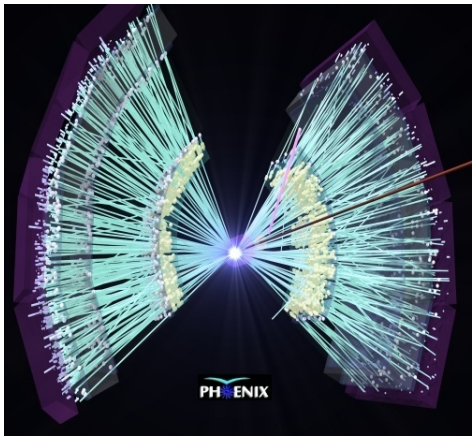
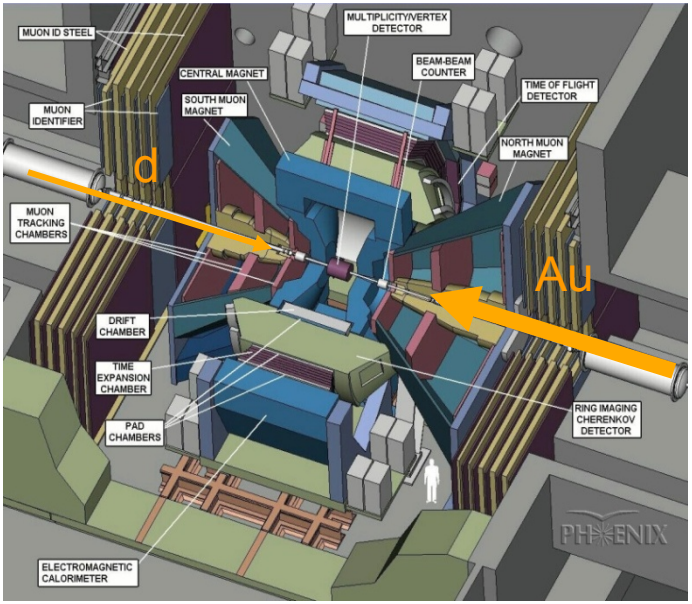


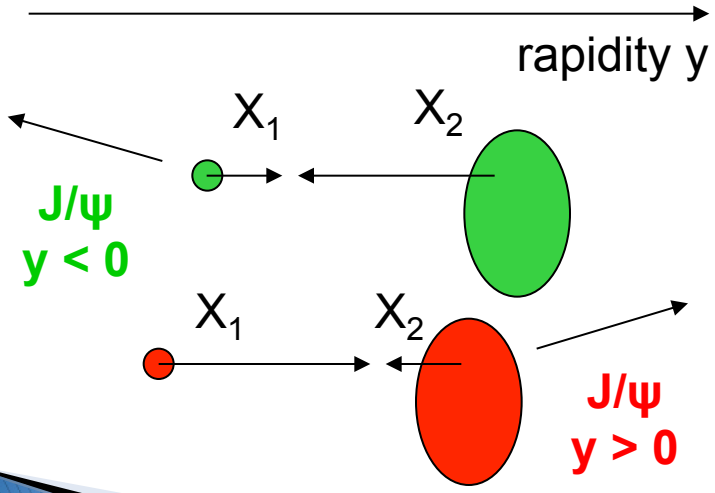
Quarkonium Results at PHENIX

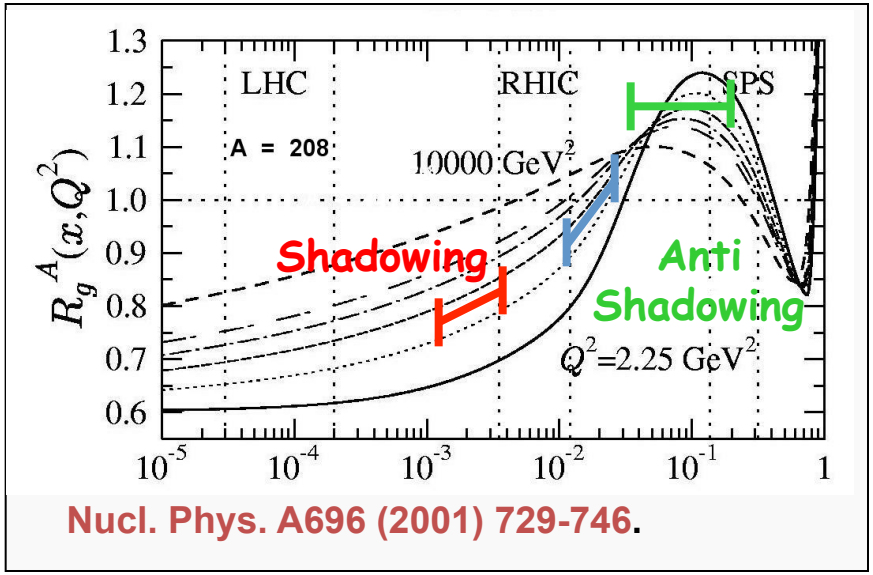
Marzia Rosati
Iowa State University

PHENIX J/ψ Measurement



- J/ψ is mostly produced by gluon fusion, and thus sensitive to gluon pdf
- Phenix probes different momentum fraction of Au gluons
  - South ($y < -1.2$) : large X_2 (in gold) ~ 0.090
  - North ($y > 1.2$) : small X_2 (in gold) ~ 0.003
  - Central ($y \sim 0$) : intermediate X_2 ~ 0.020



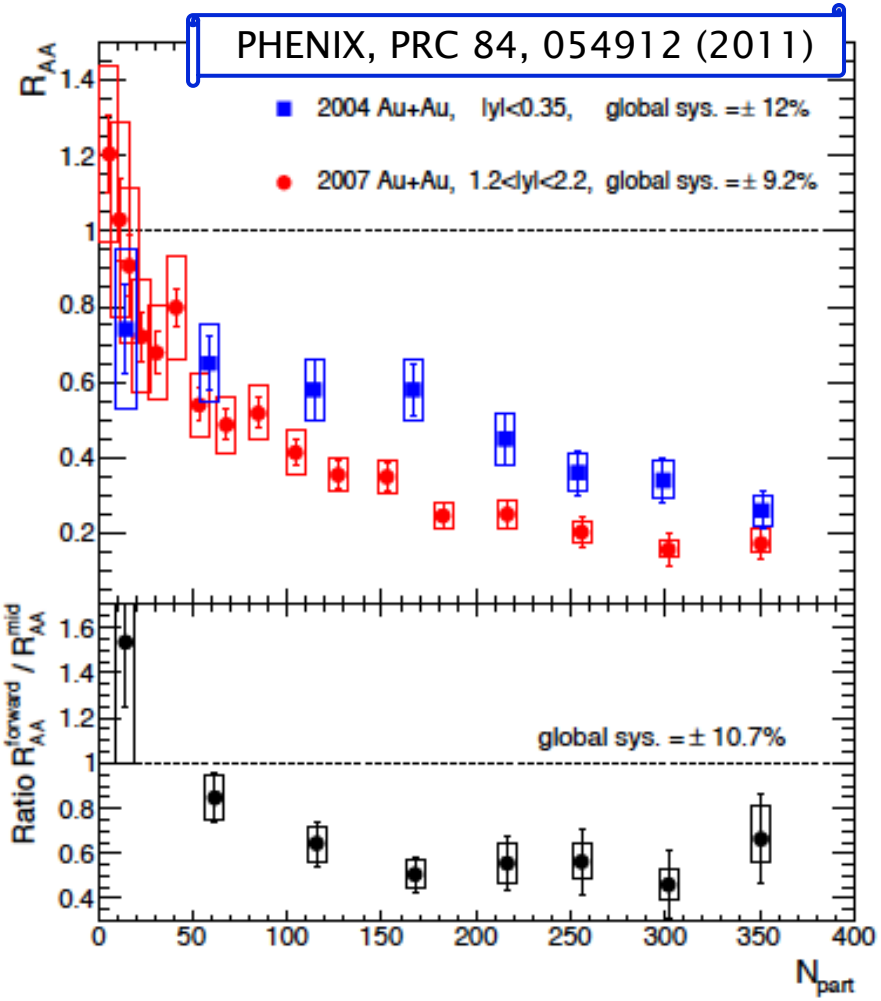


Nucl. Phys. A696 (2001) 729-746.

