Measurement of inclusive branching fraction for $\psi' \to K_s^0 X$

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Outline

- Introduction
- Measurement of cross sections
- Analysis of cross sections
- Summary

Introduction

- The hadronic decay of ψ' provides us some informations to better understanding of the decay mechanism;
- This study of $\psi' \rightarrow K_s^0 X$ will give an inclusive branching fraction. And to compare with the exclusive branching fraction, it will probably help us to find some unknown final states of ψ' that contains K_s^0 mesons;
- In this analysis, we measured the inclusive branching fraction by analyzing the observed cross sections of $e^+e^- \rightarrow K_s^0 X$;

Data sets and MC samples

- **Boss Version:** 6.6.4.p01
- **Data Sample:** The data sets is taken from 3.640GeV to 3.705GeV in 2010;
- **The Monte Carlo are generated separately by KKMC + BesEvtGen**;

The components of $e^+e^- \rightarrow K_s^0X$ in the energy range 3.640 to 3.705GeV:

- Continuum Process;
- J/ψ Decay;
- ψ' Decay;

Event Selection

- **Good charged track:**
  - At least three good charged track;
  - $|R_{xy}| < 10.0$cm and $|R_z| < 20.0$cm;(**For π from K_s^0**)
  - $|R_{xy}| < 1.0$cm and $|R_z| < 10.0$cm; (**For particle not from K_s^0**)
  - $|\cos\theta| < 0.93$;

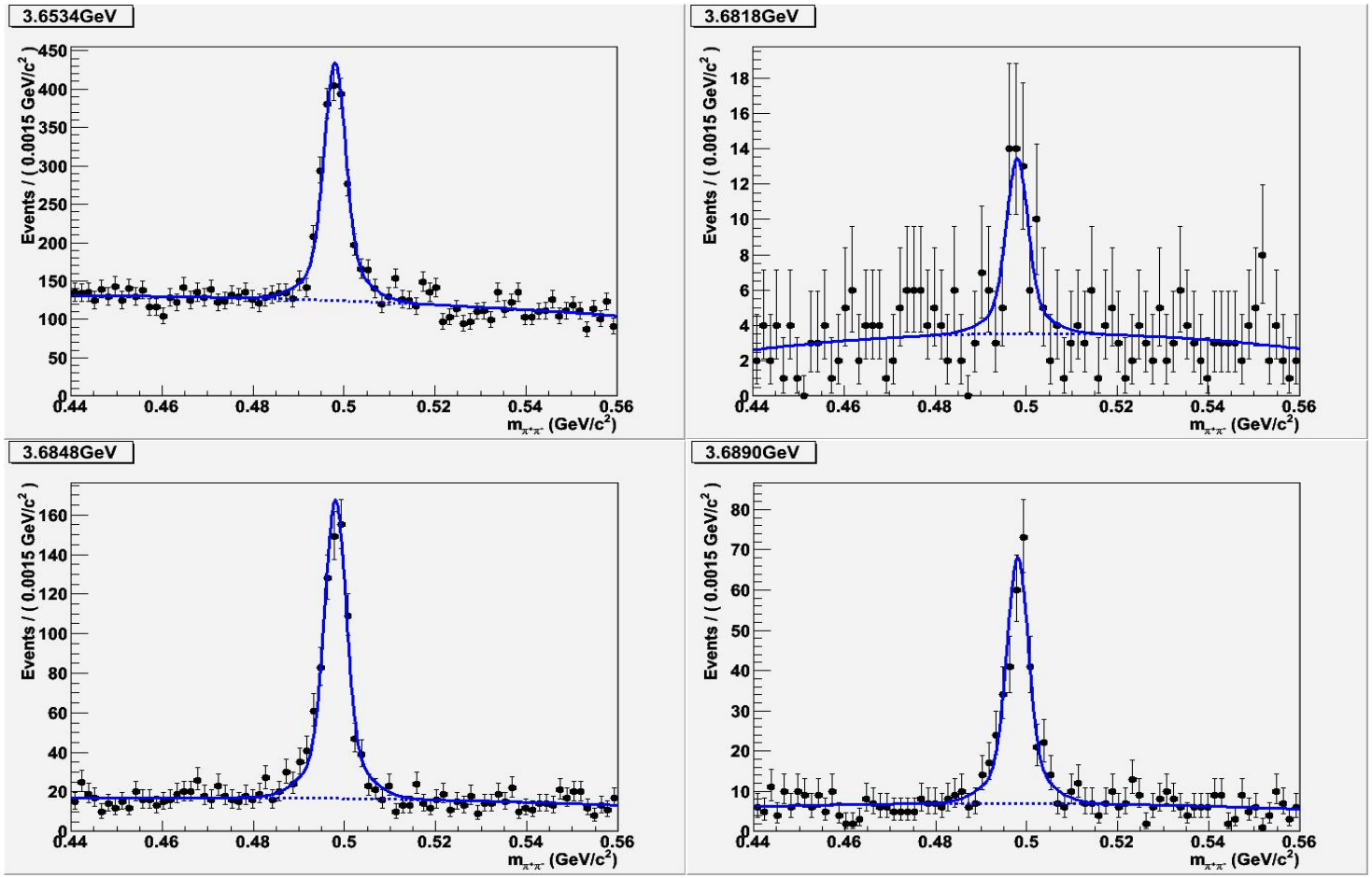
- **K_s^0 reconstruction:**
  - Vertex fit;
  - If more than one combinations, we retain the longest decay length (L_{max}) of K_s^0 and require $L_{max} > 0.4$cm;

