BESIII recent results on hadron states and spectroscopy

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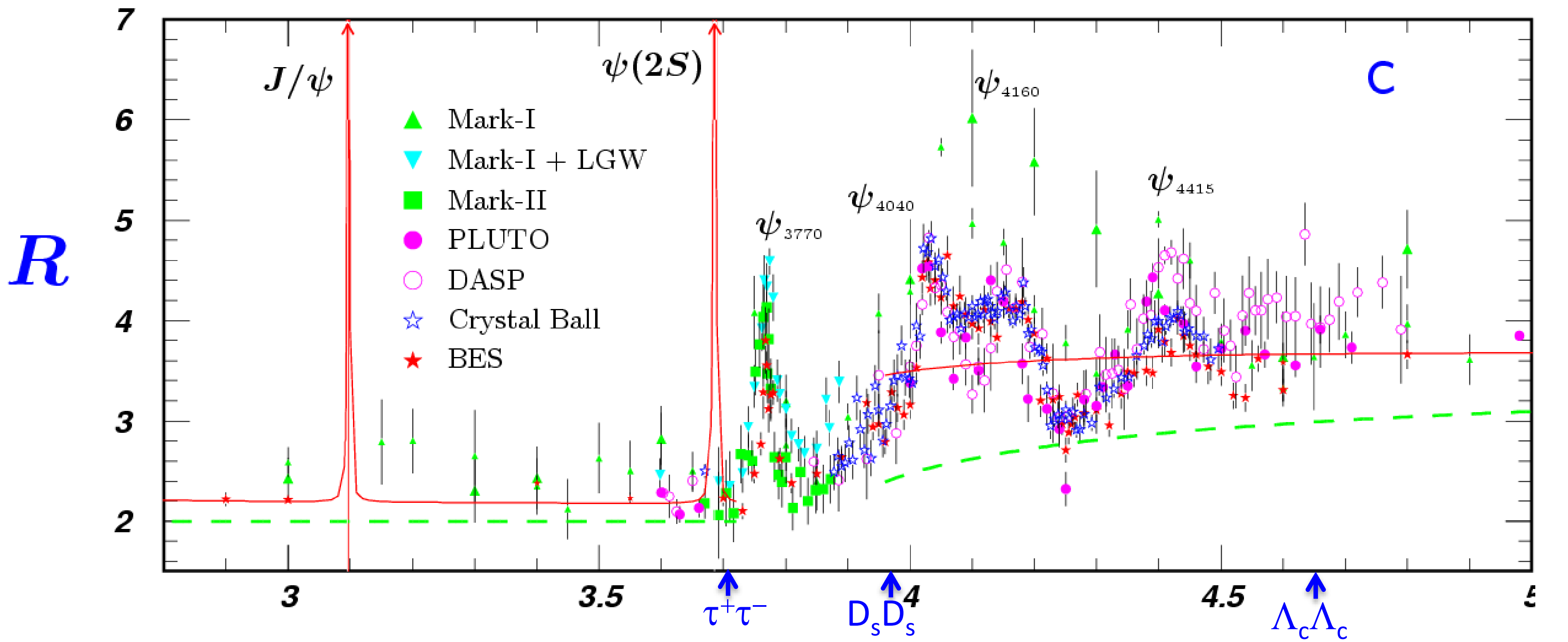
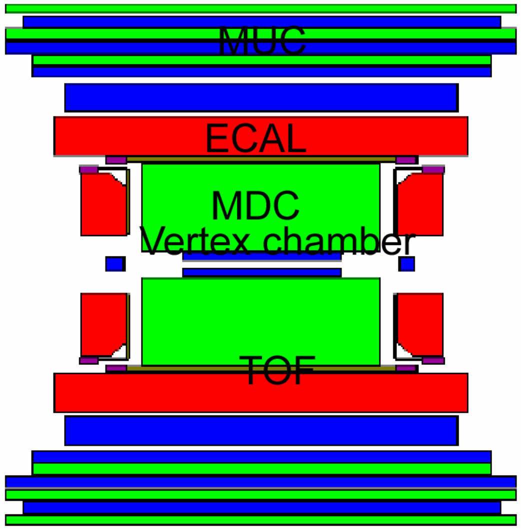
The Stage for a τ-c Factory

- Rich of **resonances**, charmonia and charmed mesons.
- **Threshold** characteristics (pairs of τ, D, D_s, charmed baryons…).
- **Transition** between perturbative and non-perturbative **QCD**.
- The **new hadrons**:glueballs, hybrids, multi-quark states

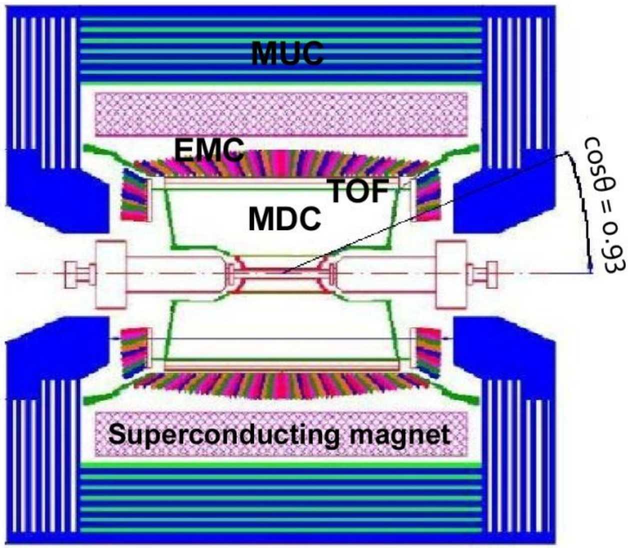


From BESII To BESIII

BES II @ BEPC



BES III @ BEPC II



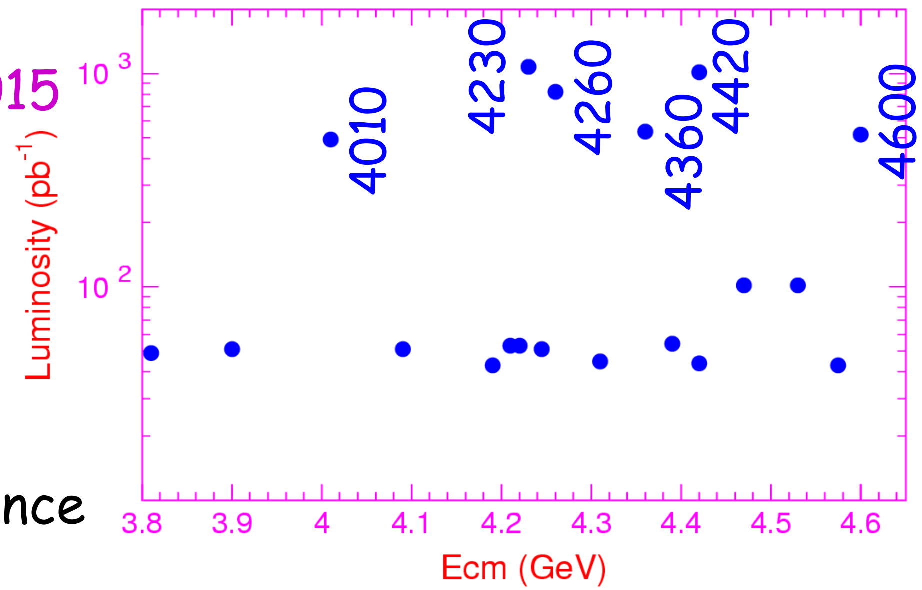
	BESII	BESIII
MDC	$\sigma(p)/p = 1.78\,\% \cdot \sqrt{1 + p^2}$ $dE/dx_{reso} = 8\,\%$	$\sigma(p_t)/p_t = 0.32\,\% \cdot p_t$ $dE/dx_{reso} < 6\,\%$
TOF	180 ps (for bhabha)	90 ps (for bhabha)
EMC	$\sigma(E)/E = 22\% \cdot \sqrt{E}$	$\sigma(E)/E = 2.3\,\% \cdot \sqrt{E}$
MUC	3 layers for barrel	9 layers for barrel, 8 for endcap

BESIII data samples

~ 0.5 B	$\psi(3686)$ events	~ 24×CLEO-c
~ 1.3 B	J/ψ events	~ 21×BESII
~ 2.9/fb	$\psi(3770)$	~ 3.5×CLEO-c
~5/fb	**XYZ** states above 4 GeV	Unique

- 20 points for R &QCD Scan: 500/pb finished in May 1st, 2015
- Y(2175) resonance: 100 /pb : finished in June 15, 2015

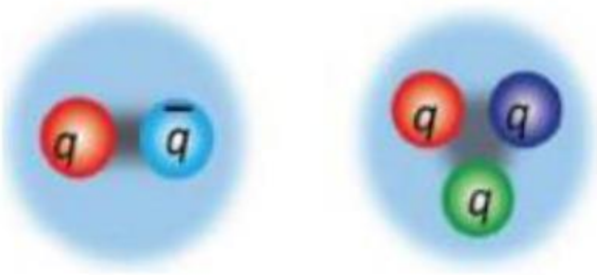
2016: we will take 3/fb Ds data about 4170 MeV ~ 5×CLEO-c



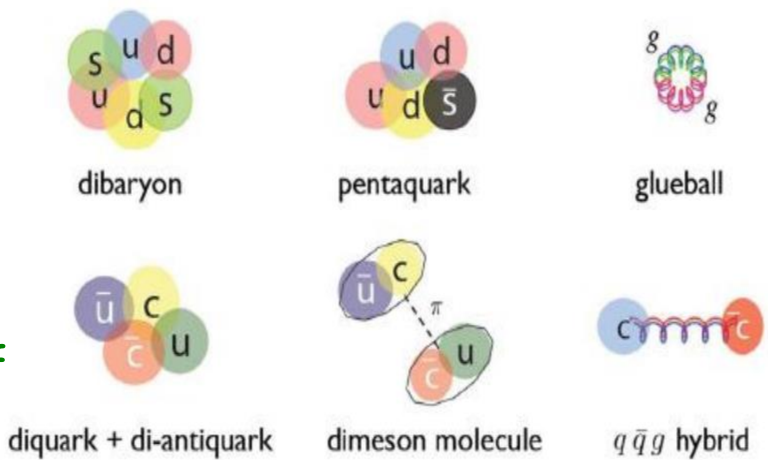
~ other data sets: tau, Λ_c, resonance scan and continuum, etc.

Hadron States

- Hadrons:
  - 2 quarks(meson) or 3 quarks(baryon)
  - Described with quark model(QM)
    - precision spectroscopy



- QCD suggests:
  - Molecule: bound state of two hadrons
  - Multi-quark states:(qqqq, qqqqq, …)
  - Glueball:(gg, ggg, …)
  - Hybrid:(qqg, …)
    - search and spectroscopy of unexpected states



Clean environment and high luminosity at BESIII are helpful to resolve the puzzles

Spectroscopy and hadron physics:

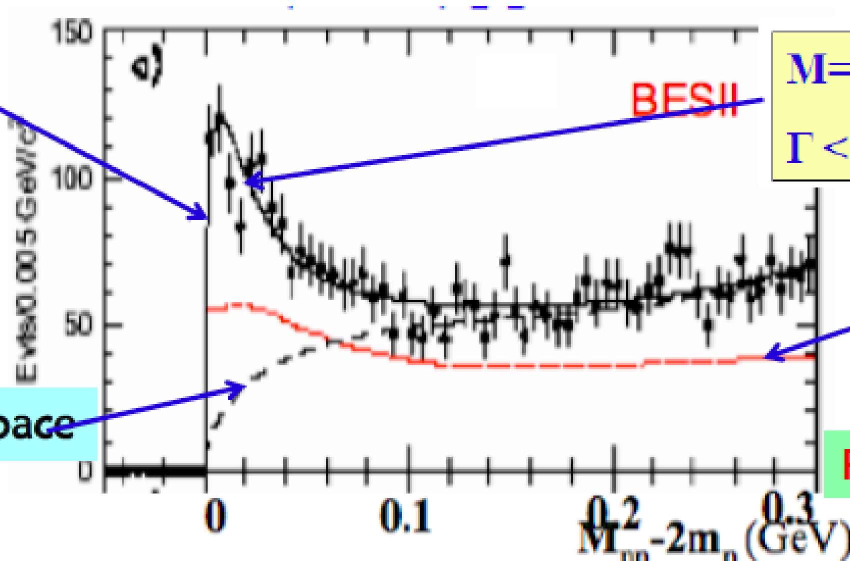
Highlighted topics from BESIII

- Light meson spectroscopy
- EM Dalitz Decay Studies
- New Physics searches

X(18XX): BESII legacy

$J/\psi \to \gamma p\bar{p}$ (58M J/ψ events)

A fit using an acceptance-weighted S-wave BW Plus bkg.



