Measurement of vector mesons via di-electrons in Cu+Cu collisions at $\sqrt{s_{NN}}$=200 GeV at RHIC-PHENIX

Susumu Oda
CNS, University of Tokyo
for the PHENIX collaboration

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東京大学大学院理学系研究科附属
原子核科学研究センター
Center for Nuclear Study (CNS)

PHENIX

1. Physics motivation

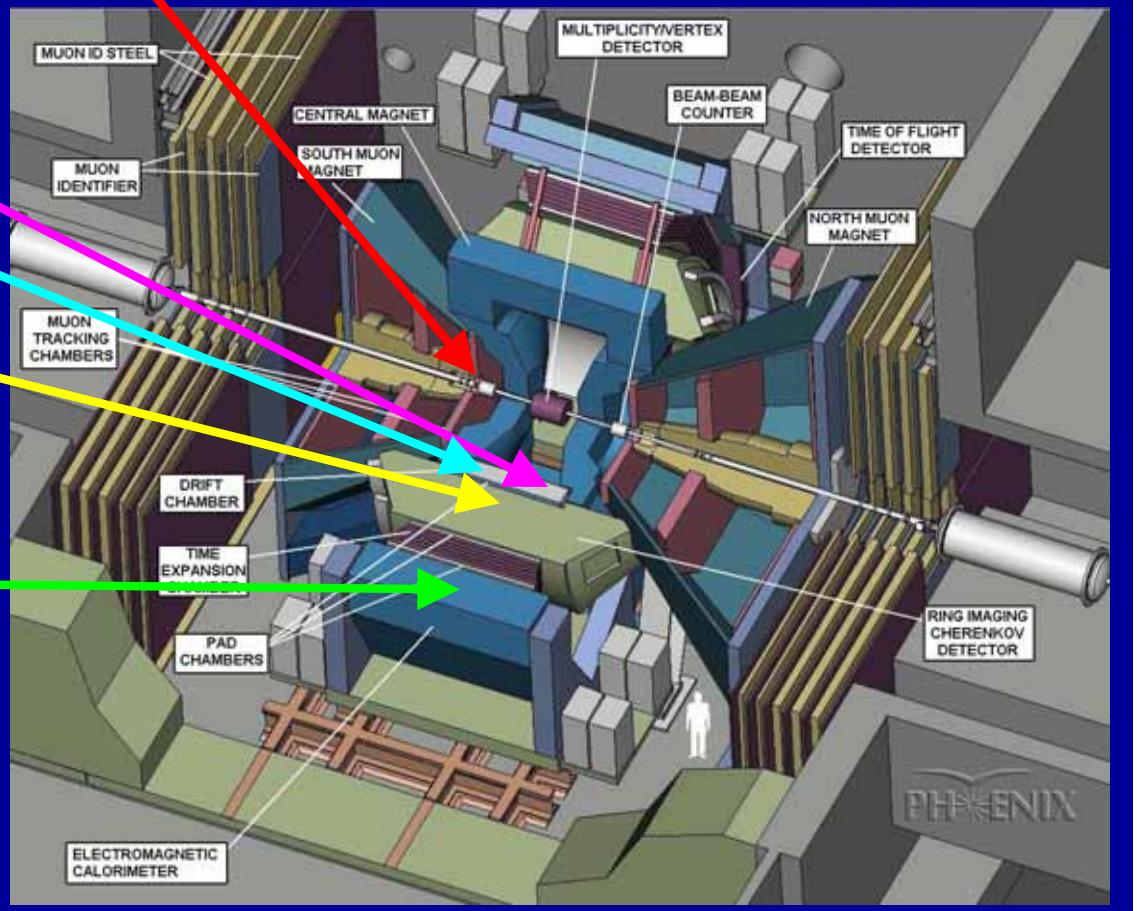
- Vector mesons (ρ, ω, ϕ, J/ψ, ψ' and Υ) have di-lepton decay channels.
- Lepton is a transparent probe of hot and dense matter.

