J/ψ MEASUREMENTS AT STAR

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Outline

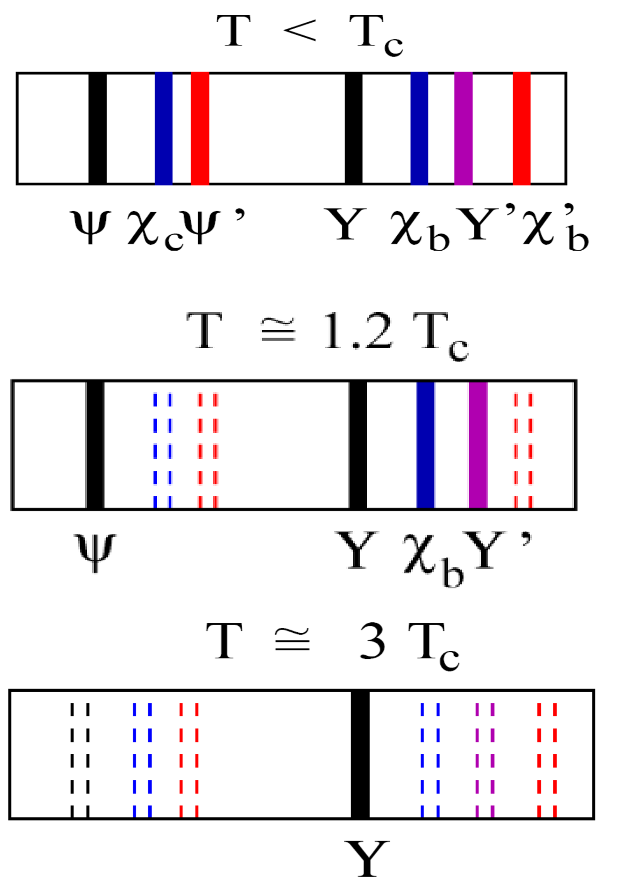
- Motivation for J/ψ measurements.
- STAR detector and particle identification.
- J/ψ production in p+p and Au+Au collisions.
- J/ψ elliptic flow in semi-central Au+Au collisions.
- J/ψ – hadron correlations.
- J/ψ polarization in p+p collisions.
- Future of J/ψ measurements.
- Conclusions.

Quarkonia in nuclear matter

- J/ψ could originate from different sources: direct production (production mechanism is unclear) and feeddowns from ψ', χ, B mesons.

- With increasing temperature of nuclear matter the different quarkonium states “melt” sequentially as a function of their binding strength: the most loosely bound state disappears first, the ground state last. → QGP THERMOMETER. J/ψ at 200 GeV is expected to melt in central Au+Au collisions.

- Also other effects as cold nuclear matter effects and regeneration could influence the observed yields.



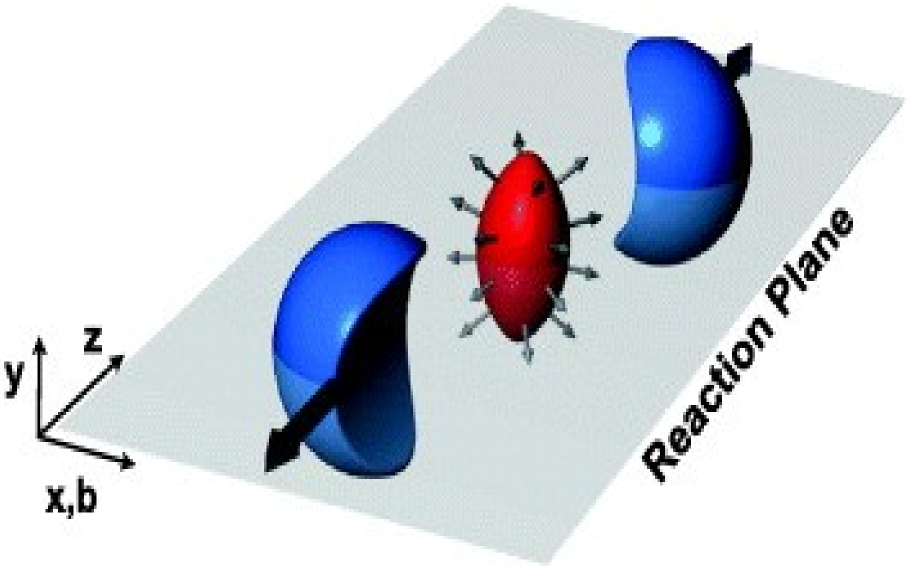
H. Satz, Nucl. Phys. A (783):249-260(2007)

J/ψ elliptic flow v_2 - motivation

- J/ψ v_2 measurement is a tool to decide if J/ψs come from charm quark and antiquark coalescence.

