XYZ at BESIII

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(IHEP)

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Contents

- Introduction
  - Z
  - X
  - Y
- Summary

In my talk,

   Z: Zc's, charged charmonium-like structures. At least 4 quarks

   Y: $J^{pc} = 1^{--}$; can be produced in e^+e^- annihilation

   X: J^{pc} is not 1^{--}; cannot be produced in e^+e^- annihilation

BESIII:

a Y(4260) factory
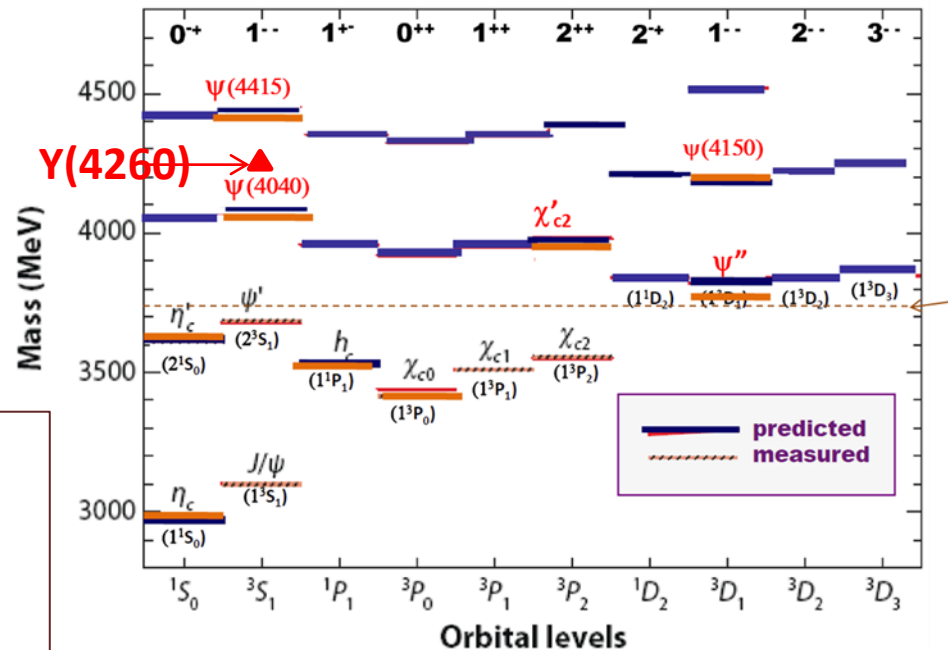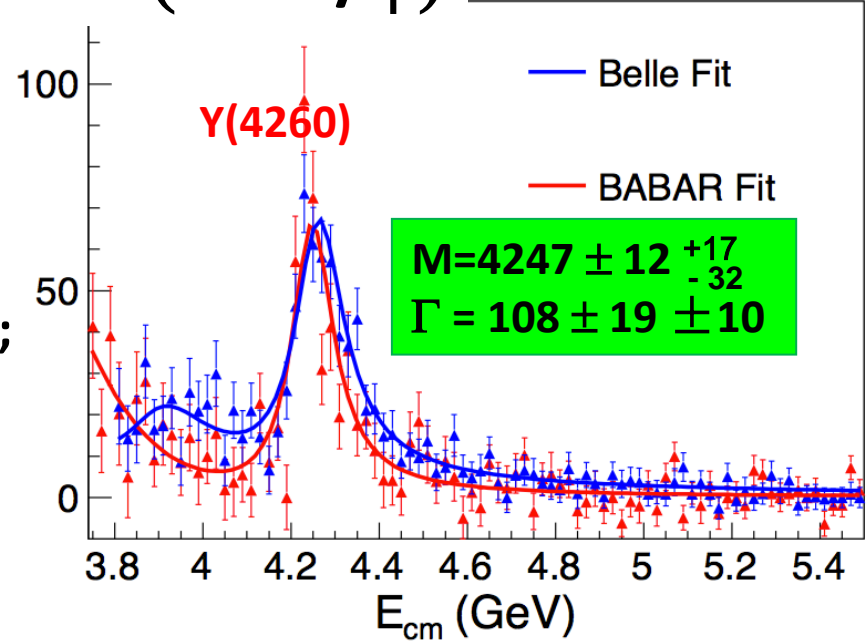
- Y(4260) observed in the M($\pi^+\pi^-$J/ψ) in the ISR process;

  not seen in inclusive hadron X-section;
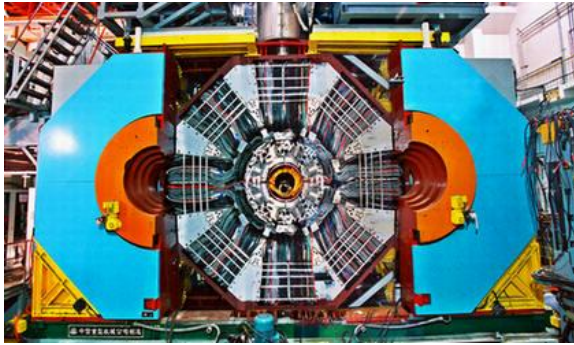 not seen in open charm X-section

  No place in quark model for Y(4260); candidate for a hybrid state

- The only seen decays are $\pi\pi$J/ψ

- Direct production at BES/BEPCII

  The same for Y(4360).

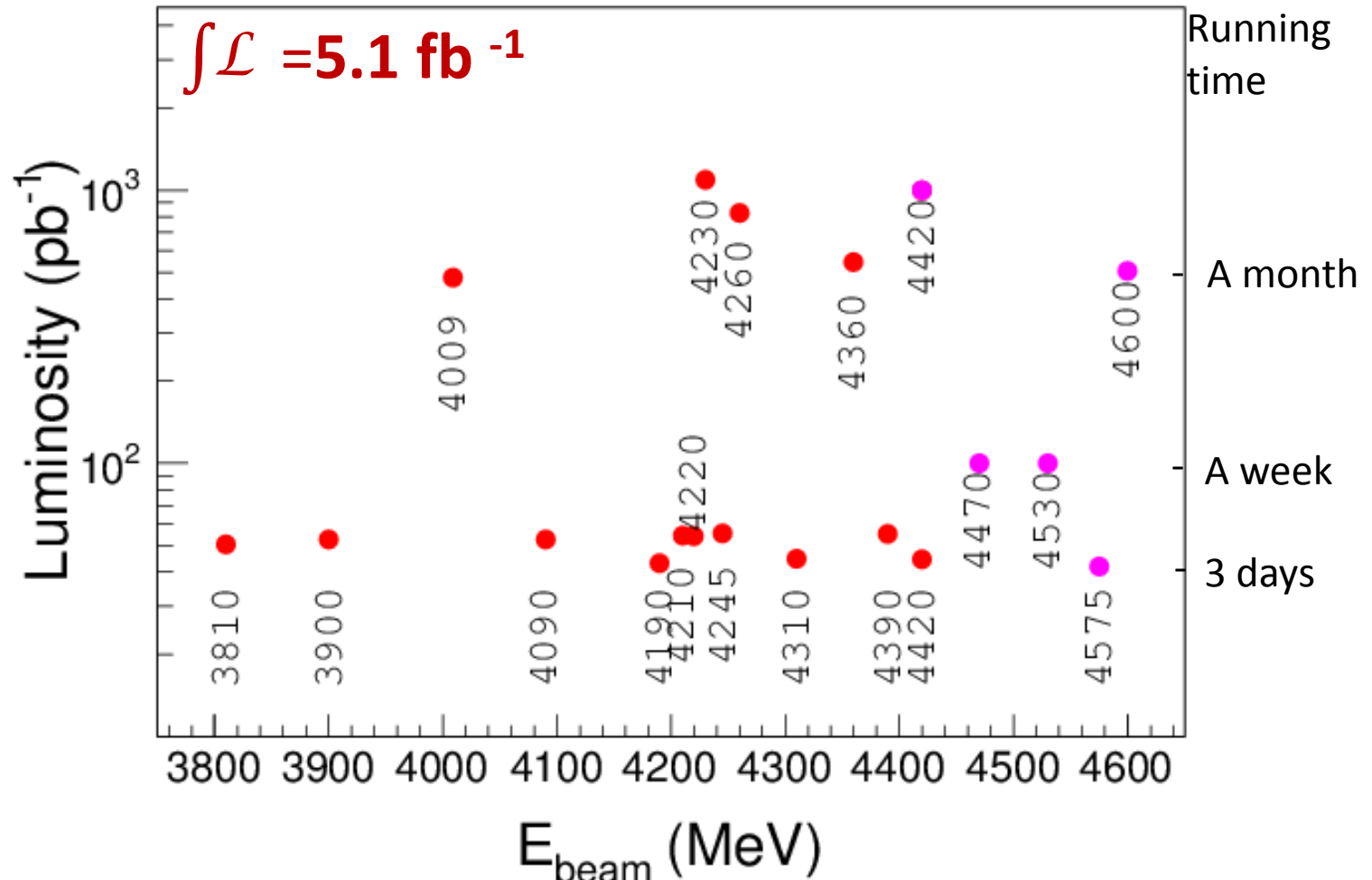*BESIII takes data at Y(4260), Y(4360) and around to study their properties.*

M($\pi^+\pi^-$J/ψ)

M=4247 $\pm$ 12 $^{+17}_{-32}$
Γ = 108 $\pm$ 19 $\pm$ 10

The center-of-mass energy $\sqrt{S}$: 2 - 4.6 GeV

Results based on the data above 3.8 GeV

$\int \mathcal{L}$ =**5.1 fb** $^{-1}$

Zc

All Zc's established

State	Mass (MeV/c²)	Width (MeV)	Decay	Process	[Ref]
$Z_c(3900)^\pm$	$3899.0 \pm 3.6 \pm 4.9$	$46 \pm 10 \pm 20$	$\pi^\pm J/\psi$	$e^+e^- \to \pi^+\pi^- J/\psi$	1*
$Z_c(3900)^0$	$3894.8 \pm 2.3 \pm 2.7$	$29.6 \pm 8.2 \pm 8.2$	$\pi^0 J/\psi$	$e^+e^- \to \pi^0\pi^0 J/\psi$	2*
$Z_c(3885)^\pm$	$3883.9 \pm 1.5 \pm 4.2$ Single D tag	$24.8 \pm 3.3 \pm 11.0$ Single D tag	$(D\bar{D}^*)^\pm$	$e^+e^- \to (D\bar{D}^*)^\pm \pi^\mp$	3*
	$3881.7 \pm 1.6 \pm 2.1$ Double D tag	$26.6 \pm 2.0 \pm 2.3$ Double D tag	$(D\bar{D}^*)^\pm$	$e^+e^- \to (D\bar{D}^*)^\pm \pi^\mp$	4*
$Z_c(3885)^0$	$3885.7^{+4.3}_{-5.7} \pm 8.4$	$35^{+11}_{-12} \pm 15$	$(D\bar{D}^*)^0$	$e^+e^- \to (D\bar{D}^*)^0 \pi^0$	5*
$Z_c(4020)^\pm$	$4022.9 \pm 0.8 \pm 2.7$	$7.9 \pm 2.7 \pm 2.6$	$\pi^\pm h_c$	$e^+e^- \to \pi^+\pi^- h_c$	6*
$Z_c(4020)^0$	$4023.9 \pm 2.2 \pm 3.8$	fixed	$\pi^0 h_c$	$e^+e^- \to \pi^0\pi^0 h_c$	7*
$Z_c(4025)^\pm$	$4026.3 \pm 2.6 \pm 3.7$	$24.8 \pm 5.6 \pm 7.7$	$D^*\bar{D}^*$	$e^+e^- \to (D^*\bar{D}^*)^\pm \pi^\mp$	8*
$Z_c(4025)^0$	$4025.5^{+2,0}_{-4.7} \pm 3.1$	$23.0 \pm 6.0 \pm 1.0$	$D^*\bar{D}^*$	$e^+e^- \to (D^*\bar{D}^*)^0 \pi^0$	9*

References:
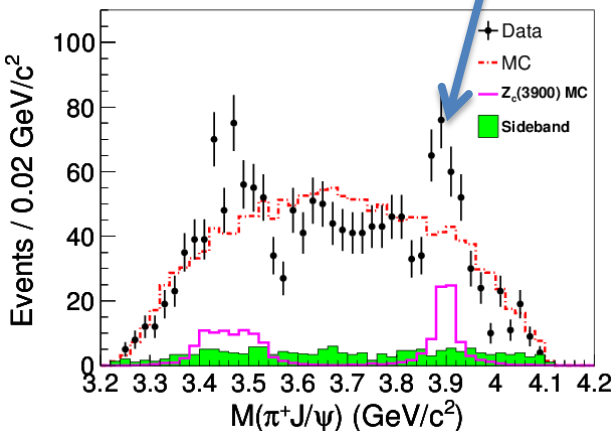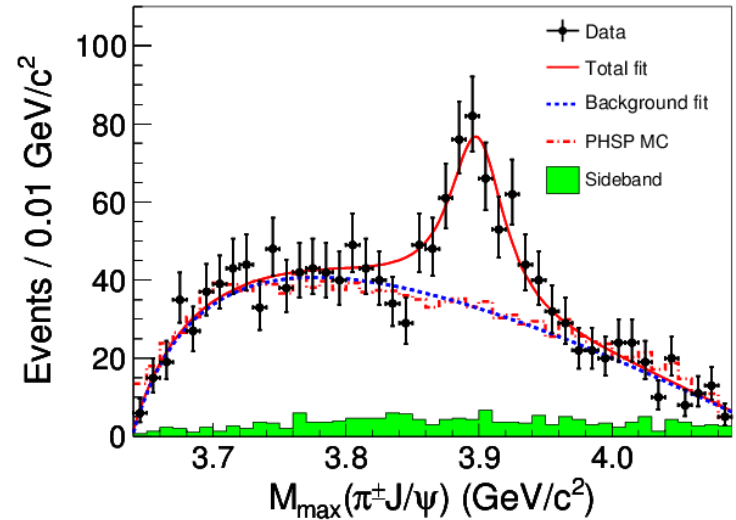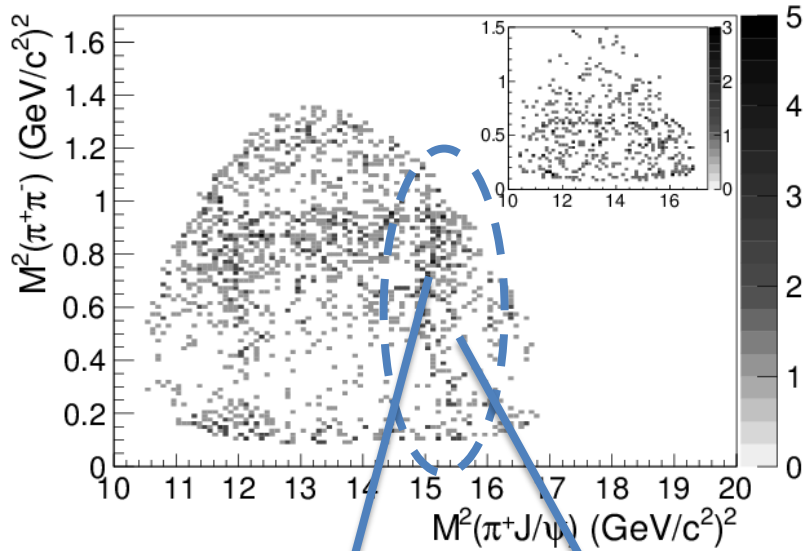1*: PRL,110,252001; 2*: arXiv:1506.06018; 3*: PRL,112, 022001; 4*: arXiv:1509.01398
5*: arXiv:1509.xxxxx
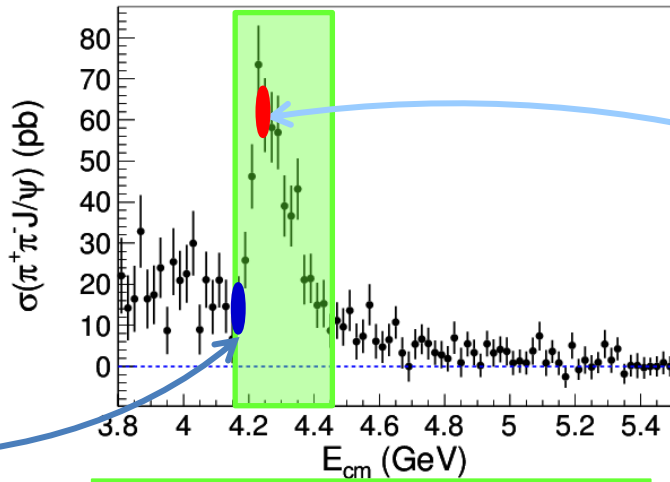6*: PRL,110, 252001; 7*: PRL,113,212002; 8*: PRL,112, 132001 ; 9*: arXiv:1507.02404
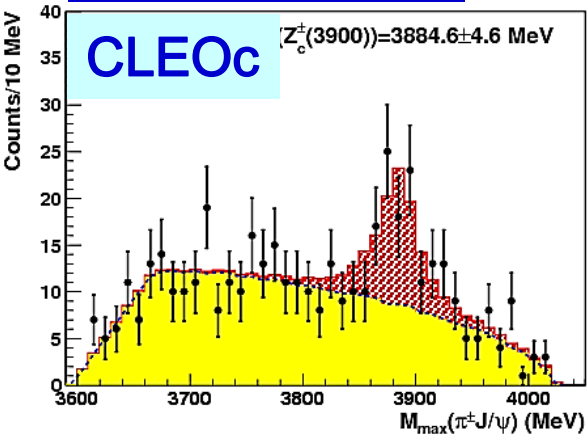
1*. Observation of $Z_c^\pm(3900)$

Based on 525 pb^{-1} @ 4.26GeV
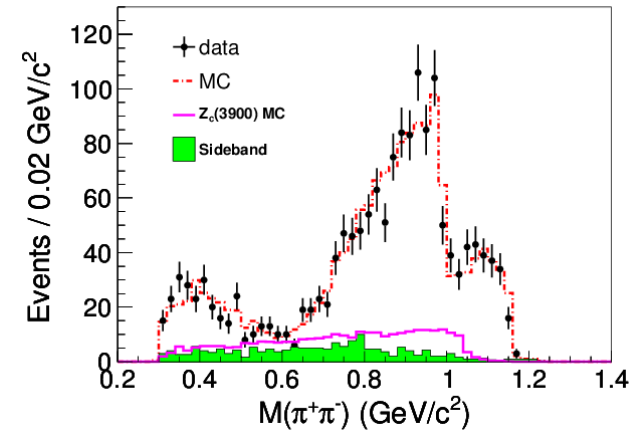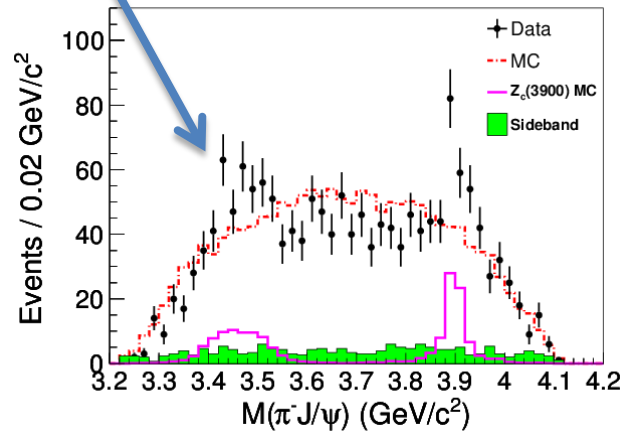
M($\pi^+\pi^-$J/ψ) = 4.17