$M_{\pi^+\pi^-}$ spectrum

- **Invariant mass spectra of $\pi^+\pi^-$:**

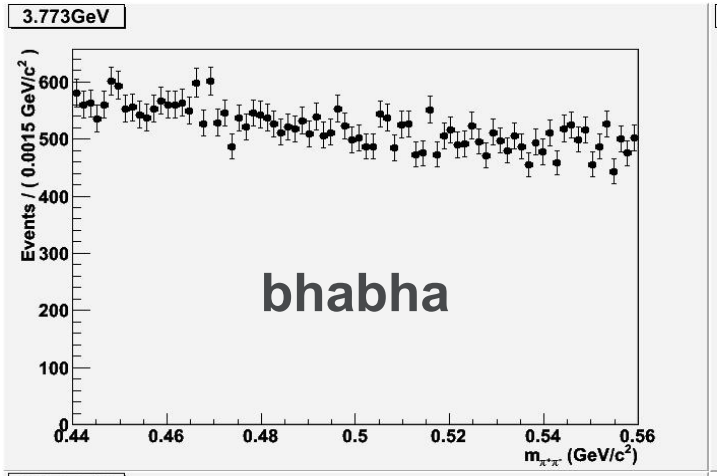
Signal: Double Gaussian

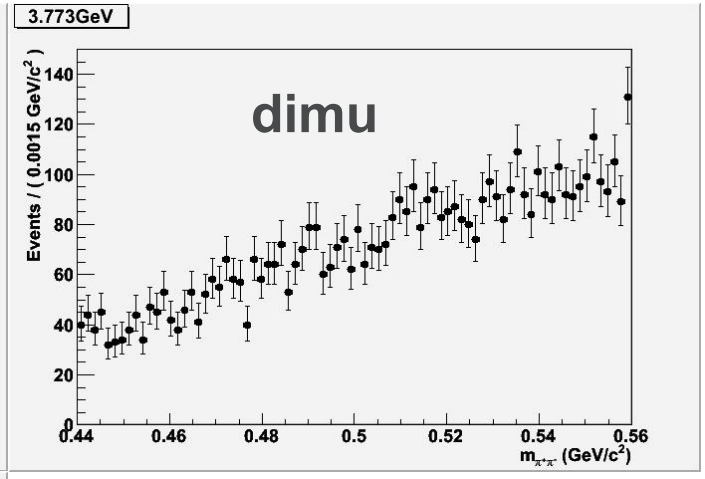
Background: Second-order Chebychev polynomial

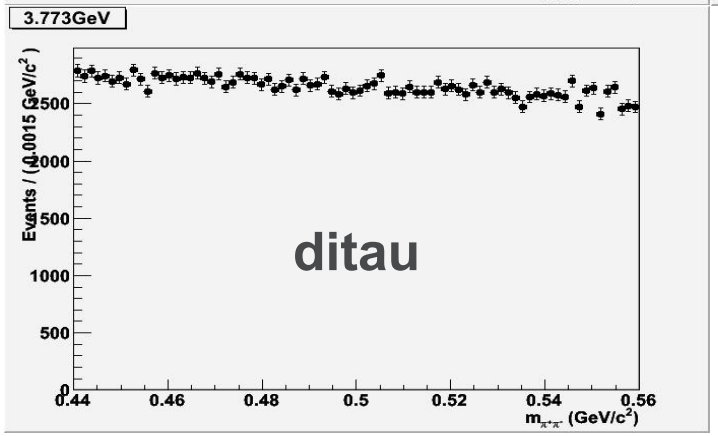


Background Analysis

- To analyze the QED background, we checked the invariant mass spectra of $\pi^+\pi^-$ from bhabha, dimu and ditau MC at E_{cm} = 3.773GeV;



