Υ measurements in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV with the STAR experiment

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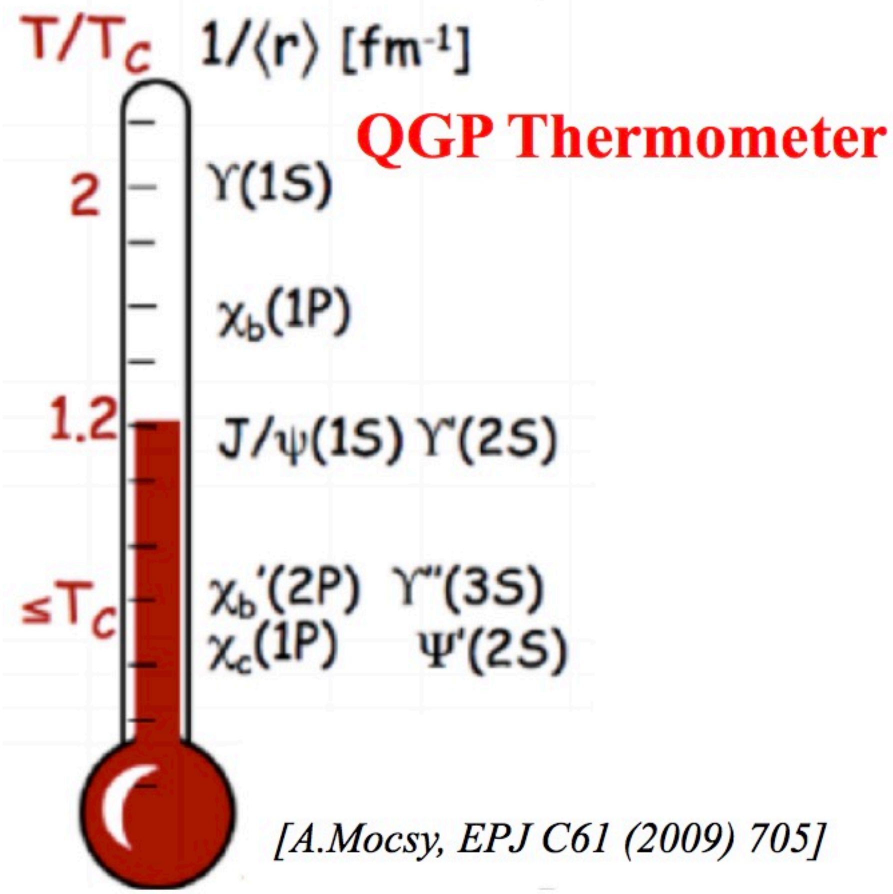
Outline

- Motivation
- STAR experiment
- Υ measurements in Au+Au collisions at STAR:
  - Υ(1S) suppression (R_{AA} vs. centrality, p_T)
  - Υ(2S+3S) suppression (R_{AA} vs. centrality, p_T)
- Comparison with LHC results and theoretical calculations
- Summary

Motivation

- **Color-screening: quark-antiquark potential is color-screened in the QGP by the surrounding partons ⇒ *dissociation***

Illustration: A.Rothkopf



[A.Mocsy, EPJ C61 (2009) 705]

- **"Thermometer": different states dissociate at different temperatures ⇒ *sequential suppression***

Υ is a cleaner probe at RHIC:

