STCF上 D_s/D 的物理模拟研究

On behalf of the D_s/D group at STCF

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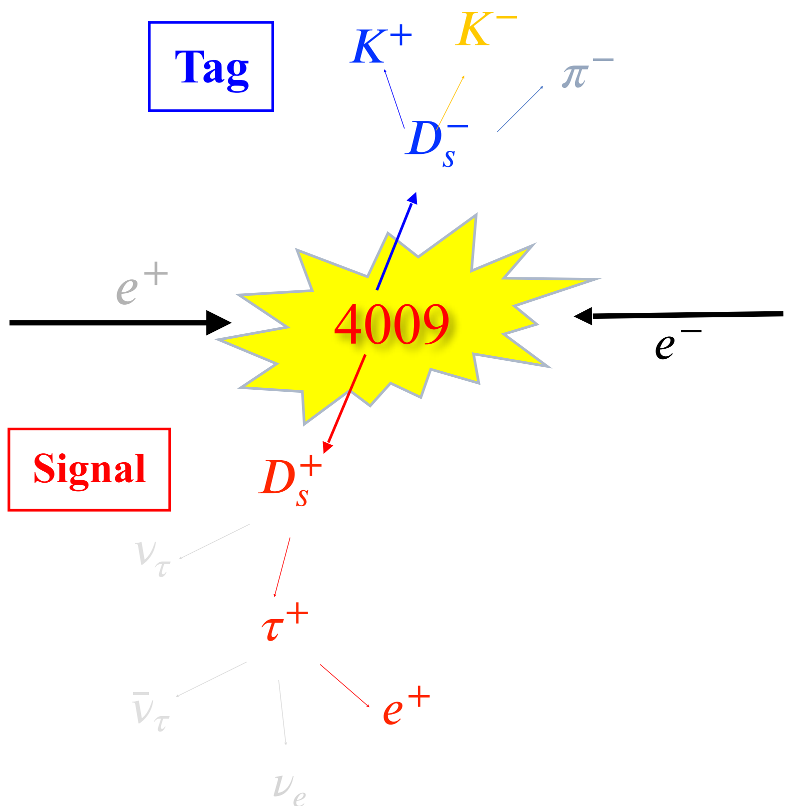
Outline

1. $D_s^+ \to l^+\nu \ (l = \mu, \tau)$ **@4.009 GeV**
    - $\mu^+\nu_\mu$ 刘佳俊 等 helloliujiajun@163.com
    - $\tau^+\nu_\tau \ (\tau^+ \to e^+\nu_e\bar{\nu}_\tau)$ 李惠静 等 lihuijing@htu.edu.cn
2. $D^0 \to K_1(1270)^- e^+\nu_e$ 范玉兰 等 2018202020010@whu.edu.cn
3. $D \to K^0_{S,\,L}\ \pi^+\pi^-$ 侯颖锐 等 houyingrui16@mails.ucas.ac.cn

Tagging method

$e^+e^- \to D_s^+ D_s^-$ @4.009 GeV

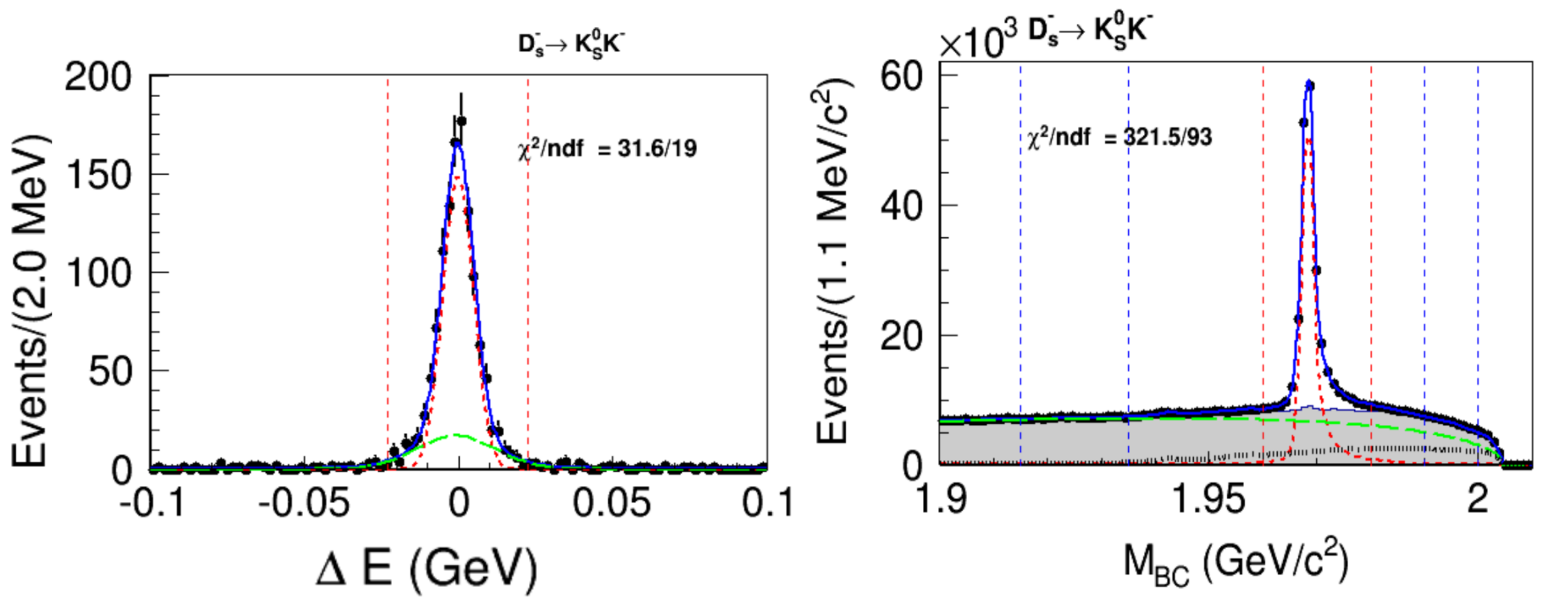


$$\mathcal{B}_{sig}^{\alpha} = \frac{N_{sig}^{obs,\alpha}\epsilon_{tag}^{\alpha}}{N_{tag}^{obs,\alpha}\epsilon_{tag,sig}^{\alpha}\mathcal{B}_{\tau^+\to e^+\nu_e\bar{\nu}_\tau}}$$

For tag side:

Minimum $|\Delta E|$: to select the best tag $D_{(s)}$ candidate/charge/tag mode/event.

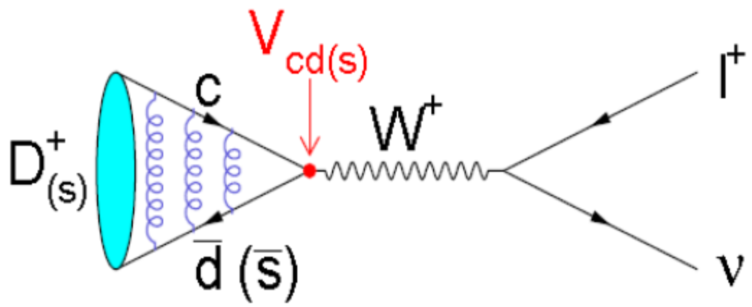
$$\Delta E = E_{tag} - E_{beam}, \qquad M_{BC} = \sqrt{E_{beam}^2 - \left|\vec{p}_{tag}\right|^2}$$



1. $D_s^+ \to l^+\nu$

Improve the measured precisions of :

- **branching fraction→decay constant $f_{D_s^+}$ and CKM element $|V_{cs}|$;**



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

BESIII samples:
Data: 0.482 fb^{-1};
Cocktail MC: 5x data.

STCF sample:
cocktail MC: 0.1 ab^{-1} (59 rounds);
Fast simulation.

Signal MC sample:
generated for each tag mode;
Obtain the DT efficiency.

$$D_s^+ \to \mu^+ \nu_\mu$$

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Data sets

BOSS version: 703

Method: double tag

Channel: $e^+e^- \to D_s^+ D_s^-$

Signal mode: $D_s^+ \to \mu^+\nu_\mu$

14 tag modes:

