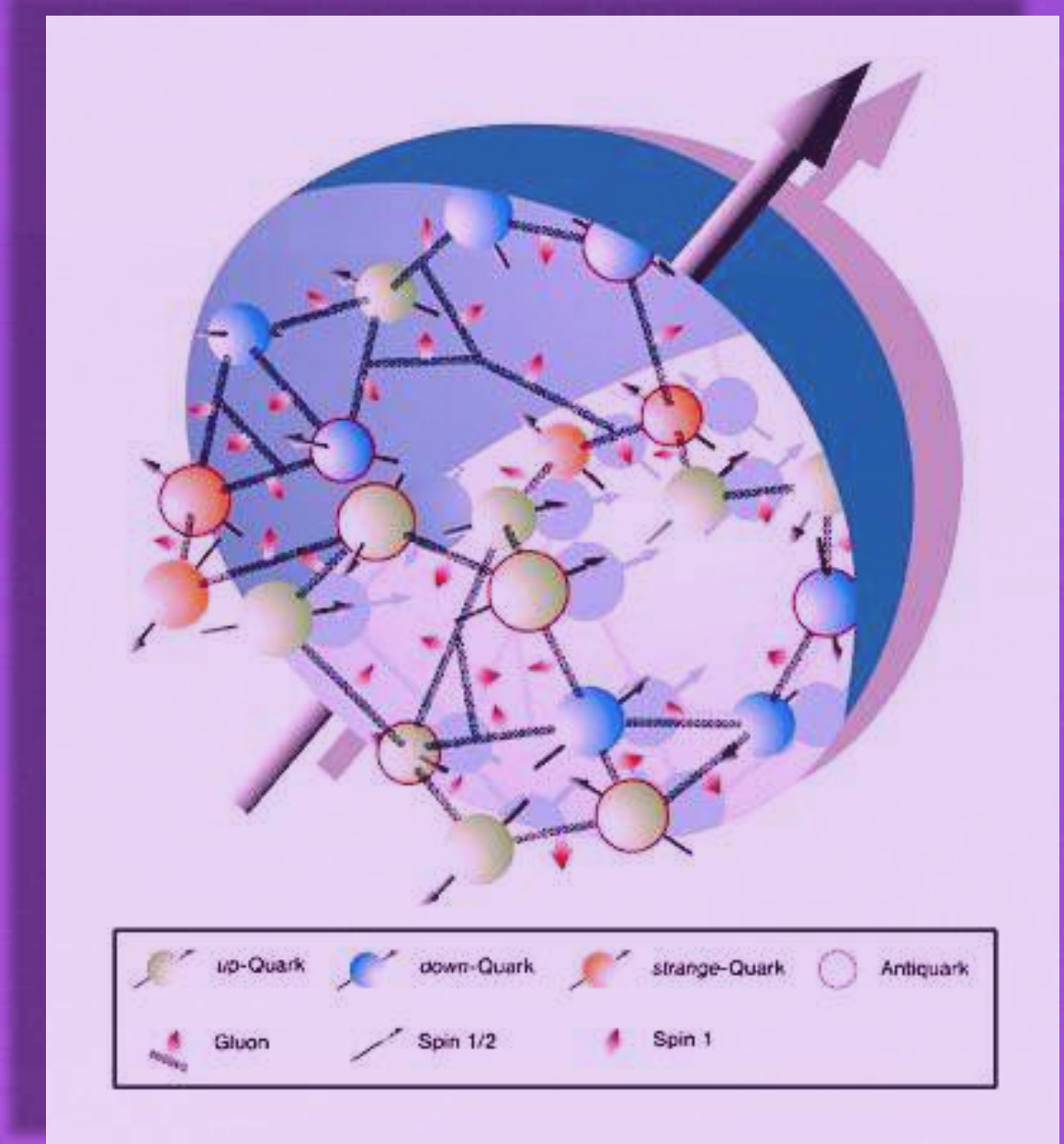
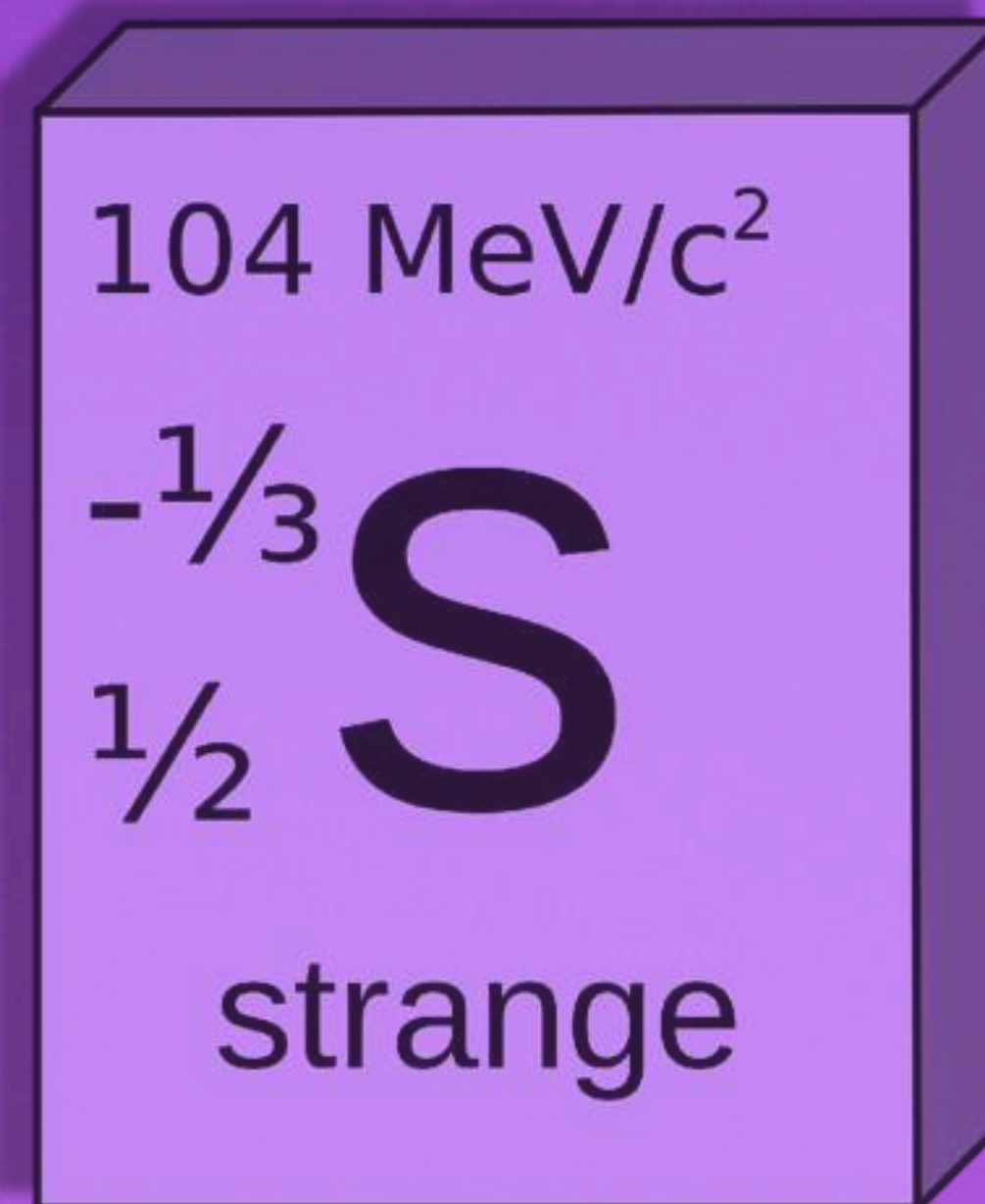


ELUCIDATING STRANGENESS

with

ELECTROMAGNETIC PROBES

QUARKS	u up-Quark	c charm-Quark	t top-Quark	g gluon	H Higgs Boson
	d down-Quark	s strange-Quark	b bottom-Quark	γ photon	
LEPTONS	e electron	μ muon	τ tau	Z Z boson	
	ν _e electron neutrino	ν _μ muon neutrino	ν _τ tau neutrino	W W boson	
	GAUGE BOSONS				



ASLI ACAR – UNIVERSITY OF YORK

THE STANDARD MODEL

	1 st	2 nd	3 rd		
QUARKS	2.3 M u 2/3 1/2 up	1.27 G c 2/3 1/2 charm	173.1 G t 2/3 1/2 top	Mass: eV/c ² Charge Spin Name	126 G H 0 0 higgs
	4.8 M d -1/3 1/2 down	95 M s -1/3 1/2 strange	4.2 G b -1/3 1/2 bottom	g 0 1 gluon	
	0.511 M e -1 1/2 electron	105.7 M μ -1 1/2 muon	1.78 G τ -1 1/2 tau	γ 0 1 photon	
LEPTONS	<2.2 ν_e 0 1/2 e neutrino	0.17 M ν_μ 0 1/2 μ neutrino	<15.5 M ν_τ 0 1/2 τ neutrino	W ±1 1 W boson	Z 0 1 Z boson
	FERMIONS			GAUGE BOSONS	

HADRONS



⇒ MESONS



⇒ BARYONS

QCD PUZZLES

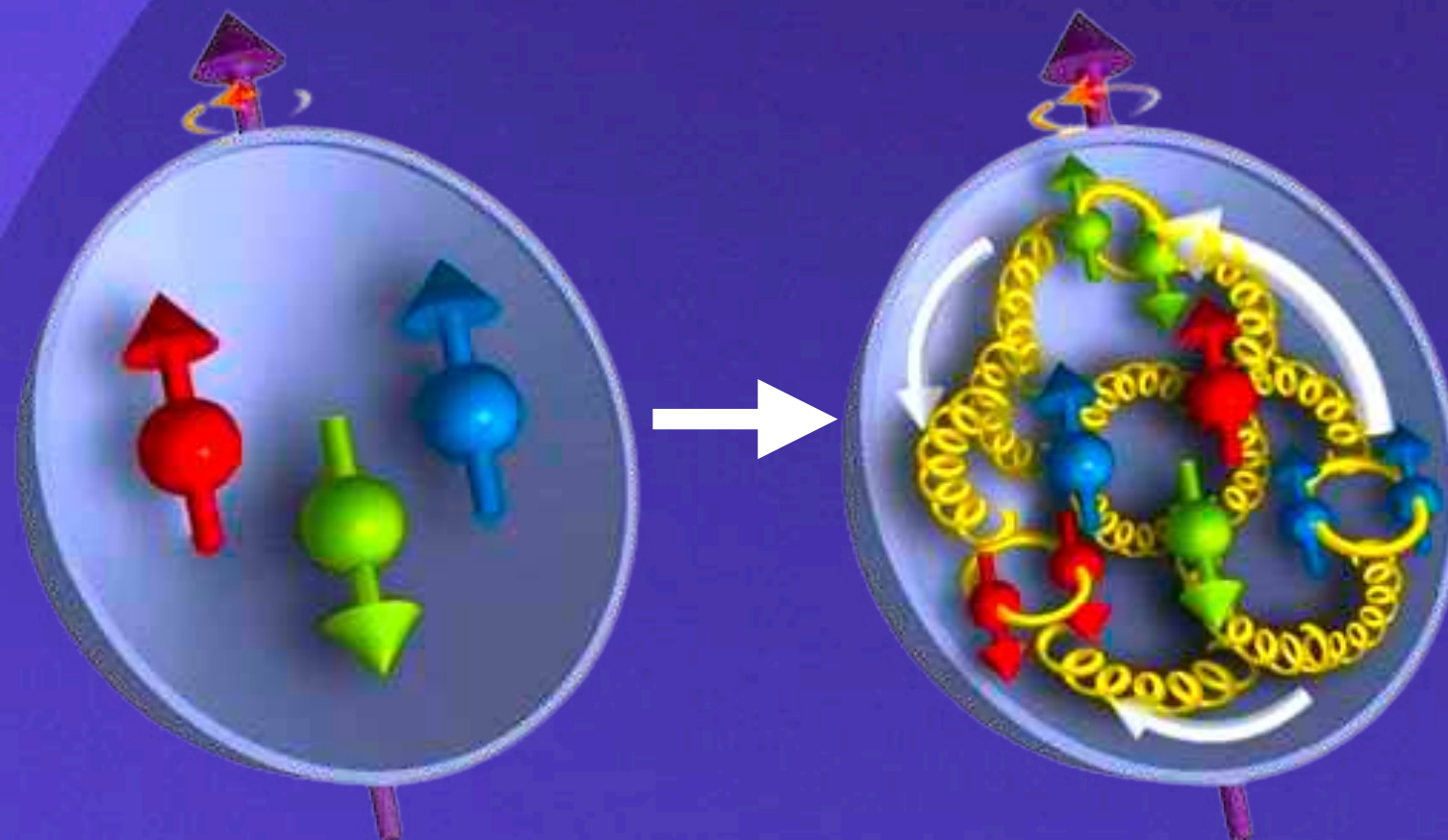
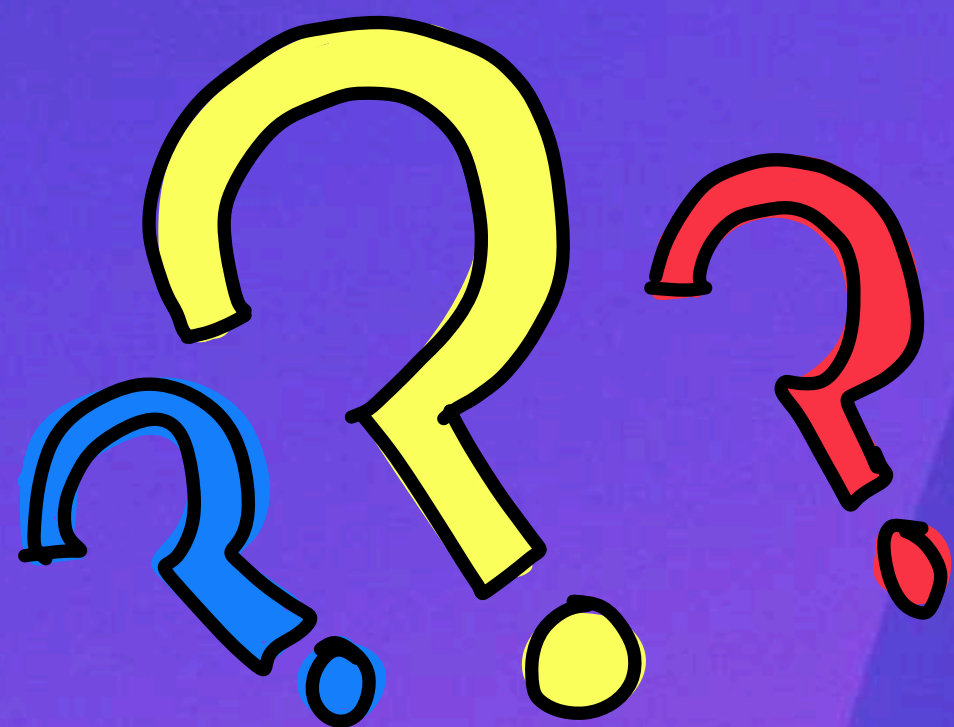
ISGUR & CAPSTICK

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						

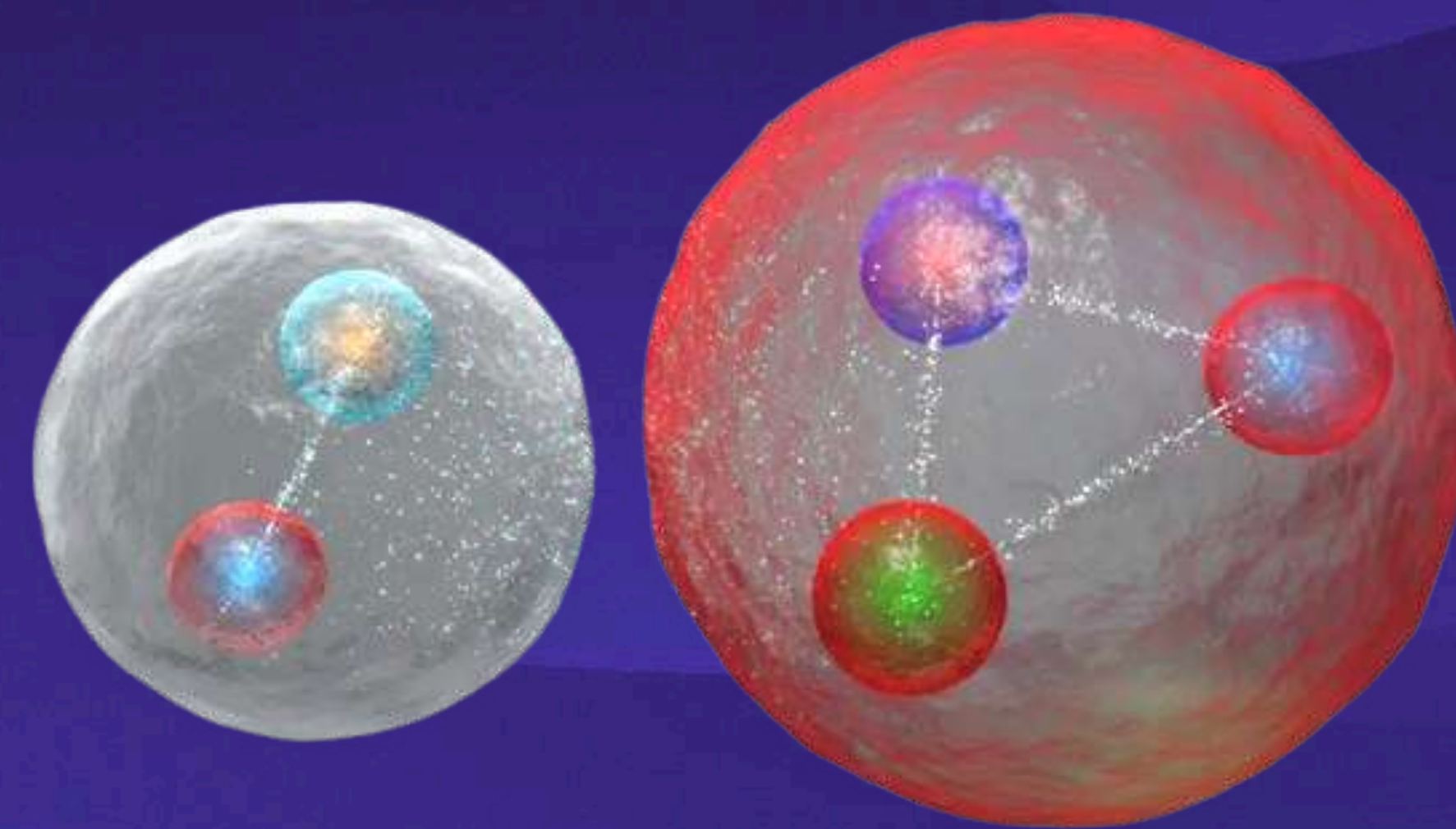
94
STATES

RELATIVIZED
QUARK
MODEL



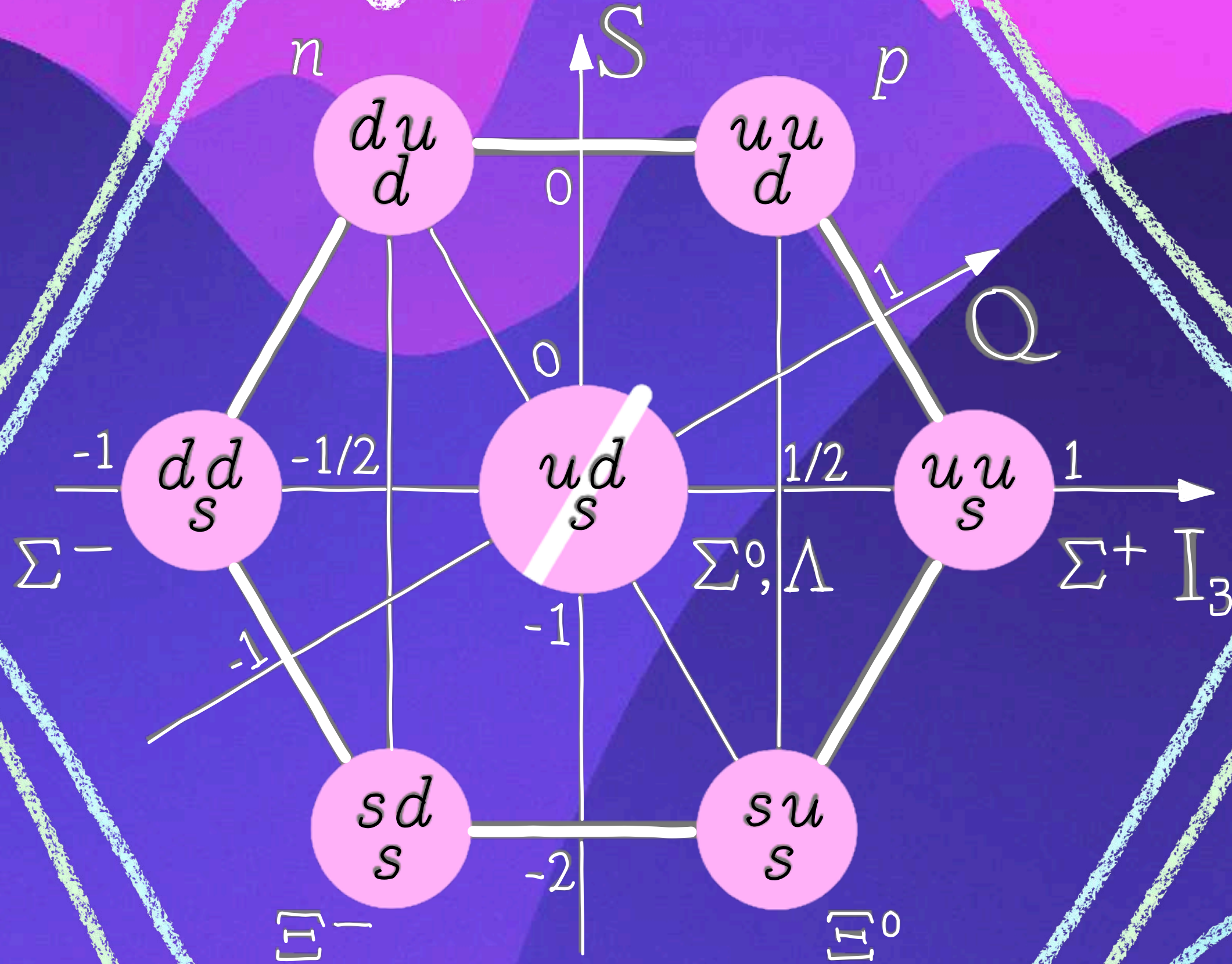
DO WE UNDERSTAND
BARYONS?

