High-p_T J/ψ production in U+U collisions at STAR

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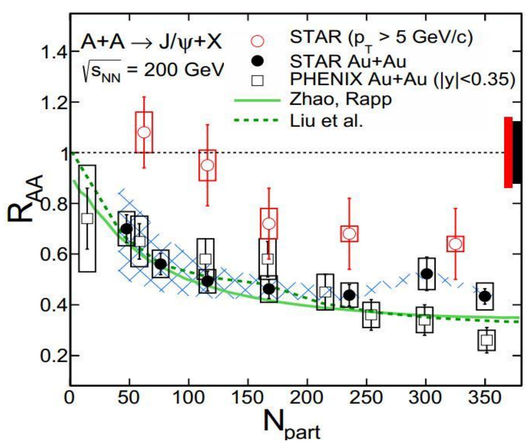
Abstract

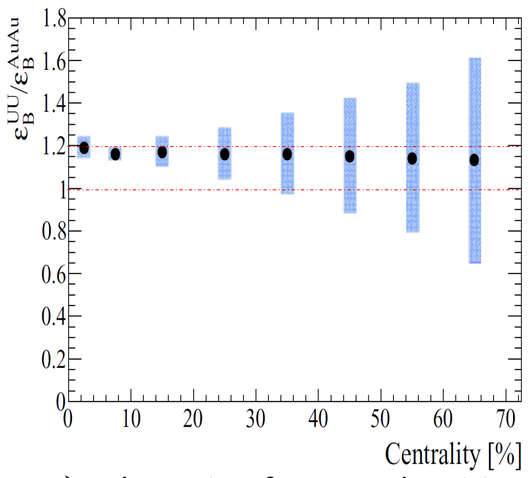
High-p_T J/ψ measurements provide a unique probe to study heavy quarkonium production mechanism. The previous J/ψ measurement in Au+Au collisions show a significant suppression in the 0-30% most central collisions. Since secondary production via $c\bar{c}$ recombination and so-called cold nuclear matter effects are small at high p_T, these results point to the color screening features. The energy density is expected to be on average about 20% higher in U+U collisions than in Au+Au collisions, therefore the J/ψ measurement in U+U collisions at high p_T can provide new insight in the study of color screening features for charmonium.

In this presentation we report the status of the analysis of mid-rapidity (|y|<1) J/ψ→e^+e^- production in U+U collisions at $\sqrt{s_{NN}}$=193 GeV at STAR using RHIC year 2012 data triggered with the Barrel Electromagnetic Calorimeter. Significant suppression is observed in 0-60% minimum bias events, and the level of the suppression is consistent with Au+Au collisions at 200 GeV.

Previous Measurements



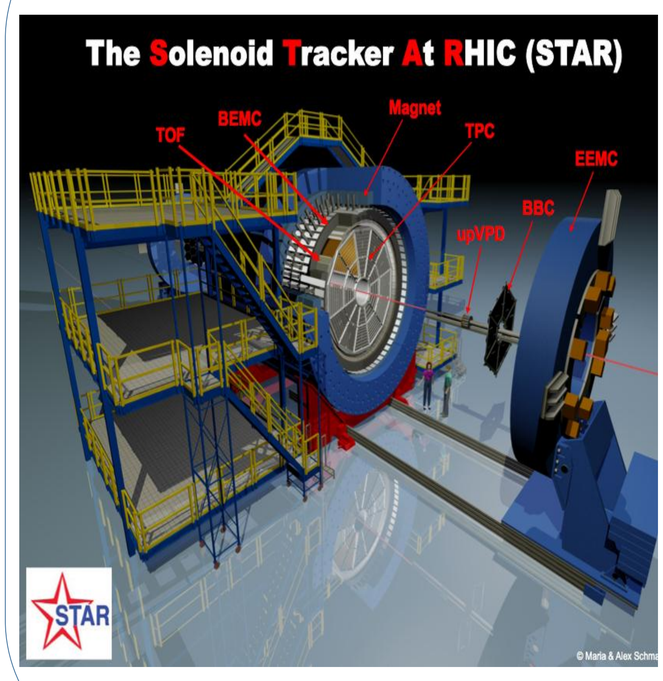
- J/ψ R_{AA} versus N_{part} in Au+Au 200 GeV[1] [2].



- The ratio of energy densities in U+U and Au+Au collisions as a function of centrality[3].

