

# A Simple Analysis of a Few Reactions using Pythia MC

$$\gamma p \rightarrow \pi^+ \pi^- p$$

$$\gamma p \rightarrow \pi^+ \pi^- \pi^0 p$$

$$\gamma p \rightarrow K^+ K^- p$$

$$\gamma p \rightarrow \pi^+ \pi^- \pi^+ \pi^- p$$

$$\gamma p \rightarrow \pi^+ \pi^- \pi^+ \pi^- \pi^0 p$$

$$\gamma p \rightarrow \pi^+ \pi^- \pi^+ \pi^- \pi^+ \pi^- p$$

Ryan Mitchell

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# Overview

**Data:** use 10M generated Pythia events from the second data challenge (*run 9001 — medium EM background*).

**Event Selection:** use only loose track and shower cuts and a global kinematic fit (*vertex and four-momentum fits combined*) to select events (*more details later*).

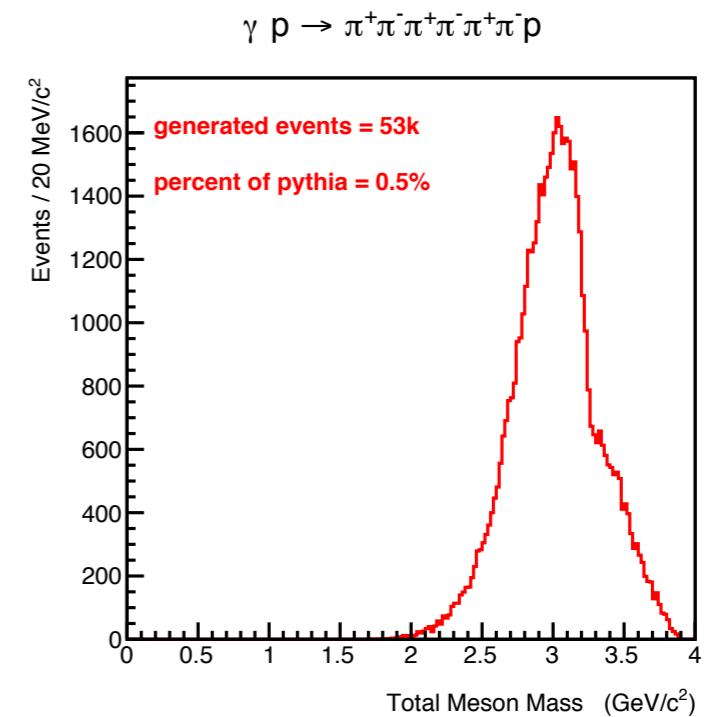
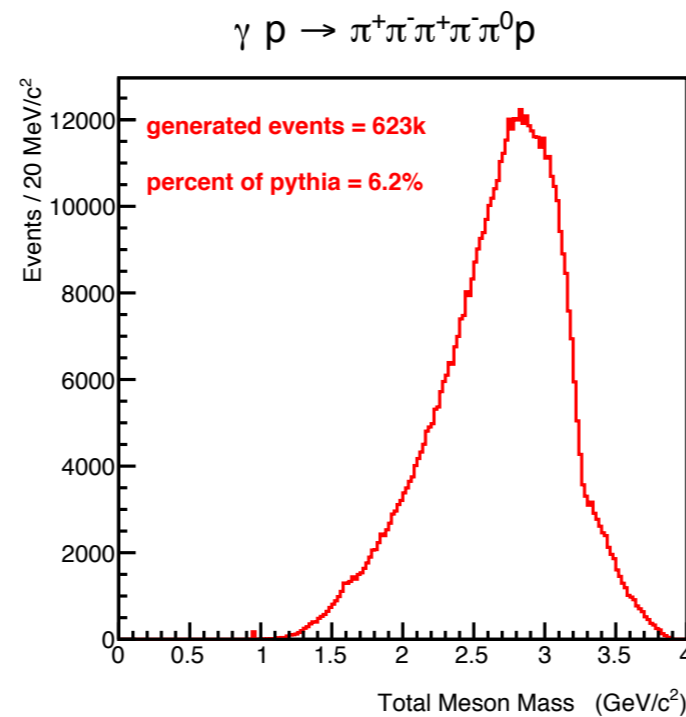
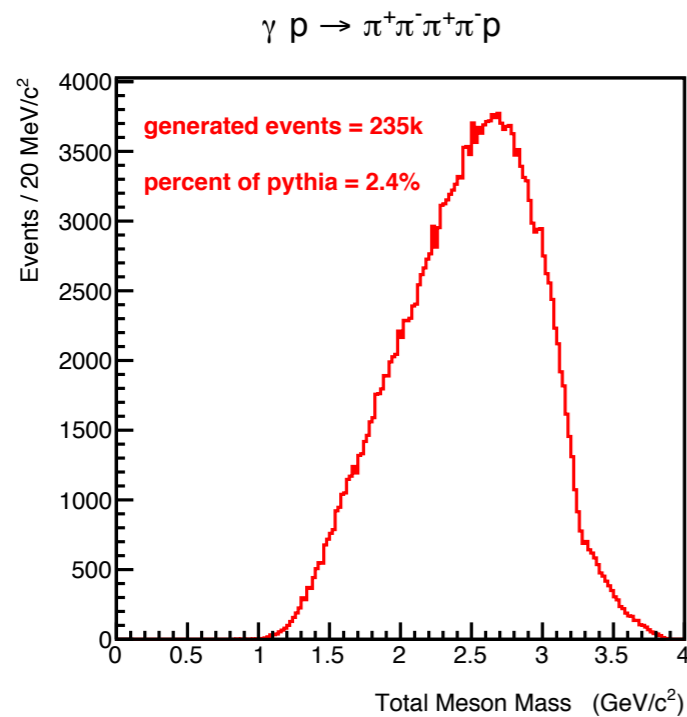
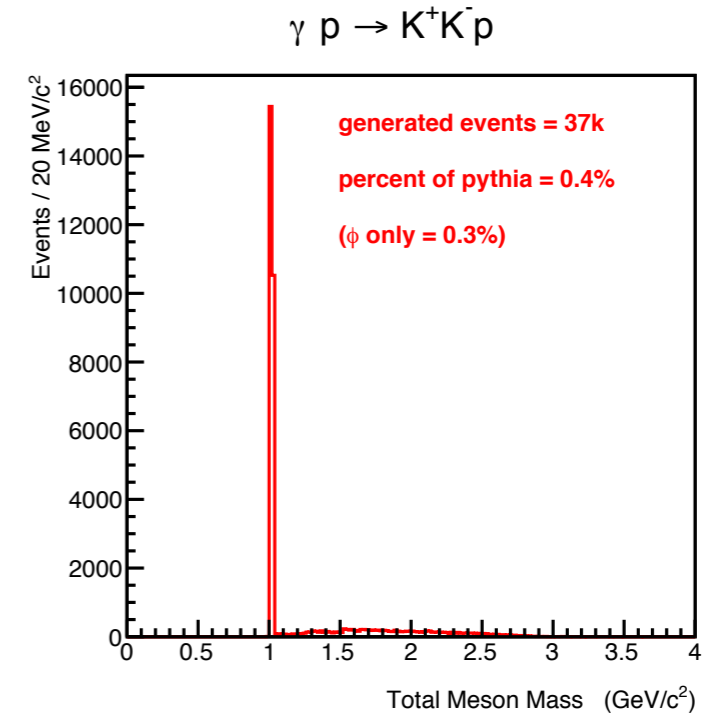
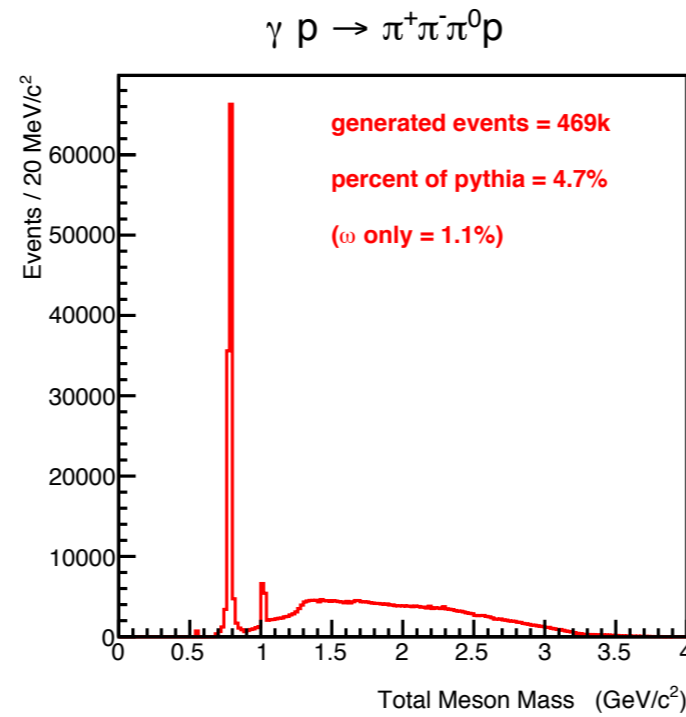
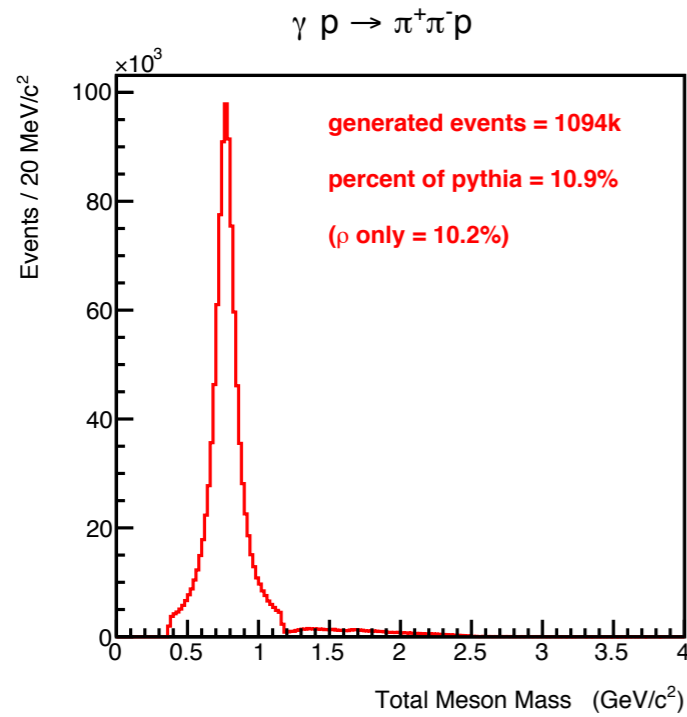
**Goal:** look at efficiencies, purities, and dominant backgrounds.

**Analysis Code:** use analysis code (`FSFilter`) developed for CLEO and BES analyses to make trees.

**Code Versions:** `jana_0.7.1p3`, `ccdb_1.02`, `hdds-2.1`,  
`sim-recon-2014-06-30`

# Generator-Level Distributions

(using *DMCThrown* objects)



# Event Selection

**Tracks:** (1) start with a list of `DChargedTrackHypothesis` objects extracted with the “Combo” tag (every track has all hypotheses reconstructed); (2) use tracks with a tracking  $CL > 5.77 \times 10^{-7}$  ( $5\sigma$ ); (3) don't use PID information (for now).

**Showers:** (1) start with a list of `DNeutralParticle` objects; (2) require each to have energy  $> 100$  MeV; (3) require each to have  $FOM > 5.77 \times 10^{-7}$ .

