

# Kinematic Fitting for $b_1\pi$ Events

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# Kinematic Fitting

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- ▶ Fit with constraints
- ▶ Constraints:
  - ▶ Conservation of energy and momentum
  - ▶ Mass constraint (i.e.  $\pi^0 \rightarrow \gamma\gamma$ )
- ▶ Informally: wiggle the measured values (within errors) to satisfy constraints
- ▶ Formally: least-squares fit with constraints enforced by Lagrange multipliers

# What's the point?

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- ▶ **Cut out bad events**
  - ▶ Confidence level measures goodness of fit
  - ▶ Cuts out a well-defined amount of signal
- ▶ **Better understand errors**
  - ▶ Confidence level and pull distribution show how well errors are estimated
- ▶ **Improve errors on measured quantities**

# Hall D software & Procedure

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- ▶ Generate signal (genr8)

$$\gamma p \rightarrow X(2000) p$$

$$\hookrightarrow b_1 \pi^-$$

$$\hookrightarrow \omega \pi^+$$

$$\hookrightarrow \pi^0 \pi^+ \pi^-$$

$$\hookrightarrow \gamma \gamma$$

- ▶ Final state:  $p\pi^+\pi^+\pi^-\pi^-\gamma\gamma$
- ▶ Several exotic quantum number mesons can decay to  $b_1\pi$

# Hall D software & Procedure

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- ▶ **Generating background**
  - ▶ bggen/pythia
- ▶ **Simulation**
  - ▶ hd\_parsim
  - ▶ Modified to get error matrices for each particle
- ▶ **Analysis**
  - ▶ DKinFit class takes particles'4-momenta & error matrices and does the fit

# $b_1\pi$ results

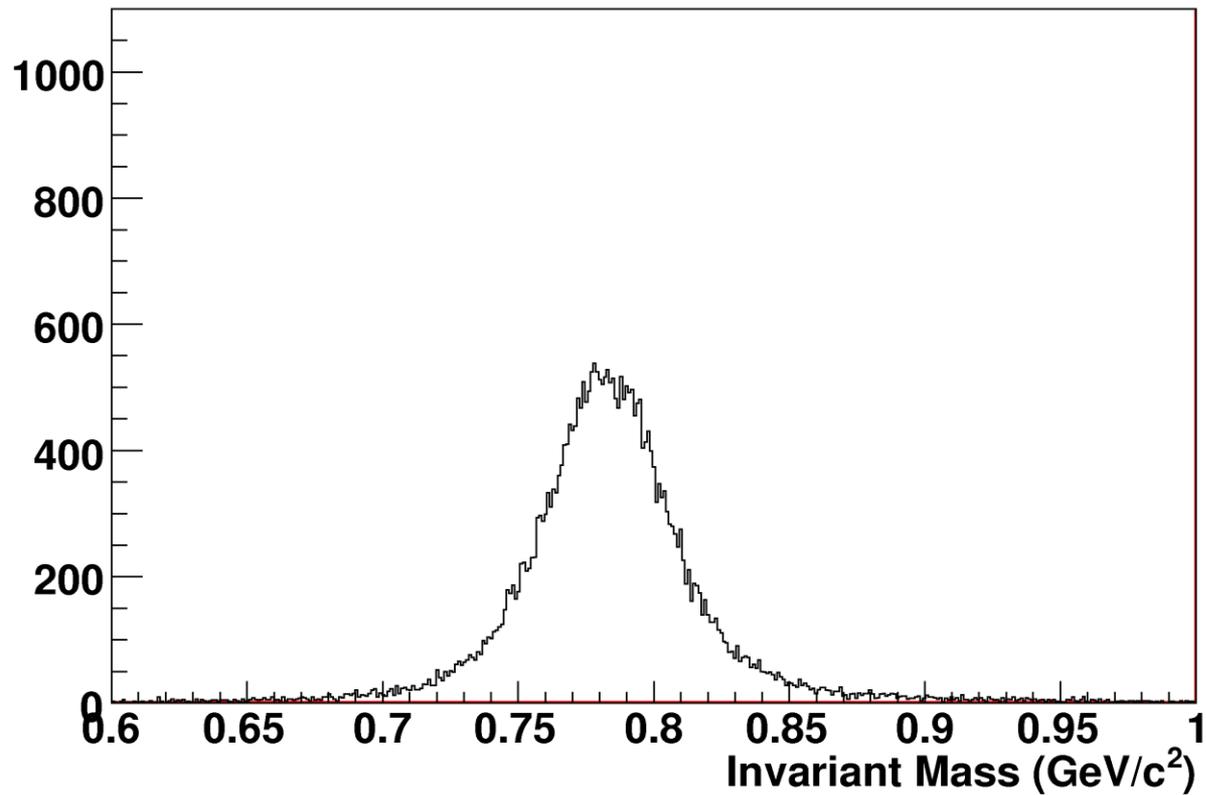
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- ▶ No background
- ▶ Only look at events with final state  $\rho\pi^-\pi^-\pi^+\pi^+\gamma\gamma$ 
  - ▶ Eliminates events with lost particles
- ▶ Plot  $\omega$  mass ( $\pi^+\pi^-\gamma\gamma$ )
  - ▶ Cheating by only looking at “correct”  $\pi$ 's
- ▶ Fits with and without  $\pi^0$  mass constraint

