

Observation of the $X(1840)$ at BESIII

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BESIII Detector

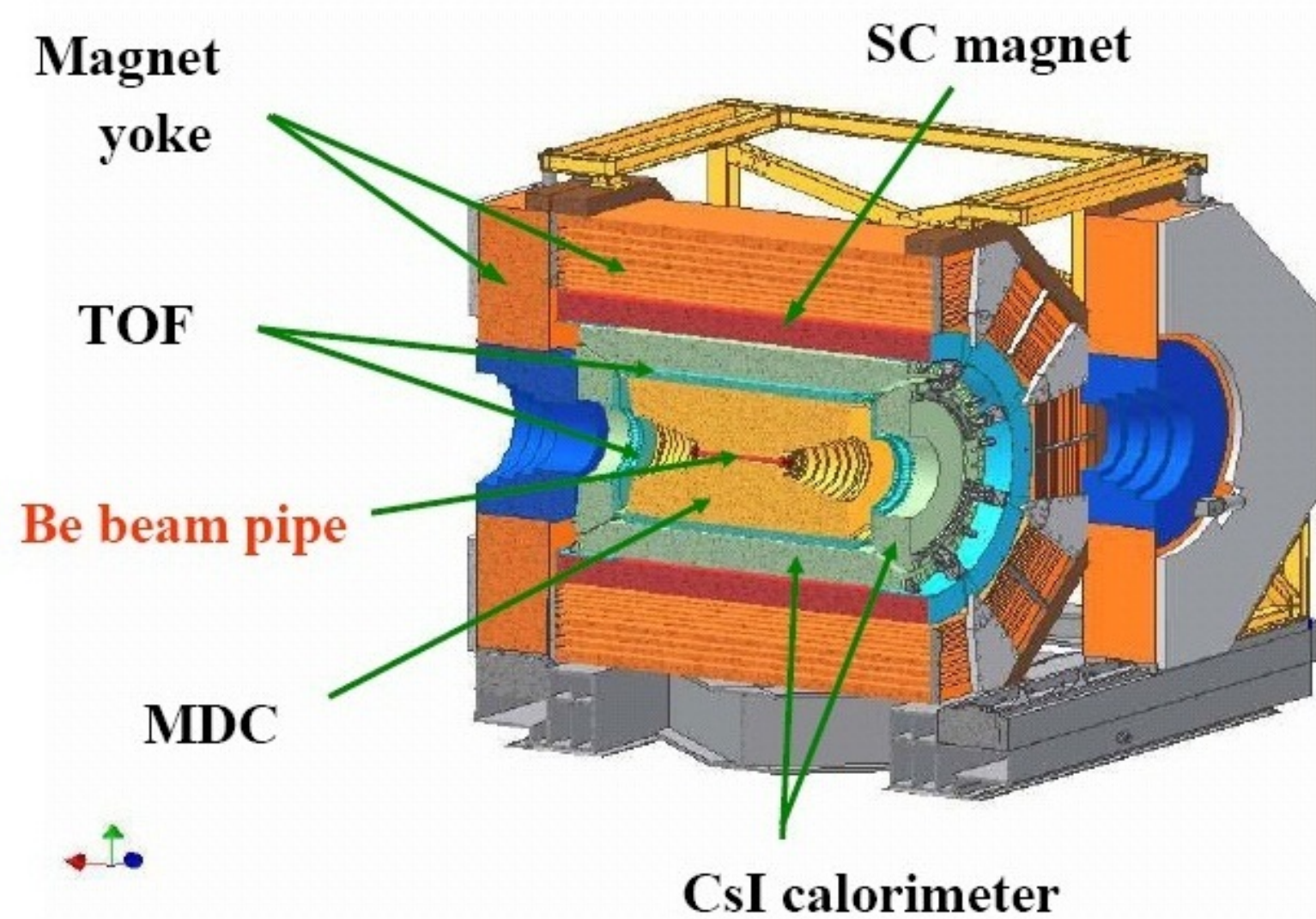


Figure 1: BESIII Detector

J/ψ and ψ' at BESIII

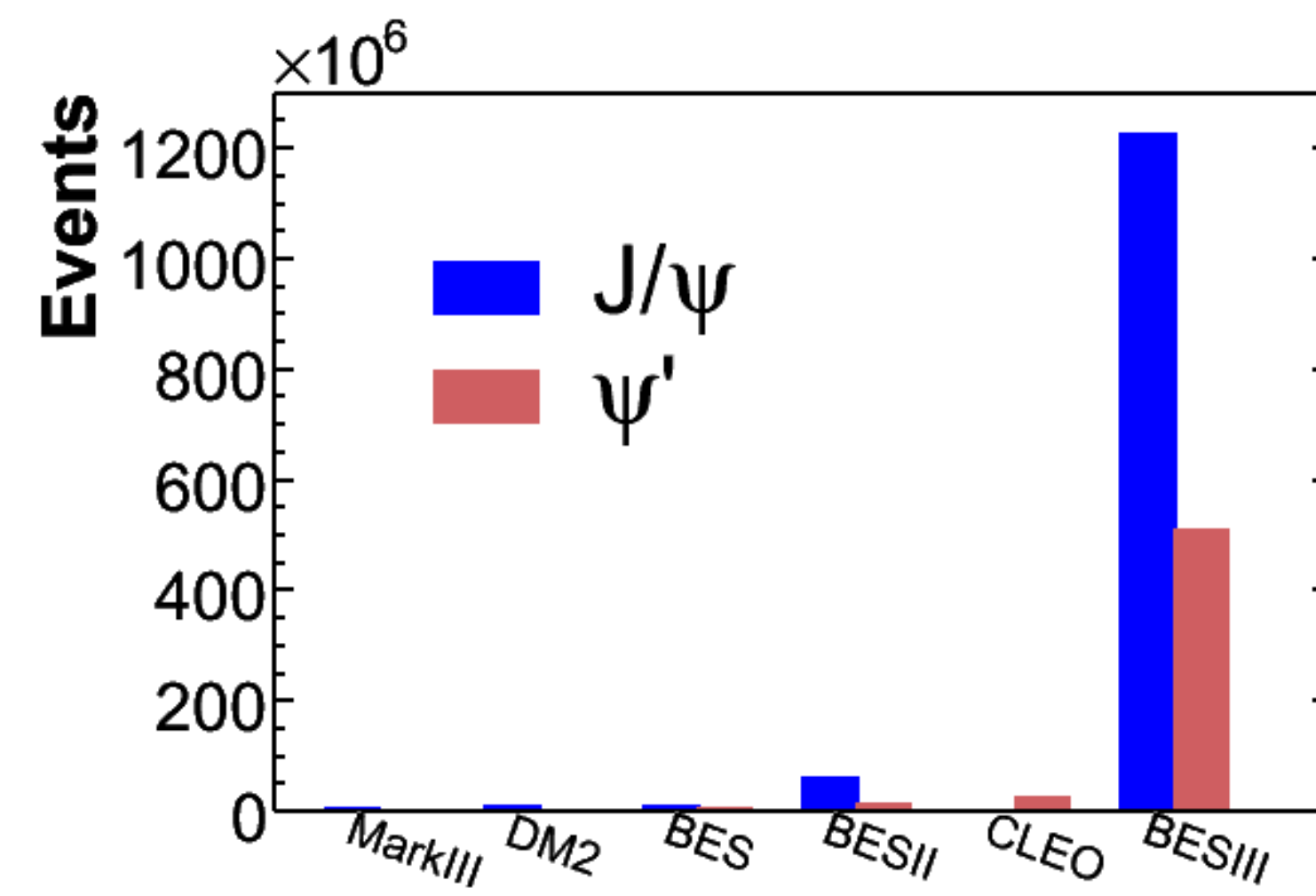


Figure 2: J/ψ and ψ' data sample

Introduction

- J/ψ decays: a good place for searching for the 'unconventional' hadrons (e.g., glueballs, exotic states)
- Interesting results from BESII, CLEO-c and BESIII (e.g., the $X(1835)$, $X(p\bar{p})$)
- To understand their nature, more experimental results are needed

Analysis of $J/\psi \rightarrow \gamma 3(\pi^+\pi^-)$

- $J/\psi \rightarrow \gamma 3(\pi^+\pi^-)$ is studied based on 225.3 million J/ψ events
- A structure (referred to as the $X(1840)$) is observed in $3(\pi^+\pi^-)$ mass spectrum
- No evident η' signal is observed

