UNIVERSITÀ DEGLI STUDI DI TORINO

BESIII

INFN Istituto Nazionale di Fisica Nucleare

XYZ studies @the BESIII experiment

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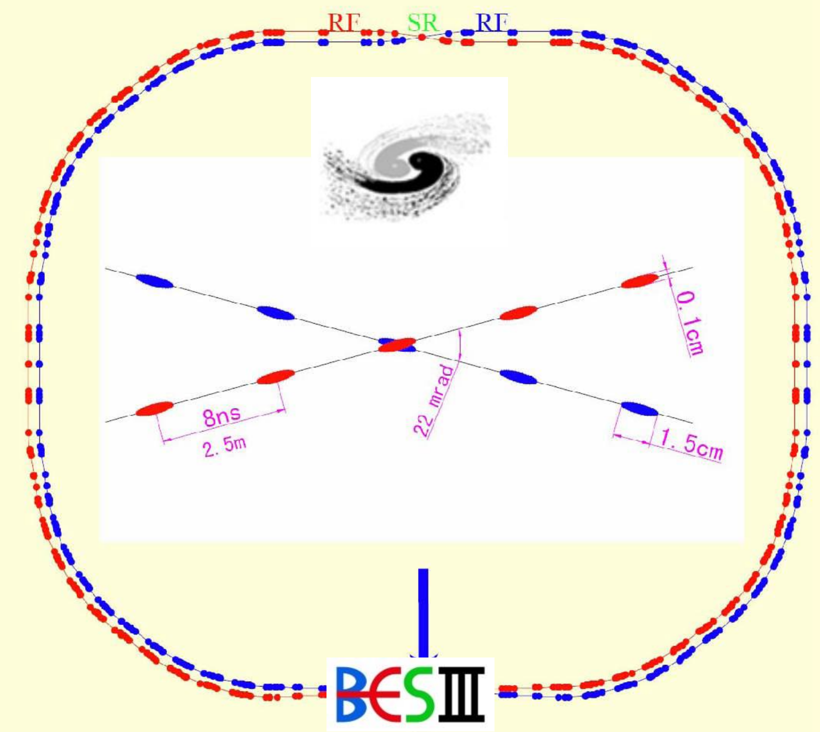
Les Rencontres de Physique de la Vallee d'Aoste
La Thuile, March 6-12, 2016

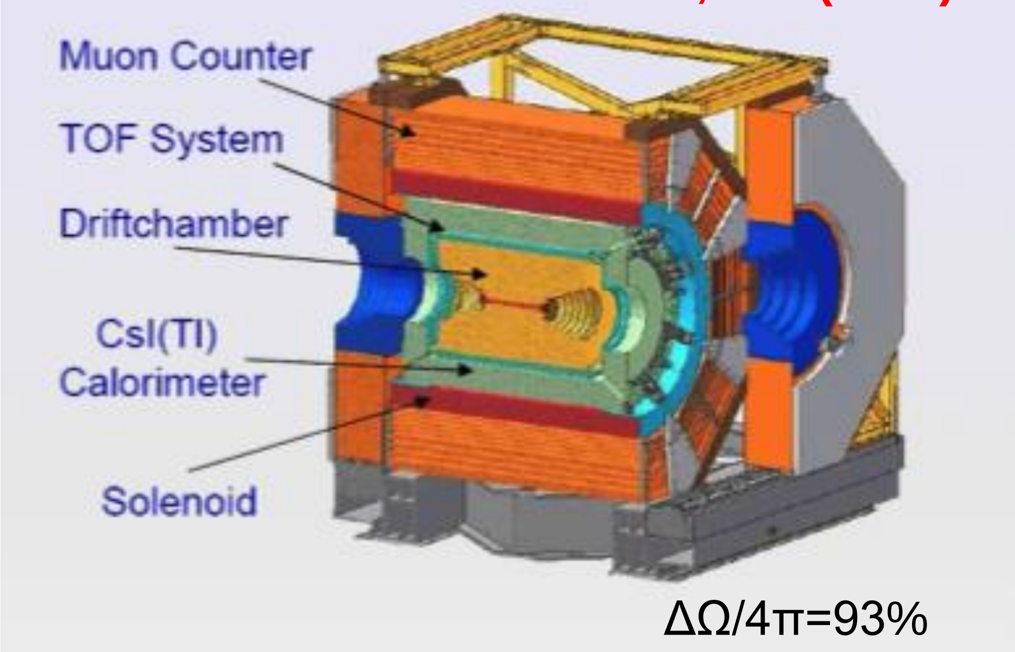
Outline

- Introduction to BESIII
- XYZ studies :
  selected results
- Conclusions

BEPCII & BESIII



Nucl. Instr. Meth. A614, 345 (2010)



Double ring collider
Beam energy 1 . . . 2.3 GeV
Single beam current 0.91 A
Crossing angle: ±11 mrad
Design luminosity @Ψ(3770)=10^{33} cm^{-2} s^{-1}
Achieved: 85%
BEMS by Laser compton back
Scattering $\Delta E/E$ ≈5 *10^{-5}
Energy spread : 5.16 ∙ 10^{-4}

MDC: main drift chamber (He 60%,propane 40%)) σ(p)/p < 0.5 % @1 GeV, σ(xy) =130 μm, 6% dE/dx for MIP pions

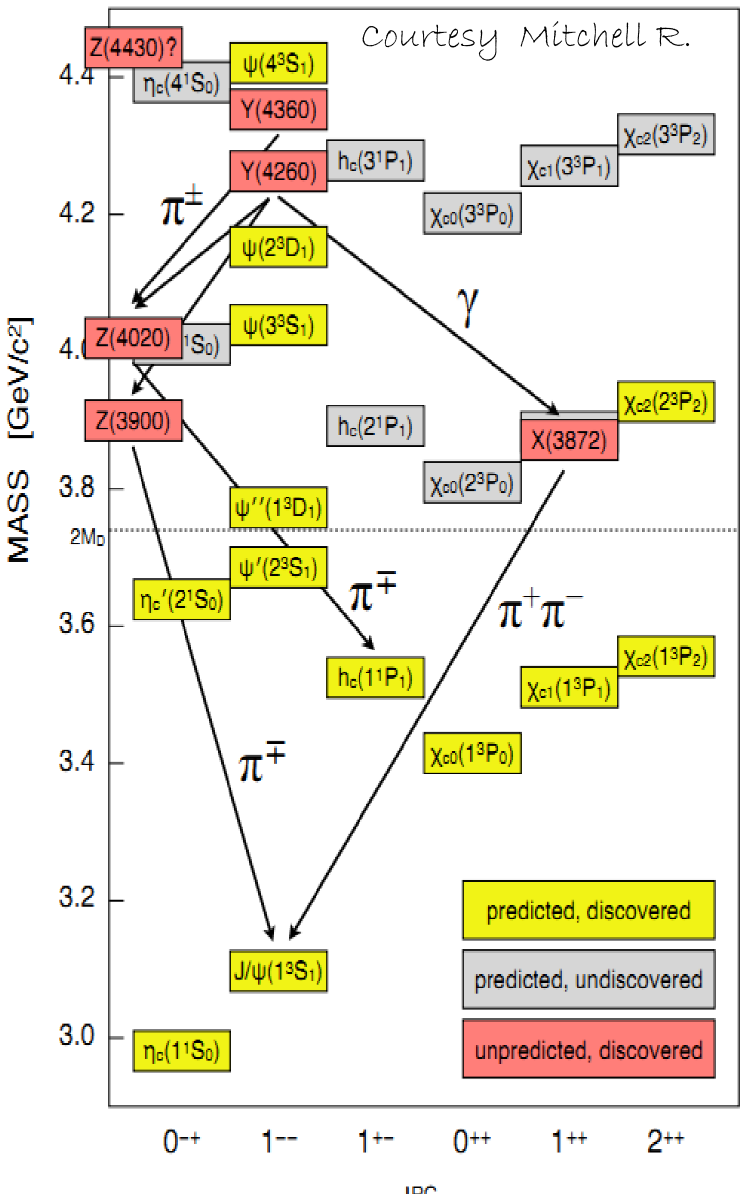
TOF: time of flight (two layers plastic scintillator): σ~ 90 ps (barrel)

EMC: Cs I(Tl), barrel+2 end caps:
σ(E)/E < 2.5 %, σ(x) < 6mm for 1 GeV e-

MUC: RPC: σ(xy) < 2 cm

Important upgrades in the next future: CGEM, ETOF

The BESIII contribute



For predict. Barnes *et al.*, PRD 72, 054026 (2005)
(not all XYZ candidates shown!)

Many unexpected states reported above the $D\bar{D}$ threshold (the so-called XYZ).

X : charmonium-like states with $J^{PC} \neq 1^{--}$
Observed in B decays, pp and pp collisions

radiative or hadronic transition from Y

Y : charmonium-like states with $J^{PC} = 1^{--}$
Can be produced in direct e+e- annihilation (or in ISR)

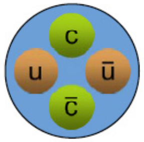
Hadronic transition from Y

Z : charmonium-like states which can carry electric charge. Must contain at least a $c\bar{c}$ and a light $q\bar{q}$ pair

BEPCII& BESIII can be used as a Y(4260) (Y(4360)) factory We can study the connections between X , Y and Z and the cross-section as CME function.

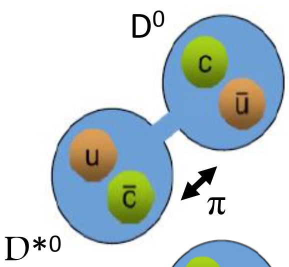
Nature of XYZ states

- **Tetraquarks** (Maiani et al,…)
  - Bound states of **4 quarks, Large number** of states expected ,**Small widths** above threshold

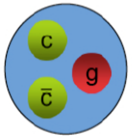


- **Molecular states (**Weinberg, Tornqvist, Swanson …)
  - Loosely bound states of a **pair of mesons** , **Small number** of states,

  Small widths above threshold

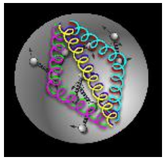


- **Hybrids** (Zhu, Close..)
  - Bound States with a pair of quarks and **excited gluonic** degrees of freedom
  - Lattice and model predictions for the **lowest-mass** hybrid ~ **4.2 GeV/c^2**



- **Glueball**

  Bound states of gluons



- **HadroCharmonium (**Voloshin et al)

  Compact charmonium enbadded in light quark mesonic excitation interacting by analog of Van der Waals

- **Others: Threshold**, **cusp**, or **coupled-channel** effect
  - Produce a **cross section enhancement**

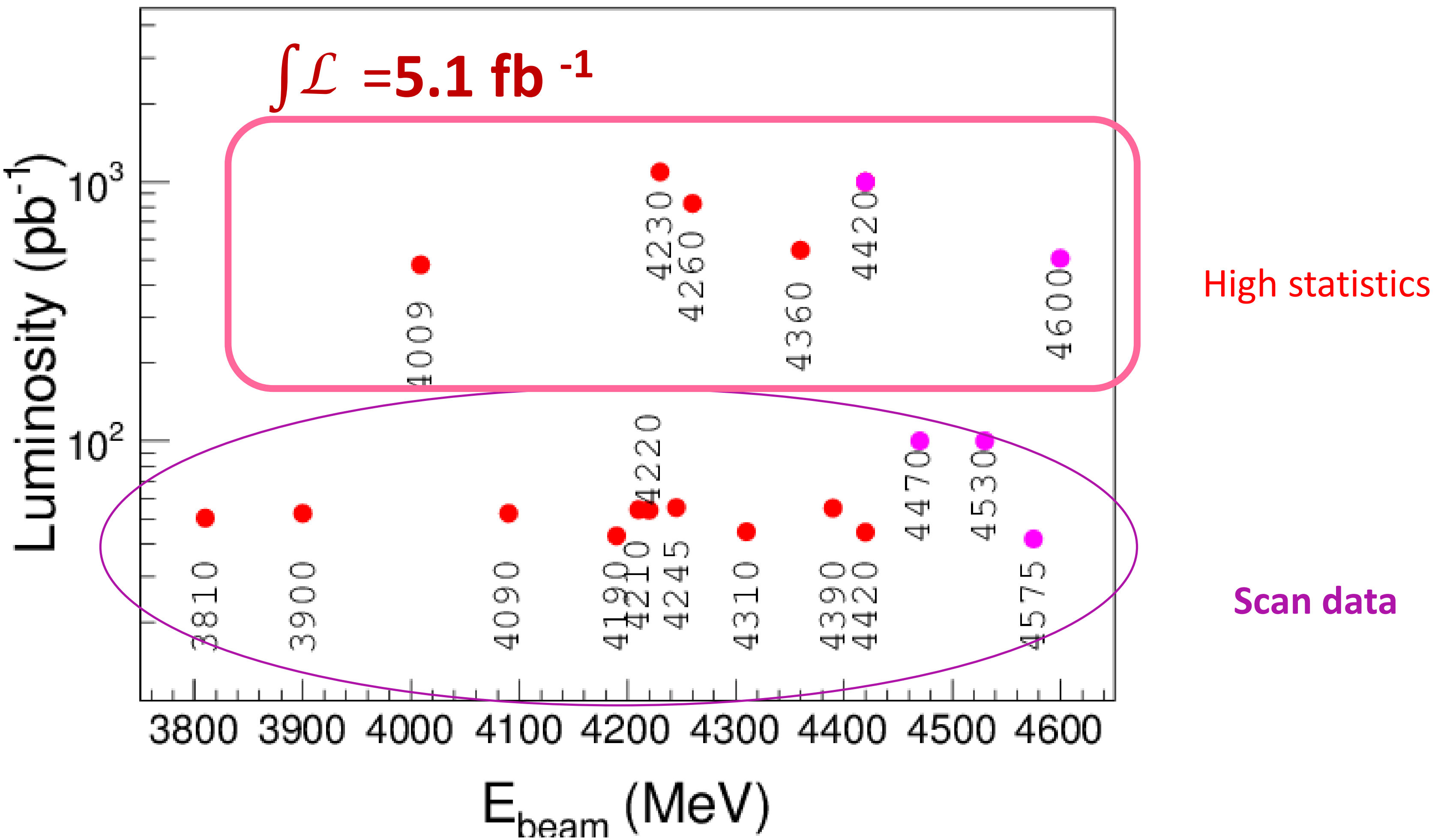
EXPERIMENTAL CONTRIBUTION

1)Establish the spectrum: search for more XYZ states, determine their properties and investigate new decays for known ones

