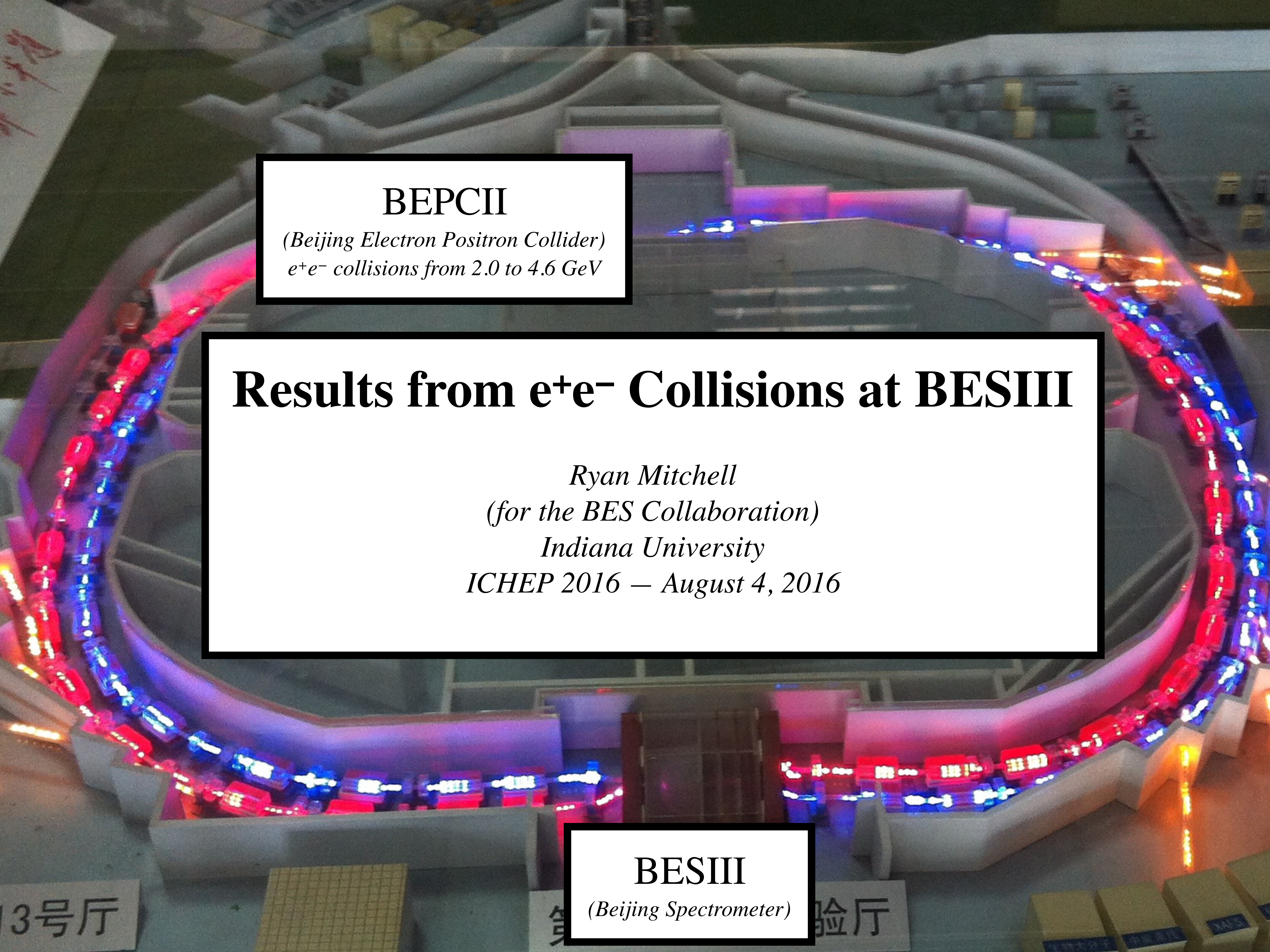


BEPCII
(Beijing Electron Positron Collider)
e^+e^- collisions from 2.0 to 4.6 GeV

Results from e^+e^- Collisions at BESIII

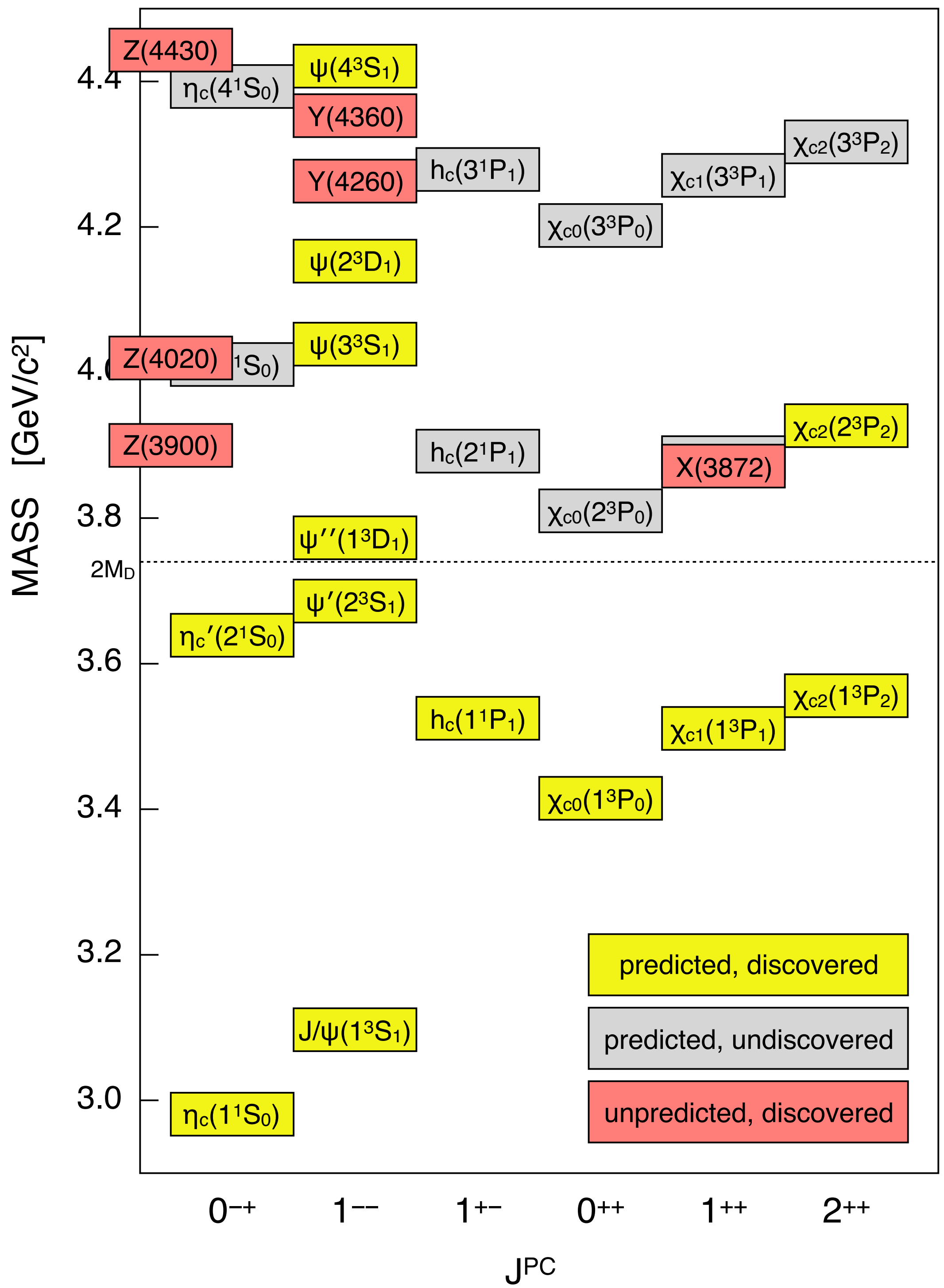
Ryan Mitchell
(for the BES Collaboration)
Indiana University
ICHEP 2016 — August 4, 2016

BESIII
(Beijing Spectrometer)

BESIII Energy Range and Data Sets

Charmonium Spectrum

predictions based on PRD 72, 054026 (2005)
measurements from PDG 2014



Data Sets (primary):

(e^+e^- collisions at E_{CM} between 2.0 and 4.6 GeV)

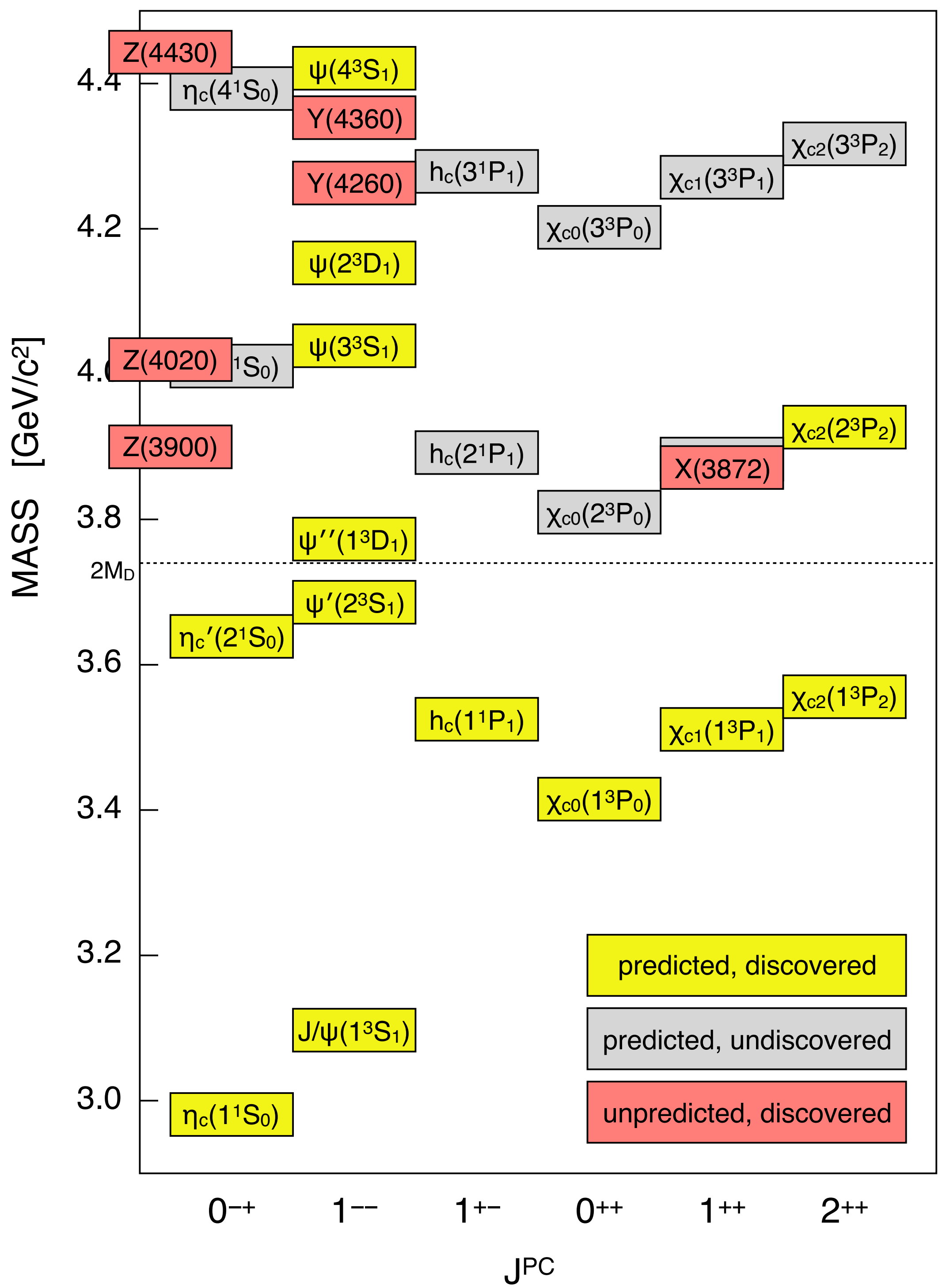
2009: 106M $\psi(2S)$
225M J/ψ
2010: 975 pb^{-1} at $\psi(3770)$
2011: 2.9 fb^{-1} at **ψ(3770)** *(total)*
482 pb^{-1} at **4.01 GeV**
2012: 0.45B **ψ(2S)** *(total)*
1.3B **J/ψ** *(total)*
2013: 1092 pb^{-1} at **4.23 GeV**
826 pb^{-1} at **4.26 GeV**
540 pb^{-1} at **4.36 GeV**
~50 pb^{-1} at **3.81, 3.90, 4.09, 4.19, 4.21, 4.22, 4.245, 4.31, 4.39, 4.42 GeV**
2014: 1029 pb^{-1} at **4.42 GeV**
110 pb^{-1} at **4.47 GeV**
110 pb^{-1} at **4.53 GeV**
48 pb^{-1} at **4.575 GeV**
567 pb^{-1} at **4.6 GeV**
0.8 fb^{-1} **R-scan** from 3.85 to 4.59 GeV (104 points)
2015: **R-scan** from 2-3 GeV + **2.175 GeV** data
2016: ~3fb^{-1} at 4.18 GeV (for **D_s**) *JUST COMPLETED*
*2017: ~10 × 500 pb^{-1} between **4.19** and **4.30 GeV***
2017 SUBJECT TO CHANGE, OF COURSE!

+ Initial State Radiation (ISR)

BESIII Highlights

Charmonium Spectrum

predictions based on PRD 72, 054026 (2005)
measurements from PDG 2014



A Few Highlights:

(1) $e^+e^- \to \pi^+\pi^-$ and the
Anomalous Magnetic Moment of the Muon
(using ISR data)

(2) $e^+e^- \to p^+p^-$ and the
Electromagnetic Form Factors of the Proton
(using ISR data)

(3) $h_c \to \gamma\eta^{(\prime)}$ and
Studies of Charmonium
(using $\psi(2S)$ data)

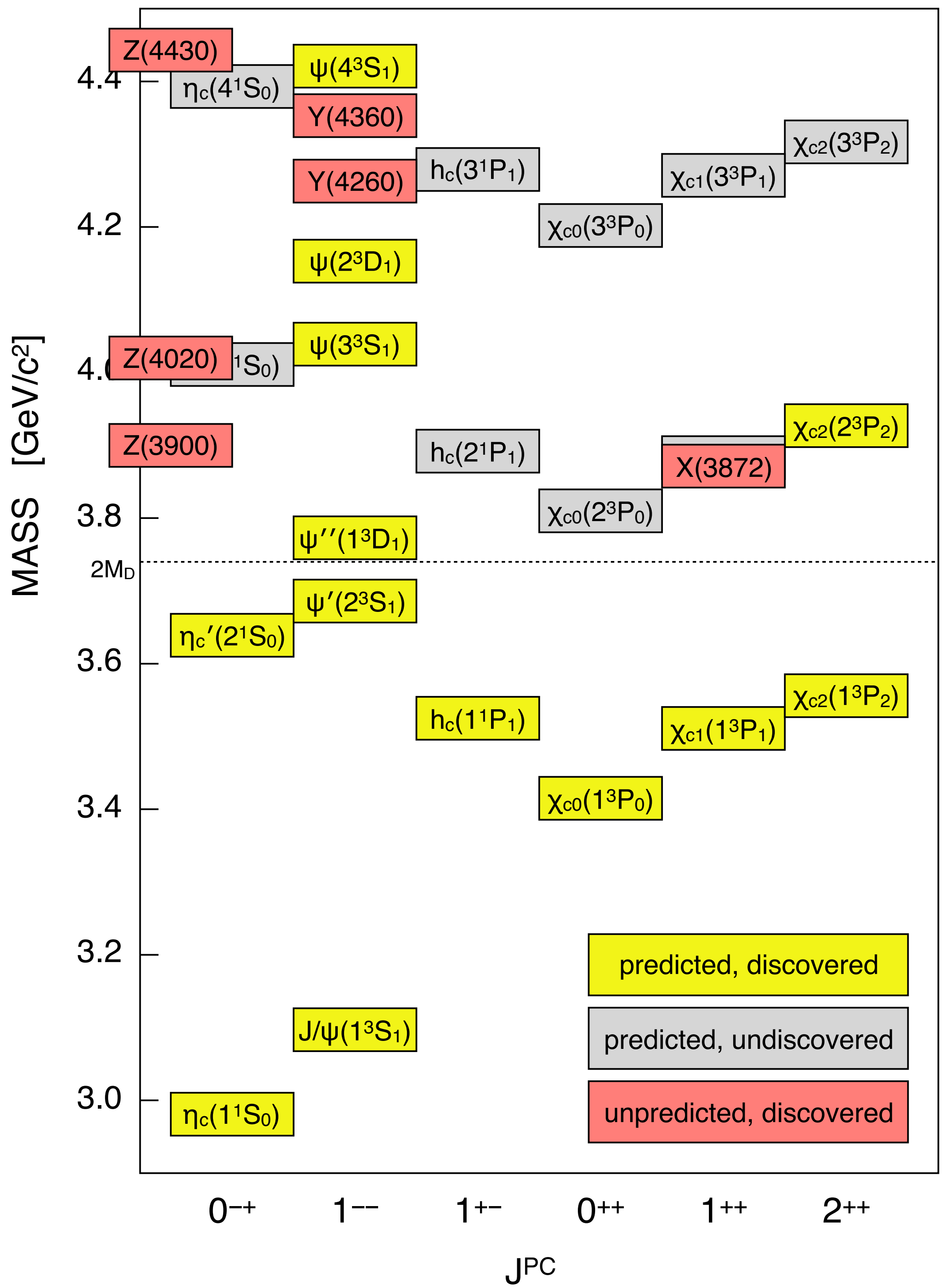
(4) $e^+e^- \to \pi^+\pi^- J/\psi$, $\pi^+\pi^-\psi(2S)$, $\pi^+\pi^- h_c$
and the "Y" States
(using "XYZ" data)

(5) $e^+e^- \to \gamma\pi^+\pi^- J/\psi$ and $\gamma\phi J/\psi$
and the "X" States
(using "XYZ" data)

BESIII Highlights

Charmonium Spectrum

predictions based on PRD 72, 054026 (2005)
measurements from PDG 2014



A Few Highlights:

(1) $e^+e^- \to \pi^+\pi^-$ and the
Anomalous Magnetic Moment of the Muon
(using ISR data)

(2) $e^+e^- \to p^+p^-$ and the
Electromagnetic Form Factors of the Proton
(using ISR data)

(3) $h_c \to \gamma\eta^{(\prime)}$ and
Studies of Charmonium
(using $\psi(2S)$ data)

(4) $e^+e^- \to \pi^+\pi^-J/\psi$, $\pi^+\pi^-\psi(2S)$, $\pi^+\pi^-h_c$
and the "Y" States
(using "XYZ" data)

(5) $e^+e^- \to \gamma\pi^+\pi^-J/\psi$ and $\gamma\phi J/\psi$
and the "X" States
(using "XYZ" data)

(1) $e^+e^- \to \pi^+\pi^-$ and the Anomalous Magnetic Moment of the Muon

- There is currently a $\gtrsim$**3σ difference** between the Standard Model (SM) and the experimental (E821) value for the anomalous magnetic moment of the muon ($a_\mu = (g_\mu\text{-}2)/2$):

$a_\mu^{SM} = (11659180.2 \pm 4.9) \times 10^{-10}$ *(EPJC 71, 1515 (2011))*
$a_\mu^{E821} = (11659209.1 \pm 6.3) \times 10^{-10}$ *(PDG 2014)*

$\Delta a_\mu = a_\mu^{E821} - a_\mu^{SM} = (28.9 \pm 8.0) \times 10^{-10}$ (3.6σ)

- The error in the SM calculation is dominated by the Hadronic Vacuum Polarization (HVP), which is estimated using experimental input for $e^+e^- \to$ hadrons.

