超级陶粲装置
Super Tau-Charm Facility

Ξ超子CP破坏模拟研究

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Outline

- Introduction
- Formalism & MC production
- Event selection
- BESIII & STCF comparisons
- Extract parameters
- Estimate statistical uncertainty
- Summary

Introduction

- CP violation(CPV) has been observed in K, B, D meson systems and Λ_b^0 baryon system. However, further searches for CPV in other baryon decays remain crucial for discovering additional sources of CPV beyond the Standard Model.
- Measurement of asymmetry parameters of hyperon weak decay can be used to test the CP violation

$$\alpha = \frac{2Re\left(A_S^* \cdot A_p\right)}{|A_S|^2 + |A_P|^2} \qquad \frac{dN}{d\Omega} \propto 1 + \alpha \overrightarrow{P_Y} \cdot \hat{p}_d \qquad A_{CP} = \frac{\alpha + \bar{\alpha}}{\alpha - \bar{\alpha}}$$

($\mathcal{O}^{\Xi} \sim 10^{-5}$)

Phys.Rev.D 67 (2003) 056001

- The multi-step decay chain $e^+e^- \rightarrow J/\psi \rightarrow \Xi^-\bar{\Xi}^+$ offers us much more experimental information than Λ decay. And this decay features a multi-particle final state, making it useful for evaluating OSCAR's performance.

Formalism & MC production

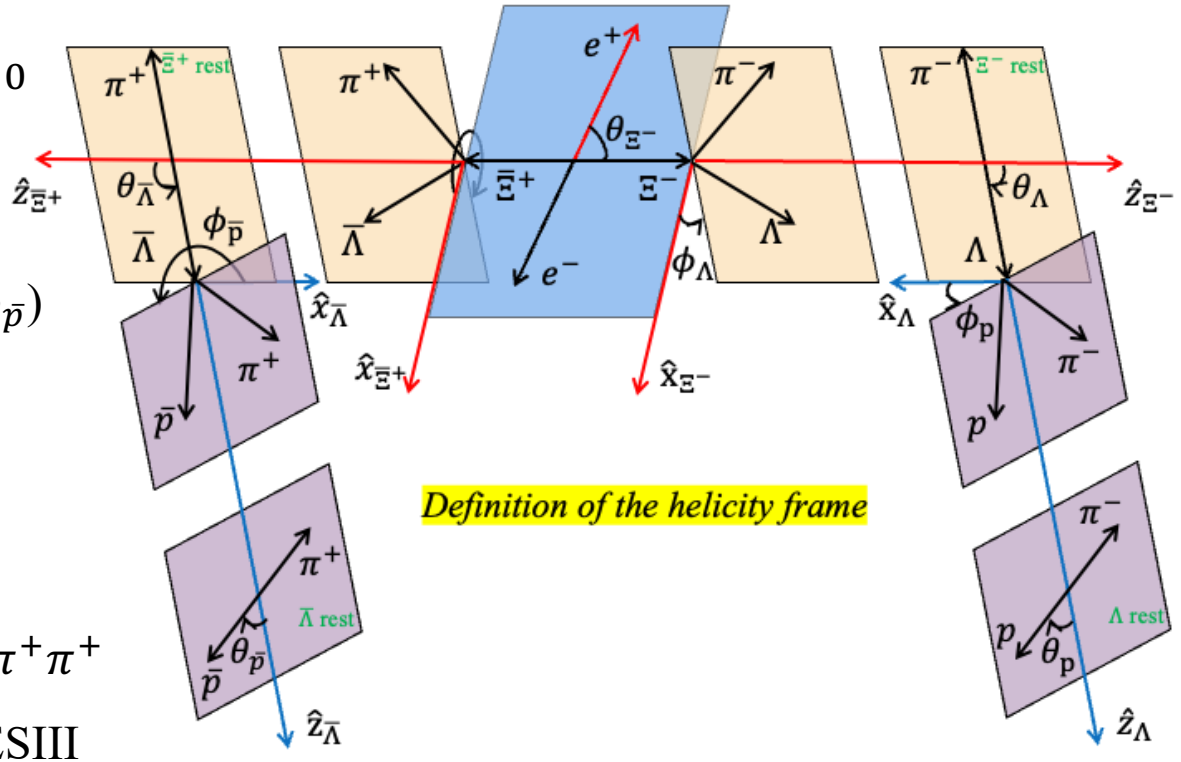
- Angular distribution:

  Phys. Rev. D 99, 056008 (2019)

$$\mathcal{W}(\xi;\omega) = \sum_{\mu,\bar{\nu}=0}^{3}\sum_{\mu'=0}^{3}\sum_{\bar{\nu}'=0}^{3} C_{\mu\bar{\nu}} a^{\Xi}_{\mu\mu'} a^{\Lambda}_{\mu'0} a^{\bar{\Xi}}_{\bar{\nu}\bar{\nu}'} a^{\bar{\Lambda}}_{\bar{\nu}'0}$$

  - Parameters: $(\alpha_{J/\psi},\ \Delta\Phi,\ \alpha_{\Xi},\ \bar{\alpha}_{\Xi},\ \phi_{\Xi},\ \bar{\phi}_{\Xi},\ \alpha_{\Lambda},\ \bar{\alpha}_{\Lambda})$
  - Helicity angles: $(\theta_{\Xi},\ \theta_{\Lambda},\ \phi_{\Lambda},\ \theta_{\bar{\Lambda}},\ \phi_{\bar{\Lambda}},\ \theta_{p},\ \phi_{p},\ \theta_{\bar{p}},\ \phi_{\bar{p}})$

- Signal MC production
  - OSCAR version: 2.6.2 updated (git download date:2025/06/25)
  - Signal channel: $J/\psi \to \Xi^-\bar{\Xi}^+ \to \Lambda\pi^-\bar{\Lambda}\pi^+ \to p\pi^-\pi^-\bar{p}\pi^+\pi^+$
  - 0.2 million DIYMC with the input parameters from BESIII publication *Nature 606, 64–69 (2022)*



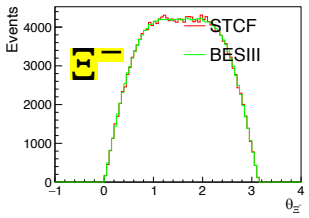
Event selection

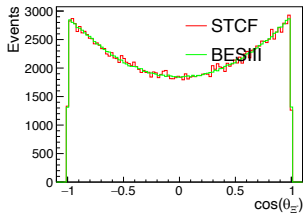
- Charged tracks
  - $|cos\theta| < 0.93$
  - No requirement for vertex
  - $N_{\mathrm{poz}} \geq 3$ & $N_{\mathrm{neg}} \geq 3$
- Proton and pion selection:
  - For N_{poz}:
    - p: $p > 0.3$ GeV/c
    - π^+: $p < 0.3$ GeV/c
  - For N_{neg}:
    - $\bar{p}$: $p > 0.3$ GeV/c
    - π^-: $p < 0.3$ GeV/c
- Λ、Ξ^- reconstruction
  - Loop p and π^- candidates
  - Λ : vertex fit
  - Ξ^-: vertex fit and second vertex fit
  - The best Λ and Ξ^- candidates from combination with minimum $\sqrt{\left(m_{p\pi^-} - M_\Lambda\right)^2 + \left(m_{p\pi^-\pi^-} - M_\Xi\right)^2}$
- $\bar{\Lambda}$、$\bar{\Xi}^+$ reconstruction
  - Loop $\bar{p}$ and π^+ candidates
  - $\bar{\Lambda}$: vertex fit
  - $\bar{\Xi}^+$: vertex fit and second vertex fit
  - The best $\bar{\Lambda}$ and $\bar{\Xi}^+$ candidates from combination with minimum $\sqrt{\left(m_{\bar{p}\pi^+} - M_\Lambda\right)^2 + \left(m_{\bar{p}\pi^+\pi^+} - M_\Xi\right)^2}$
- 4C kinematic fit
  - Do kinematic fit on Ξ^- $\bar{\Xi}^+$