$D_s^- \to K^+K^-\pi^-(101)$

$K^+K^-\pi^-\pi^0(102)$

$\pi^-\pi^-\pi^+(103)$

$K_S^0K^-(104)$

$K_S^0K^-\pi^0(105)$

$K^-\pi^-\pi^+(107)$

$K_S^0K_S^0\pi^-(109)$

$K_S^0K^+\pi^-\pi^-(110)$

$K_S^0K^-\pi^+\pi^-(111)$

$\pi^-\eta_{\gamma\gamma}(113)$

$\pi^-\eta_{\pi^+\pi^-\pi^0}(114)$

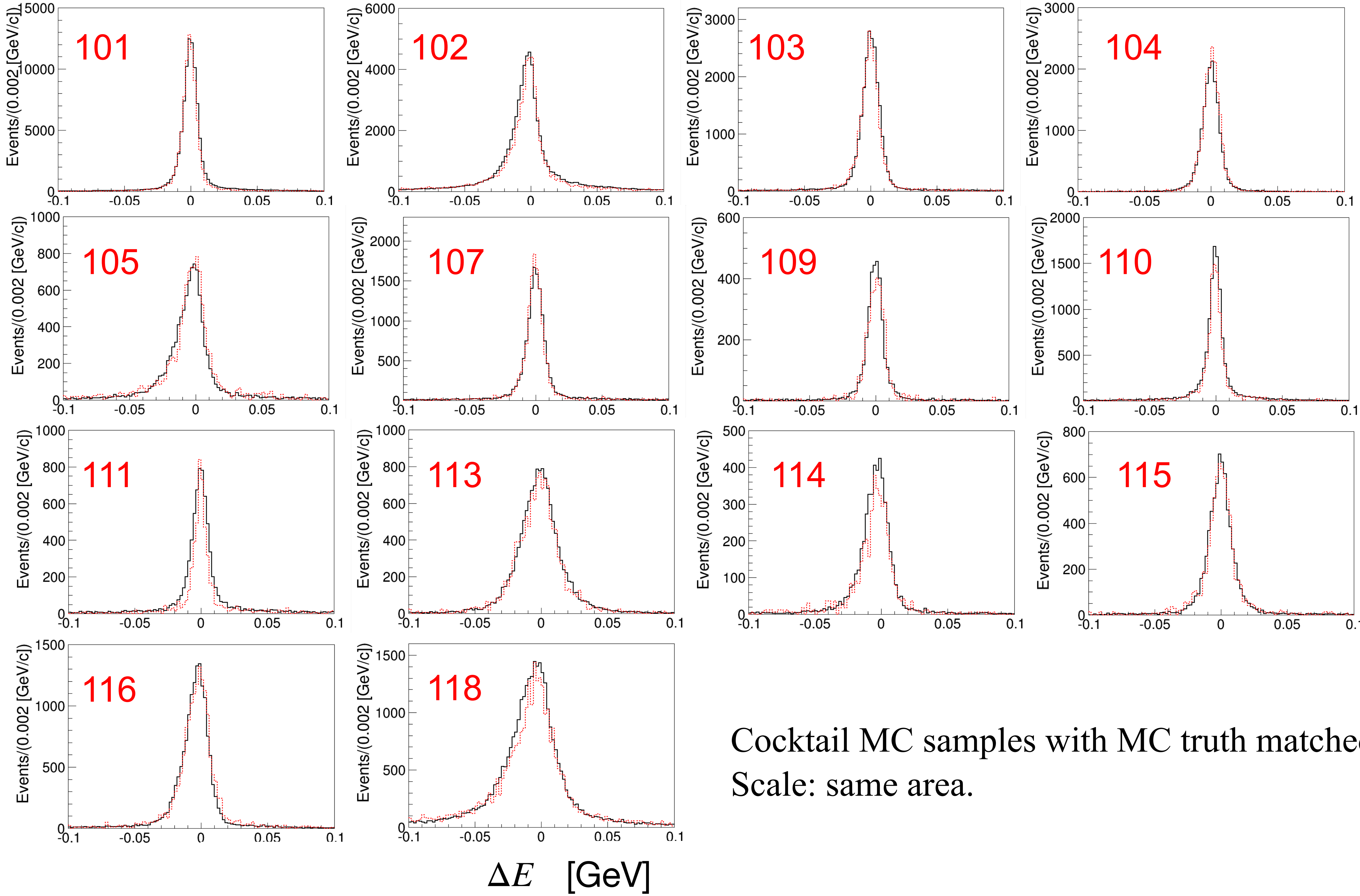
$\pi^-\eta'_{\pi^+\pi^-\eta_{\gamma\gamma}}(115)$

$\pi^-\eta'_{\gamma\rho^0_{\pi^+\pi^-}}(116)$

$\rho^-_{\pi^-\pi^0}\eta_{\gamma\gamma}(118)$

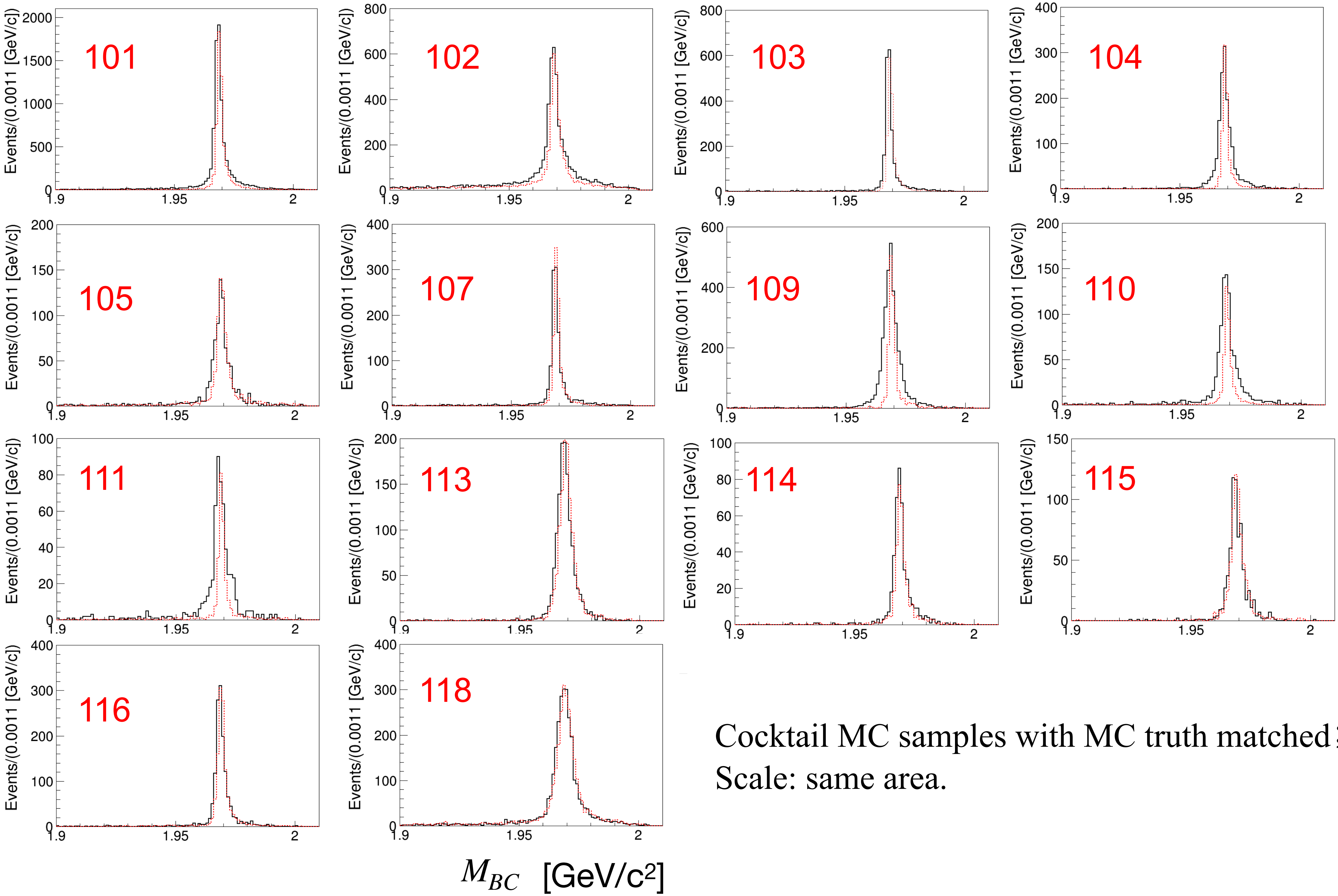
The charge conjugated channels are also implied.

Comparison of ΔE between BESIII and STCF



Cocktail MC samples with MC truth matched；
Scale: same area.

Comparison of M_{BC} between BESIII and STCF



Cocktail MC samples with MC truth matched;
Scale: same area.

Comparison of ST efficiency (%) between BESIII and STCF

Tag mode	STCF (10 rounds)	BESIII
$K^+K^-\pi^-(101)$	39.87±0.22	40.73±0.55
$K^+K^-\pi^-\pi^0(102)$	17.16±0.31	16.53±1.00
$\pi^-\pi^-\pi^+(103)$	51.97±0.90	56.06±2.14
$K^0_SK^-(104)$	43.68±0.46	48.39±0.94
$K^0_SK^-\pi^0(105)$	21.37±0.75	20.25±1.87
$K^-\pi^-\pi^+(107)$	41.11±1.40	45.31±3.73
$K^0_SK^0_S\pi^-(109)$	22.87±1.04	22.58±1.70
$K^0_SK^+\pi^-\pi^-(110)$	22.97±0.62	20.92±0.56
$K^0_SK^-\pi^+\pi^-(111)$	20.03±1.44	19.38±2.05
$\pi^-\eta_{\gamma\gamma}(113)$	49.18±0.71	47.22±1.74
$\pi^-\eta_{\pi^+\pi^-\pi^0}(114)$	30.14±0.70	26.56±1.66
$\pi^-\eta'_{\pi^+\pi^-\eta_{\gamma\gamma}}(115)$	26.32±0.42	23.53±1.00
$\pi^-\eta'_{\gamma\rho^0_{\pi^+\pi^-}}(116)$	32.41±0.64	34.05±1.60
$\rho^-_{\pi^-\pi^0}\eta_{\gamma\gamma}(118)$	21.81±0.34	19.80±0.88

Consistent;
The largest absolute difference is about 5%.

