第五届强子与重味物理理论与实验联合研讨会

BESIII 实验粲重子近期进展

秦佳佳(南华大学)

On behalf of the BESIII Collaboration

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Outline

- **Introduction**
- **BESIII experiment**
- **Λ_c^+ new results**
- **Summary**

✓ Exclusive hadronic decays

- $\Lambda_c^+ \to \Sigma^0 K_S^0 \pi^+ \; and \; \Lambda_c^+ \to \Sigma^0 K_S^0 K^+$ Submitted to JHEP
- $\Lambda_c^+ \to p\eta'$ Submitted to JHEP
- $\Lambda_c^+ \to$ 12 channels Submitted to JHEP
- $\Lambda_c^+ \to pK_S^0$、$\Lambda\pi^+$、$\Sigma^0\pi^+$、$\Sigma^+\pi^0$ Submitted to PRX
- $\Lambda_c^+ \to pK^+K^-$ Submitted to PRD

✓ Inclusive decays

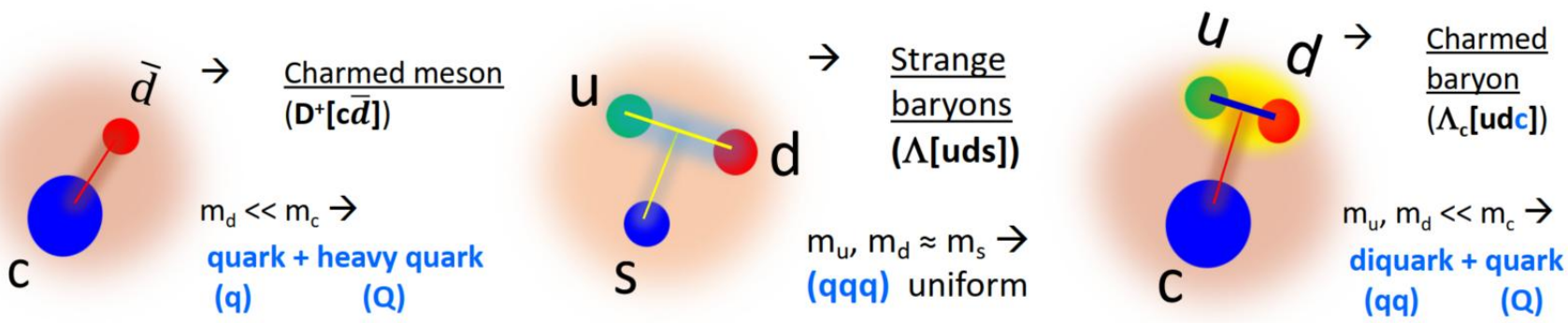
- $\Lambda_c^+ \to \Lambda X$ Submitted to PRL

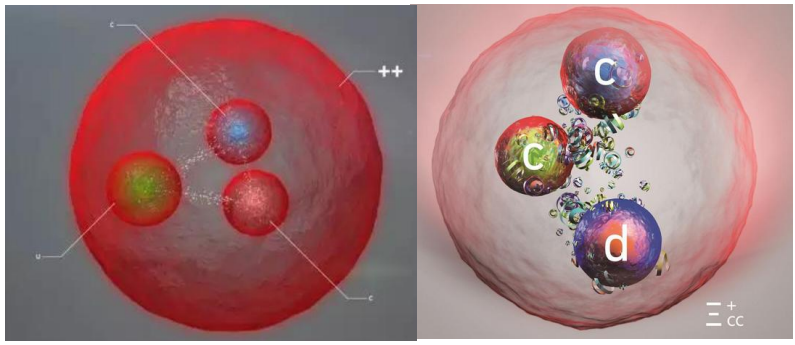
✓ Semi-leptonic decays

- $\Lambda_c^+ \to \Sigma^+\pi^-e^+\nu_e$ Submitted to PRD

Introduction

- Ground state charmed baryon Λ_c^+, observed >40 years, characteristics still not very clear.
- Provides important information to understand strong and weak interactions.
- Complementary to charmed mesons (W-exchange).
- Calculation is difficult, many phenomenology methods developed and most need experimental results as input.
- Excited-charmed, bottomed and doubly charmed baryons eventually decay to Λ_c^+.





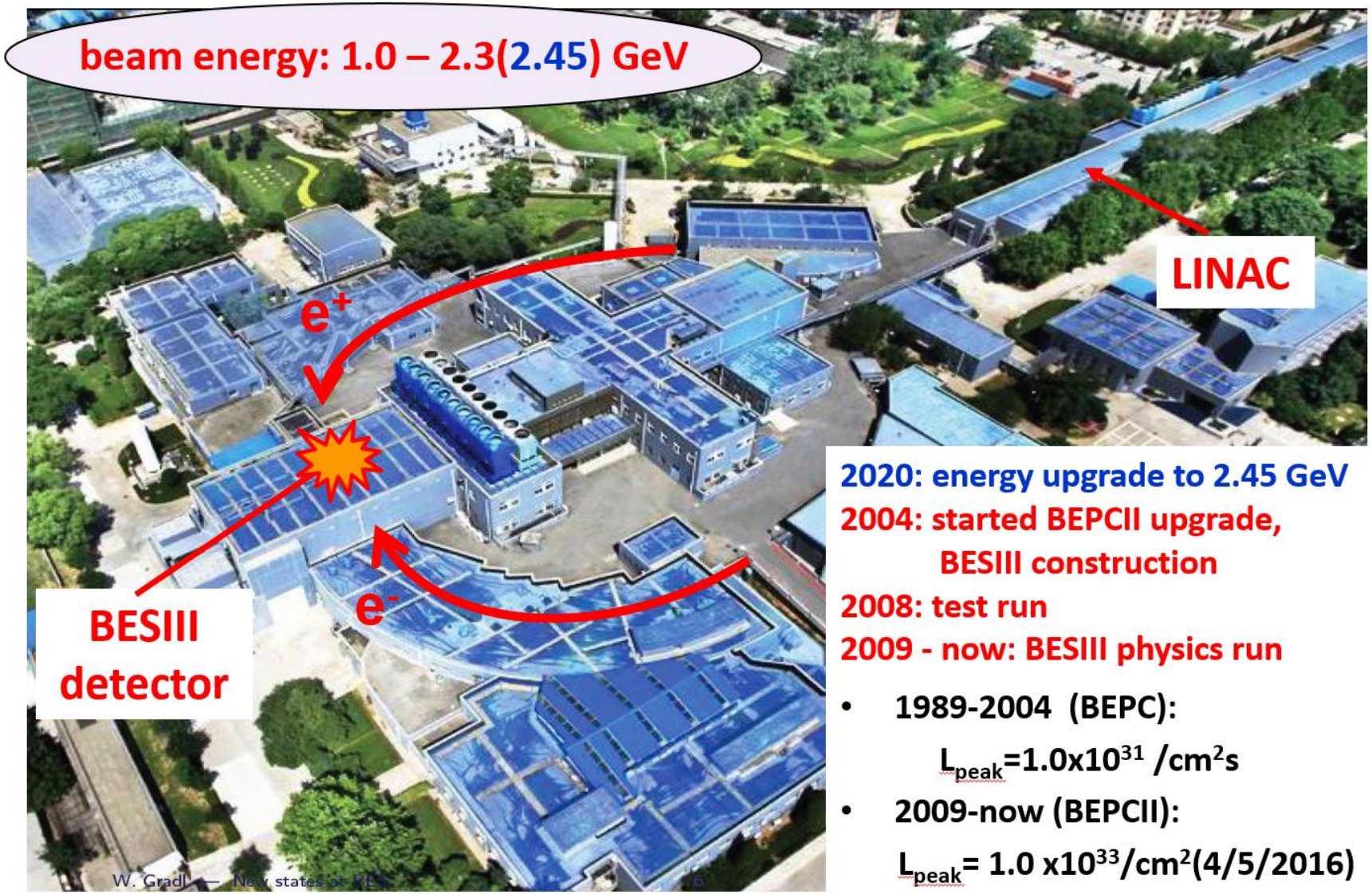
LHCb find $\Xi_{cc}^{++} \to \Lambda_c^+ K^- \pi^+ \pi^+$ 2017

LHCb find $\Xi_{cc}^{+} \to \Lambda_c^+ K^- \pi^+$ 2026

Experimental status

- Λ_c^+ today:
  - ~30% still unknown
  - Most are statistical uncertainty dominated
  - Partial wave analysis much less than charmed meson
  - …
- More data, more channels and more variables
  - BEPCII-U is collecting 4.68 GeV data now (9 fb^{-1} more)
  - Cabibbo-suppressed and multi-body decays
  - Branching fraction, decay asymmetry parameter, CP violation variables
  - …

BEPCII



2020: energy upgrade to 2.45 GeV

2004: started BEPCII upgrade,
BESIII construction

2008: test run

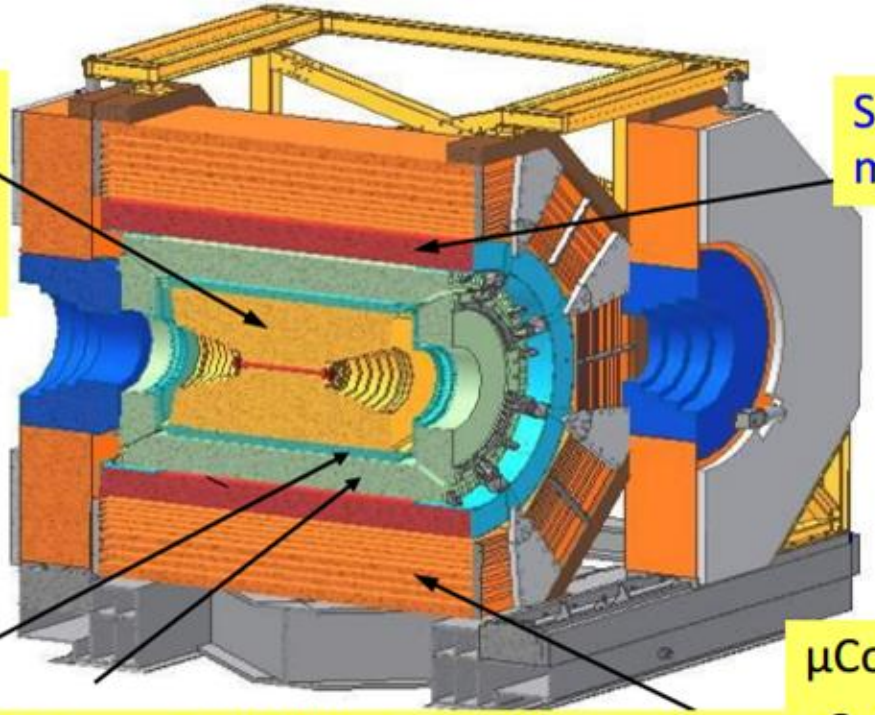
2009 - now: BESIII physics run

- 1989-2004 (BEPC):
  $L_{peak}=1.0\times10^{31}$ /cm^{2}s
- 2009-now (BEPCII):
  $L_{peak}= 1.0\times10^{33}$/cm^2(4/5/2016)

BESIII detector

NIM A614, 345 (2010)

The BESIII Detector



Drift Chamber (MDC)

$\sigma P/P\ (^0/_0) = 0.5\%(1GeV)$

$\sigma_{dE/dx}\ (^0/_0) = 6\%$

Super-conducting magnet (1.0 tesla)

Time Of Flight (TOF)