- Yields of heavy quarkonia will be suppressed in a deconfined QGP by color screening.
- However, the yields will be modified by other competing processes.
  - Recombination, shadowing, heavy quark energy loss, etc.
- Therefore, systematic study of quarkonia production is important.
  - Nuclear species (p+p, d+Au, Cu+Cu and Au+Au)
  - Collision energy (22.4 GeV, 62.4 GeV, 130 GeV and 200 GeV)

- Chiral symmetry restoration can be studied by in-medium modification of low mass vector mesons.
  - Change of BdN/dy, mass and/or mass width

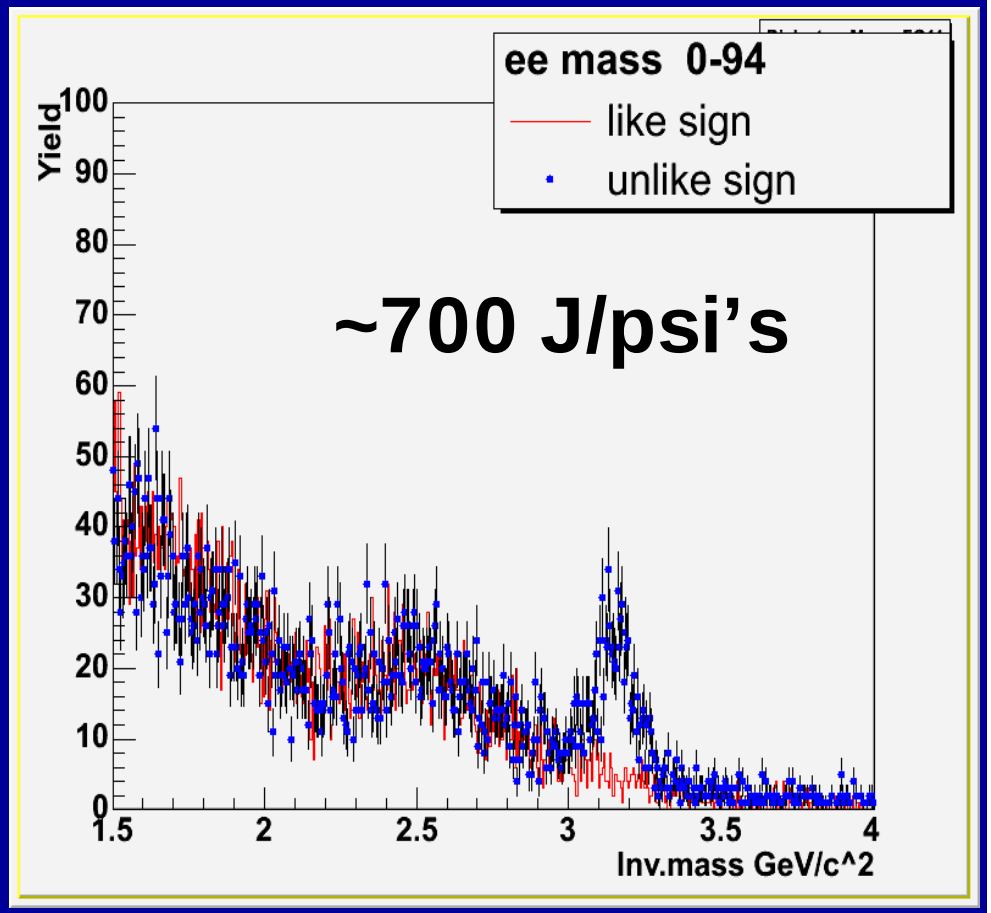
2. PHENIX Experiment

- **Beam Beam Counter**
  - Minimum bias trigger
  - Collision vertex
  - Centrality
- **Drift Chamber and Pad Chamber**
  - Momentum
- **Ring Imaging Cherenkov**
  - Electron ID
  - Electron trigger
- **EM Calorimeter**
  - Energy
  - Track matching
  - Electron trigger



