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BESIII

Recent charmed baryon results from BESIII

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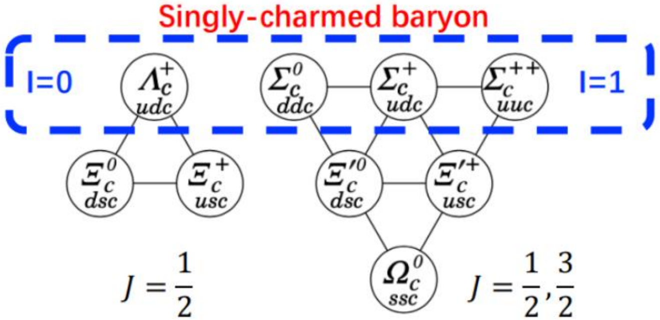
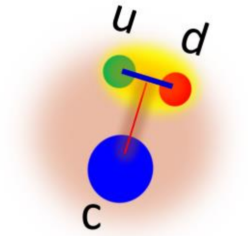
Introduction of Λ_c^+ physics

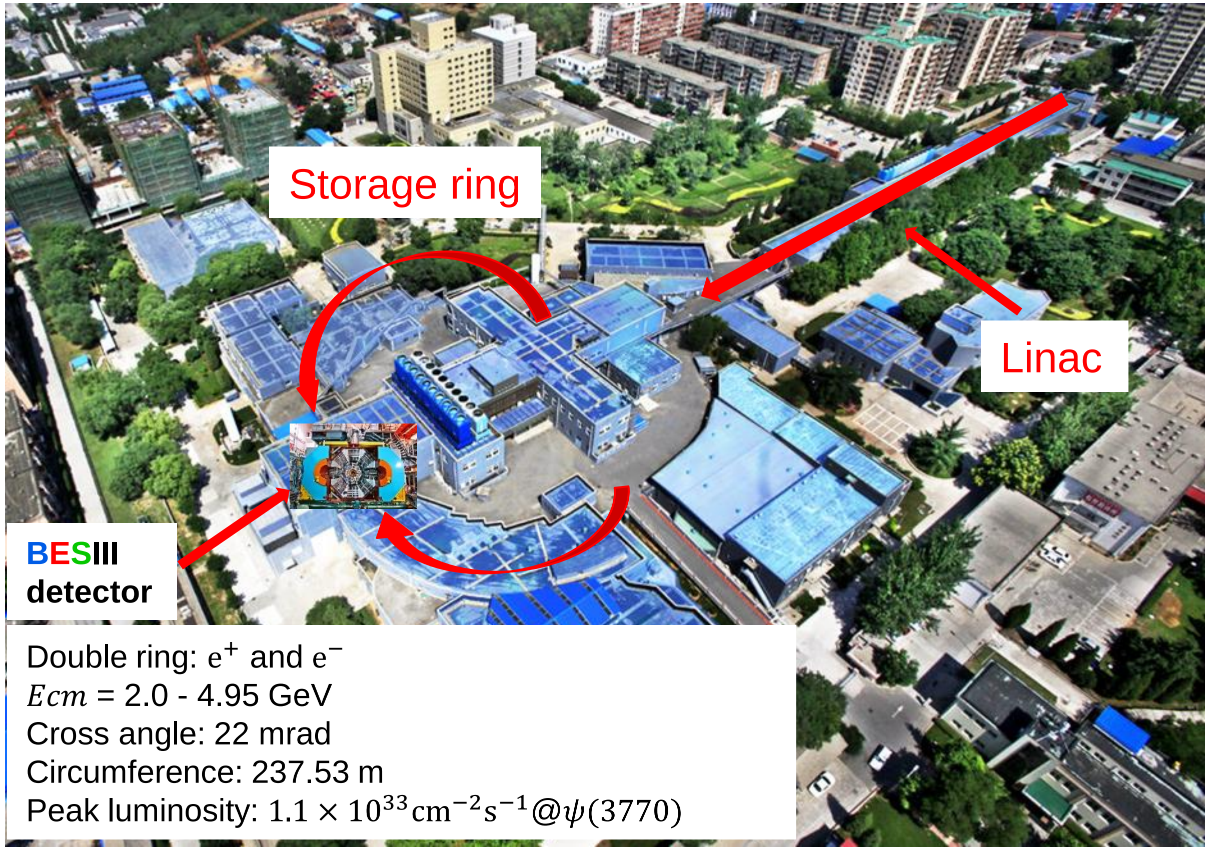
- The lightest charmed baryon, most of the charmed baryons and many b-baryons decay to Λ_c^+.
- Naive quark model picture of Λ_c^+ : a heavy quark (c) with an unexcited spin-zero diquark ($u-d$).



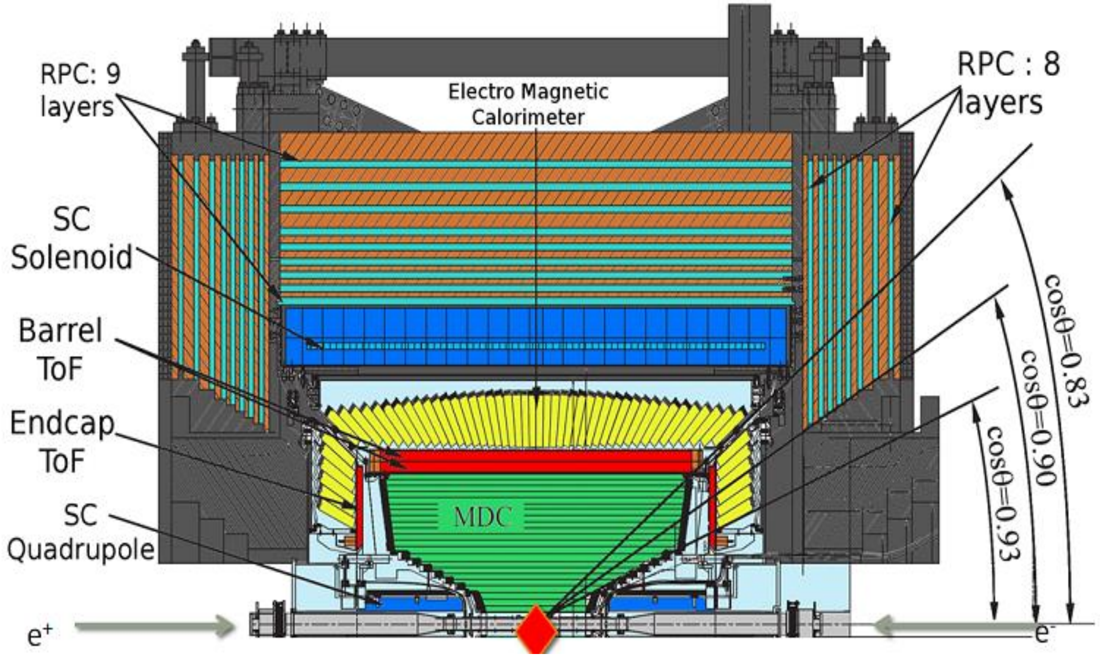


Diquark correlation is enhanced by weak Color Magnetic Interaction with a heavy quark (HQET).

- Excellent ground to study the dynamics of light quarks in the environment of a heavy quark.
- Reveal information of strong- and weak-interactions in charm region, complementary to charmed mesons.
- Excellent platform for understanding QCD with transitions involving the charm quark.
- Total measured BF is ~70%.
- Experimental results provide precise test for low-energy non-perturbative QCD phenomenological model and LQCD calculations, promote the understanding of the mechanism of strong interaction in charm region.



Double ring: e^{+} and e^{-}
Ecm = 2.0 - 4.95 GeV
Cross angle: 22 mrad
Circumference: 237.53 m
Peak luminosity: $1.1 \times 10^{33} \mathrm{cm}^{-2} \mathrm{s}^{-1} @ \psi(3770)$



Λ_c^+ data taking at BESIII

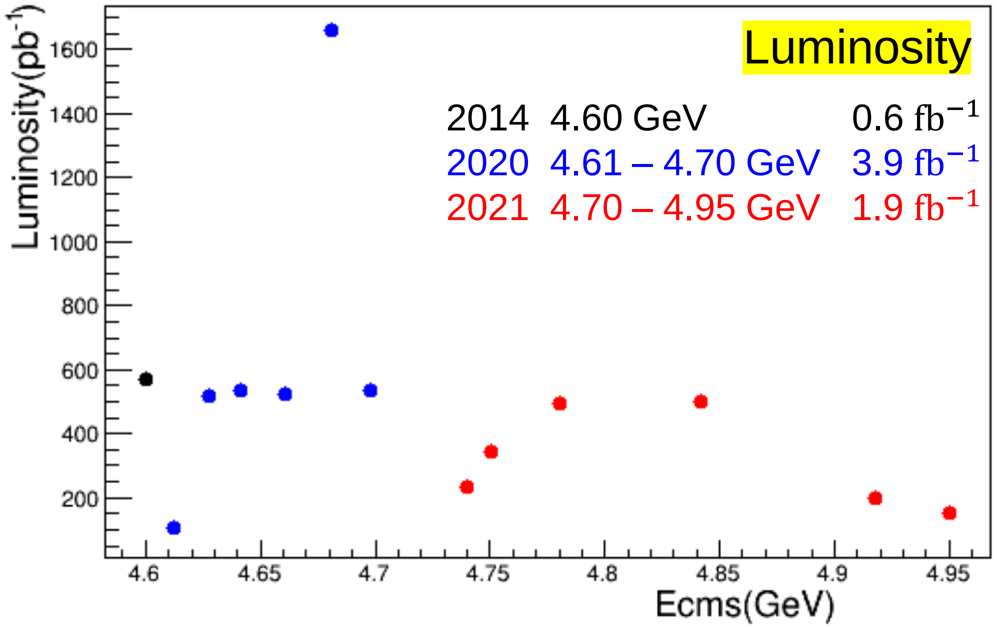
- BESIII, $\tau - c$ energy region experiment:

  Large samples collected near the $\boldsymbol{\Lambda_c^+\bar{\Lambda}_c^-}$ production threshold → clean environment, low background.

  High tagging efficiency. Precision measurement.

- For 4.6~4.7 GeV, $\Lambda_c^+\bar{\Lambda}_c^-$ produced in pairs with no additional accompany hadrons. This unique data offer ideal opportunities to study Λ_c^+ decays.

