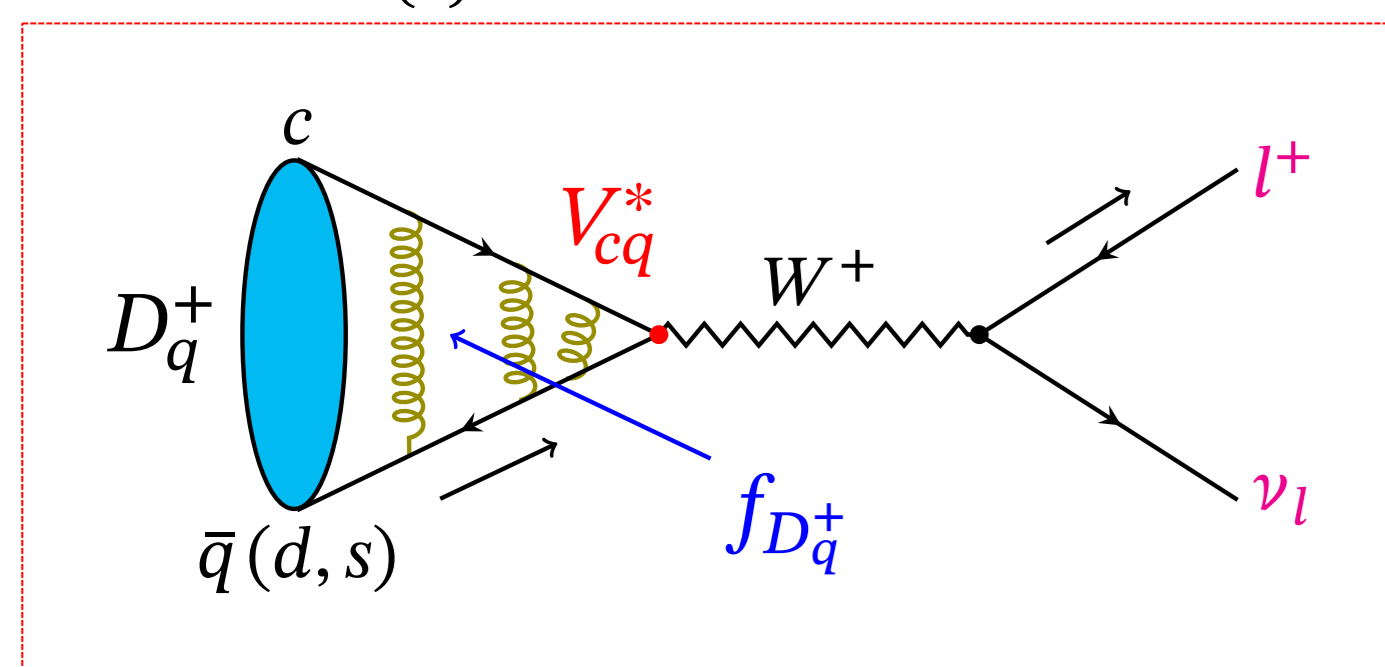


## Introduction

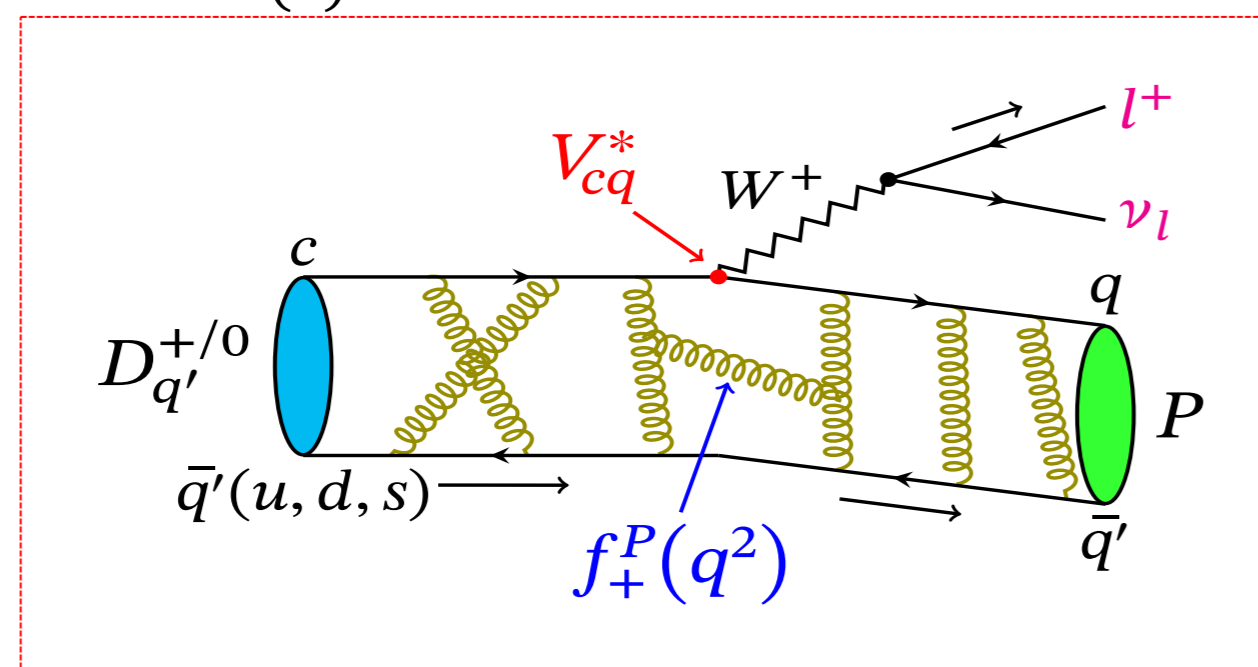
In the SM:

•  $D_{(s)}$  pure leptonic decay:



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

•  $D_{(s)}$  semi-leptonic decay:



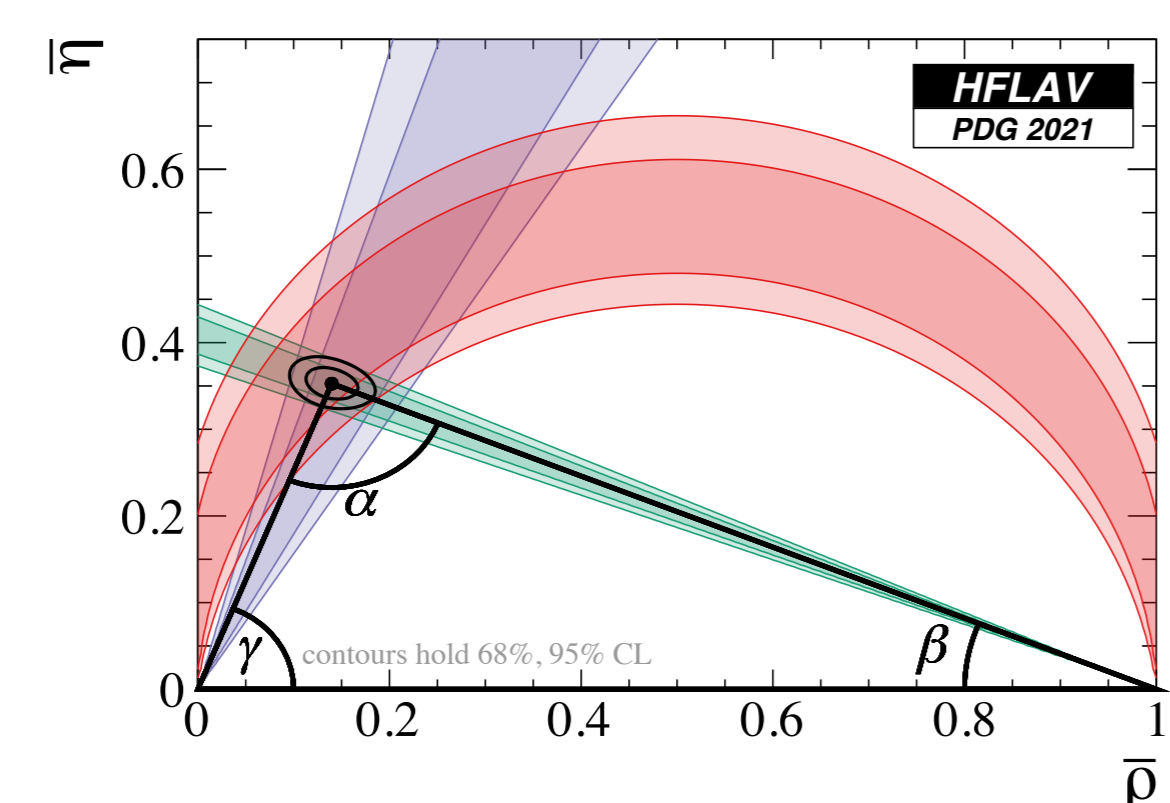
$$\Gamma \propto |f_+(q^2)|^2 \cdot |V_{cd(s)}|^2$$

A bridge to precisely measure

- ✓ Decay constant  $f_{D_{(s)}^+}$ , 