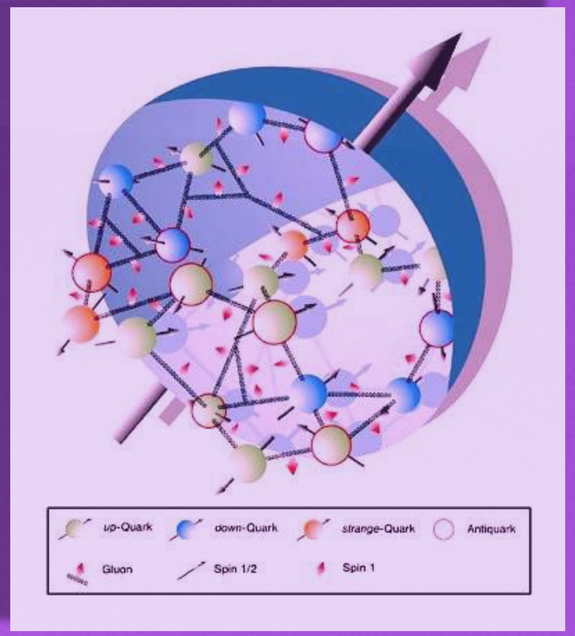
ELUCIDATING STRANGENESS with ELECTROMAGNETIC PROBES



ASLI ACAR – UNIVERSITY of YORK

QCD PUZZLES

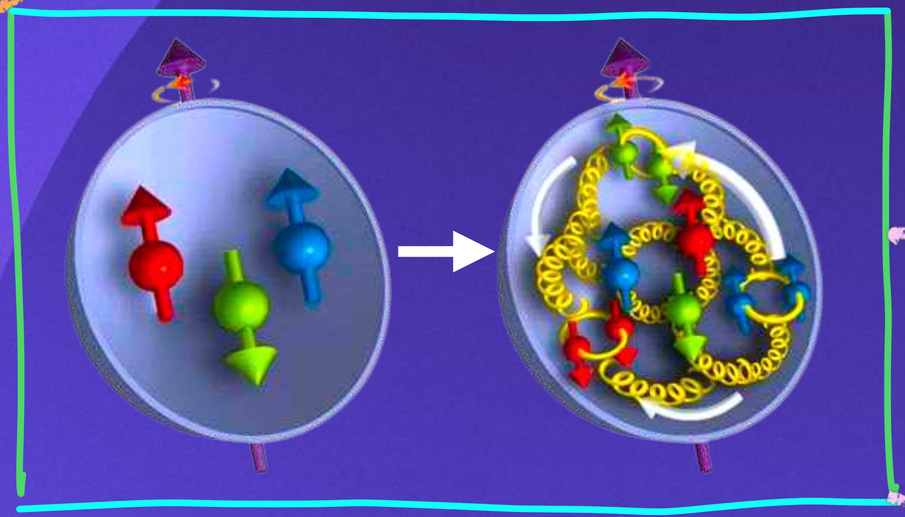
ISGUR & CAPSTICK

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

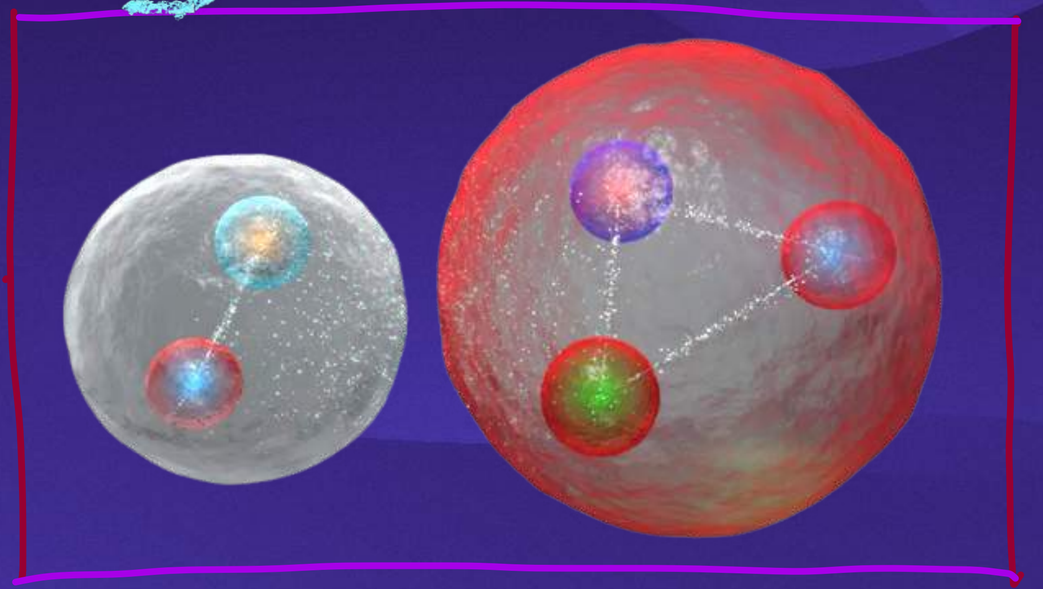
State, J^P	Predicted masses (MeV)							
$\Xi\,\frac{1}{2}^+$	1305							
$\Xi\,\frac{3}{2}^+$	1505							
$\Xi^*\,\frac{1}{2}^-$	1755	1810	1835	2225	2285	2300	2320	2380
$\Xi^*\,\frac{3}{2}^-$	1785	1880	1895	2240	2305	2330	2340	2385
$\Xi^*\,\frac{5}{2}^-$	1900	2345	2350	2385				
$\Xi^*\,\frac{1}{2}^-$	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						

44 STATES

RELATIVIZED QUARK MODEL

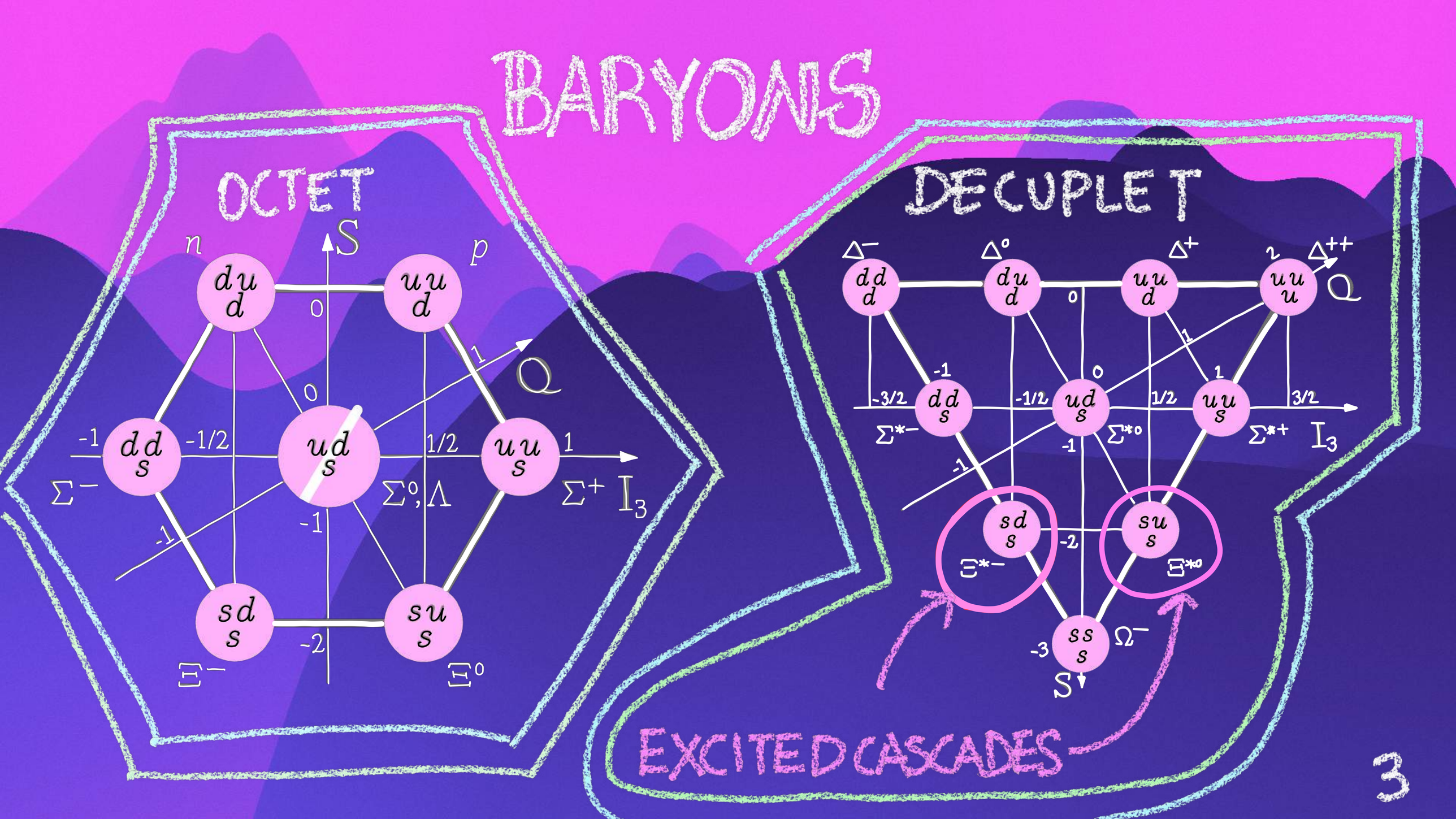


MESON-BARYON MOLECULES



DO WE UNDERSTAND BARYONS?

BARYONS


OCTET
n
p
S
Q
I3
Σ⁻
Σ⁰,Λ
Σ⁺
Ξ⁻
Ξ⁰
DECUPLET
Δ⁻
Δ⁰
Δ⁺
Δ⁺⁺
Σ*⁻
Σ*⁰
Σ*⁺
Ξ*⁻
Ξ*⁰
Ω⁻
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

NOW

1981

6 EXCITED STATES IN PDG

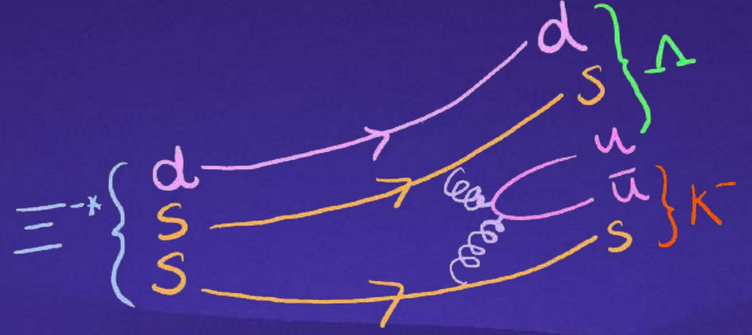
NOT MUCH PROGRESS IN PAST 4 DECADES

MISSING J^P and BRANCHING RATIOS

Ξ(1690) $I(J^P) = \frac{1}{2}(?^?)$

Mass $m = 1690 \pm 10$ MeV [c]
Full width $\Gamma < 30$ MeV

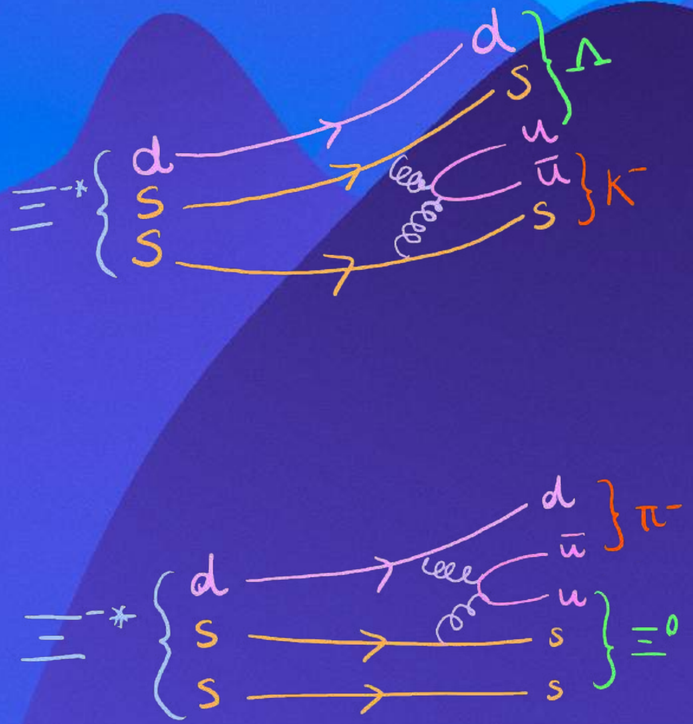
Ξ(1690) DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Lambda\overline{K}$	seen	240
$\Sigma\overline{K}$	seen	70
$\Xi\pi$	seen	311
$\Xi^-\pi^+\pi^-$	possibly seen	213