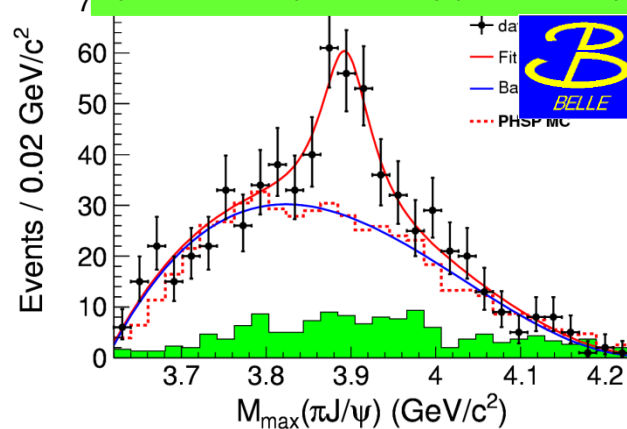(4.15 < M($\pi^+\pi^-$J/ψ) < 4.45)

M($\pi^+\pi^-$J/ψ) = 4.26

CLEOc

M($Z_c^\pm$(3900)) = 3884.6±4.6 MeV

BELLE

BESIII

PLB 727, 366 (586 pb-1)   *PRL,111,252002 (967 fb-1)*   PRL,110,252001(525 pb-1)
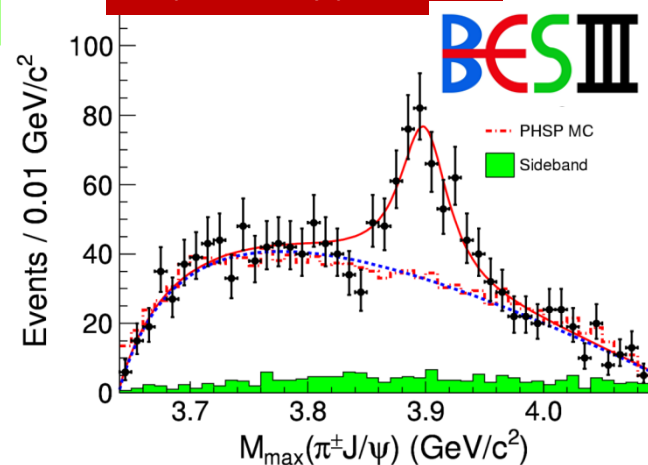
• M = 3885±5±1 MeV	• M = 3894.5±6.6±4.5 MeV	• M = 3899.0±3.6±4.9 MeV
• Γ = 34±12±4 MeV	• Γ = 63±24±26 MeV	• Γ = 46±10±20 MeV
• 81 ± 20 events	• 159 ± 49 events	• 307 ± 48 events
• 6.1σ	• >5.2σ	• >8σ

2*. Observation of $Z_c^0(3900)$ in $e^+e^- \rightarrow \pi^0\pi^0 J/\psi$
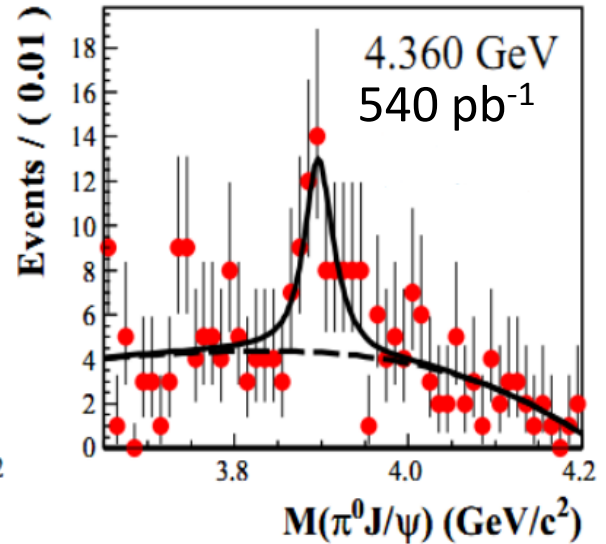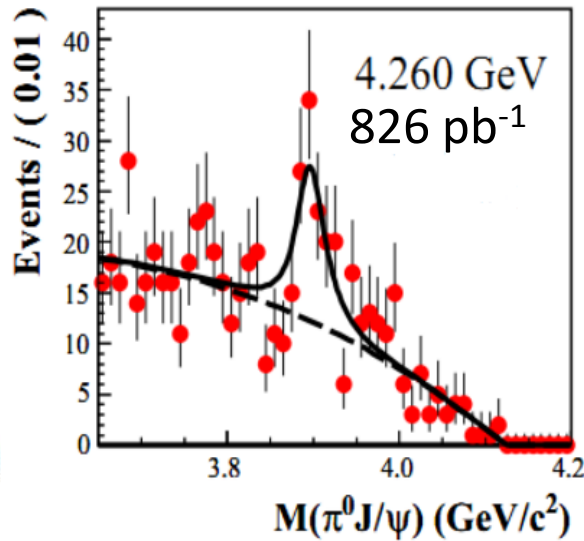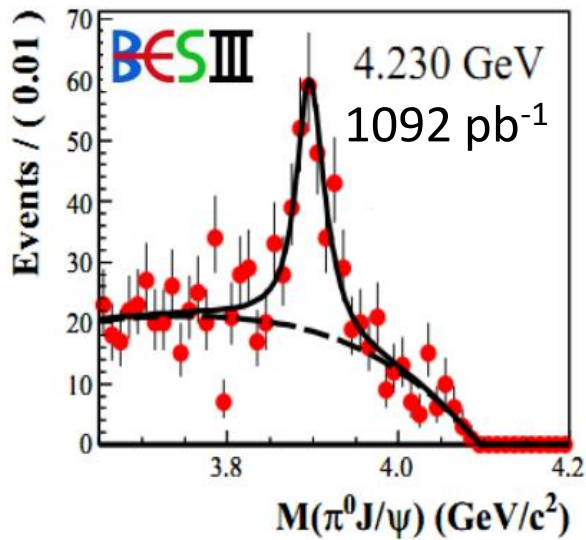
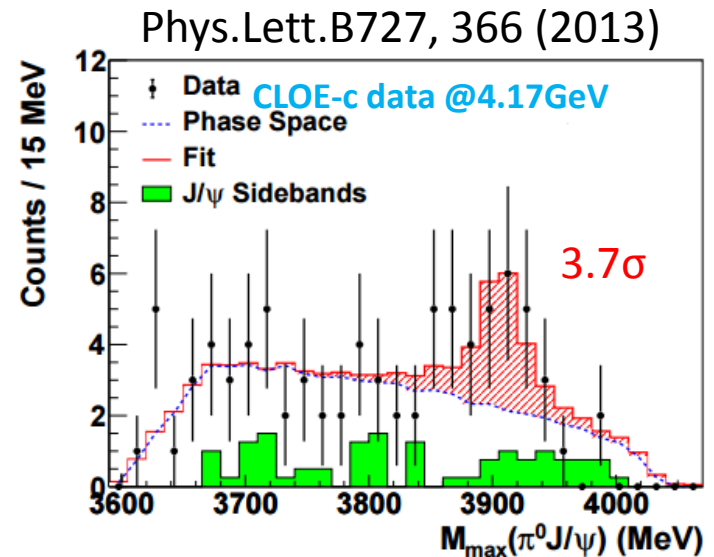Simultaneous fit to the $M(\pi^0 J/\psi)$ for 4230, 4260, 4360 MeV.

Mass = 3894.8 ±2.3 MeV

Γ = 29.6 ±8.2 MeV

Significance = 10.4 σ

$\sigma(e^+e^- \rightarrow \pi^0\pi^0 J/\psi)/\ \sigma(e^+e^- \rightarrow \pi^+\pi^- J/\psi) \approx 0.5$

arXiv:1506.06018, accepted by PRL

Phys.Lett.B727, 366 (2013)

3*. $Z_c^{\pm}(3885) \to (DD^*)^{\pm}$ via $e^+e^- \to \pi^{\pm}(DD^*)^{\mp}$

- Using 525 pb^{-1} @$\sqrt{S}$ = 4.26 GeV
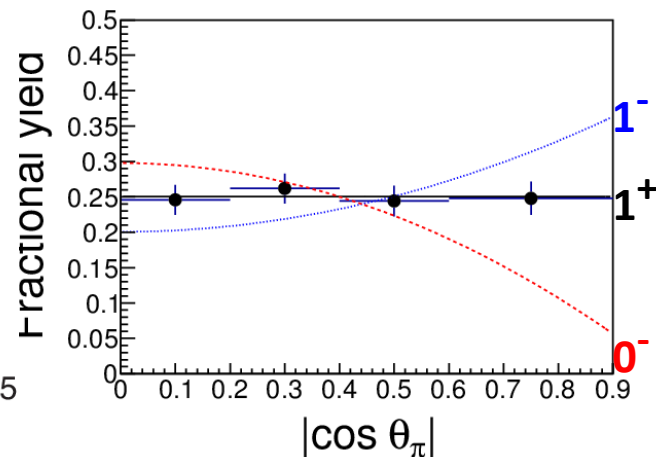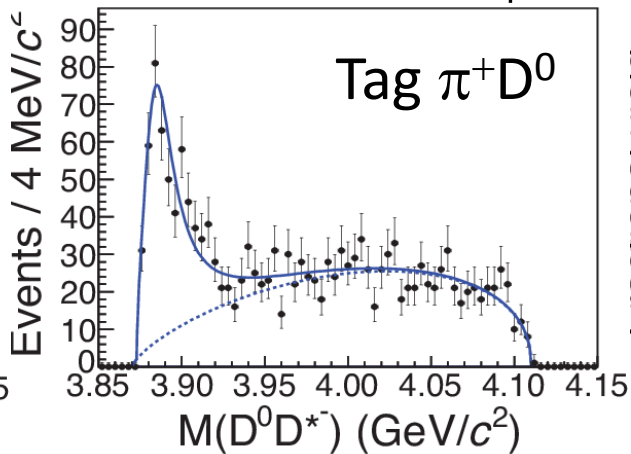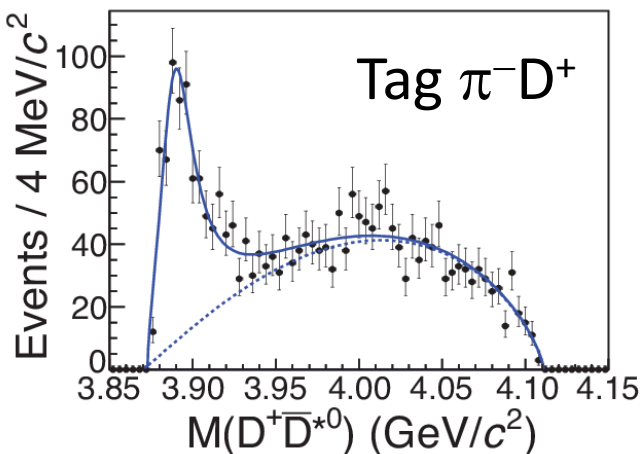 - M = 3884 $\pm$ 4 MeV;
  - Γ = 25 $\pm$ 11 MeV

- **The π angular distribution establishes J^P= 1$^+$**

  0$^-$, π in P-wave: dN/dcos$\theta_\pi \propto \sin^2\theta_\pi$

  1$^-$, π in P-wave: dN/dcos$\theta_\pi \propto 1+\cos^2\theta_\pi$

  1$^+$, π in S-wave: dN/dcos$\theta_\pi \propto$ flat

Single-tag technique
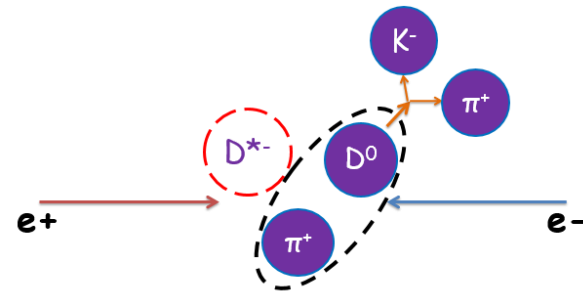
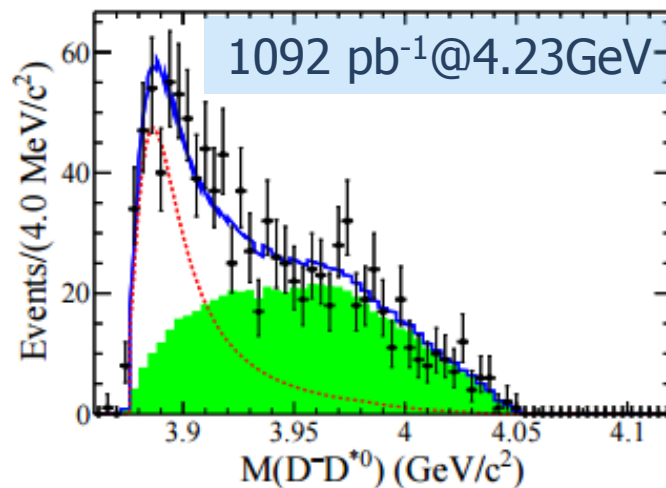- If Z$_c$(3885) is Z$_c$(3900) , $\dfrac{\Gamma(Zc(3900)\to DD*)}{\Gamma(Zc(3900)\to \pi J/\psi)}$ = 6.2 $\pm$ 2.9
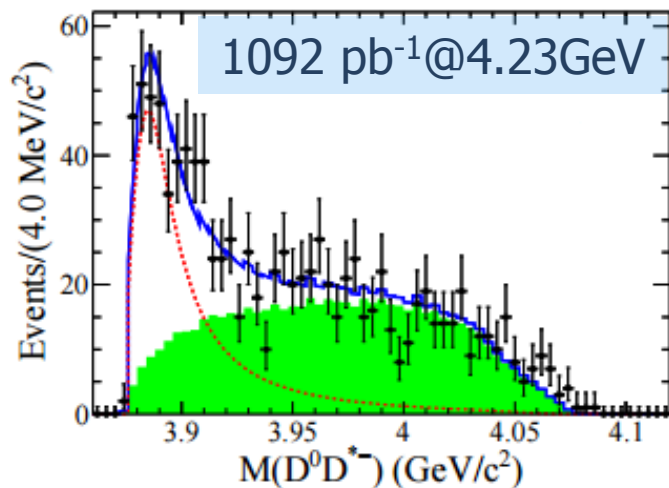
Tag π^-D$^+$

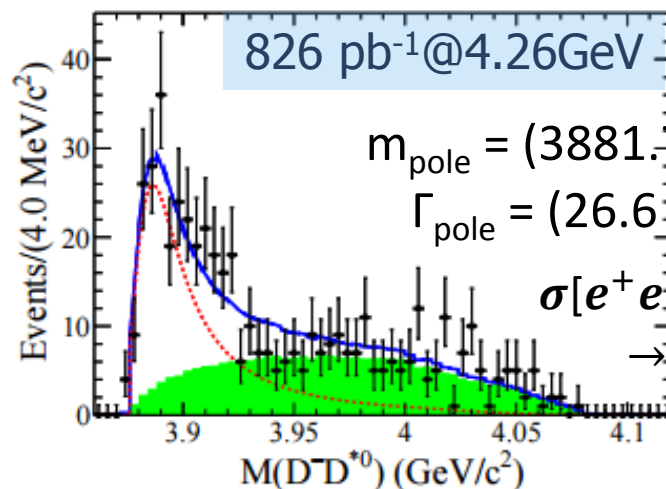Tag π^+D^0
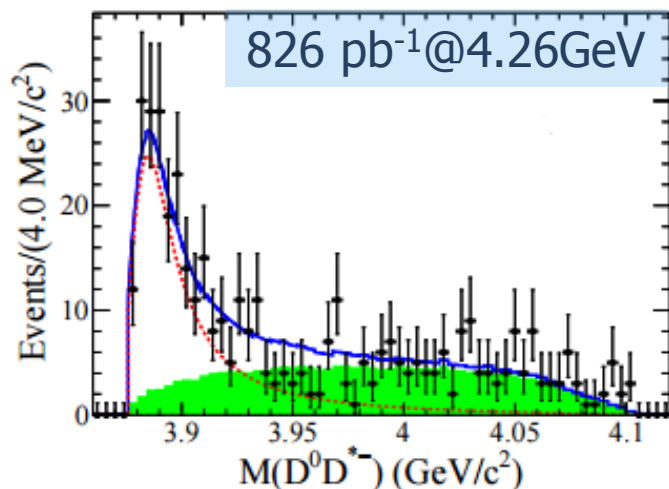
10

4*. Double-tag

Simultaneous Fit

$e^+e^- \rightarrow \pi^+ D^0 D^{*-}$ $\qquad$ $e^+e^- \rightarrow \pi^+ D^- D^{*0}$

Double D tag analysis strategy: Tag 'bachelor' π^+ and two D mesons

$m_{pole} = (3881.7 \pm 1.6 \pm 2.1)$ MeV/c^2

$\Gamma_{pole} = (26.6 \pm 2.0 \pm 2.3)$ MeV

$\sigma[e^+e^- \rightarrow Z_c(3885)^\pm \pi^\mp \rightarrow (D\bar{D}^*)^\pm \pi^\mp] =$
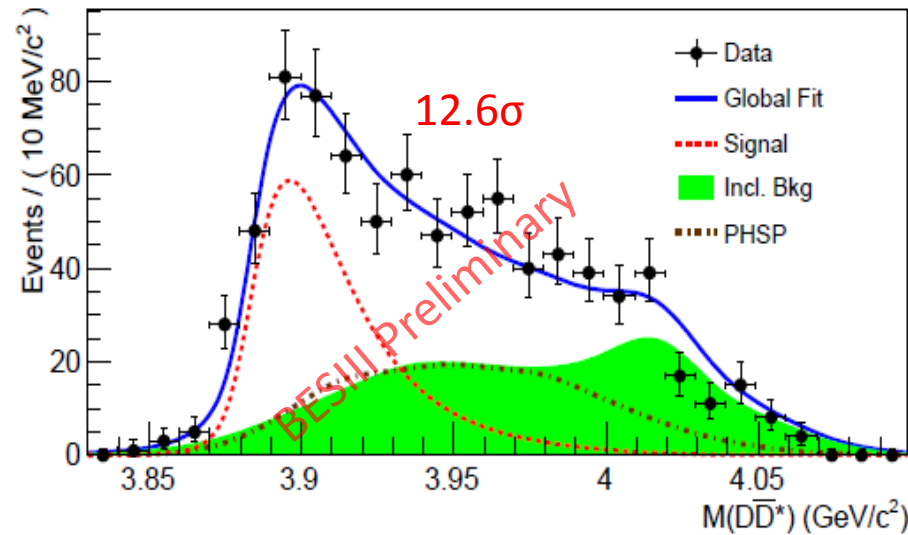
$(108.4 \pm 6.9 \pm 9.1)$ pb @4.26 GeV

The measured m_{pole}, Γ_{pole}, σ and J^P are consistent with single D tag results. 11