- Double-tag (DT) method can be used:
  - ✓ Lower backgrounds.
  - ✓ Most systematic uncertainties in tag side can be cancelled.
  - ✓ Measure absolute BFs.
  - ✓ Kinematic relation to constrain missing particle.



Double-tag method

- **Model-independent**

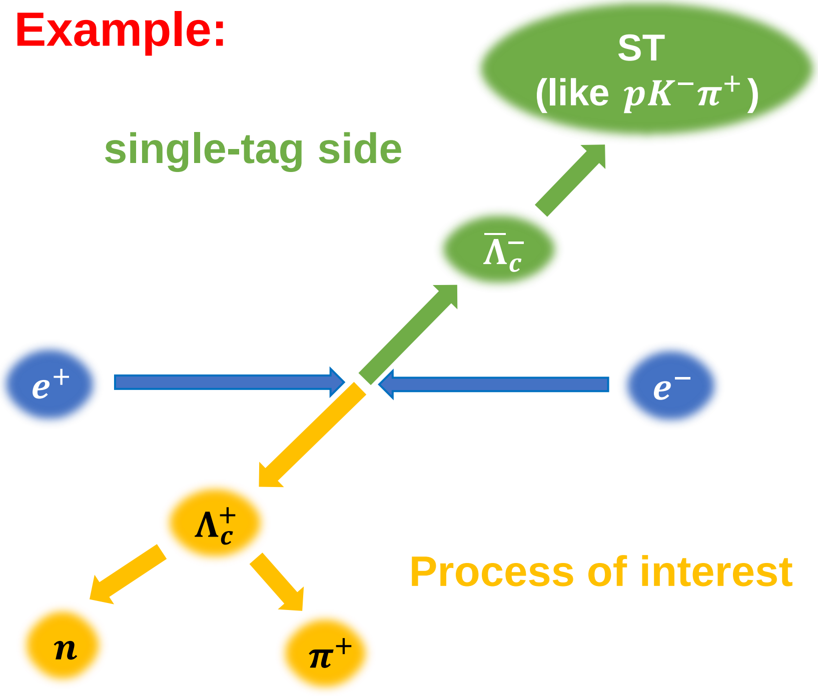
$$N_{i\,ST} = 2N_{\Lambda_c^+\bar{\Lambda}_c^-} \times \mathcal{B}_i \times \varepsilon_{i\,ST}$$

$$N_{i\,DT} = 2N_{\Lambda_c^+\bar{\Lambda}_c^-} \times \mathcal{B}_i \times \mathcal{B}_i \times \varepsilon_{i\,DT}$$

$$\mathcal{B}_s = \frac{\Sigma N_{i\,DT}}{N_{i\,ST} \times \varepsilon_{i\,DT} / \varepsilon_{i\,ST}}$$

i for each tag mode

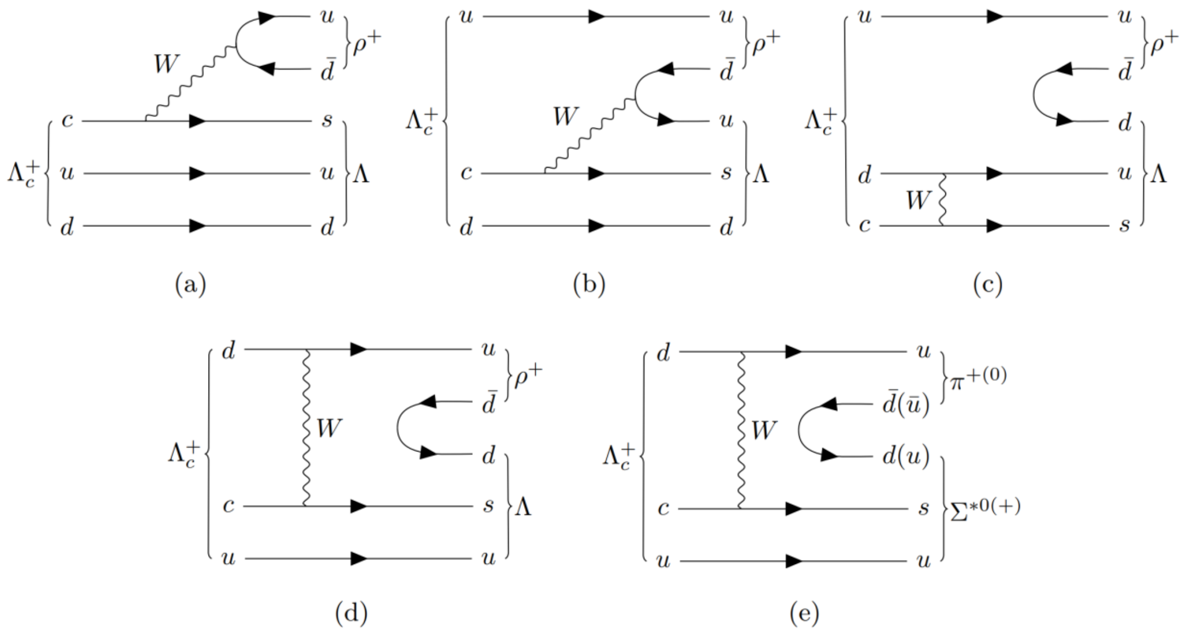
Example:



	decay modes of ST $\bar{\Lambda}_c^-$	absolute BR(%)
1	$\bar{p}K^+\pi^-$	6.28 ± 0.32
2	$\bar{p}K_S^0$	1.59 ± 0.08
3	$\bar{\Lambda}\pi^-$	1.30 ± 0.07
4	$\bar{p}K^+\pi^-\pi^0$	4.46 ± 0.30
5	$\bar{p}K_S^0\pi^0$	1.97 ± 0.13
6	$\bar{\Lambda}\pi^-\pi^0$	7.1 ± 0.4
7	$\bar{p}K_S^0\pi^+\pi^-$	1.60 ± 0.12
8	$\bar{\Lambda}\pi^-\pi^+\pi^-$	3.64 ± 0.29
9	$\bar{\Sigma}^0\pi^-$	1.29 ± 0.07
10	$\bar{\Sigma}^-\pi^+\pi^-$	4.50 ± 0.25
11	$\bar{\Sigma}^-\pi^0$	1.25 ± 0.10
12	$\bar{\Sigma}^0\pi^-\pi^0$	3.5 ± 0.4
13	$\bar{p}\pi^+\pi^-$	0.46 ± 0.03
14	$\bar{\Sigma}^0\pi^-\pi^+\pi^-$	1.11 ± 0.30

$\sim 40\%$

Partial wave analysis of $\Lambda_c^+ \to \Lambda\pi^+\pi^0$



$\Lambda_c^+ \to \Lambda\rho^+$ consists of both factorizable(a) and non-factorizable(b-d) contributions.

$\Lambda_c^+ \to \Sigma(1385)\pi$ consists of pure non-factorizable(e) contribution.

- BFs: related to the modulus squared of the sum of different topological amplitudes.

  Decay asymmetry parameters: relevant to the interference of the internal partial wave amplitudes.

- Non-factorizable contribution is more difficult to treat than factorizable in theoretical calculations.

  Provide important inputs to the theoretical calculations.

Partial wave analysis of $\Lambda_c^+ \to \Lambda\pi^+\pi^0$

- $\mathcal{B}(\Lambda_c^+ \to \Lambda\pi^+\pi^0)$ measured by BESIII with high precision[1]
- $\mathcal{B}(\Lambda_c^+ \to \Lambda\rho(770)^+) < 6\%$ by CLEO2[2]
- No previous BF measurement of $\Lambda_c^+ \to \Sigma(1385)\pi$.
- PWA intermediate processes in $\Lambda_c^+ \to \Lambda\pi^+\pi^0$ are interesting in theoretical calculations.
  - ✓ **Fit fractions (FFs)** and the partial wave amplitudes of intermediate resonances are derived.
  - ✓ Combining the FFs with the $\mathcal{B}(\Lambda_c^+ \to \Lambda\pi^+\pi^0) = (7.1 \pm 0.4)\%$ from PDG, determine $\boldsymbol{\mathcal{B}(\Lambda_c^+ \to \Lambda\rho(770)^+)}$ and $\boldsymbol{\mathcal{B}(\Lambda_c^+ \to \Sigma(1385)\pi)}$ using the partial wave amplitudes.
  - ✓ **Decay asymmetry parameters** are determined, test theoretical calculations of the partial waves interference effects.

[1]Phys.Rev.Lett.116.052001, [2]Phys.Lett.B.325.257

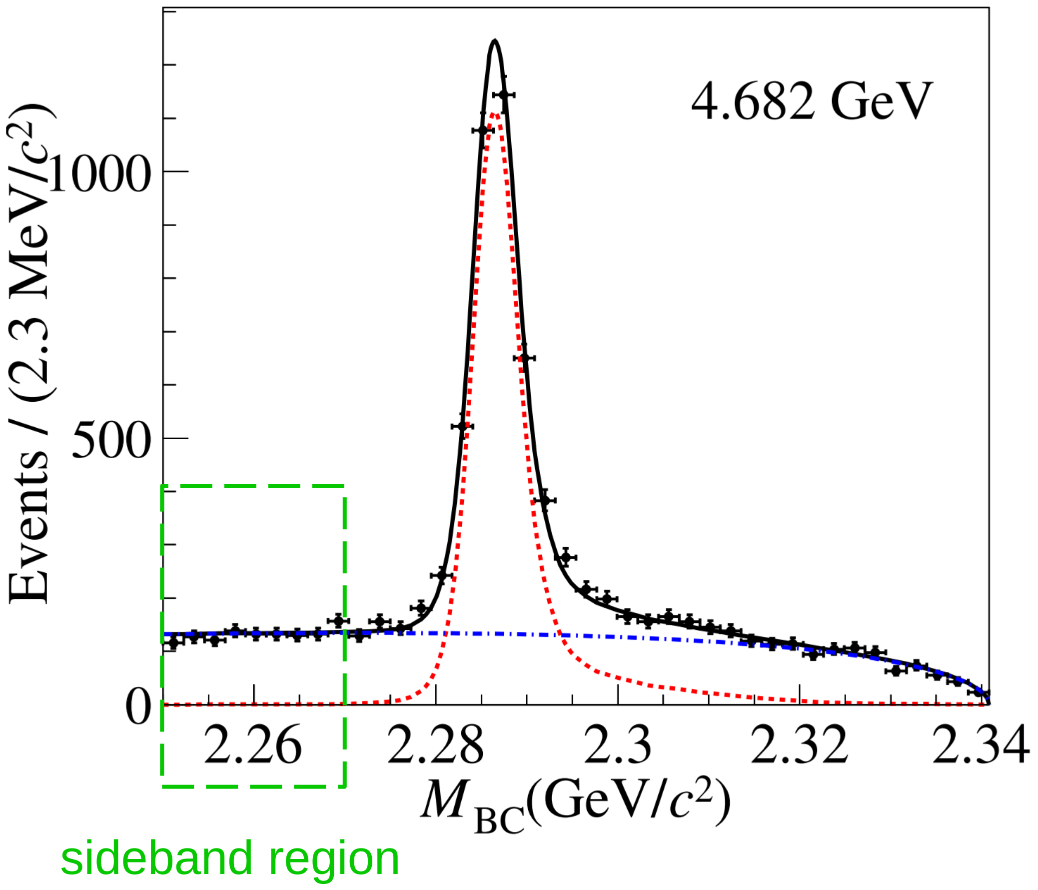
Partial wave analysis of $\Lambda_c^+ \to \Lambda\pi^+\pi^0$

J. High Energ. Phys. **2022**, 33 (2022)

- Use new-developed TensorFlow based package TF-PWA* to perform the PWA fit.

