

Status of XYZ states at BESIII

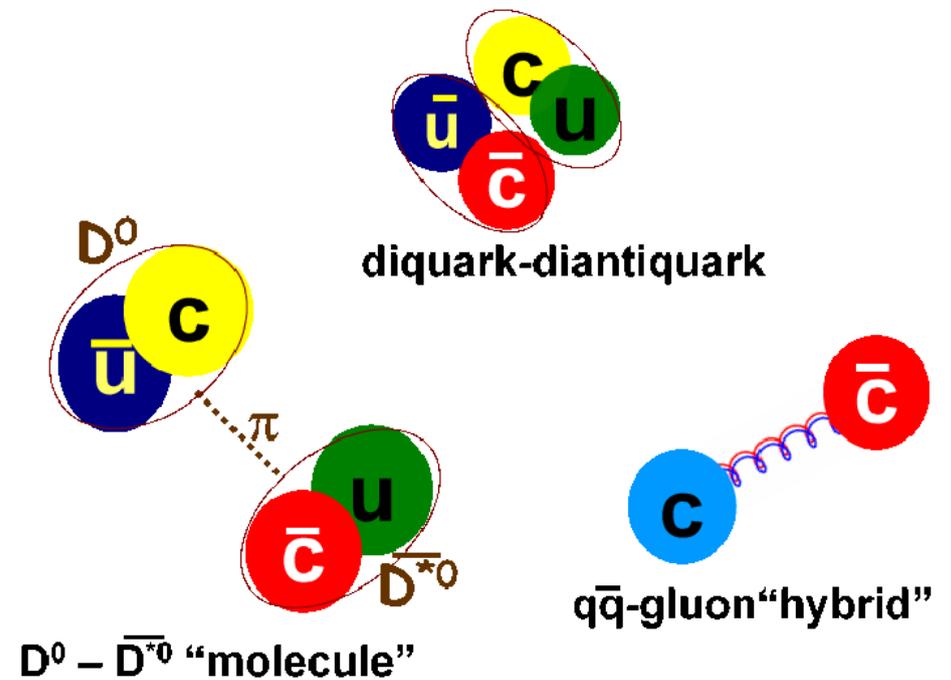
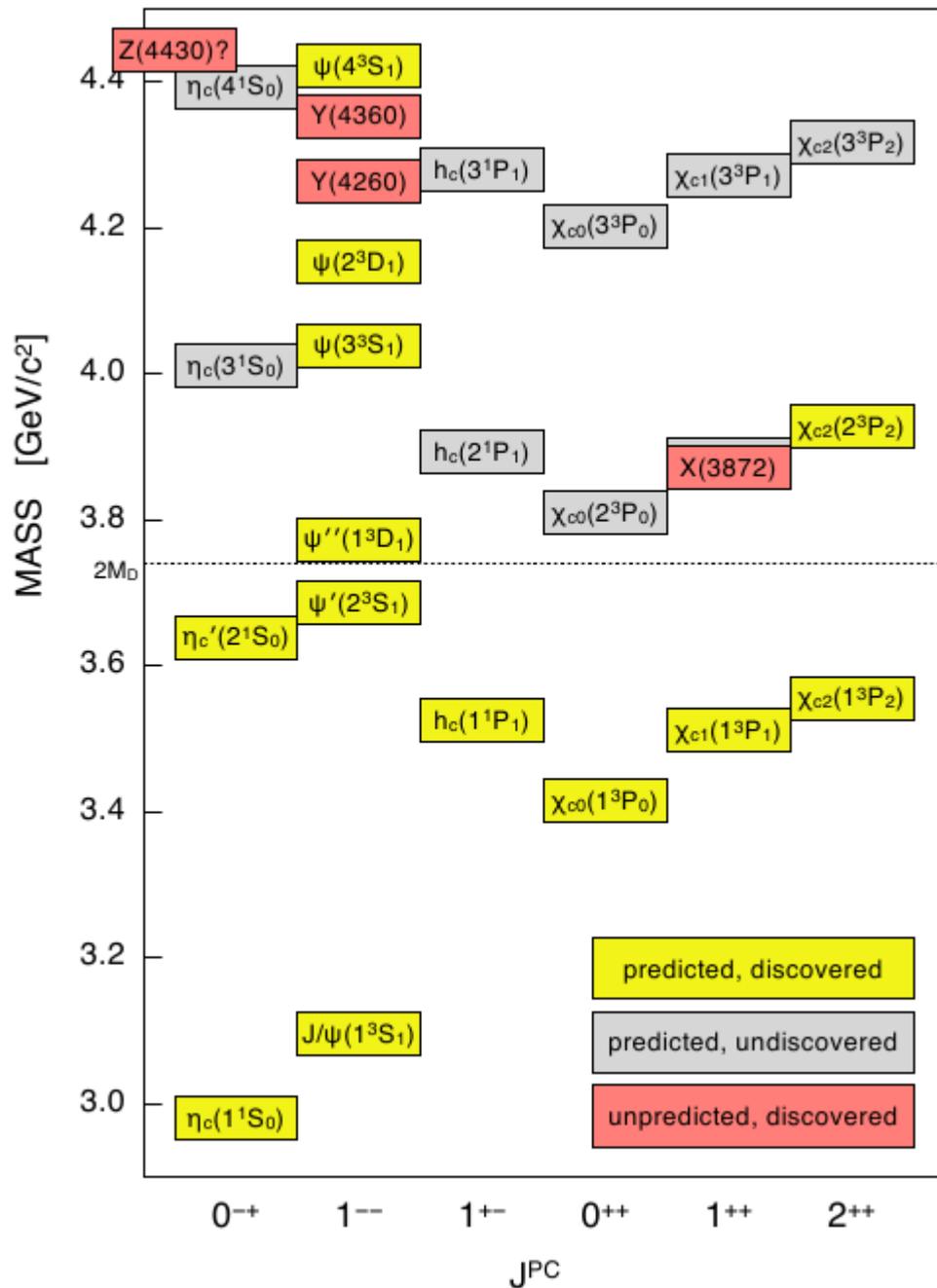
A.Kupsc

for the **BESIII** Collaboration

- $Z_c(3900)$, $Z_c(4020)$ states in $e^+e^- \rightarrow \pi\pi J/\psi$, $\pi\pi h_c$, $D\bar{D}^*$, $D^*\bar{D}^*$
- $e^+e^- \rightarrow \gamma X(3872)$
- $e^+e^- \rightarrow \omega\chi_{c0}$



