Charm Meson Physics at BESIII

Lei Li

For BESIII Collaboration

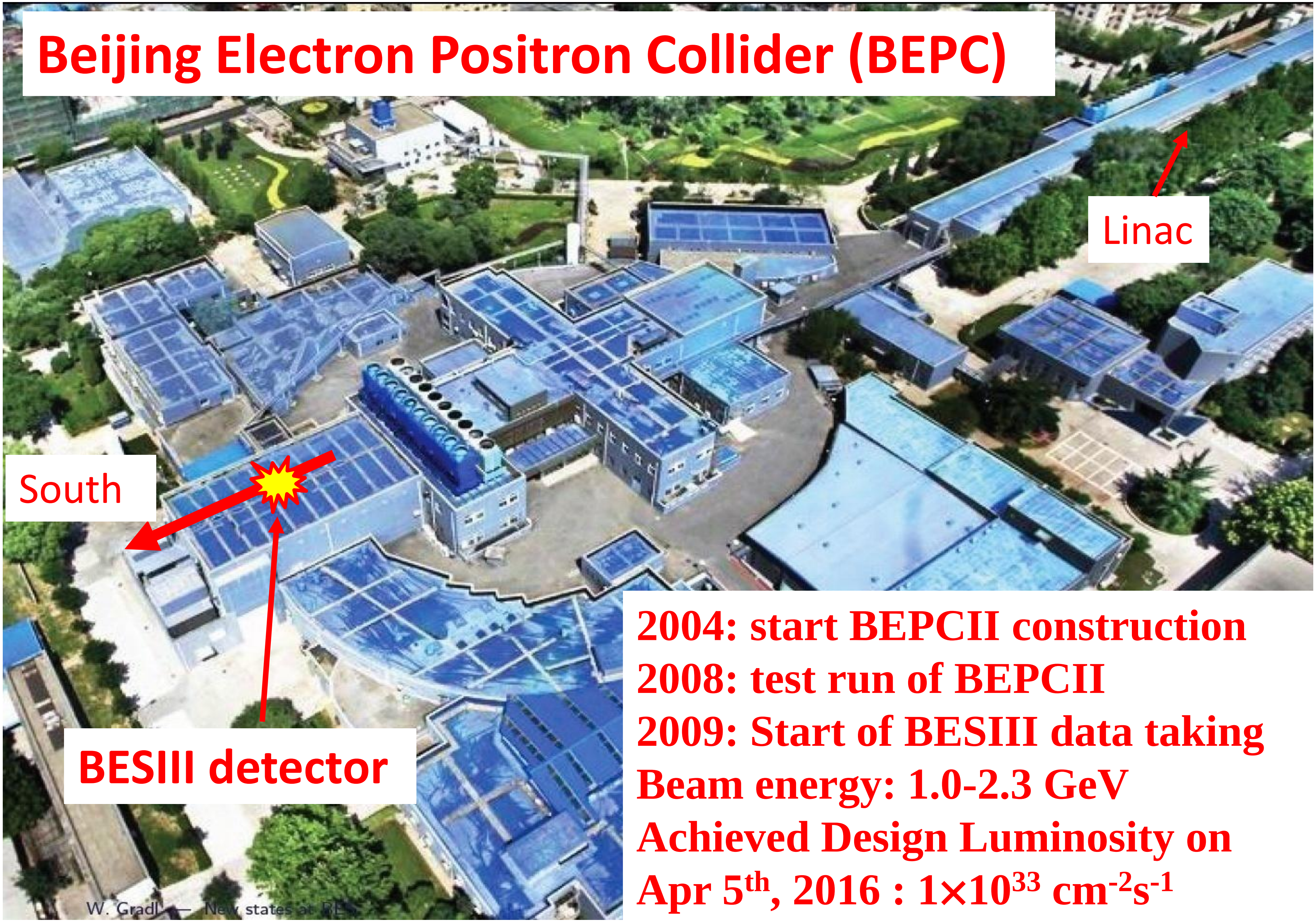
Beijing Institute of Petro-chemical Technology (BIPT)

21st International Conference on Particles and Nuclei (PANIC 2017)
国家会议中心 (China national conference center), Sep.1-Sep. 5, Beijing

Outline

- Introduction to BEPCII/BESIII experiment
- Charm meson decays
  - $D_{(s)}$ (semi-)leptonic decays
  - $D_{(s)}$ hadronic decays
- Summary

Beijing Electron Positron Collider (BEPC)



2004: start BEPCII construction
2008: test run of BEPCII
2009: Start of BESIII data taking
Beam energy: 1.0-2.3 GeV
Achieved Design Luminosity on Apr 5th, 2016 : 1×10^{33} $cm^{-2}s^{-1}$

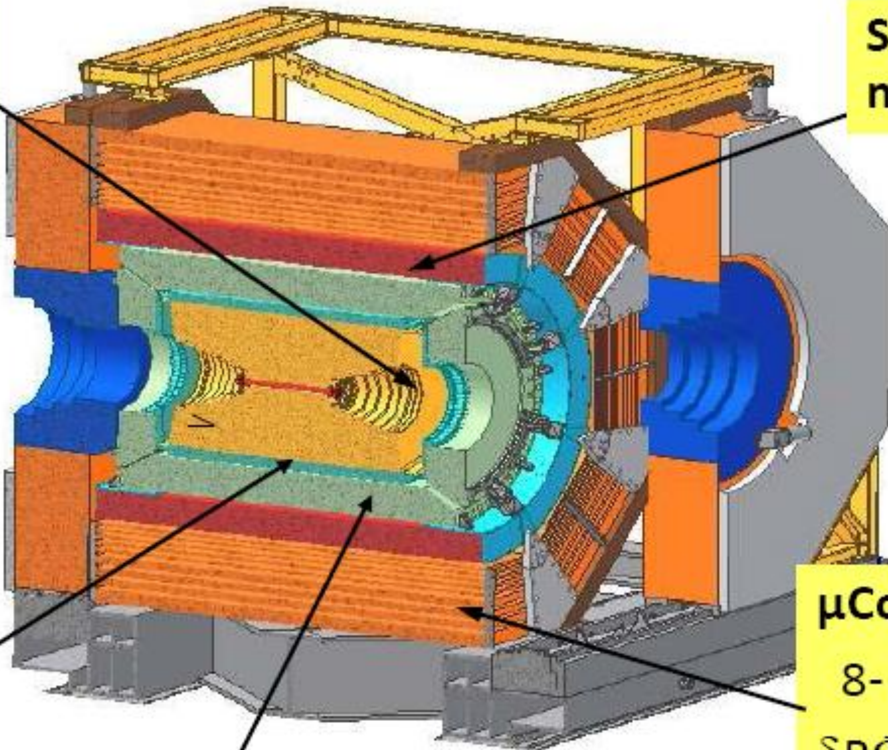
BESIII Detector

Drift Chamber (MDC)

$\sigma P/P$ ($^0/_0$) = 0.5%(1GeV)

$\sigma_{dE/dx}$ ($^0/_0$) = 6%

Super-conducting magnet (1.0 tesla)



Time Of Flight (TOF)

σ_T: 90 ps Barrel

110 ps endcap

μCounter

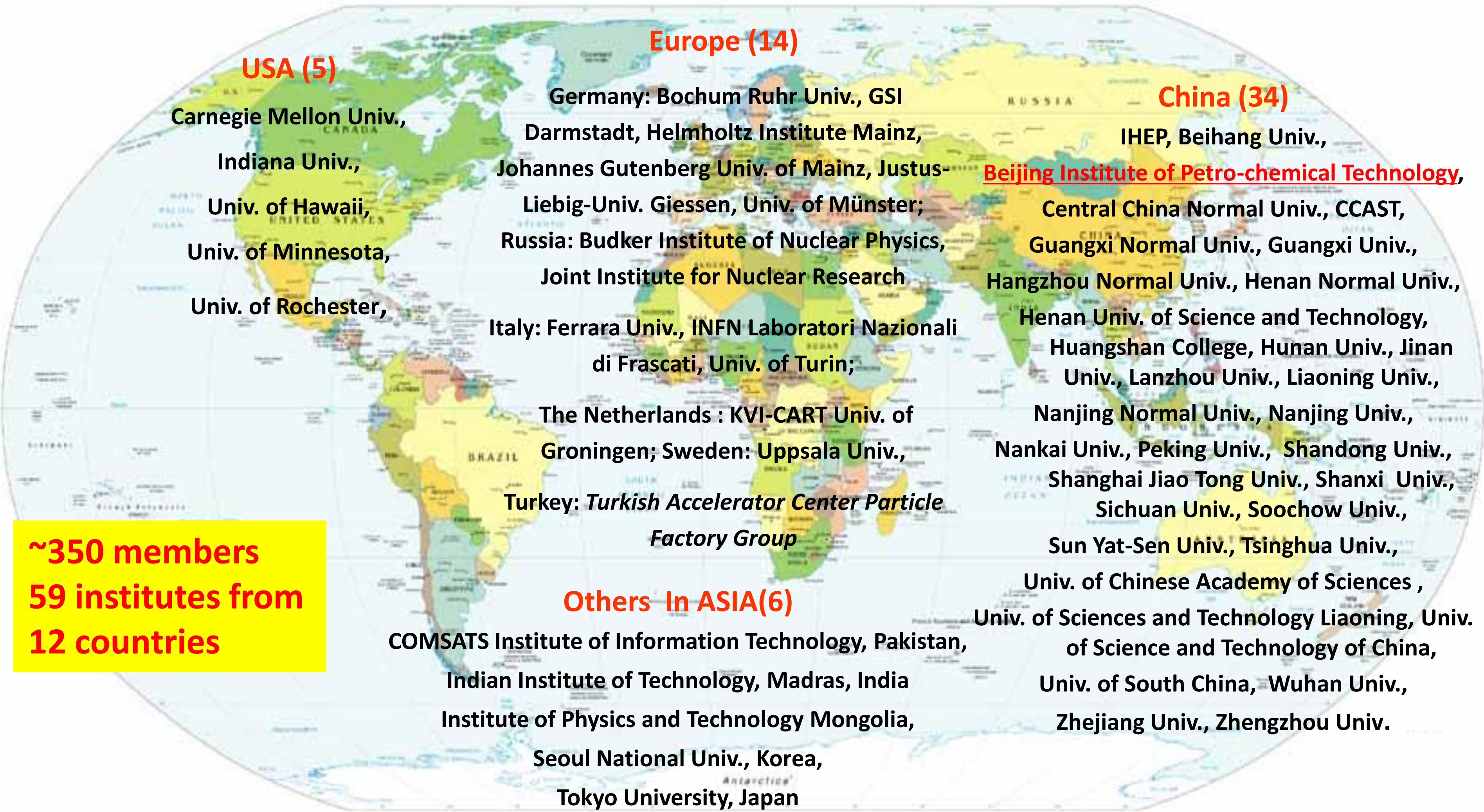
8- 9 layers RPC

$\delta R\Phi$=1.4 cm~1.7 cm

EMC: $\sigma E/\sqrt{E}$($^0/_0$) = 2.5 % (1 GeV)

(CsI) $\sigma_{z,\phi}$(cm) = 0.5 - 0.7 cm/$\sqrt{E}$

BESIII Collaboration



USA (5)

Carnegie Mellon Univ.,

Indiana Univ.,

Univ. of Hawaii,

Univ. of Minnesota,

Univ. of Rochester,

Europe (14)

Germany: Bochum Ruhr Univ., GSI Darmstadt, Helmholtz Institute Mainz, Johannes Gutenberg Univ. of Mainz, Justus-Liebig-Univ. Giessen, Univ. of Münster;
Russia: Budker Institute of Nuclear Physics, Joint Institute for Nuclear Research

Italy: Ferrara Univ., INFN Laboratori Nazionali di Frascati, Univ. of Turin;

The Netherlands : KVI-CART Univ. of Groningen; Sweden: Uppsala Univ.,

Turkey: *Turkish Accelerator Center Particle Factory Group*

China (34)

IHEP, Beihang Univ.,
Beijing Institute of Petro-chemical Technology,
Central China Normal Univ., CCAST,
Guangxi Normal Univ., Guangxi Univ.,
Hangzhou Normal Univ., Henan Normal Univ.,
Henan Univ. of Science and Technology,
Huangshan College, Hunan Univ., Jinan Univ., Lanzhou Univ., Liaoning Univ.,
Nanjing Normal Univ., Nanjing Univ.,
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Univ. of Chinese Academy of Sciences ,
Univ. of Sciences and Technology Liaoning, Univ. of Science and Technology of China,
Univ. of South China, Wuhan Univ.,
Zhejiang Univ., Zhengzhou Univ.

Others In ASIA(6)

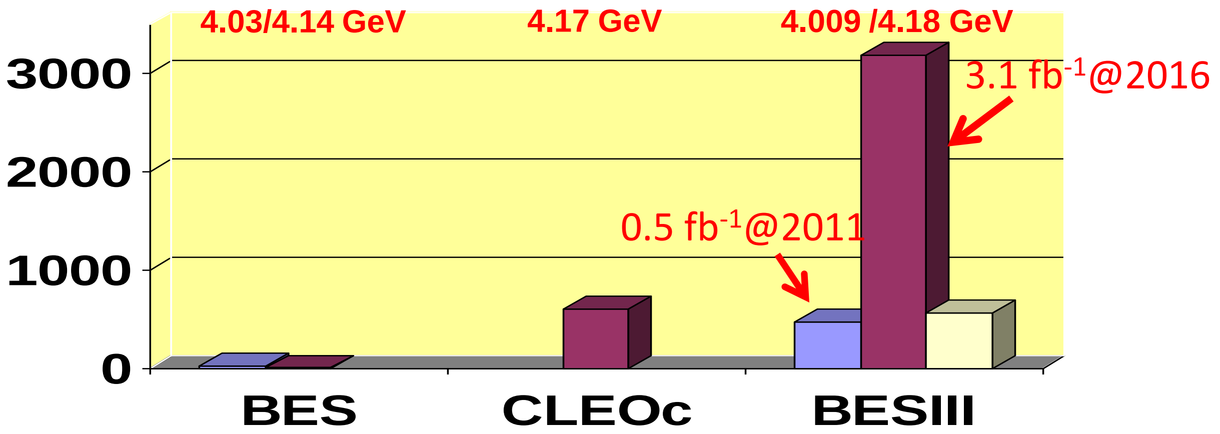
COMSATS Institute of Information Technology, Pakistan,
Indian Institute of Technology, Madras, India
Institute of Physics and Technology Mongolia,
Seoul National Univ., Korea,
Tokyo University, Japan
Univ. of Punjab, Pakistan

