Search for Zc(3900) in $Y(4260) \to \pi^+\pi^-\psi(3686)$ @ BESIII

ustc group meeting

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outline

- update of $\pi^+\pi^-\psi'$ selection
- $\sigma(\pi^+\pi^-\psi')$ lineshape measurement
- non ψ' backgrounds in Zc measurement
- Zc measurement
- Conclusion

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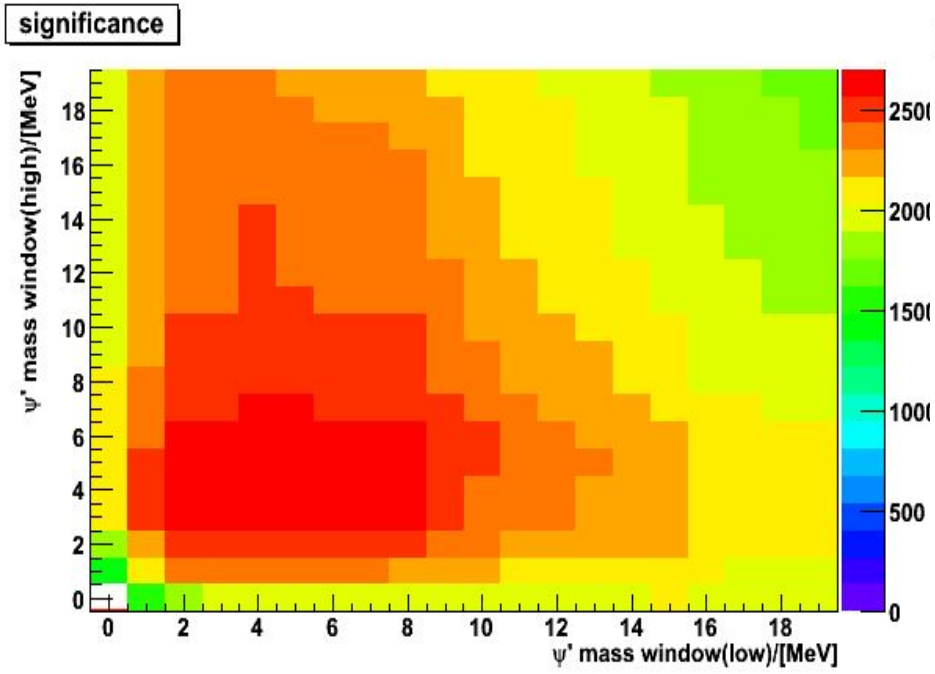
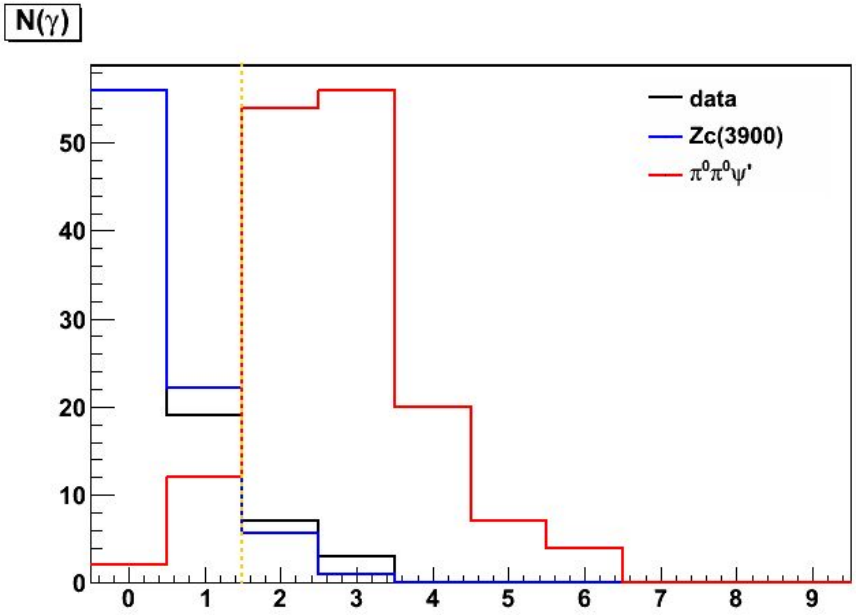
update of $\pi^+\pi^-\psi'$ selection

1. μ selection: cut L(μ1)+L(μ2) ≧ 8 is removed;
2. ψ' selection: ψ' mass window has been optimized to be:
   [3.68, 3.693]GeV;
3. N(γ): to suppress π0π0ψ' background, the number of photons is required to be smaller than 2.