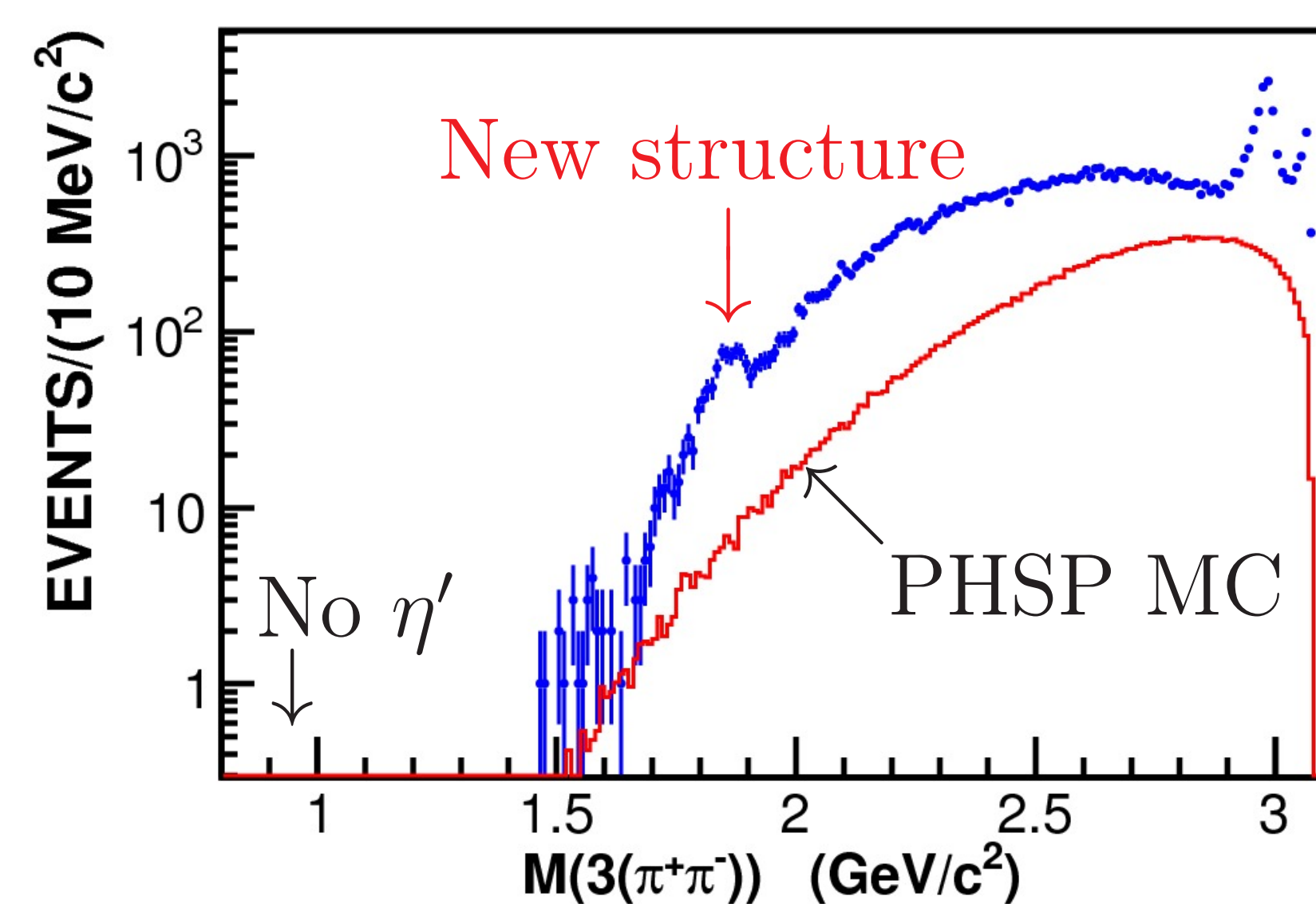


Figure 3: Distribution of the mass of $3(\pi^+\pi^-)$

Upper limit of $\eta' \rightarrow 3(\pi^+\pi^-)$

- No η' signal event
- Expected background event is 0
- $N_{up} = 2.44$ @ 90% C.L. (the Feldman-Cousins frequentist approach)
- Considering the systematic uncertainties,
 $\mathcal{B}(\eta' \rightarrow 3(\pi^+\pi^-)) < 3.1 \times 10^{-5}$ @ 90% C.L.