# $b_1\pi$ results: before fitting

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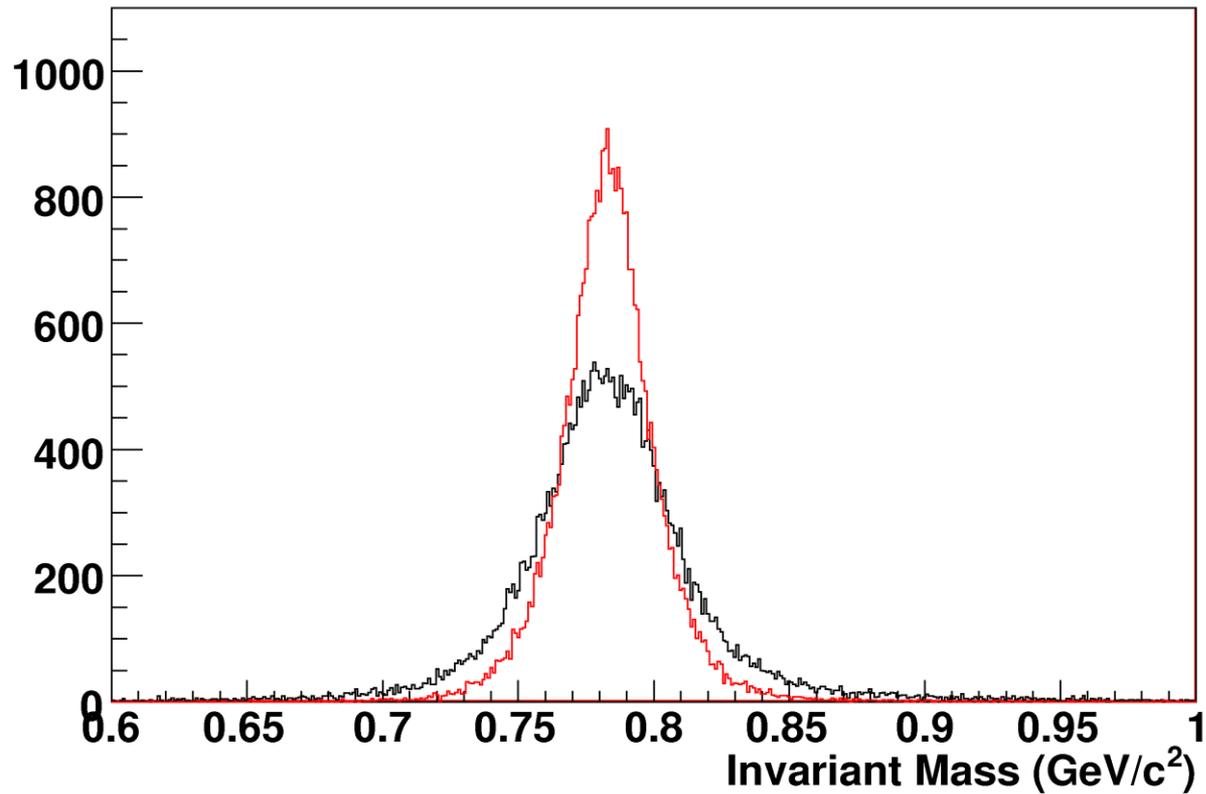
$\pi^+\pi^-\gamma\gamma$  invariant mass