[1]STAR Collaboration, Phys Lett B 722 (2013)
[2]STAR Collaboration, arXiv:1310.3563
[3]D. Kikola et al., Phys Rev C 84, 054907 (2011)

STAR Detector



Large acceptance

- -1<η<1, 2π in azimuthal

Time Projection Chamber

- (TPC) – tracking, particle identification (dE/dx), momentum

Time of Flight detector

- (TOF) – particle identification (1/β)
- Together with TPC provide a good separation of electrons from hadrons up to 1.5 GeV/c

Barrel ElectroMagnetic Calorimeter

- Tower Δη x Δϕ = 0.05 x 0.05
- (BEMC) – electron identification(p/E) at high p_T, triggering

Barrel Shower Maximum Detector

- (BSMD) – electron identification(n_η,n_ϕ) at high p_T
- Δη x Δϕ = 0.007 x 0.007 at ~5X_0
- Measure shower size and shower position

Electron Identification

Dateset --110M EMC triggered events, Threshold: E_T>2.6 GeV

Sample Luminosity: 1034 μb^{-1} (equivalent to 341M minimum bias events)

J/ψ→e^+e^- branch ratio: $(5.94 \pm 0.06)\,\%$

Non-triggered Electron:

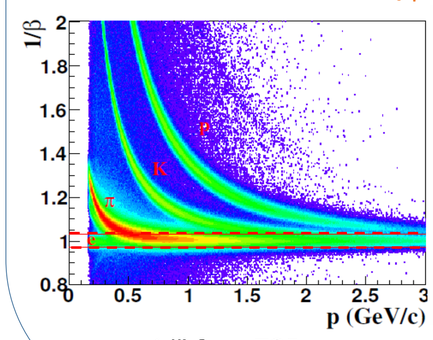
- -1.5 < nσ$_e$ <2
- 0.97< 1/β <1.03

Triggered Electron:

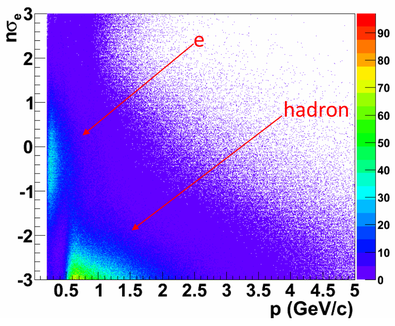
- -2 < nσ$_e$ <2
- BEMC cut (0.3<pc/E<1.5)
- BSMD cut ($n_\eta \geq 2, n_\Phi \geq 2$)

Low p_T: TPC + TOF

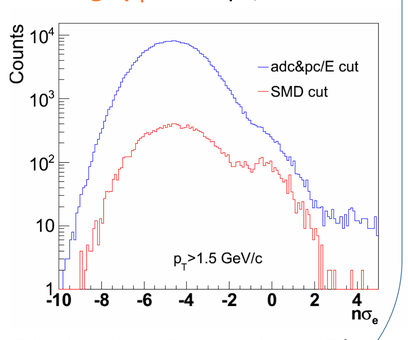
High p_T: TPC + pc/E + SMD



1/β from TOF
|1/β −1| < 0.03

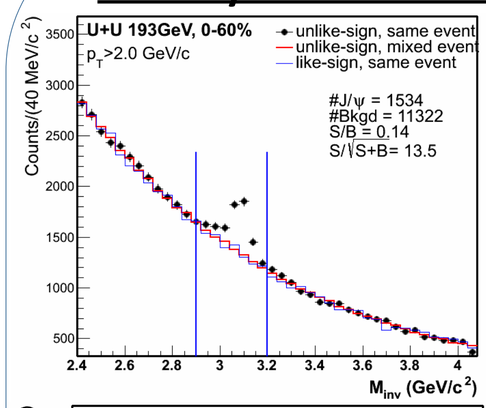


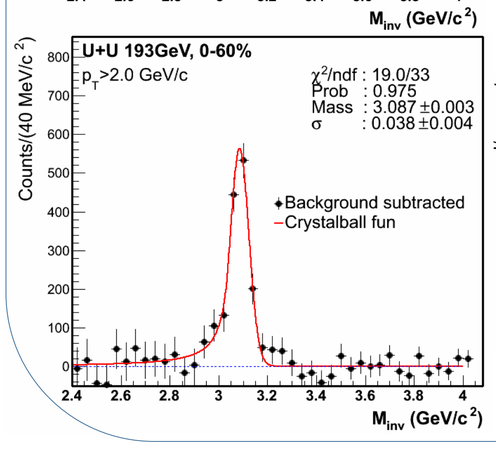
Normalized dE/dx from TPC after β selection