cutflow in $Y(4260) \to \pi^+\pi^-\psi(3686)$

channel /cut	ee(6trk)	ee(5trk)	mm(6trk)	mm(5trk)
Ntot	100000	100000	100000	100000
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PID	70642	70642	70642	70642
vertex fit	68485	68485	68485	68485
4C kinematic fit	59557	59557	59557	59557
χ^2_{4c}	11358	9616	16161	13633
m(J/ψ)	11355	9162	16153	13454
5C kinematic fit	11053	8214	15714	11866
6C kinematic fit	10718	7686	15256	11054
m(ψ')	7962	5509	11295	7992
Ks veto	7808	3733	11094	5302
N(γ) < 2	7808	3479	11094	4850

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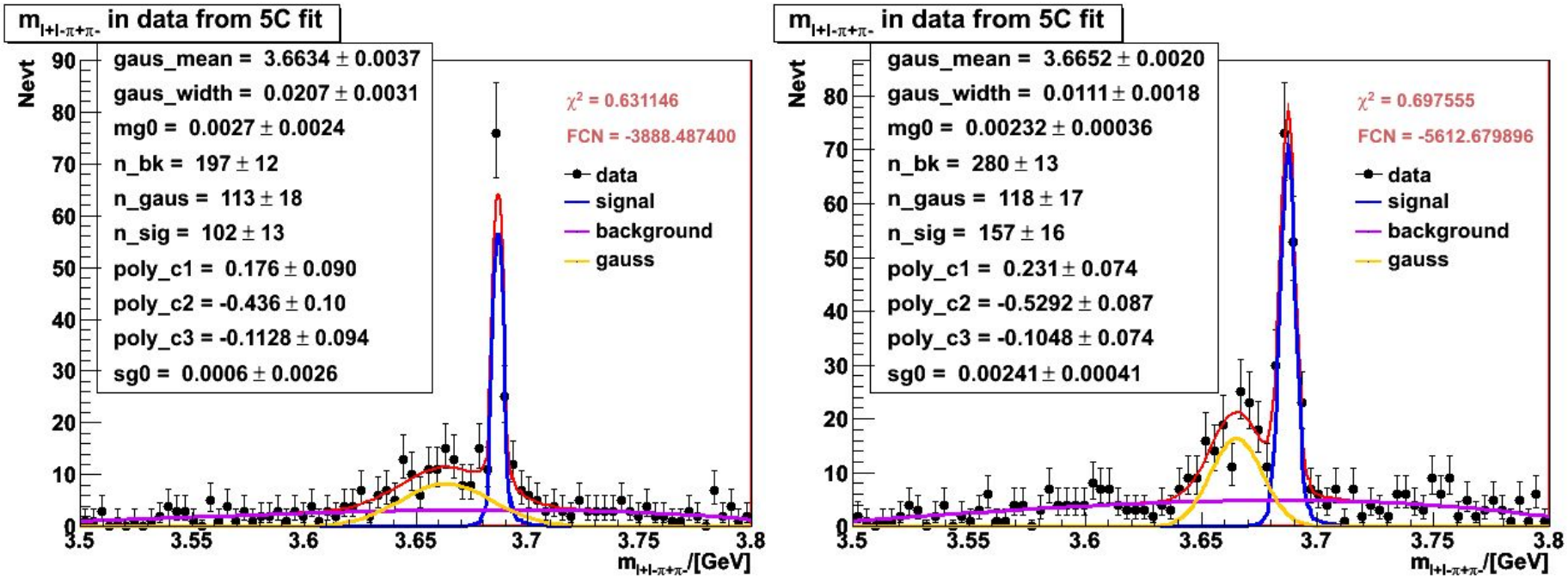
efficiency and RCF

Ecm(GeV)	ε(ee)	ε(μμ)	(1+δ)(ee)	(1+δ)(μμ)
4.009	0.10278	0.14637	0.73905	0.74216
4.090	0.1649	0.23346	0.794155	0.793759
4.190	0.17586	0.25264	0.847307	0.847968
4.210	0.17693	0.25426	0.845	0.846188
4.220	0.17813	0.2535	0.842748	0.843444
4.230	0.18078	0.25688	0.839996	0.839199
4.245	0.18248	0.25763	0.836524	0.838429
4.260	0.1898	0.26941	0.847042	0.845389
4.310	0.18356	0.26102	0.918362	0.918596
4.360	0.18647	0.26732	0.945101	0.944481
4.390	0.18697	0.2679	0.94932	0.948515
4.420	0.18924	0.26994	0.951435	0.95148

