X(3872) at DØ

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What is X(3872)

Discovered by Belle with $B^+ \to J/\Psi\, \pi^+ \pi^- K^+$

B mass | M(J/Ψππ) | Energy difference

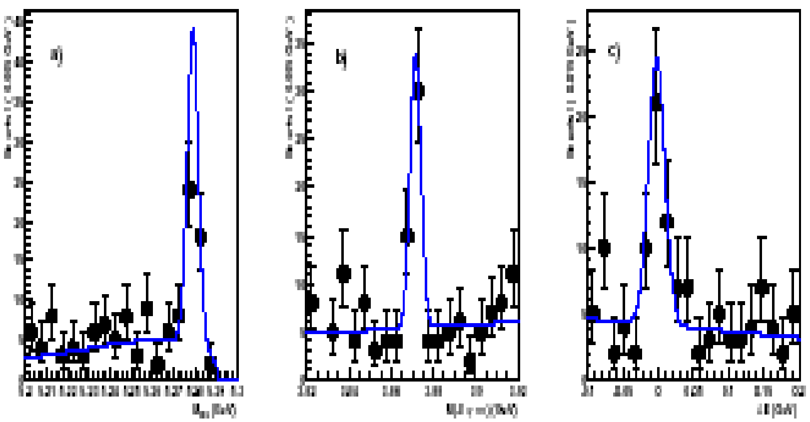
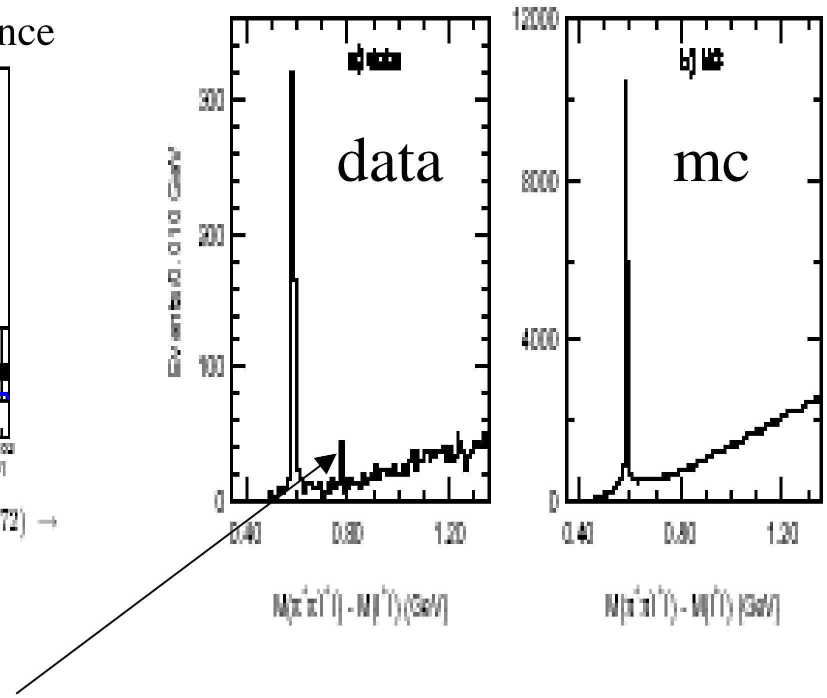
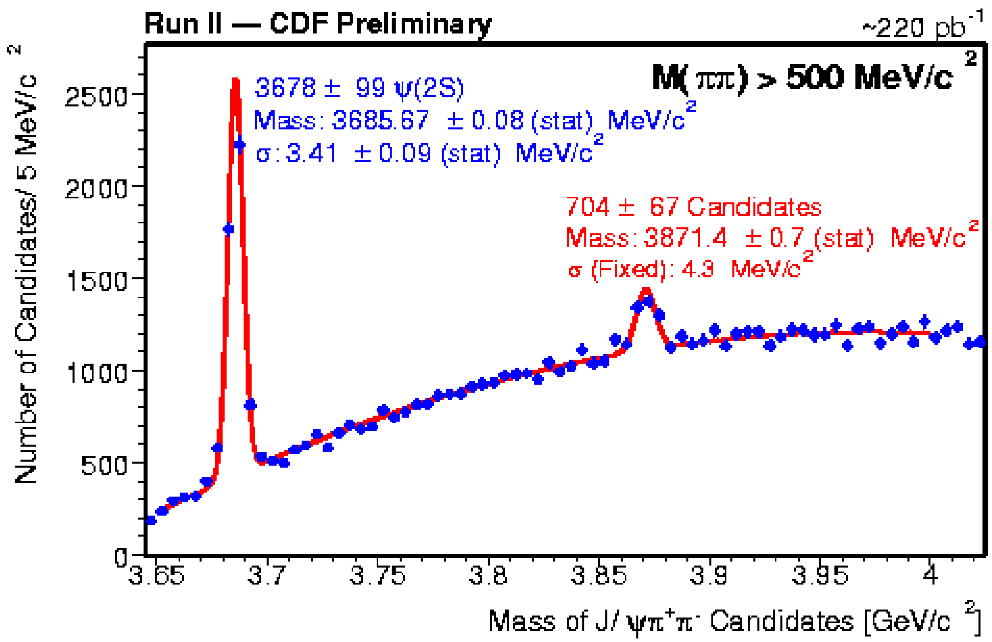


FIG. 2: Signal-band projections of (a) M_{bc}, (b) $M_{\pi^+\pi^- J/\psi}$ and (c) ΔE for the $X(3872) \to \pi^+\pi^- J/\psi$ signal region with the results of the unbinned fit superimposed.