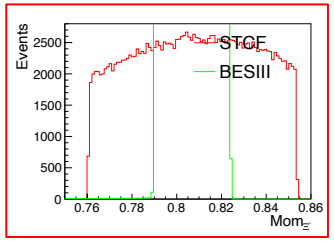
The selection criteria are the same as BESIII

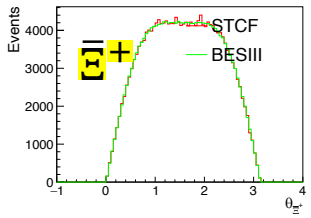
BESIII & STCF comparisons

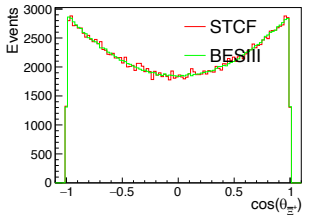
In Truth level: check θ, $cos\theta$, Mom

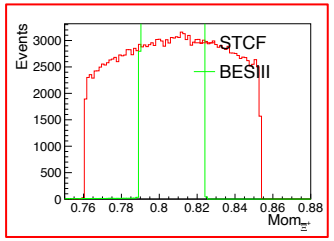


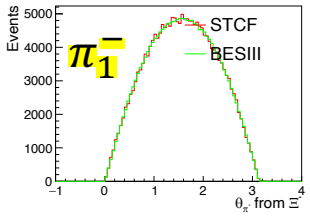


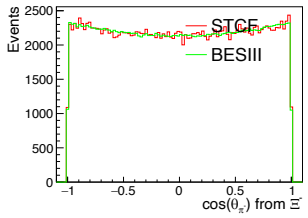


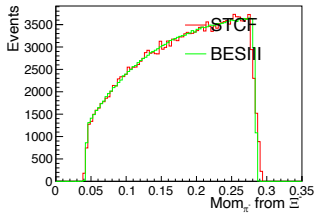


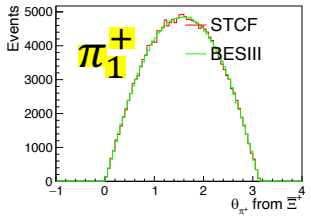


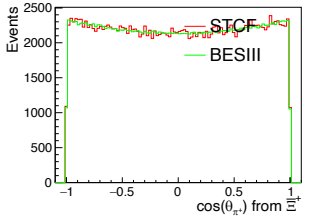


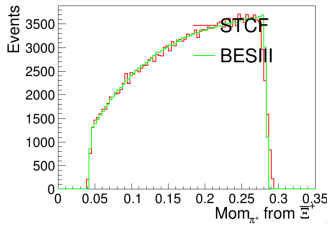


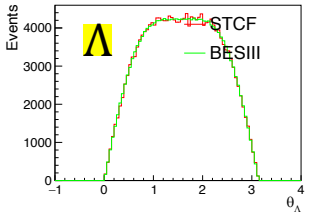


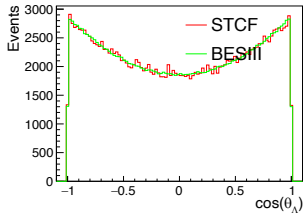


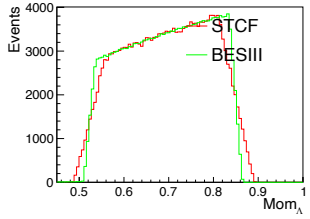


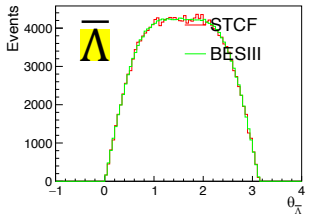


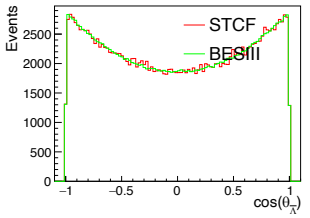


