Tsinghua University

Poster summary-

Hadronic Charm Decays at BESIII

Shuaiying Li
Tsinghua University

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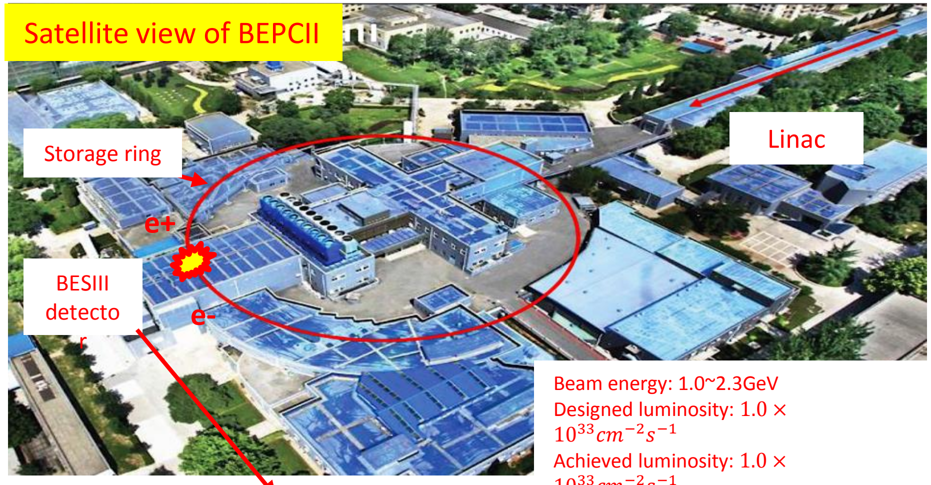
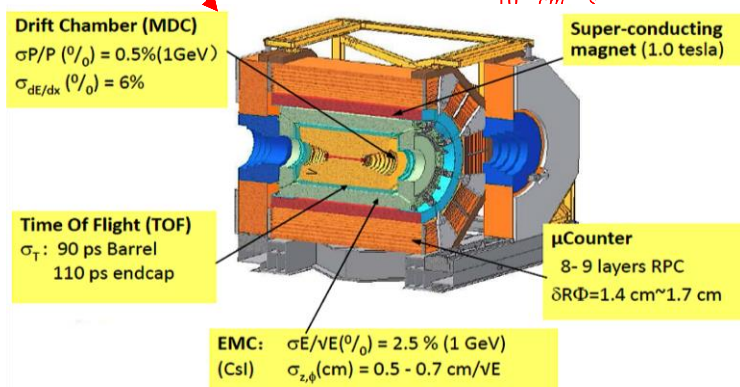




BESIII The BESIII experiment at the Beijing Electron Positron Collider (BEPCII) has accumulated the world's largest samples of e^+e^- collisions in the tau-charm region. Based on the open-charm data samples of $D^{0(+)}$, D_s^+ and Λ_c^+, we can study the hadronic charm decays under a uniquely clean background.

BESIII

D_s^+ Meson

$D_s^+ \to p\bar{n}$

- The only kinematically allowed hadronic decay, involving baryons.
- Absolute BF to be $(1.21 \pm 0.10 \pm 0.05) \times 10^{-3}$ [PRD99,031101(2019)]
- The short distance dynamics is not the driven mechanism. The hadronization process, driven by nonperturbative dynamics determines the underlying physics. [PLB663,326(2008)].

$D_s^+ \to K_S^0 K^+$ and $K_L^0 K^+$

- As in $D_s^+ \to K_S^0 K^+$ and $D_s^+ \to K_L^0 K^+$ could interfere, So can the CF and DCS amplitudes in D_s decays: $D_s^+ \to K^0 K^+$ and $D_s^+ \to \bar{K}^0 K^+$.
- Such interference effect could also lead to CPV: $A_{\rm CP} \sim 10^{-3}$, predicted by D. Wang et al.[PRL119,181802(2017)]
- BF($D_s^+ \to K_S^0 K^+$)=$(1.425 \pm 0.038 \pm 0.031)\%$, consistent with the WA.
- BF($D_s^+ \to K_L^0 K^+$)=$(1.485 \pm 0.039 \pm 0.046)\%$, 1st measurement.
- K_S^0/K_L^0 asymmetry:$R = \frac{\mathcal{B}(D_s^+ \to K_S^0 K^+) - \mathcal{B}(D_s^+ \to K_L^0 K^+)}{\mathcal{B}(D_s^+ \to K_S^0 K^+) + \mathcal{B}(D_s^+ \to K_L^0 K^+)} =$ $(-2.1 \pm 1.9 \pm 1.6)\%$, consistent with zero.
- $A_{\rm CP}(D_s \to K_S K) = (0.6 \pm 2.8 \pm$