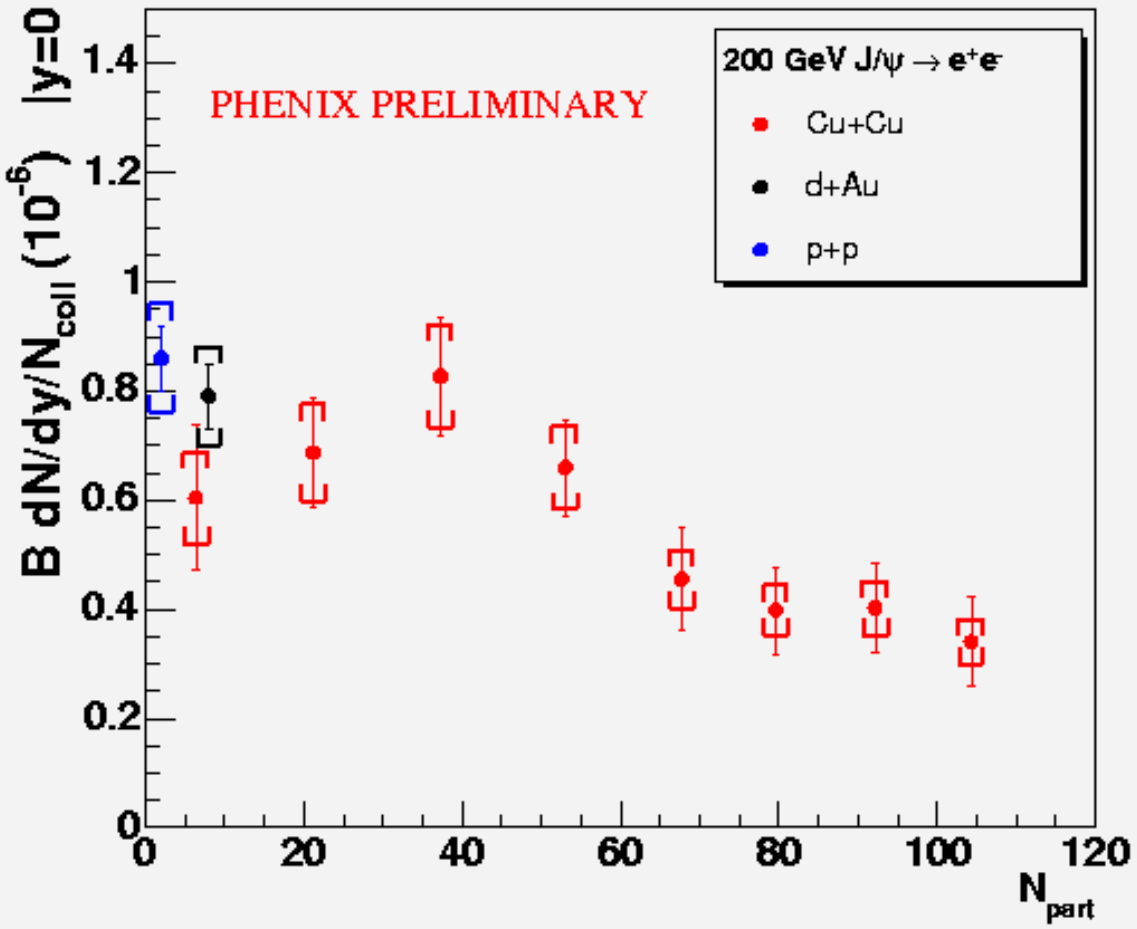
3-1. Analysis of J/psi Signal counting

- Electron trigger data set is analyzed.
  - 6.36 Billion minimum bias events
- Like sign method is used to estimate combinatorial background.
  - $N_{J/psi} = N_{+-} - (N_{++} + N_{--})$
- Mass window
  - $2.9 < \text{mass} < 3.3\ \text{GeV}/c^2$



