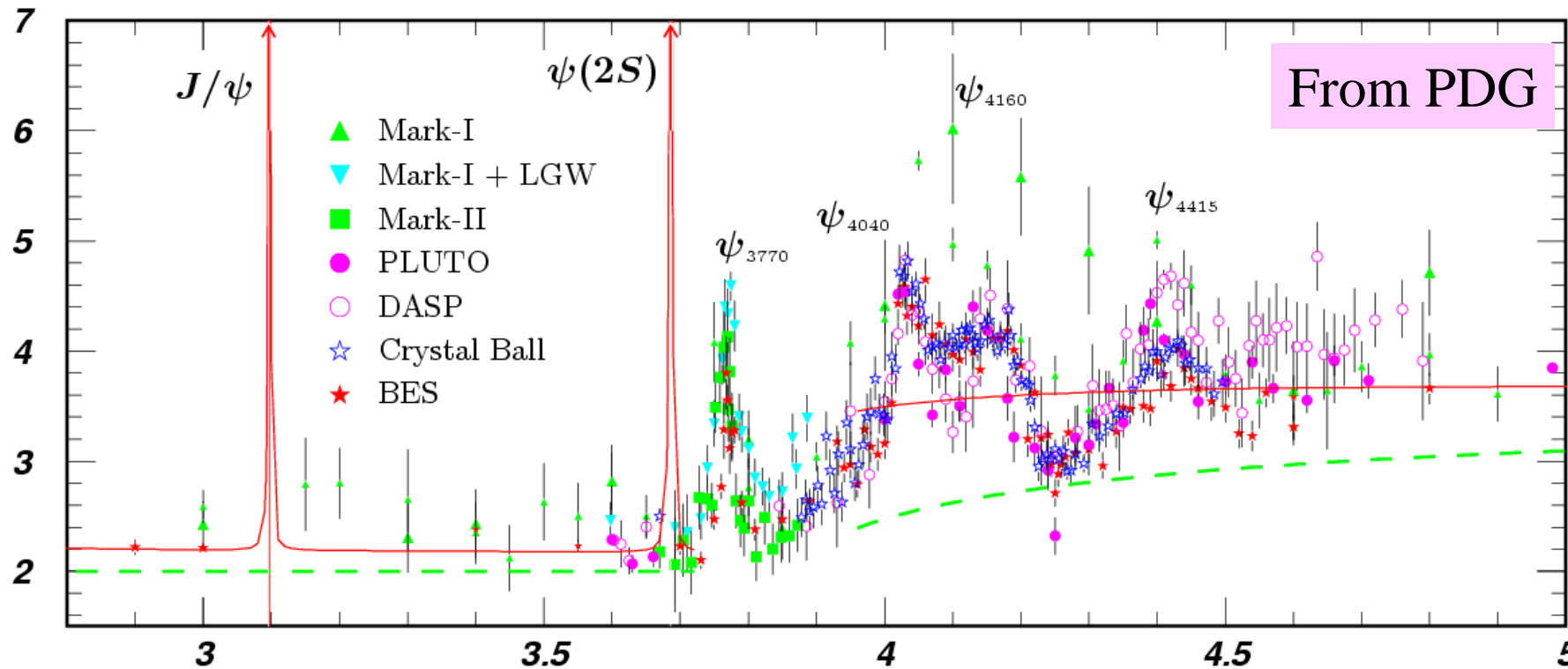# Experimental facts on the Y states
(the curves may be biased)

Changzheng YUAN

QWG'07, Hamburg

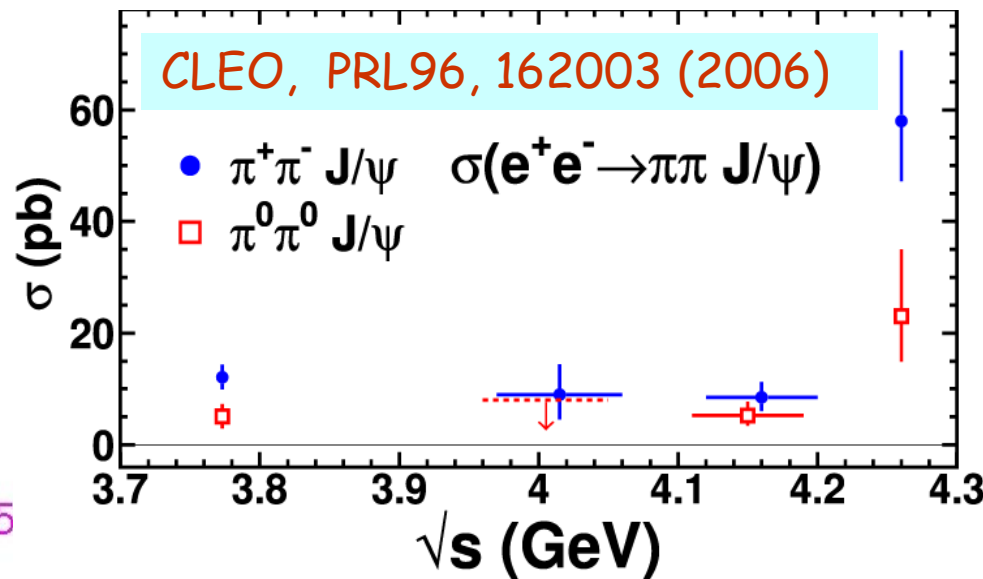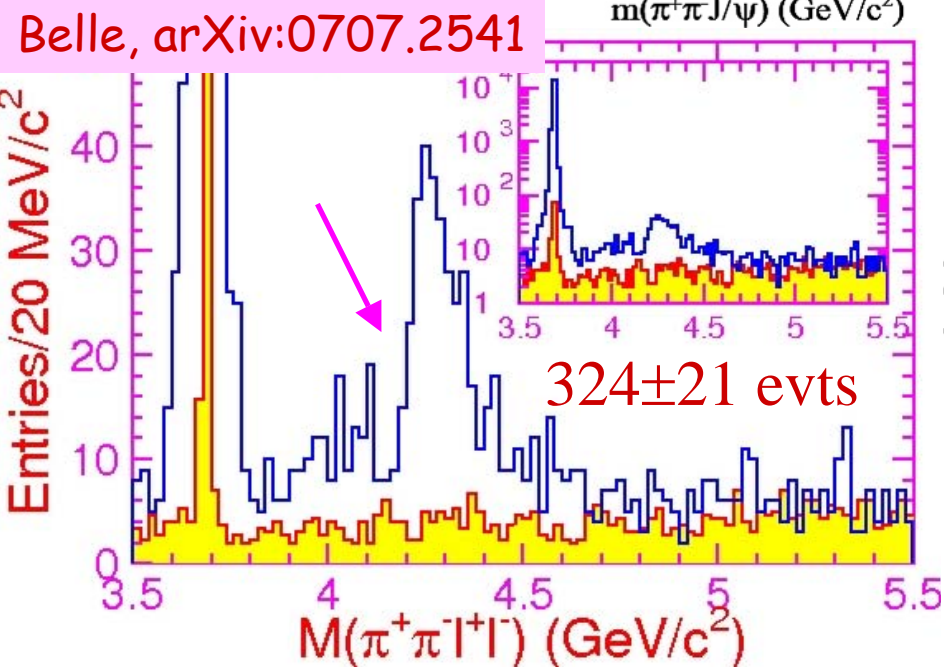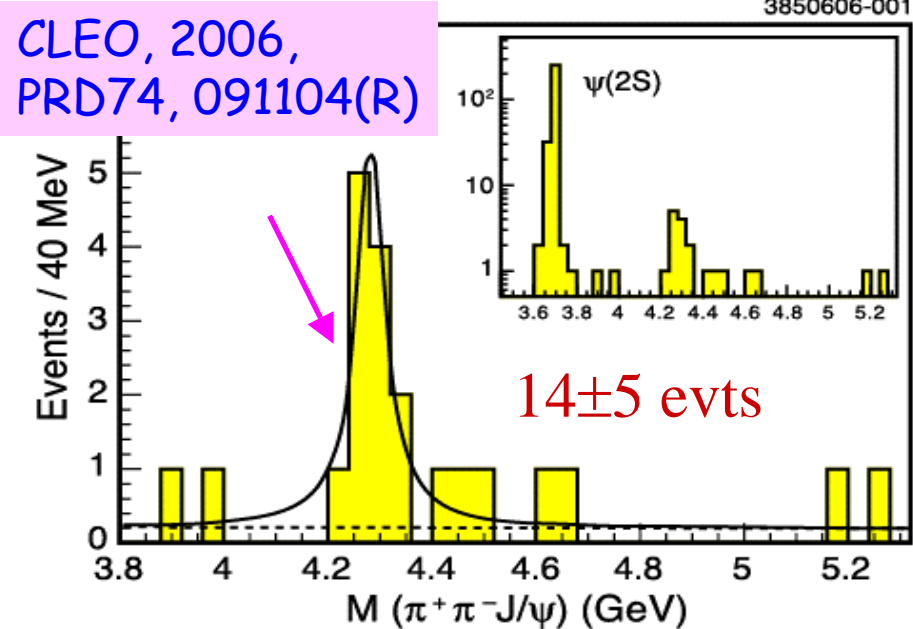Oct. 19, 2007

