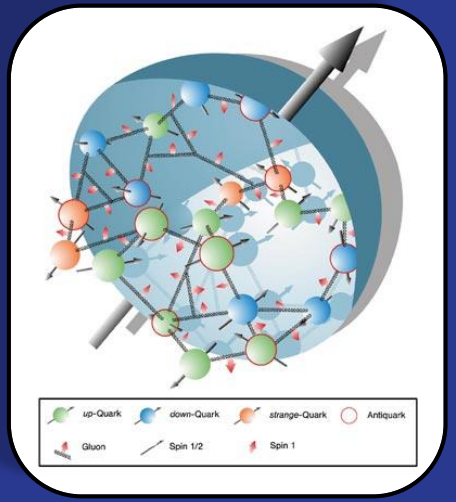
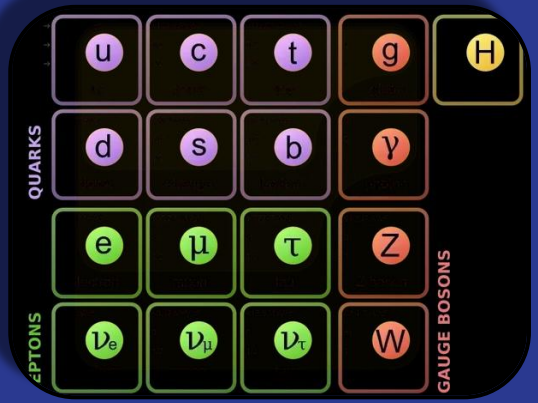
ELUCIDATING STRANGENESS WITH CLAS12





104 MeV/c^2

$-\frac{1}{3}$

$\frac{1}{2}$ S

strange

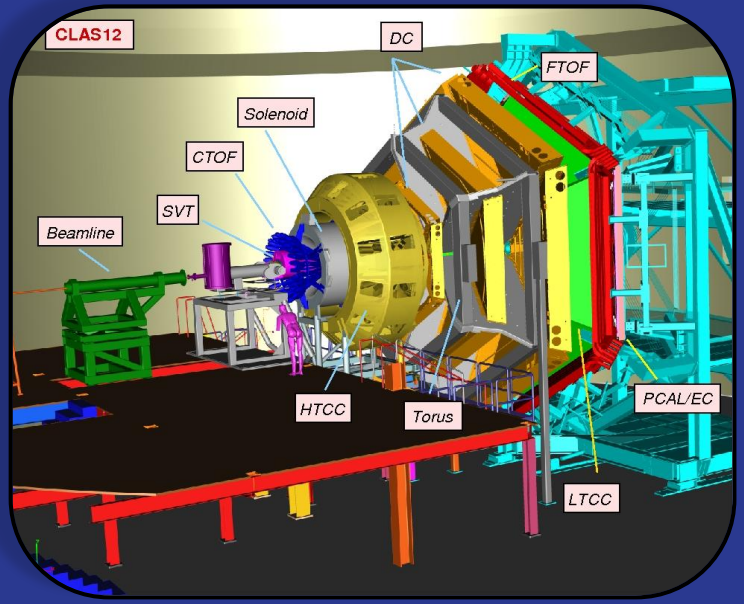
UNIVERSITY of York

Science and Technology Facilities Council

Asli G. Acar (asli.acar@york.ac.uk)

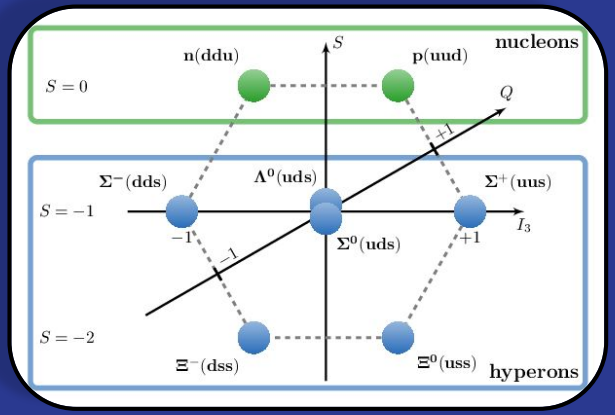
Jefferson Lab

HALL B



THE CLAS12 SPECTROMETER

THE VERY STRANGE EXPERIMENT



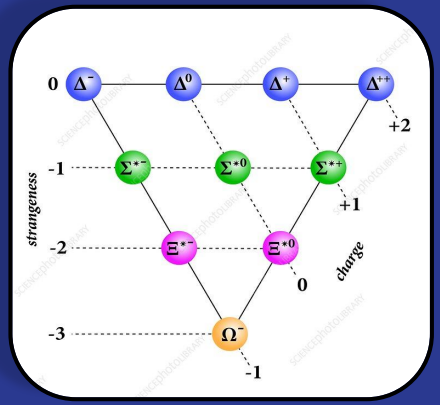


TABLE VIII. The Ξ and Ω baryons below 2400 and 2500 MeV, respectively.

