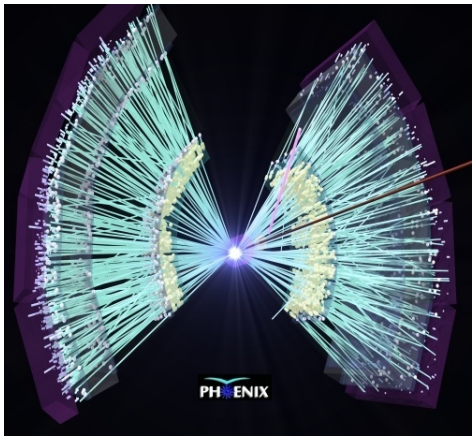


PHENIX

Measurement of Υ(1S+2S+3S) Production at PHENIX [arXiv:1404.2246]

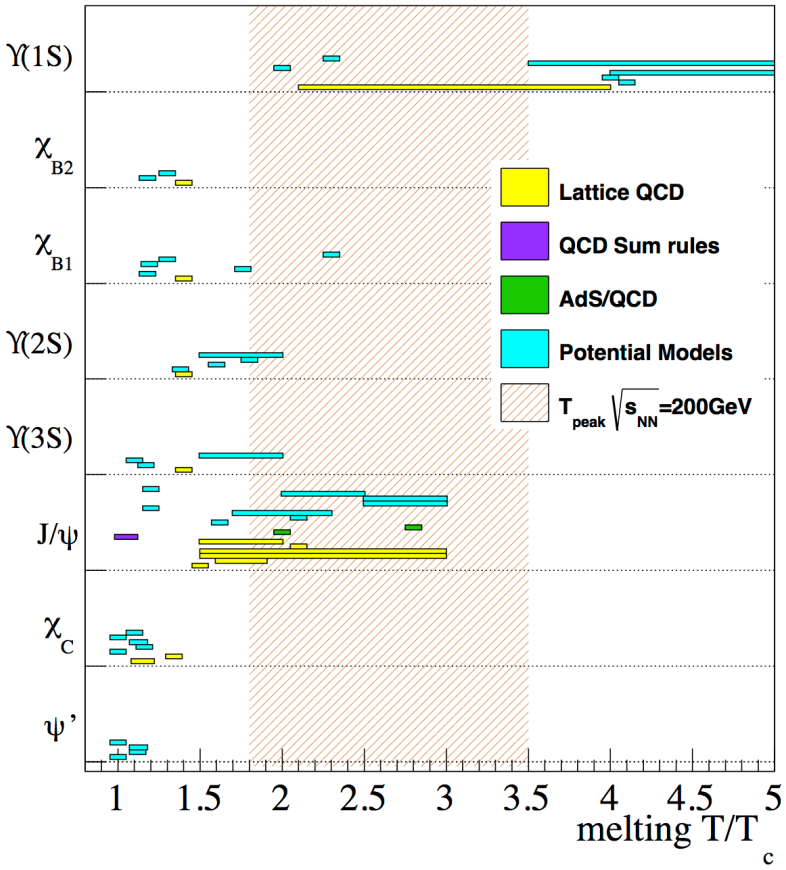
NEW!

Marzia Rosati

Iowa State University

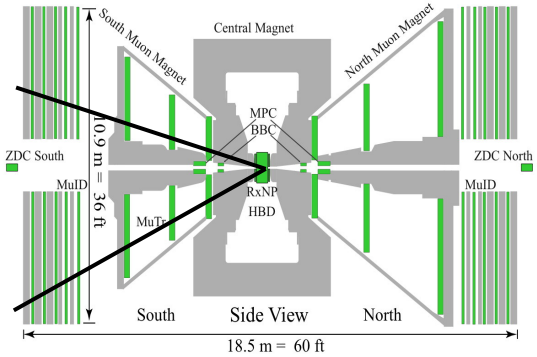
Quarkonium as QGP thermometer

- Dissociation of quarkonium by color screening in the QGP is predicted to be different for various states
- Loosely bound states melt first
- At about ~2.5T_c only J/ψ and ϒ survive

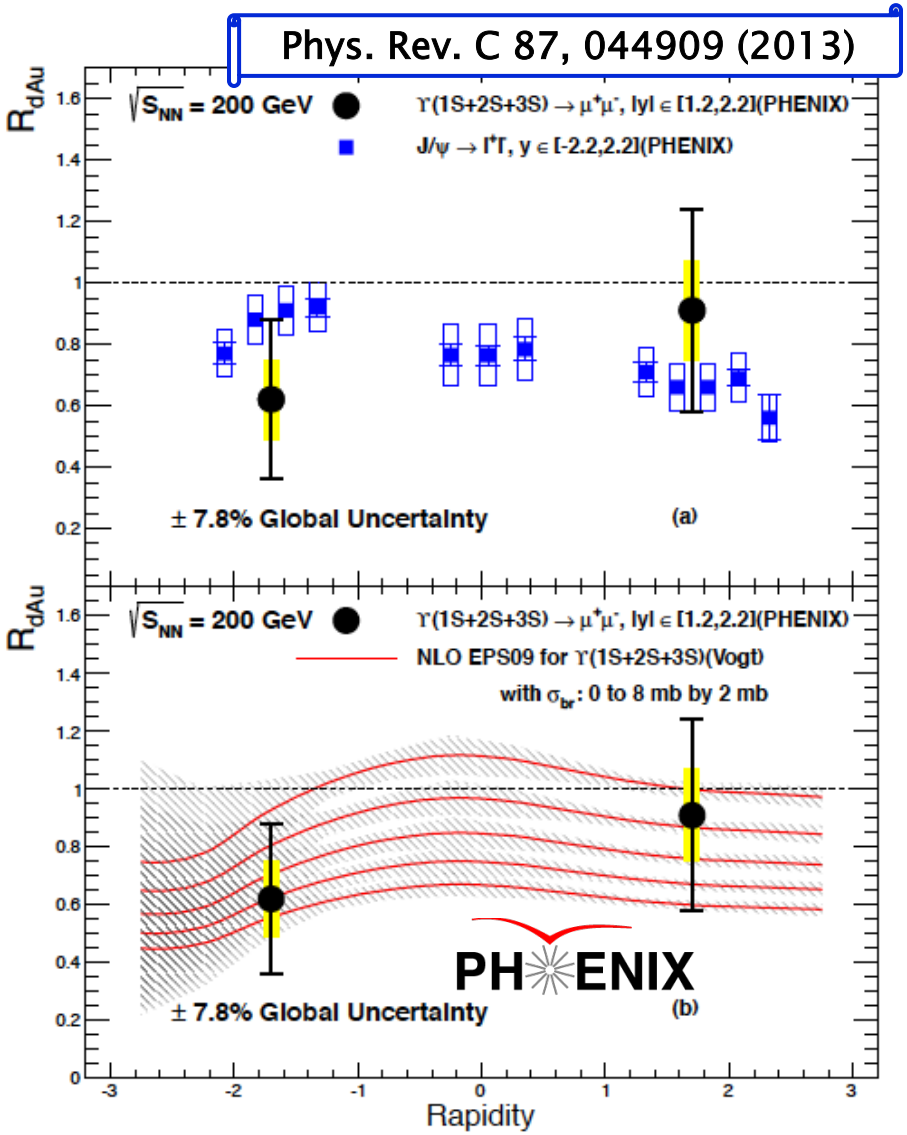


First Measurement of Υ(1S+2S+3S) at RHIC : R_{dA} at forward rapidity

- J/ψ
- Υ



Phys. Rev. C 87, 044909 (2013)

