Update the measurement of the cross section of $e^+e^- \to \Omega^-\bar{\Omega}^+$

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Data and MC samples

- Data samples:

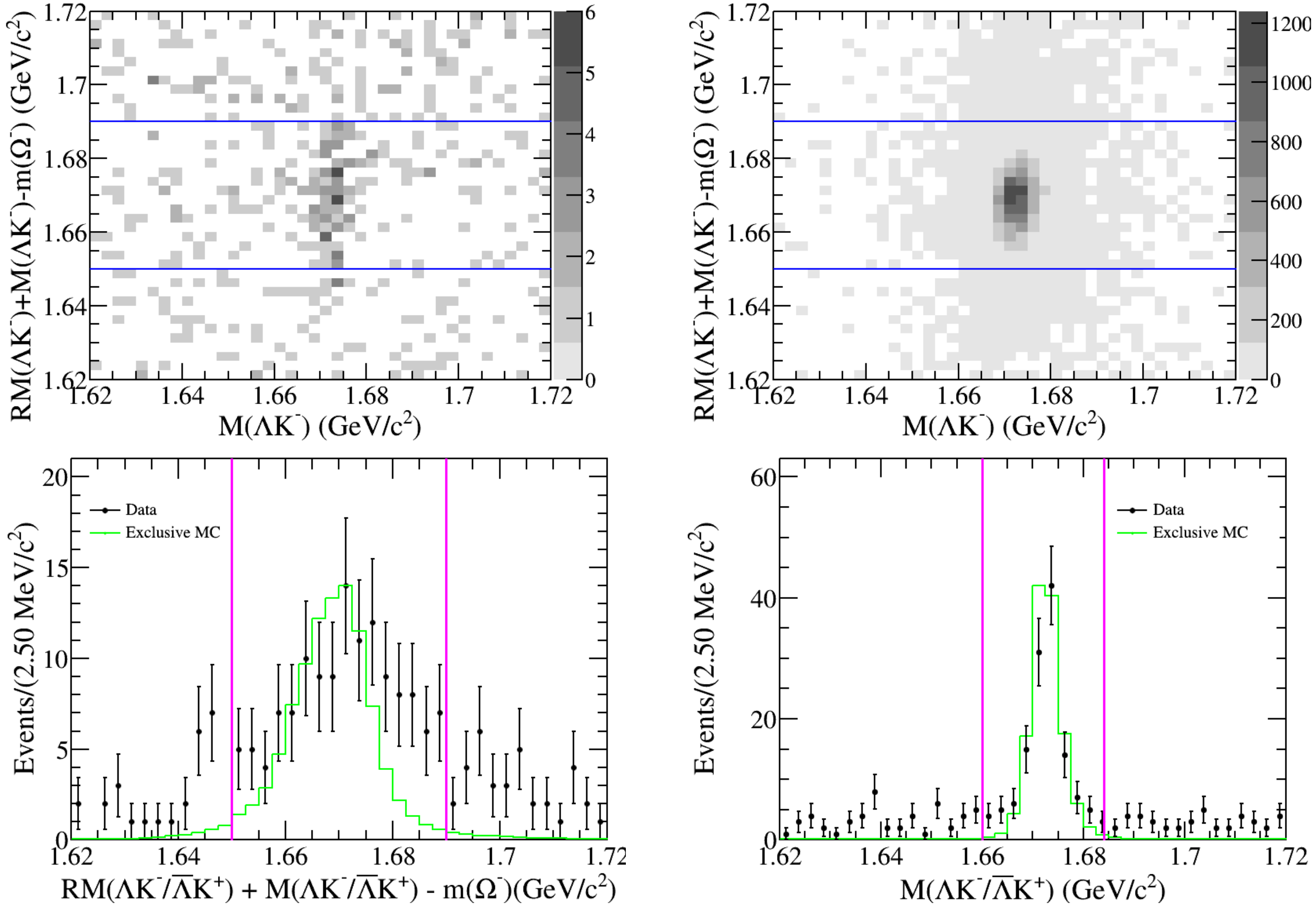
Energy (MeV)	Luminosity (pb^{-1})	Analysis Environment	Energy (MeV)	Luminosity (pb^{-1})	Analysis Environment
3773.0	2931.8	BOSS6.6.4.p02	4237	528.9	BOSS7.0.2.p01
4007.6	481.96	BOSS6.6.4.p01	4246	532.7	BOSS7.0.2.p01
4180	3189.0	BOSS7.0.2.p01	4258.0	825.7	BOSS6.6.4.p01
4190	521.9	BOSS7.0.2.p01	4270	529.3	BOSS7.0.2.p01
4200	523.7	BOSS7.0.2.p01	4280	174.5	BOSS7.0.2.p01
4210	511.2	BOSS7.0.2.p01	4358.3	539.8	BOSS6.6.4.p01
4220	508.2	BOSS7.0.2.p01	4415.6	1073.6	BOSS6.6.4.p01
4226.3	1091.7	BOSS6.6.4.p01	4599.5	566.9	BOSS6.6.4.p01

