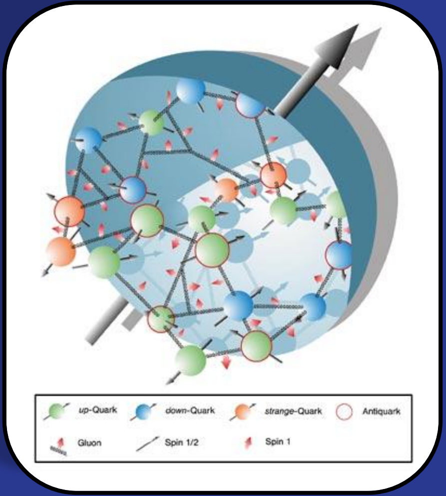
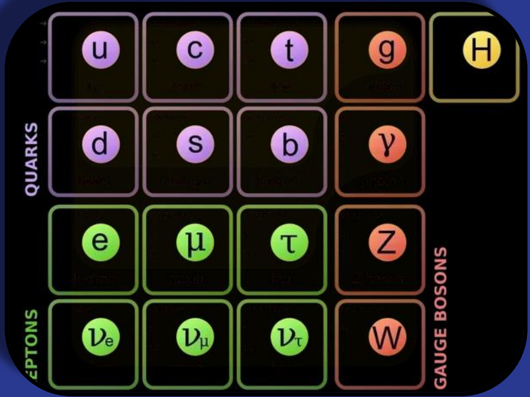
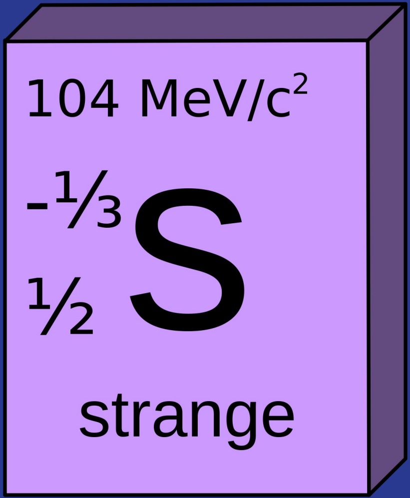
ELUCIDATING STRANGENESS WITH CLAS12



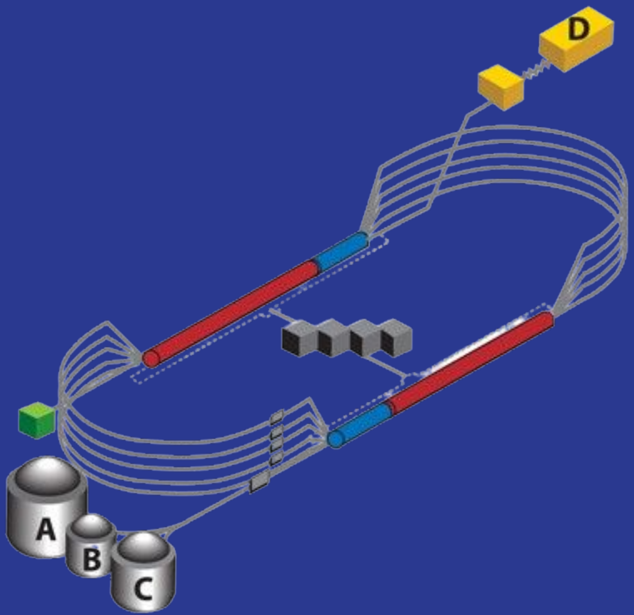




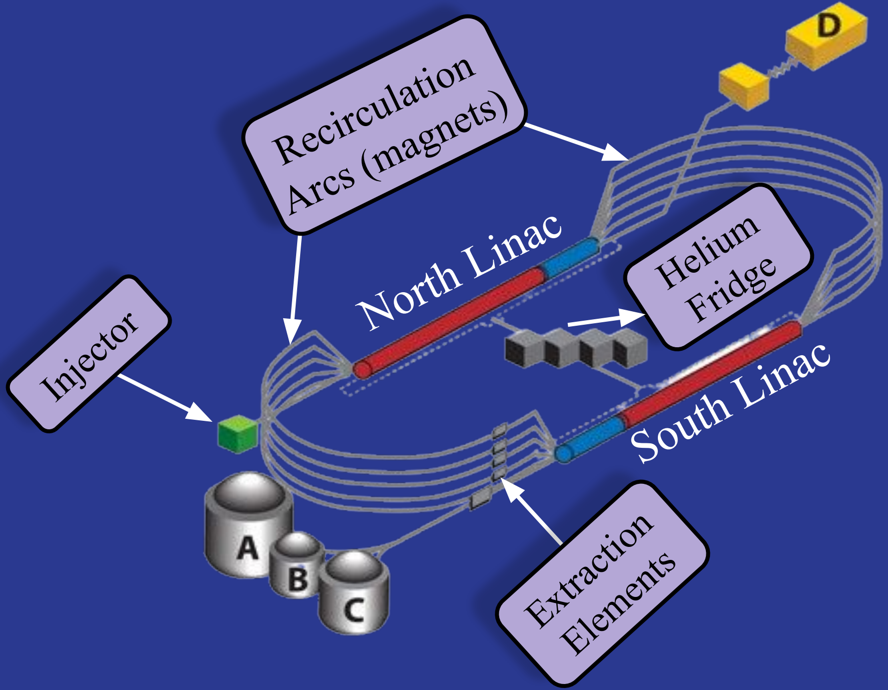
Asli G. Acar (asli.acar@york.ac.uk)