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  $\gamma/\phi_3$  with  $B$  decays.

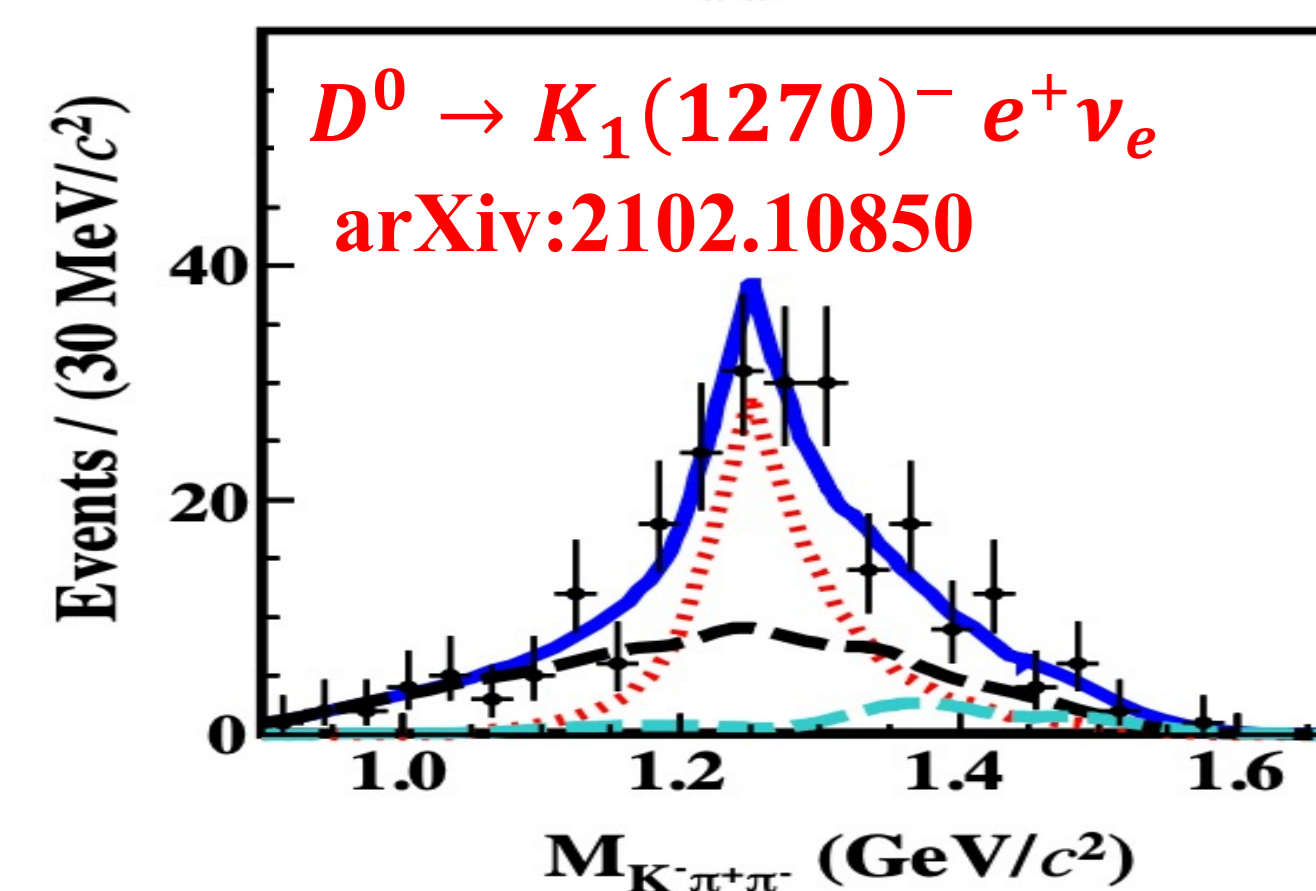
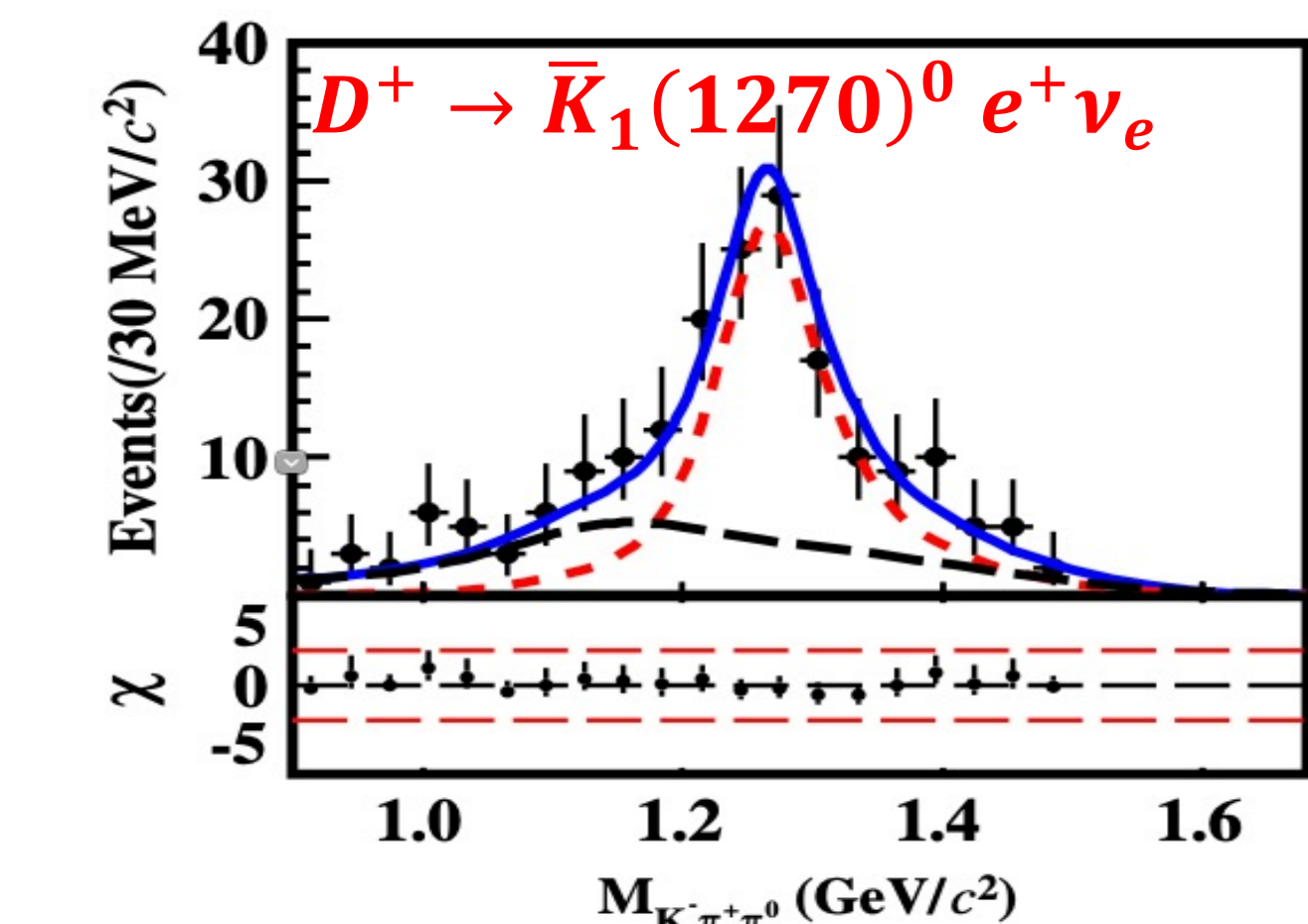


