

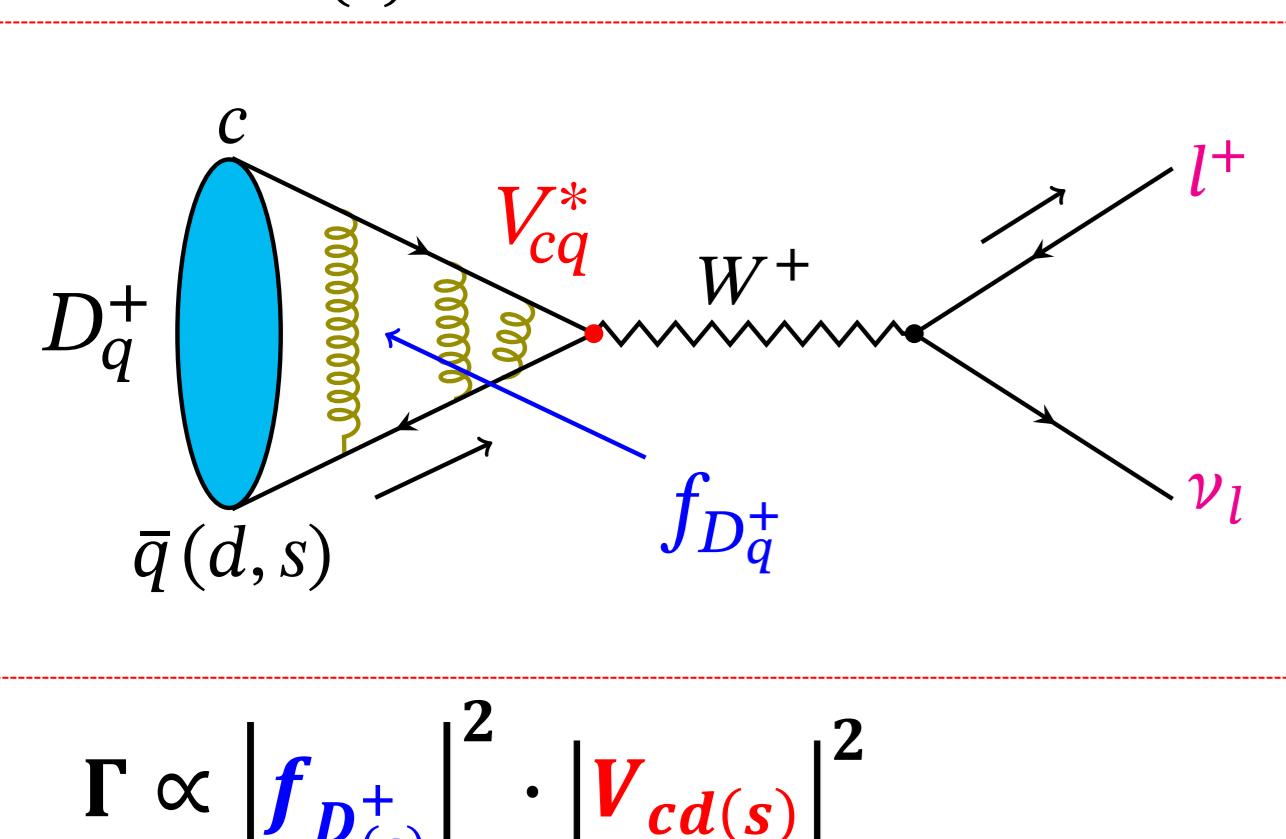
Recent charmed meson decays at BESIII

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Introduction

In the SM:

- $D_{(s)}$ pure leptonic decay:



- $$\Gamma \propto |f_{D_q^+}|^2 \cdot |V_{cd(s)}|^2$$
- ✓ Decay constant $f_{D_q^+}$, form factor $f_+(0)$: better calibrate LQCD;
 - ✓ CKM matrix element $|V_{cd(s)}|$: better test the CKM unitarity;
 - ✓ Lepton flavor universality (LFU) test.

- D^0 hadronic decay:

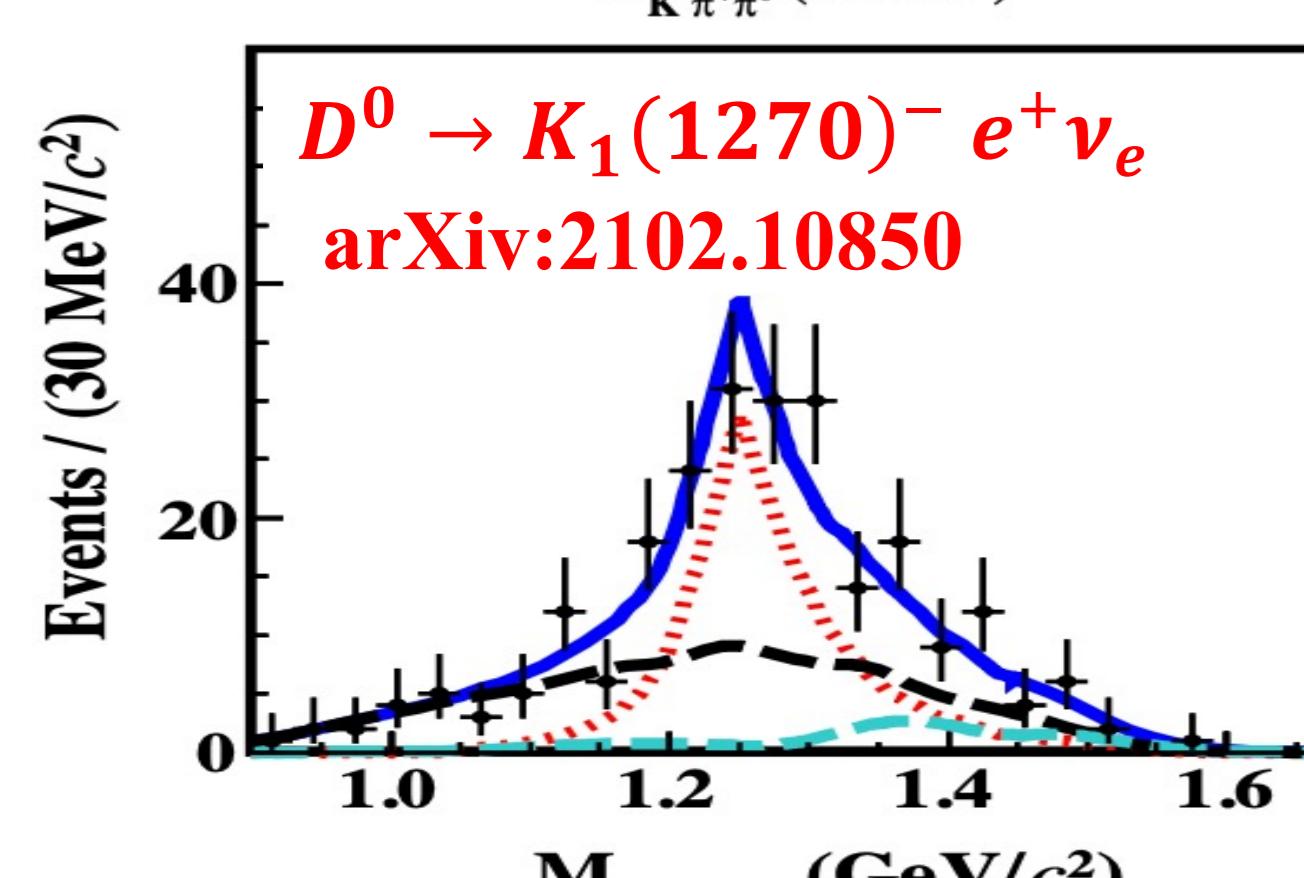
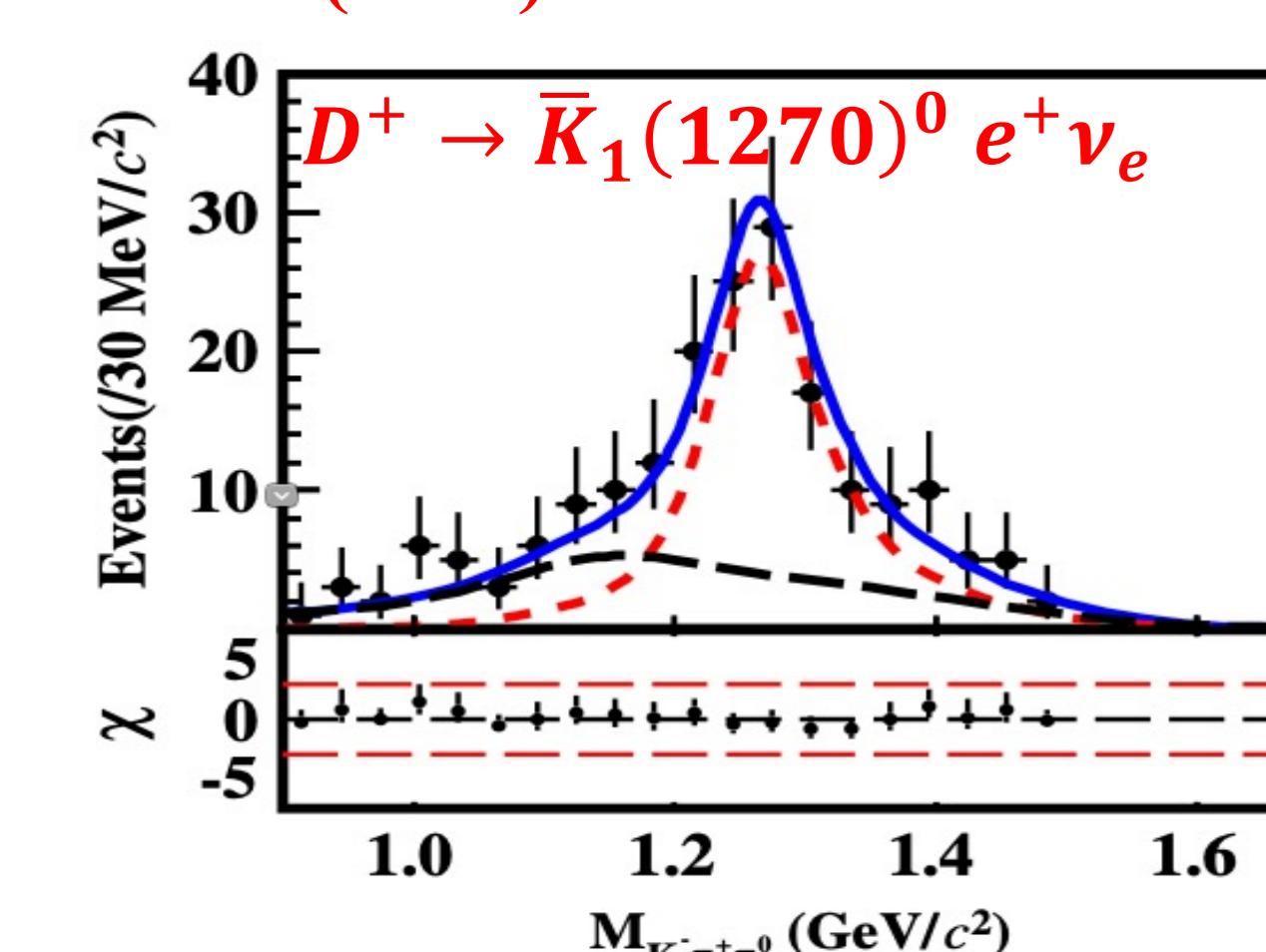
- ✓ The strong-phase difference $\Delta\delta_D$: unique quantum-correlated $D^0 \bar{D}^0$ from $\psi(3770)$ decay at $\sqrt{s} = 3.773$ GeV, which ensures a binned model-independent measurement of the CKM angle γ/ϕ_3 with B decays.

- BESPII and BESIII: please see Patrik Adlarson's talk.