ψ' fitting function

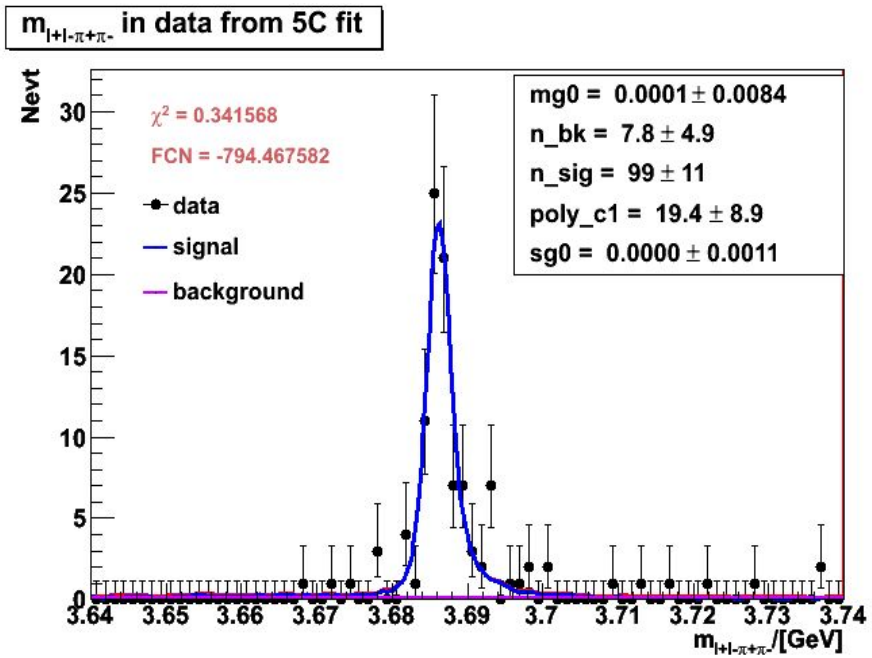


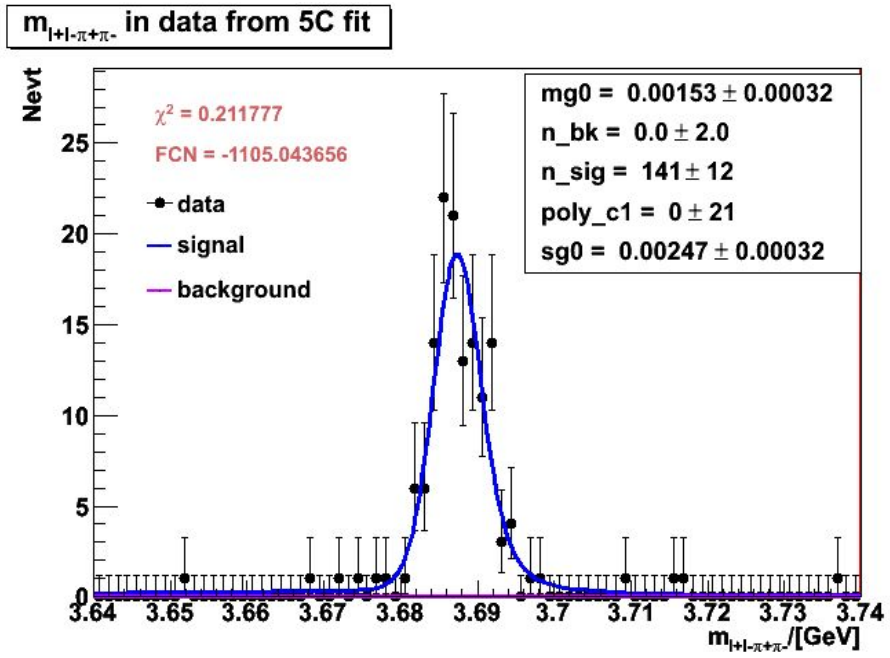
- the data fitted includes 4 kinds of $\pi^+\pi^-$J/ψ combinations

  MC_shape×Gauss + Wide_Gauss + Polynominal
- $\sigma(Y(4260)\rightarrow\pi^+\pi^-\psi')$ is measured to be:

  σ_{ee} = 19.024±2.425 pb; $\sigma_{\mu\mu}$ = 20.704±2.110 pb;
- the results is consistent with previous measured results!

