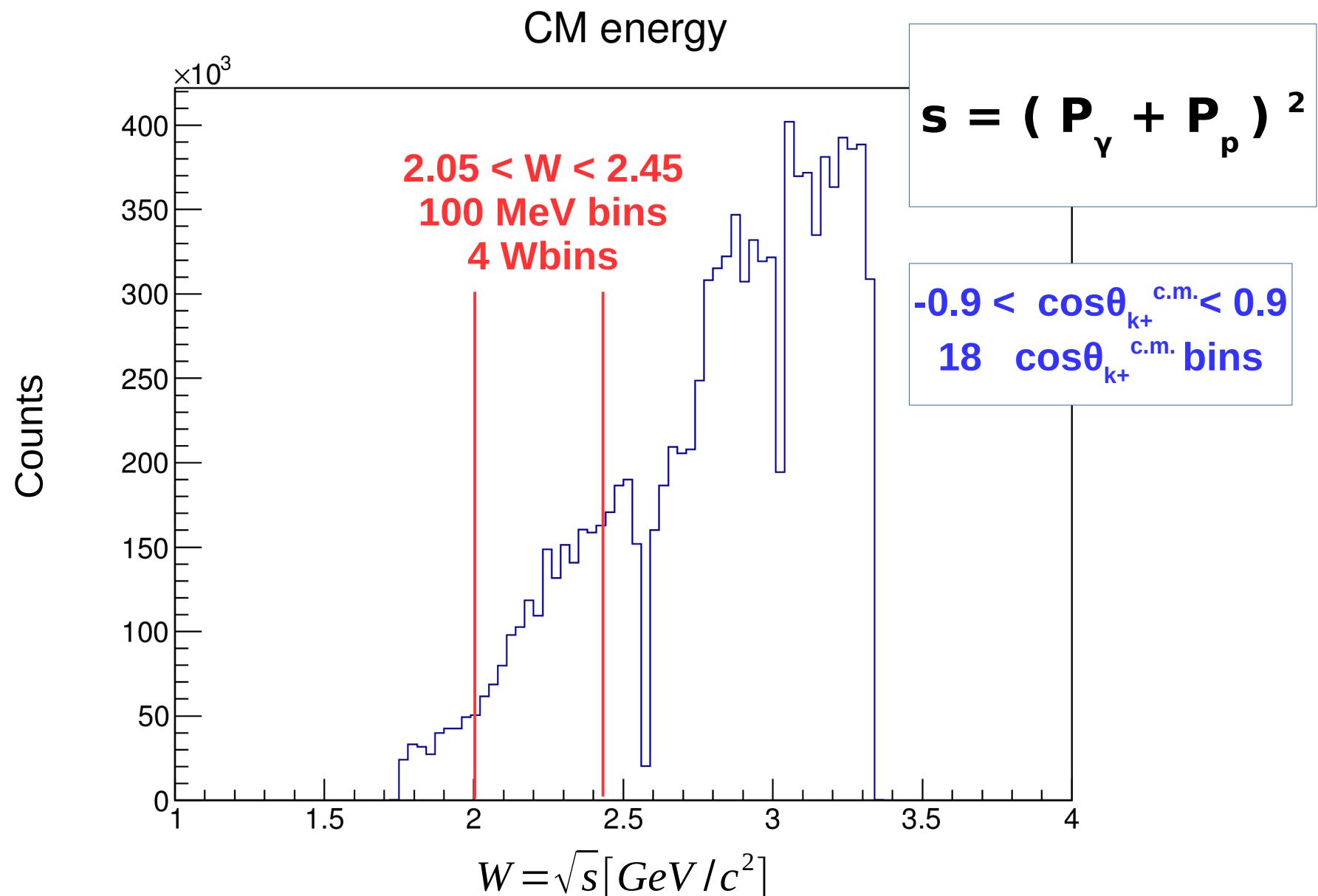
$\Lambda(1520) \rightarrow \Sigma^+ + \pi^-$



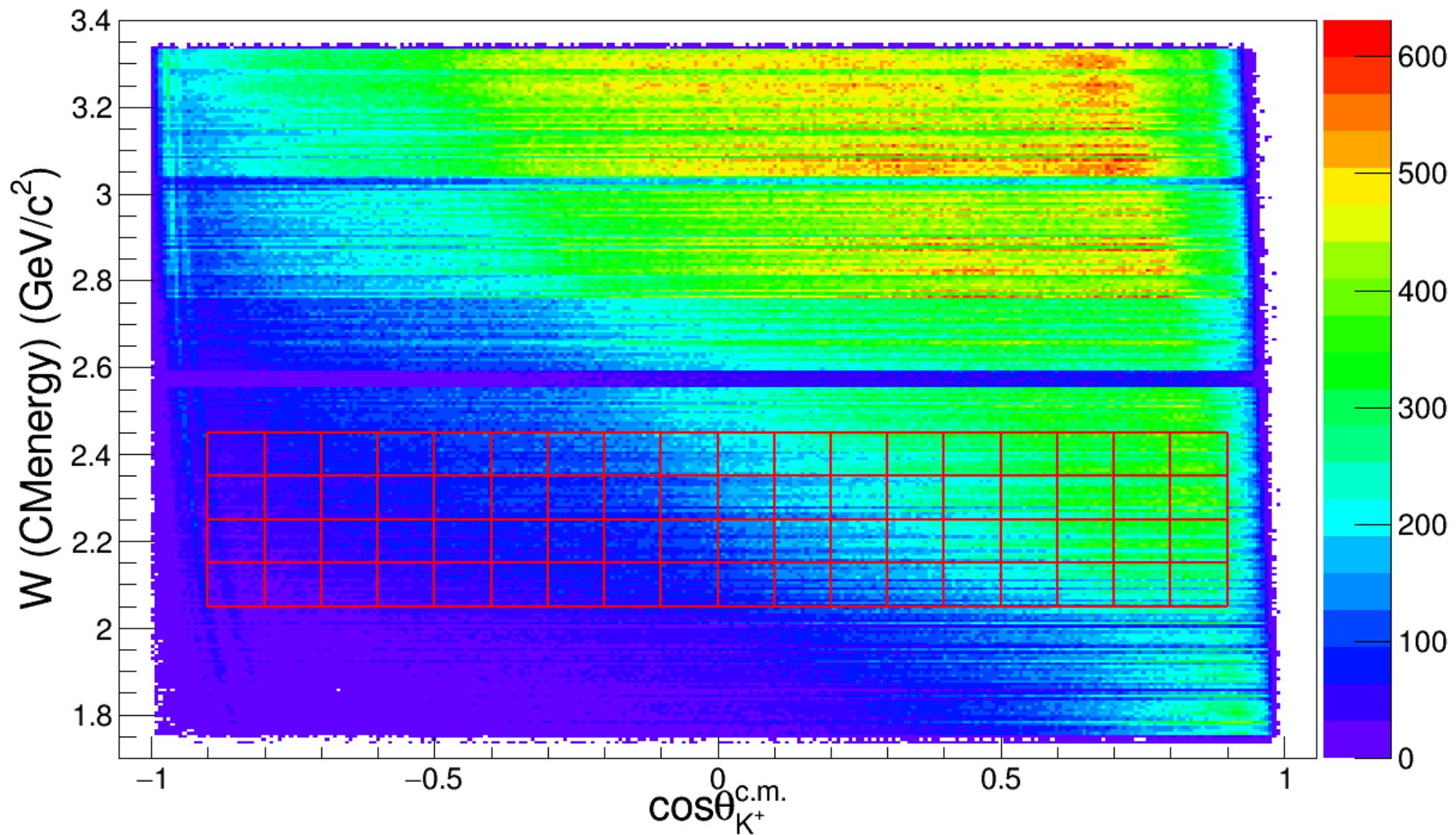
$\Lambda(1520) \rightarrow \Sigma^- + \pi^+$



