粲介子半轻衰变中的轻强子

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2025年轻强子专题研讨会

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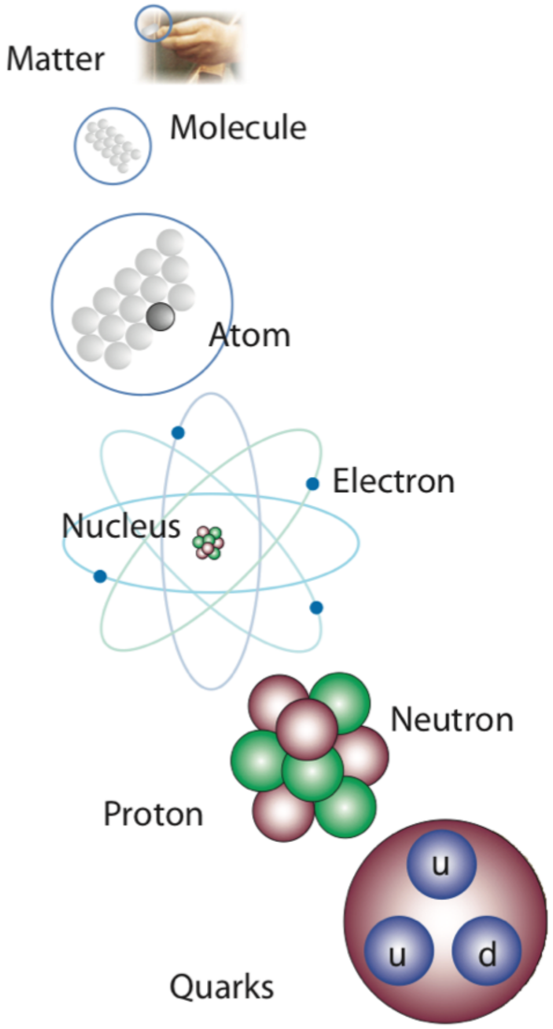
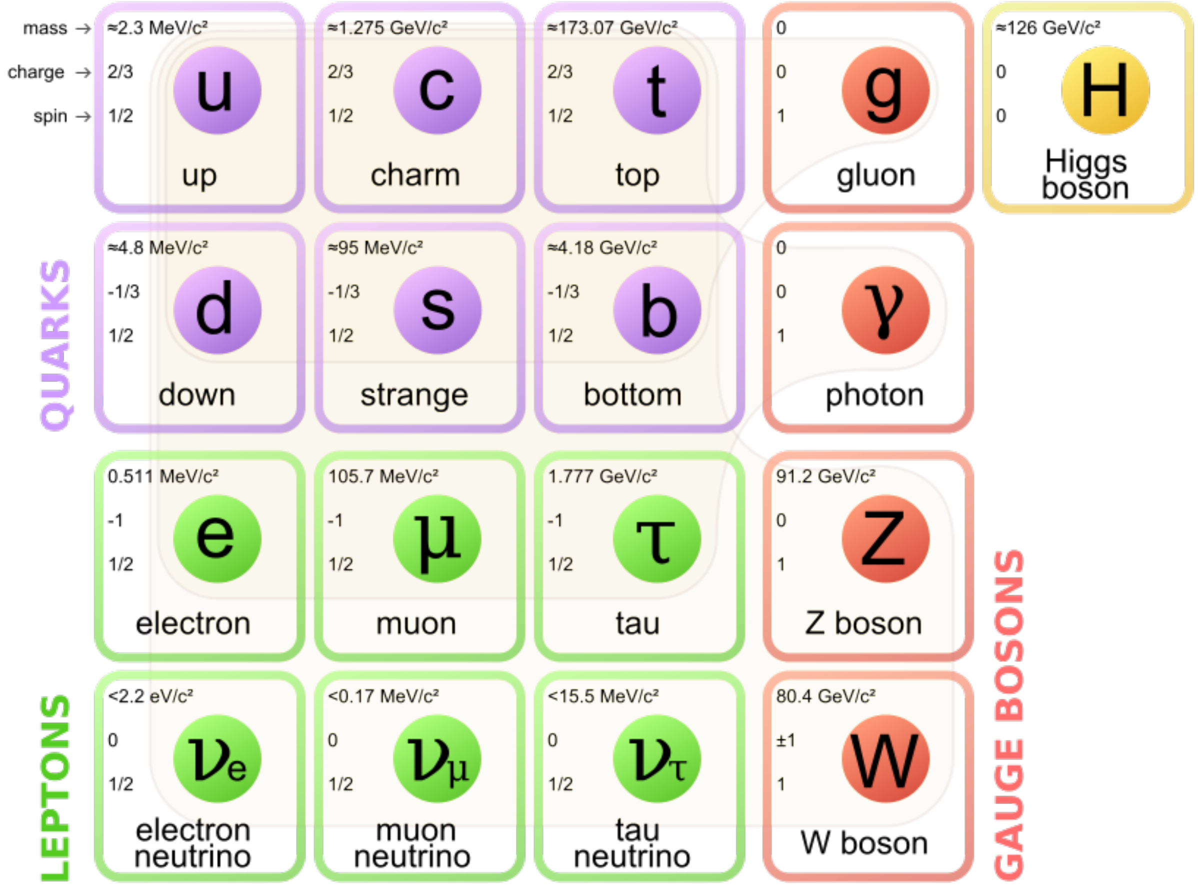
HUNAN UNIVERSITY

Content

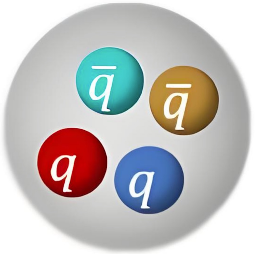
Physics motivation



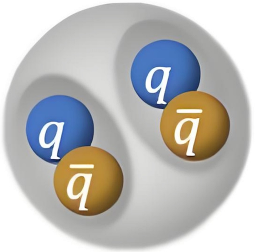


- **All matters are made out of quarks and leptons.**
- **Ordinary hadrons: Meson and Baryon.**

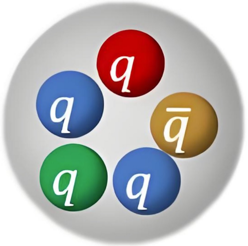
Physics motivation



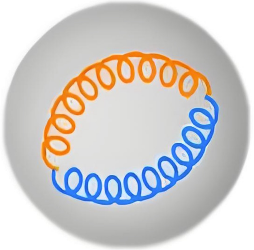
Tetraquark



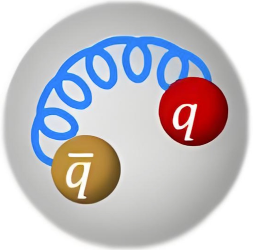
Hadronic molecules



Pentaquark



Glueball



hybrid

- **How about light scalar mesons:**

  $f_0(500), K^*(700), f_0(980)$ **and** $a_0(980)$, etc

★ **Semi-leptonic decay of charmed meson is an ideal probe for their nature!**

Physics motivation

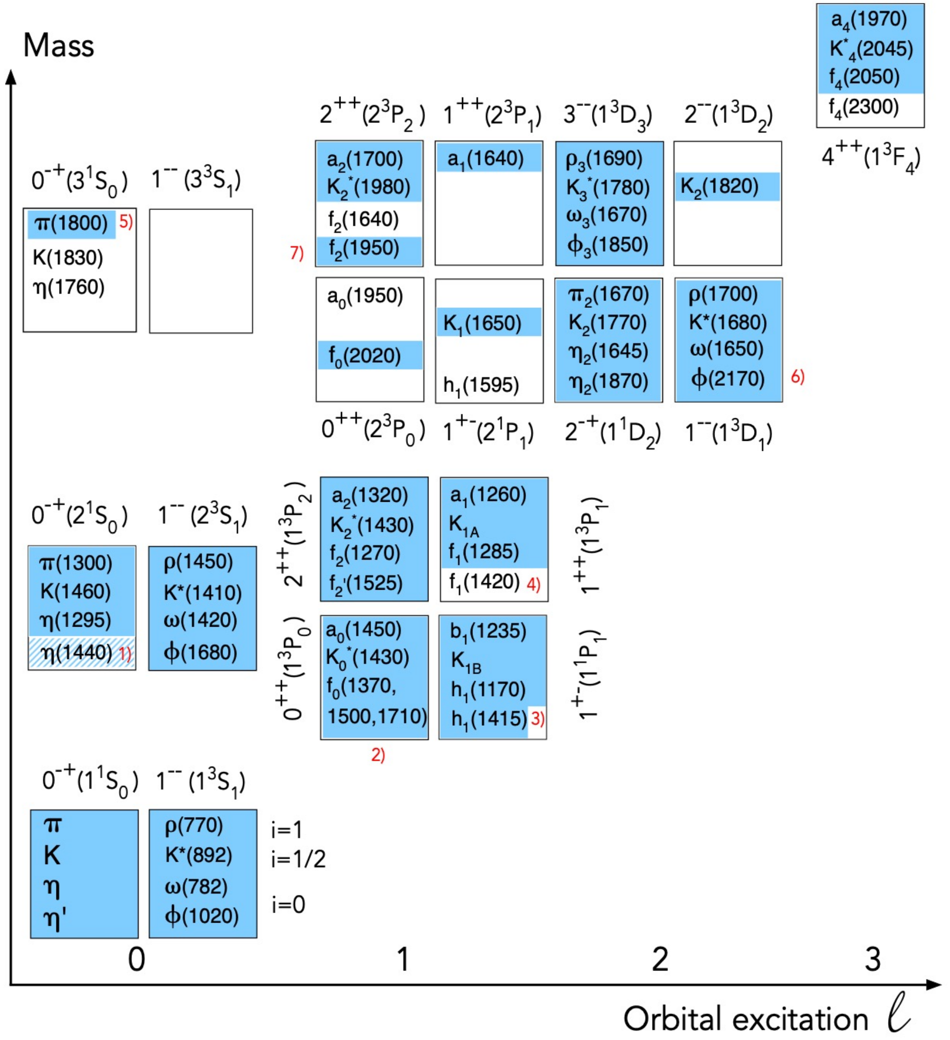
- **How about orbitally and radially excited states of strange and light mesons**

➔ $K_0^*(1430)$, $K^*(1410)$, $K_1(1270)$, $K_1(1400)$, $K_2^*(1430)$

➔ $f_0(1370)$, $f_0(1500)$, $f_1(1285)$, $f_1(1420)$, $f_2(1270)$

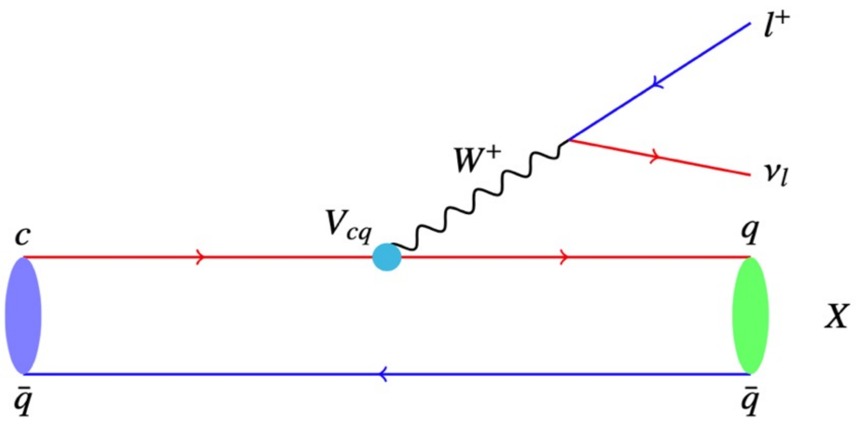
➔ $a_0(1450)$, $a_1(1260)$, $a_2(1320)$, $b_1(1235)$, …

★ Semi-leptonic decay of charmed meson is an ideal probe for their nature!



