NOVEL KAON ID

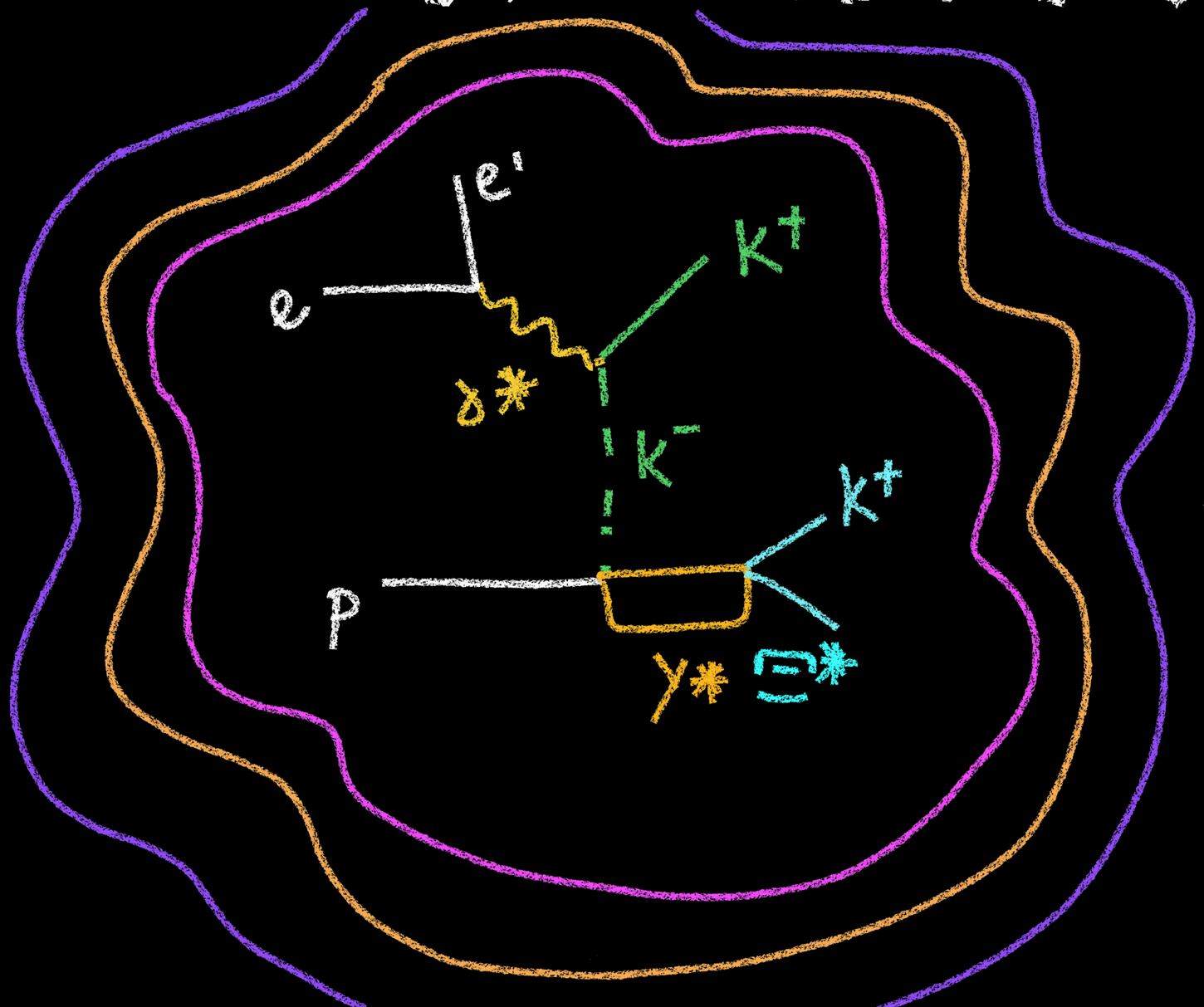
with

MULTI-DIMENSIONAL

S-WEIGHTS

ASLI ACAR - UNIVERSITY of YORK

THE CHANNEL



EXCITED CASCADE PRODUCTION

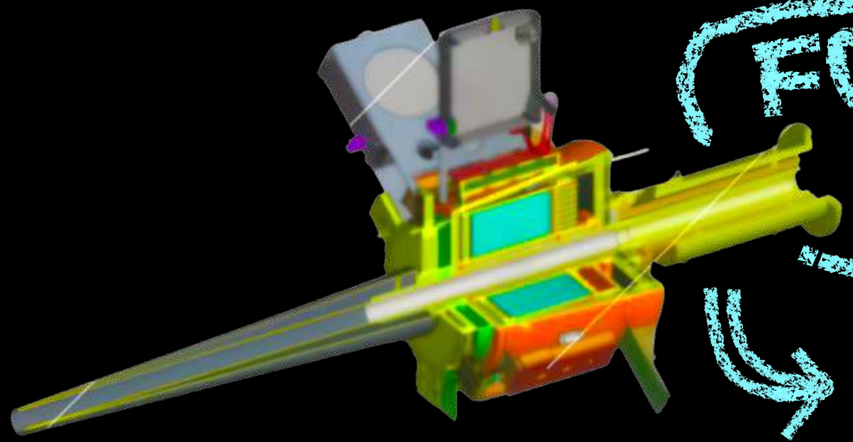
$2K^+$ & e^- DETECTED

FD

FD/FT

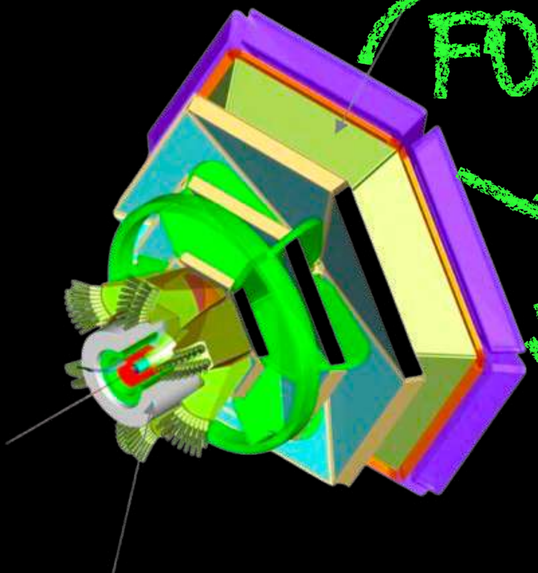
DETECTORS

FORWARD TAGGER



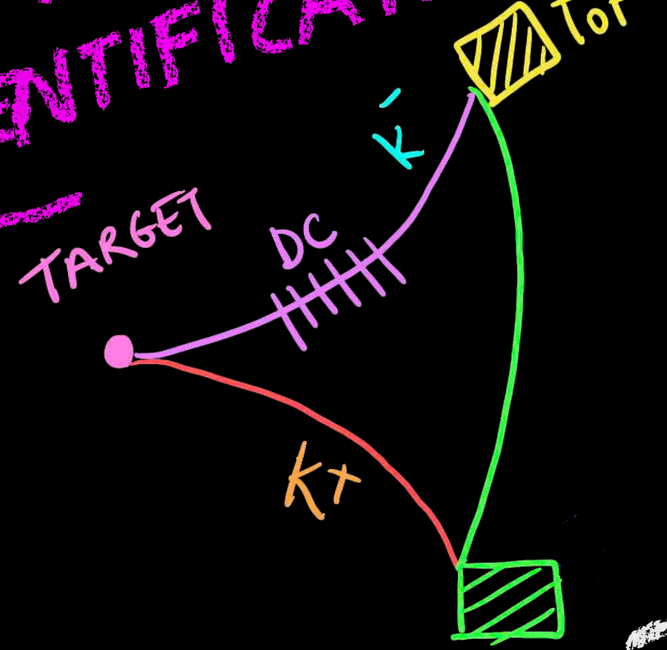
* $2.5^\circ < \theta < 4.5^\circ$
* LOW Q^2
* CALORIMETER