σ_T: 90 ps Barrel

110 ps endcap

EMC: $\sigma E/\sqrt{E}(^0/_0) = 2.5\ \%\ (1\ GeV)$

(CsI) $\sigma_{z,\phi}(cm) = 0.5 - 0.7\ cm/\sqrt{E}$

μCounter

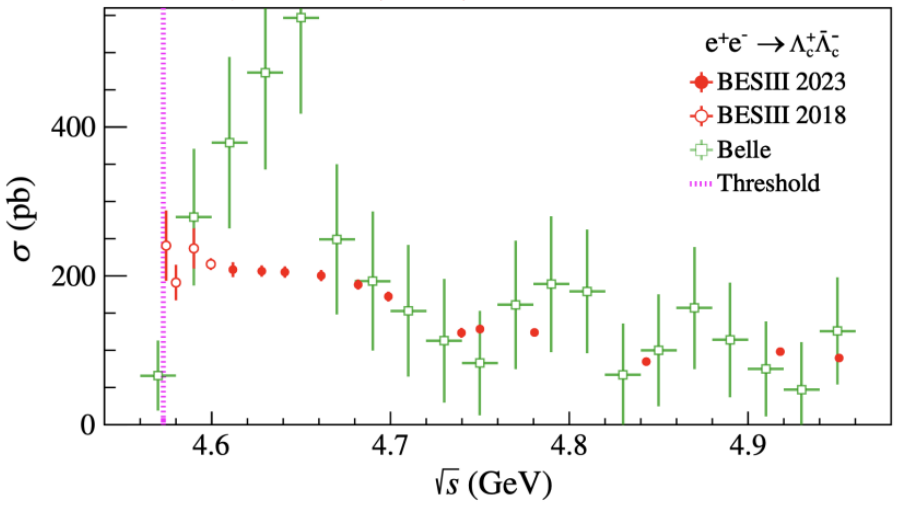
8- 9 layers RPC

$\delta R\Phi$=1.4 cm~1.7 cm

Data samples

- Totally about 50 fb^{-1} from 2.0-4.95 GeV
- Data for charmed baryon studies
  - ✓ 0.587 fb^{-1} @4.6 GeV in 2014
  - ✓ 3.9 fb^{-1} 4.61-4.70 GeV scan data in 2020-2021
  - ✓ 1.9 fb^{-1} 4.74-4.95 GeV scan data 2021-2022
  - ✓ Totally ~6.4 fb^{-1} data from 13 energy points, ~1million pairs

PRL **131**, 191901 (2023)

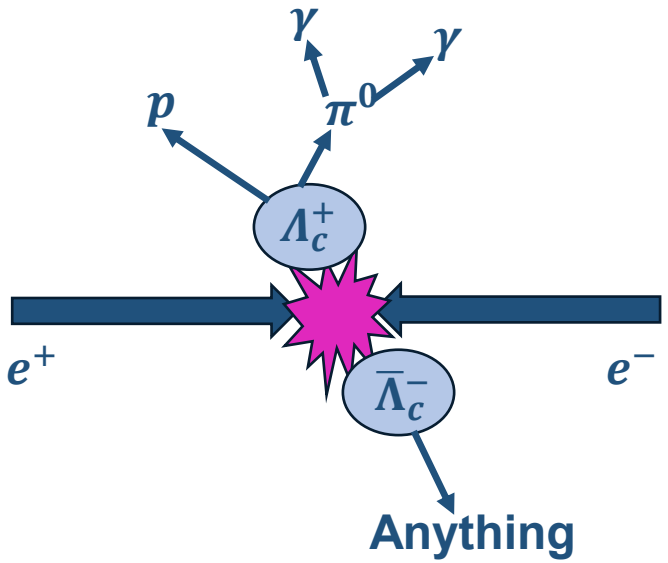


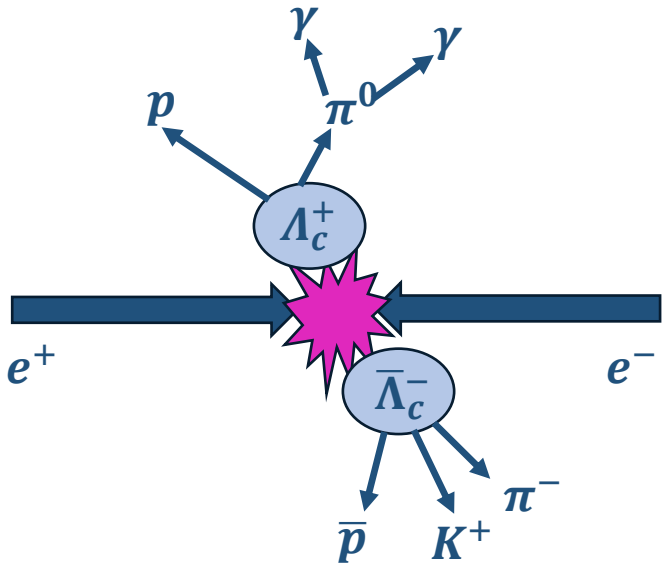
CPC **46**, 113003 (2022)

Sample	E_{cms}/MeV	$\mathscr{L}_{\mathrm{Bhabha}}/\mathrm{pb}^{-1}$
4610	4611.86±0.12±0.30	103.65±0.05±0.55
4620	4628.00±0.06±0.32	521.53±0.11±2.76
4640	4640.91±0.06±0.38	551.65±0.12±2.92
4660	4661.24±0.06±0.29	529.43±0.12±2.81
4680	4681.92±0.08±0.29	1667.39±0.21±8.84
4700	4698.82±0.10±0.36	535.54±0.12±2.84
4740	4739.70±0.20±0.30	163.87±0.07±0.87
4750	4750.05±0.12±0.29	366.55±0.10±1.94
4780	4780.54±0.12±0.30	511.47±0.12±2.71
4840	4843.07±0.20±0.31	525.16±0.12±2.78
4920	4918.02±0.34±0.34	207.82±0.08±1.10
4950	4950.93±0.36±0.38	159.28±0.07±0.84

Unique abilities in Λ_c^+ decays

- Single-Tag method (ST)
  - ✓ High efficiency vs High background
- Double-Tag method (DT)
  - ✓ Low background vs low efficiency
  - ✓ Absolute BFs
  - ✓ Missing particles
- Deep learning method
  - ✓ Powerful vs validation
  - ✓ Event level topology
  - ✓ Two missing particles
  - ✓ …

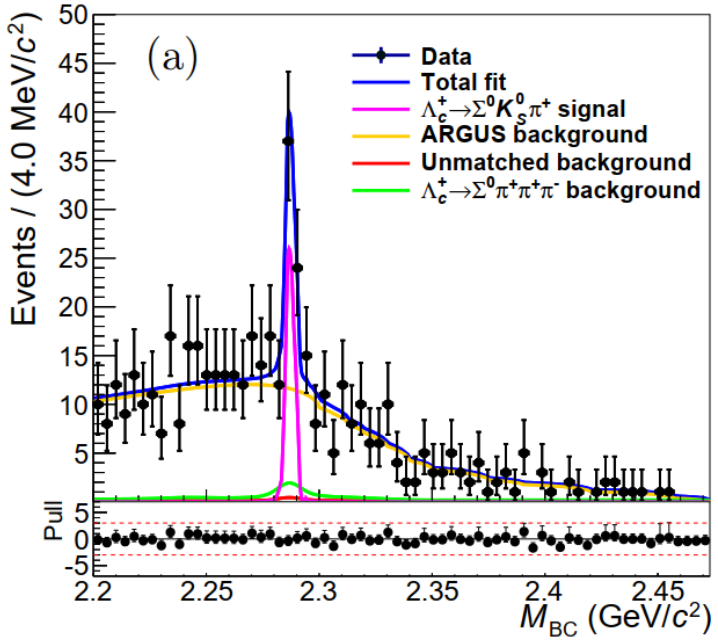


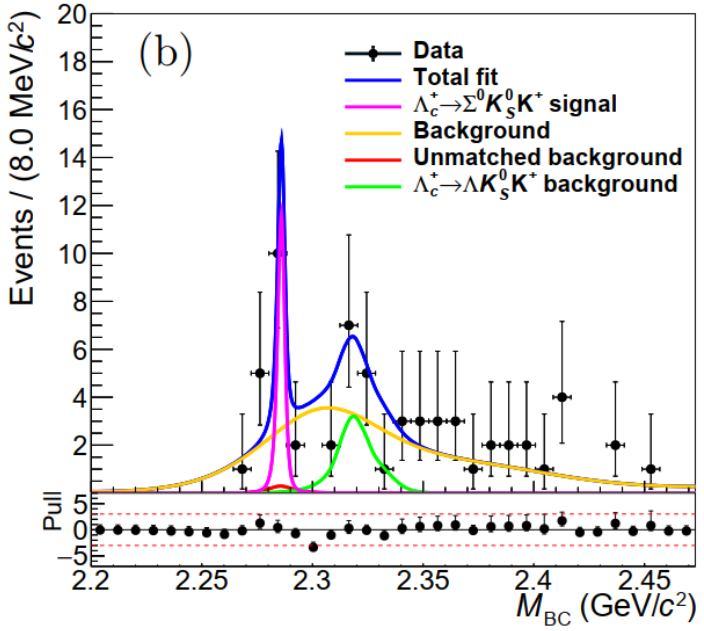


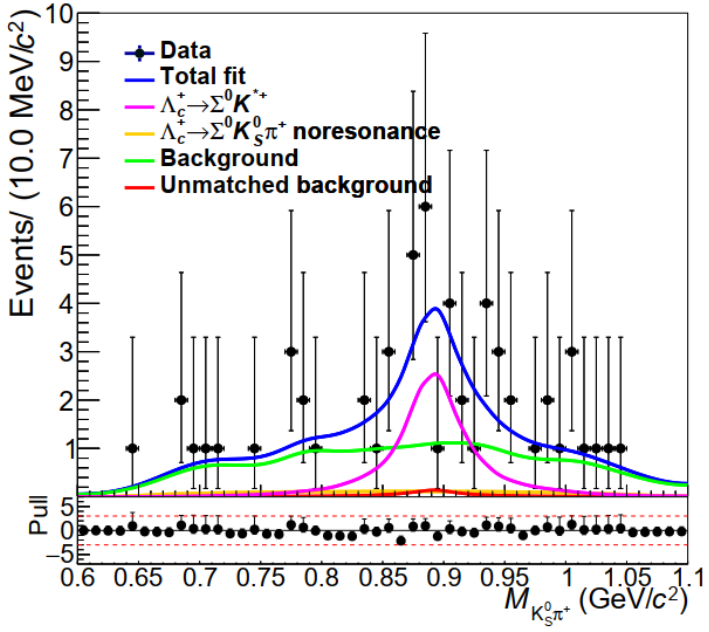
$\Lambda_c^+ \to \Sigma K_S^0 \pi^+$ & $\Lambda_c^+ \to \Sigma K_S^0 K^+$

Submitted to JHEP(arXiv:2602.22754)

- SCS $\Lambda_c^+ \to \Sigma K_S^0 \pi^+$ never been searched, $\Lambda_c^+ \to \Sigma K^*$ and $\Lambda_c^+ \to \Sigma^* K_S^0$ could contribute
- CF $\Lambda_c^+ \to \Sigma K_S^0 K^+$ not been observed, only an upper limit 1.28×10^{-3} @90% C.L. (DT from BESIII), $\Lambda_c^+ \to \Sigma a_0(980)^+$ could contribute
- All involve internal W-emission and W-exchange contributions
- ST method used, $\Lambda_c^+ \to \Sigma K_S^0 \pi^+$ with 5.9 σ and $\Sigma K_S^0 K^+$ with 3.7 σ