  (*BESIII Preliminary: https://github.com/jiangyi15/tf-pwa)

- **Helicity amplitude**.
- PWA is able to extract the intermediate processes explicitly.
- Single tag method, ~10k signal candidates, purities > 80%



Partial wave analysis of $\Lambda_c^+ \to \Lambda\pi^+\pi^0$

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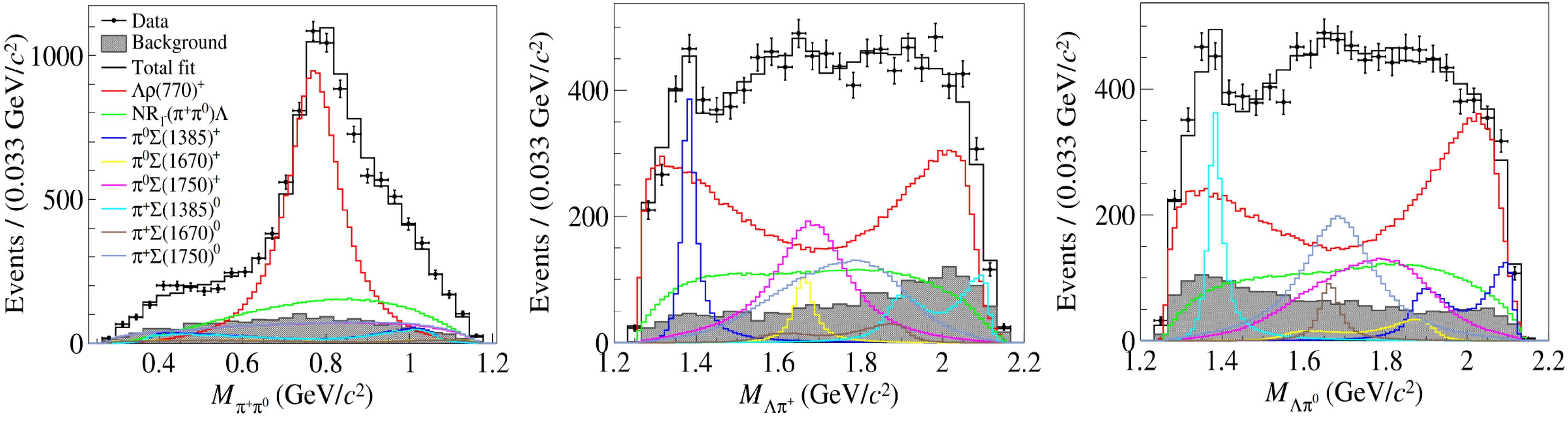
Fit results on invariant mass spectra:



Partial wave analysis of $\Lambda_c^+ \to \Lambda\pi^+\pi^0$

J. High Energ. Phys. **2022**, 33 (2022)

- First PWA performed in charmed baryon hadronic decay
- Using $\mathcal{B}(\Lambda_c^+ \to \Lambda\pi^+\pi^0) = 7.1 \pm 0.4\,\%$, $\mathcal{B}(\Sigma(1385) \to \Lambda\pi) = (87.0 \pm 1.5)\%$ from PDG
  Combined with FFs from PWA:

	Theoretical calculation		This work	PDG
$10^2 \times \mathcal{B}(\Lambda_c^+ \to \Lambda\rho(770)^+)$	4.81 ± 0.58 [13]	4.0 [14, 15]	4.06 ± 0.52	< 6
$10^3 \times \mathcal{B}(\Lambda_c^+ \to \Sigma(1385)^+\pi^0)$	2.8 ± 0.4 [16]	2.2 ± 0.4 [17]	5.86 ± 0.80	—
$10^3 \times \mathcal{B}(\Lambda_c^+ \to \Sigma(1385)^0\pi^+)$	2.8 ± 0.4 [16]	2.2 ± 0.4 [17]	6.47 ± 0.96	—
$\alpha_{\Lambda\rho(770)^+}$	-0.27 ± 0.04 [13]	-0.32 [14, 15]	-0.763 ± 0.070	—
$\alpha_{\Sigma(1385)^+\pi^0}$	$-0.91^{+0.45}_{-0.10}$ [17]		-0.917 ± 0.089	—
$\alpha_{\Sigma(1385)^0\pi^+}$	$-0.91^{+0.45}_{-0.10}$ [17]		-0.79 ± 0.11	—

α extracted through results of internal partial wave amplitudes

Ref. [13]: Phys. Rev. D 101 (2020) 053002.
Ref. [14,15]: Phys. Rev. D 46 (1992) 1042; Phys. Rev. D 55 (1997) 1697.
Ref. [16]: Eur. Phys. J. C 80 (2020) 1067.
Ref. [17]: Phys. Rev. D 99 (2019) 114022

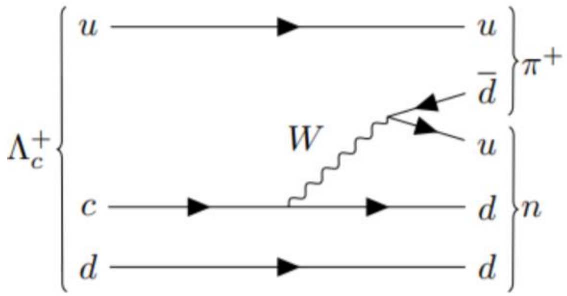
First observation of the SCS Decay $\Lambda_c^+ \to n\pi^+$

- Singly-Cabbibo-Suppressed (SCS) decay, contains non-negligible non-factorizable contributions.
- Provide information about factorizable and non-factorizable interference; constrain non-factorizable contributions; precise experimental inputs; test different phenomenological models.
- **DT method and missing technique**.

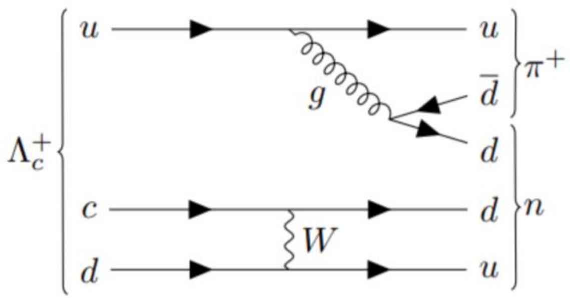
Phys. Rev. Lett. 128, 142001 (2022)

$$M_{rec}^2 = (E_{\text{beam}} - E_{\pi^+})^2/c^4 - \left|\rho \cdot \vec{p}_0 - \vec{p}_{\pi^+}\right|^2/c^2$$

- E_{π^+} and $\vec{p}_{\pi^+}$: energy and momentum of π^+ candidate.
- $\rho = \sqrt{(E_{\text{beam}}^2)/c^2 - m_{\Lambda_c^+}^2 c^2}$
- $\vec{p}_0 = -\vec{p}_{\bar{\Lambda}_c^-}/|\vec{p}_{\bar{\Lambda}_c^-}|$ is the unit direction opposite to the ST $\bar{\Lambda}_c^-$.

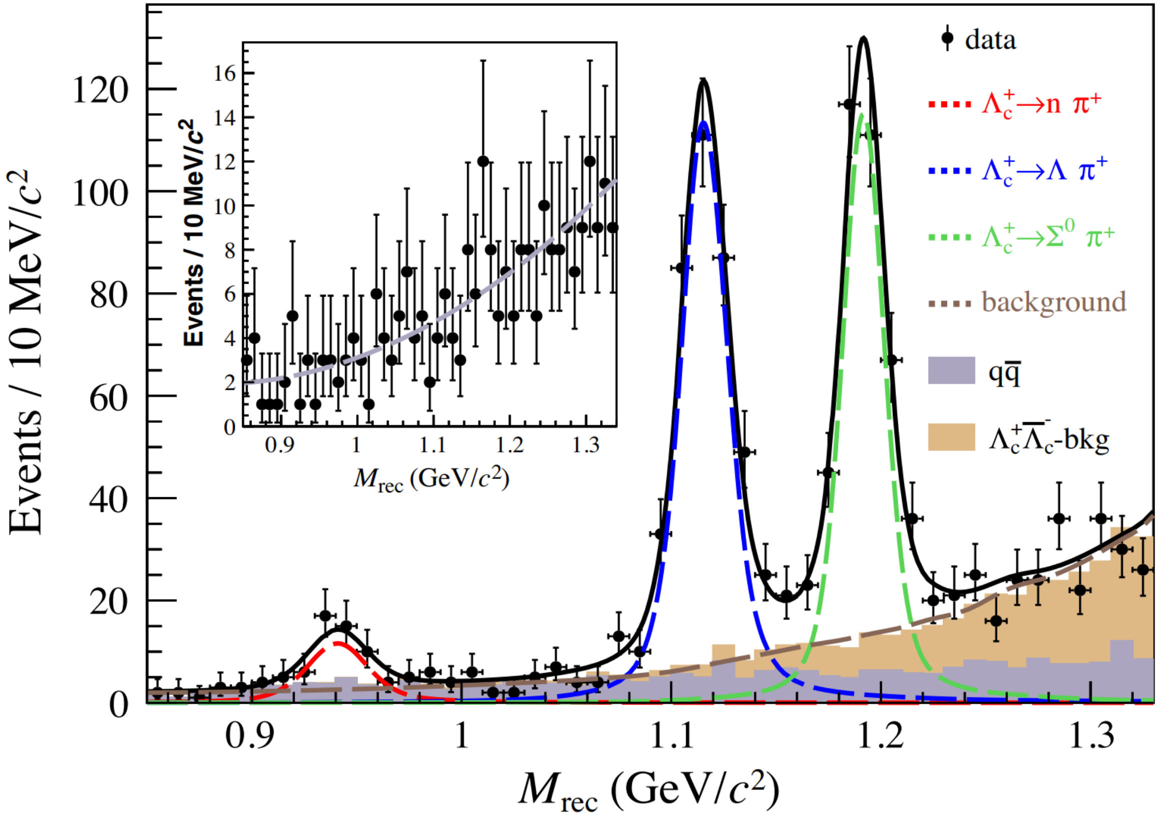


internal W-emission



W-exchange

First observation of the SCS Decay $\Lambda_c^+ \to n\pi^+$



Phys. Rev. Lett. 128, 142001 (2022)

