Data quality check using $e^+e^- \to D_s^+ D_s^-$ and $\gamma\pi^+\pi^- J/\psi$

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Outline

Introduction

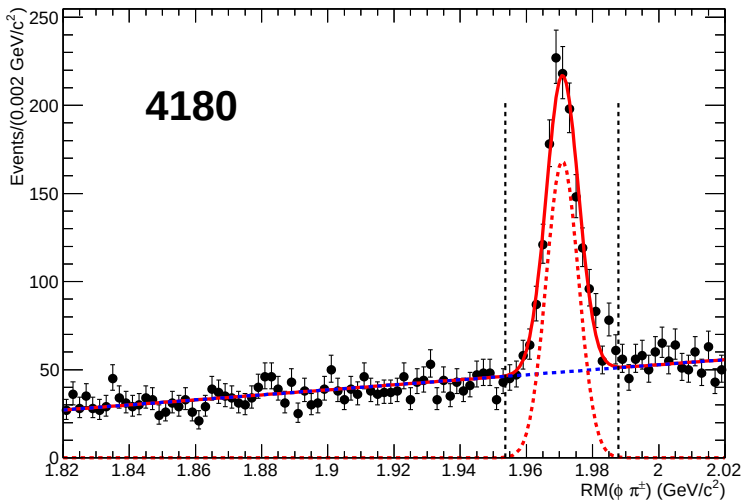
1. $e^+e^- \to D_s^+ D_s^-$
   - Check the resolution for the reconstructed D_s.
   - Check the mass and resolution for the recoil D_s.
   - Scatter plot for 4200 data.
2. $e^+e^- \to \gamma\pi^+\pi^- J/\psi$
   - Check the mass and resolution for the $\psi(3686)$ using ISR process.
   - Check the cross section for $\gamma X(3872)$.

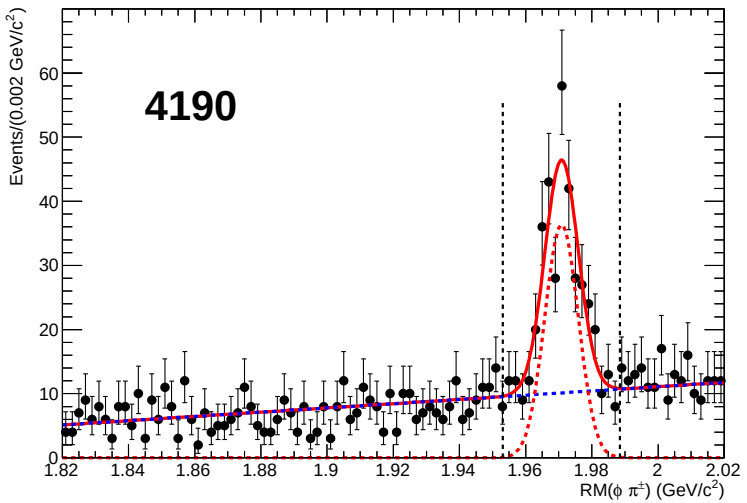
$e^+e^- \to D_s^+ D_s^-$

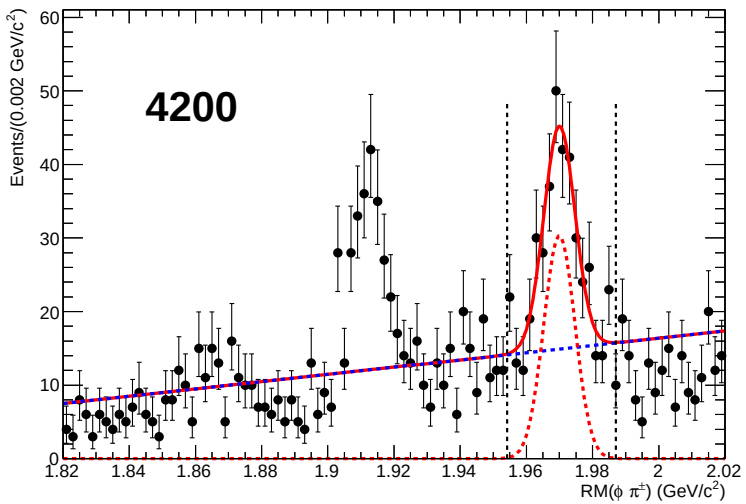
1. At least three good charged tracks.
2. Use PID to select kaon from pion.
3. Require the invariant mass $M(K^+K^-) \in [1.004, 1.034]$ GeV.
4. Analyze D_s^+ and D_s^- separately and combine together.
5. Use all the combinations.

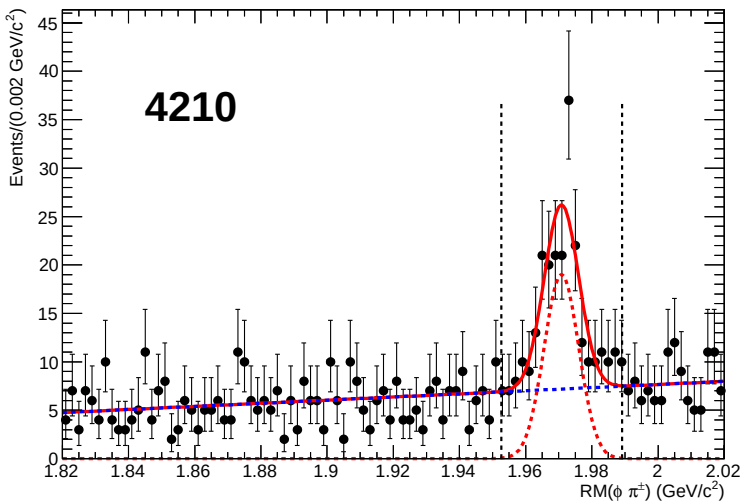
Data set: 4180, 4190, 4200 and 4210 data, run number up to 49183.

