بسم الله الرحمن الرحيم

إبراهيم ١٤٢١

STUDY OF J/Ψ DECAYS INTO $\pi^0 X$

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INTRODUCTION

Three light flavored two body decays of J/ψ have been discussed

1. $$J/\psi \rightarrow \pi^0 \rho$$

2. $$J/\psi \rightarrow \pi^0 k_s^0$$

3. $$J/\psi \rightarrow \pi^0 f_0$$

MOTIVATION

To explore about

$$J/\psi \rightarrow \pi^0 \rho$$

1. Leads towards $\rho\pi$ $puzzle$

2. Strangeness violating decay of $J/\psi \rightarrow \pi^0 k_s^0$

3. Iso-spin violation of $J/\psi \rightarrow \pi^0 f_0$

STUDY OF $J/\psi \rightarrow \pi^0 X$

$\pi^+\pi^-$

$\gamma\gamma$

EVENTS SELECTION

- Charged tracks

  2 good charge tracks with ngood=2 and $|\cos\theta|<0.93$.

  - $\Sigma Q_i=0$

- PID $\chi^2(i) = \chi^2_{TOF}(i) + \chi^2_{\frac{dE}{dx}}(i)$

DE/DX and TOF information are combined to identify particles.

- Pxy > 50MeV
- Kinematic fit

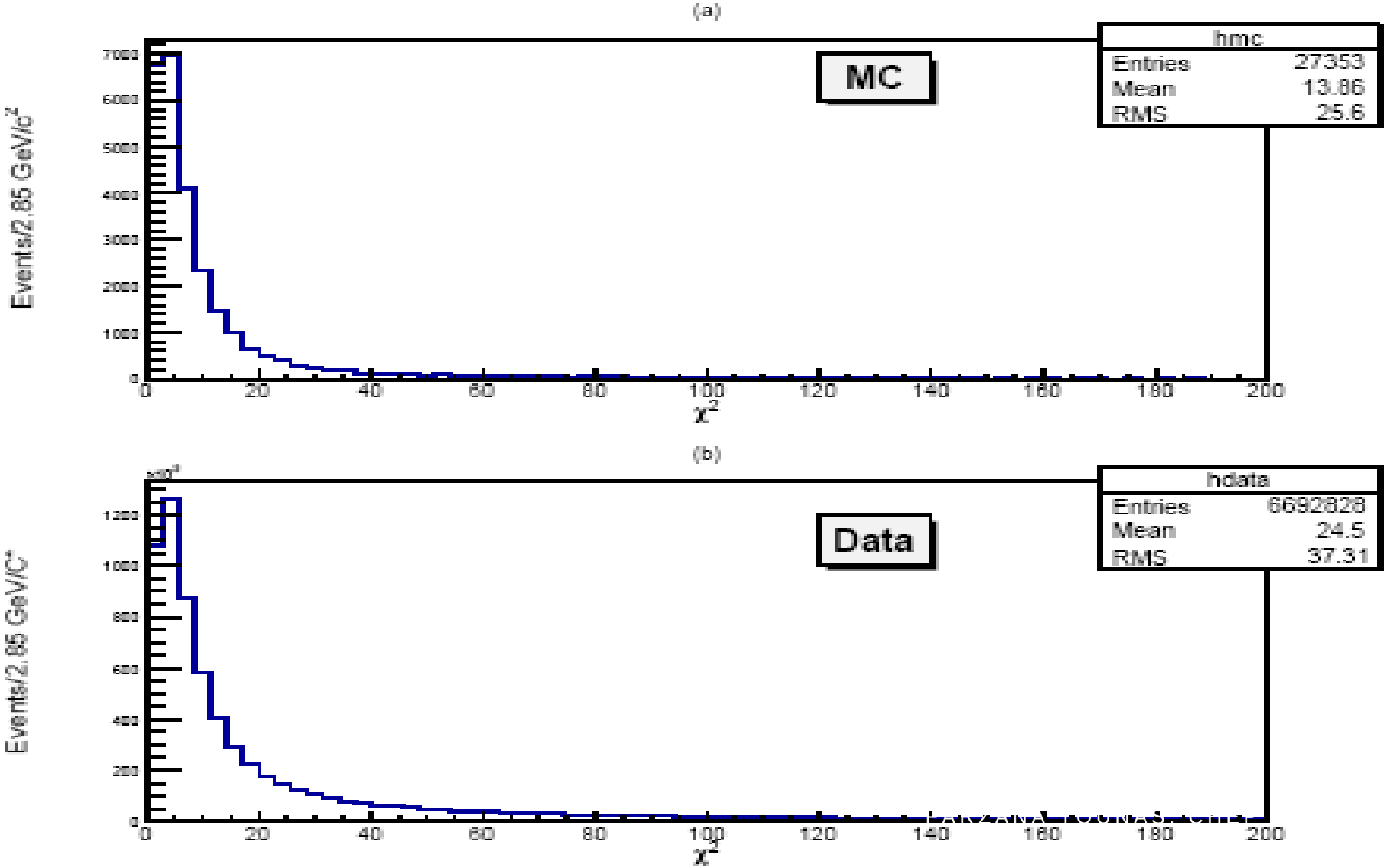
  $\chi^2_{4c}(\pi^+ \pi^- \gamma\gamma) < 40$