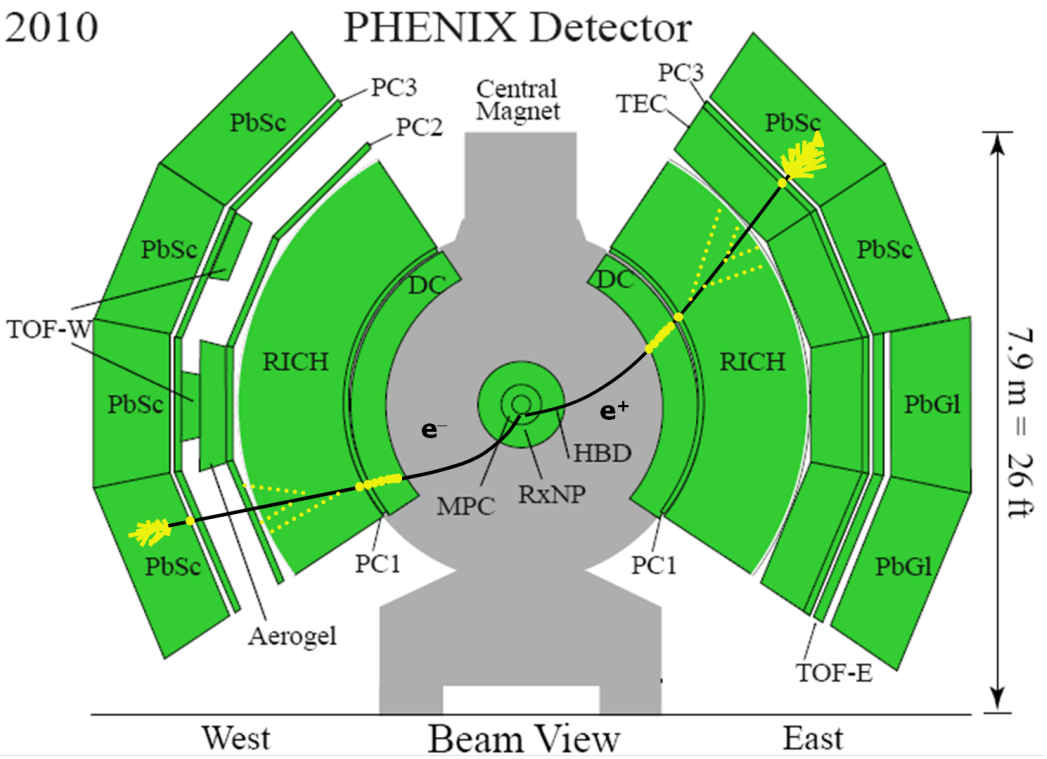


$$R_{dAu} = \frac{dN^{\Upsilon}_{dAu}/dy}{< N_{coll} > dN^{\Upsilon}_{pp}/dy}$$

Suppression consistent with NLO+EPS09 trend but unable to constrain breakup cross section

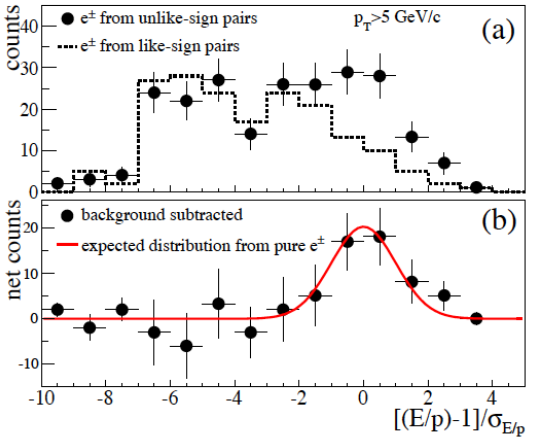
PHENIX $\Upsilon \rightarrow e^+e^-$ measurement at y=0

