Group Report on Recent Work

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Introduction

We optimized the selection with ROOT scripts, with the max $S = \frac{N_S}{\sqrt{N_S+N_B}}$, where S is the significance, N_S is the number of signal events, and N_B is the number of background events.

And we used the signal MC to determine the number of signal events N_S, and the inclusive MC the number of background and signal events $N_S + N_B$, which we verified as a reasonable option.

Optimization

We did topology analysis after we got the inclusive MC Results, and found the main background are:

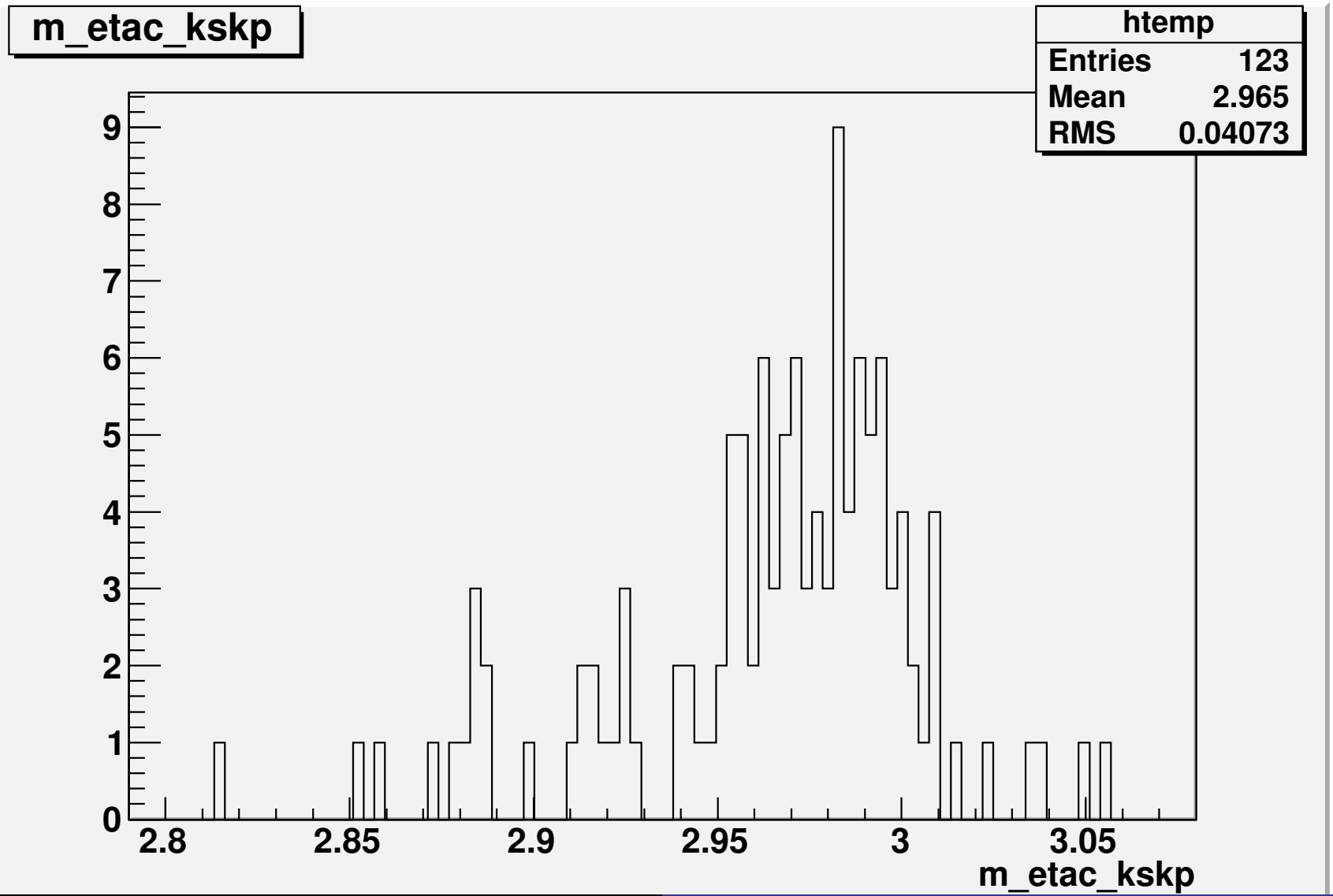
- $\psi(3686) \to \pi^0\pi^0 J/\psi$
- $\psi(3686) \to \gamma\chi_{cj}$
- $\psi(3686) \to \pi^+\pi^- J/\psi$