5*. $Z_c(3885)^0$ in $e^+e^- \to \pi^0(D\bar{D}^*)^0$

Based on
1092pb^{-1} @ 4.23 & 826 pb^{-1} @ 4.26 GeV

12.6σ

BESIII Preliminary

$m_{pole} = (3885.7^{+4.3}_{-5.7} \pm 8.4)$ MeV/c^2

$\Gamma_{pole} = (35^{+11}_{-12} \pm 15)$ MeV

$\sigma[e^+e^- \to Z_c(3885)^0\pi^0 \to (D\bar{D}^*)^0 \pi^0]$
$= (77 \pm 13 \pm 17)$ pb @4.23 GeV

$\sigma[e^+e^- \to Z_c(3885)^0\pi^0 \to (D\bar{D}^*)^0 \pi^0]$
$= (47 \pm 9 \pm 10)$ pb @4.26 GeV

Another isospin triplet is established
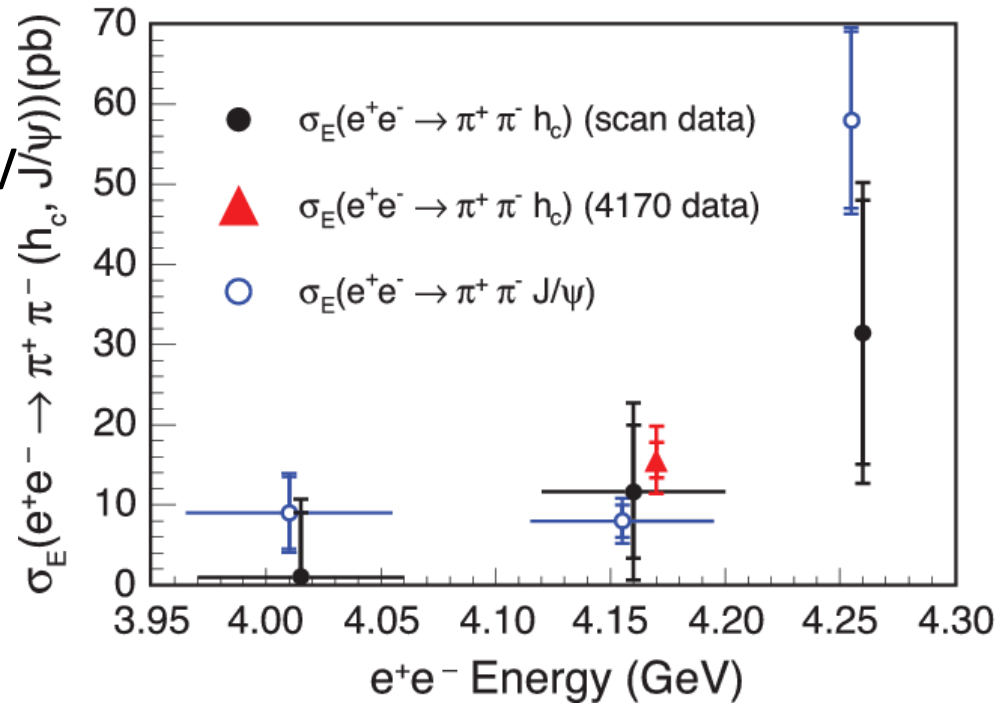$Z_c(3885)^{\pm/0}$

Double D tag analysis strategy:

$e^+e^- \to D^+D^{*-}\pi^0 \to D^+\bar{D}^0\pi^-\pi^0$

$e^+e^- \to D^0\bar{D}^{*0}\pi^0 \to D^0\bar{D}^0\pi^0\pi^0$

e⁺e⁻ →π⁺π⁻h$_c$
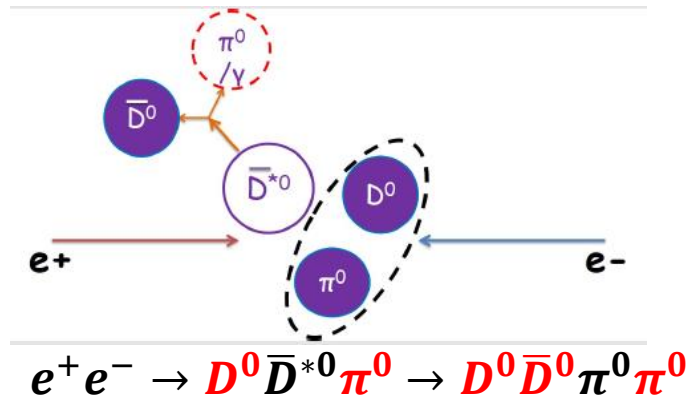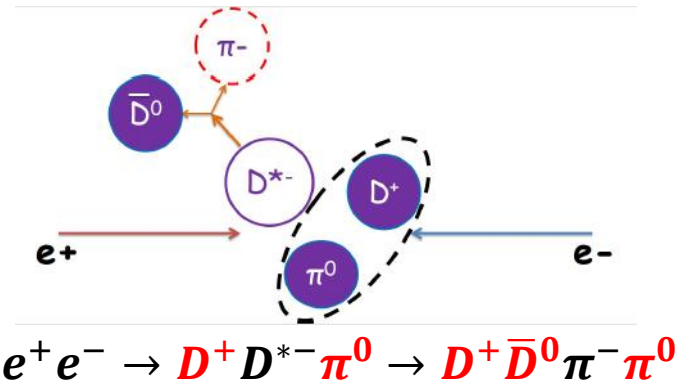
- Significant $\pi^+\pi^-h_c$ production reported by CLEO at 4170 MeV

- Correlated with Y(4260)?

- h_c is spin singlet (s=0) state; J/ψ has spin=1

4250311-004a

PRL,107,041803

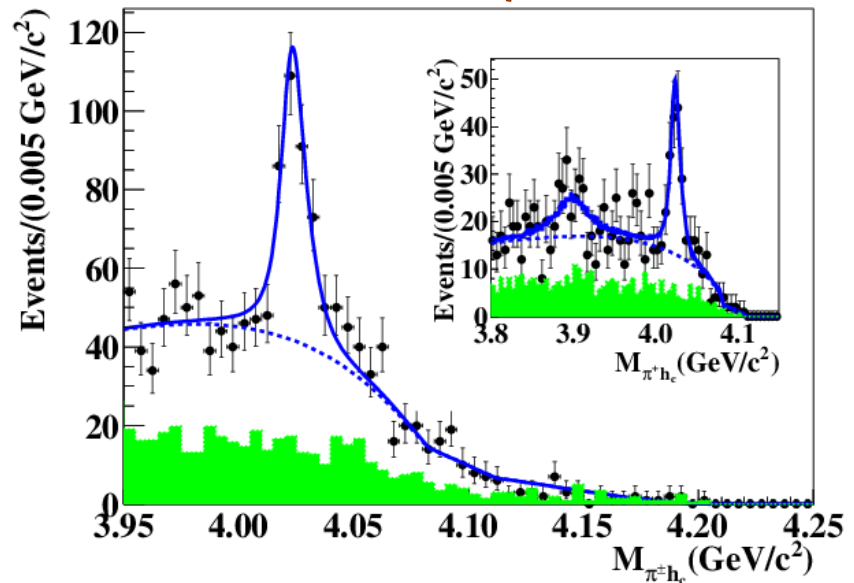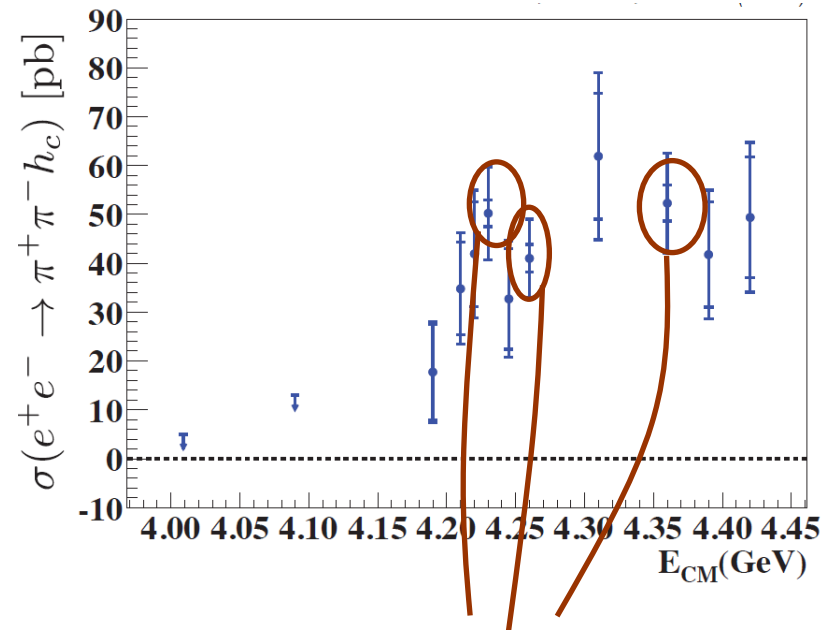- Explore $\pi^+\pi^-$ transitions to h_c as a function of E$_{cm}$

- Search for $\pi^{\pm}h_c$ states

6*. Observation of $Z_c^\pm(4020) \rightarrow \pi^\pm h_c$ in $e^+e^- \rightarrow \pi^+\pi^- h_c$

- No sharp structure in the $\sigma(\pi^+\pi^- h_c)$. Correlation with Y(4260) is unclear

- Narrow $\pi^\pm h_c$ structure observed
  - **M[$Z_c(4020)$] = 4023 $\pm$ 3 MeV**
  - **Γ[$Z_c(4020)$] = 8 $\pm$ 4 MeV**

- $Zc \rightarrow \pi^\pm h_c$ prodution rate is uniform at the 3 energies. ~10 bp^{-1}

- No evidence for $Zc(3900) \rightarrow \pi^\pm h_c$
  - at Ecm = 4260 MeV
  $\sigma(e^+e^- \rightarrow \pi Z_c(3900) \rightarrow \pi^+\pi^- h_c)$ < 10 pb
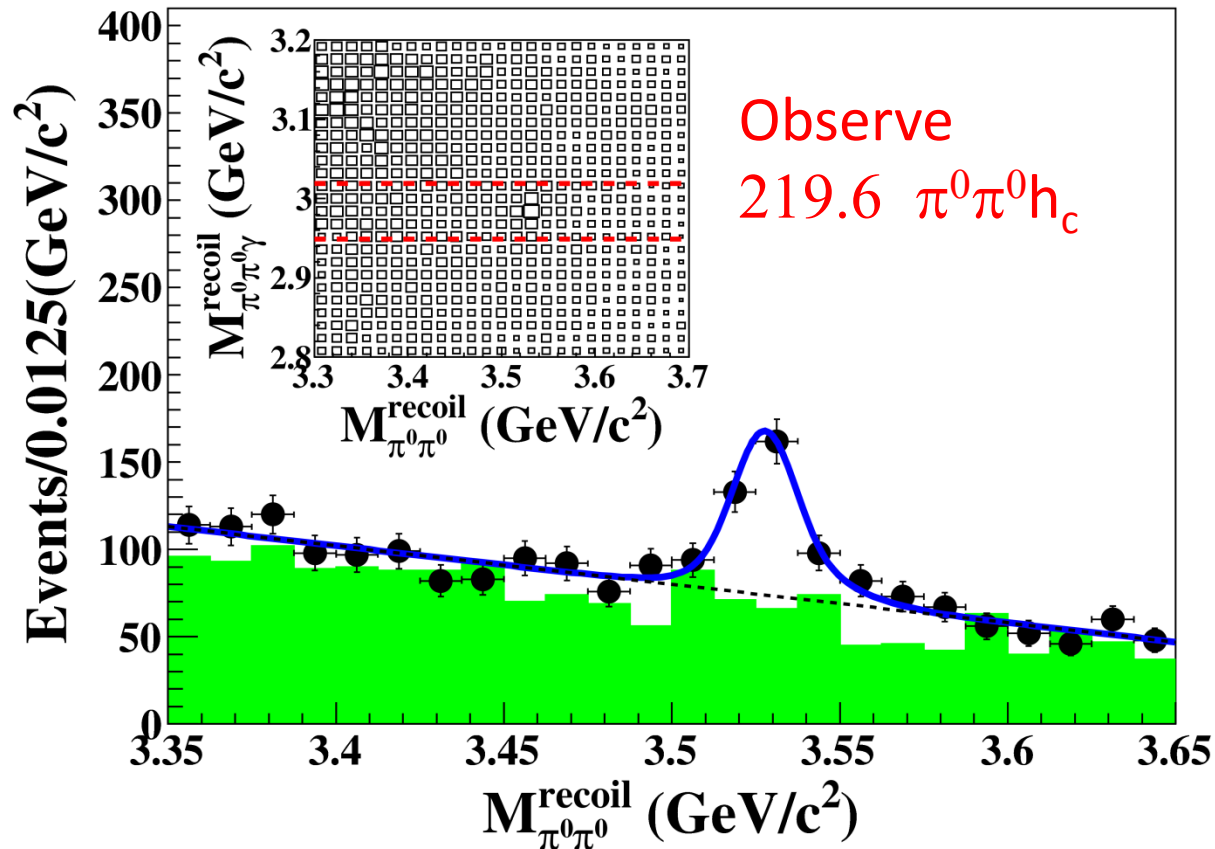 $\sigma(e^+e^- \rightarrow \pi Z_c(3900) \rightarrow \pi^+\pi^- J/\psi)$ = 13 $\pm$ 5 pb

[PRL, 110, 252001]

e$^+$e$^-$ → π^{0}π^{0}h$_c$

h$_c$→γη$_c$, η$_c$-->hadrons [16 exclusive decay modes]

pp̄, π$^+$π$^-$K$^+$K$^-$, π$^+$π$^-$pp̄, 2(K$^+$K$^-$), 2(π$^+$π$^-$), 3(π$^+$π$^-$), 2(π$^+$π$^-$)K$^+$K$^-$, K$_S$^{0}K$^+$π$^-$+c.c., K$_S$^{0}K$^+$π$^-$π$^+$π$^-$+c.c., K$^+$K$^-$π^0, ppπ^0, K$^+$K$^-$η, π$^+$π$^-$η, π$^+$π$^-$π^{0}π^0, 2(π$^+$π$^-$)η, 2(π$^+$π$^-$π^0),

~40% of η$_c$ decay

Observe
219.6 π^{0}π^{0}h$_c$

The Ecms = 4.23, 4.26, 4.36 GeV (~2.5fb^{-1})

7*. Observation of $Z_c^0(4020) \rightarrow \pi^0 h_c$ in $e^+e^- \rightarrow \pi^0\pi^0 h_c$

- The $\sigma(\pi^0\pi^0 h_c)$ is consistent to be half of $\sigma(\pi^+\pi^- h_c)$ within 2σ

  $\sigma(\pi^0\pi^0 h_c)/\sigma(\pi^+\pi^- h_c) = 0.63 \pm 0.9$

- Narrow $\pi^\pm h_c$ structure observed
  - **M[$Z_c(4020)$] = 4023.3 $\pm$ 2.2 $\pm$ 3.8 MeV**
  - **Γ[$Z_c(4020)$] is fixed at 8 MeV**

- No significant evidence for $Z_c(3900) \rightarrow \pi^0 h_c$

- **Very likely the neutral isospin partner of the charged $Z_c(4020)$**
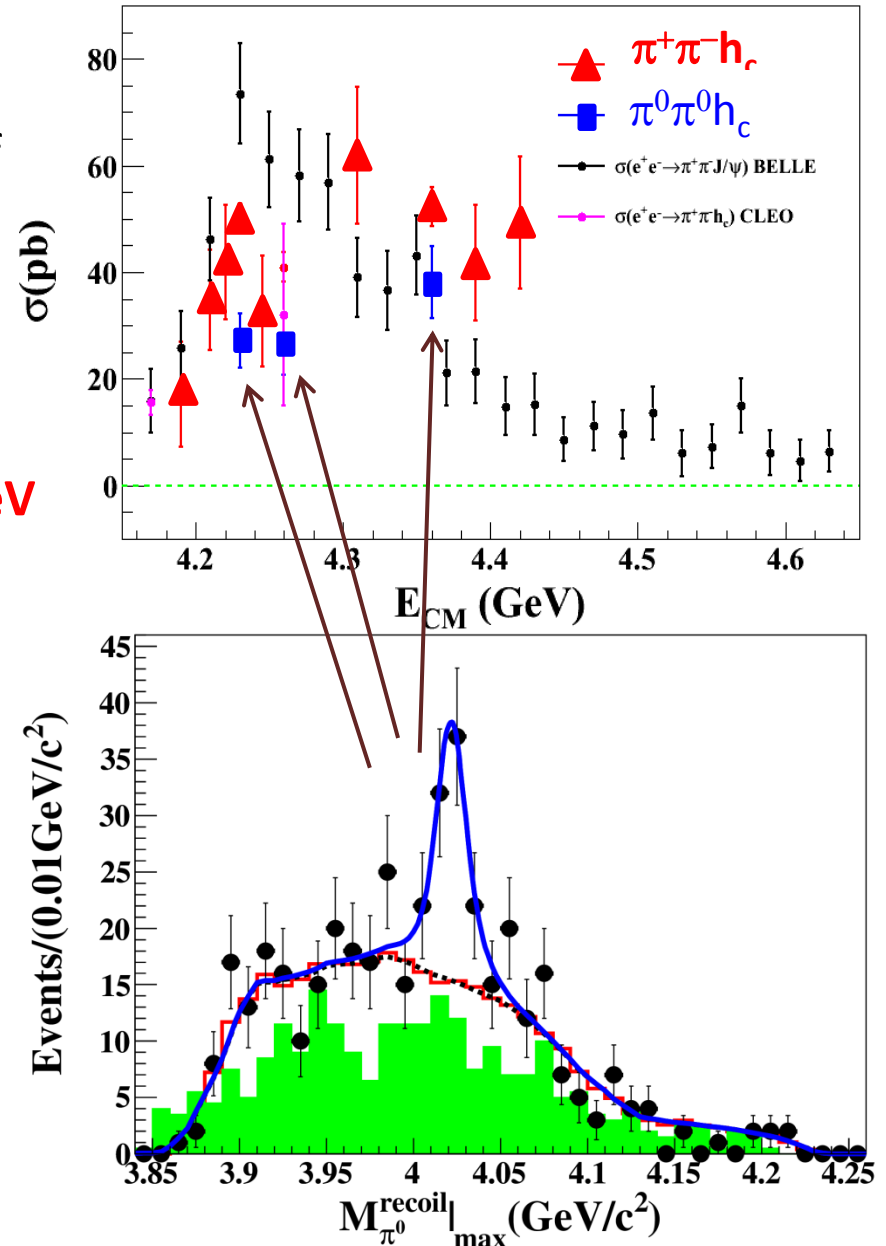
8*. Observation of $Z_c^{\pm}(4020) \to (D^*\overline{D}^*)^{\pm}$ in $e^+e^- \to \pi^{\pm}(D^*\overline{D}^*)^{\mp}$ at $\sqrt{s} = 4.26\,\text{GeV}$

Based on 827 pb^{-1} @ 4.26 GeV

- Deviation from phase space decay
  - Could be described by a charged state decaying to $D^*\overline{D}^*$

