The Study of $h_c \to \pi^0 / \eta \ K^+K^-$

Guangyong Zhang
Ronggang Ping
Daihui Wei

Outline

- 1、Motivation
- 2、Data sets
- 3、Event Selection and Background Study
- 4、Branching Fractions
- 5、Summary

Motivation

- The charmonium spin-singlet state, $h_c(^1p_1)$, was firstly observed by E835 experiment, and then confirmed by CLEO-c. The BESIII experiment improved the measurements of the properties of h_c production and decay width with higher statistics data set.
- Because it is difficult to produce the spin-singlet states in e^+e^- collisions. Only a few decay modes of h_c are observed . Searches for new h_c decay modes are useful for understanding the dynamics of QCD, which can promote the development of theoretical models.
- We searches the h_c decay $h_c \to \pi^0/\eta\ K^+K^-$ from the decay $\psi(2S) \to \pi^0 h_c$

$h_c(1P)$ DECAY MODES	Fraction (Γ_i/Γ)	Co
$J/\psi(1S)\pi\pi$	not seen	
$p\bar{p}$	$< 1.5 \times 10^{-4}$	
$\eta_c(1S)\gamma$	(51 ± 6) %	
$\pi^+\pi^-\pi^0$	$< 2.2 \times 10^{-3}$	
$2\pi^+2\pi^-\pi^0$	$(2.2^{+0.8}_{-0.7})$ %	
$3\pi^+3\pi^-\pi^0$	< 2.9 %	

Data sets

- Boss Version: 6.6.4 p03
- Data sets:

  106.8M ψ' of year 2009

  341.1M ψ' of year 2012
- Signal MC :$\psi(2S) \to \pi^0 h_c, h_c \to \pi^0 K^+ K^-$