MESON-BARYON
MOLECULES

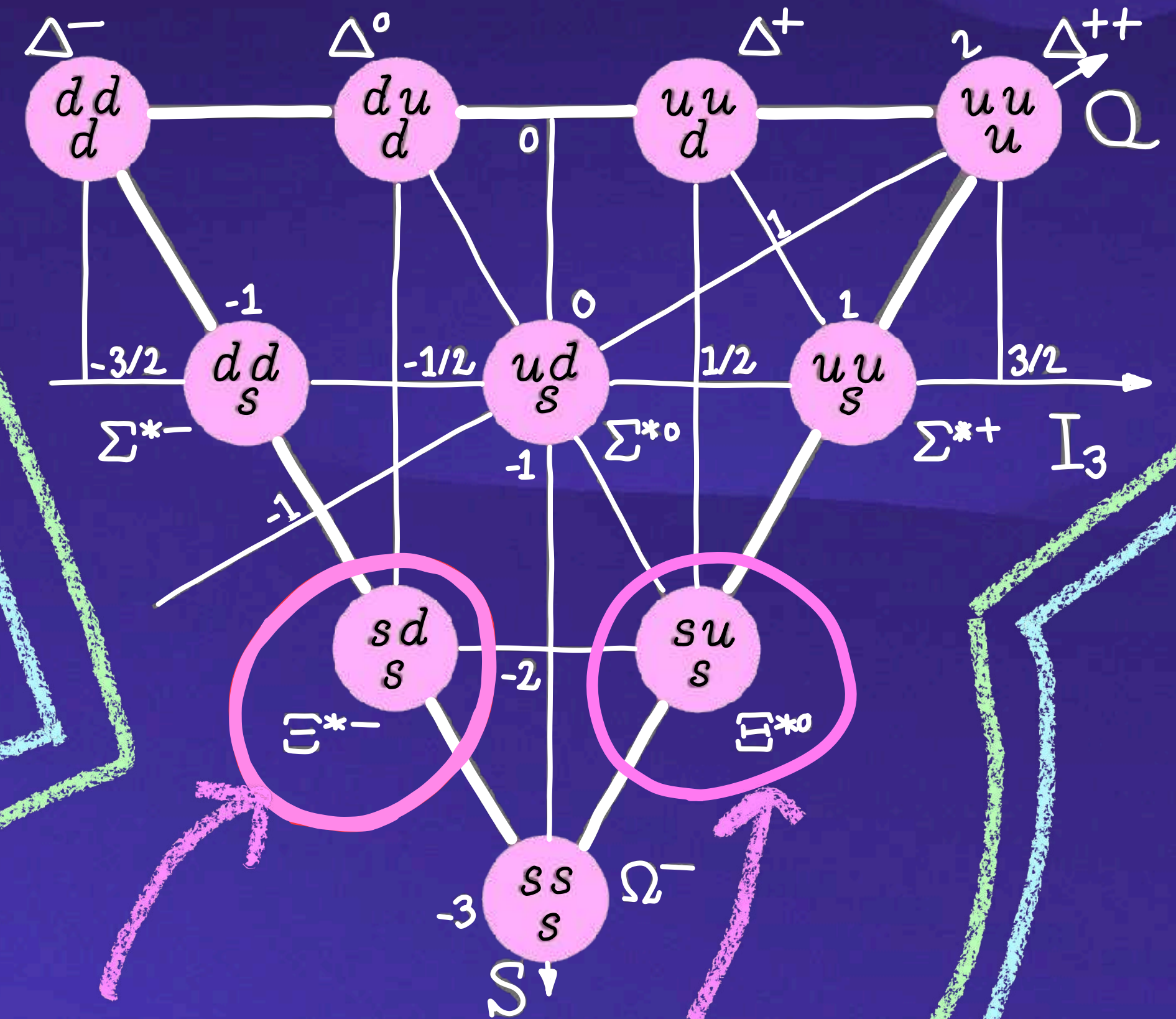


BARYONS

OCTET



DECUPLET



EXCITED CASCADES

THE MISSING STATES

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

6

EXCITED
STATES IN
PDG

NOT MUCH PROGRESS
IN PAST: 4 DECADES

NOW

1981

MISSING J^P and BRANCHING RATIOS

$\Xi(1690)$

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

Mass $m = 1690 \pm 10$ MeV [c]

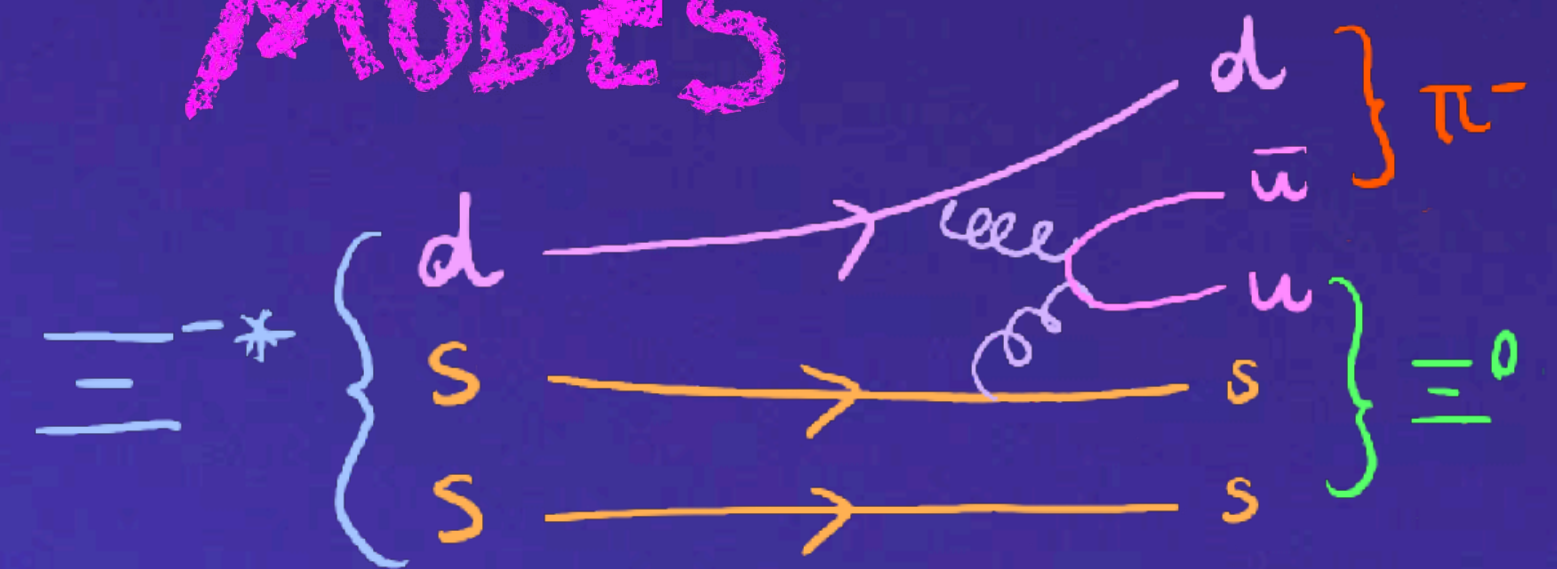
Full width $\Gamma < 30$ MeV

$\Xi(1690)$ DECAY MODES

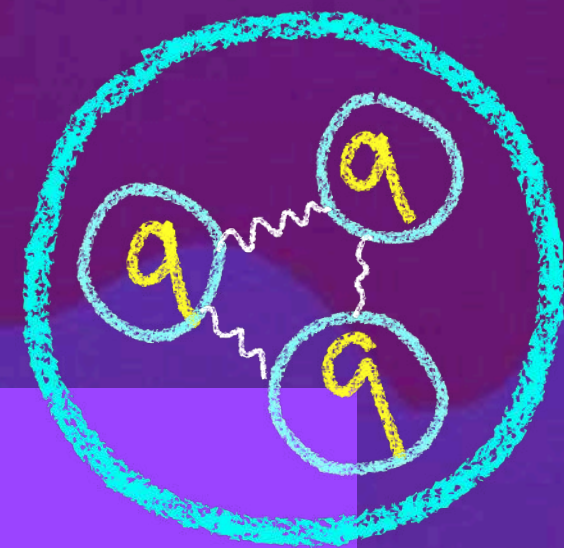
	Fraction (Γ_i/Γ)	p (MeV/c)
$\Lambda \bar{K}$	seen	240
$\Sigma \bar{K}$	seen	70
$\Xi \pi$	seen	311
$\Xi^- \pi^+ \pi^-$	possibly seen	213



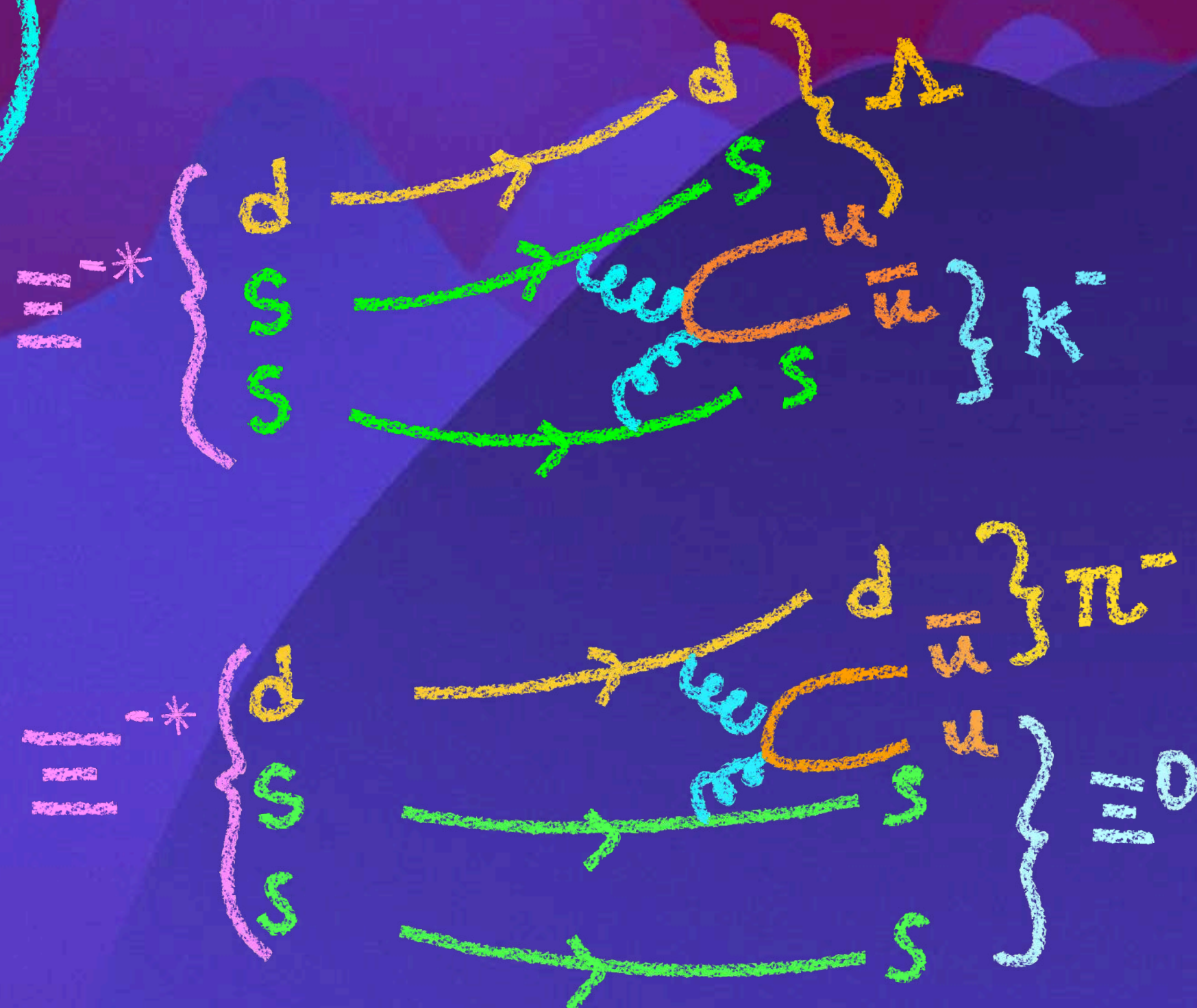
POSSIBLE DECAY MODES



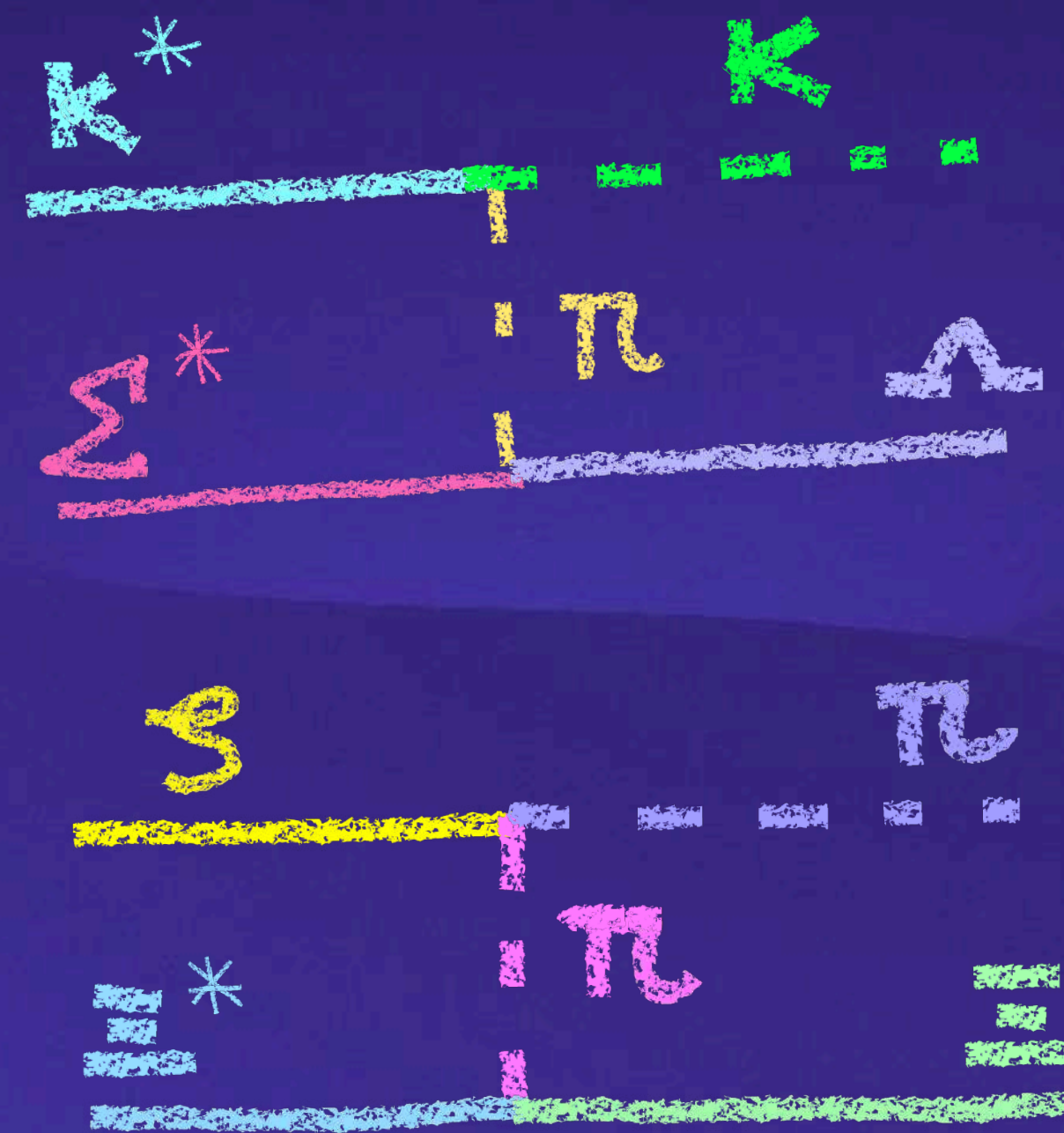
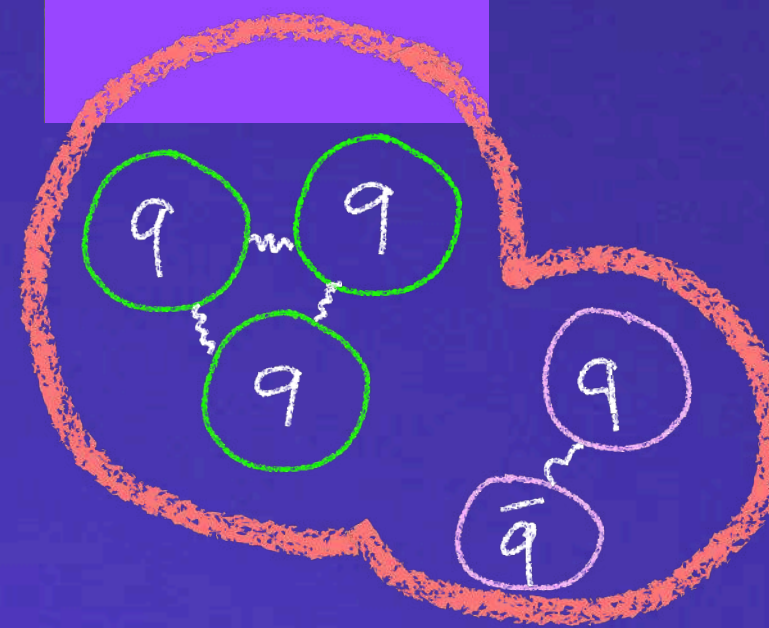
THEORETICAL MODELS