- Regeneration is negligible

  A. Emerick, X. Zhao & R. Rapp: EPJ A48 (2012) 72

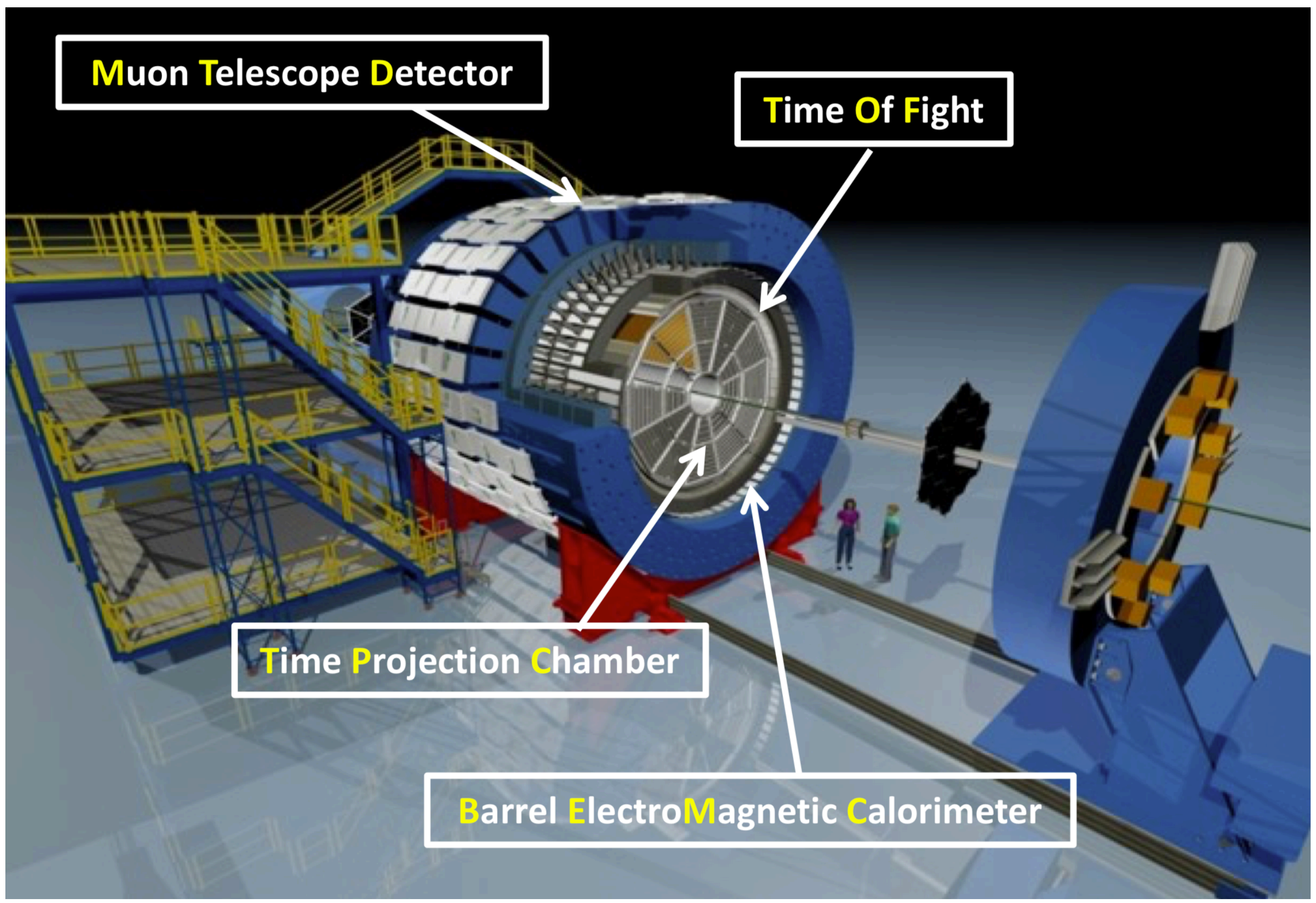
- Co-mover absorption is negligible

  Lin & Ko: PLB 503 (2001) 104

The Solenoidal Tracker at RHIC

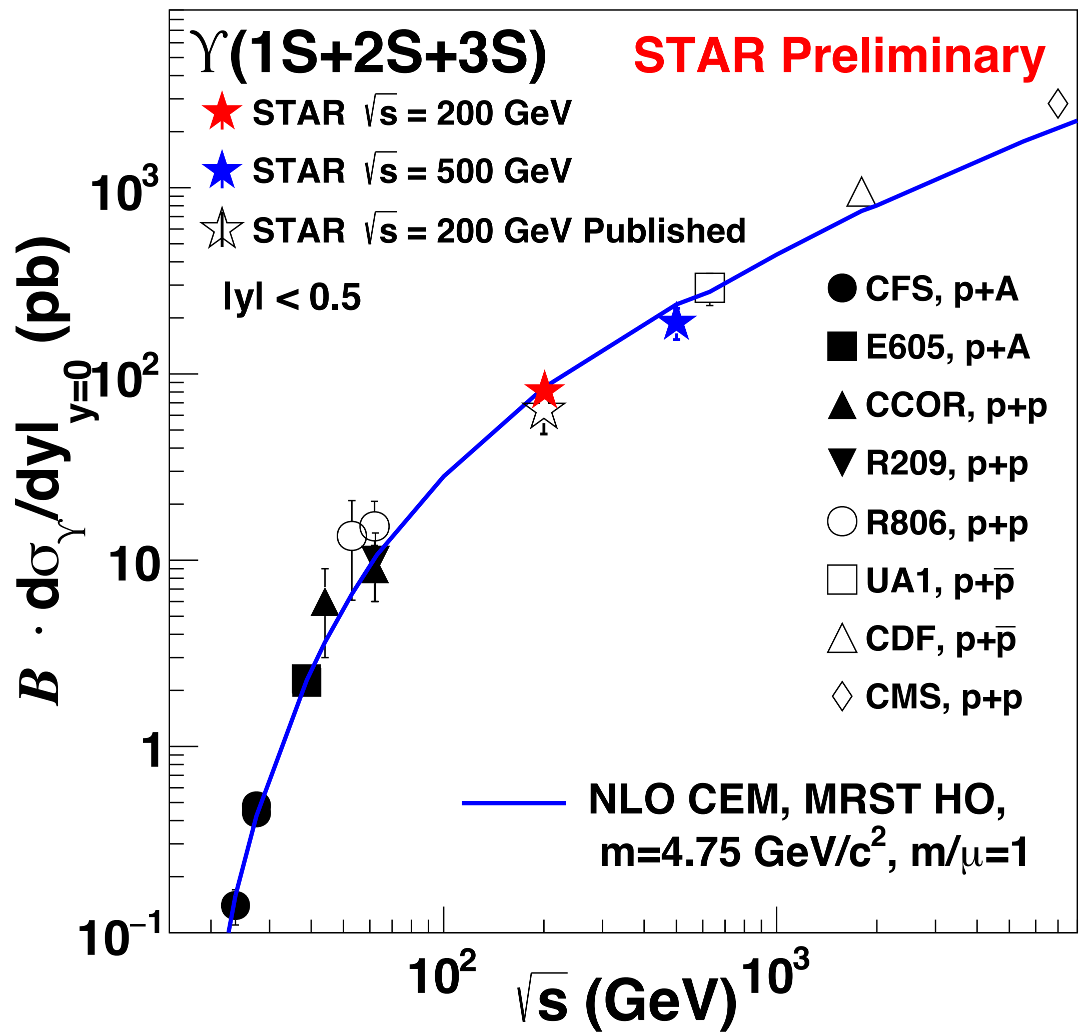
STAR

Mid-rapidity coverage : $|\eta| < 1$, $0 < \varphi < 2\pi$



- **TPC**
  - Tracking, PID
- **TOF**
  - Measure time of flight
- **BEMC**
  - Trigger and identification of high-p_T electrons
- **MTD** ($|\eta| < 0.5$, 45% in φ)
  - Dimuon trigger and muon identification
  - Less Bremsstrahlung: helps separate Υ(2S+3S) from Υ(1S)

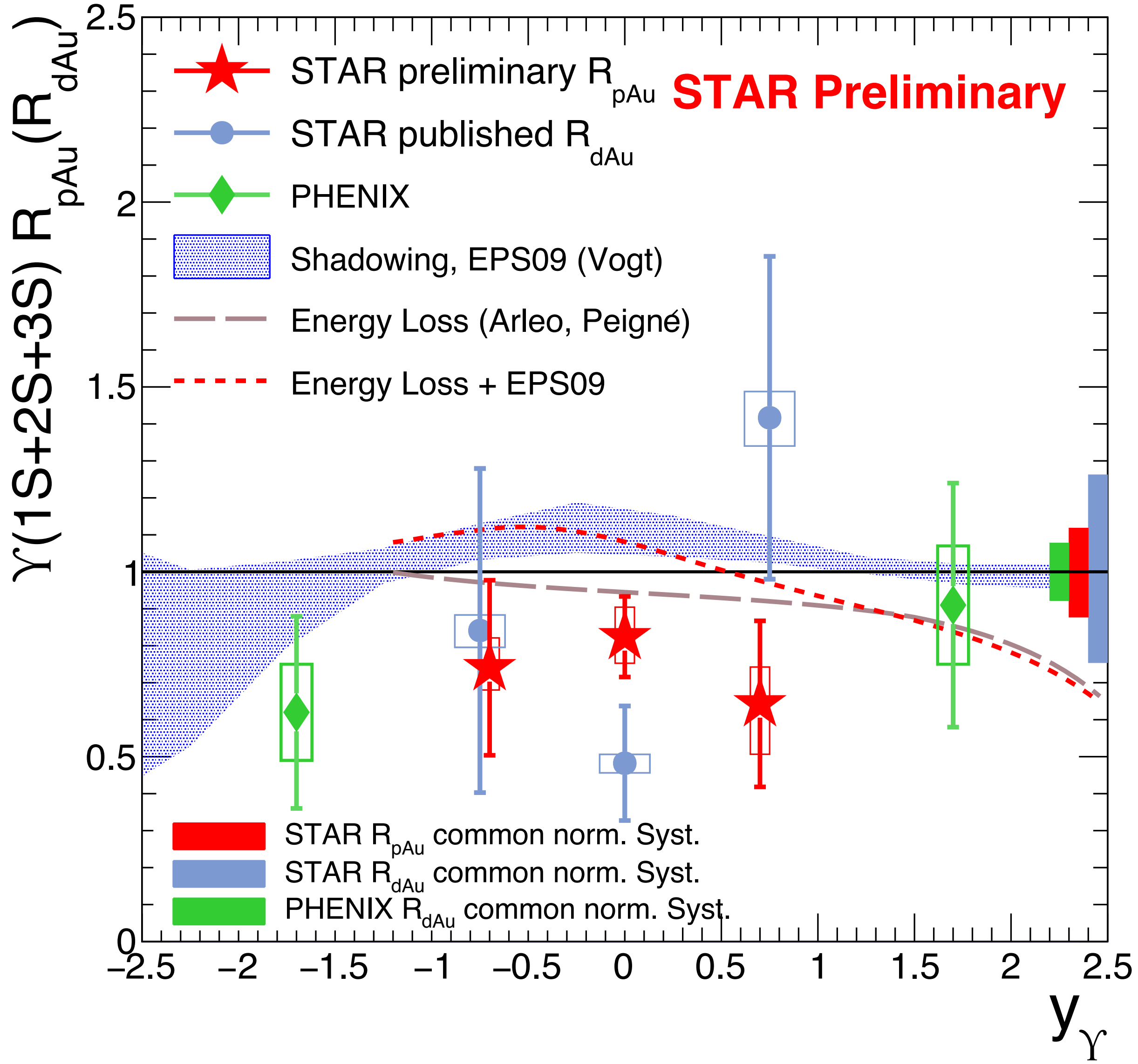
Υ cross-section in p+p collisions



p+p@200 GeV: σ = 81 ± 5(stat.) ± 8(syst.) pb

- Baseline for p+A and A+A collisions with improved precision
- Consistent with the Color Evaporation Model (CEM) prediction

Υ(1S+2S+3S) R_{pAu} at 200 GeV



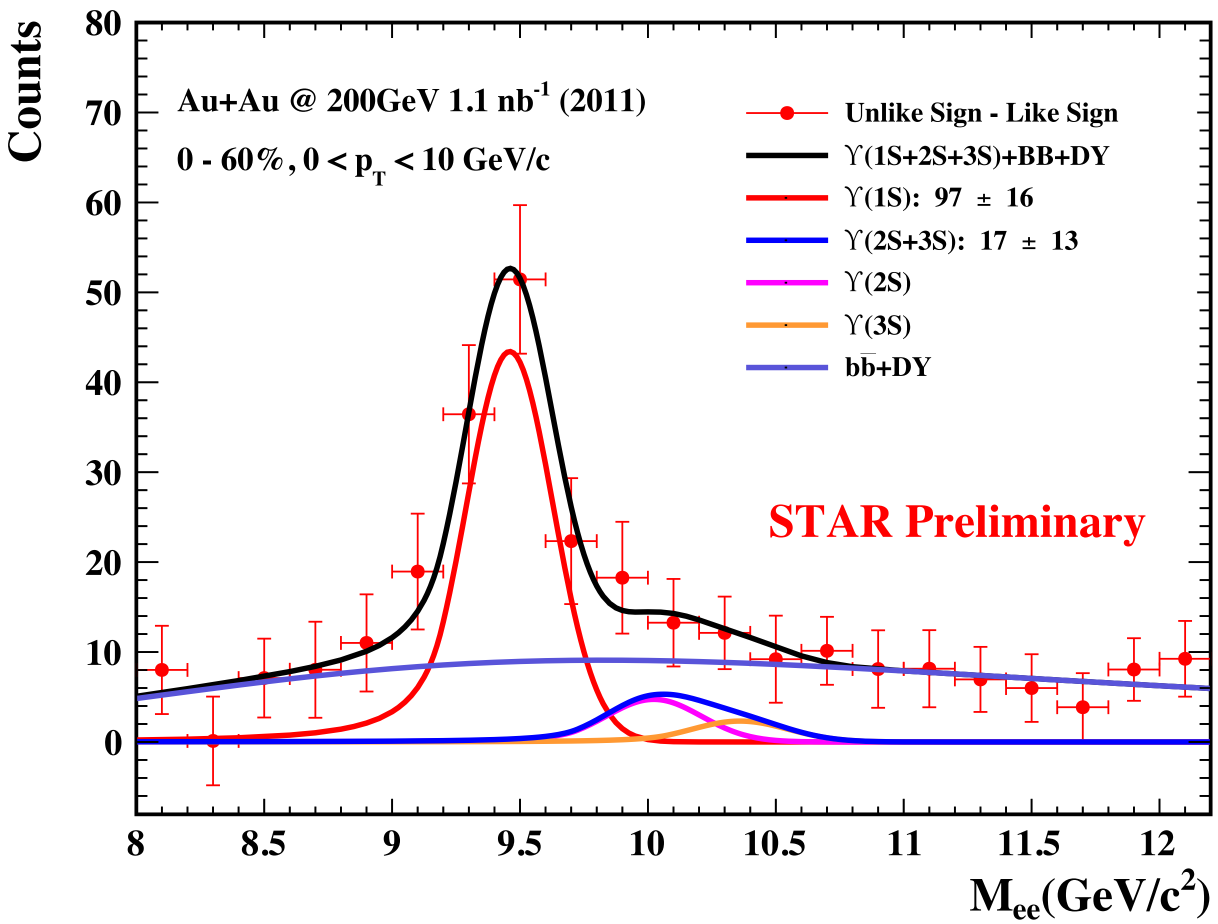
p+Au@200 GeV: RpAu = $0.82 \pm 0.10(\text{stat.})^{+0.08}_{-0.07}$ (syst.) ± 0.10 (global)

