

Measurement of
 $B^0 \rightarrow J\psi\pi^+\pi^-$ Branching Fractions
with the BaBar Detector

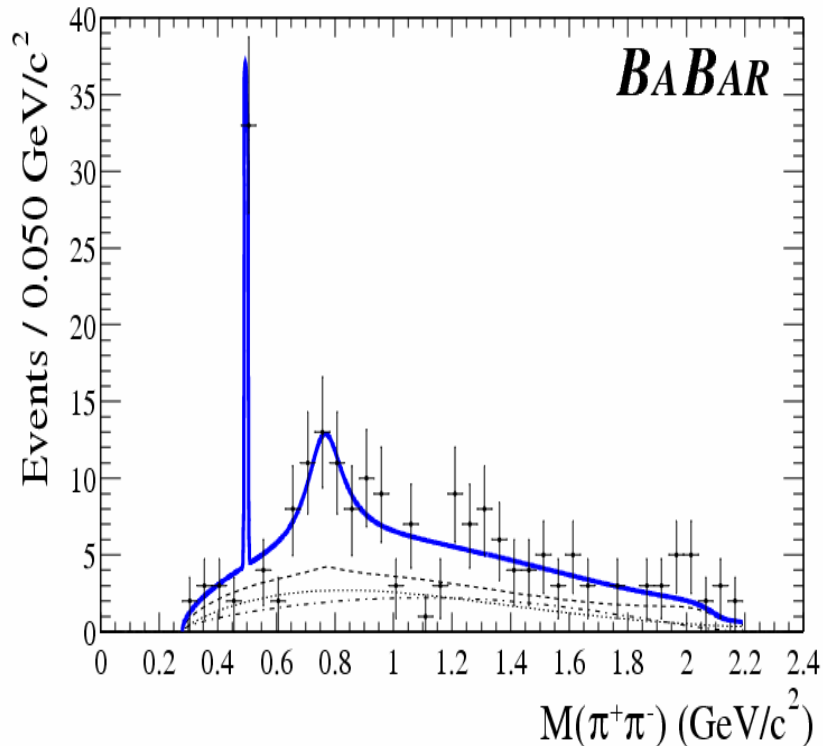
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The University of Manchester



Past Results

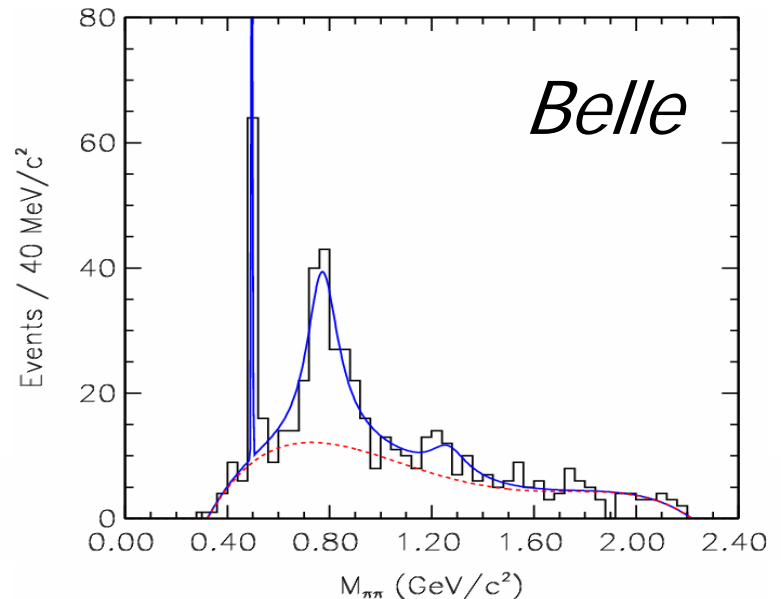
■ BaBar

- Int. Luminosity: 51 fb^{-1}
- $\text{BR}(B^0 \rightarrow J/\psi \pi^+ \pi^-)_{\text{total}} = (4.6 \pm 0.9) \times 10^{-5}$
- $\text{BR}(B^0 \rightarrow J/\psi \rho^0(770)) = (1.6 \pm 0.7) \times 10^{-5}$