Invariant mass spectrum for all centrality bins

3-2. Analysis of J/psi Yields vs. Nparticipant

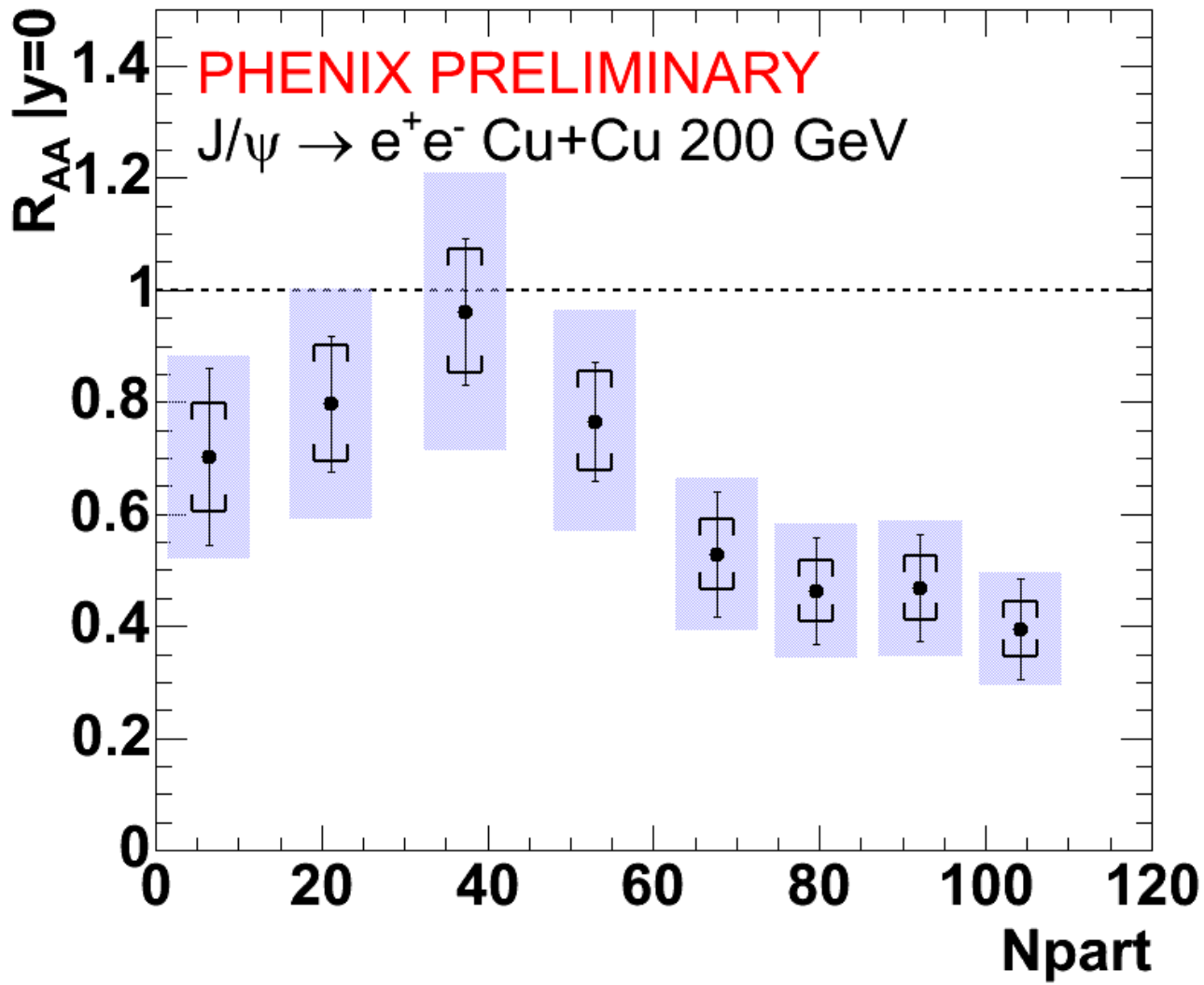


- Solid line : statistical error
- Bracket : point systematic error
- An overall scale systematic error of 18% is not shown.

- Centrality bins
  - 0 – 5%
  - 5 – 10%
  - 10 – 15%
  - 15 – 20%
  - 20 – 30%
  - 30 – 40%
  - 40 – 60%
  - 60 – 94%

- Strong suppression in central collisions.