- Indicates CNM effects
- Additional suppression mechanism beyond nPDF effects seems to be needed

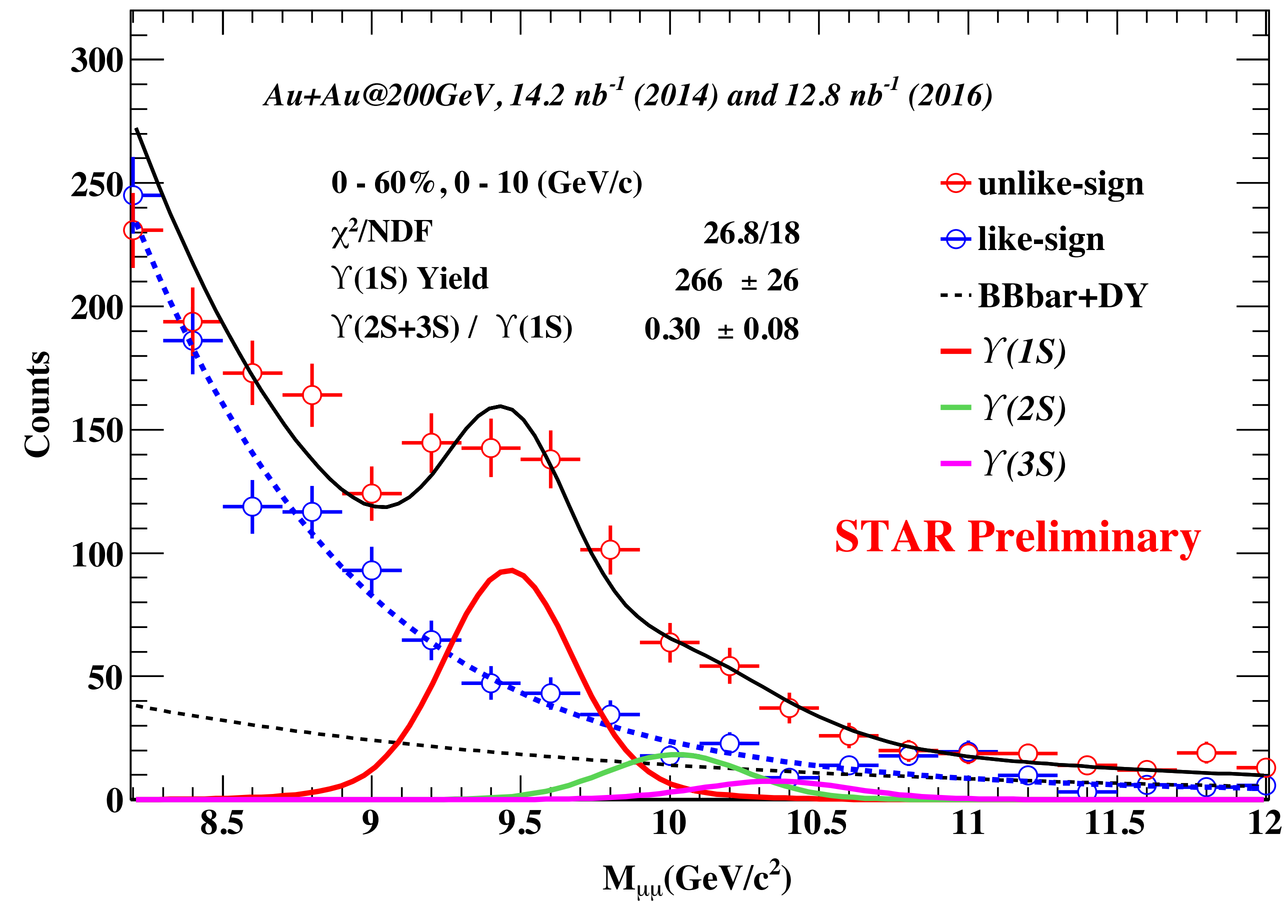
ϒ signals in Au+Au@200 GeV

STAR

ϒ➔e^+e^- (2011)



ϒ➔$\mu^+\mu^-$ (2014+2016)



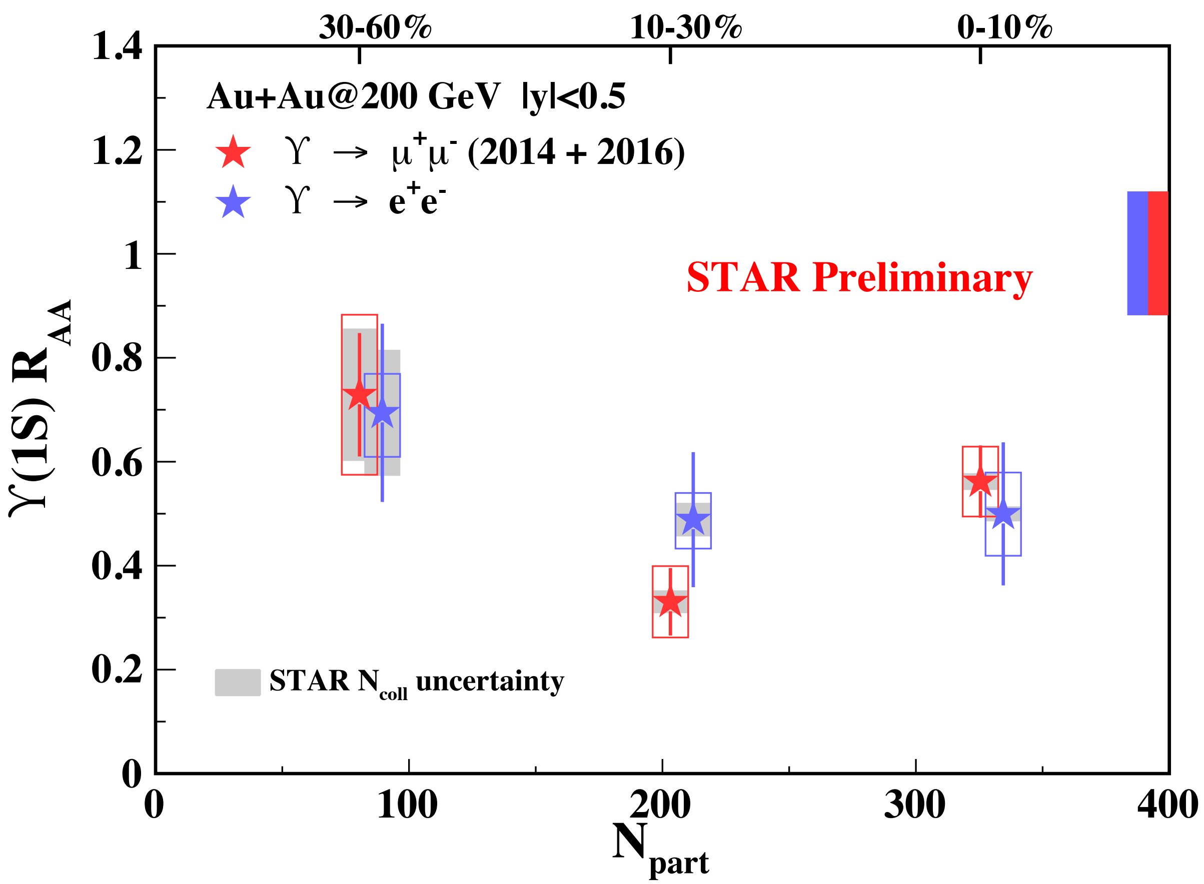
ϒ signal shape:

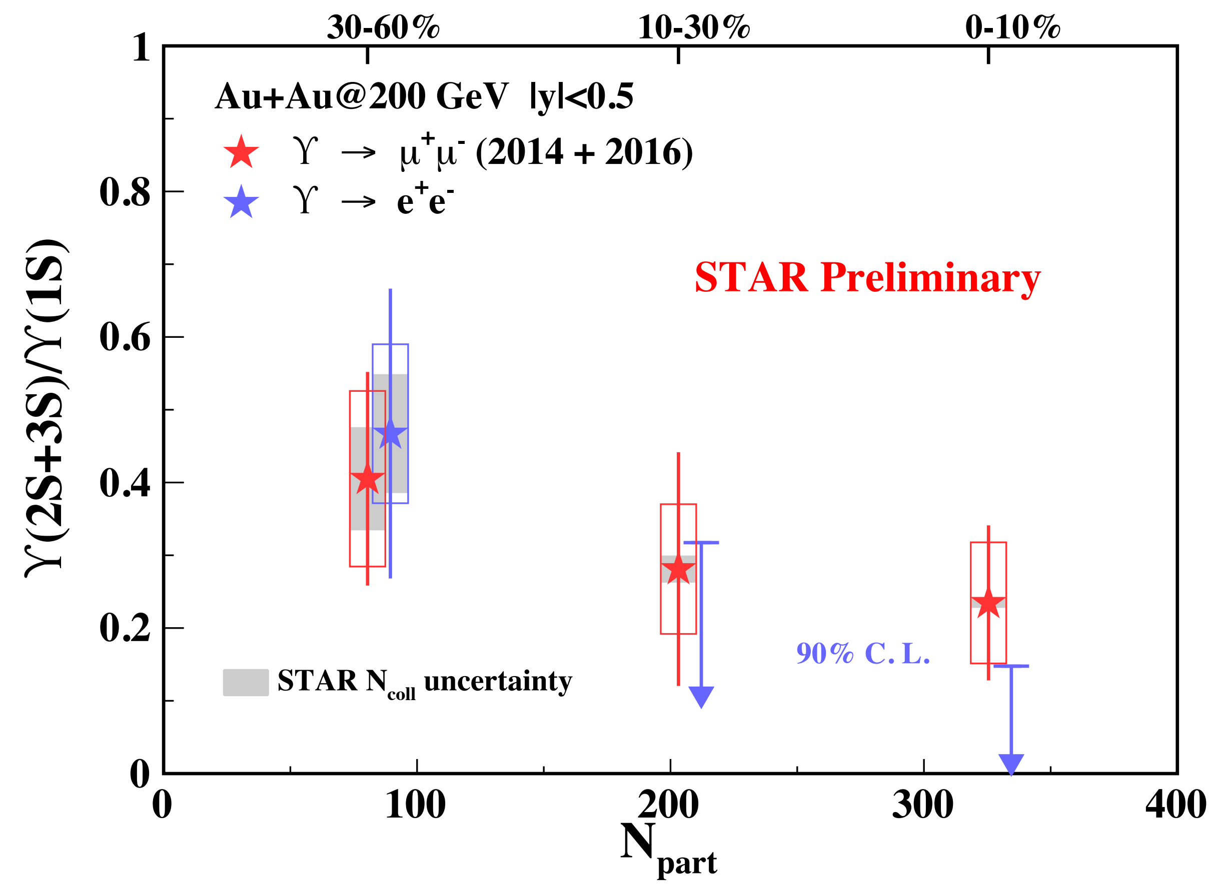
- STAR detector simulation

Residual background ($b\bar{b}$ + Drell-Yan):

- PYTHIA simulation

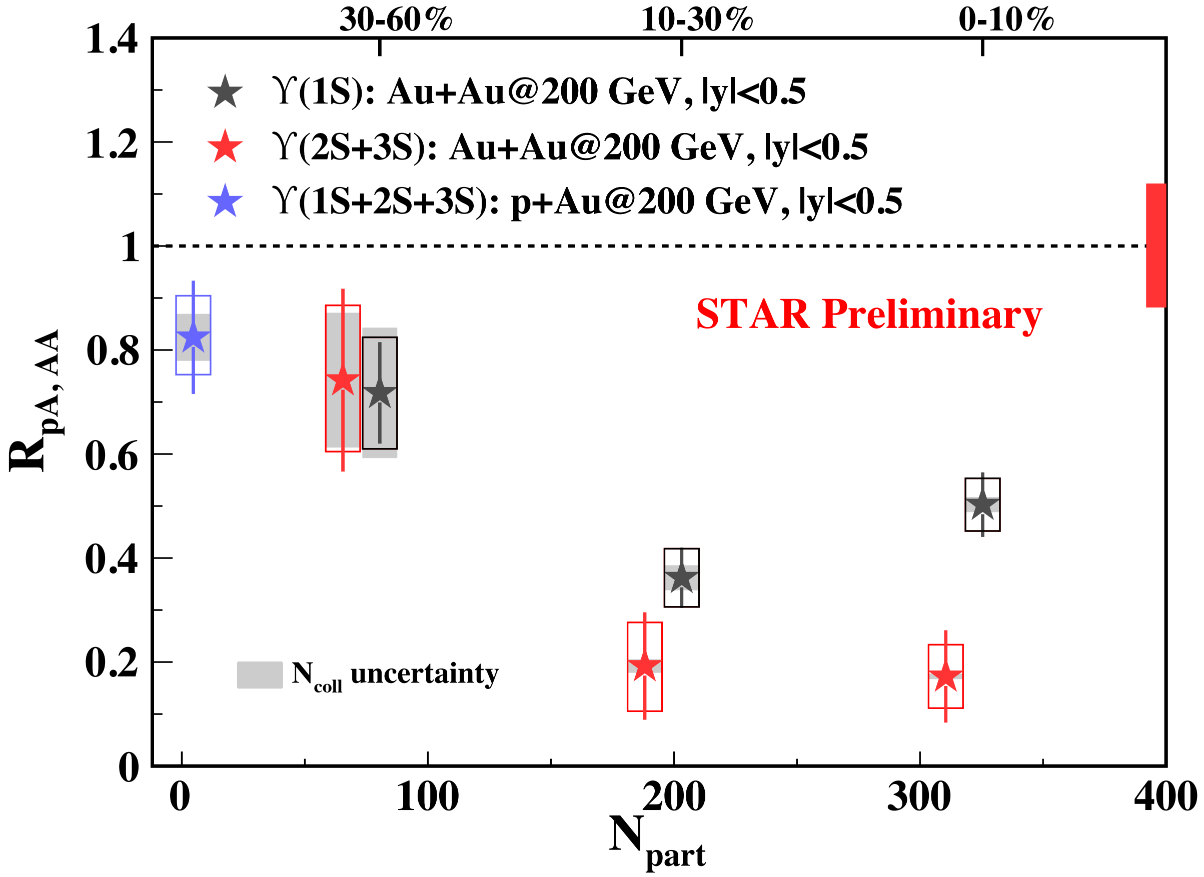
Dielectron vs. dimuon





- Consistent between the dielectron and dimuon channels
- Both results are combined to achieve better precision

Υ suppression at RHIC



p+Au:

Υ(1S+2S+3S)

- **Indicates CNM effects**

Au+Au:

Υ(1S):

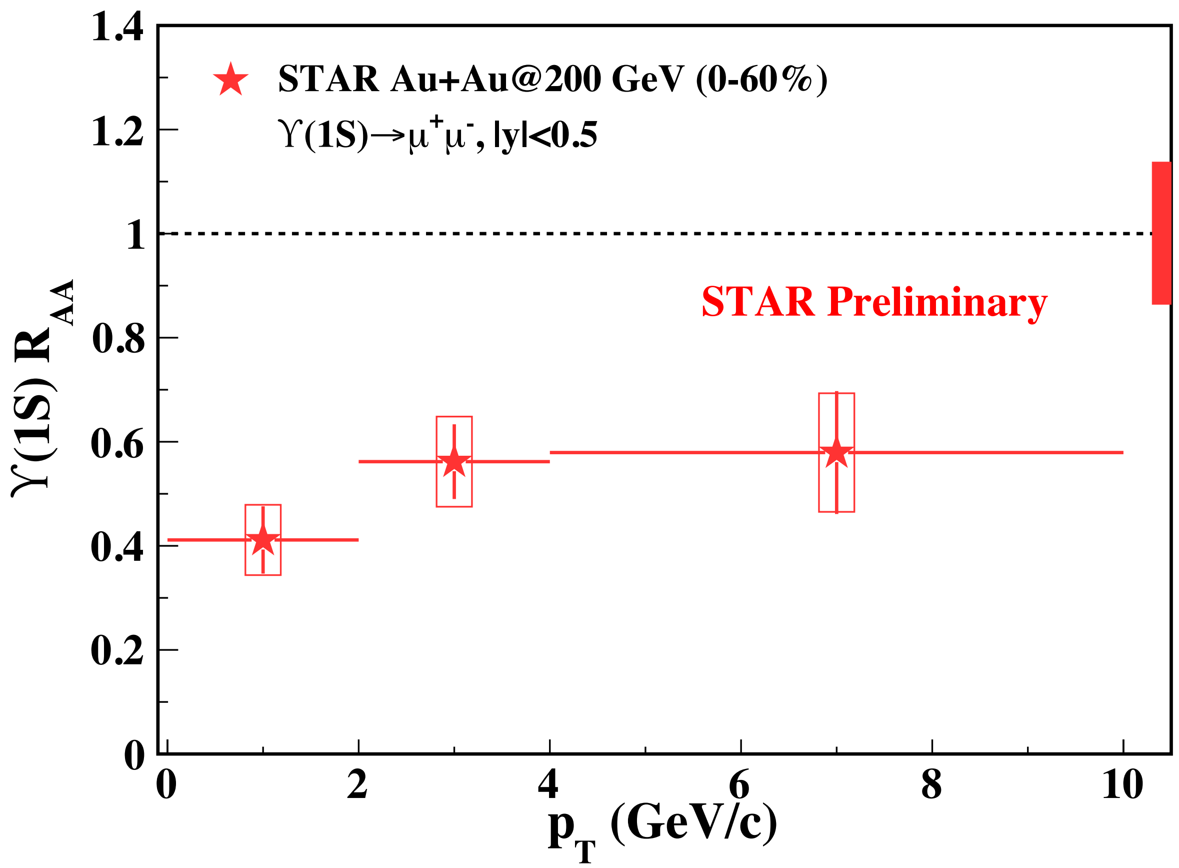
- **Stronger suppression towards central collisions**