ANALYSIS OF $J/\psi \rightarrow \pi^0 \rho$

$\pi^+\pi^-$

$\gamma\gamma$

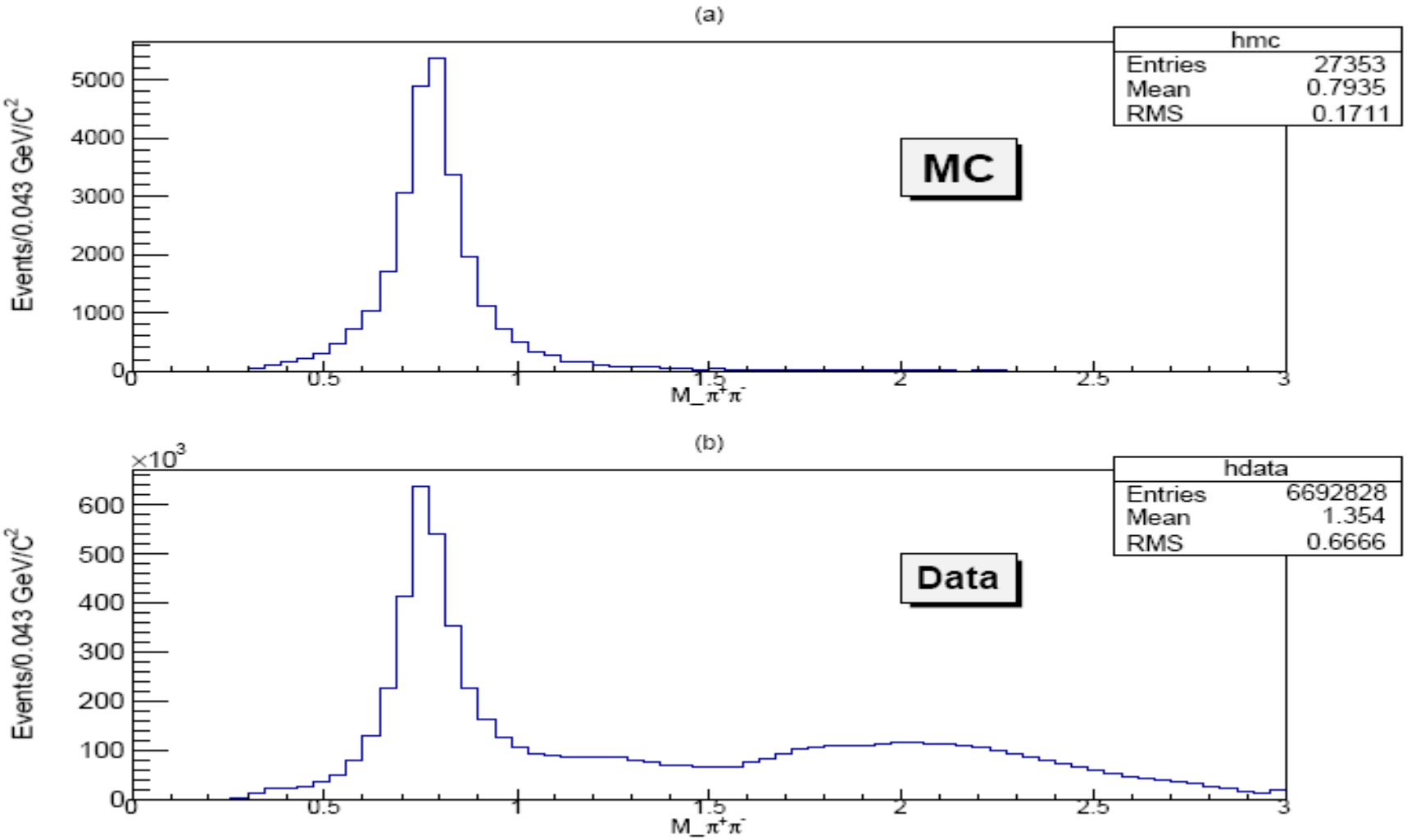
χ^2_{4C} DISTRIBUTION



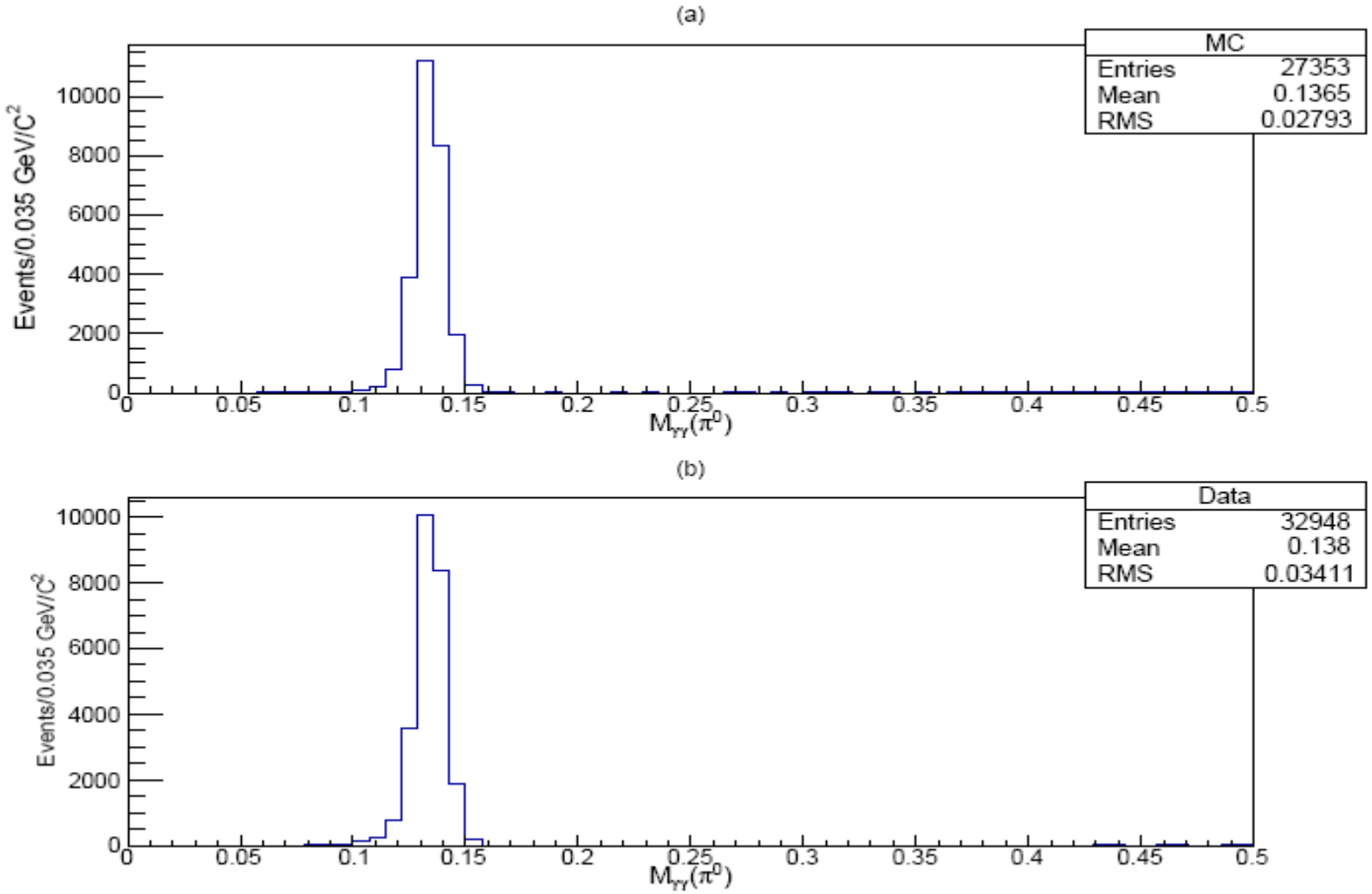
SELECTION OF ρ^0 AND π^0

- To find π^0 and ρ^0 at the same time for all possible $\pi^0\rho^0$ combinations that can pass fitting.

