BOSS version : 6.6.4 p03
Dataset :5 millions Signal MC (09)
ψ(2S) data (09,12)
ψ(2S) inclusive MC (09,12)

```
Decay psi(2S)
1.0  Lambda0 anti-Lambda0   eta'                PHSP;
Enddecay

Decay Lambda0
1.0   p+  pi-                    PHSP;
Enddecay

Decay anti-Lambda0
1.0   anti-p- pi+                 PHSP;
Enddecay

Decay eta'
1.0  gamma pi+ pi-                          PHSP;
Enddecay



End
~
```

Event selection

- Charged track :

1. At least 3 positive and 3 negative charged track;
2. Polar angle of each track in MDC: | cos θ| < 0.93;

- Good shower:

1. Shower energy: Eγ > 25MeV for the barrel EMC (| cos θ| < 0.8), Eγ > 50MeV for the endcap EMC (0.86 < | cos θ| < 0.92) ;
2. Opening angle between shower and the nearest charged track > 10°;
3. Nshower >=1;

- PID:prob(p)>prob(π)&&prob(p>prob(K),set PID p;
- Vertex fit:

1. At least one $\mathrm{p}\pi^-$ and one $p^-\pi^+$ candidate are required to pass the $\Lambda(\bar{\Lambda})$ vertex fit successfully by looping over all the combinations of positive and negative charged tracks. the one with minimum value of $\sqrt{(M_{p\pi}-M_{\Lambda})^2}$ is retained;

- 4C Kinematic fit(1 gamma): constrain to $\psi(2s)'s$ four momenta;
- 1C Kinematic fit(1 gamma): miss one pi;
- 4C Kinematic fit(2 gamma);

Cut:$L_{\Lambda(\bar{\Lambda})}$>0 cm

$M_{\Lambda(\bar{\Lambda})}$ ∈(1.11,1.122)GeV

χ^2(1gamma)< χ^2(2gamma)

χ^2(1gamma)<20;

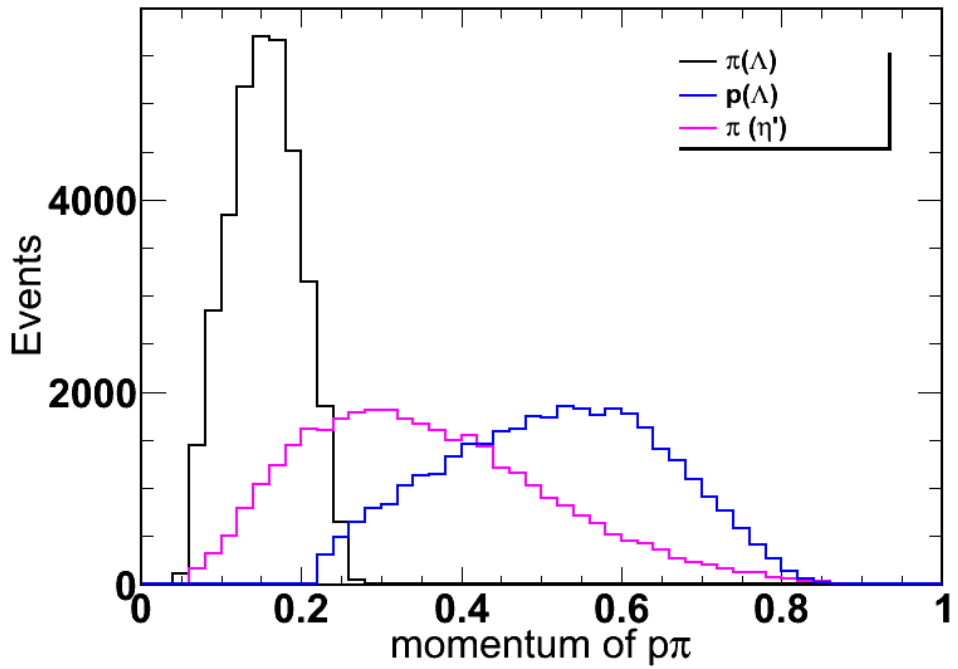
$\mathrm{M}_{\eta'}$ ∈(0.9,1.02)Gev;

