D_s physics at BESIII

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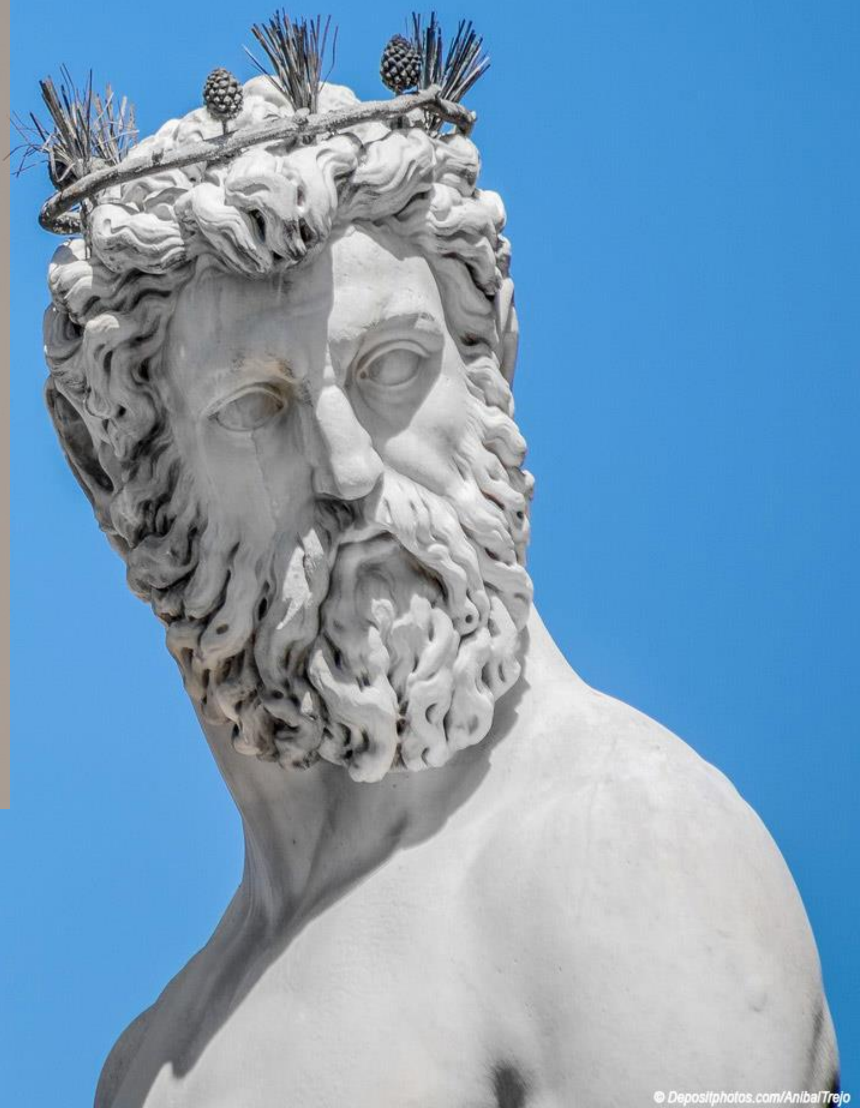
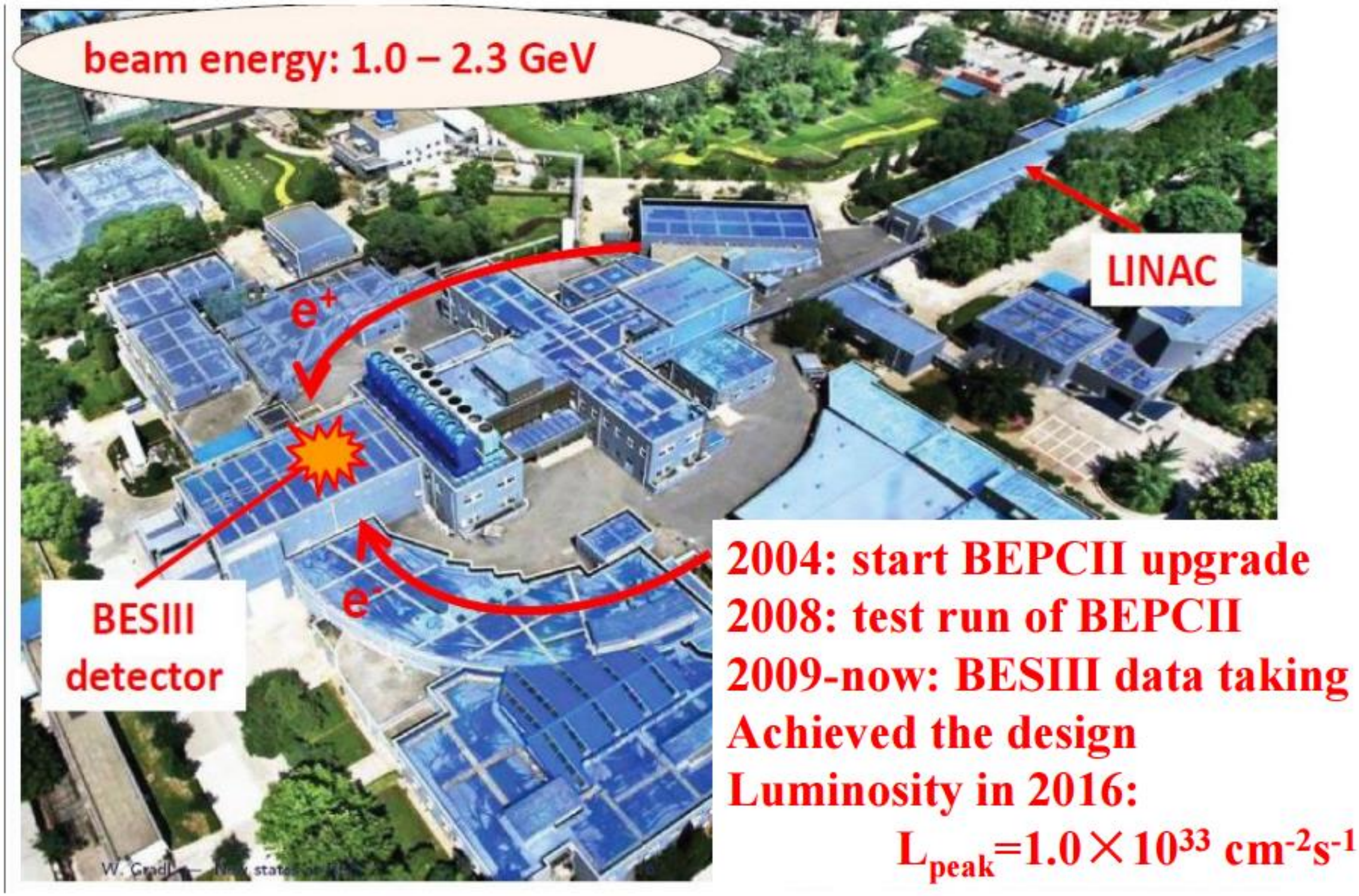