- M[$Z_c(4025)$] = 4026 $\pm$ 3 MeV
- Γ[$Z_c(4025)$] = 25 $\pm$ 6 MeV
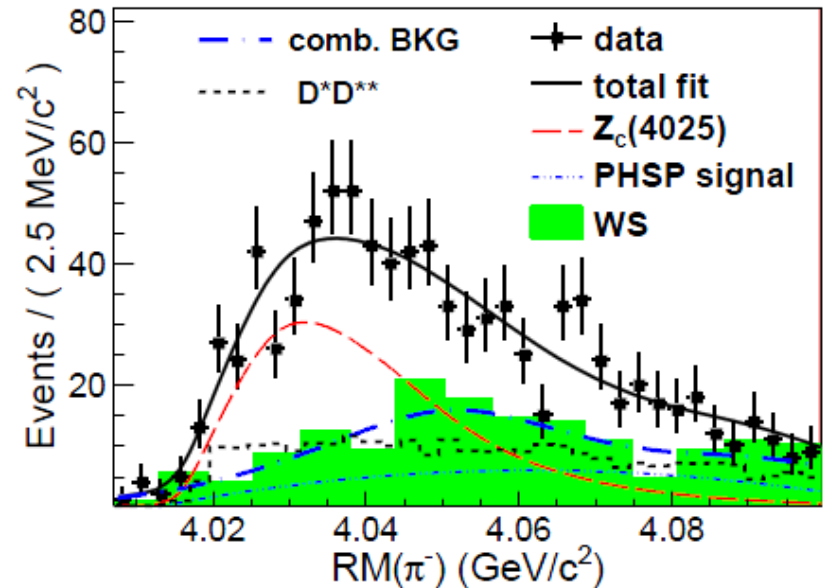
$\sigma[e^+e^- \to (D^*\overline{D}^*)^{\pm}\pi^{\mp}] = (137 \pm 9 \pm 15)$ pb @4.26 GeV

$\dfrac{\sigma[e^+e^- \to Z_c(4025)^{\pm}\pi^{\mp} \to (D^*\overline{D}^*)^{\pm}\pi^{\mp}]}{\sigma[e^+e^- \to (D^*\overline{D}^*)^{\pm}\pi^{\mp}]} = (65 \pm 9 \pm 6)\%$ @4.26GeV

- If $Z_c(4025)^{\pm}$ is the $Z_c(4020)$, $\dfrac{\Gamma(Zc(4020) \to D^*\overline{D}^*)}{\Gamma(Zc(4020) \to \pi h_c)} = 12 \pm 5$

9*.Observation of $Z_c(4025)^0$ in $e^+e^- \rightarrow (D^*\overline{D}^*)^0\pi^0$

Based on
1092pb-1 @ 4.23 & 826 pb-1 @ 4.26 GeV

arXiv:1507.02404

Double D tag analysis strategy:

Particle will be detected

Particle will not be detected

$m_{pole} = (4025.5^{+2,0}_{-4.7}\pm 3.1)$ MeV/c^2

$\Gamma_{pole} = (23.0\pm 6.0\pm 1.0)$ MeV

$\sigma[e^+e^- \rightarrow Z_c(3885)^0\pi^0 \rightarrow (D\overline{D}^*)^0 \pi^0]$

$= (61.6\pm 8.2\pm 9.0)$ pb @4.23 GeV

$\sigma[e^+e^- \rightarrow Z_c(3885)^0\pi^0 \rightarrow (D\overline{D}^*)^0 \pi^0]$

$= (43.4\pm 8.0\pm 5.4)$ pb @4.26 GeV

Another isospin triplet is established $Z_c(4025)^{\pm/0}$

No Z$_c$→ωπ signals found in e⁺e⁻ →ωπ π
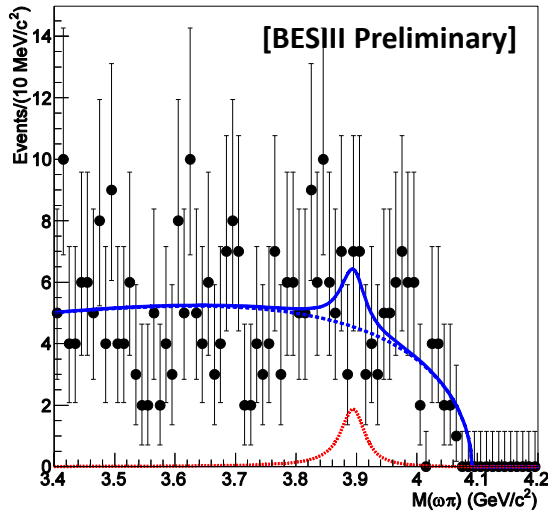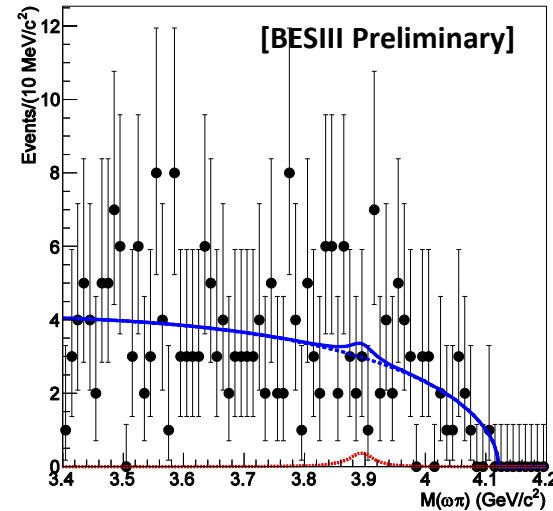
1094 pb⁻¹ @4230   827 pb⁻¹ @4260

- Fitting with acceptance weighted S-wave BW folded with Gaussian + ARGUS BGNo interference is considered

The non-observation of Zc →ω π (a typical decay mode of a 1⁺ resonance) may indicate that the annihilation of ccbar in Zc is suppressed.

Charged Z_c^+ charmonium-like state is smoking guns for exotic state with at least four quarks.

Many proposals
- Hadronic molecules,
  arXiv:1303.6608, 1304.2882, 1304.1850

- Tetraquark states
  arXiv:1110.1333, 1303.6857
  arXiv:1304.0345, 1304.1301

- Meson loop (arXiv:1303.6355)

- ISPE model (arXiv:1303.6842)
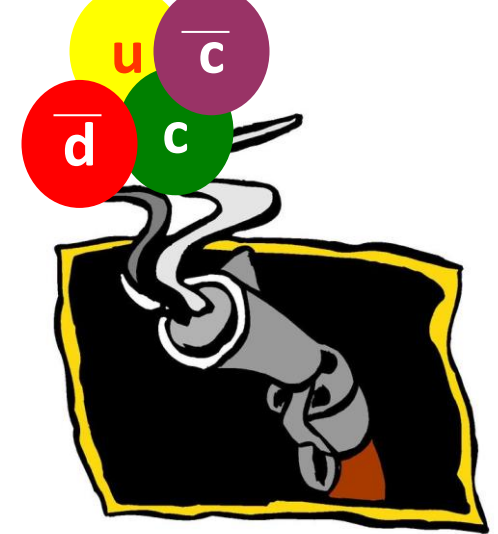
Smoking guns for 4-quark states

tetraquark

4 quarks

molecule

π

Exotic!

X
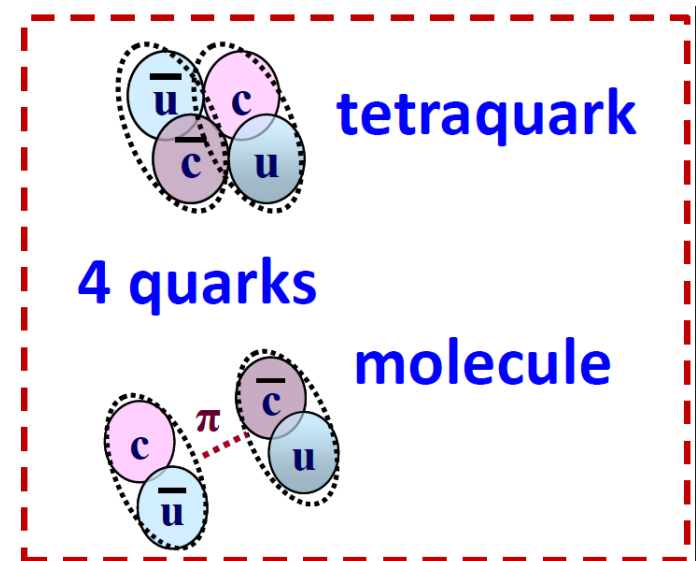
Y(4260)→ γX(3872)   RPL,112,092001

Γ_{ee} **X(3872)**   PLB,749,414

X(3823) ($\psi(1^3D_2)$)   PRL,115,011803

e⁺e⁻ → γX(3872)

- Search for $\gamma X(3872)$ with $X(3872) \rightarrow \pi\pi J/\psi$ at E_{cm}=4.23, 4.26 and 4.36 GeV

- Summed over all data X(3872) significance = 6.3 σ
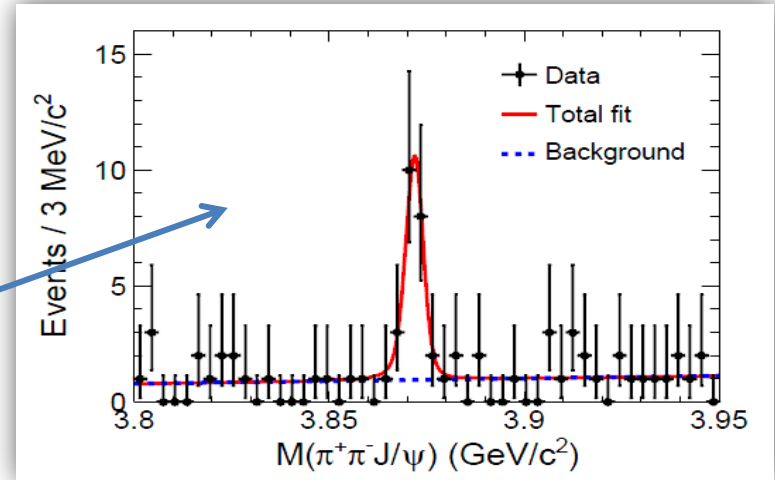
- Production in Y(4260) decay suggestive, but not conclusive

- If from Y(4260)

$$\frac{B(Y(4260)\rightarrow \gamma X(3872))}{B(Y(4260)\rightarrow \pi^+\pi^- J/\psi)} \approx 0.1$$
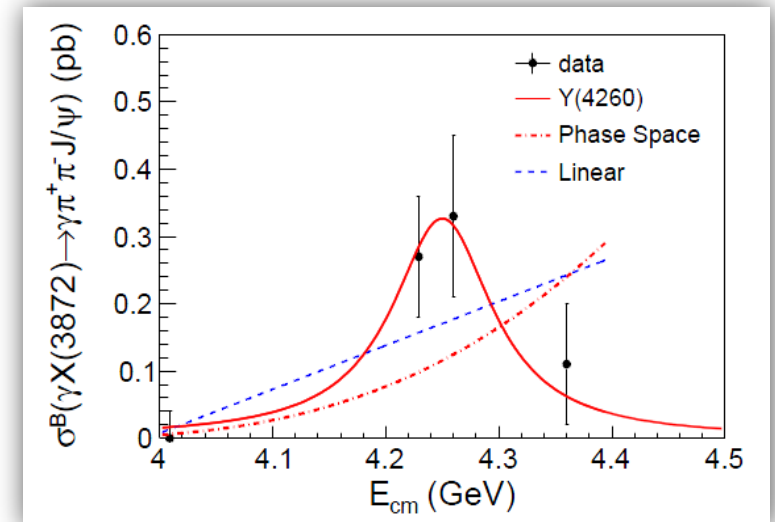
Electronic width $\Gamma_{ee}^{X(3872)}$ via $e^+e^- \to \gamma_{ISR} X(3872) \to \gamma_{ISR}\pi\pi J/\psi$

482pb^{-1}
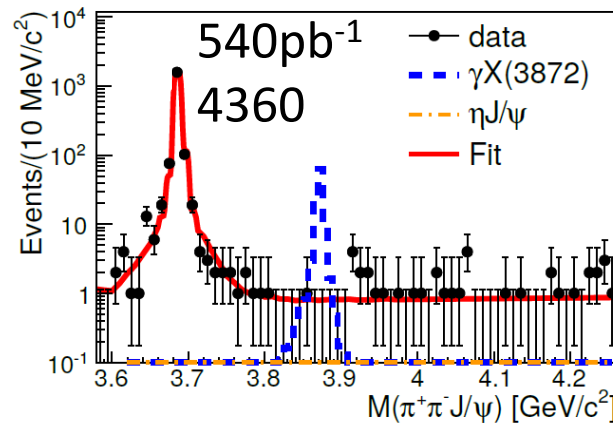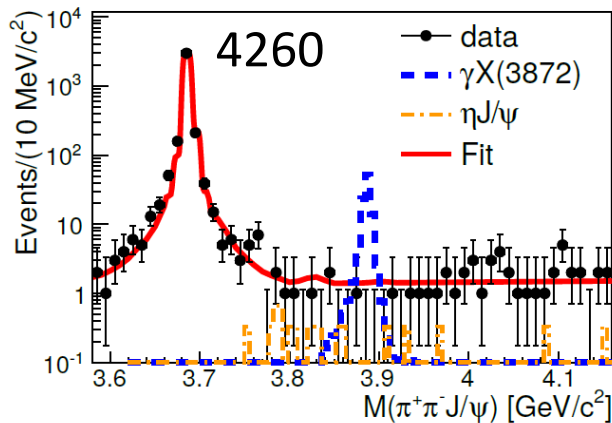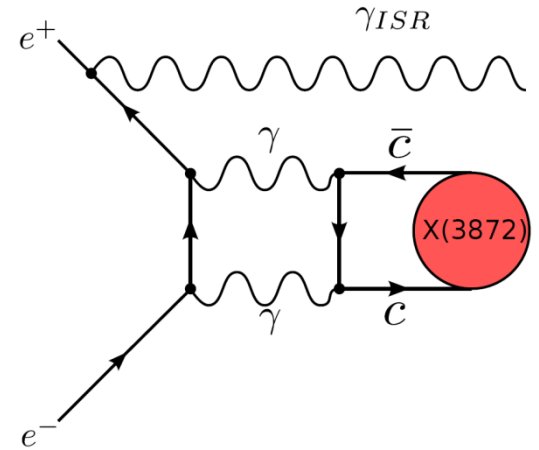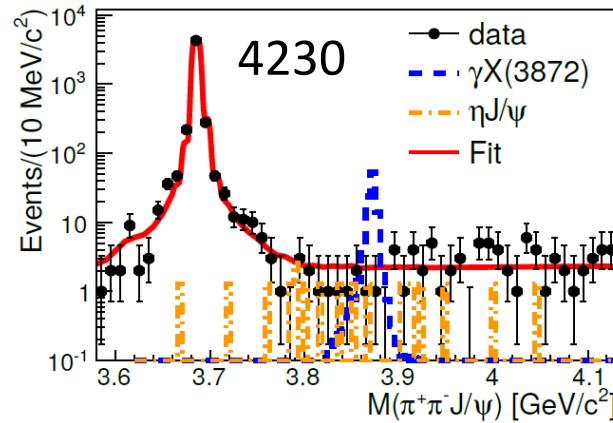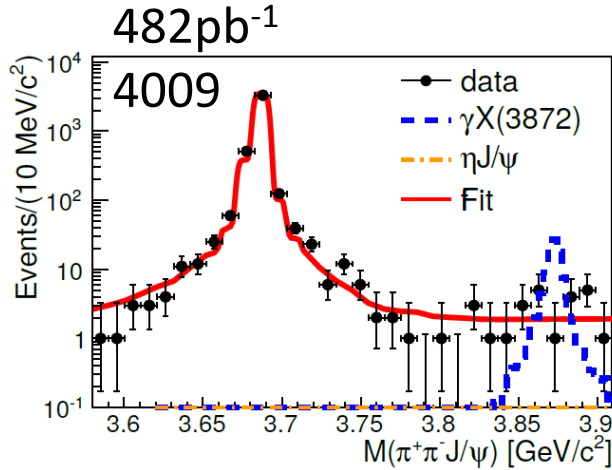
Using the γ_{ISR} untagged method

