

Data quality checking by $e^+e^- \rightarrow \pi^0\pi^0 J/\psi$ process

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Data Sets

- ❑ Boss Version 664.p01, 702.p01;
- ❑ 2012-2013 old data samples;
- ❑ 2017 new data samples

Event selection

- **Good Charged Tracks Selection**

$$|V_r| < 1.0, |V_z| < 10.0, |\cos\theta| < 0.93;$$

$$N_{\text{good}} = 2; N(l^-) = N(l^+) = 1, l = e(\mu);$$

- **Good Photon**

$$E_{\text{barrel}} > 25 \text{ MeV } (|\cos\theta| < 0.8);$$

$$E_{\text{endcap}} > 50 \text{ MeV } (0.86 < |\cos\theta| < 0.92);$$

$$\theta(\gamma, \text{charge}) > 5^\circ;$$

$$0 \leq \text{TDC} \leq 14;$$

$$N_{\text{good}}(\gamma) \geq 4;$$

- **Vertex fit (for l^+l^-)**

$$\chi^2 < 200$$

- **π^0 Selection (1C Kinematic fit)**

$$M(\gamma\gamma) \in (0.1, 0.16)$$

$$\chi_{1c}^2 < 200 \text{ for } \pi^0 \text{ candidates};$$

$$n(\pi^0\pi^0) \leq 2 \text{ when } M(\gamma\gamma) \in (0.12, 0.15);$$

- **4C Kinematic fit**

$$\chi_{4c}^2(\pi^0\pi^0 J/\psi) < 80;$$

$$\chi_{\text{sum}}^2 = \chi_{\pi 1}^2 + \chi_{\pi 2}^2 + \chi_{4c}^2 \text{ has minimal value}$$

Event selection

- PID between electron and muon

e^+e^- : E/p ratio > 0.7 for both tracks;

$\mu^+\mu^-$: E/p ratio < 0.3 for both tracks,
nlayer > 6 for at least one track;

- Cut for invariant mass

$M(\pi^0) \in (0.12, 0.15)$

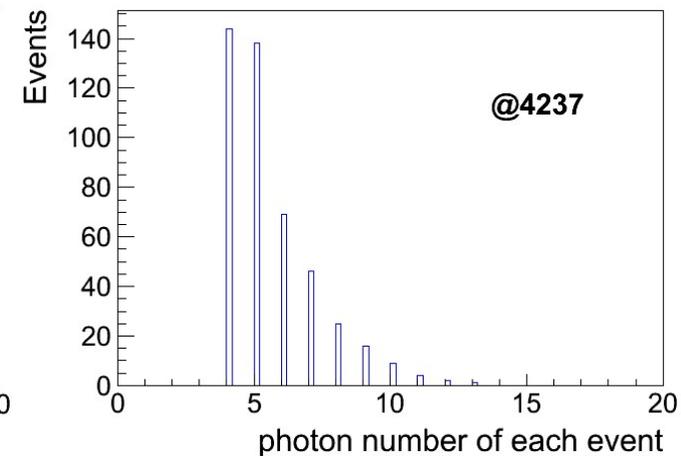
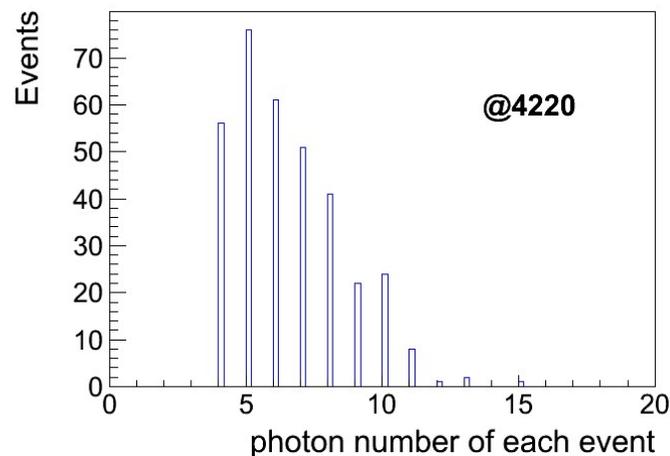
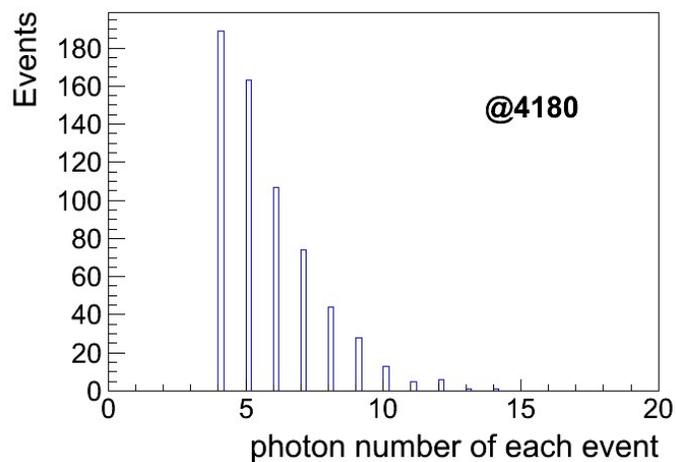
$M(J/\psi) \in (2.95, 3.2)$

- Angle cut for electron

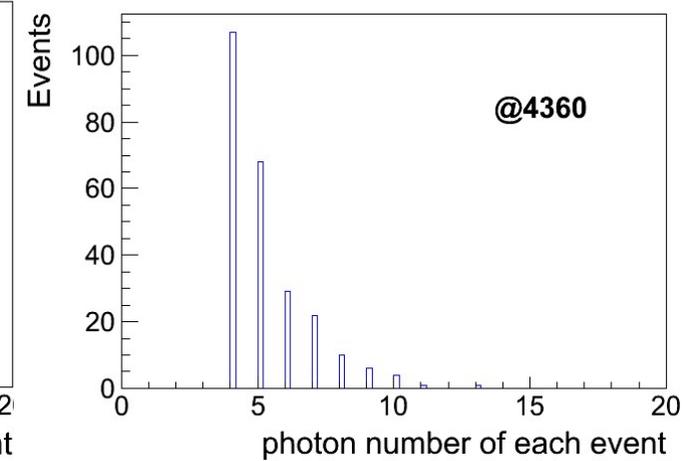
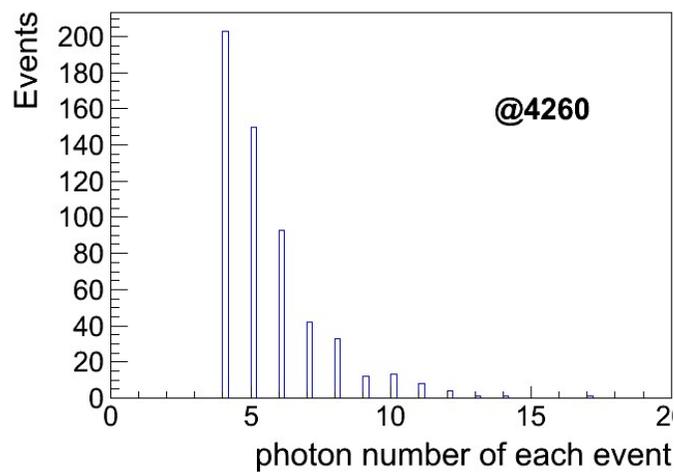
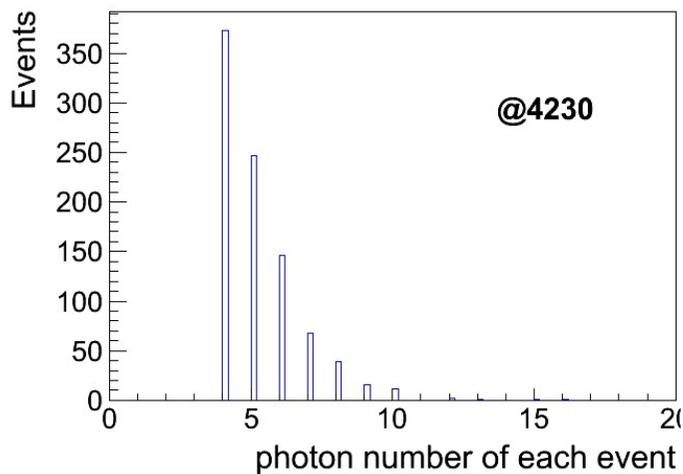
Angle(e^+e^-) $< 175^\circ$ when $\cos(\theta_+) > 0.5$ or $\cos(\theta_-) < -0.5$