JEFFERSON LAB

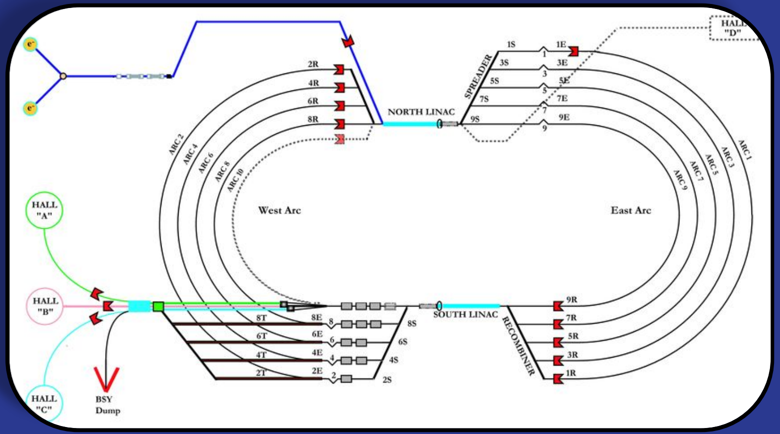
CEBAF ACCELERATOR



CEBAF

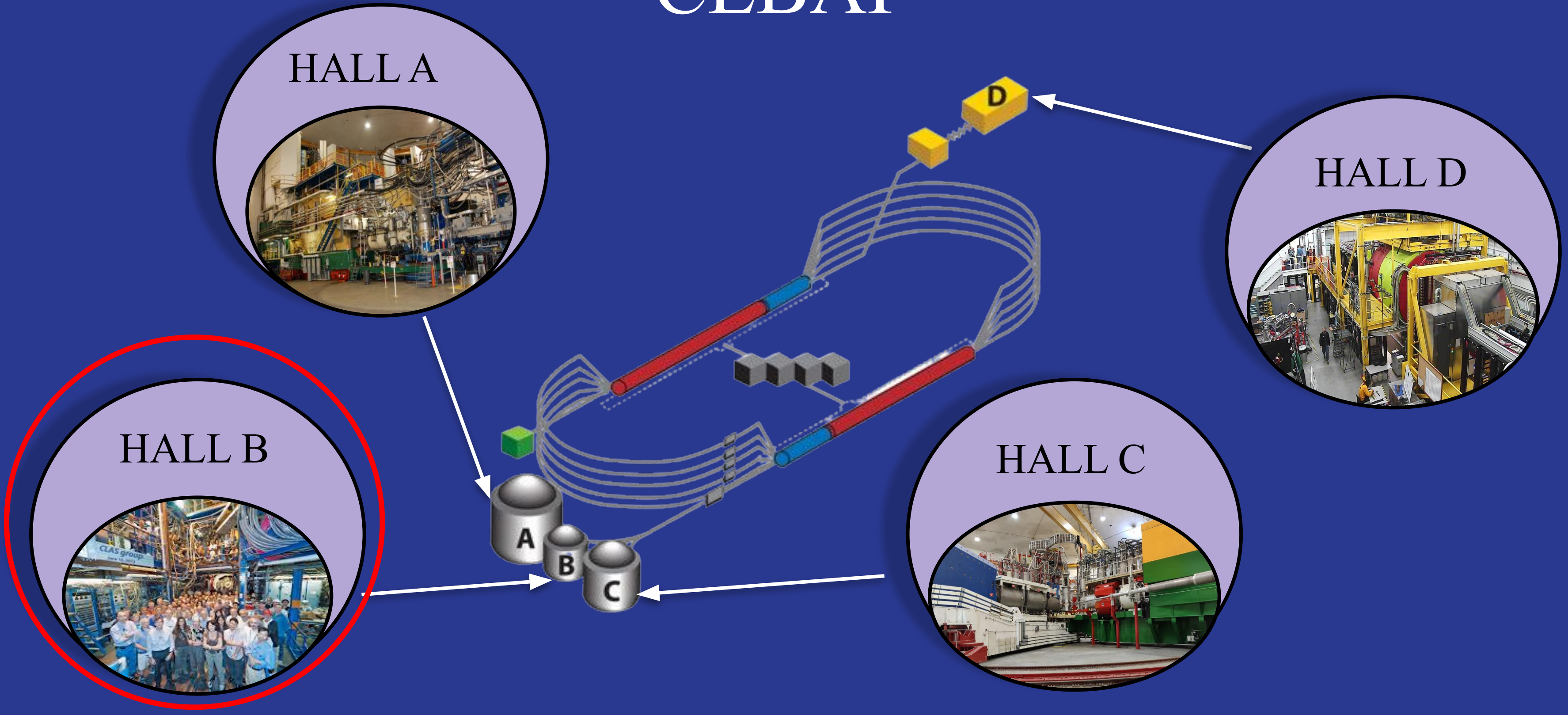


Recirculation Arcs (magnets)
North Linac
Helium Fridge
Injector
South Linac
Extraction Elements
A
B
C
D

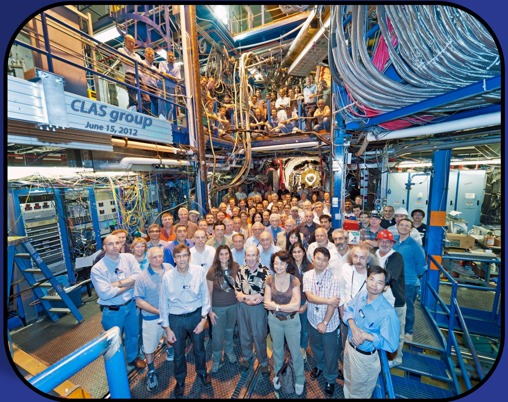


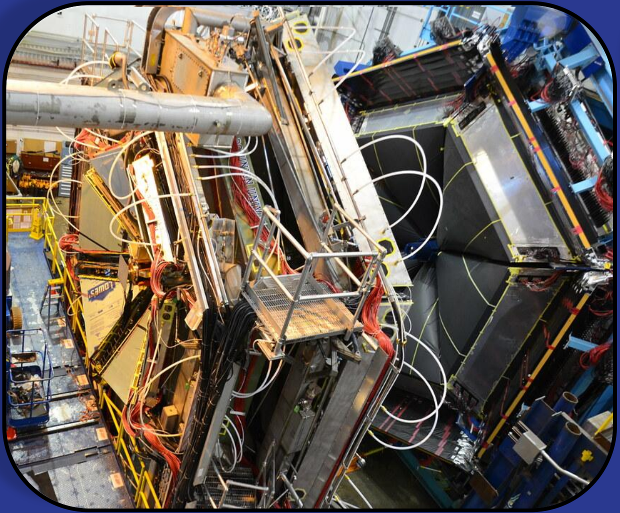
NORTH LINAC
SOUTH LINAC
SPREADER
RECOMBINER
West Arc
East Arc
HALL "A"
HALL "B"
HALL "C"
HALL "D"
BSY Dump