■ Belle

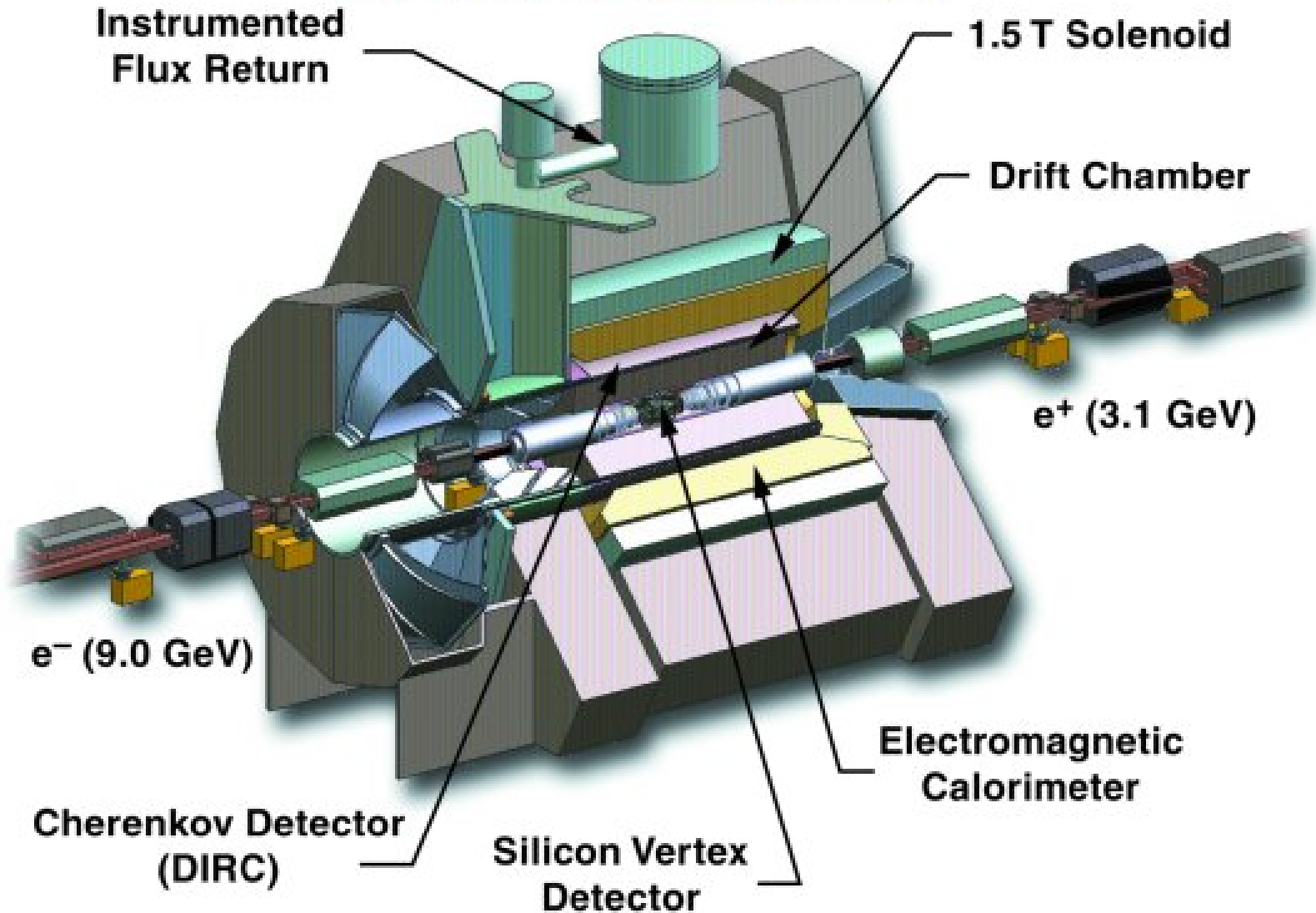
- Int. Luminosity: 120 fb^{-1}
- $\text{BR}(B^0 \rightarrow J/\psi \rho^0(770)) = (2.8 \pm 0.4) \times 10^{-5}$
- $\text{BR}(B^0 \rightarrow J/\psi \pi^+ \pi^- \text{ (non-res)}) < 1 \times 10^{-5} \text{ (90\% C.L.)}$
- $\text{BR}(B^0 \rightarrow J/\psi f_2) < 1.5 \times 10^{-5} \text{ (90\% C.L.)}$



Motivation

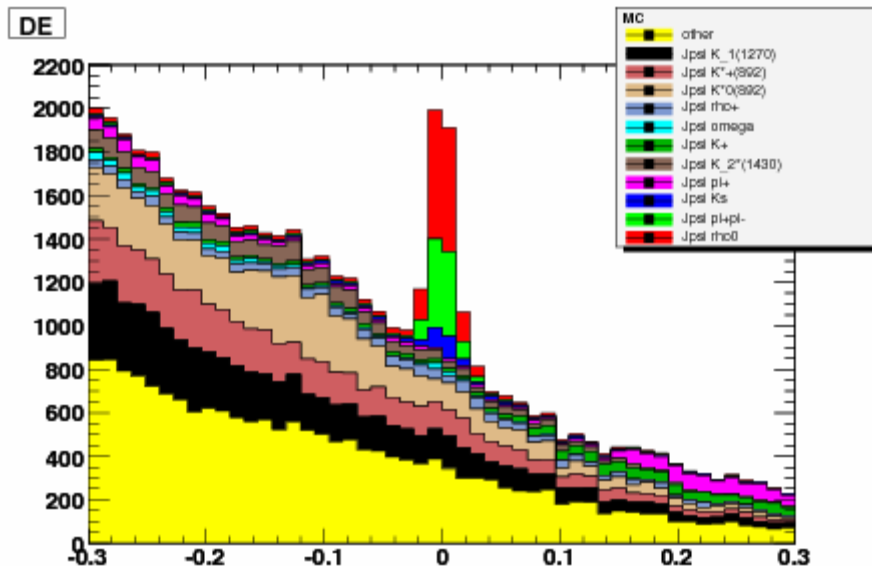
- We have much more data now, i.e., $\sim 300 \text{ fb}^{-1}$. Hence we will be able to
 - Reduce errors for modes with existing branching fractions hence increasing their significance
 - Set branching fractions for modes with upper limits only
 - Discover (or possibly deny the existence of other resonances) that may appear due to higher statistics, i.e., f_2
 - Explain inconsistencies of Belle results with past BaBar results for the resonant and non-resonant components of $B^0 \rightarrow J/\psi \pi^+ \pi^-$
 - Set up the framework for angular analysis of $B^0 \rightarrow J/\psi \rho^0(770)$