~350 members
59 institutes from 12 countries

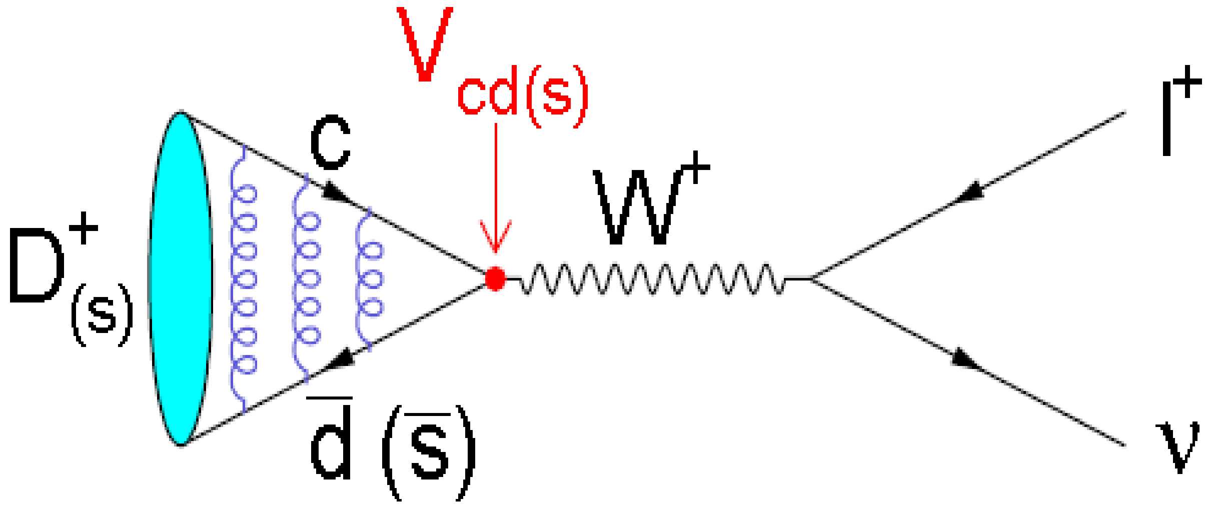
Data samples in this talk

➢ $D^{0(+)}$ samples at 3.773 GeV

➢ D_s^+ samples at 4.009/4.18 GeV



$D_{(s)}^+$ Leptonic Decays



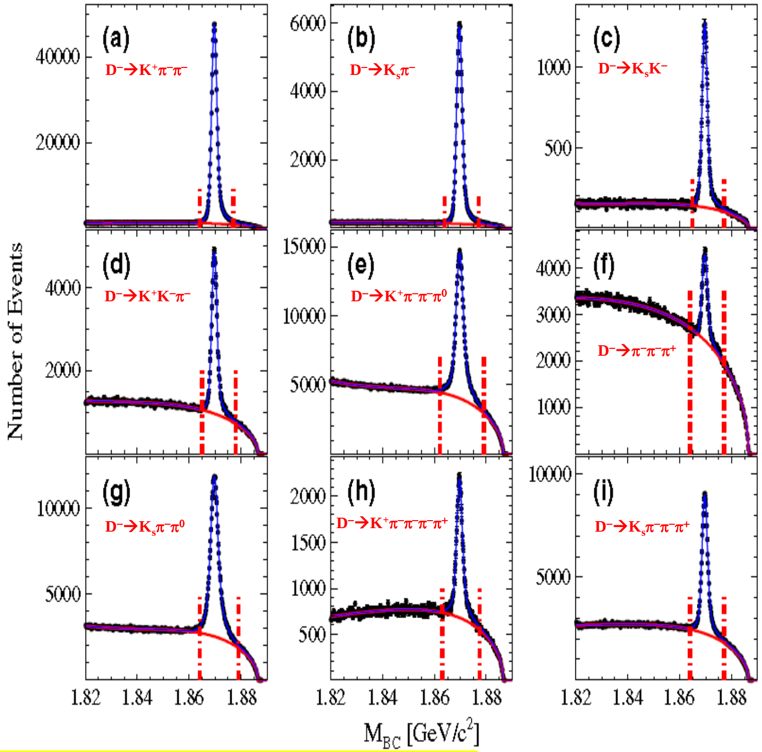
In the SM: $\Gamma(D^+_{(s)} \to \ell^+ \nu_\ell) = \frac{G_F^2 f^2_{D^+_{(s)}}}{8\pi} |V_{cd(s)}|^2 m_\ell^2 m_{D^+_{(s)}} \left(1 - \frac{m_\ell^2}{m^2_{D^+_{(s)}}}\right)^2$

Bridge to precisely measure

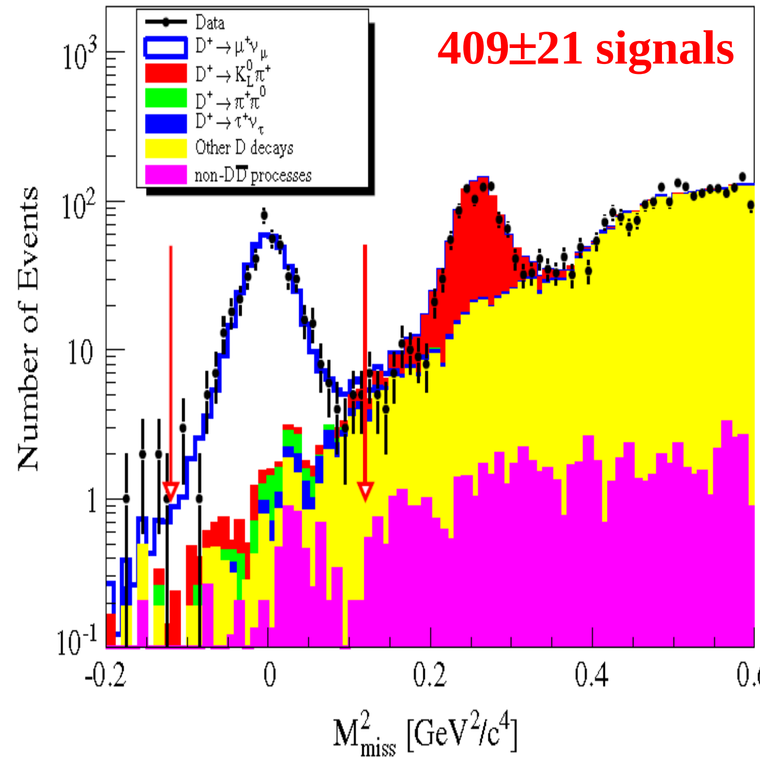
- ✓ Decay constant $f_{D(s)+}$ with input $|V_{cd(s)}|^{CKMfitter}$
- ✓ CKM matrix element $|V_{cd(s)}|$ with input $f^{LQCD}_{D(s)+}$

Measurement of $B[D^+\to\mu^+\nu]$, f_{D+} and $|V_{cd}|$

$e^+e^-\to\psi(3770)\to D^+D^-$



2.93 fb^{-1} data@ 3.773 GeV
PRD89(2014)051104R



$N_{D^-_{tag}} = (170.31 \pm 0.34)\times 10^4$

$B[D^+\to\mu^+\nu]=(3.71\pm0.19\pm0.06)\times10^{-4}$

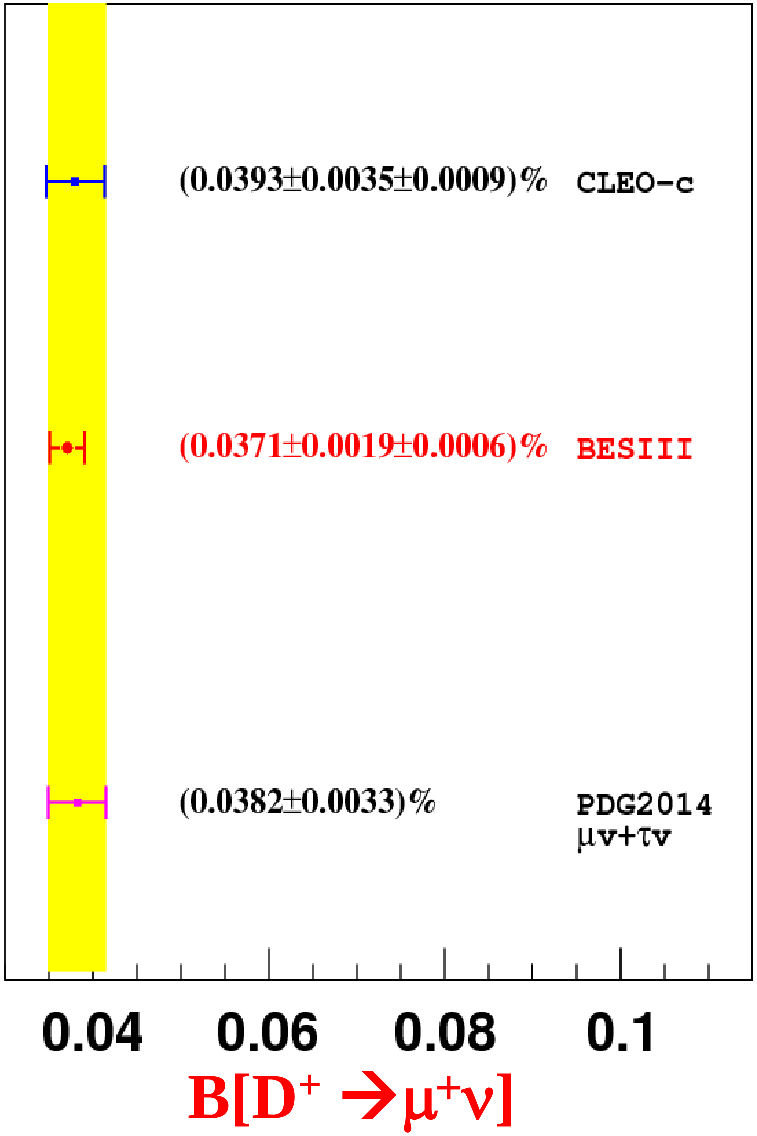
Input t_{D+}, m_{D+}, $m_{\mu+}$ on PDG and $|V_{cd}|$ of CKM-Fitter

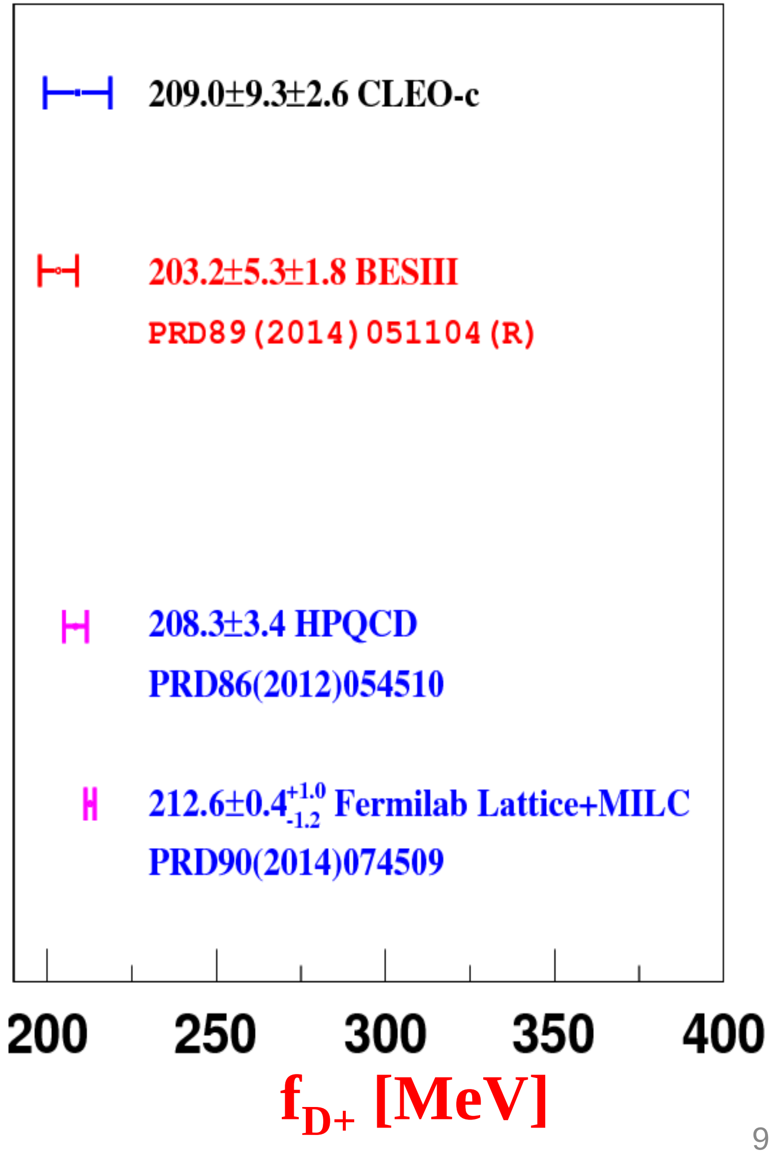
$f_{D+}=(203.2\pm5.3\pm1.8)$ MeV

Input t_{D+}, m_{D+}, $m_{\mu+}$ on PDG and LQCD calculated f_{D+}=207±4 MeV[PRL100(2008)062002]

$|V_{cd}|=0.2210\pm0.0058\pm0.0047$

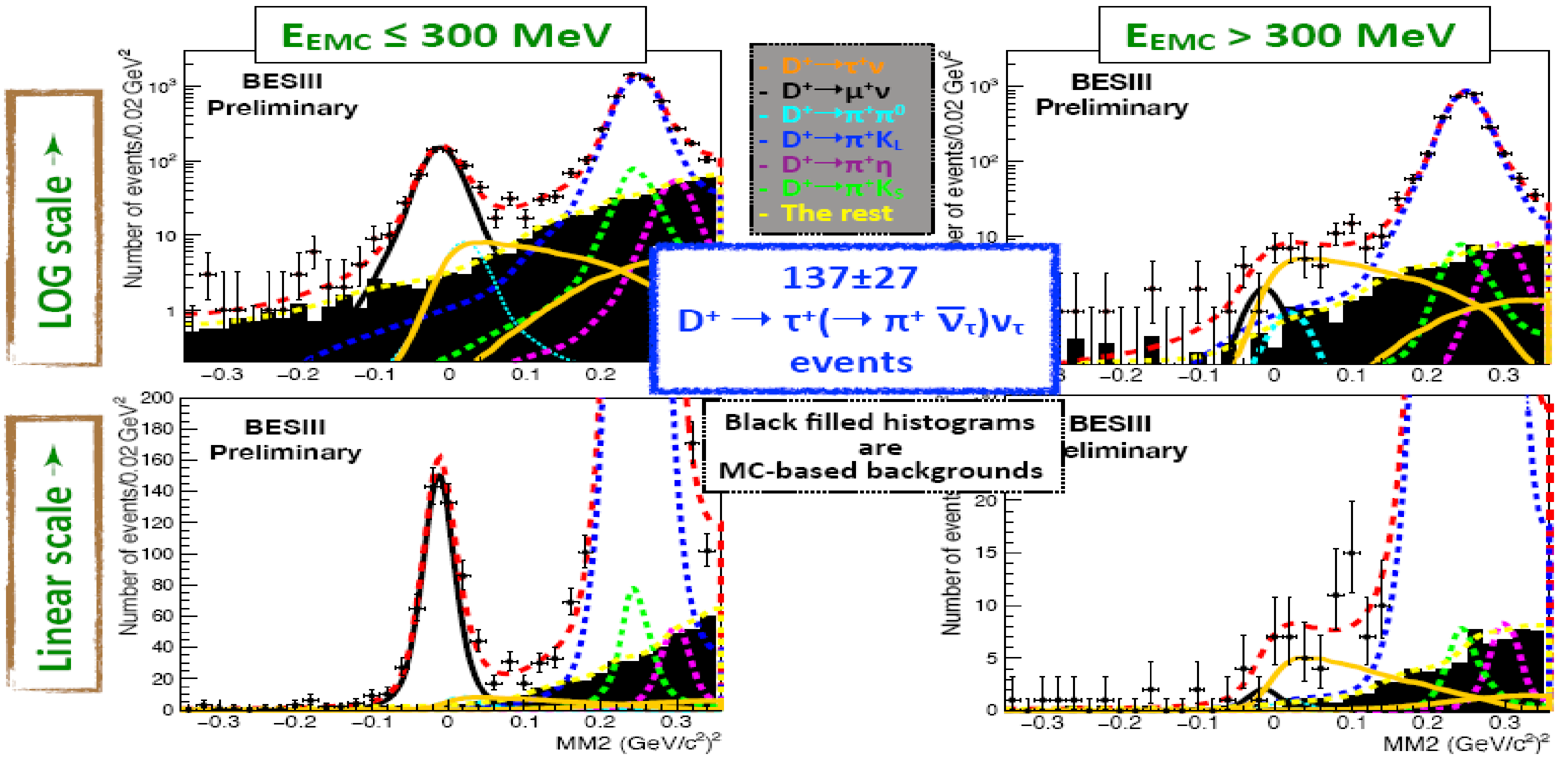
Comparisons of $B[D^+ \to \mu^+ \nu_\mu]$ and f_{D^+}



