Study of $e^+e^- \to \omega\chi_{c0}$ around $\sqrt{s} = 4.2$ GeV

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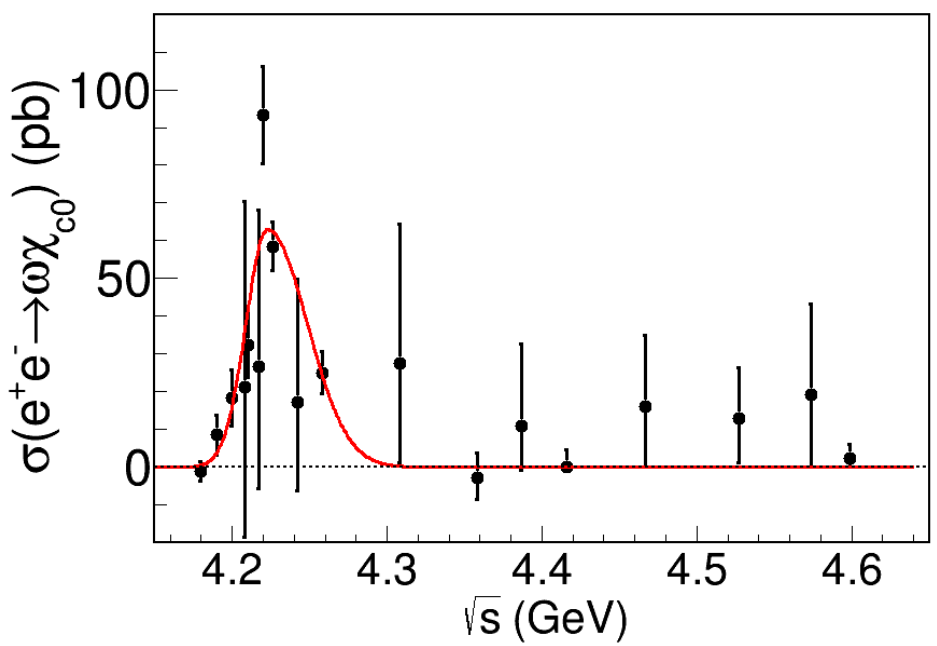
Iteration function

$$f(\sqrt{s}) = \begin{cases} A \cdot exp\left(-\frac{(\sqrt{s}-\mu)^2}{2{\sigma_1}^2}\right), & \sqrt{s} \le \mu \\ A \cdot exp\left(-\frac{(\sqrt{s}-\mu)^2}{2{\sigma_2}^2}\right), & \sqrt{s} > \mu \end{cases}$$



$A = 63,\ \mu = 4.222,\ \sigma_1 = 0.014,\ \sigma_2 = 0.026$

Cross section measurement

$$e^+e^- \to \omega\chi_{c0}$$

$\sqrt{s}$(GeV)	$\mathcal{L}_{int}$(pb^{-1})	N^{sig}	$1+\delta$(s)	$\frac{1}{\lvert 1-\Pi\rvert^2}$	$\epsilon(\%)$	σ^B(pb)
4.18	3161	-5.3±13.1	0.63	1.055	25.30	-1.0 ± 2.5
4.19	517.5	7.1±4.4	0.64	1.056	24.99	8.1 ± 5.0
4.20	519.4	15.8±6.4	0.65	1.057	25.26	17.4 ± 7.1
4.21	509.0	29.4±7.9	0.68	1.057	25.89	30.7 ± 8.3
4.22	500	86.4±11.8	0.71	1.057	25.82	88.3 ± 12.1

