

Overview of BESIII

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On behalf of BESIII Collaboration

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and Opportunities Worldwide

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Outline

- **Introduction**
- **Status of BESIII**
- **Selected results from BESIII**
- **Summary**

Beijing Electron Positron Collider (BEPC)

beam energy: 1.0 – 2.3 GeV

LINAC

e^+



e^-

BESIII
detector

- 2004: started BEPCII upgrade, BESIII construction
- 2008: test run
- 2009 - now: BESIII physics run

- 1989-2004 (BEPC):

$$L_{\text{peak}} = 1.0 \times 10^{31} / \text{cm}^2 \text{s}$$

- 2009-now (BEPCII):

$$L_{\text{peak}} = 0.85 \times 10^{33} / \text{cm}^2 \text{s}$$

Upgraded BEPC-BEPCII

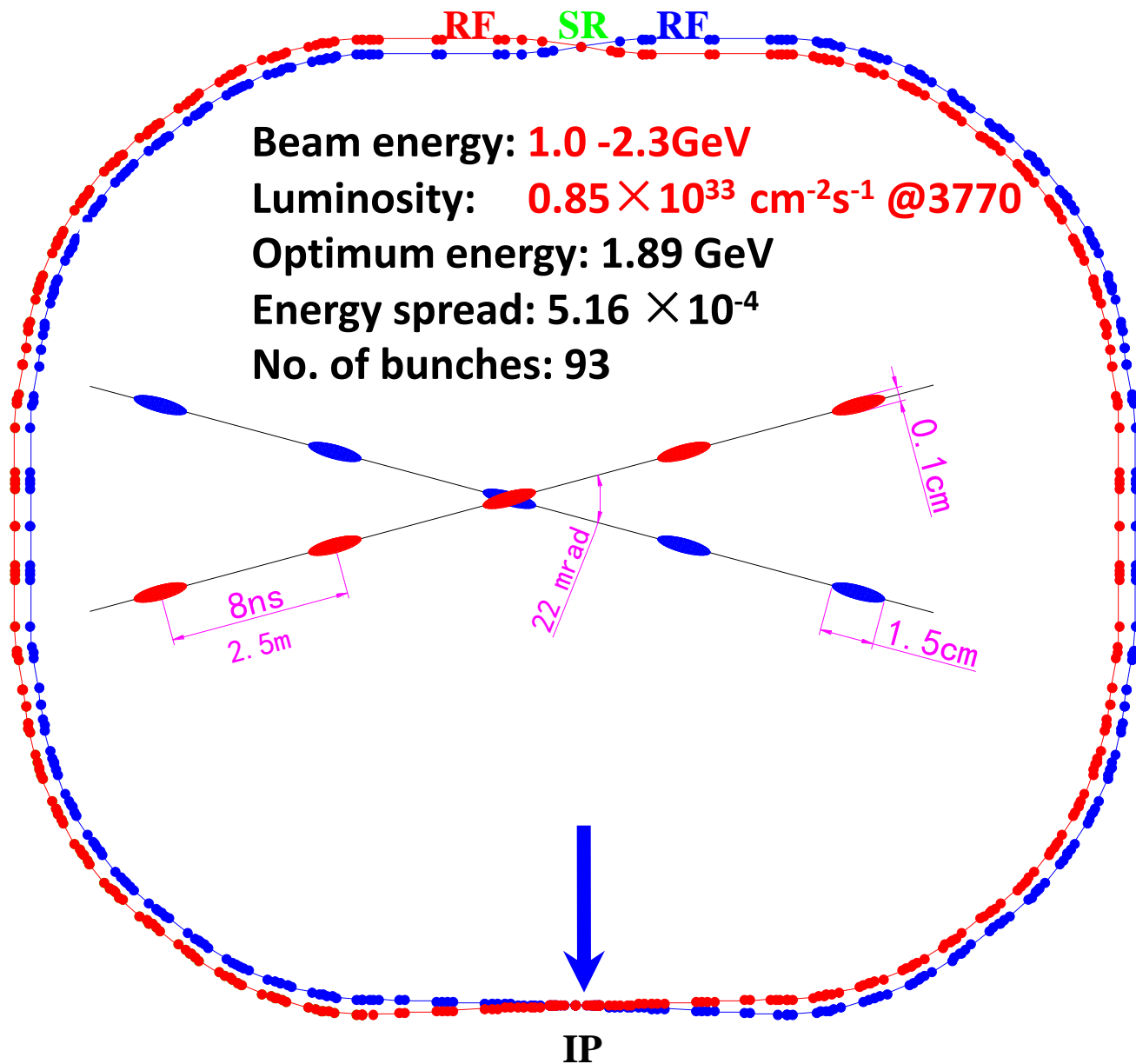
Beam energy: 1.0 -2.3GeV

Luminosity: $0.85 \times 10^{33} \text{ cm}^{-2}\text{s}^{-1}$ @3770

Optimum energy: 1.89 GeV

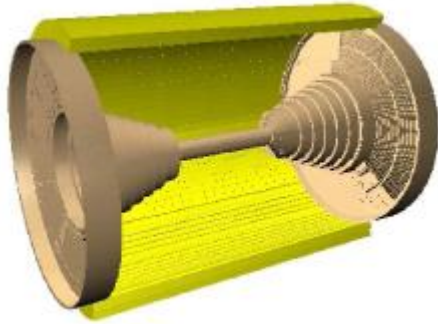
Energy spread: 5.16×10^{-4}

No. of bunches: 93

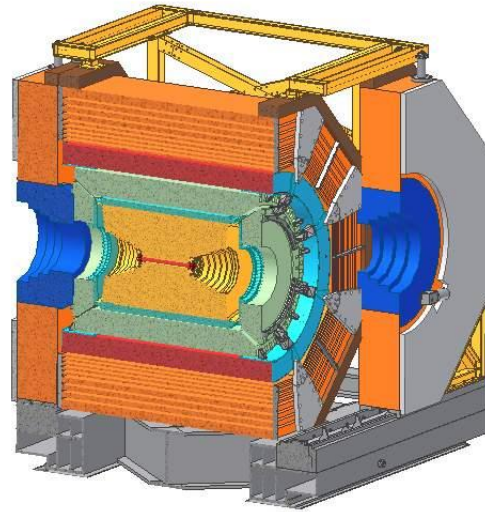


BESIII Detector

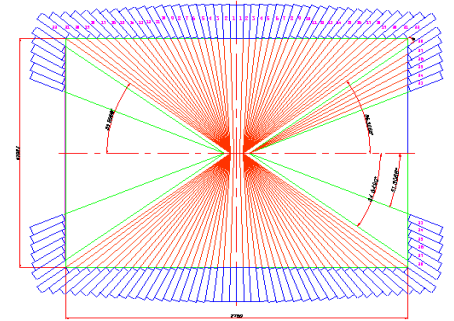
MDC



R inner: 63mm ;
R outer: 810mm
Length: 2582 mm
Layers: 43

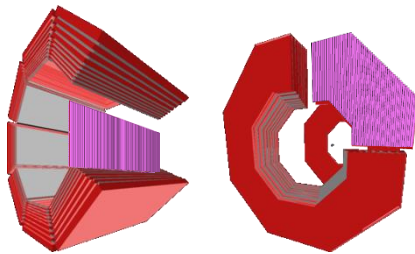


CsI(Tl) EMC



Crystals: 28 cm ($15 X_0$)
Barrel: $|\cos\theta| < 0.83$
Endcap:
 $0.85 < |\cos\theta| < 0.93$

RPC MUC



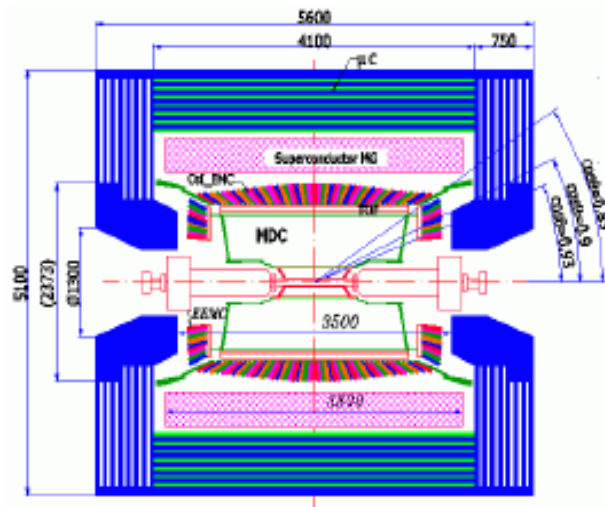
BMUC: 9 layers – 72 modules
EMUC: 8 layers – 64 modules

TOF

BTOF: two layers
ETOF: 48 for each



BESIII Detector



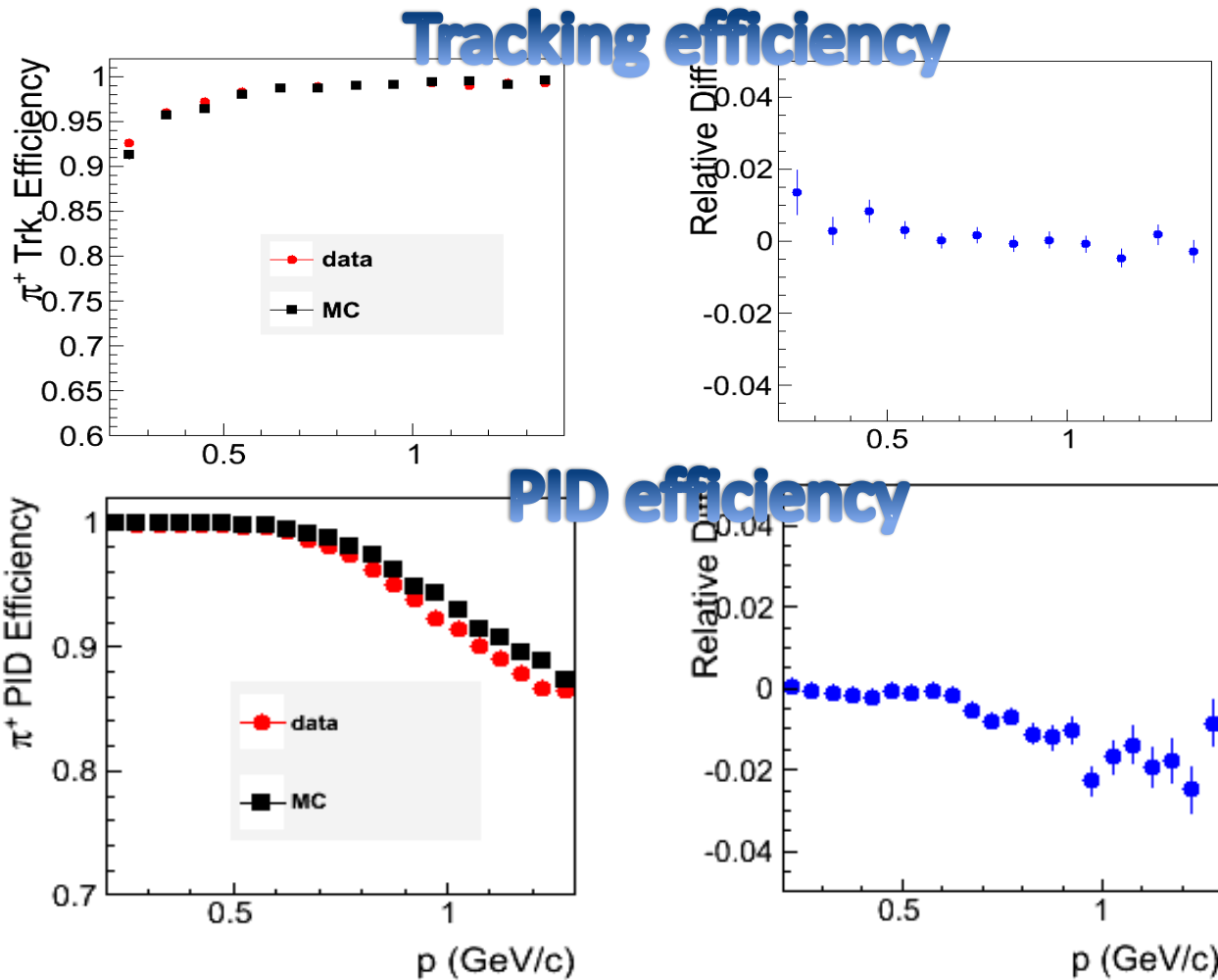
Exps.	MDC Wire resolution	MDC dE/dx resolution	EMC Energy resolution
CLEO	110 μm	5%	2.2-2.4 %
Babar	125 μm	7%	2.67 %
Belle	130 μm	5.6%	2.2 %
BESIII (XYZ data)	115 μm	<5% (Bhabha)	2.3%

- New ETOF (MRPC), will be installed
- New Inner MDC, being built

Exps.	TOF time resolution
CDFII	100 ps
Belle	90 ps
BESIII (XYZ data)	68 ps (BTOF) 100 ps (ETOF)

Data/Monte-Carlo Consistency

- For tracking efficiency, data/MC difference < 1%
- For particle identification efficiency, data/MC difference < 2%



BESIII Collaboration

Political Map of the World, June 1999

US (5)

Univ. of Hawaii
Carnegie Mellon Univ.
Univ. of Minnesota
Univ. of Rochester
Univ. of Indiana

Europe (13)

Germany: Univ. of Bochum,
Univ. of Giessen, GSI

Univ. of Johannes Gutenberg
Helmholtz Ins. In Mainz

Russia: JINR Dubna; BINP Novosibirsk

Italy: Univ. of Torino, Frascati Lab, Ferrara Univ.

Netherland: KVI/Univ. of Groningen

Sweden: Uppsala Univ.

Turkey: Turkey Accelerator Center

Mongolia (1)

Institute of phys. & Tech.

Korea (1)

Seoul Nat. Univ.

Japan (1)

Tokyo Univ.

Pakistan (2)

Univ. of Punjab
COMSAT CIIT

China (32)

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., Beihang 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.

