

Charm physics program at STCF

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(On behalf of the STCF working group)



Charm Physics in the High-Luminosity Super τ -Charm Factory
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Facilities for Charm Study

- ❑ LHCb: huge x-sec, boost, 9 fb^{-1} now (x40 current B-factories)
- ❑ B-factories (Belle (II), BaBar): more kinematic constrains, clean environment, $\sim 100\%$ trigger efficiency
- ❑ τ -charm factory : Low backgrounds and high efficiency; missing technique; Quantum correlations and CP-tagging are unique;
 - BESIII: 20 fb^{-1} at 3.773 GeV ; 6 fb^{-1} at 4.18 GeV ; 15 fb^{-1} @ $4.6\text{-}4.9 \text{ GeV}$
 - Super τ -Charm Factory (STCF): 4×10^9 pairs of $D^{\pm,0}$, $10^8 D_s$ and Λ_c pairs per year
 - Highlighted Physics programs
 - Precise measurement of (semi-)leptonic decay (f_D , f_{D_s} , CKM matrix...)
 - $D^0 - \bar{D}^0$ mixing, CPV
 - Rear decay (FCNC, LFV, LNV....)
 - Charmed baryons (J^{PC} , Decay modes, absolute BF)
 - Excited charmed meson and baryon states: like D_J , D_{sJ} , Λ_c^* (mass, width, J^{PC} , decay modes)
 - Light meson and hyperon spectroscopy studied in charmed hadron decays

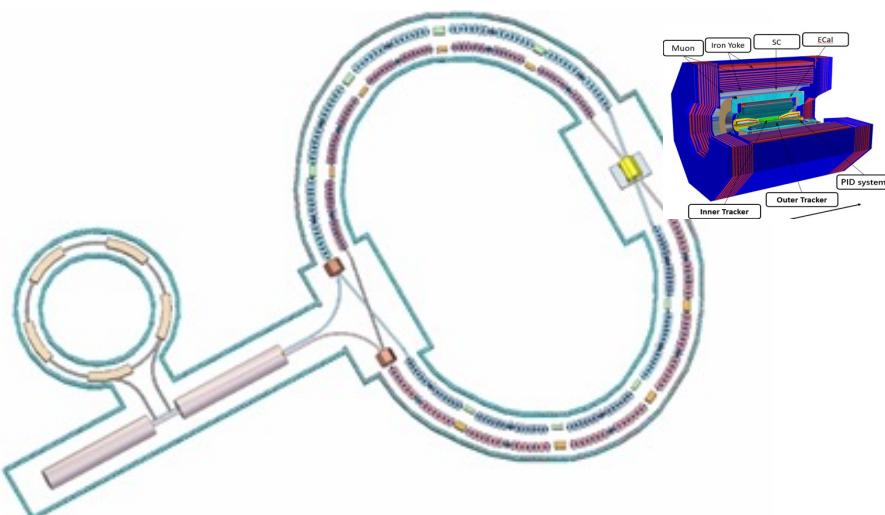
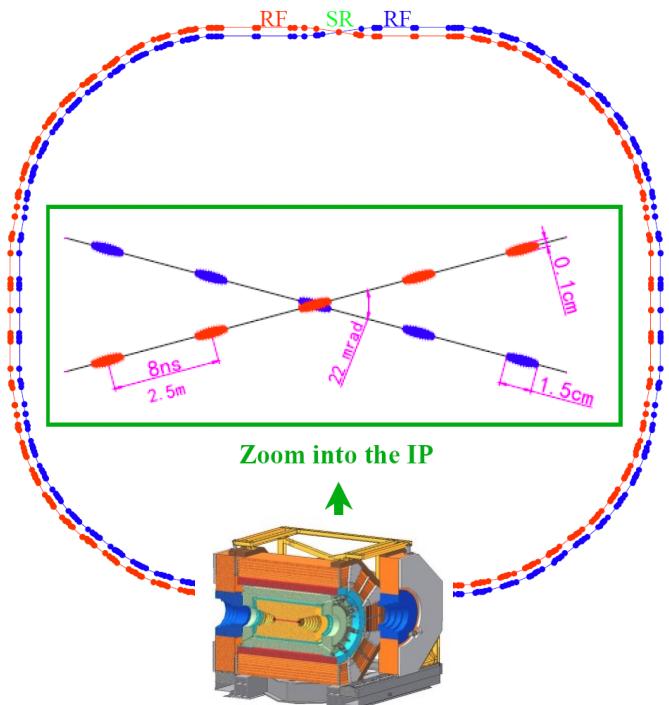
BEPCII and STCF in China

BEPCII

- Peak lumi. $0.6\text{--}1 \times 10^{33}$ cm $^{-2}$ s $^{-1}$ at 3.773 GeV
- Energy range $E_{cm} = 2 - 4.6$ GeV
- No Polarization

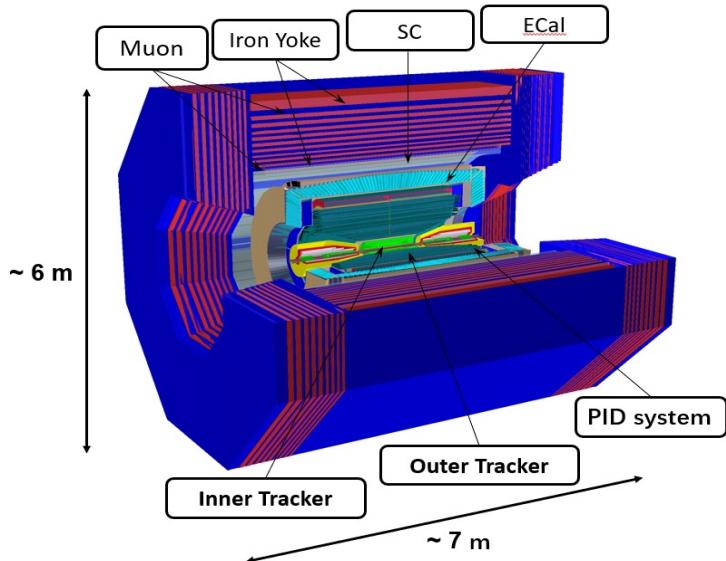
Designed STCF

- Peak lumi. $>0.5 \times 10^{35}$ cm $^{-2}$ s $^{-1}$ at 4 GeV
- Energy range $E_{cm} = 2 - 7$ GeV
- Potential to increase luminosity and realize beam polarization



