

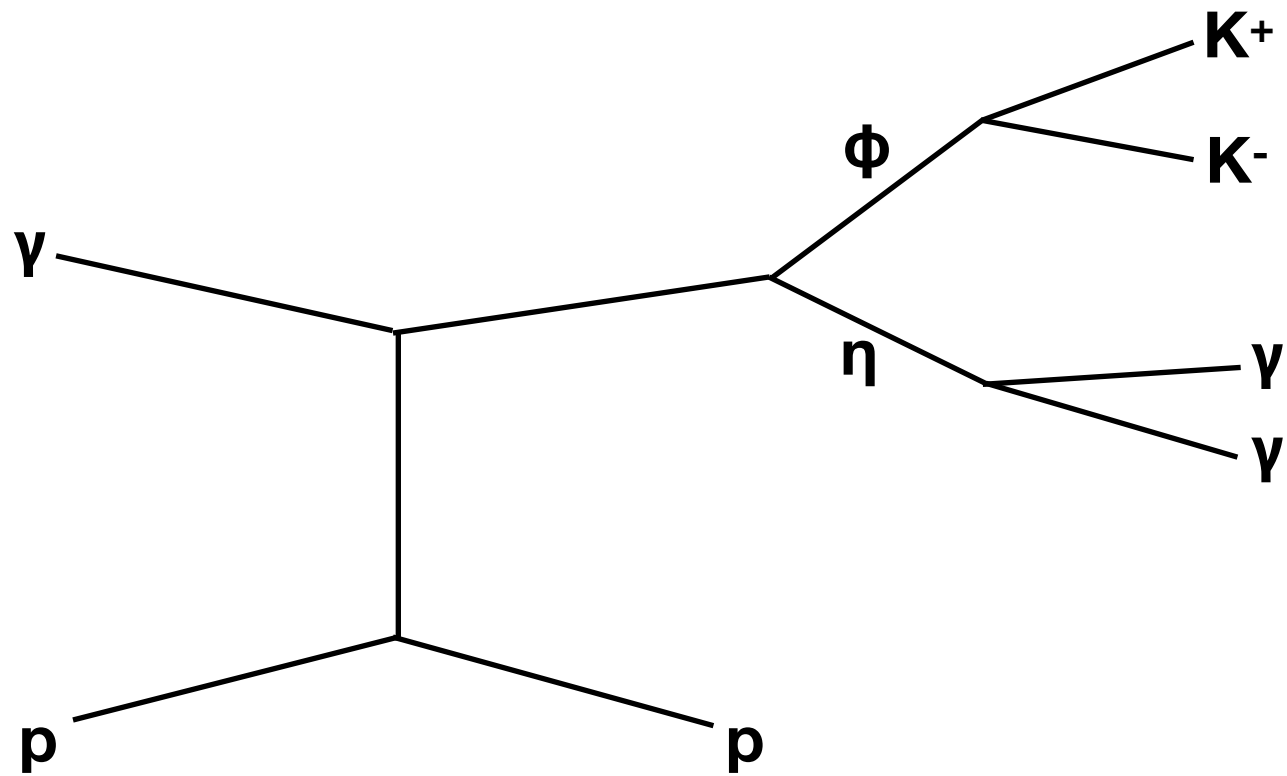
$\gamma p \longrightarrow p \phi \eta$ Update

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Florida State University
02/21/2019

Outline

- Motivation
- Cuts
- Selecting $\phi\eta$ Events
- Preliminary Results

$$\gamma p \longrightarrow p \phi \eta$$



- Spring 2017 Data Set
- 21,822 total events after selection cuts

Data Selection for $\gamma p \rightarrow p \phi \eta$

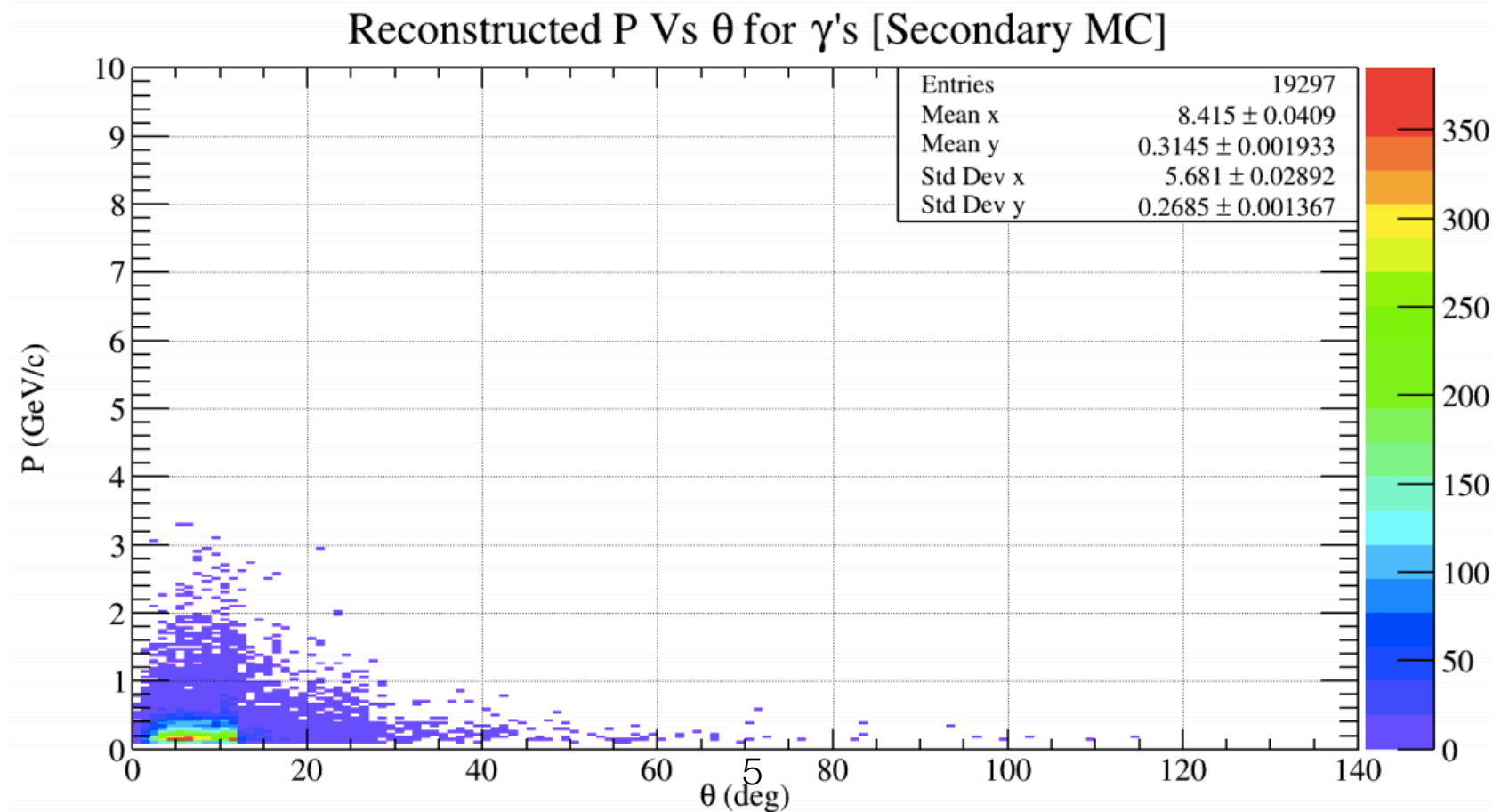
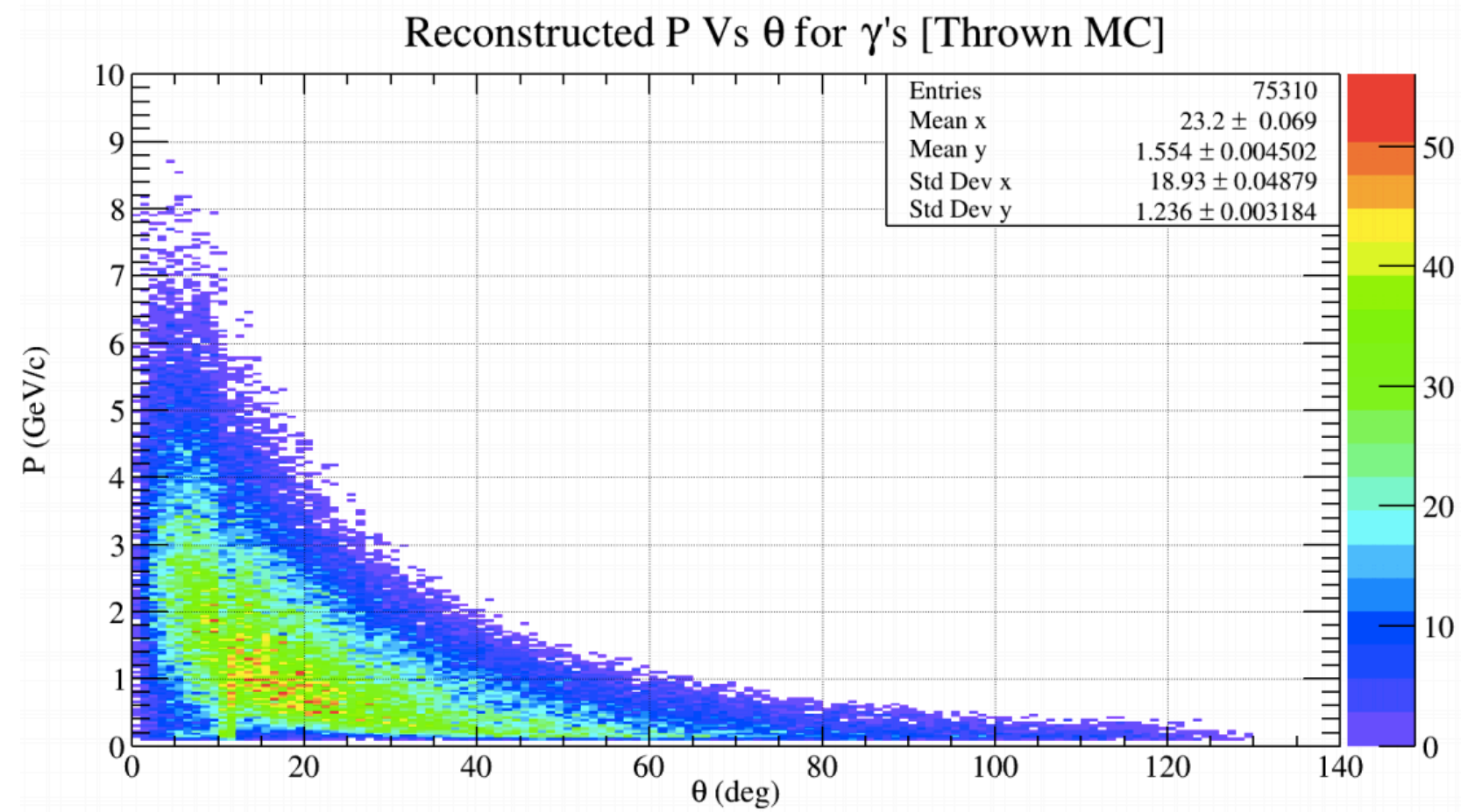
Standard GlueX Cuts:

- RF Timing (3 beam bunches)
- $51 \text{ cm} < \text{Vertex } Z < 79 \text{ cm}$
- Vertex $R \leq 1 \text{ cm}$
- dE/dX in CDC for proton
- PID Timing Cuts
- $|\text{MM}^2| < 0.02$
- Unused Shower Energy $< 50 \text{ MeV}$

Cuts Specifically for $\phi \eta$:

- K^+K^- Invariant Mass < 1.055
- $0.3 < \gamma\gamma$ Invariant Mass < 0.8
- Beam Photon With Best MM^2
- FCAL Photon $E < 500 \text{ MeV}$
- At least 1 Kaon I.D. from TOF
- Kaon Timing from TOF Only

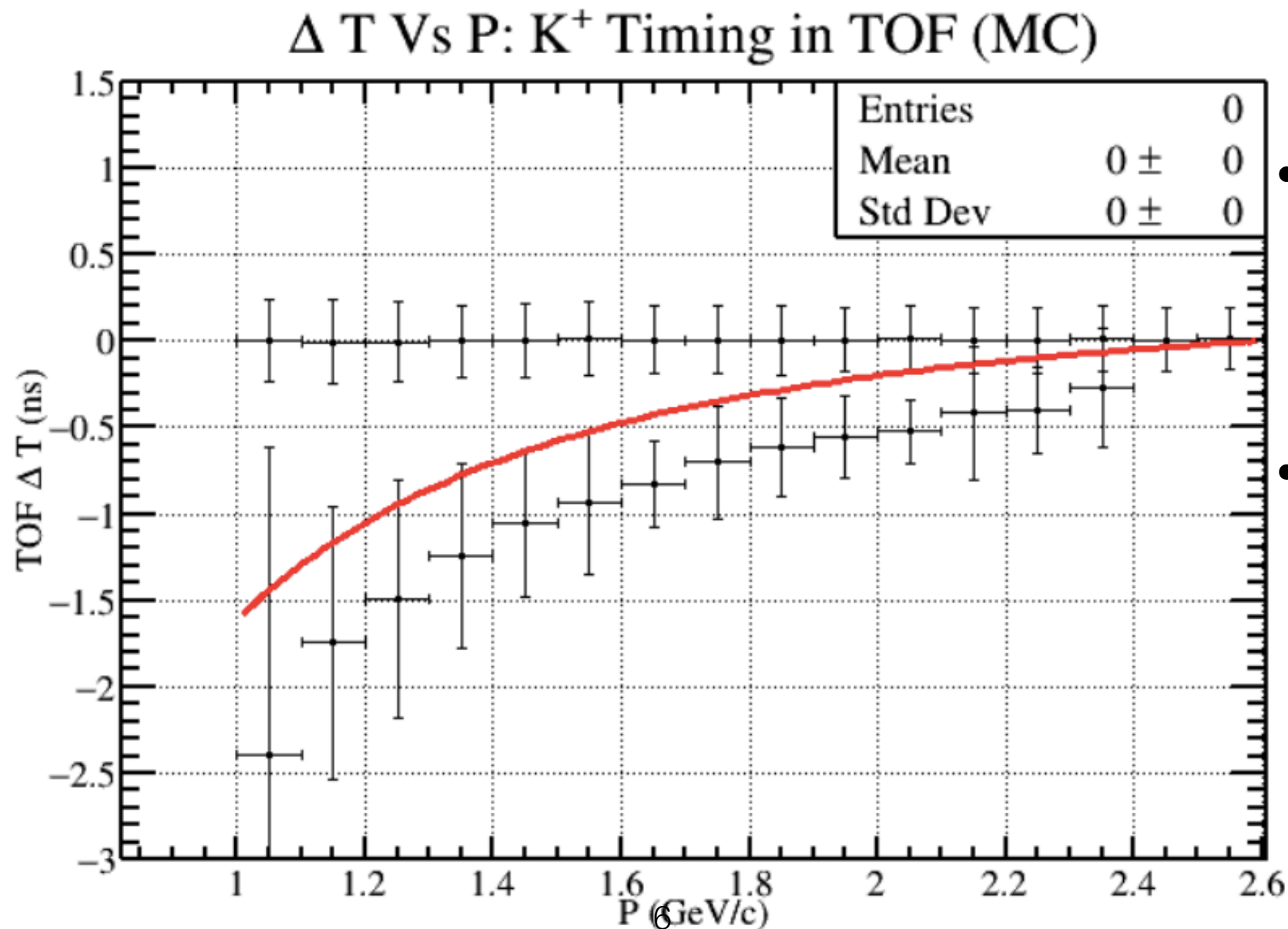
FCAL Photon $E < 500$ MeV



At least 1 Kaon ID from TOF

$$t = \frac{\delta X}{V} = \frac{\delta X}{\beta c} \quad t = \frac{\delta X}{c} \frac{\sqrt{m_i^2 + P^2}}{P}$$

