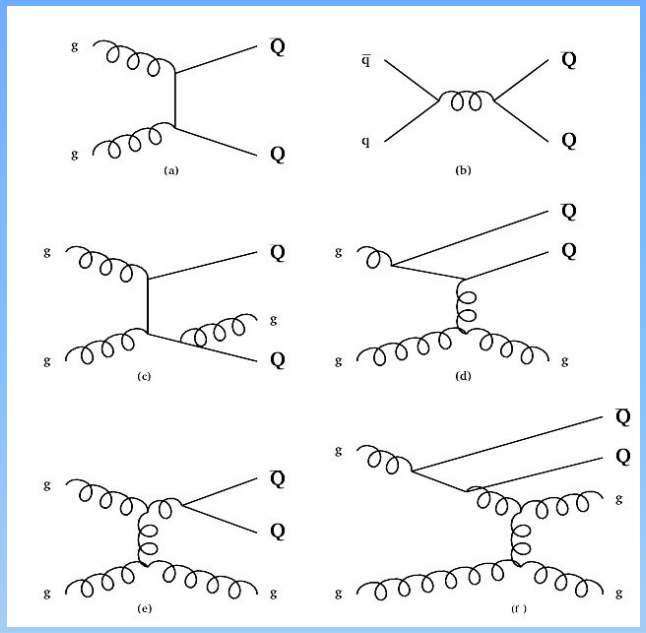
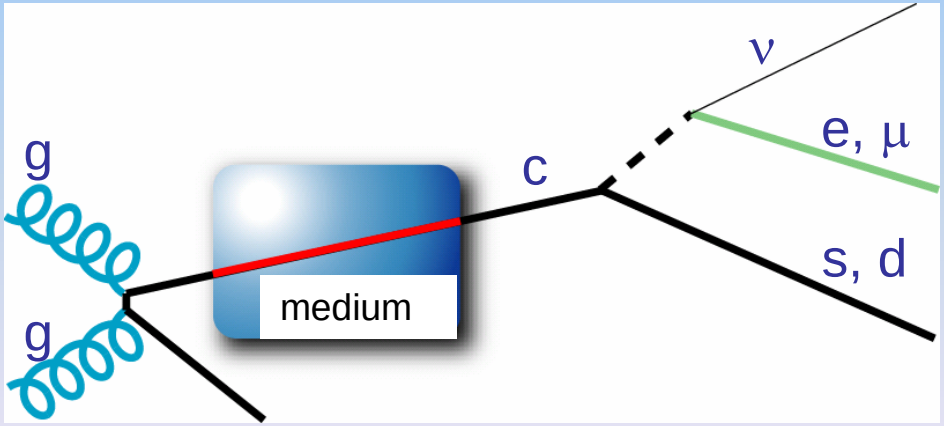
Measurements of Charm and Charmonium Production by PHENIX

Ken Read
ORNL / University of Tennessee
On behalf of the PHENIX Collaboration

Measuring Charm and Charmonium Production

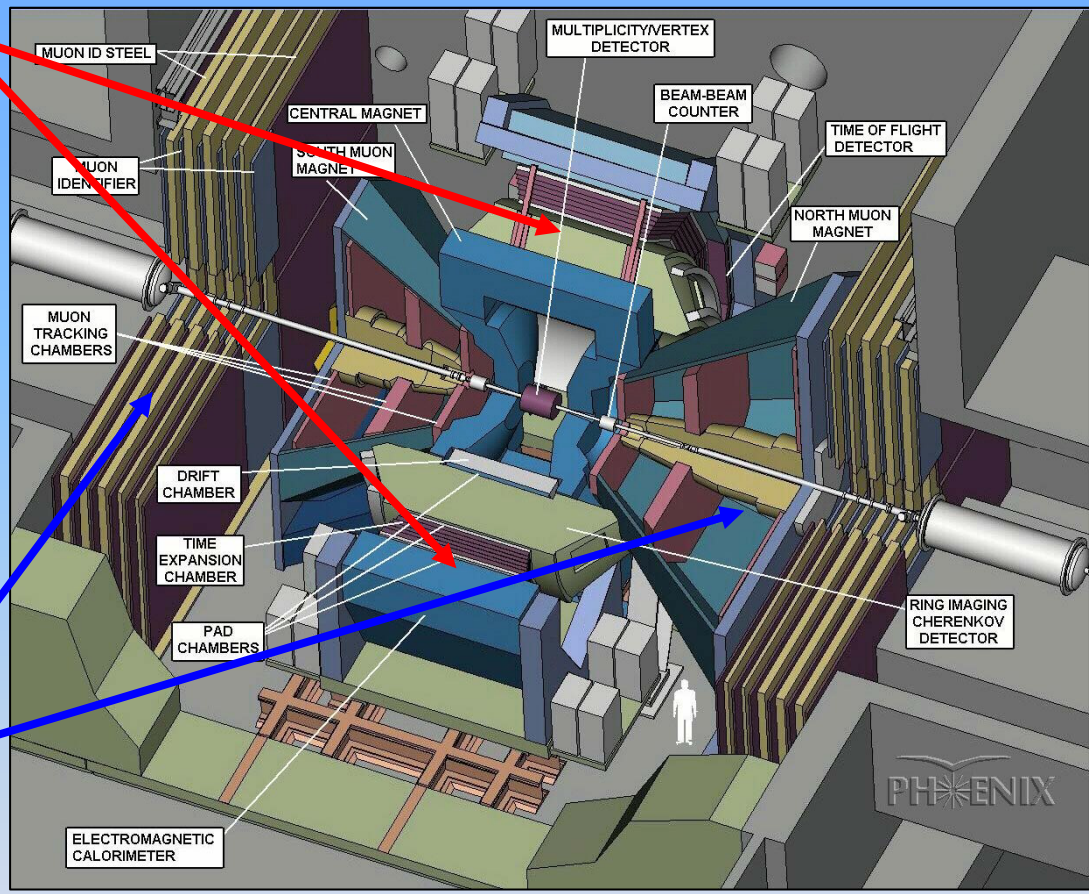
- p+p collisions
  - Test pQCD predictions at $\sqrt{s}$ = 200 GeV
  - Establish a baseline for total charm production for the heavy ion program
- Au+Au collisions
  - Measure medium modification effects (charm energy loss, collective flow)
  - Study potential thermal production of charm from QGP
  - Establish open charm baseline for J/ψ production





