

Study of $e^+e^- \rightarrow \omega\pi^0/\eta$

@1.840 – 2.125 GeV

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Outline



- Motivation
- Data sample
- Event selection
- Signal events extraction
- Measured cross section
- Summary



Motivation

- In low-energy e^+e^- collision experiments, the vector mesons ω and their low lying excited states can be produced abundantly.
- However, some of the higher lying excitations are not fully identified . It is especially in the region low 2 GeV where further experimental insight is needed to resolve.



Data sample

- Boss version: 6.6.5p01 && 7.1.1

- R-scan data sets:

Data sample used in this analysis.

- MC samples generated by ConExc

500K signal MC samples for efficiency study:

$$e^+e^- \rightarrow \omega(\pi^+\pi^-\pi^0)\pi^0(\gamma\gamma)$$



Event Selection @ 2.125 GeV

□ Good charged track: $V_r < 1 \text{ cm}$, $|V_z| < 10 \text{ cm}$, $|\cos\theta| < 0.93$, $N_{good} \geq 2$

□ Neutral track: $E_{barrel} > 25 \text{ MeV}$ && $|\cos\theta| < 0.80$

$E_{endcap} > 50 \text{ MeV}$ && $0.86 < |\cos\theta| < 0.93$

$0 \leq TDC \leq 700 \text{ ns}$, $N_{gam} \geq 4$

□ $\pi/K/p$ PID: For π : $\text{Prob}(\pi) > \text{Prob}(K)$ && $\text{Prob}(\pi) > \text{Prob}(p)$

$N(\pi^+) = N(\pi^-) = 1$

□ Vertex fit ($\pi^+\pi^-$): The two charged pions are used to reconstruct primary vertex

□ Kinematic fit ($\pi^+\pi^-4\gamma$): For six pairs of 4γ combination, two π^0 candidates are chose

with the smallest $\chi^2_{\pi^0\pi^0}$, which is defined as

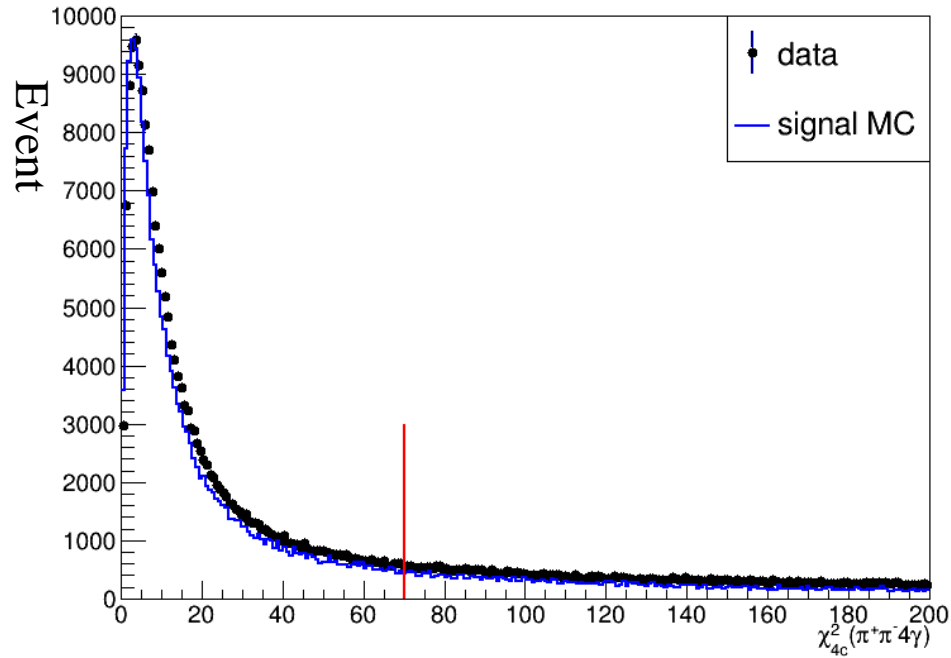
$$\chi^2_{\pi^0\pi^0} = \frac{(M(\gamma_1\gamma_2) - M_{\pi^0}^{PDG})^2}{\sigma_{\pi^0}^2} + \frac{(M(\gamma_3\gamma_4) - M_{\pi^0}^{PDG})^2}{\sigma_{\pi^0}^2}$$

For 5 γ , $\chi^2_{4c}(\pi^+\pi^-4\gamma) < \chi^2_{4c}(\pi^+\pi^-5\gamma)$

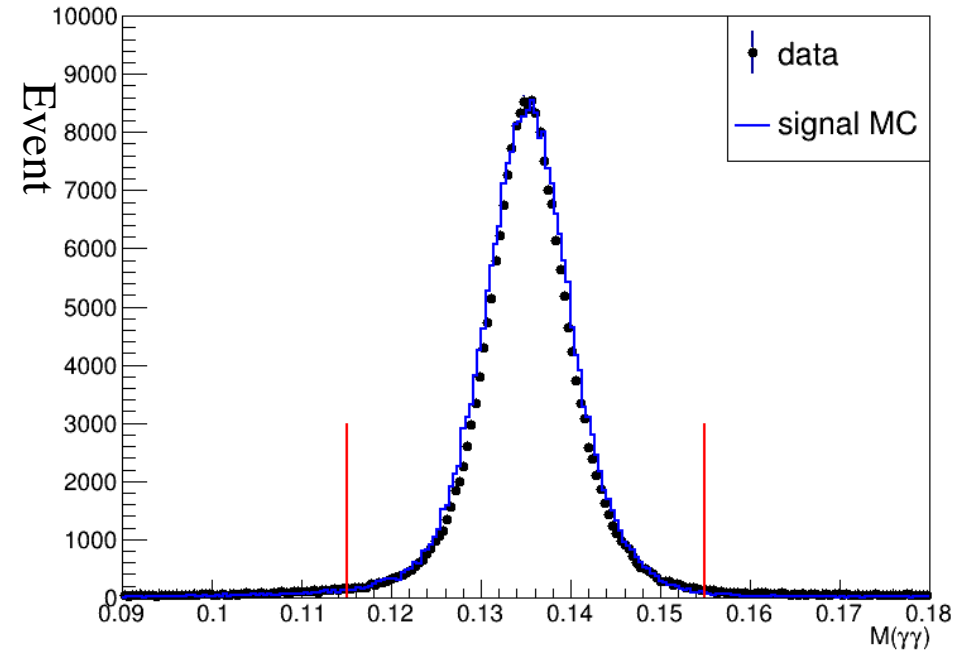
→ suppress background events from the $e^+e^- \rightarrow \omega\gamma_{ISR}$ and $e^+e^- \rightarrow \omega\pi^0\pi^0$ processes

