The 14th International workshop on Heavy Quarkonium

$\psi^{(\prime)}$ decays involving baryon final states

Liang Yan

(On behalf of BESIII Collaboration)

Fudan University

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Outline

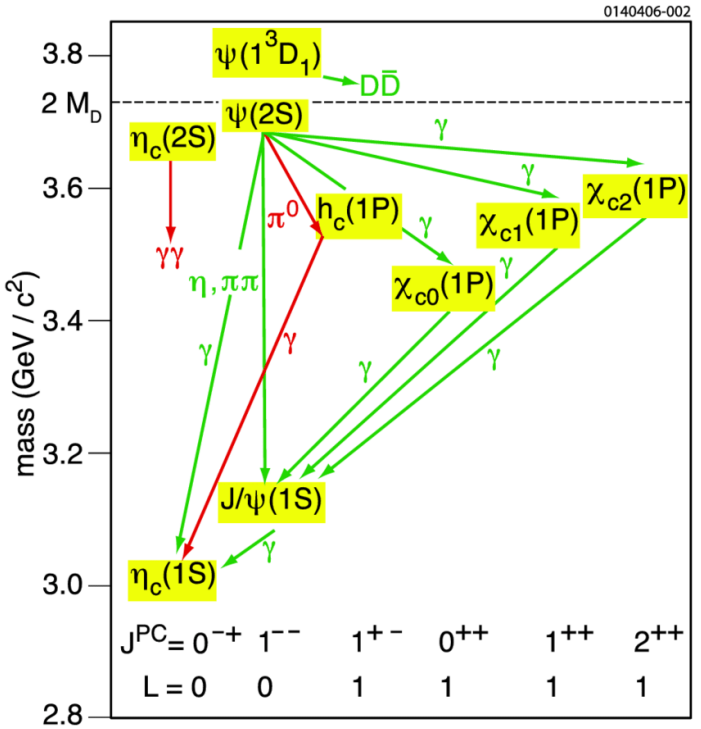
- Introductions to $\psi^{(\prime)}$ and baryons
- Recent results at BESIII
  - ❖Decay into $B\bar{B}$ pairs
  - ❖Decay into B_8B_{10}
  - ❖Decay into Baryons plus mesons
- Summary

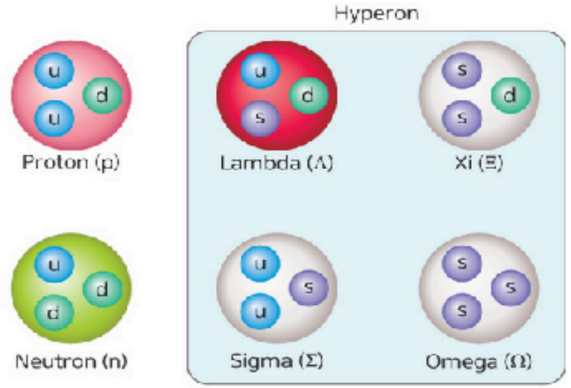
BESIII Experiment

$\psi(2S)$: World largest datasets collected in 2009 and 2012, 448.1M events, directly generated in e^+ e^- collision.

χ_{cJ}: produced via radiative decay from $\psi(2S)$, the BR is ~ 10%, very low background level.

Baryon: A laboratory for strong interaction and inner structures.