  $\psi(2S) \to \pi^0 h_c, h_c \to \eta K^+ K^-$
- Inclusive MC: 2009 MC 、2012 MC

The Study of $\psi(2S) \to \pi^0 h_c, h_c \to \pi^0 K^+ K^-$

Event selections

Charged tracks

$|R_{xy}| < 1cm, |R_z| < 10cm$

$|\cos\theta| < 0.93$

$N = 2, \sum Q = 0$

6C kinematic fit

Select the photons with least χ^2

$\chi^2 < 36$

Good photon

$0 \le TDC \le 14$

$Barrel:$

$E > 0.025\ Gev, |\cos\theta| < 0.8$

$Endcap:$

$E > 0.050\ Gev, 0.86 < |\cos\theta| < 0.92$

$\Delta\theta > 10^0$

$N_\gamma \ge 4$

PID

$K: \chi^2(\mathrm{K}) < \chi^2(\pi)$, $\chi^2(\mathrm{K}) < \chi^2(\mathrm{p})$

$\pi: \chi^2(\pi) < \chi^2(\mathrm{K})$, $\chi^2(\pi) < \chi^2(\mathrm{p})$

$p: \chi^2(\mathrm{p}) < \chi^2(\mathrm{K})$, $\chi^2(\mathrm{p}) < \chi^2(\pi)$

To remove μ

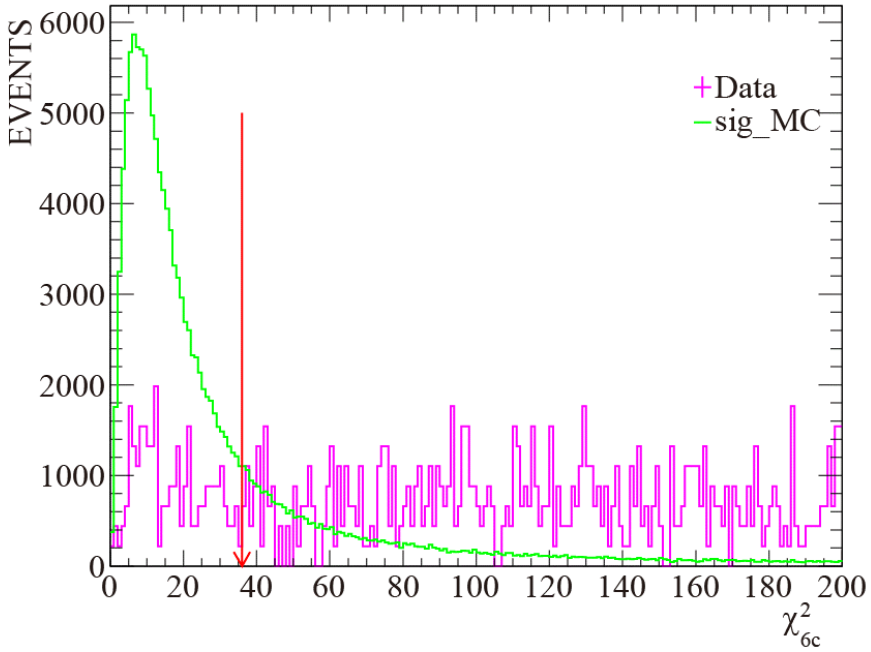
$mupLayer[0] < 7;$

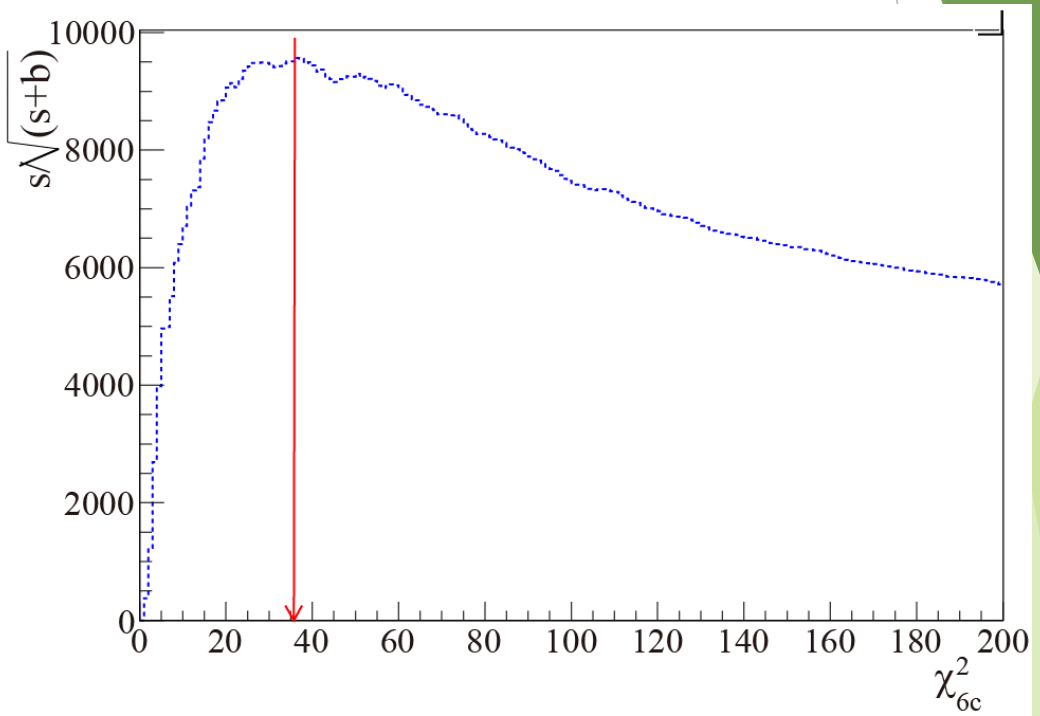
$mumLayer[0] < 7;$

mass window

$$|\mathrm{m}_{K^+K^-\pi^0} - m_{h_c}| < 7MeV/c^2$$

The χ^2 of kinematic fit



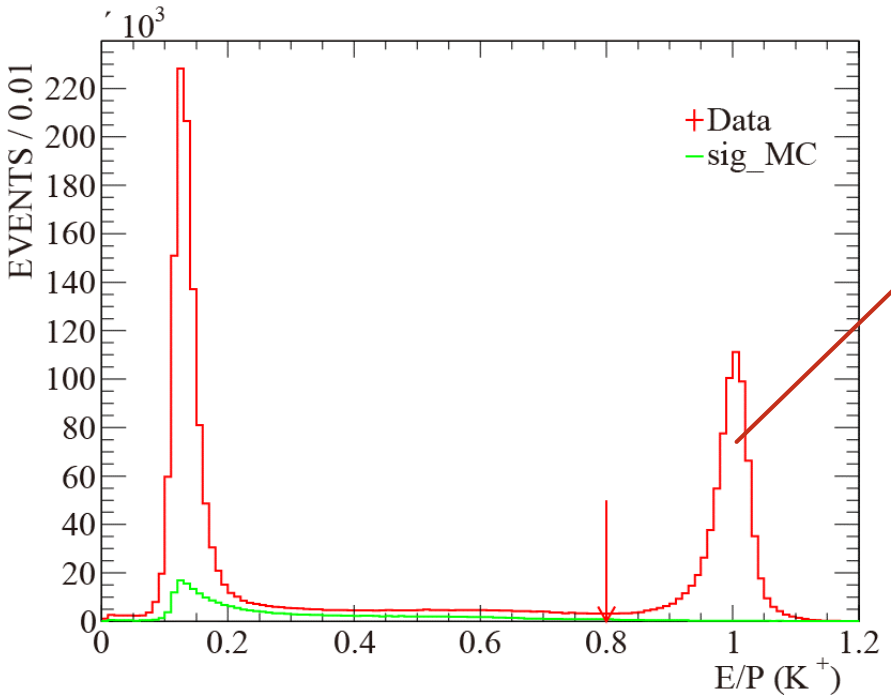


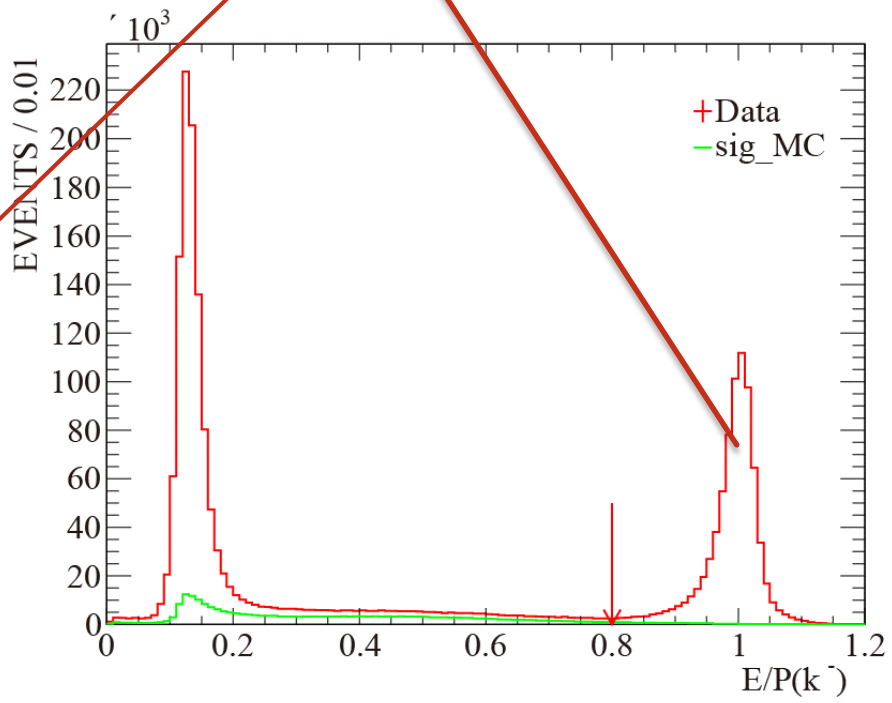
χ^2 distribution from 6C : $\chi^2_{6c} < 36$