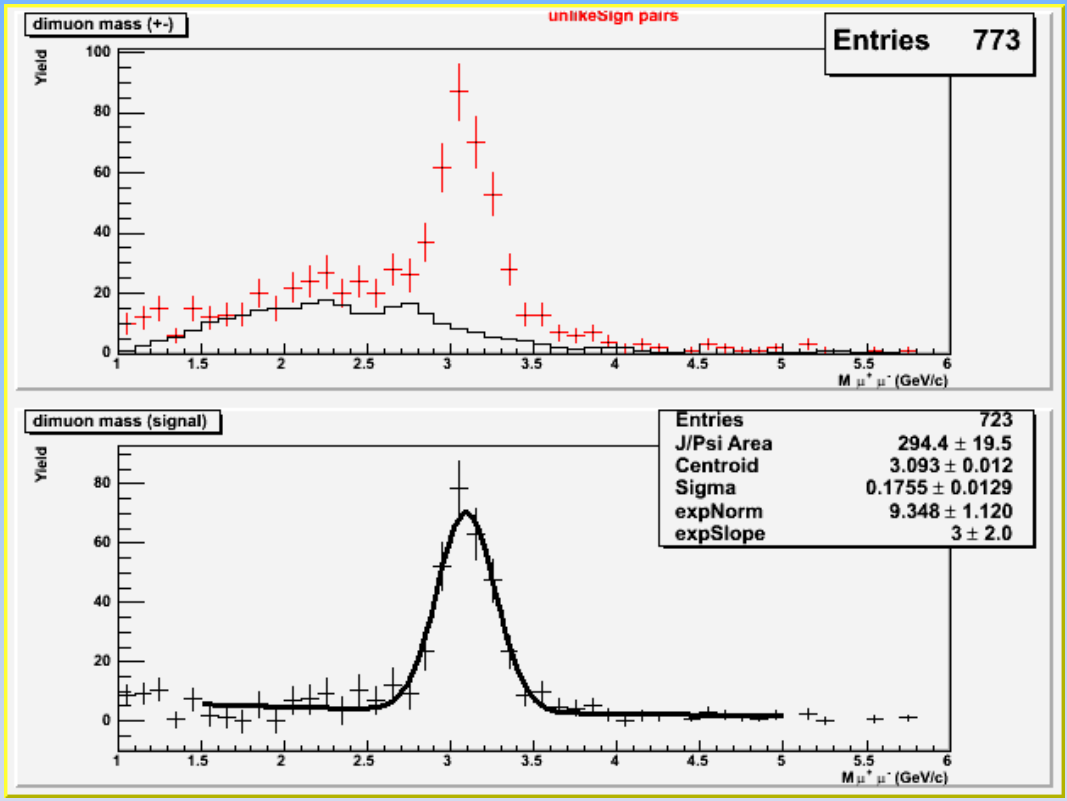
PHENIX Experiment

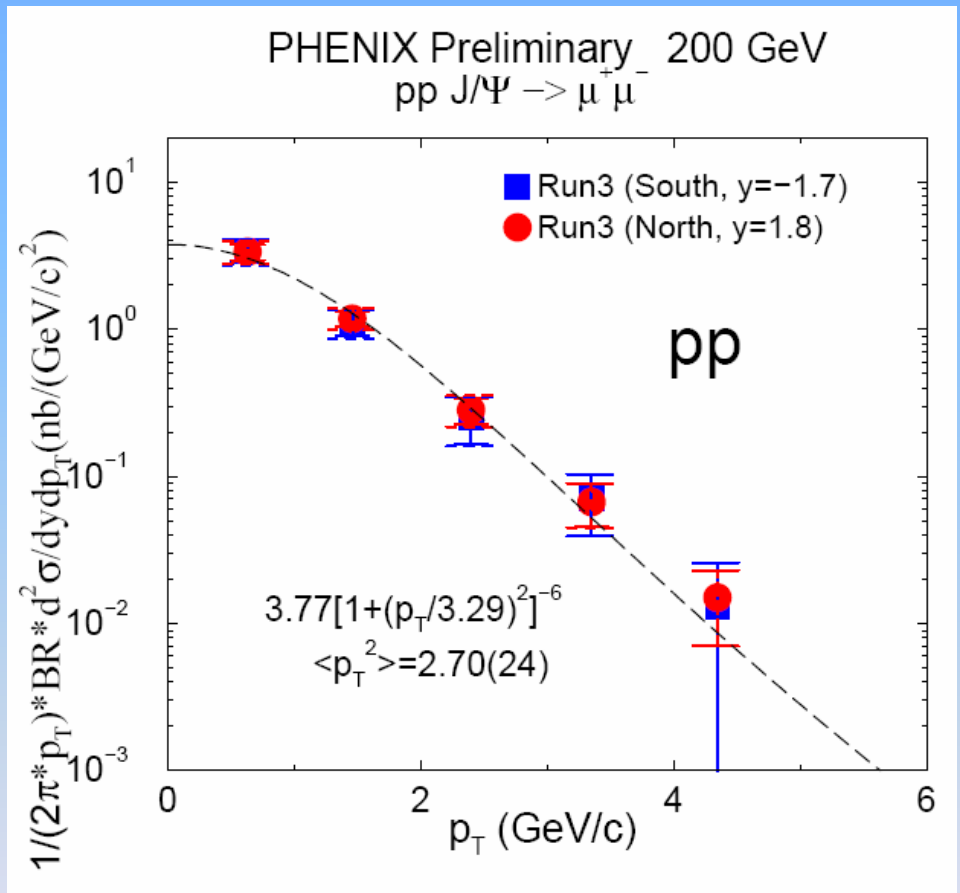
- Electron measurements
  - $|\eta|<0.35$
  - Two separate arms $2x\Delta\phi = 90^0$
  - $\delta p/p \sim 1\% \; p$
  - RICH ($\gamma_{thr}=35$)
  - e/π separation up to $p_T \sim 4.8$ GeV/c
- Muon measurements
  - $1.2 < |\eta| < 2.4$
  - Two separate arms at forward and backward rapidity



