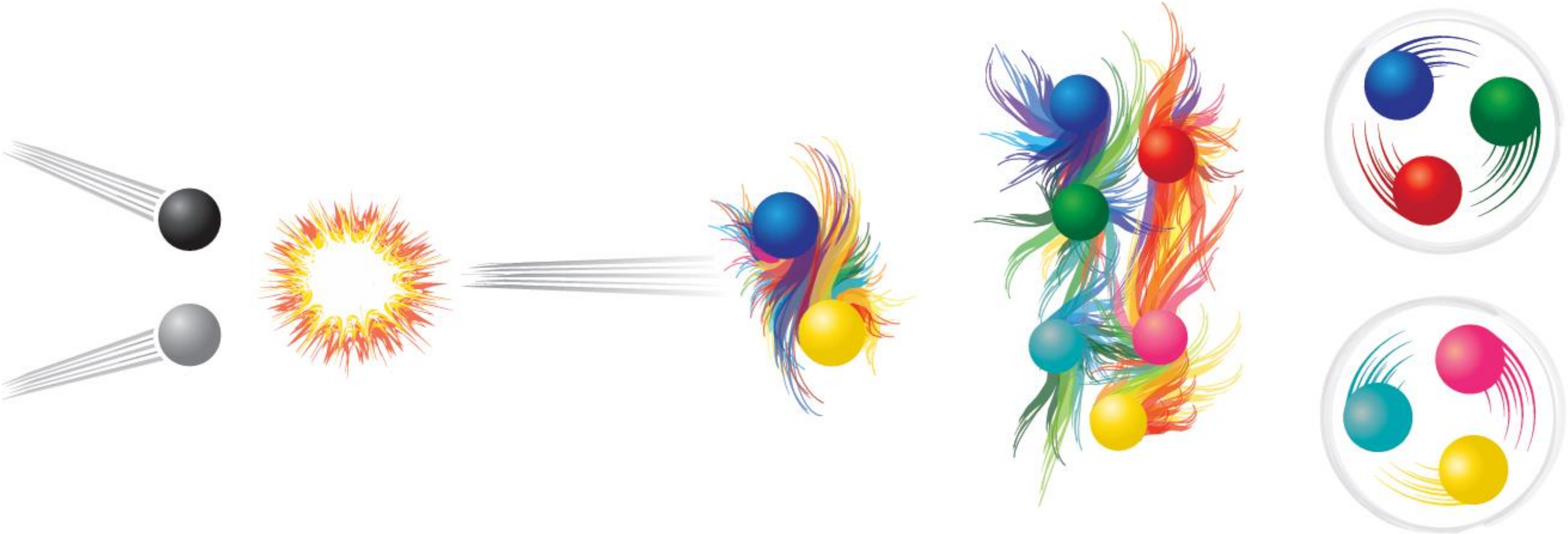
Baryons at the Belle II and BESIII experiments



15th International Workshop on the Physics of Excited Nucleons,
Sevilla, Spain, September 6-11 2026

Prof. Dr. Karin Schönning, Uppsala University, on behalf of the BESIII and Belle II collaborations

Picture credit: Göran Durgé

Outline

- Baryon Physics with e^+e^- colliders
- BESIII and Belle II
- Recent highlights from Belle II
- Recent highlights from BESIII

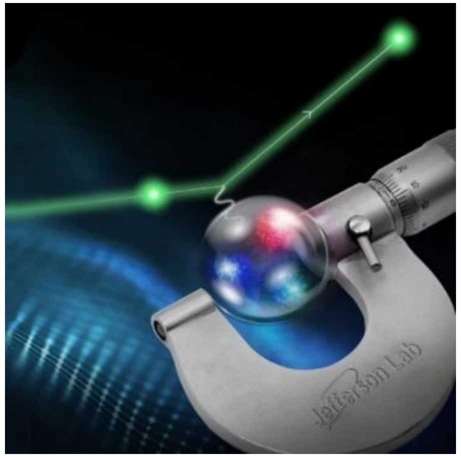
Baryon Physics with e^+e^- colliders

Advantages of e^+e^- colliders:

- **Clean** production process with a well-known **initial state.**
- Baryon-antibaryon **symmetric**.
- Suitable for **near-4π detectors**

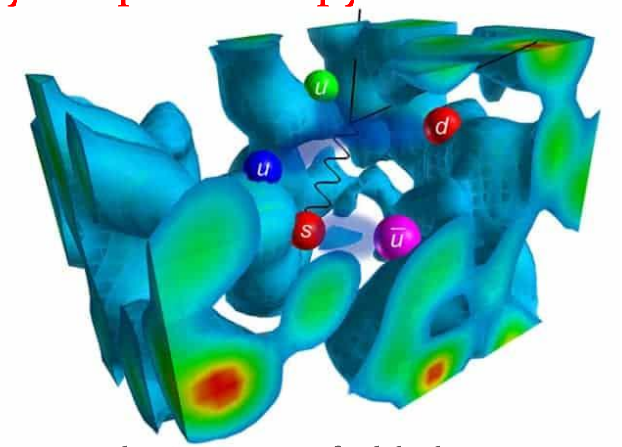
  → allows an **exclusive** or **highly constrained** final state!
- Broad baryon physics scope.

Baryon Structure



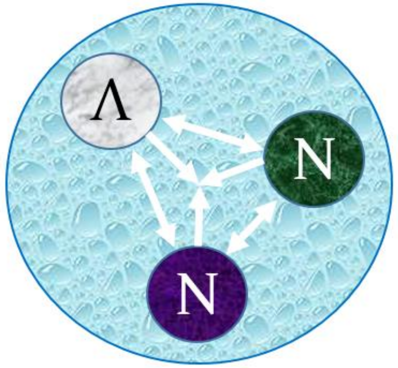
Credit: DOE's Jefferson Lab

Baryon Spectroscopy

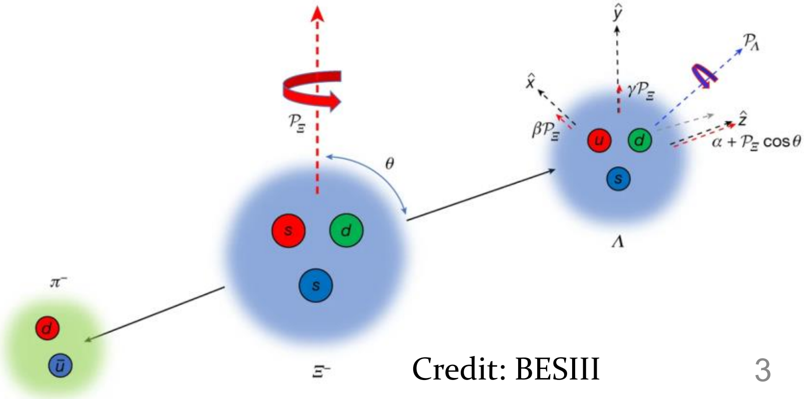


Credit Derek B Leinweber/University of Adelaide

Baryon and Antibaryon Interactions



Baryon Decays and Symmetry Tests



Credit: BESIII

Baryon Structure at e^+e^- colliders

Time-like EM form factors

- ”Snapshots” of the time evolution of the baryon-antibaryon.
- Allow study of unstable baryons.
- Access option 1: e^+e^- annihilation into an **exclusive** final state.
- Access option 2: Baryon Dalitz decays.

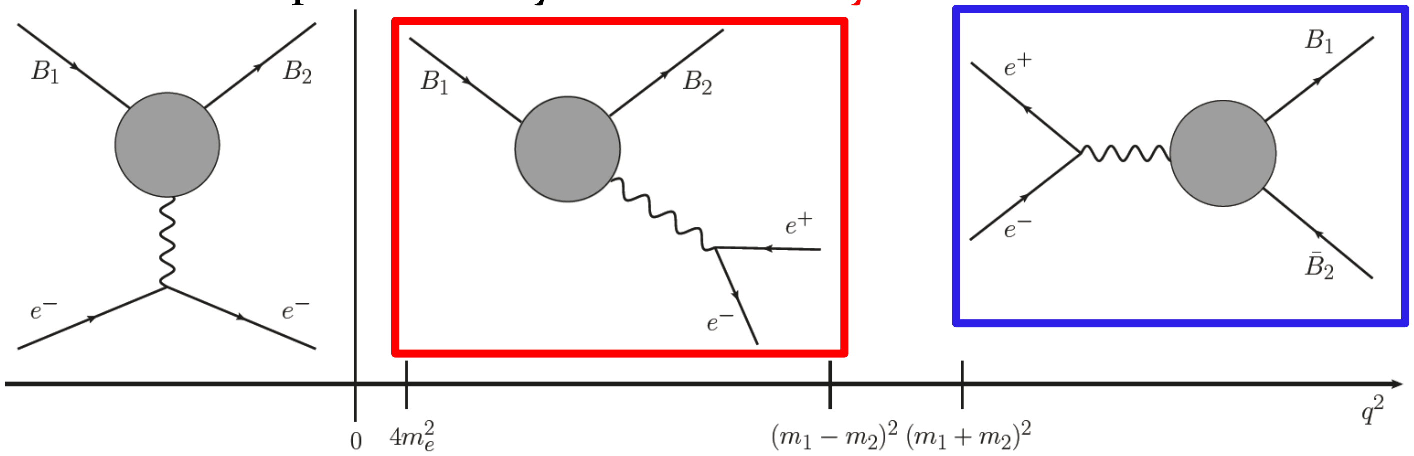


Figure adapted from E. Perotti, PhD thesis (Uppsala 2020)

Fragmentation functions

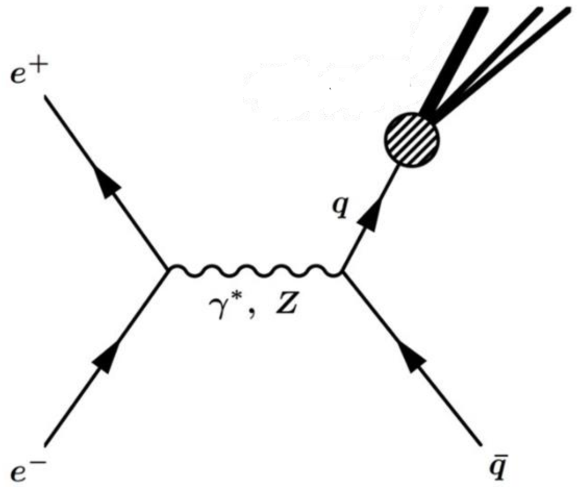


Figure adapted from *PTEP* 2016 (2016) 11, 113B04

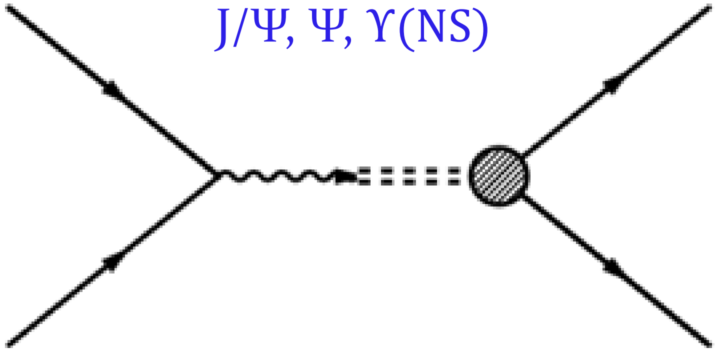
- Quantify coloured partons forming colour-neutral hadrons.
- Access in **inclusive** hadron production from e^+e^- annihilation.

Baryon Decays & Spectroscopy at e^+e^- colliders

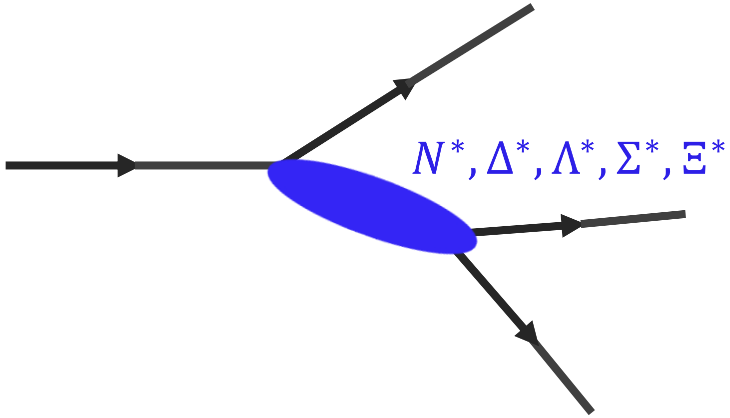
Exploit

- Abundant production and well-known initial state in

Quarkonium decays
J/Ψ, Ψ, $\Upsilon(NS)$



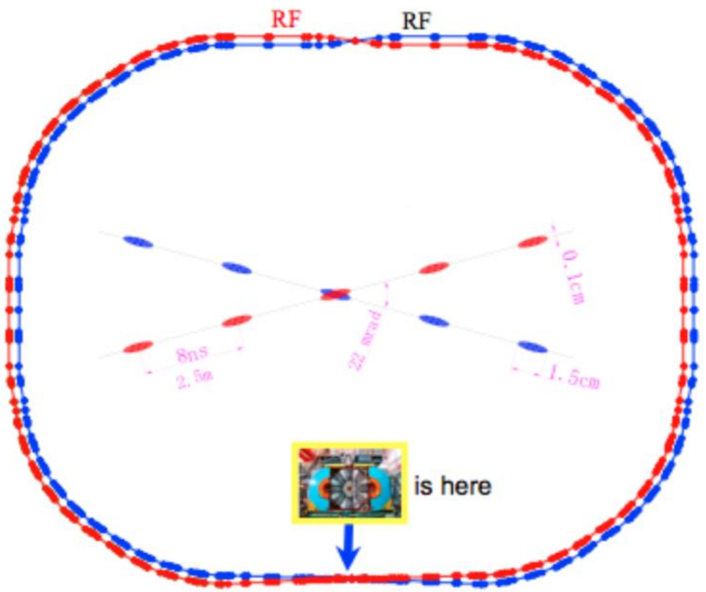
Decaying charm baryons $\Lambda_c^+, \Xi_c^+, \Xi_c^0$
produced in the $e^+e^- \to c\bar{c}$ continuum



- Versatile detectors for reconstruction of final state particles:

$\gamma, \pi^\pm, \pi^0, \eta, K_S, K_L, p, \bar{p}, \bar{n}, e^\pm, \mu^\pm$ ...