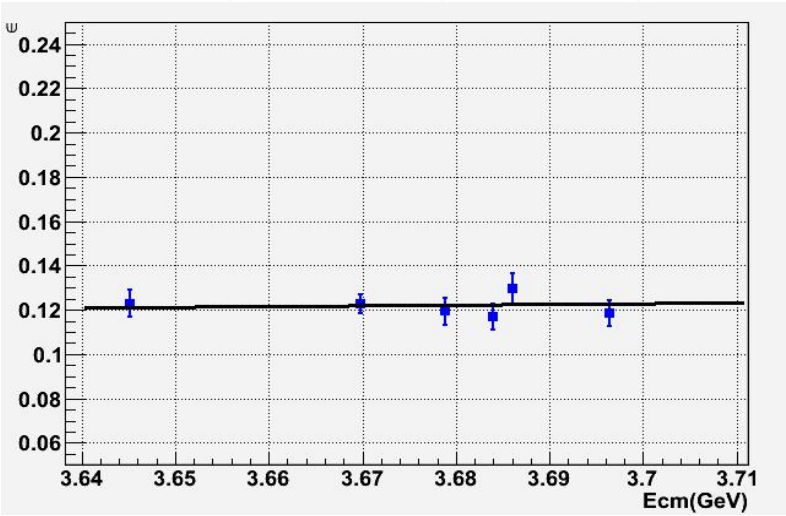




There is no peaking background

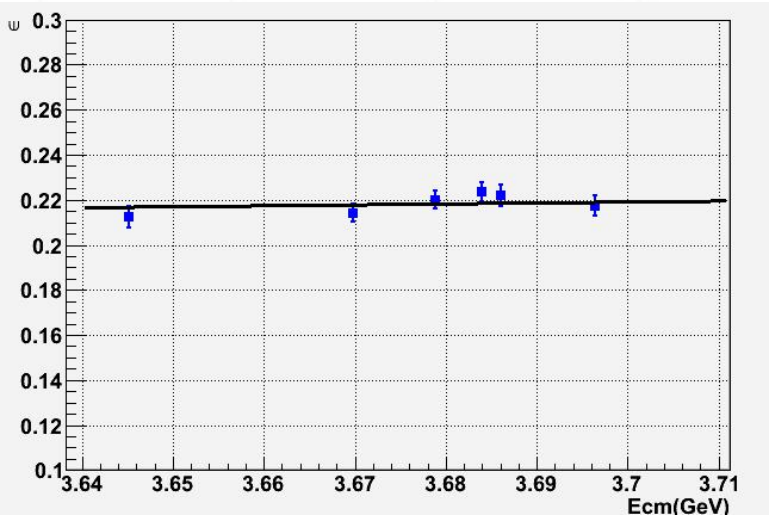
Efficiency

- Continuum process:



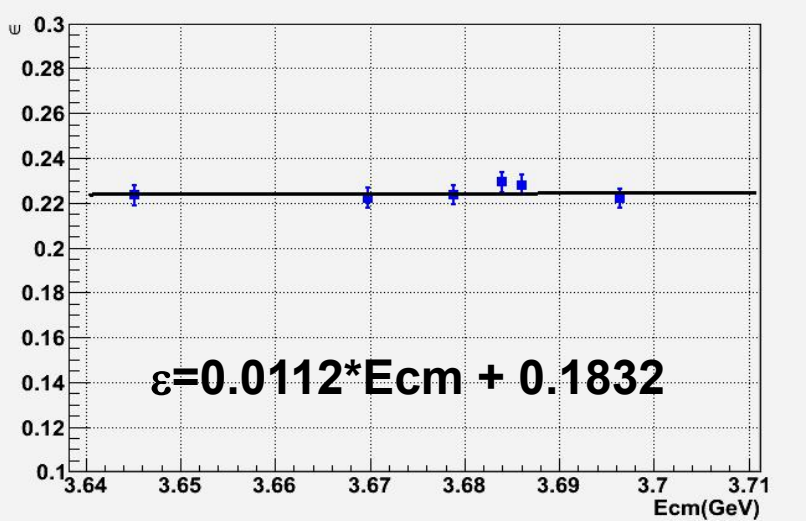
ε=0.0323*Ecm + 0.0035

- ψ' decay:



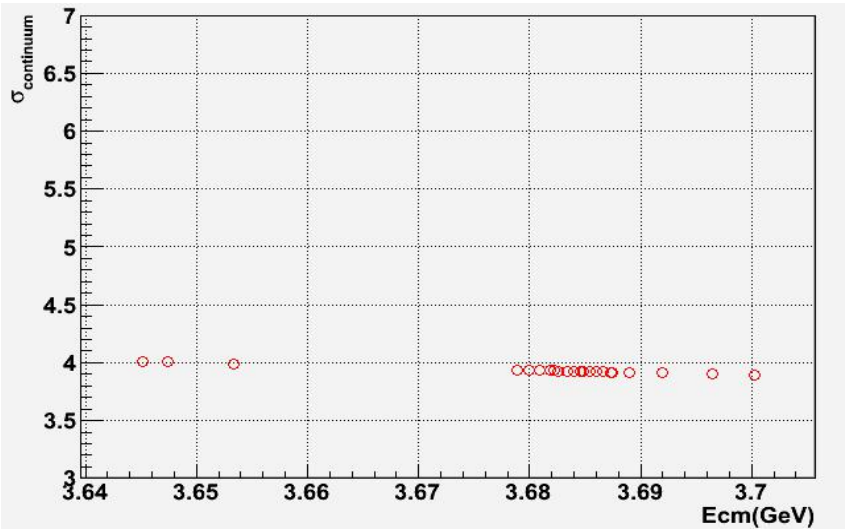
ε=0.0421*Ecm + 0.0633

- J/ψ decay:

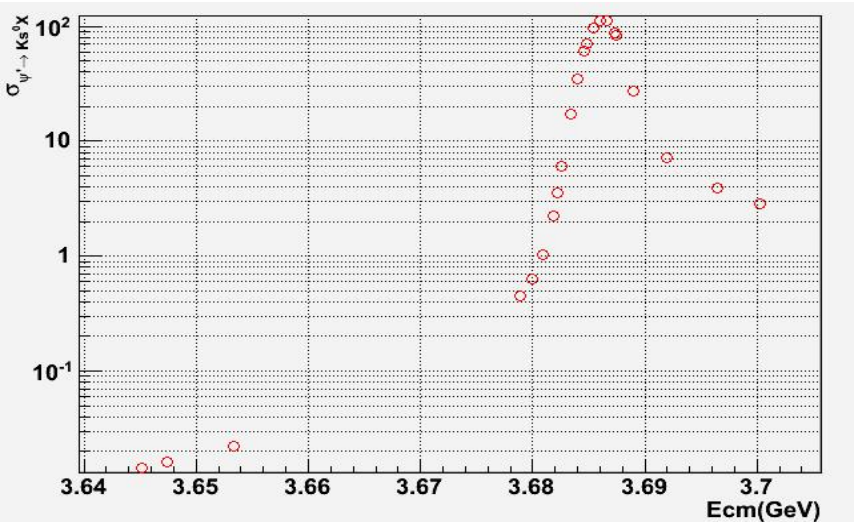


ISR cross section

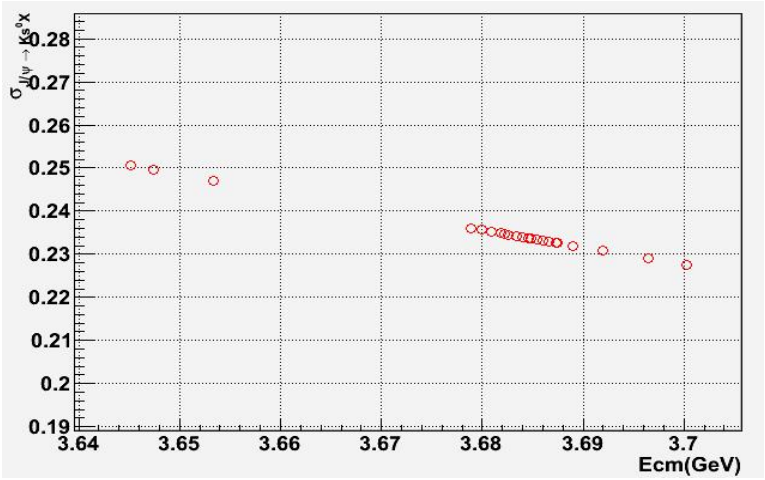
- Here shows the ISR cross sections of each process:
  - Continuum:



  - ψ' decay:



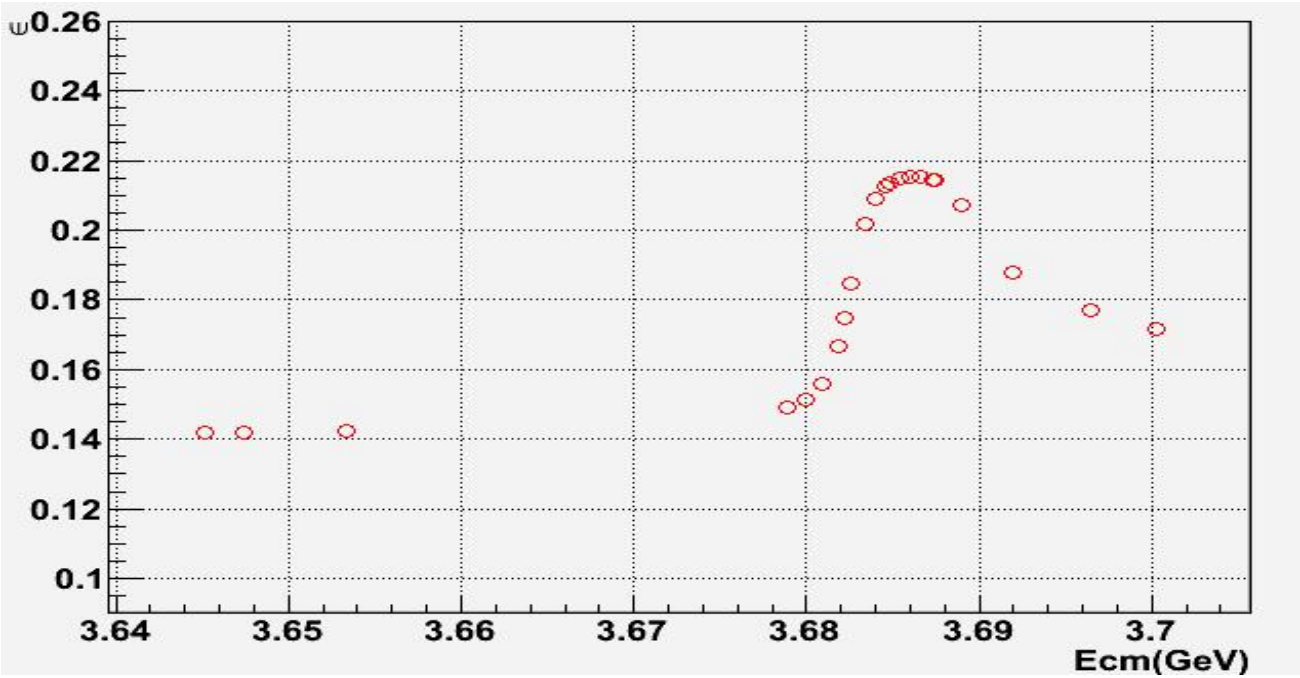
  - J/ψ decay:



Total Efficiency

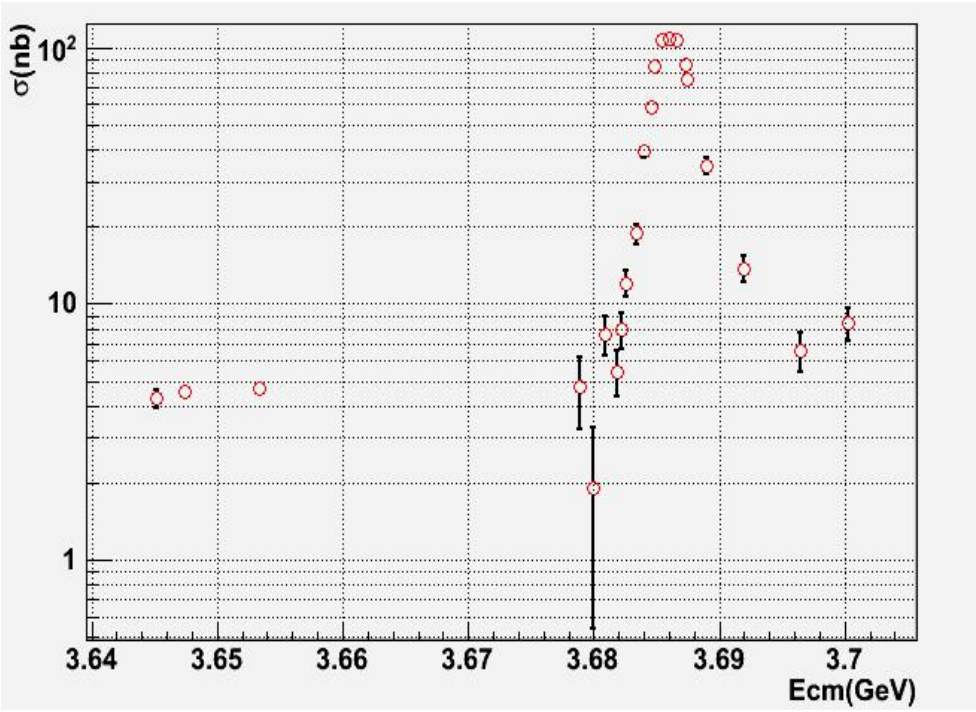
- With these expected reconstruction efficiencies and the ISR cross sections, we obtained the total efficiencies for selection of $e^+e^- \rightarrow K_s^0X$:

$$\varepsilon_{tot} = \frac{1}{\sigma_{con} + \sigma_{J/\psi} + \sigma_{\psi'}} (\sigma_{con}\varepsilon_{con} + \sigma_{J/\psi}\varepsilon_{J/\psi} + \sigma_{\psi'}\varepsilon_{\psi'})$$



Observed cross sections

- According to the formula below, we obtained the observed cross sections for $e^+e^- \rightarrow K_s^0X$:



$$\sigma^{obs}_{e^+e^-\rightarrow K_s^0X} = \frac{N^{obs}_{e^+e^-\rightarrow K_s^0X}(E_{cm,i})}{L(E_{cm,i})\times\varepsilon_{e^+e^-\rightarrow K_s^0X}(E_{cm,i})}$$

Nobs:Number of signal events;

L: The integrated luminosities;

ε: The detection efficiencies;

Expected cross sections

- The expected cross section for K_s^0X production can be written as:

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$$\sigma^{\exp}_{K_s^0 X}(s) = \int_0^{\infty} ds' G(s,s') \int_0^1 dx \cdot \sigma^{Drss}_{K_s^0 X}(s(1-x)) \underline{F(x,s)}$$

Sampling function

$$\sigma^{Drss}_{K_s^0 X}(s(1-x)) = \underline{|A_{\psi(3686)}|^2 + |A_{J/\psi}|^2} + |A_{continuum}|^2$$

To be descripted by Breit-Wigner function

$$A_{continuum} = \sqrt{\frac{f}{E^n_{cm}}}$$

$$G(s,s') = \frac{1}{\sqrt{2\pi}\Delta} e^{-\frac{(\sqrt{s}-\sqrt{s'})^2}{2\Delta^2}}$$

To describe the BEPCII c.m.energy distribution

χ^2 fit

- We made a χ^2 fit to these observed cross sections:

$$\chi^2 = \sum_{i=1}^{N} \left(\frac{\sigma^{obs}_{K^0_s X}(E_{cm,i}) - \sigma^{\exp}_{K^0_s X}(E_{cm,i})}{\Delta_{\sigma^{obs}_{K^0_s X}(E_{cm,i})}} \right)$$

$\sigma^{obs}_{K^0_s X}(E_{cm,i})$ ----- The measured value of the observed cross section;