$D_s^+ \to \omega\pi^+/K^+$

Pure W annihilation processes（sensitive to direct CP violation）According to Qin et al.[PRD89, 054006], this implies that $A_{\rm CP} \sim -0.6 \times 10^{-3}$

- $\omega\pi$: (6.7σ);
  $\mathcal{B}(D_s \to \omega\pi) = (1.77 \pm 0.32 \pm 0.13) \times 10^{-3}$;
  Consistent with CLEO's measurement[PRD80,051102] but more precise.
- ωK: (4.4σ);
  $\mathcal{B}(D_s \to \omega K) = (0.87 \pm 0.24 \pm 0.08) \times 10^{-3}$;
  First evidence! [PRD99,091101(2019)]

Amplitude analysis of $D_s^+ \to \pi^+\pi^0\eta$

- W-annihilation dominant

Improved precision:
$\mathcal{B}(D_s^+ \to \pi^+\pi^0\eta) = (9.50 \pm 0.28 \pm 0.41)\%$
First measurement(16.2σ): $\mathcal{B}\big(D_s^+ \to$

Λ_c^+ Meson

$\Lambda_c^+ \to \Lambda X$

- BF($\Lambda_c^+ \to \Lambda X$)=$(38.2^{+2.8}_{-2.2} \pm 0.8)\%$
- Also, look for;

$$A_{CP} = \frac{\mathcal{B}(\Lambda_c^+ \to \Lambda X) - \mathcal{B}(\bar{\Lambda}_c^- \to \bar{\Lambda} X)}{\mathcal{B}(\Lambda_c^+ \to \Lambda X) + \mathcal{B}(\bar{\Lambda}_c^- \to \bar{\Lambda} X)}$$

- $A_{CP} = (+2.1^{+7.0}_{-6.6} \pm 1.4)\%$

[PRL121,062003(2018)]

$\Lambda_c^+ \to \Lambda\eta\pi^+$ and $\Lambda_c^+ \to \Sigma(1385)^+\eta$

[PRD99,032010(2019)]

	$\Lambda\eta\pi^+$	$\Sigma^{*+}\eta$
N_{sig}	154 ± 17	54 ± 11
$\varepsilon(\%)$	15.73 ± 0.01	12.84 ± 0.01
$B(\%)$	$1.84 \pm 0.21 \pm 0.15$	$0.91 \pm 0.18 \pm 0.09$

$\Lambda_c^+ \to \Sigma^+(\eta/\eta')$

- CF decays, proceed through nonfactorizable internal W-mission/exchange.
- Measured:

$\mathrm{BF}(\Lambda_c^+ \to \Sigma^+\eta)/\mathrm{BF}(\Lambda_c^+ \to \Sigma^+\pi^0) =$
$0.35 \pm 0.16 \pm 0.03$
$(< 0.58@90\%\ \mathrm{C.L.})$

$\mathrm{BF}(\Lambda_c^+ \to \Sigma^+\eta')/\mathrm{BF}(\Lambda_c^+ \to \Sigma^+\omega) =$
$0.86 \pm 0.34 \pm 0.07$
$(< 1.20@90\%\ \mathrm{C.L.})$ [CPC43,083002(2019)]

- Other recent results not mentioned in this report:

Amplitude analysis of $D^0 \to K^-\pi^+\pi^0\pi^0$
Phys.Rev.D99,092008(2019)

Search for the radiative decay $D_s^+ \to \gamma e^+\nu_e$
Phys.Rev.D99,072002(2019)

Study of the dynamics of $D_s^+ \to \eta' e^+\nu_e$
Phys.Rev.Lett.122,121801(2019)

Study of $D_s^+ \to \mu^+\nu_\mu$
Phys.Rev.Lett.122,071802(2019)

Study of $D^+ \to K^0_{S,L}K^+(\pi^0)$
Phys.Rev.D99,032002(2019)

Study of $D_s^+ \to K^{*0}e^+\nu_e$
Phys.Rev.Lett.122,061801(2019)

Study of $D^{0(+)} \to \pi\pi e^+\nu_e$
Phys.Rev.Lett.122,062001(2019)

Study of $D^0 \to \bar{K}^0\pi^- e^+\nu_e$
Phys.Rev.D99,011103(2019)