$\chi^2(\pi^0\pi^0) < \chi^2(\pi^0\eta)$ && $\chi^2(\pi^0\pi^0) < \chi^2(\eta\eta)$

Event Selection @ 2.125 GeV

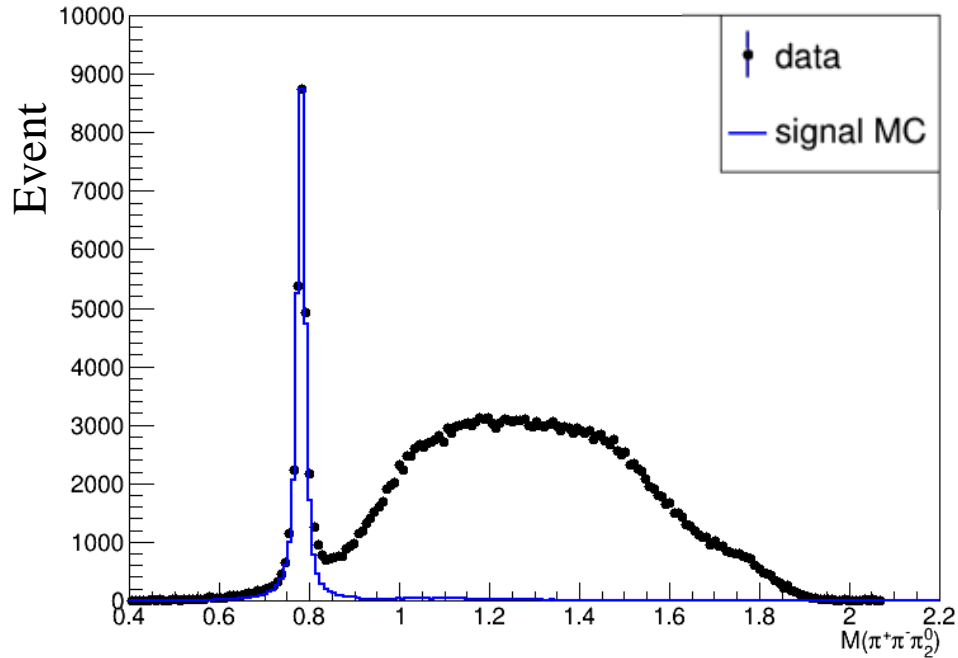


Cut 1 : $\chi_{4c}^2(\pi^+\pi^-4\gamma) < 70$



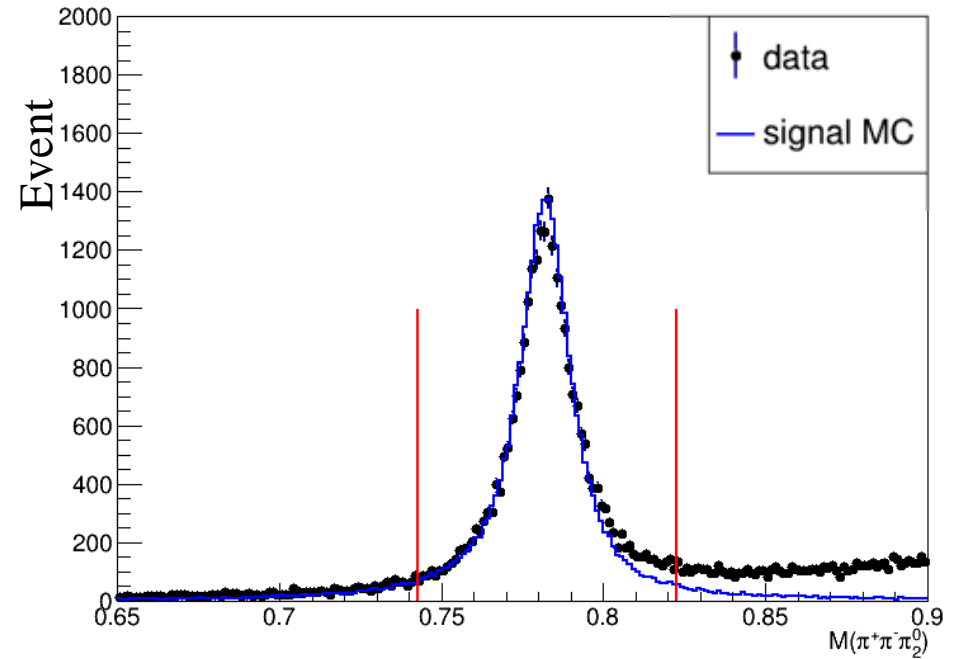
Cut 2 : $|M(\gamma\gamma) - M(\pi^0)^{PDG}| < 20\text{MeV}$