Distribution of normalized dE/dx after various cuts

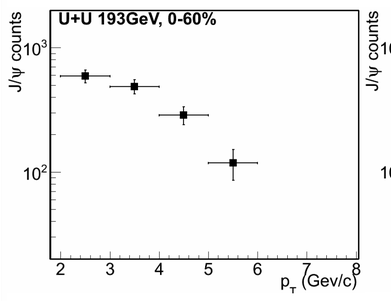
Analysis Technique



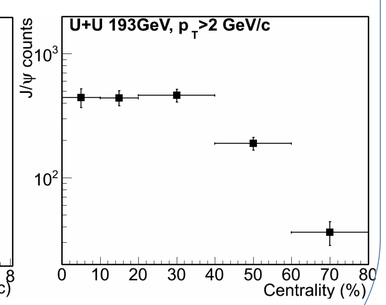


- Reconstruction method:
  - "TPC electron" + "EMC electron"
- Background reconstruction:
  - Like-Sign (same event)
  - Unlike-Sign (mixed event)
  - We normalize UnLike-Sign mixed events background to like-sign in the mass range 2-4 GeV/c^2

-- J/ψ counted in mass window 2.9-3.2 GeV/c^2

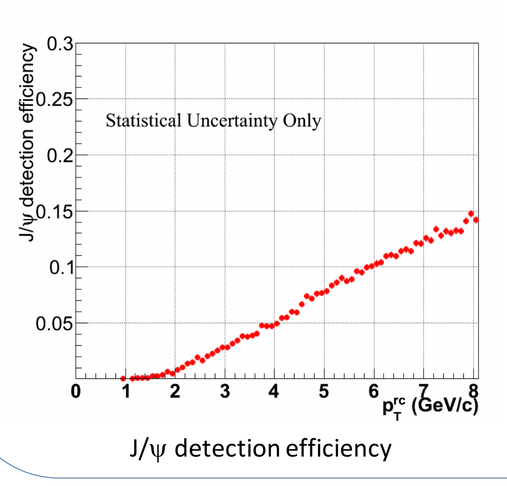


Raw J/ψ Yield vs. p_T

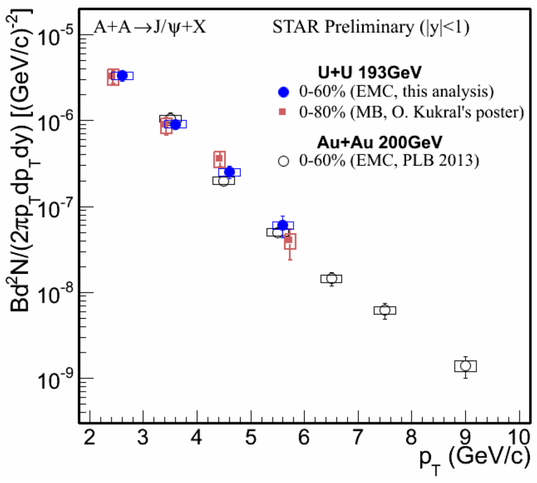


Raw J/ψ Yield vs. centrality

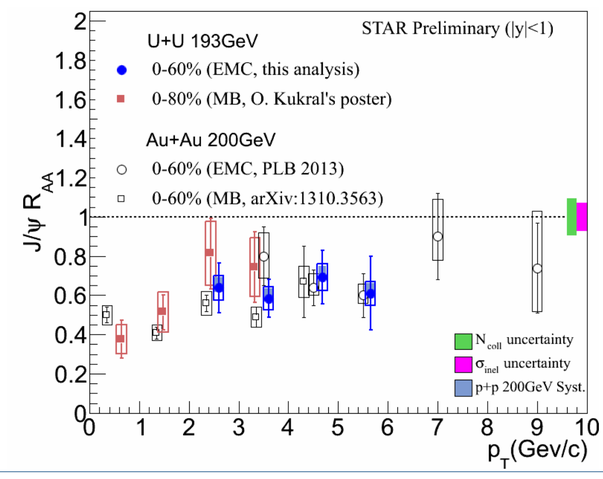
J/ψ invariant yield



J/ψ detection efficiency



Nuclear Modification Factor



$$R_{AA}(p_T) = \frac{Yield_{AA}(p_T)/\langle N_{coll}\rangle}{Yield_{pp}(p_T)}$$

- Currently use 200 GeV p+p data as baseline (PLB 722).
- Significant suppression observed in 193 GeV U+U collisions with a similar level as 200 GeV Au+Au.

R_{AA} vs. p_T in U+U 193 GeV

Summary and Outlook

- **J/ψ production in U+U collisions at 193 GeV are measured at mid-rapidity (|y|<1) at STAR.**
- **Significant suppression observed in 0-60% events with a similar level as 200 GeV Au+Au.**
- **The centrality dependence and final systematic uncertainty evaluations are in progress.**