	Decay	Yields	Branching fraction
Red peak	$\Lambda_c^+ \to n\pi^+$	$50\ \pm 9$	$6.6 \pm 1.2_{stat} \pm 0.4_{syst} \times 10^{-4}$
Blue peak	$\Lambda_c^+ \to \Lambda\pi^+$	$376\ \pm 22$	$1.31 \pm 0.08_{stat} \pm 0.05_{syst} \times 10^{-4}$
Green peak	$\Lambda_c^+ \to \Sigma^0\pi^+$	$343\ \pm 22$	$1.22 \pm 0.08_{stat} \pm 0.07_{syst} \times 10^{-4}$

Consistent with PDG

First measurement of SCS decay involving a neutron in the final state

$\mathbf{7.3\sigma}$!

First observation of the SCS Decay $\Lambda_c^+ \to n\pi^+$

Phys. Rev. Lett. 128, 142001 (2022)

$\mathcal{B}(\Lambda_c^+ \to n\pi^+) \times 10^{-4}$	R $= \mathcal{B}(\Lambda_c^+ \to n\pi^+)/\mathcal{B}(\Lambda_c^+ \to p\pi^0)$	Reference	phenomenological models
4	2	PRD 55, 7067 (1997)	SU(3) flavor symmetry model
9	2	PRD 93, 056008 (2016)	
11.3 ± 2.9	2	PRD 97, 073006 (2018)	
8 or 9	4.5 or 8.0	PRD 49, 3417 (1994)	constituent quark model
2.66	3.5	PRD 97, 074028 (2018)	a dynamical calculation based on pole model and current-algebra
6.1 ± 2.0	4.7	PLB 790, 225 (2019)	SU(3) flavor symmetry including the contributions from $\mathcal{O}(\overline{15})$
7.7 ± 2.0	9.6	JHEP 02 (2020) 165	topological-diagram approach

Use $\mathcal{B}(\Lambda_c^+ \to p\pi^0) < 0.8 \times 10^{-5}$ @90% C.L. from Belle PRD 103, 072004 (2021)

$R = \mathcal{B}(\Lambda_c^+ \to n\pi^+)/\mathcal{B}(\Lambda_c^+ \to p\pi^0) > 7.2$ @90% C.L.

Disagree with most phenomenological model predictions

Improved results with larger data set, in particular concerning the $\mathcal{B}(\Lambda_c^+ \to p\pi^0)$, will come out soon.

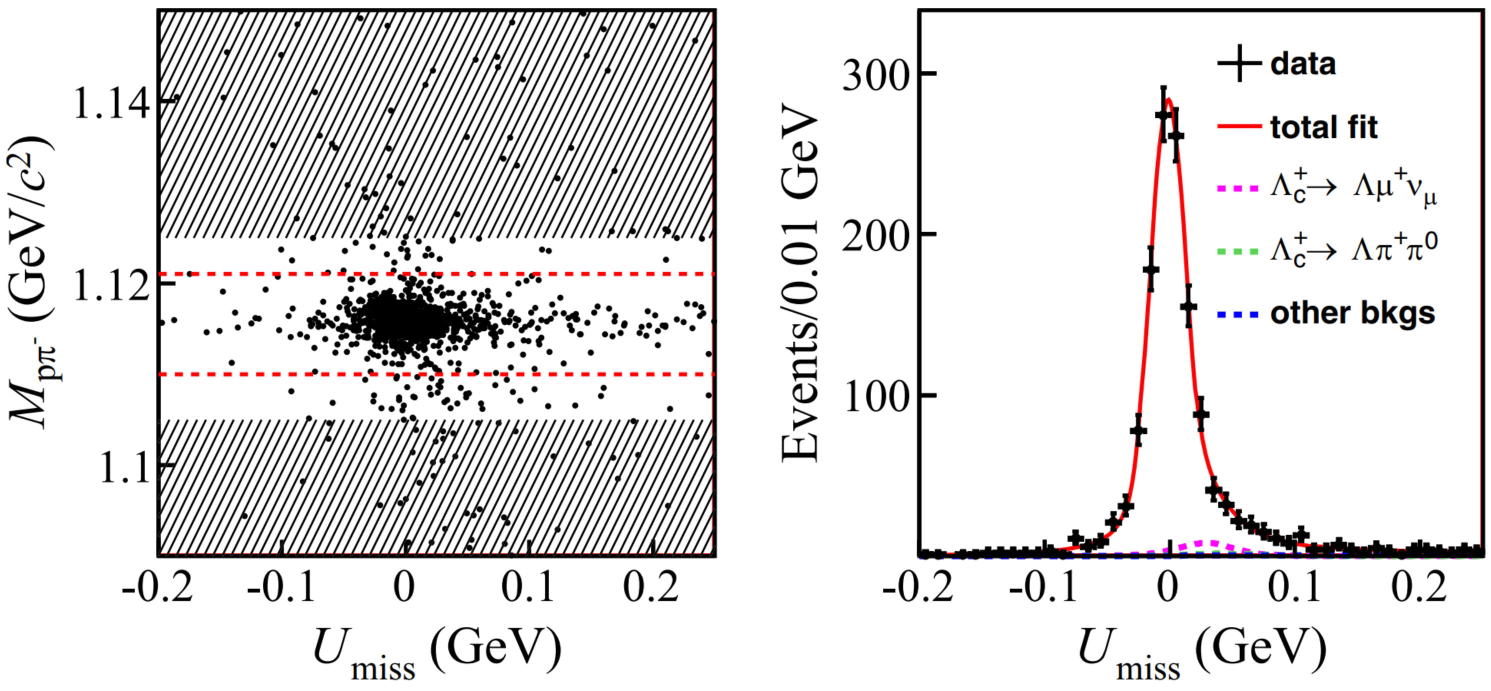
Measurement of $\Lambda_c^+ \to \Lambda e^+ \nu_e$

- Its decay rate depends on $|V_{cs}|$ and strong interaction effects parametrized by form factors describing initial and final baryons hadronic transition.
- LQCD predicted both the differential decay rates and the form factors. However, no direct experimental comparisons.
- Test on Lattice calculations, important information on strong interactions in charm baryon sector.

Measurement of $\Lambda_c^+ \to \Lambda e^+ \nu_e$

DT method and missing technique

Phys. Rev. Lett. 129, 231803 (2022)



$$E_{\rm miss} = E_{\rm beam} - \Sigma_f E_f$$
$$\vec{p}_{\rm miss} = \vec{p}_{\Lambda_c} - \Sigma_f \vec{p}_f$$
$$U_{\rm miss} = E_{\rm miss} - |\vec{p}_{\rm miss}|$$

Fit on $U_{\rm miss}$ to extract signal yields

$N^{\rm DT} = 1253 \pm 39$

Most precise measurement $\mathcal{B}(\Lambda_c^+ \to \Lambda e^+ \nu_e) = (3.56 \pm 0.11 \pm 0.07)\%$

precision improved by threefold

Comparison with theoretical models

	$\mathcal{B}(\Lambda_c^+ \to \Lambda e^+ \nu_e)$ (%)
Constituent quark model (HONR) [9]	4.25
Light-front approach [10]	1.63
Covariant quark model [11]	2.78
Relativistic quark model [12]	3.25
Non-relativistic quark model [13]	3.84
Light-cone sum rule [14]	3.0 ± 0.3
Lattice QCD [15]	3.80 ± 0.22
$SU(3)$ [16]	3.6 ± 0.4
Light-front constituent quark model [17]	3.36 ± 0.87
MIT bag model [17]	3.48
Light-front quark model [18]	4.04 ± 0.75
This Letter	$3.56 \pm 0.11 \pm 0.07$

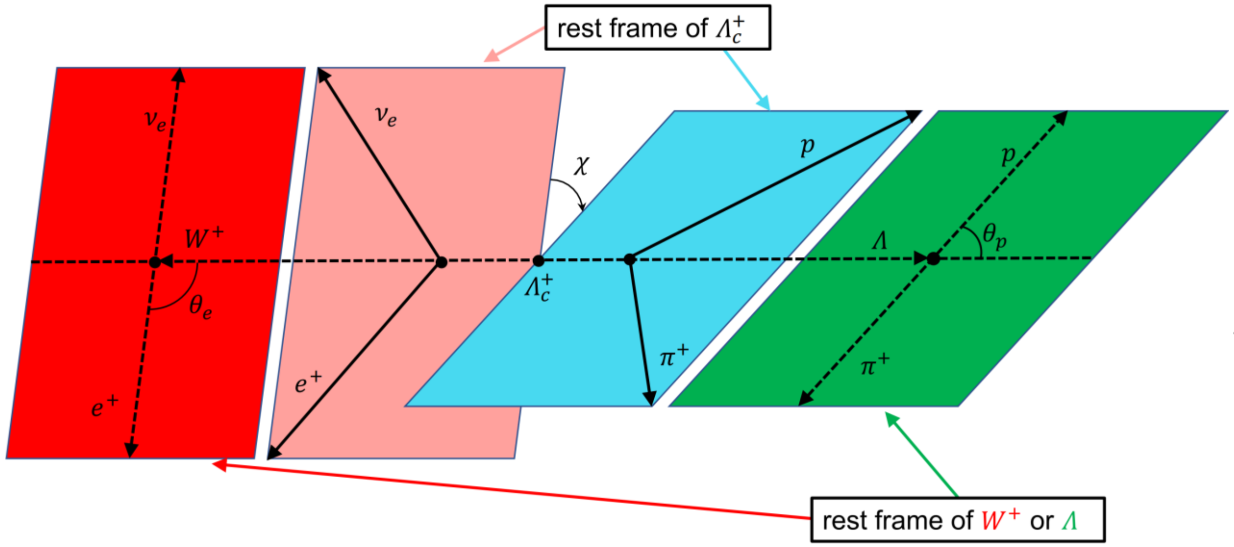
Phys. Rev. Lett. 129, 231803 (2022)