Study of $D^0 \to K^-\mu^+\nu_\mu$
Phys.Rev.Lett.122,011804(2019)

Measurement of $\Lambda_c^+ \to Xe^+\nu_e$
Phys.Rev.Lett.121,251801(2018)

Amplitude analysis of $D^+ \to K_S^0\pi^+\pi^+\pi^-$
arXiv:1901.05936, submitted to PRD

Λ_c decay asymmetry

arXiv: 1905.04707,
submitted to PRL(may transfer to PRD)

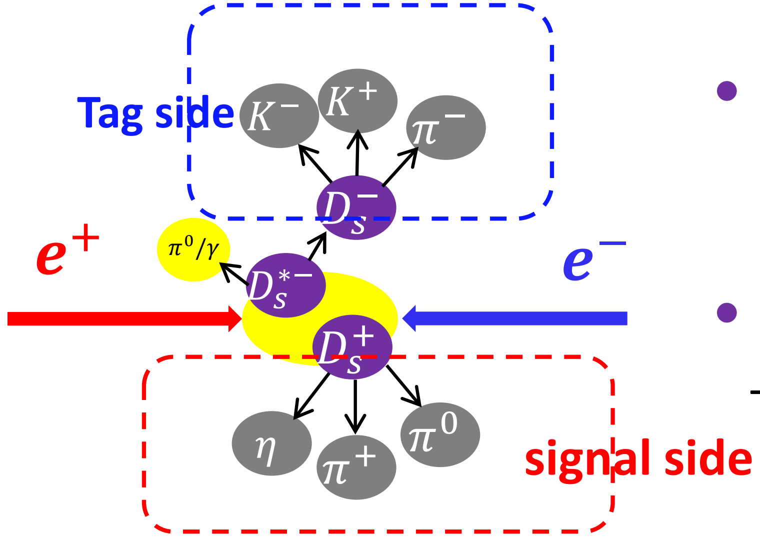
- Our results include new measurement, have confirmed and improved the precisions over the previous results.
- More measurements in D_s hadronic decays are coming.
- Planning to take more data at/near E_{cm} ~ 4.6 GeV as well as E_{cm}= 3.773 GeV soon, which will allow us to even improve further precisions and rare forbidden searches in D_s/Λ_c decays.

Thank you!

Back up

Back up

Analysis technique

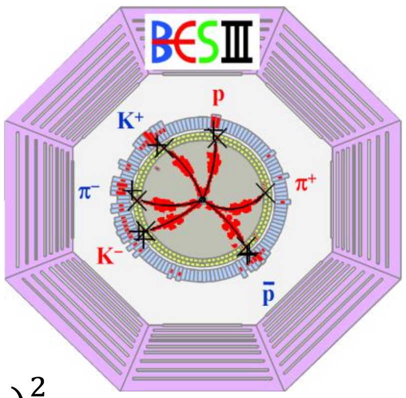


- **Single Tag(ST):**
  -reconstruct only one of the $D_s^+ D_s^- (\Lambda_c^+ \overline{\Lambda}_c^-)$

- **Double Tag(DT):**
  - reconstruct both of $D_s^+ D_s^- (\Lambda_c^+ \overline{\Lambda}_c^-)$

➢ Advantages of DT method:
- Clean environment with no additional hadrons
- DT provides access to absolute BFs

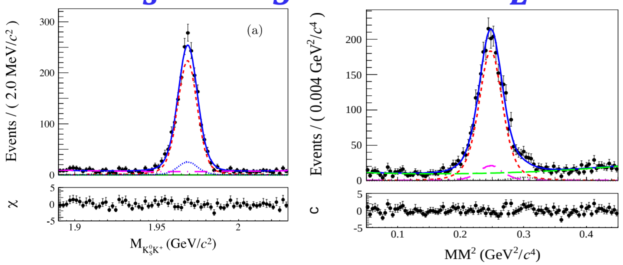
- Beam-constraint mass: $M_{\mathrm{BC}} \equiv \sqrt{E_{\mathrm{beam}}^2/c^4 - |\vec{p}_{\overline{\Lambda}_c^+}|^2/c^2}$
- Energy difference: $\Delta E = E_{\overline{\Lambda}_c^+} - E_{\mathrm{beam}}$