FORWARD DETECTOR

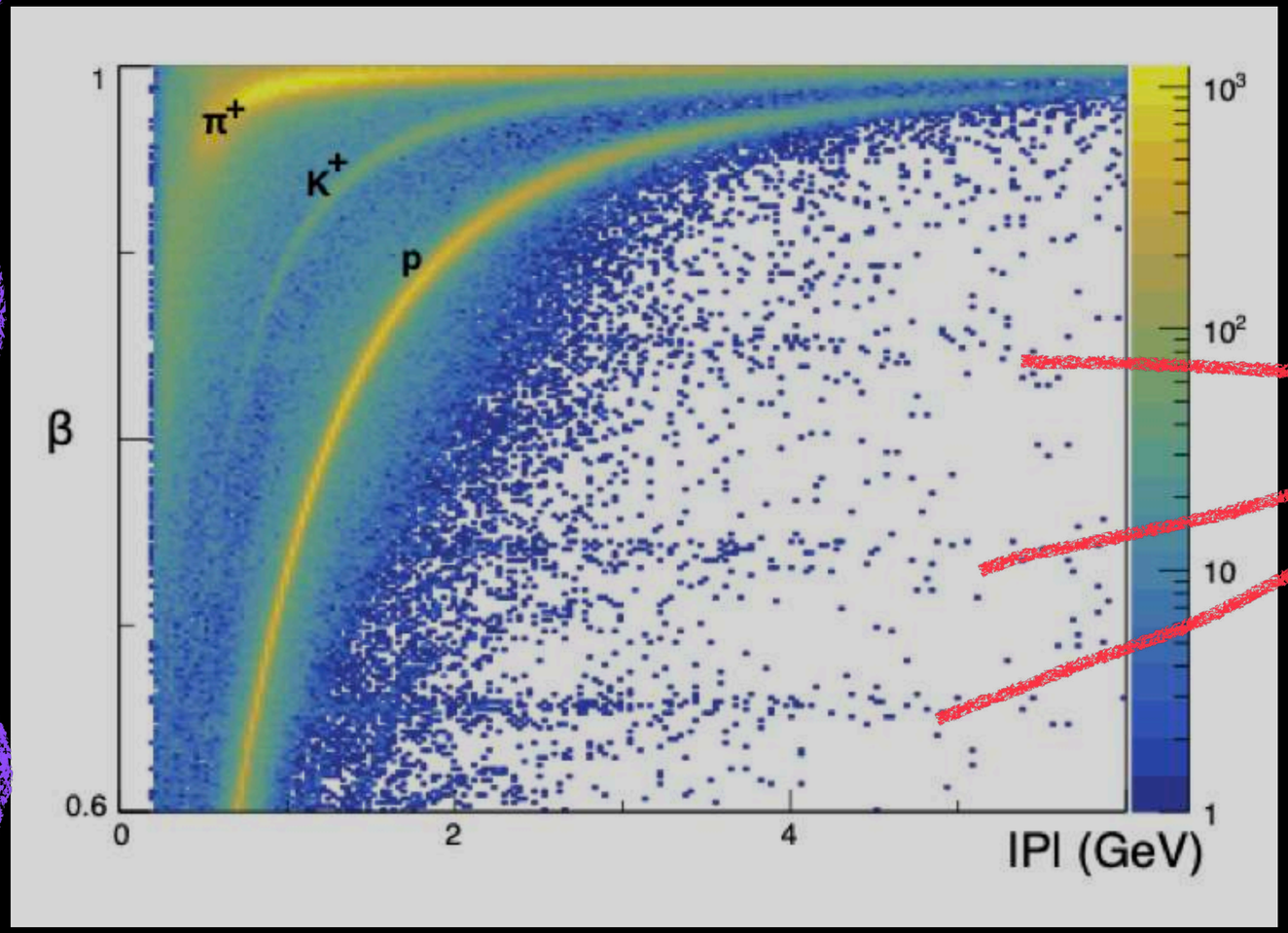


* $5^\circ < \theta < 35^\circ$
* HIGH Q^2
* MAGNETIC SPECTROSCOPY

PARTICLE IDENTIFICATION



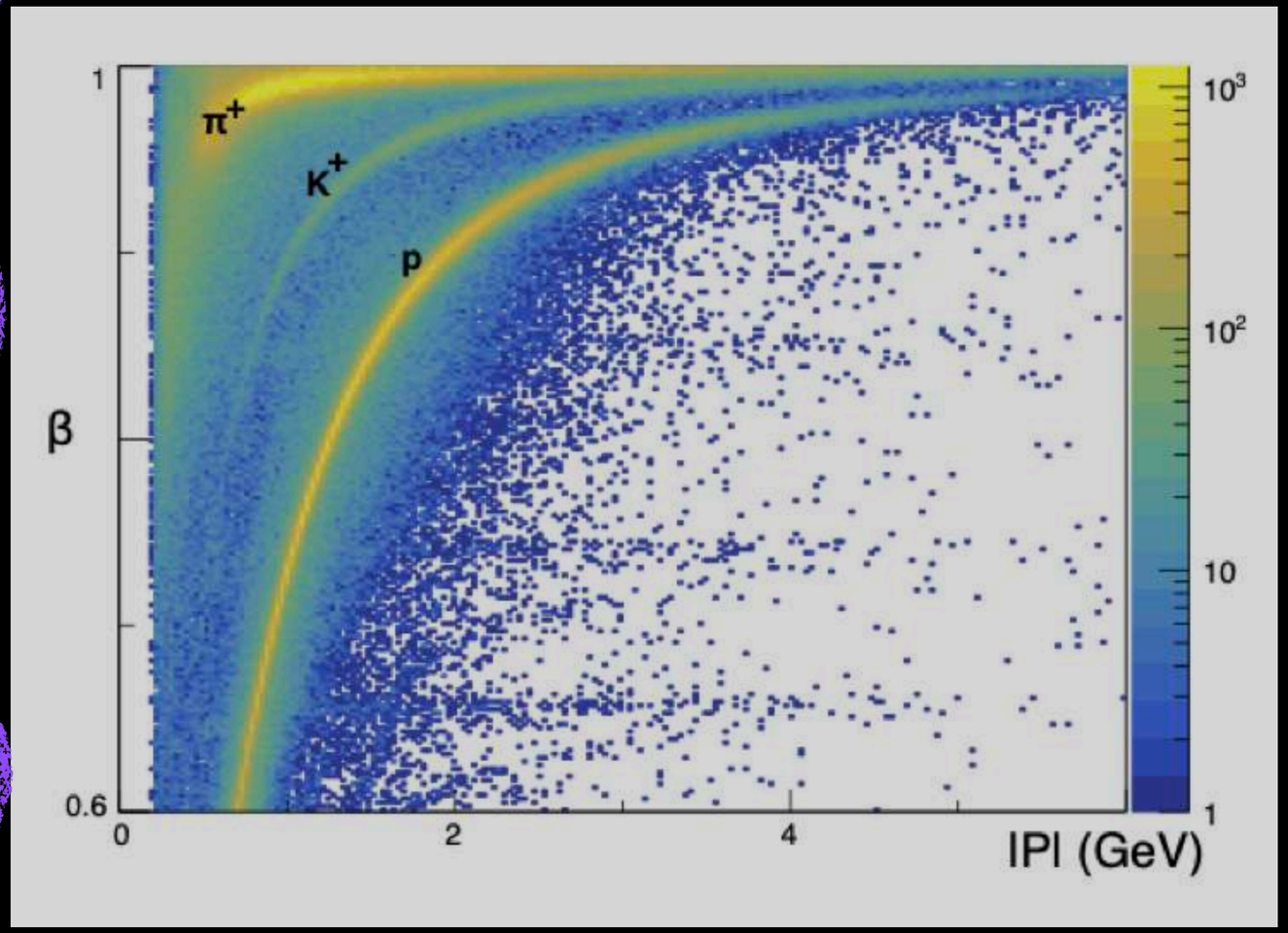
PID from TOF



π^+, K^+, P BANDS

PARTICLES PRODUCED IN NEIGHBORING e^- BEAM BUNCHES

PID from TOF

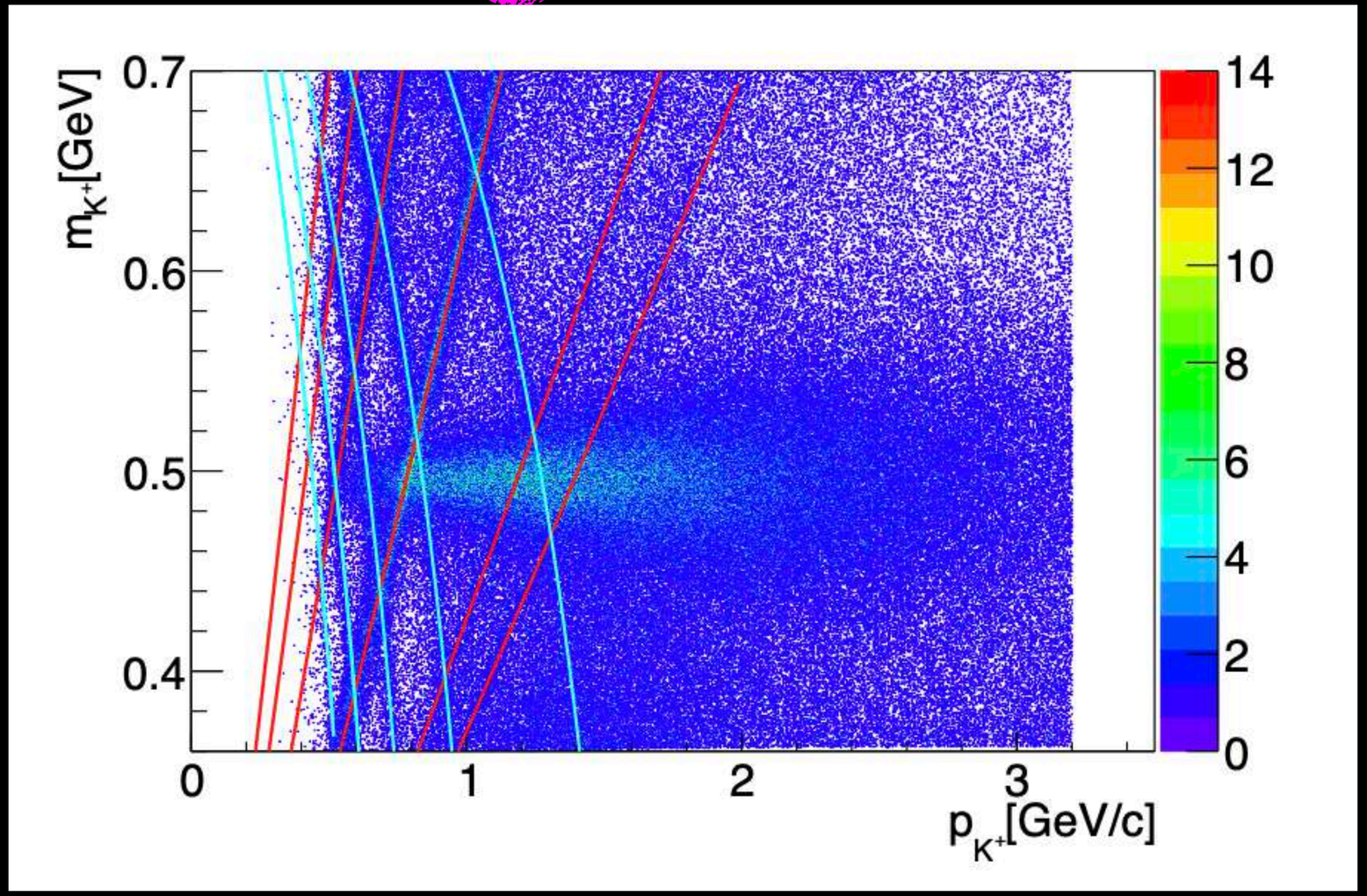


$$m^2 = \frac{|P|^2}{\beta^2} - |P|^2$$

WHERE

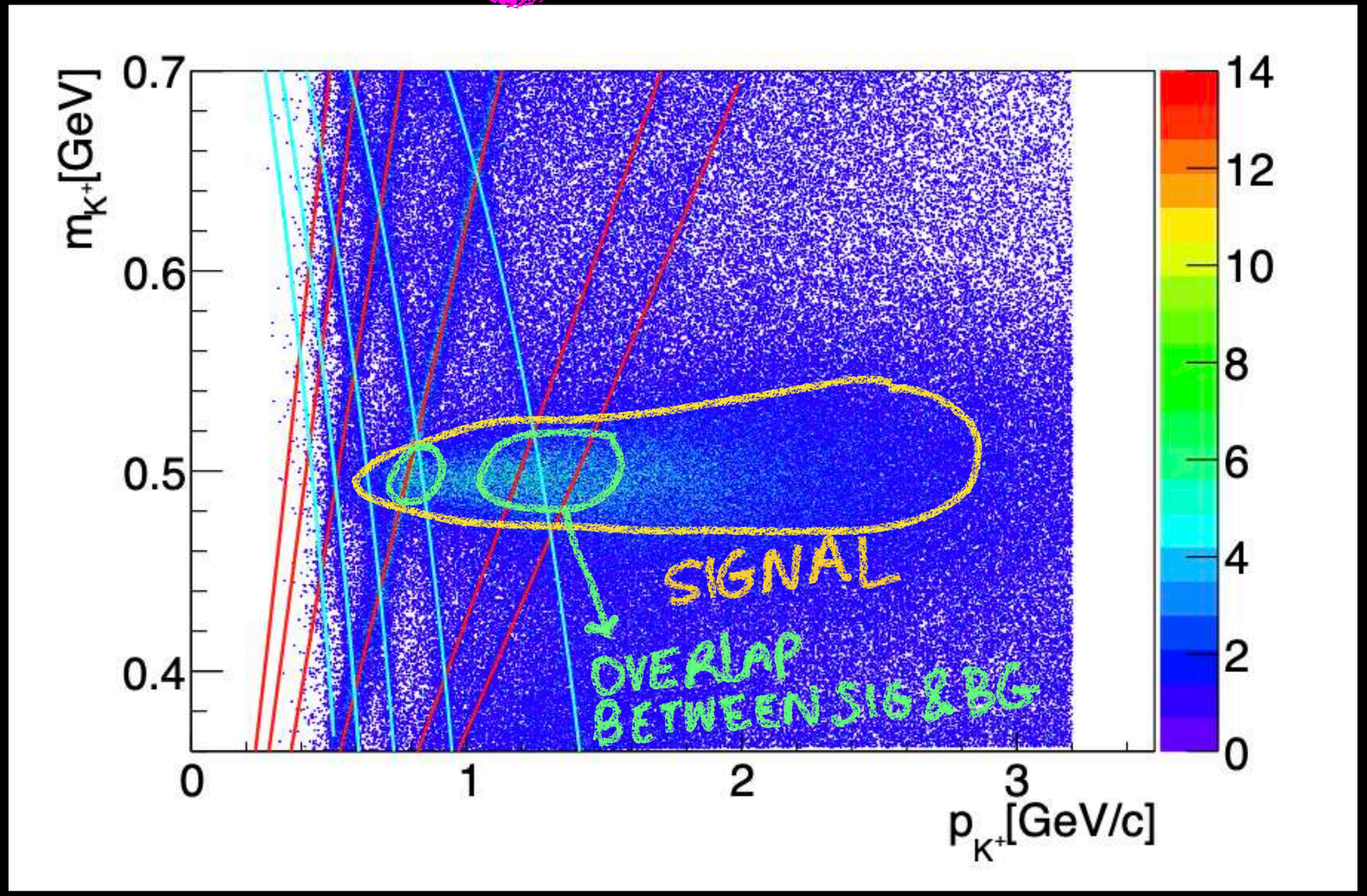
$$\beta = \frac{v}{c}$$

PID from TOF



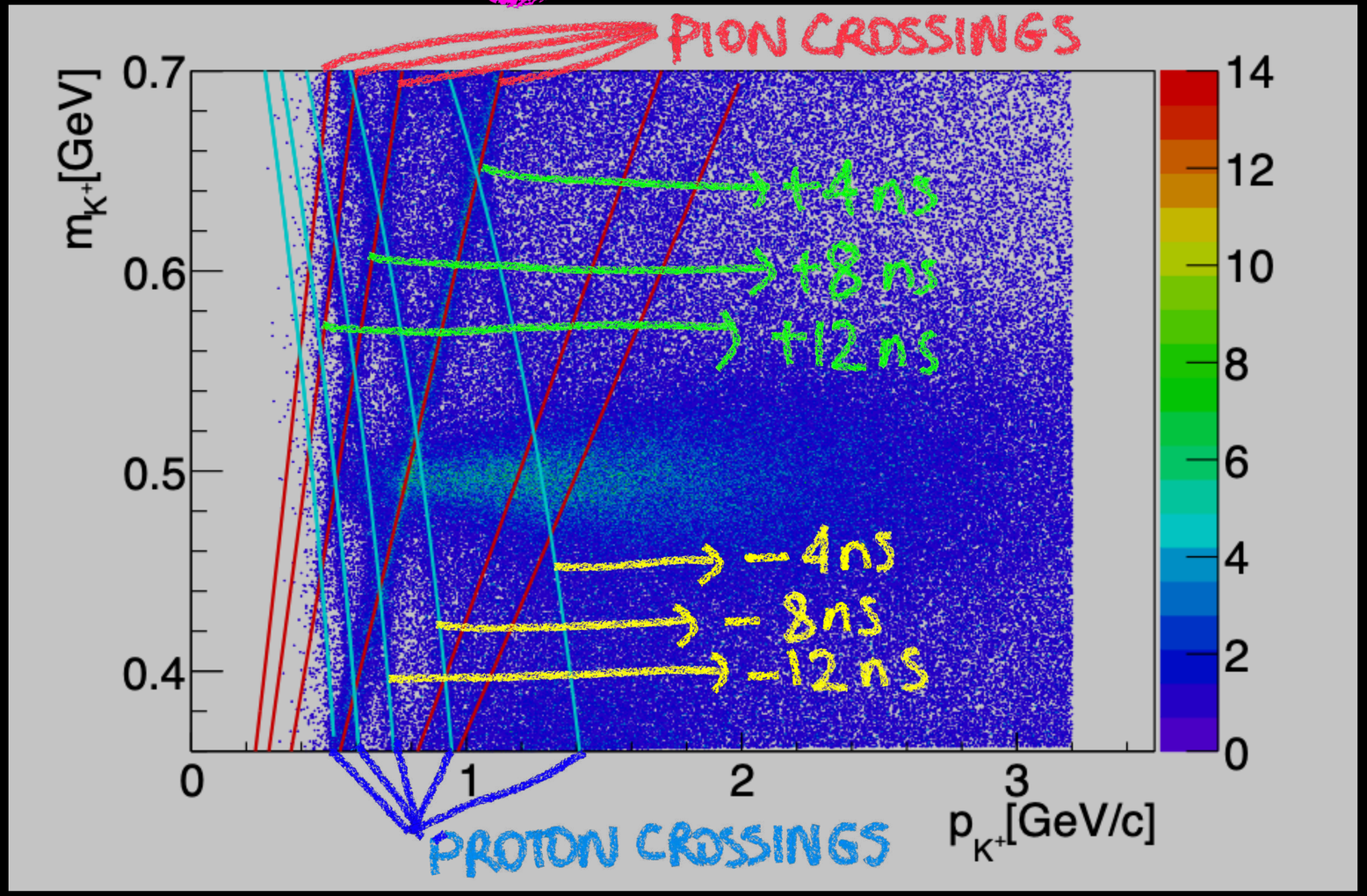
KAON MASS CALCULATED FROM β, VERSUS KAON MOMENTUM

PID from TOF



SIGNIFICANT OVERLAP BETWEEN SIGNAL & BACKGROUND...

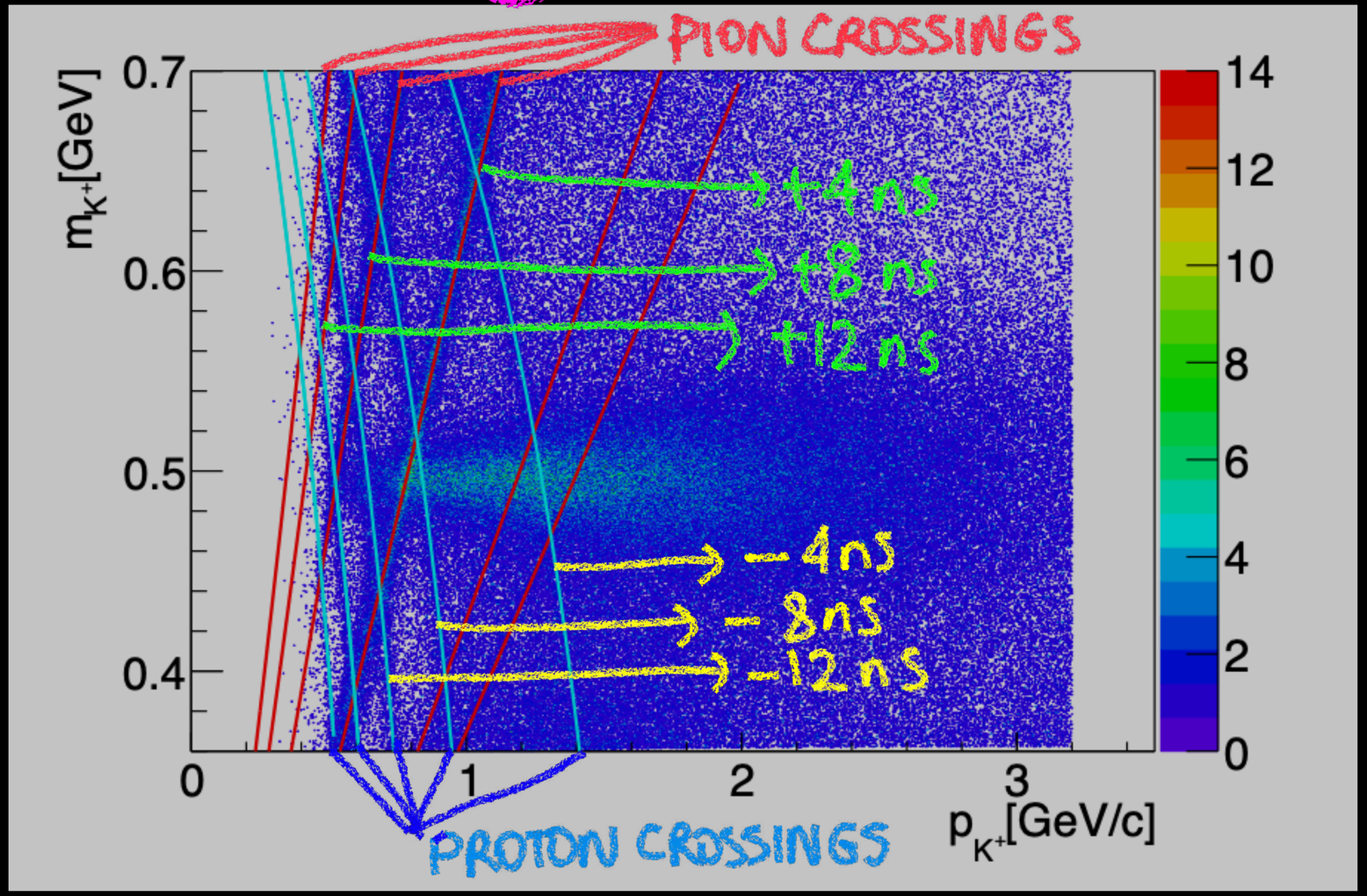
PID from TOF



OUT-OF-TIME BG

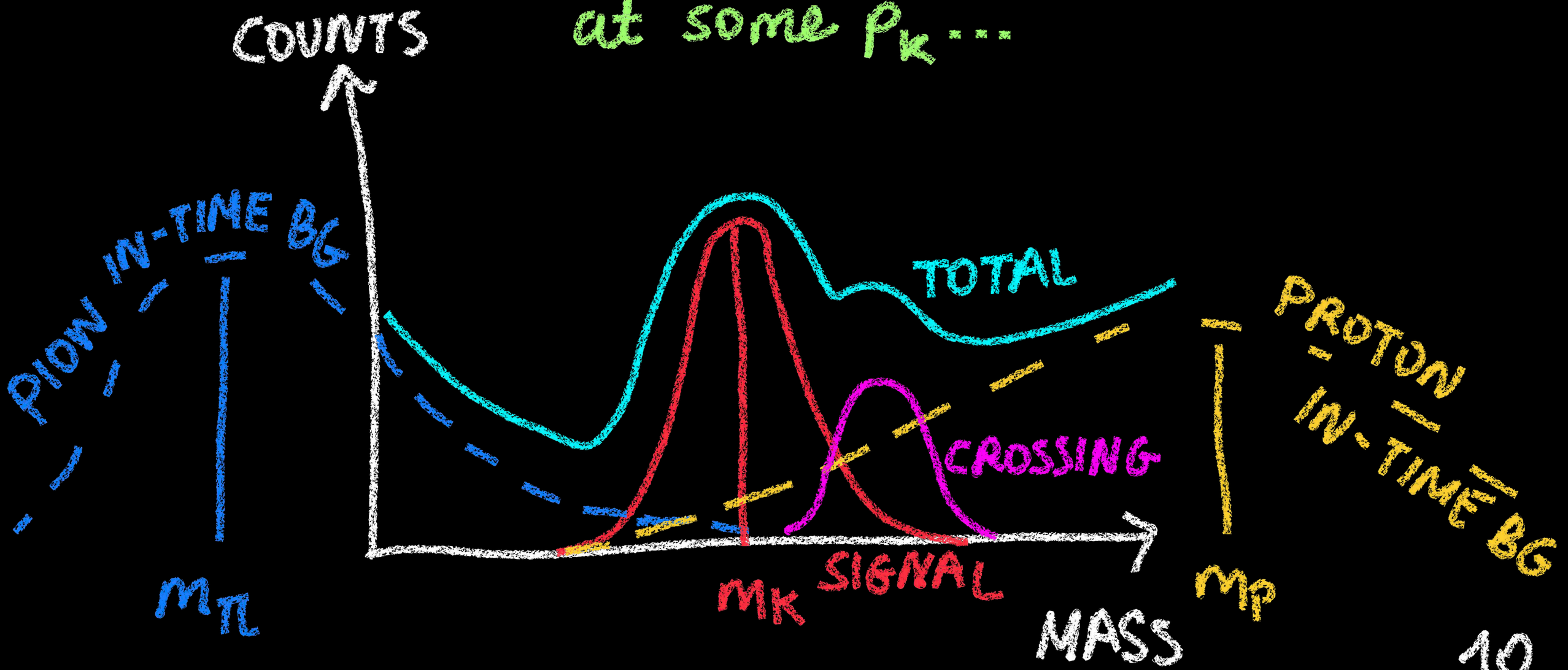
ANALYTICAL FUNCTIONS FOR CROSSINGS CAN BE CALCULATED USING β.

PID from TOF

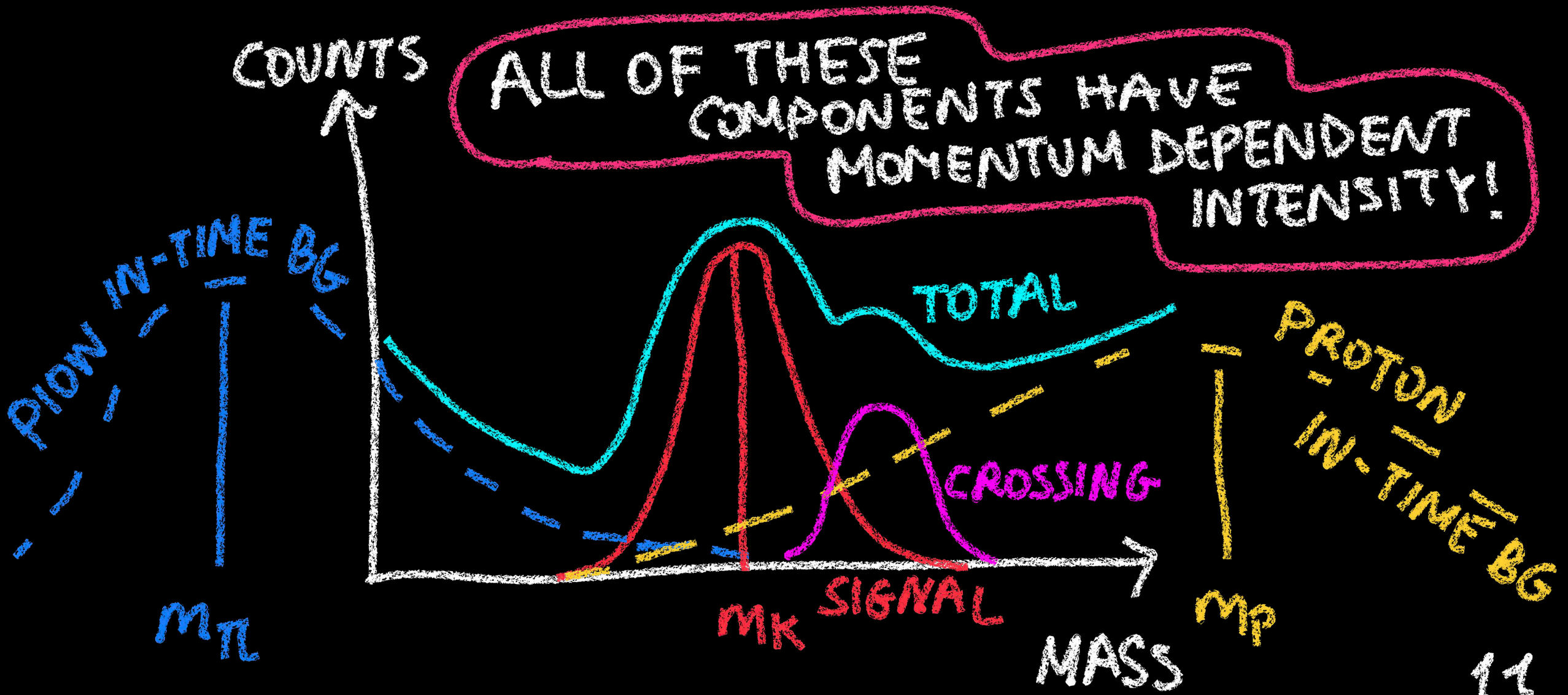


KAON MASS AS A DISCRIMINATORY VARIABLE?