2) Build connections: look for transitions between different states

Data sample for XYZ studies

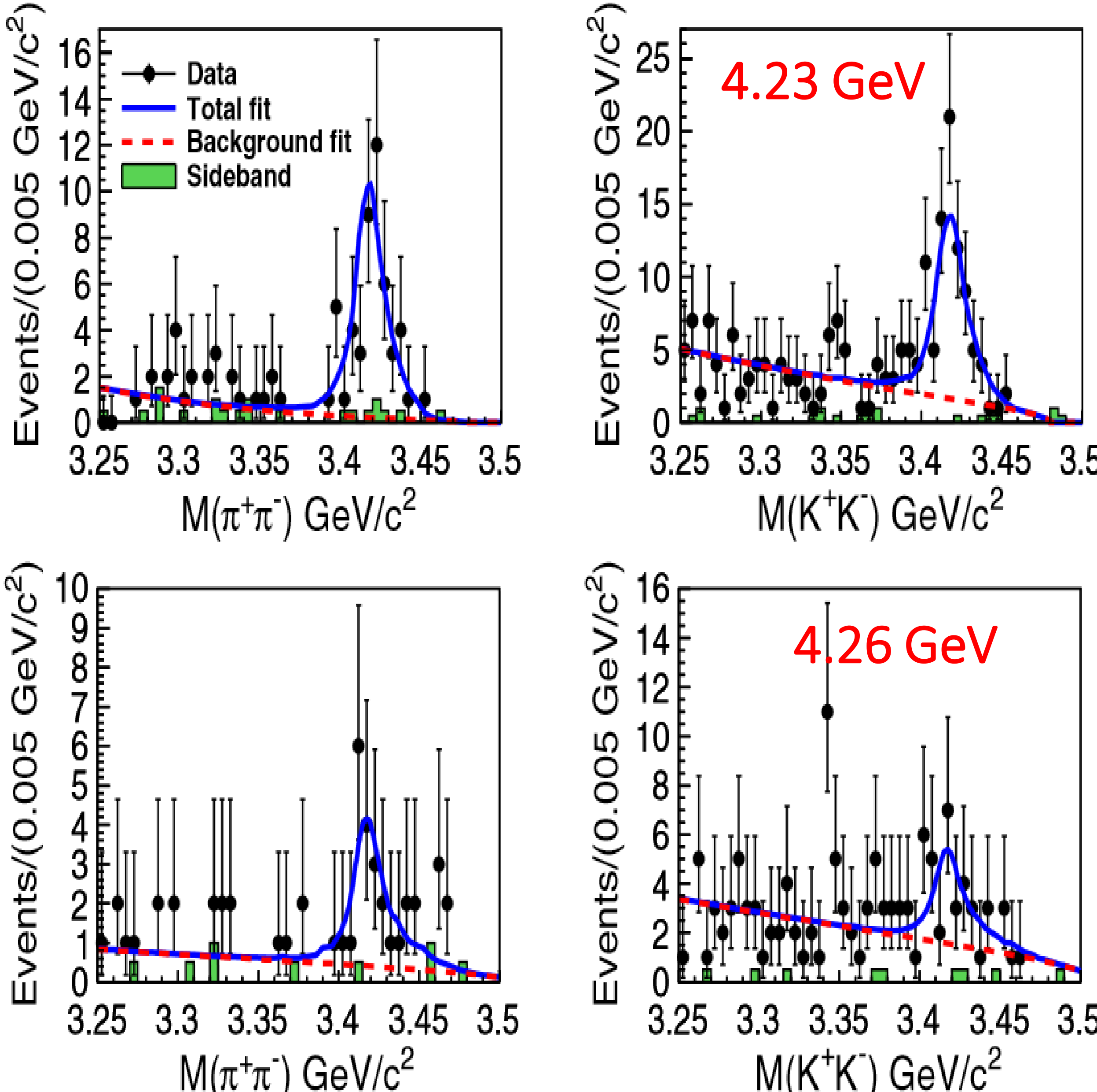
A dedicated program started in 2012 : 18 energy points.



+ the largest samples of J/Ψ, Ψ',Ψ(3770)
+ 104 energy points between 3.85 and 4.59 GeV(0.8/fb)
+ 20 energy points between 2.0 and 3.1 GeV

Y

Study of $e^+e^- \to \omega\chi_{c0}$



PRL 114,092003(2015)

9 C.M.E.
from 4.21 to 4.42 GeV

$\omega \to \pi^+\pi^-\pi^0$
$\chi_{c0} \to K^+K^-/\pi^+\pi^-$

Simultaneous UMLH fit to $\pi^+\pi^-/K^+K^-$ IM

Fixed N($\pi^+\pi^-$)/N(K^+K^-)

Bkg:ARGUS

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

Phase-space modified Breit-Wigner

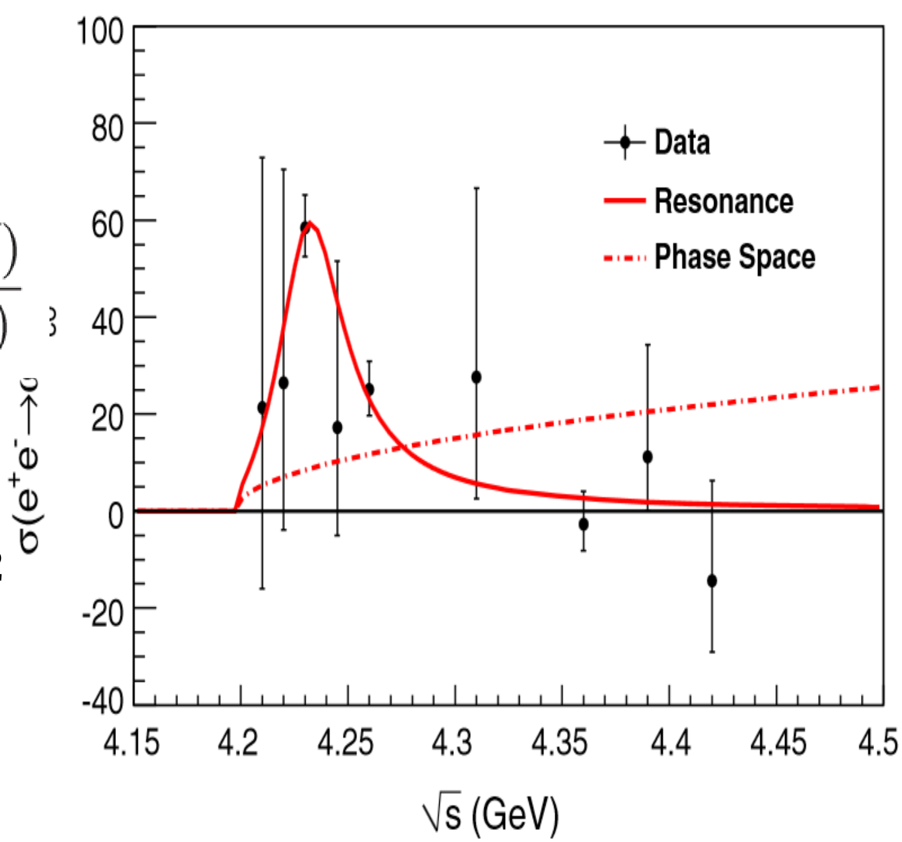
$$BW(\sqrt{s}) = \frac{\Gamma_{ee}\mathcal{B}(\omega\chi_{c0})\Gamma_t}{(s-M^2)^2+(M\Gamma_t)^2} \times \frac{\Phi(\sqrt{s})}{\Phi(M)}$$

$\Gamma_{ee}\mathcal{B}(\omega\chi_{c0}) = (2.7 \pm 0.5 \pm 0.4)$ eV

$M(Y) = (4230 \pm 8 \pm 6)$ MeV/c^2

$\Gamma_t = (38 \pm 12 \pm 2)$ MeV

with significance $> 9\sigma$

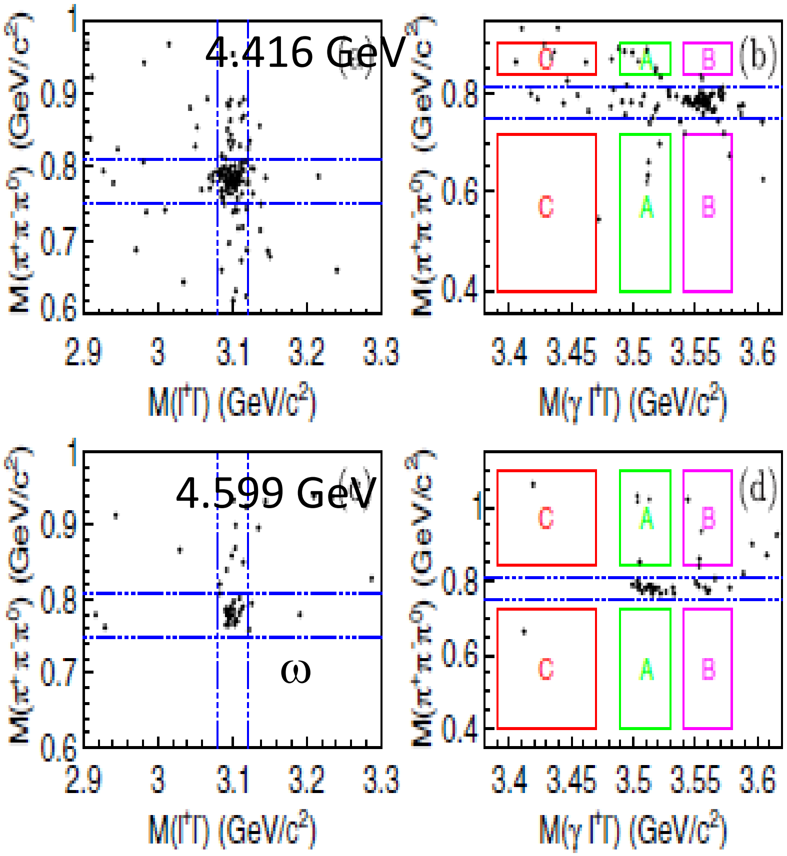


Inconsistent with Y(4260)

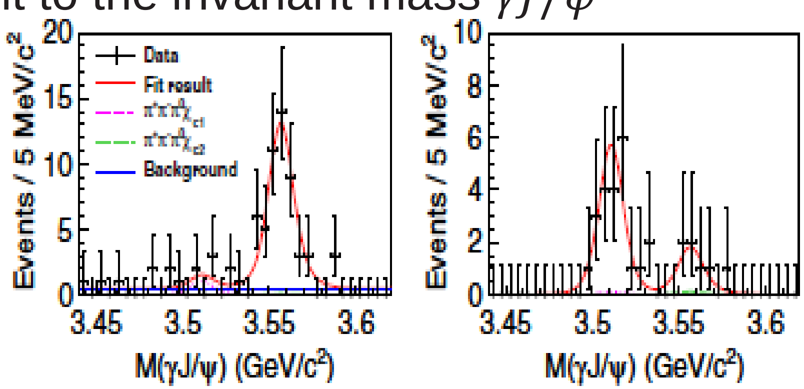
New structure?Tetraquark(**Phys. Rev. D 91, 117501**), hint in $\pi^+\pi^- h_c$ (Chin. Phys, C38,043001)? Due to missing charmonium state Ψ(4s)[**Phys. Rev. D 91, 094023**]? Due to the tail of ψ(4160) ? Threshold effect?