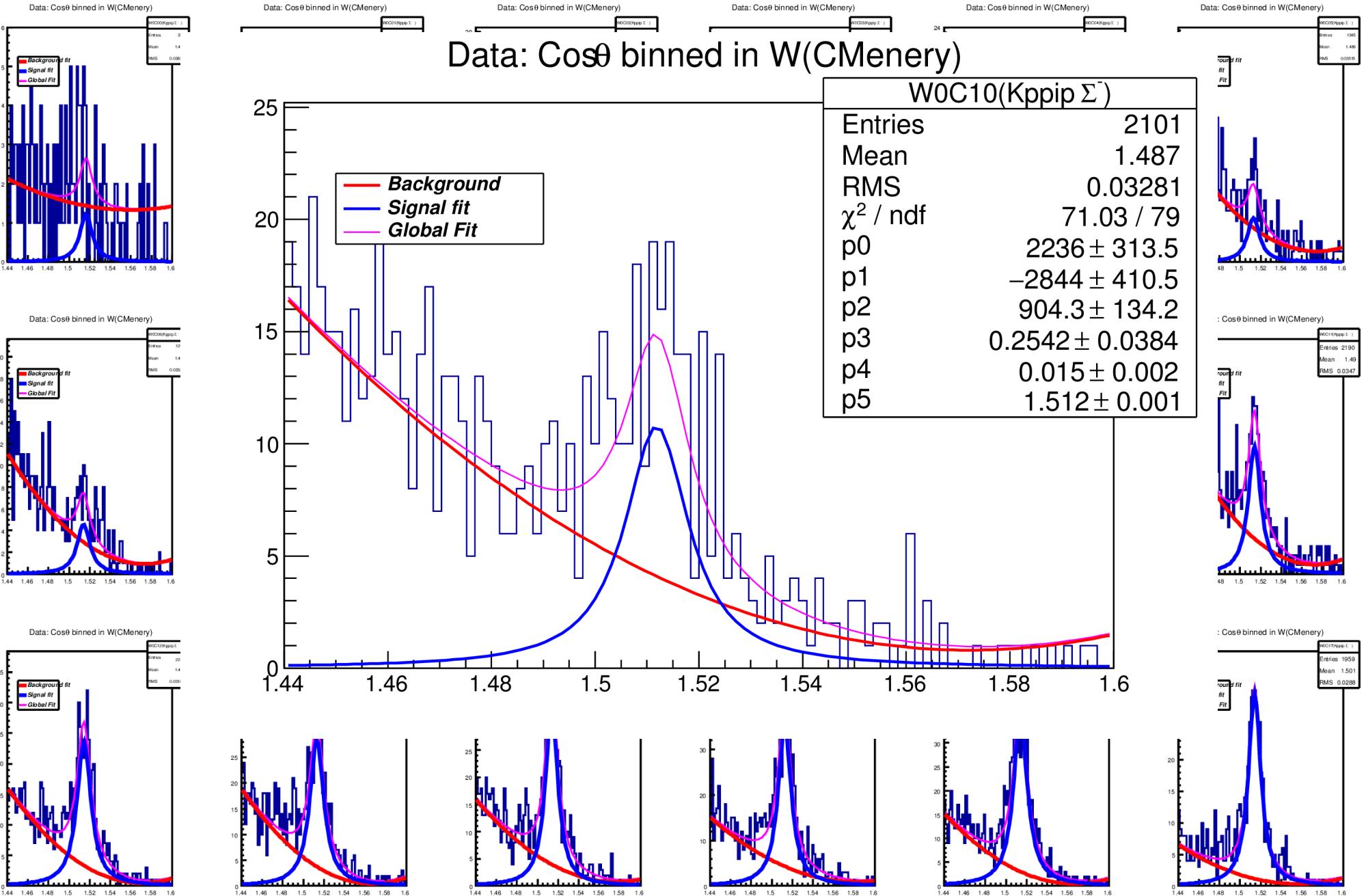
Analysis W



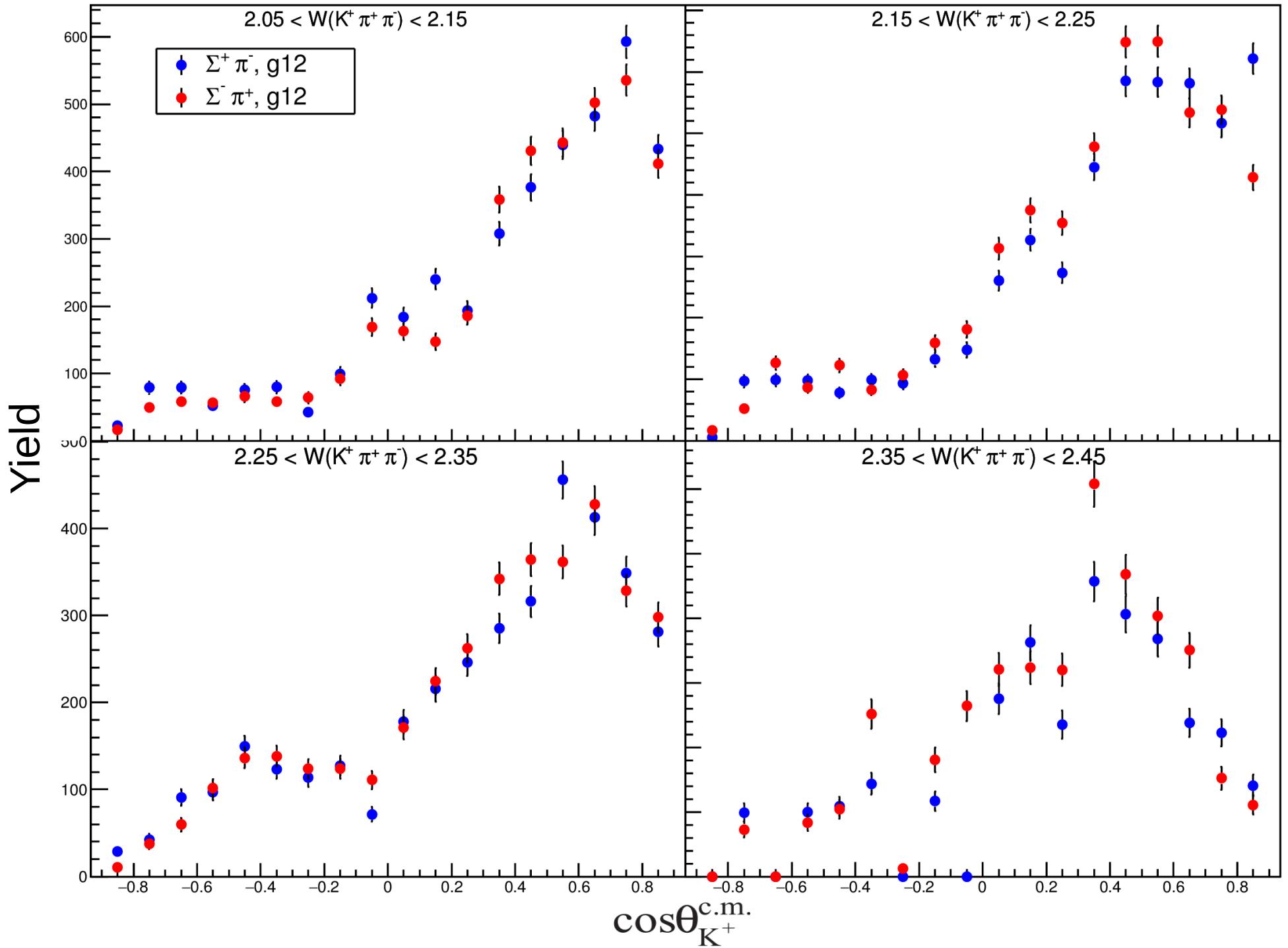
Bin Scheme



Yield Extraction & Fit



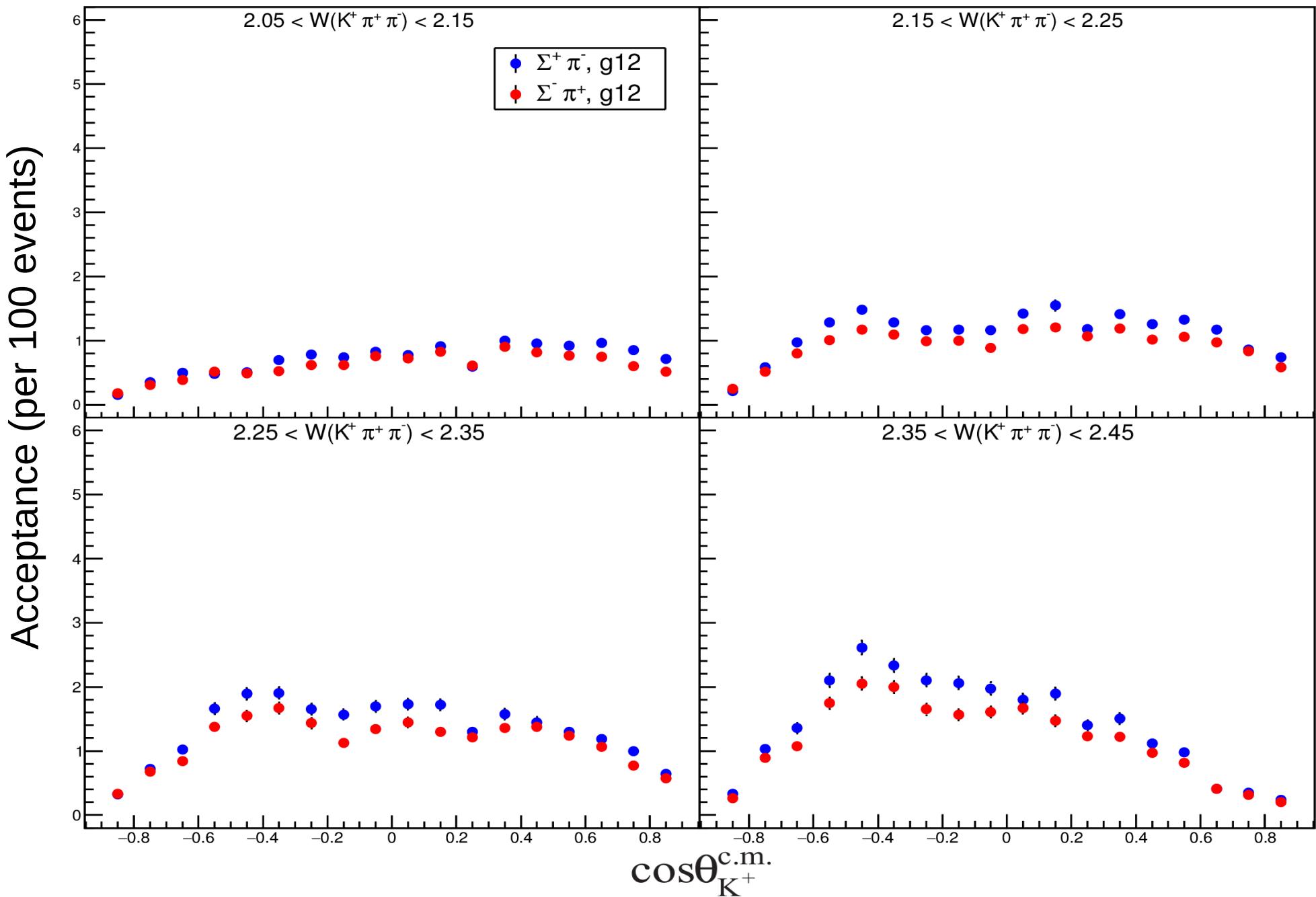
Yield Plot (Lorentzian)



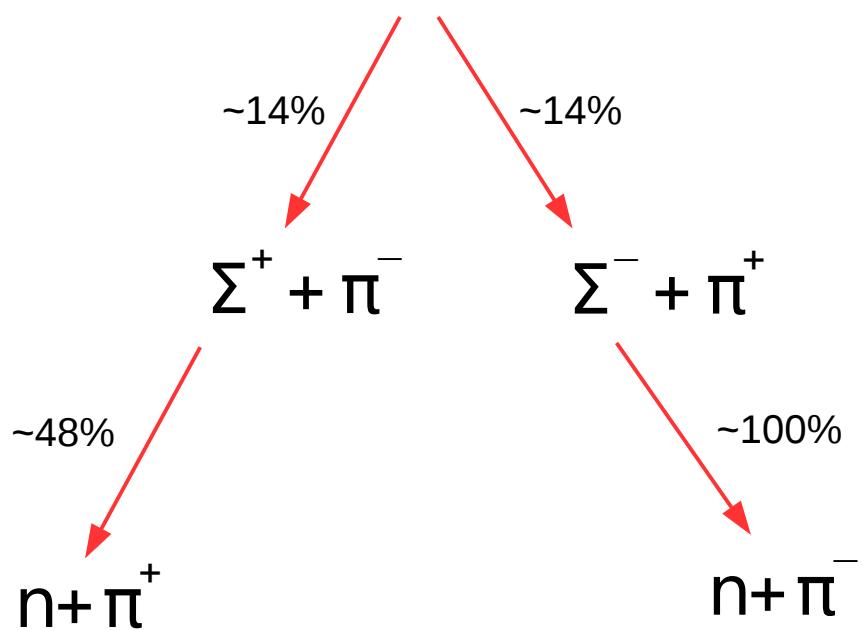
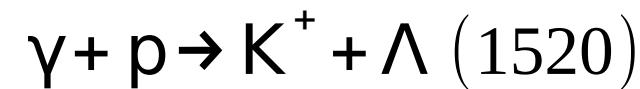
Acceptance (Lorentzian signal)