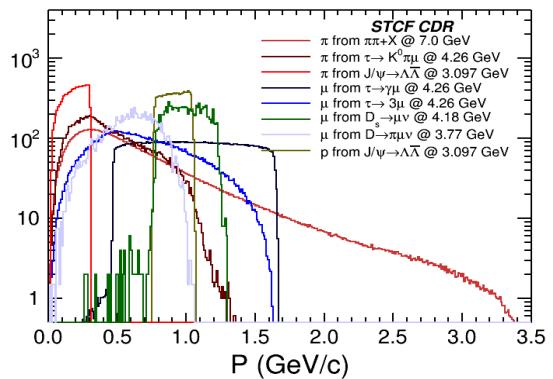
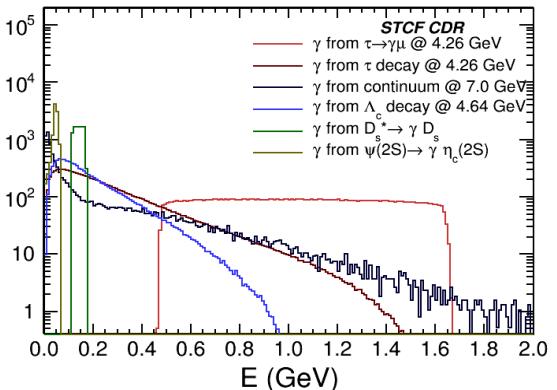
1 ab $^{-1}$ data expected per year

STCF Detector



Requirement:

- High detection efficiency and good resolution
- Superior PID capability
- Tolerance to high rate/background environment



ITK

$<0.25\%X_0$ / layer
 $\sigma_{xy} < 100$ mm

MDC

$\sigma_{xy} < 130$ mm
 $\sigma p/p \sim 0.5\% @ 1$ GeV
 $dE/dx \sim 6\%$

PID

π/K (and K/p) 3-4 σ separation
up to 2 GeV/c

EMC

E range: 0.025-2 GeV
 $\sigma_E @ 1$ GeV: 2.5% in barrel, 4%
at endcaps
Pos. Res. : ~ 4 mm

MUD

0.4 - 1.8 GeV
 π suppression >30



Tentative Plan

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031-2040	2041-2042
CDR															
TDR															
Construction															
In operation															
Upgrade															

Activities: <http://cicpi.ustc.edu.cn/indico/categoryDisplay.py?categoryId=2>

Total cost: 4.5B RMB

STCF
Conceptual Design Report

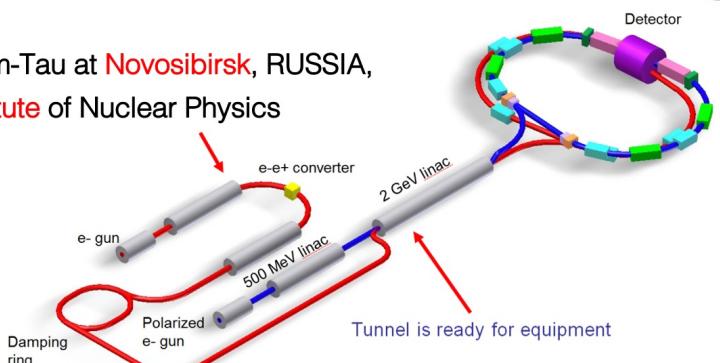
Volume I - Physics



The first version of CDR (three volumes) to be published soon

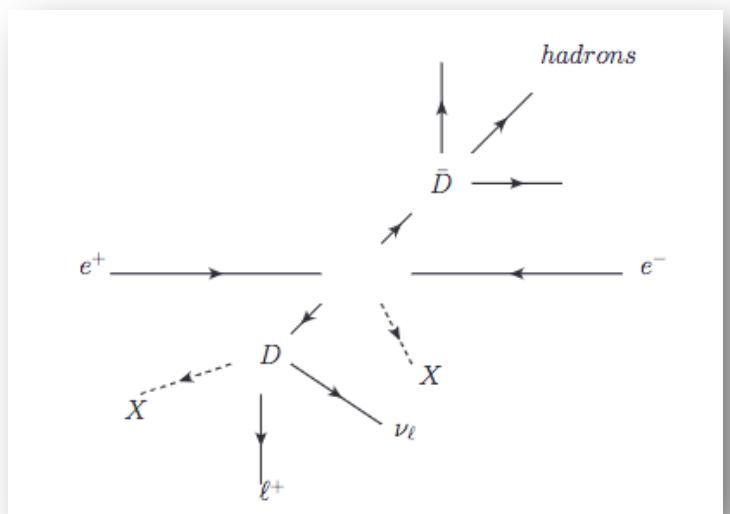
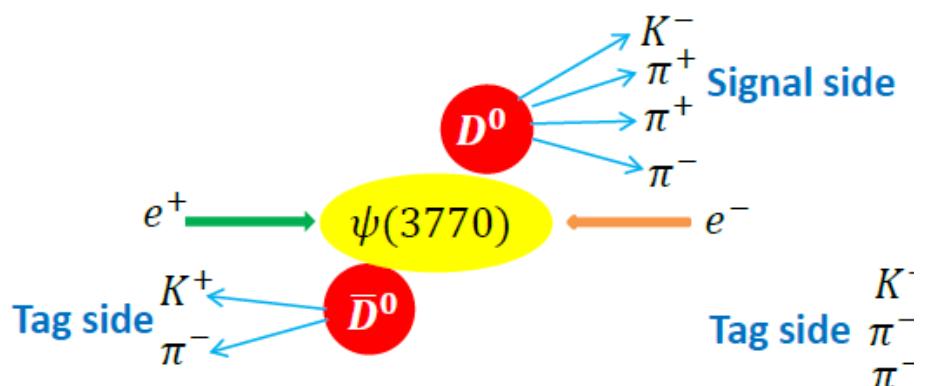
The STCF Study Group
April, 2020

Super Charm-Tau at Novosibirsk, RUSSIA,
Budker Institute of Nuclear Physics



- Pre-Agreement of **Joint effort** on R&D, details are under negotiation
- **Joint workshop** between China, Russia, and Europe
 - 2018 UCAS (March), Novosibirsk (May), Orsay (December)
 - 2019 Moscow(September)
 - 2020 Online (Nov.), 2021 Online (Nov.)