For $e^+e^- \to \omega\chi_{c1,2}$ no significant signals and set up limits of cross sections at pb level at these energy points. → inconsistent with the prediction[molecular model+ symmetry analysis arXiv:1406.6879]

Observation of $e^+e^- \to \omega\chi_{cJ}$

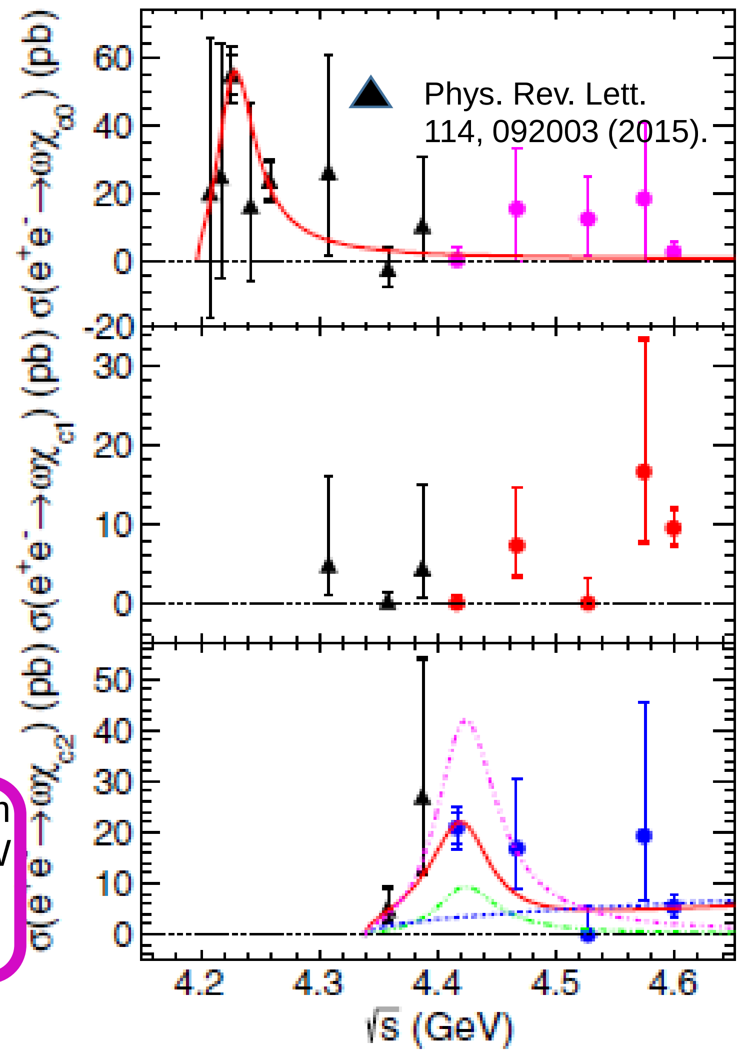


Fit to the invariant mass $\gamma J/\psi$



PRD 93, 011102(R) (2016)

5 data samples with CME>4.4 GeV (2014 data)

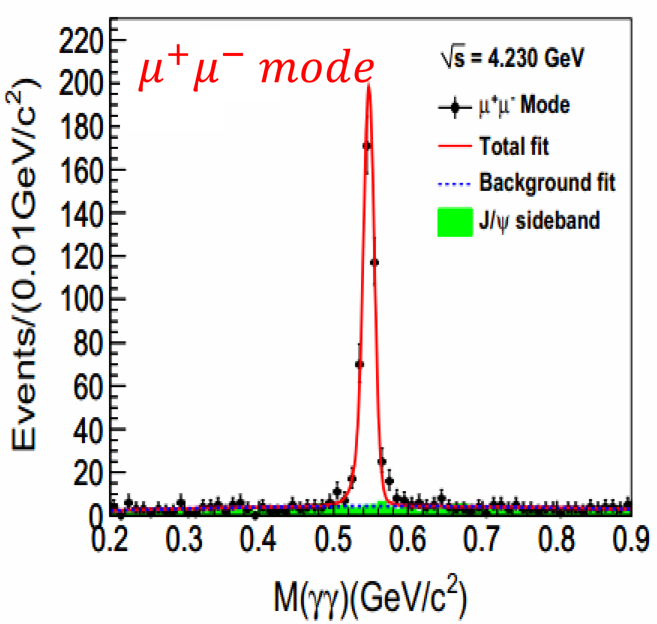


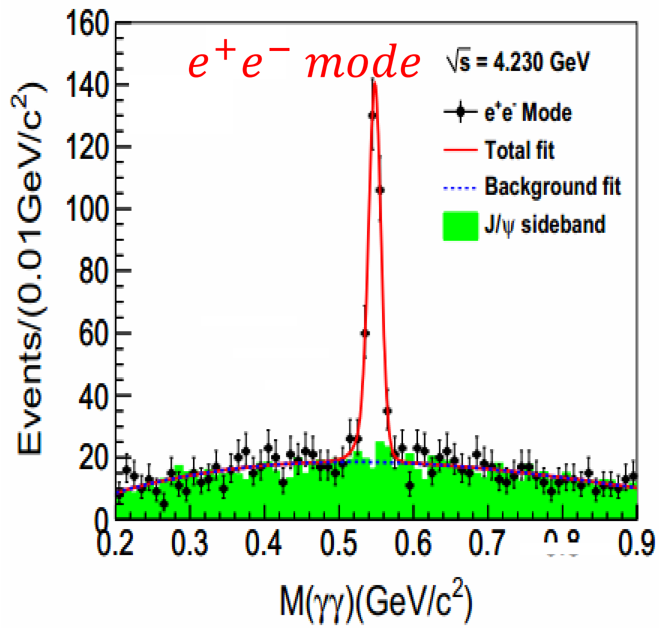
Coherent sum of ψ(4415) BW and PHSP term

different production mechanisms ? Further studies @higher energy can help.

Measurement of $e^+e^- \to \eta J/\psi$

PRD91,11, 112005





$\eta \to \gamma\gamma$

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

UML to extract η signals

PDF-MC shape conv, with gaussian

Bkg-Cheb. Pol.

>8 σ

No signal for $e^+e^- \to \pi^0 J/\psi$

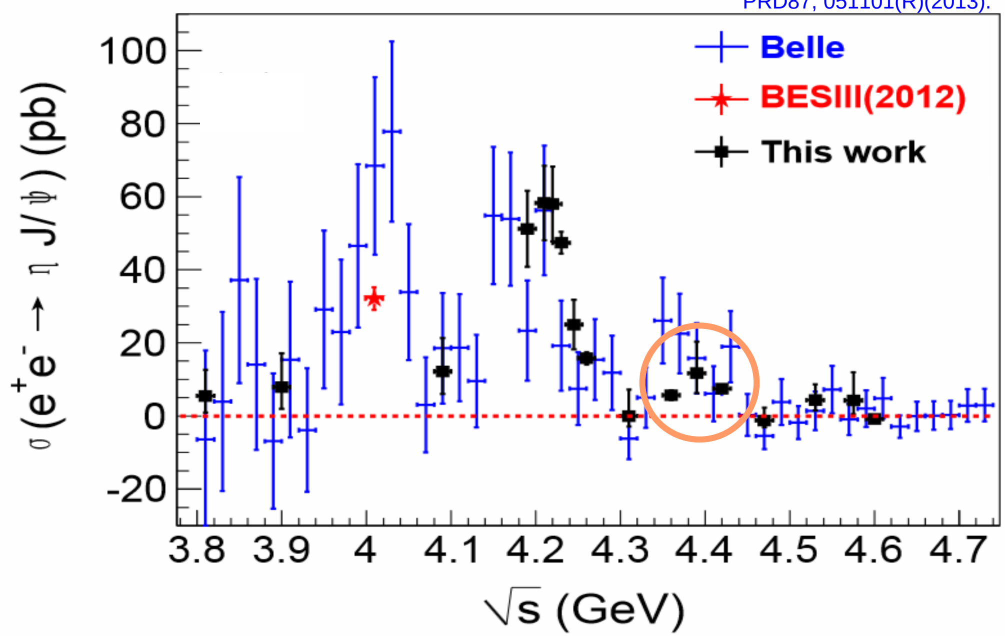
Analysis extended to other 15 data samples (6 with significance >5 σ for the others UL)from 3.810 to 4.600 GeV

No trivial structure. Peak @4.2 GeV?

Other Y states?

We need data in the region(4.1~4.2 GeV)

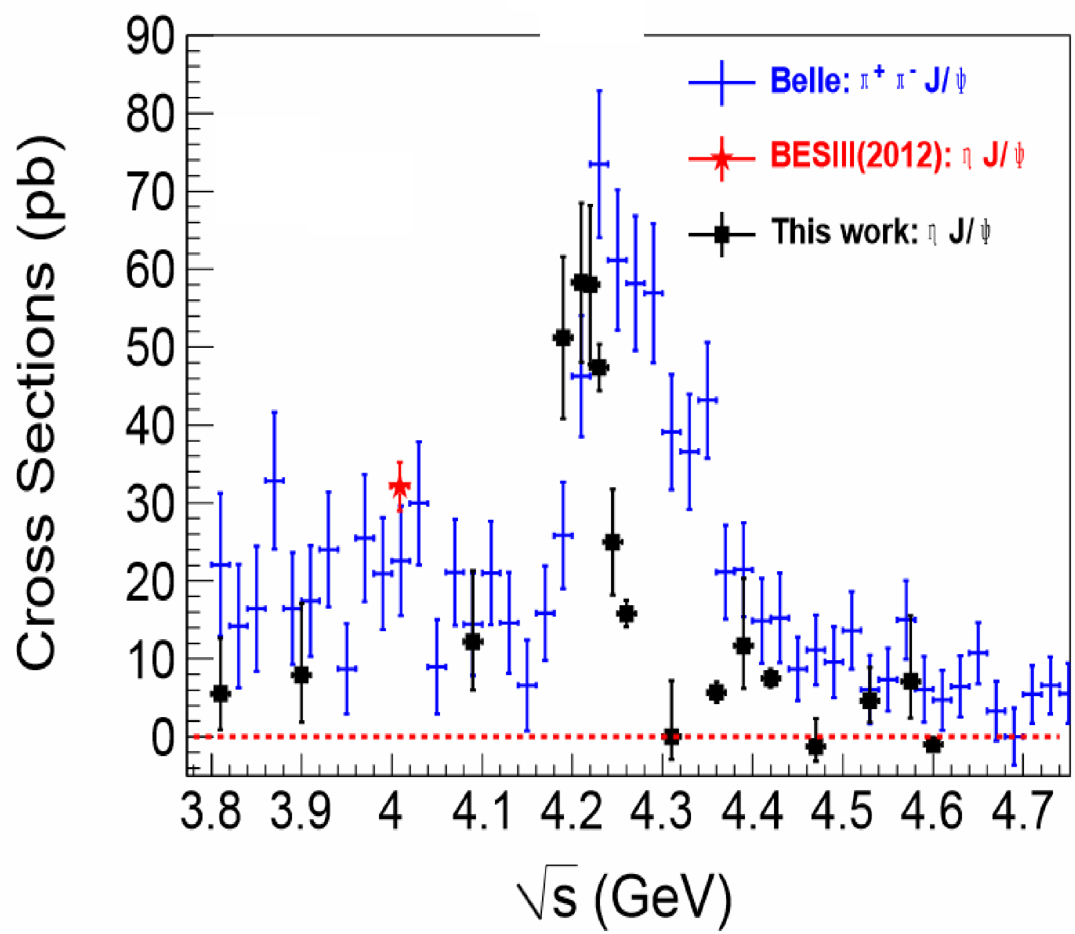
PRD87, 051101(R)(2013).