GEANT Based MC Simulation

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



Differential Cross-section



Differential Cross-section

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

τ = Branching ratio

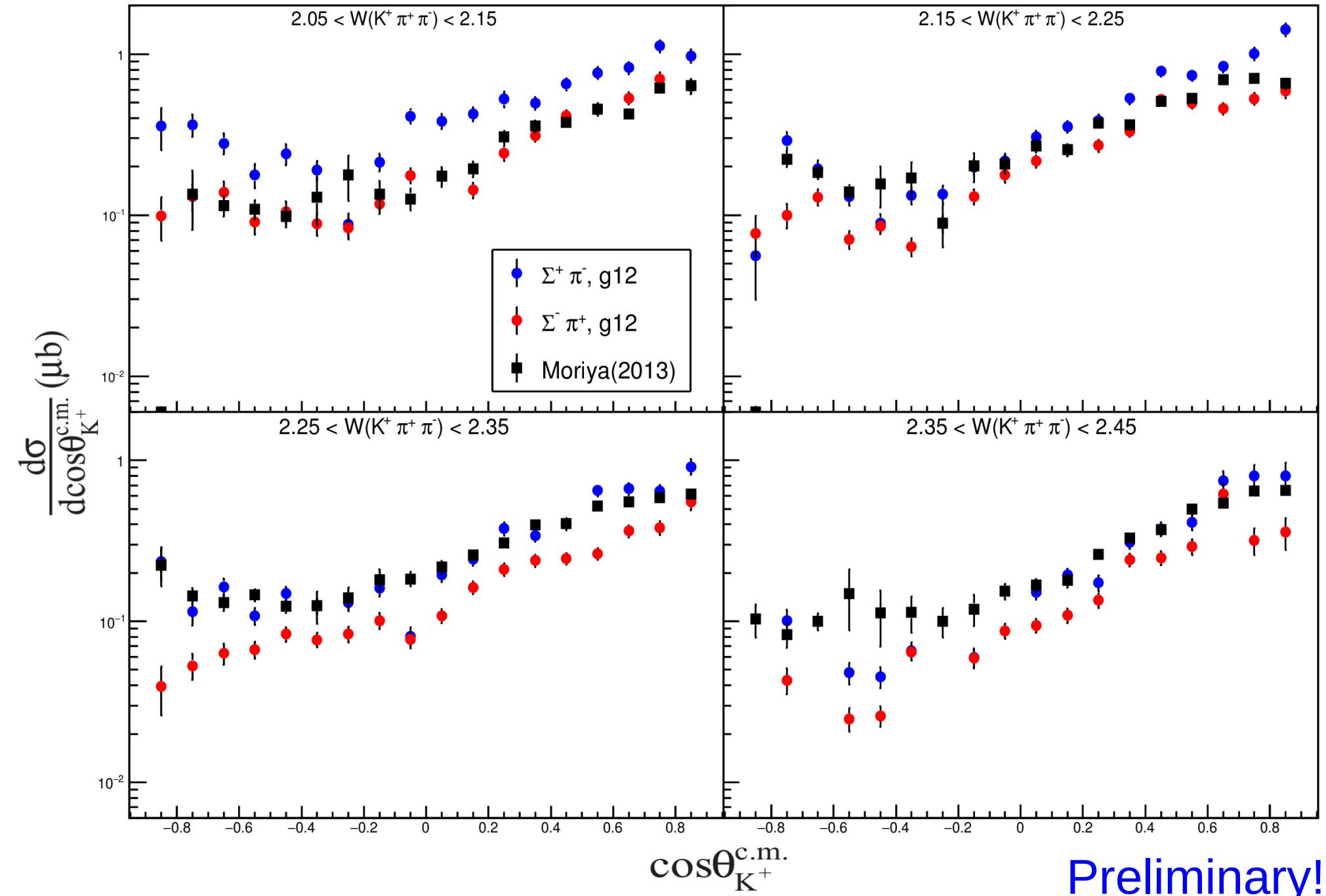
Y_d = Signal Yield

A = Acceptance

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

$L(W)$ = Luminosity

Differential Cross-section



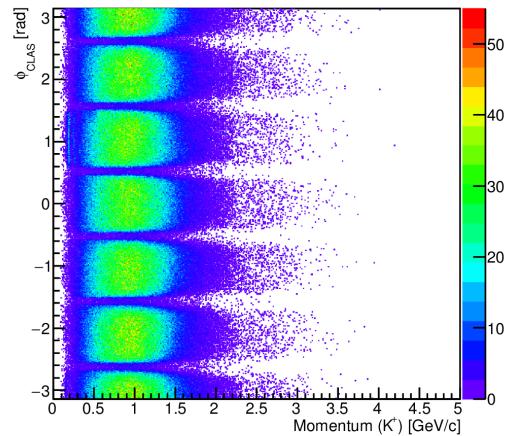
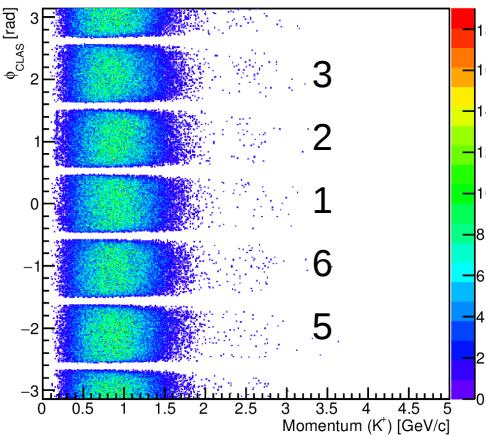
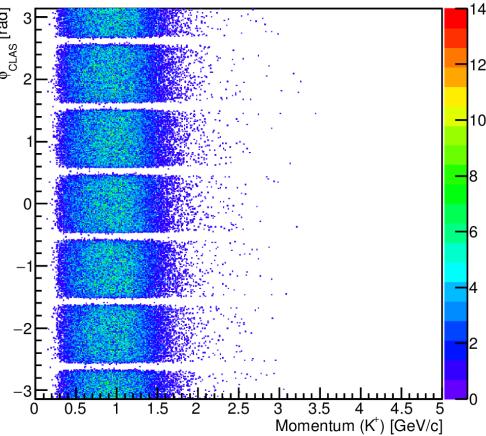
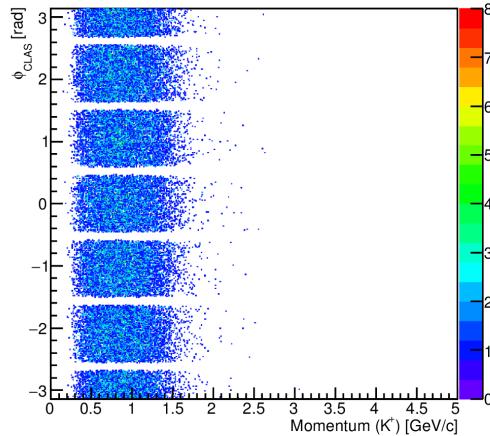
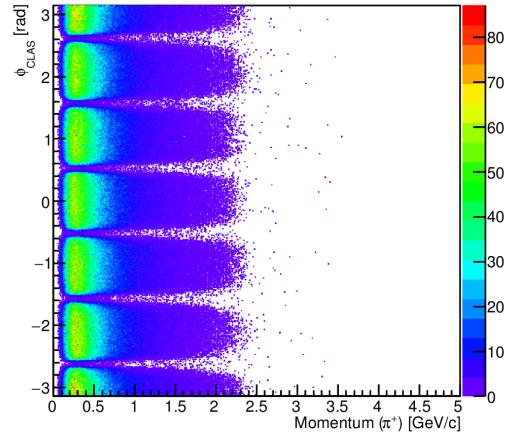
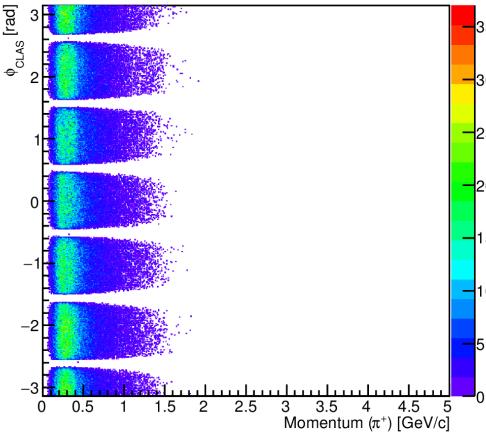
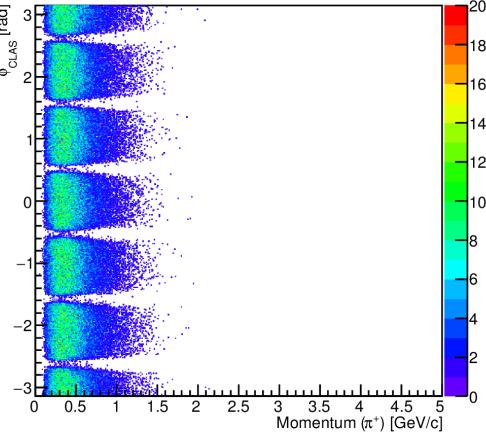
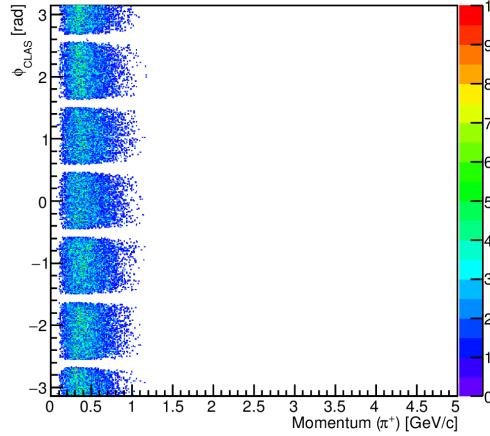
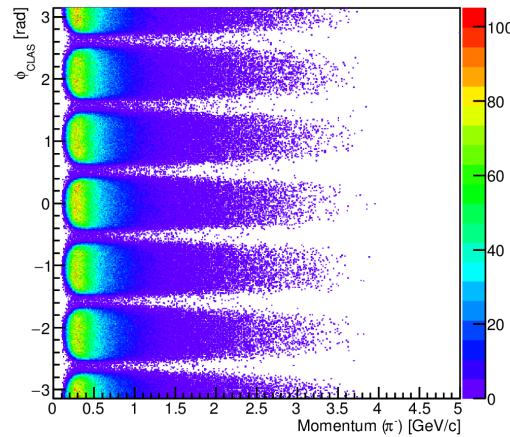
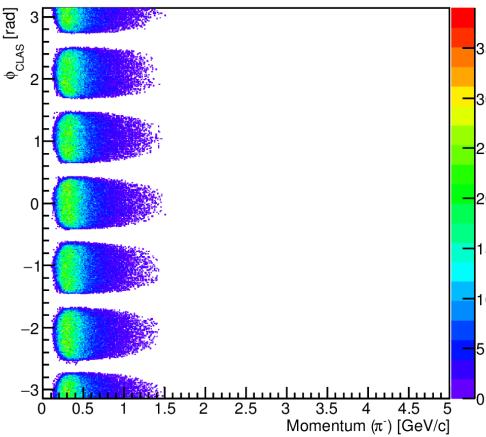
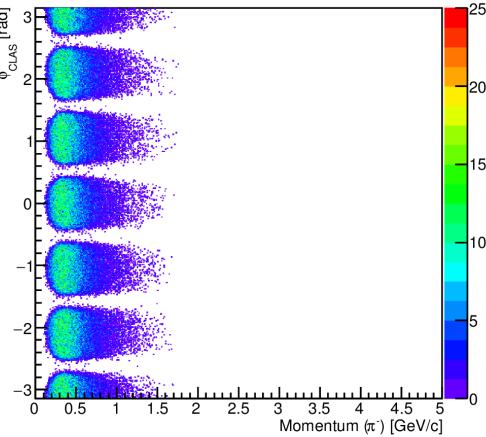
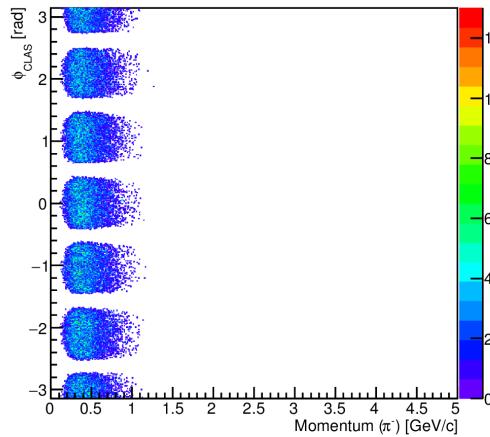
Outlook