BESIII at BEPC-II



BEPC-II, Beijing

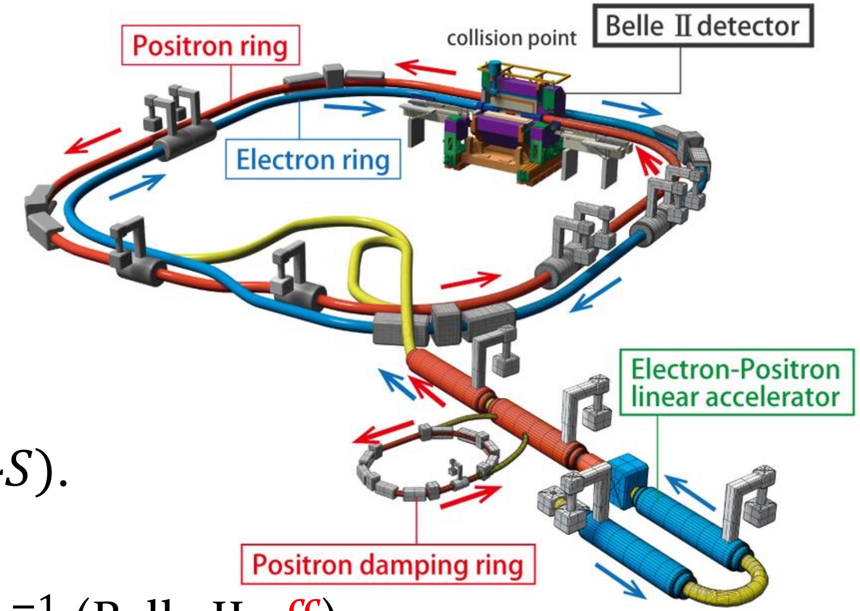
- Nearly symmetric e^+e^- collider.
- E_{CMS} within 2.0 – 4.95 GeV $\rightarrow$ τ-charm region.
- Peak luminosity $1.1 \cdot 10^{33}\ cm^{-2}s^{-1}$.
- Design luminosity $1.0 \cdot 10^{33}\ cm^{-2}s^{-1}$

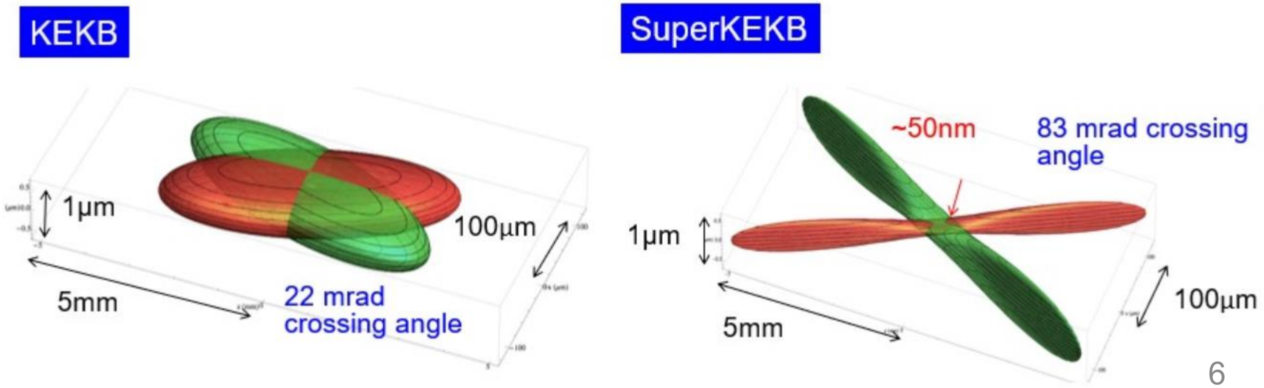
Belle II at SuperKEKB

Super-KEKB, Tsukuba

- Asymmetric e^+e^- collider
  - $E(e^+) = 4$ GeV,
  - $E(e^-) = 7$ GeV.
- Optimised near $\Upsilon(4S)$.
- Peak luminosity
  - $5.32 \cdot 10^{34}\ cm^{-2}s^{-1}$ (Belle II off)
  - $5.28 \cdot 10^{34}\ cm^{-2}s^{-1}$ (Belle II on)

  thanks to *nanobeam* technology.

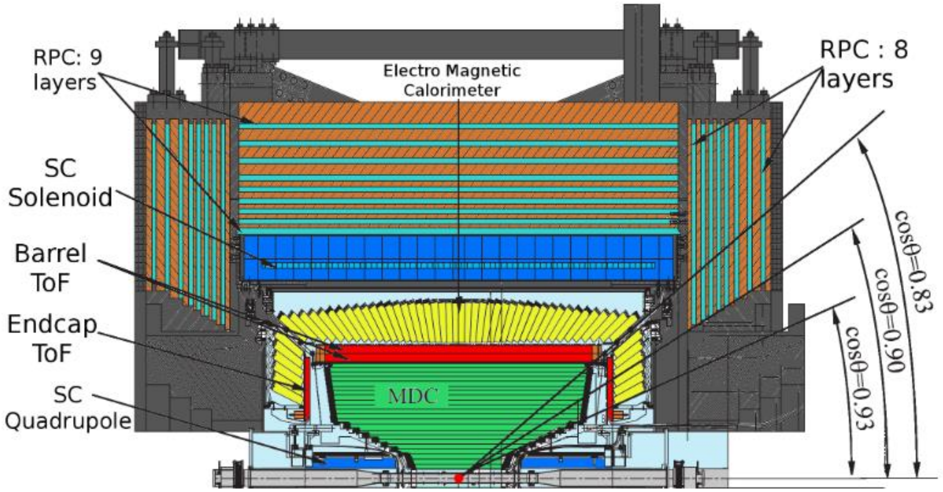




BESIII and Belle II

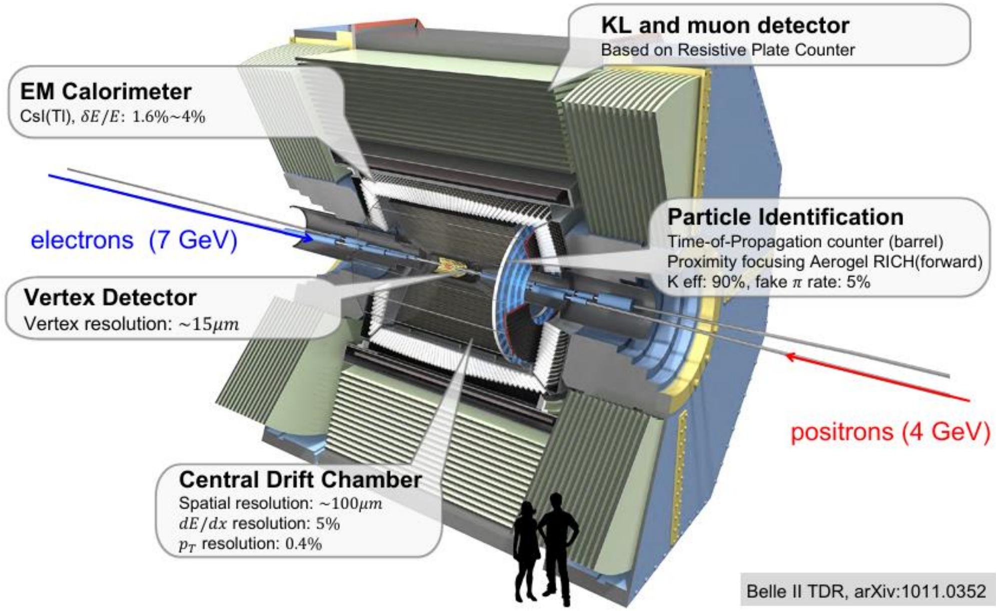
Both detectors are near-4π and offer high-precision tracking, PID and calorimetry.

BESIII also comprises a muon system and has replaced the inner MDC with a cylindrical GEM detector.



Baryons with BESIII: nucleons, strange hyperons and the lightest single-charm Λ_c^+ and Σ_c baryons.

Belle II has vertex detectors and a dedicated muon + K_L system.



Baryons with Belle II: Ground-state and excited strange, heavy charm and strange-charm baryons.

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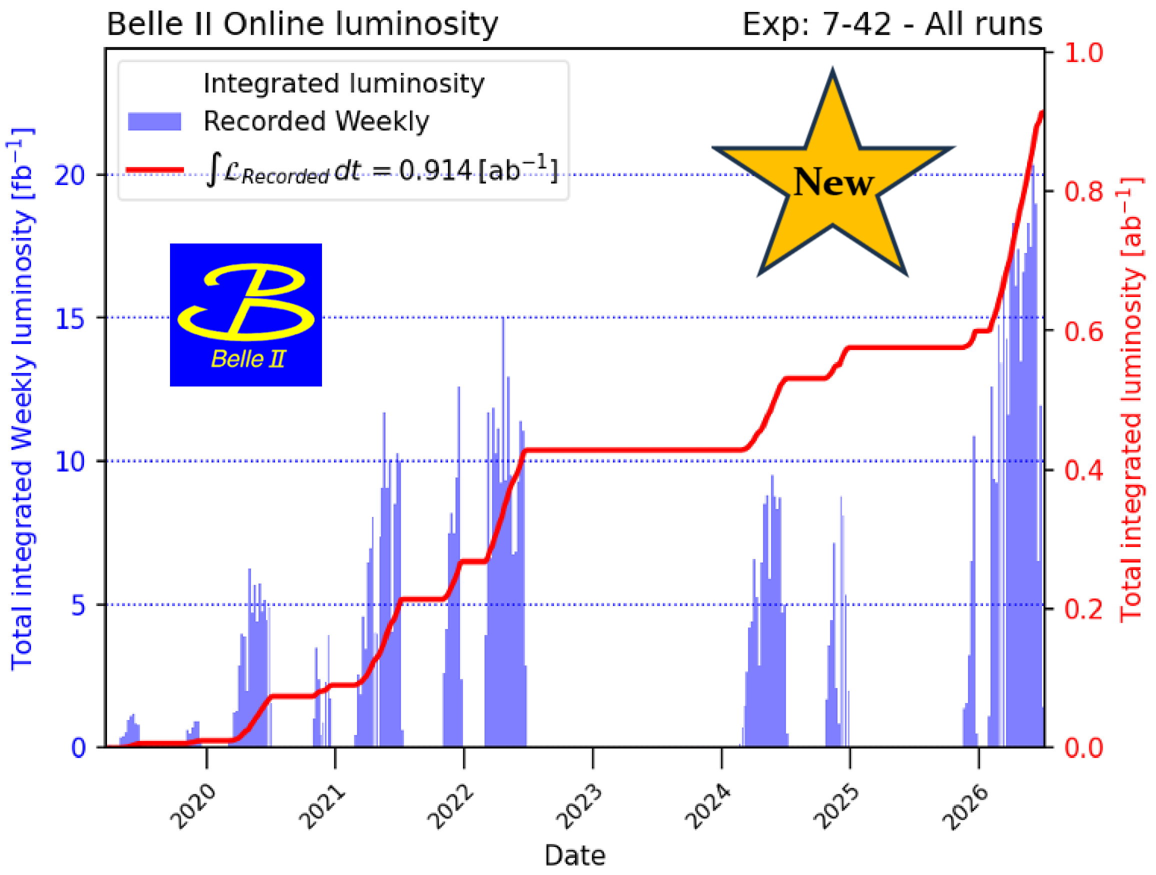
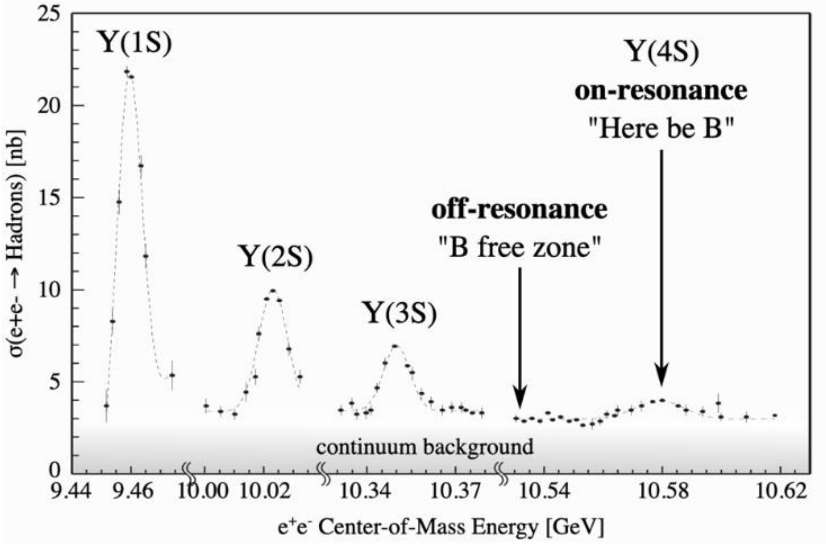
Recent highlights from Belle II

Belle II luminosity

Belle II 2019-2026: $\int \mathcal{L}_{rec} = 0.914\ ab^{-1}$

Belle 1999-2010: $\int \mathcal{L}_{rec} = 0.980\ ab^{-1}$





Belle II data

- $808\ fb^{-1}$ at $\Upsilon(4S)$ ($> 711\ fb^{-1}$ from Belle)
- Data per ab^{-1} ($\cdot 10^9$ events):
  - 1.1 $B\bar{B}$
  - **1.3 $c\bar{c}$** Important for baryon physics!
  - 2.1 $q\bar{q}$ ($q = u, d, s$)
  - 0.9 $\tau^+\tau^-$

Most results in this talk are obtained with Belle + Belle II data.

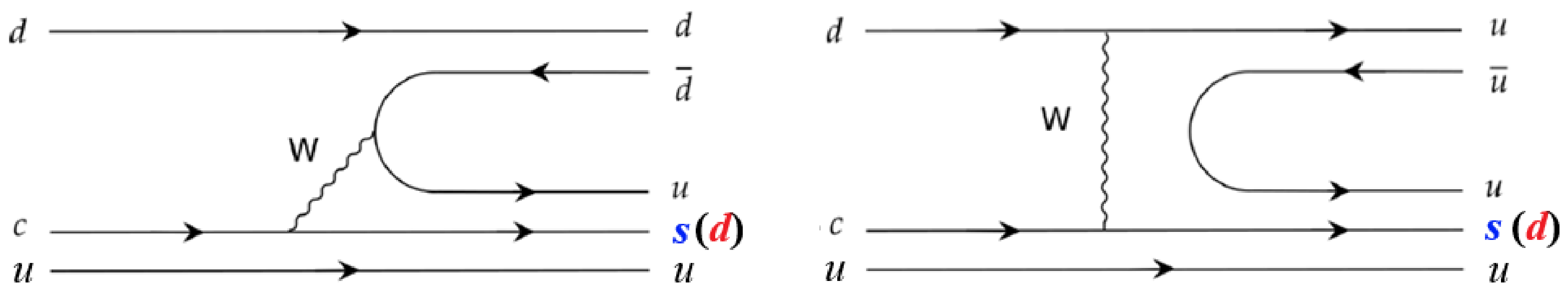
Charm baryon decays with Belle II

- Charm hadrons are the only probe of up-type hadron decays

  → transitions within quark generations: $c \to sW$ (Cabibbo-favoured, CF)

  or between: $c \to dW$ (Cabibbo-suppressed, CS).