PRD91,11, 112005

Cross section $e^+e^- \to \eta J/\psi$

Comparison with Belle's result for $e^+e^- \to \gamma_{ISR}\pi\pi J/\psi$ (PRL99, 182004(2007))

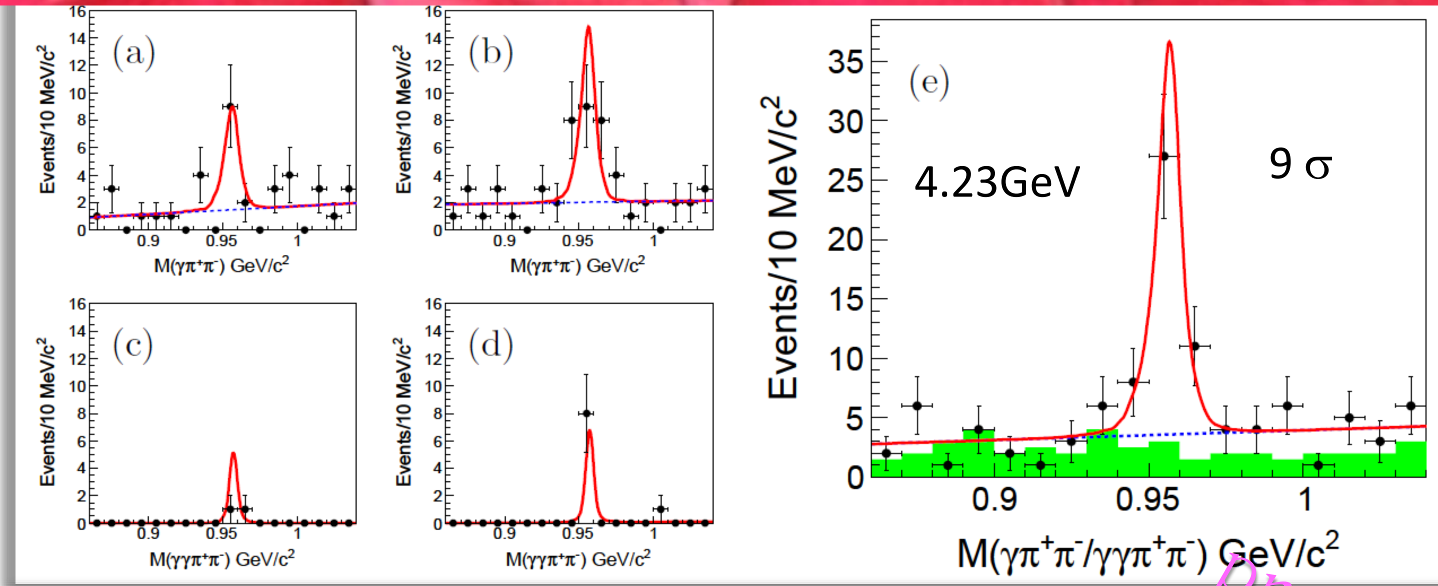


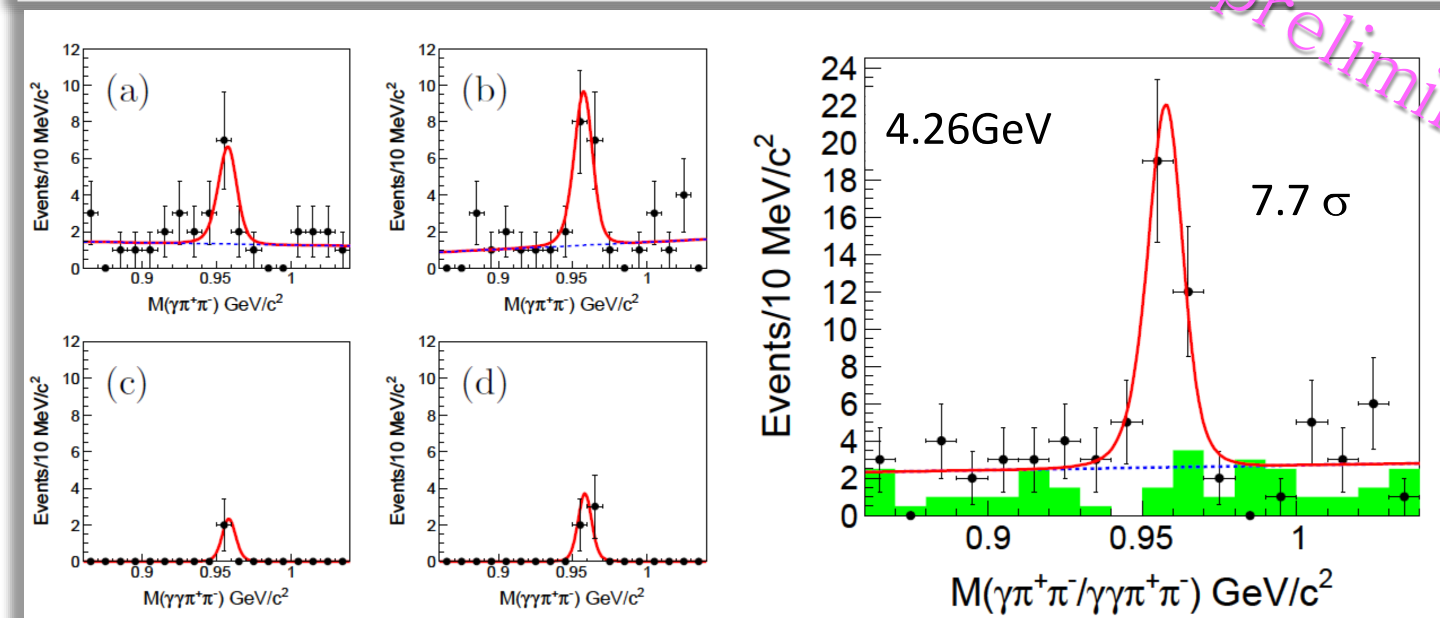
Inconsistent with Y(4260)-> $\pi^+\pi^- J/\psi$ → Different dynamics

Consistent with NRQCD (+LC approach η) calculation (PRD 89, 074006(2014))

PRD91,11, 112005

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



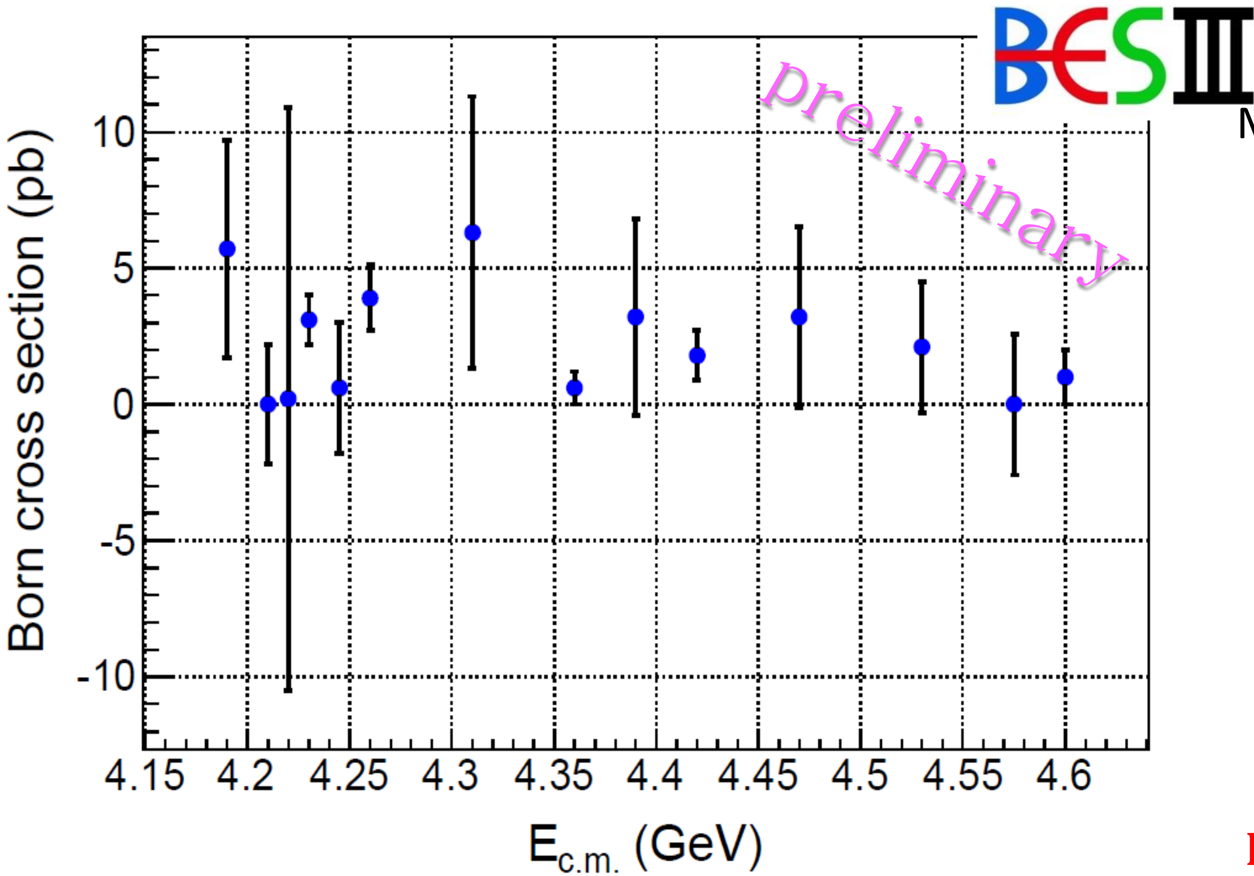


First observation

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

Cross section of $e^+e^- \to \eta' J/\psi$

Significant signal @4.230,4.260 GeV. UL (90% CL) on cs of other 12 cme points.



Much lower than $\eta J/\psi$, lower than NRQCD calculation (PRD 89, 074006(2014))

PRD 89, 074006(2014)

Energy (GeV)	4.300	4.310	4.400	4.420	4.500	4.530	4.600	4.600
Cross section(pb)	34.1	< 5.3	24.2	< 14.7	16.4	< 4.0	12.6	< 5.8

Search for $Y(4140) \to \phi J/\psi$

First evidence by CDF (2009) in $B^+ \to \phi J/\psi K^+$, not confirmed by Belle & LHCb & BABAR in the same process. Recently D0 and CMS observations.

It is the first XYZ decaying into two vector mesons made up by $c\bar{c}$ and $s\bar{s}$.

C=+1 → **we can search for it in radiative transitions of Y(4260)**

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

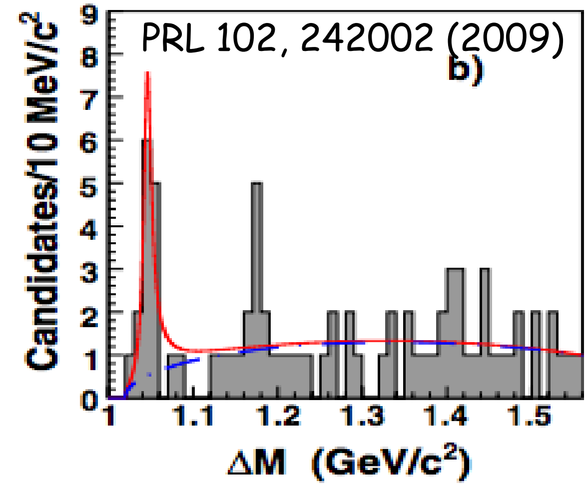
$J/\psi \to e^+e^-/\mu^+\mu^-$

ϕ decay modes

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.

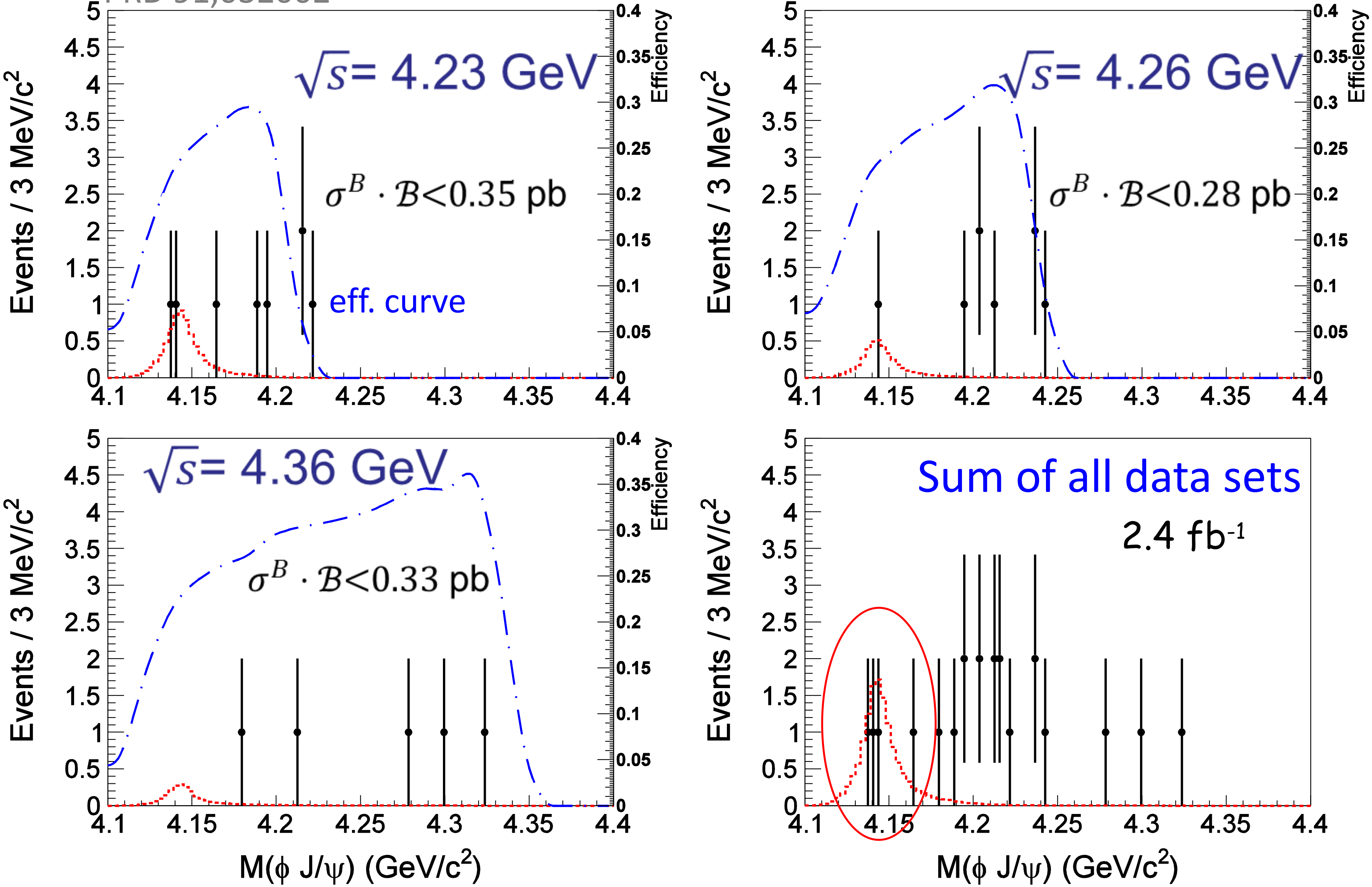
3. $\phi \to \pi^+\pi^-\pi^0$
   Full reconstruction.