THE MODEL

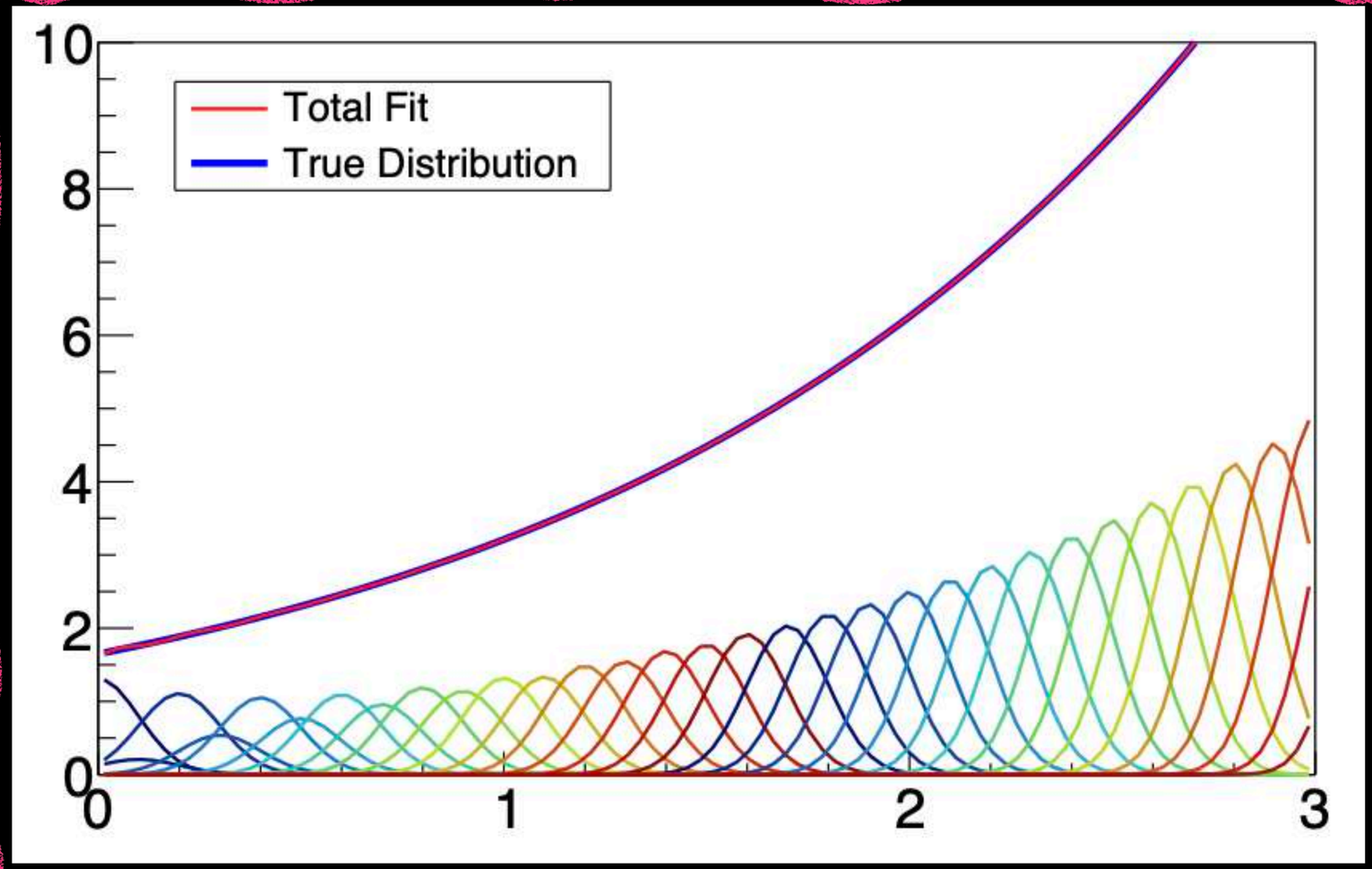

at some p_K ...
COUNTS
PION IN-TIME BG
TOTAL
PROTON IN-TIME BG
CROSSING
SIGNAL
m_{π}
m_K
m_p
MASS

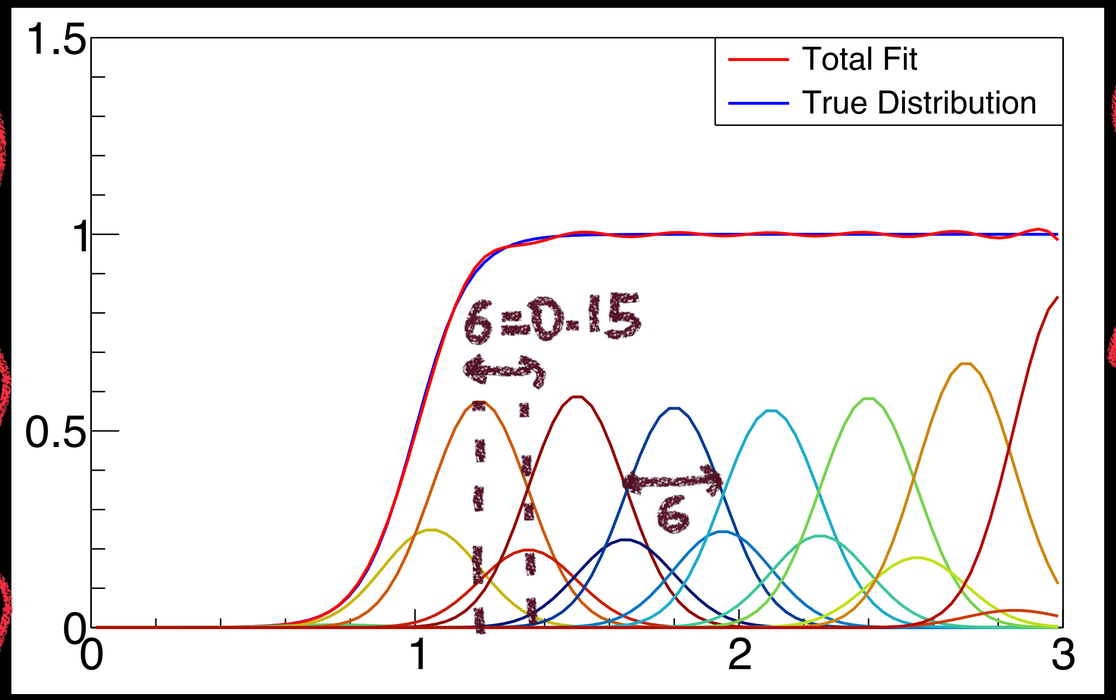
THE MODEL

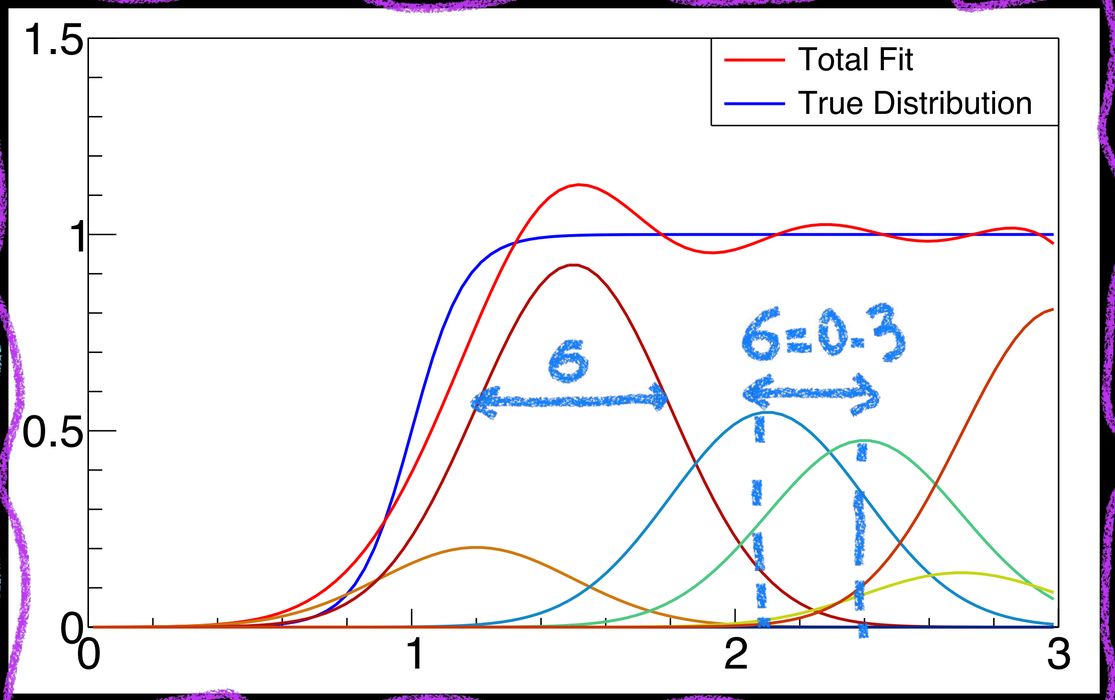

ALL OF THESE COMPONENTS HAVE MOMENTUM DEPENDENT INTENSITY!
COUNTS
PION IN-TIME BG
TOTAL
PROTON IN-TIME BG
CROSSING
SIGNAL
m_{π}
m_K
m_p
MASS

GAUSSIAN SAMPLING

1. DEFINED RANGES.
2. POSITIVELY DEFINED.
3. CONTROL of MAXIMUM RESOLVABLE GRADIENT.
4. FLEXIBLE.
5. NO CROSS-CORRELATION
6. ONE PARAMETER PER GAUSSIAN (HEIGHT)

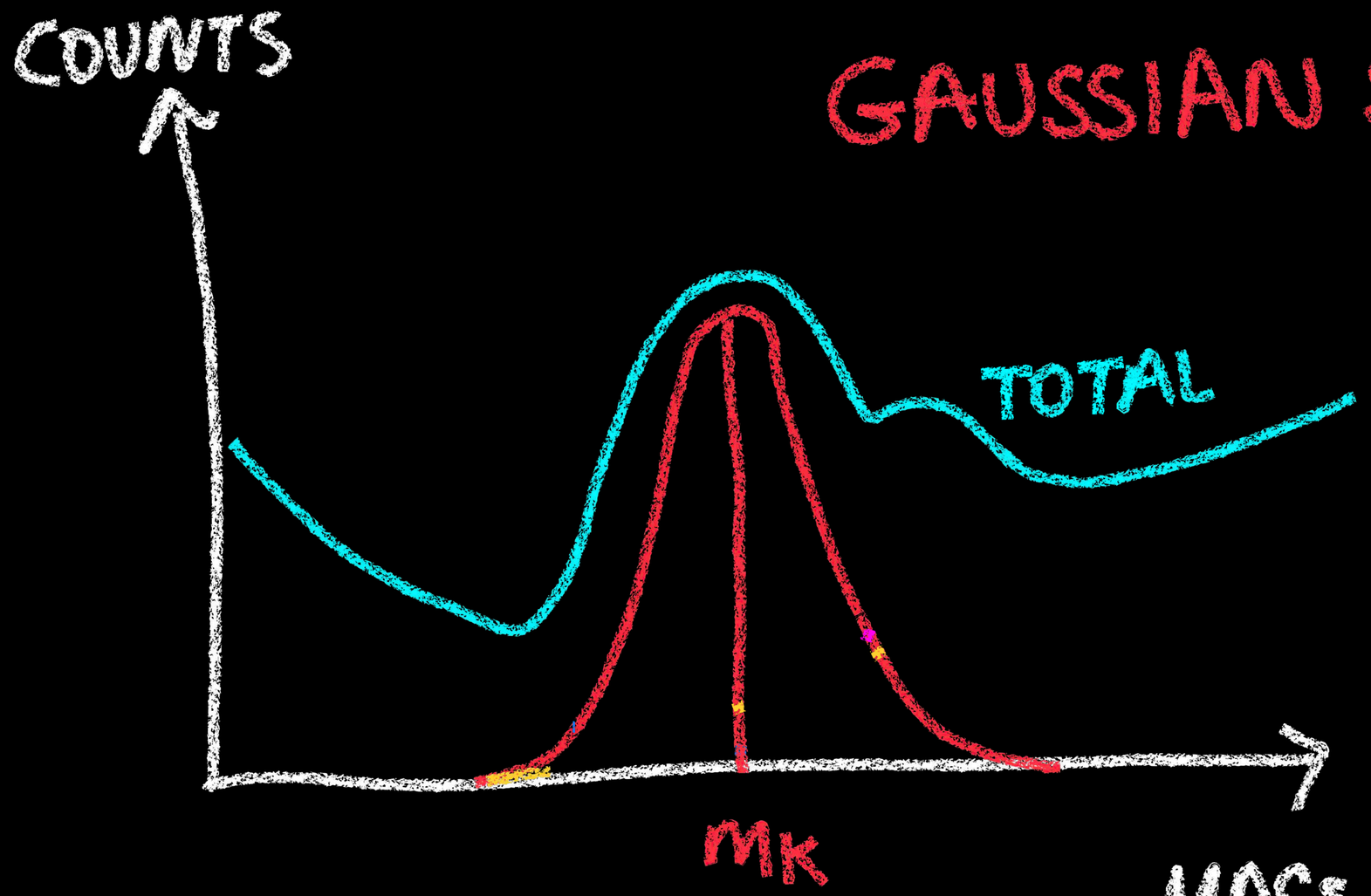




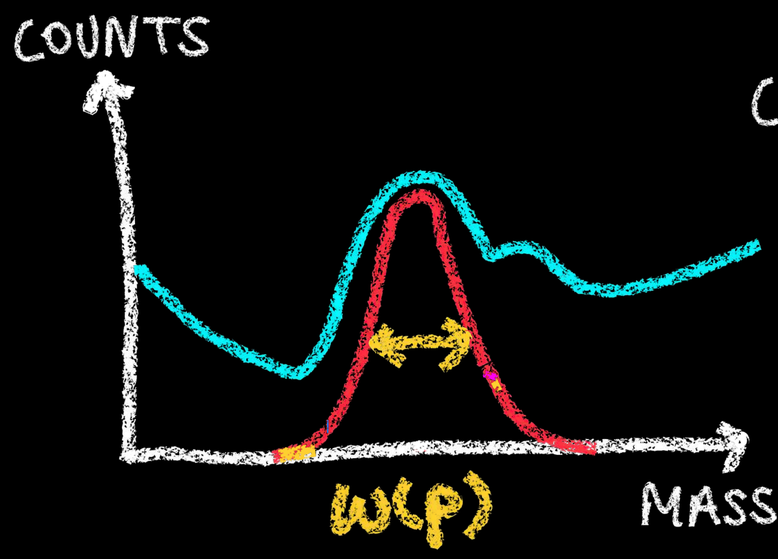


THE CHOICE OF δ DEPENDS ON THE FUNCTION...

