



# Measurement of $J/\psi$ Elliptic Flow in Au+Au Collisions at $\sqrt{s_{NN}}=200$ GeV in STAR



QIU Hao (Institute of Modern Physics / Brookhaven National Laboratory)

for the STAR Collaboration

## Abstract

$J/\psi$  elliptic flow ( $v_2$ ) is sensitive to the  $J/\psi$  production mechanism and the collective motion of heavy quarks. It is predicted that  $J/\psi$  produced through direct nucleon-nucleon process have very limited  $v_2$ , and  $J/\psi$  produced by the recombination of c and  $\bar{c}$  pairs could carry finite  $v_2$ , depending on the interaction between charm quarks and the medium. We present STAR's  $J/\psi$   $v_2(p_T)$  measurement from 200 GeV Au+Au collisions. Considering errors of the measurement, the results are found to be consistent with zero, thus disfavor the case that  $J/\psi$  is produced dominantly by coalescence of thermalized charm quarks.

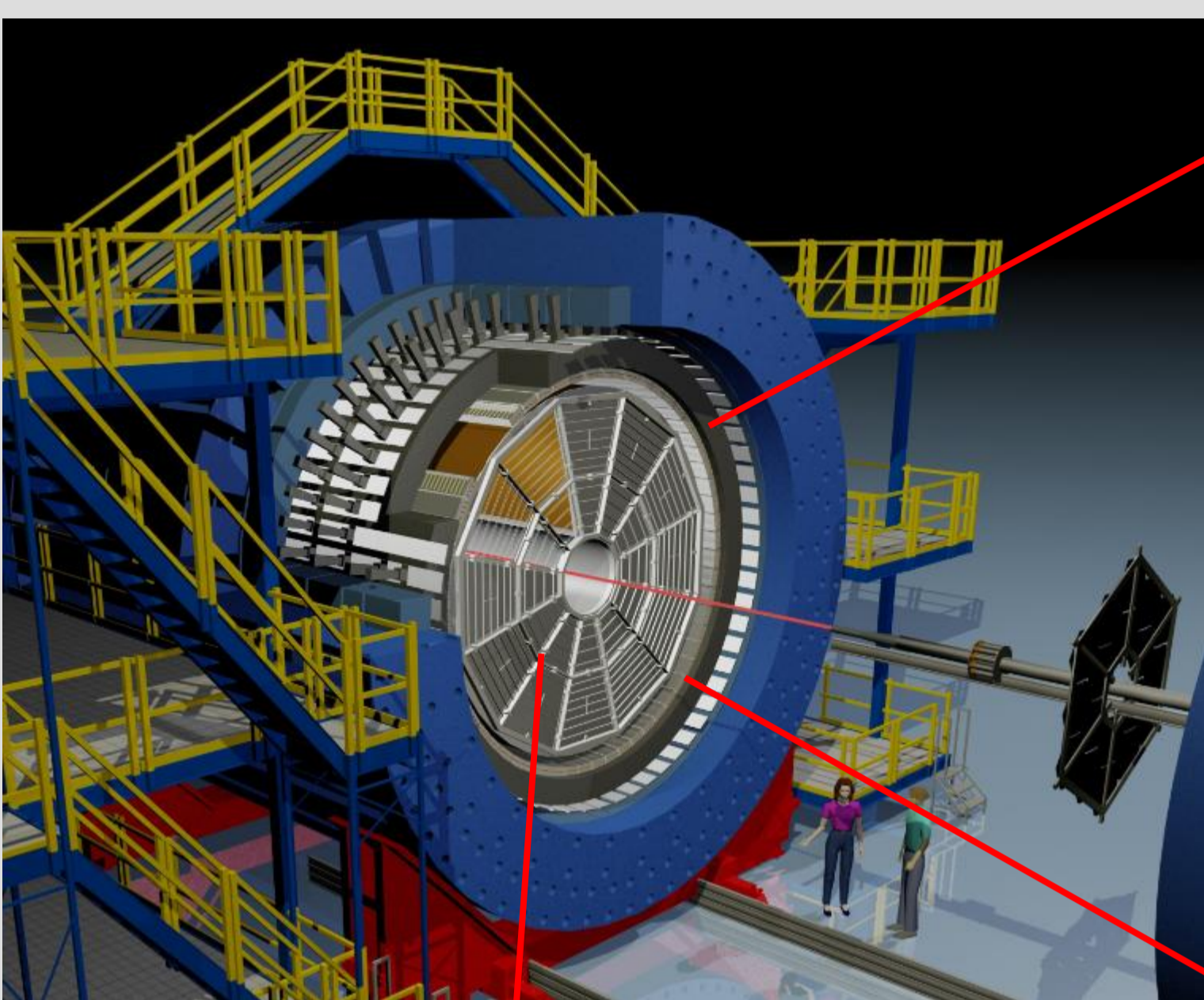
## Motivation

$J/\psi$  elliptic flow ( $v_2$ ) can be used to probe its production mechanism.