■ BESPII and BESIII: please see Patrik Adlarson's talk.

- 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

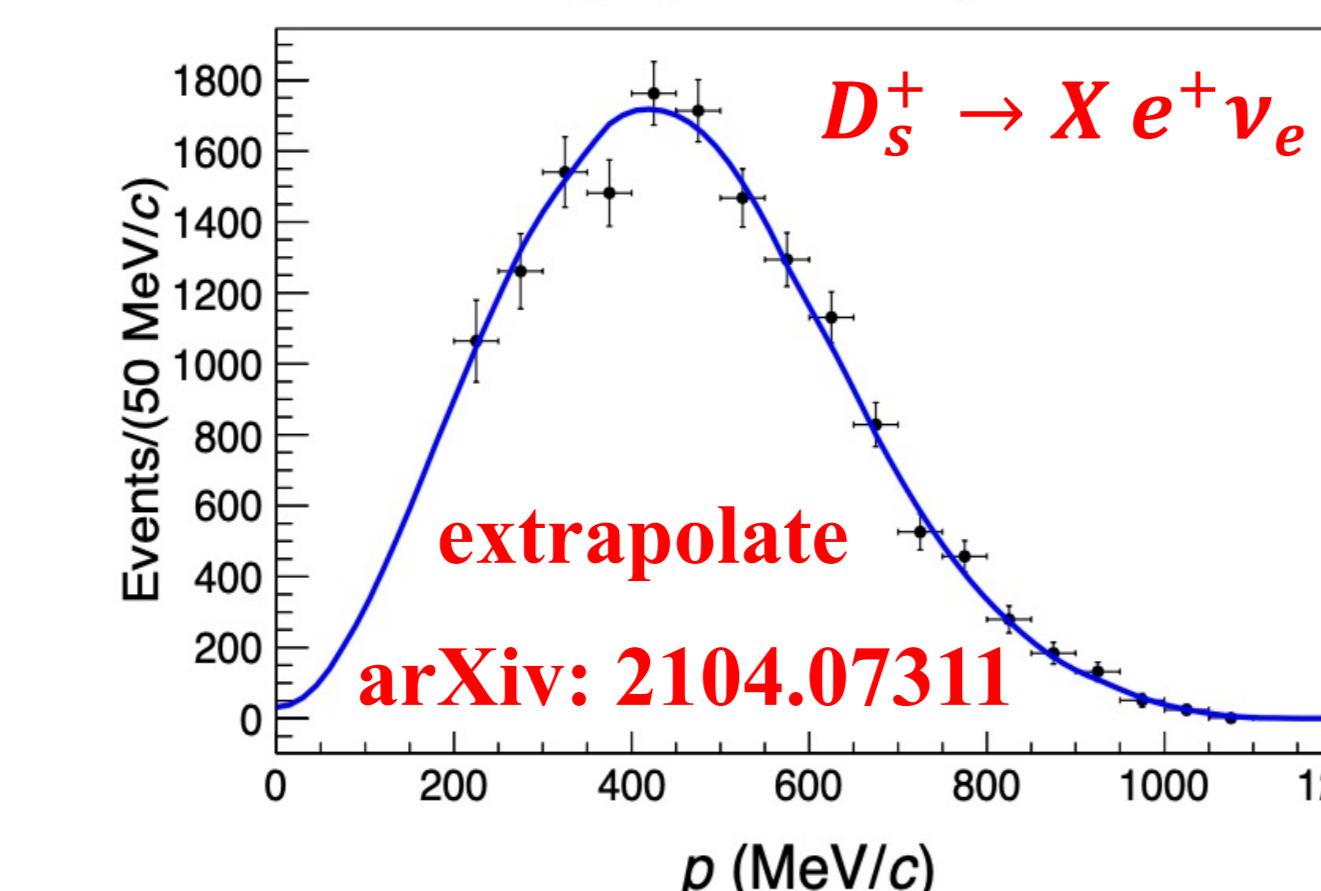
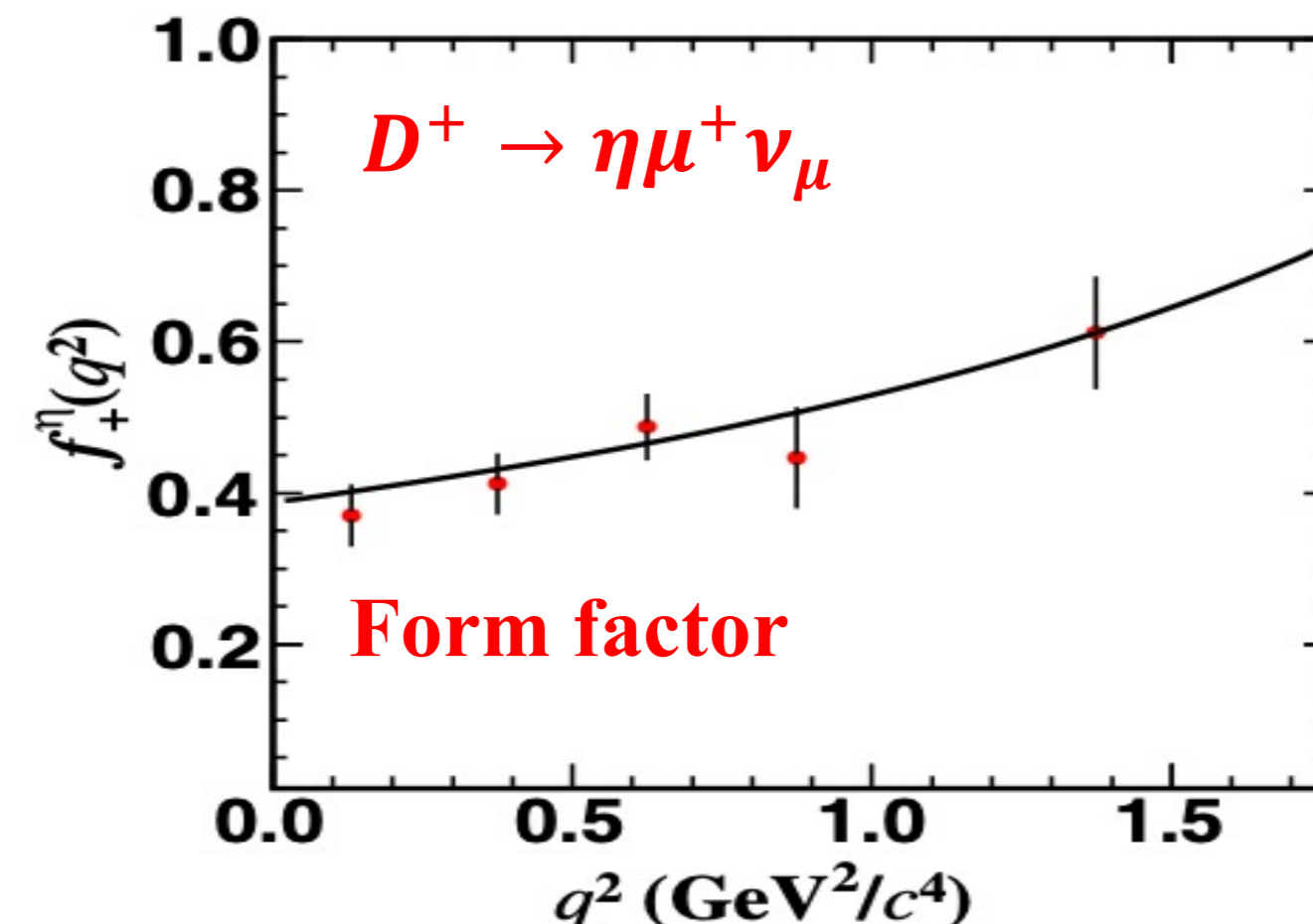
PRL123(2019)231801



$$\frac{\Gamma_{D^0 \rightarrow K_1(1270)^- e^+ \nu_e}}{\Gamma_{D^+ \rightarrow \bar{K}_1(1270)^0 e^+ \nu_e}} = 1.20 \pm 0.02 \pm 0.14 \pm 0.04.$$

(isospin symmetry prediction: 1)