$\Lambda_c^+ \to \Sigma K_S^0 \pi^+$ & $\Lambda_c^+ \to \Sigma K_S^0 K^+$

Submitted to JHEP(arXiv:2602.22754)

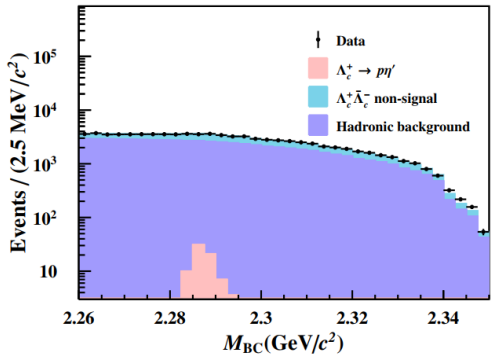
Decay mode	$\Lambda_c^+ \to \Sigma^0 K_S^0 \pi^+$	$\Lambda_c^+ \to \Sigma^0 K^{*+}(K^{*+} \to K_S^0 \pi^+)$	$\Lambda_c^+ \to \Sigma^0 K_S^0 K^+$
Theory calculations	(0.17 ± 0.05) [18]	(0.40 ± 0.10) [25]	(0.12 ± 0.04) [18]
Experimental results	-	-	< 1.28 [20]
This work	$(0.58 \pm 0.14_{\text{stat.}} \pm 0.04_{\text{syst.}})$	$(0.41 \pm 0.19 \pm 0.03)$	$(0.35 \pm 0.16_{\text{stat.}} \pm 0.04_{\text{syst.}})$ < 1.23

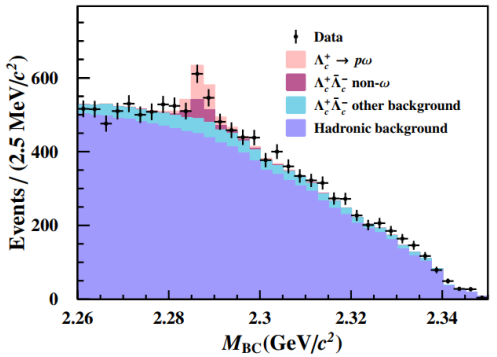
- $\mathcal{B}(\Lambda_c^+ \to \Sigma K_S^0 \pi^+)$ higher than SU(3) prediction based on non-resonant contribution
- $\mathcal{B}(\Lambda_c^+ \to \Sigma K^{*+})$ consistent with SU(3) prediction, resonant contribution plays a very significant role
- $\mathcal{B}(\Lambda_c^+ \to \Sigma K_S^0 K^+)$ consistent with previous search and SU(3) prediction

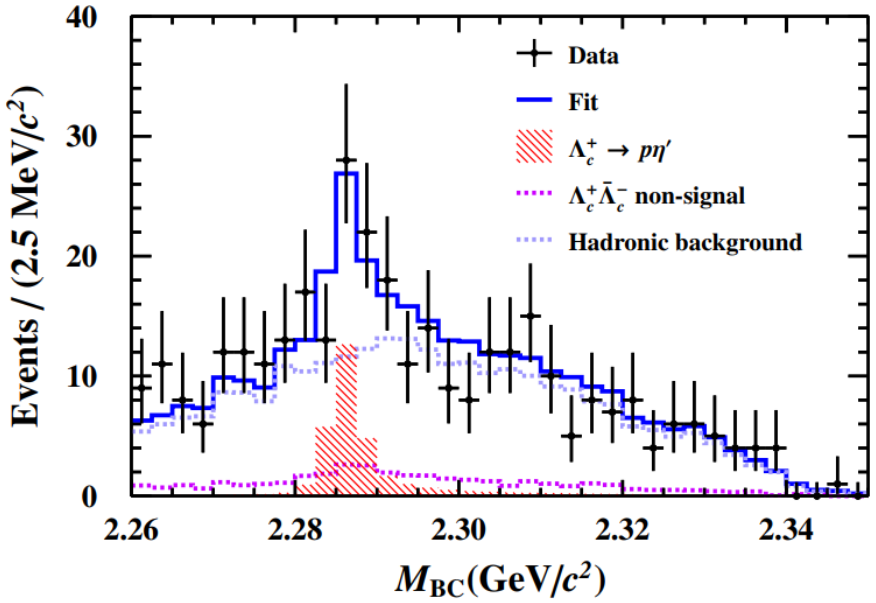
$\Lambda_c^+ \to p\eta'$

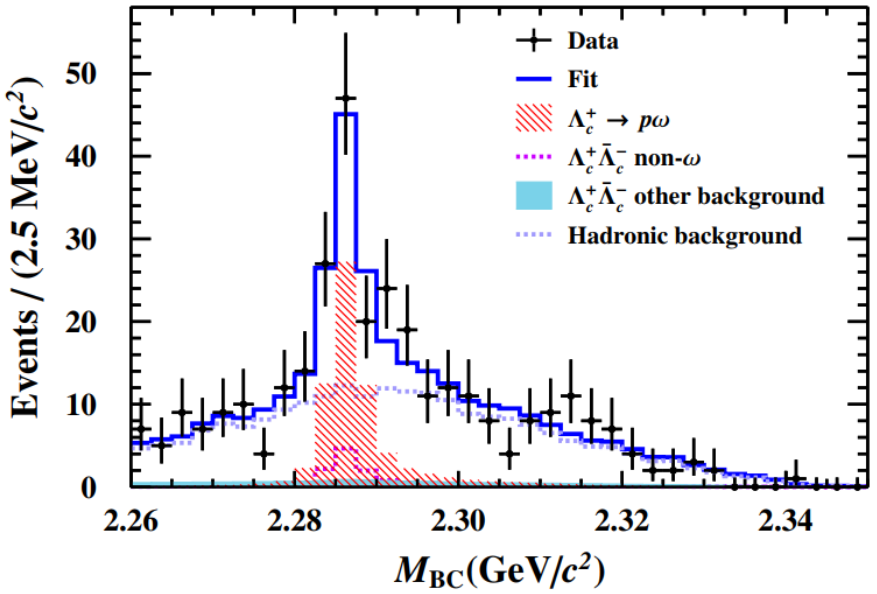
Submitted to JHEP (arXiv: 2602.11974)

- Two-body SCS decay with much interest, predictions range from $10^{-3} - 10^{-4}$
- Experimental results 2022:
  - Belle first observed with $5.4\ \sigma$
  - BESIII observed an evidence with DT of $3.6\ \sigma$
- ST and Deep neural network (DNN) used





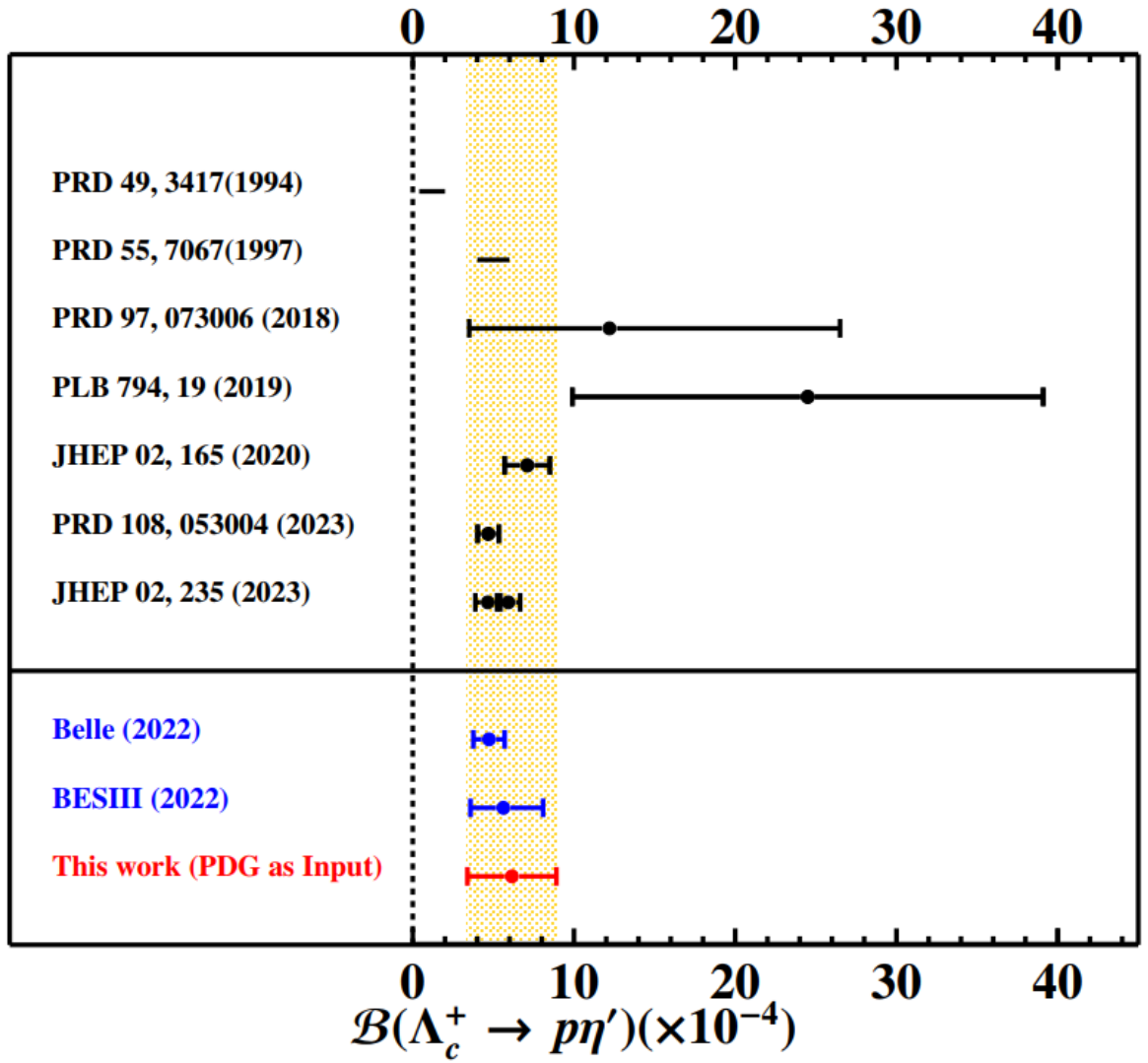




$\Lambda_c^+ \to p\eta'$

Submitted to JHEP (arXiv: 2602.11974)

- Evidence with $3.4\ \sigma$
- $\frac{\mathcal{B}(\Lambda_c^+ \to p\eta')}{\mathcal{B}(\Lambda_c^+ \to p\omega)} = 0.55 \pm 0.22 \pm 0.05$
- ✓ $\mathcal{B}(\Lambda_c^+ \to p\eta') = (6.15 \pm 2.45 \pm 0.53 \pm 1.16) \times 10^{-4}$, consistent with previous results and most predictions
- ST and DNN suppress background by two orders of magnitude, higher signal yield than DT



$\Lambda_c^+ \to$ 12 hadronic modes

Submitted to JHEP (arXiv: 2601.01503v2)

- CF modes including the golden mode $\Lambda_c^+ \to pK^-\pi^+$ were measured 2016 with $0.587\ \mathrm{fb}^{-1}$ 4.6 GeV data
  - $\mathcal{B}(\Lambda_c^+ \to pK^-\pi^+) = (6.24 \pm 0.28)\%$, precision is crucial for other experiments and excited-charm and bottom baryons (e.g. LHCb, Belle and Babar)
  - More data and better simulation, a global least-square fit is implemented simultaneously