State, J^P	Predicted masses (MeV)							
$\Xi\frac{1}{2}^+$	1305							
$\Xi\frac{3}{2}^+$	1505							
$\Xi^*\frac{1}{2}^-$	1755	1810	1835	2225	2285	2300	2320	2380
$\Xi^*\frac{3}{2}^-$	1785	1880	1895	2240	2305	2330	2340	2385
$\Xi^*\frac{5}{2}^-$	1900	2345	2350	2385				
$\Xi^*\frac{7}{2}^-$	2355							
$\Xi^*\frac{1}{2}^+$	1840	2040	2100	2130	2150	2230	2345	
$\Xi^*\frac{3}{2}^+$	2045	2065	2115	2165	2170	2210	2230	2275
$\Xi^*\frac{5}{2}^+$	2045	2165	2230	2230	2240			
$\Xi^*\frac{7}{2}^+$	2180	2240						

Isgur & Capstick (1986)

44 Ξ states predicted…

THE VERY STRANGE EXPERIMENT

Current Particle	Current Status	Previous Mass	Previous Status	Mass from MPS (MeV)
$\Xi(1318)$	****	1320	****	1320 ± 6
$\Xi(1530)$	****	1530	****	1541 ± 12
$\Xi(1620)$	*	1630	**	
$\Xi(1690)$	***	1680	**	
$\Xi(1820)$	***	1820	***	1822 ± 6
$\Xi(1950)$	***	1940	**	
$\Xi(2030)$	***	2030	***	2022 ± 7
$\Xi(2120)$	*	2120	*	
$\Xi(2250)$	**	2250	*	2214 ± 5
$\Xi(2370)$	**	2370	**	2356 ± 10
$\Xi(2500)$	*	2500	**	2505 ± 10

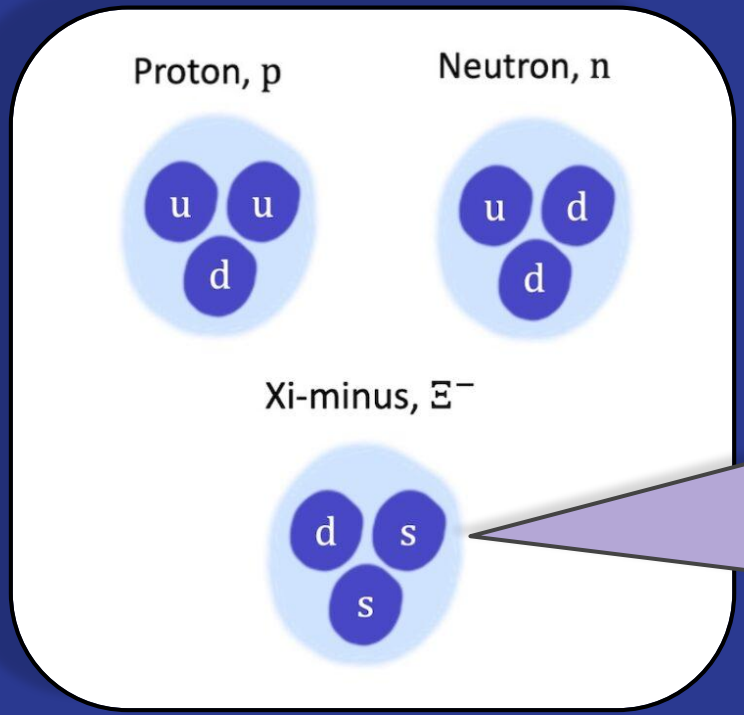
Now

1981

Only 6 states "established" according to the PDG!

Not much progress in the last three decades …

THE VERY STRANGE EXPERIMENT



Why look into Ξ cascade baryons?

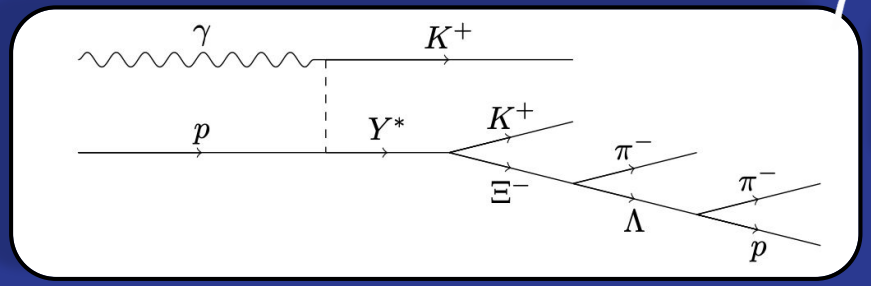
1. Theoretical controversies about certain states (i.e., 1620)
2. The hyperon puzzle?
3. Quantum numbers information of new & missing states
4. Bridging light (ultra-relativistic) flavours with heavy (non-relativistic)

CASCADES

Consider the following reaction:

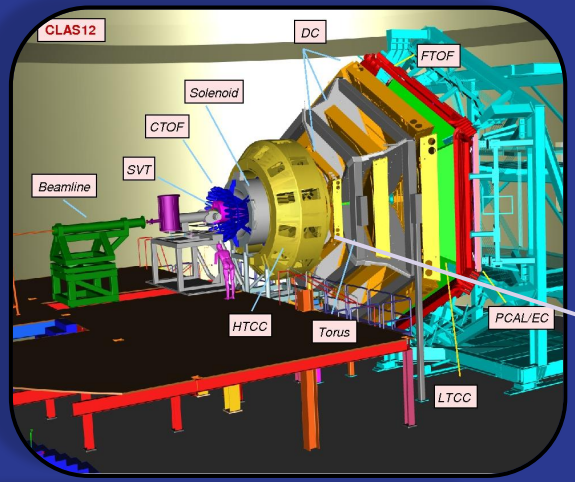
$$e^- p \rightarrow e'^- \Xi^{*-} K^+ K^+$$
$$\hookrightarrow \Lambda K^-$$
$$\hookrightarrow p\pi^-$$

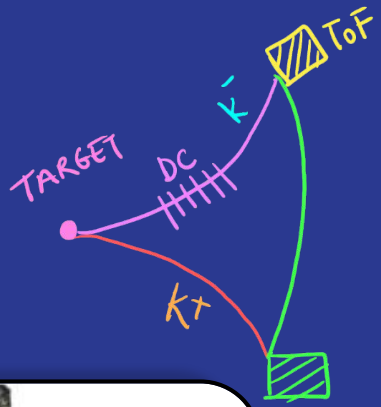
We can plot the missing mass of $K^+ K^+ e'^-$ to observe the cascade baryons.