BABAR Detector



Selection & Fit (A)

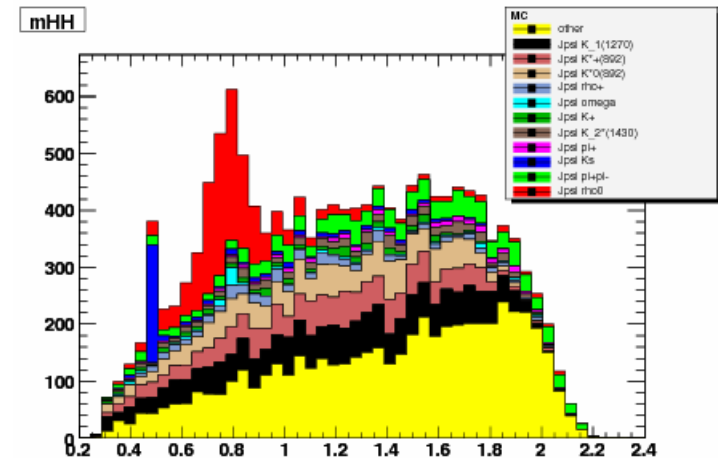
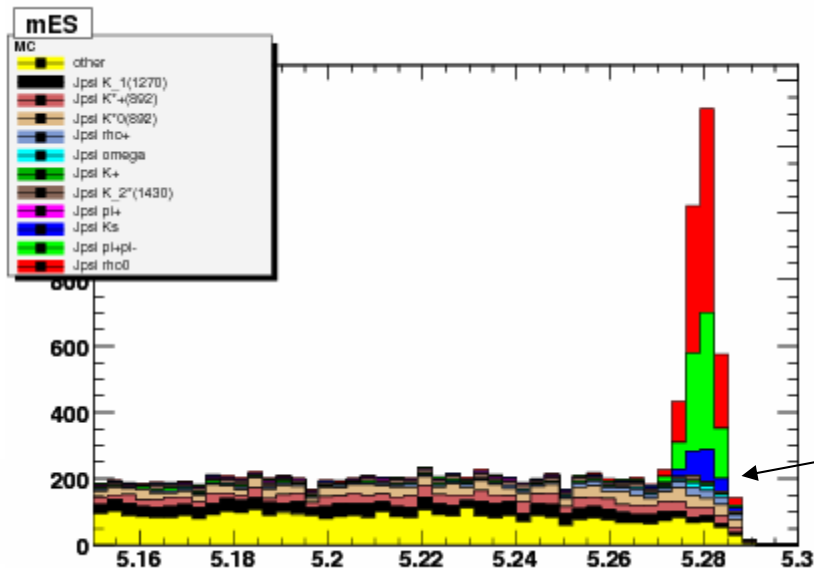
- Initially events have to pass the following cuts:
 - Kinematic & geometric constraint on the vertex fit
 - Lepton ID
 - Jpsi mass ($2.98 < J\psi_{ee} < 3.14$, $3.06 < J\psi_{\text{mumu}} < 3.14$)
 - Tightest pion ID
- Then the best candidate is selected for each event by passing the criteria of having the smallest DE.



$$\Delta E = E_B^{cms} - E_{beam}^{cms}$$

Selection & Fit (B)