Physics motivation

??? ➠ **Why is the semi-leptonic decay of charmed meson?**



$$\Gamma(D_{(s)} \to S(A)\, \ell^{+}\nu_{\ell}) \propto |V_{cd(s)}|^2 |f_{+}(q^2)|^2\, dq^2$$

- **Clean environment:** hadrons ***X*** can be separated from leptons pair.
- **High statistics** of charmed meson at experiments.
- **Original purpose :**
  - Hadronic Form factor (FF) measurement ➔ **Test different QCD models (LQCD/QCDSR)**
  - $\mathcal{R}_{\mu/e} = \mathcal{B}(D_{(s)} \to X\mu^{+}\nu_{\mu})/\mathcal{B}(D_{(s)} \to Xe^{+}\nu_{e})$ measurement ➔ **Test lepton flavor universality (LFU)**

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Data sample

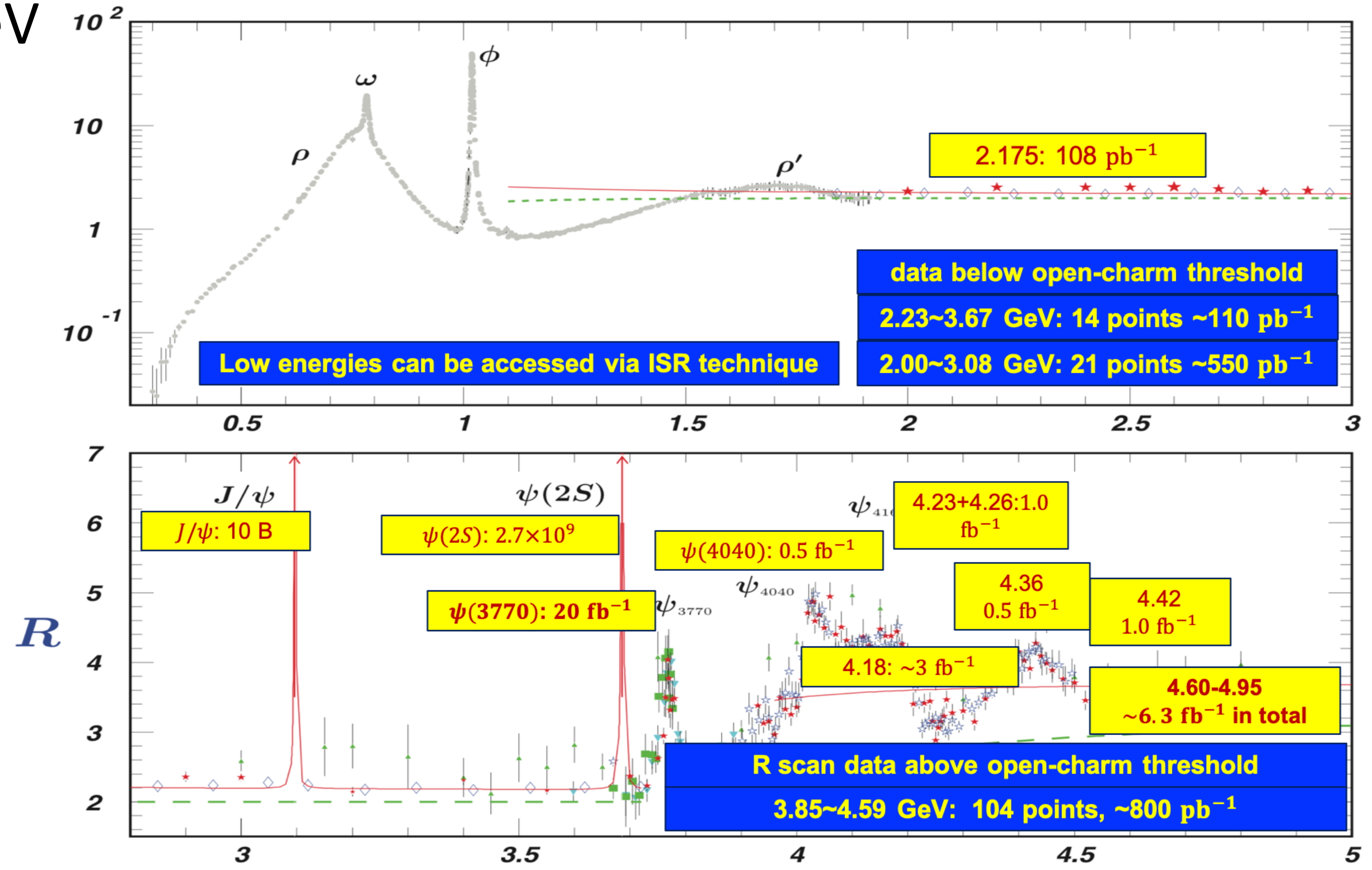
- Symmetric e^+e^- collider @2 – 5GeV
- Pair-production near threshold
- $D\bar{D}$@3.773GeV

  2.93 fb^{-1} 2010-2011

  4.99 fb^{-1} 2021-2022

  8.16 fb^{-1} 2021-2022

  4.19 fb^{-1} 2022-2024

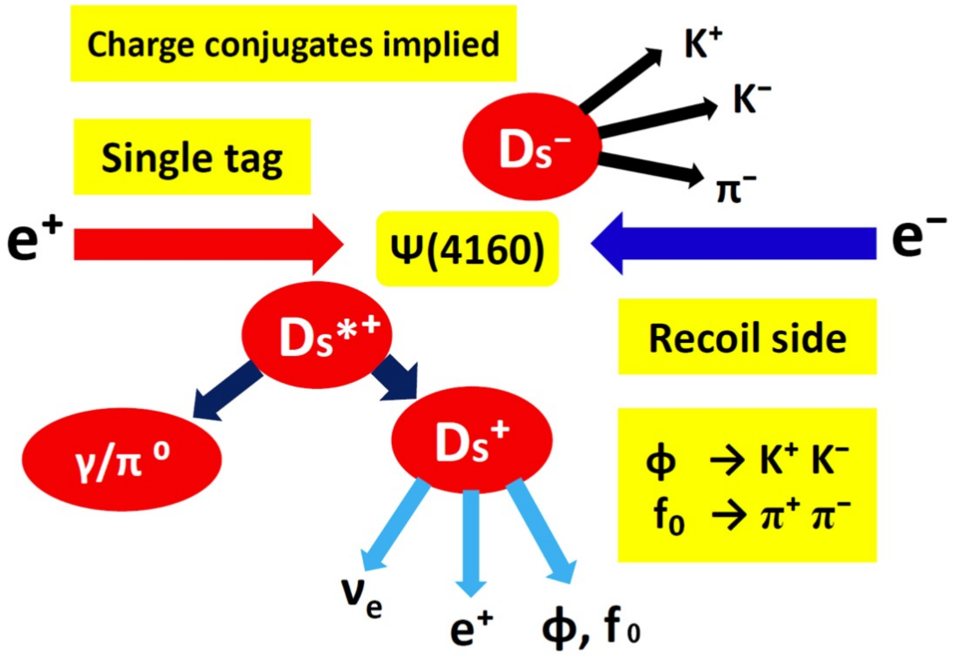


~20 fb^{-1} on the $\psi(3770)$ had been collected!

- $D_sD_s^*$ @4.13-4.23GeV: 7.33 fb^{-1}

Analysis method: Double Tag

Take Ds decay as an example (complicated case)



$\mathcal{B}_\gamma(D_S^* \to \gamma D_S)$

$$N_{tag} = 2N_{D_S^+ D_S^-} \mathcal{B}_{tag}\, \epsilon_{tag}$$
$$N_{sig} = 2N_{D_S^+ D_S^-} \mathcal{B}_{tag} \mathcal{B}_{sig} \mathcal{B}_\gamma \epsilon_{sig}$$

$$\mathcal{B}_{sig} = \frac{N_{sig}}{\mathcal{B}_\gamma N_{tag} \epsilon_{sig} / \epsilon_{tag}}$$

$$\mathcal{B}_{sig} = \frac{N_{sig}}{\mathcal{B}_\gamma \sum_\alpha N_{tag}^\alpha \epsilon_{sig}^\alpha / \epsilon_{tag}^\alpha}$$

- Mature method
- Absolute BF measurement
- Low background
- Systematic cancellation (tag)

$$U_{\text{miss}} = E_{\text{miss}} - |\vec{p}_{\text{miss}}|$$
$$M_{\text{miss}}^2 = E_{\text{miss}}^2 - |\vec{p}_{\text{miss}}|^2$$

The differential decay rate of $D_{(s)} \to S\,\ell\,\nu_\ell$

$$\Gamma(D_{(s)} \to S\ell^+\nu_\ell)/dq^2 \propto |V_{cd(s)}|^2|f_+(q^2)|^2$$

$S: a_0(980), f_0(500), f_0(980)$

- Use least χ^2 method to fit the measured partial decay width in different q^2 bin.
- Taking the correlations among q^2 bins into account.
- FF in different form (The width needs to be considered ?)

– **Single pole form**

$$f_+(q^2) = \frac{f_+(0)}{1 - q^2/M_{pole}^2}$$

– **Modified pole model**

$$f_+(q^2) = \frac{f_+(0)}{\left(1 - \frac{q^2}{M_{pole}^2}\right)\left(1 - \alpha\frac{q^2}{M_{pole}^2}\right)}$$

– **ISGW2 model**

$$f_+(q^2) = f_+(q_{max}^2)\left(1 + \frac{r^2}{12}(q_{max}^2 - q^2)\right)^{-2}$$

– **Series expansion model**

$$f_+(t) = \frac{1}{P(t)\Phi(t,\ t_0)}a_0(t_0)(1 + \sum_{k=1}^{\infty} r_k(t_0)\left[z(t,t_0)\right]^k)$$

The differential decay rate of $D_{(s)} \to S \ell \nu_\ell$

- Point-like differential decay rate:

$$\frac{d\Gamma(D_{(s)}\to S\ell^+\nu_\ell)}{dq^2} = \frac{G_F^2|V_{cd(s)}|^2}{24\pi^3} p_S^3(m_\ell)|f_+(q^2)|^2$$

- Double differential decay rate:

(N.N.Achasov *et al.*, PRD102,016022(2020); W. Wang, PLB759,501(2016))

$$\frac{d^2\Gamma(D_{(s)}\to S\ell^+\nu_\ell)}{dsdq^2} = \frac{G_F^2|V_{cd(s)}|^2}{192\pi^4 m_{D_{(s)}}^3} \lambda^{\frac{3}{2}}\left(m_{D_{(s)}}^2, s, q^2\right)|f_+(q^2)|^2 P(s)$$

$$P(s) = \begin{cases} \dfrac{g_1\rho_{\pi\pi/\pi\eta}}{|m_0^2 - s - i(g_1\rho_{\pi\pi/\pi\eta} + g_1\rho_{KK})|^2}, & \text{Flatte: } f_0(980)/a_0(980) \\ \dfrac{m_{f_0}\Gamma(s)}{(s-m_{f_0}^2)^2 + m_{f_0}^2\Gamma^2(s)}, & \text{RBW: } f_0(500) \\ \dfrac{m_r\Gamma_{tot}(s)}{(m_r^2 - s - g_1^2\frac{s-s_A}{m_r^2-s_A}z(s))^2 + m_r^2\Gamma_{tot}^2(s)}, & \text{Bugg: } f_0(500) \end{cases}$$