PRD 92,032002

Search for $Y(4140) \rightarrow \phi J/\psi$

PRD 91,032002



Combine 6 modes (3 ϕ modes X 2 J/ψ modes)

Search for $Y(4140) \to \phi J/\psi$

No significant Y(4140) signal found @ BESIII

PRD 92,032002

$\sqrt{s}$ (GeV/c^2)	Luminosity (pb^{-1})	$(1+\delta)$	$\sigma^B \times \mathcal{B}$ (UL 90%CL)
4.23	1094	0.840	<0.35
4.26	827	0.847	<0.28
4.36	545	0.944	<0.33

Systematic error included

X(3872) production rates (BESIII) are of the same order of magnitude
$[\sigma^B(e^+e^- \to \gamma X(3872)) \times \mathcal{B}(X(3872) \to \pi^+\pi^- J/\psi)]$
at 4.23 GeV: 0.27± 0.09± 0.02 pb
at 4.26 GeV: 0.33±0.12±0.02 pb

Taking $\mathcal{B}(X(3872) \to \pi^+\pi^- J/\psi)$ = 5%. from arXiv:0910.3138
And estimating $\mathcal{B}(Y(4140) \to \phi J/\psi)$ = 30% (part. width from molecule calculation, PRD 80, 054019. & Γtot from CDF arXiv:0920.313)

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

Search for $Y(4260) \to J/\psi \eta \pi^0$

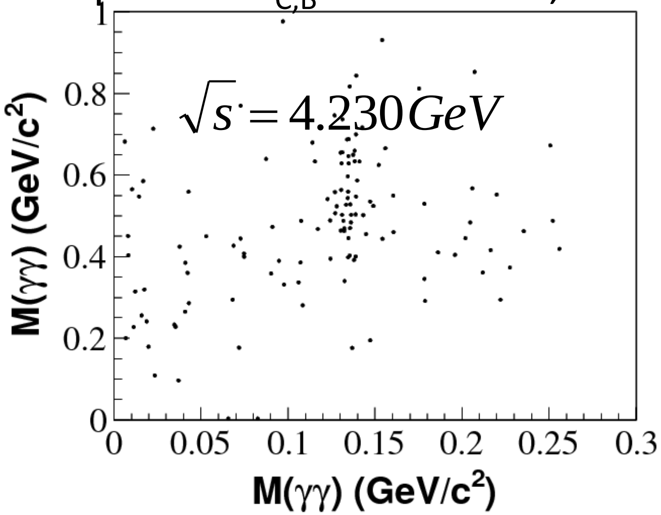
<u>Isospin violating processes can probe the nature of Y(4260).</u>

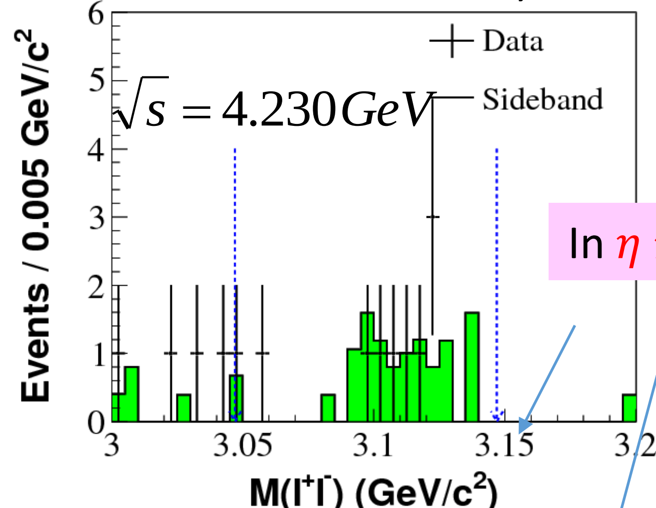
Theoretical predictions (L. Maiani et al.,PRD 87 111102 ,D_1D molecule: X. Wu et al., PRD 89, 054038 For Hadroquarkonium of Z_{CB}:M.Voloshin, PRD 86 034013 Tetraquark of $Z_{C,B}$: A. Ali et al., PRL 104 162001, PRL 106 092002*)*

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

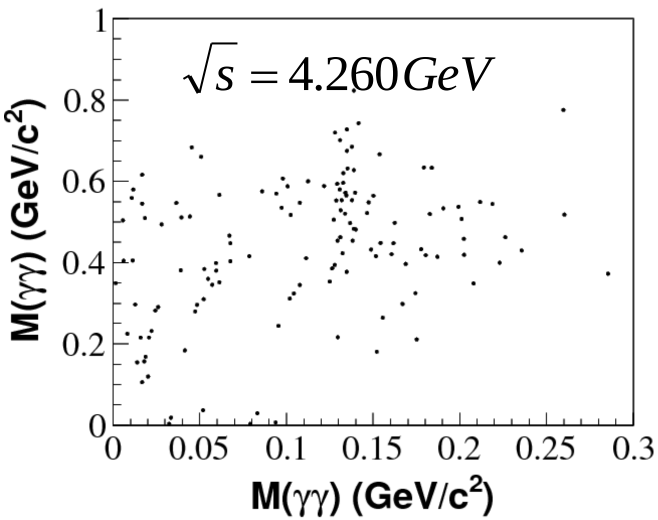
$\eta \to \gamma\gamma$

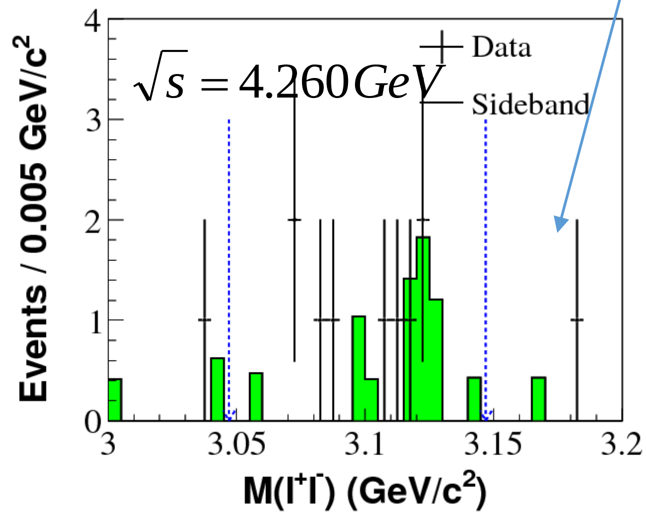
$\pi^0 \to \gamma\gamma$





In $\eta\ \pi^0$ signal region





No signal observed Exceeding bkg(2d $\eta\ \pi^0$ sidebands)

PRD92,1, 012008

6 data samples @different CME

Search for $Y(4260)\to J/\psi\eta\pi^0$

The Born cross section at 90% CL.

$\sqrt{s}$ (GeV)	$\mathcal{L}$ (pb^{-1})	$(1+\delta^r)$	$(1+\delta^v)$	$(\epsilon^{ee}\mathcal{B}^{ee} + \epsilon^{\mu\mu}\mathcal{B}^{\mu\mu})$ (%)	$N^{\rm obs}$	$N^{\rm bkg}$	$N^{\rm up}$	$\sigma^{\rm Born}_{\rm UL}$ (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

UL are well above the prediction for the D_1D molecule model, (0.05 pb at 4.290 GeV) [X. G. Wu et al., PRD 89, 054038] →needed 100x luminosity to reach sensitivity

Z

BESIII: Z_c states

Necessarily exotic (at least $c\bar{c}$ and a light $q\bar{q}$)

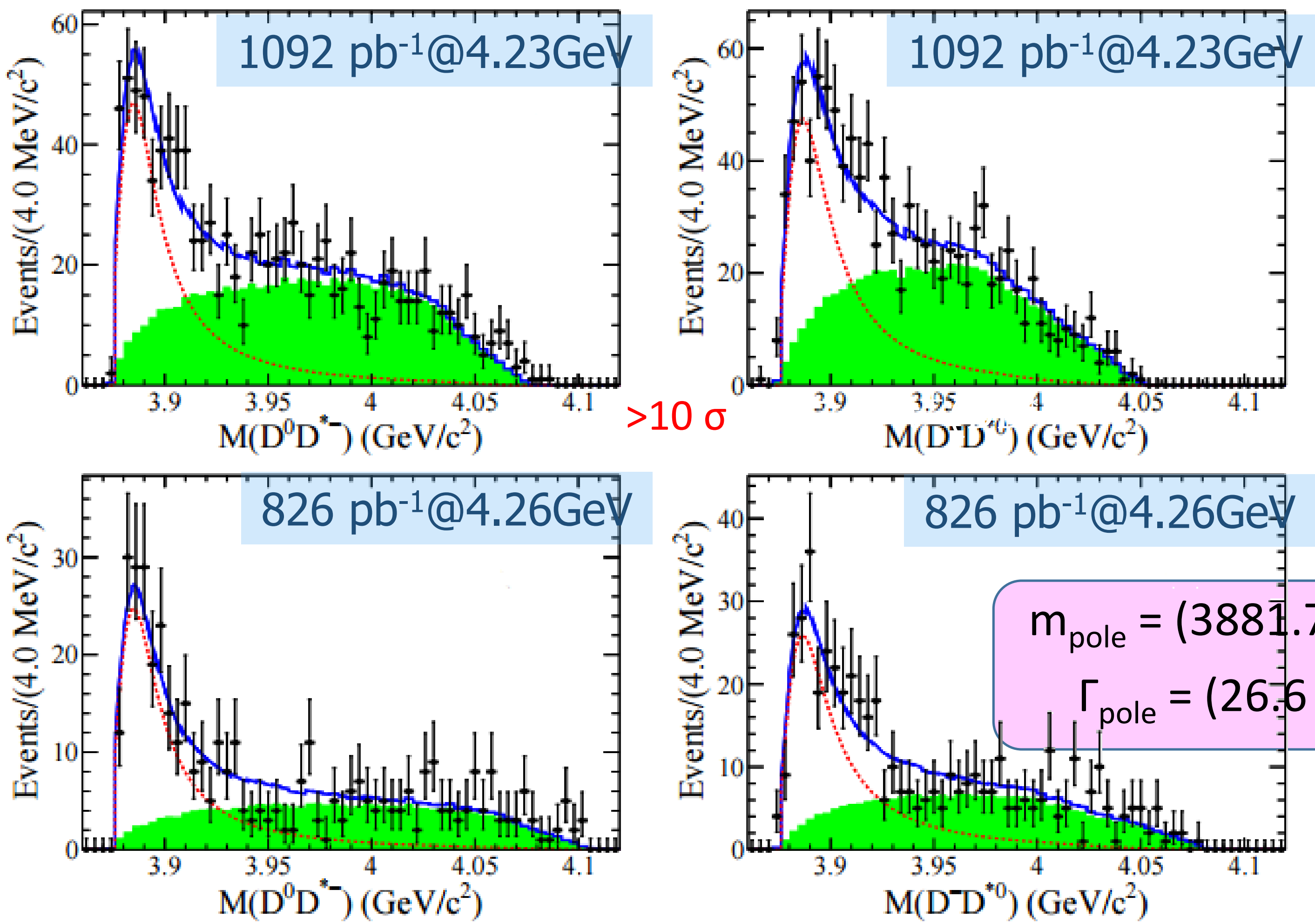
State	Mass (MeV/c²)	Width (MeV)	Decay	Process	[Ref]
$Z_c(3900)^{\pm}$	$3899.0 \pm 3.6 \pm 4.9$	$46 \pm 10 \pm 20$	$\pi^{\pm} J/\psi$	$e^+e^- \to \pi^+\pi^- J/\psi$	1
$Z_c(3900)^0$	$3894.8 \pm 2.3 \pm 2.7$	$29.6 \pm 8.2 \pm 8.2$	$\pi^0 J/\psi$	$e^+e^- \to \pi^0\pi^0 J/\psi$	2
$Z_c(3885)^{\pm}$	$3883.9 \pm 1.5 \pm 4.2$ 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
$Z_c(3885)^{\pm}$	$3881.7 \pm 1.6 \pm 2.1$ 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