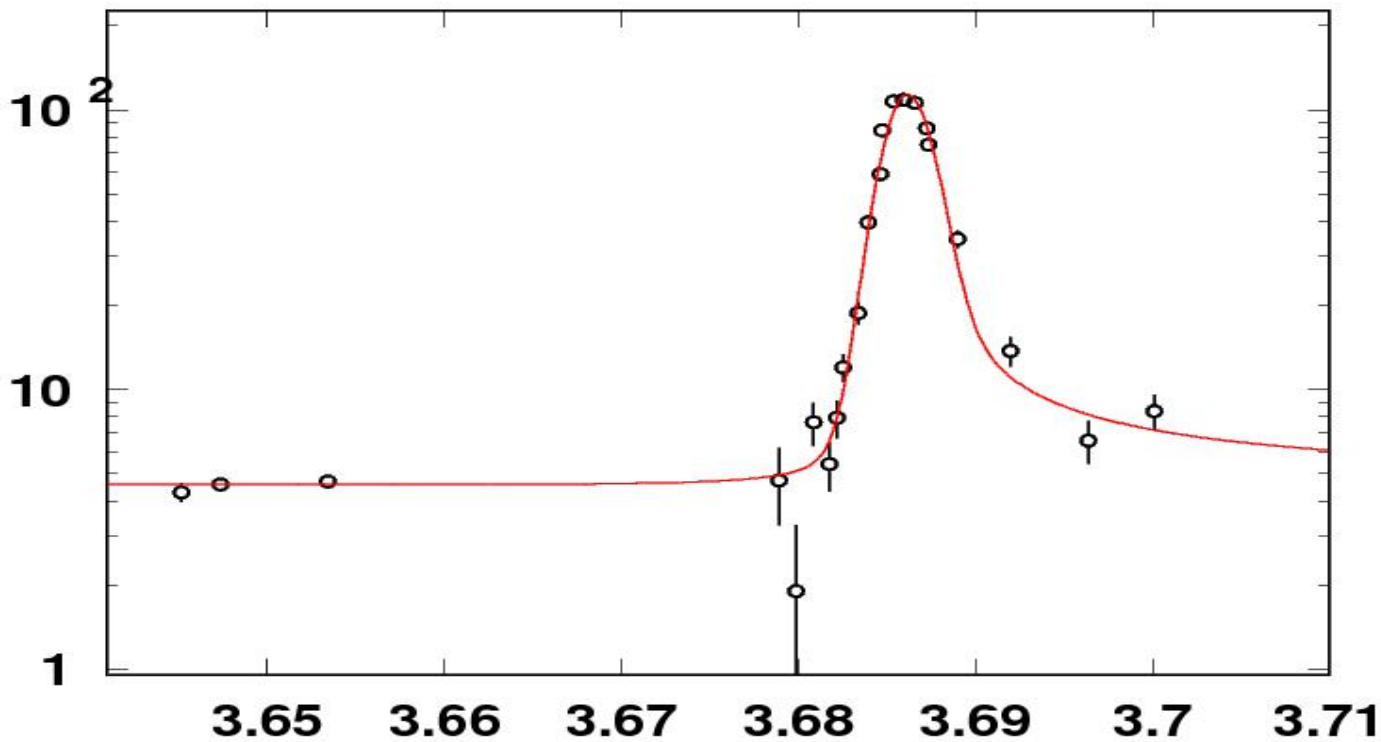
$\sigma^{\exp}_{K^0_s X}(E_{cm,i})$ ----- The theoretically expected cross section;

$\Delta_{\sigma^{obs}_{K^0_s X}(E_{cm,i})}$ ----- The point-to-point errors at the i.th c.m energy;

N ----- Number of the data sets collected at different energy points;

Fit Result

- To fit with these observed cross sections, we can get the branching fraction for $\psi' \rightarrow K_s^0 X$:



$$Br(\psi' \rightarrow K_s^0 X) = (16.16 \pm 0.30 \pm \Delta_{sys})\%$$

Summary

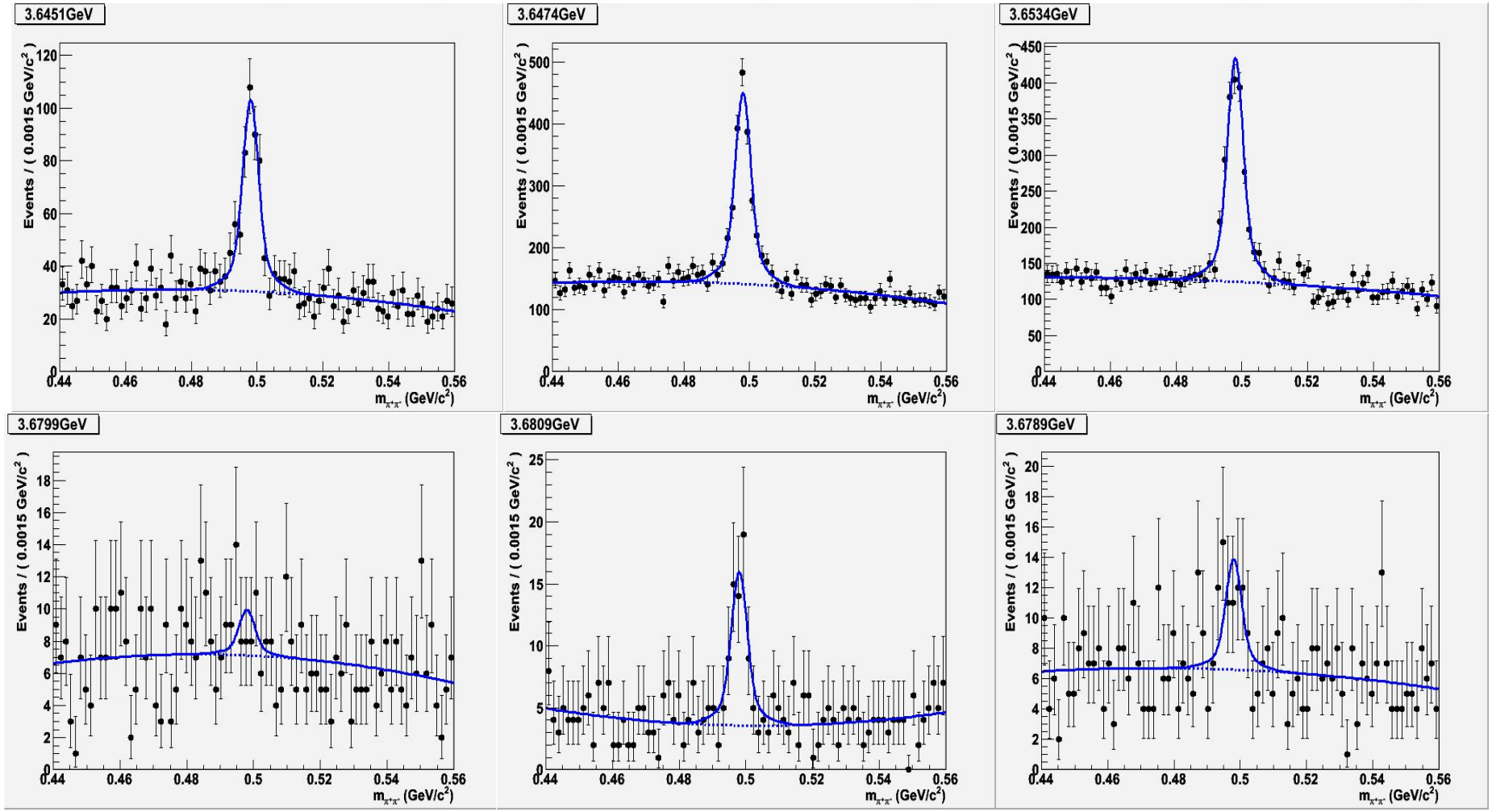
- We measured the observed cross sections for $e^+e^- \rightarrow K_s^0X$ in the energy region 3.64 to 3.705GeV;
- By analyzing these cross sections, we obtianed the inclusive branching fraction for $\psi' \rightarrow K_s^0X$, and the result gives:

$$Br[\psi(3686) \rightarrow K_s^0X] = (16.16 \pm 0.30 \pm \triangle_{sys})\%$$

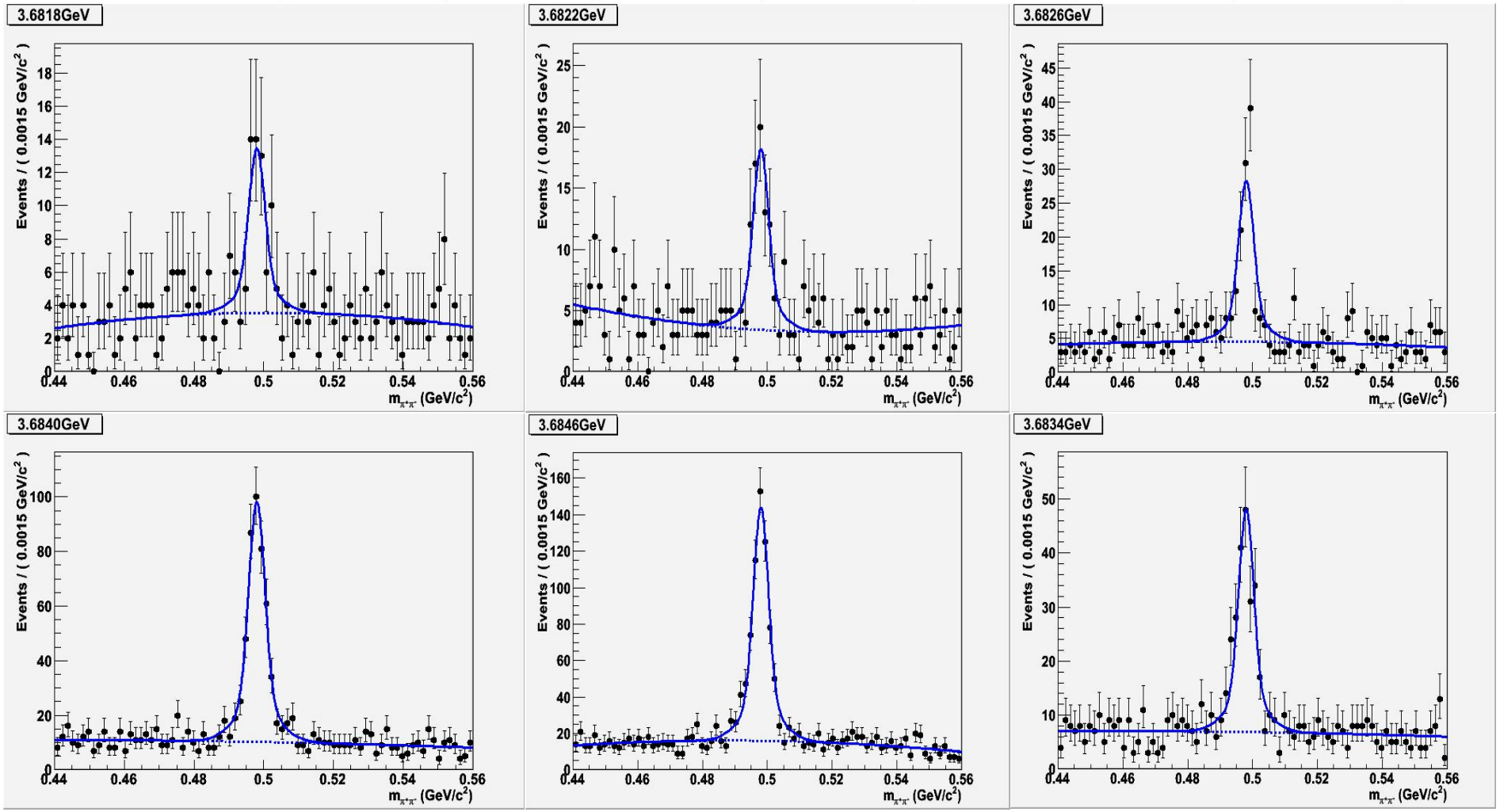
Thank You!