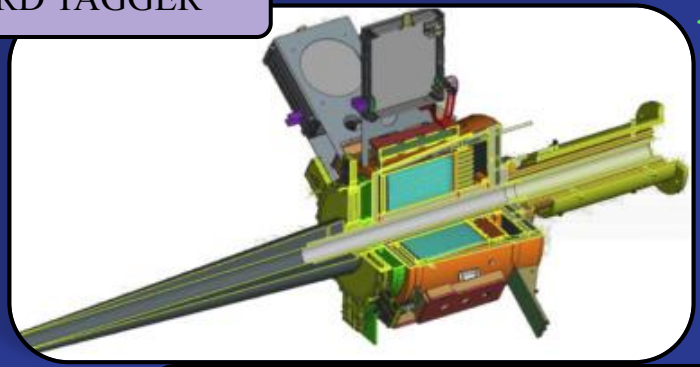
Ground state cascade

DATA ANALYSIS



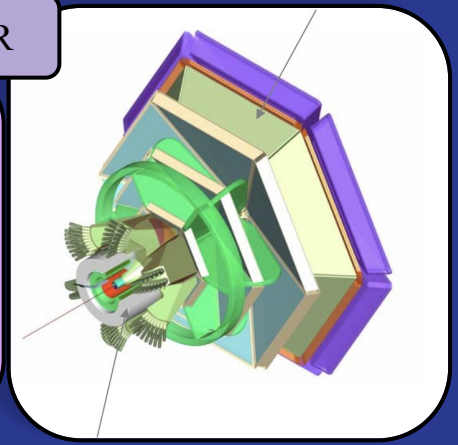


FORWARD TAGGER



Covers angular range 2.5°<θ<4.5°, Quasi-real photoproduction at low Q^2. Precision not as high as FD.

FORWARD DETECTOR

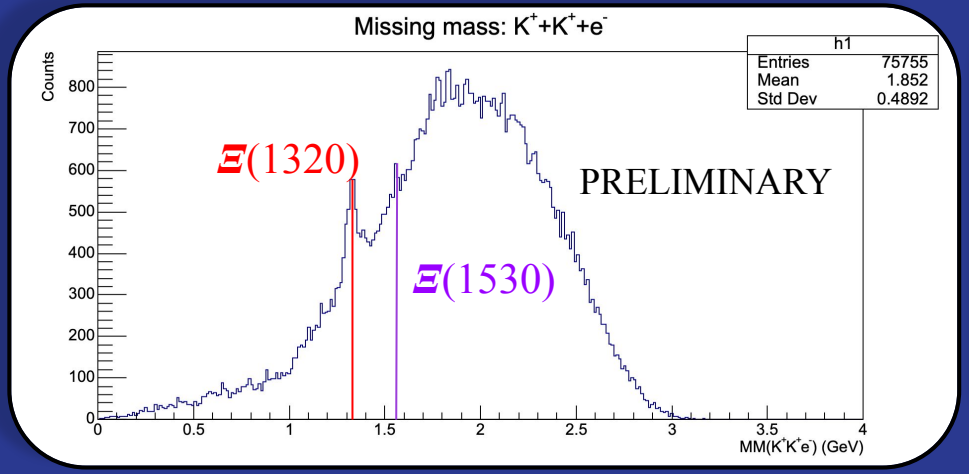


Covers angular range 5°<θ<35°. Higher Q^2 values but higher precision.

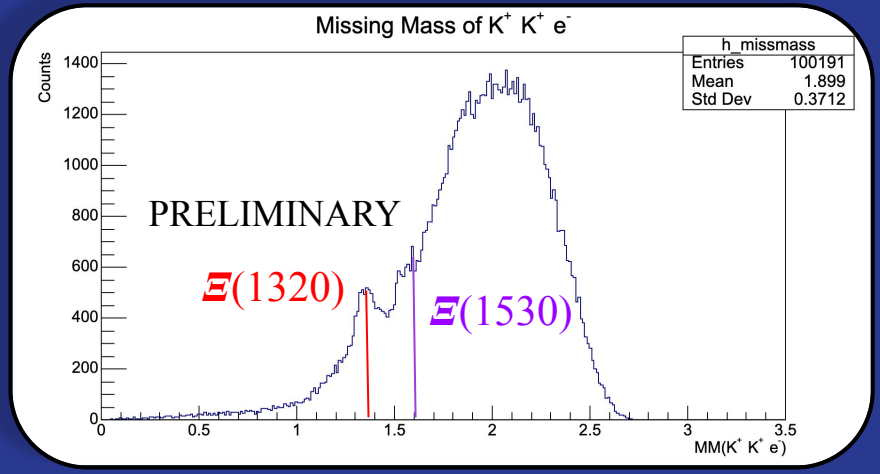
DATA ANALYSIS

Looking at MM(K^+ K^+ e'$^-$) for Fall 2018 pass 2 data from Jefferson Lab:

FORWARD DETECTOR

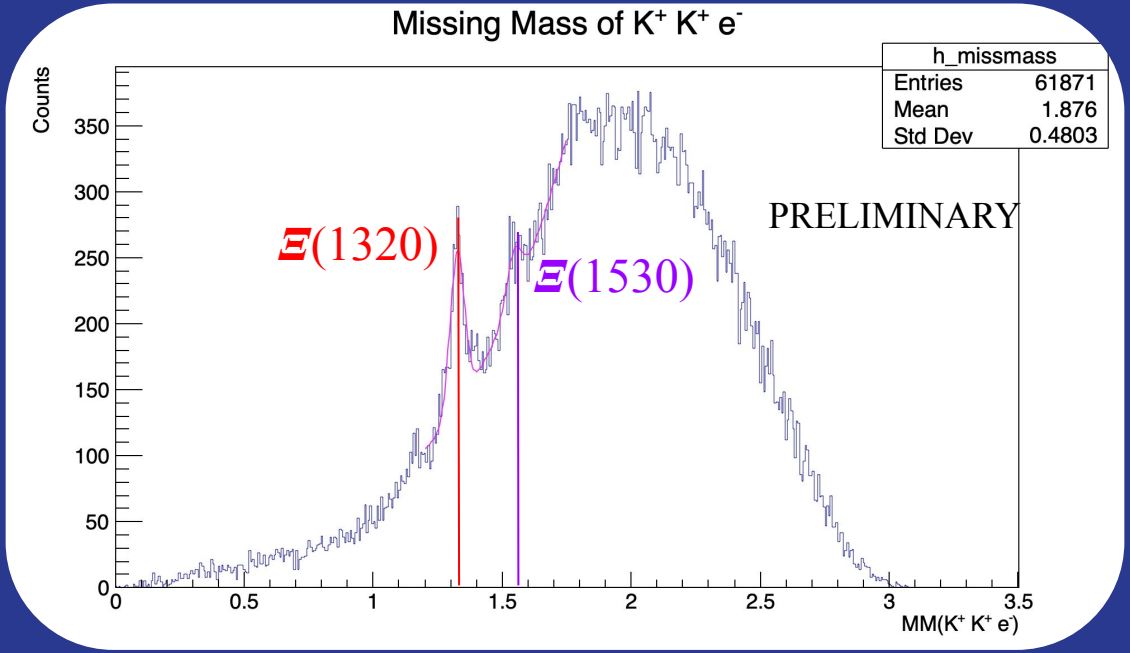


FORWARD TAGGER

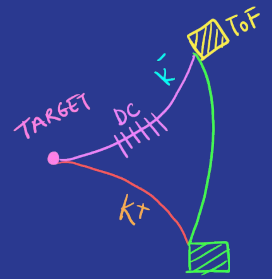


DATA ANALYSIS

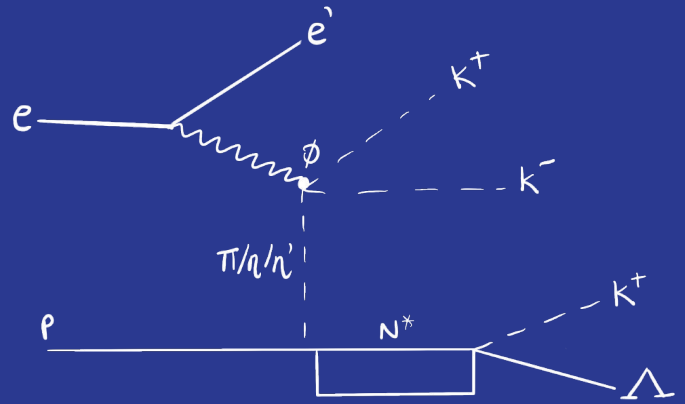
Due to higher precision, initially choosing all particles in the FD.