Example



- Coupling between quark generations quantified by the complex CKM phase

  → Drives CP violation in the Standard Model.

- Complex interplay between weak and strong interactions

  → Strong, non-factorisable contributions important.

Two-body decays of Ξ_c

Phys. Rev. D 113, 032015 (2026)

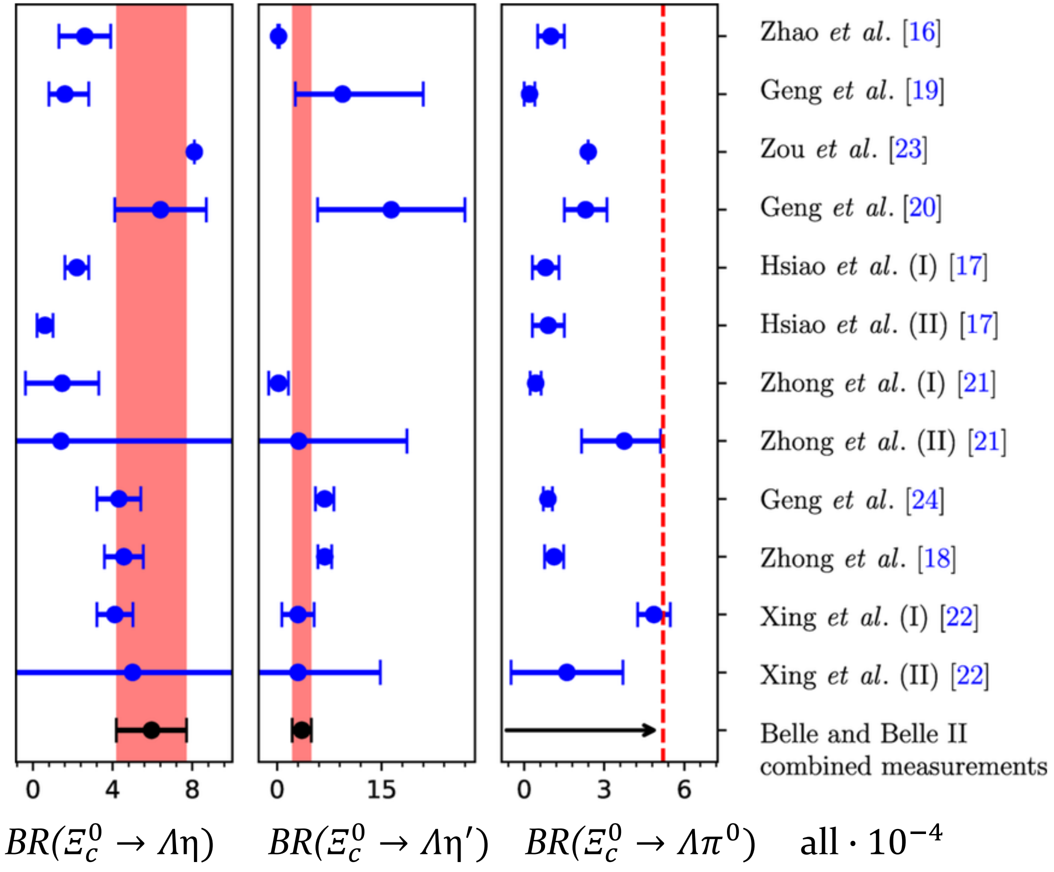


Figure from Ref. [1]
*BRs are relative to $\Xi_c^0 \to \Xi^-\pi^+$ and $\Xi_c^+ \to \Xi^- 2\pi^+$

With 980 fb^{-1} from Belle and 430 fb^{-1} from Belle II:

New

[1] PRD 113,032015 (2026):
- First BR* measurement of CS decays $\Xi_c^0 \to \Lambda\eta, \Lambda\eta'$
- Upper limit of $\Xi_c^0 \to \Lambda\pi^0$.

[2] JHEP 08, 195 (2025):
- First BR* measurement of CF decay $\Xi_c^+ \to \Sigma^+ K_S$ and CS decay $\Xi_c^+ \to \Xi^0 K^+$.
- Most precise BR* measurement of CF decay $\Xi_c^+ \to \Xi^0\pi^+$.

[3] JHEP 03, 061 (2025):
- First BR* measurements of CS decays $\Xi_c^+ \to pK_S$, $\Xi_c^+ \to \Lambda\pi^+$ and $\Xi_c^+ \to \Sigma^0\pi^+$.

[4] JHEP10, 045 (2024):
- First BR* measurement of CF decays $\Xi_c^0 \to \Xi^0\pi^0$, $\Xi_c^+ \to \Xi^0\eta$ and $\Xi_c^+ \to \Xi^0\eta'$.

Two-body decays of Ξ_c

JHEP10, 045 (2024)

Charm baryon decay asymmetry

- Includes 980 fb^{-1} from Belle and 430 fb^{-1} from Belle II [1].
- Exploits $W(cos\theta_{\Xi}) \propto (1 + \alpha_{\Xi_0}\alpha_{\Xi}\, cos\theta_{\Xi})$.
- Uses PDG /BESIII value for α_{Ξ} [2].
- **First** measurement of $\alpha_{\Xi c}$:

$$\alpha_{\Xi c}(\Xi_c^0 \rightarrow \Xi^0\pi^0) = -0.90 \pm 0.15 \pm 0.23$$

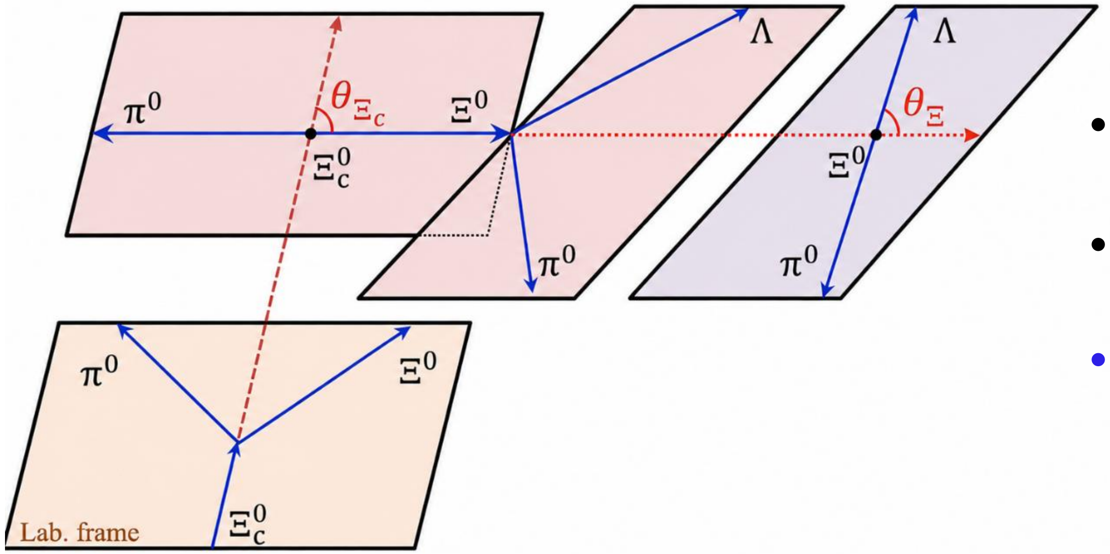
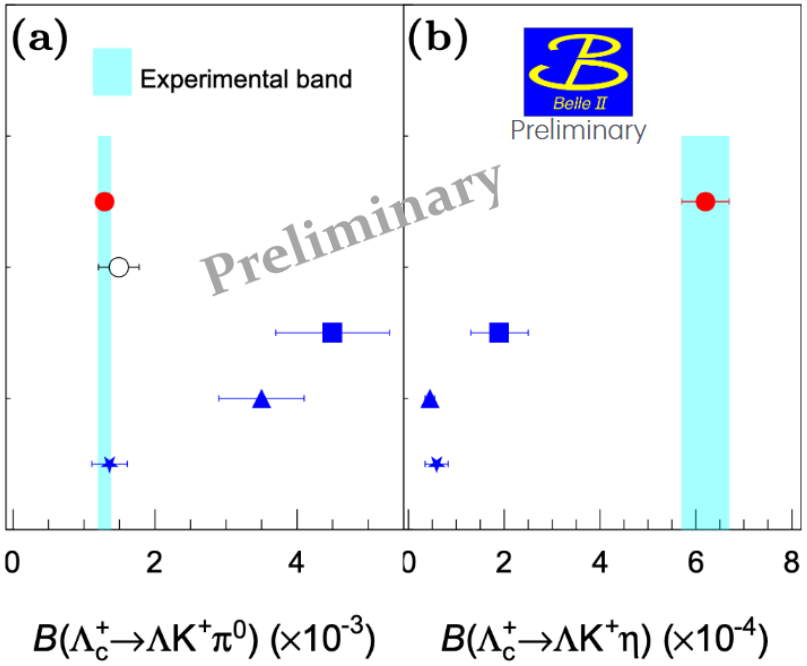


Figure adapted by ChatGPT from [3].

[1] Belle + Belle II, JHEP10, 045 (2024).
[2] BESIII, Phys.Rev.D 108 (2023) 3, L031106
[3] Belle, Science Bulletin 68, 583 (2023)

Three-body decays of Λ_c^+

Study of CS decays $\Lambda_c^+ \rightarrow \Lambda K^+ \pi^0$ and $\Lambda_c^+ \rightarrow \Lambda K^+ \eta$
obtained with
980 fb^{-1} from Belle
and 570 fb^{-1} from Belle II.



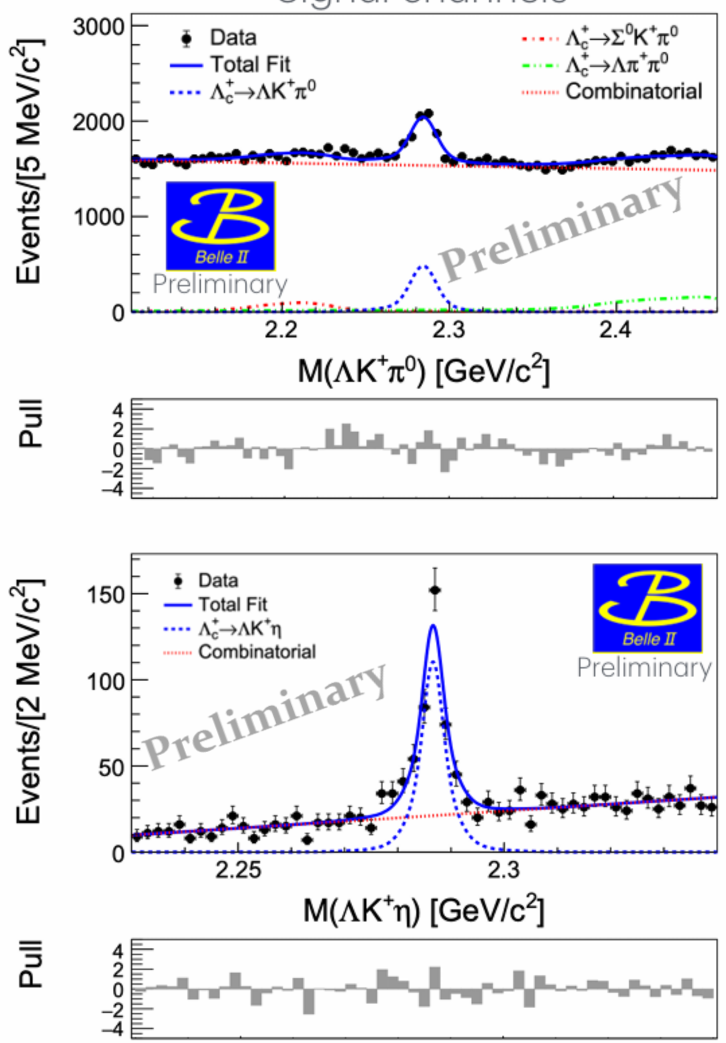
Most precise!

First!

- ● **Preliminary** Belle + Belle II
- ○ BESIII, PRD 109, 032003 (2024)
- ■ Geng, PRD 99, 073003 (2019)
- ▲ Cen, EPJC 79, 946 (2019)
- * Geng, PRD 109, 093002 (2024)

BRs are relative to $\Lambda_c^+ \rightarrow \Lambda \pi^+ \pi^0$.