Content

01 **Physics motivation ✓**

02 **Data and analysis method ✓**

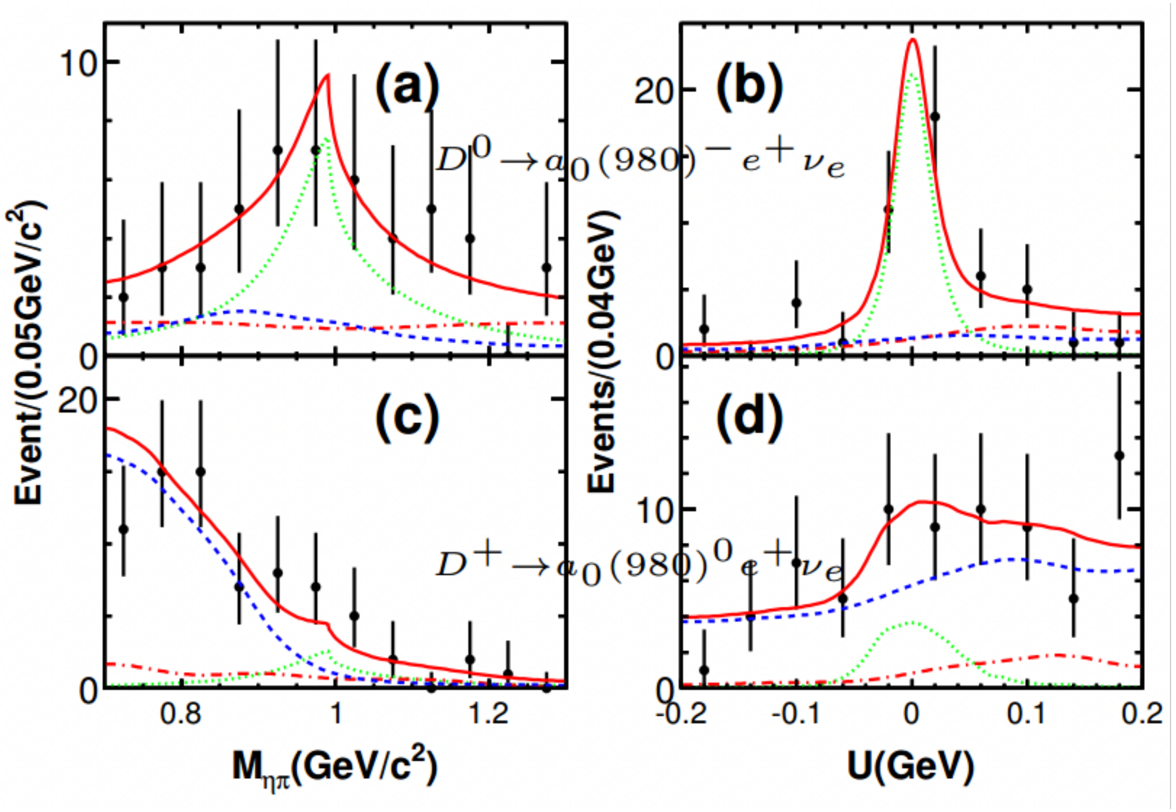
03 **Some recent results ✓**

04 **Summary and Prospect**

First observation of $D^0 \to a_0(980)^- e^+ \nu_e$

Phys. Rev. Lett. 121, 081802 (2018)

- $2.93\ \text{fb}^{-1}$ data @ $3.773\ \text{GeV}$
- $N_{sig}^{D^0} = 25.7^{+6.4}_{-5.7}$
- $N_{sig}^{D^+} = 10.2^{+5.0}_{-4.1}$
- BFs help to understand the nature of the $\boldsymbol{a_0(980)}$



Decay	BF ($\times 10^{-4}$)	Significance
$D^0 \to a_0(980)^- e^+ \nu_e,\ a_0(980)^- \to \eta\pi^-$	$1.33^{+0.33}_{-0.29} \pm 0.09$	6.4σ
$D^+ \to a_0(980)^0 e^+ \nu_e,\ a_0(980)^0 \to \eta\pi^0$	$1.66^{+0.81}_{-0.66} \pm 0.11$ < 3.0 (90% C.L.)	2.9σ

Study of the decay $D^0 \to a_0(980)^-(\eta\pi^-)e^+\nu_e$

Phys. Rev. D 111, L091501 (2025)

- 7.93 fb^{-1} data @ 3.773 GeV ➔ $N_{\mathrm{sig}} = 51.8 \pm 10.0$
- **Updated BF measurement** of $D^0 \to a_0(980)^- e^+\nu_e$.

$\mathcal{B}(D^0 \to a_0(980)^- e^+\nu_e, a_0(980)^- \to (\eta\pi^-))$

$= (0.86 \pm 0.17 \pm 0.05)\times 10^{-4}$

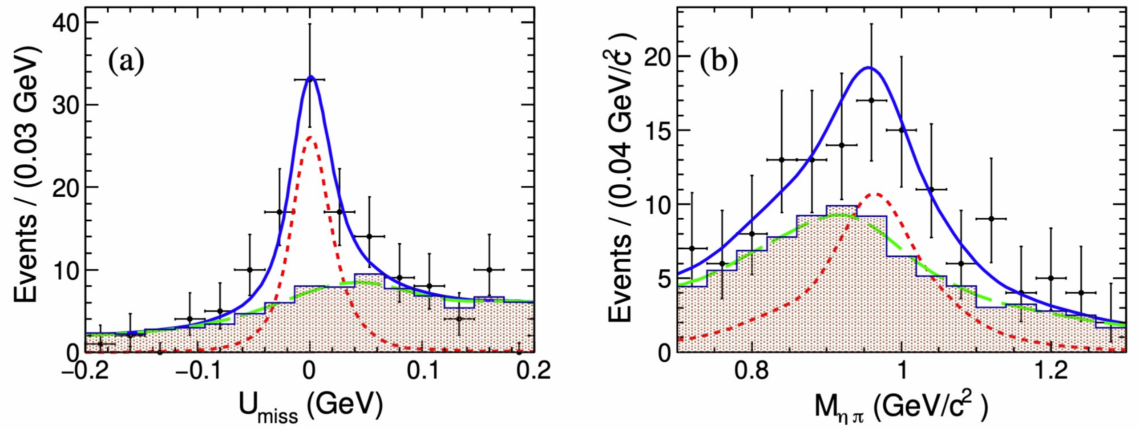
- **First FF measurement:**

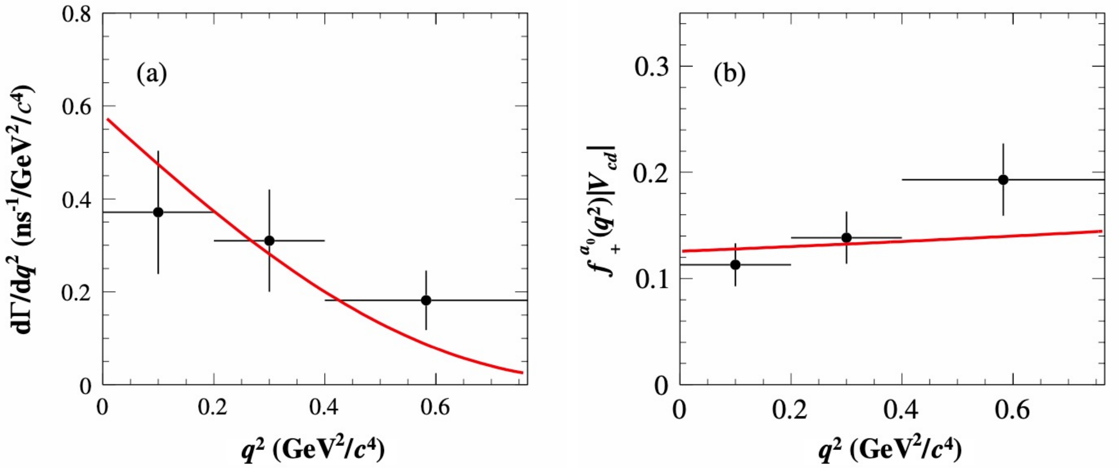
Single-pole form for FF and Bugg form for $a_0(980)^-$

➔ $f_+^{a_0}(0)|V_{cd}| = 0.126 \pm 0.013 \pm 0.003$

➔ $f_+^{a_0}(0) = 0.559 \pm 0.056 \pm 0.013$

ps: $|V_{cd}| = 0.22487 \pm 0.00068$ from SM global fit (PDG2024)





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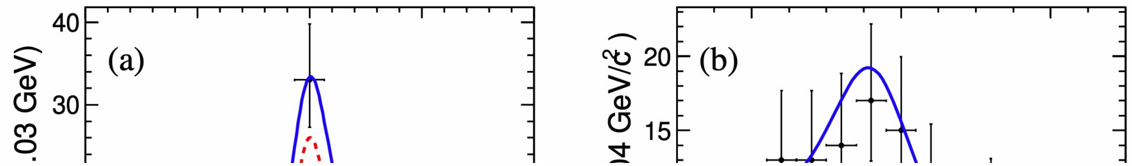
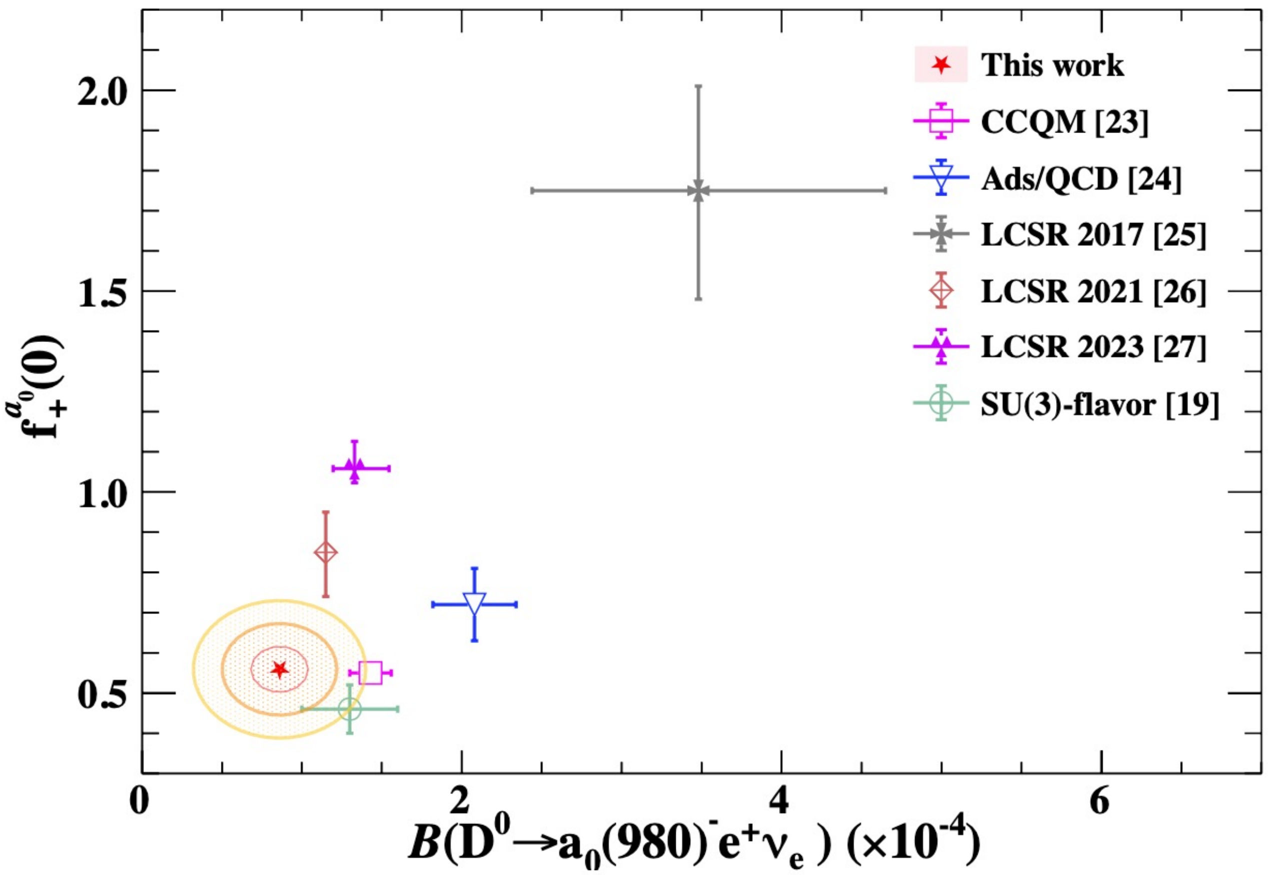




