Study of $e^+e^- \rightarrow \chi_{c1}$ at center-of-mass energies

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Outline

- **Motivation**
- **Data Sample and MC Simulation**
- **Analysis**
  - $e^+e^- \rightarrow \phi\phi$ PHSP
  - $\phi \rightarrow K^+K^-$ **VSS**
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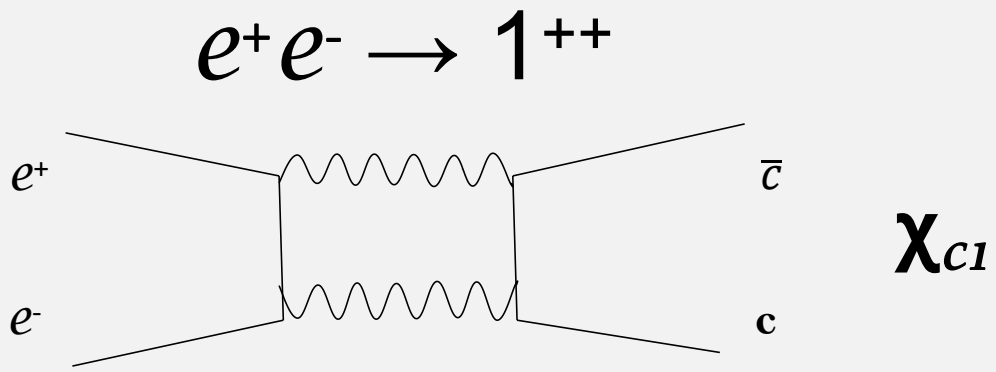
Motivation

Up to now, only vector resonance (JPC = 1^{--}) production has been observed in electron positron annihilation, C even resonances are only found in decay processes of vector resonances or in γγ scattering processes. In principle, the direct production of 1^{++} states, like χ_{c1}, can also happen through two virtual photons exchange process, as shown in Fig. 1, this has never be seen experimentally.



Data sample

sample		Ecms(MeV)	luminosity(1/pb)
data	χ_{c1}	3490.0	12.1
	χ_{c1}	3509.7	39.3
	χ_{c1}	3508.0	181.8
	χ_{c1}	3510.6	184.6
	χ_{c1}	3514.4	40.9
			Bos7703
incMC	3773	qqbar	

Preliminary selection

Charged tracks
- $|R_r| < 1$ cm, $|R_z| < 10$cm
- $|\cos\theta| < 0.93$
- $N = 4$, $N_m = N_p = 2$