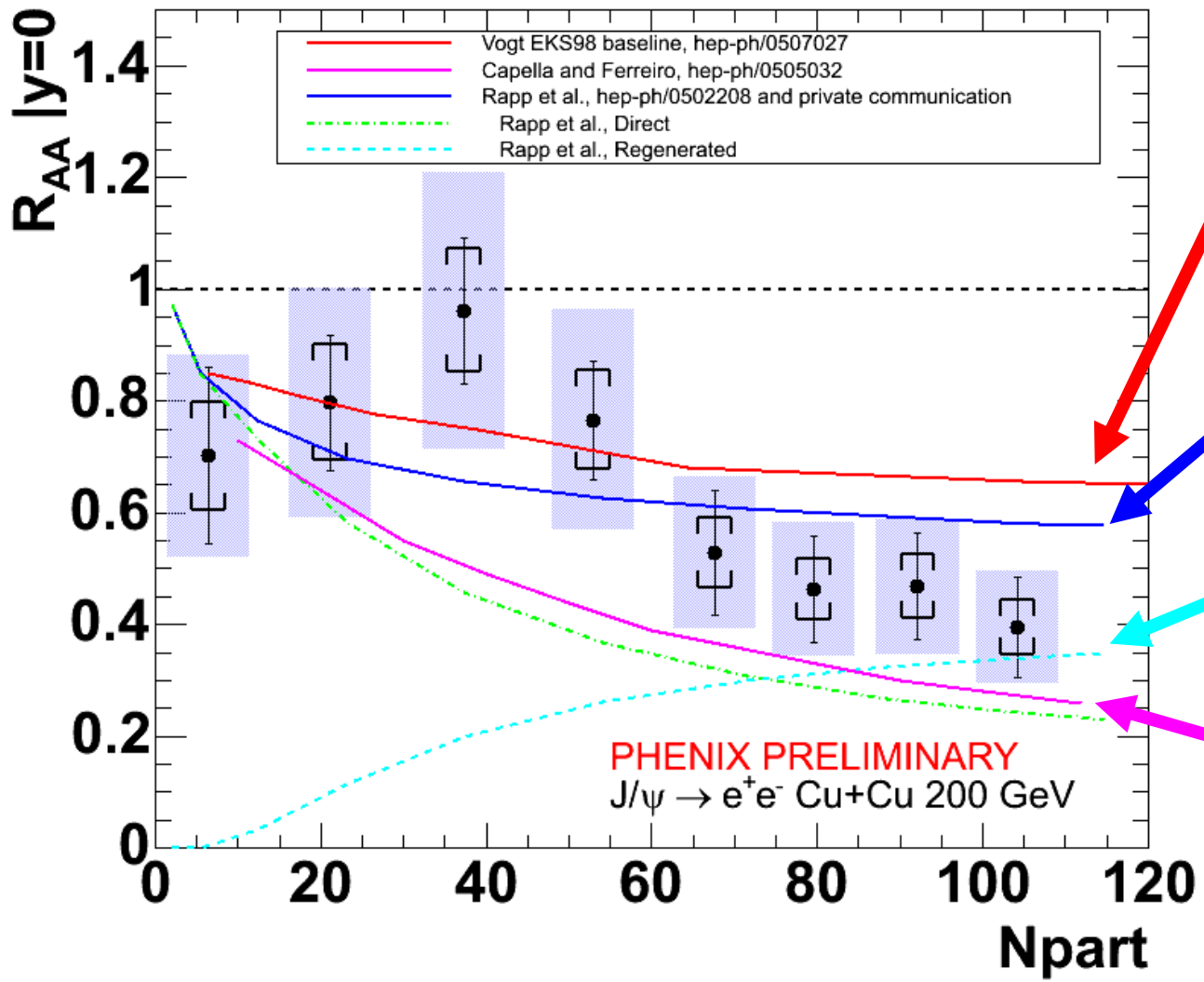
3-3. Analysis of J/psi Nuclear modification factor R_{AA} vs. N_{part}



- Solid line : statistical error
- Bracket : point systematic error
- Box : 26% overall scale systematic error