Outline

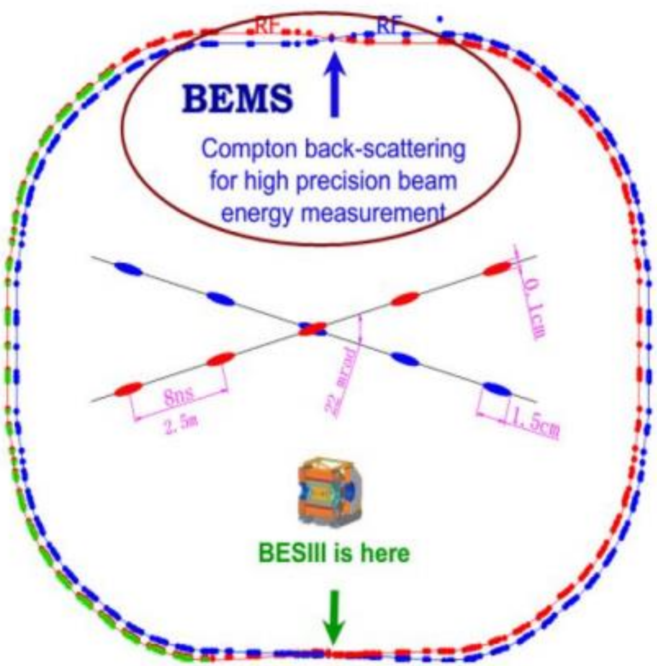
- **Introduction to BEPCII/BESIII**
- **Data sample at 4.009 GeV**
- **Analysis results**
  - $D_s \to \mu\nu/\tau\nu$
  - $D_s \to \eta'X/\eta'\rho$
  - $D_s \to \eta^{(')}e\nu$
  - Other results
    - D^{*0} branching fractions
- **Summary**

BEPCII

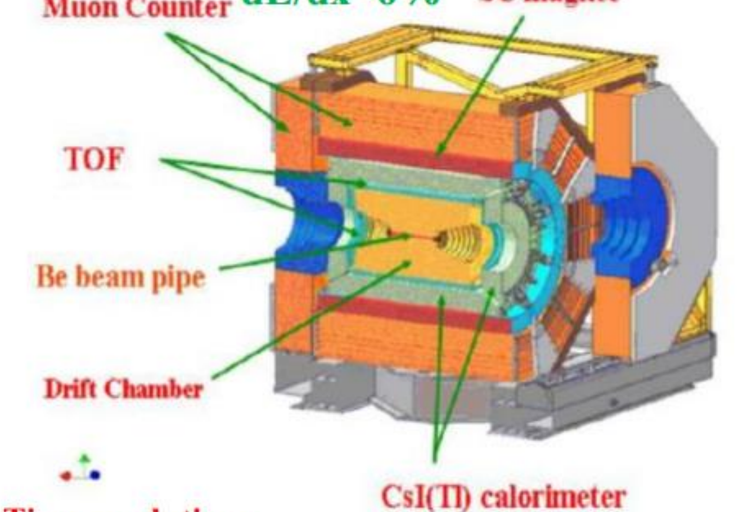

beam energy: 1.0 – 2.3 GeV
LINAC
e+
e-
BESIII detector
2004: start BEPCII upgrade
2008: test run of BEPCII
2009-now: BESIII data taking
Achieved the design
Luminosity in 2016:
$L_{peak}=1.0\times10^{33}\ cm^{-2}s^{-1}$

BESIII detector

NIM A614, 345 (2010)



Excellent tracking:
δp/p=0.5%@1GeV
dE/dx=6%



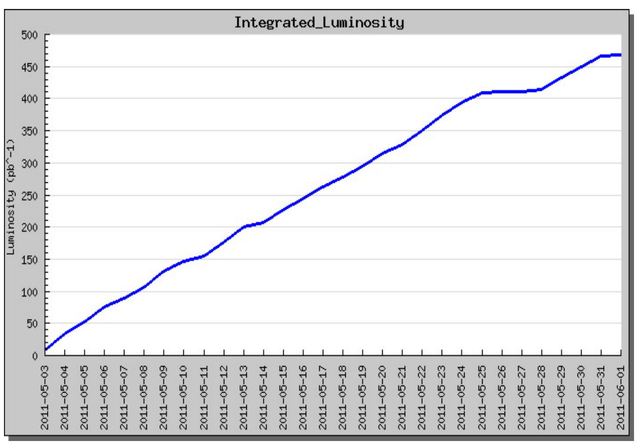
Time resolution:
90ps@BTOF
110ps@ETOF

Shower reconstruction:
δE/E=2.5%@1GeV

The new BESIII detector is hermetic for neutral and charged particle with excellent resolution, PID, and large coverage.

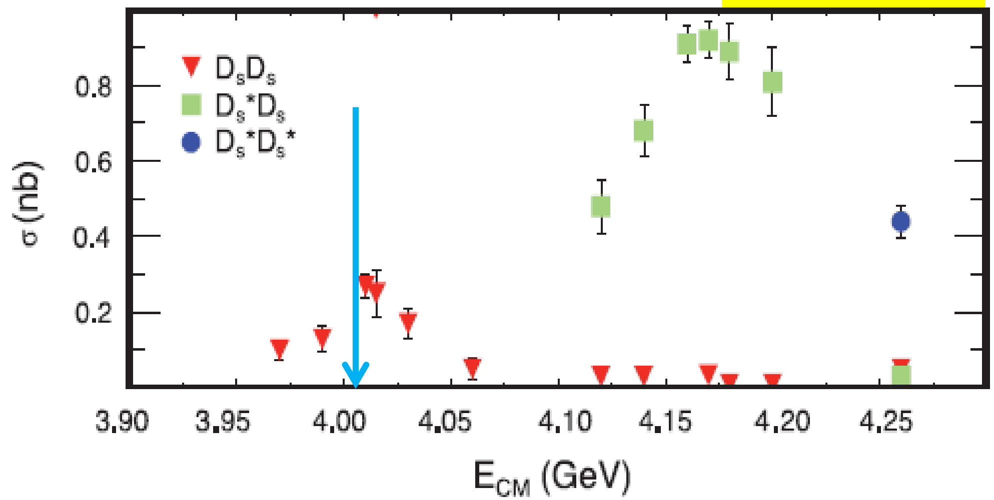
Data samples

- **482 pb^{-1} $\psi(4040)$ data @ 4.009 GeV**
  - Primary to search XYZ particles
  - Enhanced $D_s D_s$ production
  - Below $D_s D_s^*$ threshold, low background level



Integrated luminosity

PRD 80, 072001

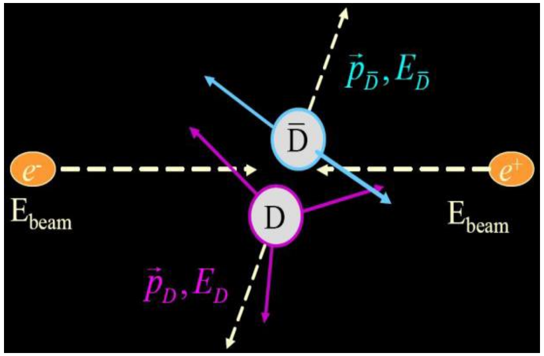


Charm meson production near threshold

- **Near the peak of $\psi(4040)$ resonance, only D_sD_s pairs are produced**

Pros

- ✓ Clean environment
- ✓ Known initial energy
- ✓ Both D_s^+ and D_s^- can fully reconstructed
- ✓ Absolute measurement



- **Analysis technique**
  - Single tag (ST): high efficiency, high background level
  - Double tag (DT): low efficiency, low background level

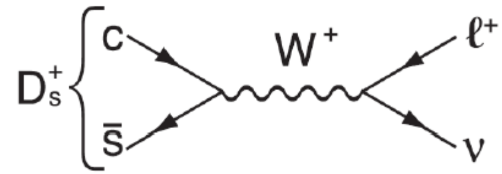
- **Useful Variables**
  - Beam constraint mass: $M_{BC} = \sqrt{E_{beam}^2 - p_{D_s}^2}$ (better resolution)
  - Energy difference: $\Delta E = E_{beam} - E_{D_s}$

arXiv 1608.06732

Measurement of the branching fractions of $D_s \to \mu\nu, D_s \to \tau\nu(\tau \to \pi\bar{\nu})$ and the decay constant f_{D_s}