Back up

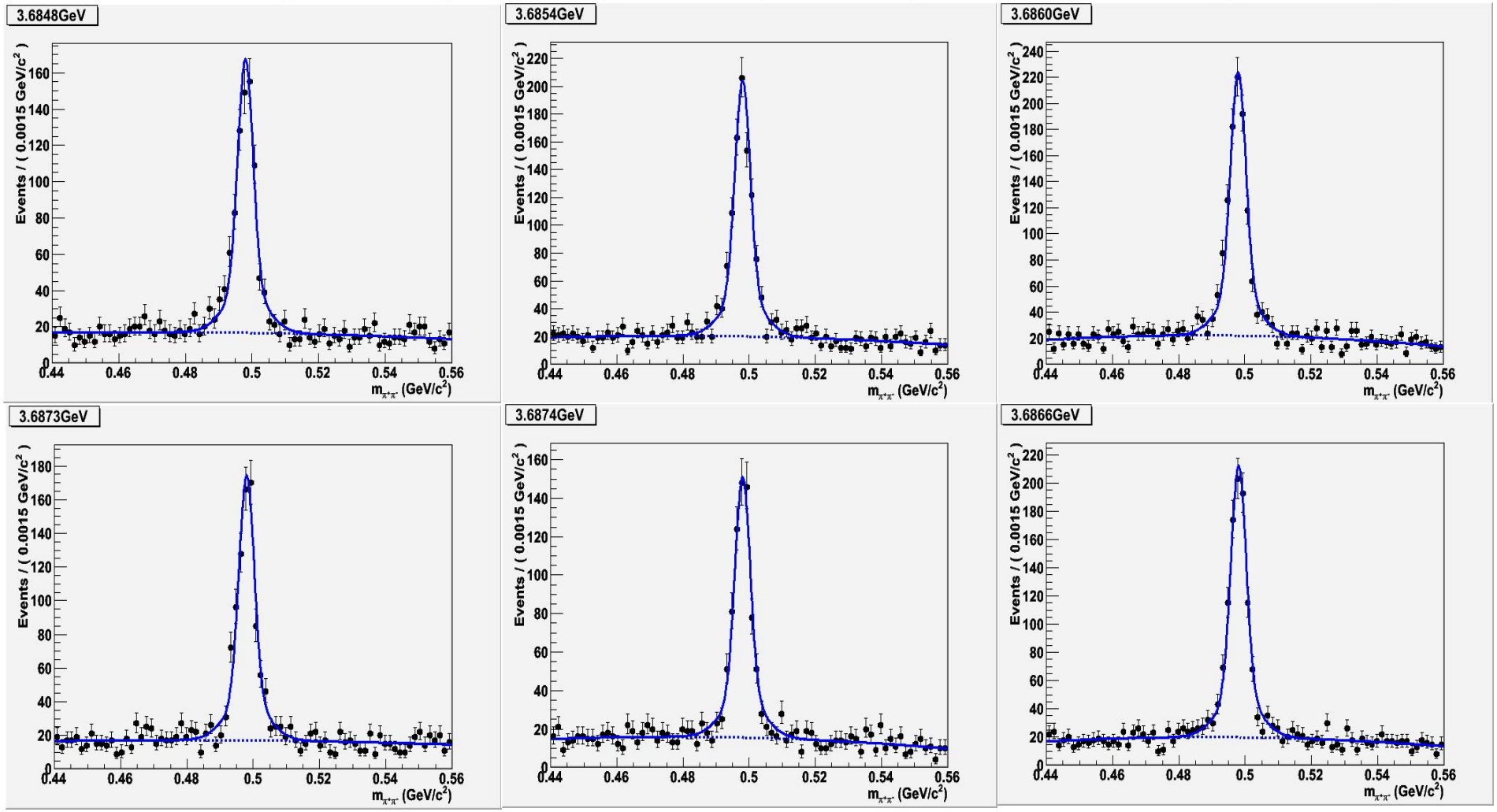
Invariant mass spectra of $\pi^+\pi^-$



Invariant mass spectra of $\pi^+\pi^-$



Invariant mass spectra of $\pi^+\pi^-$



Invariant mass spectra of $\pi^+\pi^-$