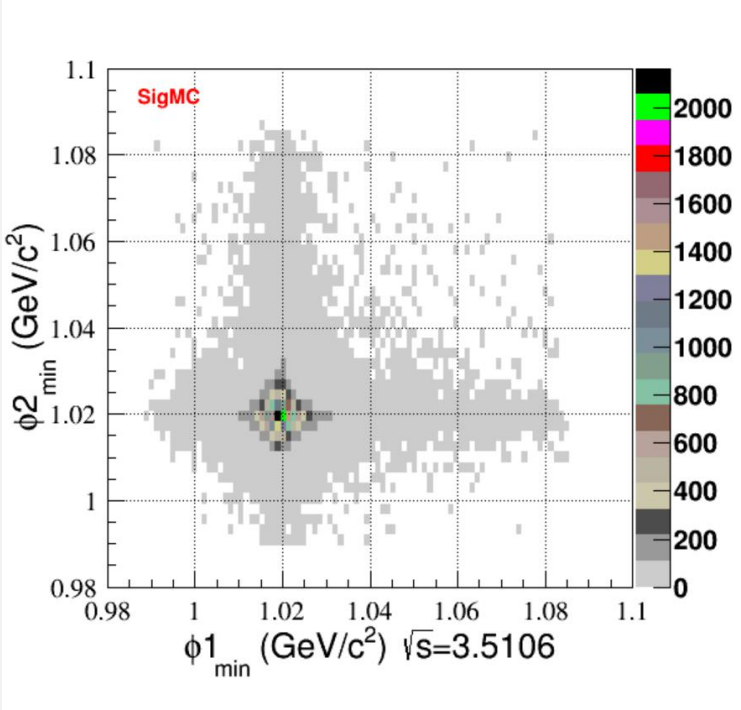
Vertex Fit for

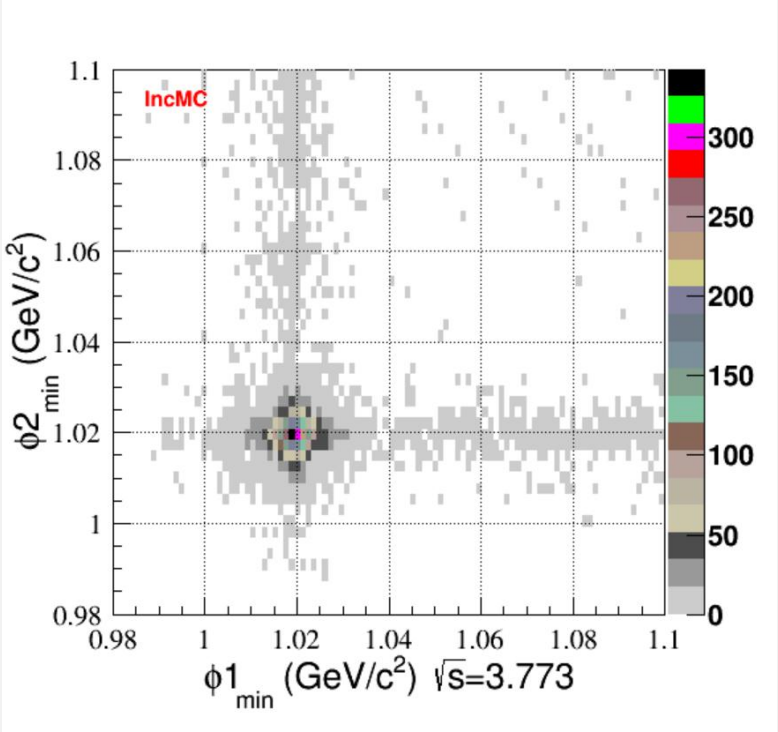
$2(K^+K^-)$

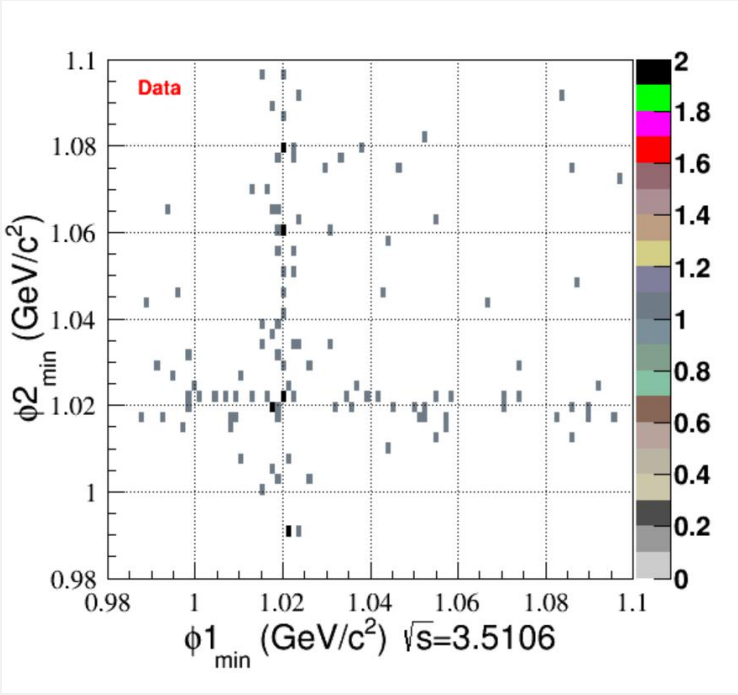
A 4C kinematic fit with
$e^+e^- \rightarrow K^+K^-K^+K^-$
- **Additional 4C kinematic fit for** $^2(K^+K^-)\gamma$ **final states.**

Good photon
- $0 \leq TDC \leq 14$
- **Barrel :** $E > 0.025$ **GeV,** $|\cos\theta| < 0.8$
- **End cap :** $E > 0.050$ **GeV,** $0.86 < |\cos\theta| < 0.92$
- $N_\gamma \leq 6$

