Update cross section of $e^+ e^- \to \pi^+ \pi^- J/\psi$

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Motivation

- We plan to update the $e^+ e^- \rightarrow \pi^+ \pi^- J/\psi$ cross section with new XYZ data, to precisely measure Y(4260) parameters;

- We might have a chance to study Y$\rightarrow \pi^\pm Z_c(3900)^\mp$ at BESIII;
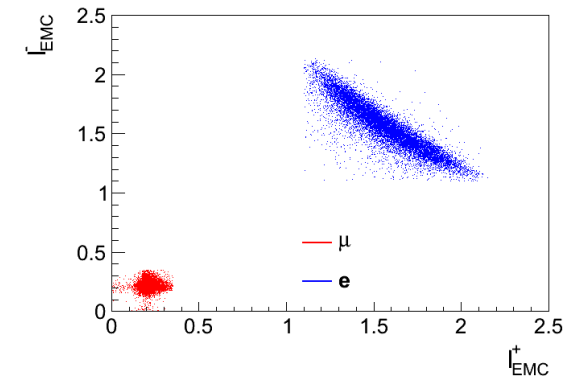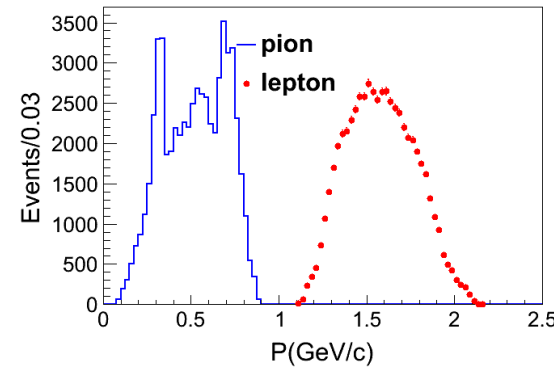
Intial check(@4230 and @ 4260):

- boss version boss664p01;

- MC of $e^+ e^- \rightarrow Y(4260) \rightarrow \pi^+ \pi^- J/\psi$ MassH2 (produced by Zhiqing) ;
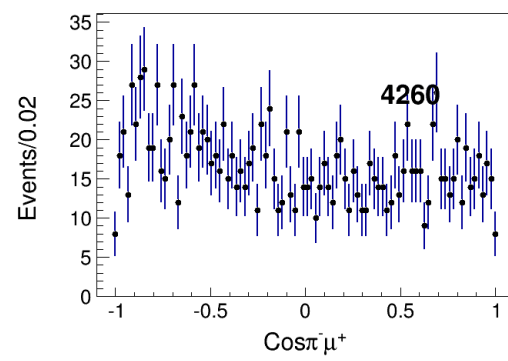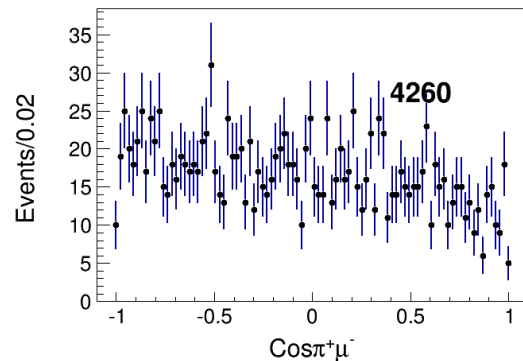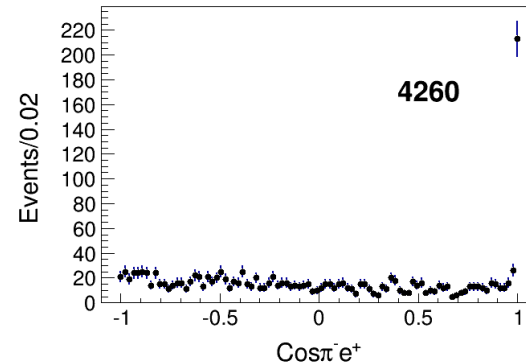
Event Selection

❏ **Initial Selection**
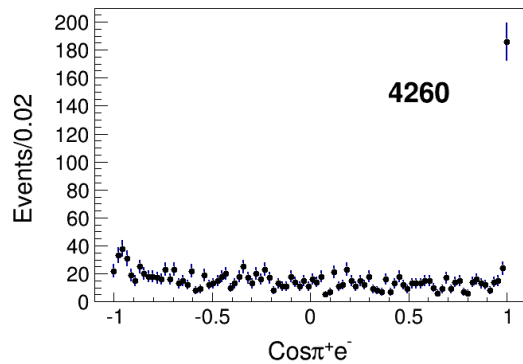- Charged track :
  - ➤ Rxy<1cm，|Rz| <10cm ; |cosθ|<0.93;

