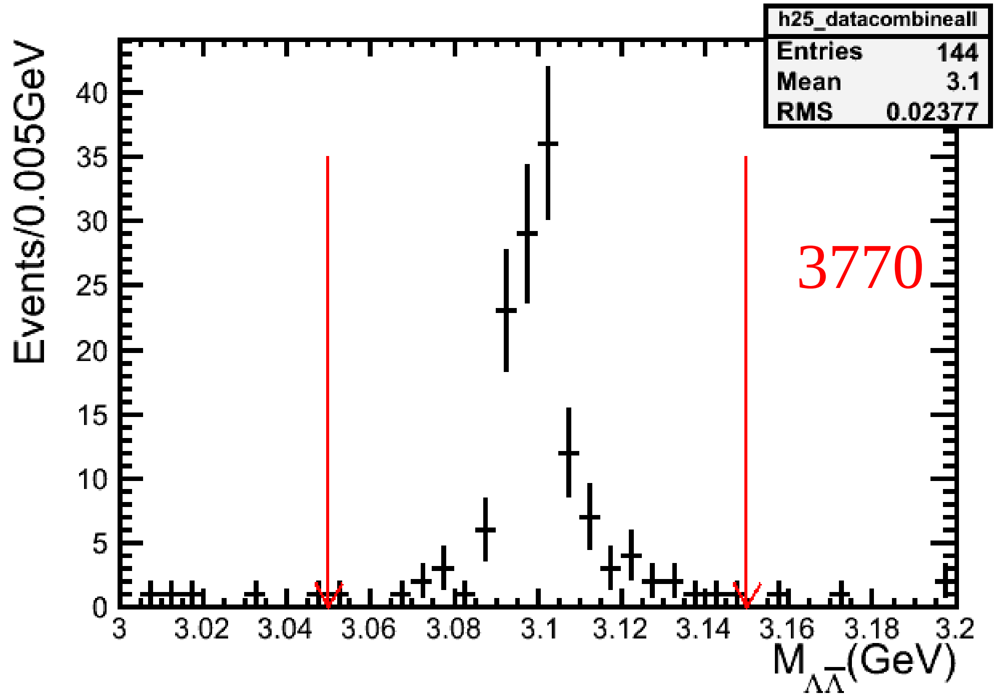
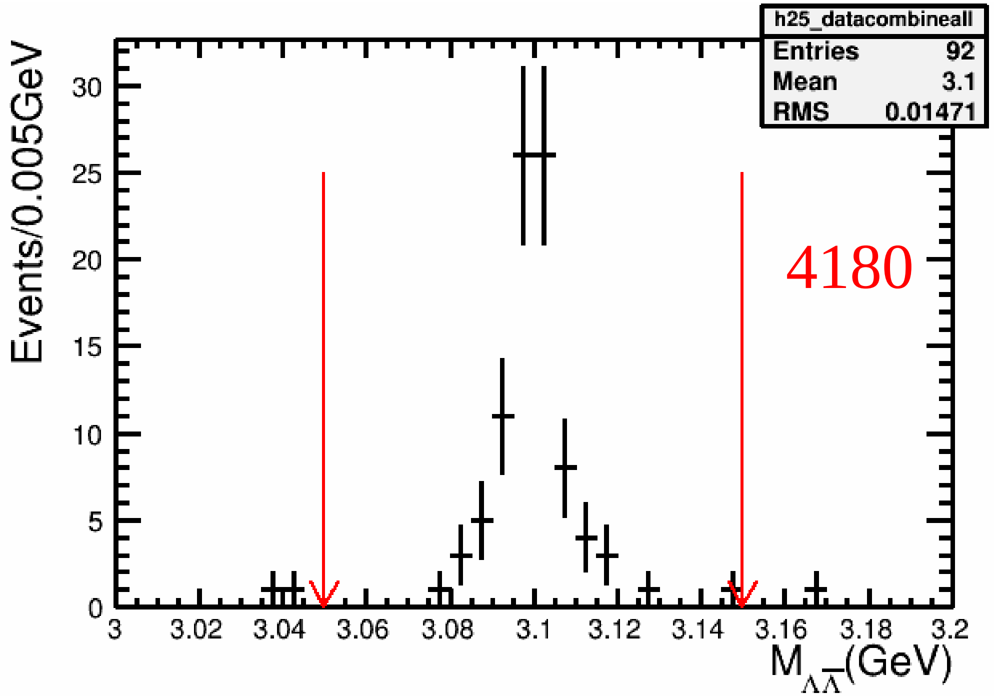
Br($J/\psi \to \Lambda\bar{\Lambda}$) measurement at two energy points