[1] PRL,110,252001; *[2] PRL115,112003;* *[3] PRL,112, 022001;* *[4]* PRD 92, 092006;
[5] PRL 115, 222002; *[6] PRL,110, 252001; [7] PRL,113,212002; [8] PRL,112, 132001 ;*
[9] PRL 115 , 182002

Confirmation of $Z_c(3885)^{\pm}$ with double D tag

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

Phys. Rev. D 92, 092006



Double D tag technique:

Tag 'bachelor' π^+ and two D mesons

After kinematic fit look in mass recoiling against π^+

Simultaneous Fit: thresh. modified BW+ bkg from PHSP MC

m_{pole} = (3881.7 ± 1.6 ± 2.1) MeV/c^2

Γ_{pole} = (26.6 ± 2.0 ± 2.3) MeV

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

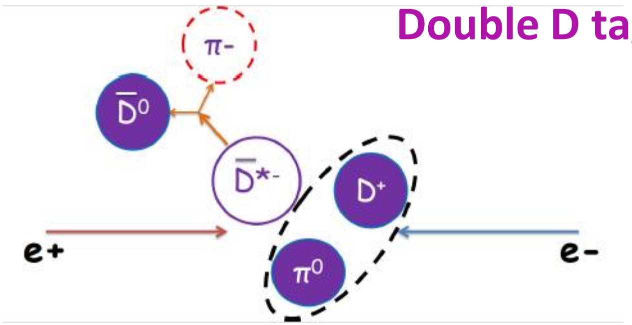
The measured m_{pole}, Γ_{pole}, $\boldsymbol{\sigma}$ and $J^P = 1^+$ are consistent with single D tag results.

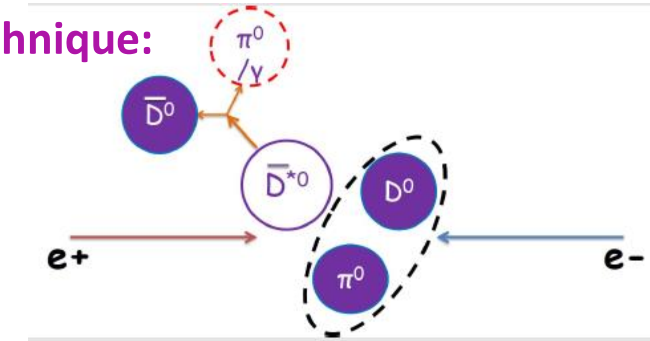
$Z_c(3885)^0$ in $e^+e^- \to \pi^0(D\bar{D}^*)^0$

Phys. Rev. Lett. 115, 222002

Based on 1092pb^{-1} @ 4.230 & 826 pb^{-1} @ 4.260 GeV

Double D tag technique:





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

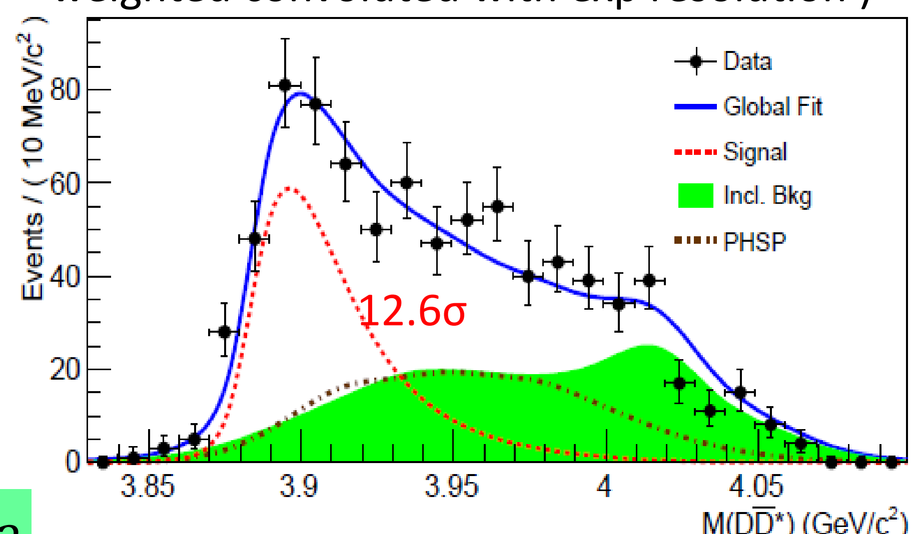
$e^+e^- \to D^0\bar{D}^{*0}\pi^0 \to D^0\bar{D}^0\pi^0\pi^0$

Mass dependent width s-wave BW (efficiency weighted convoluted with exp resolution)

Simultaneous fit:

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

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



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

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

$$R = \frac{B(Z_C(3885)^0 \to D^+D^{*-})}{B(Z_C(3885)^0 \to D^0\bar{D}^{*0})} = 0.96 \pm 0.18 \pm 0.12$$

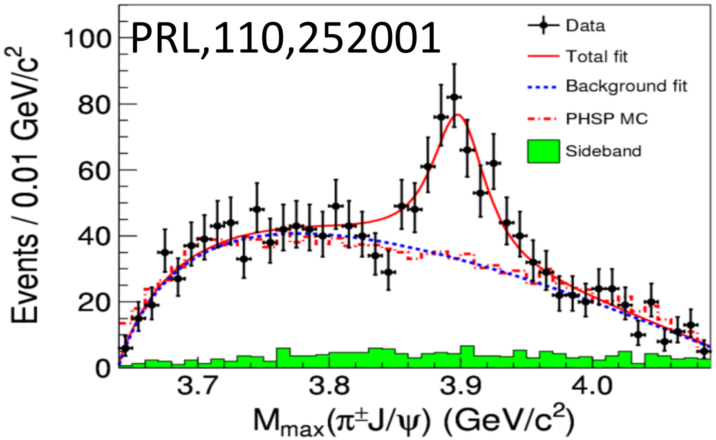
Consistent with unity (no isospin viol)

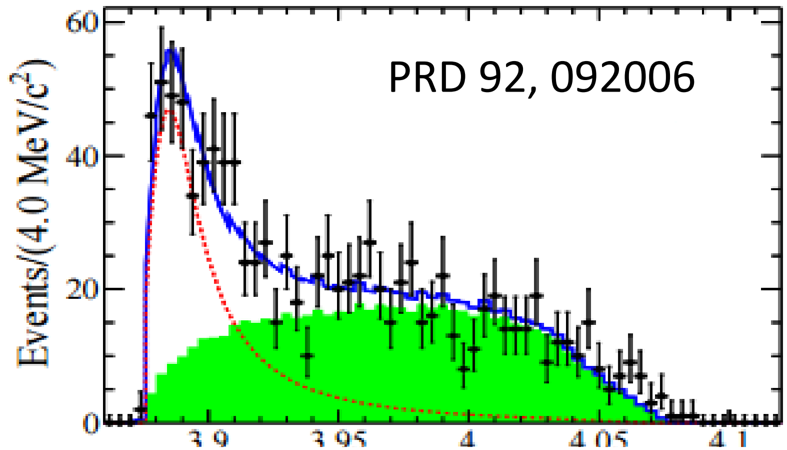
Isospin triplet is established
$Z_c(3885)^{\pm/0}$

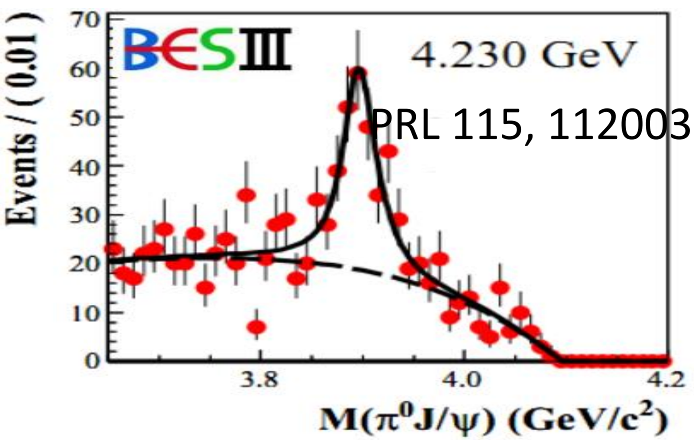
Isospin triplet Zc(3900)/Zc(3885)

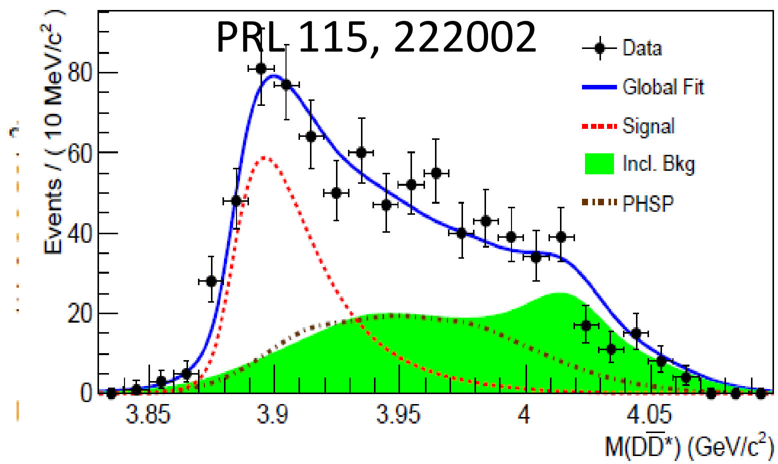
PWA on-going in BESIII will shed light on this issue

Hadro-charmonium, Molecule, Tetraquark?









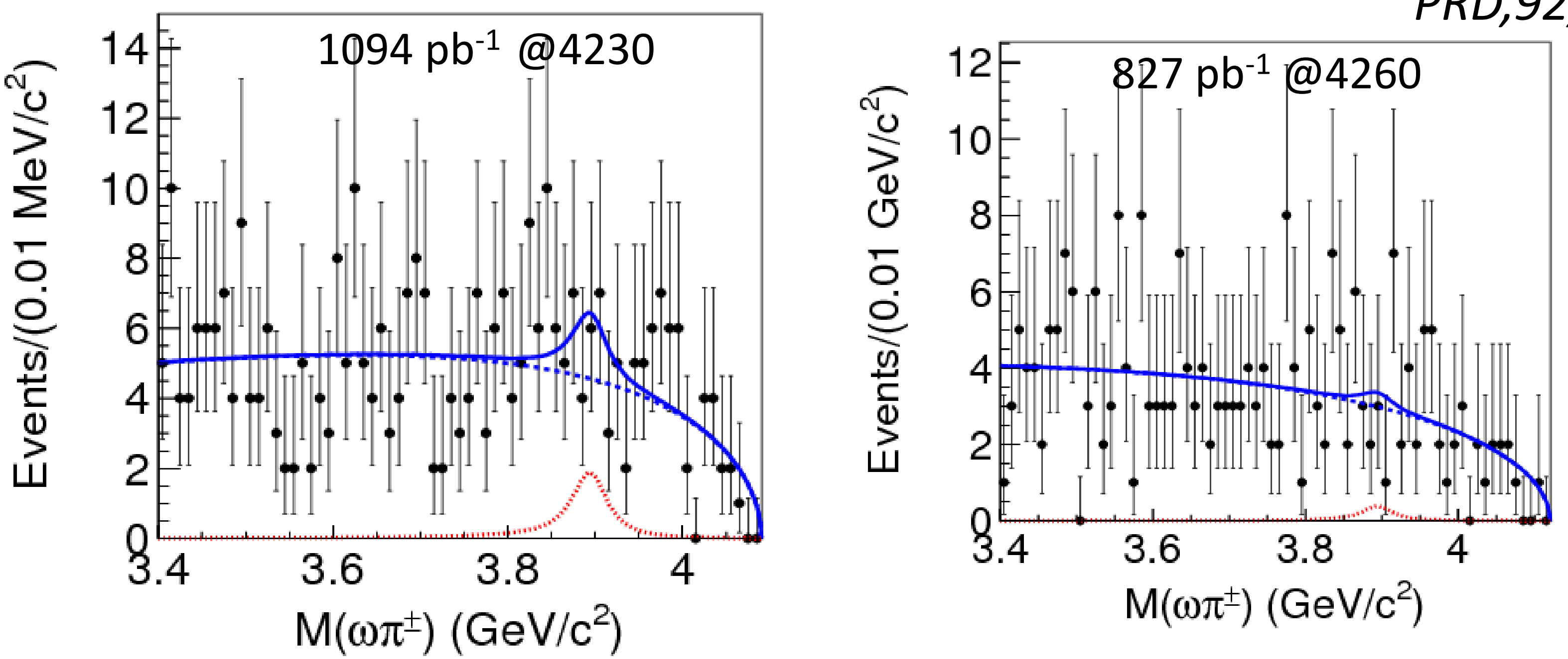
Assuming they are the same:

$$\frac{B(\boldsymbol{Z_c} \to \bar{D}\boldsymbol{D}^*\ )}{B(\boldsymbol{Z_c} \to J/\psi\pi)} = 6.2 \pm 1.1 \pm 2.7$$