INVARIANT MASS $M(\pi^+ \pi^-)$



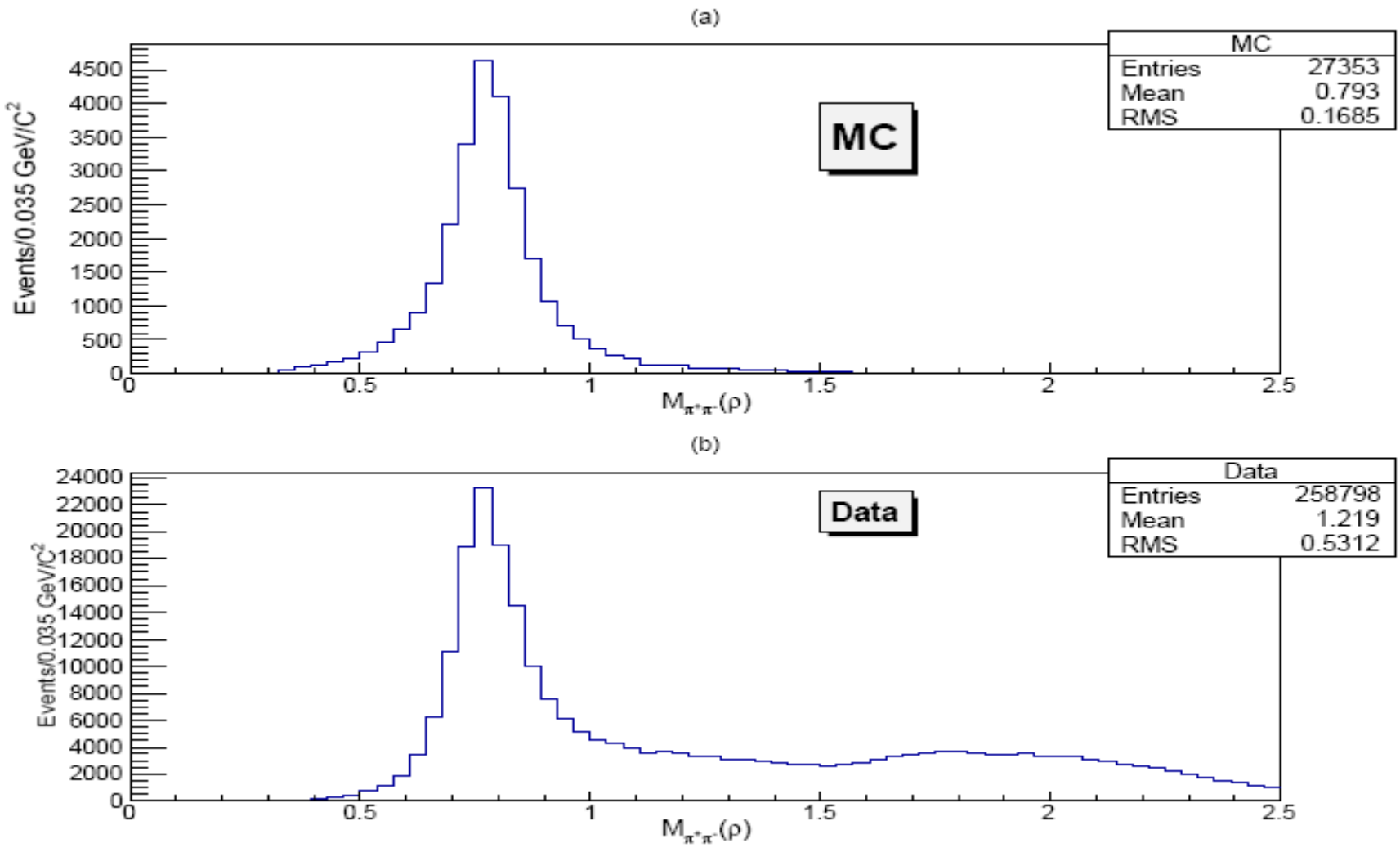
INVARIANT MASS OF $\gamma\gamma(\pi^0)$



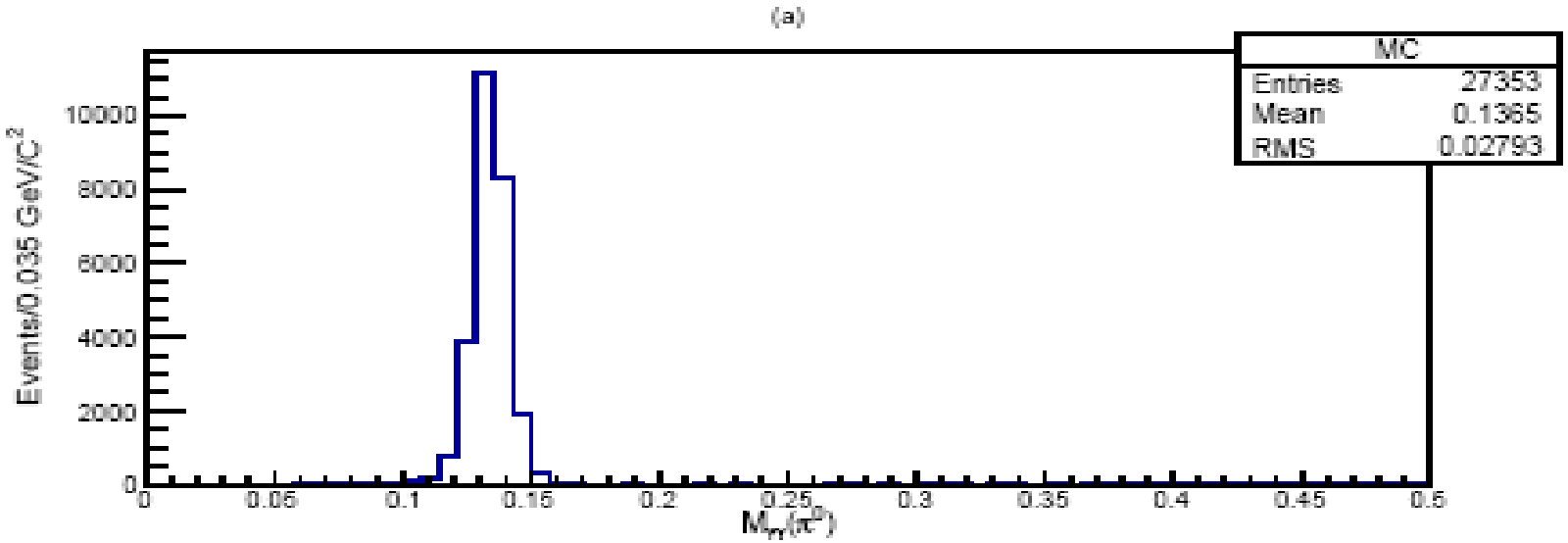
FINAL EVENT SELECTION CRITERIA

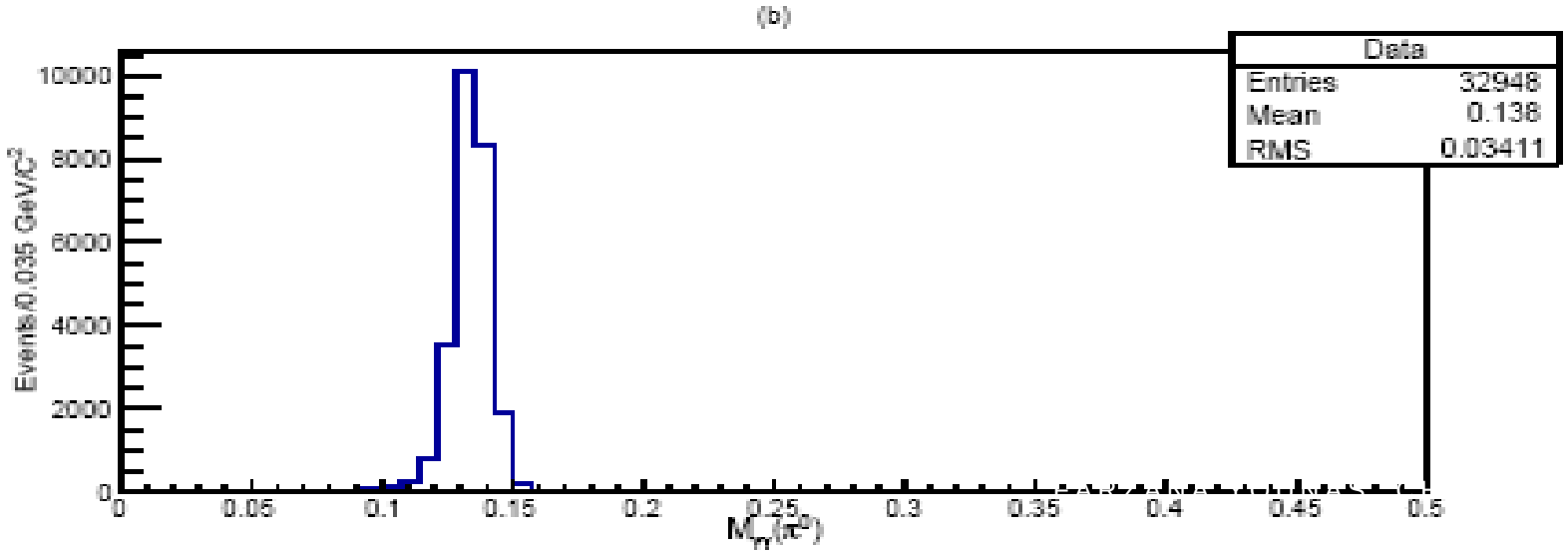
- $\chi^2 < 40$
- $R_{xy} < 4$
- $n\gamma == 2$
- $DLRatio > \pi^+\pi^-(\rho) > 2$
- $|M_{\pi^0} - 0.139| < 0.02$

INVARIANT MASSES OF $\pi^+ \pi^-$(MC & DATA) AFTER FINAL SELECTION CRITERIA



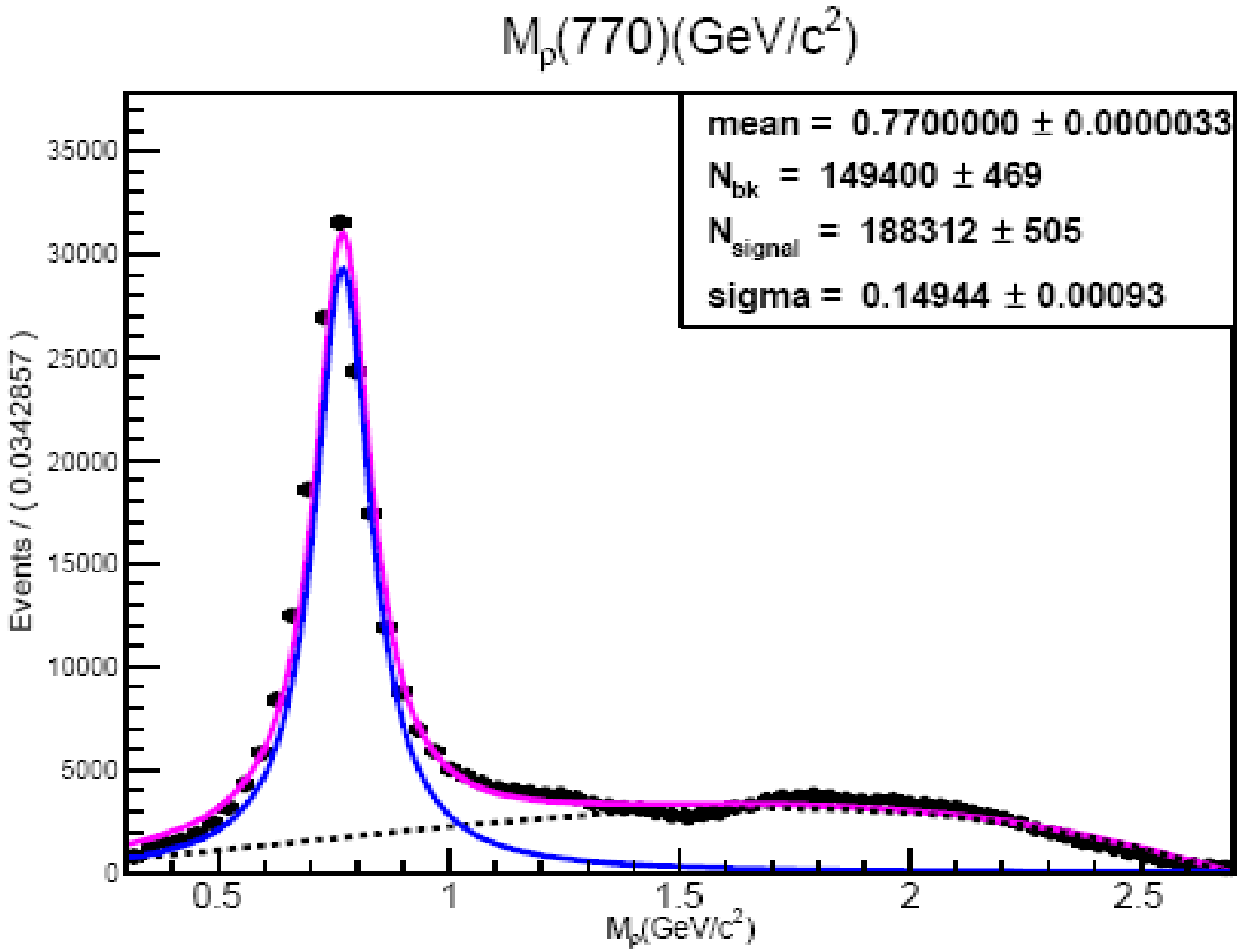
RESULTS FOR INVARIANT MASS M$\gamma\gamma$ (π^0)AFTER FINAL EVENT SELECTION





FIT RESULTS OF INVARIANT MASS

$M_{\pi^+\pi^-} \rightarrow \rho$



DETECTION EFFICIENCY

We generated 3 X 10^5 MC events, after final selection and background suppression the detection efficiency is,

$$\text{Detection efficiency} = \frac{27353}{100000} \times 100$$

$$\varepsilon = 27.357\%$$

BRANCHING FRACTION OF $J/\psi \rightarrow \pi^0 \rho$

$$B(J/\psi \rightarrow \pi^\circ X) = \frac{N_{obs}^{UL}}{N_{J/\psi} . B(\rho \rightarrow \pi^+ \pi^-) . B(\pi^0 \rightarrow \gamma\gamma) . \varepsilon}$$

$$B(J/\psi \rightarrow \rho\pi^0) = 2.8 \pm 0.06 \times 10^{-4}$$

SYSTEMATIC ERRORS

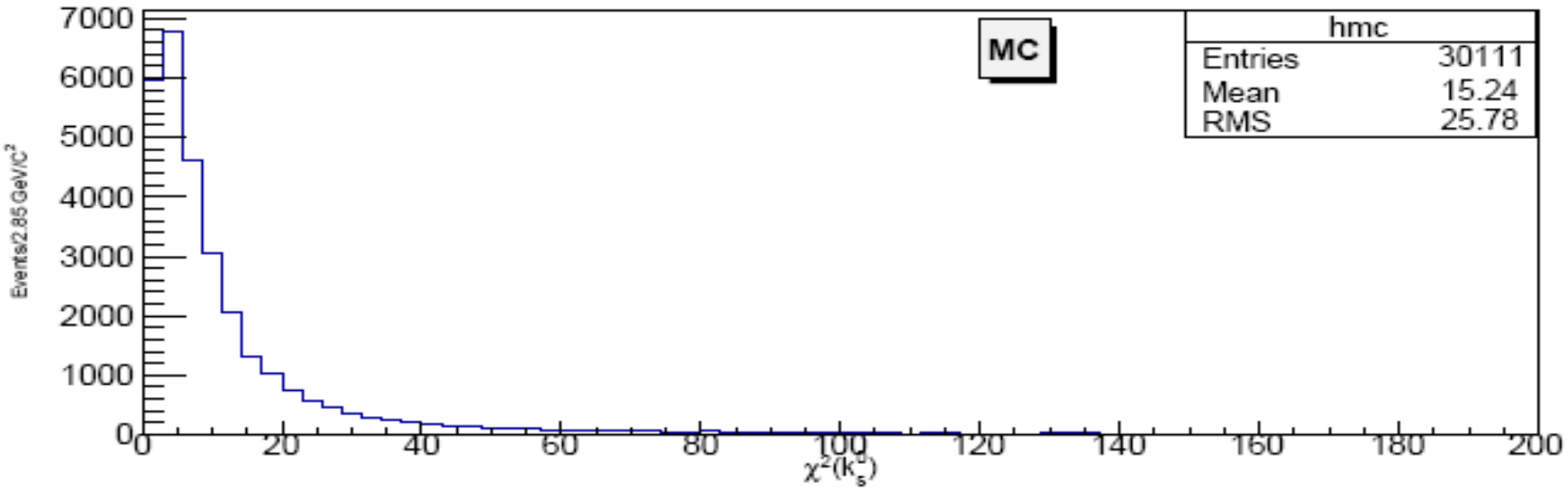
Sources	$J/\psi \rightarrow \rho\pi^0$
MDC Track	4.0
γ Detection	2.0
Pid	2.0
MC Model	0.36
π^0Selection	0.6
J/$\boldsymbol{\psi}$ Number	4.72
Total Error	6.83