Charmonium(- like) states before 2013

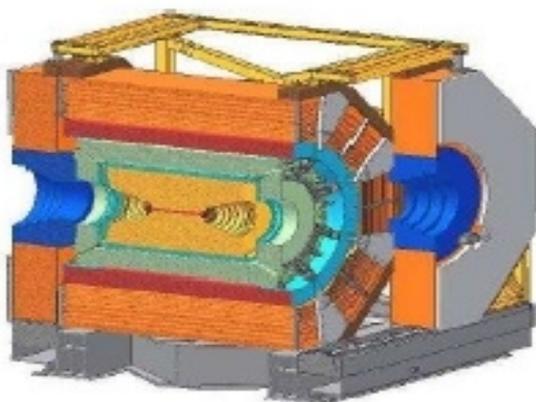


BEPCII (Beijing)

Linac

Storage ring

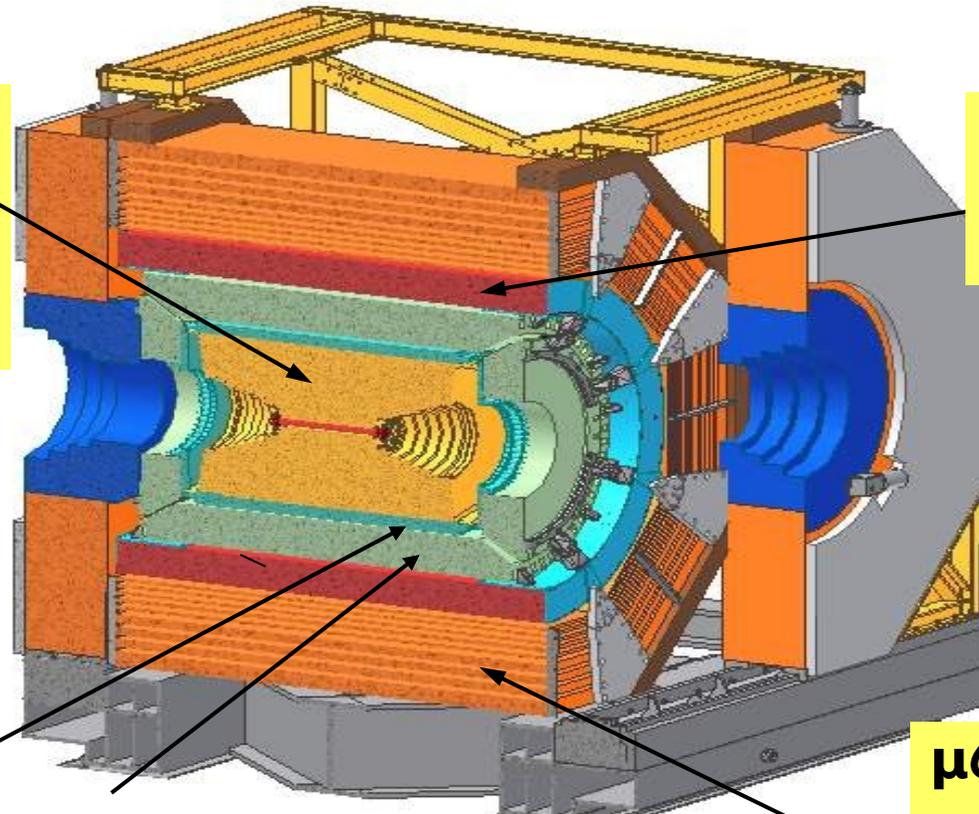
BESIII at BEPCII



τ -charm factory $2 < \sqrt{s} < 4.6$ GeV:

- Charmonium spectroscopy/decays
- Light hadron physics
- Charm physics
- τ physics
- R-scan

BESIII Detector



Drift Chamber (MDC)
 $\sigma_{P/P} = 0.5\% (1\text{ GeV})$
 $\sigma(dE/dx) = 6\%$

Superconducting magnet (1.0 Tesla)

Time Of Flight (TOF)
 $\sigma(t) : 90 \text{ ps Barrel}$
 110 ps endcap

EMC : $\sigma_{E/\sqrt{E}} = 2.5\% (1 \text{ GeV})$
(CsI) $\sigma_{z\phi} (\text{cm}) = 0.5 - 0.7 \text{ cm}/\sqrt{E}$

μ Counter
8- 9 layers RPC
 $\delta R\Phi = 1.4 - 1.7 \text{ cm}$

BESIII Collaboration

US (6)
Univ. of Hawaii
Univ. of Washington
Carnegie Mellon Univ.
Univ. of Minnesota
Univ. of Rochester
Univ. of Indiana

Germany (5)
Univ. of Bochum, Univ. of Giessen, GSI, Univ. of Johannes Gutenberg, Helmholtz Ins. In Mainz

Pakistan (2)
Univ. of Punjab
COMSAT CIIT

Italy (3)
Univ. of Torino, Frascati Lab, Univ. of Ferrara

Korea (1)
Seoul Nat. Univ.