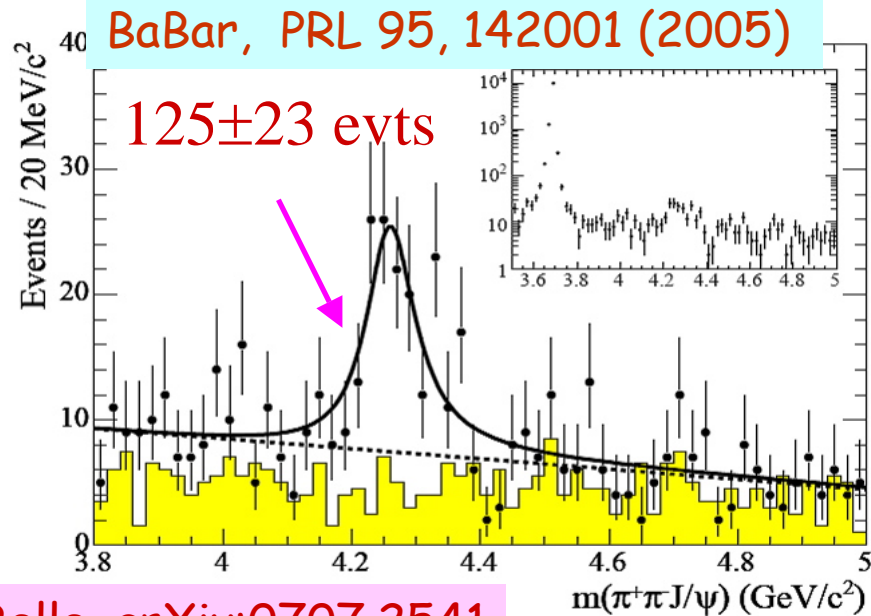# R values

The Y states should also appear in
this plot (between 4.0 and 4.7 GeV!

Y(4260) in all experiments

BaBar, PRL 95, 142001 (2005)

125±23 evts

CLEO, 2006, PRD74, 091104(R)

14±5 evts

Belle, arXiv:0707.2541

324±21 evts

CLEO, PRL96, 162003 (2006)

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

- $\pi^+\pi^-$ J/ψ
- $\pi^0\pi^0$ J/ψ

Y(4260) parameters

BaBar :

$m = 4259 \pm 8^{+2}_{-6}$ MeV

$\Gamma = 88 \pm 23^{+6}_{-4}$ MeV
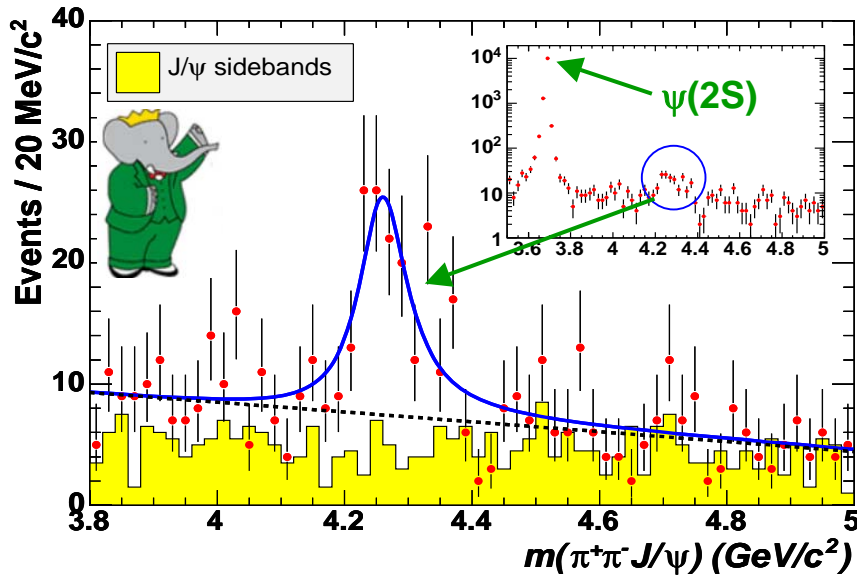
$\Gamma_{e^+e^-} \cdot B\left(\pi^+\pi^- J/\psi\right) = 5.5 \pm 1.0^{+0.8}_{-0.7}$ eV

Belle (BaBar - like fit) :