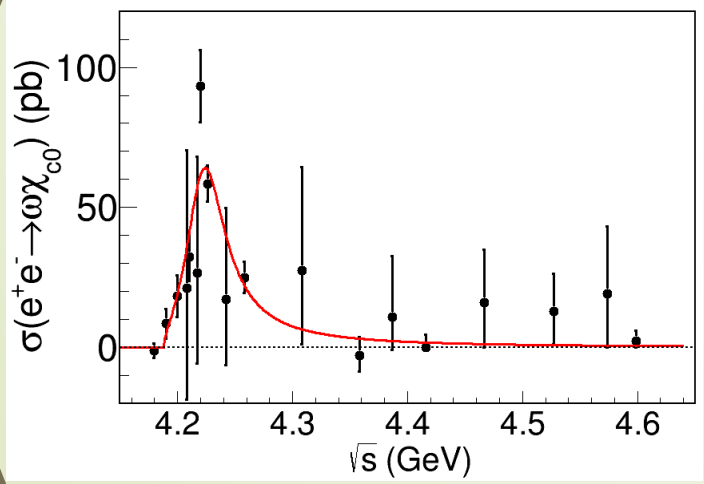
Fit to line-shape

$$\mathrm{BW}(\sqrt{s}) = \frac{12\pi \cdot (\hbar c)^2 \cdot \Gamma_{ee} \cdot \mathcal{B}(\omega\chi_{c0}) \cdot \Gamma_t}{(s - M^2)^2 + M^2 \Gamma_t{}^2} \times \frac{\Phi(\sqrt{s})}{\Phi(M)}$$

$$\Phi(\sqrt{s}) = \frac{P}{\sqrt{s}} = \frac{\sqrt{(s - (m_1 + m_2)^2)(s - (m_1 - m_2)^2)}}{2s}$$

$\omega(782)$ MASS	782.65 ±0.12 MeV (S = 1.9)
$\omega(782)$ WIDTH	8.49 ±0.08 MeV
$\chi_{c0}(1P)$ MASS	3414.75 ±0.31 MeV
$\chi_{c0}(1P)$ WIDTH	10.5 ±0.6 MeV

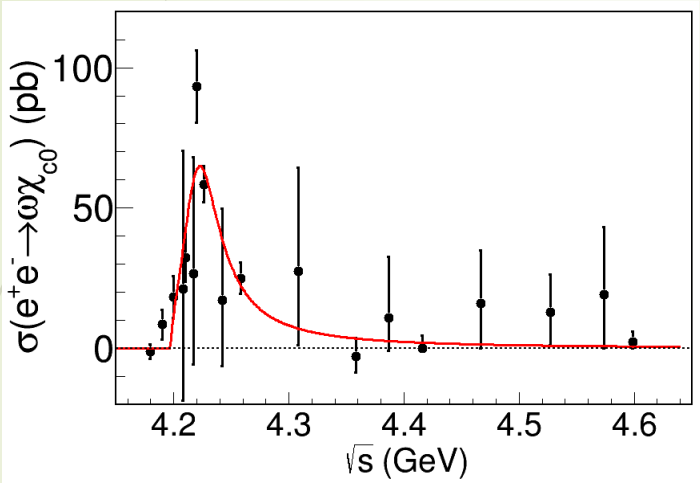
$$m_1 = M_\omega - 0.5\Gamma_\omega \qquad m_2 = M_{\chi_{c0}} - 0.5\Gamma_{\chi_{c0}}$$



$$M = (4220.9 \pm 2.8)\ \mathrm{MeV}/c^2$$
$$\Gamma_t = (42.4 \pm 8.0)\ \mathrm{MeV}$$

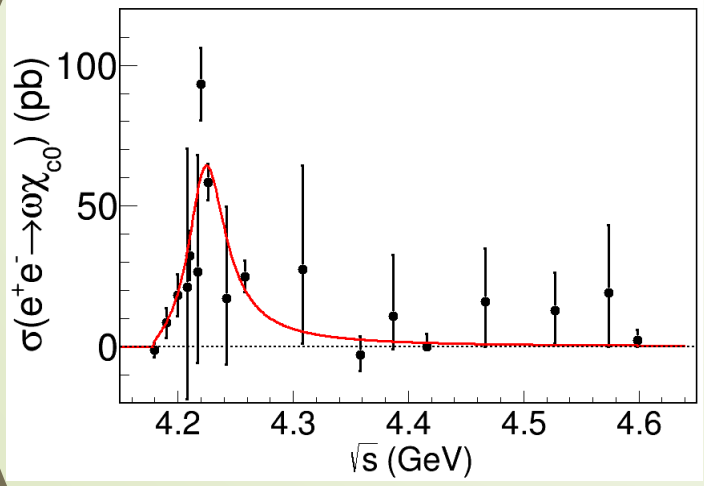
Fit to line-shape

$m_1 = M_\omega$ $m_2 = M_{\chi_{c0}}$



$M = (4218.2 \pm 3.0)\ \mathrm{MeV}/c^2$
$\Gamma_t = (41.8 \pm 8.6)\ \mathrm{MeV}$