J/ψ Production

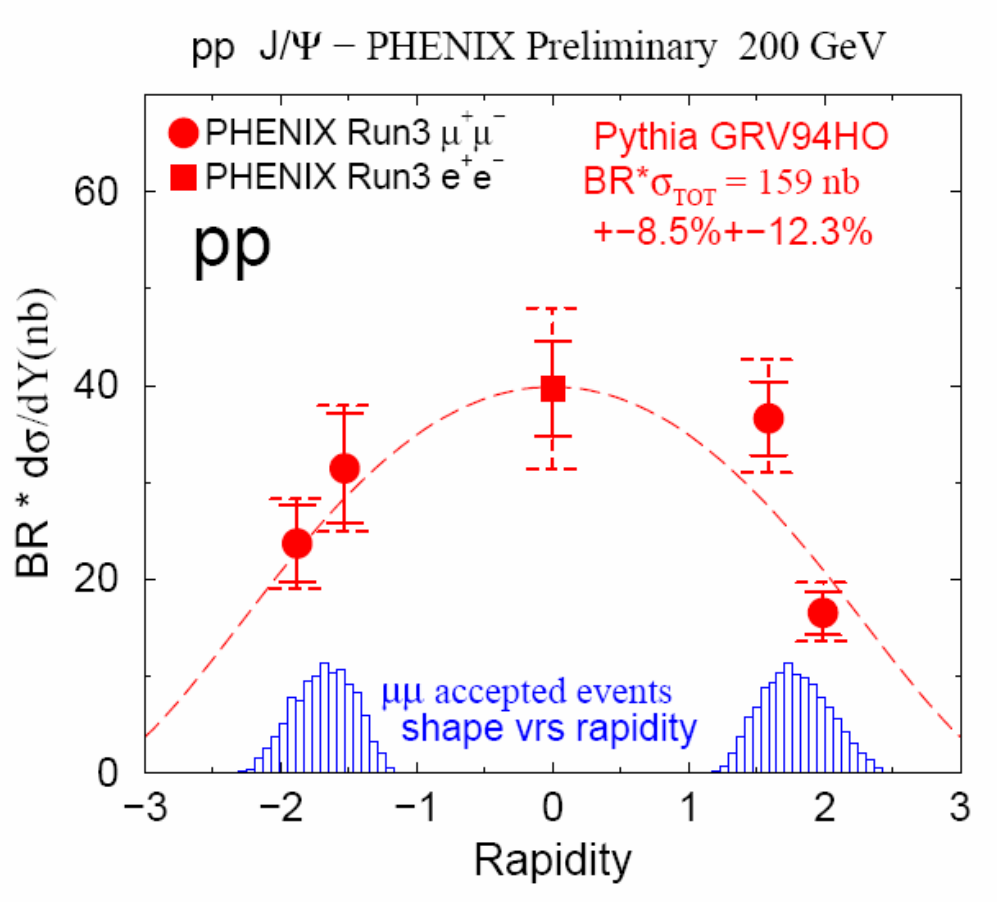
p+p collisions at $\sqrt{s}$ = 200 GeV

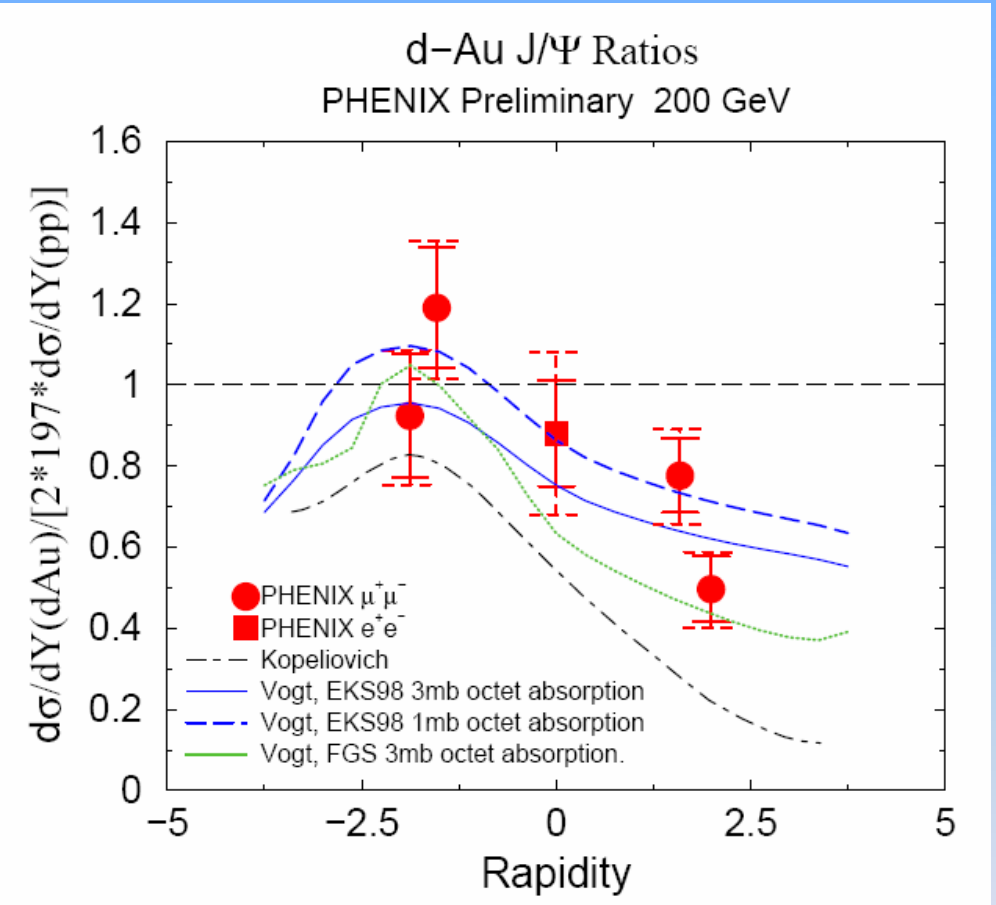




J/ψ Production

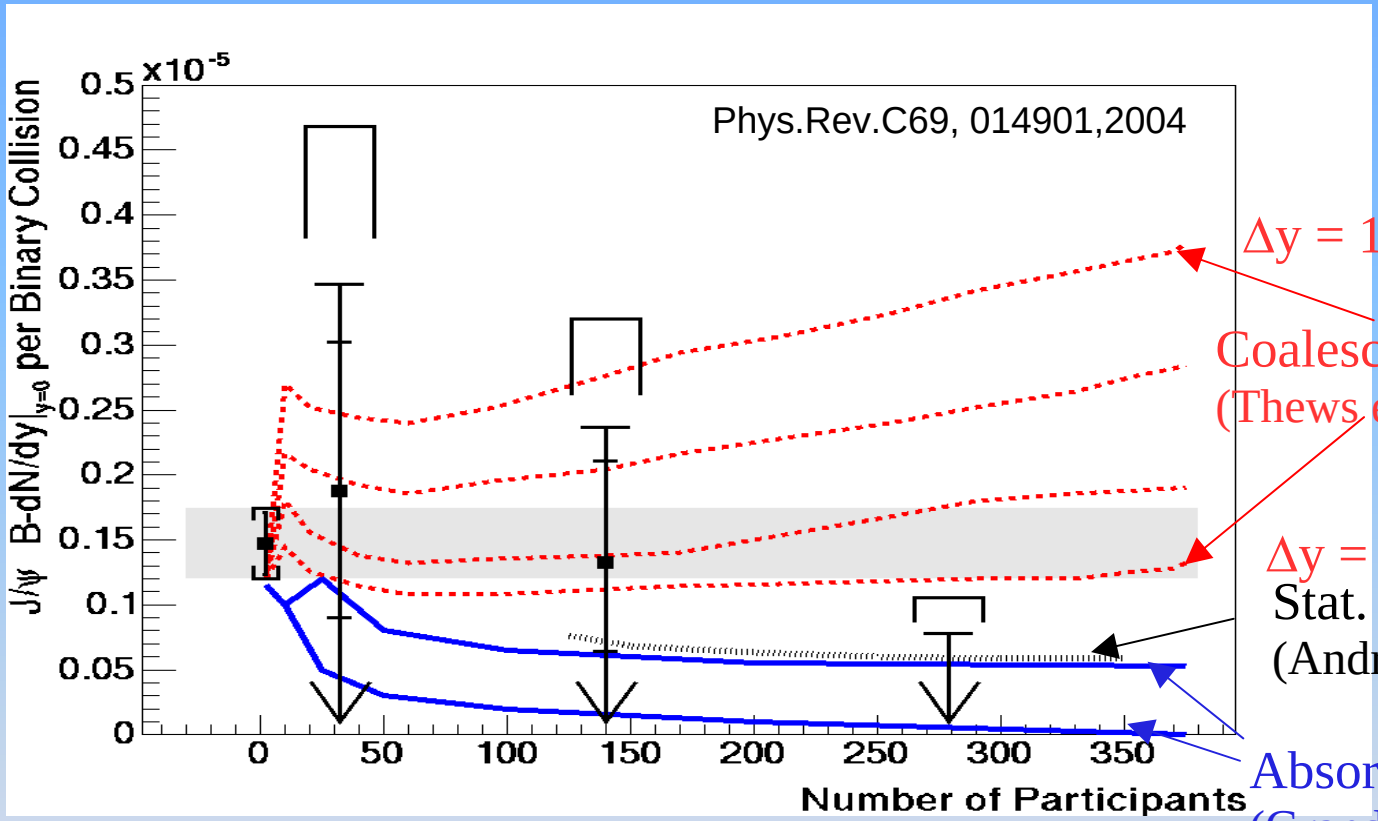
PHENIX p+p and d+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV





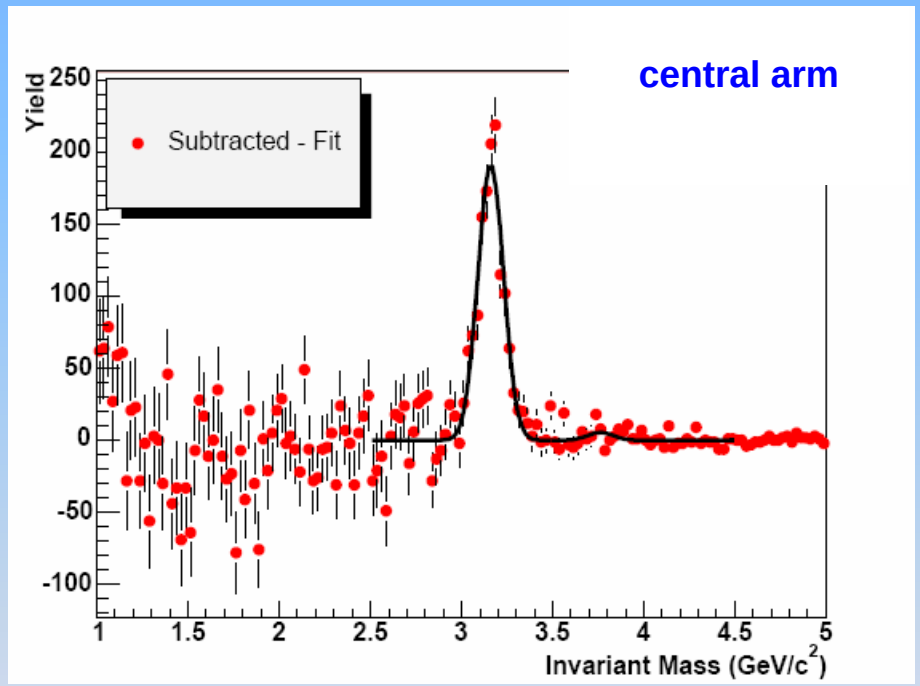
J/ψ Production

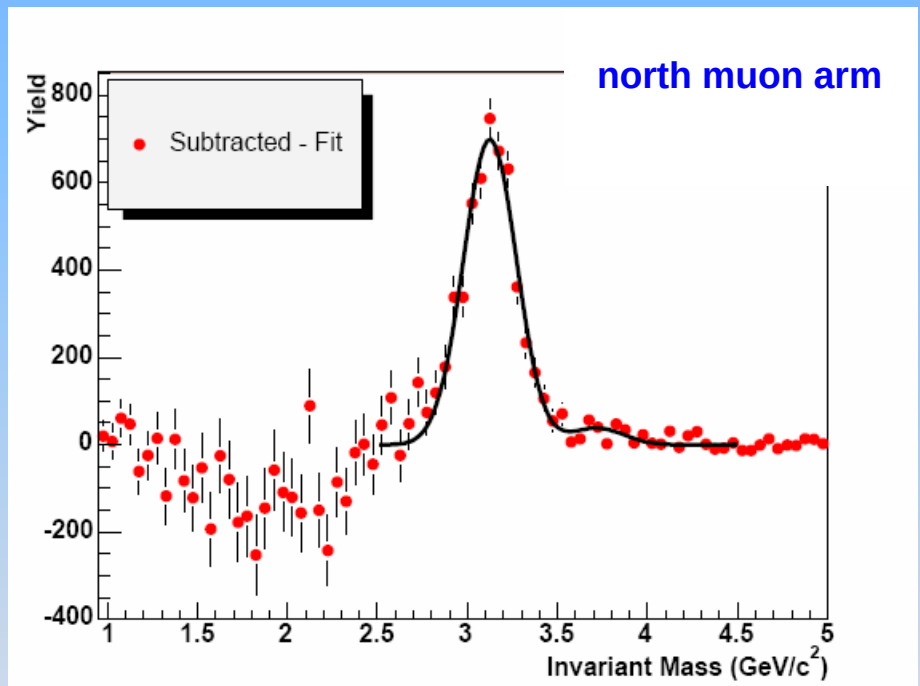
PHENIX Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV



Cu+Cu Collisions 2005

Automatically generated near-online near-physics plots.
“Raw plots” not yet corrected for acceptance or efficiency.