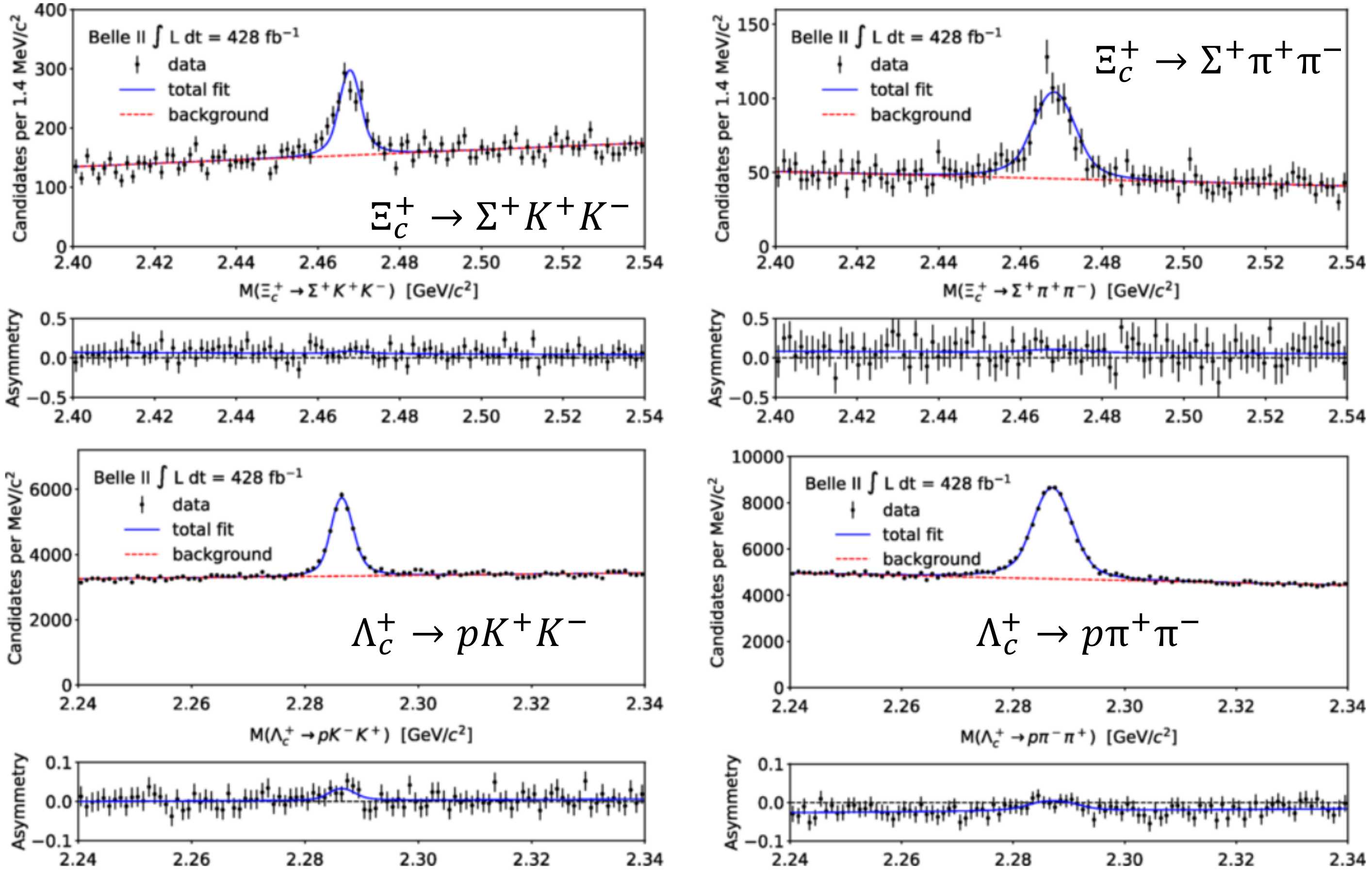
Signal channels



CP tests in three-body decays

Phys. Rev. D 113, 032017 (2026)

New



- Obtained with 428 fb^{-1} of Belle II data
- CP asymmetry from decay widths:

$$A_{CP}(X_c^+ \to f^+) = \frac{\Gamma(X_c^+ - f^+) - \Gamma(\bar{X}_c^- - \bar{f}^-)}{\Gamma(X_c^+ - f^+) + \Gamma(\bar{X}_c^- - \bar{f}^-)}$$

- First measurements of individual 3-body baryon decays (all CS):

$A_{CP}(\Xi_c^+ \to \Sigma^+ K^+ K^-) = (3.7 \pm 6.6 \pm 0.6)\%$

$A_{CP}(\Xi_c^+ \to \Sigma^+ \pi^+ \pi^-) = (9.5 \pm 6.8 \pm 0.5)\%$

$A_{CP}(\Lambda_c^+ \to p K^+ K^-) = (3.9 \pm 1.7 \pm 0.7)\%$

$A_{CP}(\Lambda_c^+ \to p \pi^+ \pi^-) = (0.3 \pm 1.0 \pm 0.2)\%$

- U-spin ($d \leftrightarrow s$ exchange) sums:

$$A_{CP}(\Xi_c^+ \to \Sigma^+ \pi^+ \pi^-) + A_{CP}(\Lambda_c^+ \to p K^+ K^-) = (13.4 \pm 7.0 \pm 0.9)\%$$

$$A_{CP}(\Xi_c^+ \to \Sigma^+ K^+ K^-) + A_{CP}(\Lambda_c^+ \to p \pi^+ \pi^-) = (4.0 \pm 6.6 \pm 0.7)\%$$

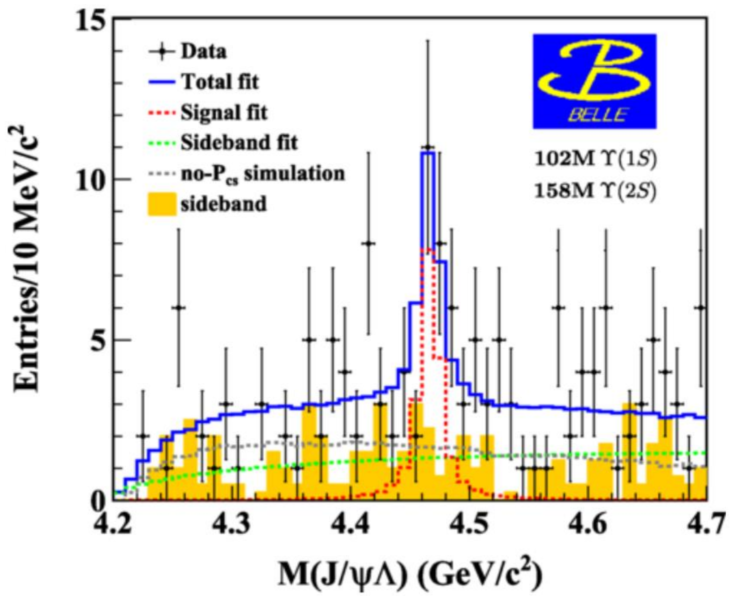
Consistent with CP and U-spin symmetry!

Search for pentaquarks

Phys. Rev. Lett. 135, 041901 (2025)

- Analysis of 102 M events of $\Upsilon(1S)$ and 158 M events of $\Upsilon(2S)$ from Belle [1].
- Belle II analysis framework.
- Search for $[udsc\bar{c}]$ pentaquark states in $\Upsilon(NS) \rightarrow J/\Psi\Lambda\bar{\Lambda}$ $+anything$.
- Confirmation with 3.3σ of $P_{c\bar{c}s}(4459)^0$ found by LHCb [2].
- No evidence of $P_{c\bar{c}s}(4338)^0$.

Mode	$\mathcal{B}(\times10^{-6})$
$\Upsilon(1S) \rightarrow P_{c\bar{c}s}(4459)^0/\bar{P}_{c\bar{c}s}(4459)^0 + \text{anything}$	$3.5 \pm 2.0 \pm 0.2$
$\Upsilon(2S) \rightarrow P_{c\bar{c}s}(4459)^0/\bar{P}_{c\bar{c}s}(4459)^0 + \text{anything}$	$2.9 \pm 1.7 \pm 0.4$
$\Upsilon(1S) \rightarrow P_{c\bar{c}s}(4338)^0/\bar{P}_{c\bar{c}s}(4338)^0 + \text{anything}$	< 1.8
$\Upsilon(2S) \rightarrow P_{c\bar{c}s}(4338)^0/\bar{P}_{c\bar{c}s}(4338)^0 + \text{anything}$	< 1.6



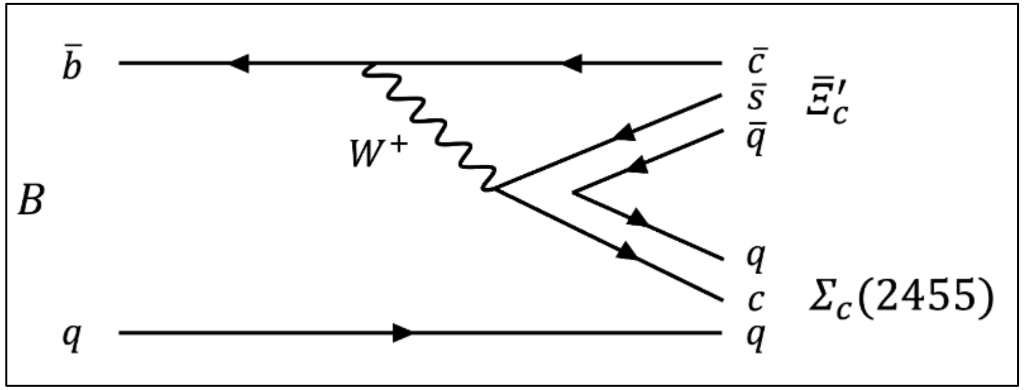
[1] Belle + Belle II, Phys. Rev. Lett. 135, 041901 (2025)
[2] LHCb: PRL 115, 072001 (2015); *ibid.* 122, 222001 (2019)

15

Charm baryon pairs from B decays

[1] Phys. Rev. D **112**, L051101 (2025): $e^+e^- \to \Upsilon(4S) \to B\bar{B}, B \to \Xi_c\bar{\Sigma}_c(2455) + c.c.$

- 711 fb^{-1} Belle + 365 fb^{-1} Belle II.
- Significances > 6σ, BRs **larger** than single-charm $B \to p\bar{\Sigma}_c(2455)$.
- Results consistent with diquark model.

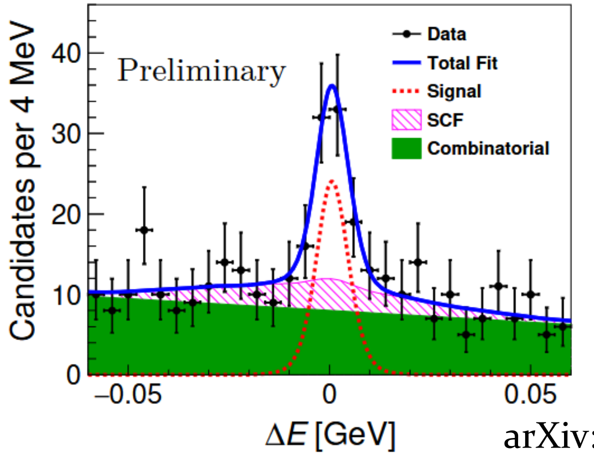


[2] arXiv:2606.12905, acc. by Phys. Rev. D:

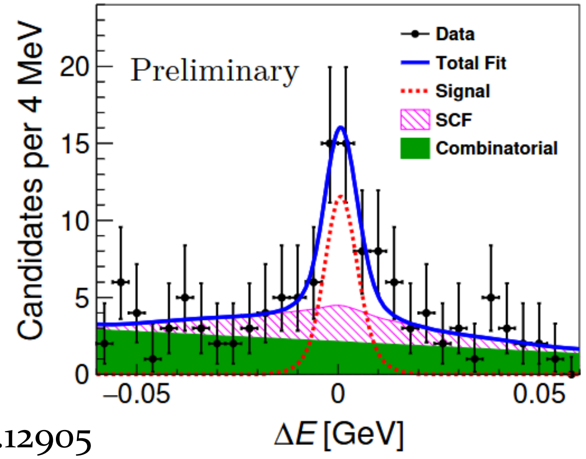
New

- 711 fb^{-1} Belle + 492 fb^{-1} Belle II.
- Same final state as above + an extra γ from $\Xi_c' \to \Xi_c\gamma$.
- BRs **2-3 times larger** for sextet Ξ_c' than for ground-state Ξ_c.

Decay	BR $(\cdot 10^{-4})$ $\pm$ stat. $\pm$syst. $\pm$syst. from BR(Ξ_c)
$B^+ \to \bar{\Xi}_c^- \Sigma_c^{++}(2455)$ [1]	$5.74 \pm 1.11 \pm 0.42^{+2.47}_{-1.53}$
$B^0 \to \bar{\Xi}_c^0 \Sigma_c^0(2455)$ [1]	$4.83 \pm 1.12 \pm 0.37^{+0.72}_{-0.6}$
$B^+ \to \bar{\Xi}_c^{-\prime} \Sigma_c^{++}(2455)$ [2]	$16.8 \pm 3.1 \pm 1.2^{+14.9}_{-5.4}$
$B^0 \to \bar{\Xi}_c^{0\prime} \Sigma_c^0(2455)$ [2]	$12.8 \pm 3.2 \pm 1.0^{+3.0}_{-2.1}$



arXiv:2606.12905



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More baryon results from Belle + Belle II

- Measurement of the Λ_c^+ lifetime, Phys. Rev. Lett. **130**, 071802 (2023).
  $\rightarrow$ Most precise to date!

- Measurement of the Ω_c^0 lifetime, Phys. Rev. D **107**, 3, L031103 (2023).

- Measurement of the BR of $\Lambda_c^+ \rightarrow pK_S^0\pi^0$, Phys. Rev. D **112**, 1, 012013 (2025)

- Search for the baryon number and lepton number violating decays $\tau^- \rightarrow \Lambda\pi^-$ and $\tau^- \rightarrow \overline{\Lambda}\pi^-$, Phys. Rev D **110**, 112003 (2024).

- Search for $\Xi^0 p, \Omega^- p$ and $\Omega^- n$ dibaryons in $\Upsilon(1S)$ and $\Upsilon(2S)$ decays, arXiv:2605.29778 (2026).

New

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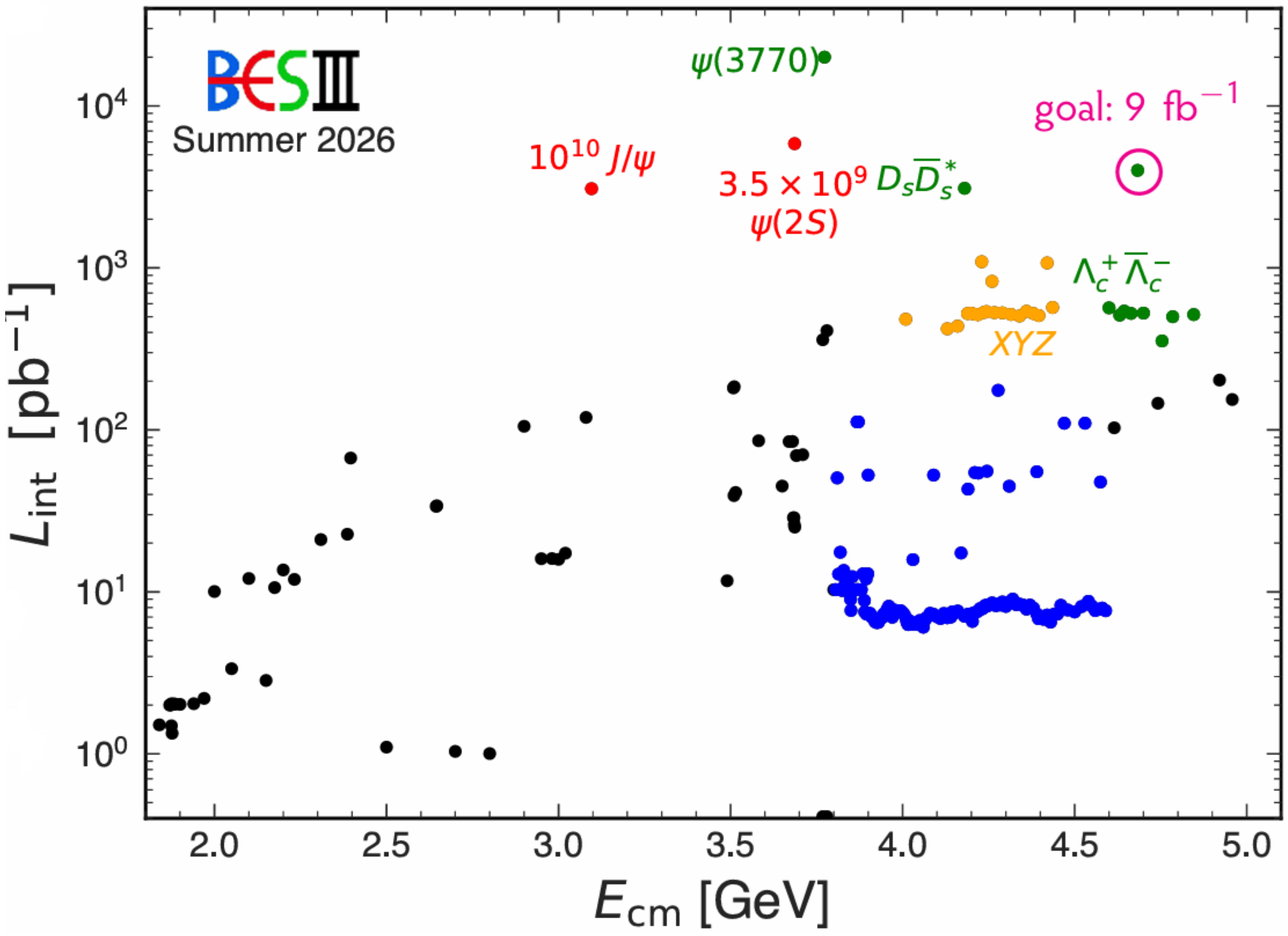
Recent highlights from BESIII