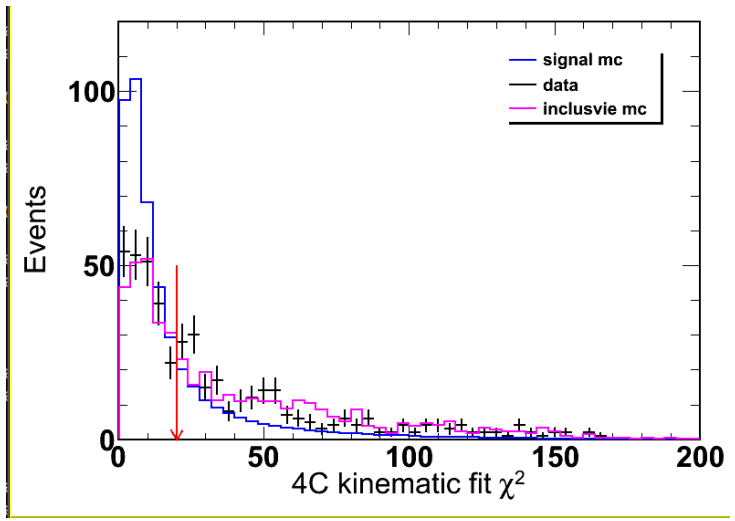
$M_{\Lambda\bar{\Lambda}}$<2.73GeV;

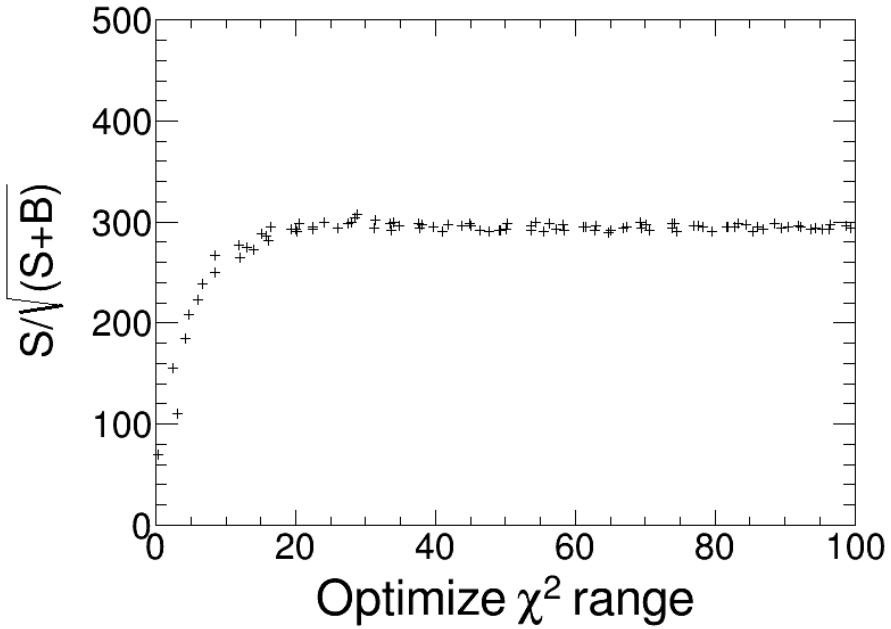
| $M_{\gamma\Lambda(\bar{\Lambda})}$ - 1.193Gev | >10 MeV;

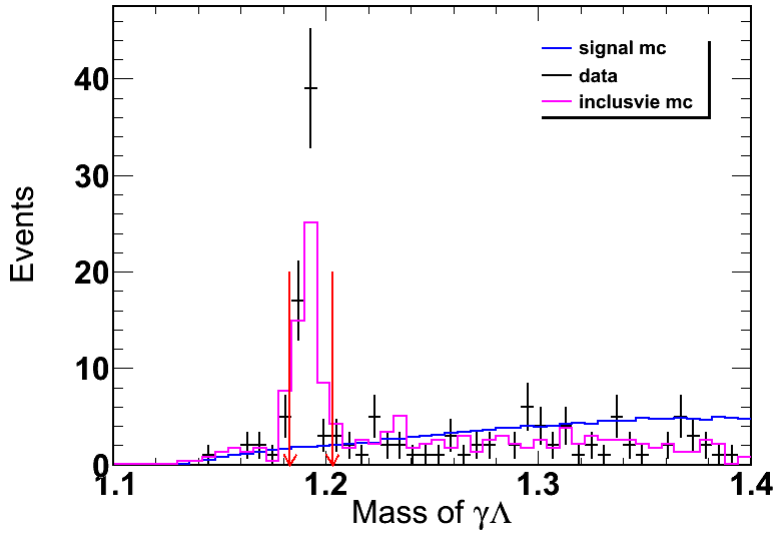
Veto $\mathrm{M}_{\gamma}^{\mathrm{recoil}}$ ∈(2.954,3.034),(3.404,3.424),(3.501,3.521),(3.546,3.566);