CENTRAL ARMS



Electrons at mid-rapidity:
$|\eta|<0.35$
$|\Delta\phi|>2 \times \pi/2$
$p_T>0.2$

PID with RICH and EMCAL

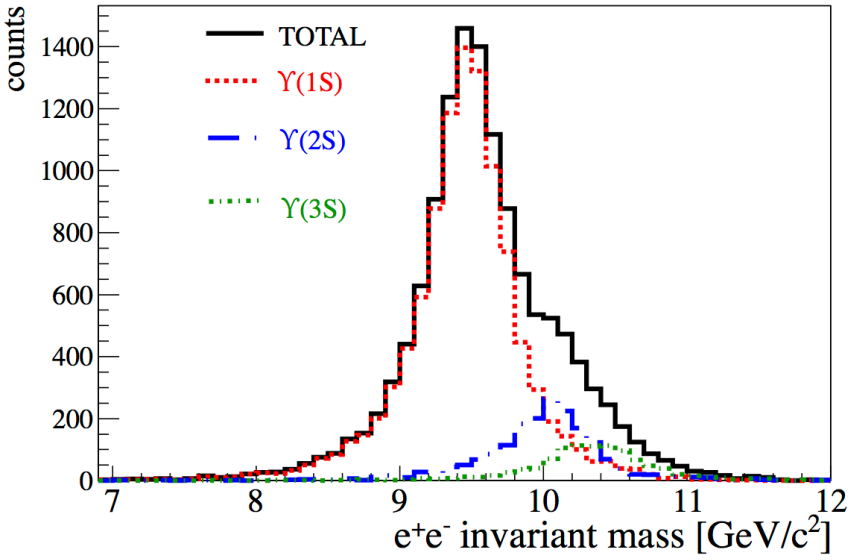


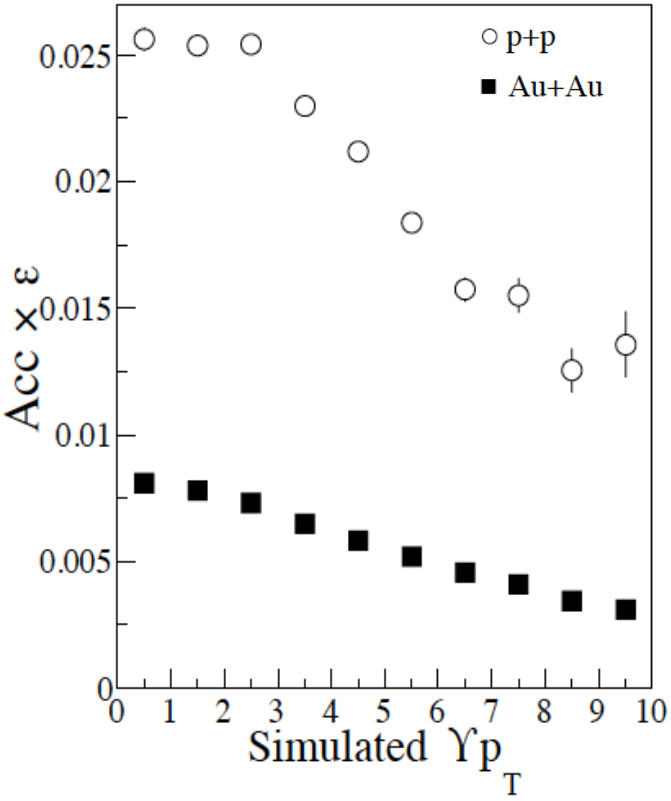
Excellent PID
For $p_T>5$GeV

ϒ Reconstruction at mid-rapidity

Simulated ϒ (1S+2S+3S) using the PHENIX detector simulation and relative yields from CDF experiment

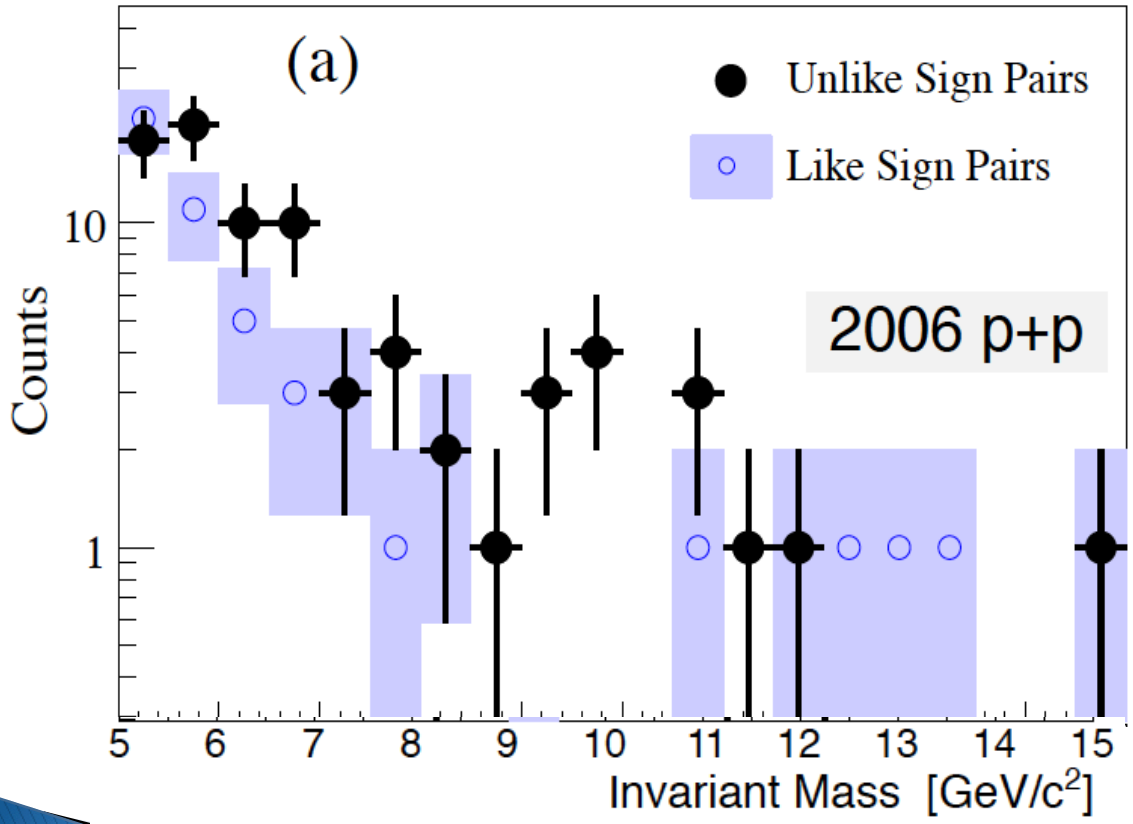
ϒ*State*	Mass	BR%	fraction of total ϒ
1S	9.46	2.38	73%
2S	10.02	1.91	17%
3S	10.36	2.18[1]	10%