MC and data analysis

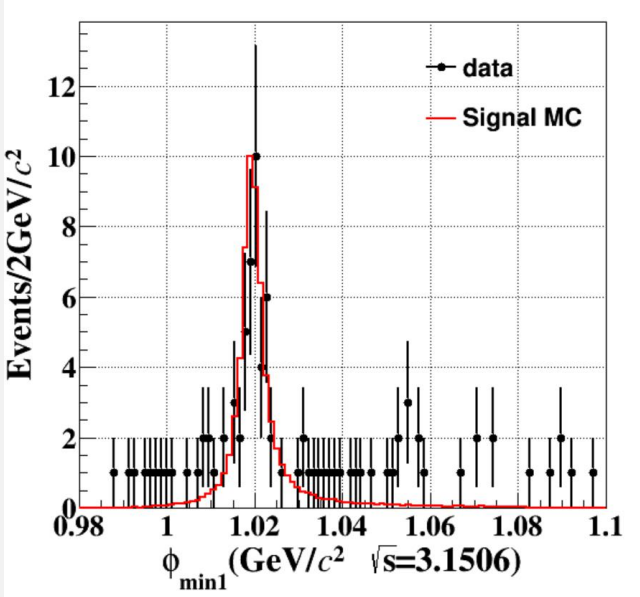


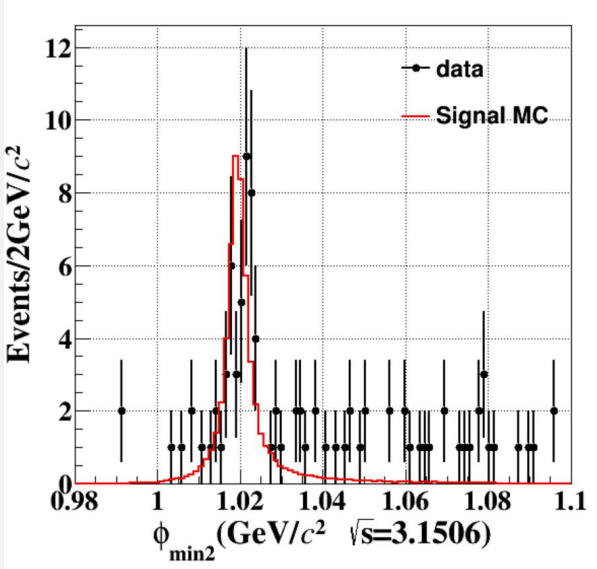


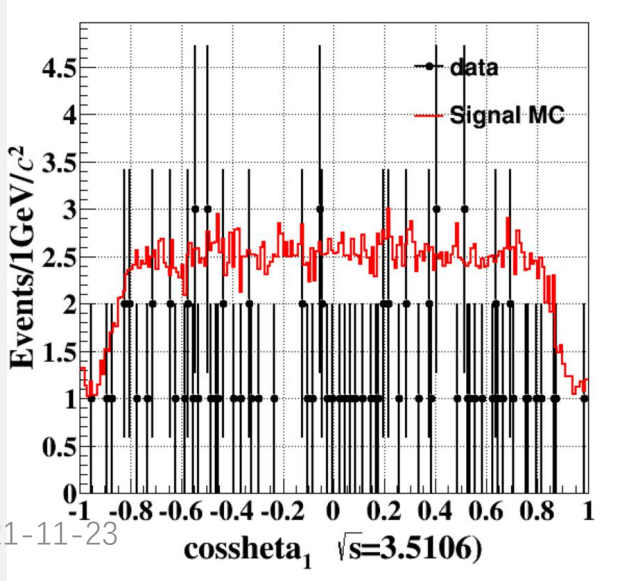


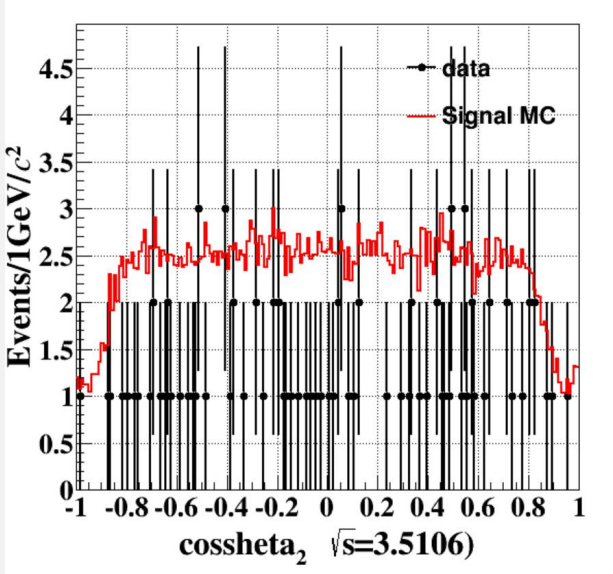
- ϕ_1<1.1GeV
- ϕ_2<1.1GeV
- χ^2<42

MC and data analysis









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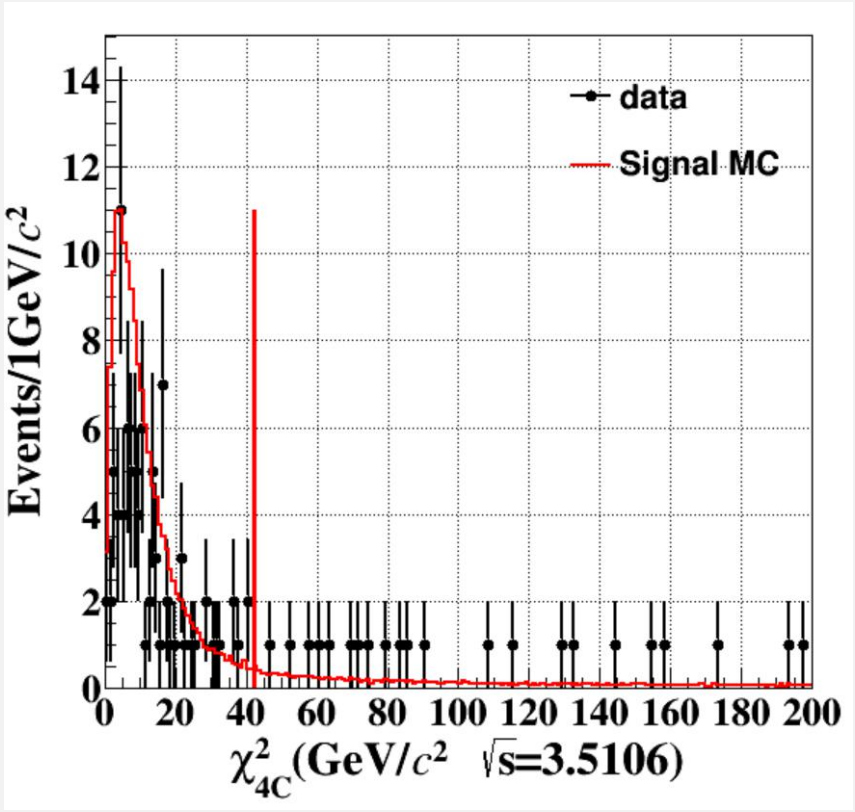