Veto $M_{2\pi}^{recoil}$ ∈(3.077,3.117)

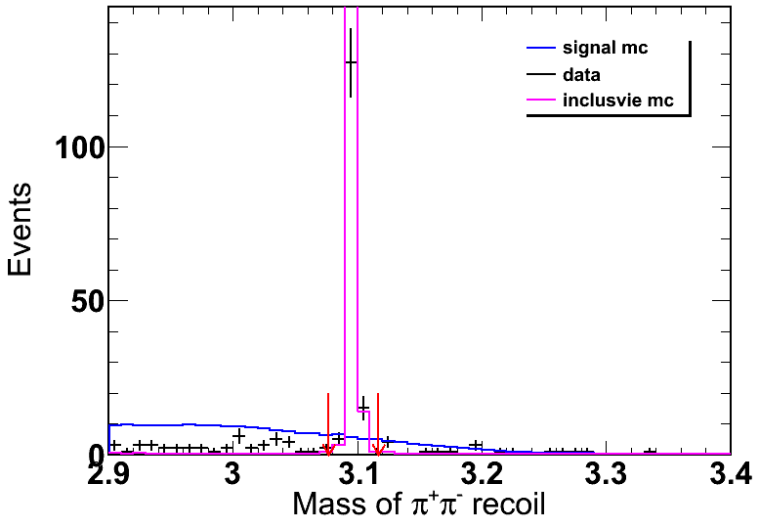

π(Λ)
p(Λ)
π (η')
Events
4000
2000
0
0
0.2
0.4
0.6
0.8
1
momentum of pπ


signal mc
data
inclusvie mc
Events
100
50
0
0
50
100
150
200
4C kinematic fit χ^2

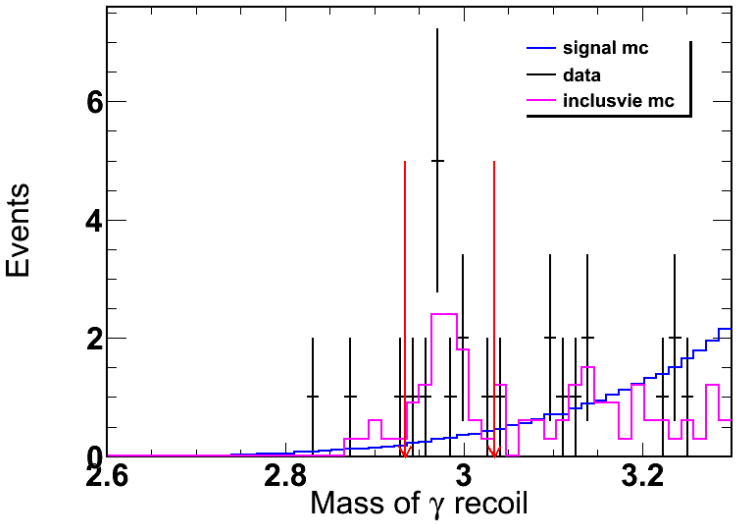

$S/\sqrt{(S+B)}$
500
400
300
200
100
0
0
20
40
60
80
100
Optimize χ^2 range

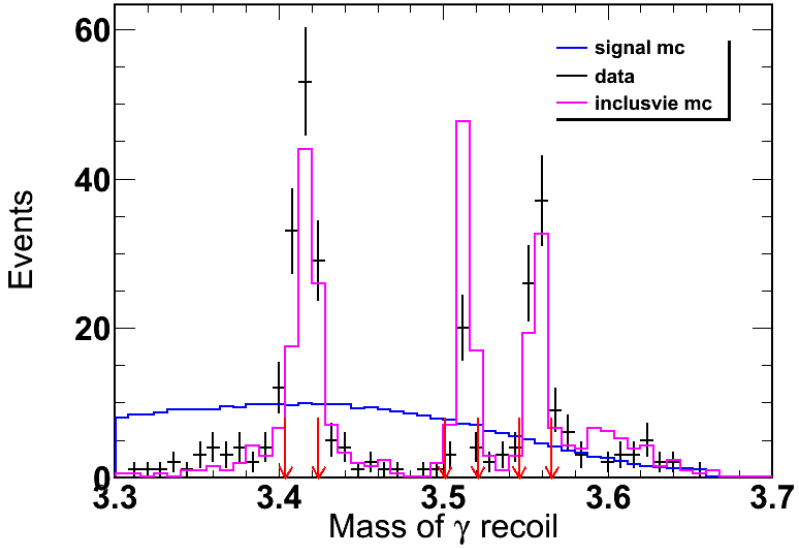


| $M_{\gamma\Lambda(\bar{\Lambda})}$ - 1.193Gev | >10 MeV;



