中国科学技术大学
University of Science and Technology of China

Jan 20 report

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2025 年 1 月 20 日

1 Motivation

2 Data Sets

3 Event Selection

4 Background study

5 cross section measurement

6 Branch Fraction of $J/\psi \to K^+K^-$

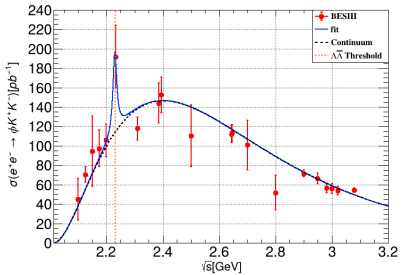
7 Summary

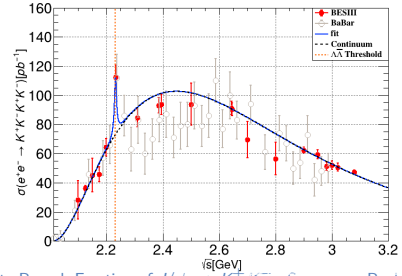
Motivation:

- measure the cross section of $e^+e^- \to \phi K^+K^-$ via ISR
- study the structure near 2.2324GeV which BaBar and BESIII have observed
- study the spectrum of M(K^+K^-)

Reference to:

- B.Aubert et al.(BaBar Collaboration),PhysRevD.86.012008(2012)
- M.Ablikim et al.(BESIII Collaboration),PhysRevD.100.032009(2019)





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- ⋆ Data
  - $\Upsilon(4S)$: $360.531 fb^{-1}$
  - $\Upsilon(4S)$ off resonance : $41.424 fb^{-1}$
  - $\Upsilon(5S)$: $19.34 fb^{-1}$
  - $\mathcal{L}_{tot} = 421.295\ \mathrm{fb}^{-1}$ (BaBar: $454\ \mathrm{fb}^{-1}$)
- ⋆ generic MC (MC15rd ,$\mathcal{L}_{gMC} = 4\mathcal{L}_{data}$)
  - `/belle/collection/MC/MC15rd_exp20-26_4S_v2`
  - `/belle/collection/MC/MC15rd_exp7-18_4S_v3`
- ⋆ SignalMC
  - 10M run independent events generated by `PHOKHARA_EvtGen`

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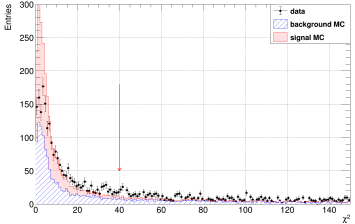
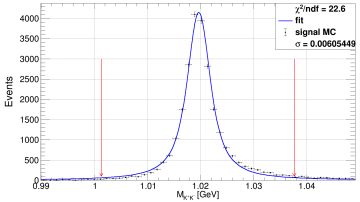
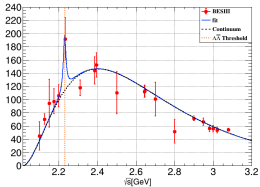
- Charged track selection:
  - $dr < 0.5$, $|dz| < 2$
  - $N_{good} = 4$, $\sum Q = 0$
- Photon selection:
  - Select photon with highest energy
  - $E \geq 3$ GeV
- PID selection:
  - $binaryPID = \frac{\mathcal{L}_K}{\mathcal{L}_k + \mathcal{L}_\pi} > 0.6$
  - Number of good kaon ≥ 3
- 3C kinematic fit:
  - Event survives 3C fit
  - $\chi^2 < 40$
- ϕ mass window:
  - $1.00133653 < M_{K^+K^-} < 1.03766347$
- Select combination with minimum χ^2







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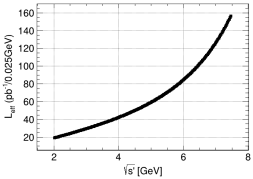

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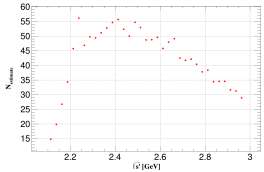
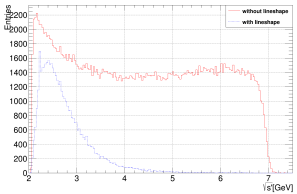


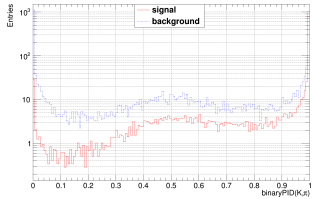
图: cross section

图: effective luminosity

图: estimate entries



- $N_{estimate} = 1495.38$
- $N_{generate} = 26350, with \sqrt{s'} < 3GeV$
- Normalization constant = 0.0567508