- Direct pQCD production  $\rightarrow$  Limited  $v_2$
- Produced by coalescence of thermalized charm quarks  $\rightarrow$  Large  $v_2$

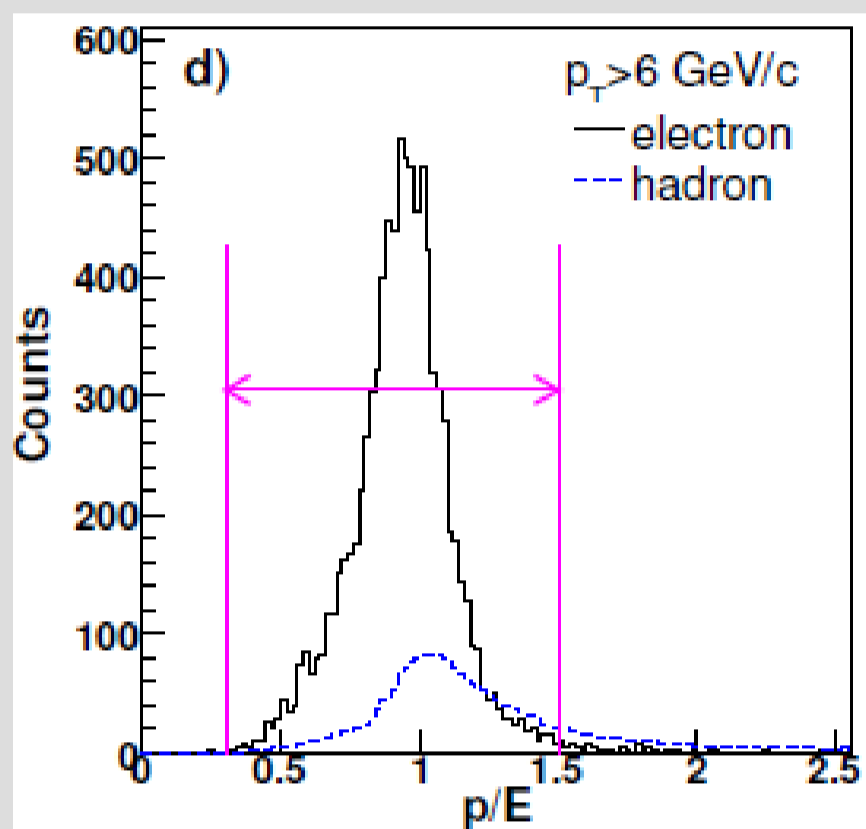