Charmed meson decays



Precision measurement of CKM elements

CKM matrix elements are **fundamental SM parameters** that describe the mixing of quark fields due to weak interaction.

- A precise test of EW theory
- New physics beyond SM?

$$\begin{pmatrix} d' \\ s' \\ b' \end{pmatrix} = \begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix} \begin{pmatrix} d \\ s \\ b \end{pmatrix}$$

BESIII + B factories + LQCD

Three generations of quarks?

Unitary matrix?

Expected precision < 2% at BESIII

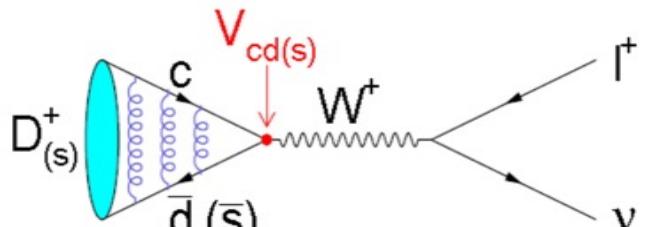
BESIII + B factories + LHCb + LQCD

A direct measurement of $V_{cd(s)}$ is one of the most important tasks in charm physics

$D_{(s)}$ (Semi-)Leptonic decay

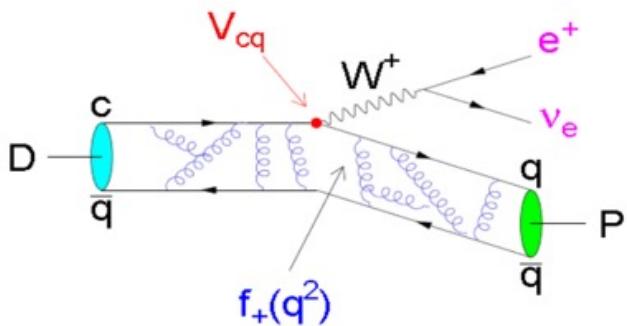
Purely Leptonic:

$$\Gamma(D_{(s)}^+ \rightarrow \ell^+ \nu_\ell) = \frac{G_F^2 f_{D_{(s)}^+}^2}{8\pi} |V_{cd(s)}|^2 m_\ell^2 m_{D_{(s)}^+} \left(1 - \frac{m_\ell^2}{m_{D_{(s)}^+}^2}\right)^2$$



Semi-Leptonic:

$$\frac{d\Gamma}{dq^2} = \frac{G_F^2}{24\pi^3} |V_{cs(d)}|^2 p_{K(\pi)}^3 |f_+^{K(\pi)}(q^2)|^2,$$



Directly measurement : $|V_{cd(s)}| \times f_{D(s)}$ or $|V_{cd(s)}| \times FF$

- Input $f_{D(s)}$ or $f^{K(\pi)}(0)$ from LQCD $\Rightarrow |V_{cd(s)}|$
- Input $|V_{cd(s)}|$ from a global fit $\Rightarrow f_{D(s)}$ or $f^{K(\pi)}(0)$
- Validate LQCD calculation of Input $f_{B(s)}$ and provide constraint of CKM-unitarity



$D_{(s)}$ Leptonic decay

	BESIII	STCF	Belle II
Luminosity	2.93 fb^{-1} at 3.773 GeV	1 ab^{-1} at 3.773 GeV	50 ab^{-1} at $\Upsilon(nS)$
$\mathcal{B}(D^+ \rightarrow \mu^+ \nu_\mu)$	$5.1\%_{\text{stat}} 1.6\%_{\text{syst}}$ [6]	$0.28\%_{\text{stat}}$	—
f_{D^+} (MeV)	$2.6\%_{\text{stat}} 0.9\%_{\text{syst}}$ [6]	$0.15\%_{\text{stat}}$	—
$ V_{cd} $	$2.6\%_{\text{stat}} 1.0\%_{\text{syst}}^*$ [6]	$0.15\%_{\text{stat}}$	—
$\mathcal{B}(D^+ \rightarrow \tau^+ \nu_\tau)$	$20\%_{\text{stat}} 10\%_{\text{syst}}$ [7]	$0.41\%_{\text{stat}}$	—
$\mathcal{B}(D^+ \rightarrow \tau^+ \nu_\tau)$	$21\%_{\text{stat}} 13\%_{\text{syst}}$ [7]	$0.50\%_{\text{stat}}$	—
$\mathcal{B}(D^+ \rightarrow \mu^+ \nu_\mu)$	—	—	—
Luminosity	3.2 fb^{-1} at 4.178 GeV	1 ab^{-1} at 4.009 GeV	50 ab^{-1} at $\Upsilon(nS)$
$\mathcal{B}(D_s^+ \rightarrow \mu^+ \nu_\mu)$	$2.8\%_{\text{stat}} 2.7\%_{\text{syst}}$ [8]	$0.30\%_{\text{stat}}$	$0.8\%_{\text{stat}} 1.8\%_{\text{syst}}$
$f_{D_s^+}$ (MeV)	$1.5\%_{\text{stat}} 1.6\%_{\text{syst}}$ [8]	$0.15\%_{\text{stat}}$	—
$ V_{cs} $	$1.5\%_{\text{stat}} 1.6\%_{\text{syst}}$ [8]	$0.15\%_{\text{stat}}$	—
$f_{D_s^+}/f_{D^+}$	$3.0\%_{\text{stat}} 1.5\%_{\text{syst}}$ [8]	$0.21\%_{\text{stat}}$	—
$\mathcal{B}(D_s^+ \rightarrow \tau^+ \nu_\tau)$	$2.2\%_{\text{stat}} 2.6\%_{\text{syst}}^\dagger$	$0.24\%_{\text{stat}}$	$0.6\%_{\text{stat}} 2.7\%_{\text{syst}}$
$f_{D_s^+}$ (MeV)	$1.1\%_{\text{stat}} 1.5\%_{\text{syst}}^\dagger$	$0.11\%_{\text{stat}}$	—
$ V_{cs} $	$1.1\%_{\text{stat}} 1.5\%_{\text{syst}}^\dagger$	$0.11\%_{\text{stat}}$	—
$\bar{f}_{D_s^+}^{\mu\&\tau}$ (MeV)	$0.9\%_{\text{stat}} 1.0\%_{\text{syst}}^\dagger$	$0.09\%_{\text{stat}}$	$0.3\%_{\text{stat}} 1.0\%_{\text{syst}}$
$ \bar{V}_{cs}^{\mu\&\tau} $	$0.9\%_{\text{stat}} 1.0\%_{\text{syst}}^\dagger$	$0.09\%_{\text{stat}}$	—
$\mathcal{B}(D_s^+ \rightarrow \tau^+ \nu_\tau)$	$3.6\%_{\text{stat}} 3.0\%_{\text{syst}}^\dagger$	$0.38\%_{\text{stat}}$	$0.9\%_{\text{stat}} 3.2\%_{\text{syst}}$
$\mathcal{B}(D_s^+ \rightarrow \mu^+ \nu_\mu)$	—	—	—