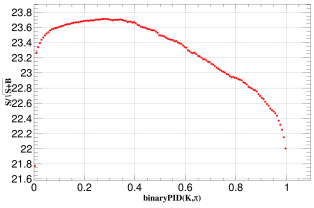
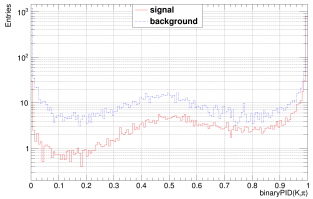


图: binaryPID(K^+ from $/phi$)



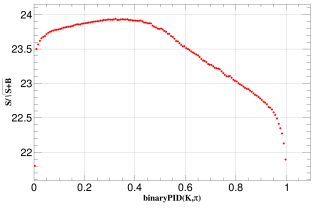
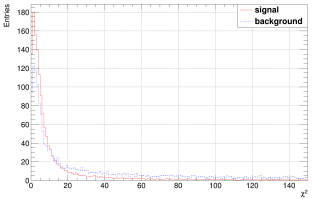


图: binaryPID(the other K^+)



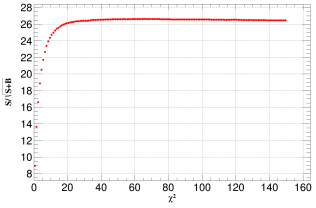


图: χ^2

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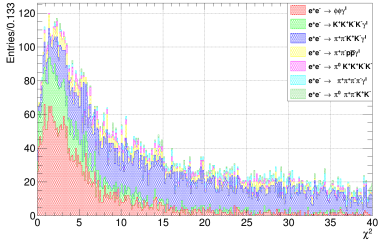

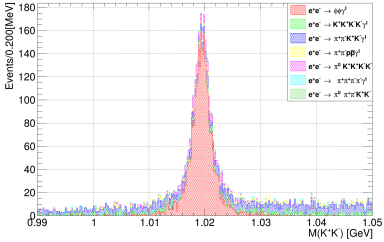

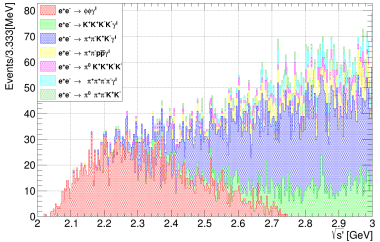

Table 1: Decay trees and their respective initial-final states.

rowNo	decay tree (decay initial-final states)	iDecyTr	iDecyFSta	nEv	sCEv
1	$e^+e^- \to K^+K^-\rho^0,\rho^0 \to K^+K^-$ ($e^+e^- \to K^+K^+K^-K^-$)	166	96	4611	4611
2	$e^+e^- \to K^+K^-\rho^0,\rho^0 \to \pi^+\pi^-$ ($e^+e^- \to K^+K^-K^+K^-$)	165	95	2965	7576
3	$e^+e^- \to \phi\phi\gamma',\phi \to K^+K^-,\phi \to K^+K^-$ ($e^+e^- \to K^+K^-K^+K^-\gamma'$)	169	96	1568	9144
4	$e^+e^- \to \phi\phi\gamma',\phi \to K^+K^-,\phi \to K^+K^-$ ($e^+e^- \to K^+K^-K^+K^-\gamma'$)	171	95	1026	10170
5	$e^+e^- \to K^+K^-\rho\gamma',\rho \to \pi^+\pi^-,\phi \to K^+K^-$ ($e^+e^- \to K^+K^-K^+K^-\pi^+\pi^-\gamma'$)	167	97	929	11099
6	$e^+e^- \to K^+K^-K^+K^-$ ($e^+e^- \to K^+K^-K^+K^-$)	172	96	777	11876
7	$e^+e^- \to \pi^+K^+K^-\rho^0,K^- \to \pi^+K^-$ ($e^+e^- \to \pi^+\pi^-K^+K^-K^-$)	5	5	630	12506
8	$e^+e^- \to \pi^+K^+K^-\rho^0,K^- \to \pi^-K^+$ ($e^+e^- \to \pi^+\pi^-K^+K^-K^+$)	31	5	616	13122
9	$e^+e^- \to \pi^+K^+K^-\pi^+\pi^-,K^- \to \pi^+K^-$ ($e^+e^- \to \pi^+\pi^-K^+K^-\pi^+\pi^-$)	19	16	498	13621
10	$e^+e^- \to K^+K^-K^+K^-\pi^+\pi^-$ ($e^+e^- \to K^+K^-K^+K^-\pi^+\pi^-$)	176	95	472	14093
11	$e^+e^- \to \pi^+K^+K^-\pi^+\pi^-,K^- \to \pi^-K^+$ ($e^+e^- \to \pi^+\pi^-K^+K^-\pi^+\pi^-$)	20	16	460	14553
12	$e^+e^- \to \rho^0K^+K^-,\rho^0 \to \pi^+\pi^-$ ($e^+e^- \to \pi^+\pi^-K^+K^-$)	190	5	394	14947
13	$e^+e^- \to \pi^+\pi^-K^+K^-$ ($e^+e^- \to \pi^+\pi^-K^+K^-$)	22	5	325	15272
14	$e^+e^- \to \phi\phi\gamma',\phi \to K^+K^-,\phi \to K^+K^-$ ($e^+e^- \to K^+K^-K^+K^-\gamma'$)	168	97	301	15573
15	$e^+e^- \to \rho^0K^+K^-,\rho^0 \to \pi^+\pi^-$ ($e^+e^- \to \pi^+\pi^-K^+K^-\gamma'$)	174	16	244	15817
16	$e^+e^- \to \pi^+\pi^-K^+K^-$ ($e^+e^- \to \pi^+\pi^-K^+K^-\gamma'$)	47	16	225	16042
17	$e^+e^- \to K^+K^-\rho\gamma',\rho \to \pi^+\pi^-,\phi \to K^+K^-$ ($e^+e^- \to K^+K^-K^+K^-\pi^+\pi^-\gamma'$)	188	105	201	16243