Photon number of each event(data)

New data

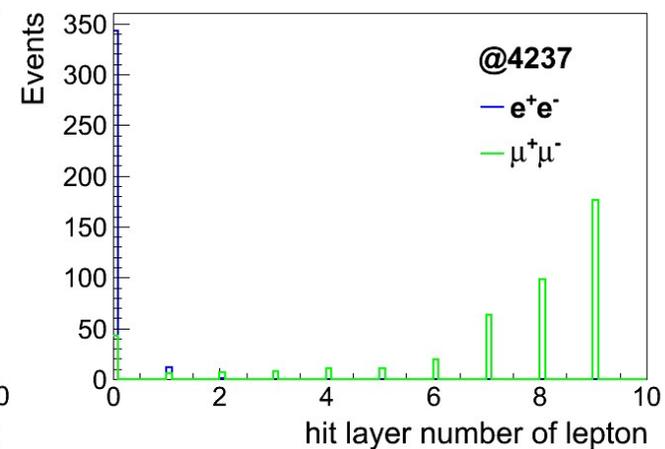
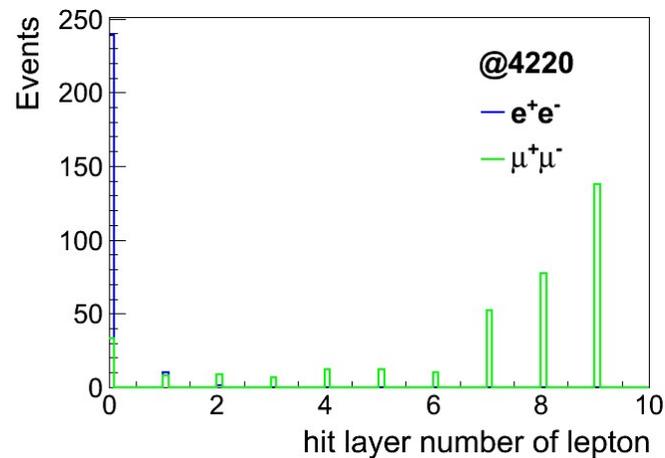
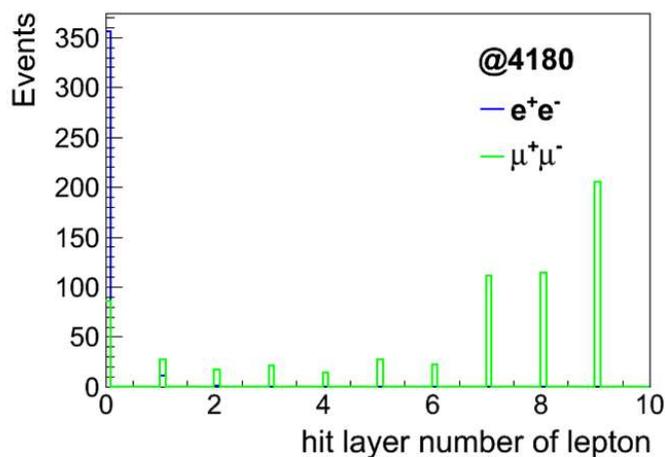


Old data

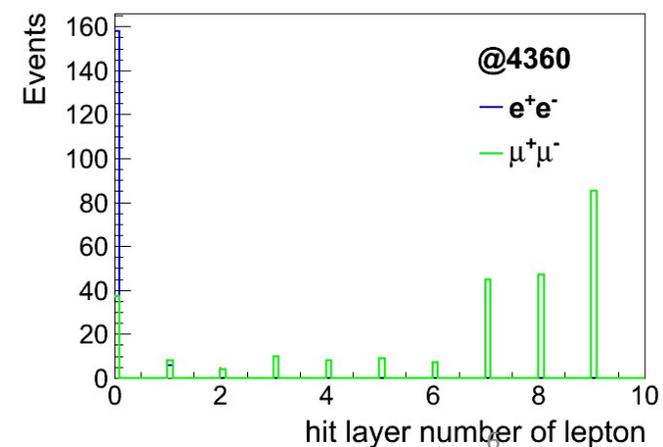
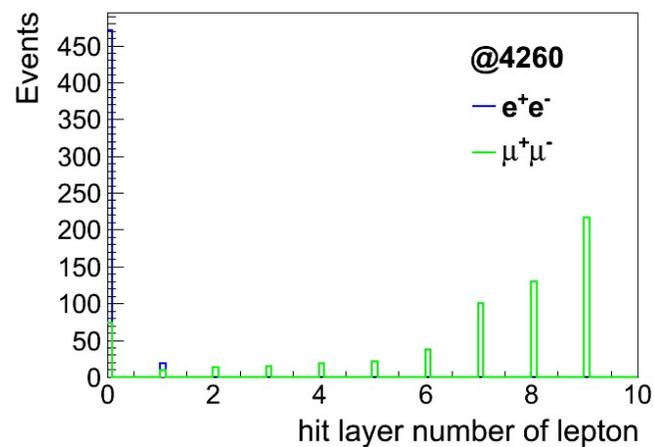
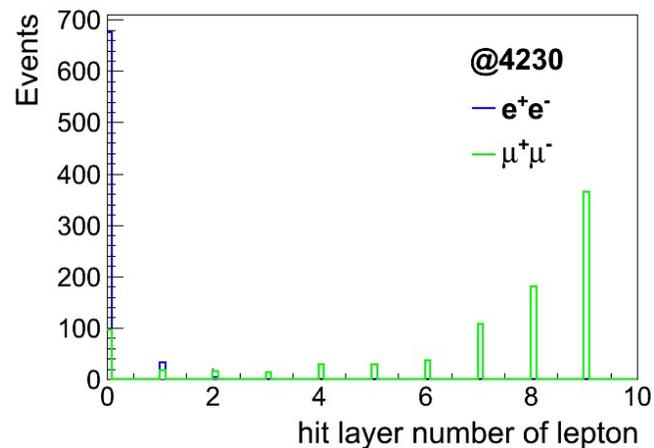


Hit layer number on MUC(data)