SMALL compared to open-carm vs hidden-charm ratios for conventional charmonium above open-charm thr. (for $\psi(4040)$ about $192{+-}27$)

Search for $Z_c^{\pm}(3900) \to \omega\pi^{\pm}$ in $e^+e^- \to \omega\pi\pi$

PRD,92,032009



$\sigma(e^+ e^- \to Z_C^{\pm}\pi^{\mp}, Z_C^{\pm} \to \omega\pi^{\pm})$<0.27 pb $\sigma(e^+ e^- \to Z_C^{\pm}\pi^{\mp}, Z_C^{\pm} \to \omega\pi^{\pm})$<0.18 pb

- UML Fitting with acceptance weighted S-wave BW folded with Gaussian + ARGUS background, interference effect neglected
- No significant signal found for this typical decay mode of a 1^+ resonance

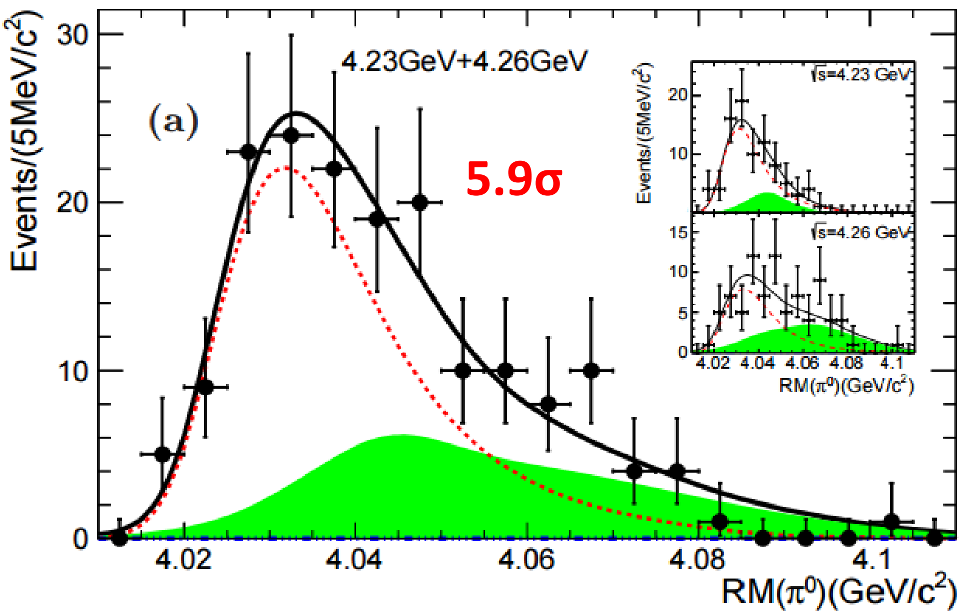
Compared to the sum of $Z_C^{\pm} \to J/\psi\pi^{\pm}$ and $Z_c \to D\bar{D}^*$ is less than 0.2%

.

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

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

Phys.Rev.Lett. 115 , 182002



Double D tag technique, reconstructed by hadronic decays

Can't be explained by PHSP+incl.bkg

Fitted with BW modified by phase space factor:

m_{pole} = $(4025.5^{+2,0}_{-4.7} \pm 3.1)$ MeV/c²

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

$\sigma[e^+e^- \to Z_c(4025)^0\pi^0 \to (D^*\bar{D}^*)^0\ \pi^0]$
= $(61.6 \pm 8.2 \pm 9.0)$ pb @4.23 GeV

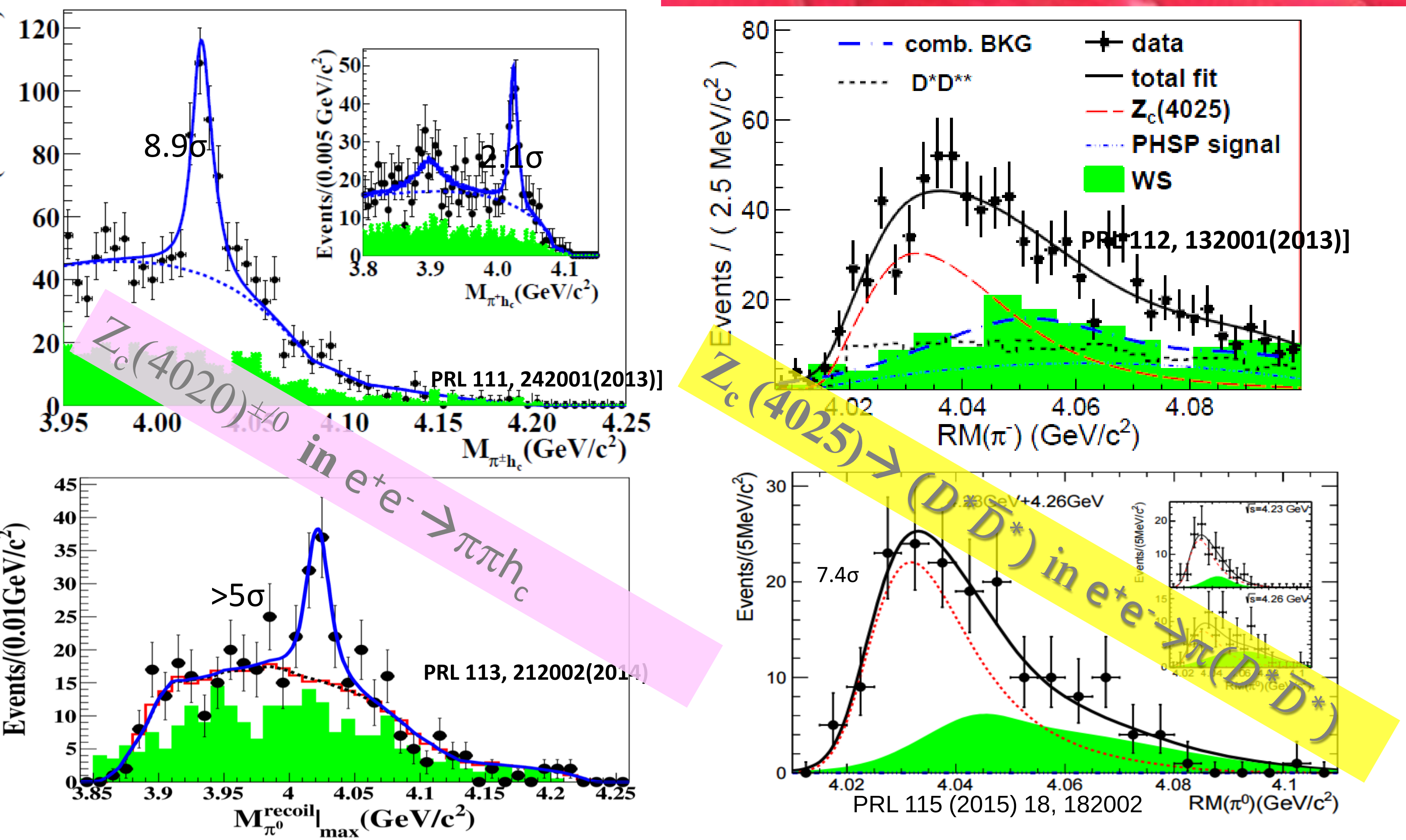
$\sigma[e^+e^- \to Z_c(4025)^0\pi^0 \to (D^*\bar{D}^*)^0\ \pi^0]$
= $(43.4 \pm 8.0 \pm 5.4)$ pb @4.26 GeV

$$R = \frac{\sigma[e^+e^- \to Z_c(4025)^0\pi^0 \to (D^*\bar{D}^*)^0\ \pi^0]}{\sigma[e^+e^- \to Z_c(4025)^+\pi^- \to (D^*\bar{D}^*)^+\ \pi^-]}$$

Compatible with unity (ok Isospin simmetry)

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

Isospin triplet Zc(4020)/Zc(4025)



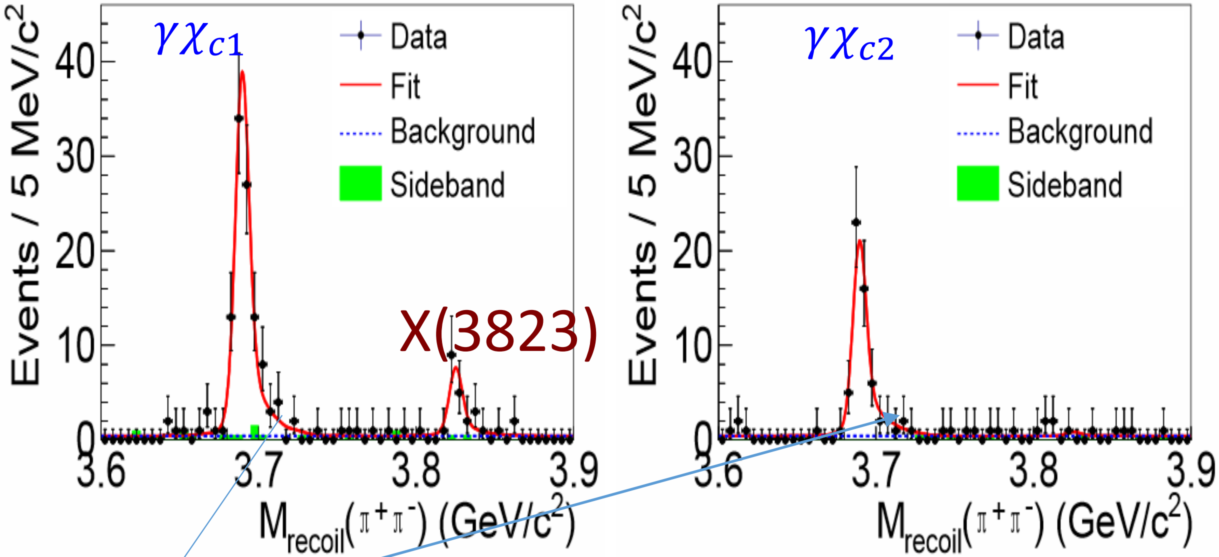
Coupling to $D^*\bar{D}^*$ larger than to πh_c if $Z_c(4025)$ and $Z_c(4020)$ are the same state. Further studies are needed to come to a firm conclusion

$$\frac{\Gamma(Zc(4020)\to D^*\bar{D}^*)}{\Gamma(Zc(4020)\to \pi h_c)} = 12 \pm 5$$

X

Observation of X(3823)

PRL,115,011803



ψ' to calibrate the fit

$e^+e^- \to \pi^+\pi^- X(3823)$

$X(3823) \to \gamma\chi_{cj}$

$\chi_{c1} \to \gamma J/\psi$

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

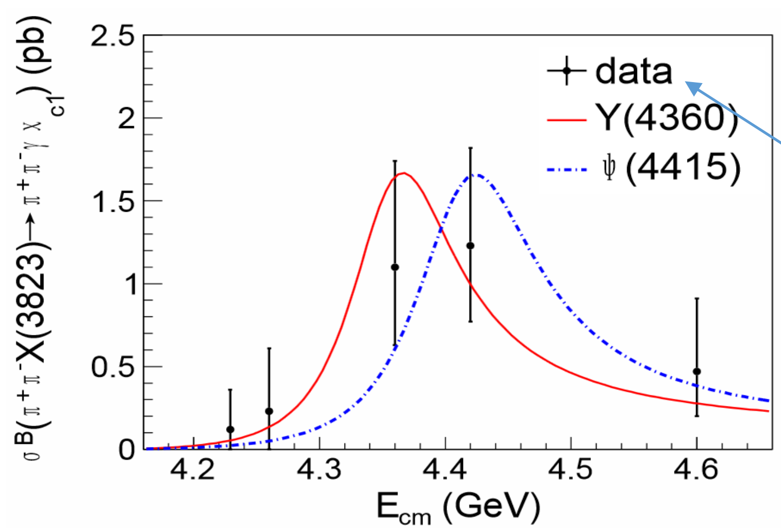
Simultaneous UMLH fit on $M_{recoil}(\pi^+\pi^-)$

Signal 6.2 σ in $\gamma\chi_{c1}$

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

$\Gamma(X(3823)) < 16$ MeV at 90% C. L.

consistent with Belle



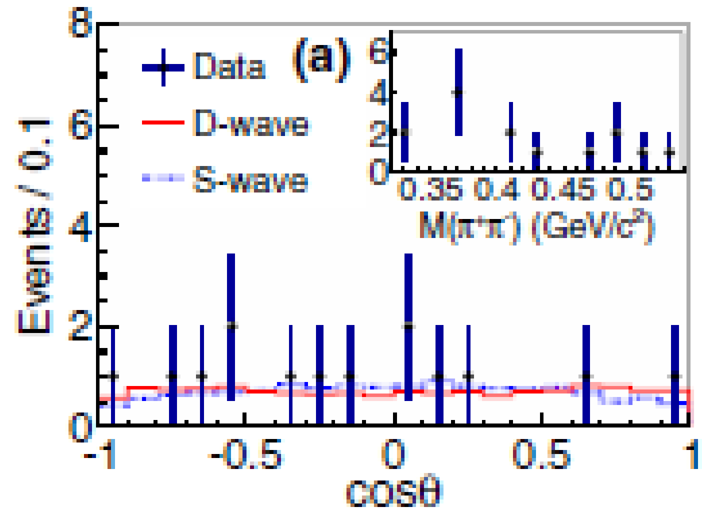
Due to limited statistics both hypoteses Can be accepted

Is X(3823) the $\psi(1^3D_2)$?