PRL124(2020)231801

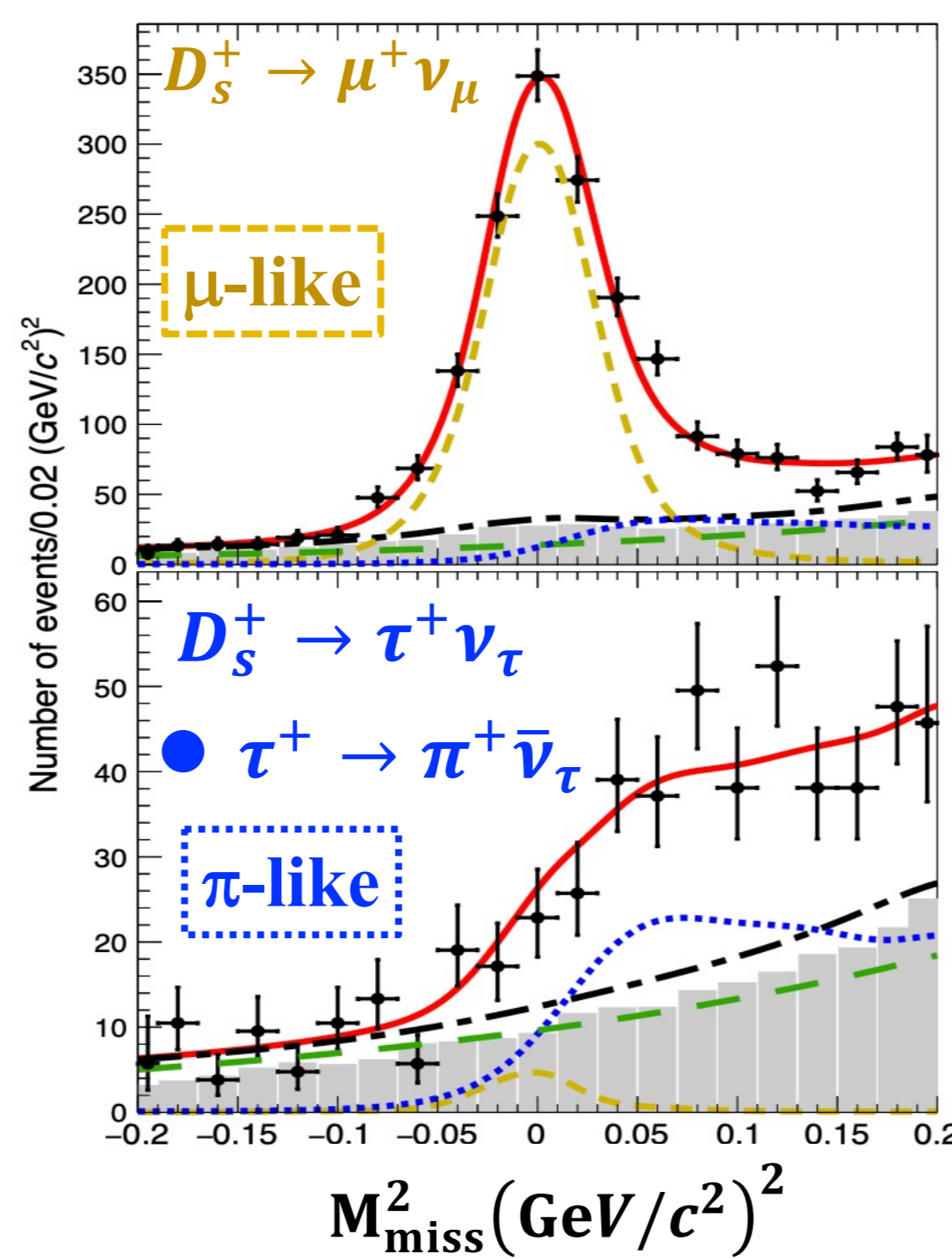


$$\frac{\Gamma_{D_s^+ \rightarrow X e^+ \nu_e}}{\Gamma_{D^0 \rightarrow X e^+ \nu_e}} = 0.790 \pm 0.016 \pm 0.020.$$

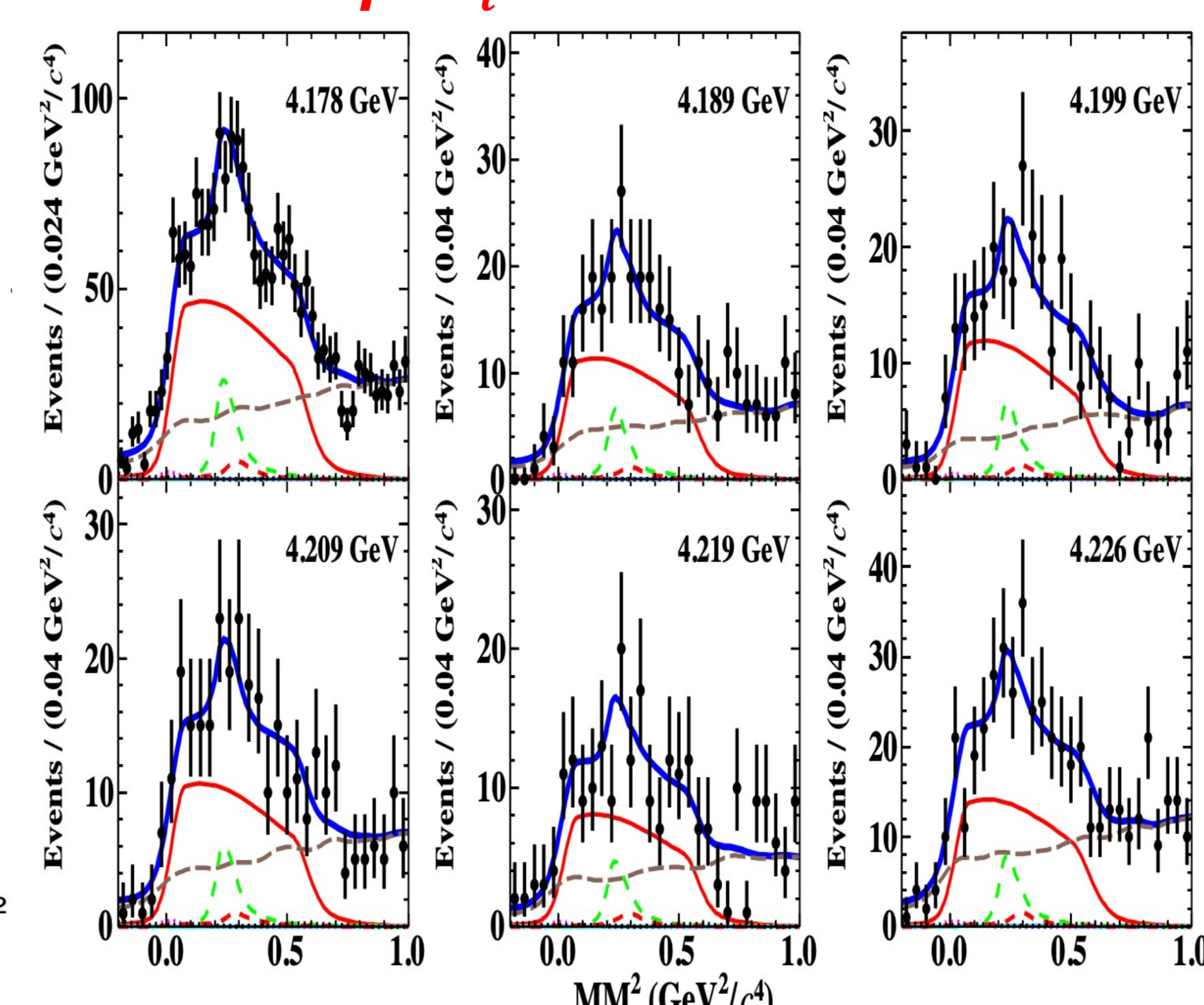
(prediction: 0.813)