Υ(2S+3S):

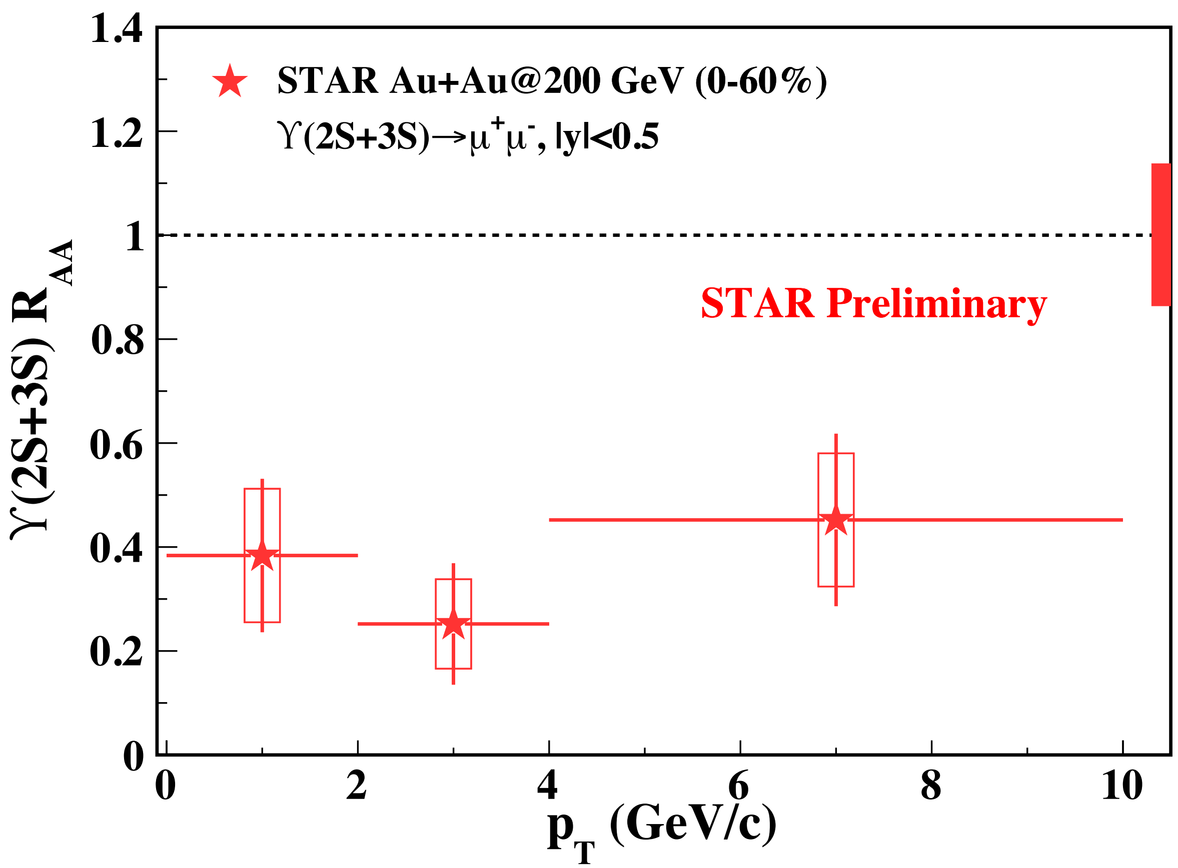
- **Stronger suppression in more central collisions**
- **More suppressed than Υ(1S) in 0-10% central collisions ⇒ sequential suppression**

Υ suppression at RHIC

Υ(1S):



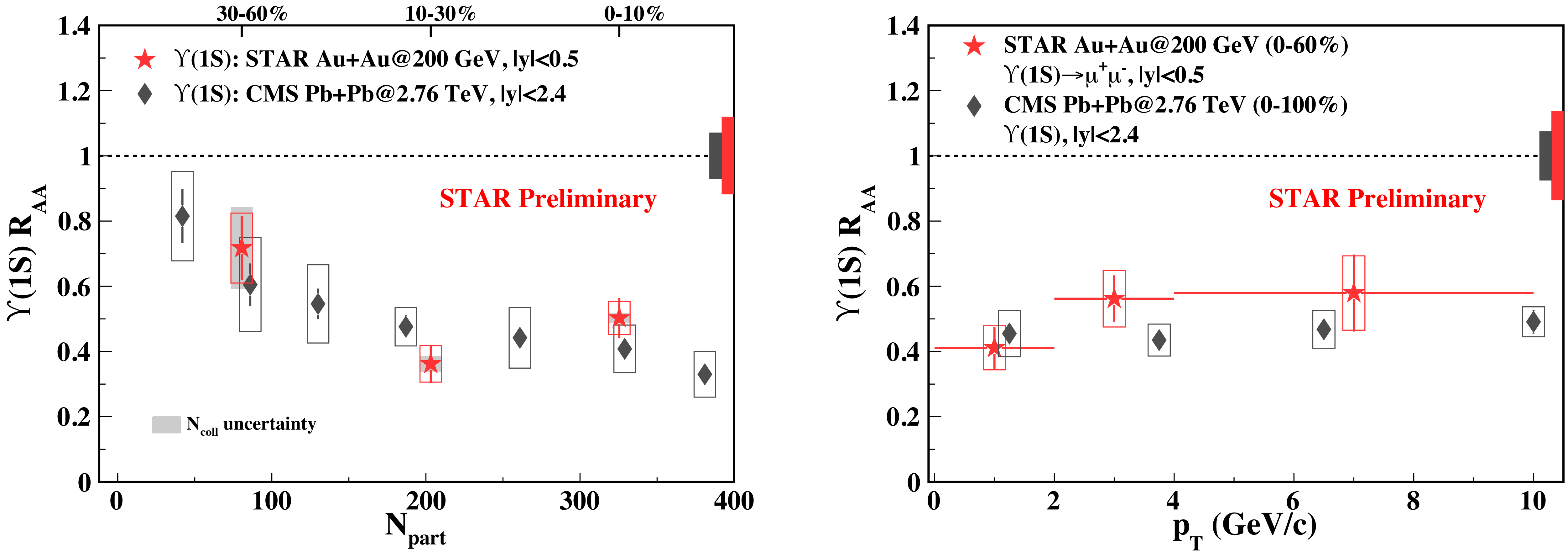
Υ(2S+3S):



Υ(1S) and Υ(2S+3S):