BESIII luminosity

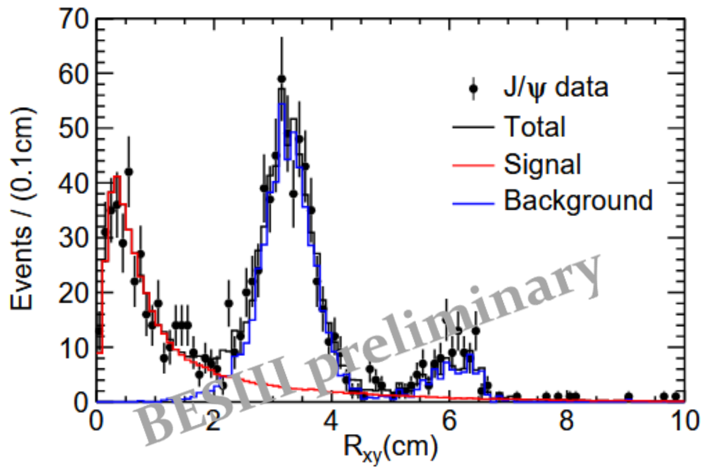


Baryon-antibaryon pairs from

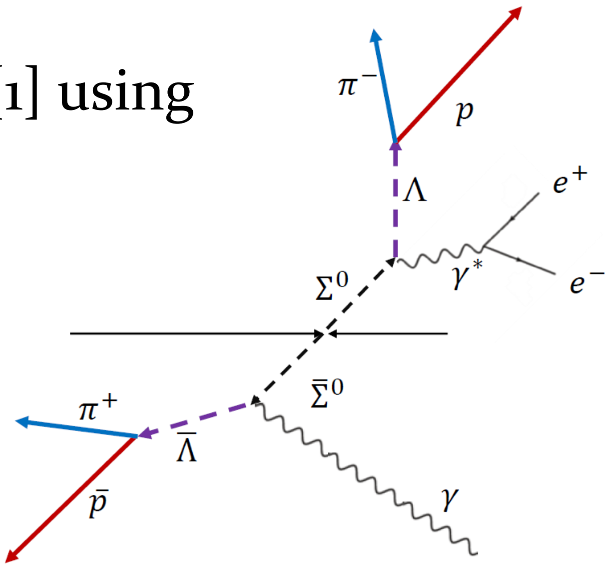
- 10^{10} J/Ψ events
- $3.5 \cdot 10^9$ $\Psi'(3686)$ events
- 20 fb^{-1} at $\Psi(3773)$
- The $q\bar{q}$ continuum in
  [1.8 , 3.08] GeV (light and strange)
  and > **3.735 GeV** (triple-strange and charm)

New

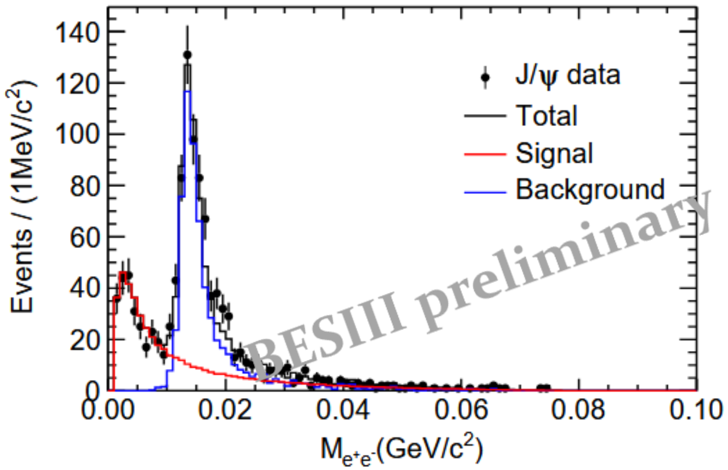
First measurement of $BR(\Sigma^0 \rightarrow \Lambda e^+ e^-)$

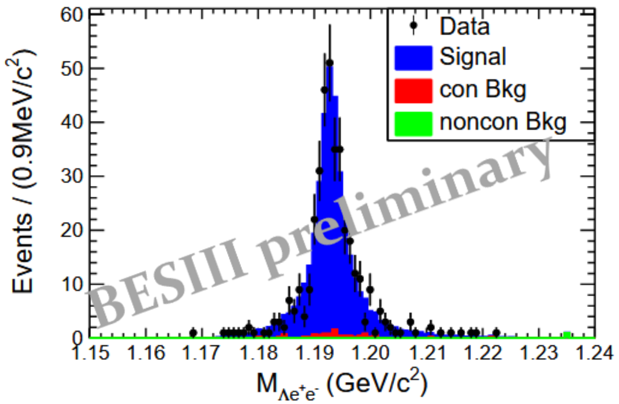


New study of the Dalitz decay by BESIII [1] using Σ^0 from $J/\Psi \rightarrow \Sigma^0\bar{\Sigma}^0$.



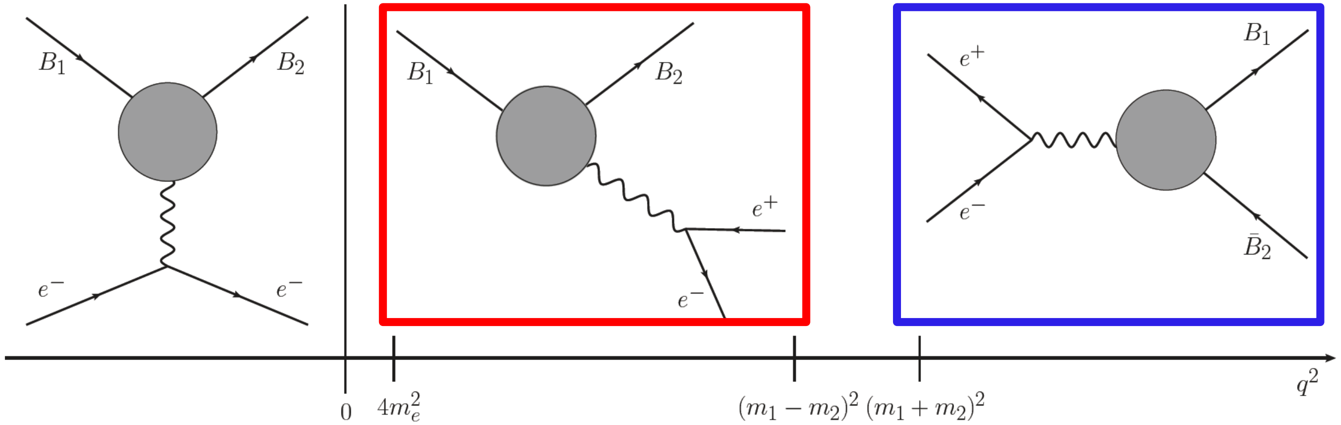
- Well-known from BESIII [2]
- $\Sigma^0 \rightarrow \Lambda\gamma$ reference for BR.
- Tag $\bar{\Sigma}^0$ in $\bar{\Sigma}^0 \rightarrow \bar{\Lambda}\gamma$.
- Identify Dalitz decay $\Sigma^0 \rightarrow \Lambda e^+ e^- \rightarrow p\pi^- e^+ e^-$.
- Externally converted γ separable through e^+e^- mass and vertex.





[1] arXiv: 2608.16076
[2] Phys. Rev. Lett. **133**, 101902 (2024).

First measurement of $BR(\Sigma^0 \to \Lambda e^+ e^-)$



New

Preliminary results:

$\boldsymbol{BR}(\Sigma^0 \to \Lambda e^+ e^- + \text{c.c.}) = (6.34 \pm 0.25 \pm 0.23) \cdot 10^{-3}$ [1]

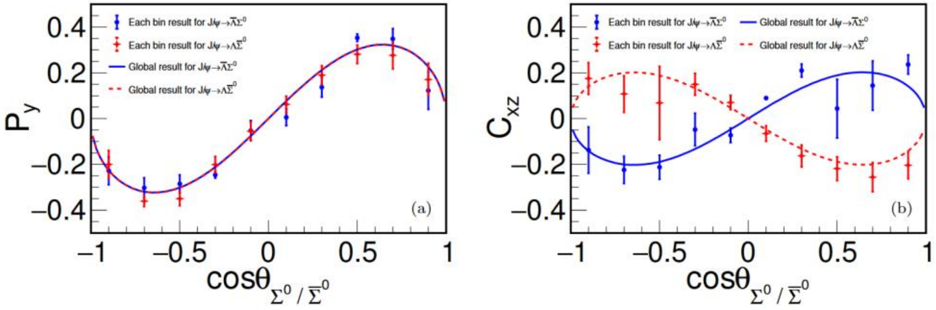
Theory prediction: $\boldsymbol{BR}\ (\Sigma^0 \to \Lambda e^+ e^- + \text{c.c.}) = 5.5 \cdot 10^{-3}$ [2].

Measured transition magnetic moment:

$\mu = (1.74 \pm 0.03 \pm 0.09)\mu_N$

Related BESIII studies of the $\Sigma^0 \to \Lambda$ transition:

- First complete measurement of the complex $\Sigma^0\Lambda$ EM form factors [3].



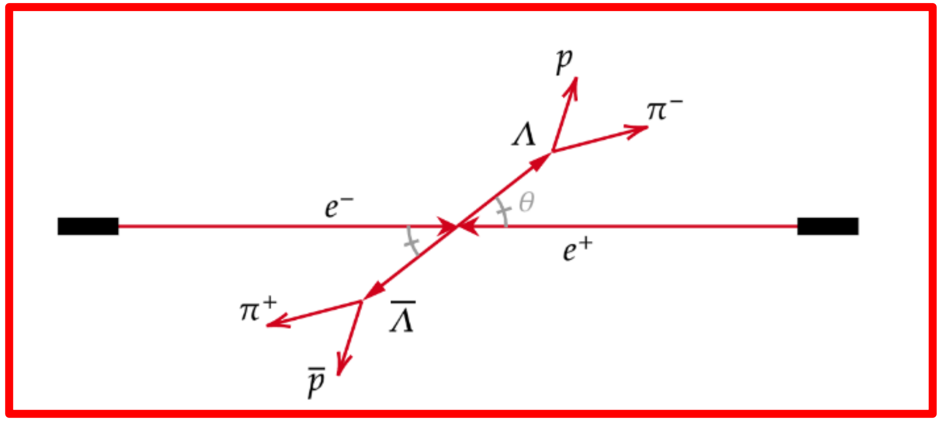
- The $e^+e^- \to \Sigma^0\bar{\Lambda}$ cross-section lineshape in [2.3094, 3.0800] GeV [4].

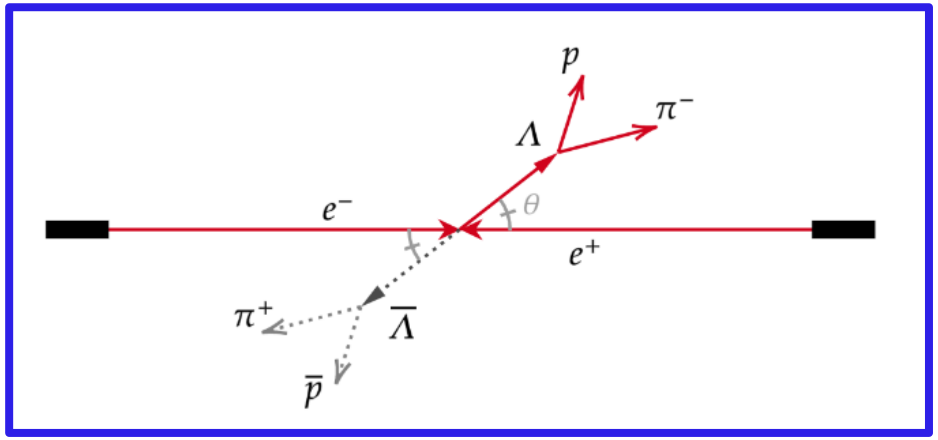
[1] BESIII, arXiv: 2608.16076 (2026).
[2] Feinberg, Phys. Rev. 109, 1019 (1958).
[3] BESIII, *Nature Commun.* 15, 1, 8812 (2024).
[4] BESIII, *Phys.Rev.D* 109, 1, 012002 (2024).