Univ. of Sci. & Tech. Liaoning

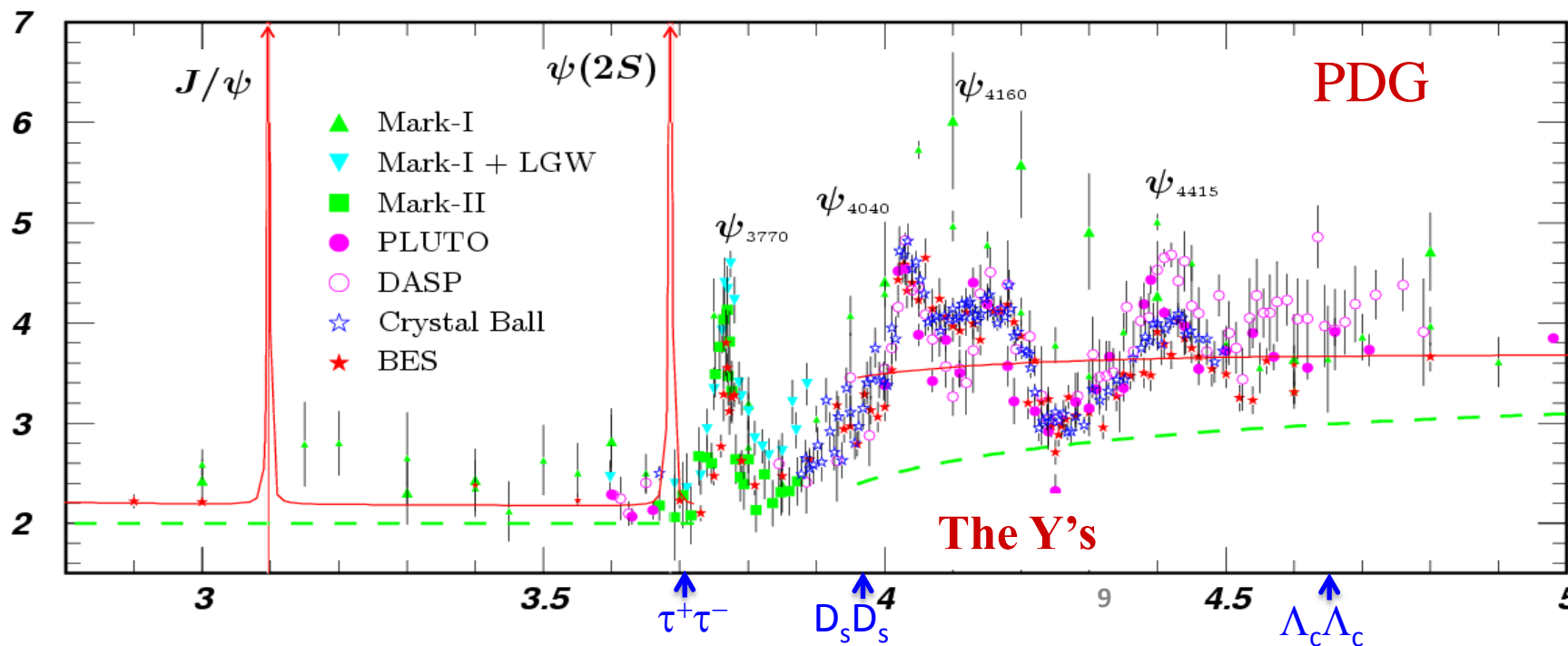
~400 members

from 55 institutions in 12 countries

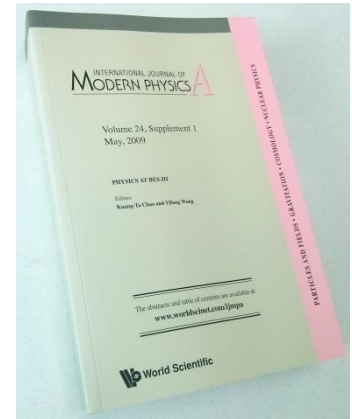
Features of the BEPC Energy Region

- Rich of **resonances**: charmonia and charm mesons
- **Threshold** characteristics (pairs of τ , D , D_s , ...)
- **Transition between** smooth and resonances, perturbative and non-perturbative QCD
- Energy location of the **new hadrons**: glueballs, hybrids, multi-quark states

R



Physics Topics at BESIII



◆ Hadron spectroscopy

- search for the new forms of hadrons
- meson spectroscopy
- baryon spectroscopy

Int. J. Mod. Phys. A, Vol. 24 (2009)

◆ Study of the production and decay mechanisms of charmonium states: J/ψ , $\psi(2S)$, $\eta_c(1S)$, $\chi_{c\{0,1,2\}}$, $\eta_c(2S)$, $h_c(1P_1)$, $\psi(3770)$, etc.

Calibrate QCD

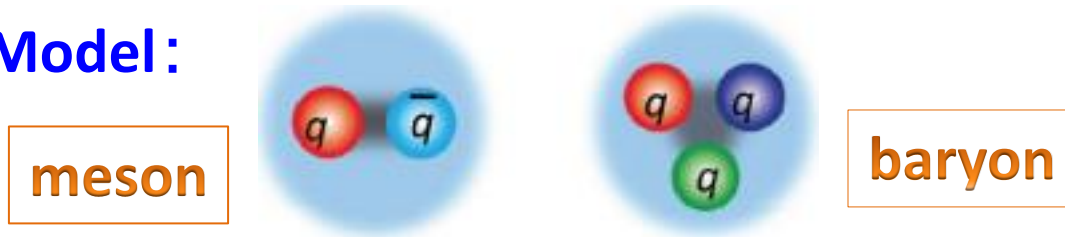
XYZ states

- ◆ Precision measurement of R values, hadron FF, ...
- ◆ Charm physics, charmed baryon
- ◆ Rare decays, new physics₁₀

New forms of hadrons

- Conventional hadrons consist of 2 or 3 quarks :

Naive Quark Model:

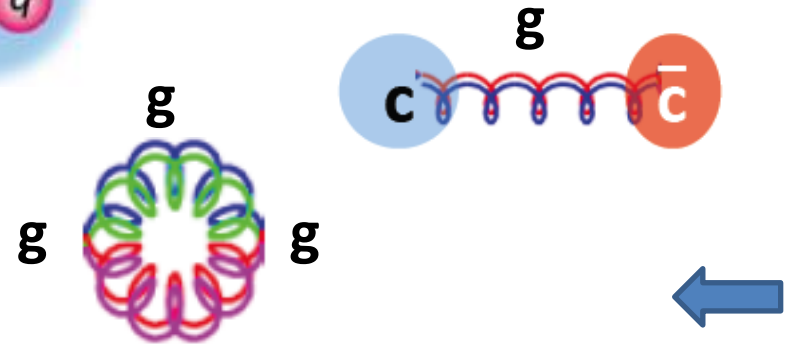


- QCD predicts the new forms of hadrons:

- Multi-quark states : Number of quarks ≥ 4

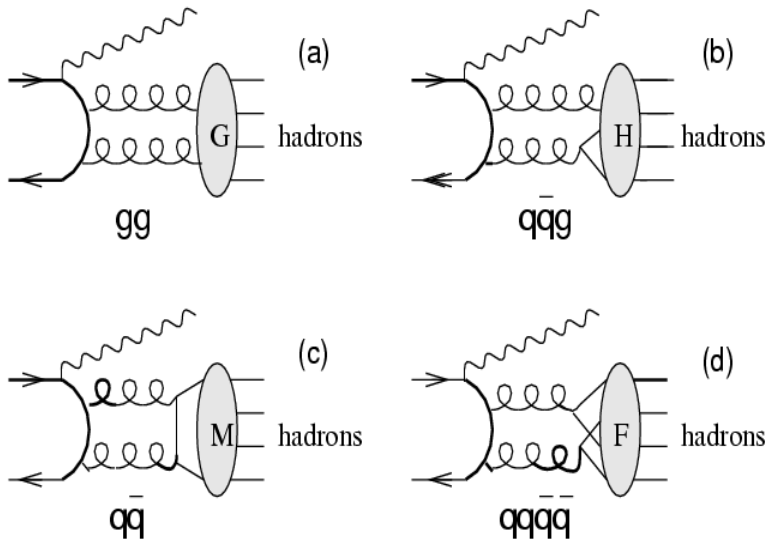


- Hybrids : $q\bar{q}g$, $qqqg$...
- Glueballs : gg , ggg ...



None of the new forms of hadrons is settled !

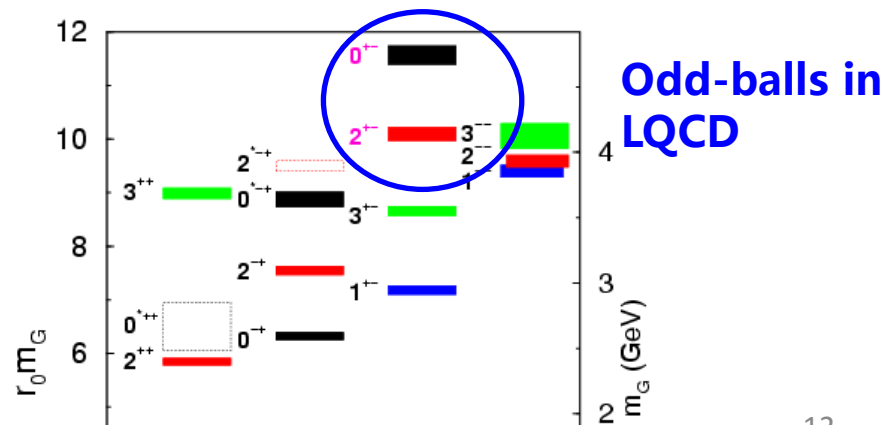
Charmonium decays provide ideal hunting ground for light glueballs and hybrids



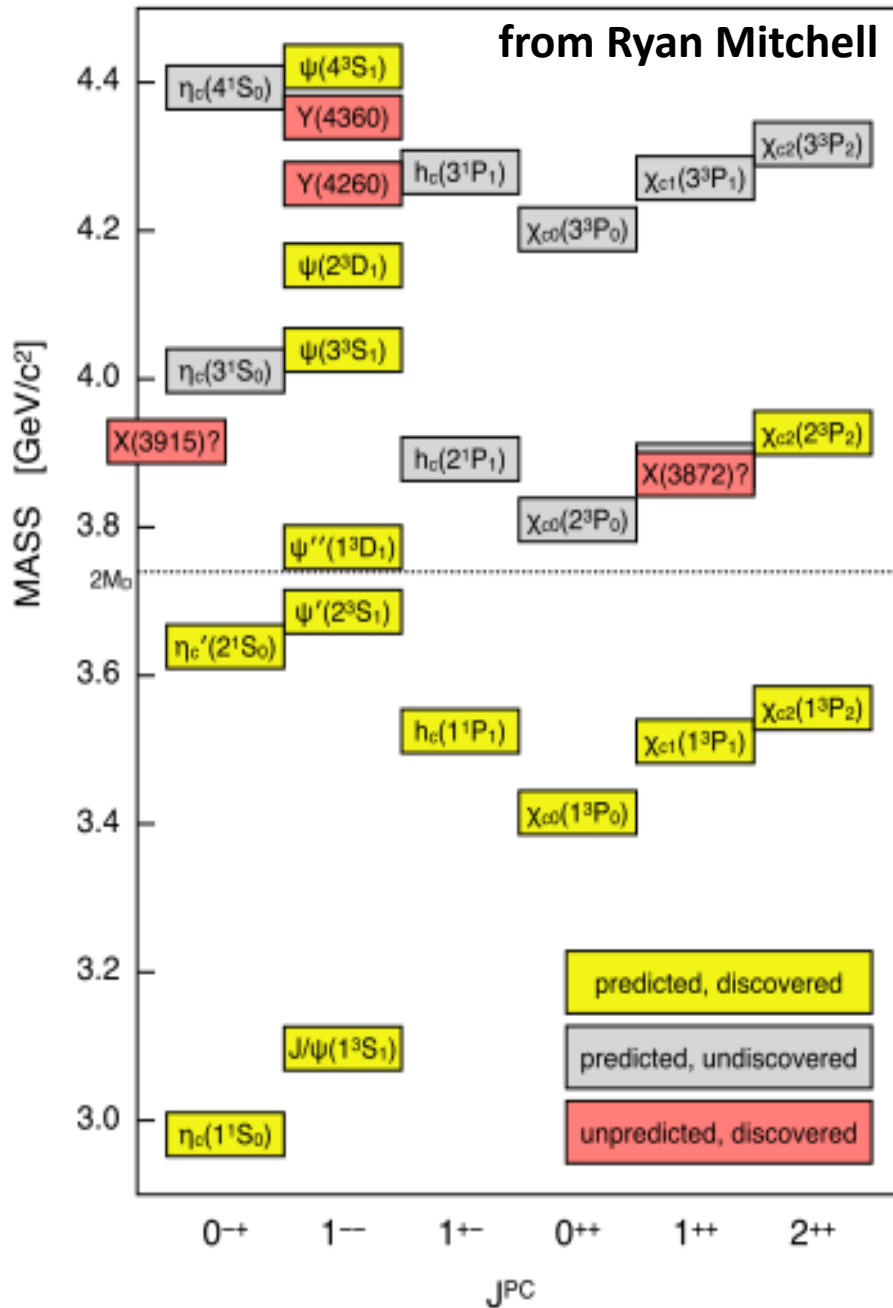
$$\Gamma(J/\psi \rightarrow \gamma G) \sim O(\alpha_s^2), \Gamma(J/\psi \rightarrow \gamma H) \sim O(\alpha_s^3),$$

$$\Gamma(J/\psi \rightarrow \gamma M) \sim O(\alpha_s^4), \Gamma(J/\psi \rightarrow \gamma F) \sim O(\alpha_s^4)$$

- “Gluon-rich” process
- Clean high statistics data samples from e+e- annihilation
- $I(J^{PC})$ filter in strong decays of charmonium