Russia (2)
JINR Dubna, BINP Novosibirsk

Japan (1)
Tokyo Univ

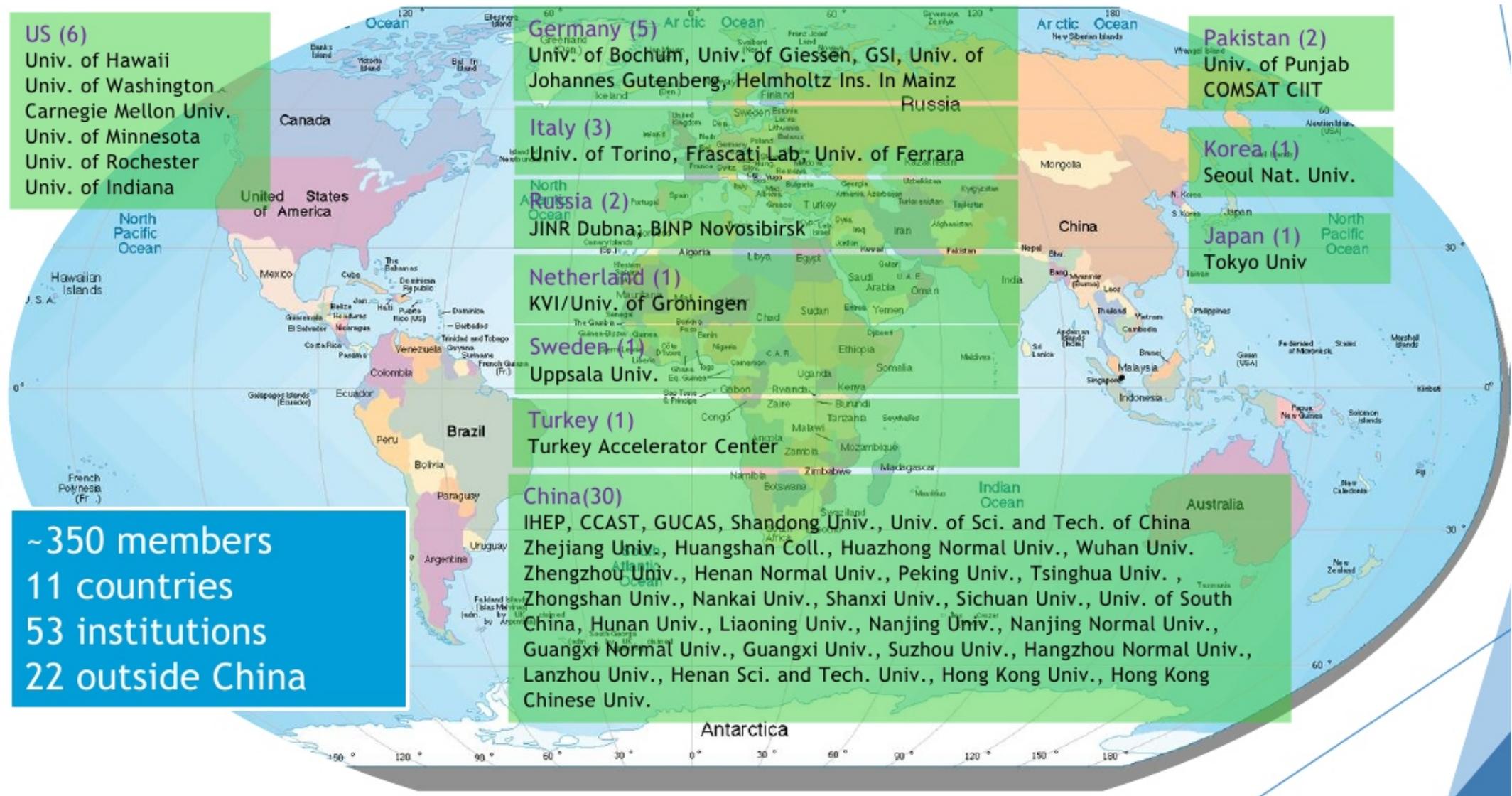
Netherlands (1)
KVI/Univ. of Groningen

Sweden (1)
Uppsala Univ.

Turkey (1)
Turkey Accelerator Center

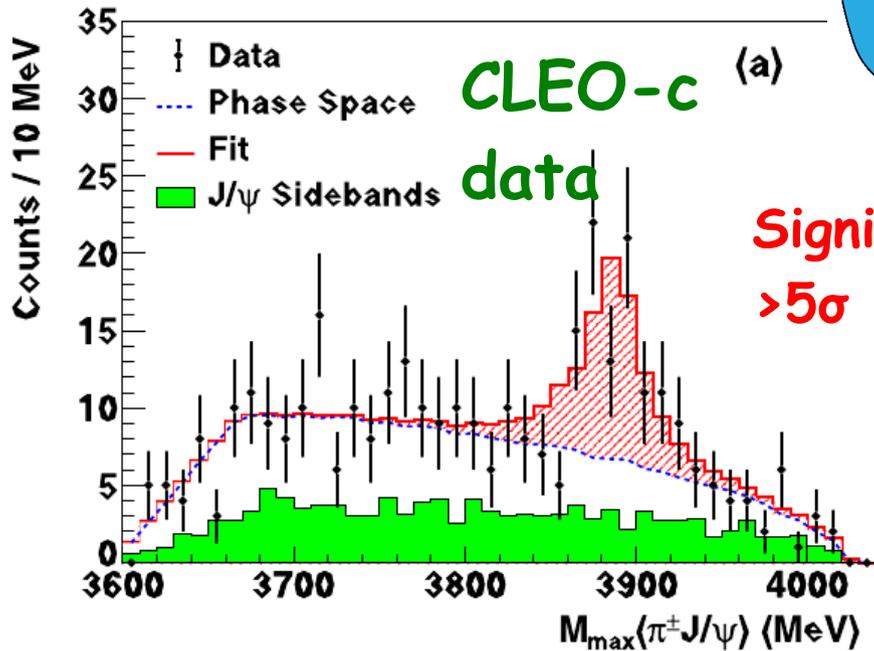
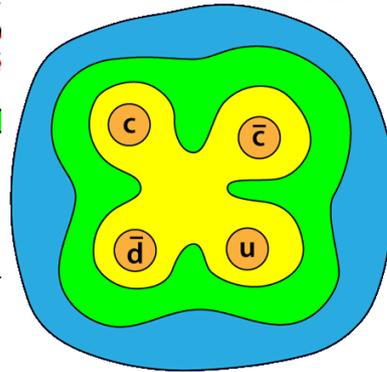
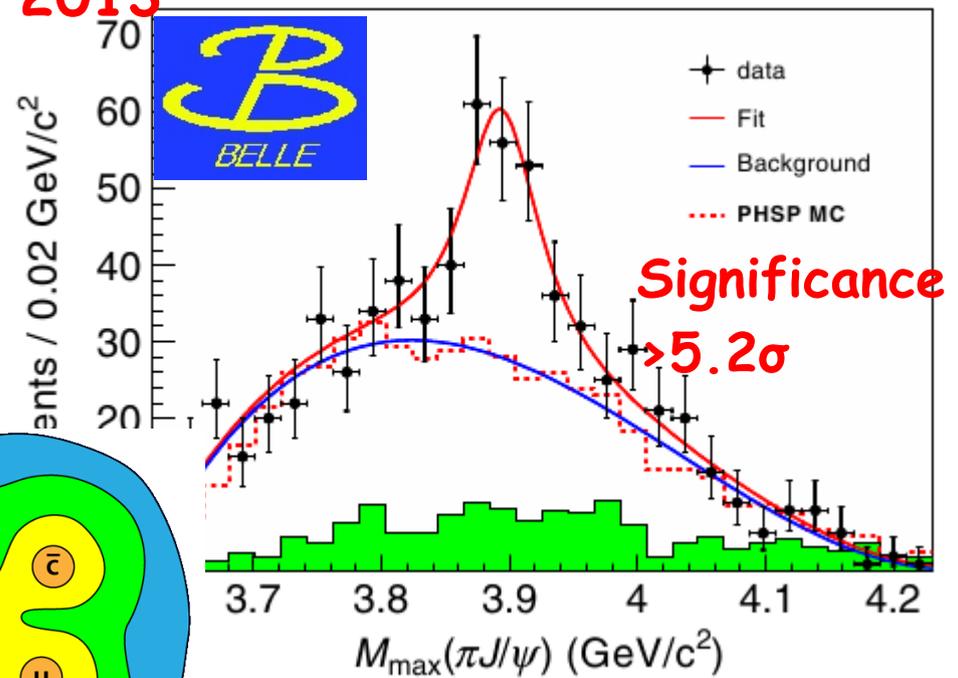
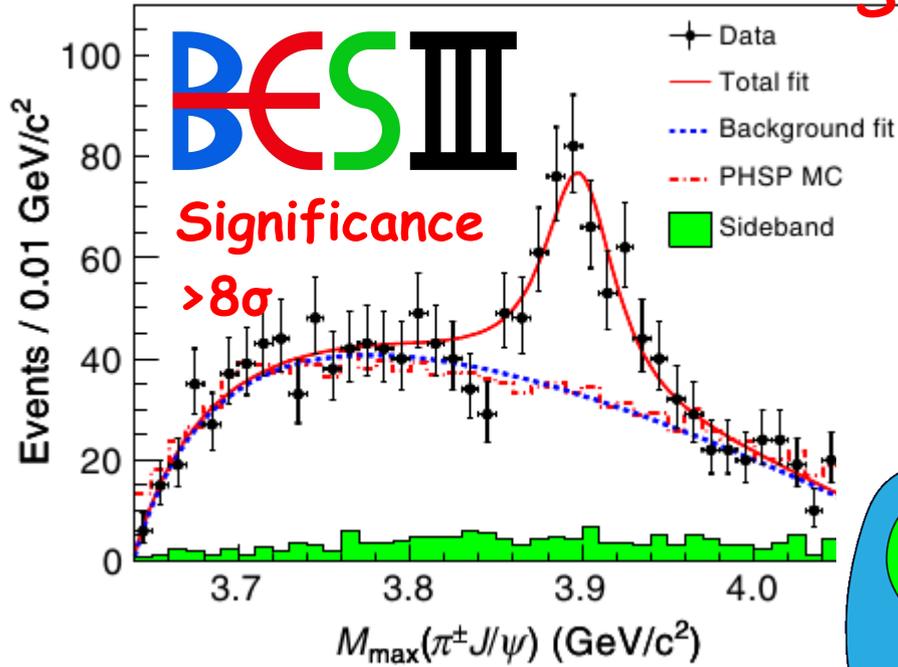
China (30)
IHEP, CCAST, GUCAS, Shandong Univ., Univ. of Sci. and Tech. of China, Zhejiang Univ., Huangshan Coll., Huazhong Normal Univ., Wuhan Univ., Zhengzhou Univ., Henan Normal Univ., Peking Univ., Tsinghua Univ., Zhongshan Univ., Nankai Univ., Shanxi Univ., Sichuan Univ., Univ. of South China, Hunan Univ., Liaoning Univ., Nanjing Univ., Nanjing Normal Univ., Guangxi Normal Univ., Guangxi Univ., Suzhou Univ., Hangzhou Normal Univ., Lanzhou Univ., Henan Sci. and Tech. Univ., Hong Kong Univ., Hong Kong Chinese Univ.