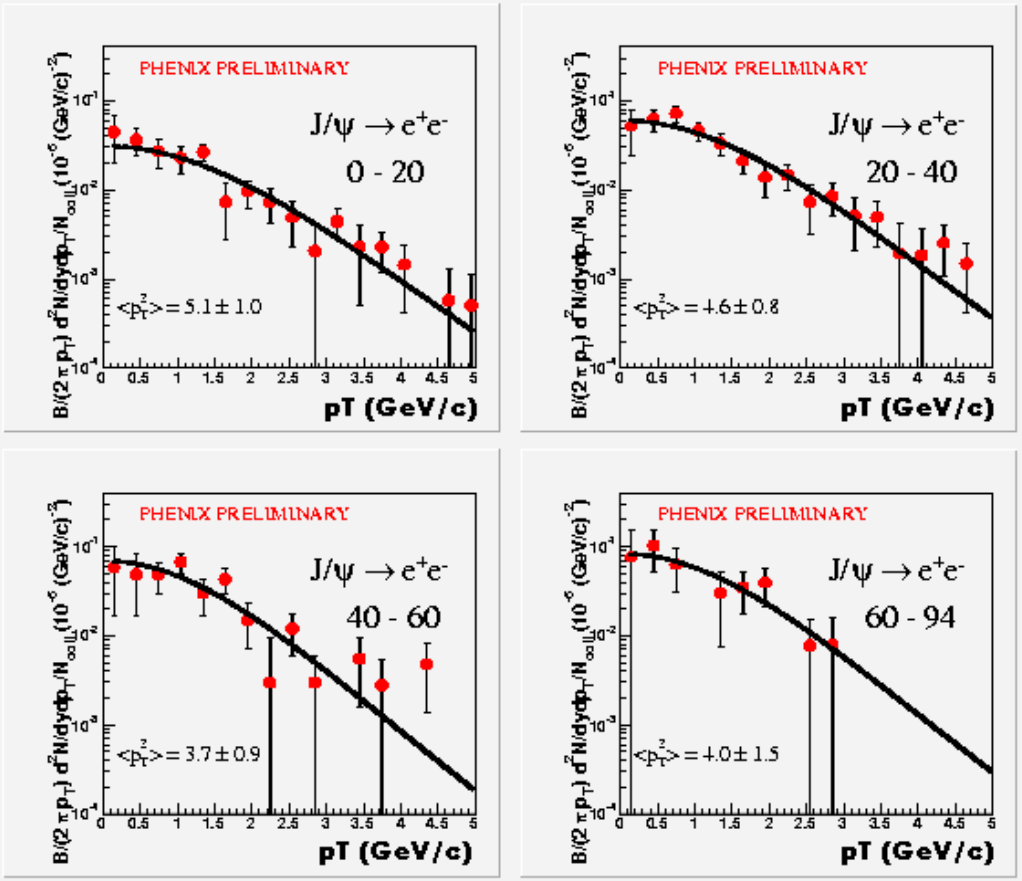
3-4. Comparison with models

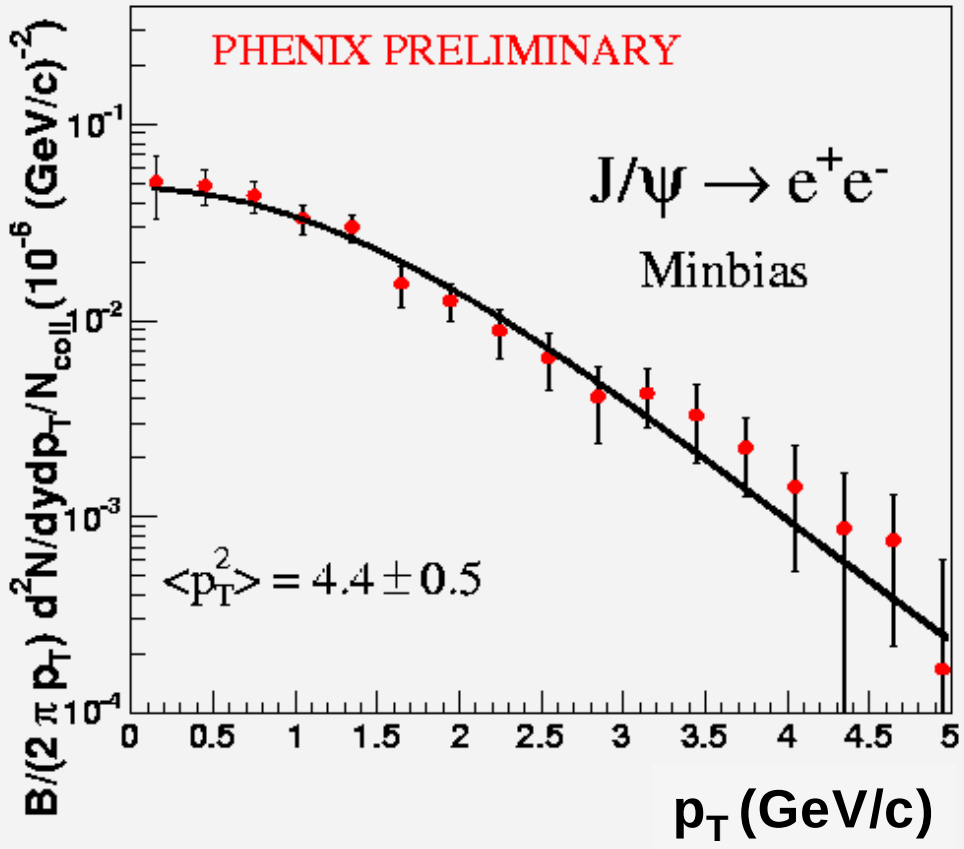
R_{AA} vs. N_{part}



- Cold nuclear matter model of R.Vogt seems to underpredict our observed suppression.
  - E866
- Recombination model of R.Rapp et al. seems to underpredict the suppression too.
  - Regenerated component has a large contribution even in Cu+Cu collisions.
- Comover model of A.Capella and E.G.Ferreiro seems to overpredict the suppression.
  - NA50