$|\cos\theta_{ISR}| > 0.95$ to remove $Y(4260) \to \gamma X(3872)$

With X(3872)$\to\pi\pi J/\psi$ >3%
$\Gamma_{ee}(3872) < 4.3$eV

PLB,749, 414

$e^+e^- \to \pi^+\pi^- X, X \to \gamma\chi_{cJ}, \chi_{cJ} \to \gamma J/\psi$
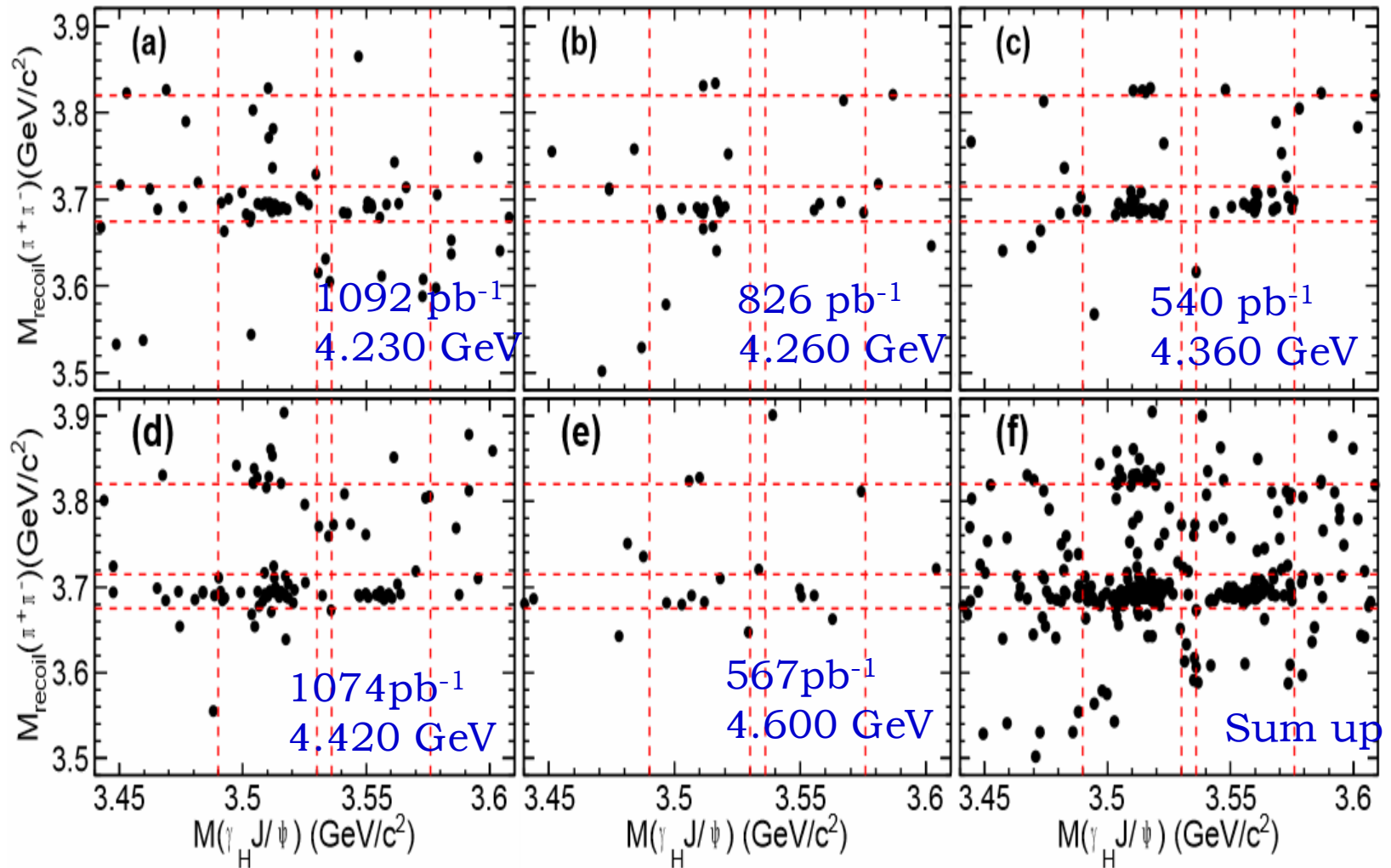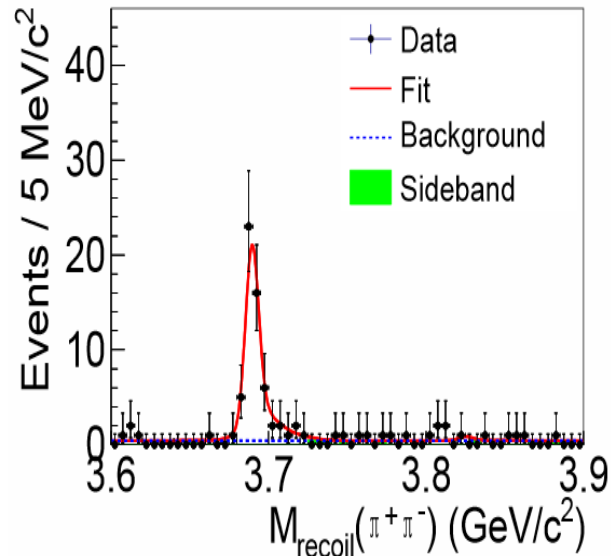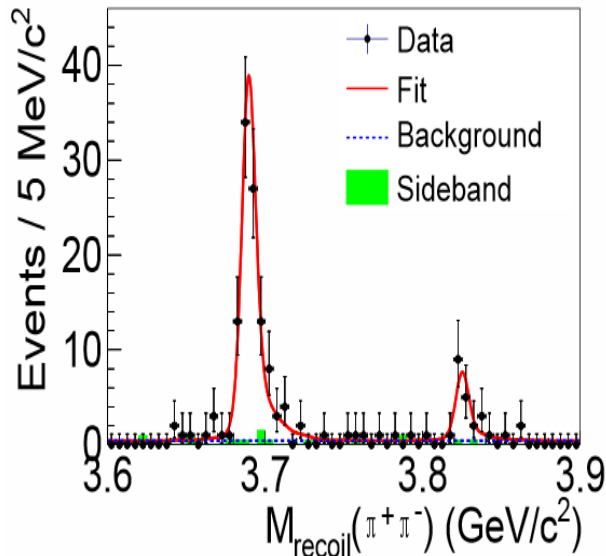
Simultaneous fit of $\gamma\chi_{c1}$ (left) and $\gamma\chi_{c2}$ (right) events

$M(X(3823)) = (3821.7 \pm 1.3(stat) \pm 0.7(syst))$ MeV/c^2

$\Gamma(X(3823)) < 16$ MeV at 90% C. L. consist with Belle
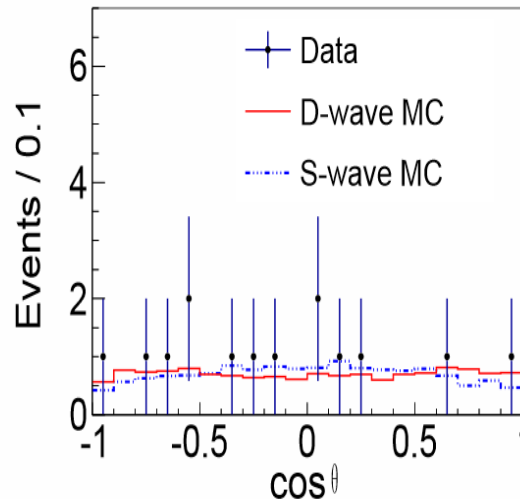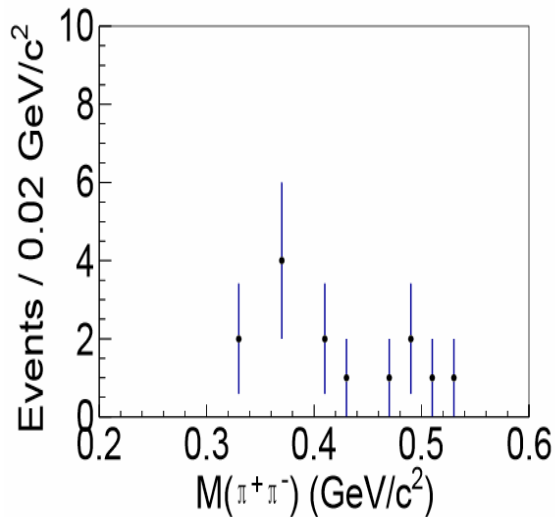
D-wave is expected. Limited statistics limited informations

X-section $\sigma[e^+e^- \rightarrow \pi^+\pi^- X(3823)] \cdot \mathcal{B}(X(3823) \rightarrow \gamma\chi_{c1})$

$$\frac{\sigma[e^+e^- \rightarrow \pi^+\pi^- X(3823)] \cdot \mathcal{B}(X(3823) \rightarrow \gamma\chi_{c1})}{\sigma[e^+e^- \rightarrow \pi^+\pi^- \psi'] \cdot \mathcal{B}(\psi' \rightarrow \gamma\chi_{c1})}$$

$= 0.20^{+0.13}_{-0.10}$ (4.36 GeV)
$= 0.39^{+0.21}_{-0.17}$ (4.42 GeV)

$$\frac{\mathcal{B}(X(3823) \rightarrow \gamma\chi_{c2})}{\mathcal{B}(X(3823) \rightarrow \gamma\chi_{c1})}$$
< 0.42 at 90% C.L.

≈ 0.24 (PRD 55,4001)
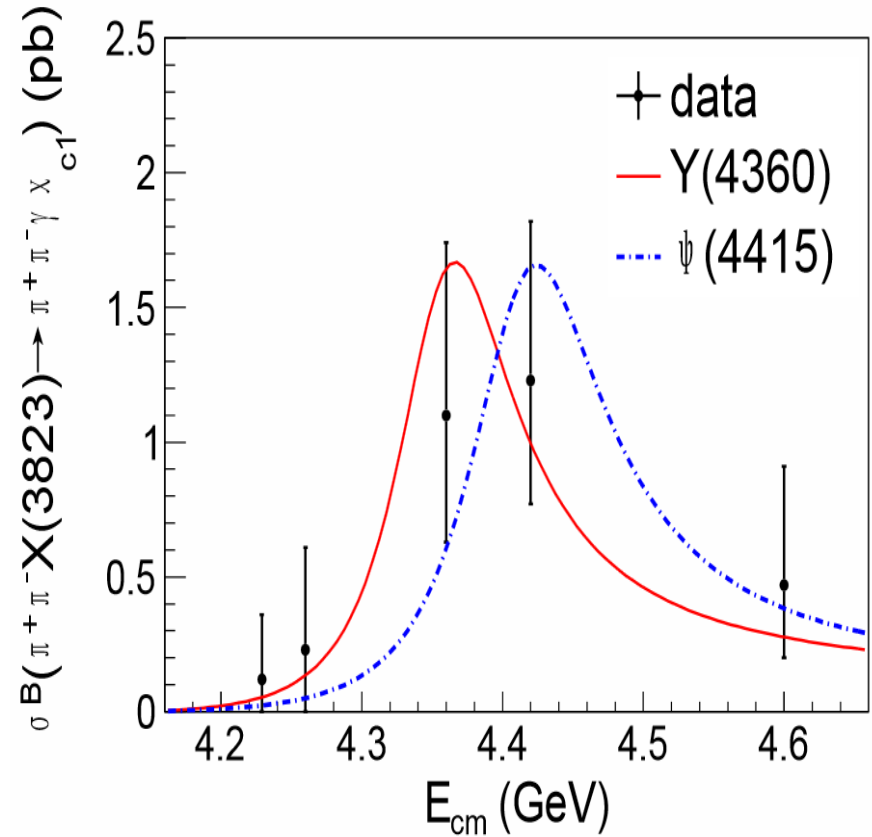
It agrees with the expectations for the $\psi(1^3D_2))$ state.

Υ

1. $e^+e^- \rightarrow \omega\chi_{c0}$ PRL,114,092003
2. $e^+e^- \rightarrow \eta J/\psi$ PRD91,11, 112005
3. $e^+e^- \rightarrow \eta'J/\psi$ preliminary
4. Search for Y(4140)$\rightarrow\phi J/\psi$ PRD 92,032002
5. $e^+e^- \rightarrow \gamma \chi_{cJ}$ at $\sqrt{s} > 4\text{GeV}$ CPC, 39(4) (2015) 041001
6. Search for the isospin violating decay
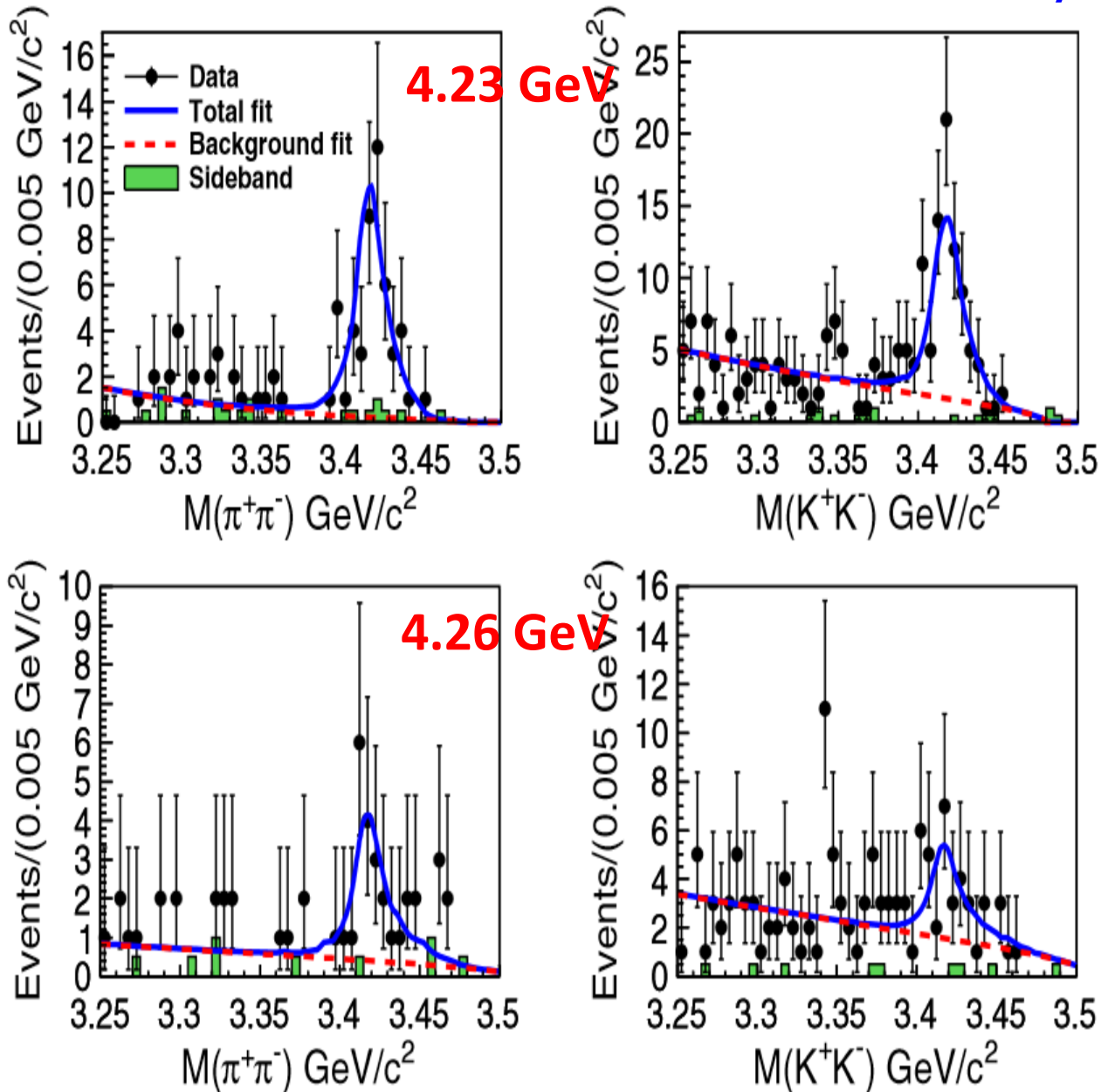   Y(4260)$\rightarrow$J/$\psi\eta\pi^0$ PRD92,1, 012008

1. Study of $\omega\chi_{c0}$ from 4.21 to 4.42 GeV
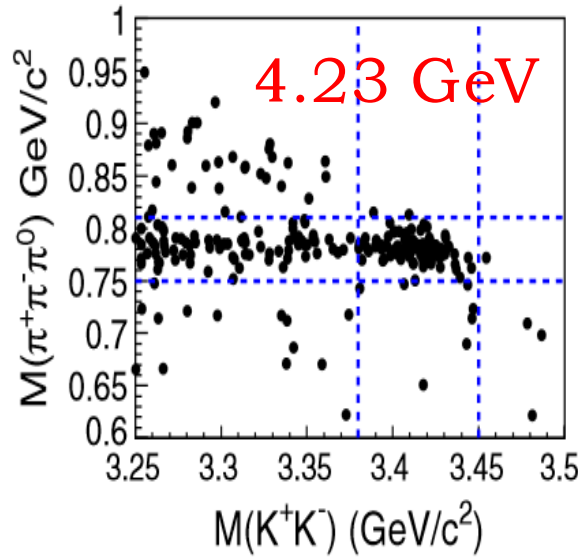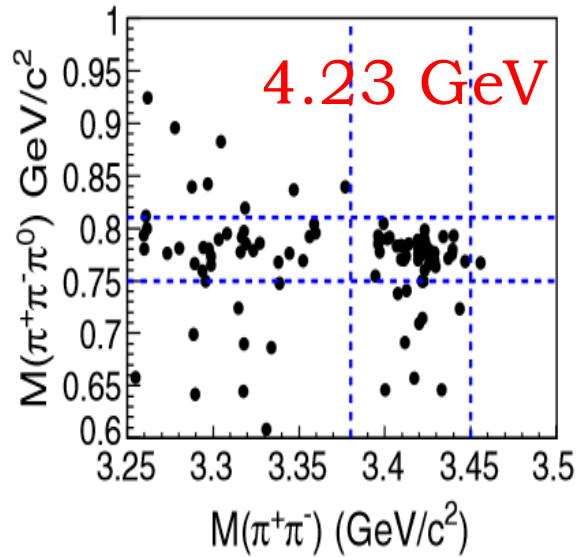
$$\omega \to \pi^+\pi^-\pi^0$$
$$\chi_{c0} \to K^+K^-/\pi^+\pi^-$$
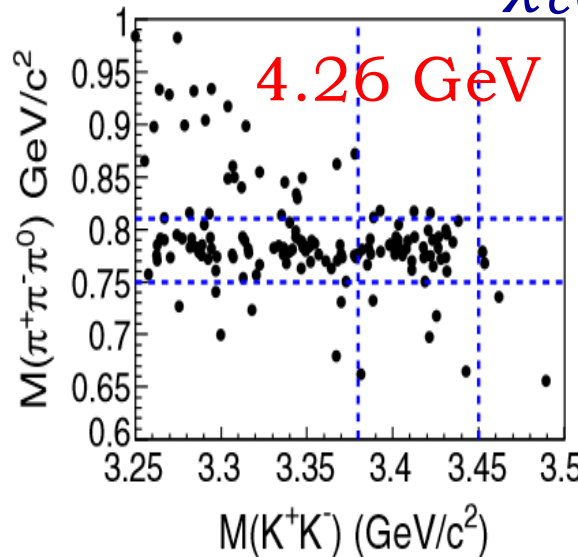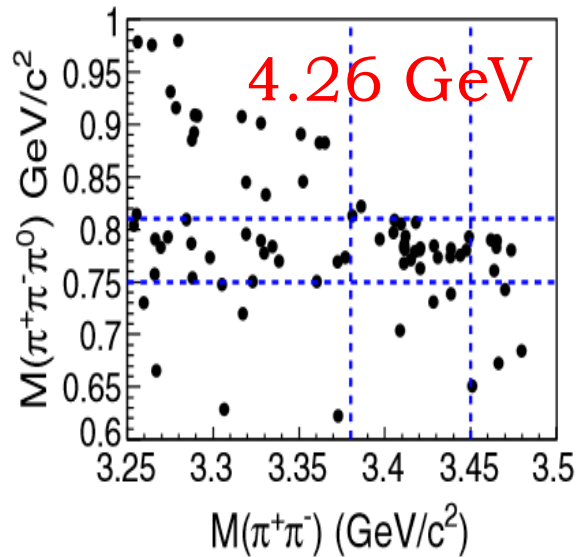
Simultaneous unbinned LH fit to $\pi^+\pi^-/K^+K^-$

Fit to $\sigma(e^+e^- \to \omega\chi_{c0})$

Phase-space modified Breit-Wigner

$$\text{BW}(\sqrt{s}) = \frac{\Gamma_{ee}\mathcal{B}(\omega\chi_{c0})\Gamma_t}{(s-M^2)^2 + (M\Gamma_t)^2} \times \frac{\Phi(\sqrt{s})}{\Phi(M)}$$

with significance $> 9\sigma$

$\Gamma_{ee}\mathcal{B}(\omega\chi_{c0}) = (2.7 \pm 0.5)$ eV

$M(Y) = (4230 \pm 8)$ MeV/c^2

$\Gamma_t = (38 \pm 12)$ MeV

Not consistent with $Y(4260) \to \pi\pi J/\psi$
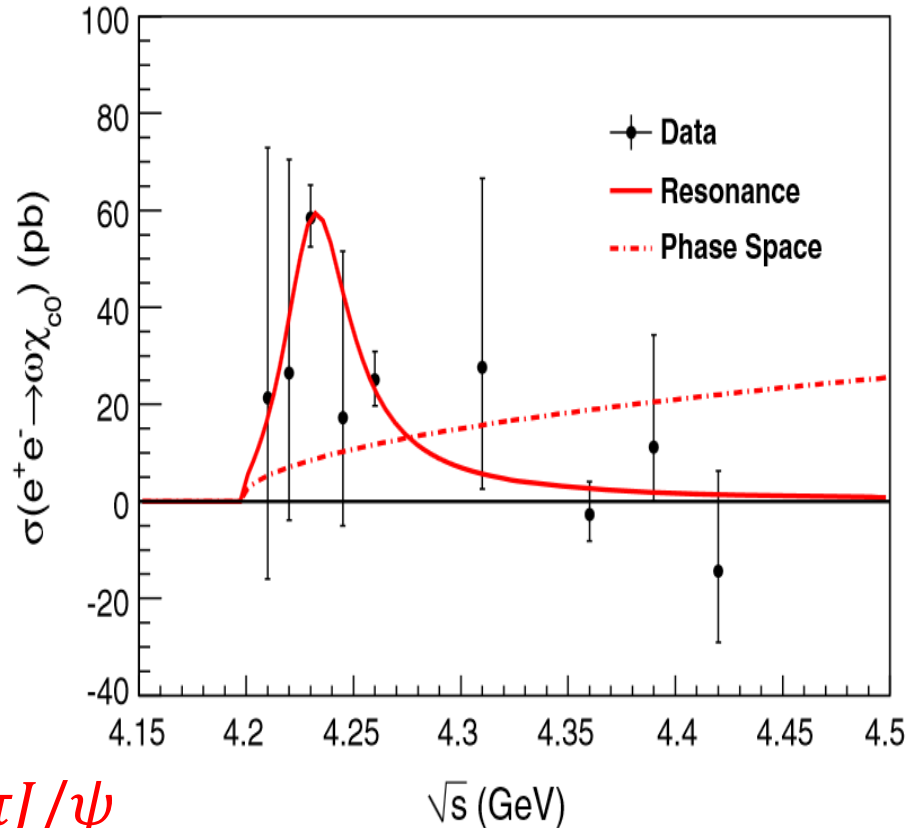
2. Cross section of $e^+e^- \to \eta J/\psi$