$m = 4263 \pm 6$ MeV

$\Gamma = 126 \pm 18$ MeV

$\Gamma_{e^+e^-} \cdot B\left(\pi^+\pi^- J/\psi\right) = 9.7 \pm 1.1$ eV
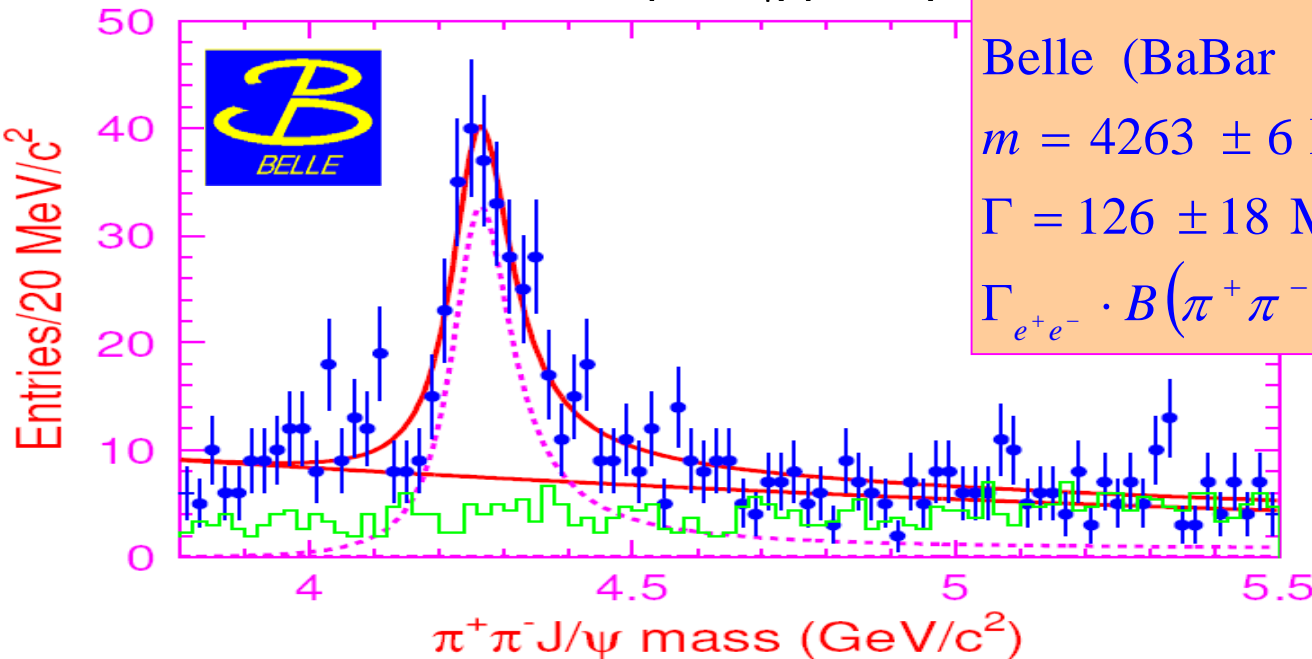
Y(4260)+Y(4008) parameters
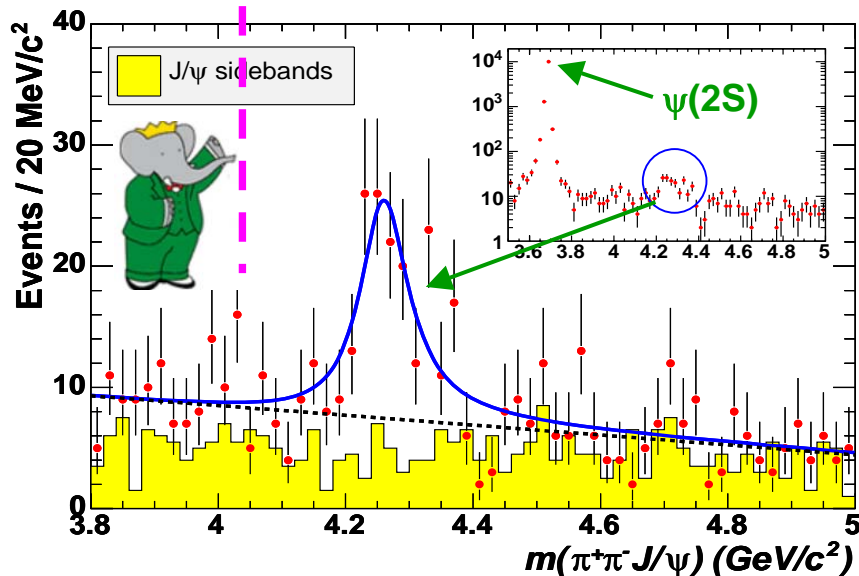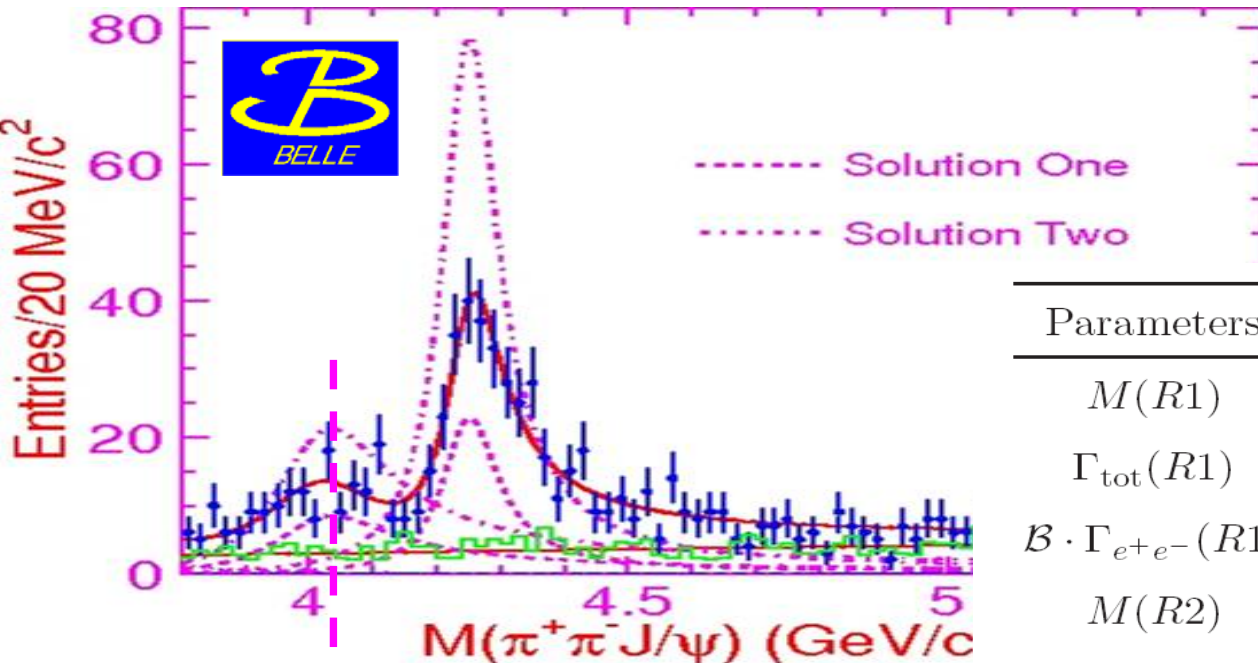
Parameters	Solution I	Solution II
$M(R1)$	$4008 \pm 40^{+114}_{-28}$	
$\Gamma_{\text{tot}}(R1)$	$226 \pm 44 \pm 87$	
$\mathcal{B} \cdot \Gamma_{e^+e^-}(R1)$	$5.0 \pm 1.4^{+6.1}_{-0.9}$	$12.4 \pm 2.4^{+14.8}_{-1.1}$
$M(R2)$	$4247 \pm 12^{+17}_{-32}$	
$\Gamma_{\text{tot}}(R2)$	$108 \pm 19 \pm 10$	
$\mathcal{B} \cdot \Gamma_{e^+e^-}(R2)$	$6.0 \pm 1.2^{+4.7}_{-0.5}$	$20.6 \pm 2.3^{+9.1}_{-1.7}$
ϕ	$12 \pm 29^{+7}_{-98}$	$-111 \pm 7^{+28}_{-31}$