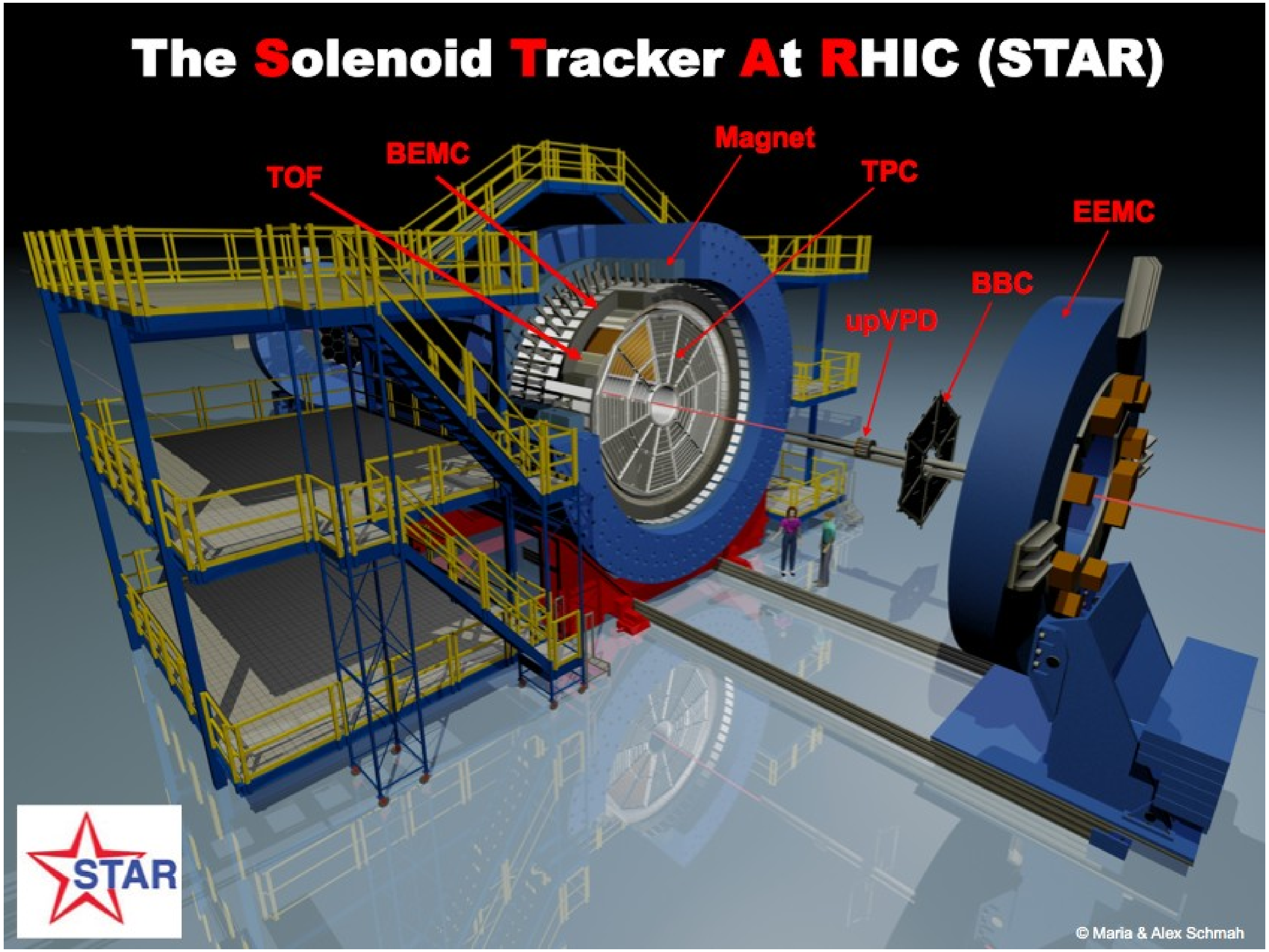
- J/ψ produced by pQCD → small or zero v_2
- Recombinated J/ψ → large v_2 (when charm quarks can flow)

- Comparison with model allows consider the contribution from both – direct and recombinated J/ψ – to the total yield.



New J. Phys. 13 (2011) 055008

STAR detector at RHIC



Large acceptance:

$|\eta|<1,\ 0<\phi<2\pi$

Time Projection Chamber – tracking, particle identification, momentum

Time of Flight detector – particle identification

BEMC – energy deposited in towers, triggering

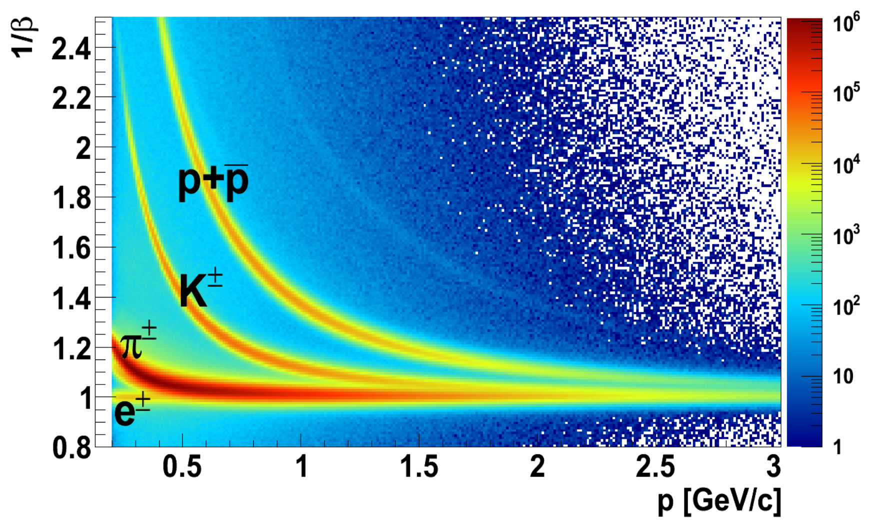
Electron identification

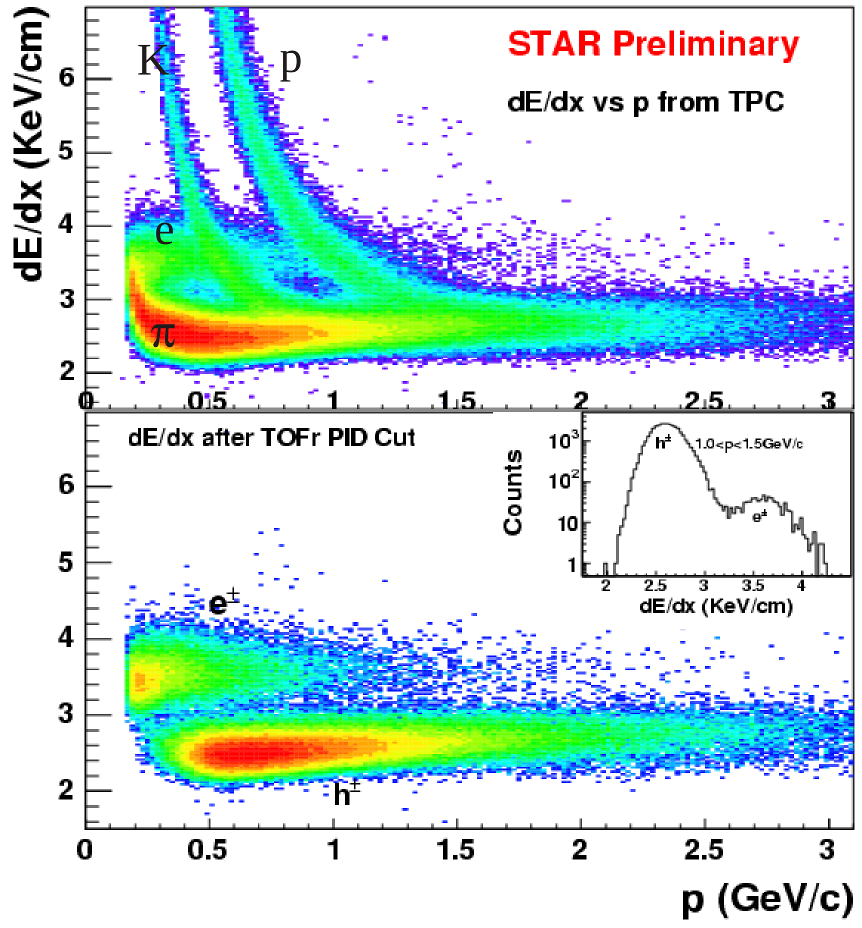
- J/ψ are reconstructed via electron-positron decay channel (BR 5.9%).
- Electrons are identified from:

  TPC – dE/dx information, momentum

  ToF - particle velocity 1/β

  BEMC – E/p (energy deposited in tower)

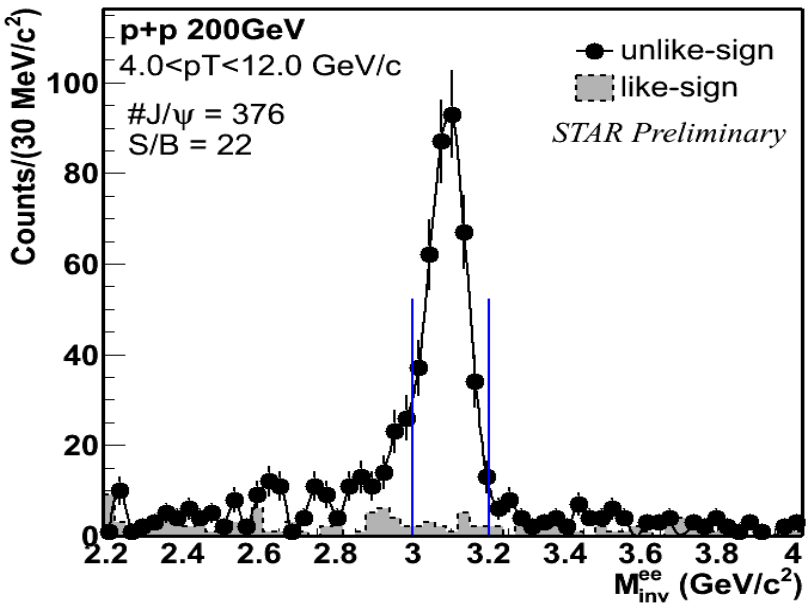


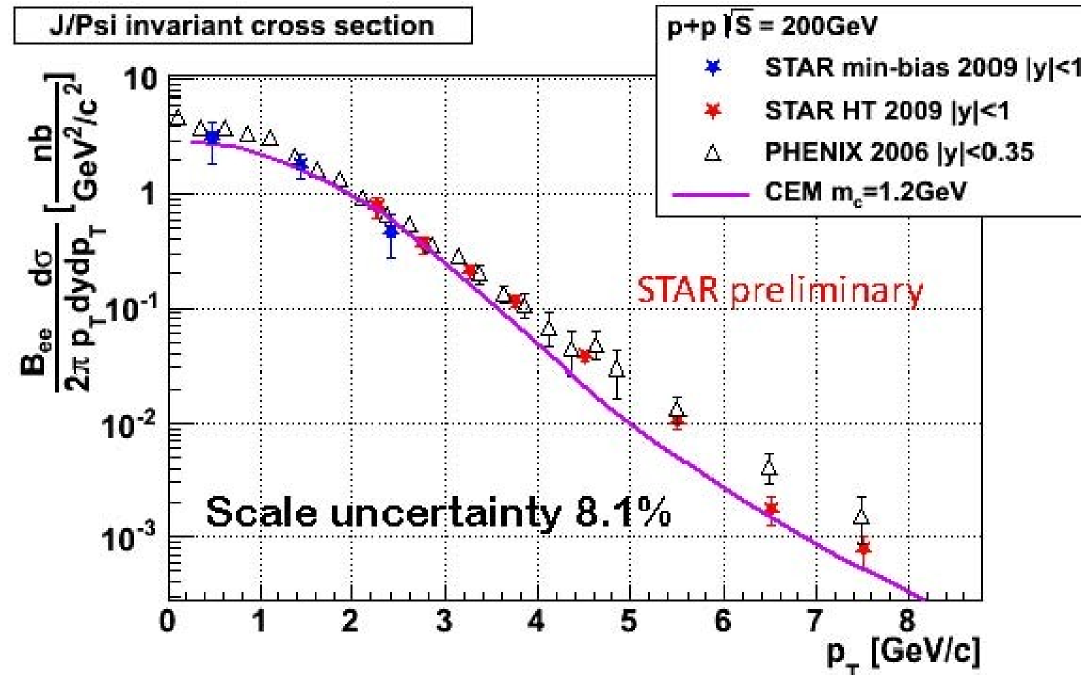


TPC and ToF together are great tool for distinguish electrons and hadrons in low p region.