Observation of the $X(1840)$

- Signal shape: a Breit-Wigner with the effects of the phase space factor, the detection efficiency and the mass resolution
- Statistical significance: 7.6σ
- $M = 1842.2 \pm 4.2^{+7.1}_{-2.6}$ MeV/ c^2
- $\Gamma = 83 \pm 14 \pm 11$ MeV
- $\mathcal{B}(J/\psi \rightarrow \gamma X(1840)) \times \mathcal{B}(X(1840) \rightarrow 3(\pi^+\pi^-)) = (2.44 \pm 0.36^{+0.60}_{-0.74}) \times 10^{-5}$

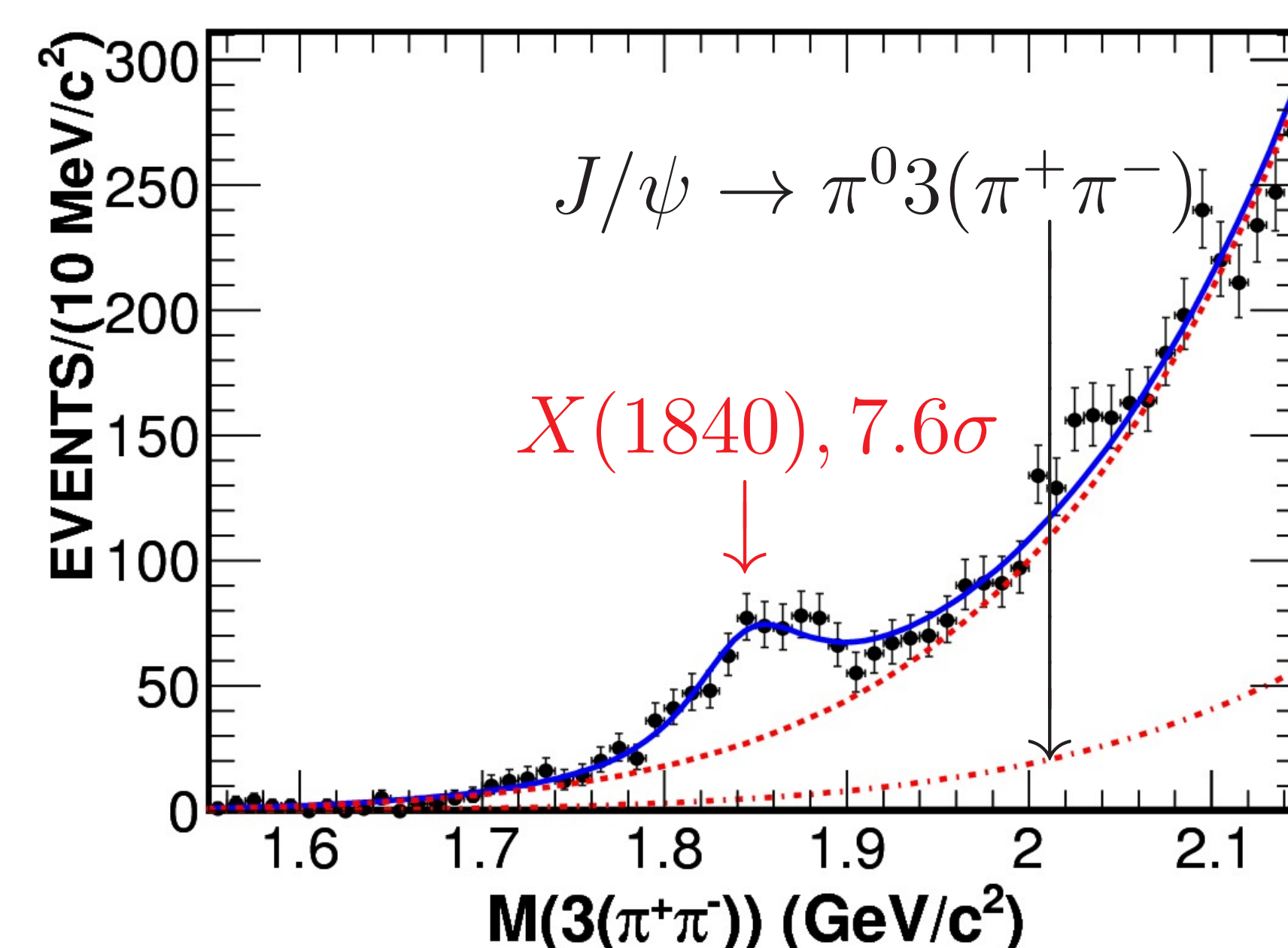


Figure 4: The fit of mass spectrum of $3(\pi^+\pi^-)$

Comparison of Observations