POSSIBLE DECAY MODES

THEORETICAL MODELS

3q STATE

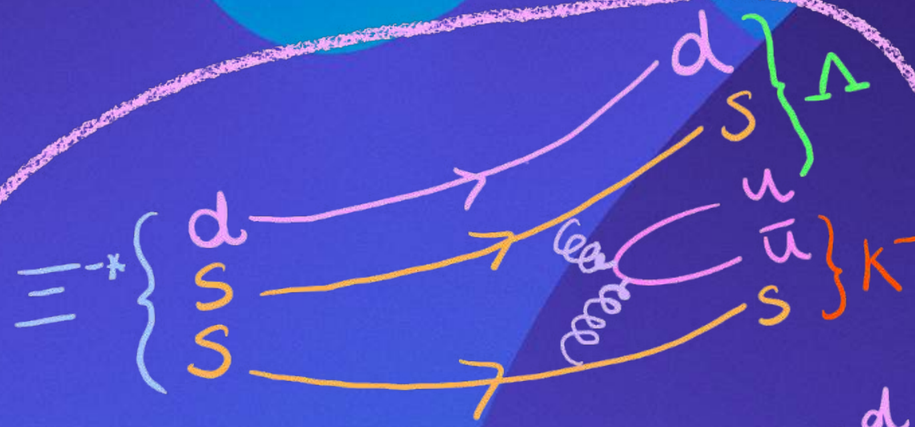


MOLECULAR

SU(3) CLEBSH-GORDAN

FROM DECUPLET

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



TWO OF THE POSSIBLE CHANNELS

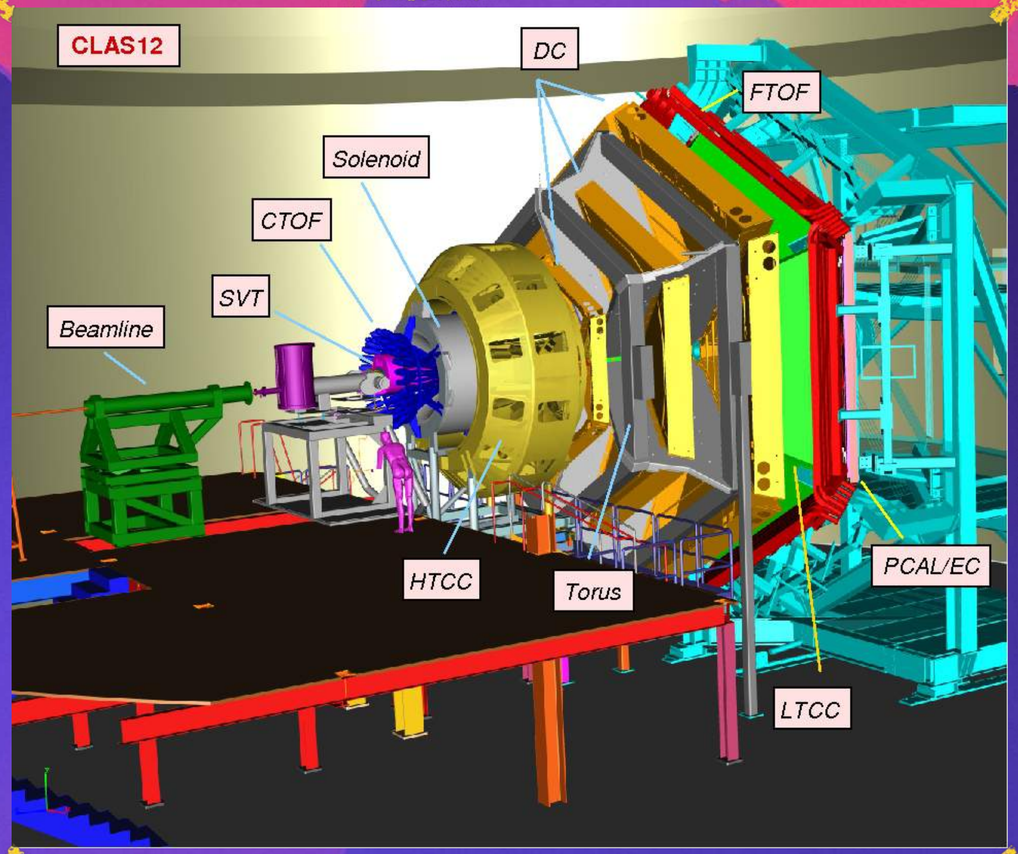
FROM OCTET

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

ALL CHANNELS POSSIBLE!

JEFFERSON LAB

CLAS12

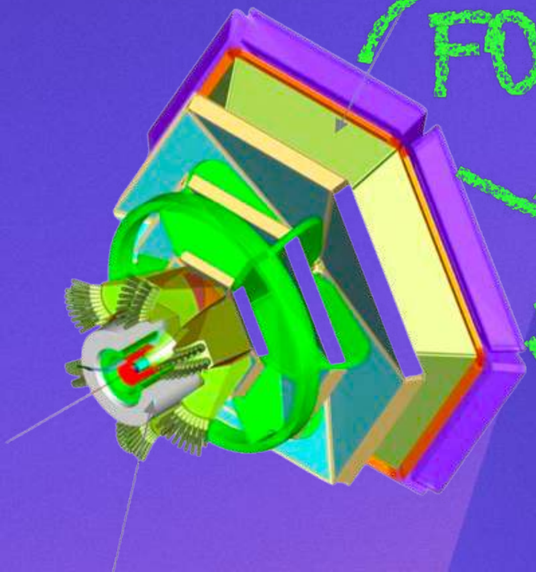

CLAS12
DC
FTOF
Solenoid
CTOF
SVT
Beamline
HTCC
Torus
PCAL/EC
LTCC

DETECTORS

FORWARD TAGGER

- $2.5^\circ < \theta < 4.5^\circ$
- Low Q^2
- calorimeter

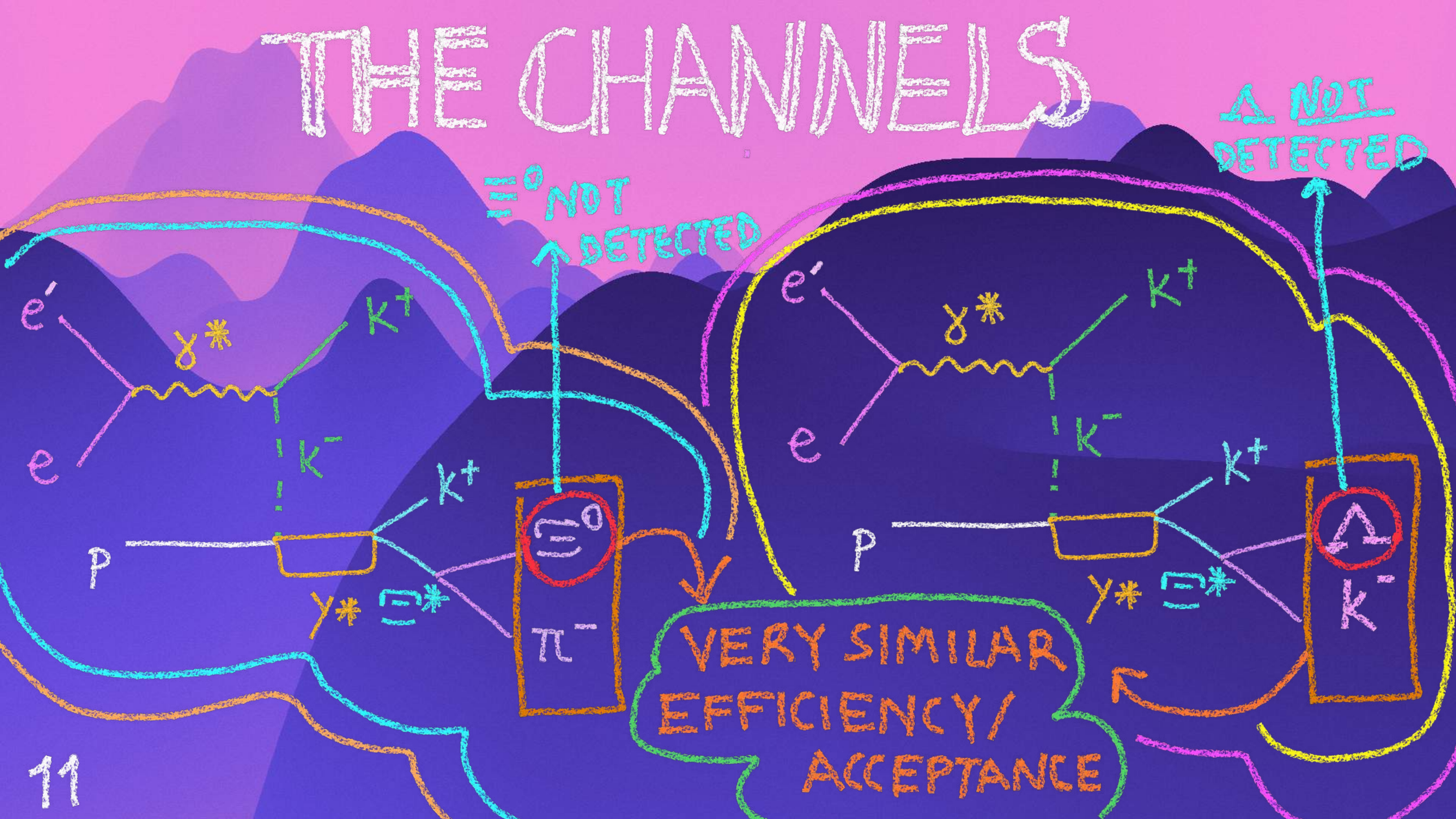
FORWARD DETECTOR



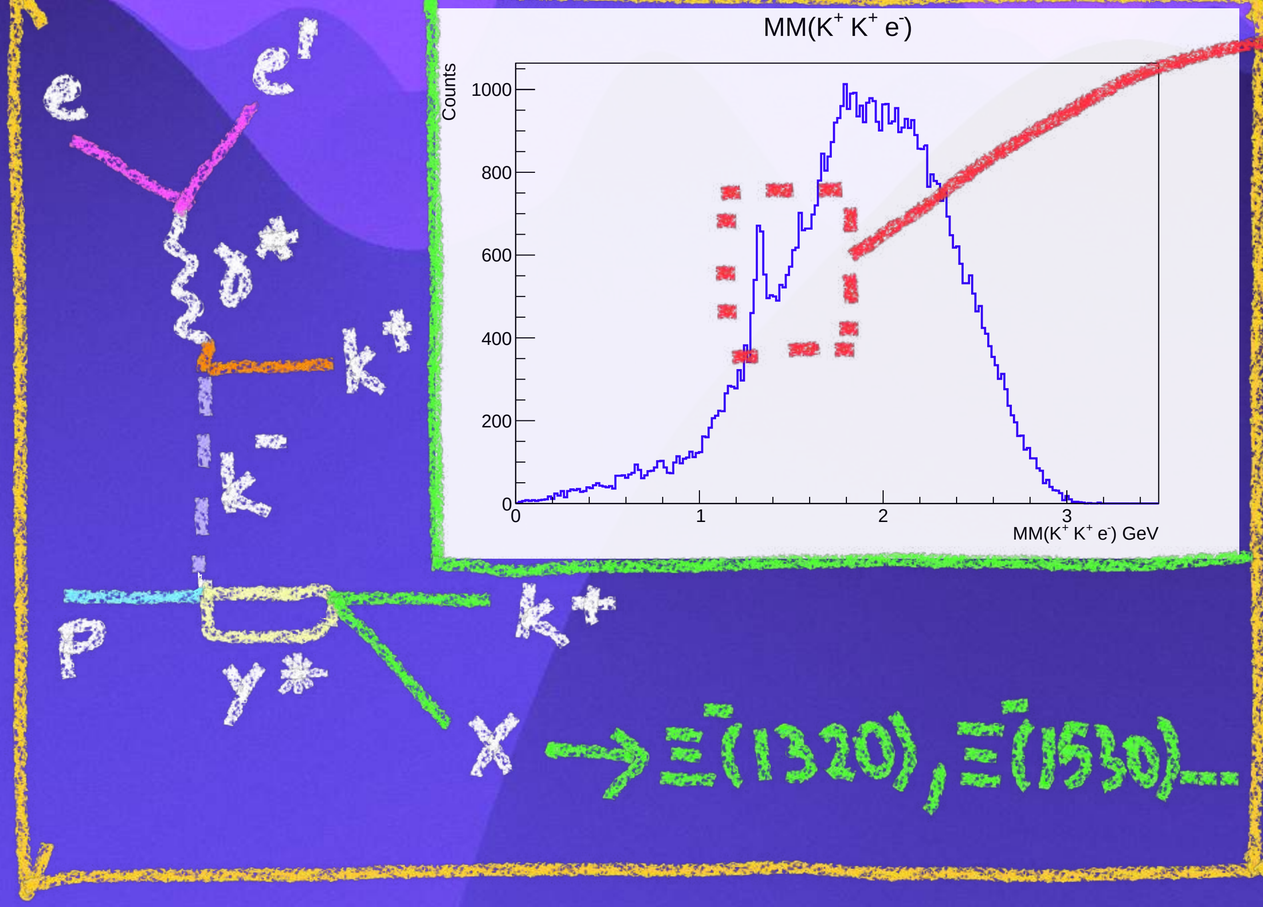
- $5^\circ < \theta < 35^\circ$
- High Q^2
- magnetic spectroscopy