- The cross section for $e^+e^- \to$ hadrons, in turn, is dominated by $e^+e^- \to \pi^+\pi^-$ in the region of the ϱ meson.

- But here there are experimental differences between BaBar and KLOE:

BaBar *(PRD 86, 032013 (2012))*:
$a_\mu^{\pi\pi}(600\text{-}900\ \text{MeV}) = (376.7 \pm 2.6) \times 10^{-10}$
KLOE *(PLB 720, 336 (2013))*:
$a_\mu^{\pi\pi}(600\text{-}900\ \text{MeV}) = (366.7 \pm 2.8) \times 10^{-10}$

- This discrepancy can be addressed using ISR *(starting with 2.9 fb^{-1} at an energy of 3.773 GeV)* at BESIII.

(1) $e^+e^- \to \pi^+\pi^-$ and the Anomalous Magnetic Moment of the Muon

- There is currently a $\gtrsim$**3σ difference** between the Standard Model (SM) and the experimental (E821) value for the anomalous magnetic moment of the muon ($a_\mu = (g_\mu\text{-}2)/2$):

$a_\mu^{SM} = (11659180.2 \pm 4.9) \times 10^{-10}$ *(EPJC 71, 1515 (2011))*
$a_\mu^{E821} = (11659209.1 \pm 6.3) \times 10^{-10}$ *(PDG 2014)*

$\Delta a_\mu = a_\mu^{E821} - a_\mu^{SM} = (28.9 \pm 8.0) \times 10^{-10}$ (3.6σ)

- The error in the SM calculation is dominated by the Hadronic Vacuum Polarization (HVP), which is estimated using experimental input for $e^+e^- \to$ hadrons.

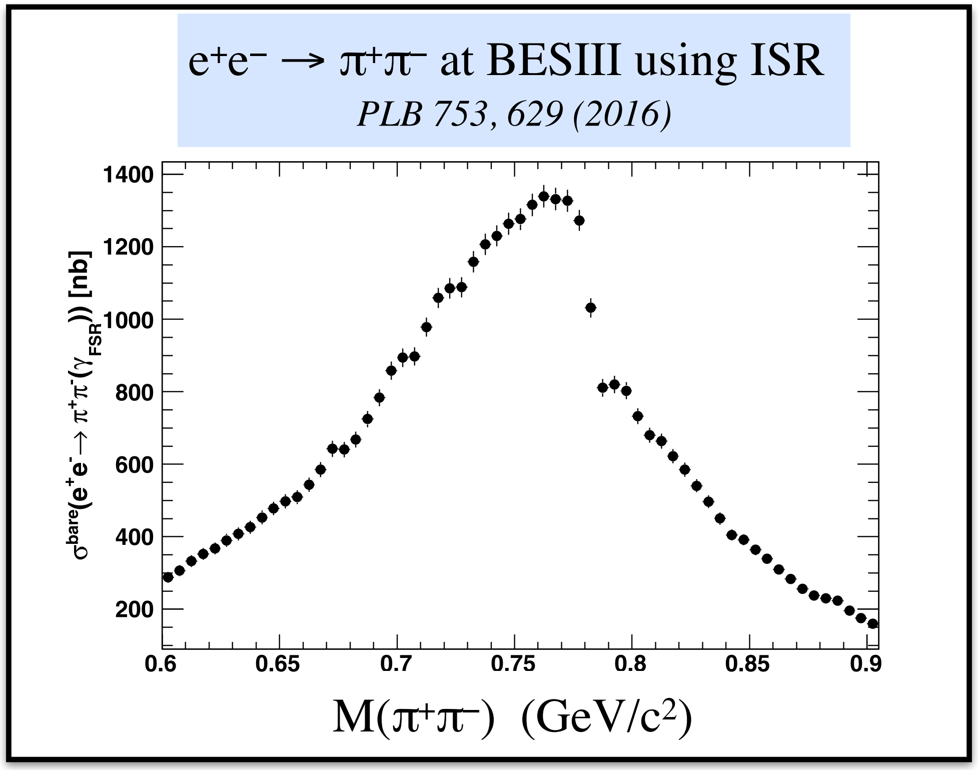
- The cross section for $e^+e^- \to$ hadrons, in turn, is dominated by $e^+e^- \to \pi^+\pi^-$ in the region of the ϱ meson.

- But here there are experimental differences between BaBar and KLOE:

BaBar *(PRD 86, 032013 (2012))*:
$a_\mu^{\pi\pi}(600\text{-}900\ \text{MeV}) = (376.7 \pm 2.6) \times 10^{-10}$
KLOE *(PLB 720, 336 (2013))*:
$a_\mu^{\pi\pi}(600\text{-}900\ \text{MeV}) = (366.7 \pm 2.8) \times 10^{-10}$

- This discrepancy can be addressed using ISR *(starting with 2.9 fb^{-1} at an energy of 3.773 GeV)* at BESIII.

First measure $\sigma(e^+e^- \to \pi^+\pi^-)$:



(1) $e^+e^- \to \pi^+\pi^-$ and the Anomalous Magnetic Moment of the Muon

- There is currently a $\gtrsim$**3σ difference** between the Standard Model (SM) and the experimental (E821) value for the anomalous magnetic moment of the muon ($a_\mu = (g_\mu\text{-}2)/2$):

$a_\mu^{SM} = (11659180.2 \pm 4.9) \times 10^{-10}$ *(EPJC 71, 1515 (2011))*
$a_\mu^{E821} = (11659209.1 \pm 6.3) \times 10^{-10}$ *(PDG 2014)*

$$\Delta a_\mu = a_\mu^{E821} - a_\mu^{SM} = (28.9 \pm 8.0) \times 10^{-10} \ (3.6\sigma)$$

- The error in the SM calculation is dominated by the Hadronic Vacuum Polarization (HVP), which is estimated using experimental input for $e^+e^- \to$ hadrons.

- The cross section for $e^+e^- \to$ hadrons, in turn, is dominated by $e^+e^- \to \pi^+\pi^-$ in the region of the ρ meson.

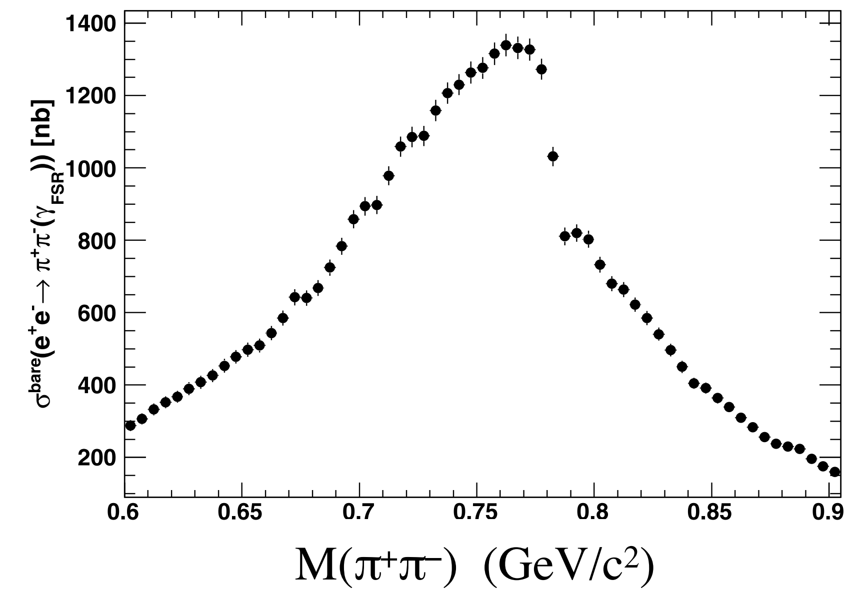
- But here there are experimental differences between BaBar and KLOE:

BaBar *(PRD 86, 032013 (2012))*:
$$a_\mu^{\pi\pi}(600\text{-}900\ \mathrm{MeV}) = (376.7 \pm 2.6) \times 10^{-10}$$
KLOE *(PLB 720, 336 (2013))*:
$$a_\mu^{\pi\pi}(600\text{-}900\ \mathrm{MeV}) = (366.7 \pm 2.8) \times 10^{-10}$$

- This discrepancy can be addressed using ISR *(starting with 2.9 fb^{-1} at an energy of 3.773 GeV)* at BESIII.

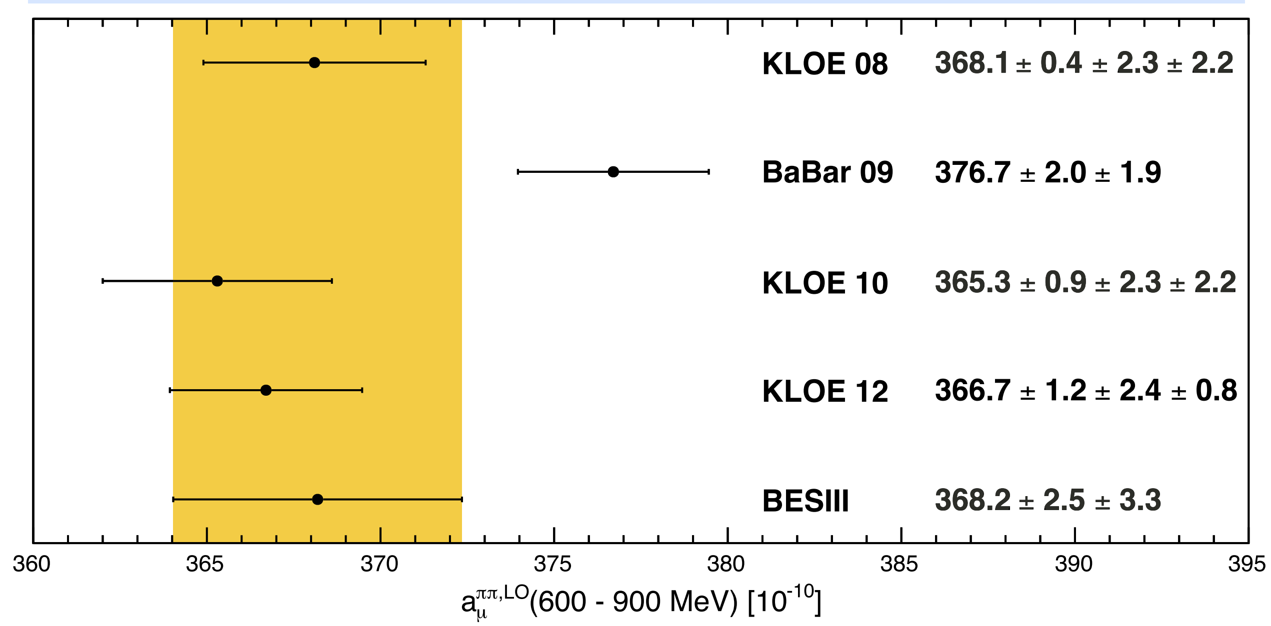
First measure $\sigma(e^+e^- \to \pi^+\pi^-)$:

$e^+e^- \to \pi^+\pi^-$ at BESIII using ISR
PLB 753, 629 (2016)



Then integrate using a dispersion relation *(ZPC 67, 585 (1995))*:

$e^+e^- \to \pi^+\pi^-$ contribution to Standard Model calculation of a_μ
PLB 753, 629 (2016)

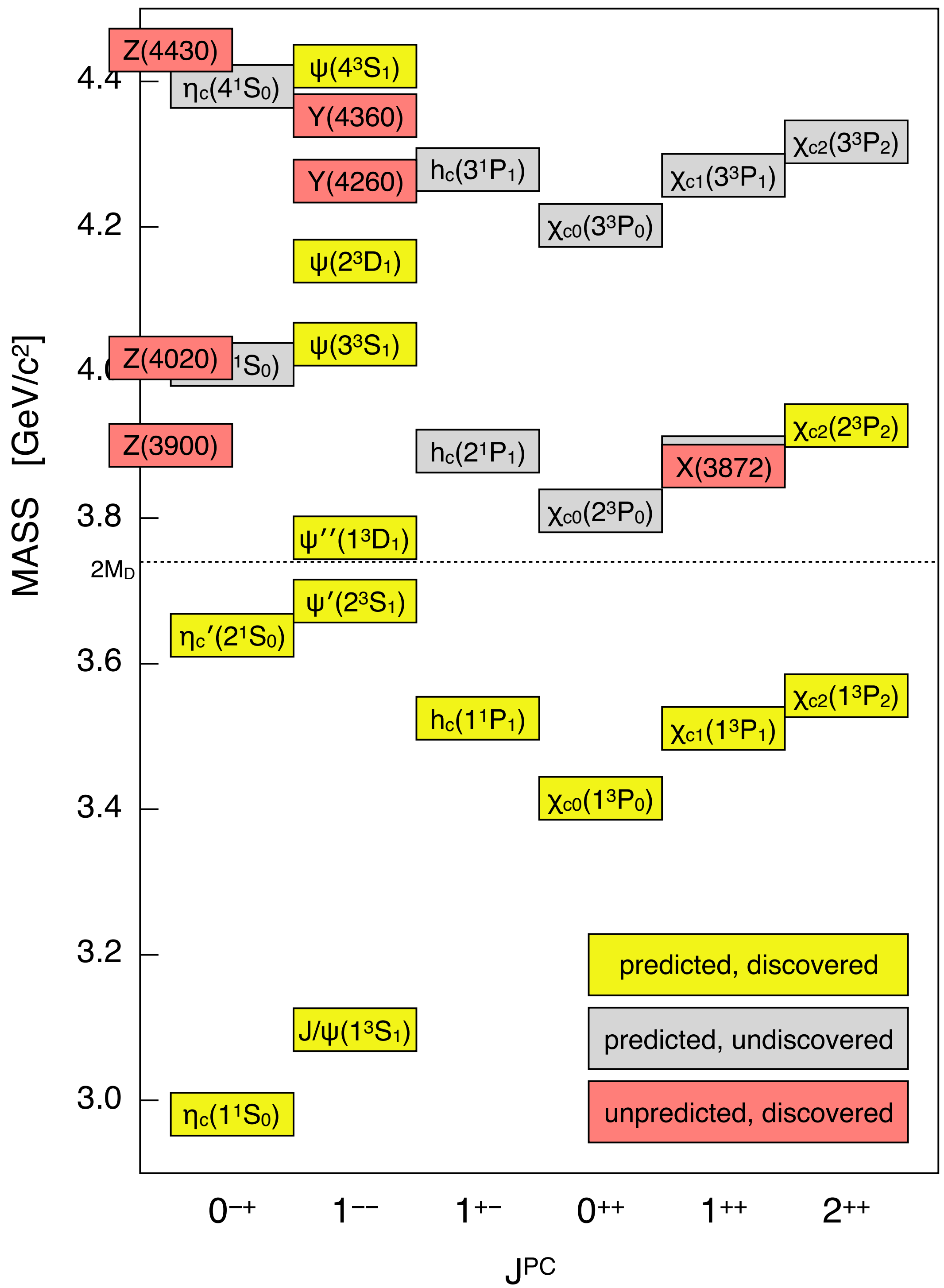


⇒ BESIII confirms the $\gtrsim$3σ difference in a_μ.