4.23 GeV

$\eta \to \gamma\gamma$
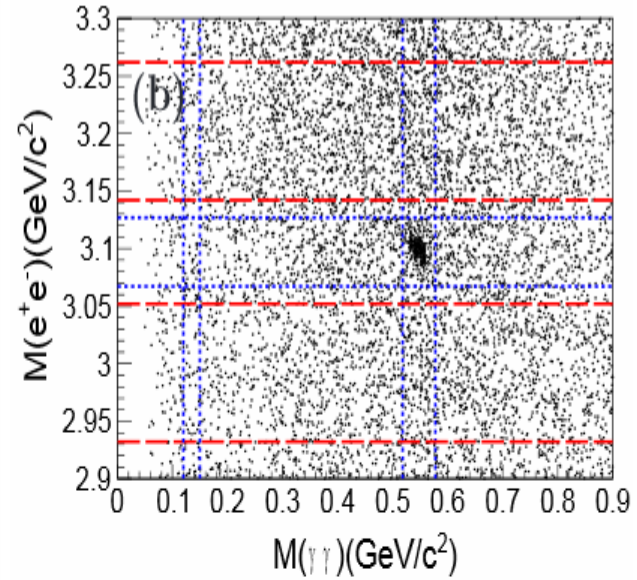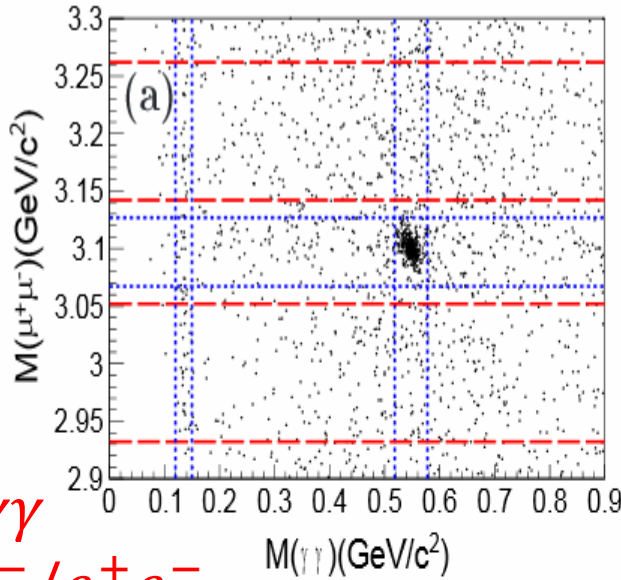
$J/\psi \to \mu^+\mu^-/e^+e^-$

4.26 GeV
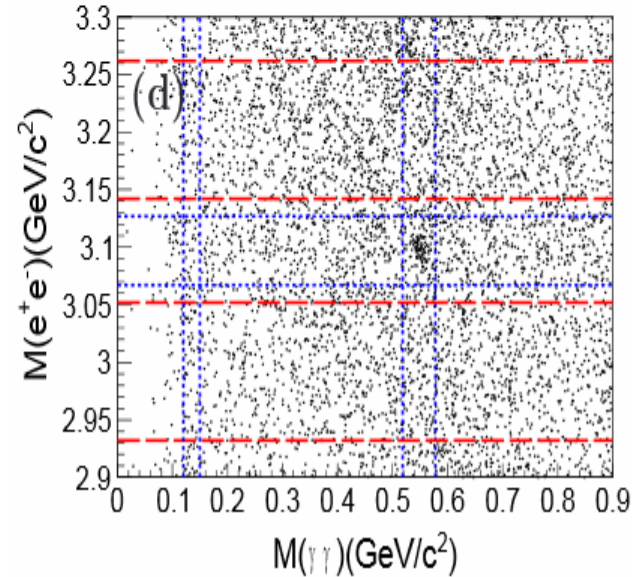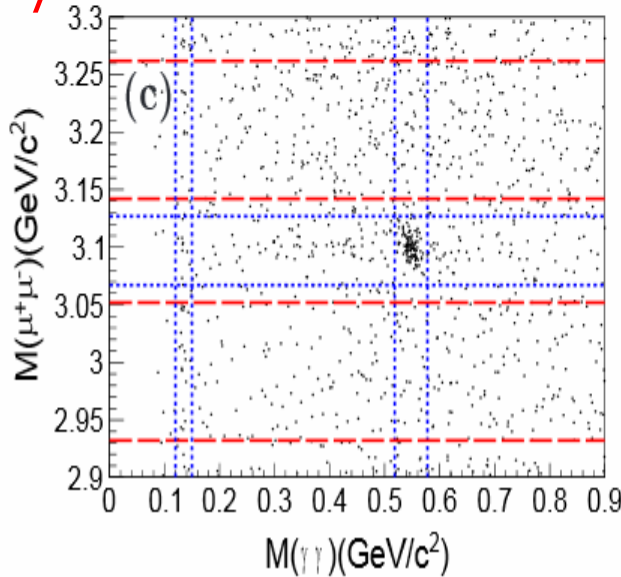
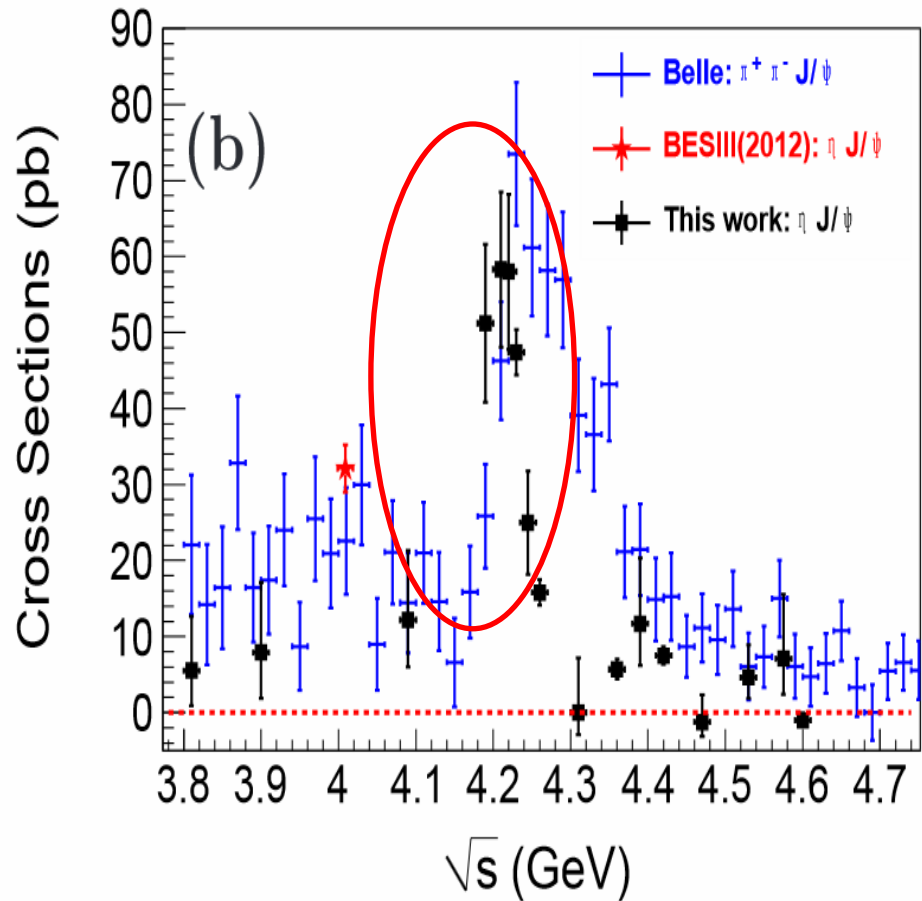$$e^+e^- \to \eta J/\psi$$
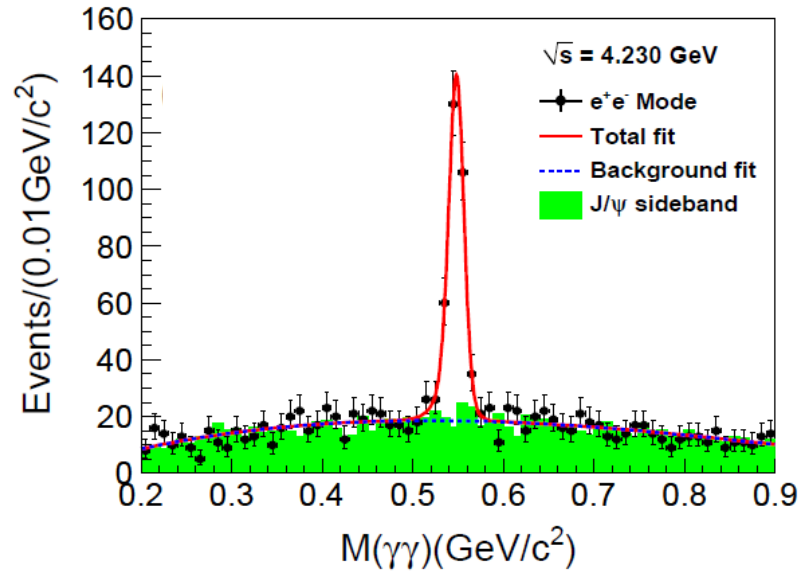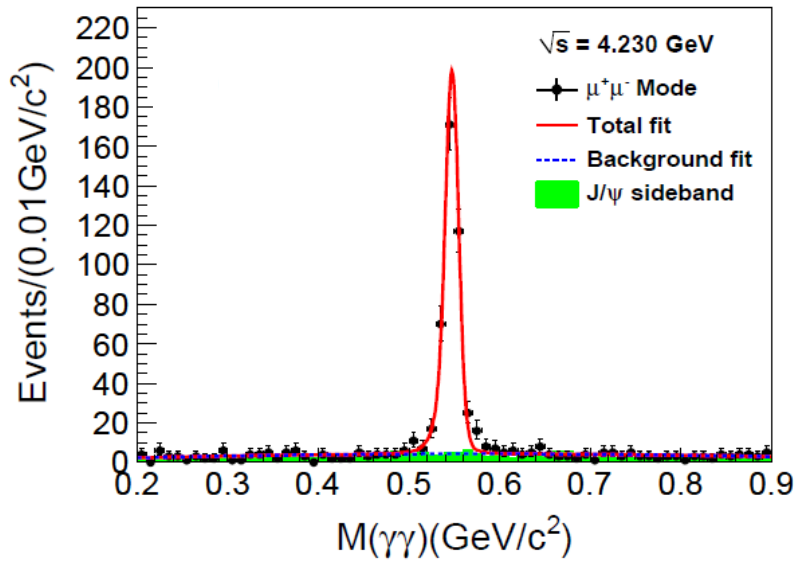
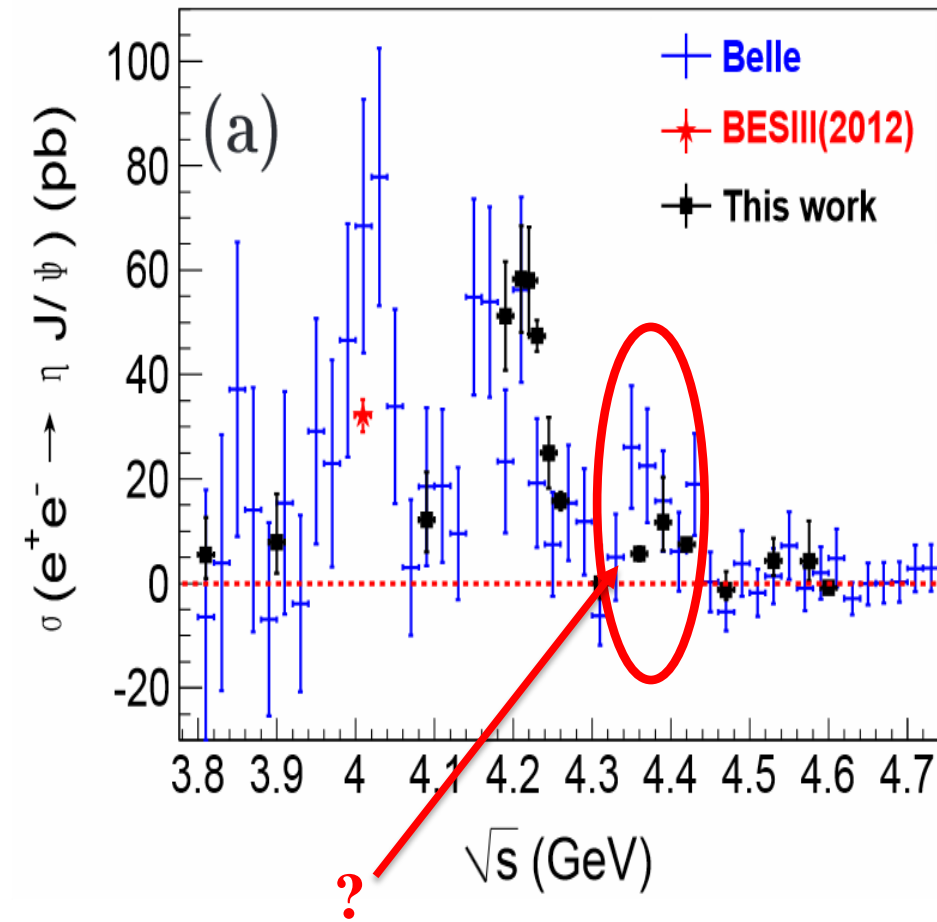$$e^+e^- \to \pi^0 J/\psi$$
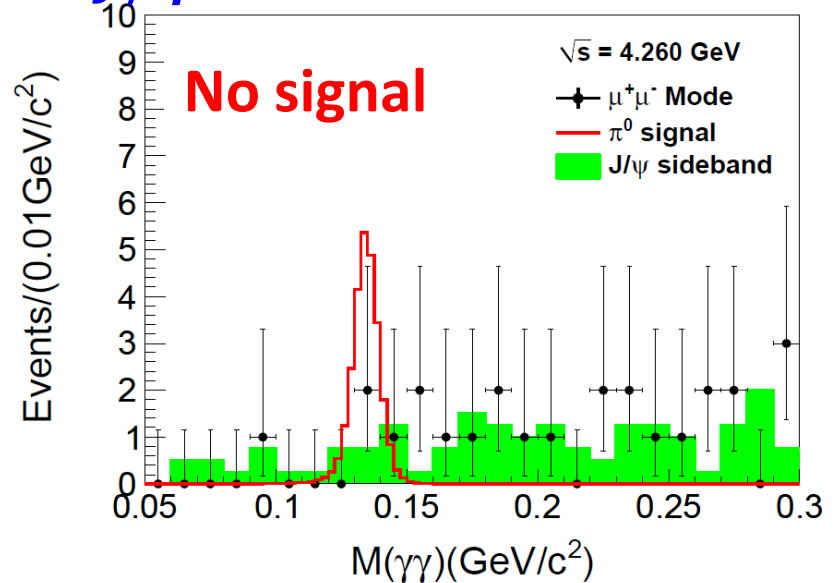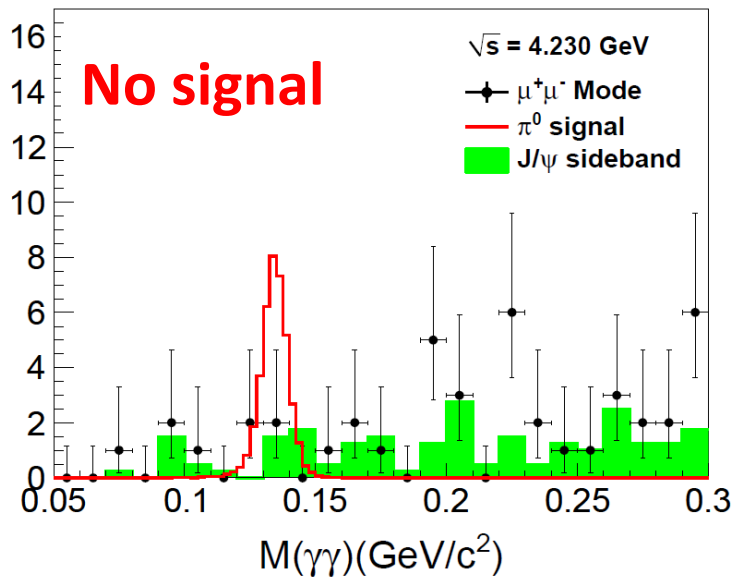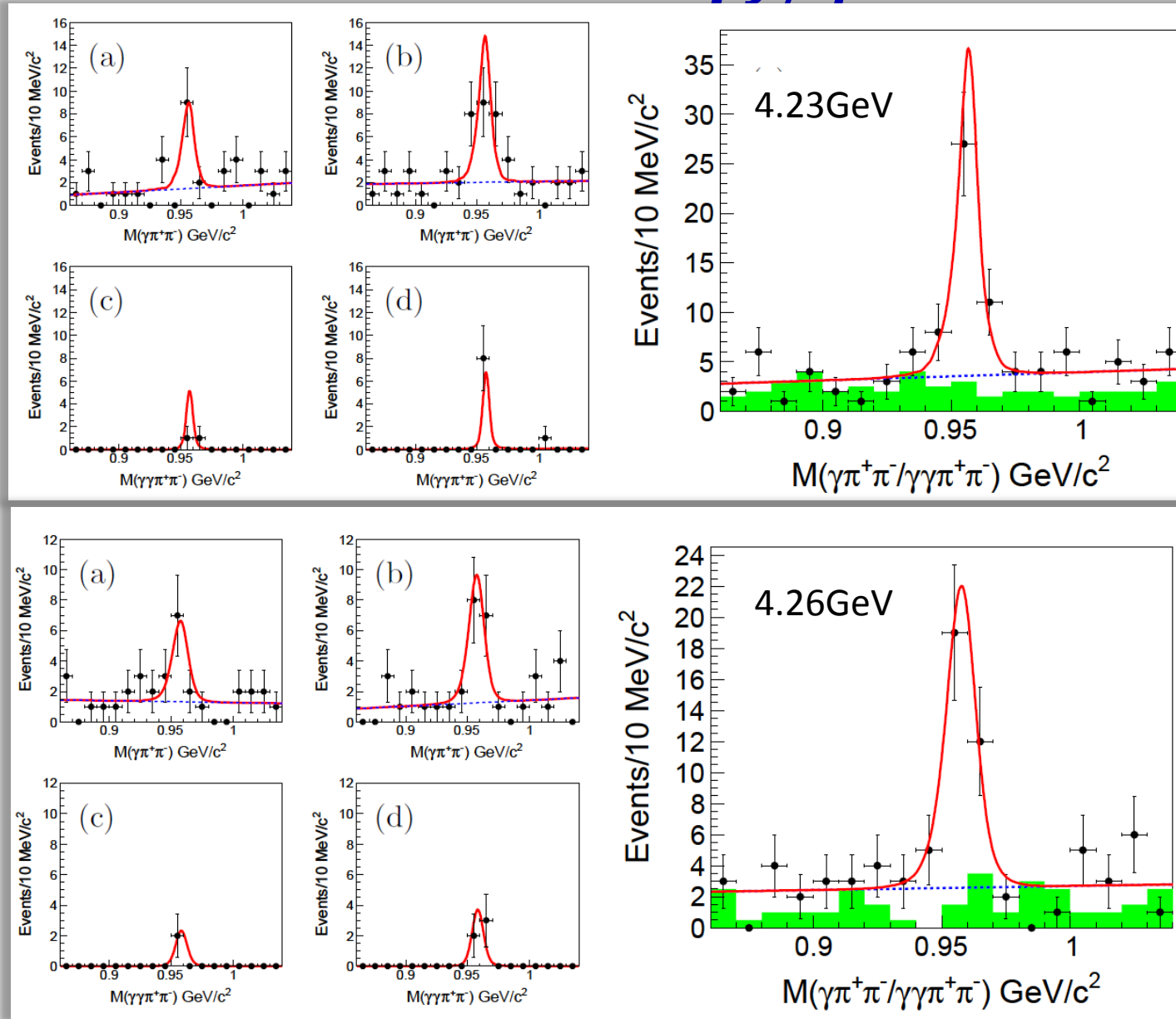
Born cross section of $e^+e^- \to \eta J/\psi$
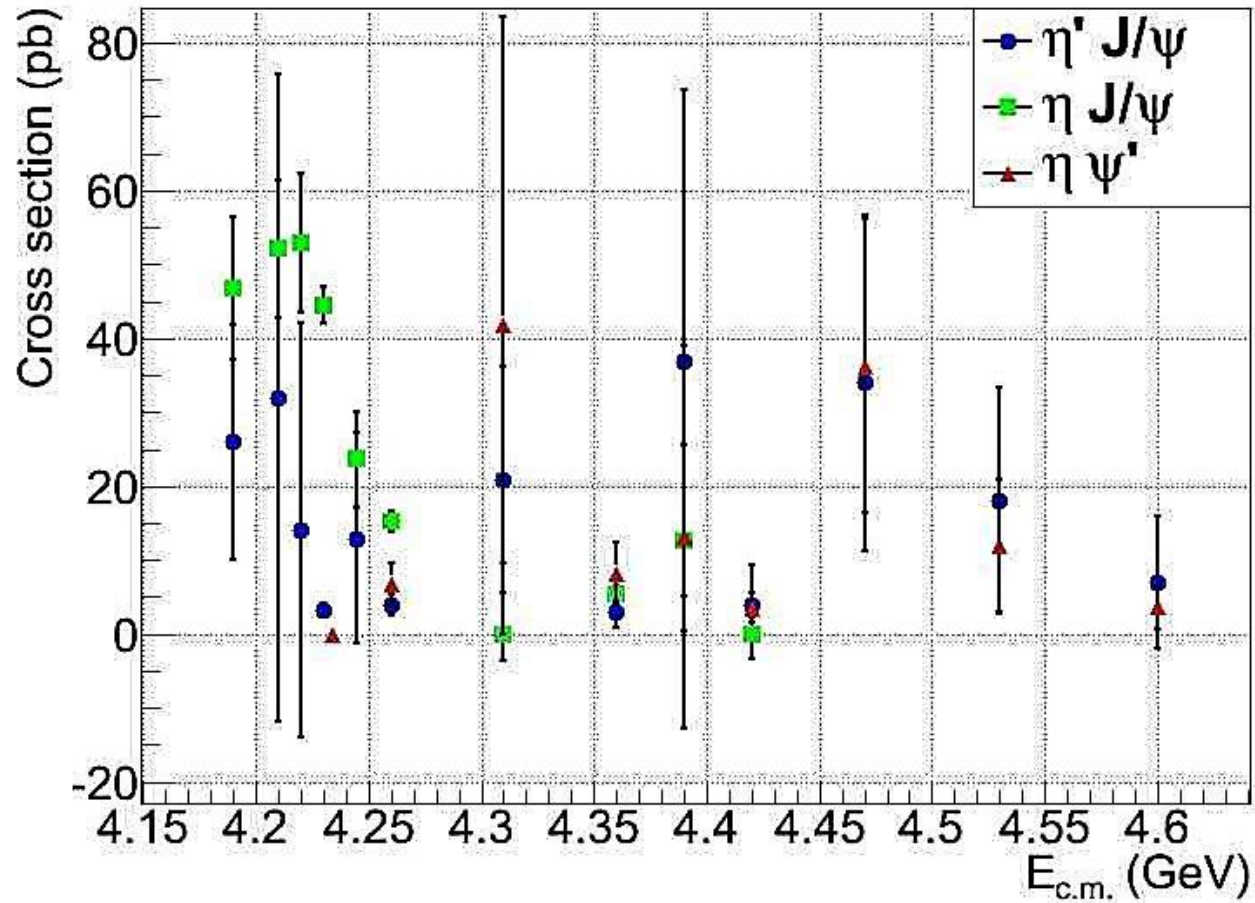
3. Cross section of $e^+e^- \to \eta' J/\psi$