- No significant p_T dependence

Υ(1S) suppression: RHIC vs. LHC

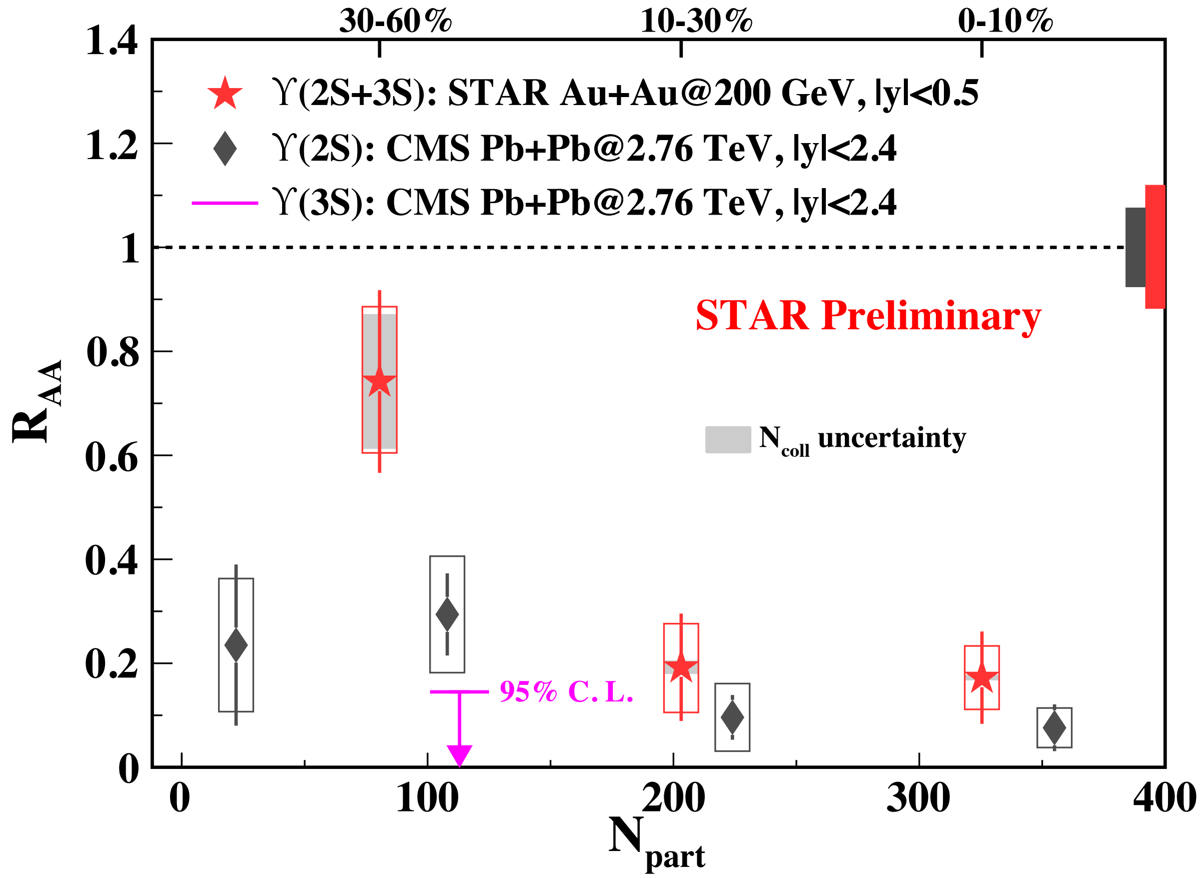


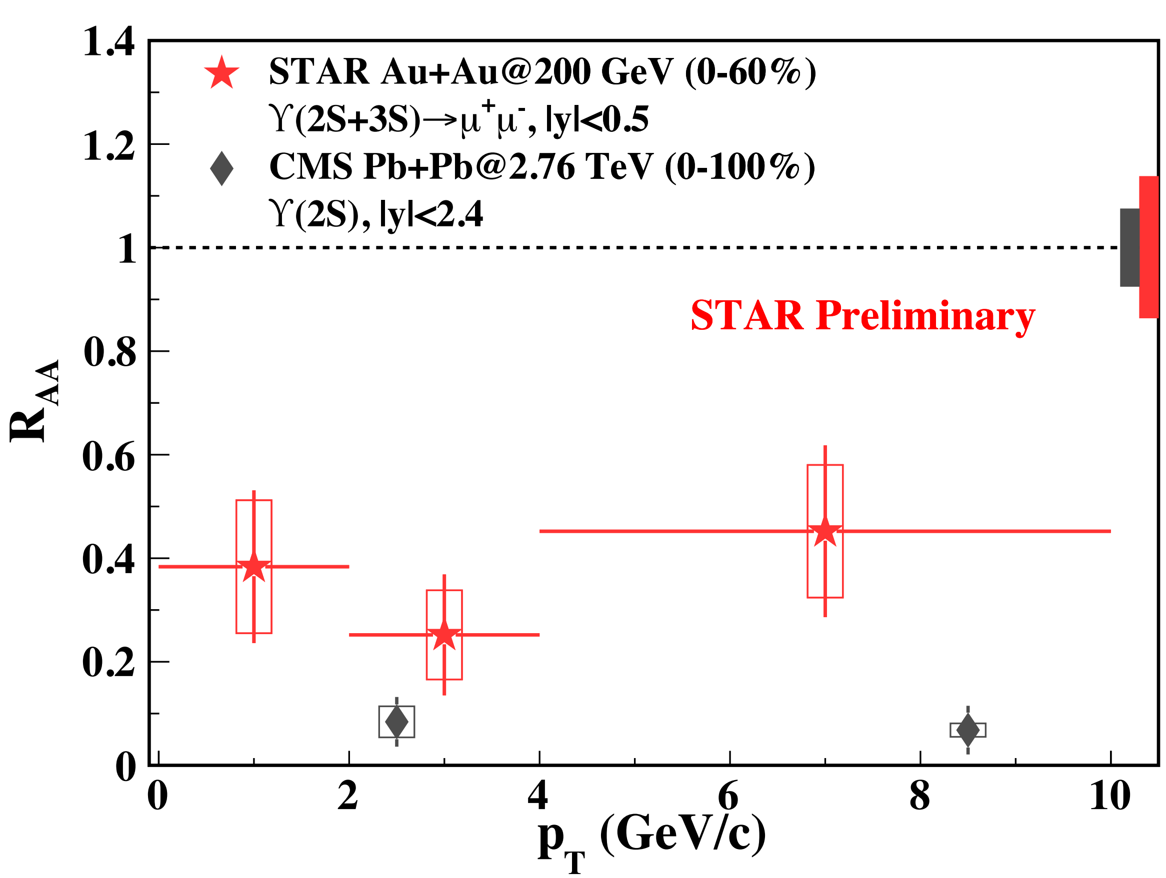
CMS, PLB 770 (2017) 357

Υ(1S) suppression is similar at RHIC and the LHC:

- **Similar CNM effects (~ 20-30%)**
- **Contribution of highly suppressed excited Υ states**