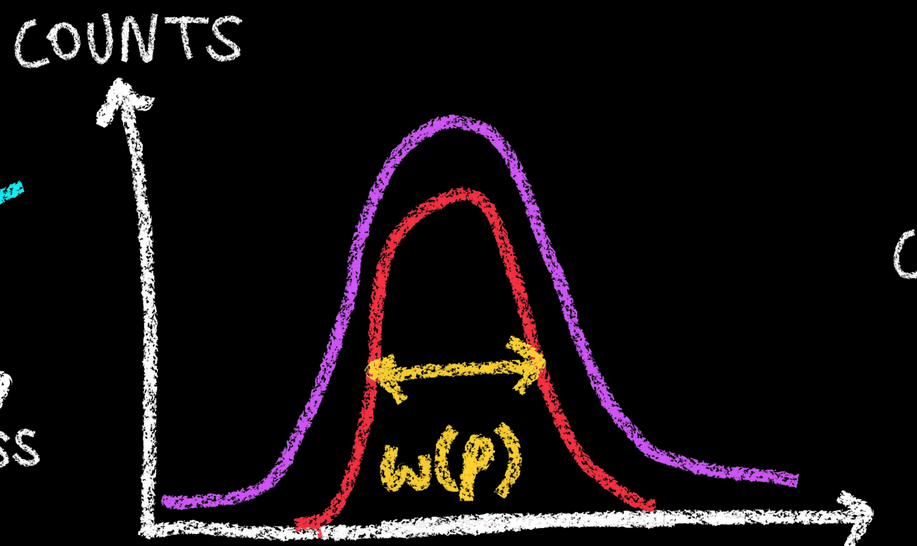
THE MODEL



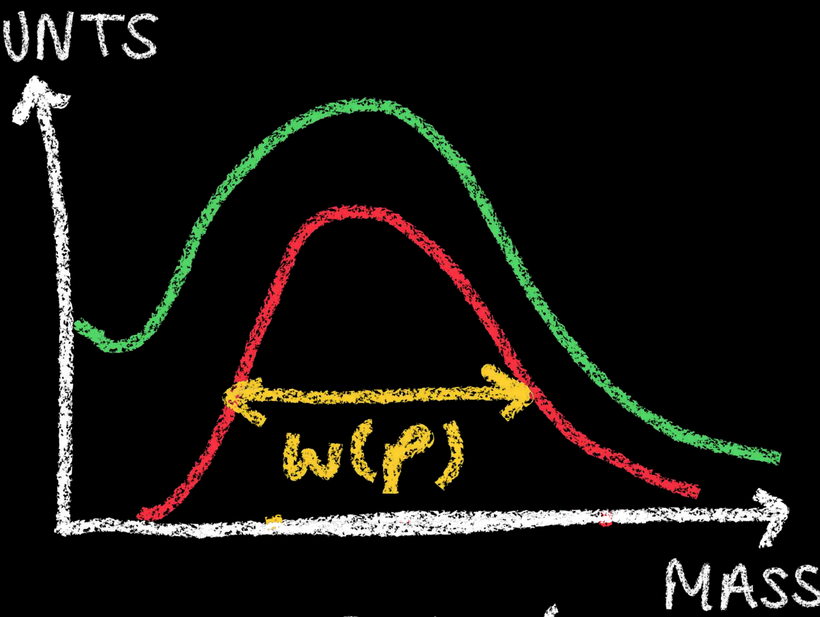
THE MODEL



p = 0.8 GeV



p = 1.5 GeV



p = 3 GeV

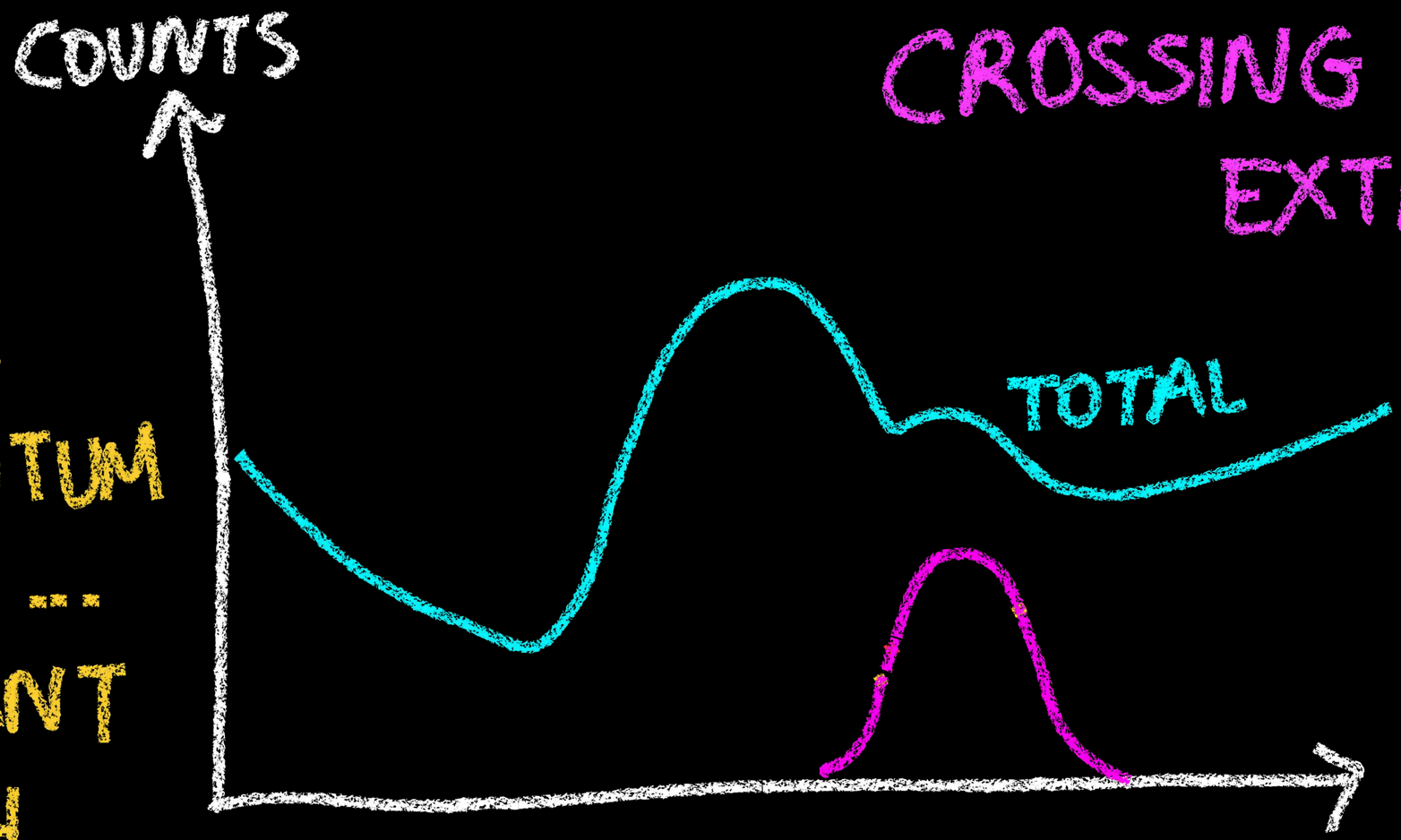
MOMENTUM DEPENDENT WIDTH:

$$w(p) = \sqrt{T_0^2 + T_1(p-\mu)^2}$$

EXTRACT T_0, FIT T_1.

THE MODEL

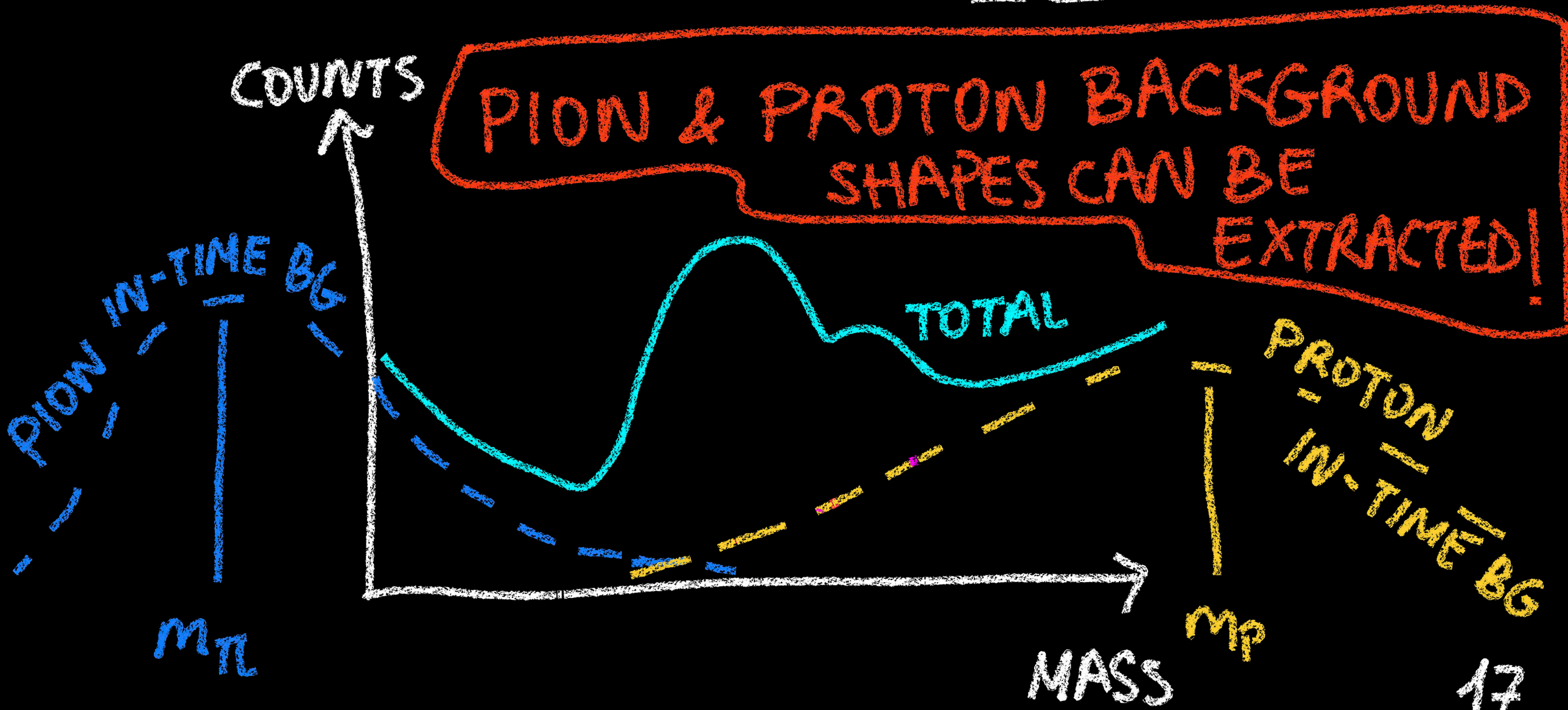
SPAN SMALL MOMENTUM RANGE... CONSTANT WIDTH.



CROSSING FUNCTIONS EXTRACTED ANALYTICALLY

THE MODEL

PION & PROTON BACKGROUND SHAPES CAN BE EXTRACTED!



THE MODEL

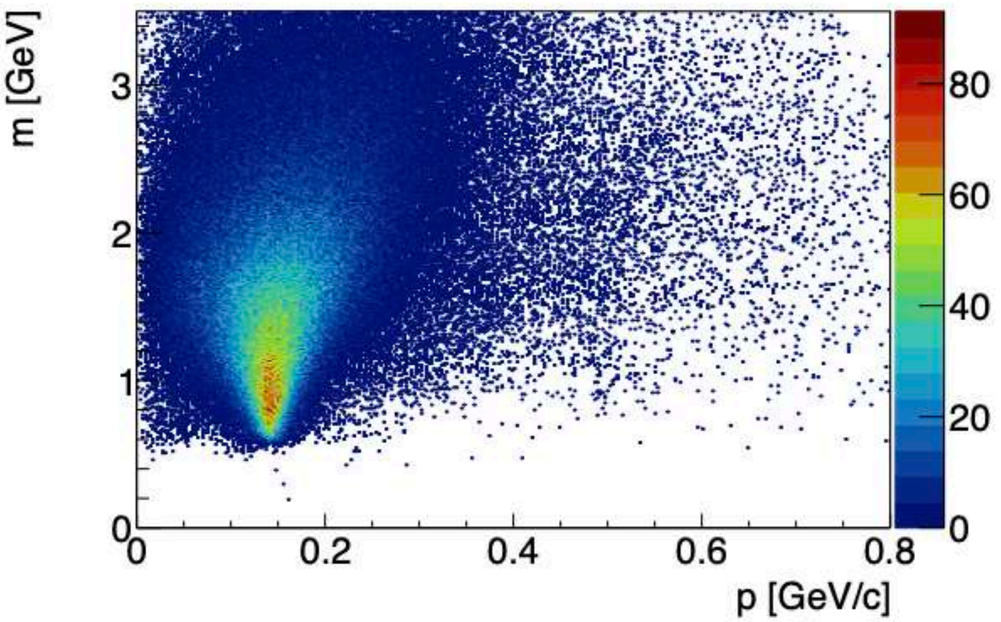
$ep \longrightarrow ep\pi^+\pi^-$ → DETECT $ep\pi^-$ & ONE OTHER POSITIVELY CHARGED PARTICLE (π^+ TAIL EXTRACTION)

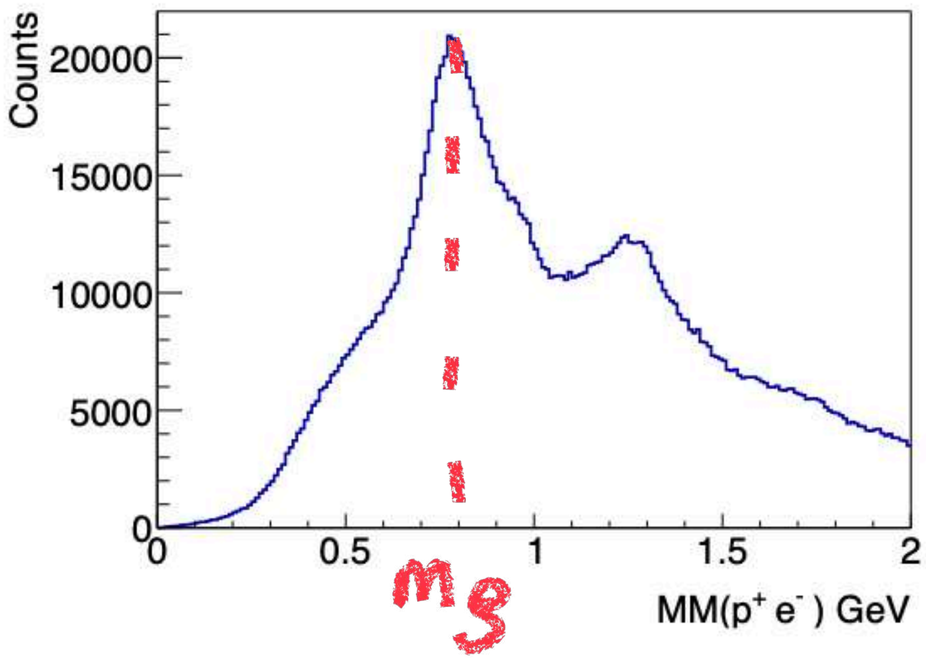
↓

DETECT $e\pi^+\pi^-$ & ONE OTHER POSITIVELY CHARGED PARTICLE (p TAIL EXTRACTION)

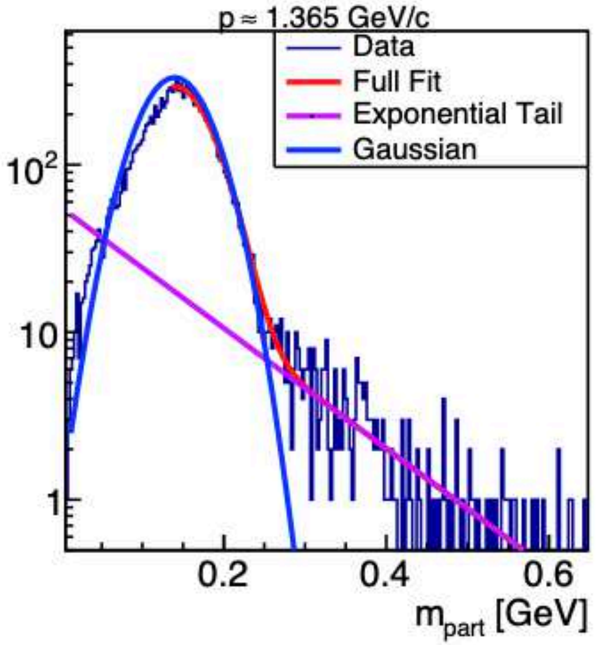
THE MODEL

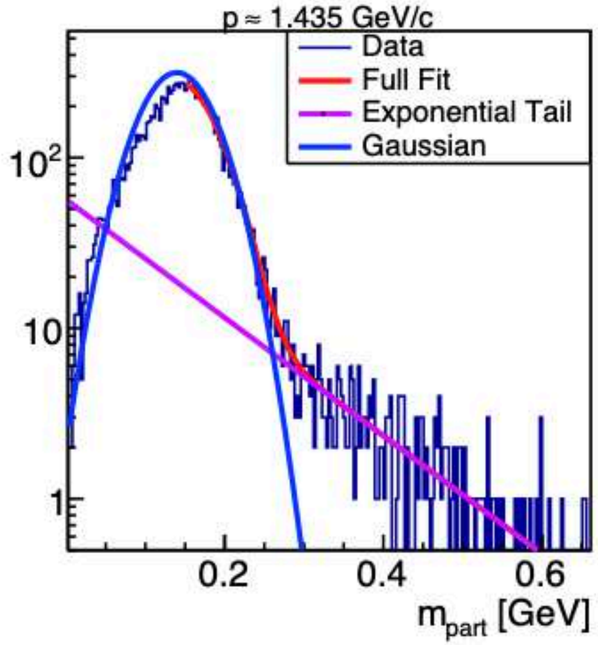
π^+ TAIL EXTRACTION

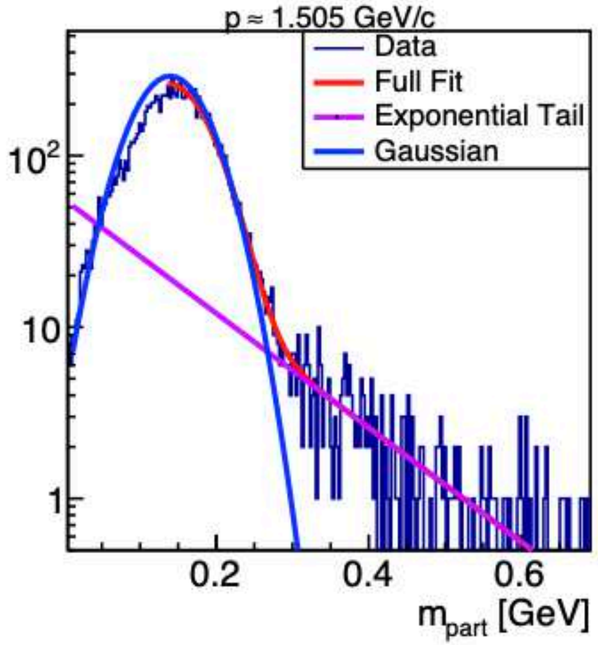




THE MODEL



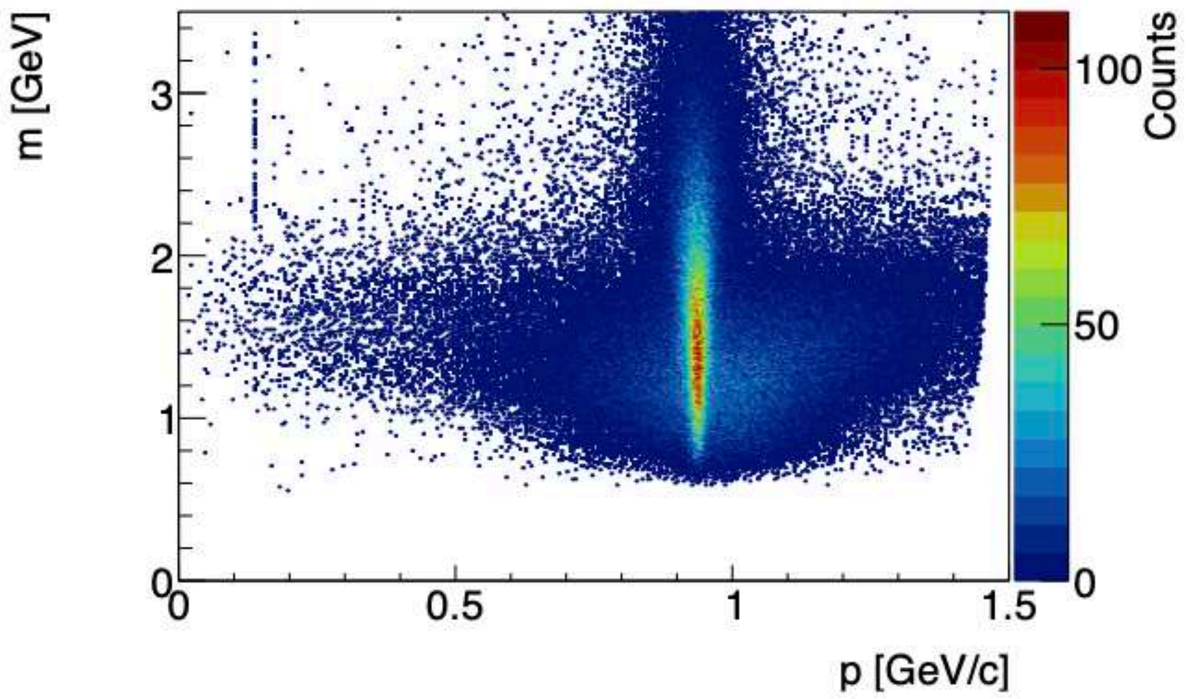


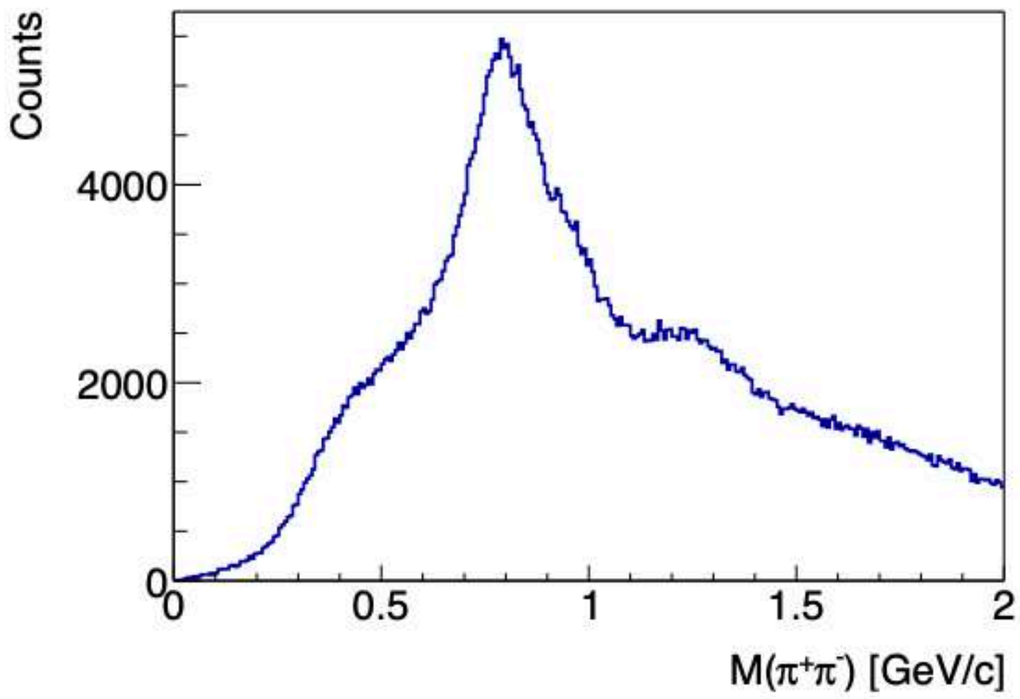


PLOT SLICES & FIT ITERATIVELY TO EXTRACT FULL SHAPE → GAUSSIAN AT m_π + EXPONENTIAL TAILS.