## $J/\psi$ Identification

$J/\psi \rightarrow e^+e^-$  decay branching ratio 5.9 %

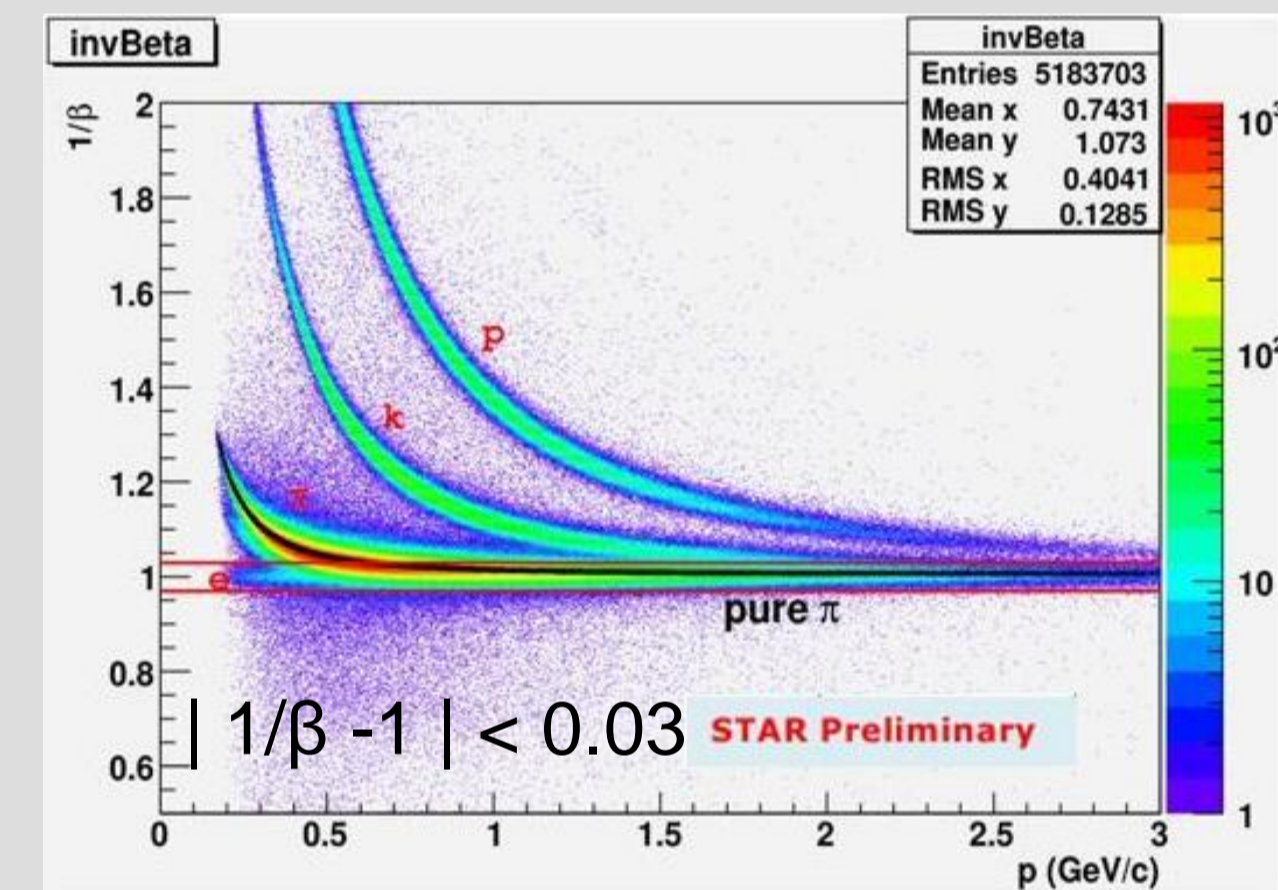


Barrel Electro-Magnetic Calorimeter (BEMC)

$0.3 < p/E < 1.5$   
Equal entries for e vs. h.