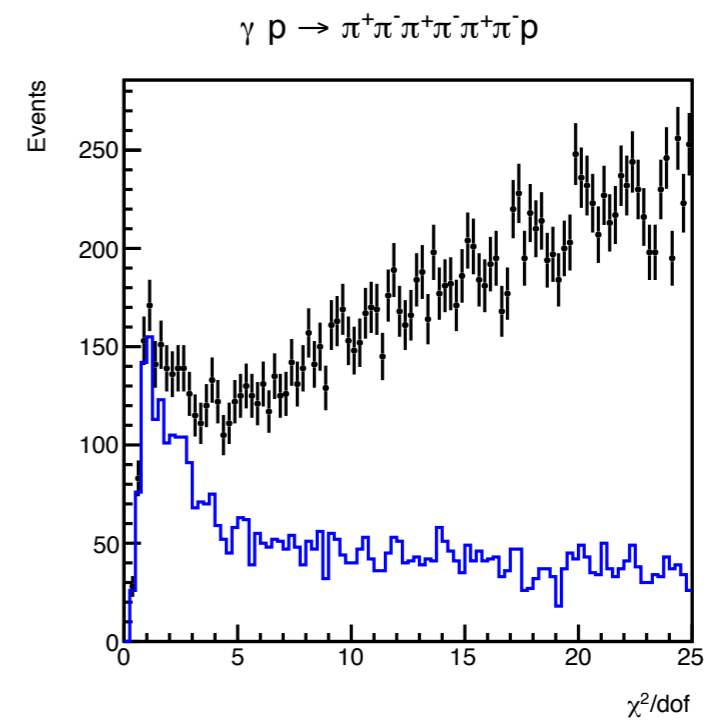
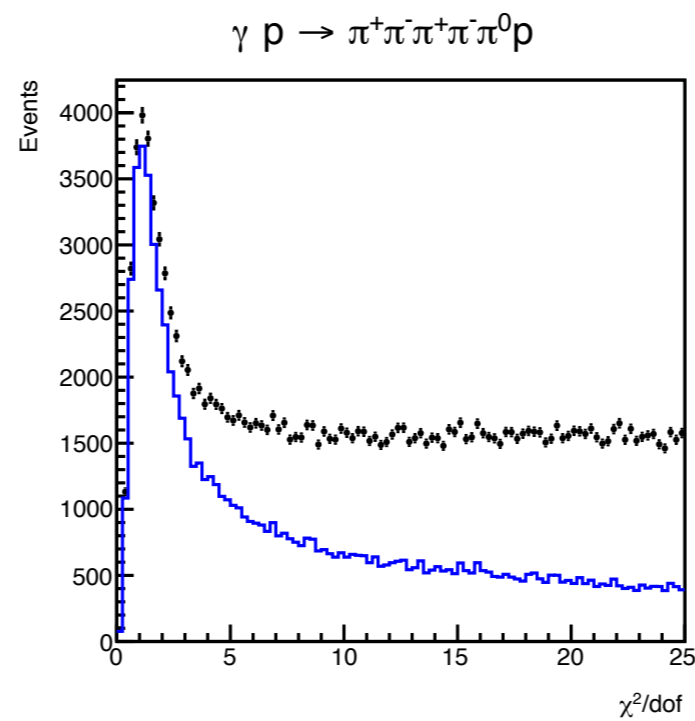
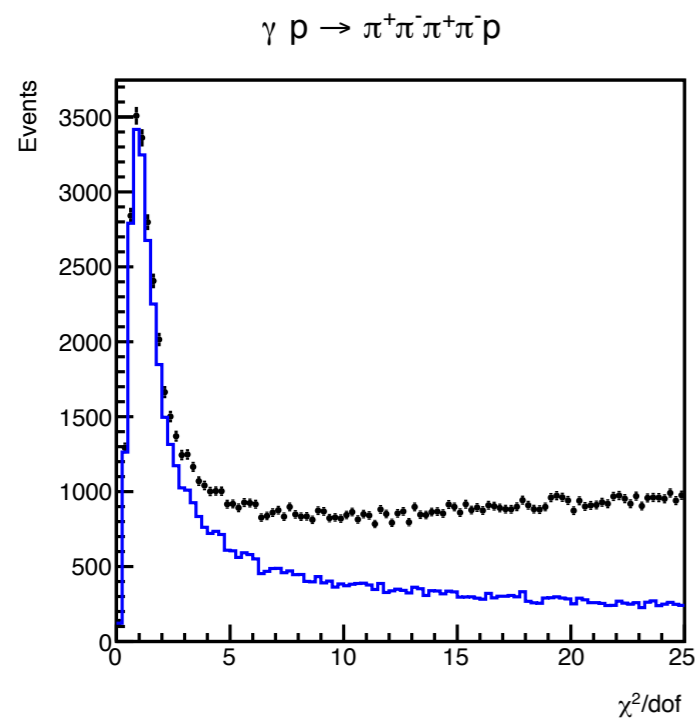
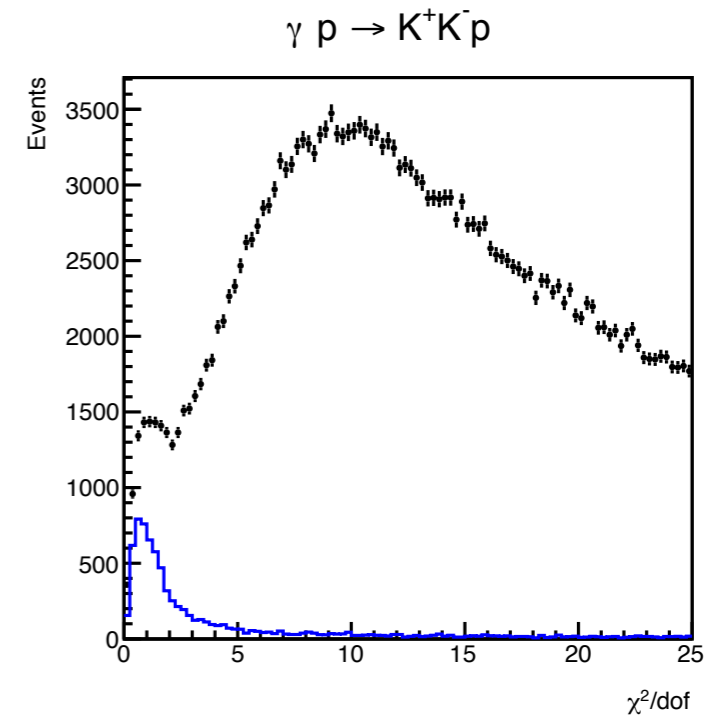
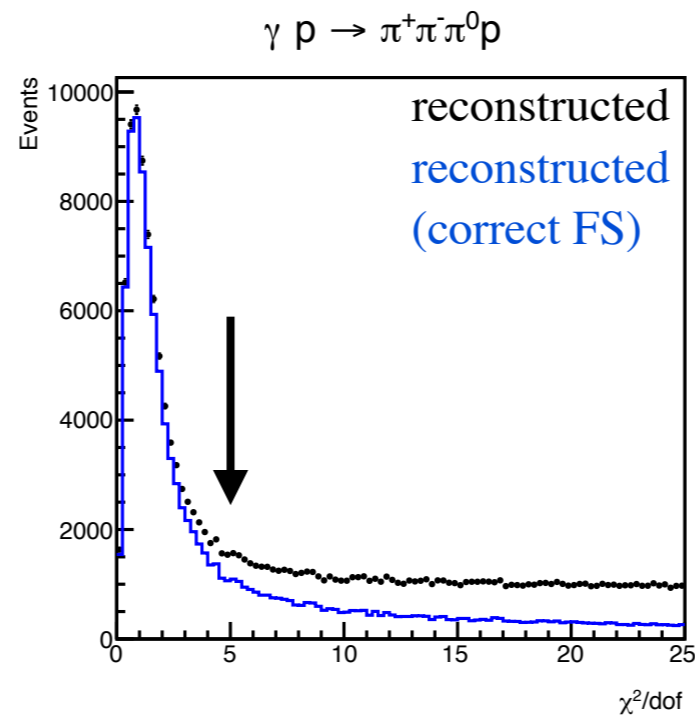
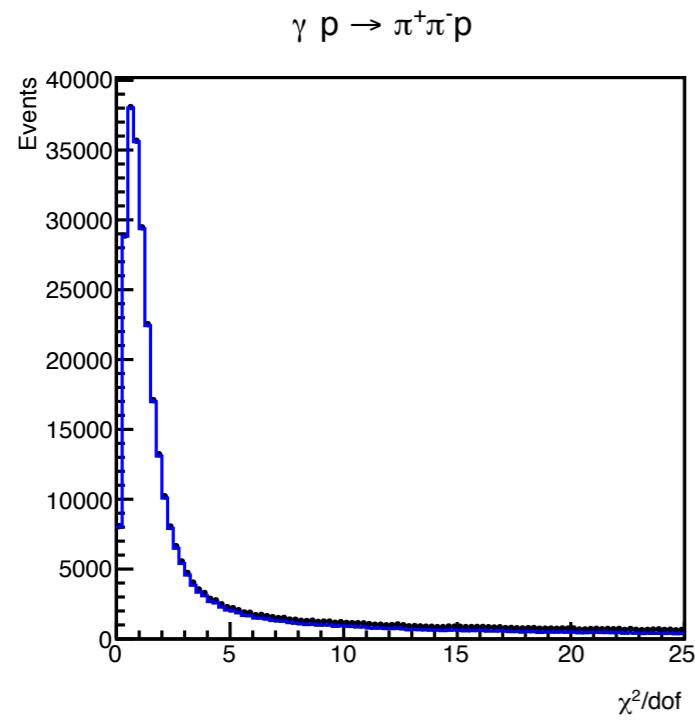
**Kinematic Fit:** (1) use `DKinFitter_GlueX` for kinematic fitting; (2) do combined vertex and four-momentum fits using all combinations of tracks and showers for a given final state; (3) do not include the  $\pi^0$  mass (for now); (4) take the combination within a given final state with the best  $\chi^2/\text{dof}$  to avoid double-counting; (5) require  $\chi^2/\text{dof} < 5$ .

$\pi^0$ : require  $105 < M(\gamma\gamma) < 165$  MeV/ $c^2$  (using the  $\gamma$  four-vectors after the kinematic fit).

**To speed processing:** (1) allow up to four extra “good” tracks (tracks that pass the track requirements listed above); (2) require measured z-momentum be within 2 GeV/ $c$  of the beam momentum; (3) require the measured transverse momentum be less than 500 MeV/ $c$ .

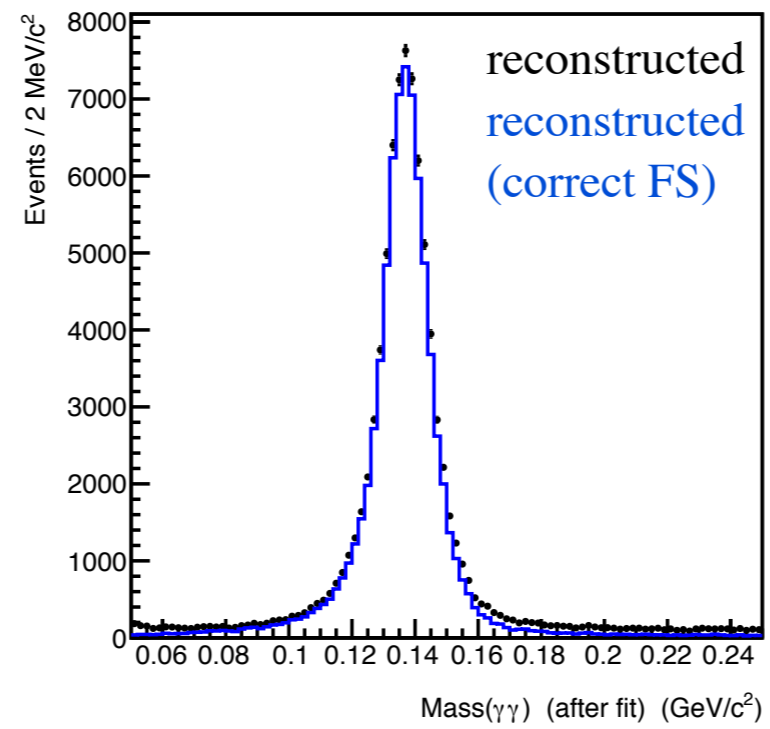
# Kinematic Fit $\chi^2/\text{dof}$

(showing all  $\chi^2/\text{dof}$  — not just the best)