J/ψ spectra in p+p collisions at √s=200GeV

p+p spectrum as a baseline



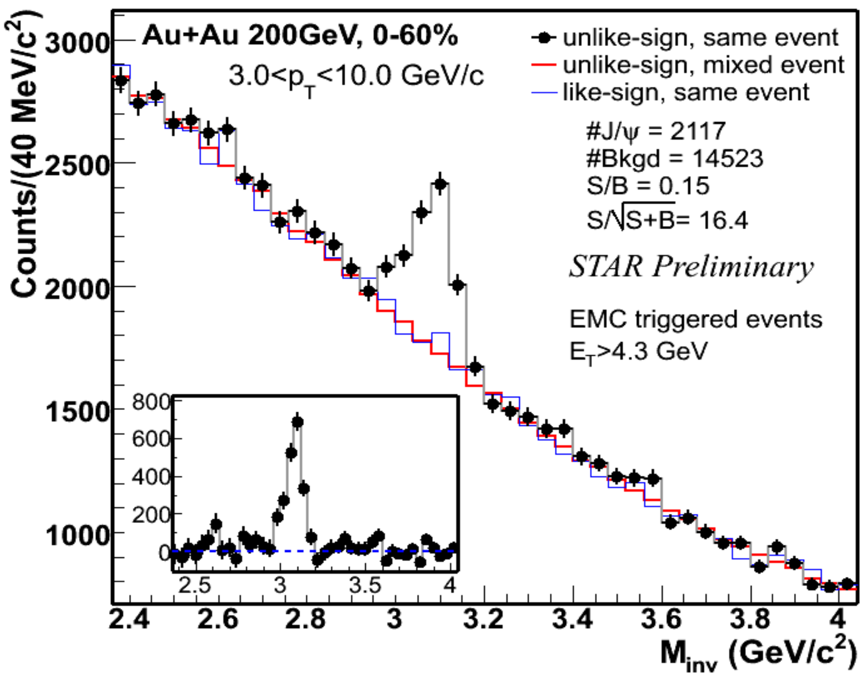


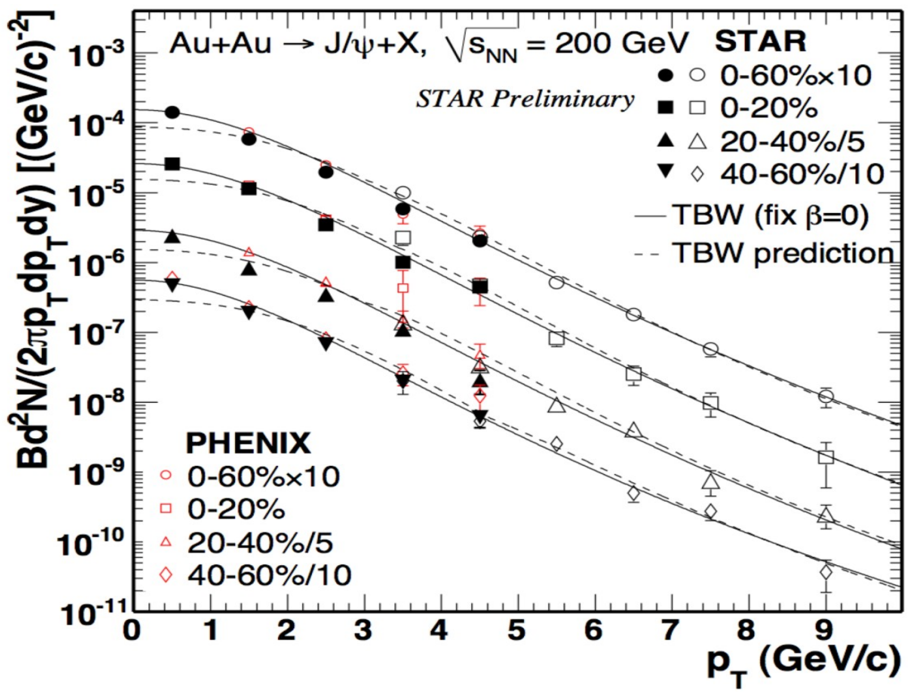
arXiv:1107.0532v1 [hep-ex]

Signal was obtained via e^+e^- channel.
Strong signal for high p_T.

- Results are consistent with other measurements.