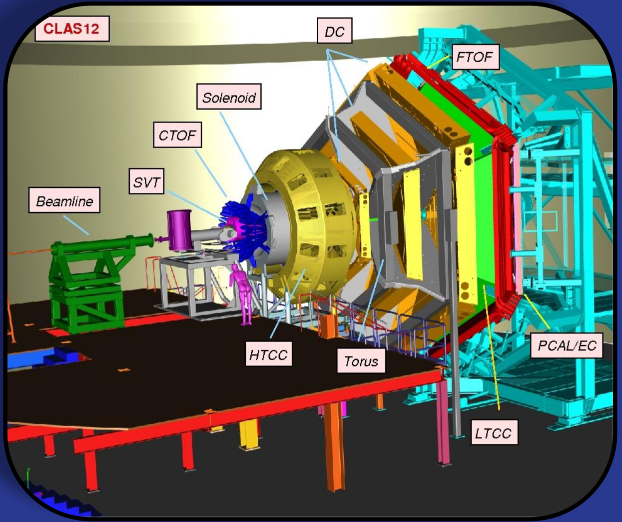
CEBAF



HALL B







THE CLAS12 SPECTROMETER

HALL B

	E12-11-003	A	B	Deeply Virtual Compton Scattering on the Neutron with CLAS12 at 11 GeV	S. Niccolai* D. Sokhan	CEA Saclay	90	A	38	Proposal 1-page summary Updated PAC 38 Proposal
★	E12-11-106	A	B	High Precision Measurement of the Proton Charge Radius	A. Gasparian* D. Dutta H. Gao M. Khandaker	NCAT State U Mississippi State Duke U	15	A	39	Proposal 1-page summary
☆	E12-12-001	A	B	Timelike Compton Scattering and J/psi photoproduction on the proton in e+e- pair production with CLAS12 at 11 GeV	P. Nadel-Turonski* M. Guidal T. Horn R. Paremuzyan S. Stepanyan	USC CUA JLab JLab	120	A-	39	Proposal 1-page summary
★	E12-12-007	A	B	Exclusive Phi Meson Electroproduction with CLAS12	F. X. Girod-Gard* M. Guidal V. Kubarovsky P. Stoler C. Weiss	JLab JLab RPI JLab	60	B+	39	Proposal 1-page summary
	E12-11-005A	G	B	Photoproduction of the very strangest baryons on a proton target in CLAS12	L. Guo* M. Dugger J. Goetz E. Pasyuk I. Strakovsky D. Watts N. Zachariou V. Ziegler	FIU Arizona SU Ohio U JLab GWU U of Edinburgh EBOR JLab			40	Proposal 1-page summary
	E12-06-108A	G	B	Exclusive N* --> KY Studies with CLAS12	D. Carman* R. Gothe V. Mokeev	JLab USC JLab			42	Proposal 1-page summary
	E12-06-112A/E12-09-008A	G	B	Semi-Inclusive \Lambda electroproduction in the Target Fragmentation Region	M. Mirazita	INFN			42	Proposal 1-page summary 1-page summary (2)

THE "VERY STRANGE" EXPERIMENT

Photoproduction of the Very Strangest Baryons on a Proton Target in CLAS12

A. Afanasev, W.J. Briscoe, H. Haberzettl, D. Schott, I.I. Strakovsky*, and R.L. Workman
The George Washington University, Washington, DC 20052, USA

M.J. Amaryan, G. Gavalian, and M.C. Kunkel
Old Dominion University, Norfolk, VA 23529, USA

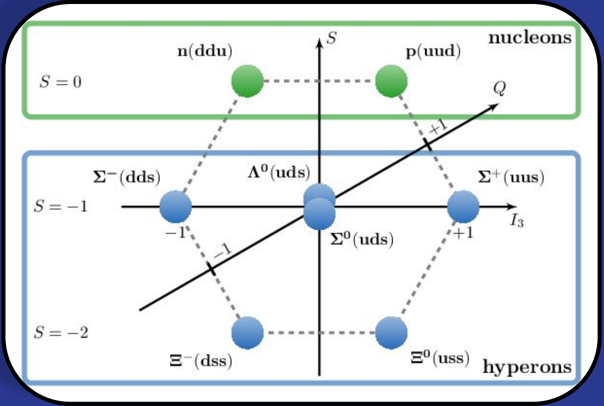
Ya.I. Azimov
Petersburg Nuclear Physics Institute, Gatchina, Russia 188300

N. Baltzell
Argonne National Laboratory, Argonne, IL 60439, USA

M. Battaglieri, A. Celentano, R. De Vita, M. Osipenko, M. Ripani, and M. Taiuti
INFN, Sezione di Genova, 16146 Genova, Italy

V.N. Baturin, S. Boyarinov, V.D. Burkert, D.S. Carman, V. Kubarovsky, V. Mokeev, E. Pasyuk*, S. Stepanyan, D.P. Weygand, and V. Ziegler*

THE VERY STRANGE EXPERIMENT



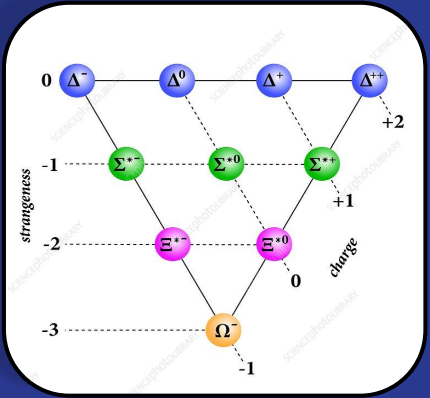


TABLE VIII. The Ξ and Ω baryons below 2400 and 2500 MeV, respectively.

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)
Ξ(1318)	****	1320	****	1320 ± 6
Ξ(1530)	****	1530	****	1541 ± 12
Ξ(1620)	*	1630	**	
Ξ(1690)	***	1680	**	
Ξ(1820)	***	1820	***	1822 ± 6
Ξ(1950)	***	1940	**	
Ξ(2030)	***	2030	***	2022 ± 7
Ξ(2120)	*	2120	*	
Ξ(2250)	**	2250	*	2214 ± 5
Ξ(2370)	**	2370	**	2356 ± 10
Ξ(2500)	*	2500	**	2505 ± 10

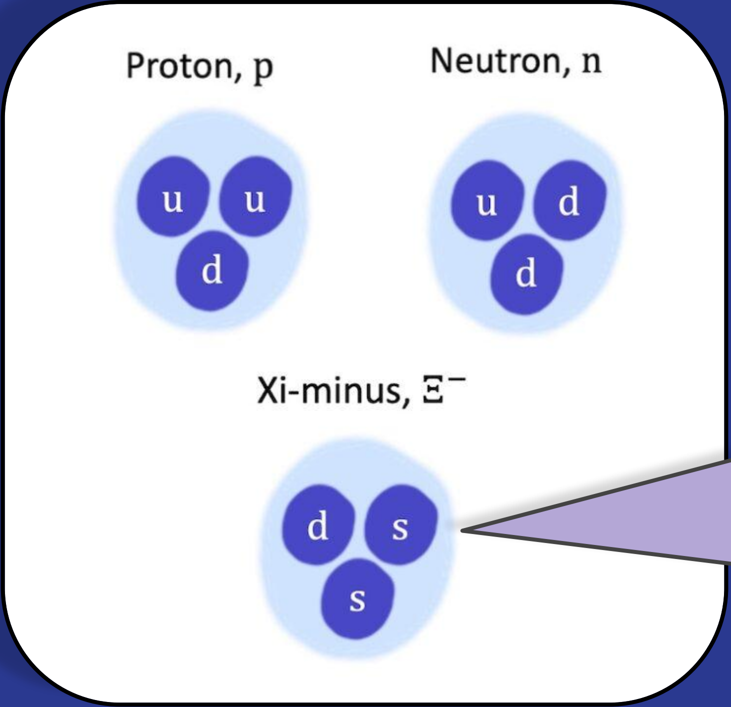
Now

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?