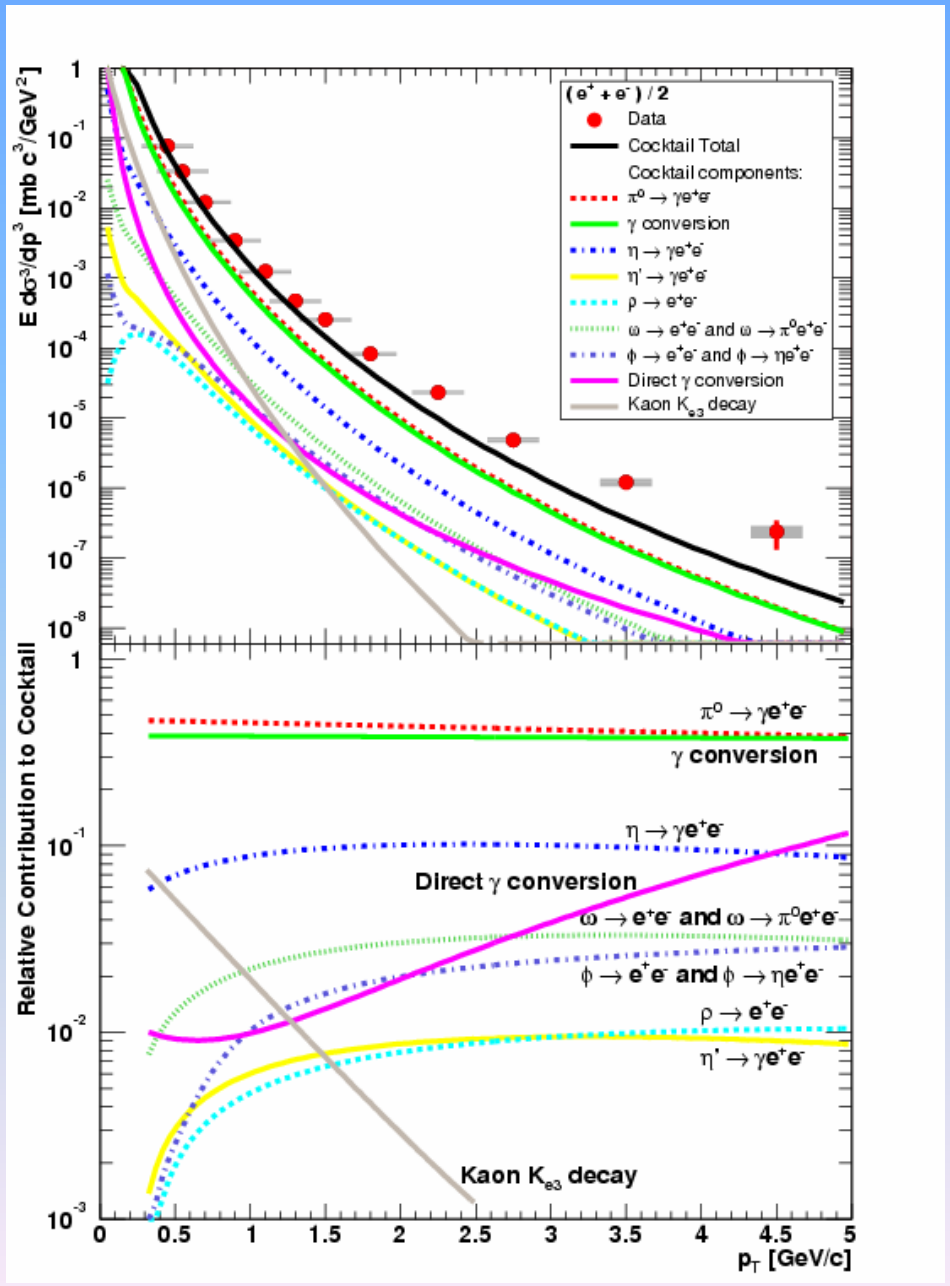


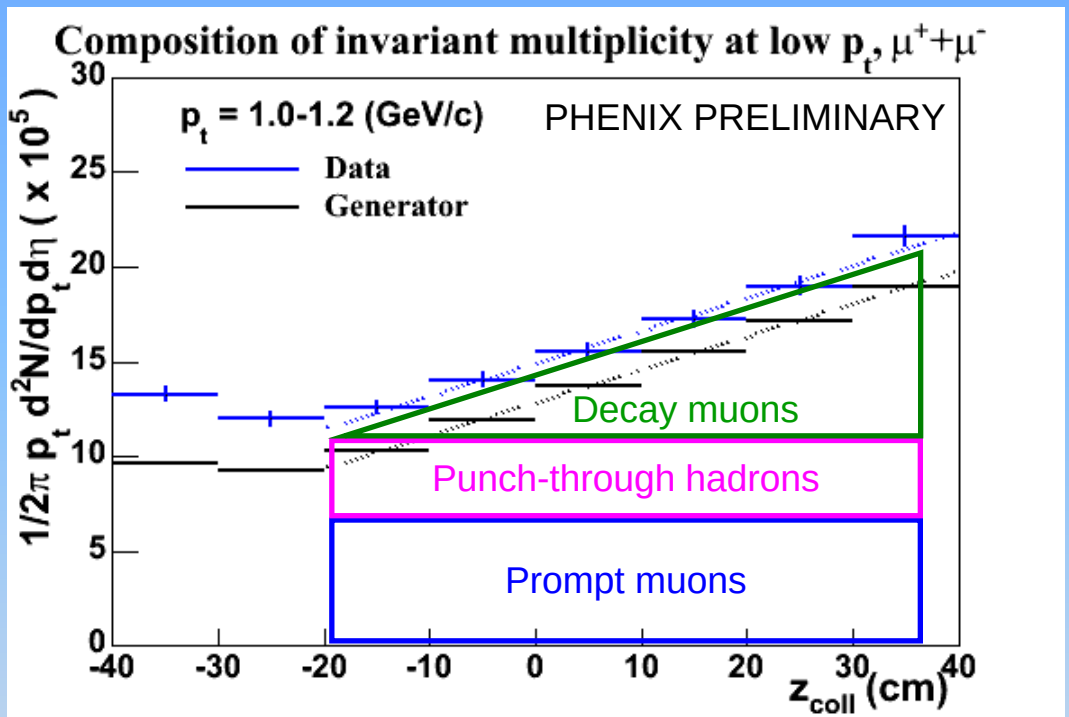


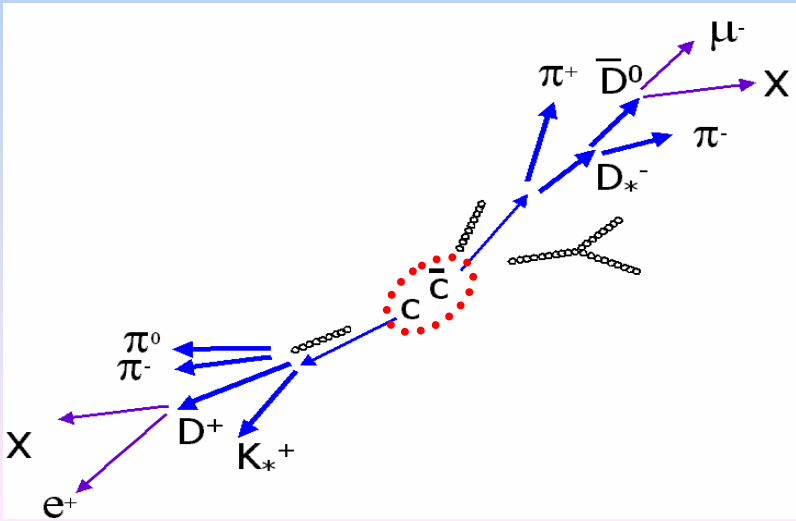
Results from 2004 high statistics Au+Au run in preparation.

Extracting Heavy Flavor Production

PHENIX p+p collisions at $\sqrt{s}$ = 200 GeV

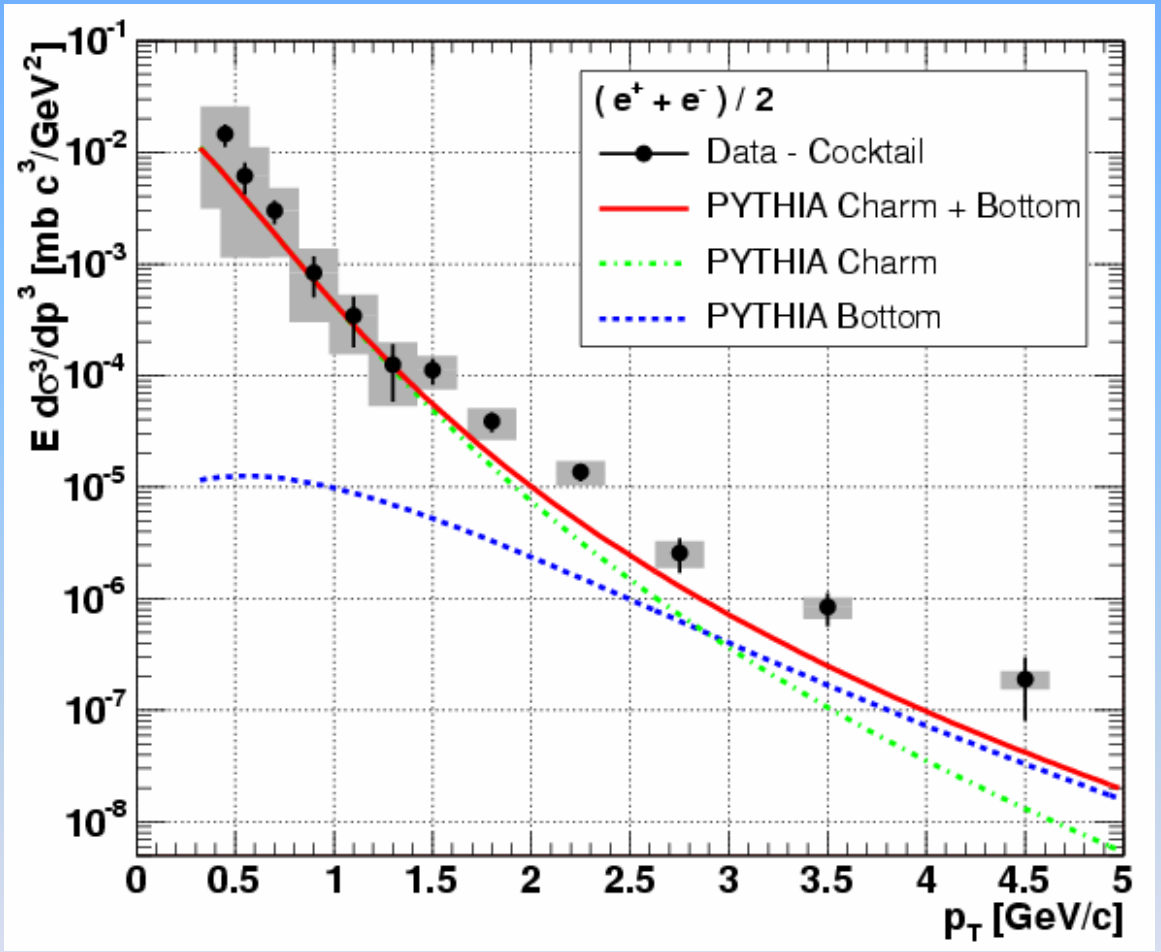






Heavy Flavor Production (electrons)