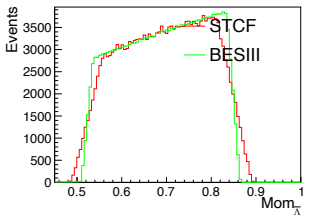


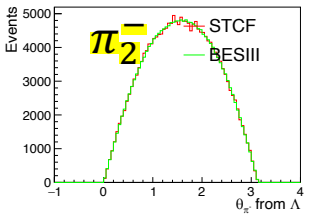


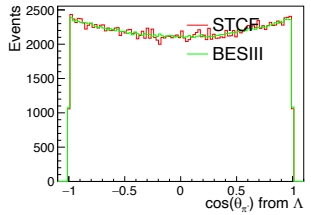


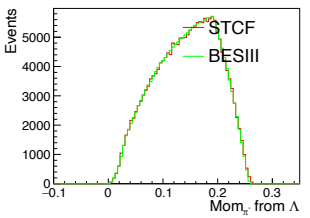


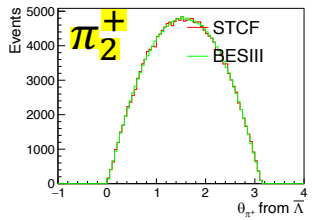


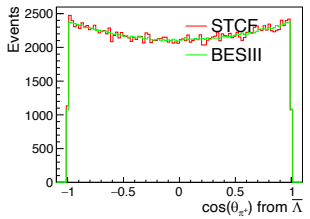


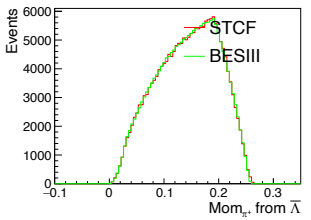


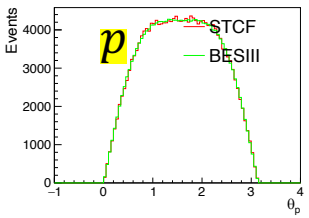


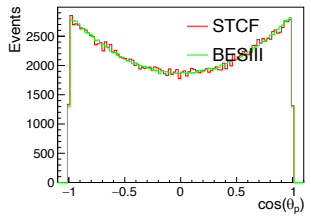


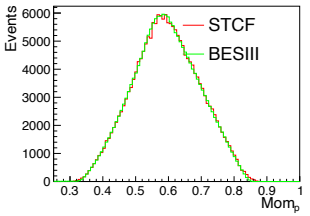


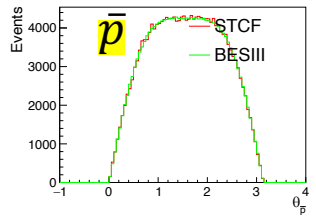


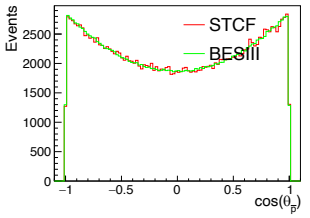


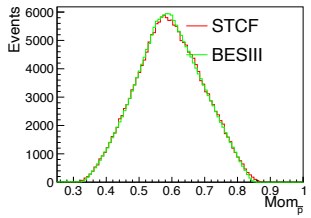






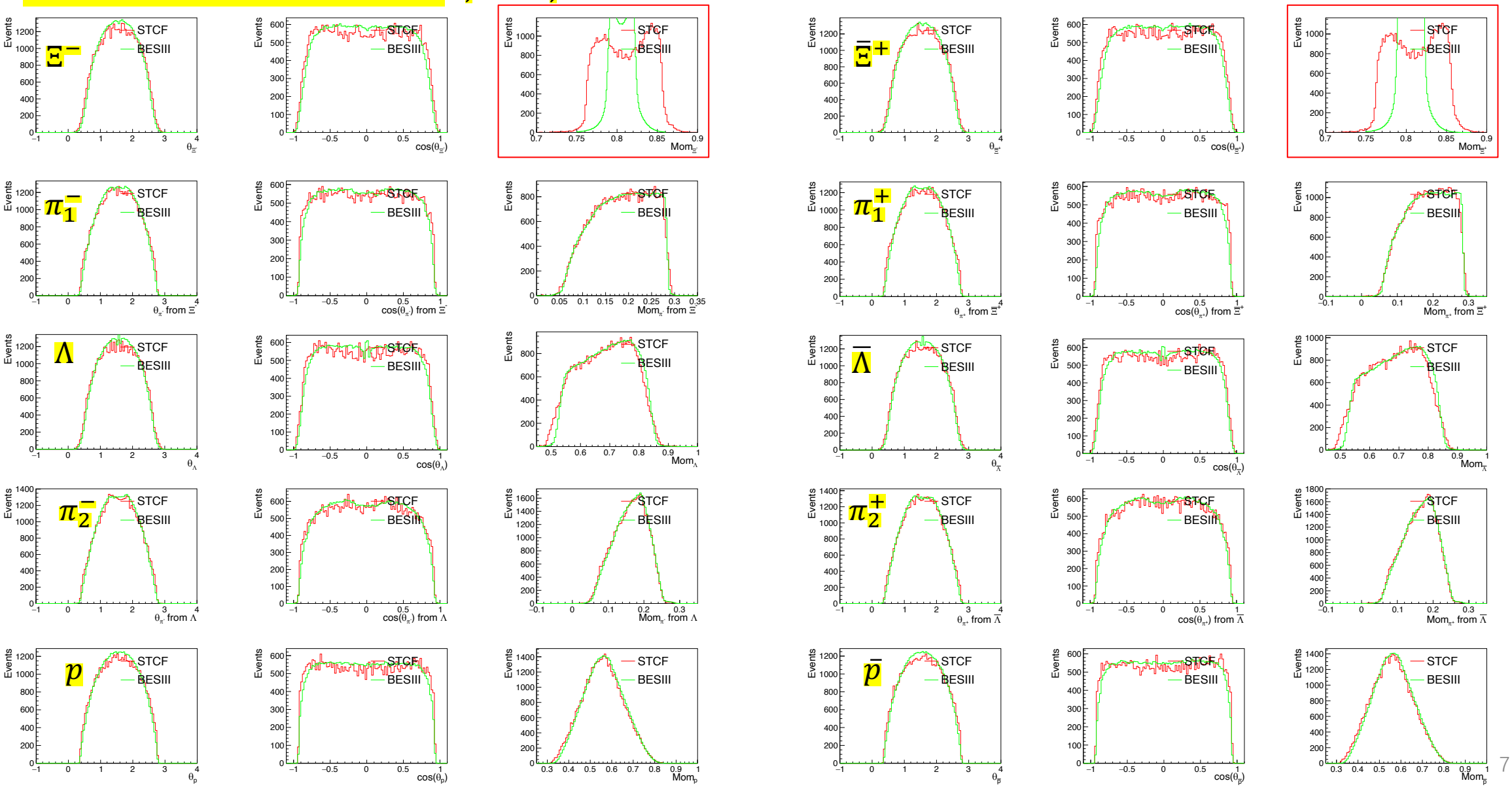






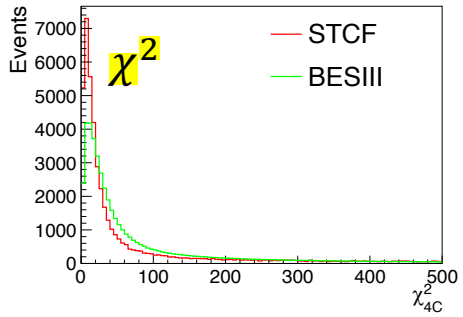
BESIII & STCF comparisons

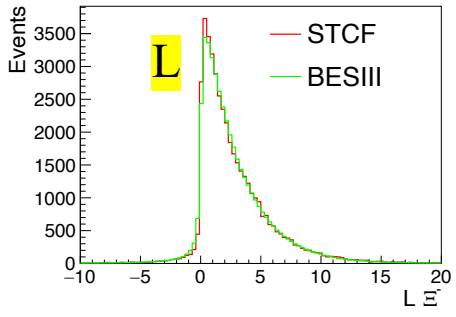
In reconstruction level: check $\theta, cos\theta, Mom$