Event Selection @ 2.125 GeV



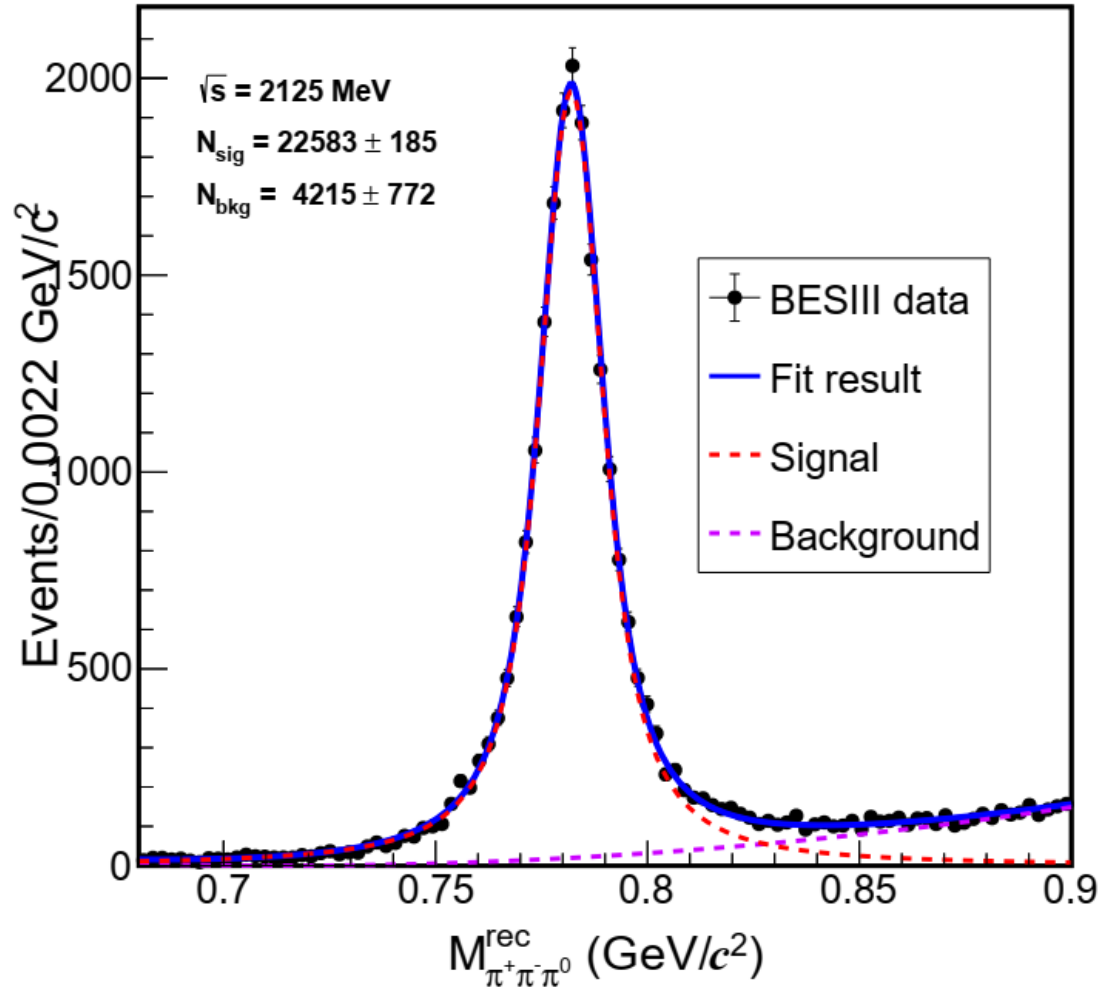
The bachelor π^0 is tagged as π_1^0 and the π^0 from decay is tagged as π_2^0 .

The π^0 , combined with $\pi^+\pi^-$ more close to ω^{PDG} mass, is considered as the π_2^0 , and another π^0 is π_1^0 .



the $M(\pi^+\pi^-\pi_2^0)$ invariant mass distribution within [0.65, 0.9] GeV.

Signal events extraction



Consist with PDG Value:

$$\text{Mass}(\omega) = 782.66$$

$$\text{Width} = 8.68 \pm 0.13 \text{ MeV}$$

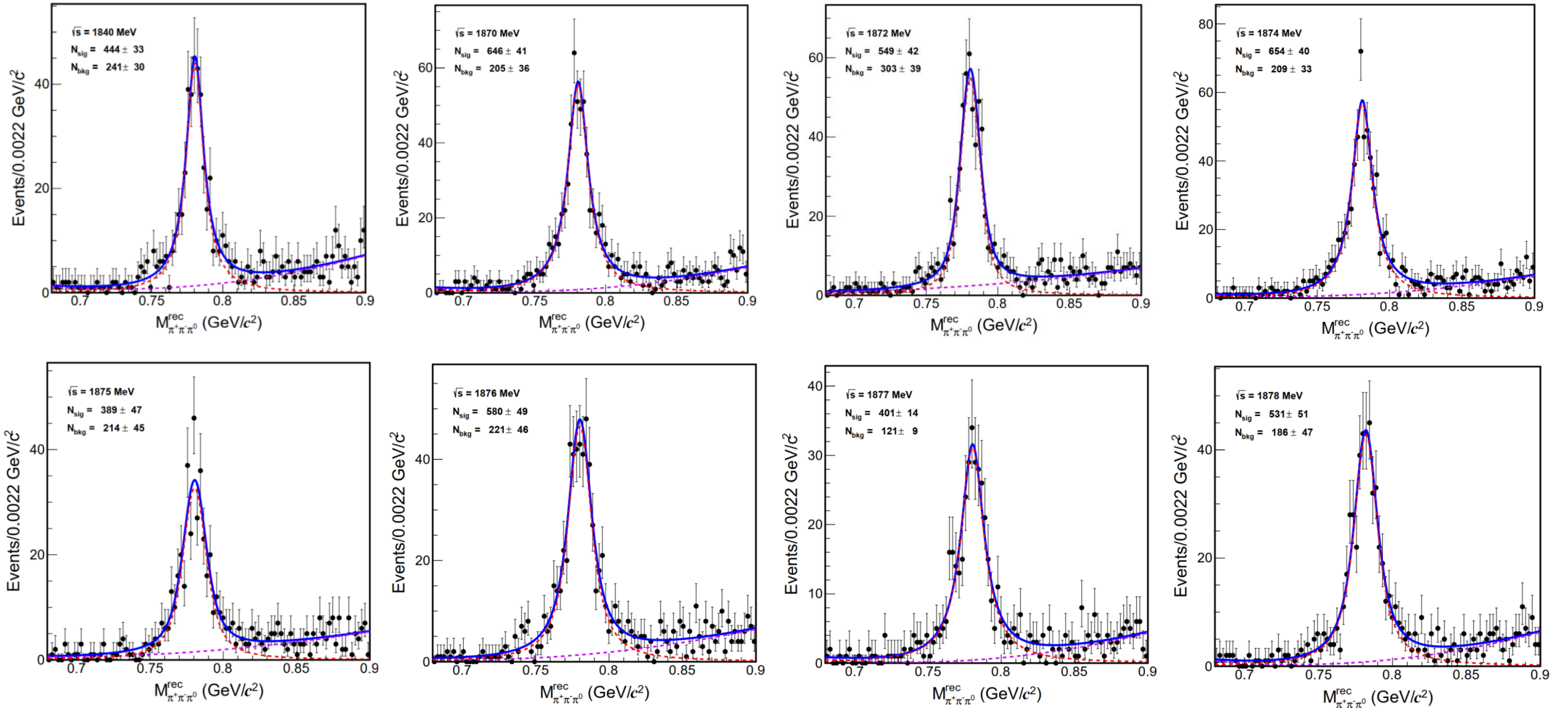
Fitting function:

For data: Breit-Wigner \otimes Gaussian + the Second order of Chebychev

For MC: Only number counting

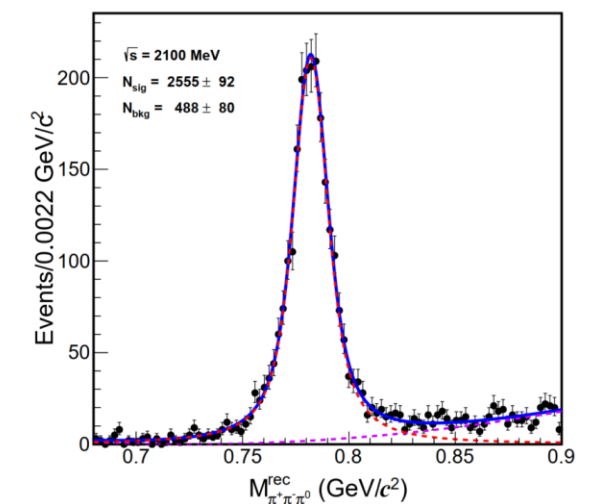
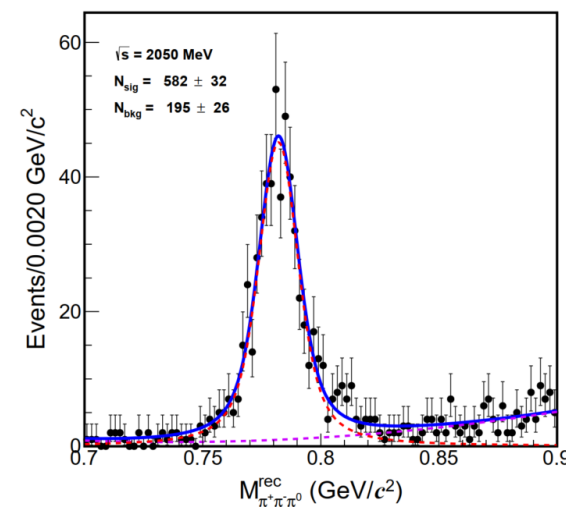
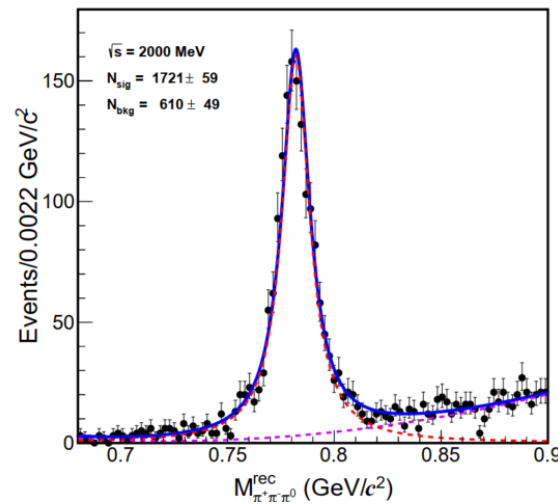
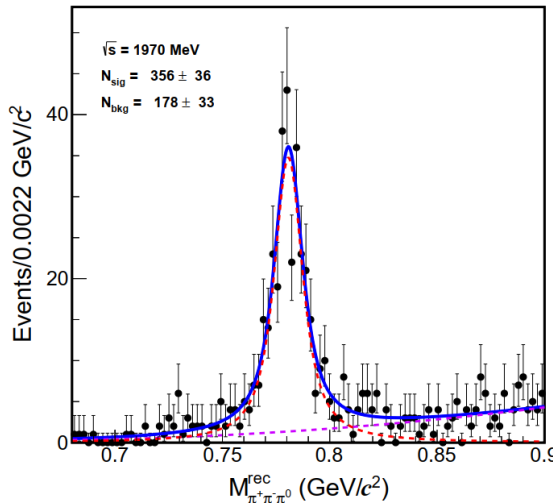
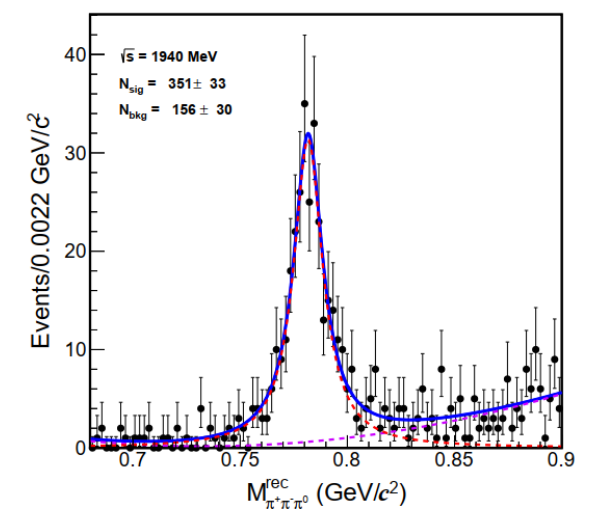
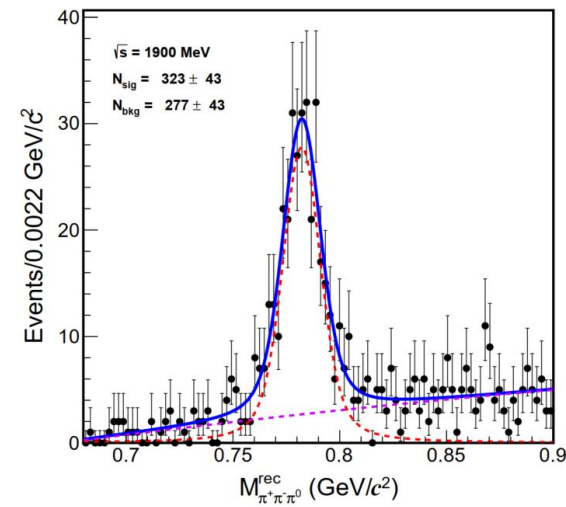
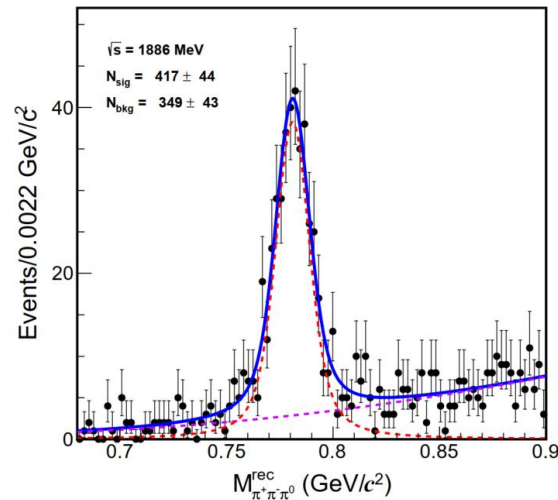
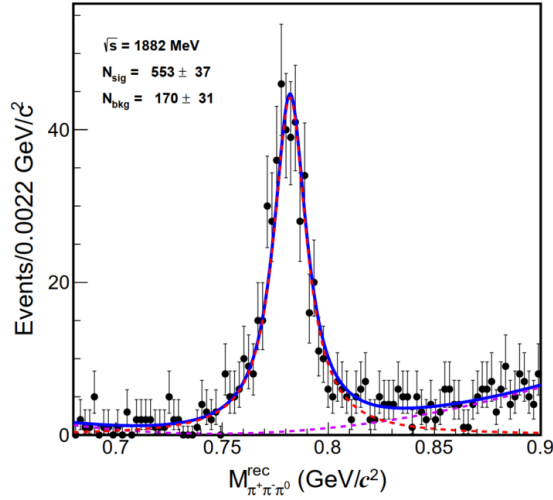
$$\sigma = \frac{N_{\text{signal}}}{L \times \varepsilon \times Br^2(\pi^0 \rightarrow \gamma\gamma) \times Br(\omega \rightarrow \pi^+\pi^-\pi^0) \times (1 + \delta)}$$