Fit result for the recoil mass distribution of D_s



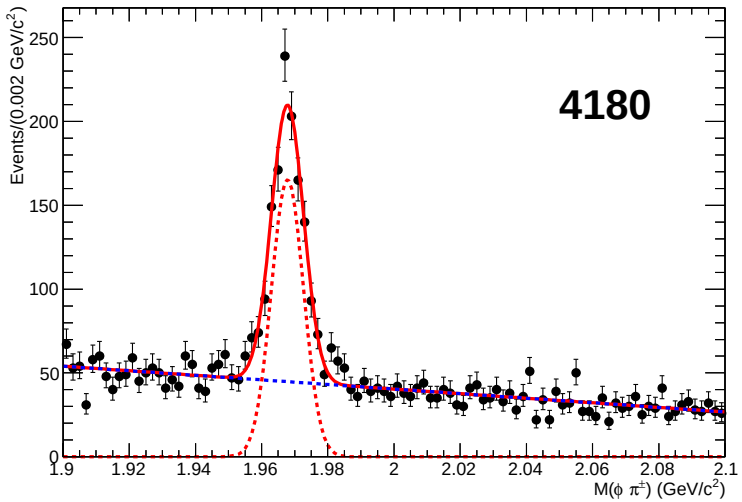


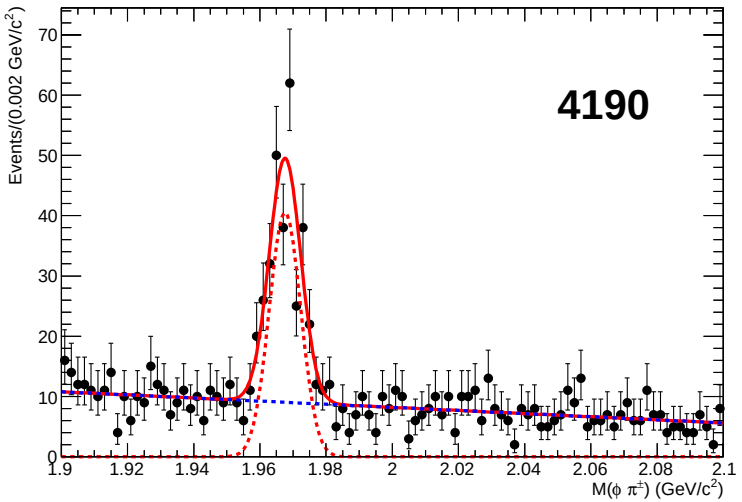


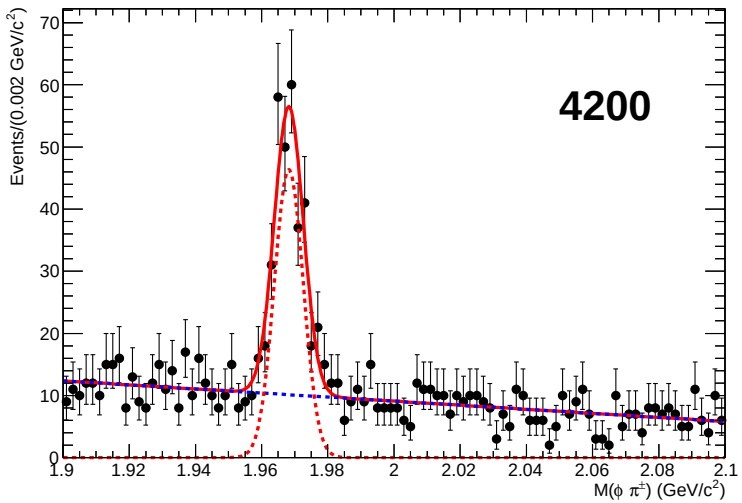


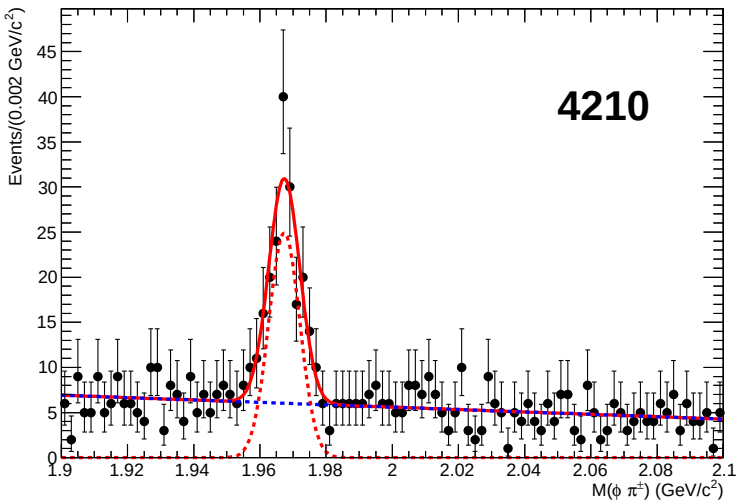
Strange distribution at 1.93 GeV only from 4200 data.