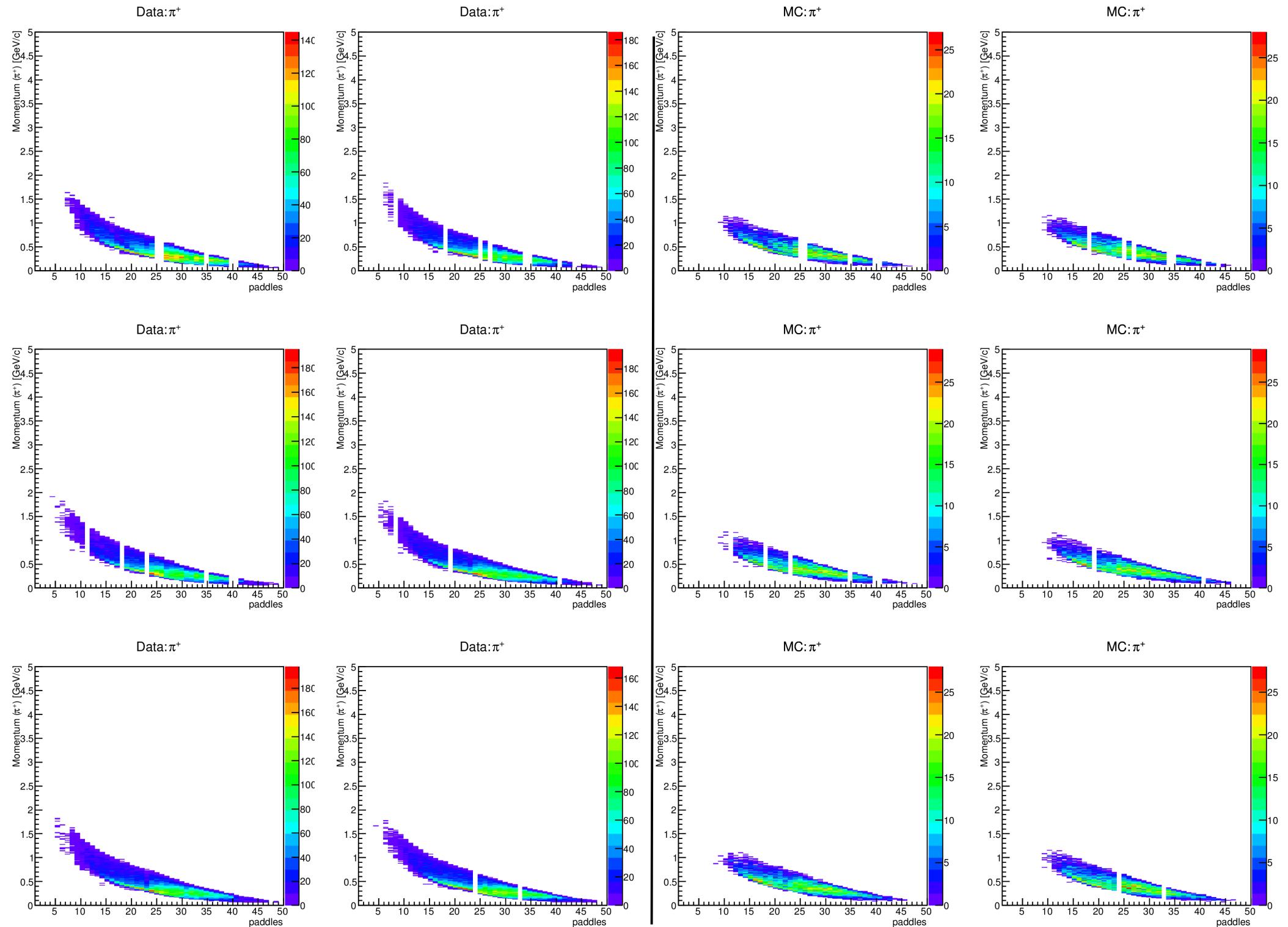
- This work presents preliminary look at the $\Lambda(1520)$ cross-section using CLAS g12
- For now, the results show consistent shape for cross-section
- New MC are on the way with same intermediate skim routine consistent with the data.
- Fitting scheme needs more play for better yield extraction using Voit function.
- All standard g12 corrections with check list and additional paddle cuts are to be taken into account.
- In Future, preliminary analysis for higher mass resonances, ie, $\Lambda(1670)$ & $\Lambda(1690)$ will be done

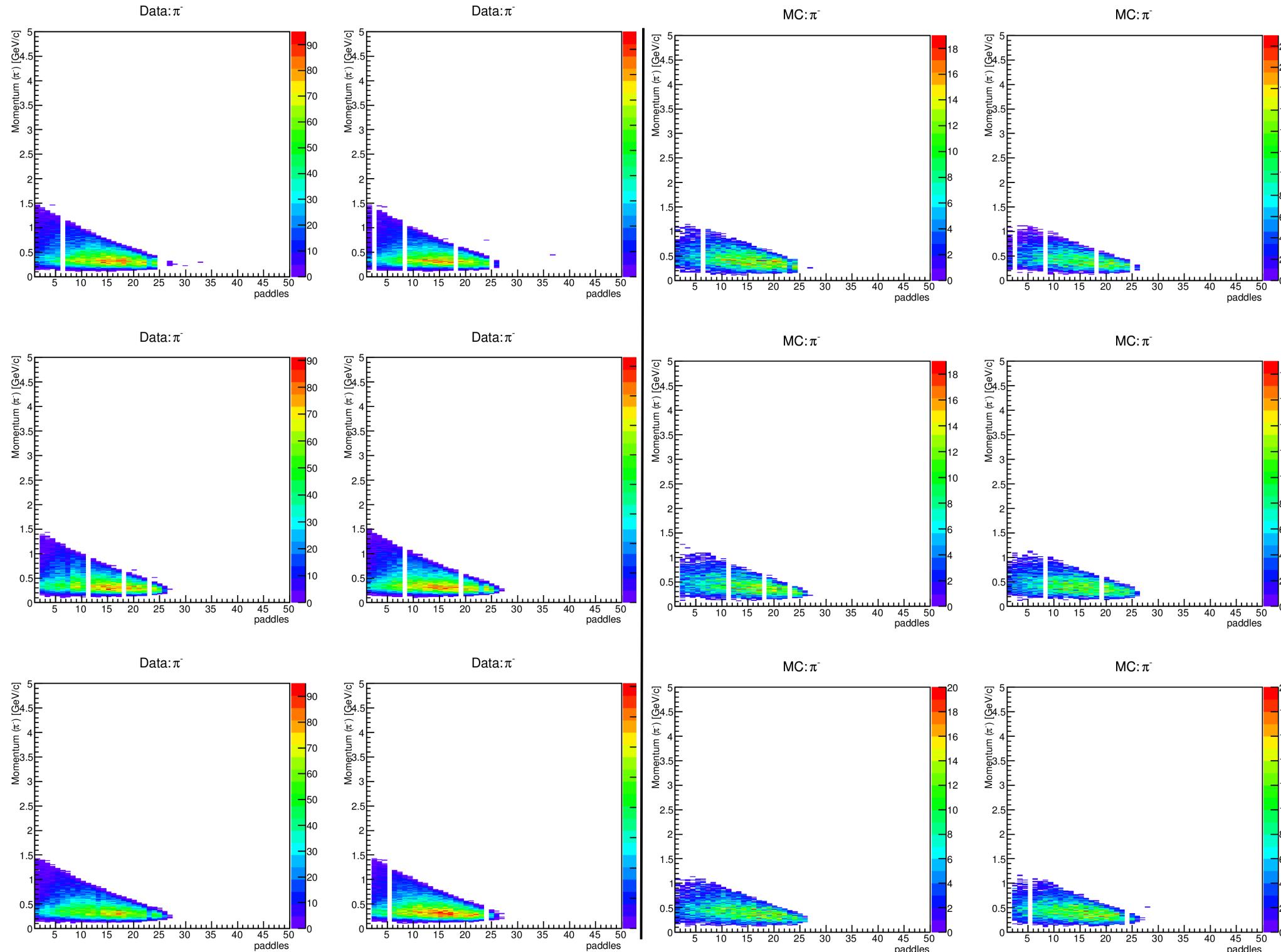
Extras

Used PART bank reconstruction for the analysis. EVNT was NOT used	N/A	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Momentum corrections as described in the g12 note	N/A	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Beam energy correction as described in the g12 note	N/A	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Inclusive Good run list as described in table 7. Individual analysis may use a subset of it	N/A	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Target density and its uncertainty as described in the g12 note	N/A	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Photon flux calculation procedure as described in the g12 note	N/A	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Lower limit for the systematic uncertainty of normalized yield is 5.7%	N/A	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Photon polarization calculation procedure as described in the g12 note	N/A	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Systematic uncertainty of the photon polarization as described in the g12 note	N/A	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
gsim parameters	N/A	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
gpp smearing parameters	N/A	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
DC efficiency map	N/A	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
EC knockout	N/A	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Φ Vs p

Data: K^+ Data: K^+ MC: K^+ MC: K^+ Data: π^+ Data: π^+ MC: π^+ MC: π^+ Data: π^- Data: π^- MC: π^- MC: π^- 

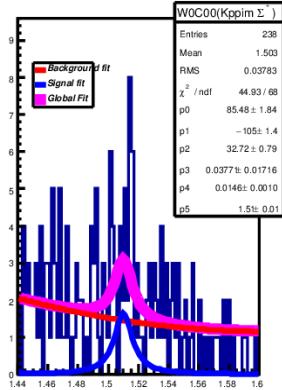




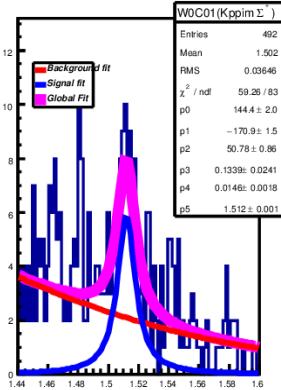
2.05 < W < 2.15

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

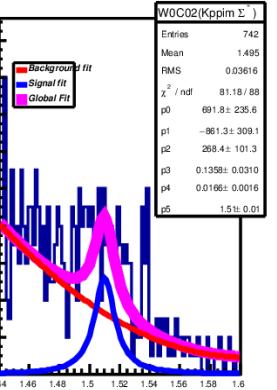
Data: Cosθ binned in W(CMenergy)