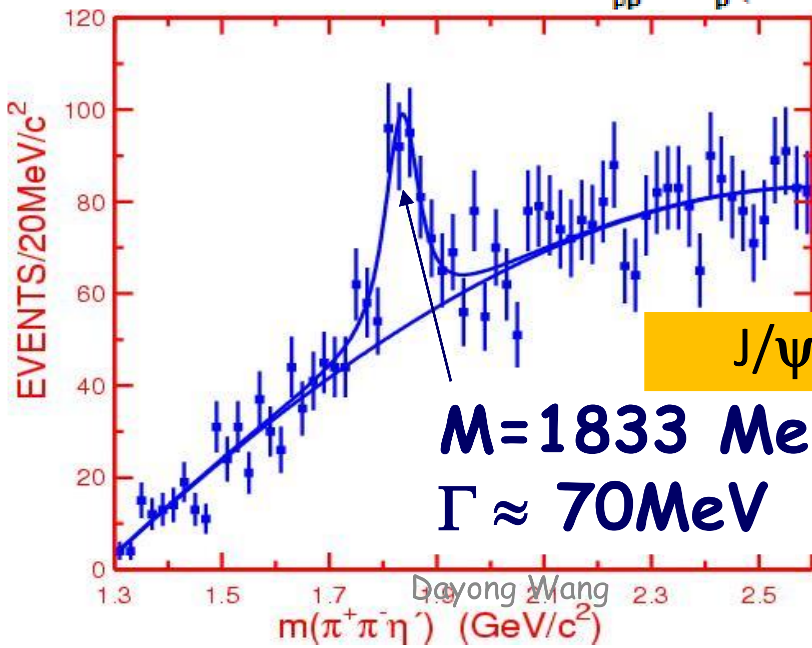
$M=1859^{+3}_{-10}{}^{+5}_{-25}$ MeV/c²

$\Gamma < 30$ MeV/c² (90% CL)

acceptance

3-body phase space

PRL 91, 022001 (2003)



$J/\psi \to \gamma X(1835) \to \gamma(\pi^+\pi^-\eta')$

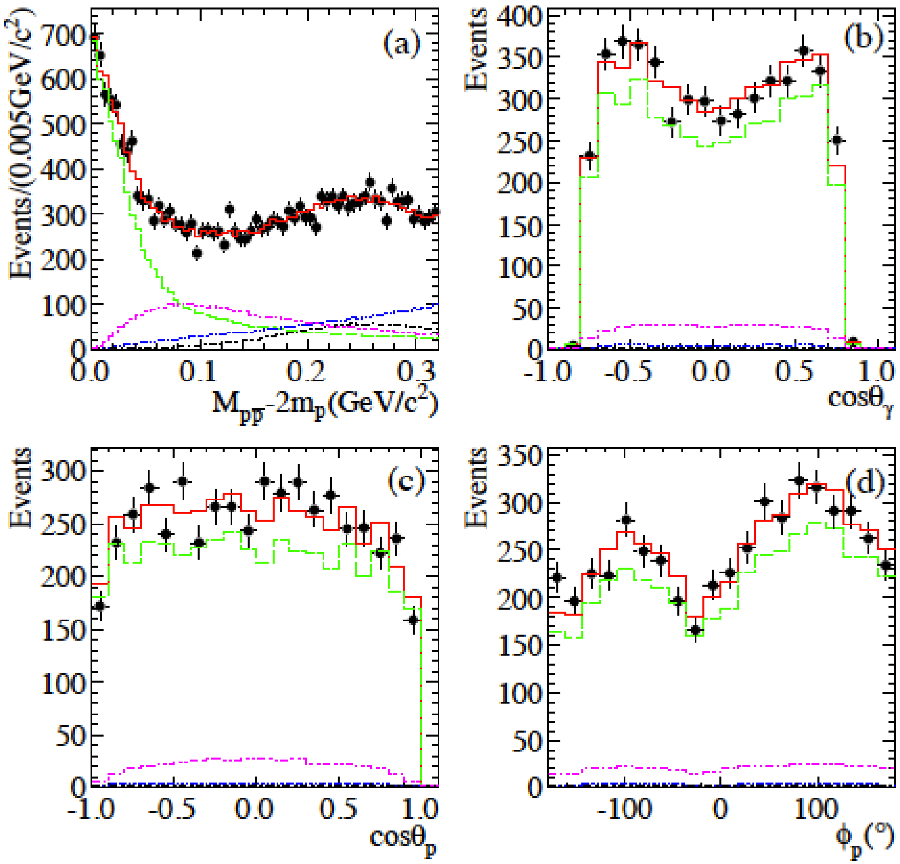
M=1833 MeV

$\Gamma \approx$ 70MeV

BESII PRL 95, 262001 (2005)

BESIII with 5x more data

$J/\psi \rightarrow \gamma p\bar{p}$



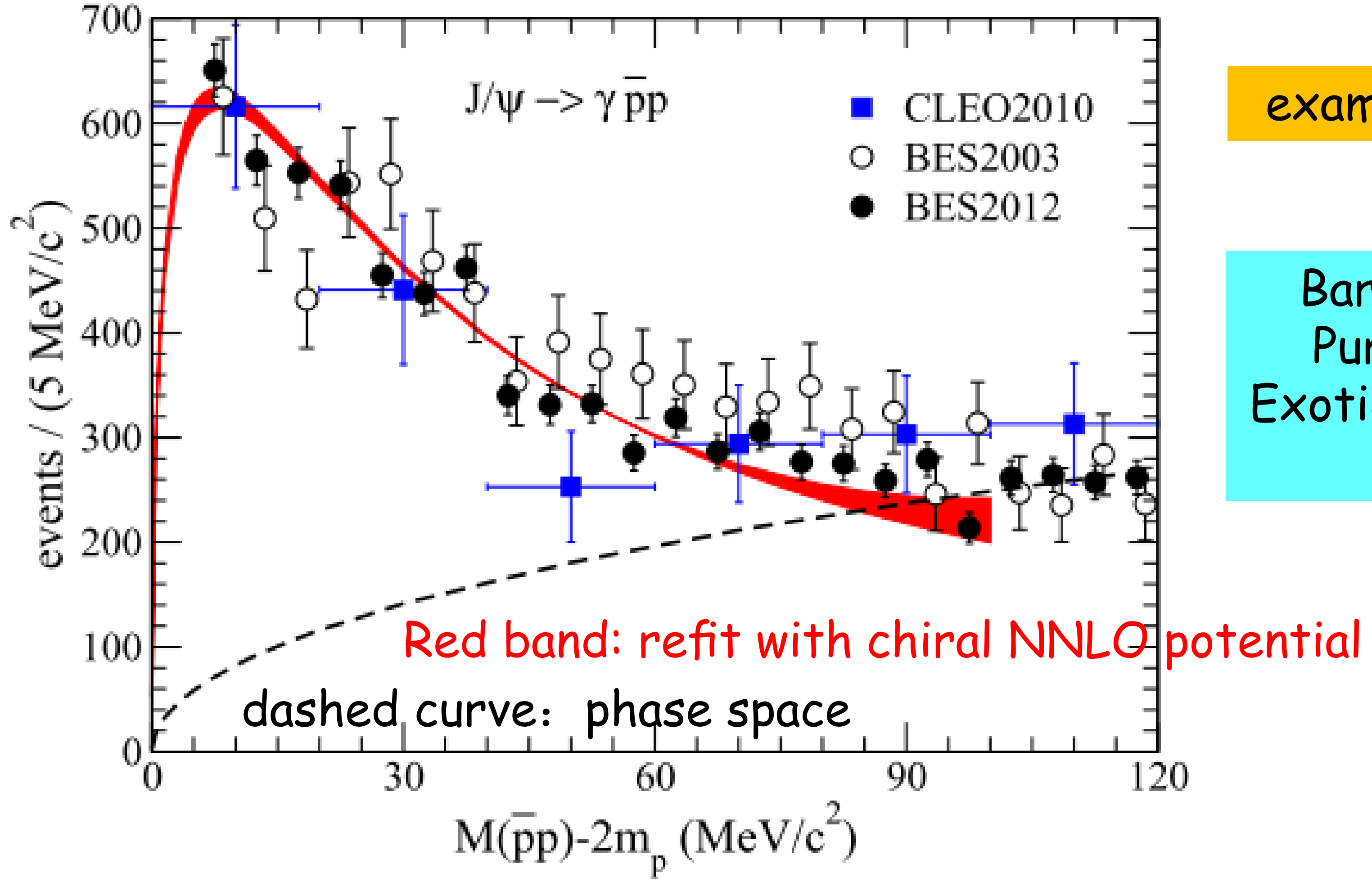
BESIII PRL 108, 112003 (2012)

Partial Wave Analysis:

- $J^{PC}= 0^{-+}$ >6.8σ better than other assignments
- I=0 FSI improves the fit quality by ~7σ
- $M=1832^{+19}_{-5}\,^{+18}_{-33} \pm 19_{model}$ MeV $\approx 2m_p-40$ MeV
- $\Gamma=13 \pm 20^{+11}_{-33}$ MeV; < 76 MeV
- $Bf(J/\psi \rightarrow \gamma X) \times Bf(X \rightarrow \bar{p}p)=$ $(9.0^{+0.4}_{-1.1}\,^{+1.5}_{-5.0} \pm 2.3_{model}) \times 10^{-5}$
  ➔suggests $Bf(X \rightarrow p\bar{p})$~large

Understanding the enhancement

Plot from: Kang, Haidenbauer, Meißner, Phys. Rev. D 91, 074003 (2015)



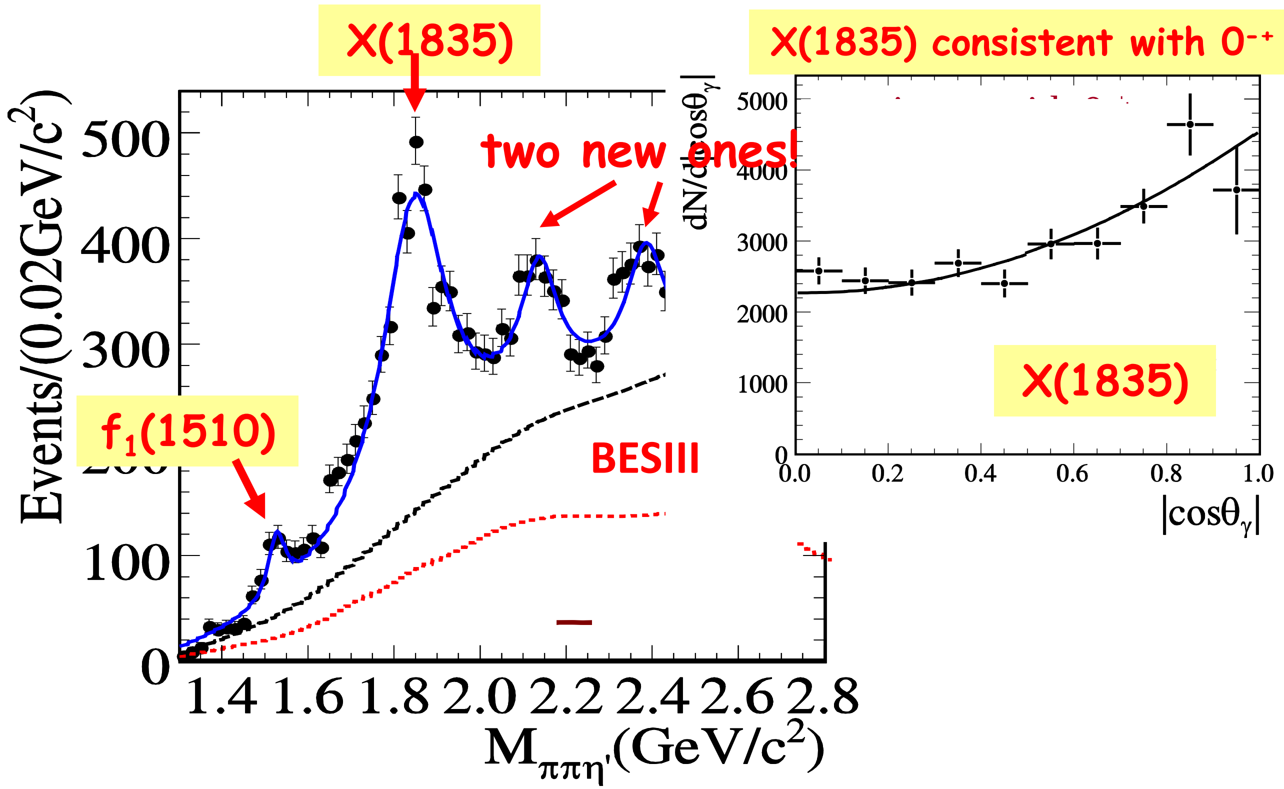
example

Baryonium
Pure FSI
Exotic glueball
……

X(1835) confirmed at BESIII

$J/\psi \to \gamma\eta'\pi^+\pi^-$
$\eta' \to \eta\pi^+\pi^-$
$\eta' \to \gamma\pi^+\pi^-$

PRL 106, 072002 (2011)