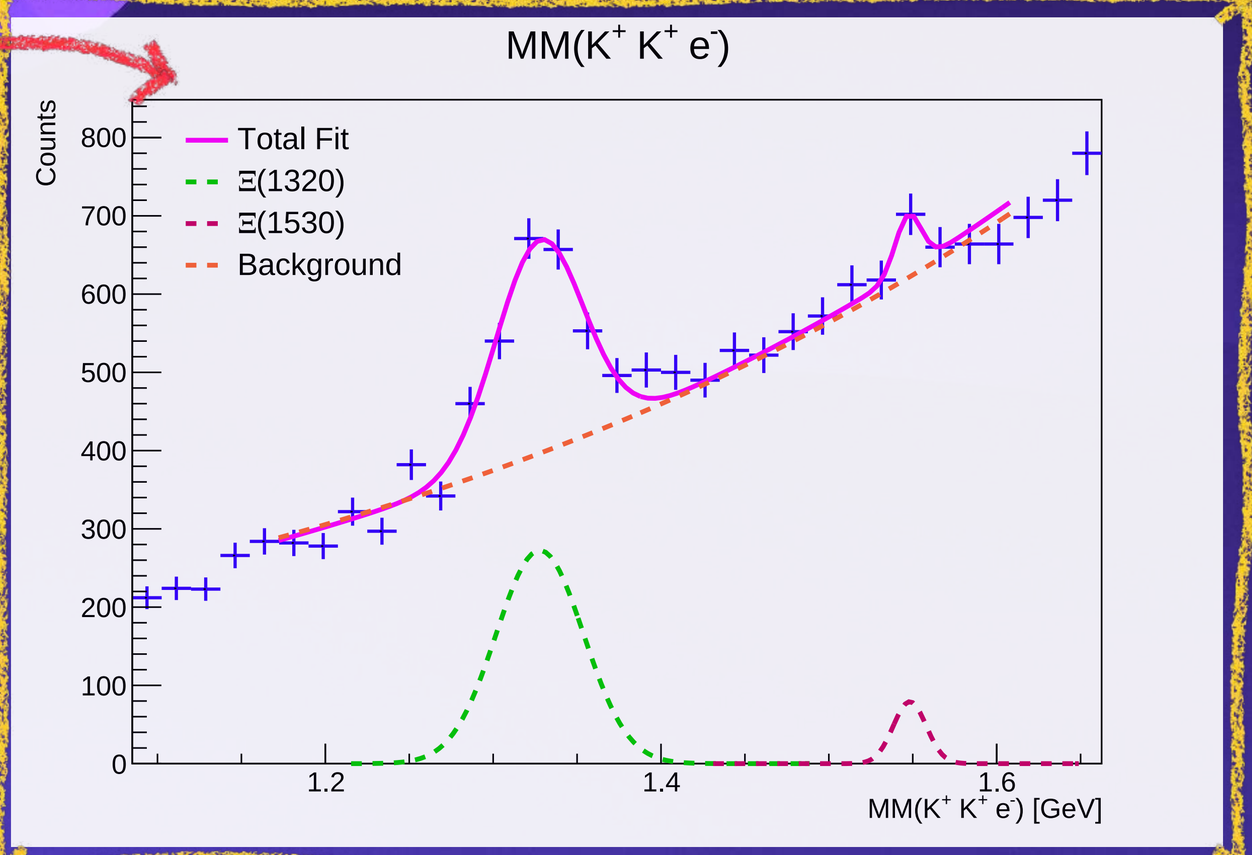
PARTICLE IDENTIFICATION

THE CHANNELS



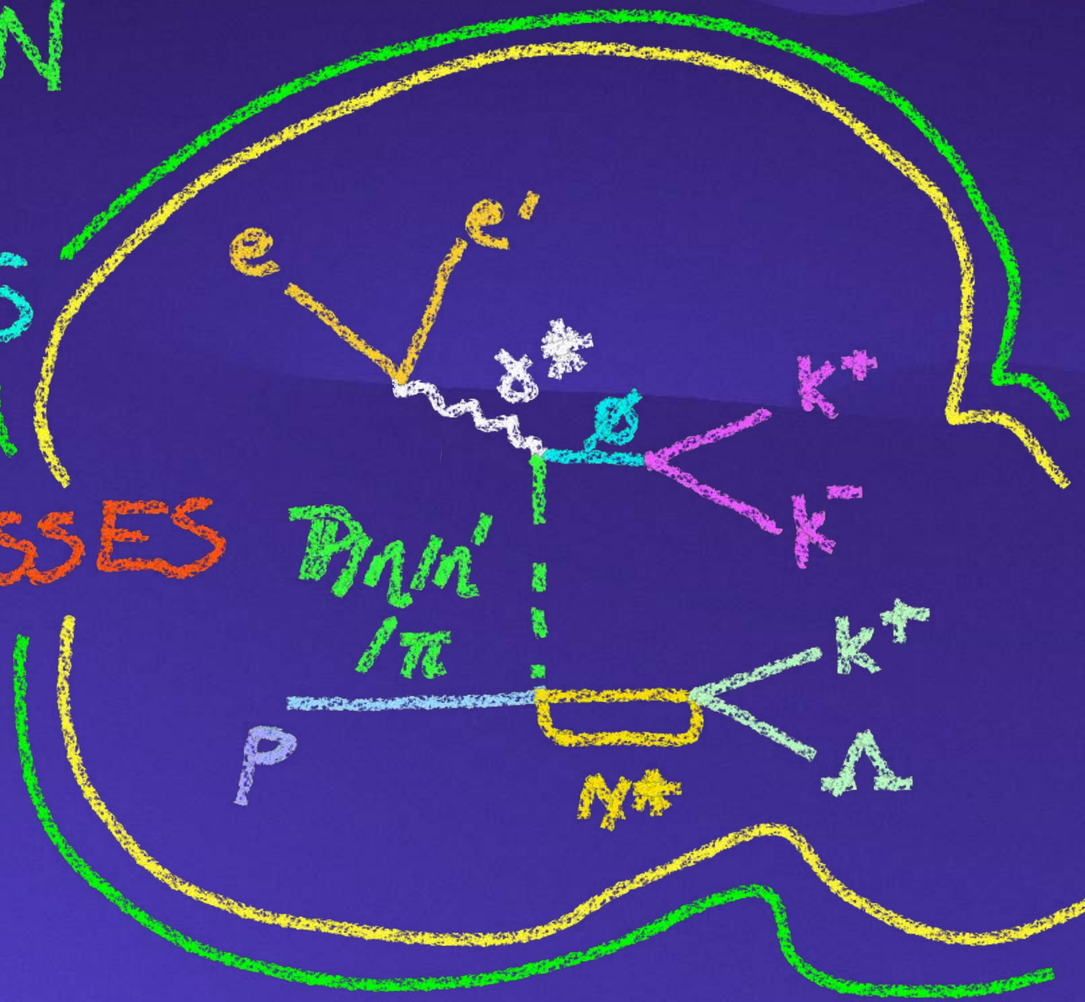
FORWARD DETECTOR



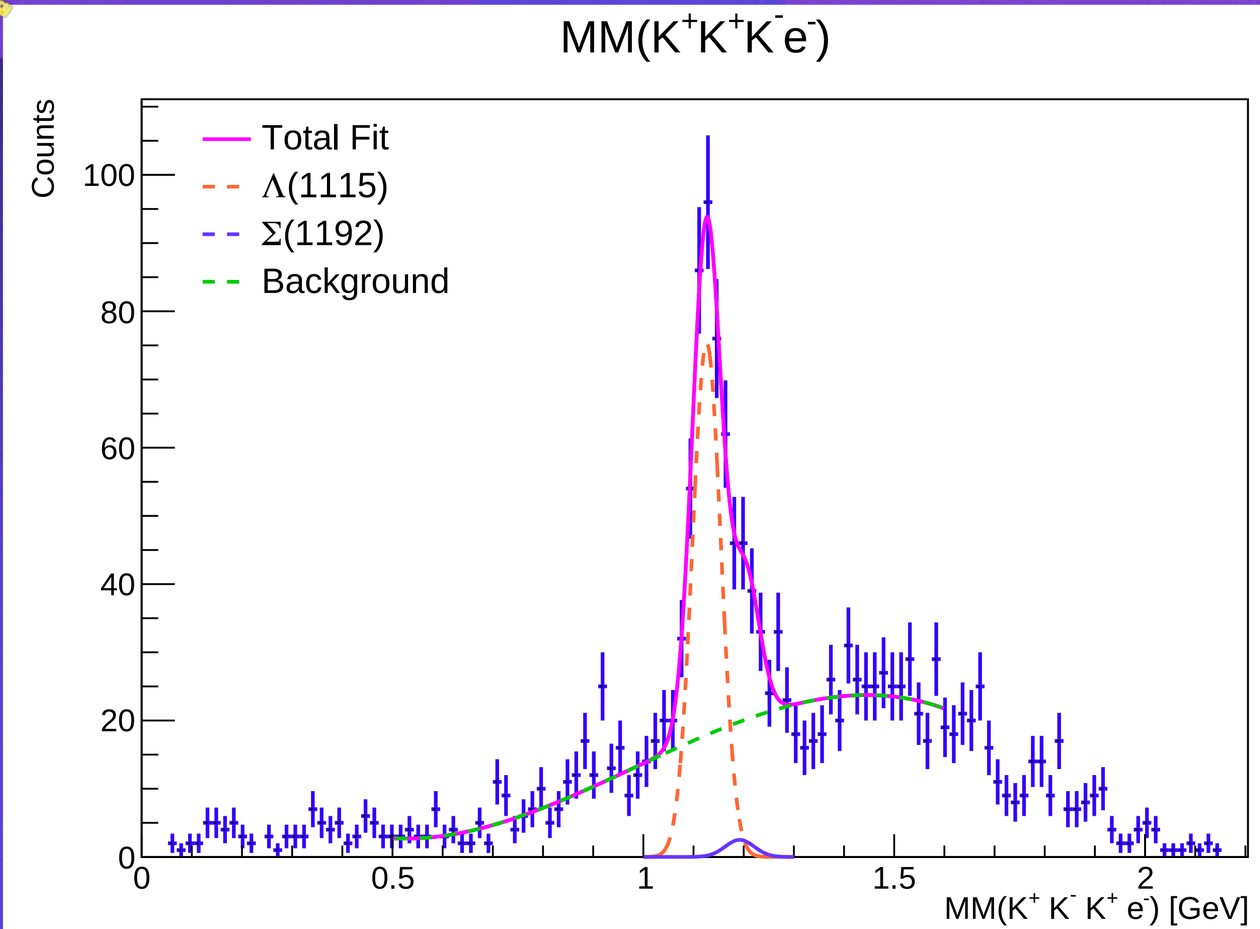


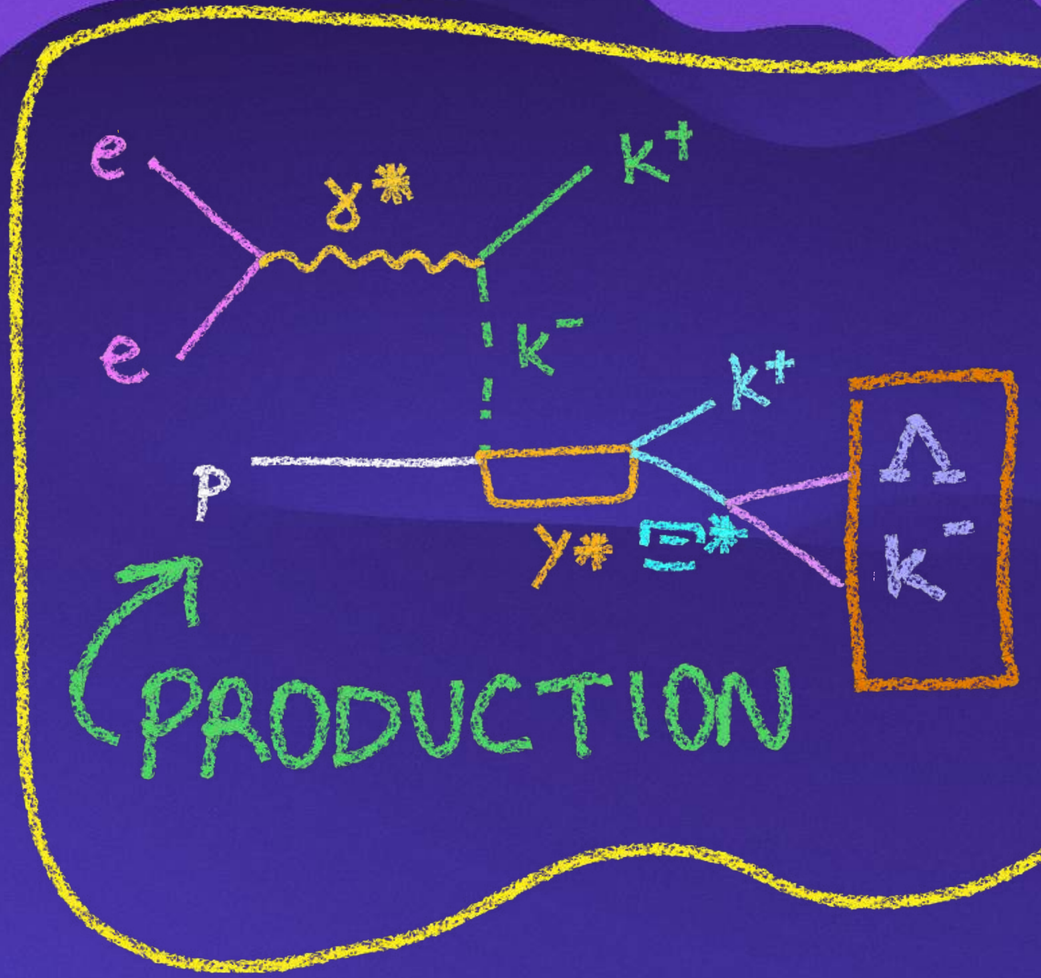
BACKGROUND

1. K/π MISIDENTIFICATION
2. OUT OF TIME PARTICLES