ϒ Production at mid-rapidity in p+p

- Invariant mass distribution for all dielectrons shows excess at ~ 9.5 GeV

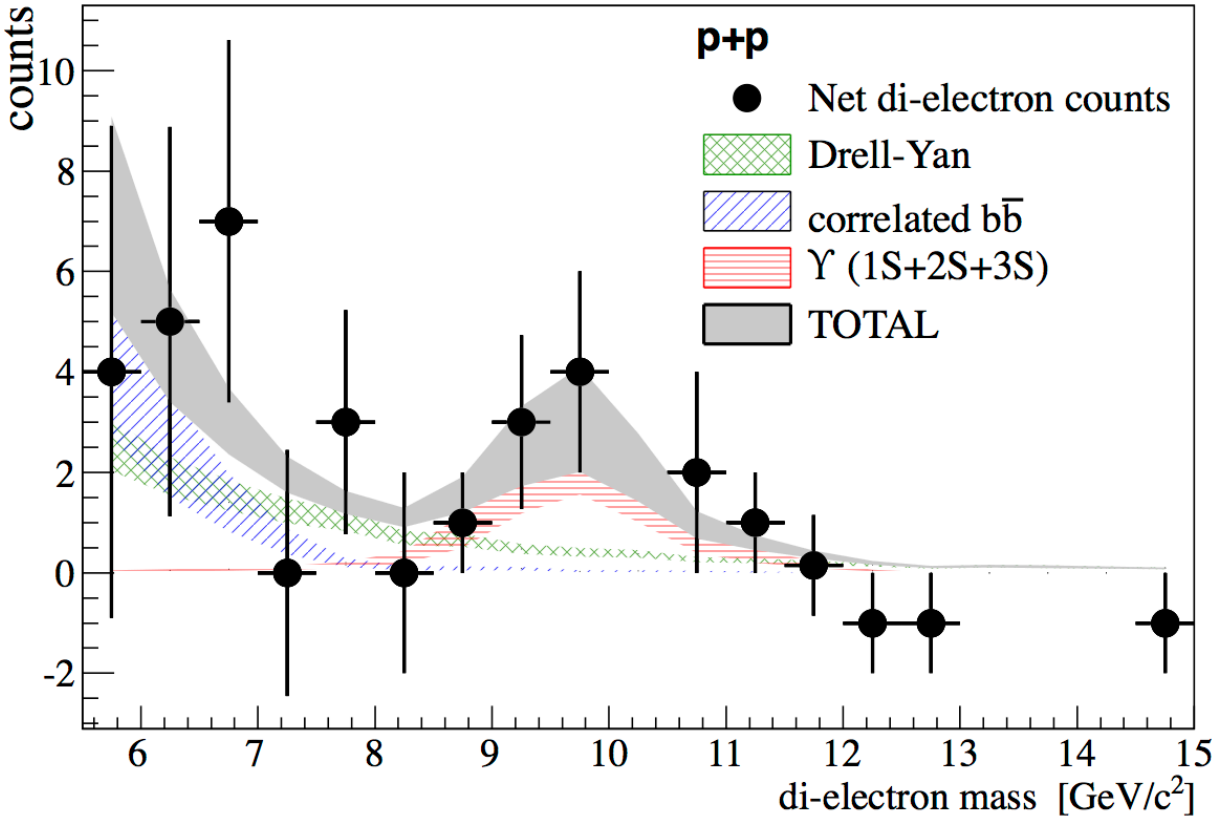


Black Points: N_{unlike} Opposite Sign Pairs

Blue Points: N_{like} Same Sign Pairs

Correlated dielectron pairs are estimated by taking the difference

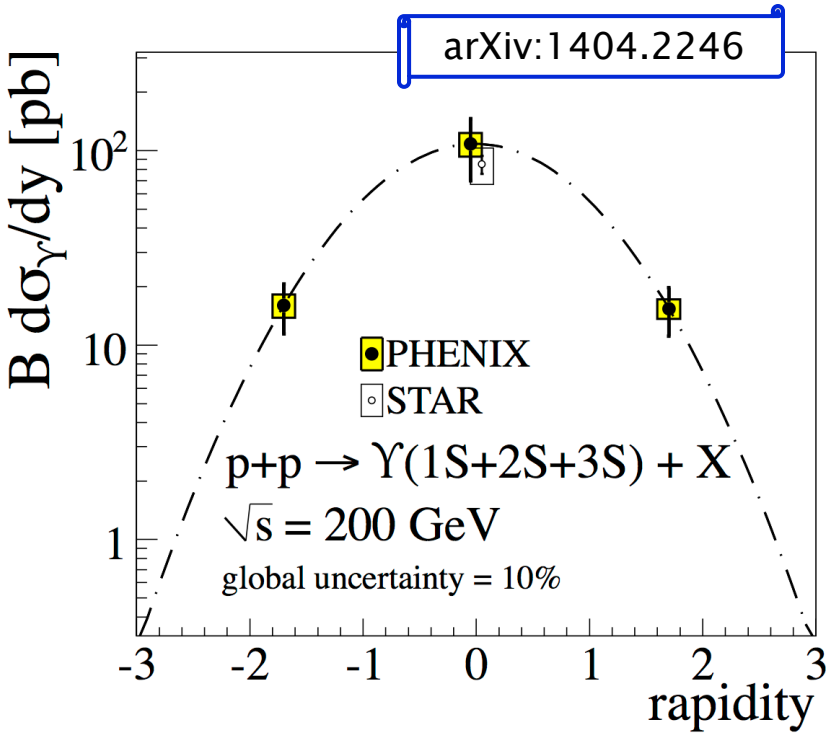
Fitting Correlated Invariant Mass Spectrum

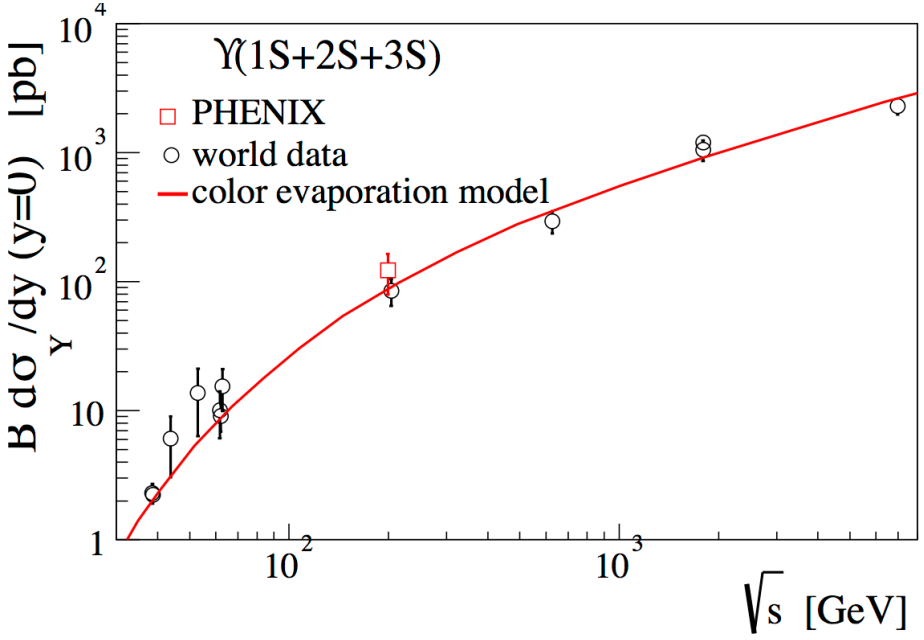


- Fraction of correlated signal, f_{cont}, coming from Drell Yan and $b\bar{b}$ leptonic decays is estimated by fitting

$$N_{\Upsilon} = (N_{\text{unlike}} - N_{\text{like}})\,(1 - f_{\text{cont}})$$

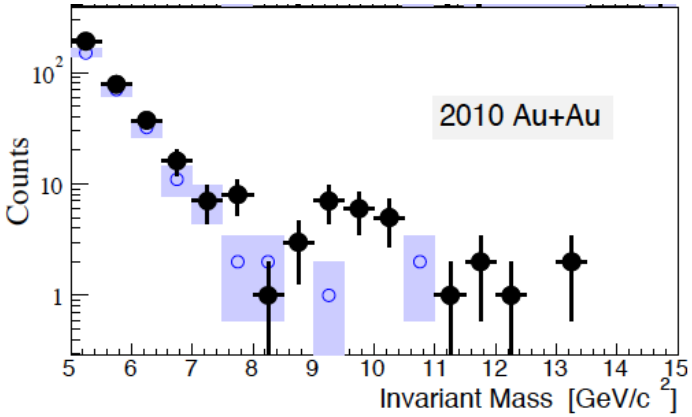
ϒ cross section at mid-rapidity





$$B\frac{d\sigma\Upsilon}{dy} = \frac{\sigma_{pp}}{\Delta y}\frac{N_\Upsilon}{N_{\mathrm{BBC}}\cdot Acc\cdot\varepsilon}$$