# $b_1\pi$ results: after fitting

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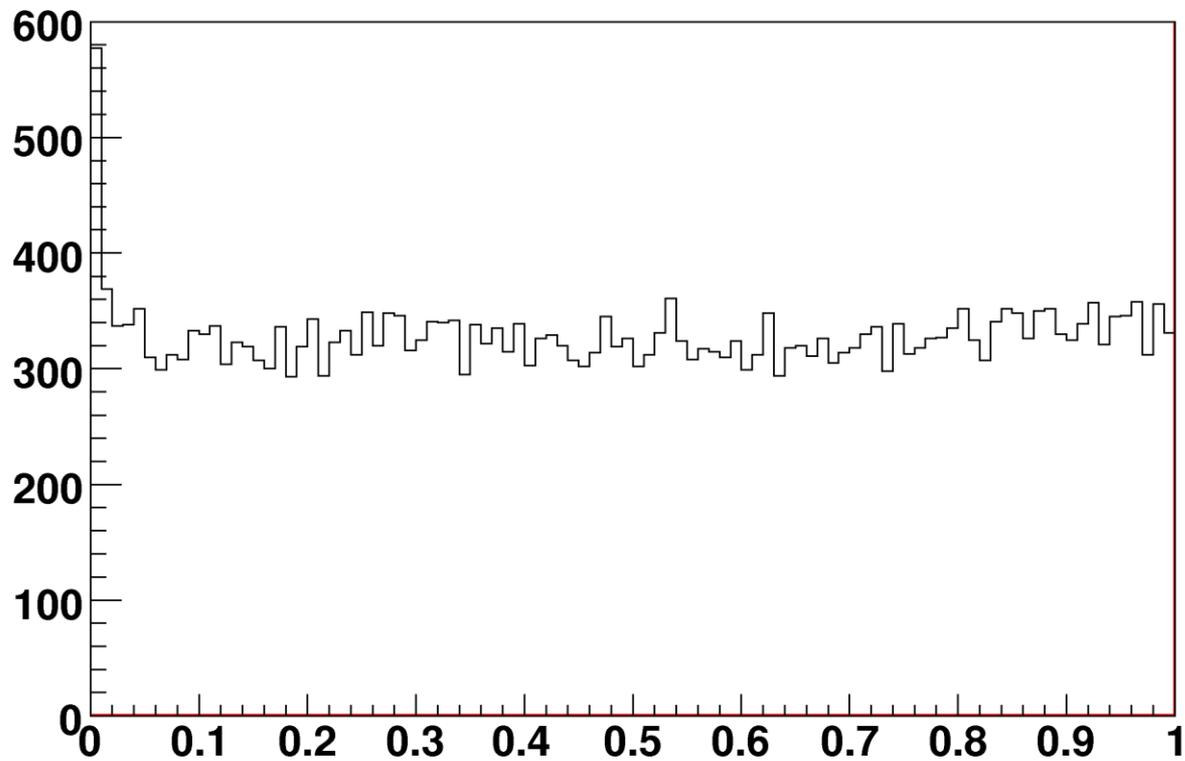
$\pi^+\pi^-\gamma\gamma$  invariant mass