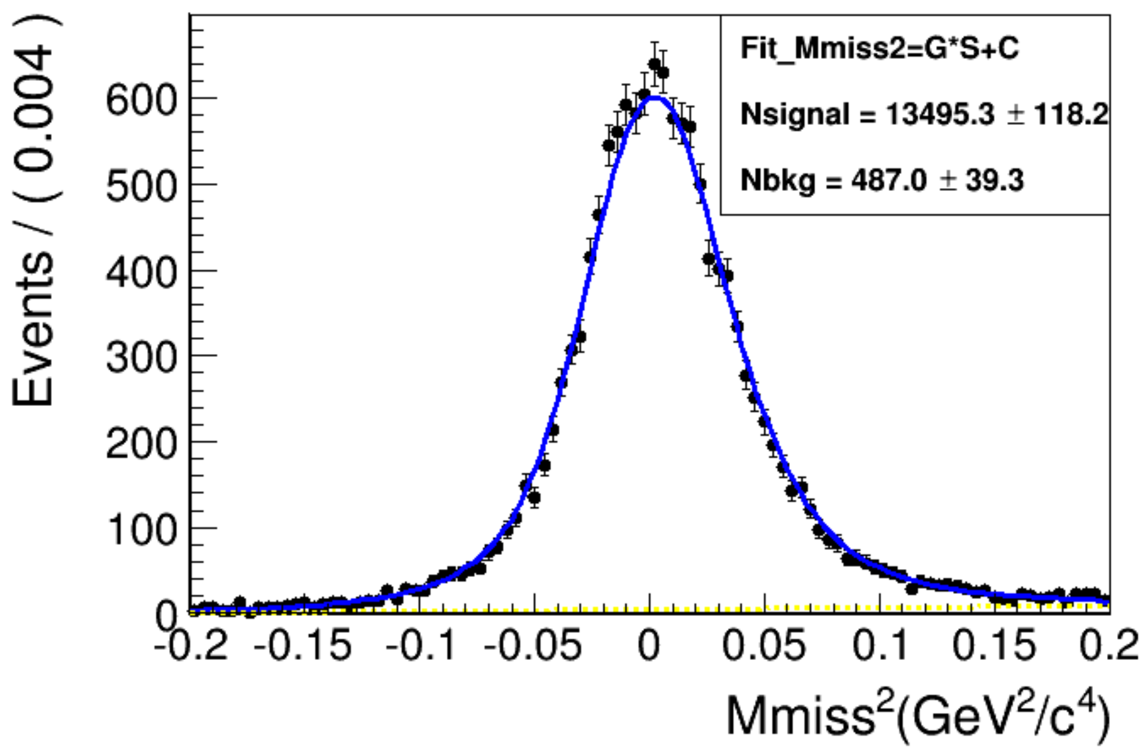
Comparison of DT efficiency (%) with different muon selections at STCF

Tag mode	MUC100	MUC101	MUC102
$K^+K^-\pi^-(101)$	32.17±0.08	28.08±0.04	22.94±0.07
$K^+K^-\pi^-\pi^0(102)$	14.69±0.09	12.56±0.08	10.27±0.08
$\pi^-\pi^-\pi^+(103)$	42.24±0.08	36.16±0.08	29.63±0.08
$K_S^0K^-(104)$	34.75±0.09	29.73±0.09	24.33±0.08
$K_S^0K^-\pi^0(105)$	18.25±0.12	15.58±0.11	12.82±0.10
$K^-\pi^-\pi^+(107)$	36.17±0.16	30.95±0.15	25.17±0.15
$K_S^0K_S^0\pi^-(109)$	19.59±0.19	16.80±0.18	13.59±0.16
$K_S^0K^+\pi^-\pi^-(110)$	19.84±0.11	16.98±0.11	13.91±0.10
$K_S^0K^-\pi^+\pi^-(111)$	18.41±0.07	15.72±0.07	12.85±0.06
$\pi^-\eta_{\gamma\gamma}(113)$	44.11±0.08	37.78±0.08	30.81±0.07
$\pi^-\eta_{\pi^+\pi^-\pi^0}(114)$	25.53±0.07	21.86±0.07	17.90±0.06
$\pi^-\eta'_{\pi^+\pi^-\eta_{\gamma\gamma}}(115)$	22.24±0.07	19.07±0.06	15.57±0.06
$\pi^-\eta'_{\gamma\rho^0_{\pi^+\pi^-}}(116)$	25.95±0.07	22.22±0.07	18.16±0.06
$\rho^-_{\pi^-\pi^0}\eta_{\gamma\gamma}(118)$	18.12±0.06	15.54±0.06	12.69±0.05

The probabilities of pion misidentified as muon for MUC100, 101, 102 are

$$(\frac{1}{30}, \frac{1}{60}, \frac{1}{100}) * prob(\mu)$$
$$> prob(e/K/p)$$

Measured branching fraction at STCF



Combined 14 tag modes

$$E_{\text{miss}} = E_{\text{beam}} - E_{\mu^+}$$

$$\vec{p}_{miss} = -\vec{p}_{tag} - \vec{p}_{\mu^+}$$

$$M^2_{\text{miss}} = E^2_{\text{miss}} - \left|\vec{p}_{\text{miss}}\right|^2$$

DT efficiency: MUC100

The signal efficiency is (83.23±0.27)%.

Sample	Integrated Luminosity	$B(D_s^+ \to \mu^+\nu_\mu)(\times 10^{-3})$
STCF @4.009 GeV	100 fb^{-1}	$5.60 \pm 0.05_{stat}$
BESIII @4.009 GeV [PRD94(2016)072004]	0.482 fb^{-1}	$4.95 \pm 0.67_{stat} \pm 0.26_{syst}$
BESIII @4.178 GeV [PRL122(2019)071802]	3.19 fb^{-1}	$5.49 \pm 0.16_{stat} \pm 0.15_{syst}$

$D_s^+ \to \tau^+\nu_\tau\ (\tau^+ \to e^+\nu_e\bar{\nu}_\tau)$

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Data sets

BOSS version: 703

Method: double tag

Channel: $e^+e^- \to D_s^+ D_s^-$

Signal mode: $D_s^+ \to \tau^+\nu_\tau \ (\tau^+ \to e^+\nu_e\bar{\nu}_\tau)$

11 tag modes:

$D_s^- \to K_S^0 K^-$

$D_s^- \to K_S^0 K^- \pi^+\pi^-$

$D_s^- \to K_S^0 K^+ \pi^-\pi^-$

$D_s^- \to K^+K^-\pi^-$

$D_s^- \to K^+K^-\pi^-\pi^0$

$D_s^- \to K^-\pi^-\pi^+$

$D_s^- \to \pi^-\pi^-\pi^+$

$D_s^- \to \pi^-\eta_{\gamma\gamma}$

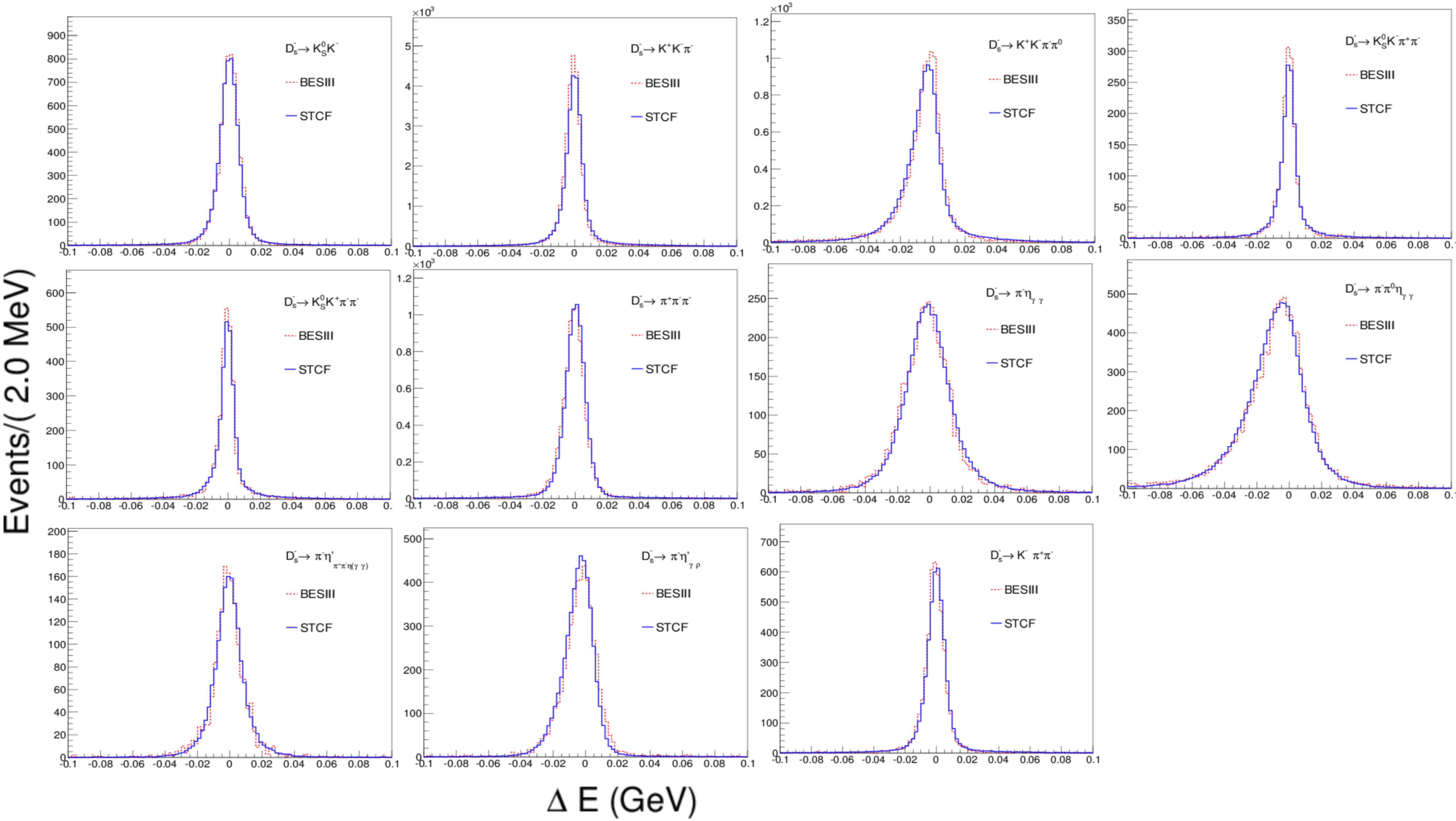
$D_s^- \to \pi^-\eta_{\gamma\gamma}\pi^0$