CDF confirmed result



What is it ?

- Unknown at this time c-cbar, meson molecule, … ?
- Belle has 35.7 $\pm$ 6.8 events (~150 fb^{-1})
- CDF has 704 $\pm$ 67 events (~220 pb^{-1})
- D0 should be able see this state if it is ~20% of the Psi(2S)
- With large event sample can study properties of the X to determine what it is.

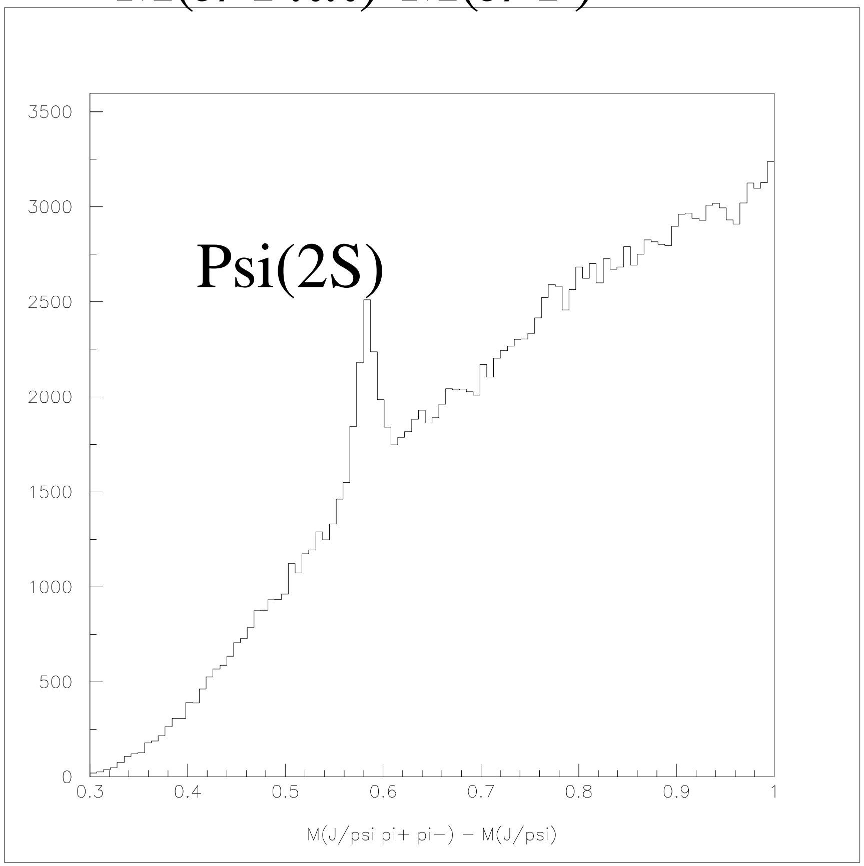
Search for X state

- Searching for X->J/Ψ $\pi^+ \pi^-$
- Data: B group picked ~114 pb-1 of J/Ψ–>μμ events which have been reprocessed the AA-extended tracking.
- SMT hits > 0 for all tracks
- Psi Pt>4 GeV
- Psi mass 2.6-3.4
- Pion Pt>0.4 GeV
- Pions within same "jet" as J/Psi.
- Vertex χ^2 J/Ψππ<16
- ΔM(J/Ψππ-J/Ψ)<1.0