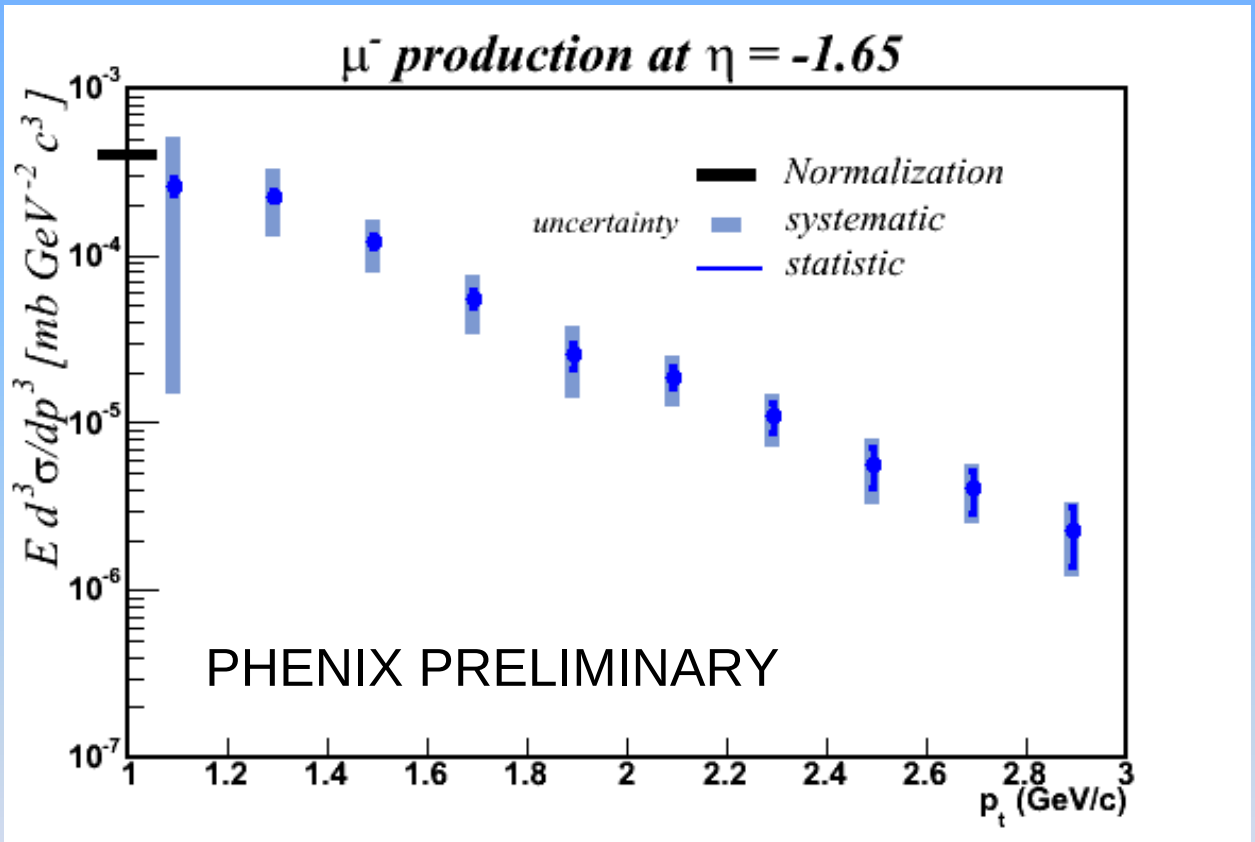
PHENIX p+p collisions at $\sqrt{s}$ = 200 GeV



Spectrum is harder than PYTHIA prediction for leading order only (shown) without full hard scattering turned on.

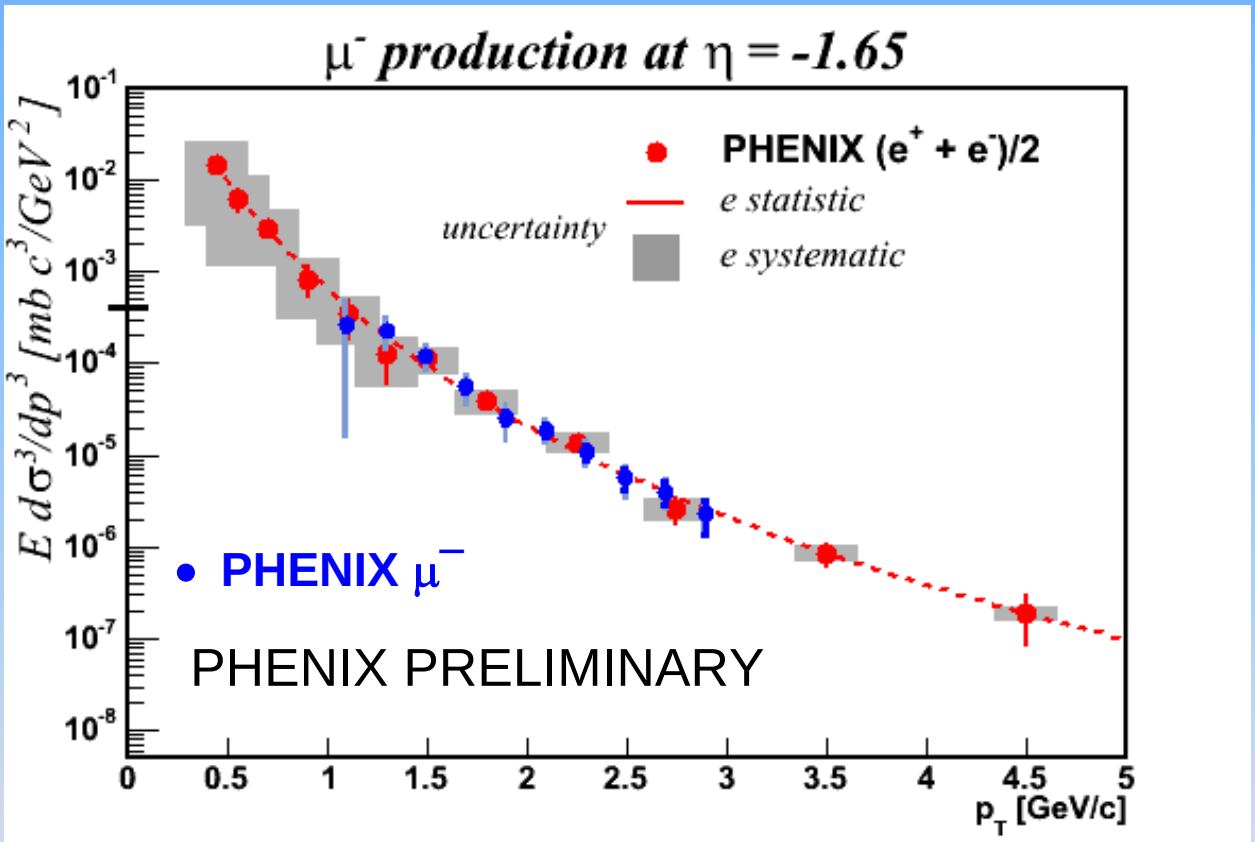
Heavy Flavor Production (muons)