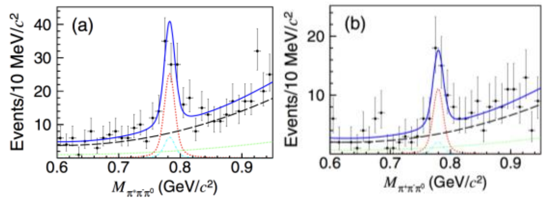
- Missing mass: $M_{\mathrm{miss}} = \sqrt{E_{\mathrm{miss}}^2 - c^2|\vec{p}|^2}$
- Missing-mass-squared: $MM^2 = (P_{e^+e^-} - P_{D_s^-} - P_\gamma - P_{K^+})^2$
- Charge conjugation implied

Back up

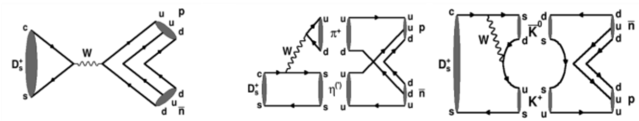
$D_s^+ \to K_S K^+$ and $K_L K^+$

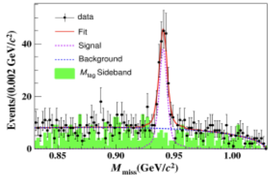


$D_s^+ \to \omega\pi^+/K^+$

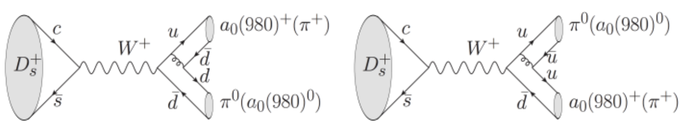


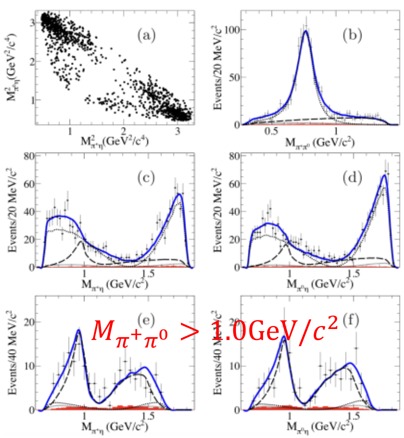
$D_s^+ \to p\bar{n}$





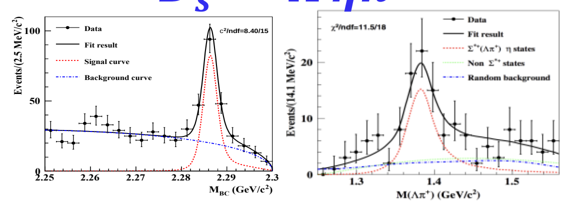
$D_s^+ \to \pi^+\pi^0\eta$



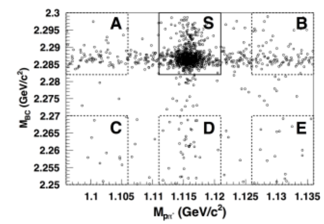


Amplitude	ϕ_n (rad)	FF$_n$
$D_s^+ \to \rho^+\eta$	0.0 (fixed)	$0.783 \pm 0.050 \pm 0.021$
$D_s^+ \to (\pi^+\pi^0)_V\eta$	$0.612 \pm 0.172 \pm 0.342$	$0.054 \pm 0.021 \pm 0.025$
$D_s^+ \to a_0(980)\pi$	$2.794 \pm 0.087 \pm 0.044$	$0.232 \pm 0.023 \pm 0.033$

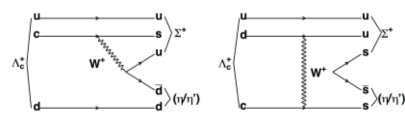
$D_s^+ \to \Lambda\,\eta\pi^+$

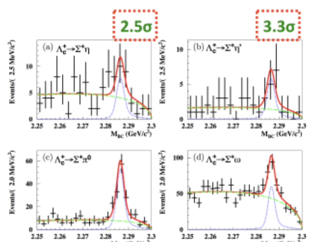


$D_s^+ \to \Lambda\,X$



$D_s^+ \to \Sigma^+(\eta/\eta')$





Decay mode	Körner [5]	Sharma [3]	Zenczykowski [4]	Ivanov [6]	CLEO [12]	This work
$\Lambda_c^+ \to \Sigma^+\eta$	0.16	0.57	0.94	0.11	0.70±0.23	0.41±0.20 (<0.68)
$\Lambda_c^+ \to \Sigma^+\eta'$	1.28	0.10	0.12	0.12	-	1.34±0.57 (<1.9)