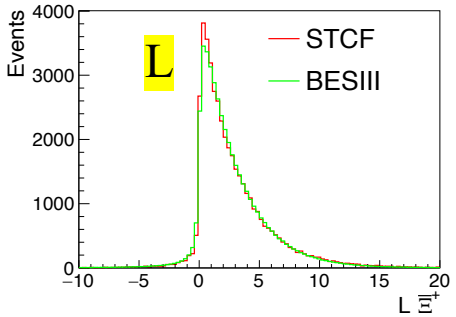


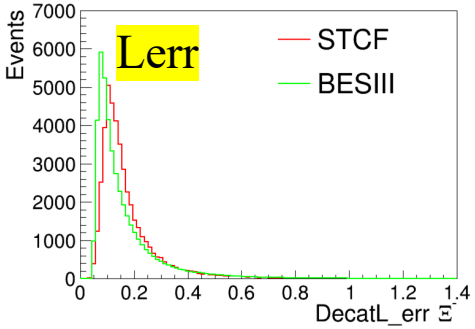
BESIII & STCF comparisons

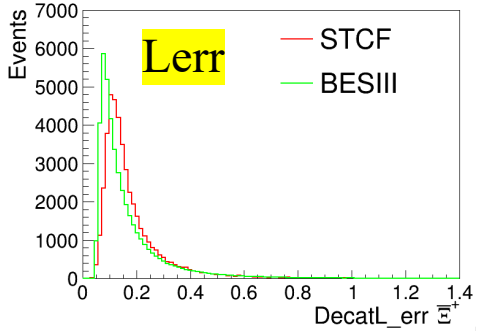
Check χ^2, L, Lerr, L/Lerr, Mass

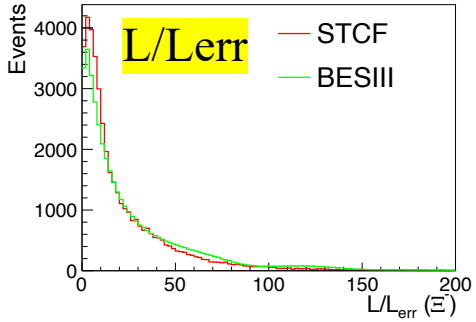


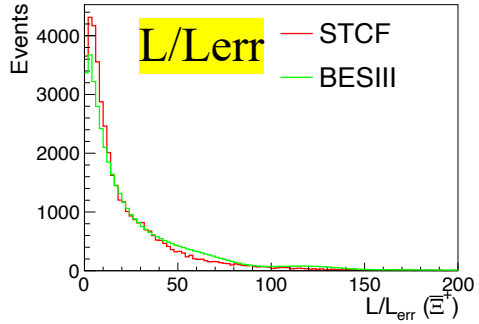


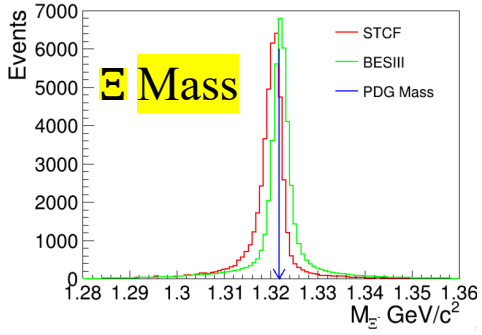


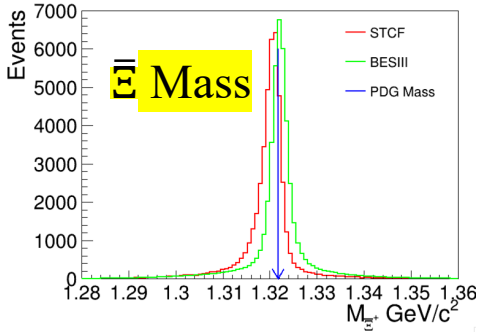


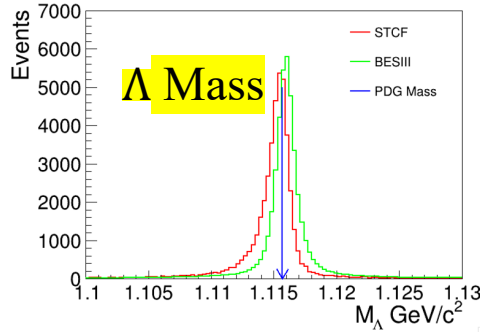


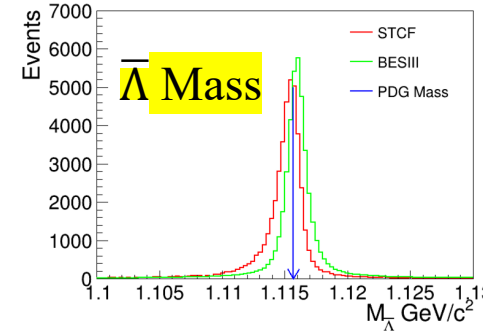






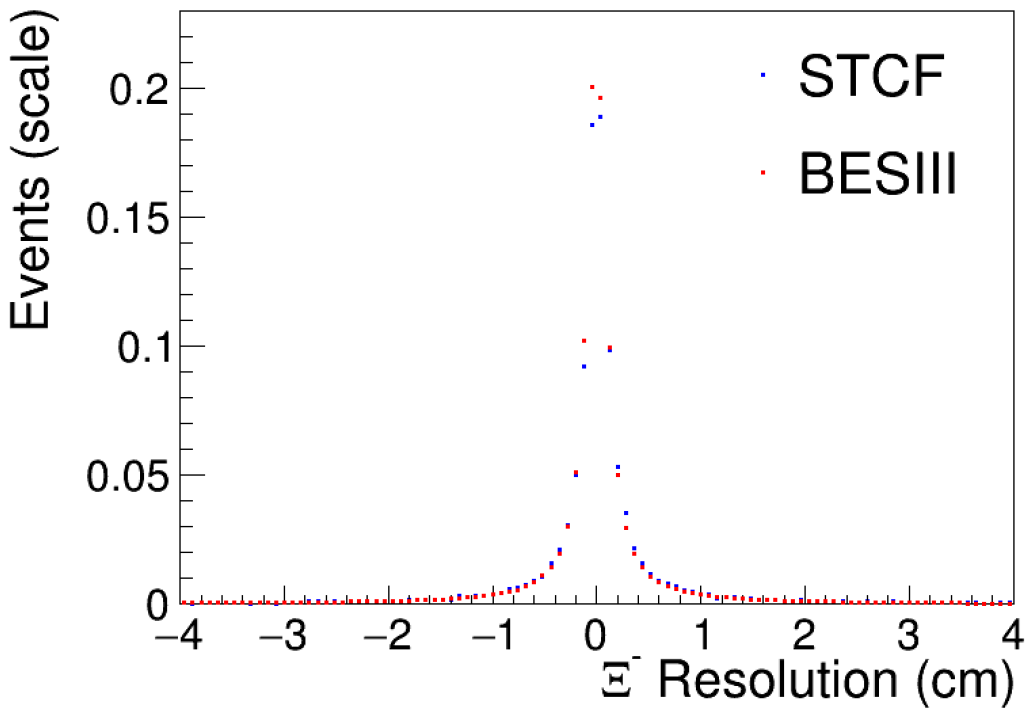


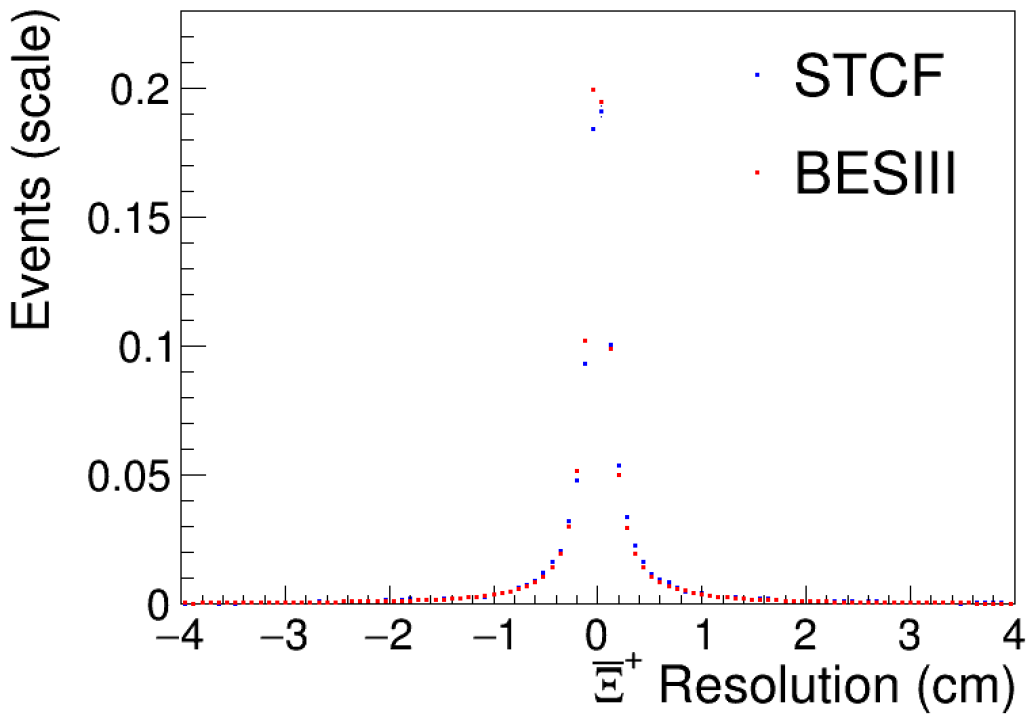




BESIII & STCF comparisons

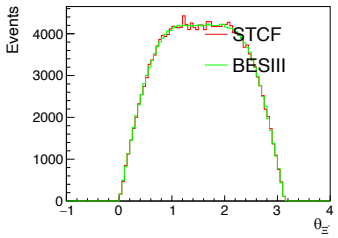
Check resolution of decay length

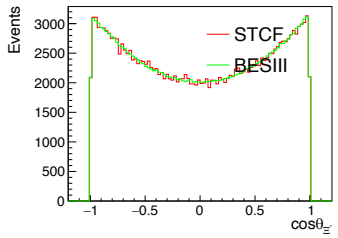


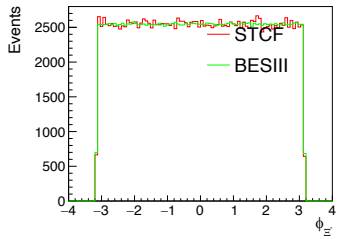


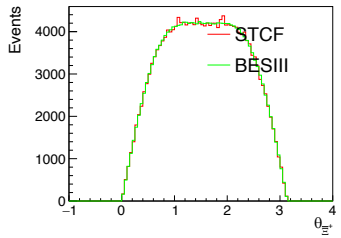
BESIII & STCF comparisons

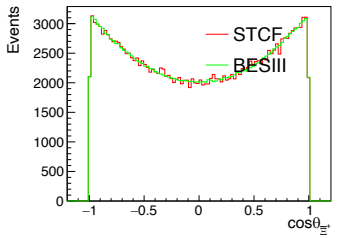
Check Helicity angles in truth level:

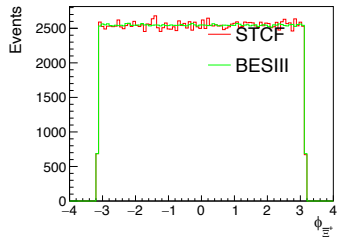


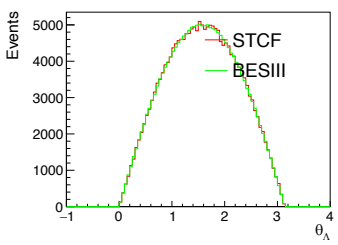


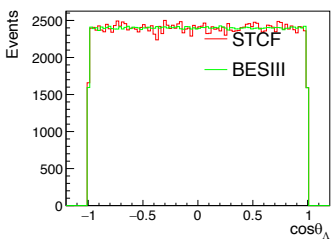


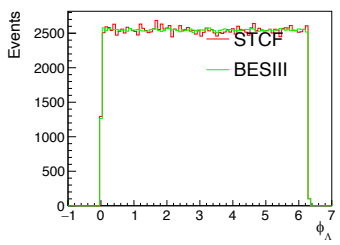


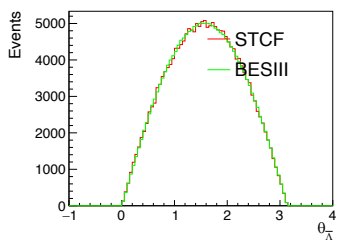


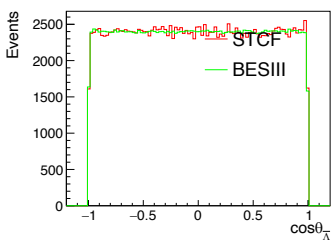


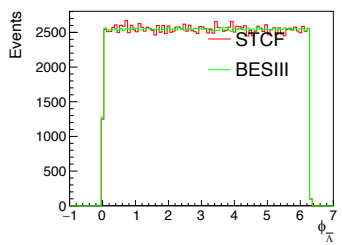


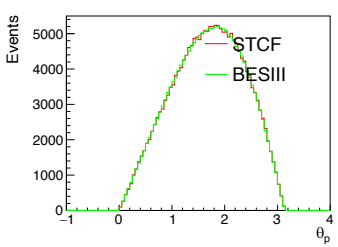


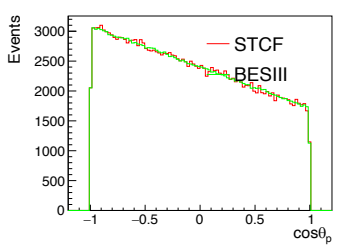


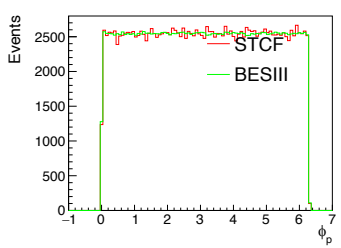


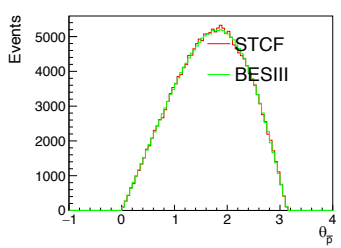


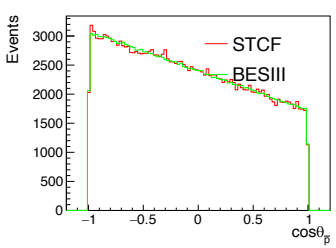


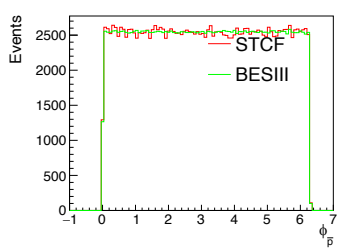






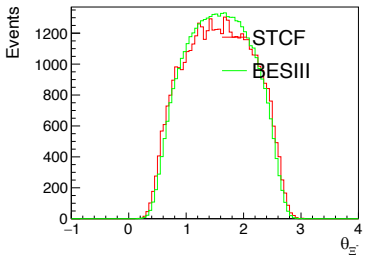


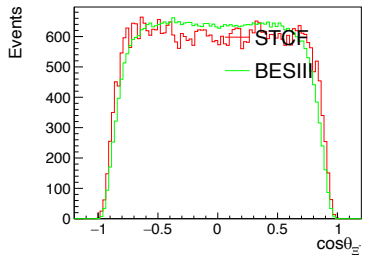


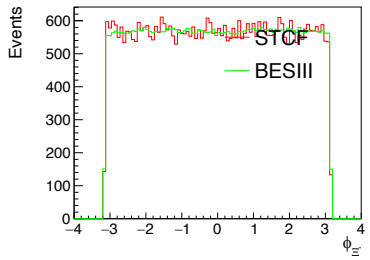


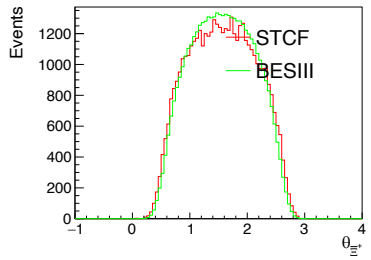
BESIII & STCF comparisons

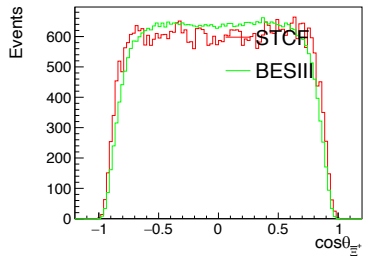
Check Helicity angles in reconstruction level:

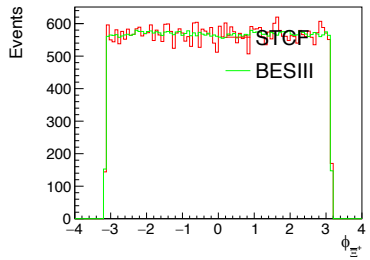


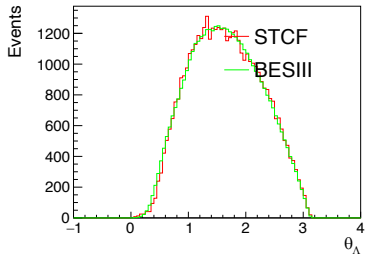


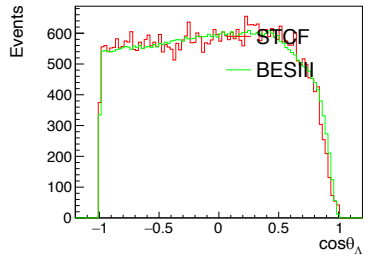


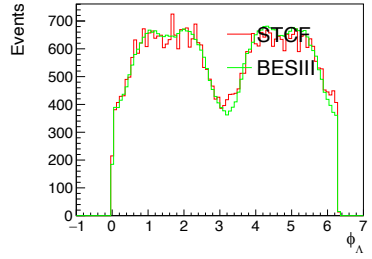


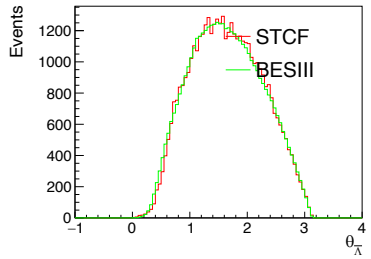


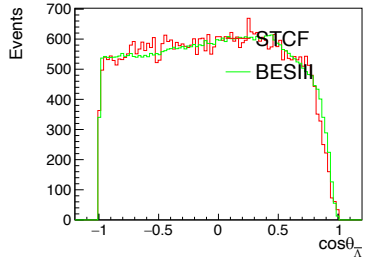


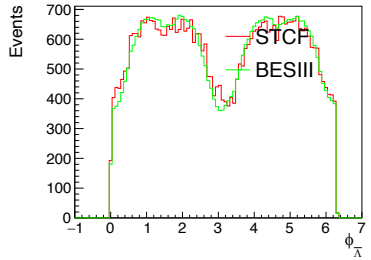


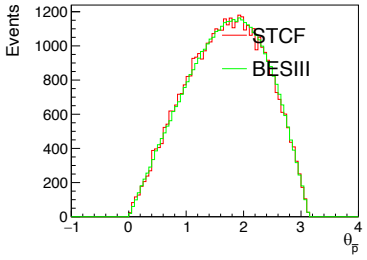


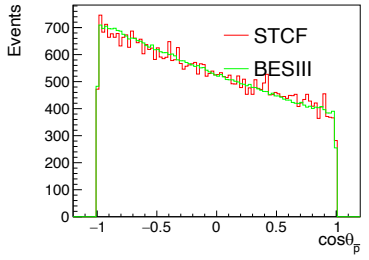


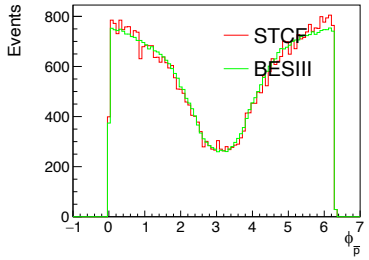


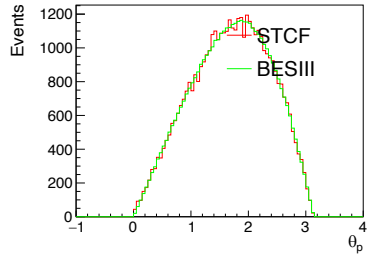


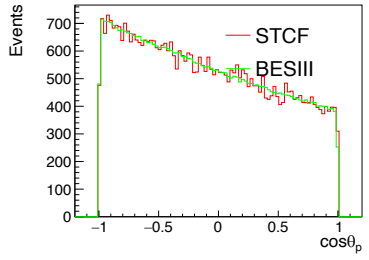


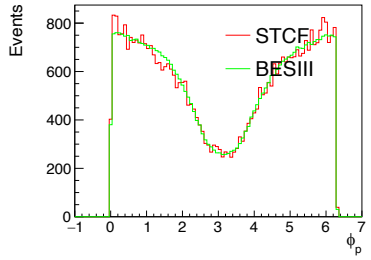












BESIII & STCF comparisons

- With reference to BESIII, we have added further selection criteria.
  - $\chi^2_{4C} < 200$
  - $L_{\Xi^-/\bar{\Xi}^+} > 0$ cm
  - $1.306\ \mathrm{GeV}/c^2 < M_{\Xi^-/\bar{\Xi}^+} < 1.338\ \mathrm{GeV}/c^2$
  - $1.111\ \mathrm{GeV}/c^2 < M_{\Lambda/\bar{\Lambda}} < 1.121\ \mathrm{GeV}/c^2$

No background mix in OSCAR

BESIII Signal MC	Events	Eff. (%)	Re. Eff.(%)
	9,000,000	100.0	
Charged tracks	3057857	34.0	
Λ、Ξ^- Rec.	2545353	28.3	83.2
$\bar{\Lambda}$、$\bar{\Xi}^+$ Rec.	2092432	23.2	82.2
4C fit	1724213	19.2	82.4
χ^2_{4C} cut	1526267	17.0	88.5
$L_{\Xi^-/\bar{\Xi}^+}$ cuts	1359450	15.1	89.1
$M_{\Xi^-/\bar{\Xi}^+}$ cuts	1281108	14.2	94.2
$M_{\Lambda/\bar{\Lambda}}$ cuts	1126527	12.5	87.9

OSCAR Signal MC	Events	Eff. (%)	Re. Eff.(%)
	200,000	100.0	
Charged tracks	106291	53.1	
Λ、Ξ^- Rec.	85268	42.6	80.2
$\bar{\Lambda}$、$\bar{\Xi}^+$ Rec.	68674	34.3	80.5
4C fit	44665	22.3	65.0
χ^2_{4C} cut	40014	20.0	89.6
$L_{\Xi^-/\bar{\Xi}^+}$ cuts	36764	18.4	91.9
$M_{\Xi^-/\bar{\Xi}^+}$ cuts	35385	17.7	96.3
$M_{\Lambda/\bar{\Lambda}}$ cuts	31196	15.6	88.2

Extract parameters

- The parameters are extracted using the maximum likelihood fitting method.
- The contribution of the background is not taken into account.