PHENIX J/ψ Measurement in A+A

- 200 GeV
  - Au+Au
  - Cu+Cu
  - Cu+Au
  - U+U
- 62.4 GeV
  - Au+Au
- 39 GeV
  - Au+Au

Suppression in Au+Au at 200 GeV

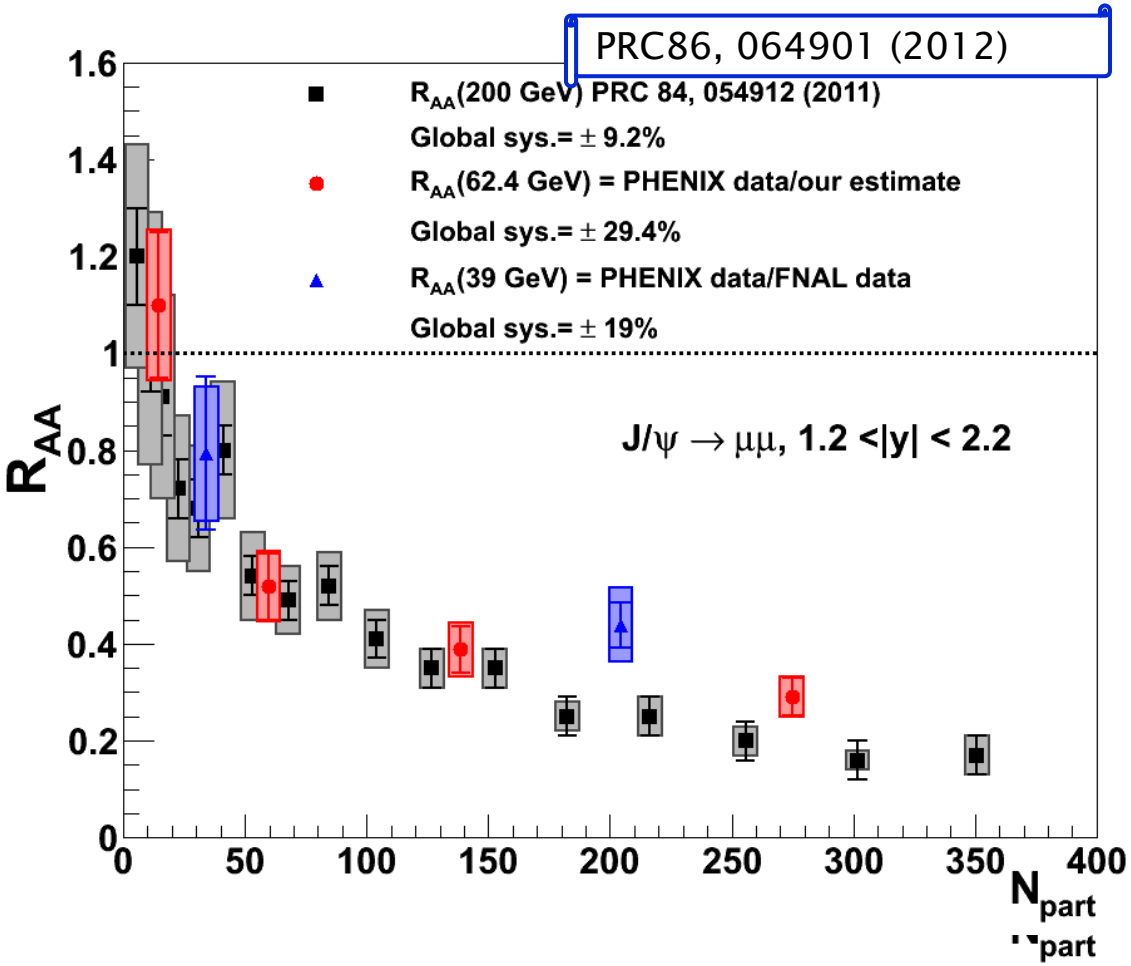


- Smooth suppression with increasing collision centrality
- Forward rapidity more suppressed than mid-rapidity

200 GeV
Au+Au
Cu+Cu
Cu+Au
U+U
62.4 GeV
Au+Au
39 GeV
Au+Au

J/ψ R_{AuAu} vs Collision energy

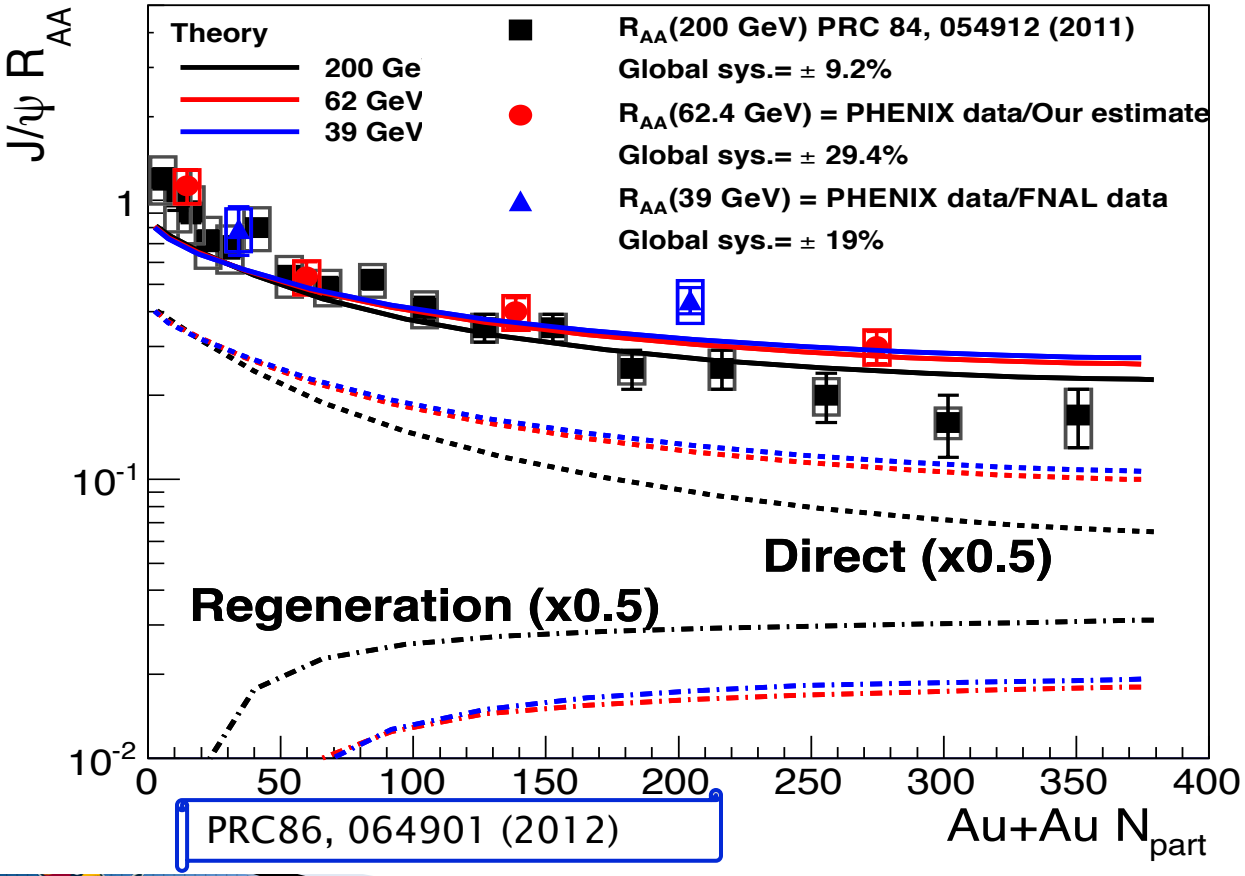
200 GeV
Au+Au
Cu+Cu
Cu+Au
U+U
62.4 GeV
Au+Au
39 GeV
Au+Au



62 GeV suppression follows the trend of the 200 GeV and constrains theoretical models…

J/ψ R_{AuAu} vs Collision energy Theory comparison

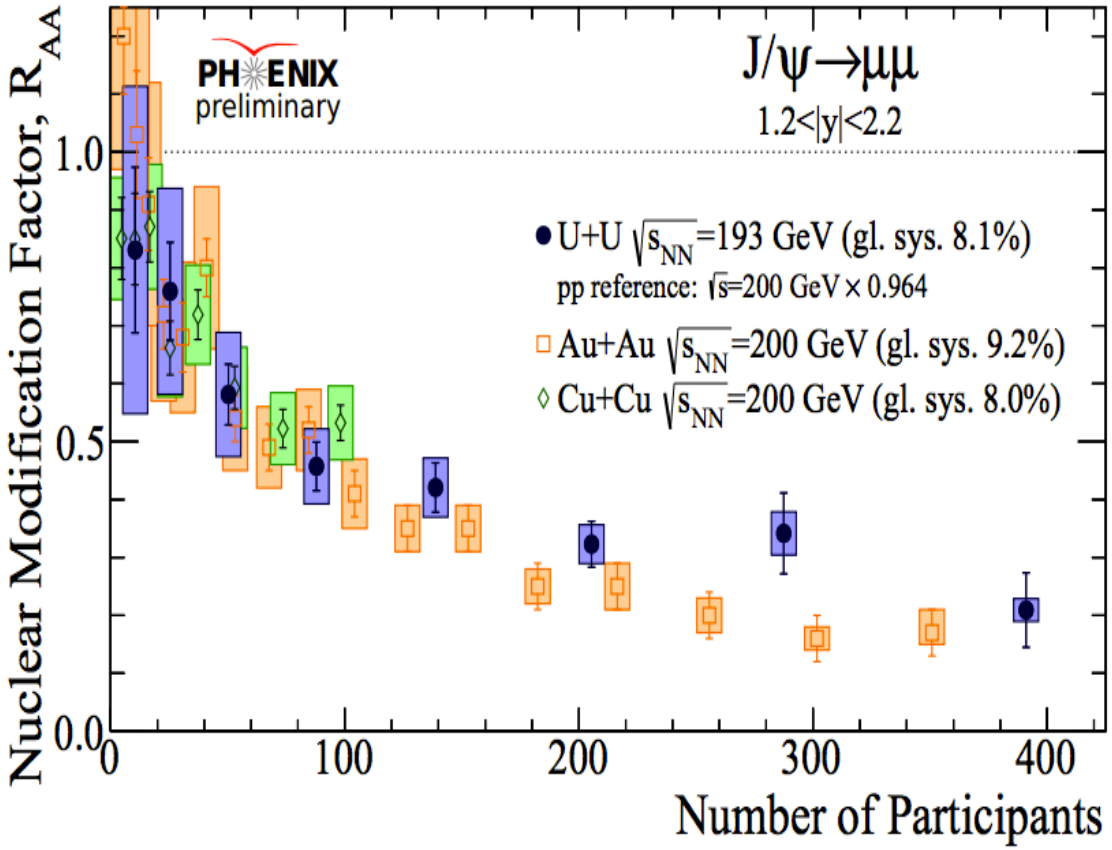
X. Zhao, R. Rapp
Phys Rev C82 064905 (2010)