STUDY OF $J/\psi \rightarrow \pi^0 k_s^0$

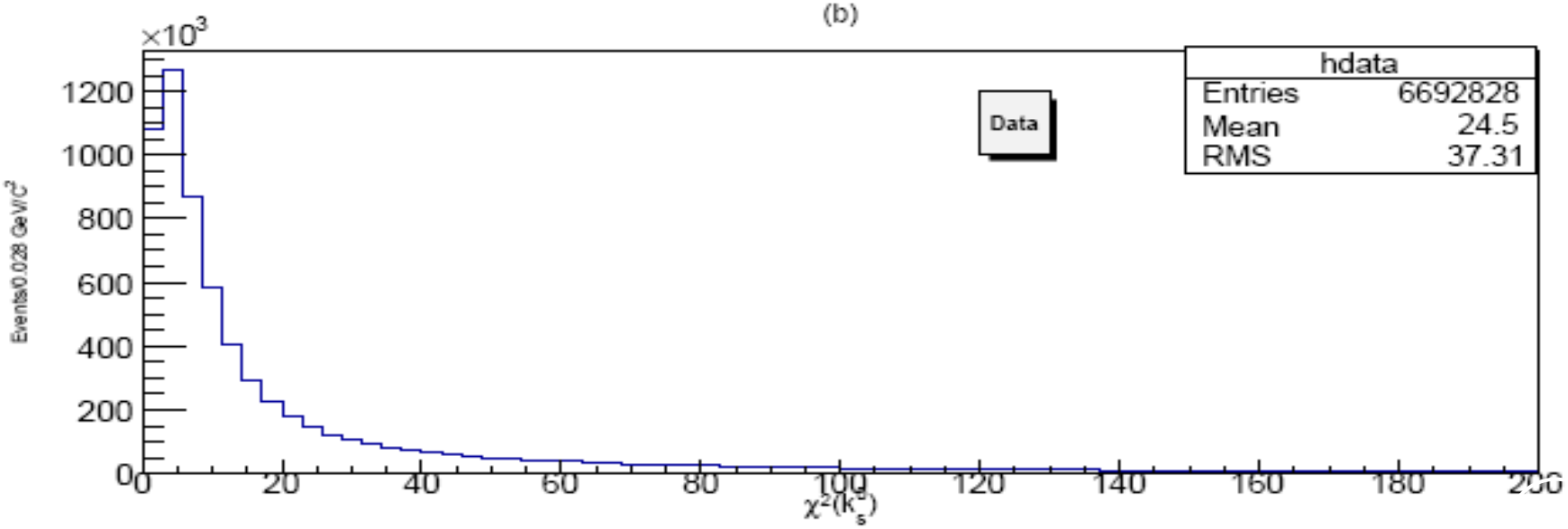
$\pi^0 \rightarrow \gamma\gamma$

$k_s^0 \rightarrow \pi^+\pi^-$

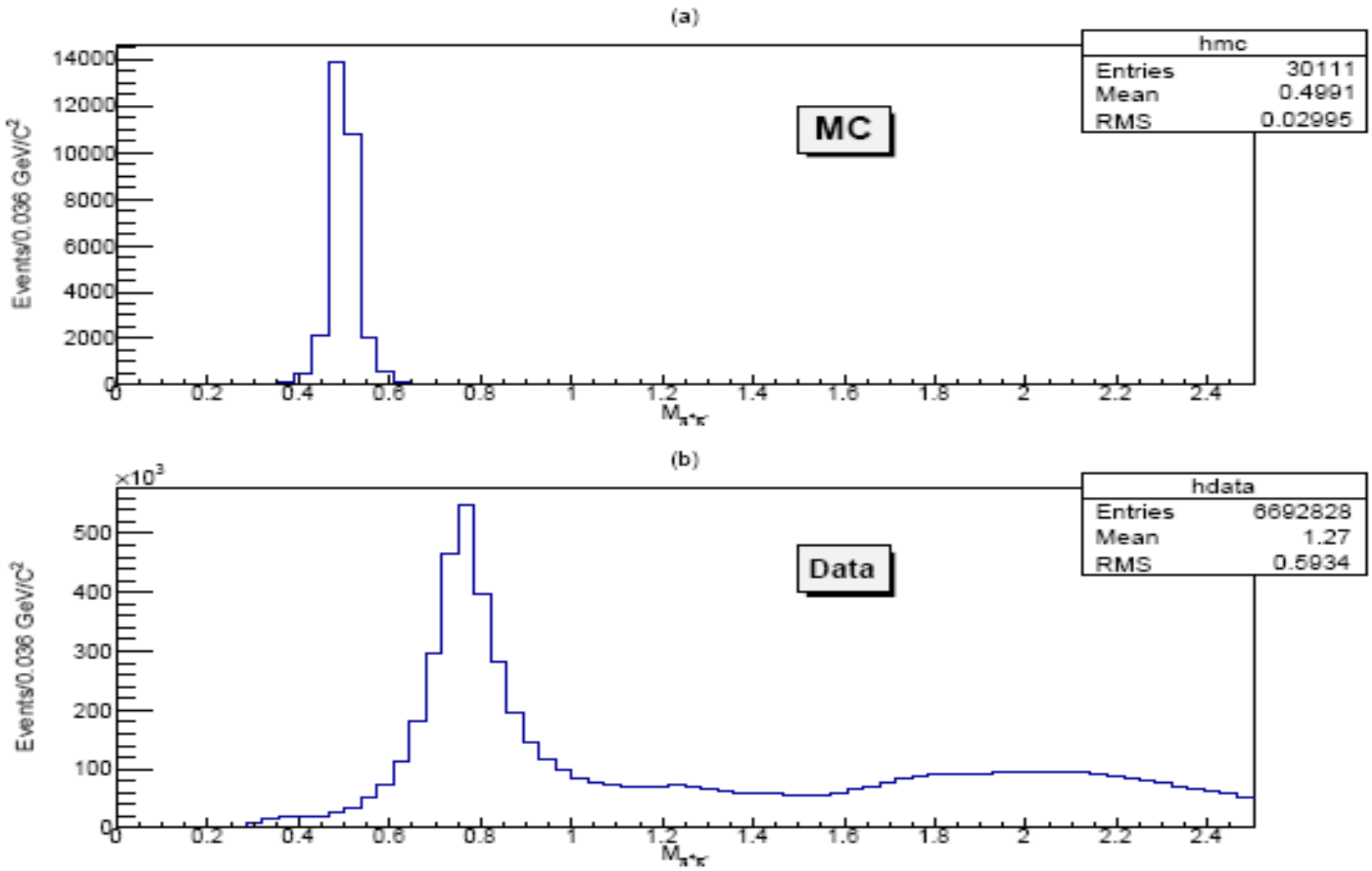
χ^2_{4C} DISTRIBUTION



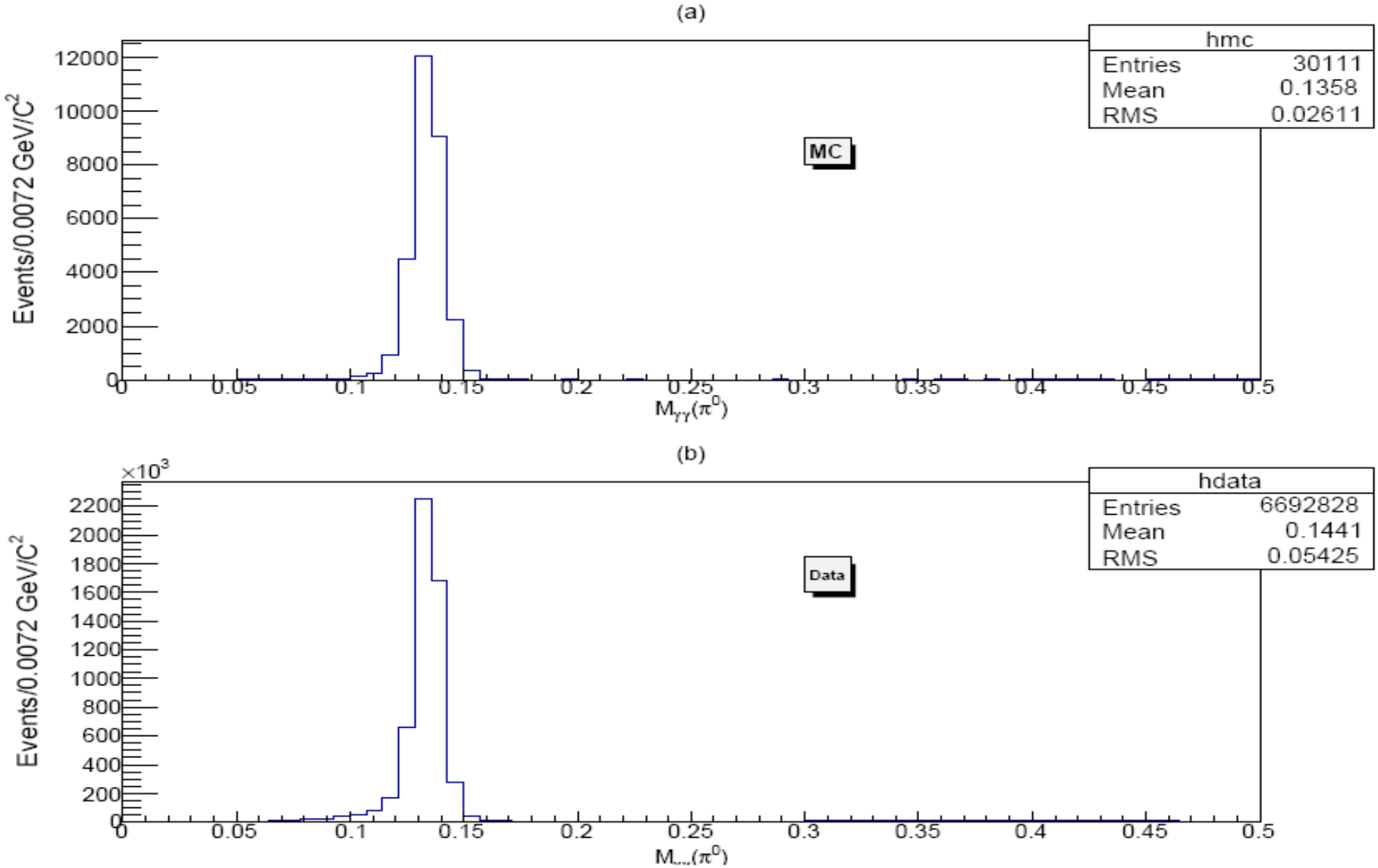
(b)