Likelihood function:

$$\mathscr{L}(\xi_1, \xi_2, \xi_3, \dots, \xi_N; \Omega) = \prod_{i=1}^{N} \mathscr{P}(\xi_i; \Omega) = \prod_{i=1}^{N} \frac{\mathscr{W}(\xi_i; \Omega)\epsilon(\xi_i)}{\mathscr{N}(\Omega)}$$

Normalization factor:

$$\mathscr{N} = \mathscr{C}^{-1} = \int \mathscr{W}(\xi_i; \Omega)\epsilon(\xi_i)d\xi$$

MLL function:

$$\mathcal{S} = -ln\mathcal{L}_{data}$$

- 1M mDIY MC and 10M PHSP MC are generated.

	sim	rec	ana	sum	Final events
mDIY	256G	252G	2G	510G	155596
PHSP	2.0T	2.6T	20G	4.62T	1615231

Extract parameters

	This work	Nature Physics 2022 (BESIII 09+12 data)
$\boldsymbol{\alpha_{J/\psi}}$	0.5832 ± 0.0081	0.586 ± 0.012
$\boldsymbol{\Delta\Phi}$	1.2690 ± 0.0313	1.213 ± 0.046
$\boldsymbol{\alpha_{\Xi}}$	-0.3769 ± 0.0048	-0.376 ± 0.007
$\boldsymbol{\bar{\alpha}_{\Xi}}$	0.3741 ± 0.0048	0.371 ± 0.007
$\boldsymbol{\alpha_{\Lambda}}$	0.7555 ± 0.0074	0.757 ± 0.011
$\boldsymbol{\bar{\alpha}_{\Lambda}}$	-0.7552 ± 0.0074	-0.763 ± 0.011
$\boldsymbol{\phi_{\Xi}}$	-0.0006 ± 0.0135	0.011 ± 0.019
$\boldsymbol{\bar{\phi}_{\Xi}}$	-0.0087 ± 0.0135	-0.021 ± 0.019
$\boldsymbol{A_{CP}^{\Xi}}=(\alpha_{\Xi}+\bar{\alpha}_{\Xi})/(\alpha_{\Xi}-\bar{\alpha}_{\Xi})$	0.0038 ± 0.0092	0.006 ± 0.013
$\boldsymbol{A_{CP}^{\Lambda}}=(\alpha_{\Lambda}+\bar{\alpha}_{\Lambda})/(\alpha_{\Lambda}-\bar{\alpha}_{\Lambda})$	0.0002 ± 0.0082	-0.004 ± 0.012
$\boldsymbol{\Delta\phi_{CP}^{\Xi}}=(\phi_{\Xi}+\bar{\phi}_{\Xi})/2$	-0.0046 ± 0.0098	-0.005 ± 0.014

The results are consistent with the BESIII published results within 2σ.

Estimate statistical uncertainty

- Based on 1 million statistics to estimate the statistical errors of the parameters.
  - STCF expected J/ψ events: 3.4×10^{12}
  - Branch ratio of $J/\psi \to \Xi^-\bar{\Xi}^+$: 9.7×10^{-4}
  - Branch ratio of $\Xi^-(\bar{\Xi}^+) \to \Lambda\pi^-(\bar{\Lambda}\pi^+)$: 0.999
  - Branch ratio of $\Lambda(\bar{\Lambda}) \to p\pi^-(\bar{p}\pi^+)$: 0.639
- The expected events of $J/\psi \to \Xi^-\bar{\Xi}^+ \to \Lambda\pi^-\bar{\Lambda}\pi^+ \to p\pi^-\pi^-\bar{p}\pi^+\pi^+$ is about 1.34393×10^9.
- The scale factor can be defined: $\sqrt{1.0\times10^6/1.34939\times10^9}$ ≈0.0272

	1M signal	Estimate statistical uncertainty		1M signal	Estimate statistical uncertainty
$\boldsymbol{\alpha_{J/\psi}}$	0.5832 ± 0.0081	2.20×10^{-4}	$\boldsymbol{A_{CP}^{\Xi}}$	0.0038 ± 0.0092	2.5×10^{-4}
$\boldsymbol{\Delta\Phi}$	1.2690 ± 0.0313	8.51×10^{-4}	$\boldsymbol{A_{CP}^{\Lambda}}$	0.0002 ± 0.0082	2.2×10^{-4}
$\boldsymbol{\alpha_{\Xi}}$	-0.3769 ± 0.0048	1.31×10^{-4}	$\boldsymbol{\Delta\phi_{CP}^{\Xi}}$	-0.0046 ± 0.0098	2.7×10^{-4}
$\boldsymbol{\bar{\alpha}_{\Xi}}$	0.3741 ± 0.0048	1.31×10^{-4}			
$\boldsymbol{\alpha_{\Lambda}}$	0.7555 ± 0.0074	2.01×10^{-4}			
$\boldsymbol{\bar{\alpha}_{\Lambda}}$	-0.7552 ± 0.0074	2.01×10^{-4}			
$\boldsymbol{\phi_{\Xi}}$	-0.0006 ± 0.0135	3.67×10^{-4}			
$\boldsymbol{\bar{\phi}_{\Xi}}$	-0.0087 ± 0.0135	3.67×10^{-4}			

Summary

- The process $e^+e^- \to J/\psi \to \Xi^-\ \bar{\Xi}^+$ has been generated using the OSCAR software. And the signal events have been preliminarily selected.
- Based on the expectation that the STCF will collect 3.4×10^{12} J/ψ events per year, the precision of CP violation in Ξ and Λ decays is expected to be at the level of 10^{-4}.