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

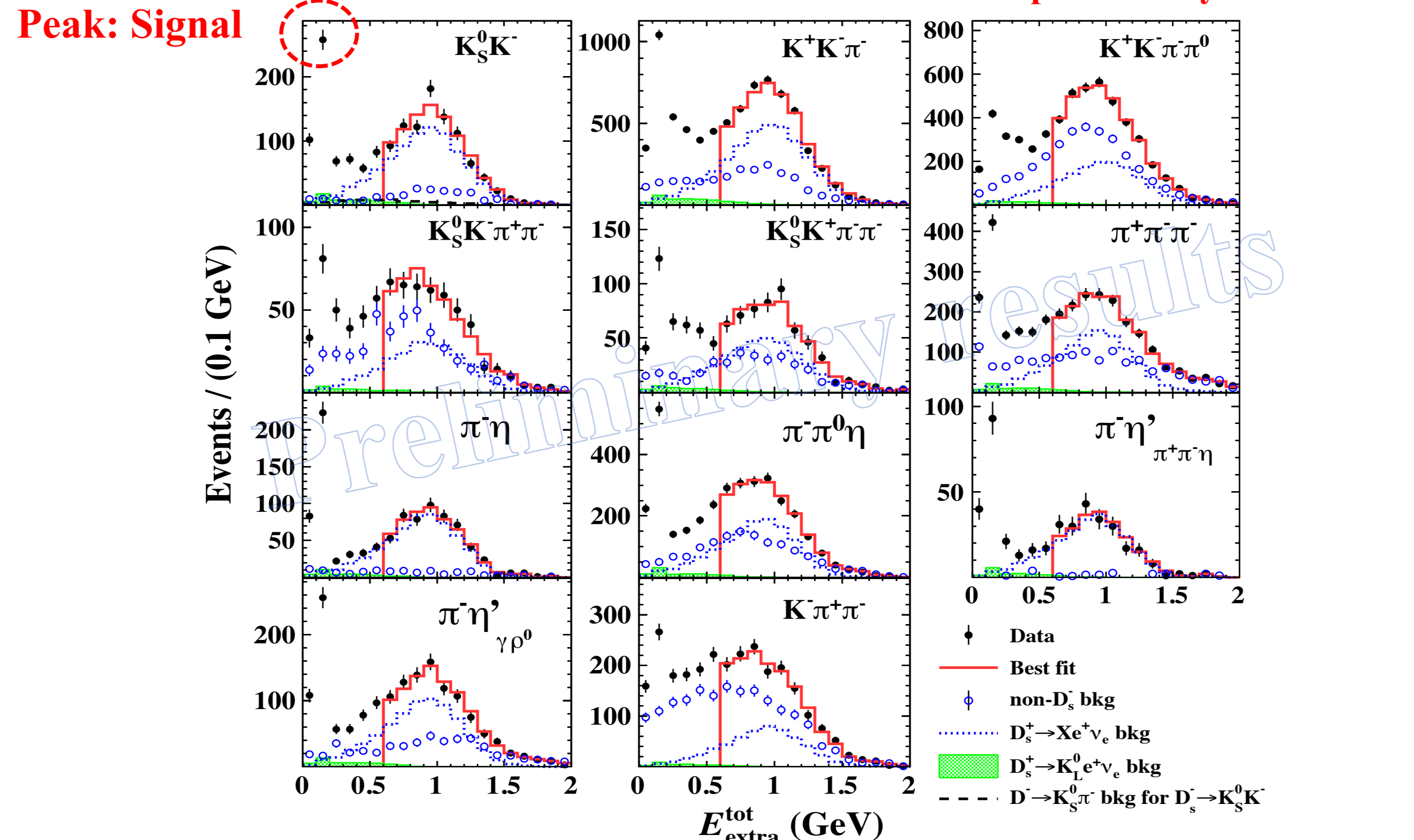
arXiv: 2102.11734



•  $\tau^+ \rightarrow \rho^+ \bar{\nu}_\tau$  arXiv: 2105.07178



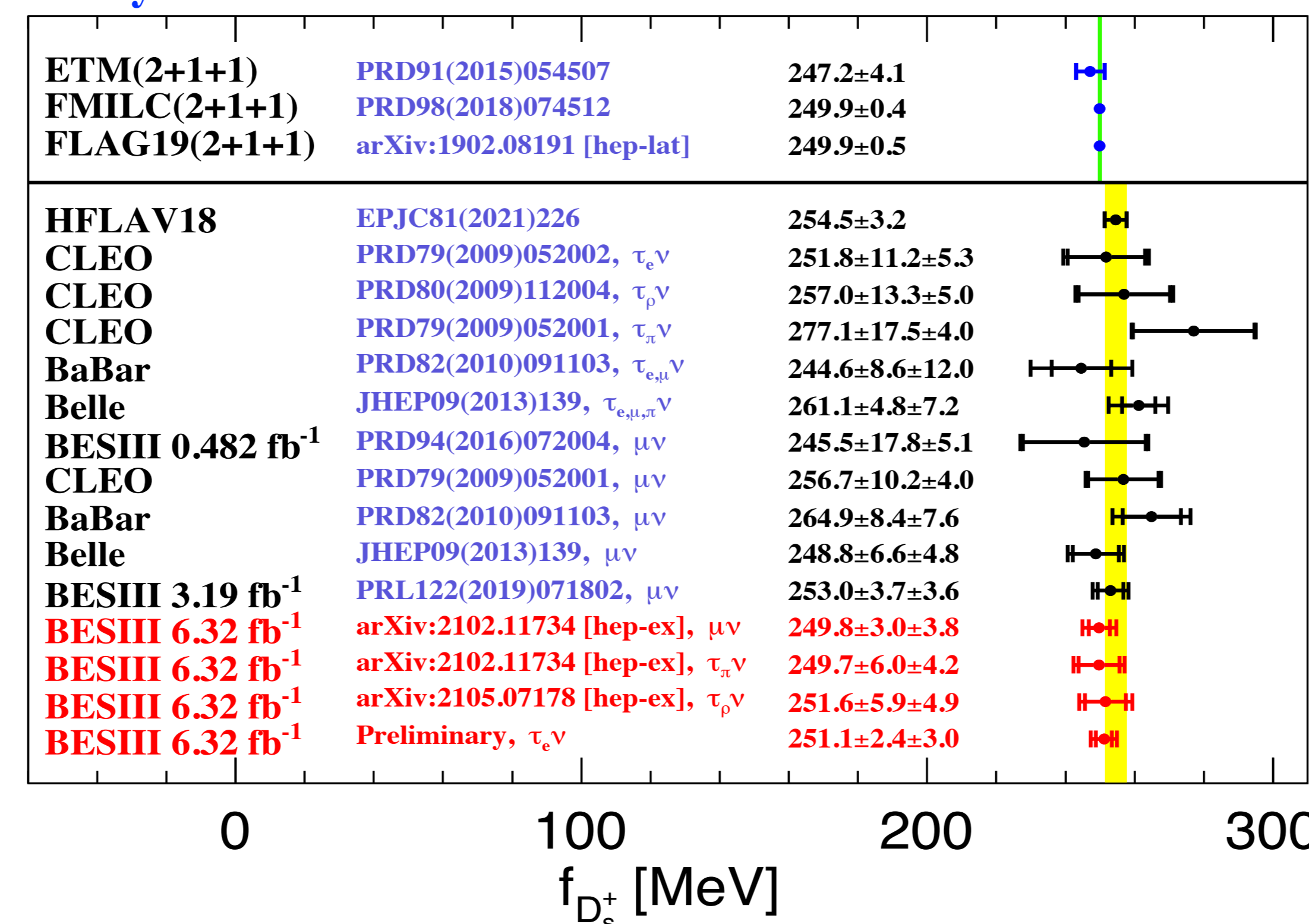
Peak: Signal



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

SM prediction: 9.75  
No LFU violation in  $\tau$ - $\mu$  flavors with the current precision.