3-5. Analysis of J/psi p_T spectra



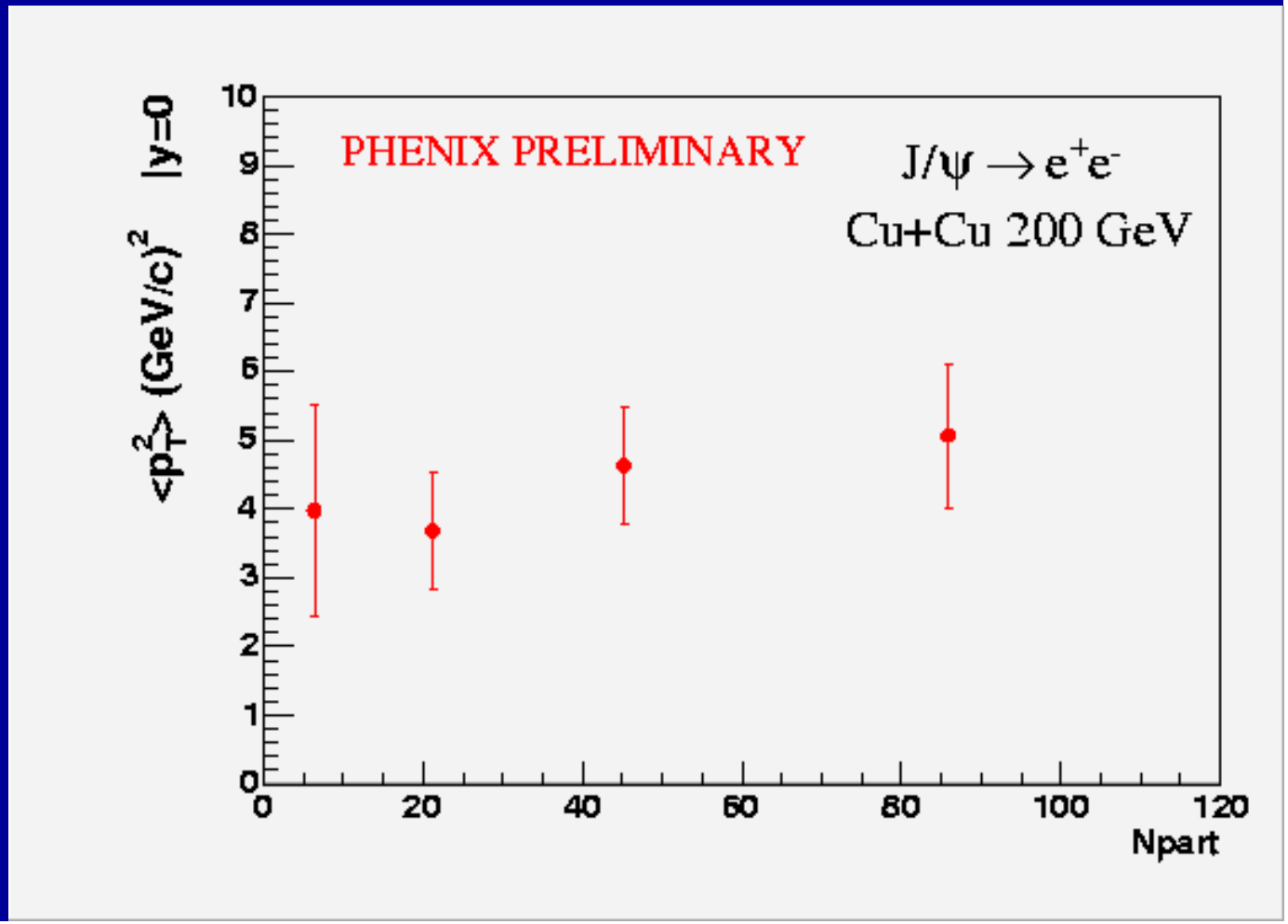


$$\frac{1}{2\pi p_T}\frac{d^2N}{dydp_T} \approx \frac{A}{\left(1+\left(p_T/B\right)^2\right)^6}$$

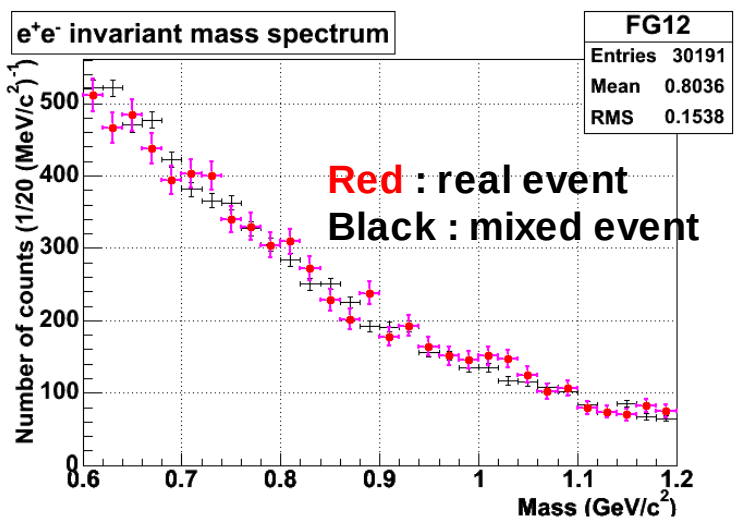
$$\left\langle p_T^2 \right\rangle = (B/2)^2$$