$\sqrt{s}$(MeV)	$N_{\Lambda_c^+\bar{\Lambda}_c^-}(\times 10^3)$	σ(pb)	$\lvert G_{\mathrm{eff}}\rvert(\times 10^{-2})$
4599.53	$98.0 \pm 1.8 \pm 0.5$	$213.1 \pm 3.9 \pm 1.9$	$53.8 \pm 0.5 \pm 0.2$
4611.86	$17.7 \pm 0.5 \pm 0.1$	$211.5 \pm 6.0 \pm 2.0$	$49.5 \pm 0.7 \pm 0.2$
4628.00	$89.8 \pm 1.6 \pm 0.4$	$207.6 \pm 3.7 \pm 1.8$	$45.6 \pm 0.4 \pm 0.2$
4640.91	$96.1 \pm 1.9 \pm 0.5$	$206.5 \pm 4.1 \pm 1.9$	$43.5 \pm 0.4 \pm 0.2$
4661.24	$94.3 \pm 1.8 \pm 0.5$	$206.2 \pm 3.9 \pm 2.0$	$41.2 \pm 0.4 \pm 0.2$
4681.92	$284.3 \pm 4.9 \pm 1.3$	$192.0 \pm 3.3 \pm 1.8$	$38.1 \pm 0.4 \pm 0.2$
4698.82	$84.2 \pm 1.7 \pm 0.4$	$172.0 \pm 3.5 \pm 2.2$	$35.0 \pm 0.4 \pm 0.2$

$\Lambda_c^+ \to$ 12 hadronic modes

Submitted to JHEP (arXiv: 2601.01503v2)

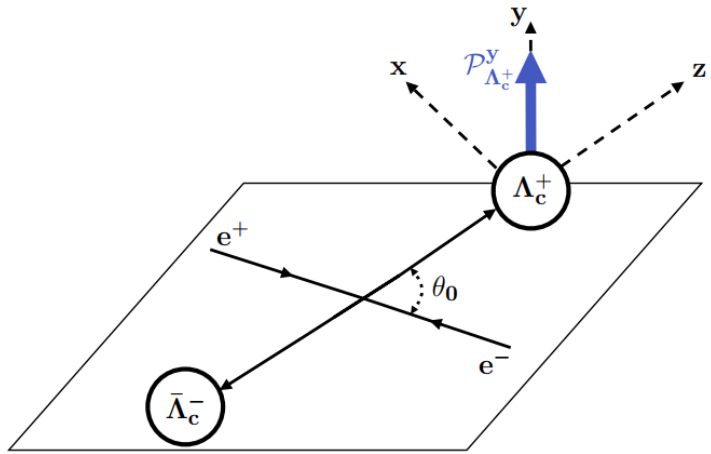
- Most precise measurement:
  - Improved by a factor of 2-3
  - Cross sections and Λ_c^+ effective form factors at different energy are consistent with and more precise than our previous measurements 2023 (one mode and 4.6-4.95 GeV).

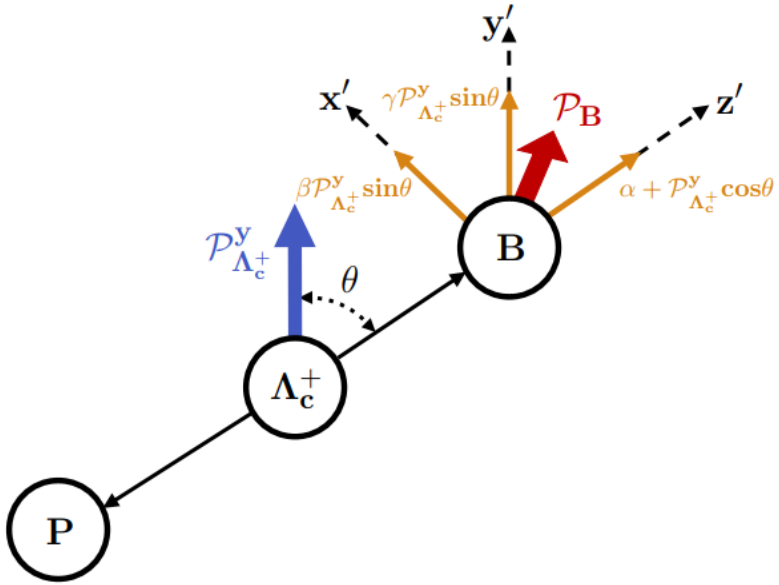
Signal mode	Global fit	PDG
pK_S^0	$1.70 \pm 0.03 \pm 0.05$	1.59 ± 0.07
$pK^-\pi^+$	$6.61 \pm 0.11 \pm 0.12$	6.24 ± 0.28
$pK_S^0\pi^0$	$2.19 \pm 0.06 \pm 0.05$	1.96 ± 0.12
$pK_S^0\pi^+\pi^-$	$1.88 \pm 0.04 \pm 0.07$	1.59 ± 0.11
$pK^-\pi^+\pi^0$	$4.89 \pm 0.10 \pm 0.11$	4.43 ± 0.28
$\Lambda\pi^+$	$1.32 \pm 0.03 \pm 0.03$	1.29 ± 0.05
$\Lambda\pi^+\pi^0$	$6.67 \pm 0.13 \pm 0.10$	7.02 ± 0.35
$\Lambda\pi^+\pi^-\pi^+$	$4.09 \pm 0.09 \pm 0.10$	3.61 ± 0.26
$\Sigma^0\pi^+$	$1.45 \pm 0.03 \pm 0.03$	1.27 ± 0.06
$\Sigma^+\pi^0$	$1.37 \pm 0.04 \pm 0.03$	1.24 ± 0.09
$\Sigma^+\pi^+\pi^-$	$4.58 \pm 0.10 \pm 0.10$	4.47 ± 0.22
$p\pi^+\pi^-$	$0.50 \pm 0.02 \pm 0.01$	0.46 ± 0.03

$\Lambda_c^+ \to pK_S^0$、$\Lambda\pi^+$、$\Sigma^0\pi^+$、$\Sigma^+\pi^0$

Submitted to PRX (arXiv:2508. 11400v3)

- Decay asymmetry parameters α, β, γ provide irreplaceable constraints on models
- Transverse polarization ($\mathcal{P}_T$) of $e^+e^- \to \Lambda_c^+ \bar{\Lambda}_c^-$ never been observed
  - Similar with hyperon pair productions, Λ_c^+ can acquire polarization
  - Comes from electromagnetic form factors of Λ_c^+
  - Changes with center-of-mass energy E_{cms}
  - $\Lambda_c^+ \to \mathrm{p}K^-\pi^+$ included in the simultaneous fit





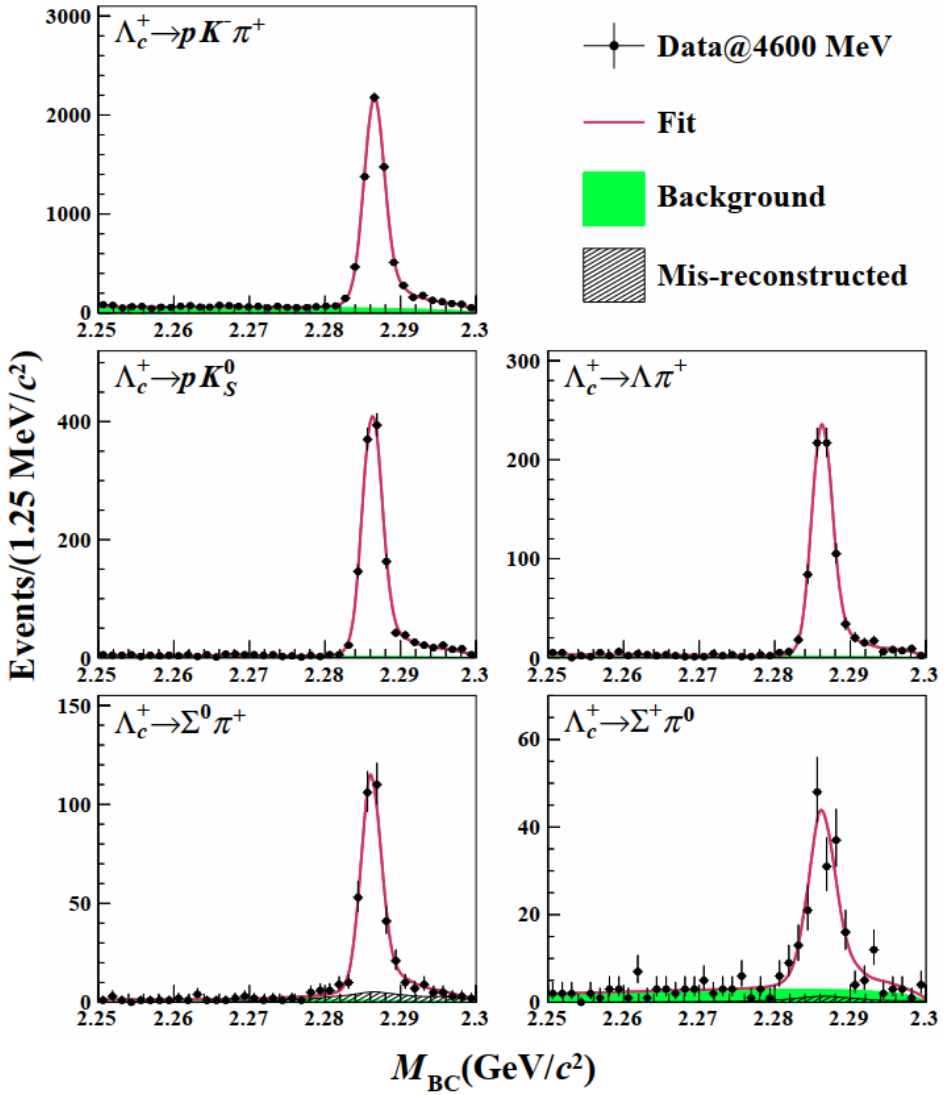
$$\alpha_{BP}^{\Lambda_c^+} = \frac{2Re(S^*P)}{|S|^2+|P|^2} = \frac{|A_{-1/2}|^2-|A_{1/2}|^2}{|A_{1/2}|^2+|A_{-1/2}|^2}$$