Motivation

- **The leptonic decays of D_s meson:**



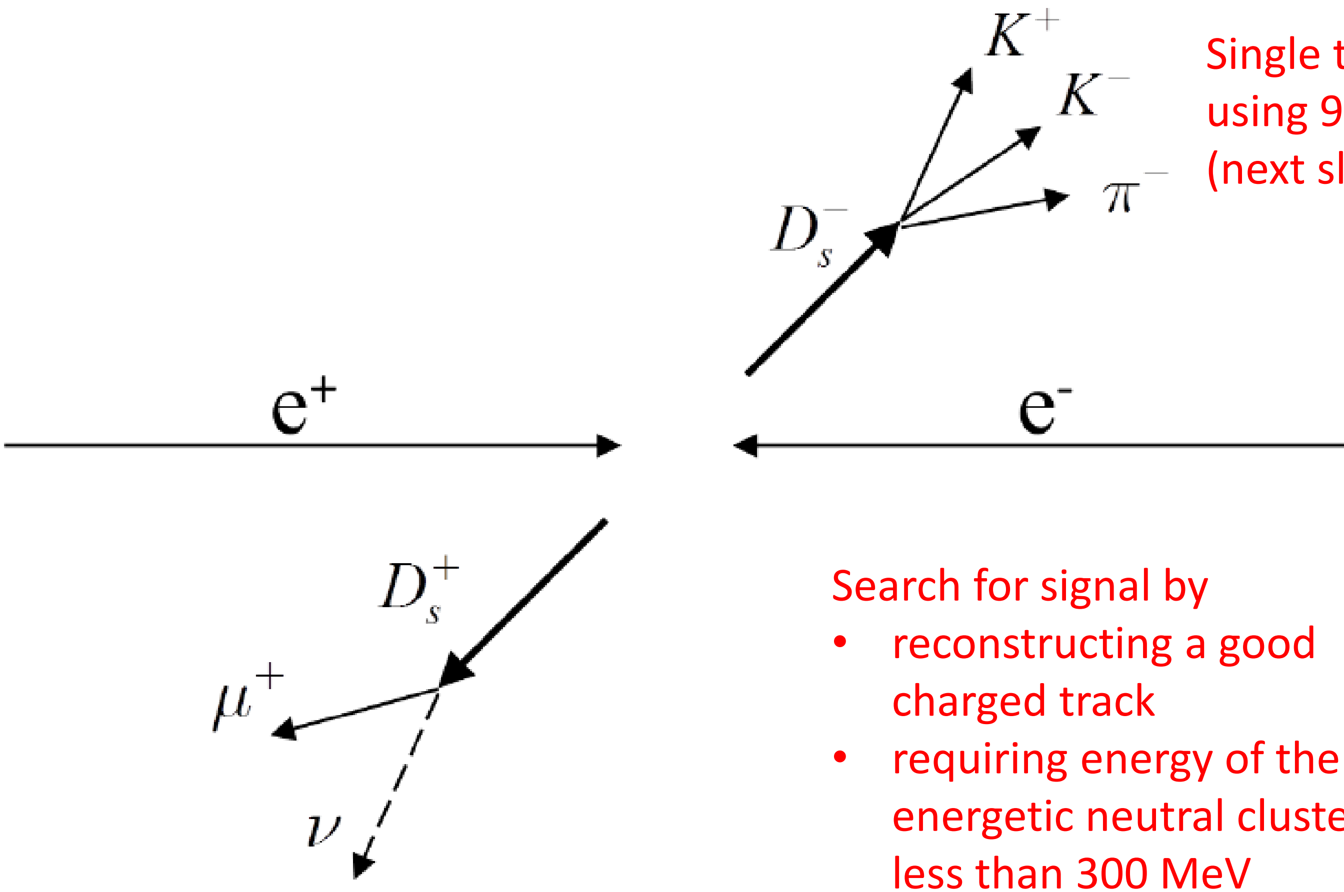
$$\Gamma\left(D_s^+ \to \ell^+ \nu_\ell\right) = \frac{G_F^2}{8\pi} f_{D_s^+}^2 m_\ell^2 m_{D_s^+} \left(1 - \frac{m_\ell^2}{m_{D_s^+}^2}\right)^2 |V_{cs}|^2$$

- **There is a rough 2σ difference between experimental measurement and unquenched lattice calculation, which may indicate the possible presence of new physics**

Model	f_{Ds} (MeV)
Experimental average of $\mu\nu + \tau\nu$	257.5 ± 4.6
Lattice QCD (*PDG 2016*)	249.0 ± 1.2

- **Measure f_{Ds} using 482 pb^{-1} of e+e- data taken at 4.009 GeV at BESIII**
  - Clean sample: below the DsDs* production threshold
  - Small D_sD_s cross section, ~1/3 of DsDs*'s at 4.17 GeV

DT method

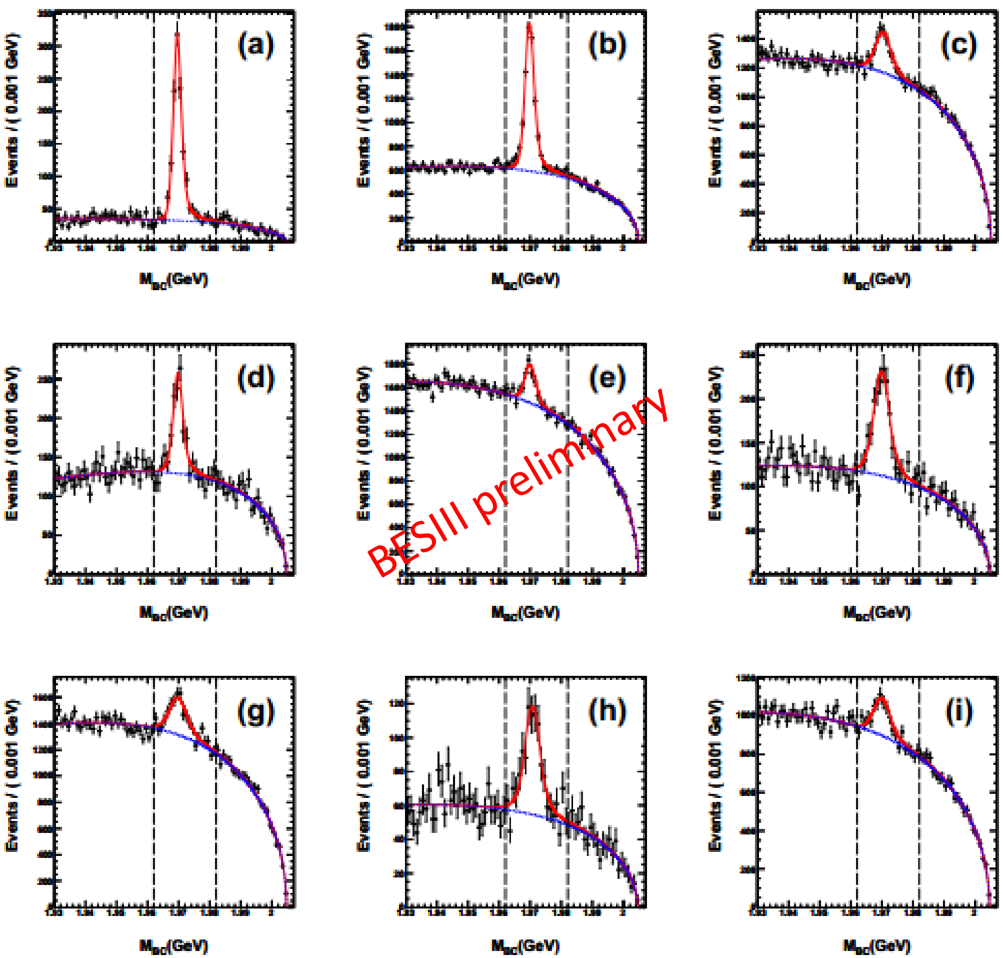


(or $D_s^+ \to \tau^+\nu; \tau^+ \to \pi^+\bar{\nu}$)