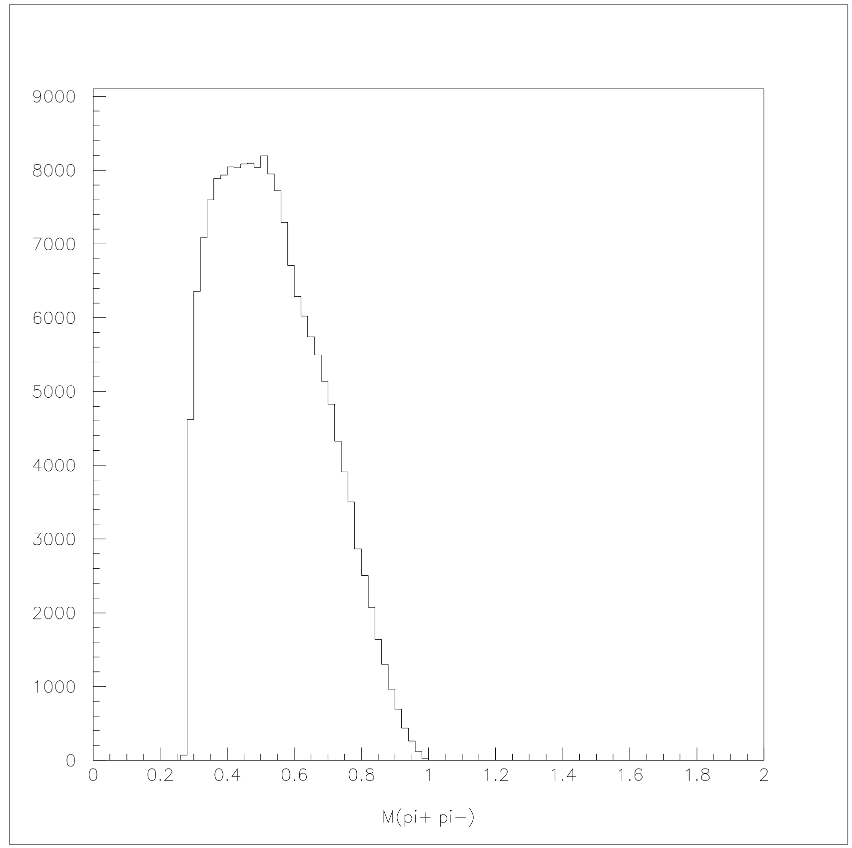
Initial selection cuts

Result

M(J/Ψππ)-M(J/Ψ)



M(ππ)