QED background

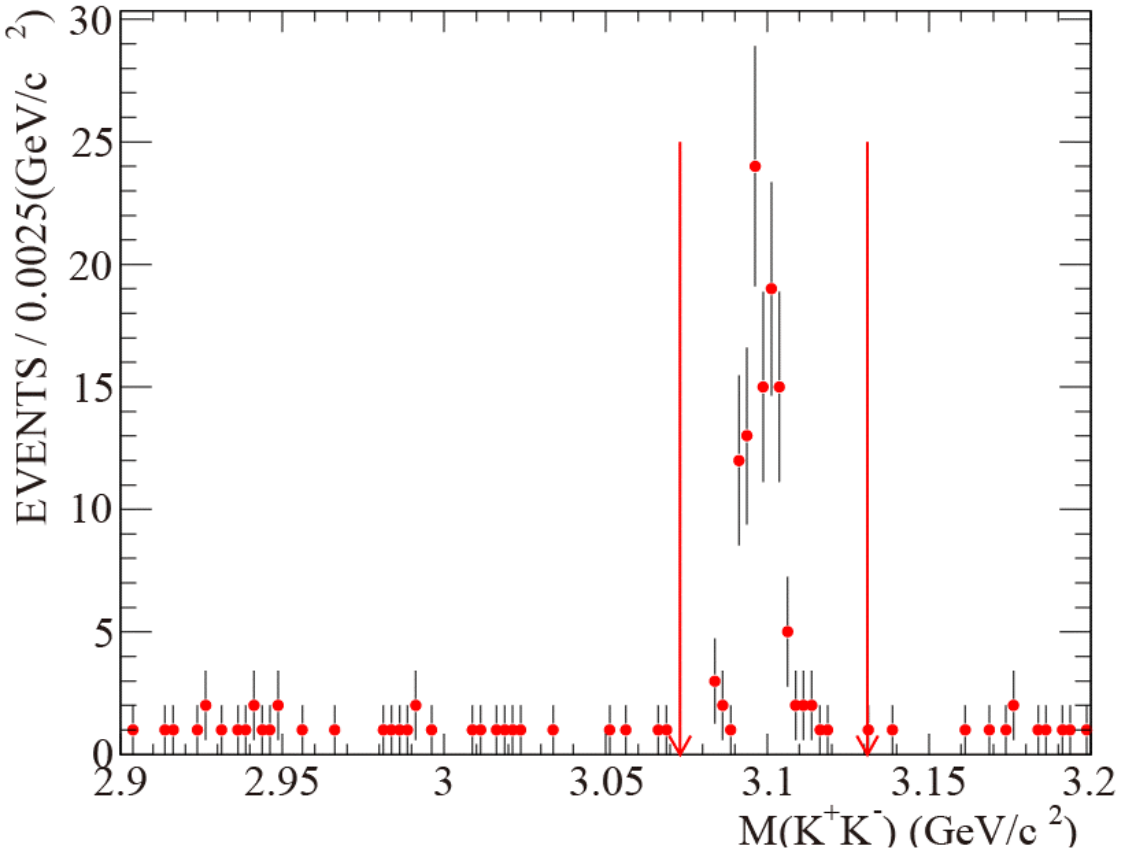
$$\frac{E}{P} < 0.8$$

e^+e^-



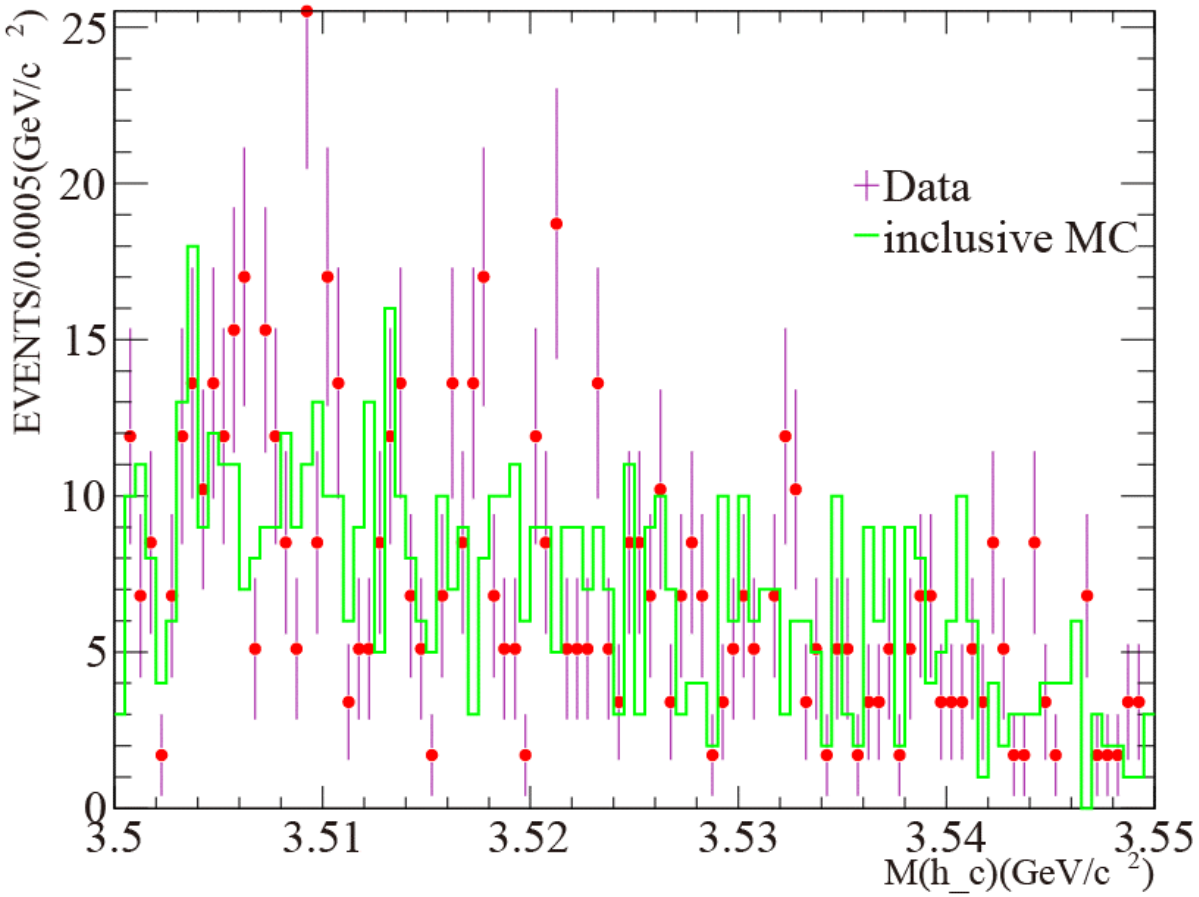


To remove J/ψ : $|M_{k^+k^-} - M_{J/\psi}| > 24MeV/c^2$



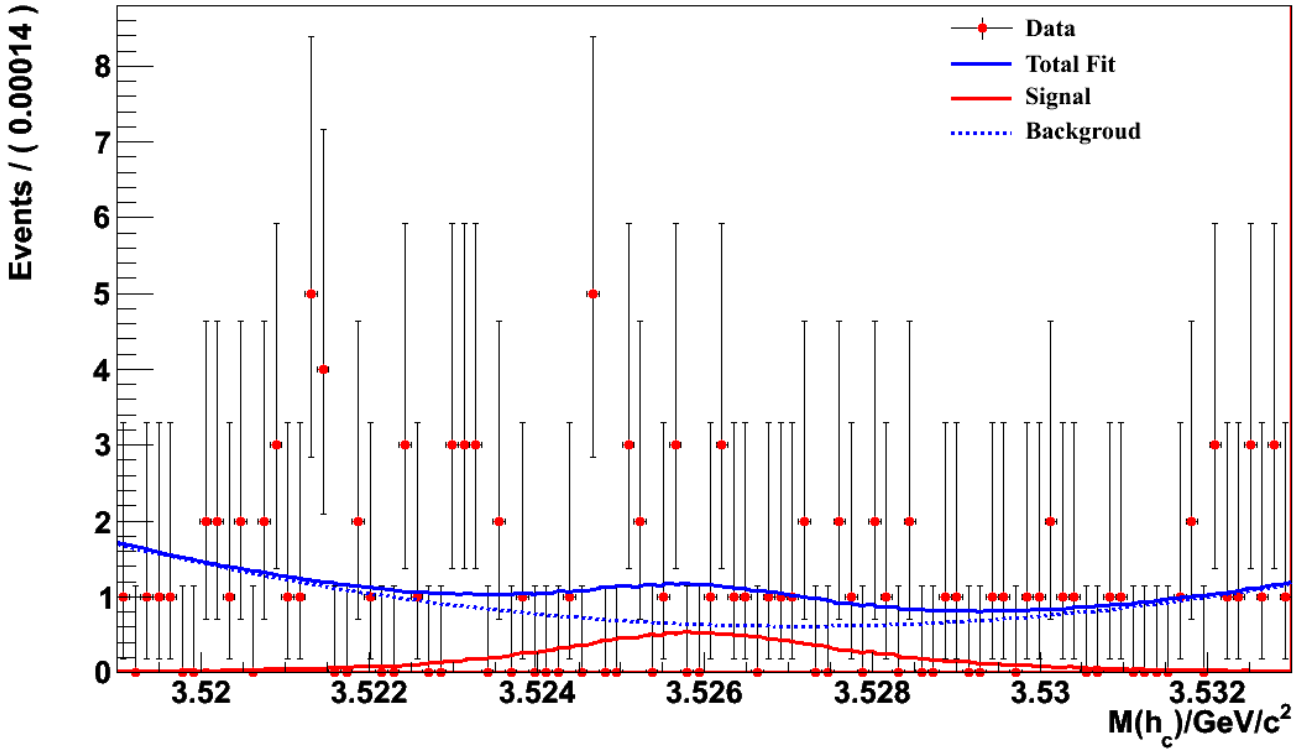
No.	decay chain	final states	iTopo	nEvt	nTot
0	$\psi' \to K_1^- K^+,\ K_1^- \to K_0^{*-}\pi^0,\ K_0^{*-} \to K^-\pi^0,$	$\psi' \to \gamma\gamma\gamma\gamma K^+K^-$	0	50	50
1	$\psi' \to K^- K_1^+,\ K_1^+ \to \pi^0 K_0^{*+},\ K_0^{*+} \to \pi^0 K^+,$	$\psi' \to \gamma\gamma\gamma\gamma K^+K^-$	2	43	93
2	$\psi' \to K^- K_1^+,\ K_1^+ \to \pi^0 K^{*+},\ K^{*+} \to \pi^0 K^+,$	$\psi' \to \gamma\gamma\gamma\gamma K^+K^-$	1	35	128
3	$\psi' \to K_1^- K^+,\ K_1^- \to K^{*-}\pi^0,\ K^{*-} \to K^-\pi^0,$	$\psi' \to \gamma\gamma\gamma\gamma K^+K^-$	4	26	154
4	$\psi' \to K^{*-} K^{*+},\ K^{*-} \to K^-\pi^0,\ K^{*+} \to \pi^0 K^+,$	$\psi' \to \gamma\gamma\gamma\gamma K^+K^-$	11	22	176
5	$\psi' \to K^-\pi^0 K^{*+},\ K^{*+} \to \pi^0 K^+,$	$\psi' \to \gamma\gamma\gamma\gamma K^+K^-$	5	14	190
6	$\psi' \to K^{*-}\pi^0 K^+,\ K^{*-} \to K^-\pi^0,$	$\psi' \to \gamma\gamma\gamma\gamma K^+K^-$	3	11	201
7	$\psi' \to \gamma\chi_{c2},\ \chi_{c2} \to K^-\pi^0 K^+,$	$\psi' \to \gamma\gamma\gamma K^+K^-$	6	9	210
8	$\psi' \to \gamma\chi_{c1},\ \chi_{c1} \to K^- K^{*+},\ K^{*+} \to \pi^0 K^+,$	$\psi' \to \gamma\gamma\gamma K^+K^-$	12	2	212
9	$\psi' \to \pi^0\pi^0 J/\psi,\ J/\psi \to \pi^-\pi^+,$	$\psi' \to \gamma\gamma\gamma\gamma\pi^+\pi^-$	9	1	213
10	$\psi' \to K^{*-} K_0^{*+},\ K^{*-} \to K^-\pi^0,\ K_0^{*+} \to \pi^0 K^+,$	$\psi' \to \gamma\gamma\gamma\gamma K^+K^-$	10	1	214
11	$\psi' \to \gamma\chi_{c1},\ \chi_{c1} \to K^{*-} K^+,\ K^{*-} \to K^-\pi^0,$	$\psi' \to \gamma\gamma\gamma K^+K^-$	7	1	215
12	$\psi' \to \gamma\eta_c,\ \eta_c \to \bar{K}^0\pi^- K^+,\ \bar{K}^0 \to K_S,\ K_S \to \pi^0\pi^0,$	$\psi' \to \gamma\gamma\gamma\gamma\gamma K^+\pi^-$	8	1	216
13	$\psi' \to K_0^{*-} K^{*+},\ K_0^{*-} \to K^-\pi^0,\ K^{*+} \to \pi^0 K^+,$	$\psi' \to \gamma\gamma\gamma\gamma K^+K^-$	13	1	217
14	$\psi' \to K^{*-} K_2^{*+},\ K^{*-} \to K^-\pi^0,\ K_2^{*+} \to \pi^0 K^+,$	$\psi' \to \gamma\gamma\gamma\gamma K^+K^-$	14	1	218
15	$\psi' \to K_1^- K^+,\ K_1^- \to K^-\omega,\ \omega \to \gamma\pi^0,$	$\psi' \to \gamma\gamma\gamma K^+K^-$	15	1	219
16	$\psi' \to \gamma\chi_{c2},\ \chi_{c2} \to \rho^-\pi^0\pi^+,\ \rho^- \to \pi^-\pi^0,$	$\psi' \to \gamma\gamma\gamma\gamma\pi^+\pi^-$	16	1	220
17	$\psi' \to \eta J/\psi,\ \eta \to \pi^0\pi^0\pi^0,\ J/\psi \to \pi^-\pi^+,$	$\psi' \to \gamma\gamma\gamma\gamma\gamma\gamma\pi^+\pi^-$	17	1	221
18	$\psi' \to \gamma\chi_{c1},\ \chi_{c1} \to K^{*-}\gamma_{FSR} K^+,\ K^{*-} \to K^-\pi^0,$	$\psi' \to \gamma\gamma\gamma\gamma_{FSR} K^+K^-$	18	1	222
19	$\psi' \to \gamma\chi_{c0},\ \chi_{c0} \to K^{*-}\pi^0 K^+,\ K^{*-} \to K^-\pi^0,$	$\psi' \to \gamma\gamma\gamma\gamma\gamma K^+K^-$	19	1	223
20	$\psi' \to \gamma\chi_{c0},\ \chi_{c0} \to K_1^- K^+,\ K_1^- \to K_0^{*-}\pi^0,\ K_0^{*-} \to K^-\pi^0,$	$\psi' \to \gamma\gamma\gamma\gamma\gamma K^+K^-$	20	1	224