cross check of $\sigma(\pi^+\pi^-\psi')$ measurement



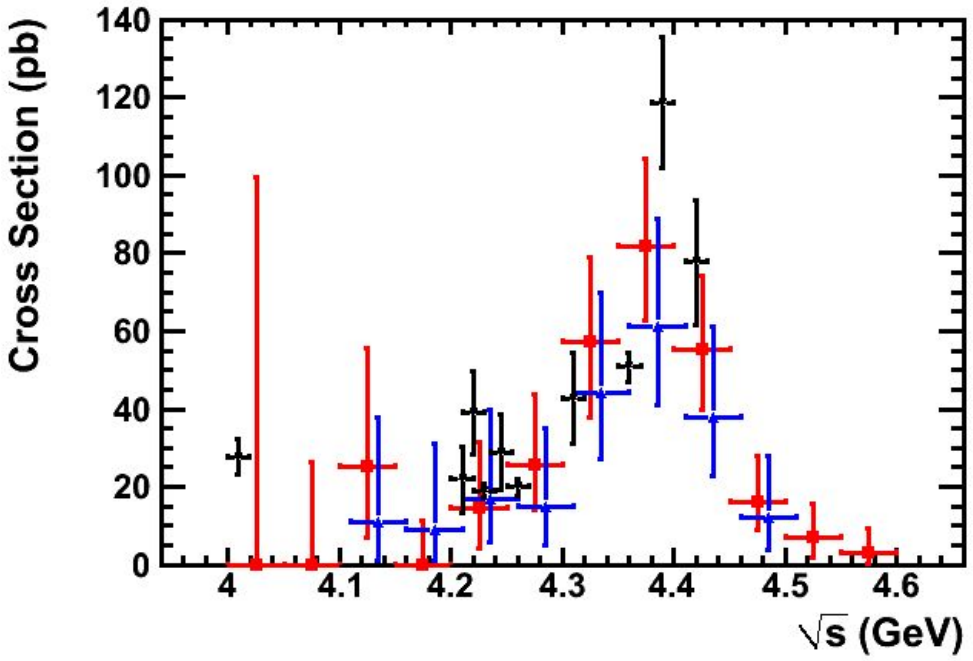


- the data fitted includes the π+π-J/ψ if all the other three combinations are outside ψ' signal region.
- $\sigma(Y(4260)\rightarrow\pi^+\pi^-\psi')$ is measured to be:

  σ_{ee} = 24.134±2.682 pb; $\sigma_{\mu\mu}$ = 24.395±2.076 pb;
- the results is consistent with the nominal results!

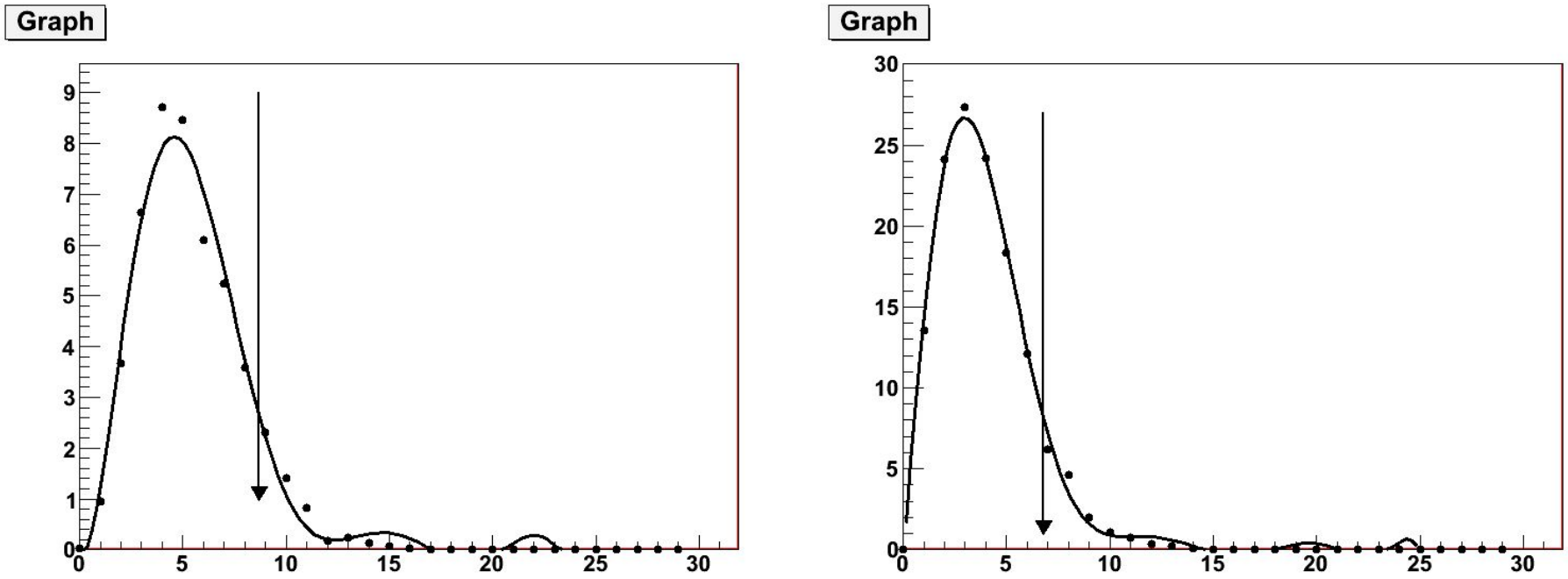
$\sigma(\pi^+\pi^-\psi')$ lineshape measurement