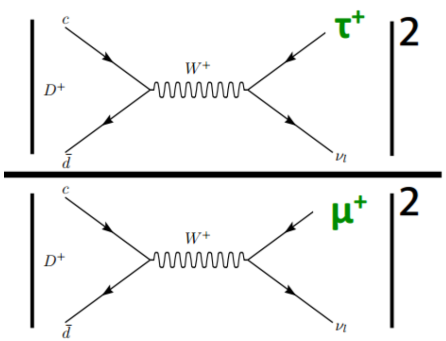


Evidence for $D^+ \to \tau^+(\pi^+\nu)\nu$ (>4σ)

with six dominant D^- ST channels



$B[D^+\to\tau^+\nu]=(1.20\pm0.24_{stat.})\times10^{-3}$



$$\equiv R \equiv \frac{\Gamma(D^+\to\tau^+\nu)}{\Gamma(D^+\to\mu^+\nu)} = \frac{m_{\tau^+}^2\left(1-\frac{m_{\tau^+}^2}{M_{D^+}^2}\right)^2}{m_{\mu^+}^2\left(1-\frac{m_{\mu^+}^2}{M_{D^+}^2}\right)^2}$$

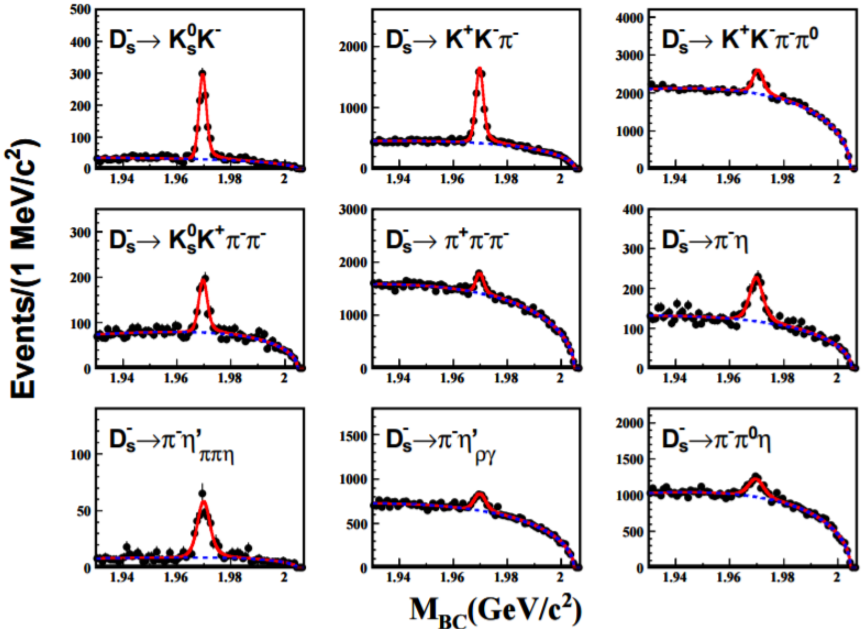
SM prediction: 2.66±0.01

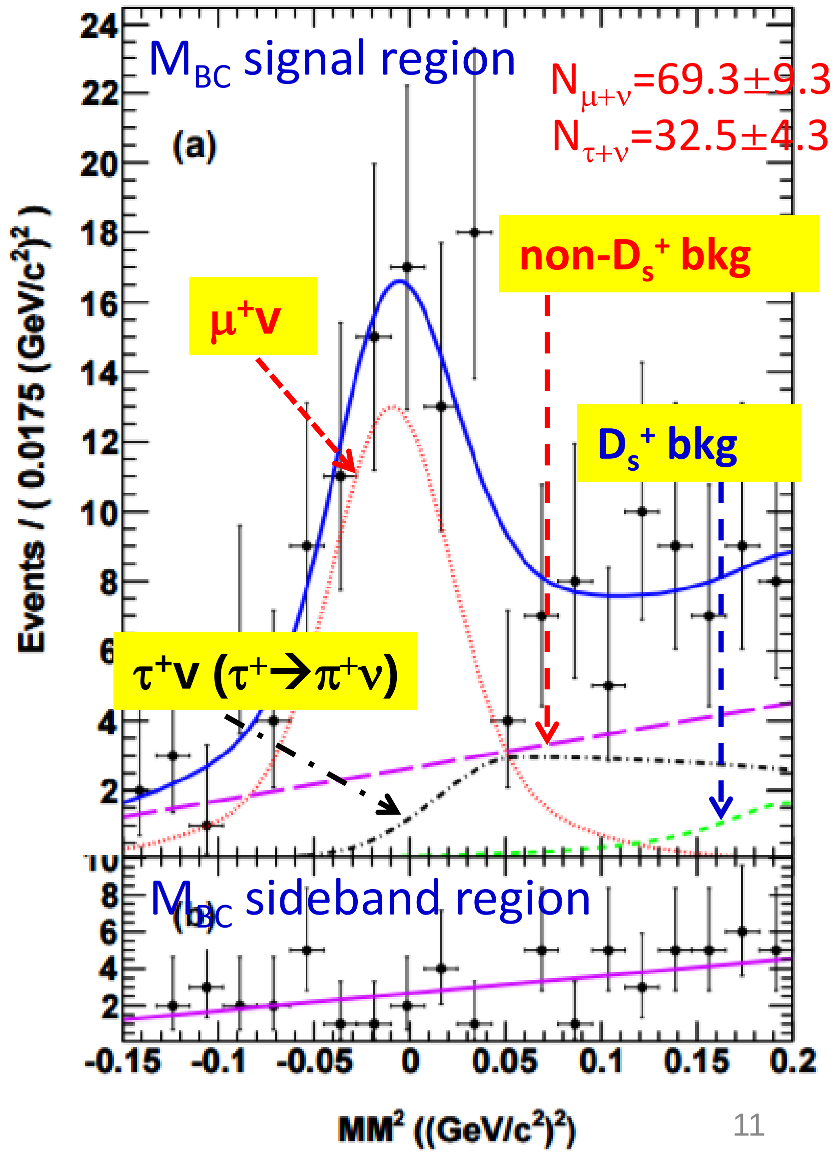
BESIII: 3.21±0.64
consistent with SM (0.9σ)

Measurement of $B[D_s^+ \rightarrow \mu^+ \nu]$ and $f_{D_s^+}$

9 ST modes are used @4.009 GeV

PRD94(2016)072004





$N_{Ds\text{-}Tag}=15127\pm321$

$B[D_s^+ \rightarrow \mu^+ \nu]=(0.495\pm0.067\pm0.026)\%$

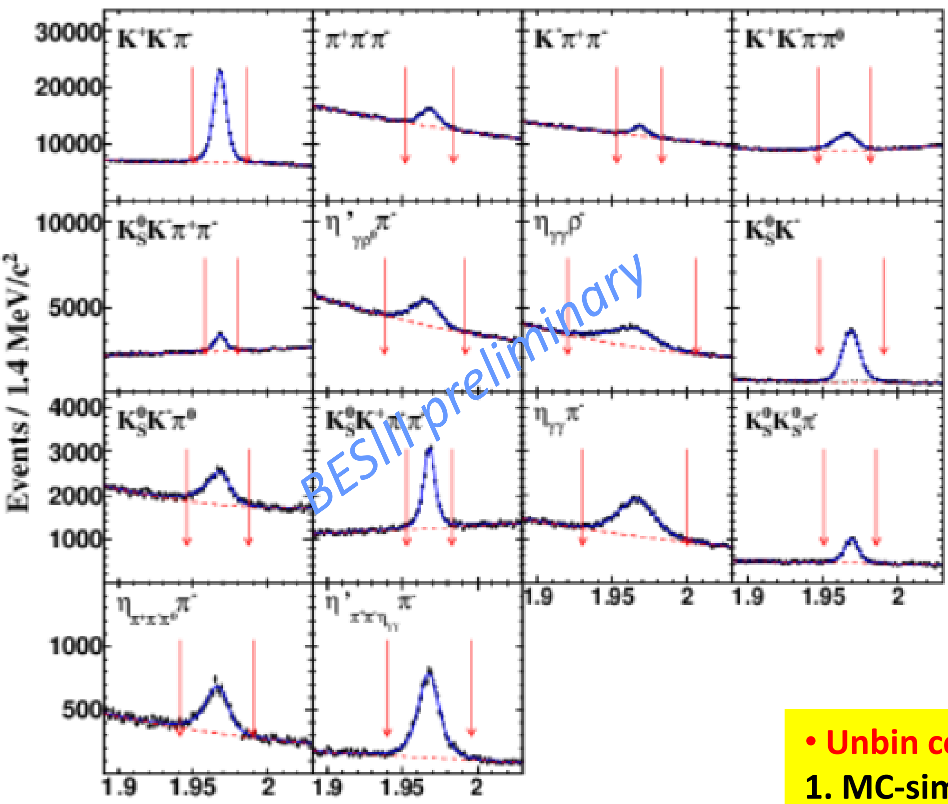
$B[D_s^+ \rightarrow \tau^+ \nu]=(4.83\pm0.65\pm0.26)\%$

$f_{Ds+}=(241.0\pm16.3\pm6.6)$ MeV

Measurement of $B[D_s^+ \to \mu^+ \nu]$

- ✓ In 2016, 3.19 fb^{-1} data were collected at E_{cm}=4.178 GeV, ~6M D_s mesons were collected. With such data sample, BFs for D_s Leptonic decays can be greatly improved and the decay constant f_{D_s} can be performed.
- ✓ 14 ST channels are used to reconstruct D_s^- mesons.

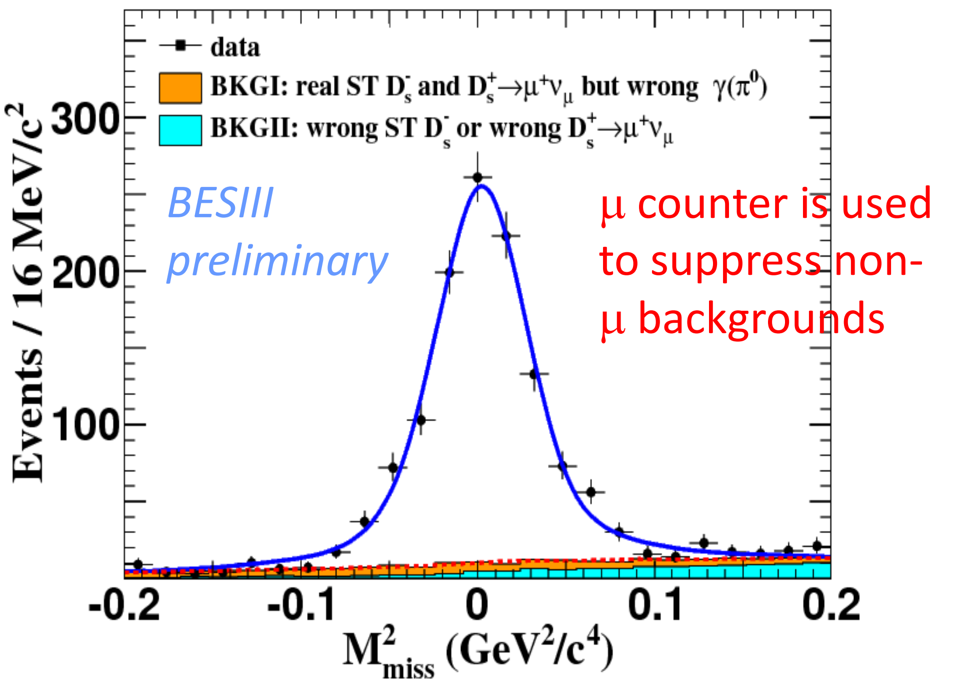
Accumulate ~0.389M ST D_s^- mesons



$M_{D_s^-}$ (GeV/c^2)

BESIII Preliminary results:

$B[D_s^+ \to \mu^+ \nu] = (5.28 \pm 0.15_{stat} \pm 0.14_{syst}) \times 10^{-3}$



- **Unbin constrained fit to M_{miss}^2 distribution:**

1. MC-simulated shapes are used to model the signal and backgrounds
2. Constraining signal/BKGI ratio via signal MC
3. Fixing BKGII via inclusive MC

Measurement of f_{Ds+} and $|V_{cs}|$

BESIII Preliminary results:

- With the measured $B[D_s^+ \rightarrow \mu^+\nu_\mu]$, we obtain:

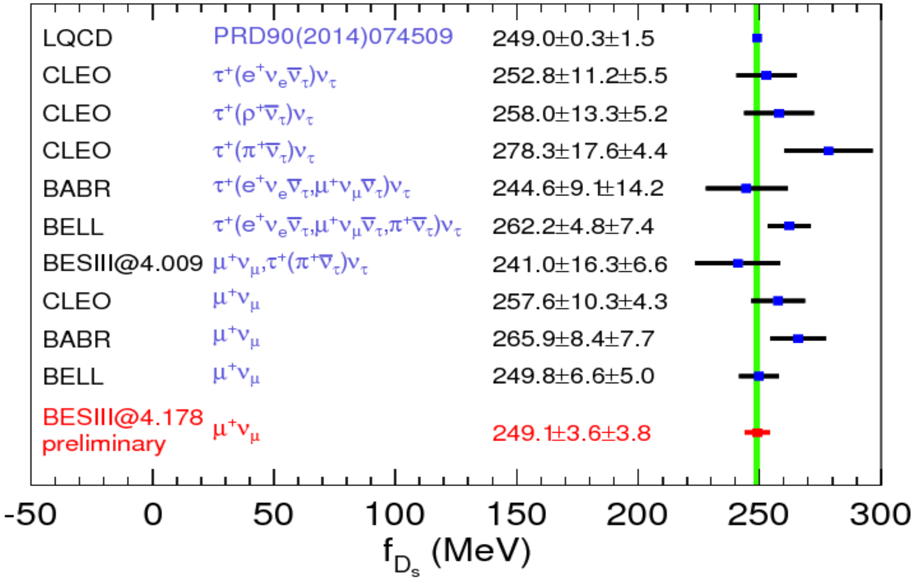
$$f_{Ds}|V_{cs}|=242.5\pm3.5_{stat}\pm3.3_{BF\ syst}\pm1.7_{\tau Ds[PDG16]}\ \text{MeV}$$

