J/ψ polarization measurement in p+p collisions at $\sqrt{s}$ = 500 GeV in STAR

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Abstract

Experimental data on the J/ψ cross section in p+p collisions can be described relatively well by many models that are currently available on the market. These models have different predictions regarding the J/ψ polarization. Therefore measurements of the J/ψ polarization may allow discriminating among the models and provide new insight into the J/ψ production mechanism.
The previous STAR J/ψ polarization analysis [1] was performed only for the polarization parameter λ_θ and in one reference frame due to limited statistics. Proton-proton data taken in year 2011 at RHIC at √s = 500 GeV with integrated luminosity of 22 pb^{-1} will allow us to extract the full information about the dielectron decay angular distribution of the J/ψ in different reference frames. In this presentation, the status of the J/ψ polarization measurement at mid-rapidity at √s = 500 GeV in p+p collisions in the STAR experiment is shown.

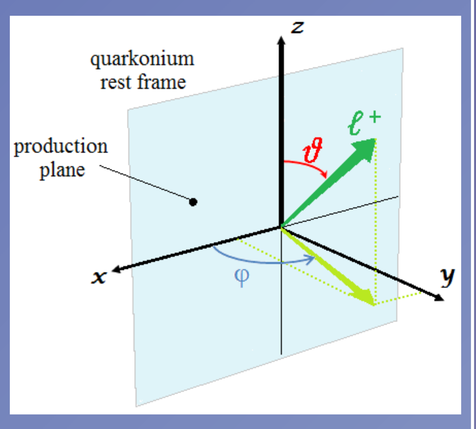
Method - decay angular distribution

J/ψ polarization is analyzed via the angular distribution of a lepton pair from the J/ψ decay :

$$\frac{d^2N}{d(\cos\theta)\,d\varphi} \propto 1+\lambda_\theta \cos^2\theta + \lambda_\varphi \sin^2\theta \cos 2\varphi + \lambda_{\theta\varphi} \sin 2\theta \cos\varphi$$

Polar angle **θ** - angle between momentum of a positive lepton in the J/ψ rest frame and the polarization axis z.
φ angle is a corresponding azimuthal angle.

z is the polarization axis and depends on the choise of the reference frame.
In the ***helicity frame*** z axis is defined along the J/ψ momentum in the center of mass frame.



Frame-invariant approach [2] : $\tilde{\lambda} = \frac{\lambda_\theta + 3\lambda_\varphi}{1-\lambda_\varphi}$

Dataset, cuts and electron identification

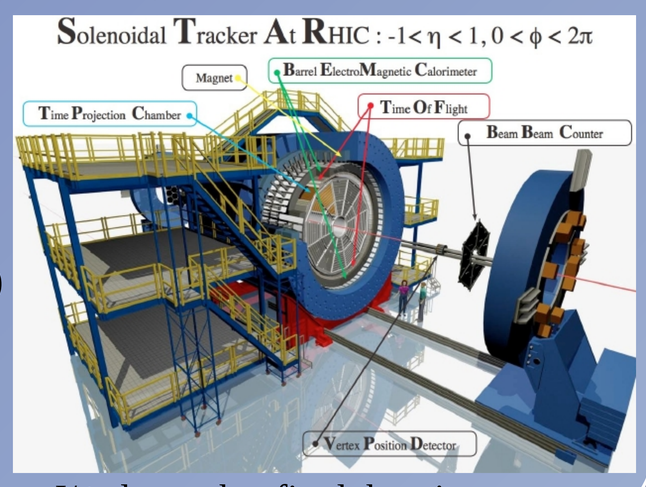
- p+p collisions at √s = 500 GeV from the year of 2011.
- High Tower Trigger – trigger is fired when transverse energy in BEMC tower E_T > 4.3 GeV.
- Integrated luminosity ~ 22 pb^{-1}.

J/ψ is reconstructed through its dielectron decay channel:

$$J/\psi \rightarrow e^+e^- \ (BR\ 5.9\%)$$

Electrons identification:

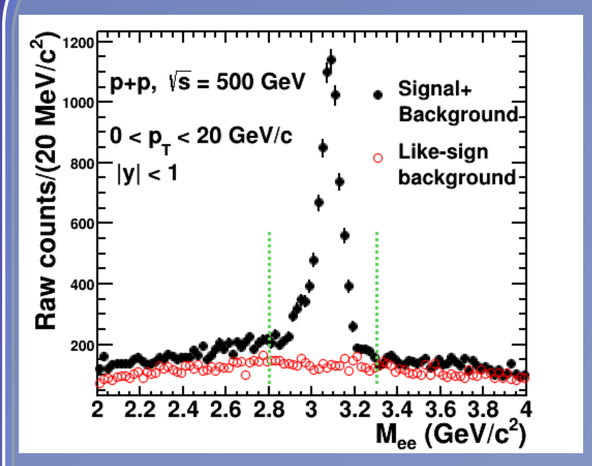
- TPC – dE/dx information
- BEMC – E/p > 0.5
  (E - single BEMC tower energy)
- TOF – |1/β-1| < 0.03
  (β = pathLength/TimeOfFlight/c)



Kinematic cuts:

- p_T > 0.3 GeV/c
- |η| < 1
- p_T > 3.5 GeV/c - for electron from J/ψ decay that fired the trigger