Simultaneous fit to $\eta' \to \gamma\pi^+\pi^-/\eta\pi^+\pi^-, J/\psi \to \mu^+\mu^-/e^+e^-$

The cross-section

4. Search for Y(4140)→ϕ J/ψ

e+e- → γ ϕ J/ψ; $J/\psi \to e^+e^-/\mu^+\mu^-$

1. $\phi \to K^+K^-$
   Partial reconstruction, only require one K

2. $\phi \to K_S K_L$
   Partial reconstruction, only require K_S; the K_L not reconstructed.

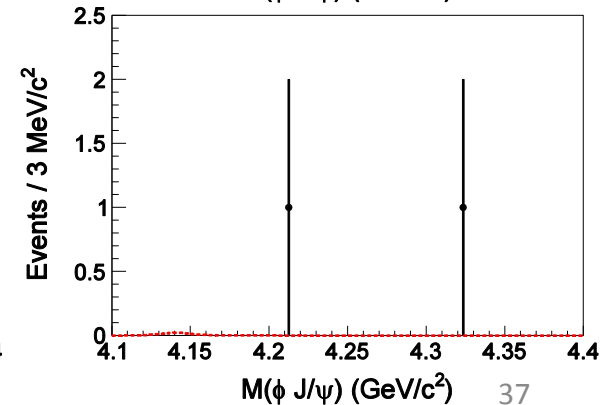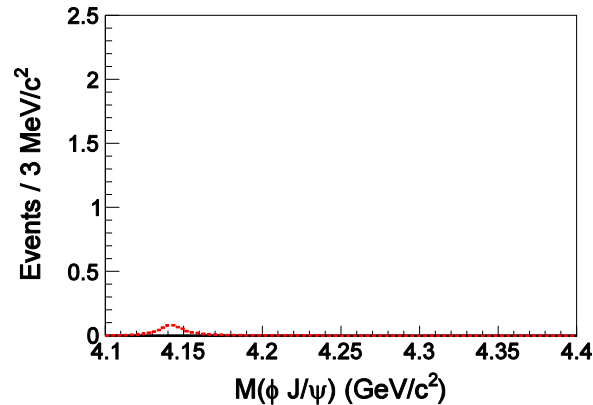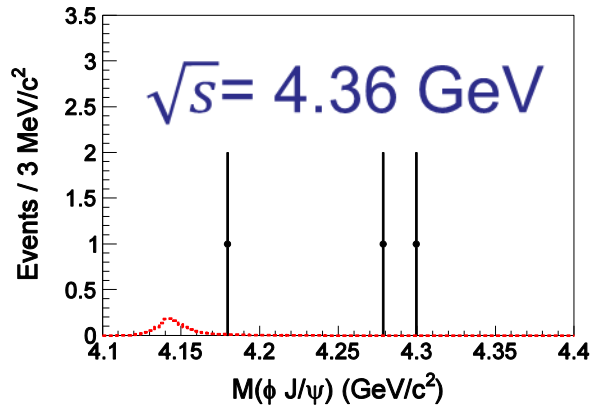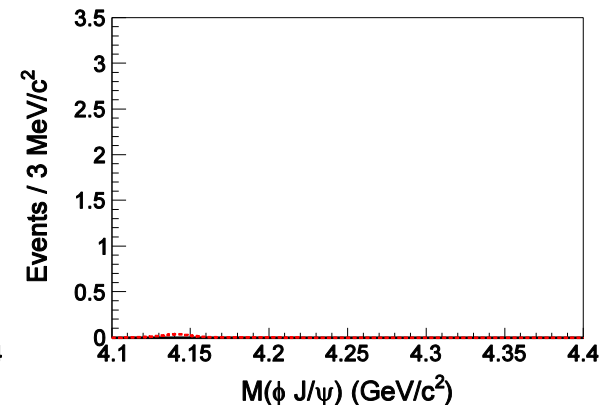3. $\phi \to \pi^+\pi^-\pi^0$
   Full reconstruction.

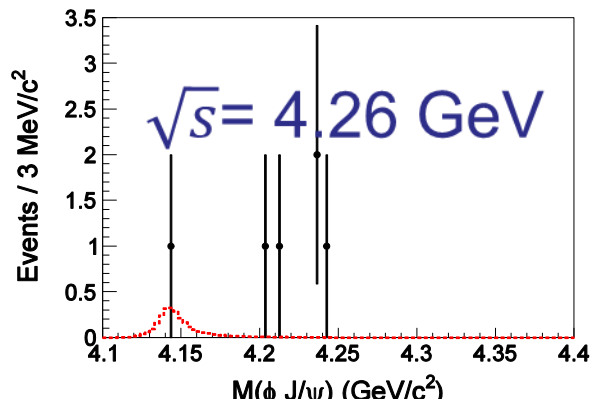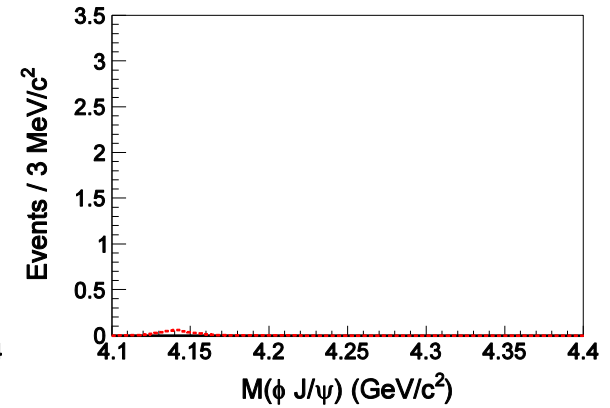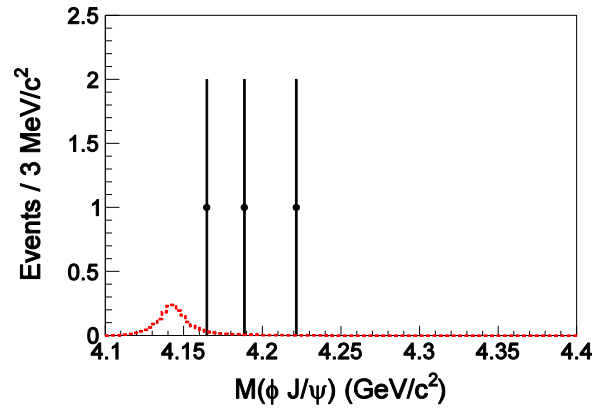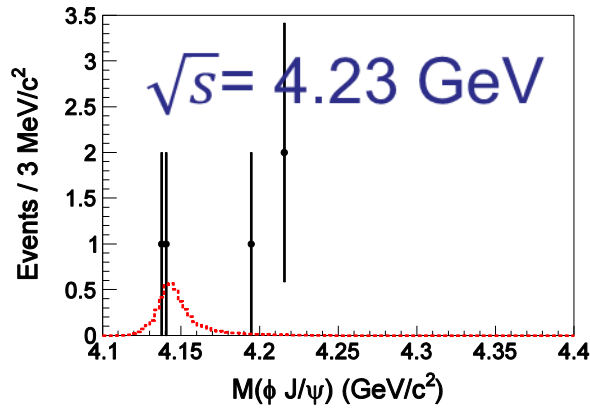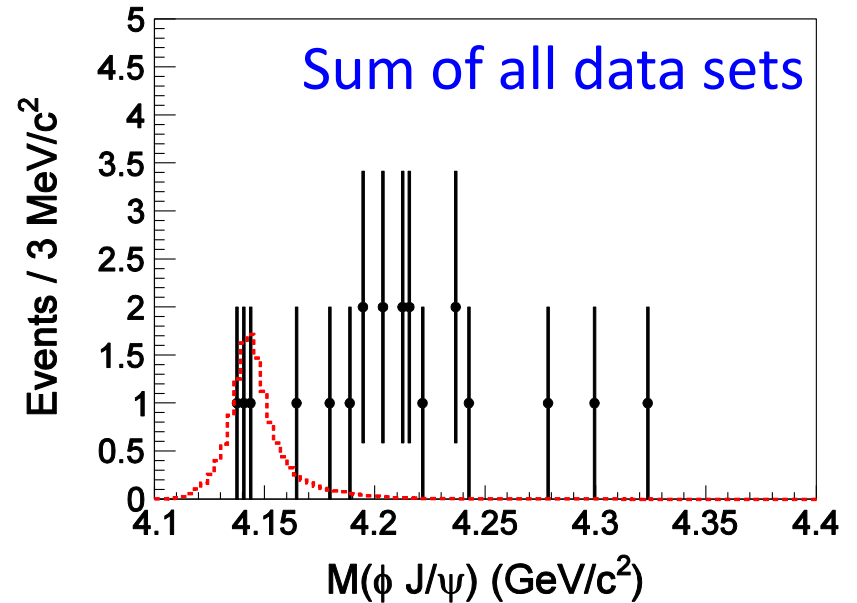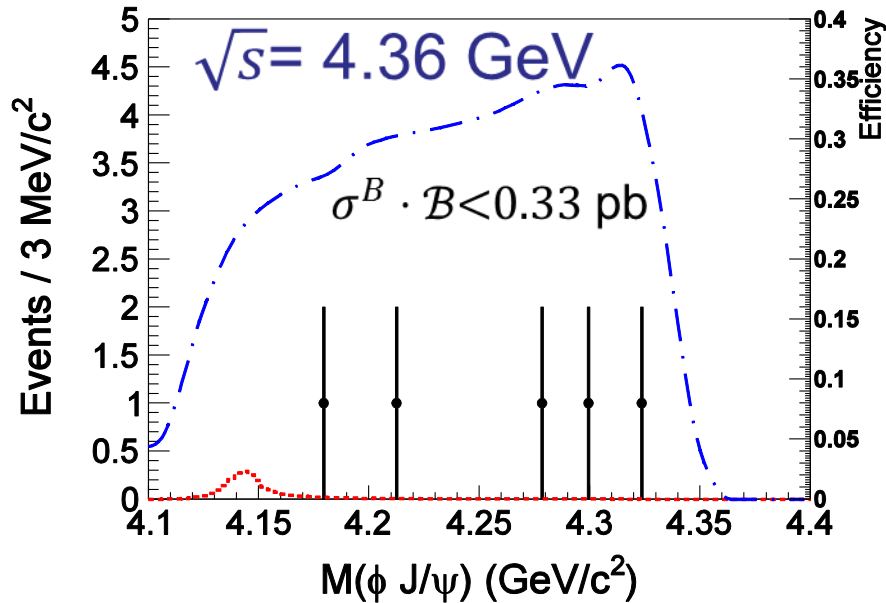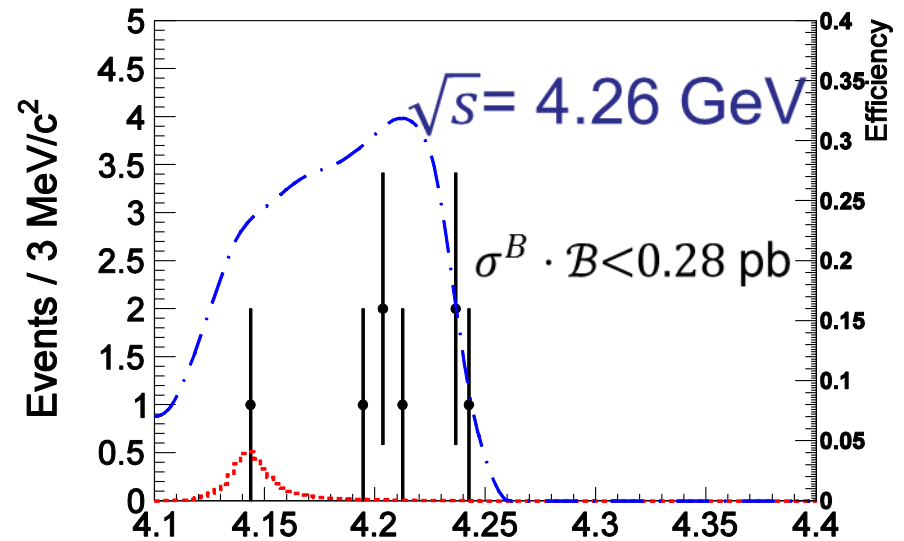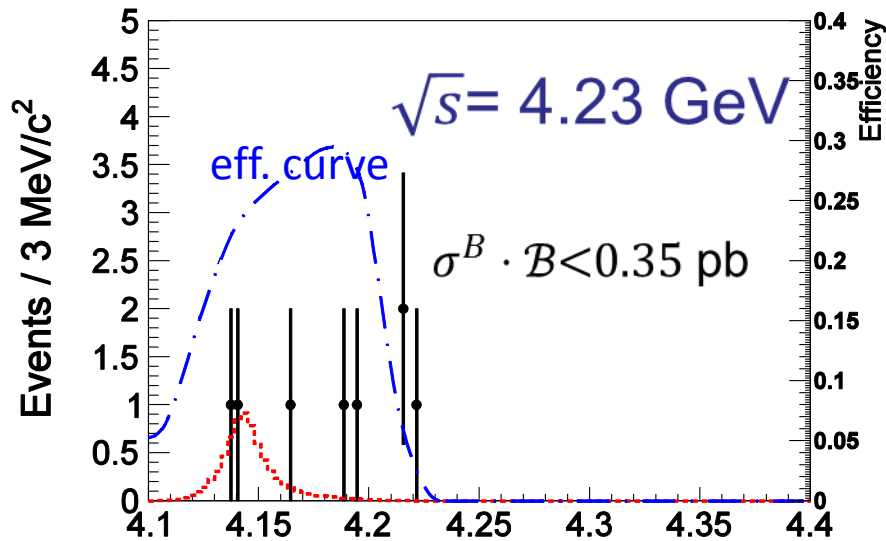$\phi \rightarrow K^+K^-$ $\phi \rightarrow K^0_S K^0_L$ $\phi \rightarrow \pi^+\pi^-\pi^0$