BESIII Highlights

Charmonium Spectrum

predictions based on PRD 72, 054026 (2005)
measurements from PDG 2014



A Few Highlights:

(1) $e^+e^- \to \pi^+\pi^-$ and the
Anomalous Magnetic Moment of the Muon
(using ISR data)

(2) $e^+e^- \to p^+p^-$ and the
Electromagnetic Form Factors of the Proton
(using ISR data)

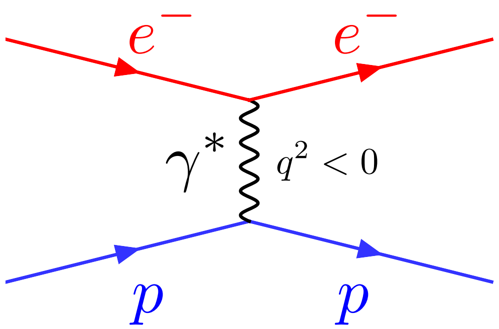
(3) $h_c \to \gamma\eta^{(\prime)}$ and
Studies of Charmonium
(using $\psi(2S)$ data)

(4) $e^+e^- \to \pi^+\pi^-J/\psi$, $\pi^+\pi^-\psi(2S)$, $\pi^+\pi^-h_c$
and the "Y" States
(using "XYZ" data)

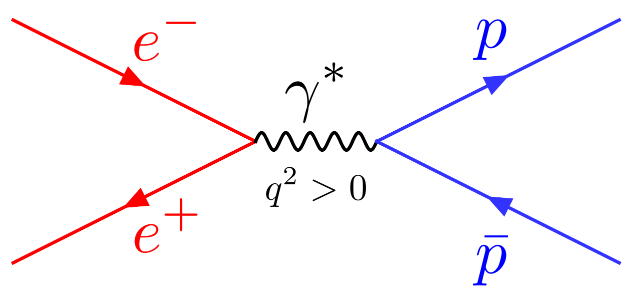
(5) $e^+e^- \to \gamma\pi^+\pi^-J/\psi$ and $\gamma\phi J/\psi$
and the "X" States
(using "XYZ" data)

(2) $e^+e^- \rightarrow p^+p^-$ and the Electromagnetic Form Factors of the Proton

Electromagnetic Form Factors:



Spacelike Region



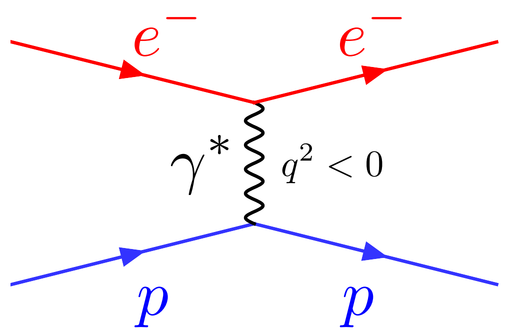
Timelike Region

$$\frac{d\sigma_{p\bar{p}}(q^2)}{d\cos\theta_p} = \frac{2\pi\alpha^2\beta C}{4q^2}\left[\left|G_M(q^2)\right|^2(1+\cos^2\theta_p) + \frac{4m_p^2}{q^2}\left|G_E(q^2)\right|^2\sin^2\theta_p\right]$$

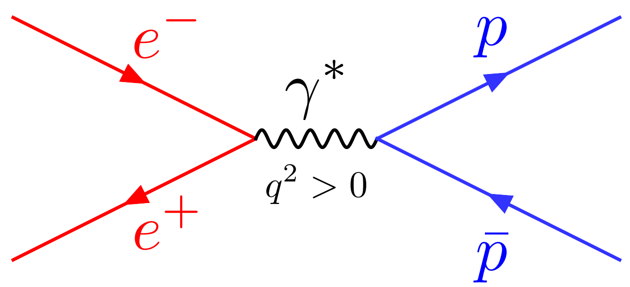
- q^2 — momentum transfer
- θ_p — proton angle
- α — fine structure constant
- β — proton velocity
- C — Coulomb correction factor
- m_p — proton mass
- $G_E(q^2), G_M(q^2)$ — electromagnetic form factors

(2) $e^+e^- \to p^+p^-$ and the Electromagnetic Form Factors of the Proton

Electromagnetic Form Factors:



Spacelike Region



Timelike Region

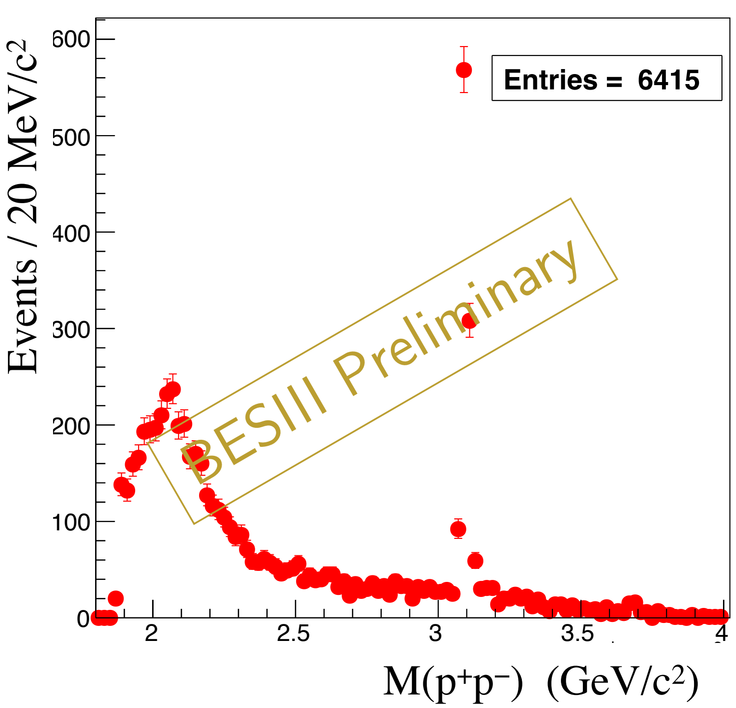
$$\frac{d\sigma_{p\bar{p}}(q^2)}{d\cos\theta_p} = \frac{2\pi\alpha^2\beta C}{4q^2}\left[\left|G_M(q^2)\right|^2(1+\cos^2\theta_p) + \frac{4m_p^2}{q^2}\left|G_E(q^2)\right|^2\sin^2\theta_p\right]$$

q^2 — momentum transfer
θ_p — proton angle
α — fine structure constant
β — proton velocity
C — Coulomb correction factor
m_p — proton mass
$G_E(q^2), G_M(q^2)$ — electromagnetic form factors

Use 7.4fb^{-1} of data to measure $e^+e^- \to p^+p^-$ using ISR:

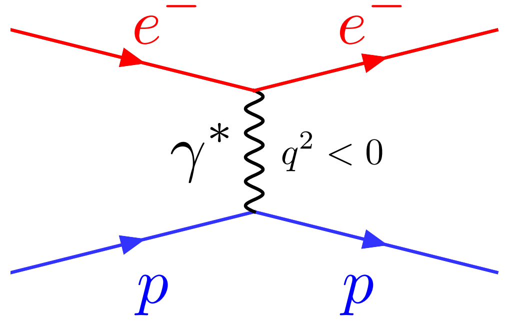
$e^+e^- \to p^+p^-$ using ISR (from 7 E_{CM})

BESIII preliminary

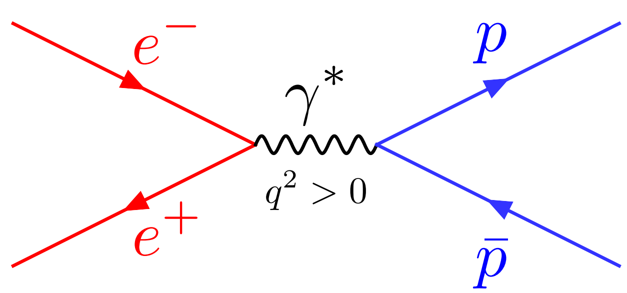


(2) $e^+e^- \to p^+p^-$ and the Electromagnetic Form Factors of the Proton

Electromagnetic Form Factors:



Spacelike Region



Timelike Region

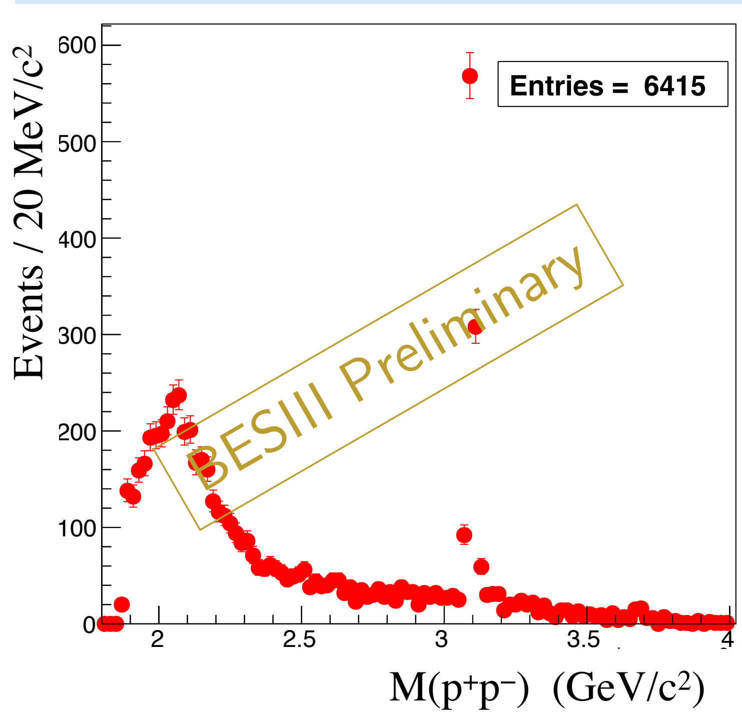
$$\frac{d\sigma_{p\bar{p}}(q^2)}{d\cos\theta_p} = \frac{2\pi\alpha^2\beta C}{4q^2}\left[\left|G_M(q^2)\right|^2(1+\cos^2\theta_p) + \frac{4m_p^2}{q^2}\left|G_E(q^2)\right|^2\sin^2\theta_p\right]$$

q^2 — momentum transfer
θ_p — proton angle
α — fine structure constant
β — proton velocity
C — Coulomb correction factor
m_p — proton mass
$G_E(q^2), G_M(q^2)$ — electromagnetic form factors

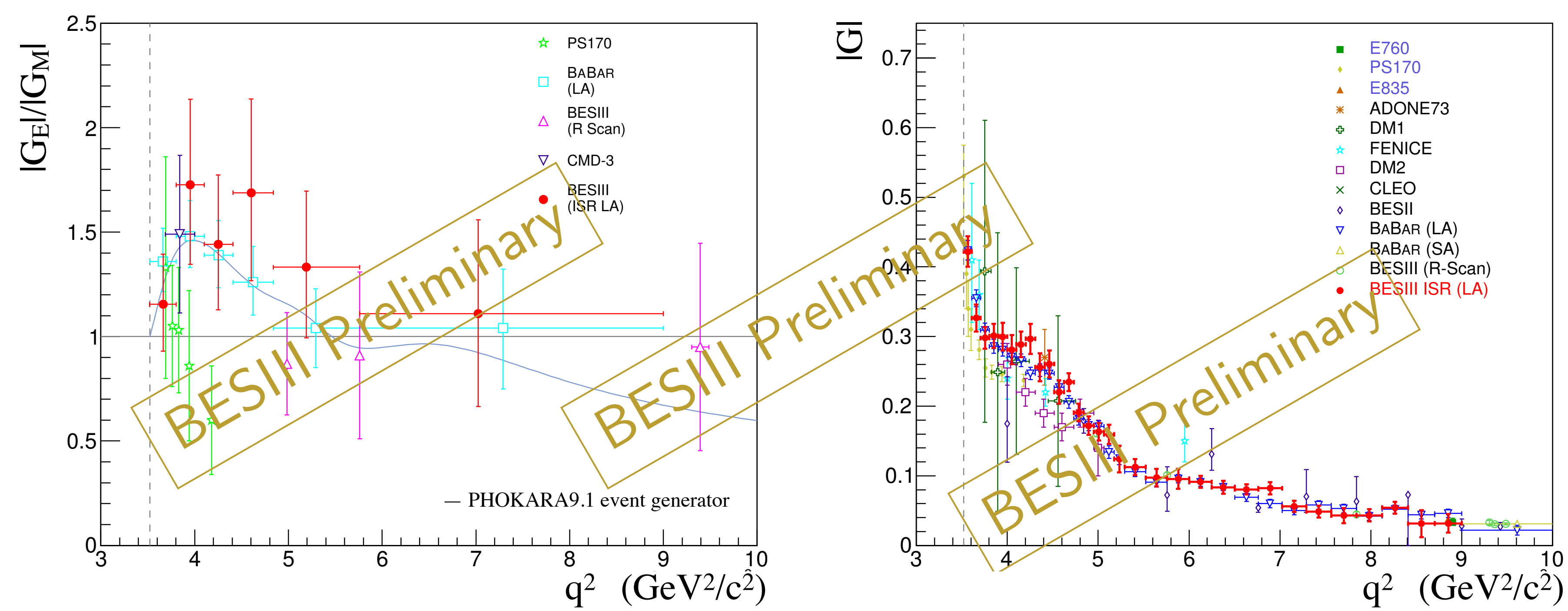
Use 7.4fb^{-1} of data to measure $e^+e^- \to p^+p^-$ using ISR:

Fit the ϑ_p distribution in bins of q^2 to get $|G_E|/|G_M|$; integrate over the ϑ_p distribution and set $|G| = |G_E| = |G_M|$ to get $|G|$:

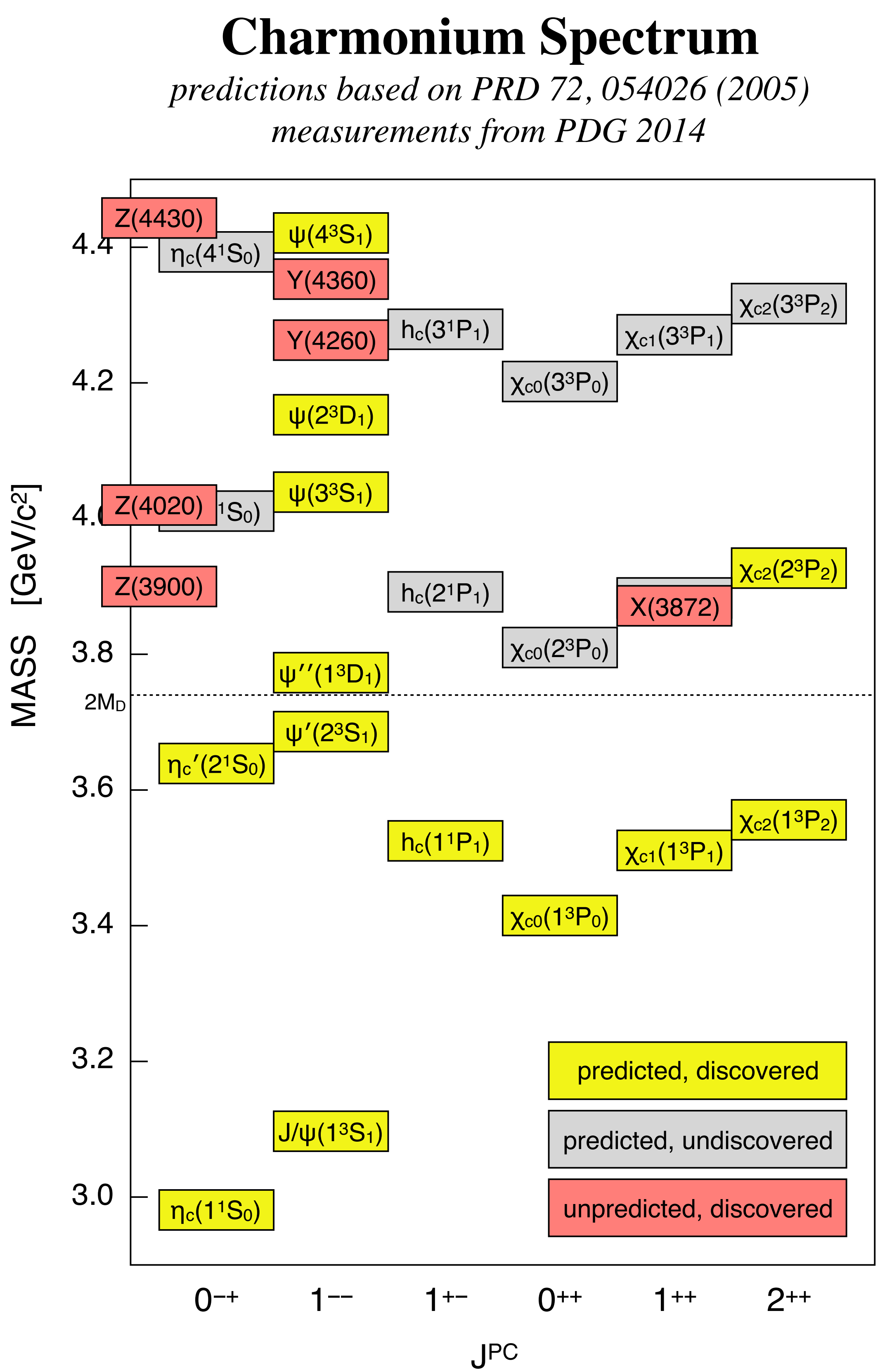
$e^+e^- \to p^+p^-$ using ISR (from 7 E_{CM})
BESIII preliminary