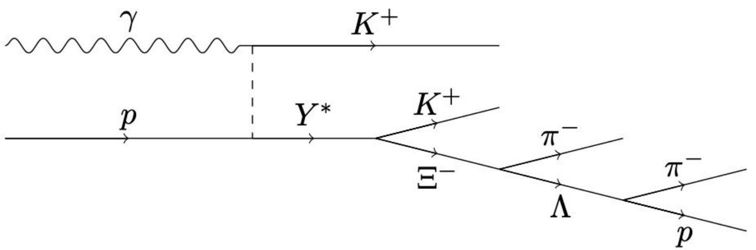
1. Theoretical controversies about certain states (i.e., 1620)
2. The hyperon puzzle?
3. Spin-parity information of new & missing states
4. Bridging light (ultra-relativistic) quarks with heavy (non-relativistic)

CASCADES

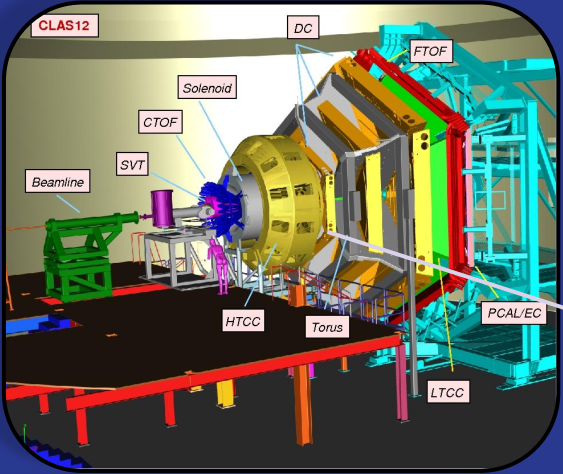
Consider the following reaction:

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

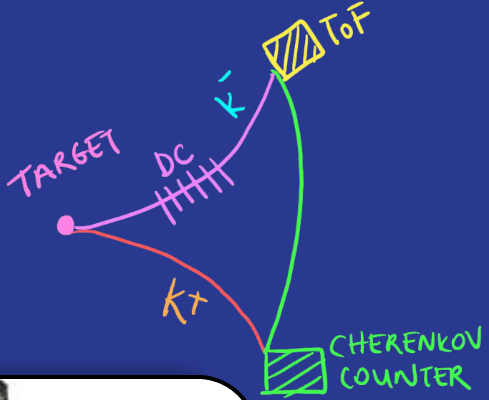
We can plot the missing mass of $K^+ K^+ e'^-$ to observe the cascade baryons.



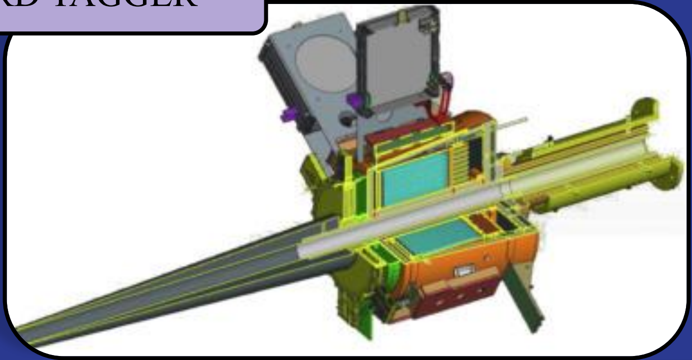
Ground state cascade



DATA ANALYSIS



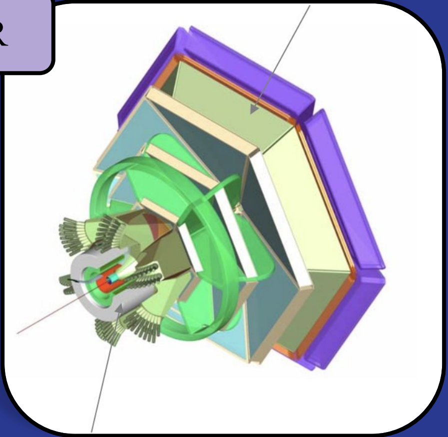
FORWARD TAGGER



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

FORWARD DETECTOR

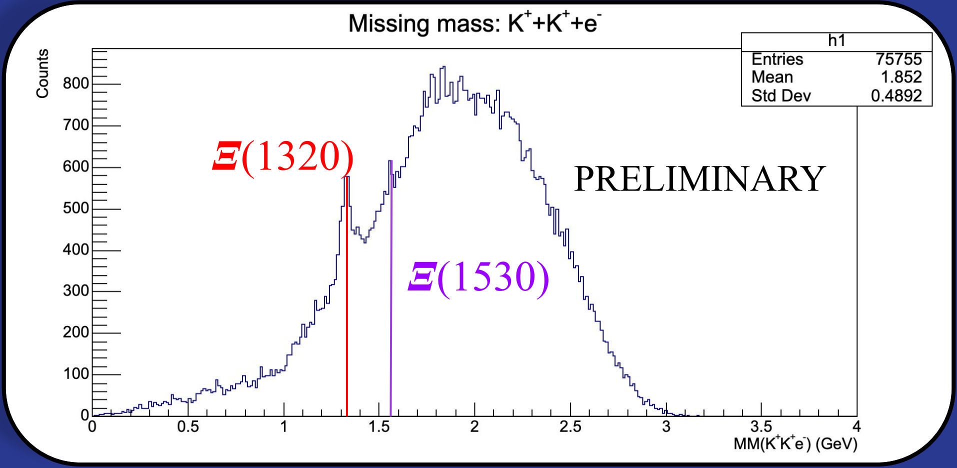
Covers angular range 5°<θ<35°. Higher Q^2 values but higher precision.