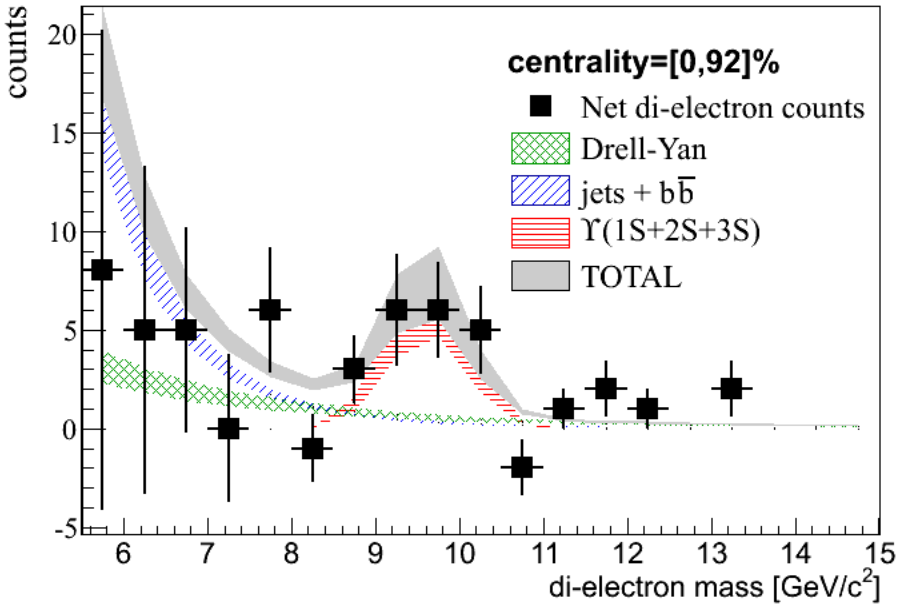
ϒ Production at mid-rapidity in MB Au+Au



- Opposite sign
  −
- Same sign
  =
- Correlated pairs

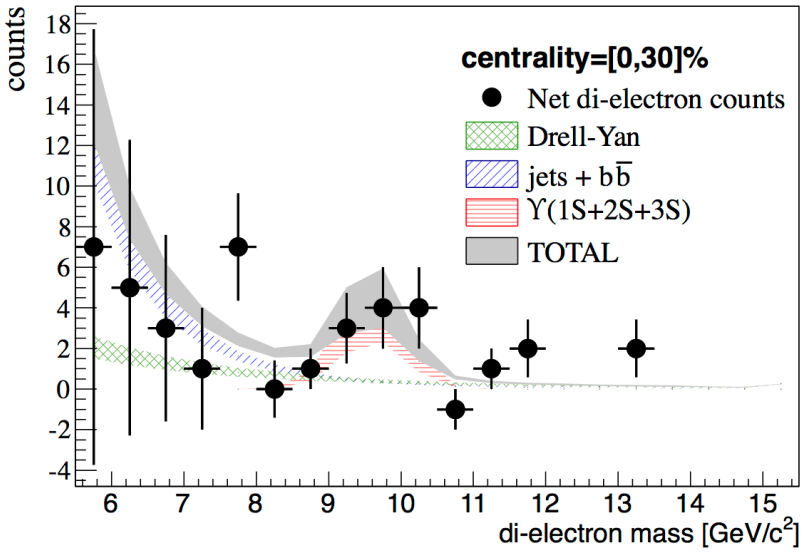
Correlated continuum background from Drell-Yan and open bottom (semi-leptonic decays) evaluated by fit with:

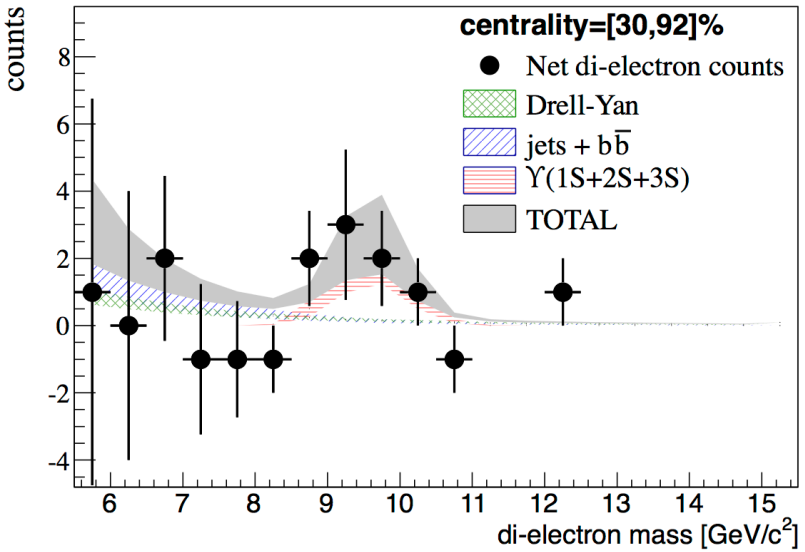
- ✓ DY estimated by NLO calculation and varied within theory errors
- ✓ b and jets shape as power law function