J/ψ spectra in Au+Au collisions at $\sqrt{s_{NN}}$=200GeV

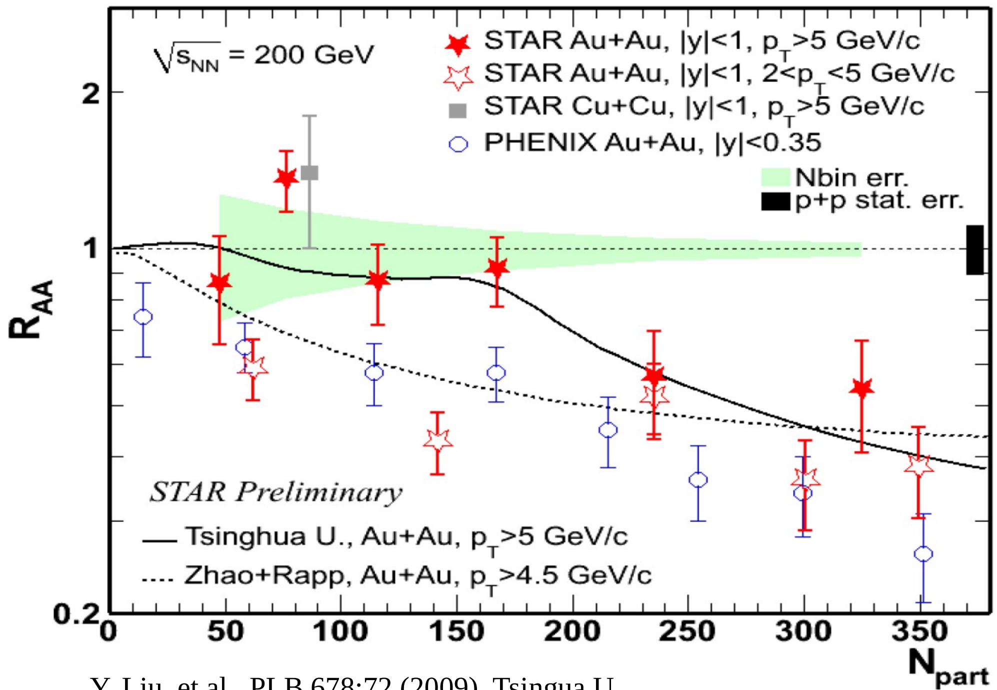




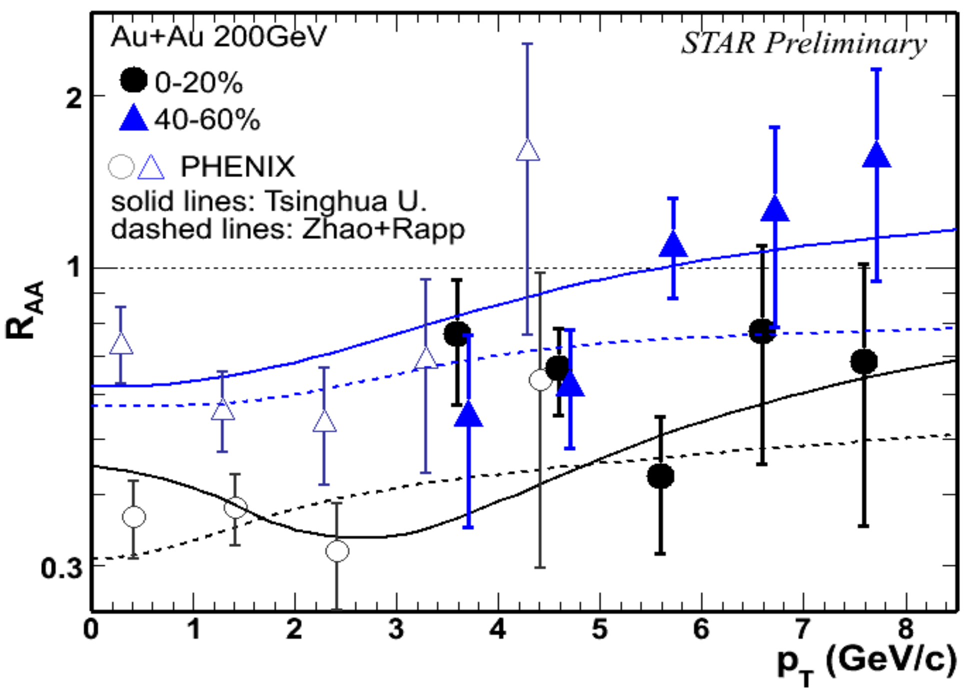
- High significance.
- Consistent with other RHIC measurements. Moreover we extend p_T region up to 10GeV/c.
- Measured spectra mismatch the blast wave model predictions from light hadrons in low p_T region.

Phys. Rev. Lett. 98, 232301 (2007)
JPG 37, 085104 (2010)
ArXiv:1101.1912 (2011)

R_{AA} in Au+Au collisions



Y. Liu, et al., PLB 678:72 (2009), Tsingua U.
X. Zhao and R.Rapp, PRC 82, 064905(2010)

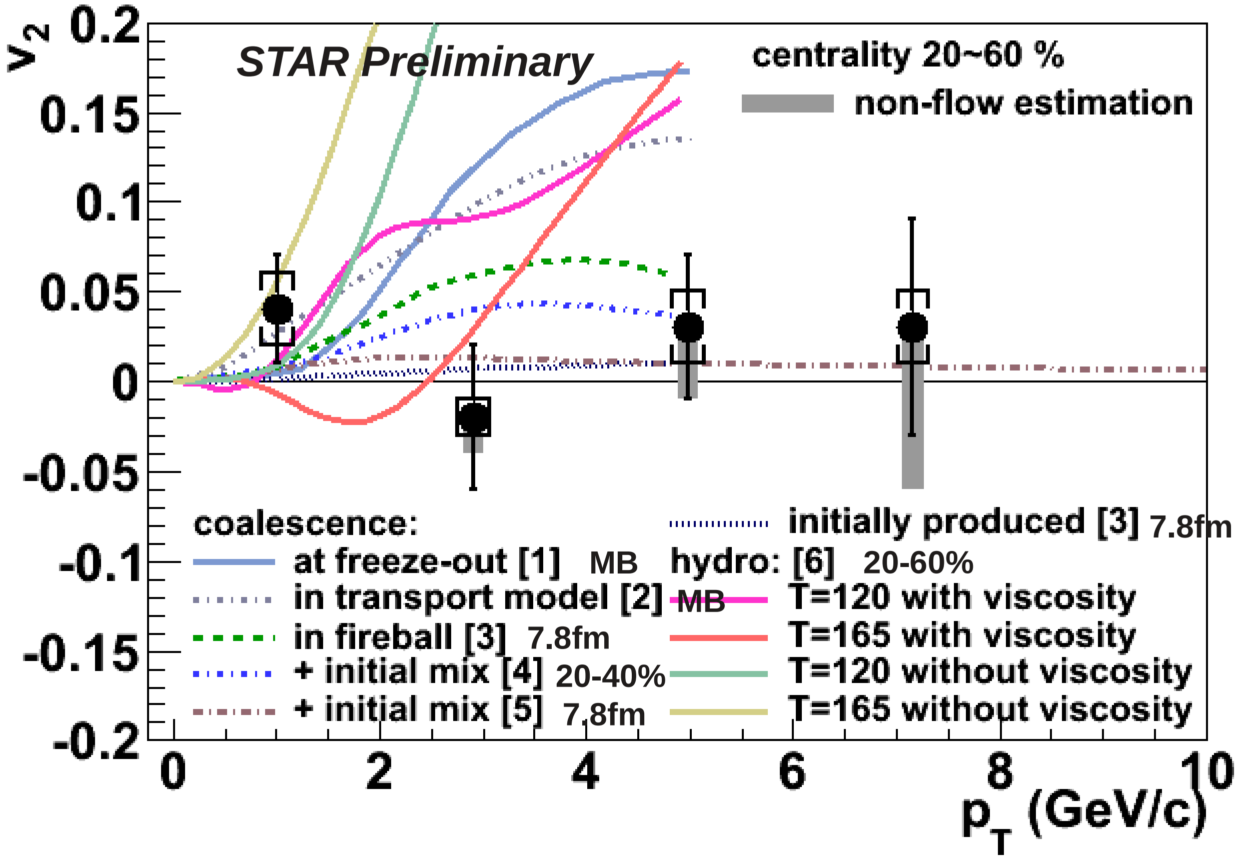


STAR CuCu: PRC80, 014922(R), PLB 678:72 (2009), PRC 82,064905(2010)
PHENIX: PRL98, 232301

- Suppression of J/ψ in central and semi-central collisions is observed.
- R_{AA} increases with p_T and decreases with centrality.
- At high p_T suppression is present only in central collisions.