- $\sigma(Y(4260)\rightarrow\pi^+\pi^-\psi')$ lineshape:



- I only show the nominal results with its statistic error, and it is generally consistent with the measurement from Belle(red) and Babar(blue).

uplimit of $\sigma(\pi^+\pi^-\psi')$ at 4.09 and 4.19GeV



- Since the significance of observed ψ' signal in data @ 4.09GeV(left) and 4.19GeV(right) is less than 3σ, I estimated the uplimit of $\sigma(\pi^+\pi^-\psi')$ to be:

$\sigma(4.09\text{GeV}) \leq 25.91\text{pb}$ @ 90% C.L.

$\sigma(4.19\text{GeV}) \leq 21.54\text{pb}$ @ 90% C.L.

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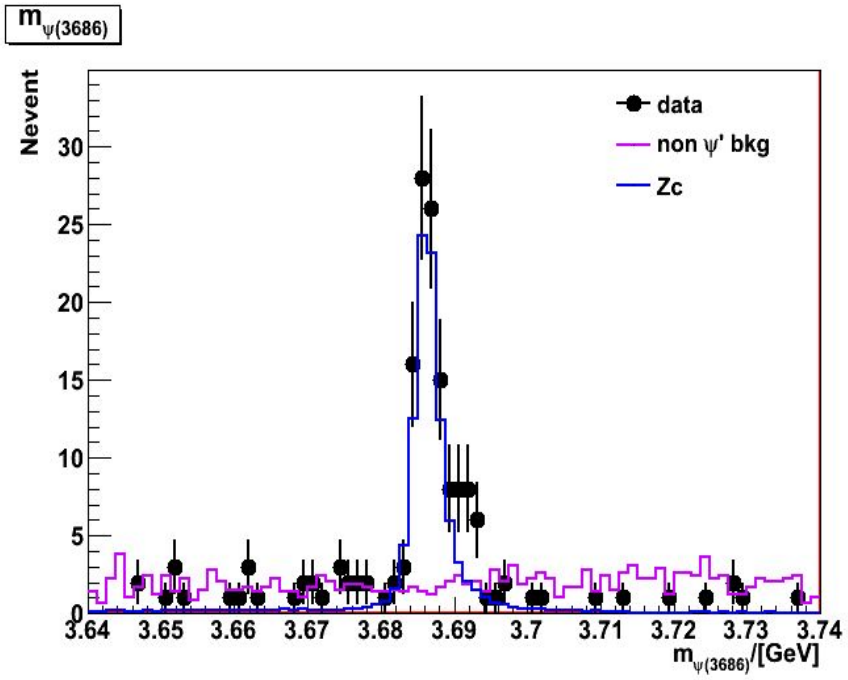
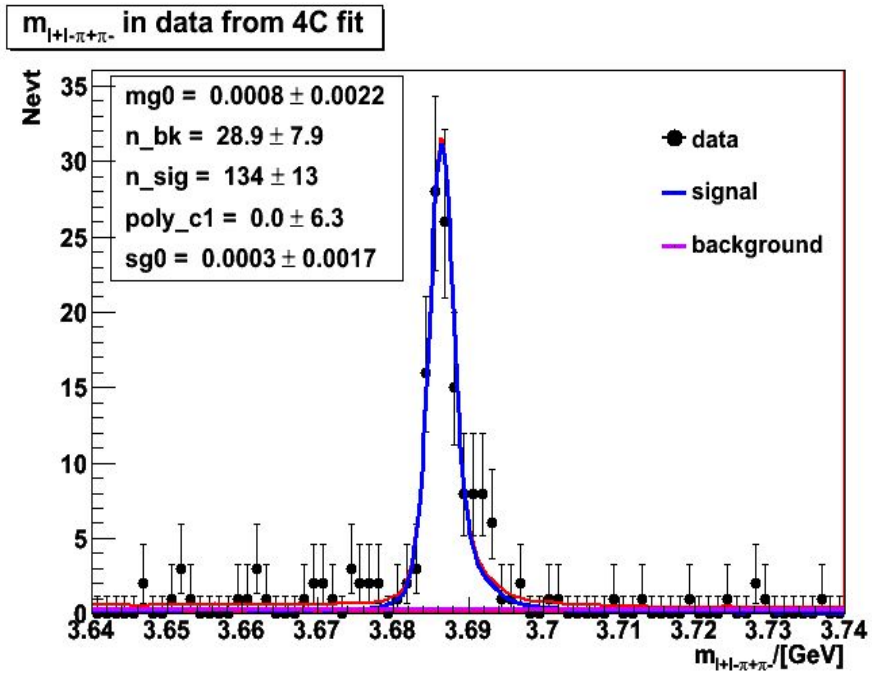
non ψ' background in Zc measurement