* assuming Belle II improved systematics by a factor 2

Stat. uncertainty is close to theory precision
Syst. uncertainty is challenging



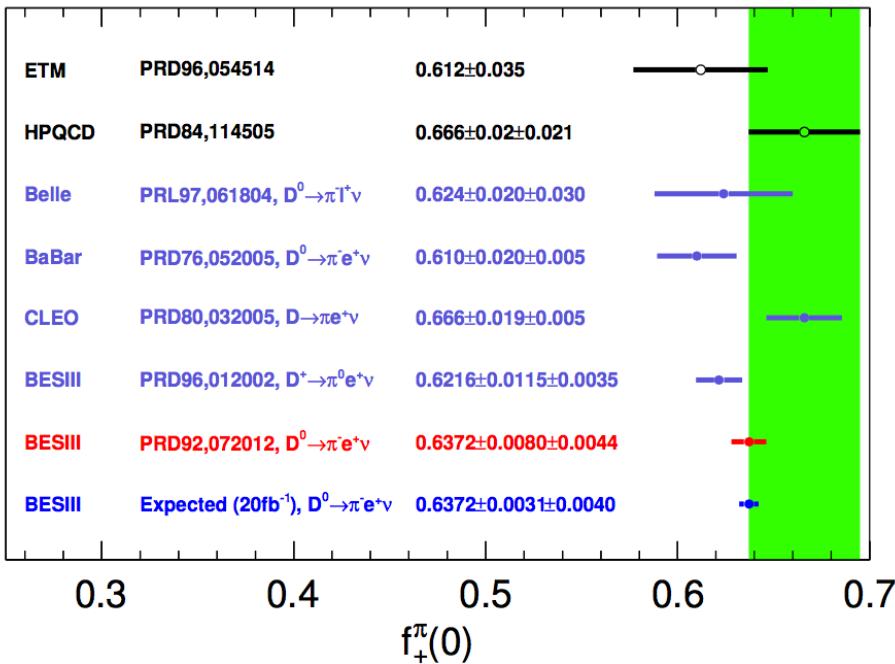
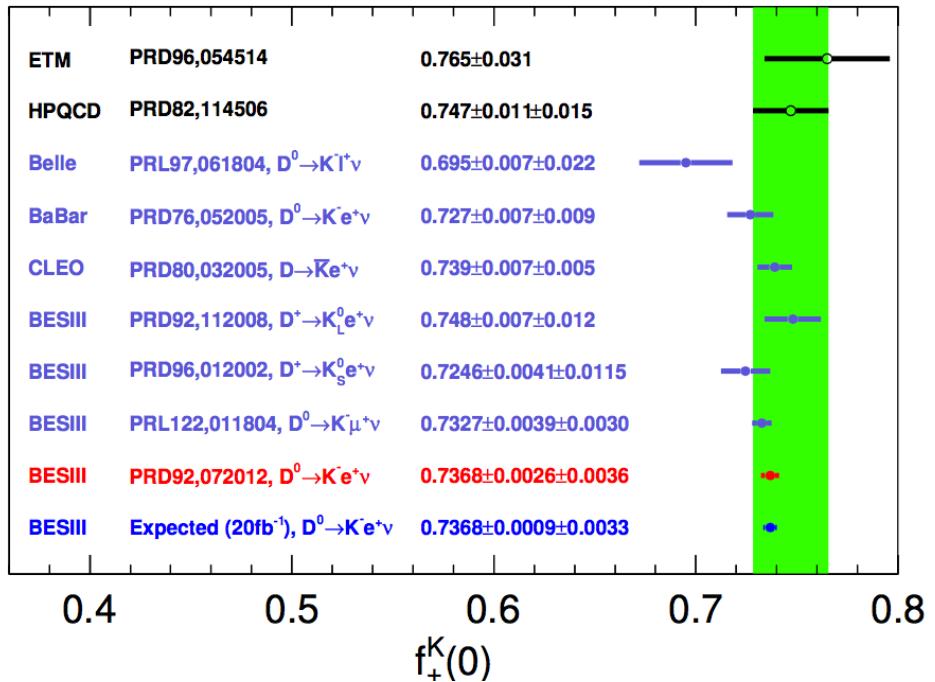
Prospects on the semi-leptonic decays