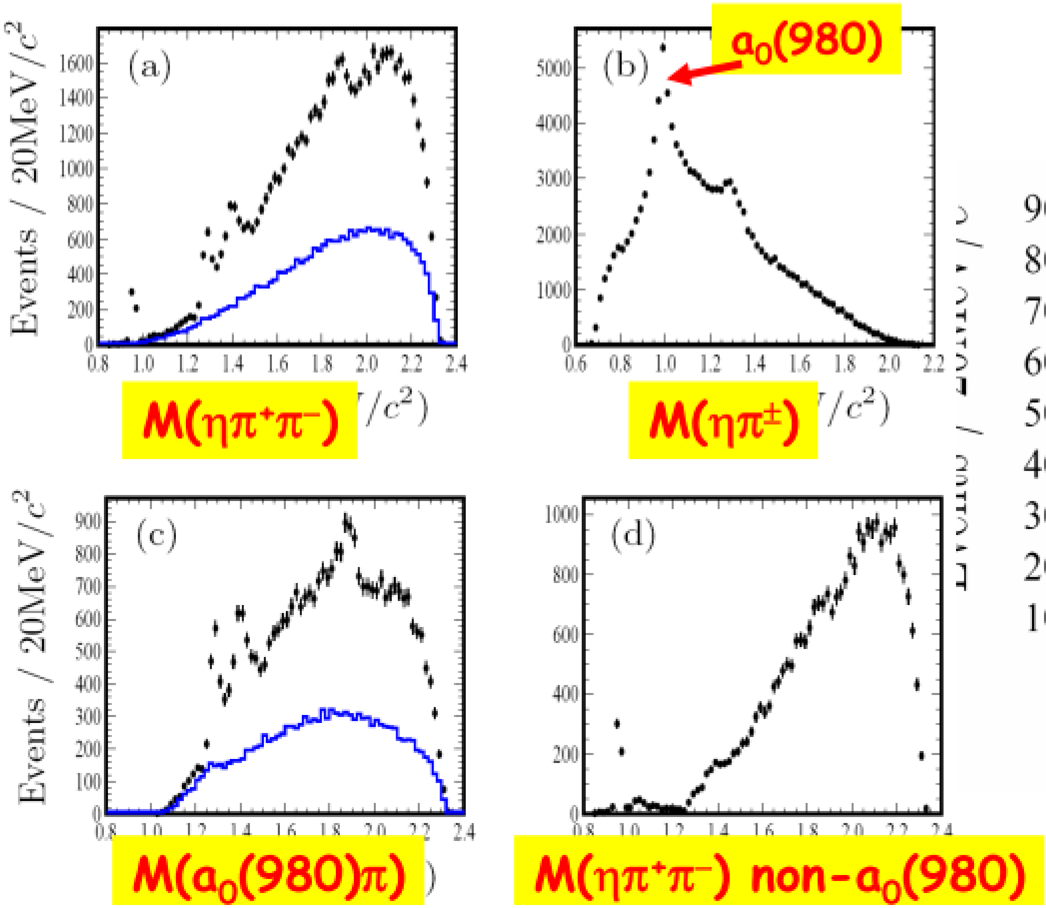


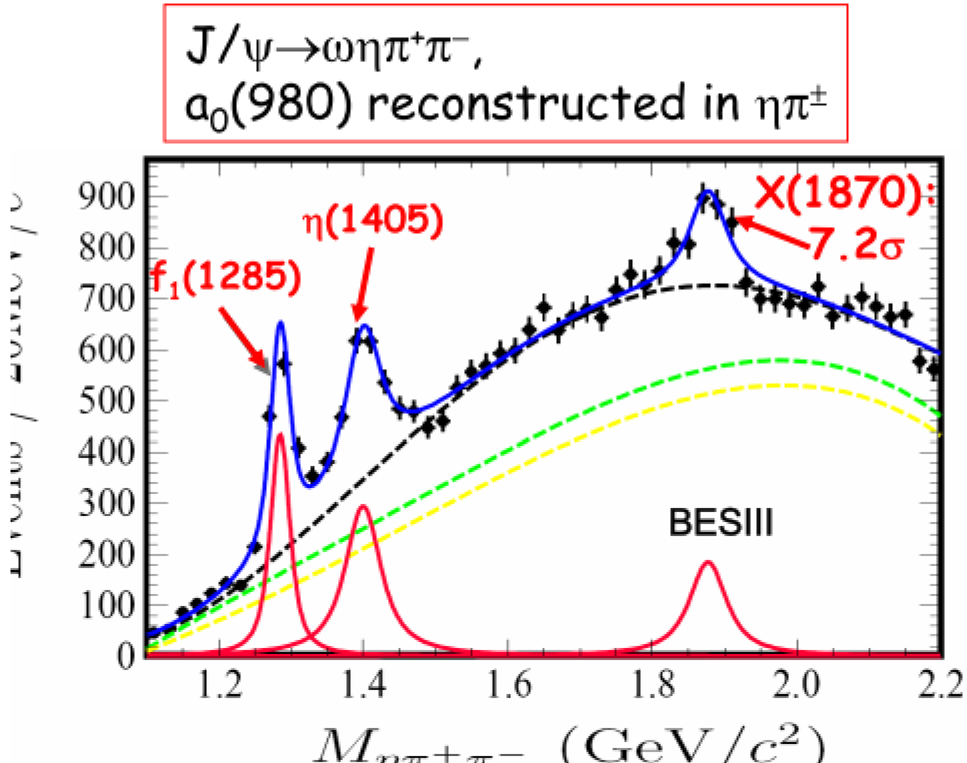
Resonance	M(MeV/c²)	Γ(MeV/c²)	Stat.Sig.
X(1835)	$1836.5 \pm 3.0^{+5.6}_{-2.1}$	$190.1 \pm 9.0^{+38}_{-36}$	>20σ
X(2120)	$2122.4 \pm 6.7^{+4.7}_{-2.7}$	$83 \pm 16^{+31}_{-11}$	7.2σ
X(2370)	$2376.3 \pm 8.7^{+3.2}_{-4.3}$	$83 \pm 17^{+44}_{-6}$	6.4σ

narrow!!

X(1835): same mass and J^{PC} as the pp peak, but larger width

Observation of X(1870)



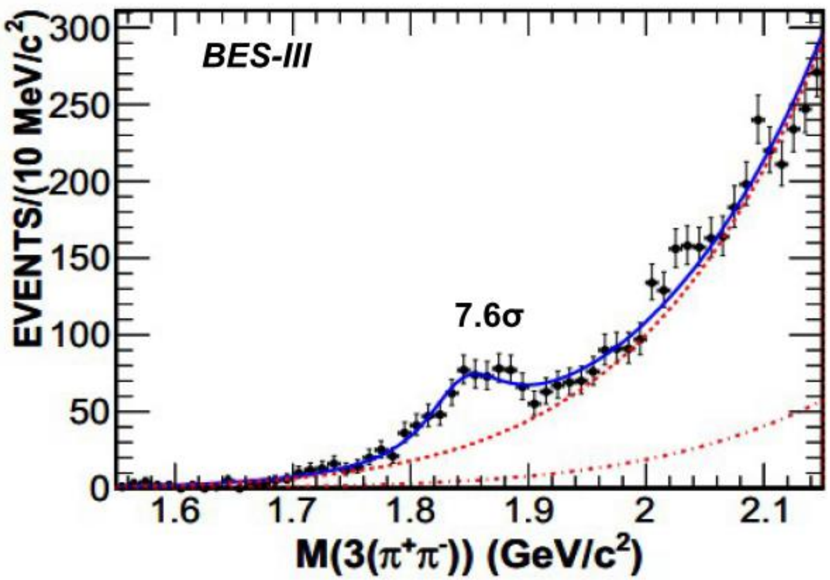


Phys.Rev.Lett.107,182001 (2011)

- A resonance with mass of 1.87 GeV and width of 57 MeV is observed.

- Simple fit shows:
  - $M = 1877.3 \pm 6.3^{+3.4}_{-7.4}$ MeV
  - $\Gamma = 57 \pm 12^{+19}_{-4}$ MeV
  - Significance: 7.2σ

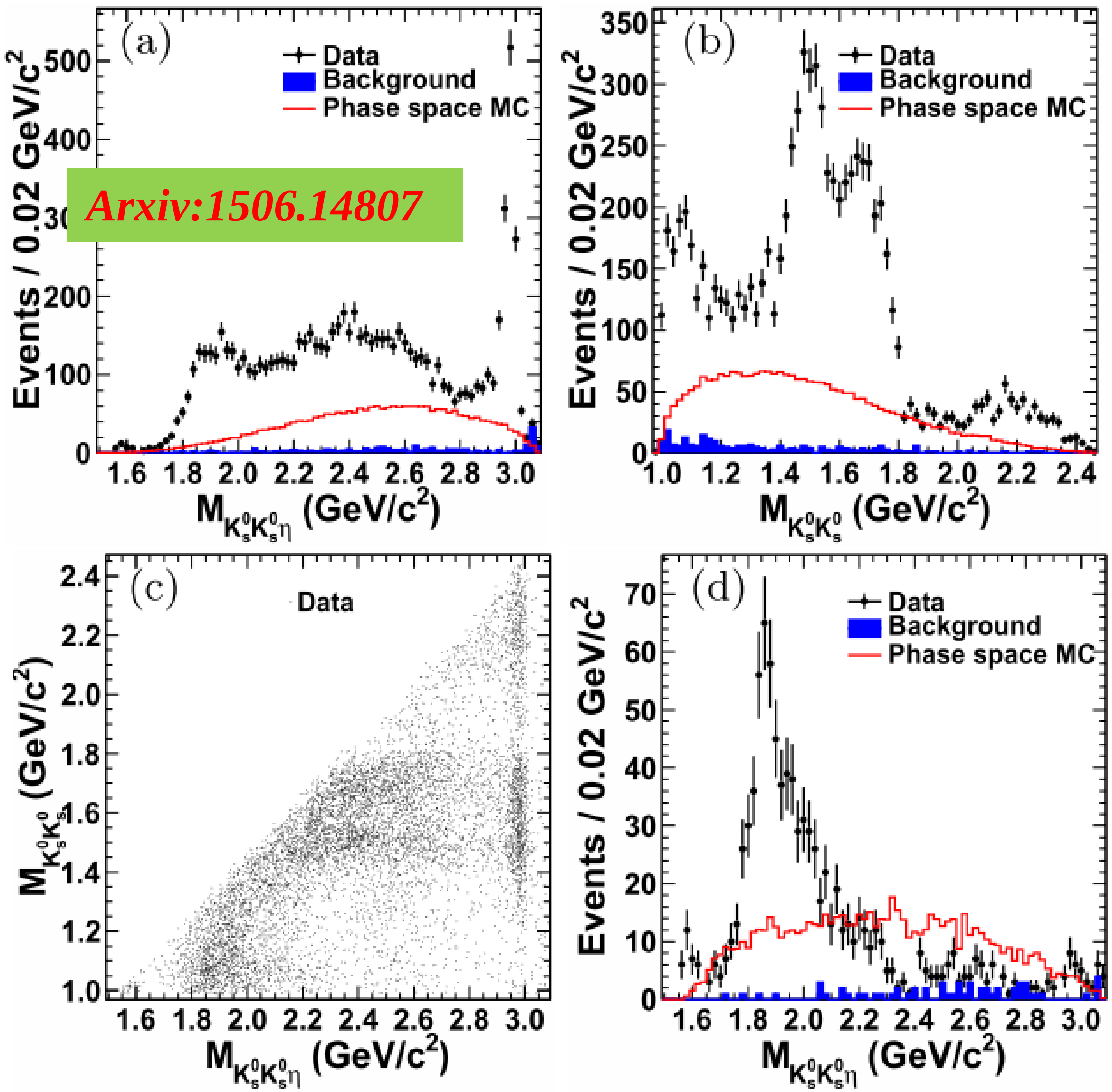
X(1840) in $J/\Psi \rightarrow \gamma 3(\pi^{+}\pi^{-})$



- A structure is observed in $3(\pi^+\pi^-)$ mass spectrum
  $M=1842.2\pm4.2^{+7.1}_{-2.6}$ MeV/c^2 $\Gamma=83\pm14\pm11$ MeV/c 2
- Mass is consistent with X(1835) from $J/\Psi \rightarrow \gamma\pi^+\pi^-\eta'$ confirmed by BES-III and CLEO-c, but the width is much smaller
- A new decay mode of X(1835)?

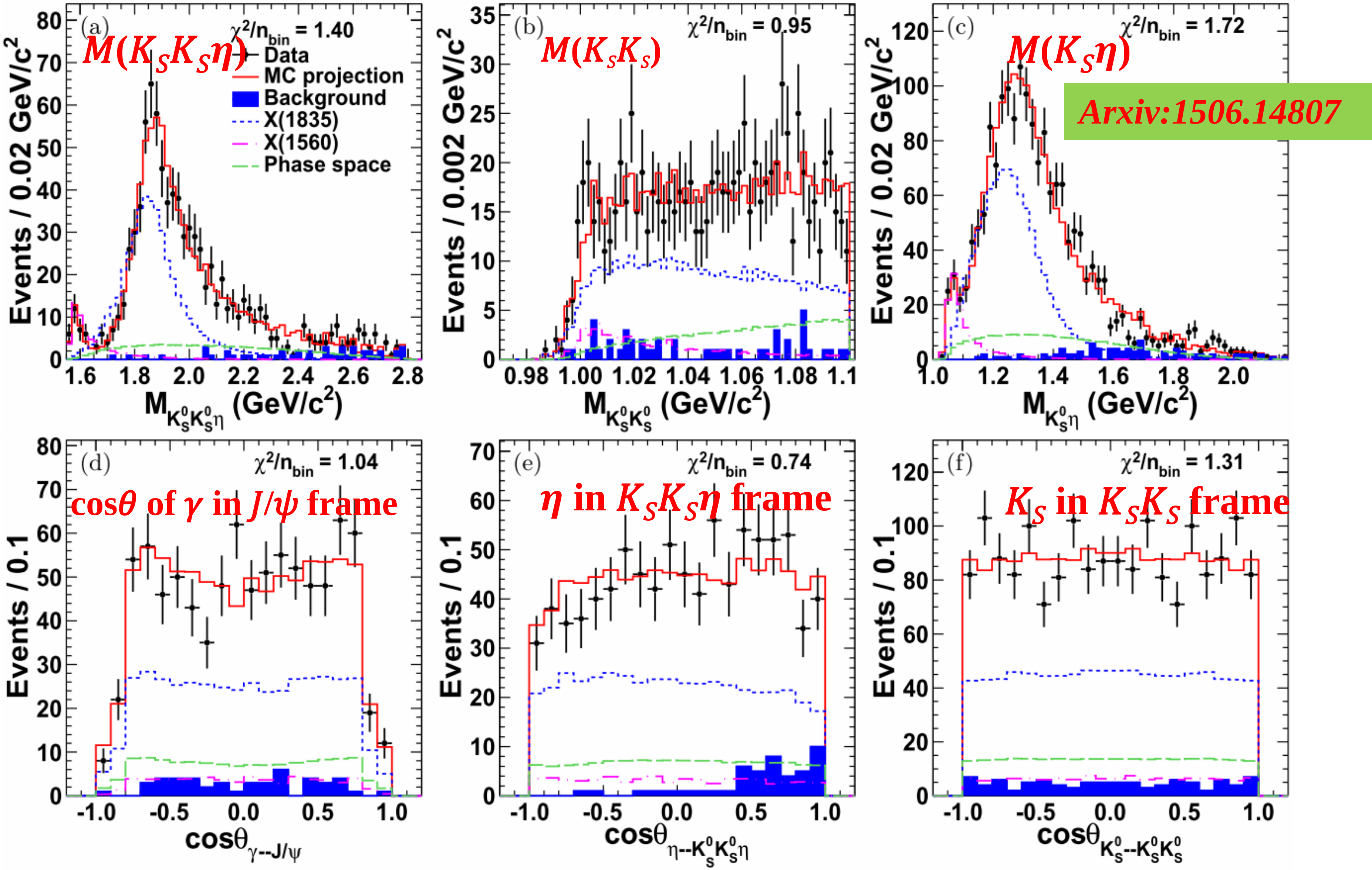
PRD88 (2013) 091502(R)

$J/\psi \rightarrow \gamma K_s K_s \eta$:Mass spectra



- Crucial to measure the J^{PC} of X(1835) and for new decay modes
- No background from $J/\psi \rightarrow K_S K_S \eta$ and $J/\psi \rightarrow K_S K_S \eta \pi^0$, due to exchange symmetry and CP conservation
- The structure around 1.85 GeV/c^2 in the $K_S K_S \eta$ mass spectrum is strongly correlated with $f_0(980)$
- To reduce complexities, we perform PWA by requiring $M(K_S K_S)$<1.1 GeV/c^2

MC Projections of Nominal PWA Fit



$J/\psi \to \gamma K_s K_s \eta$ Results

Arxiv:1506.14807

- The PWA fit requires a contribution from X(1835)→$K_S K_S \eta$ with a statistical significance greater than 12.9 σ, where the $K_S K_S$ system is dominantly produced through the f_0(980)
- The spin-parity of the X(1835) is determined to be 0^{-+}
- The measured mass and width of the X(1835) are consistent with values obtained from the decay $J/\psi \to \gamma \pi\pi\eta'$ by BESIII
- These results are all first-time measurements and can provide important information to further understand the nature of the X(1835)

State	J^{PC}	Decay Mode	Mass (MeV/c^2)	Width (MeV)	Product Branching Ratio	Significance
X(1835)*	0^{-+}	$K_S K_S \eta$	$1844 \pm 9^{+16}_{-25}$	$192^{+20}_{-17}{}^{+62}_{-43}$	$(3.31^{+0.33}_{-0.30}{}^{+1.96}_{-1.29})*10^{-5}$	> 12.9 σ
X(1835)**	---	$\pi^+\pi^-\eta'$	$1836.5 \pm 3.0^{+5.6}_{-2.1}$	$190 \pm 9^{+38}_{-36}$	$(2.87 \pm 0.09^{+0.49}_{-0.52})*10^{-4}$	> 20 σ
X($p\bar{p}$)***	0^{-+}	$p\bar{p}$	$1832^{+19}_{-5}{}^{+18}_{-17} \pm 19$	<76@90%C.L.	$(9.0^{+0.4}_{-1.1}{}^{+1.5}_{-5.0} \pm 2.3)*10^{-5}$	> 30 σ

*This result ** PRL 106, 072002 (2011), the angular distribution consists with 0^{-+} hypothesis *** PRL 108, 112003 (2012)

- Another 0^{-+} state X(1560) is also observed with a statistical significance greater than 8.9σ and interfere with the X(1835). η(1405)/η(1475)?
- X(18XX): more to come, stay tuned!