- Data sets: $e^+e^- \rightarrow \psi(3770) \rightarrow D^0 \bar{D}^0$, $D^+ D^-$ 2.93 fb⁻¹ @3.773 GeV
 $e^+e^- \rightarrow D_s^{*+} D_s^-$ 6.32 fb⁻¹ @4.178 - 4.226 GeV

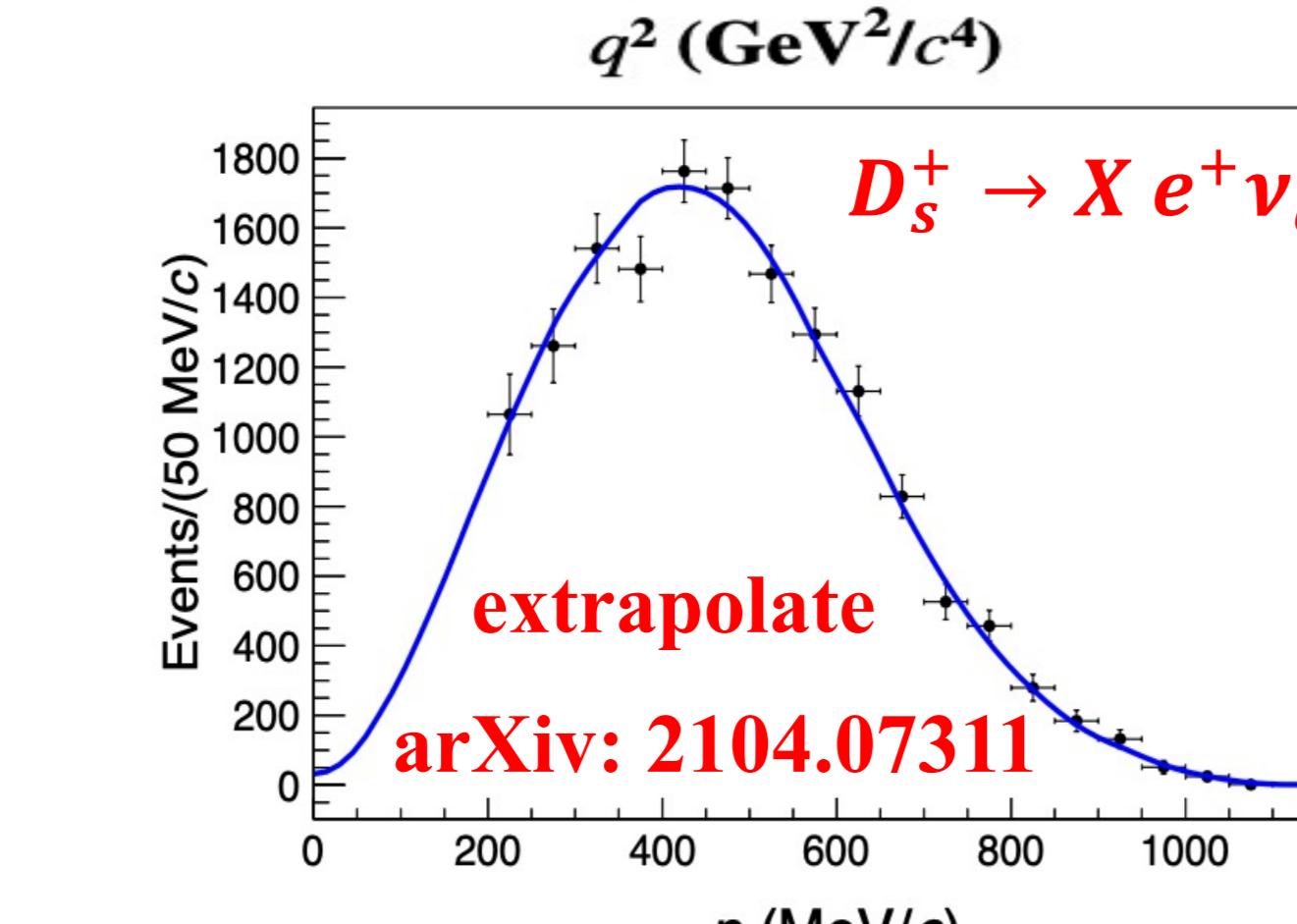
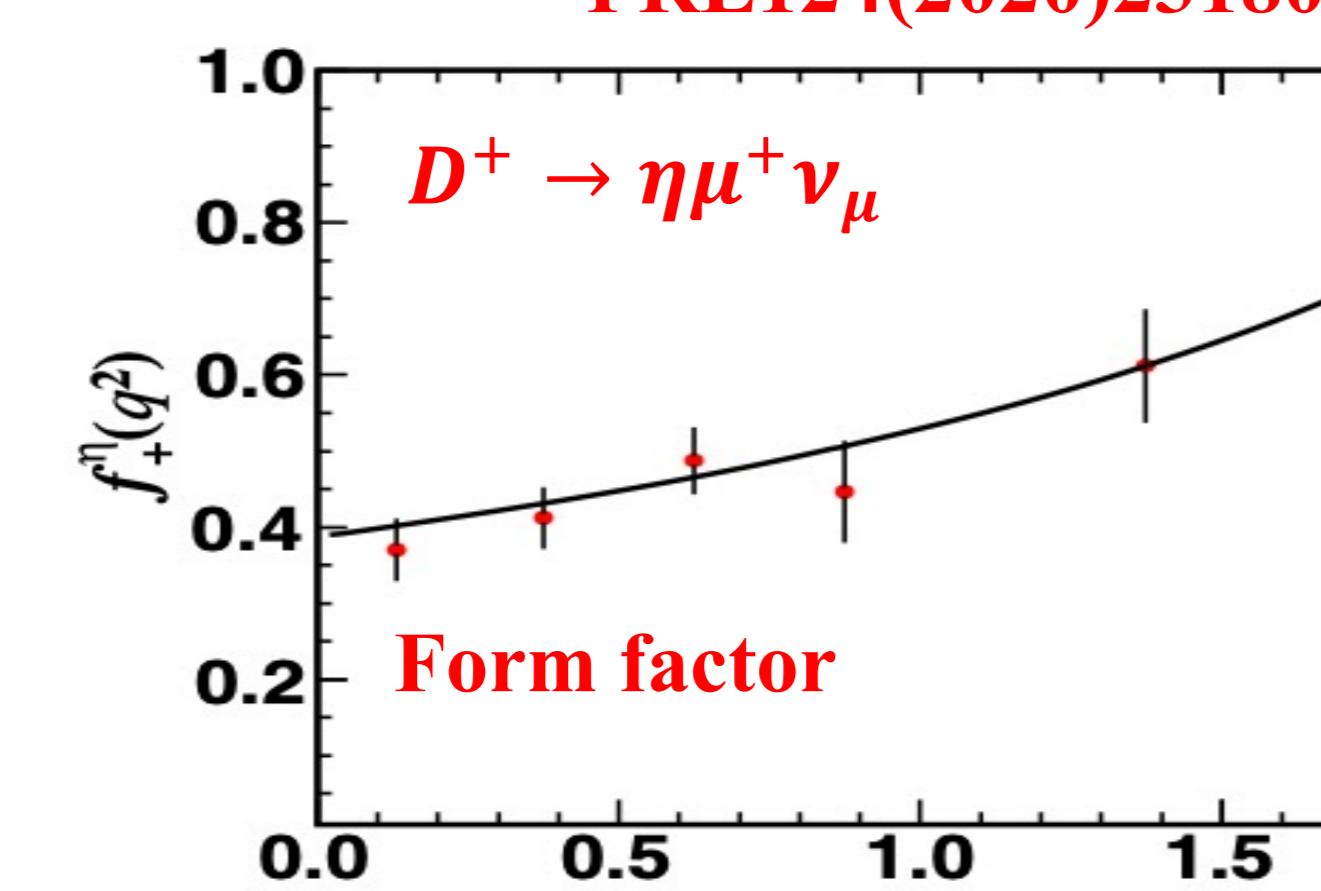
Semi-leptonic $D_{(s)}^+$ decays