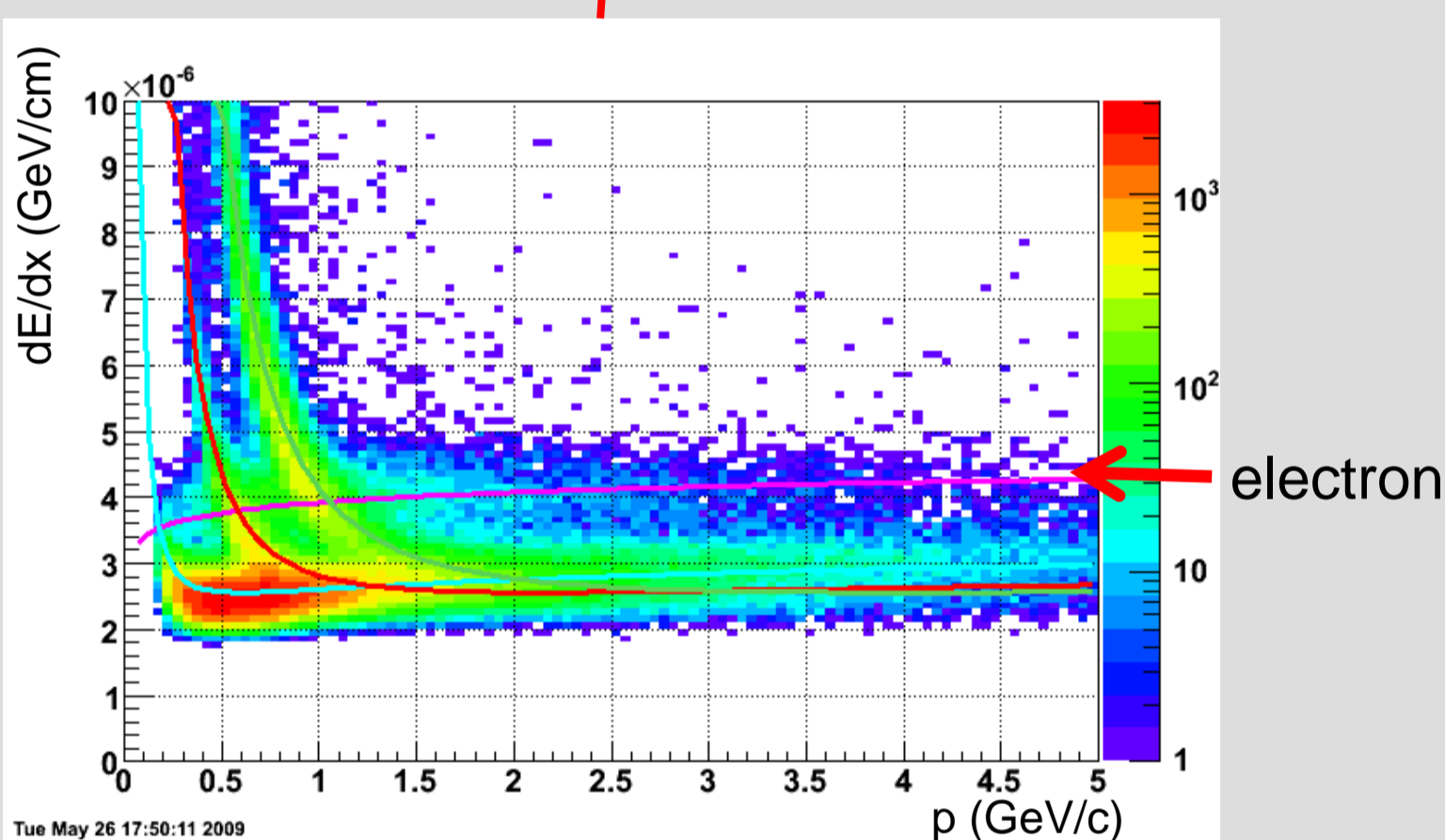


Time Of Flight (TOF) detector

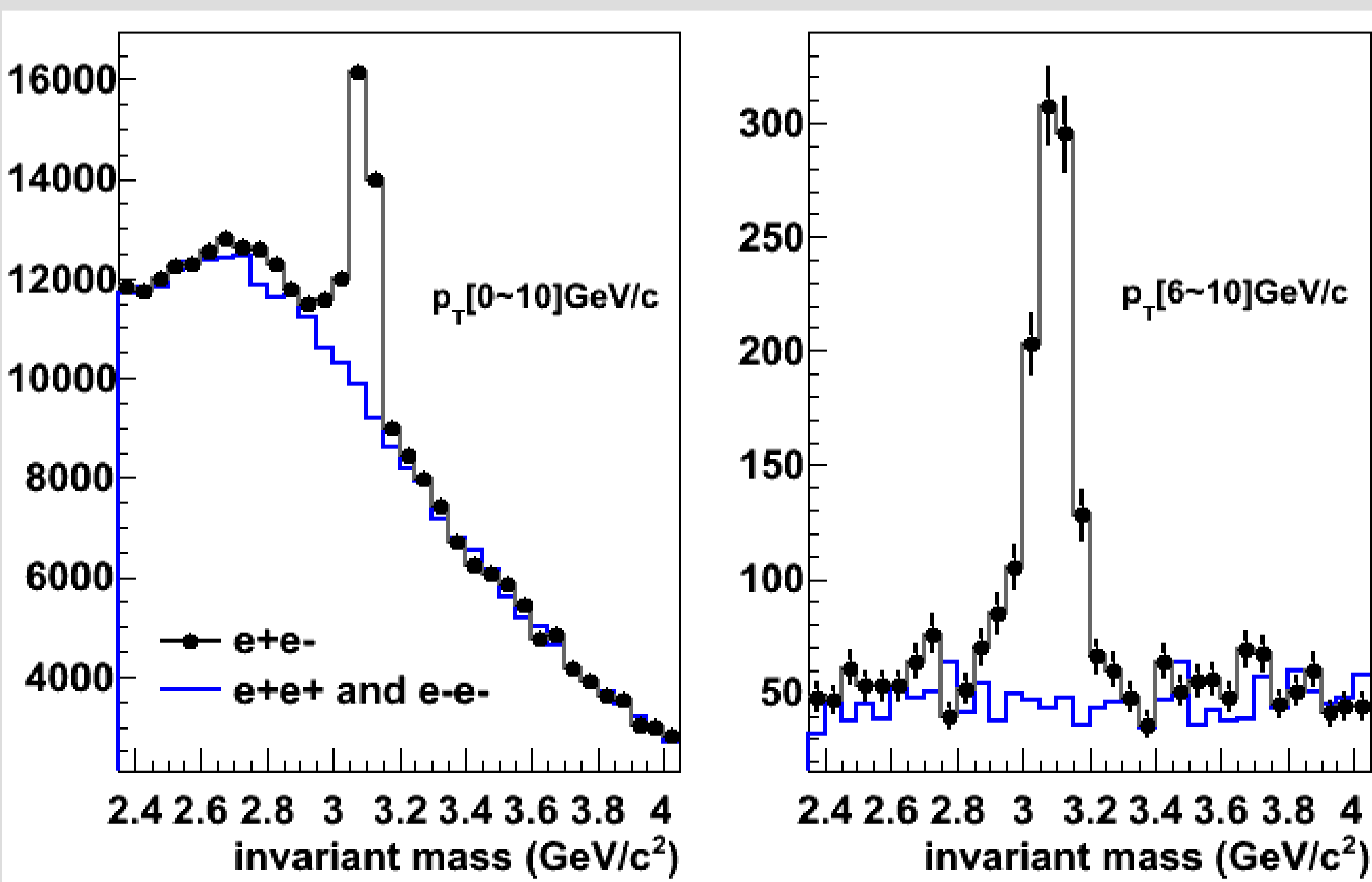


$\beta = \text{path length} / \text{TOF} / c$