Single tag D_s^- using 9 modes (next slide)

Search for signal by
- reconstructing a good charged track
- requiring energy of the most energetic neutral cluster is less than 300 MeV

D_s single tag



15127 ± 312 D_s events in total

	Mode
(a)	$K_S^0 K^-$
(b)	$K^+ K^- \pi^-$
(c)	$K^+ K^- \pi^- \pi^0$
(d)	$K_S^0 K^+ \pi^- \pi^-$
(e)	$\pi^+ \pi^- \pi^-$
(f)	$\pi^- \eta$
(g)	$\pi^- \pi^0 \eta$
(h)	$\pi^- \eta' (\eta' \to \pi^+ \pi^- \eta)$
(i)	$\pi^- \eta' (\eta' \to \pi^+ \pi^- \gamma)$

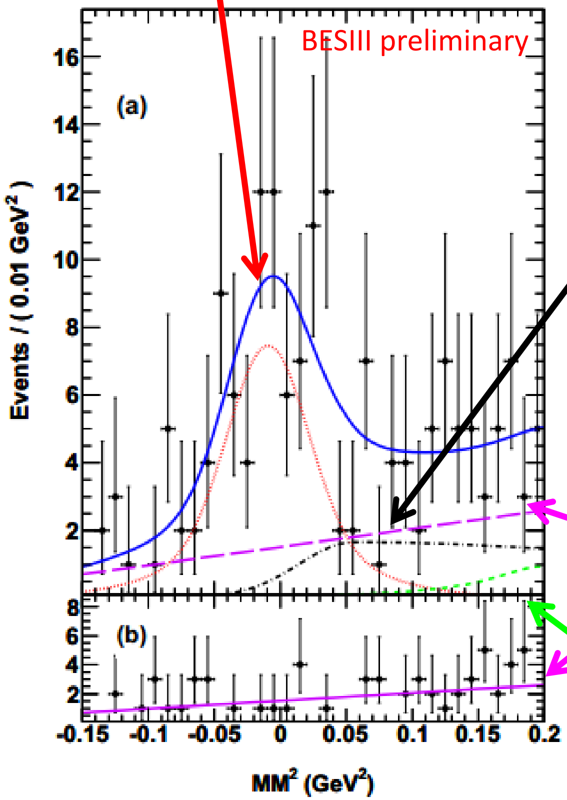
M_{BC} signal: (1.962, 1982) GeV
M_{BC} sideband: (1.946, 1.956) and (1.946, 1.956) GeV

SM-constrained fit to MM^2

Unbinned likelihood fit

$\mu\nu$

$\tau\nu$



Non-D_s bkg (by M_{BC} sideband)

D_s bkg (by MC simulation)

$$MM^2 = (E_{beam} - E_{\mu^+})^2 - (-\boldsymbol{p}_{D_s^-} - \boldsymbol{p}_{\mu^+})^2$$

Constrain $\tau\nu/\mu\nu$ to the SM prediction (9.76)

Mode	Branching fractions (%)
$D_s^+ \to \mu^+\nu$	$0.495 \pm 0.067 \pm 0.026$*
$D_s^+ \to \tau^+\nu$	$4.83 \pm 0.65 \pm 0.26$

*1% radiative correction

Note:
MM^2 in (a) signal region and (b) M_{BC} sideband region

Non-SM-constrained fit to MM^2

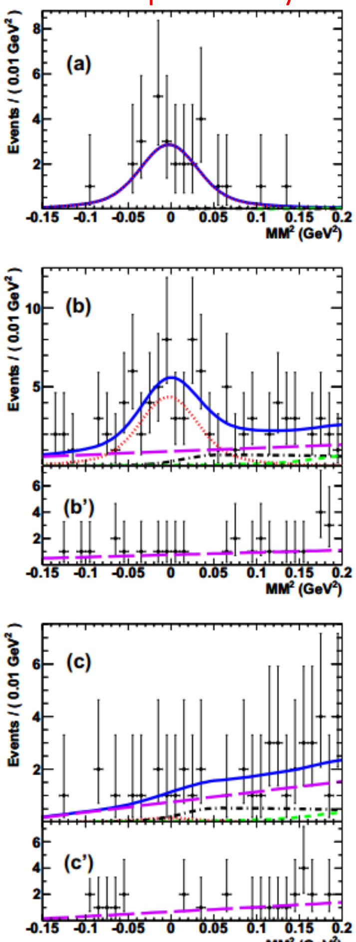
Unbinned likelihood fit

BESIII preliminary

Sub-sample I

Sub-sample II

Sub-sample III



Color-code:

$\mu\nu$

$\tau\nu$

Non-D_s bkg

D_s bkg

Make good use of MUC/EMC information to improve the fit uncertainty

- Divide the data sample into three sub-samples based on muon/pion favored criteria *mu-id*(MUC) and *pi-id*(EMC):
  - I: TRUE(*mu-id*) & FALSE(*pi-id*)
  - II: FALSE(*mu-id*) & FALSE(*pi-id*)
  - III: TRUE(*pi-id*)
- Simultaneously fit sub-sample I/II/III constraining the fractions of $\tau\nu$ and $\mu\nu$ in the three sub-samples individually

Mode	Branching fractions (%)
$D_s^+ \to \mu^+\nu$	$0.517 \pm 0.075 \pm 0.021$*
$D_s^+ \to \tau^+\nu$	$3.28 \pm 1.83 \pm 0.37$

*1% radiative correction

Systematics

BESIII preliminary

Sources	Constrained measurement		Unconstrained measurement	
	$D_s^+ \to \mu^+\nu_\mu$	$D_s^+ \to \tau^+\nu_\tau$	$D_s^+ \to \mu^+\nu_\mu$	$D_s^+ \to \tau^+\nu_\tau$
Number of tags	1.7	1.7	1.7	1.7
Track finding	1.0	1.0	1.0	1.0
Extra shower cut	0.5	0.5	0.5	0.5
MM^2 resolution	2.3	2.3	2.5	5.5
MM^2 fitting range	1.2	1.6	1.8	0.3
Background	4.4	4.4	2.3	9.4
Signal relative fractions in the three sub-samples	-	-	1.1	1.1
Radiative correction	1.0	-	1.0	-
$\mathcal{B}(\tau^+ \to \pi^+\bar{\nu_\tau})$	-	0.6	-	0.6
MC statistics	0.5	0.6	0.5	0.6
Sum	5.6	5.7	4.6	11.2

- For a DT analysis, uncertainties related to ST selection are cancelled
- Due to the low statistics, uncertainties related to the MM^2 fits make the major contribution to the systematics
- Uncertainty in the radiative correction is taken 100% of Dobrescu and Kronfeld's calculation (PRL 100, 241802 (2008))

Decay constant f_{D_s}

arXiv 1608.06732

$$f_{D_s^+} = \frac{1}{G_F m_\ell \left(1 - \frac{m_\ell^2}{m_{D_s^+}^2}\right) |V_{cs}|} \sqrt{\frac{8\pi \mathcal{B}(D_s^+ \to \ell^+ \nu_\ell)}{m_{D_s^+} \tau_{D_s^+}}}$$

Experiment	Mode	BF (%)	$f_{D_s^+}$ (MeV)
CLEO-c *	μν	$0.565 \pm 0.045 \pm 0.017$	$259 \pm 6.2 \pm 3.0$
BaBar **	μν	$0.602 \pm 0.038 \pm 0.034$	$258.4 \pm 6.4 \pm 7.5$
Belle ***	μν	$0.531 \pm 0.028 \pm 0.020$	$257.8 \pm 4.2 \pm 4.8$
This work (preliminary)	μν	$0.495 \pm 0.067 \pm 0.026$	$241.0 \pm 16.3 \pm 6.6$

Model	$f_{D_s^+}$ (MeV)
Lattice (HPQCD)	$246.0 \pm 0.7 \pm 3.5$
Lattice (FNAL + MILC)	$246.4 \pm 0.5 \pm 3.6$

* PRD79, 052001 (2009)
** PRD82, 091103 (2010)
*** JHEP09, 139 (2013)

Our results are statistical limited.
Compatible with previous experiments & LQCD calculations.