PRL123(2019)231801



$$\frac{\Gamma_{D^0 \rightarrow K_1(1270)^- e^+ \nu_e}}{\Gamma_{D^+ \rightarrow K_1(1270)^0 e^+ \nu_e}} = 1.20 \pm 0.02 \pm 0.14 \pm 0.04. \quad (\text{isospin symmetry prediction: } 1)$$

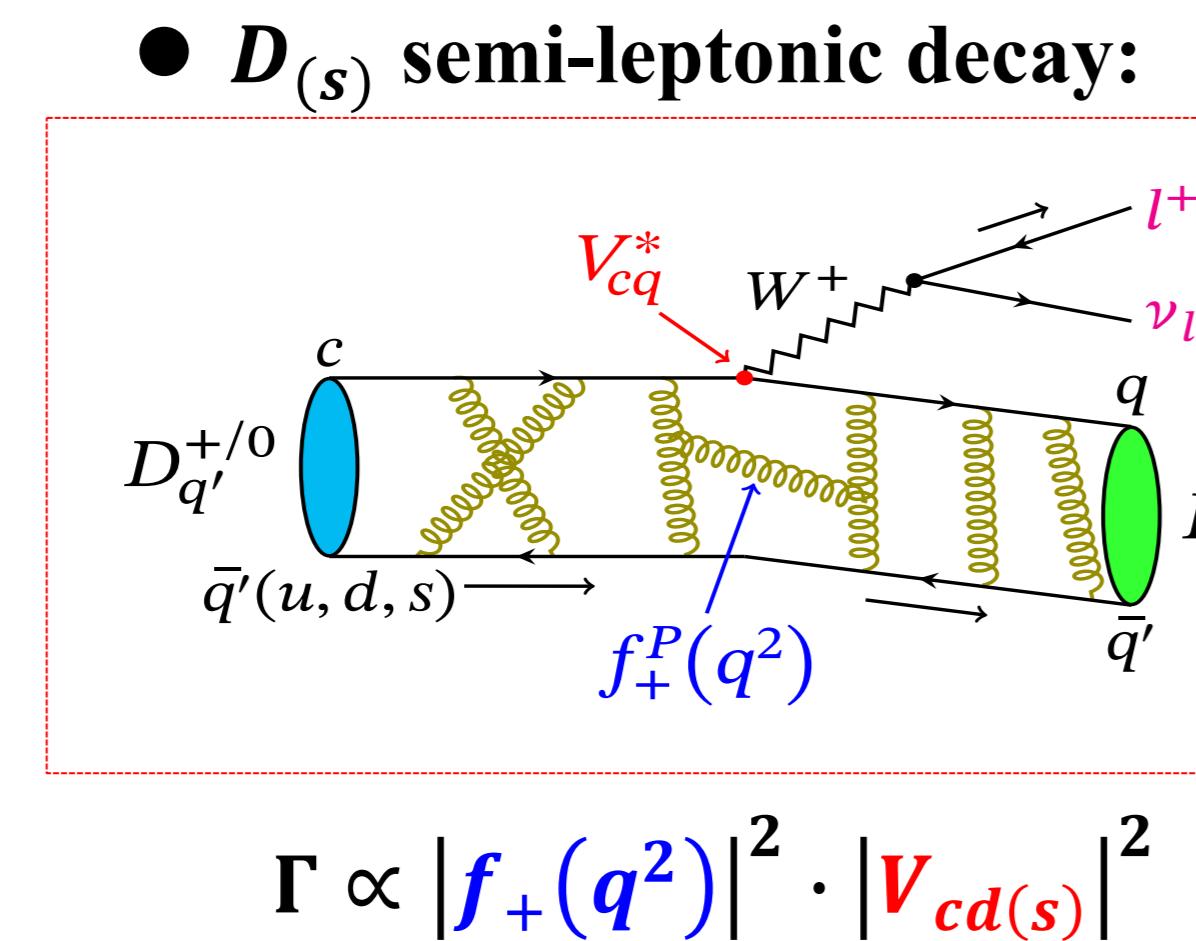
PRL124(2020)231801



$$\frac{\Gamma_{D_s^+ \rightarrow X e^+ \nu_e}}{\Gamma_{D^0 \rightarrow X e^+ \nu_e}} = 0.790 \pm 0.016 \pm 0.020. \quad (\text{prediction: } 0.813)$$

arXiv: 2102.11734

- $D_{(s)}$ semi-leptonic decay:



$$\Gamma \propto |f_{D_{q'}^{+/-}}(q^2)|^2 \cdot |V_{cd(s)}|^2$$

A bridge to precisely measure

✓ Decay constant $f_{D_{q'}^{+/-}}$, form factor $f_+(0)$: better calibrate LQCD;

✓ CKM matrix element $|V_{cd(s)}|$: better test the CKM unitarity;