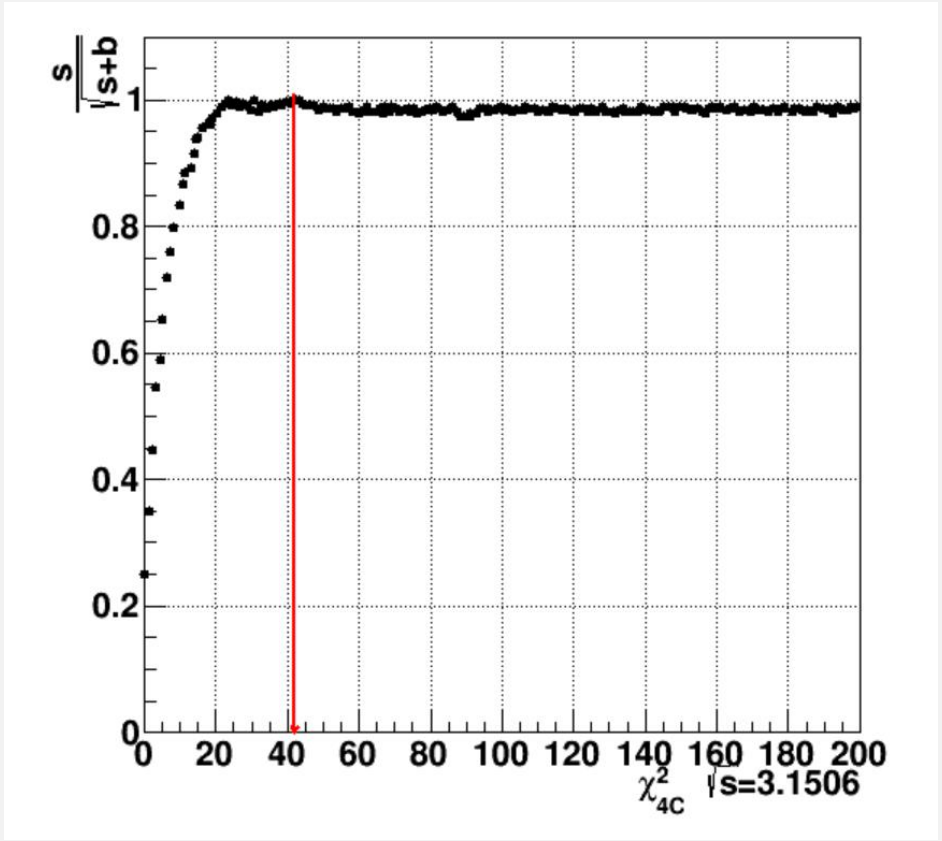

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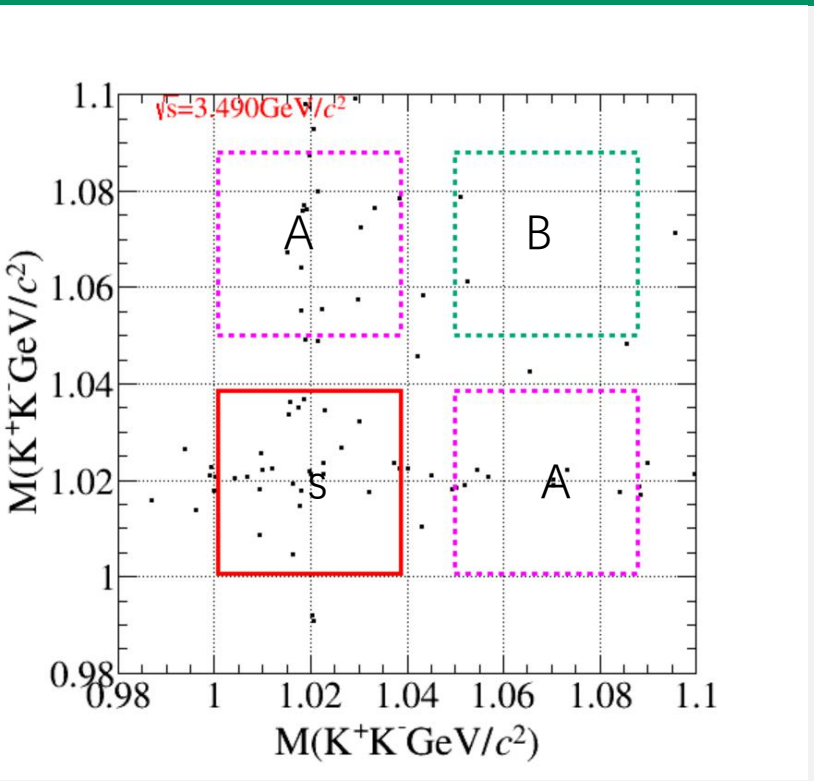
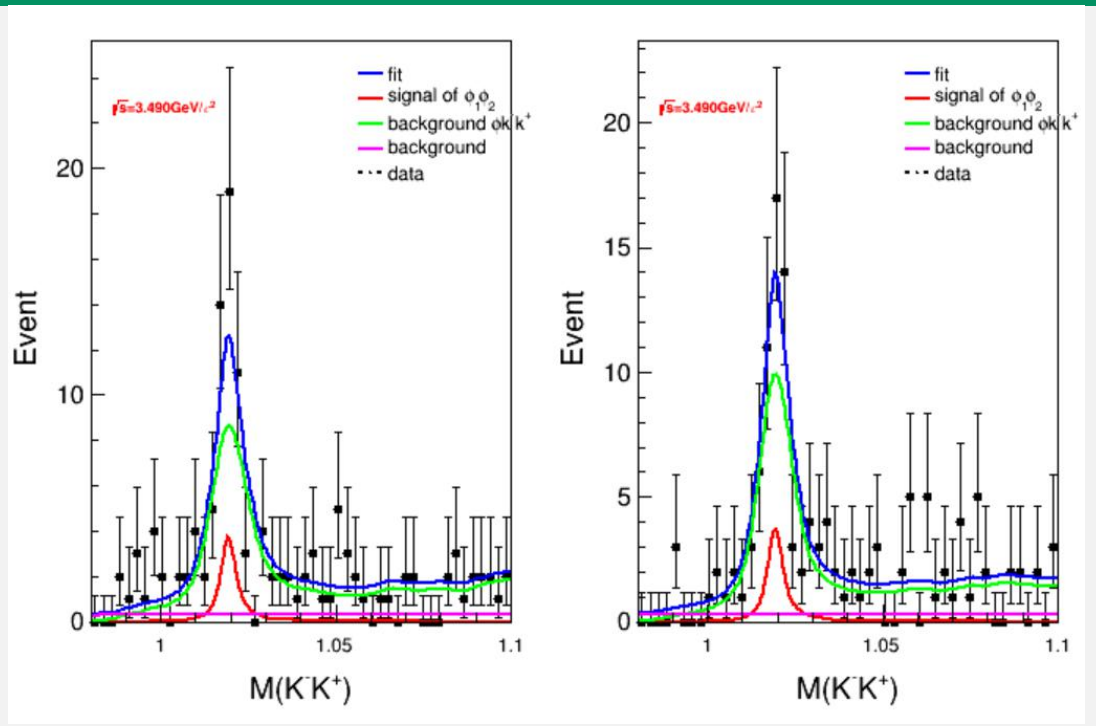
2D VS Sideband