The Ratio $|G_E|/|G_M|$ and the Effective Form Factor $|G|$ as a function of q^2
BESIII preliminary



BESIII Highlights



A Few Highlights:

(1) $e^+e^- \to \pi^+\pi^-$ and the Anomalous Magnetic Moment of the Muon
(using ISR data)

(2) $e^+e^- \to p^+p^-$ and the Electromagnetic Form Factors of the Proton
(using ISR data)

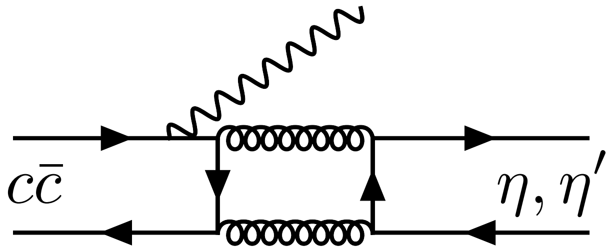
(3) $h_c \to \gamma\eta^{(\prime)}$ and Studies of Charmonium
(using $\psi(2S)$ data)

(4) $e^+e^- \to \pi^+\pi^- J/\psi$, $\pi^+\pi^-\psi(2S)$, $\pi^+\pi^- h_c$ and the "Y" States
(using "XYZ" data)

(5) $e^+e^- \to \gamma\pi^+\pi^- J/\psi$ and $\gamma\phi J/\psi$ and the "X" States
(using "XYZ" data)

(3) $h_c \to \gamma\eta^{(\prime)}$ and Studies in Charmonium

One outstanding issue in charmonium is the "ϱπ" family of puzzles:



$$\frac{\mathcal{B}(J/\psi \to \gamma\eta)}{\mathcal{B}(J/\psi \to \gamma\eta')} = (21.1 \pm 0.9)\%$$

(PRD 79, 111101 (2009))

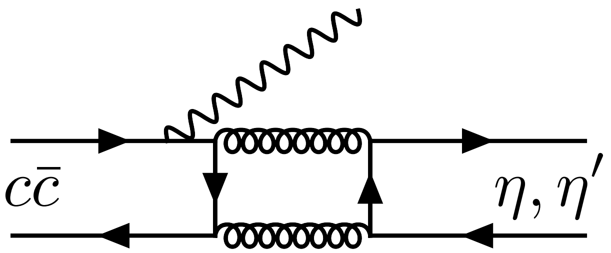
but

$$\frac{\mathcal{B}(\psi(2S) \to \gamma\eta)}{\mathcal{B}(\psi(2S) \to \gamma\eta')} = (1.1 \pm 0.4)\%$$

(PRL 105, 261801 (2010))

(3) $h_c \to \gamma\eta^{(\prime)}$ and Studies in Charmonium

One outstanding issue in charmonium is the "ρπ" family of puzzles:



$$\frac{\mathcal{B}(J/\psi \to \gamma\eta)}{\mathcal{B}(J/\psi \to \gamma\eta')} = (21.1 \pm 0.9)\%$$

(PRD 79, 111101 (2009))

but

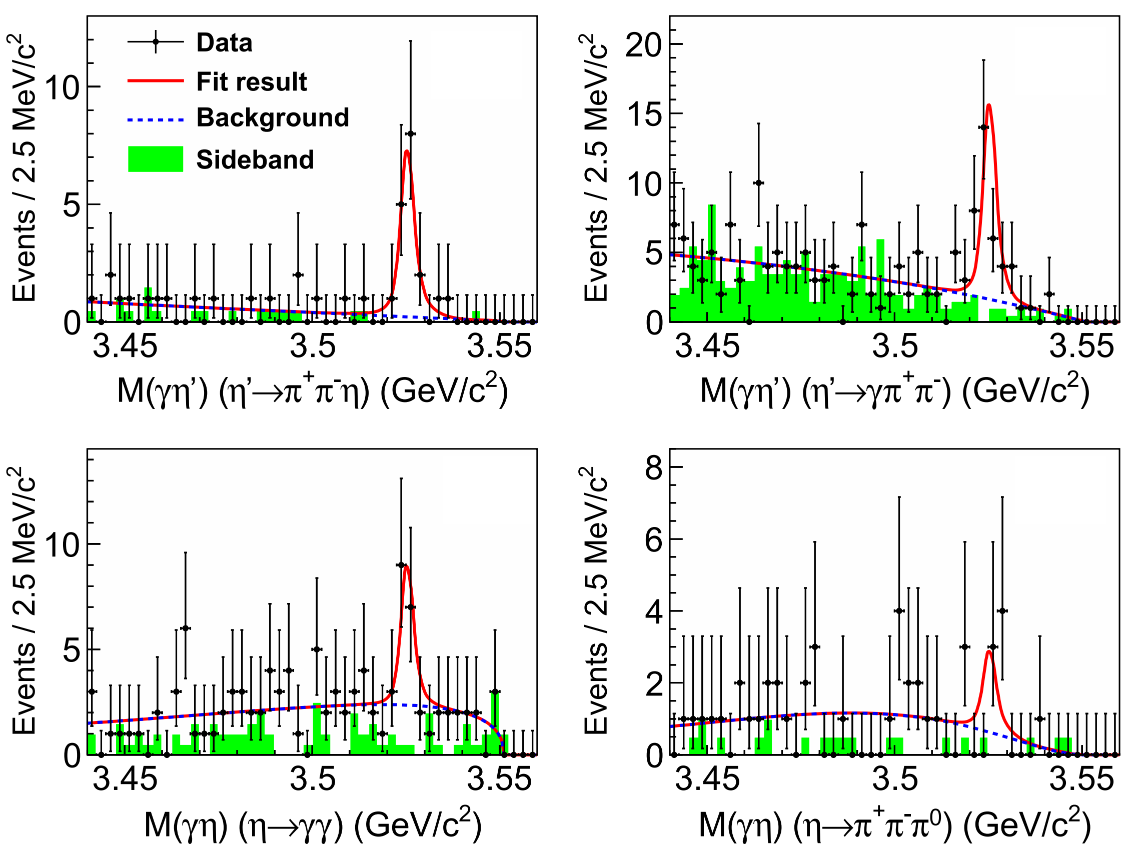
$$\frac{\mathcal{B}(\psi(2S) \to \gamma\eta)}{\mathcal{B}(\psi(2S) \to \gamma\eta')} = (1.1 \pm 0.4)\%$$

(PRL 105, 261801 (2010))

Measure the same ratio for the h_c using the full sample of 450 million $\psi(2S)$ decays at BESIII; use $\psi(2S) \to \pi^0 h_c$ and $h_c \to \gamma\eta^{(\prime)}$ and do simultaneous fits with two η' modes and two η modes:

Measurement of $h_c \to \gamma\eta^{(\prime)}$ at BESIII

PRL 116, 251802 (2016)



$$\mathcal{B}(h_c \to \gamma\eta) = (4.7 \pm 1.5 \pm 1.4) \times 10^{-4}$$

$$\mathcal{B}(h_c \to \gamma\eta') = (15.2 \pm 2.7 \pm 2.9) \times 10^{-4}$$

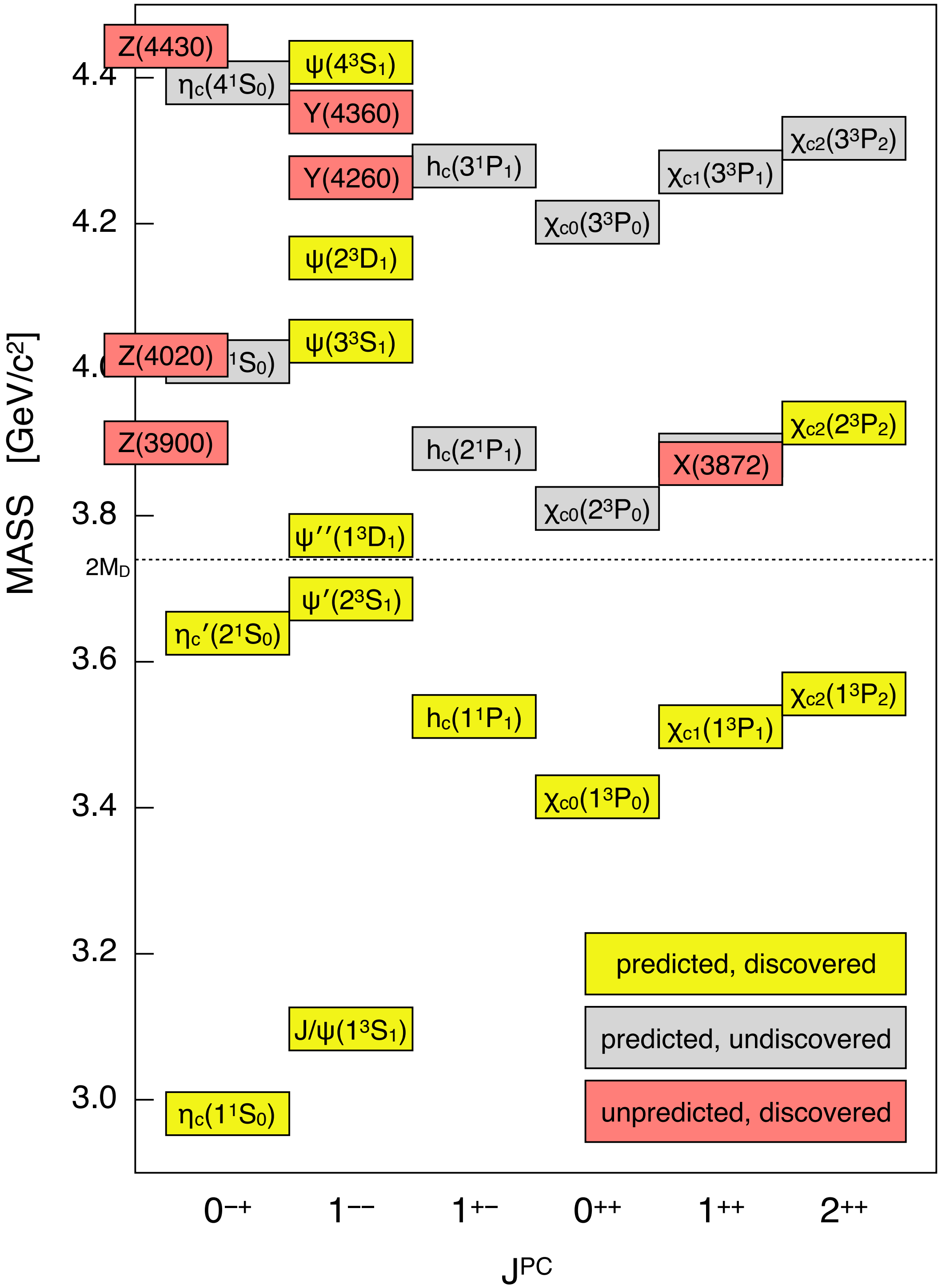
$$\frac{\mathcal{B}(h_c \to \gamma\eta)}{\mathcal{B}(h_c \to \gamma\eta')} = (30.7 \pm 11.3 \pm 8.7)\%$$

indicates the same problem is not apparent in h_c decays.

BESIII Highlights

Charmonium Spectrum

predictions based on PRD 72, 054026 (2005)
measurements from PDG 2014



A Few Highlights:

(1) $e^+e^- \to \pi^+\pi^-$ and the
Anomalous Magnetic Moment of the Muon
(using ISR data)

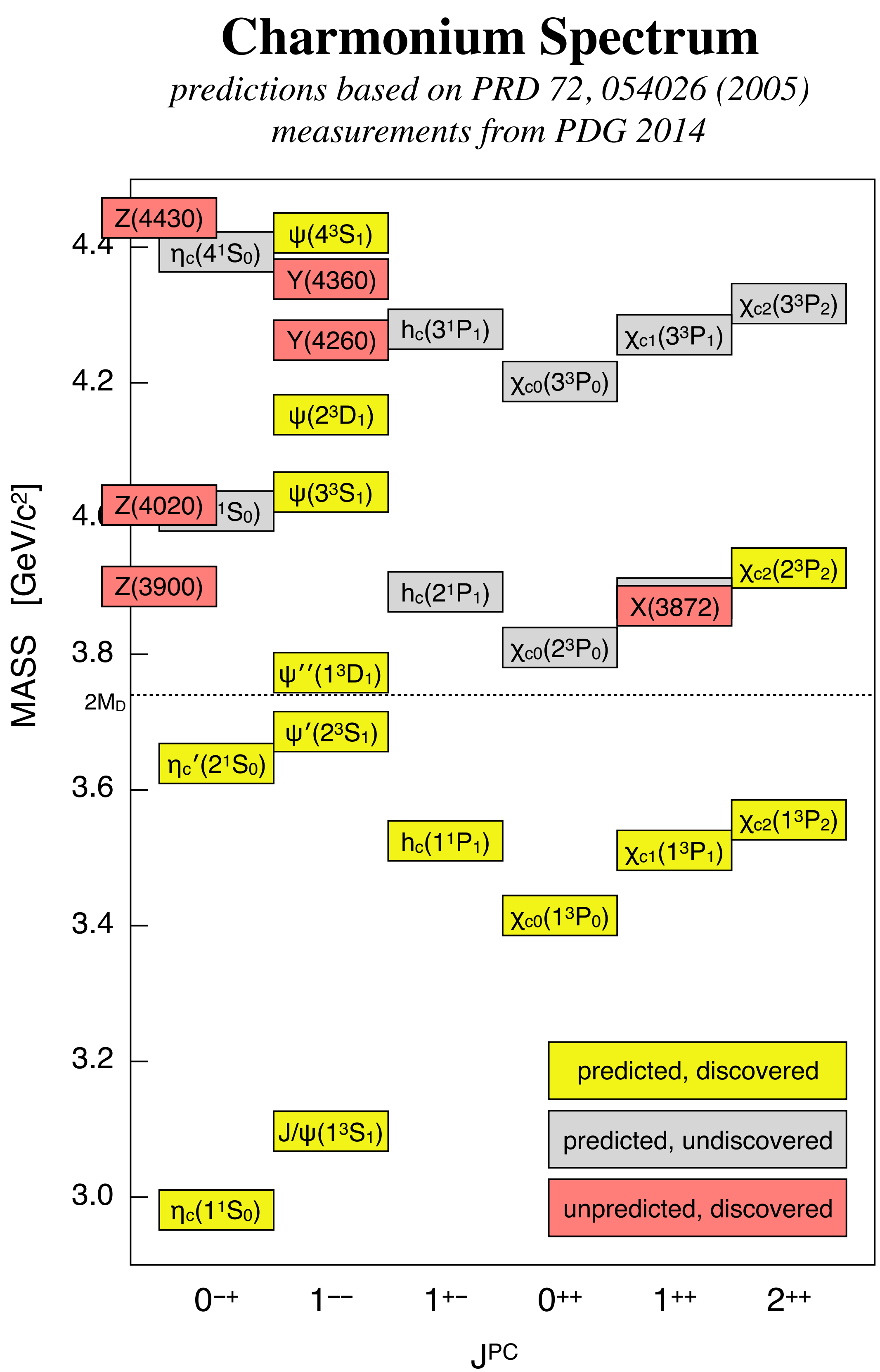
(2) $e^+e^- \to p^+p^-$ and the
Electromagnetic Form Factors of the Proton
(using ISR data)

(3) $h_c \to \gamma\eta^{(\prime)}$ and
Studies of Charmonium
(using $\psi(2S)$ data)

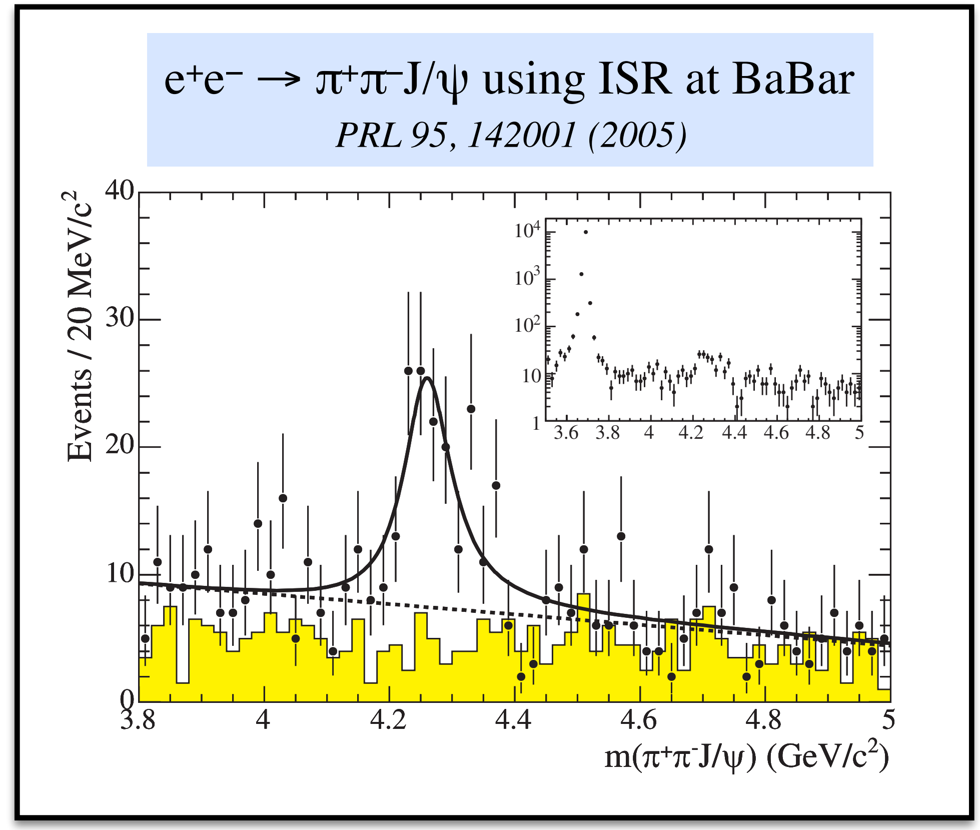
(4) $e^+e^- \to \pi^+\pi^- J/\psi$, $\pi^+\pi^-\psi(2S)$, $\pi^+\pi^- h_c$
and the "Y" States
(using "XYZ" data)