200 GeV
Au+Au
Cu+Cu
Cu+Au
U+U
62.4 GeV
Au+Au
39 GeV
Au+Au

62 agrees with data, suggesting similarity of R_{AA} from 39 to 200 GeV originates from cancellation of suppression and regeneration

J/ψ R_{AA} vs System Size



200 GeV
- Au+Au
- Cu+Cu
- Cu+Au
- U+U

62.4 GeV
- Au+Au

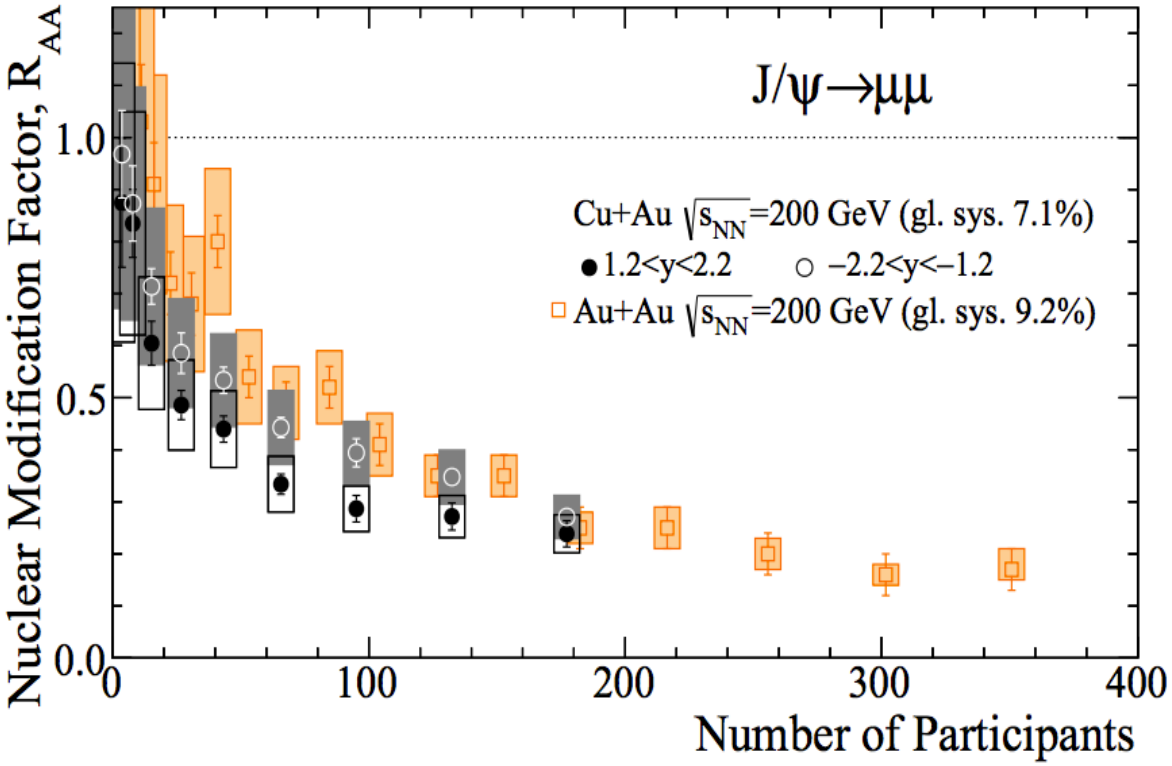
39 GeV
- Au+Au

- Qualitatively similar suppression from Cu+Cu to U+U.
- Somewhat weaker suppression in central U+U collisions? Higher coalescence?

J/ψ in Asymmetric Collision R_{CuAu}

200 GeV
Au+Au
Cu+Cu
Cu+Au
U+U
62.4 GeV
Au+Au
39 GeV
Au+Au

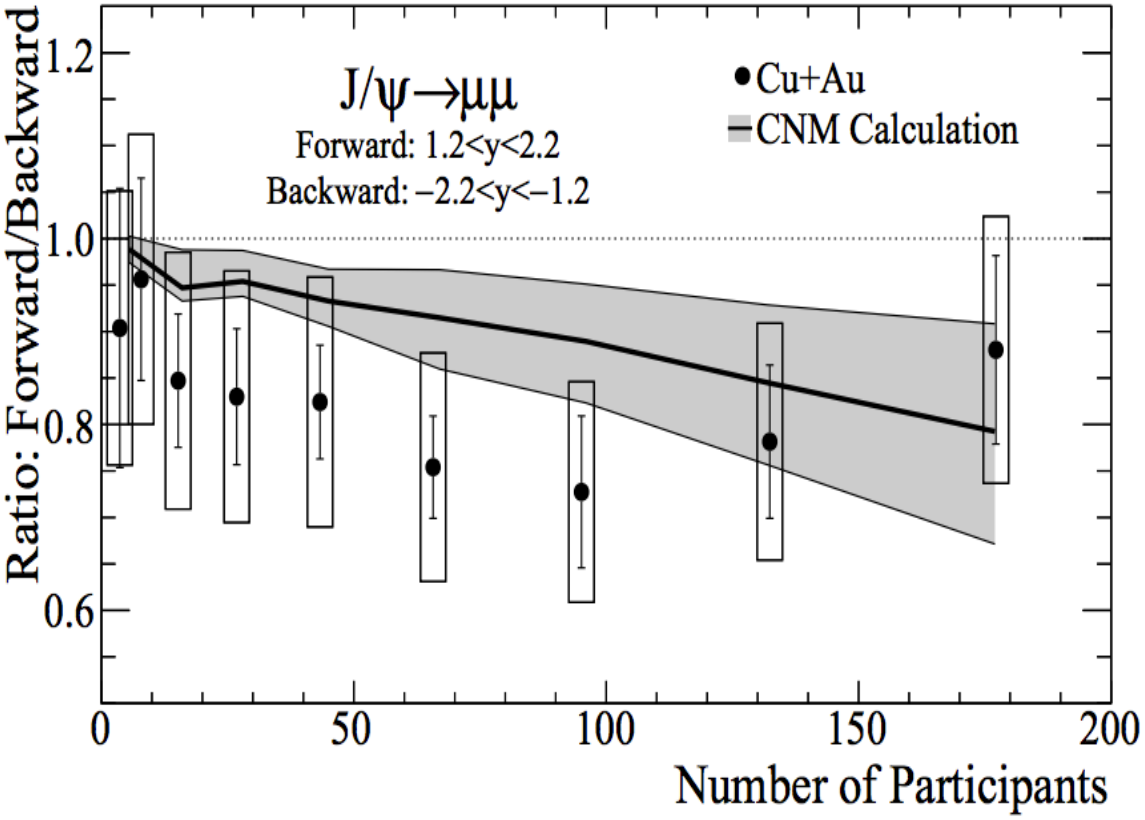
arXiv:1404.1873



- suppression in Cu+Au comparable to Au+Au but somewhat smaller
- Cu-going more suppressed than Au-going.