Charmonium spectroscopy



- Charmonium states below open charm threshold are all observed

Above open charm threshold:

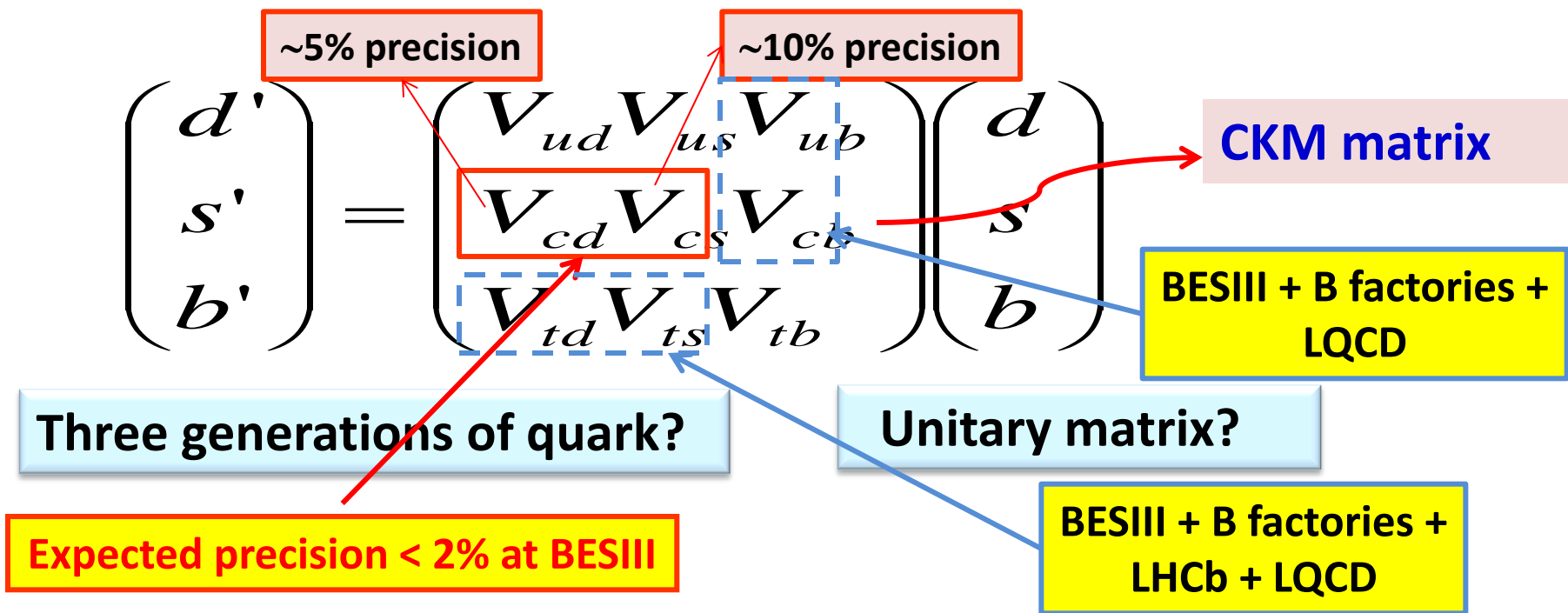
- many expected states not observed
- many unexpected observed

- | | | |
|---------|-----------|---------|
| Z(4430) | X(3872) | X(3915) |
| Z(4250) | | X(4160) |
| Z(4050) | XYZ(3940) | Y(4008) |
| Z(3900) | | Y(4140) |
| | | Y(4260) |
| | | Y(4360) |
| | | X(4350) |
| | | Y(4660) |

Precision measurement of CKM elements

-- Test EW theory

CKM matrix elements are fundamental SM parameters that describe the mixing of quark fields due to weak interaction.



Precision measurement of CKM matrix elements

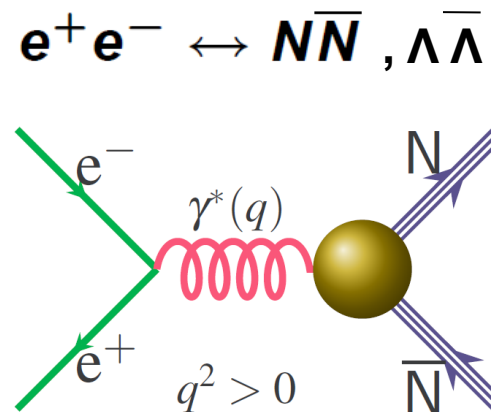
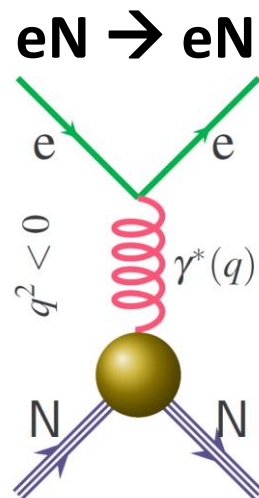
-- a precise test of SM model

New physics beyond SM?

Nucleon Form Factor

- Fundamental properties of the nucleon
 - Connected to charge, magnetization distribution
 - Crucial testing ground for models of the nucleon internal structure
 - Necessary input for experiments probing nuclear structure, or trying to understand modification of nucleon structure in nuclear medium
- Can be measured from space-like processes (eN) (precision 1%) or time-like process (e⁺e⁻ annihilation) (precision 10%-30%)

Space-like:
FF real



Time-like:
FF complex

Selected results

- **XYZ studies**
- **Scalars**
- **Baryons**
- **Charm physics**
- **Nucleon form factor**
- **Λ_c absolute branching fractions**

Observation of $Z_c(3900)^\pm$

$Z_c(3900)^+$:

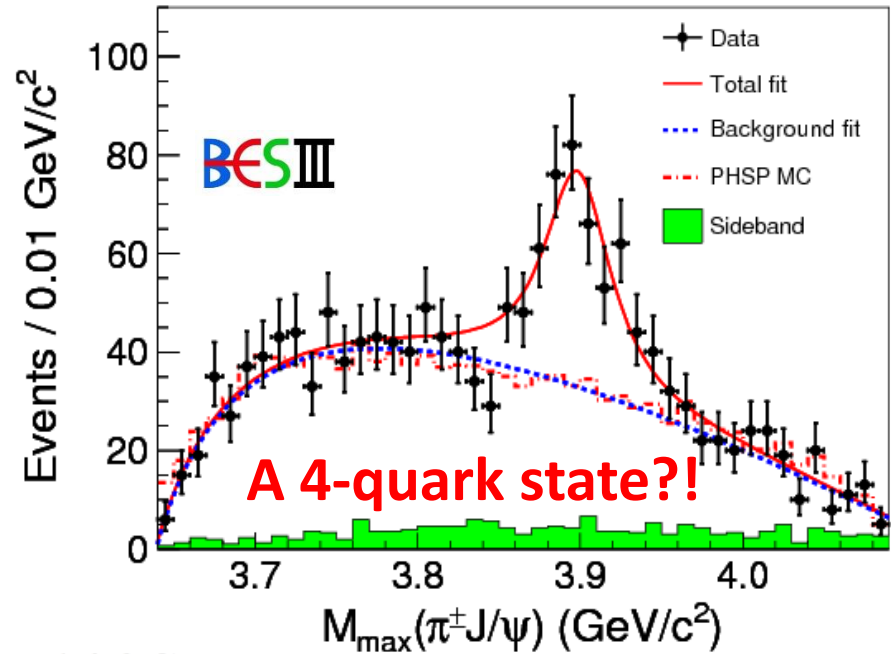
$$m = (3899.0 \pm 3.6 \pm 4.9) \text{ MeV}/c^2$$

$$\Gamma = (46 \pm 10 \pm 20) \text{ MeV}$$

Mass close to $D\bar{D}^*$ threshold

Decays to $J/\psi \rightarrow$ contains $c\bar{c}$
 Electric charge \rightarrow contains $u\bar{d}$

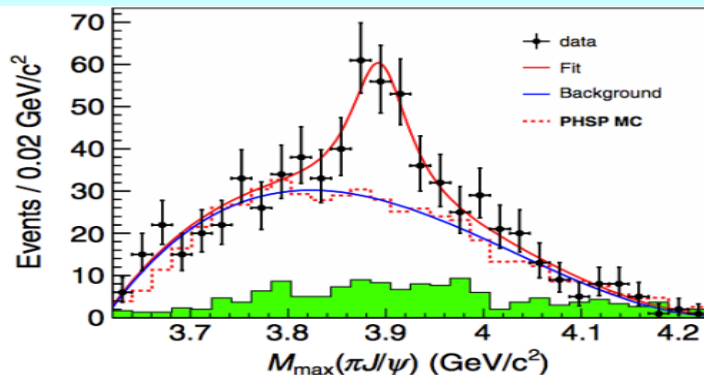
BESIII: PRL 110, 252001 (2013)



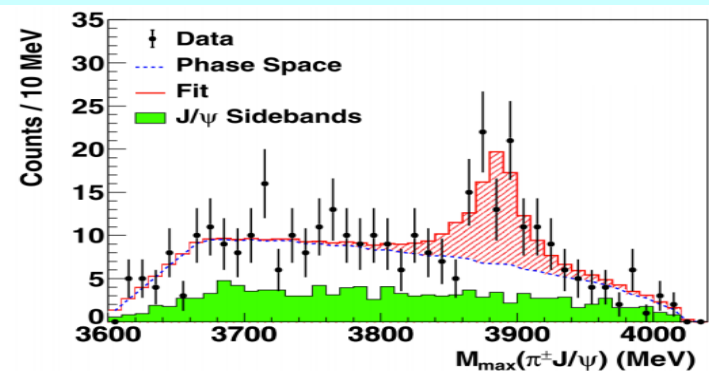
$$\sigma[e^+e^- \rightarrow \pi^+\pi^-J/\psi] = 62.9 \pm 1.9 \pm 3.7 \text{ pb at } 4.26 \text{ GeV}$$

$$\frac{\sigma[e^+e^- \rightarrow \pi^\pm Z_c(3900)^\mp \rightarrow \pi^+\pi^-J/\psi]}{\sigma[e^+e^- \rightarrow \pi^+\pi^-J/\psi]} = (21.5 \pm 3.3 \pm 7.5)\% \text{ at } 4.26 \text{ GeV}$$

Belle with ISR data (PRL 110, 252002)

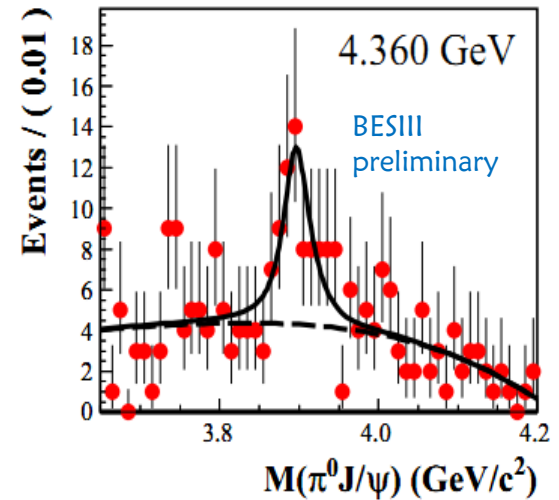
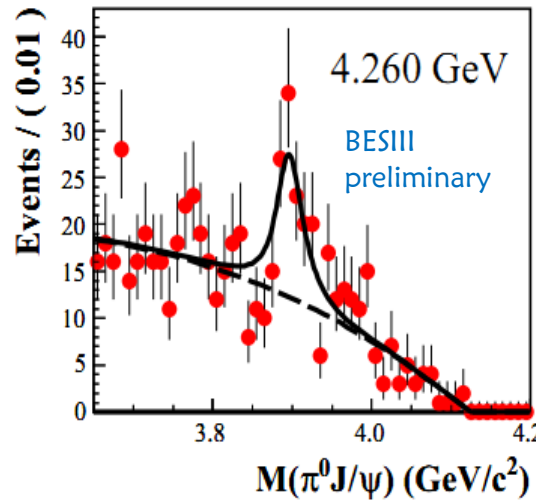
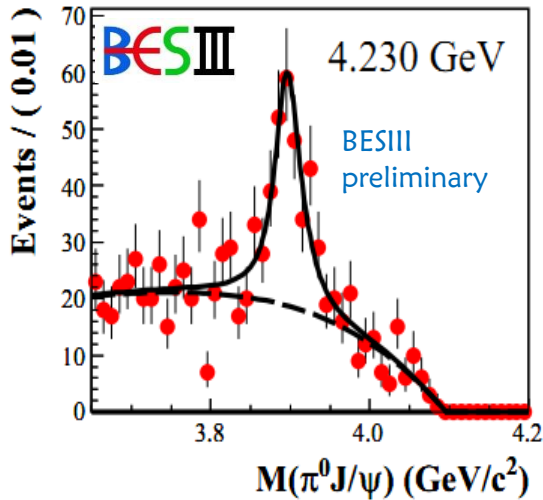


CLE0c data at 4.17 GeV (PLB 727, 366)



The neutral isospin partner: $Z_c(3900)^0$

Studying the $e^+e^- \rightarrow \pi^0\pi^0 J/\psi$ process



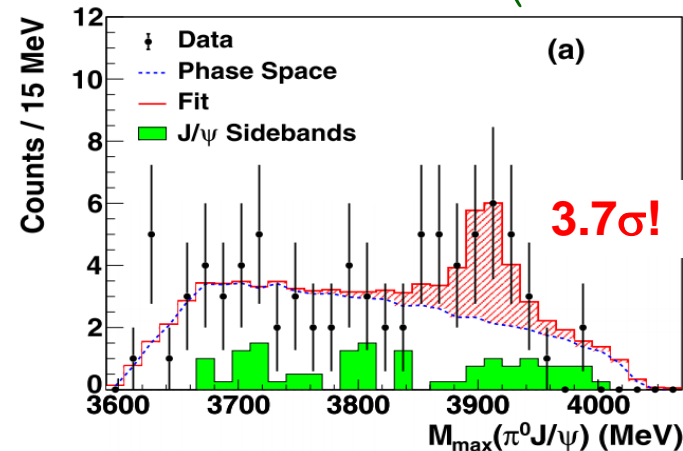
A structure on $\pi^0 J/\psi$ invariant mass spectrum can be observed:

Mass = $3894.8 \pm 2.3 \pm 2.7$ MeV
 Width = $29.6 \pm 8.2 \pm 8.2$ MeV
 Significance = 10.4σ



Isospin triplet is established!