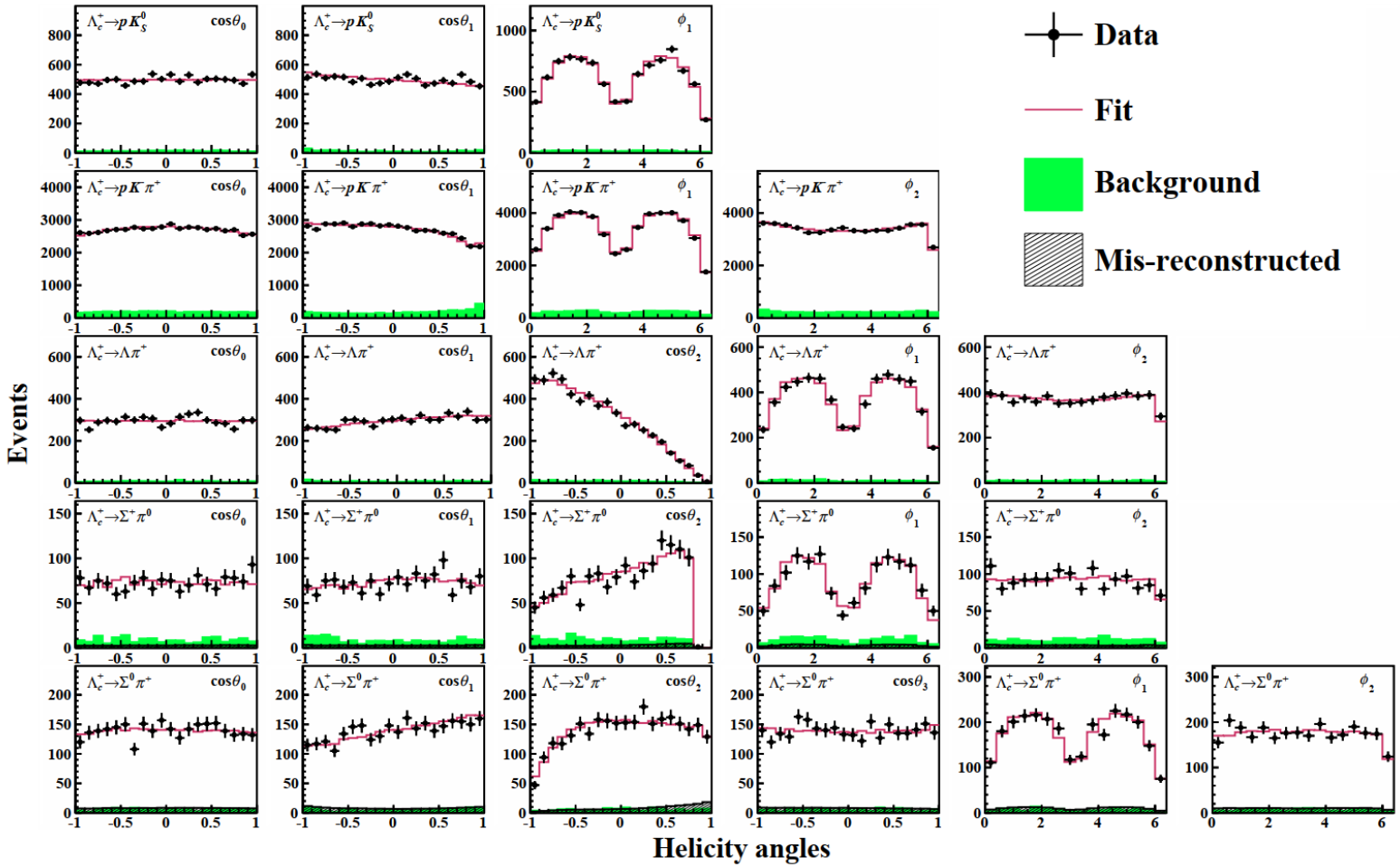
$$\mathcal{P}^{y}_{\Lambda_c^+}(\cos\theta_0) = \frac{3}{2(3+\alpha_0)}\sqrt{1-\alpha_0^2}\sin\theta_0\cos\theta_0\sin\Delta\Phi,$$

$\Lambda_c^+ \to pK_S^0$、$\Lambda\pi^+$、$\Sigma^0\pi^+$、$\Sigma^+\pi^0$

Submitted to PRX (arXiv:2508. 11400v3)

A simultaneous unbinned maximum log-likelihood fit





$\Lambda_c^+ \to pK_S^0$、$\Lambda\pi^+$、$\Sigma^0\pi^+$、$\Sigma^+\pi^0$

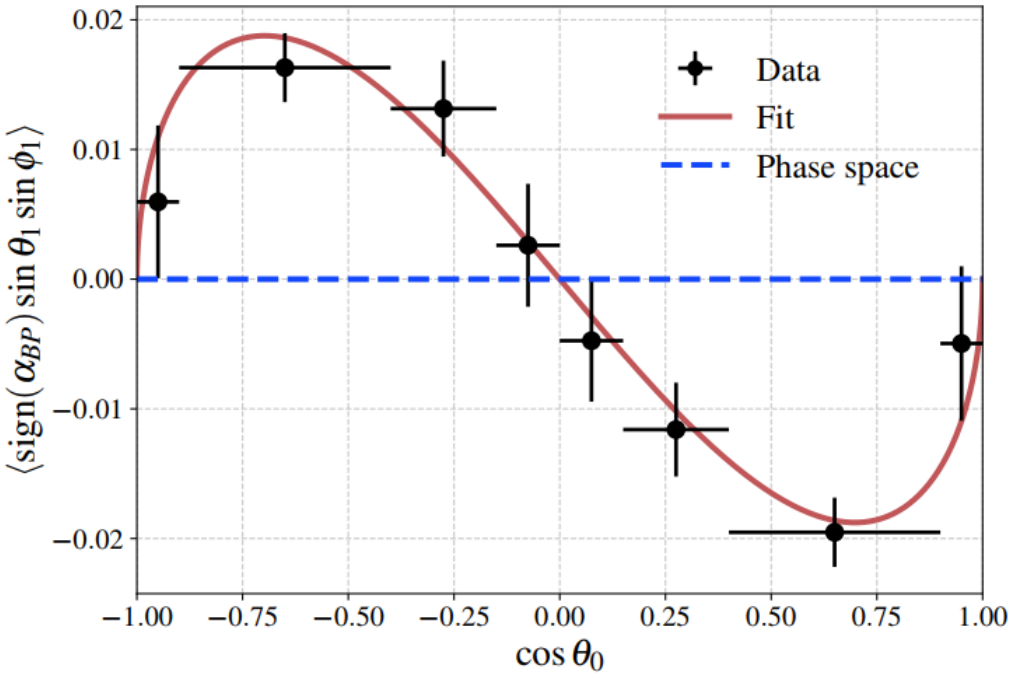
Submitted to PRX (arXiv:2508. 11400v3)

$\sqrt{s}$ [MeV]	α_0 in previous work [17, 82]	α_0 in this work	$\Delta\Phi$ [rad]	SL	$\mathcal{P}_{\Lambda_c^+}^{y,max}$
4600	$-0.20 \pm 0.04 \pm 0.02$	$-0.226 \pm 0.030 \pm 0.004$	$-0.100 \pm 0.069 \pm 0.009$	2.2 σ	$-0.026 \pm 0.018 \pm 0.002$
4612	$-0.26 \pm 0.09 \pm 0.01$	$-0.160 \pm 0.083 \pm 0.004$	$-0.146 \pm 0.162 \pm 0.030$	1.1 σ	$-0.038 \pm 0.042 \pm 0.008$
4628	$-0.21 \pm 0.04 \pm 0.01$	$-0.181 \pm 0.038 \pm 0.001$	$-0.371 \pm 0.082 \pm 0.012$	6.8 σ	$-0.095 \pm 0.020 \pm 0.003$
4641	$-0.09 \pm 0.05 \pm 0.01$	$-0.060 \pm 0.039 \pm 0.003$	$-0.398 \pm 0.073 \pm 0.015$	7.6 σ	$-0.099 \pm 0.017 \pm 0.004$
4661	$-0.02 \pm 0.05 \pm 0.01$	$0.008 \pm 0.044 \pm 0.003$	$-0.496 \pm 0.088 \pm 0.021$	8.5 σ	$-0.119 \pm 0.019 \pm 0.005$
4682	$0.15 \pm 0.03 \pm 0.01$	$0.102 \pm 0.029 \pm 0.003$	$-0.502 \pm 0.054 \pm 0.021$	14.1 σ	$-0.116 \pm 0.011 \pm 0.005$
4699	$0.34 \pm 0.07 \pm 0.01$	$0.305 \pm 0.055 \pm 0.010$	$-0.545 \pm 0.114 \pm 0.028$	7.1 σ	$-0.112 \pm 0.021 \pm 0.007$
4740	$0.49 \pm 0.16 \pm 0.03$	$0.358 \pm 0.126 \pm 0.008$	$-0.097 \pm 0.190 \pm 0.016$	0.4 σ	$-0.020 \pm 0.039 \pm 0.004$
4750	$0.42 \pm 0.10 \pm 0.01$	$0.347 \pm 0.079 \pm 0.004$	$-0.316 \pm 0.142 \pm 0.019$	3.1 σ	$-0.065 \pm 0.029 \pm 0.005$
4781	$0.17 \pm 0.07 \pm 0.01$	$0.157 \pm 0.062 \pm 0.007$	$-0.395 \pm 0.126 \pm 0.028$	5.1 σ	$-0.090 \pm 0.027 \pm 0.007$
4843	$0.38 \pm 0.10 \pm 0.01$	$0.282 \pm 0.089 \pm 0.019$	$-0.385 \pm 0.153 \pm 0.034$	3.6 σ	$-0.082 \pm 0.031 \pm 0.008$
4918	$0.62 \pm 0.17 \pm 0.01$	$0.612 \pm 0.150 \pm 0.019$	$-0.423 \pm 0.272 \pm 0.024$	1.9 σ	$-0.067 \pm 0.043 \pm 0.013$
4951	$0.63 \pm 0.21 \pm 0.01$	$0.744 \pm 0.179 \pm 0.007$	$-0.700 \pm 0.392 \pm 0.058$	1.8 σ	$-0.086 \pm 0.050 \pm 0.030$

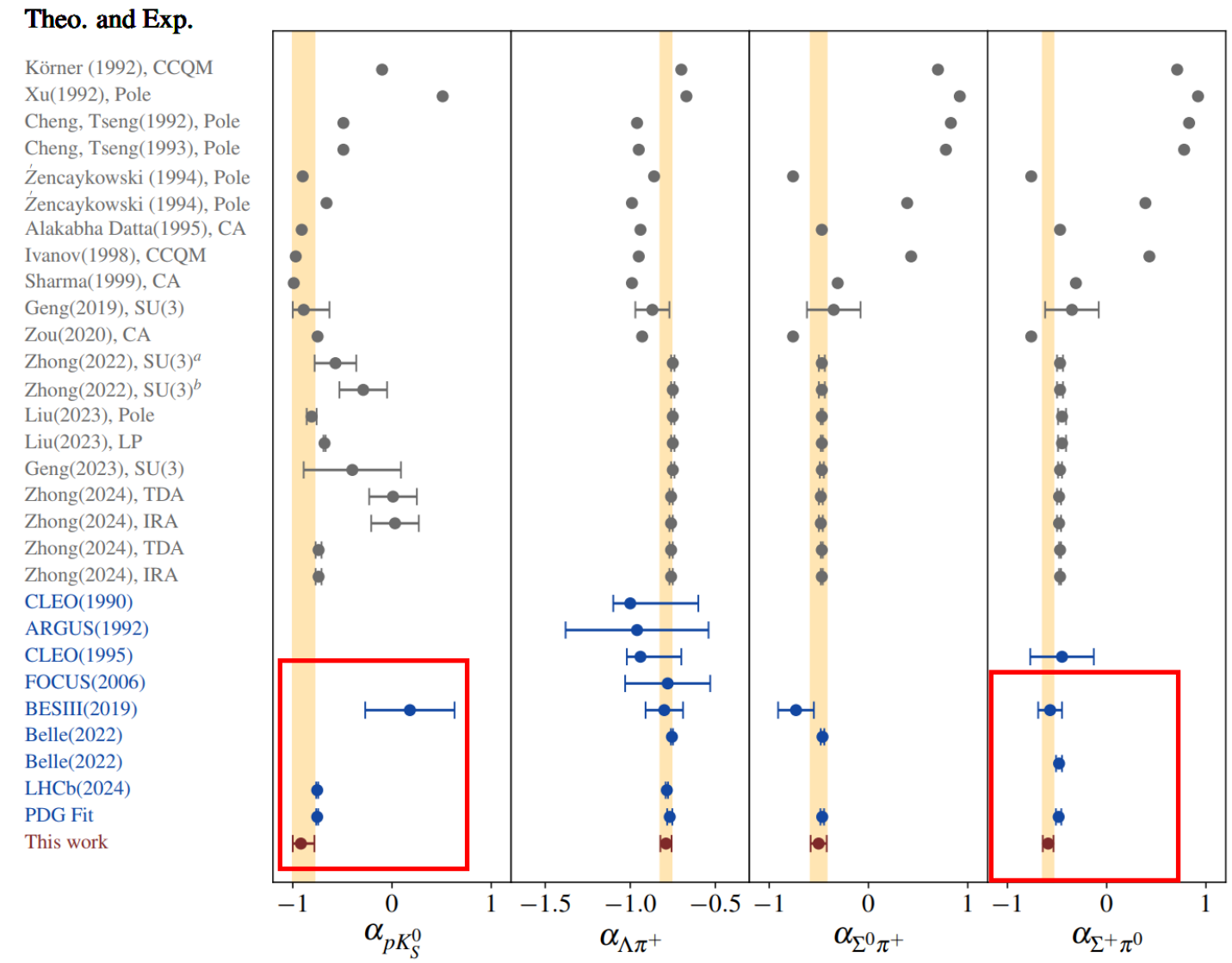
- EMFF-related α_0 consistent with previous results but more precise
- Polarization is strongly dependent on Λ_c^+ momentum direction $cos\theta_0$(max~12%)