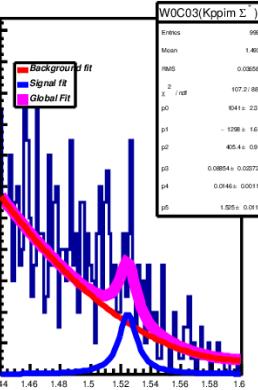
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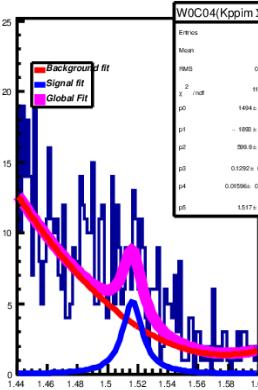
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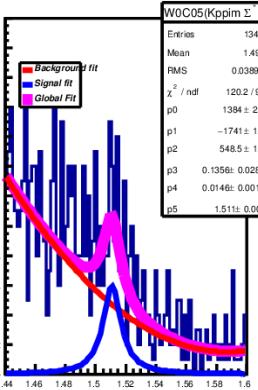
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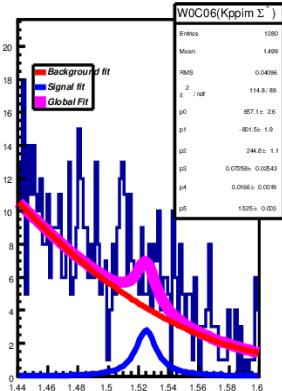
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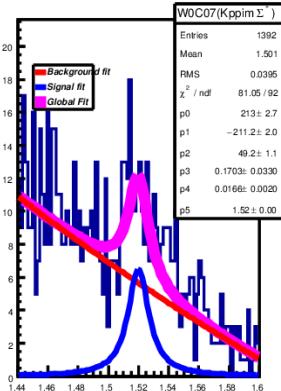
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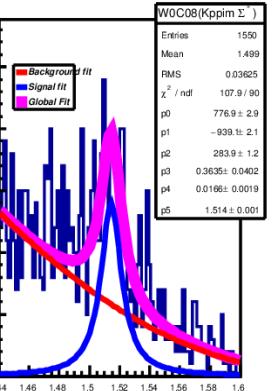
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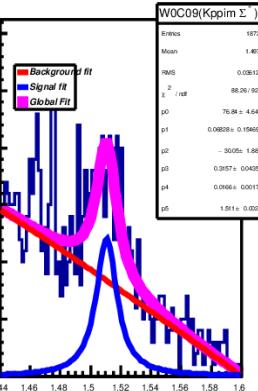
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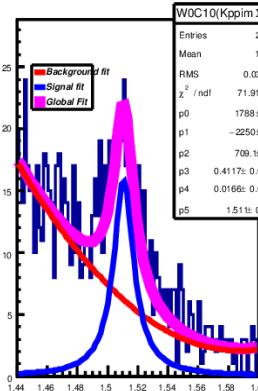
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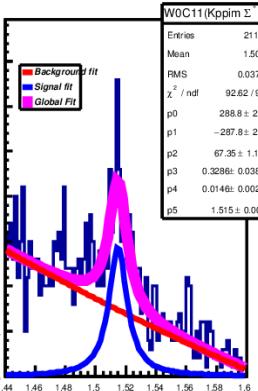
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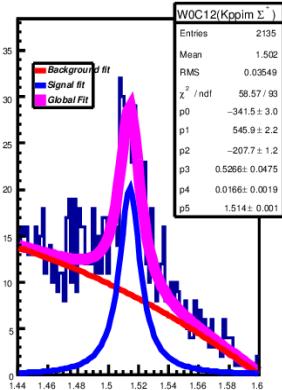
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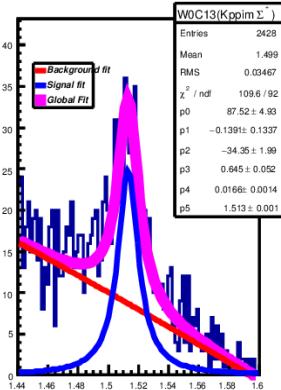
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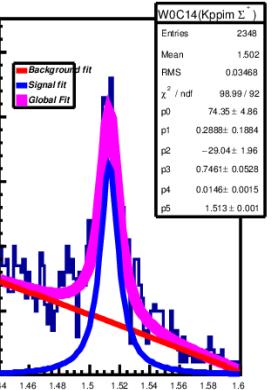
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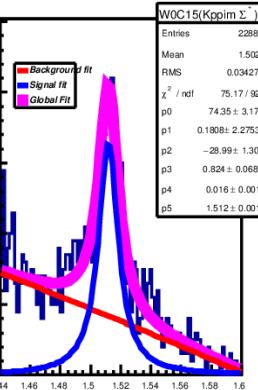
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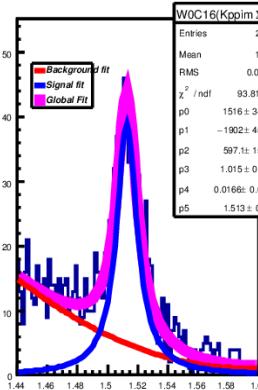
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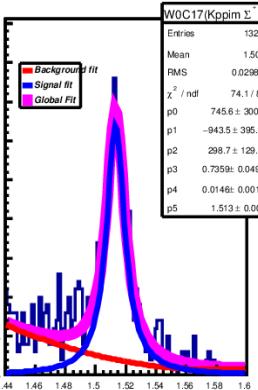
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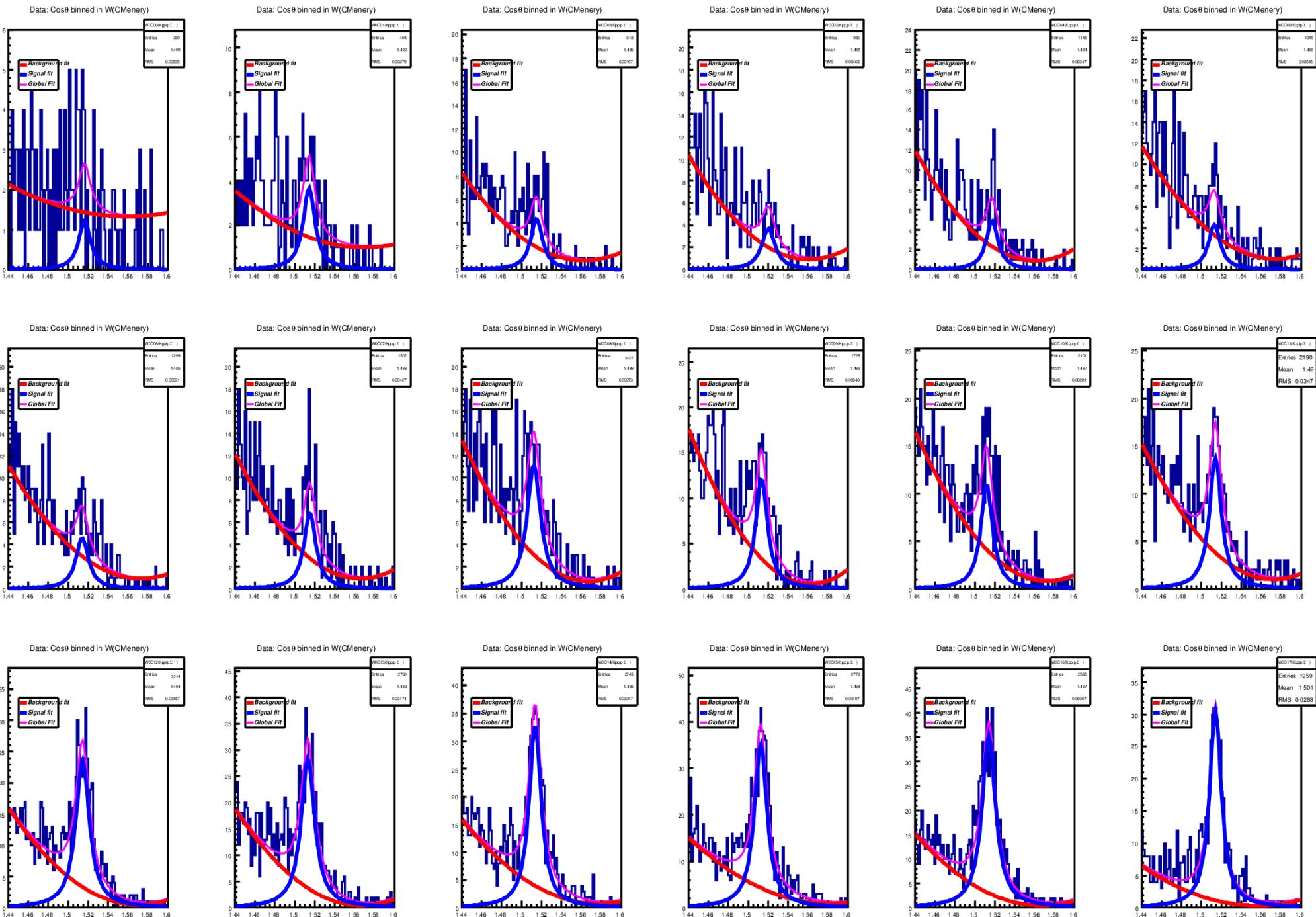