LFU test at STCF

	BESIII	BESIII	Belle	Belle II
Luminosity	2.9 fb ⁻¹ @3.773 GeV	20 fb ⁻¹ @3.773 GeV	0.28 ab ⁻¹	50 ab ⁻¹
$D^0 \rightarrow K^- e^+ \nu_e$	0.4% _{stat.} 0.5% _{syst.}	0.2% _{stat.} 0.4% _{syst.}	1.0% _{stat.} 3.2% _{syst.} *	0.1% _{stat.} 1.6% _{syst.} *
$D^0 \rightarrow K^- \mu^+ \nu_\mu$	0.5% _{stat.} 0.4% _{syst.}	0.2% _{stat.} 0.4% _{syst.}	—	—
$D^0 \rightarrow \pi^- e^+ \nu_e$	1.3% _{stat.} 0.7% _{syst.}	0.5% _{stat.} 0.4% _{syst.}	3.2% _{stat.} 4.8% _{syst.} *	0.2% _{stat.} 2.4% _{syst.} *
$D^0 \rightarrow \pi^- \mu^+ \nu_\mu$	NA	0.8% _{stat.} 0.8% _{syst.}	—	—
$D^0 \rightarrow K^{*-} e^+ \nu_e$	—	—	—	—
r_V	5.0% _{stat.} 2.0% _{syst.}	2.0% _{stat.} 2.0% _{syst.}	—	—
r_A	10.0% _{stat.} 2.0% _{syst.}	4.0% _{stat.} 2.0% _{syst.}	—	—
$D^0 \rightarrow a_0^-(980) e^+ \nu_e$	NA	10.0% _{stat.} 5.0% _{syst.}	—	—
$D^0 \rightarrow K_1^-(1270) e^+ \nu_e$	NA	10.0% _{stat.} 5.0% _{syst.}	—	—
$D^+ \rightarrow K^0 e^+ \nu_e$	0.6% _{stat.} 1.7% _{syst.}	0.2% _{stat.} 1.0% _{syst.}	—	—
$D^+ \rightarrow K_L^0 e^+ \nu_e$	0.9% _{stat.} 1.6% _{syst.}	0.4% _{stat.} 1.0% _{syst.}	—	—
$D^+ \rightarrow K^0 \mu^+ \nu_\mu$	NA	0.3% _{stat.} 1.0% _{syst.}	—	—
$D^+ \rightarrow \bar{K}^{*0} e^+ \nu_e$	—	—	—	—
$A_1(0)$	1.7% _{stat.} 2.0% _{syst.}	0.7% _{stat.} 1.0% _{syst.}	—	—
r_V	4.0% _{stat.} 0.5% _{syst.}	1.6% _{stat.} 0.5% _{syst.}	—	—
r_A	5.0% _{stat.} 1.0% _{syst.}	2.0% _{stat.} 1.0% _{syst.}	—	—
$D^+ \rightarrow \pi^0 e^+ \nu_e$	1.9% _{stat.} 0.5% _{syst.}	0.7% _{stat.} 0.5% _{syst.}	—	—
$D^+ \rightarrow \pi^0 \mu^+ \nu_\mu$	NA	1.0% _{stat.} 1.0% _{syst.}	—	—
$D^+ \rightarrow \eta e^+ \nu_e$	4.5% _{stat.} 2.0% _{syst.}	2.0% _{stat.} 2.0% _{syst.}	—	—
$D^+ \rightarrow \eta' e^+ \nu_e$	NA	10.0% _{stat.} 5.0% _{syst.}	—	—
$D^+ \rightarrow \omega e^+ \nu_e$	—	—	—	—
r_V	7.2% _{stat.} 4.8% _{syst.}	3.0% _{stat.} 2.0% _{syst.}	—	—
r_A	14% _{stat.} 5.0% _{syst.}	3.0% _{stat.} 2.0% _{syst.}	—	—
$D^+ \rightarrow a_0^0(980) e^+ \nu_e$	NA	10.0% _{stat.} 5.0% _{syst.}	—	—
$D^+ \rightarrow \bar{K}_1^0(1270) e^+ \nu_e$	NA	10.0% _{stat.} 5.0% _{syst.}	—	—
$D^{0(+)} \rightarrow \rho^{-(0)} e^+ \nu_e$	—	—	—	—
r_V	5.0% _{stat.} 4.0% _{syst.}	2.0% _{stat.} 2.0% _{syst.}	—	—
r_A	8.0% _{stat.} 4.0% _{syst.}	3.0% _{stat.} 2.0% _{syst.}	—	—

STCF will largely improve
the precisions of the form
factors over all the modes

Form factors $f_+^{D \rightarrow h}$



validations on the LQCD results



Lepton Flavor Universality

LFU is **critical** to test the SM and search for new physics beyond the SM

Purely Leptonic:

$$|R_{D_{(s)}^+}| = \frac{\Gamma(D_{(s)}^+ \rightarrow \tau^+ \nu_\tau)}{\Gamma(D_{(s)}^+ \rightarrow \mu^+ \nu_\mu)} = \frac{m_{\tau^+}^2 \left(1 - \frac{m_{\tau^+}^2}{m_{D_{(s)}^+}^2}\right)^2}{m_{\mu^+}^2 \left(1 - \frac{m_{\mu^+}^2}{m_{D_{(s)}^+}^2}\right)^2}$$

Semi-Leptonic:

$$R_{\mu/e} = \frac{\Gamma_{D \rightarrow h \mu \nu \mu}}{\Gamma_{D \rightarrow h e \nu e}}$$

	$R(D_s^+)$	$R(D^+)$	$R(K^-)$	$R(\bar{K}^0)$	$R(\pi^-)$	$R(\pi^0)$
SM	19.74(1)	2.66(1)	0.975(1)	0.975(1)	0.985(2)	0.985(2)
BESIII	10.19(52)	3.21(64)	0.974(14)	1.013(29)	0.922(37)	0.964(45)

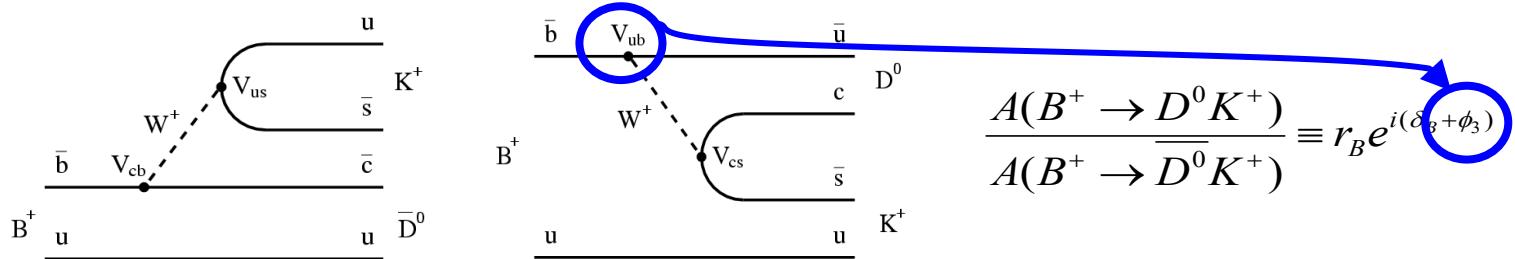
BESIII
 $\sim 1\sigma$ difference

BESIII
 $\sim 2\sigma$ difference

- Large uncertainty from BESIII, dominant by statistically limited
- STCF would improve them significantly