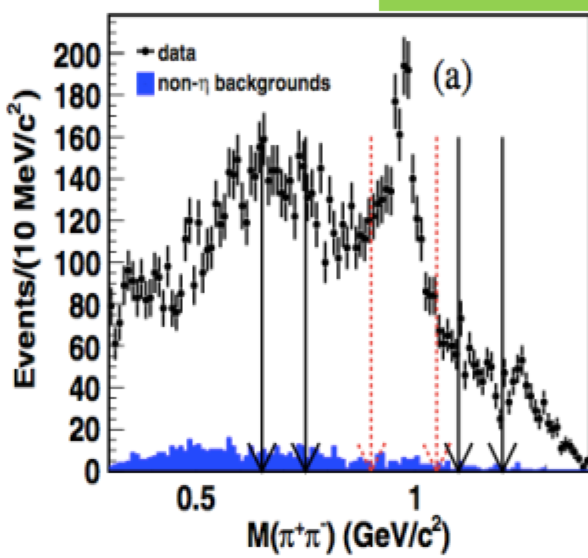
$J/\psi \to \eta\phi\pi\pi$

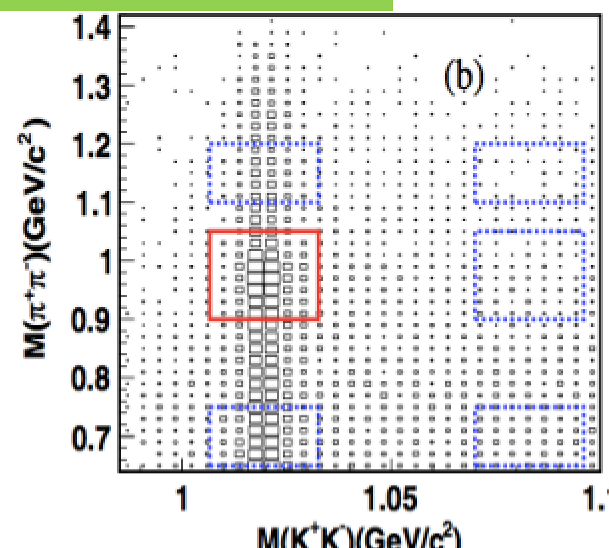
1. Observation of the Y(2175) resonance (called also ϕ(2170))
   - s-quark counterpart of the Y(4260)?
   - ss-gluon hybrid? Or excited ϕ state? Tetraquark state? $\Lambda\bar{\Lambda}$ bound state? Ordinary $\phi f_0(980)$ resonance produced by interactions between the final state particles?
2. Investigate the properties of $f_1(1285)$, the $\eta(1295)$, and the $\eta(1405)/\eta(1475)$ resonances
3. Search for X(1835) and X(1870) states

PRD 91,052017 (2015)

M(ππ) and M(KK) after event and track selection:

- Clear $f_0(980)$ signal
- Non-η bkg in the $f_0(980)$ mass region is small and can be neglected
- non-$f_0(980)$ and non-ϕ events used to estimate background contribution: 2D-sidebands





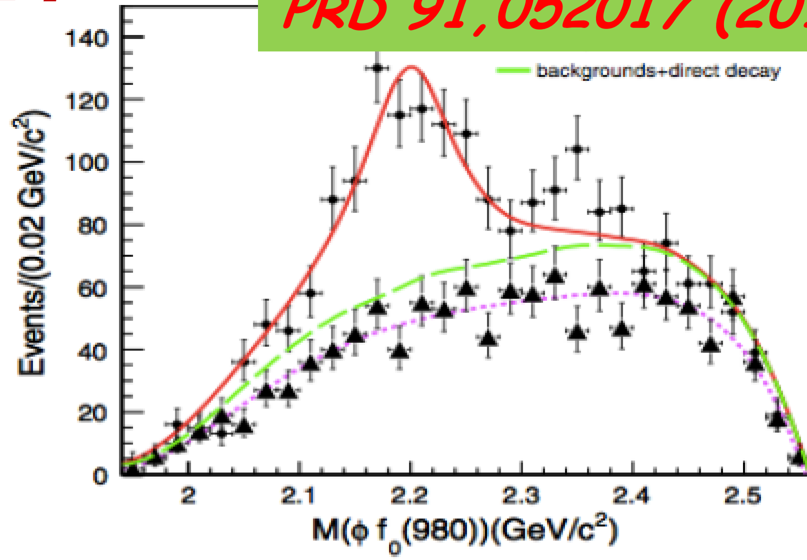
$J/\psi\rightarrow\eta\phi\pi\pi$

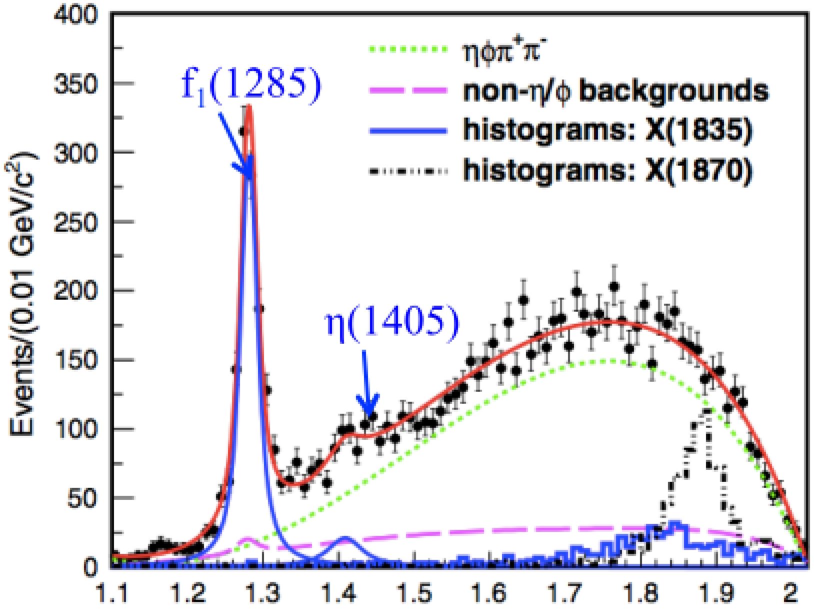
PRD 91,052017 (2015)

Unbinned maximum likelihood fit is performed to the $\phi f_0(980)$ invariant mass distribution

- No interference between Y(2175) and direct three-body decay of $J/\psi\rightarrow\eta\phi f_0(980)$
- Y(2175) resonance observed with a significance greater than **10σ**

$M=2200 \pm 6 \pm 5$ MeV/c^2 $\Gamma=104 \pm 15 \pm 15$ MeV





$\eta\pi\pi$ mass spectrum recoiling against the ϕ:

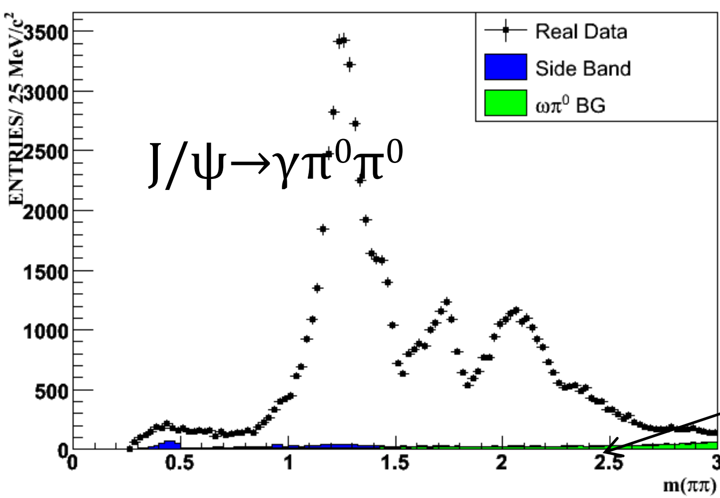
- Fit includes contributions from the $f_1(1285)$ and $\eta(1405)$ signals, the $J/\psi\rightarrow\eta\phi\pi\pi$ decay, and backgrounds from non-η and non-ϕ processes
- No evidence of X(1835) and X(1870) states

$B(J/\psi\rightarrow\phi f_1\rightarrow\phi\eta\pi\pi) = (1.20\pm0.06\pm0.14) \times 10^{-4}$

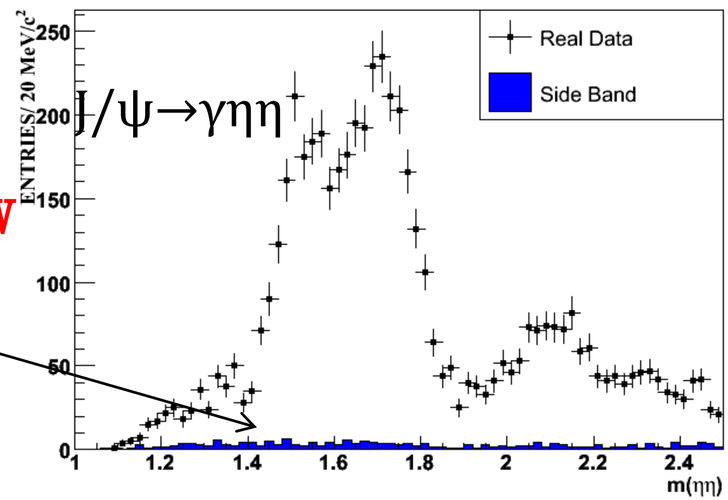
$B(J/\psi\rightarrow\phi\eta(1405)\rightarrow\phi\eta\pi\pi) = (2.01\pm0.58\pm0.82) \times 10^{-5}$

PWA of $J/\psi \to \gamma\eta\eta$ and $\gamma\pi^0\pi^0$

- $J/\psi \to \gamma\eta\eta$ was only studied in 1982 by Crystal Ball with very low statistics.
- Study of J/ψ decays to P(η, π) could provide information in intermediate states, important for glueball hunting
- Neutral channels at BESIII has special advantage