3. OTHER PHYSICAL PROCESSES

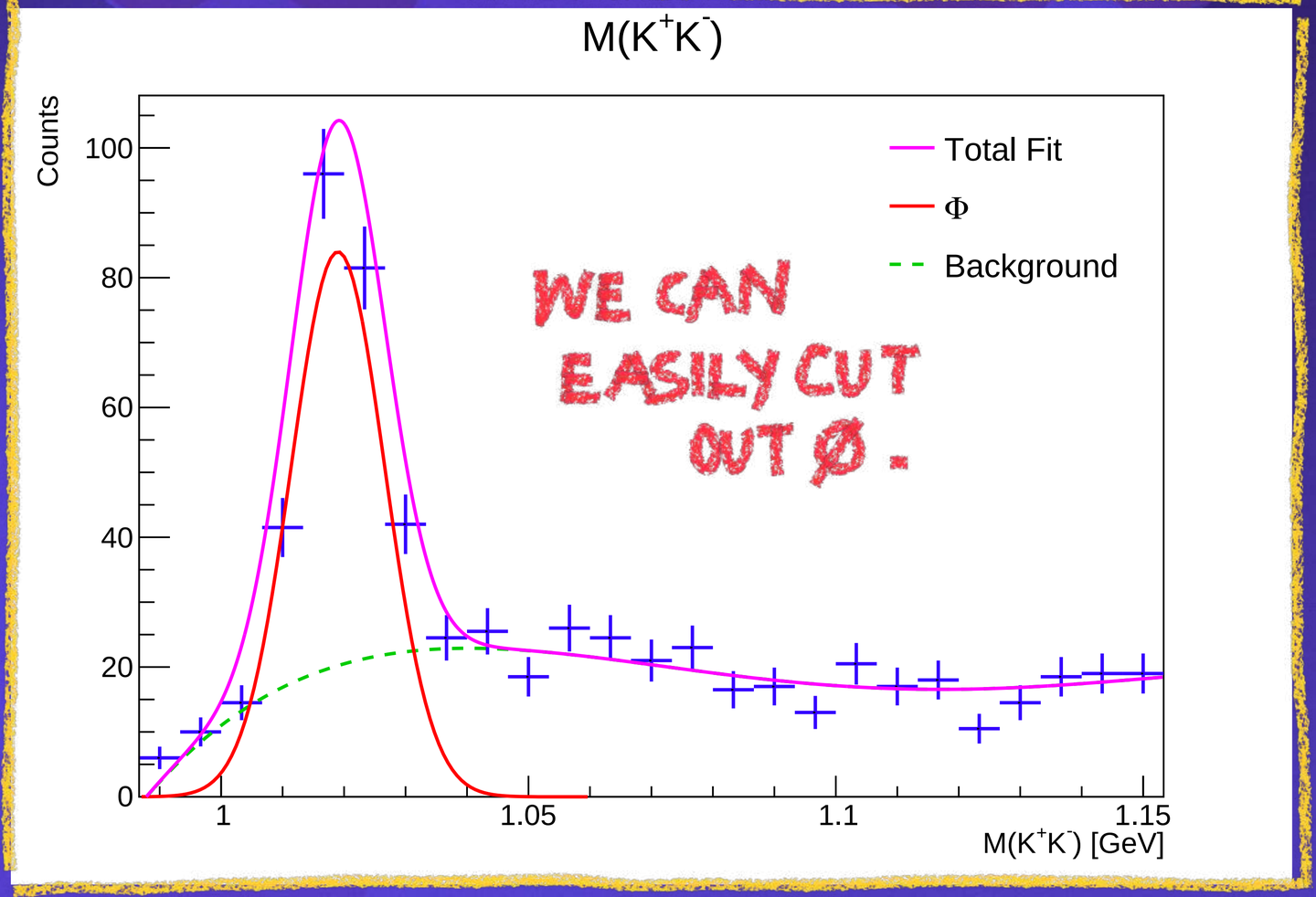


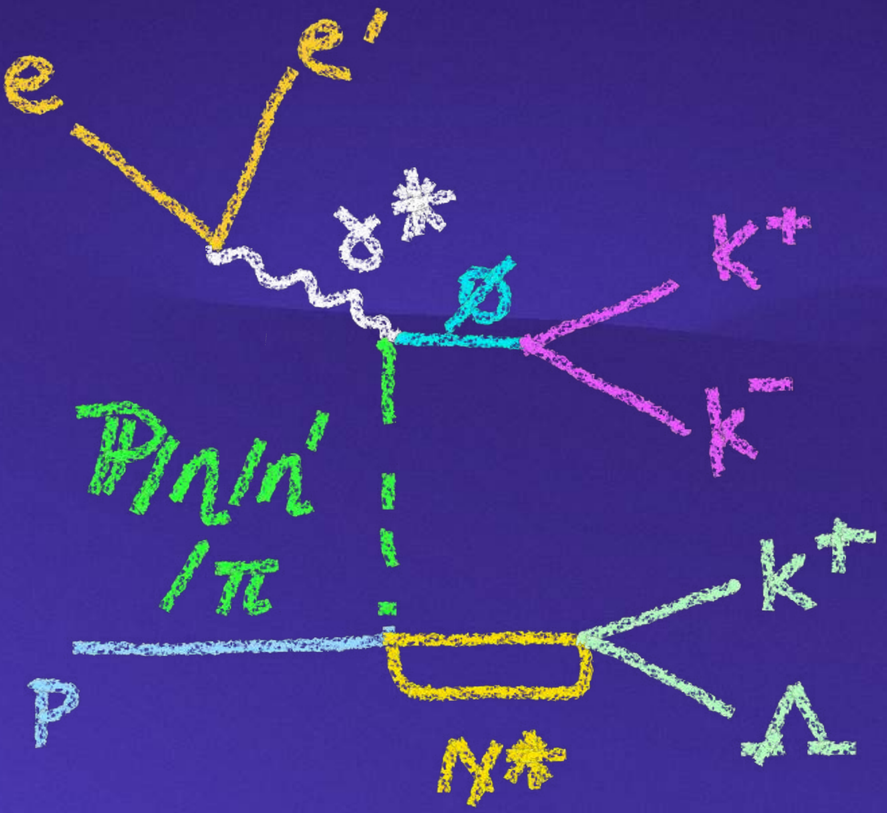
$K^+K^+K^-\Lambda$ CHANNEL



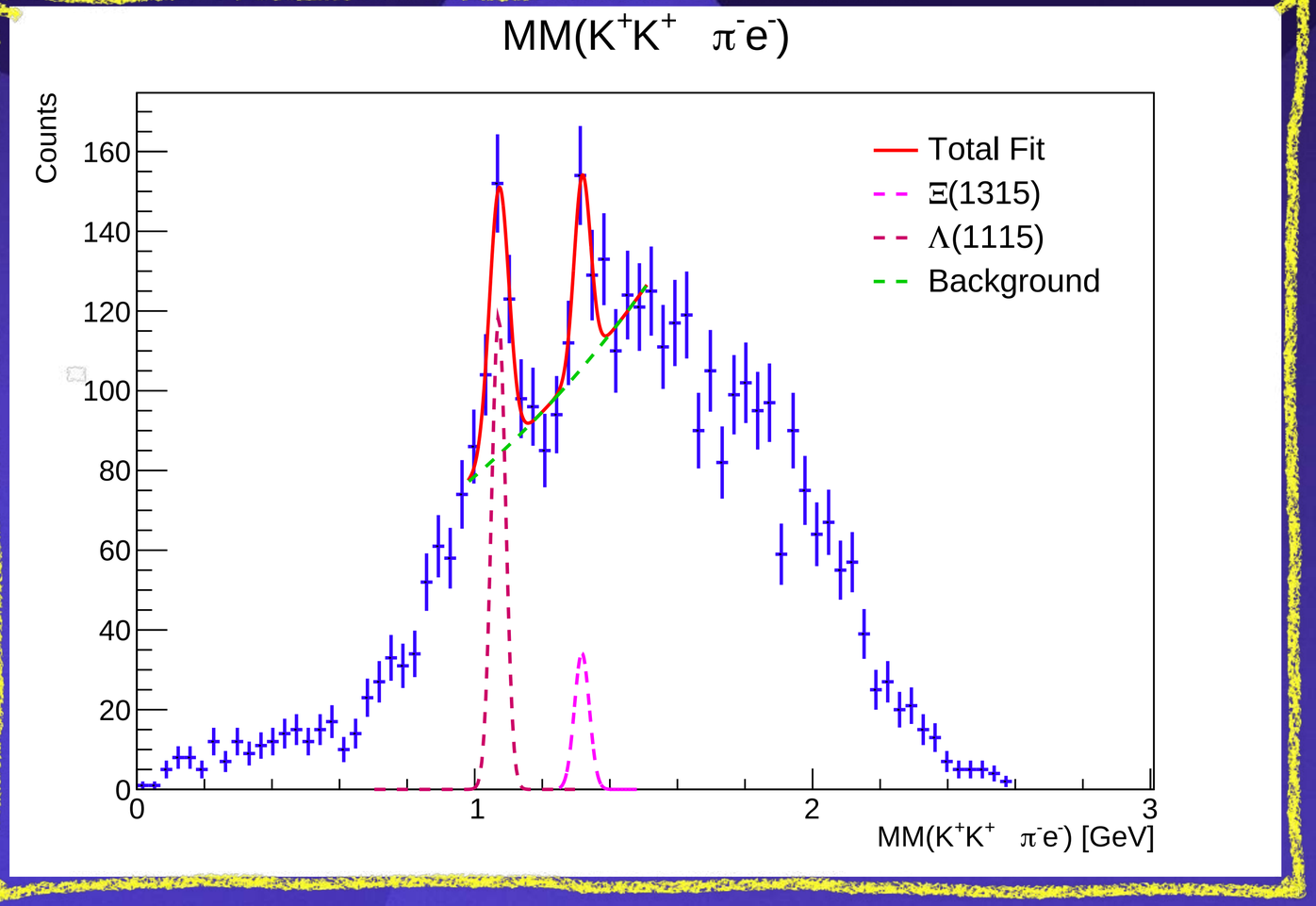


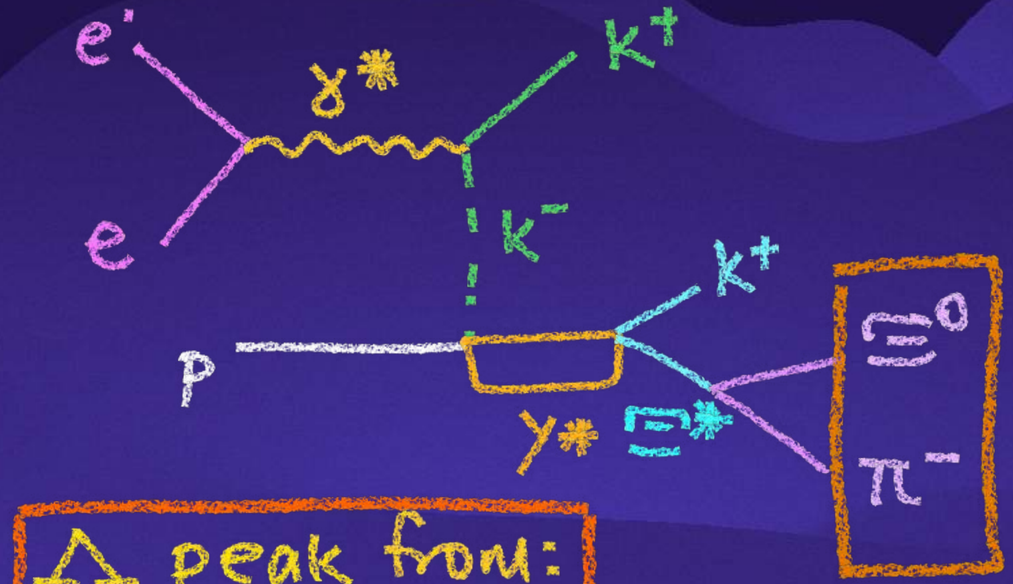
BACKGROUND RECONSTRUCTION