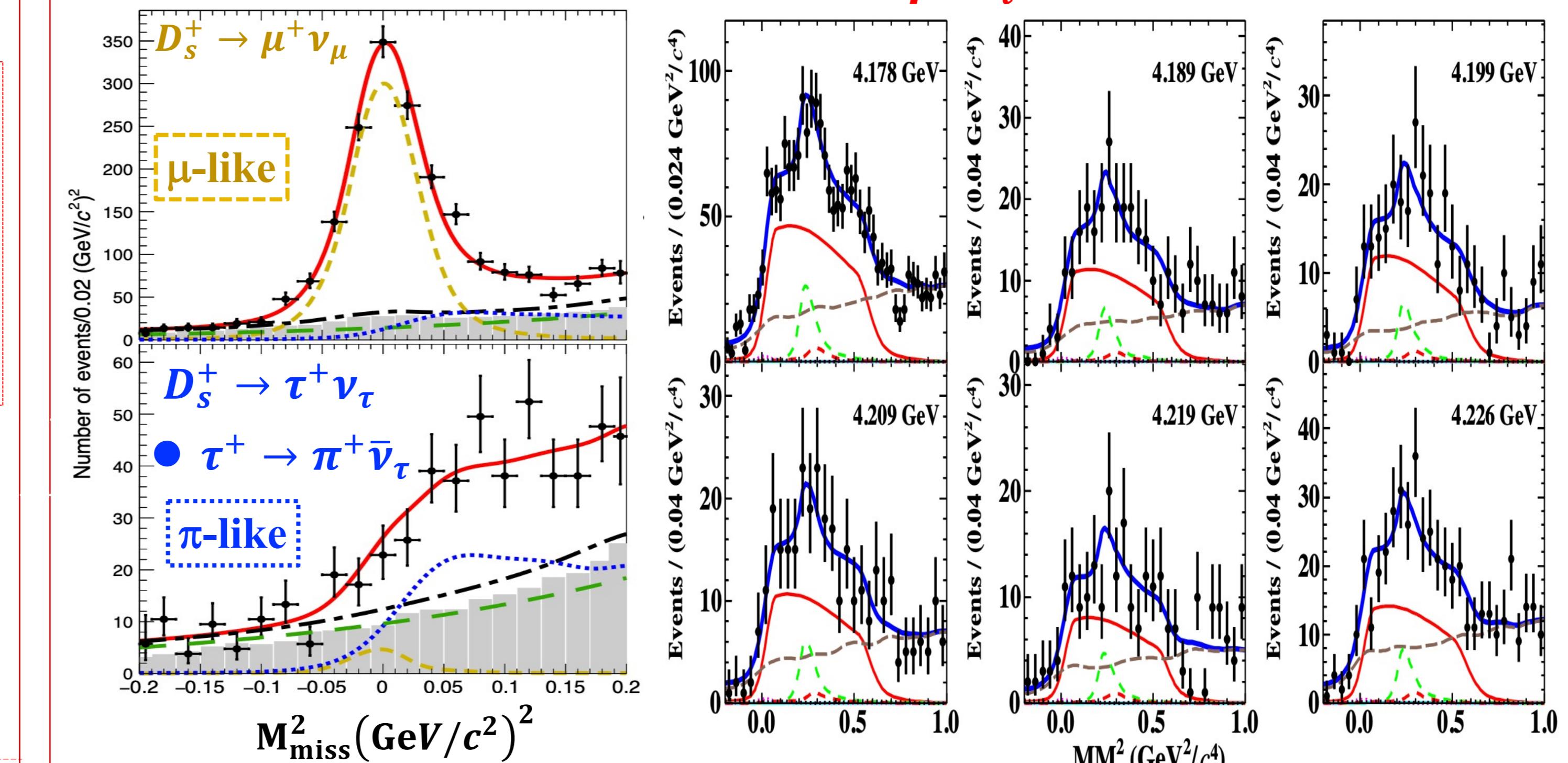
✓ Lepton flavor universality (LFU) test.

$D_s^+ \rightarrow l^+ \nu_l$

arXiv: 2105.07178

- $\tau^+ \rightarrow \rho^+ \bar{\nu}_\tau$

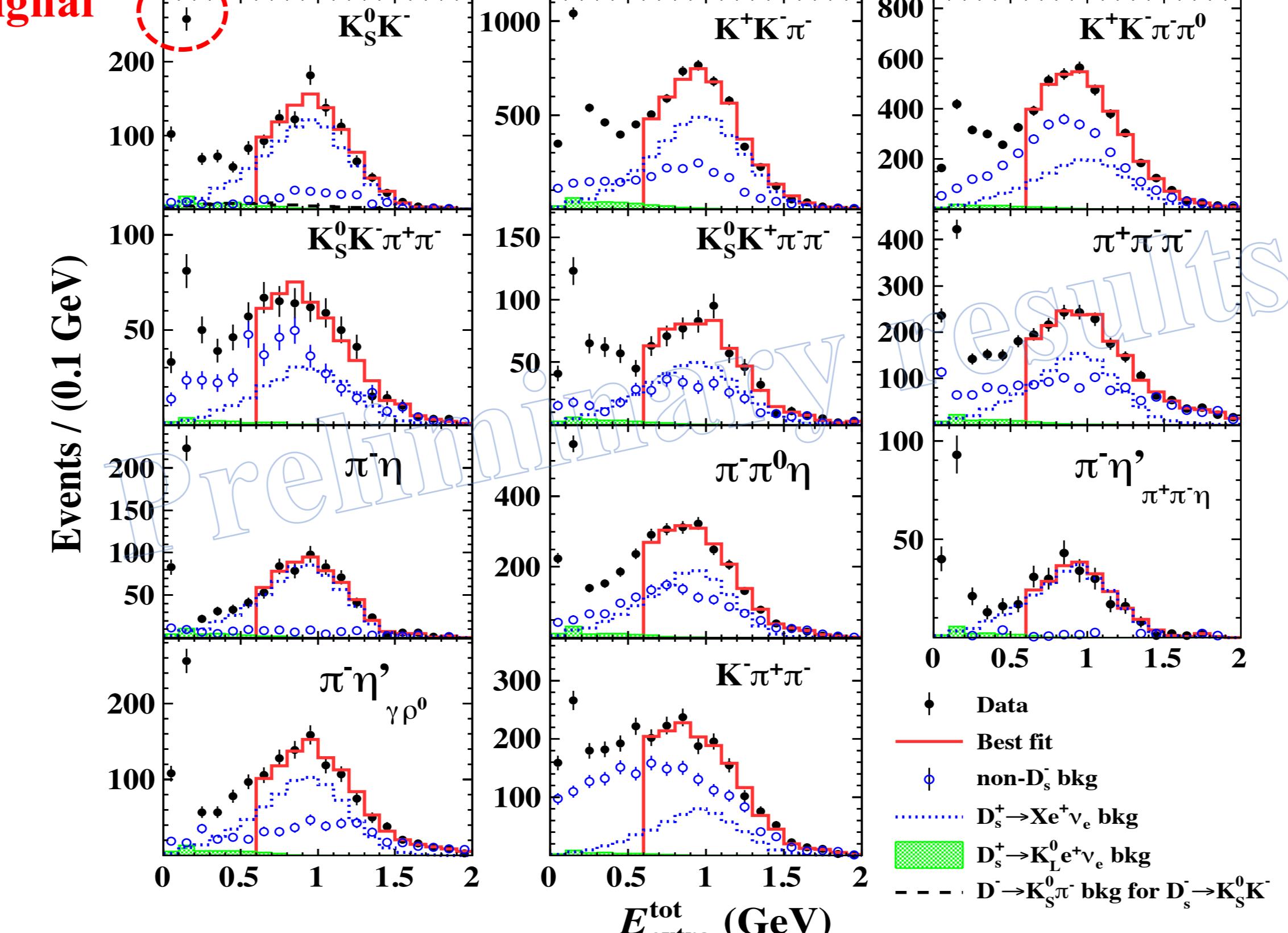
arXiv: 2105.07178



Peak: Signal

- $\tau^+ \rightarrow e^+ \nu_e \bar{\nu}_\tau$

BESIII preliminary



$$R_{\tau/\mu} = \frac{\Gamma(D_s^+ \rightarrow \tau^+ \nu_\tau)}{\Gamma(D_s^+ \rightarrow \mu^+ \nu_\mu)} = 9.67 \pm 0.34$$