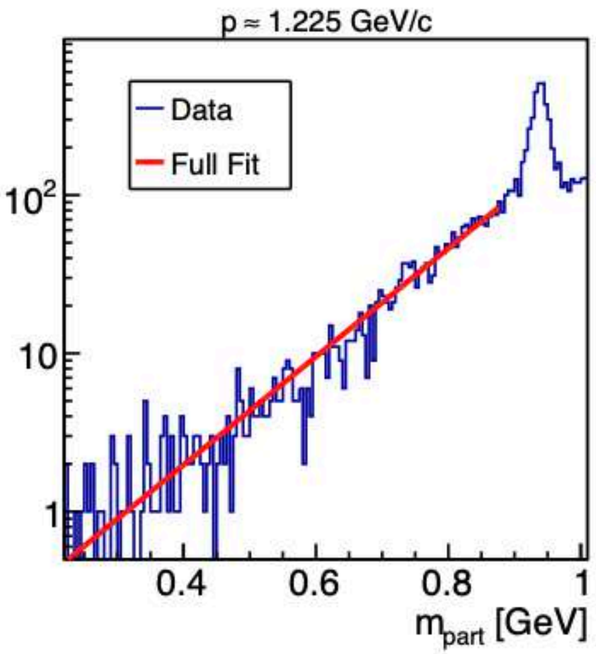
THE MODEL

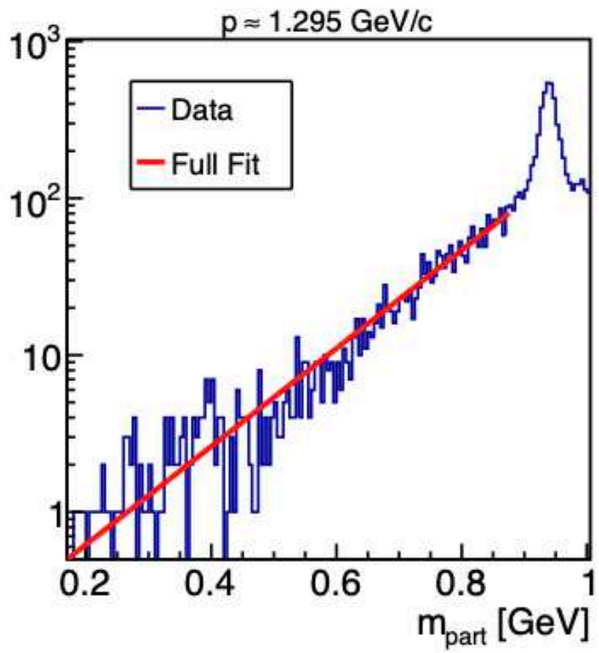
P TAIL EXTRACTION

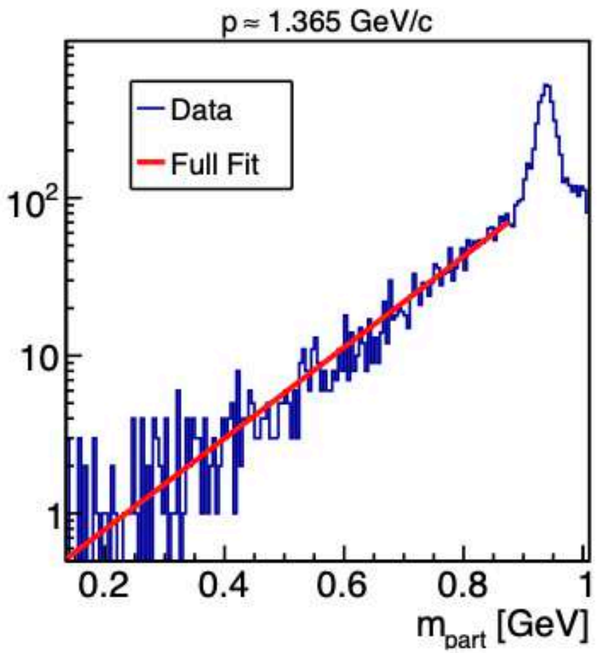




THE MODEL



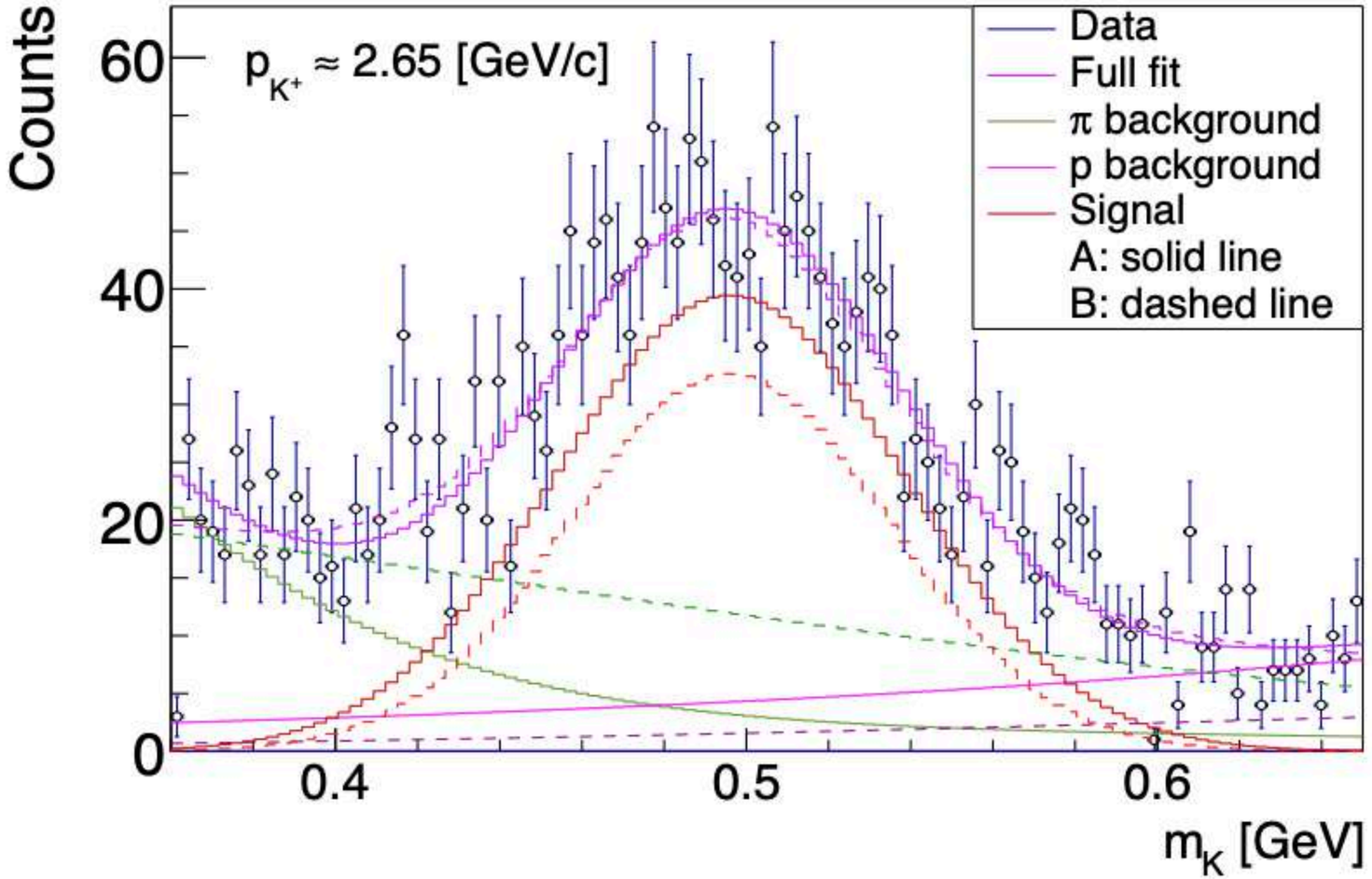




PROTON GAUSSIAN NOT PRESENT in m_K RANGE

↳ EXPONENTIAL TAIL SUFFICIENT.

THE MODEL



A: AFTER IN-TIME BG SHAPE EXTRACTION

B: BEFORE IN-TIME BG SHAPE EXTRACTION

SEQUENTIAL WEIGHTING

WE HAVE TWO KAONS TO FIT ...

↳ FIT KAON 1 (FAST) FIRST

↳ WEIGHTED FIT ON KAON 2 (SLOW)

SEQUENTIAL WEIGHTING

WE HAVE TWO KAONS TO FIT...

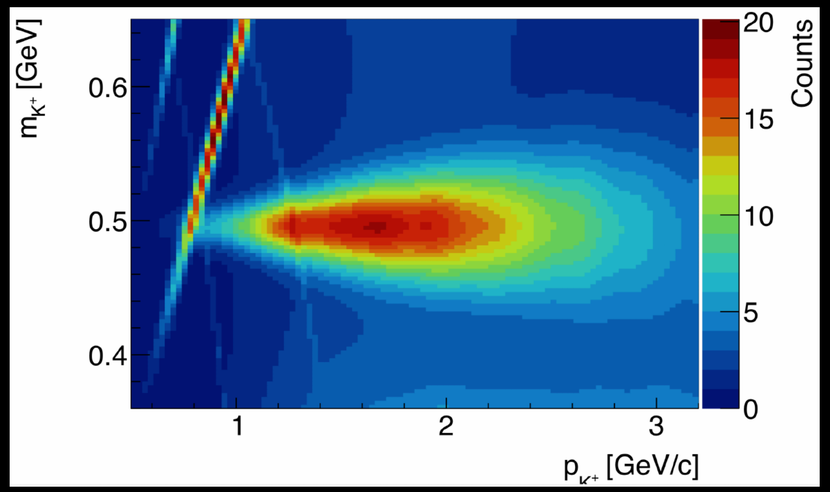
↳ FIT KAON 1 (FAST) FIRST

↳ WEIGHTED FIT ON KAON 2 (SLOW)