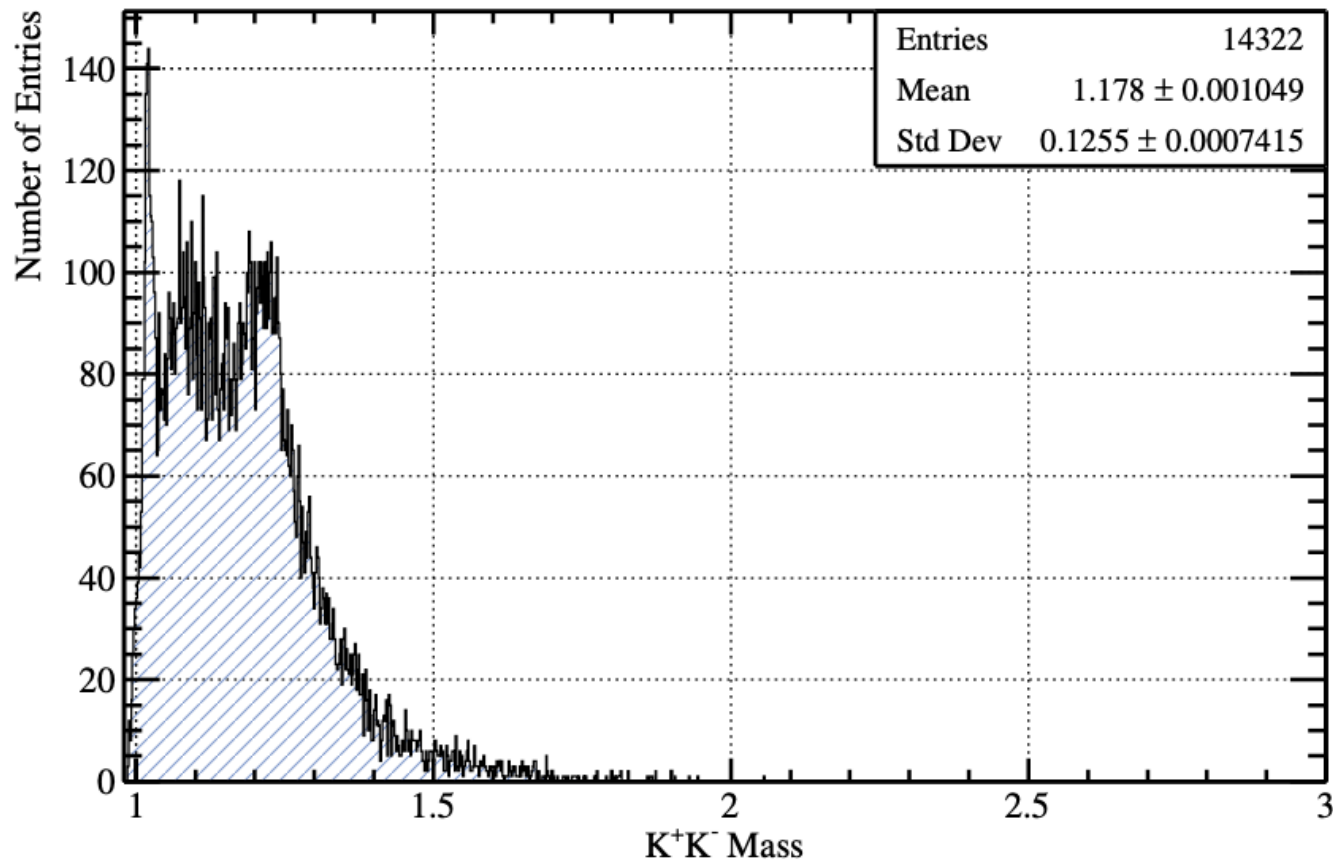
$$\delta t = \frac{\delta X}{c} \frac{\sqrt{m_\pi^2 + P^2} - \sqrt{m_K^2 + P^2}}{P}$$



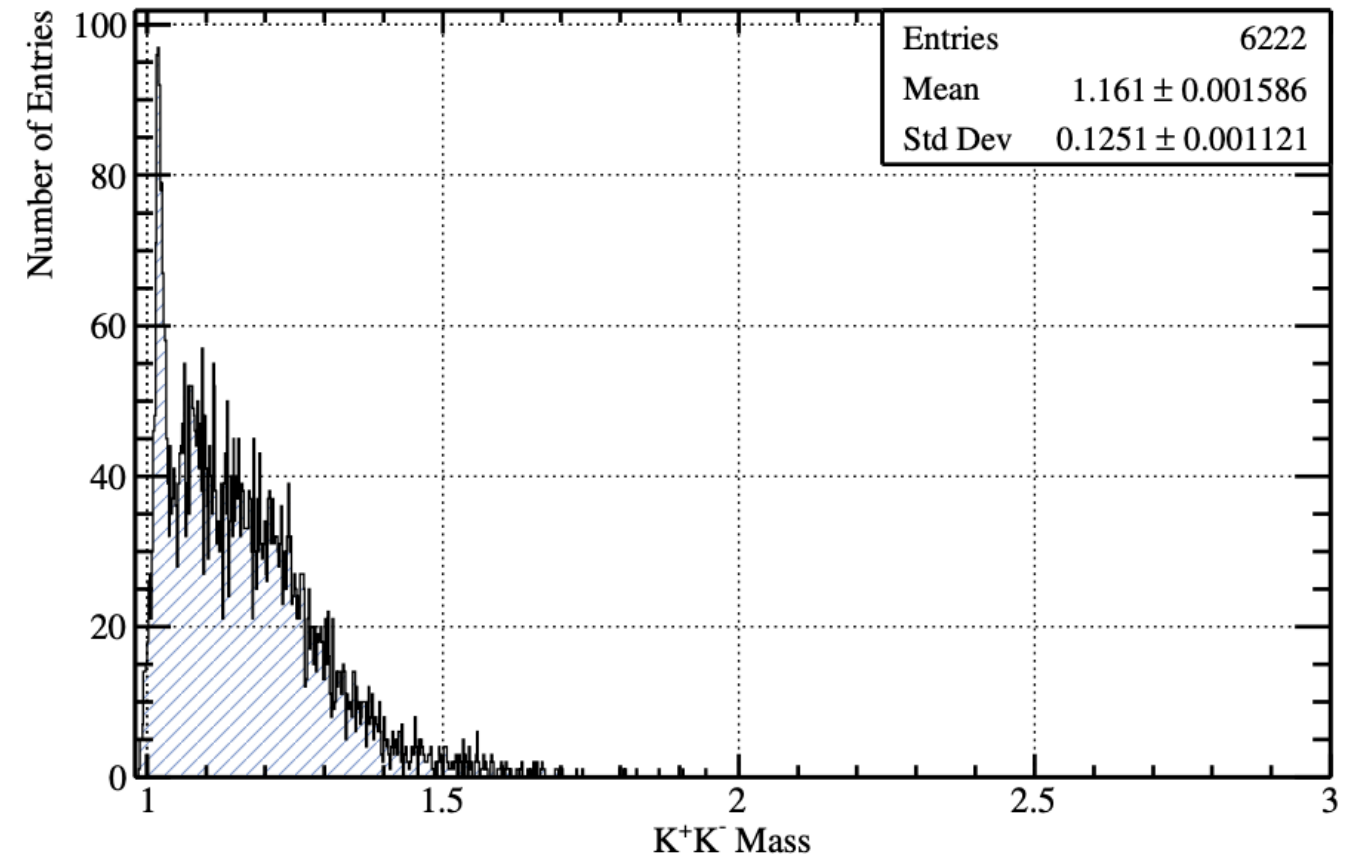
- Each event must have at least 1 Kaon ID from TOF
- A Kaon ID is any Kaon above the red line