$\sqrt{s}$= 4.23 GeV

$\sqrt{s}$= 4.26 GeV

$\sqrt{s}$= 4.36 GeV

37
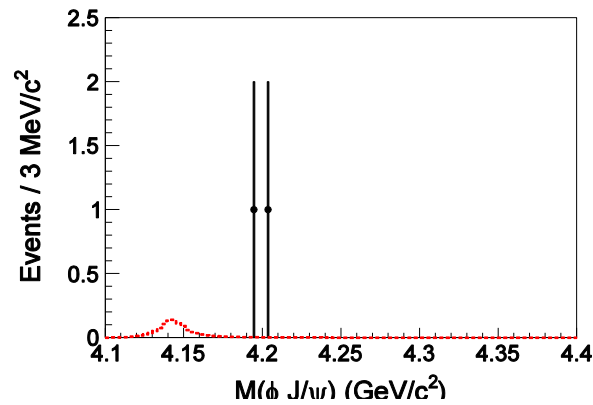
Combine 6 modes (3 ϕ modes $\otimes$ 2 J/ψ modes)

No Y(4140) signal found @ BESIII

Set upper limit at the 90% CL. for
$$\sigma^B \times \mathcal{B} = \sigma^B(e^+e^- \to \gamma Y(4140)) \times \mathcal{B}(Y(4140) \to \phi J/\psi)$$

$\sqrt{s}$ (GeV/c^2)	Luminosity (pb^{-1})	$(1 + \delta)$	$\sigma^B \times \mathcal{B}$
4.23	1094	0.840	<0.35
4.26	827	0.847	<0.28
4.36	545	0.944	<0.33

Systematic error included

Compared with the X(3872) product ion
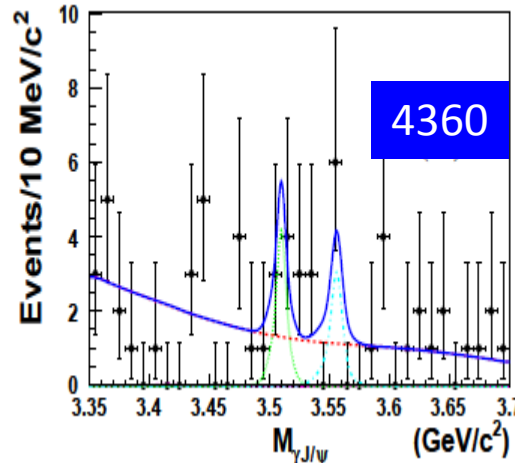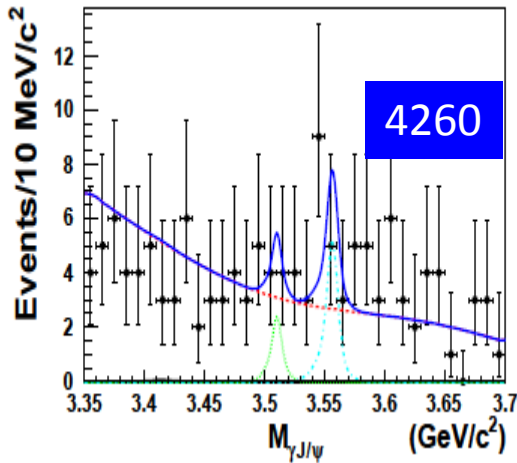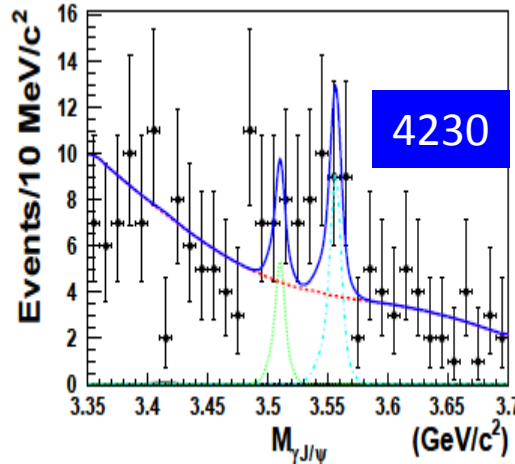$$\sigma^B(e^+e^- \to \gamma X(3872)) \times \mathcal{B}(X(3872) \to \pi^+\pi^- J/\psi)$$

Take $\mathcal{B}(X(3872) \to \pi^+\pi^- J/\psi)$ = 5%.   arXiv: 0910.3138

And $\mathcal{B}(Y(4140) \to \phi J/\psi)$ = 30%, molecular calculation,   PRD 80, 054019.

$$\frac{\sigma^B(e^+e^- \to \gamma Y(4140))}{\sigma(e^+e^- \to \gamma X(3872))} \le 0.1 \text{ at } \sqrt{s}=4.23 \text{ and } 4.26 \text{ GeV.}$$

5. Evidence for e⁺e⁻→γχ_cJ

fit to M(γJ/ψ)
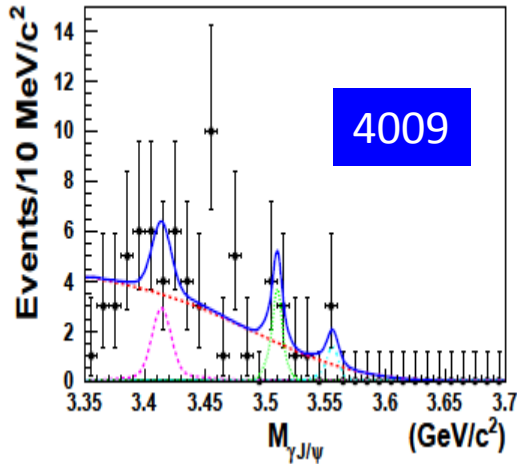
Signal: a double-Gaussian with shape parameters determined from MC at 4260 MeV

Background: radiative dimu MC shape

Data:

- limited statistics

- *is not consistent with being background*

$e^+e^- \rightarrow \gamma\chi_{cJ}$
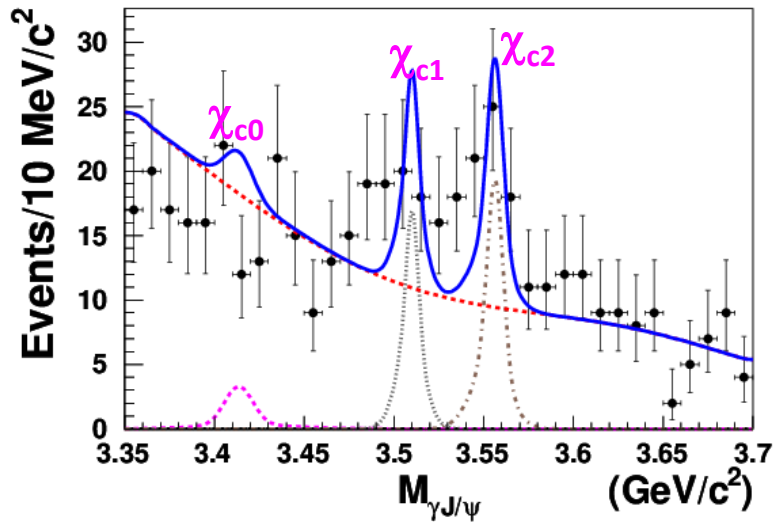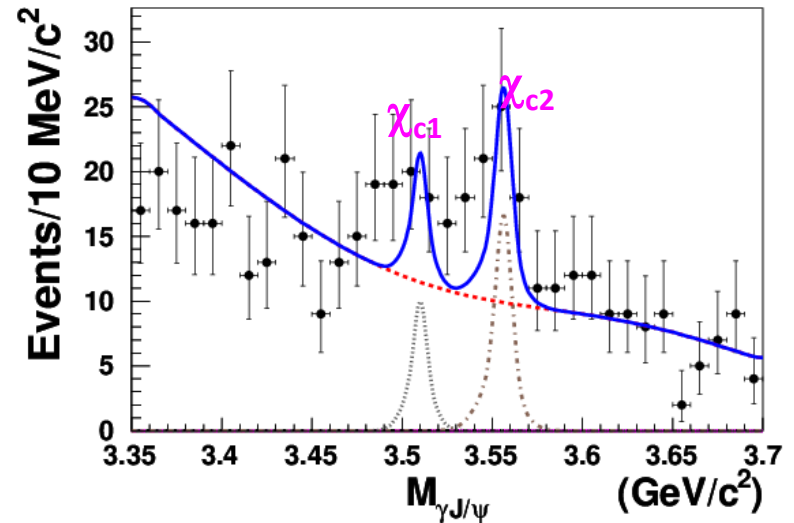
Fit to M(γJ/ψ) for _summing the events in the 4 CME points_

A simultaneous fit to M(γJ/ψ) at 4 CME points _with assuming the production $\sigma(e^+e^- \rightarrow \gamma\chi_{cJ})$ at different $\sqrt{s}$ follows the lineshape of Y(4260)_

the statistical significance is **1.2σ, 3.0σ, 3.4σ** _for_ χ_{c0}, χ_{c1}, χ_{c2} respectively.

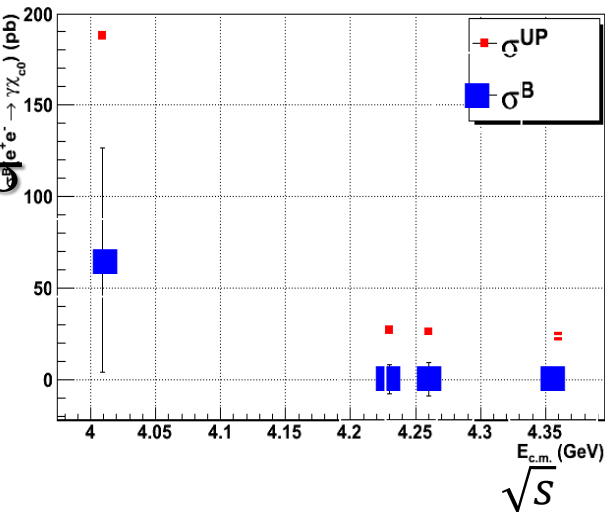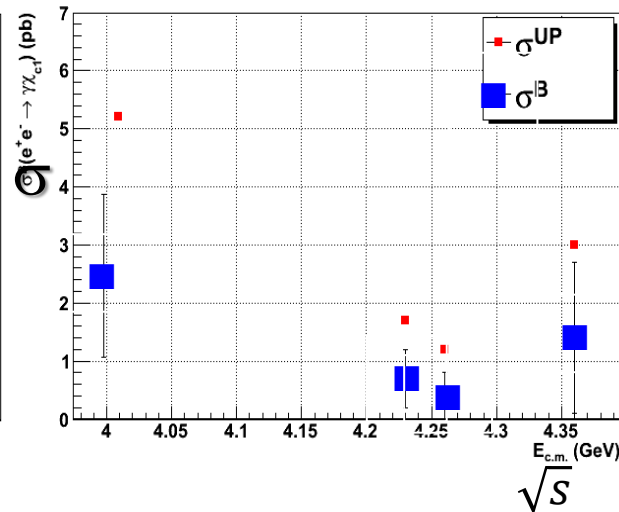the stat. significance is **0, 2.4, 4.0 σ** for χ_{c0}, χ_{c1}, χ_{c2} , respectively

The measured Born corss-section
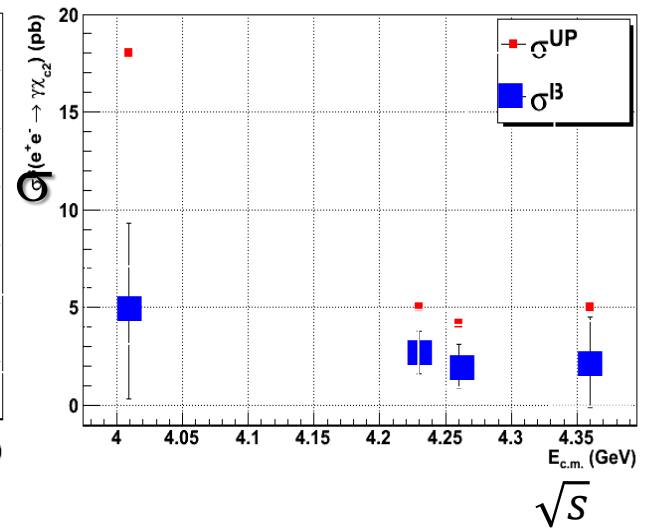## $\sigma(e^+e^- \rightarrow \gamma\chi_{cJ})$

$e^+e^- \rightarrow \gamma\chi_{c0}$

$e^+e^- \rightarrow \gamma\chi_{c1}$

$e^+e^- \rightarrow \gamma\chi_{c2}$

The upper limits on the cross section of $e+e- \rightarrow \gamma\chi_{cJ}$ are compatible with the theoretical predication.
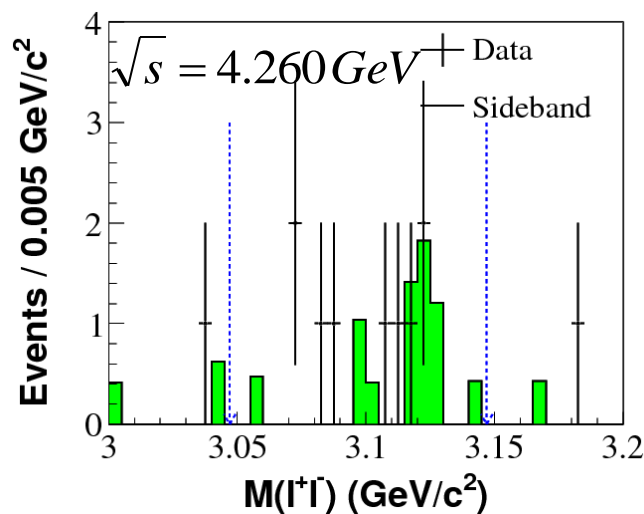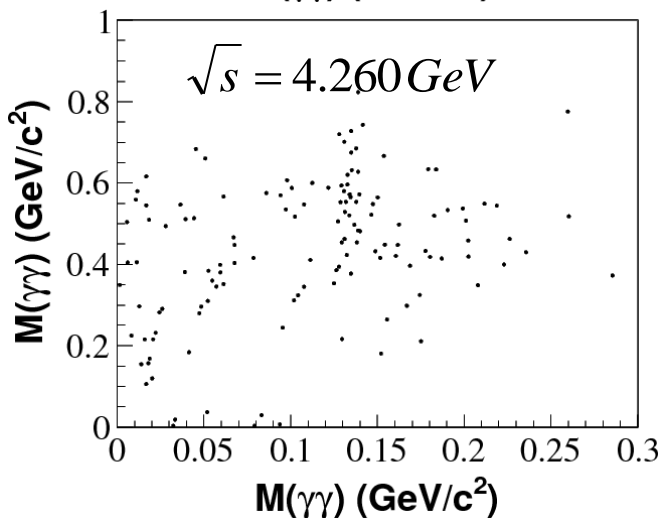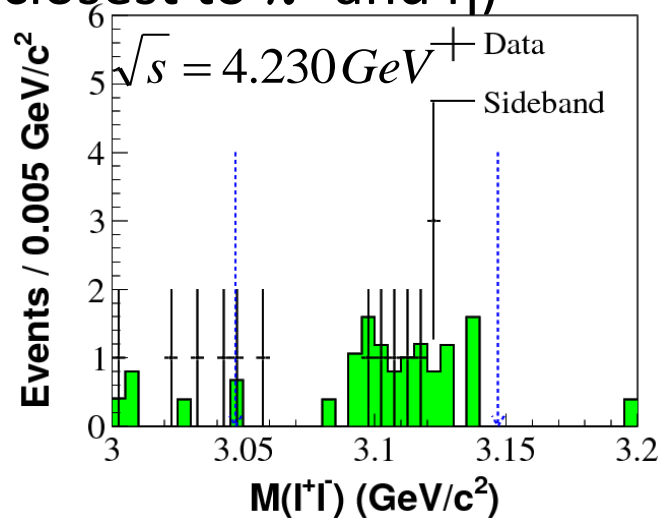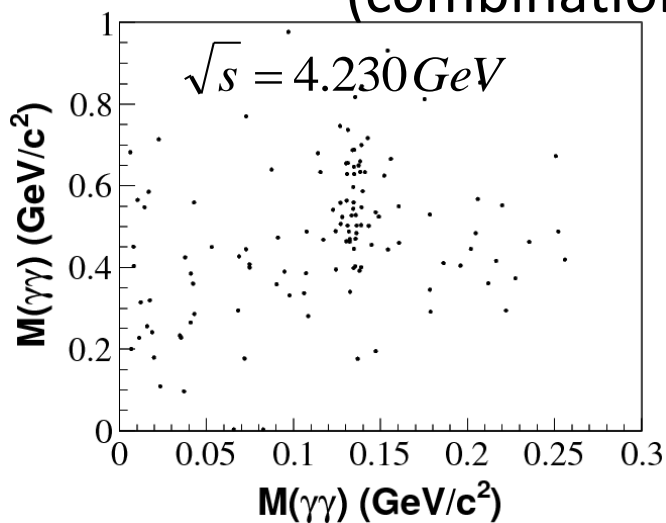
Ref: arXiv:1310.8597

6. Search for Y(4260)→J/ψηπ⁰ yields no signal

Scatter Plot of M(γγ) and M(l⁺l⁻)   *PRD92,1, 012008*

(combination closest to π⁰ and η)

The Born cross section at 90% CL.

$\sqrt{s}$ (GeV)	$\mathcal{L}$ (pb^{-1})	$(1+\delta^r)$	$(1+\delta^v)$	$(\epsilon^{ee}\mathcal{B}^{ee} + \epsilon^{\mu\mu}\mathcal{B}^{\mu\mu})$ (%)	N^{obs}	N^{bkg}	N^{up}	$\sigma_{\text{UL}}^{\text{Born}}$ (pb)
4.009	482.0	0.838	1.044	$2.1 \pm 0.1(sys.)$	5	1	598.1	3.6
4.226	1047.3	0.844	1.056	$2.2 \pm 0.1(sys.)$	12	11	592.9	1.7
4.257	825.6	0.847	1.054	$2.2 \pm 0.1(sys.)$	12	8	654.1	2.4
4.358	539.8	0.942	1.051	$2.2 \pm 0.1(sys.)$	5	4	283.2	1.4
4.416	1028.9	0.951	1.053	$2.3 \pm 0.1(sys.)$	5	6	342.7	0.9
4.599	566.9	0.965	1.055	$2.4 \pm 0.1(sys.)$	6	3	418.4	1.9

Summary

- BESIII have observed the charged and neutral Zc states; confirmed by Belle and CLEO.

- New decays and new particles have been studied at CME above 4 GeV.

- There also seem a lot of unanswered questions. BESIII will continue to study this energy region.