Fit result for invariant mass distribution of D_s

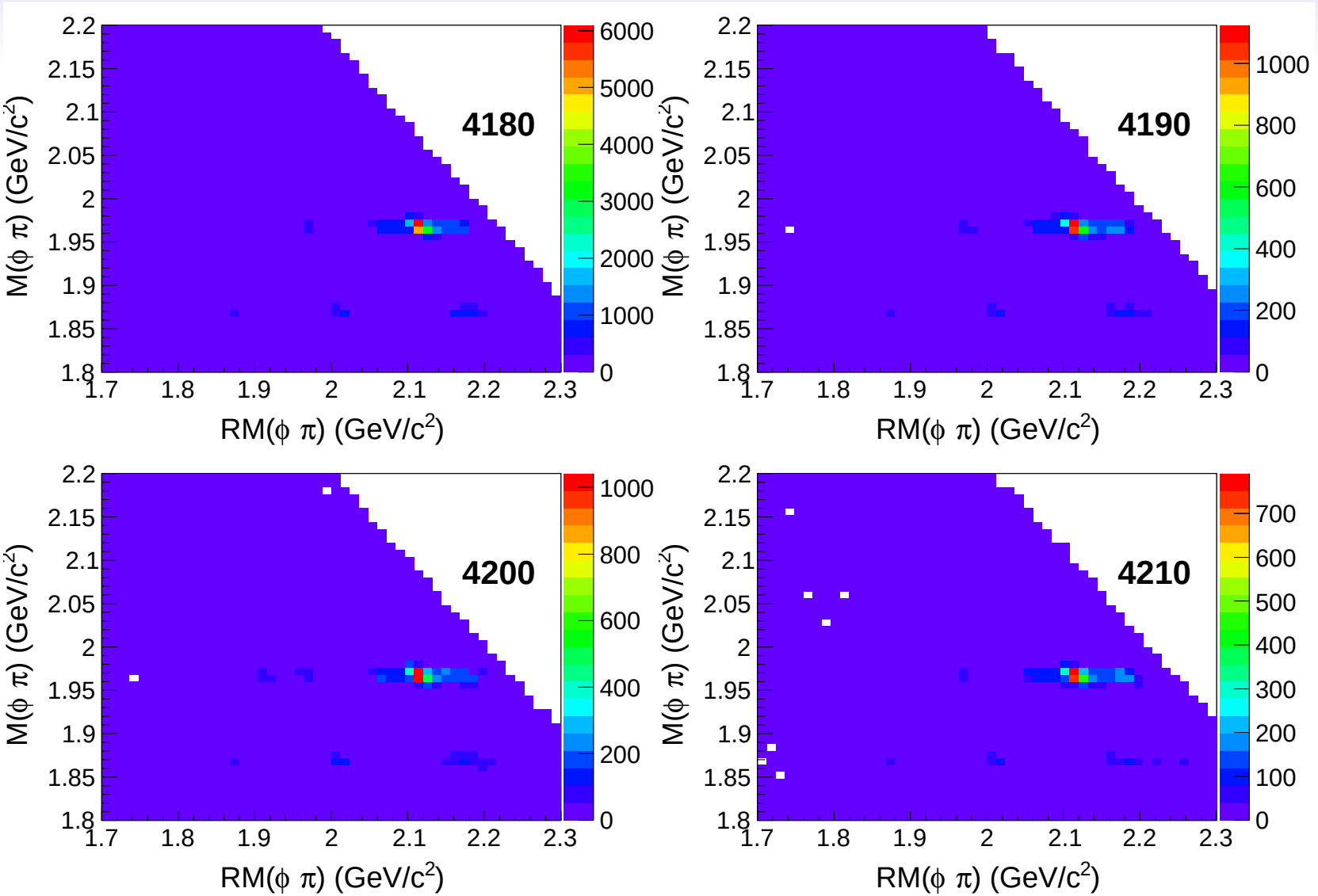






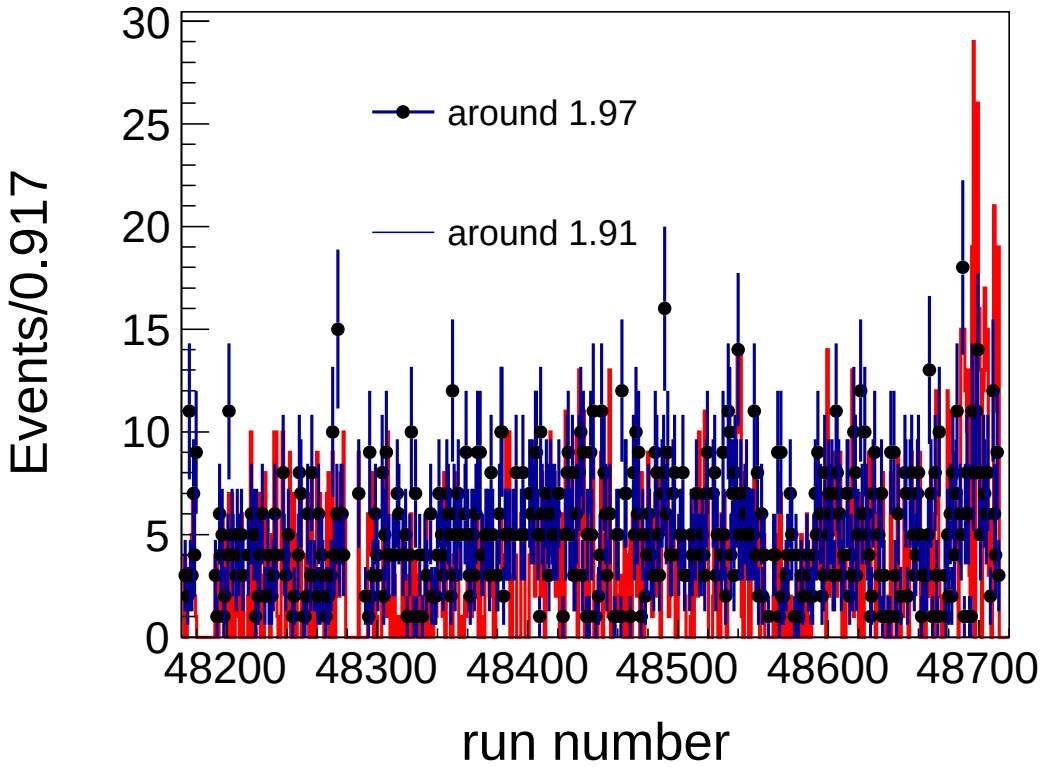


Check the possible source for the strange peak



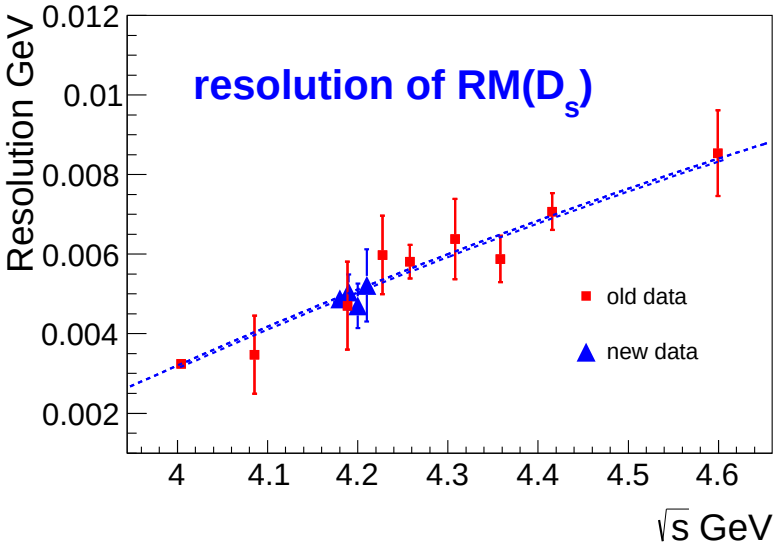
The strange peak has real D_s signal and only exist in 4200 data.