- Signal MC (0.1M): $e^+e^- \to \Omega^-\bar{\Omega}^+, \Omega^- \to \Lambda K^-, \bar{\Omega}^+ \to anything$, [PHSP/J2BB2, optimize in the future].

Event selection

- At least three charged tracks are required and their polar angles θ must satisfy $|\cos\theta| < 0.93$;
- $K^{\pm}$ list: $\mathcal{L}$(K) > $\mathcal{L}(\boldsymbol{\pi})$, $\mathcal{L}$(K) > 0;
- Proton list: $\mathcal{L}$(p) > 0, $\mathcal{L}$(p)>$\mathcal{L}$(K) and $\mathcal{L}$(p)>$\mathcal{L}(\boldsymbol{\pi})$;
- Loop the remaining charged tracks to find an charged pion and then reconstruct the $\Lambda/\overline{\Lambda}$;
- Loop all of K^-/K^+ and $\Lambda/\overline{\Lambda}$ candidates and perform a vertex fit for $K^-\Lambda/K^+\overline{\Lambda}$ and a secondary vertex fit for $\Omega^-/\overline{\Omega}^+$;
- The decay lengths of $\Lambda/\overline{\Lambda}$ and Ω^- must satisfy $L/\sigma > 2$, the signal region of $M(p\pi^-)$ is $1.111<M(p\pi^-)<1.121$ GeV/c^2;
- If there is more than one Ω^- candidates, the candidate with minimum χ^2 is selected.

Signal extraction (all data)



The recoil mass of ΛK^- has a broad width, so we require a loose signal region ([1.65, 1.69] GeV/c^2) and extract the signal yield in the invariant mass of ΛK^-. The background can be describe by a 1st order polynomial function. The signal region is $1.66 < M(\Lambda K^-) < 1.684$ GeV/c^2, the sideband regions are is [1.62, 1.644] GeV/c^2 and [1.696, 1.72] GeV/c^2.