$M(\pi\pi)>0.5$ GeV

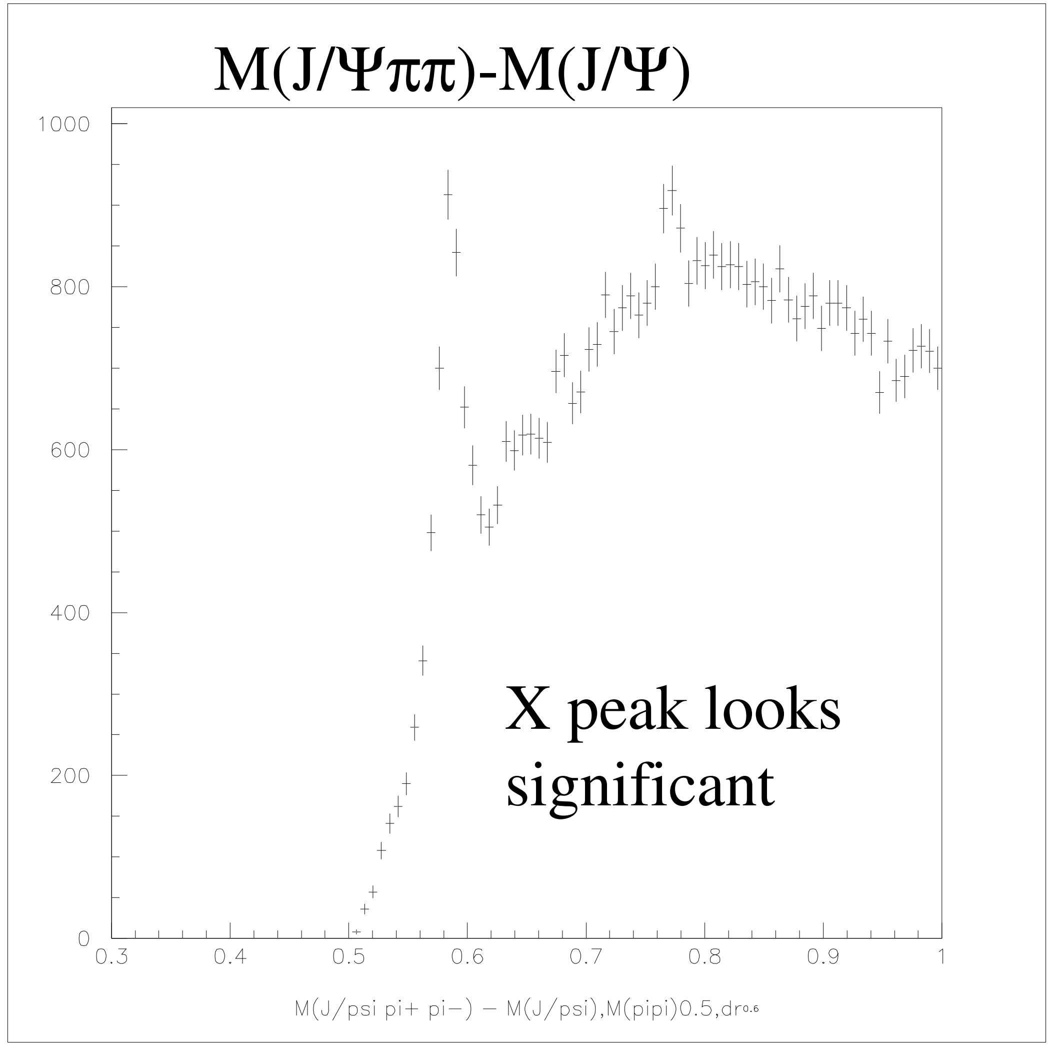
$\Delta R([J/\Psi\pi\pi]-[\pi])<0.6$

Mass constrain
J/Ψ and plot
$J/\Psi\pi\pi$-PDG J/Ψ mass

or

Do not mass
constrain and plot
$J/\Psi\pi\pi$- J/Ψ mass

Same answer

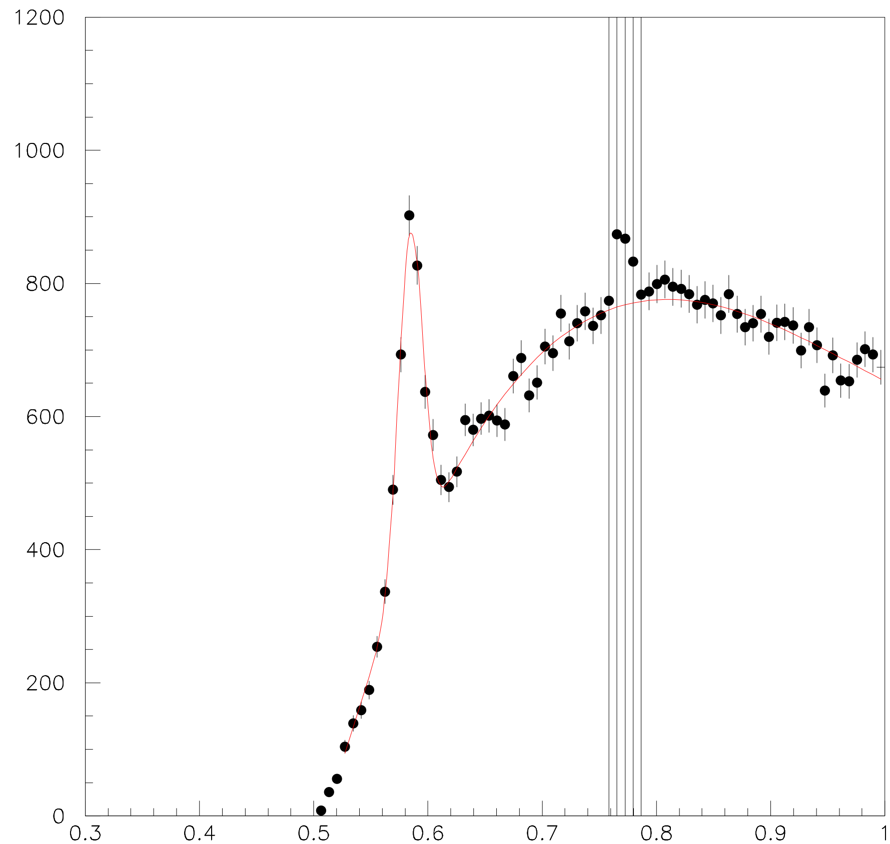


Is the peak significant??

Need to decide on how to Define significance.