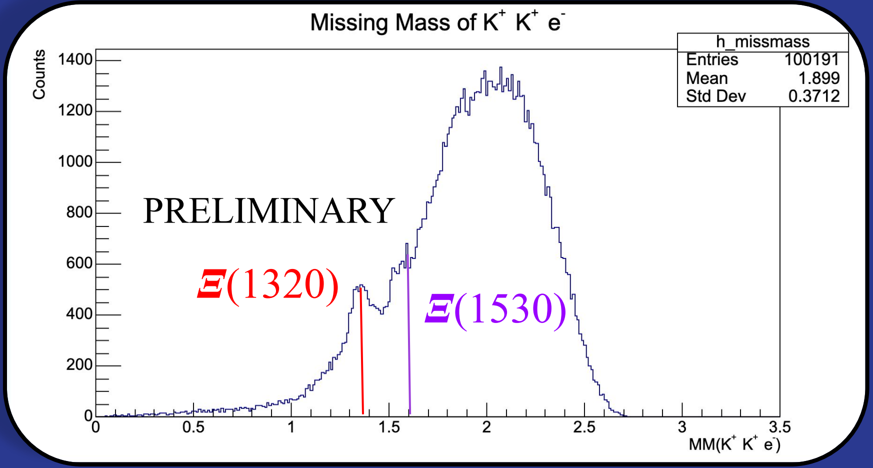
DATA ANALYSIS

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

FORWARD DETECTOR

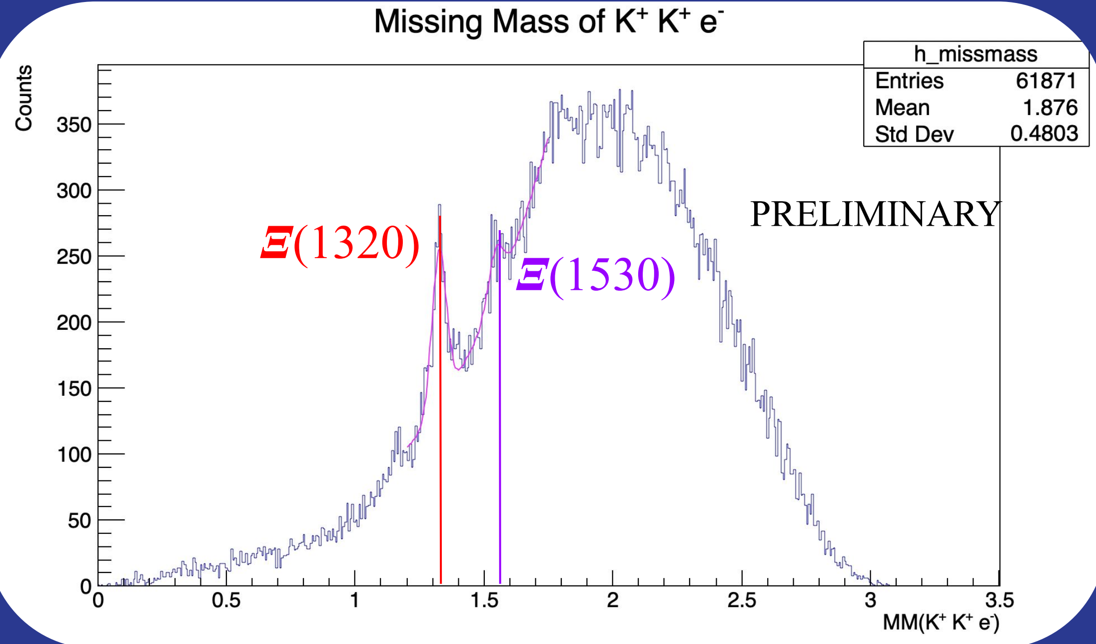


FORWARD TAGGER



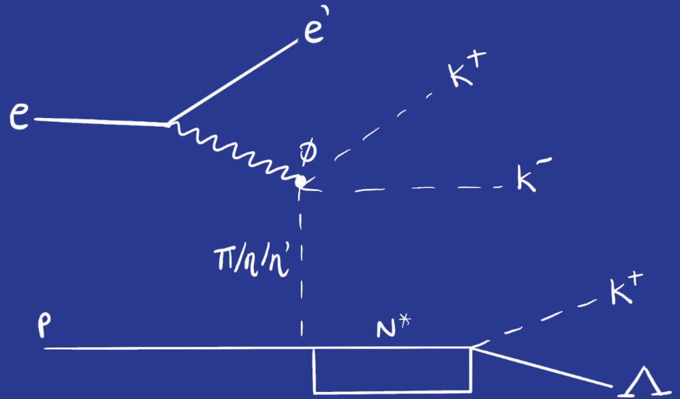
DATA ANALYSIS

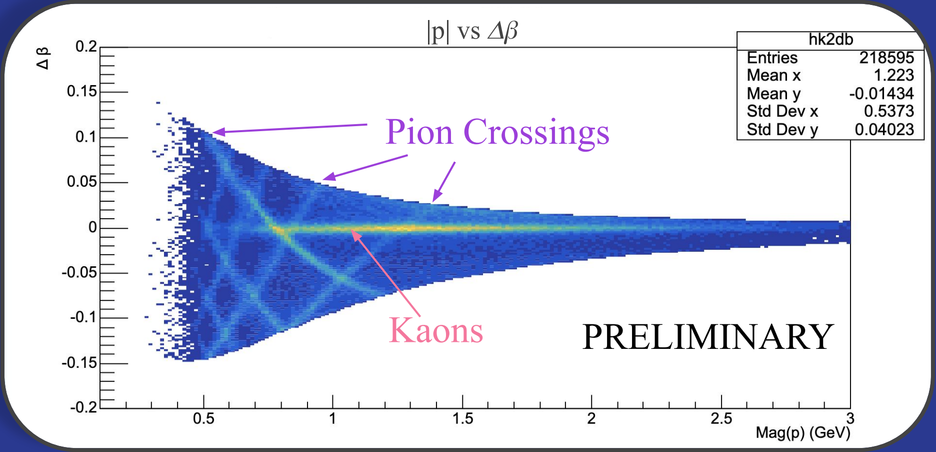
Due to higher precision, initially choosing all particles in the FD.