Time Projection Chamber (TPC)



## $J/\psi$ Signal

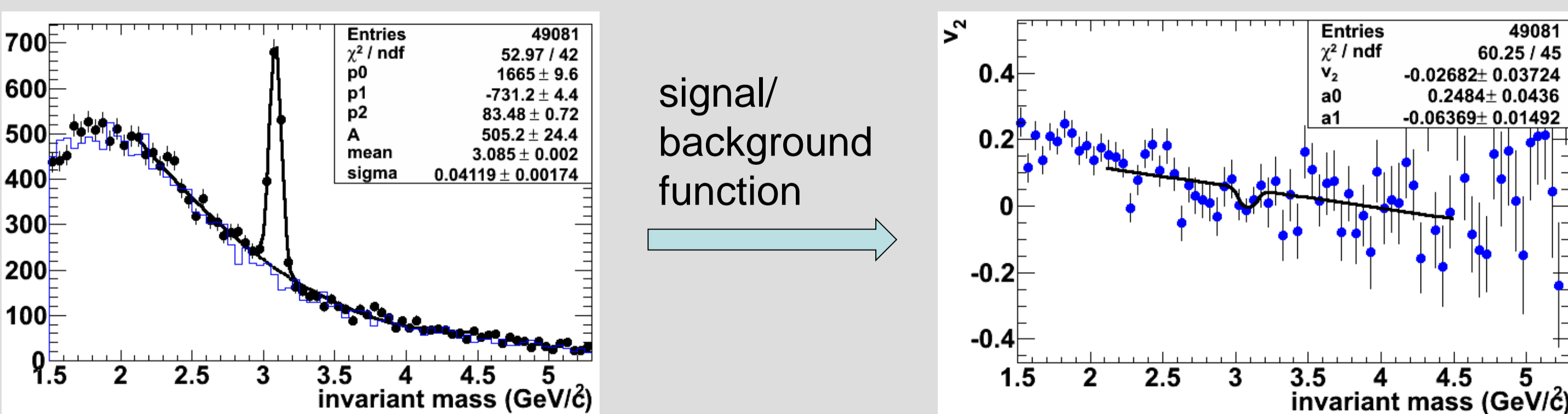


- > 14000  $J/\psi$ s identified
- > prominent signal for  $p_T > 6$  GeV/c region.