$\Lambda_c^+ \to pK_S^0$、$\Lambda\pi^+$、$\Sigma^0\pi^+$、$\Sigma^+\pi^0$

Submitted to PRX (arXiv:2508. 11400v3)



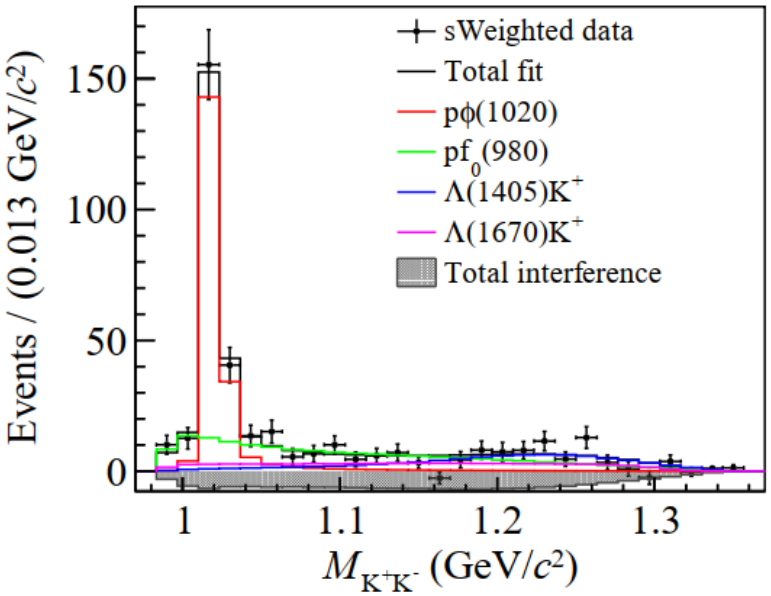
Dynamic parameters $A = s, B = \kappa p$, relative phase shift $\delta_p - \delta_s$, other two Lee-Yang parameters, $\alpha -$ induced CP, weak and strong phase shifts observables also obtained

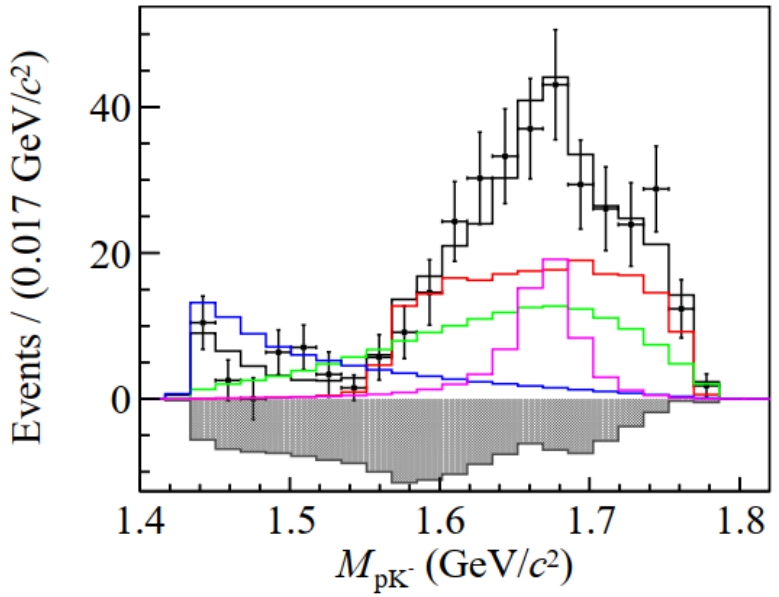


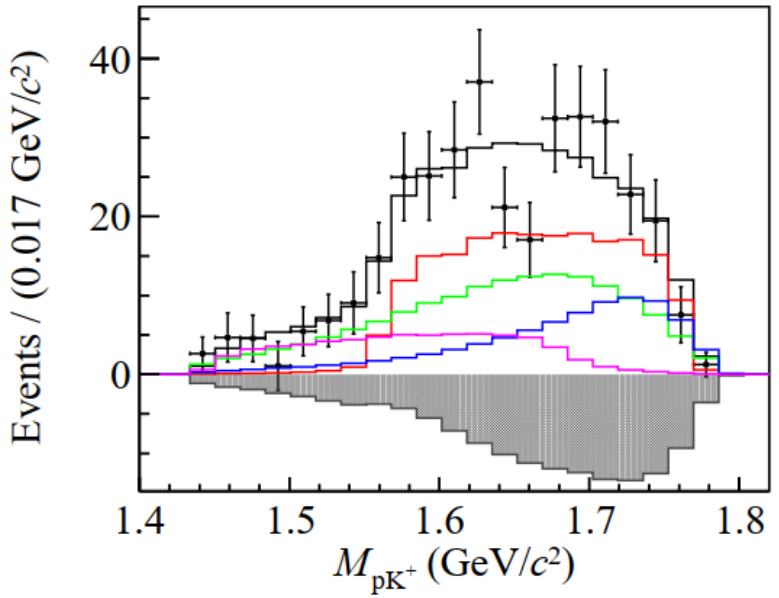
$\Lambda_c^+ \to pK^+K^-$

Submitted to PRD (arXiv:2603.08469)

- Partial wave analysis:
  - ✓ SCS decay and large $\mathcal{B}$, golden channel for investigating CP violation in charmed baryon decays
  - ✓ Dominate by $\Lambda_c^+ \to p\phi(1020)$, but interference with the three-body decay







$\Lambda_c^+ \to pK^+K^-$

Submitted to PRD (arXiv:2603.08469)

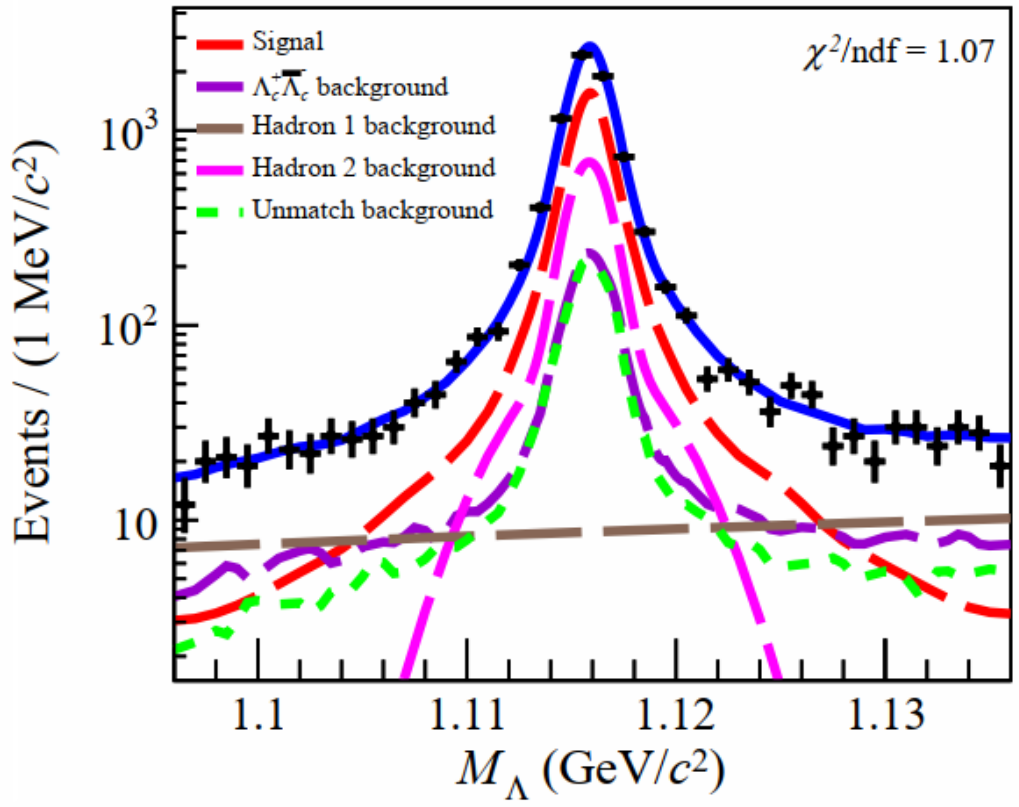
Prediction or measurement	$\Lambda_c^+ \to pK^+K^-$ (%)	$\Lambda_c^+ \to p\phi(1020)$ (%)
Körner(1992), CCQM [9]	...	0.003
Źencaykowski(1994), Pole [10]	...	0.10
Źencaykowski(1994), Pole [11]	...	0.14
Alakabha Datta(1995), CA [12]	...	0.063
Cheng, Tseng(1993), Pole [13]	...	0.073
Ivanov(1998), CCQM [14]	...	$0.138 - 0.657^*$
CLEO(1996) [26]	$0.244 \pm 0.056 \pm 0.044$	$0.150 \pm 0.038 \pm 0.019$
Belle(2002) [27]	$0.088 \pm 0.013 \pm 0.013$	$0.094 \pm 0.013 \pm 0.013$
BESIII(2016) [28]	$0.107 \pm 0.016 \pm 0.007$	$0.106 \pm 0.019 \pm 0.010$
LHCb(2018) [29]	$0.106 \pm 0.002 \pm 0.005$	...
PDG(2024) [23]	0.106 ± 0.006	0.106 ± 0.014