Excess of events also seen around 4 GeV in BaBar; can do a similar analysis as Belle did.
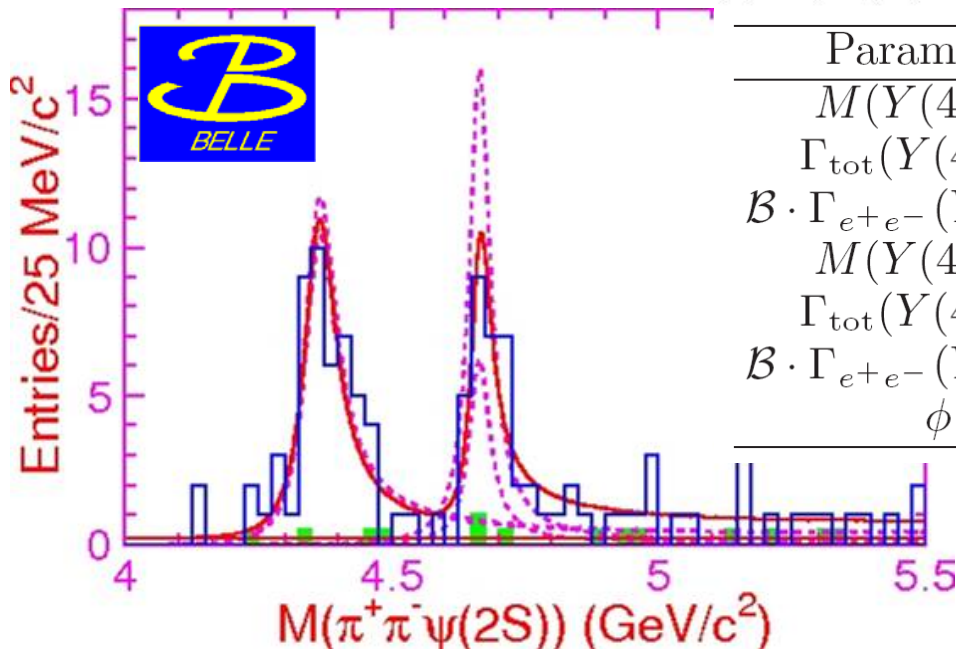
Y(4360)+Y(4660) parameters
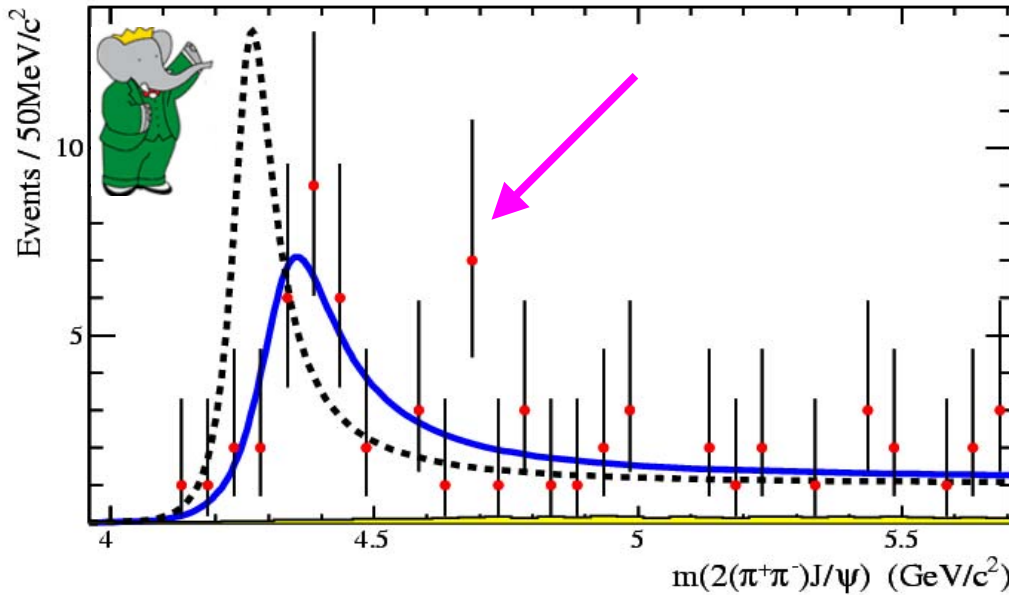
Single BW:
M = (4324±24) MeV
Γ= (172±33) MeV

BaBar can do a 2-BW fit

Parameters	Solution one	Solution two
$M(Y(4360))$	$4361 \pm 9 \pm 9$	
$\Gamma_{tot}(Y(4360))$	$74 \pm 15 \pm 10$	
$\mathcal{B} \cdot \Gamma_{e^+e^-}(Y(4360))$	$10.4 \pm 1.7 \pm 1.5$	$11.8 \pm 1.8 \pm 1.4$
$M(Y(4660))$	$4664 \pm 11 \pm 5$	
$\Gamma_{tot}(Y(4660))$	$48 \pm 15 \pm 3$	
$\mathcal{B} \cdot \Gamma_{e^+e^-}(Y(4660))$	$3.0 \pm 0.9 \pm 0.3$	$7.6 \pm 1.8 \pm 0.8$
ϕ	$39 \pm 30 \pm 22$	$-79 \pm 17 \pm 20$

Y(xxxx) in K⁺K⁻J/ψ?

New resonance or just continuum production, or other mechanism?