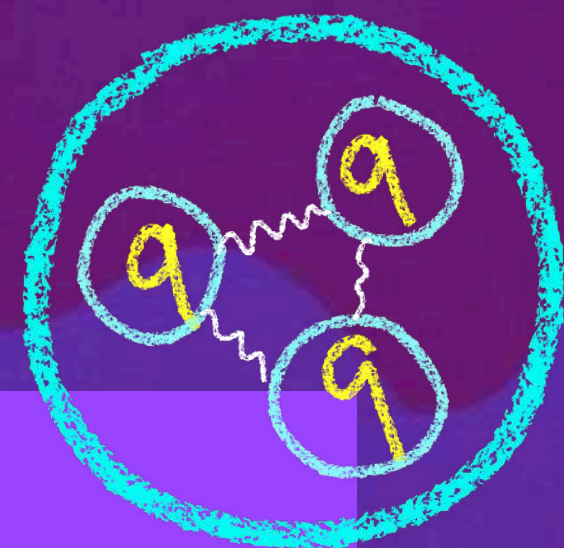
3q STATE



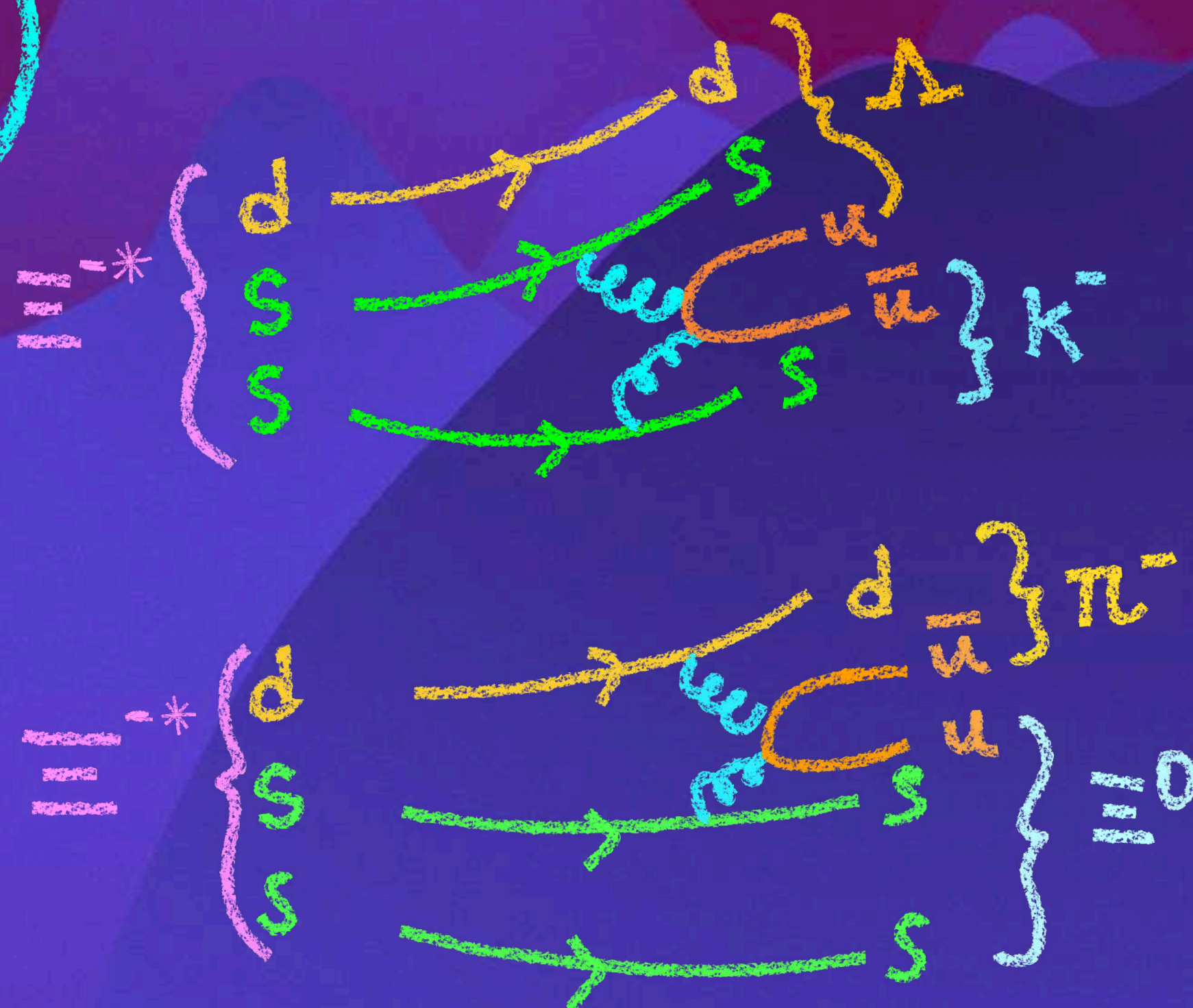
MOLECULAR



THEORETICAL MODELS

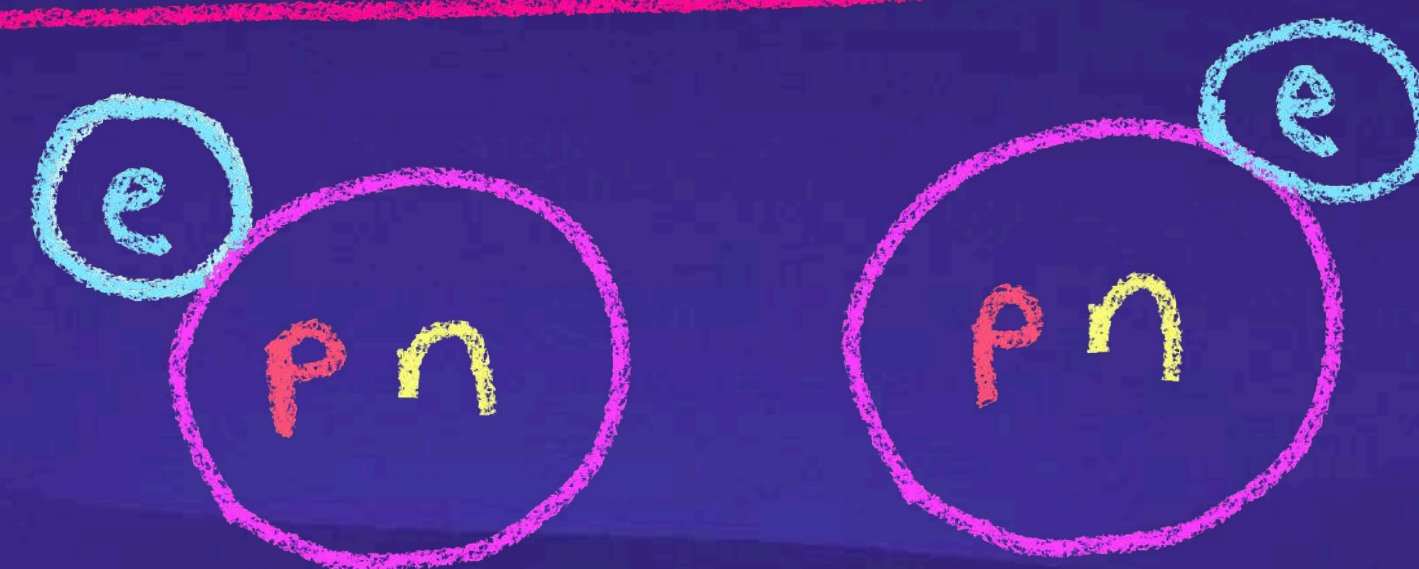


3q STATE



MOLECULAR

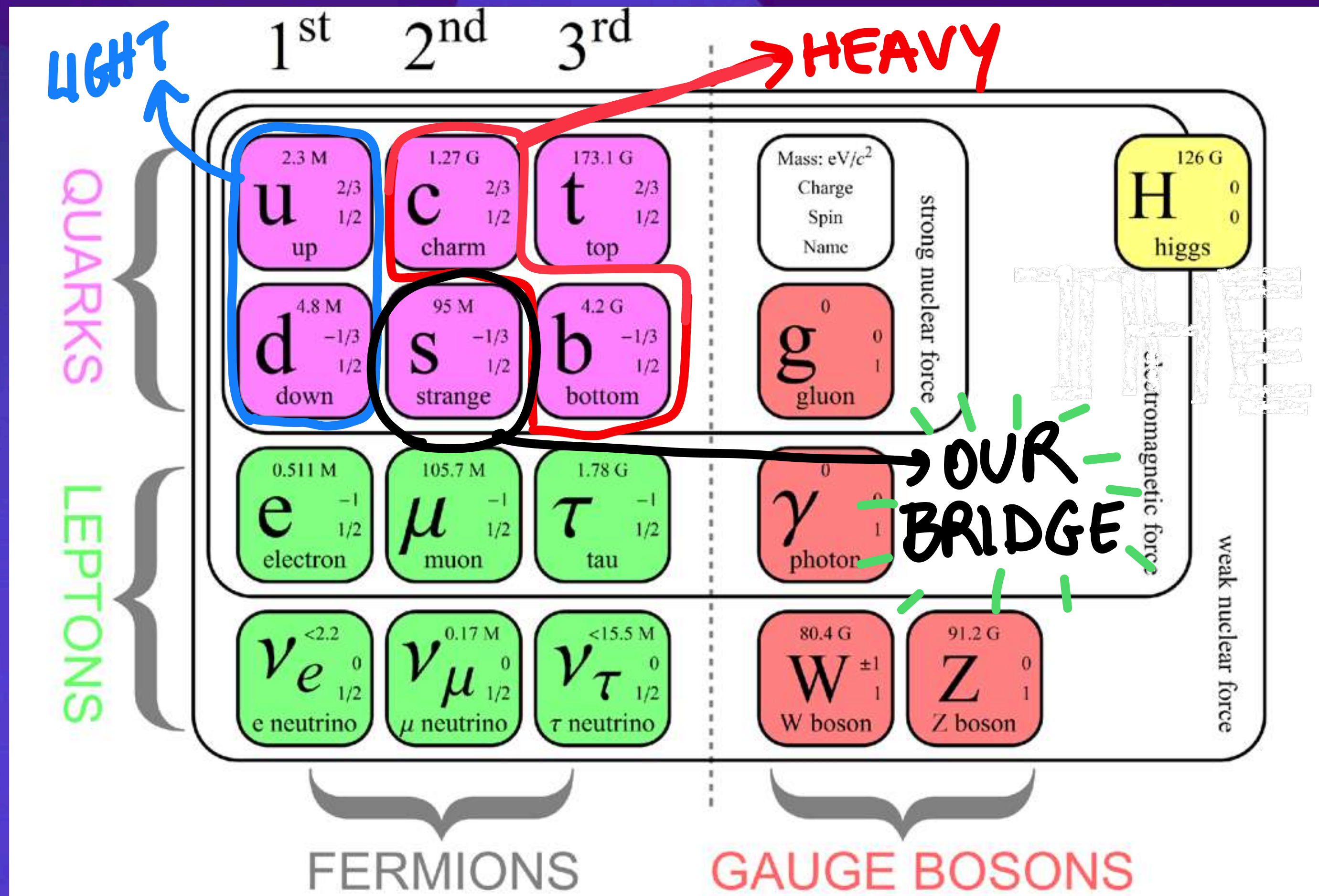
DEUTERIUM MOLECULE



He ATOM



THE LIGHT, THE HEAVY & THE STRANGE



1.27 GeV
2/3
1/2
C
charm

4.2 GeV
-1/3
1/2
b
bottom

104 MeV
-1/3
1/2
S
strange

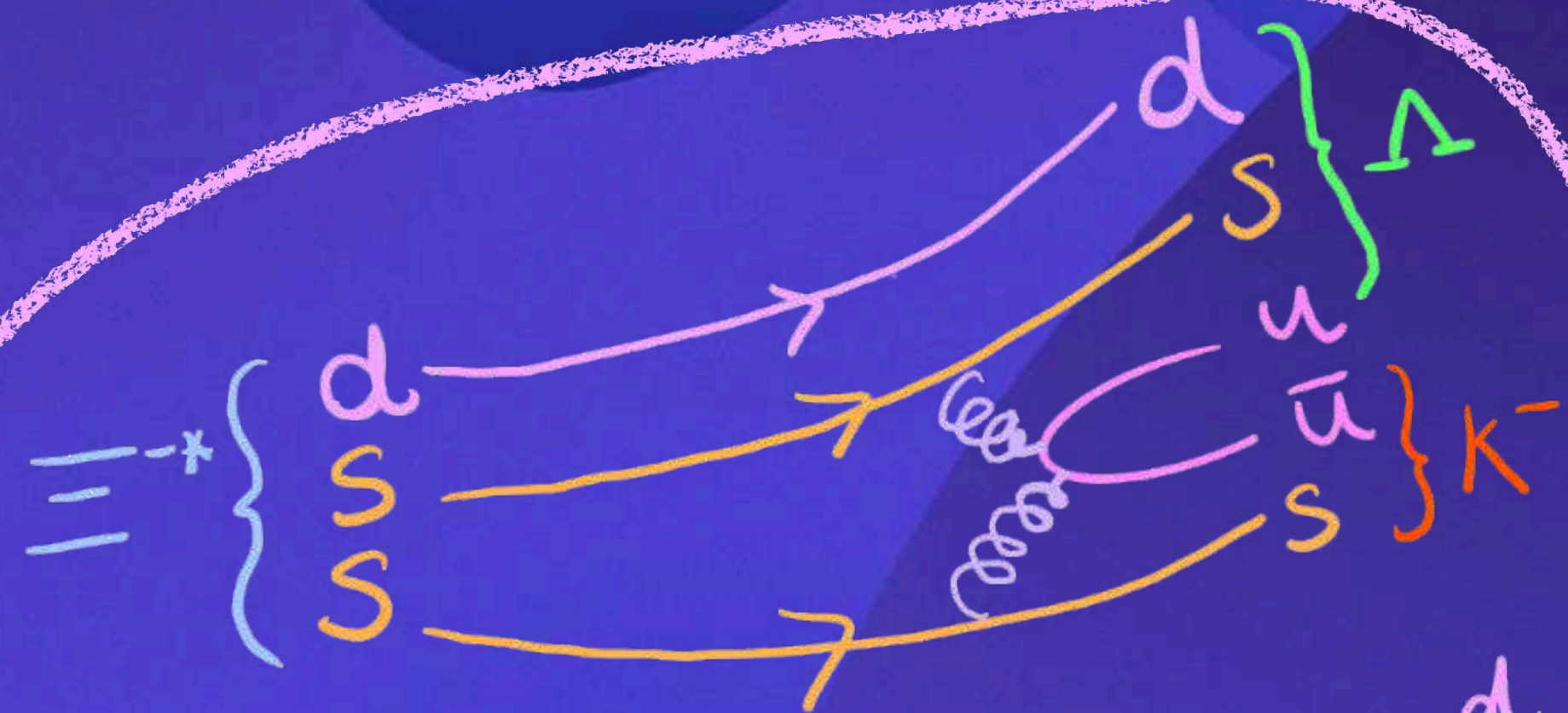
2.4 MeV
2/3
1/2
u
up

4.8 MeV
-1/3
1/2
d
down

SU(3) CLEBSH = GORDAN

FROM DECUPLLET

$$|\Xi^*\rangle = \frac{1}{2}|\Xi\pi\rangle + \frac{1}{2}|\Sigma\bar{K}\rangle + \frac{1}{2}|\Xi\eta\rangle - \frac{1}{2}|\Lambda\bar{K}\rangle$$



TWO OF
THE
POSSIBLE
CHANNELS

FROM OCTET

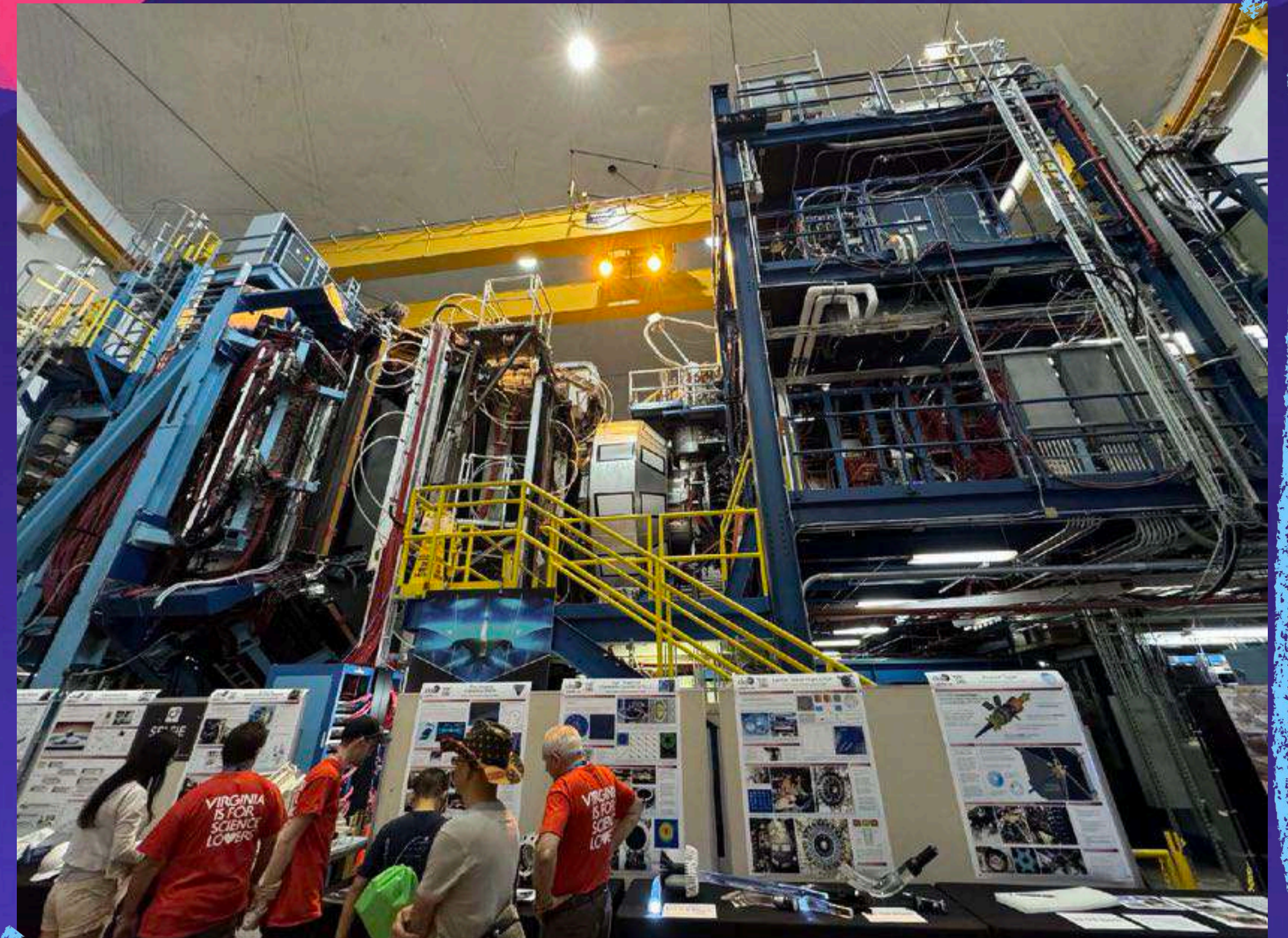
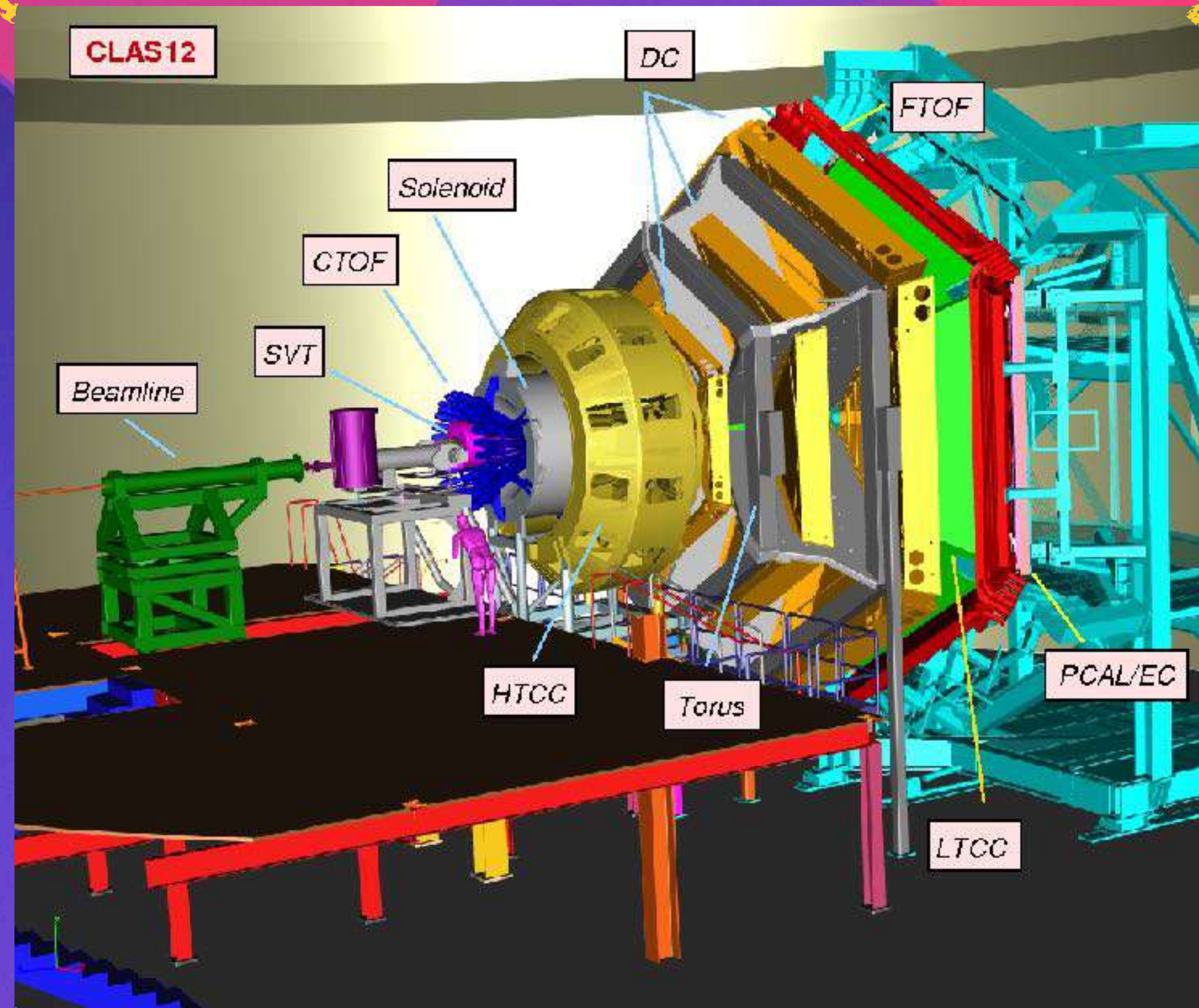
$$|\Xi^*\rangle = \frac{1}{2}|\Xi\pi\rangle + \frac{1}{2}|\Sigma\bar{K}\rangle - \frac{1}{2}|\Xi\eta\rangle + \frac{1}{2}|\Lambda\bar{K}\rangle$$

ALL CHANNELS
POSSIBLE!