The ψ' spectrum contains all kinds of $\pi^+\pi^-$J/ψ combination with no more than one combination in ψ' mass window, the non ψ' background gives a flat distribution, so we estimate, in the signal region:

N(non ψ') = 28.9*0.013/0.1 * 0.96 = 3.61

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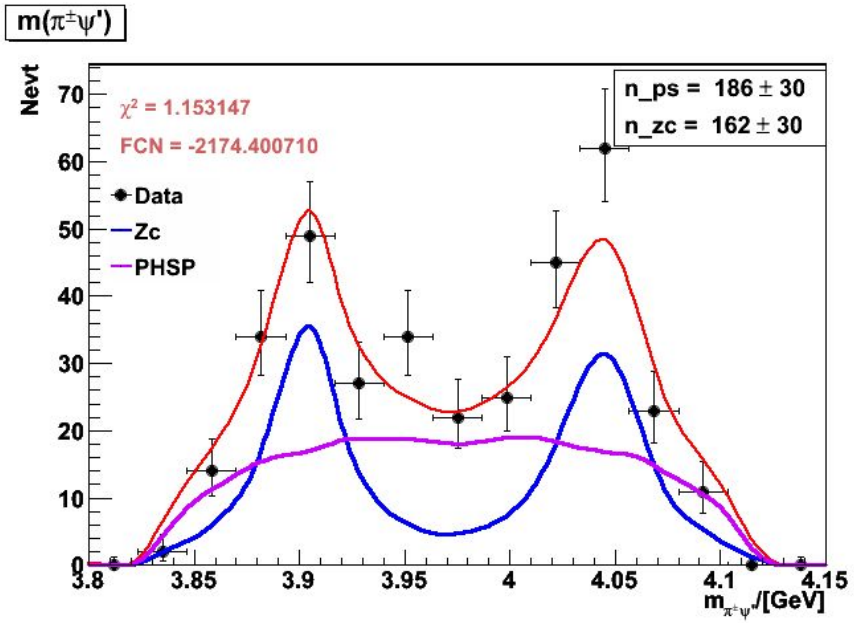
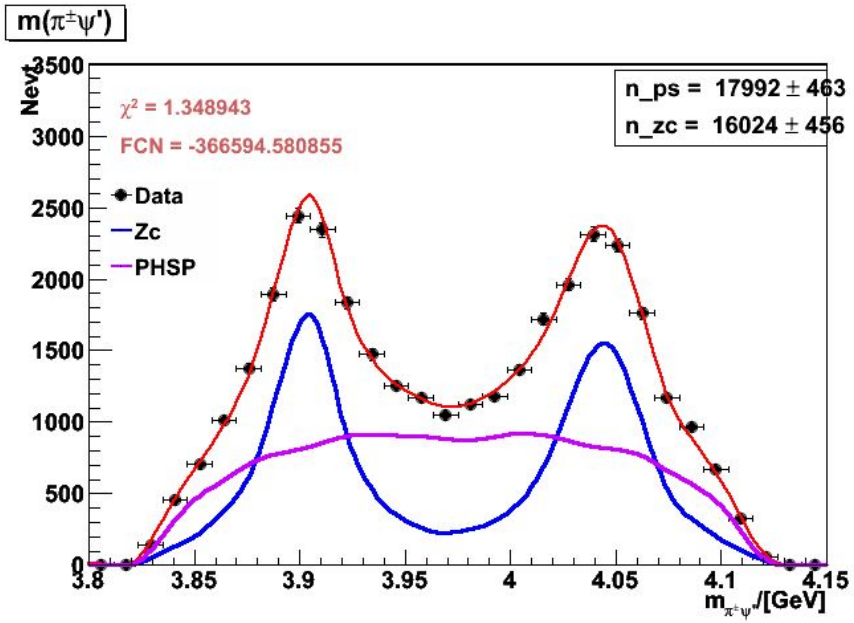
Zc fitting at 4.26GeV