PDG $\psi(4415)$ + 1 BW:
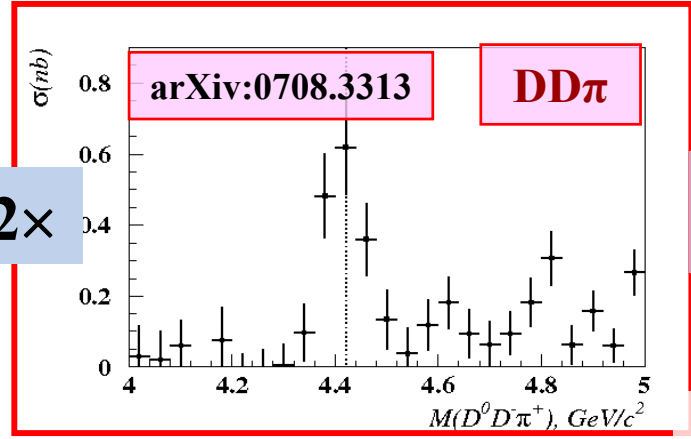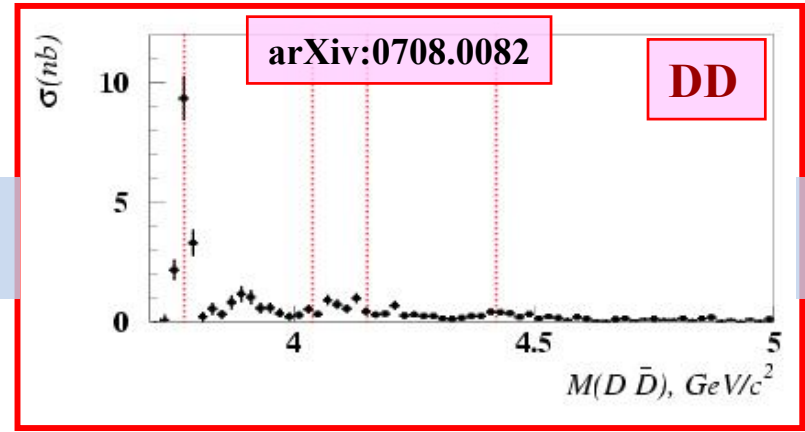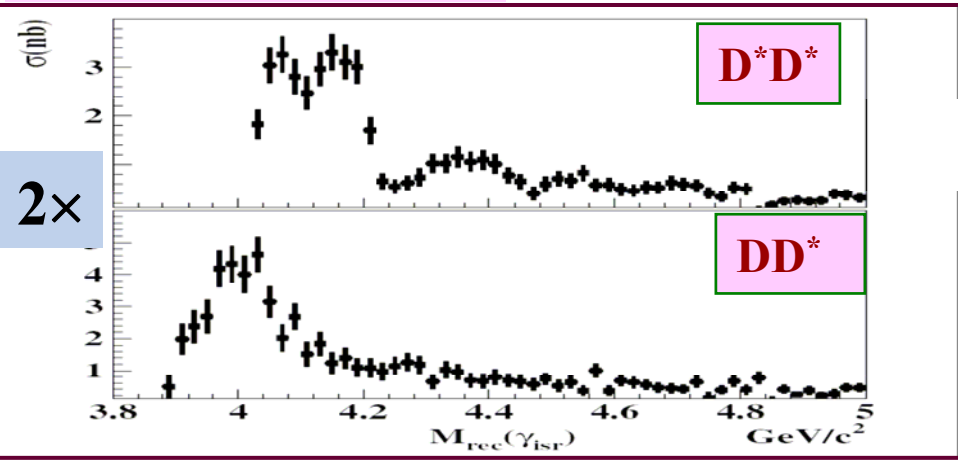M = (4875 ± 132) MeV
Γ = (630 ± 126) MeV
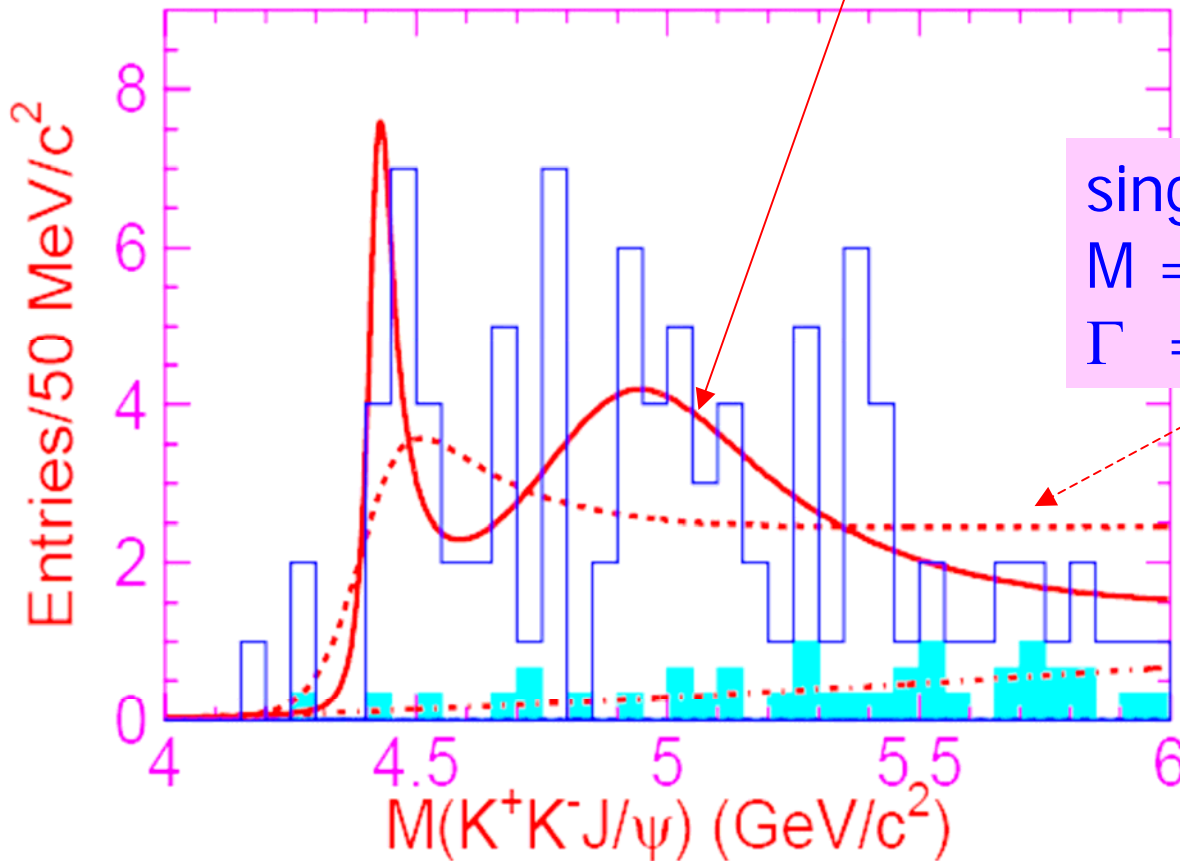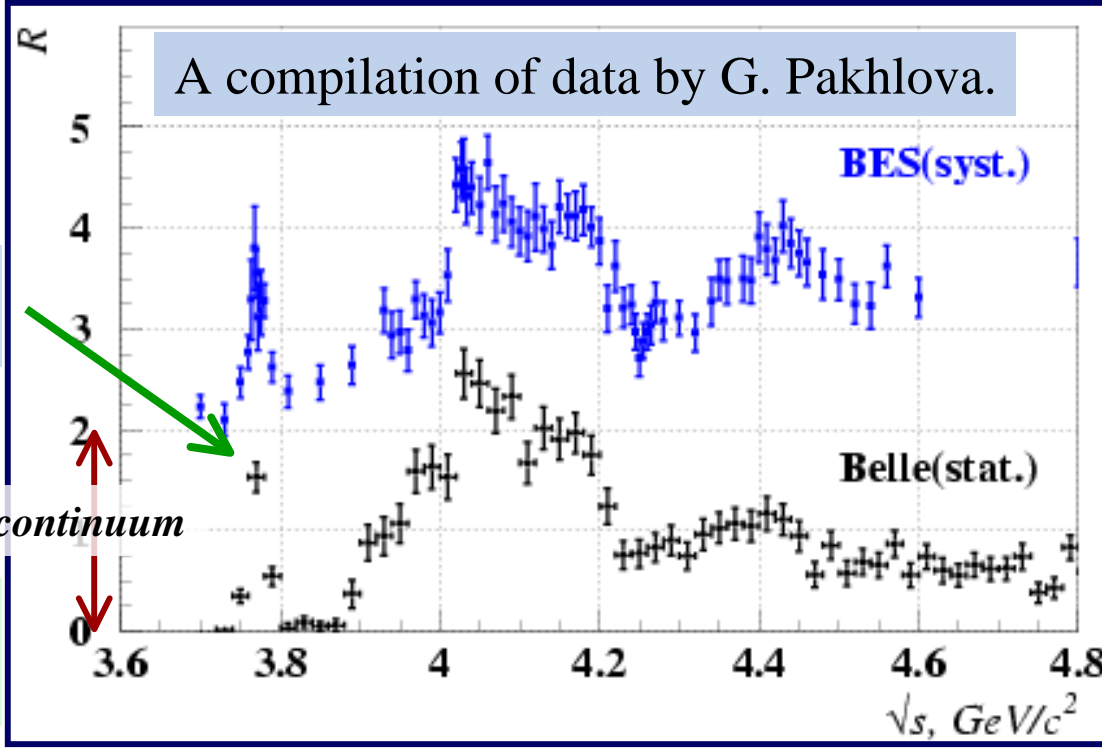
single BW:
M = (4430 ± 38) MeV
Γ = (254 ± 49) MeV

The decays of the ψ states?