DATA ANALYSIS

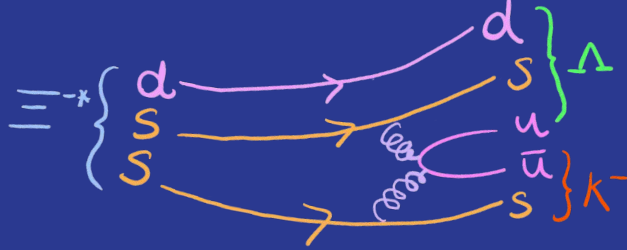
- Fall 2018 data.
- All particles in the Forward Detector → better resolution.
- Background: kaon production, and Kaon/pion misidentification ⟶ background subtraction

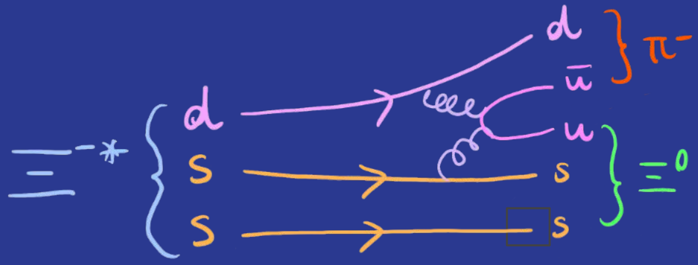




DATA ANALYSIS

We can have:





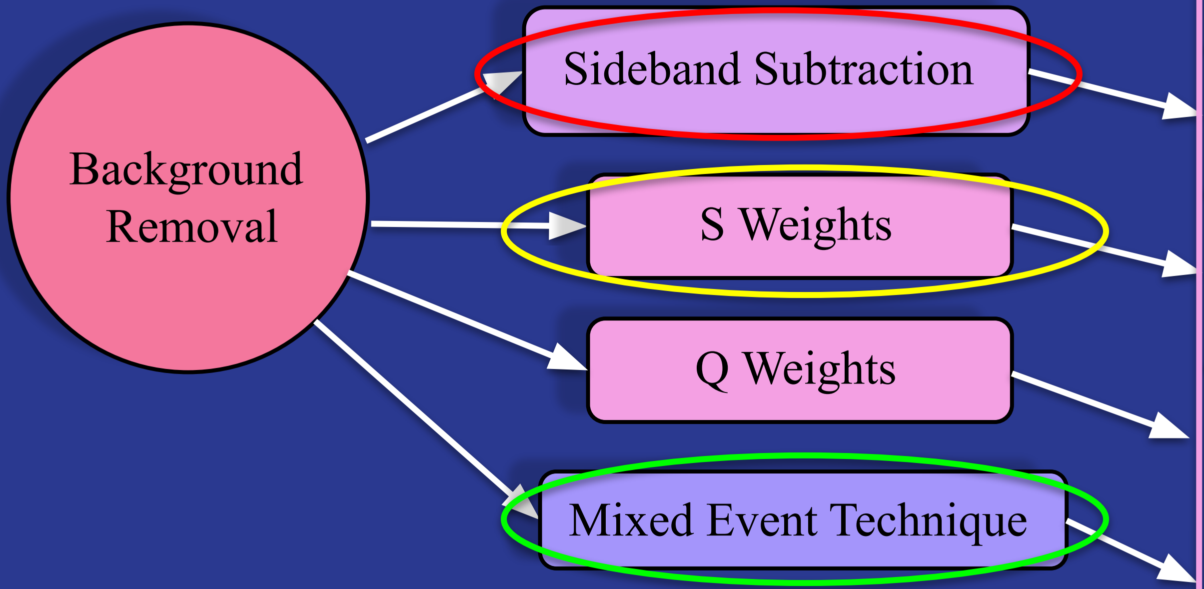
$\Xi^* \to \Lambda K$

$\Xi^* \to \Xi \pi$

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

DATA ANALYSIS

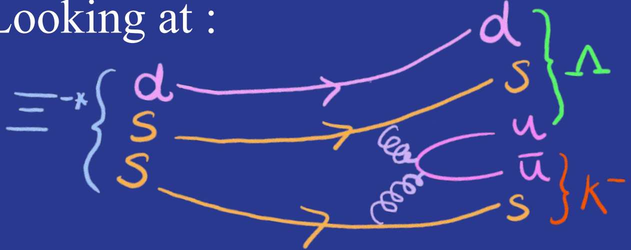
- Initial data exploration (red)
- Possible choice (yellow)
- Best choice (green)



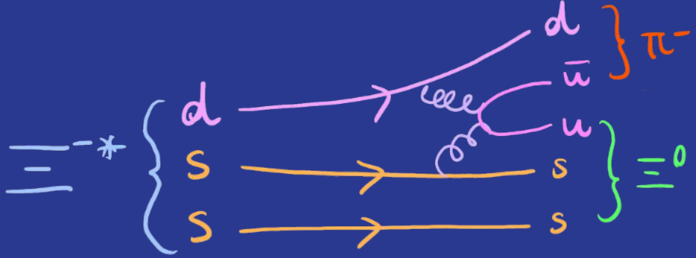
PROS	CONS
Straightforward	Risk of Over/Under-subtraction
Multi-dimensional identifiers with sophisticated weights	Difficulty handling distributions with signal peaks close together
Straightforward to compute weights; generalised version of sideband	Not appropriate for low statistics; computationally expensive
Can handle distributions with signal peaks close together	Can give incorrect results when there is large signal to background