New data

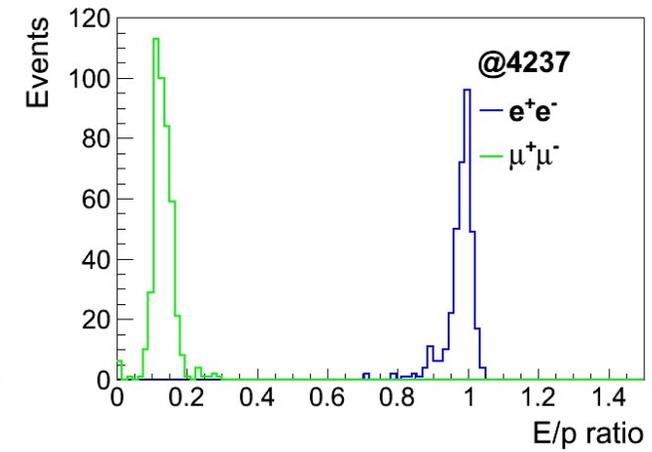
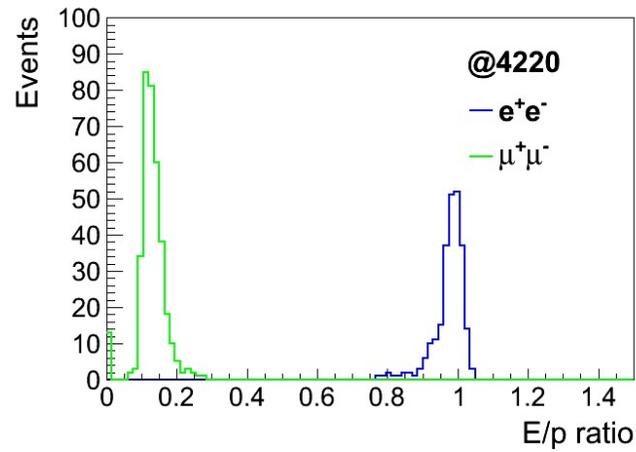
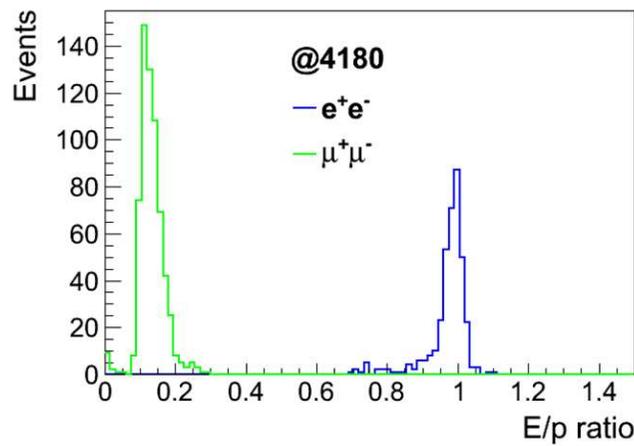


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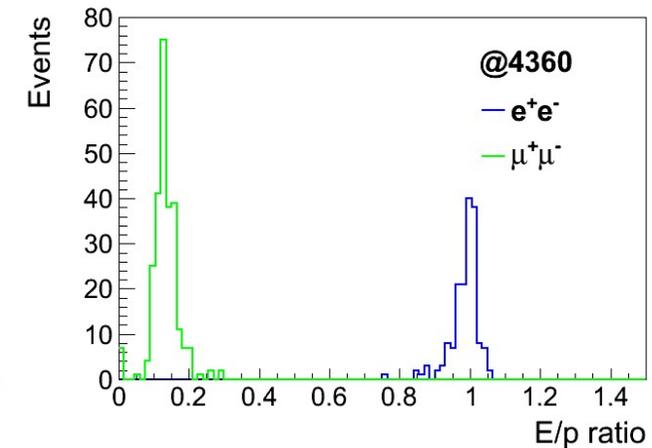
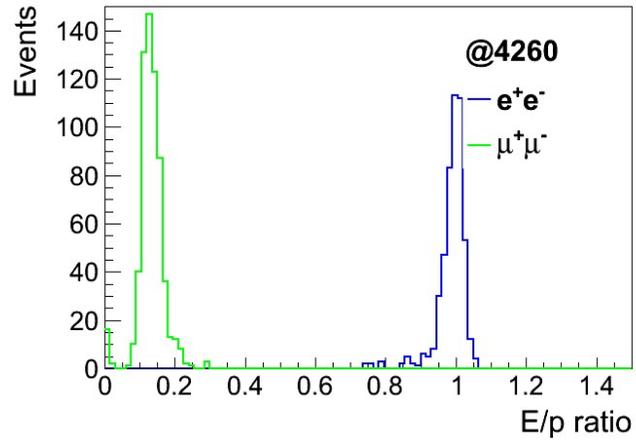
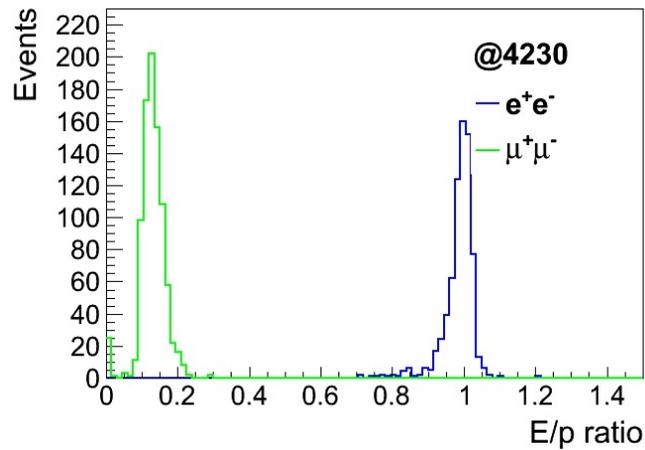


E/p ratio of leptons(data)