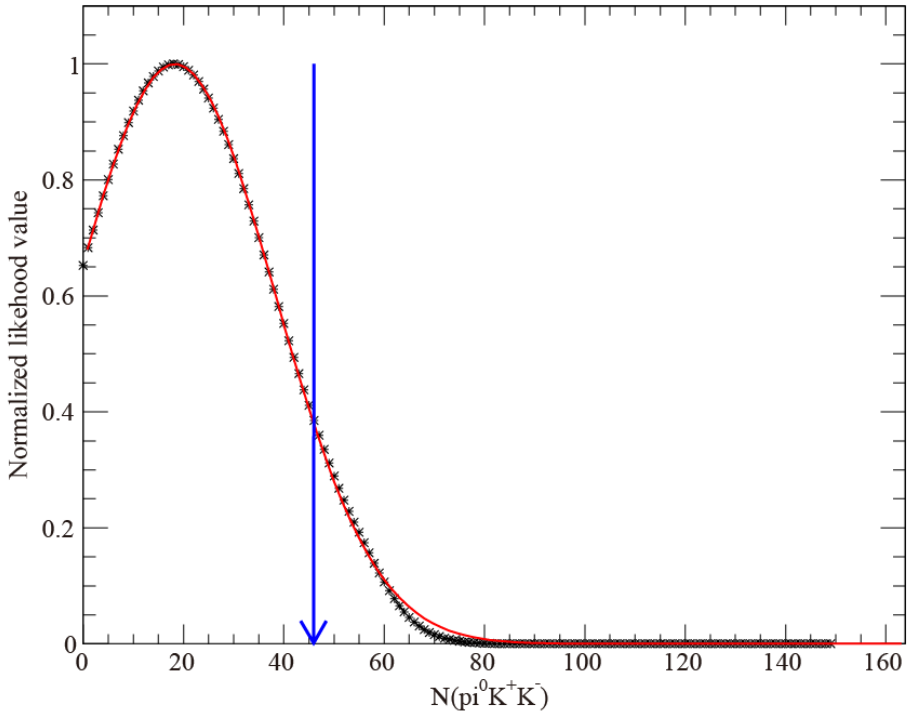
Table 1:



No signal h_c observed

The Study of $\psi(2S) \to \pi^0 h_c, h_c \to \pi^0 K^+ K^-$





$$N_{h_c} = 18.1 \pm 19.8$$

$$(< 46 @ 90\% C.L.)$$

Signa: h_c singal MC shape

Background:a 2-st polynomial function

Branching fraction

$$B(h_c \to \pi^0 K^+ K^-) = \frac{N_{signal}}{N_{tot}^{\psi'} B(\psi' \to \pi^0 h_c) B(\pi^0 \to \gamma\gamma) \varepsilon_{MC}}$$

$$\varepsilon_{MC} = 12.0\%$$

Mode	Events	Eff.(%)	Br(10^{-3})	Significant
$h_c \to \pi^0 K^+ K^-$	<46	12.0	1.03	_

The Study of $\psi(2S) \to \pi^0 h_c, h_c \to \eta K^+ K^-$

Event selections

Charged tracks

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$|\cos\theta| < 0.93$

$N = 2, \sum Q = 0$

4C kinematic fit

Select the photons with least χ^2

$\chi^2 < 24$

Good photon

$0 \le TDC \le 14$

$Barrel:$

$E > 0.025\ GeV, |\cos\theta| < 0.8$

$Endcap:$

$E > 0.050\ GeV, 0.86 < |\cos\theta| < 0.92$

$\Delta\theta > 10^0$

$N_\gamma \ge 4$

PID

$K: \chi^2(\mathrm{K}) < \chi^2(\pi)$, $\chi^2(\mathrm{K}) < \chi^2(\mathrm{p})$

$\pi: \chi^2(\pi) < \chi^2(\mathrm{K})$, $\chi^2(\pi) < \chi^2(\mathrm{p})$

$p: \chi^2(\mathrm{p}) < \chi^2(\mathrm{K})$, $\chi^2(\mathrm{p}) < \chi^2(\pi)$

To remove μ

$mupLayer[0] < 7;$

$mumLayer[0] < 7;$

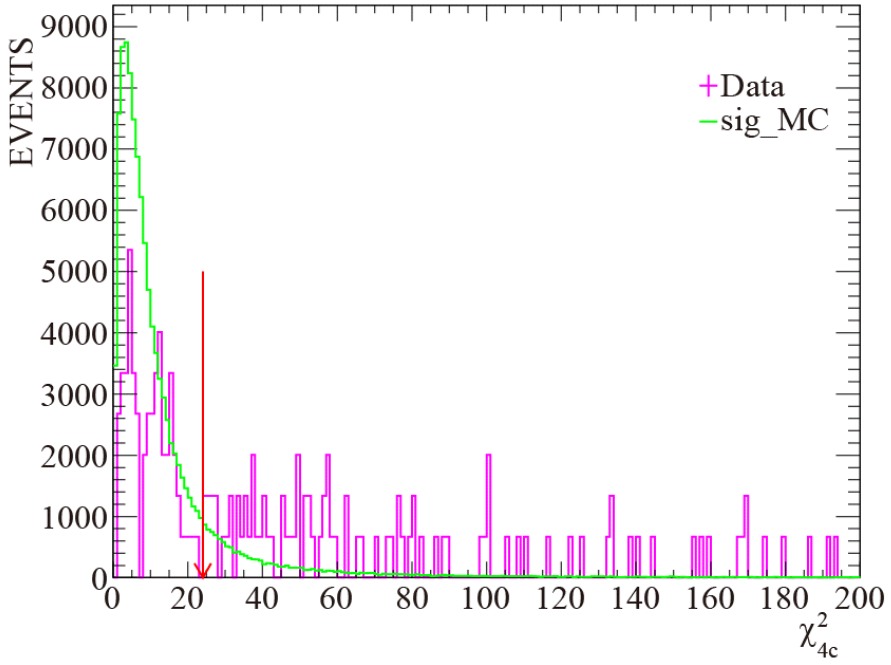
mass window

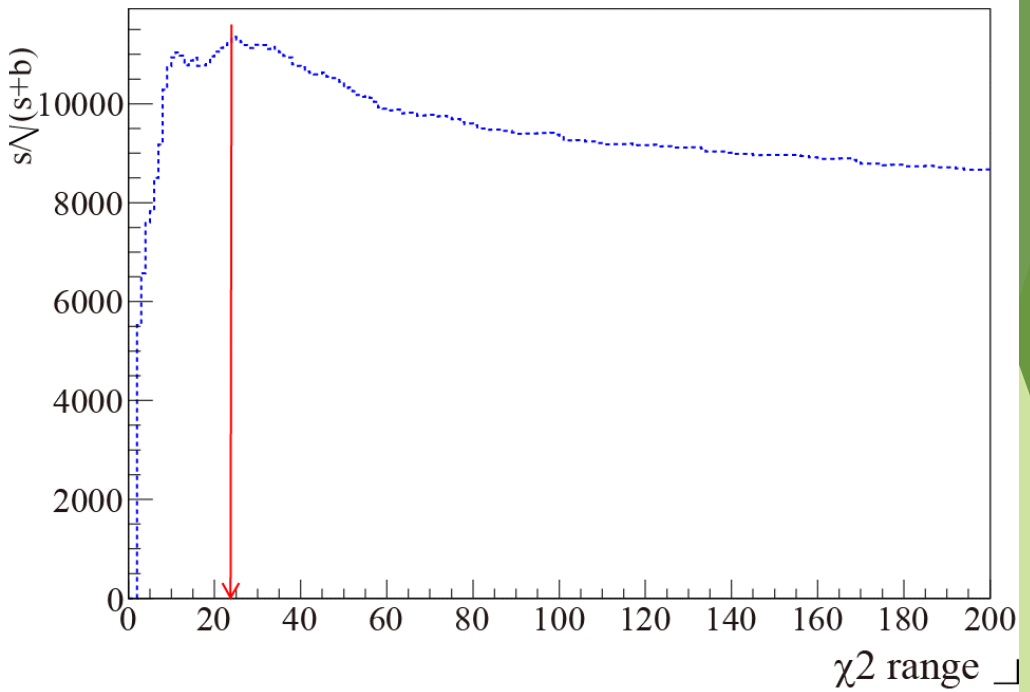
$|\mathrm{m}_{K^+K^-\eta} - m_{h_c}| < 17 MeV / c^2$