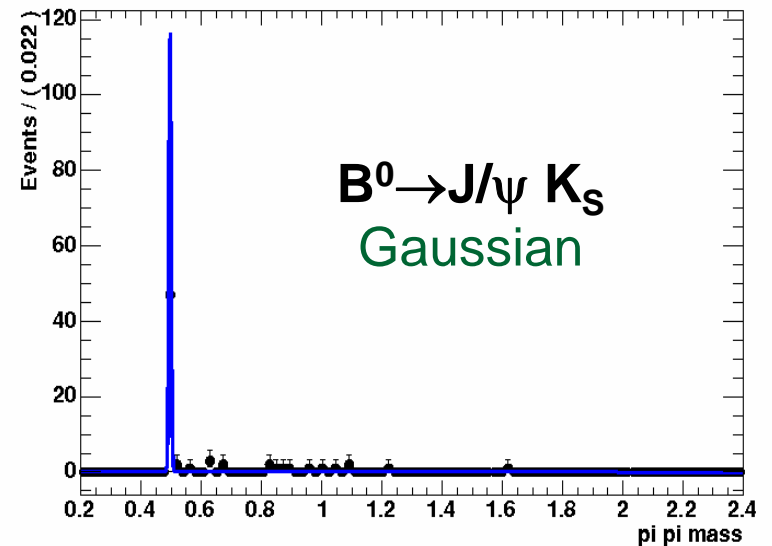
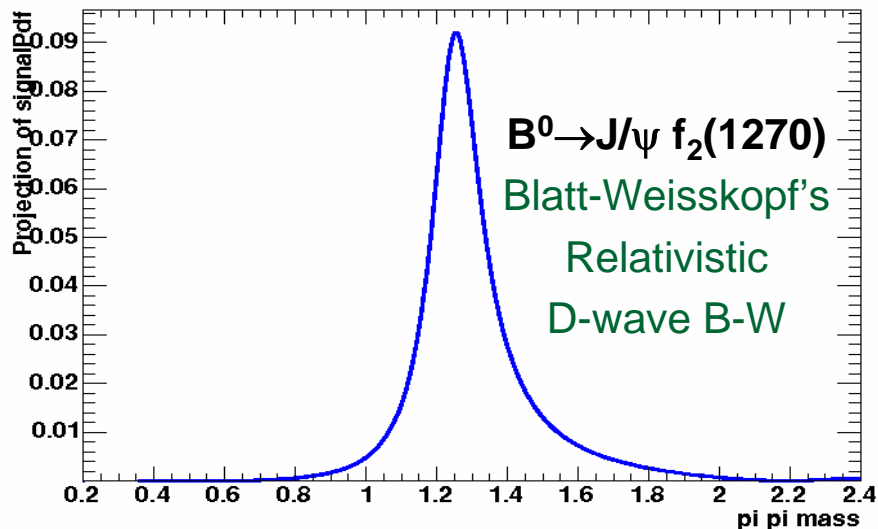
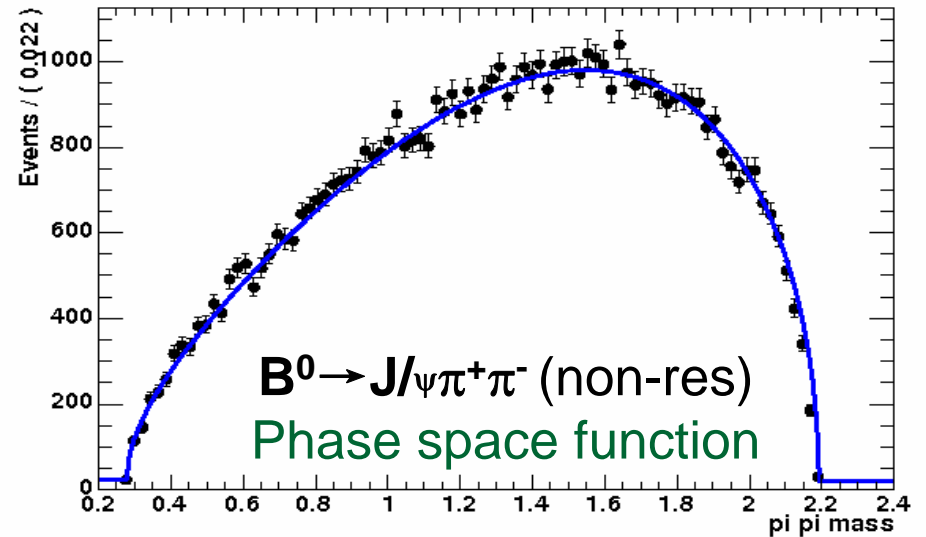
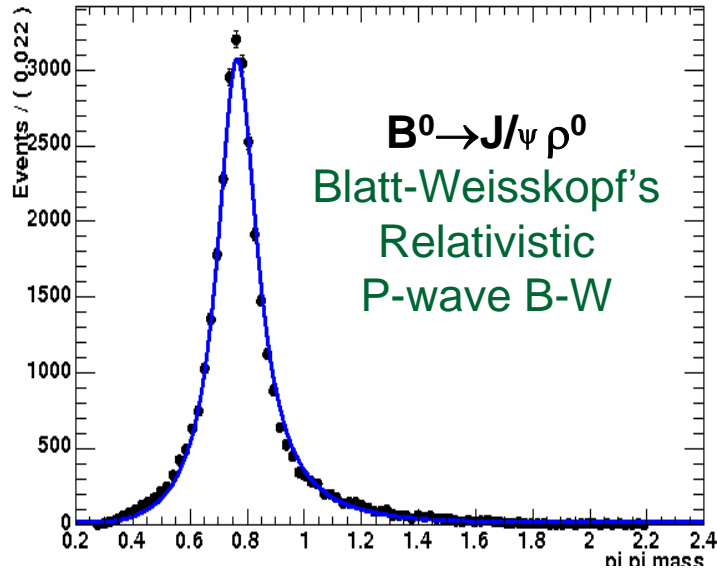
- A 2D fit is then made on the MES and the Invariant mass (m_{HH}) plot to obtain the number of events for a specific mode
- Our fit is divided into 4 types:
 - Signal modes
 - Exclusive Jpsi background modes
 - Inclusive Jpsi background
 - Non-Jpsi background