CLEO data at 4.17 GeV (PLB 727, 366)



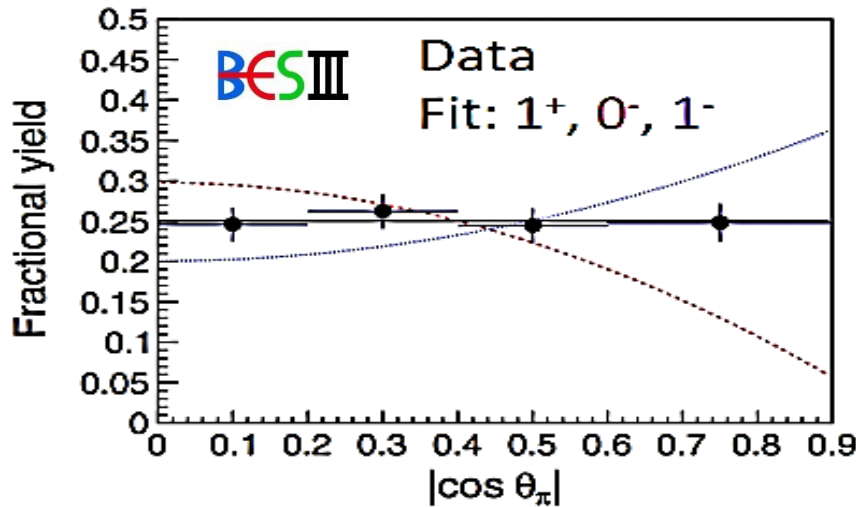
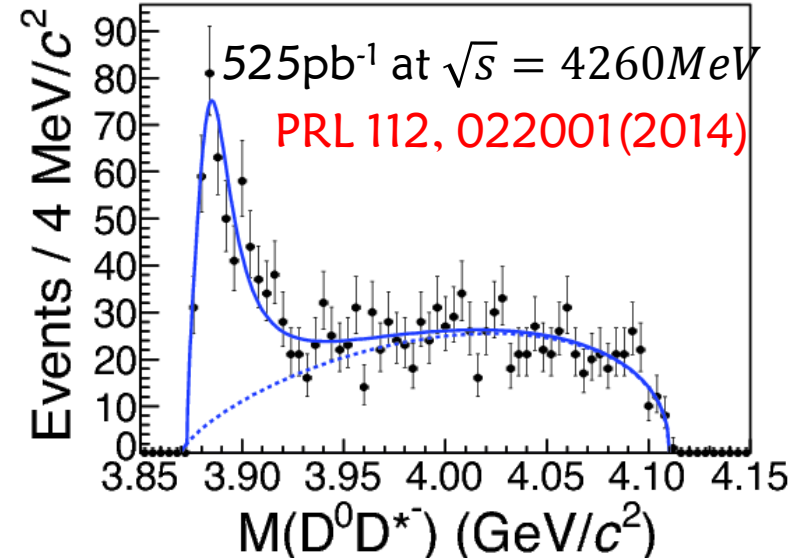
Observation of $Z_c(3885)^\pm$ in $e^+e^- \rightarrow \pi^\pm (D\bar{D}^*)^\mp$ at $\sqrt{s} = 4.26\text{GeV}$ using single D tag method



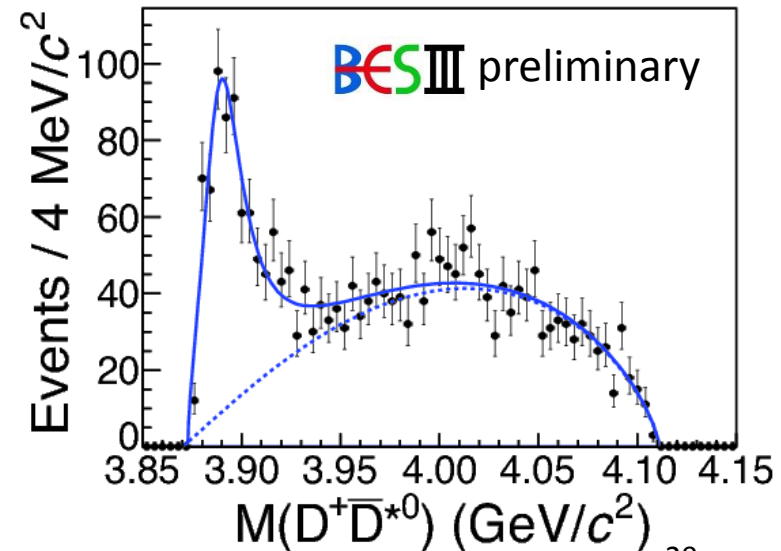
Reconstruct the π^+ and $D^0 \rightarrow K^-\pi^+$ and infer the D^{*-} .
 (Also analyze $\pi^+D^-D^{*0}$ with the same method.)

Enhancement at $D\bar{D}^*$ threshold in both channels ($Z_c(3885)^+$):

Mass = $3883.9 \pm 1.5 \pm 4.2 \text{ MeV}$, (fit with BW function)
 Width = $24.8 \pm 3.3 \pm 11.0 \text{ MeV}$



Fit to angular distribution favors $J^P = 1^+$ over 0^- and 1^-



Observation of $Z_c(4020)^\pm$

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

$h_c \rightarrow \gamma\eta_c$,

$\eta_c \rightarrow 16$ hadronic decay modes

The cross section of $e^+e^- \rightarrow \pi^+\pi^-h_c$ is measured, and the shape is not trivial.

A structure, $Z_c(4020)^\pm$, is observed.

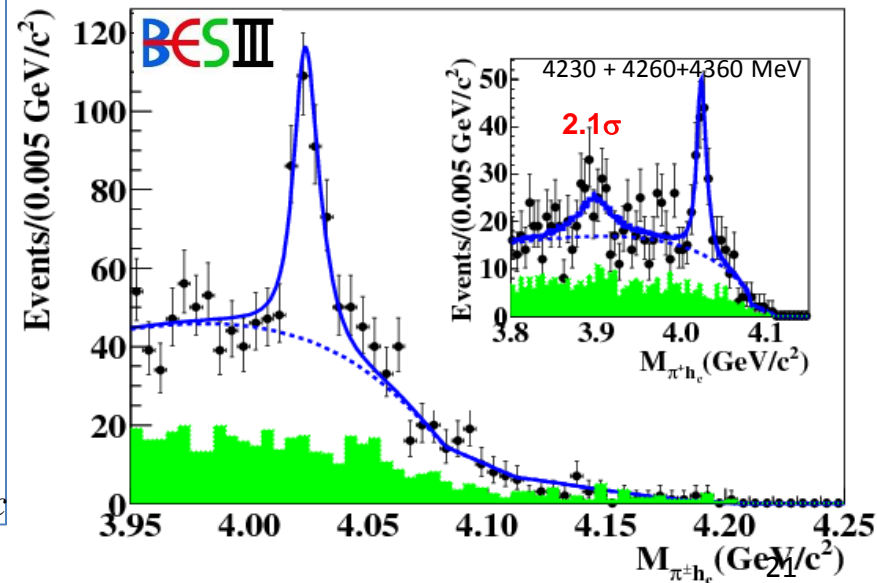
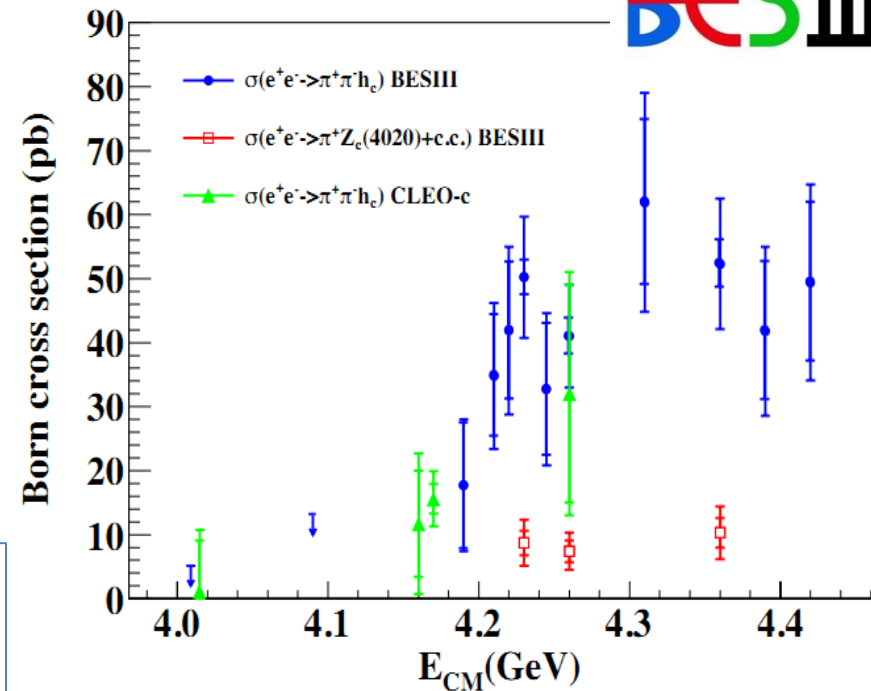
Mass = $4022.9 \pm 0.8 \pm 2.7$ MeV,

Width = $7.9 \pm 2.7 \pm 2.6$ MeV

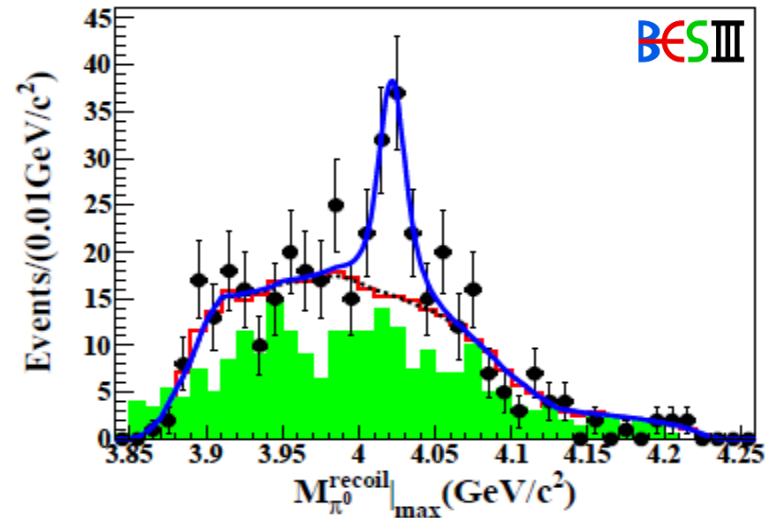
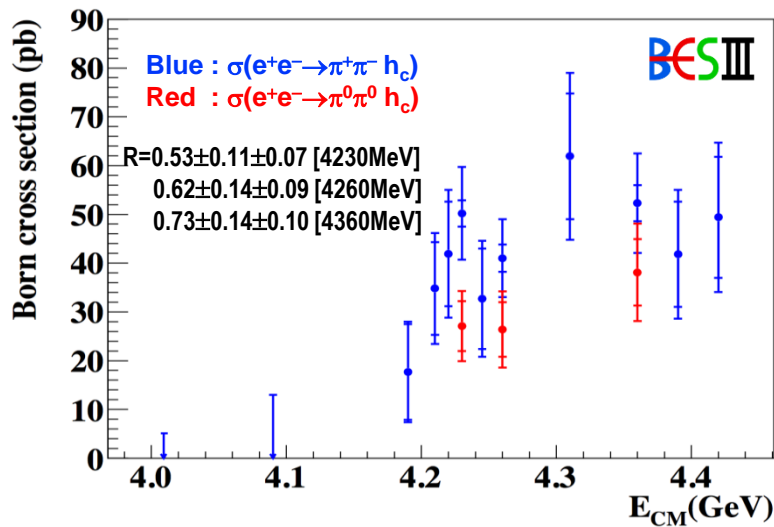
A weak evidence for $Z_c(3900)^\pm \rightarrow \pi^\pm h_c$

PRL 111, 242001(2013)

BES III



Observed neutral $Z_c(4020)^0$ in $e^+e^- \rightarrow \pi^0\pi^0 h_c$



$$M[Z_c(4020)^0] = 4023.6 \pm 2.2 \pm 3.9 \text{ MeV}$$

$$[M[Z_c(4020)^\pm]] = 4022.9 \pm 0.8 \pm 2.7 \text{ MeV}$$

–Width fixed to charged $Z_c(4020)$

–Significance : $>5\sigma$

Observation of
neutral $Z_c(4020)$

Isovector nature
of Z_c states
established

Observation of $Z_c(4025)^\pm$

$$e^+e^- \rightarrow \pi^\pm (D^* \bar{D}^*)^\mp \text{ at } \sqrt{s} = 4.26 \text{ GeV}$$

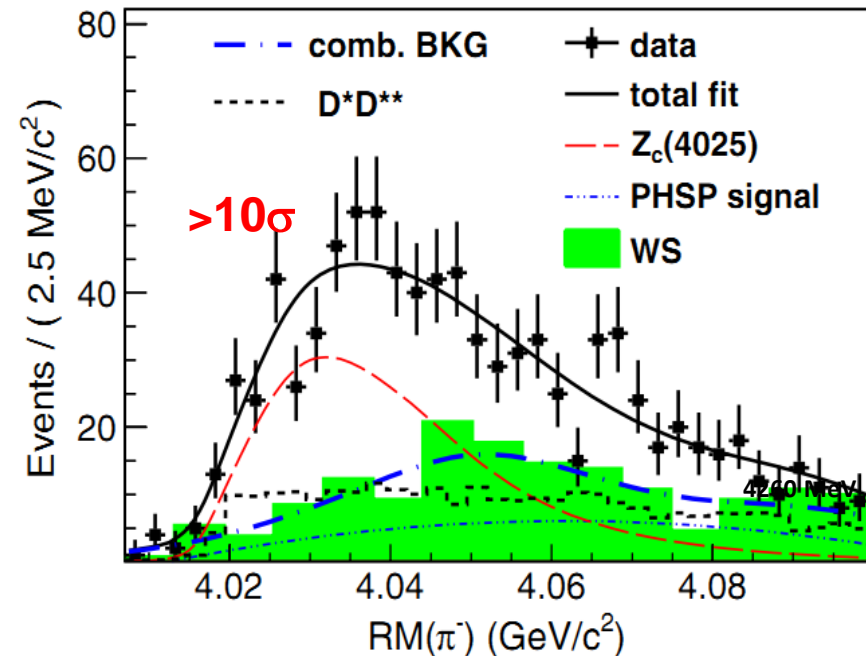
Tag a D^+ and a bachelor π , reconstruct one π^0 to suppress the background.