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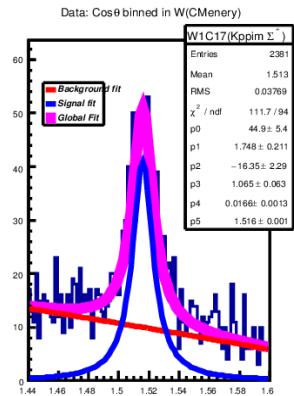
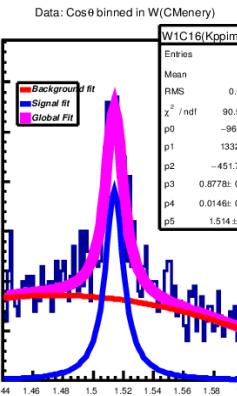
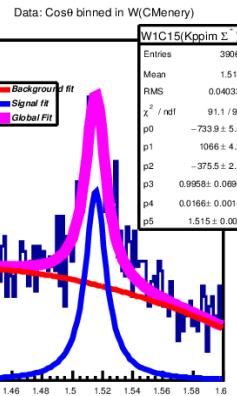
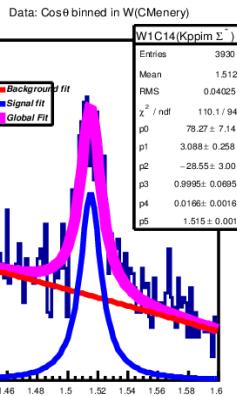
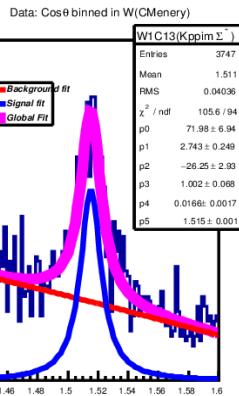
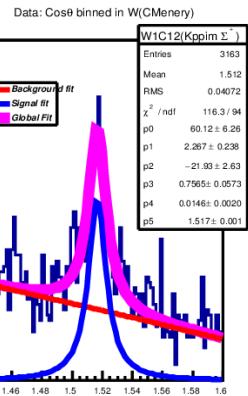
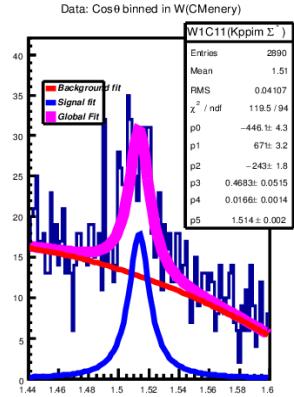
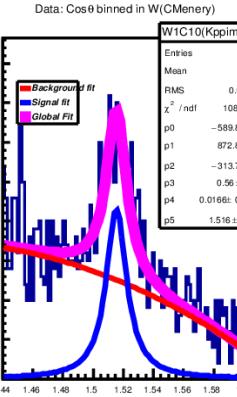
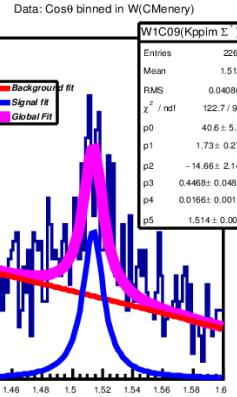
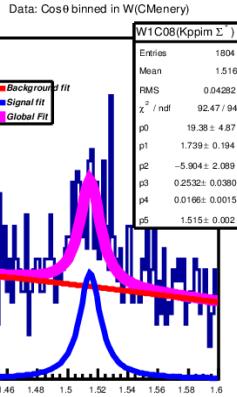
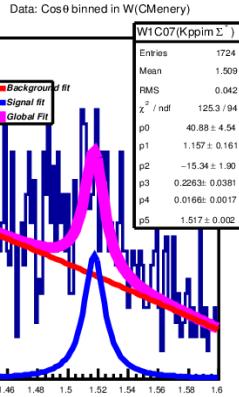
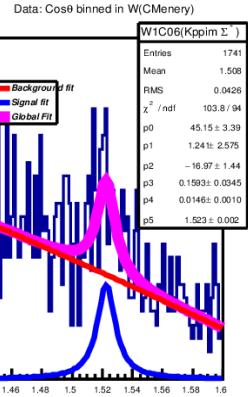
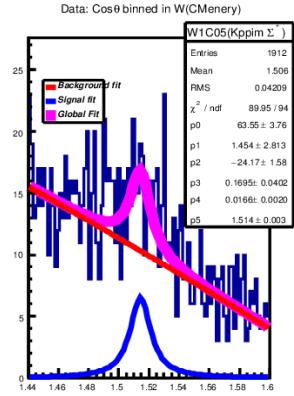
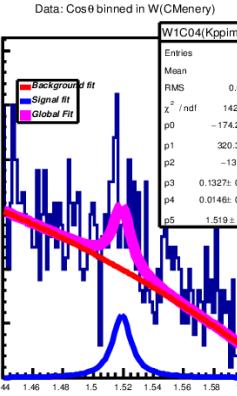
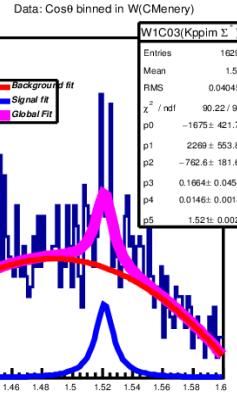
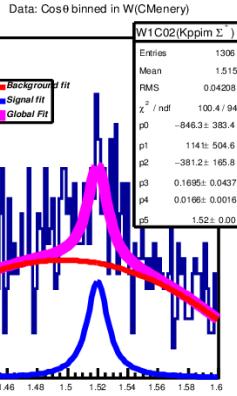
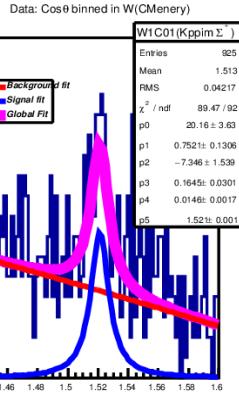
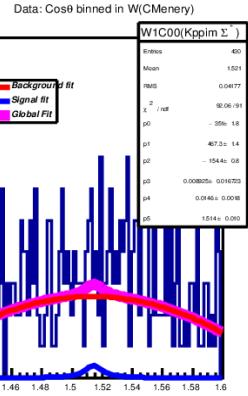
$$2.05 < W < 2.15$$

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



2.15 < W < 2.25

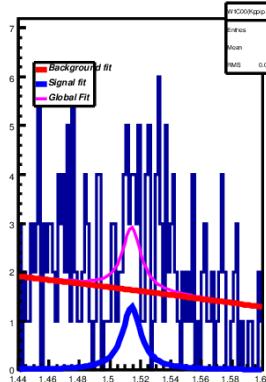
$$\Lambda(1520) \rightarrow \Sigma^+ + \pi^-$$



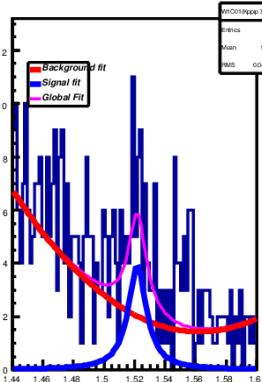
$2.15 < W < 2.25$

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

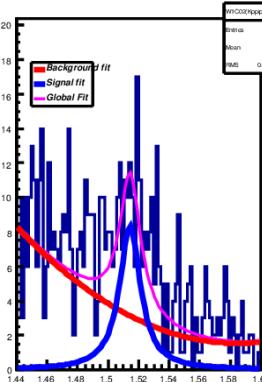
Data: $\cos\theta$ binned in W(CMenergy)



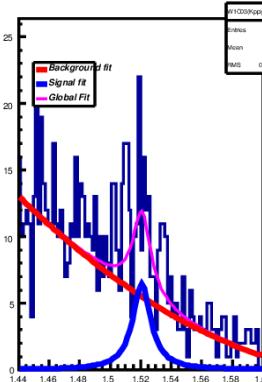
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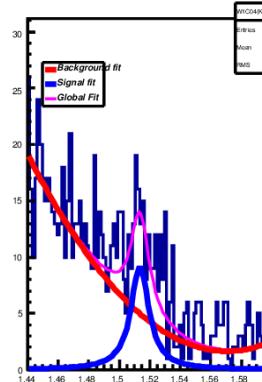
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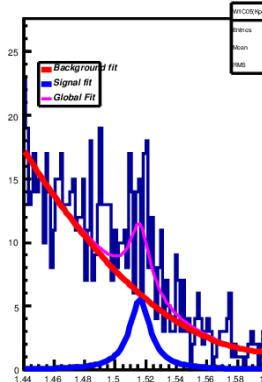
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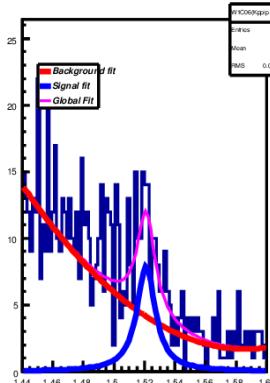
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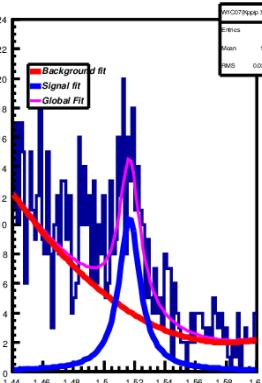
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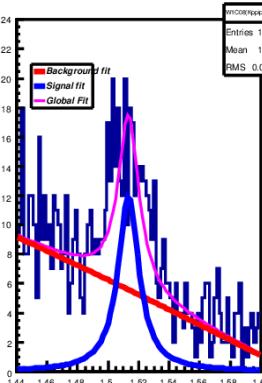
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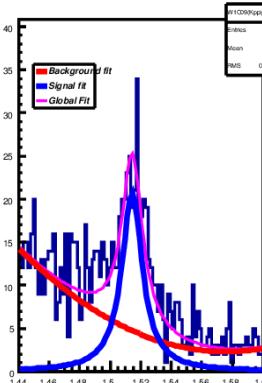
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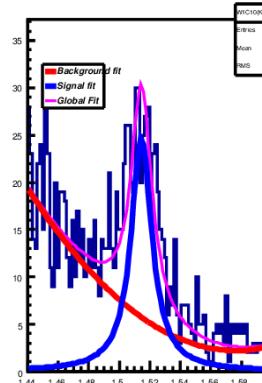
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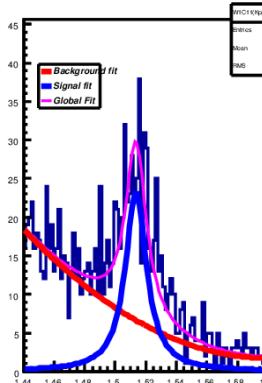
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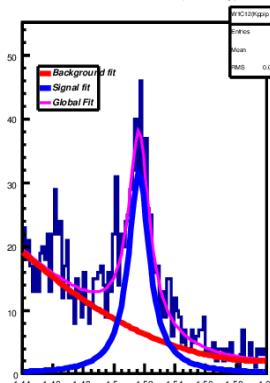
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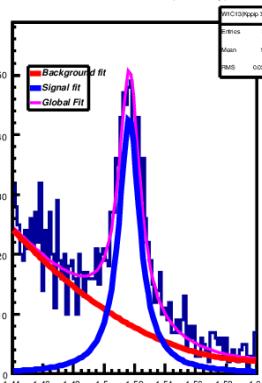
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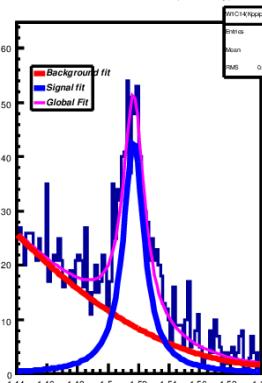
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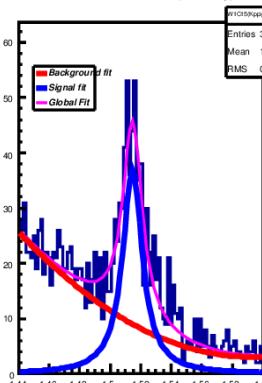
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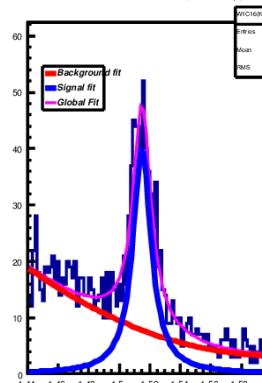
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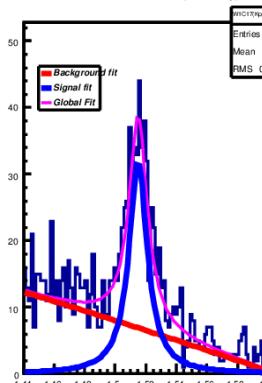
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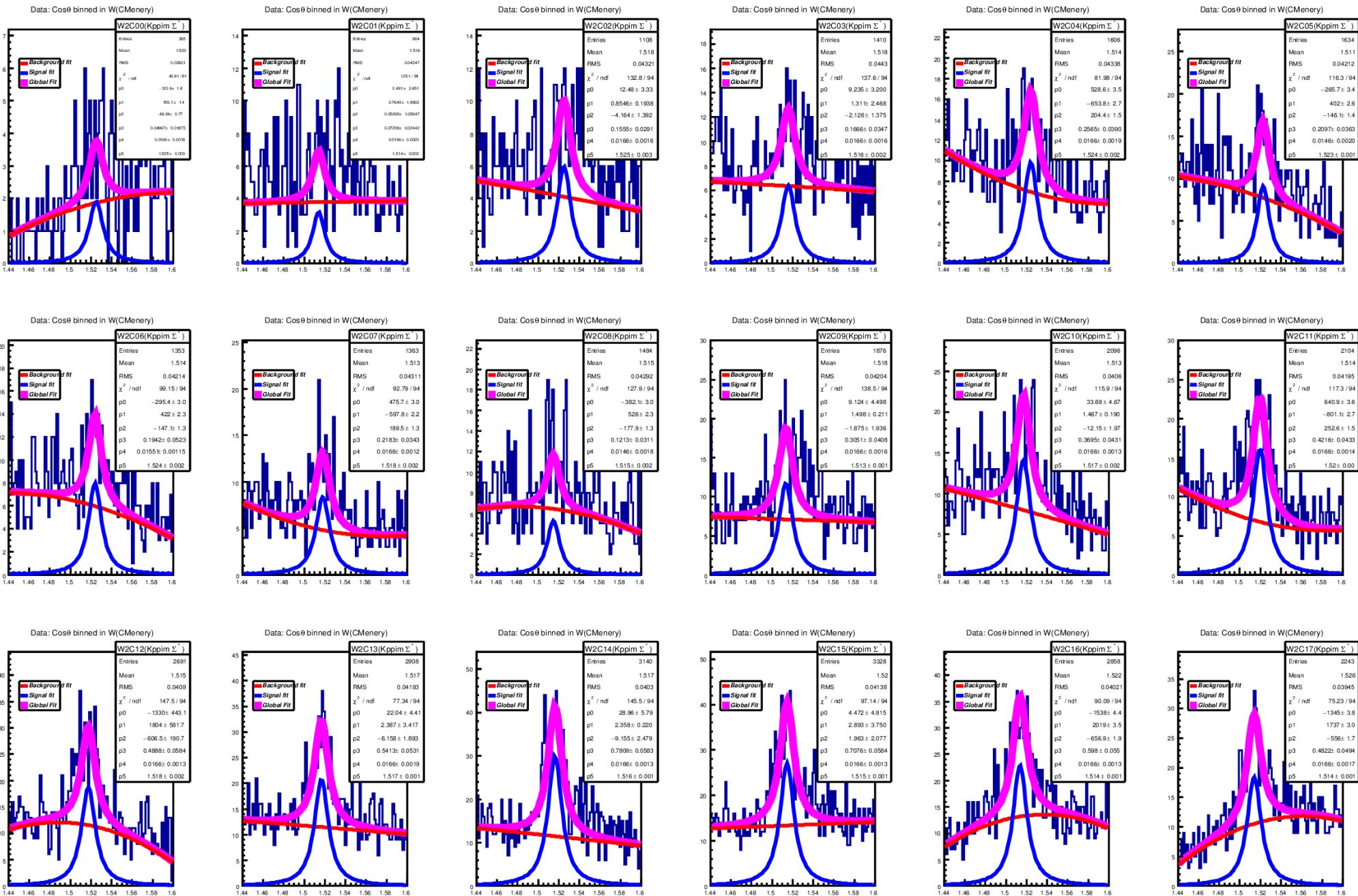