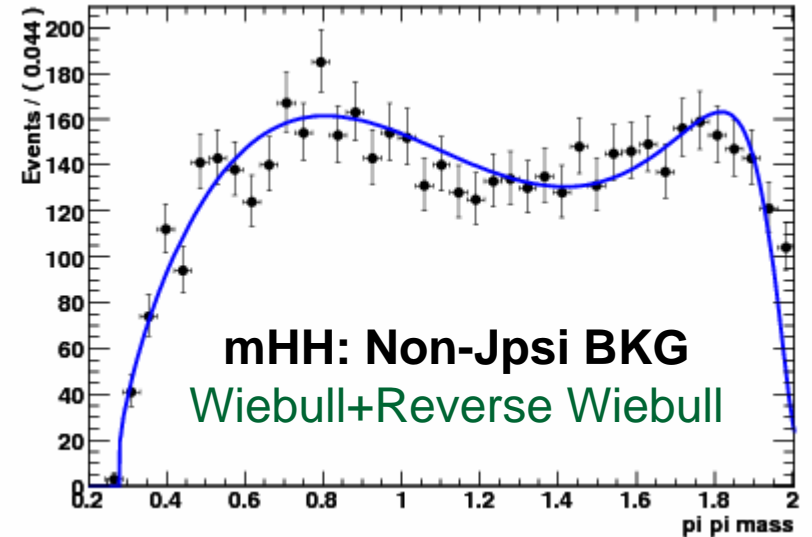
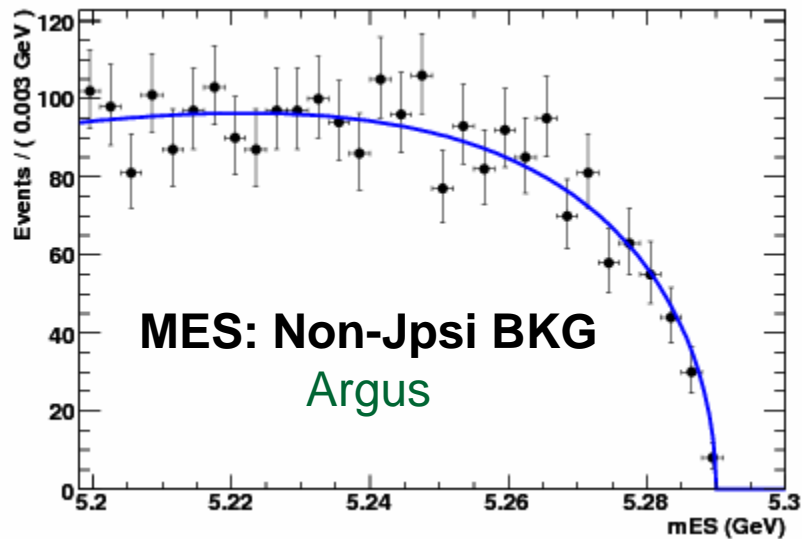
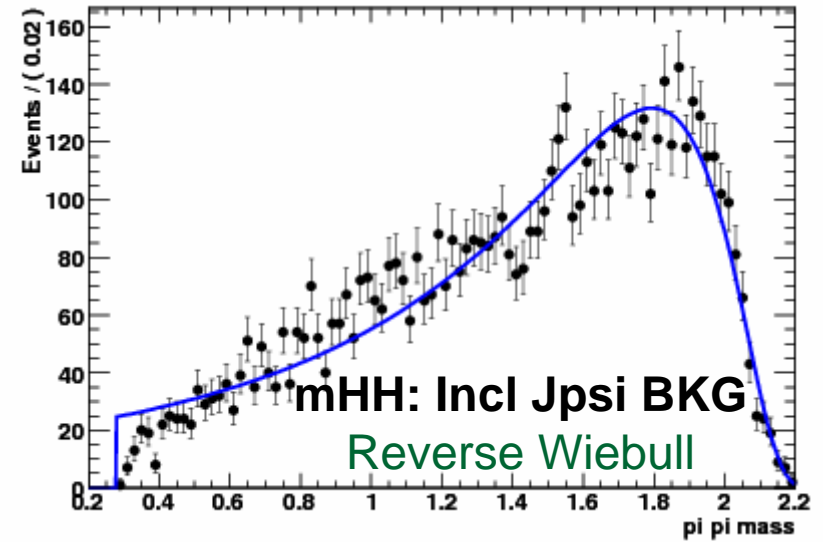
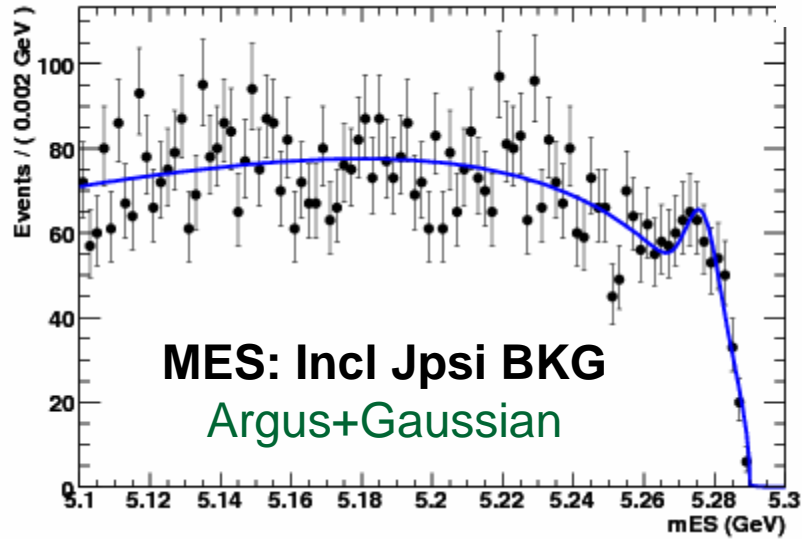
$$M_{ES} = \sqrt{\left(E_{beam}^{cms}\right)^2 - \left(p_B^{cms}\right)^2}$$