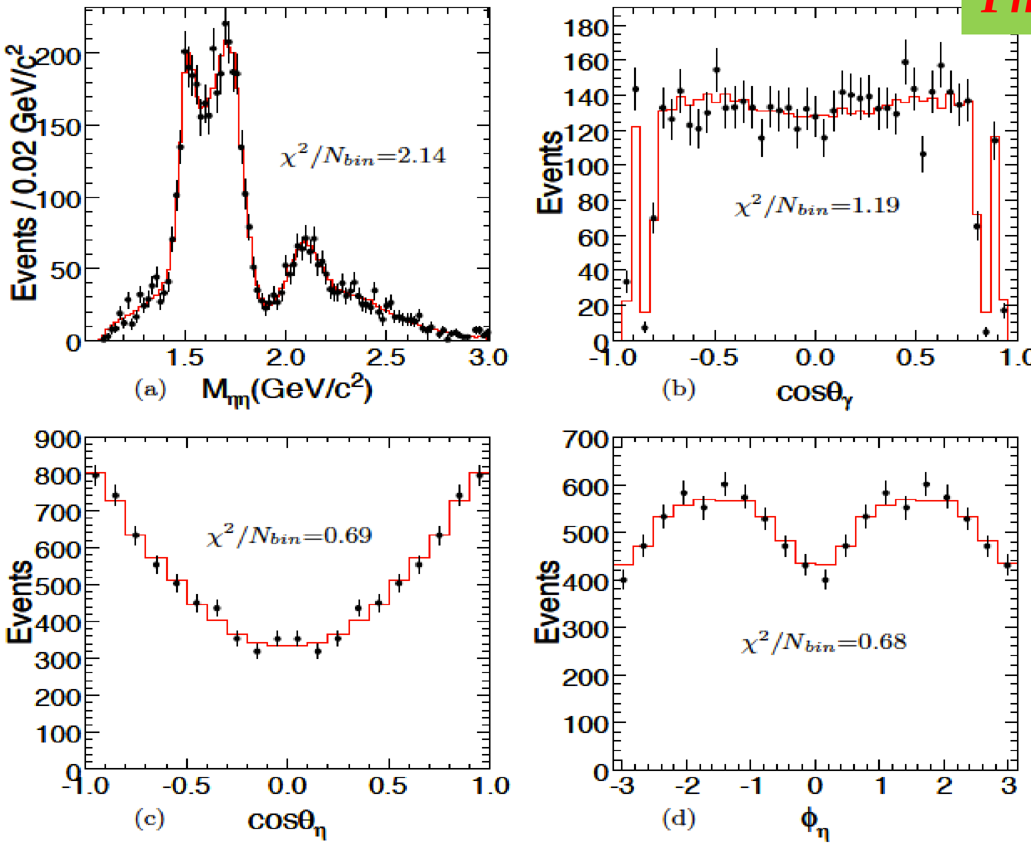


Very low BKG



PWA in J/ψ→γηη

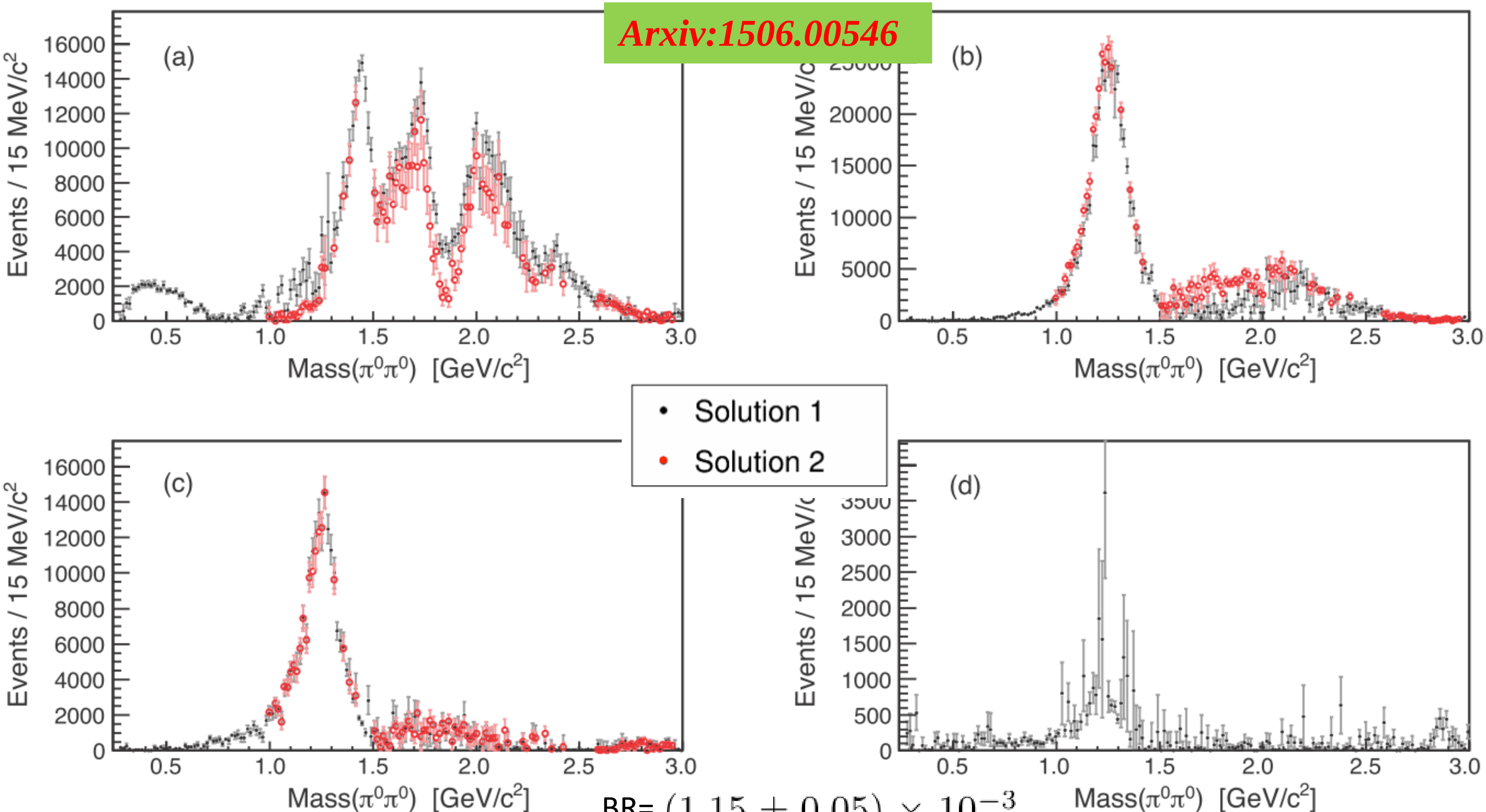
Phys. Rev. D. 87, 092009 (2013)



- $f_0(1710)$ and $f_0(2100)$ are dominant scalars
- $f_0(1500)$ exists (8.2σ)
- $f_2'(1525)$ is the dominant tensor
- $f_2(1810)$ and $f_2(2340)$ exist (6.4 and 7.6σ)

Resonance	Mass (MeV/c^2)	Width (MeV/c^2)	$\mathcal{B}(J/\psi \to \gamma X \to \gamma\eta\eta)$	Significance
$f_0(1500)$	1468^{+14+23}_{-15-74}	$136^{+41+28}_{-26-100}$	$(1.65^{+0.26+0.51}_{-0.31-1.40}) \times 10^{-5}$	8.2σ
$f_0(1710)$	$1759 \pm 6^{+14}_{-25}$	$172 \pm 10^{+32}_{-16}$	$(2.35^{+0.13+1.24}_{-0.11-0.74}) \times 10^{-4}$	25.0σ
$f_0(2100)$	$2081 \pm 13^{+24}_{-36}$	273^{+27+70}_{-24-23}	$(1.13^{+0.09+0.64}_{-0.10-0.28}) \times 10^{-4}$	13.9σ
$f_2'(1525)$	$1513 \pm 5^{+4}_{-10}$	75^{+12+16}_{-10-8}	$(3.42^{+0.43+1.37}_{-0.51-1.30}) \times 10^{-5}$	11.0σ
$f_2(1810)$	1822^{+29+66}_{-24-57}	$229^{+52+88}_{-42-155}$	$(5.40^{+0.60+3.42}_{-0.67-2.35}) \times 10^{-5}$	6.4σ
$f_2(2340)$	$2362^{+31+140}_{-30-63}$	$334^{+62+165}_{-54-100}$	$(5.60^{+0.62+2.37}_{-0.65-2.07}) \times 10^{-5}$	7.6σ

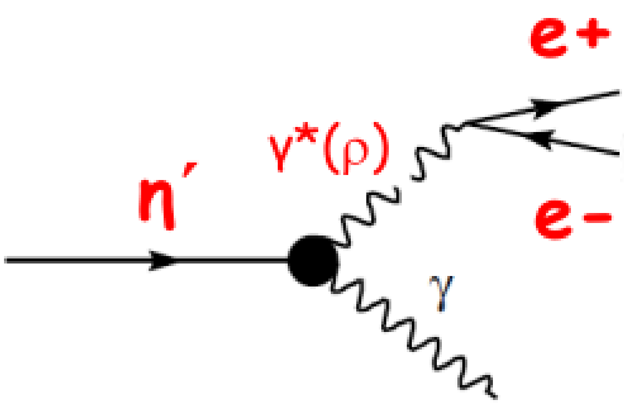
MIPWA of $J/\psi \rightarrow \gamma\pi^0\pi^0$



BR= $(1.15 \pm 0.05) \times 10^{-3}$

$\eta' \to \gamma e^+ e^-$: Motivation

- ✓ Investigate the inner structure of the meson
- ✓ Transition form factor to better understand the anomalous muon magnetic moment
- ✓ VMD multipole FF: $F(q^2) = N \sum_V \frac{g_{\eta'\gamma V}}{2 g_{V\gamma}} \cdot \frac{m_V^2}{m_V^2 - q^2 - i\Gamma_V m_V}$

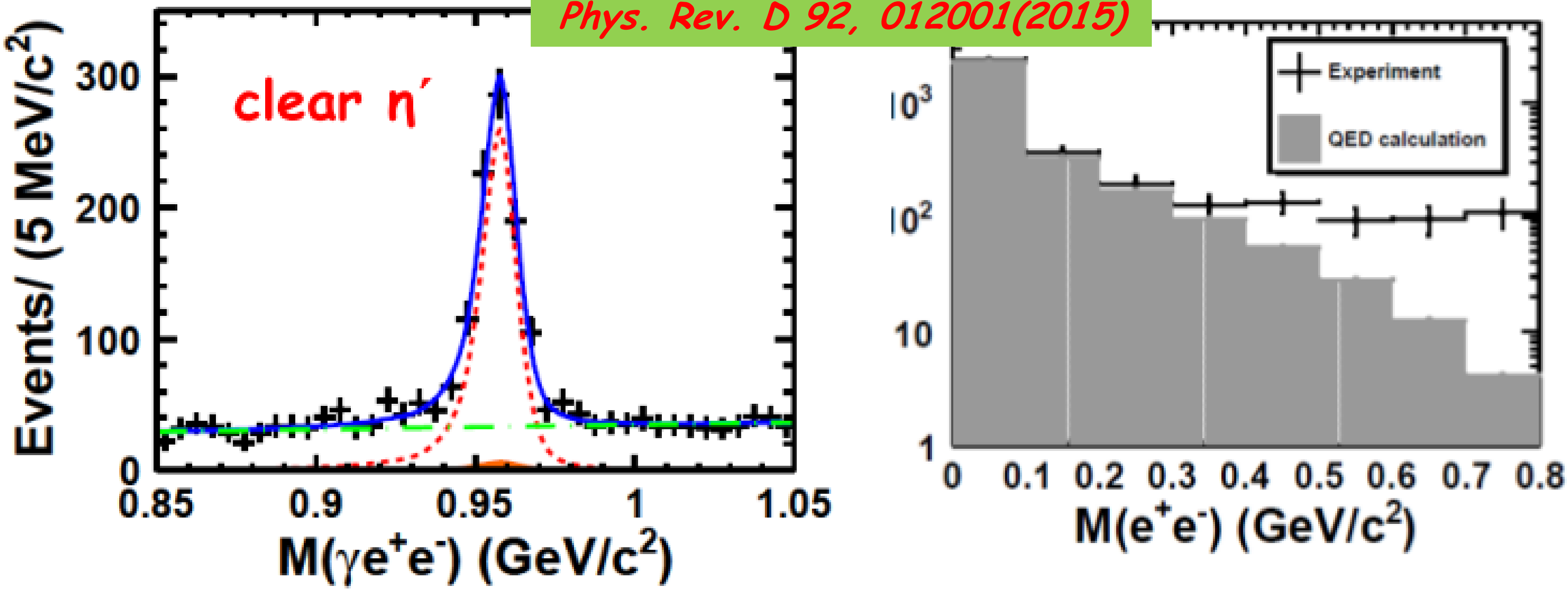


$$\frac{d\Gamma(\eta' \to \gamma l^+ l^-)}{dq^2 \Gamma(\eta' \to \gamma\gamma)} = [\mathrm{QED}(q^2)] \times |F(q^2)|^2$$

$$= \frac{2\alpha}{3\pi} \frac{1}{q^2} \sqrt{1 - \frac{4m_l^2}{q^2}} \left(1 + \frac{2m_l^2}{q^2}\right) \left(1 - \frac{q^2}{m_{\eta'}^2}\right)^3 |F(q^2)|^2$$

First observation of $\eta' \to \gamma e^+ e^-$

Phys. Rev. D 92, 012001(2015)

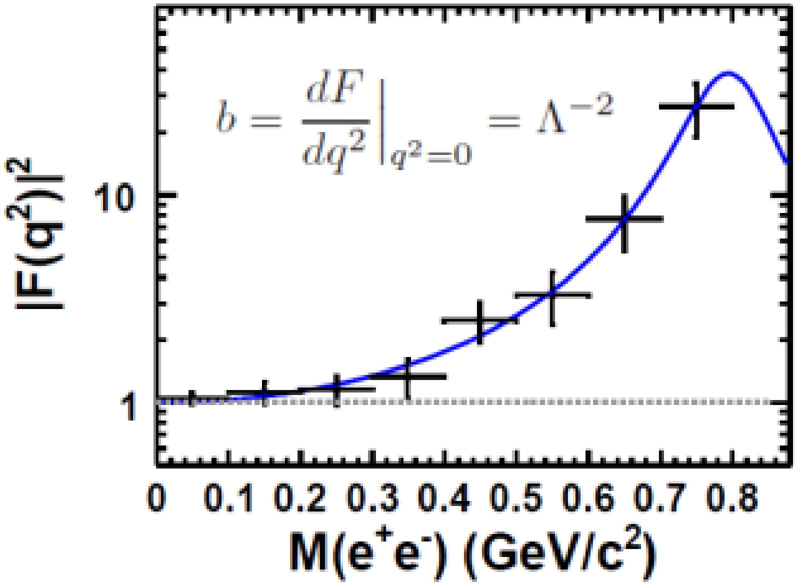


$$\frac{\Gamma(\eta' \to \gamma e^+ e^-)}{\Gamma(\eta' \to \gamma\gamma)} = (2.13 \pm 0.09(\mathrm{stat.}) \pm 0.07(\mathrm{sys.})) \times 10^{-2}$$

$$\mathcal{B}(\eta' \to \gamma e^+ e^-) = (4.69 \pm 0.20(\mathrm{stat.}) \pm 0.23(\mathrm{sys.})) \times 10^{-4}$$

4.2×10^{-4} effective meson theory, PRC61,035206

$\eta' \rightarrow \gamma e^+ e^-$: Transition Form Factor



$$|F(q^2)|^2 = \frac{\Lambda^2(\Lambda^2+\gamma^2)}{(\Lambda^2-q^2)^2+\Lambda^2\gamma^2}$$

$$\Lambda_{\eta'} = (0.79 \pm 0.04(\mathrm{stat.}) \pm 0.02(\mathrm{sys.}))\ \mathrm{GeV}$$

$$\gamma_{\eta'} = (0.13 \pm 0.06(\mathrm{stat.}) \pm 0.03(\mathrm{sys.}))$$

$$b_{\eta'} = (1.60 \pm 0.17(\mathrm{stat.}) \pm 0.08(\mathrm{sys.}))\ \mathrm{GeV}^{-2}$$

Phys. Rev. D 92, 012001(2015)

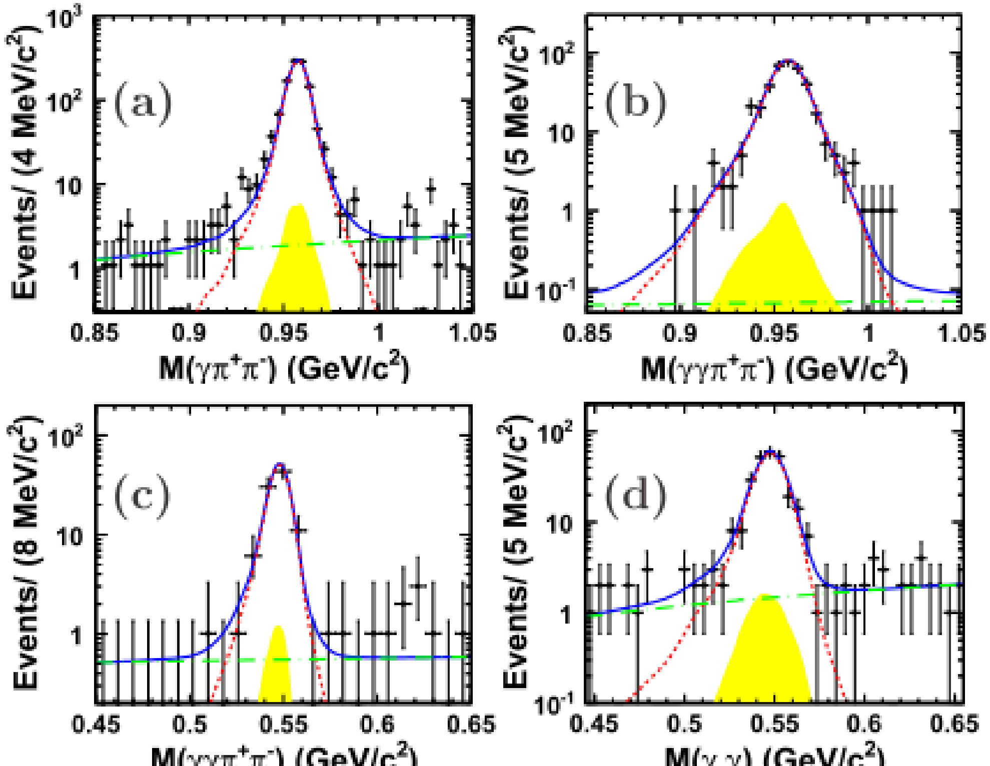
- In agreement with the results of $\eta' \rightarrow \gamma\mu^+\mu^-$ from CELLO