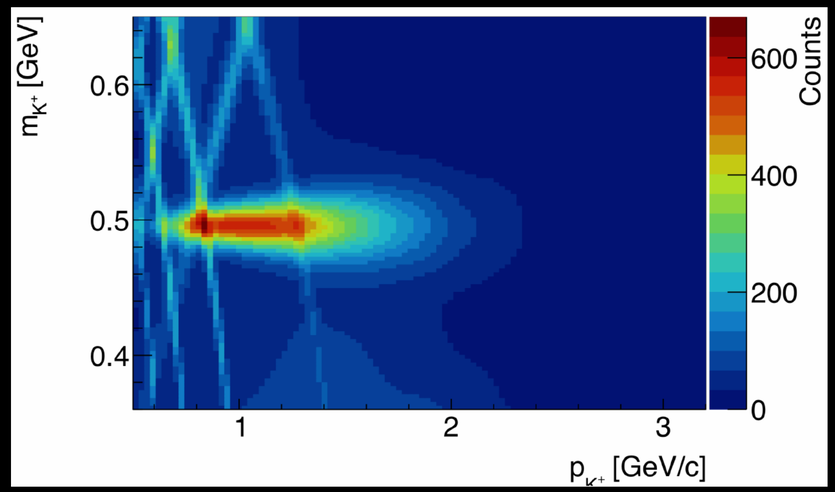
SEQUENTIAL S-WEIGHTING

PUTTING IT TOGETHER

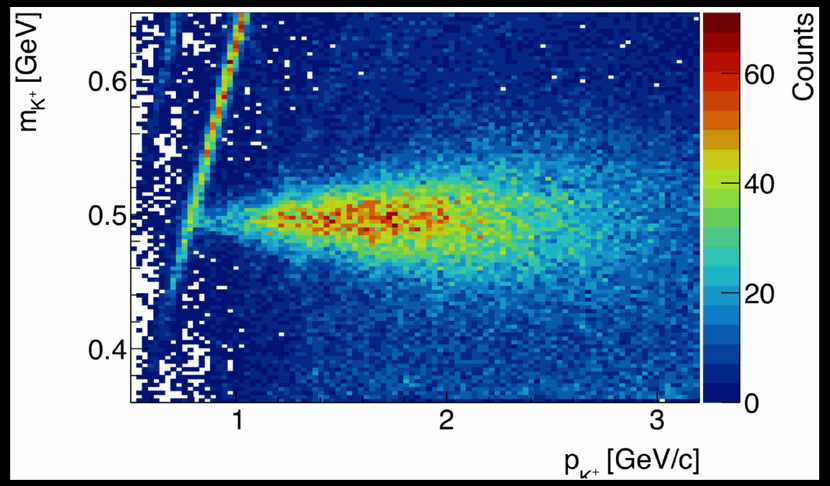
KAON 1 MODEL



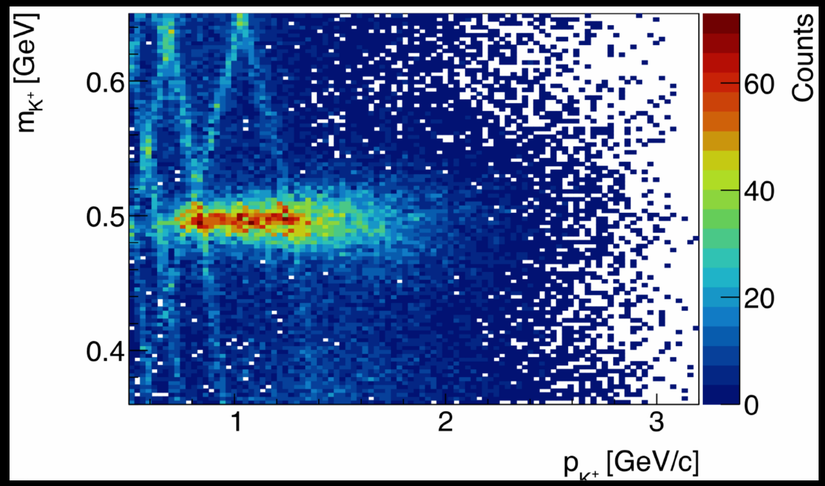
KAON 2 MODEL



KAON 1 DATA

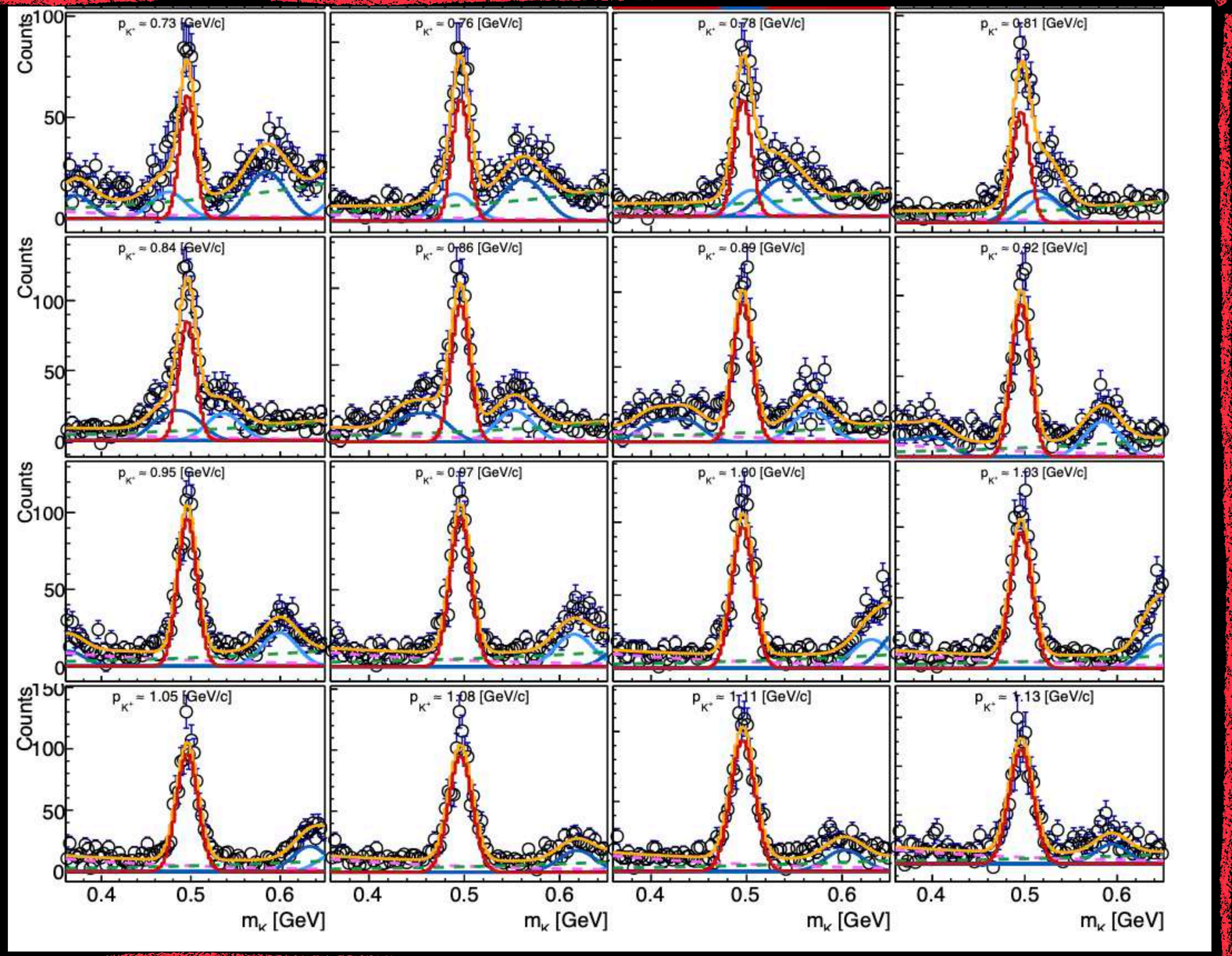


KAON 2 DATA

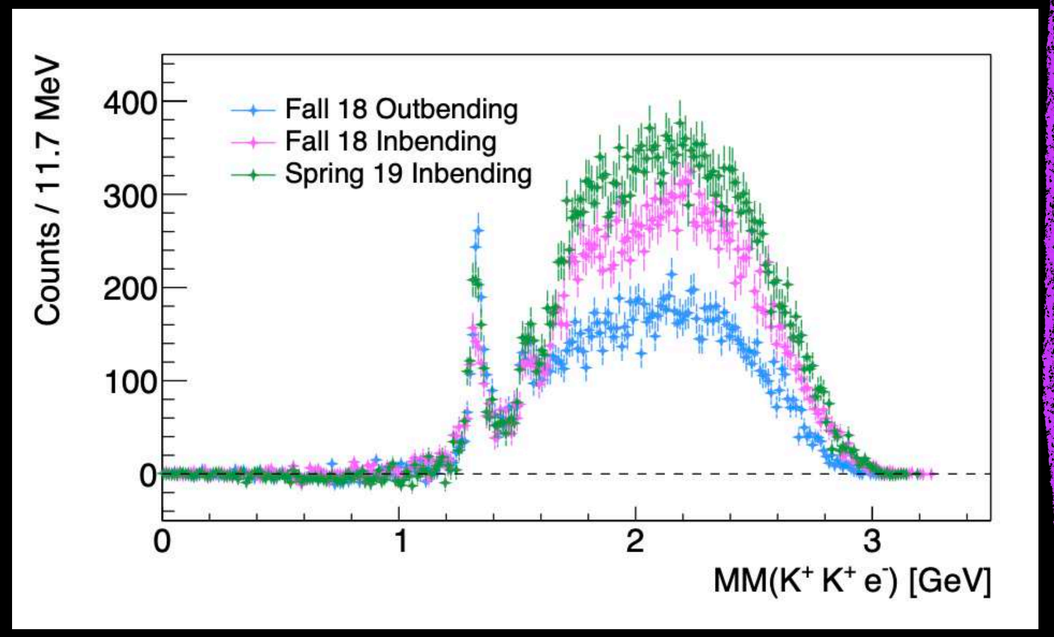


PUTTING IT TOGETHER

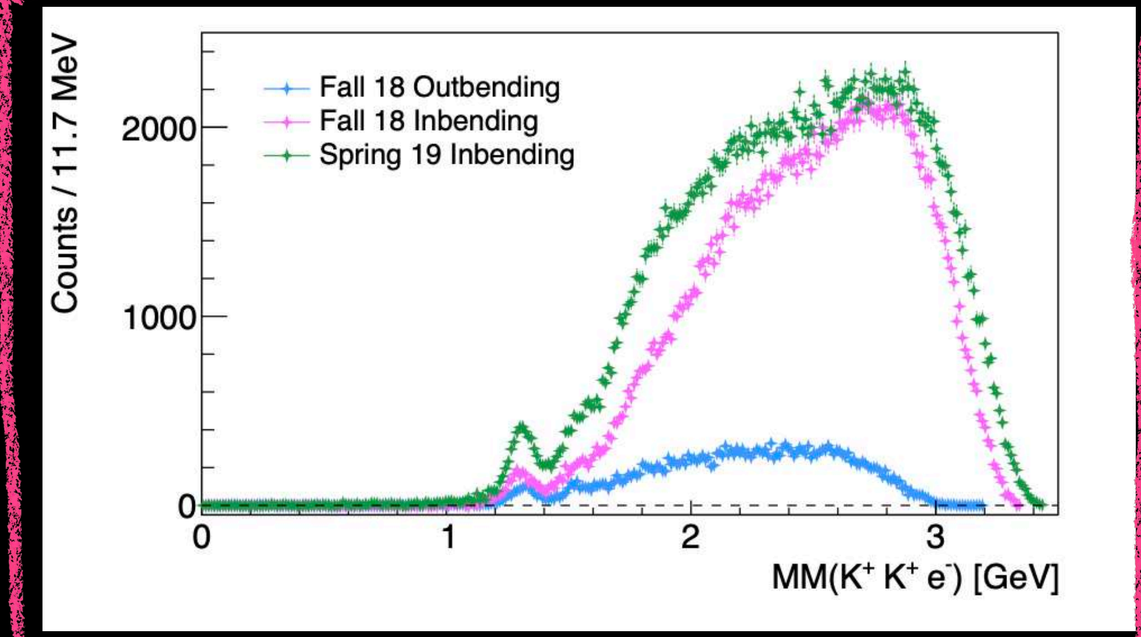
SLICES



FINAL RESULTS



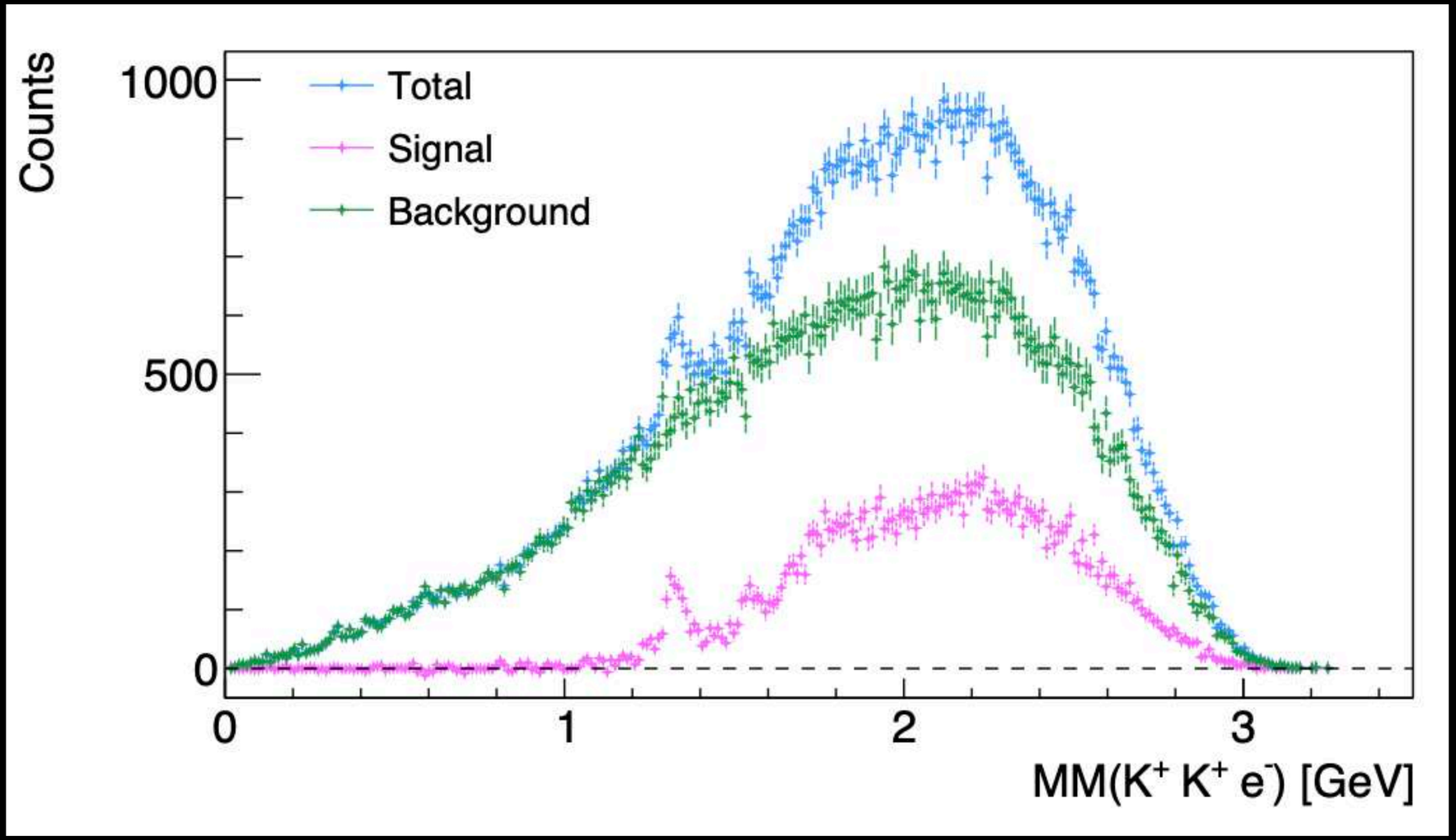
e^- in FD



e^- in FT

S-WEIGHTED SIGNALS!

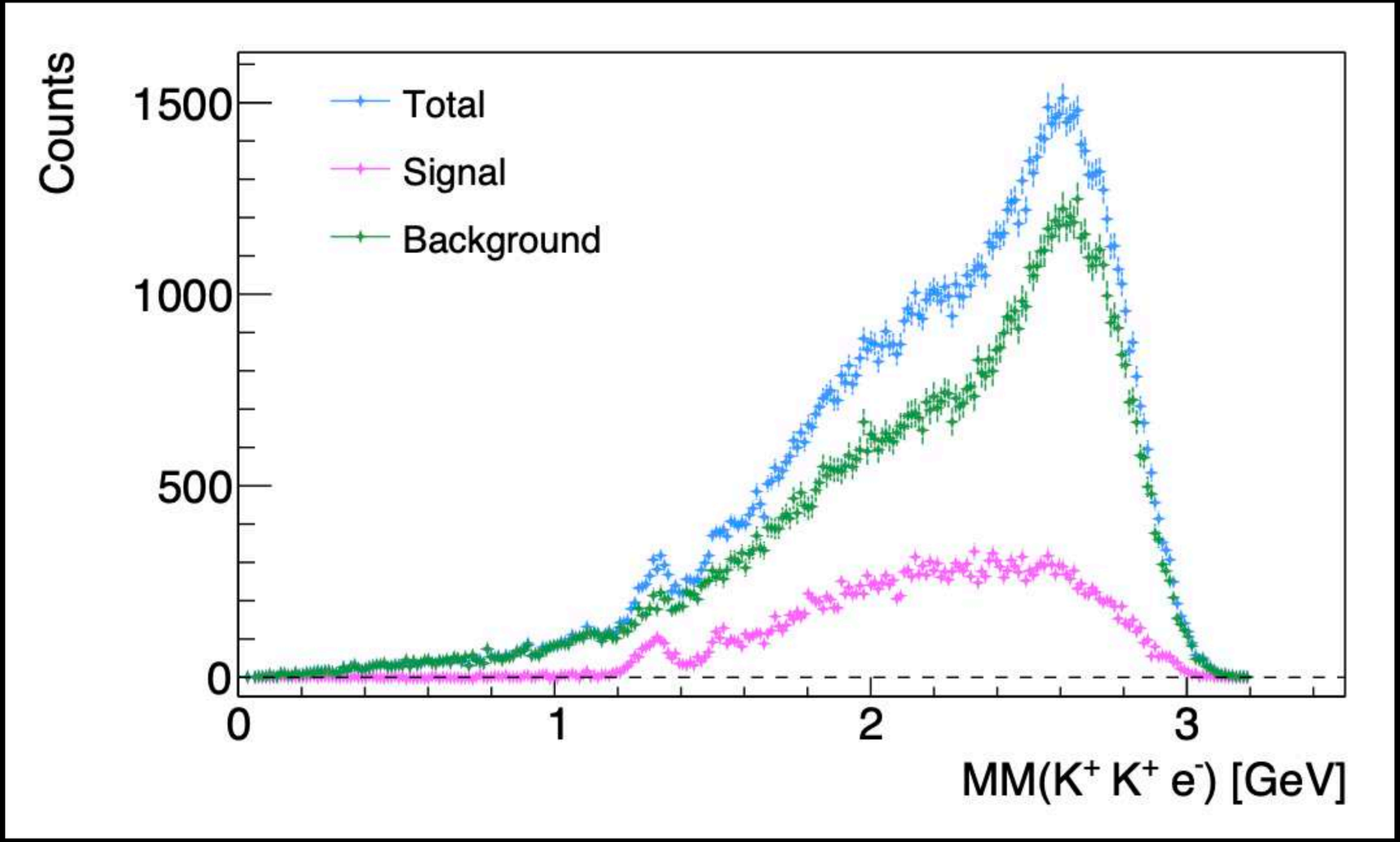
FINAL RESULTS



TOTAL, SIG & BG DISTRIBUTIONS FROM S-WEIGHTS

FALL 18 INBENDING e^- in FD.

FINAL RESULTS



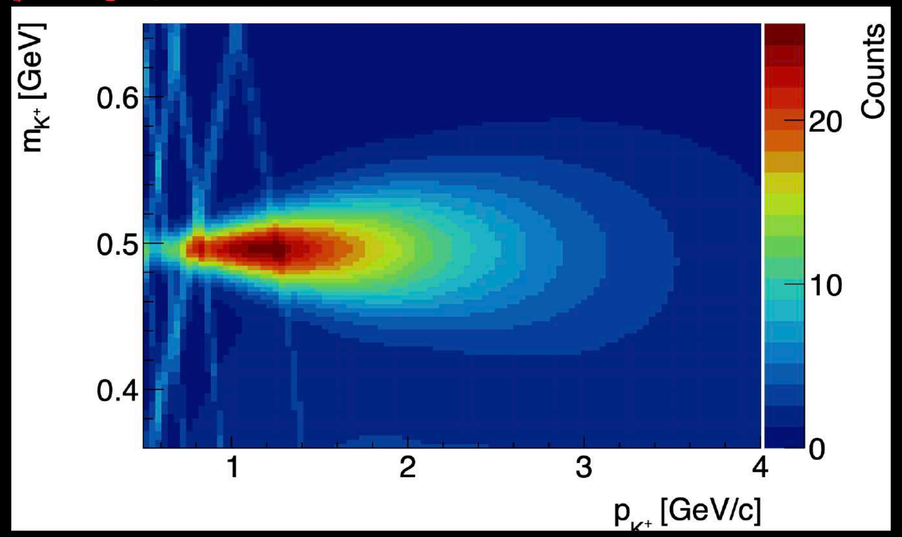
TOTAL, SIG & BG DISTRIBUTIONS FROM S-WEIGHTS

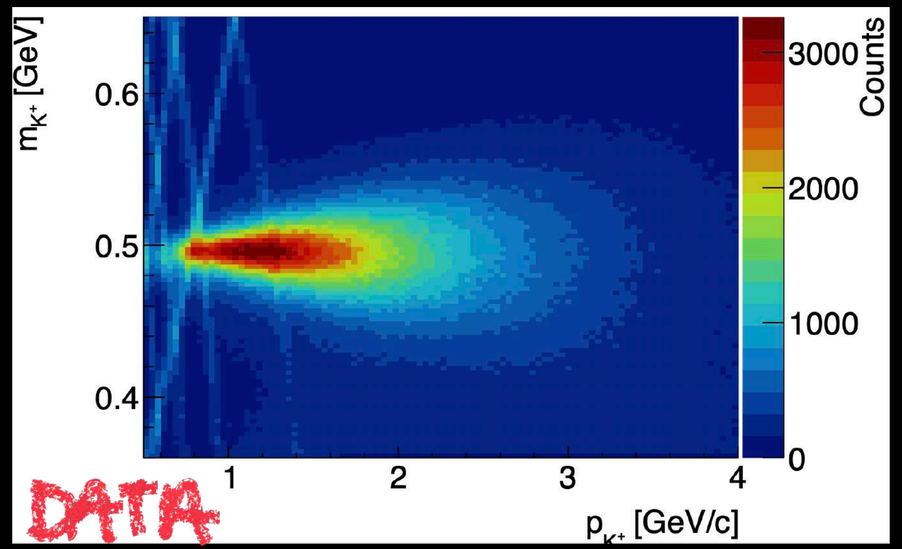
FALL 18 OUTBENDING

e^- in FT.