Optimization Results

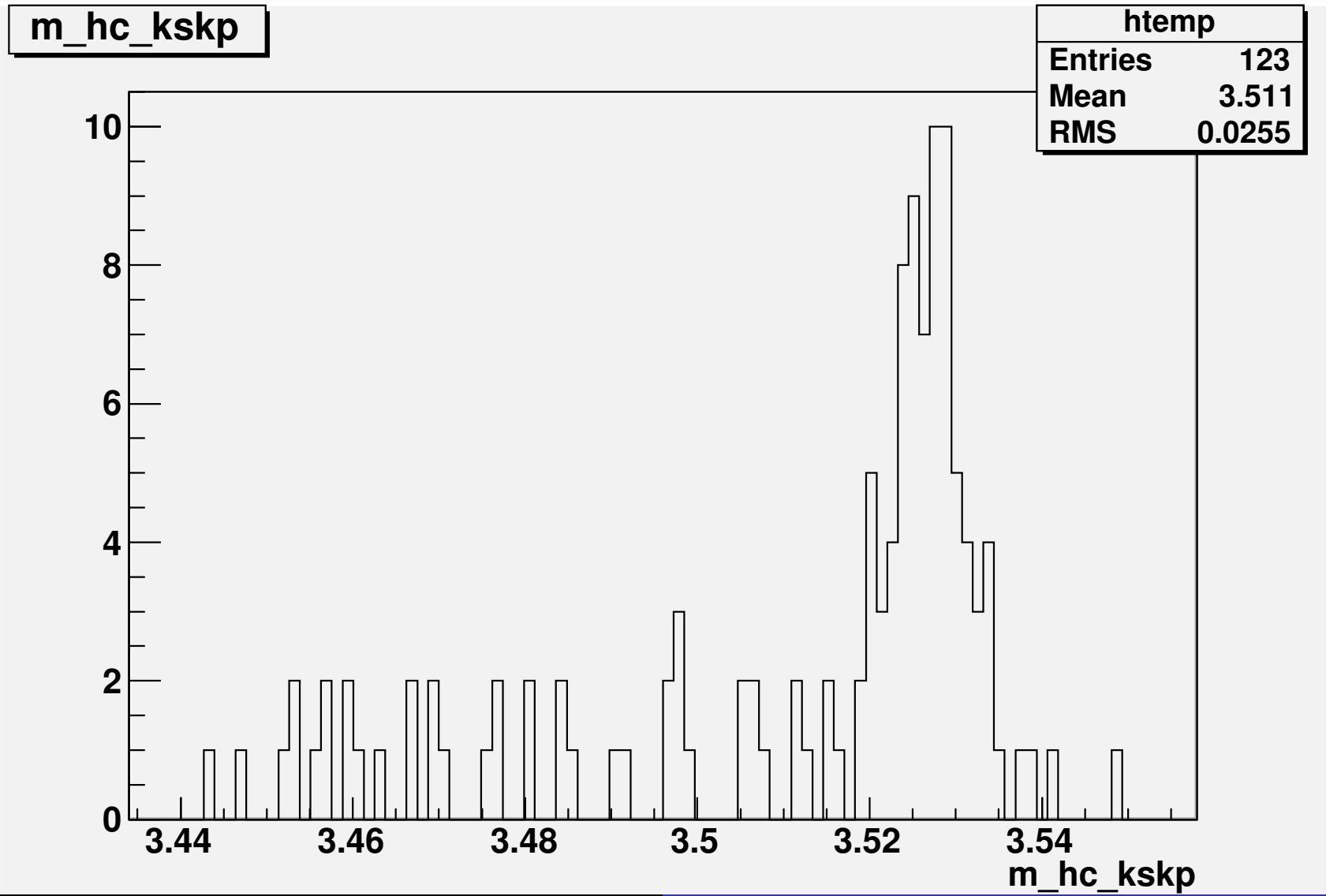
Using a ROOT scripts, we got the Optimization as below:

- $0 < \chi^2_{4C} < 25$;
- $0.125 < m_{\pi^0} < 0.138$;
- $0.45 < E(\gamma_{E1}) < 0.53$;
- $|m_{recoil}(\pi^0\pi^0) - M_{J/\psi}| < 0.033$;
- $|m_{recoil}(\gamma) - M_{\chi_{c0}}| < 0$;
- $|m_{recoil}(\gamma) - M_{\chi_{c1}}| < 0.004$;
- $|m_{recoil}(\gamma) - M_{\chi_{c2}}| < 0.002$;
- $|m_{recoil}(\pi^+\pi^-) - M_{J/\psi}| < 0.004$.

Distribution of m_{η_c}



Distribution of m_{h_c}



Topology analysis

No.	decay chain	final states	iTopo	nEvt	nTot
0	$\psi' \to \pi^0 h_c,\ h_c \to \gamma\eta_c,\ \eta_c \to K^0\pi^- K^+,\ K^0 \to K_S,\ K_S \to \pi^-\pi^+,$	$\psi' \to \gamma\gamma\gamma K^+\pi^+\pi^-\pi^-$	2	38	38
1	$\psi' \to \pi^0 h_c,\ h_c \to \gamma\eta_c,\ \eta_c \to K^-\pi^+ K^0,\ K^0 \to K_S,\ K_S \to \pi^-\pi^+,$	$\psi' \to \gamma\gamma\gamma\pi^+\pi^+\pi^- K^-$	6	35	73
2	$\psi' \to \gamma\chi_{c2},\ \chi_{c2} \to \bar{K}^0\rho^- K^+,\ \bar{K}^0 \to K_S,\ \rho^- \to \pi^-\pi^0,\ K_S \to \pi^-\pi^+,$	$\psi' \to \gamma\gamma\gamma K^+\pi^+\pi^-\pi^-$	24	6	79
3	$\psi' \to K^-\bar{K}^*\gamma\pi^+,\ \bar{K}^* \to \bar{K}^0\pi^0,\ \bar{K}^0 \to K_S,\ K_S \to \pi^-\pi^+,$	$\psi' \to \gamma\gamma\gamma\pi^+\pi^+\pi^- K^-$	1	5	84
4	$\psi' \to \pi^-\gamma K^* K^+,\ K^* \to \pi^0 K^0,\ K^0 \to K_S,\ K_S \to \pi^-\pi^+,$	$\psi' \to \gamma\gamma\gamma K^+\pi^+\pi^-\pi^-$	5	4	88
5	$\psi' \to \gamma\chi_{c2},\ \chi_{c2} \to K^-\rho^+ K^0,\ \rho^+ \to \pi^0\pi^+,\ K^0 \to K_S,\ K_S \to \pi^-\pi^+,$	$\psi' \to \gamma\gamma\gamma\pi^+\pi^+\pi^- K^-$	14	3	91
6	$\psi' \to \gamma\chi_{c2},\ \chi_{c2} \to \bar{K}^* K^*,\ \bar{K}^* \to K^-\pi^+,\ K^* \to \pi^0 K^0,\ K^0 \to K_S,\ K_S \to \pi^-\pi^+,$	$\psi' \to \gamma\gamma\gamma\pi^+\pi^+\pi^- K^-$	11	2	93
7	$\psi' \to \gamma\chi_{c1},\ \chi_{c1} \to \pi^0 K^0 K^*,\ K^0 \to K_S,\ K^* \to \pi^- K^+,\ K_S \to \pi^-\pi^+,$	$\psi' \to \gamma\gamma\gamma K^+\pi^+\pi^-\pi^-$	12	2	95
8	$\psi' \to \gamma\chi_{c1},\ \chi_{c1} \to K^-\rho^+ K^0,\ \rho^+ \to \pi^0\pi^+,\ K^0 \to K_S,\ K_S \to \pi^-\pi^+,$	$\psi' \to \gamma\gamma\gamma\pi^+\pi^+\pi^- K^-$	13	2	97