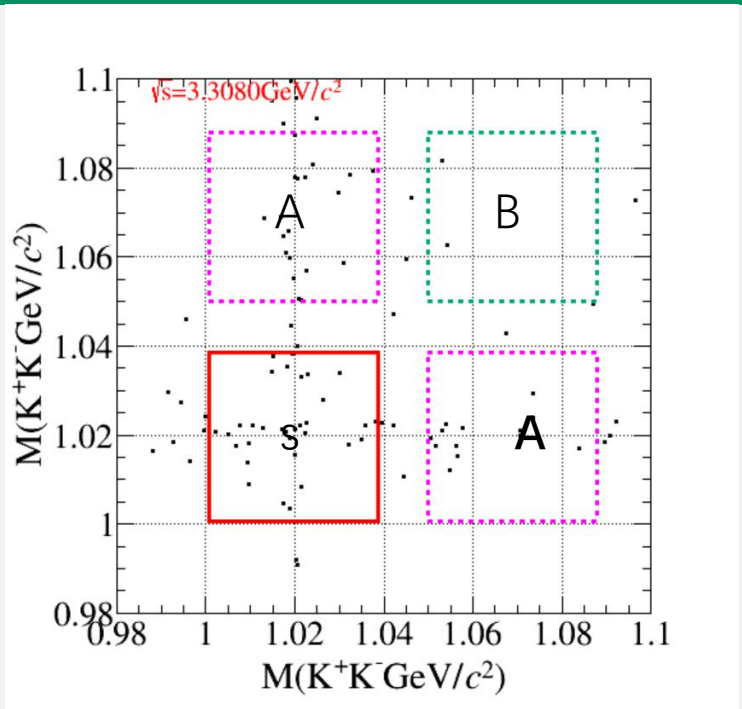


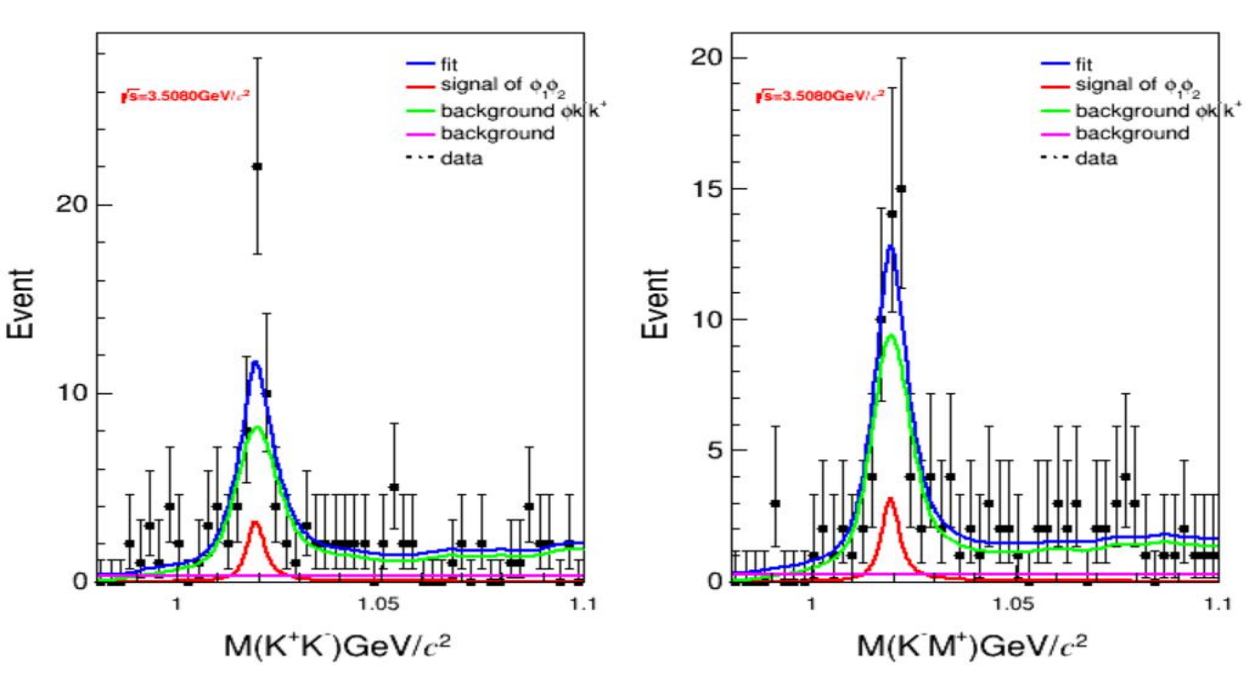


S: Signal regions A and B are sideband regions
S=40 A=37 B=4
S-A+B=7

- **Black: error bar**
- **Blue: data fitting results**
- **Green: Phikk is the background and the number of cases is NBkg1=98.0±12.2**
- **Pink: 4K is background, and the number of cases is NBkg2=15.4±6.6**
- **Red dotted line: Number of signal instances is Nsig=11.6±5.3**