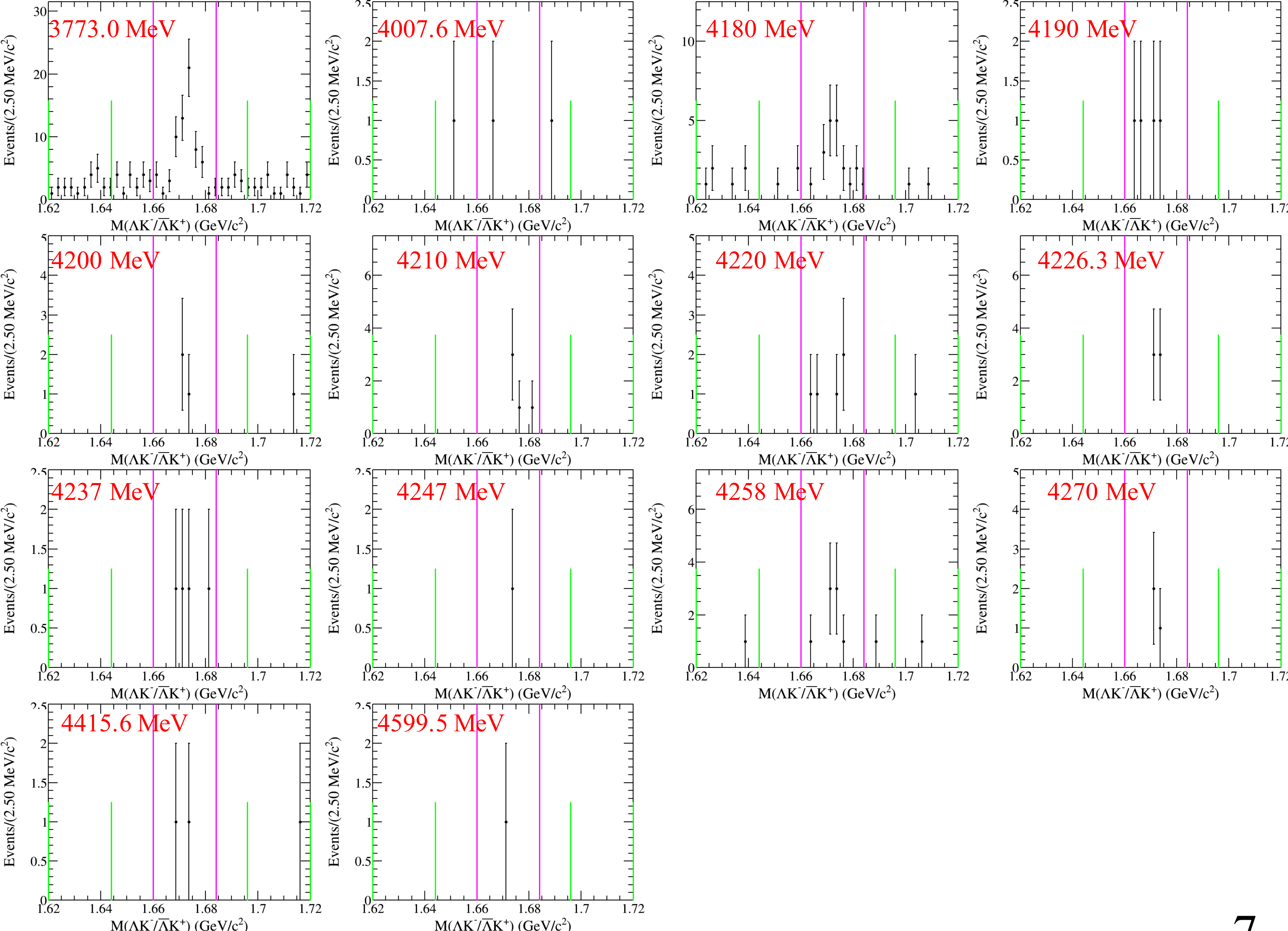
Signal extraction

$$N^{sig}_{\Omega^-\bar{\Omega}^+} = N^{signal} - f \cdot N^{sideband}$$

- $N^{sig}_{\Omega^-\bar{\Omega}^+}$ is the signal yield of $e^+e^- \to \Omega^-\bar{\Omega}^+$;
- N^{signal} is the number of events in the $M(\Lambda K^-)$ signal region;
- $N^{sideband}$ is the number of events in the $M(\Lambda K^-)$ sideband regions;
- f is the scale factor (0.5).

Energy (MeV)	N^{signal}	$N^{sideband}$	$N^{sig}_{\Omega^-\Omega^+}$	Energy (MeV)	N^{signal}	$N^{sideband}$	$N^{sig}_{\Omega^-\Omega^+}$
3773.0	68	44	$46.0^{+10.0}_{-8.9}$	4237	4	0	$4.0^{+3.2}_{-1.9}$
4007.6	1	0	$1.0^{+2.4}_{-0.8}$	4246	1	0	$1.0^{+2.4}_{-0.8}$
4180	20	8	$16.0^{+5.9}_{-4.6}$	4258.0	8	2	$7.0^{+4.2}_{-2.8}$
4190	4	0	$4.0^{+3.2}_{-1.9}$	4270	3	0	$3.0^{+3.0}_{-1.6}$
4200	3	1	$2.5^{+3.1}_{-1.7}$	4280	0	0	0
4210	5	0	$5.0^{+3.4}_{-2.2}$	4358.3	0	0	0
4220	5	1	$4.5^{+3.6}_{-2.2}$	4415.6	2	1	$1.5^{+2.9}_{-1.4}$
4226.3	6	0	$6.0^{+3.6}_{-2.4}$	4599.5	1	0	$1.0^{+2.4}_{-0.8}$

Using the counting method, the signal yield of $e^+e^- \to \Omega^-\bar{\Omega}^+$ at all data sets is $102.5^{+12.7}_{-11.6}$.