J/ψ in CuAu

arXiv:1404.1873

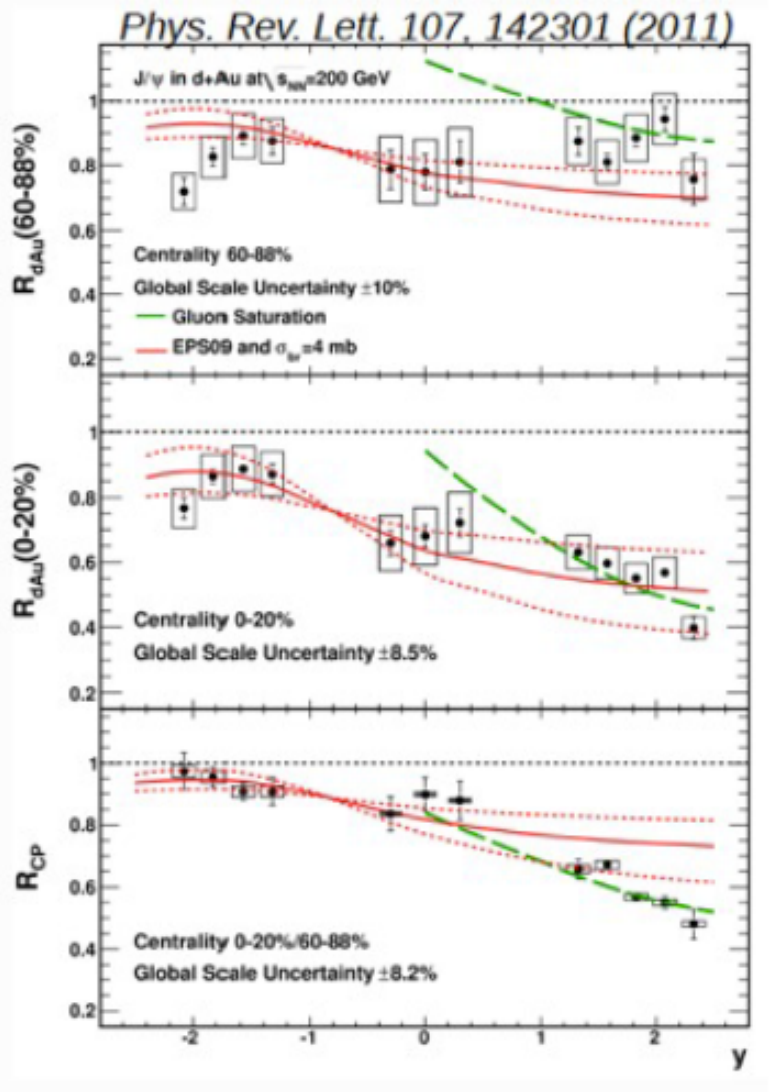


200 GeV
Au+Au
Cu+Cu
Cu+Au
U+U
62.4 GeV
Au+Au
39 GeV
Au+Au

- CNM effects:
  - Cu-going R_{AA} probes low x gluons in Au long proper crossing time.
  - Au-going R_{AA} probes low x in Cu, short proper crossing time.

CNM = EPS09 + 4mb breakup (Phys. Rev. C84, 044911, 2011)

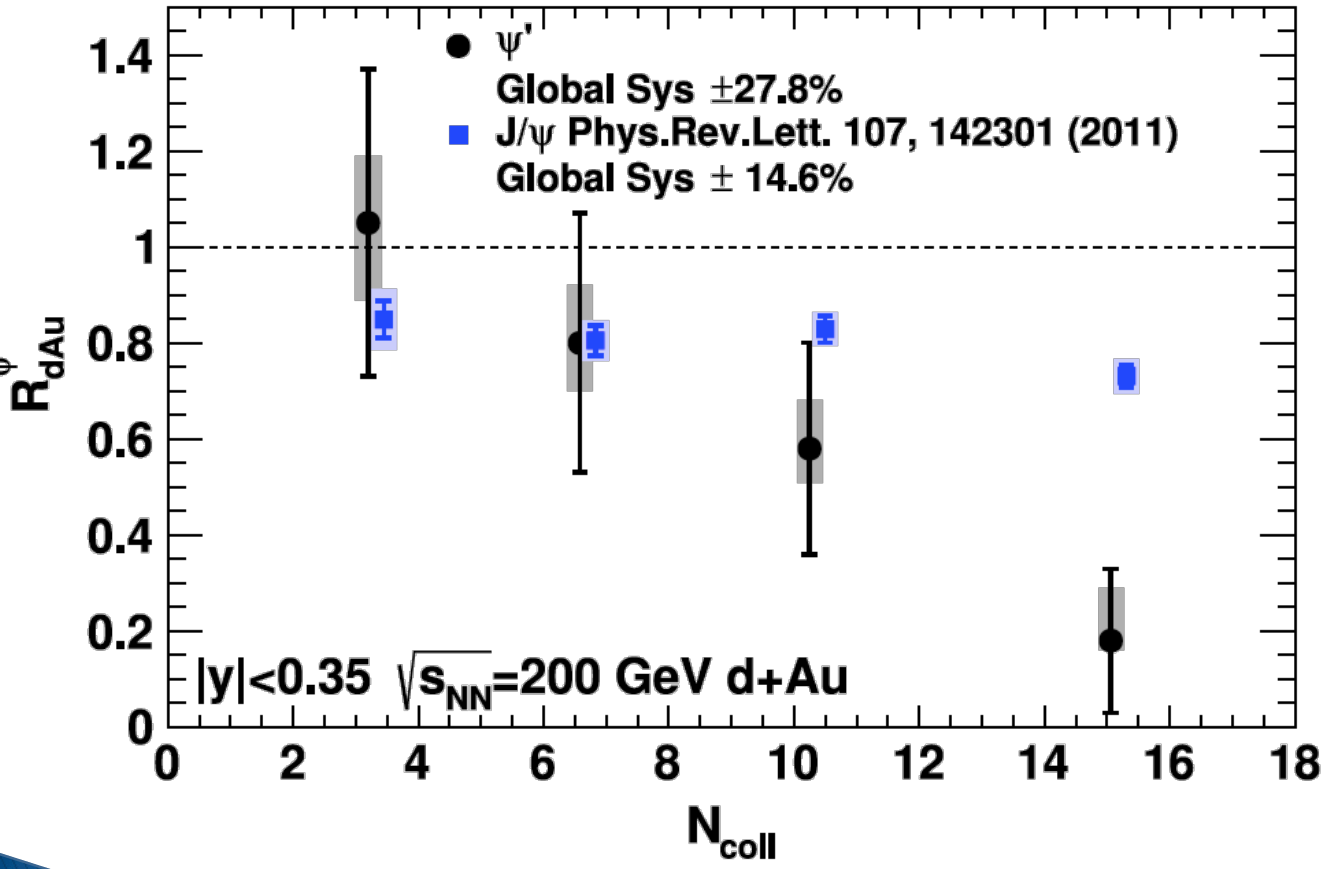
PHENIX J/ψ Measurement in d+Au



- Strong centrality dependence not expected from EPS09 or breakup cross section

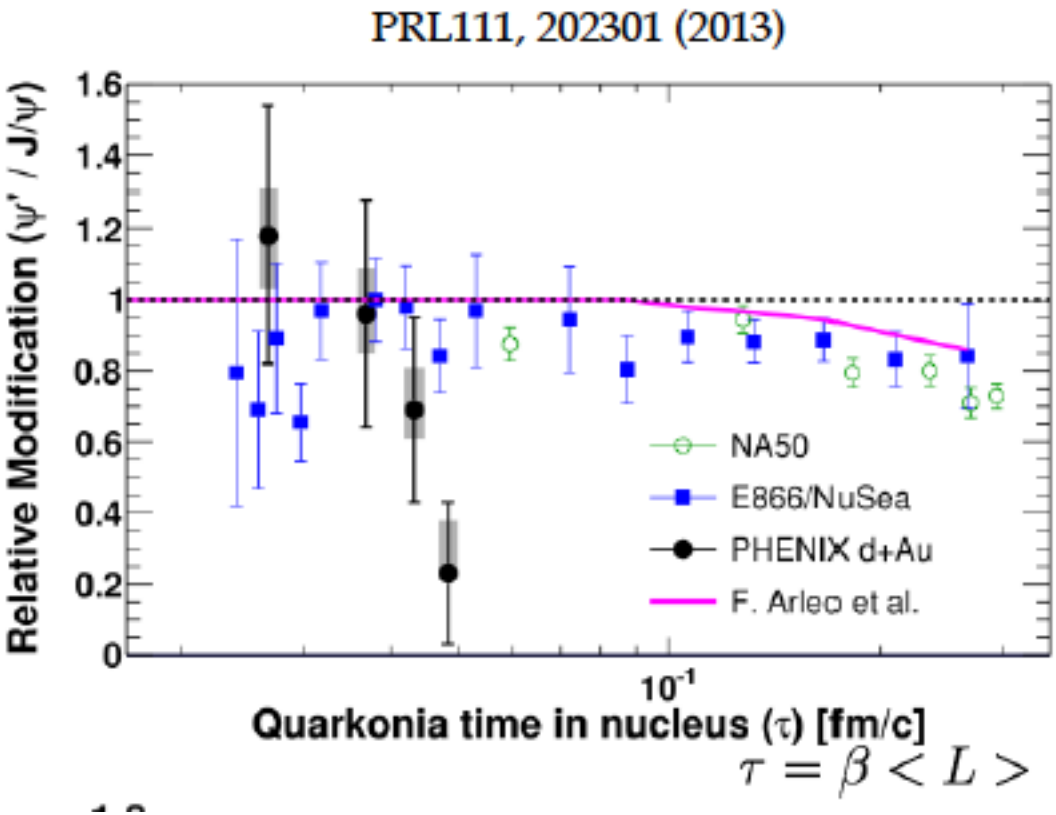
Ψ' and J/Ψ R_{dAu} at midrapidity

PRL 111, 202301 (2013)