  - ➤ charged track =4 ; total charge =0;

  - ➤ identify charged track:

    - • P>1.06 GeV leptons
    - • P<=1.06 GeV pion

  - ➤ identify leptons:
    - • E_emc < 0.35 GeV muon;
    - • E_emc > 1.1 GeV electron;

  - ➤ Vertex and 4C kinematic fit ;
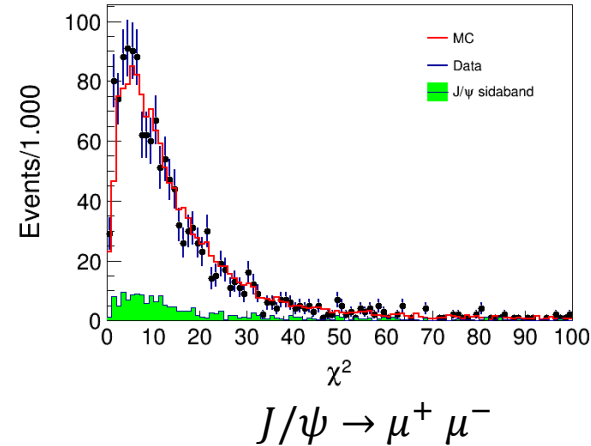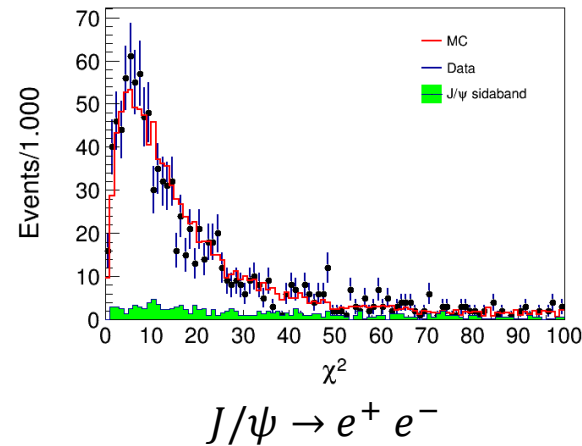
❑ **Further selection:**

Obviously, there are large gamma conversion events

- To suppress gamma conversion events
  ➢ let $\cos(\pi^+ \pi^-) < 0.98$;

- Check others angle distribution:

$J/\psi \to e^+ e^-$

$J/\psi \to \mu^+ \mu^-$
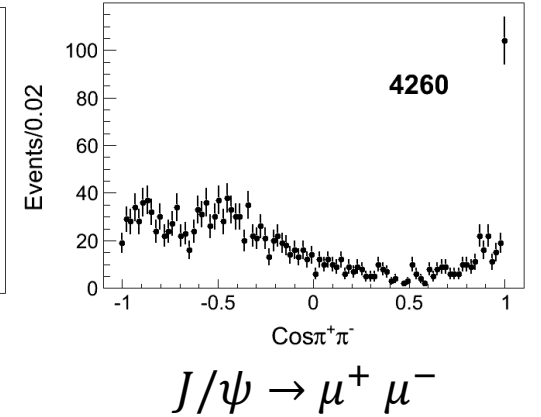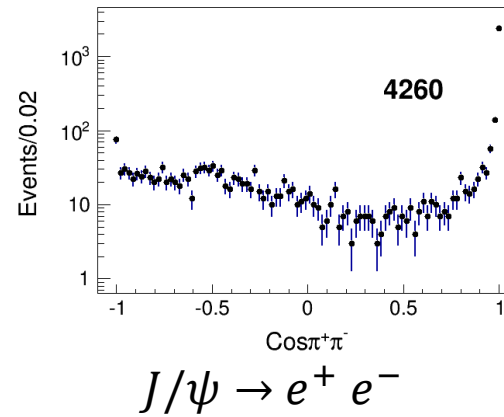
➢ still have large gamma conversion events in ee channel , let $\cos(\pi^+ e^-) < 0.98$ && $\cos(\pi^- e^+) < 0.98$;

- After above cut(MC after PULL distribution correction):

$$J/\psi \to e^+ e^-$$

$$J/\psi \to \mu^+ \mu^-$$

➢ let $\chi^2{}_{4c} < 60$;

- Further selection summary:

➢ $\cos(\pi^+ \pi^-) < 0.98$ && $\cos(\pi^+ e^-) < 0.98$ && $\cos(\pi^- e^+) < 0.98$ && $\chi^2{}_{4c} < 60$ in $J/\psi \to e^+ e^-$ channel;

➢ $\cos(\pi^+ \pi^-) < 0.98$ && $\chi^2{}_{4c} < 60$ in $J/\psi \to \mu^+ \mu^-$ channel;

Cross Section Measurement

After all the above selection,the dominant background event come from $e^+ e^- \to \pi^+ \pi^- \pi^+ \pi^-$ both in $e^+ e^-$ and $\mu^+ \mu^-$ channel(inMC study), we use J/ψ sideband describe this background:

$$\sigma_{dress} = \frac{N_{sig}}{\mathcal{L}(1 + \delta)\epsilon\mathcal{B}}$$

- N_{sig} is the number of J/ψ events ,we get it by using MC shape convolving with a free parameter Gaussian function add 1nd-order Chebychev polynomial fit to DATA ;

- $\mathcal{L}$ is the integrate luminosity;

- $(1 + \delta)$ is radiative correction factor (Use the value in memo[1]);

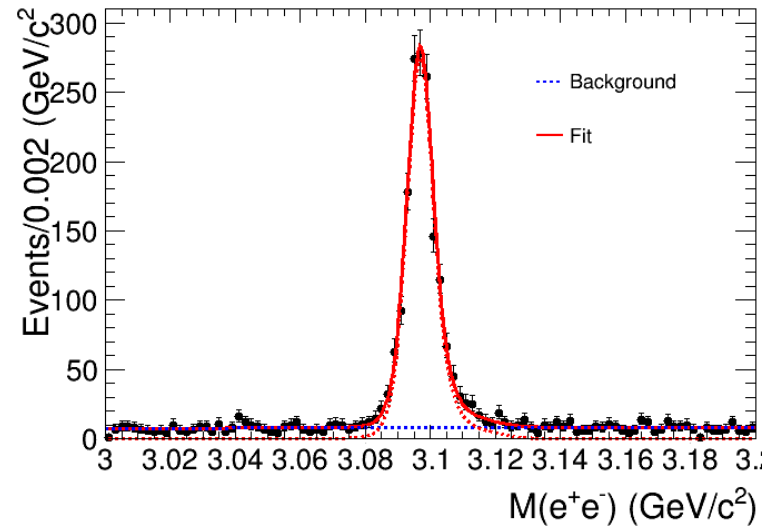- $\mathcal{B}$ is the Branching fraction of $J/\psi \to l^+ l^-$;

[1] http://docbes3.ihep.ac.cn/DocDB/0004/000473/013/ppJpsi_v8.pdf

Fit result @4230
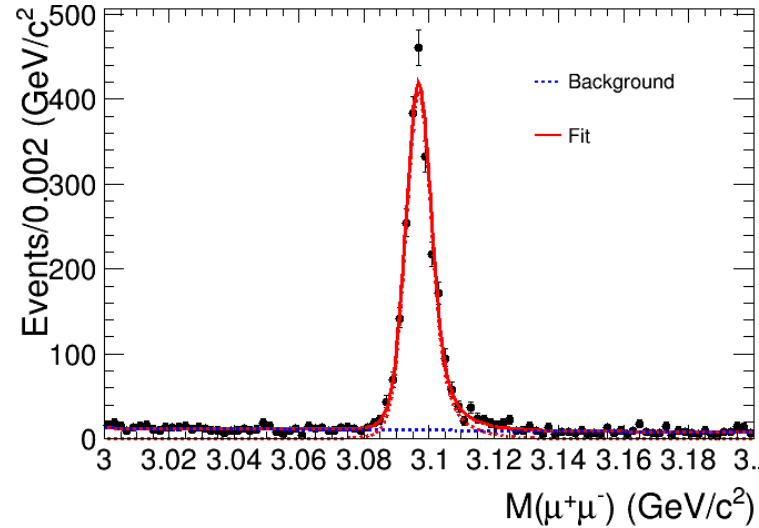
N_sig= 2254.69±50.11 ϵ=0.545

N_sig=1575.51±42.15 ϵ=0.383

$\sigma(\mu\mu) = 84.98\pm1.89$ pb

$\sigma(ee) = 84.34 \pm 2.26$ pb

Zhiqing's Memo:

$\sqrt{s}$ (GeV)	$\mathcal{L}$ (pb^{-1})	$N^{\text{sig}}(\mu^+\mu^-/e^+e^-)$	$\epsilon(\% : \mu^+\mu^-/e^+e^-)$	$1+\delta$	σ^{dress}(pb : $\mu^+\mu^-/e^+e^-$)
4.2263	1091.7	$2261.9 \pm 52.4/1591.2 \pm 44.4$	0.544/0.385	0.748	$85.3 \pm 2.0 \pm 4.9/84.8 \pm 2.4 \pm 5.0$

Fit result @4260
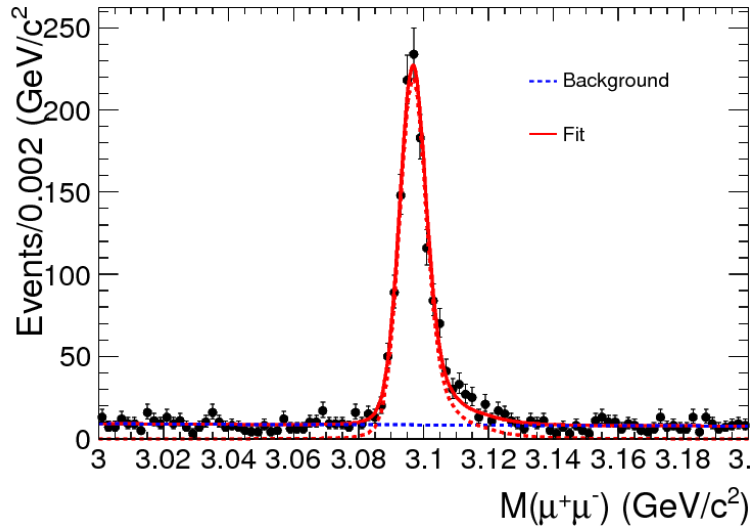
N_sig=1293.5 ±39.00 ϵ=0.5221

$\sigma(\mu\mu) = 59.01 \pm 1.78$ pb

N_sig= 910.22±32.35 ϵ=0.366
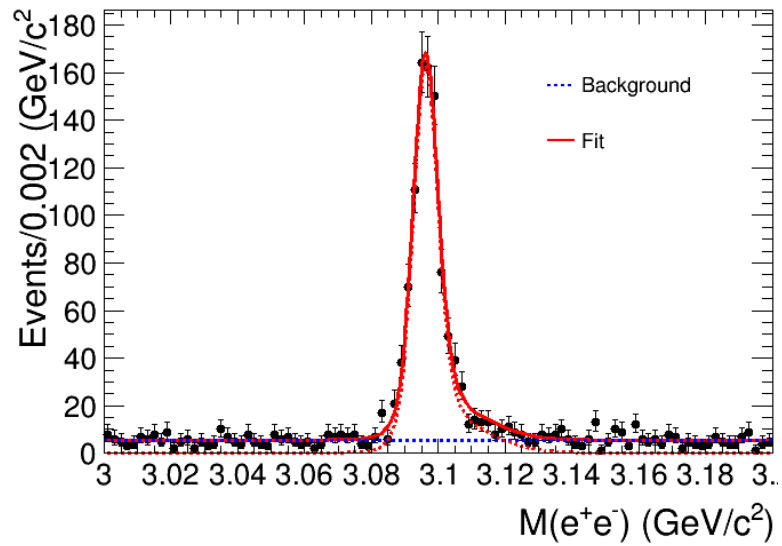
$\sigma(ee) = 59.13\pm2.10$ pb

Zhiqing's Memo:

$\sqrt{s}$ (GeV)	$\mathcal{L}$ (pb^{-1})	$N^{\text{sig}}(\mu^+\mu^-/e^+e^-)$	$\epsilon(\%:\mu^+\mu^-/e^+e^-)$	$1+\delta$	σ^{dress}(pb : $\mu^+\mu^-/e^+e^-$)
4.2580	825.7	$1318.6 \pm 41.3/901.5 \pm 34.3$	0.522/0.366	0.853	$60.1 \pm 1.9 \pm 3.4/58.6 \pm 2.3 \pm 3.5$

Summary

@4230	$\sigma_{dress}\ (\mu\mu)$ pb	σ_{dress}(ee) pb	@4260	$\sigma_{dress}\ (\mu\mu)$ pb	σ_{dress}(ee) pb
My results	84.98±1.89	84.34 ± 2.26	My results	59.01 ± 1.78	59.13±2.10
Zhiqing's	85.3± 2.0	84.8± 2.4	Zhiqing's	60.1± 1.9	58.6± 2.3
Difference (%)	0.38	0.55	Difference (%)	1.84	0.89

- The difference between the results is small , we plan to measure all energy points' cross section;

Thank you!