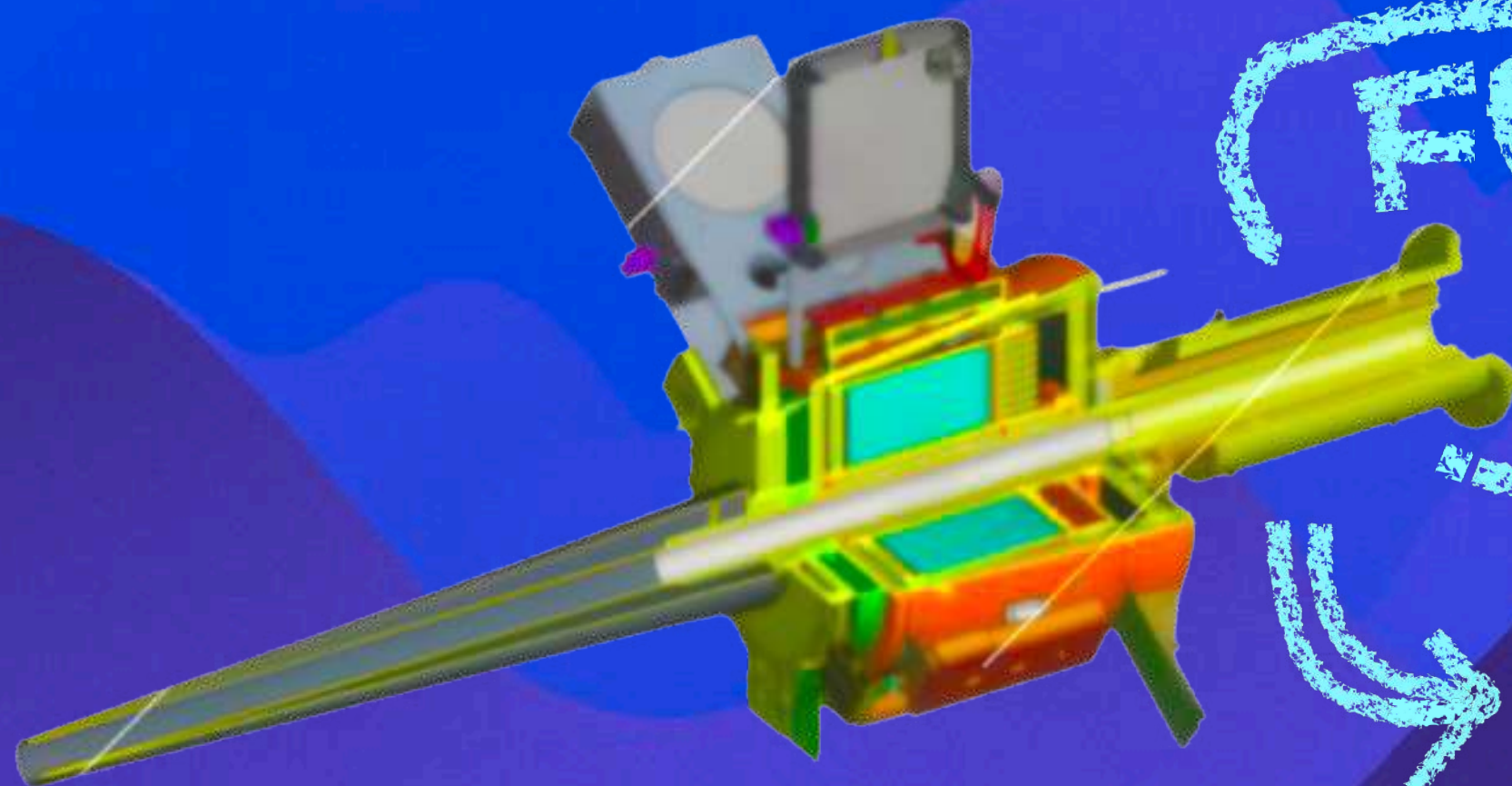
JEFFERSON LAB



CLAS 12



DETECTORS

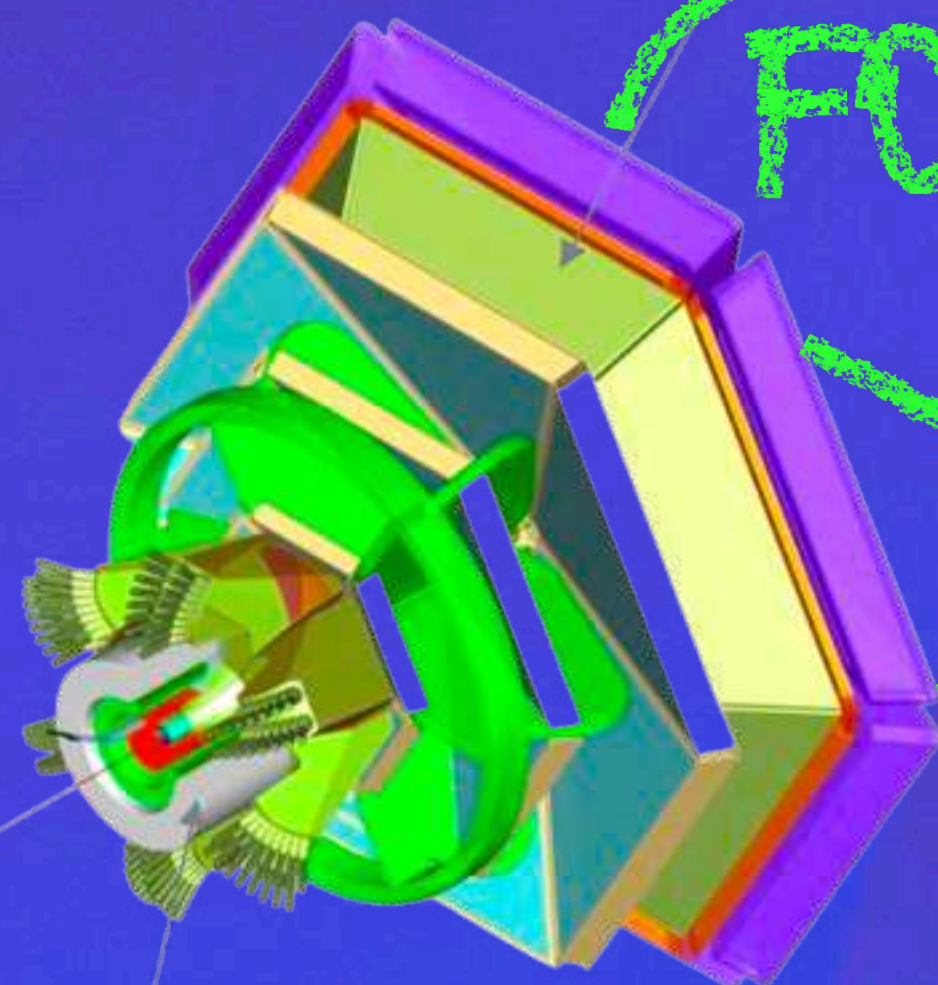


FORWARD
TAGGER

* $2.5^\circ < \theta < 4.5^\circ$

* LOW Q^2

* CALORIMETER



FORWARD
DETECTOR

* $5^\circ < \theta < 35^\circ$

* HIGH Q^2

* MAGNETIC SPECTROSCOPY

PARTICLE
IDENTIFICATION

TARGET

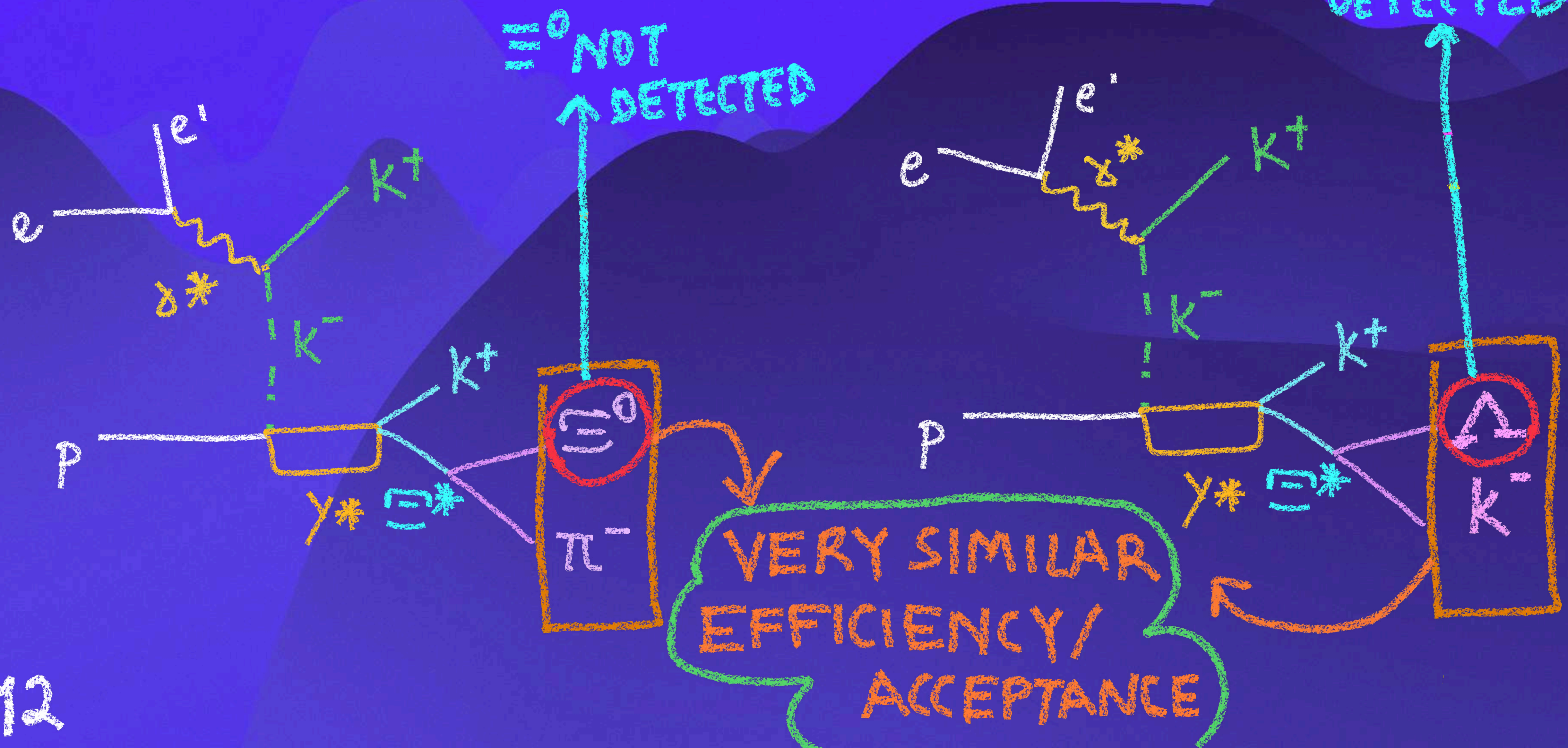
DC

K^+

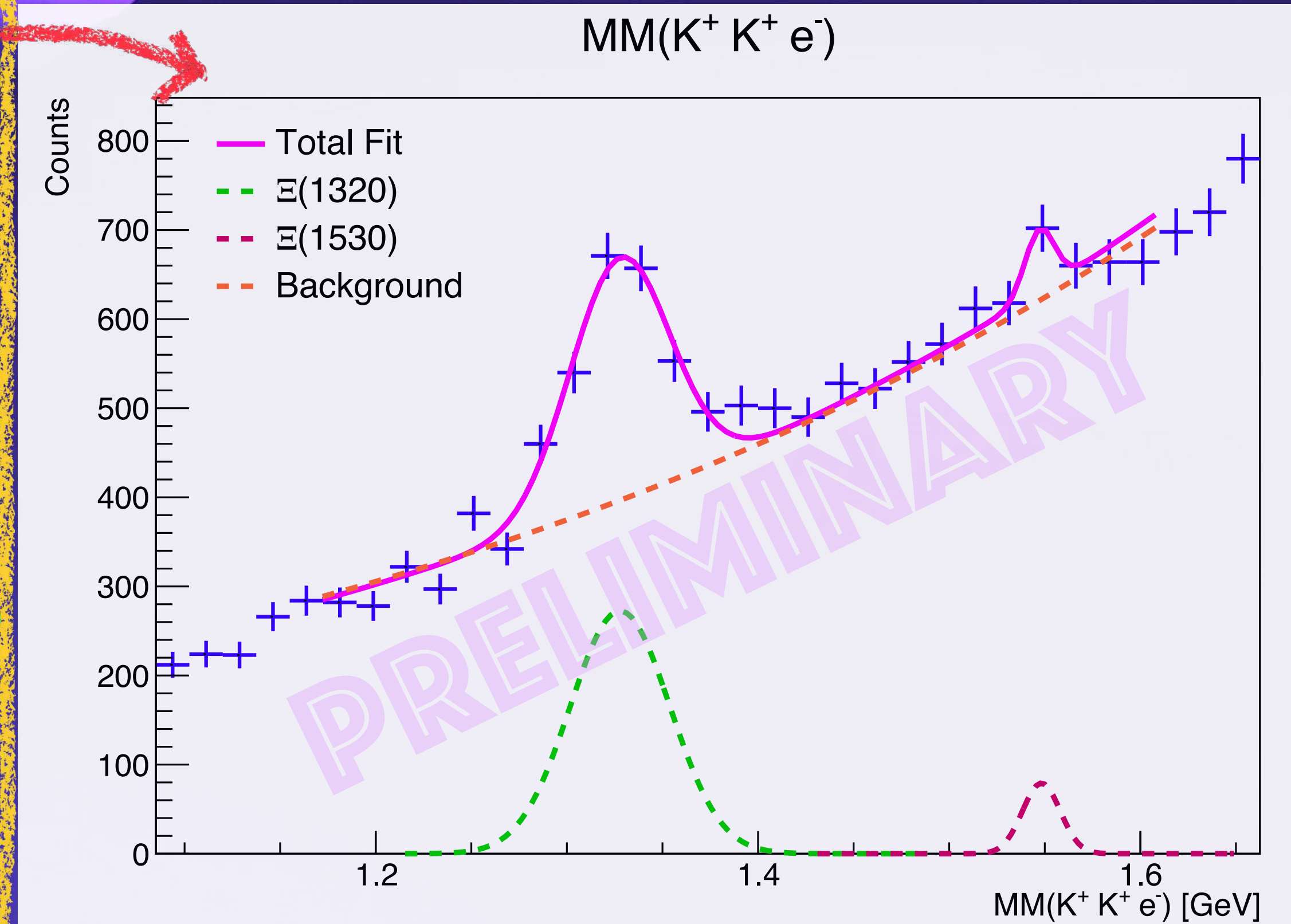
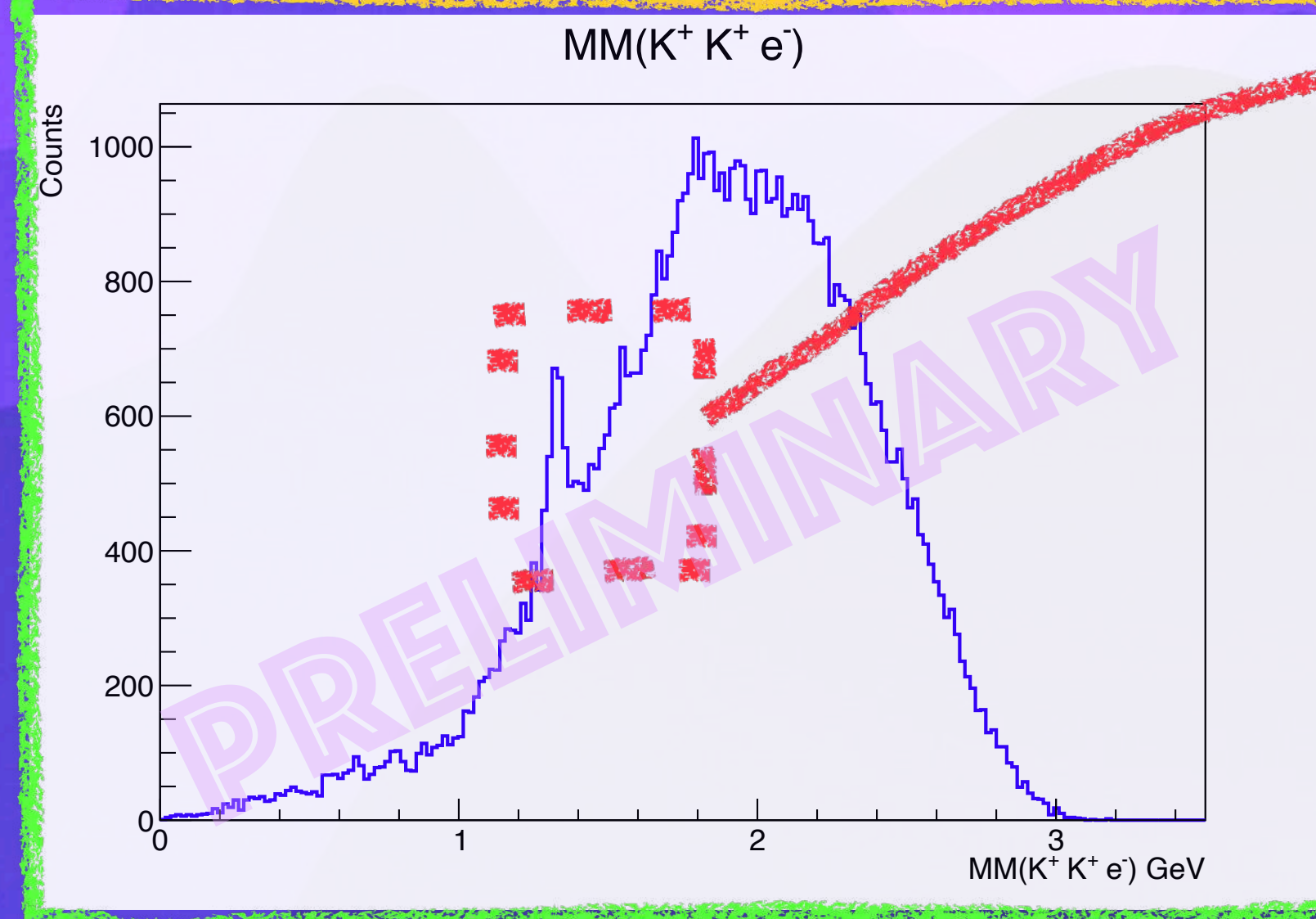
K^-