$D_s^- \to \pi^-\eta'_{\pi^+\pi^-\eta_{\gamma\gamma}}$

$D_s^- \to \pi^-\eta'_{\gamma\rho^0_{\pi^+\pi^-}}$

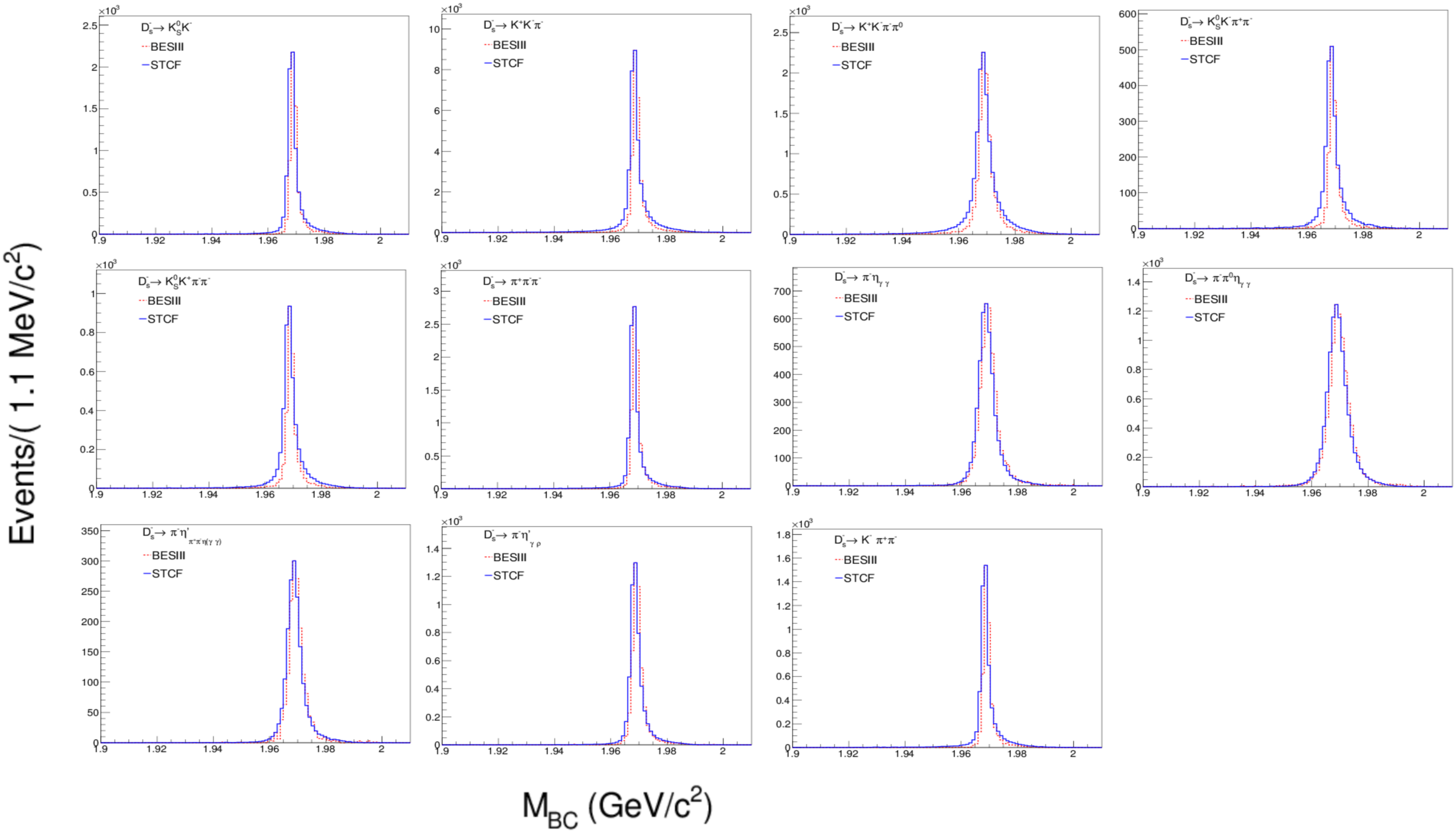
The charge conjugated channels are also implied.

Comparison of ΔE between BESIII and STCF



Cocktail MC samples with MC truth matched.
Scale: same area.

Comparison of M_{BC} between BESIII and STCF



Cocktail MC samples with MC truth matched；

Scale: same area

Comparison of ST efficiency (%) between BESIII and STCF

Consistent;
The largest absolute difference is about 7%.

Mode	$\epsilon_{\rm ST}^{\rm STCF}$ (%)	$\epsilon_{\rm ST}^{\rm BESIII}$ (%)	$\epsilon_{\rm ST}^{\rm BESIII\ PRD94(2016)072004}$
$D_s^- \to K_S^0 K^-$	28.11 ± 0.09	34.78 ± 0.52	32.36 ± 0.24
$D_s^- \to K^+ K^- \pi^-$	42.53 ± 0.07	41.38 ± 0.34	42.45 ± 0.18
$D_s^- \to K^+ K^- \pi^- \pi^0$	15.29 ± 0.07	11.99 ± 0.36	12.56 ± 0.21
$D_s^- \to K_S^0 K^- \pi^+ \pi^-$	12.82 ± 0.23	13.04 ± 0.96	
$D_s^- \to K_S^0 K^+ \pi^- \pi^-$	14.64 ± 0.11	14.80 ± 0.50	16.17 ± 0.25
$D_s^- \to \pi^+ \pi^- \pi^-$	55.98 ± 0.25	57.38 ± 1.30	58.27 ± 0.87
$D_s^- \to \pi^- \eta_{\gamma\gamma}$	19.39 ± 0.08	18.47 ± 0.49	18.26 ± 0.26
$D_s^- \to \pi^- \pi^0 \eta_{\gamma\gamma}$	9.97 ± 0.05	7.92 ± 0.32	9.62 ± 0.12
$D_s^- \to \pi^- \eta'_{\pi^+\pi^-\eta(\gamma\gamma)}$	4.19 ± 0.02	3.20 ± 0.10	4.67 ± 0.08
$D_s^- \to \pi^- \eta'_{\gamma\rho^0}$	10.27 ± 0.06	9.87 ± 0.30	12.09 ± 0.25
$D_s^- \to K^- \pi^+ \pi^-$	47.01 ± 0.38	48.25 ± 1.88	

The branching fractions of sub-particles decays is included.

Comparison of ST efficiency(%) with $D_s^+ \to \mu^+\nu_\mu$analysis

Mode	$D_s^+ \to \mu^+\nu_\mu$ (10x)	$D_s^+ \to \tau^+\nu_\tau$ (59x)
$D_s^- \to K_S^0 K^-$	43.68 ± 0.46	40.62 ± 0.12
$D_s^- \to K^+ K^- \pi^-$	39.87 ± 0.22	42.53 ± 0.07
$D_s^- \to K^+ K^- \pi^- \pi^0$	17.16 ± 0.31	15.47 ± 0.07
$D_s^- \to K_S^0 K^- \pi^+ \pi^-$	20.03 ± 1.44	18.53 ± 0.33
$D_s^- \to K_S^0 K^+ \pi^- \pi^-$	22.97 ± 0.62	21.15 ± 0.16
$D_s^- \to \pi^+ \pi^- \pi^-$	51.97 ± 0.90	55.98 ± 0.25
$D_s^- \to \pi^- \eta_{\gamma\gamma}$	49.18 ± 0.71	49.19 ± 0.19
$D_s^- \to \pi^- \pi^0 \eta_{\gamma\gamma}$	21.81 ± 0.34	25.60 ± 0.12
$D_s^- \to \pi^- \eta'_{\pi^+\pi^-\eta(\gamma\gamma)}$	26.32 ± 0.42	24.94 ± 0.12
$D_s^- \to \pi^- \eta'_{\gamma\rho^0}$	32.41 ± 0.64	35.53 ± 0.20
$D_s^- \to K^- \pi^+ \pi^-$	41.11 ± 1.40	47.01 ± 0.38

Consistent;
The largest absolute difference is about 6%.

The branching fractions of sub-particles decays is not included.