$m_1 = M_\omega - \Gamma_\omega$ $m_2 = M_{\chi_{c0}} - \Gamma_{\chi_{c0}}$



$M = (4222.7 \pm 3.0)\ \mathrm{MeV}/c^2$
$\Gamma_t = (39.7 \pm 7.3)\ \mathrm{MeV}$

Fit to line-shape

$m_1 = M_\omega - 0.5\Gamma_\omega$
$m_2 = M_{\chi c0} - 0.5\Gamma_{\chi c0}$

$M = (4220.9 \pm 2.8)\ \mathrm{MeV}/c^2$
$\Gamma_t = (42.4 \pm 8.0)\ \mathrm{MeV}$

Central value

$m_1 = M_\omega$
$m_2 = M_{\chi c0}$

$M = (4218.2 \pm 3.0)\ \mathrm{MeV}/c^2$
$\Gamma_t = (41.8 \pm 8.6)\ \mathrm{MeV}$

Sys. error

$m_1 = M_\omega - \Gamma_\omega$
$m_2 = M_{\chi c0} - \Gamma_{\chi c0}$

$M = (4222.7 \pm 3.0)\ \mathrm{MeV}/c^2$
$\Gamma_t = (39.7 \pm 7.3)\ \mathrm{MeV}$

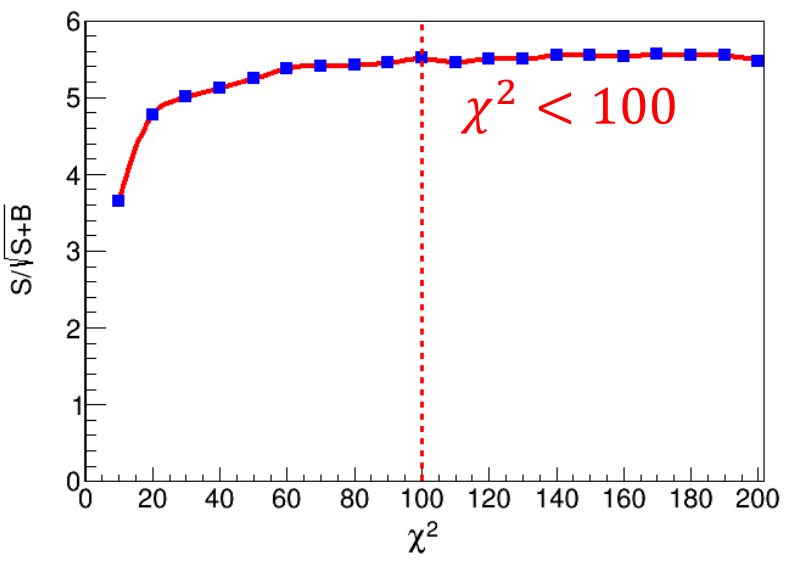
Sys. error

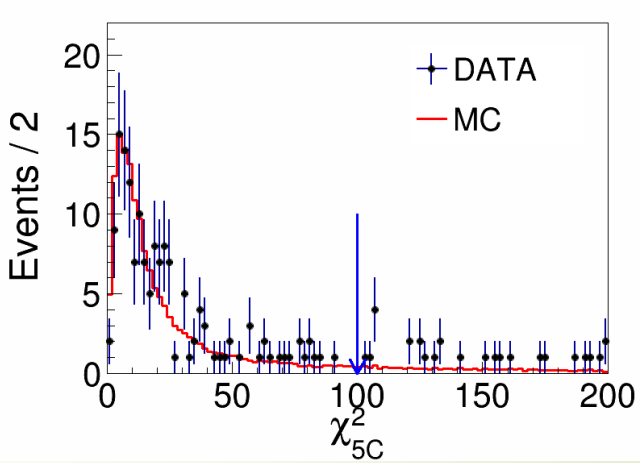
Optimize χ^2

$$\text{FOM}=\frac{S}{\sqrt{S+B}}$$

S: MC simulation

S + B: Data in χ_{c0} signal region $[3.38, 3.44]$ GeV

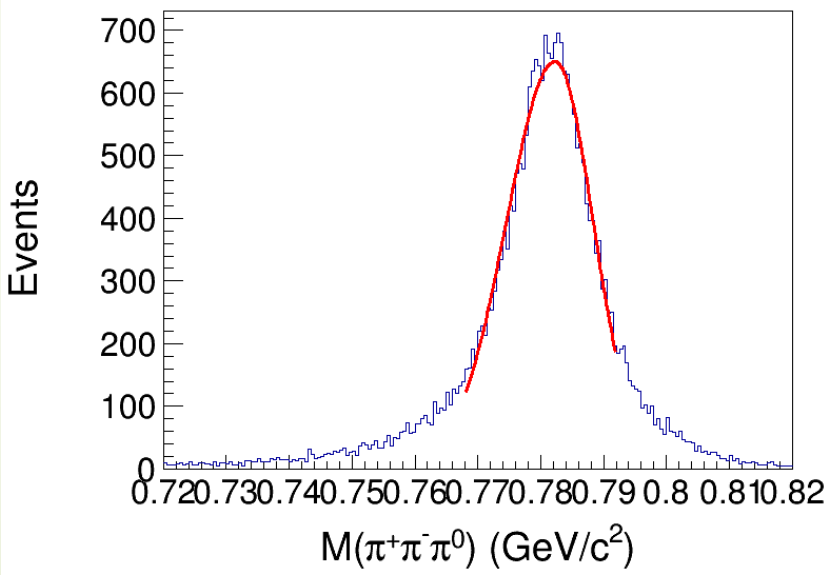




The χ^2 requirement is reasonable from MC χ^2 distribution

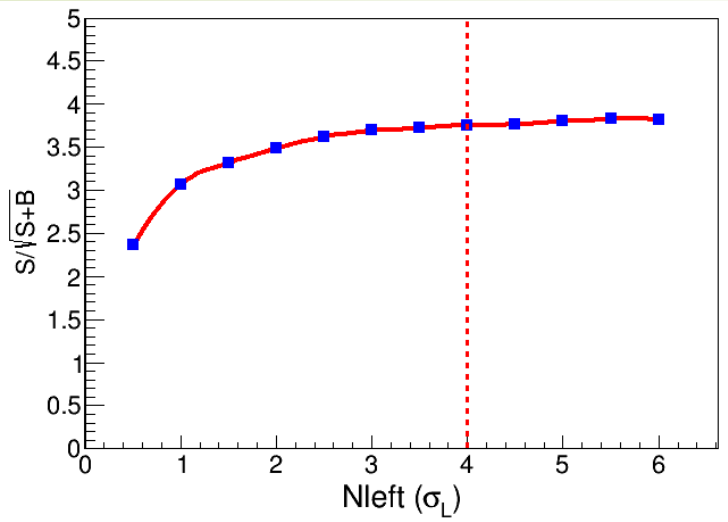
Optimize ω mass window

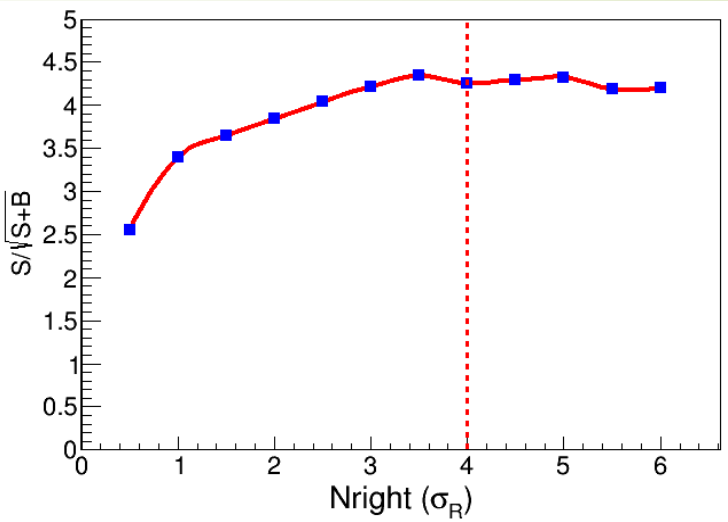
$$f(m) = \begin{cases} A \cdot exp\left(-\frac{(m-\mu)^2}{2\sigma_L{}^2}\right), & m \leq \mu \\ A \cdot exp\left(-\frac{(m-\mu)^2}{2\sigma_R{}^2}\right), & m > \mu \end{cases}$$