(5) $e^+e^- \to \gamma\pi^+\pi^- J/\psi$ and $\gamma\phi J/\psi$
and the "X" States
(using "XYZ" data)

(4) $e^+e^- \to \pi^+\pi^- J/\psi$, $\pi^+\pi^-\psi(2S)$, $\pi^+\pi^- h_c$ and the “Y” States



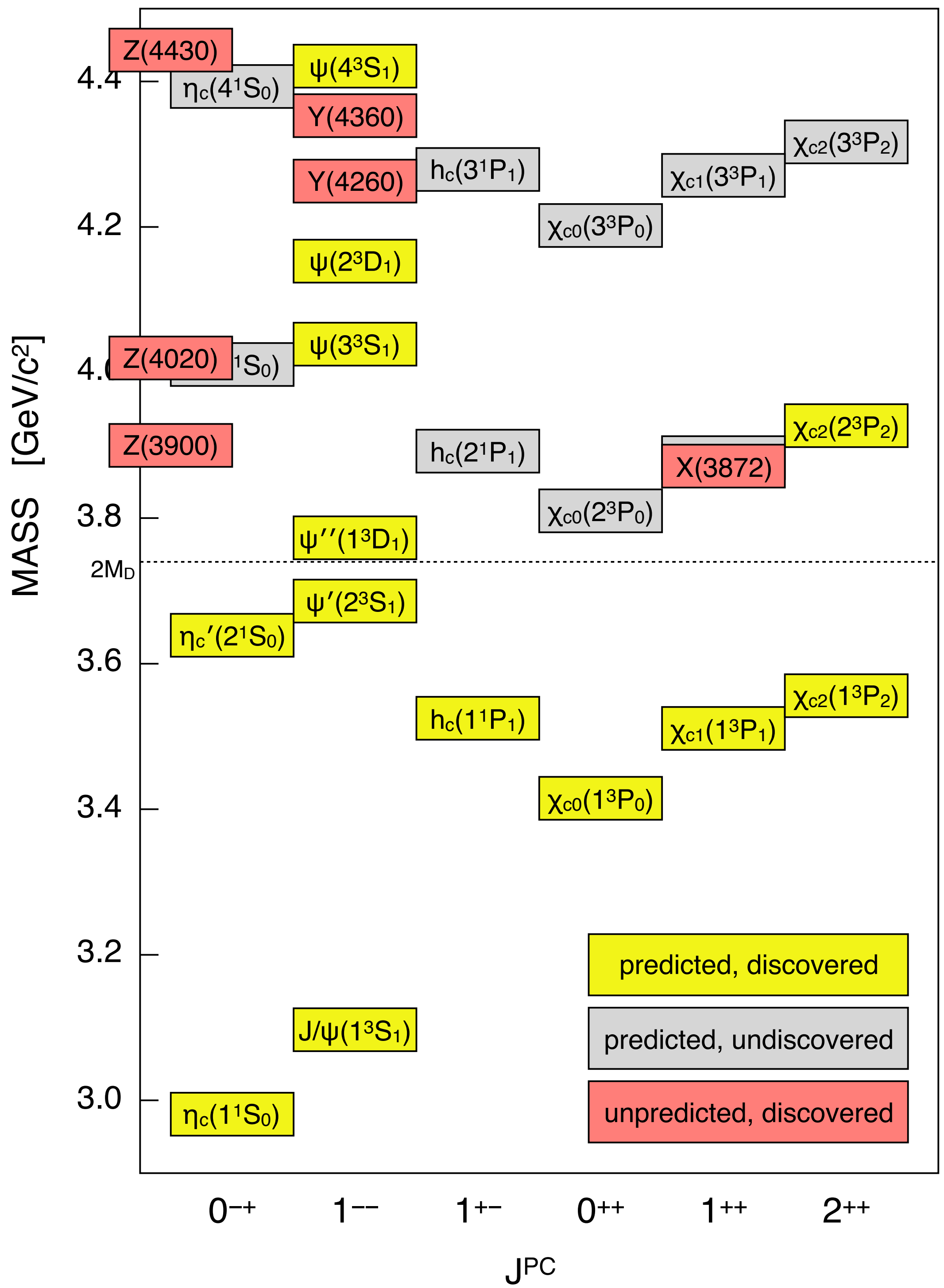
Discovery of the Y(4260) in $\pi^+\pi^- J/\psi$:



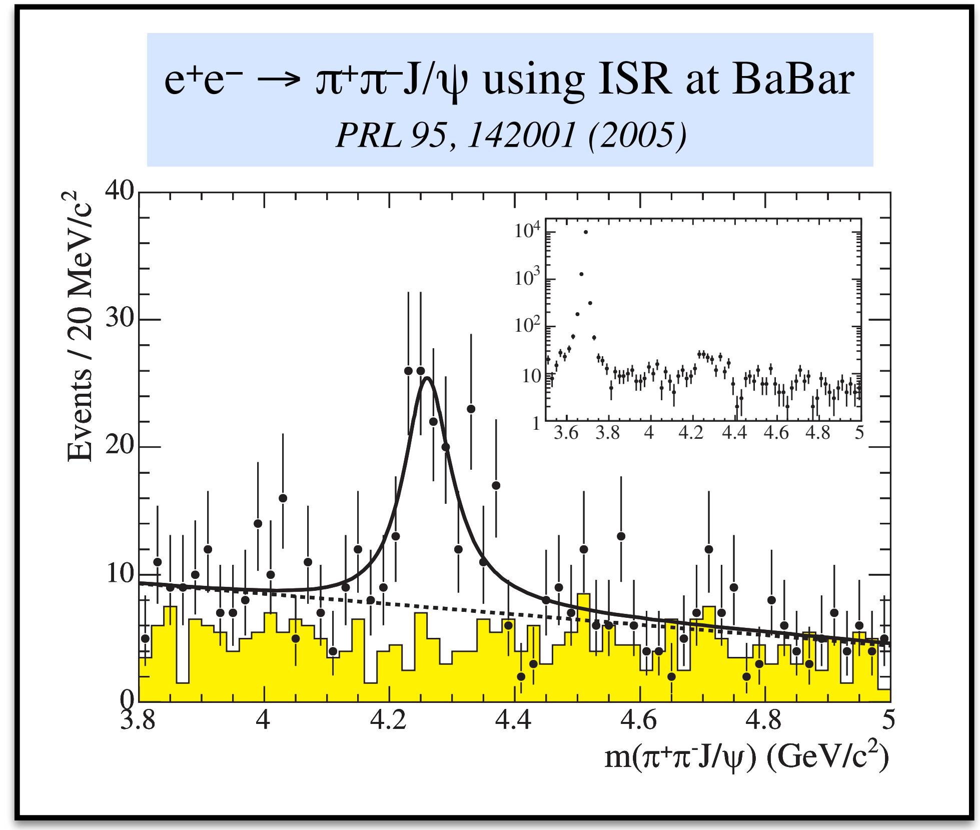
(4) $e^+e^- \to \pi^+\pi^- J/\psi$, $\pi^+\pi^-\psi(2S)$, $\pi^+\pi^- h_c$ and the "Y" States

Charmonium Spectrum

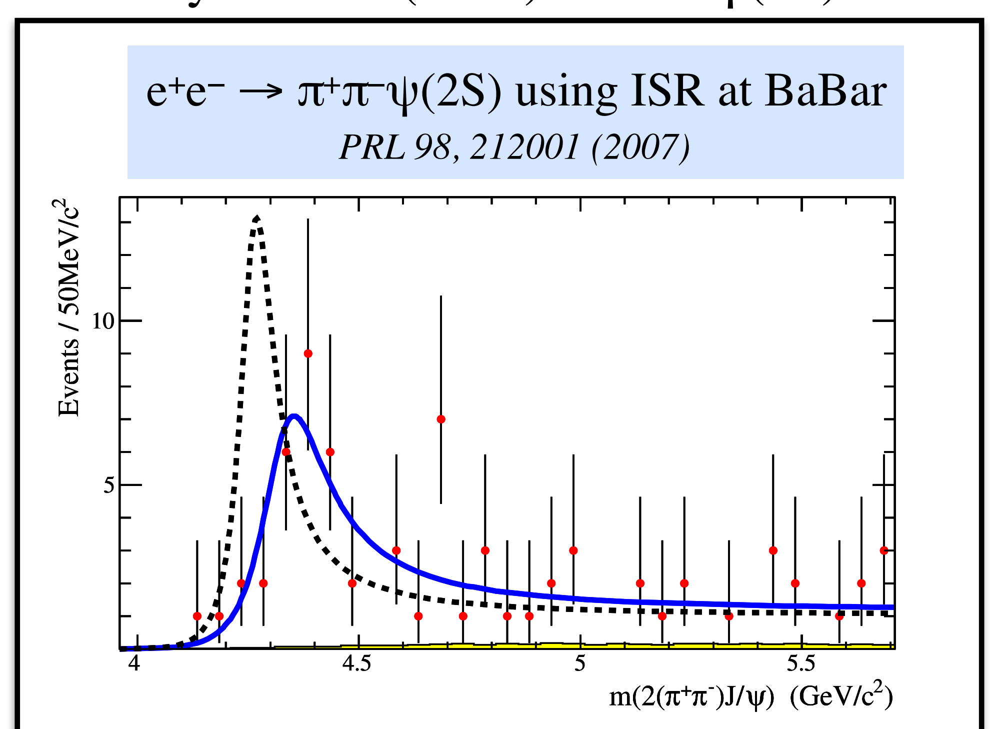
predictions based on PRD 72, 054026 (2005)
measurements from PDG 2014



Discovery of the Y(4260) in $\pi^+\pi^- J/\psi$:

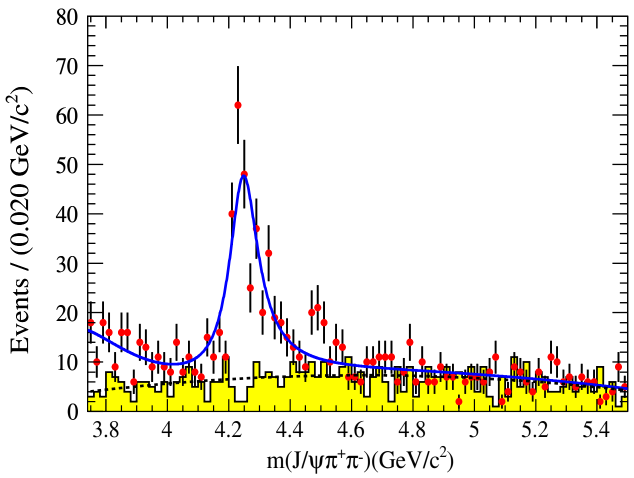


Discovery of the Y(4360) in $\pi^+\pi^-\psi(2S)$:

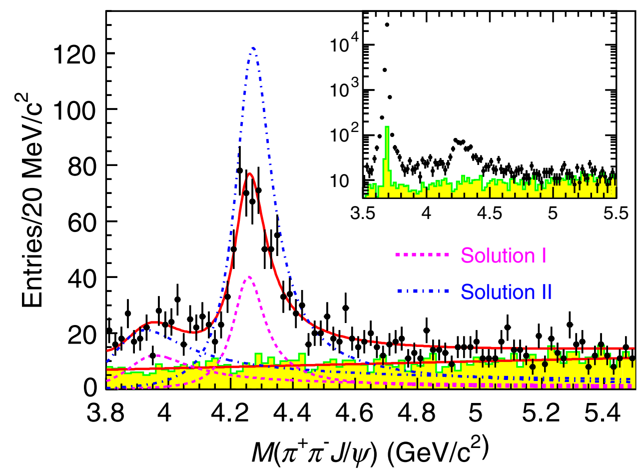


(4) $e^+e^- \to \pi^+\pi^- J/\psi$, $\pi^+\pi^-\psi(2S)$, $\pi^+\pi^- h_c$ and the "Y" States

$e^+e^- \to \pi^+\pi^- J/\psi$ using ISR at BaBar
PRD 86, 051102(R) (2012)



$e^+e^- \to \pi^+\pi^- J/\psi$ using ISR at Belle
PRL 110, 252002 (2013)

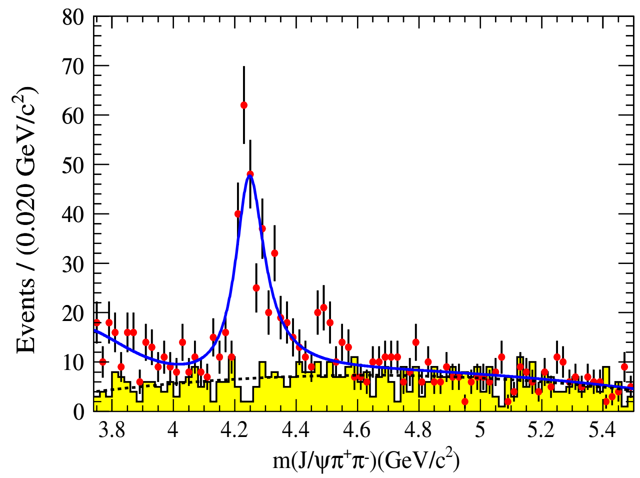


⇒ asymmetric shape?
a low-mass peak ("Y(4008)")?

(4) $e^+e^- \to \pi^+\pi^- J/\psi$, $\pi^+\pi^-\psi(2S)$, $\pi^+\pi^- h_c$ and the "Y" States

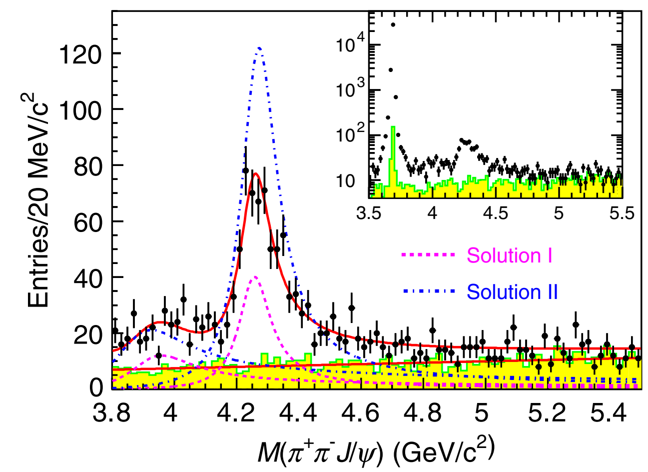
$e^+e^- \to \pi^+\pi^- J/\psi$ using ISR at BaBar

PRD 86, 051102(R) (2012)



$e^+e^- \to \pi^+\pi^- J/\psi$ using ISR at Belle

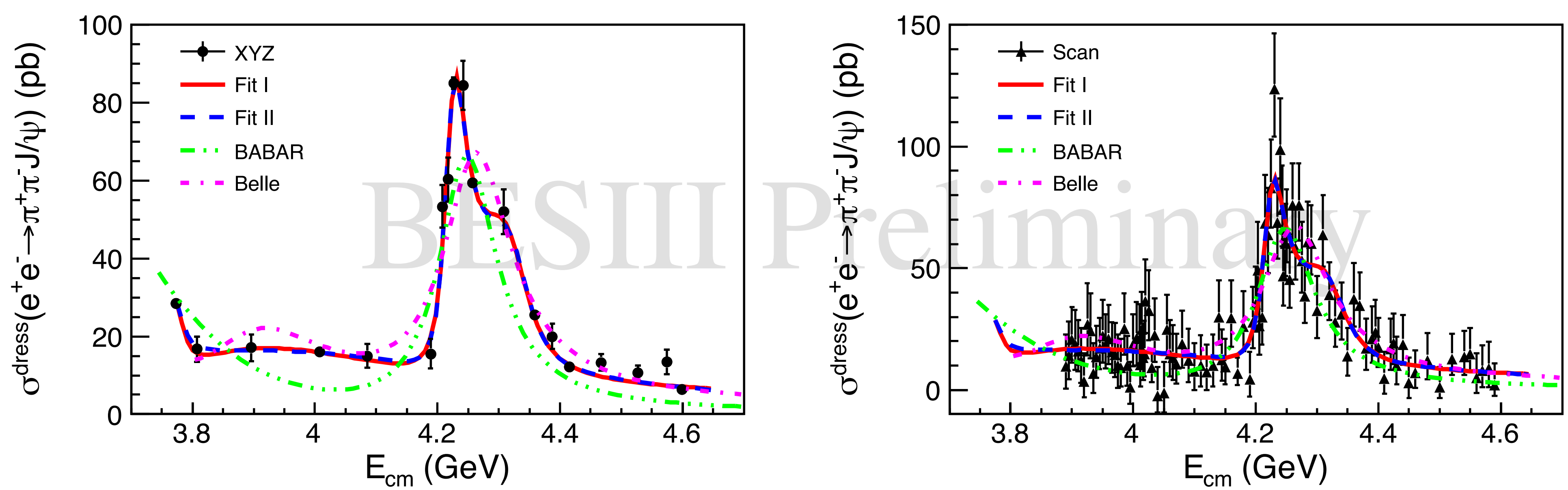
PRL 110, 252002 (2013)



⇒ asymmetric shape?
a low-mass peak ("Y(4008)")?