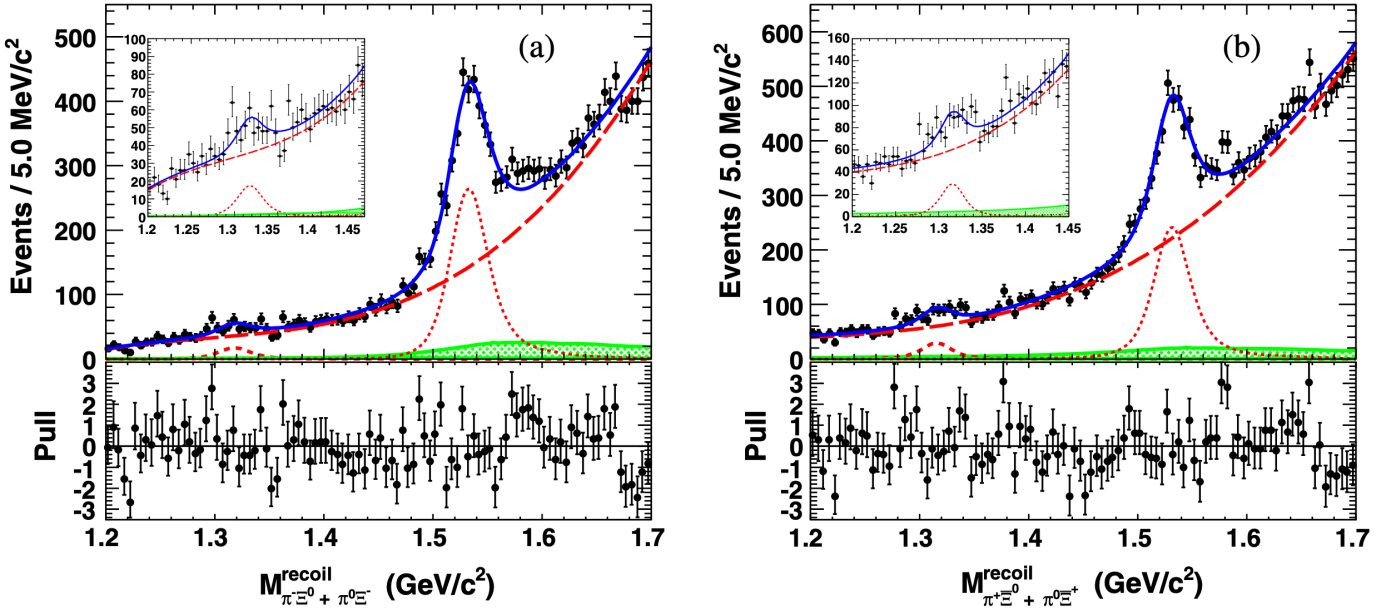


$\psi(2S)\to\Xi(1530)^{-}\bar{\Xi}(1530)^{+}$ and $\Xi(1530)^{-}\bar{\Xi}^{+}$

Phys. Rev. D 100, 051101 (2019)

- Searching for the decays into octet-decuplet baryonic pairs.
- Measure the angular distribution parameter to test theorectical models.

- ✓ The observation of $\psi(2S)\to\Xi(1530)^{-}\bar{\Xi}^{+}$ indicate the SU(3) flavor symmetry is still broken in the $\psi(2S)$ case, which further validates the generality of SU(3) flavor symmetry breaking.
- ✓ The measured angular distrbution parameter α agrees with theoretical predictions, which are 0.18 and 0.31.