Mass and width(~) in agreement with potential model

Above $D\bar{D}$ and below $D\bar{D}^*$, expected narrow as found

D-wave expected. Due to low statistics both Hypoteses can be accepted



X(3823) scattering angle

R=$\frac{\mathcal{B}(X(3823)\to\gamma\chi_{c2})}{\mathcal{B}(X(3823)\to\gamma\chi_{c1})} < 0.42$ at 90% C.L.   ≈0.2 (PRD 55,4001)

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

$=0.20^{+0.13}_{-0.10}$ (4.36 GeV)

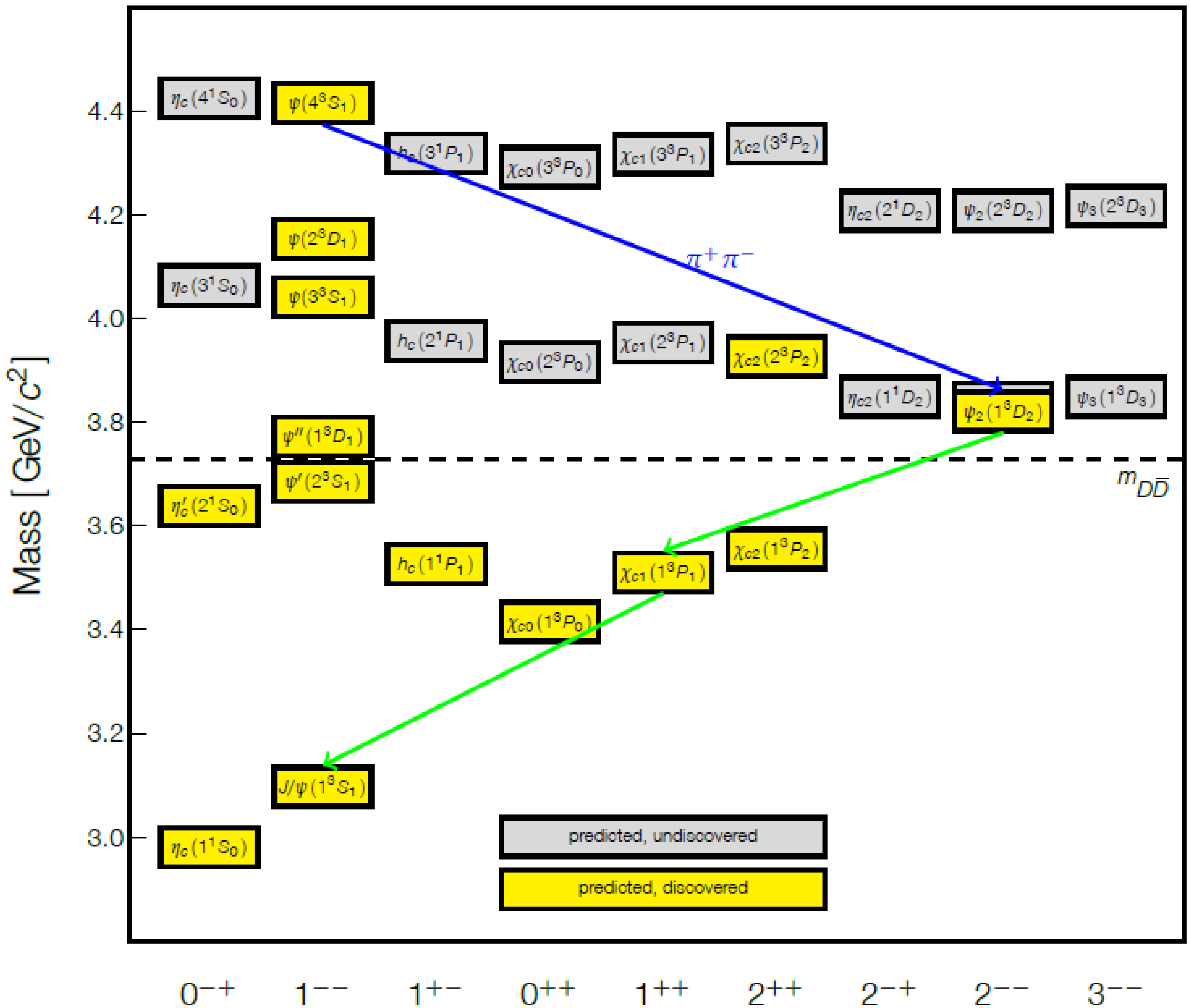
$=0.39^{+0.21}_{-0.17}$ (4.42 GeV)

J^P by exclusion:

$1^1D_2 \to \gamma\chi_{c1}$ forbidden

$1^3D_3 \to \gamma\chi_{c1}$ has zero amplitude

It's a good candidate to be $\psi(1^3D_2)$

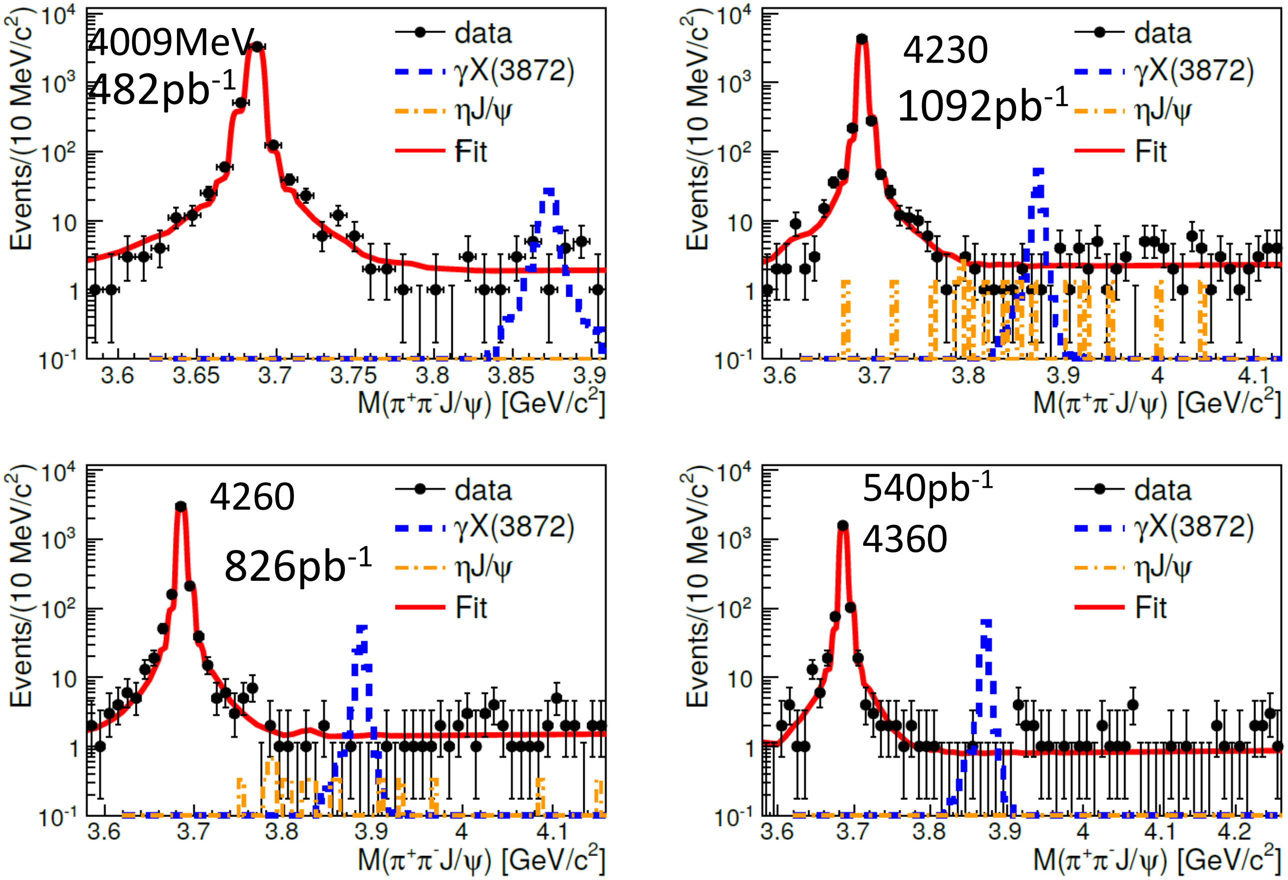


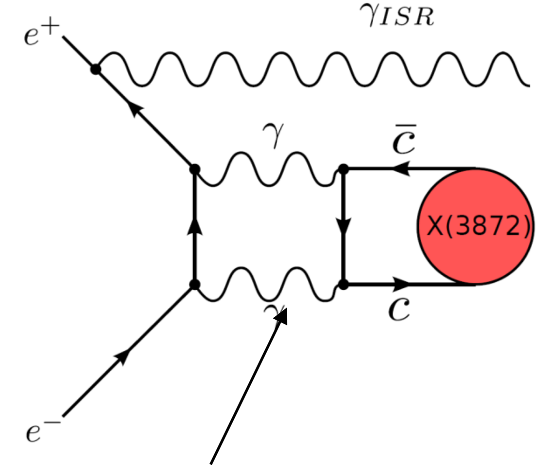
Mass [GeV/c²]
4.4
4.2
4.0
3.8
3.6
3.4
3.2
3.0
ηc(4¹S₀)
ψ(4³S₁)
hc(3¹P₁)
χc0(3³P₀)
χc1(3³P₁)
χc2(3³P₂)
ηc2(2¹D₂)
ψ2(2³D₂)
ψ3(2³D₃)
ψ(2³D₁)
ηc(3¹S₀)
ψ(3³S₁)
π⁺π⁻
hc(2¹P₁)
χc0(2³P₀)
χc1(2³P₁)
χc2(2³P₂)
ηc2(1¹D₂)
ψ2(1³D₂)
ψ3(1³D₃)
ψ''(1³D₁)
ψ'(2³S₁)
m_DD̄
η'c(2¹S₀)
hc(1¹P₁)
χc1(1³P₁)
χc2(1³P₂)
χc0(1³P₀)
J/ψ(1³S₁)
ηc(1¹S₀)
predicted, undiscovered
predicted, discovered
0⁻⁺
1⁻⁻
1⁺⁻
0⁺⁺
1⁺⁺
2⁺⁺
2⁻⁺
2⁻⁻
3⁻⁻

Electronic width $\Gamma_{ee}^{X(3872)}$ via $e^+e^- \to \gamma_{ISR} X(3872) \to \gamma_{ISR}\pi\pi J/\psi$

Electronic width of X(3872) strongly depends on its substructure. Theoretical predictions are under construction. Would help to rule out hypotheses.

PLB,749, 414





Production via a two-photon box diagram.

γ_{ISR} untagged method and $X(3872) \to \pi\pi J/\psi$

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

CME>4000 MeV 2.94 fb^{-1}

Γ_{ee}(X(3872) B(X(3872)→$\pi\pi J/\psi$)<0.13eV U.L.
Assuming B(X(3872)→$\pi\pi J/\psi$) >3%
Γ_{ee}(X(3872))<4.3eV U.L. 90% CL

for ordinary charmonium 0.044-0.46 eV

VMD-model predicts 0.03 eV (PLB 736(2014) 221) w/o assumption on its nature

Summary

- BESIII is taking data since 2009 and already has world's largest data samples of various Y and Charmonium states
- Many interesting results in the XYZ studies
- Many others are on the way by BESIII
- Some X,Y, Z correlations found
- Still remain unanswered questions
- Expected more data in the future. (until 2020-2022. ;-) for BESIII)

Thank you!!!!

BESIII :400 members 55 institutions 11 nations