~350 members
11 countries
53 institutions
22 outside China



Observation of $Z_c^\pm(3900)$ in $e^+e^- \rightarrow \pi^+\pi^-J/\psi$

Spring 2013



- Couples to $c\bar{c}$
- Has electric charge
- At least 4-quarks

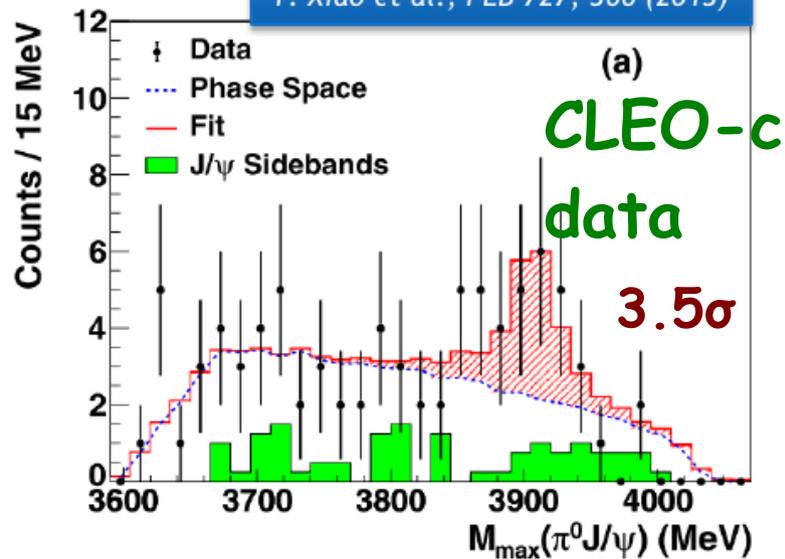
BESIII: PRL 110 252001 0.5fb^{-1} @4.26 GeV

BELLE: PRL 110 252002

CLEO-c data: PLB 727, 366

Observation of $Z_c^0(3900)$ in $e^+e^- \rightarrow \pi^0\pi^0J/\psi$

T. Xiao et al., PLB 727, 366 (2013)

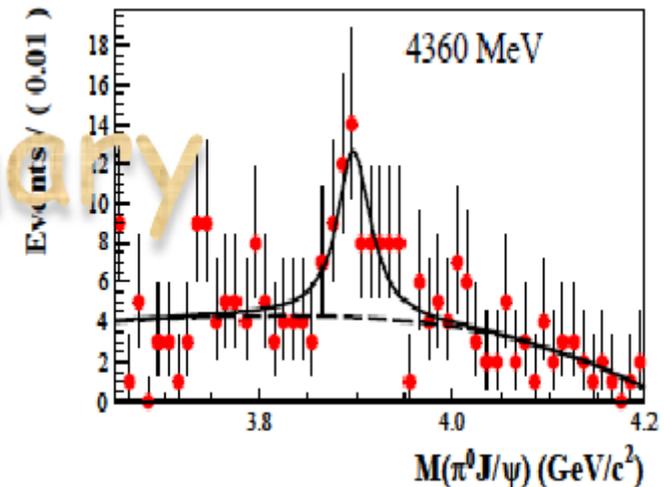
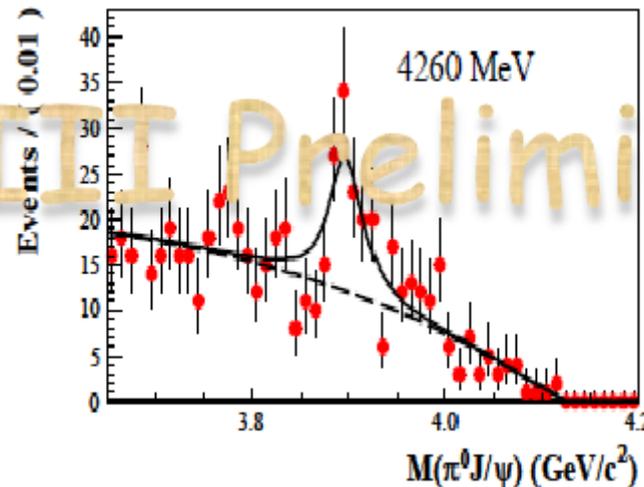
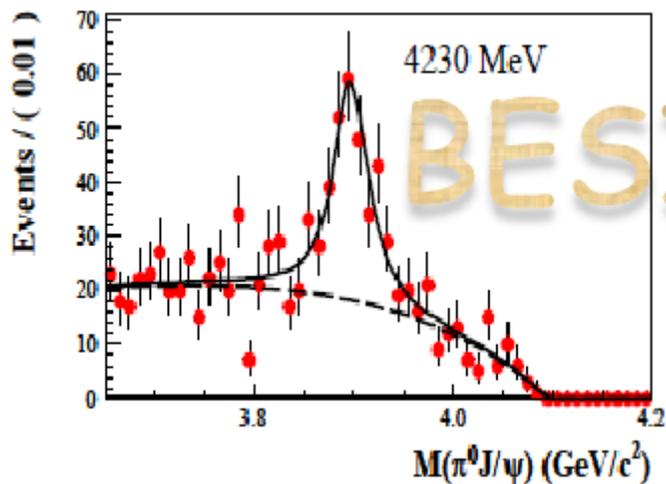