A structure, named as $Z_c(4025)$, can be observed in the recoil mass of the bachelor π^- .

$$M(Z_c(4025)) = 4026.3 \pm 2.6 \pm 3.7 \text{ MeV};$$

$$\Gamma(Z_c(4025)) = 24.8 \pm 5.6 \pm 7.7 \text{ MeV}$$

PRL 112, 132001 (2014)



$$\sigma[e^+e^- \rightarrow (D^* \bar{D}^*)^\pm \pi^\mp] = 137 \pm 9 \pm 15 \text{ pb at } 4.26 \text{ GeV}$$

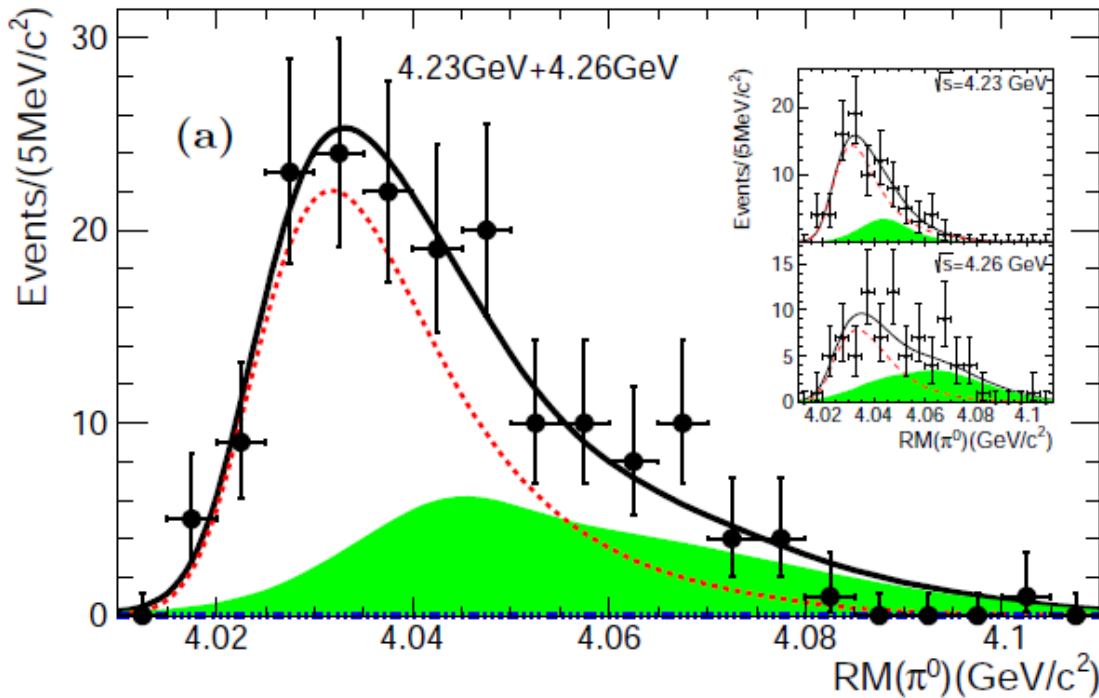
$$\frac{\sigma[e^+e^- \rightarrow \pi^\pm Z_c(4025)^\mp \rightarrow (D^* \bar{D}^*)^\pm \pi^\mp]}{\sigma[e^+e^- \rightarrow (D^* \bar{D}^*)^\pm \pi^\mp]} = 0.65 \pm 0.09 \pm 0.06 \text{ at } 4.26 \text{ GeV}$$

Coupling to \bar{D}^*D^* is much larger than to πh_c if $Z_c(4025)$ and $Z_c(4020)$ are the same state.

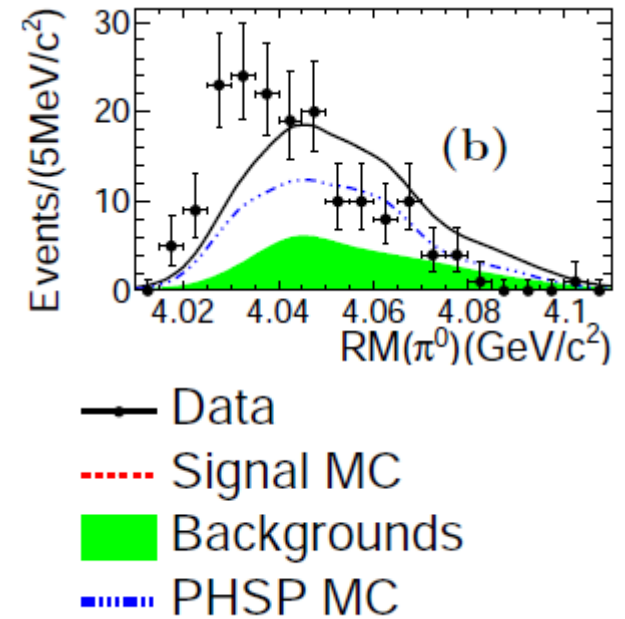
Observation of $Z_c(4025)^0$ in $e^+e^- \rightarrow \pi^0(D^* \bar{D}^*)^\mp$



[arXiv:1507.02404](https://arxiv.org/abs/1507.02404)

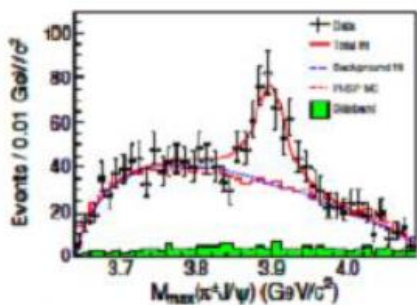


Phase space + BG

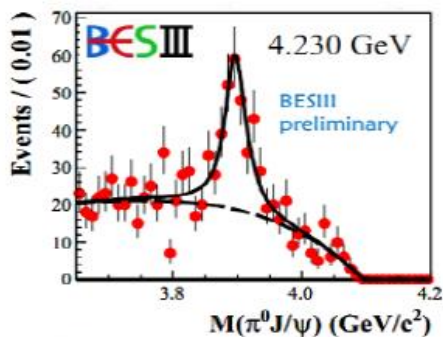


Data sample	Mass(MeV/c ²)	Width(MeV/c ²)	$\sigma(e^+e^- \rightarrow Z_c(4025)^0 \pi^0 \rightarrow D^* \bar{D}^* \pi^0)$ (pb)
@4.23GeV	$4025.5^{+2.0}_{-4.7} \pm 3.1$	$23.0 \pm 6.0 \pm 1.0$	$61.6 \pm 8.2 \pm 9.0$
@4.26GeV			$43.4 \pm 8.0 \pm 5.4$

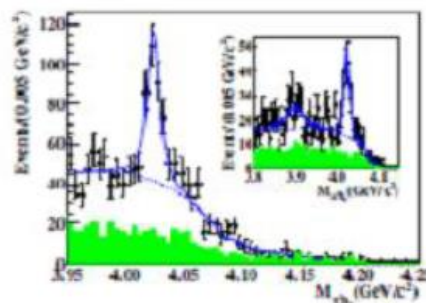
From Kornicer CHARM 2015



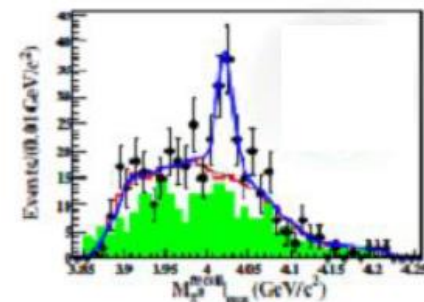
$$e^+e^- \rightarrow \pi^- \pi^+ J/\psi$$



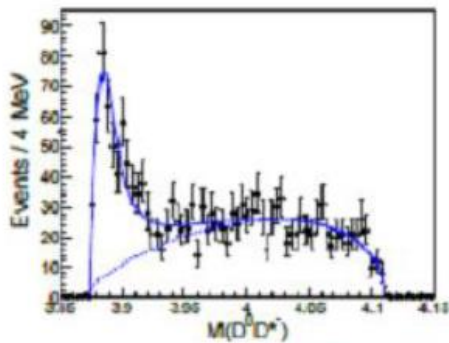
$$e^+e^- \rightarrow \pi^0 \pi^0 J/\psi$$



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



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



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

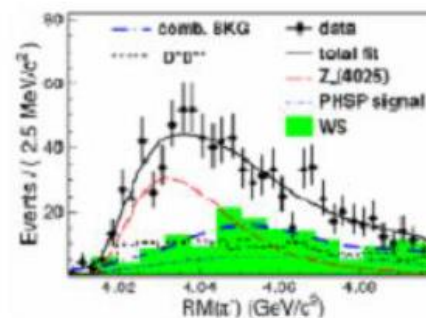
$$Z_c(3900)^{+?}$$

preliminary

BESIII

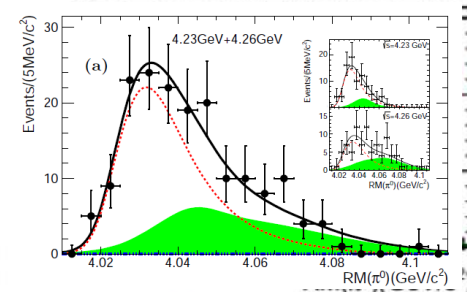
SOON ...

$$Z_c(3900)^{0?}$$



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

$$Z_c(4020)^{+?}$$



$$e^+e^- \rightarrow \pi^0 (D^* \bar{D}^*)^0$$

$$Z_c(4020)^{0?}$$

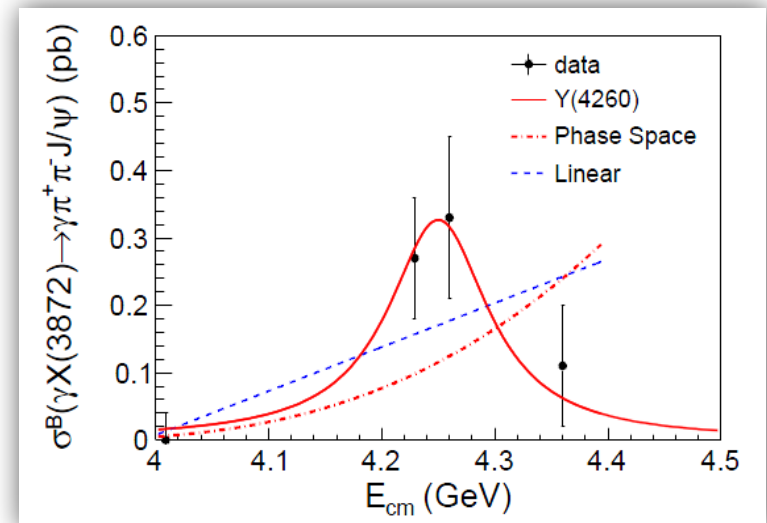
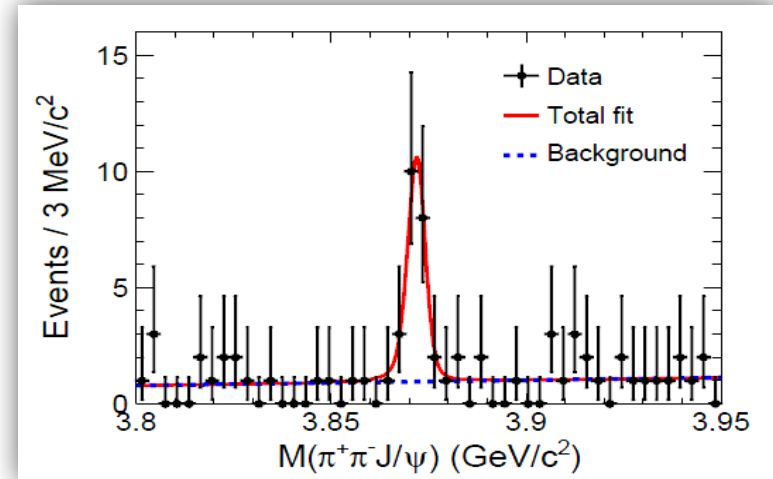
Summary on Z_c states