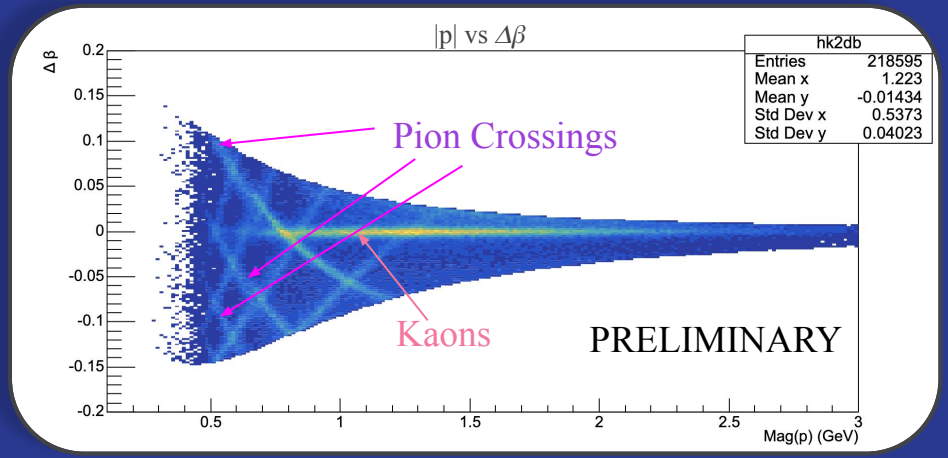


DATA ANALYSIS



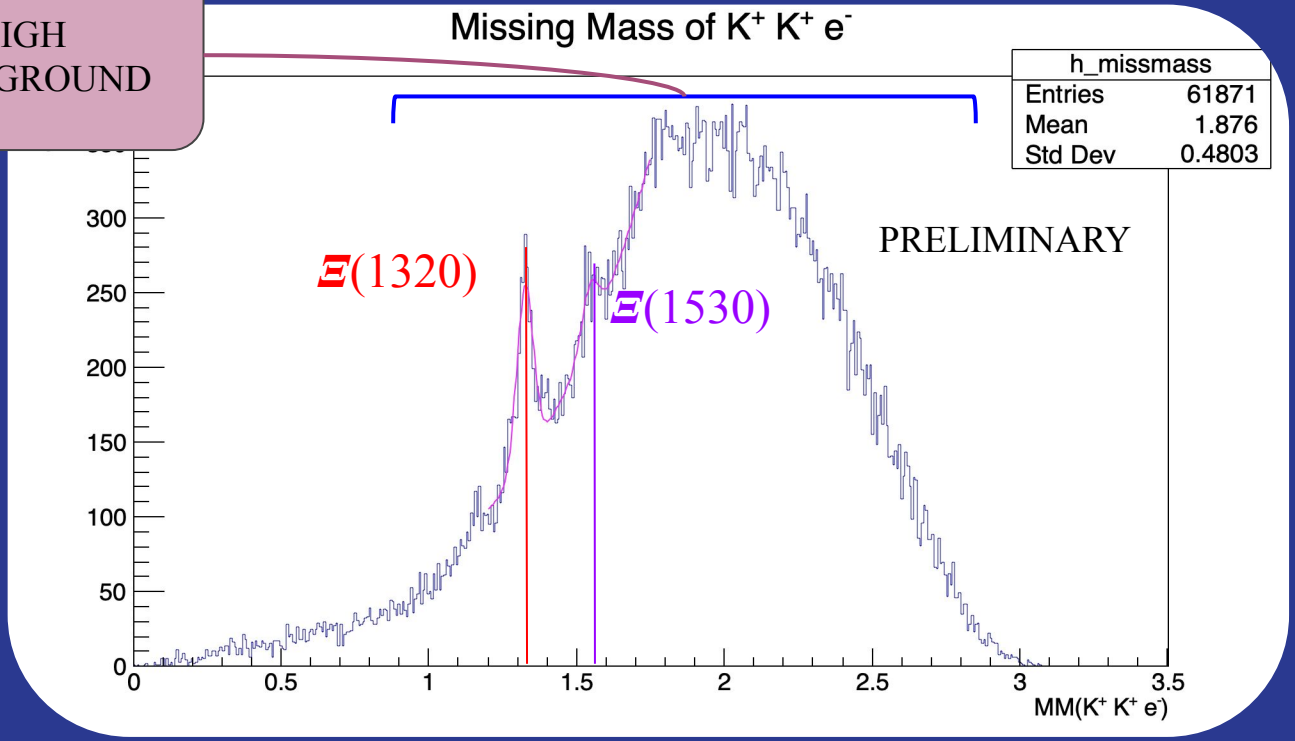
- Fall 2018 data.
- All particles in the Forward Detector → better resolution.
- Background: kaon production, and Kaon/pion misidentification ⟶ background subtraction





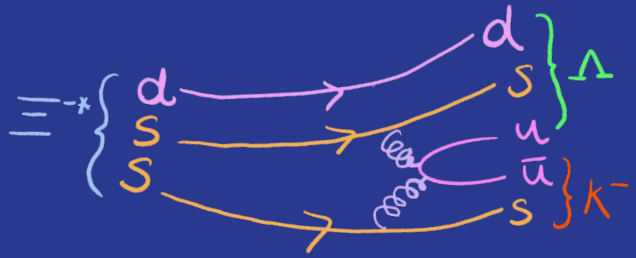
DATA ANALYSIS

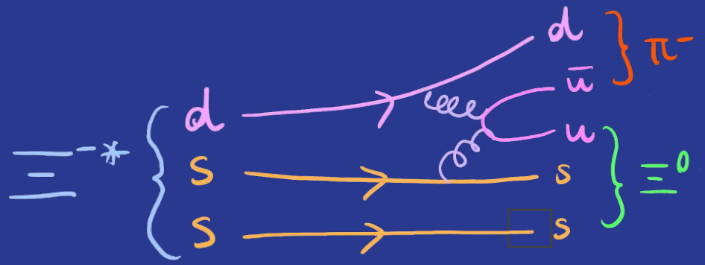
HIGH BACKGROUND



DATA ANALYSIS

We can have:





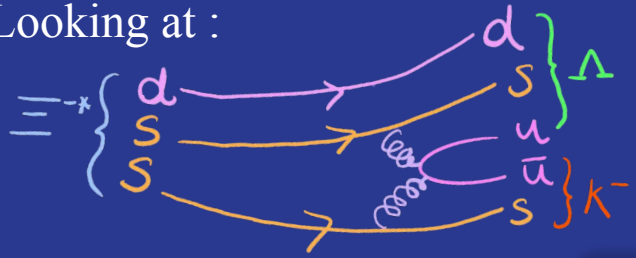
$\Xi^* \rightarrow \Lambda K$

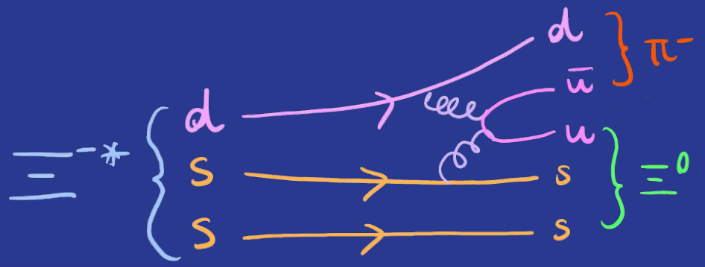
$\Xi^* \rightarrow \Xi \pi$

Relative branchings from SU(3)→ both decays into octet of baryons and octet of mesons → Clebshes and momentum dependence (quark states)