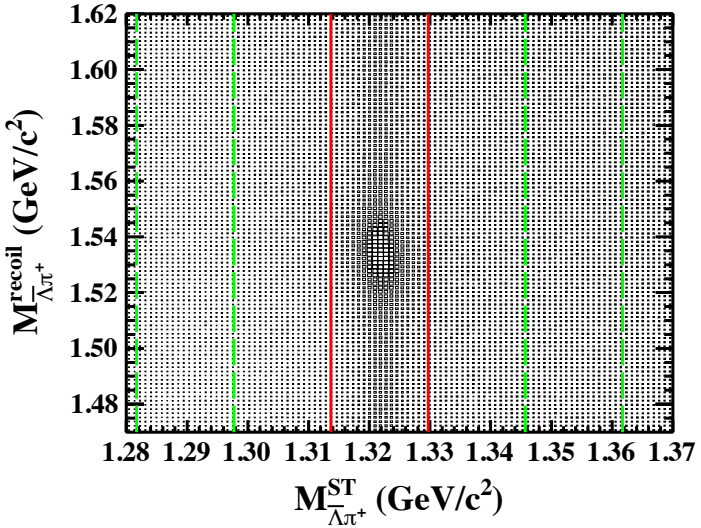


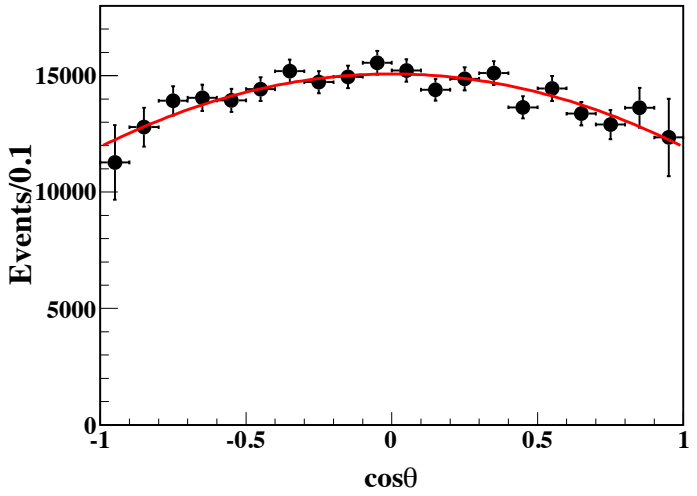
	$\psi(3686)\to\Xi(1530)^{-}\bar{\Xi}(1530)^{+}$		$\psi(3686)\to\Xi(1530)^{-}\bar{\Xi}^{+}$	
Tag mode	$\Xi(1530)^{-}$	$\bar{\Xi}(1530)^{+}$	$\Xi(1530)^{-}$	$\bar{\Xi}(1530)^{+}$
$N_{\rm obs}$	2664 ± 114	2403 ± 132	152 ± 37	247 ± 48
ϵ_1 (%)	7.85 ± 0.09	7.16 ± 0.08	8.89 ± 0.09	8.42 ± 0.09
ϵ_2 (%)	8.91 ± 0.09	8.17 ± 0.09	10.58 ± 0.10	9.82 ± 0.10
$S(\sigma)$	23.0	18.2	4.4	5.3
α	$0.43\pm0.30\pm0.09$	$0.36\pm0.35\pm0.08$	...	...
$\mathcal{B}(10^{-5})$	$11.51\pm0.49\pm0.92$	$11.36\pm0.62\pm1.14$	$0.57\pm0.14\pm0.05$	$0.93\pm0.18\pm0.10$
$\alpha^{\rm com}$	$0.40\pm0.24\pm0.06$		...	
$\mathcal{B}^{\rm com}(10^{-5})$	$11.45\pm0.40\pm0.59$		$0.70\pm0.11\pm0.04$	

$J/\psi \to \Xi(1530)^- \bar{\Xi}^+$

Phys. Rev. D 101, 012004 (2020)

- The SU(3) flavor symmetry breaking decay (B_8B_{10})
  - The branching ratio is anomalously large comparing to SU(3)-allowed decays.
  - Angular distribution has the potential to bring more insight into the SU(3)-flavor violation mechanism.





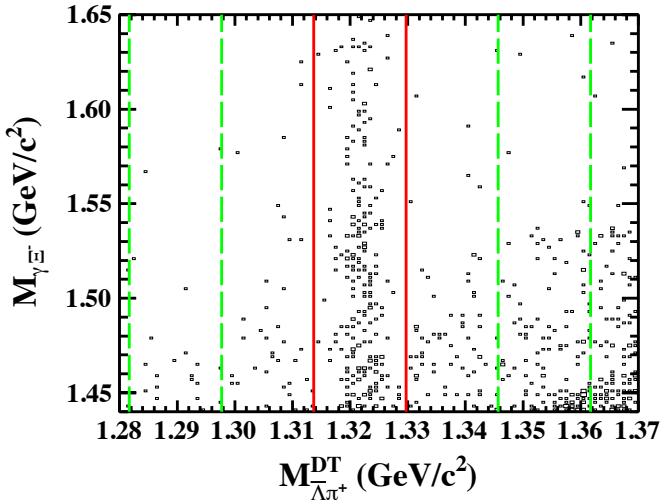
Br($J/\psi \to \Xi(1530)^- \bar{\Xi}^+$ +c.c.) = (3.17 ± 0.02 ± 0.08) X 10^{-4} (an order of magnitude improved precision)