RGB VALIDATION

MODEL



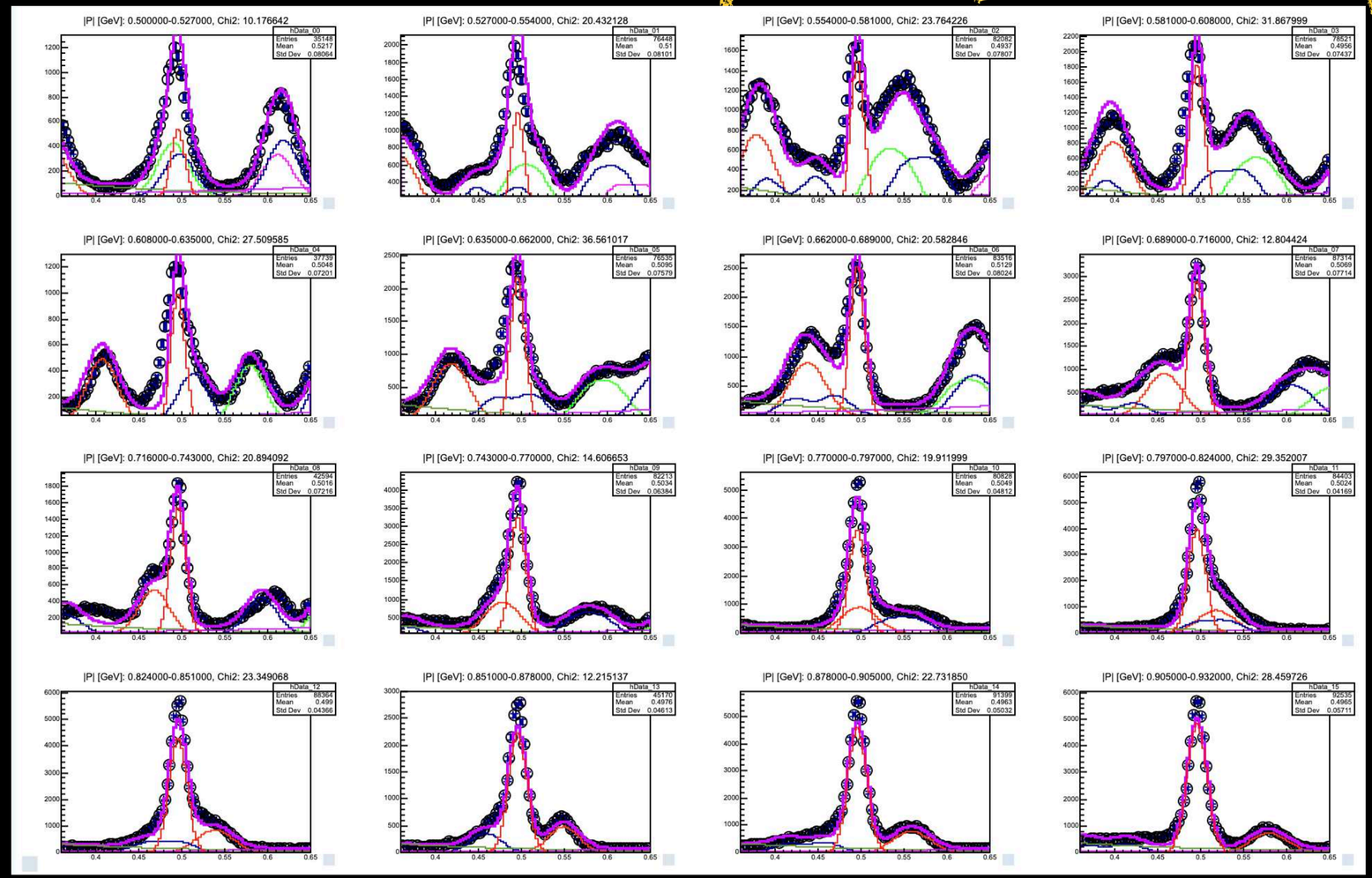


DATA

PRELIMINARY

1D SLICES

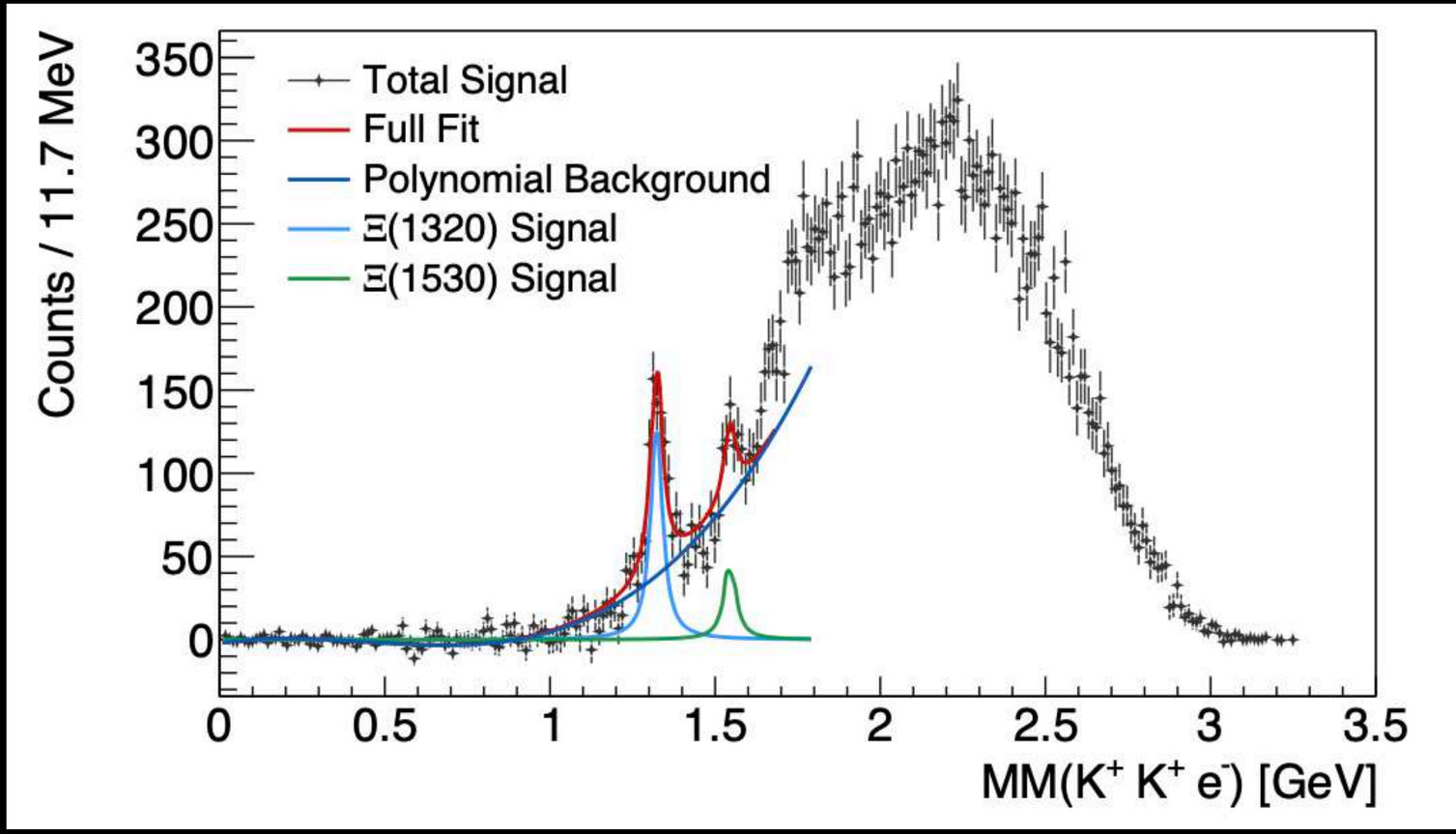
PLOTS FROM JOSHUA BRYCE



CONCLUSIONS

1. NEW ROBUST KAONID
2. DIFFERENT RUN GROUPS TESTED
3. ANALYSIS NOTE SUBMITTED!

RGA FALL 18 INBENDING

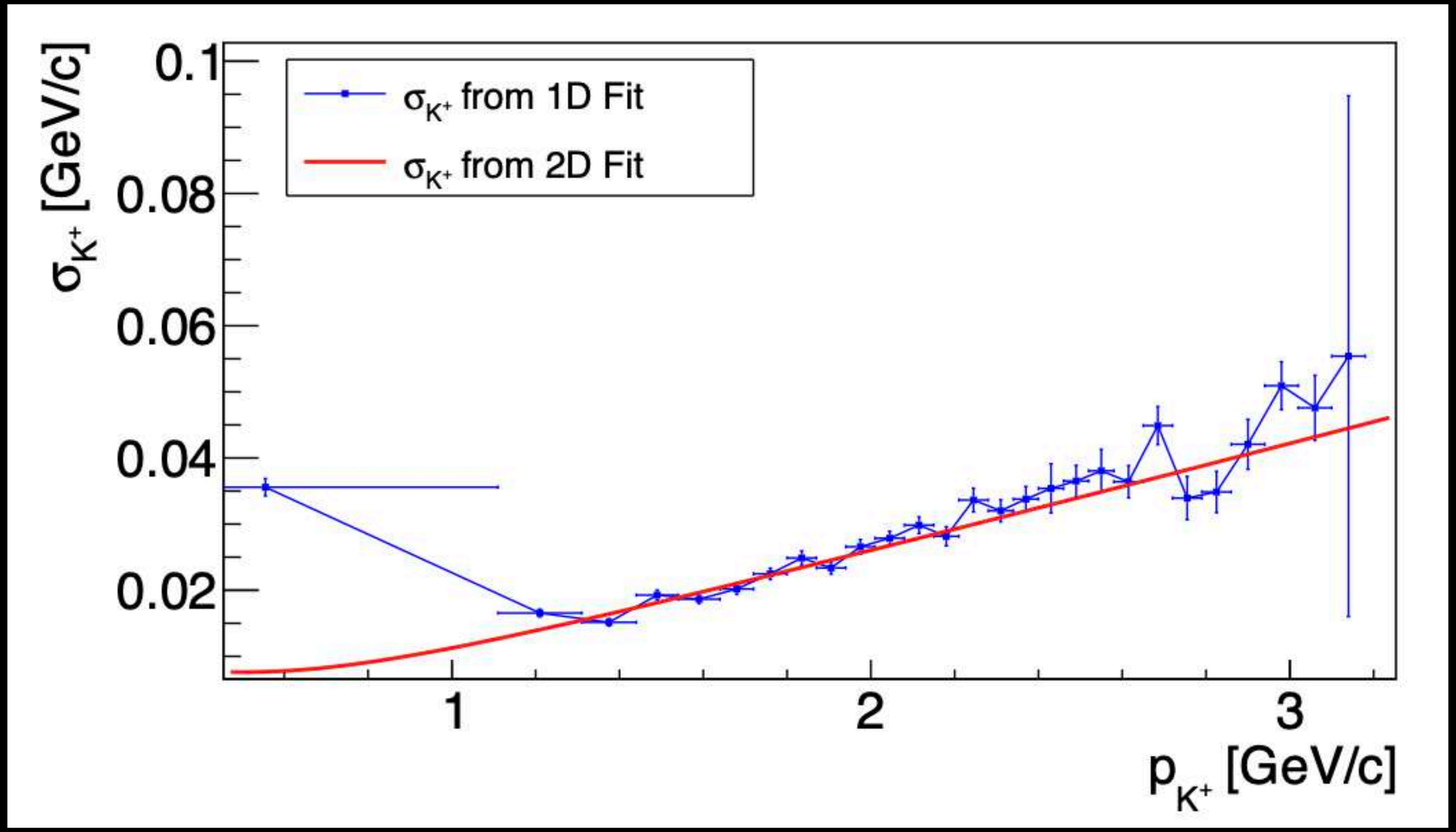


BACK-UP #1

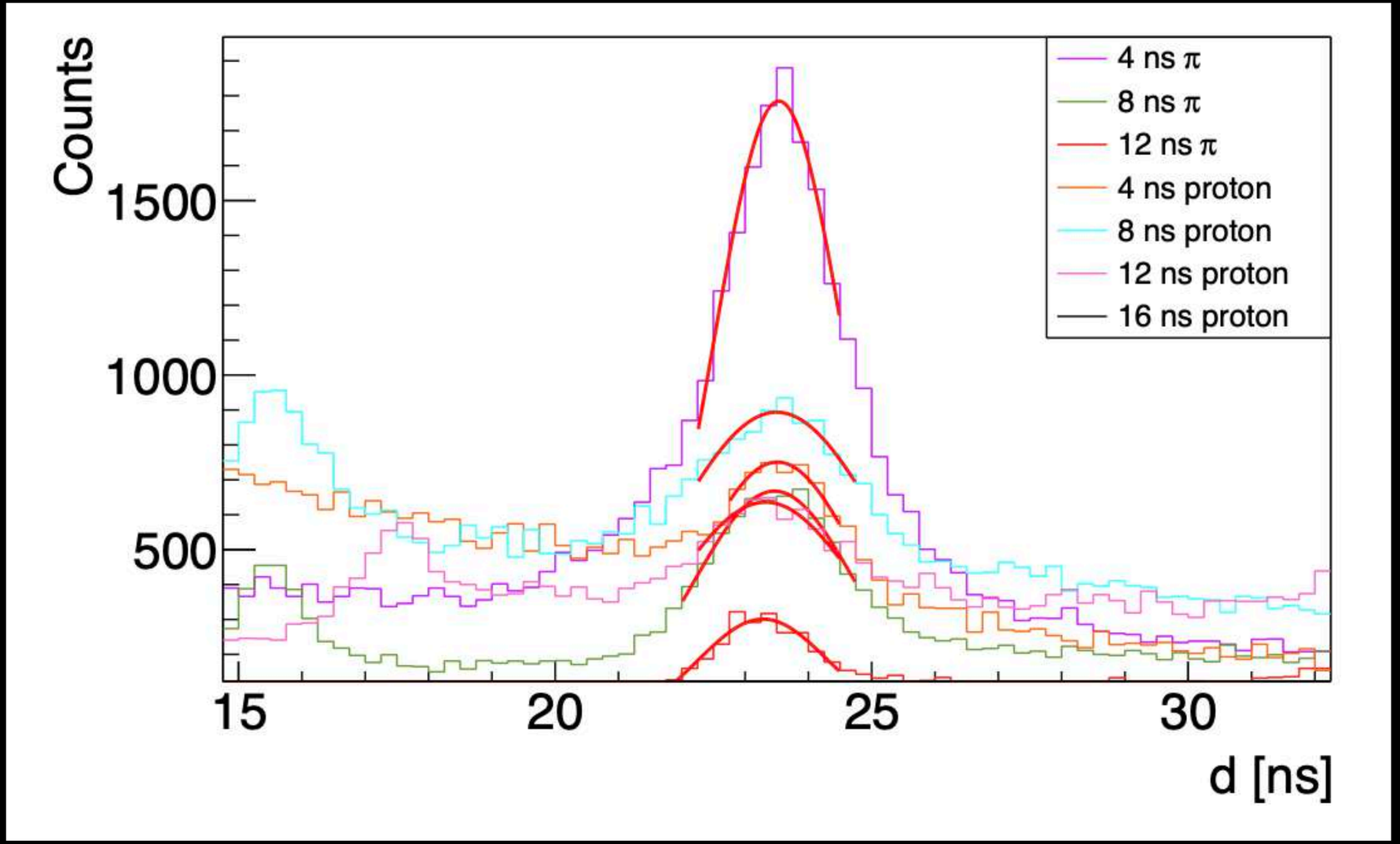
e^- in FD						
Run Period	Total	Background	Signal	$\Xi^-(1320)$	$\Xi^-(1530)$	Signal(%)
Fall 18 Inbending	111257	85469	25788	707.5	216.5	23.2
Fall 18 Outbending	89705	72532	17173	1247.5	385.6	19.1
Spring 19 Inbending	164726	133649	31077	1127	503.7	18.9
Total	365688	291650	**74,038**	3082	1105.8	
e^- in FT						
Fall 18 Inbending	809503	609141	200362	1457.9	498.2	24.8
Fall 18 Outbending	123848	95993	27855	853.3	433.2	22.5
Spring 19 Inbending	1047984	791814	256170	3524.4	1168.1	24.4
Total	1981335	1496948	**484,387**	5835.6	2099.6	

Table 1: Total yields for all time periods used in this analysis.

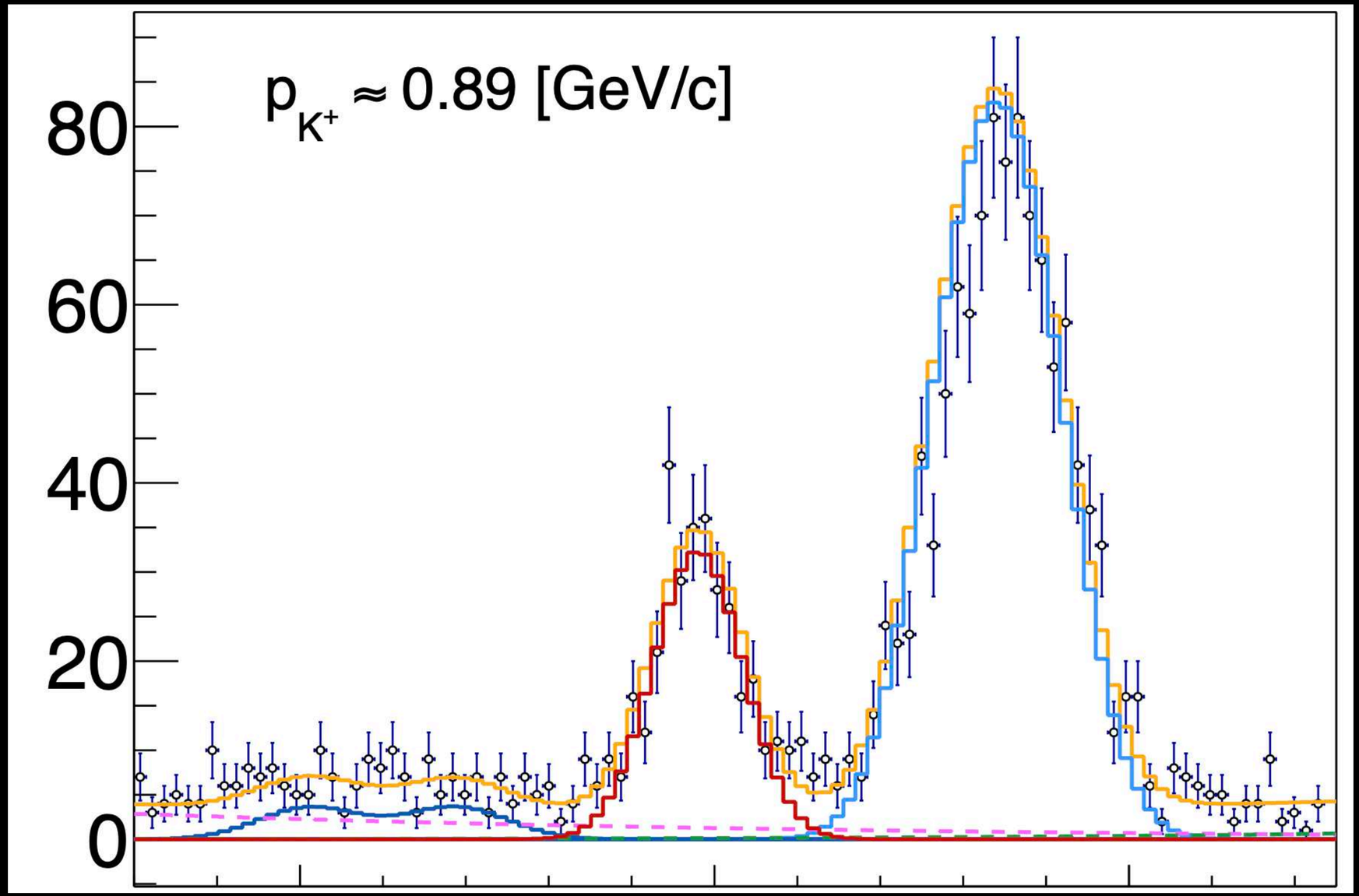
BACK-UP # 2


σ_{K^+} from 1D Fit
σ_{K^+} from 2D Fit
σ_{K^+} [GeV/c]
0.1
0.08
0.06
0.04
0.02
1
2
3
p_{K^+} [GeV/c]

BACK-UP #3

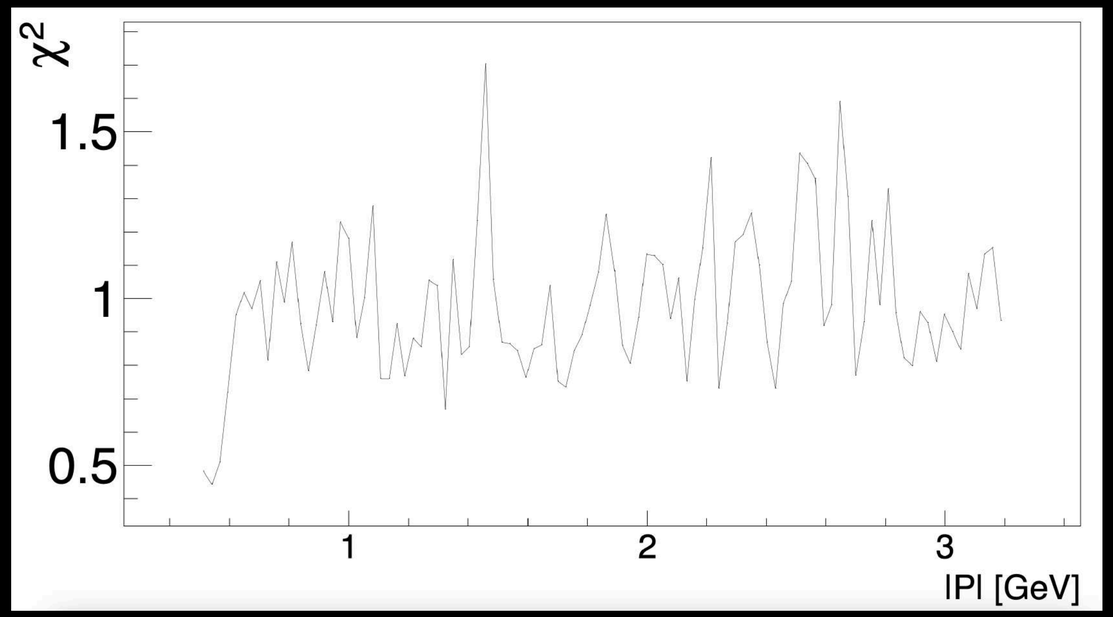

Counts
1500
1000
500
15
20
25
30
d [ns]
4 ns π
8 ns π
12 ns π
4 ns proton
8 ns proton
12 ns proton
16 ns proton