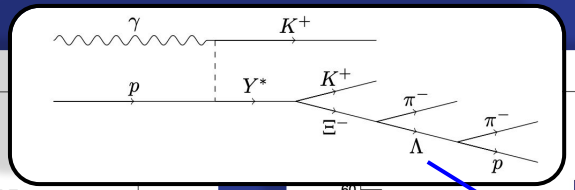
SIDEBAND SUBTRACTION

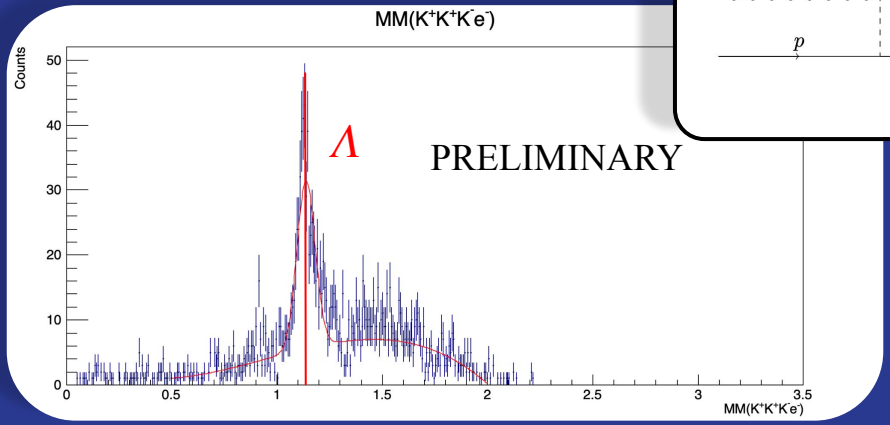
Looking at :

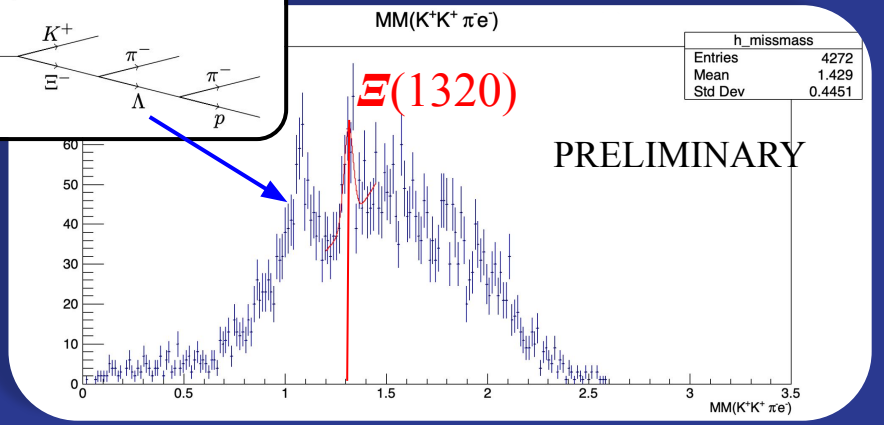




(Possible sigma contamination)



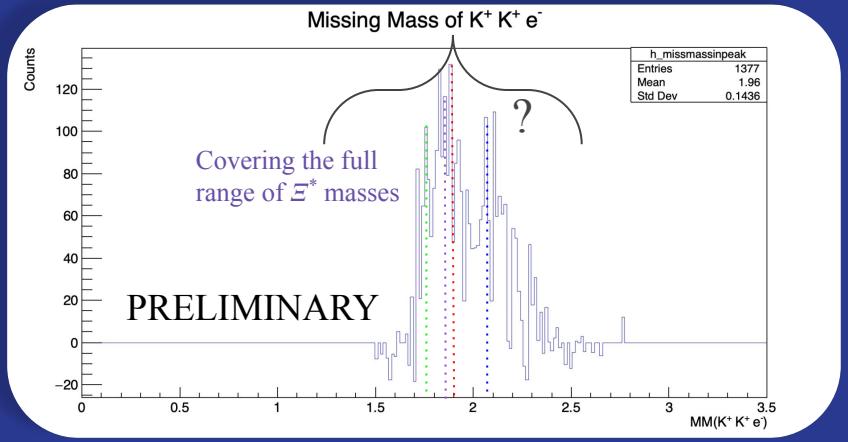




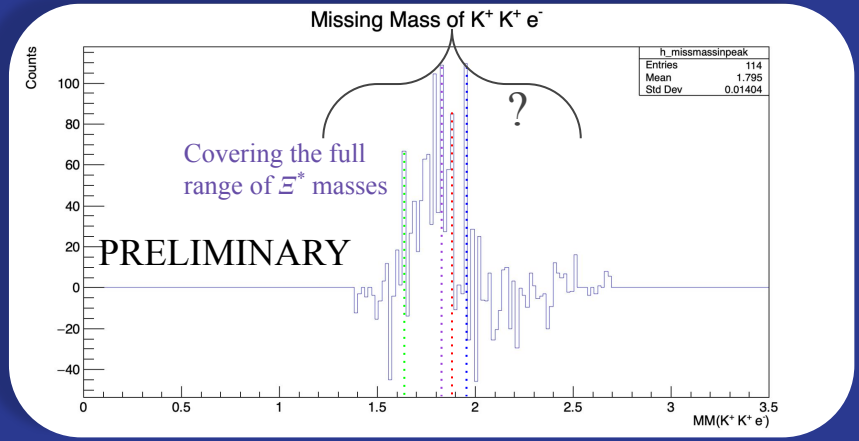
SIDEBAND SUBTRACTION

Sideband subtracted plots of MM($K^+ K^+ e'^-$) using:

MM($K^+ K^+ K^- e'^-$)