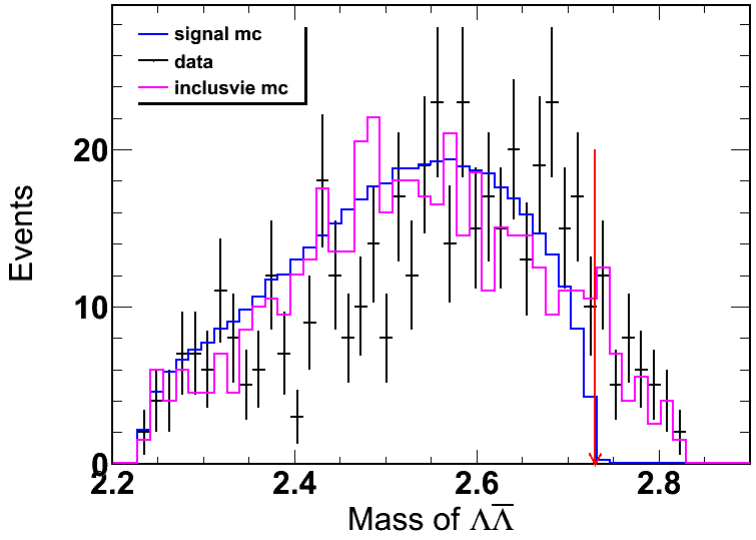
Veto $M_{2\pi}^{recoil}$ ∈(3.077,3.117)





$|M_{\gamma}^{recoil}$-2.984GeV|>50Mev; $|M_{\gamma}^{recoil}-M_{\chi cj}|$>10MeV

Eliminate η_c ,χ_{cj}



$M_{\Lambda\bar{\Lambda}}$<2.73GeV;

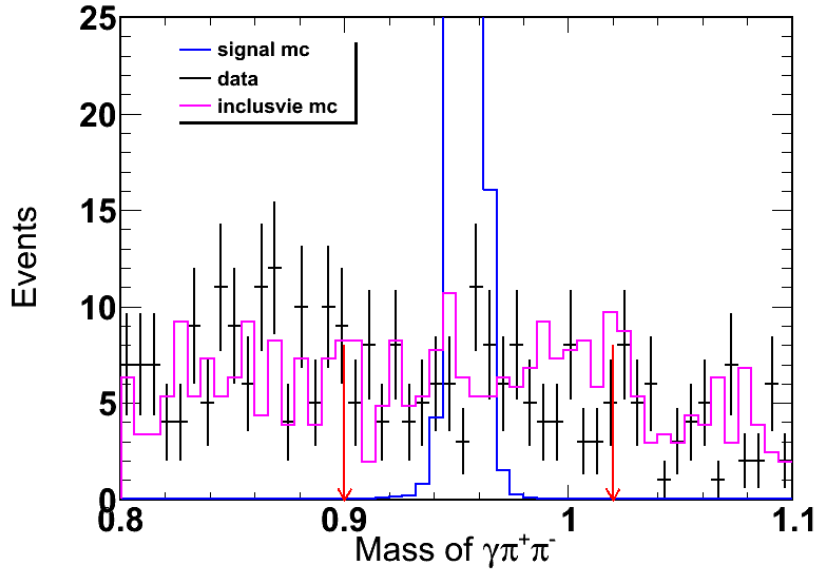


Table 1: Decay trees and their respective final states.