$|\mathrm{m}_{\gamma\gamma} - m_{\eta}| < 24\ MeV / c^2$

$|\mathrm{m}_{\gamma\gamma} - m_{\pi^0}| < 14\ MeV / c^2$

The χ^2 of kinematic fit



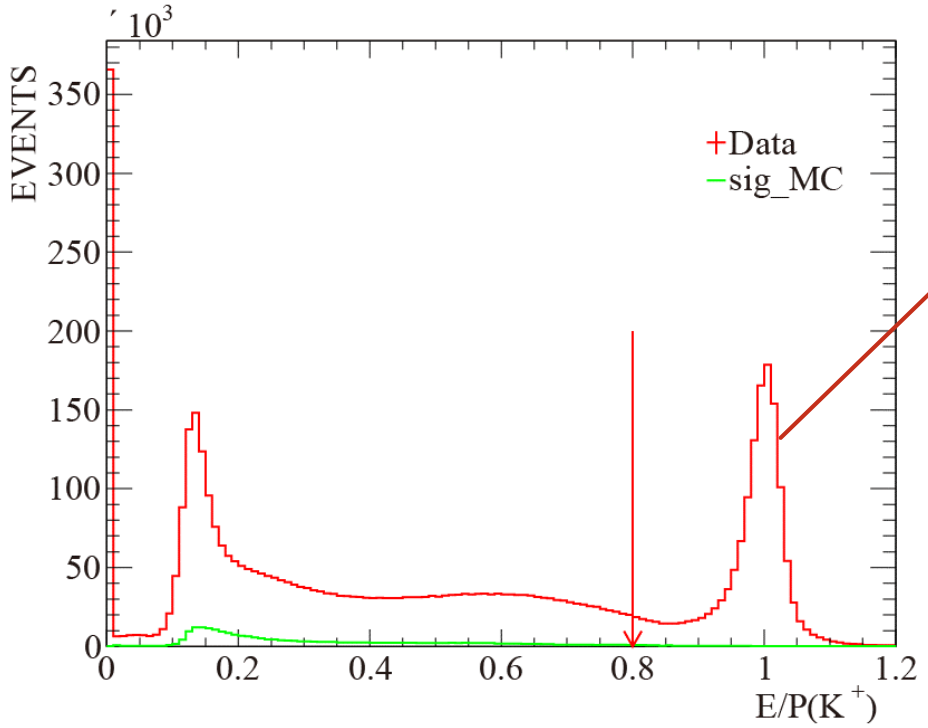


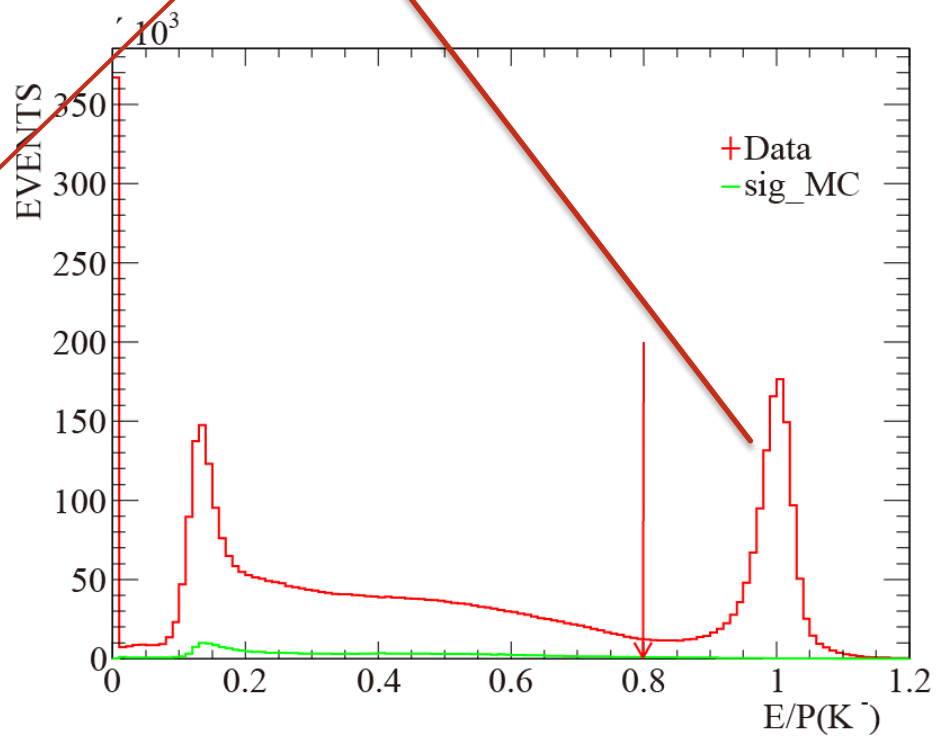
χ^2 distribution from 4C : $\chi^2_{4c} < 24$