New data

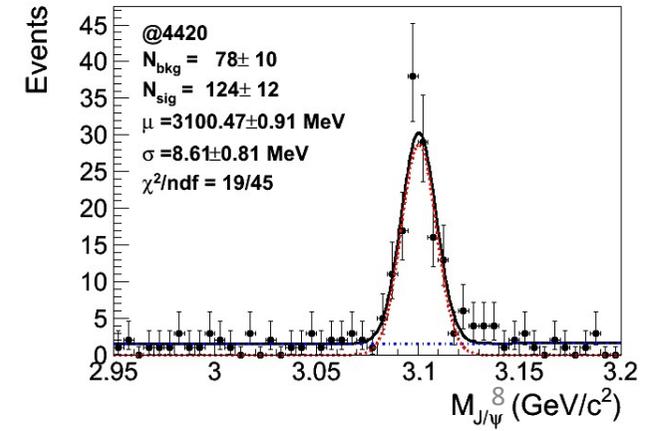
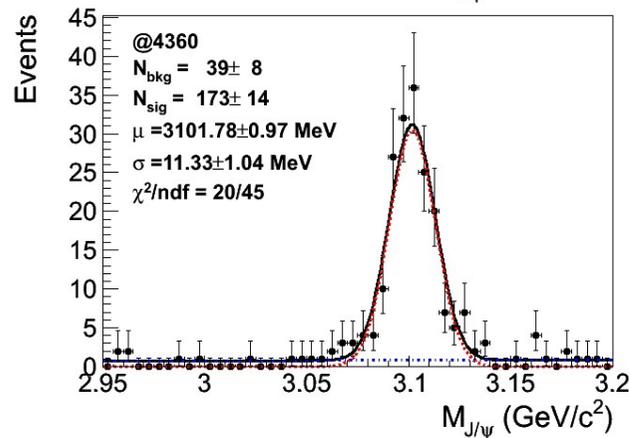
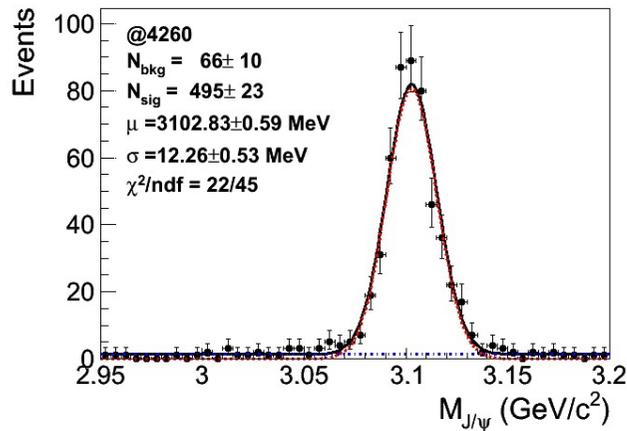
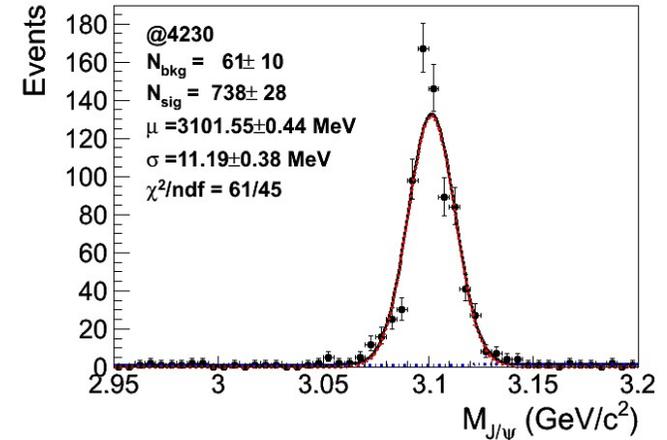
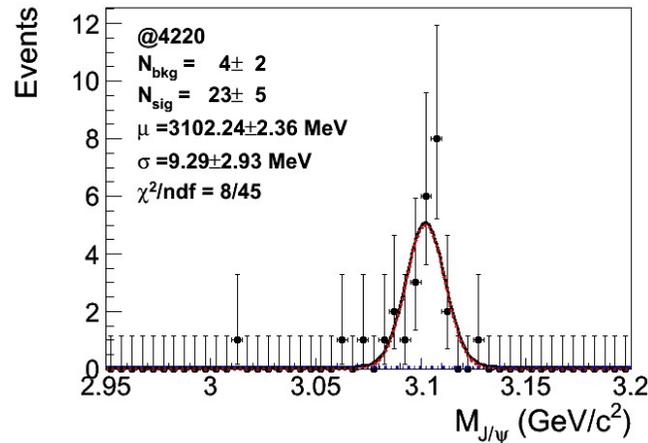
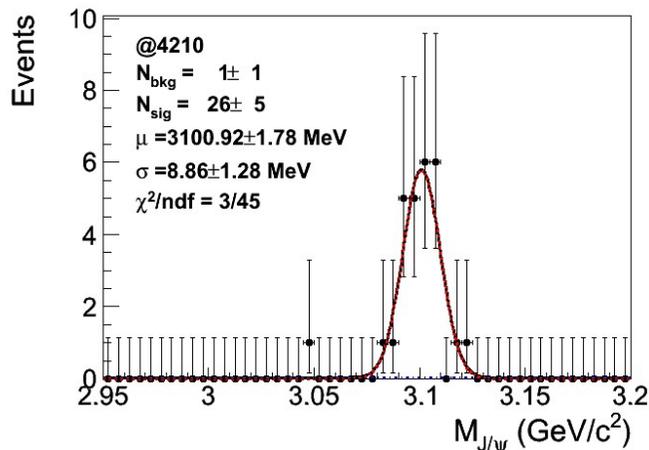


Old data



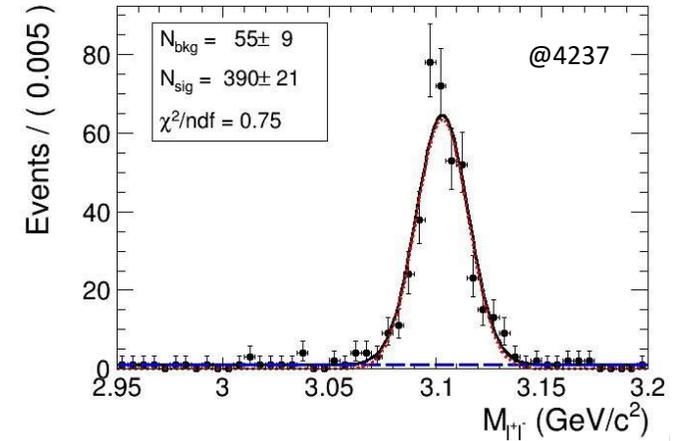
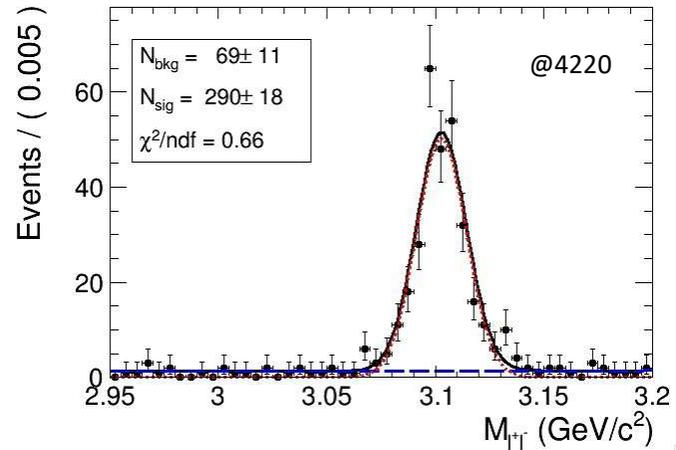
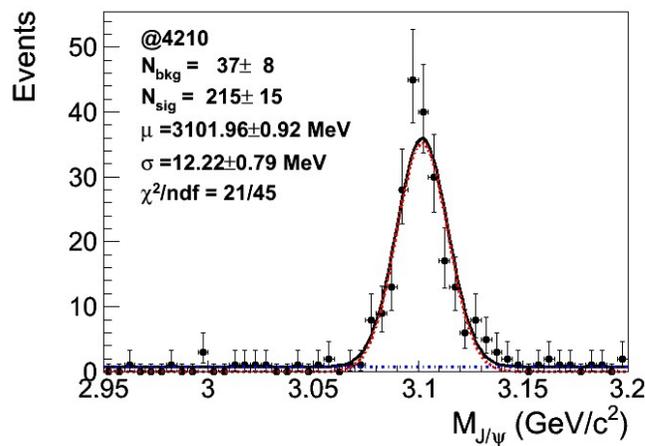
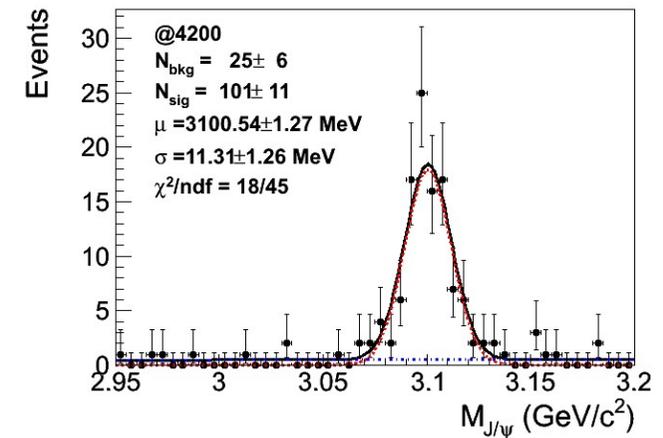
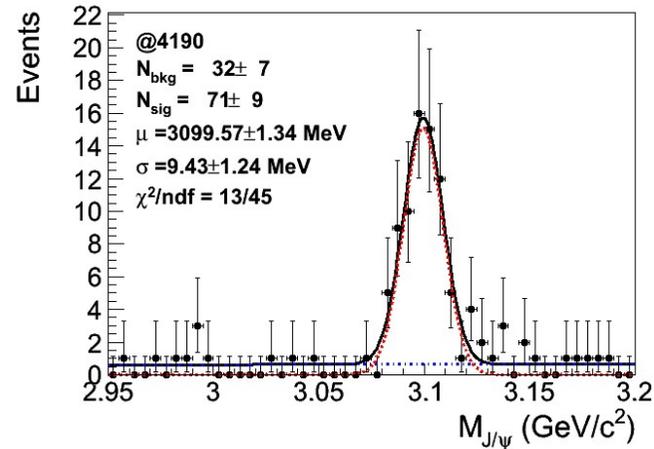
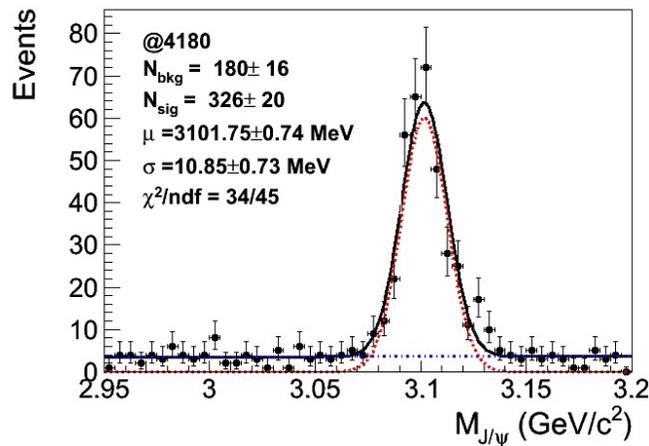
Fit result of old data (664p01)