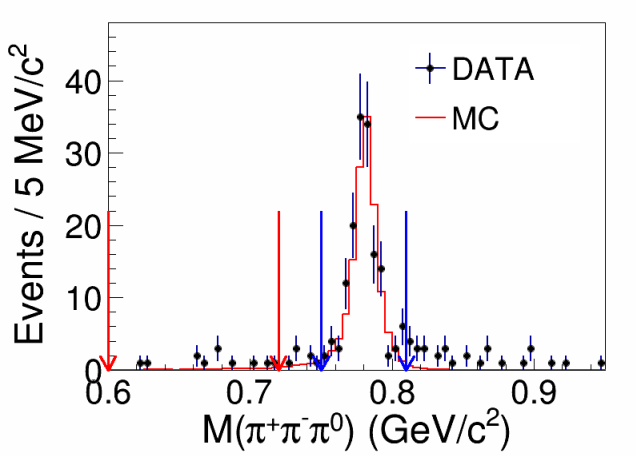
$\sigma_L = 8$ MeV $\quad\quad$ $\sigma_R = 6$ MeV

Optimize ω mass window





ω mass window: $[M_\omega - 4\sigma_L,\ M_\omega + 4\sigma_R]$



The ω mass window requirement is reasonable from MC $M(\pi^+\pi^-\pi^0)$ distribution

Optimize ω mass window

$\sqrt{s}$(GeV)	σ_L (MeV)	σ_R (MeV)	ω mass window (MeV/c^2)
4.18	19	6	[0.71, 0.81]
4.19	11	6	[0.74, 0.81]
4.20	8	6	[0.75, 0.81]
4.21	8	6	[0.75, 0.81]
4.22	8	6	[0.75, 0.81]

Tracking efficiency

$$e^+e^- \to \pi^+\pi^-K^+K^-$$

$$\varepsilon = \frac{n}{N}$$

N : (nGood = 3) || (nGood = 4)
for π^+, at least have a π^-, K^+, K^-
for π^-, at least have a π^+, K^+, K^-

n : nGood = 4

Good track : $|R_{xy}| < 1\text{cm}, |R_z| < 10\text{cm}, |cos\theta| < 0.93$

π : $P_\pi > P_K, P_\pi > P_p, P_\pi > 0.001, E_{emc} < 1$ GeV

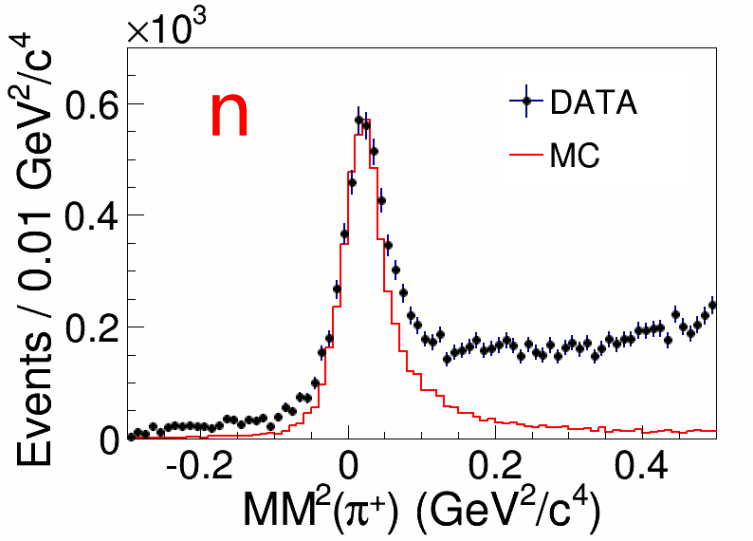
K : $P_K > P_\pi, P_K > P_p, P_K > 0.001, E_{emc} < 1$ GeV