BESIII

New BESIII data:

2.8 fb⁻¹ at 10 energies: 4.26 - 4.42 GeV

$Z_c^0(3900)$ observed with significance >10.4 σ



Observation of $Z_c^0(3900)$ in $e^+e^- \rightarrow \pi^0\pi^0 J/\psi$

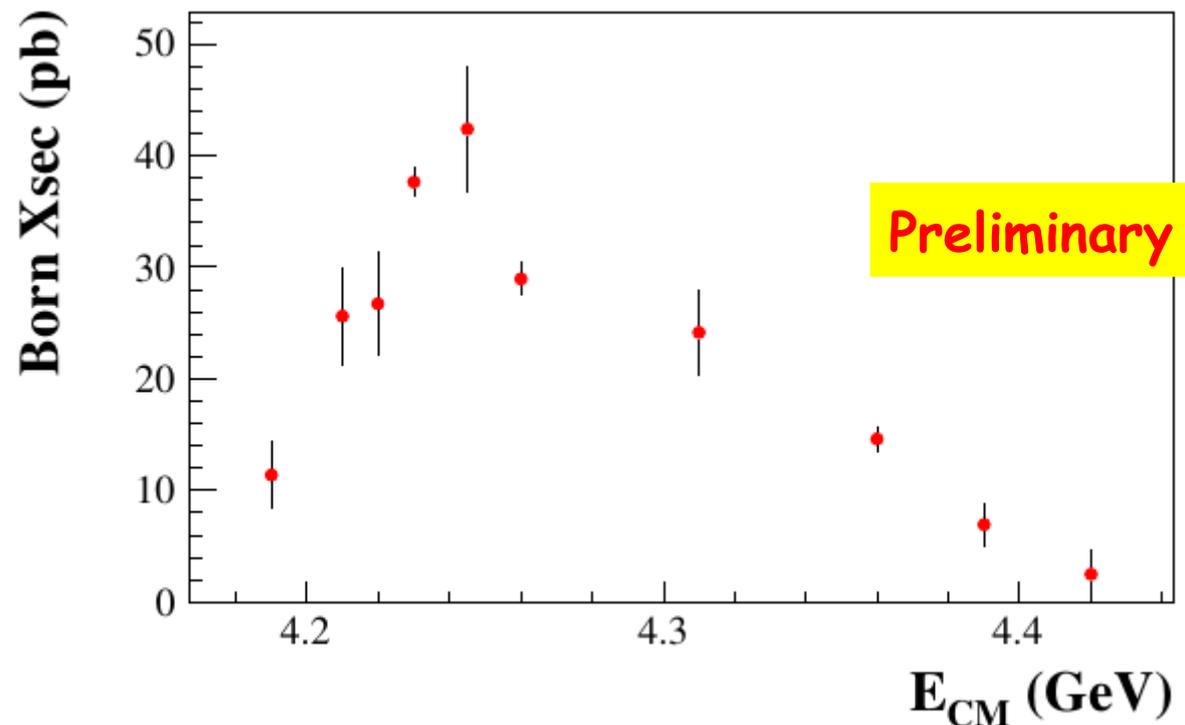
parameters extracted from simultaneous fit to the $\pi^0 J/\psi$ invariant mass distributions for:

4230 MeV, 4260 MeV and 4360 MeV subsamples.

$$M = 3894.8 \pm 2.3 \text{ MeV}$$

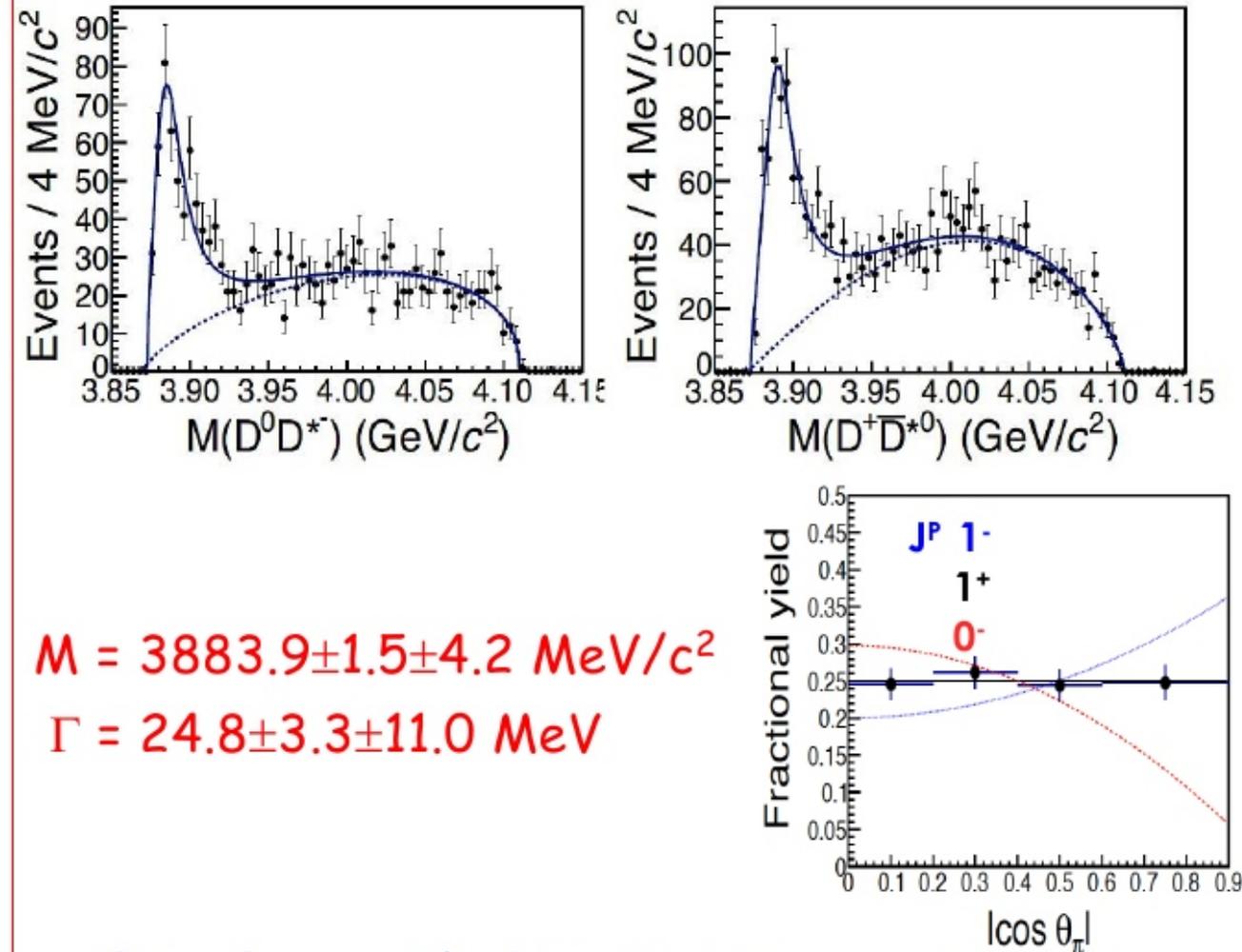
$$\Gamma = 29.6 \pm 8.2 \text{ MeV}$$

Preliminary yields of $Z_c^0(3900)$, at 10 energy points:



Nature of Zc(3900) and observation of Zc(4020)

$$e^+e^- \rightarrow \pi^- (D^* \bar{D})^+$$



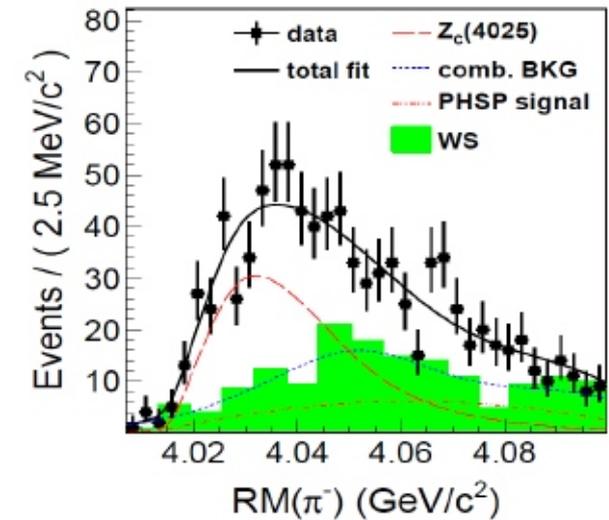
$$M = 3883.9 \pm 1.5 \pm 4.2 \text{ MeV}/c^2$$

$$\Gamma = 24.8 \pm 3.3 \pm 11.0 \text{ MeV}$$

- fits favor 1⁺ distribution assumption

PRL 112, 022001 (2014)

$$e^+e^- \rightarrow \pi^- (D^* \bar{D}^*)^+$$



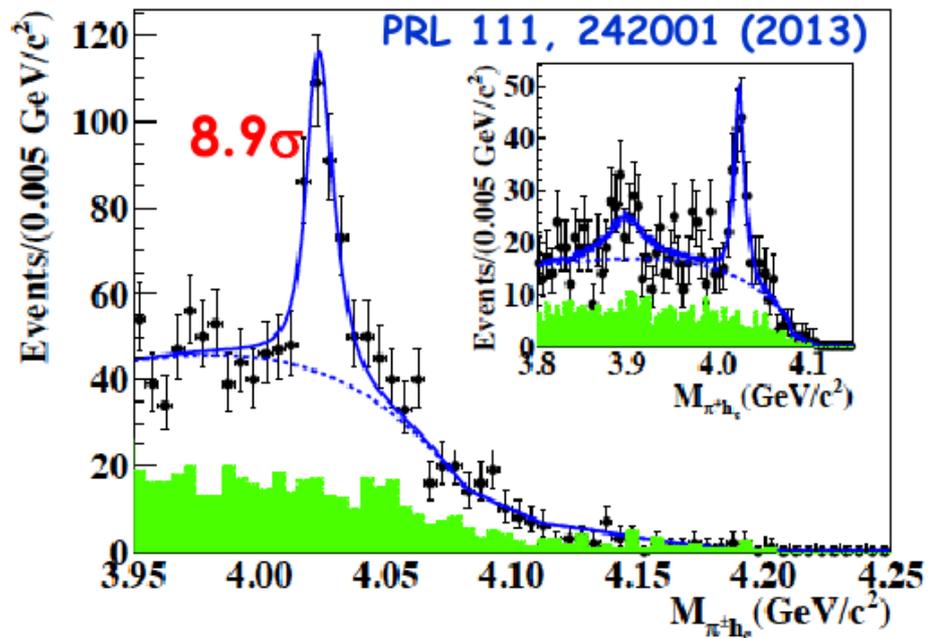
$$M = 4026.3 \pm 2.6 \pm 3.7 \text{ MeV}/c^2$$