Data used in this analysis:

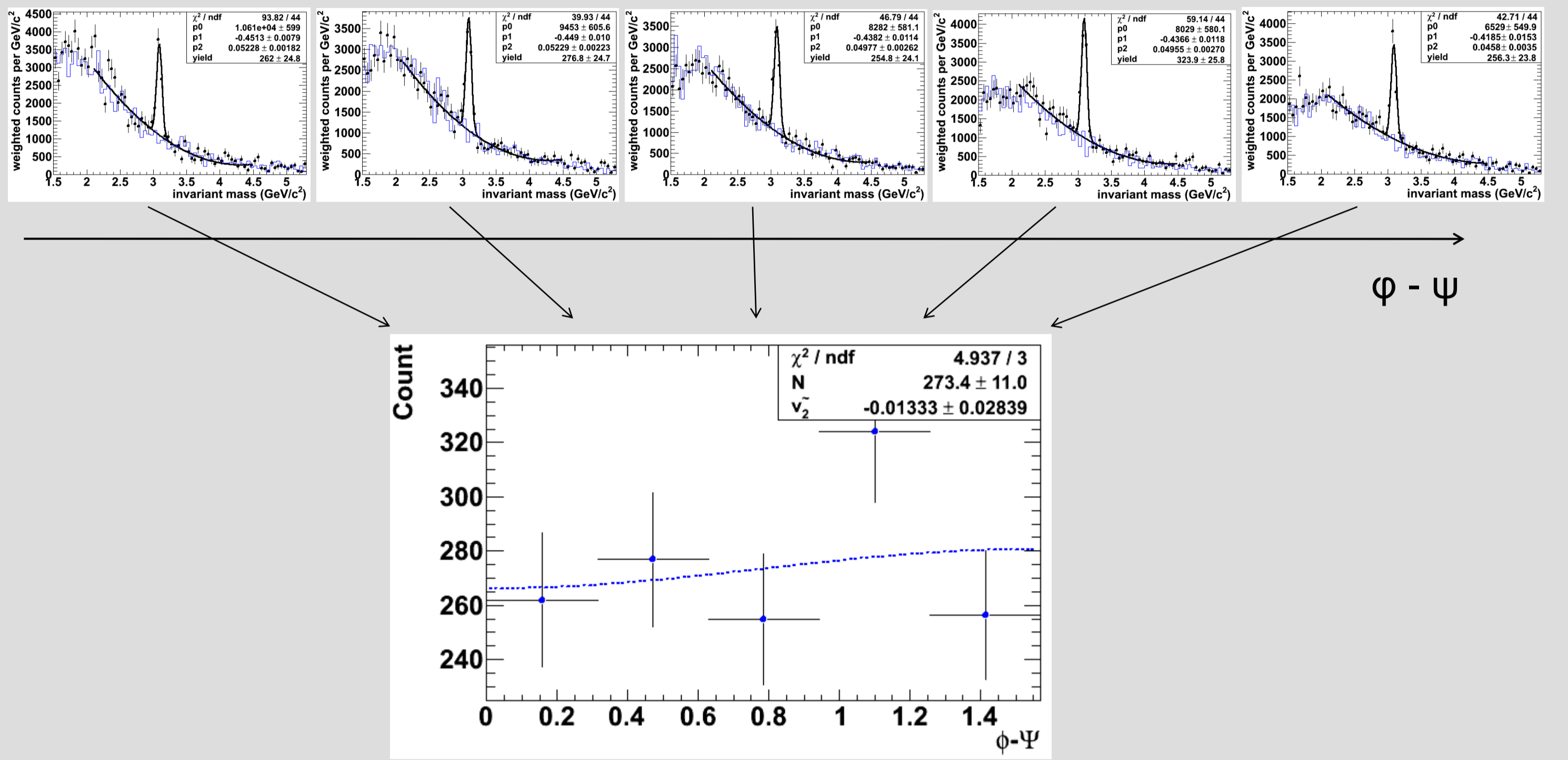
- > 350 million minimum bias events
- > 270 million central events
- > BEMC high tower triggered events equivalent to ~ 7 billion minimum bias in the relatively higher  $p_T$  region.