$$R_{AA}(p_T) = \frac{Yield(A+A)}{Yield(p+p) \times \langle N_{coll} \rangle}$$

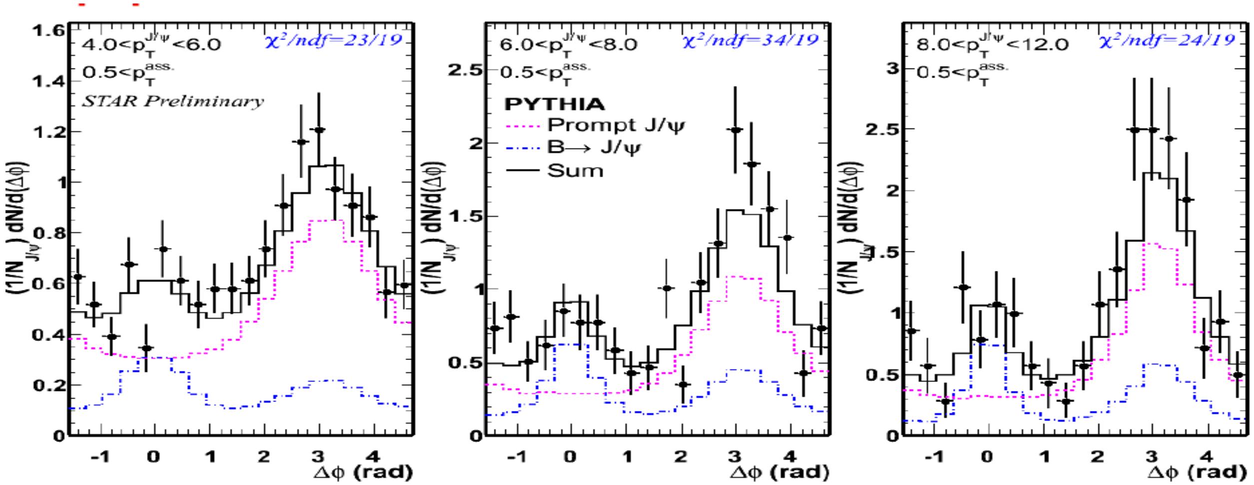
J/ψ elliptic flow v_2 - results



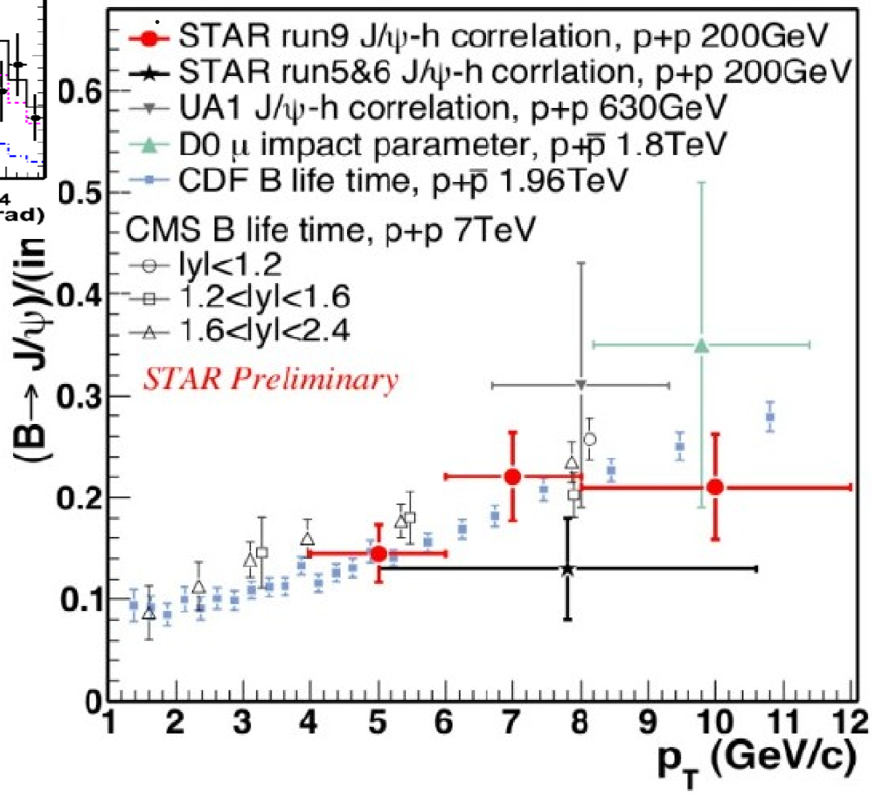
- J/ψ v_2 is consistent with zero at high-p_T.
- J/ψ v_2 measurement disfavors coalescence from thermalized charm quarks.

[1] V. Greco, C.M. Ko, R. Rapp, PLB 595, 202.
[2] L. Ravagli, R. Rapp, PLB 655, 126.
[3] L. Yan, P. Zhuang, N. Xu, PRL 97, 232301.
[4] X. Zhao, R. Rapp, 24th WWND, 2008.
[5] Y. Liu, N. Xu, P. Zhuang, Nucl. Phy. A, 834, 317.
[6] U. Heinz, C. Shen, priviate communication.