At least 1 Kaon ID from TOF

Before TOF Kaon ID

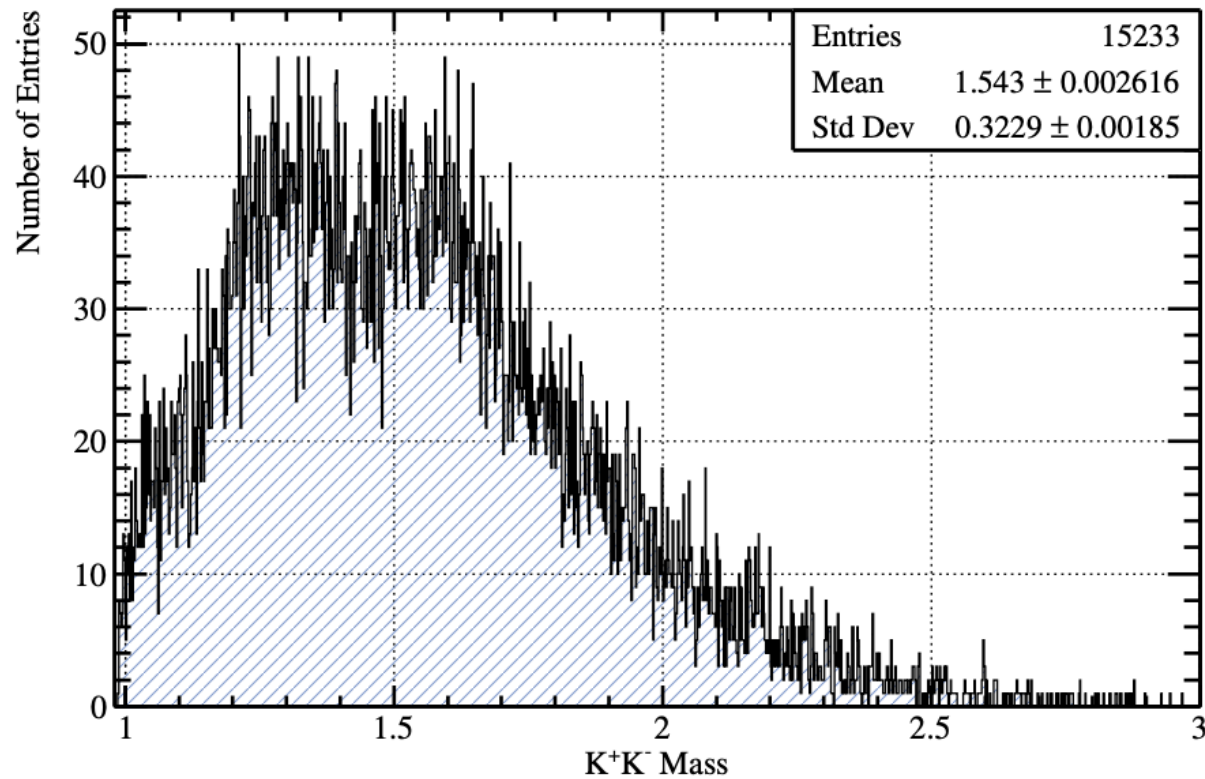


After TOF Kaon ID Selection

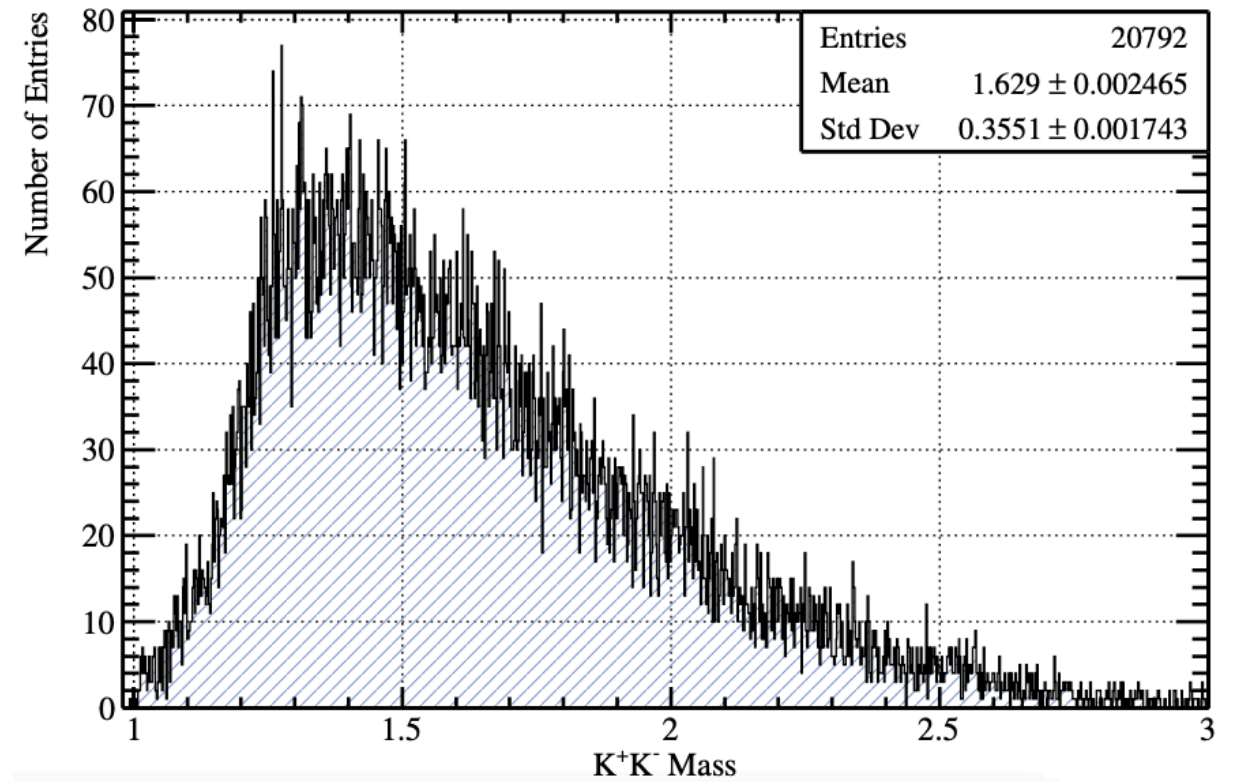


ϕ Only Seen in TOF

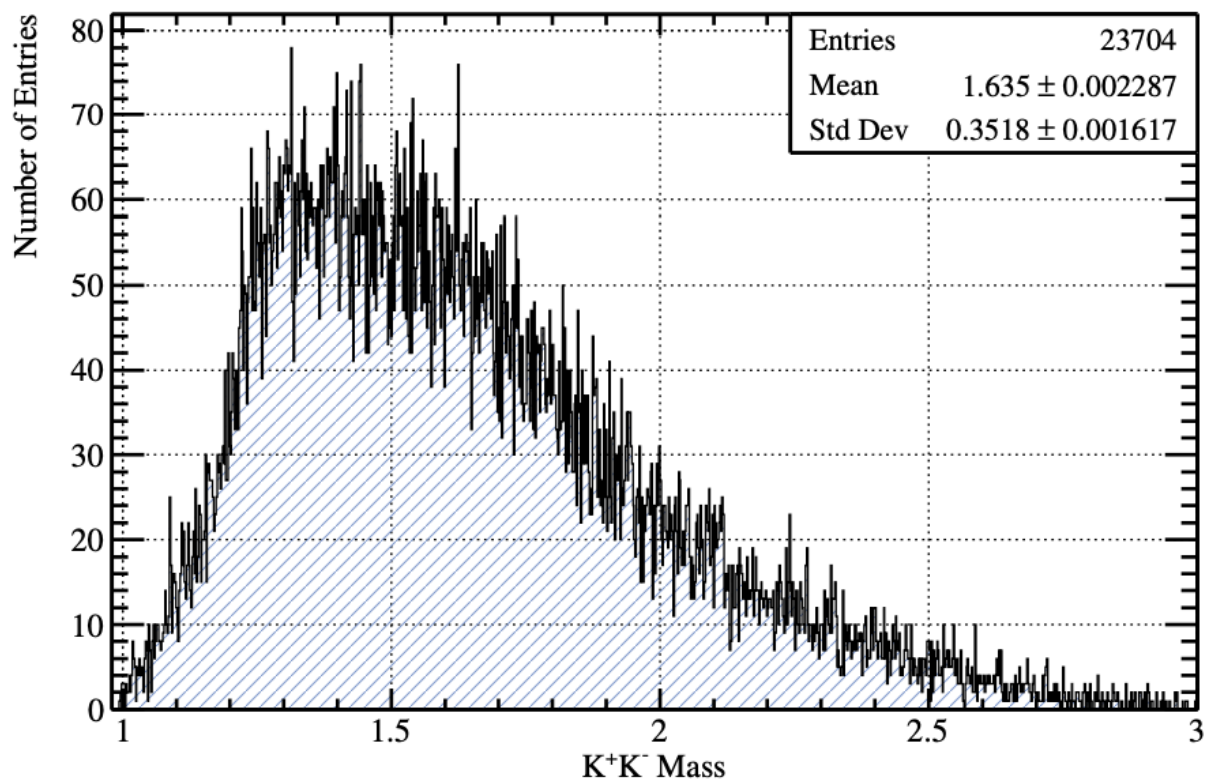
ProjectionY of binx=1 [x=-0.5..0.5] [$K_{\text{BCAL}}^+ K_{\text{BCAL}}^-$]



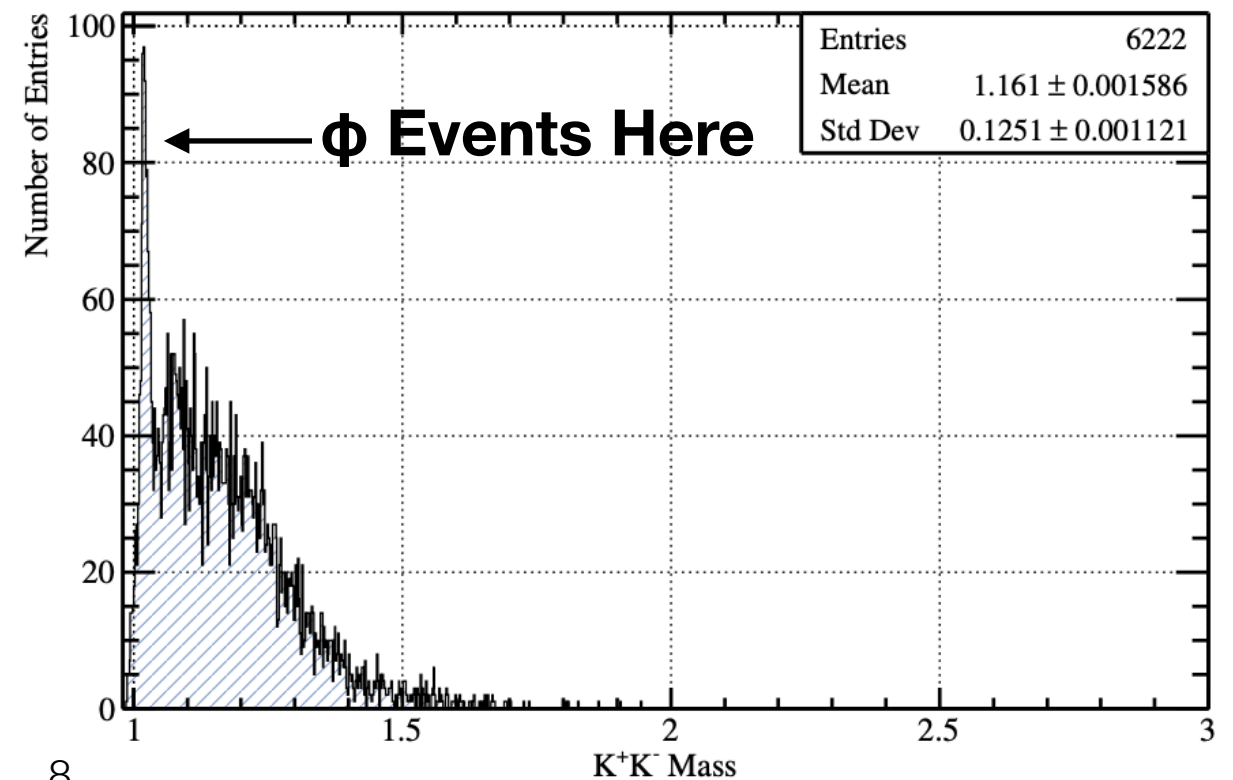
ProjectionY of binx=3 [x=1.5..2.5] [$K_{\text{BCAL}}^+ K_{\text{TOF}}^-$]



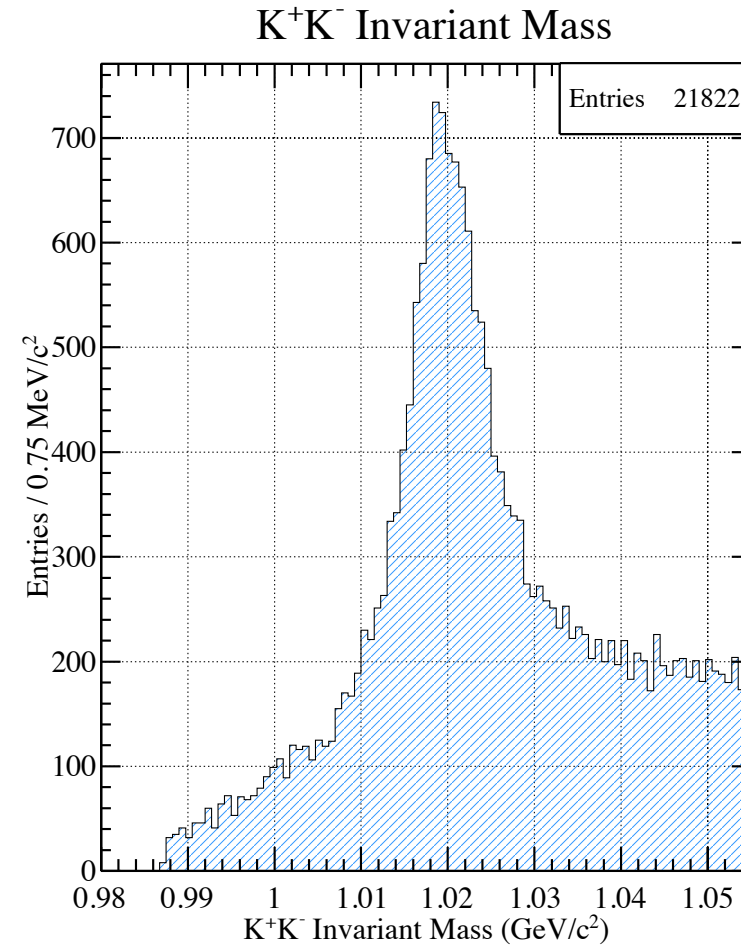
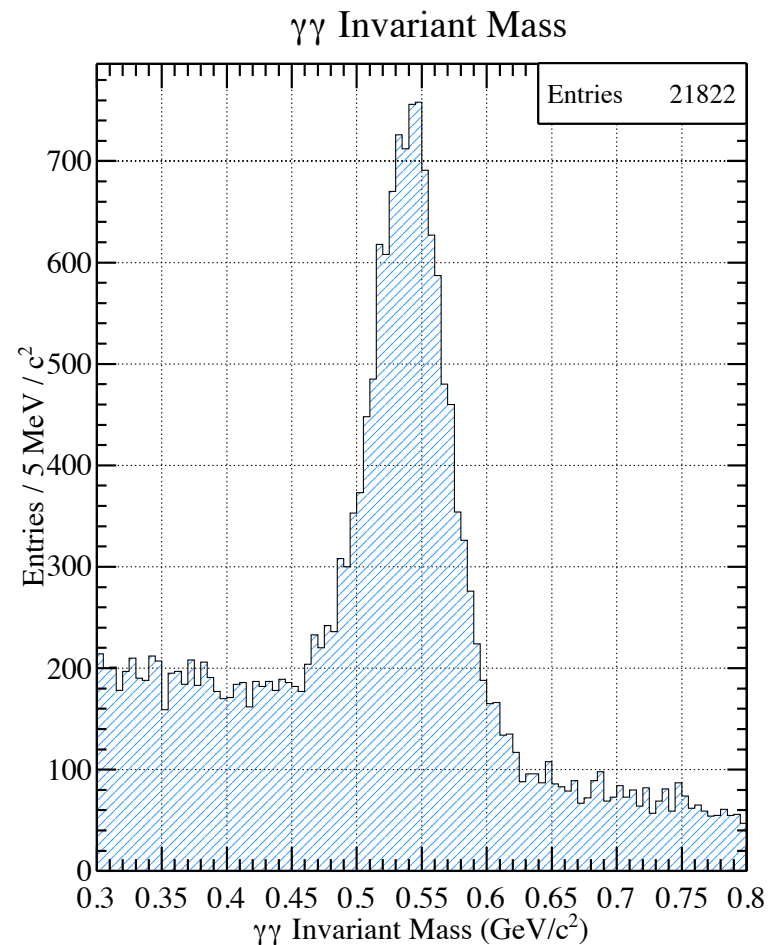
ProjectionY of binx=7 [x=5.5..6.5] [$K_{\text{TOF}}^+ K_{\text{BCAL}}^-$]



ProjectionY of binx=9 [x=7.5..8.5] [$K_{\text{TOF}}^+ K_{\text{TOF}}^-$]