Υ(2S+3S) suppression: RHIC vs. LHC



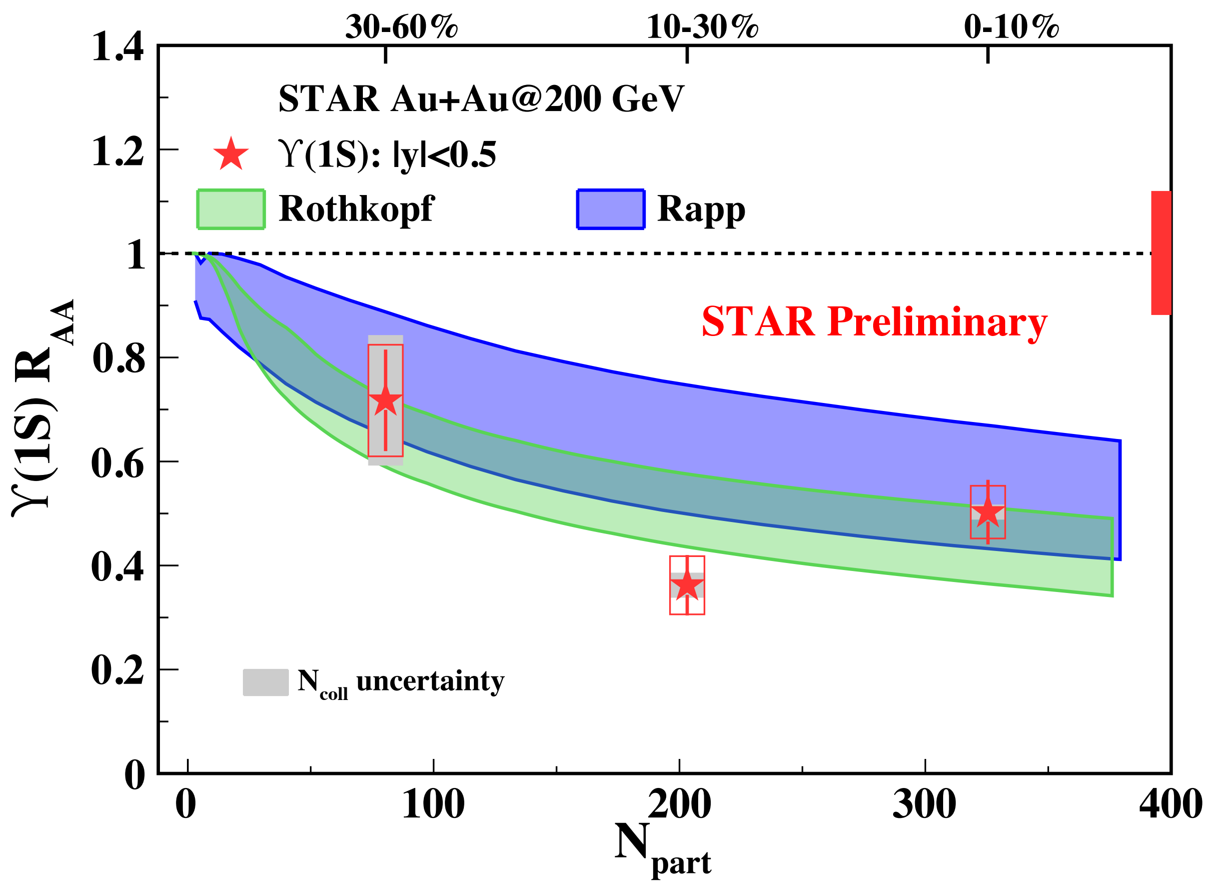


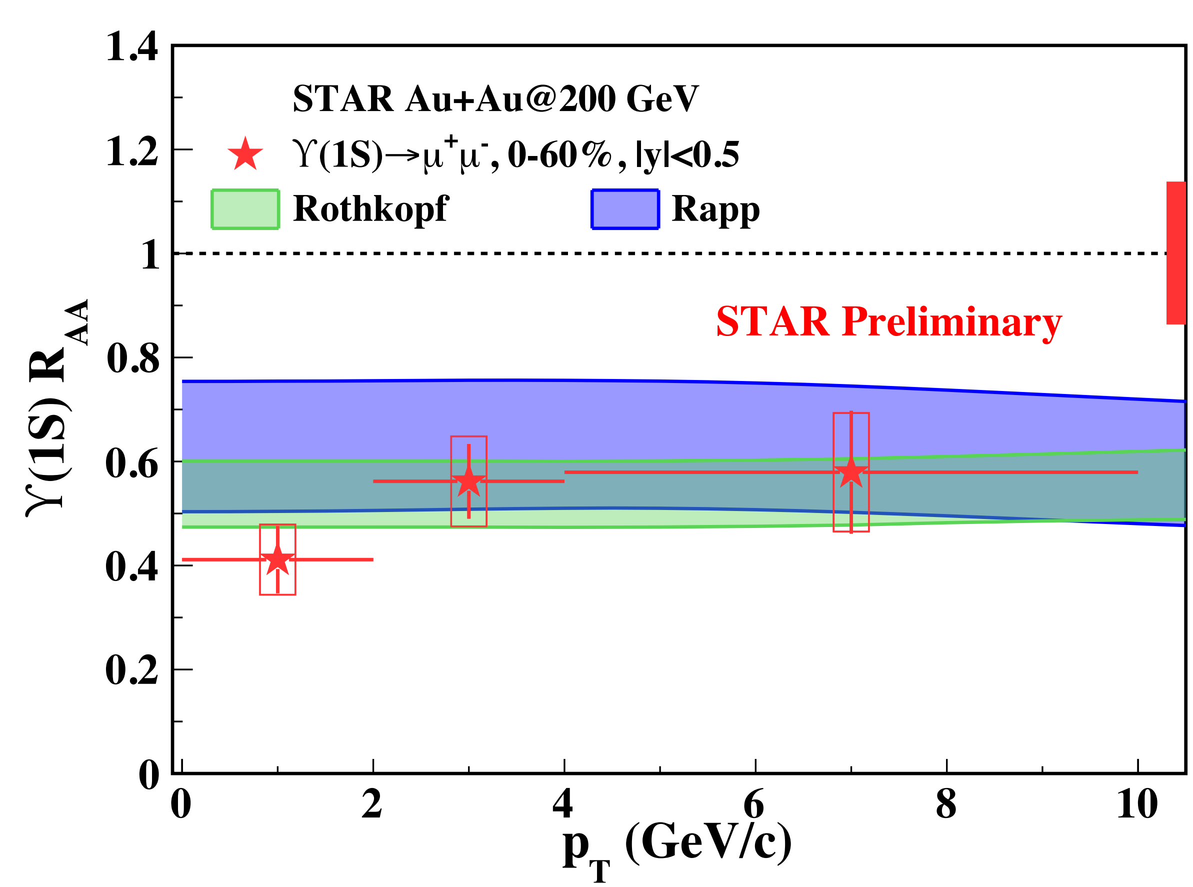
CMS, PLB 770 (2017) 357

Υ(2S+3S):

- **Indication of less suppression at RHIC than at the LHC in peripheral collisions**

Υ(1S) suppression: data vs. models





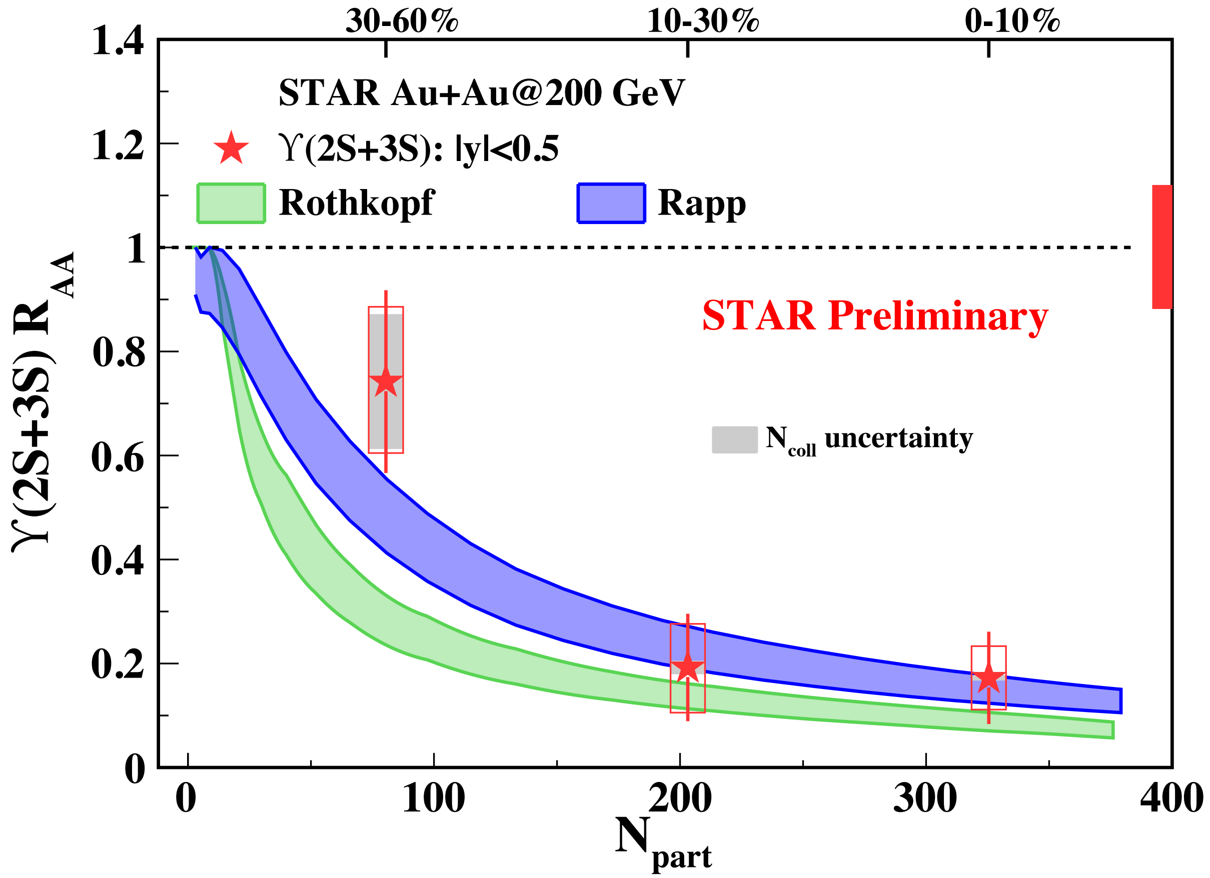
Both models show good agreement with data:

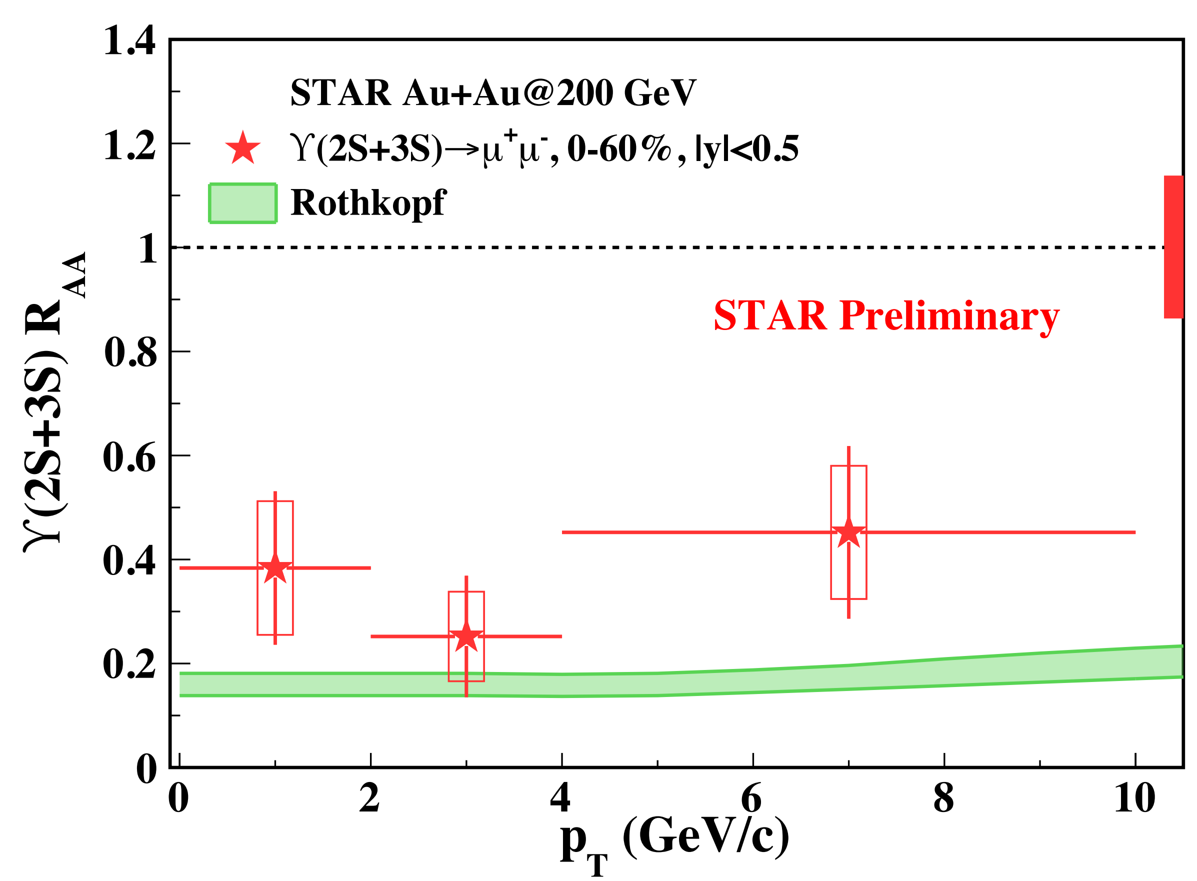
B. Krouppa, A. Rothkopf, M. Strickland: PRD 97, 01601