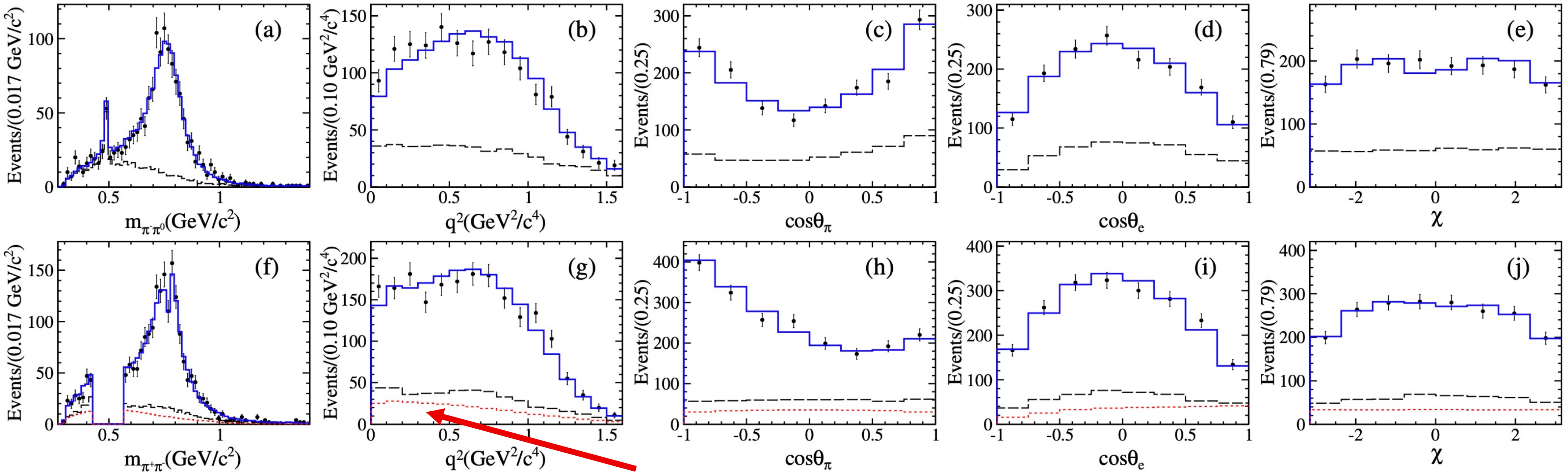
First observation of $D^+ \to f_0(500)e^+\nu_e$

Phys. Rev. Lett. 122, 062001 (2019)

$N_{sig}^{D^0} = 1498$ (Bkg:~33.3%)
$N_{sig}^{D^+} = 2017$ (Bkg:~23.8%)

D^0

D^+



$f_{f_0(500)} = (25.7 \pm 1.6 \pm 1.1)\%$

- 2.93 fb^{-1} data @ 3.773 GeV
- $R = \frac{\mathcal{B}(D^+\to f_0(500)e^+\nu_e)+\mathcal{B}(D^+\to f_0(980)e^+\nu_e)}{\mathcal{B}(D^+\to a_0(980)e^+\nu_e)} > 2.7@90\%CL$
- Favor tetraquark (R=3, PRD82, 034016(2010)) for f_0 and a_0

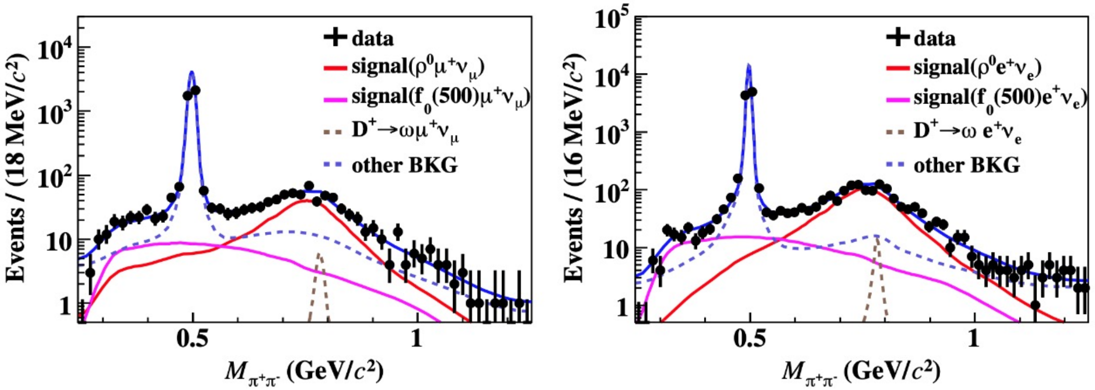
Signal mode	This analysis ($\times10^{-3}$)
$D^0 \to \pi^-\pi^0 e^+\nu_e$	$1.445 \pm 0.058 \pm 0.039$
$D^0 \to \rho^- e^+\nu_e$	$1.445 \pm 0.058 \pm 0.039$
$D^+ \to \pi^-\pi^+ e^+\nu_e$	$2.449 \pm 0.074 \pm 0.073$
$D^+ \to \rho^0 e^+\nu_e$	$1.860 \pm 0.070 \pm 0.061$
$D^+ \to \omega e^+\nu_e$	$2.05 \pm 0.66 \pm 0.30$
$D^+ \to f_0(500)e^+\nu_e$, $f_0(500) \to \pi^+\pi^-$	$0.630 \pm 0.043 \pm 0.032$
$D^+ \to f_0(980)e^+\nu_e$, $f_0(980) \to \pi^+\pi^-$	<0.028

Study of the decay $D^+ \to f_0(500)\ell^+\nu_\ell$

Phys. Rev. D 110, 092008 (2024)

- 2.93 fb^{-1} data @ 3.773 GeV
- **First observation** of $D^+ \to f_0(500)(\pi^+\pi^-)\mu^+\nu_\mu$.

Signal mode	N_{obs}	$\mathcal{S}$ (σ)	ϵ_{sig} (%)	$\mathcal{B}_{sig}(\times 10^{-3})$
$f_0(500)\mu^+\nu_\mu$	209 ± 38	5.9	18.93 ± 0.13	0.72 ± 0.13
$\rho^0\mu^+\nu_\mu$	496 ± 38	> 10	19.86 ± 0.13	1.64 ± 0.13
$f_0(500)e^+\nu_e$	412 ± 43	> 10	44.76 ± 0.25	0.60 ± 0.06
$\rho^0 e^+\nu_e$	1237 ± 47	> 10	44.12 ± 0.25	1.84 ± 0.07



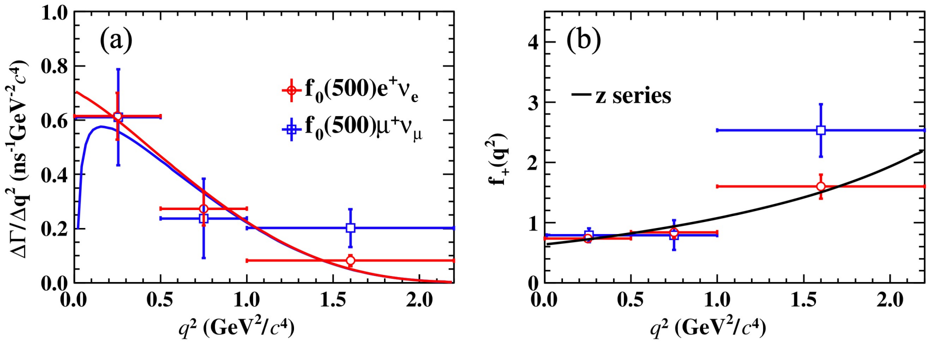
➔ The measured BF of $D^+ \to f_0(500)\ell^+\nu_\ell$ are closer to **tetraquark assumption**.
R.M. Wang et al, PRD107,056022 (2023)
Y.K. Hsiao et al, arXiv:2306.06091

- **First FF measurement** of $D^+ \to f_0(500)(\pi^+\pi^-)\ell^+\nu_\ell$.

Based Z series expansion for FF and Bugg form for $f_0(500)$

➔ $f_+^{f_0}(0)|V_{cd}| = 0.143 \pm 0.014 \pm 0.011$

➔ $f_+^{f_0}(0) = 0.63 \pm 0.06 \pm 0.05$



ps: $|V_{cd}| = 0.22486 \pm 0.00067$ from SM global fit (PDG2022)

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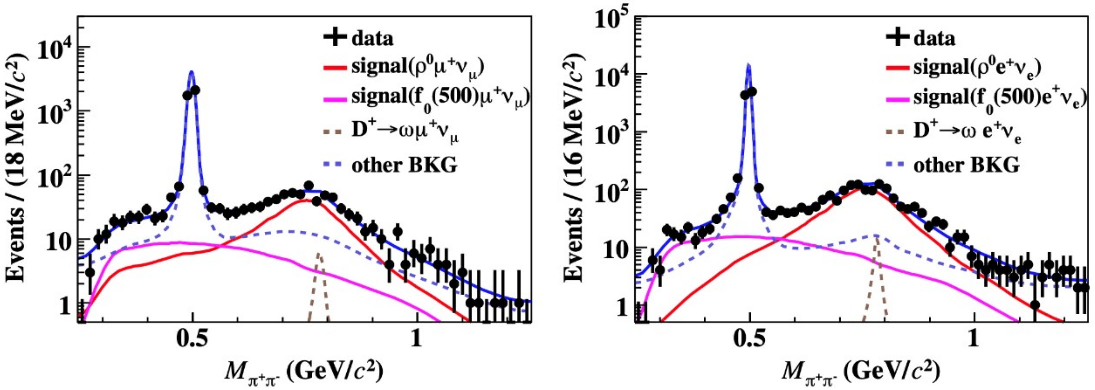

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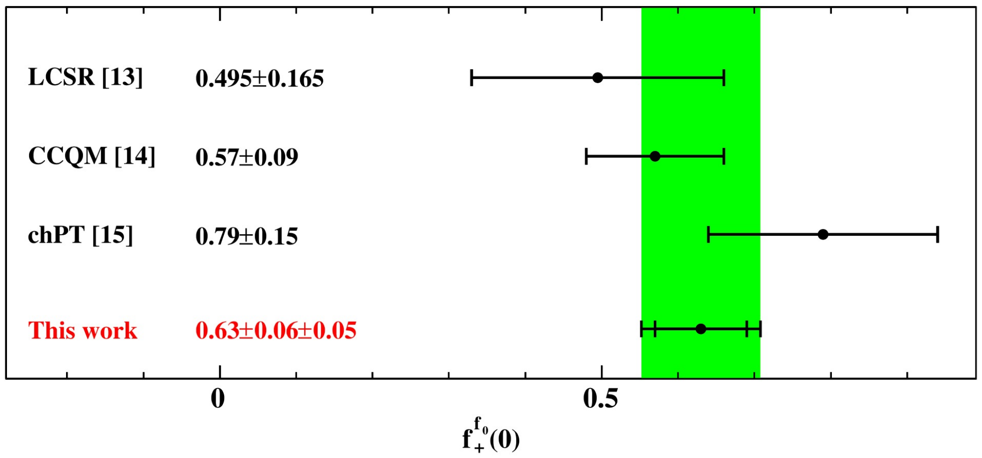


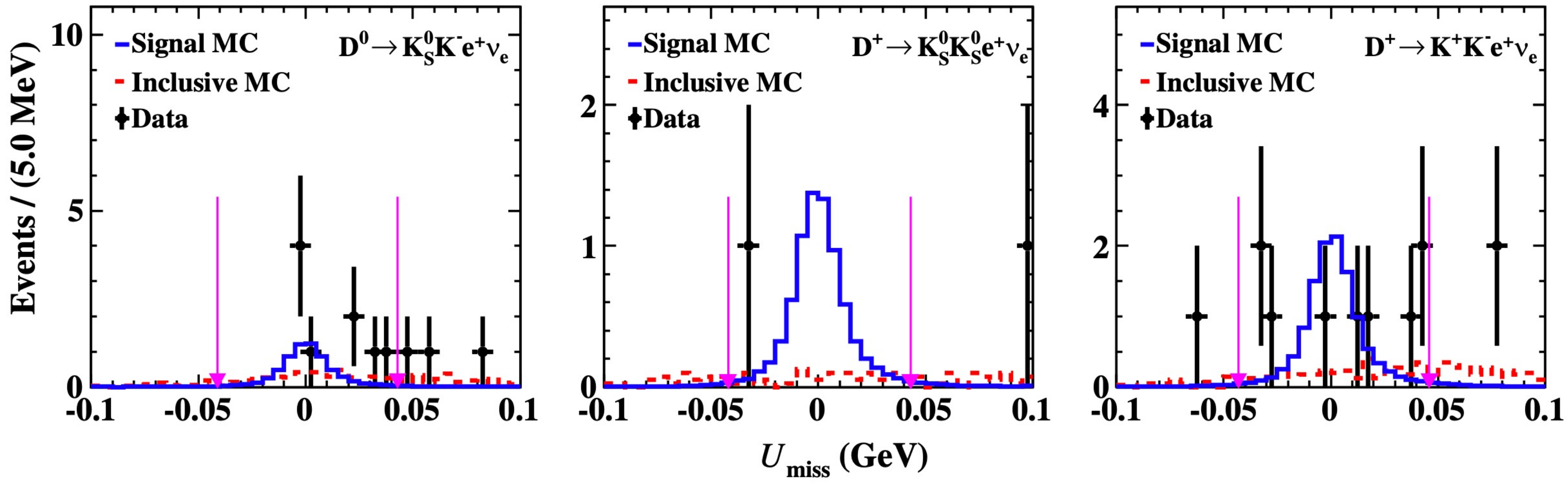
Search for the decay $D \to K\bar{K}e^+\nu_e$