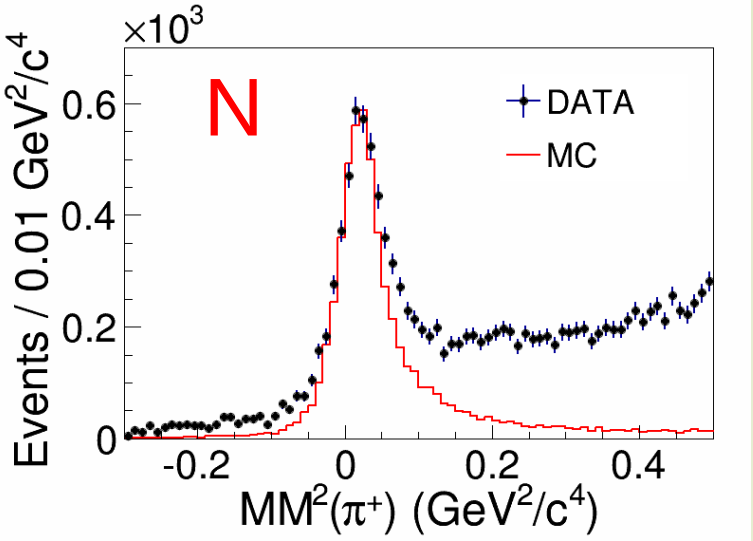
Boss version : 7.0.2.p01

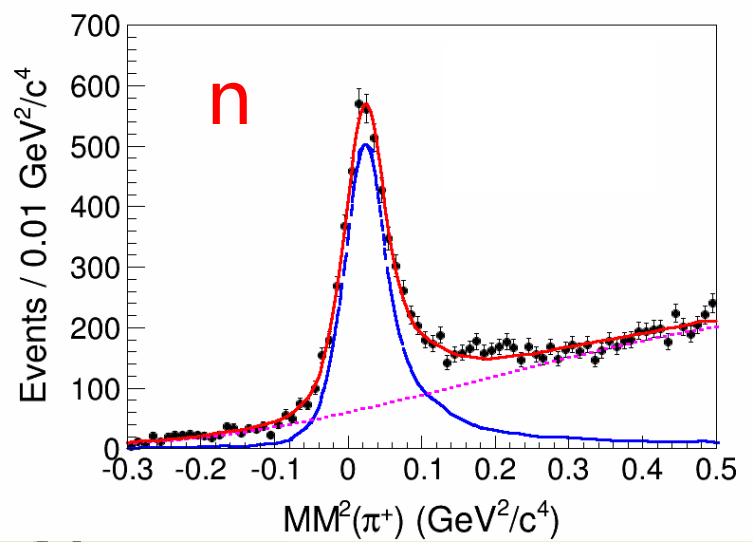
Data : 4.19 GeV, 4.20 GeV, 4.21, … GeV

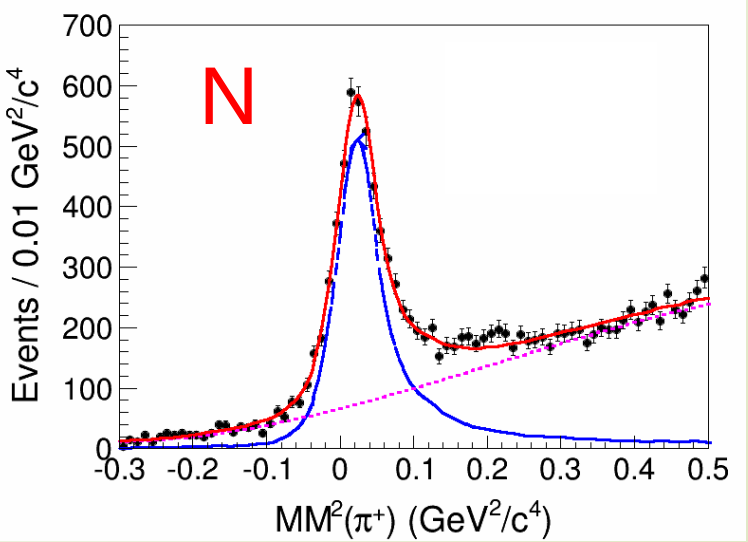
Tracking efficiency

$$P_t \in (0.5, 0.7)\text{GeV}$$









Summary

1、Changing the iteration function to solve threshold problem.

2、Optimizing the χ^2 and ω mass window requirements.

3、Will update the results using new reconstruction data.

4、Will update the memo.

5、Will check tracking efficiency(on going) and photon detection for data at $\sqrt{s} = 4.19, 4.20, 4.21$ ... GeV.

Thanks for your attention!

BACK UP

$$\mathrm{FOM}=\frac{S}{\sqrt{S+B}}$$

S: MC simulation

B: Data in χ_{c0} sideband region $[3.30, 3.36]$ GeV