$e^+e^- \to \pi^+\pi^- J/\psi$ at BESIII (direct)

BESIII Preliminary (NEW!)



Conclusion 1: The cross section is inconsistent with a single peak for the Y(4260)!

Two peaks are favored over one peak by > 7σ.

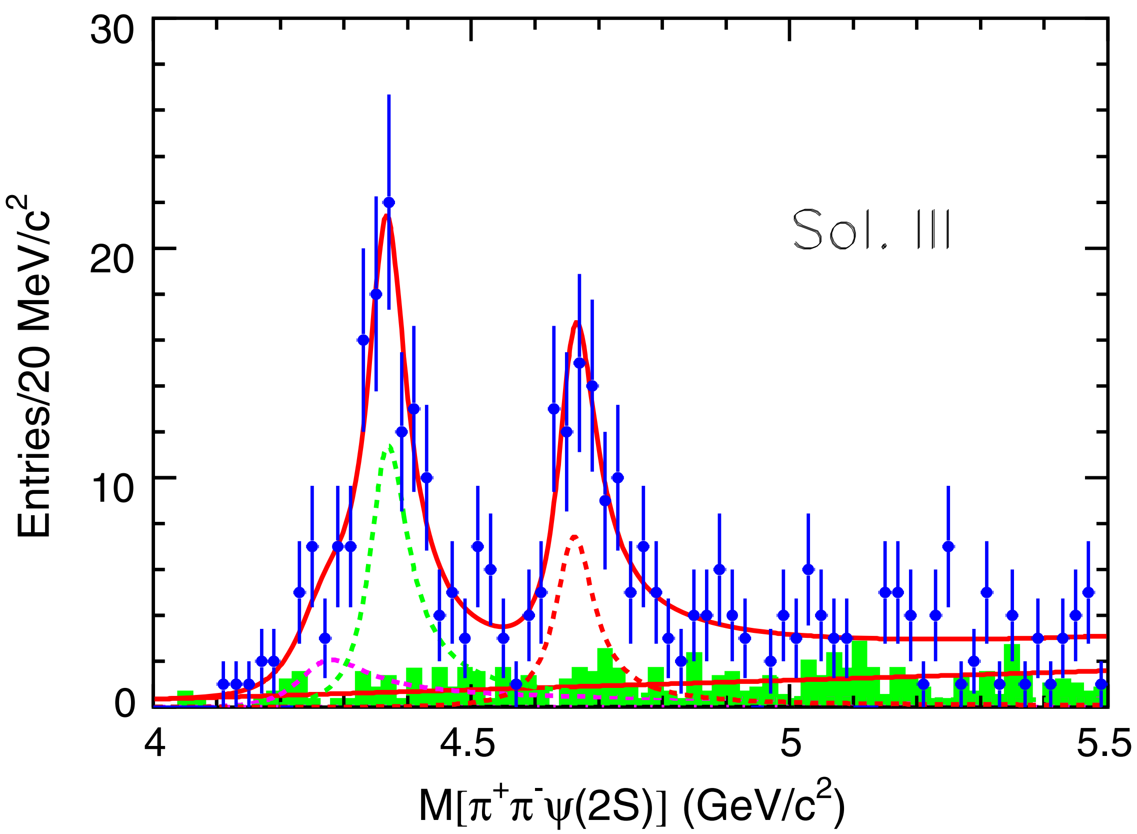
Conclusion 2: The Y(4008) is not needed to describe the BESIII data.

Fit I with a wide low-mass Breit-Wigner is equivalent to
Fit II with an interfering non-resonant exponential shape.

(4) $e^+e^- \to \pi^+\pi^- J/\psi$, $\pi^+\pi^-\psi(2S)$, $\pi^+\pi^- h_c$ and the "Y" States

$e^+e^- \to \pi^+\pi^-\psi(2S)$ using ISR at Belle

PRD 91, 112007 (2015)

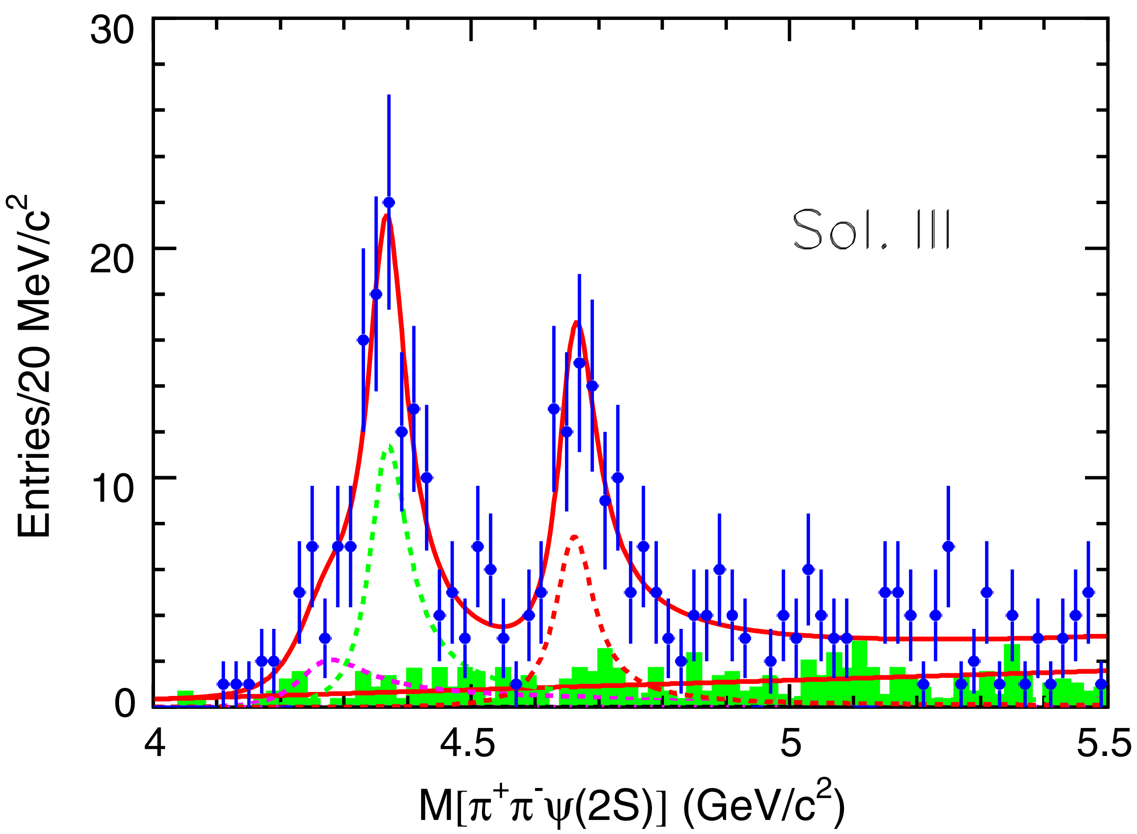


- In $\pi^+\pi^-\psi(2S)$, there are clear indications of the Y(4360) and Y(4660).
- Significance of the Y(4260) is $< 3\sigma$.

(4) $e^+e^- \to \pi^+\pi^- J/\psi$, $\pi^+\pi^-\psi(2S)$, $\pi^+\pi^- h_c$ and the “Y” States

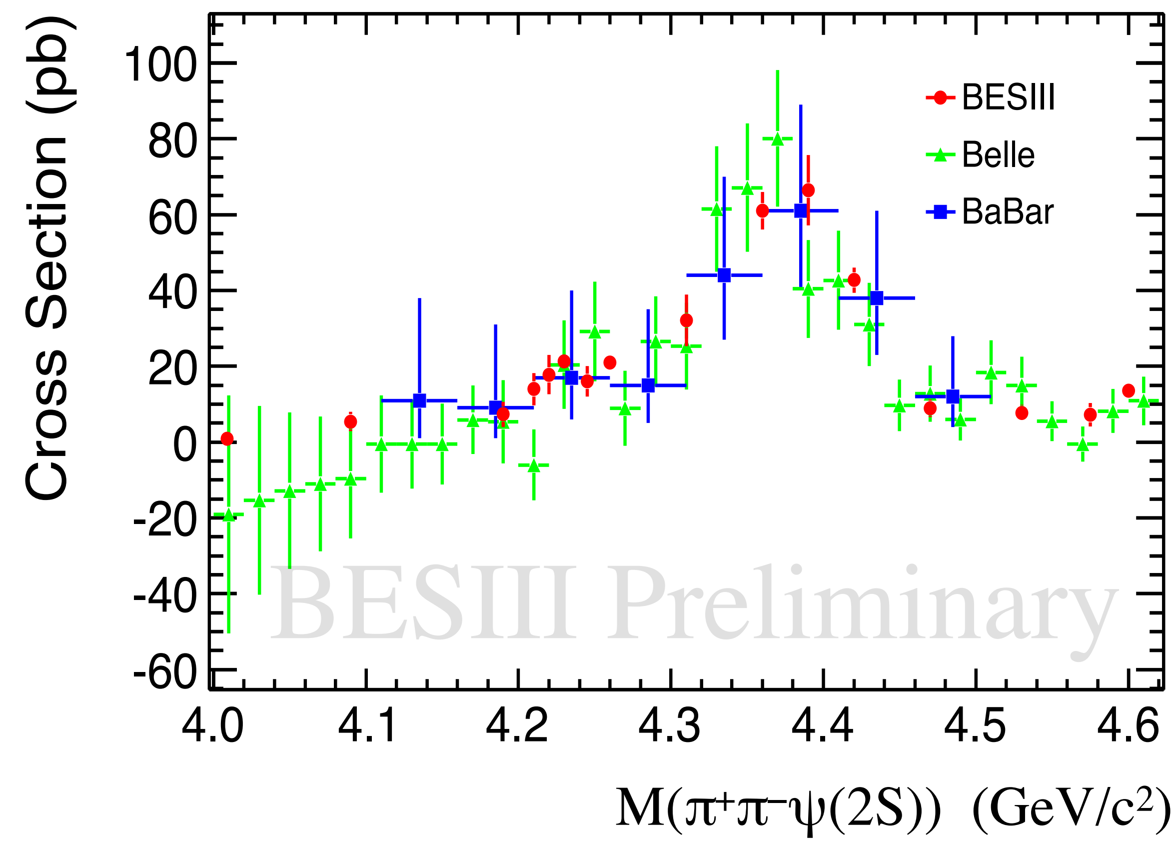
$e^+e^- \to \pi^+\pi^-\psi(2S)$ using ISR at Belle

PRD 91, 112007 (2015)



$e^+e^- \to \pi^+\pi^-\psi(2S)$ at BESIII (direct)

BESIII Preliminary (NEW!)



- In $\pi^+\pi^-\psi(2S)$, there are clear indications of the Y(4360) and Y(4660).
- Significance of the Y(4260) is $< 3\sigma$.

- BESIII confirms the lineshape for the Y(4360).
- More data will be taken soon to thoroughly study the region between 4.2 and 4.3 GeV.
- An analysis of the $\pi^\pm\psi(2S)$ substructure will be released soon.

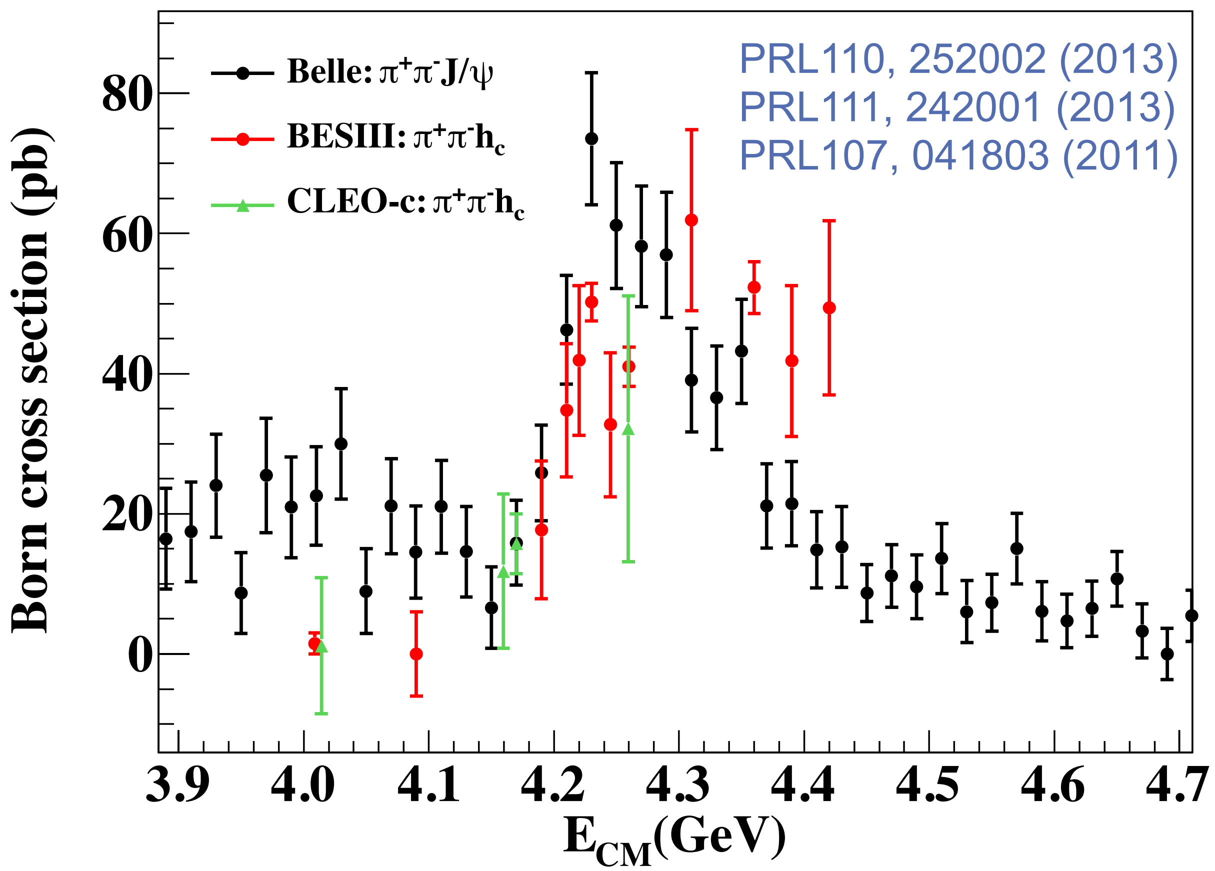
(4) $e^+e^- \rightarrow \pi^+\pi^- J/\psi$, $\pi^+\pi^-\psi(2S)$, $\pi^+\pi^- h_c$ and the "Y" States

$e^+e^- \rightarrow \pi^+\pi^- h_c$ at CLEO and BESIII and $\pi^+\pi^- J/\psi$ at Belle

PRL 107, 041803 (2011)

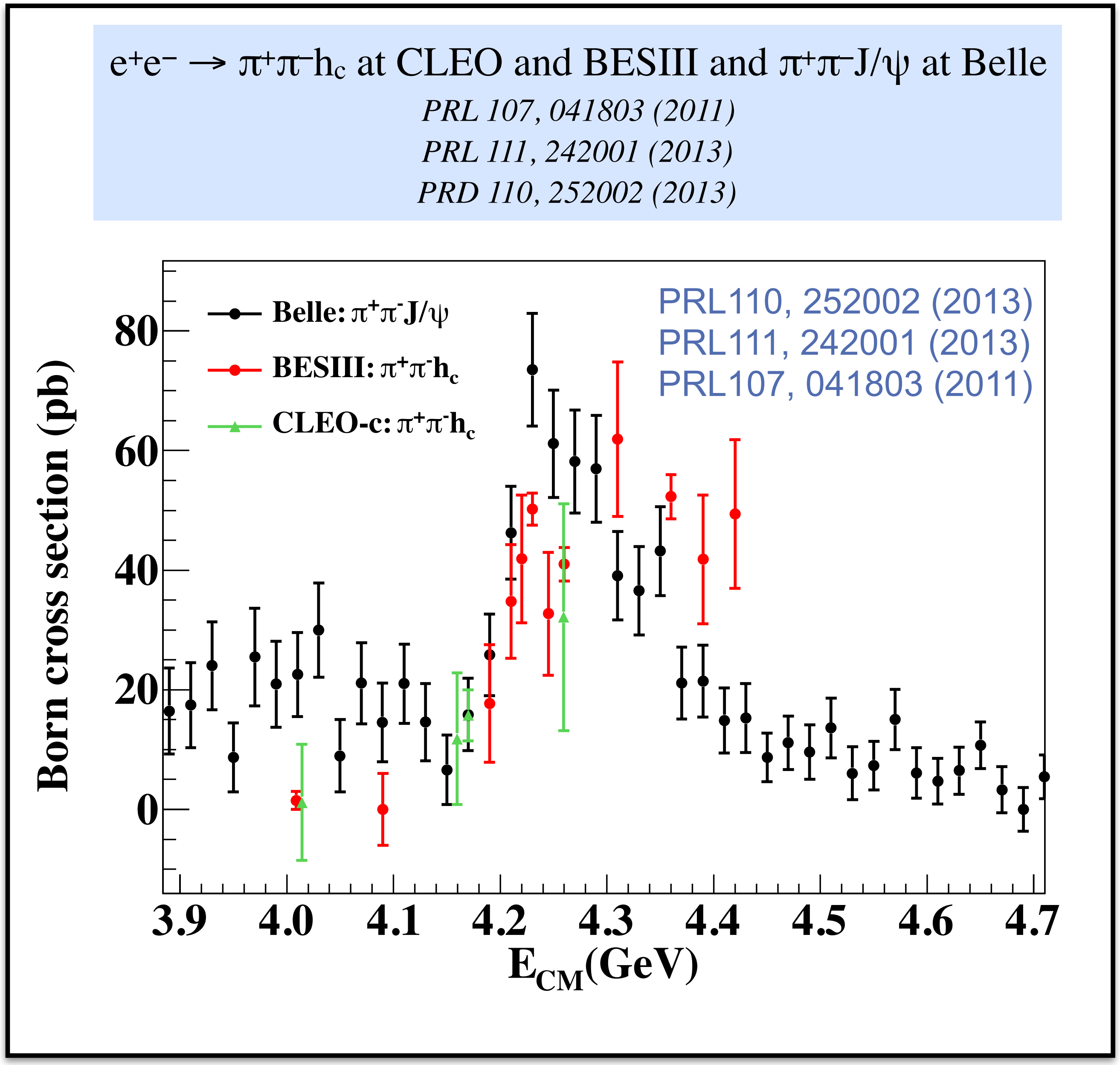
PRL 111, 242001 (2013)