D*D*

DD*

2×

+

arXiv:0708.0082

DD

+

2×

arXiv:0708.3313

DDπ

=

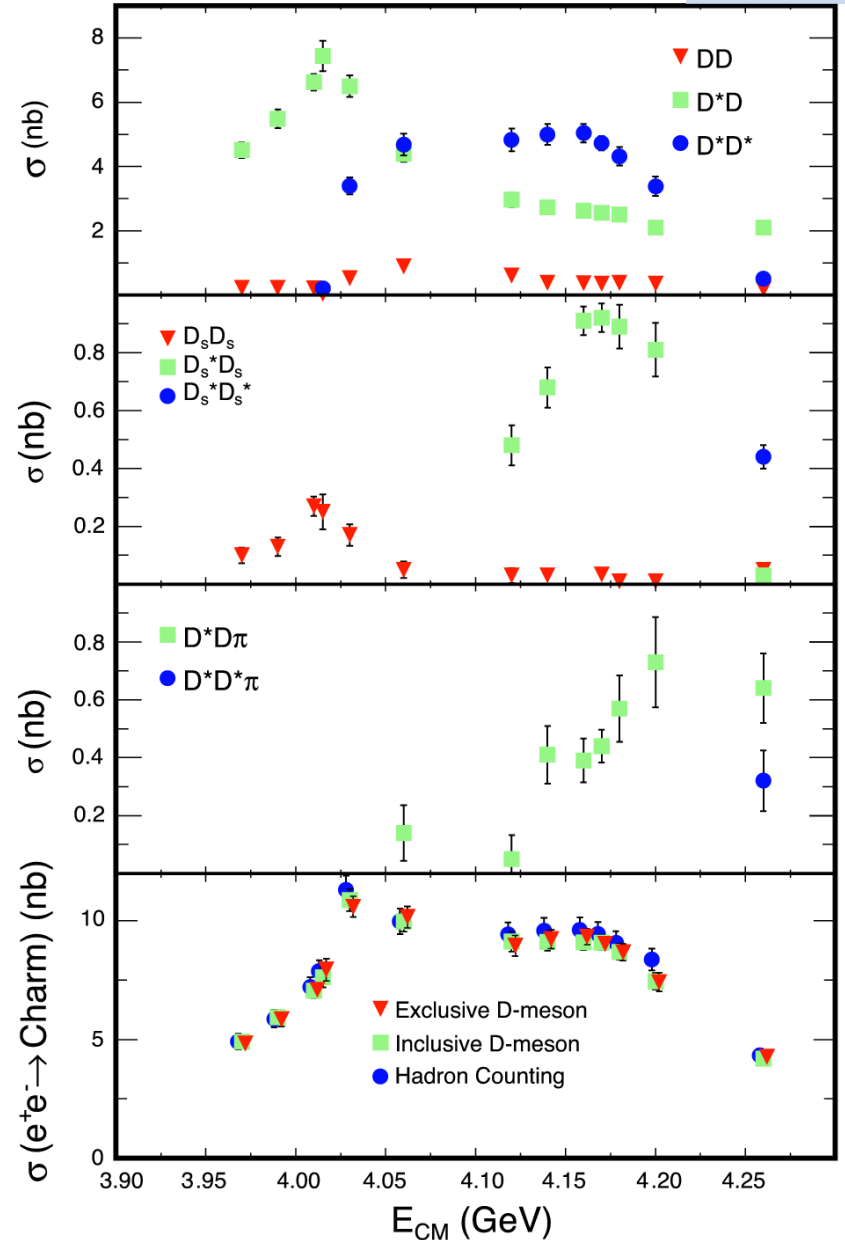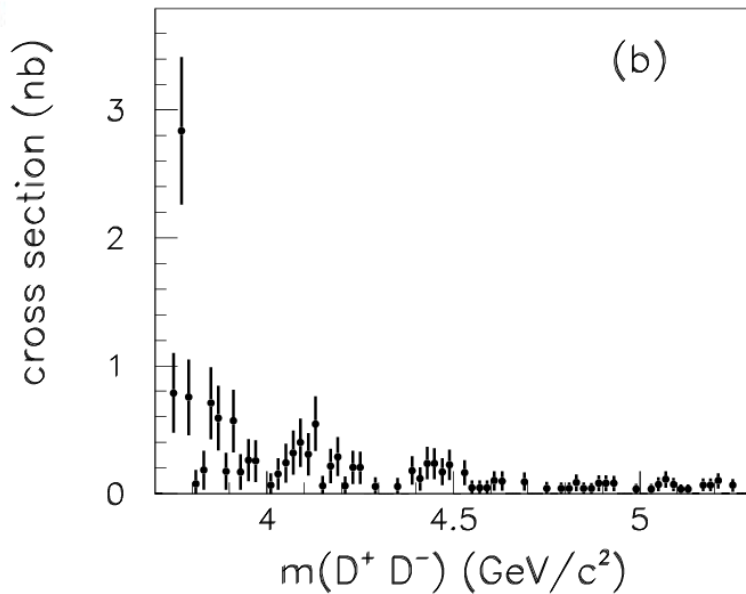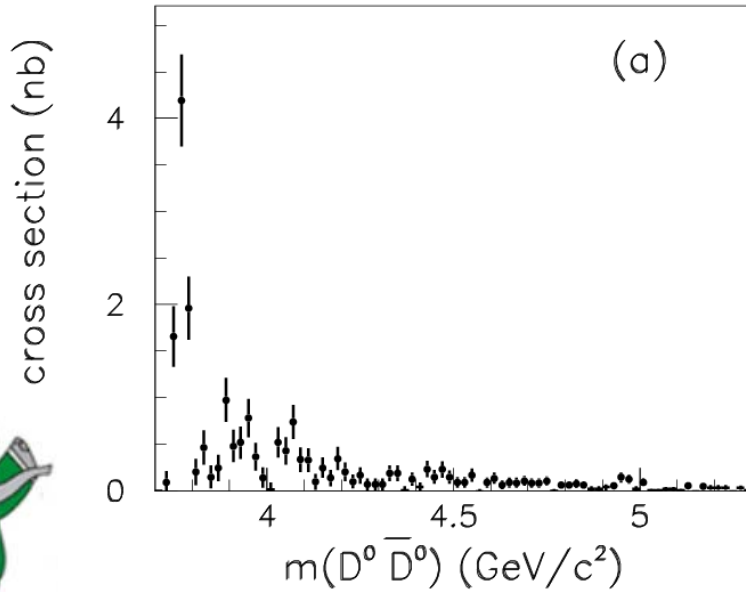A compilation of data by G. Pakhlova.

BES(syst.)

Belle(stat.)

uds-continuum

These 4 final states almost saturate inclusive cross section

The decays of the ψ states?