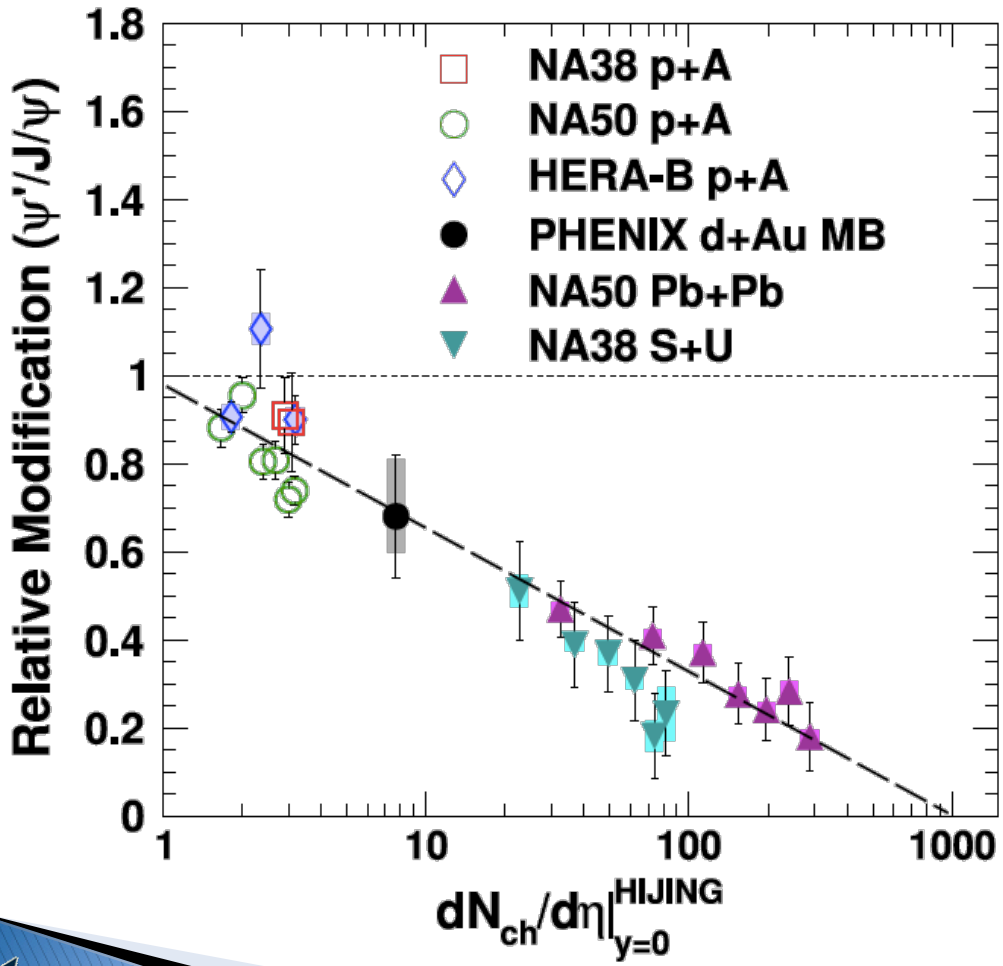
- Ψ' is ~3 times more suppressed in most central collisions than J/Ψ.
- Very different trend with N_{COLL}.

Ψ’/ J/Ψ ratio



- Bound ccbar cross nucleus as a preresonant state
- Ψ’ and J/Ψ should have the same suppression

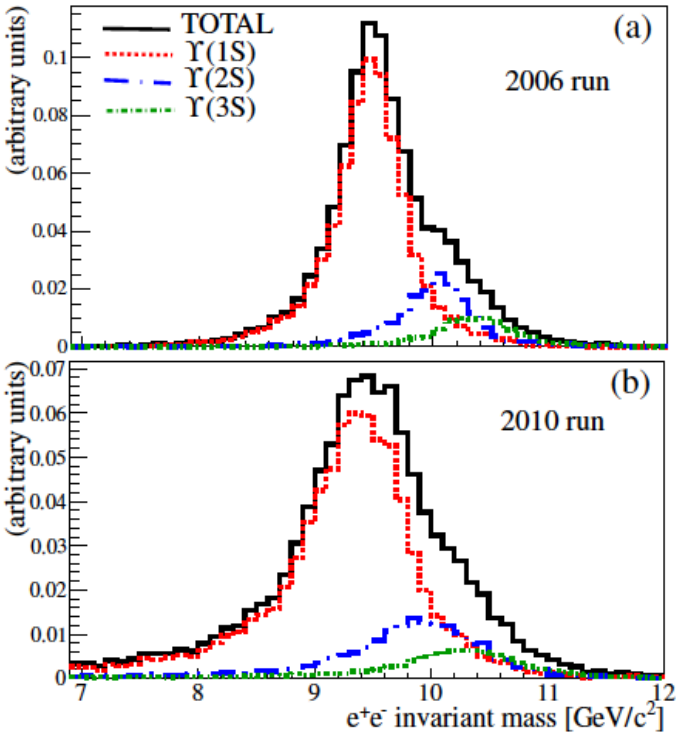
Relative suppression of Ψ' and J/Ψ



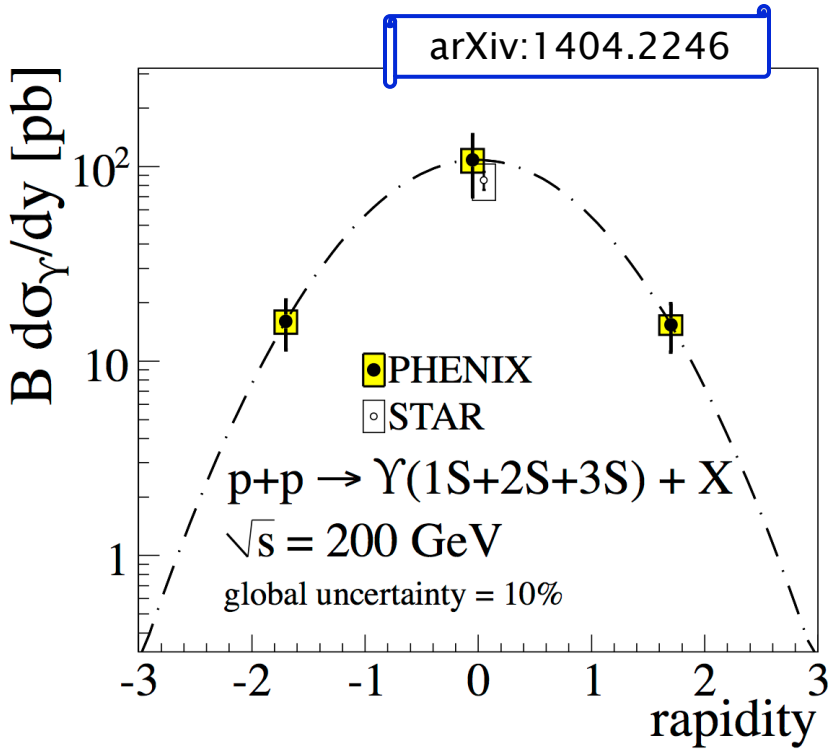
- Relative modification in *all* systems follows common trend with increasing produced particle density.
- Co-mover (or medium) density seems to be the relevant quantity.

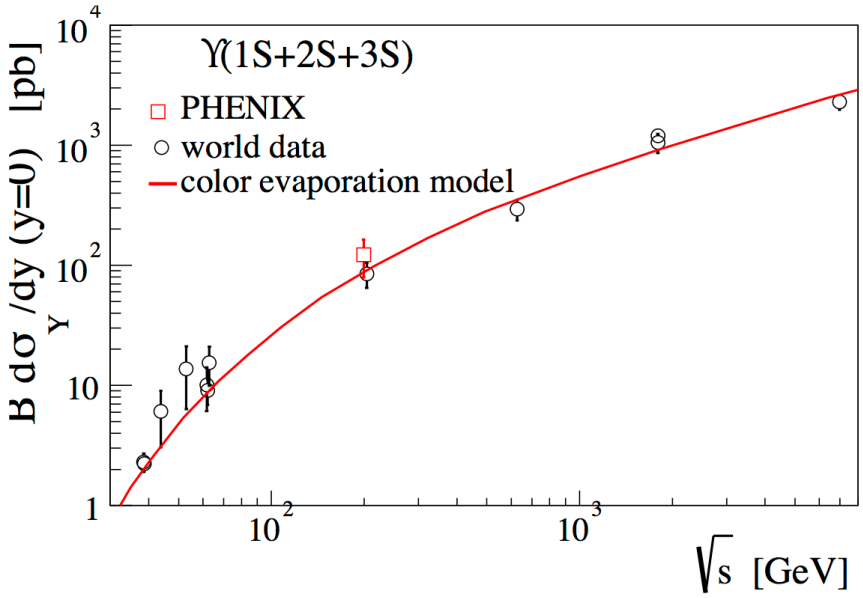
PHENIX Υ(1S+2S+3S) Measurement

- Mass resolution doesn't unable PHENIX to separate the 1S+2S+3S states.