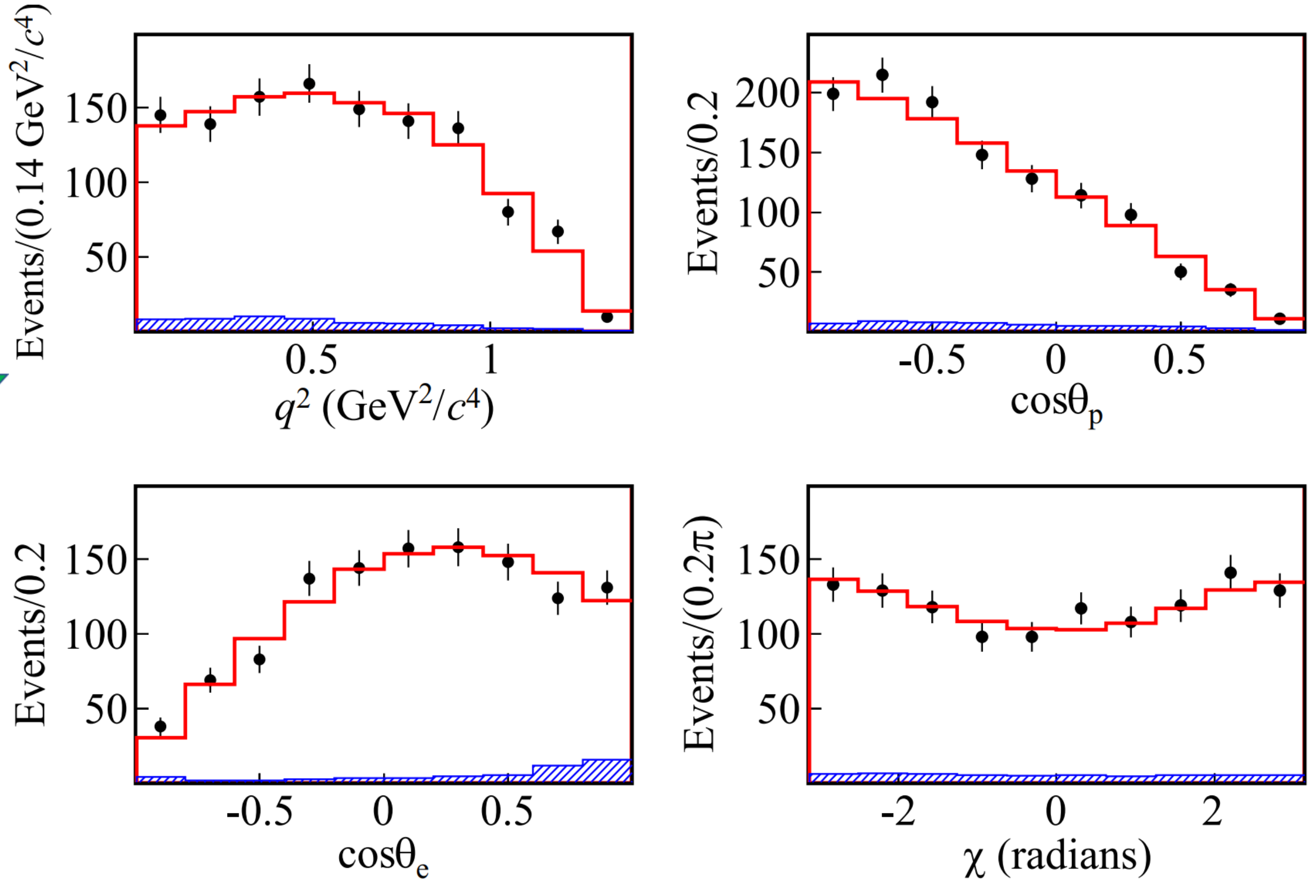
$> 2\sigma$ deviation
disfavors these predictions @ $\mathrm{C.L.}$ more than 95%

4-dimensional fit

Phys. Rev. Lett. 129, 231803 (2022)

q^2: $e^+\nu_e$ mass squared



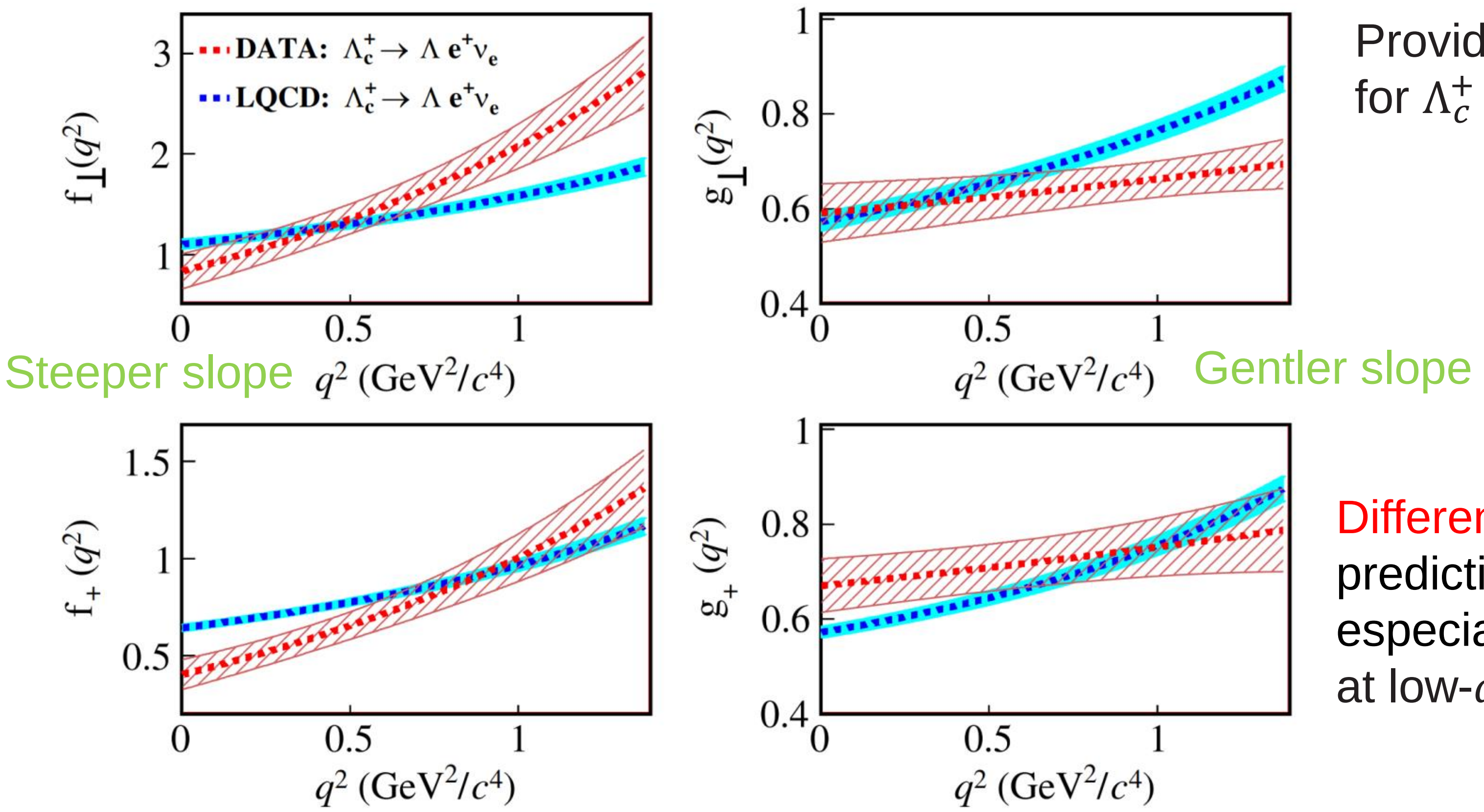


Projections of the fitted kinematic variables

Comparisons between data and LQCD prediction

Form factor

Phys. Rev. Lett. 129, 231803 (2022)



Provide **first direct comparisons to LQCD** for $\Lambda_c^+ \to \Lambda$ decay form factor