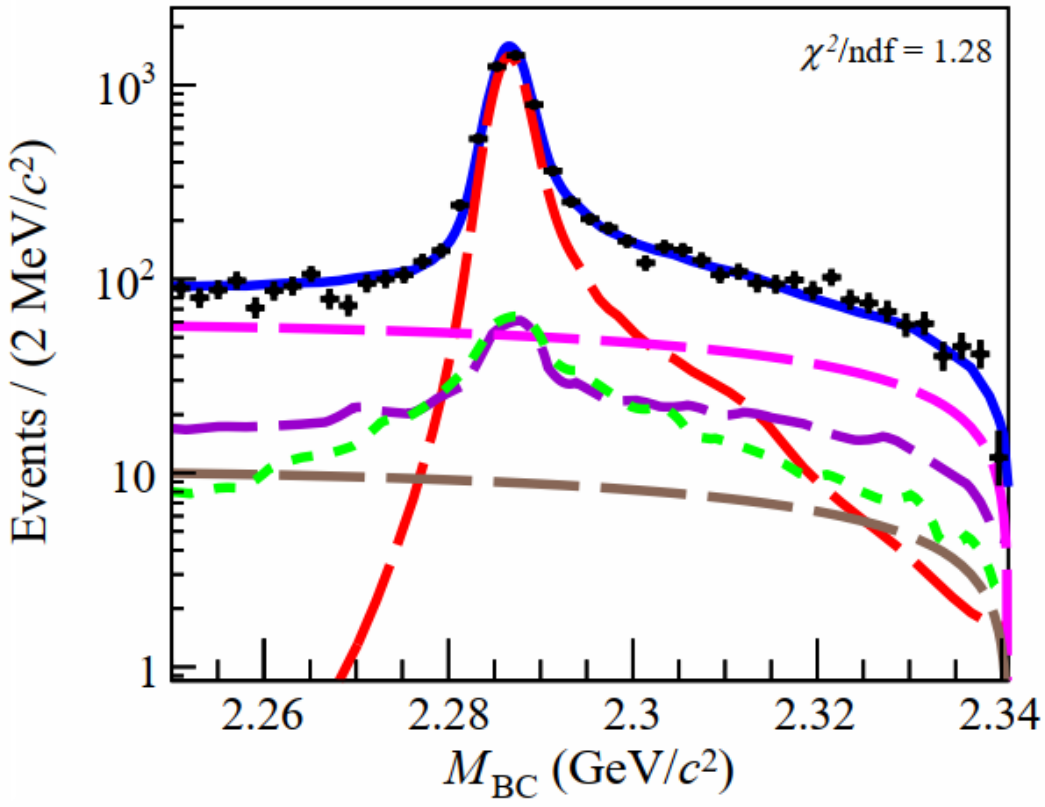
- $\mathcal{B}(\Lambda_c^+ \to pK^+K^-) = (9.94 \pm 0.65 \pm 0.50) \times 10^{-4}$, more precise but deviates from CLEO's by 2σ
- $\mathcal{B}\left(\Lambda_c^+ \to p\phi(1020)\right) = (1.21 \pm 0.11 \pm 0.08 \pm 0.01) \times 10^{-3}$, most precise one

$\Lambda_c^+ \to \Lambda X$

Submitted to PRL (arXiv:2602.24089)

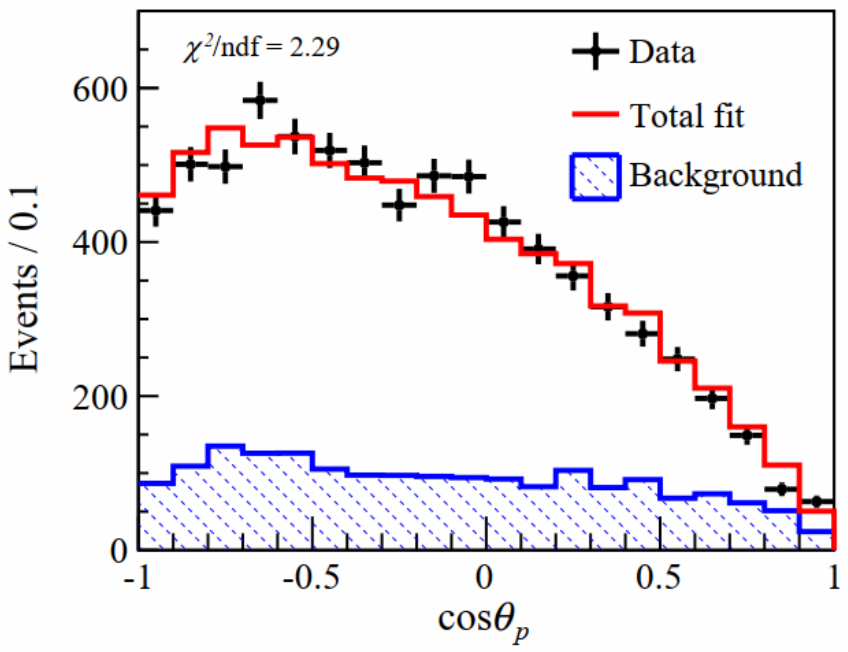
- Inclusive analysis:
  - ✓ Infer the extent of the undiscovered decays
  - ✓ BESIII 2018 measured $\mathcal{B}(\Lambda_c^+ \to \Lambda X) = (38.2^{+2.8}_{-2.2} \pm 0.9)\%$ vs observed exclusive $(31.36 \pm 1.09)\%$
  - ✓ More data could measure more precise $\mathcal{B}$, inclusive CPV and longitudinal polarization of Λ
- 2-D fit and DT method

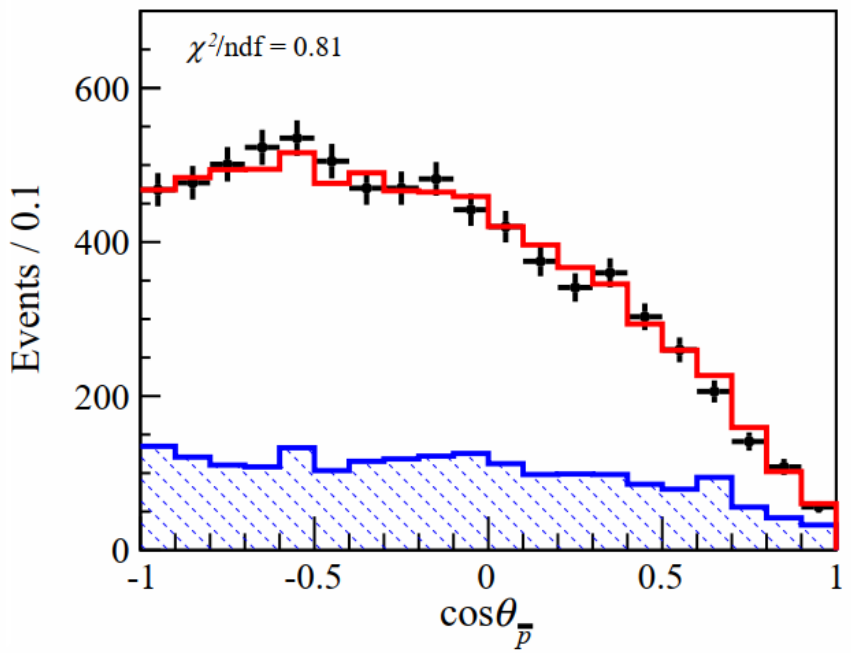




$\Lambda_c^+ \to \Lambda X$

Submitted to PRL (arXiv:2602.24089)





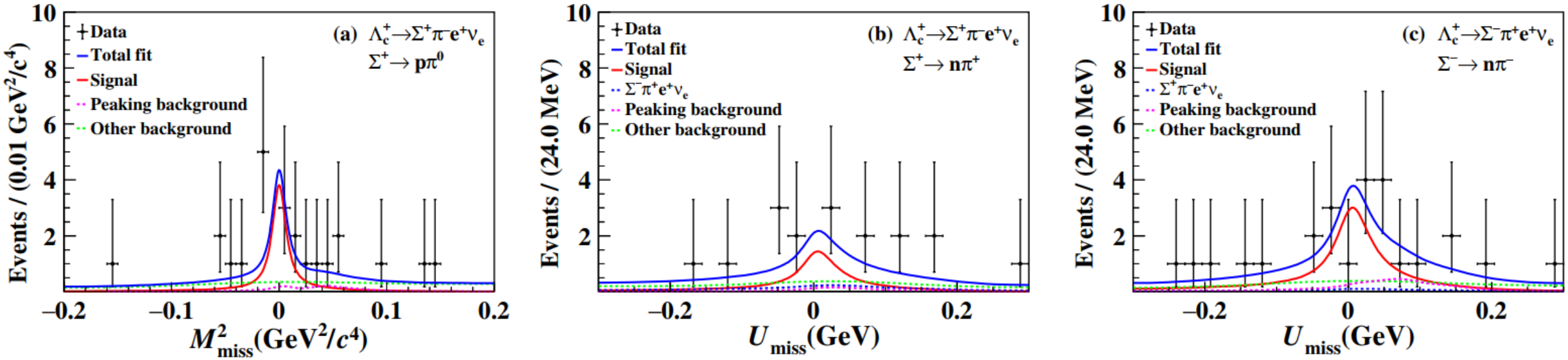
$$\frac{d\Gamma}{d\cos\theta_p} \propto 1 + \mathcal{P}_\Lambda \alpha_- \cos\theta_p$$

- ✓ $\mathcal{B}(\Lambda_c^+ \to \Lambda X) = (38.07 \pm 0.38 \pm 0.49)\%$, precision improved by a factor of four, $(6.71 \pm 1.25)\%$ unknown
- ✓ $\mathcal{A}_{CP}^{dir} \equiv [\mathcal{B}(\Lambda_c^+ \to \Lambda X) - \mathcal{B}(\Lambda_c^+ \to \bar{\Lambda} X)]/\ [\mathcal{B}(\Lambda_c^+ \to \Lambda X) + \mathcal{B}(\Lambda_c^+ \to \bar{\Lambda} X)] = (1.5 \pm 1.0 \pm 1.0)\%$
- ✓ $\mathcal{P}_\Lambda = -0.393 \pm 0.055 \pm 0.020$ and $\mathcal{P}_{\bar{\Lambda}} = 0.288 \pm 0.056 \pm 0.017$
- ✓ $\mathcal{A}_{CP}^{pol} \equiv (\mathcal{P}_\Lambda \alpha_- - \mathcal{P}_{\bar{\Lambda}} \alpha_+)/\ (\mathcal{P}_\Lambda \alpha_- + \mathcal{P}_{\bar{\Lambda}} \alpha_+) = 0.15 \pm 0.12 \pm 0.04$

$\Lambda_c^+ \to \Sigma^\pm \pi^\mp e^+ \nu$

Submitted to PRD (arXiv: 2512.05178)

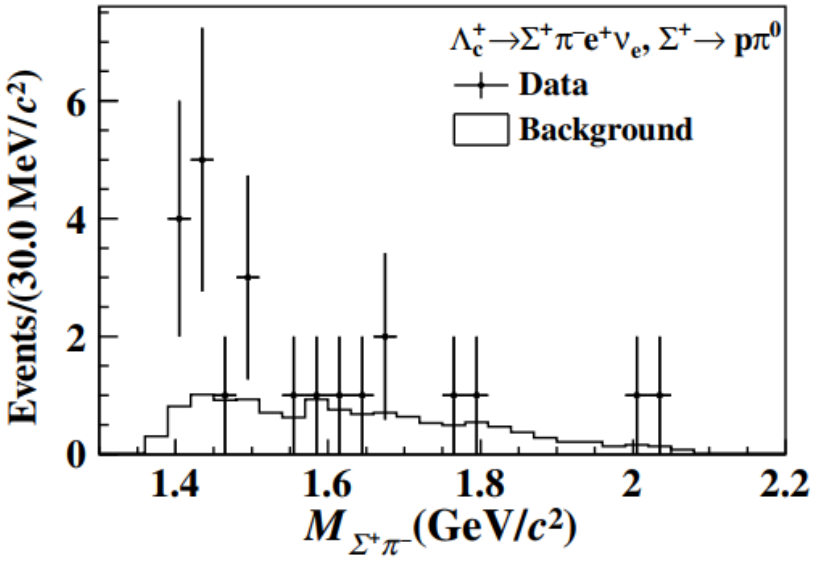
- BESIII have seen $\Lambda_c^+ \to \Lambda^* e^+ \nu$ evidence with $\Lambda_c^+ \to p K^- e^+ \nu$, $\mathcal{B}(\Lambda^* \to \Sigma\pi)$ is large
- Under isospin symmetry, the two should be same