## Invariant mass method to calculate $v_2$

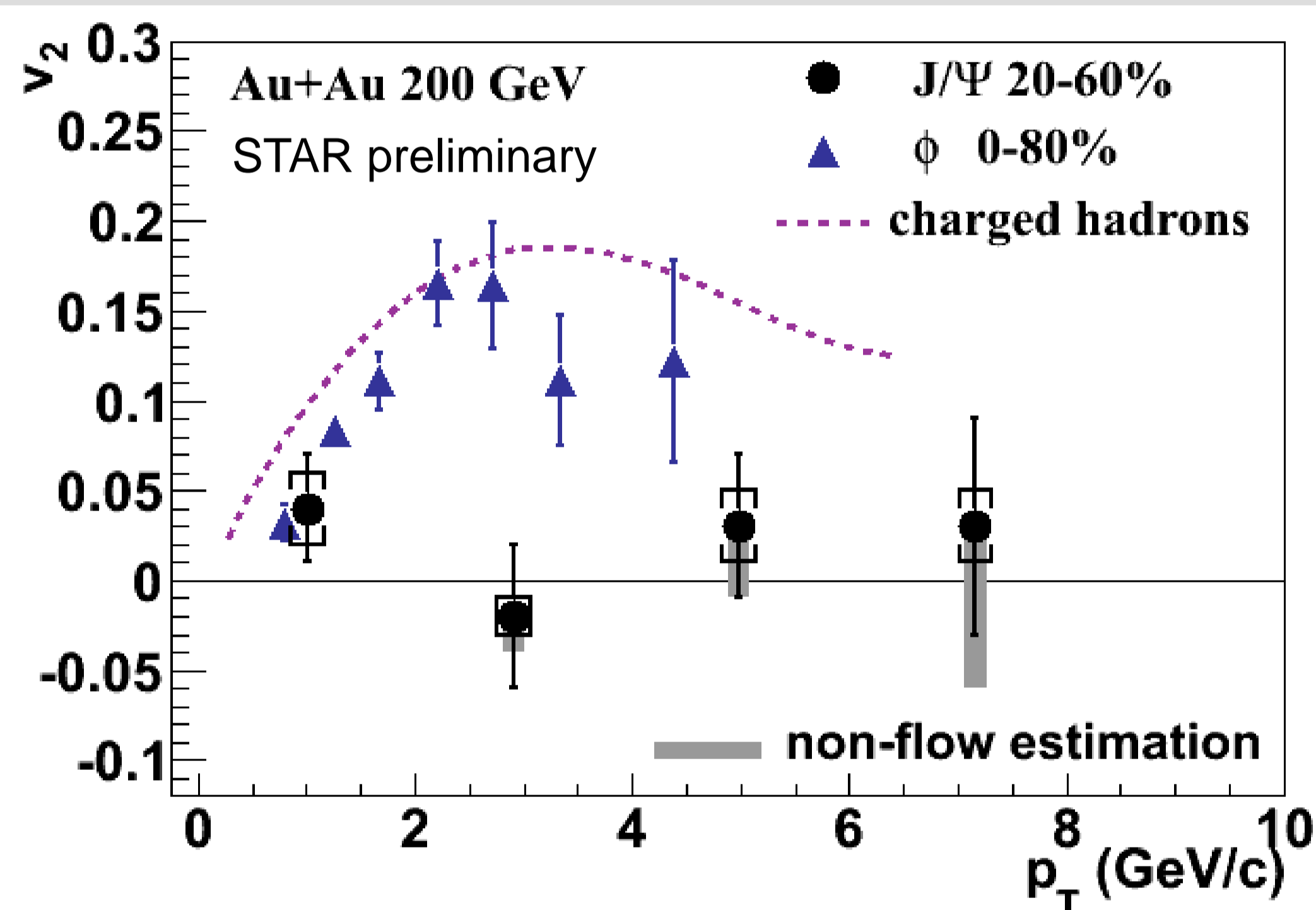


$$v_{2\_overall}(m) = (v_{2\_J/\psi} * s(m) + v_{2\_background}(m) * b(m)) / (s(m) + b(m))$$