PHENIX p+p collisions at $\sqrt{s}$ = 200 GeV



Comparison of electron and muon results

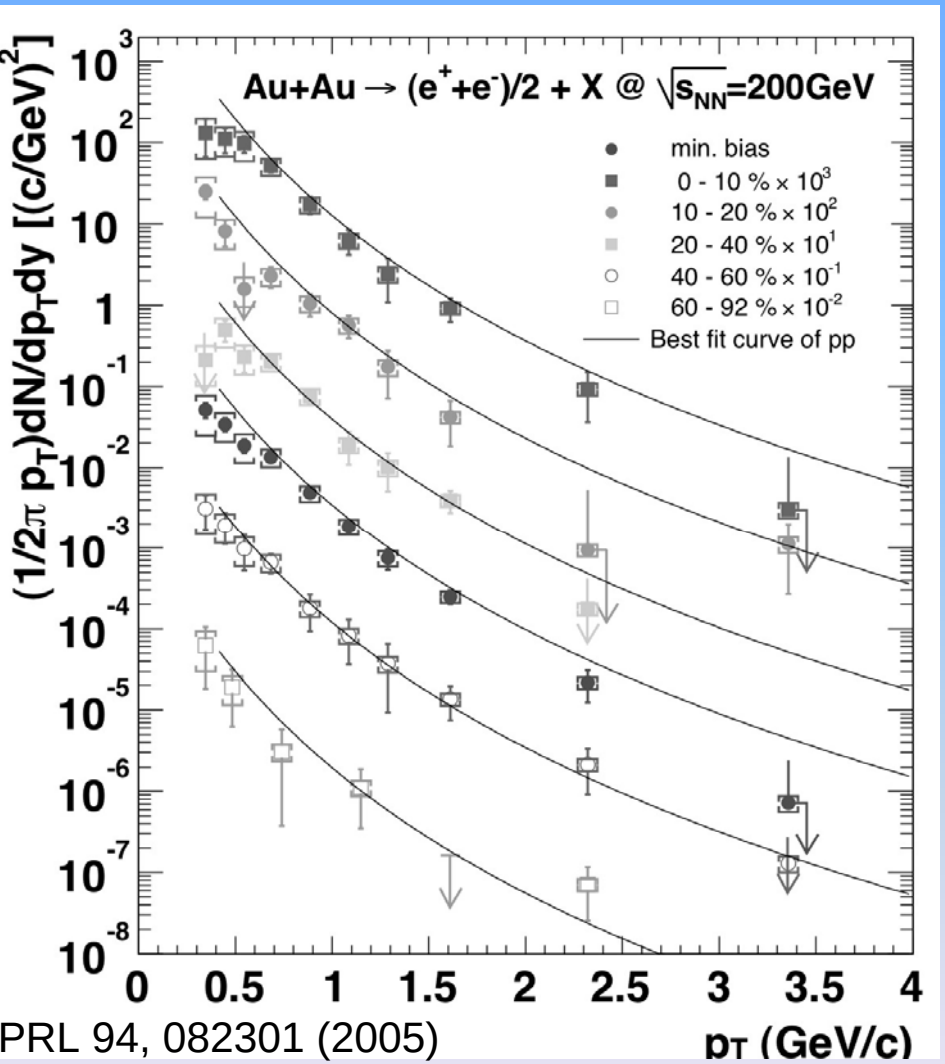
PHENIX p+p collisions at $\sqrt{s}$ = 200 GeV



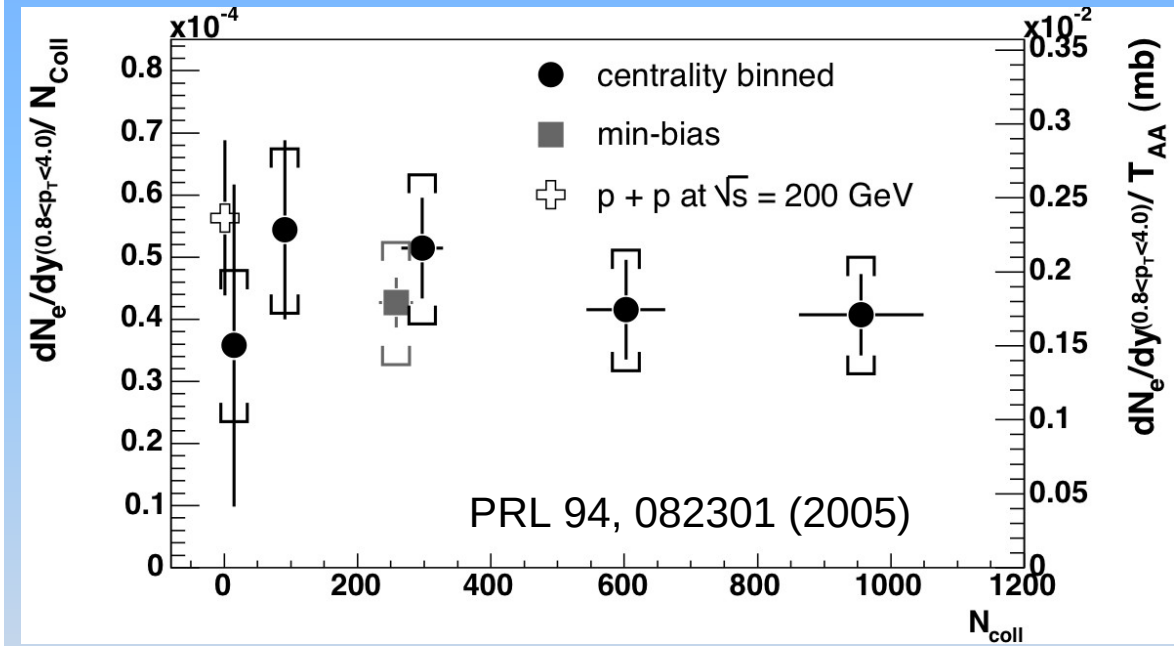
Electron production at η= 0
Muon production at η= 1.65

Heavy Flavor Production (electrons)

PHENIX Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV



PRL 94, 082301 (2005)