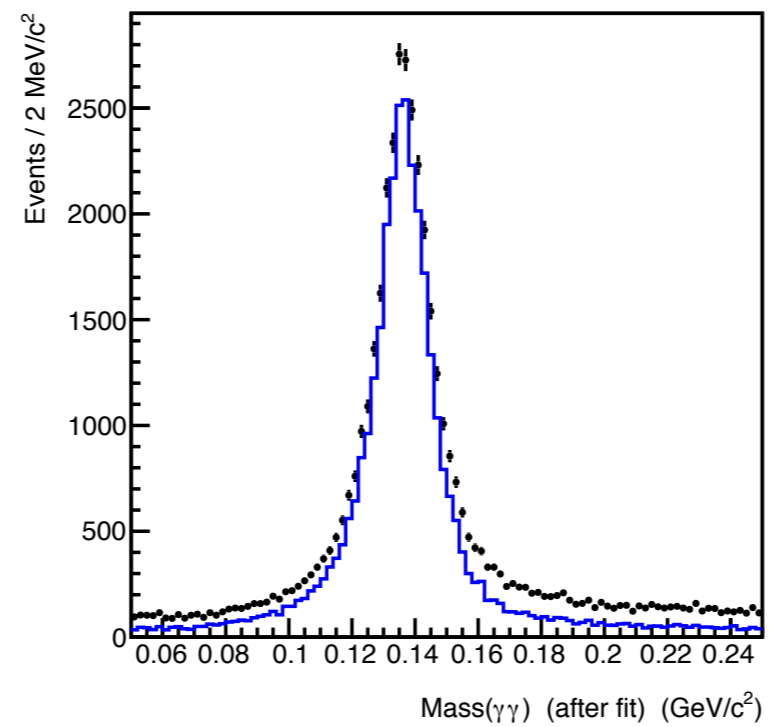


# Reconstructed $\pi^0$ Mass

$$\gamma p \rightarrow \pi^+ \pi^- \pi^0 p$$

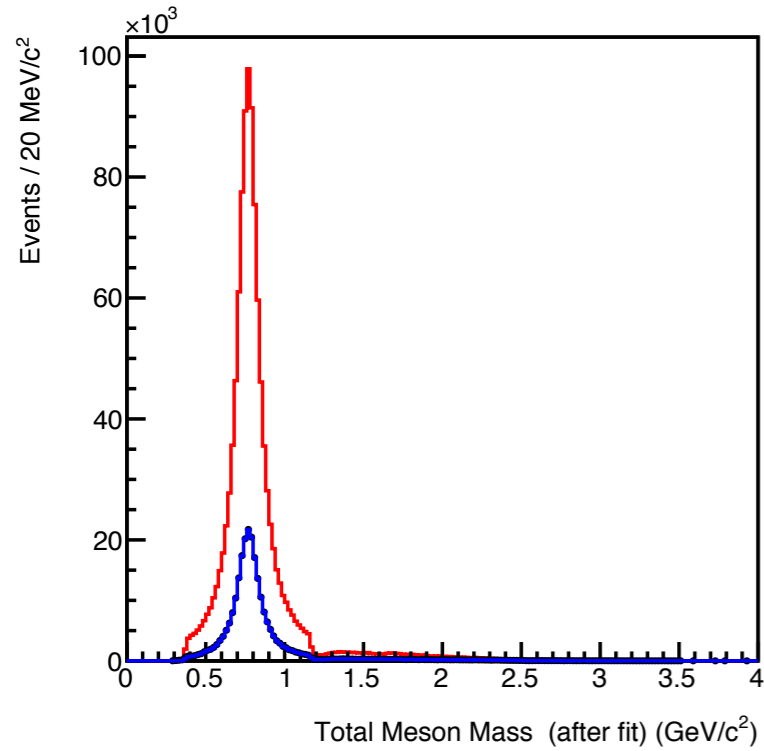


$$\gamma p \rightarrow \pi^+ \pi^- \pi^+ \pi^- \pi^0 p$$

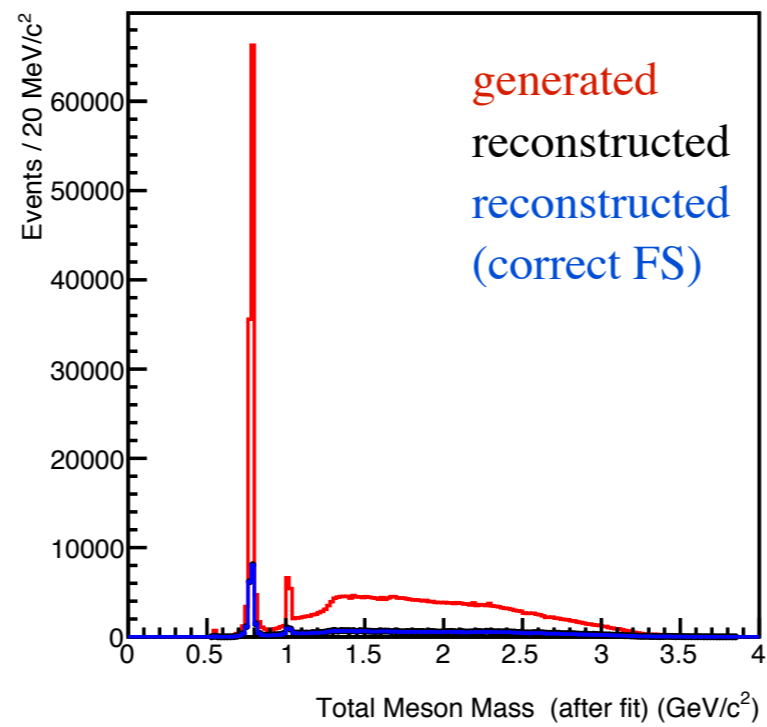


# Total Meson Mass

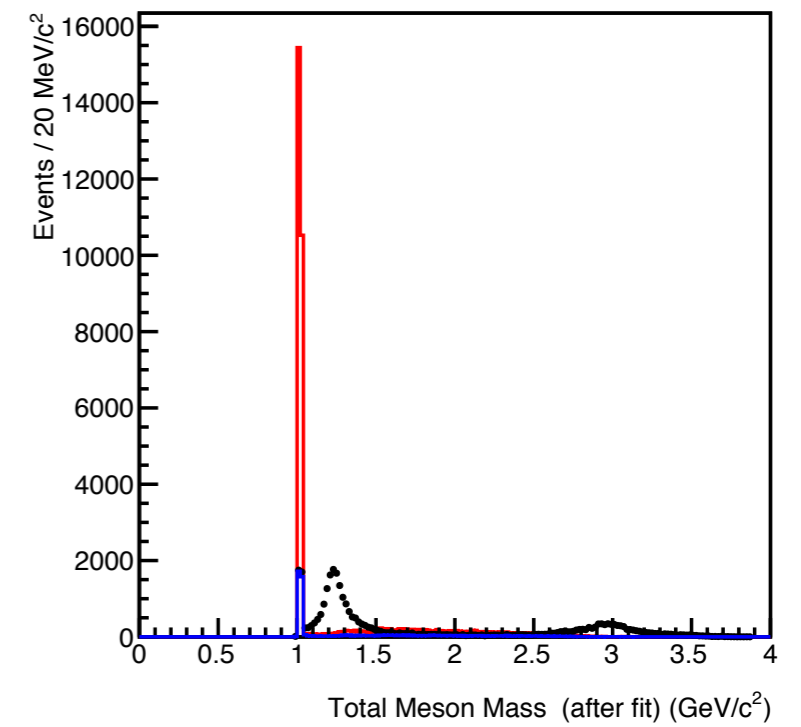
$\gamma p \rightarrow \pi^+\pi^-p$



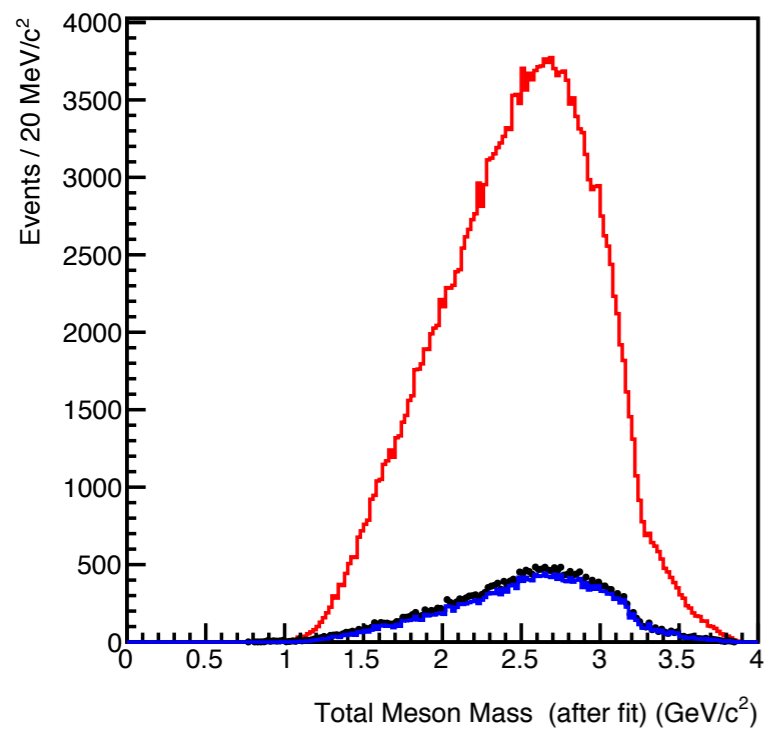
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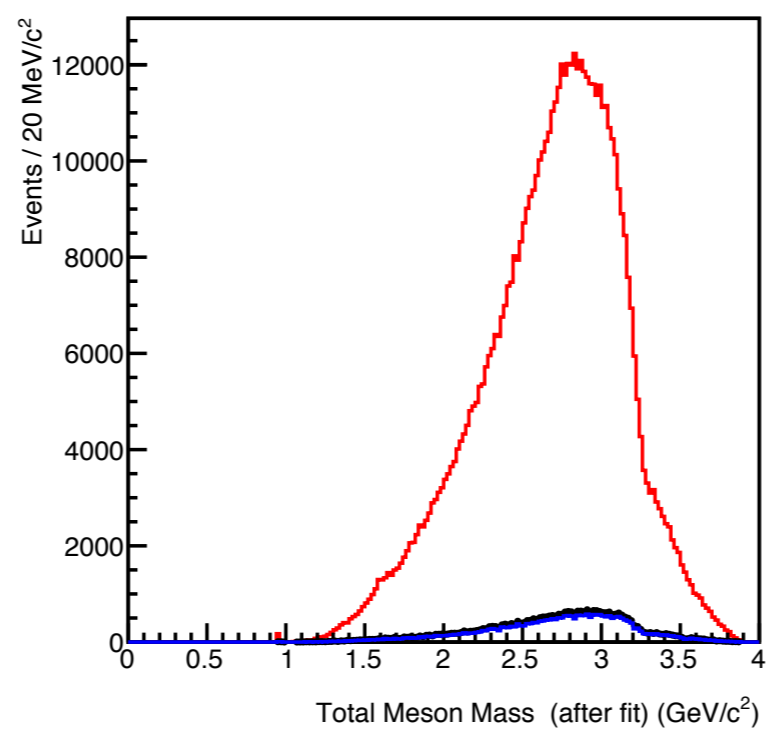
$\gamma p \rightarrow K^+K^-p$



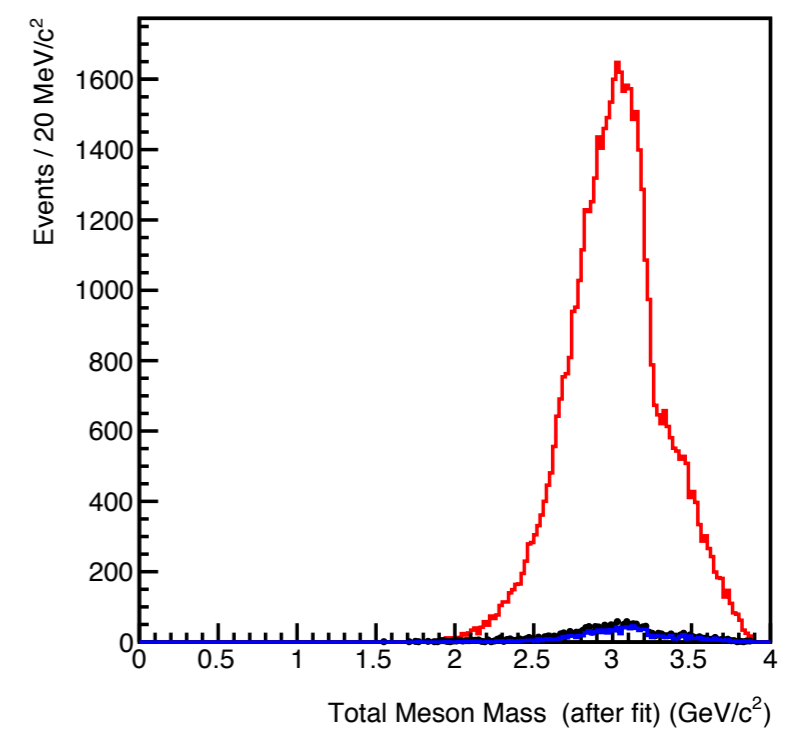
$\gamma p \rightarrow \pi^+\pi^-\pi^+\pi^-p$