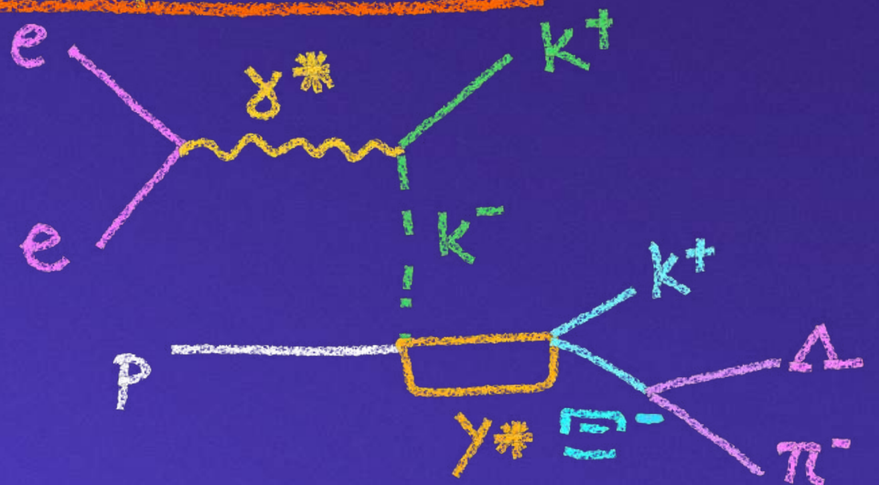


$K^+K^+\Xi^0\pi^-$ CHANNEL

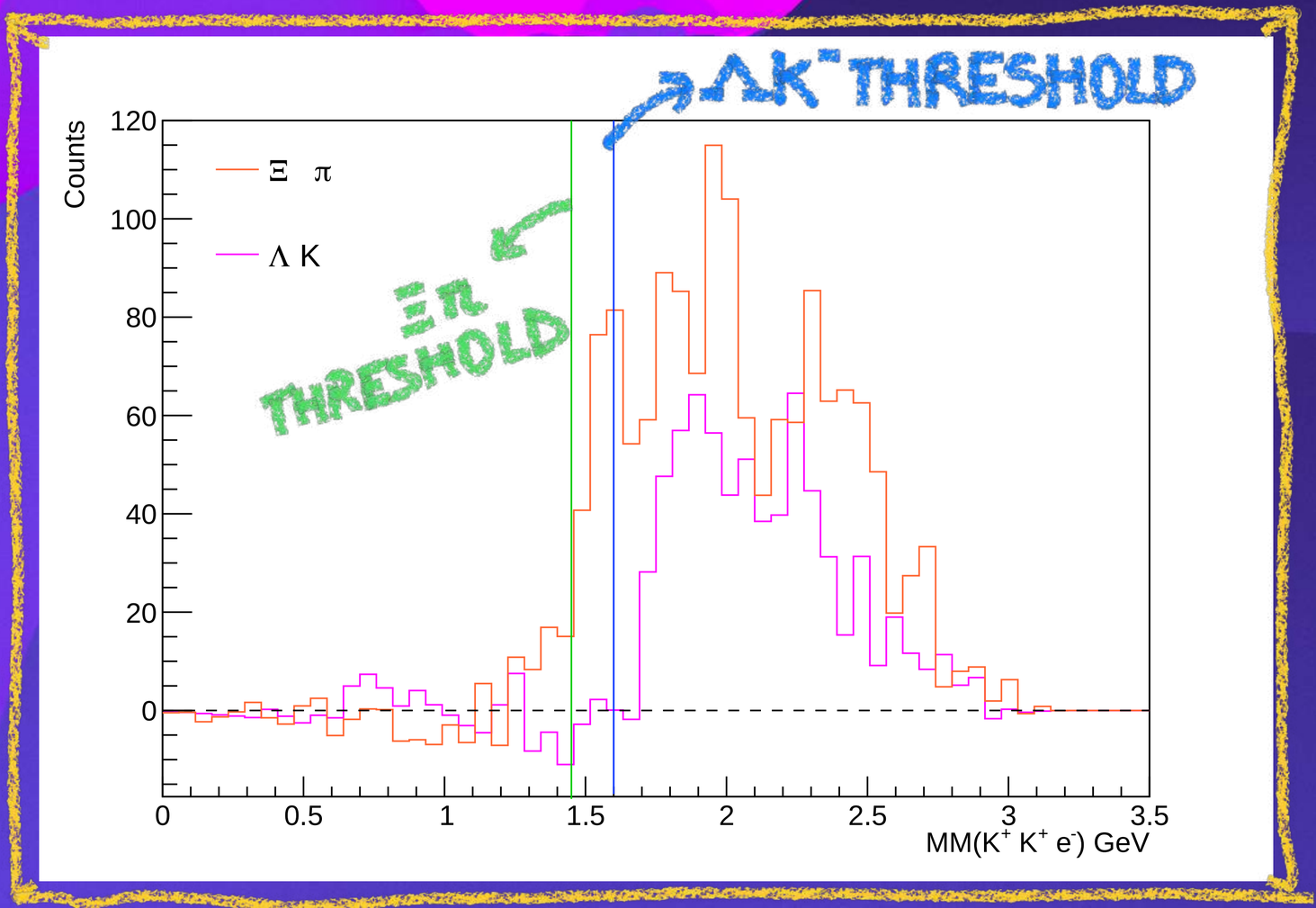




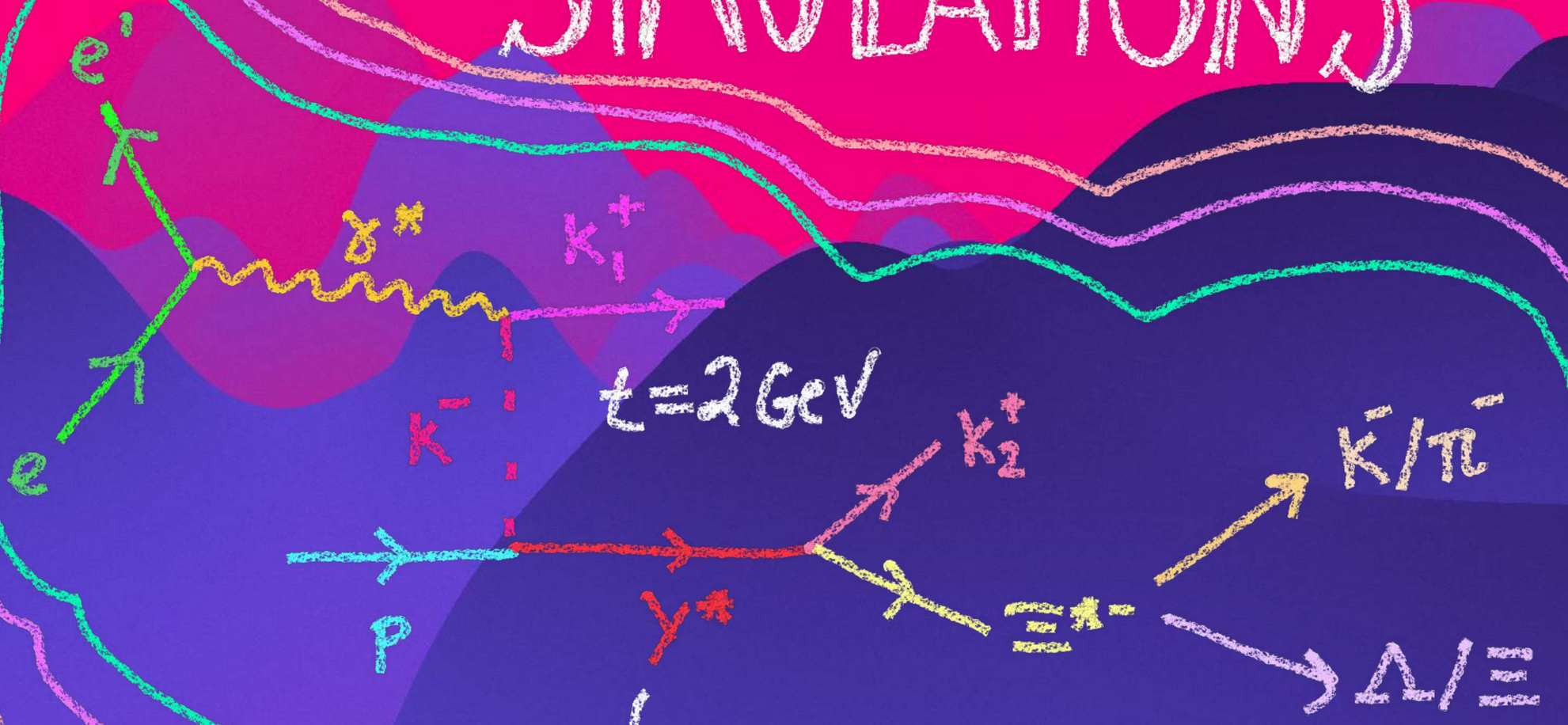
Δ peak from:



FIRST LOOK AT BACKGROUND SUBTRACTED YIELDS



SIMULATIONS

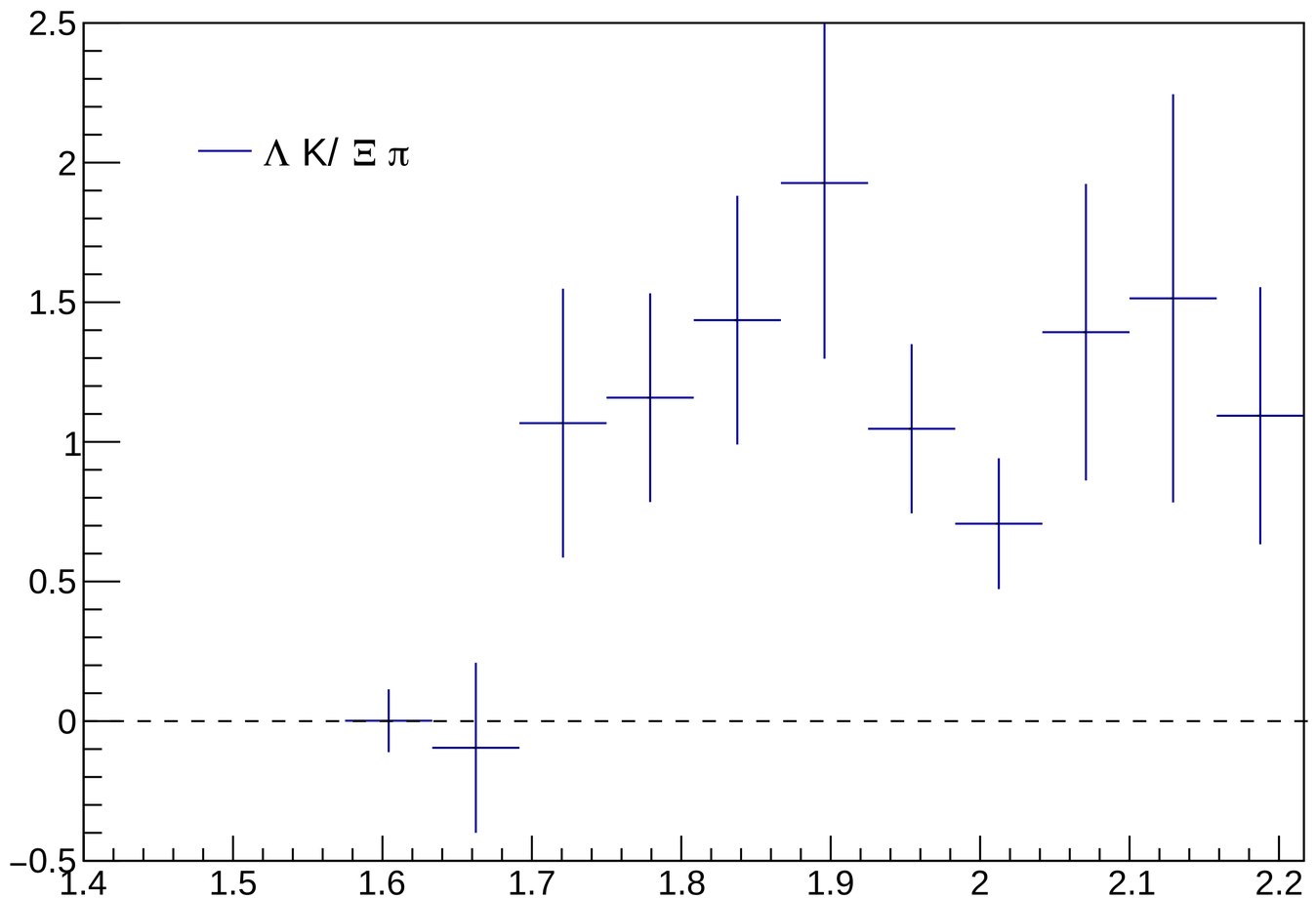


↳ S = -1 Hyperon.