QED background

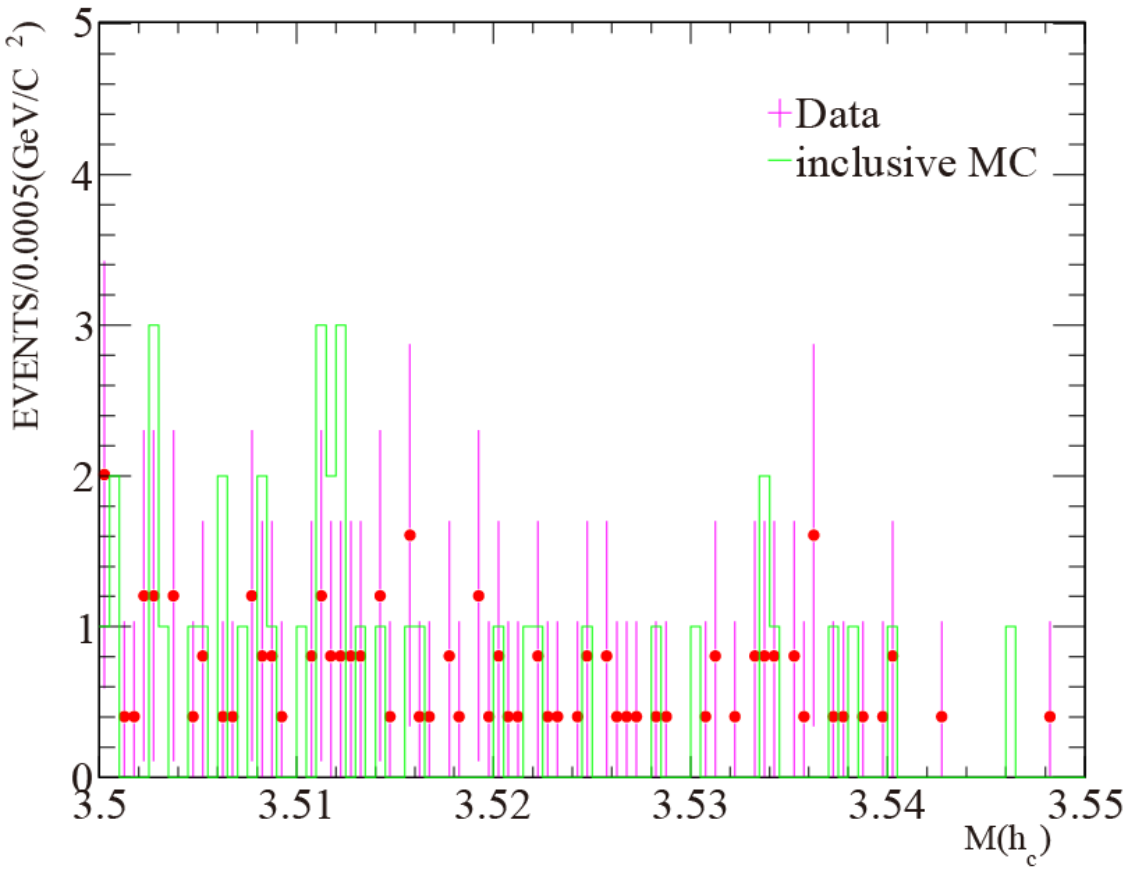
$$\frac{E}{P} < 0.8$$

e^+e^-

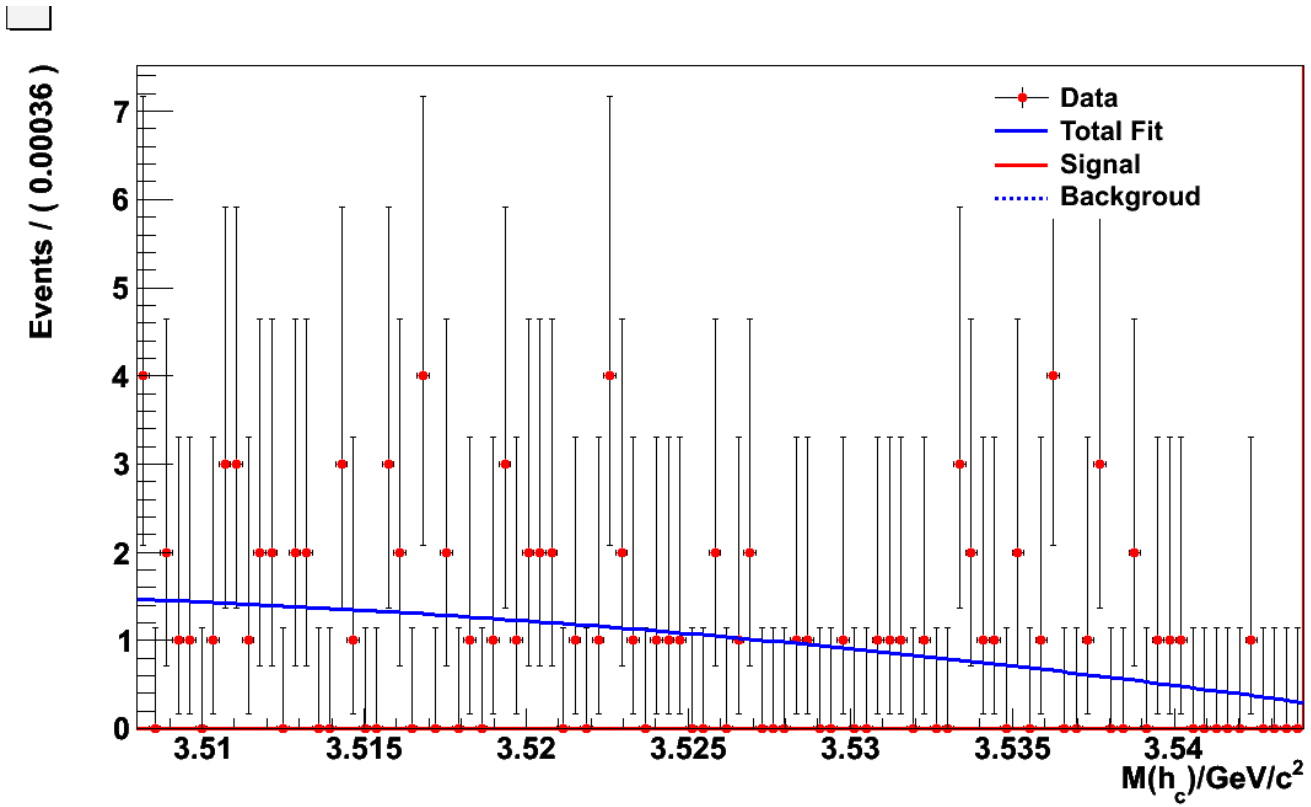


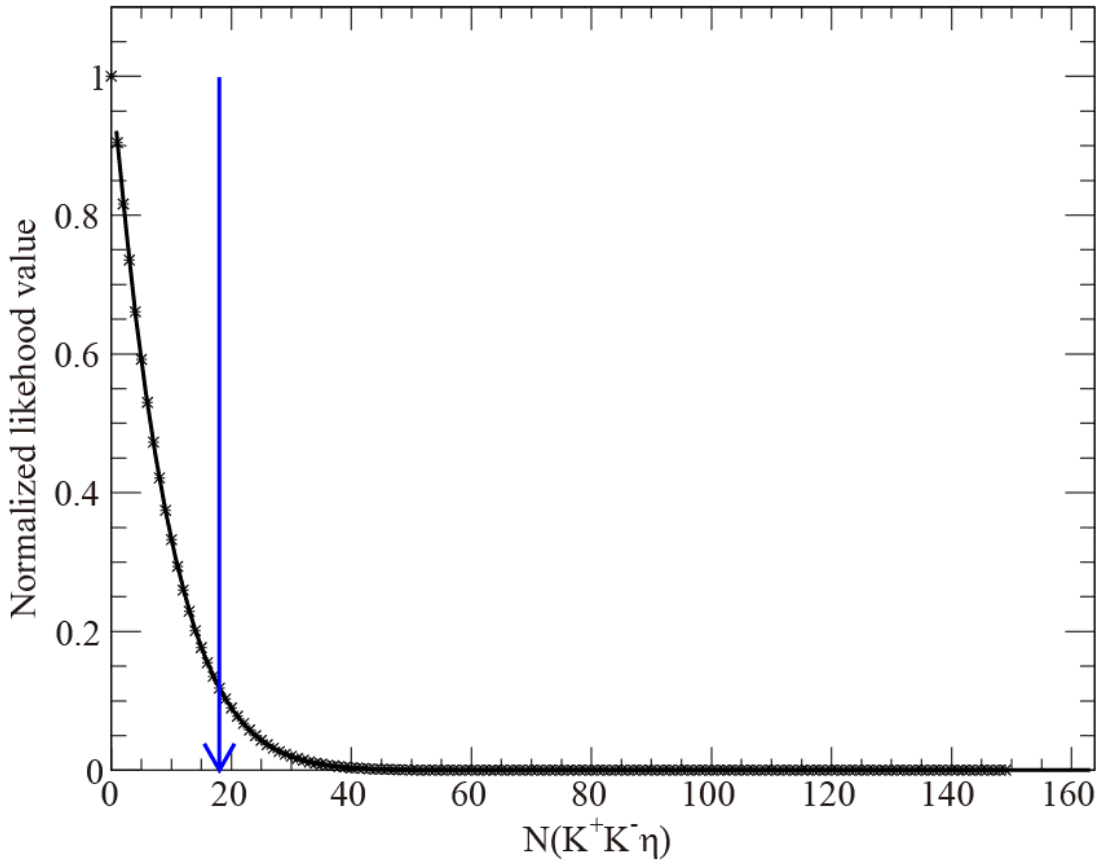


No.	decay chain	final states	iTopo	nEvt	nTot
0	$\psi' \to \eta J/\psi,\ \eta \to \gamma\gamma,\ J/\psi \to K^{*-}K^{+},\ K^{*-} \to K^{-}\pi^{0},$	$\psi' \to \gamma\gamma\gamma\gamma K^{+}K^{-}$	9	7	7
1	$\psi' \to \eta J/\psi,\ \eta \to \gamma\gamma,\ J/\psi \to K^{-}K^{*+},\ K^{*+} \to \pi^{0}K^{+},$	$\psi' \to \gamma\gamma\gamma\gamma K^{+}K^{-}$	7	4	11
2	$\psi' \to \gamma\chi_{c2},\ \chi_{c2} \to K^{*-}\pi^{0}K^{+},\ K^{*-} \to K^{-}\pi^{0},$	$\psi' \to \gamma\gamma\gamma\gamma\gamma K^{+}K^{-}$	2	3	14
3	$\psi' \to \gamma\chi_{c2},\ \chi_{c2} \to \gamma J/\psi,\ J/\psi \to K^{-}K^{*+},\ K^{*+} \to \pi^{0}K^{+},$	$\psi' \to \gamma\gamma\gamma\gamma K^{+}K^{-}$	11	3	17
4	$\psi' \to \gamma\chi_{c0},\ \chi_{c0} \to K^{*-}\pi^{0}K^{+},\ K^{*-} \to K^{-}\pi^{0},$	$\psi' \to \gamma\gamma\gamma\gamma\gamma K^{+}K^{-}$	4	2	19
5	$\psi' \to \gamma\chi_{c0},\ \chi_{c0} \to K^{-}\pi^{0}\pi^{0}K^{+},$	$\psi' \to \gamma\gamma\gamma\gamma\gamma K^{+}K^{-}$	0	2	21
6	$\psi' \to K^{-}\gamma_{FSR}\pi^{0}K^{*+},\ K^{*+} \to \pi^{0}K^{+},$	$\psi' \to \gamma\gamma\gamma\gamma\gamma_{FSR}K^{+}K^{-}$	6	1	22
7	$\psi' \to K_1^{-}K^{+},\ K_1^{-} \to K_0^{*-}\pi^{0},\ K_0^{*-} \to K^{-}\pi^{0},$	$\psi' \to \gamma\gamma\gamma\gamma K^{+}K^{-}$	3	1	23
8	$\psi' \to K_1^{-}K^{+},\ K_1^{-} \to K^{-}\omega,\ \omega \to \gamma\pi^{0},$	$\psi' \to \gamma\gamma\gamma K^{+}K^{-}$	8	1	24
9	$\psi' \to \gamma\chi_{c1},\ \chi_{c1} \to K^{*-}\gamma_{FSR}K^{+},\ K^{*-} \to K^{-}\pi^{0},$	$\psi' \to \gamma\gamma\gamma\gamma_{FSR}K^{+}K^{-}$	1	1	25
10	$\psi' \to \pi^{0}\pi^{0}J/\psi,\ J/\psi \to K^{-}K^{*+},\ K^{*+} \to \pi^{0}K^{+},$	$\psi' \to \gamma\gamma\gamma\gamma\gamma\gamma K^{+}K^{-}$	10	1	26
11	$\psi' \to \gamma\chi_{c2},\ \chi_{c2} \to \gamma J/\psi,\ J/\psi \to K^{-}\pi^{0}K^{+},$	$\psi' \to \gamma\gamma\gamma\gamma K^{+}K^{-}$	5	1	27
12	$\psi' \to K^{-}\pi^{0}K^{*+},\ K^{*+} \to \pi^{0}K^{+},$	$\psi' \to \gamma\gamma\gamma\gamma K^{+}K^{-}$	12	1	28