$\gamma p \rightarrow \pi^+\pi^-\pi^+\pi^0p$



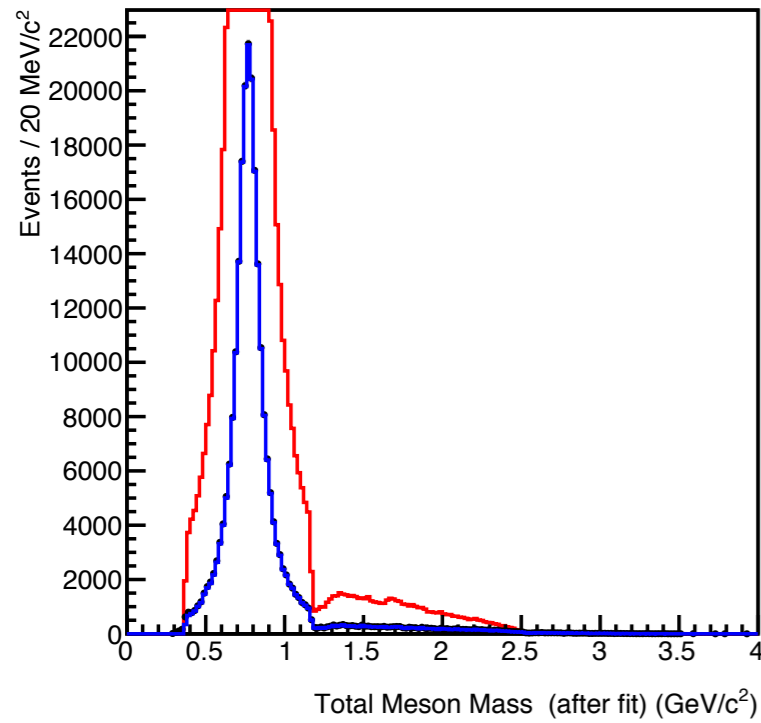
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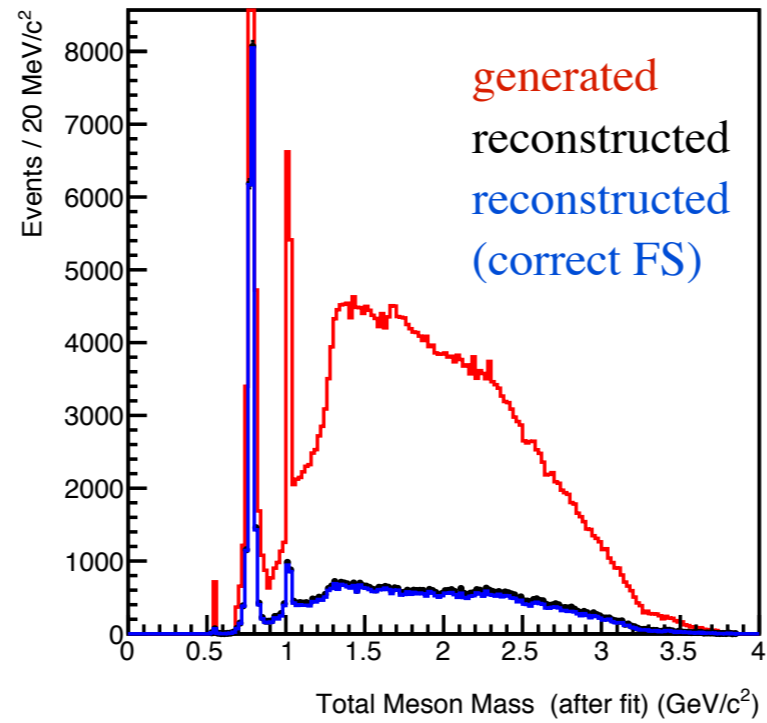
# Total Meson Mass

(zoomed in)

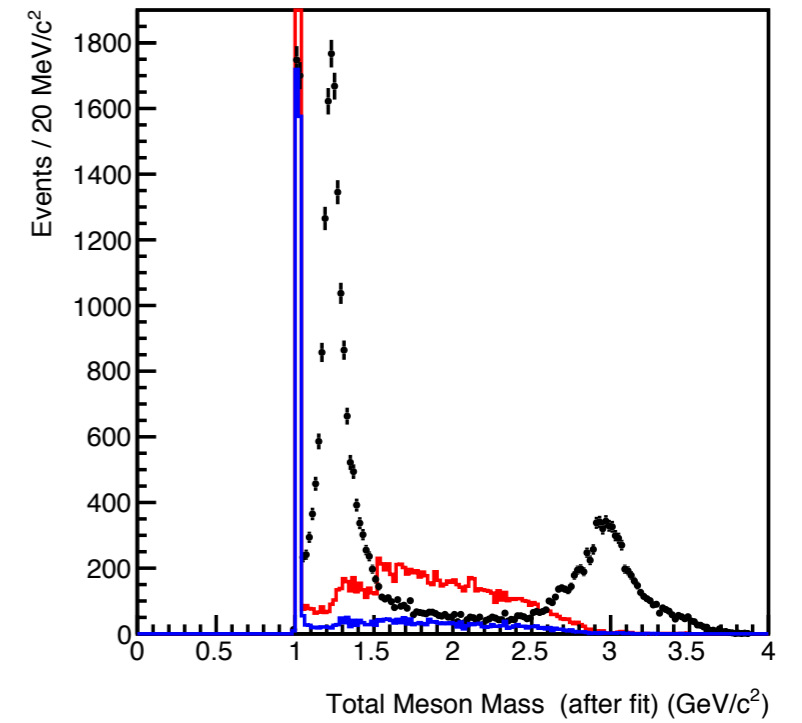
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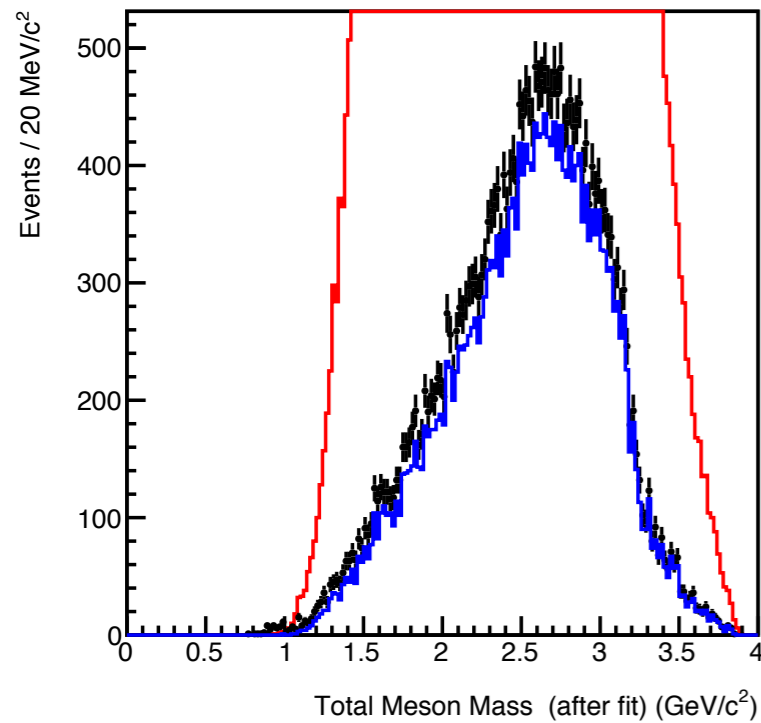
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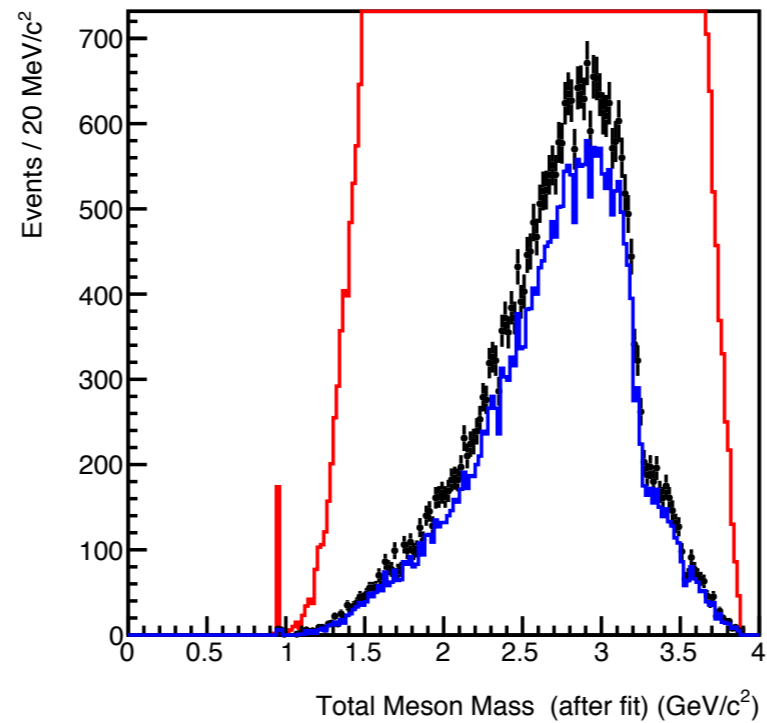
$\gamma p \rightarrow K^+K^-p$



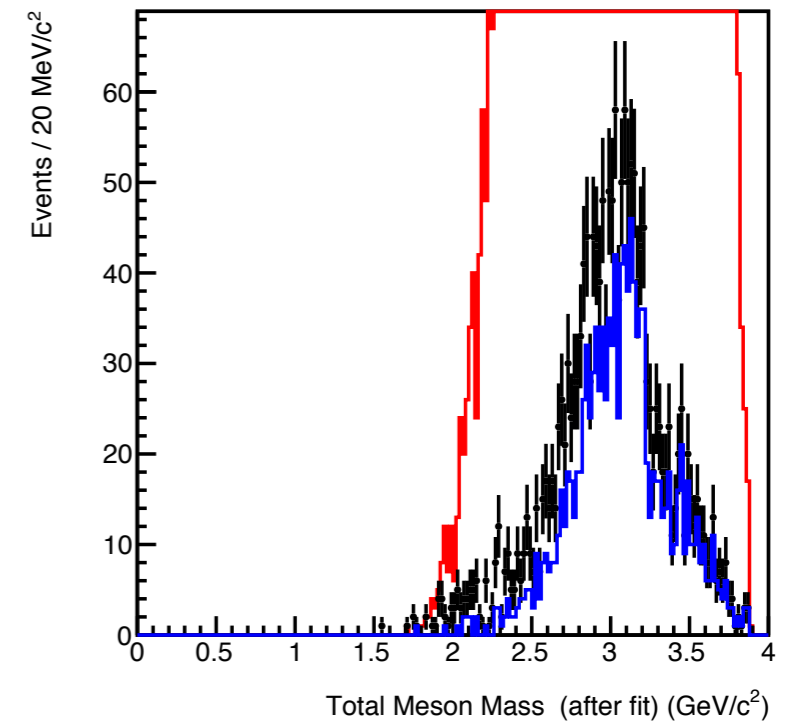
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$\gamma p \rightarrow \pi^+\pi^-\pi^+\pi^0p$



$\gamma p \rightarrow \pi^+\pi^-\pi^+\pi^-\pi^+p$

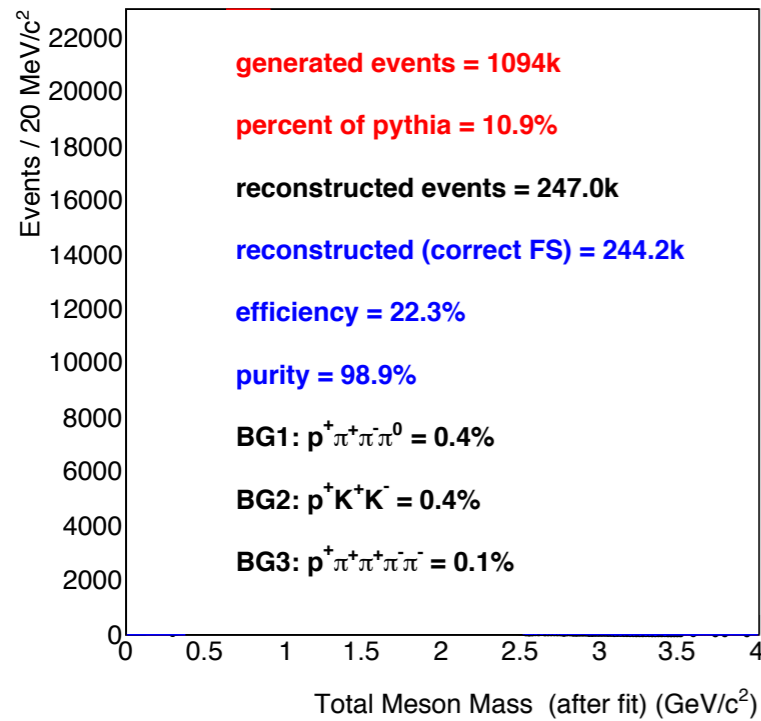




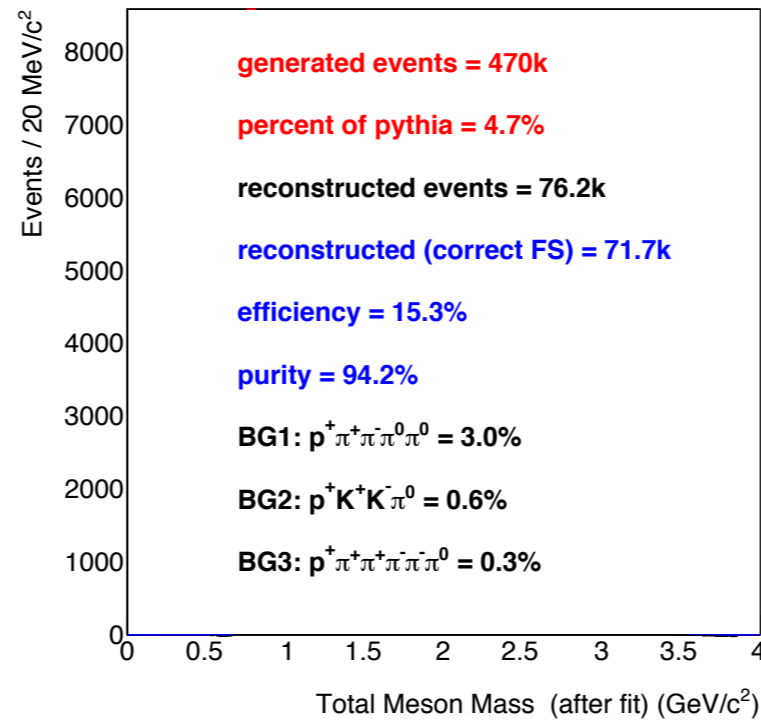
# Total Meson Mass

(numbers)