- Gaussian+1st polynomial



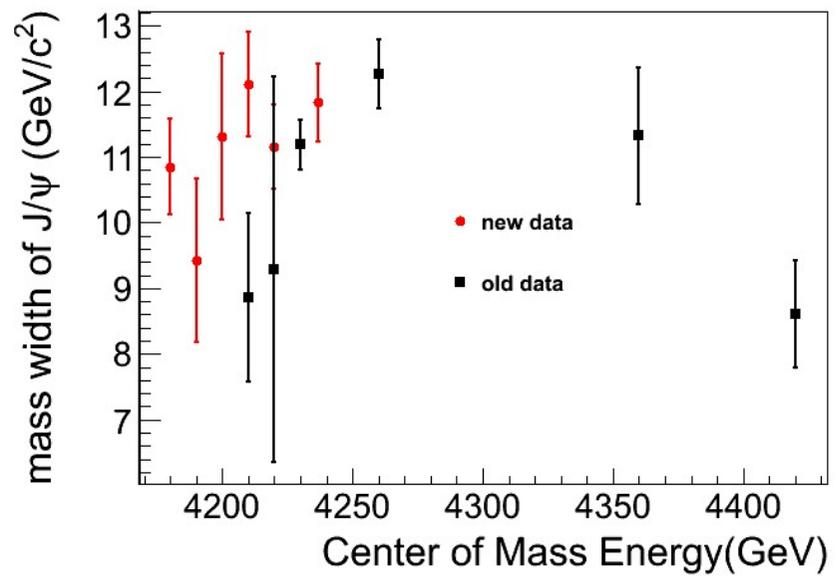
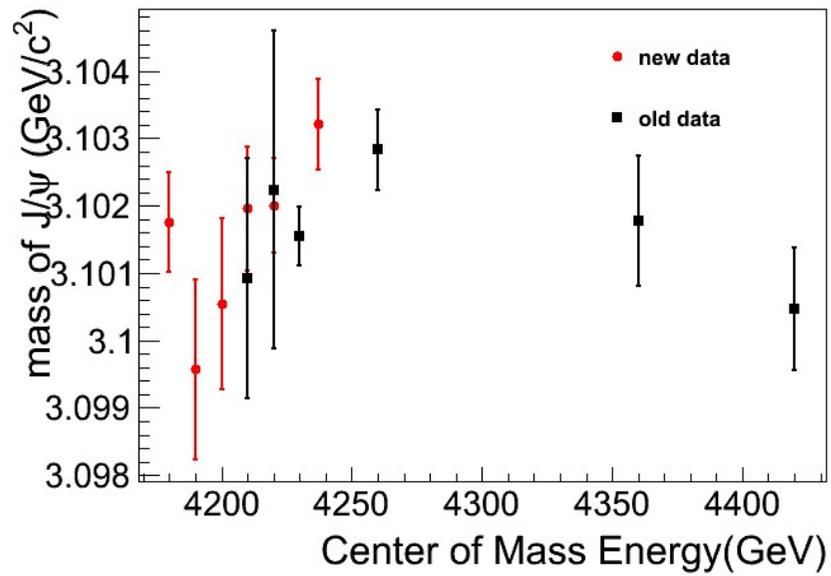
Fit result of new data (702p01)