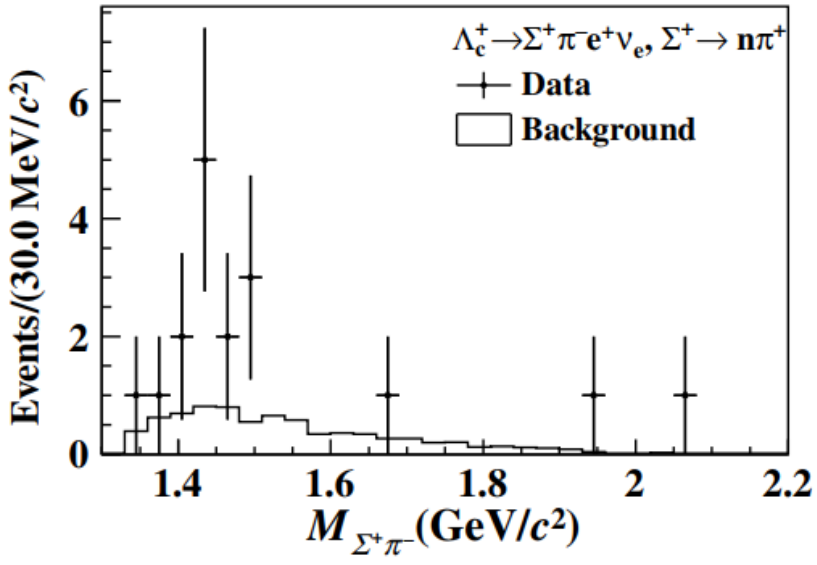


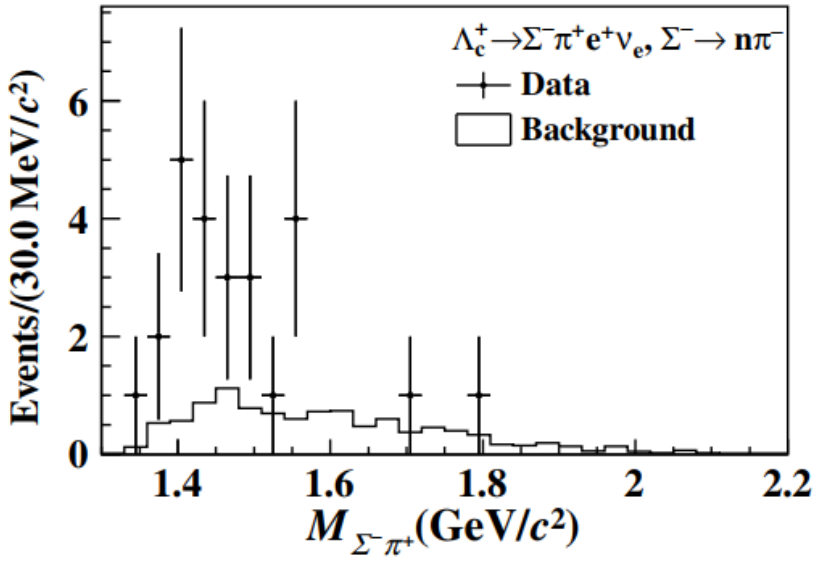
- ✓ Evidence is found with $3.6\,\sigma$
- ✓ $\mathcal{B}\left(\Lambda_c^+ \to \Sigma^\pm \pi^\mp e^+ \nu\right) = (7.7^{+2.5}_{-2.3} \pm 1.3) \times 10^{-4}$, assume all $\Sigma^\pm\pi^\mp$ from Λ^*, consistent with quark model prediction 0.36% within $2\,\sigma$

$\Lambda_c^+ \to \Sigma^{\pm}\pi^{\mp}e^+\nu$

Submitted to PRD (arXiv: 2512.05178)



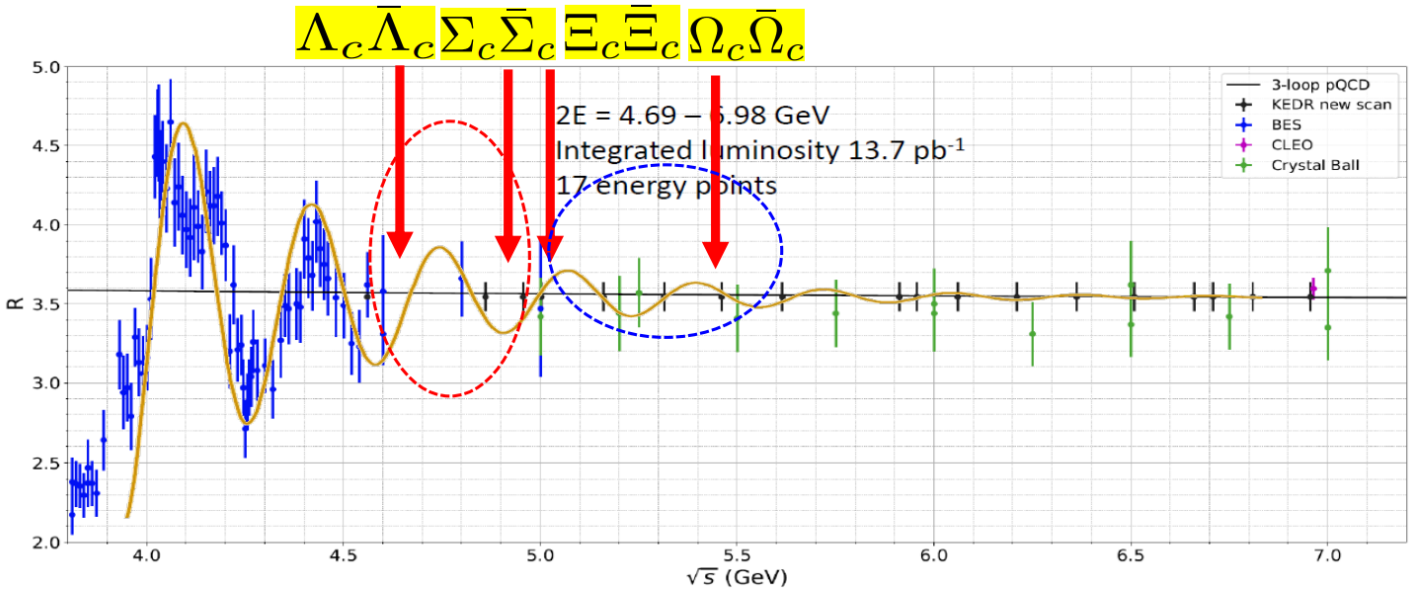


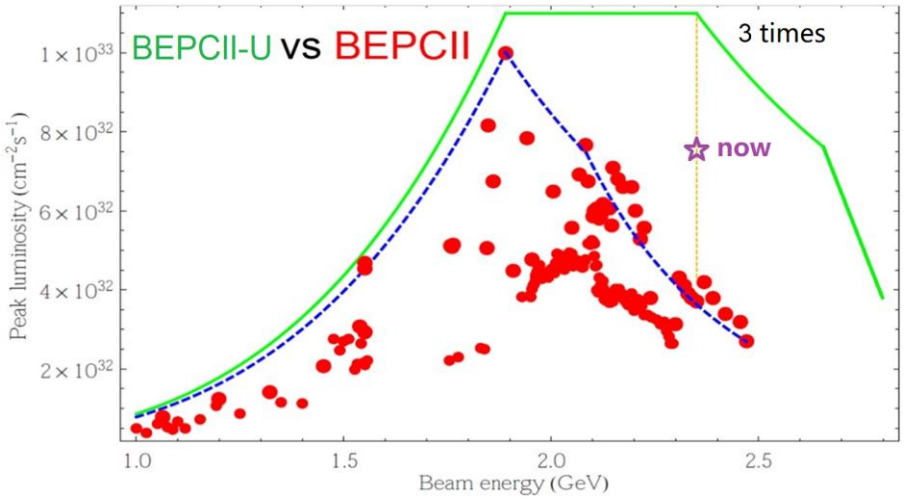


Hint for Λ^*

Prospect

- BEPCII-U and BESIII is currently working well and may have a major machine upgrade in the future ($\times$ 10 lumi.)
  - Triple the luminosity @4.7 GeV (now about 2 times)
  - Center-of-mass energy will up to 5.6 GeV
  - Replaced inner MDC with CGEM

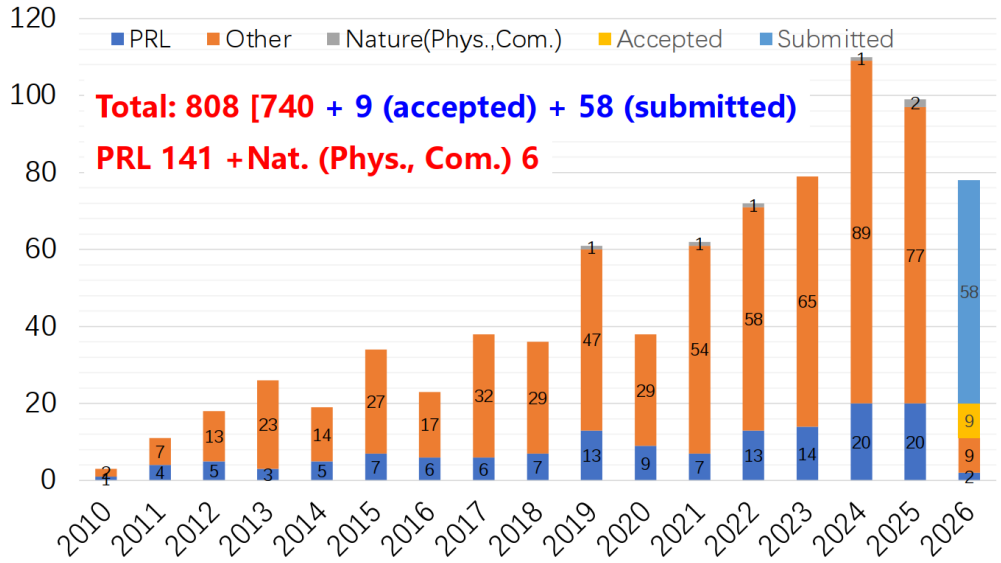




- 9 fb^{-1} more 4.68 GeV Λ_c^+ data is collecting from 2026.02-2027
- >5 GeV data will start in 2028

Summary

- World's largest threshold data makes BESIII dominant Λ_c^+ measurments.
- Fruitful results released recently
  - Hadronic decays
  - Inclusive decays
  - Semi-leptonic decays
  - …



- First observation of the transverse polarization of Λ_c^+ and deep learning method provides opportunity to many analyses of BESIII.
- BEPCII-U is more efficient and 9 fb^{-1} more data is collecting @ 4.68 GeV.
- Charm is charming, more will come...

Thanks for your attention!

BACK UP

$$|\mathcal{M}(\phi,\theta,\chi,\kappa)|^2 \propto I_0(\kappa)(1+\alpha_0\cos^2\theta_0 + \sum_j \sqrt{1-\alpha_0^2}\sin\Delta_0\sin\theta_0\cos\theta_0 R_{2j}(\theta,\phi,\chi)\alpha_j(\kappa)),$$

$$|G_{\text{eff}}| = \sqrt{\frac{\sigma}{\frac{\sigma_0}{3}\left(1+\frac{\kappa}{2}\right)}},$$

$$\frac{d\Gamma}{d\cos\theta_0\, d\cos\theta_1\, d\phi_1} \propto 1+\alpha_0\cos^2\theta_0 + \alpha_{\Lambda_c^+} P^T(\cos\theta_0)\sin\theta_1\sin\phi_1,$$