ToF

THE CHANNELS



FORWARD DETECTOR



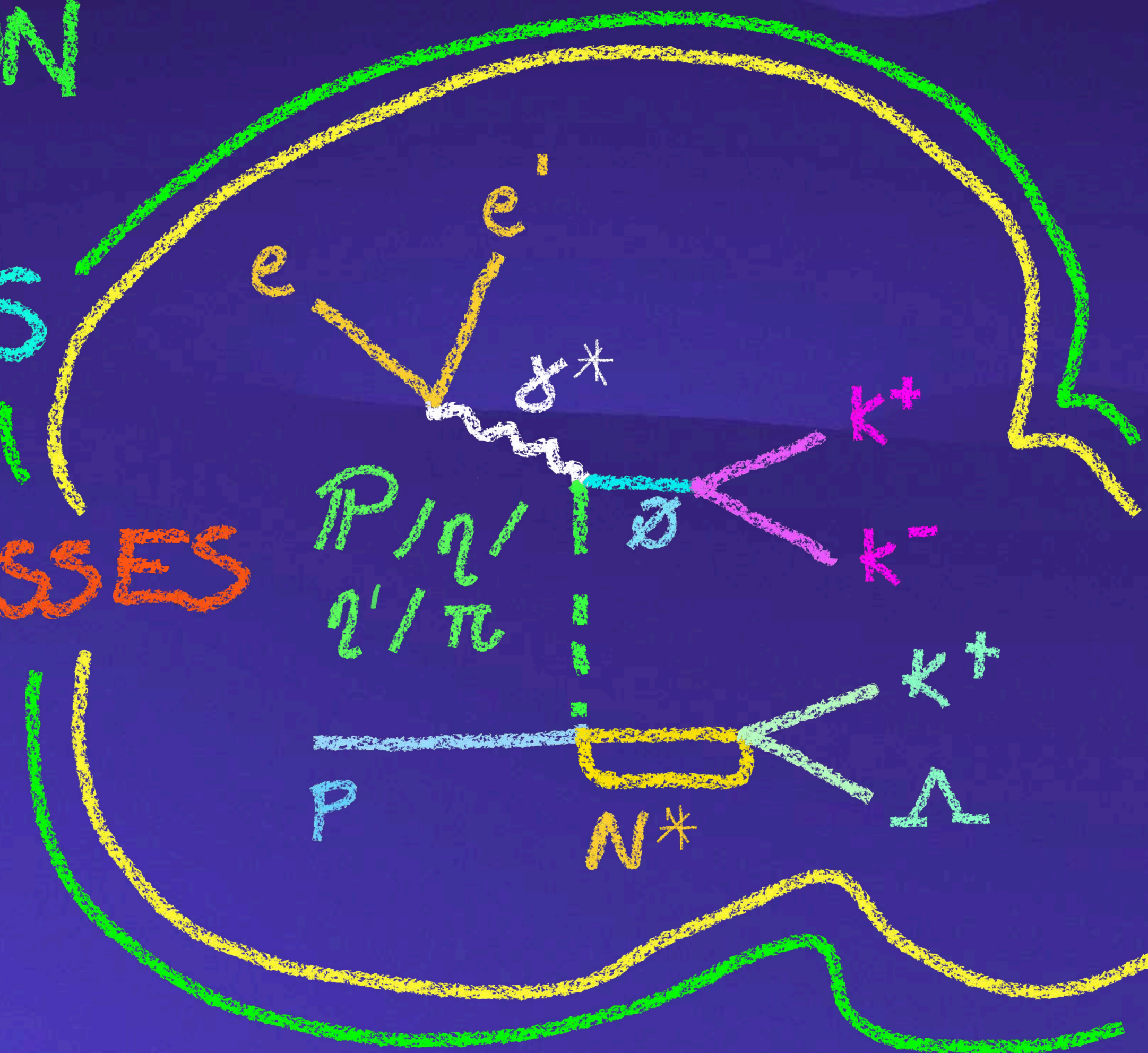
$X \rightarrow E(1320), E(1530)$

BACKGROUND

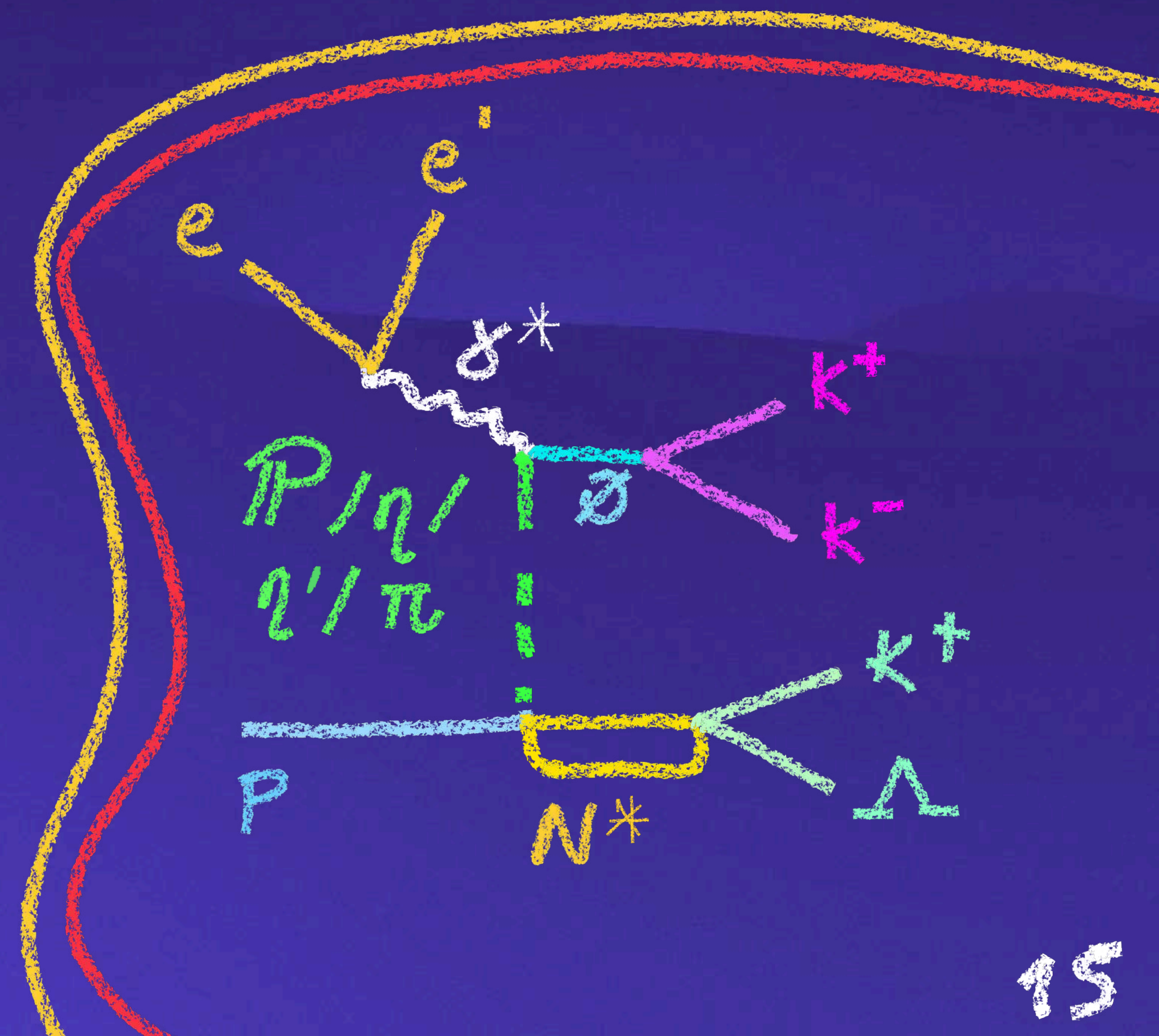
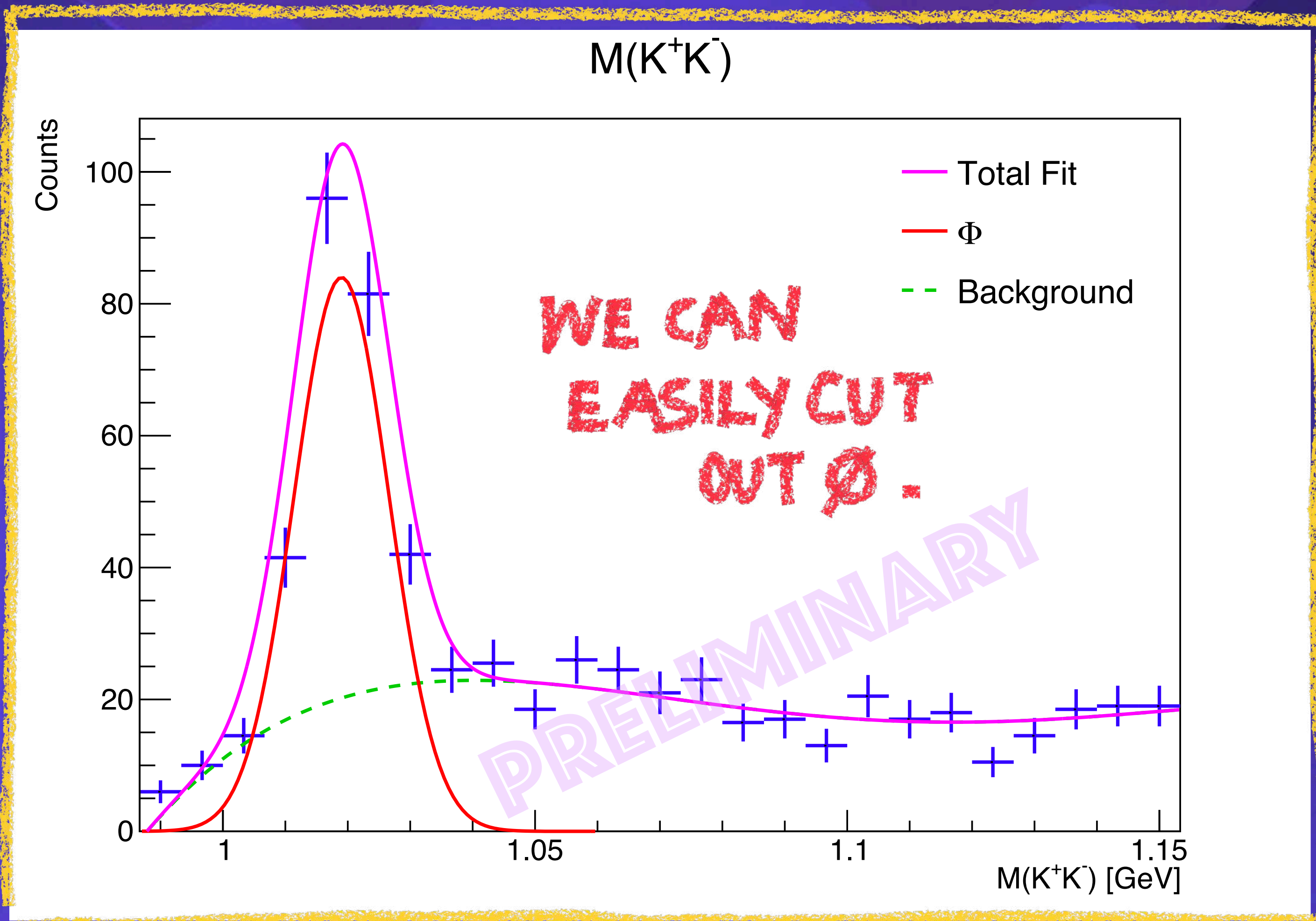
1. K/TL MISIDENTIFICATION

2. OUT OF TIME PARTICLES

3. OTHER PHYSICAL PROCESSES

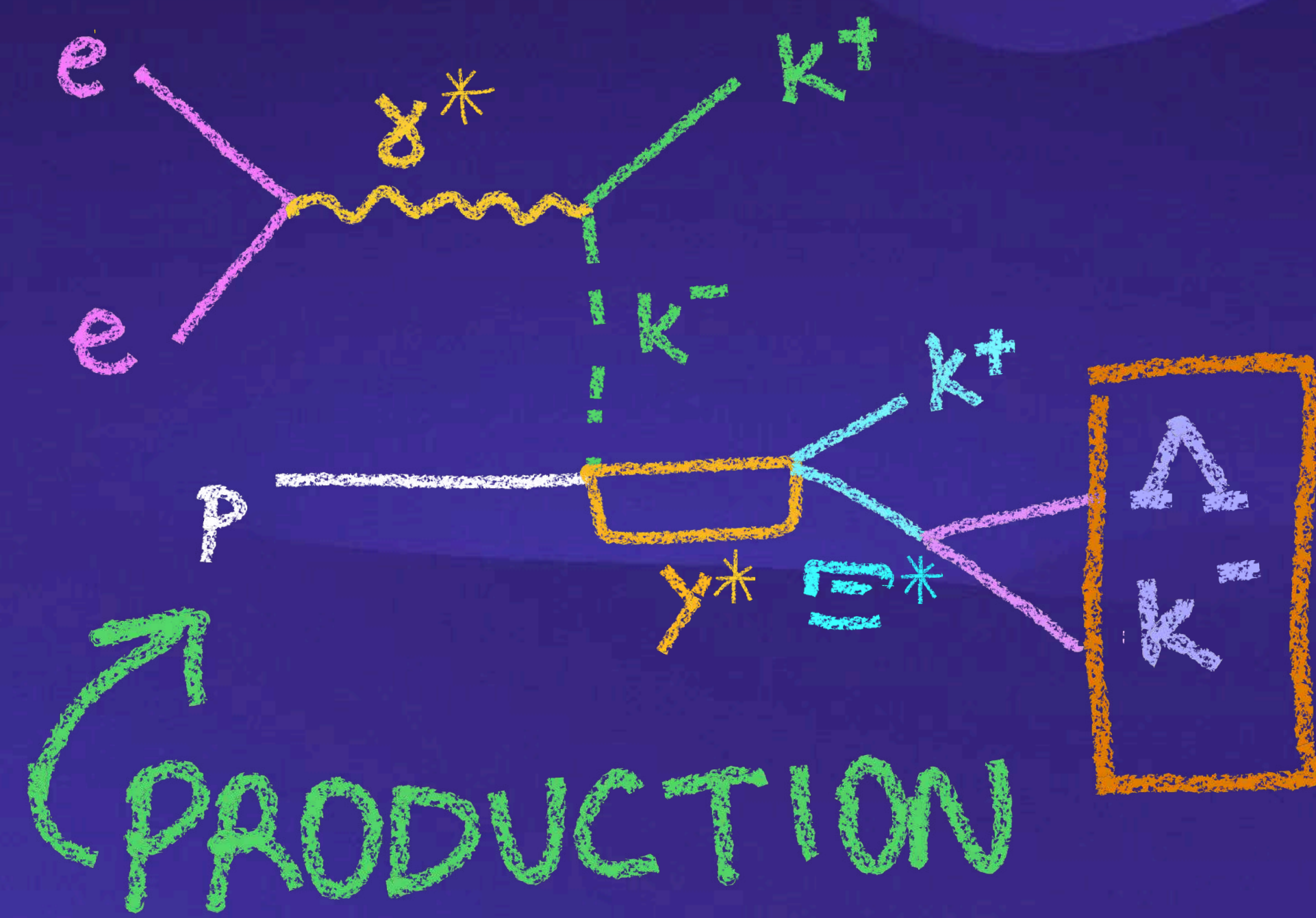
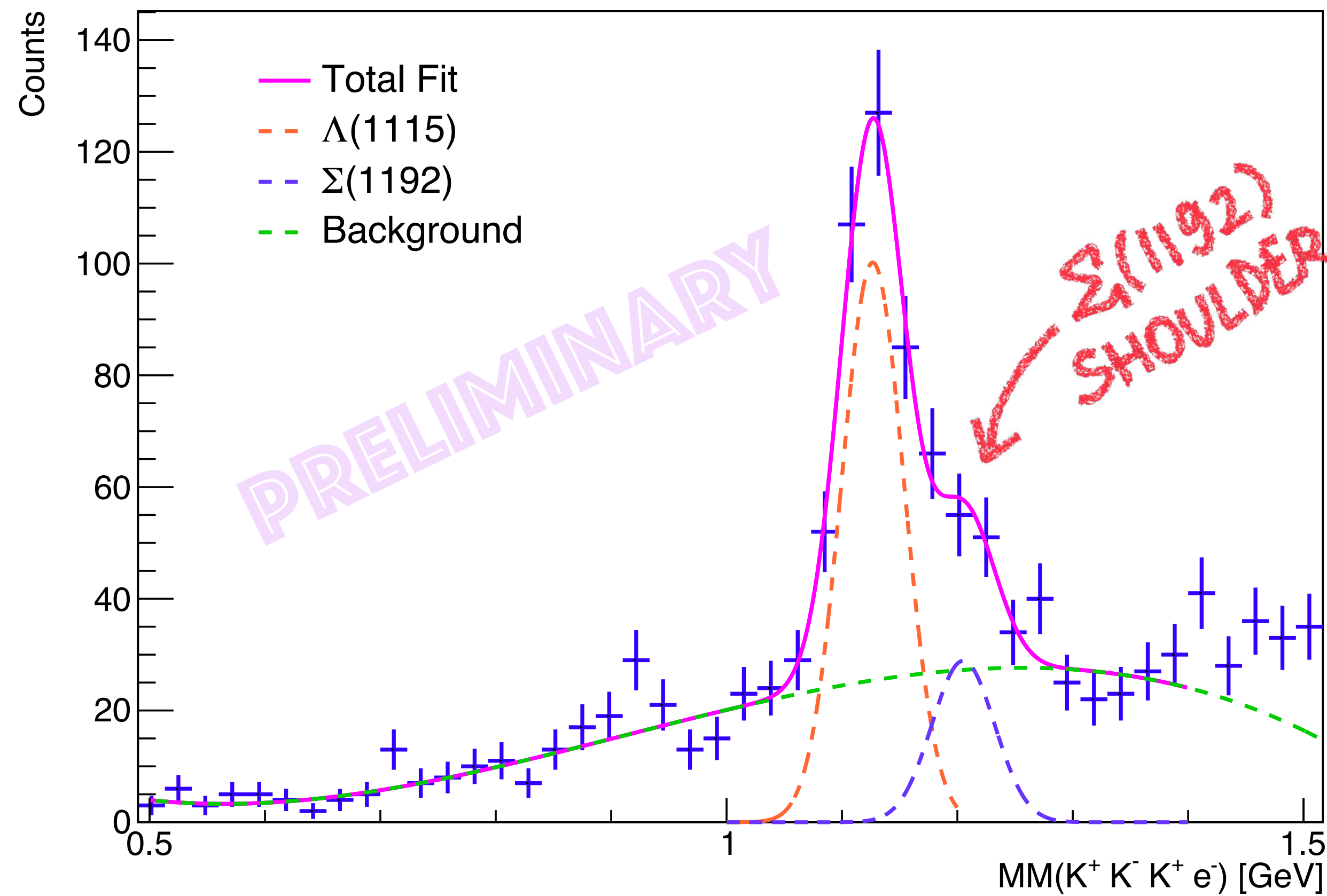


BACKGROUND RECONSTRUCTION

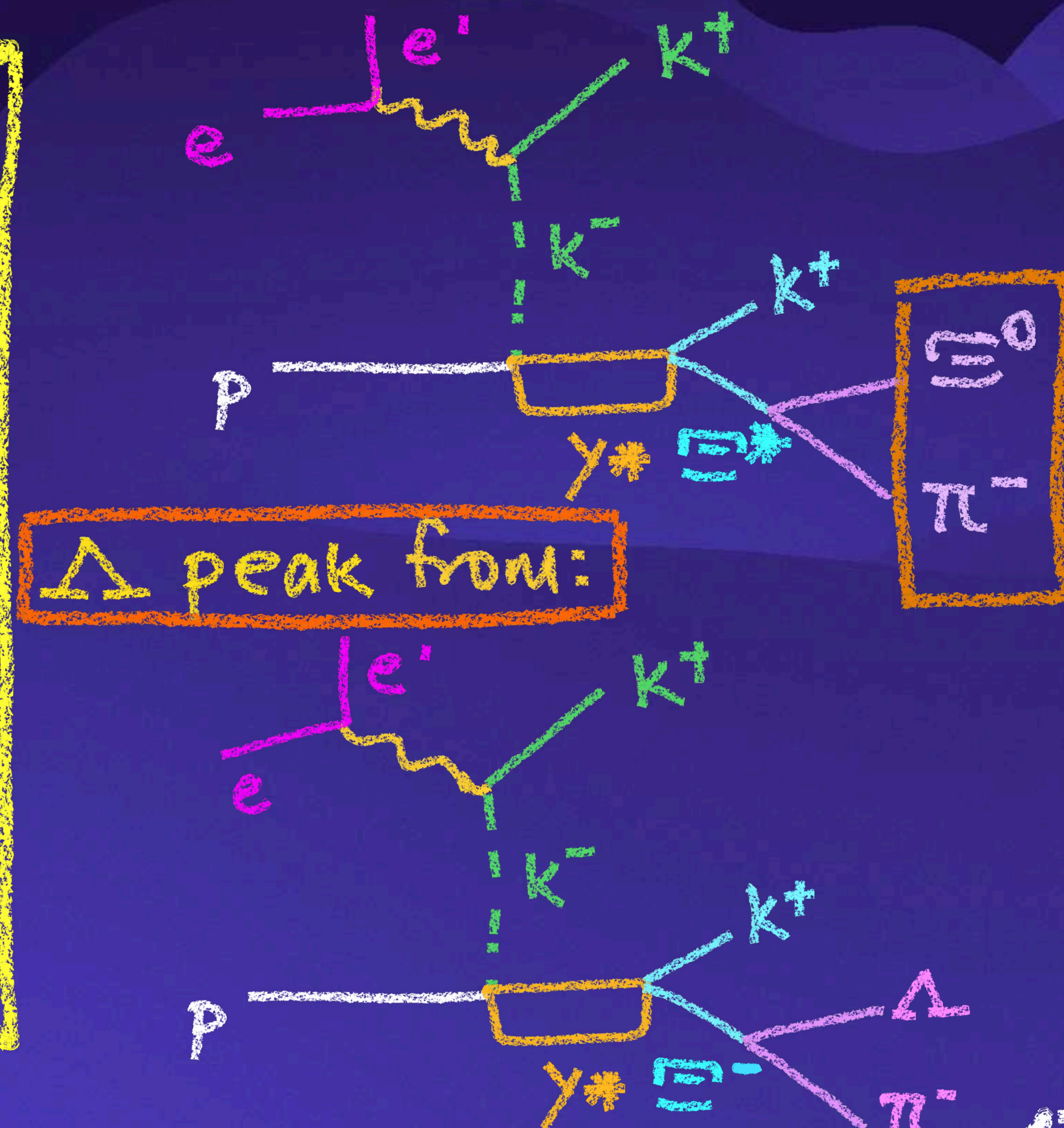
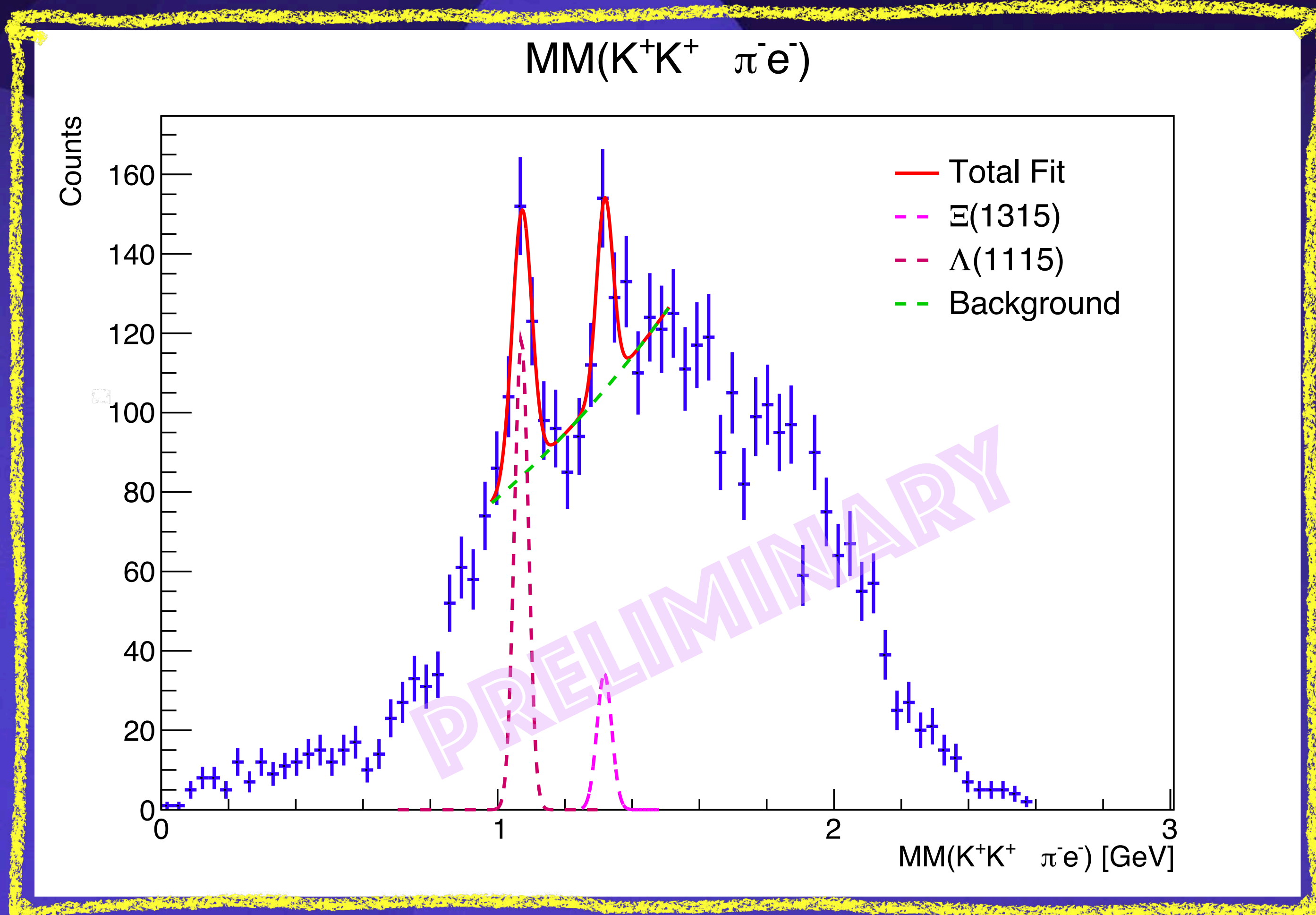