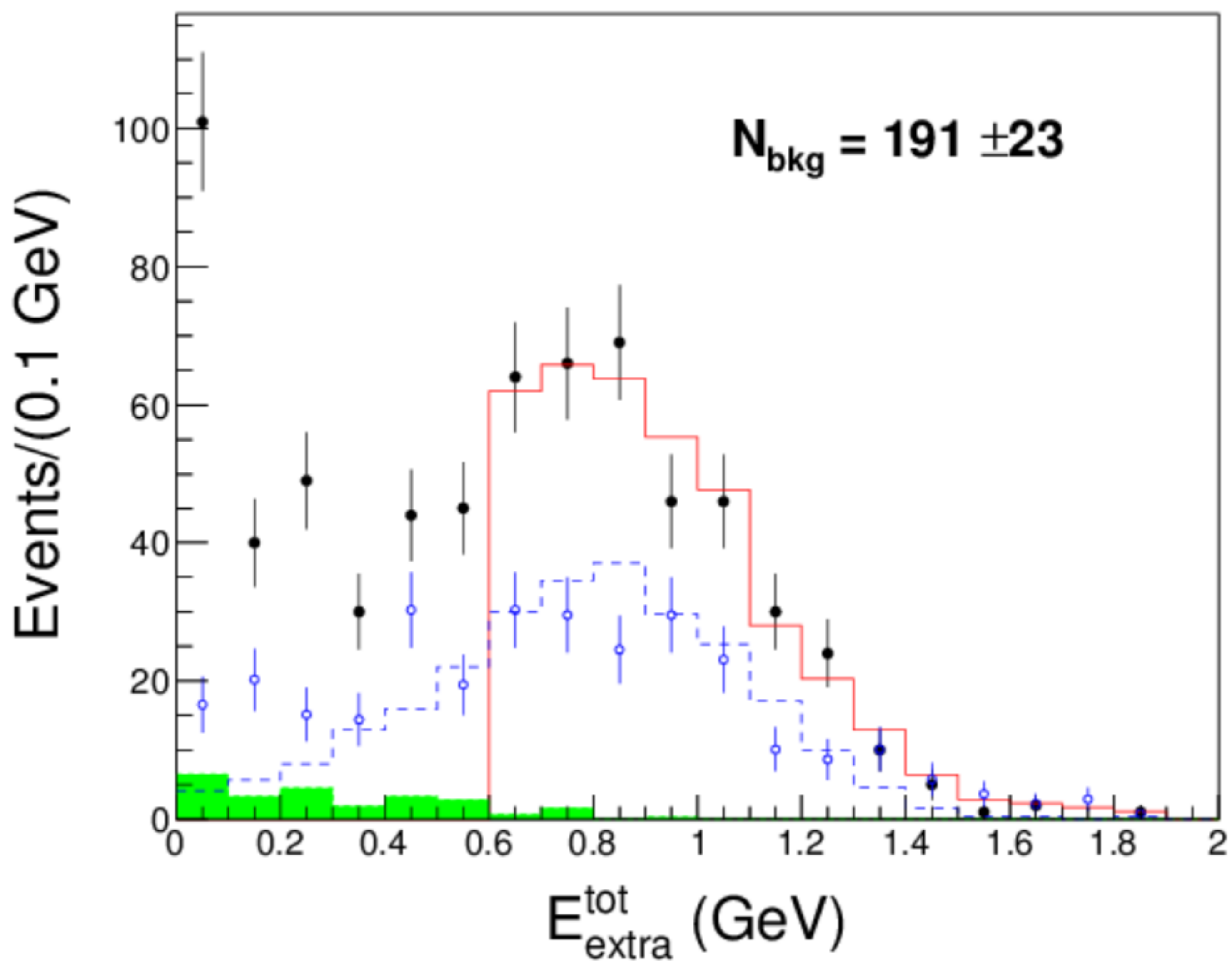
Comparison of Signal efficiency between BESIII and STCF

Mode	STCF(%)	BESIII(%)
$D_s^- \to K_S^0 K^-$	66.62	71.61
$D_s^- \to K^+ K^- \pi^-$	65.12	66.05
$D_s^- \to K^+ K^- \pi^- \pi^0$	64.99	59.47
$D_s^- \to K_S^0 K^- \pi^+ \pi^-$	67.63	63.86
$D_s^- \to K_S^0 K^+ \pi^- \pi^-$	67.86	64.76
$D_s^- \to \pi^+ \pi^- \pi^-$	68.54	72.45
$D_s^- \to \pi^- \eta_{\gamma\gamma}$	68.64	72.08
$D_s^- \to \pi^- \pi^0 \eta_{\gamma\gamma}$	68.46	69.26
$D_s^- \to \pi^- \eta'_{\pi^+\pi^-\eta(\gamma\gamma)}$	68.26	70.21
$D_s^- \to \pi^- \eta'_{\gamma\rho^0}$	68.39	72.31
$D_s^- \to K^- \pi^+ \pi^-$	66.90	70.55

Fitting result of DT side at BESIII

Definition of E^{tot}_{extra}:

The total energies of the good showers, except for the photons used in the tag side.

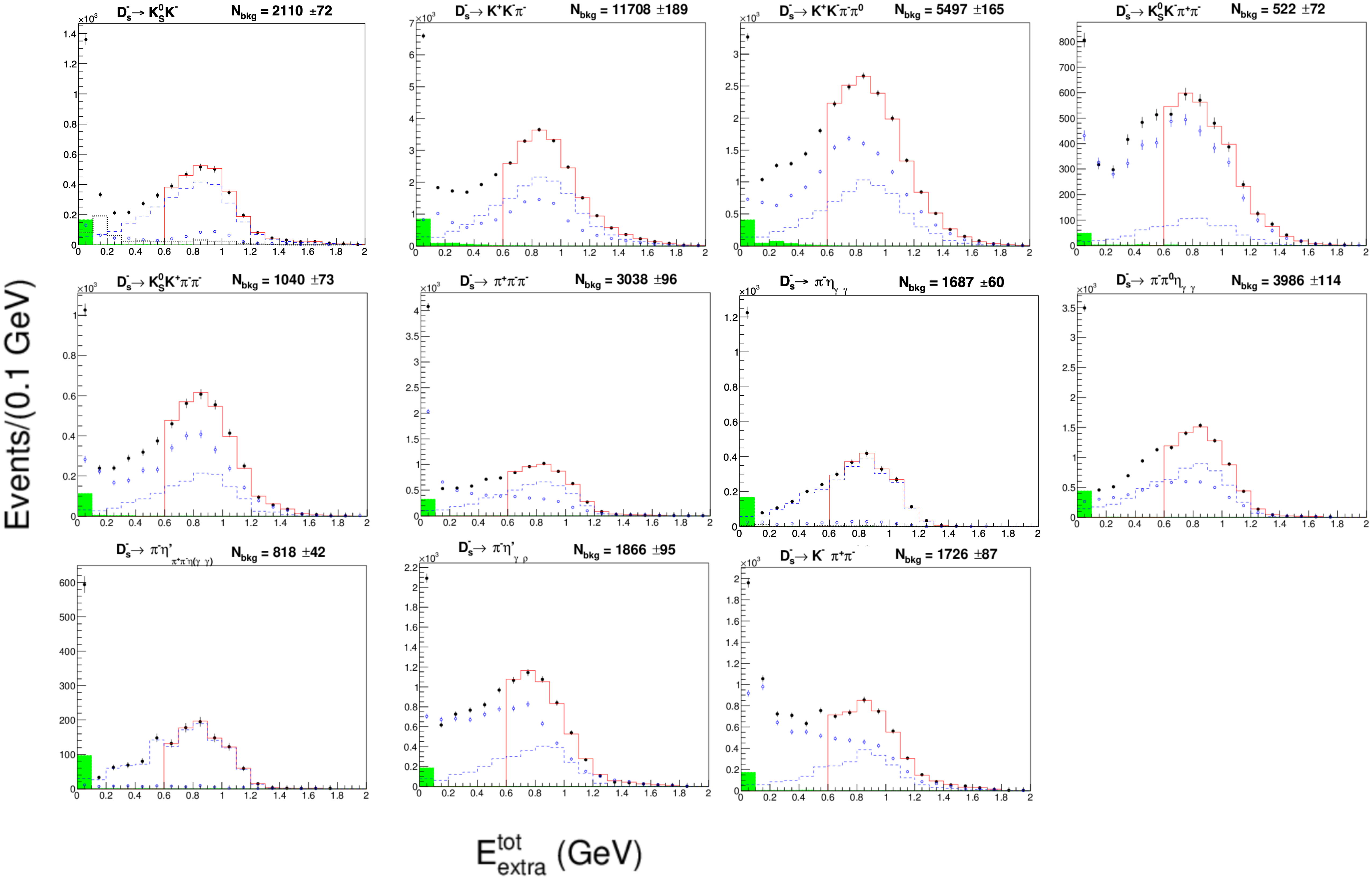


Combine 11 tag modes

Solid dots: data 0.482 fb^{-1}
Open dots with error bar: M_{BC} sideband (fix);
Dashed blue: D_s^+ semileptonic decay (float)
Shaded green: $D_s^+ \to K_L^0 e^+ \nu_e$ decay (fix);
Solid red line: fit results

$$N^{sig}_{DT} = N^{tot}_{sig} - f_1 \cdot N_{\text{Class I}} - N_{\text{Class II}} - f_2 \cdot N_{\text{Class III}},$$