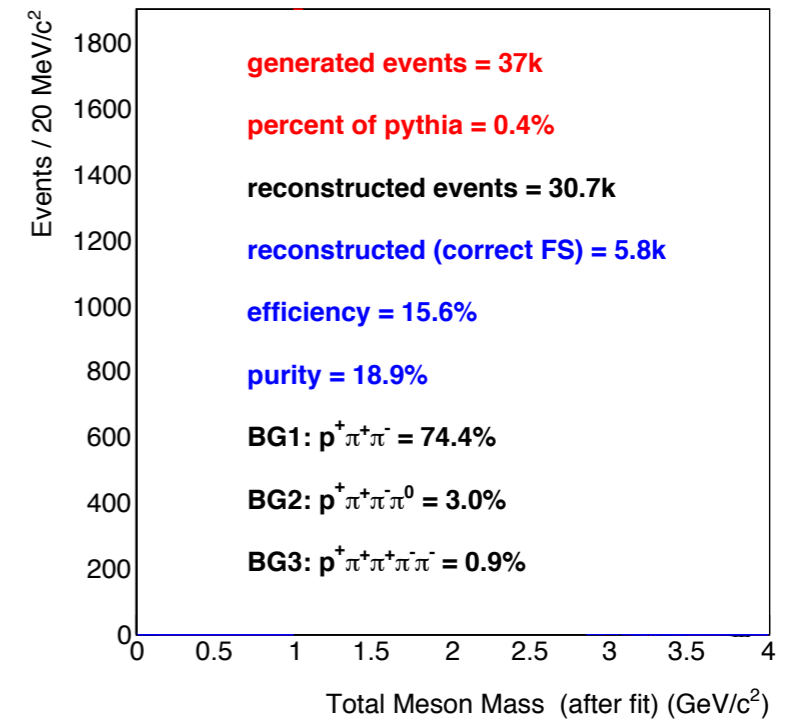
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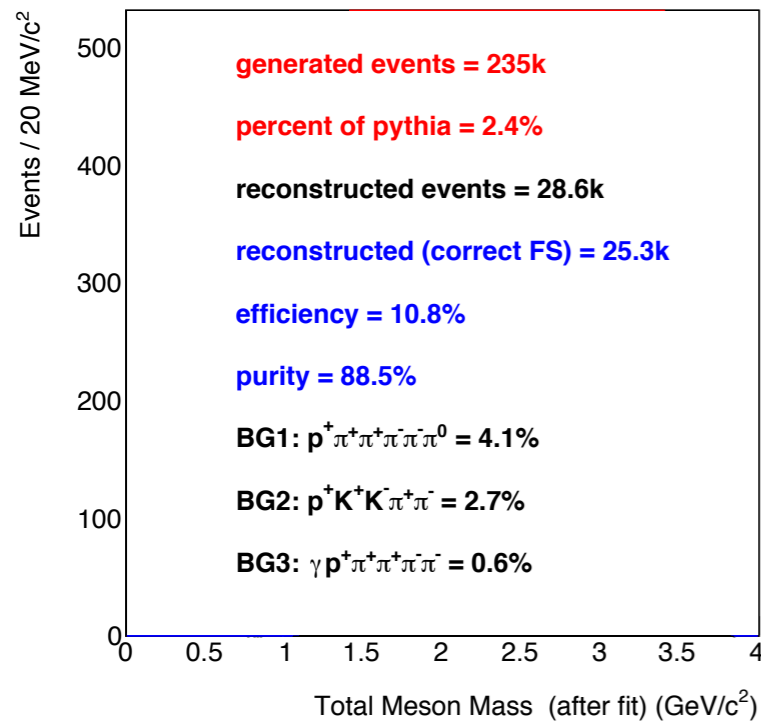
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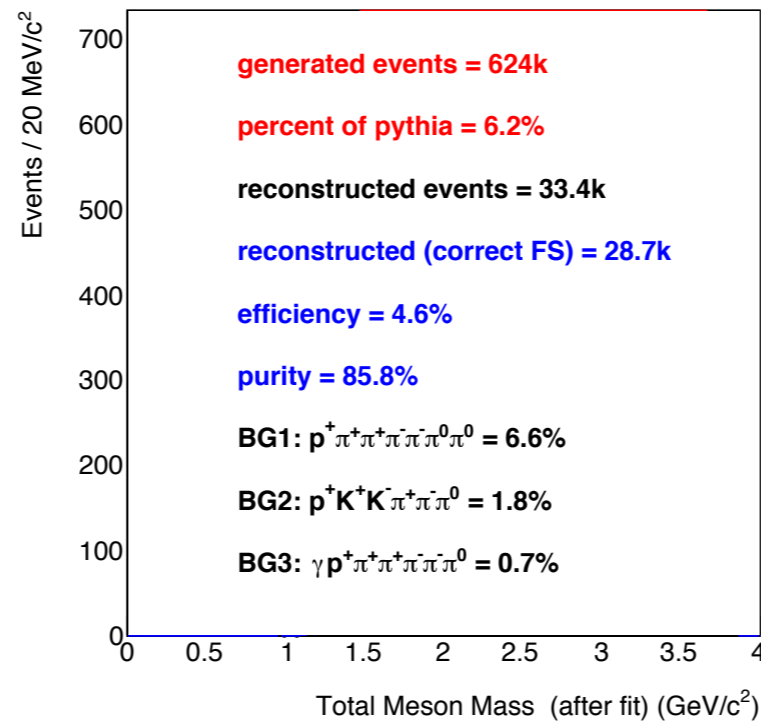
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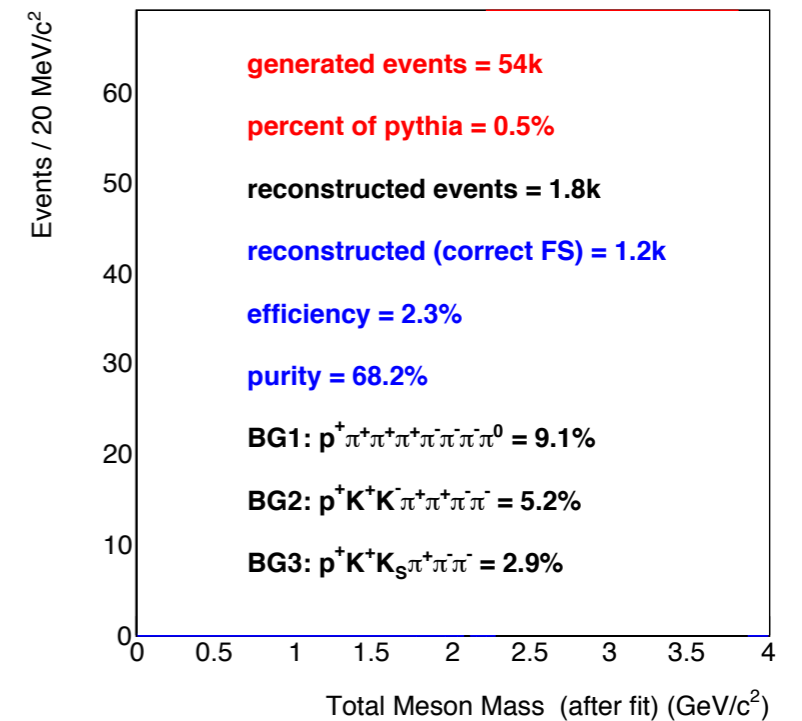
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$$\gamma p \rightarrow \pi^+\pi^-\pi^+\pi^-\pi^0p$$