Υ Invariant Yield vs centrality

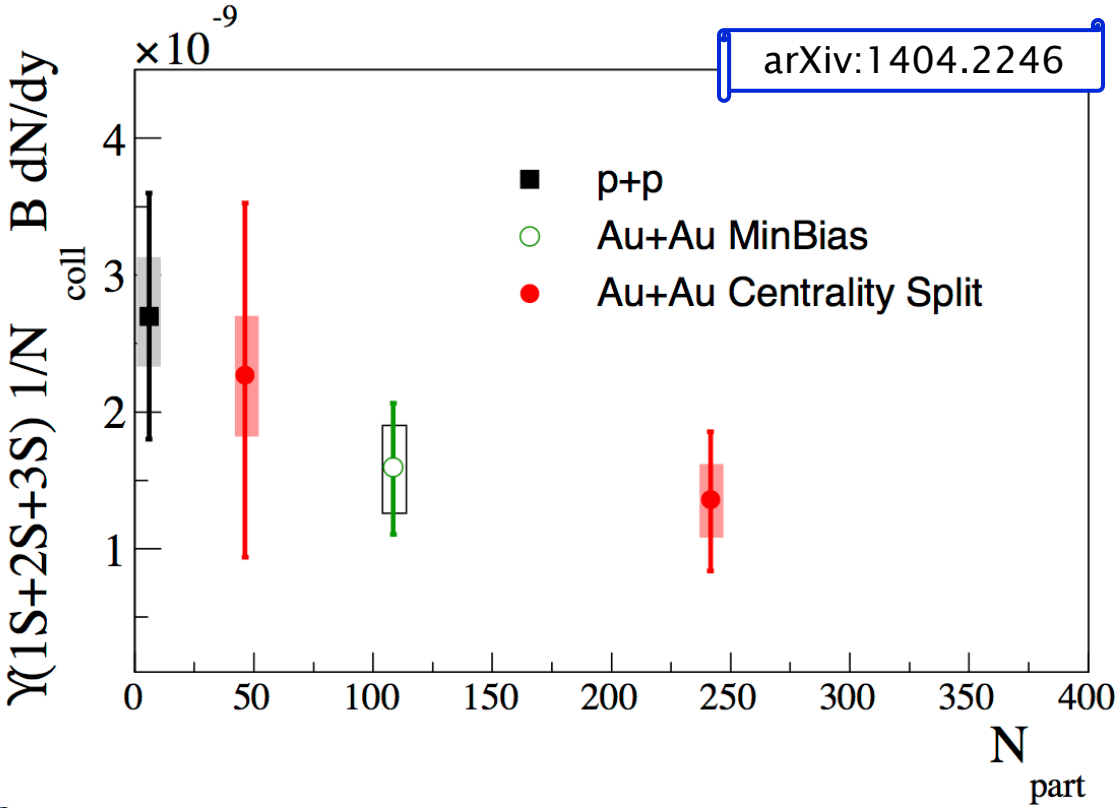
- Data set divided into 2 samples
  - Central [0–30%]
  - Mid-peripheral [30%–92%]





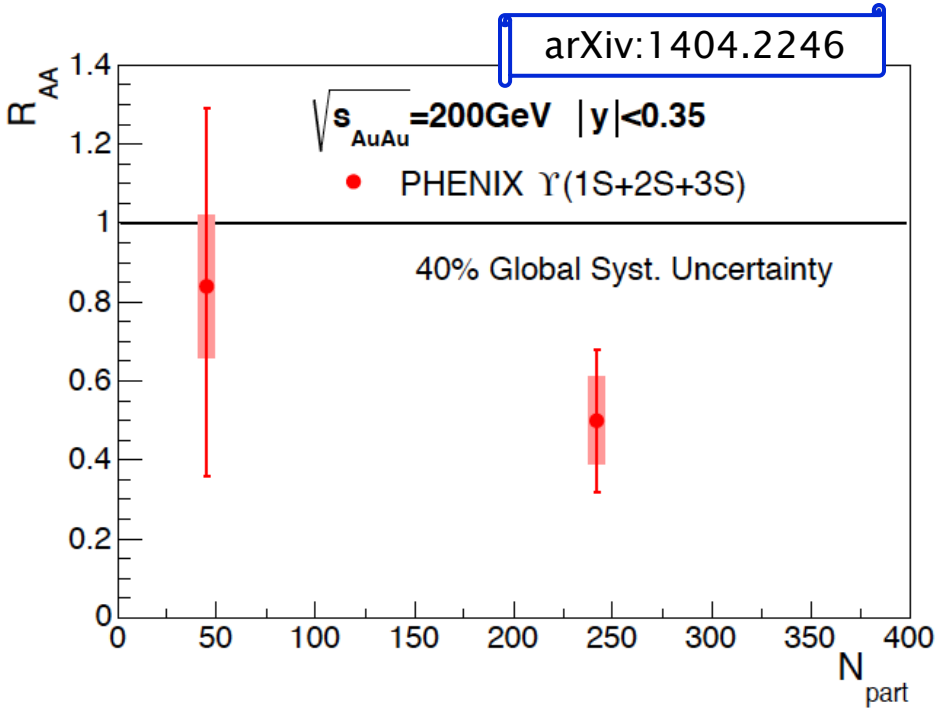
Υ Invariant Yield/N_{coll} versus N_{part}

$$BdN/dy = \frac{1}{\Delta y} \times \frac{N_{\Upsilon}}{N_{BBC} \times A \times \epsilon}$$