$K^+K^+K^-\Delta$ CHANNEL

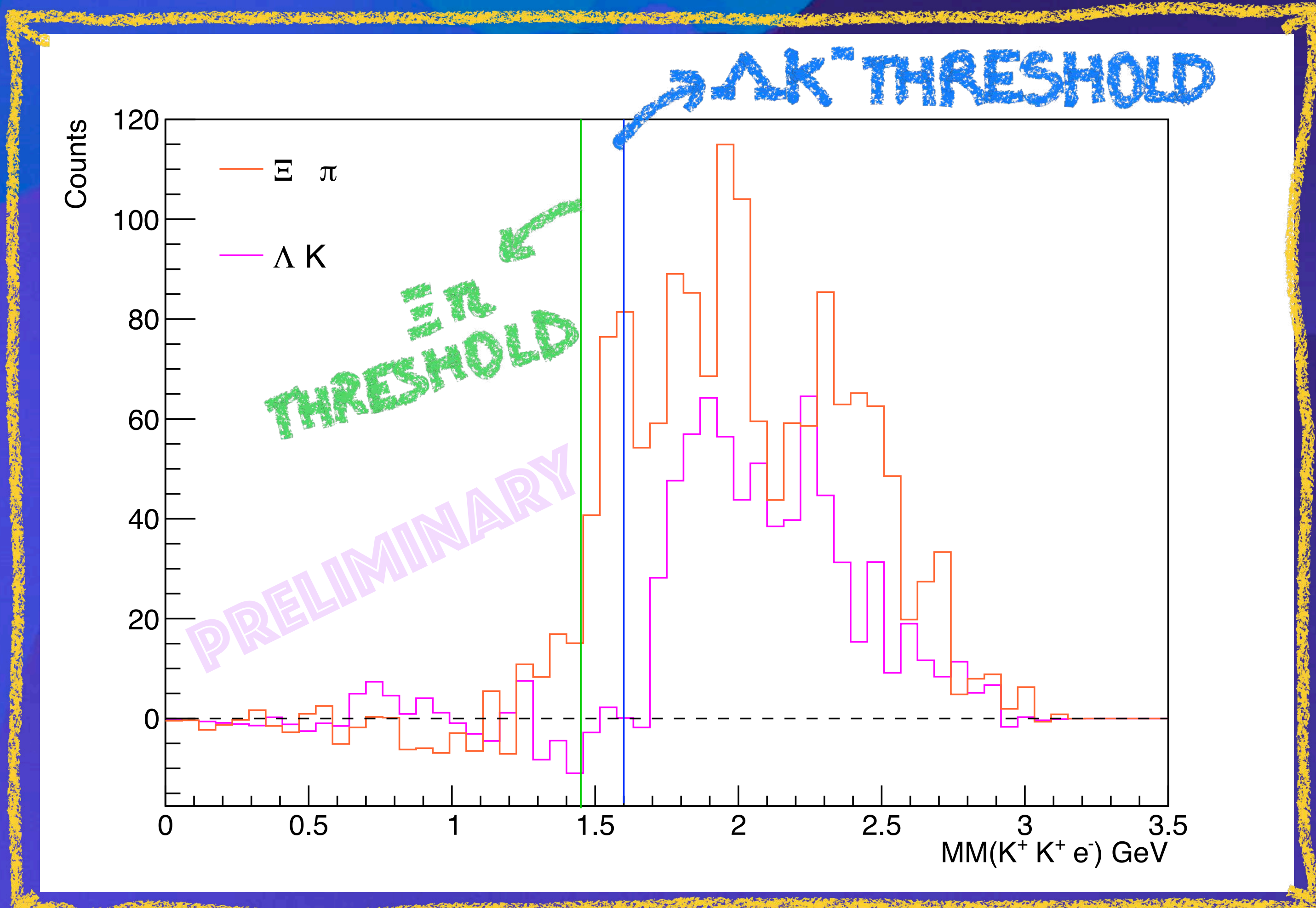
MM($K^+K^+K^-e^-$)



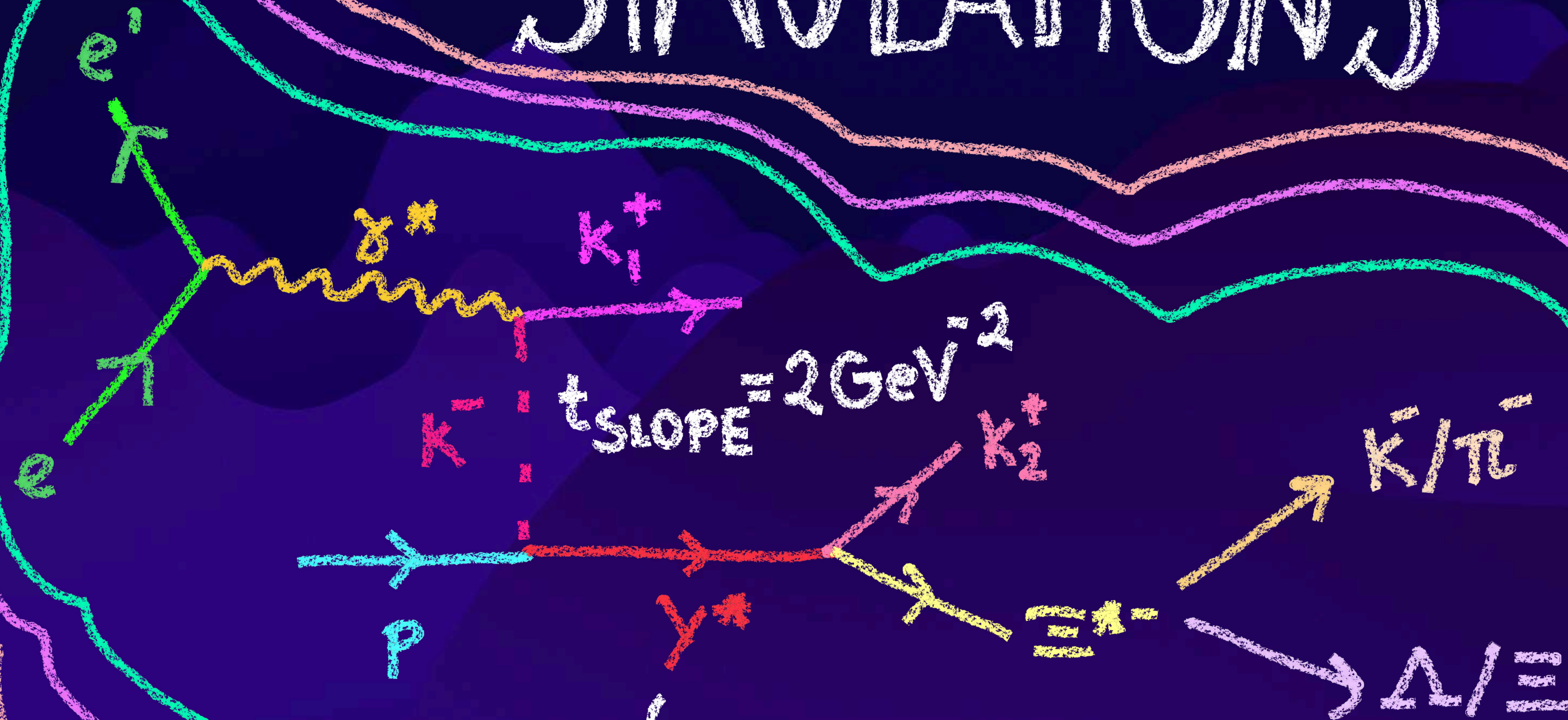
$K^+K^+\Xi^0\pi^-$ CHANNEL



FIRST LOOK AT BACKGROUND SUBTRACTED YIELDS



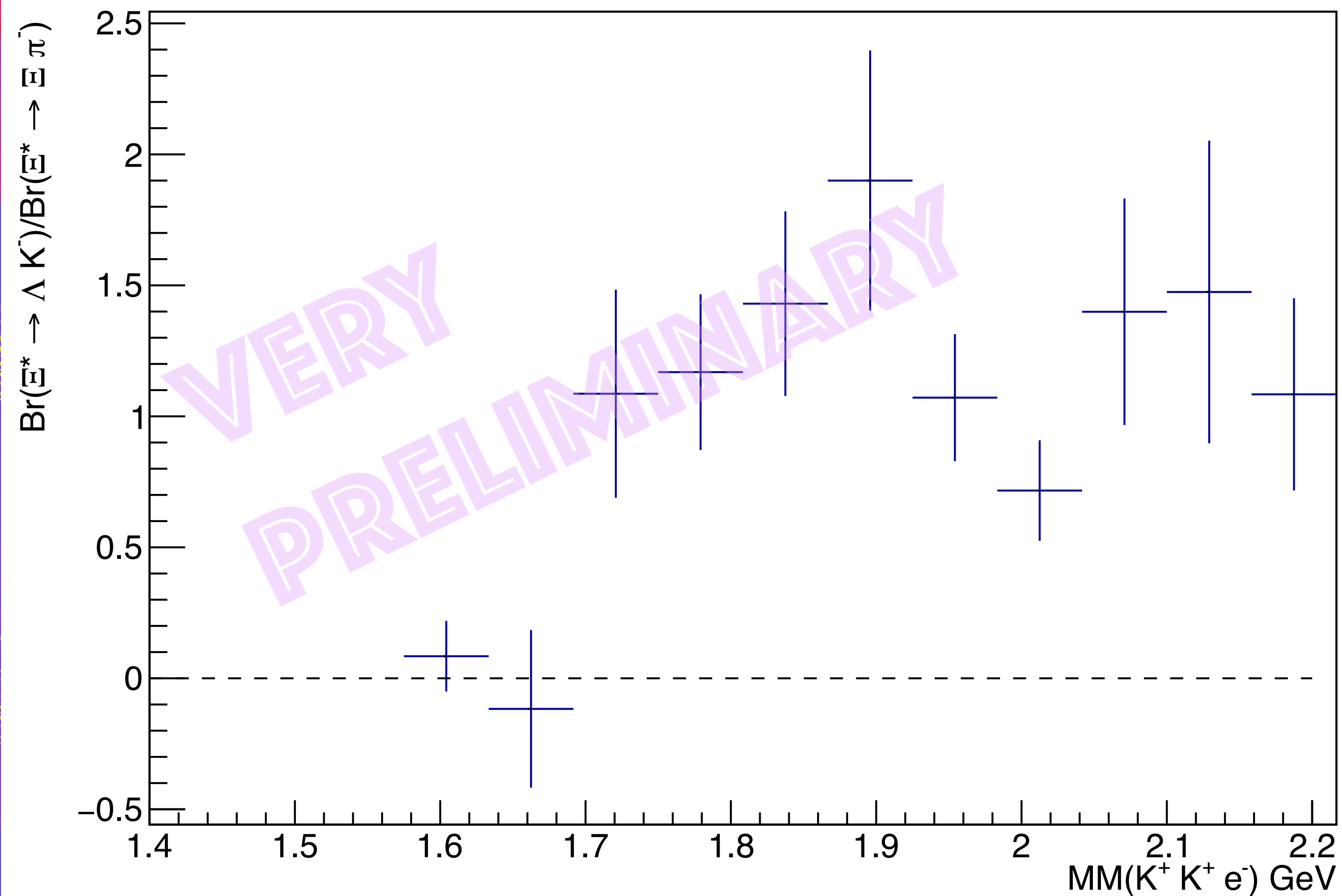
SIMULATIONS



$\hookrightarrow S = -1$ Hyperon.

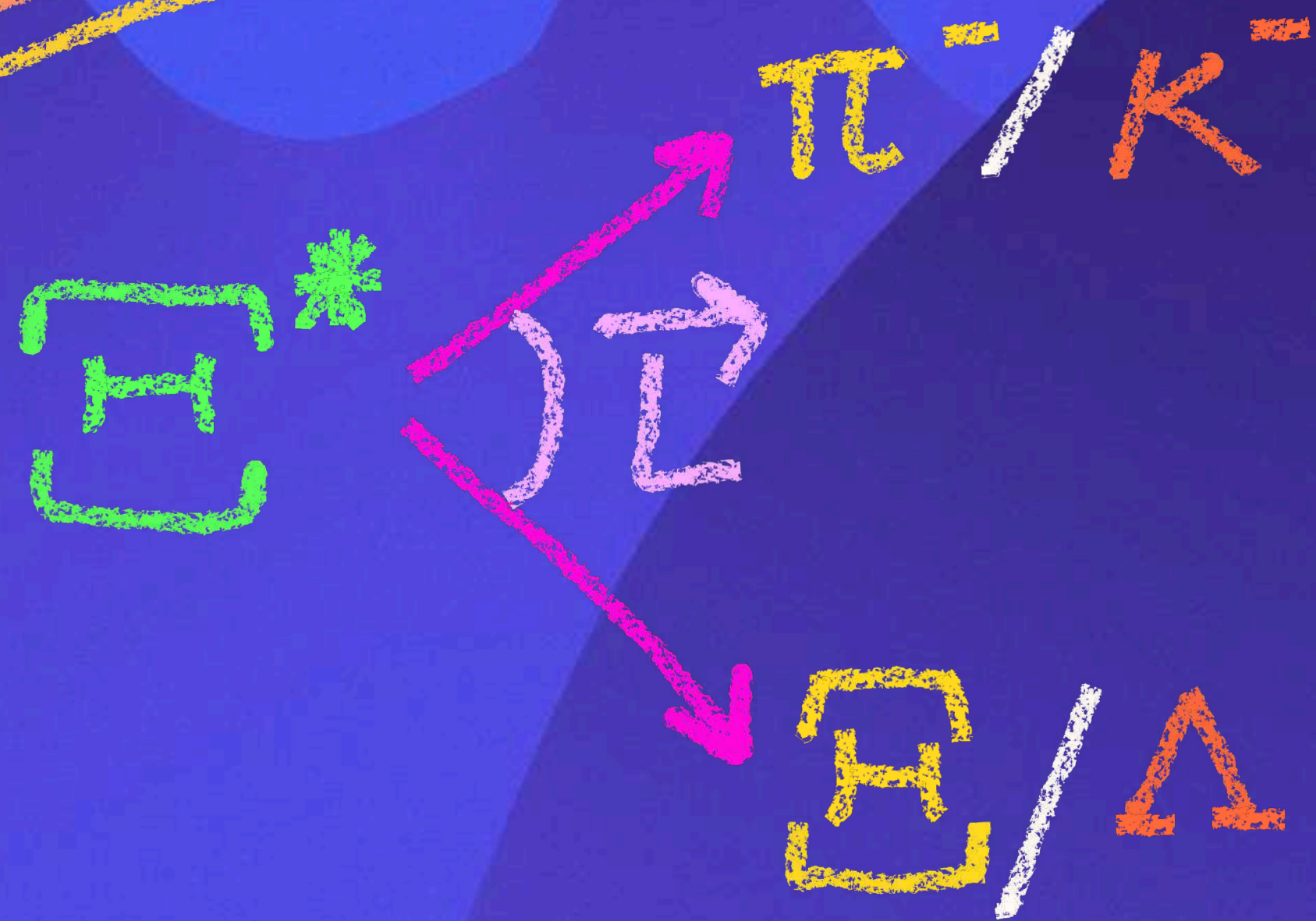
$m = 3 \text{ GeV}, \Gamma = 1 \text{ GeV}$

ACCEPTANCE/EFFICIENCY CORRECTED BRANCHINGS



TOWARDS J^P ...

ANGULAR COVERAGE OF K^- & π^-



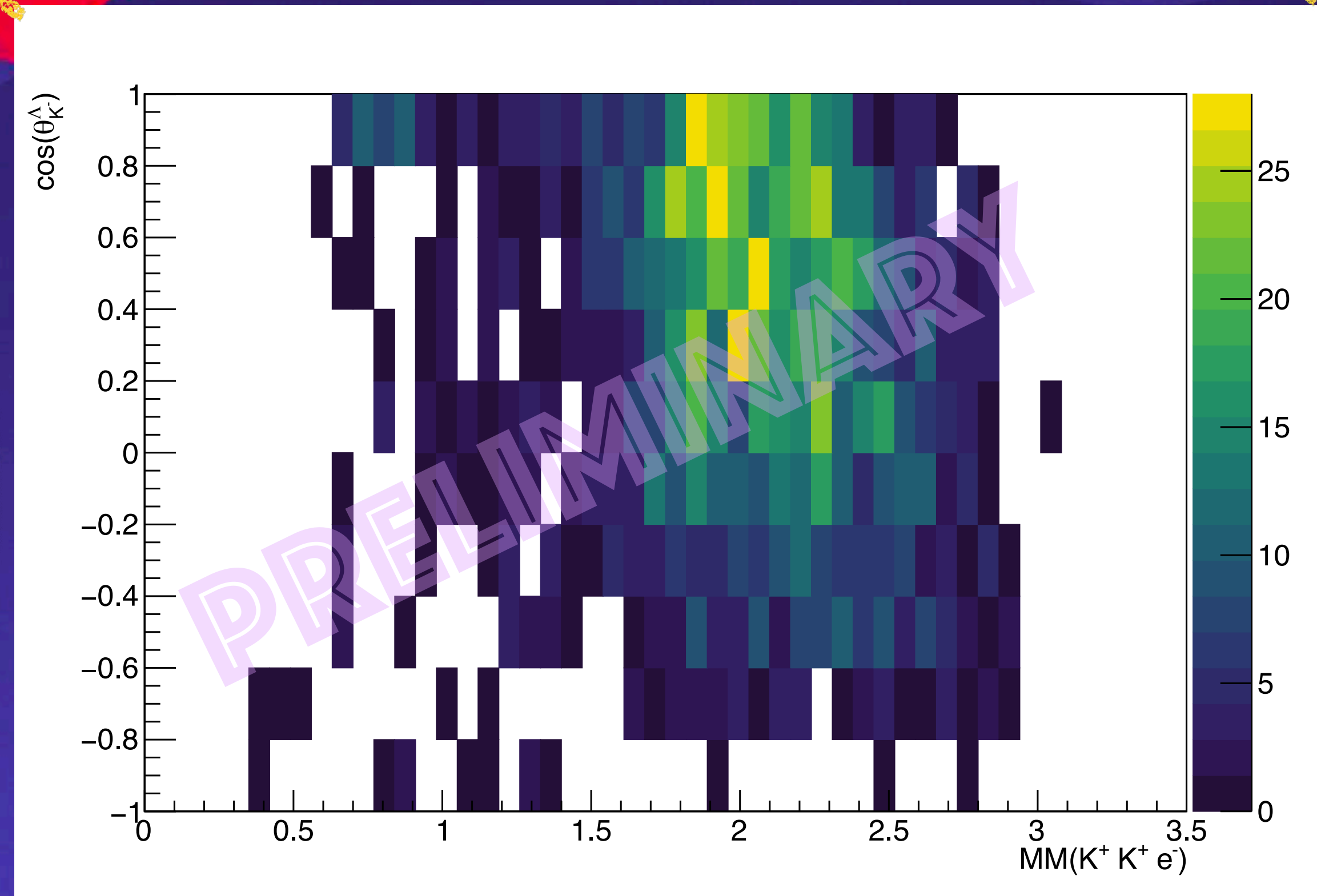
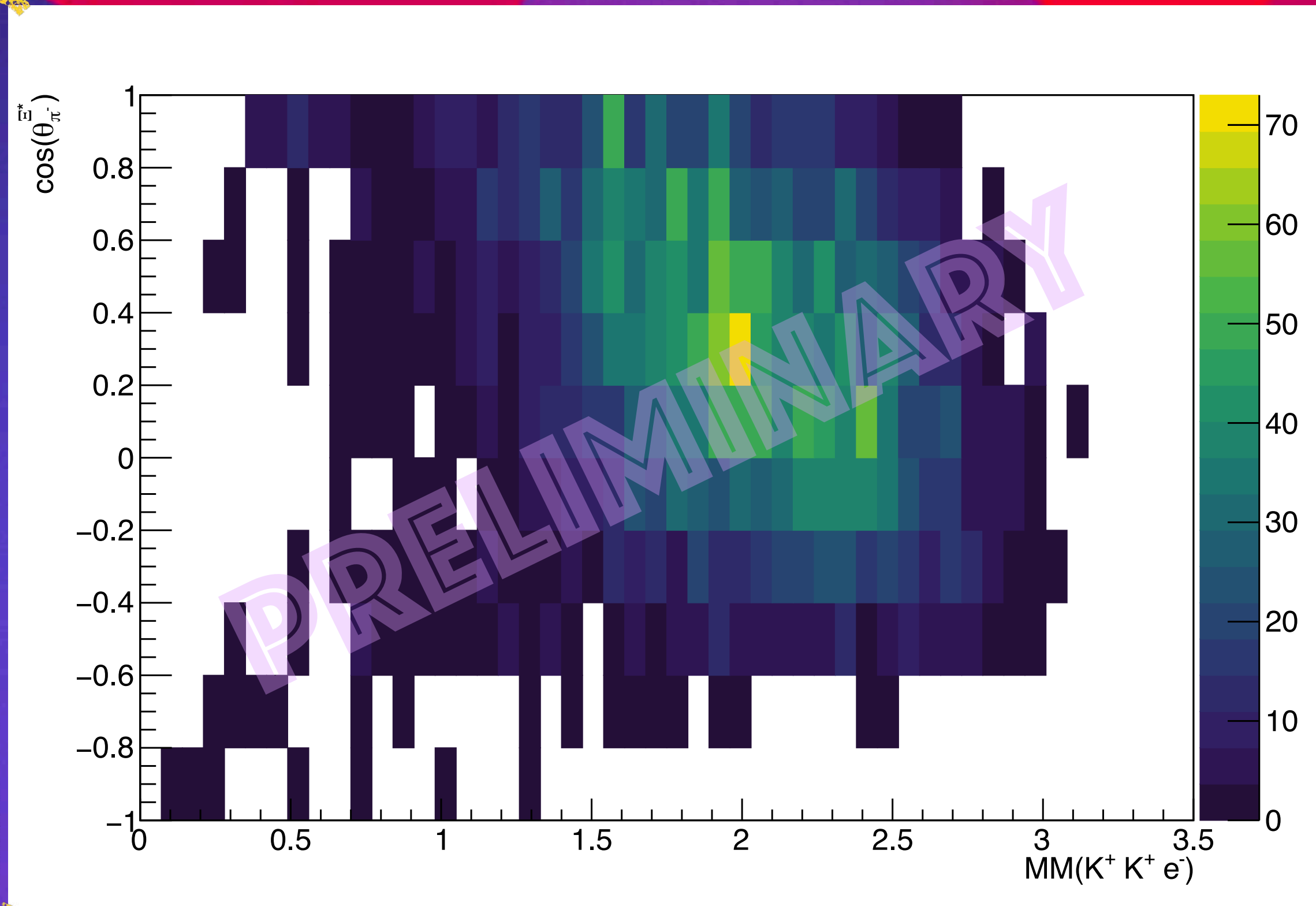
$$\vec{J} = \vec{L} + \vec{S}$$

$$J^P = (L + S_E)^{(-1)^{L+1}}$$

TOWARDS J^P ...