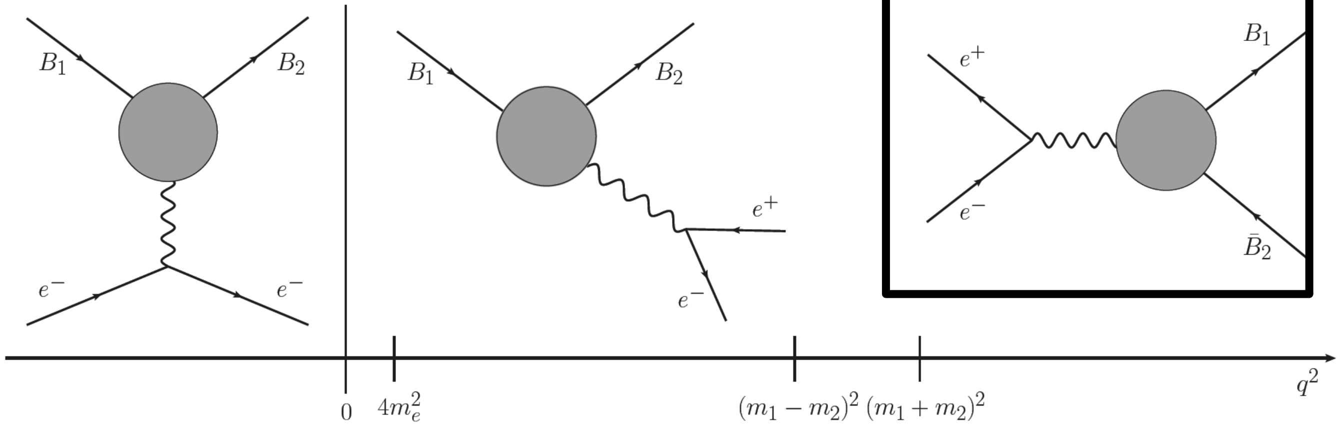
New measurements of Λ and Λ_c^+ EM Form Factors

- $e^+e^- \to Y\bar{Y} \to B\pi\bar{B}\pi$ from scan data
  - Combine **double-tag** and **single-tag** data for $\Lambda \to p\pi^-$.
  - Combine 2-body and 3-body **single-tag** decays of Λ_c^+ .

- Exploit spin polarisation and correlations to extract complex EM form factors from angles [1].







[1] Fäldt & Kupsc, Phys. Lett. B 772 (2017) 16.

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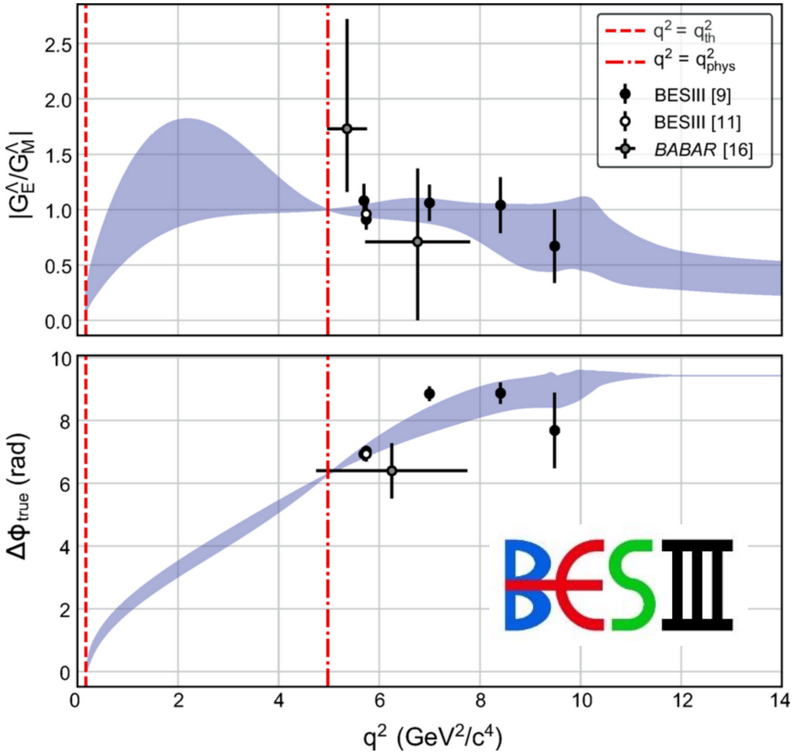
Λ EMFFs

- Measured EMFF ratio $R(q^2) = |\frac{G_E(q^2)}{G_M(q^2)}|$ and phase $\Delta\Phi(q^2)$ at 5 energies in [2.38, 3.08] GeV [1].
- Fit based on dispersion relations [2] to BESIII and BABAR [3] data.

Phys. Rev. Lett. 135, 191 902 (2025)



Charge RMS radius

$\bar{r}_E^\Lambda = -0.076 \pm 0.043\ fm$

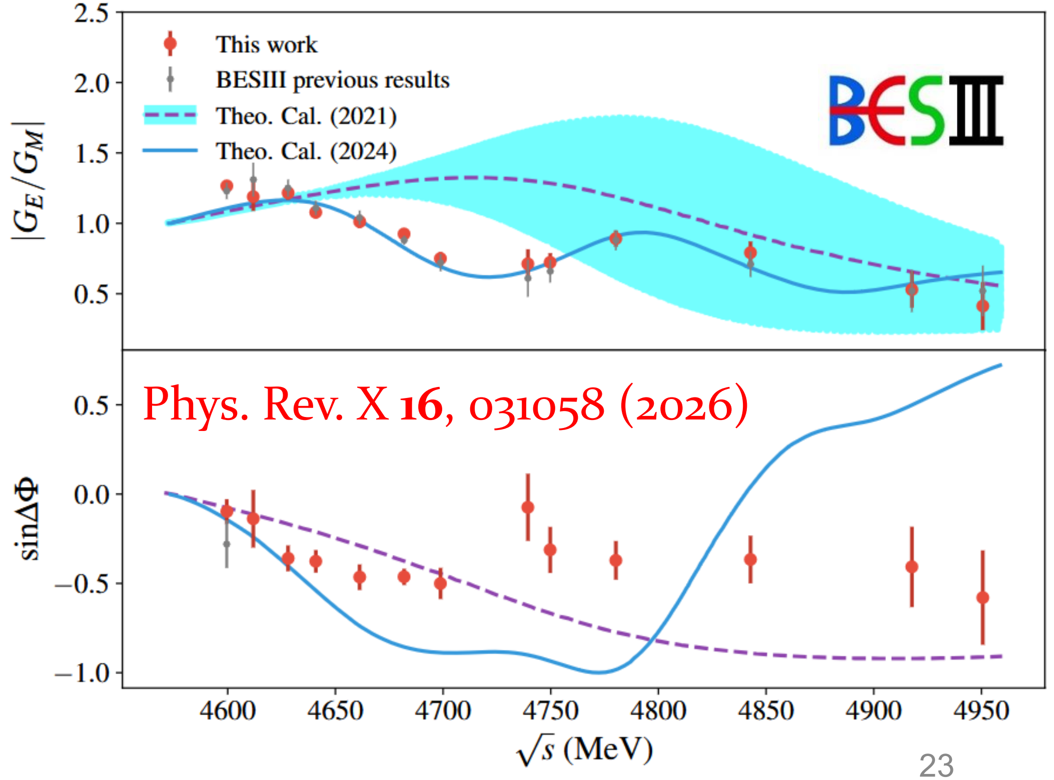
→ Asymmetric charge distribution, d,s quarks at the centre.

[1] BESIII, PRL **135**, 191 902 (2025)
[2] Mangoni *et al.*, PRD 104, 116016 (2021)
[3] BABAR: PRD **76**, 092006
[4] BESIII, Phys. Rev. X **16**, 031058 (2026).

New Λ_c^+ EMFFs

- Scan data at 13 energies in [4.6 , 4.95] GeV [4].
- Combined four 2-body and one 3-body decay mode.
- Significant polarisation: $4\% < \sqrt{<|P^y_{\Lambda_c^+}|^2>} < 18\%$
- Measured $R(q^2)$ and $sin\Delta\Phi(q^2)$.

Phys. Rev. X **16**, 031058 (2026)



CP tests in strange hyperon decays

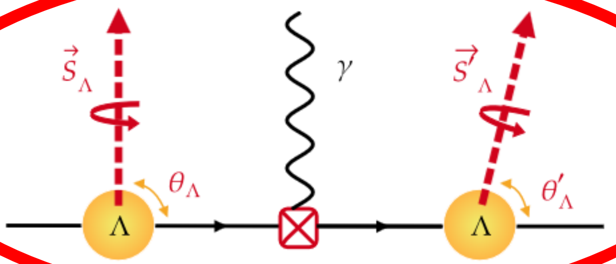
- Exploit same formalism for $e^+e^- \to Y\bar{Y} \to B\pi\bar{B}\pi$ [1] as for the EMFF measurement [2].

  $\to$ Recent CP tests through $A_{CP} = \frac{\alpha+\bar{\alpha}}{\alpha-\bar{\alpha}}$ in Λ,Σ decays:
  - $J/\Psi \to \Lambda\bar{\Lambda} \to n\pi^0\bar{p}\pi^-$ [3]
  - J/Ψ & $\Psi(3686) \to \Sigma^+\bar{\Sigma}^- \to p\pi^0\bar{p}\pi^0$ [4]
  - $J/\Psi \to \Sigma^0\bar{\Sigma}^0 \to \Lambda\gamma\bar{\Lambda}\gamma p\pi^-\gamma\bar{p}\pi^+\gamma$ [5] $\to$ **strong and weak CP tests** in Σ^0 EM decay!

- Expanded formalism encoding **P- and CP-violating form factors F_A and H_T** allows the search for hyperon Electric Dipole Moment (EDM) [6].
  - Alternative to the spin-precession method.
  - First measurement consistent with zero EDM.

New

[1] Fäldt & Kupsc, PLB 772, 16-20 (2017).
[2] BESIII, PRL **135**, 191 902 (2025).
[3] BESIII, PRL **136**, 251802 (2026).
[4] BESIII, PRL **135**, 141804 (2025).
[5] BESIII, PRL **133**, 101902 (2024).
[6] BESIII, Science **393**, 1027-1030 (2026)



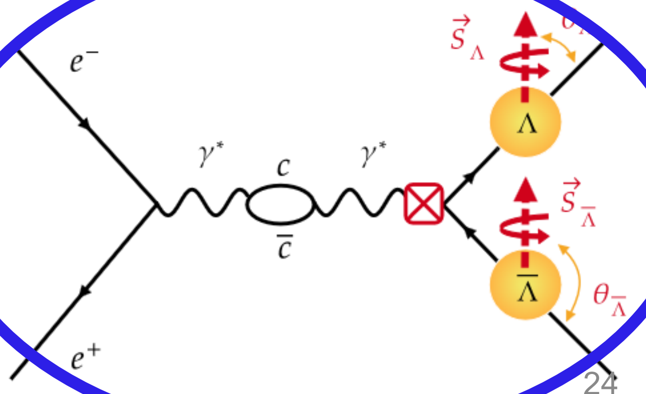


Figure from [6]

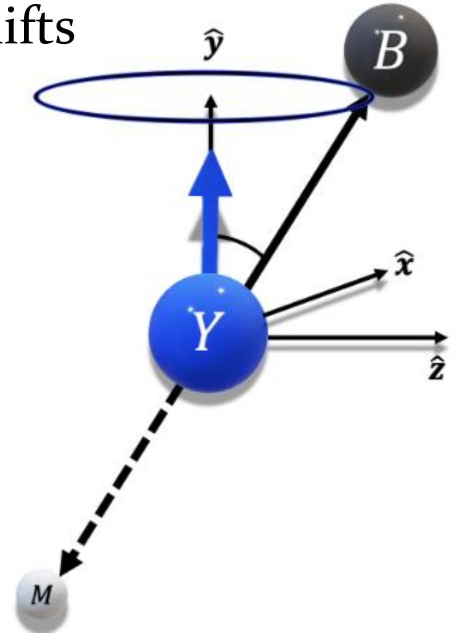
Sequential baryon decays

CP test in the **one-step decay** process $Y \to BM$ involves strong and weak phase shifts

$$A_{CP} = \frac{\alpha+\bar{\alpha}}{\alpha-\bar{\alpha}} \approx -\tan(\delta_p - \delta_s)\tan(\xi_p - \xi_s)\ ^*$$

CP conserving, depend on strong FSI

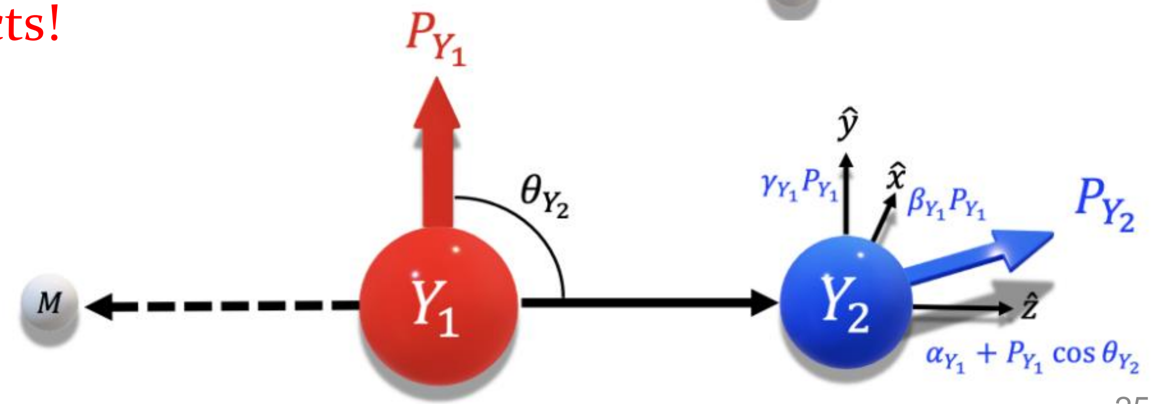
$\neq 0 \to$ CP violating



CP tests in **sequential decays** $Y_1 \to Y_2 M_1 \to B M_2 M_1$ involves only the weak:

$$\Delta\phi_{CP} = \frac{\phi+\bar{\phi}}{2} \approx \frac{\alpha}{\sqrt{1-\alpha^2}}(\xi_p - \xi_s)_{LO}\ ^*$$

$\to$ More sensitive to CP violating effects!



Figures from Schönning *et al.*, Chin. Phys. C **47** 052002 (2023)

Sequential strange hyperon decays

Recent CP tests in sequential Ξ decays:

- $\Xi^-\bar{\Xi}^+ \to \Lambda\pi^-\bar{\Lambda}\pi^+ \to p\pi^-\pi^-\bar{p}\pi^+\pi^+ + c.c.$ [1,2]
- $\Xi^-\bar{\Xi}^+ \to \Lambda\pi^-\bar{\Lambda}\pi^+ \to p\pi^-\pi^-\bar{n}\pi^0\pi^+ + c.c.$ [3]
- $\Xi^0\bar{\Xi}^0 \to \Lambda\pi^0\Lambda\pi^0 \to p\pi^-\pi^0\bar{p}\pi^+\pi^0 + c.c.$ [4]

New

$\to$ Most precise measurement of weak phase differences so far!