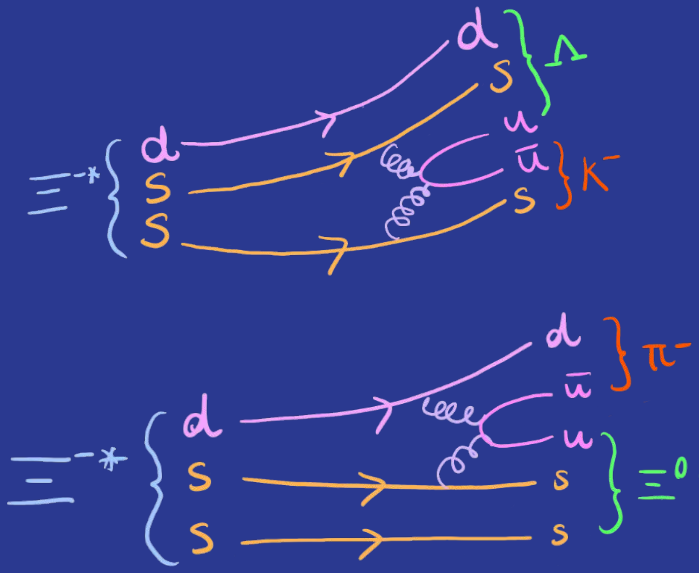


MM($K^+ K^+ \pi^- e'^-$)

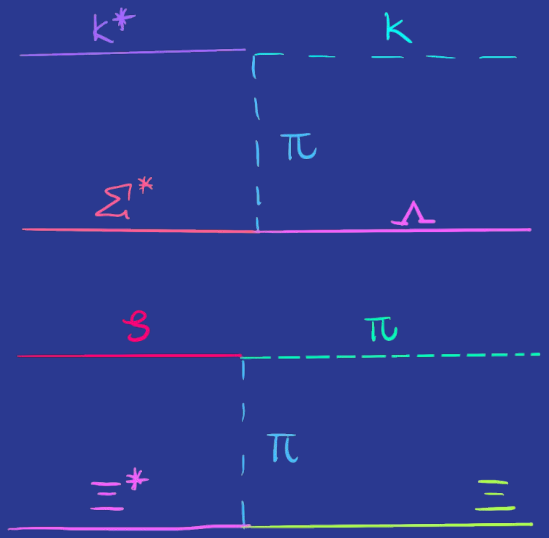


TOWARDS BRANCHING RATIOS

3q state



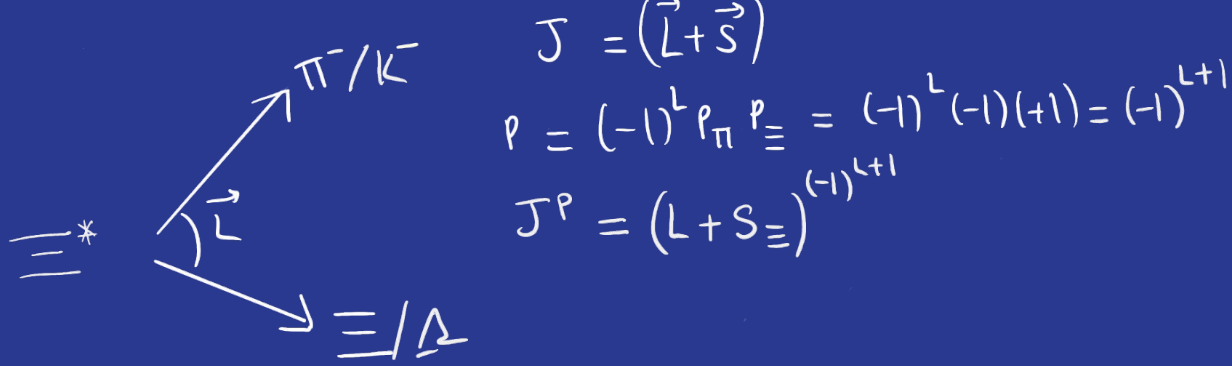
Molecular state



TOWARDS QUANTUM NUMBERS

Looking at angular coverage of K^- and π^-:

$\theta^{\Xi^*}_{\pi/K} \rightarrow L \rightarrow$ Quantum numbers



$$\vec{J} = (\vec{L} + \vec{S})$$

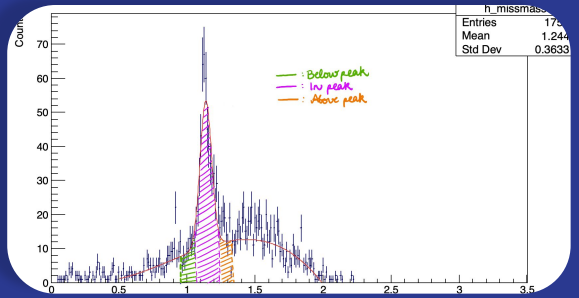
$$P = (-1)^L P_\pi P_\Xi = (-1)^L (-1)(+1) = (-1)^{L+1}$$