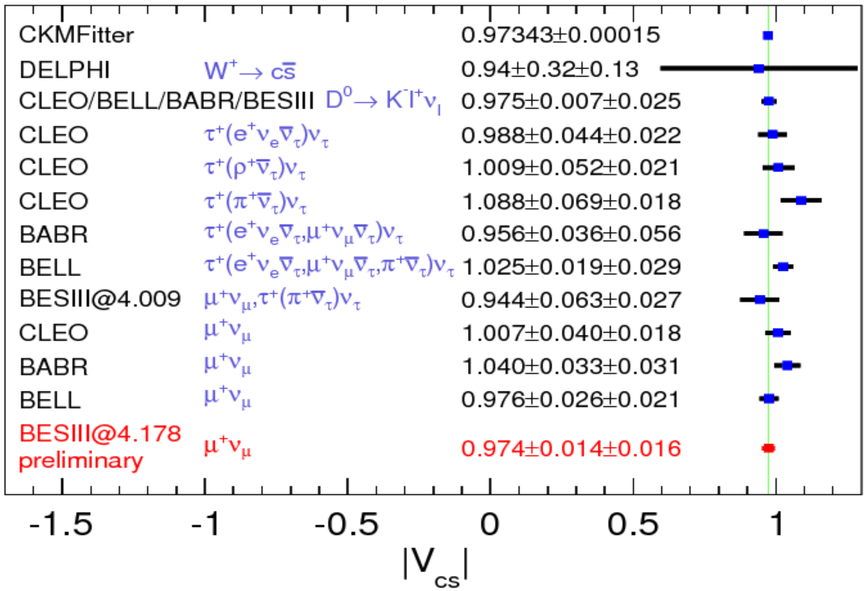
- If taking $|V_{cs}|^{CKMfitter}$ as input, we obtain:

$$f_{Ds}=249.1\pm3.6_{stat}\pm3.8_{syst}\ \text{MeV}$$

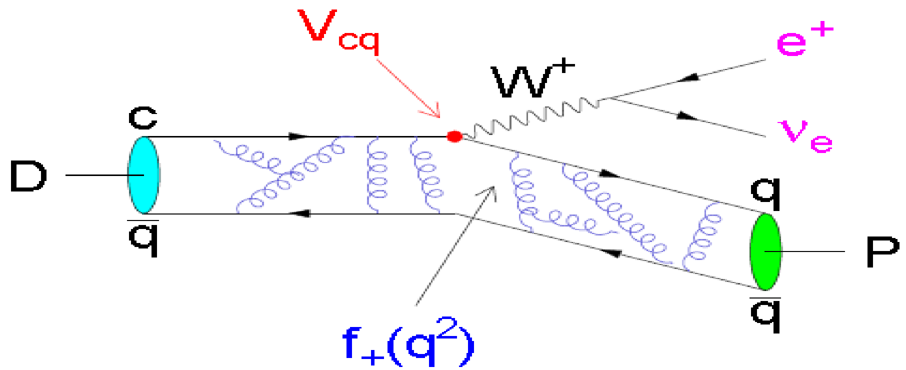
- If taking $f_{Ds}^{LQCD\ (PRD90(2014)074509)}$ as input, we obtain:

$$|V_{cs}|=0.974\pm0.014_{stat}\pm0.016_{syst}$$





Semileptonic Decay of $D^0 \to K(\pi)^- e^+ \nu$



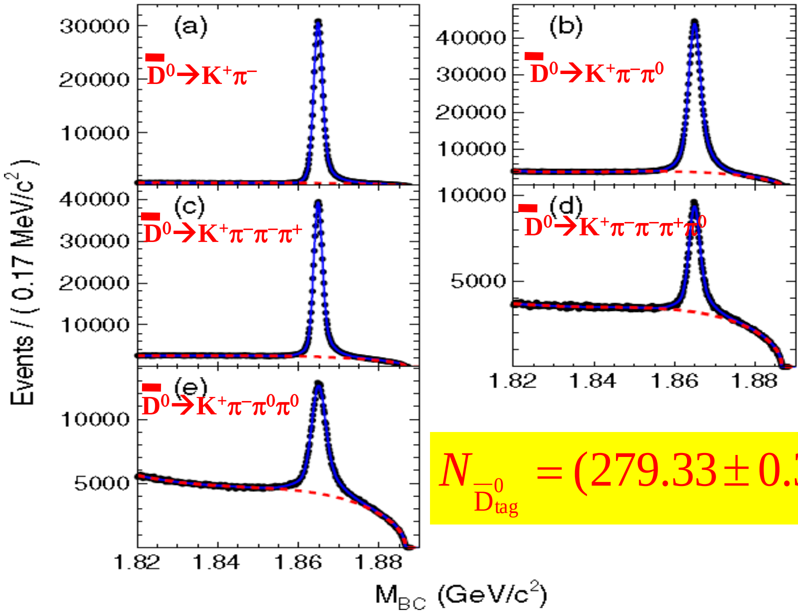
Differential rates: $$\frac{d\Gamma}{dq^2} = X \frac{G_F^2 |V_{cd(s)}|^2}{24\pi^3} p^3 |f_+(q^2)|^2$$

Bridge to precisely measure

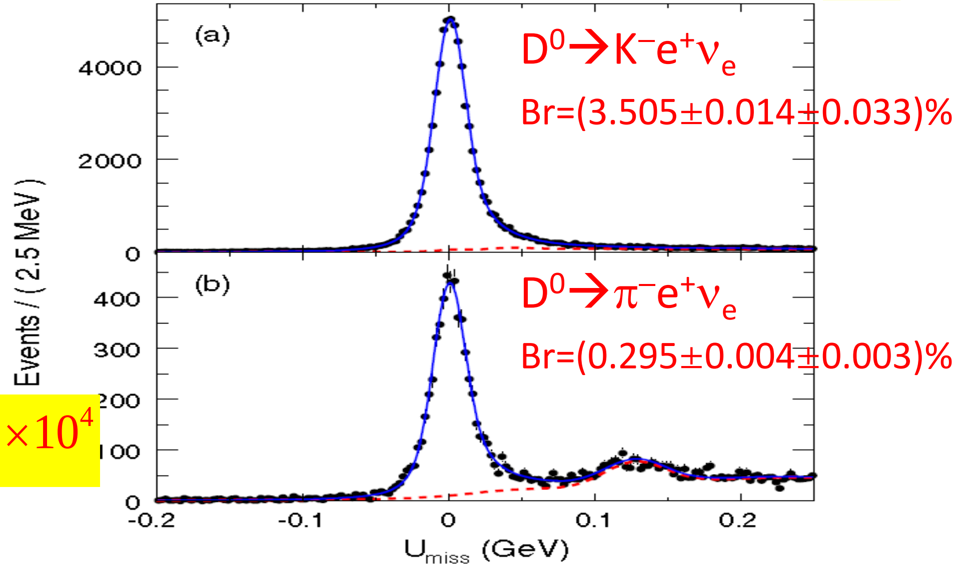
- ✓ Form factors $f_+^{D\to K(\pi)}(0)$ with input $|V_{cd(s)}|^{CKMfitter}$
  - Single pole
    $$f_+(q^2) = \frac{f_+(0)}{1 - \frac{q^2}{M^2_{\rm pole}}}$$
  - Modified pole
    $$f_+(q^2) = \frac{f_+(0)}{(1 - \frac{q^2}{M^2_{\rm pole}})(1 - \alpha \frac{q^2}{M^2_{\rm pole}})}$$
  - ISGW2
    $$f_+(q^2) = f_+(q^2_{\rm max}) \left(1 + \frac{r^2_{\rm ISGW2}}{12}(q^2_{\rm max} - q^2)\right)^{-2}$$
  - Series expansion
    $$f_+(t) = \frac{1}{P(t)\Phi(t,t_0)} a_0(t_0) \left(1 + \sum_{k=1}^{\infty} r_k(t_0)[z(t,t_0)]^k\right)$$
- ✓ CKM matrix element $|V_{cs(d)}|$ with input $f_+^{LQCD, D\to K(\pi)}(0)$

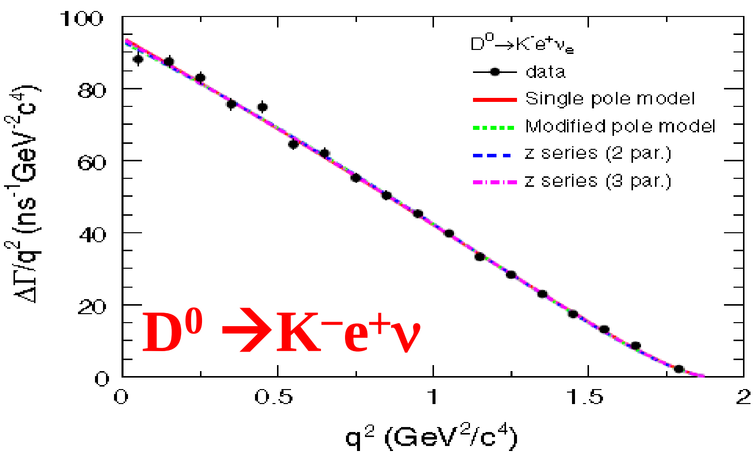
Semileptonic Decay of $D^0 \rightarrow K(\pi)^- e^+ \nu$

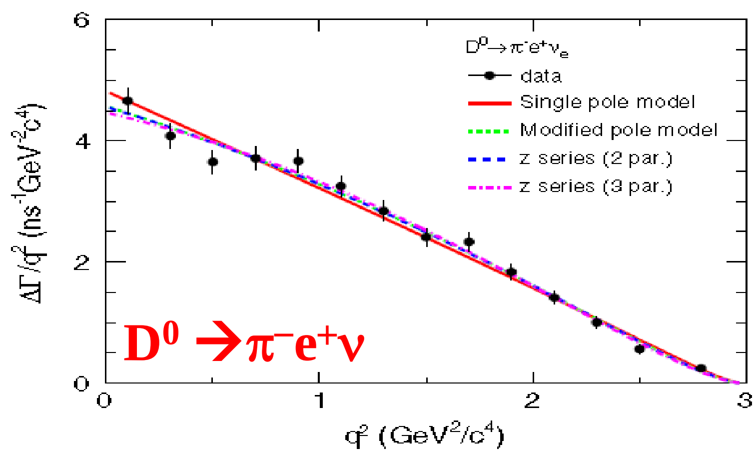
PRD92(2015)072012



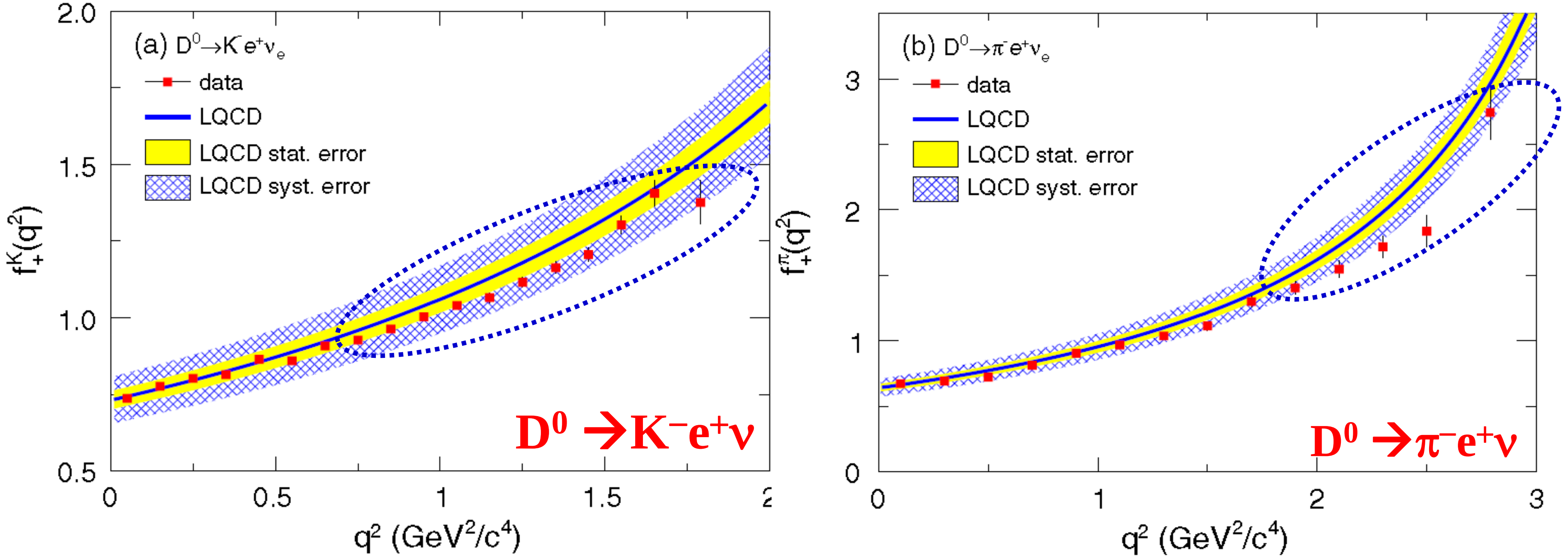
$$N_{\bar{D}^0_{tag}} = (279.33 \pm 0.37) \times 10^4$$







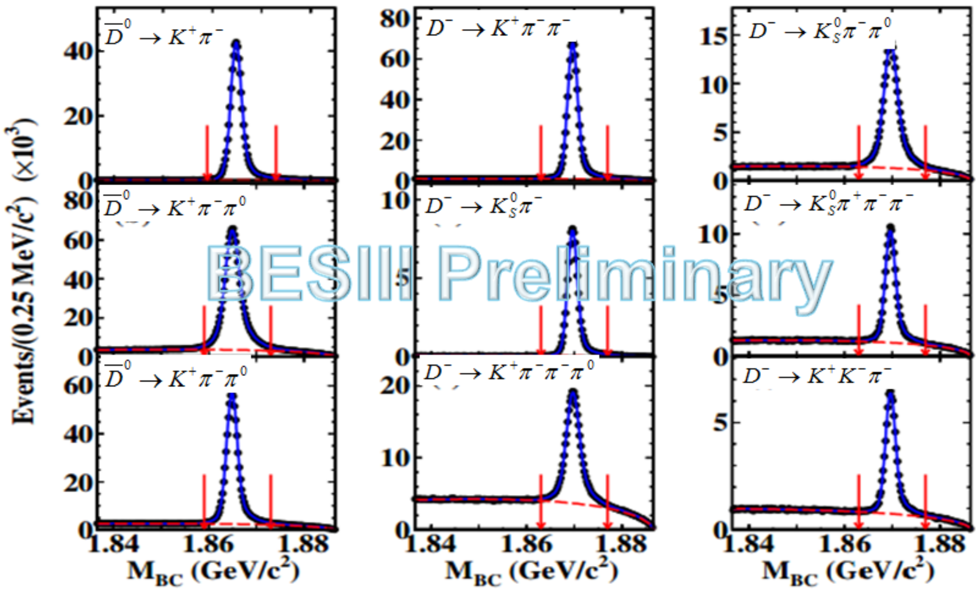
✓ Comparisons of the measured form factors with the LQCD calculations