No h_c signal observed





$$N_{h_c} = 0 \pm 5.0$$

$$(< 18 @ 90\% C.L.)$$

Signa: h_c singal MC shape

Background:a 2-st polynomial function

Branching fraction

$$B(h_c \to \eta K^+K^-) = \frac{N_{signal}}{N_{tot}^{\psi'} B(\psi' \to \eta h_c) B(\pi^0 \to \gamma\gamma)\varepsilon_{MC}}$$

$$\varepsilon_{MC} = 11.7\%$$

Mode	Events	Eff.(%)	Br(10^{-3})	Significant
$h_c \to \eta K^+K^-$	<18	11.7	1.0	_

Systematic errors

Sources	Method
Tracking efficiency	2% per charged track
Detection efficiency of π^0	3% per π^0
Signal shape	Vary the from Γ_{h_c} 0.4—1.5 MeV/c^2
Uncertainty of Background Modeling	Try a 3rd order polynomial
Fitting rang	Vary the fitting range
Kinematic fit	Correct the track helix parameters
Uncertainty of MC models	Try different generator model: AngSam 1 1
$B(\pi^0 \to \gamma\gamma)$	0.033% for each π^0
Total number of ψ'	The total number ψ' of in 2009 and 2012
Background vetos	Vary the vetos

Systematic errors

Sources	$K^+K^-\pi_0$	$K^+K^-\eta$
Tracking efficiency	4.0%	4.0%
Detection efficiency of π_0	6.0%	3.0%
Signal shape	2.5% -2.4%	0.5% -0.4%
Uncertainty of Background Modeling	5.3%	5.6%
Fitting rang	4.7%	16.7%
Kinematic fit	1.2%	0.7%
Uncertainty of MC models	1.6%	0.8%
$B(\pi^0 \to \gamma\gamma)$	0.07%	0.04%
Total number of ψ'	0.7%	0.7%
Background vetos	7.0%	0
Sum of all	12.7% -12.7%	19.1% -19.1%

XYZ data

- Maybe the XYZ data is more suitable for research h_c ?

$\sqrt{s}$ (GeV)	$\mathcal{L}$ (pb^{-1})	$n_{h_c}^{\rm obs}$	$(1+\delta)\sum_{i=1}^{16}\epsilon_i\mathcal{B}(\eta_c\to X_i)(\%)$	$\lvert 1+\Pi\rvert^2$	$\sigma^{\rm B}$ (pb)
3.8962	52.6	$-1.5^{+1.9}_{-0.8}$	0.78	1.049	$-6.8^{+8.4}_{-3.7}\pm 0.6\pm 0.8$
4.0076	482.0	$7.6^{+7.2}_{-4.7}$	1.42	1.044	$2.0^{+2.0}_{-1.3}\pm 0.3\pm 0.2$
4.0855	52.6	$-1.6^{+4.2}_{-1.5}$	1.85	1.052	$-3.1^{+8.0}_{-2.9}\pm 0.4\pm 0.4$
4.1886	43.1	$7.4^{+5.7}_{-3.1}$	1.96	1.056	$16.6^{+12.5}_{-6.8}\pm 1.8\pm 2.0$
4.2077	54.6	$23.6^{+7.2}_{-4.7}$	1.99	1.057	$40.7^{+12.3}_{-8.0}\pm 3.9\pm 4.8$
4.2171	54.1	$25.3^{+7.8}_{-5.3}$	2.03	1.057	$43.2^{+13.2}_{-8.9}\pm 4.2\pm 5.1$
4.2263	1091.7	669 ± 32	2.07	1.056	$55.2\pm 2.6\pm 6.1\pm 6.5$
4.2417	55.6	$25.5^{+8.1}_{-5.6}$	2.17	1.056	$39.9^{+12.5}_{-8.6}\pm 3.8\pm 4.7$
4.2580	825.7	443 ± 27	2.23	1.054	$46.3\pm 2.8\pm 5.1\pm 5.5$
4.3079	44.9	$34.3^{+8.3}_{-5.8}$	2.22	1.052	$65.0^{+15.6}_{-10.9}\pm 6.1\pm 7.7$
4.3583	539.8	357 ± 24	2.26	1.051	$55.8\pm 3.7\pm 6.2\pm 6.6$
4.3874	55.2	$30.2^{+8.8}_{-6.1}$	2.30	1.051	$45.5^{+12.9}_{-9.0}\pm 4.4\pm 5.4$
4.4156	1073.6	685 ± 35	2.28	1.053	$52.1\pm 2.7\pm 5.9\pm 6.1$
4.4671	109.9	$27.1^{+9.7}_{-7.2}$	2.38	1.055	$19.3^{+6.9}_{-5.1}\pm 2.4\pm 2.3$
4.5271	110.0	$-1.3^{+7.5}_{-4.9}$	2.39	1.055	$-0.9^{+5.3}_{-3.5}\pm 0.1\pm 0.1$
4.5745	47.7	$9.2^{+6.8}_{-4.3}$	2.37	1.055	$15.1^{+11.2}_{-7.1}\pm 2.1\pm 1.8$
4.5995	566.9	$52.0^{+16.9}_{-14.3}$	2.38	1.055	$7.2^{+2.3}_{-2.0}\pm 0.7\pm 0.8$