20211208

Signal extract for J/ψ

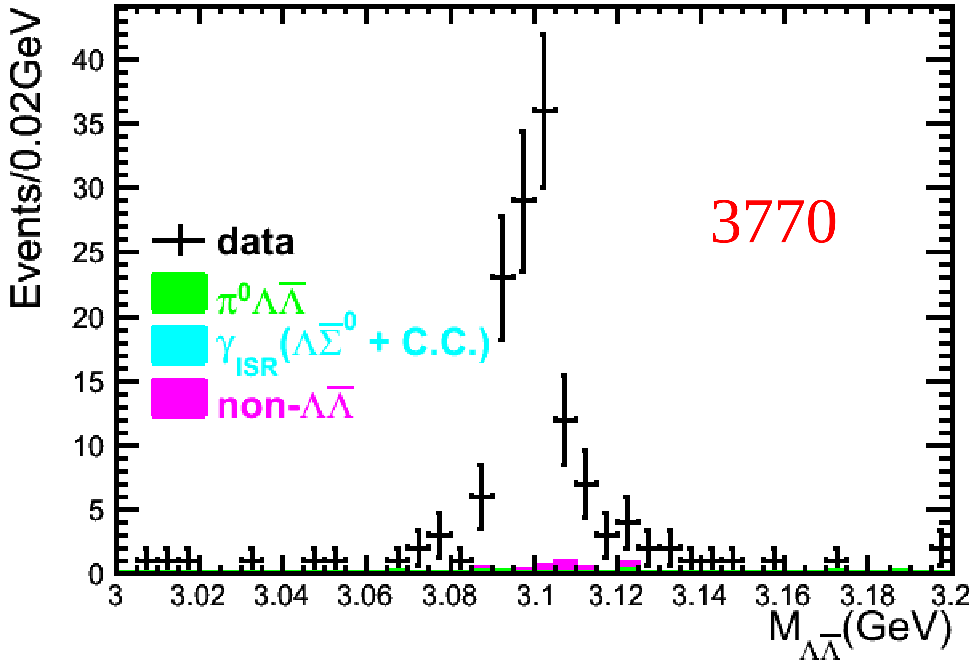




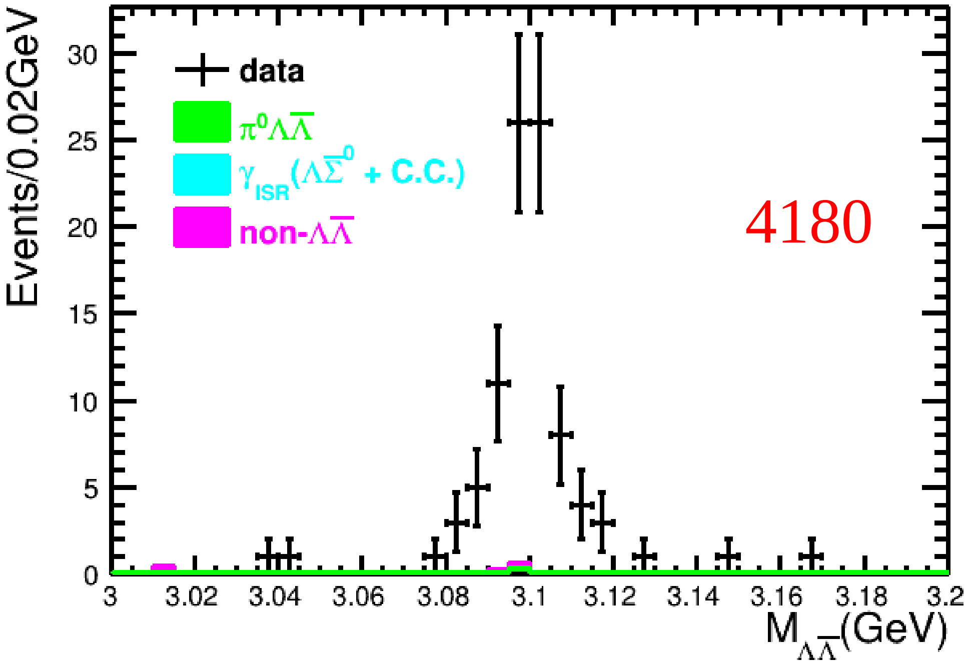
- Red arrows are the boundaries between the signal regions and sidebands.
- Signal region: 3.05GeV~3.15GeV.
- Sidebands: 3.00GeV~3.05GeV and 3.15GeV~3.20GeV.
- Signal events obtained by counting the events in the signal region and subtract the events in sidebands:

$$N_{sig} = (N_{obs} - N_{bkg})_{sigreg} - (N_{obs} - N_{bkg})_{sidebands}$$

Data distribution near J/ψ with main background



pi0lamlam bkg = 3.72452
gamLambdaSigma bkg = 0.184865
non-lamlam bkg = 3.18381



pi0lamlam bkg = 0.242263
gamLambdaSigma bkg = 0.184926
non-lamlam bkg = 0.954074

- Signal extract at 3770:

$(M_{\Lambda\bar{\Lambda}})$ corr	N_{obs}	$N_{\pi^0\Lambda\bar{\Lambda}}$	$N_{\Lambda\Sigma}$	$N_{non-\Lambda\bar{\Lambda}}$	N_{sig}
Signal region	134.00 ± 11.58	2.30 ± 0.62	0.09 ± 0.01	3.22 ± 1.80	128.39 ± 11.74
Sideband1	6.00 ± 2.45	0.48 ± 0.24	0.06 ± 0.01	-0.02 ± 0.00	5.48 ± 2.46
Sideband2	3.00 ± 1.73	0.70 ± 0.32	0.04 ± 0.00	-0.01 ± 0.00	2.27 ± 1.76

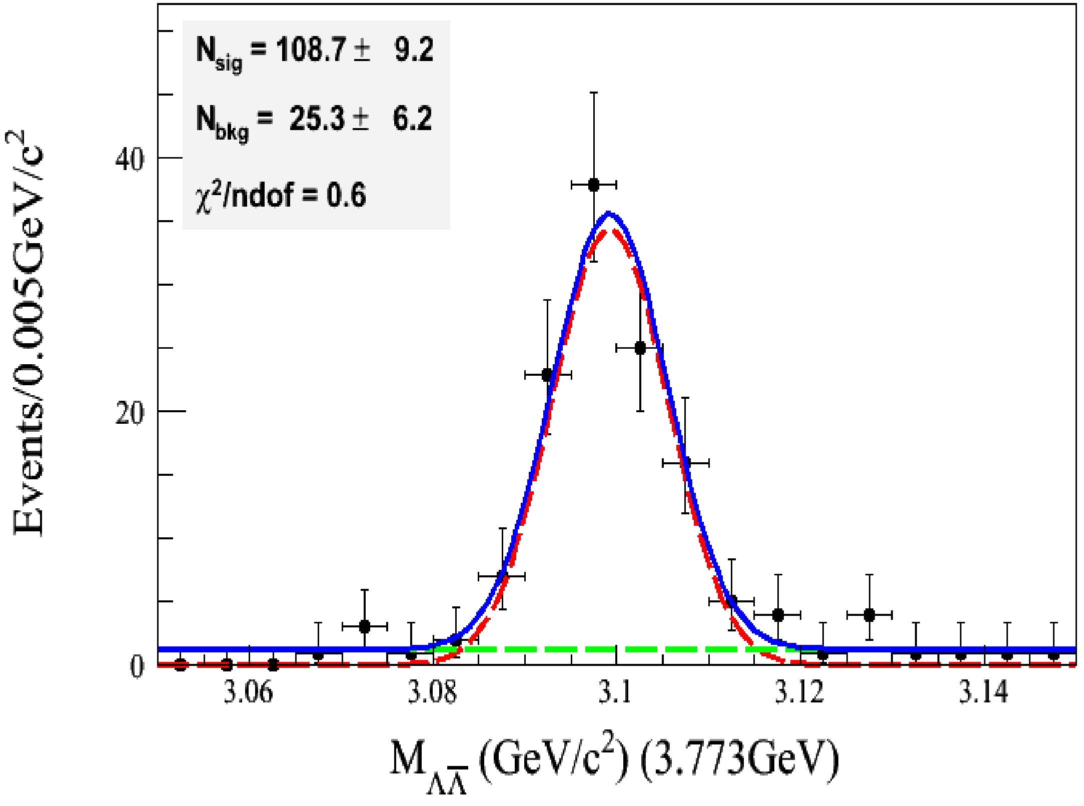
- $N_{sig}(3770) = 120.64 \pm 12.12$

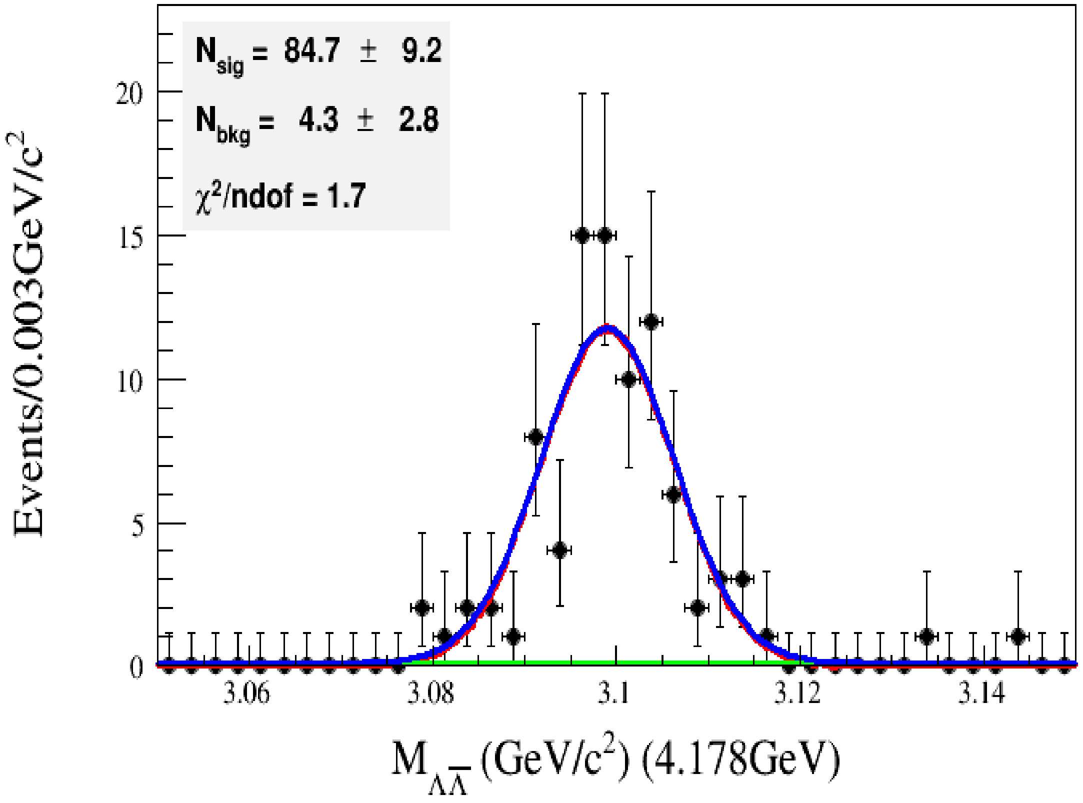
- Signal extract at 4180:

$(M_{\Lambda\bar{\Lambda}})$ corr	N_{obs}	$N_{\pi^0\Lambda\bar{\Lambda}}$	$N_{\Lambda\Sigma}$	$N_{non-\Lambda\bar{\Lambda}}$	N_{sig}
Signal region	89.00 ± 9.43	0.24 ± 0.35	0.10 ± 0.01	0.48 ± 0.71	88.18 ± 9.46
Sideband1	2.00 ± 1.41	0.06 ± 0.15	0.05 ± 0.00	0.47 ± 0.71	1.42 ± 1.58
Sideband2	1.00 ± 1.00	-0.06 ± 0.09	0.03 ± 0.00	-0.01 ± 0.00	1.04 ± 1.00