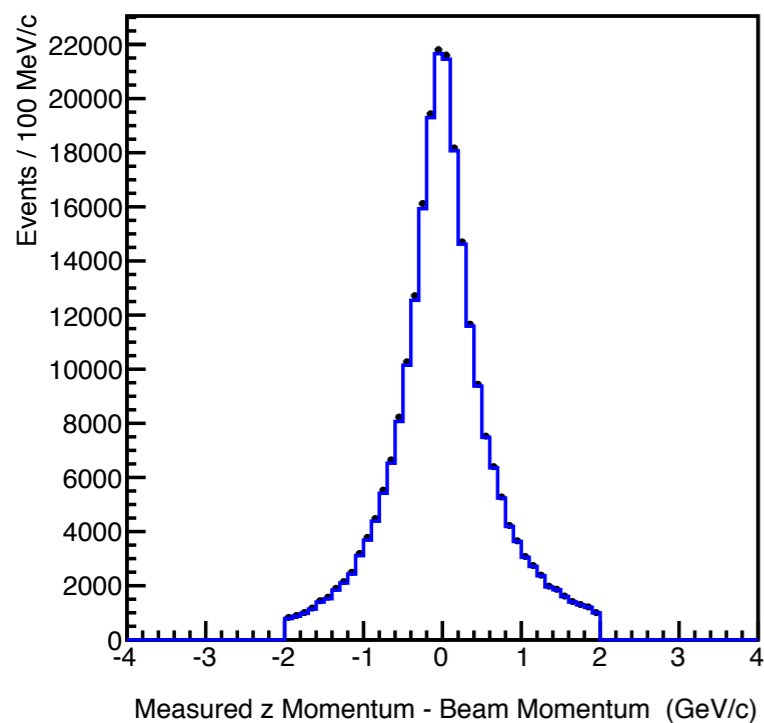


$$\gamma p \rightarrow \pi^+\pi^-\pi^+\pi^-\pi^+\pi^-p$$

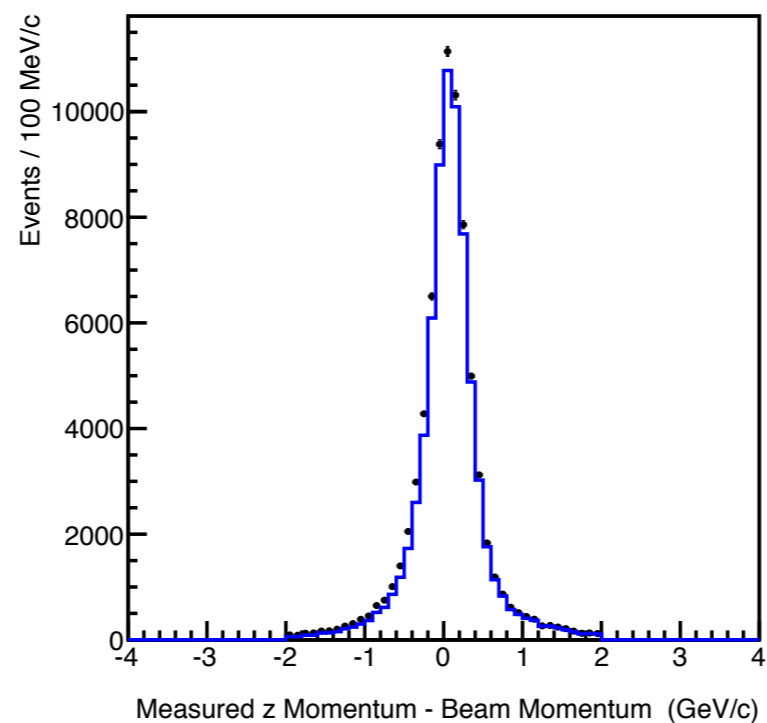


# Measured z-momentum – Beam Momentum

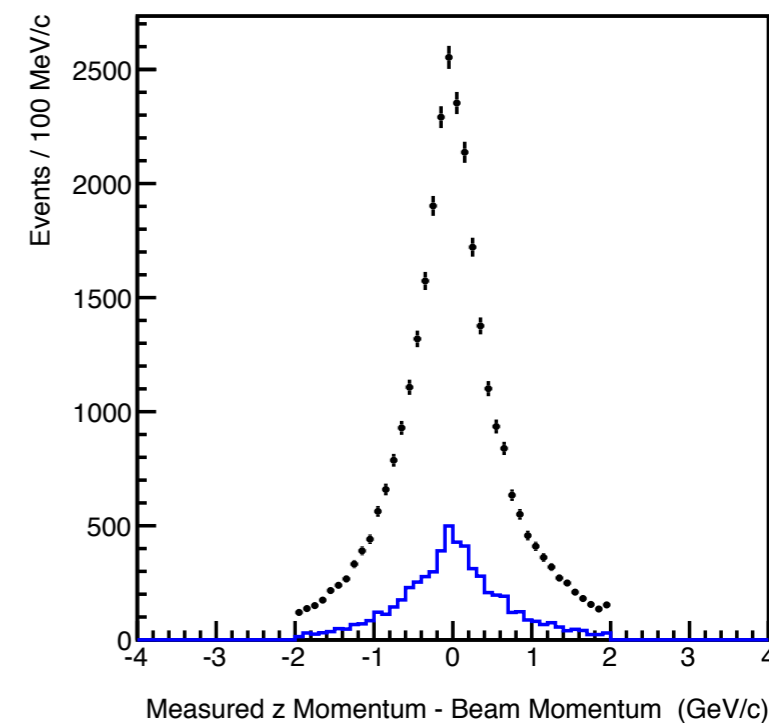
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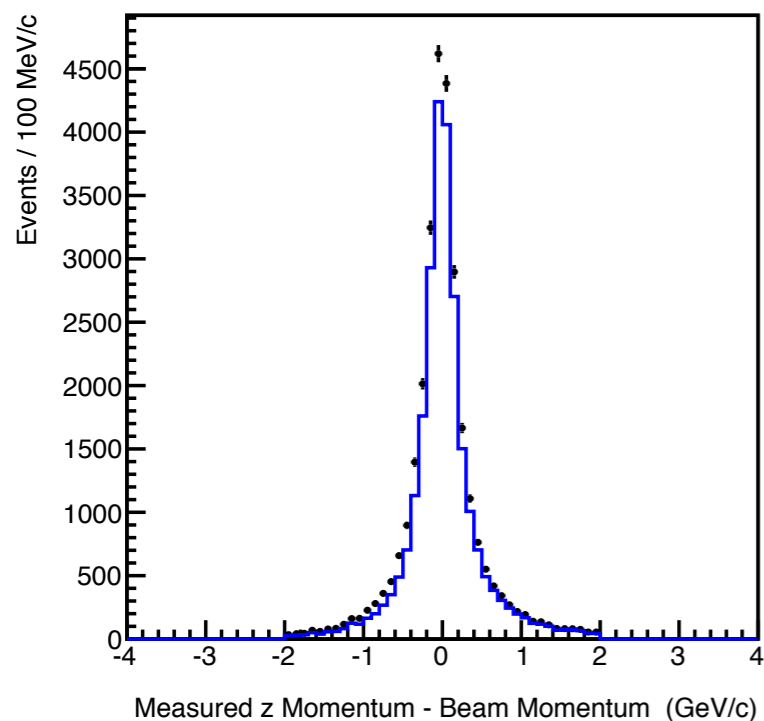
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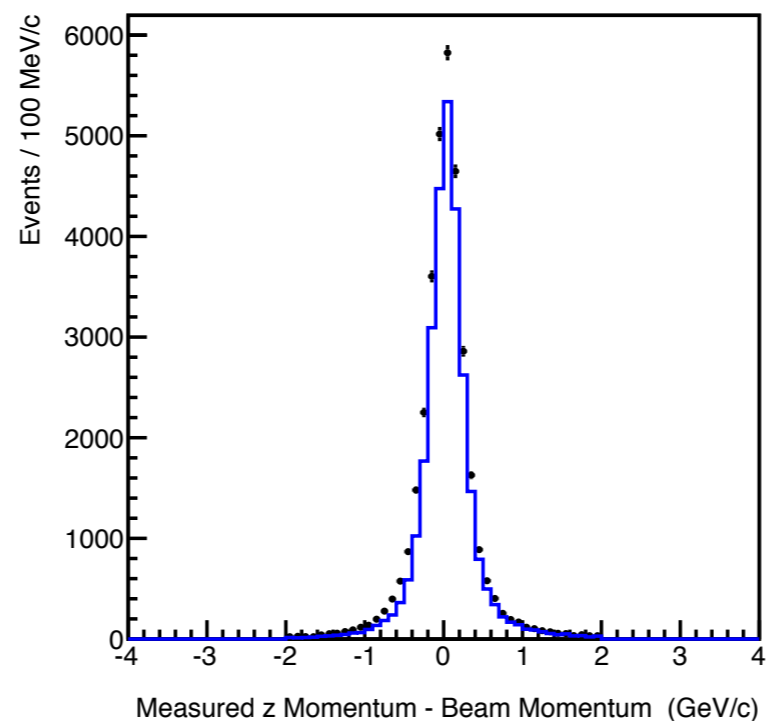
$\gamma p \rightarrow K^+K^-p$



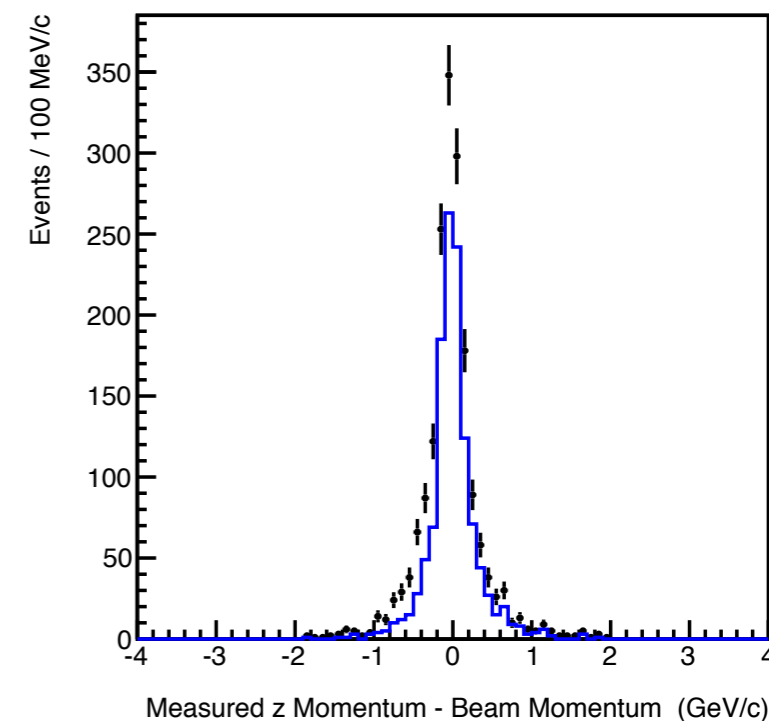
$\gamma p \rightarrow \pi^+\pi^-\pi^+\pi^-p$