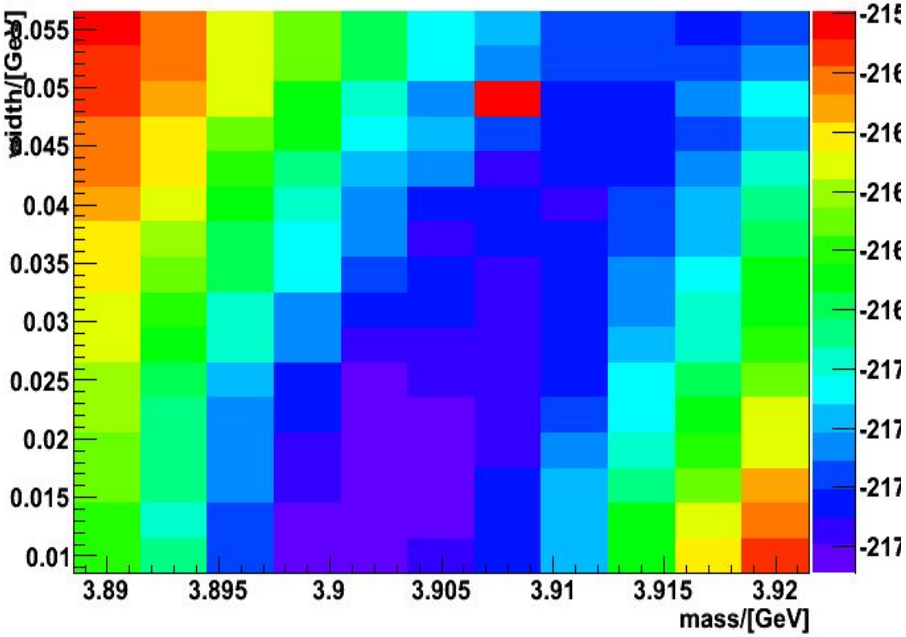


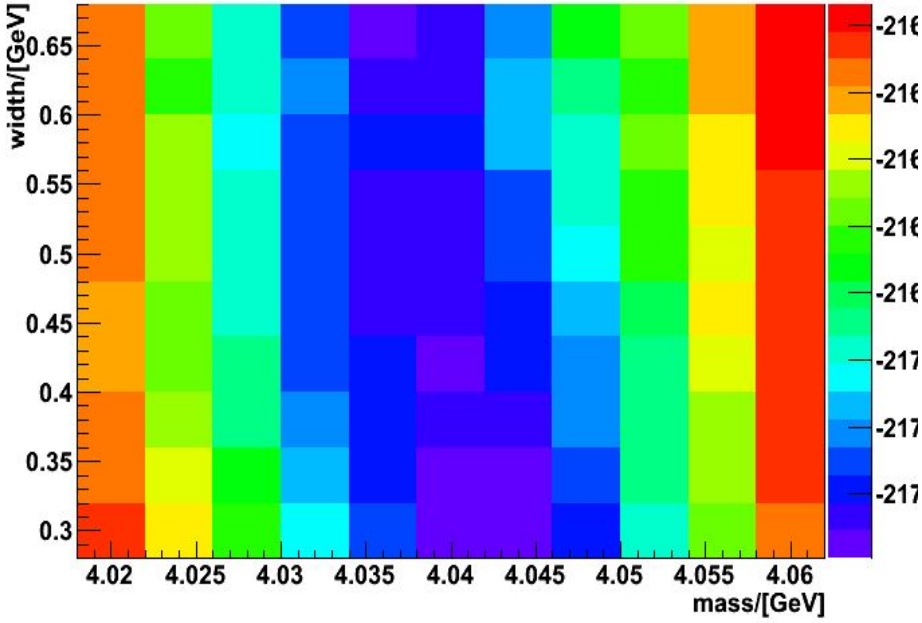


- The $\pi^{\pm}\psi'$ mass is fitted to a function including the contribution of the Zc signal(MC shape) and PHSP(MC shape).
- I/O check of the fitting function is shown on the right plot: (18000PHSP + 16000Zc)
- Significance of Zc signal:

$$\int_{-S}^{S} \frac{1}{\sqrt{2\pi}} e^{-x^2/2} = \int_{0}^{u_{obs}} \chi^2(u;r)du;$$
$$u_{obs} = 2(lnL(s+b) - lnL(b))$$

mass and width scan of Zc measurement





fitting results with maximum likelihood value:

Zc(3900): mass=3.902GeV, width=0.02GeV

Zc(4040): mass=4.04GeV, width=0.035GeV

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- $\sigma(\pi^+\pi^-\psi')$ lineshape is measured with BESIII data, which is consistent with Belle and Babar measurement within statistic error.