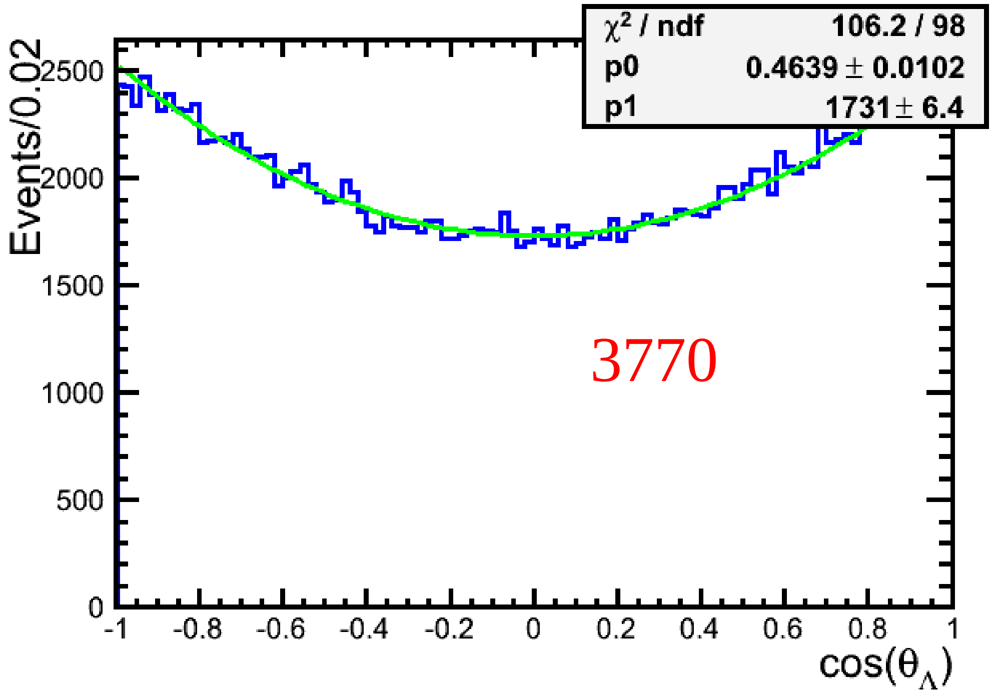
- $N_{sig}(4180) = 85.72 \pm 9.64$

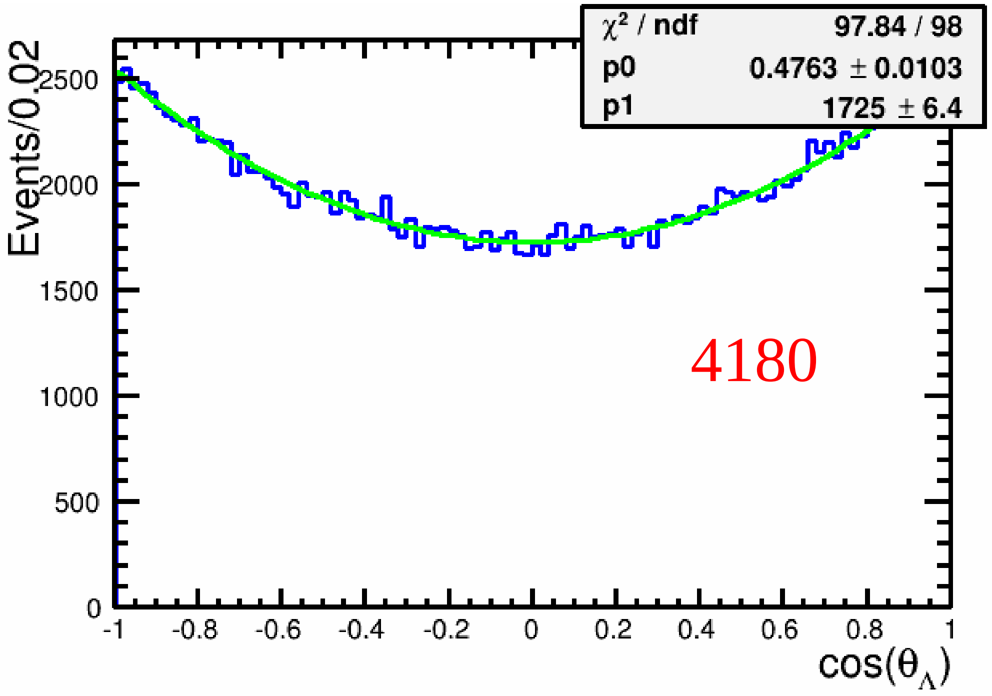
Fit to obtain the signal yields





- MC of $e^+e^- \to \gamma J/\psi \to \gamma\Lambda\bar{\Lambda}$ generated to estimate the detection efficiency





- Angular distribution of Λ described by: $1 + \alpha \cos\theta_\Lambda$, with input $\alpha = 0.469$.