- S/Sqrt(B)
- Probability of fit

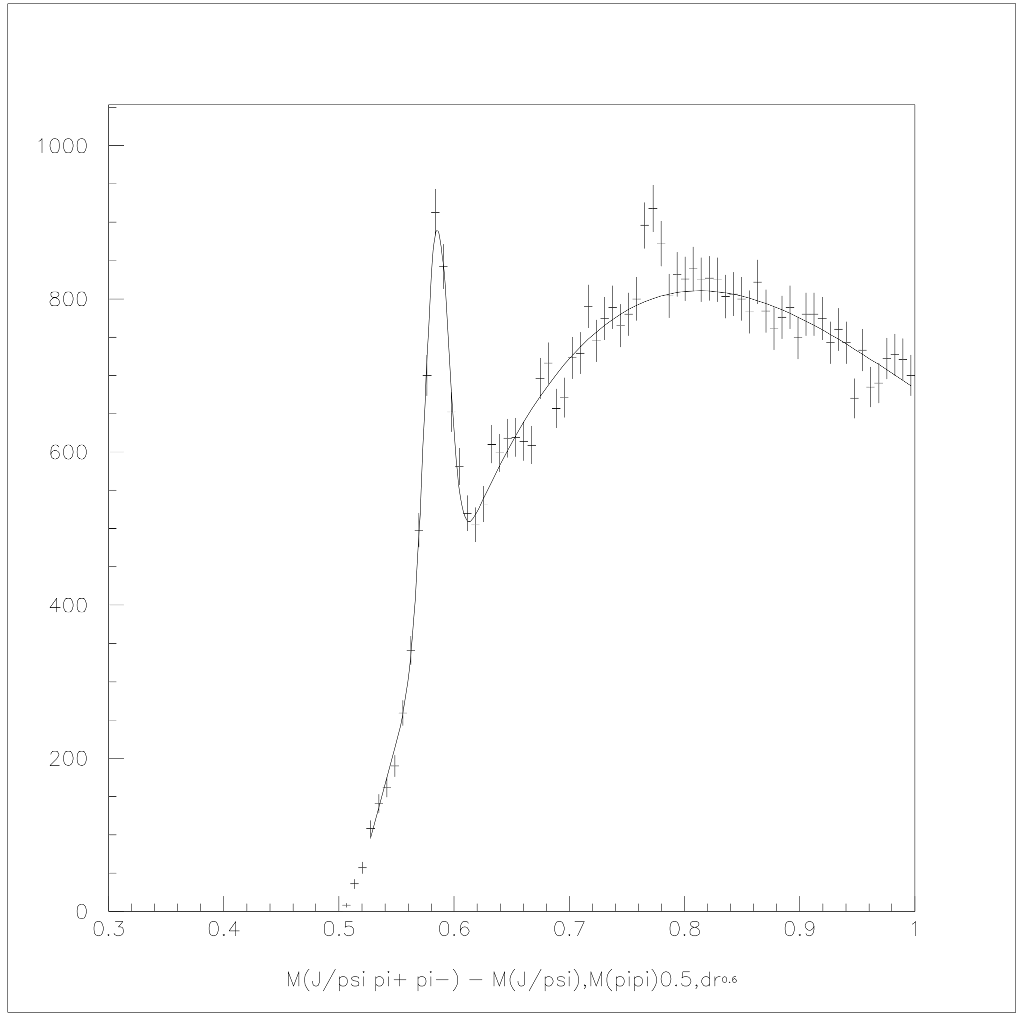
✓ Δ Chisq



“Remove” X and fit to p3
Chisq/dof=48/56

Fit to Gaussian + p3
p3 fixed from previous fit

Chisq/dof=74.62/61

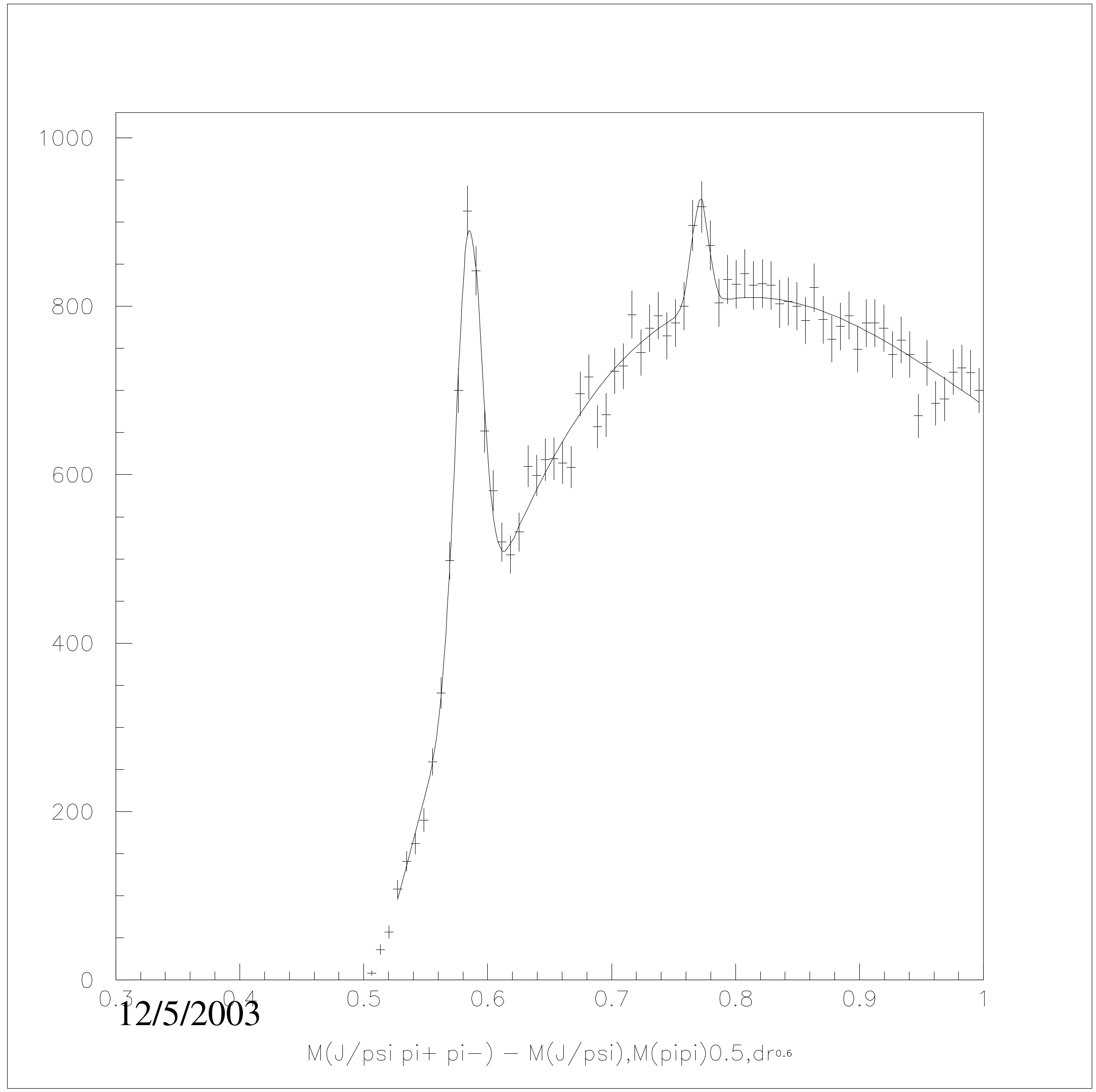


Fix Gaussian and p3 from first fit
and add in another Gaussian for X particle.
Allow all parameters in X Gaussian to float