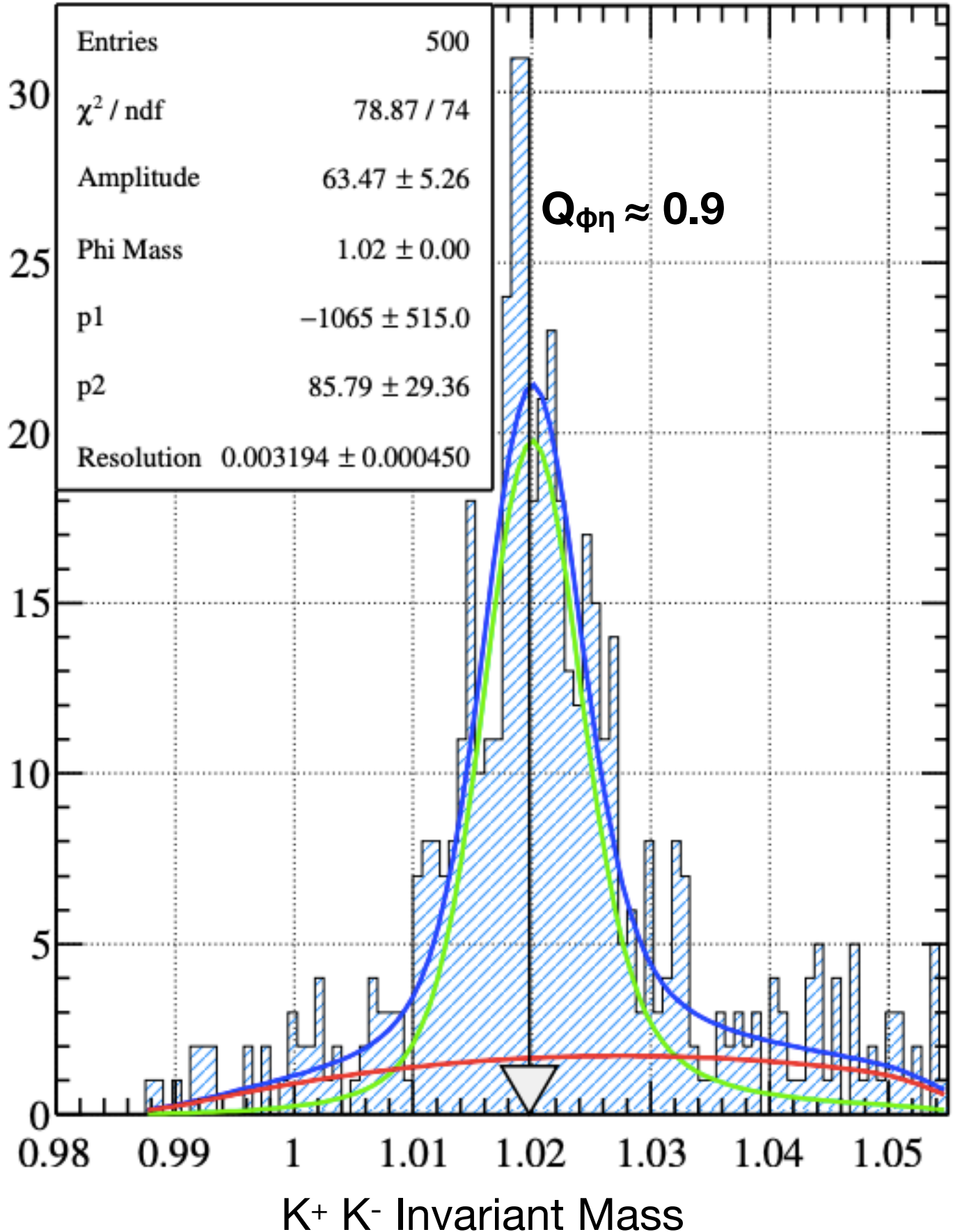
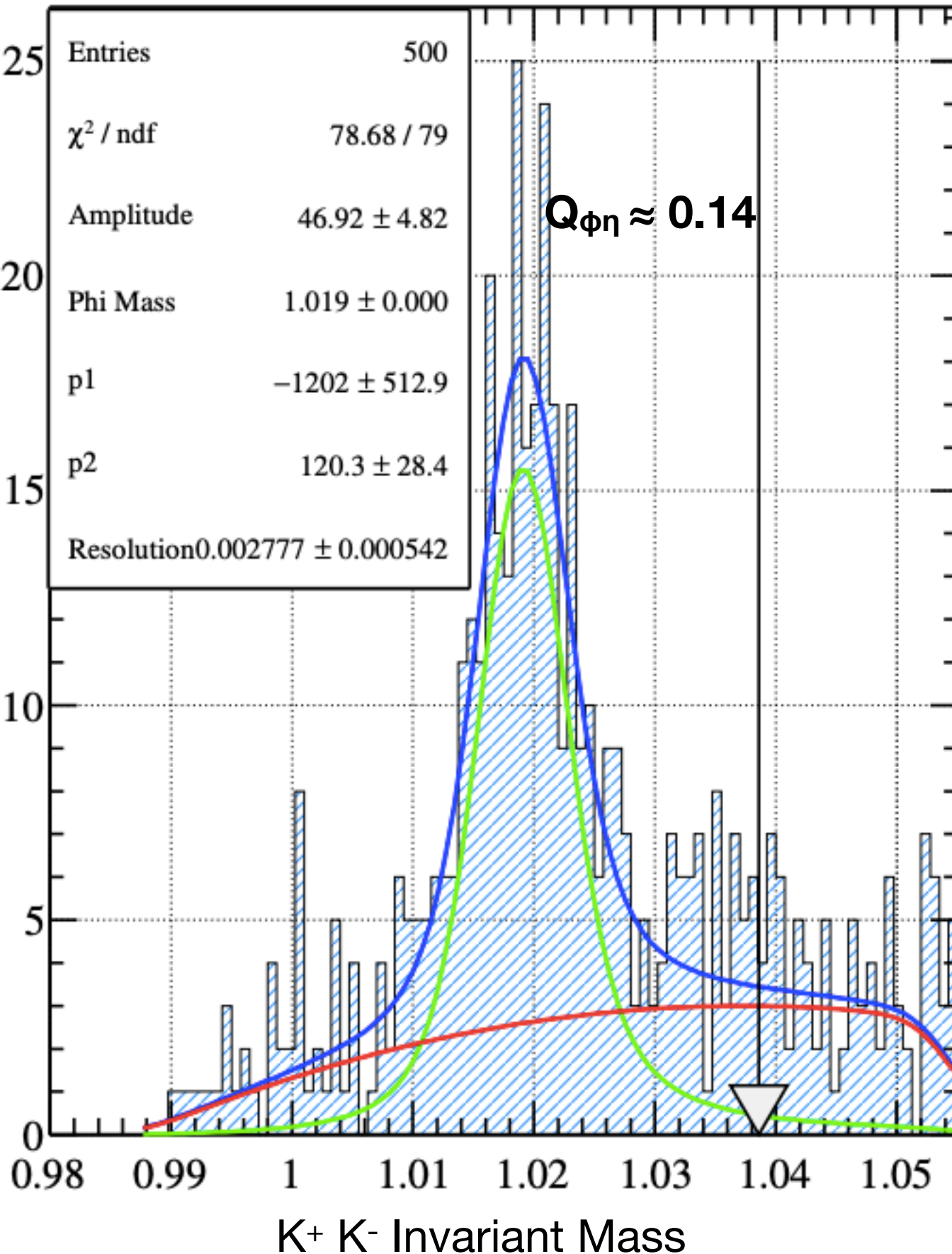


Selecting $\phi\eta$ Events

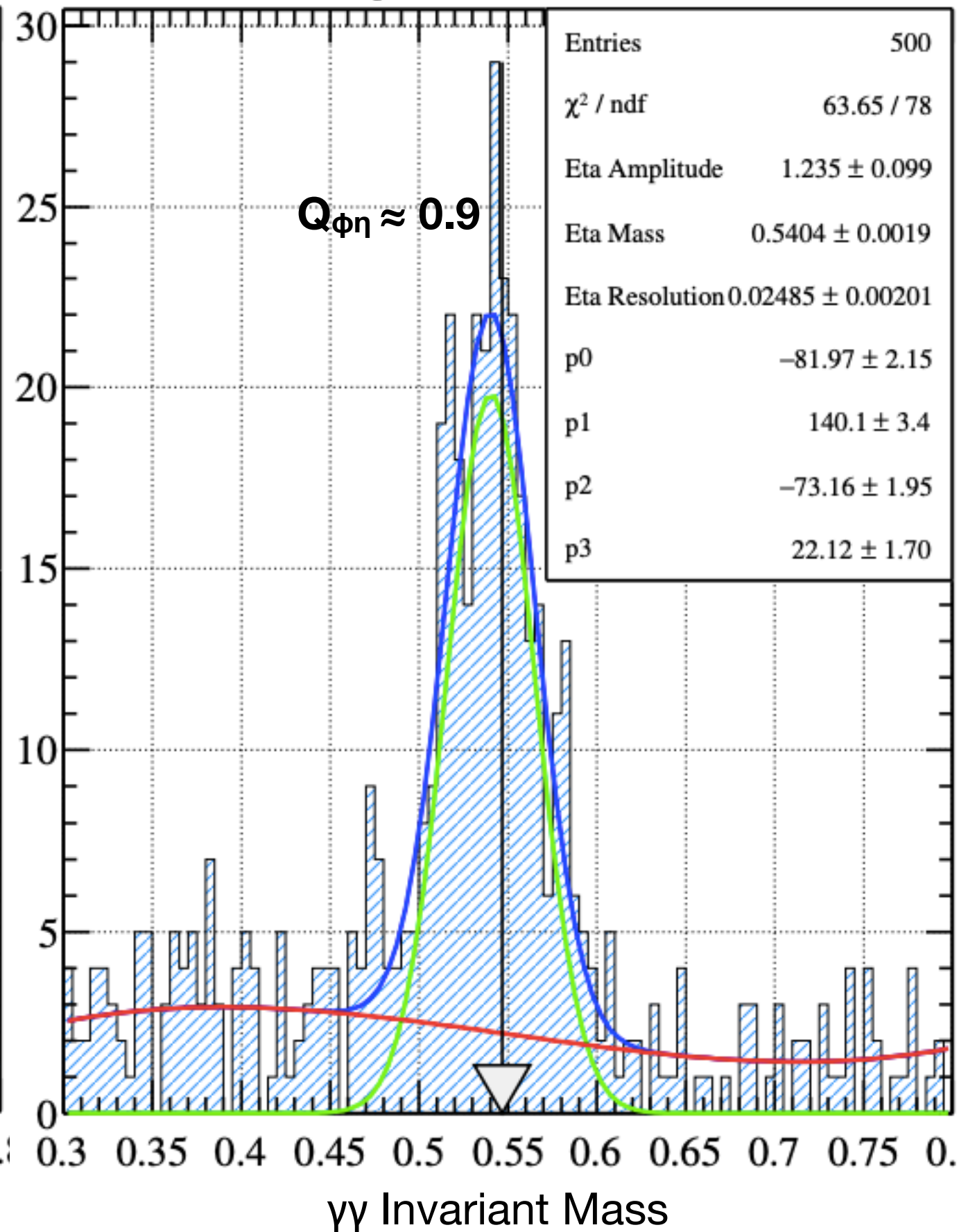
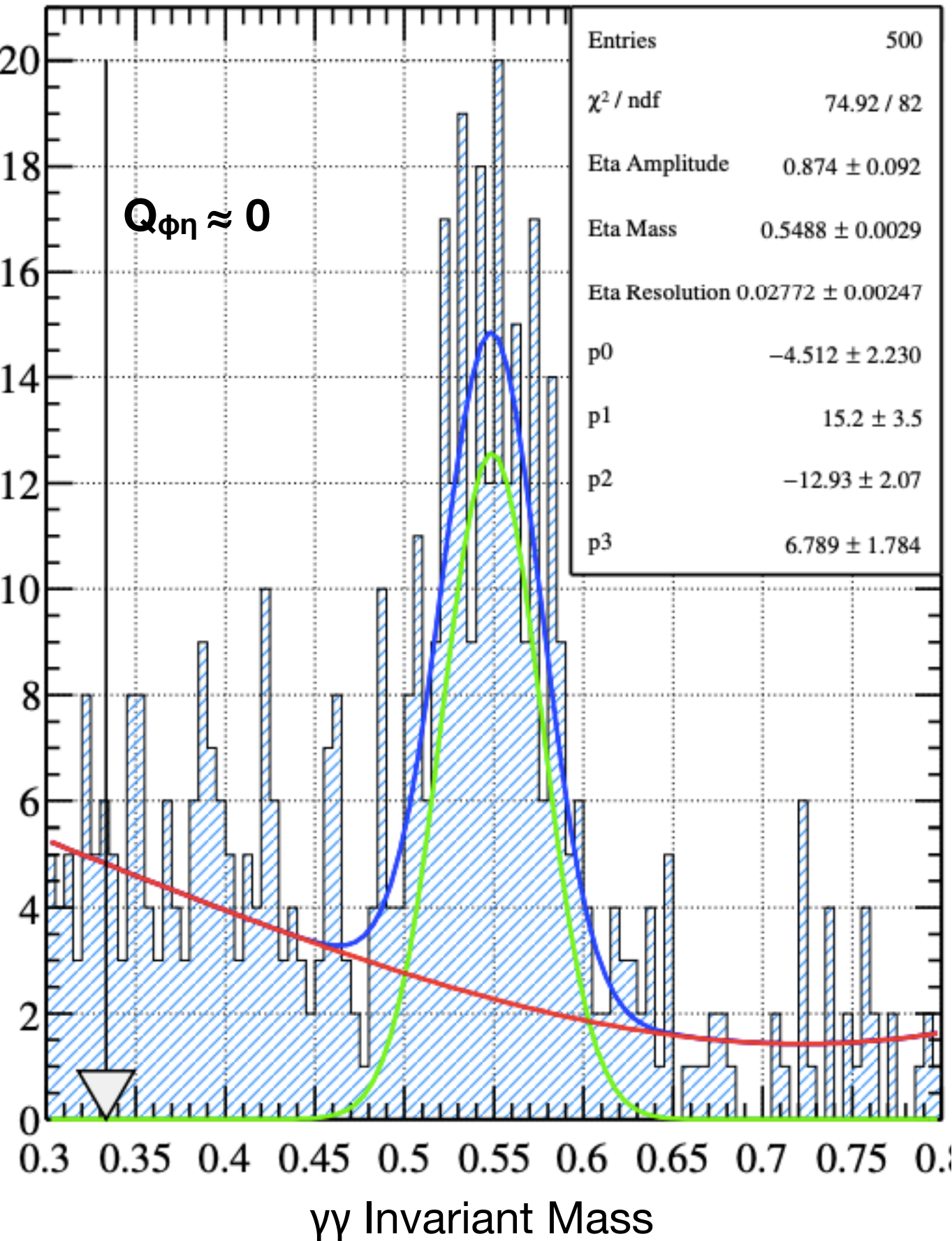


- Elliptical Subtraction
- Q_ϕ w/ η Selection
- $Q_\phi \times Q_\eta$
- $Q_{\phi\eta}$
- Q_η w/ ϕ Selection