The Y's in all final states

The Y's and
the ψ's

CHARMONIUM (?) SPECTRUM
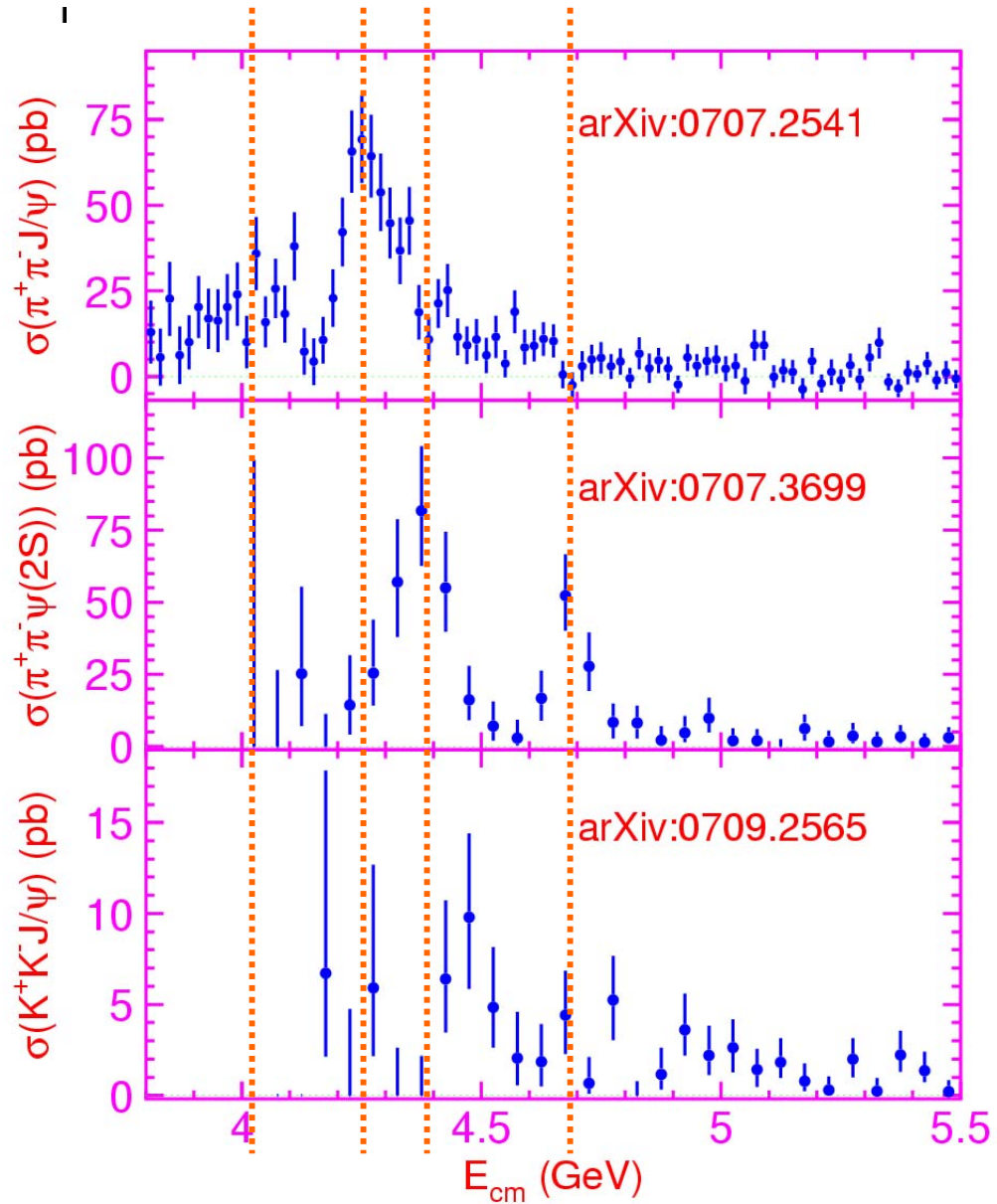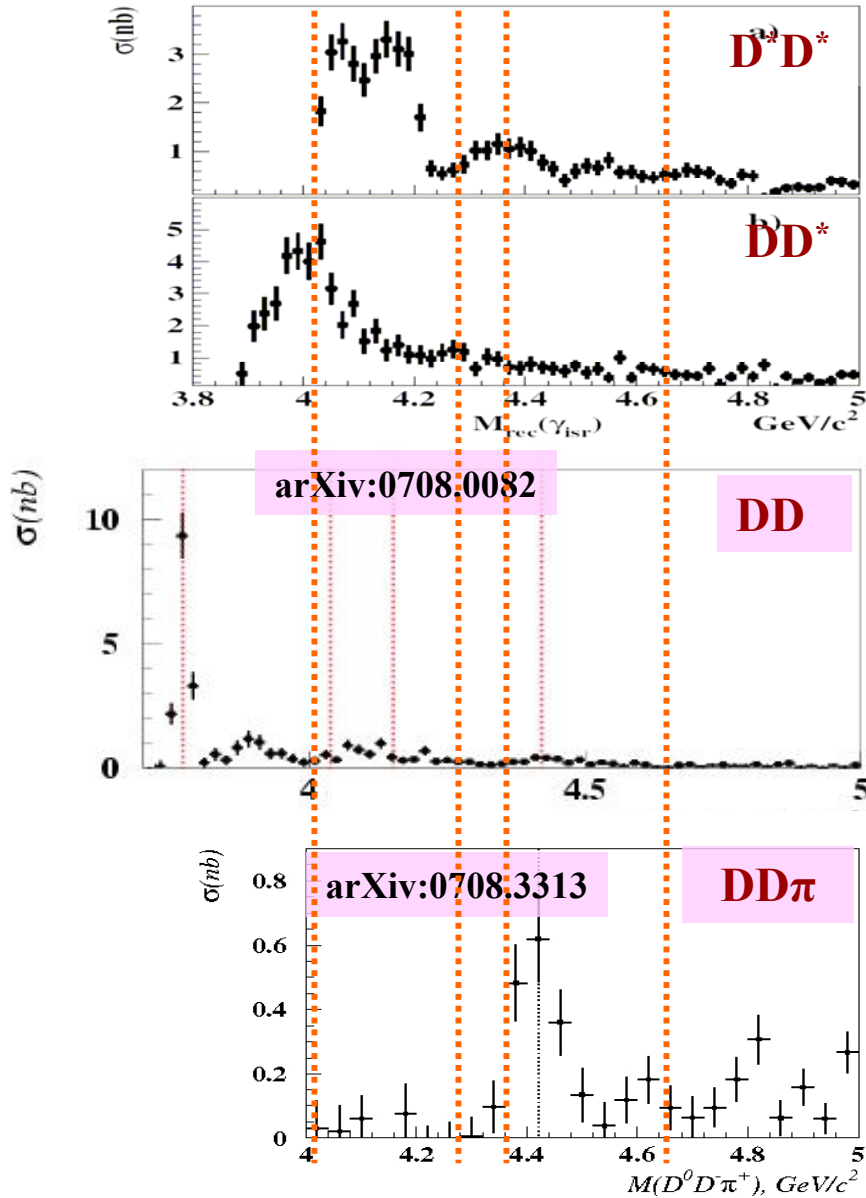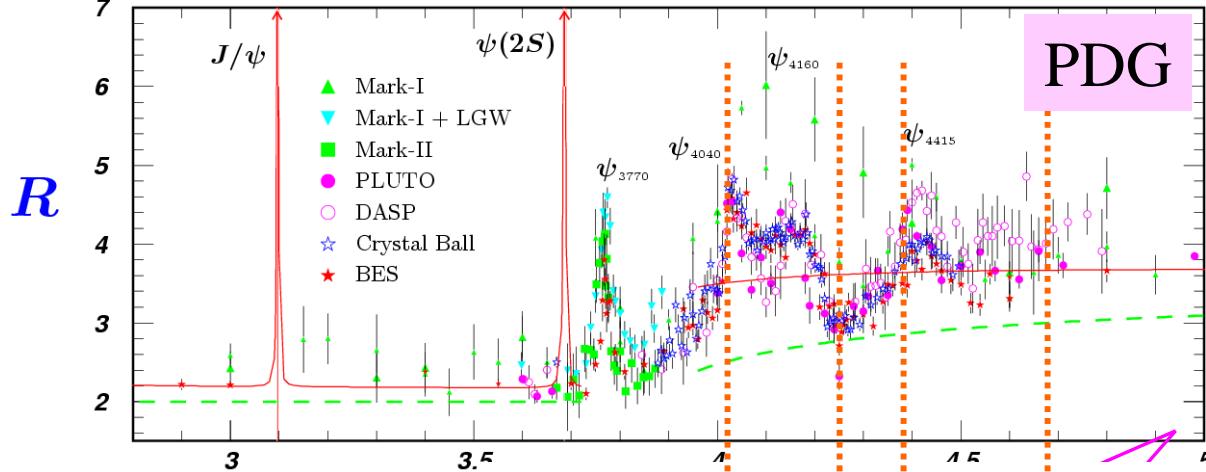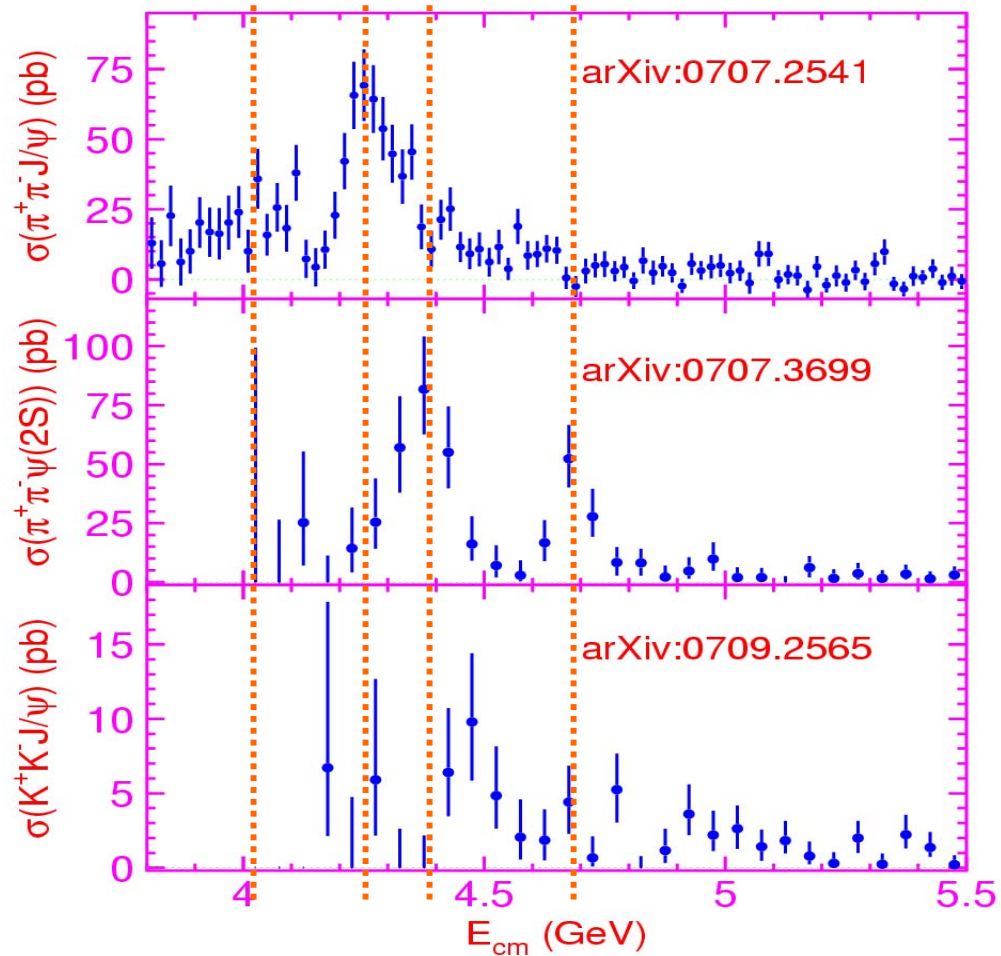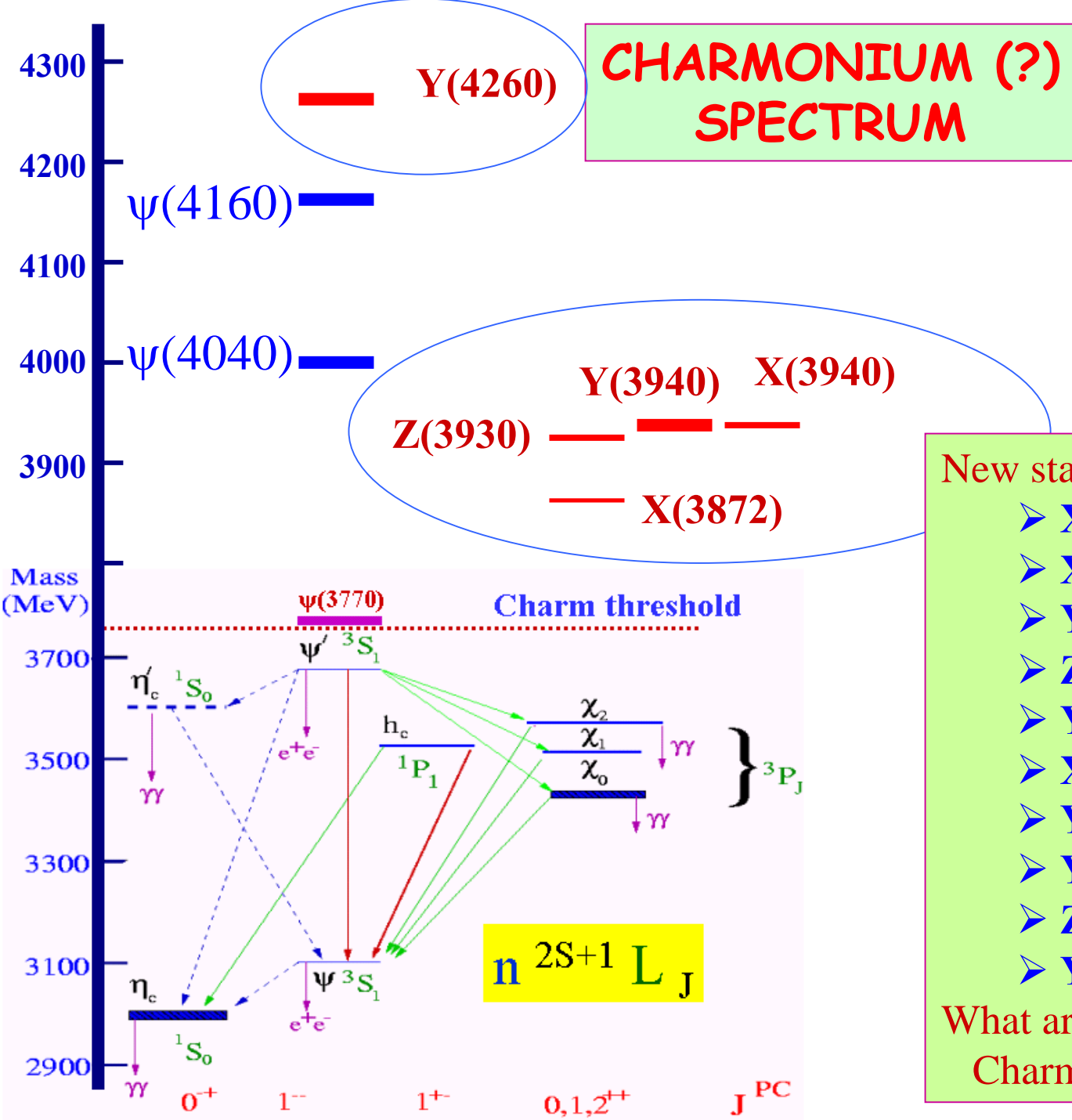
Less known states:
- $\psi(4040)$
- $\psi(4160)$
- $\psi(4415)$

New states from B-factories:
- ➢ **X(3872)=DD* (?)**
- ➢ **X(3940)=η_c(3S) (?)**
- ➢ **Y(3940)=?**
- ➢ **Z(3930)=χ_{c2}(2P)**
- ➢ **Y(4008)= ψ(3S) (?)**
- ➢ **X(4160)=χ_{c0}(3P) (?)**
- ➢ **Y(4260)=hybrid (?)**
- ➢ **Y(4324)/Y(4360)=?**
- ➢ **Z(4430)=tetraquark(?)**
- ➢ **Y(4660)= ψ(5S) (?)**

What are they?
Charmonia? Exotic states?