Phys. Rev. D 109, 072003 (2024)

- 7.9 fb^{-1} data @ 3.773 GeV [2010,2011,2021]
- No significant signal is observed, upper limits are determined at 90%CL assuming $a_0(980)$ contribution:

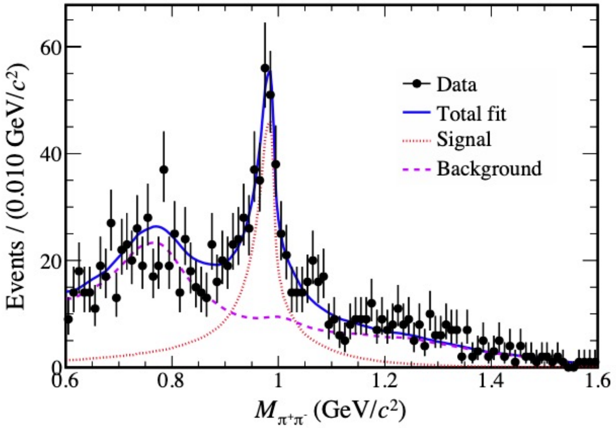
$$\mathcal{B}(D^0 \to K_S^0 K^- e^+\nu_e) < 2.13\times10^{-5}$$

$$\mathcal{B}(D^+ \to K_S^0 K_S^0 e^+\nu_e) < 1.54\times10^{-5}, \mathcal{B}(D^+ \to K^+K^- e^+\nu_e) < 2.10\times10^{-5}$$



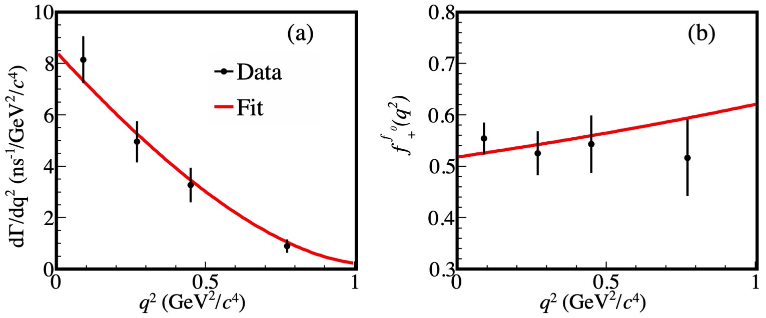
Study of the $f_0(980)$ and $f_0(500)$ through the decay $D_s^+ \to \pi^+\pi^- e^+\nu_e$

Phys. Rev. Lett. 132, 141901 (2024)



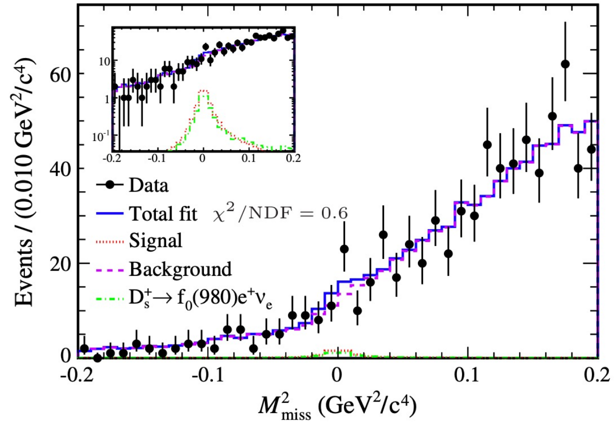
- 7.33 fb^{-1} data @ 4.128-4.226 GeV ➔ $N_{\text{sig}} = 439 \pm 33$
- $\mathcal{B}(D_s^+ \to f_0(980)e^+\nu_e, f_0(980) \to \pi^+\pi^-) = (1.72 \pm 0.13 \pm 0.10)\times10^{-3}$
  - ➔ **$s\bar{s}$ is dominant** based on $|f_0(980)\rangle = \sin\phi|\frac{1}{\sqrt{2}}(u\bar{u} + d\bar{d})\rangle + \cos\phi\,|s\bar{s}\rangle$

    $\phi = (19.7 \pm 12.8)^\circ$
- **First form factor measurement** with simple pole form:
  - ➔ $f_+^{f_0}(0)|V_{cs}| = 0.504 \pm 0.017 \pm 0.035$
  - ➔ $f_+^{f_0}(0) = 0.518 \pm 0.018 \pm 0.036$ ($|V_{cs}| = 0.97349 \pm 0.00016$ PDG2022)



	This work	CLFD [6]	DR [6]	QCDSR [7]	QCDSR [8]	LCSR [9]	LFQM [11]	CCQM [12]
$f_+^{f_0}(0)$	$0.518 \pm 0.018_{\text{stat}} \pm 0.036_{\text{syst}}$	0.45	0.46	0.50 ± 0.13	0.48 ± 0.23	0.30 ± 0.03	0.24 ± 0.05	0.36 ± 0.02
Difference (σ)	—	1.7	1.4	0.1	0.2	4.3	4.3	2.8
ϕ	$\phi = (19.7 \pm 12.8)^\circ$	$(32 \pm 4.8)^\circ$	$(41.3 \pm 5.5)^\circ$	35°	$(8^{+21}_{-8})^\circ$	—	$(56 \pm 7)^\circ$	31°

- **First search** of $D_s^+ \to f_0(500)e^+\nu_e, f_0(500) \to \pi^+\pi^-$ ($M_{\pi^+\pi^-} < 0.45$ GeV/c²)
- $\mathcal{B}(D_s^+ \to f_0(500)e^+\nu_e, f_0(500) \to \pi^+\pi^-) < 3.3\times10^{-4}$



Study of the $f_0(980)$ and $f_0(500)$ through the decay $D_s^+ \to \pi^+\pi^- e^+\nu_e$

Phys. Rev. Lett. 132, 141901 (2024)

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  - ➔ **$s\bar{s}$ is dominant** based on $|f_0(980)\rangle = \sin\phi|\frac{1}{\sqrt{2}}(u\bar{u} + d\bar{d})\rangle + \cos\phi\,|s\bar{s}\rangle$
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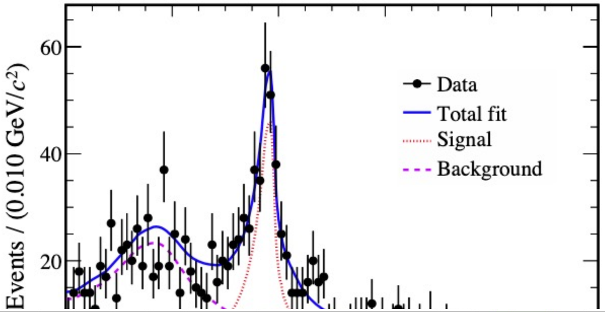
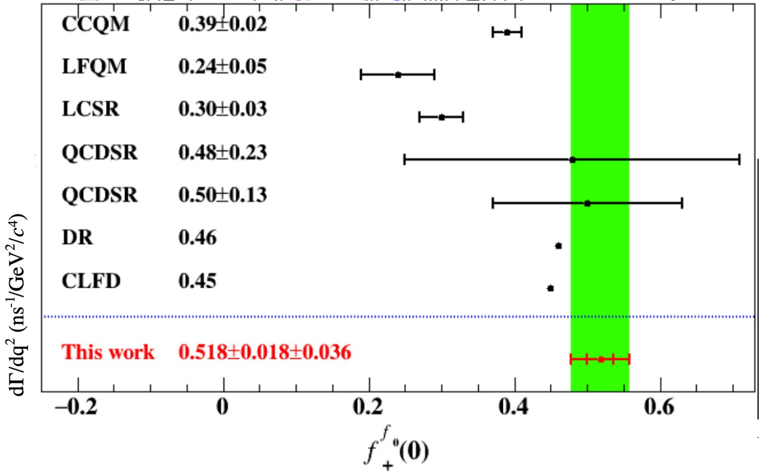
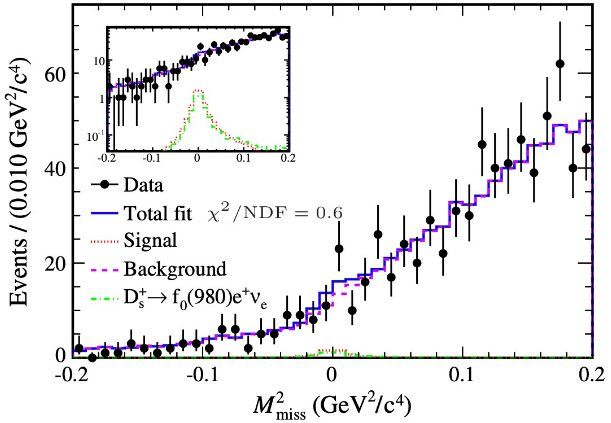
  - ➔ $f_+^{f_0}(0)|V_{cs}| = 0.504 \pm 0.017 \pm 0.035$
  - ➔ $f_+^{f_0}(0) = 0.518 \pm 0.018 \pm 0.036$ ($|V_{cs}| = 0.97349 \pm 0.00016$ PDG2022)





	This work	CLFD [6]	DR [6]	QCDSR [7]	QCDSR [8]	LCSR [9]	LFQM [11]	CCQM [12]
$f_+^{f_0}(0)$	$0.518 \pm 0.018_{\mathrm{stat}} \pm 0.036_{\mathrm{syst}}$	0.45	0.46	0.50 ± 0.13	0.48 ± 0.23	0.30 ± 0.03	0.24 ± 0.05	0.36 ± 0.02
Difference (σ)	—	1.7	1.4	0.1	0.2	4.3	4.3	2.8
ϕ	$\phi = (19.7 \pm 12.8)^\circ$	$(32 \pm 4.8)^\circ$	$(41.3 \pm 5.5)^\circ$	35°	$(8^{+21}_{-8})^\circ$	—	$(56 \pm 7)^\circ$	31°

- **First search** of $D_s^+ \to f_0(500)e^+\nu_e, f_0(500) \to \pi^+\pi^-$ ($M_{\pi^+\pi^-} < 0.45$ GeV/c²)
- $\mathcal{B}(D_s^+ \to f_0(500)e^+\nu_e, f_0(500) \to \pi^+\pi^-) < 3.3\times 10^{-4}$



Search for the $b_1(1235)$ in $D \to b_1(1235)e^+\nu_e$

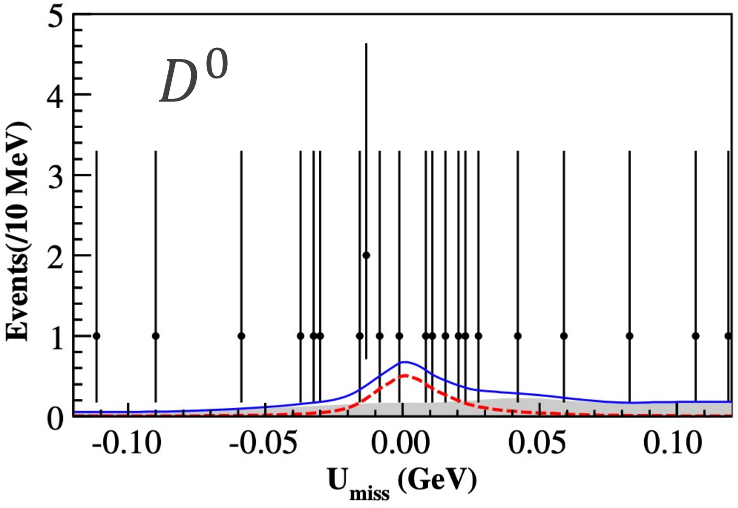
Phys. Rev. D 102, 112005 (2020)

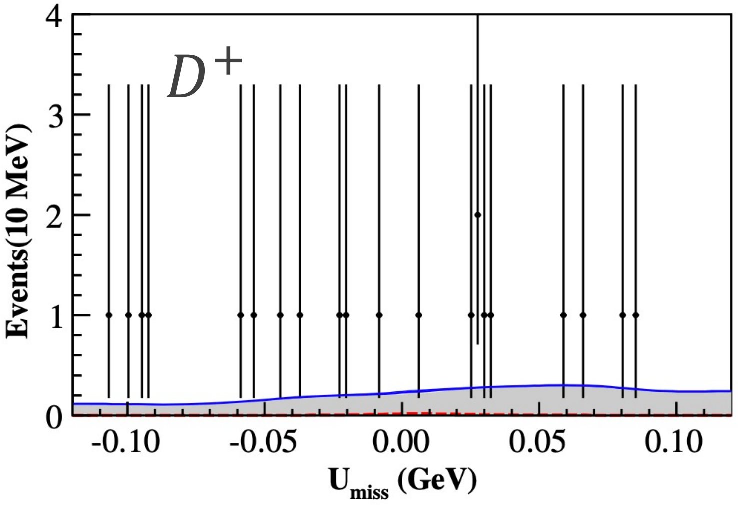
- 2.93 fb^{-1} data @ 3.773 GeV
- First search and upper limit measurement on BF:

$\mathcal{B}(D^0 \to b_1(1235)^- e^+\nu_e, b_1(1235)^- \to \omega\pi^-) < 1.12\times10^{-4}$@90%C.L.