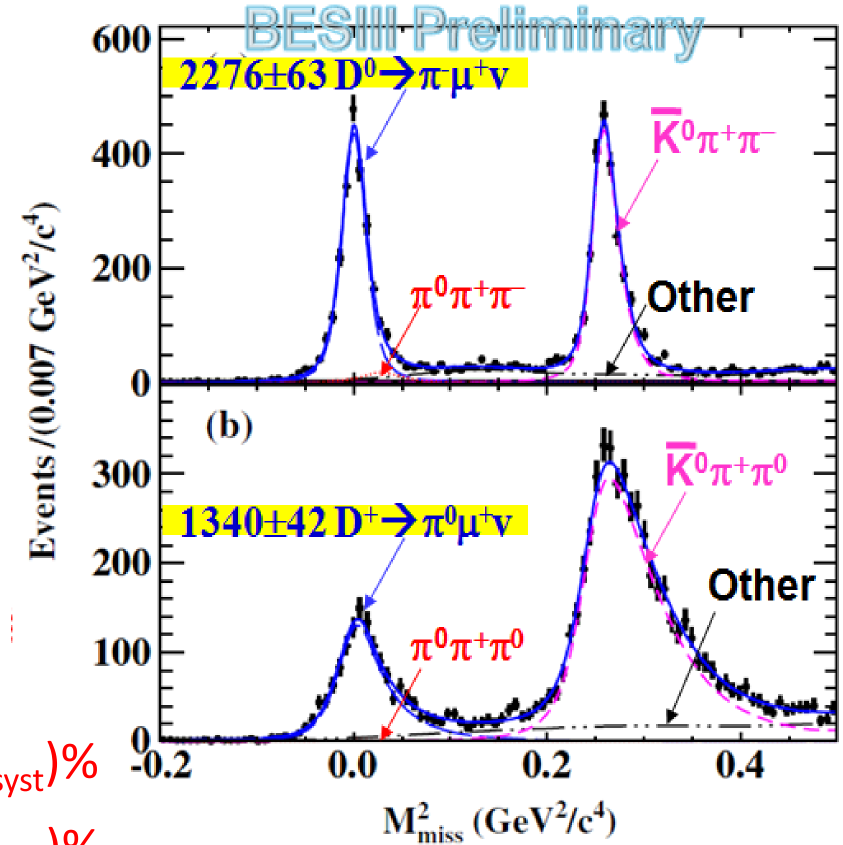


		$D^0 \to K^- e^+ \nu$		$D^0 \to \pi^- e^+ \nu$
Simple Pole	$f_K^+(0)\lvert V_{cs}\rvert$	**0.7209±0.0022±0.0033**	$f_\pi^+(0)\lvert V_{cd}\rvert$	**0.1475±0.0014±0.0005**
	M_{pole}	**1.9207±0.0103±0.0069**	M_{pole}	**1.9114±0.0118±0.0038**
Mod. Pole	$f_K^+(0)\lvert V_{cs}\rvert$	**0.7163±0.0024±0.0034**	$f_\pi^+(0)\lvert V_{cd}\rvert$	**0.1437±0.0017±0.0008**
	α	**0.3088±0.0195±0.0129**	α	**0.2794±0.0345±0.0113**
two-parameter series expansion	$f_K^+(0)\lvert V_{cs}\rvert$	**0.7172±0.0025±0.0035**	$f_\pi^+(0)\lvert V_{cd}\rvert$	**0.1435±0.0018±0.0009**
	r_1	**-2.2278±0.0864±0.0575**	r_1	**-2.0365±0.0807±0.0260**
three-parameter series expansion	$f_K^+(0)\lvert V_{cs}\rvert$	**0.7196±0.0035±0.0041**	$f_\pi^+(0)\lvert V_{cd}\rvert$	**0.1420±0.0024±0.0010**
	r_1	**-2.3331±0.1587±0.0804**	r_1	**-1.8434±0.2212±0.0690**
	r_2	**3.4223±3.9090±2.4092**	r_2	**-1.3871±1.4615±0.4677**

Measurements of $D^0 \to \pi^- \mu^+ \nu$ and $D^+ \to \pi^0 \mu^+ \nu$

- 3 ST $\bar{D}^0$ and 6 ST D^- channels are used.





✓ preliminary results:

$Br[D^0 \to \pi^- \mu^+ \nu_\mu] = (0.267 \pm 0.007_{stat} \pm 0.007_{syst})\%$

$Br[D^+ \to \pi^0 \mu^+ \nu_\mu] = (0.342 \pm 0.011_{stat} \pm 0.010_{syst})\%$

✓ Test of lepton universality:

$$R_{LU}^{0(+)} = B(D^{0(+)} \to \pi^{-(0)} \mu^+ \nu) / B(D^{0(+)} \to \pi^{-(0)} e^+ \nu) \sim 0.97$$

→ ZPC46(1990)93, PRD69 (2004)074025, PLB633(2006)61 and PDG16

$$R_{LU}^{0} = B(D^{0} \to \pi^{-} \mu^+ \nu) / B(D^{0} \to \pi^{-} e^+ \nu) = 0.918 \pm 0.036$$

$$R_{LU}^{+} = B(D^{+} \to \pi^{0} \mu^+ \nu) / B(D^{+} \to \pi^{0} e^+ \nu) = 0.921 \pm 0.045$$

agree with expectation based on lepton universality within 1.5 σ and 1.1 σ.

Study of $D^0 \to a_0(980)^- e^+ \nu$ and $D^+ \to a_0(980)^0 e^+ \nu$

- To uncover the nontrivial internal structure of light scalar mesons, traditional $q\bar{q}$ states, four-quark system.
- It provides a model-independent way to understand the classification of the light scalar mesons.

$$R \equiv \frac{B(D^+ \to f_0 l^+ \nu) + B(D^+ \to \sigma l^+ \nu)}{B(D^+ \to a_0 l^+ \nu)}$$

R=1(3) if those mesons are traditional $q\bar{q}$ (tetra quark) system.

[W. Wang and C-D. Lu, PRD 82 034016 (2010)]

- **BESIII provides the first search for these two SL decays.**
- **preliminary results:**

$$B(D^0 \to a_0(980)^- e^+ \nu_e) \times B(a_0(980)^- \to \eta\pi^-)$$
$$= (1.12 \pm 0.29(\text{stat}) \pm 0.10(\text{syst})) \times 10^{-4}$$

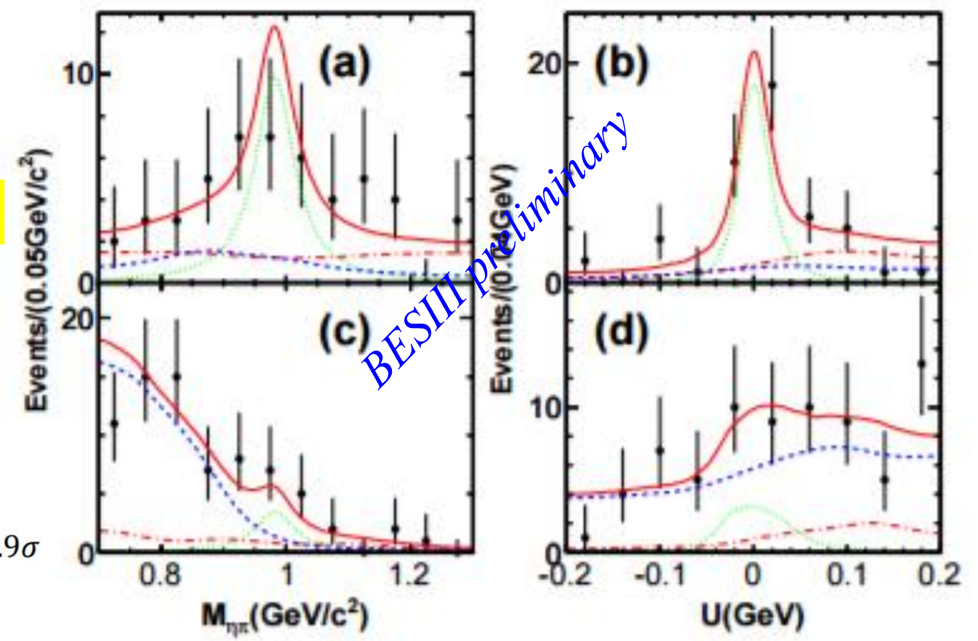
5.9σ

$$B(D^+ \to a_0(980)^0 e^+ \nu_e) \times B(a_0(980)^0 \to \eta\pi^0)$$
$$= (1.47 \pm 0.66(\text{stat}) \pm 0.14(\text{syst})) \times 10^{-4}$$

3.0σ

$$B(D^+ \to a_0(980)^0 e^+ \nu_e) \times B(a_0(980)^0 \to \eta\pi^0)$$
$$< 2.7 \times 10^{-4} \quad @\ 90\%\ \text{C.L.}$$

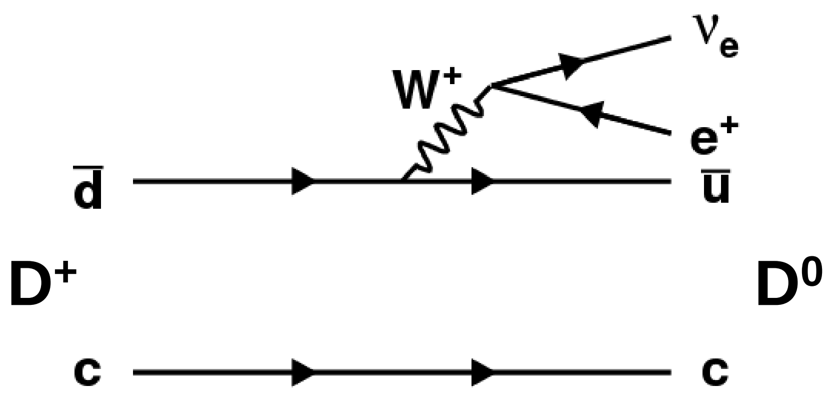
Projections of 2-dimensional unbinned fits



Search for the rare decay $D^+ \rightarrow D^0 e^+ \nu$

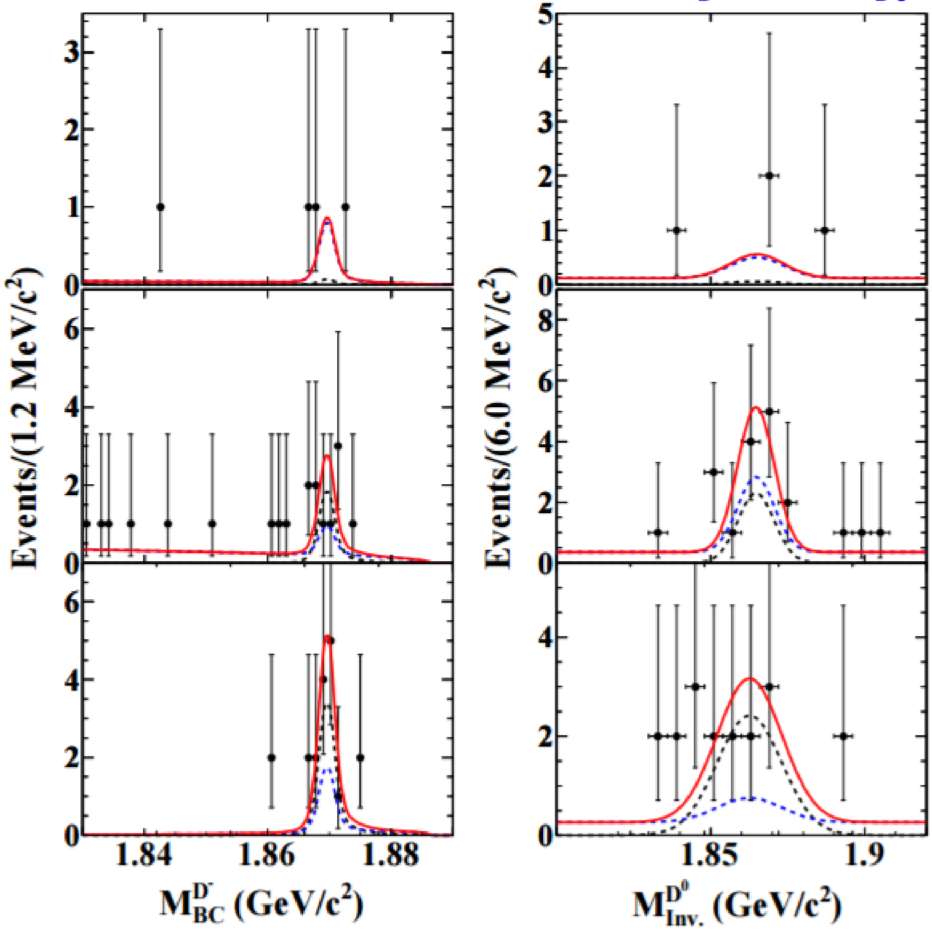
- 6 ST channels are used to reconstruct D^- mesons.

arXiv:1708.06856



In the limit of flavor SU(3) symmetry of the light quarks, the matrix elements of the weak current is constrained and the decay rate of $D^+ \rightarrow D^0 e^+ \nu_e$ is predicted to be about 2.78×10^{-13} [EPJC59,841(2009)]