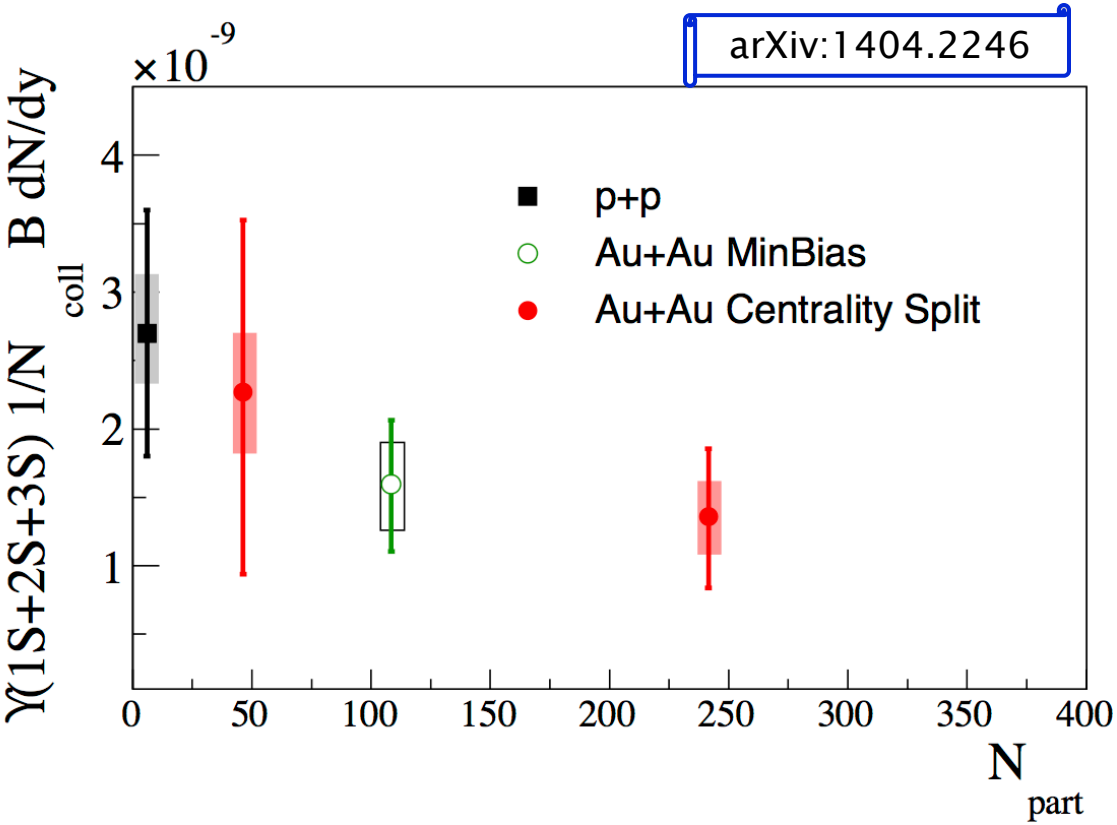


ϒ cross section in pp at mid-rapidity



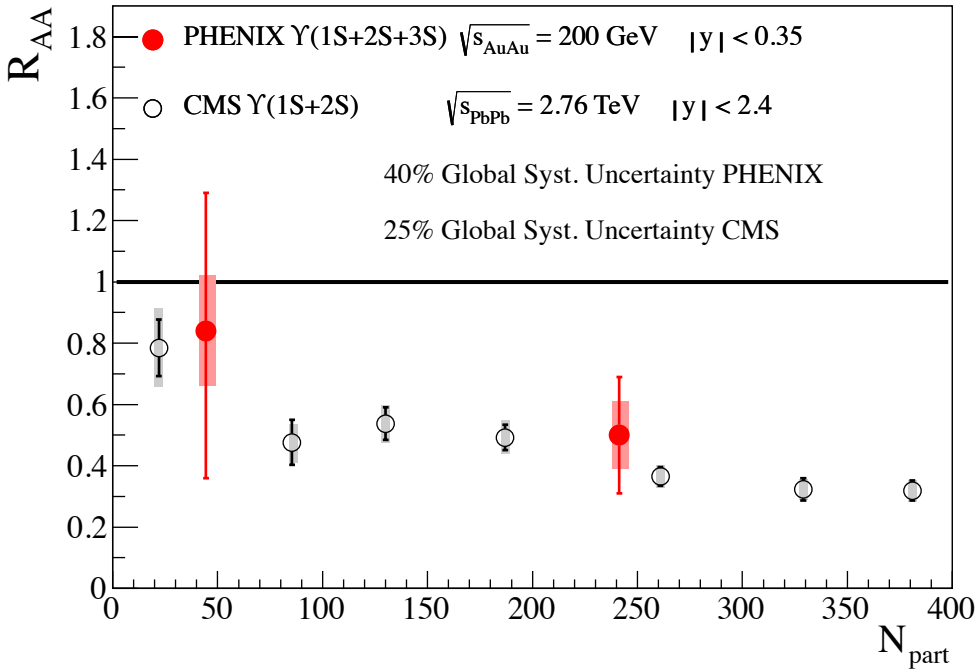


Υ Invariant Yield/N_{coll} versus N_{part}



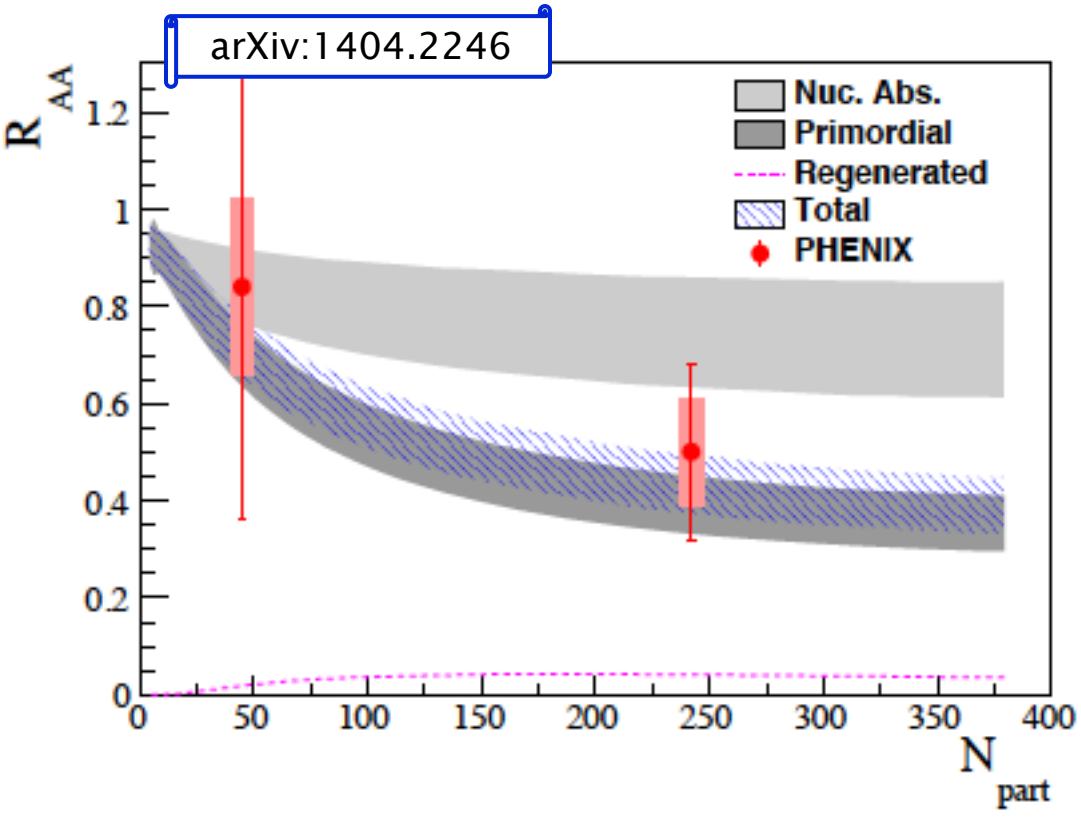
For central Au+Au collisions Υ invariant yield at mid-rapidity is reduced relative to expected N_{coll} scaling