INVARIANT MASS OF $M_{\pi^+\pi^-}$ K_S^0 (MC & DATA) AFTER INITIAL SELECTION CRITERIA



INVARIANT MASS OF $\gamma\gamma(\pi^0)$ MC & DATA AFTER INITIAL SELECTION CRITERIA



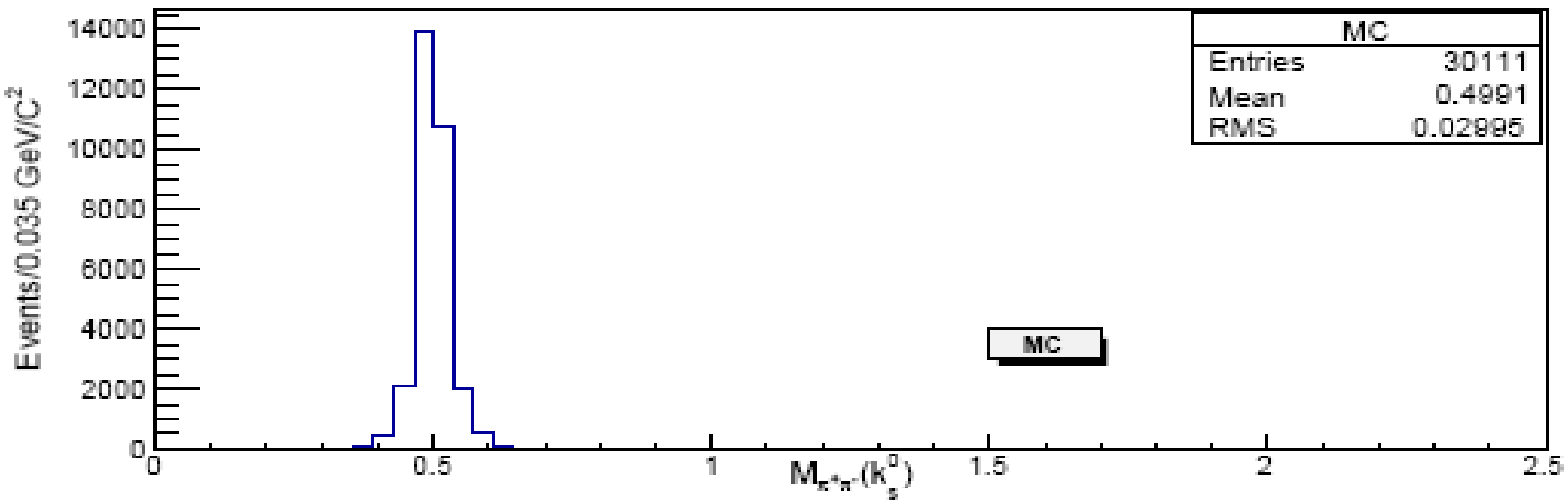
FINAL SELECTION CRITERIA FOR INVARIANT MASS

$M_{\pi^+\pi^-} \rightarrow k_s^0$

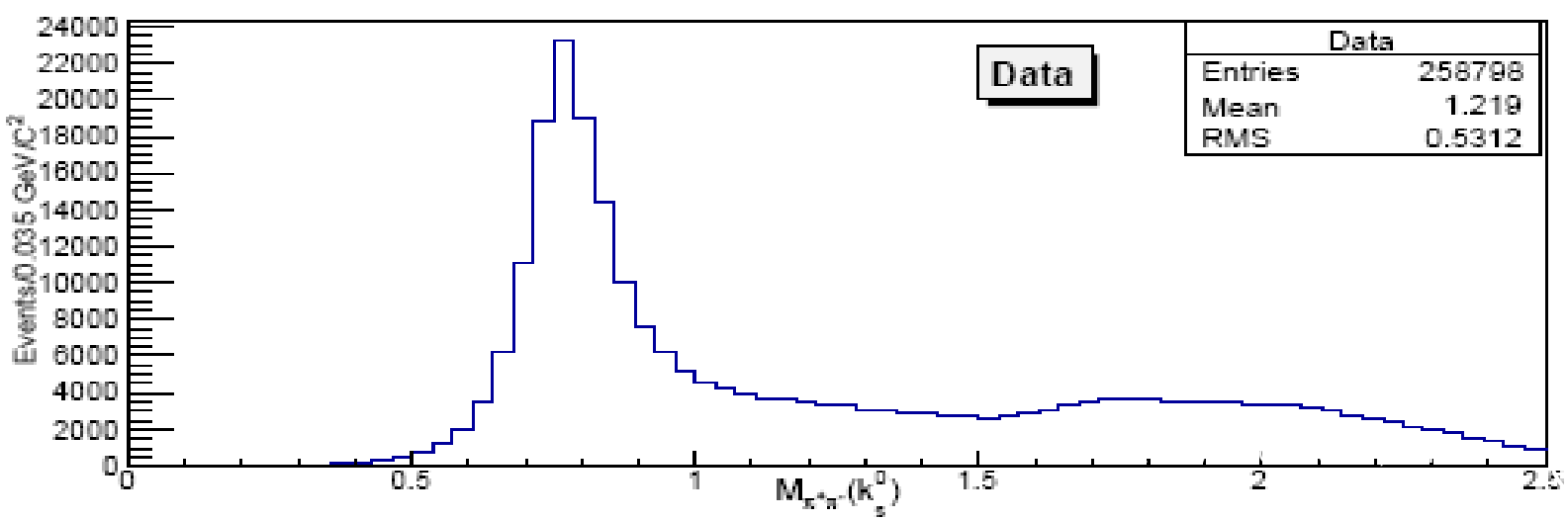
- $\chi^2 < 40$
- $n\gamma == 2$
- $DecayLengthRatio > \pi^+\pi^- (k_s^0) > 2$
- $R_{xy} < 4$
- $|M_{\pi_0} - 0.139| < 0.21$

RESULTS FOR INVARIANT MASS AFTER FINAL EVENT SELECTION $M_{\pi^+\pi^-} \rightarrow k_s^0$

(a)



(b)



SIDEBAND ANALYSIS FOR J/Ψ→ $K_S^0 \pi^0$

In order to calculate upper limit

Assuming 3 events

INVARIANT MASS OF $M_{\pi^+\pi^-}$ (K_S^0)