J/ψ – hadron correlation, B → J/ψ feed down



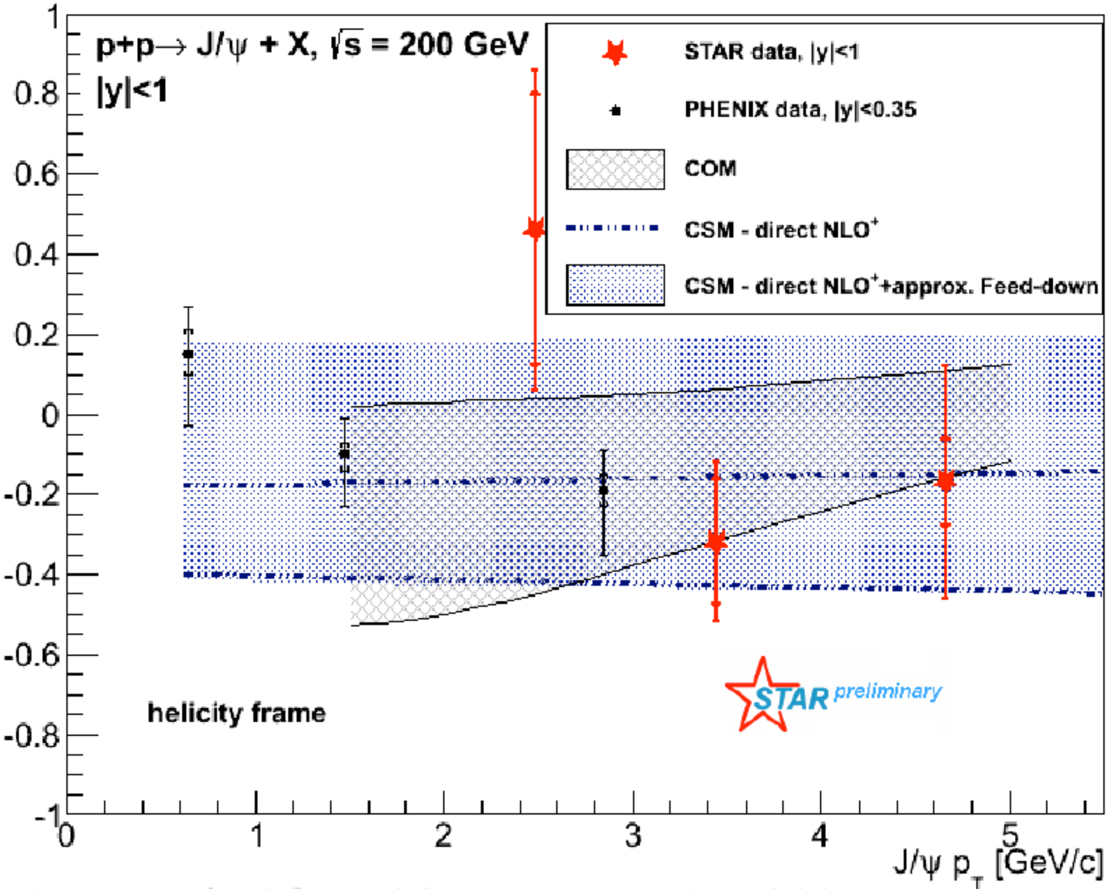
J/ψ – hadron correlation.



- Determination of B → J/ψ contibution to J/ψ production.
- Comparision with other collaborations results shows no beam energy dependence.
- Feed down contribution was established as 10-25 percent.

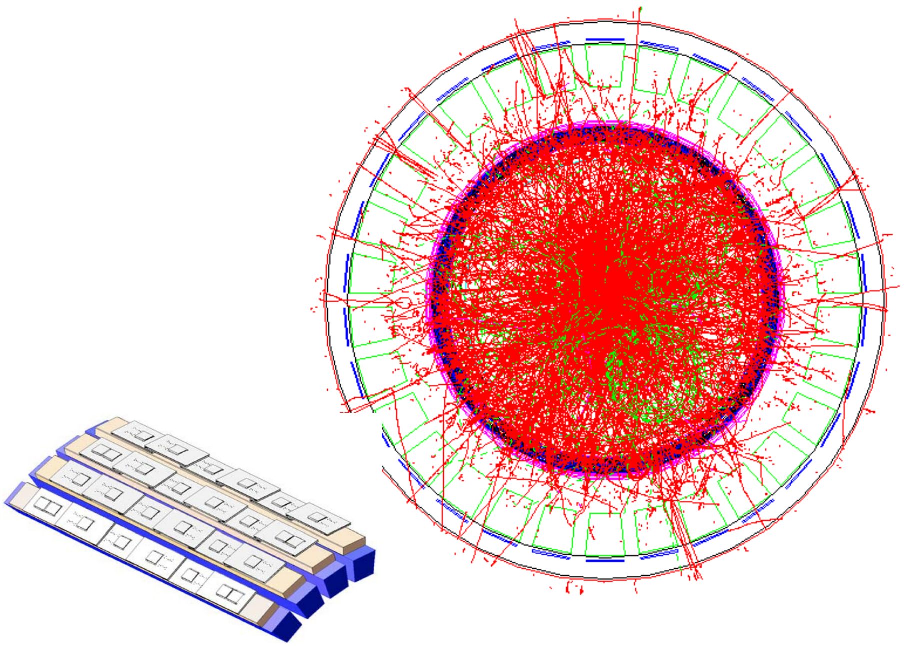
J/ψ polarization in p+p collisions at √s=200GeV