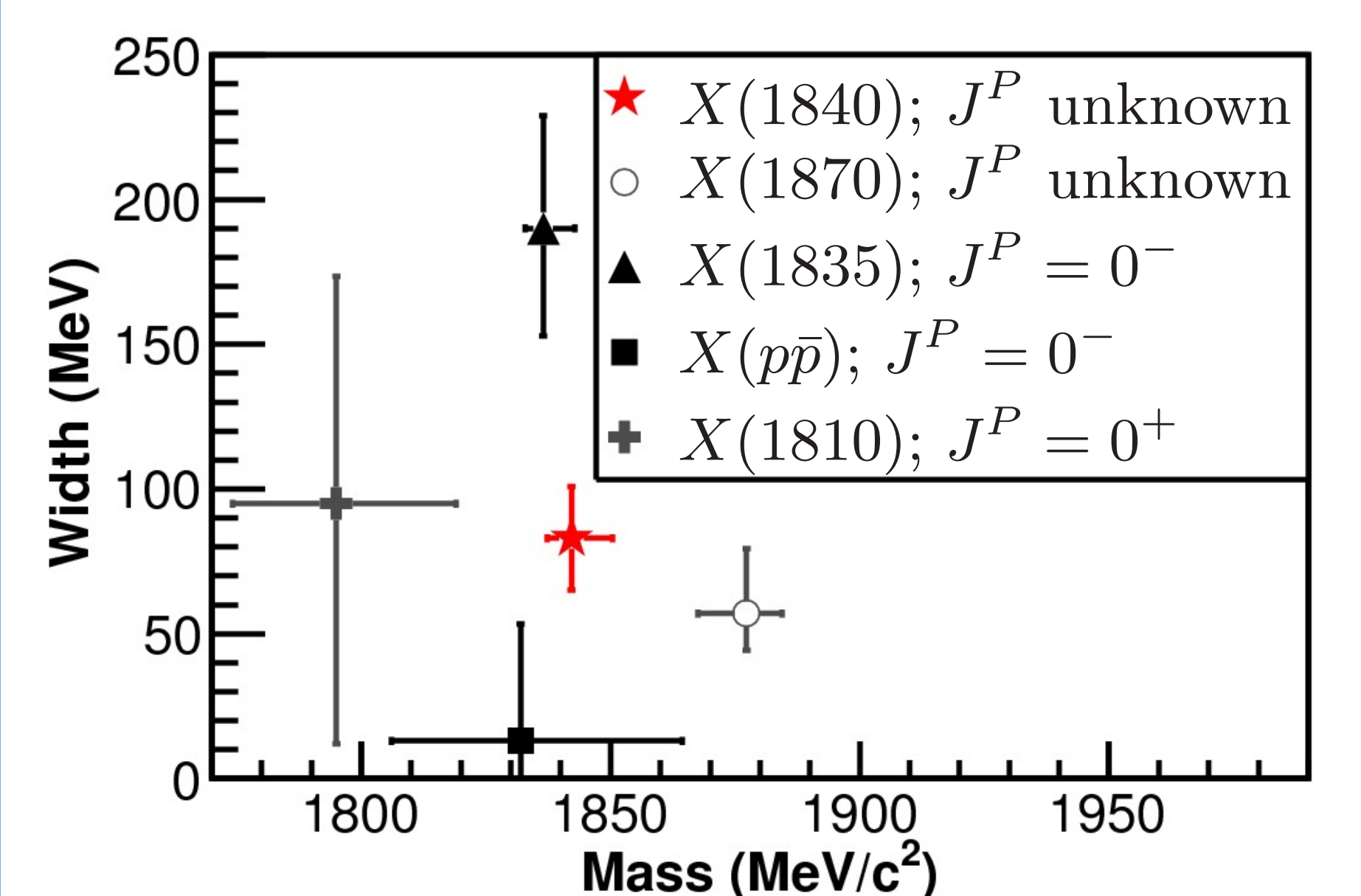


Figure 5: Comparison of observations at BESIII

Summary

- No η' signal is observed, $\mathcal{B}(\eta' \rightarrow 3(\pi^+\pi^-)) < 3.1 \times 10^{-5}$ @ 90% C.L.
- A structure, the $X(1840)$, is observed with a statistical significance of 7.6σ
- The nature of the $X(1840)$:
Same as the $X(1835)/X(p\bar{p})/\dots$? New resonance?
Conventional hadron? $p\bar{p}$ threshold structure? ...
- Further study is needed (e.g., determination of the J^P)

References

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