- Cross section measurement of $e^+e^- \to \gamma J/\psi \to \gamma\Lambda\bar{\Lambda}$

$\sqrt{s}$(GeV)	$N_{sig}(J/\psi)$	ε	$\mathcal{L}(\mathrm{fb}^{-1})$	σ(fb)
3.773	120.64 ± 12.12	0.070 ± 0.001	2.932	1439.55 ± 146.08
4.178	85.72 ± 9.64	0.070 ± 0.001	3.189	940.43 ± 106.61

- Branching ratio extracted by formula:

$$\sigma(s) = \frac{12\pi^2\Gamma(V \to e^+e^-)\mathcal{B}(V \to f)}{m_V s} W(s, x_0)$$

- $\Gamma(V \to e^+e^-)$: electronic width of the vector meson V.
- m_V: mass of the vector meson V.
- $x_0 = 1 - m_V^2/s$
- $\mathcal{B}(V \to f)$: branching ratio of V to final state f.
- $W(s, x_0)$: probability function for ISR photon emission.

- Branching ration measurement of $J/\psi \to \Lambda\bar{\Lambda}$:

$\sqrt{s}$(GeV)	σ(fb)	$W(s, x_0)$	$\Gamma(J/\psi \to e^+e^-)\mathcal{B}(J/\psi \to f)$(eV)
3.773	1439.55 ± 146.08	0.171	8.06 ± 0.82
4.178	940.43 ± 106.61	0.115	9.60 ± 1.09

- With $m_{J/\psi} = (3.096900 \pm 0.000006)GeV$, from PDG.
- $\Gamma = (92.6 \pm 1.7)$keV, $\mathcal{B}(J/\psi \to e^+e^-) = (5.971 \pm 0.032)\%$, $\Gamma(J/\psi \to e^+e^-) = \Gamma \times \mathcal{B}(J/\psi \to e^+e^-) = (5.529 \pm 0.106)keV$, from PDG.
- $\mathcal{B}(J/\psi \to \Lambda\bar{\Lambda})$ is calculated as $(1.46 \pm 0.15) \times 10^{-3}$ and $(1.74 \pm 0.20) \times 10^{-3}$ at 3770 and 4180, respectively.
- Combine: $(1.56 \pm 0.12) \times 10^{-3}$
- PDG: $(1.89 \pm 0.09) \times 10^{-3}$

- Another formula used to extract the branching ratio:

$$\mathcal{B}(J/\psi \to \Lambda\bar{\Lambda}) \times \Gamma(J/\psi \to e^+e^-) = \frac{N_{sig}(J/\psi \to \Lambda\bar{\Lambda}) \times m_{J/\psi}^2}{6\pi^2 \times d\mathcal{L}/dM \times \varepsilon \times Br^2(\Lambda \to p\pi) \times C}$$

- Using this formula, with $N_{sig}(J/\psi \to \Lambda\bar{\Lambda})$ and ε got before, $m_{J/\psi}$ and $\Gamma(J/\psi \to e^+e^-)$ and B$r(\Lambda \to p\pi)$ from PDG, $d\mathcal{L}/dM =$ $0.2199\,\mathrm{nb}^{-1}/\mathrm{MeV}$ and $0.1312\,\mathrm{nb}^{-1}/\mathrm{MeV}$ at 3.773GeV and 4.178GeV respectively, we calculate the $\mathcal{B}(J/\psi \to \Lambda\bar{\Lambda})$ once again.
- $\mathcal{B}(J/\psi \to \Lambda\bar{\Lambda})$ is calculated as $(1.45 \pm 0.15) \times 10^{-3}$ and $(1.72 \pm 0.20) \times 10^{-3}$ at 3770 and 4180, respectively.
- Combine: $(1.55 \pm 0.12) \times 10^{-3}$
- PDG $(1.89 \pm 0.09) \times 10^{-3}$