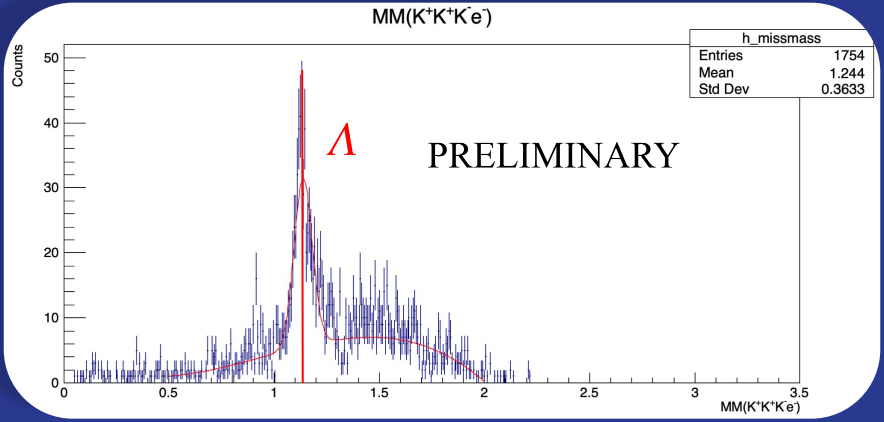
SIDEBAND SUBTRACTION

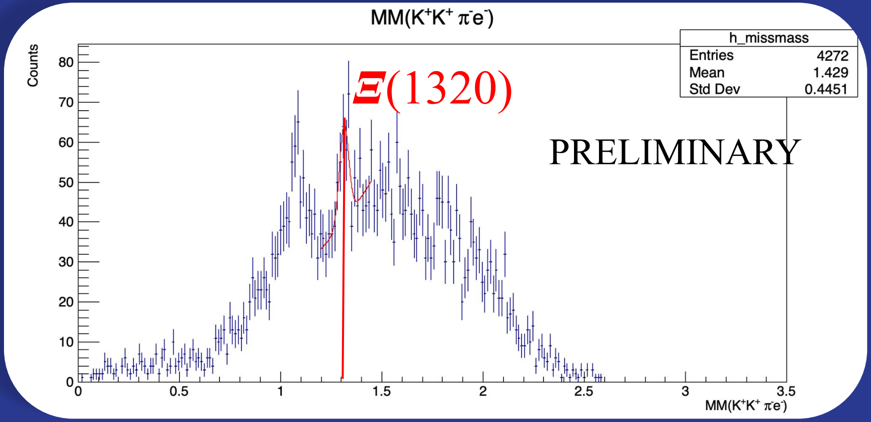
Looking at :



(Possible sigma contamination)





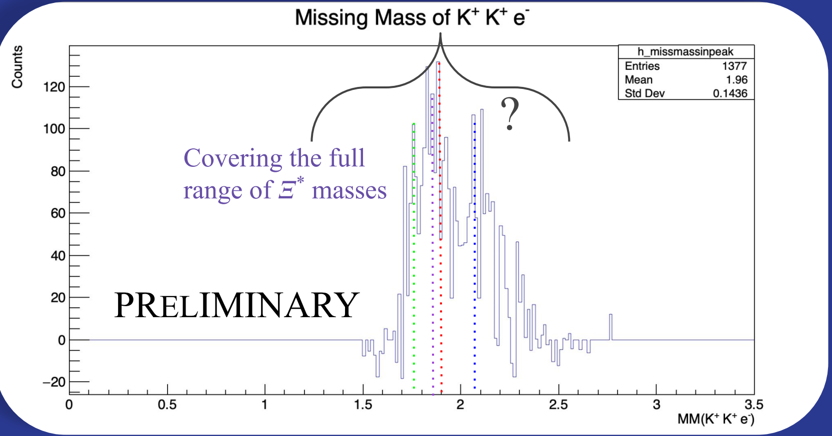


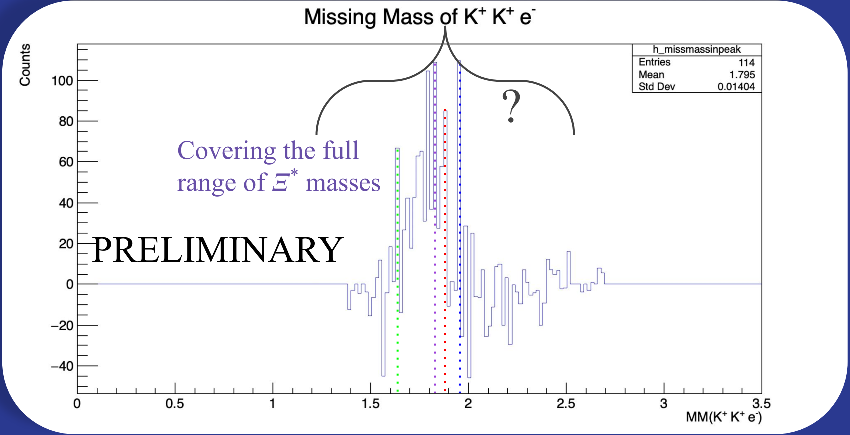
SIDEBAND SUBTRACTION

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

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

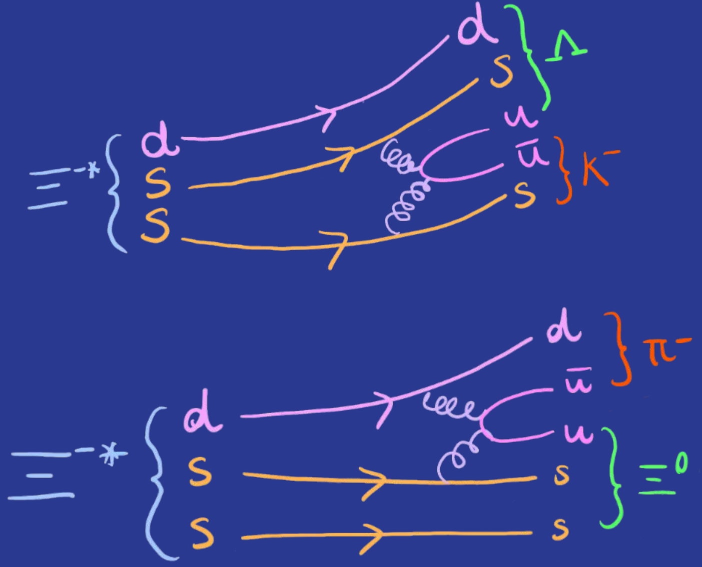
MM($K^+ K^+ \pi^- e'^-$)



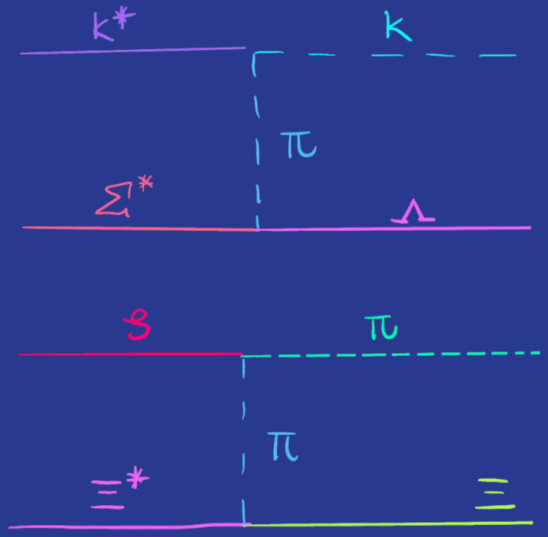


TOWARDS BRANCHING RATIOS …

3q state



Molecular state



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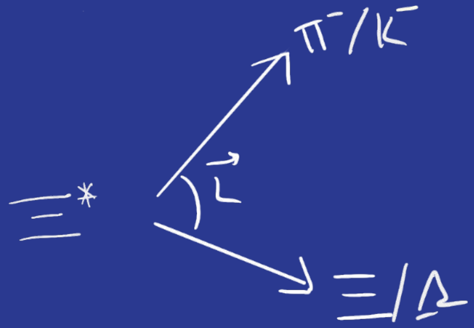
TOWARDS SPIN-PARITY…