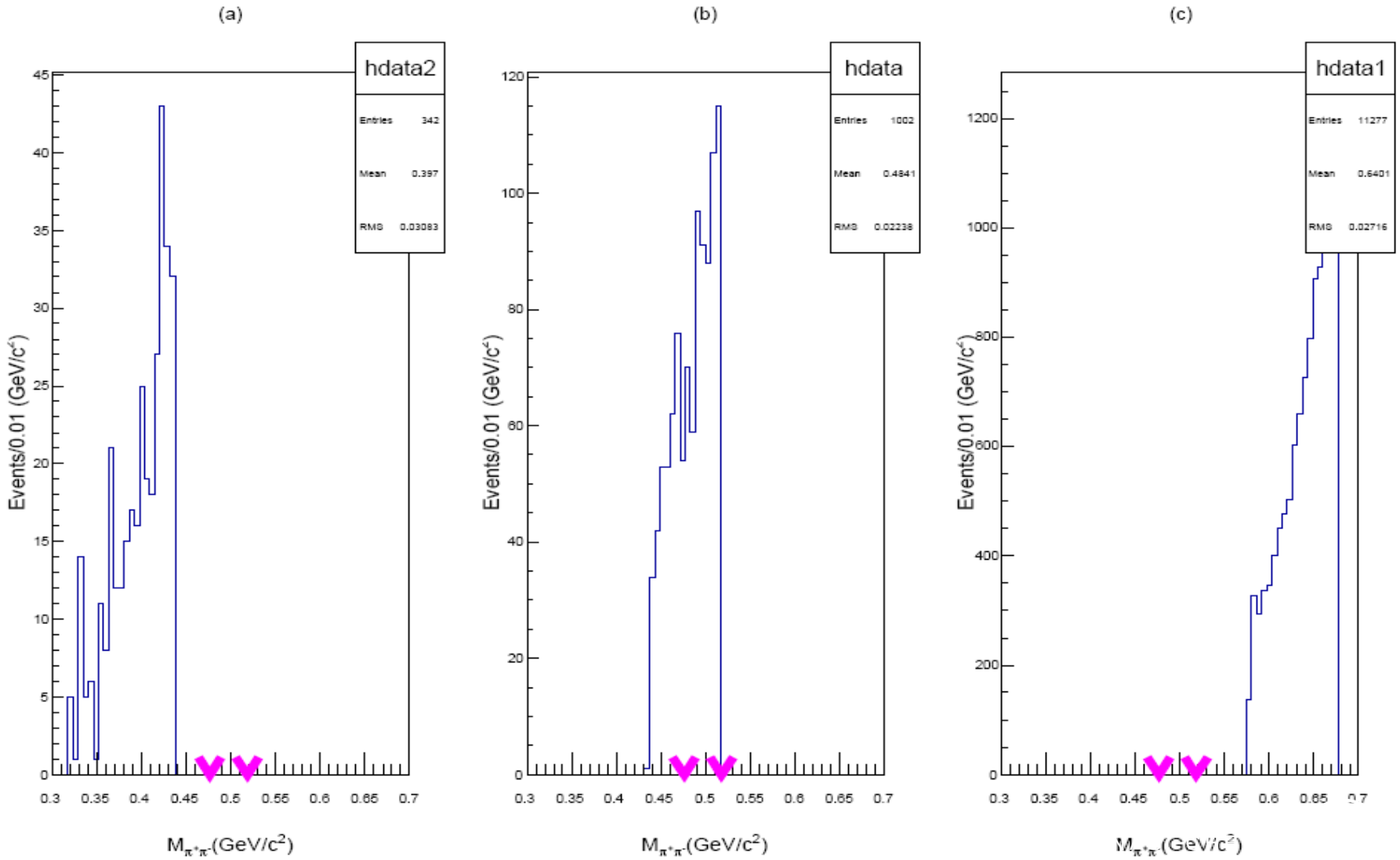


Fig. 5.23 (a) Invariant mass $M_{\pi^+\pi^-}$ (a) the K_S^0 peak, (b) Peak

DETECTION EFFICIENCY

We generated 3 X 10^5 MC events, after final selection and background suppression the detection efficiency is,

$$\text{Detection efficiency} = \frac{30111}{100000} \times 100$$

$$\varepsilon = 30\%$$

UPPER LIMIT OF BRANCHING FRACTION

$$B(J/\psi \rightarrow \pi^{\circ} X) \leq \frac{N_{obs}}{N_{J/\psi} . B(k_s^0 \rightarrow \pi^+ \pi^-) . B(\pi^0 \rightarrow \gamma\gamma) . \varepsilon}$$

$$B(J/\psi \rightarrow k_s^0 \pi^0) < 1.1 \pm 0.06 \times 10^{-9}$$

SYSTEMATIC ERRORS

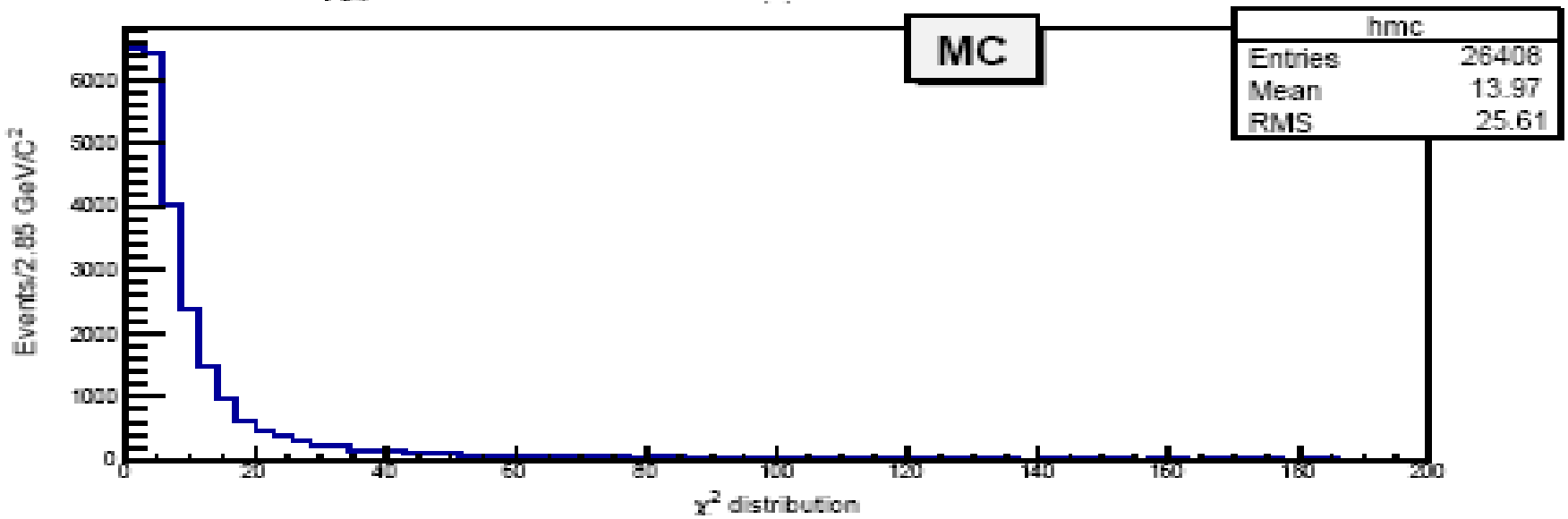
Sources	$J/\psi \rightarrow k_s^0 \pi^0$
MDC Track	4.0
γ Detection	2.0
Pid	2.0
MC Model	0.006
π^0Selection	0.6
J/ψ Number	4.72
Total Error	6.82