2D VS Sideband

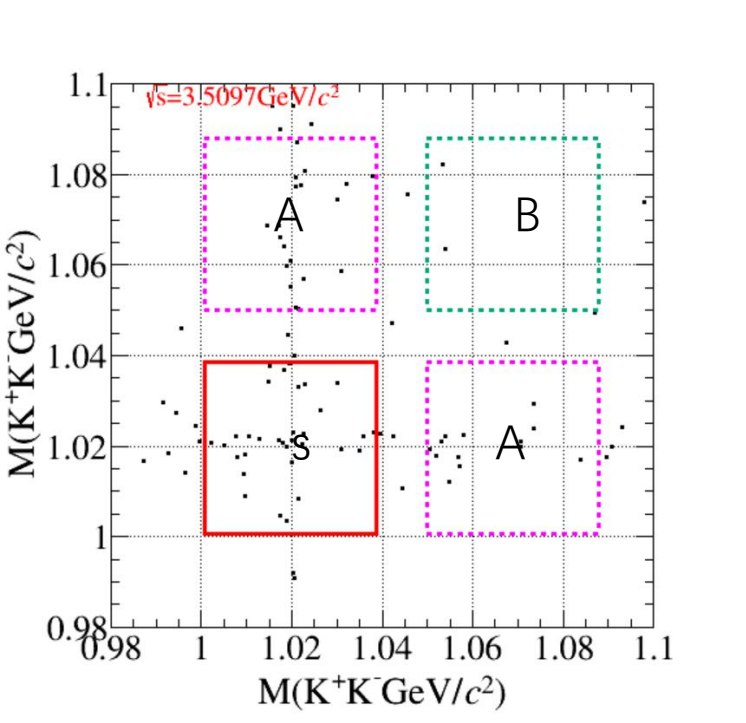


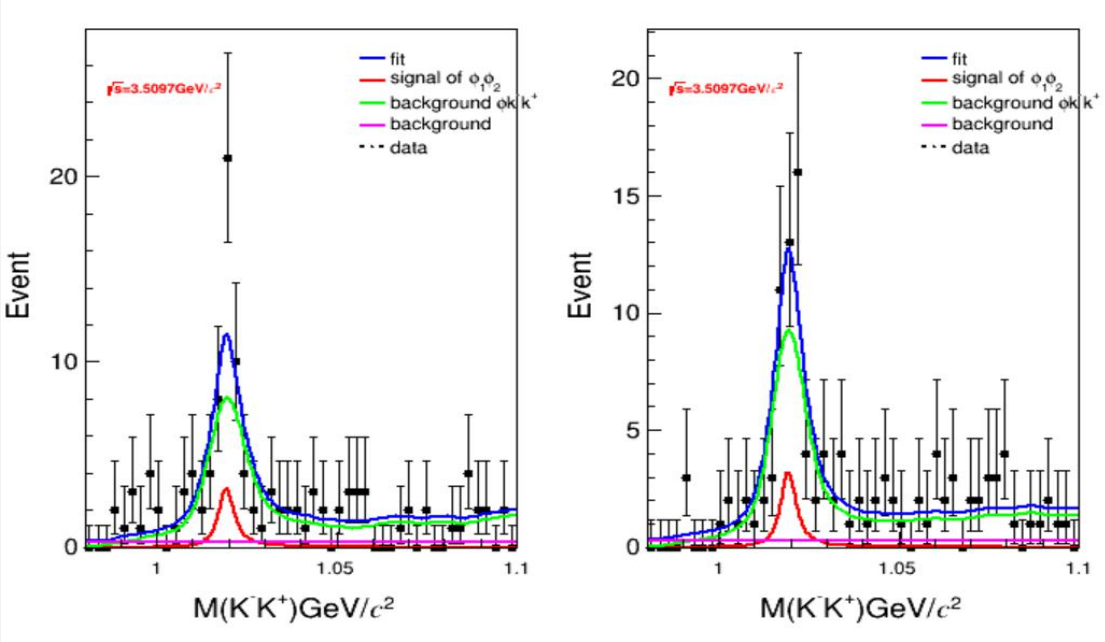


S: Signal regions A and B are sideband regions
S=38 A=36 B=3
S-A+B=5

- **Black: error bar**
- **Blue: data fitting results**
- **Green: Phikk is the background and the number of cases is NBkg1 =92.8±11. 9**
- **Pink: 4K is background, and the number of cases is NBkg2 =14.3±6.3**
- **Red dotted line: Number of signal instances is Nsig =9.9±5.2**

2D VS Sideband





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- **Pink: 4K is background, and the number of cases is NBkg2 =14.6±6.4**
- **Red dotted line: Number of signal instances is Nsig =9.9±5.2**

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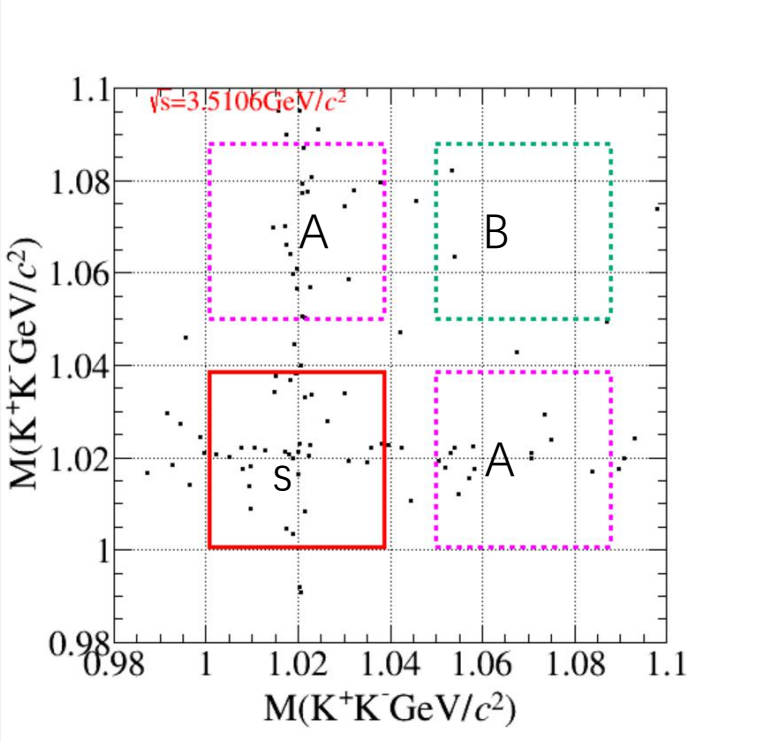