Decay constant

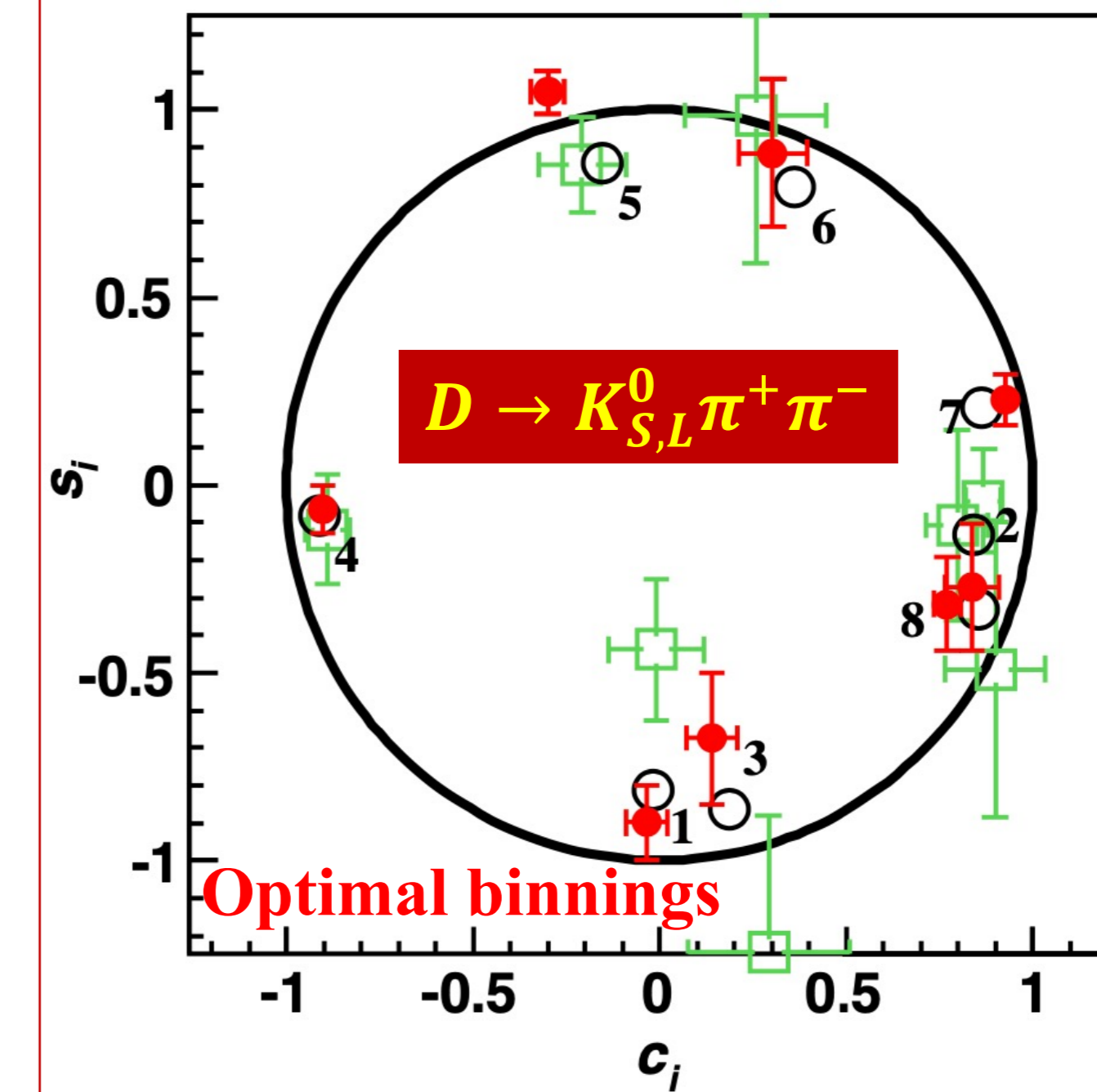


## Strong-phase parameters between $D^0$ and $\bar{D}^0$

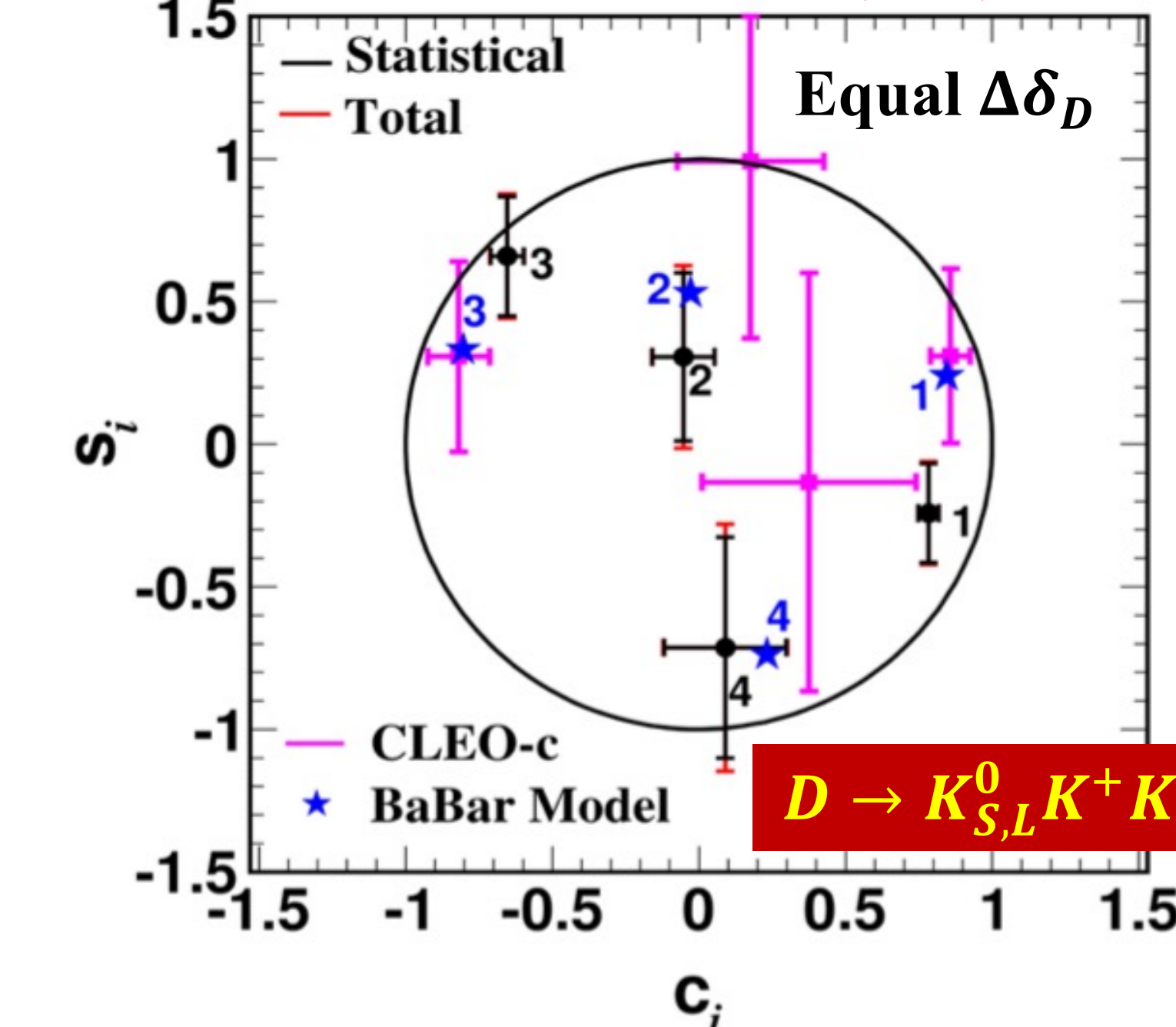
- Model-independent approach with binning the phase space regions;
- $c_i$  and  $s_i$ : the amplitude-weighted averages of  $\cos \Delta\delta_D$  and  $\sin \Delta\delta_D$  in the  $i$ th region of the Dalitz plot, respectively;

The most precise measurements to date.