## $\phi - \Psi$ method to calculate $v_2$



## Results

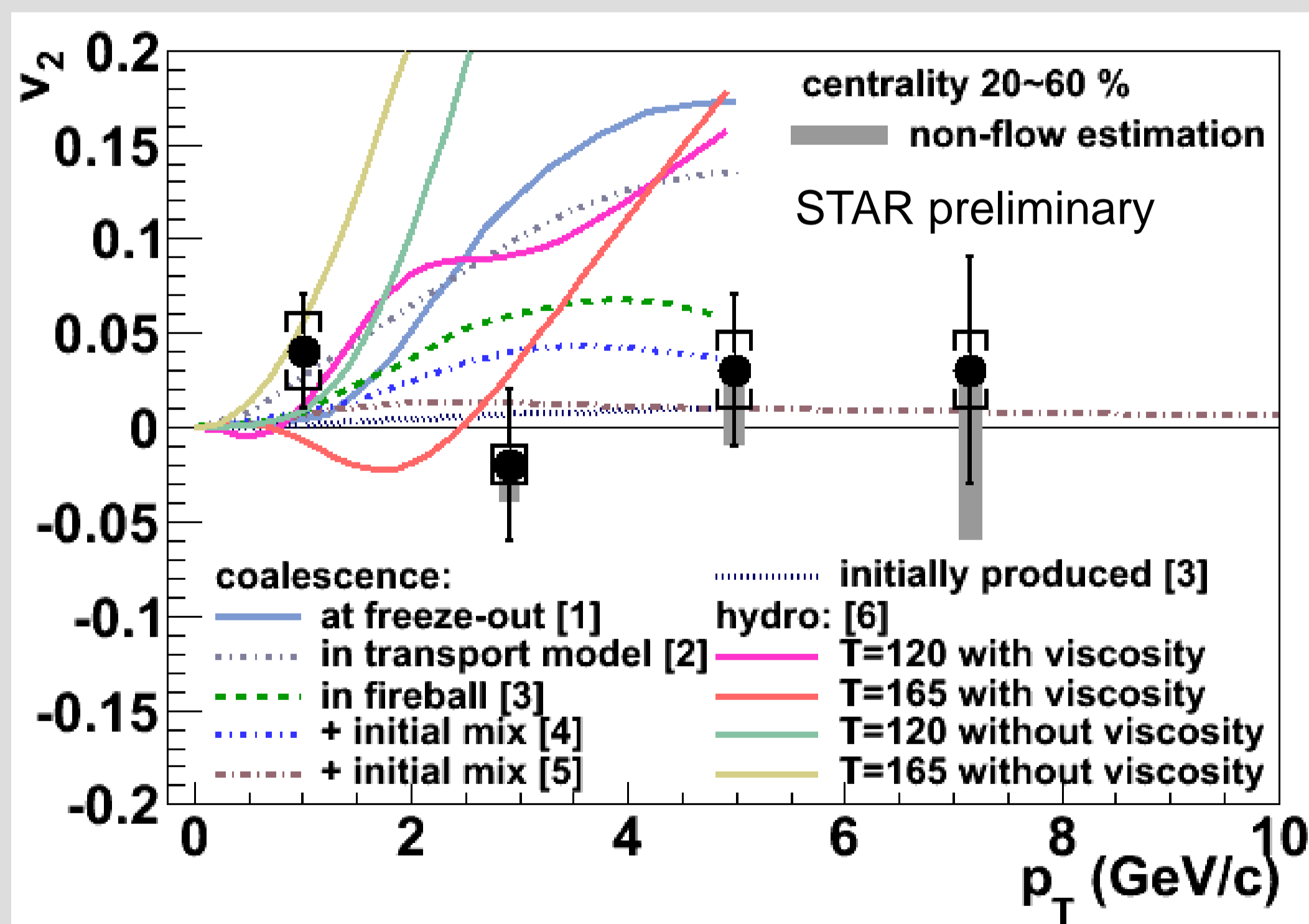


Showing on the left is  $v_2$  as a function of transverse momentum for  $J/\psi$  as well as light flavor particles. Unlike charged hadrons and  $\phi$ ,  $J/\psi$   $v_2(p_T)$  is found consistent with zero considering errors of the measurement.

The color bands represents the non-flow effect estimated from  $J/\psi$ -hadron correlation in p+p collisions. The brackets are systematic errors estimated from different methods and cuts. The mean value of  $p_T$  for each  $p_T$  bin is used.

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This plot shows the same  $J/\psi$   $v_2(p_T)$  comparing with different theoretical calculations. The data disfavors the case that  $J/\psi$  is produced dominantly by coalescence of thermalized charm quarks. More statistics (x2) are expected from the current RHIC run.

[1] V. Greco, C.M. Ko, R. Rapp, PLB 595, 202.

[2] L. Ravagli, R. Rapp, PLB 655, 126.

[3] L. Yan, P. Zhuang, N. Xu, PRL 97, 232301.

[4] X. Zhao, R. Rapp, 24th WWND, 2008.

[5] Y. Liu, N. Xu, P. Zhuang, Nucl. Phys. A, 834, 317.

[6] U. Heinz, C. Shen, private communication.

## Summary

Considering errors of the measurement,  $J/\psi$  elliptic flow measured by STAR is found to be consistent with zero, which disfavors the case that  $J/\psi$  is produced dominantly by coalescence of thermalized charm quarks. More statistics (x2) in Au+Au collisions are expected from the current RHIC run.