- Gaussian+1st polynomial



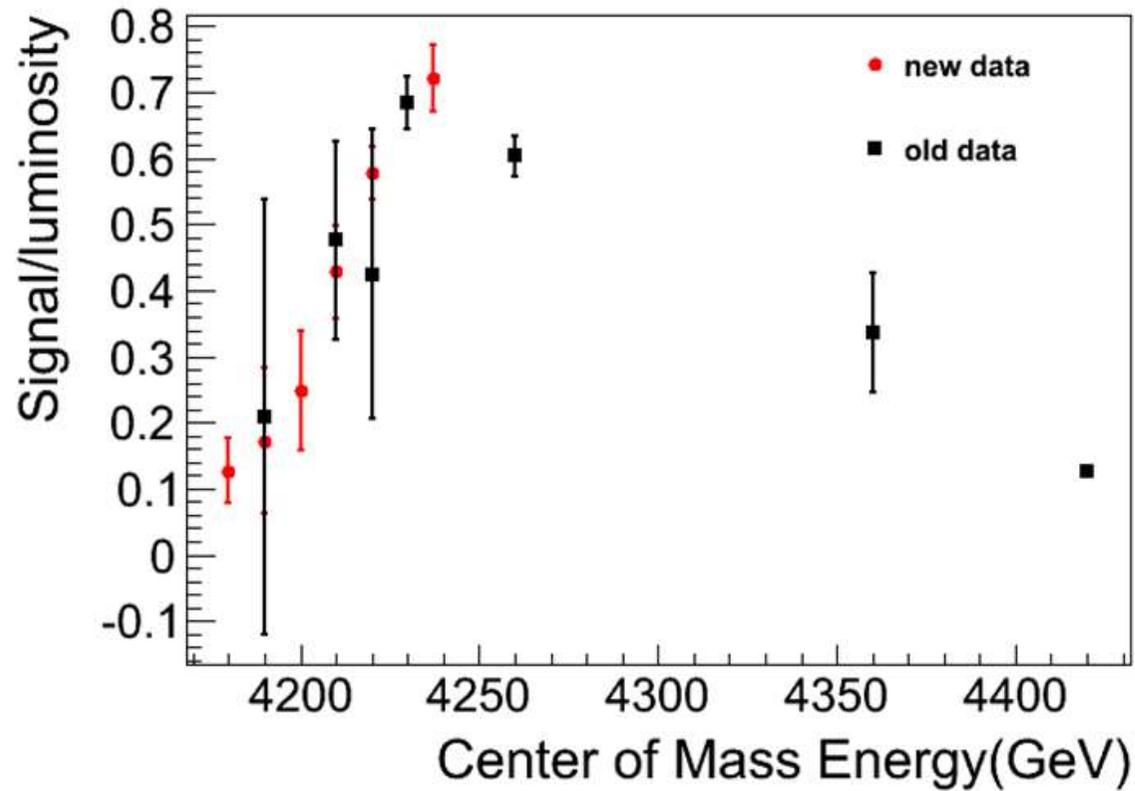
Data check

- Gaussian+1st polynomial



Data check

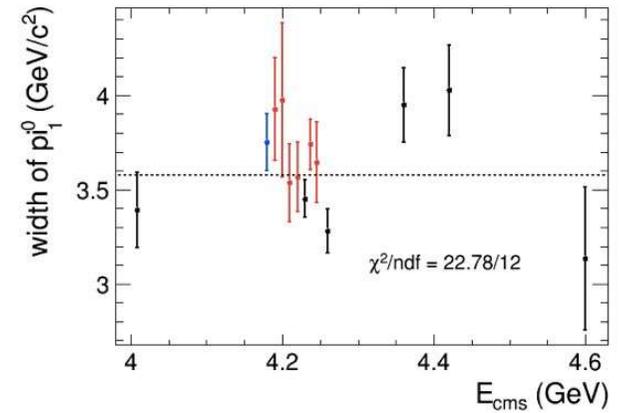
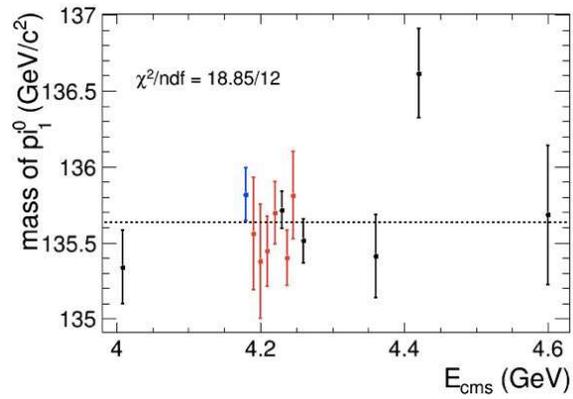
- B-W \otimes D-G+1st polynomial



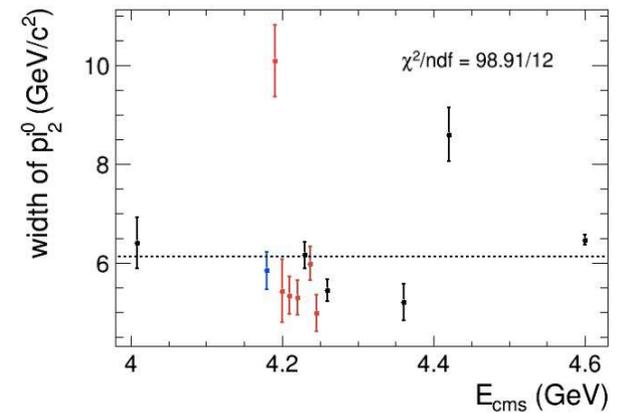
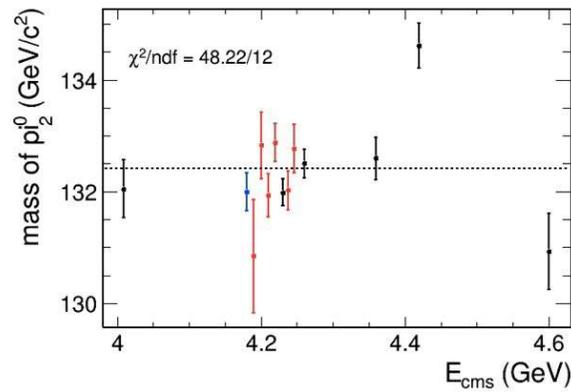
Data check

- Gaussian+1st polynomial

π_1^0



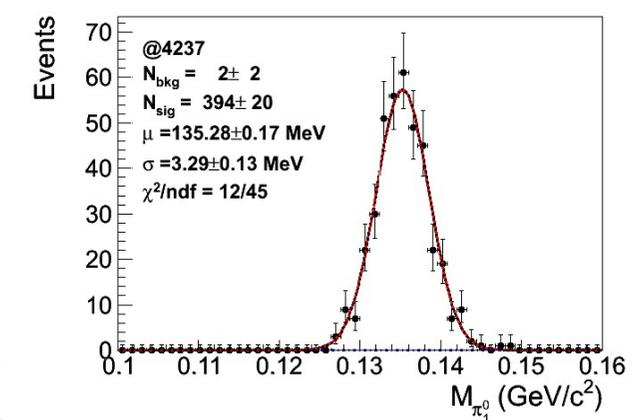
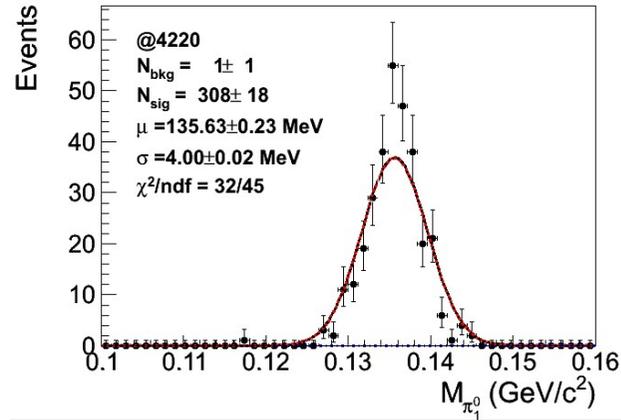
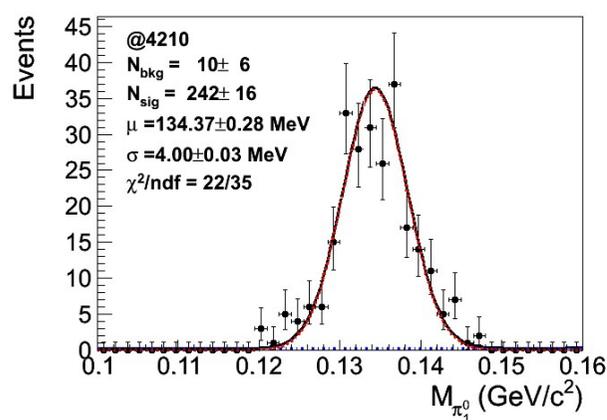
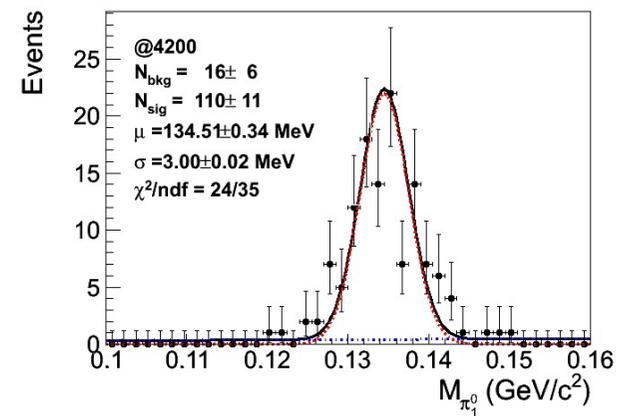
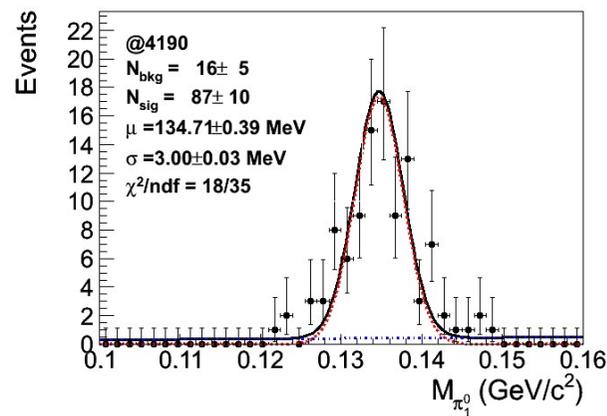
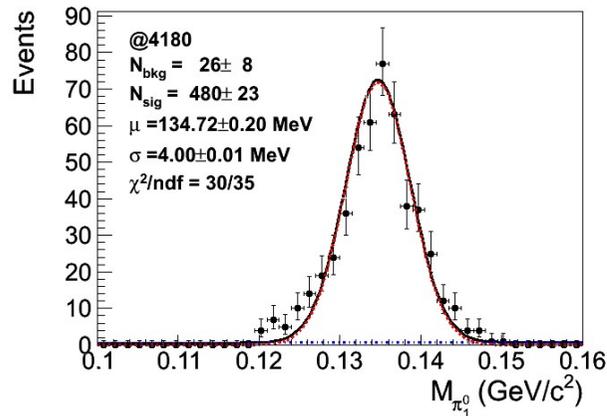
π_2^0