PRD 110, 252002 (2013)

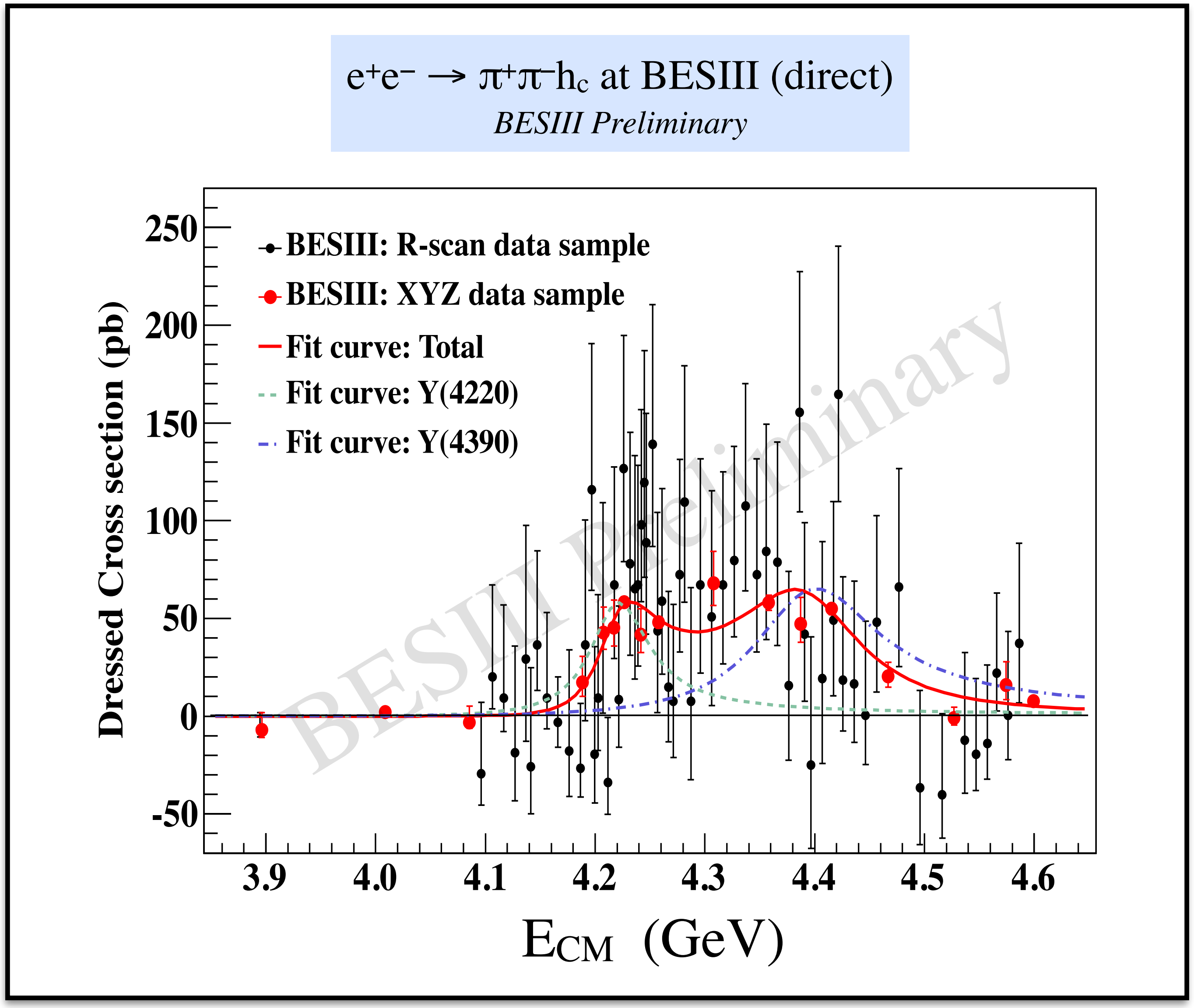


The $\pi^+\pi^- h_c$ shape is clearly different from the $\pi^+\pi^- J/\psi$ shape.

(4) $e^+e^- \to \pi^+\pi^- J/\psi$, $\pi^+\pi^-\psi(2S)$, $\pi^+\pi^- h_c$ and the "Y" States



The $\pi^+\pi^- h_c$ shape is clearly different from the $\pi^+\pi^- J/\psi$ shape.

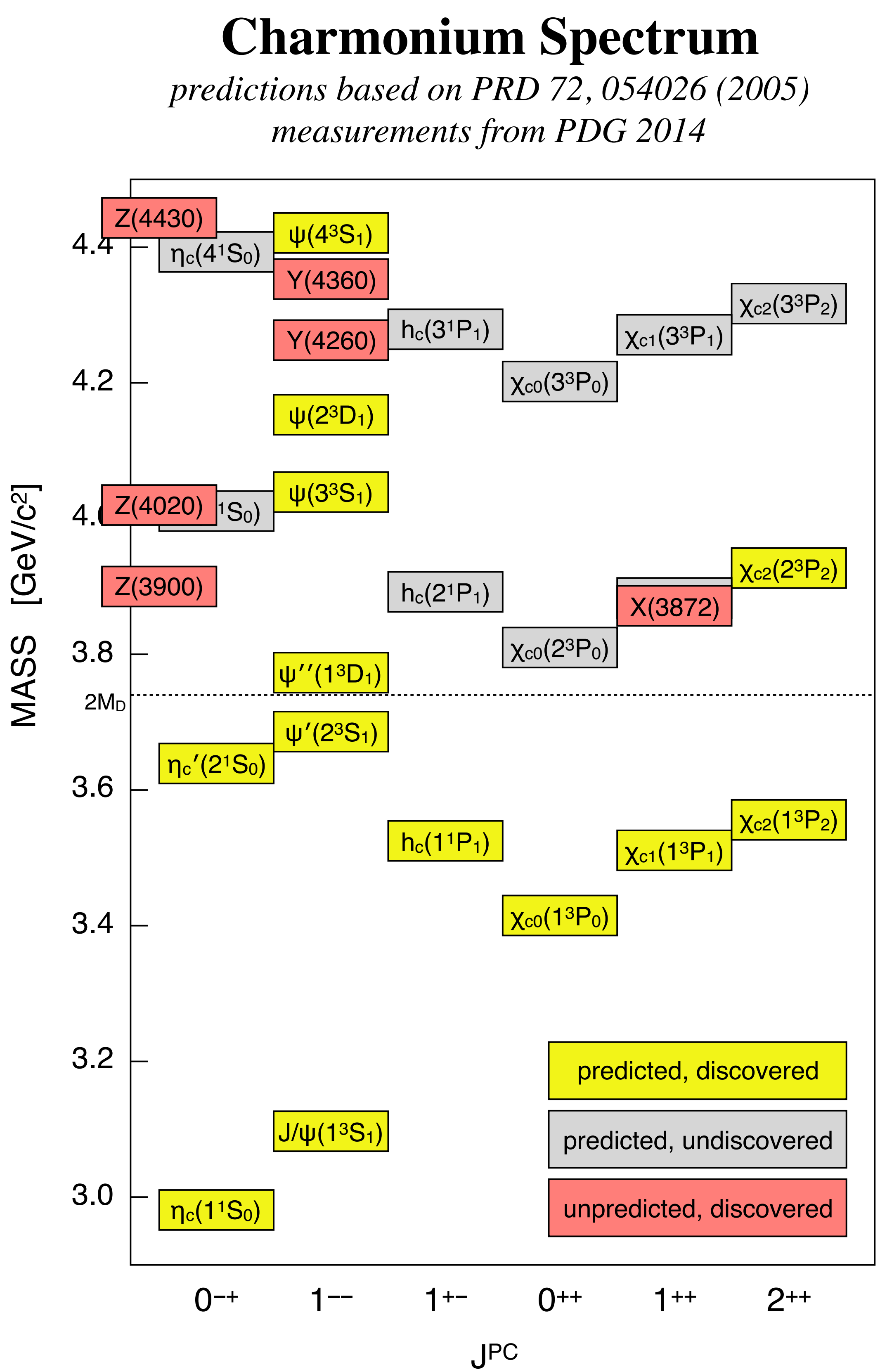


With more data, the $\pi^+\pi^- h_c$ shape appears to be consistent with two peaks:

M (MeV)	Γ_{tot} (MeV)
4218.4±4.0±0.9	66.0±9.0±0.4
4391.6±6.3±1.0	139.5±16.1±0.6

More work is needed to sort out these exclusive cross sections…

BESIII Highlights



A Few Highlights:

(1) $e^+e^- \to \pi^+\pi^-$ and the
Anomalous Magnetic Moment of the Muon
(using ISR data)

(2) $e^+e^- \to p^+p^-$ and the
Electromagnetic Form Factors of the Proton
(using ISR data)

(3) $h_c \to \gamma\eta^{(\prime)}$ and
Studies of Charmonium
(using $\psi(2S)$ data)

(4) $e^+e^- \to \pi^+\pi^- J/\psi$, $\pi^+\pi^-\psi(2S)$, $\pi^+\pi^- h_c$
and the “Y” States
(using “XYZ” data)

(5) $e^+e^- \to \gamma\pi^+\pi^- J/\psi$ and $\gamma\phi J/\psi$
and the “X” States
(using “XYZ” data)

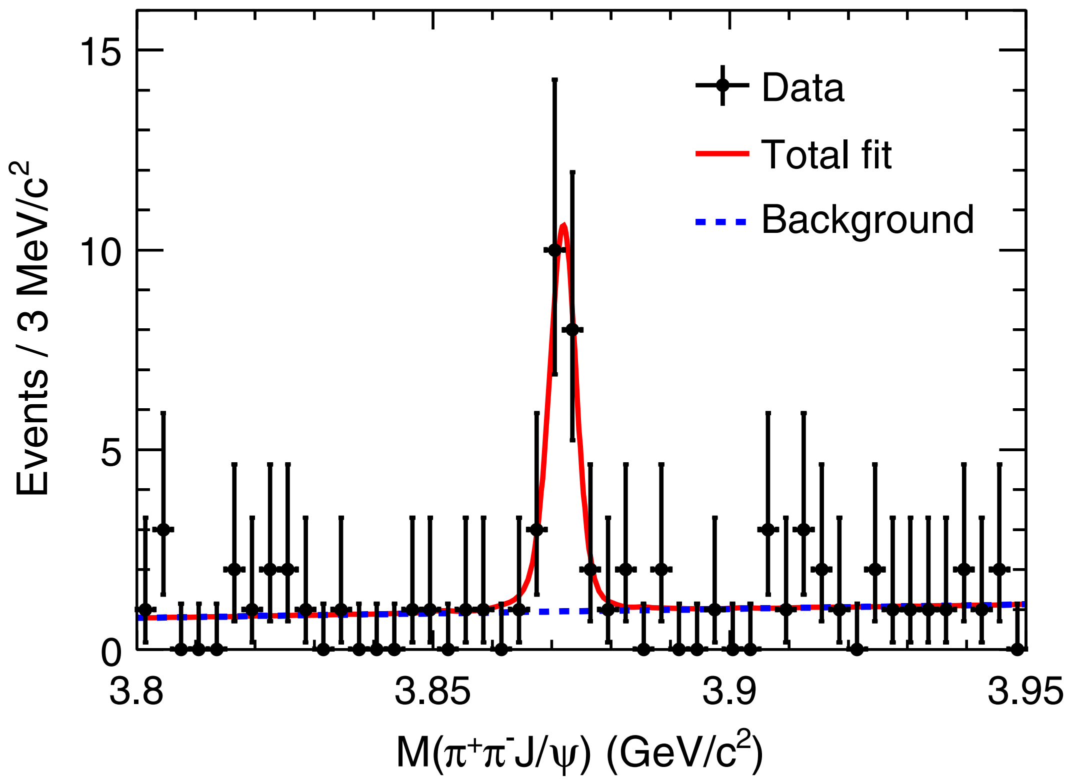
(5) $e^+e^- \to \gamma\pi^+\pi^- J/\psi$ and $\gamma\phi J/\psi$ and the "X" States

The X(3872) ($J^{PC} = 1^{++}$) is the first-discovered and best-studied of the XYZ states.
It was discovered in 2003 by Belle in $B \to K(\pi^+\pi^- J/\psi)$ *(PRL 91, 262001 (2003))*

(5) $e^+e^- \to \gamma\pi^+\pi^- J/\psi$ and $\gamma\phi J/\psi$ and the "X" States

The X(3872) ($J^{PC} = 1^{++}$) is the first-discovered and best-studied of the XYZ states.
It was discovered in 2003 by Belle in $B \to K(\pi^+\pi^- J/\psi)$ *(PRL 91, 262001 (2003))*

$e^+e^- \to \gamma(\pi^+\pi^- J/\psi)$ at BESIII
PRL 112, 092001 (2014)

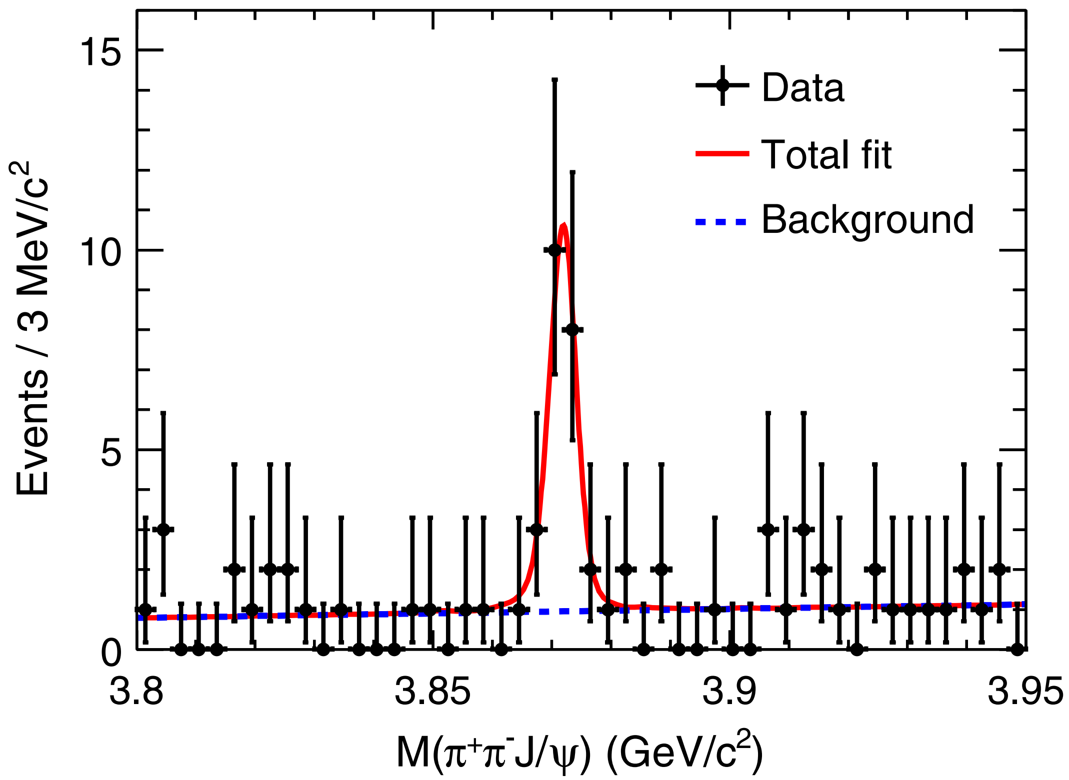


BESIII sees clear evidence for $e^+e^- \to \gamma X(3872)$.