Signal events extraction

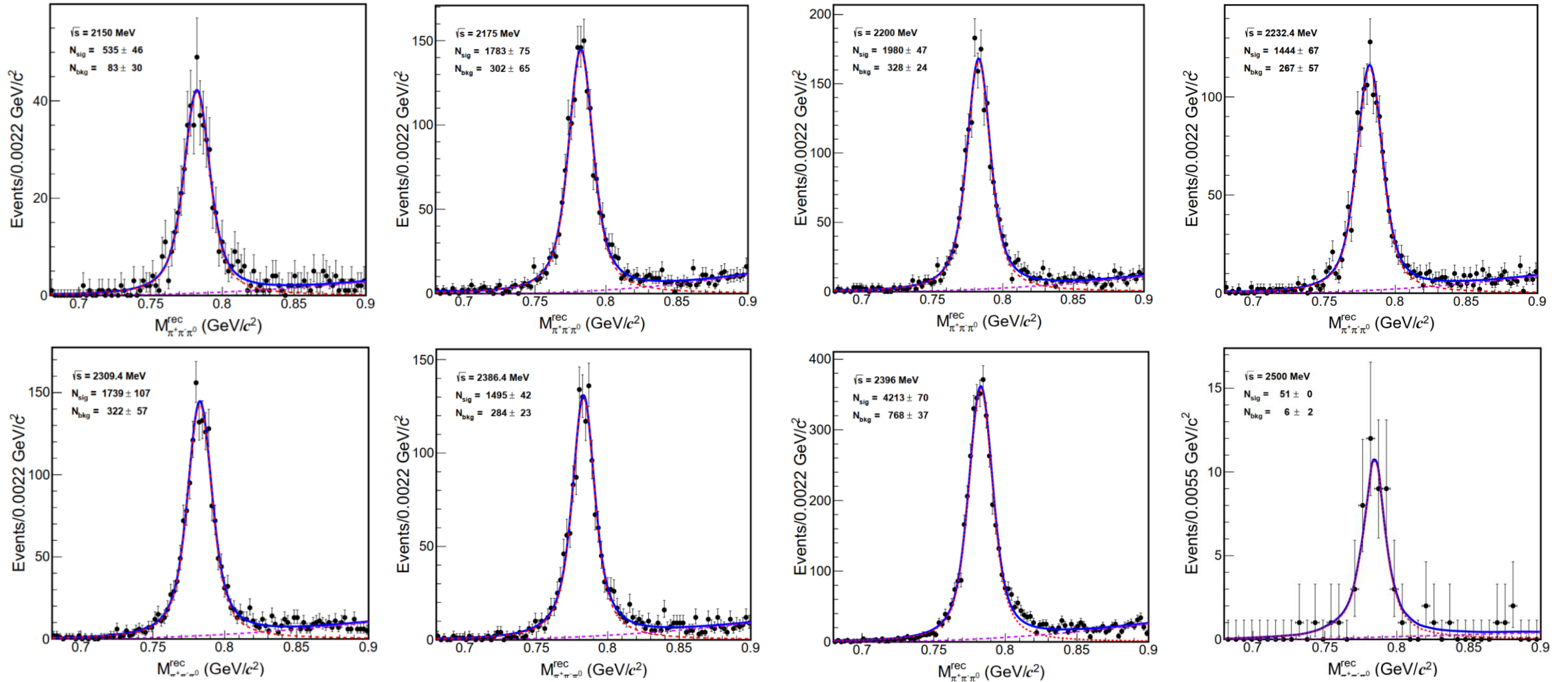




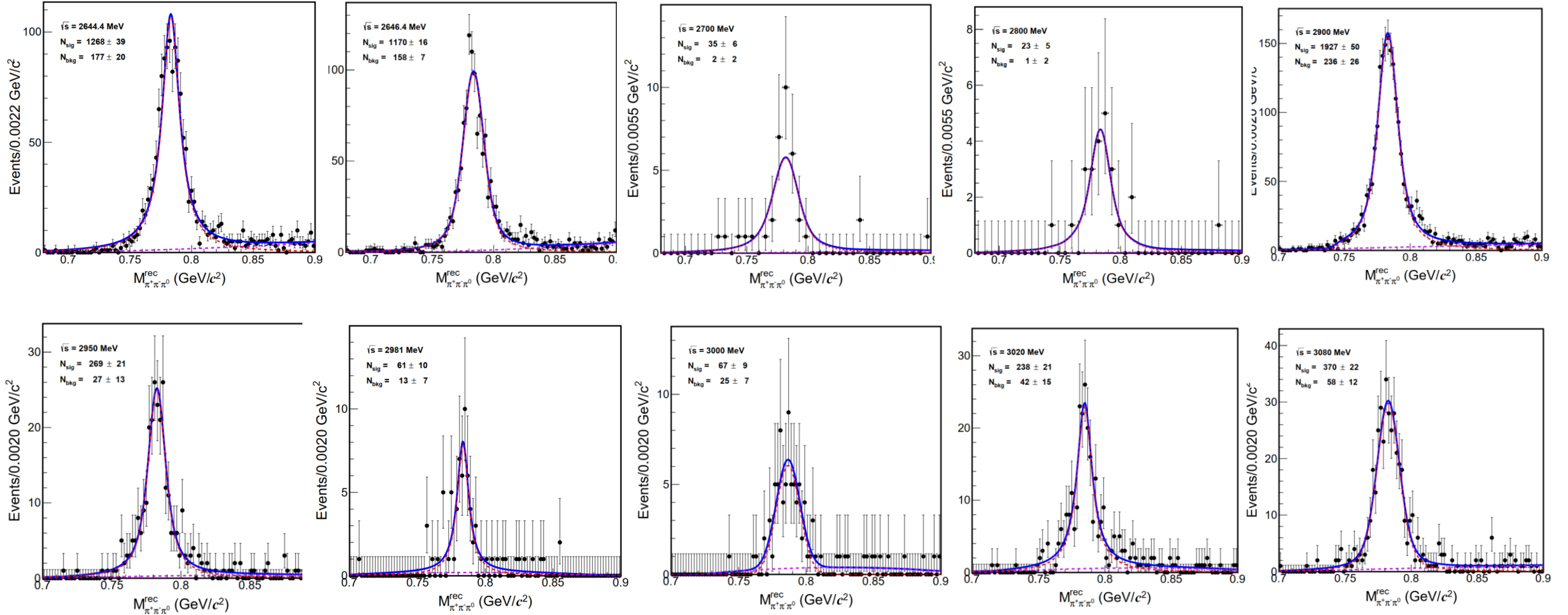
Signal events extraction



Signal events extraction

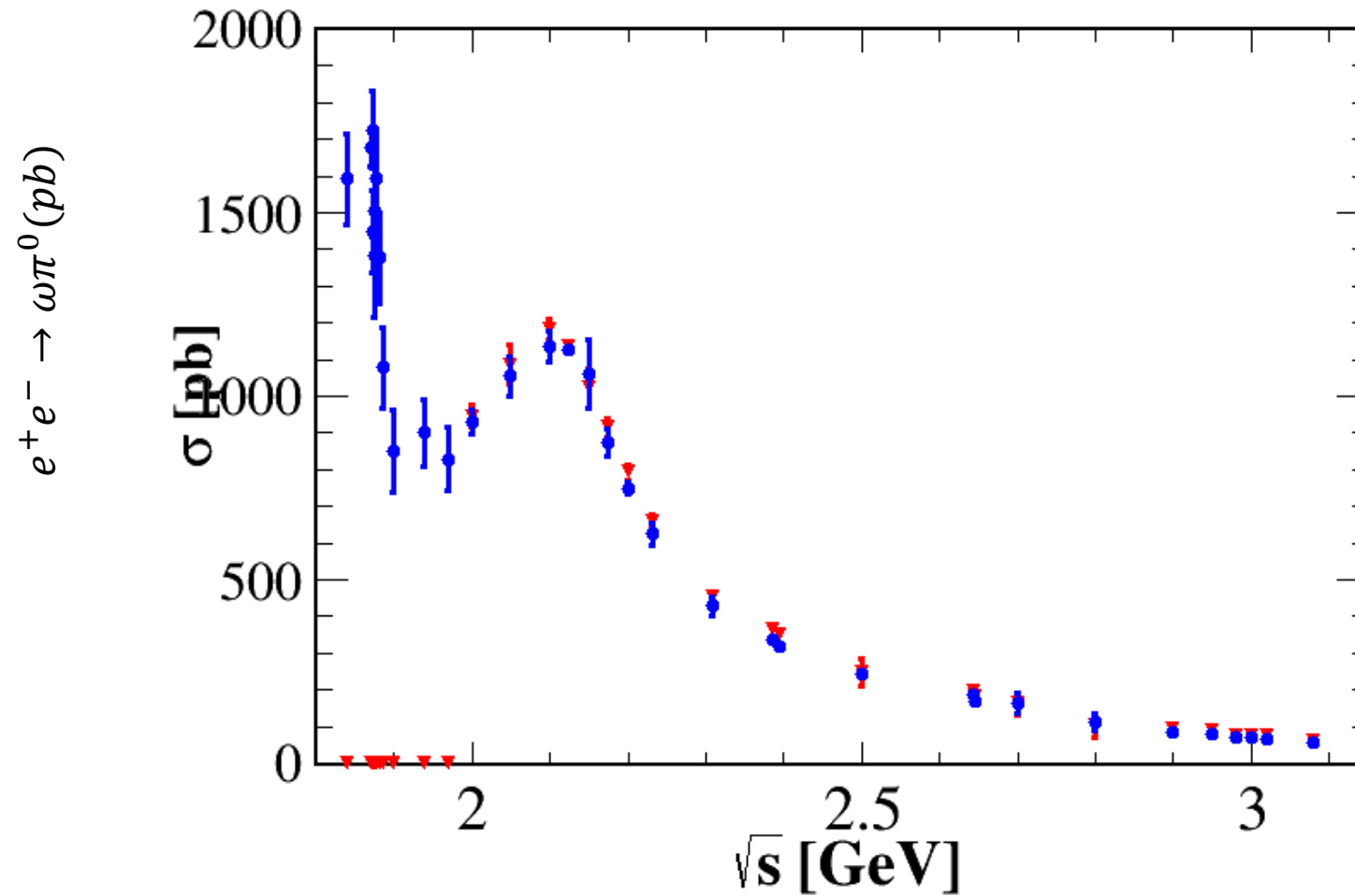


Signal events extraction