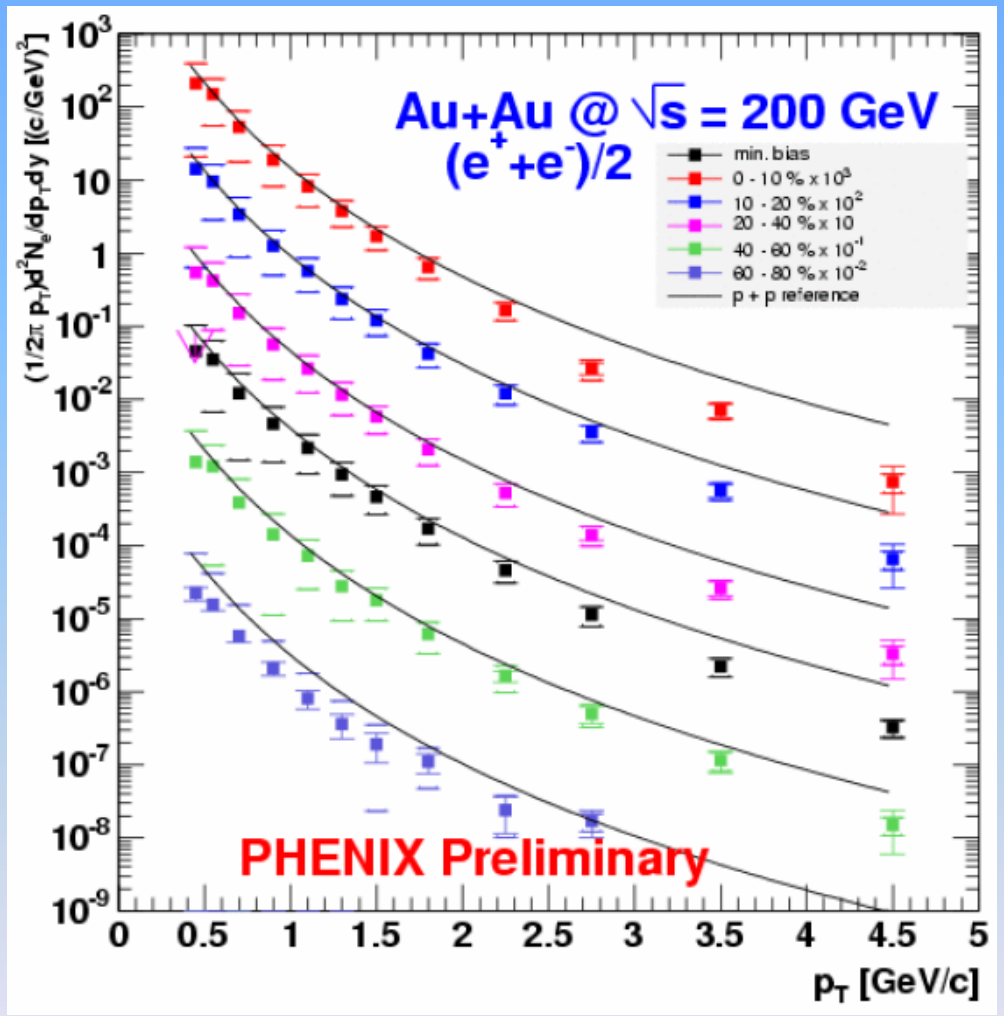


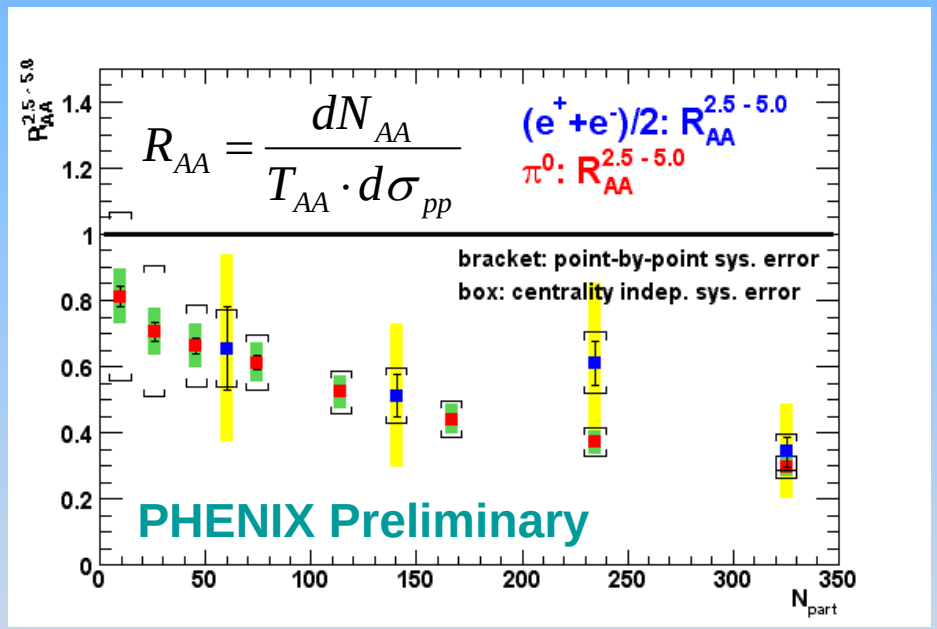
dN/dy of "non-photonic" electrons for pT > 0.8 GeV/c indicates scaling with N_{coll}

For more on high p_T suppression, see "Production of direct photons, pions, and eta in p+p and Au+Au collisions" presented by Terry Awes at 17:10 on Friday in the Hadronic Final States working group.

Heavy Flavor Production (electrons)

PHENIX Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV

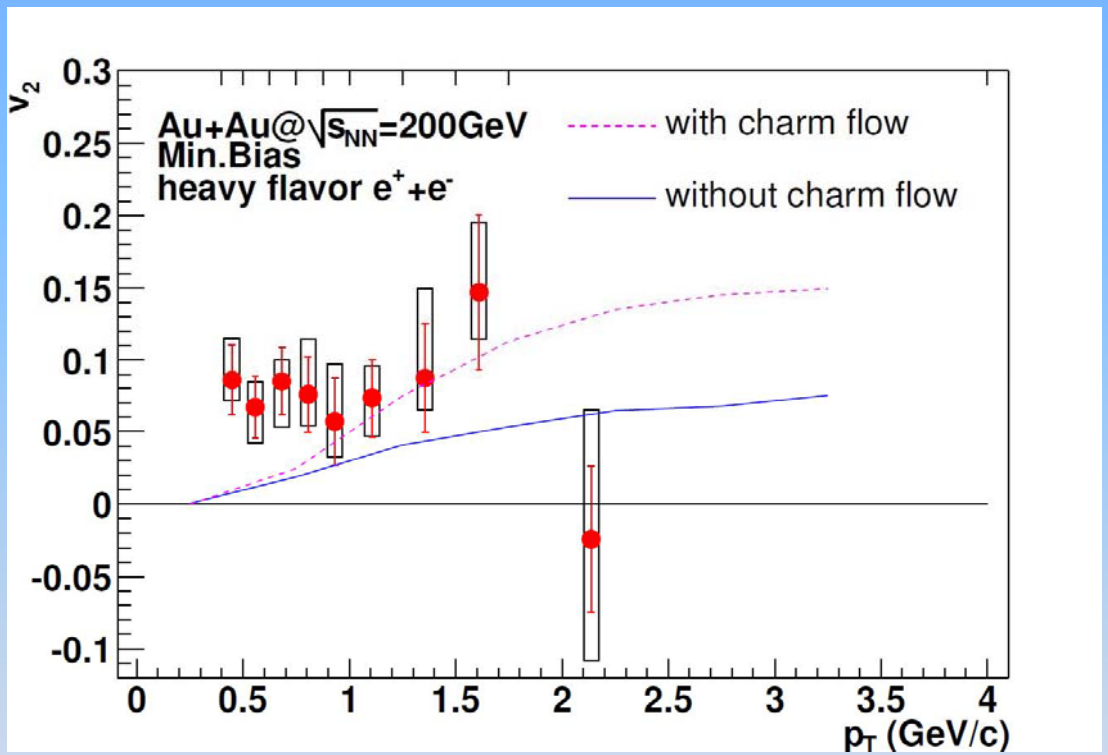




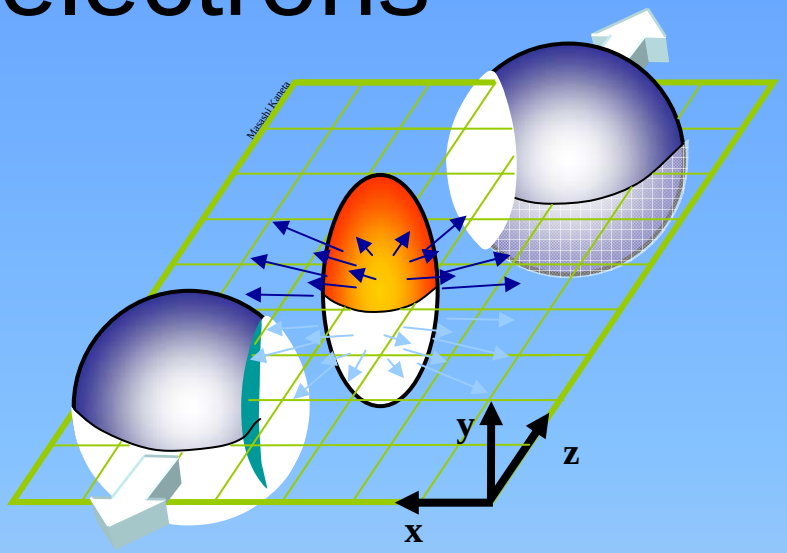
Suppression at high p_T relative to scaled p+p results.
Spectral shape modified by medium.
Pattern consistent with models incorporating heavy quark energy loss.

v_2 for Heavy Flavor electrons

PHENIX Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV



S.S. Adler, *et al.*, nucl-ex/0502009
Theoretical predictions from Greco, Ko, Rapp in Phys. Lett. B595 (2004) 202



Initial state spatial anisotropy lead to final state momentum anisotropy

$$E\frac{d^3N}{d^3p} = \frac{d^3N}{p_T d\varphi dp_T dy}\sum_{n=0}^{\infty} 2v_n \cos\left(n\left(\varphi - \Psi_R\right)\right)$$

$$v_2 = \left\langle \cos 2\left(\varphi - \Psi_R\right)\right\rangle$$

Improved measurement with higher statistics in preparation.

Summary

- Heavy flavor production has been measured via semileptonic decays in p+p, d+Au, and Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV at RHIC
- Strong modification of the electron spectra in Au+Au collisions
- Initial measurement of heavy flavor electron v_2
- Results with higher statistics and other colliding species still to come!
- For further information, see www.phenix.bnl.gov.