$\mathcal{B}(D^+ \to b_1(1235)^0 e^+\nu_e, b_1(1235)^0 \to \omega\pi^0) < 1.75\times10^{-4}$@90%C.L.

➔ Be comparable with the theoretical prediction [H. Y. Cheng and X. W. Kang, Eur. Phys. J. C 77, 587(2017)





Search for the $b_1(1235)$ in $D \to b_1(1235)e^+\nu_e$

arXiv: 2407.20551 (Submitted to PRL)

- 7.93 fb^{-1} data @ 3.773 GeV
- **First observation** ➔ $N_{\text{sig}} = 35.6 \pm 8.9$

$\mathcal{B}(D^0 \to b_1(1235)^- e^+\nu_e, b_1(1235)^- \to \omega\pi^-)$

$= (0.72 \pm 0.18^{+0.06}_{-0.08})\times 10^{-4}$

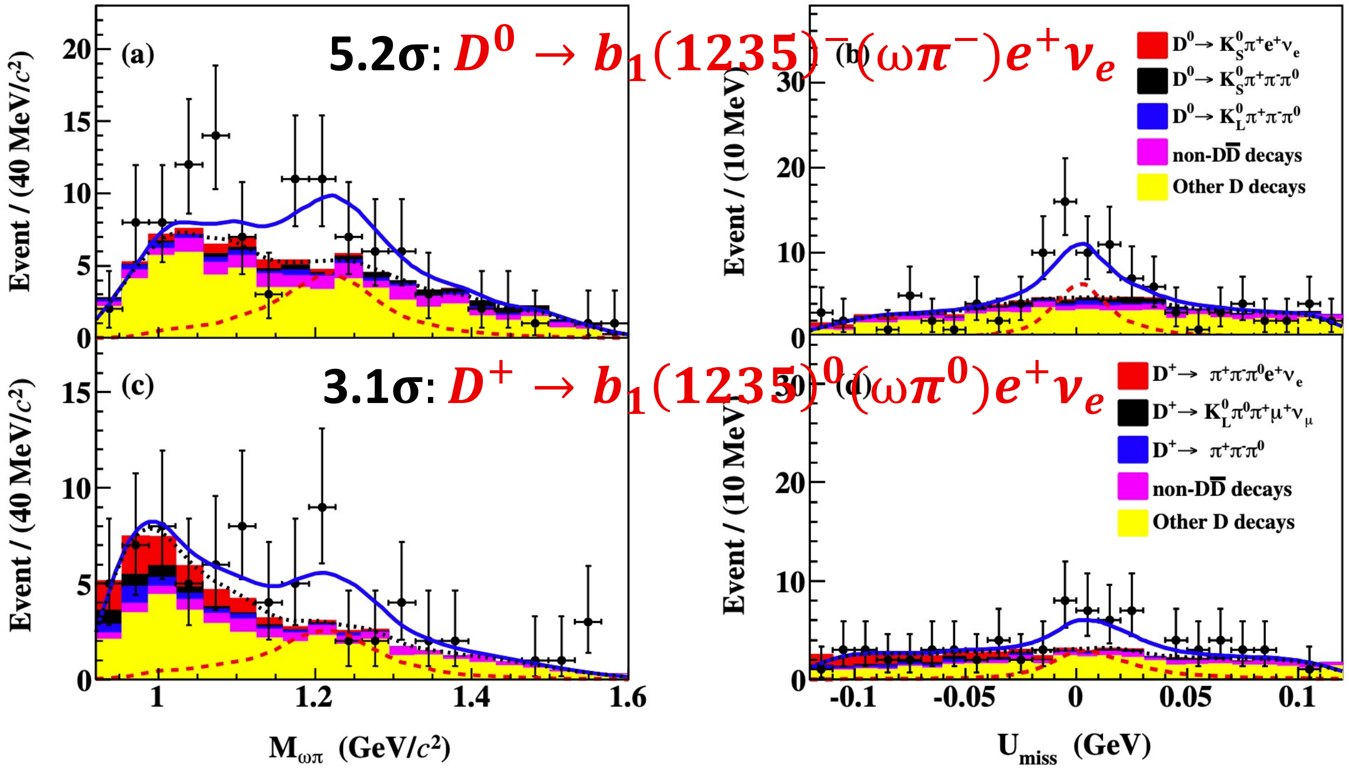
- **First evidence** ➔ $N_{\text{sig}} = 17.5 \pm 6.7$

$\mathcal{B}(D^+ \to b_1(1235)^0 e^+\nu_e, b_1(1235)^0 \to \omega\pi^0)$

$= (1.16 \pm 0.44 \pm 0.16)\times 10^{-4}$

- **Isospin conservation check:**

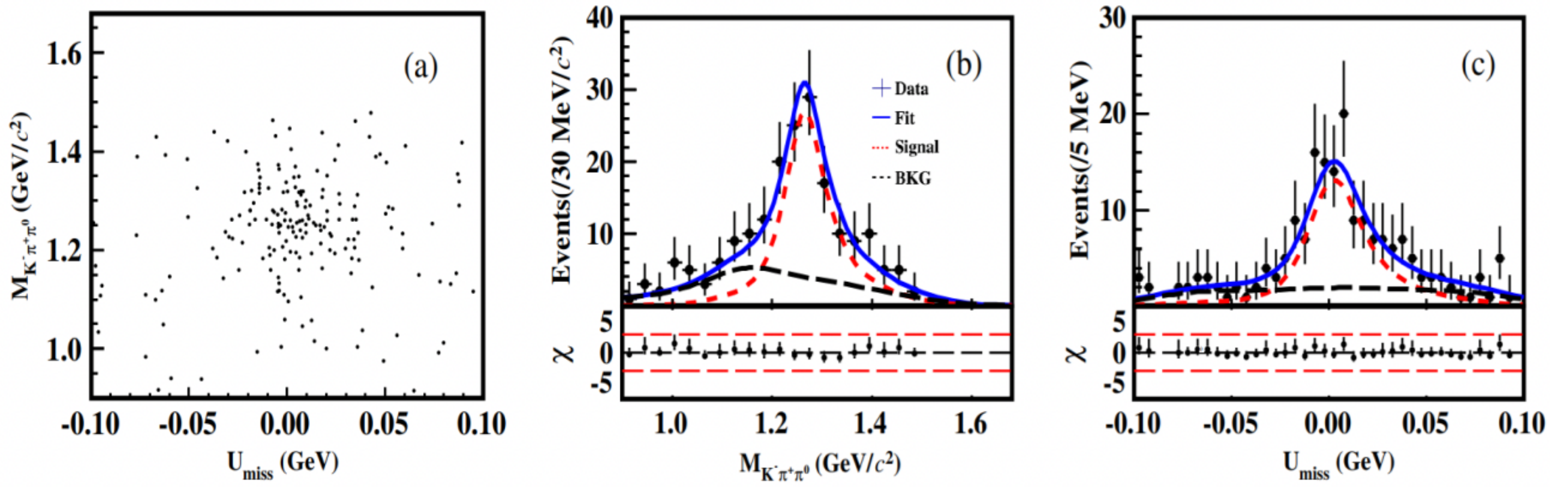
$$\frac{\Gamma(D^0 \to b_1^- e^+\nu_e)}{2\Gamma(D^+ \to b_1^0 e^+\nu_e)} = 0.78 \pm 0.19^{+0.04}_{-0.05}$$



First observation of $D^+ \to \bar{K}_1(1270)^0 e^+ \nu_e$

Phys. Rev. Lett. 123, 231801 (2019)

- 2.93 fb^{-1} data @ 3.773 GeV
- $N_{sig} = 119.7 \pm 13.3\ (> 10\sigma)$
- Agree with $\theta_{K_1} \approx 33°$or $57°$; disfavor negative sets



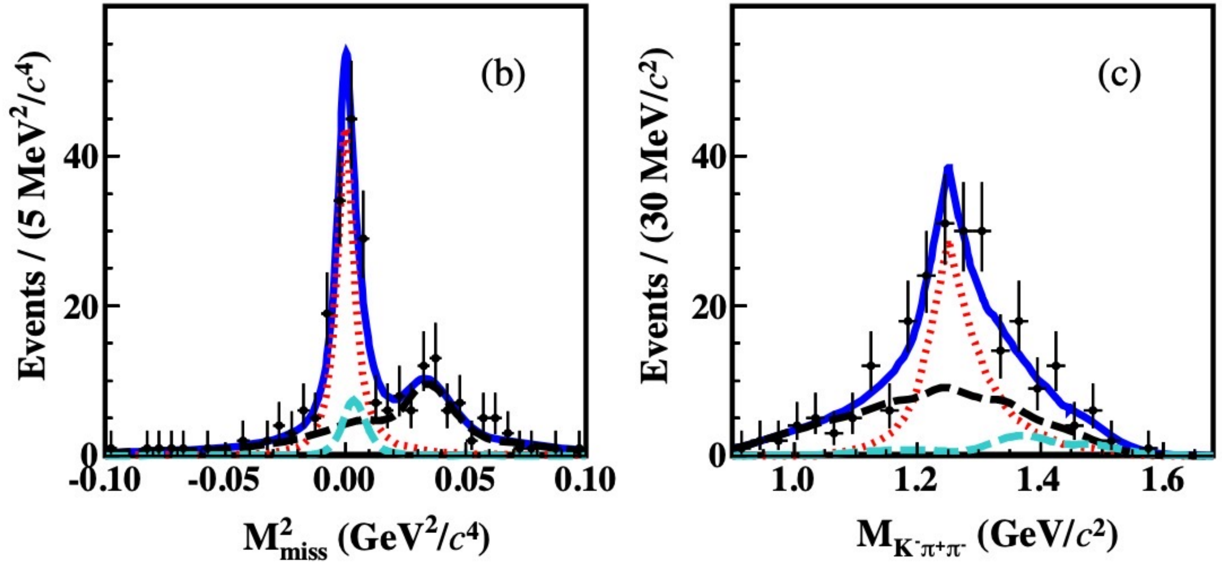
	$\mathcal{B}(D^+ \to \bar{K}_1(1270)^0 e^+ \nu_e)$
This work	$(2.30 \pm 0.26 \pm 0.18 \pm 0.25) \times 10^{-3}$
CLFQM[EPJC77,863(2017)]($\theta_{K_1} = 33°$)	$(3.20 \pm 0.40) \times 10^{-3}$
LCSR[JPG46,105006(2019)]($\theta_{K_1} < 0$)	$(17 \sim 21) \times 10^{-3}$

θ_{K_1} is the mixing angle of two states $K_{1A}(^1P_1)$ and $K_{1B}(^3P_1)$

First observation of $D^0 \to K_1(1270)^- e^+ \nu_e$

Phys. Rev. Lett. 127, 131801 (2021)