SM prediction: 9.75

No LFU violation in τ - μ flavors with the current precision.

Decay constant

ETM(2+1+1)
FMIIC(2+1+1)
FLAG19(2+1+1)

PRD91(2015)054507
PRD98(2018)074512
arXiv:1902.08191 [hep-lat]

247.2±4.1
249.9±0.4
249.9±0.5

HFLAV18
EPJ C81(2021)226

CLEO
PRD79(2009)052002, $\tau_e \nu_e$

CLEO
PRD80(2009)112004, $\tau_\pi \nu_\pi$

CLEO
PRD79(2009)052001, $\tau_\pi \nu_\pi$

Babar
PRD82(2010)091103, $\tau_{e,\mu} \nu_e$

Belle
JHEP09(2013)139, $\tau_{e,\mu} \nu_e$

BESIII 0.482 fb⁻¹
PRD94(2016)072004, $\mu \nu$

CLEO
PRD79(2009)052001, $\mu \nu$

Babar
PRD82(2010)091103, $\mu \nu$

Belle
JHEP09(2013)139, $\mu \nu$

BESIII 3.19 fb⁻¹
PRD122(2019)071802, $\mu \nu$

BESIII 6.32 fb⁻¹
arXiv:2102.11734 [hep-ex], $\mu \nu$

BESIII 6.32 fb⁻¹
arXiv:2102.11734 [hep-ex], $\tau_\nu \nu_\tau$

BESIII 6.32 fb⁻¹
arXiv:2105.07178 [hep-ex], $\tau_\nu \nu_\tau$

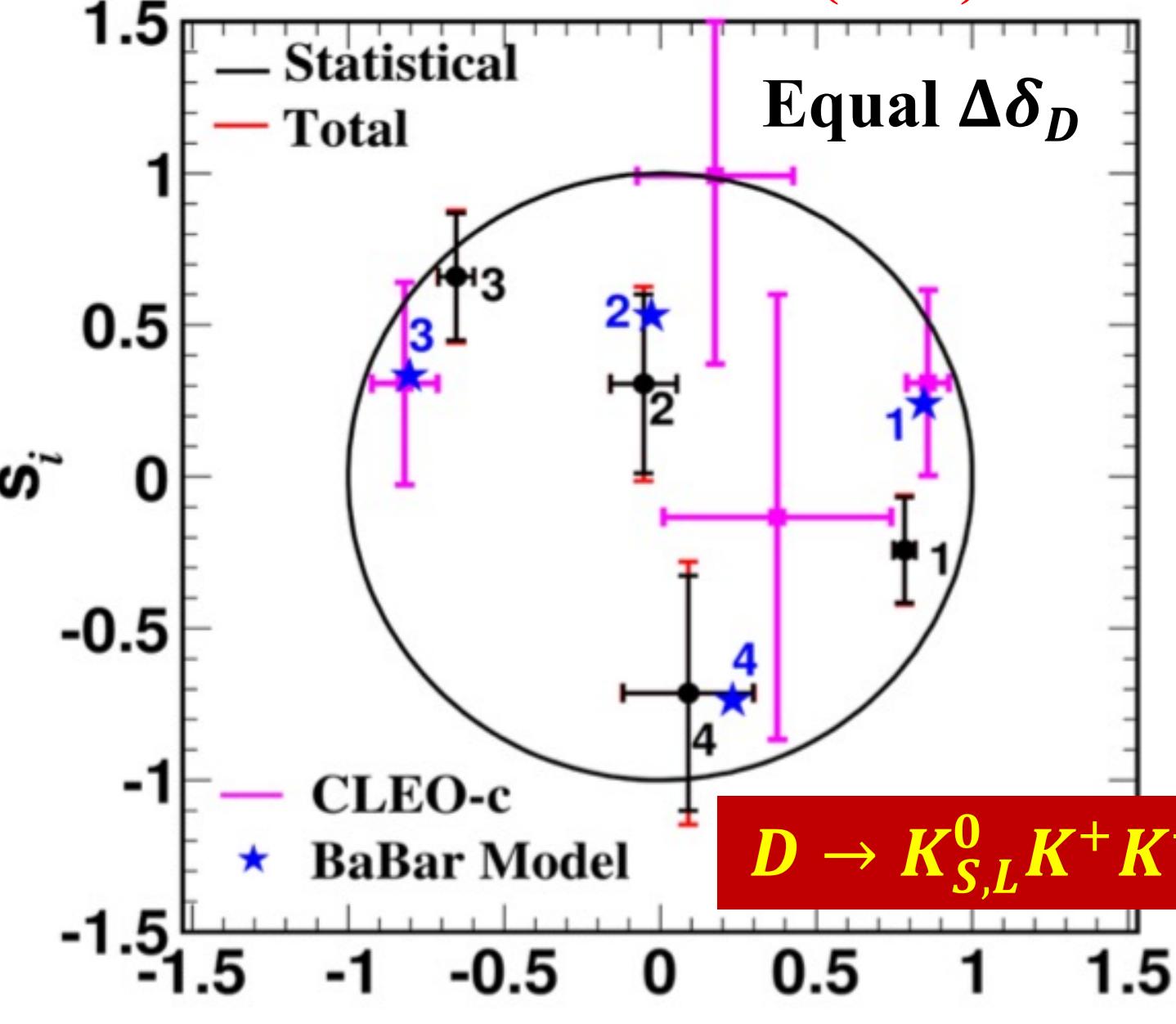
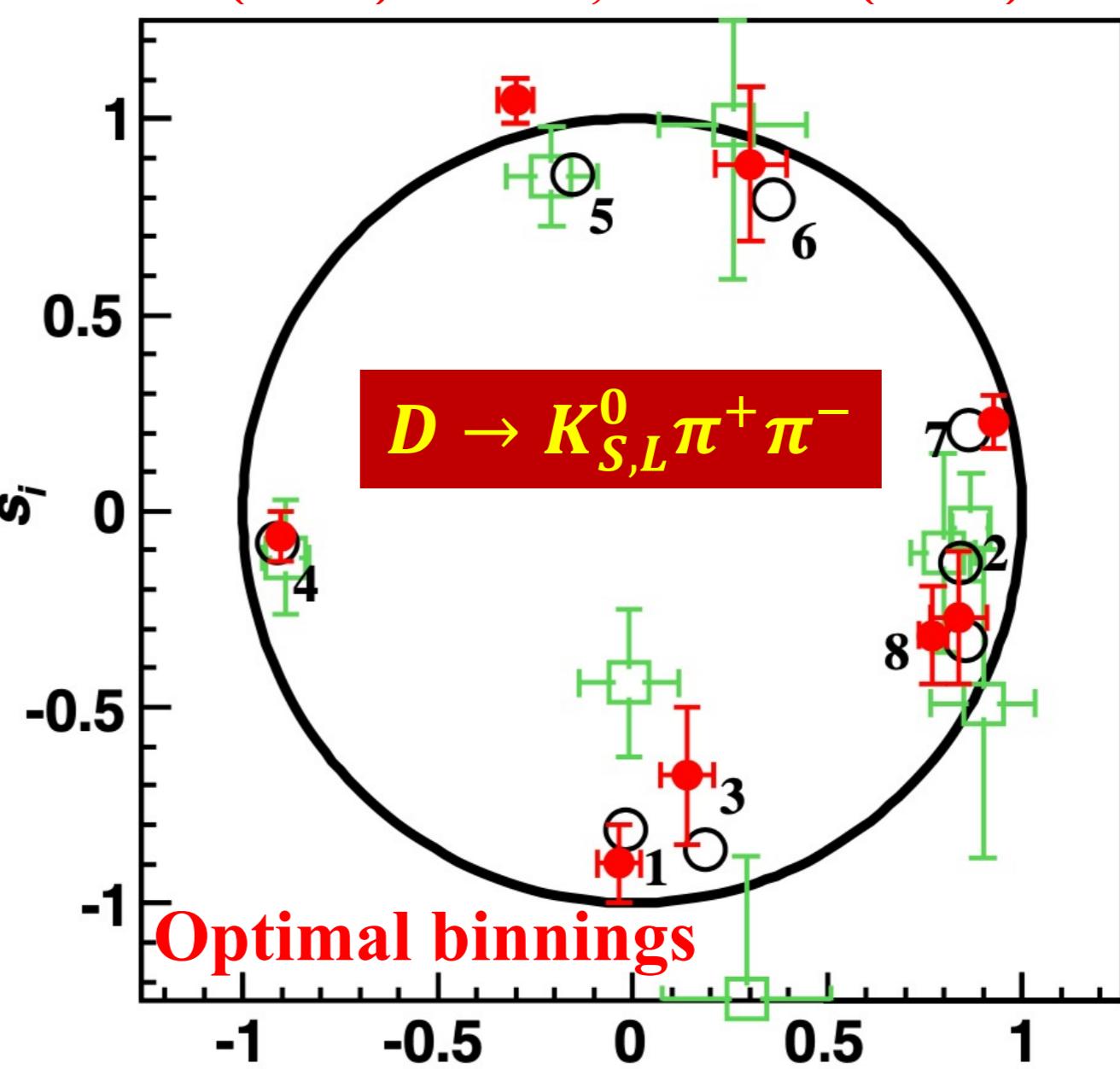
BESIII 6.32 fb⁻¹
Preliminary, $\tau_e \nu_e$