Fitting result of DT side at STCF



Measured branching fraction

Mode	STCF (%)
$D_s^- \to K_S^0 K^-$	4.75 ± 0.25
$D_s^- \to K^+ K^- \pi^-$	4.89 ± 0.10
$D_s^- \to K^+ K^- \pi^- \pi^0$	3.82 ± 0.13
$D_s^- \to K_S^0 K^- \pi^+ \pi^-$	4.59 ± 0.74
$D_s^- \to K_S^0 K^+ \pi^- \pi^-$	5.15 ± 0.38
$D_s^- \to \pi^+ \pi^- \pi^-$	3.35 ± 0.32
$D_s^- \to \pi^- \eta_{\gamma\gamma}$	4.79 ± 0.21
$D_s^- \to \pi^- \pi^0 \eta_{\gamma\gamma}$	4.34 ± 0.13
$D_s^- \to \pi^- \eta'_{\pi^+\pi^-\eta(\gamma\gamma)}$	4.23 ± 0.29
$D_s^- \to \pi^- \eta'_{\gamma\rho^0}$	3.50 ± 0.32
$D_s^- \to K^- \pi^+ \pi^-$	4.69 ± 0.46
Average	4.45 ± 0.06

← Weighted by the statistical error

Sample	Integrated Luminosity	$B(D_s^+ \to \tau^+ \nu_\tau)(\times 10^{-2})$
STCF @4.009 GeV	100 fb^{-1}	$4.45 \pm 0.06_{stat}$
BESIII @4.009 GeV $\tau^+ \to e^+ \nu_e \bar{\nu}_\tau$	0.482 fb^{-1}	$4.07 \pm 0.61_{stat}$
BESIII @4.009 GeV [PRD94(2016)072004] $\tau^+ \to \pi^+ \bar{\nu}_\tau$	0.482 fb^{-1}	$4.83 \pm 0.65_{stat} \pm 0.26_{syst}$
PDG（2018）		5.48 ± 0.23

2. $D^0 \to K_1(1270)^- e^+ \nu_e$

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2. 中科大

Motivation

1. The photon helicity in $b \to s\gamma$ is predominantly left handed, and thereby, its measurement plays a unique role in probing right-handed coupling in new physics.
2. Help to measure photon helicity in a model-independent way:

[PRL125(2020)051802]

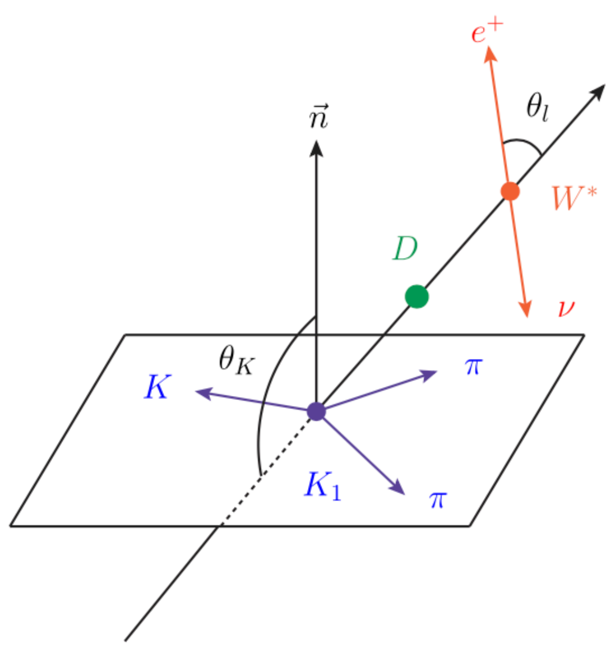


FIG. 1. Kinematics for $D \to K_{\rm res}(\to K\pi\pi)e^+\nu$. The relative angle between the normal direction of the $K_{\rm res}$ decay plane and the opposite of D flight direction in the $K_{\rm res}$ rest frame is denoted as θ_K, while θ_l is introduced as the relative angle between the flight directions of e^+ in the $e^+\nu$ rest frame and the $e^+\nu$ in the D rest frame.

$$\lambda_\gamma = \frac{4}{3}\frac{\mathcal{A}_{\rm UD}}{\mathcal{A}'_{\rm UD}}$$

$\mathcal{A}_{\rm UD}$ → $B \to K_1\gamma$

$\mathcal{A}'_{\rm UD}$ → $D \to K_1 e^+\nu$

Up-down asymmetry

$$\mathcal{A}'_{\rm UD} \equiv \frac{\Gamma_{K_1 e\nu_e}[\cos\theta_K > 0] - \Gamma_{K_1 e\nu_e}[\cos\theta_K < 0]}{\Gamma_{K_1 e\nu_e}[\cos\theta_l > 0] - \Gamma_{K_1 e\nu_e}[\cos\theta_l < 0]}$$

In SM:

$$A'_{UD} = (9.2 \pm 2.3) \times 10^{-2}$$

Data sets

Method: double tag

Channel: $e^+e^- \to \psi(3773) \to D^0\bar{D}^0$ @ 3.773 GeV

Signal mode： $D^0 \to K_1(1270)^- e^+ \nu_e$, $K_1(1270)^- \to K^-\pi^+\pi^-$

Three tag modes:

$$\bar{D}^0 \to K^+\pi^-$$

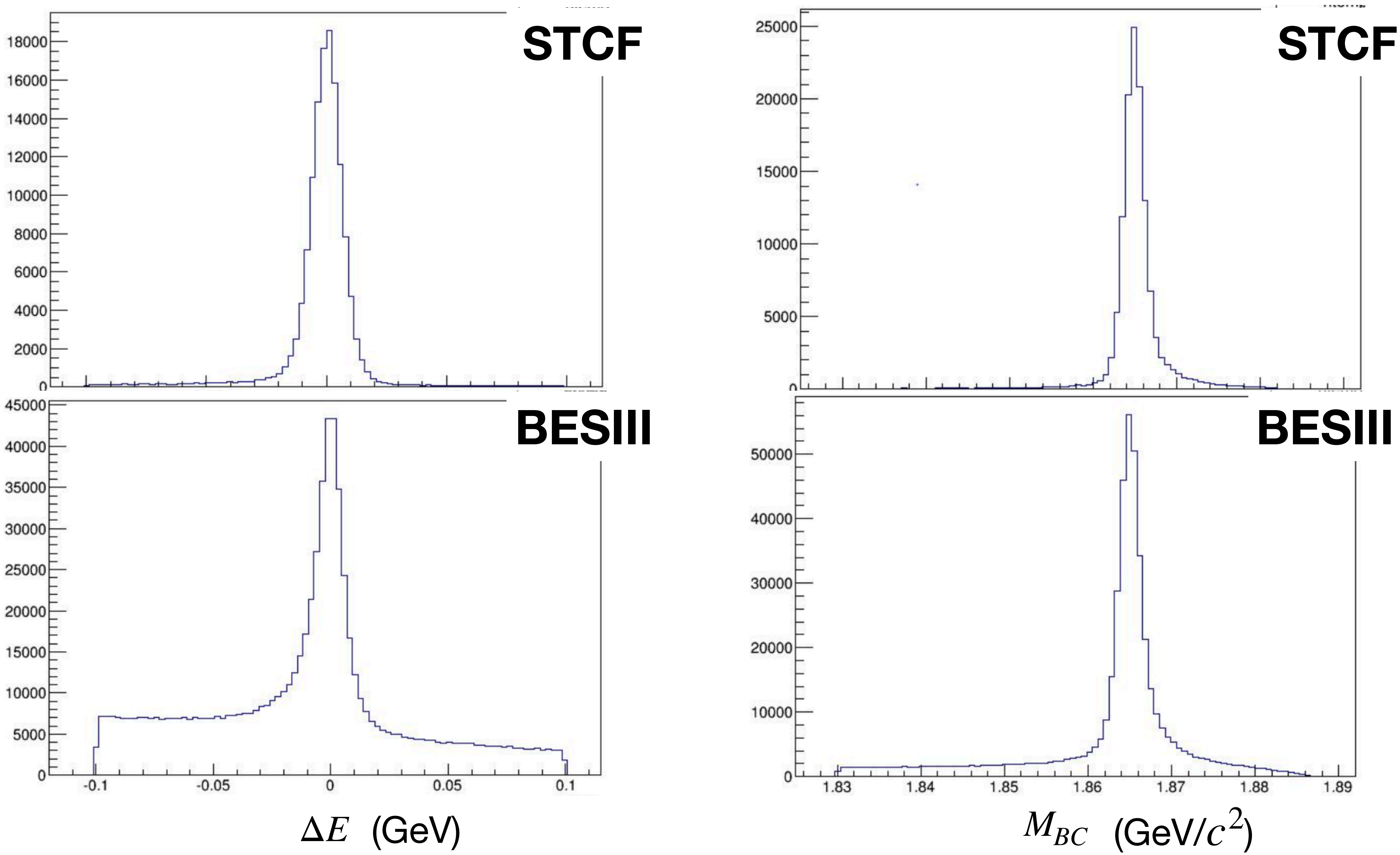
$$\bar{D}^0 \to K^+\pi^-\pi^0$$

$$\bar{D}^0 \to K^+\pi^-\pi^+\pi^-$$

The charge conjugated channels are also implied.