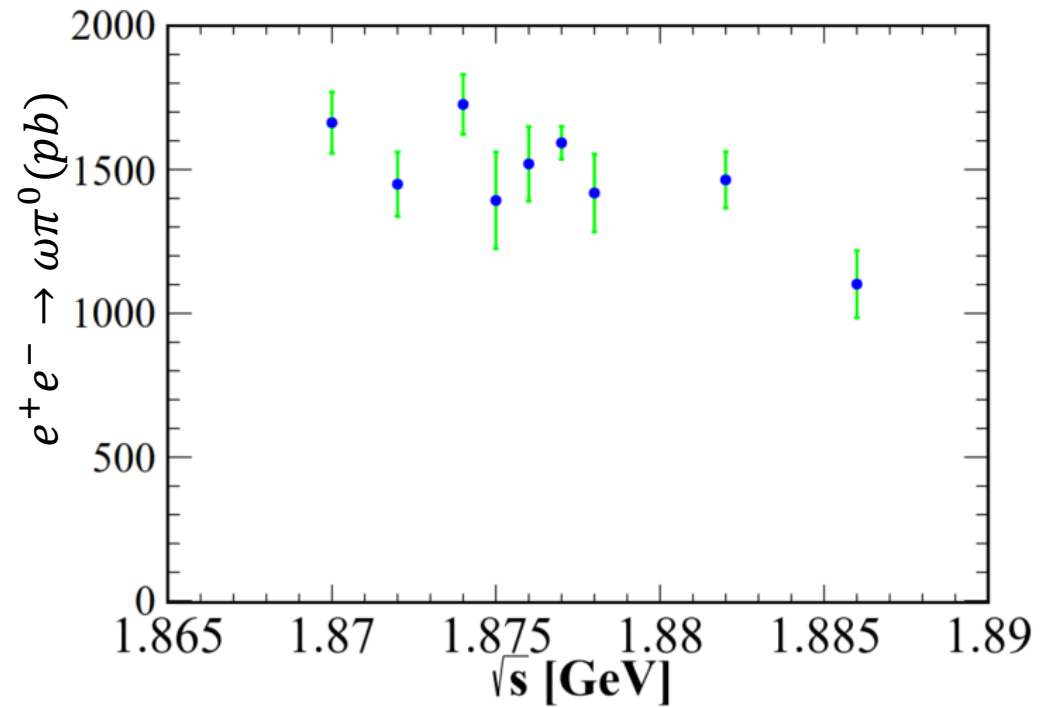
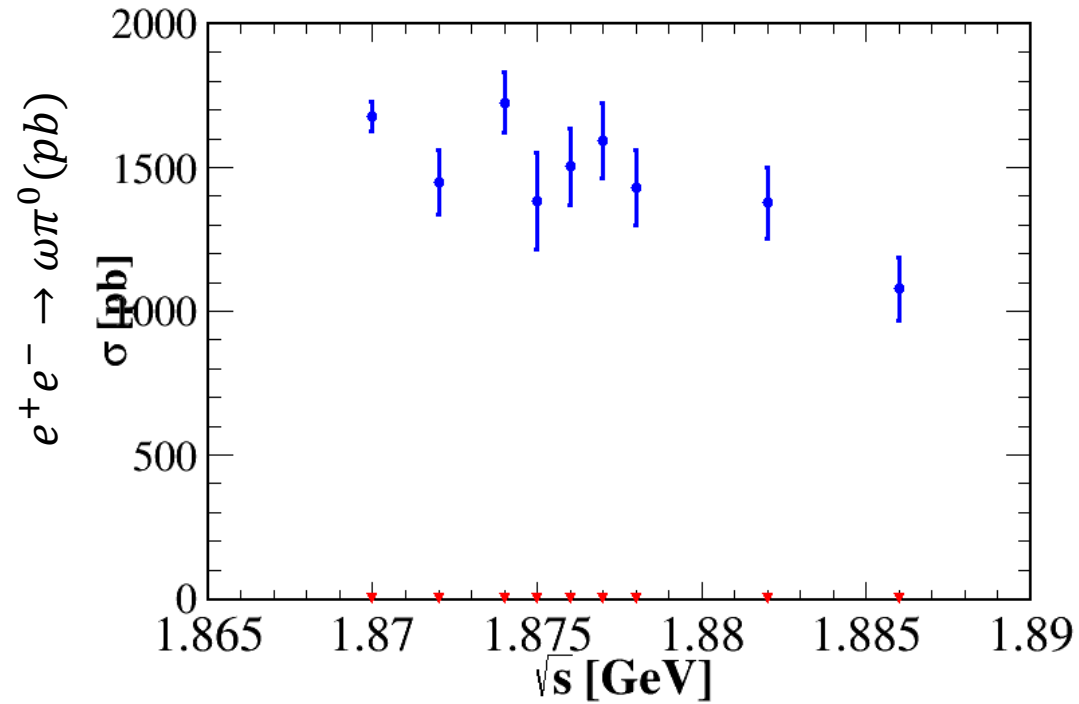


Measured cross section





Measured cross section





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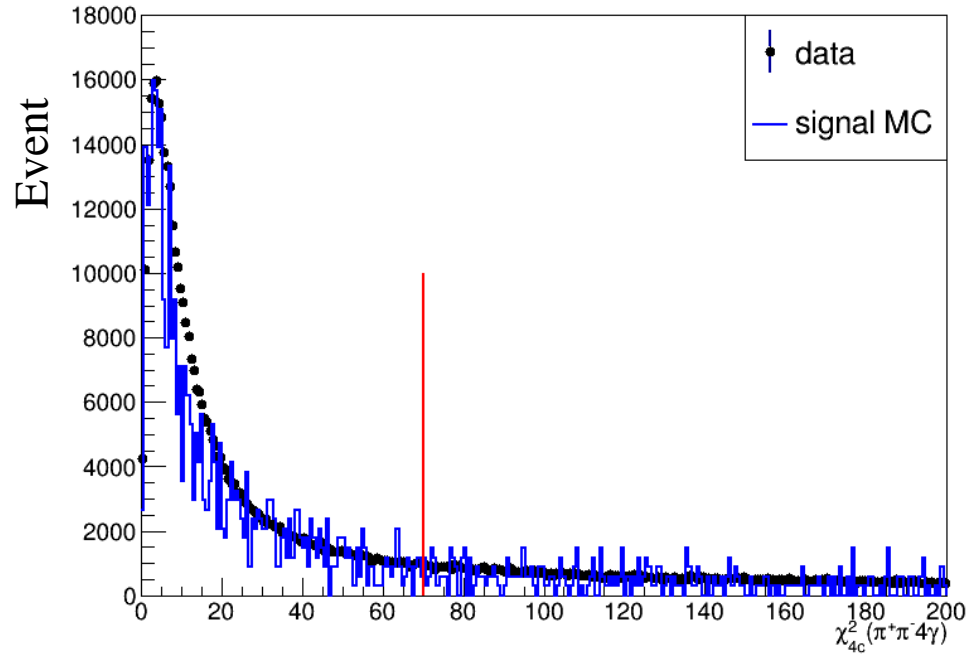