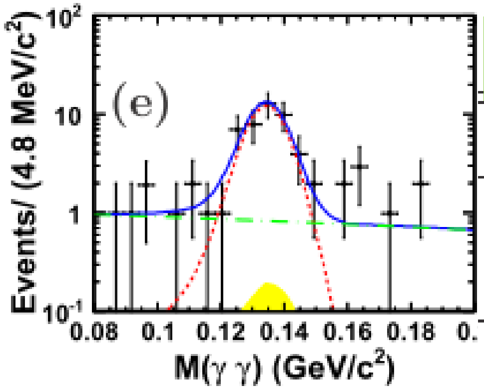
$$b_{\eta'} = (1.7 \pm 0.4)\ \mathrm{GeV}^{-2}$$

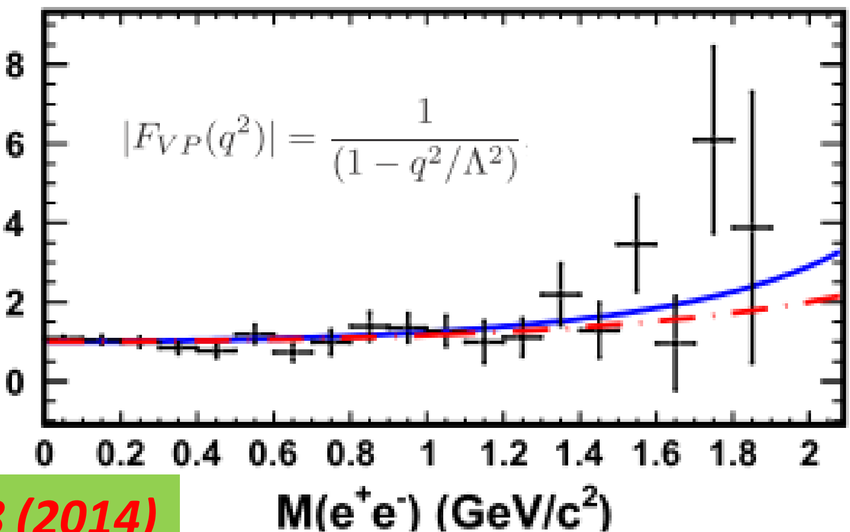
- Theoretical predictions:

$$b_{\eta'} = 1.45\ \mathrm{GeV}^{-2} \quad \text{VMD}$$
$$b_{\eta'} = 1.60\ \mathrm{GeV}^{-2} \quad \text{ChPT}$$
$$b_{\eta'} = 1.53^{+0.15}_{-0.08}\ \mathrm{GeV}^{-2} \quad \text{Dispersion}$$

First observation of $J/\psi \to Pe^+e^-$



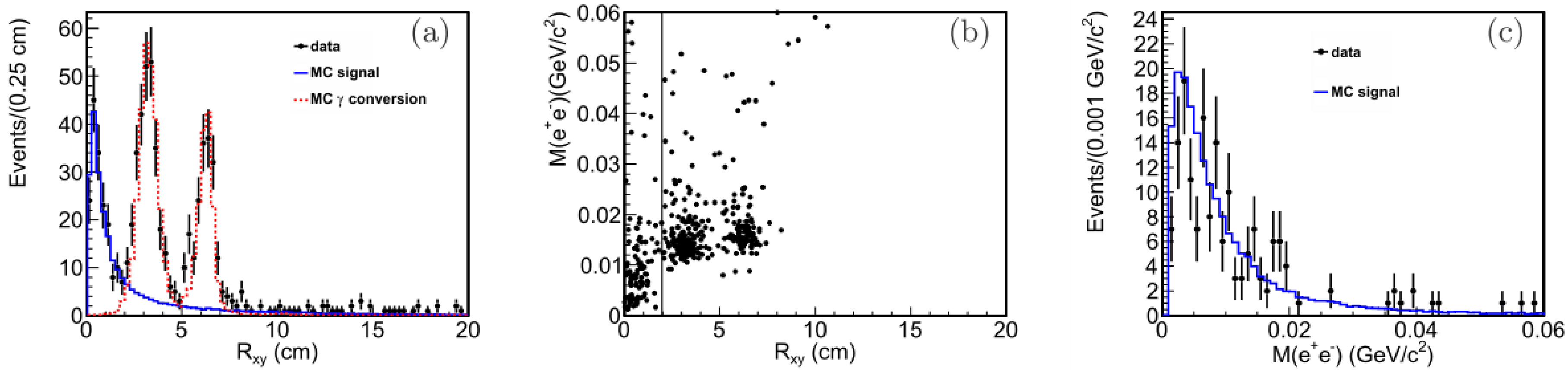




Phys. Rev. D 89, 092008 (2014)

Mode	Combined Result	Theoretical prediction
$J/\psi \to \eta' e^+e^- (\eta' \to \gamma\pi^+\pi^-)$		
$J/\psi \to \eta' e^+e^- (\eta' \to \pi^+\pi^-\eta)$	$(5.81 \pm 0.16 \pm 0.31) \times 10^{-5}$	$(5.66 \pm 0.16) \times 10^{-5}$
$J/\psi \to \eta e^+e^- (\eta \to \pi^+\pi^-\pi^0)$		
$J/\psi \to \eta e^+e^- (\eta \to \gamma\gamma)$	$(1.16 \pm 0.07 \pm 0.06) \times 10^{-5}$	$(1.21 \pm 0.04) \times 10^{-5}$
$J/\psi \to \pi^0 e^+e^- (\pi^0 \to \gamma\gamma)$	$(7.56 \pm 1.32 \pm 0.50) \times 10^{-7}$	$(3.89^{+0.37}_{-0.33}) \times 10^{-7}$

Observation of $\eta' \to \omega e^+e^-$



Arxiv:1507.06734

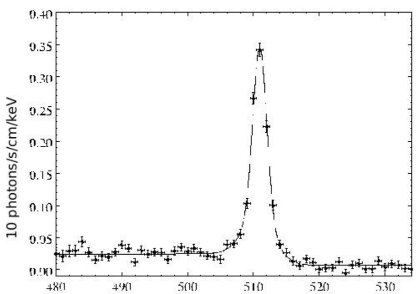
Decay mode	Yield	$\varepsilon(\%)$	Branching fraction
$\eta' \to \omega\gamma$	33187 ± 351	21.87	$(2.55 \pm 0.03 \pm 0.16) \times 10^{-2}$
$\eta' \to \omega e^+e^-$	66 ± 11	5.45	$(1.97 \pm 0.34 \pm 0.17) \times 10^{-4}$

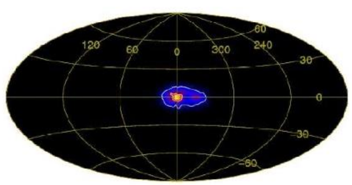
$$\frac{\mathcal{B}(\eta' \to \omega e^+e^-)}{\mathcal{B}(\eta' \to \omega\gamma)} = (7.71 \pm 1.34(\mathrm{stat}) \pm 0.54(\mathrm{syst})) \times 10^{-3}$$

New Physics Searches@BESIII

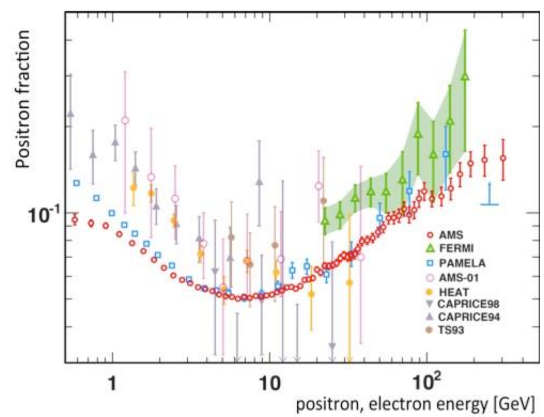
*Physics beyond the SM due to phenomena that cannot be explained within the SM framework:

- SM does not explain **gravity**
- SM does not supply any fundamental particles that are good **dark matter** candidates, nor be able to explain dark energy
- No mechanism in the SM sufficient to explain asymmetry of matter and **anti-matter**.





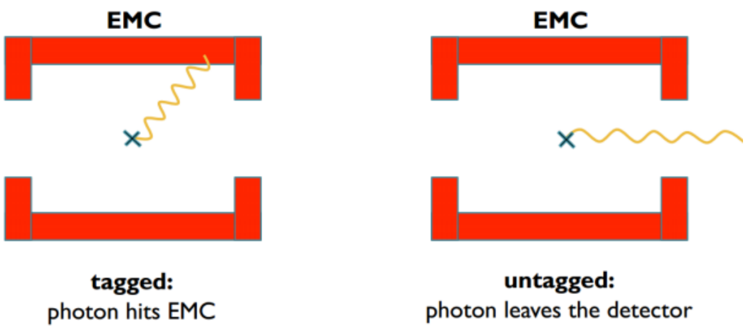
511 keV line - sky map
G. Weidenspointner et al., Nature **451** (2008) 159



NATURE, 2012.4

*No evidence of new physics been found at high energy frontier, it is important to search for new physics both directly and indirectly in the precision frontier.

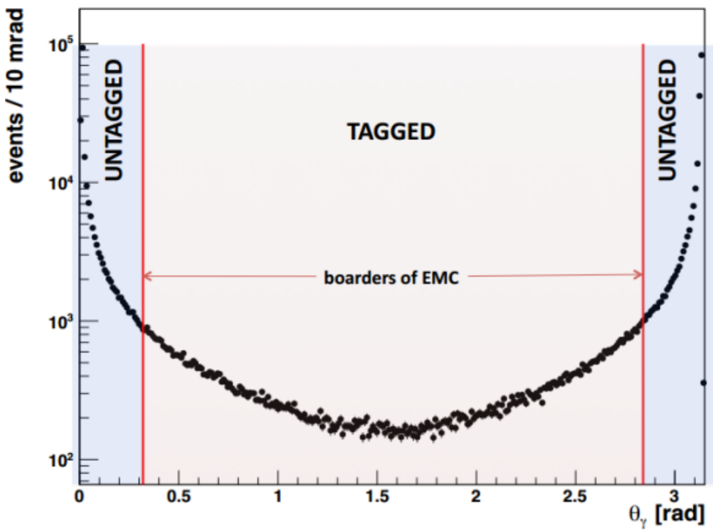
Dark photon search with ISR

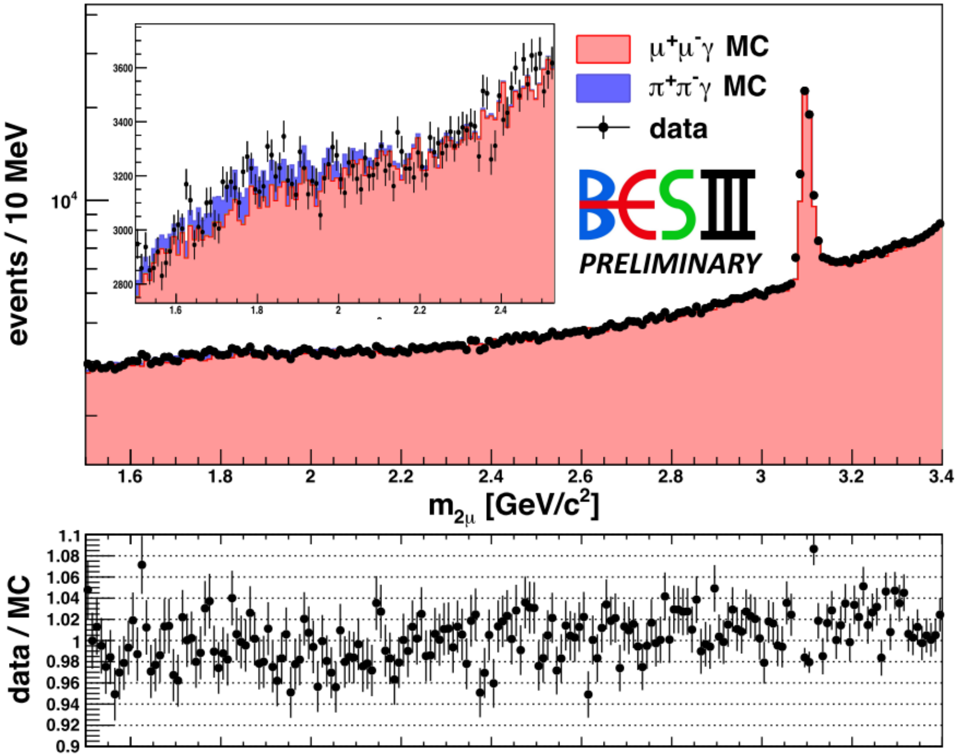


$$e^+e^- \to \gamma_{ISR}\gamma' \to \gamma_{ISR}\mu^+\mu^-$$

and

$$e^+e^- \to \gamma_{ISR}\gamma' \to \gamma_{ISR}e^+e^-$$





Work in progress

Di-muon resonance: Motivation

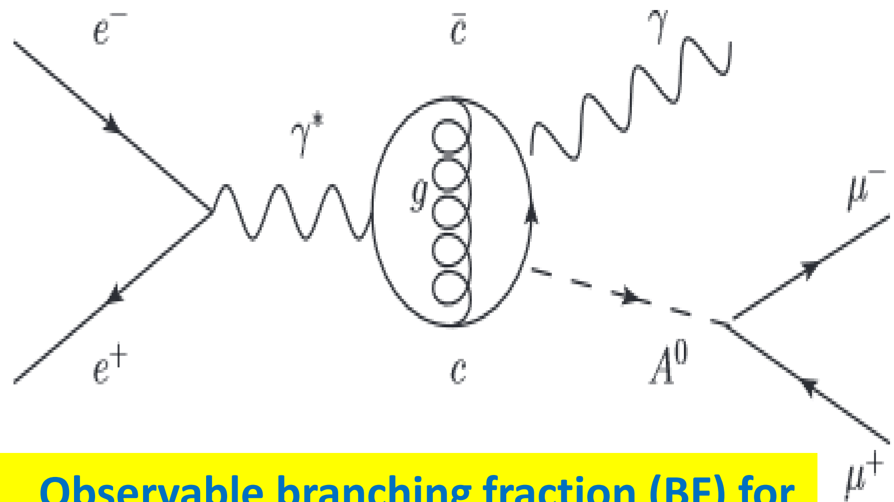
- Coupling of fermions and the CP-odd Higgs A^0