rowNo	decay tree	decay final state	iDcyTr	nEtr	nCEtr
1	$\psi' \to \chi_{c2}\gamma, \chi_{c2} \to \pi^-\bar{\Lambda}\Sigma^{*+}, \bar{\Lambda} \to \pi^+\bar{p}, \Sigma^{*+} \to \pi^+\Lambda, \Lambda \to \pi^- p$	$\pi^+\pi^+\pi^-\pi^- p\bar{p}\gamma$	1	20	20
2	$\psi' \to \chi_{c0}\gamma, \chi_{c0} \to \pi^+\Lambda\bar{\Sigma}^{*-}, \Lambda \to \pi^- p, \bar{\Sigma}^{*-} \to \pi^-\bar{\Lambda}, \bar{\Lambda} \to \pi^+\bar{p}$	$\pi^+\pi^+\pi^-\pi^- p\bar{p}\gamma$	6	19	39
3	$\psi' \to \chi_{c0}\gamma, \chi_{c0} \to \pi^+\Sigma^{*-}\bar{\Lambda}, \Sigma^{*-} \to \pi^-\Lambda, \bar{\Lambda} \to \pi^+\bar{p}, \Lambda \to \pi^- p$	$\pi^+\pi^+\pi^-\pi^- p\bar{p}\gamma$	9	19	58
4	$\psi' \to \chi_{c0}\gamma, \chi_{c0} \to \pi^-\bar{\Sigma}^{*+}\Lambda, \bar{\Sigma}^{*+} \to \pi^+\bar{\Lambda}, \Lambda \to \pi^- p, \bar{\Lambda} \to \pi^+\bar{p}$	$\pi^+\pi^+\pi^-\pi^- p\bar{p}\gamma$	5	15	73
5	$\psi' \to \chi_{c2}\gamma, \chi_{c2} \to \pi^+\Sigma^{*-}\bar{\Lambda}, \Sigma^{*-} \to \pi^-\Lambda, \bar{\Lambda} \to \pi^+\bar{p}, \Lambda \to \pi^- p$	$\pi^+\pi^+\pi^-\pi^- p\bar{p}\gamma$	10	15	88
6	$\psi' \to \chi_{c0}\gamma, \chi_{c0} \to \pi^-\bar{\Lambda}\Sigma^{*+}, \bar{\Lambda} \to \pi^+\bar{p}, \Sigma^{*+} \to \pi^+\Lambda, \Lambda \to \pi^- p$	$\pi^+\pi^+\pi^-\pi^- p\bar{p}\gamma$	23	14	102
7	$\psi' \to \pi^+\pi^- J/\psi, J/\psi \to \Lambda\bar{\Lambda}\gamma, \Lambda \to \pi^- p, \bar{\Lambda} \to \pi^+\bar{p}$	$\pi^+\pi^+\pi^-\pi^- p\bar{p}\gamma$	11	12	114
8	$\psi' \to \chi_{c2}\gamma, \chi_{c2} \to \pi^+\Lambda\bar{\Sigma}^{*-}, \Lambda \to \pi^- p, \bar{\Sigma}^{*-} \to \pi^-\bar{\Lambda}, \bar{\Lambda} \to \pi^+\bar{p}$	$\pi^+\pi^+\pi^-\pi^- p\bar{p}\gamma$	26	12	126
9	$\psi' \to \phi\Lambda\bar{\Lambda}, \phi \to \pi^+\rho^-, \Lambda \to \pi^- p, \bar{\Lambda} \to \pi^+\bar{p}, \rho^- \to \pi^0\pi^-$	$\pi^0\pi^+\pi^+\pi^-\pi^- p\bar{p}$	7	7	133
10	$\psi' \to \phi\Lambda\bar{\Lambda}, \phi \to \pi^-\rho^+, \Lambda \to \pi^- p, \bar{\Lambda} \to \pi^+\bar{p}, \rho^+ \to \pi^0\pi^+$	$\pi^0\pi^+\pi^+\pi^-\pi^- p\bar{p}$	13	6	139
11	$\psi' \to \chi_{c0}\gamma, \chi_{c0} \to \bar{\Xi}^+\Xi^-, \bar{\Xi}^+ \to \pi^+\bar{\Lambda}, \Xi^- \to \pi^-\Lambda, \bar{\Lambda} \to \pi^+\bar{p}, \Lambda \to \pi^- p$	$\pi^+\pi^+\pi^-\pi^- p\bar{p}\gamma$	15	6	145