STUDY OF $J/\psi \rightarrow \pi^0 f_0$

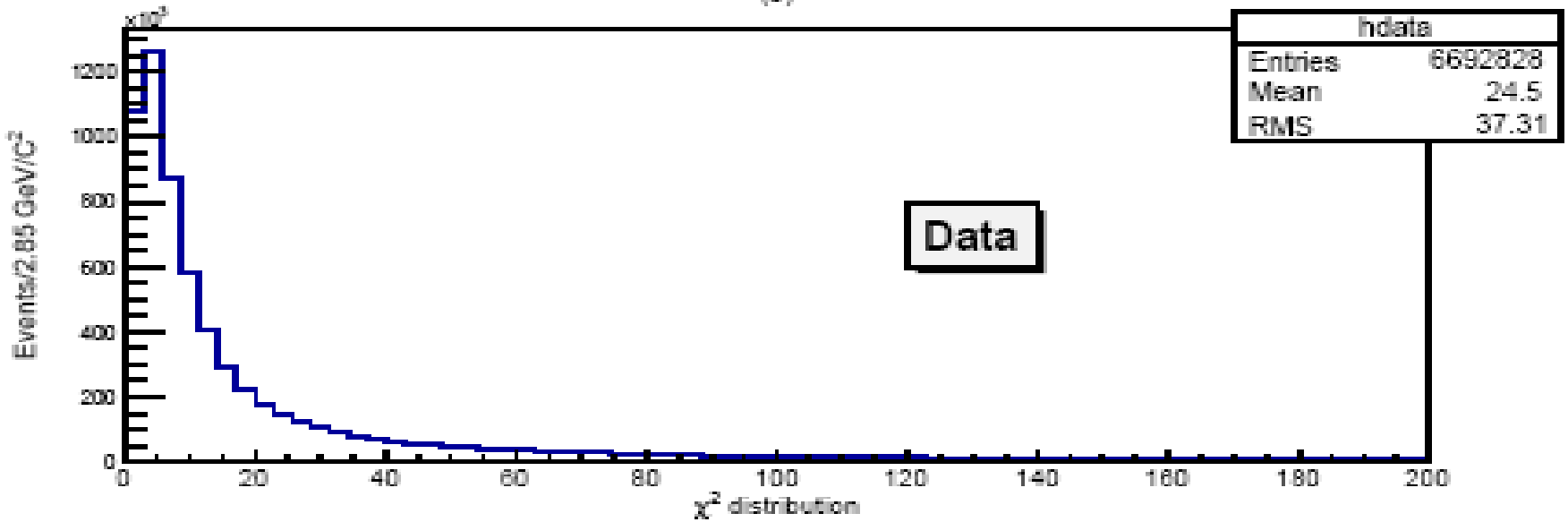
$f_0 \rightarrow \pi^+\pi^-$

$\pi^0 \rightarrow \gamma\gamma$

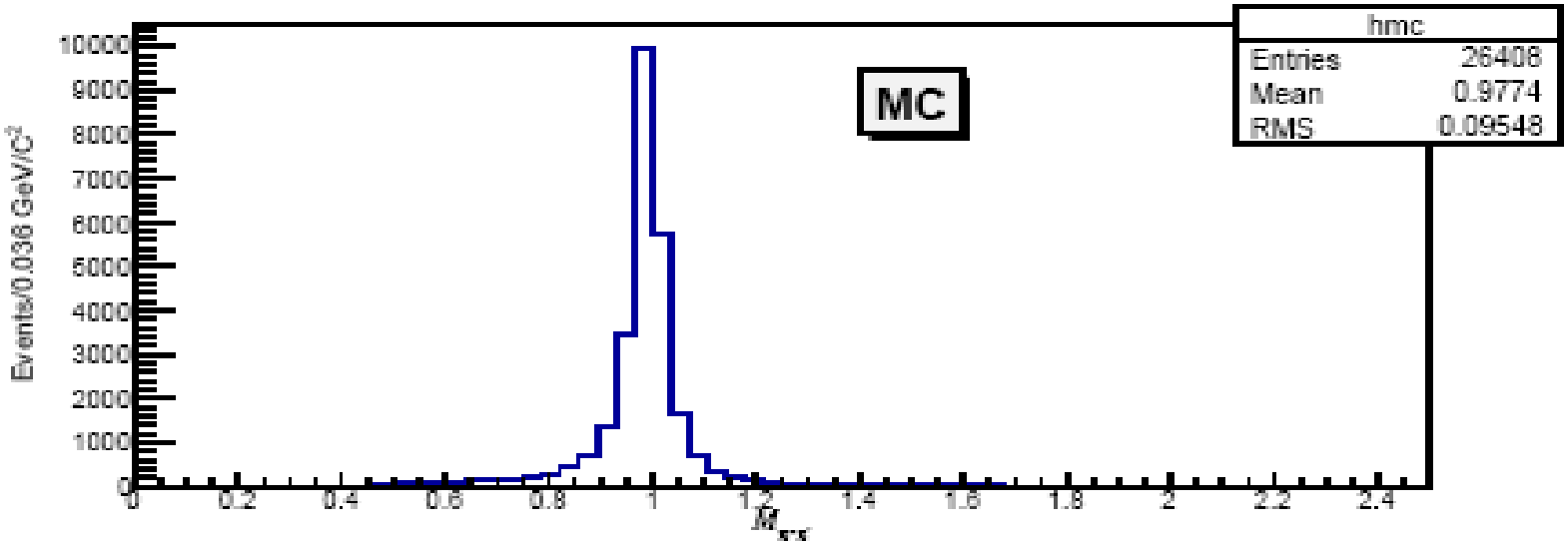
χ^2_{4C} DISTRIBUTION



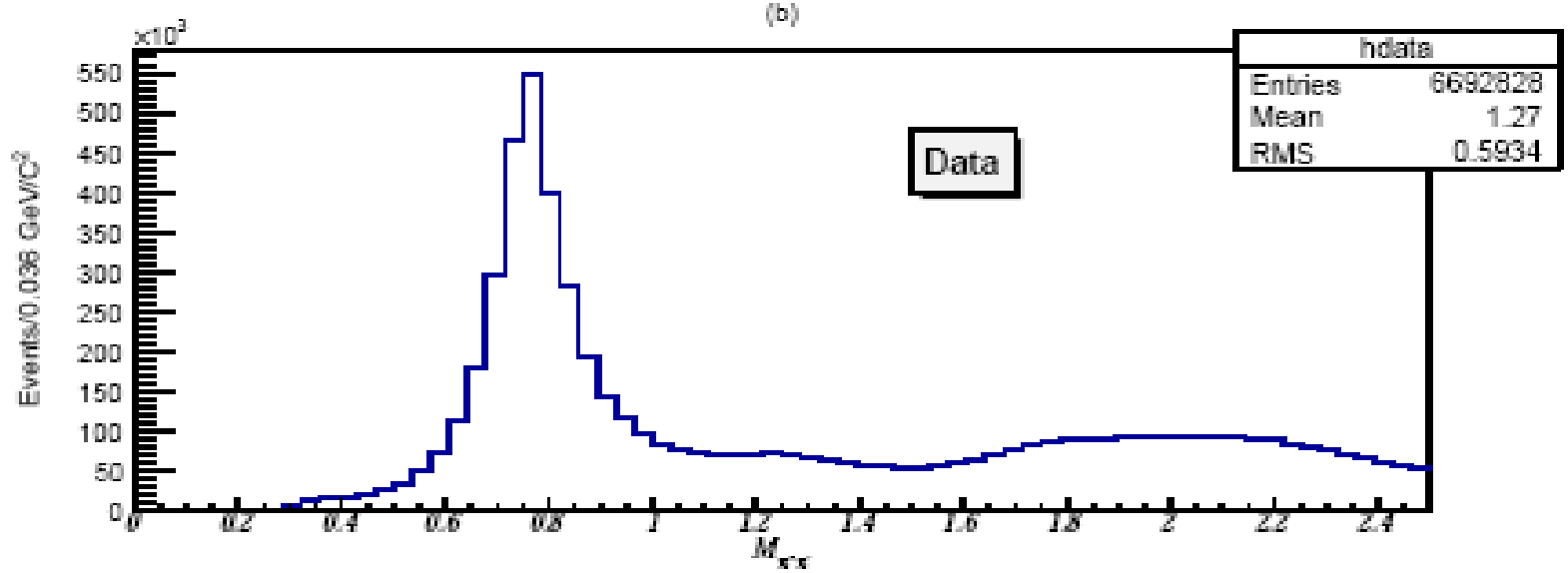
(b)



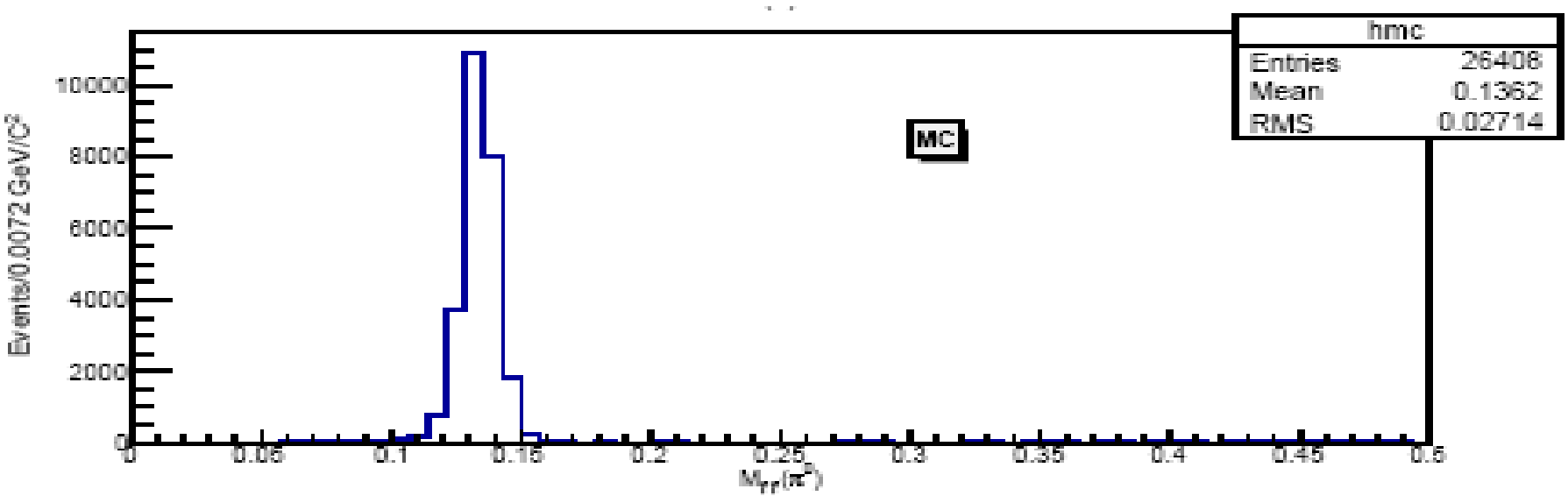
INVARIANT MASS OF $M_{\pi^+\pi^-}$ (f^0) MC & DATA AFTER INITIAL SELECTION CRITERIA



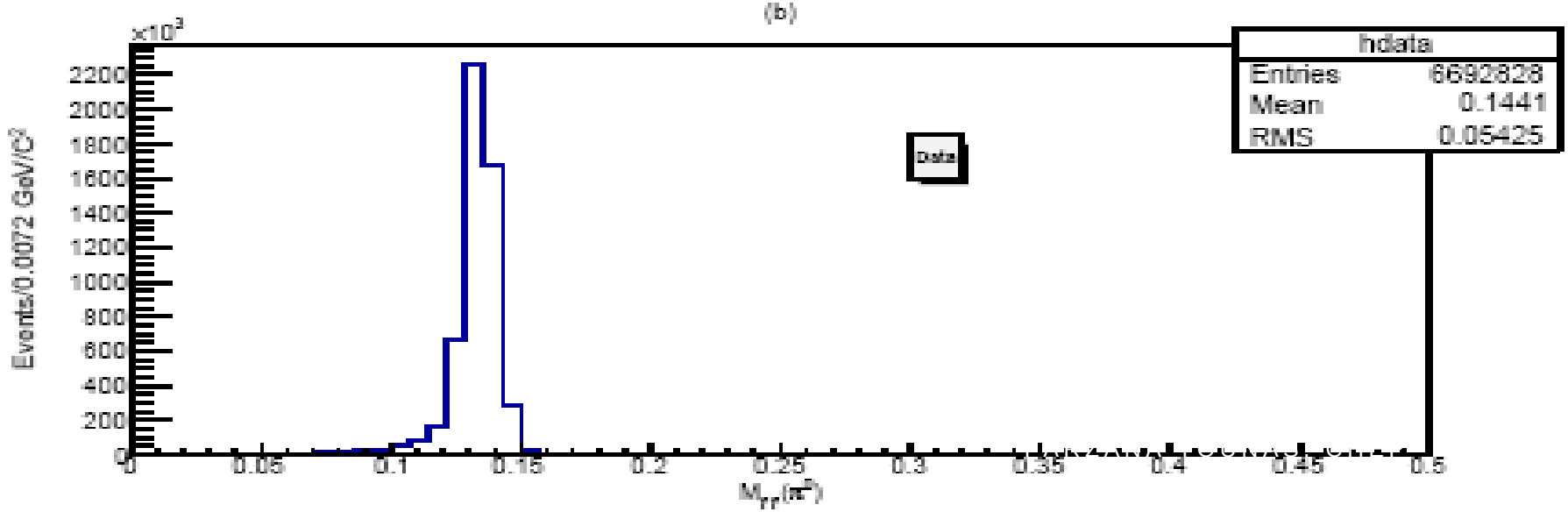
(b)



INVARIANT MASS OF $\gamma\gamma(\pi^0)$ MC & DATA AFTER INITIAL SELECTION CRITERIA



(b)