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

ϒ Nuclear Suppression versus N_{part}

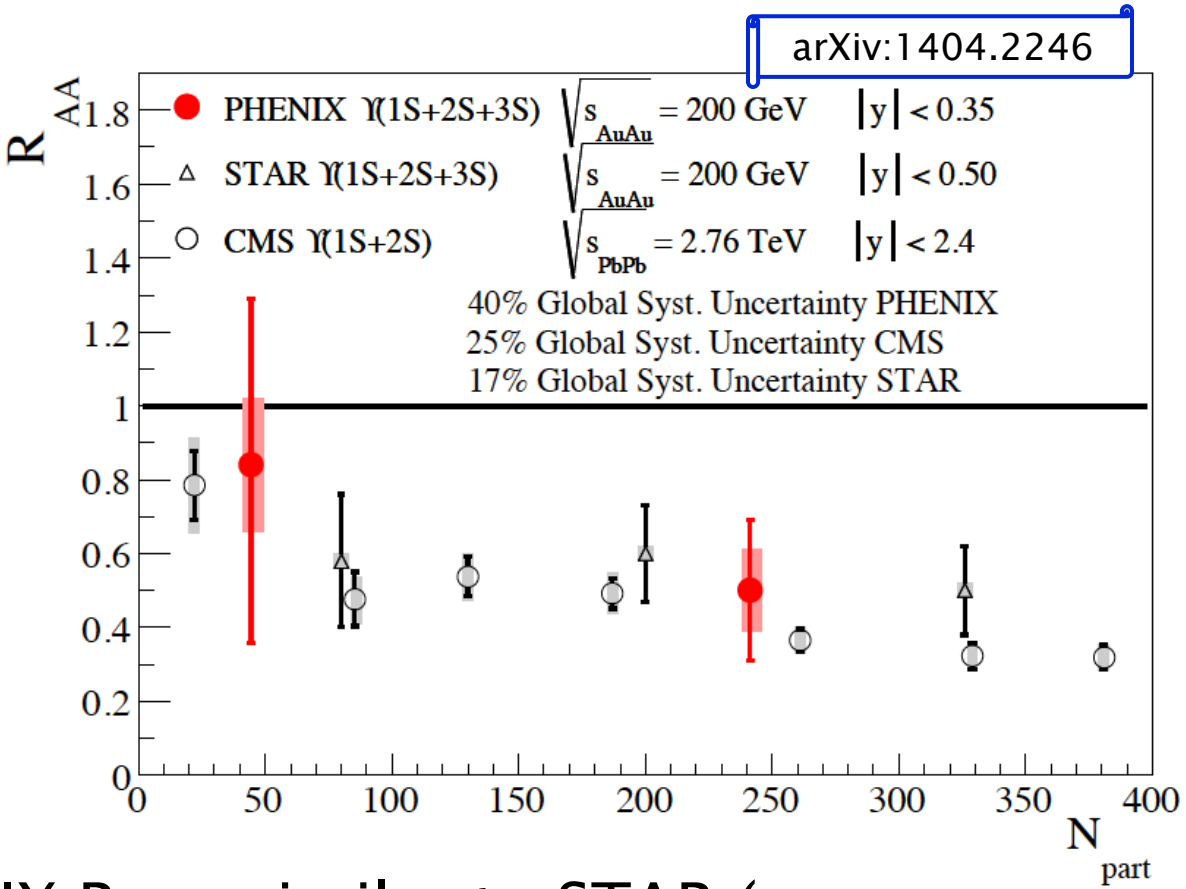


- Expected R_{AA}

	R_{AA}
no 2S or 3S	0.65 ± 0.11
no 2S,3S or χ_B	0.37 ± 0.09

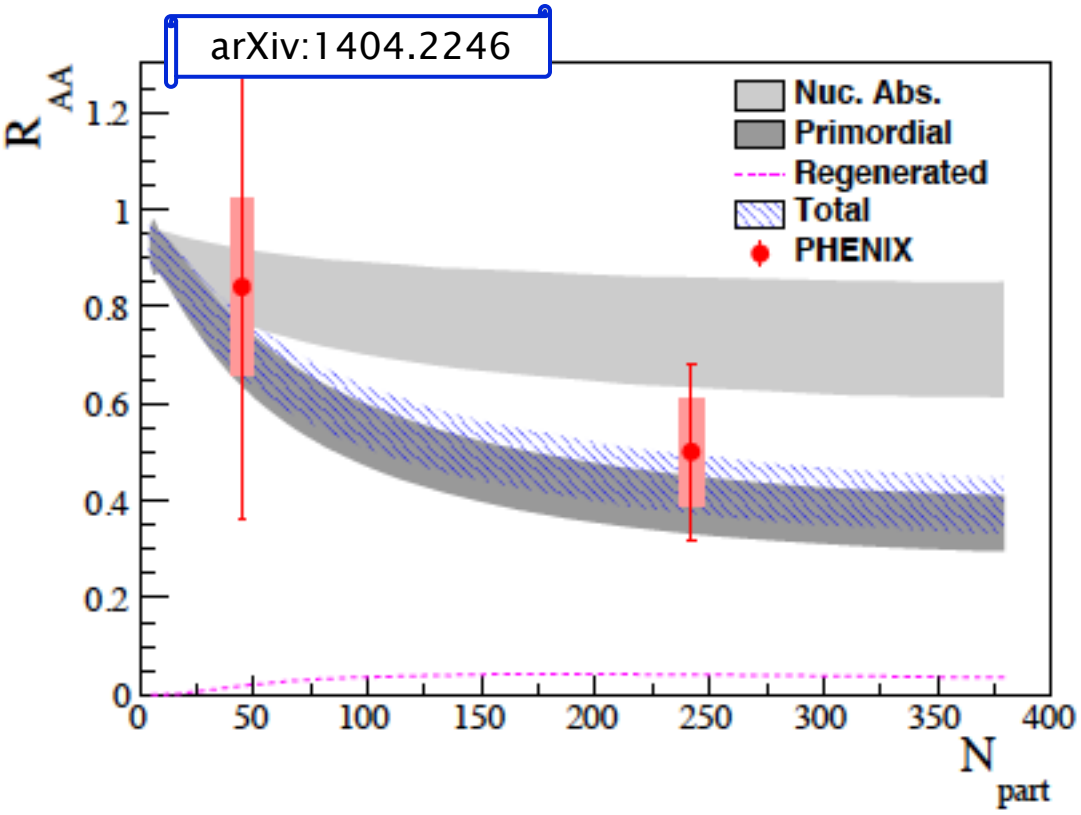
- Measured R_{AA} for most central collisions is consistent with melting of 2S+3S states

Comparison to other experiments



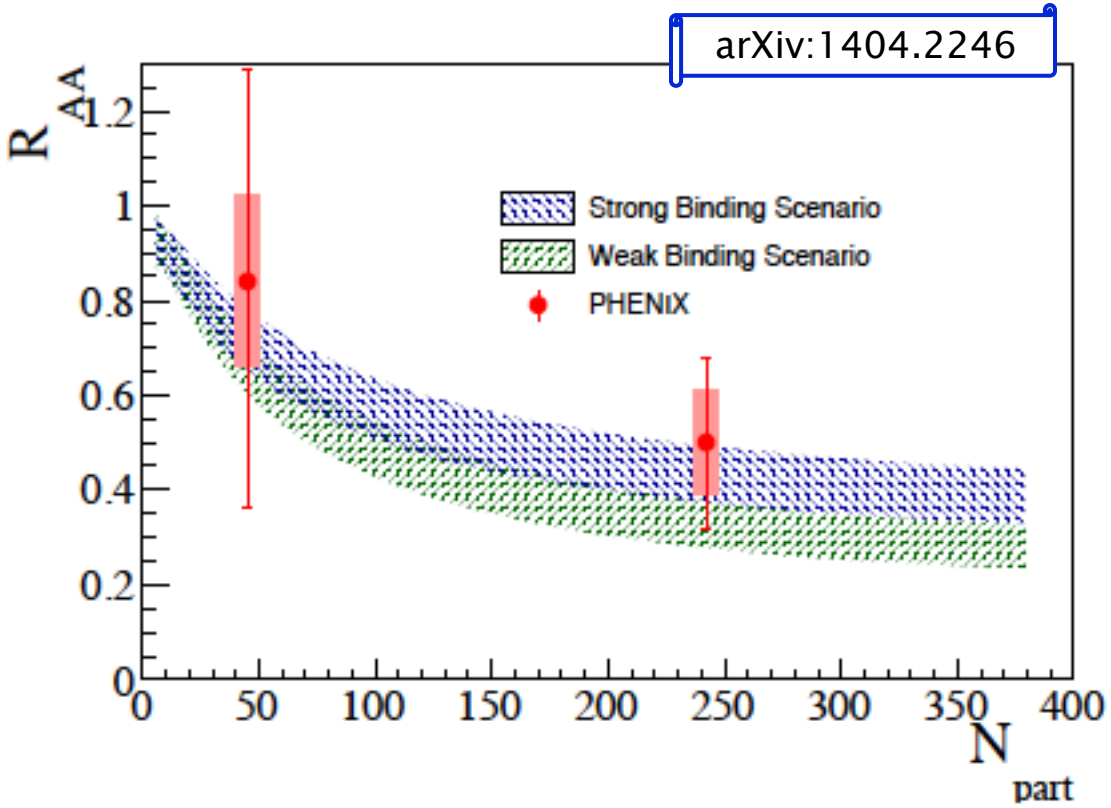
- PHENIX R_{AuAu} similar to STAR (same c.m. energy) and CMS (much higher c.m. energy)