Determination of γ/ϕ_3 angle

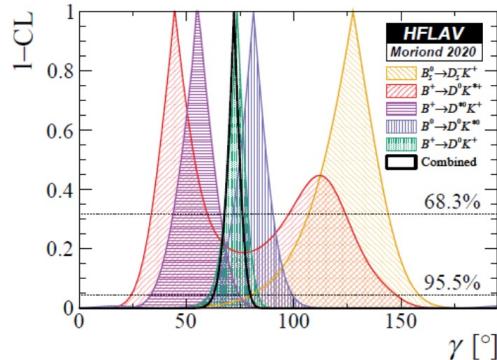
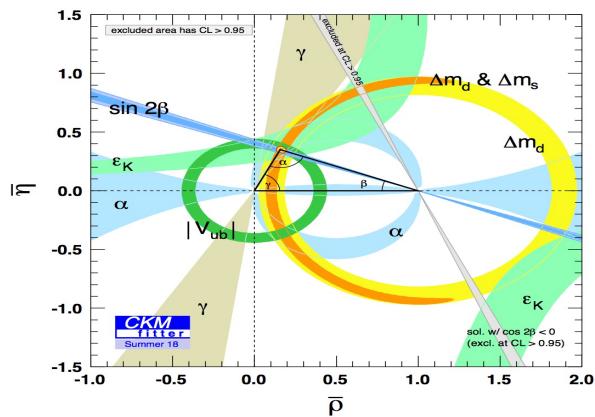
- The **cleanest way** to extract γ is from $B \rightarrow D\bar{K}$ decays:



- Interference between tree-level decays; theoretically clean
- current uncertainty $\sigma(\gamma) \sim 5^\circ$
- however, theoretical relative error $\sim 10^{-7}$ (very small!)

- Information of *D decay strong phase* is needed

- Best way is to employ **quantum coherence of DD production** at threshold



Prog. Theor. Exp. Phys. 2020 083C01 (2020)



Determination of γ/ϕ_3 angle

Runs	Collected / Expected integrated luminosity	Year attained	γ/ϕ_3 sensitivity
LHCb Run-1 [7, 8 TeV]	3 fb^{-1}	2012	8°
LHCb Run-2 [13 TeV]	5 fb^{-1}	2018	4°
Belle II Run	50 ab^{-1}	2025	1.5°
LHCb upgrade I [14 TeV]	50 fb^{-1}	2030	$< 1^\circ$
LHCb upgrade II [14 TeV]	300 fb^{-1}	(>)2035	$< 0.4^\circ$

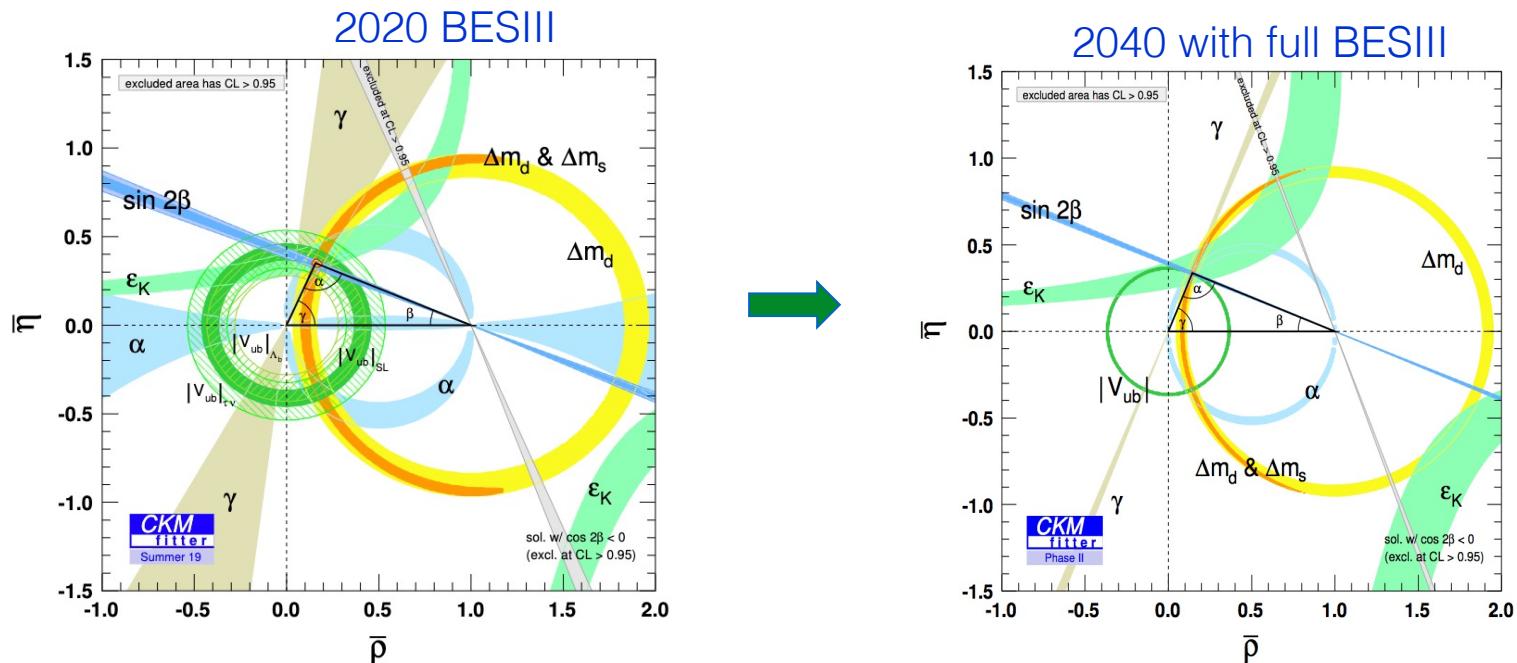
BESIII
20/fb:
 $\sigma(\gamma) \sim 0.4^\circ$

STCF is
needed!