Backup

- NN_data: 15000
  NN_PHSP: 150000

```
 FCN=-1150.41 FROM MINOS     STATUS=SUCCESSFUL    603 CALLS         791 TOTAL
                     EDM=1.14834e-06    STRATEGY= 1      ERROR MATRIX ACCURATE
  EXT PARAMETER                   PARABOLIC         MINOS ERRORS
  NO.   NAME      VALUE            ERROR      NEGATIVE      POSITIVE
   1  alpha_jpsi   5.72868e-01   2.58995e-02  -2.61054e-02   2.57068e-02
   2  dphi_jpsi    1.32543e+00   1.08340e-01  -1.02153e-01   1.15038e-01
   3  aXi         -3.71297e-01   1.55616e-02  -1.55888e-02   1.55426e-02
   4  pXi          4.12949e-02   4.51016e-02  -4.51112e-02   4.51166e-02
   5  aL           7.42387e-01   2.35686e-02  -2.35186e-02   2.36483e-02
   6  aXib         3.97930e-01   1.55645e-02  -1.55601e-02   1.55727e-02
   7  aLb         -7.56900e-01   2.34392e-02  -2.35524e-02   2.33529e-02
   8  pXib        -6.59969e-02   4.51833e-02  -4.51749e-02   4.52130e-02
                               ERR DEF= 0.5
MIGRAD状态: 3, Fmin: -1150.41
 EXTERNAL ERROR MATRIX.    NDIM=  25    NPAR=  8    ERR DEF=0.5
  6.710e-04  9.041e-04 -2.582e-06 -6.135e-06 -5.791e-05 -2.630e-06  3.127e-05 -2.767e-06
  9.041e-04  1.174e-02  1.295e-05  3.500e-04 -2.246e-04 -3.603e-05  1.781e-04 -4.754e-05
 -2.582e-06  1.295e-05  2.422e-04 -3.704e-06  9.784e-05  4.949e-06  2.047e-05  4.679e-06
 -6.135e-06  3.500e-04 -3.704e-06  2.034e-03 -2.535e-05 -1.986e-05 -3.358e-05  1.297e-04
 -5.791e-05 -2.246e-04  9.784e-05 -2.535e-05  5.560e-04  2.270e-05  2.127e-04  1.659e-06
 -2.630e-06 -3.603e-05  4.949e-06 -1.986e-05  2.270e-05  2.423e-04  1.055e-04 -8.181e-07
  3.127e-05  1.781e-04  2.047e-05 -3.358e-05  2.127e-04  1.055e-04  5.499e-04  1.979e-05
 -2.767e-06 -4.754e-05  4.679e-06  1.297e-04  1.659e-06 -8.181e-07  1.979e-05  2.042e-03
 PARAMETER  CORRELATION COEFFICIENTS
       NO.  GLOBAL      1      2      3      4      5      6      7      8
        1  0.33606   1.000  0.322 -0.006 -0.005 -0.095 -0.007  0.051 -0.002
        2  0.34958   0.322  1.000  0.008  0.072 -0.088 -0.021  0.070 -0.010
        3  0.27510  -0.006  0.008  1.000 -0.005  0.267  0.020  0.056  0.007
        4  0.10897  -0.005  0.072 -0.005  1.000 -0.024 -0.028 -0.032  0.064
        5  0.48106  -0.095 -0.088  0.267 -0.024  1.000  0.062  0.385  0.002
        6  0.29954  -0.007 -0.021  0.020 -0.028  0.062  1.000  0.289 -0.001
        7  0.48714   0.051  0.070  0.056 -0.032  0.385  0.289  1.000  0.019
        8  0.07000  -0.002 -0.010  0.007  0.064  0.002 -0.001  0.019  1.000
协方差矩阵:
0.000671005 0.000904122 -2.58167e-06 -6.13504e-06 -5.79055e-05 -2.62983e-06 3.1266e-05 -2.7669e-06
0.000904122 0.0117433 1.29519e-05 0.000349988 -0.000224624 -3.60266e-05 0.00017808 -4.75399e-05
-2.58167e-06 1.29519e-05 0.000242248 -3.70445e-06 9.7844e-05 4.94886e-06 2.04702e-05 4.67893e-06
-6.13504e-06 0.000349988 -3.70445e-06 0.0020343 -2.53535e-05 -1.98589e-05 -3.35795e-05 0.000129723
-5.79055e-05 -0.000224624 9.7844e-05 -2.53535e-05 0.000556019 2.26994e-05 0.000212651 1.65876e-06
-2.62983e-06 -3.60266e-05 4.94886e-06 -1.98589e-05 2.26994e-05 0.000242334 0.000105509 -8.18118e-07
3.1266e-05 0.00017808 2.04702e-05 -3.35795e-05 0.000212651 0.000105509 0.000549943 1.97871e-05
-2.7669e-06 -4.75399e-05 4.67893e-06 0.000129723 1.65876e-06 -8.18118e-07 1.97871e-05 0.00204167
```

	This work
$\boldsymbol{\alpha_{J/\psi}}$	0.5729 ± 0.0259
$\boldsymbol{\Delta\Phi}$	1.3254 ± 0.1083
$\boldsymbol{\alpha_{\Xi}}$	-0.3713 ± 0.0156
$\boldsymbol{\bar{\alpha}_{\Xi}}$	0.3979 ± 0.0156
$\boldsymbol{\alpha_{\Lambda}}$	0.7424 ± 0.0236
$\boldsymbol{\bar{\alpha}_{\Lambda}}$	-0.7569 ± 0.0234
$\boldsymbol{\phi_{\Xi}}$	0.0413 ± 0.0451
$\boldsymbol{\bar{\phi}_{\Xi}}$	-0.0660 ± 0.0452

➢ Generated 100w mDIY MC and 1000w PHSP MC.

```
 FCN=-11925.3 FROM MINOS     STATUS=SUCCESSFUL    541 CALLS         677 TOTAL
                     EDM=4.31895e-06    STRATEGY= 1      ERROR MATRIX ACCURATE
  EXT PARAMETER                   PARABOLIC         MINOS ERRORS
  NO.   NAME      VALUE            ERROR      NEGATIVE      POSITIVE
   1  alpha_jpsi   5.83178e-01   8.14147e-03  -8.16387e-03   8.12409e-03
   2  dphi_jpsi    1.26898e+00   3.12754e-02  -3.07583e-02   3.18343e-02
   3  aXi         -3.76881e-01   4.82244e-03  -4.82893e-03   4.81687e-03
   4  pXi         -5.65310e-04   1.34915e-02  -1.34844e-02   1.34995e-02
   5  aL           7.55463e-01   7.35484e-03  -7.35845e-03   7.35312e-03
   6  aXib         3.74051e-01   4.83752e-03  -4.83636e-03   4.83818e-03
   7  aLb         -7.55222e-01   7.38295e-03  -7.40051e-03   7.36594e-03
   8  pXib        -8.66064e-03   1.35081e-02  -1.35010e-02   1.35160e-02
                               ERR DEF= 0.5
MIGRAD状态：3, Fmin: -11925.3
 EXTERNAL ERROR MATRIX.    NDIM=  25    NPAR=  8    ERR DEF=0.5
  6.629e-05  8.980e-05 -1.962e-07 -1.631e-06 -4.853e-06  2.956e-07  4.770e-06  1.519e-06
  8.980e-05  9.782e-04 -2.323e-08  1.060e-05 -2.104e-05  2.580e-06  2.652e-05 -3.254e-06
 -1.962e-07 -2.323e-08  2.326e-05 -1.942e-07  1.060e-05  6.937e-07  2.970e-06  9.215e-07
 -1.631e-06  1.060e-05 -1.942e-07  1.820e-04  8.763e-07  6.173e-07  1.518e-06  8.482e-06
 -4.853e-06 -2.104e-05  1.060e-05  8.763e-07  5.410e-05  2.651e-06  2.167e-05  1.842e-06
  2.956e-07  2.580e-06  6.937e-07  6.173e-07  2.651e-06  2.340e-05  1.060e-05  8.475e-08
  4.770e-06  2.652e-05  2.970e-06  1.518e-06  2.167e-05  1.060e-05  5.451e-05  1.372e-06
  1.519e-06 -3.254e-06  9.215e-07  8.482e-06  1.842e-06  8.475e-08  1.372e-06  1.825e-04
 PARAMETER  CORRELATION COEFFICIENTS
       NO.  GLOBAL      1      2      3      4      5      6      7      8
        1  0.36373   1.000  0.353 -0.005 -0.015 -0.081  0.008  0.079  0.014
        2  0.38176   0.353  1.000 -0.000  0.025 -0.091  0.017  0.115 -0.008
        3  0.30464  -0.005 -0.000  1.000 -0.003  0.299  0.030  0.083  0.014
        4  0.06127  -0.015  0.025 -0.003  1.000  0.009  0.009  0.015  0.047
        5  0.50584  -0.081 -0.091  0.299  0.009  1.000  0.074  0.399  0.019
        6  0.30274   0.008  0.017  0.030  0.009  0.074  1.000  0.297  0.001
        7  0.50796   0.079  0.115  0.083  0.015  0.399  0.297  1.000  0.014
        8  0.05547   0.014 -0.008  0.014  0.047  0.019  0.001  0.014  1.000
A_CP1 (alpha_xi, alpha_xibar): 0.0037688 ± 0.0092306
A_CP2 (alpha_lam, alpha_lambar): 0.000159464 ± 0.00815962
=== Delta_phi_CP 计算结果 ===
Delta_phi_CP: -0.00461297 ± 0.00976541 rad
Delta_phi_CP: -0.264304 ± 0.559517 deg
```