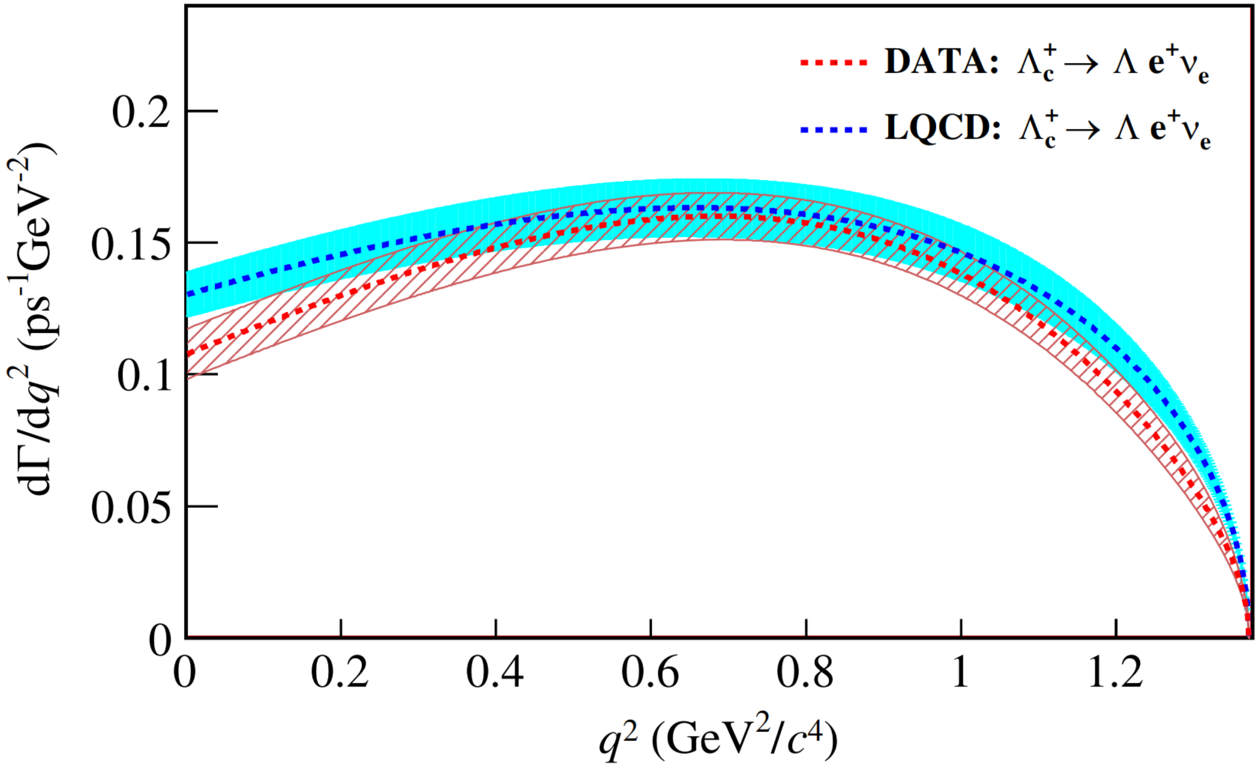
Different kinematic behavior compared to LQCD predictions,
especially at high$-q^2$ regions for $f_\perp(q^2)$ and $g_\perp(q^2)$,
at low-q^2 regions for $f_+(q^2)$.

LQCD prediction: Phys. Rev. Lett. 118, 082001 (2017)

Comparisons between data and LQCD prediction

Differential decay rate

Phys. Rev. Lett. 129, 231803 (2022)



LQCD prediction: Phys. Rev. Lett. 118, 082001 (2017)

Provide **first direct comparisons to LQCD** for differential decay rate

fair agreement throughout the q^2 region

Important inputs in understanding the Λ_c^+ SL decays. Help calibrate the calculation of SL decays of other charmed baryons and Λ_b.

Determine $|V_{cs}|$

Phys. Rev. Lett. 129, 231803 (2022)

- Combining $\mathcal{B}(\Lambda_c^+ \to \Lambda e^+ \nu_e)$ measured in this Letter, $\tau_{\Lambda_c^+}$, and the q^2-integrated rate predicted by LQCD

  $\to |V_{cs}| = 0.936 \pm 0.017_{\mathcal{B}} \pm 0.024_{\text{LQCD}} \pm 0.007_{\tau_{\Lambda_c}}$

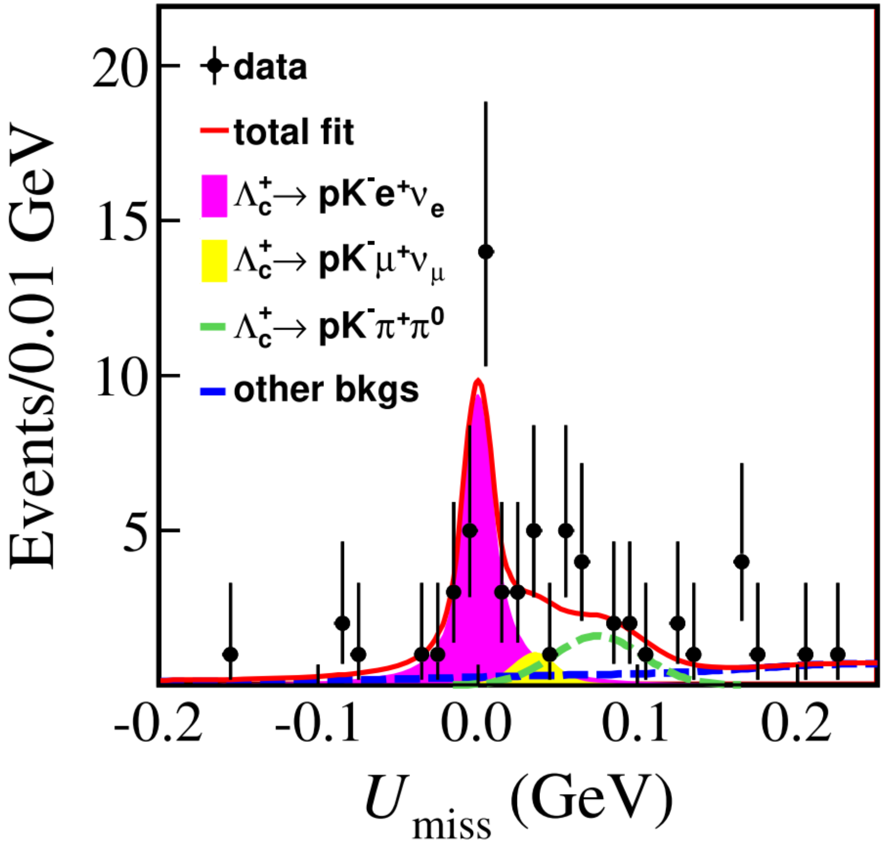
- Consistent with $|V_{cs}| = 0.939 \pm 0.038$ measured in $D \to K\ell\nu_\ell$ decays within 1σ
- Measurement of $|V_{cs}|$ via $\Lambda_c^+ \to \Lambda\ell\nu_\ell$ is an important consistency test for the SM and a probe for new physics

The observation of $\Lambda_c^+ \to pK^- e^+ \nu_e$

- Its decay rate depends on $|V_{cs}|$ and strong interaction effects parametrized by form factors describing initial and final baryons hadronic transition.
- $\mathcal{B}(\Lambda_c^+ \to \Lambda \ell^+ \nu_\ell)/\mathcal{B}(\Lambda_c^+ \to X \ell^+ \nu_\ell) \sim 1$, different with charm mesons.

  Search for unknown exclusive SL Λ_c^+ decay to validate and understand this pattern.
- LQCD calculations of $J^P = 1/2^+ \to 3/2^-$ transition are limited. No experimental data.
- $\mathcal{B}(\Lambda_c^+ \to \Lambda^* e^+ \nu_e)$ comparison help check nonrelativistic quark model and constituent quark model.

The observation of $\Lambda_c^+ \to pK^- e^+ \nu_e$



Phys. Rev. D 106, 112010 (2022)

DT method and missing technique.
Fit to the $U_{\rm miss}$ distribution

The first SL Λ_c^+ decay without Λ in the final state
Observation with 8.2σ considering systematic uncertainty

$N_{DT}^{pK^- e^+ \nu} = 33.5 \pm 6.3$

$\mathcal{B}(\Lambda_c^+ \to pK^- e^+ \nu_e) = 0.88 \pm 0.17_{\rm stat} \pm 0.07_{\rm syst} \times 10^{-3}$

$[\mathcal{B}(\Lambda_c^+ \to pK^- e^+ \nu_e)/\mathcal{B}(\Lambda_c^+ \to X e^+ \nu_e)] = 2.1 \pm 0.4_{\rm stat} \pm 0.2_{\rm syst} \times 10^{-3}$

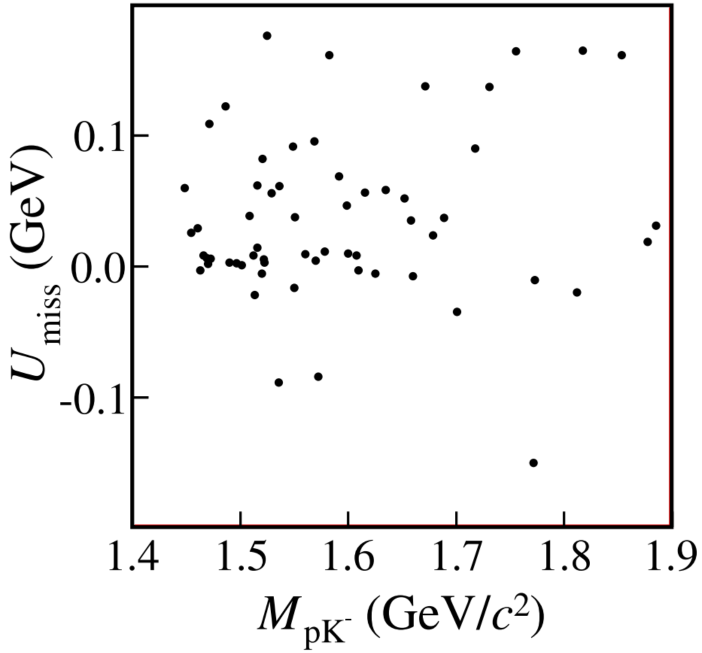
$\to$ SL Λ_c^+ decays are not saturated by the $\Lambda \ell^+ \nu_\ell$ final state

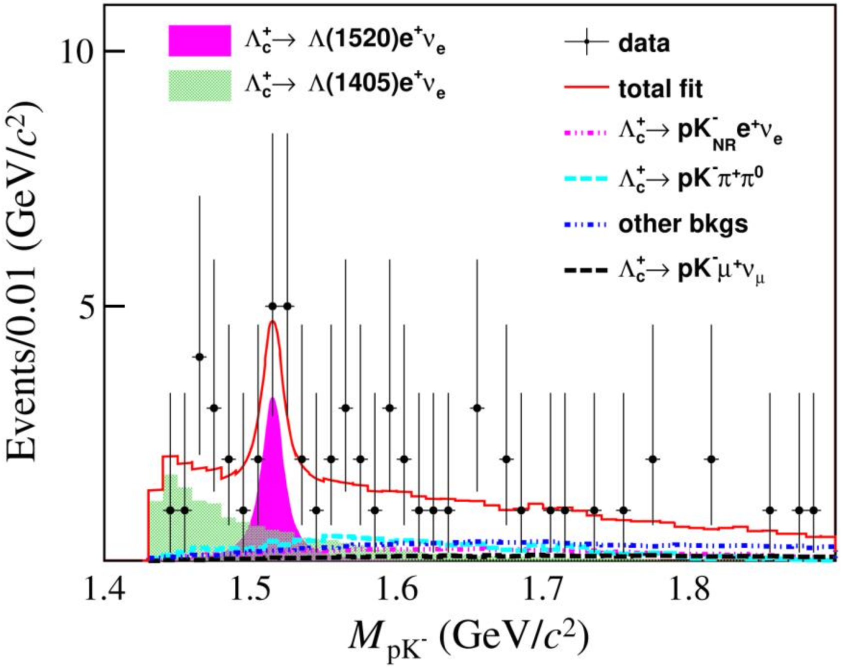
The observation of $\Lambda_c^+ \to pK^- e^+ \nu_e$