$$\Gamma = 24.8 \pm 5.6 \pm 7.7 \text{ MeV}$$

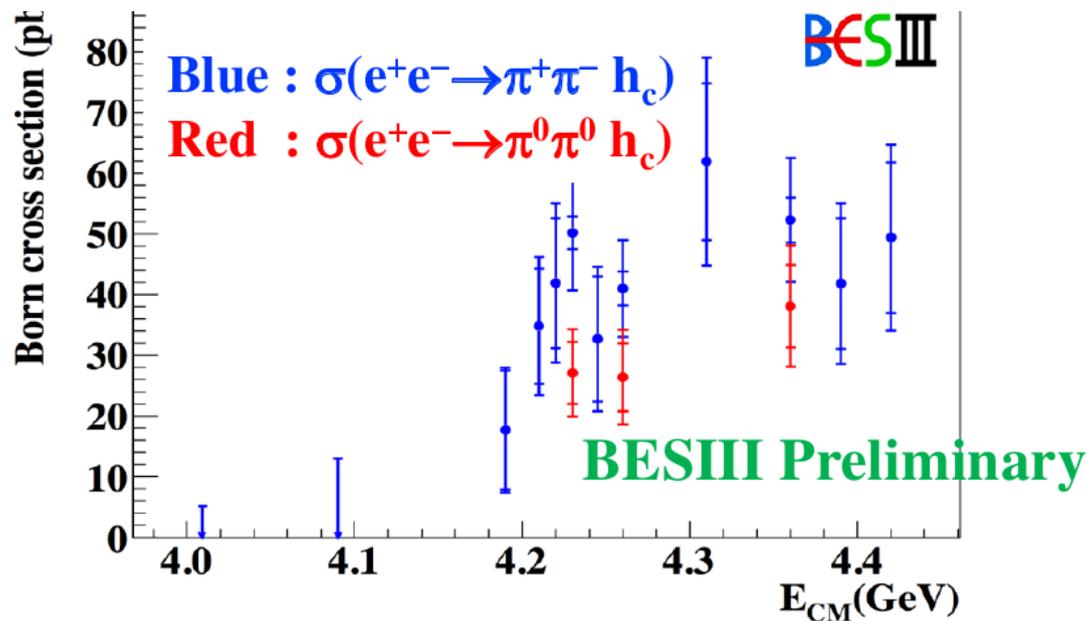
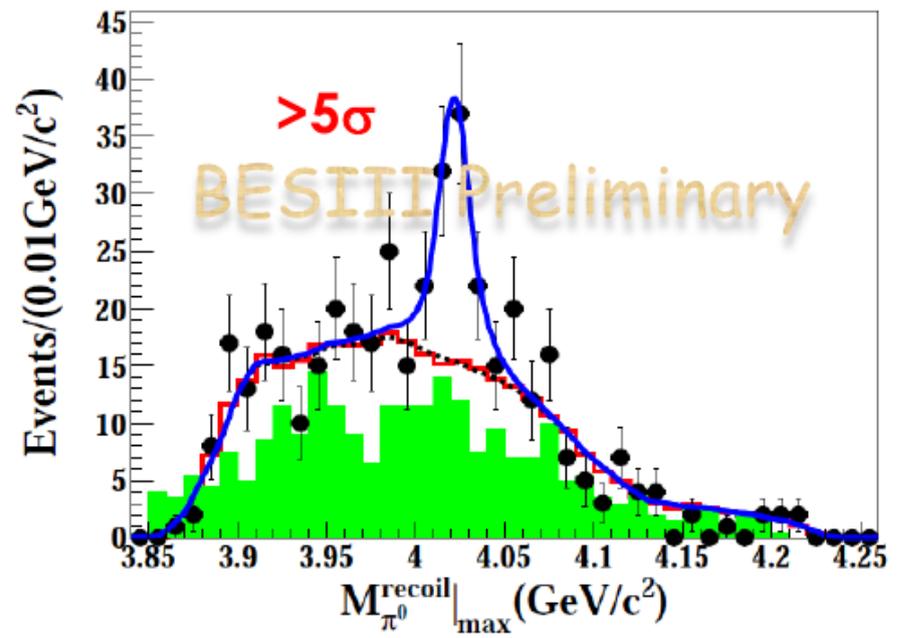
PRL 112, 132001 (2014)

Observation of $Z_c^{0,\pm}(4020)$ in $e^+e^- \rightarrow \pi\pi h_c$

$e^+e^- \rightarrow \pi^+\pi^- h_c$



$e^+e^- \rightarrow \pi^0\pi^0 h_c$



Summary of Zc states at BESIII

Channel	Mass [MeV]	Width [MeV]	
J/Ψπ±	3899.0±3.6±4.9	46±10±20	
J/Ψπ ⁰	3894.8±2.3	29.6±8.2 (prel.)	
(D \bar{D}^*) _{cc}	3883.9±1.5±4.2	24.8±3.3±11.0	D \bar{D}^* thr: 3875 MeV
h _c π±	4022.9±0.8±2.7	7.9±2.7±2.6	
h _c π ⁰	4023.6±2.2±3.9	Fixed	
(D* \bar{D}^*) _{cc}	4026.3±2.6±3.7	24.0±5.6±7.7	D* \bar{D}^* thr: 4017 MeV

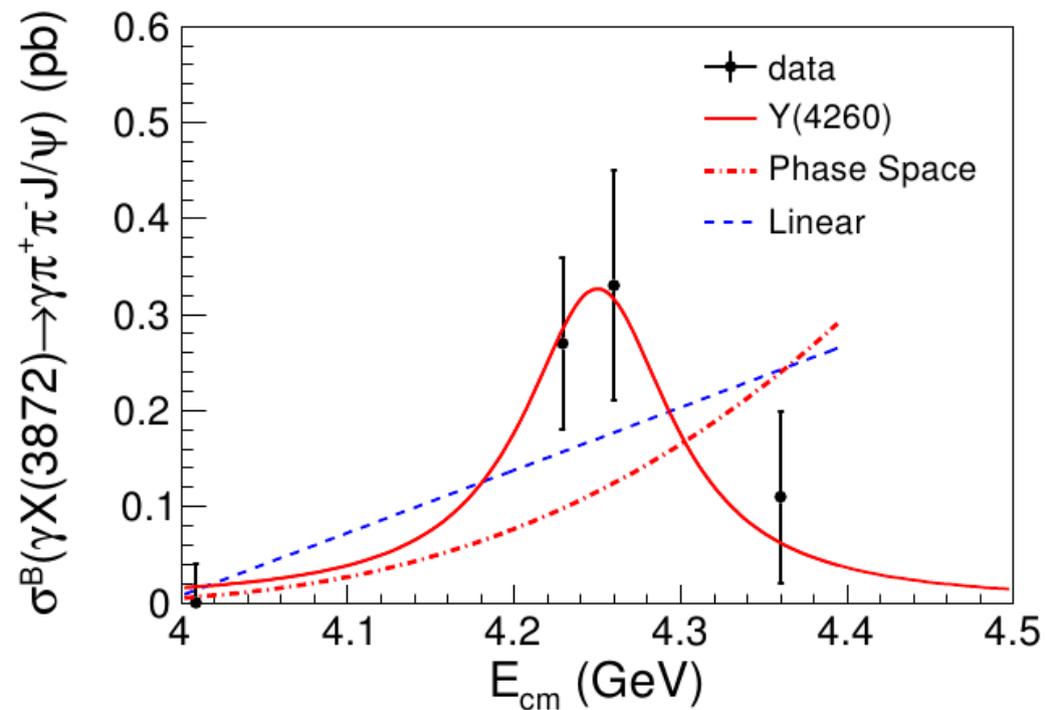
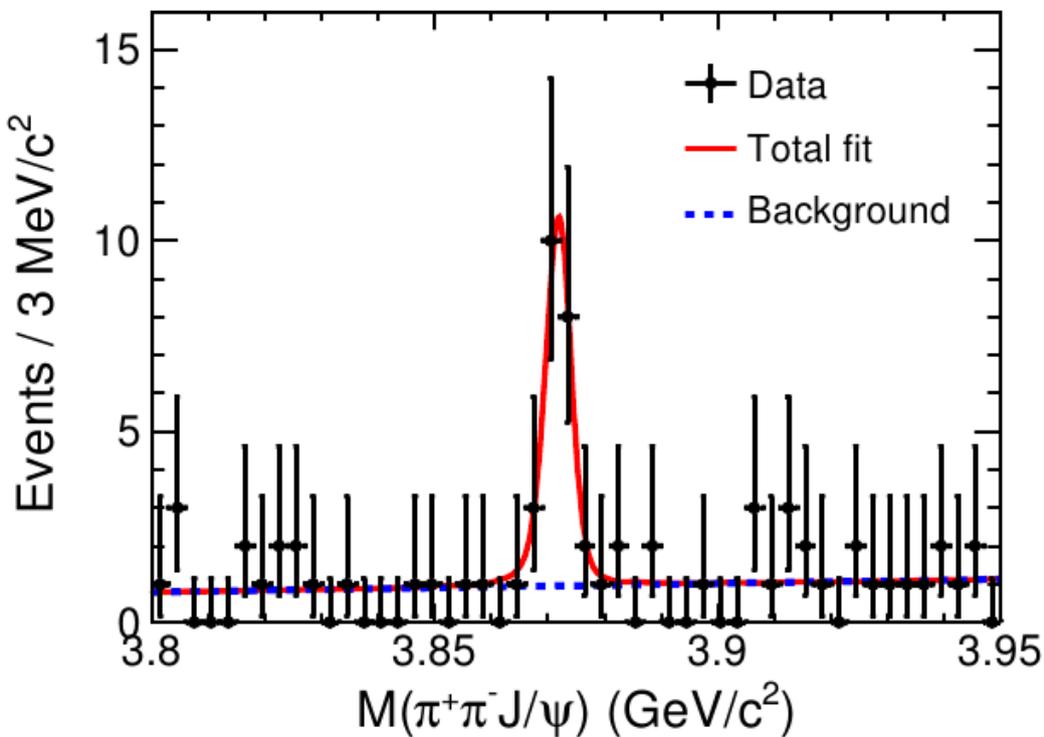
Isospin = 1