Comparison to Theory (I)



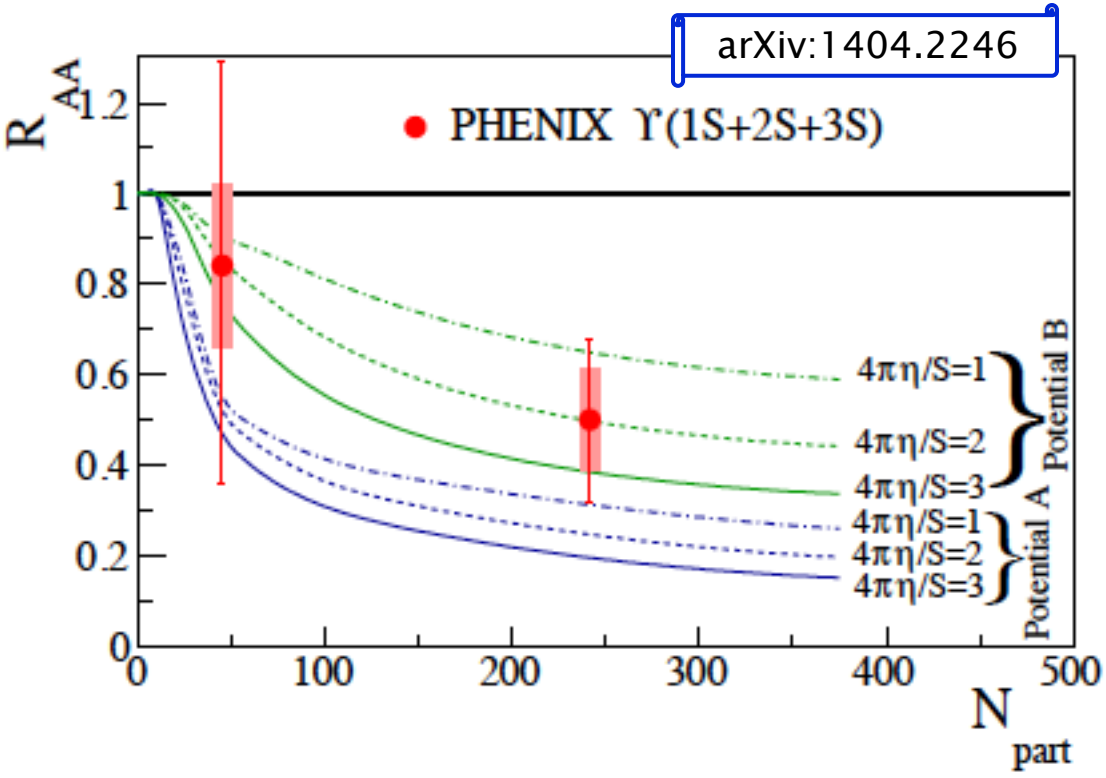
- Model based on rate equation by Emerick, Zhao and Rapp
  [Eur. Phys. J. A48,72(2012)]
- Model includes ϒ primordial formation, nuclear absorption and regeneration (very small at RHIC)
- Model consistent with data

Comparison to Theory (II)



- Data consistent with both strong and weak binding

Comparison to Theory (III)

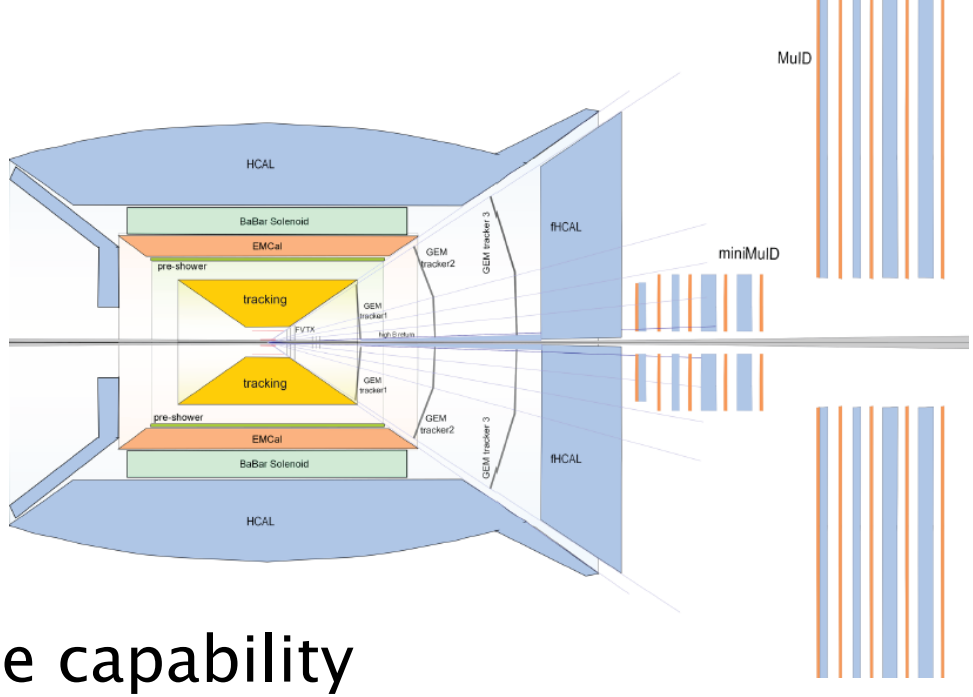


- Potential Model with finite momentum-space anisotropy by Strickland and Barzov [Nucl.Phys. A 879,23(2012)]
- Data prefers model with potential B which includes entropy contribution to the free energy but unable to constrain η/s

Conclusions

- PHENIX observed ϒ suppression in Central Au+Au Collisions
- Measured R_{AA} consistent with STAR and CMS
- Measured R_{AA} consistent with melting of ϒ(2S) and ϒ(3S) states
- Near term future: lots more data coming will improve measure R_{AA} precision at RHIC
  - in 2014 (ongoing) Au+Au run
  - in 2015 p+Au run in 2015
- Long term future -> sPHENIX

sPHENIX Plan



- maintain PHENIX high rate capability
- hadronic calorimetry
- forward detectors for useful for spin, asymmetric collisions & e-p/e-A, A-A
- large uniform acceptance
  - ~10-fold acceptance increase for quarkonia
  - good mass resolution : Υ states resolved

BACKUP

Fitting Correlated Dielectron Spectra