Phys. Rev. D 106, 112010 (2022)

Study with M_{pK^-} spectrum to understand the nature of excited Λ^* states

2D fit to M_{pK^-} vs. U_{miss}





First evidence of
$\Lambda_c^+ \to \Lambda(1520)e^+ \nu_e$ with 3.3σ
$\Lambda_c^+ \to \Lambda(1405)e^+ \nu_e$ with 3.2σ
considering systematic uncertainty

The observation of $\Lambda_c^+ \to pK^- e^+ \nu_e$

Phys. Rev. D 106, 112010 (2022)

- $\mathcal{B}(\Lambda_c^+ \to \Lambda(1520)e^+ \nu_e) = 1.02 \pm 0.52_{\text{stat}} \pm 0.11_{\text{syst}} \times 10^{-3}$
- $\mathcal{B}(\Lambda_c^+ \to \Lambda(1520) \to pK^- e^+ \nu_e) = 0.23 \pm 0.12_{\text{stat}} \pm 0.02_{\text{syst}} \times 10^{-3}$
- $\mathcal{B}(\Lambda_c^+ \to \Lambda(1405) \to pK^- e^+ \nu_e) = 0.42 \pm 0.19_{\text{stat}} \pm 0.04_{\text{syst}} \times 10^{-3}$

model predictions of BF differ by a factor of roughly 100 times

	$\mathcal{B}(\Lambda_c^+ \to \Lambda(1520)e^+\nu_e)$	$\mathcal{B}(\Lambda_c^+ \to \Lambda(1405)e^+\nu_e)$
Constituent quark model [8]	1.01	3.04
Molecular state [9]	...	0.02
Nonrelativistic quark model [10]	0.60	2.43
Lattice QCD [12,13]	0.512 ± 0.082	...
Measurement	$1.02 \pm 0.52 \pm 0.11$	$\frac{0.42\pm0.19\pm0.04}{\mathcal{B}(\Lambda(1405)\to pK^-)}$

all consistent within 2σ

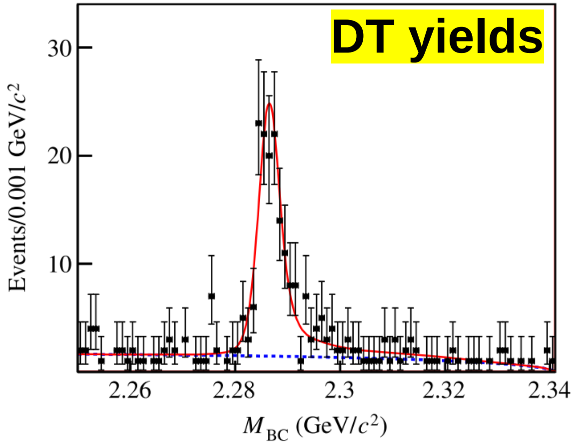
Extend the understanding of Λ_c^+ SL decays beyond $\Lambda_c^+ \to \Lambda\ell^+\nu_\ell$

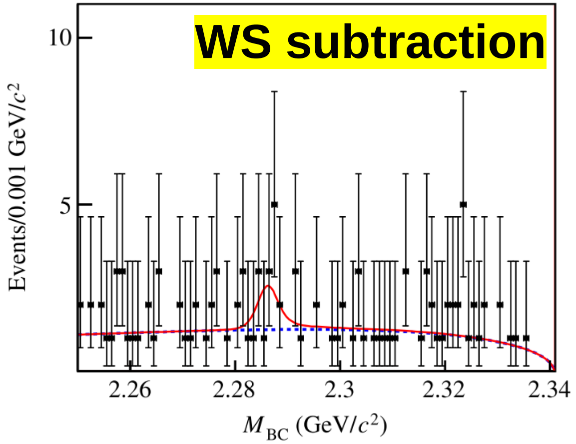
Prospects: With larger samples, amplitude analysis of pK^- mass spectrum, form factors, to understand the internal structure of the contributing Λ^* states.

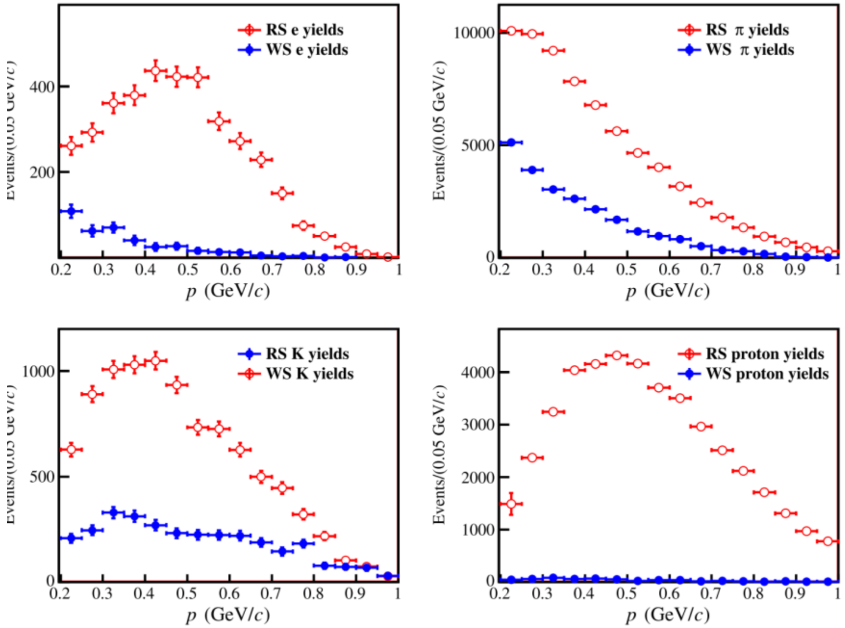
Inclusive SL decay: improved measurement of $\Lambda_c^+ \to X e^+ \nu_e$

[Phys. Rev. D 107, 052005 (2023)](#)

DT method







recoil-side e^+ momentum bin:
2 charge categories:
right-sign (RS) : opposite to ST $\bar{\Lambda}_c^-$
wrong-sign (WS) : equal to ST $\bar{\Lambda}_c^-$
use WS samples to determine the charge-symmetric backgrounds in RS samples.

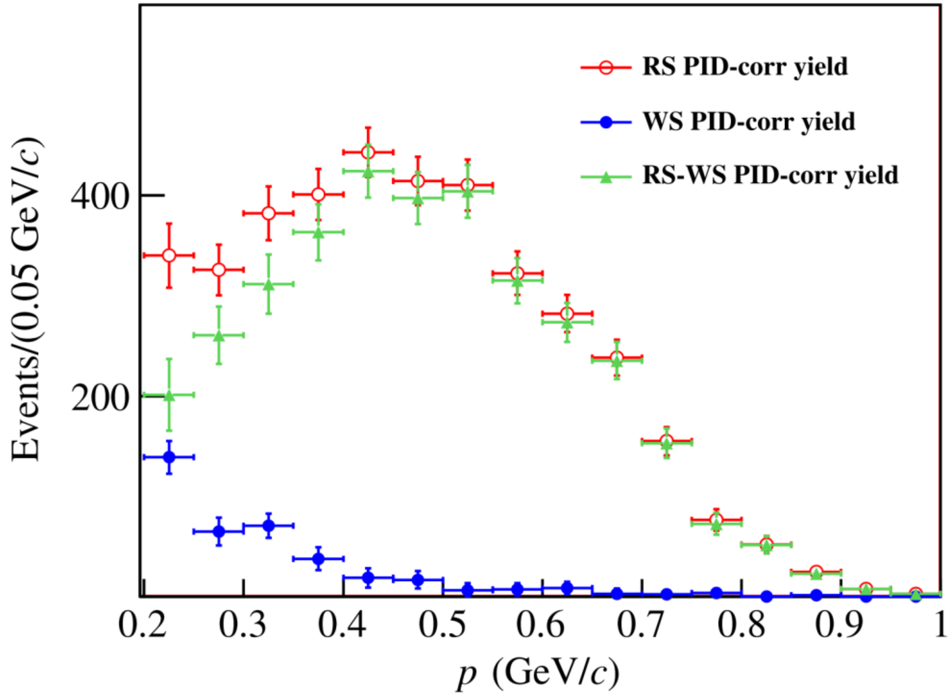
Unfolding method to obtain true signal yields.
The matrix obtained using control samples.

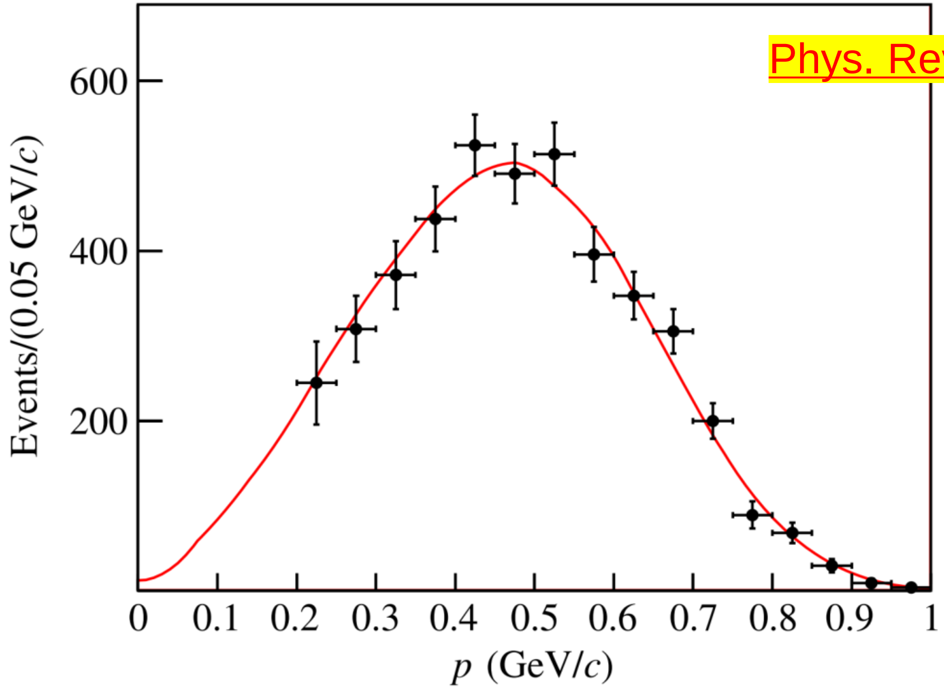
$$\begin{bmatrix} N_e^{\rm obs} \\ N_\pi^{\rm obs} \\ N_K^{\rm obs} \\ N_p^{\rm obs} \end{bmatrix} = \begin{bmatrix} P_{e\to e} & P_{\pi\to e} & P_{K\to e} & P_{p\to e} \\ P_{e\to\pi} & P_{\pi\to\pi} & P_{K\to\pi} & P_{p\to\pi} \\ P_{e\to K} & P_{\pi\to K} & P_{K\to K} & P_{p\to K} \\ P_{e\to p} & P_{\pi\to p} & P_{K\to p} & P_{p\to p} \end{bmatrix} \begin{bmatrix} N_e^{\rm true} \\ N_\pi^{\rm true} \\ N_K^{\rm true} \\ N_p^{\rm true} \end{bmatrix}$$ **PID**

$$N_{\rm e}^{\rm true}(i) = \sum_j A_{\rm TRK}(e|i,j) N_{\rm e}^{\rm prod}(j)$$ **tracking**