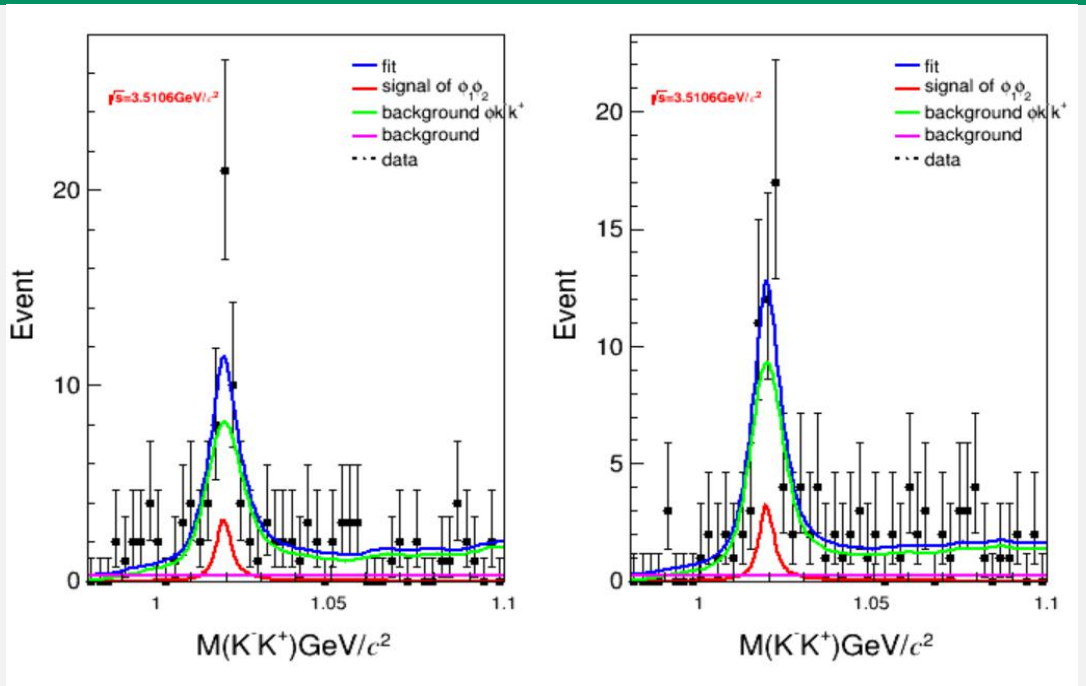

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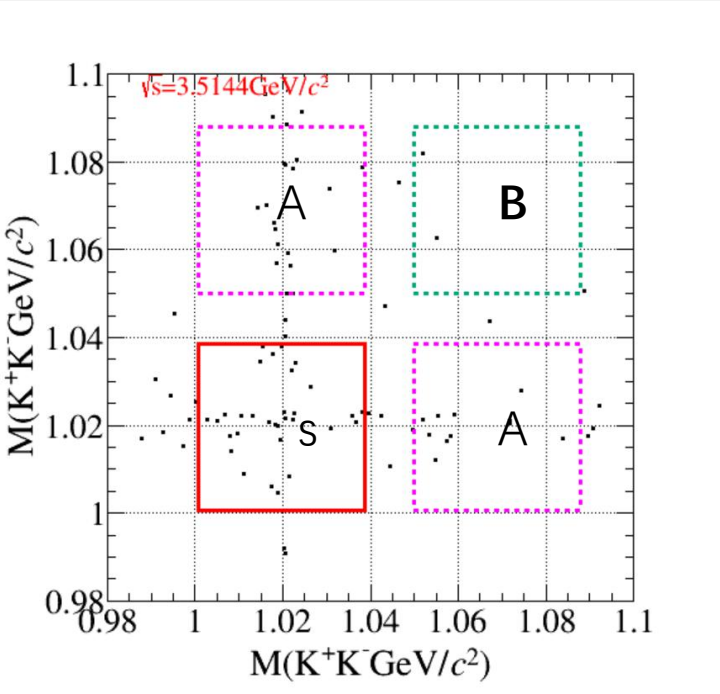
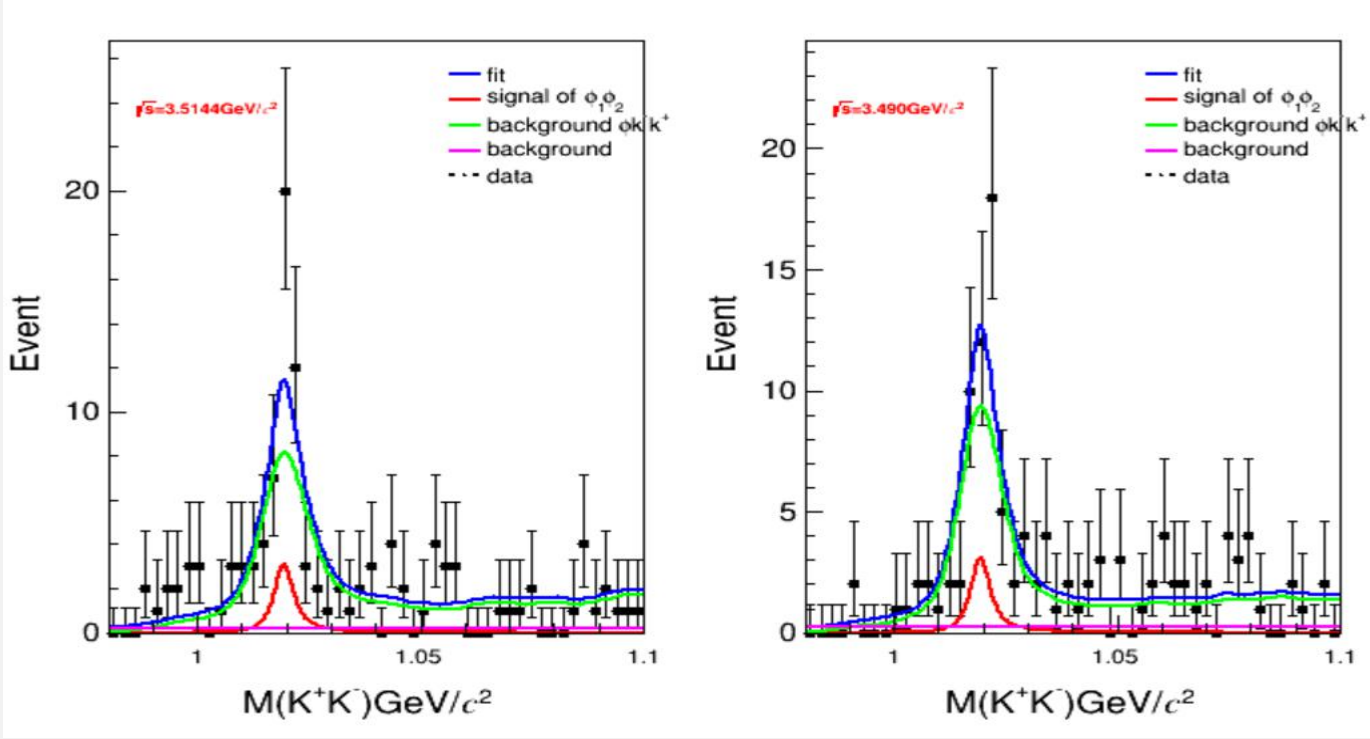
- **Pink: 4K is background, and the number of cases is NBkg2 =12.9±6.1**
- **Red line: Number of signal instances is Nsig =9.8±5.2**