From Kornicer CHARM 2015

State	Mass(MeV)	Width(MeV)	Decay mode	Process
$Z_c(3900)^\pm$	$3899.0 \pm 3.6 \pm 4.9$	$46 \pm 10 \pm 20$	$\pi^\pm J/\psi$	$e^+e^- \rightarrow \pi^+\pi^- J/\psi$
$Z_c(3900)^0$	$3894.8 \pm 2.3 \pm 2.7$	$29.6 \pm 8.2 \pm 8.2$	$\pi^0 J/\psi$	$e^+e^- \rightarrow \pi^0 \pi^0 J/\psi$
$Z_c(3885)^\pm$	$3883.9 \pm 1.5 \pm 4.2$ [single D tag]	$24.8 \pm 3.3 \pm 11.0$ [single D tag]	$D^0 D^{*-}$ $D^- D^{*0}$	$e^+e^- \rightarrow \pi^+ D^0 D^{*-}$ $e^+e^- \rightarrow \pi^+ D^- D^{*0}$
	$3884.3 \pm 1.2 \pm 1.5$ [double D tag]	$23.8 \pm 2.1 \pm 2.6$ [double D tag]		
$Z_c(4020)^\pm$	$4022.9 \pm 0.8 \pm 2.7$	$7.9 \pm 2.7 \pm 2.6$	$\pi^\pm h_c$	$e^+e^- \rightarrow \pi^+\pi^- h_c$
$Z_c(4020)^0$	$4023.9 \pm 2.2 \pm 3.8$	fixed	$\pi^0 h_c$	$e^+e^- \rightarrow \pi^0 \pi^0 h_c$
$Z_c(4025)^\pm$	$4026.3 \pm 2.6 \pm 3.7$	$24.8 \pm 5.6 \pm 7.7$	$D^{*0} D^{*-}$	$e^+e^- \rightarrow \pi^+ (D^{*+} \bar{D}^{*-})^-$
$Z_c(4025)^0$	$4025.5^{+2.0}_{-4.7} \pm 3.1$	$23.0 \pm 6.0 \pm 1.0$	$(D^* D^*)^0$	$e^+e^- \rightarrow \pi^0 (D^* D^*)^0$

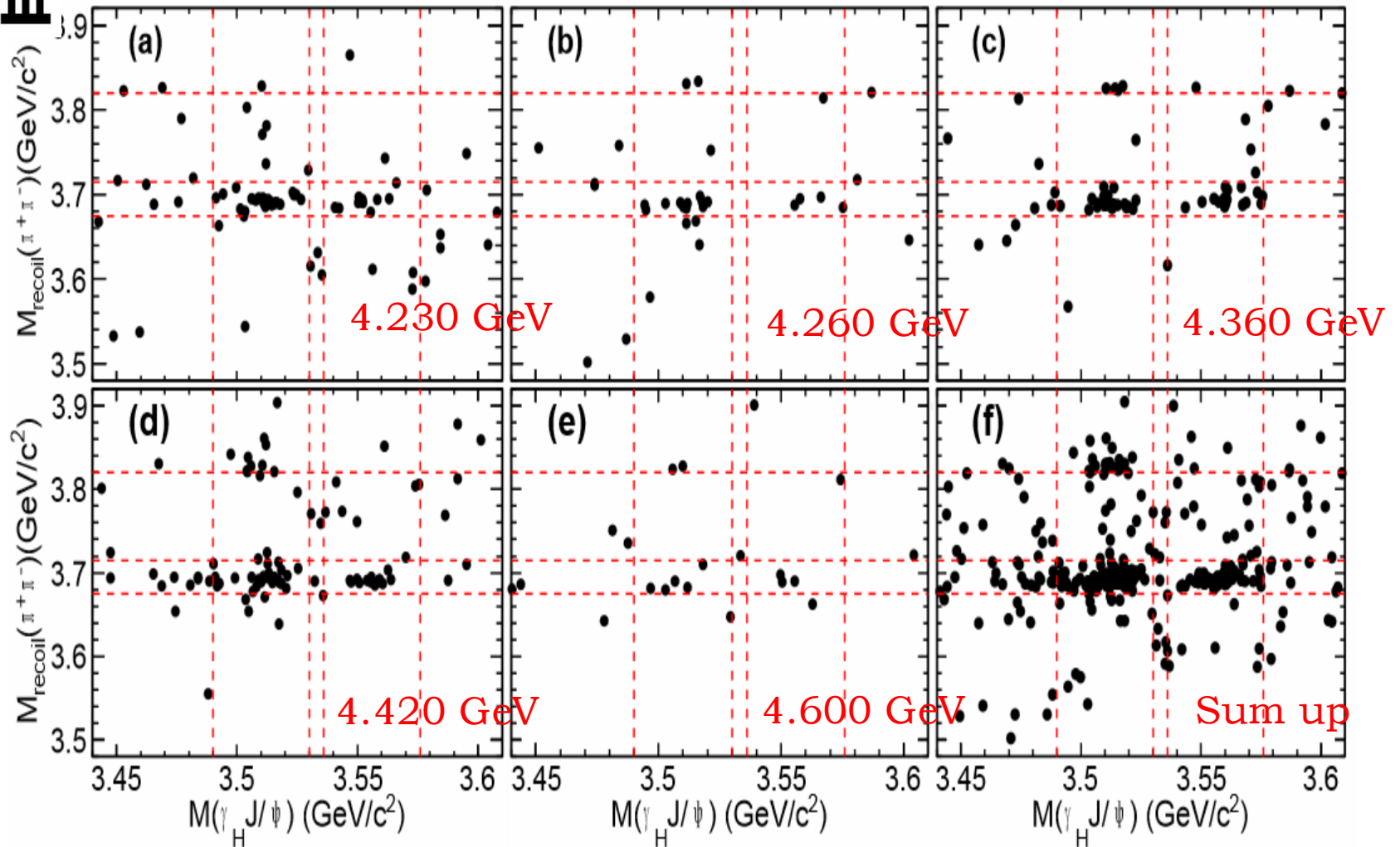
- Search for $\gamma X(3872)$ with $X(3872) \rightarrow \pi\pi J/\psi$ at $E_{cm} = 4.23, 4.26$ and 4.36 GeV
- summed over all data $X(3872)$ significance = 6.3σ
- Production in $Y(4260)$ decay suggestive, but not conclusive
- If from $Y(4260)$

$$\frac{B(Y(4260) \rightarrow \gamma X(3872))}{B(Y(4260) \rightarrow \pi^+ \pi^- J/\psi)} \sim 0.1$$



$$e^+e^- \rightarrow \pi^+\pi^-X(3823), X \rightarrow \gamma\chi_{cJ}, \chi_{cJ} \rightarrow \gamma J/\psi$$

BES III



arXiv:1503.08203

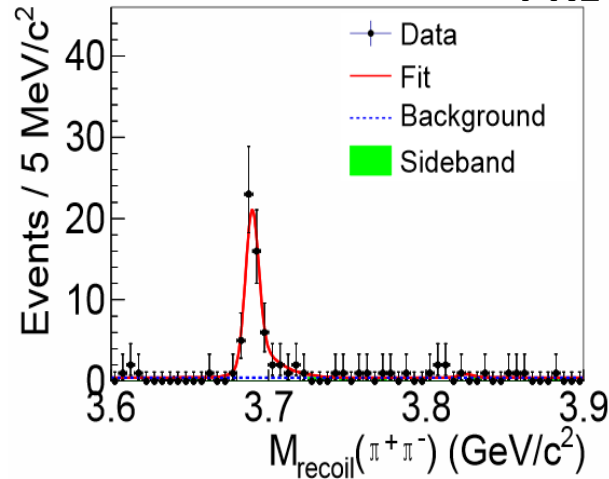
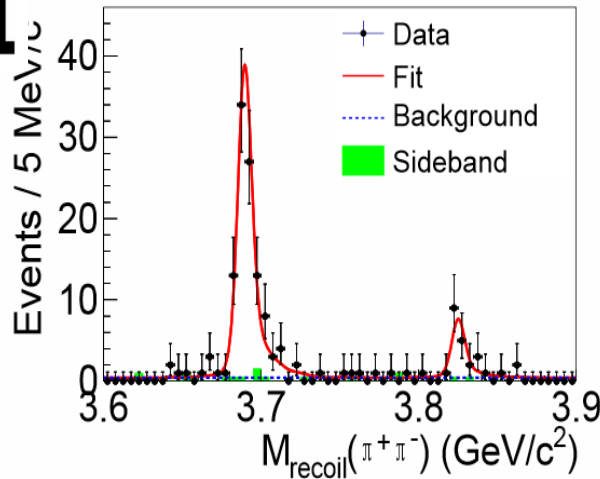
arXiv:1503.08203

$\psi(1^3D_2)$

$e^+e^- \rightarrow \pi^+\pi^-X(3823), X \rightarrow \gamma\chi_{cJ}, \chi_{cJ} \rightarrow \gamma J/\psi$

BESIII

PRL 115, 011803 (2015)

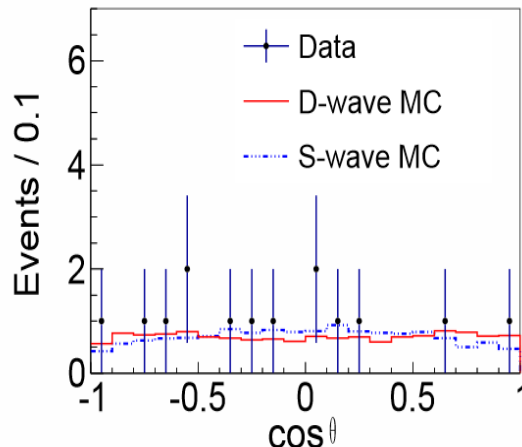
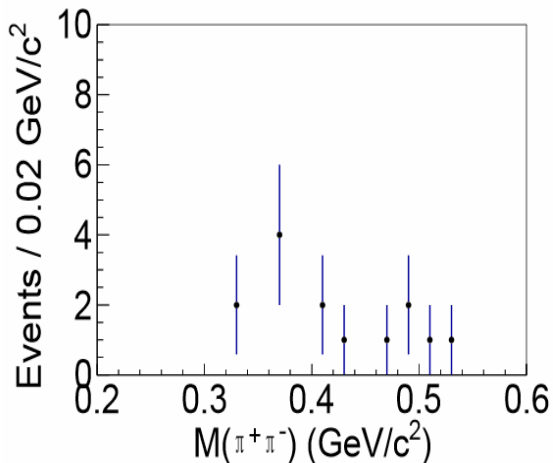


$\psi(1^3D_2)$

Simultaneous fit of $\gamma\chi_{c1}$ (left) and $\gamma\chi_{c2}$ (right) events

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

$$\Gamma(X(3823)) < 16 \text{ MeV at 90\% C. L. consist with Belle}$$



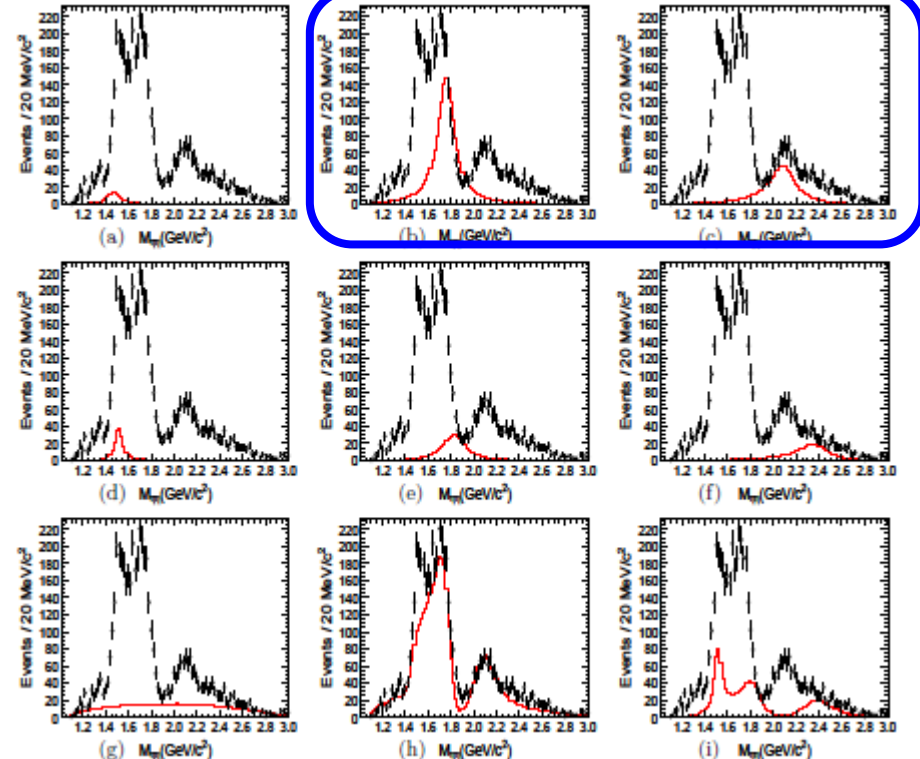
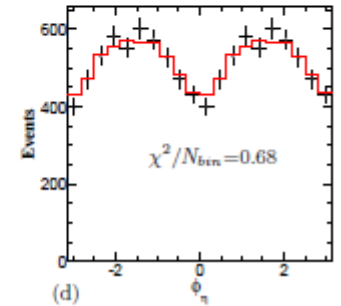
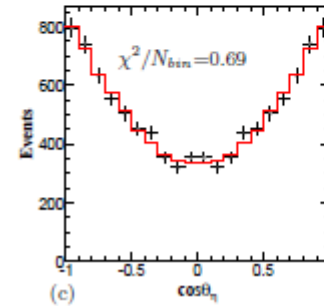
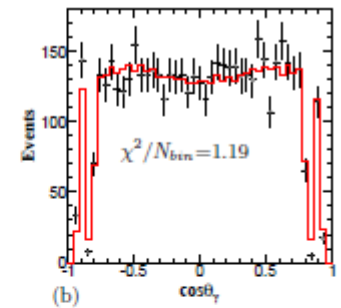
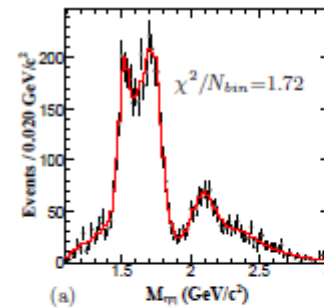
**D-wave is expected.
Limited statistics
limited information**

PWA of $J/\psi \rightarrow \gamma\eta\eta$

BES II

(Phys. Rev. D87 092009 (2013))