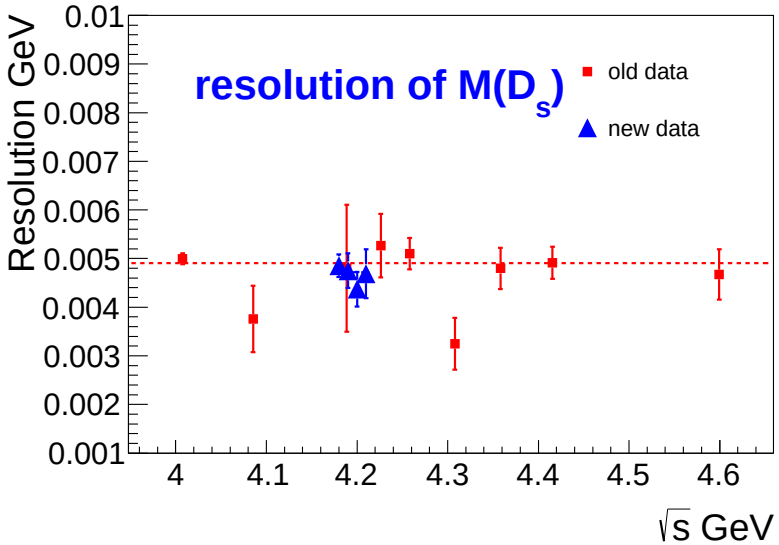
Check the possible source for the strange peak



The distribution of run numbers for the events in [1.95, 1.99] and [1.88, 1.93] GeV in the recoil mass distribution of D_s.
No obvious difference can be seen.