# $b_1\pi$ results

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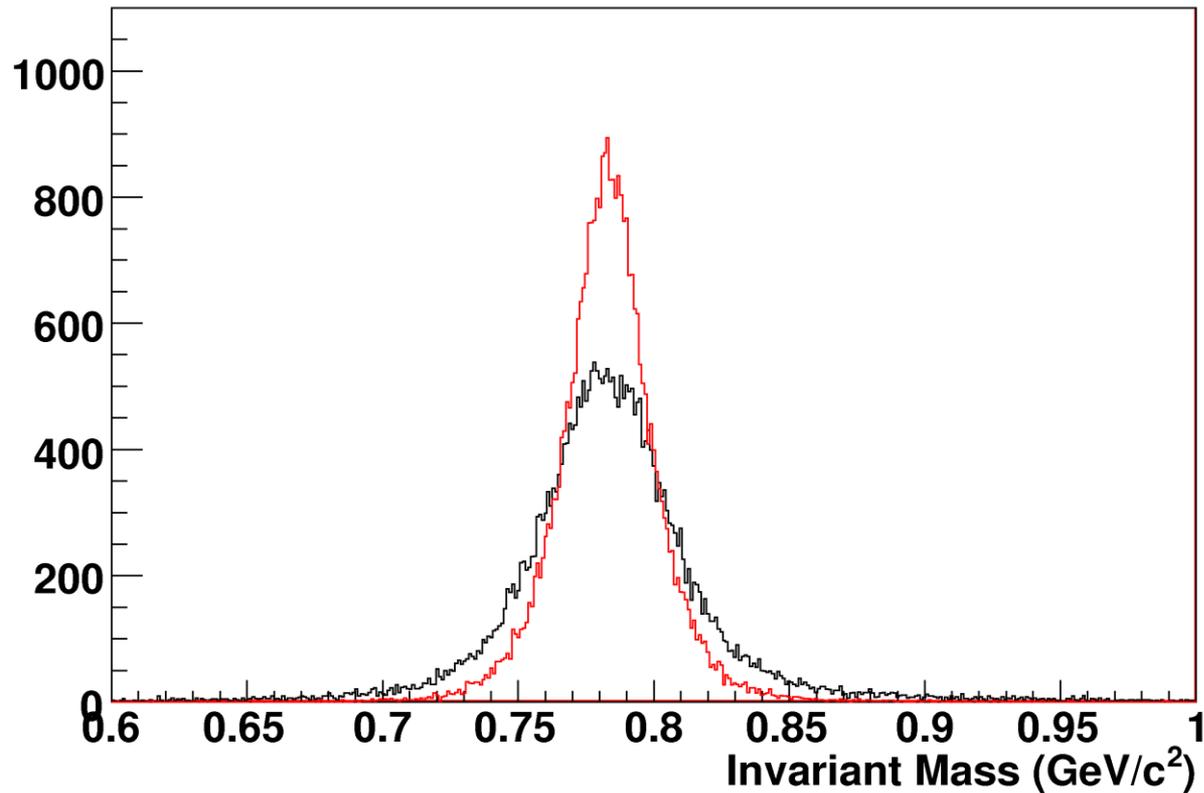
Confidence Level (with  $\pi^0$  mass constraints)