ANGULAR DISTRIBUTIONS

NOT
ACCEPTANCE/
EFFICIENCY
CORRECTED.

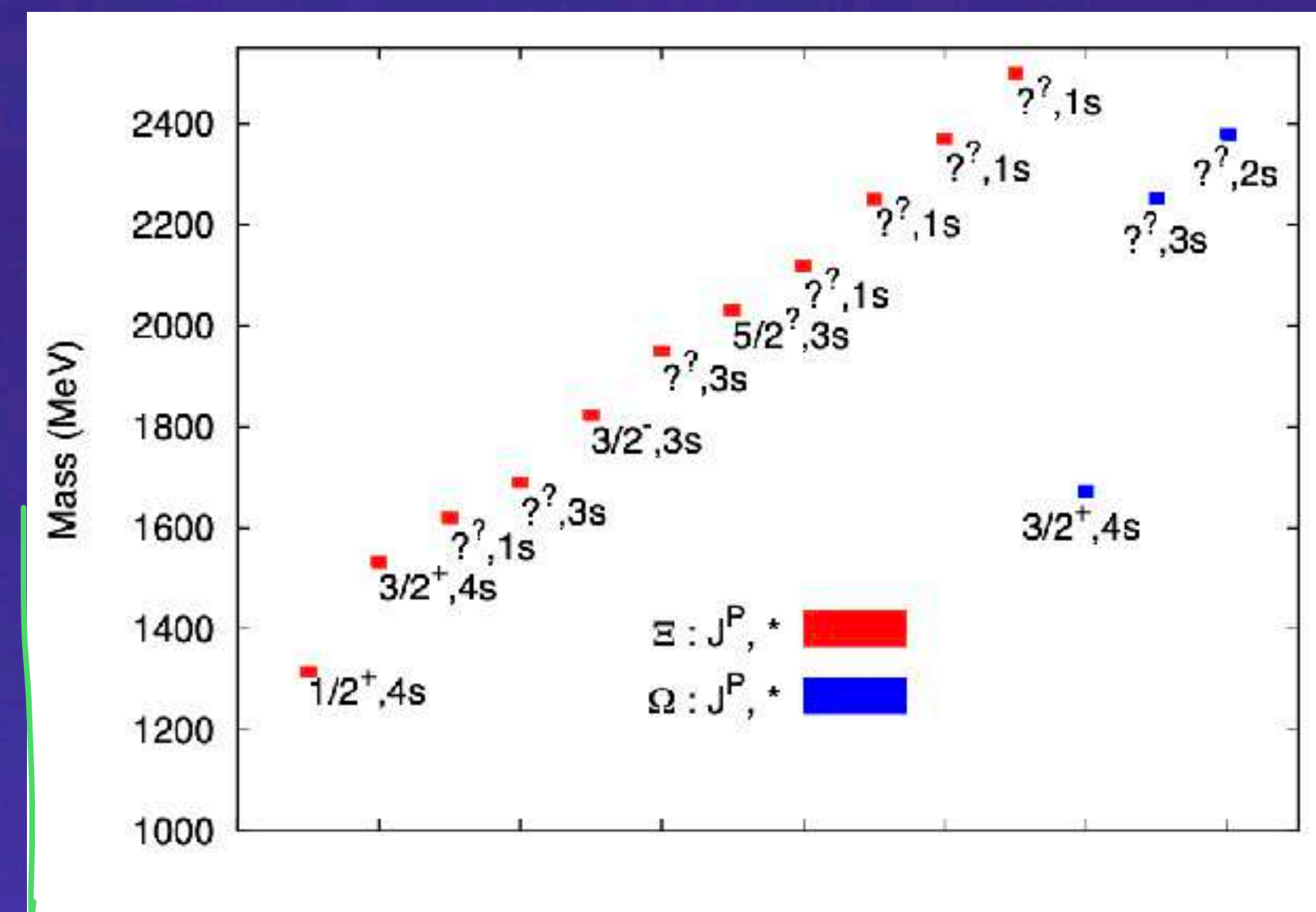
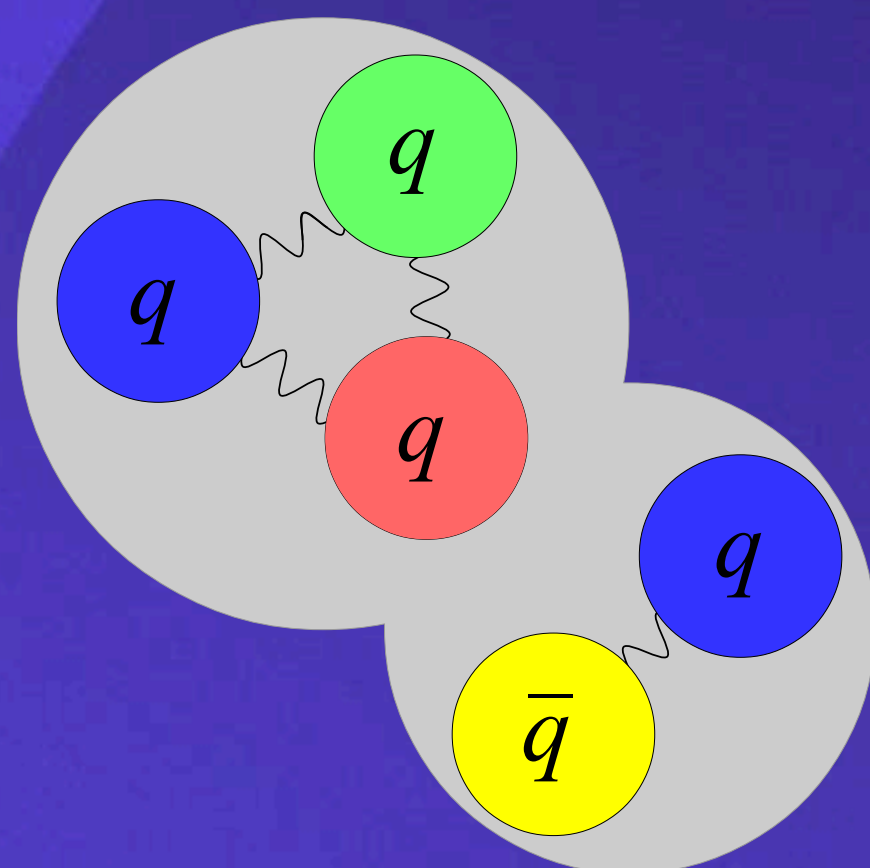
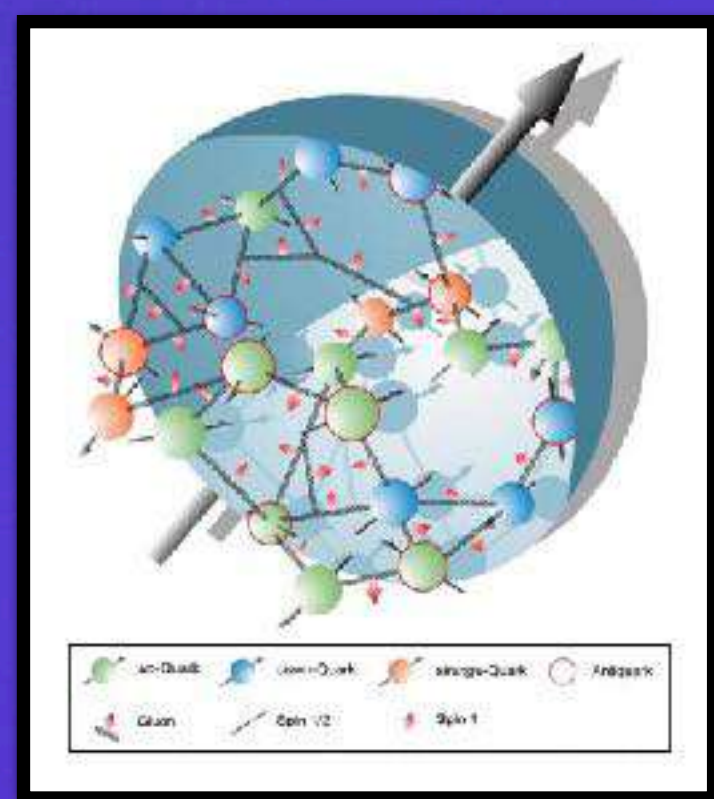


104 MeV/c²
 $-\frac{1}{3}$
 $\frac{1}{2}$ **S**
 strange

CONCLUSIONS

104 MeV/c²
 $-\frac{1}{3}$
 $\frac{1}{2}$ **S**
 strange

1. FIRST MEASUREMENT IN ELECTROPRODUCTION
2. ~6 TIMES MORE STATISTICS TO COME
3. J^P & BRANCHING RATIOS



SUPPORTED BY STFC.

Mixed Events Technique

Mixing yields from different events $\rightarrow$ uncorrelated
can model accidents $\leftarrow$

NORMAL ORDER

Event 1 $e + k_1^+ + k_2^+$

$\vdots$

Event n $e + k_1^+ + k_2^+$

SCRAMBLE ORDER OF k_2

MIXED EVENTS

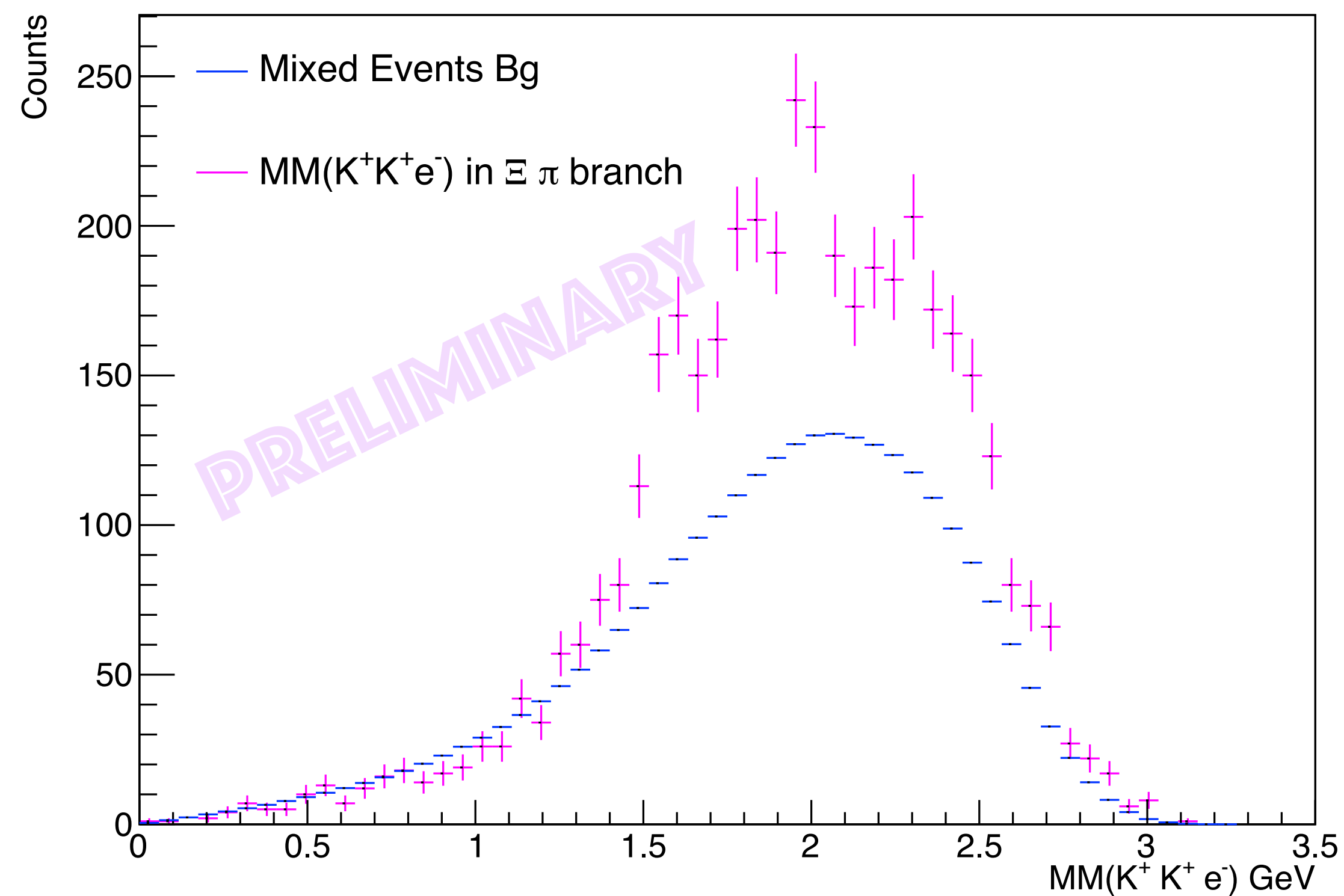
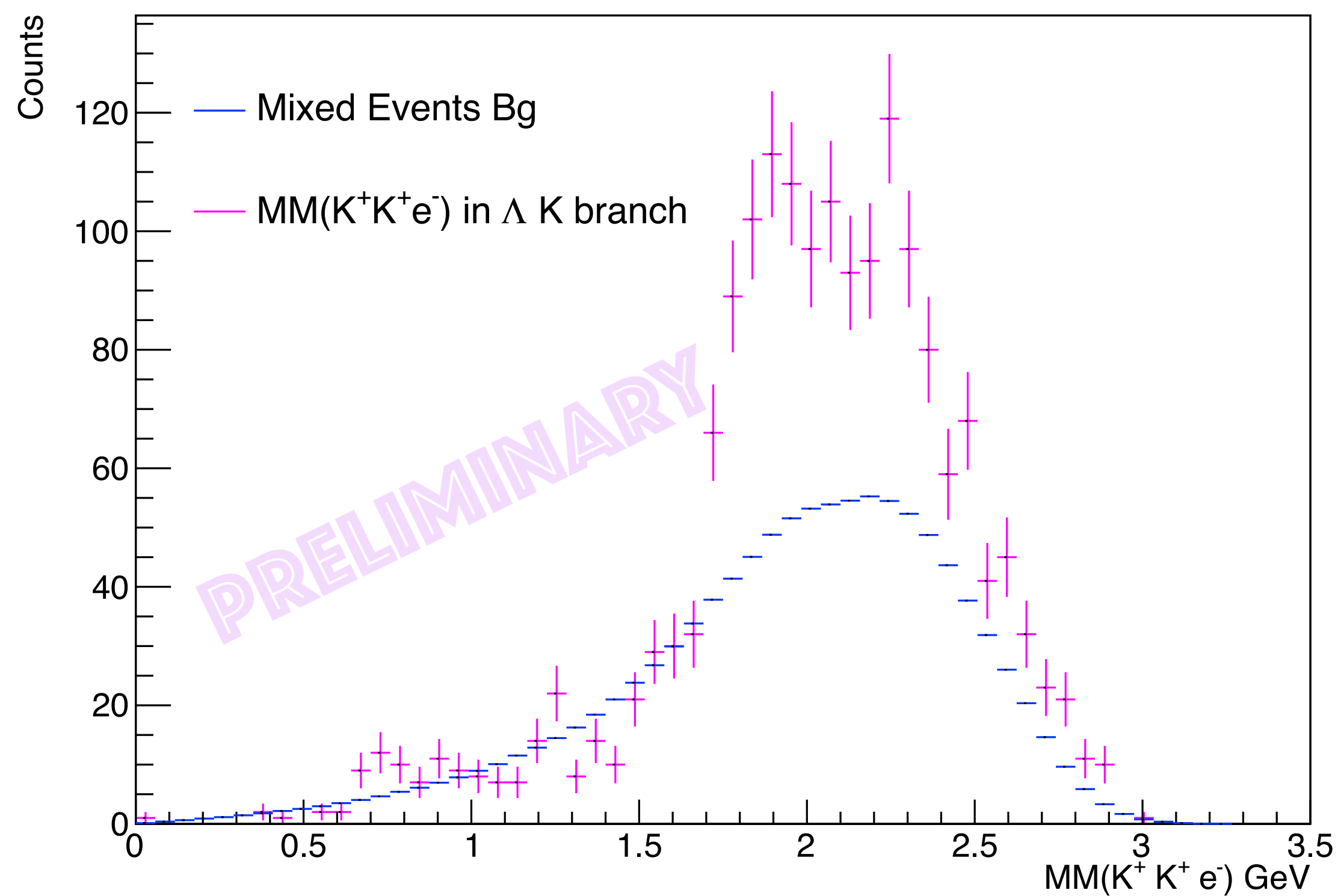
Event 1 $e + k_1^+ + \text{Event 7 } k_2^+$

Event 2 $e + k_1^+ + \text{Event 5 } k_2^+$

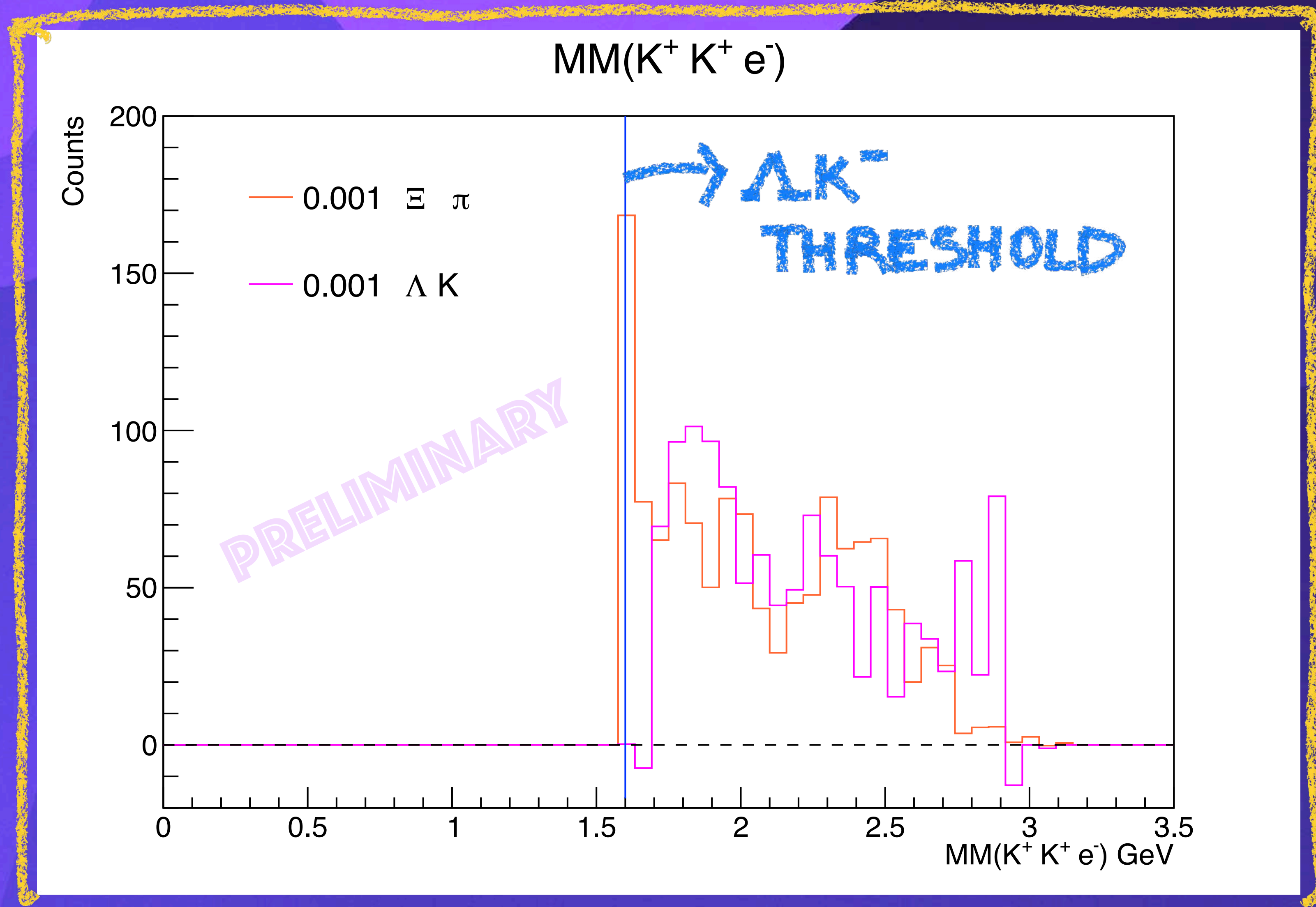
Event 3 $e + k_1^+ + \text{Event 1 } k_2^+$