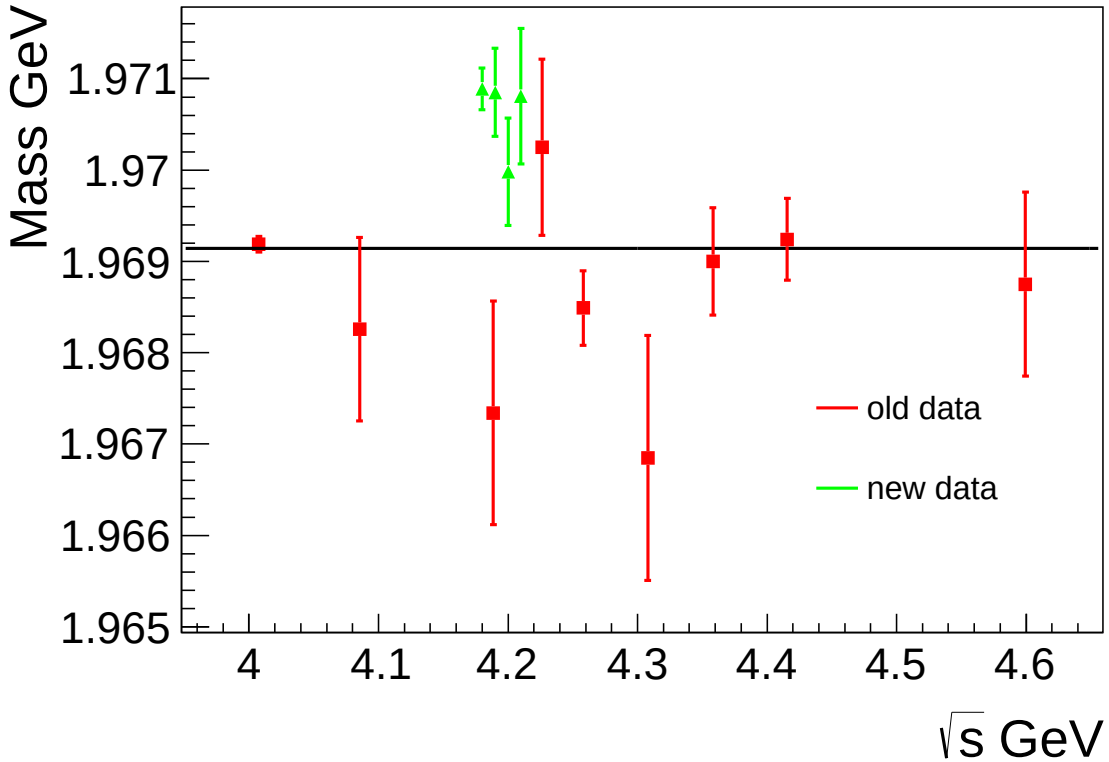
The mass resolution distribution





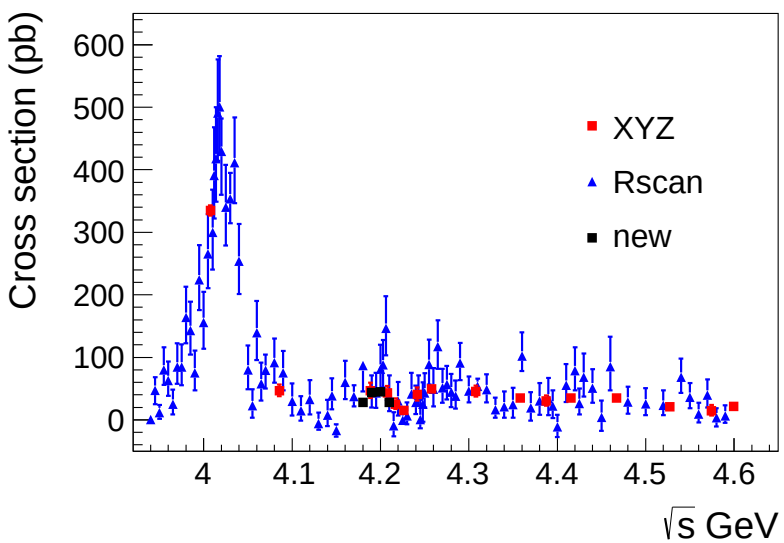
Average resolution for reconstructed D_s:
4.9 ± 0.1 MeV (old data) and 4.7 ± 0.2 MeV (new data)
Difference in resolution for the missing D_s between new and old data: 0.1%.
Almost no difference in mass resolution.

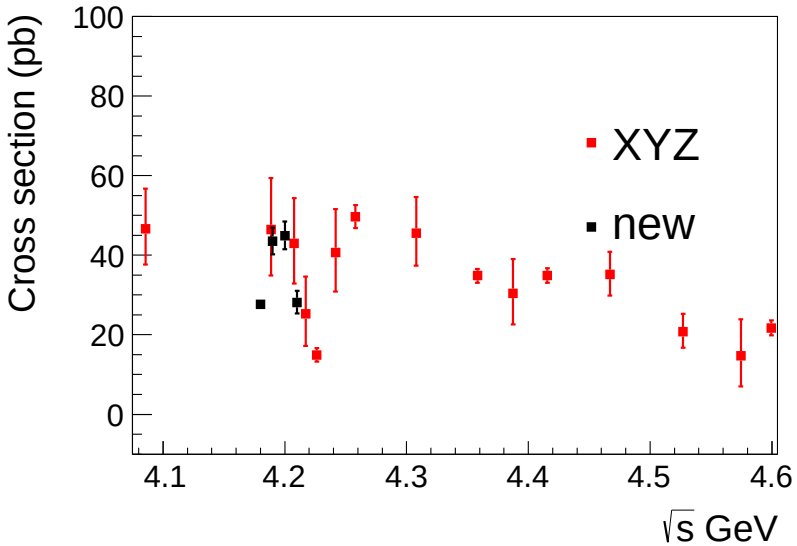
The recoil mass distribution



Sensitive with c.m. energy and ISR correction. The c.m. energy used in analysis: 4180, 4190, 4200 and 4210 MeV. The shifts should be caused by ISR correction.