[1] PRL **136**, 201802 (2026)
[2] Nature **606**, 64 (2022)
[3] PRL **132**, 101801 (2024)
[4] PRD **108**, L031106 (2023)

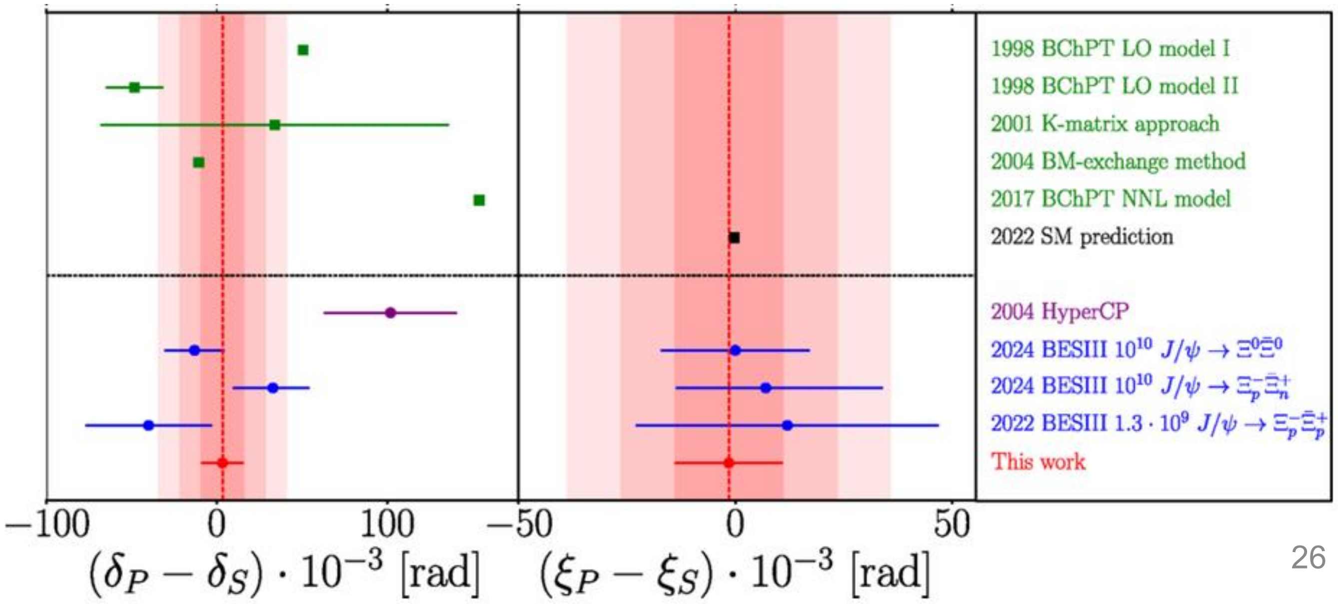
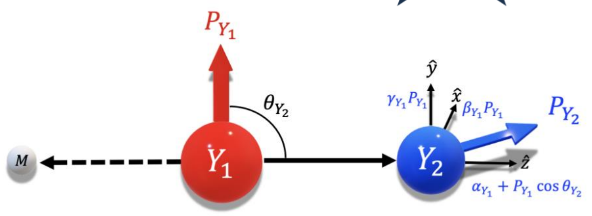


Figure from [1]

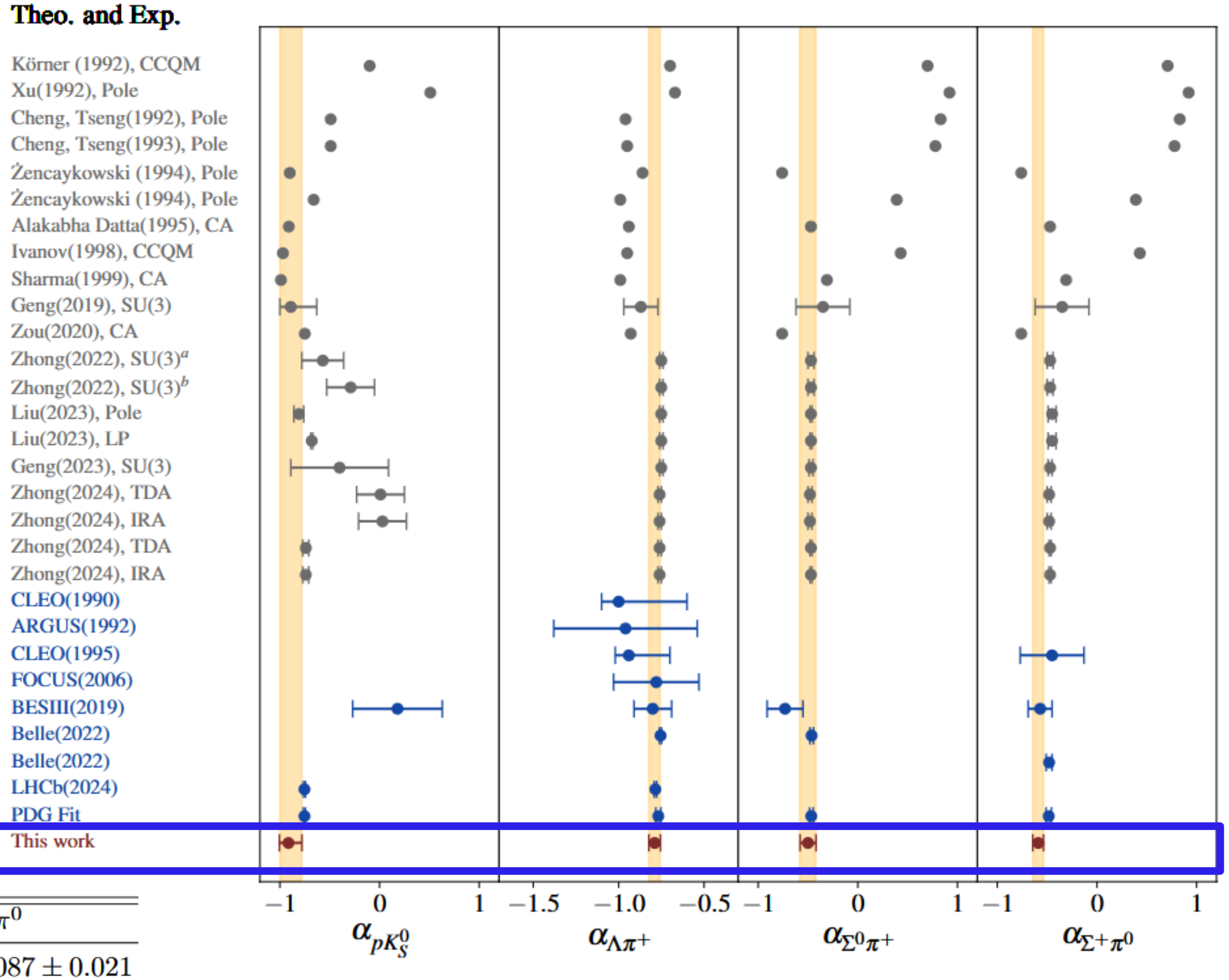
Sequential charm baryon decays

New



Preliminary results from recent study [1]:

- Weak decay asymmetry parameter **α** of:
  - $\Lambda_c^+ \to pK_S^0$
  - $\Lambda_c^+ \to \Lambda\pi^+$
  - $\Lambda_c^+ \to \Sigma^0\pi^+$
  - $\Lambda_c^+ \to \Sigma^+\pi^0$
- All results consistent with CP symmetry.
- Strong phase differences ≠ 0.



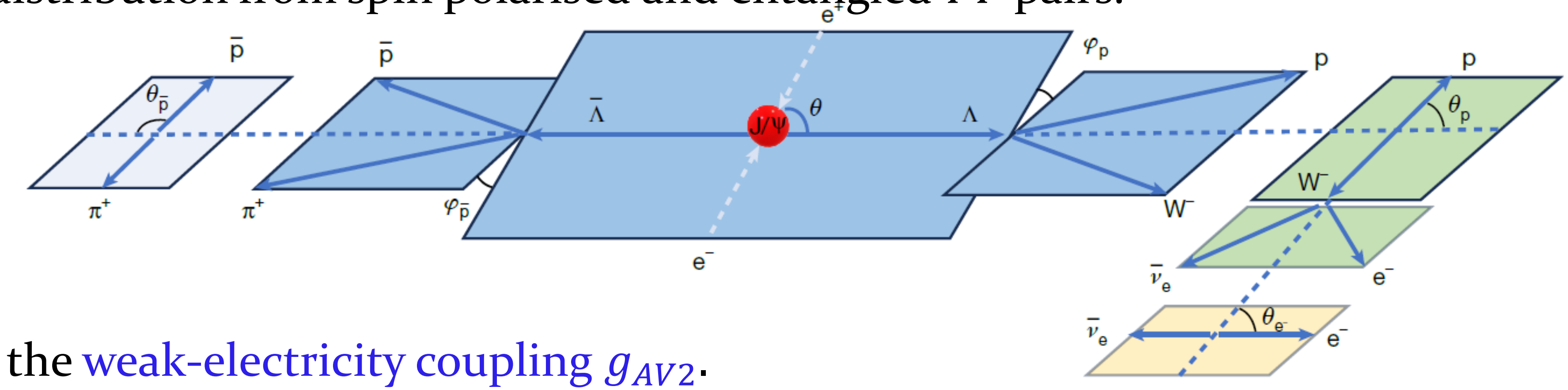
Parameter	$\Lambda_c^+ \to pK_S^0$	$\Lambda_c^+ \to \Lambda\pi^+$	$\Lambda_c^+ \to \Sigma^0\pi^+$	$\Lambda_c^+ \to \Sigma^+\pi^0$
$A_{CP}^{\alpha_{BP}}$	$0.097^{+0.113}_{-0.096} \pm 0.025$	$0.006 \pm 0.048 \pm 0.016$	$0.206^{+0.185}_{-0.147} \pm 0.023$	$-0.087 \pm 0.087 \pm 0.021$
$\tan\phi_{CP}$	···	$0.231 \pm 0.242 \pm 0.023$	$0.592 \pm 0.632 \pm 0.036$	$0.026 \pm 0.492 \pm 0.032$
$\tan\Delta_S$	···	$-0.488 \pm 0.242 \pm 0.027$	$-1.171 \pm 0.646 \pm 0.045$	$-1.272 \pm 0.496 \pm 0.049$

[1] BESIII, Phys. Rev. X **16**, 031058 (2026)

Hyperon semileptonic decays

New

- Double-tag method using $Y\bar{Y}$ pairs ($Y = \Lambda, \Xi$) in $e^+e^- \to J/\Psi \to Y\bar{Y}, Y \to Be^-\bar{\nu}_e, \bar{Y} \to \bar{B}\pi + c.c.$
  - Neutrino identified through missing kinematics.
- Exploit joint angular distribution from spin polarised and entangled $Y\bar{Y}$ pairs.



$\Lambda \to pe^-\bar{\nu}_e$ [1]:

- First measurement of the weak-electricity coupling g_{AV2}.
- Axial-vector coupling g_{AV} and weak-magnetism coupling g_W with precision comparable to resp. slightly larger to Fermilab [2] despite 20 times smaller data set.

$\Xi^- \to \Lambda e^-\bar{\nu}_e$ [3]:

- First measurement of absolute BR.
- Axial vector coupling g_{AV} and axial charge g_A^H.

[1] BESIII, Nature **657**, pages 92–97 (2026)
[2] Dworkin et al., *Phys. Rev. D* 41, 780–800 (1990).
[3] BESIII, Phys. Rev. Lett. 137, 091801 (2026)

Summary

- **BESIII** runs since 2009, has exceeded its design luminosity and **extended its energy range**.

- **Belle II** runs since 2019 and is entering the **"ab^{-1} era"** thanks to the nanobeam technology.

- The near-4π coverage and clean production mechanism enables a broad baryon physics program for **both experiments**.

- **BESIII:** pioneering and world-leading measurements on structure and decays of, in particular, strange baryons.

- **Belle II:** unique and world-leading results on charm baryon decays and lifetimes.

Outlook: Future opportunities

- **Baryon structure:**
  - Increased precision of **EM form factor** measurements with continued BESIII operation, and possible with Belle II through the ISR technique.
  - Belle II, and also BESIII, can access **baryon fragmentation functions**.

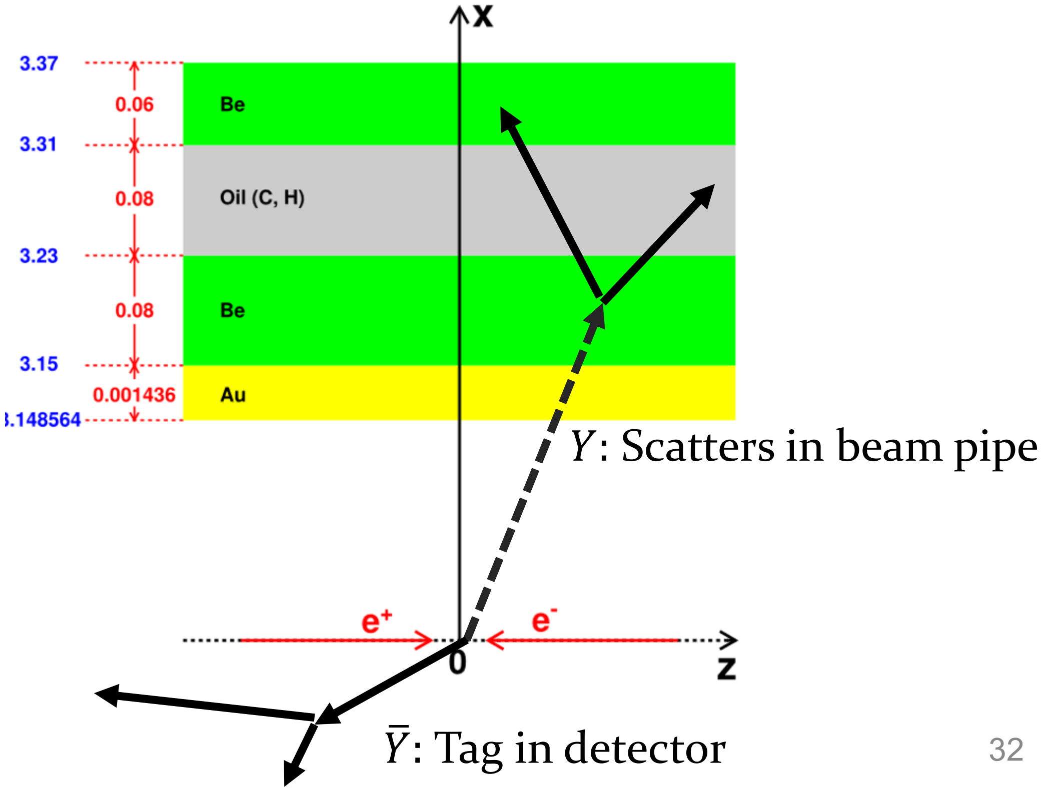
Picture credit: Göran Durgé

- **Baryon spectroscopy:** Expected progress in **multistrange spectroscopy** through charmonium decays (BESIII) and multi-body charm baryon decays (Belle II).
- **Baryon decays:** Goldmine especially for decays containing neutrals of strange hyperons (BESIII) and charm baryons (Belle II).
- **Baryon interactions:** YY and YN interactions accessible in bottomium decays (Belle II) and secondary hyperon interactions with beam pipe material (BESIII).