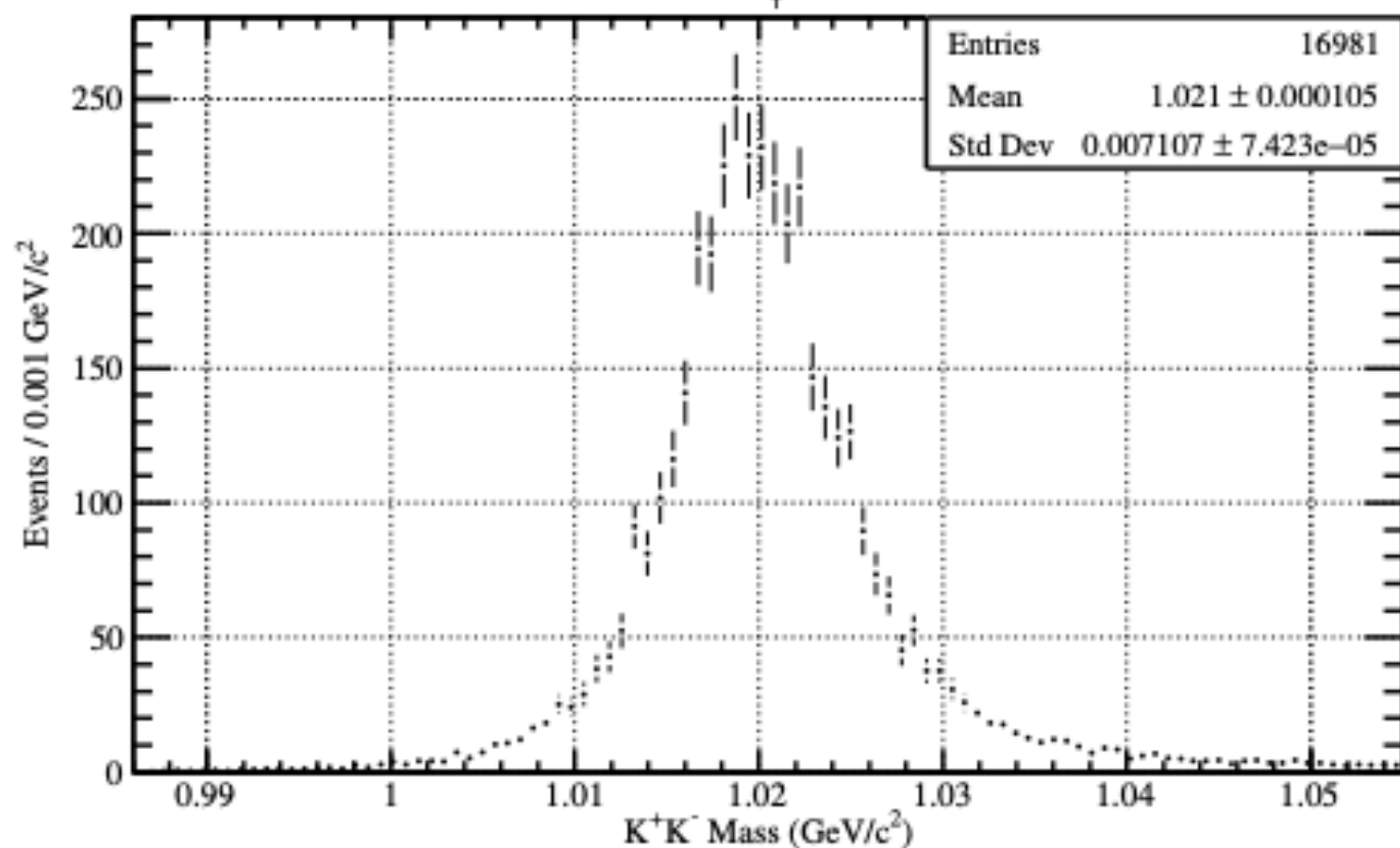
Example of Nearest Neighbors Fit



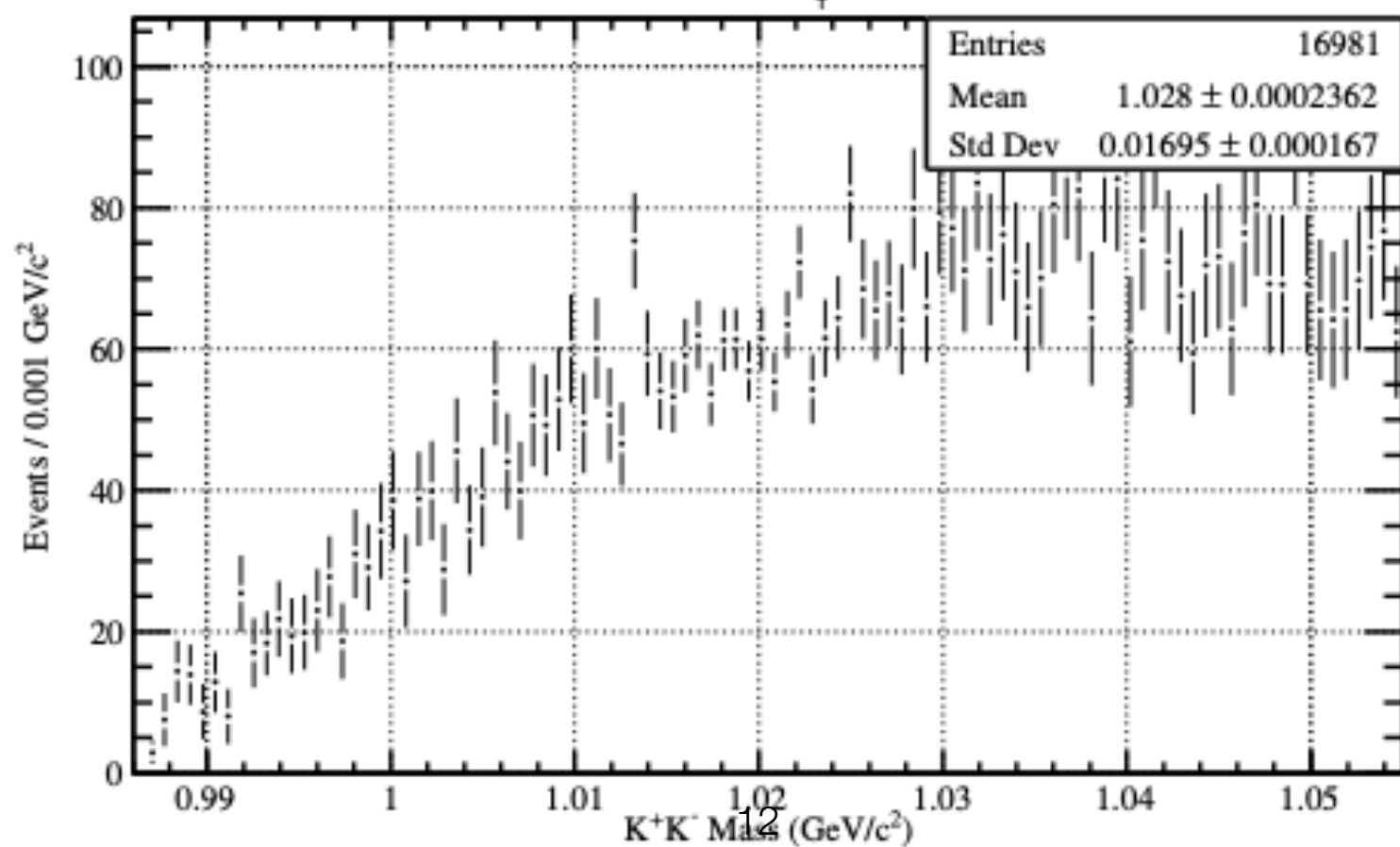
Example of Nearest Neighbors Fit



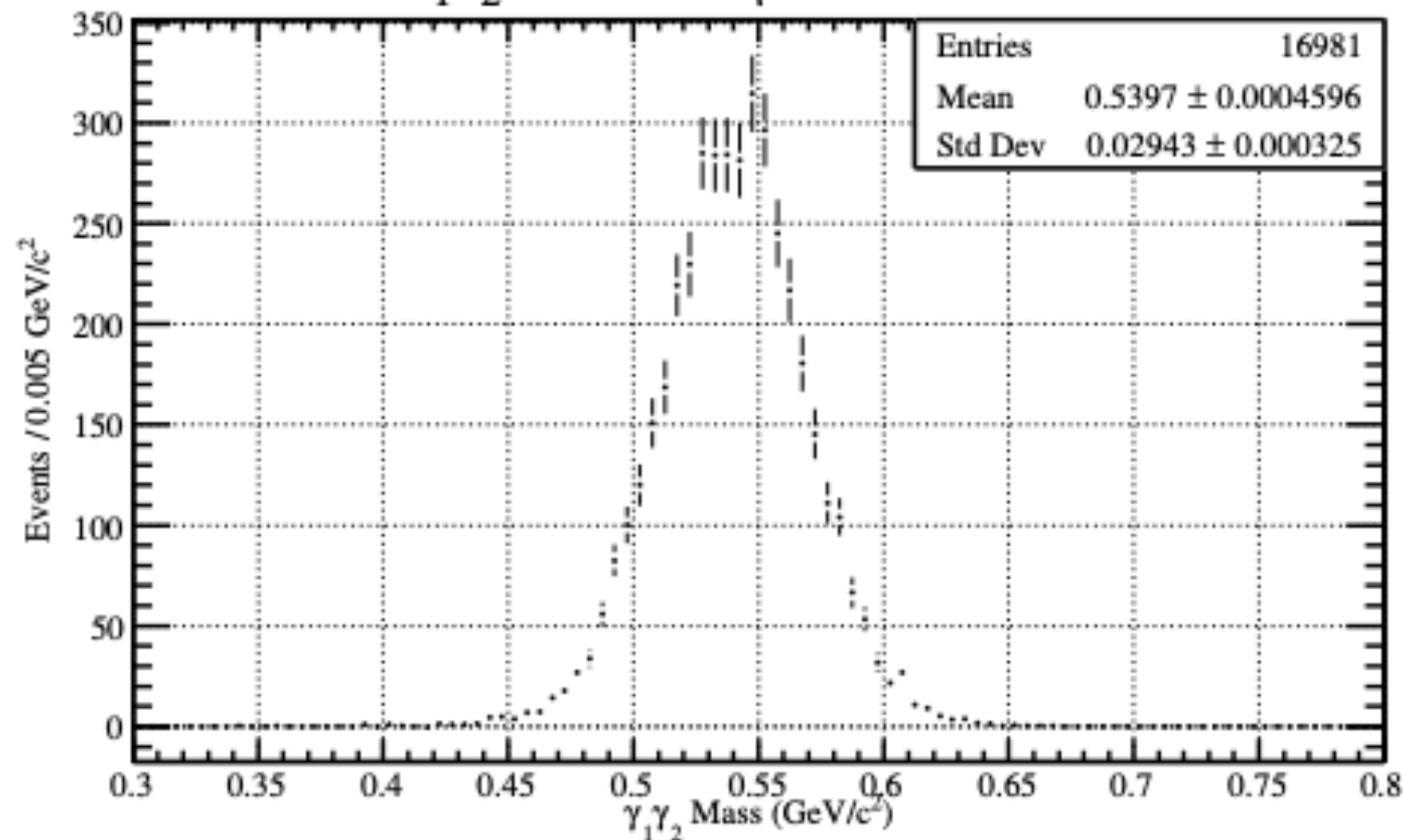
K^+K^- Mass : Q_ϕ Weighted



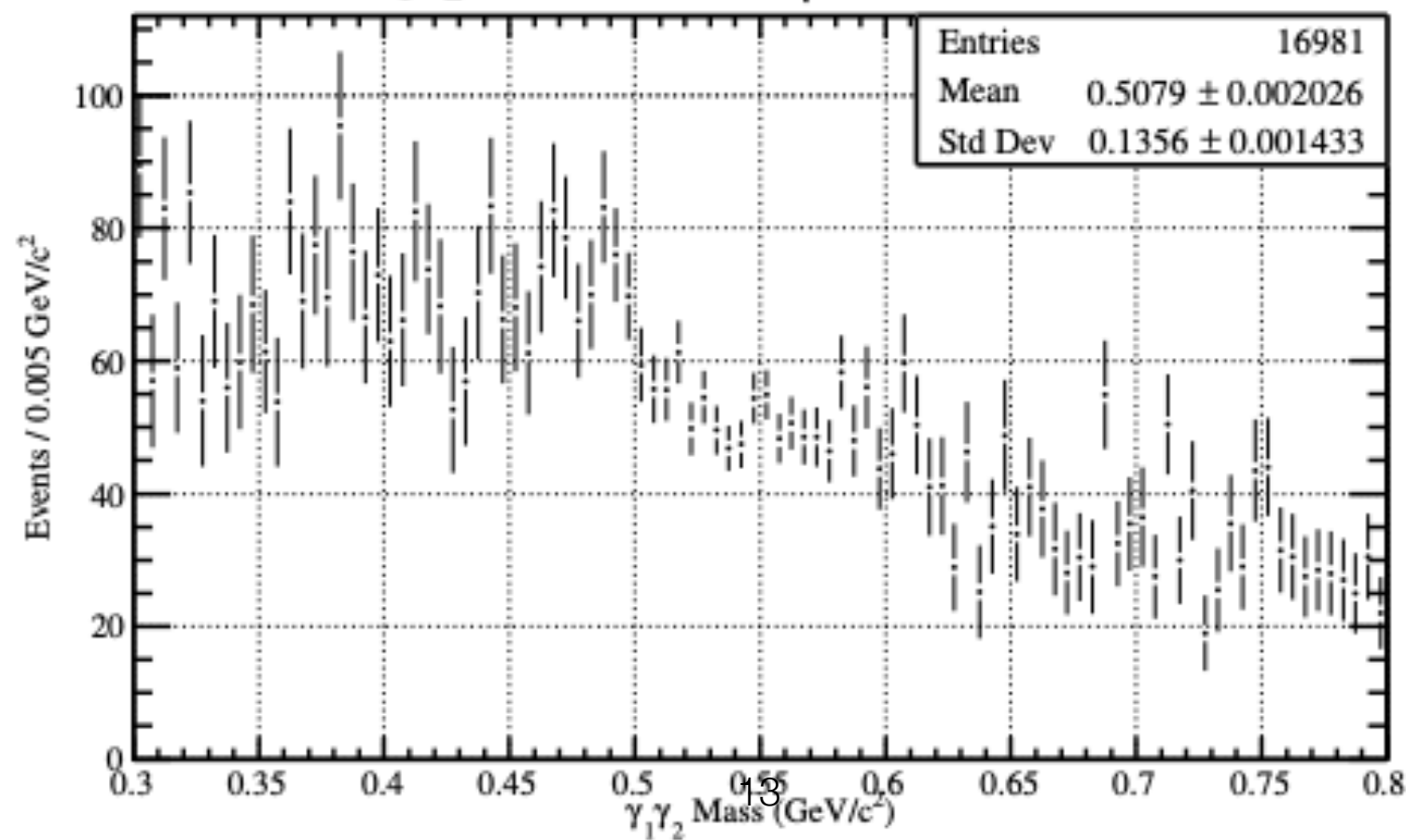
K^+K^- Mass : $1 - Q_\phi$ Weighted



$\gamma_1\gamma_2$ Mass : Q_η Weighted