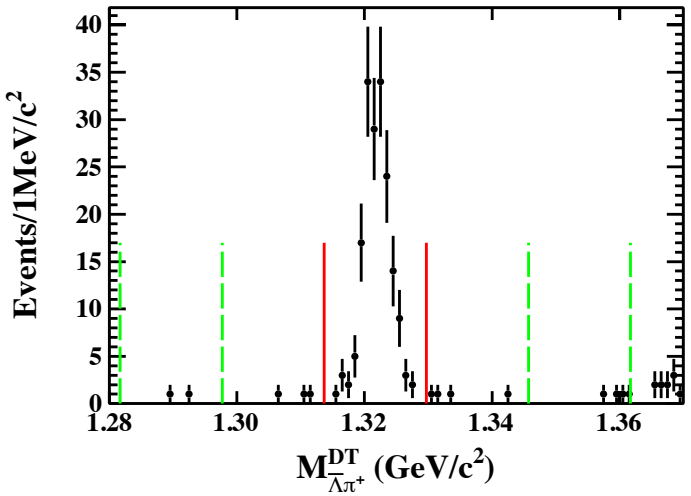
α = -0.21 ± 0.04 ± 0.06 (measured for the first time)

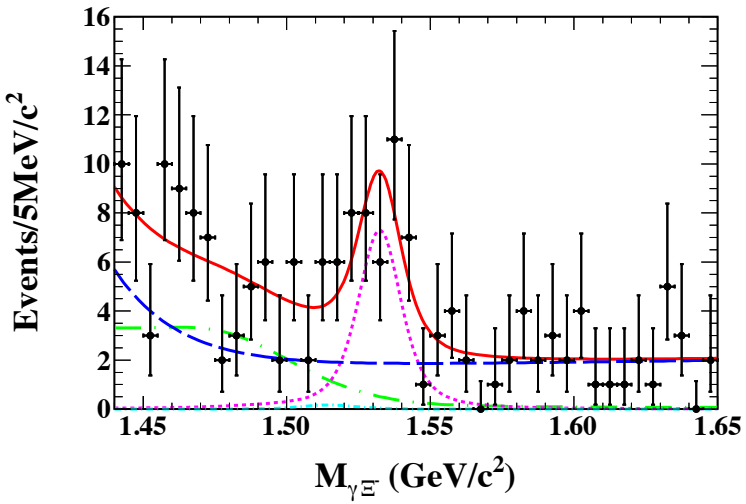
$J/\psi \to \Xi(1530)^{-}\bar{\Xi}^{+}$

Phys. Rev. D 101, 012004 (2020)

- The electromagnetic transition $\Xi(1530)^{-} \to \gamma \Xi^{-}$ is studied
  - Decuplet to Octet hyperons, a sensitive probe of their structures.
  - Only upper limit for the branching ratio < 4% at 90% CL. in 1973 in experiment.