$\gamma p \rightarrow \pi^+\pi^-\pi^+\pi^0p$

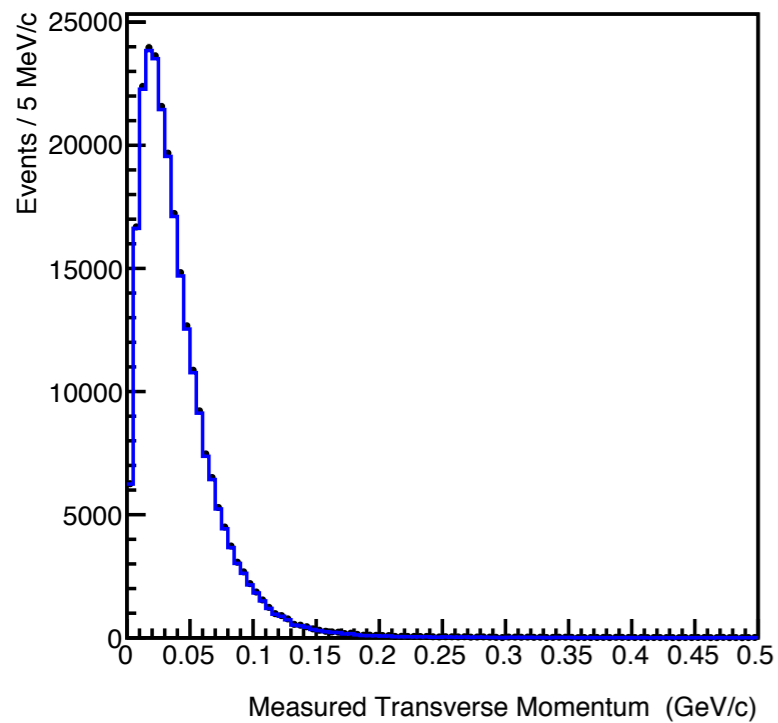


$\gamma p \rightarrow \pi^+\pi^-\pi^+\pi^-\pi^+p$

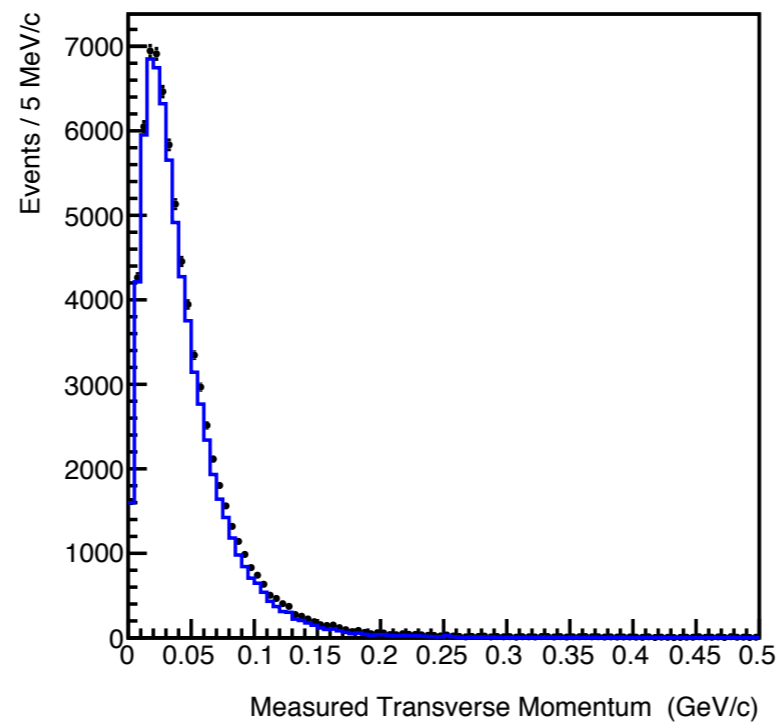


# Measured Transverse Momentum

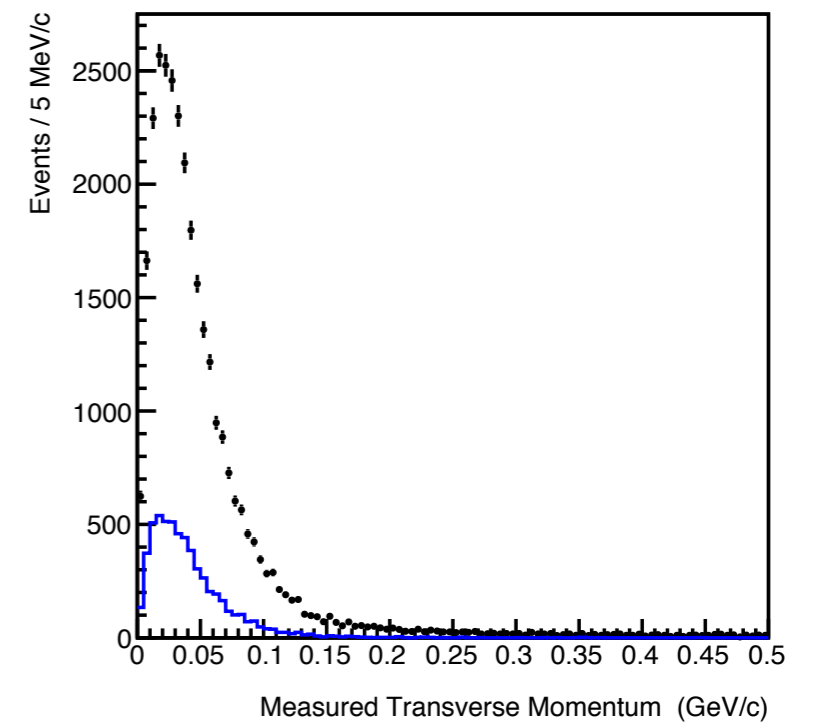
$\gamma p \rightarrow \pi^+\pi^-p$



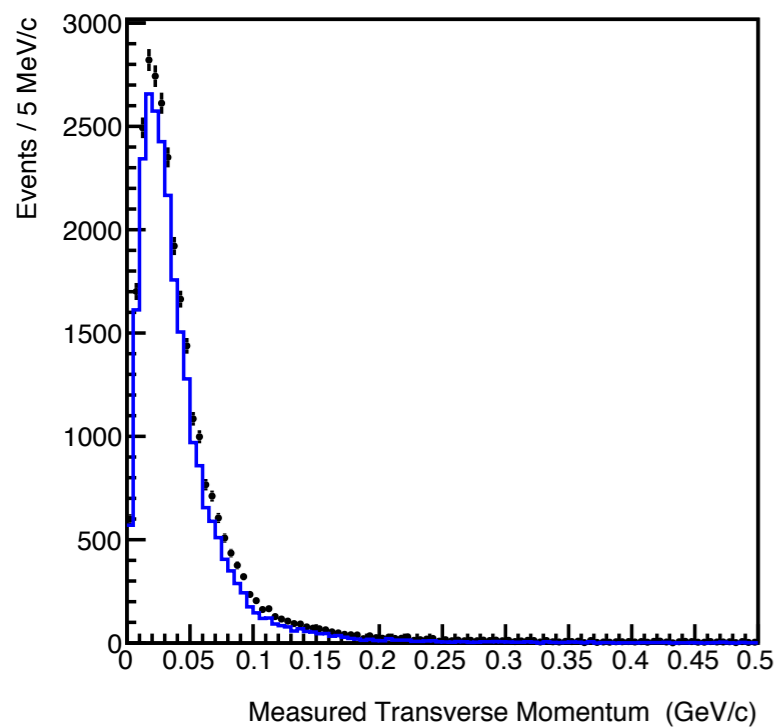
$\gamma p \rightarrow \pi^+\pi^-\pi^0p$



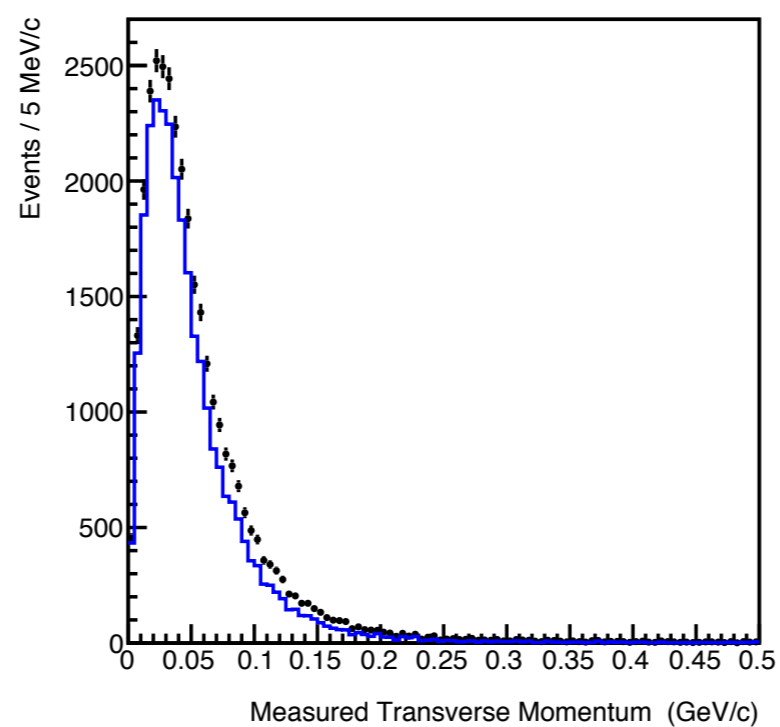
$\gamma p \rightarrow K^+K^-p$



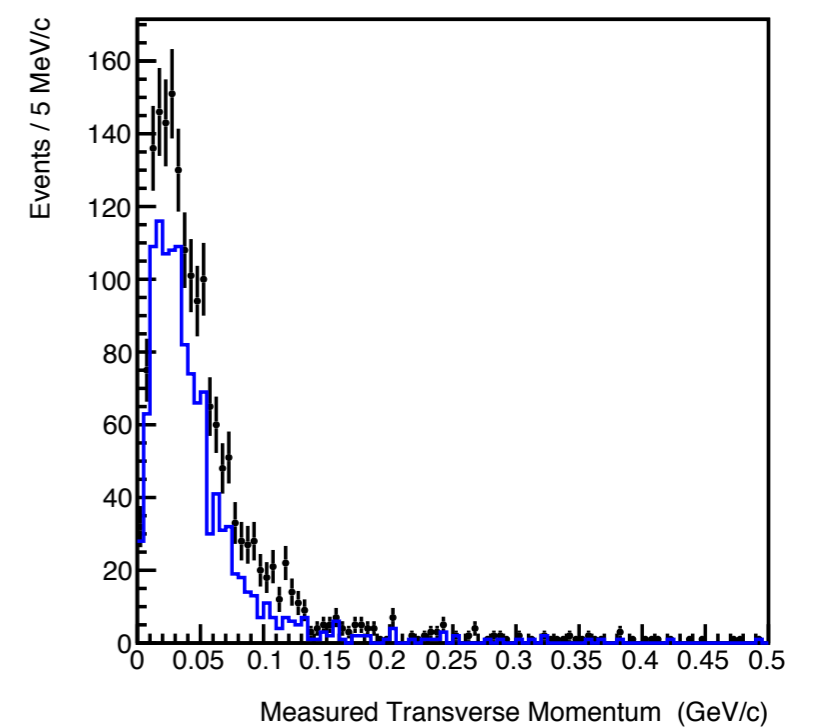
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$\gamma p \rightarrow \pi^+\pi^-\pi^+\pi^0p$

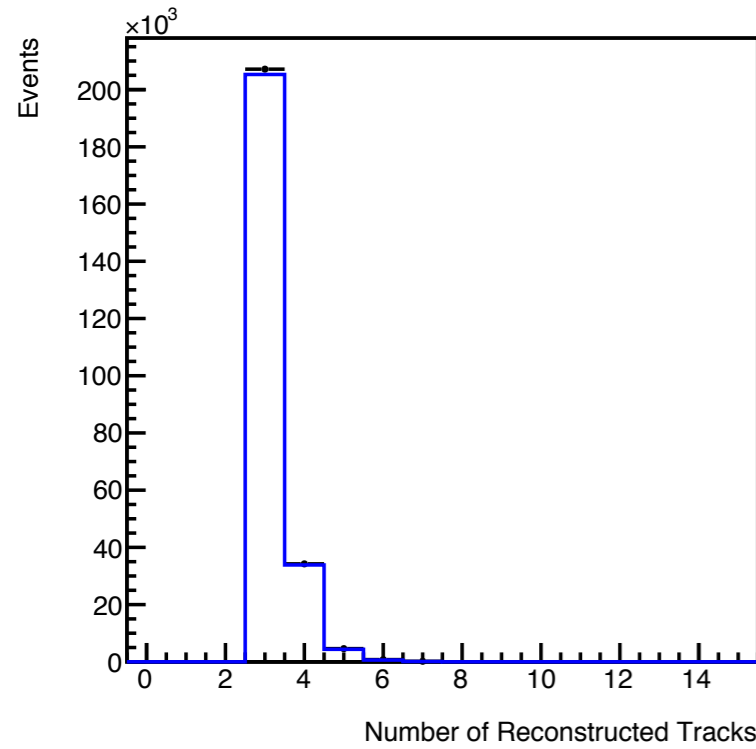


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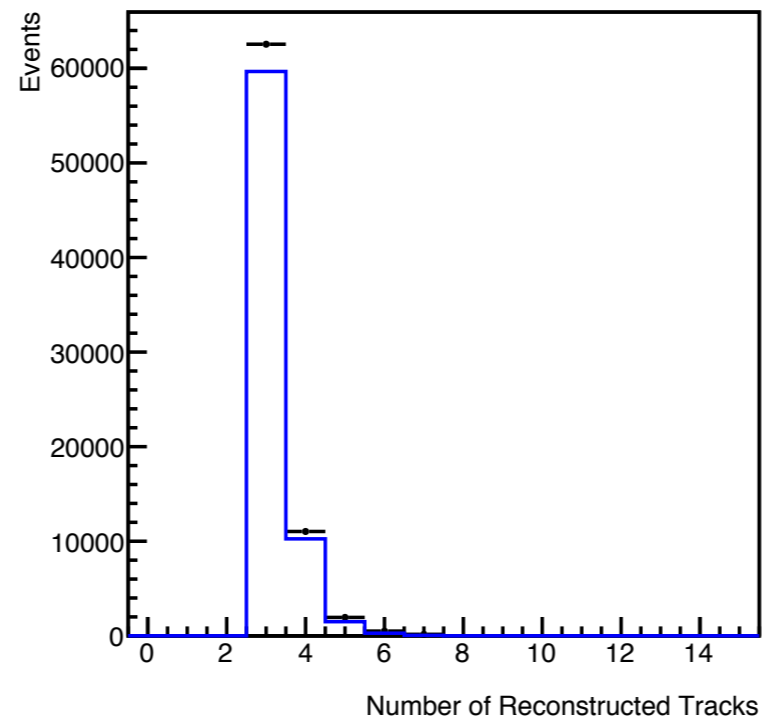