$\mu = 3$ GeV, $\Gamma = 1$ GeV

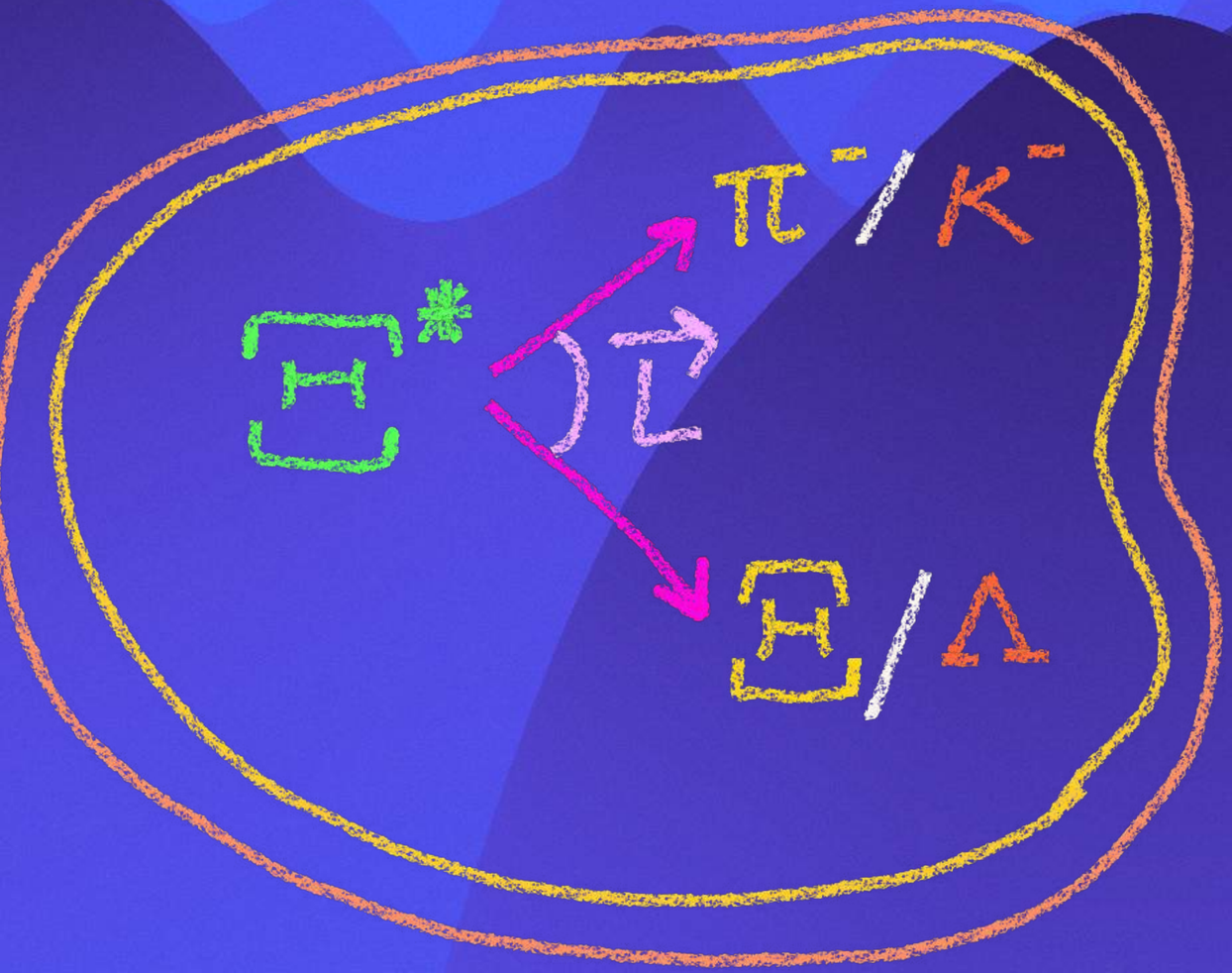
ACCEPTANCE/EFFICIENCY CORRECTED BRANCHINGS

$Br(\Xi^{*}\pi K^{+})/Br(\Xi^{*}\pi^{+})$



TOWARDS J^P...

ANGULAR COVERAGE OF K^- & π^-



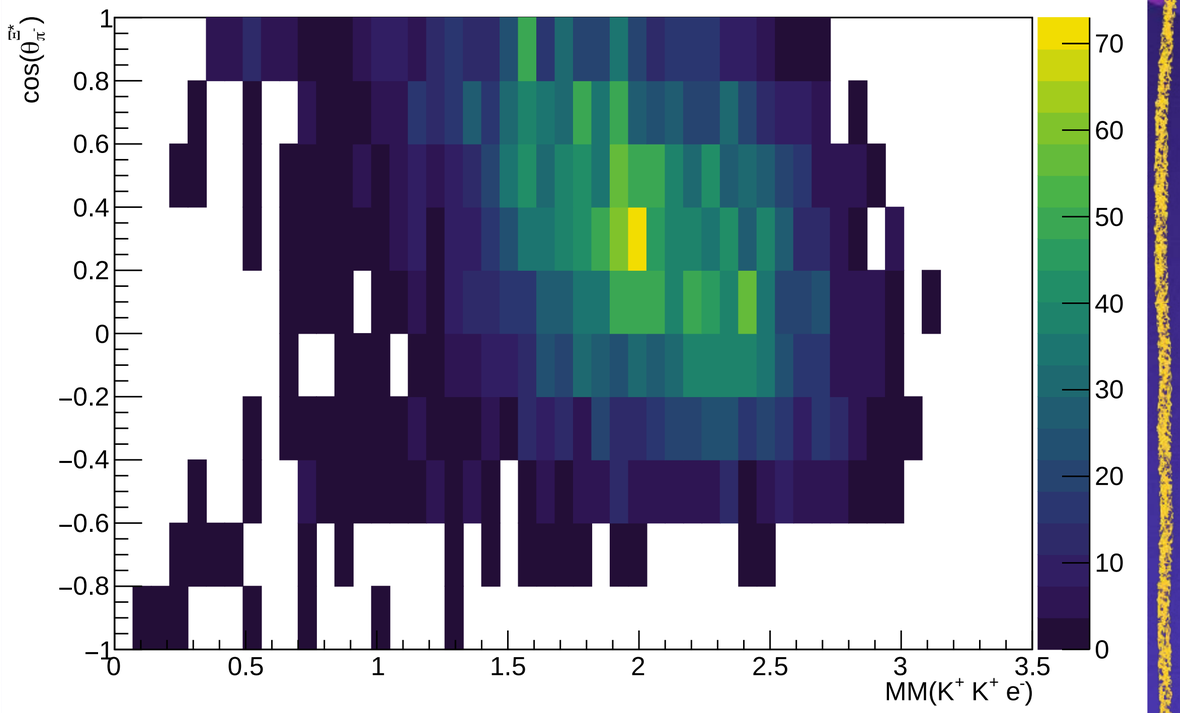
$$\vec{J} = \vec{L} + \vec{S}$$

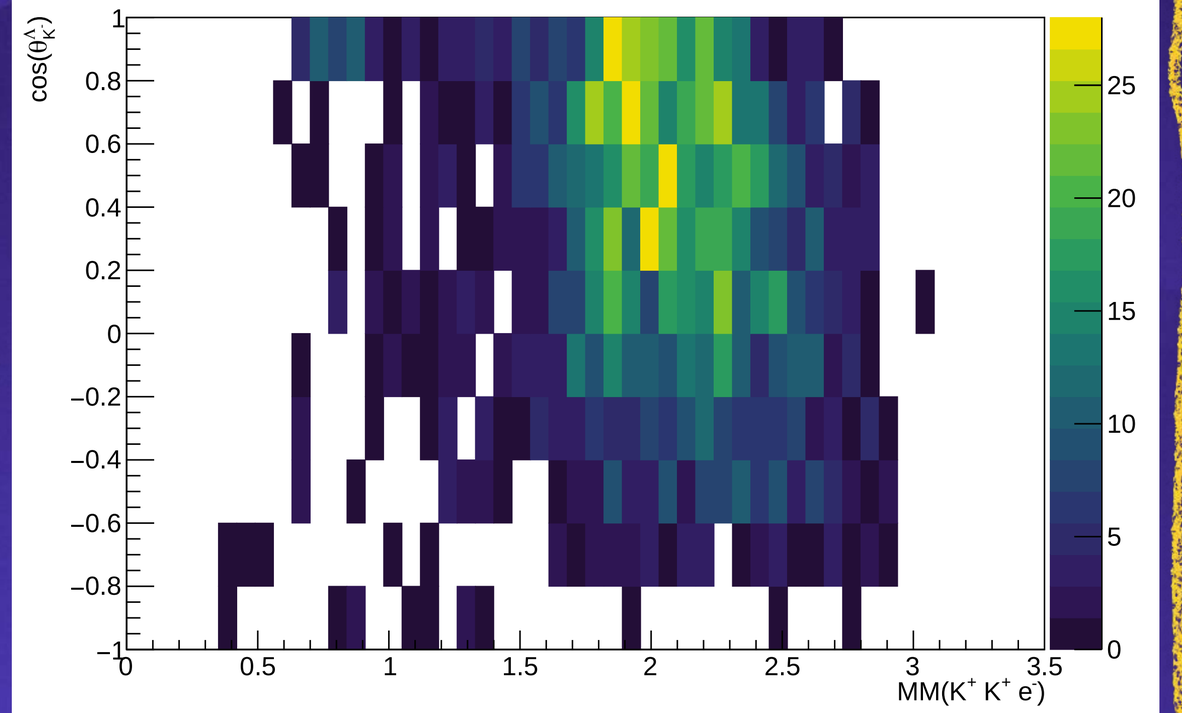
$$J^P = (L+S_\Xi)^{(-1)^{L+1}}$$

TOWARDS J^P...

ANGULAR DISTRIBUTIONS

NOT ACCEPTANCY/EFFICIENCY CORRECTED.



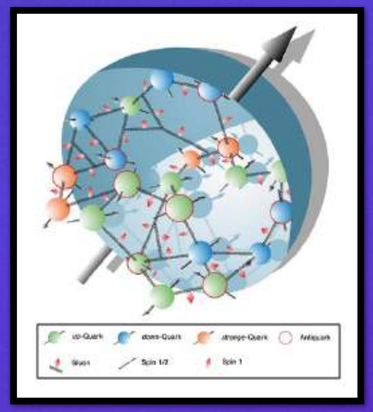


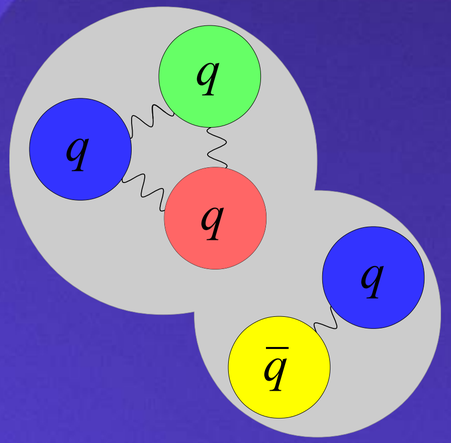
104 MeV/c^2
$-\frac{1}{3}$
$\frac{1}{2}$ S
strange