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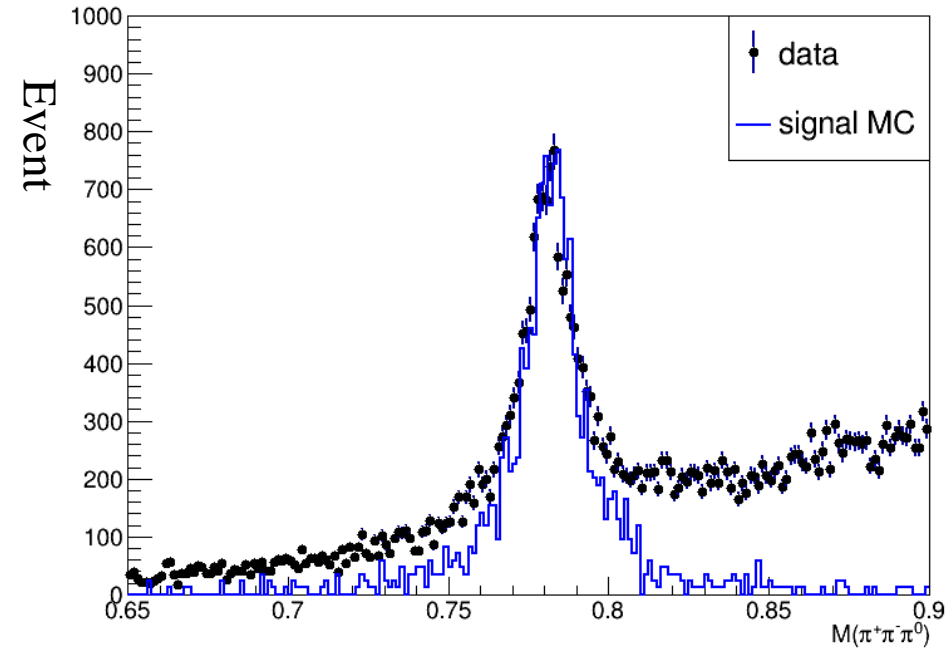
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 $\chi^2(\pi^0 \eta) < \chi^2(\pi^0 \pi^0)$ && $\chi^2(\pi^0 \eta) < \chi^2(\eta \eta)$