PLB 750, 266 (2015)

Measurement of the branching fractions of $D_s \to \eta' X$ and $D_s \to \eta' \rho$

Motivation

- **Hadronic weak decays of charmed mesons provide important information on flavor mixing, CP violation, and strong-interaction effects.**

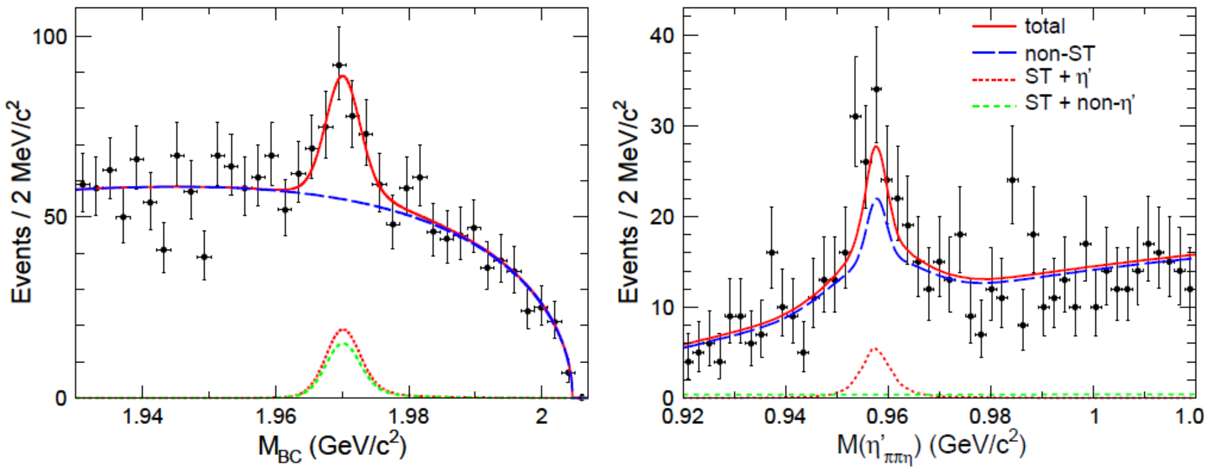
- **Discrepancy I**
  - BF($D_s^+ \to \eta' X$) = Sum[BF($D_s^+ \to \eta' \rho^+$ + exclusive in PDG)] = (18.6 $\pm$ 2.3)%
  - BF($D_s^+ \to \eta' X$) = (11.7 $\pm$ 1.8)% (CLEO-c @ Ecm~4.170 GeV *PRD79, 112008*).

- **Discrepancy II**
  - BF($D_s^+ \to \eta' \rho^+$) = (12.5 $\pm$ 2.2)% (CLEO2 @ Ecm~M(Y(4S)), *PRD58, 052002(1998)*)
  - A factorization method predicts BF($D_s^+ \to \eta' \rho^+$) = (3.0 $\pm$ 0.5)% (*F.S. Yu, et al, PRD84, 074019 (2011)*)

- **We can measure BF($\boldsymbol{D_s^+ \to \eta' X}$) and BF($\boldsymbol{D_s^+ \to \eta' \rho^+}$) at BESIII**

DT method for $D_s^+ \to \eta' X$

- **Tag side**
  - The same to $D_s \to \mu\nu$
- **Signal side**
  - Reconstruct $\eta' \to \pi\pi\eta(\eta \to \gamma\gamma)$. If multiple candidates, choose the one with minimum $\Delta M \equiv |M(\pi\pi\eta) - m(\eta')|$
  - Peaking background: wrongly reconstructed D_s accompanied by a real η'
  - 2D fit to M_{BC} and $M(\pi\pi\eta)$



DT yields: 68 ± 14

BF($D_s^+ \to \eta' X$) = $(8.8 \pm 1.8)\%$

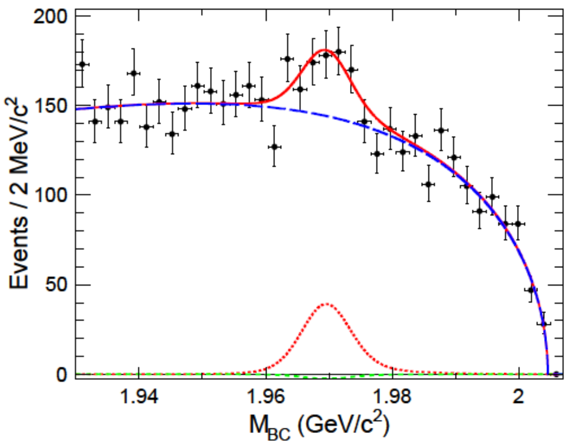
ST method for $D_s^+ \to \eta' \rho^+$

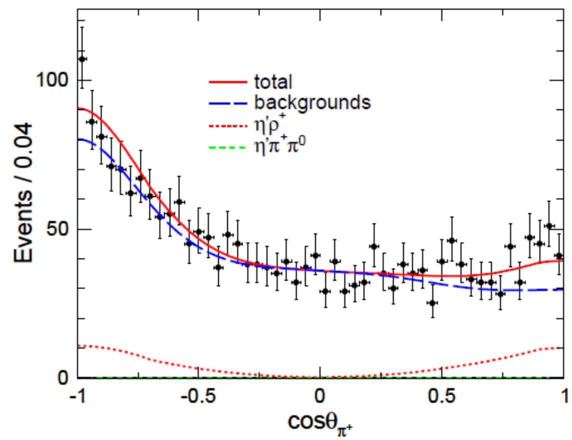
- **Fully reconstruct $\eta' \rho^+$ final state**
  - $\eta' \to \pi\pi\eta(\eta \to \gamma\gamma)$: no PID for π^+, 0.943 < M($\pi\pi\eta$) < 0.973 GeV
  - $\rho^+ \to \pi^+\pi^0(\pi^0 \to \gamma\gamma)$: no PID for π^+, |M($\pi^+\pi^0$) – m(ρ^+)| < 0.17 GeV
  - Require -0.035 < $|\Delta E|$ < 0.023 GeV

- **To separate two-body $\eta' \rho^+$ from three-body $\eta' \pi^+ \pi^0$**
  - Use helicity angle θ_{π^+}: the angle between the momentum of the π^+ from the ρ^+ decay and the direction opposite to the D_s^+ momentum in the ρ^+ rest frame.
  - $D_s^+ \to \eta' \rho^+$: $\cos^2 \theta_{\pi^+}$
  - $D_s^+ \to \eta' \pi^+ \pi^0$: flat in $\cos \theta_{\pi^+}$

ST method for $D_s^+ \to \eta' \rho^+$ (cont.)