Projections of the 2D fit to M_{D-} and M_{D0}

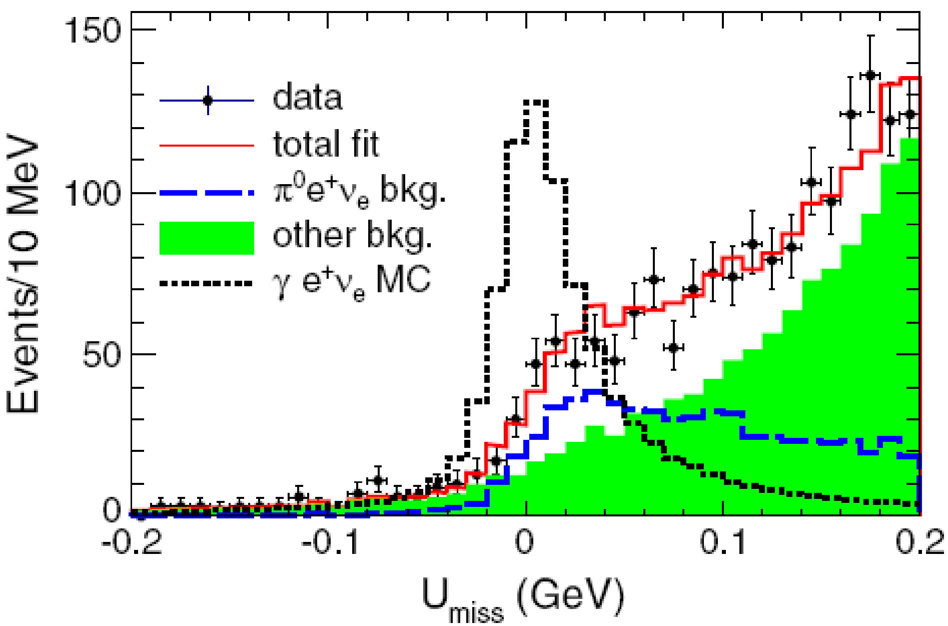


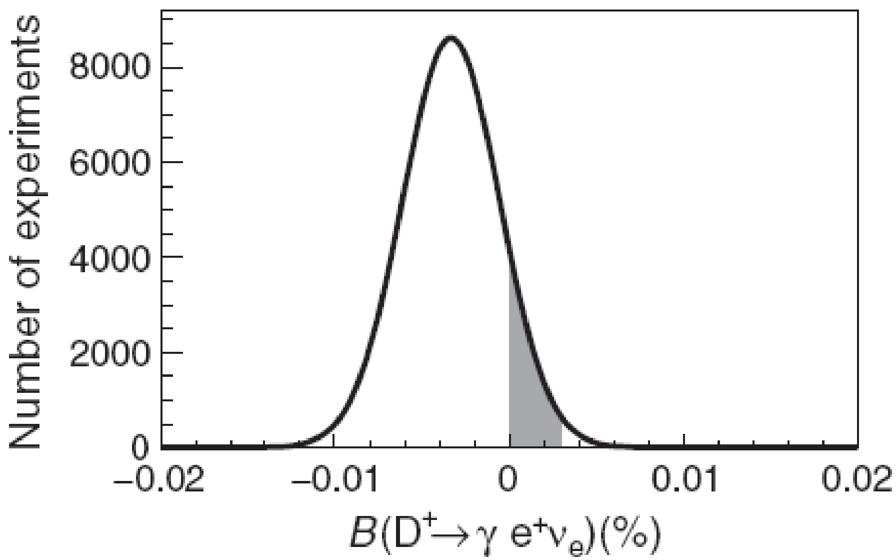
$B[D^+ \rightarrow D^0 e^+ \nu_e] < 1.0\times10^{-4}$ at 90% C.L.

Study of $D^+ \rightarrow \gamma e^+ \nu$

PRD95(2017) 071102

- 6 ST channels are used to reconstruct D^- mesons.
- $B[D^+ \rightarrow \gamma e^+ \nu]$ is not subject to the helicity suppression rule due to the presence of a radiative photon. Predications of $B[D^+ \rightarrow \gamma e^+ \nu]$ ranges $10^{-4} \sim 10^{-6}$.
- BESIII performed the first search for $D^+ \rightarrow \gamma e^+ \nu_e$.

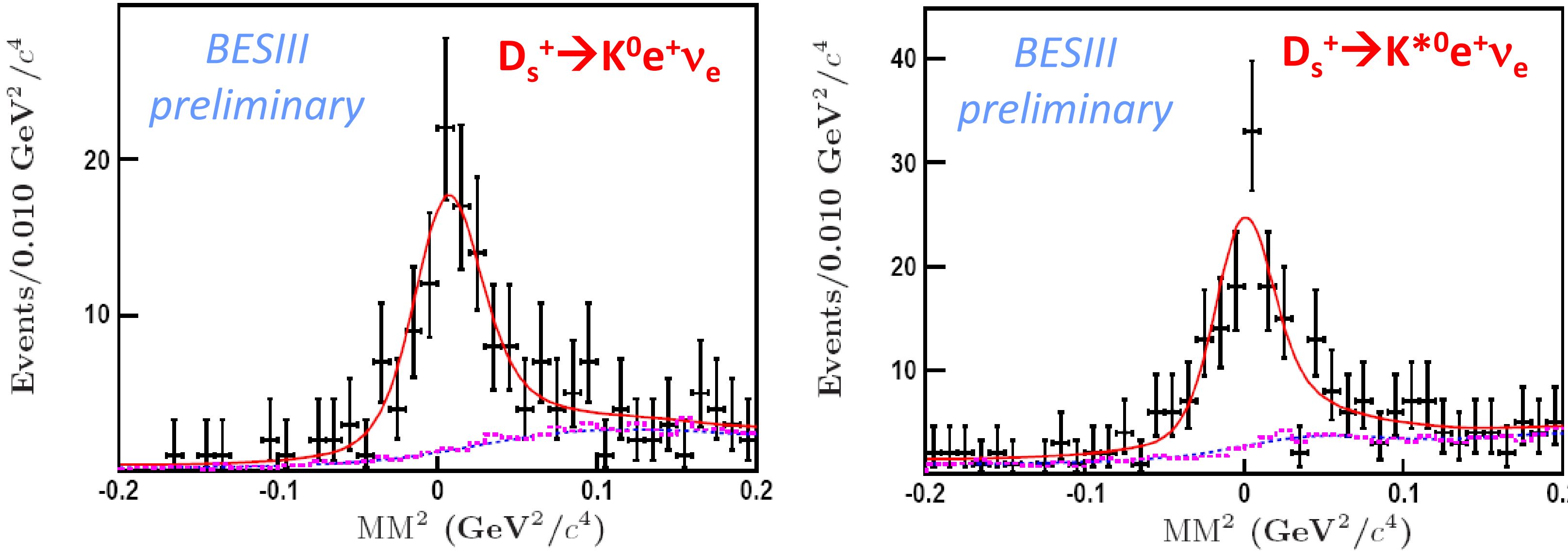




$B[D^+ \rightarrow \gamma e^+ \nu_e] < 3.0 \times 10^{-5}$ at 90% C.L.

Study of SL decay of $D_s^+ \rightarrow K^{(*)0} e^+ \nu$

✓ 13 ST channels are used to reconstruct D_s^- mesons. **3.19/fb data @ 4.178 GeV**



The dots with error bars are from data, the red show total fits, while the blue and pink dashed histograms show the fitted total backgrounds and the MC-simulated backgrounds.

- The preliminary results for branching fractions:

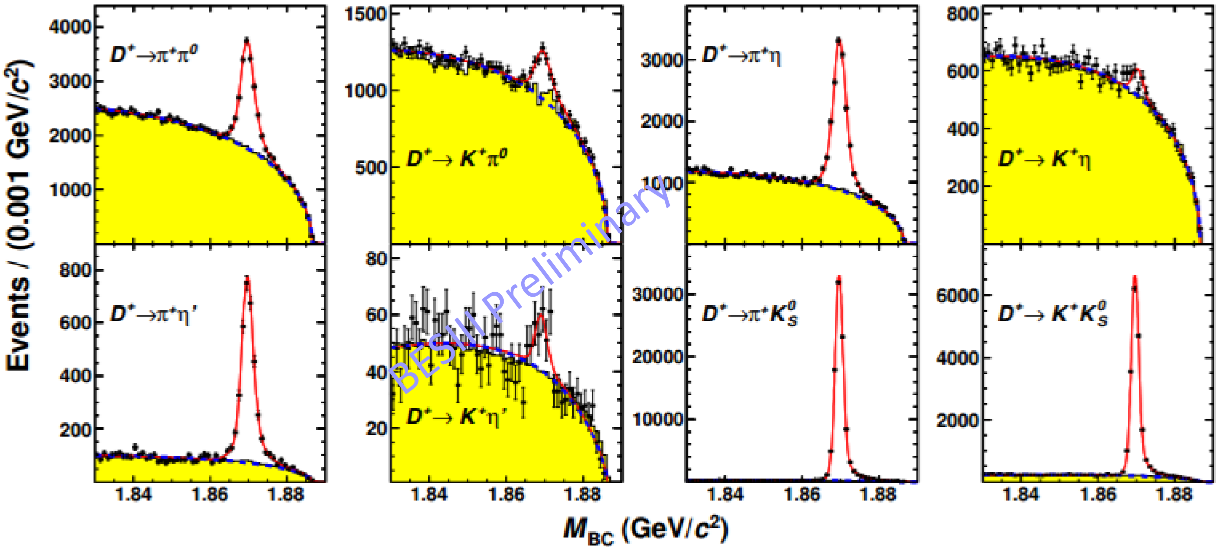
$Br[D_s^+ \rightarrow K^0 e^+ \nu_e] = (3.25 \pm 0.38_{stat} \pm 0.14_{syst}) \times 10^{-3}$ $(3.9 \pm 0.9) \times 10^{-3}$ [PDG2017]

$Br[D_s^+ \rightarrow K^{*0} e^+ \nu_e] = (2.38 \pm 0.26_{stat} \pm 0.12_{syst}) \times 10^{-3}$ $(1.8 \pm 0.4) \times 10^{-3}$ [PDG2017]

The BFs measured at BESIII are in good consistent with but more precise than the current results in PDG.

Study of the form factors in SL decays could be found in the poster of "Study of $D_s \rightarrow K^{(*)0} e^+ \nu_e$ at BESIII" provided by Yu. Zhang and also in backup slides.

BFs for D→PP



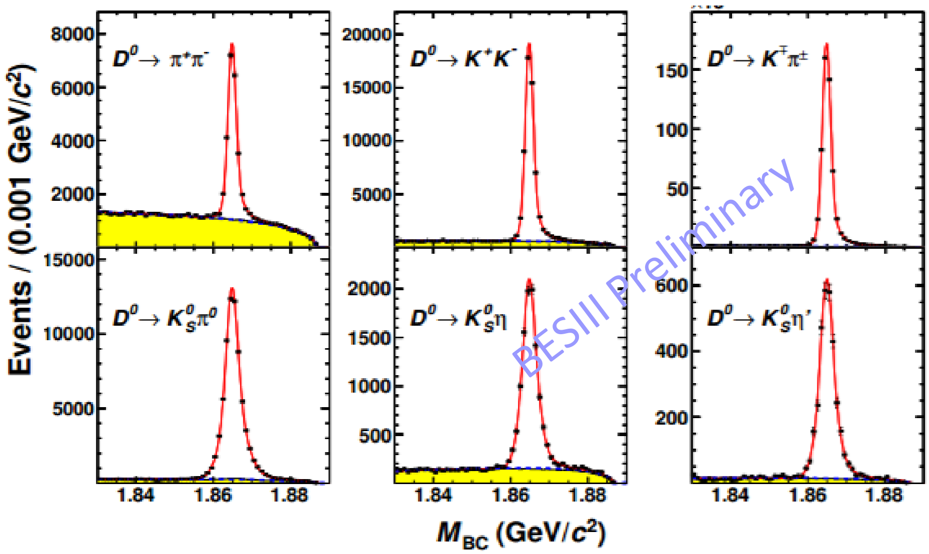
- ST method

$$M_{BC} \equiv \sqrt{E^2_{\rm beam} - (\sum_i \mathbf{p}_i)^2}$$

$$\mathcal{B} = \frac{N^{\rm signal}_{\rm net}}{2\cdot N_{D^0\bar{D}^0(D^+D^-)}\cdot\varepsilon}$$

$$N_{D^0\bar{D}^0} = (10,621 \pm 29_{\rm (stat)}) \times 10^3$$

$$N_{D^+D^-} = (8,296 \pm 31_{\rm (stat)}) \times 10^3$$

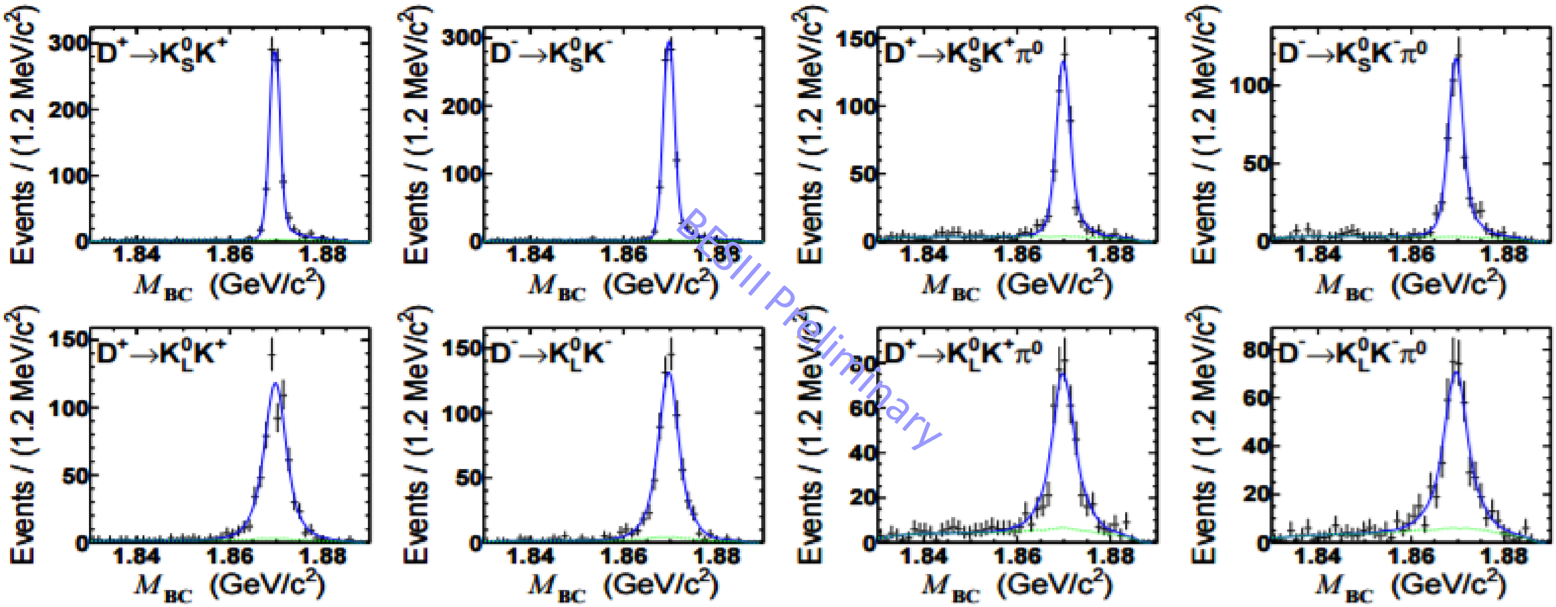


Preliminary results for BF(D→PP).