Three methods for exploiting interference (choice of D^0 decay modes):

- Gronau, London, Wyler (GLW): Use **CP eigenstates** of $D^{(*)0}$ decay,
e.g. $D^0 \rightarrow K_s \pi^0$, $D^0 \rightarrow \pi^+ \pi^-$
- Atwood, Dunietz, Soni (ADS): Use **doubly Cabibbo-suppressed** decays, e.g. $D^0 \rightarrow K^+ \pi^-$
 - With 1 ab^{-1} @ STCF : $\sigma(\cos\delta_{K\pi}) \sim 0.007$; $\sigma(\delta_{K\pi}) \sim 2^\circ \rightarrow \sigma(\gamma) < 0.5^\circ$
- Giri, Grossman, Soffer, Zupan (GGSZ): Use **Dalitz plot** analysis of 3-body D^0 decays,
e.g. $K_s \pi^+ \pi^-$; high statistics; need precise Dalitz model
 - STCF reduces the contribution of D Dalitz model to a level of $\sim 0.1^\circ$

Determination of γ/ϕ_3 angle in CKM



STCF will provide complementary information on the strong phase and allow detailed comparisons in different models



D^0 - \bar{D}^0 mixing and CPV at STCF

STCF provide **a unique place** for the study of D^0 - \bar{D}^0 mixing and CPV by means of **quantum coherence** of D^0 and \bar{D}^0 produced through

$$\psi(3770) \rightarrow (D^0 \bar{D}^0)_{CP=-} \text{ or } \psi(4040) \rightarrow D^0 \bar{D}^{*0} \rightarrow \pi^0 (D^0 \bar{D}^0)_{CP=-} \text{ or } \gamma (D^0 \bar{D}^0)_{CP=+}$$

as well as incoherent flavor specific D^0 samples: $D^{*+} \rightarrow D^0 \pi^+$

- Mixing rate $R_M = \frac{x^2+y^2}{2} \sim 10^{-5}$ with 1 ab⁻¹ data at 3.773 GeV via **same charged** final states $(K^\pm \pi^\mp)(K^\pm \pi^\mp)$ or $(K^\pm l^\mp \nu)(K^\pm l^\mp \nu)$
- Mixing parameters and CPV parameters with 1 ab⁻¹ data at 4009 MeV via coherent (C-even and C-odd) and incoherent process
- $\Delta A_{CP} \sim 10^{-3}$ for KK and $\pi\pi$ channels



Precision estimation at STCF

	1/ab @4009 MEV (only QC QC+incoherent) (very preliminary estimation)	BELLEII(50/ab) [PTEP2019, 123C01]	LHCb(50/fb) (SL Prompt) [arXiv:1808.08865]
$x(\%)$	0.036	0.035	0.03
$y(\%)$	0.023	0.023	0.019
r_{CP}	0.017	0.013	0.024
$\alpha_{CP}(\circ)$	1.3	1.0	1.7
			0.48

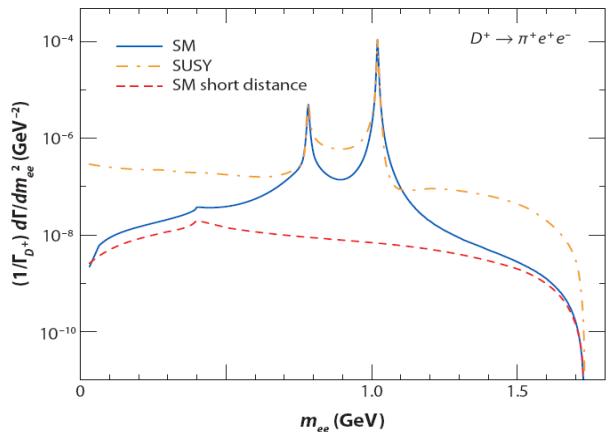
- The only QC results: contains $D^0 \rightarrow K_S\pi\pi$, $D^0 \rightarrow K^-\pi^+\pi^0$ and general CP tag decay channels; needs to be tuned
- The QC+incoherent results: combines coherent and incoherent D^0 meson samples
- The BELLE II and LHCb results only contain incoherent $D^0 \rightarrow K_S\pi\pi$ channel

Charm rare decays

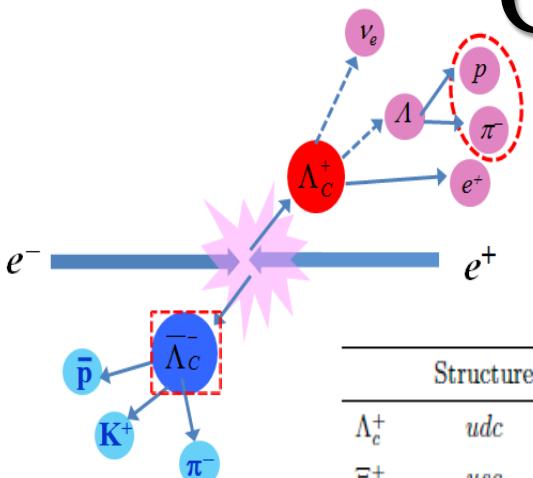
- FCNC suppressed by GIM mechanism in SM:
 - Short distance : interested, computable by pQCD, directly test SM