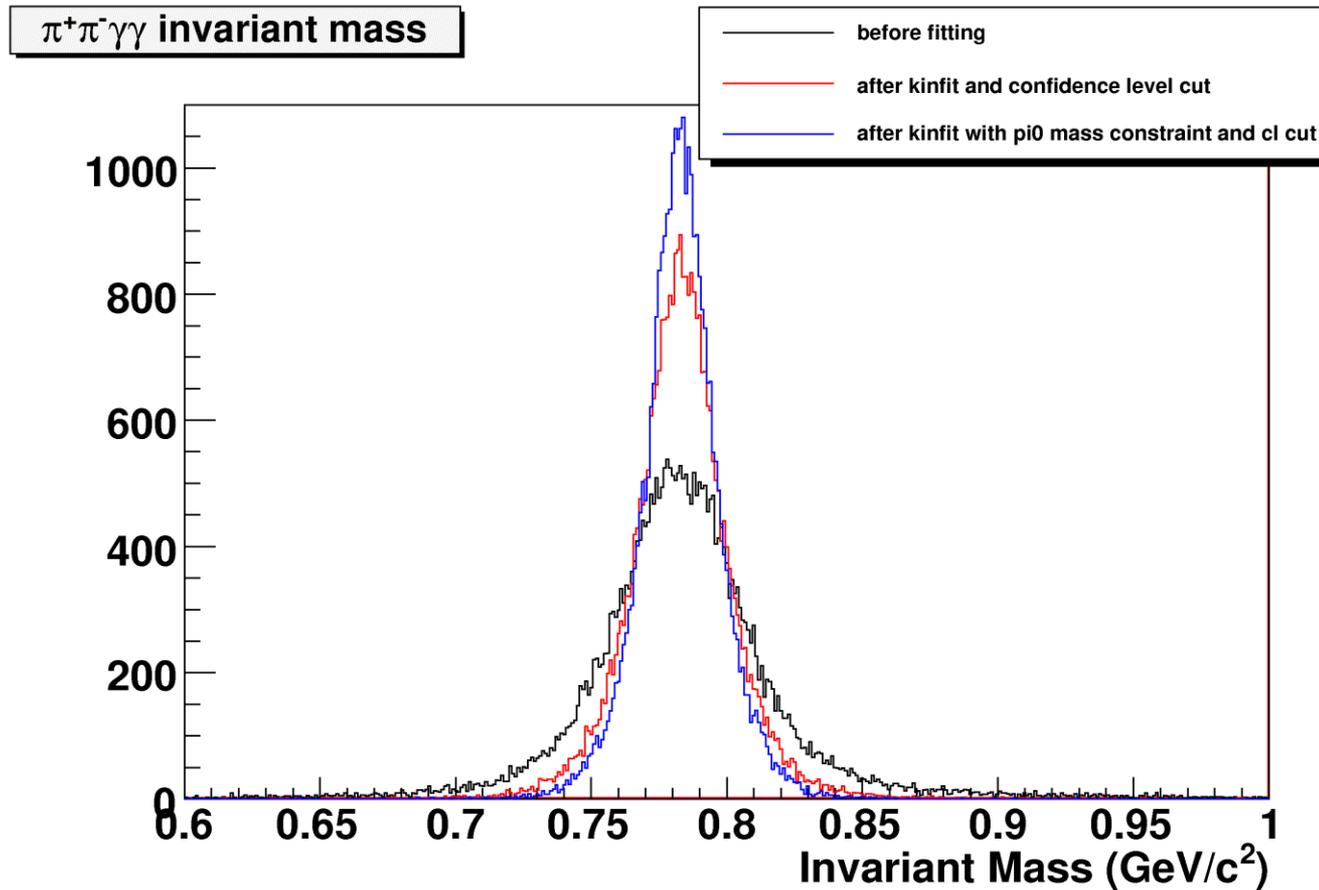
# $b_1\pi$ results: after fitting and confidence level cut

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$\pi^+\pi^-\gamma\gamma$  invariant mass



# $b_1\pi$ results



# Background results

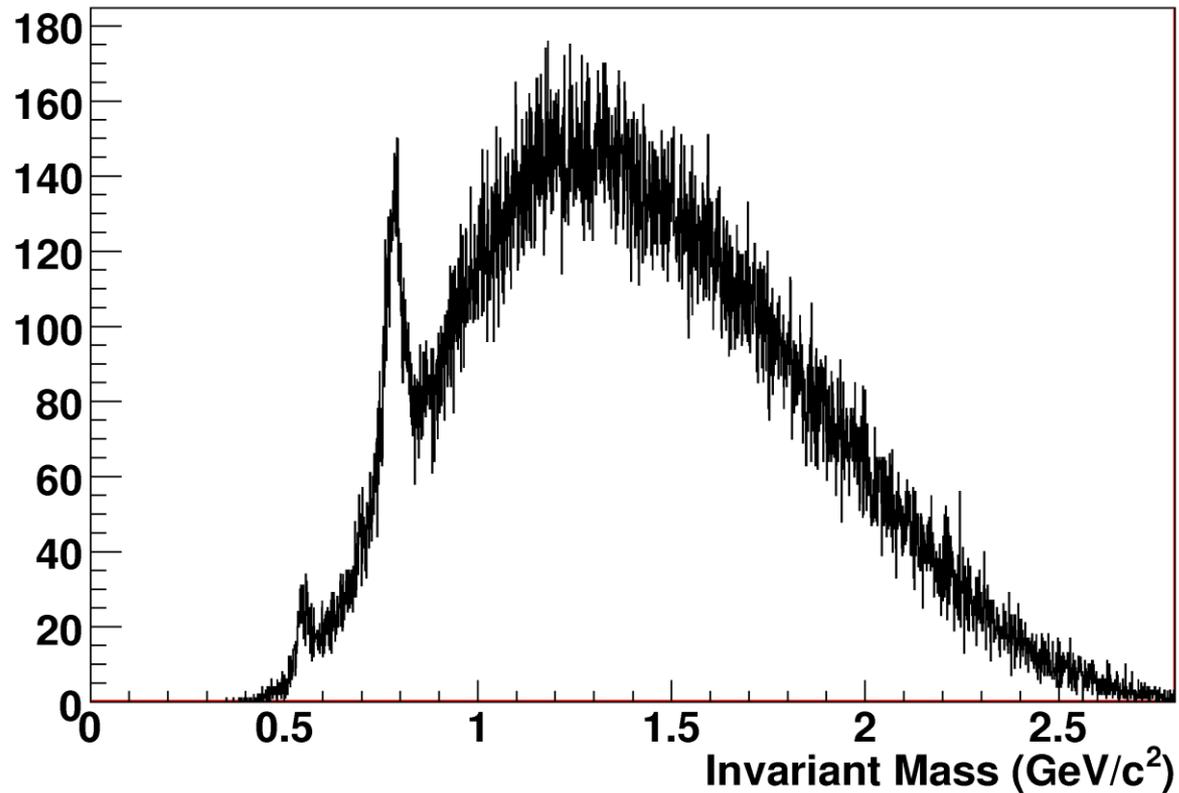
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- ▶ Again, only looking at final state  $\rho\pi^-\pi^-\pi^+\pi^+\gamma\gamma$
- ▶ End up with events with missing particles
  - ▶ Confidence level cut removes about 45% of events
- ▶ Cannot isolate a specific channel