X. Du, M. He, and R. Rapp: PRC 96, 054901 (2017)

- **Rothkopf: Complex potential (lattice QCD); No CNM or regeneration effects**
- **Rapp: T-dependent binding energy; Includes CNM and regeneration effects**

ϒ(2S+3S) suppression: data vs. models





- Rapp model describes data
- Rothkopf model calculation is lower than data in 30-60%

Summary

Υ suppression in Au+Au collisions:

Υ(1S):

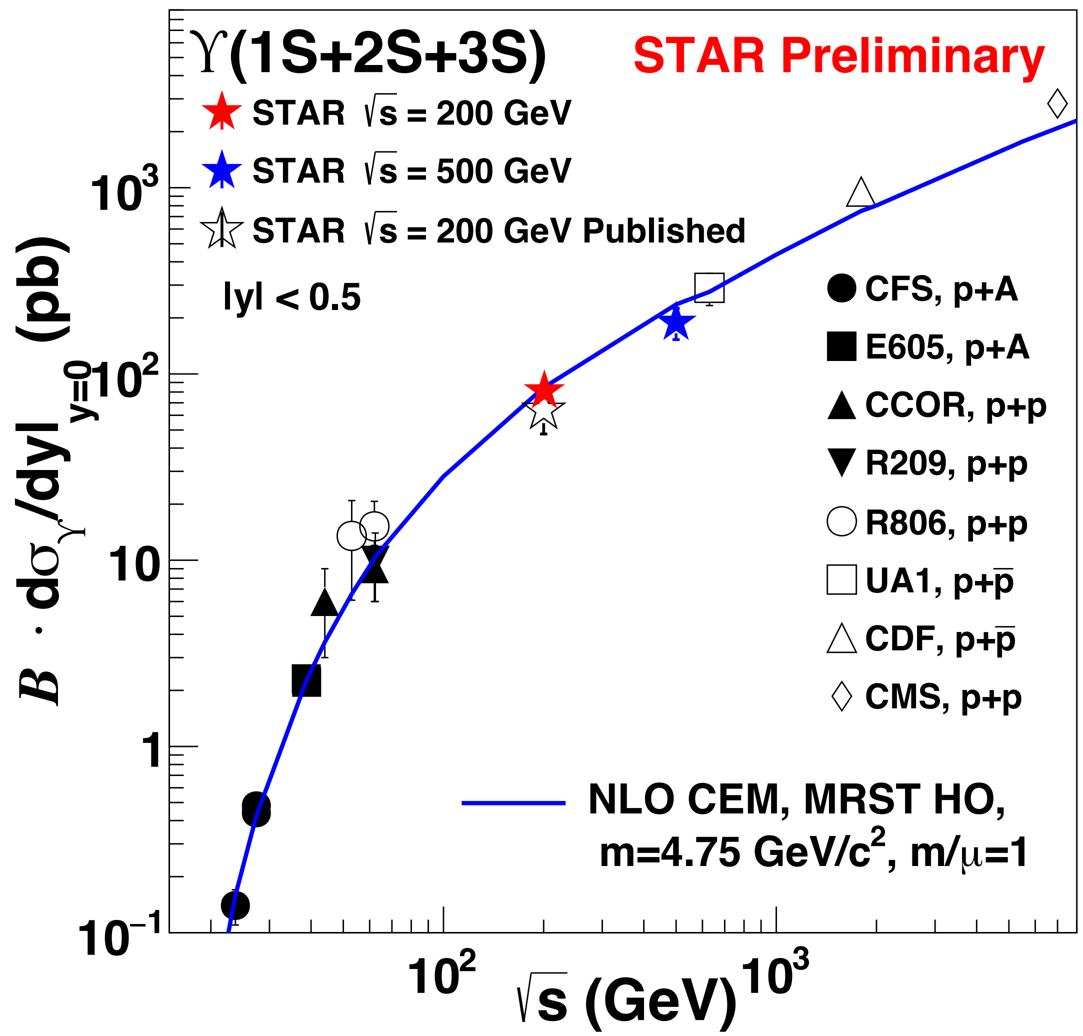
- ★ Stronger suppression towards central collisions
- ★ No obvious p_T dependence
- ★ Similar suppression as at LHC
- ★ Model predictions are consistent with data

Υ(2S+3S):

- ★ Stronger suppression towards central collisions
- ★ No obvious p_T dependence
- ★ More suppressed than Υ(1S) in 0-10% $\Rightarrow$ sequential suppression
- ★ Less suppressed at RHIC than at LHC in peripheral collisions

Backup

Υ cross-section in p+p collisions



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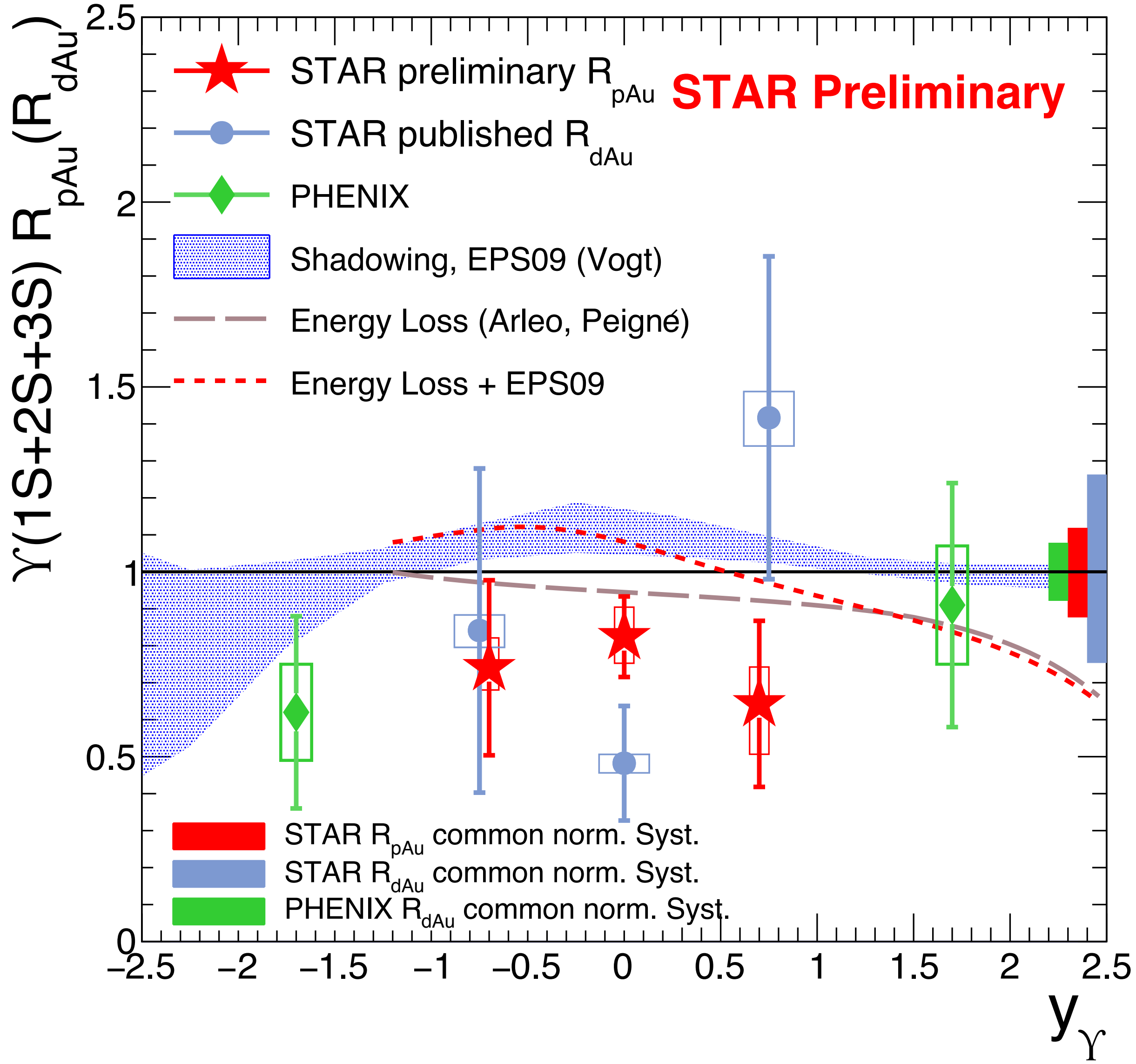

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