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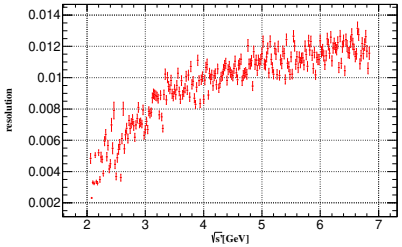
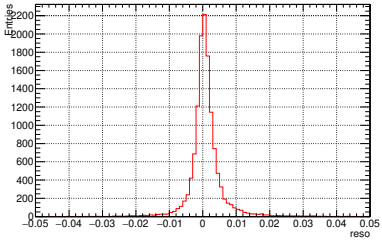
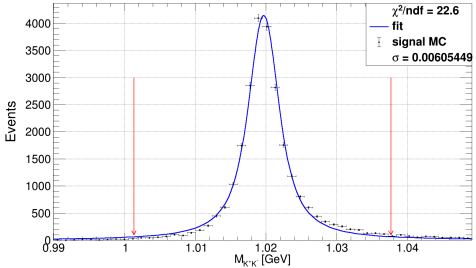


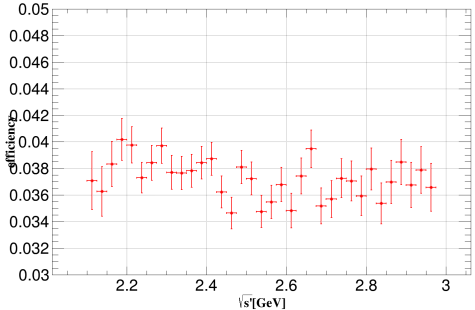


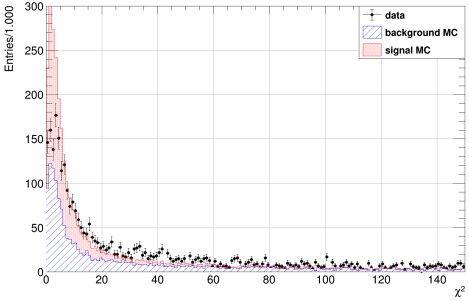
bin width:

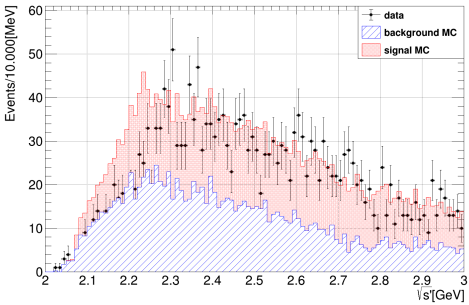
- 25MeV at 2-3GeV
- 35MeV at 3-4.5GeV
- 40MeV at 4.5-7.5GeV

using BW convolution a Guassian fit ϕ to get N_{signal}






Entries/1.000
data
background MC
signal MC
χ^2


Events/10.000[MeV]
data
background MC
signal MC
$\sqrt{s'}$[GeV]

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- 暂时存在的一些问题：
  - Data-Driving 去除本底的方式只适用于 Born 过程，在这里出现的主要峰状本底是 $e^+e^- \to \phi\phi\gamma^{\prime}$, 此方式并不合适
  - 关于 PID 的优化在与又文讨论后在细节上还存有一点问题，需进一步讨论
- to do list:
  - 产生 run-dependent 的 signalMC ？
  - 搞清 J/ϕ 分支比验证的流程
  - 其他能区的分析