Υ R_{AA} vs Collision Energy



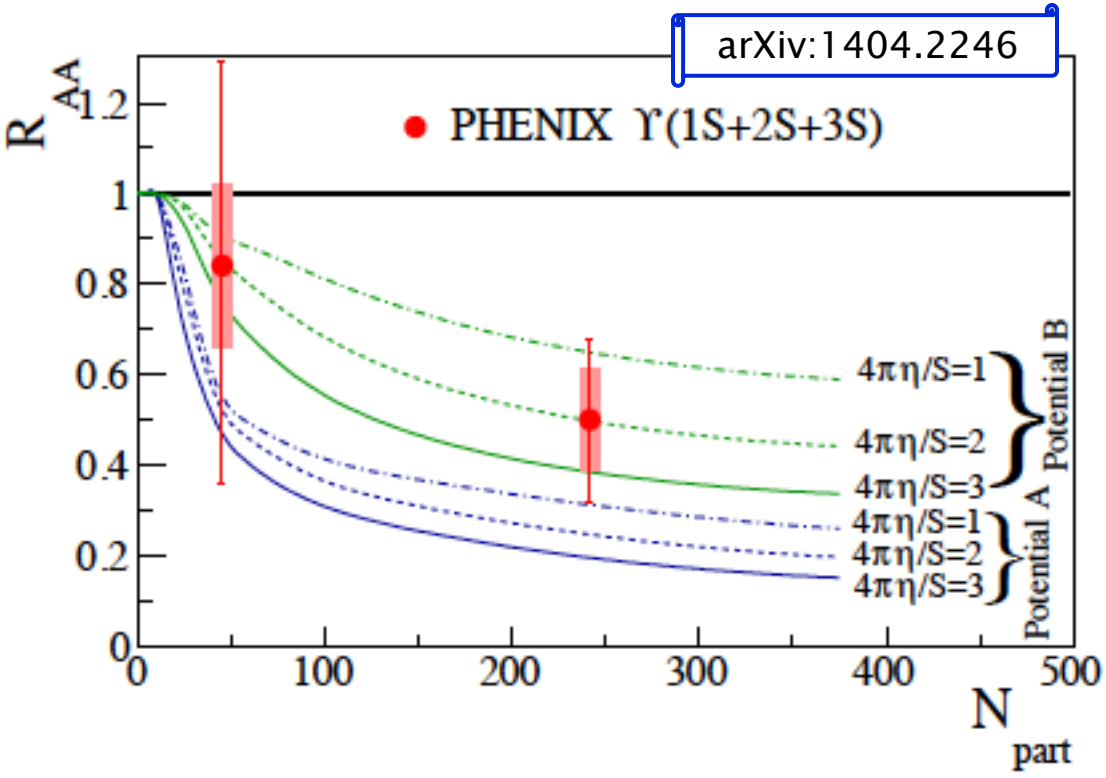
- Expected maximum R_{AA}:
  No 2S and 3S: 0.65 ± 0.11
  No 2S, 3S and chi_B: 0.37 ± 0.09
- Measured R_{AA} consistent with melting of 2S+3S.
- Consistent with LHC results for the same N_{PART}.

Comparison to Theory (I)



- Model based on rate equation by Emerick, Zhao and Rapp
  [Eur. Phys. J. A48,72(2012)]
- Model includes ϒ primordial formation, nuclear absorption and regeneration (very small at RHIC)
- Model consistent with data

Comparison to Theory (II)



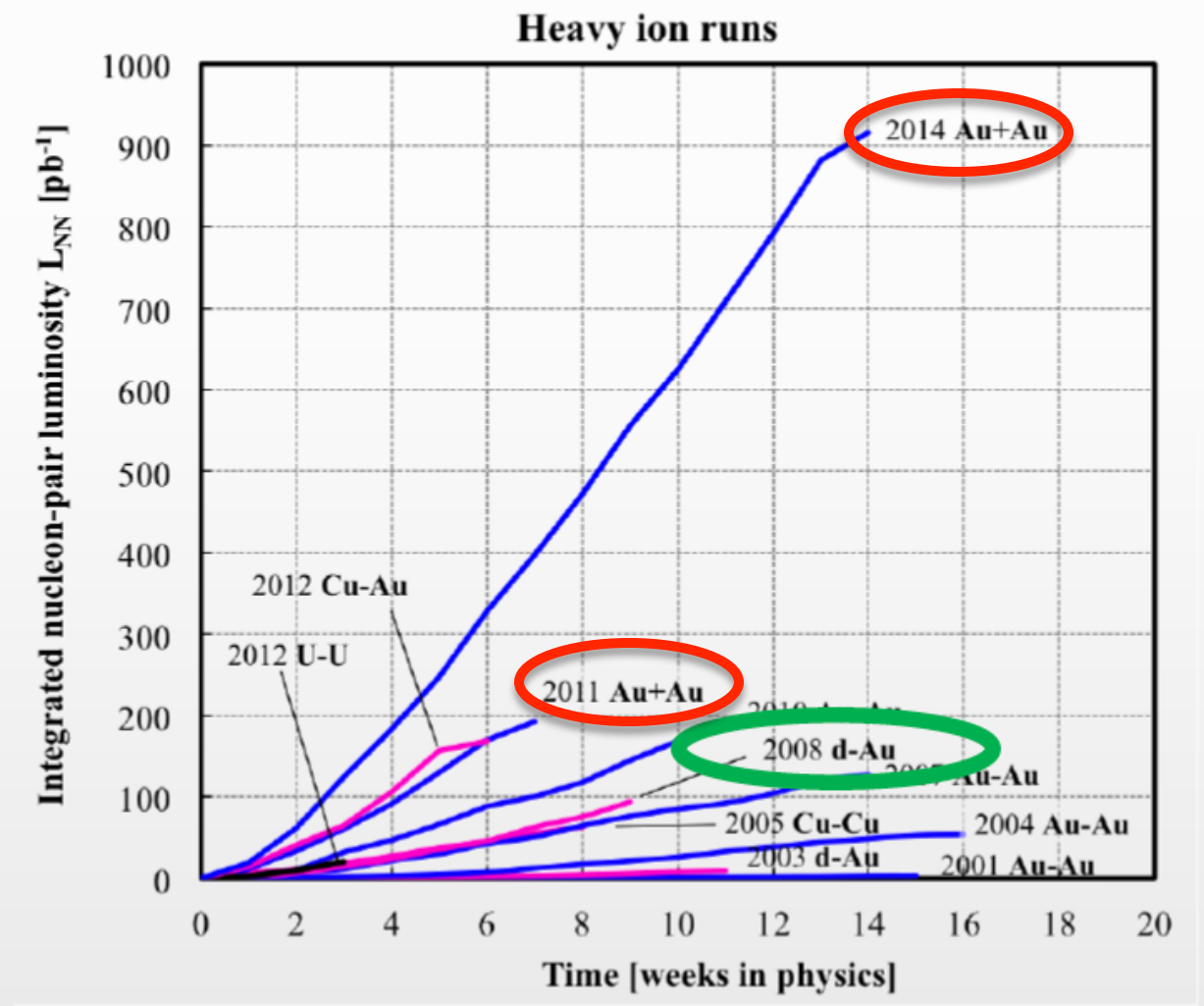
- Potential Model with finite momentum-space anisotropy by Strickland and Barzov [Nucl.Phys. A 879,23(2012)]
- Data prefers model with potential B which includes entropy contribution to the free energy but unable to constrain η/s

PHENIX 2014 Au+Au dataset

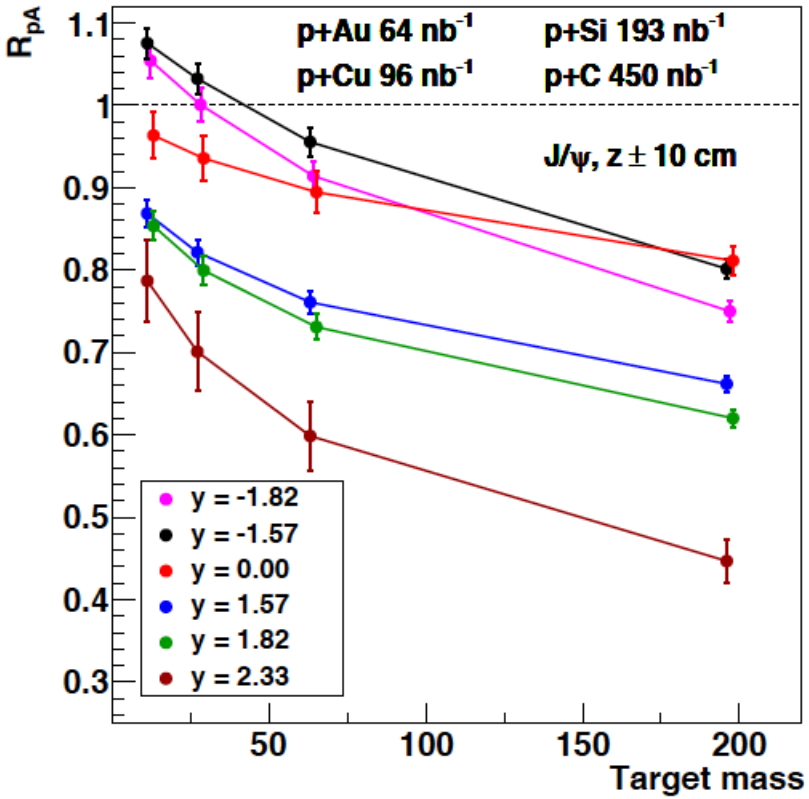
- Integrated luminosity (|z|±30 cm)