3773.0 MeV
4007.6 MeV
4180 MeV
4190 MeV
4200 MeV
4210 MeV
4220 MeV
4226.3 MeV
4237 MeV
4247 MeV
4258 MeV
4270 MeV
4415.6 MeV
4599.5 MeV
Events/(2.50 MeV/c^2)
M($\Lambda K^-/\bar{\Lambda}K^+$) (GeV/c^2)

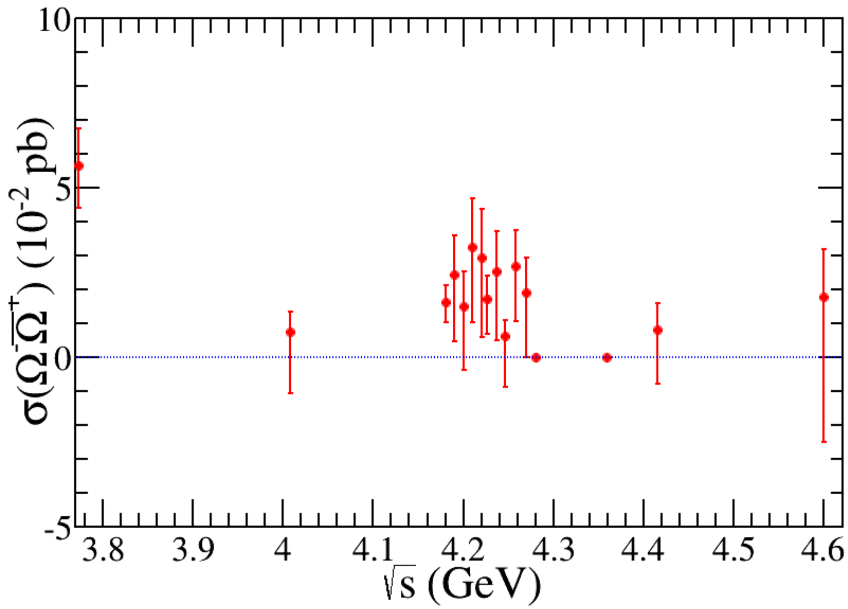
Signal efficiency (PHSP)

Energy (MeV)	ε^{PHSP} **(%)**	**Energy (MeV)**	ε^{PHSP} **(%)**
3773.0	27.75	4237	29.99
4007.6	27.75	4246	30.39
4180	30.51	4258.0	31.55
4190	31.38	4270	29.62
4200	31.50	4415.6	16.73
4210	30.04	4599.5	9.91
4220	30.18		
4226.3	31.87		

We use the PHSP to estimate an rough signal efficiency, the more precise and reasonable signal MC and the corresponding efficiency will be considered (work with jiaojiao).

Observed cross section

Energy (MeV)	σ (10^{-2} pb)	Energy (MeV)	σ (10^{-2} pb)
3773.0	$5.7^{+1.2}_{-1.1}$	4237	$2.5^{+2.0}_{-1.2}$
4007.6	$0.7^{+1.8}_{-0.6}$	4246	$0.6^{+1.5}_{-0.5}$
4180	$1.6^{+0.6}_{-0.5}$	4258.0	$2.7^{+1.6}_{-1.1}$
4190	$2.4^{+2.0}_{-1.2}$	4270	$1.9^{+1.9}_{-1.0}$
4200	$1.5^{+1.9}_{-1.0}$	4280	0
4210	$3.3^{+2.2}_{-1.4}$	4358.3	0
4220	$2.9^{+2.3}_{-1.4}$	4415.6	$0.8^{+1.6}_{-0.8}$
4226.3	$1.7^{+1.0}_{-0.7}$	4599.5	$1.8^{+4.3}_{-1.4}$



The observed cross sections of $e^+e^- \rightarrow \Omega^-\overline{\Omega}^+$ are measured.

Summary and to do list

- A clear $e^+e^- \to \Omega^-\overline{\Omega}^+$ is observed in all selected data samples;
- The signal yields of $e^+e^- \to \Omega^-\overline{\Omega}^+$ are calculated using the counting method;
- The observed cross sections are calculated.

- [ ] Optimize the signal MC and calculate the signal efficiency [work with jiaojiao]
- [ ] Systematic uncertainty estimation