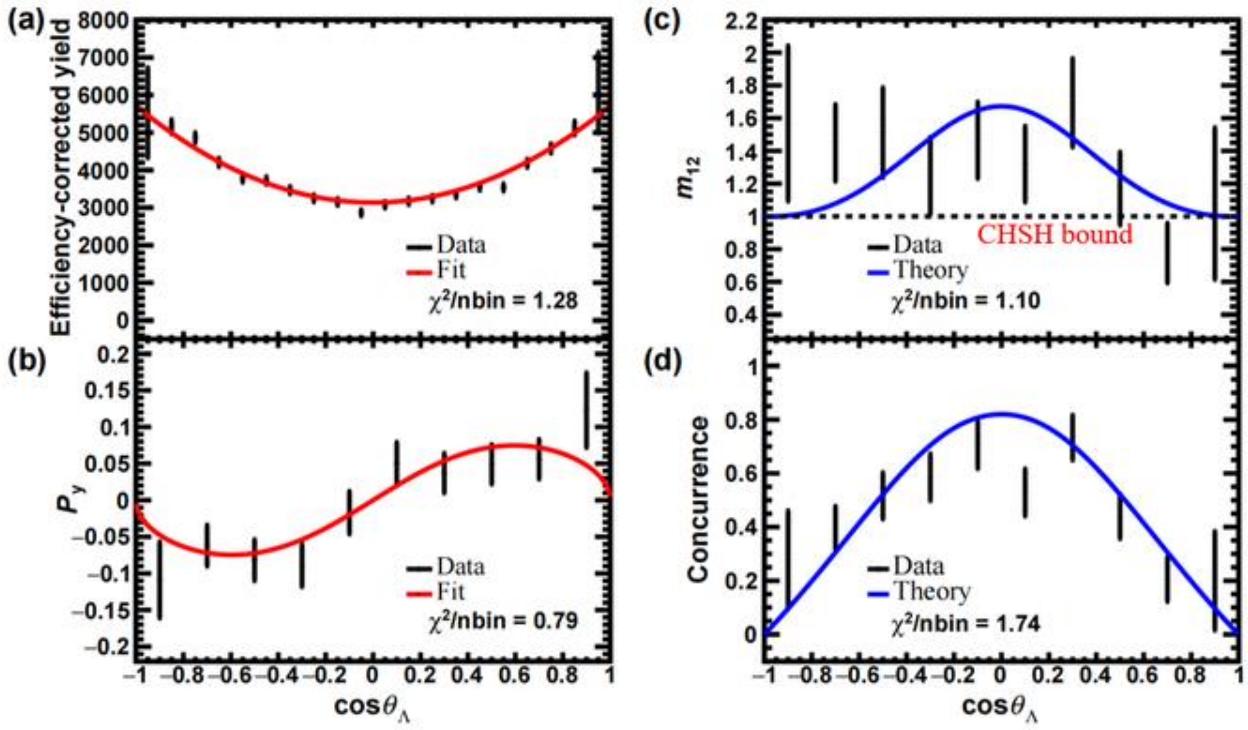
Thanks for your attention!

Hyperon-nucleon (YN) interactions

- Crucial component to predict properties of hypernuclei.
- Needed to understand the *hyperon puzzle* of neutron stars.
- Secondary YN and $\bar{Y}N$ interactions with hyperons from $e^+e^- \to J/\Psi \to Y\bar{Y}$.
- Recent YN and $\bar{Y}N$ studies:
  - $\Xi^0 n \to \Xi^- p$ [PRL 130, 251902 (2023)]
  - $\Lambda N \to \Sigma^+ X$ [PRC 109, L052201 (2024)]
  - $\Lambda p \to \Lambda p$ and $\bar{\Lambda} p \to \bar{\Lambda} p$ [PRL 132, 231902 (2024)]
  - $\bar{\Lambda} p \to K^+\pi^+\pi^- k\pi^0$, k= 1,2,3 [PRL 136, 171904 (2026)] New



Entanglement in $\Psi(3686) \to \Lambda\bar{\Lambda}$



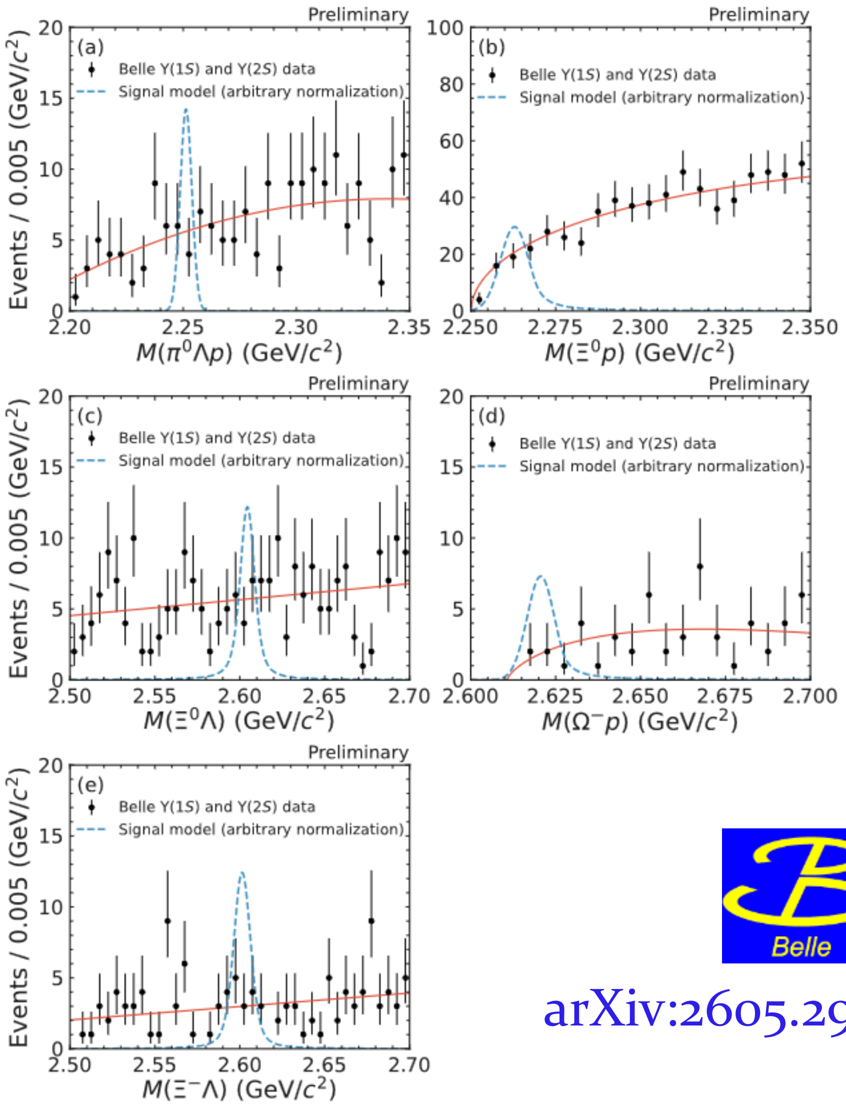
arXiv: 2509.15276 (2025), accepted by Science Bulletin

New

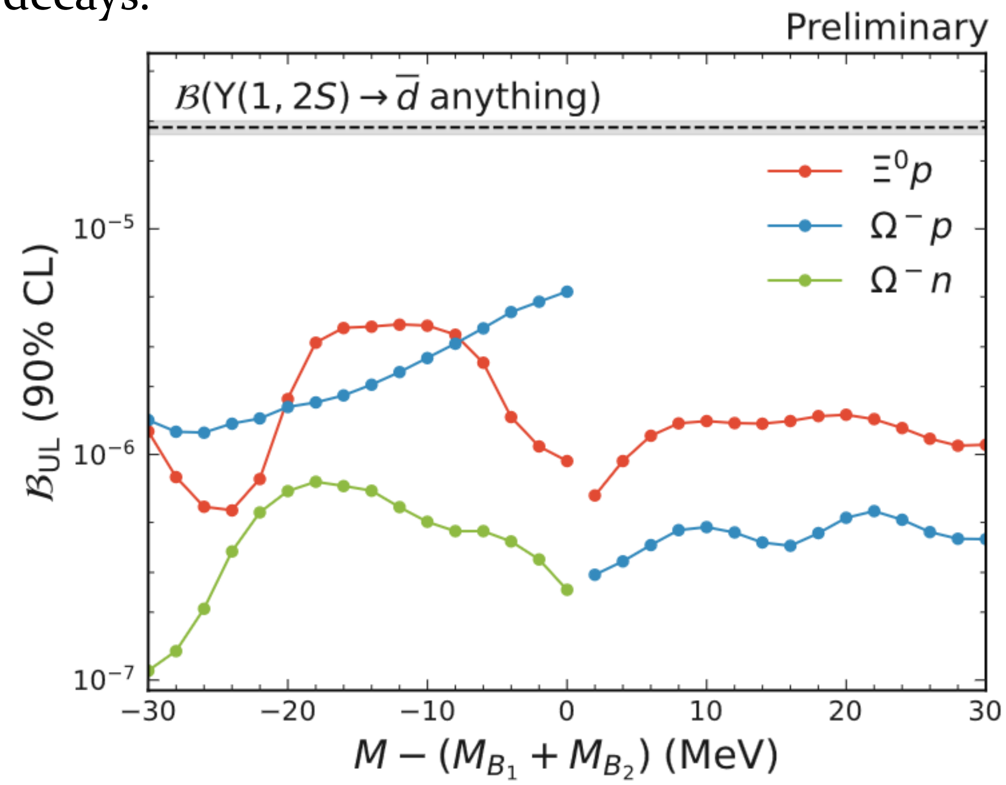
Test of Bell nonlocality through spin correlations.

Clauser-Horne-Shimony-Holt (CHSH) violation by 3.7 σ.

Search for dibaryons with Belle + Belle II

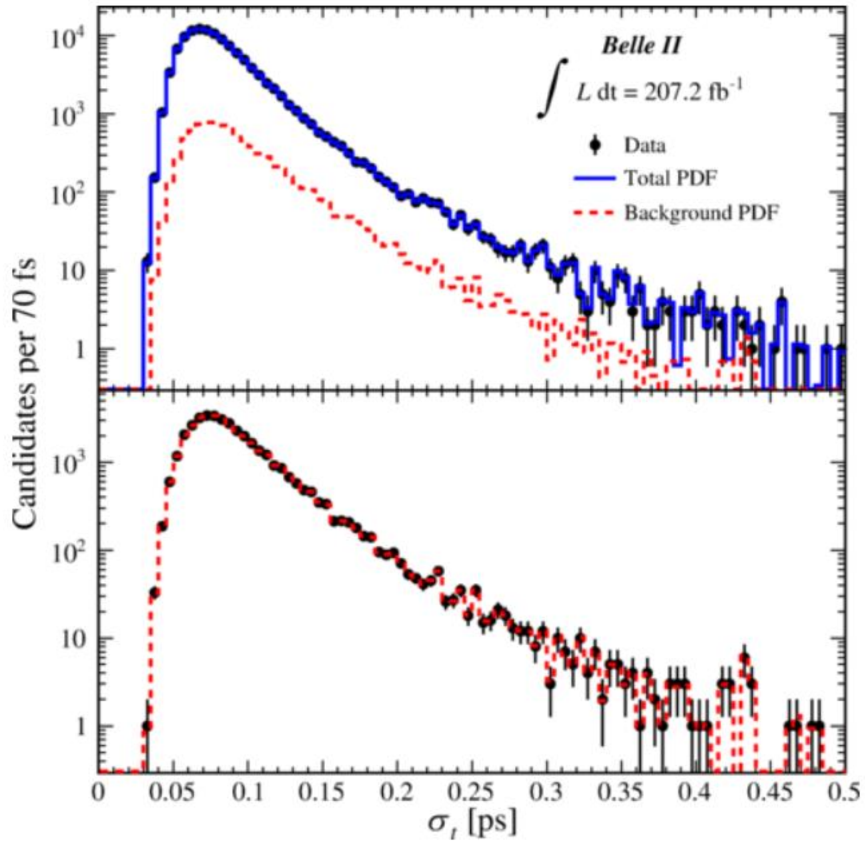


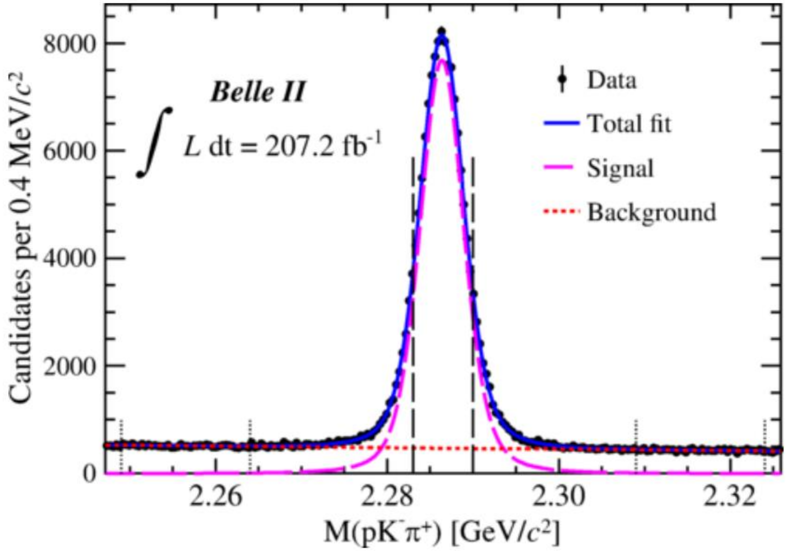
- Belle data with Belle II analysis framework.
- 102 M events of $\Upsilon(1S)$ and 158 M events of $\Upsilon(2S)$.
- Search in multibaryon final states.
- No evidence found, upper limits < $O(10^{-6}) - O(10^{-7})$ in $\Upsilon(1S)$ and $\Upsilon(2S)$ decays.



arXiv:2605.29778 (2026).

Most precise lifetime measurement of Λ_c^+





- 207 fb^{-1} *of* Belle II data used in [1].
- Previously most precise measurement from LHCb is relative to the D^+ lifetime [2].
- Belle II measurement independent of the D^+ lifetime and most precise to date.

[1] Belle II, Phys. Rev. Lett. 130, 071802 (2023).
[2] LHCb, Phys. Rev. D 100, 032001 (2019).