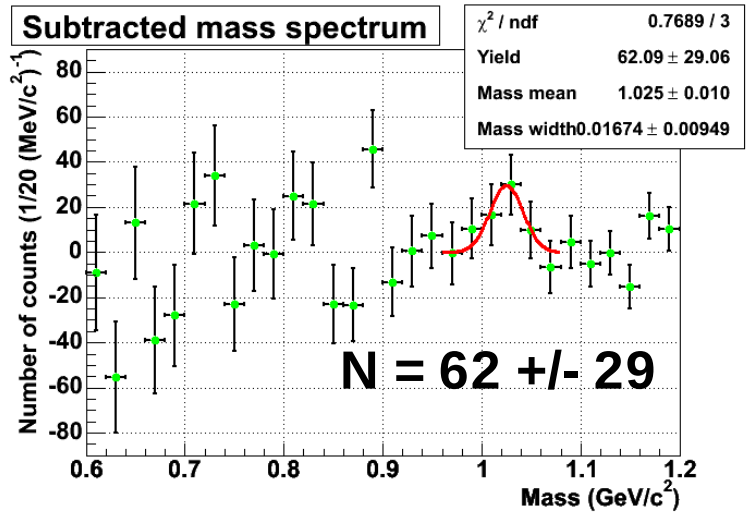
3-6. Analysis of J/psi $<p_T^2>$ vs. N_{part}

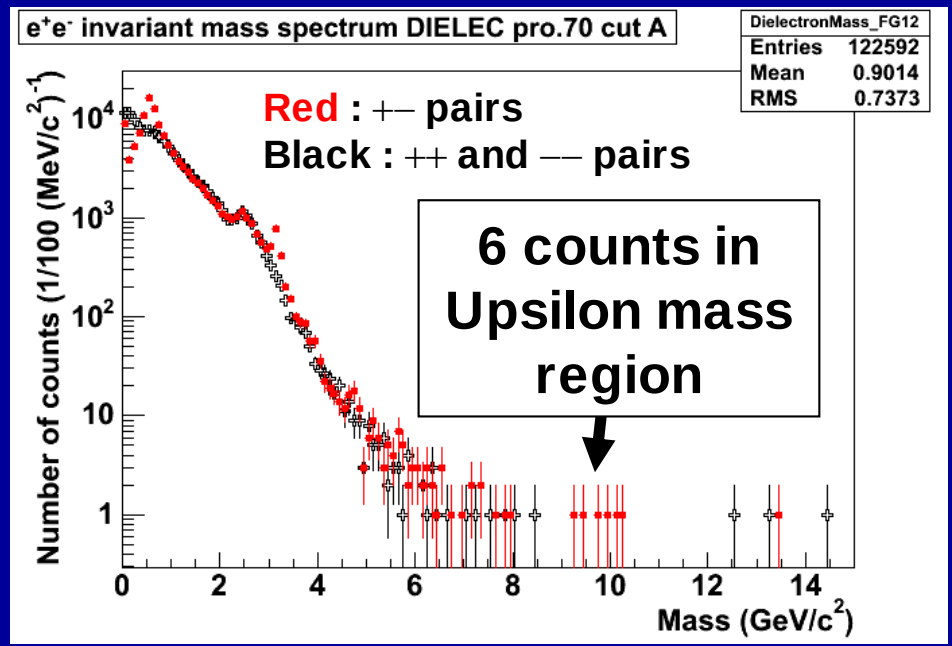
- No significant centrality dependence of $<p_T^2>$.



4. Analysis of low mass vector mesons and Upsilon







- Phi and Upsilon candidates are seen.
- ~1,000 phi's and ~10 Upsilons are expected with the whole Cu+Cu data.

5. Summary and outlook

- First results of the centrality dependence of $BdN/dy/N_{coll}$ and R_{AA} for Cu+Cu 200 GeV J/psi→e^+e^-.
  - Normal nuclear absorption seems to underpredict the observed suppression.
  - Recombination model also seems to underpredict the suppression.
  - Comover model seems to overpredict the suppression.
- First results of the J/psi p_T spectra with centrality.
  - No significant centrality dependence of $<p_T^2>$.
- Phi and Upsilon candidates are seen.

- Less systematic and statistical error results of J/psi and first results of LVM and Upsilon in Cu+Cu collisions (BdN/dy and R_{AA}) are expected after full data production (next year).