$e^+e^-\to\pi^+\pi^-h_c$ cross sections from *XYZ* data sample

the total number of h_c is about 184547

Data sets

- Boss Version: 7.0.2 p01
- Data sets: 4230 4260 4360 4420

- Signal MC : $e^+e^- \to \pi^+\pi^- h_c, h_c \to \pi^0 K^+ K^-$

$$e^+e^- \to \pi^+\pi^- h_c, h_c \to \pi^0 \pi^+ \pi^-$$

$$e^+e^- \to \pi^+\pi^- h_c, h_c \to p\bar{p}$$

Event selections for $h_c \to \pi^0 K^+ K^-$

Charged tracks

$|R_{xy}| < 1cm, |R_z| < 10cm$

$|\cos\theta| < 0.93$

$N = 4, \sum Q = 0$

4C kinematic fit

Select the photons with least χ^2

$\chi^2 < 60$

Good photon

$0 \le TDC \le 14$

$Barrel:$

$E > 0.025\ GeV, |\cos\theta| < 0.8$

$Endcap:$

$E > 0.050\ GeV, 0.86 < |\cos\theta| < 0.92$

$\Delta\theta > 10^0$

$N_\gamma \ge 2$

PID

$K: \chi^2(\mathrm{K}) < \chi^2(\pi)$, $\chi^2(\mathrm{K}) < \chi^2(\mathrm{p})$

$\pi: \chi^2(\pi) < \chi^2(\mathrm{K})$, $\chi^2(\pi) < \chi^2(\mathrm{p})$

$p: \chi^2(\mathrm{p}) < \chi^2(\mathrm{K})$, $\chi^2(\mathrm{p}) < \chi^2(\pi)$

To remove μ

$mupLayer[0] < 7;$

$mupLayer[1] < 7;$

$mumLayer[0] < 7;$

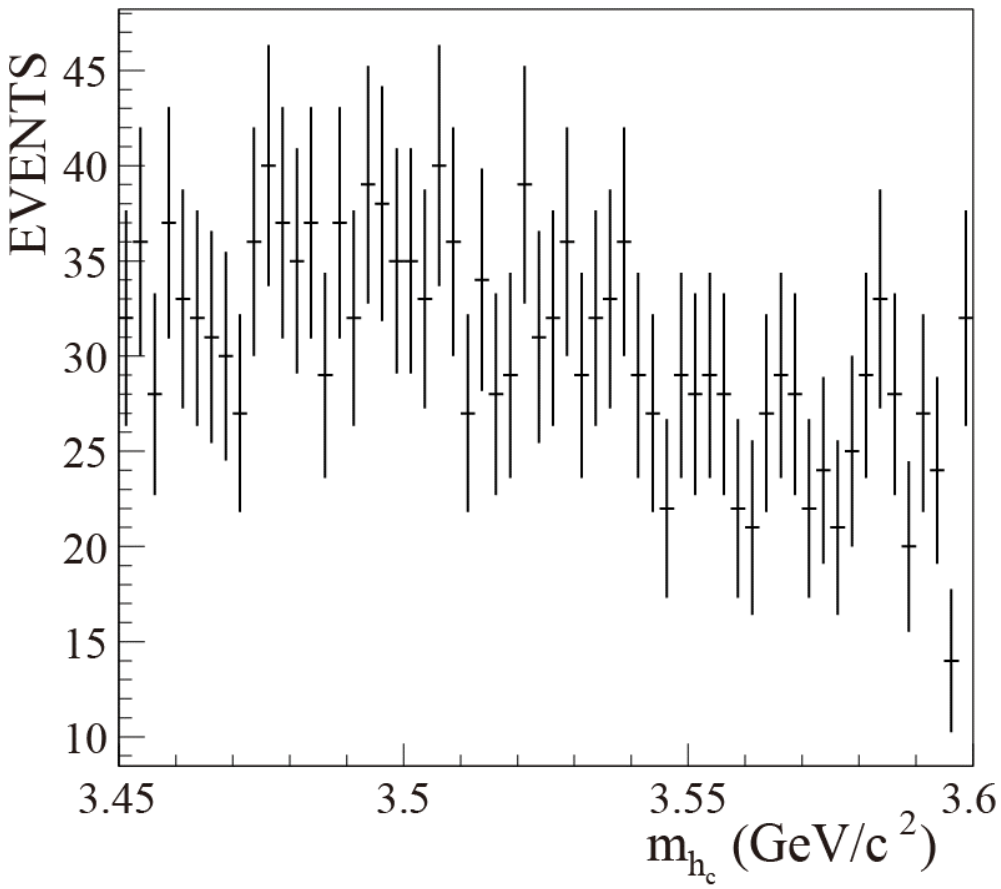
$mumLayer[1] < 7;$

mass window

$|\mathrm{m}_{K^+K^-\pi^0} - m_{h_c}| < 10 MeV / c^2$

$|\mathrm{m}_{\gamma\gamma} - m_{\pi^0}| < 17 MeV / c^2$

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



Signal efficiency is 10.73%

Event selections for $h_c \to \pi^0\pi^+\pi^-$

Charged tracks

$|R_{xy}| < 1cm, |R_z| < 10cm$

$|\cos\theta| < 0.93$

$N = 4, \sum Q = 0$

4C kinematic fit

Select the photons with least χ^2

$\chi^2 < 60$

Good photon

$0 \le TDC \le 14$

$Barrel:$

$E > 0.025\ GeV, |\cos\theta| < 0.8$

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$E > 0.050\ GeV, 0.86 < |\cos\theta| < 0.92$

$\Delta\theta > 10^0$

$N_\gamma \ge 2$

PID

$K: \chi^2(\mathrm{K}) < \chi^2(\pi)$, $\chi^2(\mathrm{K}) < \chi^2(\mathrm{p})$

$\pi: \chi^2(\pi) < \chi^2(\mathrm{K})$, $\chi^2(\pi) < \chi^2(\mathrm{p})$

$p: \chi^2(\mathrm{p}) < \chi^2(\mathrm{K})$, $\chi^2(\mathrm{p}) < \chi^2(\pi)$

To remove μ

$mupLayer[0] < 7;$

$mupLayer[1] < 7;$

$mumLayer[0] < 7;$

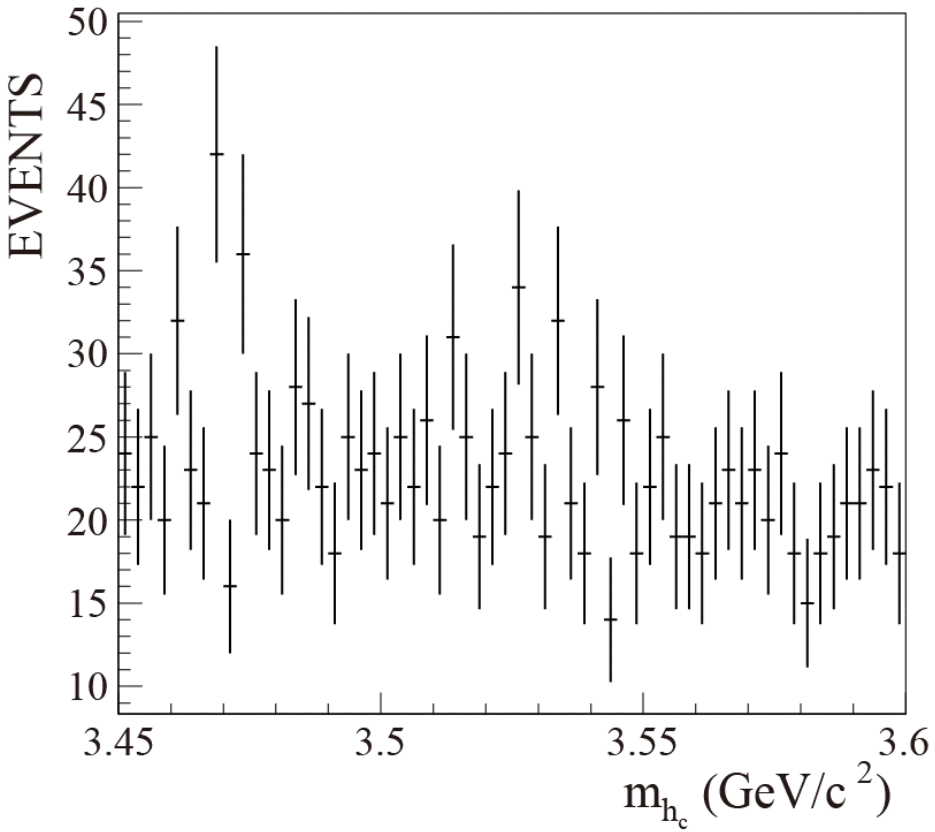
$mumLayer[1] < 7;$

mass window

$|\mathrm{m}_{\pi^+\pi^-\pi^0} - m_{h_c}| < 12 MeV / c^2$

$|\mathrm{m}_{\gamma\gamma} - m_{\pi^0}| < 18 MeV / c^2$

$$h_c \to \pi^0 \pi^+ \pi^-$$



Signal efficiency is 12.66%

Event selections for $h_c \to p\bar{p}$

Charged tracks

$|R_{xy}| < 1cm, |R_z| < 10cm$

$|\cos\theta| < 0.93$

$N = 4, \sum Q = 0$

4C kinematic fit

Select the photons with least χ^2

$\chi^2 < 60$

PID

$K: \chi^2(\mathrm{K}) < \chi^2(\pi)$, $\chi^2(\mathrm{K}) < \chi^2(\mathrm{p})$

$\pi: \chi^2(\pi) < \chi^2(\mathrm{K})$, $\chi^2(\pi) < \chi^2(\mathrm{p})$

$p: \chi^2(\mathrm{p}) < \chi^2(\mathrm{K})$, $\chi^2(\mathrm{p}) < \chi^2(\pi)$

To remove μ

$mupLayer[0] < 7;$

$mupLayer[1] < 7;$

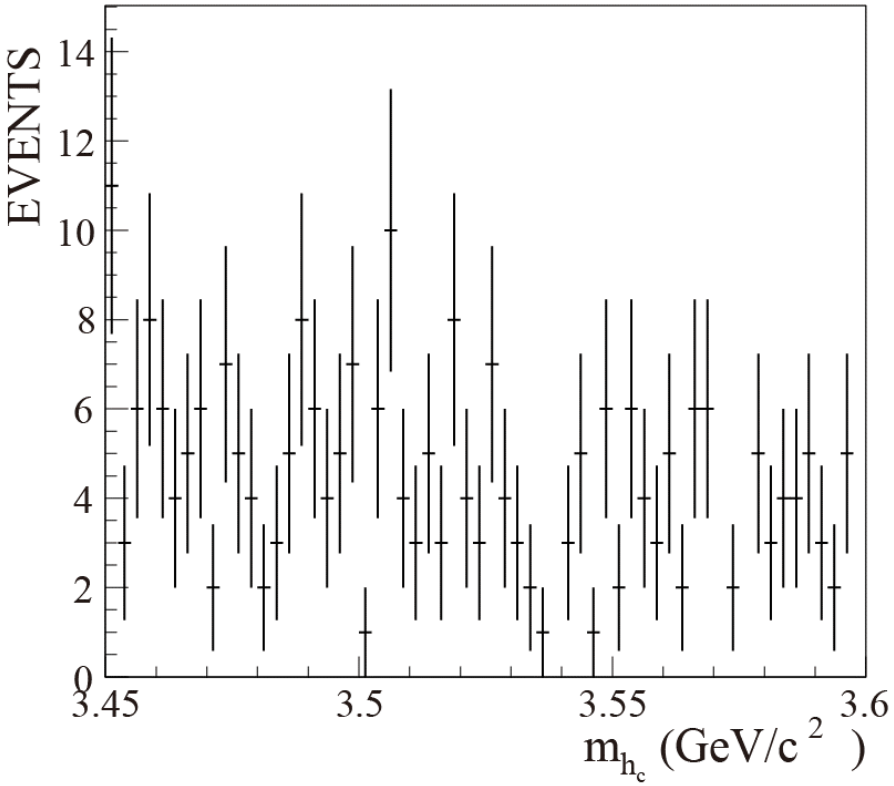
$mumLayer[0] < 7;$

$mumLayer[1] < 7;$

mass window

$|\mathrm{m}_{p\bar{p}} - m_{h_c}| < 10 MeV / c^2$

$h_c \to p\bar{p}$



Signal efficiency is 30.83%

Summary

- We perform an analysis of $\psi(2S) \to \pi^0 h_c$ to search for $h_c \to \pi^0 K^+ K^-$ and $h_c \to \eta K^+ K^-$.There is no significant signal. We give the production upper limit of $h_c \to \pi^0 / \eta \ K^+ K^-$.

- Systematic uncertainties are estimated.

Thanks for your attention