Correction (see text)	RS yields	WS yields
Observed yields	3706 ± 71	394 ± 31
PID unfolding yields	3865 ± 80	376 ± 33
WS subtraction	3489 ± 87	
Tracking unfolding yields	4333 ± 107	
Extrapolation	4692 ± 117	

Inclusive SL decay: improved measurement of $\Lambda_c^+ \to X e^+ \nu_e$





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precision improved by **more than threefold**

$\boldsymbol{\mathcal{B}(\Lambda_c^+ \to X e^+ \nu_e) = (4.06 \pm 0.10_{stat} \pm 0.09_{syst})\%}$

$\mathcal{B}(\Lambda_c^+ \to \Lambda e^+ \nu_e) = (3.56 \pm 0.11_{stat} \pm 0.07_{syst})\%$

$\mathcal{B}(\Lambda_c^+ \to p K^- e^+ \nu_e) = \left(0.88 \pm 0.15_{stat} \pm 0.07_{syst}\right) \times 10^{-3}$

Unknown decay: 0.5%

some new Λ_c^+ SL decays may exist beyond the known $\Lambda_c^+ \to \Lambda \ell^+ \nu_\ell$ and $\Lambda_c^+ \to p K^- \ell^+ \nu_\ell$ $(\ell = e,\ \mu)$

Inclusive SL decay: improved measurement of $\Lambda_c^+ \to Xe^+\nu_e$

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- Combining $\tau_{\Lambda_c^+}$ and the charge-averaged SL decay width of non-strange charmed mesons, obtain $\Gamma(\Lambda_c^+ \to Xe^+\nu_e) = (2.006 \pm 0.073) \times 10^{11}\ \mathrm{s}^{-1}$

	$\frac{\Gamma(\Lambda_c^+ \to Xe^+\nu_e)}{\bar{\Gamma}(D \to Xe^+\nu_e)}$	**model Ref.**
heavy quark expansion	1.2	Phys. Rev. D 49, 1310 (1994)
effective-quark method	1.67	Phys. Rev. D 83, 034025 (2011) Phys. Rev. D 86, 014017 (2012)
This work	$\mathbf{1.28 \pm 0.05}$	

⇨ consistent

⇨ disfavor

@ 95% C.L.

Summary

- Using $4.5\ \mathrm{fb}^{-1}$ data samples of $\Lambda_c^+\bar{\Lambda}_c^-$ collected by BESIII, many significant measurements are performed.

✓ First PWA of $\Lambda_c^+ \to \Lambda\pi^+\pi^0$ at BESIII

✓ The first observation of SCS Λ_c^+ decays, including $\Lambda_c^+ \to n\pi^+$

✓ Achievement on SL decays:

  ✓ $\Lambda_c^+ \to \Lambda e^+\nu$ with improved measurement of BF, first direct comparison of $\frac{\mathrm{d}\Gamma}{\mathrm{dq}^2}$ and Form factor with LQCD

  ✓ The first observation of $\Lambda_c^+ \to pK^-e^+\nu$, evidence of $\Lambda(1520)$ and $\Lambda(1405)$ in M_{pK^-}

  ✓ Improved measurement of inclusive SL decay $\Lambda_c^+ \to Xe^+\nu$

- BESIII has made substantial progresses on the exploration of the charmed baryon Λ_c^+ decays!

- More results will be released in the future!

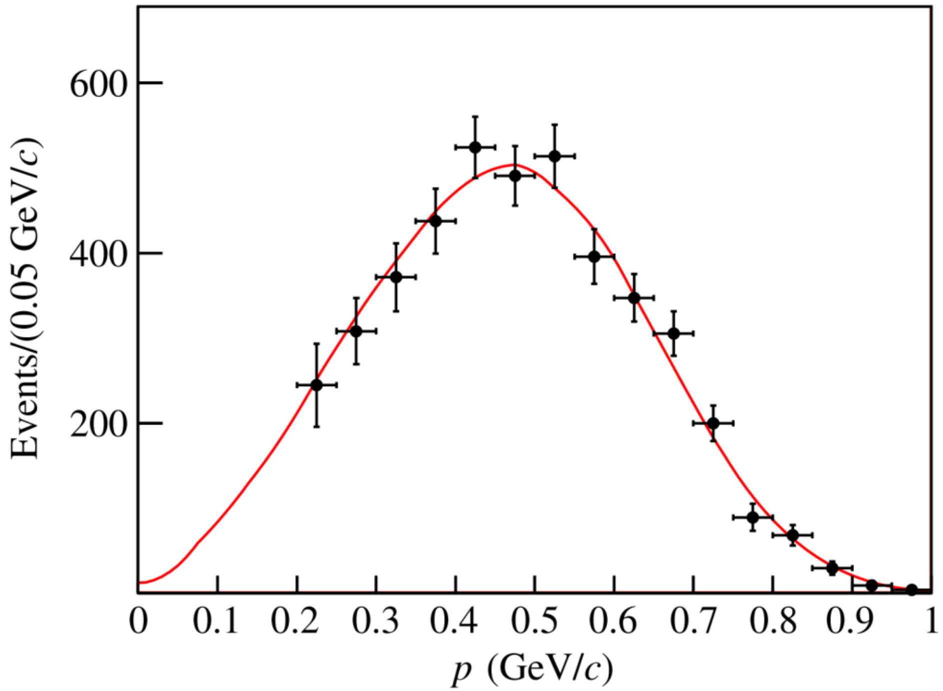
Thanks for your attention!

Backup

Inclusive SL decay: improved measurement of $\Lambda_c^+ \to X e^+ \nu_e$

- The track is required to have momentum above $200\ \mathrm{MeV}/c$ since PID is difficult at low momenta.
- The yield of positrons with $p_e \le 200\ \mathrm{MeV}/c$ is obtained by fitting the efficiency-corrected positron momentum spectrum with the sum of the spectra of the exclusive decay channels. In the fit, the BF of each component is fixed to its central value.

Decay	$\mathcal{B}$ [%]	Model
$\Lambda_c^+ \to \Lambda e^+ \nu_e$	$3.56 \pm 0.11 \pm 0.07$	References [6]
$\Lambda_c^+ \to p K^- (n \bar{K}^0) e^+ \nu_e$	$0.088 \pm 0.017 \pm 0.007$	PHSP [7]
$\Lambda_c^+ \to \Lambda(1405) e^+ \nu_e$	0.24	HQET [27,28]
$\Lambda_c^+ \to \Lambda(1520) e^+ \nu_e$	0.06	HQET [27,28]
$\Lambda_c^+ \to n e^+ \nu_e$	0.20	Quark model [29]



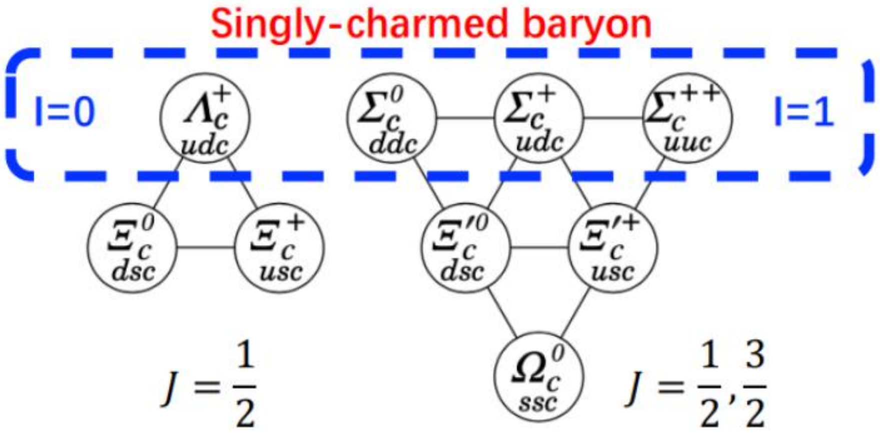
Future charmed baryon plan on BESIII

□Upgrade of BEPCII (BEPCII-U)

- improve luminosity by 3 times higher at 4.7 GeV
- Extend the maximum energy to 5.6 GeV

□Cover all the ground-state charmed baryons: studies on their production & decays, CPV search, to help developing more reliable QCD-derived models in charm sector

□Studies on the production and decays of excited charmed baryons



- Energy thresholds
  - ✓ $e^+e^- \to \Lambda_c^+\bar{\Sigma}_c^-$ 4.74 GeV
  - ✓ $e^+e^- \to \Lambda_c^+\bar{\Sigma}_c\ \pi$ 4.88 GeV
  - ✓ $e^+e^- \to \Sigma_c\ \bar{\Sigma}_c$ 4.91 GeV
  - ✓ $e^+e^- \to \Xi_c\ \bar{\Xi}_c$ 4.94 GeV
  - ✓ $e^+e^- \to \Omega_c^0\bar{\Omega}_c^0$ 5.40 GeV