- 2.93 fb^{-1} data @ 3.773 GeV ➔ $N_{sig} = 109.0 \pm 12.5$ ($> 10\sigma$)
- $\mathcal{B}(D^0 \to K_1(1270)^- e^+ \nu_e) = (1.09 \pm 0.13^{+0.09}_{-0.16} \pm 0.12)\times 10^{-3}$
- Agree with $\theta_{K_1} \approx 33°$or $57°$; disfavor negative sets
- $F_L = 0.50 \pm 0.17 \pm 0.08$ agree with LCSR [J. Phys. G 46, 105006 (2019)]



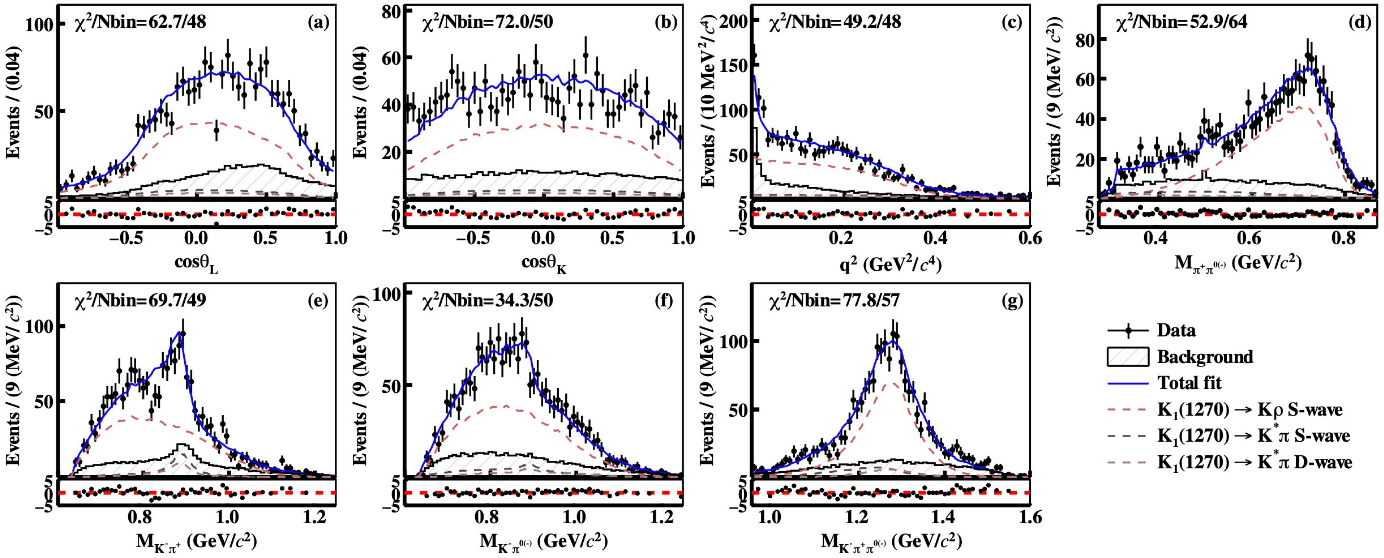
First decay dynamics study in $D \to \bar{K}_1(1270)e^+\nu_e$

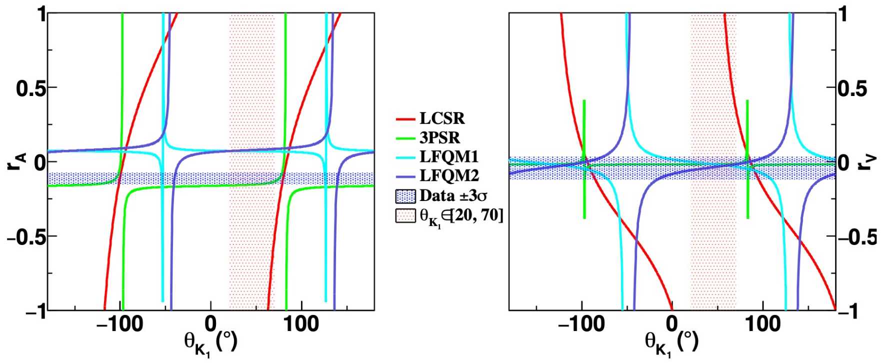
arXiv: 2503.02196 (Submitted to PRL)

- 20.3 fb^{-1} data @ 3.773 GeV ➔ $N_{SL}^{D^+(D^0)} = 1270 \pm 56\ (731 \pm 35)$
- $\mathcal{B}(D^+ \to \bar{K}_1(1270)^0 e^+\nu_e) = (2.27 \pm 0.11 \pm 0.07 \pm 0.07) \times 10^{-3}$
- $\mathcal{B}(D^0 \to K_1(1270)^- e^+\nu_e) = (1.02 \pm 0.06 \pm 0.06 \pm 0.03) \times 10^{-3}$
- First form factor measurement ($K_1(1400)$ is not observed)

Table 2. Fitted parameters and fit fractions, where the first uncertainties are statistical and the second systematic.

Variable	Value
$r_A\ (\times 10^{-2})$	$-11.2 \pm 1.0 \pm 0.9$
$r_V\ (\times 10^{-2})$	$-4.3 \pm 1.0 \pm 2.4$
$f^{D^+}_{\rho K^-}$ (%)	$79.3 \pm 2.0 \pm 25.7$
$f^{D^+}_{\pi \bar{K}^*(892)}$ (%)	$10.9 \pm 1.2 \pm 3.0$
$f^{D^0}_{\rho K^-}$ (%)	$71.8 \pm 2.3 \pm 23.9$
$f^{D^0}_{\pi \bar{K}^*(892)}$ (%)	$19.5 \pm 1.9 \pm 5.2$
$m_{K_1(1270)}$ (MeV/c^2)	$1271 \pm 3 \pm 7$
$\Gamma_{K_1(1270)}$ (MeV)	$168 \pm 10 \pm 20$





$\eta-\eta'$ study in the Decay $D \to \eta'\ell^+\nu_\ell$

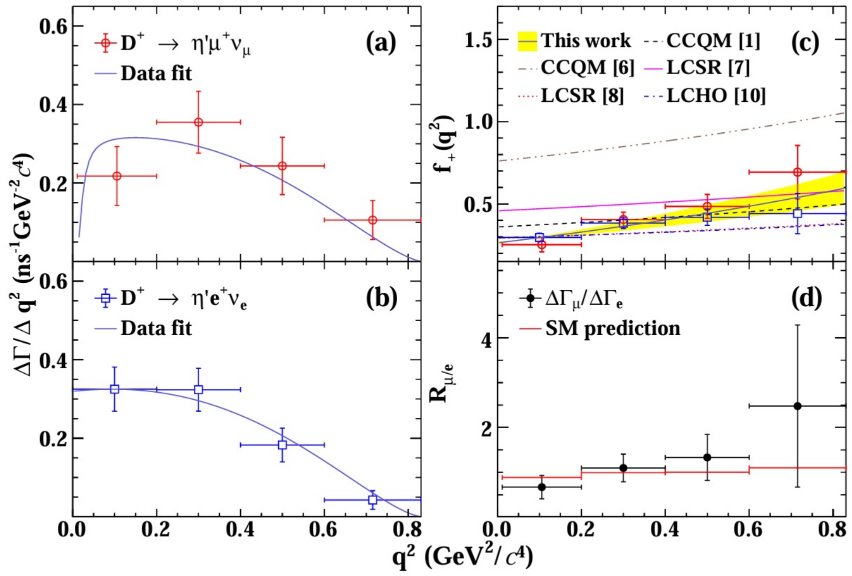
Phys. Rev. Lett. 134, 111801 (2025)

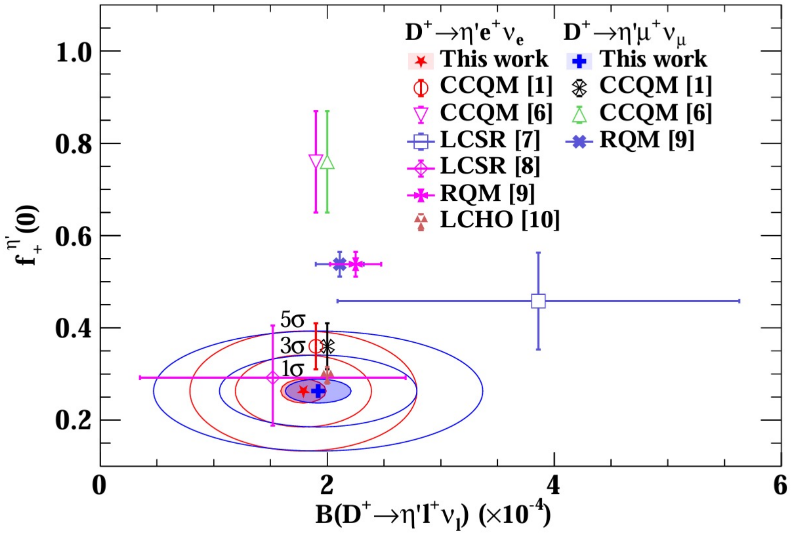
- 20.3 fb^{-1} data @ 3.773 GeV
- **First observation** of muonic channel (8.6σ)

  $\mathcal{B}(D^+ \to \eta'\mu^+\nu_\mu) = (1.92 \pm 0.28 \pm 0.08)\times 10^{-4}$

  $\mathcal{B}(D^+ \to \eta' e^+\nu_e) = (1.79 \pm 0.19 \pm 0.07)\times 10^{-4}$
- LFU test： $\mathcal{R}_{\mu/e} = 1.09 \pm 0.19 \pm 0.03$
- $\eta-\eta'$ mixing angle： $\phi_P = (39.8 \pm 0.8 \pm 0.3)^\circ$
- **First measurement** of form factor

  $f_+^{\eta'}(0)|V_{cd}| = (5.92 \pm 0.56 \pm 0.13)\times 10^{-2}$





Content

Summary and prospect

Summary:

- BESIII has the largest data samples at $D\bar{D}/D_sD_s^*$ threshold.
- Scalar/axial-vector mesons are studied systematically via semi-leptonic charm decays.
- BFs/FF measurements help to test different QCD modes and understand their nature!

Prospect:

- BESIII has **20 fb^{-1}** @3.773 GeV in total now.
- More scalar/axial-vector/tensor mesons could be studied via semi-leptonic charm decays.
  - ➔ $\boldsymbol{K_0^*(700), K_0^*(1430), f_0(1370), f_0(1500), a_0(1450)}$ **…**
  - ➔ $\boldsymbol{K_1(1400), a_1(1260), b_1(1235), f_1(1285), f_1(1420)}$ **…**
  - ➔ $\boldsymbol{a_2(1320), f_2(1270), K_2^*(1430)}$ **…**
- More results are on the way!

Thank you!