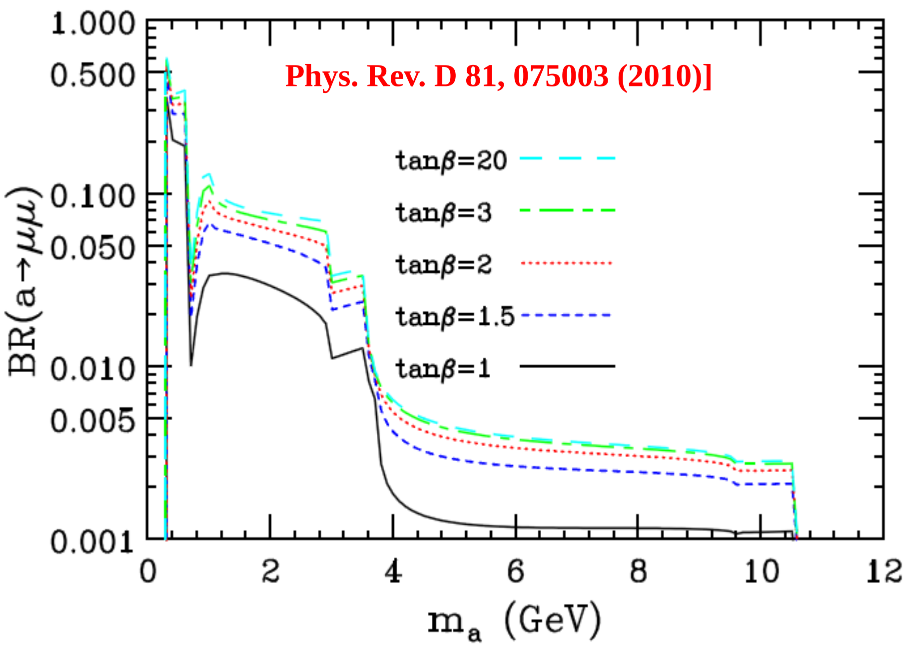
$$L_{\text{int}}^{f\bar{f}} = -\cos\theta_A \tan\beta \frac{m_f}{v} A^0 \bar{d}(i\gamma_5)d, \quad d = d,\ s,\ \mathbf{b},\ e,\ \mu,\ \tau$$

$$L_{\text{int}}^{f\bar{f}} = -\cos\theta_A \cot\beta \frac{m_f}{v} A^0 \bar{u}(i\gamma_5)u, \quad u = u,\ \mathbf{c},\ t,\ \nu_e,\ \nu_\mu,\ \nu_\tau$$

$$\tan\beta = \frac{v_u}{v_d}$$

E. Fullana et. al, Phys. Lett. B 653, 67 (2007)



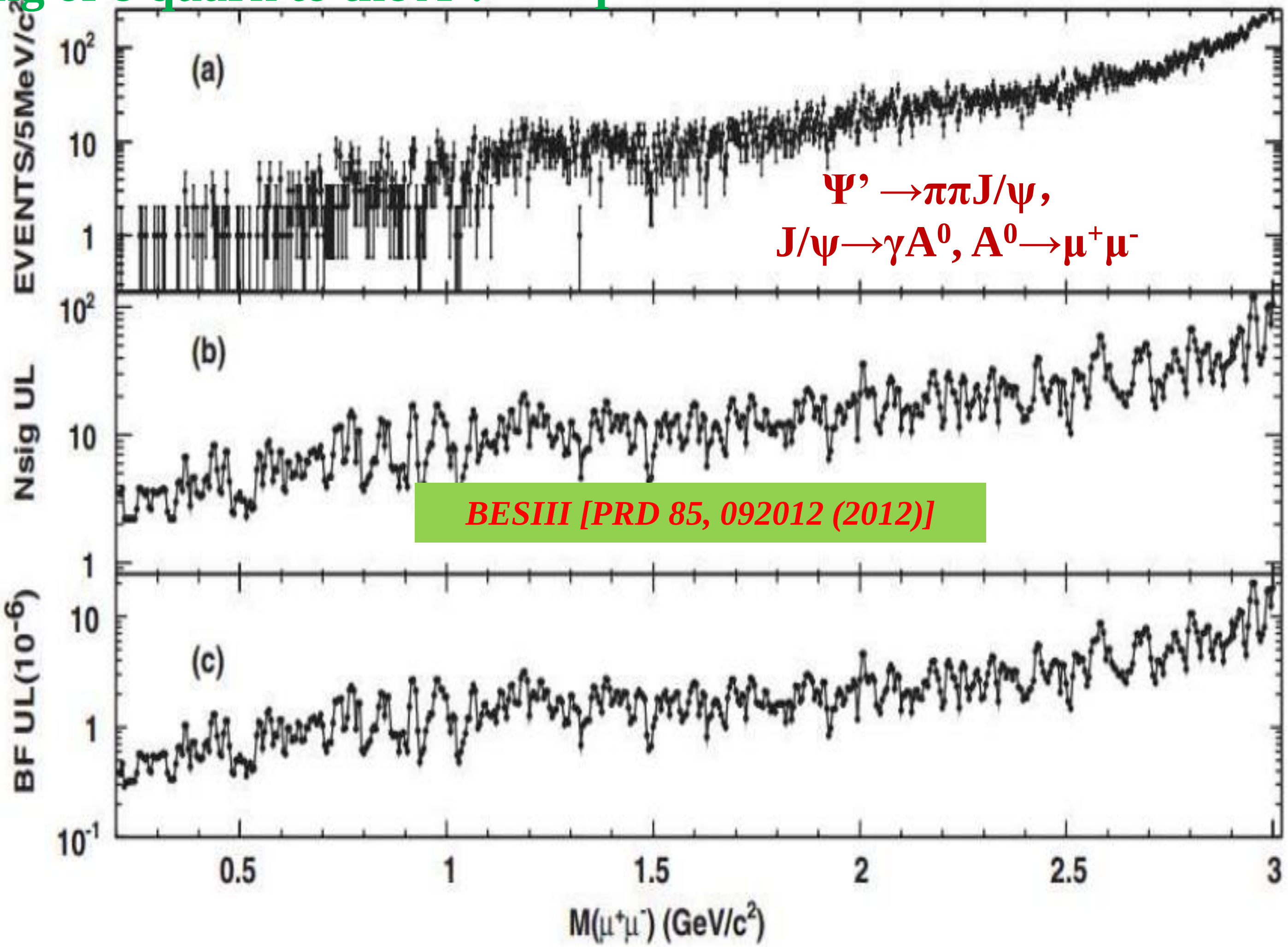


Observable branching fraction (BF) for $J/\psi \to \gamma A^0$ is possible in the range of $10^{-9} - 10^{-7}$. [PRD 76, 051105 (2007)]

❖ The CLEO [PRL101, 151802 (2008)], BaBar [PRL 103, 081803 (2009); PRD 87, 031102 (R) (2013)], BESIII [PRD 85, 092012 (2012)] and CMS [PRL 109, 121801 (2012)] experiments have reported negative results for the A^0 decaying to muon pairs using various decay channels and in five different A^0 mass ranges.

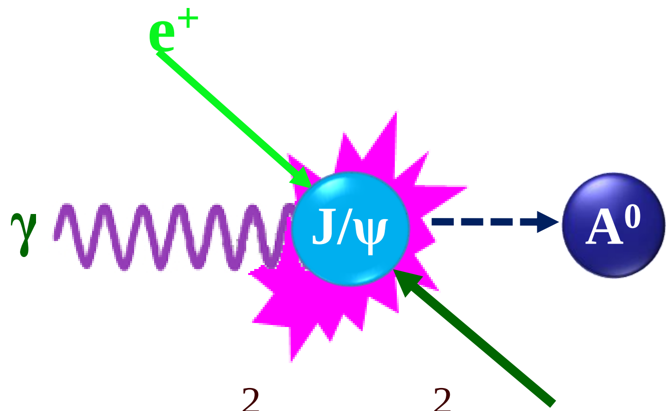
Search with Ψ’ →ππJ/ψ data

Coupling of c-quark to the A^0: Expected BF: 10^{-7} -10^{-9} [PRD 76, 051105 (2007)]



exclusion limit ranges: 4×10^{-7} - 2.1×10^{-5}

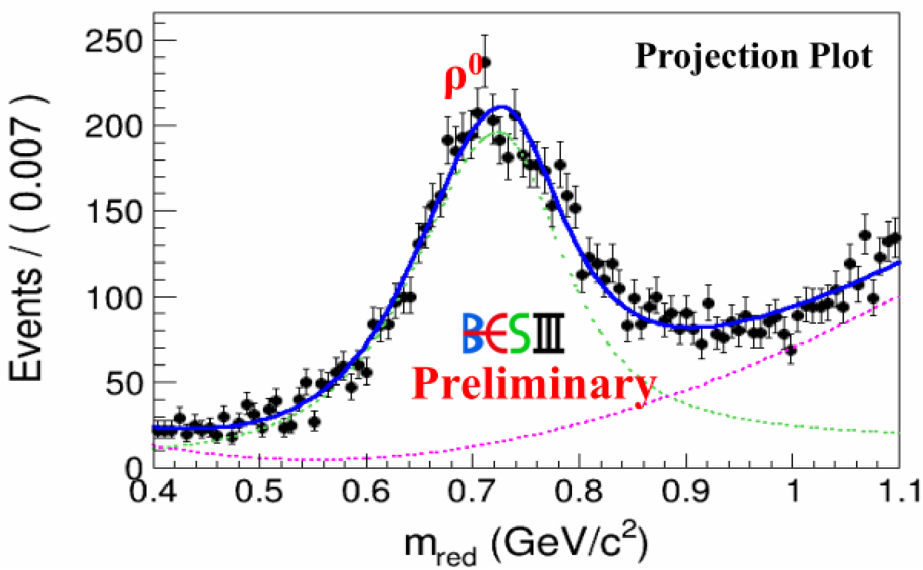
Search with J/ψ data directly

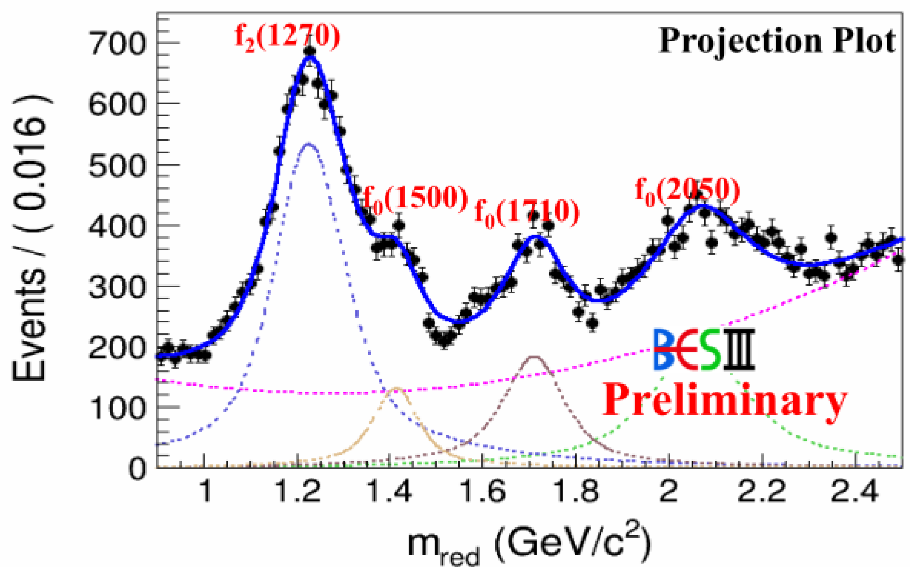


$$E_\gamma^* = \frac{m_{J/\psi}^2 - m_{A^0}^2}{2m_{J/\psi}}$$

$$m_{red} = \sqrt{m_{A^0}^2 - 4m_\mu^2}$$

Work in progress

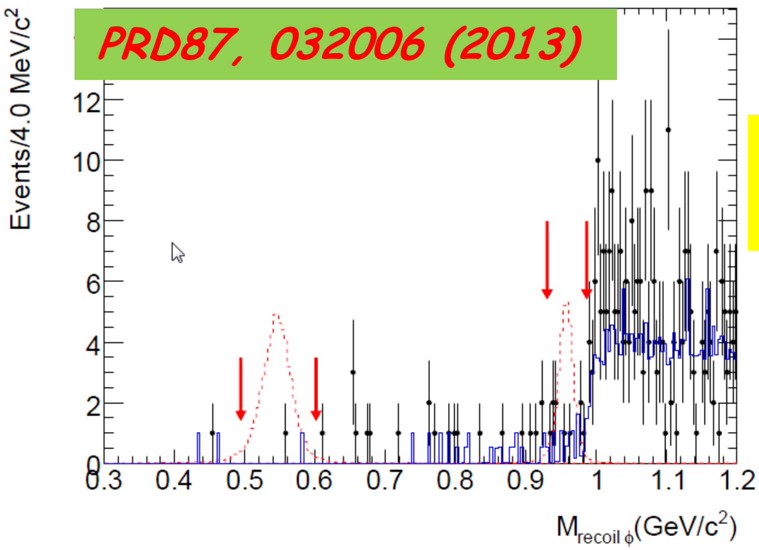




expected upper limit based on cocktail MC
can be improved w.r.t. Psi(2S) results

Probing NP with Charmonia and Charmed mesons

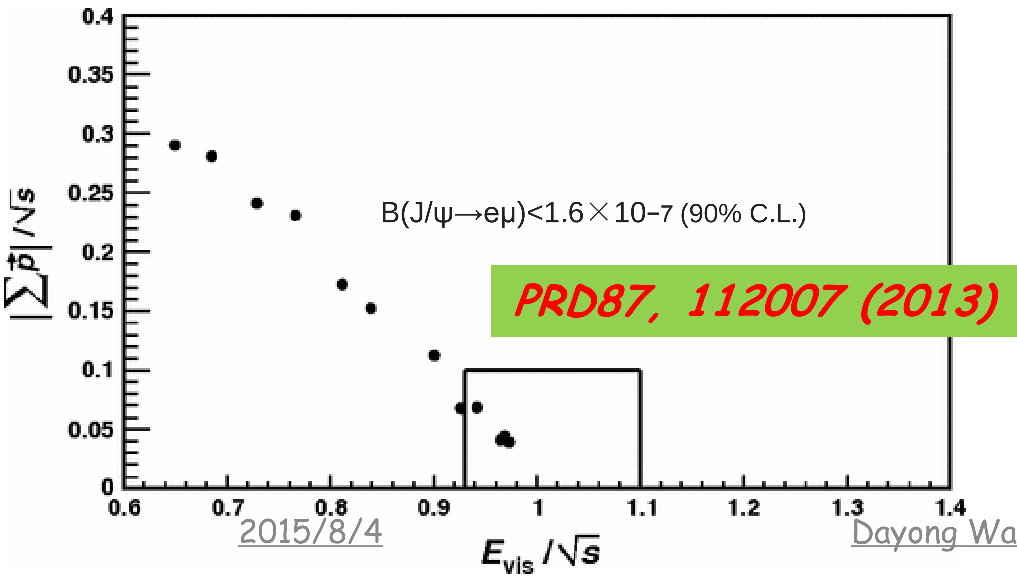
Symmetry breaking, Invisible decays, FCNC …