Born cross section distribution





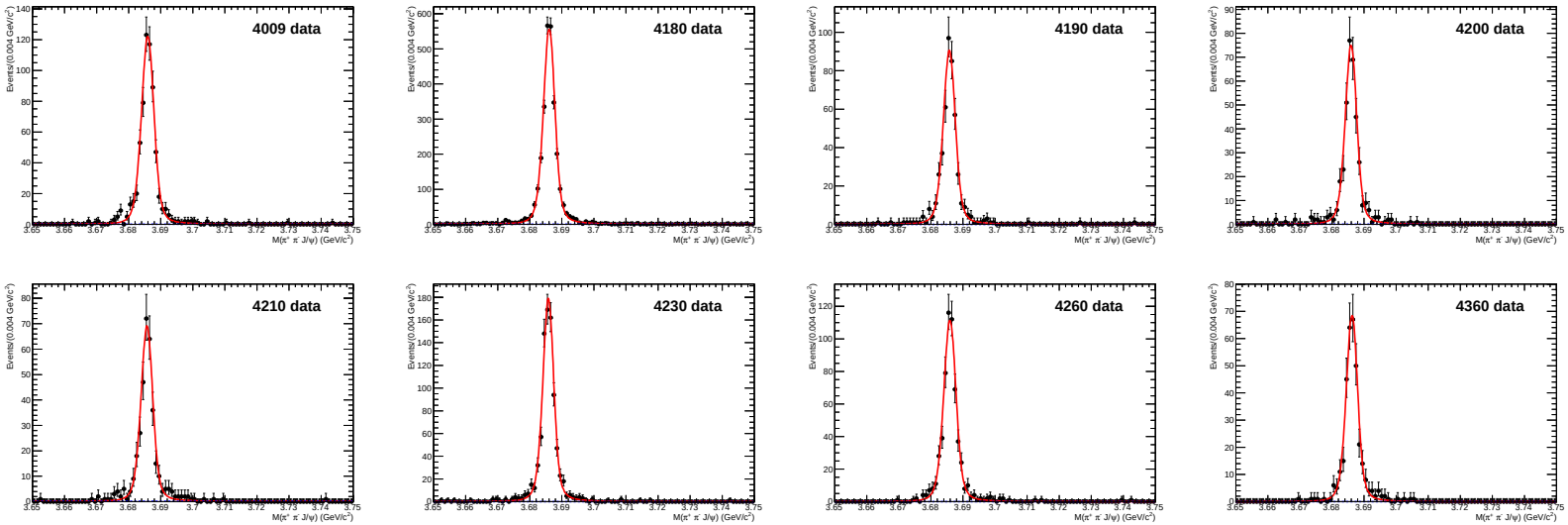
Combine the results from D_s^+ and D_s^-.
Use the interpolation from MC simulations with 10 MeV step to get efficiency and correction factor.

Strange shape around 4.2 GeV, could be caused by interference effect.

$e^+e^- \to \gamma\pi^+\pi^- J/\psi$

1. Four good charged tracks with net charge 0.
2. Use At least one good photon, use the most energic photon.
3. Use momentum to separate lepton (> 1.0 GeV)and pion.
4. Use EMC deposit energy to separate muon (< 0.6 GeV) and electron (> 1.0 GeV).
5. 4C kinematic fit and $\chi^2 < 40$ and $M(\gamma\pi^+\pi^-) > 0.6$ GeV to remove $\eta J/\psi$..
6. J/ψ signal: [3.08, 3.12] GeV
7. sideband regions: [3.00, 3.06] and [3.14, 3.20] GeV

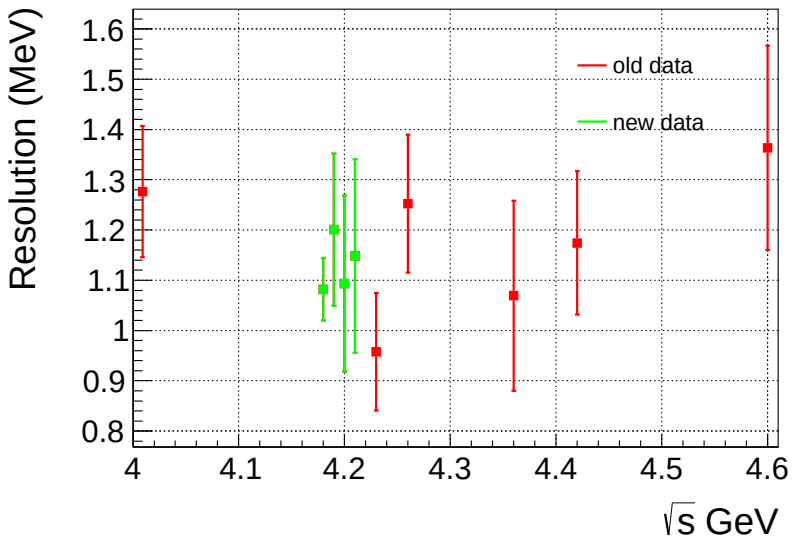
Fit result for $\gamma_{\rm ISR}\psi(3686)$