欢迎参加第三届BESIII-Belle II-LHCb粲强子物理联合研讨会

- 湖南师范大学（单葳，李龙科）：BESIII & Belle II
- 湖南大学（俞洁晟，张书磊）: BESIII & LHCb
- 中南大学（卢宇）: BESIII

注册网页：https://indico.ihep.ac.cn/event/24764/

时间：2025年6月27日-30日

地点：长沙市圣爵菲斯大酒店

群聊：第三届粲强子物理联合研讨会

该二维码7天内(5月16日前)有效，重新进入将更新

粲强子物理研究在验证标准模型和探索强相互作用机制方面具有关键作用。通过研究含粲夸克的粒子（如粲介子和粲重子），可揭示量子色动力学在低能区的非微扰特性，可探析电荷共轭-宇称联合对称性破坏（CP破坏）效应，为理解宇宙正反物质不对称性提供了独特平台。粲强子物理的研究也是寻找新物理的敏感探针。

在实验数据方面，BESIII实验于2024年圆满完成了20 /fb的psi(3770) 数据的积累；Belle II实验在10.6 GeV附近已累计采集了近600 /fb的数据；LHCb实验在TeV能区已累计采集了18 /fb的数据。这些数据提供了海量的粲强子样本，能开展丰富的粲物理研究。在此之际，召开BESIII-Belle II-LHCb粲强子物理联合研讨会是很有必要的，交流三个合作组在粲强子等方面研究的重要进展、以及粲强子物理领域理论与实验研究的热点和重点问题，探讨未来几年粲强子物理实验研究可能面临和需要重点解决的物理问题。并以此为契机，希望建立在某些互补性课题方面的合作机制，以期取得更多更有意义的物理成果。

此联合研讨会已成功举办两届：2017年南开大学举办首届，2019年山西师范大学举办第二届。本届联合研讨会由湖南师范大学、湖南大学、中南大学携手联合举办。会议得到了中国高等科学技术中心的资助和湖南省量子科学技术学会的协助。会议以口头报告和自由讨论相结合的形式举办，以促进参会专家、青年学者和研究生之间的讨论交流与合作。诚挚邀请各位专家学者莅临长沙参加此次会议。

会议网站：https://indico.ihep.ac.cn/event/24764/

会议时间：2025年6月27日--30日（27日下午注册）

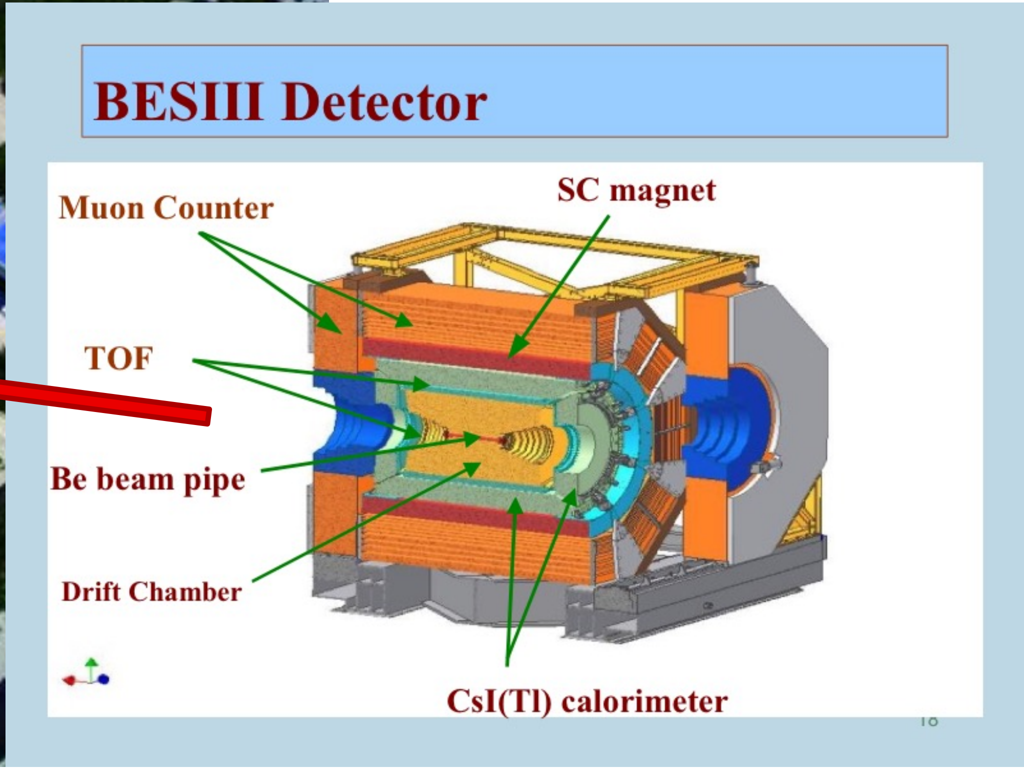
会议地点：长沙市圣爵菲斯大酒店（百度地图）

会务费：教师/博士后1500元/人；学生1000元/人；家属不收注册费。会议统一安排食宿，费用自理。会务费可现场通过POS刷卡、支付宝、微信缴费。由湖南省量子科技学会统一代收并开具发票，会务费发票将在会议结束后以电子邮件形式提供给会议注册者。
会议注册截止日期：2025年6月13日。

会议联系人：李龙科（湖南师大），15956934447，lilongke@hunnu.edu.cn；
卢　宇（中南大学），18810459153，222027@csu.edu.cn；
单　葳（湖南师大），18670371710，shanw@hunnu.edu.cn；
俞洁晟（湖南大学），18153781818，yujiesheng@hnu.edu.cn；
张书磊（湖南大学），19911568964，zhangshulei@hnu.edu.cn。

长沙F5欢迎大家!

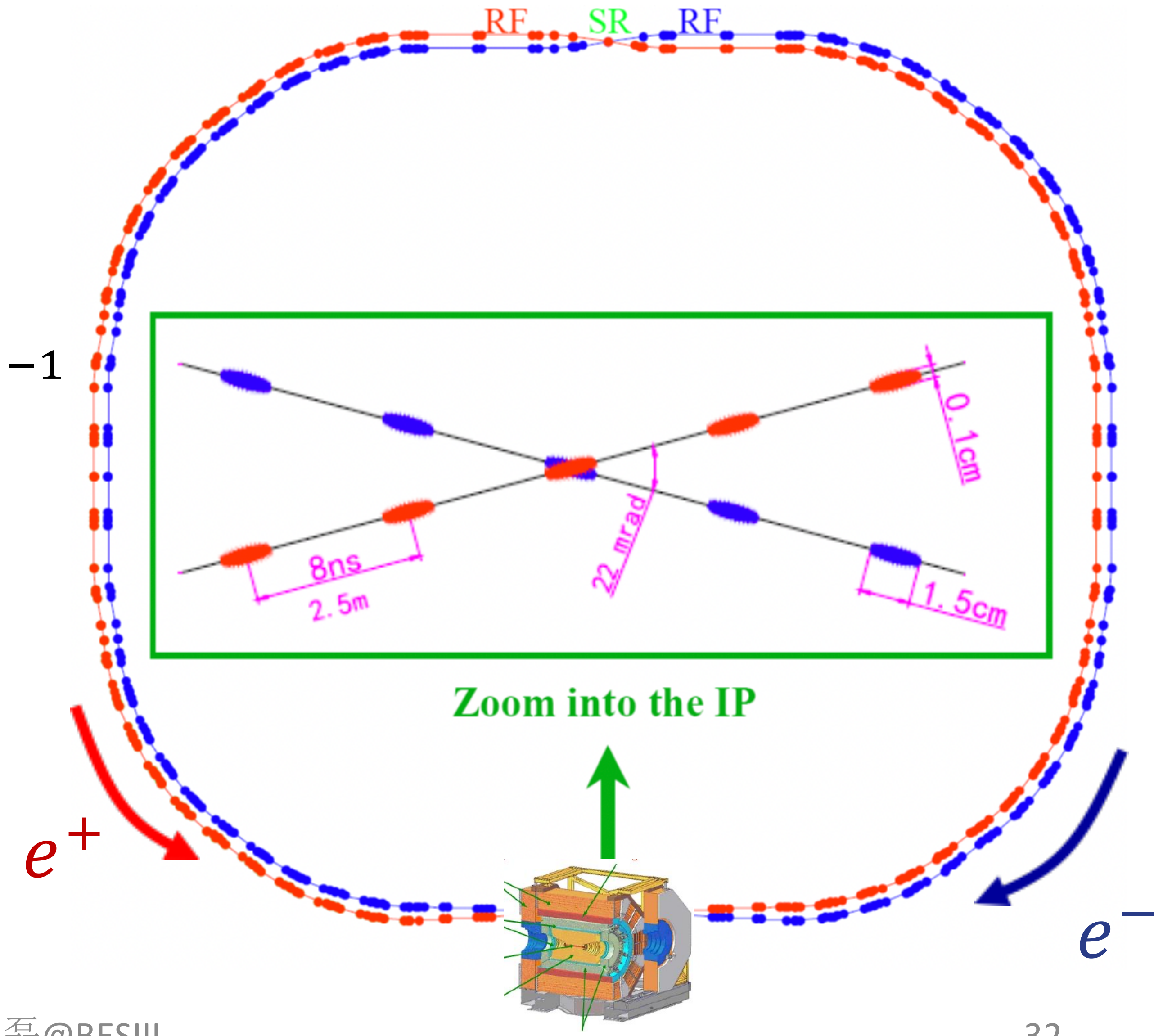
BESIII experiment



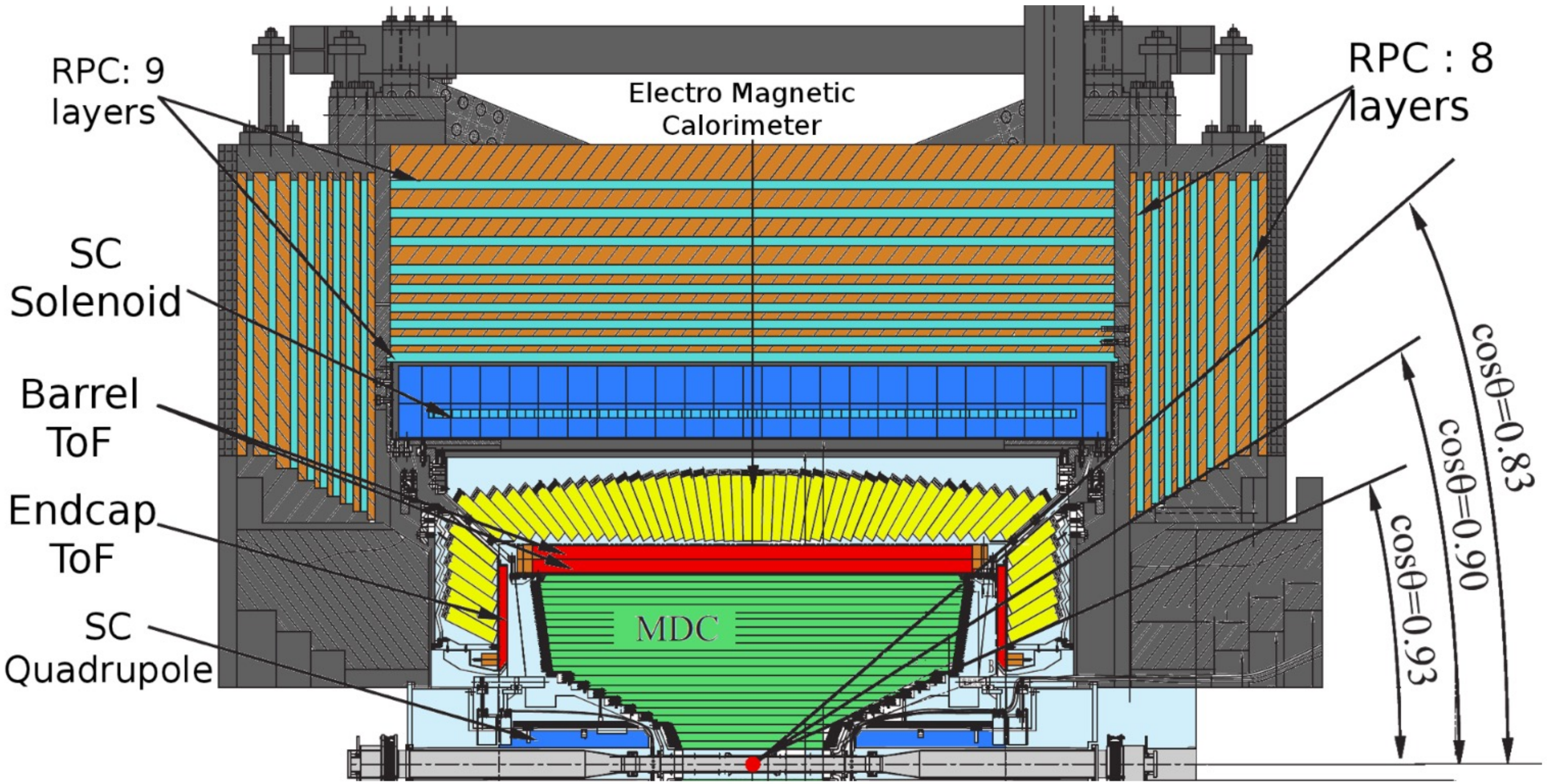
BEPCII collider

- Two ring symmetric e^+e^- collider
- Circumference: 240 m
- Design luminosity: $1{\times}10^{33} cm^{-2}s^{-1}$

  Achieved time: 5 April, 2016
- E_{cm}: 2 – 5 GeV
- Beam crossing angle: 22 mrad



BESIII detector



MDC
$\frac{\delta p}{p} < 0.5\%$ @1 GeV
$\frac{\delta(dE/dx)}{dE/dx} < 6\%$

TOF
δt 80 ps Barrel
δt 110 ps Endcap

EMC
$\frac{\delta E}{E} < 2.5\%$ @1 GeV
$\delta z = 0.6/\sqrt{E}$

MUC
$\delta(xy) <$2 cm