Comparisons of ΔE and M_{BC} between BESIII and STCF

$\bar{D}^0 \to K^+\pi^-$



Comparisons of ST efficiency (%) between BESIII and STCF

From signal MC

Mode	STCF	BESIII
$\bar{D}^0 \to K^+\pi^-$	63.42	65.77
$\bar{D}^0 \to K^+\pi^-\pi^0$	40.40	35.52
$\bar{D}^0 \to K^+\pi^-\pi^+\pi^-$	45.41	46.84

From inclusive MC

Mode	STCF	BESIII	BESIII[PRL122(2019)011804]
$\bar{D}^0 \to K^+\pi^-$	59.15 ± 0.03	66.09 ± 0.09	65.37 ± 0.09
$\bar{D}^0 \to K^+\pi^-\pi^0$	38.59 ± 0.02	34.99 ± 0.05	34.67 ± 0.04
$\bar{D}^0 \to K^+\pi^-\pi^+\pi^-$	41.22 ± 0.02	38.89 ± 0.05	38.20 ± 0.06

$3. D \to K^0_{S/L}\pi^+\pi^-$

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Physics in Quantum Coherent $D^0 - \bar{D}^0$ @4.009 GeV

- Use quantum-coherent $D^0 - \bar{D}^0$ sample to extract strong-phase difference in $K^0_{S/L}\ \pi^+\pi^-$, help to improve the precision of CKM angle γ.
- C-even QC $D^0 - \bar{D}^0$ will help to perform time-independent measurement of D^0 mixing parameter x,y related CPV parameter.

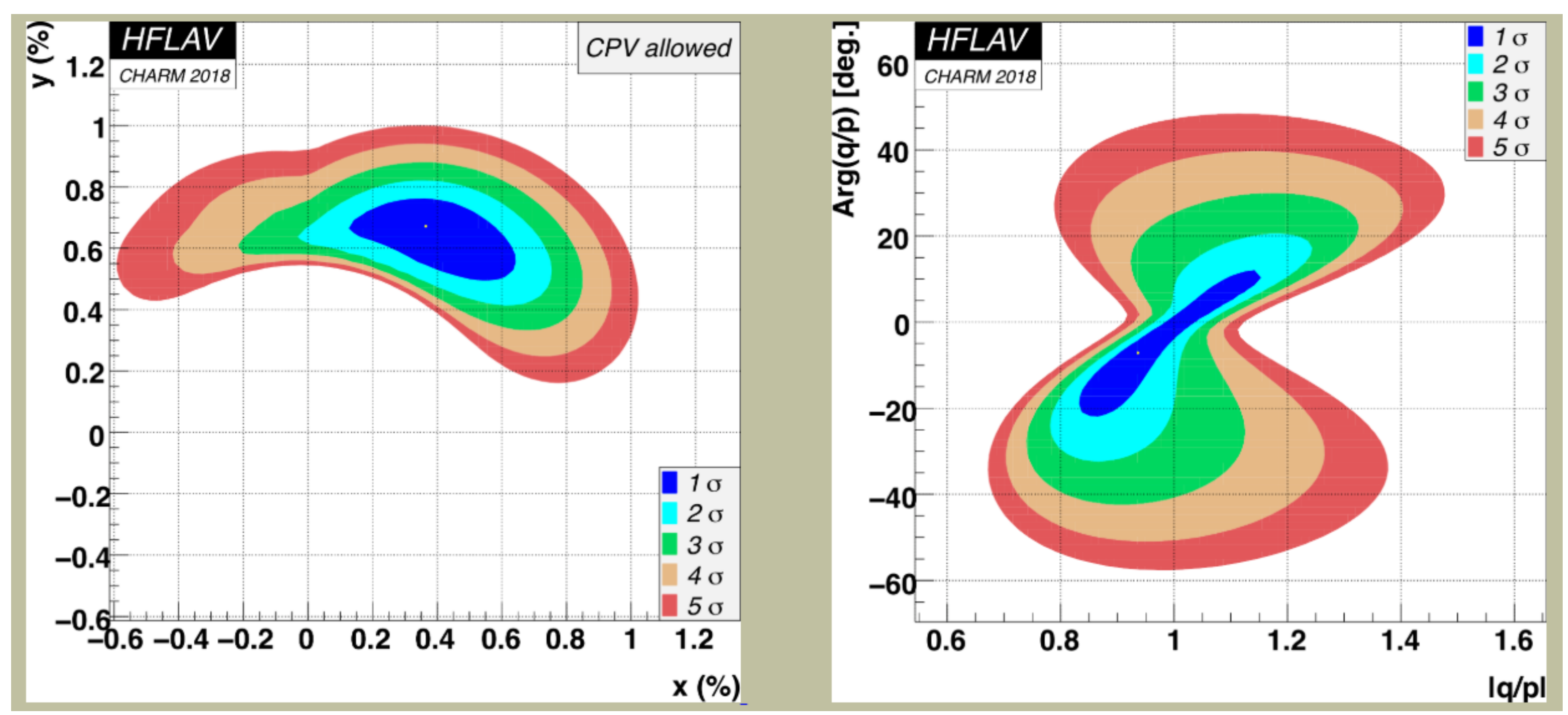
Phases of CKM elements: *Moriond 2018*

$\beta = \varphi_1 = arg\left(-\frac{V_{cd}V^*_{cb}}{V_{td}V^*_{tb}}\right)$ $\beta = (22.0 \pm 0.7)^o$

$\alpha = \varphi_2 = arg\left(-\frac{V_{td}V^*_{tb}}{V_{ud}V^*_{ub}}\right)$ $\alpha = (84.9^{+5.1}_{-4.5})^o$

$\gamma = \varphi_3 = arg\left(-\frac{V_{ud}V^*_{ub}}{V_{cd}V^*_{cb}}\right)$ $\gamma = (73.5^{+4.2}_{-5.1})^o$

~ an order of magnitude worse than that on β.



Data sets

BOSS version: 703

Method: double tag

Channel: $e^+e^- \to D^{*0}\bar{D}^0 \to D^0\bar{D}^0\pi^0/\gamma$ @4.009 GeV

Signal mode: $D_1 \to K^0_{S/L}\,\pi^+\pi^-$

14 tag modes:

Mixed CP tag	**Flavor tags**	**$CP-$even tags**	**$CP-$odd tags**
$D_2 \to K^0_S\pi^+\pi^-$	$K^+\pi^-$	K^+K^-	$K^0_S\pi^0$
	$K^+\pi^-\pi^0$	$\pi^+\pi^-$	$K^0_S\eta_{\gamma\gamma}$
	$K^+\pi^-\pi^-\pi^+$	$\pi^+\pi^-\pi^0$	$K^0_S\eta_{\pi^+\pi^-\pi^0}$
		$K^0_S\pi^0\pi^0$	$K^0_S\eta'_{\gamma\pi^+\pi^-}$
			$K^0_S\eta'_{\pi^+\pi^-\eta}$
			$K^0_S\omega$

The charge conjugated channels are also implied.

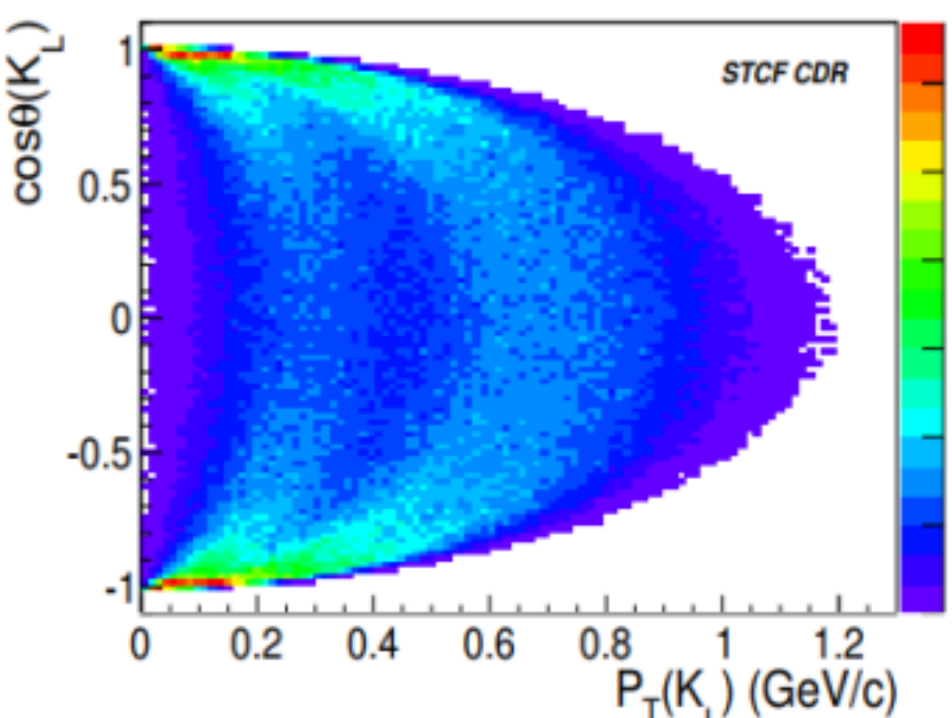
Event selection

- Based on BESIII MC, data.
- Best $D^0\bar{D}^0$ candidate is selected with the least $\Delta m \equiv \frac{m_{D_1} + m_{D_2}}{2} - m_{D^0}$
- Other two variables considered as cut variables.