MES is fitted with a gaussian for signal and an Argus function for background

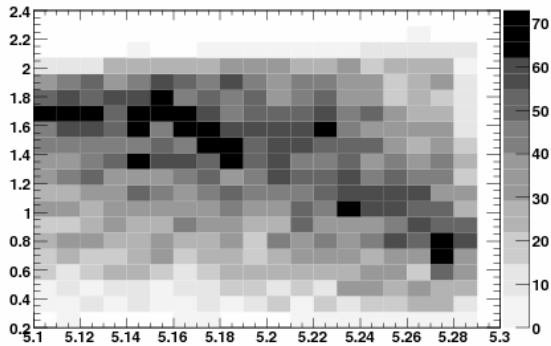
Signal Fits on Invariant Mass of PiPi



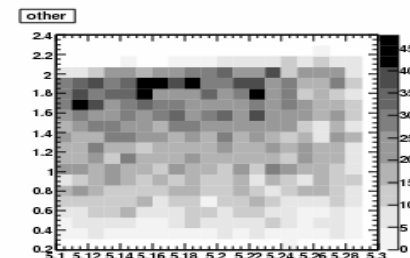
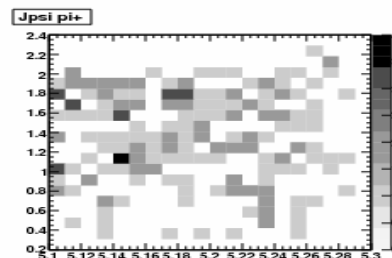
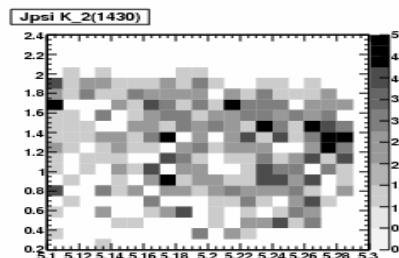
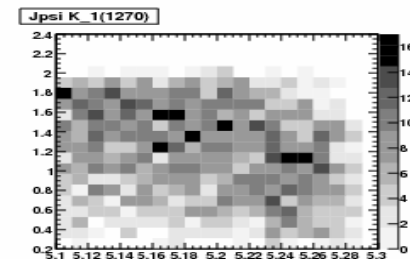
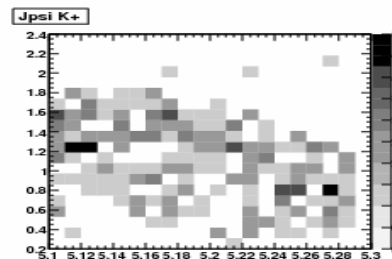
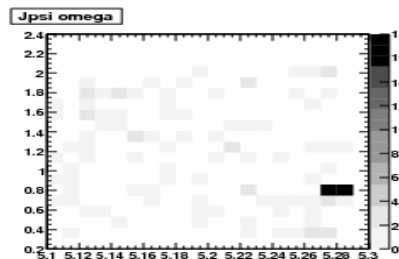
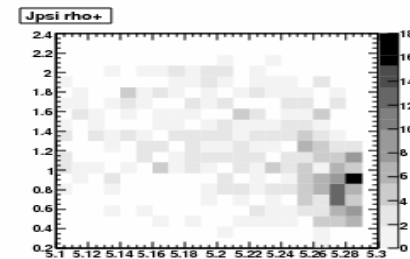
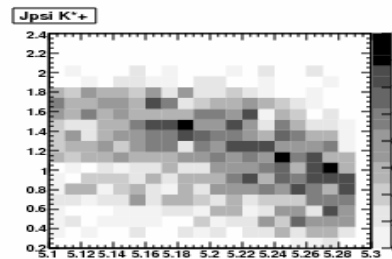
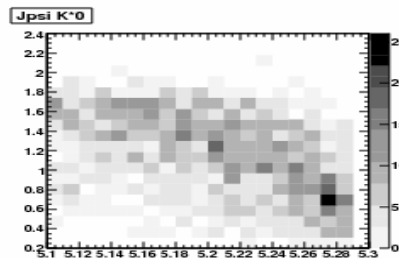
Fits to Jpsi & non-Jpsi Backgrounds