Mode	$\mathcal{B}_{\rm This\ work}$ ($\times10^{-3}$)	$\mathcal{B}_{\rm PDG}$ ($\times10^{-3}$)
$D^+\to\pi^+\pi^0$	$1.259\pm0.033\pm0.025$	1.24 ± 0.06
$D^+\to K^+\pi^0$	$0.231\pm0.021\pm0.006$	0.189 ± 0.025
$D^+\to\pi^+\eta$	$3.790\pm0.070\pm0.076$	3.66 ± 0.22
$D^+\to K^+\eta$	$0.151\pm0.025\pm0.014$	0.112 ± 0.018
$D^+\to\pi^+\eta'$	$5.12\pm0.14\pm0.21$	4.84 ± 0.31
$D^+\to K^+\eta'$	$0.164\pm0.051\pm0.025$	0.183 ± 0.023
$D^+\to K^0_S\pi^+$	$15.91\pm0.06\pm0.33$	15.3 ± 0.6
$D^+\to K^0_S K^+$	$3.183\pm0.029\pm0.067$	2.95 ± 0.15
$D^0\to\pi^+\pi^-$	$1.508\pm0.018\pm0.027$	1.421 ± 0.025
$D^0\to K^+K^-$	$4.233\pm0.021\pm0.076$	4.01 ± 0.07
$D^0\to K^\mp\pi^\pm$	$38.98\pm0.06\pm0.62$	39.4 ± 0.4
$D^0\to K^0_S\pi^0$	$12.39\pm0.06\pm0.30$	12.0 ± 0.4
$D^0\to K^0_S\eta$	$5.13\pm0.07\pm0.12$	4.85 ± 0.30
$D^0\to K^0_S\eta'$	$9.49\pm0.20\pm0.37$	9.5 ± 0.5

BFs and CP Asymmetries for $D^+ \to K_S/K_L K^+(\pi^0)$

- DT method and six D^- ST channels are used.

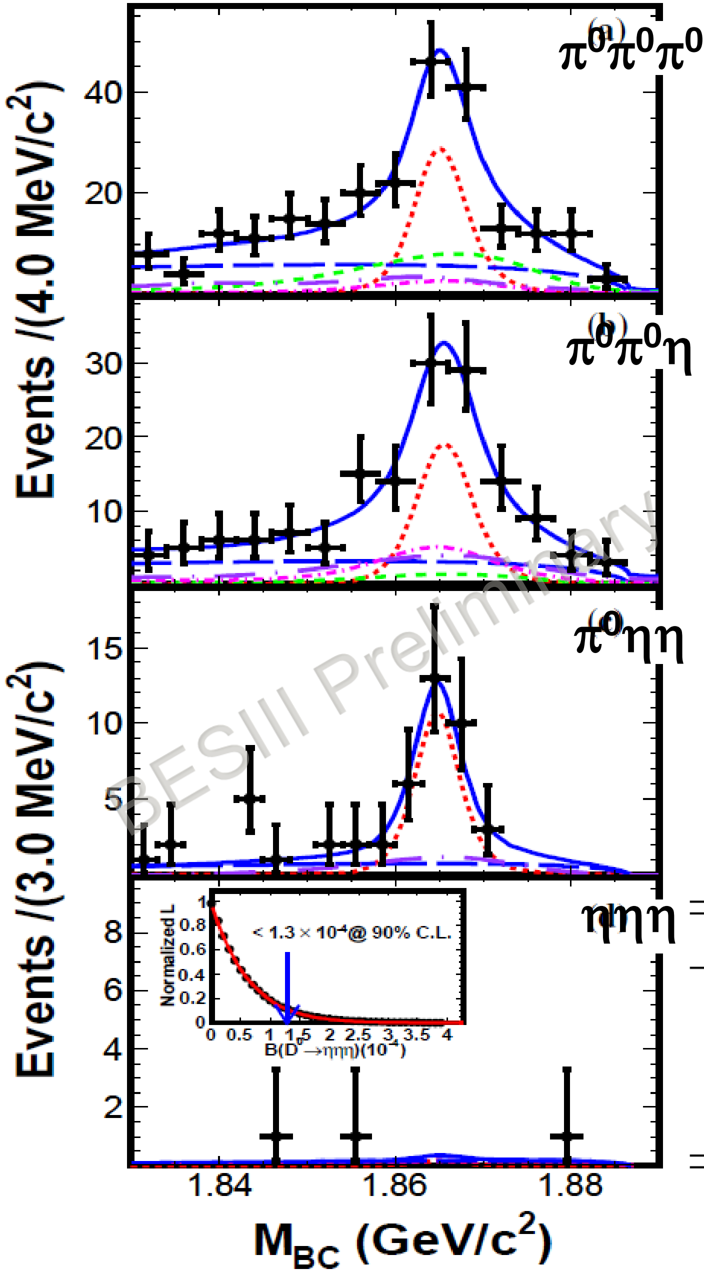


- Summary of the results (Preliminary)

Signal mode	$\mathcal{B}(D^+)$ $(\times 10^{-3})$	$\mathcal{B}(D^-)$ $(\times 10^{-3})$	$\overline{\mathcal{B}}$ $(\times 10^{-3})$	$\mathcal{B}$ (PDG) $(\times 10^{-3})$	$\mathcal{A}_{CP}$ (%)
$K_S^0 K^\pm$	$3.01 \pm 0.12 \pm 0.08$	$3.10 \pm 0.12 \pm 0.08$	$3.06 \pm 0.09 \pm 0.08$	2.95 ± 0.15	$-1.5 \pm 2.8 \pm 1.6$
$K_S^0 K^\pm \pi^0$	$5.23 \pm 0.28 \pm 0.24$	$5.09 \pm 0.29 \pm 0.22$	$5.16 \pm 0.21 \pm 0.23$	-	$1.4 \pm 4.0 \pm 2.4$
$K_L^0 K^\pm$	$3.13 \pm 0.14 \pm 0.10$	$3.32 \pm 0.15 \pm 0.11$	$3.23 \pm 0.11 \pm 0.11$	-	$-3.0 \pm 3.2 \pm 1.2$
$K_L^0 K^\pm \pi^0$	$5.17 \pm 0.30 \pm 0.21$	$5.26 \pm 0.30 \pm 0.21$	$5.22 \pm 0.22 \pm 0.21$	-	$-0.9 \pm 4.1 \pm 1.6$

- ✓ The branching fraction of $D^+ \to K_s K^+$ agrees with the CLEO result.
- ✓ The branching fractions of $D^+ \to K_s K^+ \pi^0$, $D^+ \to K_L K^+$ and $D^+ \to K_L K^+ \pi^0$ are measured for the first time.
- ✓ No evidence for CP asymmetry in the four SCS decays.

SCS Decays of $D^0 \rightarrow \pi^0\pi^0\pi^0$, $\pi^0\pi^0\eta$, $\pi^0\eta\eta$ and $\eta\eta\eta$



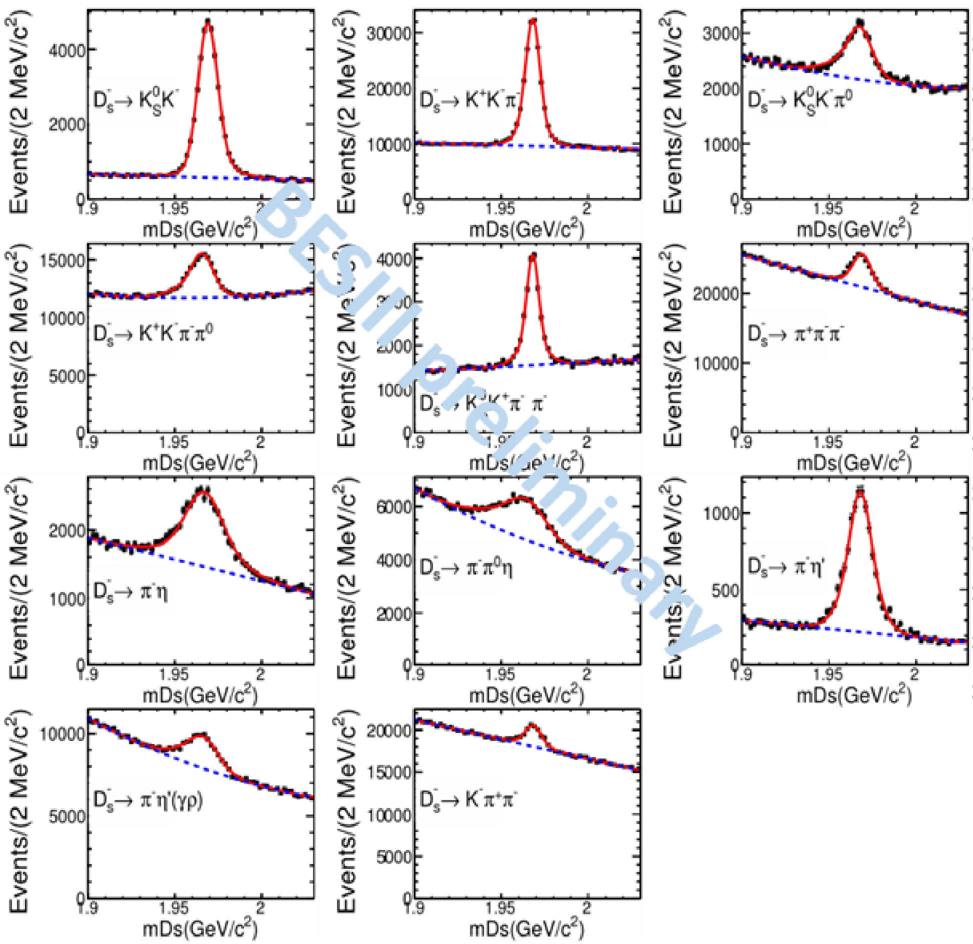
arXiv:1001.3317

- The first branching fraction result of Singly Cabibbo Suppressed decays $D^0 \rightarrow \pi^0\pi^0\pi^0$, $\pi^0\pi^0\eta$, $\pi^0\eta\eta$ and $\eta\eta\eta$.
- The most recent experimental search for $D^0 \rightarrow \pi^0\pi^0\pi^0$ is performed by CLEO Collaboration in 2006, with the 281 pb^{-1} data sample collected on $\psi(3770)$. The upper limit for $D^0 \rightarrow \pi^0\pi^0\pi^0$ is measured to be 3.5×10^{-4} at 90% confidence level;
- Three ST channels $\bar{D}^0 \rightarrow K^+\pi^-$, $K^+\pi^-\pi^0$ and $K^+\pi^-\pi^-\pi^+$ are used to reconstruct $\bar{D}^0$ mesons.

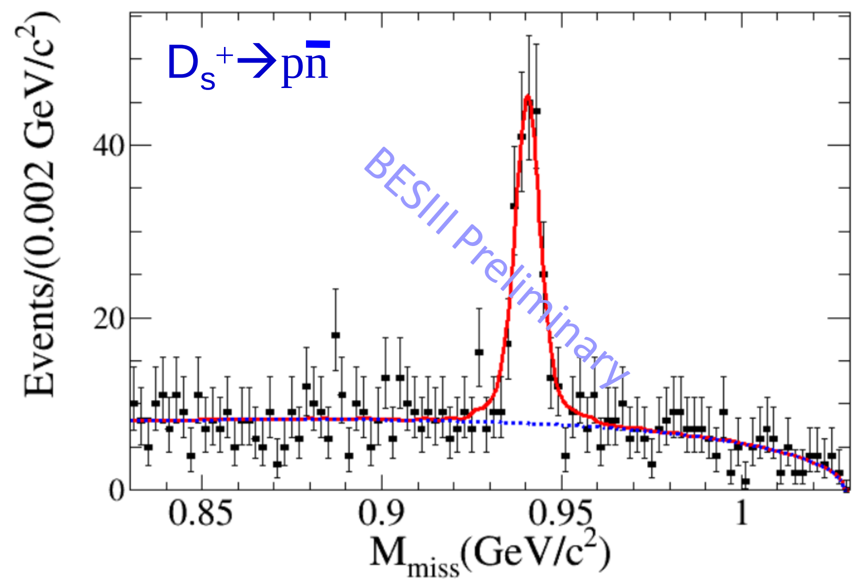
Mode	ΔE (GeV)	N_{DT}^{sig}	Significance	$\mathcal{B}$ ($\times 10^{-4}$)	$\mathcal{B}_{PDG}$ ($\times 10^{-4}$)
$\pi^0\pi^0\pi^0$	$(-0.115, 0.059)$	60 ± 13	4.8σ	$2.0 \pm 0.4 \pm 0.3$	< 3.5
$\pi^0\pi^0\eta$	$(-0.088, 0.053)$	42 ± 12	3.8σ	$3.8 \pm 1.1 \pm 0.7$	–
$\pi^0\eta\eta$	$(-0.061, 0.045)$	27 ± 6	5.5σ	$7.3 \pm 1.6 \pm 1.5$	–
$\eta\eta\eta$	$(-0.030, 0.028)$	–	–	< 1.3	–

Measurement of BF for $D_s^+ \to p\bar{n}$

✓ 11 ST channels are used to reconstruct D_s^- mesons.



- Allowed baryonic D decay mode
  short-distance expected: Br~10^{-6}
  long-distance enhance to: Br~10^{-3}
- DT method



Preliminary result: $Br[D_s^+ \to p\bar{n}] = (1.22 \pm 0.10_{stat} \pm 0.05_{syst}) \times 10^{-3}$

The results confirms CLEO-c's measurement $(1.30 \pm 0.36^{+0.12}_{-0.16}) \times 10^{-3}$ with greatly improved accuracy!

Summary

- **BESIII provides important results on charm decays**
  - **D/D_s leptonic and semi-leptonic decys**
  - **D/D_s hadronic decys**

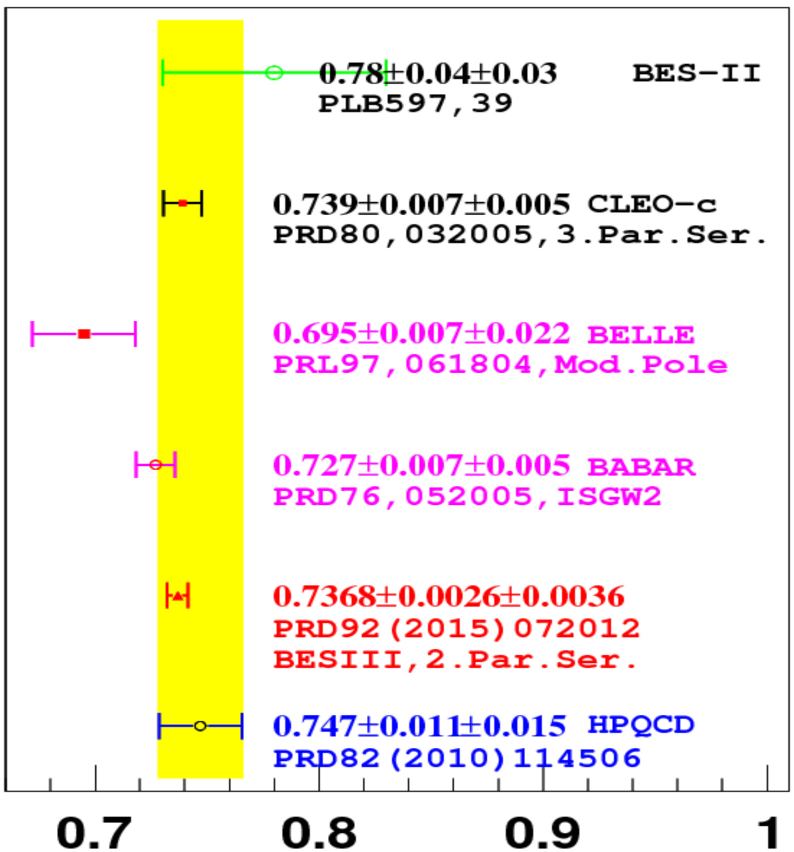
important to test LQCD calculations, CKM matrix UT, search for NP beyond SM