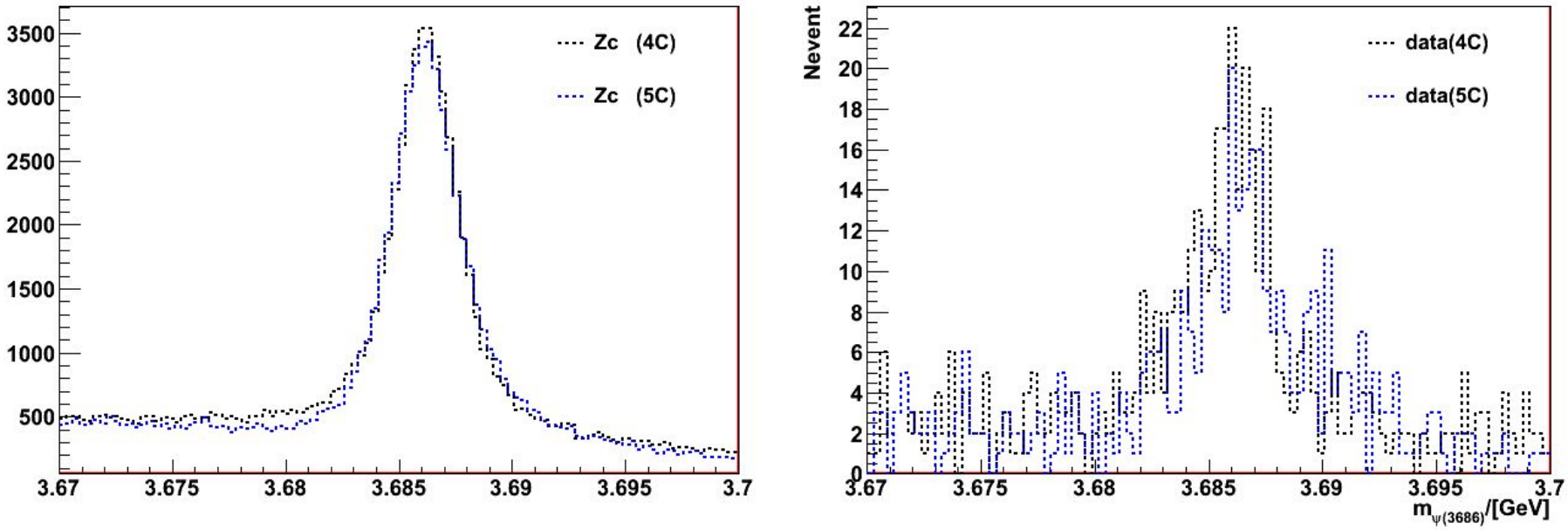
- An exotic state has been observed in $\pi^{\pm}\psi'$ mass spectrum, it could be a state at 3.902GeV with 0.02GeV width, or a state at 4.04GeV with 0.035GeV width.

- Production of such an exotic state is estimated to be:

$$R = \frac{\sigma(Y(4260) \to \pi^{\pm} Zc^{\mp} \to \pi^+\pi^-\psi')}{\sigma(Y(4260) \to \pi^+\pi^-\psi')} = 0.871$$

Back Up

ψ' signal from 4c and 5c kinematic fit



- the two plots(left:MC; right:Data) show the distributions of reconstructed ψ' mass from 4C and 5C kinematic fit:

  $m(\psi'(4C)) = m(l^+l^-\pi^+\pi^-) - m(l^+l^-) + m(J/\psi)$

  $m(\psi'(5C)) = m(l^+l^-\pi^+\pi^-)$

Resolution of ψ' mass calculated in the two methods are almost the same!

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5C kinematic fit	11053	8214	15714	11866
6C kinematic fit	10718	7815	15256	11294
m(ψ')	7542	4775	10735	7063
Ks veto	7397	3242	10547	4669
N(γ) < 2	7397	3009	10547	4267