2D VS Sideband





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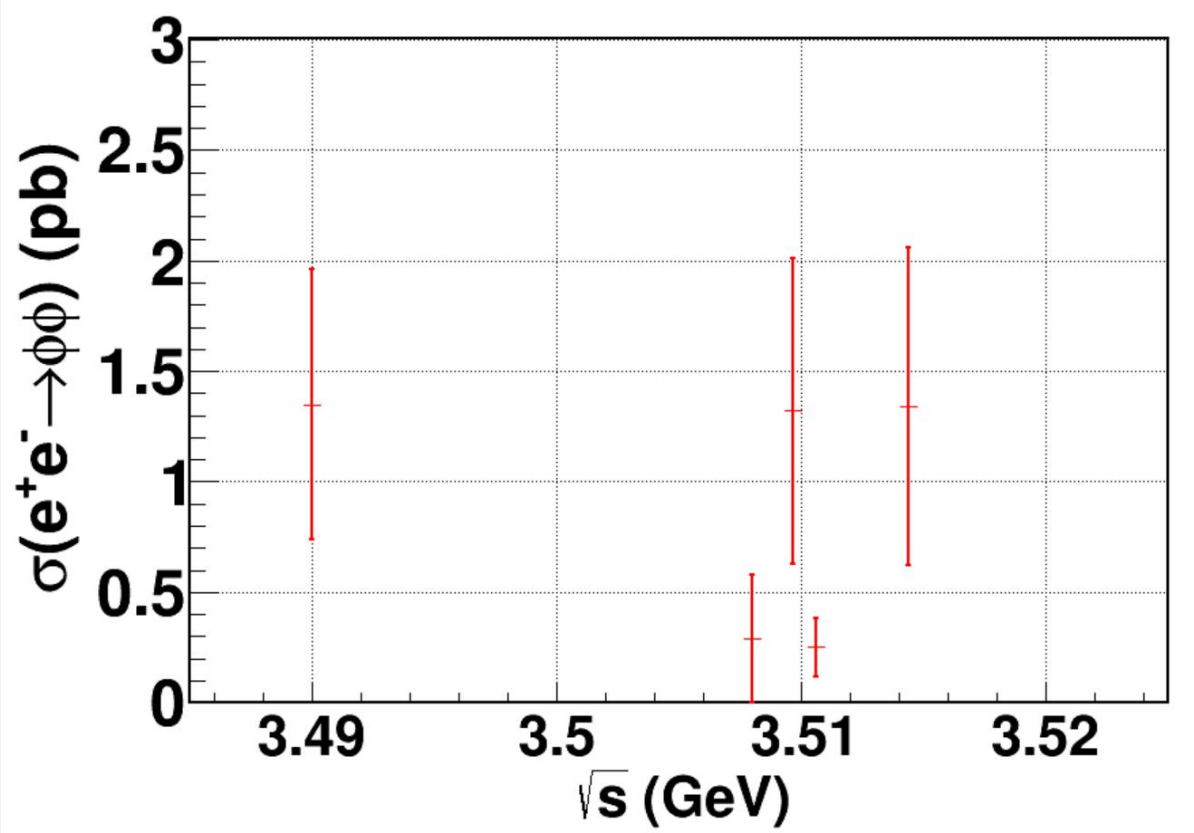
- **Pink: 4K is background, and the number of cases is NBkg2 =10.7±5.9**
- **Red dotted line: Number of signal instances is Nsig =9.7±5.2**

signal fit

$$\sigma^{obs} = \frac{N^{obs}}{l \cdot \varepsilon \cdot B(\phi \to K^+K^-) \cdot B(\phi \to K^+K^-)}$$

$\sqrt{s}$(GeV)	N^{obs}	$\pounds_{int}(pb^{-1})$	$\varepsilon(\%)$	$B^2(\phi \to K^+K^-)$	σ^{obs}
3.4900	11.63±5.27	12.1	0.35	0.24	1.35±0.61
3.5097	9 . 9 ± 5 . 2	39.3	0.80	0.24	1.32±0.69
3.5080	9 . 9 ± 5 . 2	181.8	0.79	0.24	0.29±0.15
3.5106	9 . 8 ± 5 . 2	184.6	0.34	0.24	0.25±0.13
3.5144	9 . 7 ± 5 . 2	40.9	0.74	0.24	1.34±0.72

signal fit



$$\sigma^{obs} = \frac{N^{obs}}{l \cdot \varepsilon \cdot B(\boldsymbol{\phi} \to K^+K^-) \cdot B(\boldsymbol{\phi} \to K^+K^-)}$$

Next to do

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- use $\frac{a+\cos^2\theta}{b-\cos^2\theta}$, $a=1+\frac{8m_\phi^2}{s}$, $b=1+\frac{4m_\phi^2}{s^2}$
- $\sigma^{born}=\frac{N^{obs}}{l\cdot\varepsilon\cdot B(\phi\to K^+K^-)\cdot B(\phi\to K^+K^-)\cdot\frac{1}{|1-\Pi|^2}\cdot(1+\delta(s))}$ Compute the bron cross
- Systematic uncertainty.