Chisq/dof=45.54/58

Δ Chisq=29 for 3 dof
->Prob 2.2 E-6
-> 4-5 sigma

σ of X state fits to narrower than Psi(2S)
σ Psi(2S) = .01+-.0005
σ X = .007+-0.002



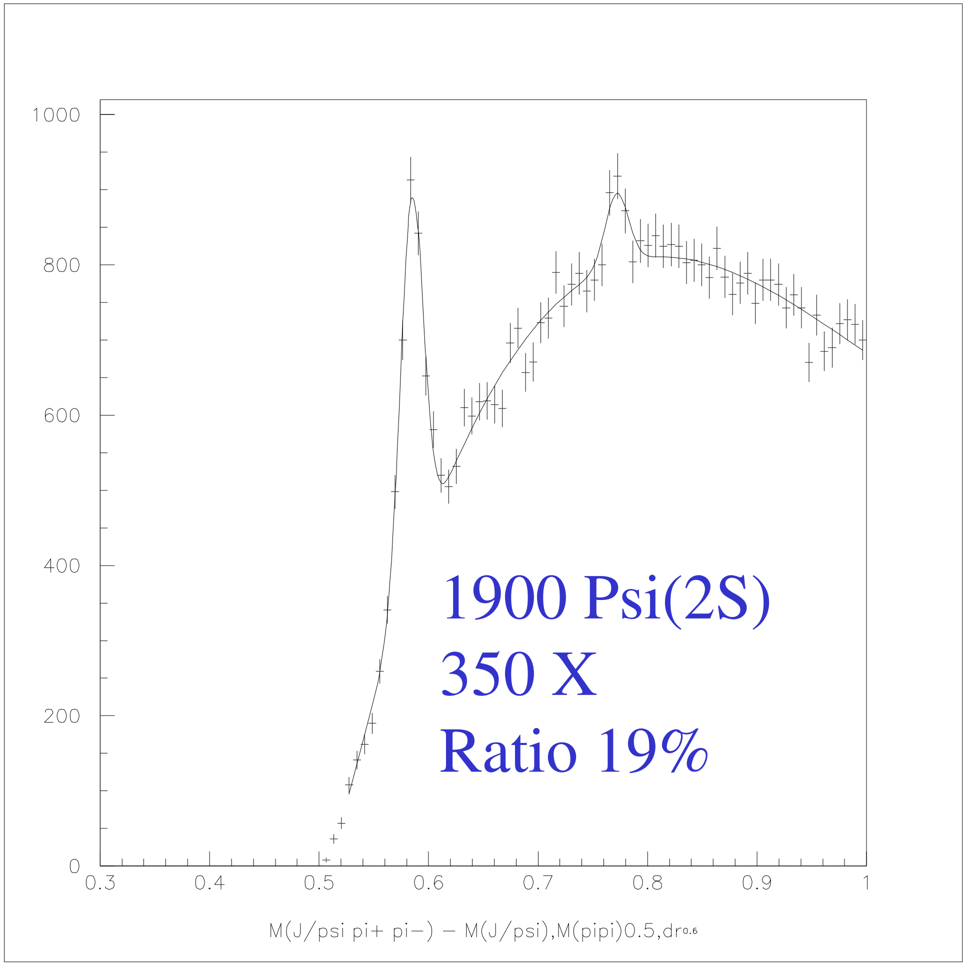
Fix σ of X to σ of Psi(2S)

Chisq=48.06/59

Δ Chisq=26.56
with 2 dof
Prob=1.7 E-6
-> 4-5 sigma

S/sqrt(B) ~ 5

Fits also done
Excluding Psi(2S) in fit.
Same result



Compare D0 and CDF

CDF

- $L=220\ pb^{-1}$
- 3678 Psi(2S)
- 700 X
- σ=0.00341
- Bck~1000 events/bin
- Mass=3871+-0.8 MeV

D0

- $L=114\ pb^{-1}$
- 1900 Psi(2S)
- 350 X
- σ=0.010
- Bck~550 events/bin
- Mass=3868 +- 2 MeV