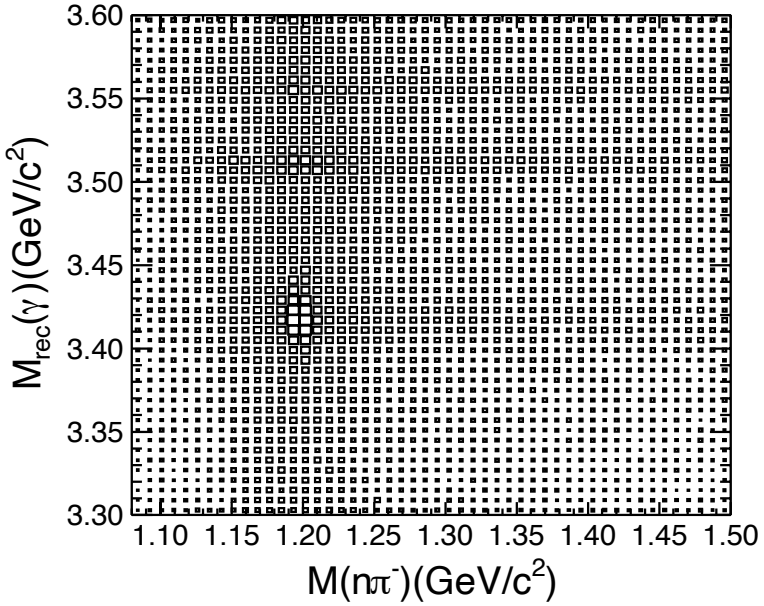


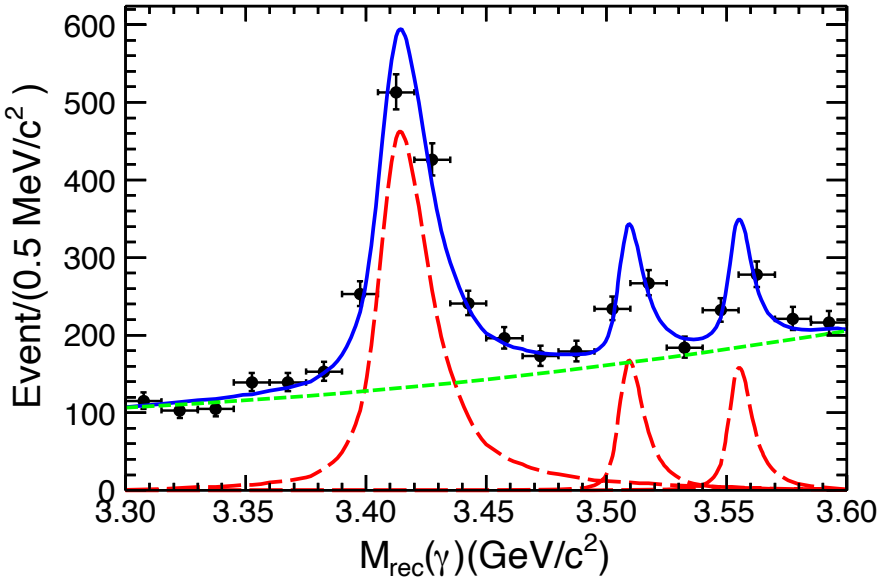
First evidence for $\Xi(1530)^{-} \to \gamma \Xi^{-}$ with significance of 3.9σ;
Upper limit at 90% C.L. is measured to be 3.7%.

$\chi_{cJ} \to \Sigma^- \bar{\Sigma}^+$

Phys. Rev. D 101, 092002 (2020)

- χ_{cJ} studies are important for testing models based on non-pQCD.
- There are some inconsistences between experiment and theory calculation especially in baryon pairs productions.





Channel	This work	Statistical significance	BESIII [13]	Theoretical predictions	
	$\chi_{cJ} \to \Sigma^-\bar{\Sigma}^+$		$\chi_{cJ} \to \Sigma^+\bar{\Sigma}^-$	COM	QCM [11]
$\chi_{c0} \to \Sigma^-\bar{\Sigma}^+$	$51.3 \pm 2.4 \pm 4.1$	$30\,\sigma$	$50.4 \pm 2.\ 5 \pm 2.7$	5.9-6.9 [5]	18.1 ± 3.9
$\chi_{c1} \to \Sigma^-\bar{\Sigma}^+$	$5.7 \pm 1.4 \pm 0.6$	$5.8\,\sigma$	$3.7 \pm 0.6 \pm 0\ .2$	3.3 [4]	...
$\chi_{c2} \to \Sigma^-\bar{\Sigma}^+$	$4.4 \pm 1.7 \pm 0.5$	$3.6\,\sigma$	$3.5 \pm 0.7 \pm 0\ .3$	5.0 [4]	4.3 ± 0.4