Data: $\cos\theta$ binned in W(CMenergy)



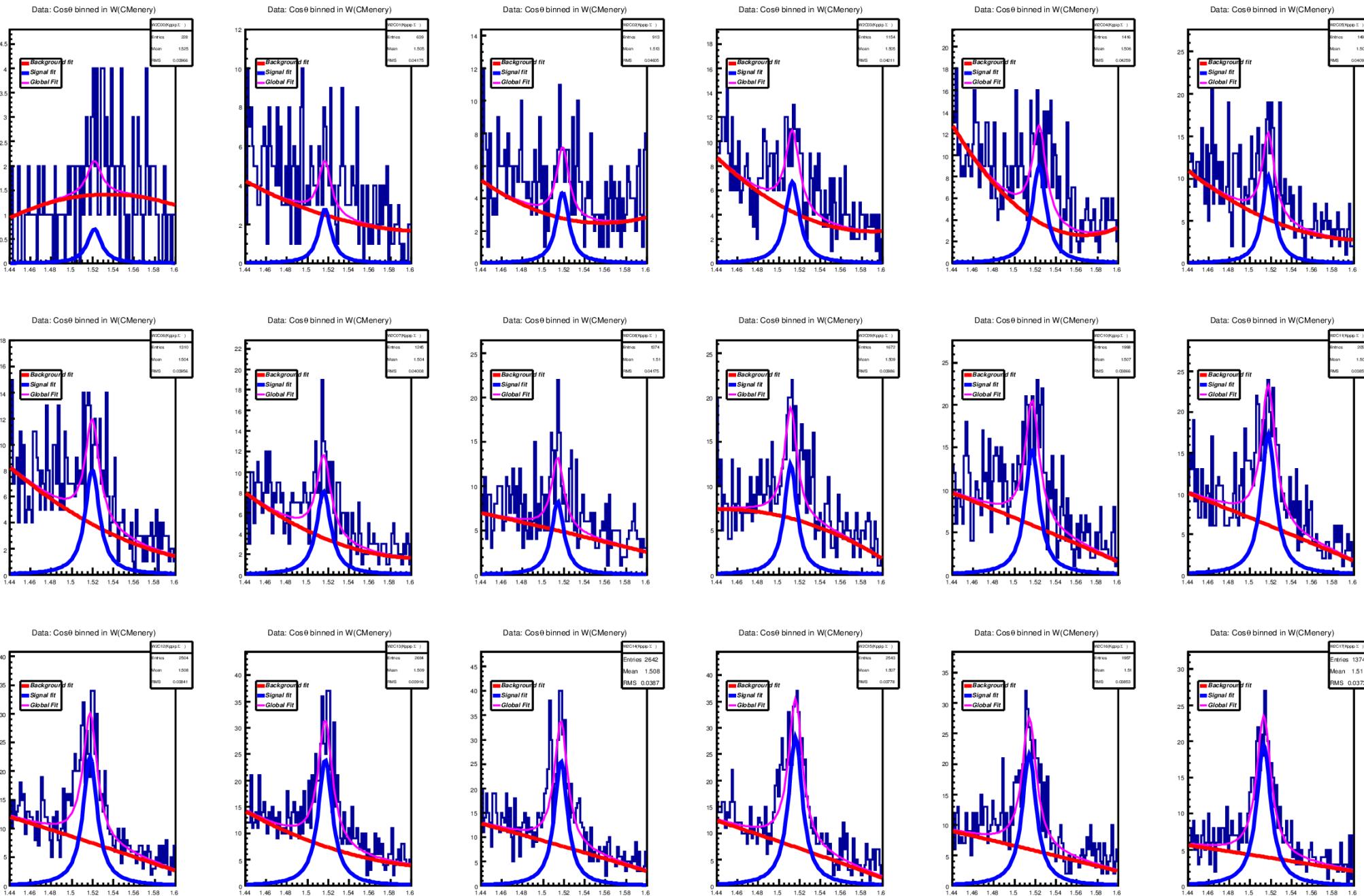
2.25 < W < 2.35

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



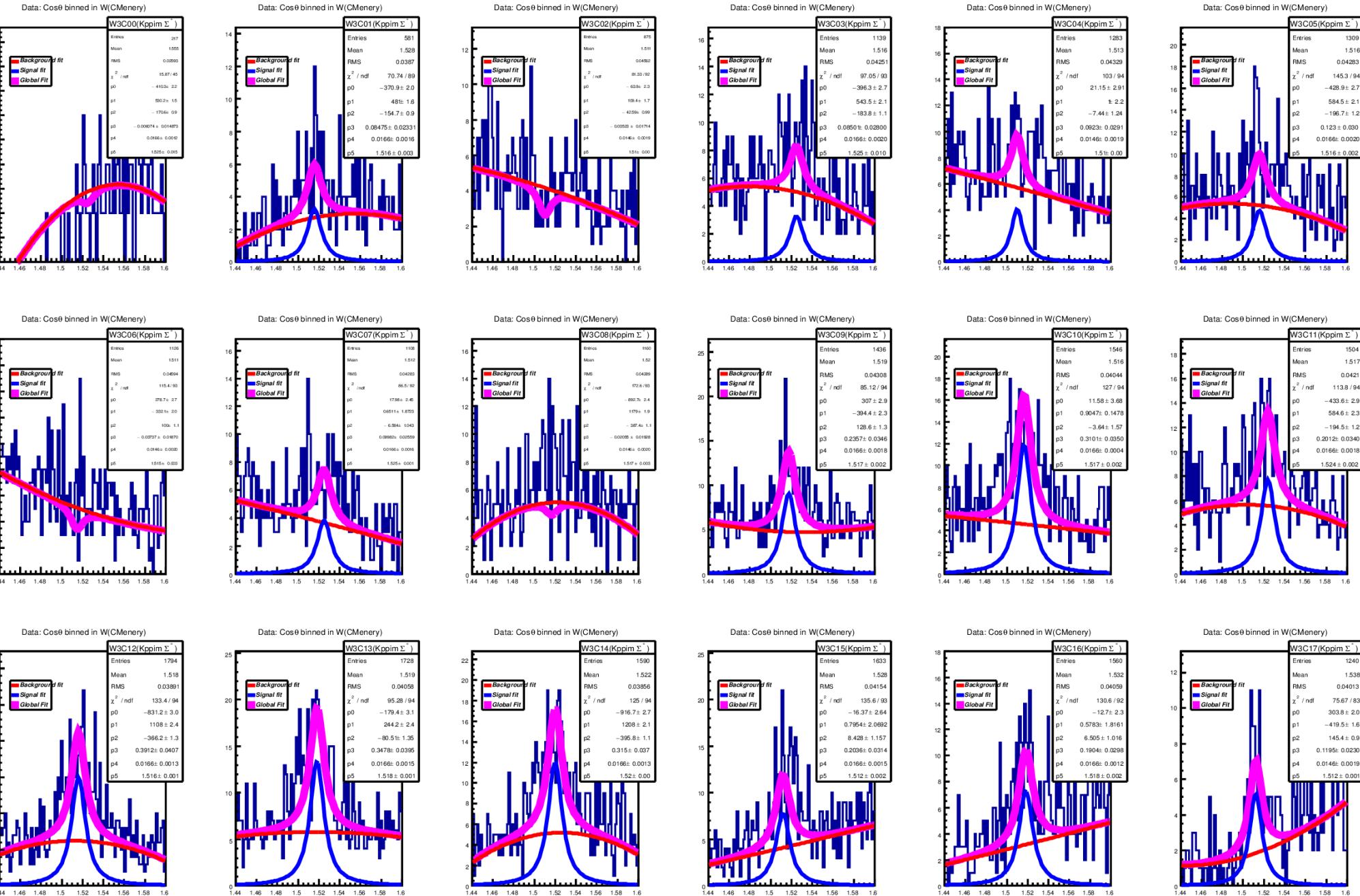
2.25 < W < 2.35

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



2.35 < W < 2.45

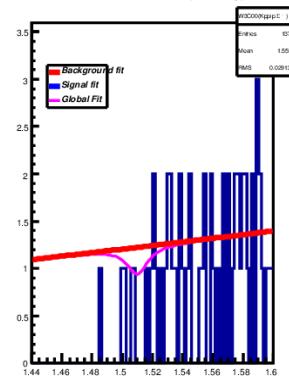
$$\Lambda(1520) \rightarrow \Sigma^+ + \pi^-$$