Event Selection @ 2.125 GeV

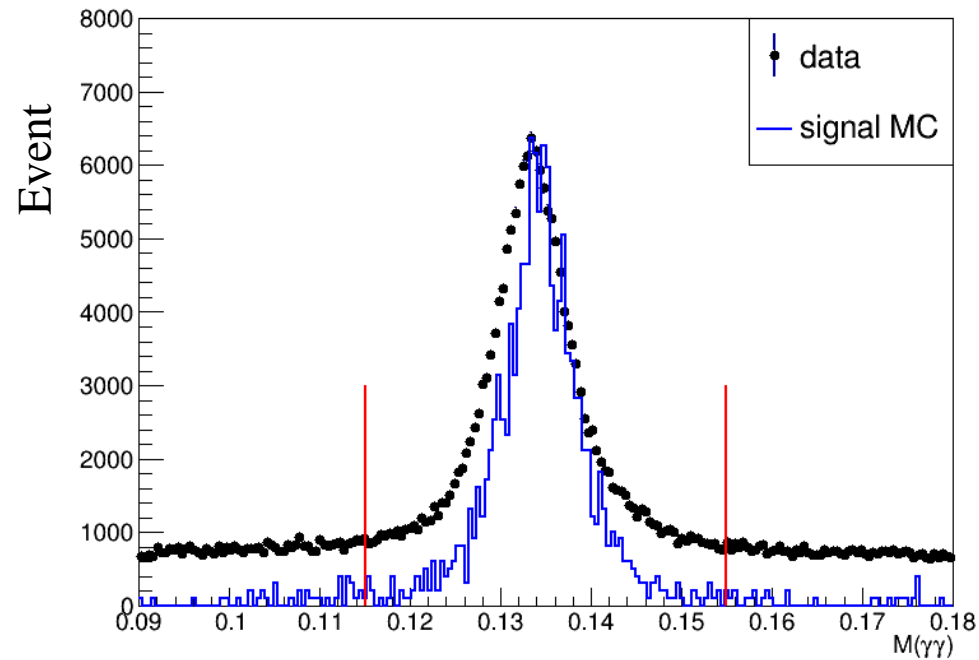


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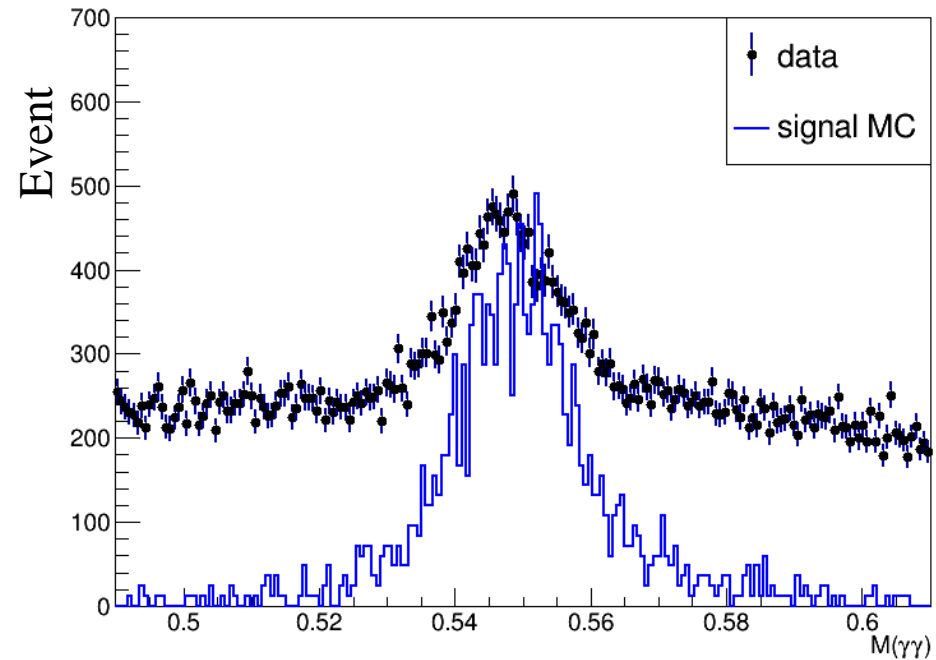


Cut 2 : the $M(\pi^+\pi^-\pi^0)$ invariant mass distribution within [0.65, 0.9] GeV .

Event Selection @ 2.125 GeV



Cut 3 : $|M(\gamma\gamma) - M(\pi^0)^{PDG}| < 20MeV$



Cut 4 : $|M(\gamma\gamma) - M(\eta)^{PDG}| < 30MeV$



- 1.872: run number :82543—82656 (82643)
- 1.874: run number :82657—82783 (82659)

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145          end of the jobOptions file
146 *****
147
148 Using the SftVer and ParVer (7.1.1, 1) for run 82643.
149 VertexDbSvc:: can not found vertex information for run:82643, boss version 7.1.1
150 4.020u 0.944s 0:14.04 35.3%      0+0k 7488+64io 3193pf+0w

146          end of the jobOptions file
147 *****
148
149 Using the SftVer and ParVer (7.1.1, 1) for run 82659.
150 VertexDbSvc:: can not found vertex information for run:82659, boss version 7.1.1
151 1.683u 0.361s 0:03.06 66.6%      0+0k 5464+48io 339pf+0w
```