# Background results: before fitting

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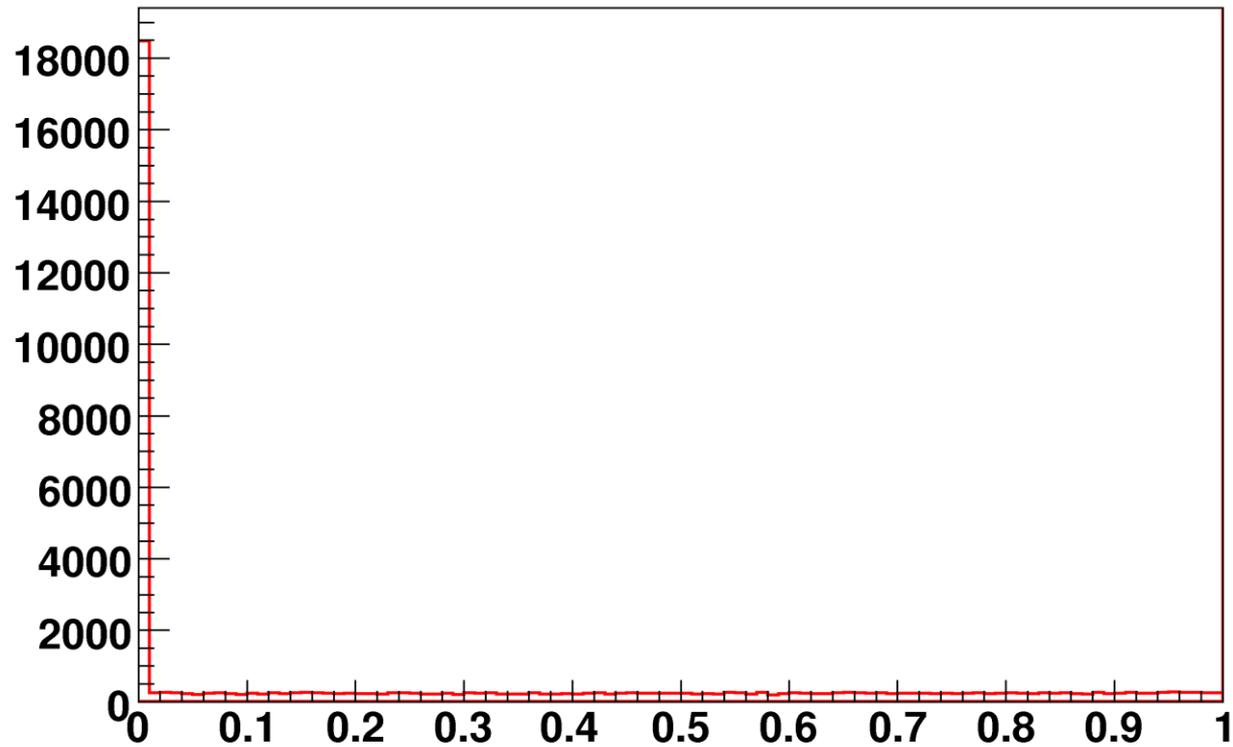
$\pi^+\pi^-\gamma\gamma$  mass, background, before kinfit