(5) $e^+e^- \to \gamma\pi^+\pi^- J/\psi$ and $\gamma\phi J/\psi$ and the "X" States

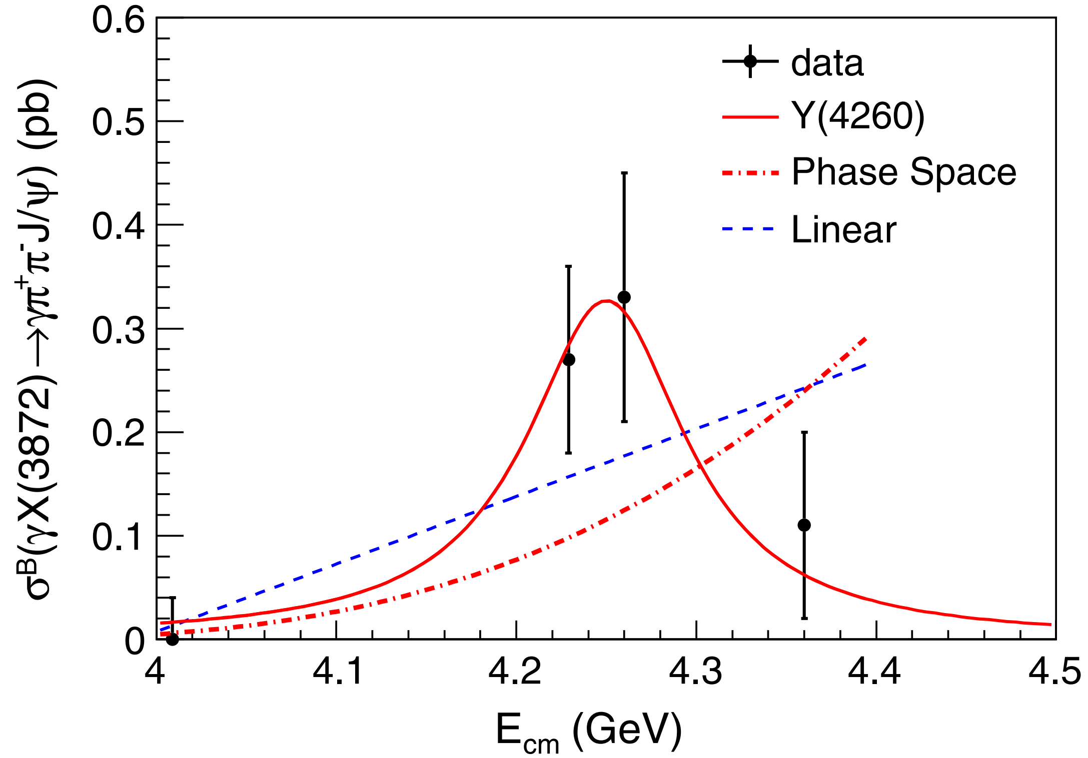
The X(3872) ($J^{PC} = 1^{++}$) is the first-discovered and best-studied of the XYZ states.
It was discovered in 2003 by Belle in $B \to K(\pi^+\pi^- J/\psi)$ *(PRL 91, 262001 (2003))*

$e^+e^- \to \gamma(\pi^+\pi^- J/\psi)$ at BESIII
PRL 112, 092001 (2014)



BESIII sees clear evidence for $e^+e^- \to \gamma X(3872)$.

$e^+e^- \to \gamma(\pi^+\pi^- J/\psi)$ at BESIII
PRL 112, 092001 (2014)



The cross section shape for $e^+e^- \to \gamma X(3872)$ hints that it may proceed through a Y, but more data is needed.

Radiative transitions provide another route to access the XYZ.

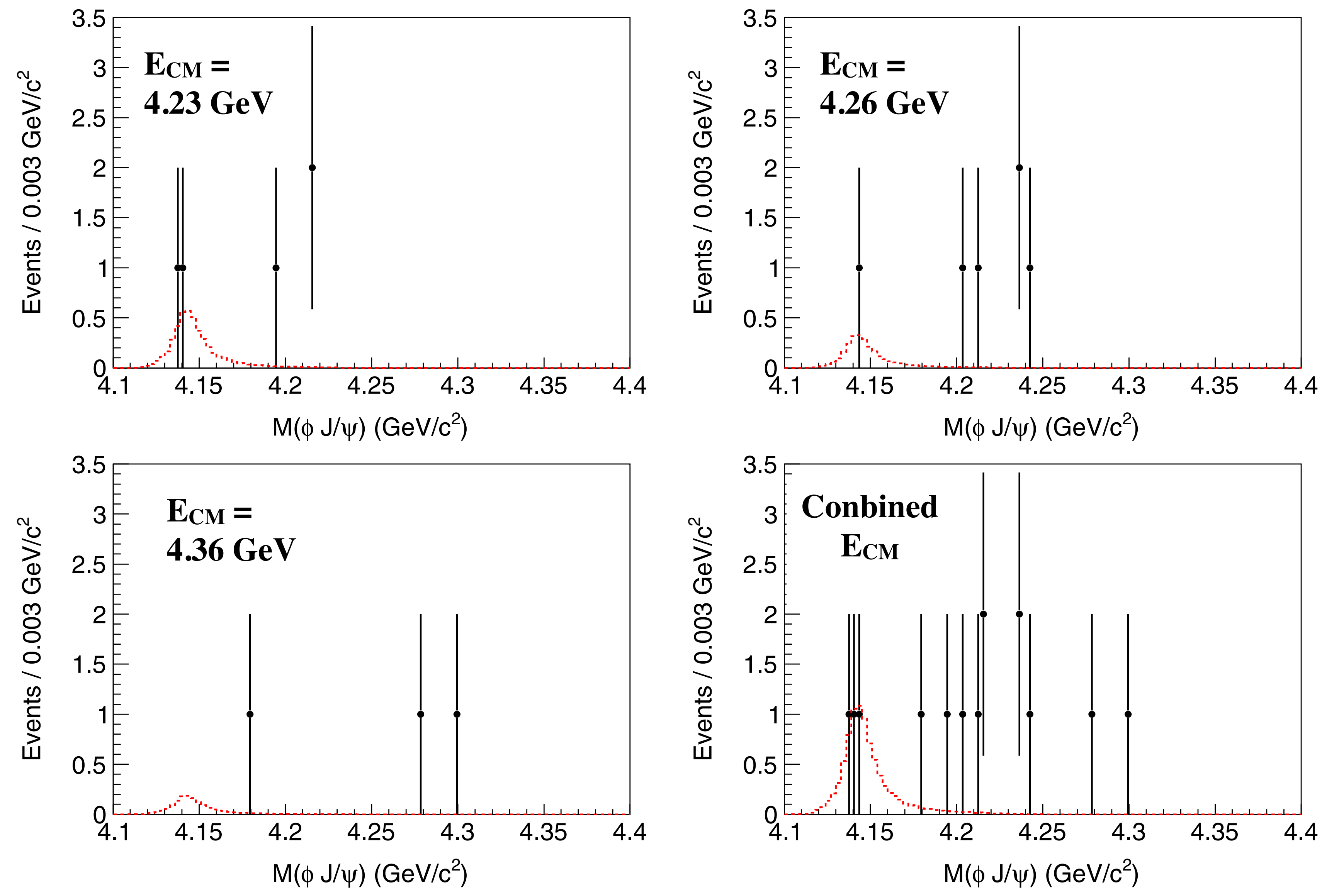
(5) $e^+e^- \to \gamma\pi^+\pi^- J/\psi$ and $\gamma\phi J/\psi$ and the "X" States

The X(4140) (or "Y(4140)") was recently confirmed at LHCb *(arXiv:1606.07898)* with $J^{PC} = 1^{++}$ in $B \to K(\phi J/\psi)$.

(5) $e^+e^- \to \gamma\pi^+\pi^- J/\psi$ and $\gamma\phi J/\psi$ and the "X" States

The X(4140) (or "Y(4140)") was recently confirmed at LHCb *(arXiv:1606.07898)* with $J^{PC} = 1^{++}$ in $B \to K(\phi J/\psi)$.

$e^+e^- \to \gamma(\phi J/\psi)$ at BESIII
PRD 91, 032002 (2015)

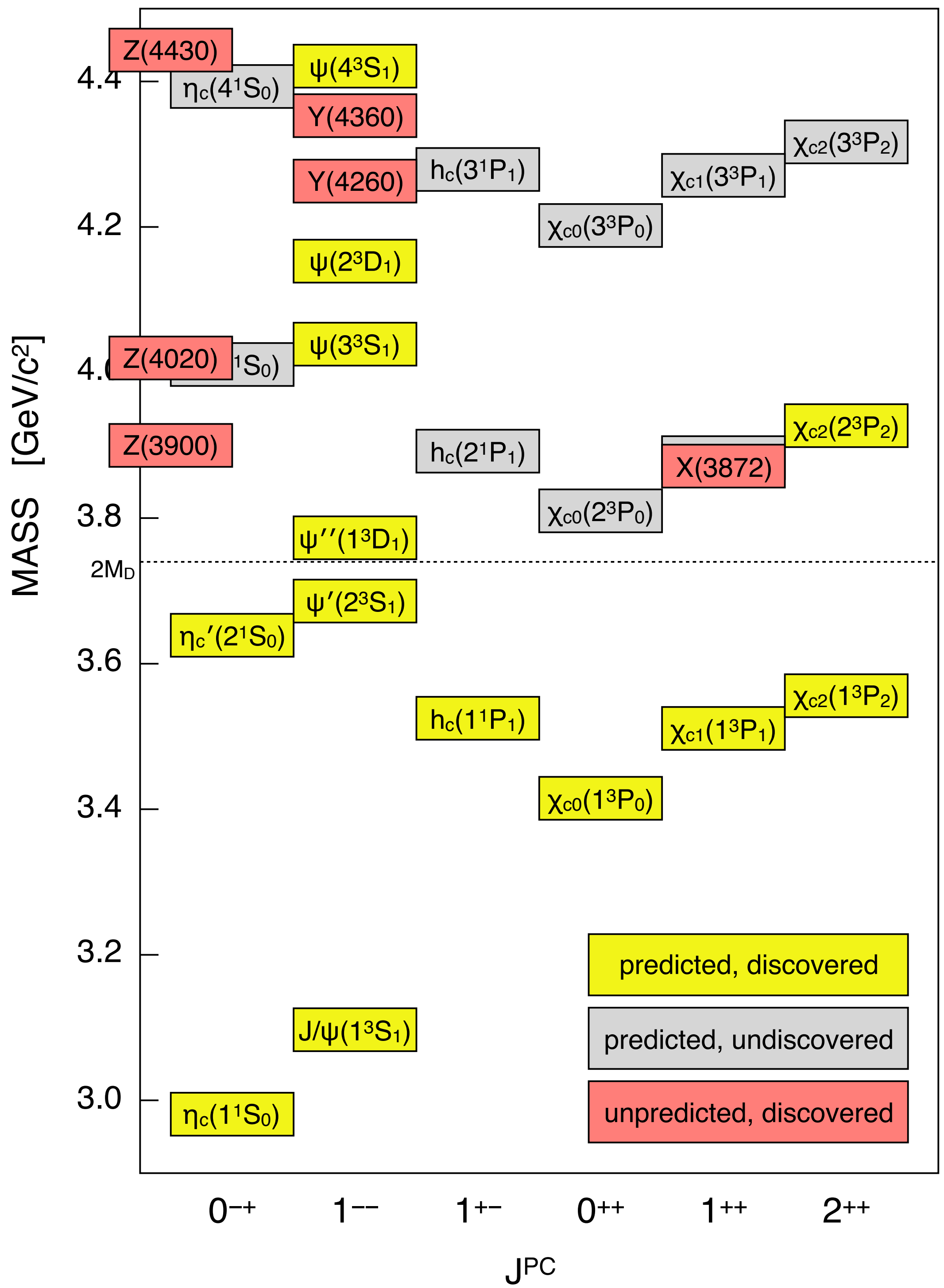


BESIII sets upper limits for $e^+e^- \to \gamma Y(4140)$ with $Y(4140) \to \phi J/\psi$.

BESIII Highlights

Charmonium Spectrum

predictions based on PRD 72, 054026 (2005)
measurements from PDG 2014



A Few Highlights:

(1) $e^+e^- \to \pi^+\pi^-$ and the
Anomalous Magnetic Moment of the Muon
(using ISR data)

(2) $e^+e^- \to p^+p^-$ and the
Electromagnetic Form Factors of the Proton
(using ISR data)

(3) $h_c \to \gamma\eta^{(\prime)}$ and
Studies of Charmonium
(using $\psi(2S)$ data)

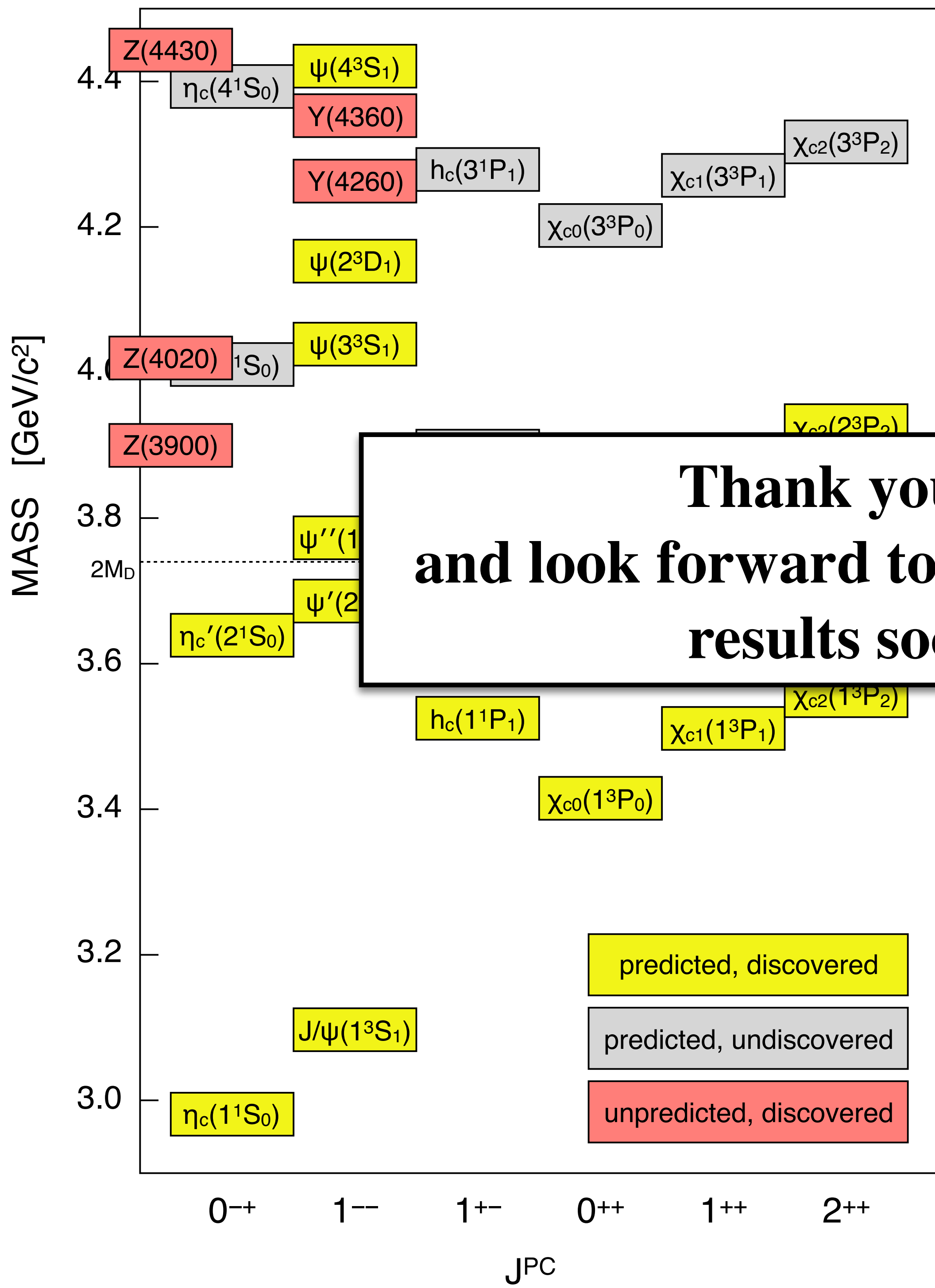
(4) $e^+e^- \to \pi^+\pi^- J/\psi$, $\pi^+\pi^-\psi(2S)$, $\pi^+\pi^- h_c$
and the "Y" States
(using "XYZ" data)

(5) $e^+e^- \to \gamma\pi^+\pi^- J/\psi$ and $\gamma\phi J/\psi$
and the "X" States
(using "XYZ" data)

BESIII Highlights

Charmonium Spectrum

predictions based on PRD 72, 054026 (2005)
measurements from PDG 2014



Thank you…
and look forward to more BESIII results soon!

A Few Highlights:

(1) $e^+e^- \to \pi^+\pi^-$ and the
Anomalous Magnetic Moment of the Muon
(using ISR data)

(2) $e^+e^- \to p^+p^-$ and the
Electromagnetic Form Factors of the Proton
(using ISR data)

(3) $h_c \to \gamma\eta^{(\prime)}$ and
Studies of Charmonium
(using $\psi(2S)$ data)

(4) $e^+e^- \to \pi^+\pi^- J/\psi$, $\pi^+\pi^-\psi(2S)$, $\pi^+\pi^- h_c$
and the "Y" States
(using "XYZ" data)

(5) $e^+e^- \to \gamma\pi^+\pi^- J/\psi$ and $\gamma\phi J/\psi$
and the "X" States
(using "XYZ" data)