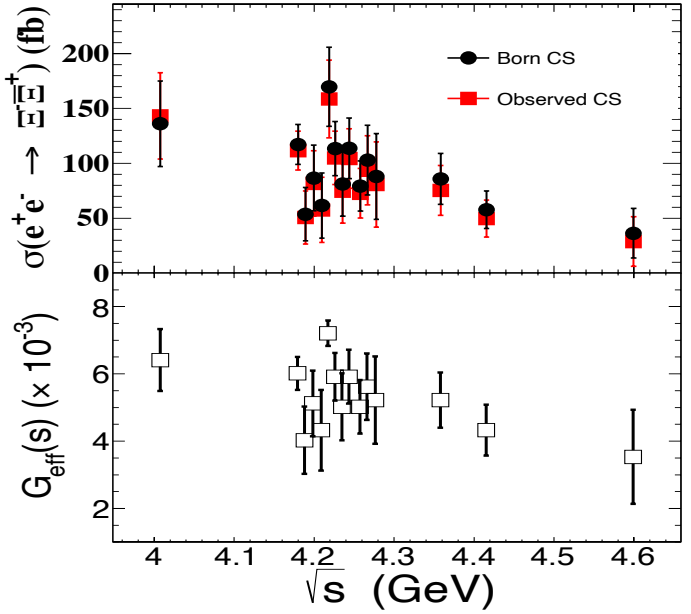
e+ e- -> $\Xi^-\ \bar{\Xi}^+$

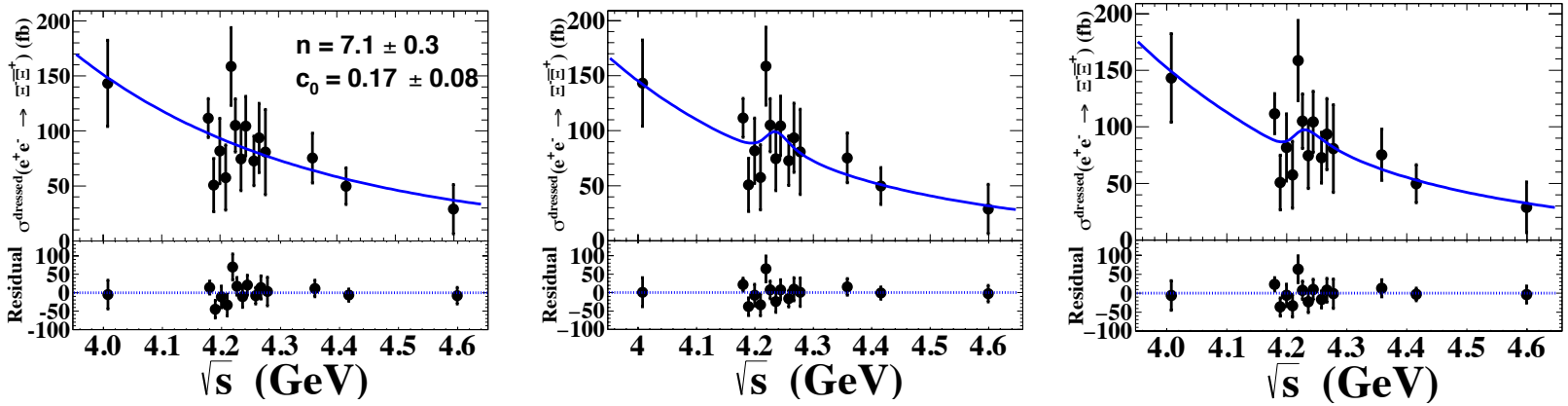
Phys. Rev. Lett 124, 032002 (2020)

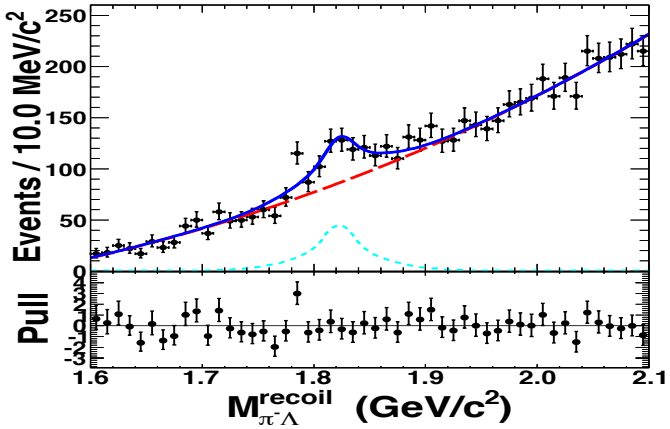
The cross section and EMFFs for $B\bar{B}$ pairs are studied above open charm threshold with single tag method.

No significant of $\psi(4230)$ or $\psi(4260)$->$\Xi^-\bar{\Xi}^+$ process is observed.