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

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



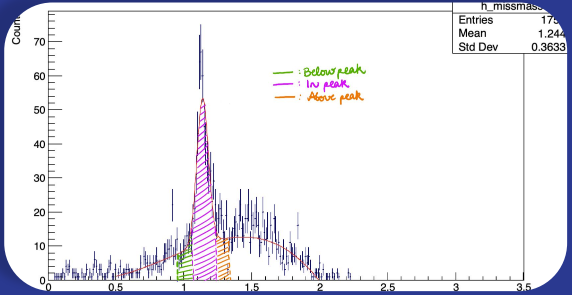
$$J = (\vec{L} + \vec{S})$$

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

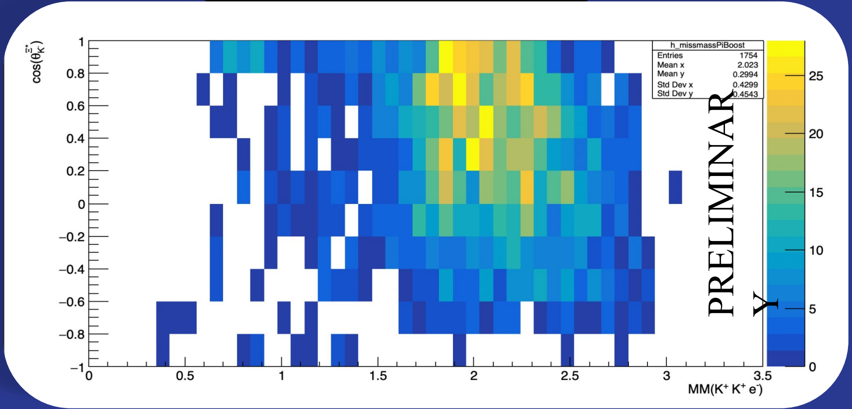
$$J^P = (L + S_\Xi)^{(-1)^{L+1}}$$

TOWARDS SPIN-PARITY…

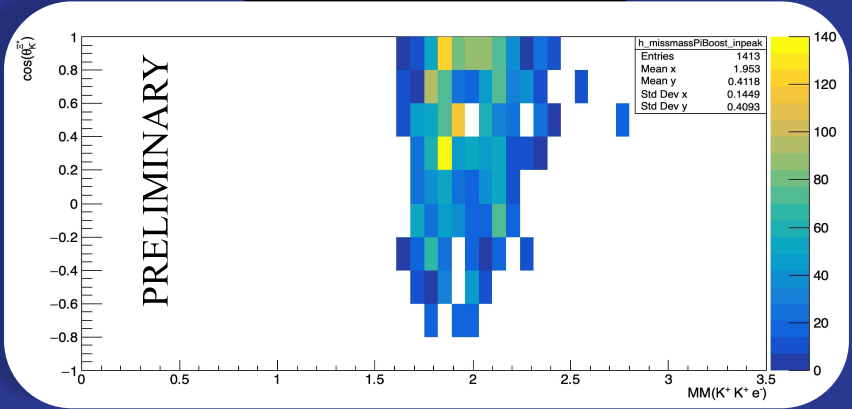
K^- Channel



BEFORE SIDEBAND SUBTRACTION

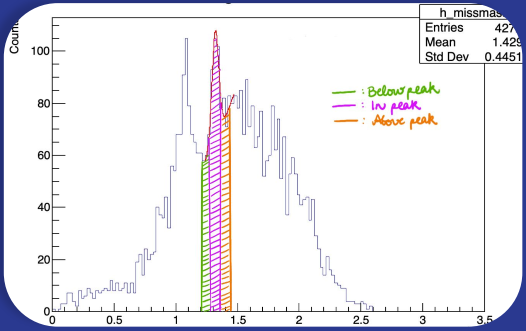


AFTER SIDEBAND SUBTRACTION

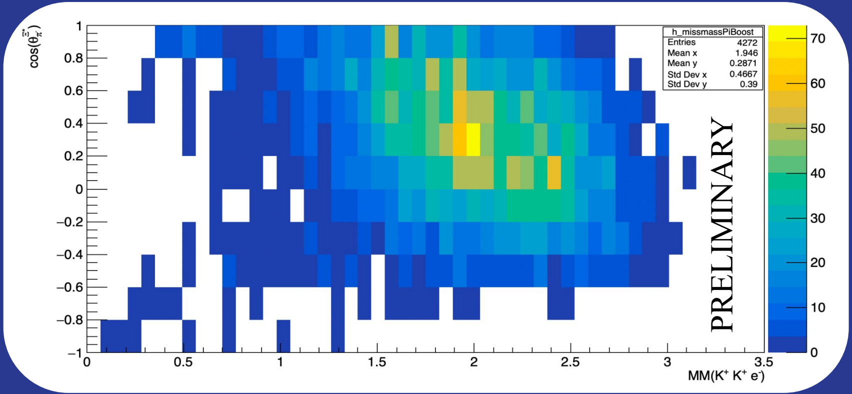


TOWARDS SPIN-PARITY…

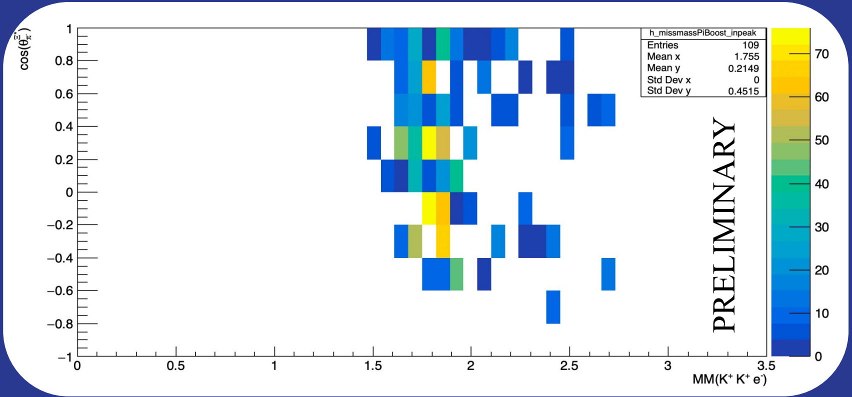
π^- Channel



BEFORE SIDEBAND SUBTRACTION



AFTER SIDEBAND SUBTRACTION



CONCLUSIONS

- Promising new results
- ~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!