Strong-phase parameters between D^0 and \bar{D}^0

- Model-independent approach with binning the phase space regions;
- c_i and s_i : the amplitude-weighted averages of $\cos \Delta\delta_D$ and $\sin \Delta\delta_D$ in the i th region of the Dalitz plot, respectively;

The most precise measurements to date.

PRL124(2020)241802; PRD101(2020)112002



Mode

$D \rightarrow K_{S,L}^0 \pi^+ \pi^-$

0.7° ~ 1.2°

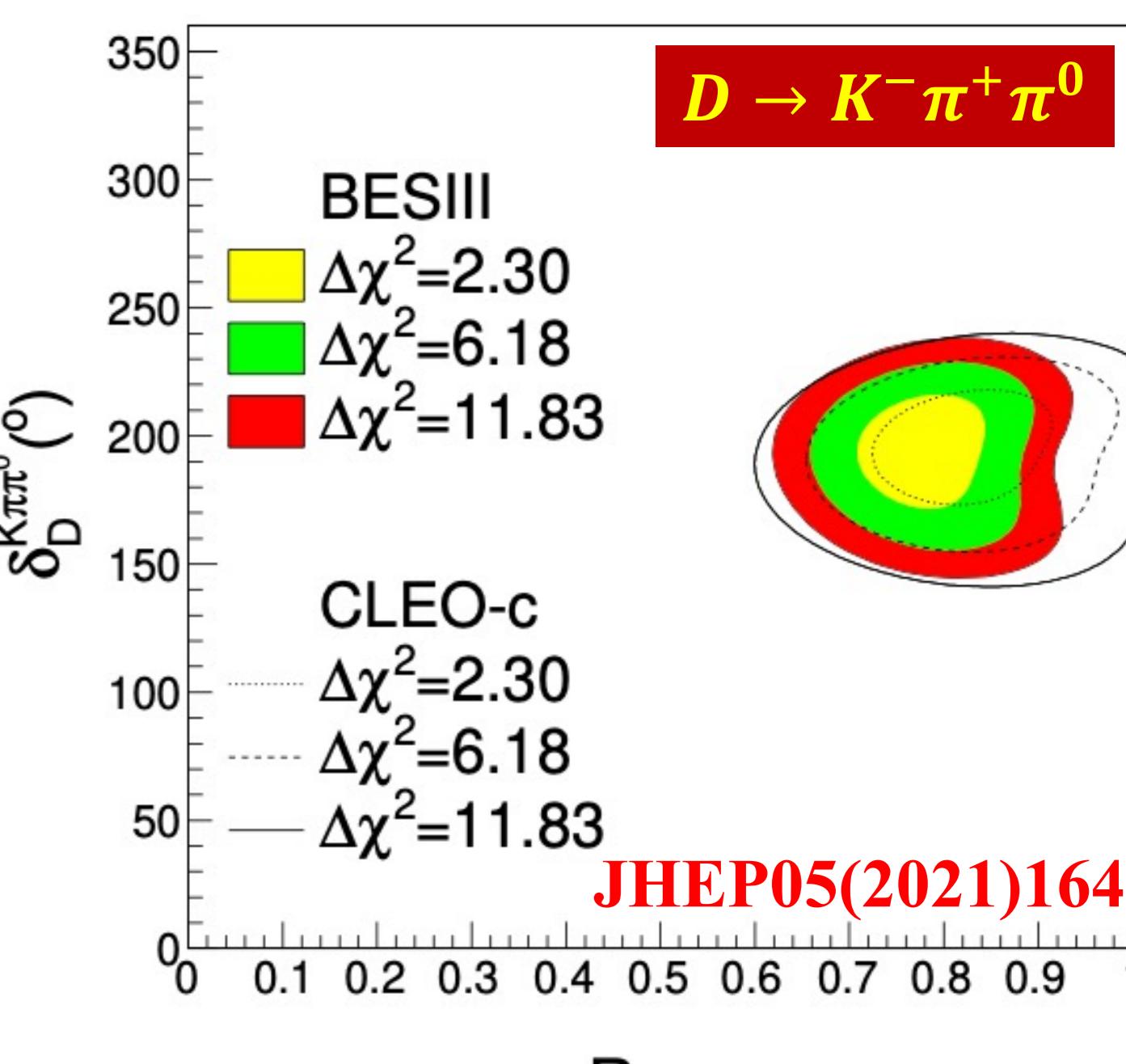
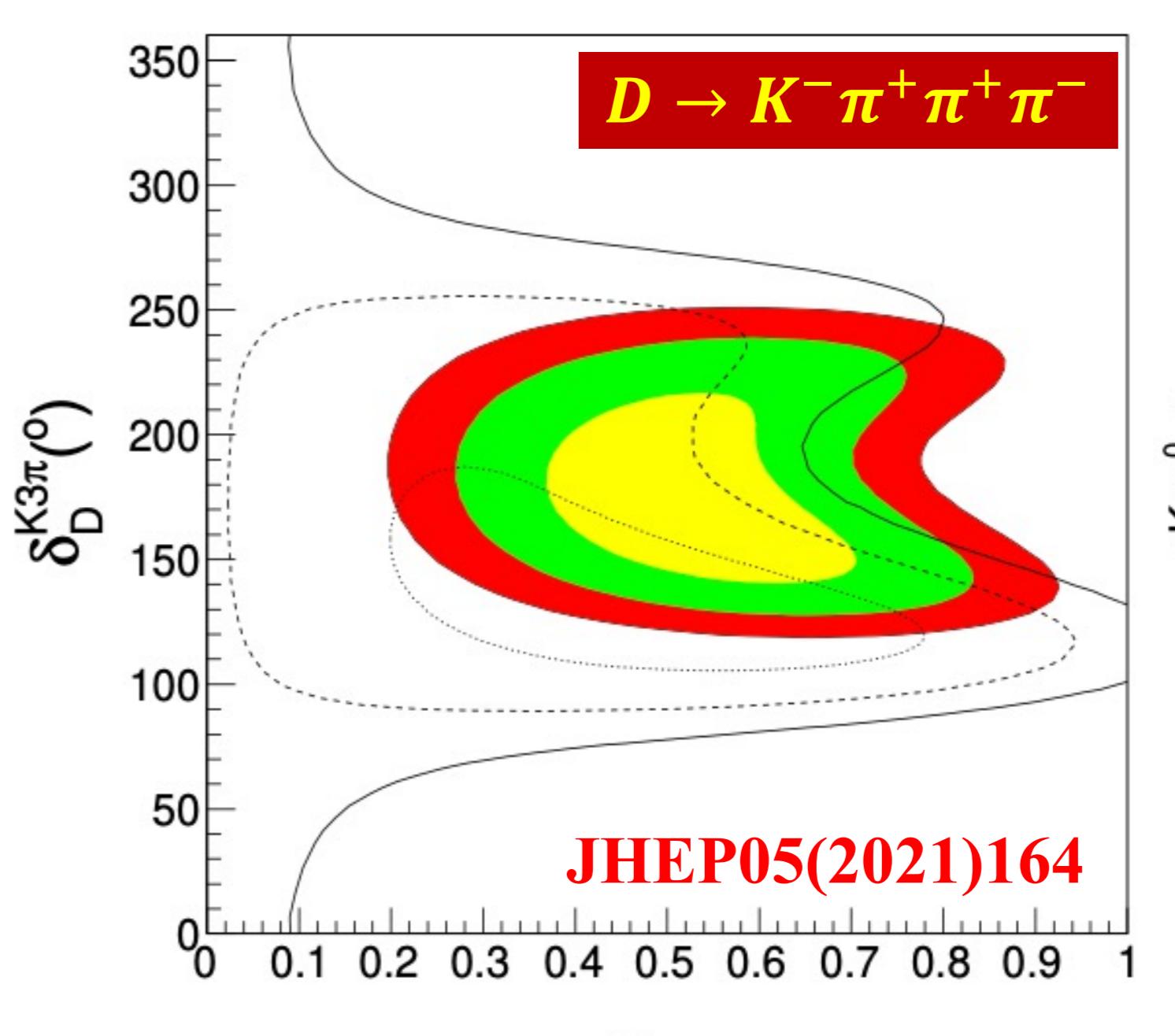
$D \rightarrow K_{S,L}^0 K^+ K^-$

1.3° ~ 2.3°

$D \rightarrow K^- \pi^+ \pi^+ \pi^-$

~6°

Scans of $\Delta\chi^2$ in a global two-dimensional parameter space



Summary

- With 2.93 fb⁻¹ @ 3.773 GeV and 6.32 fb⁻¹ from 4.178-4.226 GeV data samples, BESIII have studied the pure and semi-leptonic $D_{(s)}$ decay, as well as hadronic D decay.
- These measurements provide rigorous tests of QCD-based models and measurements of the CKM matrix elements, supply inputs to CKM weak phase measurements, and test lepton-flavor universality;
- In the near future, BESIII will collect 20 fb⁻¹ @ 3.773 GeV data sample, and 6 fb⁻¹ @ 4.178 GeV, the single precisions will be further improved.