An excited Ξ baryon is observed with M = (1825.5 ± 4.7 ± 4.7) MeV/c^2 and Γ = (17.0 ± 15.0 ± 7.9) MeV, which is consistent with $\Xi(1820)^-$ in 1σ uncertainty.



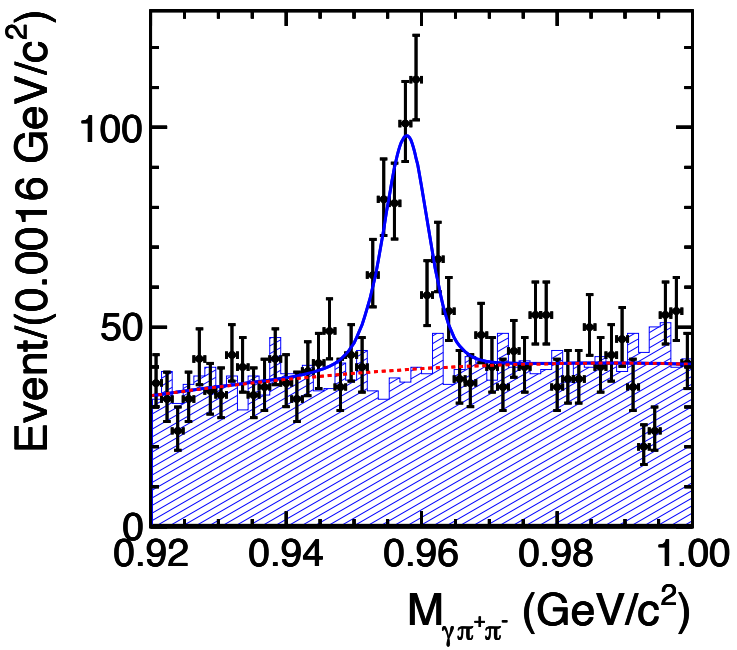


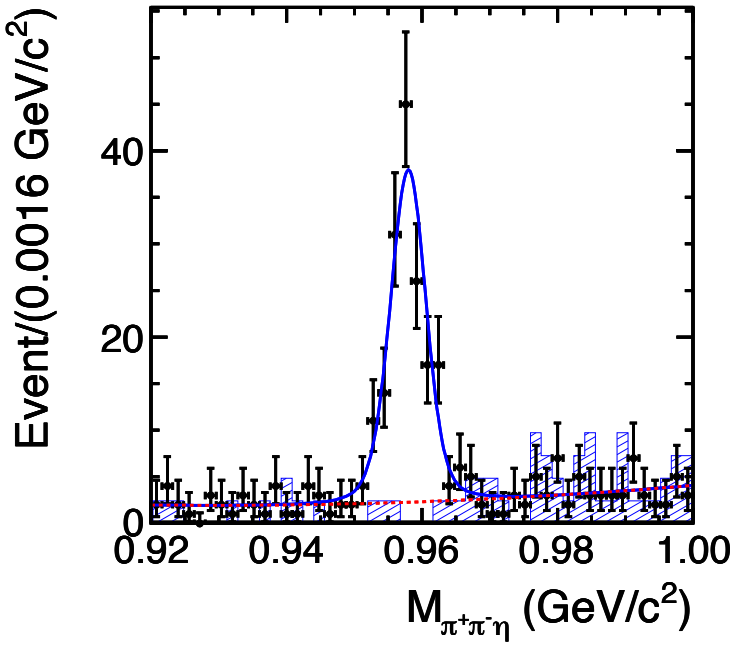


$\psi(2S)\to p\bar{p}\eta'$

Phys. Rev. D 99, 032006 (2019)

- Study the contribution of intermediate states based on nucleon and N* pole diagrams.
- η-η' mixing study