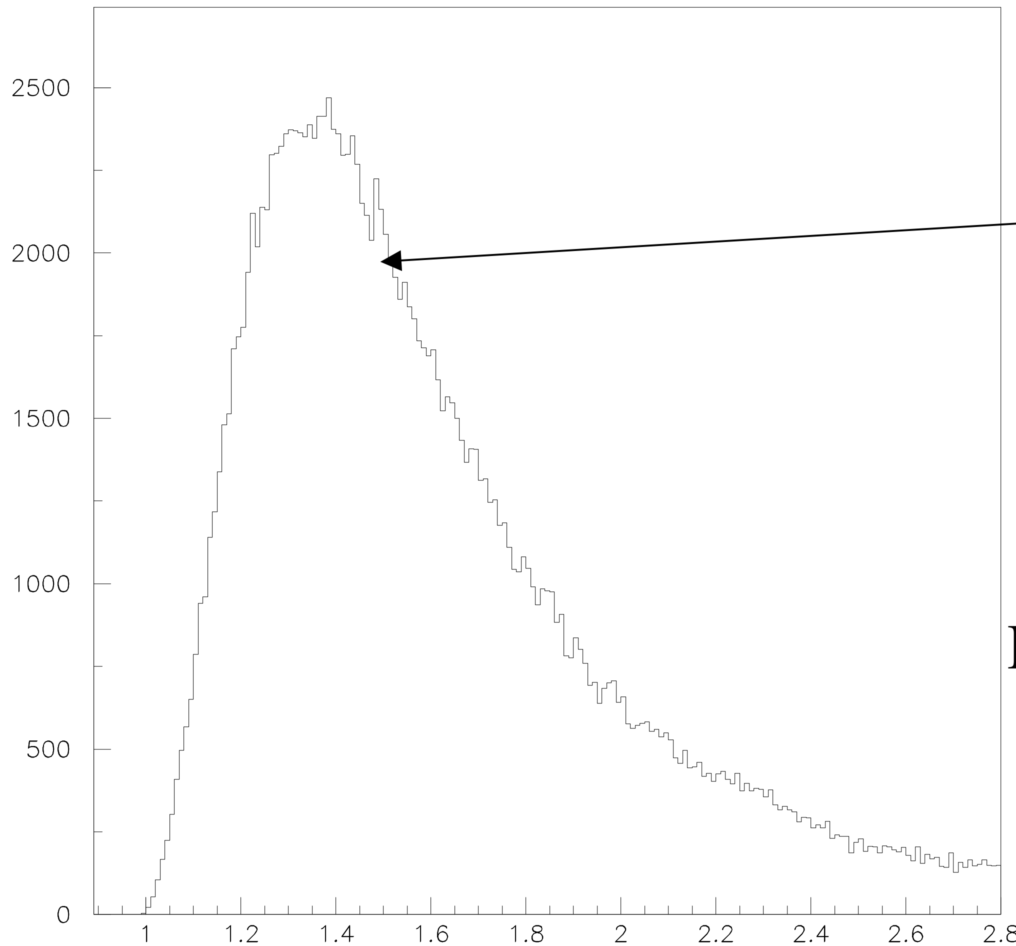
Consistent

Luck?? Possibly different efficiencies/acceptances??

Reflection ??

Need to run on MC

Look at J/Psi KK



??

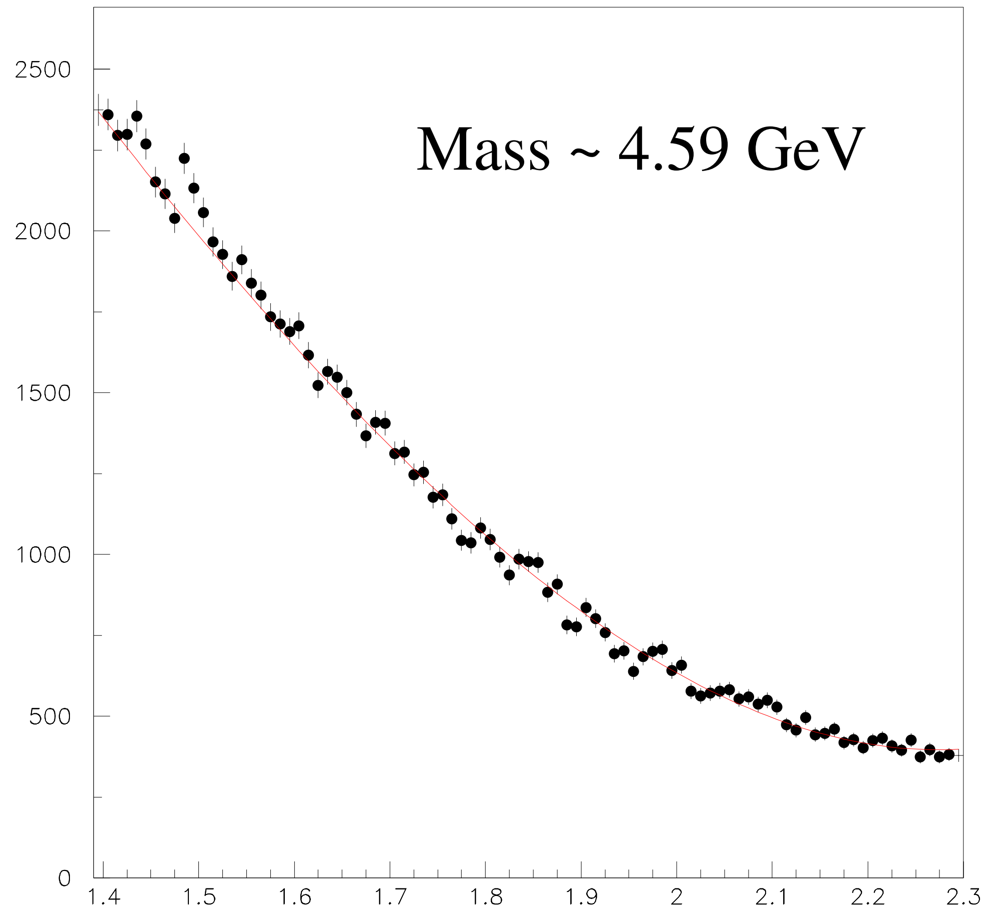
New peak ?