9	$\psi' \to \gamma\chi_{c2},\ \chi_{c2} \to K^{*-} K^{*+},\ K^{*-} \to \bar{K}^0\pi^-,\ K^{*+} \to \pi^0 K^+,\ \bar{K}^0 \to K_S,\ K_S \to \pi^-\pi^+,$	$\psi' \to \gamma\gamma\gamma K^+\pi^+\pi^-\pi^-$	0	2	99
10	$\psi' \to \gamma\chi_{c2},\ \chi_{c2} \to K^{*-} K^{*+},\ K^{*-} \to K^-\pi^0,\ K^{*+} \to \pi^+ K^0,\ K^0 \to K_S,\ K_S \to \pi^-\pi^+,$	$\psi' \to \gamma\gamma\gamma\pi^+\pi^+\pi^- K^-$	16	2	101
11	$\psi' \to \gamma\chi_{c1},\ \chi_{c1} \to \bar{K}^0\rho^- K^+,\ \bar{K}^0 \to K_S,\ \rho^- \to \pi^-\pi^0,\ K_S \to \pi^-\pi^+,$	$\psi' \to \gamma\gamma\gamma K^+\pi^+\pi^-\pi^-$	3	2	103
12	$\psi' \to \gamma\chi_{c1},\ \chi_{c1} \to K^-\pi^+ K^*,\ K^* \to \pi^0 K^0,\ K^0 \to K_S,\ K_S \to \pi^-\pi^+,$	$\psi' \to \gamma\gamma\gamma\pi^+\pi^+\pi^- K^-$	26	2	105
13	$\psi' \to \gamma\chi_{c2},\ \chi_{c2} \to \bar{K}^0\pi^- K^{*+},\ \bar{K}^0 \to K_S,\ K^{*+} \to \pi^0 K^+,\ K_S \to \pi^-\pi^+,$	$\psi' \to \gamma\gamma\gamma K^+\pi^+\pi^-\pi^-$	8	1	106
14	$\psi' \to \gamma\chi_{c2},\ \chi_{c2} \to \bar{K}^*\pi^0 K^0,\ \bar{K}^* \to K^-\pi^+,\ K^0 \to K_S,\ K_S \to \pi^-\pi^+,$	$\psi' \to \gamma\gamma\gamma\pi^+\pi^+\pi^- K^-$	9	1	107
15	$\psi' \to \gamma\eta_c,\ \eta_c \to K^-\pi^+ K^*,\ K^* \to \pi^0 K^0,\ K^0 \to K_S,\ K_S \to \pi^-\pi^+,$	$\psi' \to \gamma\gamma\gamma\pi^+\pi^+\pi^- K^-$	15	1	108
16	$\psi' \to \gamma\chi_{c1},\ \chi_{c1} \to \bar{K}^*\pi^- K^+,\ \bar{K}^* \to \bar{K}^0\pi^0,\ \bar{K}^0 \to K_S,\ K_S \to \pi^-\pi^+,$	$\psi' \to \gamma\gamma\gamma K^+\pi^+\pi^-\pi^-$	10	1	109
17	$\psi' \to K^- K_1^+,\ K_1^+ \to \rho^+ K^0,\ \rho^+ \to \pi^0\pi^+,\ K^0 \to K_S,\ K_S \to \pi^-\pi^+,$	$\psi' \to \gamma\gamma\pi^+\pi^+\pi^- K^-$	17	1	110
18	$\psi' \to \bar{K}^*\pi^0 K_2^{*0},\ \bar{K}^* \to \bar{K}^0\pi^0,\ K_2^{*0} \to \pi^- K^+,\ \bar{K}^0 \to K_S,\ K_S \to \pi^-\pi^+,$	$\psi' \to \gamma\gamma\gamma\gamma K^+\pi^+\pi^-\pi^-$	18	1	111