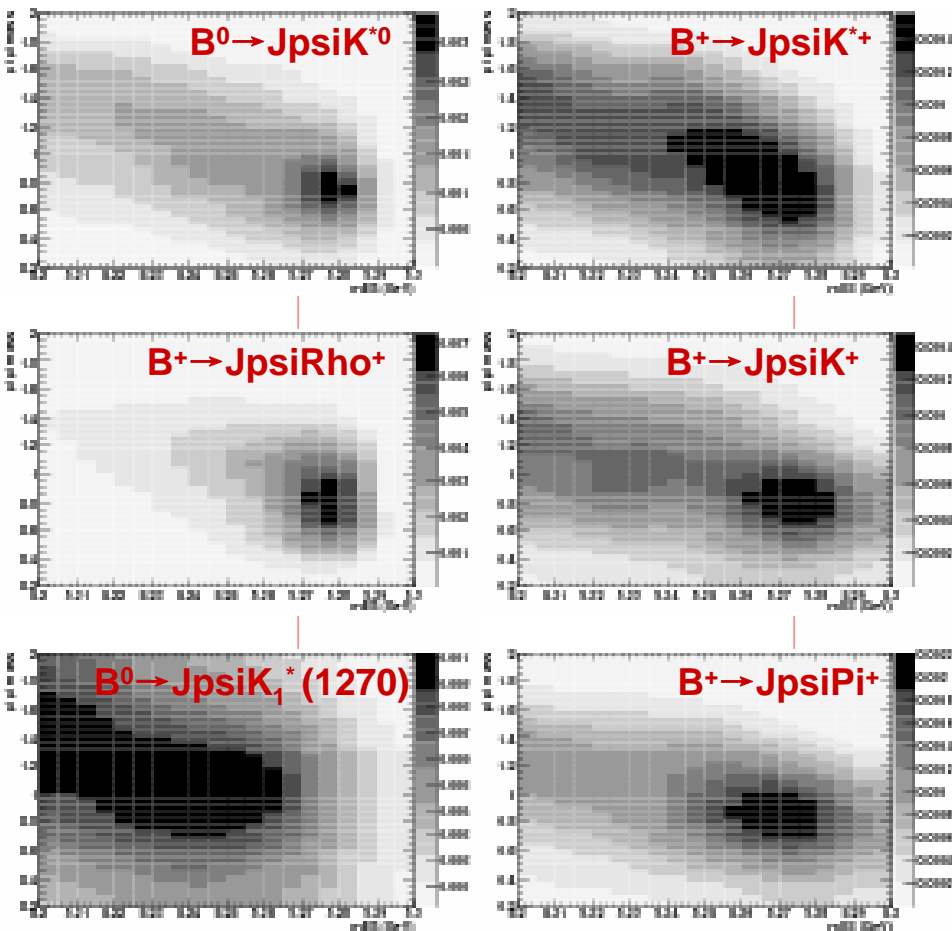
Exclusive Jpsi Background Modes (1)



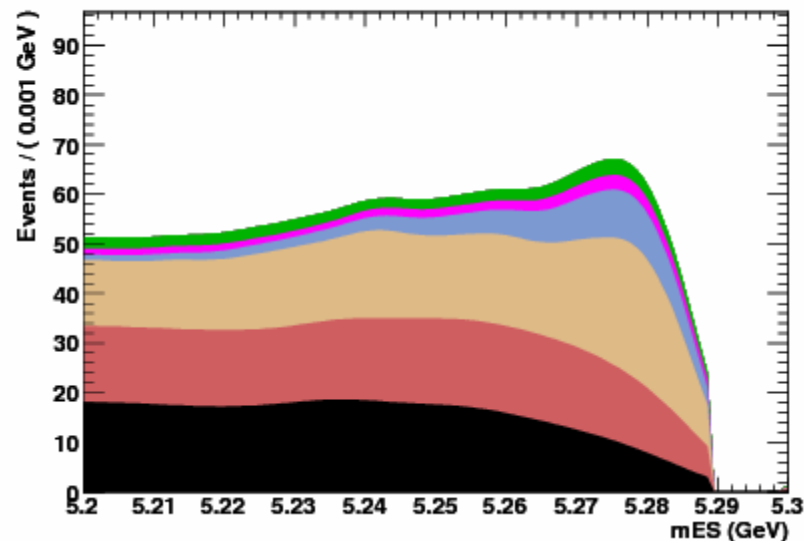
- It was discovered that the left 2D plot of invariant mass against MES of the inclusive Jpsi background gave a strong correlation.
- This resulted in the investigation of the exclusive modes that were responsible for such impermissible behaviour.
- The eight modes that were deigned to be the main culprits are plotted as shown below.



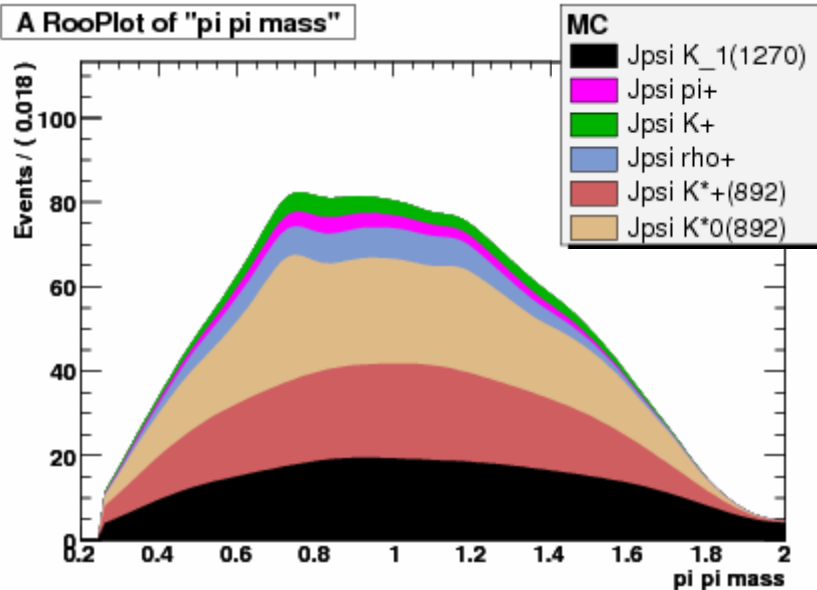
Exclusive Jpsi Background Modes (2)