# Number of “Good” Reconstructed Tracks

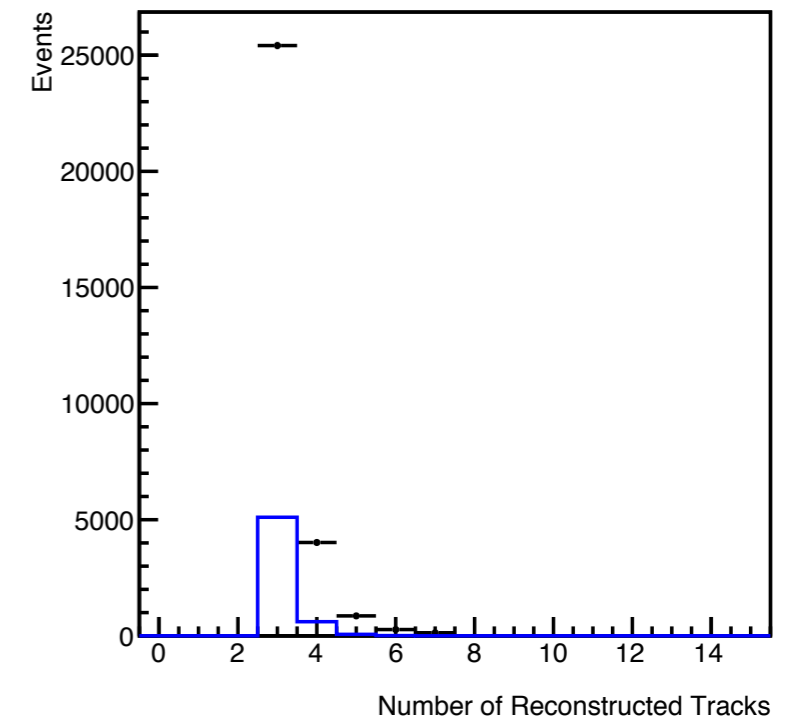
$\gamma p \rightarrow \pi^+\pi^-p$



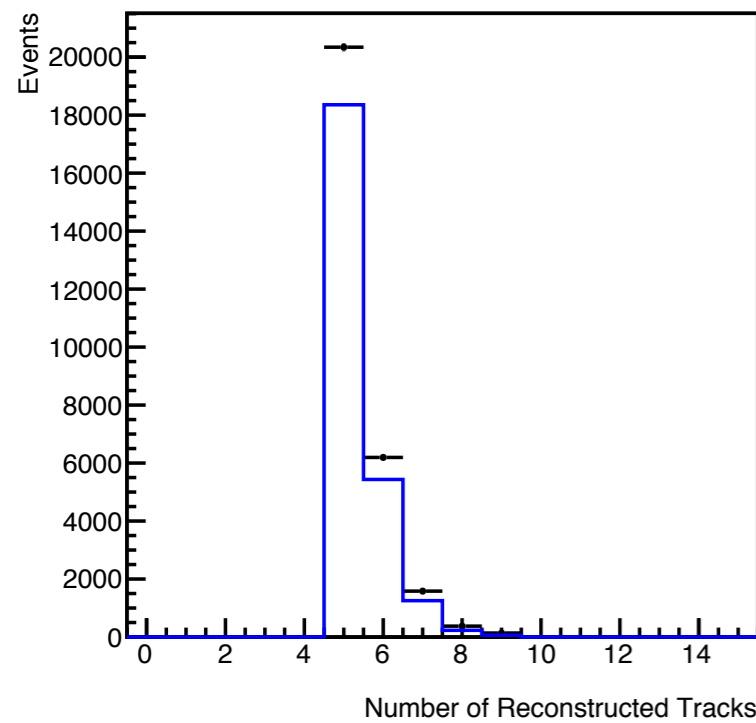
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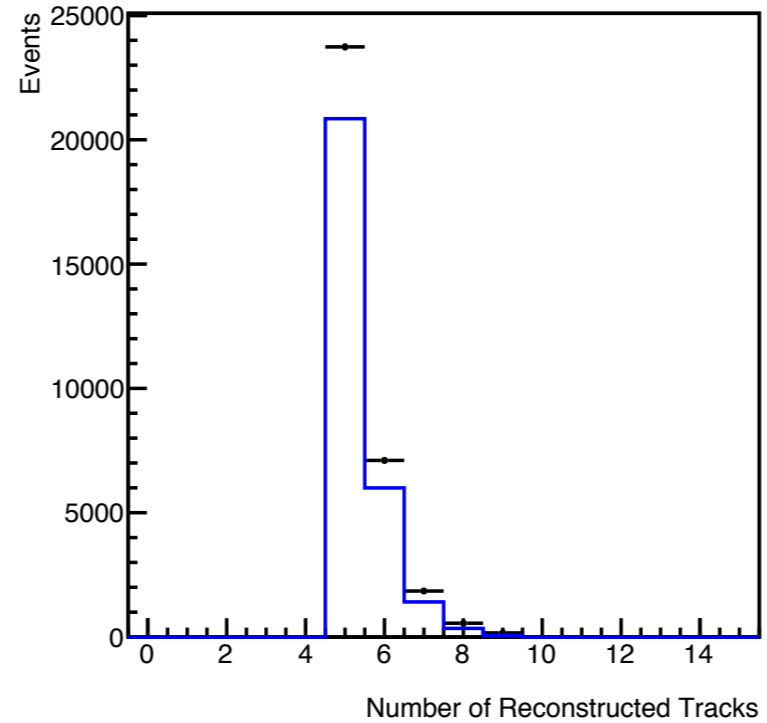
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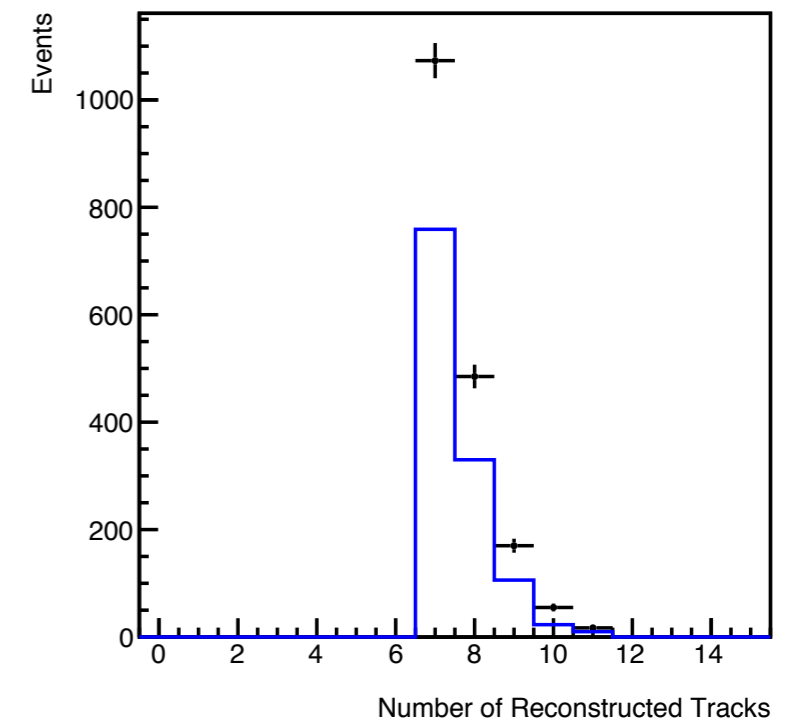
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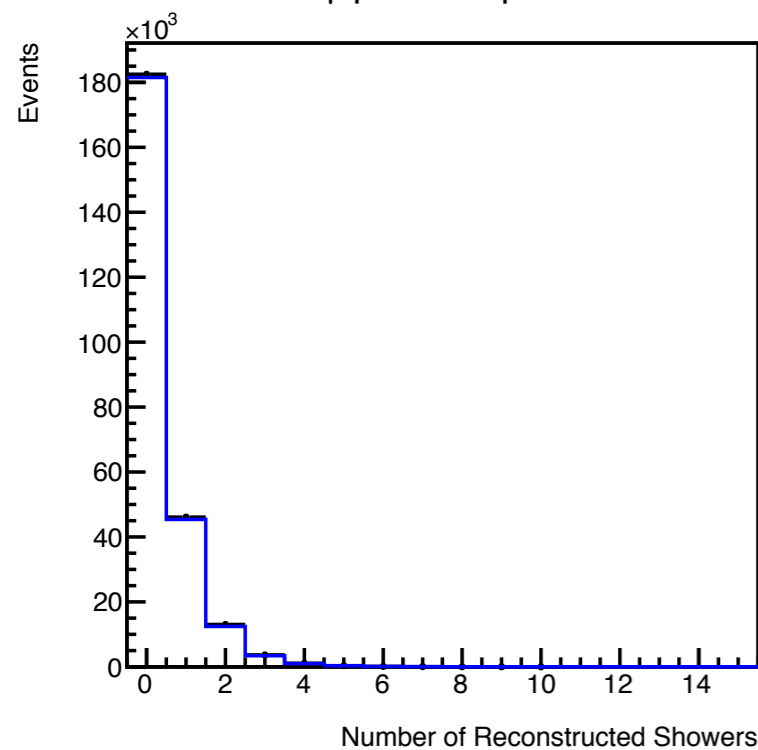


$\gamma p \rightarrow \pi^+\pi^-\pi^+\pi^-\pi^+\pi^-p$

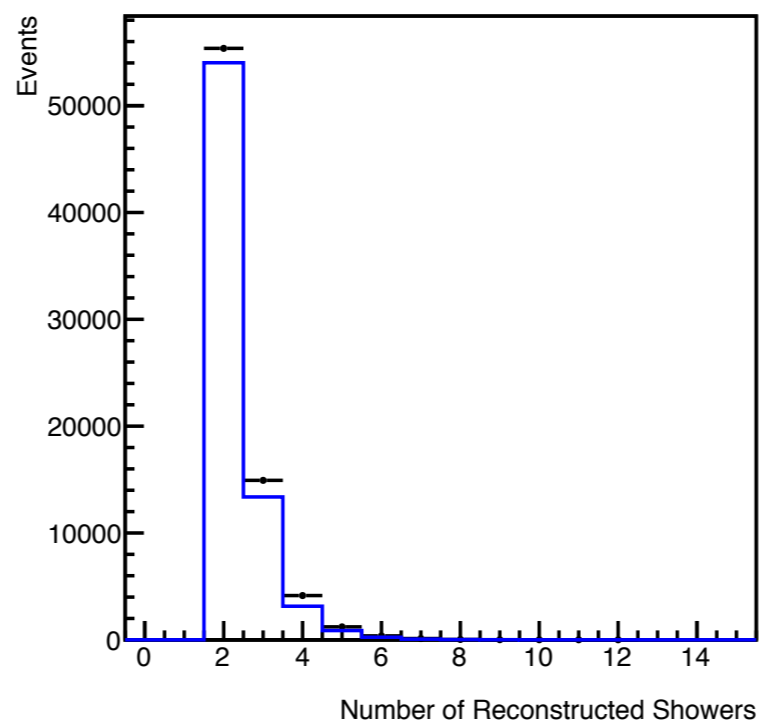


# Number of “Good” Reconstructed Showers

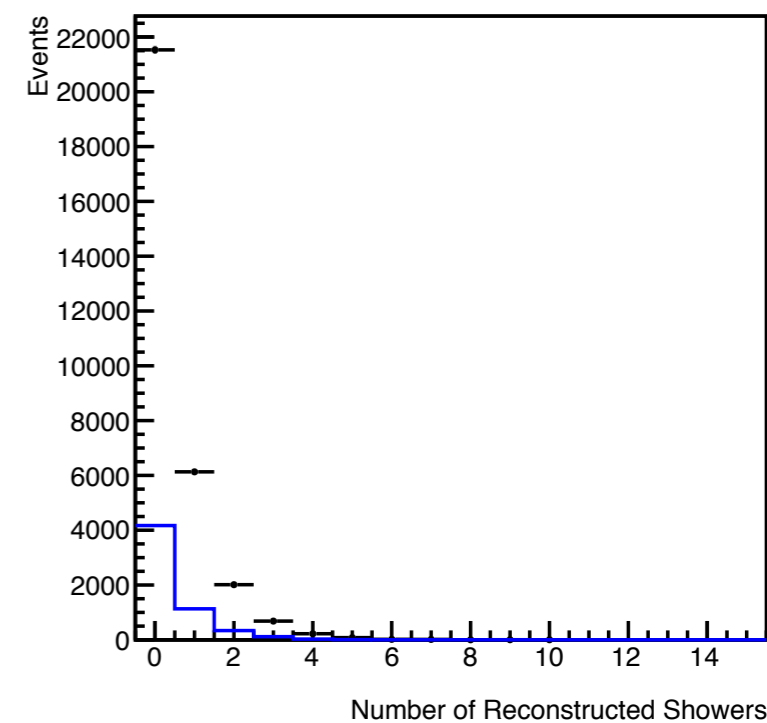
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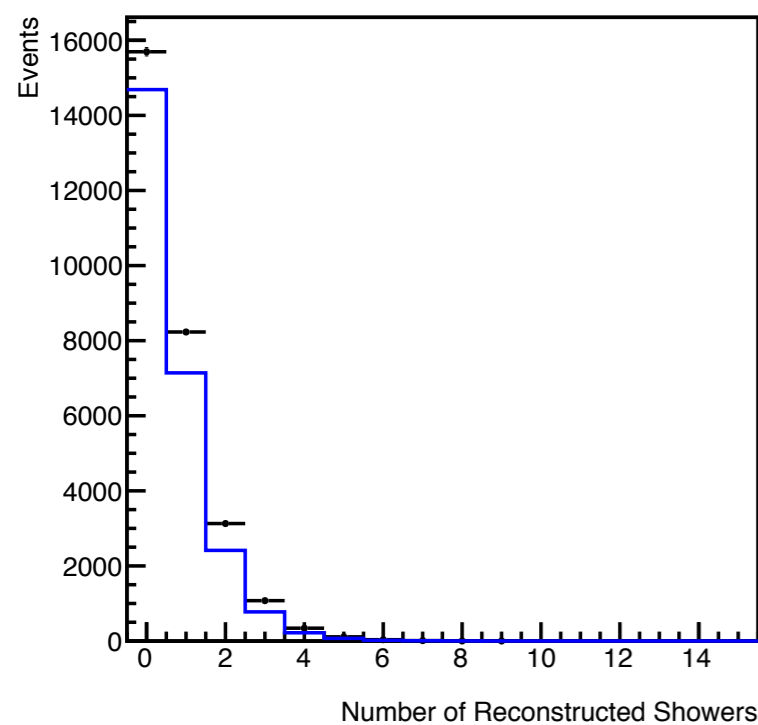
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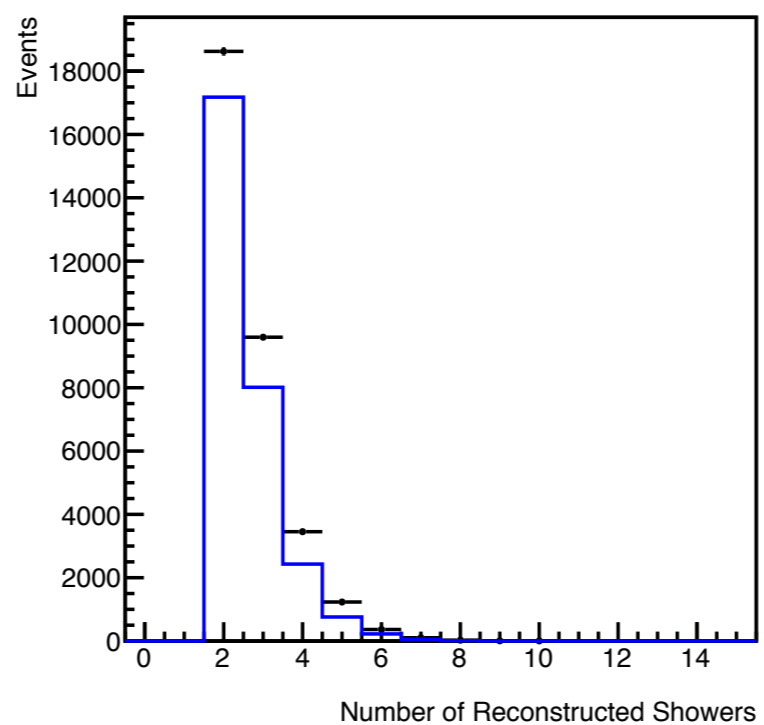
$\gamma p \rightarrow K^+K^-p$



$\gamma p \rightarrow \pi^+\pi^-\pi^+\pi^-p$



$\gamma p \rightarrow \pi^+\pi^-\pi^+\pi^-\pi^0p$



$\gamma p \rightarrow \pi^+\pi^-\pi^+\pi^-\pi^+\pi^-p$