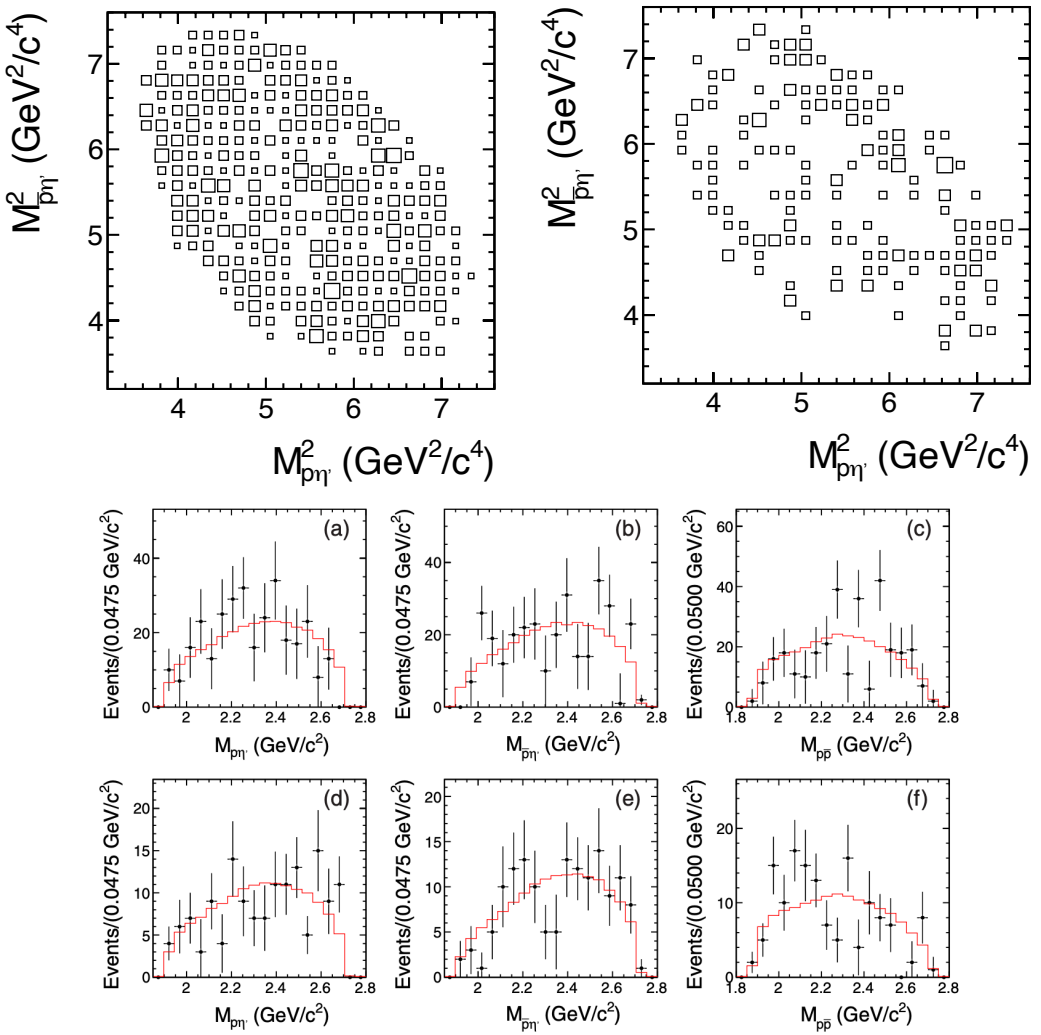


We use two decay modes to reconstruct η' signals.

ψ(2S)->p $\bar{p}$ η'

Phys. Rev. D 99, 032006 (2019)

- No obvious intermediate structures
- Observe for the first time, and braching fraction is measured to be **(1.10 ± 0.10 ± 0.08) X 10^{-5}**
- The ratio $\frac{\Gamma(\psi(3686) \to p\bar{p}\eta')}{\Gamma(\psi(3686) \to p\bar{p})} = (3.61 \pm 0.41)\%$
- The η-η' mixing angle is measured to be -24 ± 11°, which is consistent with QCD-inspired calculation and quark-line rule.



Summary

- Based on collected $\psi(2S)$ data, we observed new decay modes and tested QCD calculations in $\psi(2S)$ and χ_{CJ} regions.
- There are some hints of excited baryon states, but no conclusions because of statistics.
- We are taking more $\psi(2S)$ data now, and plan to collect 3 Billion $\psi(2S)$ events.
- More results are expected.

THANK YOU