$$J^P = (L + S_\Xi)^{(-1)^{L+1}}$$

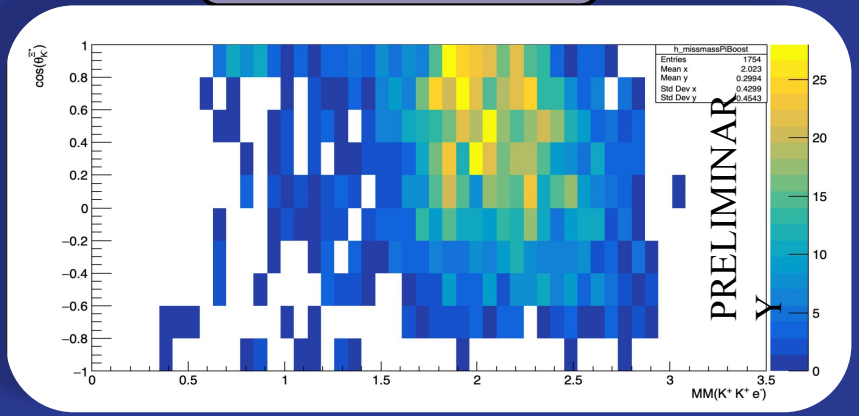
TOWARDS QUANTUM NUMBERS

$e^- p \rightarrow e'^- \Xi^{*-} K^+$
$K^+ \quad \hookrightarrow \Lambda K^-$

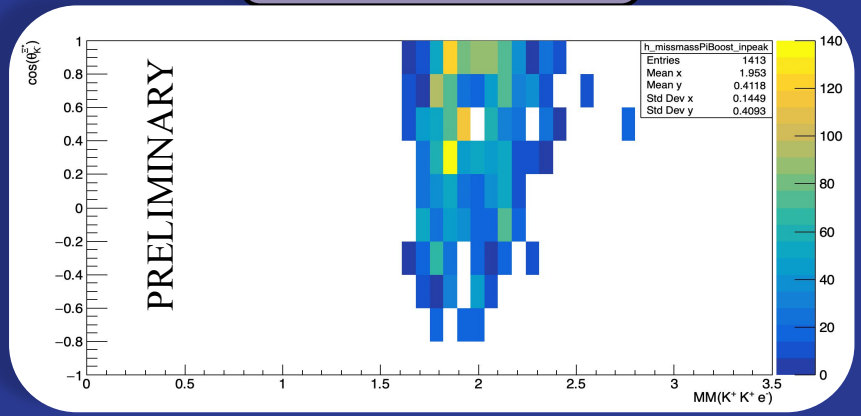
K^- Channel



BEFORE SIDEBAND SUBTRACTION



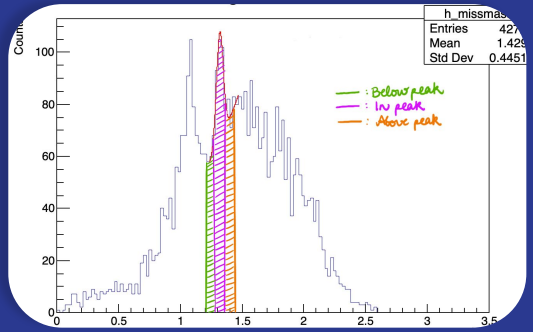
AFTER SIDEBAND SUBTRACTION



TOWARDS QUANTUM NUMBERS

$e^- p \rightarrow e'^- \Xi^{*-} K^+$
$K^+ \quad \hookrightarrow \Xi\pi^-$

π^- Channel



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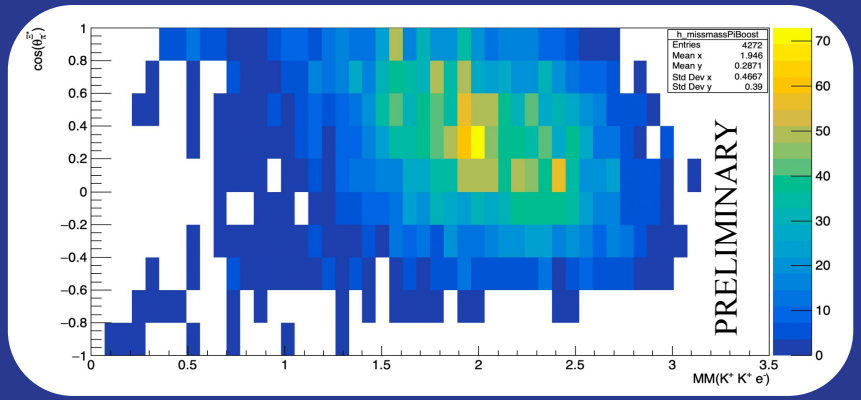
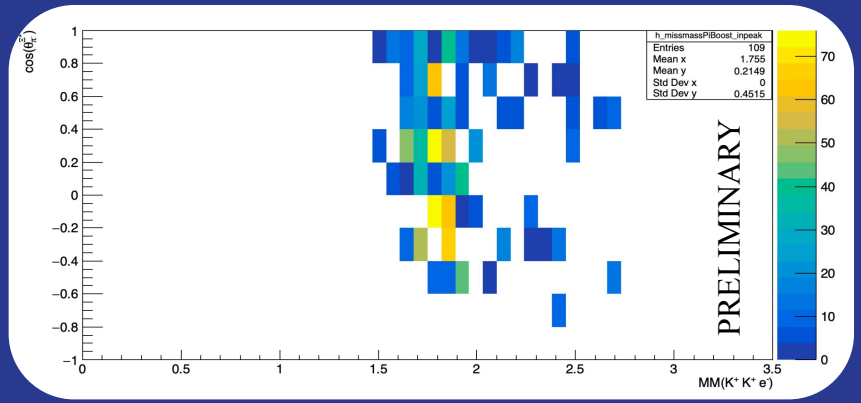


AFTER SIDEBAND SUBTRACTION



CONCLUSIONS

- Promising new results - First measurement in electroproduction!
- ~4 times more statistics to come
- Quantum numbers and decay branchings over the large part of the Ξ spectrum
- Probing cascade internal structure?
- Stay tuned!

THANKS FOR LISTENING!