Reflection ?

Bug ?

Fluctuation ?

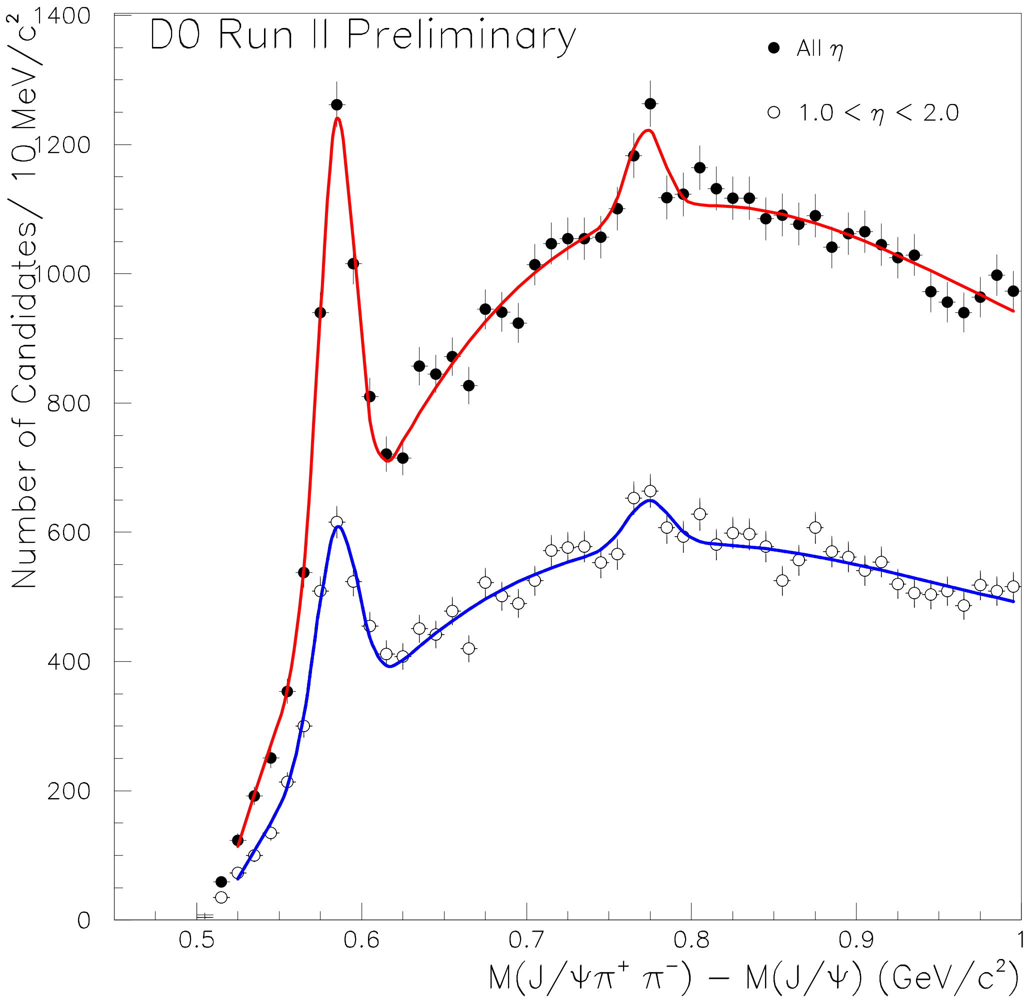
Zoom in



What can we do with it

- Significance of X peak ~5 sigma. If we break data up into 2 regions, significance in each region ~ 3 sigma.
- Since D0 has an advantage in our acceptance over CDF, look at eta dependance.

Eta dependance



Other ideas

- Look for charged analog of X. Search for J/Psi $\pi^+ \pi^0$, if seen this would rule out a c-cbar hypothesis
- Look for radiated decays to χ_c (Belle did not see any evidence of this) X->$\chi_c \gamma$ Radiative decay would favor a c-cbar hypothesis
- Not easy, need to identify low Pt π^0 and γ, backgrounds, resolution, …
- For our χ_c plot, we use photon conversions. Can we see χ_c using photons from calorimeter??
- Short lived vs long lived component.
- Isolated/non-isolated

Conclusions/To do

- X peak in picked data looks nice
- Hopefully with more data (coming soon) stronger peak will be present
- Hope to measure properties of X with the larger data set.
- Is "peak" in J/Psi KK spectrum anything??
- Lots to do …