- **More fruitful results will come out!**

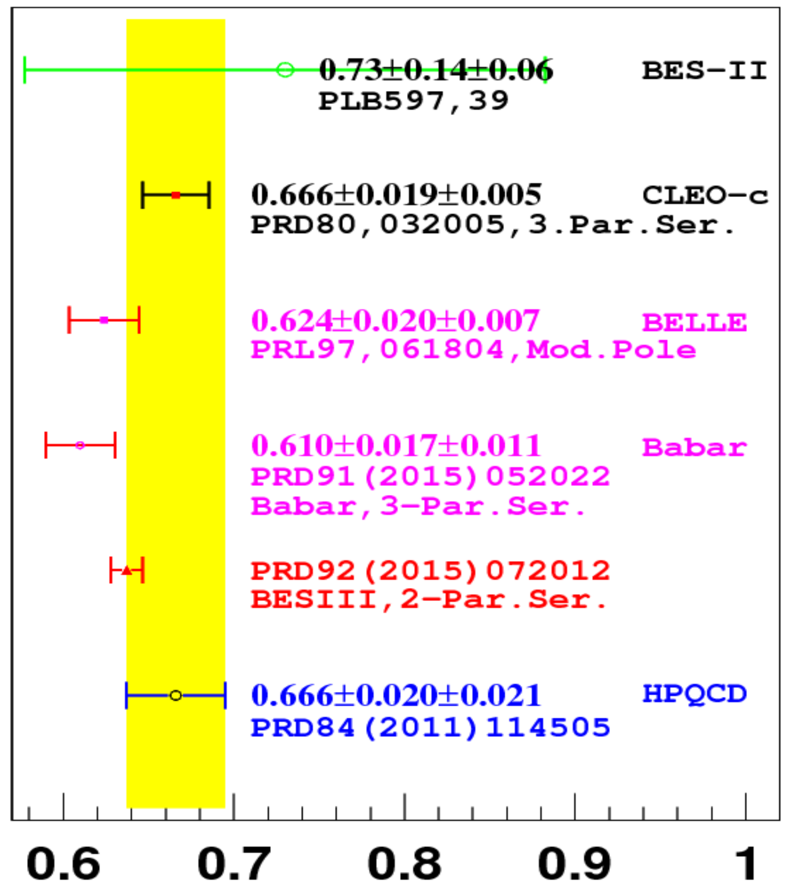
Thanks!

Measurement of $f_+^{K(\pi)}(0)$

$f^{D\to K(\pi)}_+(0)|V_{cs(d)}|$ → Input $|V_{cs(d)}|$ of CKM-Fitter → $f^{D\to K(\pi)}_+(0)$



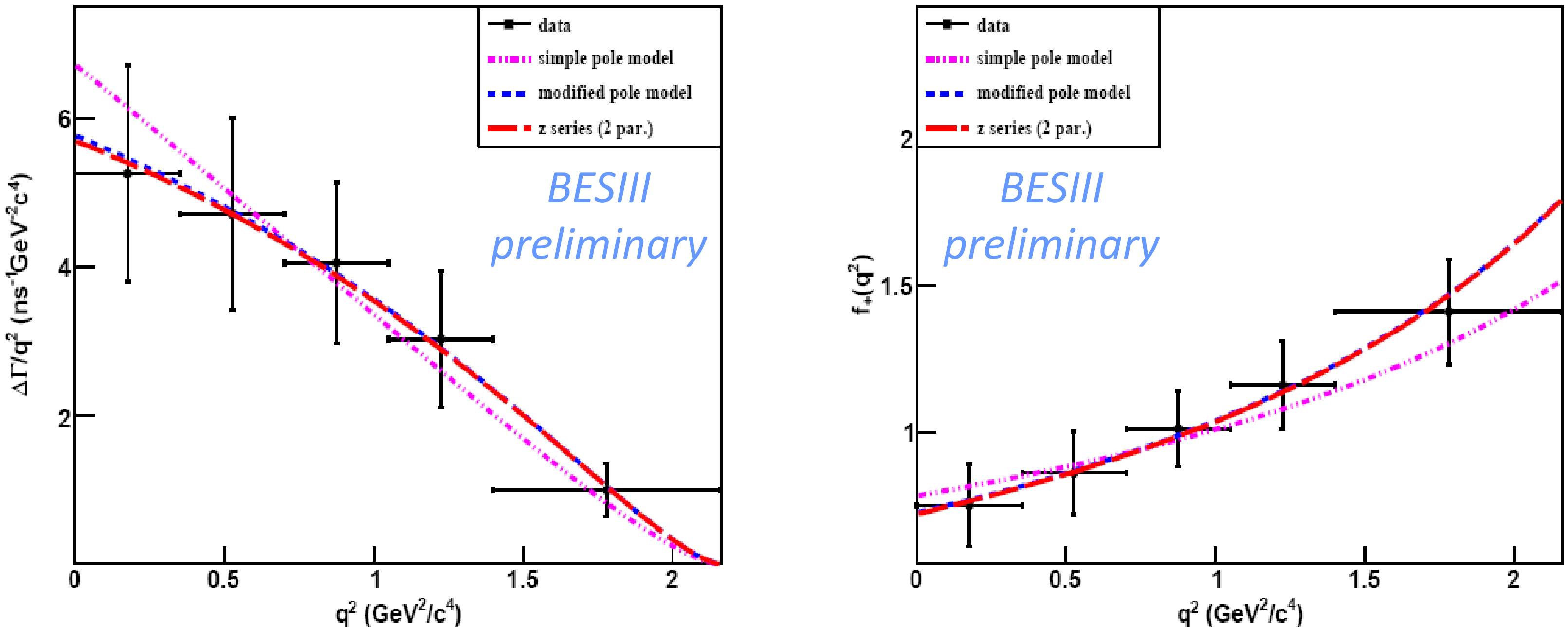
$f_+^K(0)$



$f_+^{\pi}(0)$

Form factors in $D_s^+ \rightarrow K^0 e^+ \nu$

$$\chi^2 = \sum_{ij} (\Delta\Gamma_i^{\text{measured}} - \Delta\Gamma_i^{\text{expected}}) C_{ij}^{-1} (\Delta\Gamma_j^{\text{measured}} - \Delta\Gamma_j^{\text{expected}})$$



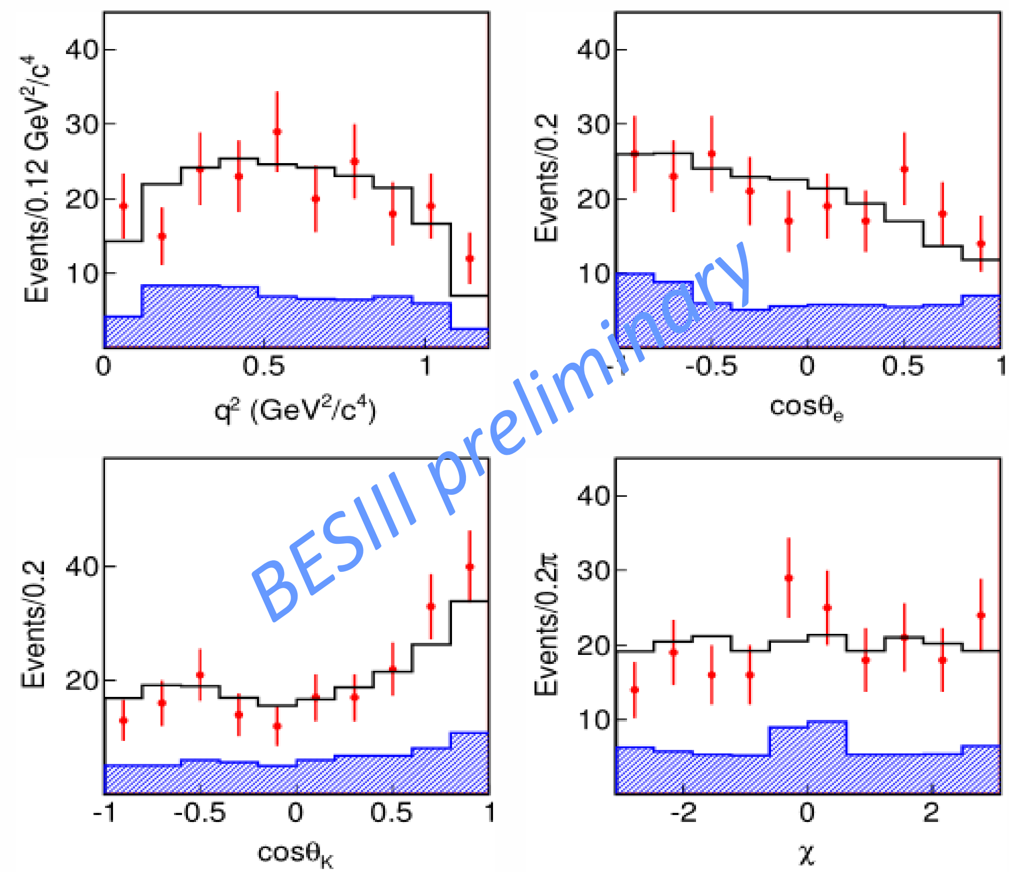
- The preliminary results for form factors:

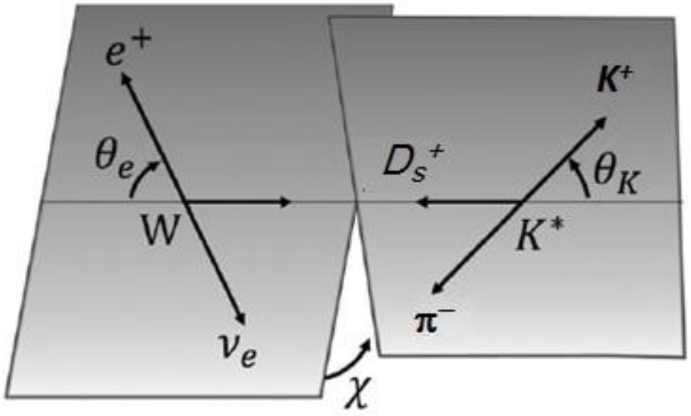
Model	Parameter	Value	$f_+(0)$
Simple pole	$f_+(0)\|V_{cd}\|$	$0.175 \pm 0.010 \pm 0.001$	$0.778 \pm 0.044 \pm 0.004$
Modified pole model	$f_+(0)\|V_{cd}\|$	$0.163 \pm 0.017 \pm 0.003$	$0.725 \pm 0.076 \pm 0.013$
	α	$0.45 \pm 0.44 \pm 0.02$	
Series two parameters	$f_+(0)\|V_{cd}\|$	$0.162 \pm 0.019 \pm 0.003$	$0.720 \pm 0.084 \pm 0.013$
	r_1	$-2.94 \pm 2.32 \pm 0.14$	

Inserting $|V_{cd}| = 0.22492 \pm 0.00050$ obtained by CKMfitter, the $f_+(0)$ can be obtained.

Form factors in $D_s^+ \to K^* e^+ \nu$

- Four dimensional un-binned likelihood fit is performed.





$$\ln \mathcal{L} = \ln \mathcal{L}_{\rm data} - f \times \ln \mathcal{L}_{\rm bkg}$$

- The preliminary results for form factors:

r_V=1.67±0.34 ±0.16 and r_2=0.77 ± 0.28±0.07

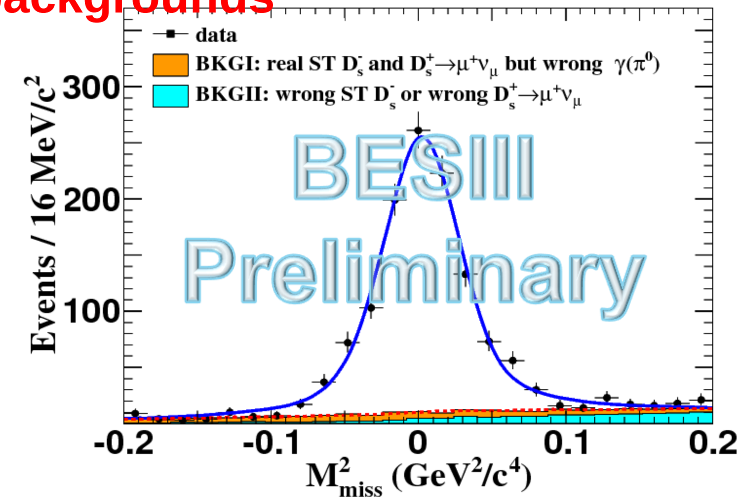
The first errors are statistical and the second are systematic.

Comparison with CLEO result

- In the case of not finding $\gamma(\pi^0)$ from D_s^{*-}, after considering effects of (possible) slightly higher cross section of $D_s^{*+}D_s^-$ and more tag modes, the ST D_s^- yield at BESIII is about 3.6% higher than CLEO, for a given luminosity data

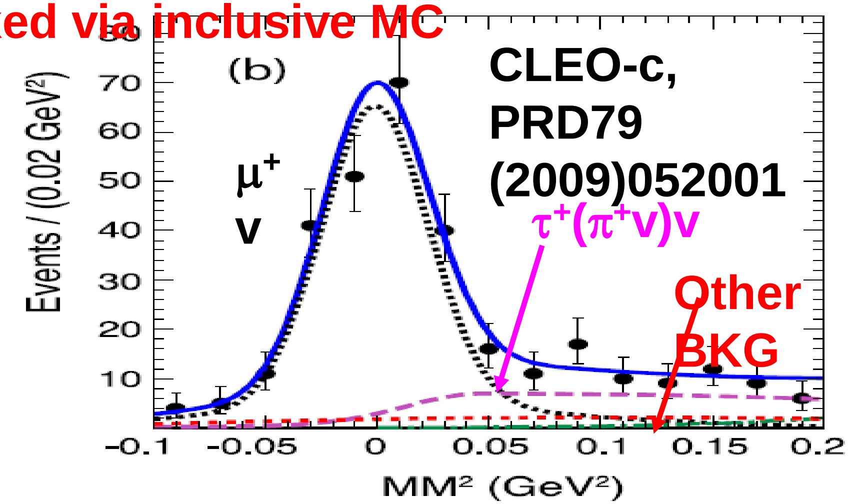
	Luminosity (pb^{-1})	Tag modes	ST yield	$\mu^+\nu$ signal yield	Non-$\mu^+\nu$ background
BESIII	3190	14	388660	1131	112
CLEOc	600	9	70514	235	>125 (float in fit)
BESIII/CLEOc	5.32		5.51	4.81	
BESIII/CLEOc–1			3.6%	-9.6%	

- BESIII μ counter loses efficiency but helps to suppress non-$\mu^+\nu$ backgrounds



$B_{BESIII}[D_s^+\to\mu^+\nu]=(5.28\pm0.15_{stat}\pm0.14_{syst})\times10^{-3}$

- At BESIII, signal/BKGI ratio is constrained via signal MC and BKGII is fixed via inclusive MC



Unconstrained fit

$B_{CLEO}[D_s^+\to\mu^+\nu]=(5.65\pm0.45_{stat}\pm0.17_{syst})\times10^{-3}$