What is nature of these states ?

- Tetraquark L. Maiani, A. Ali et al
- Hadronic molecule U.-G. Meissner, F.K. Guo et al.
- Hadro-charmonium M. B. Boloshin
- Meson loop Q. Zhao et al.
- ISPE model X. Liu et al

..

$e^+ e^- \rightarrow \gamma X(3872) \rightarrow \gamma \pi^+ \pi^- J/\psi$



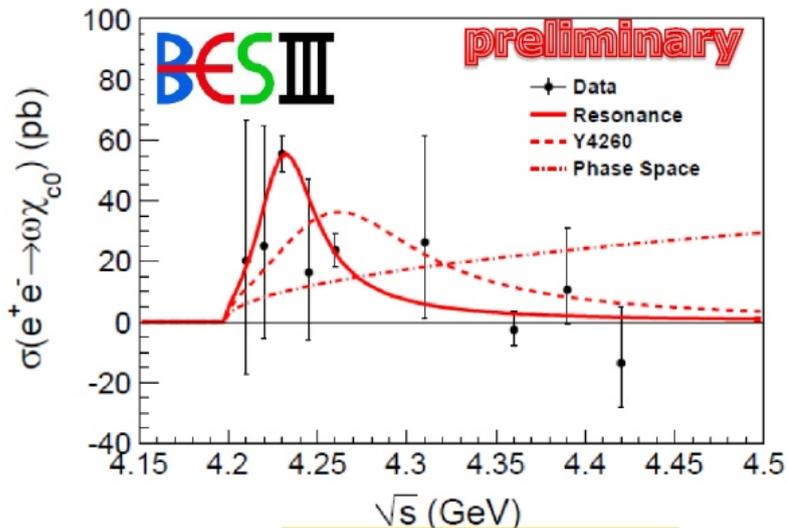
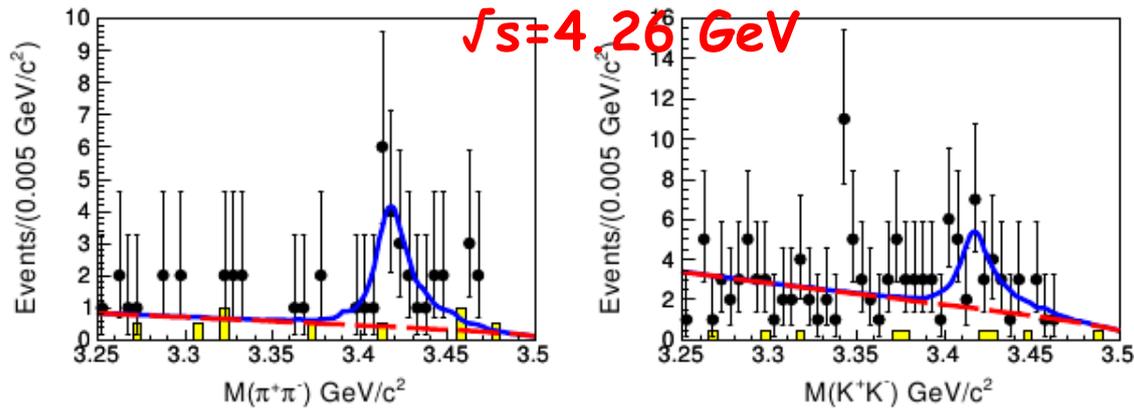
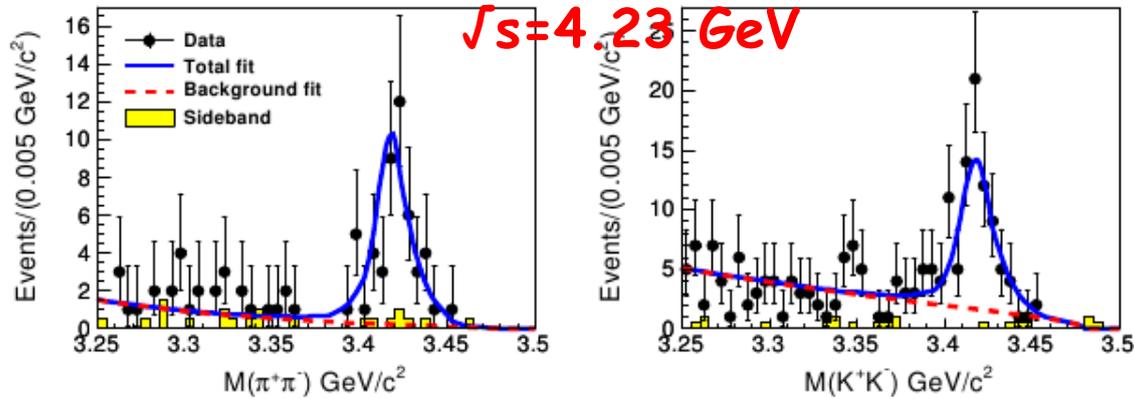
PRL 112 092001 (2014)

PRL 112 092001 (2014)

$M = (3871.9 \pm 0.7 \pm 0.2)$ MeV, $\Gamma < 2.4$ MeV, Significance: 6.3σ
 data suggest production in Y(4260) decay



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



Data collected at 4.23
and 4.26 GeV
Fit with a single BW
assumption, mass **lower** than
4.26 GeV

Summary/outlook of XYZ states at BESIII

- $Z_c(3900)^{0,\pm}, Z_c(4020)^{0,\pm}$
observed/confirmed
=> still many puzzles
- Transition: $Y(4260) \rightarrow \gamma X(3872)$
- New BESIII data 2.8 fb^{-1}
4.26 - 4.42 GeV
=> Expect more results soon