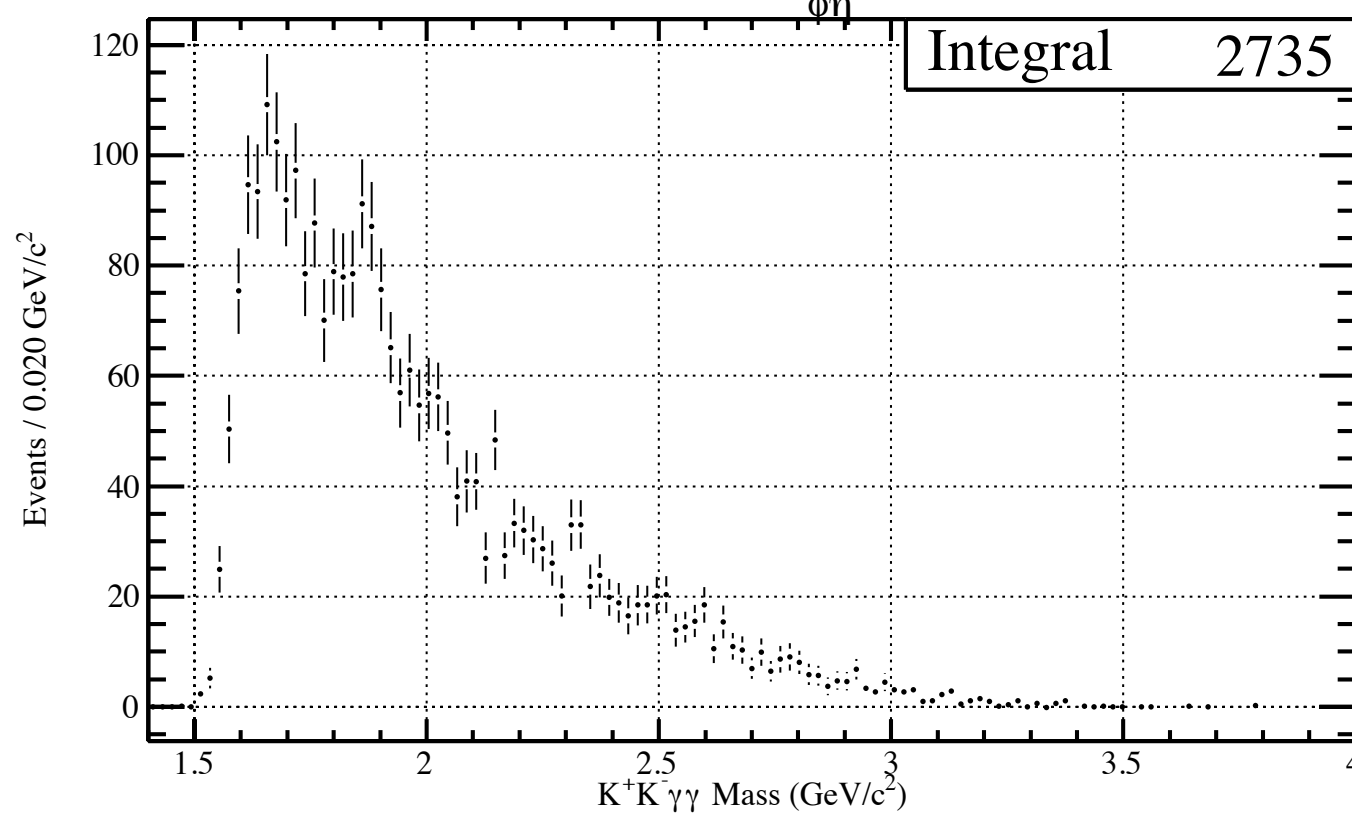


$\gamma_1\gamma_2$ Mass : 1 - Q_η Weighted



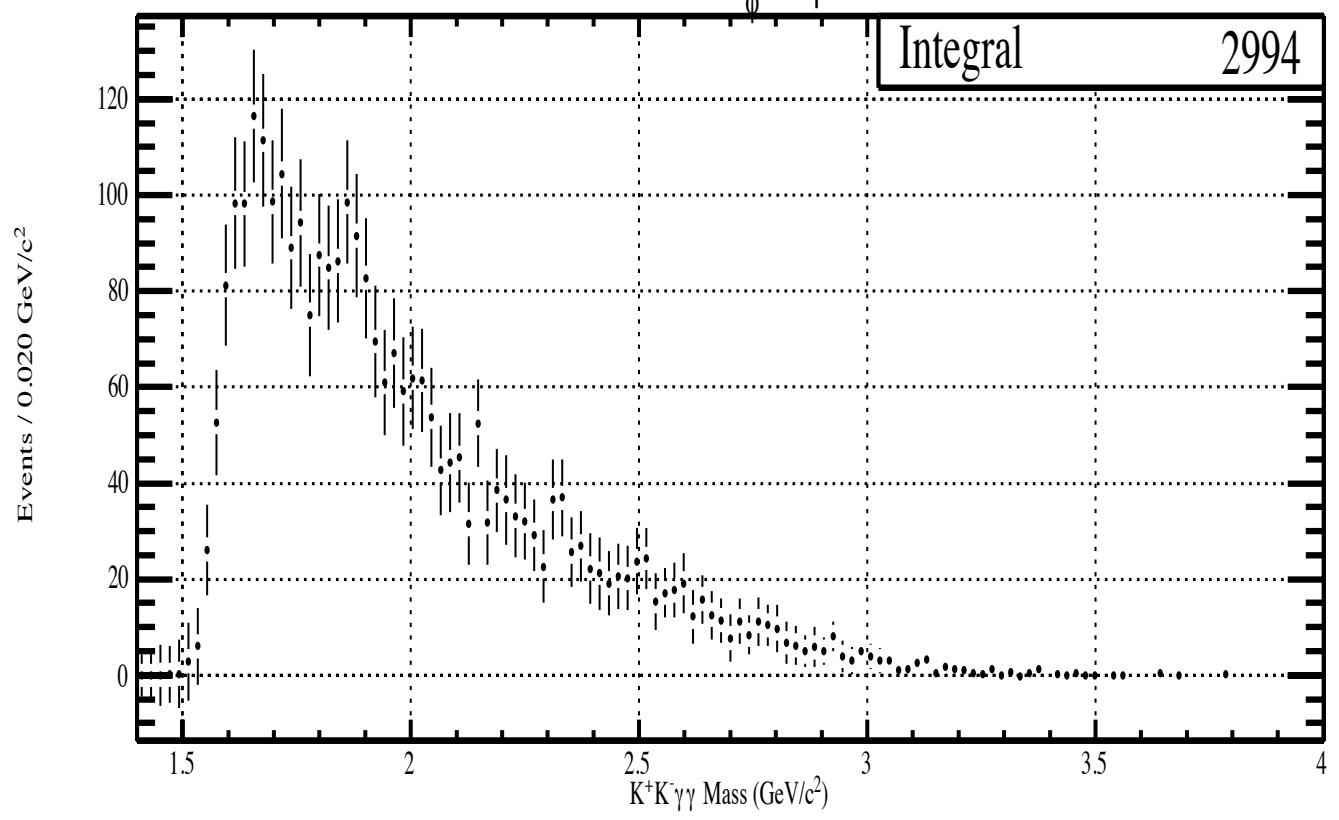
$Q_{\phi\eta}$

$K^+K^-\gamma\gamma$ Mass : $Q_{\phi\eta}$ Weighted



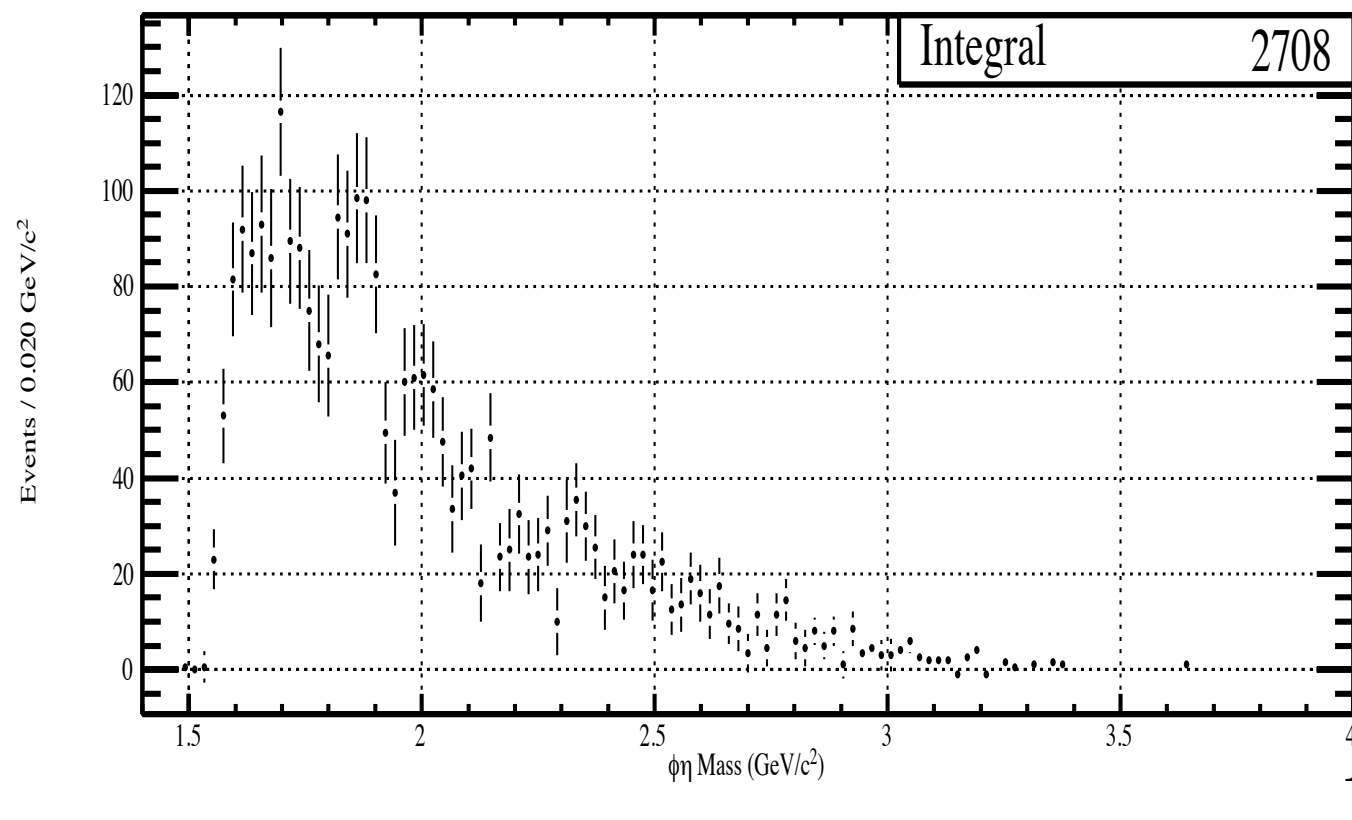
Q_{ϕ}

$K^+K^-\gamma\gamma$ Mass : $Q_{\phi} * w_{\eta}$ Weighted



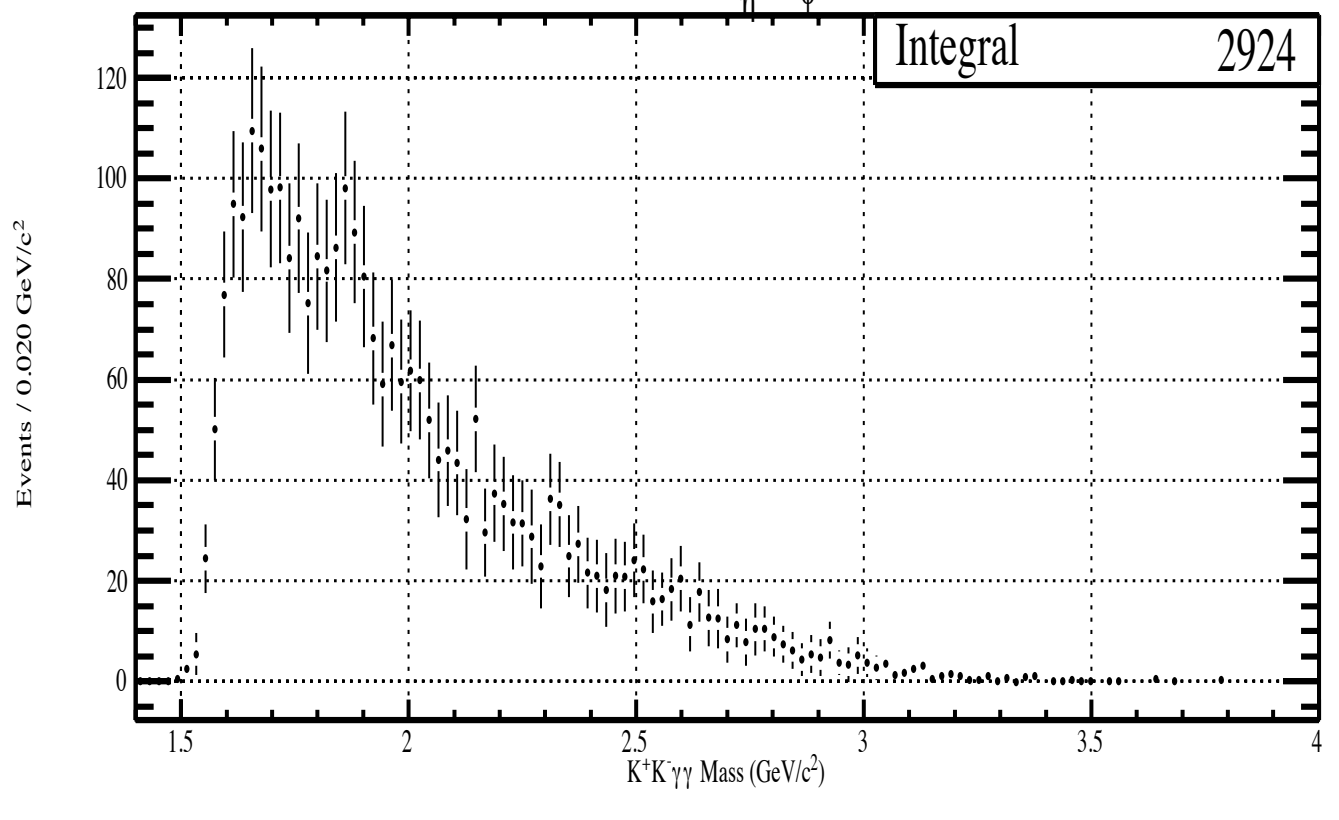
Elliptical Subtraction:

$\phi\eta$ Mass - Signal



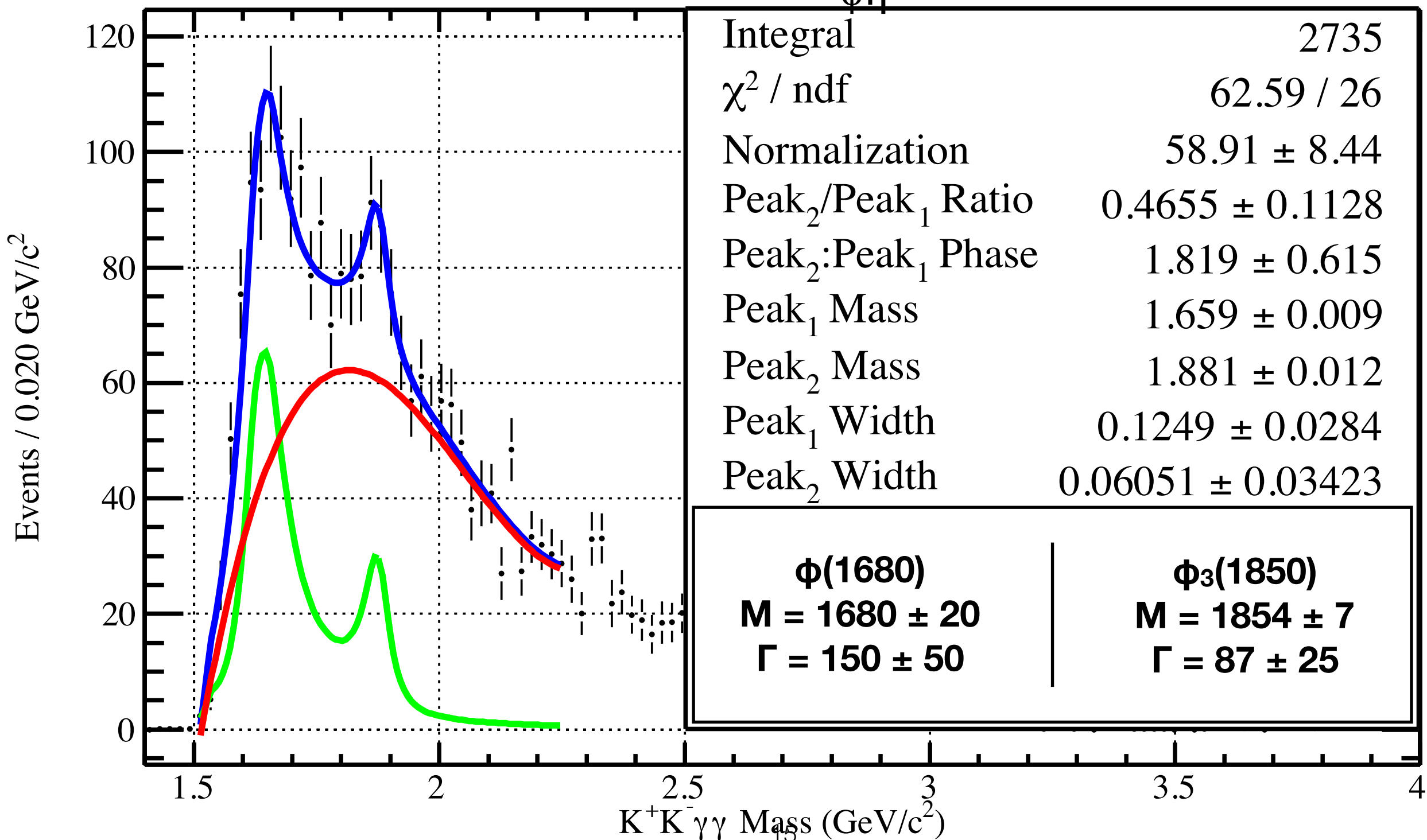
Q_{η}

$K^+K^-\gamma\gamma$ Mass : $Q_{\eta} * w_{\phi}$ Weighted

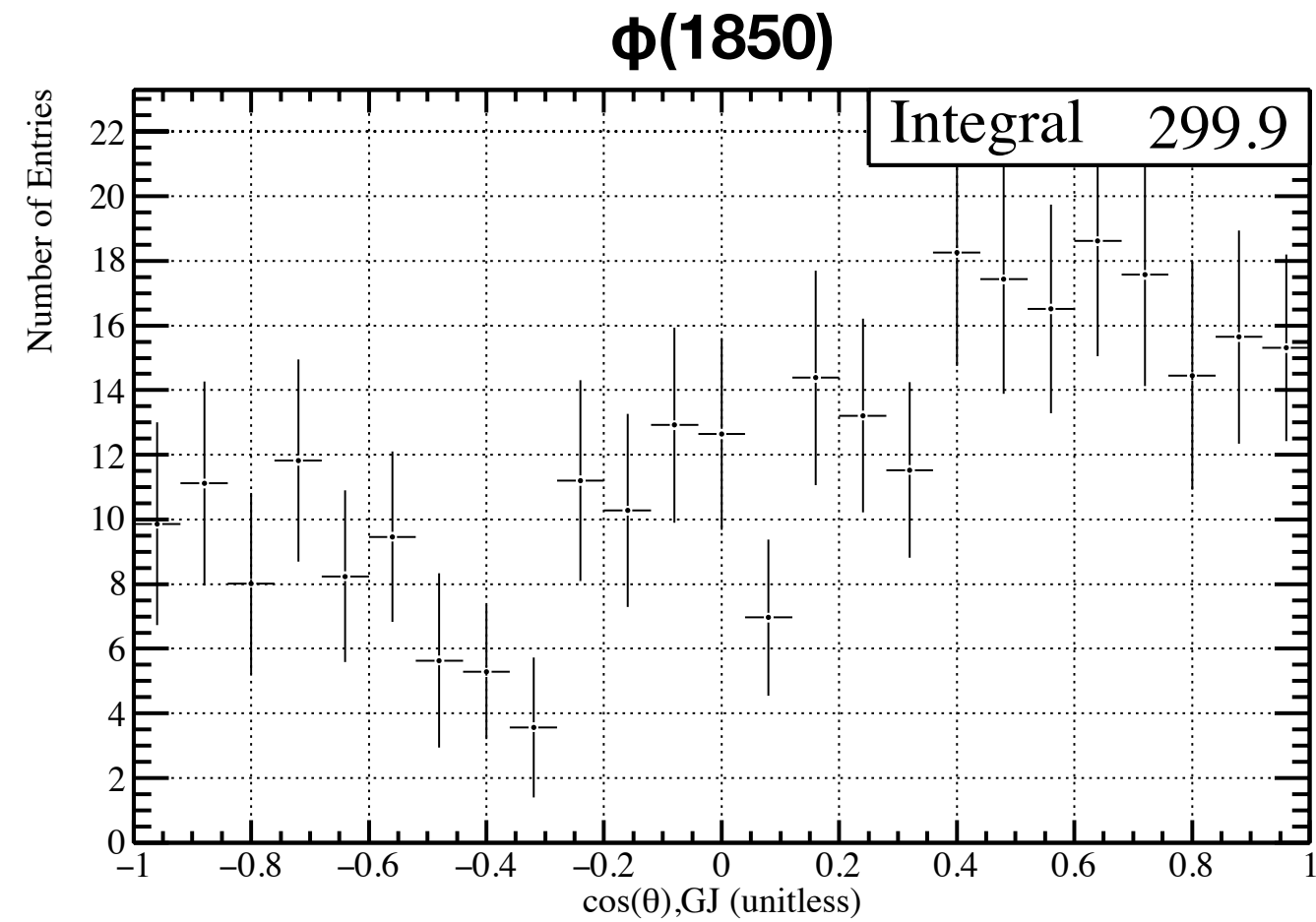
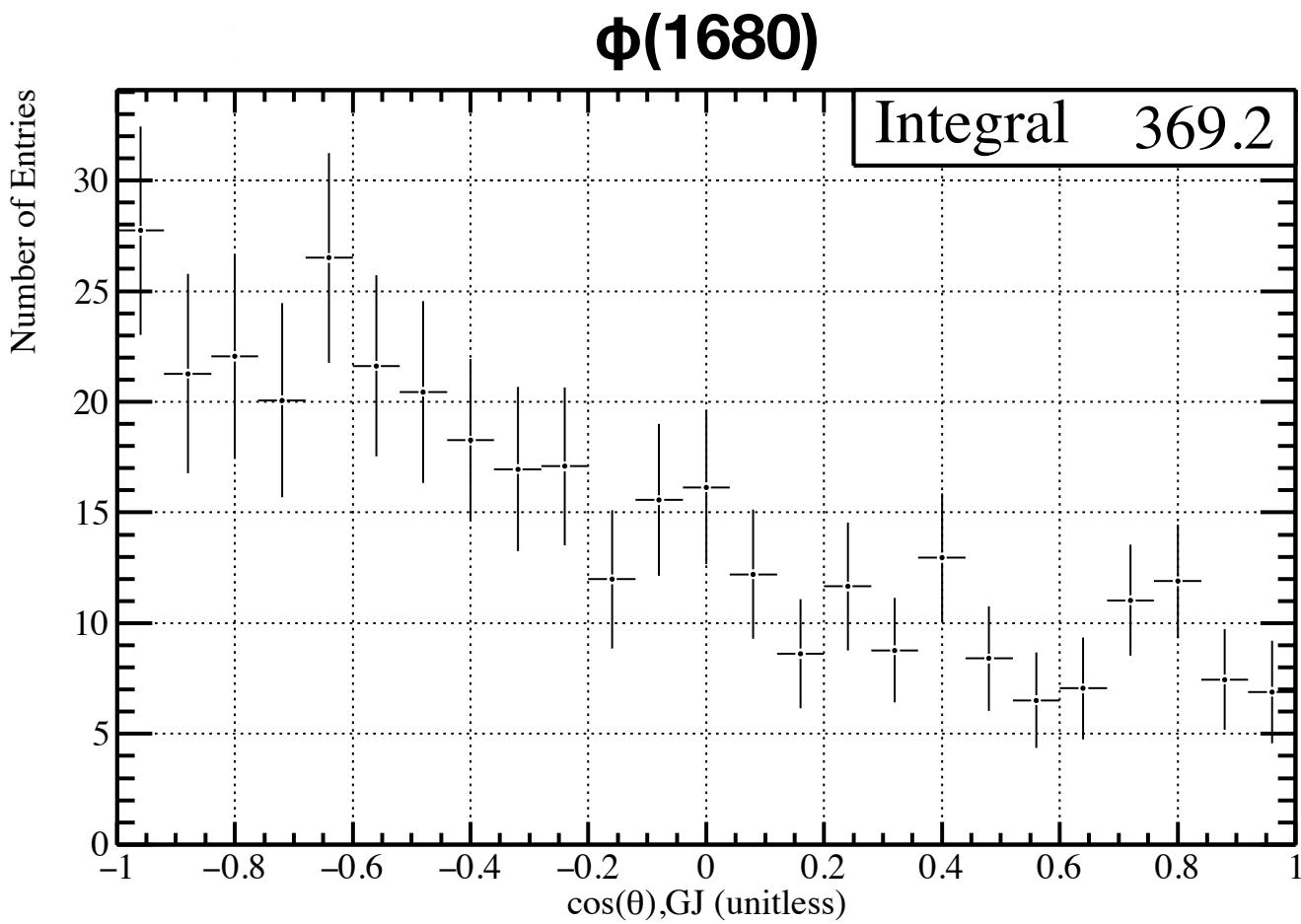