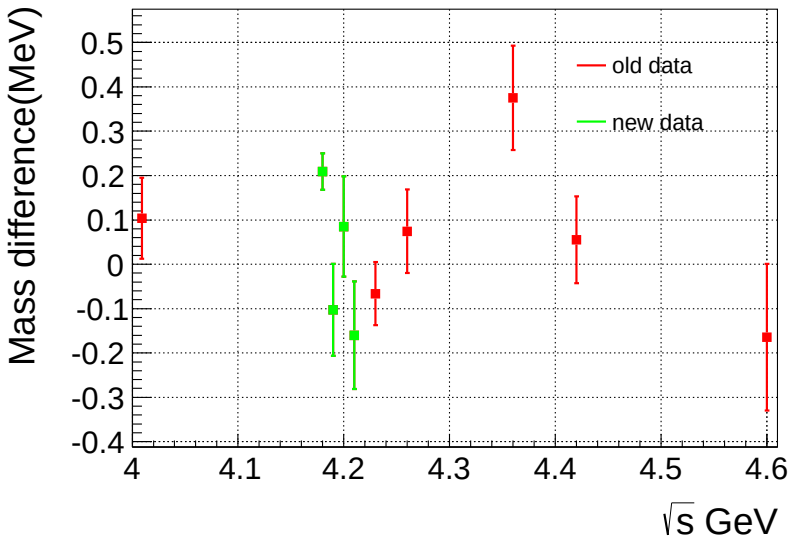


Signal shape: MC determined shape from simulation at 4.26 GeV convolved with a Gaussian.

Background: flat line.

The distributions of difference in resolution and mass



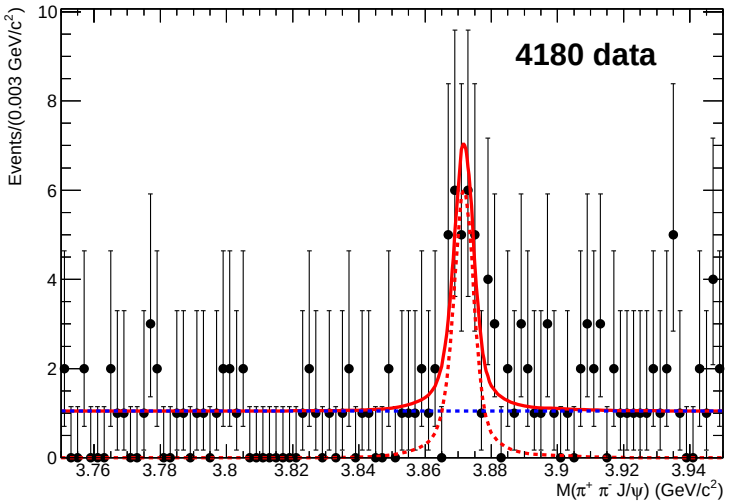


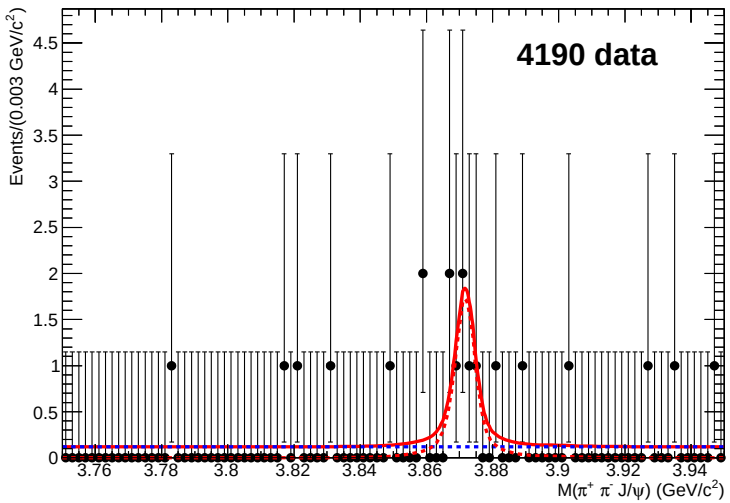
Kinematic fit is performed, so the difference in mass (right) not very useful.

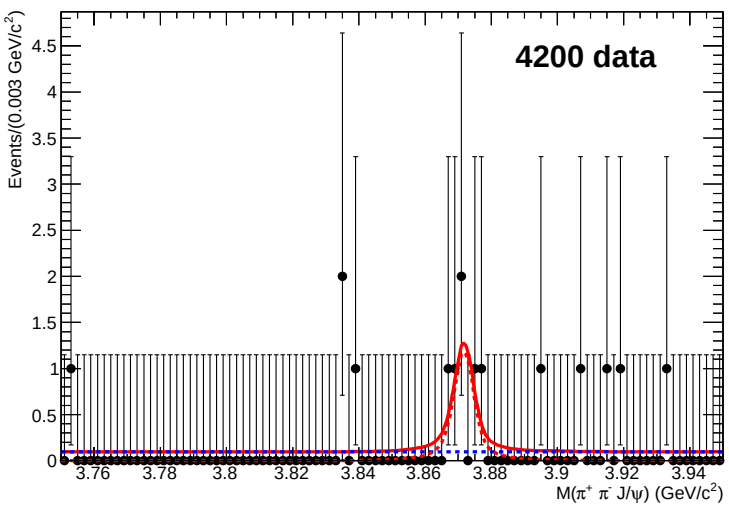
The resolution distribution seems consist.