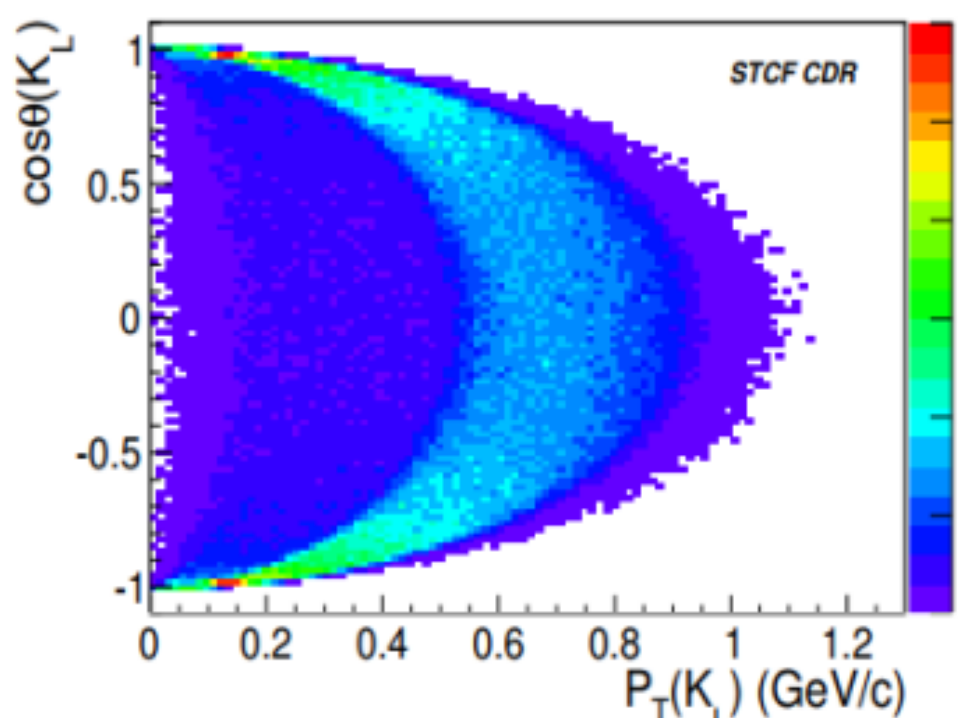
$$\Delta E = E_{CMS} - E_{D_1} - E_{D_2}$$

$$MM^2(recDD) = (E_{CMS} - E_{D_1} - E_{D_2})^2 - \left| p_{D_1} + p_{D_2} \right|^2$$

CP Tag



flavor Tag



Comparison of DT efficiency between 4.009 GeV and 3.773 GeV

vs. signal side is $K_S^0\pi^+\pi^-$

	Mode[BESIII]	4.009 GeV (%)	3.773 GeV(%) [PRD101(2020)112002]
Mixed CP tag	$K_S^0\pi^+\pi^-$	16.90	18.53 ± 0.06
Flavor tags	$K^+\pi^-$	23.51	27.28 ± 0.07
	$K^+\pi^-\pi^0$	12.86	14.45 ± 0.05
	$K^+\pi^-\pi^-\pi^+$	14.04	13.75 ± 0.05
$CP-$even tags	K^+K^-	22.74	25.97 ± 0.07
	$\pi^+\pi^-$	23.51	27.27 ± 0.07
	$\pi^+\pi^-\pi^0$	13.50	14.28 ± 0.06
	$K_S^0\pi^0\pi^0$	6.08	6.47 ± 0.03
$CP-$odd tags	$K_S^0\pi^0$	13.26	14.84 ± 0.05
	$K_S^0\eta_{\gamma\gamma}$	11.70	12.86 ± 0.05
	$K_S^0\eta_{\pi^+\pi^-\pi^0}$	4.27	6.98 ± 0.03
	$K_S^0\eta'_{\gamma\pi^+\pi^-}$	8.33	9.87 ± 0.03
	$K_S^0\eta'_{\pi^+\pi^-\eta}$	5.62	5.06 ± 0.02
	$K_S^0\omega$	4.07	6.30 ± 0.03

Preliminary estimation of the precision of mixing and CPV parameters

$N = L * \sigma * \epsilon$

- Luminosity: 1 /ab;
- D^0 decay mode: $K_S\pi\pi, K\pi, K\pi\pi^0, K3\pi, Kl\nu_l$;
- Least χ^2 fit method is used to extract mixing and CPV parameters.

$$x_D = \frac{m_2 - m_1}{\Gamma}, \quad y_D = \frac{\Gamma_2 - \Gamma_1}{2\Gamma},$$

$$r_{CP}e^{i\alpha_{CP}} = q/p.$$

$$D_{1,2} = pD^0 \pm q\overline{D}^0,$$

	C-even sample (1/ab)	HFLAV2019
σ (x)	0.036%	0.11%
σ (y)	0.023%	0.063%
σ (r_{CP})	0.017	0.045
σ (α_{CP})	0.023rad	0.078rad

statistical error only

Summary and next to do

1. The precision of the measured branching fraction is consistent with the value evaluated from BESIII for $D_s^+ \to l^+\nu_l$ analyses;
2. The single tag has been done for $D^0 \to K_1(1270)^- e^+\nu_e$;
3. Preliminary precision estimation of mixing and CPV parameters has been done for $D \to K_S^0\pi^+\pi^-$.

Next to do:

1. Optimize tracking and PID efficiencies for K/π in ST side, and resolutions of energy and position for photons in $D_s^+ \to l^+\nu_l$ analyses;
2. Finish the double tag study for $D^0 \to K_1(1270)^- e^+\nu_e$;
3. Improve the $D \to K_S^0\pi^+\pi^-$ decay, and study $D \to K_L^0\pi^+\pi^-$ decay.

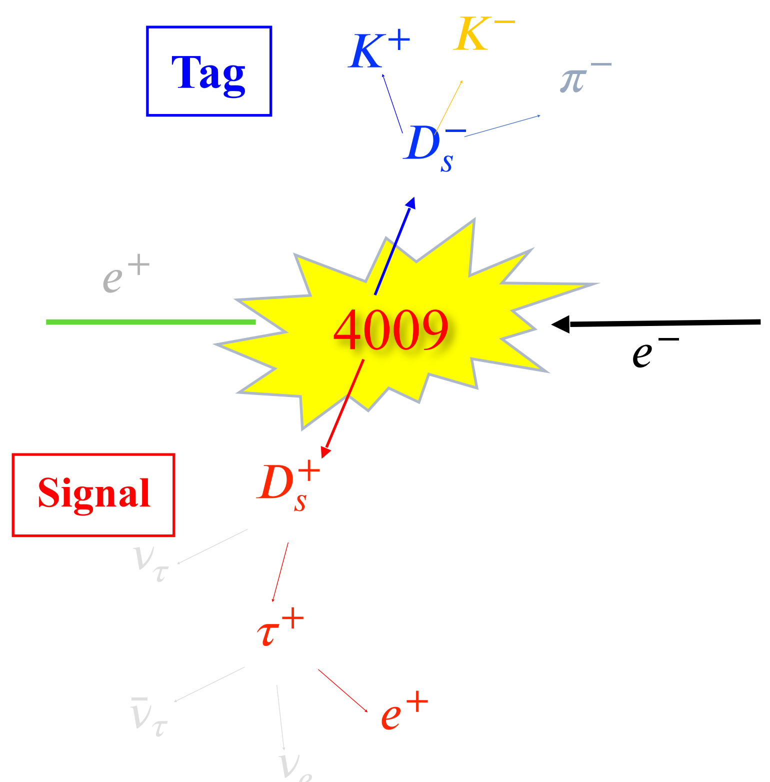
Back up

$D^{0(+)}$ and D_s^+ data set at BESIII

- $D^{0(+)}$ data:
  - Taken @ E_{cm} = 3.773 GeV.
  - Integrated luminosity = 2.93 fb^{-1}
    (The world's largest e^+e^- annihilation sample taken at the mass-threshold).
  - cross section: $\sigma(e^+e^- \to D^0\bar{D}^0)$ ~ 3.6 nb ⇒ 21 M D^0 produced!
  - cross section: $\sigma(e^+e^- \to D^+D^-)$ ~ 2.9 nb ⇒ 16 M D^+ produced!

- D_s^+ data:
  - @E_{cm} = 4.009 GeV.
    - Integrated luminosity = 0.482 fb^{-1}
    - $\sigma(e^+e^- \to D_s^+D_s^-)$ ~ 0.3 nb ⇒ 0.3 M D_s produced.
    - D_s is produced in pair with equal mass.
  - @E_{cm} = 4.178 GeV.
    - Based on the data accumulated in 2016!
    - Integrated luminosity = 3.19 fb^{-1}
    - $\sigma(e^+e^- \to D_s^*D_s)$ ~ 1 nb ⇒ ~ 6 M D_s produced!!

Analysis method



$$N_{\rm tag} = 2\, N_{D_sD_s}\, B_{\rm tag}\, \epsilon_{\rm tag}\ ;$$

$$N_{\rm sig} = 2\, N_{D_sD_s}\, B_{\rm tag}\, B_{\rm sig} B_{\tau^+\to e^+\nu_e\bar{\nu}_\tau}\, \epsilon_{\rm tag,\ sig}$$

$$B_{\rm sig} = \frac{N_{\rm sig}\, \epsilon_{\rm tag}}{N_{\rm tag}\, \epsilon_{\rm tag,sig}\, B_{\tau^+\to e^+\nu_e\bar{\nu}_\tau}}$$

$N_{D_sD_s}$: the number of D_sD_s pairs;

$B_{\rm tag}$: branching fraction of $D_s^- \to$ a tag mode;

$B_{\rm sig}$: branching fraction of $D_s^+ \to \tau^+\nu_\tau$;

$N_{\rm tag}$: ST yield;

$N_{\rm sig}$: DT yield;

$\epsilon_{\rm tag}$: ST efficiency;

$\epsilon_{\rm tag,\ sig}$: DT efficiency.

Obtained in the analysis.

The difference of MC sample between BESIII and STCF

From BESIII:

1. 包含子探测器的响应信息

From STCF:

1. 快模拟
2. 真实的信息
3. 无假光子