# Background results

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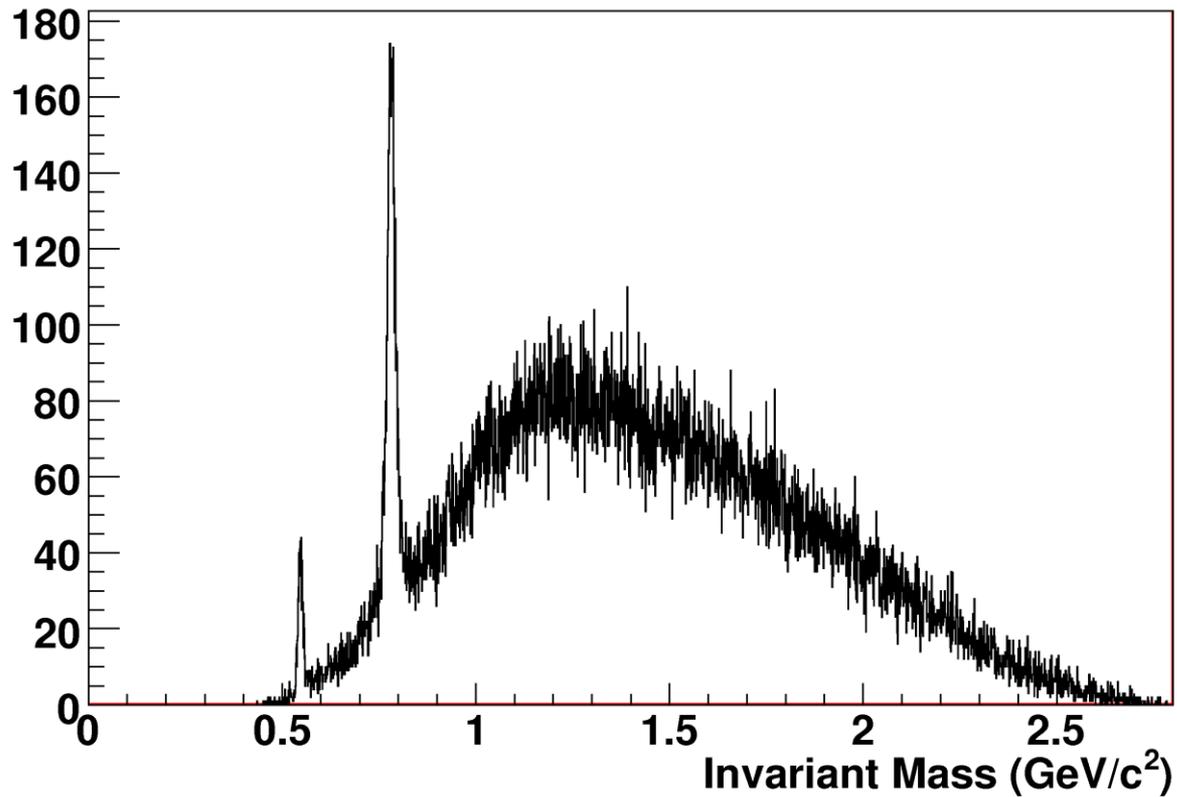
Confidence level, background events



# Background results: after

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$\pi^+\pi^-\gamma\gamma$  mass, background, after kinfitt



# Kinematic Fitting

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- ▶ Cuts bad events
- ▶ Improves errors on measured quantities
- ▶ It works!
  - ▶ Only as well as you estimate your errors