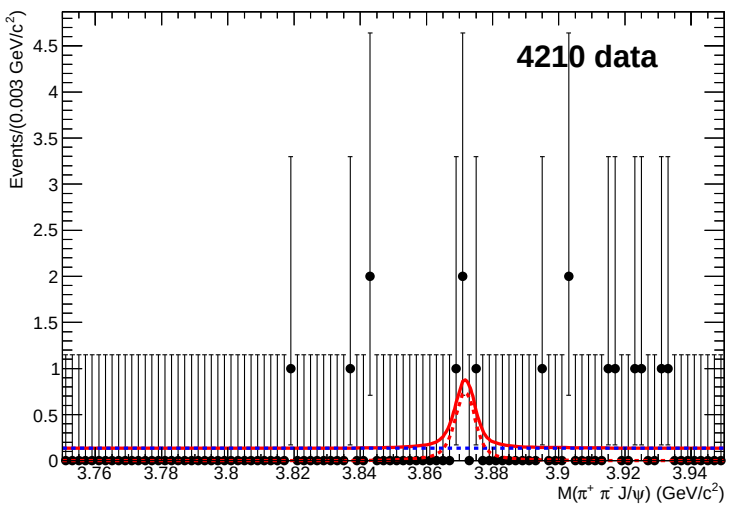
Study of $\gamma X(3872)$

Same procedure with the previous BESIII paper (PRL112,092001).



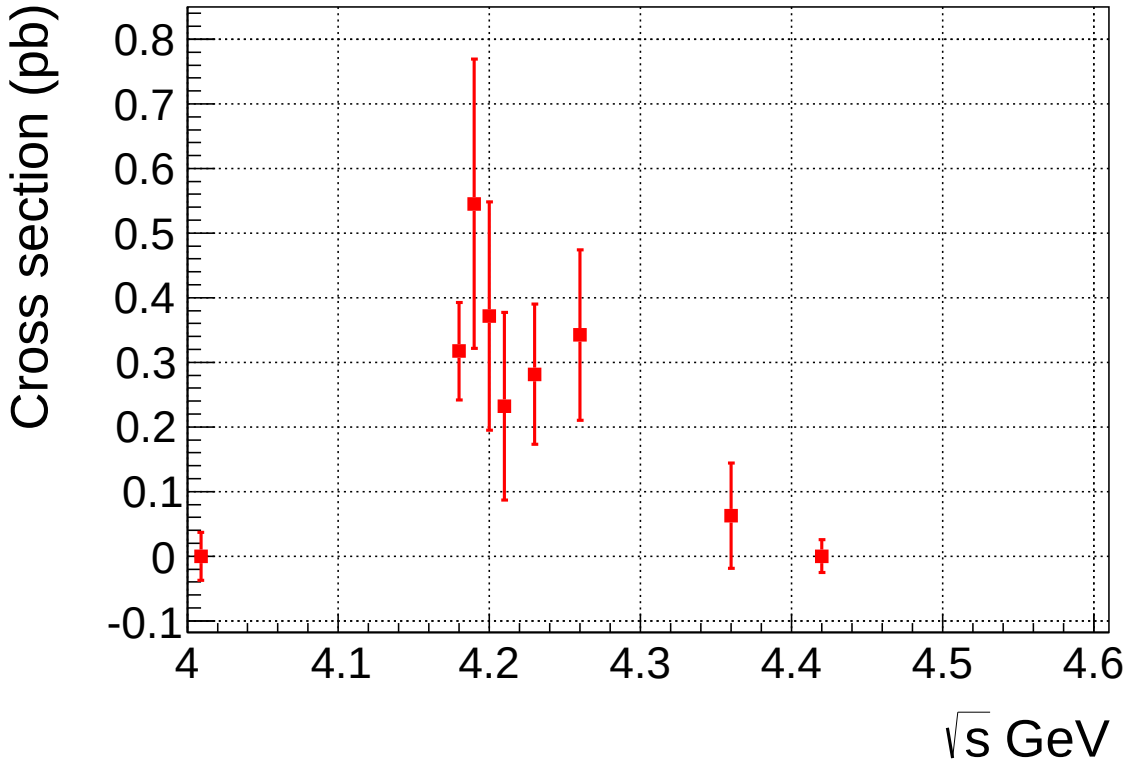






Signal shape: MC determined shape from simulation at 4.18

Cross section of $\gamma X(3872)$



Radiative correction: use the BW form of $Y(4260)$.
Luminosity: 500 pb^{-1} for 4190, 4200 and 4210 data.

Summary

- The mass resolution of the new data consist with old data.
- Strange events in 4200 data only and exist in every run.
- Cross section for $D_s^+ D_s^-$ has strange shape around 4.2 GeV.
- Cross section for $\gamma X(3872)$ around 4.19 GeV seems larger. Need more data to confirm.

Thanks for your attention.