PRL124(2020)241802; PRD101(2020)112002

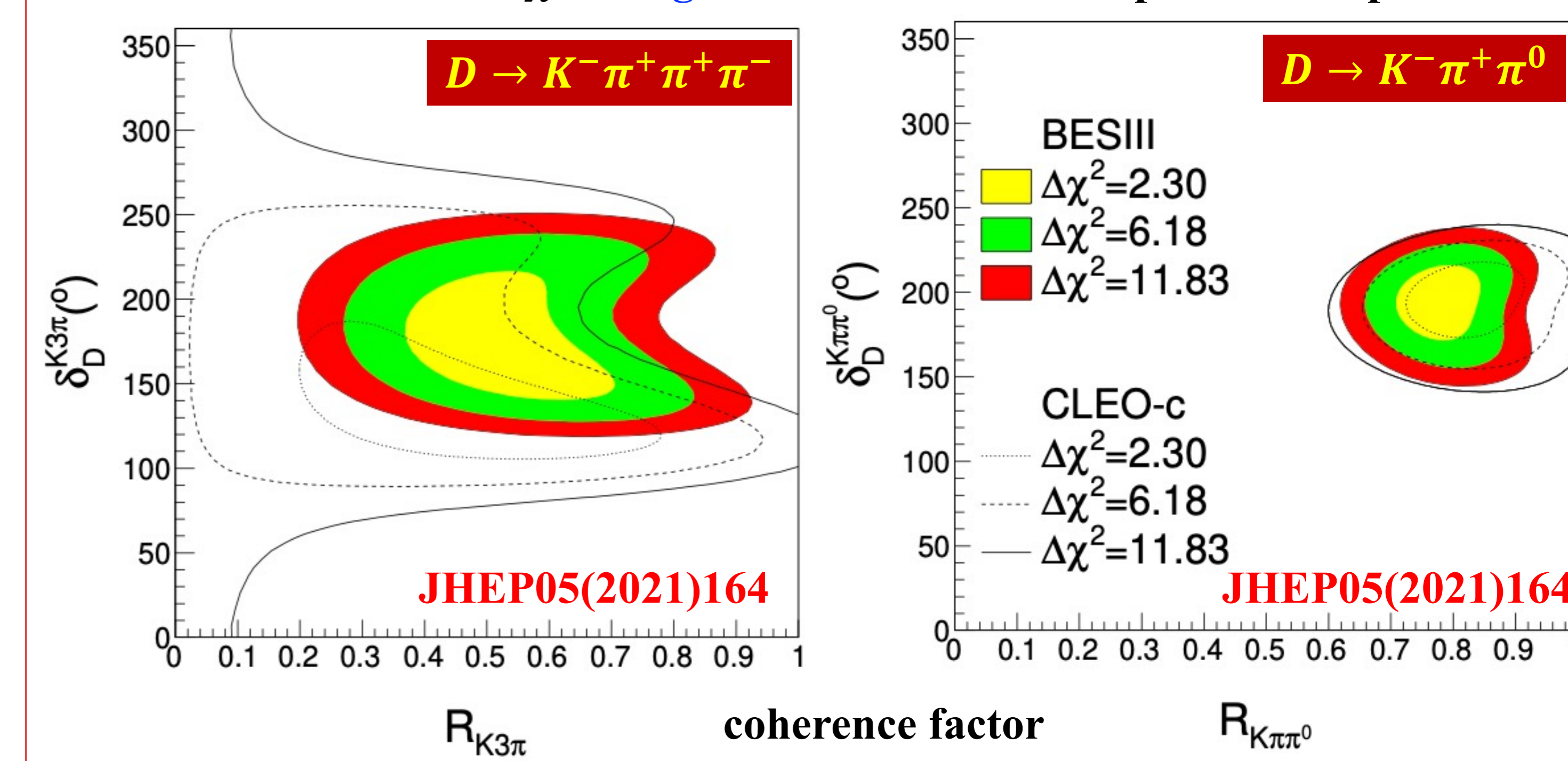


PRD102(2020)052008



Mode	The estimated uncertainty on the CKM angle $\gamma/\phi_3$
$D \rightarrow K_{S,L}^0 \pi^+ \pi^-$	$0.7^\circ \sim 1.2^\circ$
$D \rightarrow K_{S,L}^0 K^+ K^-$	$1.3^\circ \sim 2.3^\circ$
$D \rightarrow K^- \pi^+ \pi^+ \pi^-$	$\sim 6^\circ$

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 leptonic-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.