- **2D fit to $\mathrm{M_{BC}}$ and $\cos\theta_{\pi^+}$**





$\cos\theta_{\pi^+}$ bkg: $\mathrm{M_{BC}}$ sideband

$N(\eta'\rho^+) = 210 \pm 50$
$N(\eta'\pi^+\pi^0) = -13 \pm 56$

- **Measure the relative BF to cancel out ST systematics**
  - $BF(D_s^+ \to \eta'\rho^+)/BF(D_s^+ \to K^+K^-\pi^+) = 1.04 \pm 0.25$

Systematics

Source	$\mathcal{B}(D_s^+ \to \eta' X)$	$\mathcal{B}(D_s^+ \to \eta' \rho^+)$
MDC track reconstruction	2.0	
PID	2.0	3.0
π^0 detection		2.4
η detection	2.7	3.5
ΔE requirement	1.0	1.4
$M(\eta'_{\pi\pi\eta})$ requirement		2.0
$M(\eta'_{\pi\pi\eta})$ backgrounds	1.5	
Peaking backgrounds in ST	0.3	
$M_{\rm BC}$ signal shape	1.0	0.6
$M_{\rm BC}$ fit range	1.7	0.5
$\cos\theta_{\pi^+}$ backgrounds		2.9
Uncertainty of efficiency	1.6	0.5
Quoted branching fractions	1.7	3.8
Total	5.3	7.5

- ***π^0 and η detection:*** estimated from DT $D^0\bar{D}^0, D^0 \to K^-\pi^+\pi^0$ in each p bins. The disagreement between data/MC is assumed to be the same for η
- ***$\cos\theta_{\pi^+}$ background:*** change the kernel width parameter in the kernel-estimated distribution of the background events
- ***Quoted branching fractions:*** dominated by BF($D_s^+ \to K^+K^-\pi^+$) from CLEO-c (*PRD88, 032009(2013)*)

Results

PLB 750, 266 (2015)

- **BF($D_s^+ \to \eta' X$) = (8.8 $\pm$ 1.8 $\pm$ 0.5)%**
  - Consistent with CLEO-c's (11.7 $\pm$ 1.8)%
  - Weighted average of these two: (10.3 $\pm$ 1.3)%

- **BF($D_s^+ \to \eta' \rho^+$)/BF($D_s^+ \to K^+ K^- \pi^+$) = 1.04 $\pm$ 0.25 $\pm$ 0.07**
  - Inserting BF($D_s^+ \to K^+ K^- \pi^+$) from PDG, we get BF($D_s^+ \to \eta' \rho^+$) = (5.8 $\pm$ 1.4 $\pm$ 0.4)%
    - Half CLEO2's old result: (12.5 $\pm$ 2.2)%
    - Consist with CLEO-c's new BF($D_s^+ \to \eta' \pi^+ \pi^0$) (PRD 88, 032009 (2013)): (5.6 $\pm$ 0.5 $\pm$ 0.6)% (include $\eta' \rho^+$)

- **Upper limit of non-resonant BF($D_s^+ \to \eta' \pi^+ \pi^0$) < 5.1% at 90% C.L.**

arXiv 1608.06484

Measurements of the branching fractions of $D_s^+ \to \eta^{(\prime)} e^+ \nu$

Motivation

- **The semileptonic decays $D_s^+ \to \eta^{(\prime)} e\nu$ are important channels for the study of heavy quark decays**

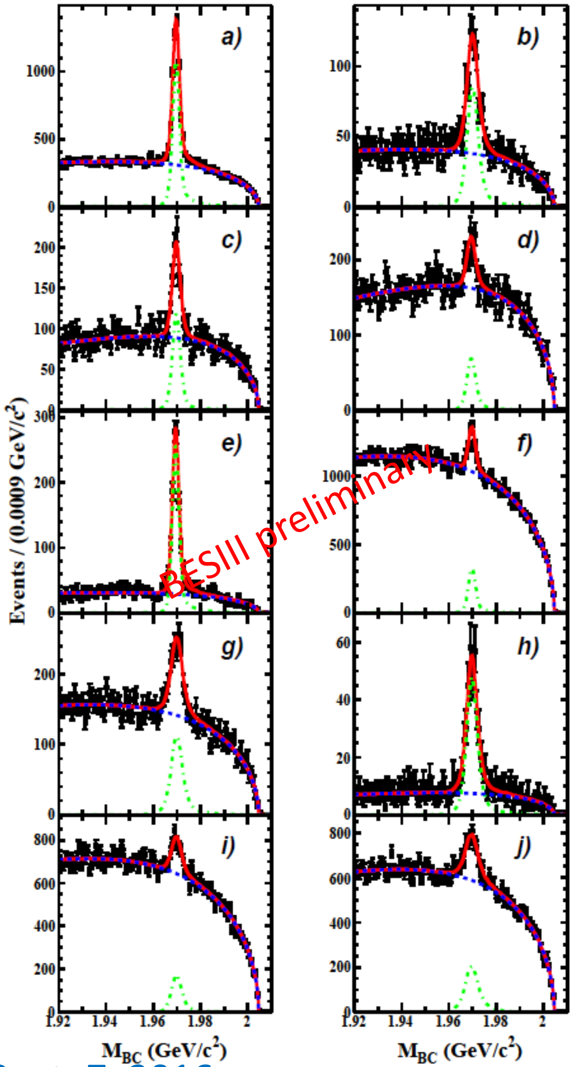
- **The inclusive semileptonic decay widths of the mesons D^0, D^+ and D_s^+ should be equal, due to SU(3) symmetry breaking and non-factorizable components.**

- **The measured inclusive semileptonic decay widths of D^0/D^+ are consistent, but 20% larger than that from D_s^+ (> 3σ)**

- **The Isgur-Scora-Grinstein-Wise form factor model (ISGW2) predicts a difference between the D and Ds+ inclusive semileptonic rates**

- **The exclusive semileptonic decay rates can provide useful information**

D_s single tag



10 tag modes (with additional $K_S^0 K^- \pi^+ \pi^-$ compared to the $D_s^+ \to \mu\nu$ analysis)

Tag Mode	ΔE (GeV)	M_{BC} (GeV/c^2)	N_{ST}	$\epsilon^{ST}_{D_s^-}$ (%)
$K^+K^-\pi^-$	$(-0.020, 0.017)$	$(1.9635, 1.9772)$	4863 ± 95	38.92 ± 0.08
$\phi(K^+K^-)\rho^-$	$(-0.036, 0.023)$	$(1.9603, 1.9821)$	616 ± 39	10.05 ± 0.07
$K_S^0 K^+\pi^-\pi^-$	$(-0.018, 0.014)$	$(1.9632, 1.9778)$	601 ± 40	23.17 ± 0.16
$K_S^0 K^-\pi^+\pi^-$	$(-0.016, 0.012)$	$(1.9622, 1.9777)$	388 ± 52	21.98 ± 0.21
$K_S^0 K^-$	$(-0.019, 0.020)$	$(1.9640, 1.9761)$	1078 ± 38	44.96 ± 0.20
$\pi^+\pi^-\pi^-$	$(-0.026, 0.022)$	$(1.9634, 1.9770)$	1525 ± 116	51.83 ± 0.14
$\eta(\gamma\gamma)\pi^-$	$(-0.052, 0.058)$	$(1.9598, 1.9824)$	840 ± 56	47.58 ± 0.24
$\eta'(\eta\pi^+\pi^-)\pi^-$	$(-0.025, 0.024)$	$(1.9604, 1.9813)$	333 ± 23	23.02 ± 0.21
$\eta'(\gamma\rho^0)\pi^-$	$(-0.041, 0.033)$	$(1.9618, 1.9790)$	1112 ± 106	38.21 ± 0.18
$\eta(\gamma\gamma)\rho^-$	$(-0.058, 0.041)$	$(1.9569, 1.9855)$	1801 ± 113	24.43 ± 0.10