Backup

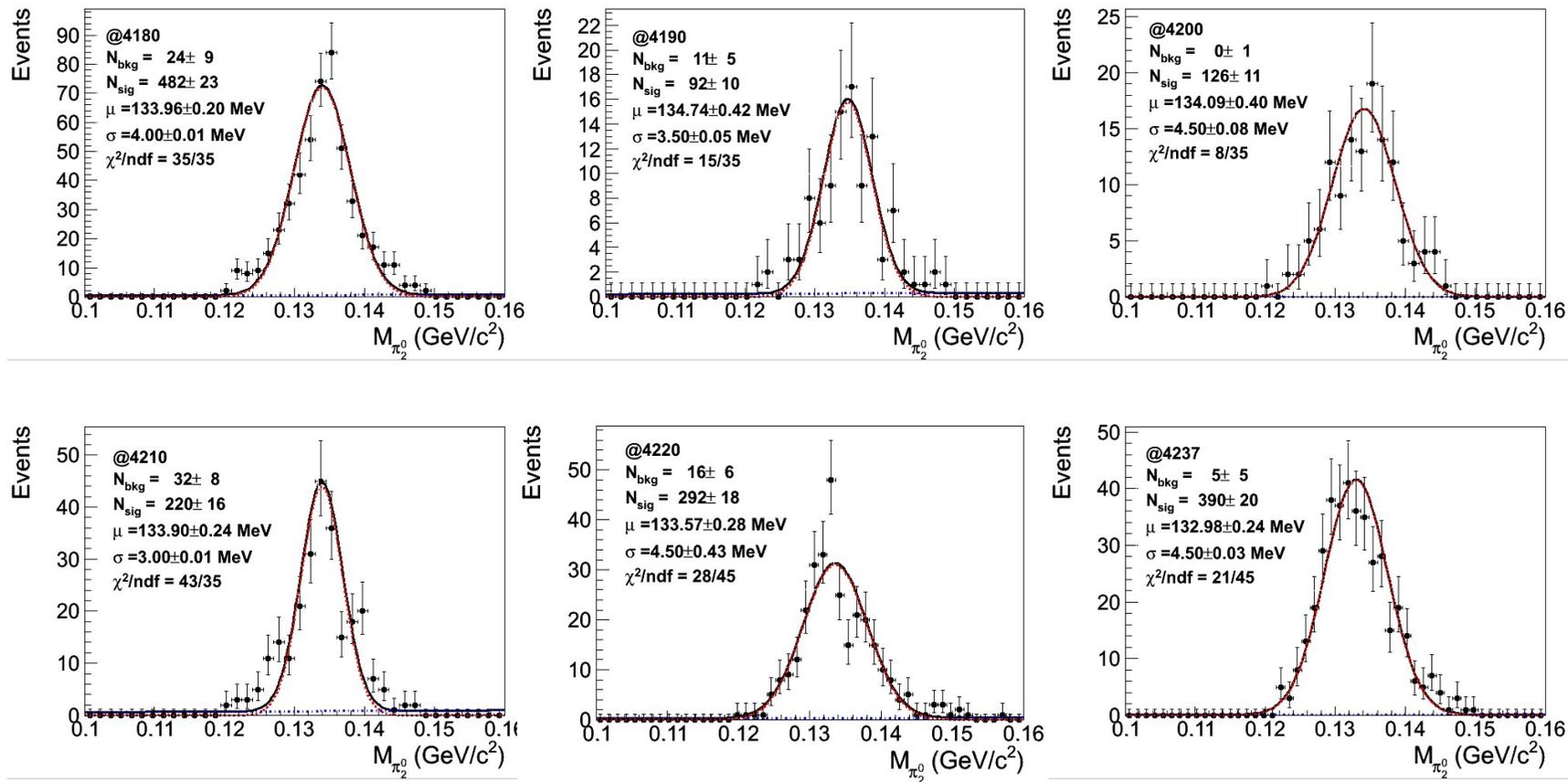
Fit result of new data(702p01)

-fit to π_1^0 (Gaussian+1st polynomial)



Fit result of new data(702p01)

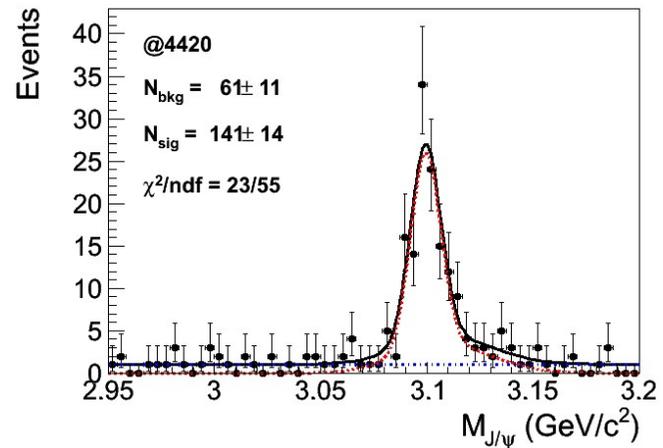
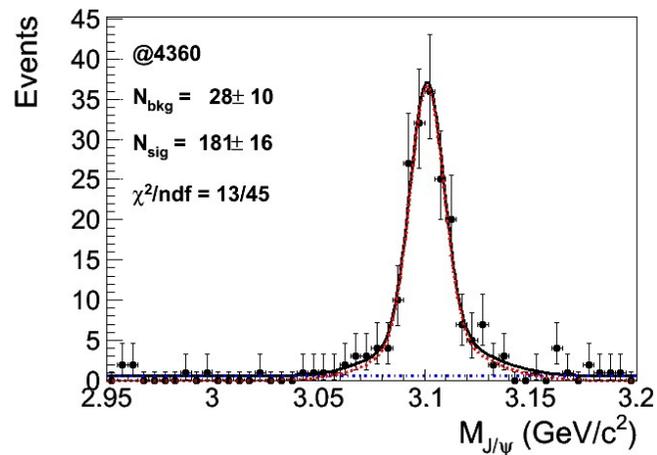
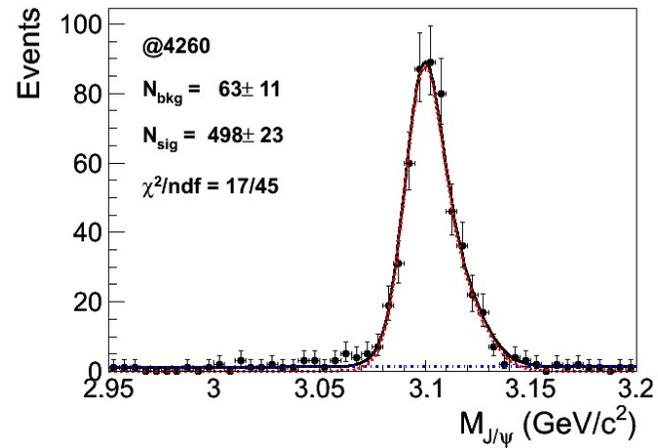
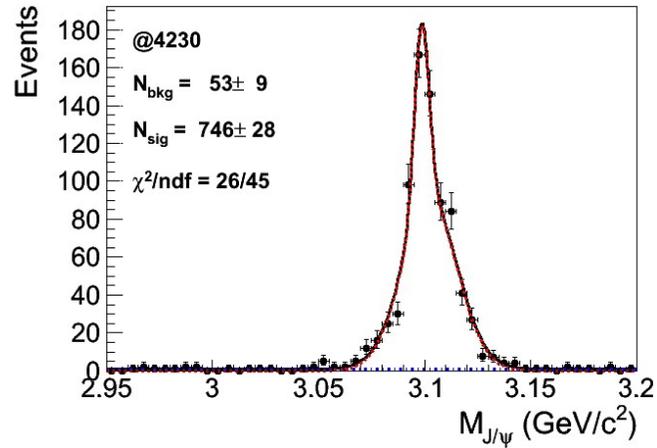
-fit to π_2^0 (Gaussian+1st polynomial)