A RooPlot of "mES"



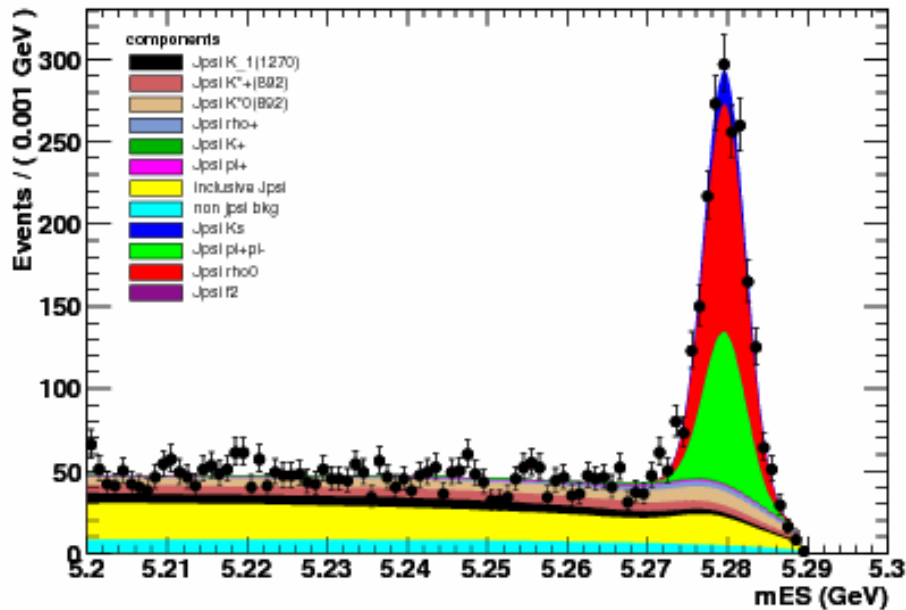
A RooPlot of "pi pi mass"



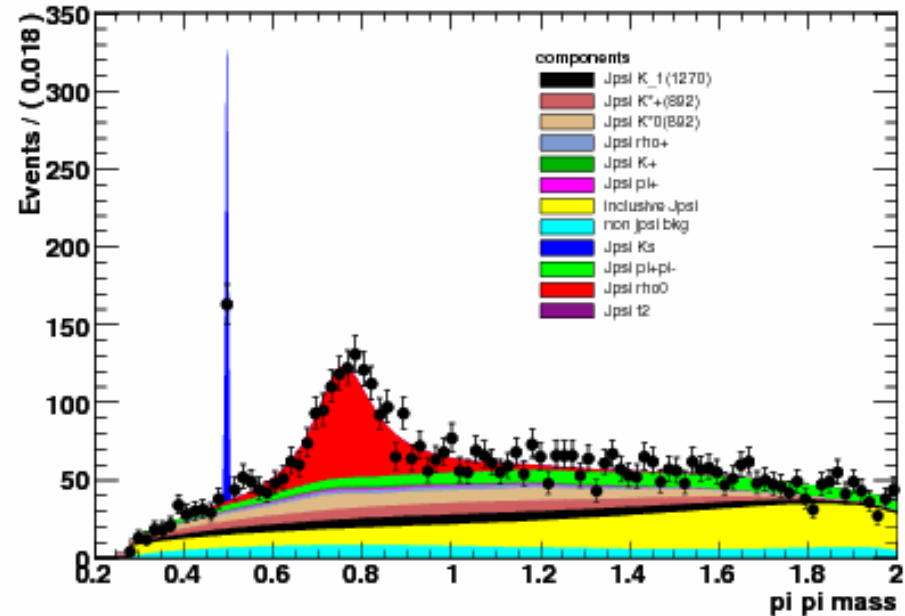
- The 2D histograms above depict the exclusive modes' MES against their corresponding invariant mass plots using a 2D-Keys fit.
- The histograms on the right are the projection of the respective slices of stacking the above 2D-plots on top of each other.
- For the exclusive modes, all parameters are fixed according to their known branching fractions from the latest PDG.

Full Final Fits on Monte Carlo

A RooPlot of "mES"



A RooPlot of "pi pi mass"



Branching Fraction of $B^0 \rightarrow J/\psi \rho^0$

Monte Carlo

3×10^{-5}

Fitted

$(3.09 \pm 0.15) \times 10^{-5}$

- The final fits describes the generic Monte Carlo pretty well and gives an excellent fit to the signal mode(s).

Conclusion

- Currently analysis is done using 205fb^{-1} . We will update it to 300fb^{-1} as well as complete the robustness test on the Toy MC studies within this fortnight.
- Analysis is blinded and we will await for our honourable Analysis Working Group's consent to unblind soon.
- On completion, plan is to submit directly to PRD-RC.