BESIII preliminary

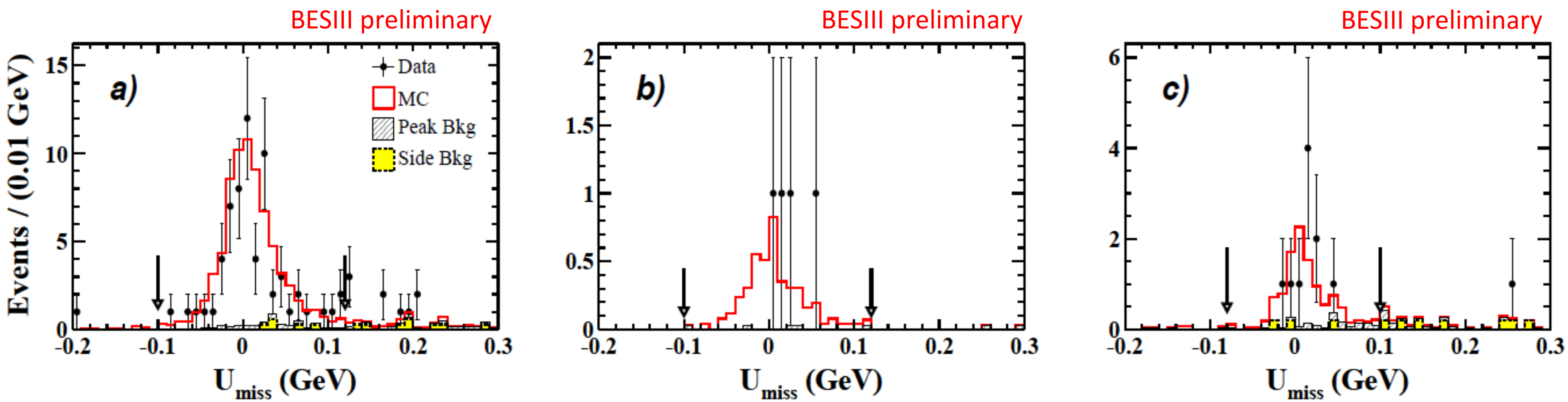
Signal side

$$N_{DT} = N_{tot} - N_{bkg}$$

N_{tot}: Count number of events from $\mathbf{U_{miss}}$
N_{bkg}: Subtract background events

- Peak bkg: estimated from MC simulation
- Side bkg: estimated from M_{BC} sideband

- ✓ Find a electron, whose confidence level satisfies $\frac{CL_e}{CL_e+CL_\pi+CL_K} < \mathbf{0.8}$
- ✓ Reconstruct a η or η' (to $\pi\pi\eta$ or $\gamma\rho$)
- ✓ Energy of the most energetic neutral cluster is less than 300 MeV



$\eta e\nu$ — 58.5 ± 8.0

$\eta'(\eta\pi\pi)e\nu$ — 3.8 ± 2.0

$\eta'(\gamma\rho)e\nu$ — 8.2 ± 3.2

Systematics

BESIII preliminary

Source	$\eta e^+\nu_e$	$\eta'(\eta\pi^+\pi^-)e^+\nu_e$	$\eta'(\gamma\rho^0)e^+\nu_e$
Number of ST D_s^-	1.8	1.8	1.8
Tracking for π^+	—	2.0	2.0
PID for π^+	—	2.0	2.0
Electron selection	1.2	1.1	1.1
$\eta(\eta')$ reconstruction	2.3	2.5	2.8
$E^{\rm max}_{{\rm extra}\gamma}$ cut	0.5	0.5	0.5
Background	0.5	0.7	0.8
Weighted efficiency	1.9	1.9	1.9
Form factor model	0.6	2.8	0.9
MC statistics	0.4	0.8	0.7
$B(\eta\to\gamma\gamma)$	0.5	0.5	—
$B(\eta'\to\eta\pi^+\pi^-)$	—	1.6	—
$B(\eta'\to\gamma\rho^0)$	—	—	1.7
$U_{\rm miss}$ requirement	0.3	0.6	0.3
Total	3.9	5.9	5.4

- ***η/η' reconstruction:*** estimated from DT $D^0\bar{D}^0$, $D^0\to K_S^0\eta$ or $K_S^0\eta'$. The data/MC difference is taken as the uncertainty.
- ***Weighted efficiency:*** uncertainty of weighting factors of the efficiency, mostly comes from the ST statistical uncertainty

Branching fraction results

arXiv 1608.06484

$$B(D_s^+ \to \eta(\eta')e^+\nu_e) = \frac{N_{\rm DT}^{\rm net}}{N_{\rm ST}^{\rm tot} \times \epsilon_{D_s^+ \to \eta(\eta')e^+\nu_e} \times B_i}$$

BESIII preliminary

	BESIII	Ref. [7]	Ref. [8]	Ref. [9]	PDG [4]
$B(D_s^+ \to \eta e^+\nu_e)[\%]$	$2.30 \pm 0.31 \pm 0.09$	—	$2.48 \pm 0.29 \pm 0.13$	$2.28 \pm 0.14 \pm 0.20$	2.67 ± 0.29
$B(D_s^+ \to \eta' e^+\nu_e)[\%]$	$0.93 \pm 0.30 \pm 0.05$	—	$0.91 \pm 0.33 \pm 0.05$	$0.68 \pm 0.15 \pm 0.06$	0.99 ± 0.23
$\frac{B(D_s^+ \to \eta' e^+\nu_e)}{B(D_s^+ \to \eta e^+\nu_e)}$	$0.40 \pm 0.14 \pm 0.02$	$0.35 \pm 0.09 \pm 0.07$	—	—	—

Agree to previous experimental measurements

Can be used to determine the $\eta - \eta'$ mixing angle and improve upon the D_s^+ semileptonic branching ratio precision

Ref. [7]: PRL 75, 3804 (1995) (CLEO II)
Ref. [8]: PRD 80, 052007 (2009) (CLEO-c)
Ref. [9]: PRD 92, 012009 (2015)

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Other results - D^{*0} branching fractions

Motivation

- **Effective models (EMs) are developed to deal with the nonperturbative effects for strong interaction in the low energy regime.**

- **A precise measurement of the branching fractions will constrain the model parameters and thereby help to improve the EMs.**

- **The decay branching fractions of D^{*0} to $D^0\pi^0$ and $D^0\gamma$ are also critical input values for many measurements such as the open charm cross sections in e^+e^- annihilation and the semileptonic decays of $B^\pm$**

- **Average result of previous measurements is of ~8% uncertainty. Our measurement with 482 pb^{-1} data sample can improve the result significantly.**

Event selection

For $\sqrt{s}$ = 4.009 GeV

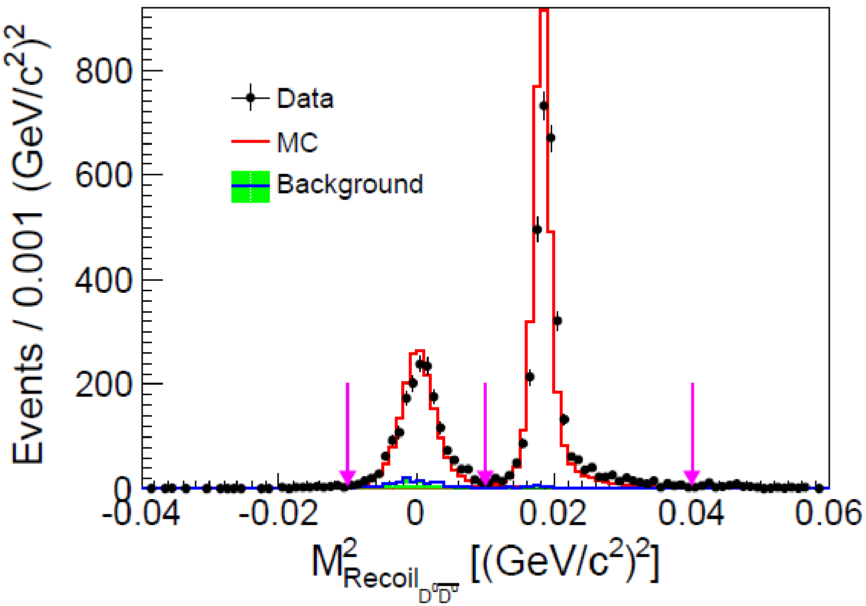
- No $D^{*0}\overline{D}^{*0}$ production
- Find D^{*0} events from $D^{*0}\overline{D}^{0}$, assuming D^{*0} only decays to $D^0\pi^0$ and $D^0\gamma$ (the next largest mode $D^0\gamma\gamma$ ~ 3.3e-5).
- Reconstruct the $D^0\overline{D}^0$ pair, require the recoil mass to form a π^0 or a photon
- 3 decay modes of D^0, 5 combinations of $D^0\overline{D}^0$