Resonance	Mass(MeV/c ²)	Width(MeV/c ²)	$\mathcal{B}(J/\psi \rightarrow \gamma X \rightarrow \gamma\eta\eta)$	Significance
$f_0(1500)$	$1468_{-15}^{+14+23}_{-74}$	$136_{-26}^{+41+28}_{-100}$	$(1.65_{-0.31}^{+0.26+0.51}) \times 10^{-5}$	8.2σ
$f_0(1710)$	$1759 \pm 6_{-25}^{+14}$	$172 \pm 10_{-16}^{+32}$	$(2.35_{-0.11}^{+0.13+1.24}) \times 10^{-4}$	25.0σ
$f_0(2100)$	$2081 \pm 13_{-38}^{+24}$	$273_{-24}^{+27+70}_{-23}$	$(1.13_{-0.10}^{+0.09+0.64}) \times 10^{-4}$	13.9σ
$f_2'(1525)$	$1513 \pm 5_{-10}^{+4}$	$75_{-10}^{+12+16}_{-8}$	$(3.42_{-0.61}^{+0.43+1.37}) \times 10^{-5}$	11.0σ
$f_2(1810)$	$1822_{-24}^{+29+66}_{-57}$	$220_{-42}^{+52+88}_{-155}$	$(5.40_{-0.67}^{+0.60+3.42}) \times 10^{-5}$	6.4σ
$f_2(2340)$	$2362_{-30}^{+31+140}_{-63}$	$334_{-54}^{+62+165}_{-100}$	$(5.60_{-0.65}^{+0.62+2.37}) \times 10^{-5}$	7.6σ



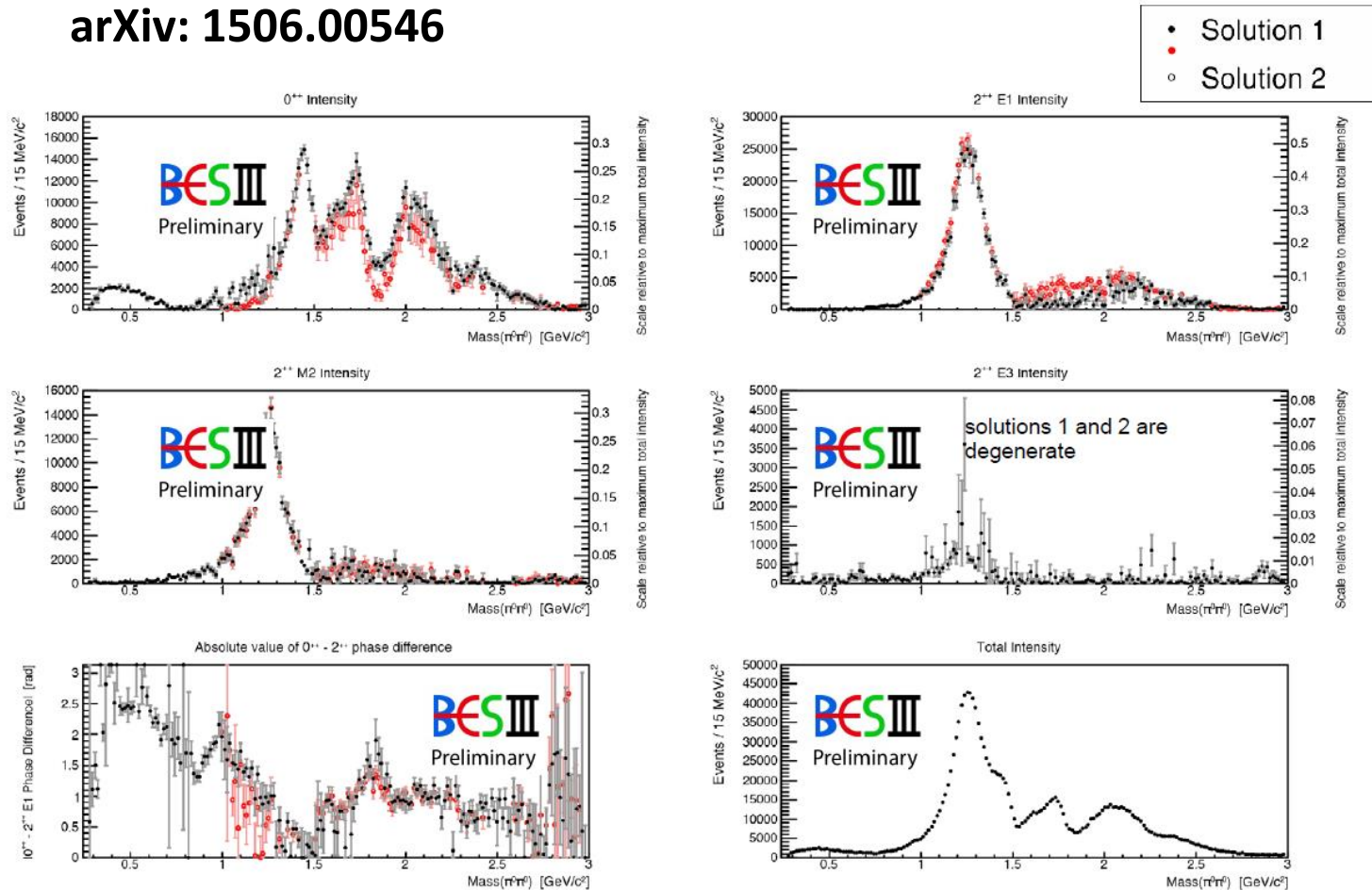
- Br of $f_0(1710)$ and $f_0(2100)$ are $\sim 10x$ larger than that of $f_0(1500)$
- Possible large overlap with LQCD predictions of 0^+ Glueball:

PRL 110 021601 (2013)

- Further studies of $J/\psi \rightarrow \gamma\eta\eta'$ and $J/\psi \rightarrow \gamma\eta'\eta'$ are crucial for glueball ID and solving the mixing scheme.

Model independent PWA of $J/\psi \rightarrow \gamma \pi^0 \pi^0$

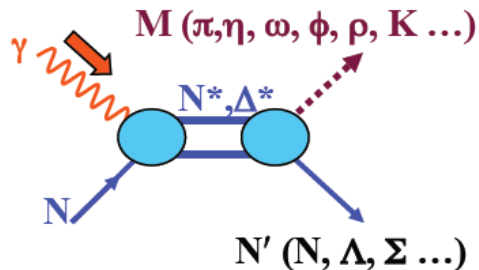
arXiv: 1506.00546



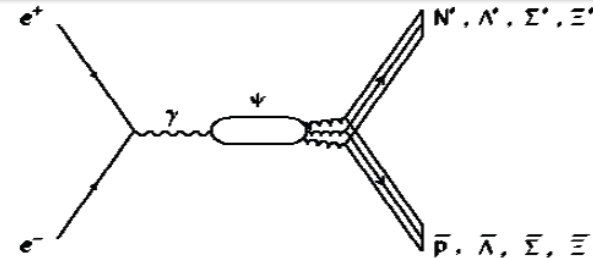
Significant features of the scalar spectrum include structures near 1.5, 1.7, and 2.0 GeV/c²

Charmonium decays provide novel insights into baryons --- complementary to other experiments

JLAB, MAMI, ELSA,



$$J/\psi(\psi') \rightarrow \bar{B}BM \Rightarrow N^*, \Lambda^*, \Sigma^*, \Xi^*$$

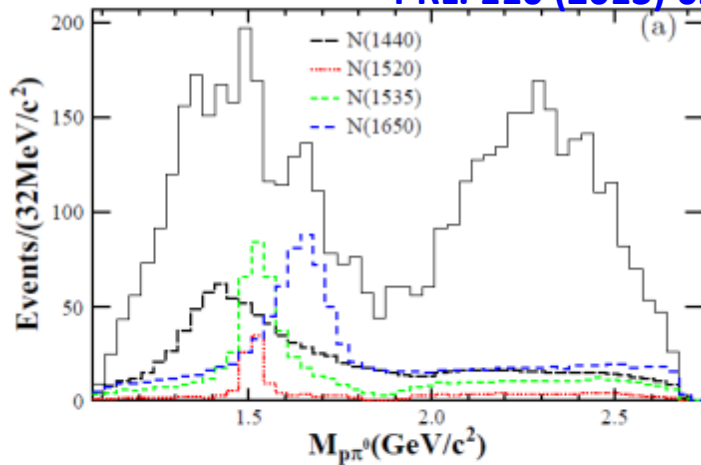


- ✓ Isospin 1/2 filter: $\psi \rightarrow N\bar{N}\pi$, $\psi \rightarrow N\bar{N}\pi\pi$
- ✓ Missing N^* with small couplings to πN & γN , but large coupling to $gggN$: $\psi \rightarrow N\bar{N}\pi/\eta/\eta'/\omega/\phi, \bar{p}\Sigma\pi, \bar{p}\Lambda K \dots$
- ✓ Not only N^* , but also $\Lambda^*, \Sigma^*, \Xi^*$
- ✓ Gluon-rich environment: a favorable place for producing hybrid (qqqg) baryons
- ✓ Interference between N^* and \bar{N}^* bands in $\psi \rightarrow N\bar{N}\pi$ Dalitz plots may help to distinguish some ambiguities in PWA of πN
- ✓ High statistics of charmonium @ BES III

Study of N^* and Ξ^*

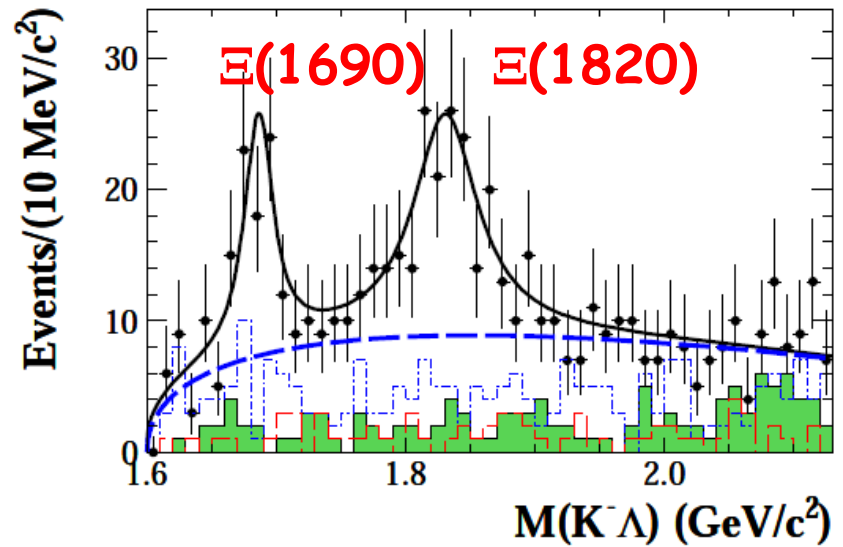
N^* in $\psi' \rightarrow \pi^0 p \bar{p}$

PRL. 110 (2013) 022001

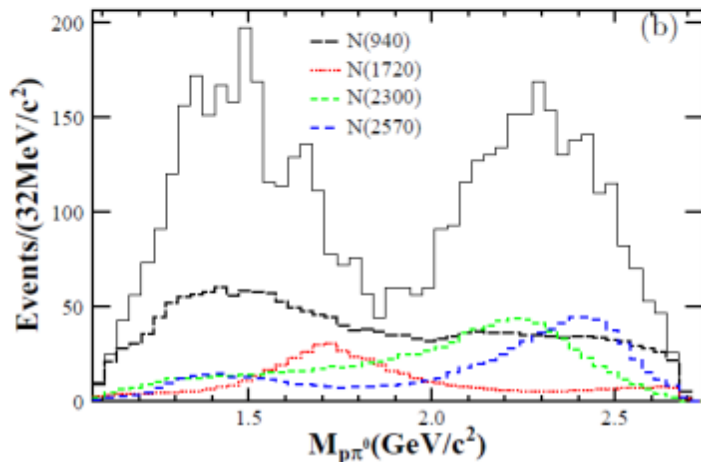


Ξ^* in $\psi' \rightarrow K \Lambda \Xi$

arXiv:1504.02025



New N^* s: $N(2300)$ and $N(257)$



- PWA of

- $J/\psi(\psi') \rightarrow \pi^0 p \bar{p}$
- $J/\psi(\psi') \rightarrow \eta p \bar{p}$
- $J/\psi(\psi') \rightarrow p K \bar{\Lambda}$
- ...