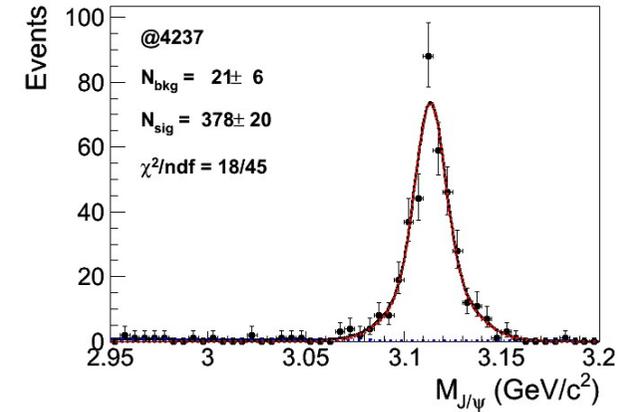
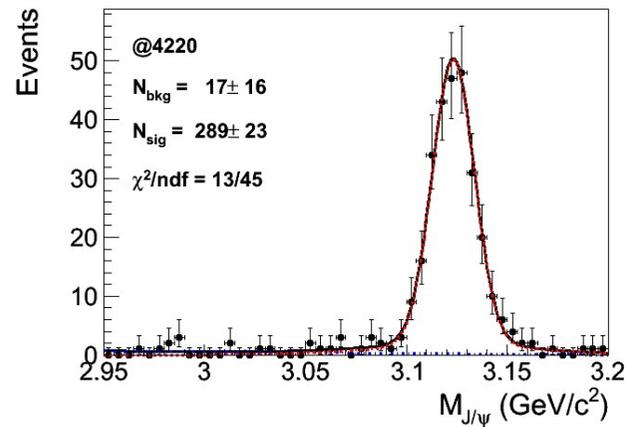
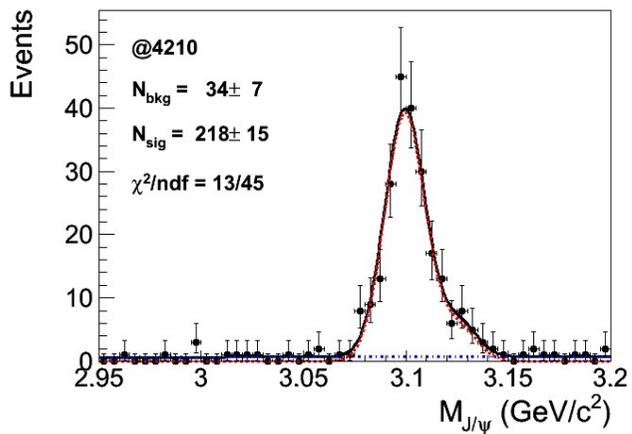
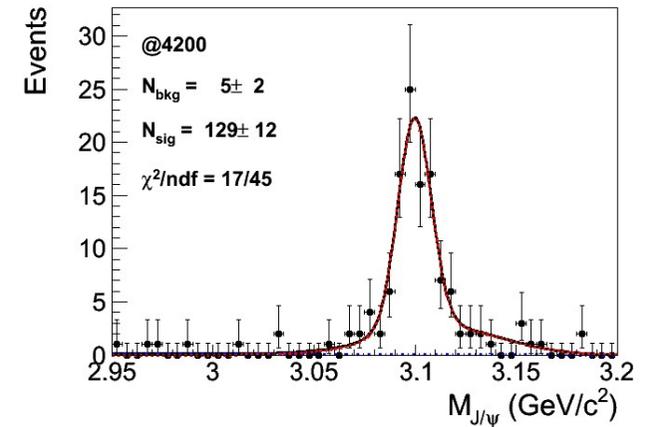
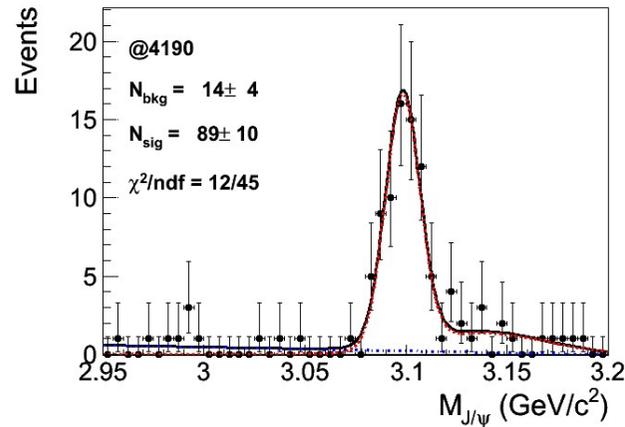
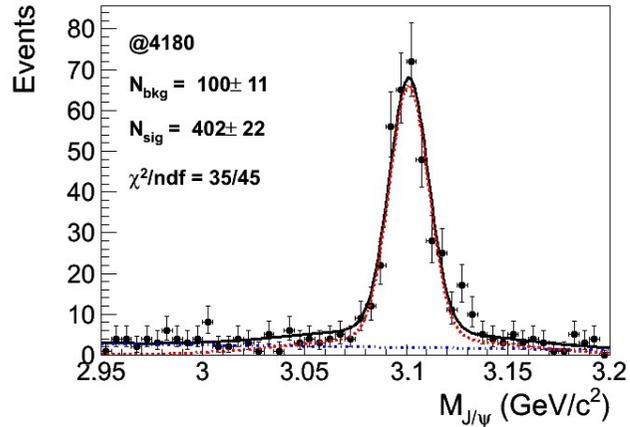
Fitting method

- Obtain $N(\pi^0\pi^0 J/\psi)$ yields from fitting to dilepton mass spectra
- A Breit-Wigner function convolved with a double-Gaussian describes J/ψ signal shape
 - The width of Breit-Wigner is fixed to the J/ψ value and the mass allowed to float
 - The mean of the first Gaussian is fixed to zero and all other parameters are allowed to float
- A first-order polynomial describes background shape

Fit result of old data (664p01)



Fit result of new data(702p01)



Fit result at different energy point

	E_{cm} (GeV)	$N(\pi^0\pi^0 J/\Psi)$	Lum.(pb ⁻¹)	N/Lum.
Old data	4190	9±3	43.09±0.03	0.21 ±0.33
	4210	26±4	54.55±0.03	0.48±0.15
	4220	23±5	54.13±0.03	0.42 ±0.22
	4230	746 ±28	1091.74±0.15	0.68±0.04
	4260	498 ± 23	825.67±0.13	0.60 ±0.03
	4360	181±16	539.84±0.10	0.34±0.09
	4420	141 ±14	1073.56 ± 0.14	0.13 ± 0.10
		E_{cm} (GeV)	$N(\pi^0\pi^0 J/\Psi)$	Lum.(pb ⁻¹)
New data	4180	402±22	3161	0.13±0.05
	4190	89±10	517.5	0.17±0.11
	4200	129±12	519.4	0.25±0.09
	4210	218±15	509.0	0.43 ±0.07
	4220	289±13	500	0.58±0.04
	4237	365±20	505.71	0.72 ±0.05