$$\mathcal{B}_{D^0 \rightarrow X_u^0 e^+ e^-} \simeq 8 \cdot 10^{-9}$$

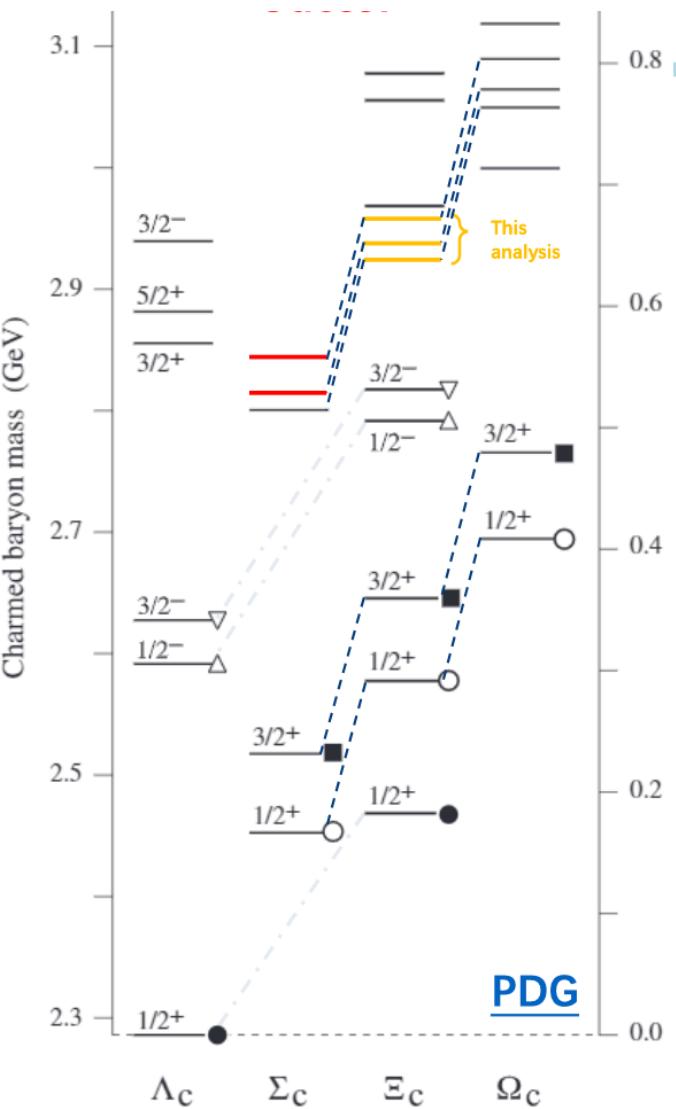
$$\mathcal{B}_{D^+ \rightarrow X_u^+ e^+ e^-} \simeq 2 \cdot 10^{-8}$$
 - Long distance effect can enhance the rate to $10^{-6} \sim 10^{-7}$, dominantly.
 - Allow with sizeable decay rate in NP
 - 1ab^{-1} @ STCF can achieve the sensitivity to $10^{-8} \sim 10^{-9}$, and test SM strictly
 - Unique searches for di-neutrino process: $\pi^0 \nu \bar{\nu}$ and $\gamma \nu \bar{\nu}$
 - Can discriminate NP from SM by measuring :
 - $D \rightarrow V l^+ l^-$: AFB asymmetry
 - $D \rightarrow P l^+ l^-$: line shape of dilepton mass, to reveal the interference effect between long-distance and FCNC weak amplitude (NP amplitude);
- LFV, LNV and BNV decays are forbidden in SM. However, NP models can allow at sizable levels.
 - STCF: $10^{-8} \sim 10^{-9}$ → stringent constrains to NP models



Charmed baryons



	Structure	J^P	Mass, MeV	Width, MeV	Decay
Λ_c^+	udc	$(1/2)^+$	2286.46 ± 0.14	(200 ± 6) fs	weak
Ξ_c^+	usc	$(1/2)^+$	$2467.8^{+0.4}_{-0.6}$	(442 ± 26) fs	weak
Ξ_c^0	dsc	$(1/2)^+$	$2470.88^{+0.34}_{-0.8}$	112^{+13}_{-10} fs	weak
Σ_c^{++}	uuc	$(1/2)^+$	2454.02 ± 0.18	2.23 ± 0.30	$\Lambda_c^+ \pi^+$
Σ_c^+	udc	$(1/2)^+$	2452.9 ± 0.4	< 4.6	$\Lambda_c^+ \pi^0$
Σ_c^0	ddc	$(1/2)^+$	2453.76 ± 0.18	2.2 ± 0.4	$\Lambda_c^+ \pi^-$
$\Xi_c'^+$	usc	$(1/2)^+$	2575.6 ± 3.1	—	$\Xi_c^+ \gamma$
Ξ_c^0	dsc	$(1/2)^+$	2577.9 ± 2.9	—	$\Xi_c^0 \gamma$
Ω_c^0	ssc	$(1/2)^+$	2695.2 ± 1.7	(69 ± 12) fs	weak
Σ_c^{*++}	uuc	$(3/2)^+$	2518.4 ± 0.6	14.9 ± 1.9	$\Lambda_c^+ \pi^+$
Σ_c^{*+}	udc	$(3/2)^+$	2517.5 ± 2.3	< 17	$\Lambda_c^+ \pi^0$
Σ_c^{*0}	ddc	$(3/2)^+$	2518.0 ± 0.5	16.1 ± 2.1	$\Lambda_c^+ \pi^-$
Ξ_c^{*+}	usc	$(3/2)^+$	$2645.9^{+0.5}_{-0.6}$	< 3.1	$\Xi_c \pi$
Ξ_c^{*0}	dsc	$(3/2)^+$	2645.9 ± 0.5	< 5.5	$\Xi_c \pi$
Ω_c^{*0}	ssc	$(3/2)^+$	2765.9 ± 2.0	—	$\Omega_c^0 \gamma$





STCF: precision studies of the charmed baryon decays

Era of precision study of the charmed baryon (Λ_c , Ξ_c and Ω_c) decays to help developing more reliable QCD-derived models in charm sector

- Hadronic decays:

to explore as-yet-unmeasured channels and understand full picture of intermediate structures in charmed baryon decays, esp., those with neutron/ Σ / Ξ particles

- Semi-leptonic decays:

to validate LQCD calculations and LFU

- Charm-flavor-conserving nonleptonic decays: $\Xi_c \rightarrow \Lambda_c^+ \pi^-$, $\Omega_c^0 \rightarrow \Xi_c^- \pi^+$

- Electro-weak radiative decays: $\Sigma_c^+ \rightarrow \Lambda_c^+ \gamma$, $\Lambda_c^+ \rightarrow \Sigma \gamma, p \gamma$, $\Xi_c^{+/0} \rightarrow \Sigma^{+/0} \gamma$

- CPV in charmed baryon: BP and BV two-body decay asymmetry, charge-dependent rate of SCS

- Rare decays: LFV, BNV, FCNC

STCF will provide very precise measurements of their overall decays, up to the unprecedented level of $10^{-6} \sim 10^{-7}$



Summary

- **STCF** will be a crucial facility in **precision frontier**
- **Important playground for studying non-perturbative QCD, constrain EW theory and test the SM**
 - ✓ CKM matrix elements
 - ✓ LQCD validations
 - ✓ Search for violation of LFU in charm sector
 - ✓ Precision measurement of the charmed baryon spectroscopy and decays
- Complementary to Belle II and LHCb in understanding the QCD/EW models and searching for new physics



Thank you!

谢谢！