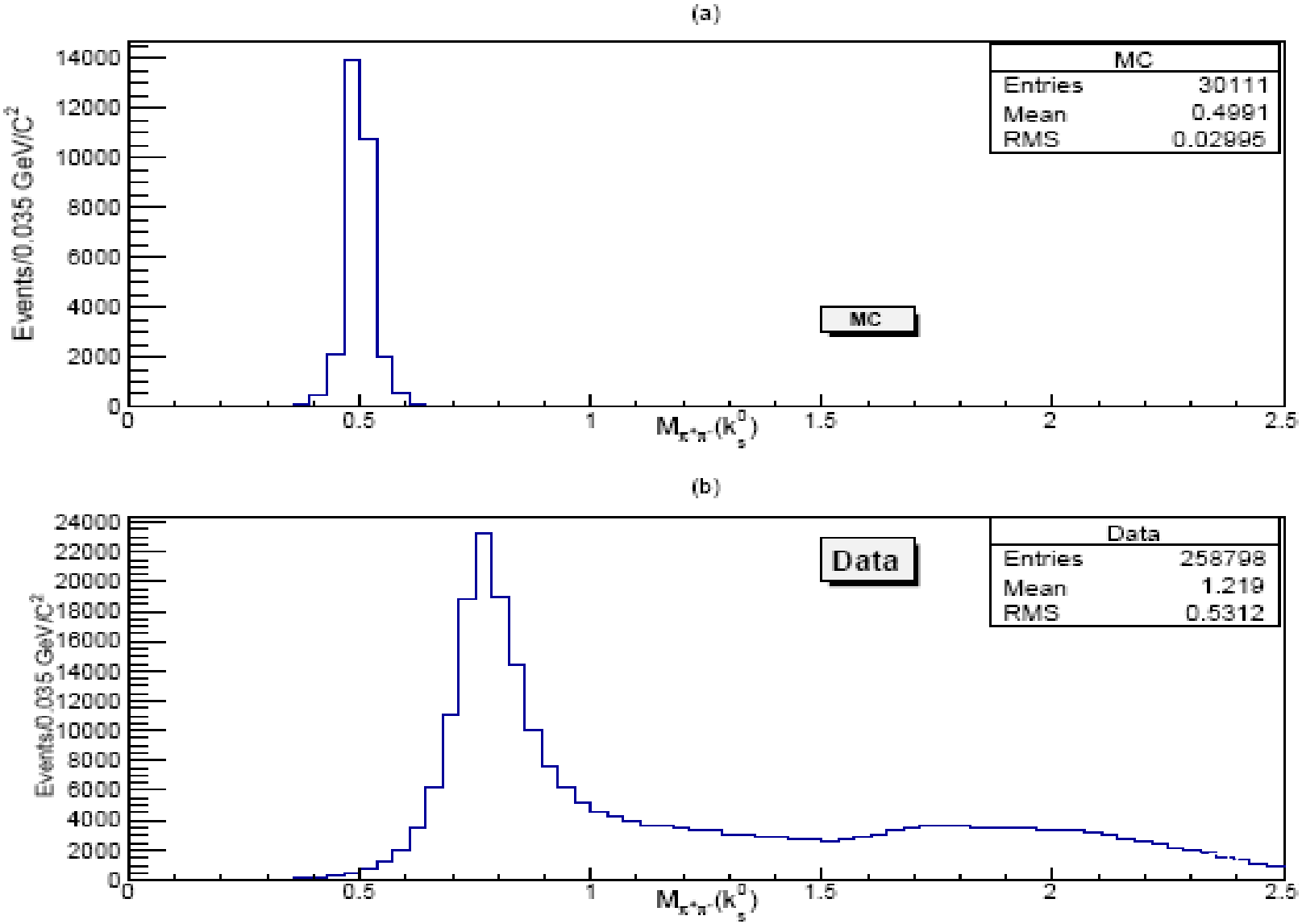


FINAL SELECTION CRITERIA FOR INVARIANT MASS $M_{\pi^+\pi^-} \rightarrow f^0$

- $\chi^2 < 40$
- $R_{xy} > 4$
- $n\gamma == 2$
- $DecayLengthRatio > \pi^+\pi^-(\rho) > 2$
- $|M_{k_s^0} - 0.493| > 0.06$
- $|M_\eta - 0.547| > 0.03$

SELECTION CRITERIA FOR INVARIANT MASS

$M_{\pi^+\pi^-} \rightarrow f_0$

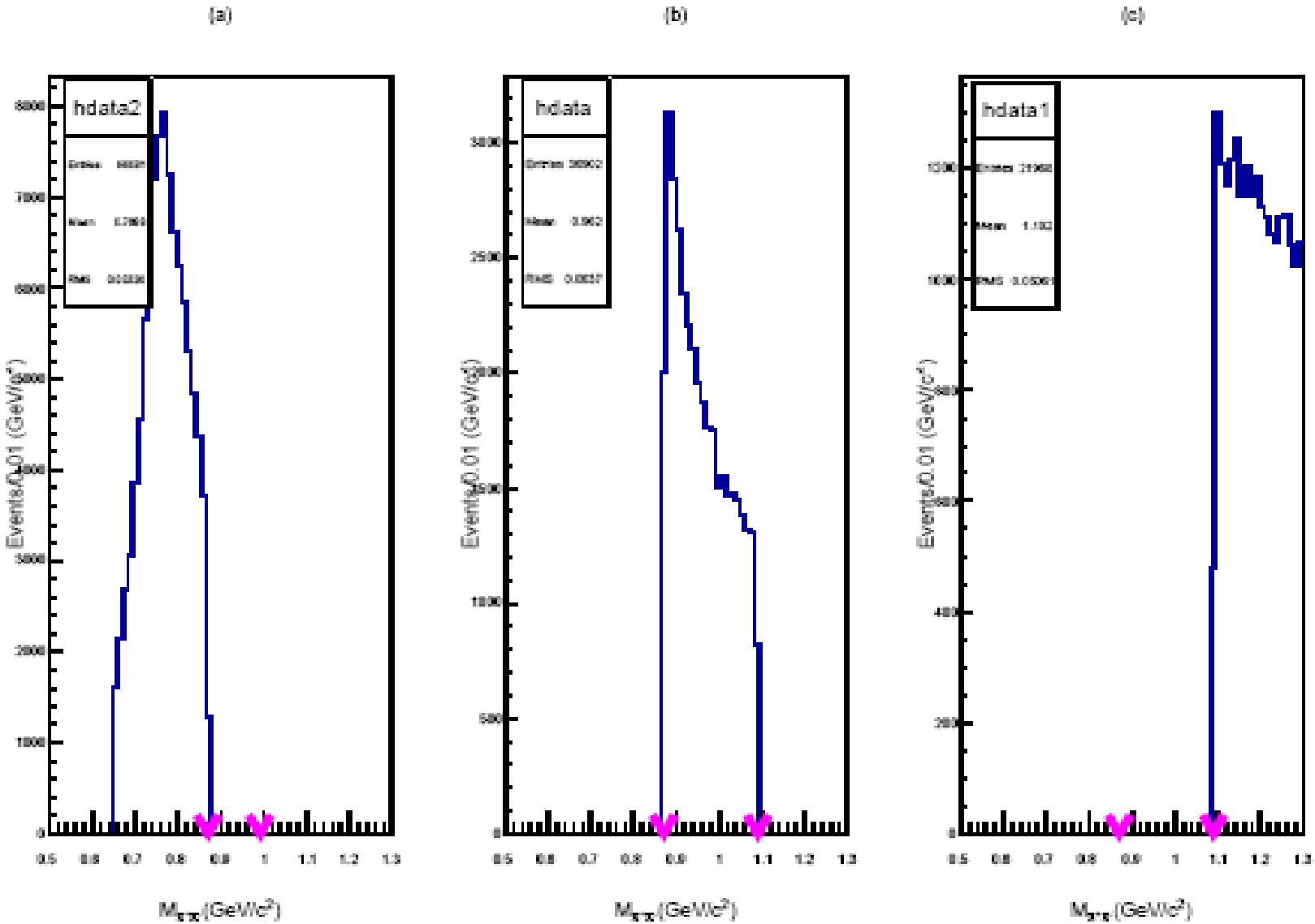


SIDEBAND ANALYSIS FOR J/Ψ→ $f^0\pi^0$

In order to calculate upper limit

Assuming 3 events

INVARIANT MASS $M_{\pi^+\pi^-}$ (f^0)



DETECTION EFFICIENCY

We generated 3 X 10^5 MC events, after final selection and background suppression the detection efficiency is,

$$\text{Detection efficiency} = \frac{26408}{100000} \times 100$$

$$\varepsilon = 26\%$$

UPPER LIMIT OF BRANCHING FRACTION

$$B(J/\psi \rightarrow \pi^{\circ} X) \leq \frac{N_{obs}}{N_{J/\psi} . B(f^{0} \rightarrow \pi^{+}\pi^{-}) . B(\pi^{0} \rightarrow \gamma\gamma) . \varepsilon}$$

$$B(J/\psi \rightarrow f^{0}\pi^{0}) < 1.06 \times 10^{-7}$$

SYSTEMATIC ERRORS

Sources	$J/\psi \rightarrow f^0\pi^0$
MDC Track	4.0
γ Detection	2.0
Pid	2.0
MC Model	0.24
π^0Selection	0.6
J/$\boldsymbol{\psi}$ Number	4.72
Total Error	6.83

CONCLUSION

Branching Fraction of

$$B(J/\boldsymbol{\psi} \rightarrow \boldsymbol{\pi^0 \rho}) = (\mathbf{2.8 \pm 0.06}) \times \mathbf{10^{-4}}$$

Upper Limit of Branching Fraction of

$$B(J/\boldsymbol{\psi} \rightarrow K_s^0 \pi^0) < (\mathbf{1.18}) \times \mathbf{10^{-8}}$$

Upper Limit of Branching Fraction

$$B(J/\boldsymbol{\psi} \rightarrow \boldsymbol{f^0} \pi^0) < \mathbf{1.06 \times 10^{-7}}$$

THANKS

QUESTIONS & SUGGESSIONS

SUGGESSION