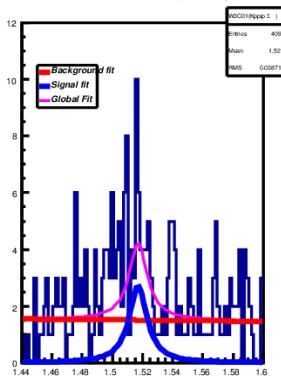
$2.35 < W < 2.45$

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

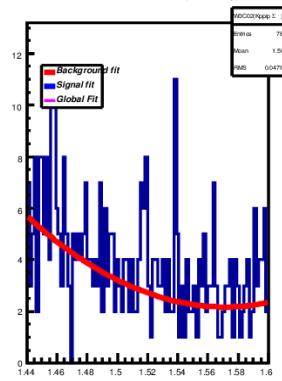
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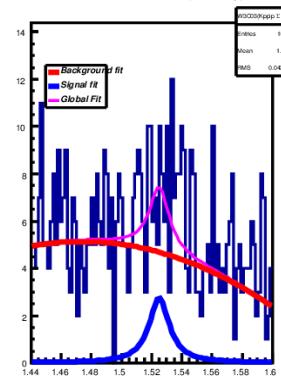
Data: $\cos\theta$ binned in $W(\text{CMenergy})$



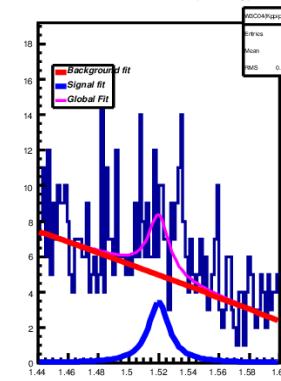
Data: $\cos\theta$ binned in $W(\text{CMenergy})$



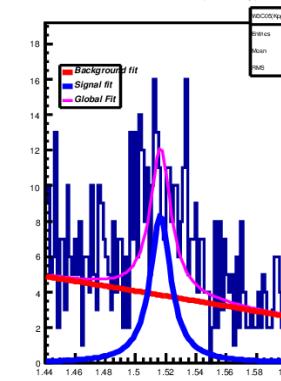
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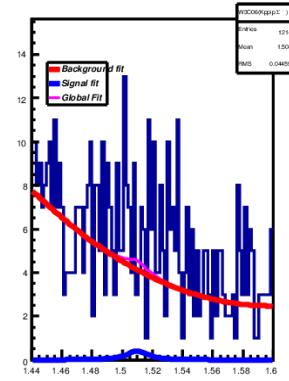
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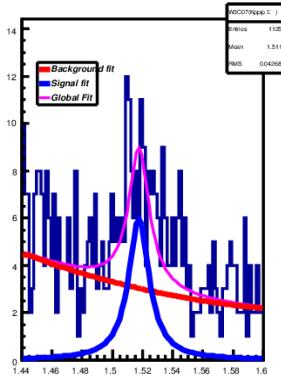
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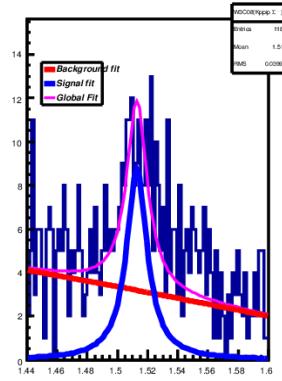
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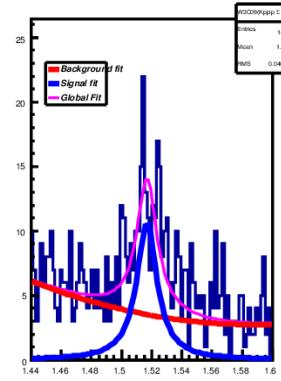
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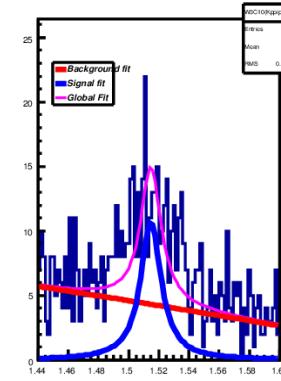
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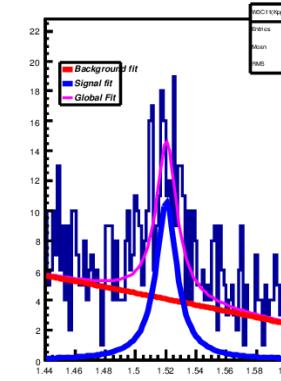
Data: $\cos\theta$ binned in $W(\text{CMenergy})$



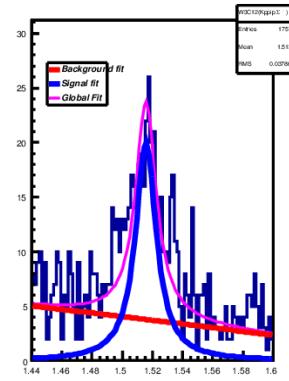
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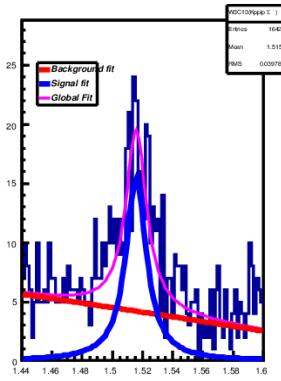
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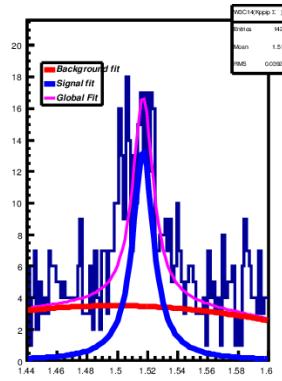
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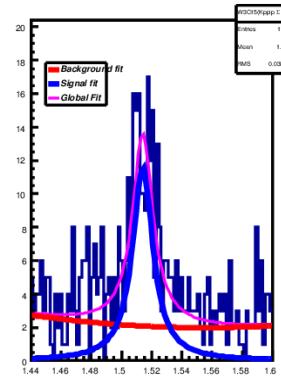
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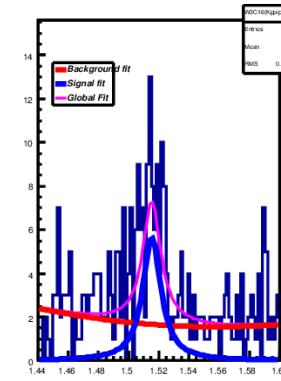
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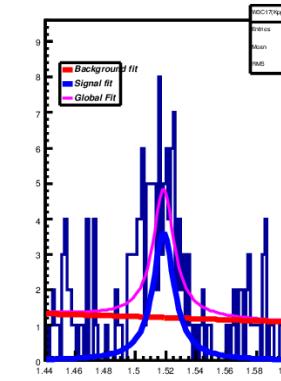
Data: $\cos\theta$ binned in $W(\text{CMenergy})$



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

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

10.2231	3.19736	7.70667	2.77609	11.7155	3.4228	2.74869	1.65792
36.6839	6.05672	16.8801	4.10854	54.4271	7.37747	39.7978	6.30855
43.2334	6.57521	38.3762	6.19486	57.4547	7.57989	45.05	6.71193
39.4354	6.27976	40.8598	6.39216	36.8375	6.06939	30.5028	5.52293
47.4557	6.88881	43.1818	6.57129	50.7022	7.12055	47.7099	6.90724
38.3693	6.19429	0 0		50.8474	7.13074	50.191	7.08456
45.2454	6.72647	35.761	5.98005	27.6365	5.25704	33.7989	5.81368
66.0276	8.12574	54.1722	7.36018	67.8879	8.23941	52.5939	7.25216
118.919	10.905	102.186	10.1087	145.607	12.0668	126.2	11.2339
124.329	11.1503	100.734	10.0366	147.293	12.1364	118.46	10.8839
104.766	10.2355	95.009	9.74725	163.21	12.7754	142.966	11.9568
133.425	11.551	112.303	10.5973	139.469	11.8097	122.734	11.0785
249.441	15.7937	182.91	13.5244	207.217	14.395	170.386	13.0532
297.435	17.2463	248.861	15.7753	273.575	16.5401	236.944	15.393
318.636	17.8504	275.639	16.6024	330.391	18.1767	296.28	17.2128
360.891	18.9971	303.956	17.4343	332.427	18.2326	273.472	16.537
378.929	19.4661	305.724	17.485	421.895	20.5401	343.96	18.5462
286.616	16.9297	241.618	15.5441	308.983	17.5779	247.589	15.735
11.4155	3.37868	11.5247	3.3948	10.0341	3.16766	15.0724	3.88232
34.9812	5.91449	10.929	3.3059	70.5721	8.40072	49.59	7.04202
92.6424	9.62509	60.7045	7.79131	64.1647	8.01028	70.8453	8.41696
60.9714	7.80842	28.6926	5.35655	63.5288	7.9705	41.7712	6.46306
90.9196	9.53518	59.1267	7.68939	64.2929	8.01829	41.3617	6.43131
58.624	7.65663	53.9913	7.34787	71.9178	8.48044	59.762	7.73059
75.2058	8.67213	68.7782	8.29326	70.3326	8.38645	61.98	7.87274
107.503	10.3684	109.564	10.4673	86.8416	9.31888	80.787	8.98816
145.284	12.0534	129.208	11.367	93.4467	9.66678	71.3005	8.44396
222.902	14.9299	182.312	13.5023	155.901	12.486	131.828	11.4816
266.325	16.3195	224.523	14.9841	232.62	15.2519	210.09	14.4945
250.434	15.8251	196.733	14.0261	195.75	13.9911	163.129	12.7722
328.382	18.1213	276.443	16.6266	335.309	18.3114	256.12	16.0038
454.44	21.3176	382.687	19.5624	421.593	20.5327	345.149	18.5782
453.217	21.2889	379.825	19.4891	398.049	19.9512	333.609	18.265
376.393	19.4008	323.928	17.998	401.513	20.0378	332.489	18.2343
395.595	19.8896	351.996	18.7615	368.6	19.199	340.441	18.451