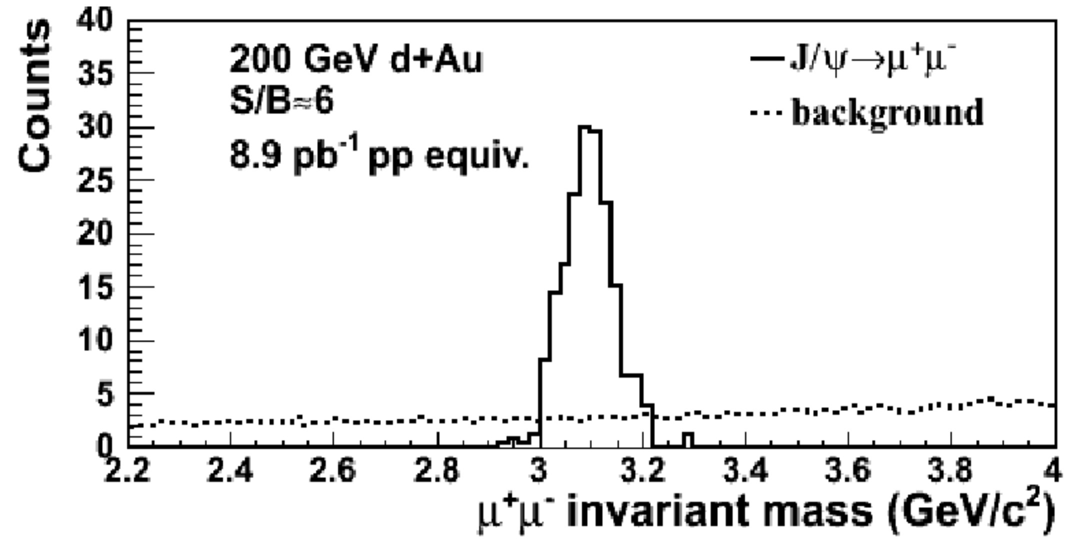
- Measurement of J/ψ polarization may help to understand its production mechanism.
- Each production model calculated with different J/ψ polarization.
- Results are consistent with COM and CSM predictions.



PHENIX: Phys. Rev. D 82, 012001 (2010)
COM: Phys. Rev. D 81, 014020 (2010)
CSM NLO+: Phys. Lett. B, 695, 149 (2011)

Muon Telescope Detector – future of J/ψ mesurements.





L. Ruan et al., Journal of Physics G: Nucl. Part. Phys. 36 (2009) 095001

MTD (MRPC): Multi-gap Resistive Plate Chamber. Gas detector.

With HFT together it will be possible to study B → J/ψ + X decays.

Predictions for J/ψ: S/B=6 in d+Au and S/B=2 in central Au+Au.

Reconstruction of J/psi in central Au+Au collisions from low to high pT – excellent mass resolution.

Conclusions

- Spectra of J/ψ measured in Au+Au collisions mismatch the blast wave model predictions from light hadrons in low p_T region.

- J/ψ - The suppression was observed in central and semi-central collisions in Au+Au collisions. The suppression decreases with p_T.

- J/ψ v_2 in Au+Au is consistent with zero at high p_T. J/ψ v_2 measurement disfavors coalescence from thermalized charm quarks.

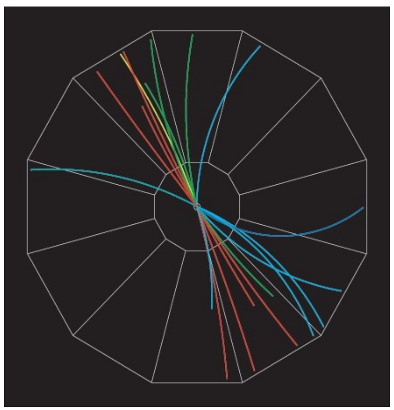
- B → J/ψ feed down contribution was determined as 10-25 percent.

- Measurement of J/ψ polarization in mid-rapidity in p+p collisions is consistent with the COM and CSM predictions.

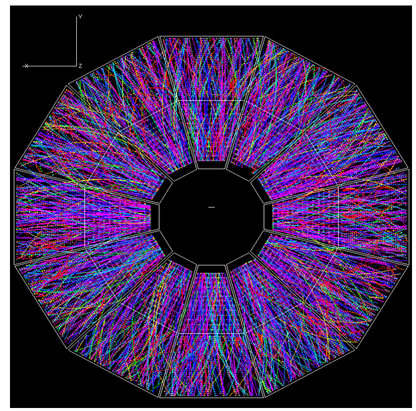
Thank you! :-)

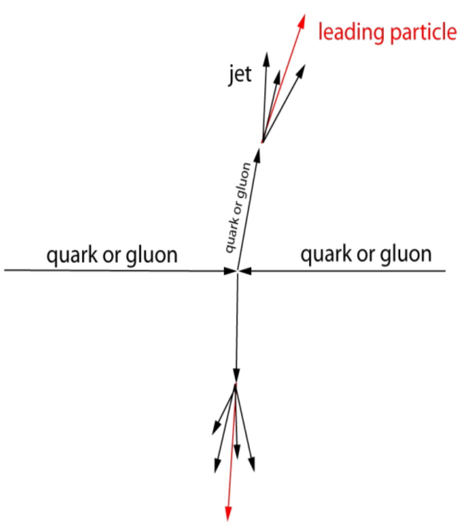
Hot and cold nuclear matter effects

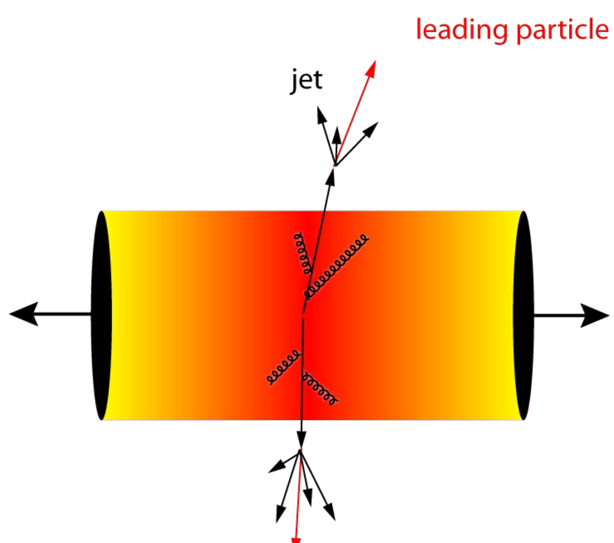
p+p



Au+Au







- nuclear modification factor R_{AA} :

$$R_{AA}(p_T) = \frac{Yield(A+A)}{Yield(p+p)\times\langle N_{coll}\rangle}$$

p+p collision as a baseline

$R_{AA} = 1$ – no nuclear effect observed
$R_{AA} < 1$ - suppression

Cold nuclear matter effects
(d+Au collisions, shadowing, nuclear absorption).

Hot nuclear matter effect
(Au+Au collisions, suppression, recombination).