$\vdots$

MIXED EVENTS BACKGROUND

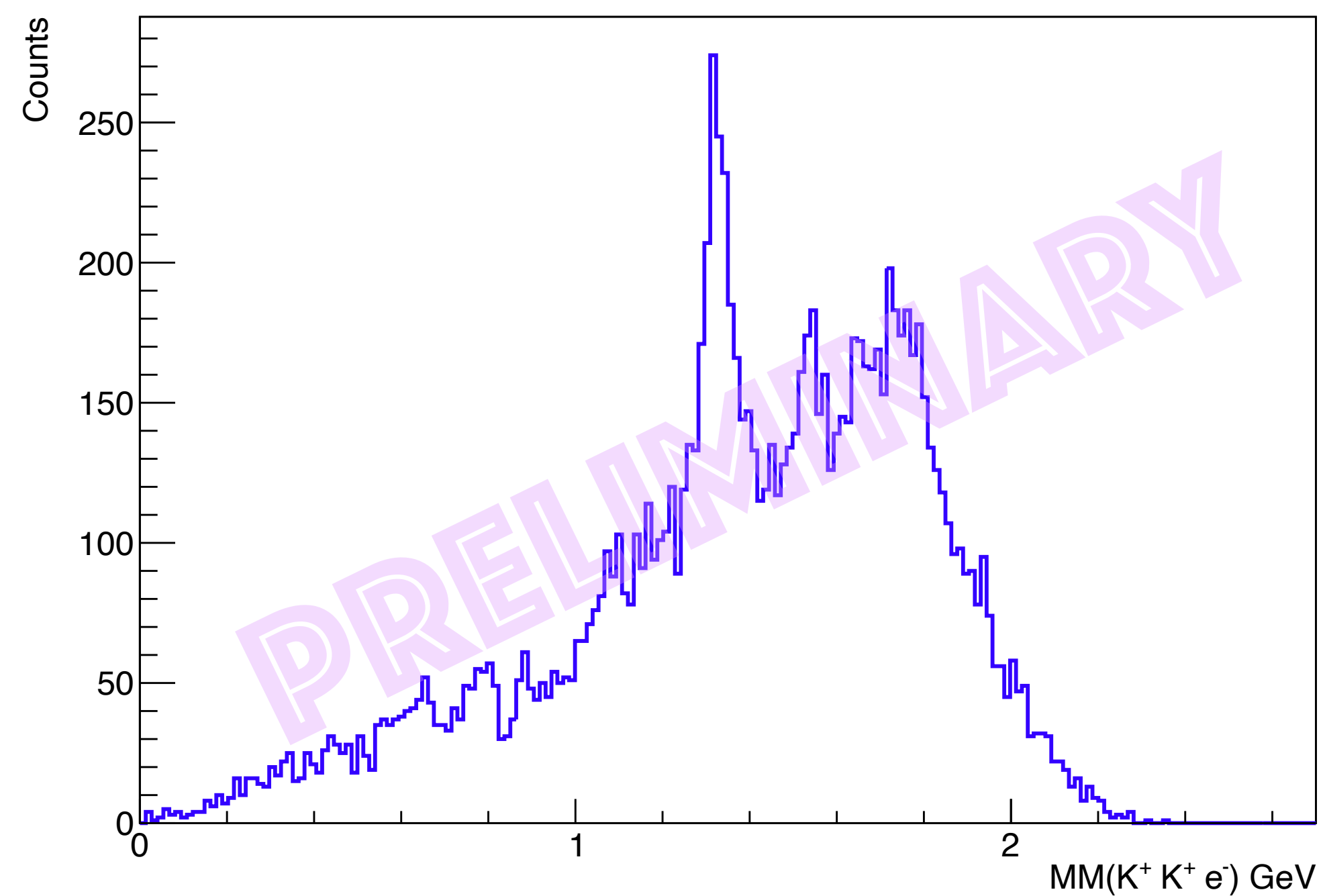


ACCEPTANCE/EFFICIENCY CORRECTED YIELDS

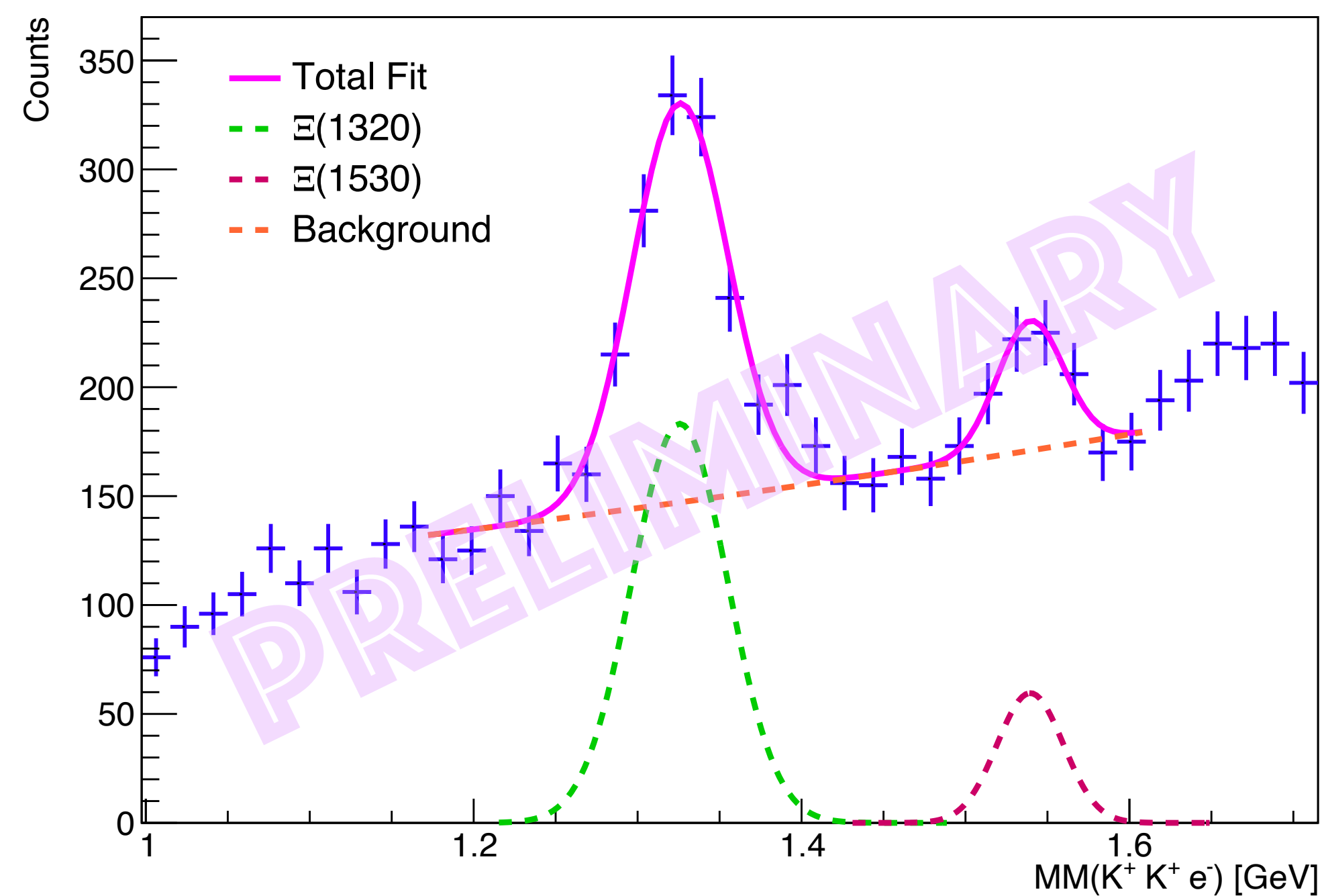


BACK=UP

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

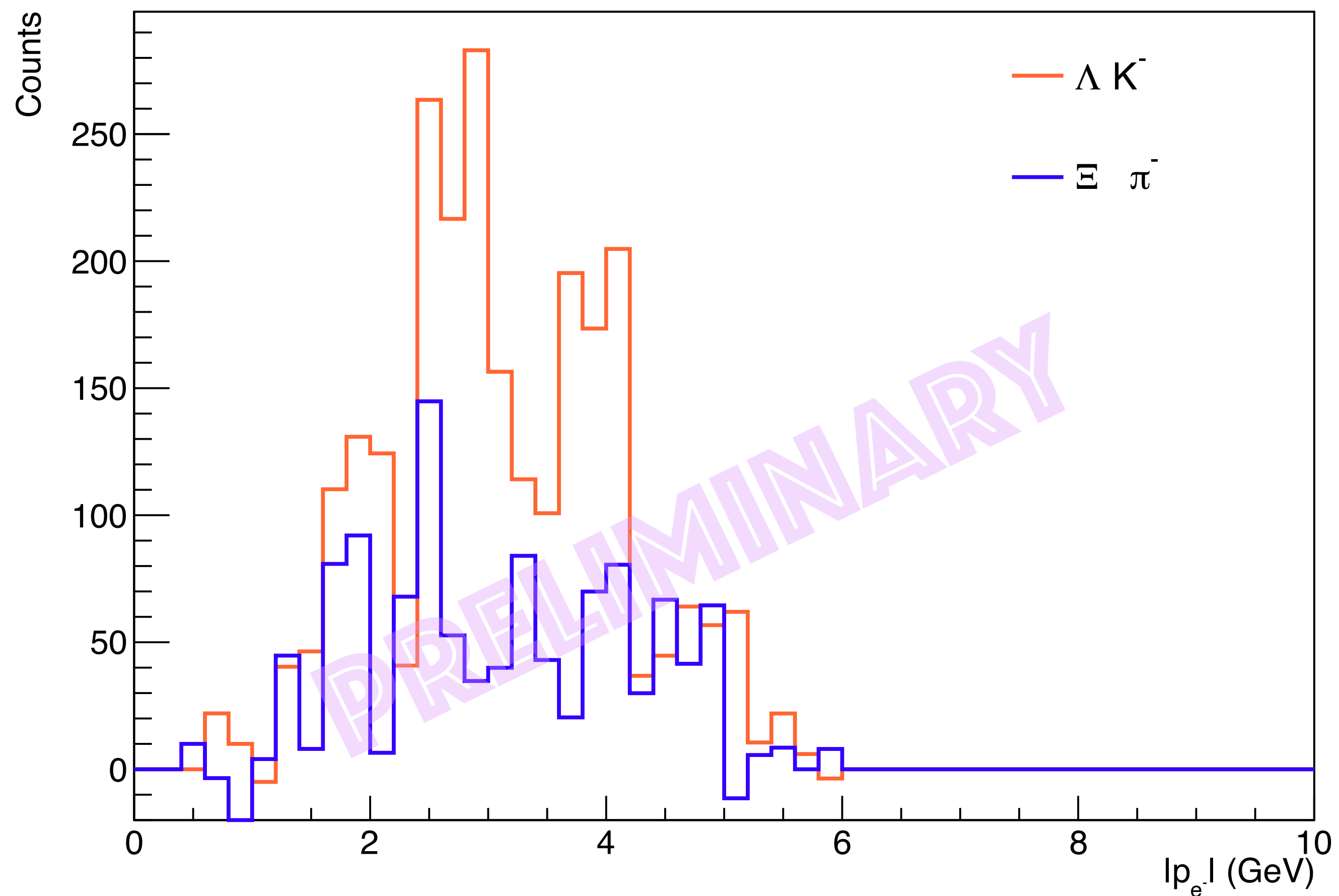


MM($K^+ K^+ e^-$)

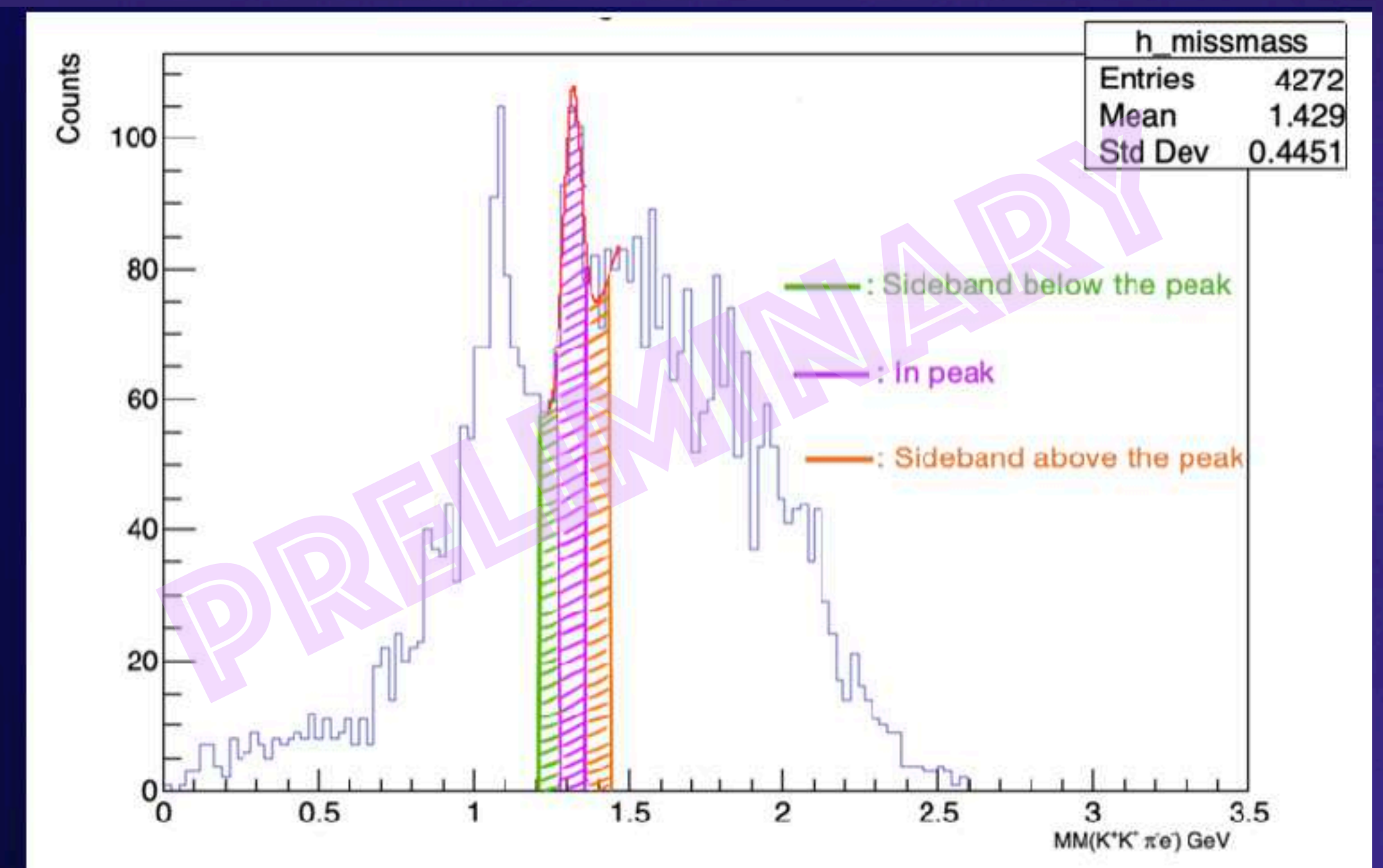
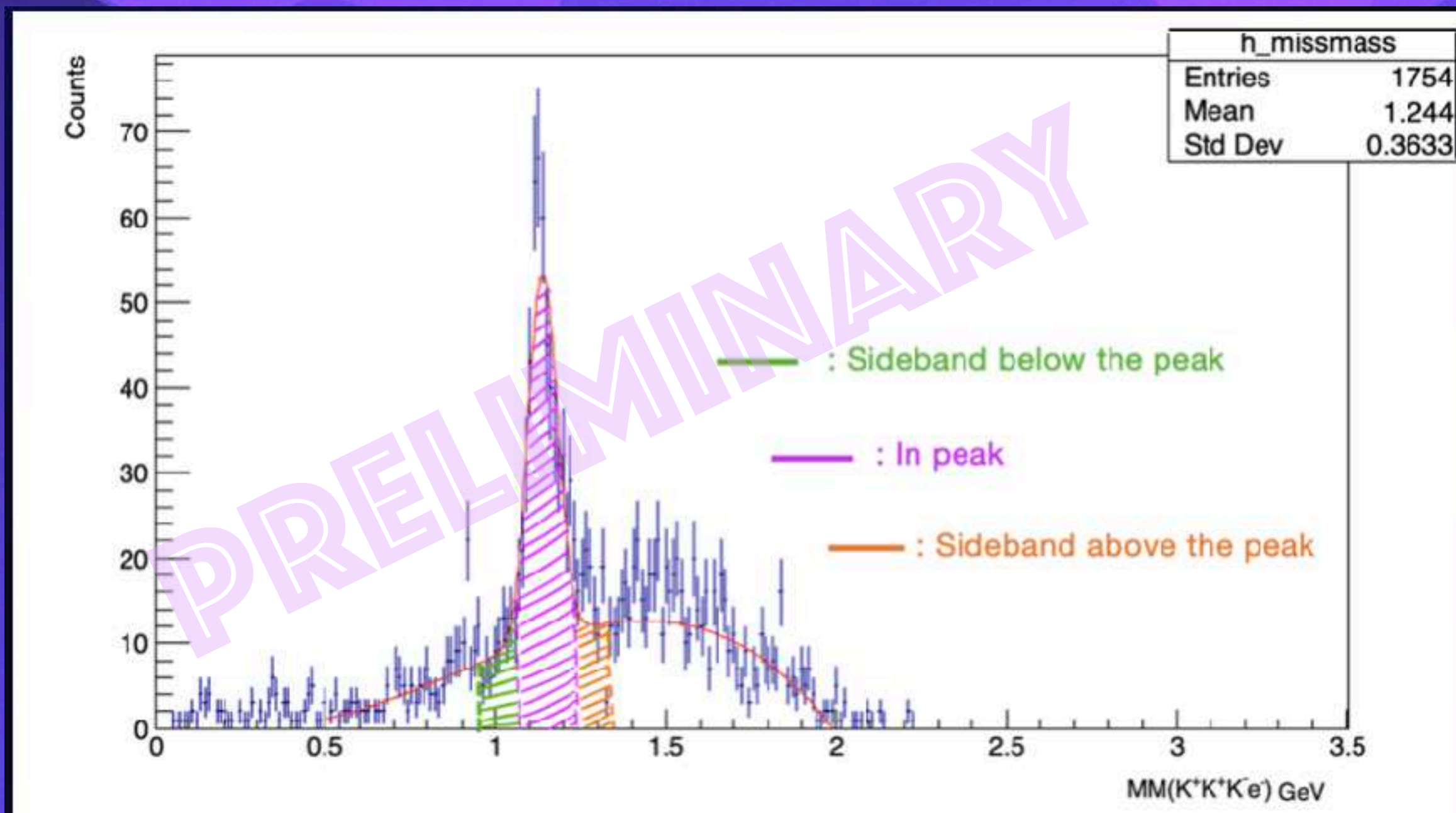


BACK=UP

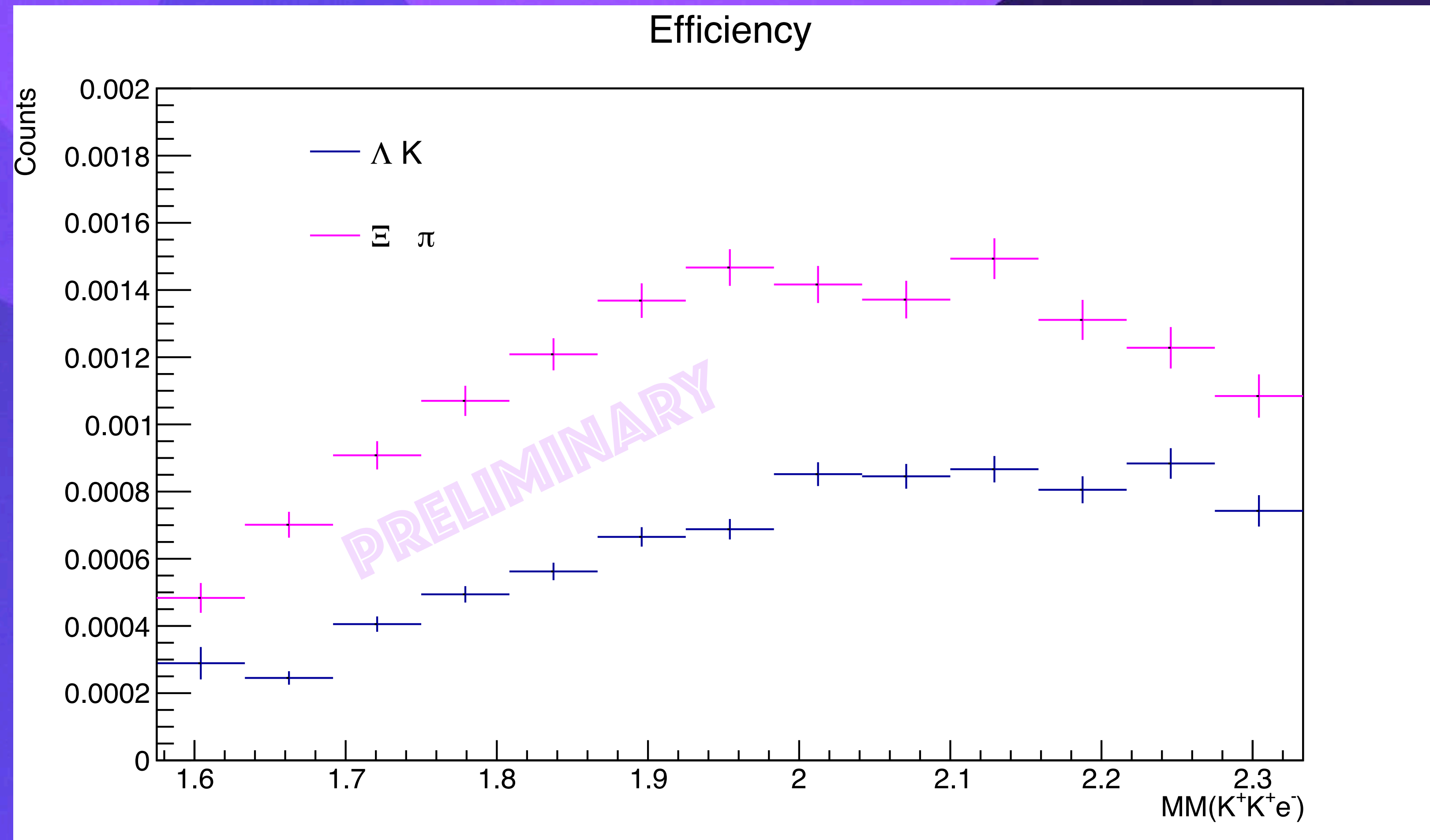
Momentum of Scattered Electron



BACK-UP



BACK-UP



BACK-UP