BACK-UP #4



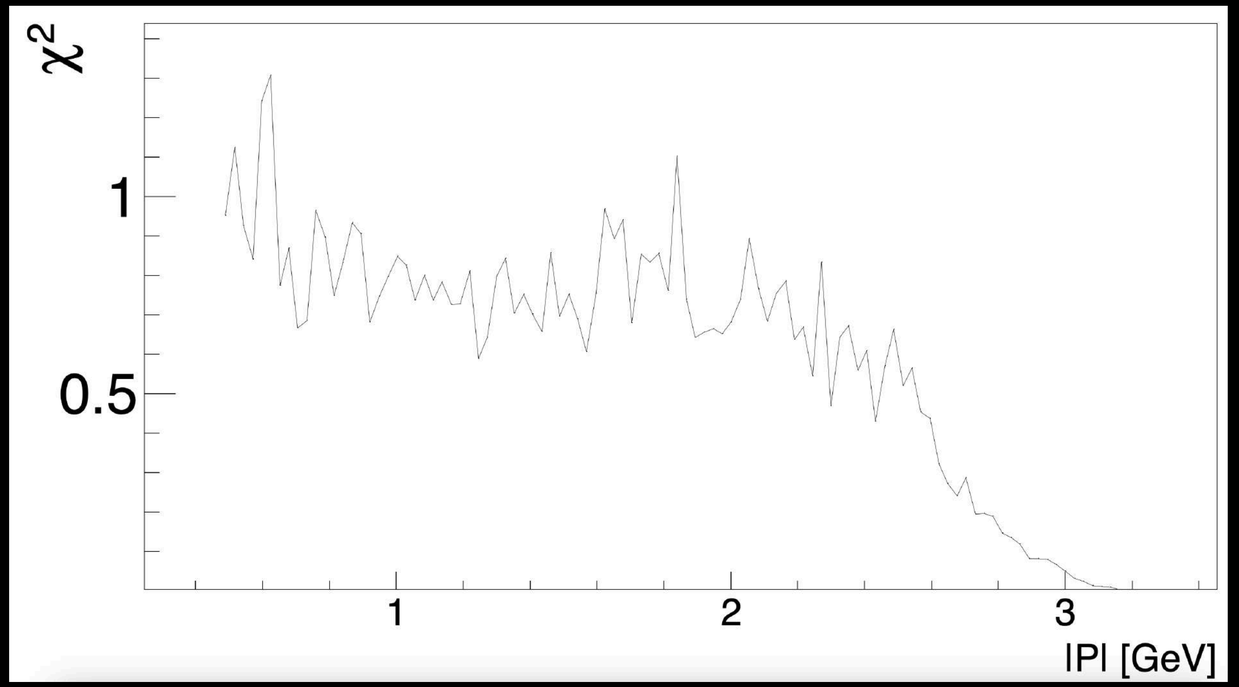
BACK-UP #5

RGA Spring 2019

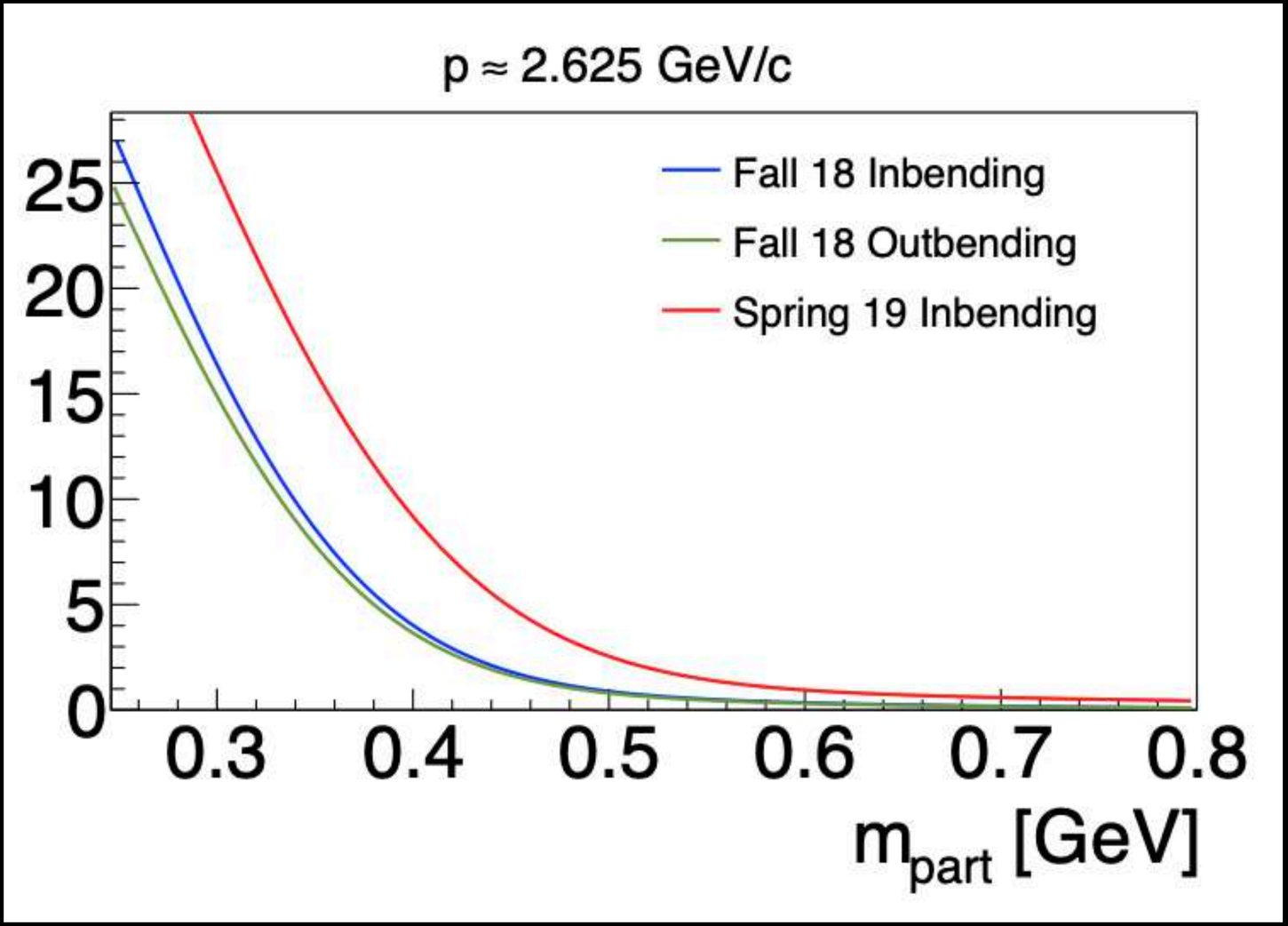


χ^2 of kaon 1

χ^2 of kaon 2

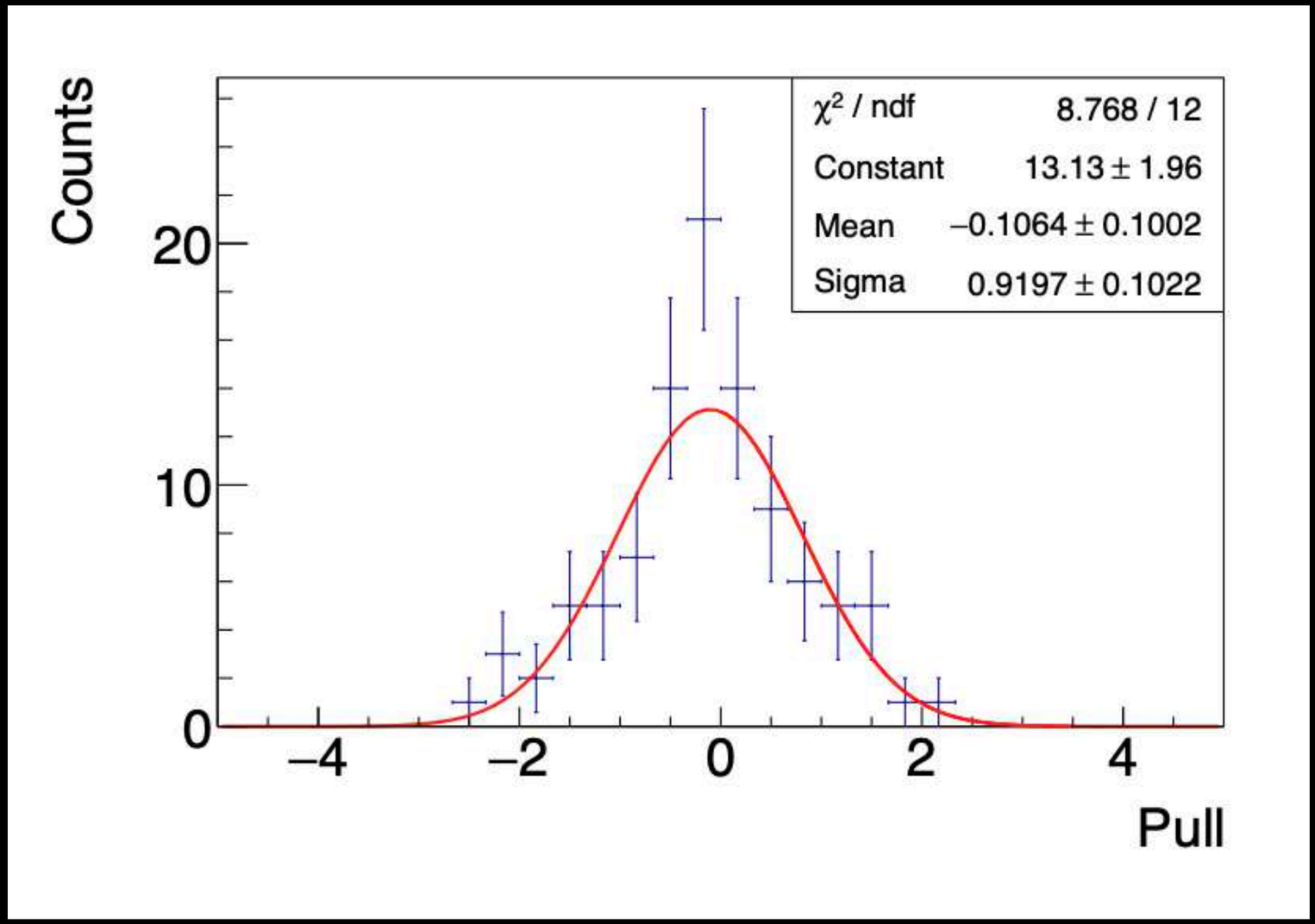


BACK-UP #6



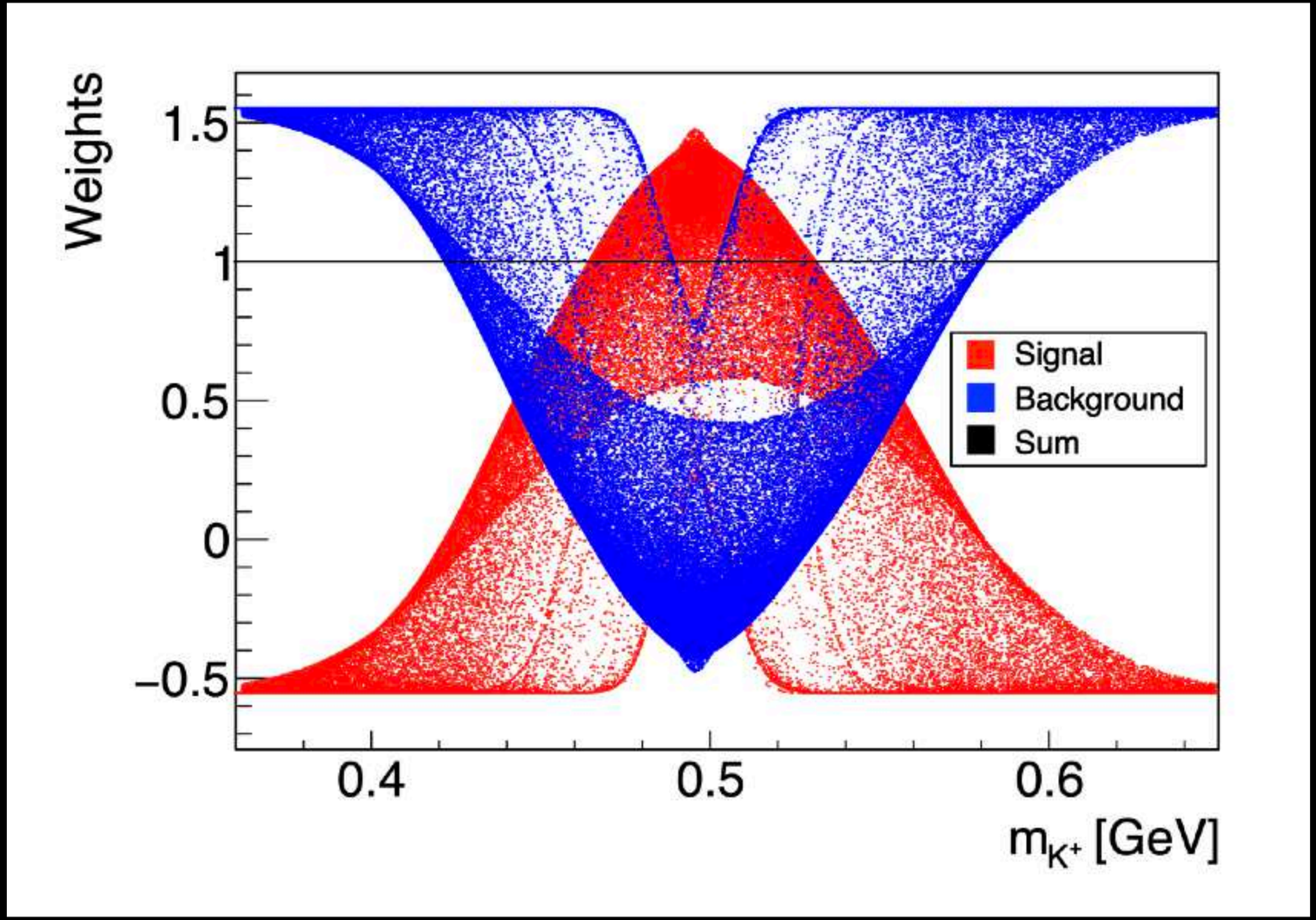
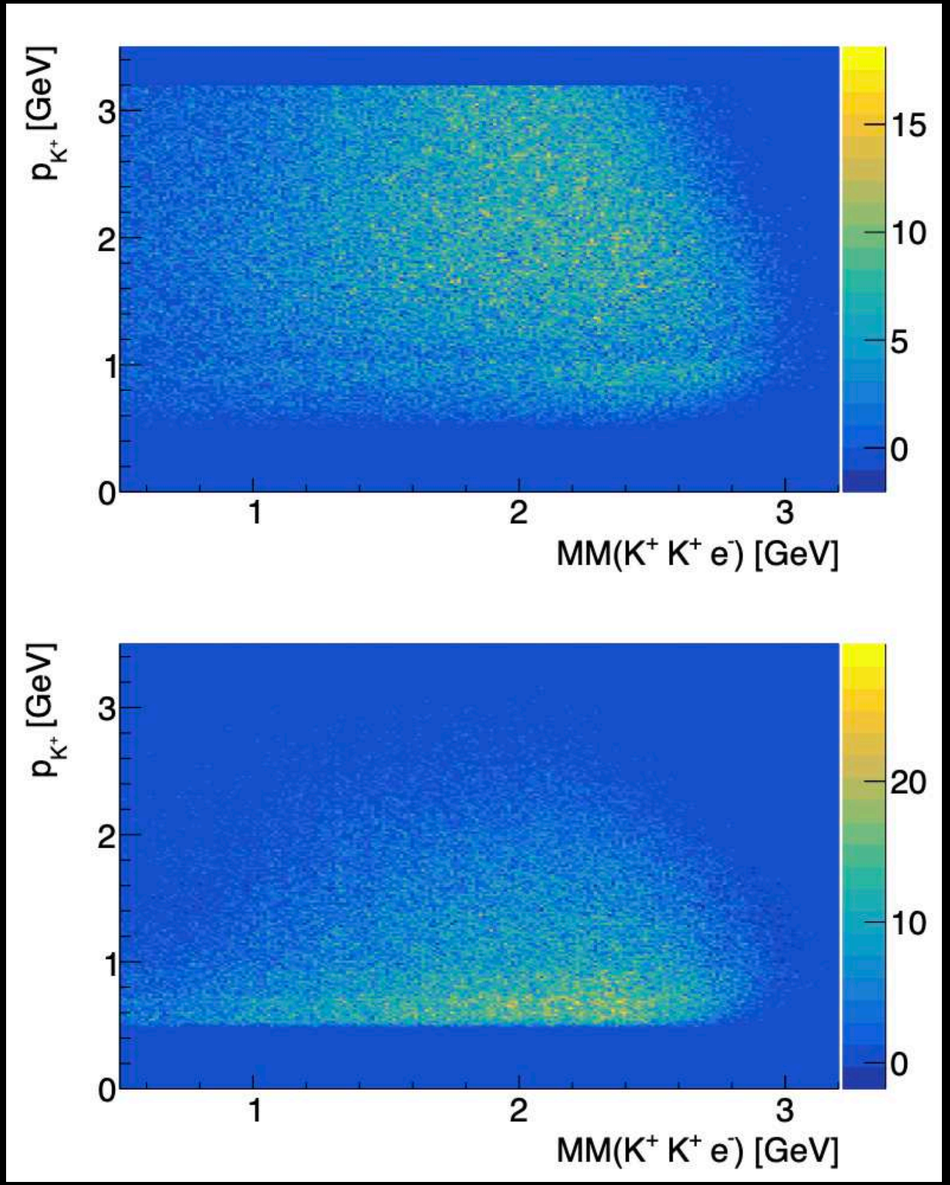
Shape comparison of π^+ background in different run periods.

BACK-UP #7



Spring 19 pulls

BACK-UP #8



BACK-UP #9