Charm physics at BESIII

Advantage of open charm at threshold

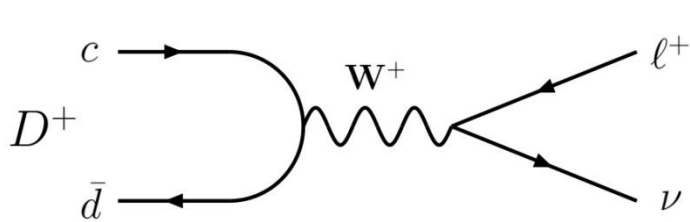
e^+e^- colliders@threshold:

$$e^+e^- \rightarrow \psi(3770) \rightarrow D^0\bar{D}^0 [C = -1] \quad \text{OR} \quad e^+e^- \rightarrow \gamma^* \rightarrow D^0\bar{D}^0\gamma [C = +1]$$

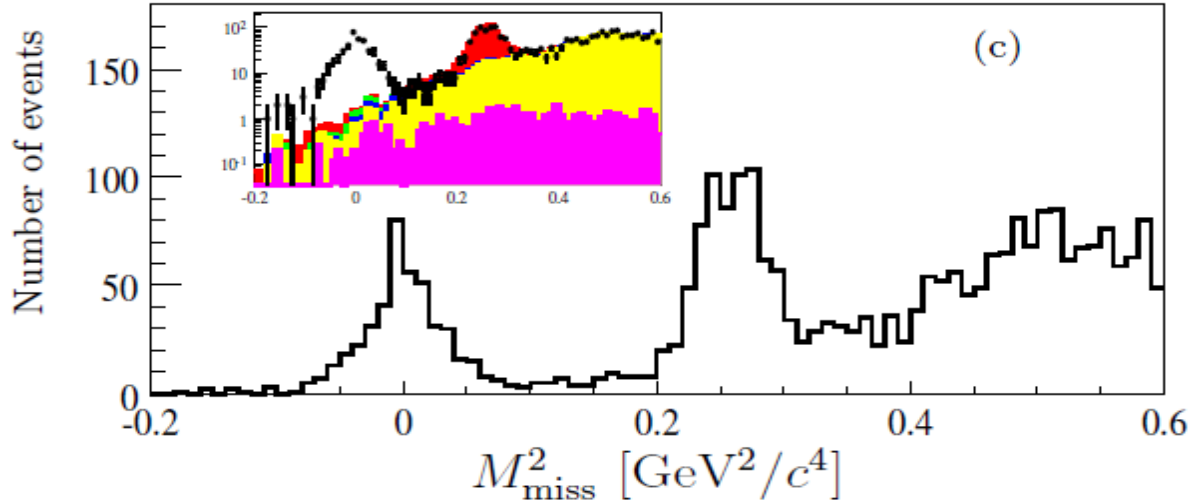
Good for charm flavor physics:

- Threshold production: clean
- Known initial energy and quantum numbers
- Both D and Dbar fully reconstructed (double tag)
- Absolute measurements

$f_{D(s)+}$: Leptonic decays



$$\Gamma(D^+ \rightarrow \ell^+ \nu_\ell) = \boxed{f_D^2 |V_{cd}|^2} \frac{G_F^2}{8\pi} m_D m_\ell^2 \left(1 - \frac{m_\ell^2}{m_D^2}\right)^2$$



$$B(D^+ \rightarrow \mu^+ \nu) = (3.72 \pm 0.19 \pm 0.06) \times 10^{-4}$$

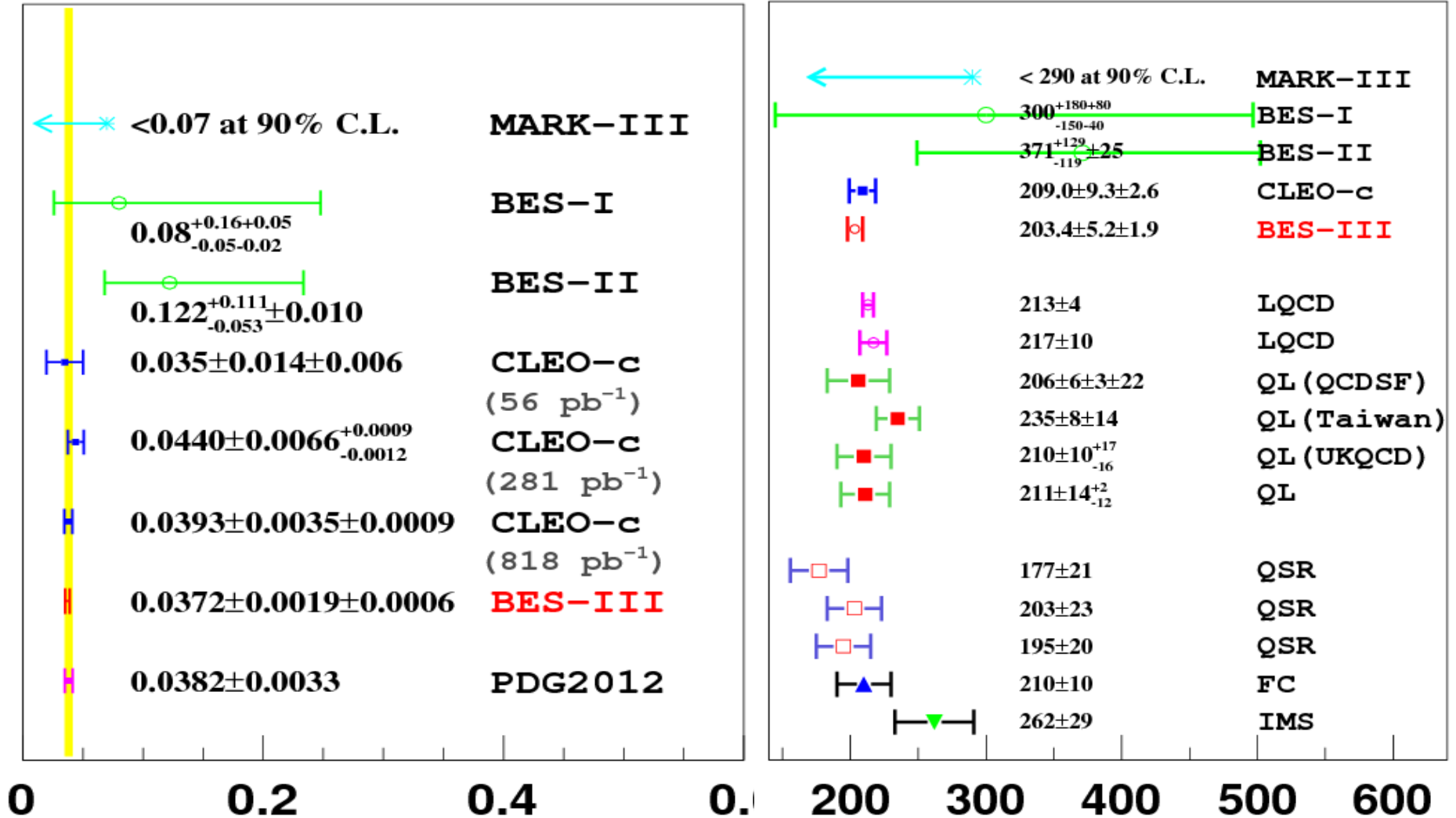
$$f_{D^+} = (203.4 \pm 5.2 \pm 1.9) \text{ MeV}$$

$$|V_{cd}| = 0.2212 \pm 0.0056 \pm 0.0047$$

\Leftarrow LQCD calculated $f_D = 207 \pm 4 \text{ MeV}$
[PRL100(2008)062002]

$B(D^+ \rightarrow \mu^+ \nu)$

f_{D^+}



BESIII: 2.7% with 2.92 fb^{-1}

BESIII final: 1.5% with 10 fb^{-1}

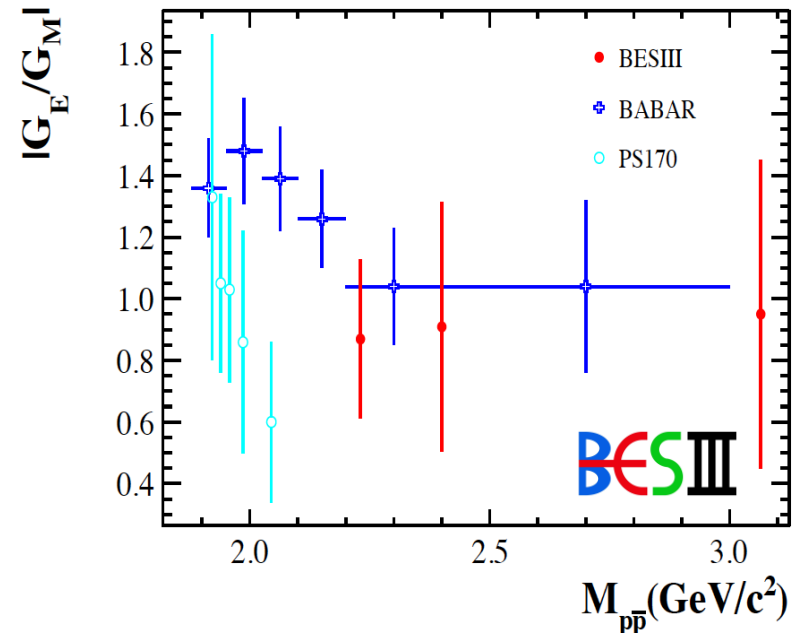
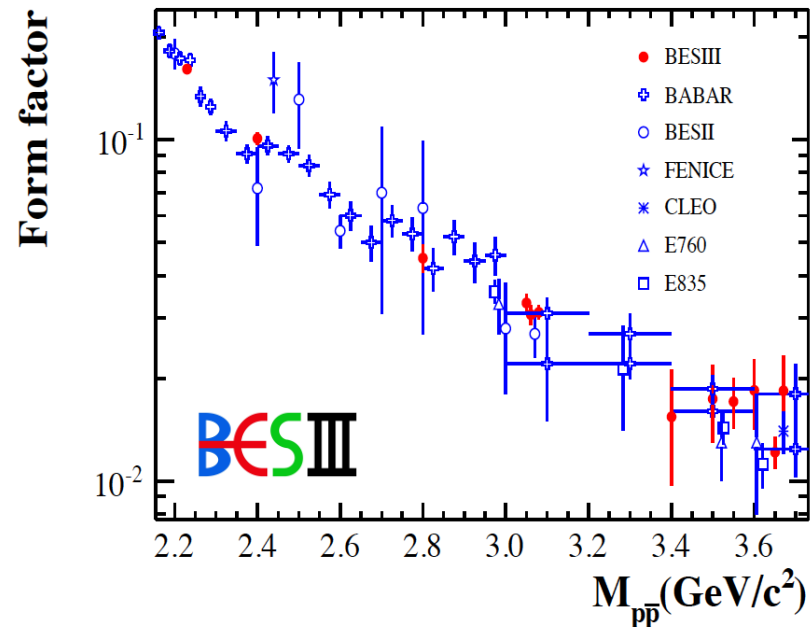
Proton FF measurement at BESIII

[Phys.Rev. D91 \(2015\) 11, 112004](#) .

Analysis Features:

- Radiative corrections from Phokhara8.0 (scan)
- Normalization to $e^+e^- \rightarrow e^+e^-$, $e^+e^- \rightarrow \gamma\gamma$ (BABAYAGA 3.5)
- Efficiencies 60% (2.23 GeV) 3% (~4 GeV)
- $|G_E/G_M|$ ratio obtained for 3 c.m. energies

E_{cm}/GeV	L_{int} / pb^{-1}
2.23	2.6
2.40	3.4
2.80	3.8
3.05, 3.06, 3.08	60.7
3.40, 3.50, 3.54, 3.56	23.3
3.60, 3.65, 3.67	63.0



• Precise study of Λ_c decays

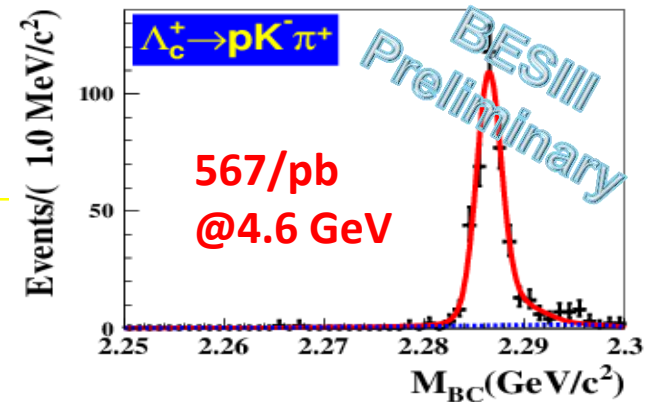
stringent test on Heavy Quark Effective Theory

- absolute branching fractions (BF) of Λ_c^+ decays suffers from large uncertainties since its discovery 30 years ago
- hadronic decays: to explore as-yet-unmeasured channels and understand full picture of intermediate structures
- semi-leptonic decays: test on form factor predictions

BESIII prel.

Decay modes	global fit \mathcal{B}	PDG \mathcal{B}	Belle \mathcal{B}
pK_S	1.48 ± 0.08	1.15 ± 0.38	
$pK^-\pi^+$	5.77 ± 0.27	5.1 ± 1.5	$6.84 \pm 0.24^{+0.21}_{-0.27}$
$pK_S\pi^0$	1.77 ± 0.12	1.65 ± 0.30	
$pK_S\pi^+\pi^-$	1.43 ± 0.10	1.30 ± 0.35	
$pK^-\pi^+\pi^0$	4.25 ± 0.22	3.4 ± 1.0	
$\Lambda\pi^+$	1.20 ± 0.07	1.07 ± 0.28	
$\Lambda\pi^+\pi^0$	6.70 ± 0.35	3.6 ± 1.3	
$\Lambda\pi^+\pi^-\pi^+$	3.67 ± 0.23	2.6 ± 0.7	
$\Sigma^0\pi^+$	1.28 ± 0.08	1.05 ± 0.28	
$\Sigma^+\pi^0$	1.18 ± 0.11	1.00 ± 0.34	
$\Sigma^+\pi^+\pi^-$	3.58 ± 0.22	3.6 ± 1.0	
$\Sigma^+\omega$	1.47 ± 0.18	2.7 ± 1.0	

only stat. errors



- ✓ $\mathcal{B}(pK^-\pi^+)$: BESIII precision comparable with Belle's result
- ✓ BESIII rate $\mathcal{B}(pK^-\pi^+)$ is smaller
- ✓ Improved precisions of the other 11 modes significantly

BESIII upgrade

- **MDC: Malter effect found in inner chamber in 2012, add water vapor to the chamber to cure the aging problem.**
- **New inner chamber is being built at IHEP. Will be ready this summer.**
- **CGEM as the inner chamber ongoing : Italy group in collaboration with groups in Germany, Sweden and IHEP.**

- **New ETOF (built by USTC & IHEP) will be installed this summer to improve the time resolution (100ps → 55ps)**

BESIII data taking status & plan (run ~8 years)

	Previous data	BESIII present & future	Goal
J/ψ	BESII 58M	1.2 B 20* BESII	10 B
ψ'	CLEO: 28 M	0.5 B 20* CLEOc	3B
ψ''	CLEO: 0.8/fb	2.9/fb 3.5*CLEOc	20 /fb
Above open charm threshold	CLEO: 0.6/fb @ ψ(4160)	0.5/fb @ ψ(4040) 2.3/fb@~4260, 0.5/fb@4360 0.5/fb@4600, 1/fb@4420	5-10 /fb
R scan & Tau	BESII	3.8-4.6 GeV at 105 energy points 2.0-3.1 GeV at 20 energy points	
Υ(2175)		100 pb ⁻¹	
ψ(4170)		3 fb ⁻¹ (next run)	

Thank you!