12	$\psi' \to \chi_{c2}\gamma, \chi_{c2} \to \pi^-\bar{\Sigma}^{*+}\Lambda, \bar{\Sigma}^{*+} \to \pi^+\bar{\Lambda}, \Lambda \to \pi^- p, \bar{\Lambda} \to \pi^+\bar{p}$	$\pi^+\pi^+\pi^-\pi^- p\bar{p}\gamma$	20	6	151
13	$\psi' \to \phi\Lambda\bar{\Lambda}, \phi \to \pi^0\rho^0, \Lambda \to \pi^- p, \bar{\Lambda} \to \pi^+\bar{p}, \rho^0 \to \pi^+\pi^-$	$\pi^0\pi^+\pi^+\pi^-\pi^- p\bar{p}$	2	6	157
14	$\psi' \to \chi_{c2}\gamma, \chi_{c2} \to \rho^0\Lambda\bar{\Lambda}, \rho^0 \to \pi^+\pi^-, \Lambda \to \pi^- p, \bar{\Lambda} \to \pi^+\bar{p}$	$\pi^+\pi^+\pi^-\pi^- p\bar{p}\gamma$	12	6	163
15	$\psi' \to \chi_{c0}\gamma, \chi_{c0} \to K^{*-}p\bar{\Lambda}, K^{*-} \to \pi^-\bar{K}^0, \bar{\Lambda} \to \pi^+\bar{p}, \bar{K}^0 \to K^0_S, K^0_S \to \pi^+\pi^-$	$\pi^+\pi^+\pi^-\pi^- p\bar{p}\gamma$	16	5	168
16	$\psi' \to \pi^-\bar{\Sigma}^{*+}\Lambda\gamma^f, \bar{\Sigma}^{*+} \to \pi^+\bar{\Lambda}, \Lambda \to \pi^- p, \bar{\Lambda} \to \pi^+\bar{p}$	$\pi^+\pi^+\pi^-\pi^- p\bar{p}\gamma^f$	4	5	173
17	$\psi' \to \chi_{c0}\gamma, \chi_{c0} \to \rho^0\Lambda\bar{\Lambda}, \rho^0 \to \pi^+\pi^-, \Lambda \to \pi^- p, \bar{\Lambda} \to \pi^+\bar{p}$	$\pi^+\pi^+\pi^-\pi^- p\bar{p}\gamma$	37	5	178
18	$\psi' \to \chi_{c1}\gamma, \chi_{c1} \to \pi^-\bar{\Lambda}\Sigma^{*+}, \bar{\Lambda} \to \pi^+\bar{p}, \Sigma^{*+} \to \pi^+\Lambda, \Lambda \to \pi^- p$	$\pi^+\pi^+\pi^-\pi^- p\bar{p}\gamma$	14	4	182
19	$\psi' \to \Sigma^{*+}\bar{\Sigma}^{*-}\gamma^f, \Sigma^{*+} \to \pi^+\Lambda, \bar{\Sigma}^{*-} \to \pi^-\bar{\Lambda}, \Lambda \to \pi^- p, \bar{\Lambda} \to \pi^+\bar{p}$	$\pi^+\pi^+\pi^-\pi^- p\bar{p}\gamma^f$	29	3	185
20	$\psi' \to \Lambda\bar{\Lambda}h_1(1170), \Lambda \to \pi^- p, \bar{\Lambda} \to \pi^+\bar{p}, h_1(1170) \to \pi^+\rho^-, \rho^- \to \pi^0\pi^-$	$\pi^0\pi^+\pi^+\pi^-\pi^- p\bar{p}$	3	3	188

criteria	Efficency(%)
$\Lambda(\bar{\Lambda})$ reconstruction	24.09
Pass 4c kinematic fit	14.69
Decay Length $\Lambda(\bar{\Lambda})$ >0 cm	12.56
$\chi^2(1\gamma) < \chi^2(2\gamma)$	6.07
$\chi^2(1\gamma) < 20$	4.26
$M_{\Lambda(\bar{\Lambda})} \in (1.11,1.122)\mathrm{GeV}/c^2$	3.95
$\mathrm{M}_{\eta'} \in (0.85,1.05)\mathrm{GeV}/c^2$	3.94
$\lvert M_{\Lambda\bar{\Lambda}} - 3.097\mathrm{Gev}\rvert > 20\mathrm{MeV}/c^2$	3.937
$\lvert M_{\gamma\Lambda(\bar{\Lambda})} - 1.193\mathrm{Gev}\rvert > 10\ \mathrm{MeV}/c^2$	3.80
Veto $\mathrm{M}_{\gamma}^{\mathrm{recoil}}$	3.38
Veto $M_{2\pi}^{recoil} \in (3.077,3.117)\ \mathrm{GeV}/c^2$	3.20