Mass Dependent Breit-Wigner Fit

$K^+K^-\gamma\gamma$ Mass : $Q_{\phi\eta}$ Weighted

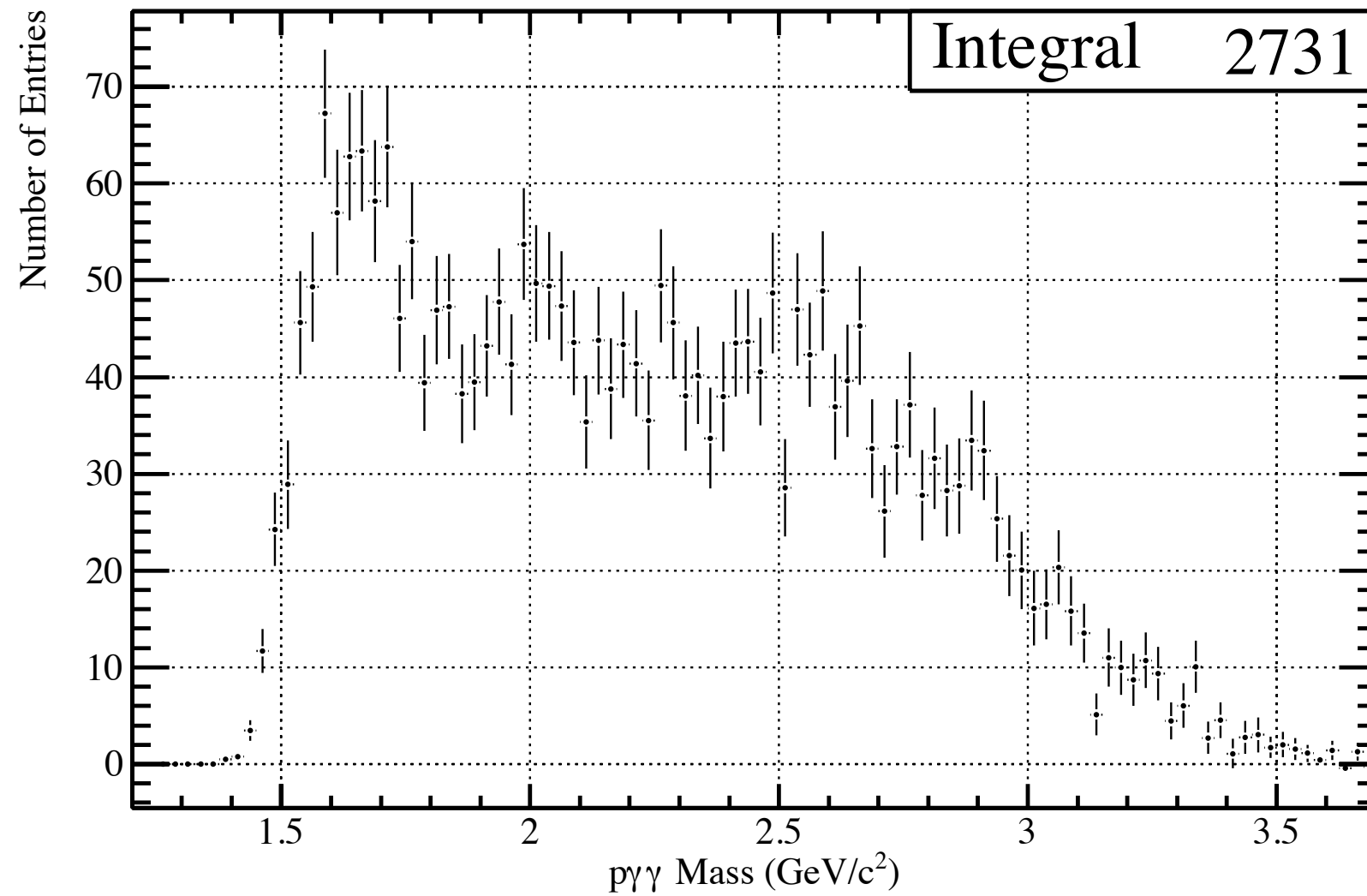


$\cos(\Theta)$ Gottfried-Jackson

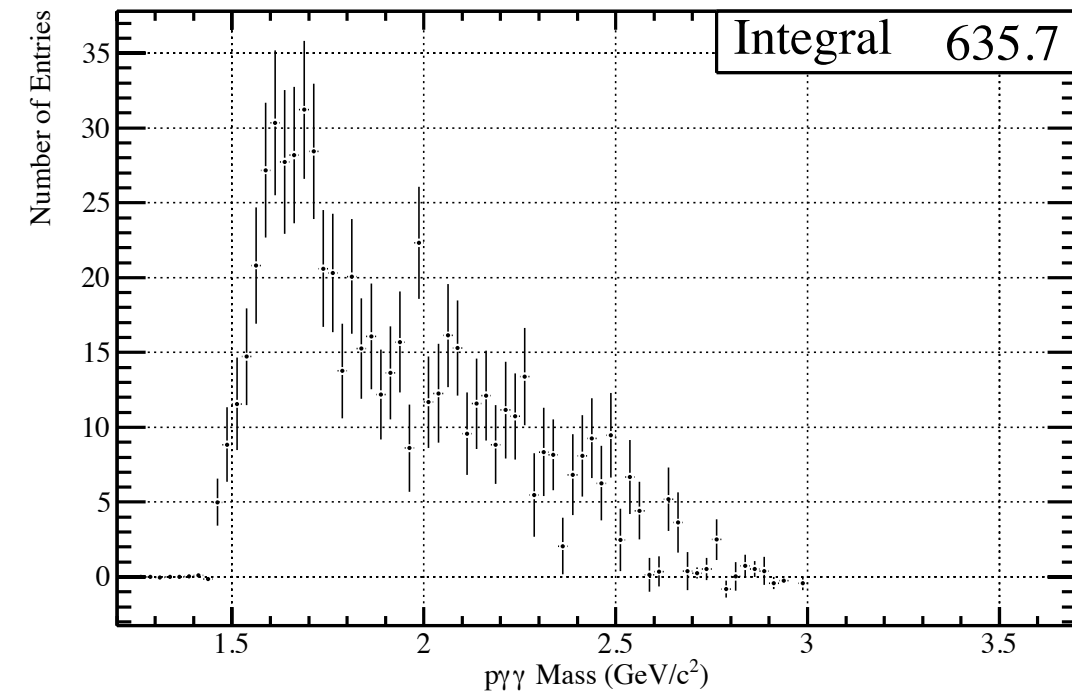


N* Background

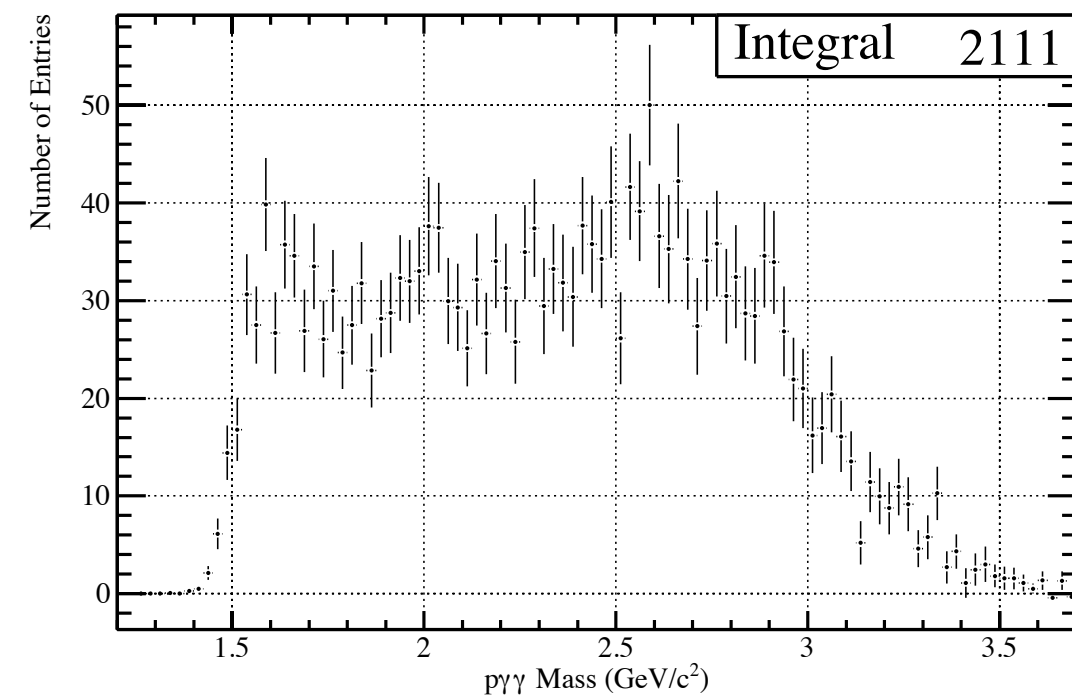
All Beam Energies



Beam Energy < 7.5 GeV



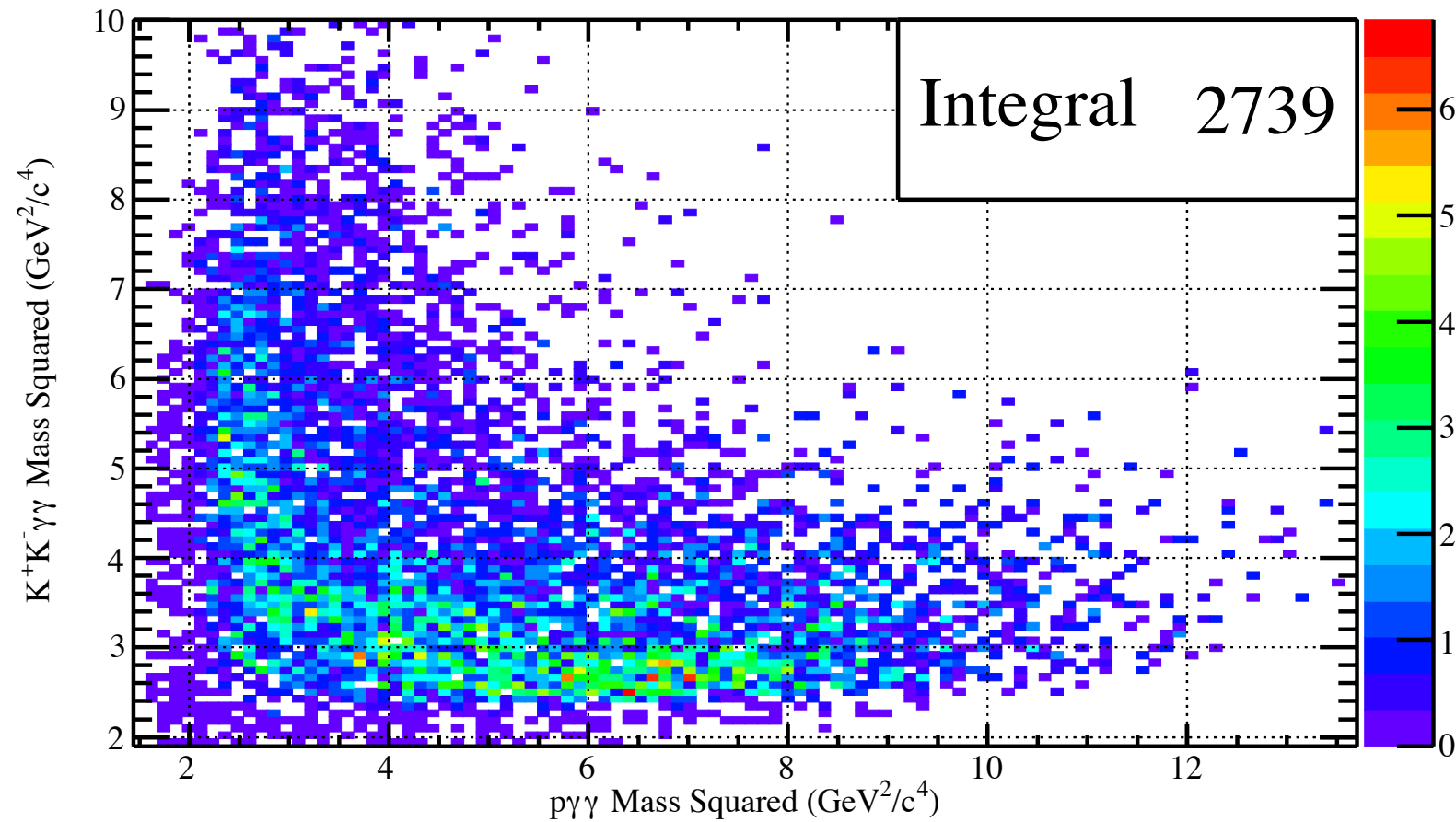
Beam Energy > 7.5 GeV



N* Background

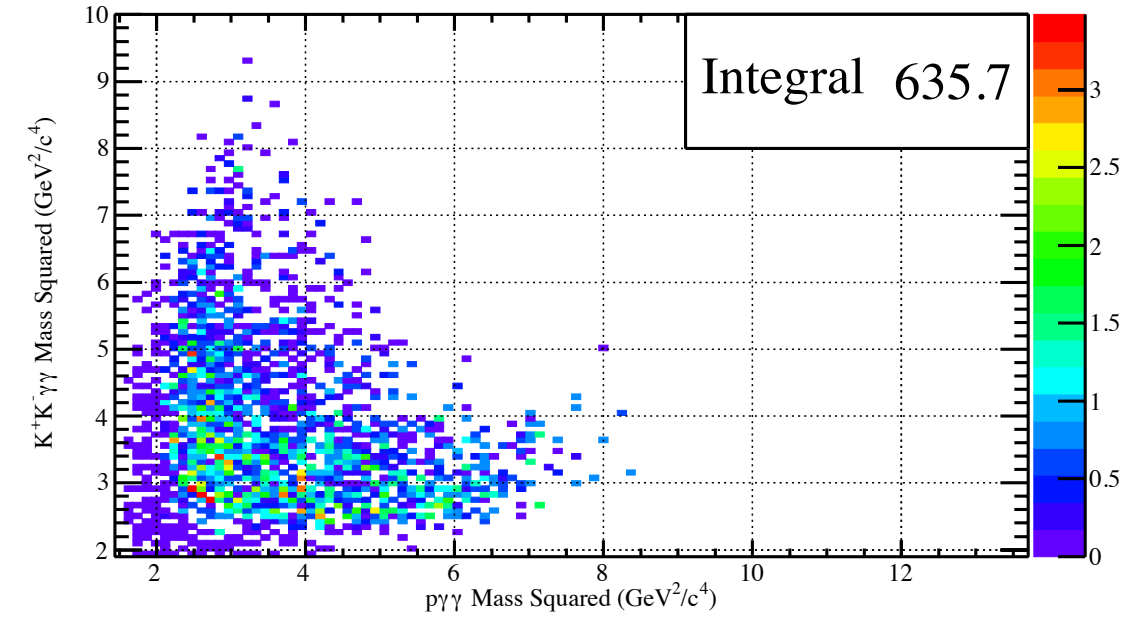
All Beam Energies

$p\gamma\gamma$ Mass Squared Vs $K^+K^-\gamma\gamma$ Mass Squared : $Q_{\phi\eta}$ Weighted



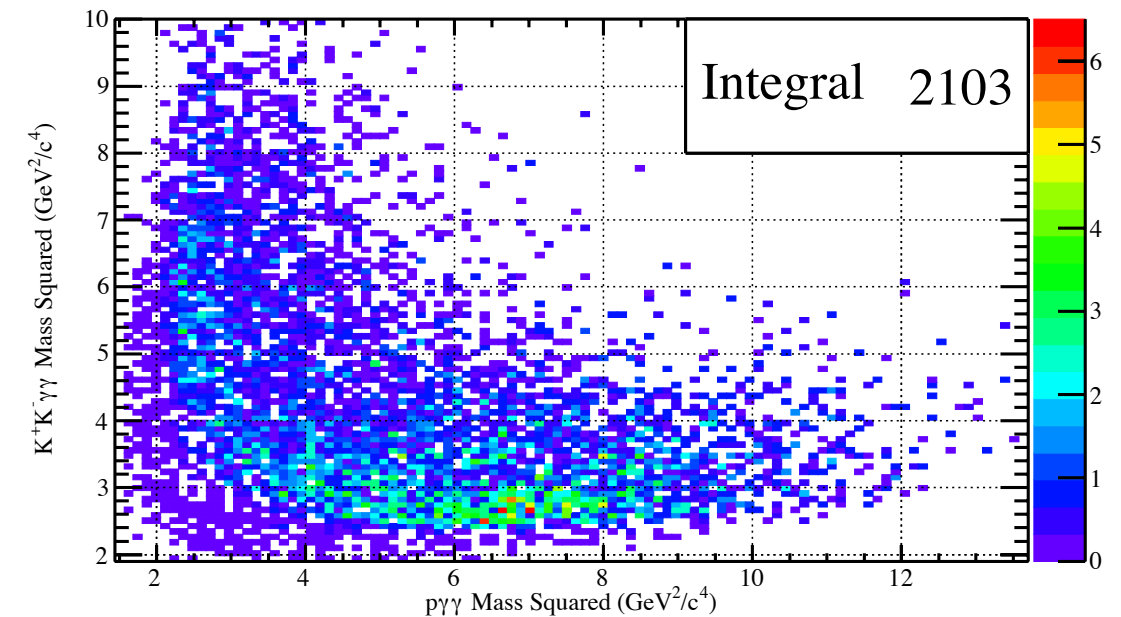
Beam Energy < 7.5 GeV

$p\gamma\gamma$ Mass Squared Vs $K^+K^-\gamma\gamma$ Mass Squared : $Q_{\phi\eta}$ Weighted



Beam Energy > 7.5 GeV

$p\gamma\gamma$ Mass Squared Vs $K^+K^-\gamma\gamma$ Mass Squared : $Q_{\phi\eta}$ Weighted



Summary

We observe two structures in the $\phi\eta$ Invariant Mass

- The first structure is consistent with the $\phi(1680)$
- The second structure is consistent with the $\phi_3(1850)$. This has only been observed in $K^-p \rightarrow K\bar{K}, K\bar{K}^*$ experiments
- Photoproduction data of $\phi\eta$ has never been published

Work in progress:

- Study N^* Background
- Acceptance Corrections