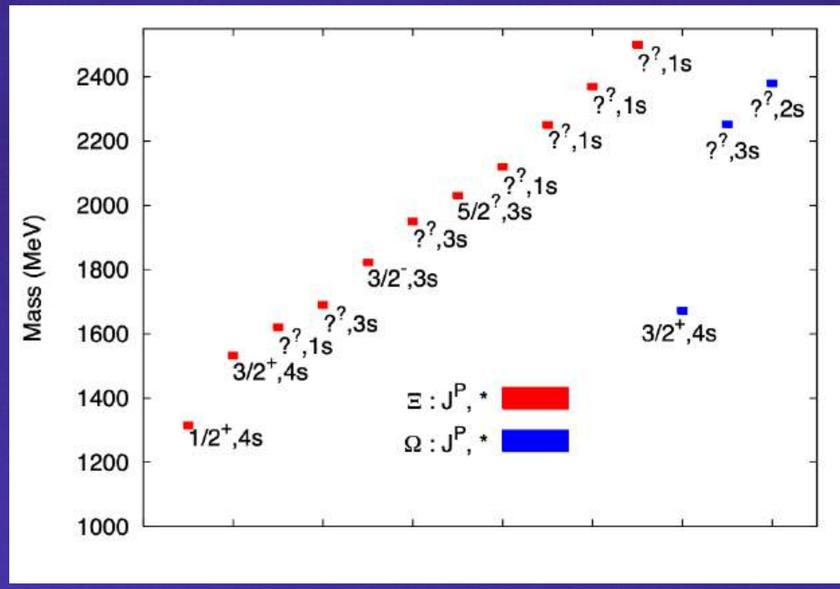
CONCLUSIONS

104 MeV/c^2
$-\frac{1}{3}$
$\frac{1}{2}$ S
strange

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

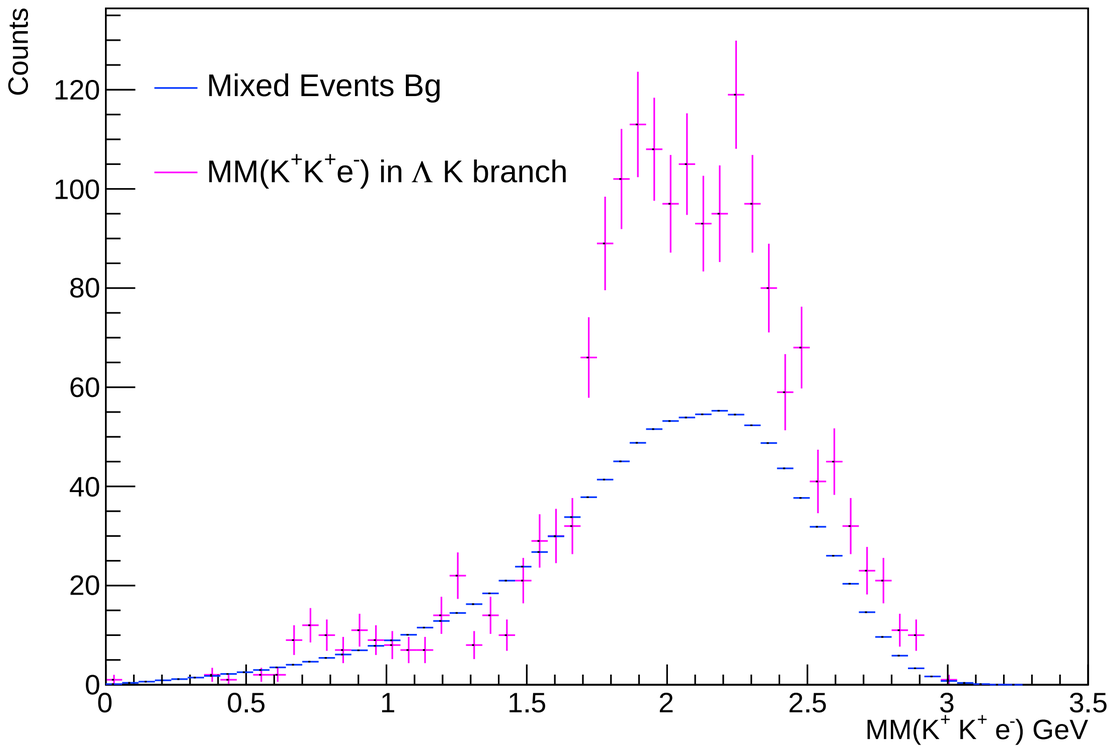


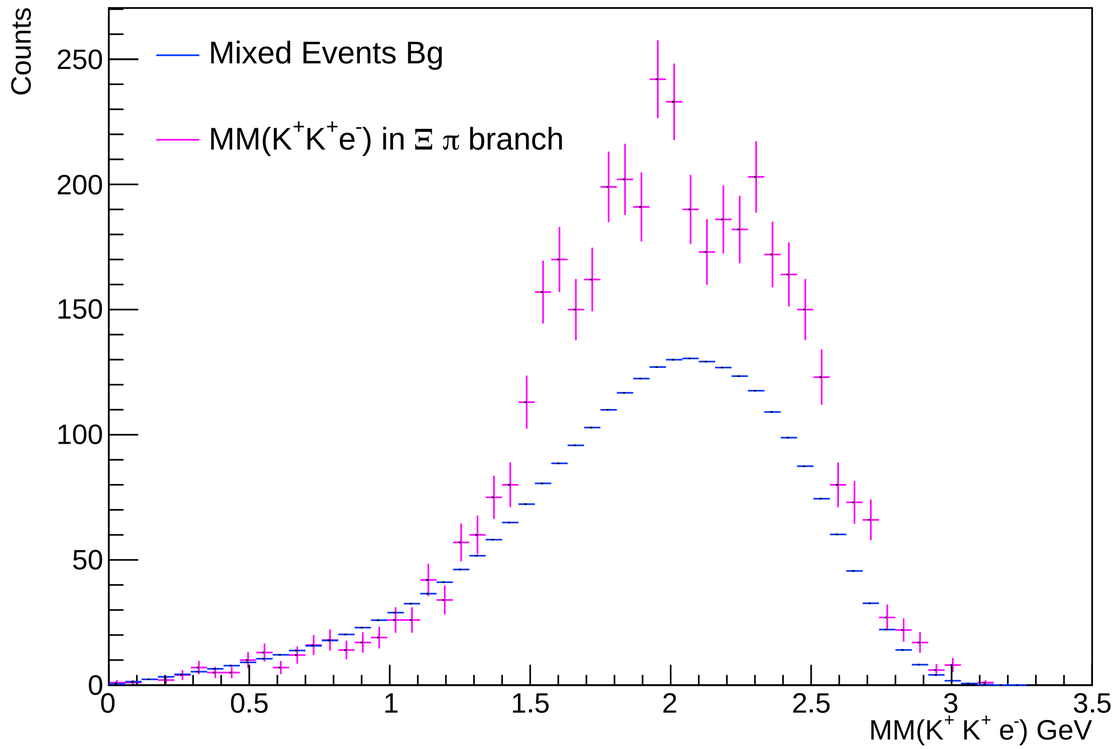




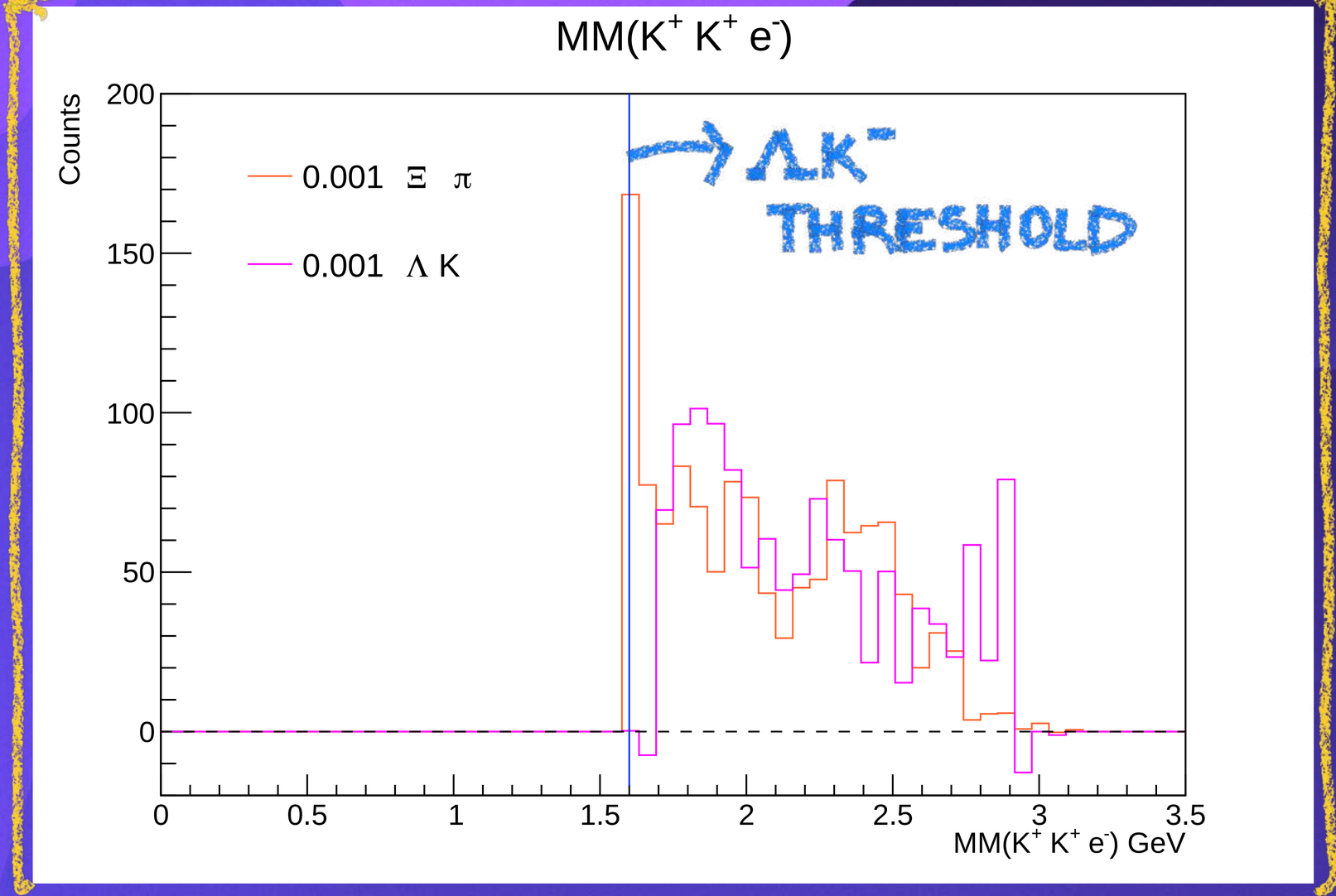
SUPPORTED BY STFC.