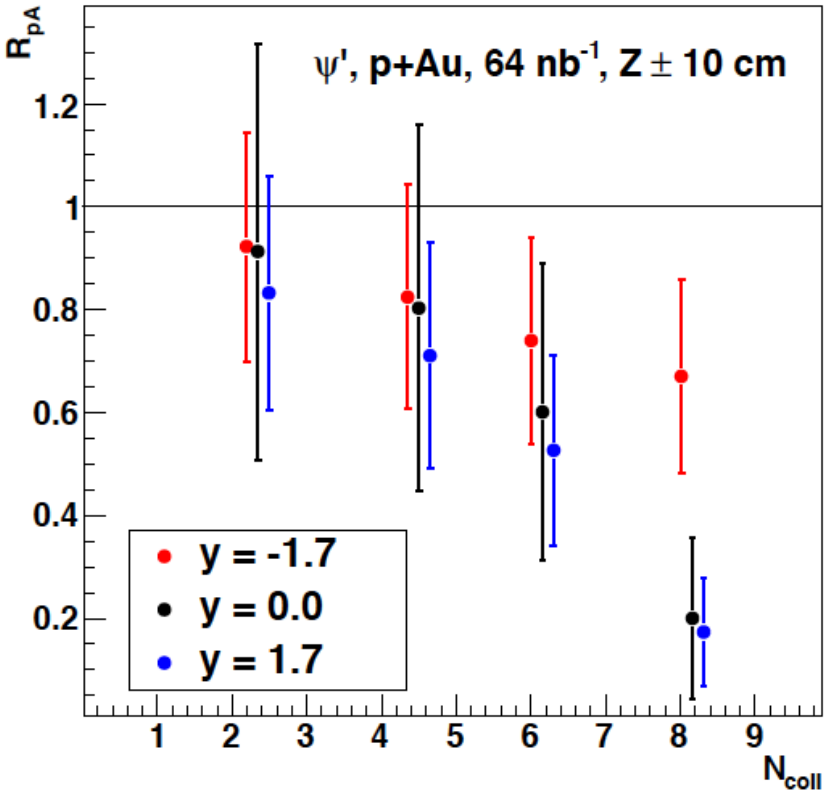
  $\mathcal{L} = 6.6\ \text{nb}^{-1}$

  - ×5 2010 dataset
  - ×8 2007 dataset



In 2015 RHIC pA Run
Projected uncertainties for J/Ψ and Ψ'

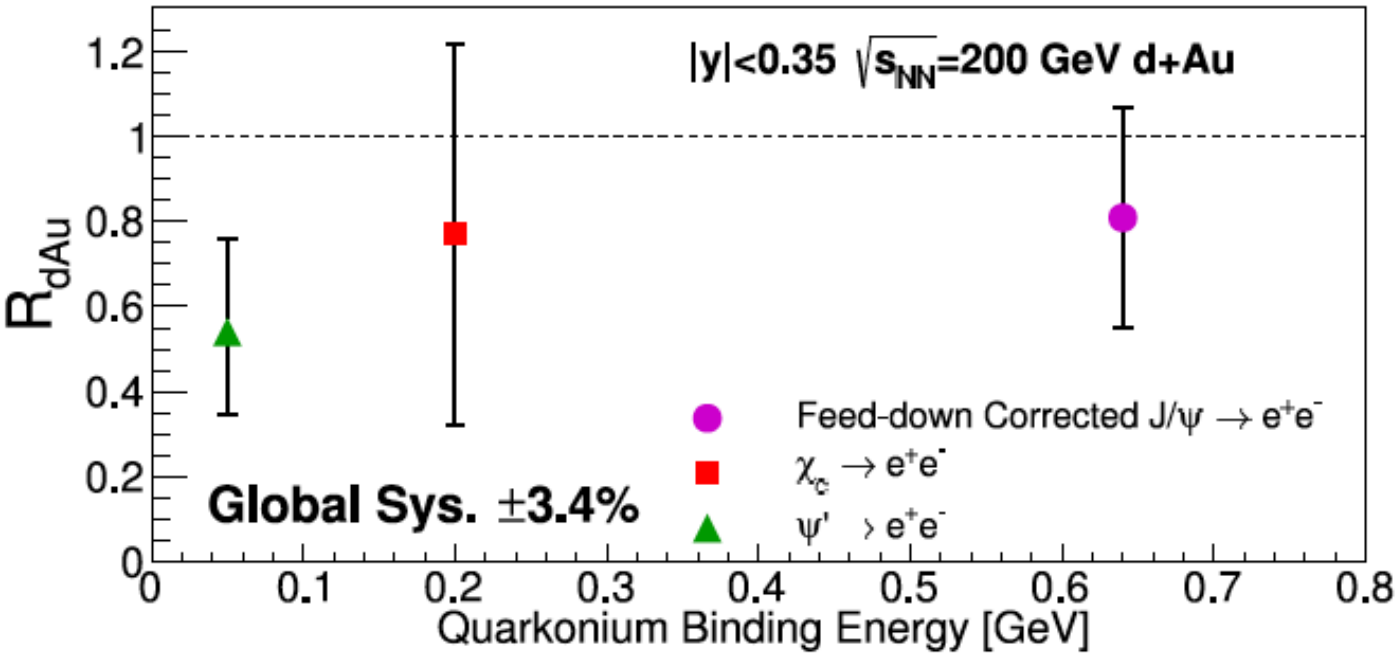




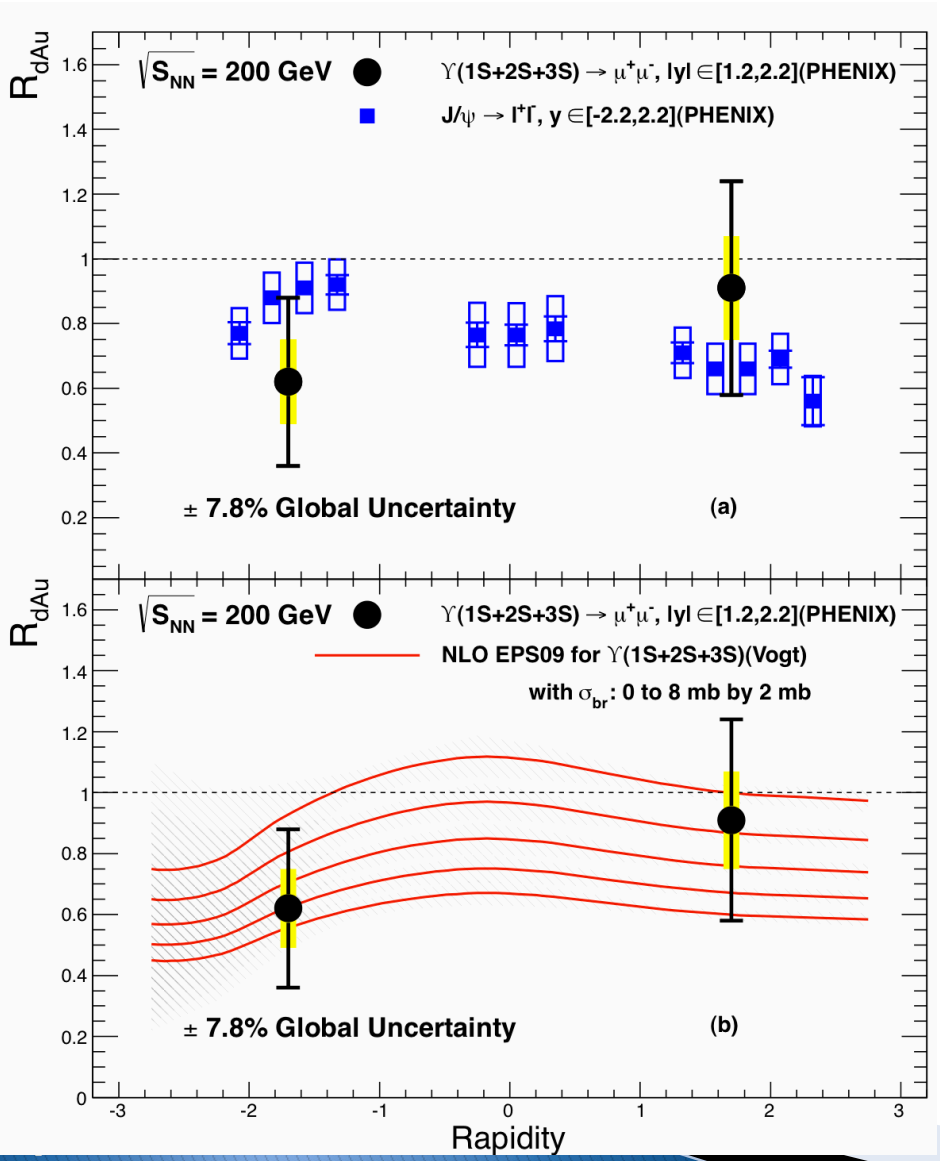
BACKUP

R_{dAu} vs binding energy

PHENIX PRL 111, 202301 (2013)



Upsilons in d+Au at forward rapidity



PHENIX, PRC 87, 044909 (2013)

Suppression consistent with NLO +EPS09 trend
(R. Vogt, PRC C81, 044903, 2010)

Unable to constrain breakup cross section due to large experimental uncertainties.