19	$\psi' \to K^- K_1^+,\ K_1^+ \to \rho^+ K^0,\ \rho^+ \to \gamma_{FSR}\pi^0\pi^+,\ K^0 \to K_S,\ K_S \to \pi^-\pi^+,$	$\psi' \to \gamma\gamma\gamma_{FSR}\pi^+\pi^+\pi^- K^-$	19	1	112
20	$\psi' \to \gamma\chi_{c2},\ \chi_{c2} \to \pi^- K^* K^+,\ K^* \to \pi^0 K^0,\ K^0 \to K_S,\ K_S \to \pi^-\pi^+,$	$\psi' \to \gamma\gamma\gamma K^+\pi^+\pi^-\pi^-$	20	1	113
21	$\psi' \to \gamma\chi_{c1},\ \chi_{c1} \to K^{*-} K^{*+},\ K^{*-} \to K^-\pi^0,\ K^{*+} \to \pi^+ K^0,\ K^0 \to K_S,\ K_S \to \pi^-\pi^+,$	$\psi' \to \gamma\gamma\gamma\pi^+\pi^+\pi^- K^-$	21	1	114
22	$\psi' \to \gamma\chi_{c2},\ \chi_{c2} \to \bar{K}^0\pi^0 K^*,\ \bar{K}^0 \to K_S,\ K^* \to \pi^- K^+,\ K_S \to \pi^-\pi^+,$	$\psi' \to \gamma\gamma\gamma K^+\pi^+\pi^-\pi^-$	22	1	115
23	$\psi' \to \gamma\chi_{c2},\ \chi_{c2} \to K^-\pi^0 K^{*+},\ K^{*+} \to \pi^+ K^0,\ K^0 \to K_S,\ K_S \to \pi^-\pi^+,$	$\psi' \to \gamma\gamma\gamma\pi^+\pi^+\pi^- K^-$	23	1	116
24	$\psi' \to \bar{K}^*\gamma K^*,\ \bar{K}^* \to K^-\pi^+,\ K^* \to \pi^0 K^0,\ K^0 \to K_S,\ K_S \to \pi^-\pi^+,$	$\psi' \to \gamma\gamma\gamma\pi^+\pi^+\pi^- K^-$	4	1	117
25	$\psi' \to \gamma\chi_{c1},\ \chi_{c1} \to K^-\bar{K}^0\pi^0\pi^+,\ \bar{K}^0 \to K_S,\ K_S \to \pi^-\pi^+,$	$\psi' \to \gamma\gamma\gamma\pi^+\pi^+\pi^- K^-$	25	1	118
26	$\psi' \to \gamma\chi_{c1},\ \chi_{c1} \to \bar{K}^*\pi^0 K^0,\ \bar{K}^* \to K^-\pi^+,\ K^0 \to K_S,\ K_S \to \pi^-\pi^+,$	$\psi' \to \gamma\gamma\gamma\pi^+\pi^+\pi^- K^-$	7	1	119
27	$\psi' \to \gamma\chi_{c2},\ \chi_{c2} \to K^{*-}\pi^0 K^+,\ K^{*-} \to \bar{K}^0\pi^-,\ \bar{K}^0 \to K_S,\ K_S \to \pi^-\pi^+,$	$\psi' \to \gamma\gamma\gamma K^+\pi^+\pi^-\pi^-$	27	1	120
28	$\psi' \to \pi^-\pi^+ K_S K_S,\ K_S \to \pi^-\pi^+,\ K_S \to \pi^0\pi^0,$	$\psi' \to \gamma\gamma\gamma\gamma\pi^+\pi^+\pi^-\pi^-$	28	1	121
29	$\psi' \to K_1^- K^+,\ K_1^- \to \bar{K}^0\rho^-,\ \bar{K}^0 \to K_S,\ \rho^- \to \pi^-\pi^0,\ K_S \to \pi^-\pi^+,$	$\psi' \to \gamma\gamma K^+\pi^+\pi^-\pi^-$	29	1	122

Table 1:

- Background analysis in 2-3 weeks