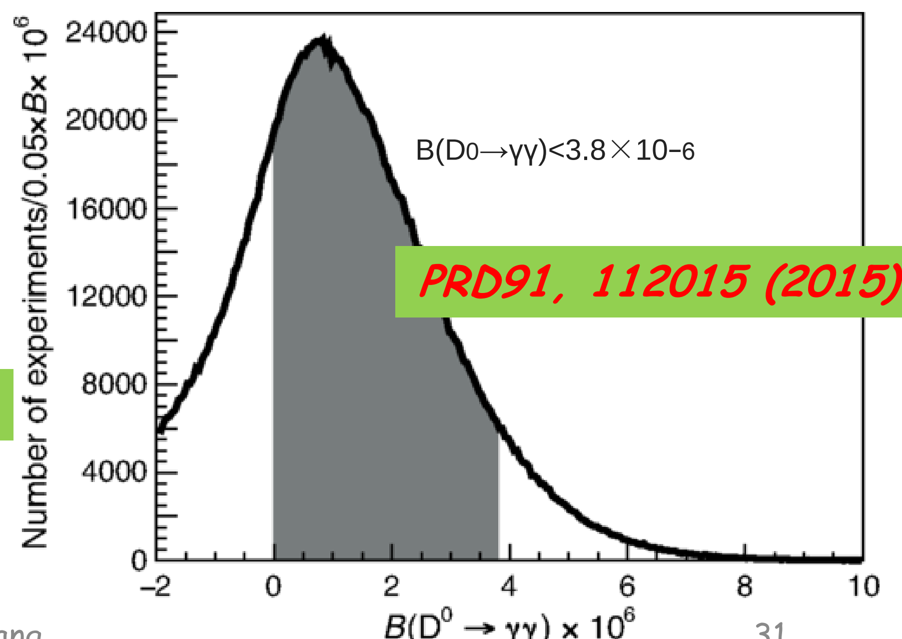


$B(\eta\to\text{invisible}) < 1.0\times 10^{-4}$
$B(\eta'\to\text{invisible}) < 5.3\times 10^{-4}$

@90%C.L.

Theory:
PRD 72, 103508(2005)
$BR(\eta\to\chi\chi) \sim 7.4\times 10^{-5}$
$BR(\eta'\to\chi\chi) \sim 8.1\times 10^{-7}$





Summary

Rich and active hadron physics programs & opportunities at BESIII.

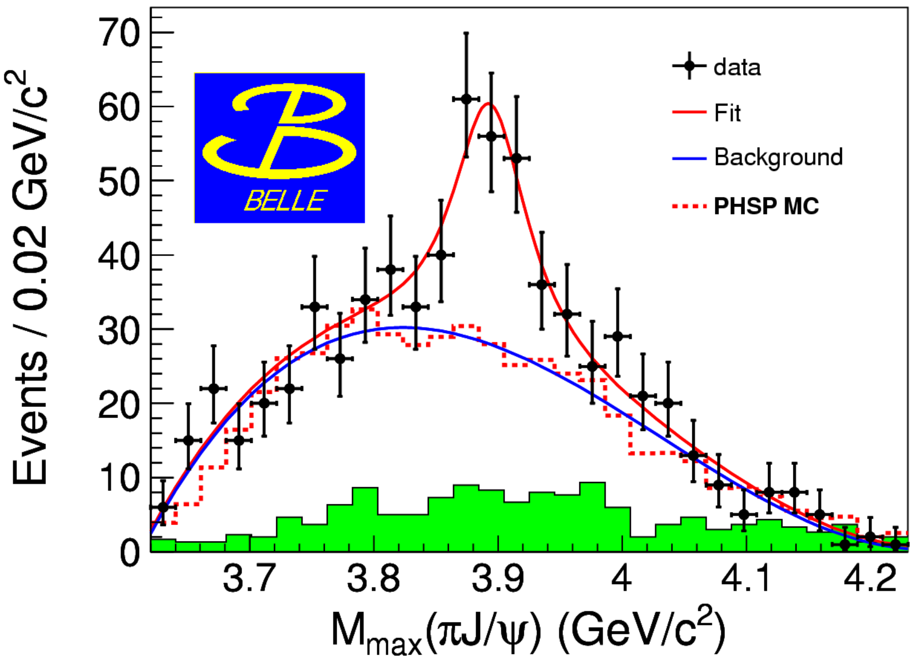
- Spectroscopy results provide insights into both normal and exotic hadron states
- Several Dalitz type decays are first observed, provide more info about meson structure
- With large statistics&high quality data, BESIII has good potential to do NP search.

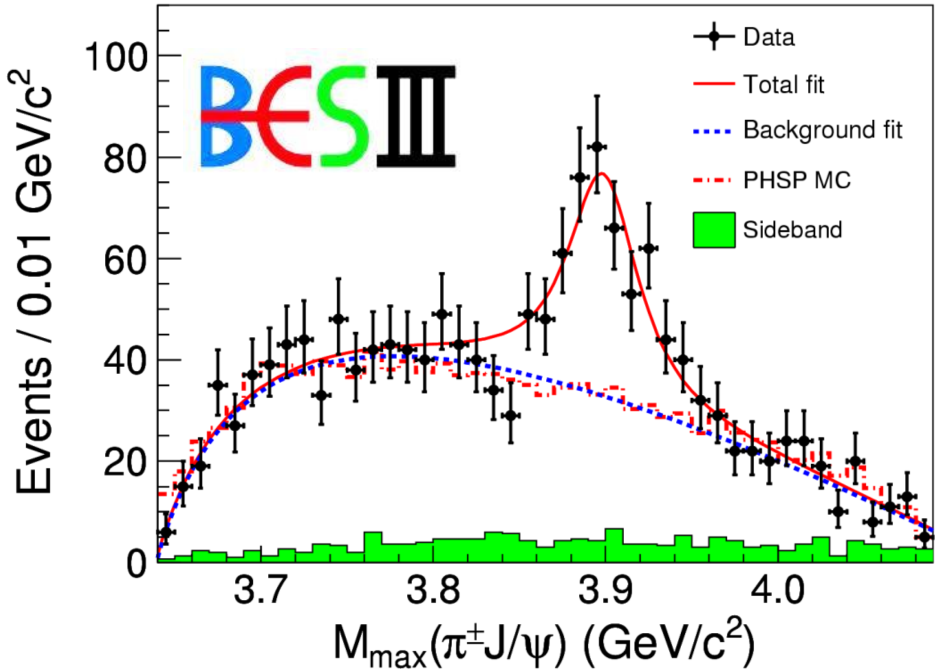
Thank you!

$Z_c(3900)$ Observed at BESIII

Belle with ISR: PRL110, 252002
967 fb^{-1} in 10 years running time

BESIII @4.260 GeV: PRL110, 252001
0.525 fb^{-1} in one month running time

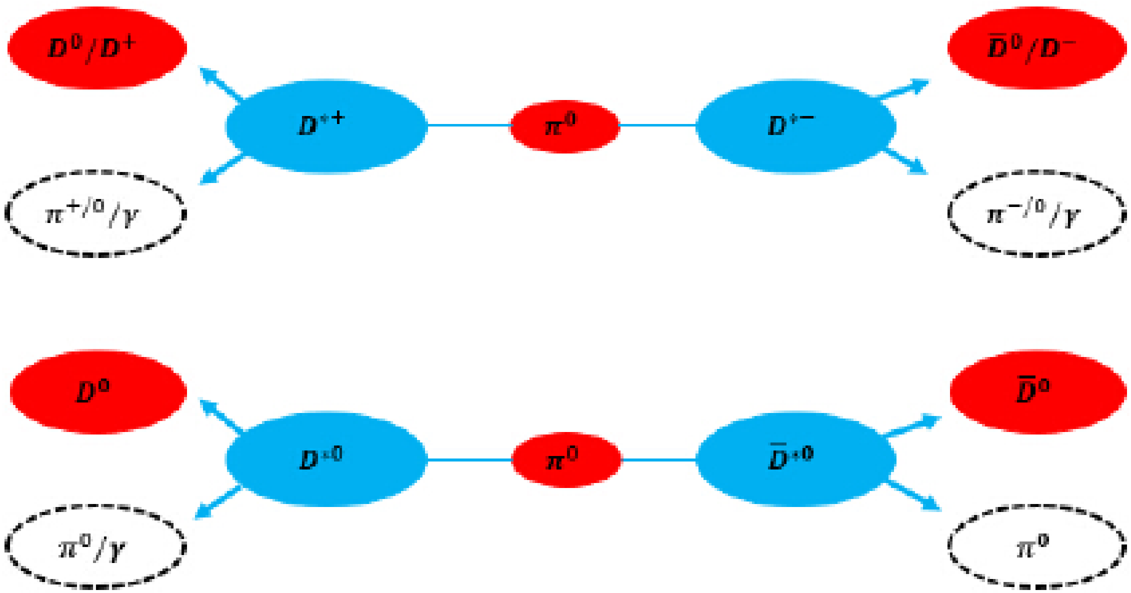




- $M = 3894.5 \pm 6.6 \pm 4.5$ MeV
- $\Gamma = 63 \pm 24 \pm 26$ MeV
- 159 ± 49 events
- $>5.2\sigma$

- $M = 3899.0 \pm 3.6 \pm 4.9$ MeV
- $\Gamma = 46 \pm 10 \pm 20$ MeV
- 307 ± 48 events
- $>8\sigma$

$Z_c(4025)^0$ in $e^+e^- \to (D^*\bar{D}^*)^0\pi^0$ — Analysis strategy

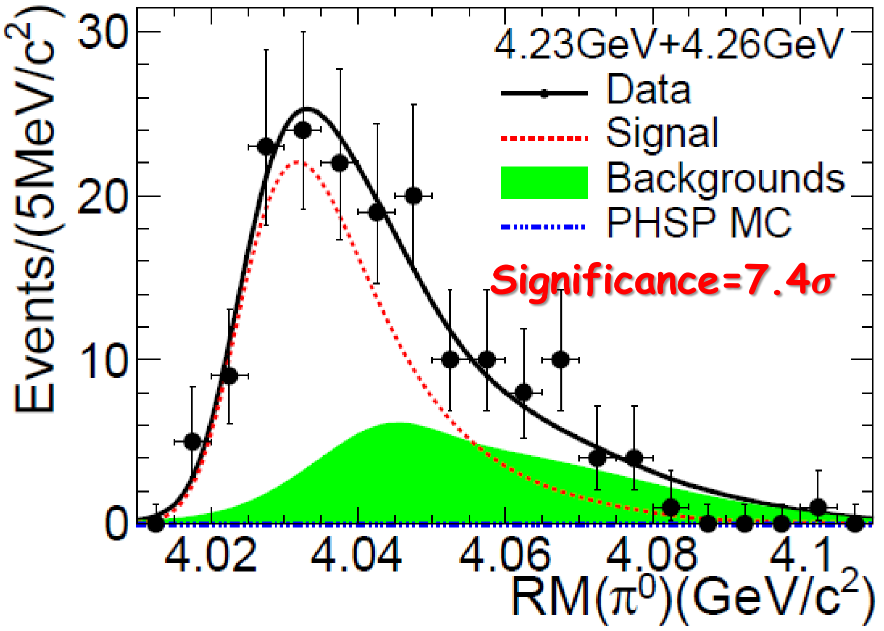


Particle will be detected

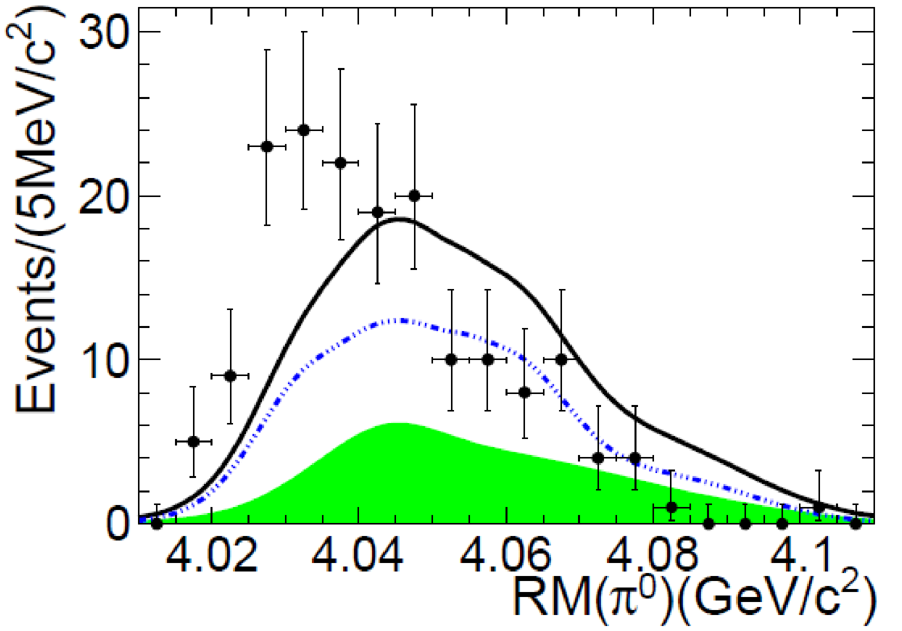
Particle will not be detected

- **Tag D and $\bar{D}$** →
  - $D^0 \to K^- \pi^+$ + c.c.
  - $D^0 \to K^- \pi^+ \pi^0$ +c.c.
  - $D^0 \to K^- \pi^+ \pi^+ \pi^-$ +c.c.
  - $D^+ \to K^- \pi^+ \pi^+$ +c.c.
- **Select π^0** →
  - γ veto
- **$M(D\pi^0)$** →
  - Reject background for π^0 from $D^* \to D\pi^0$
  - Require $M(D\pi^0)$>2.02GeV
- **$RM(D\pi^0)$ vs $RM(\bar{D}\pi^0)$** →
  - Select the $D^*D^*\pi^0$ process
- **$RM(\pi^0)$**
  - Study the recoil mass of π^0, corresponds to $M(D^*D^*)$

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



Signal+PHSP+Backgrounds



PHSP+Backgrounds

Data sample	Mass(MeV/c^2)	Width(MeV/c^2)	$\sigma(e^+e^- \to Z_c(4025)^0\pi^0 \to D^*\bar{D}^*\pi^0)$(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			$43.4 \pm 8.0 \pm 5.4$

Arxiv:1507.02404