MIXED EVENTS BACKGROUND

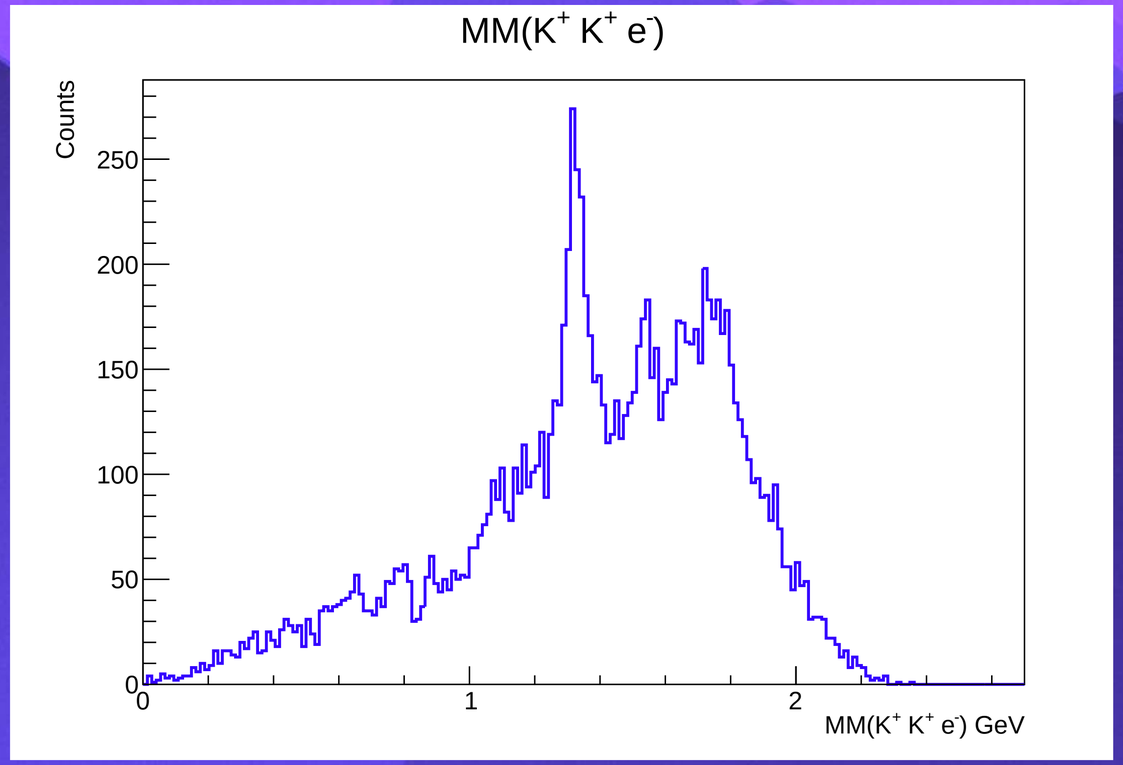


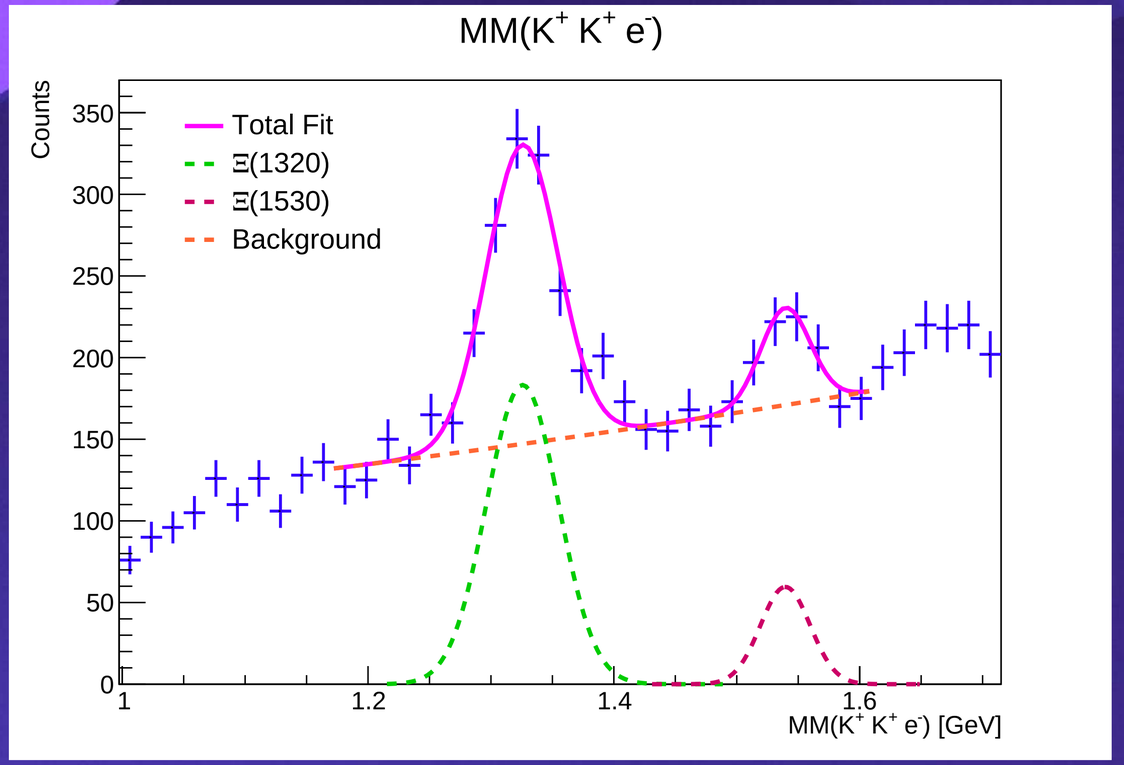


ACCEPTANCE/EFFICIENCY CORRECTED YIELDS

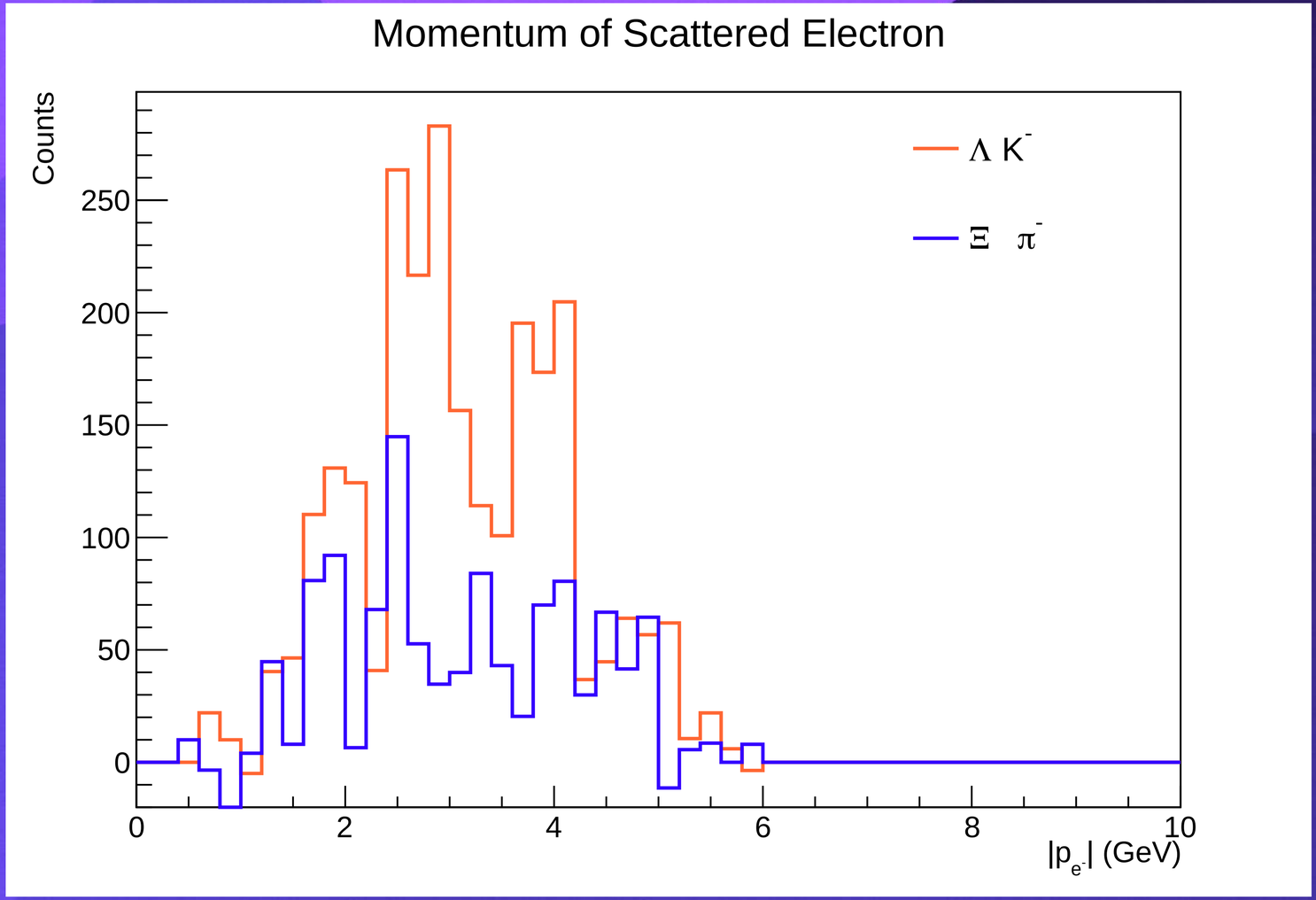


BACK-UP

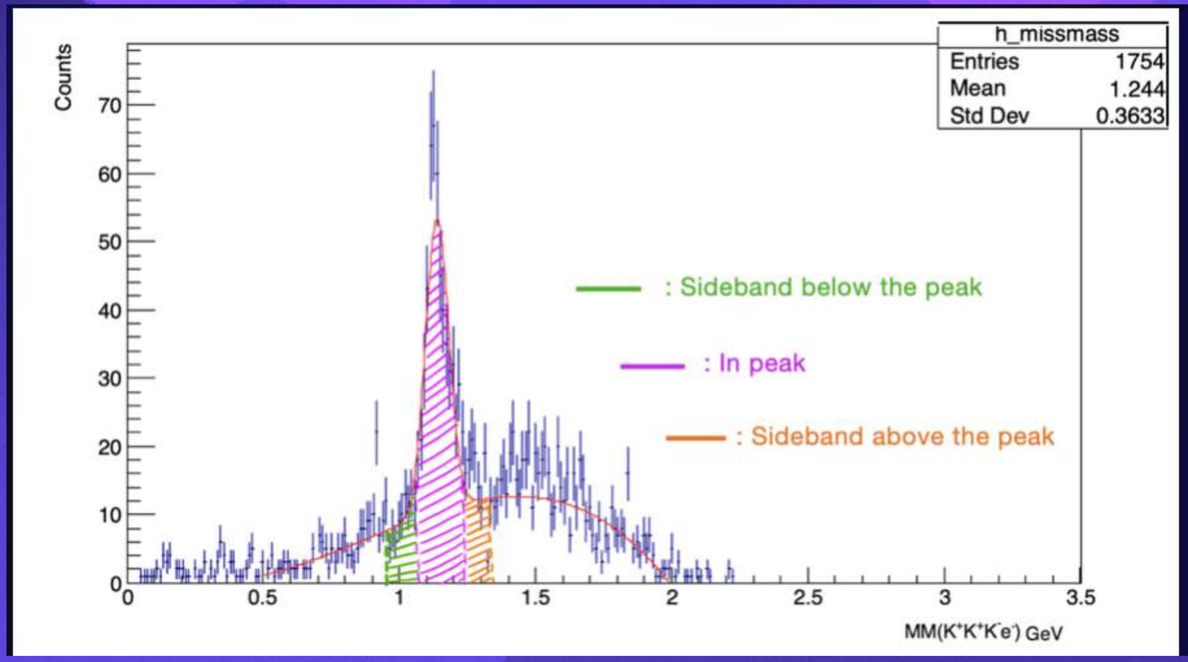

MM(K+ K+ e-)
Counts
250
200
150
100
50
0
0
1
2
MM(K+ K+ e-) GeV

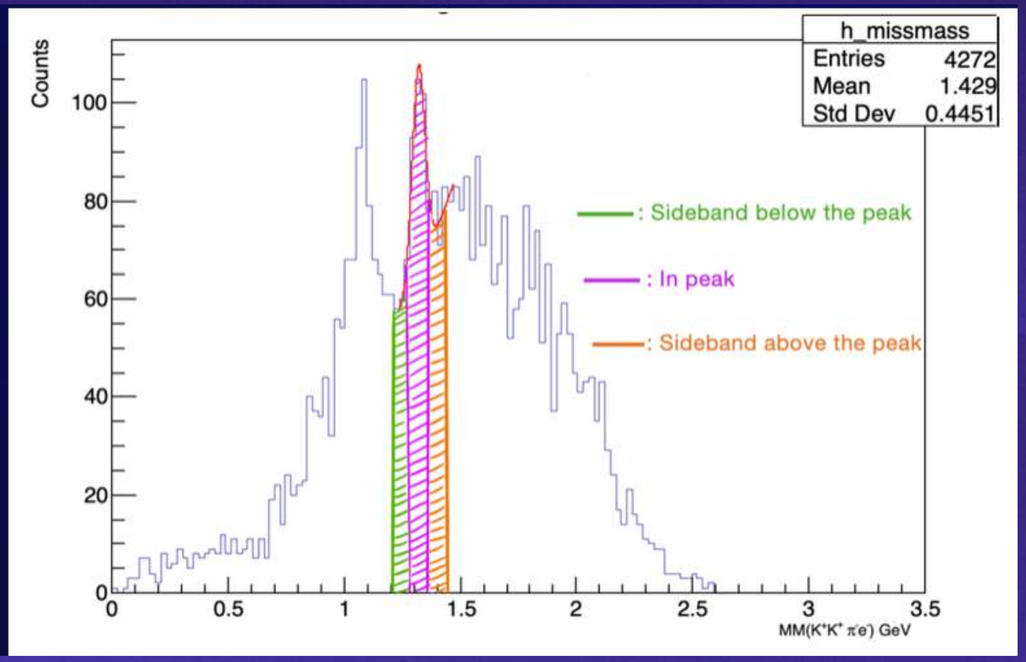

MM(K+ K+ e-)
Counts
350
300
250
200
150
100
50
0
Total Fit
Ξ(1320)
Ξ(1530)
Background
1
1.2
1.4
1.6
MM(K+ K+ e-) [GeV]

BACK-UP

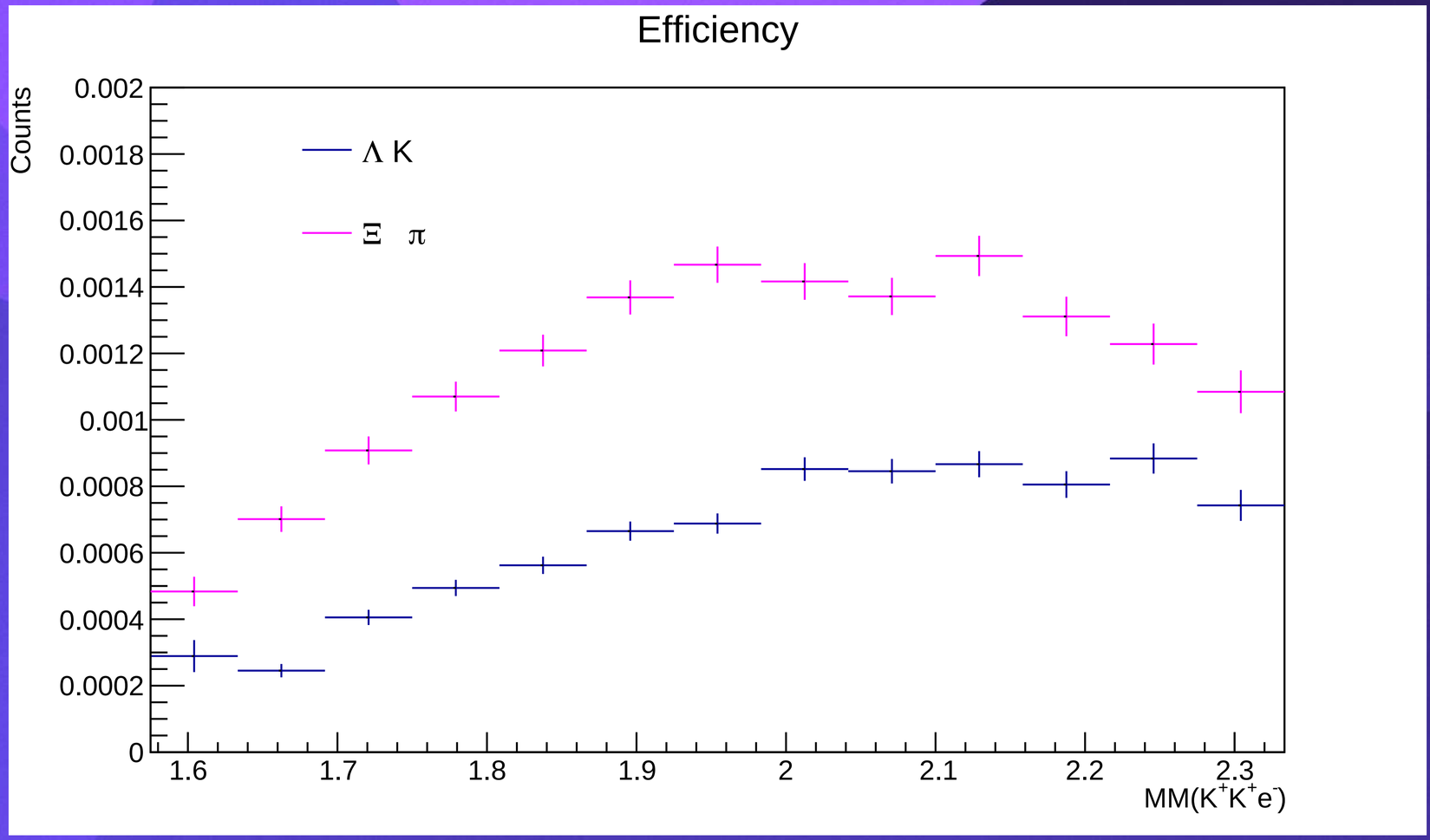

Momentum of Scattered Electron
Counts
250
200
150
100
50
0
0
2
4
6
8
10
$|p_{e^-}|$ (GeV)
Λ K^-
Ξ π^-

BACK-UP


h_missmass
Entries 1754
Mean 1.244
Std Dev 0.3633
Counts
: Sideband below the peak
: In peak
: Sideband above the peak
MM(K⁺K⁺K⁻e⁻) GeV


h_missmass
Entries 4272
Mean 1.429
Std Dev 0.4451
Counts
: Sideband below the peak
: In peak
: Sideband above the peak
MM(K⁺K⁺ π⁻e⁻) GeV

BACK-UP


Efficiency
Counts
0.002
0.0018
0.0016
0.0014
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
Λ K
Ξ π
1.6
1.7
1.8
1.9
2
2.1
2.2
2.3
MM(K+K+e-)