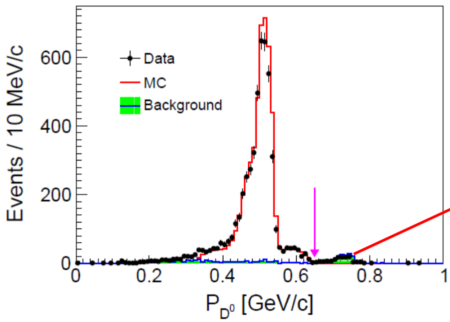
Mode	Decay of D^0	Decay of $\bar{D}^0$
I	$D^0 \to K^-\pi^+$	$\bar{D}^0 \to K^+\pi^-$
II	$D^0 \to K^-\pi^+$	$\bar{D}^0 \to K^+\pi^-\pi^0$
III	$D^0 \to K^-\pi^+\pi^0$	$\bar{D}^0 \to K^+\pi^-$
IV	$D^0 \to K^-\pi^+$	$\bar{D}^0 \to K^+\pi^-\pi^+\pi^-$
V	$D^0 \to K^-\pi^+\pi^+\pi^-$	$\bar{D}^0 \to K^+\pi^-$

- Kinematic fit
  - Constrain $D^0/\overline{D}^0$ candidate to m(D^0)
  - For π^0, |M($\gamma\gamma$)-m(π^0)| < 15 MeV. Constrain M($\gamma\gamma$) to m(π^0)

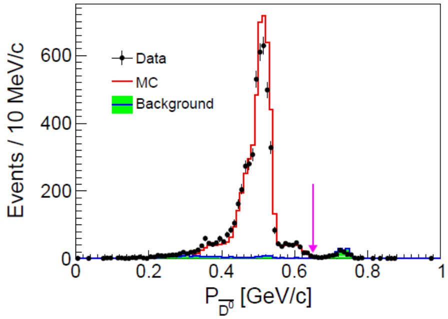
- If multiple candidates survive, choose the one with the smallest χ^2_{KF}

Signal extraction





The small peak is from $e^+e^- \rightarrow D^0\bar{D}^0$



require p_{D^0} < 0.65 GeV to veto this bkg

Signal regions: [-0.01, 0.01] GeV² for $D^0\gamma$, [0.01, 0.04] GeV² for $D^0\pi^0$

Obtain $N^{prod}_{\pi^0}$ and N^{prod}_{γ} from

$$\begin{pmatrix} N^{\rm obs}_{\pi^0} - N^{\rm bkg}_{\pi^0} \\ N^{\rm obs}_{\gamma} - N^{\rm bkg}_{\gamma} \end{pmatrix} = \begin{pmatrix} \epsilon_{\pi^0\pi^0} & \epsilon_{\gamma\pi^0} \\ \epsilon_{\pi^0\gamma} & \epsilon_{\gamma\gamma} \end{pmatrix} \begin{pmatrix} N^{\rm prod}_{\pi^0} \\ N^{\rm prod}_{\gamma} \end{pmatrix}$$

Obtained from signal regions in M^2_{recoil}

Obtained from MC simulation

Systematics

Source	(%)
Dividing line between $D^{*0} \to D^0\pi^0$ and $D^{*0} \to D^0\gamma$	0.2
Choice of signal regions	0.2
Kinematic fit	0.2
FSR simulation	0.1
Background	0.2
Statistics of MC samples	0.2
Sum	0.5

- As the branching fractions are obtained from the ratio of $D^0\pi^0$ and $D^0\gamma$ events, uncertainty related to D^0 reconstruction is cancelled
- ***FSR simulation:*** there are 20% more FSR events with charged pions in data than MC (*PRD 84, 091102 (2001)*). Correct MC simulation and take the difference as the uncertainty.
- ***Background:*** as background is estimated from MC simulation, the uncertainties of the input cross sections in simulation dominate the error.

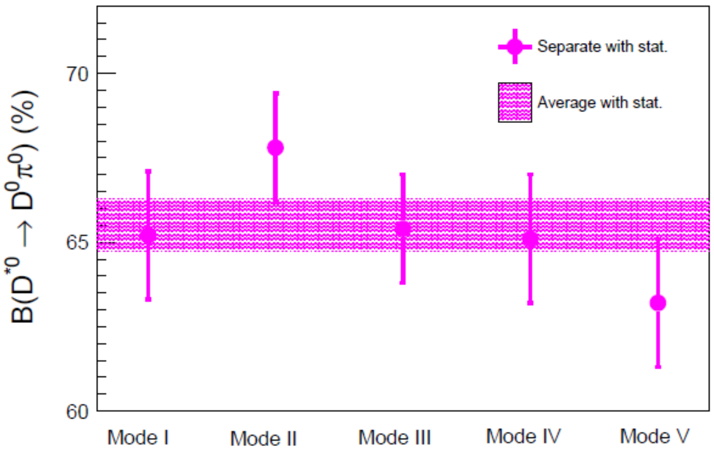
Branching fractions

PRD 91, 031101(R) (2015)

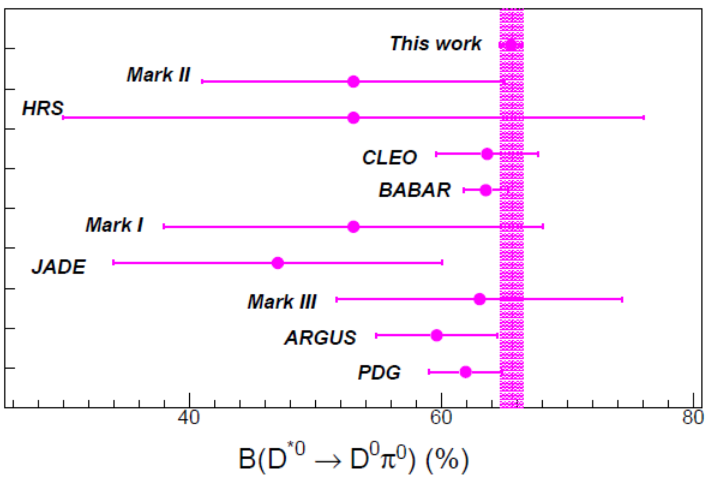
$$\mathcal{B}(D^{*0} \to D^0\pi^0) = \frac{N^{\rm prod}_{\pi^0}}{N^{\rm prod}_{\gamma} + N^{\rm prod}_{\pi^0}}$$

Weighted average for the 5 modes:

- **BF($D^{*0} \to D^0\pi^0$) = (65.5 $\pm$ 0.8 $\pm$ 0.5)%**



Consistent for the 5 individual mode and their weighted average



Our results are consistent with the previous ones and of best precision

Summary

- **With the 482 pb^{-1} of data taken at 4.009 GeV, many new results are out for BESIII**
  - $D_s \rightarrow \mu\nu/\tau\nu$ (*arXiv 1608.06732*)
  - $D_s \rightarrow \eta'X/\eta'\rho$ (*PLB 750, 266 (2015)*)
  - $D_s \rightarrow \eta^{(\prime)} e\nu$ (*arXiv 1608.06484*)
  - Other results
    - D^{*0} branching fractions (*PRD 91, 031101(R) (2015)*)

- **Look into the future …**
  - BESIII has collected 3 fb^{-1} $D_s D_s^*$ data at 4.18 GeV
    - ~15× D_s statistics to the BESIII 4.009 GeV data
    - ~5× D_s statistics to the CLEO-c 4.17 GeV data
  - More exciting results will be coming out for the coming year!!!