J/ψ signal

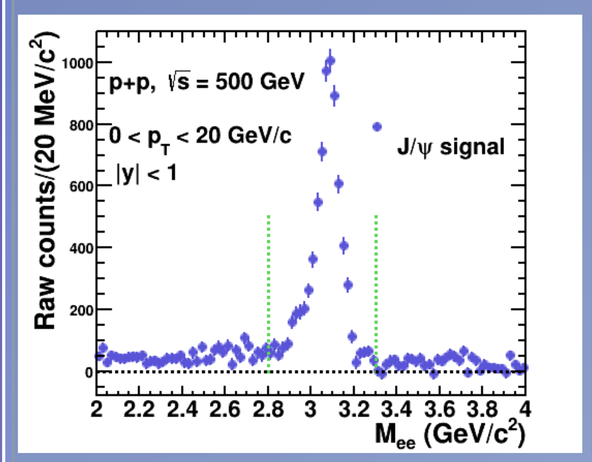


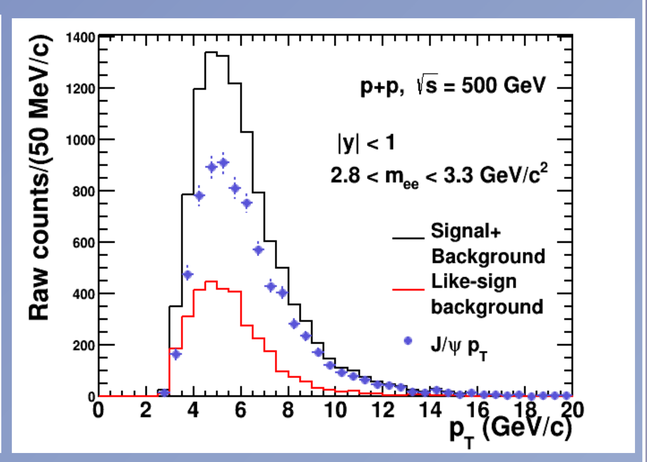
J/ψ distributions are obtained by subtracting combinatorial background estimated from like-sign pairs $e^+e^+ + e^-e^-$

J/ψ mass window:
2.8 – 3.3 GeV/c^2

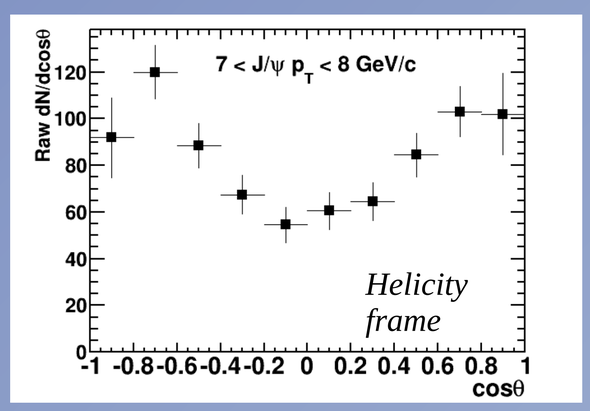
J/ψ signal from bin counting, with continuum background: ***~ 7500***

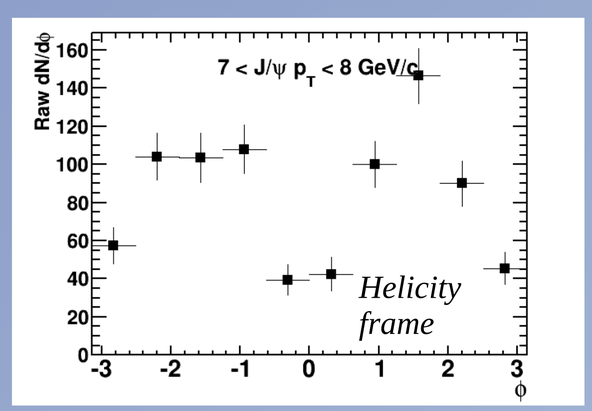
significance ~ 63 σ





Example of ***Uncorected cosθ and φ distributions,*** *Helicity frame*

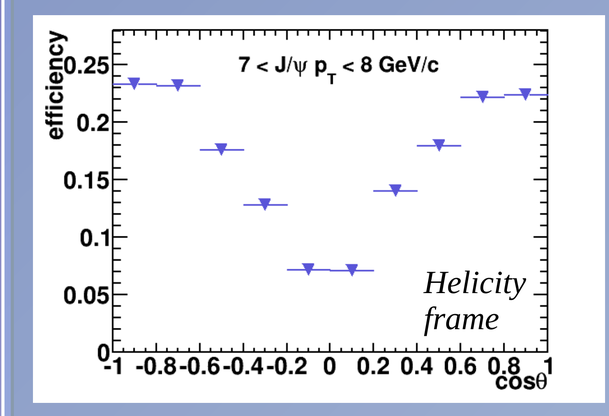


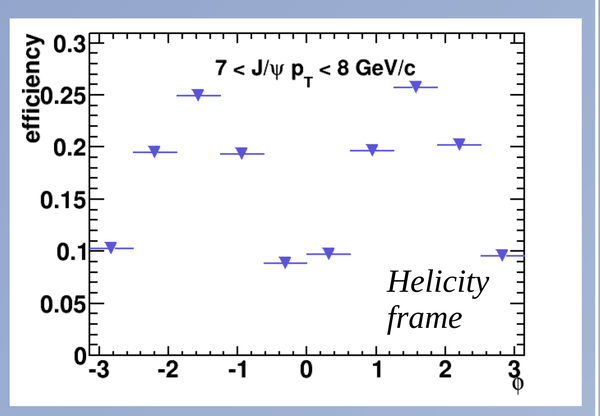


Combinatorial background subtracted

Corrections

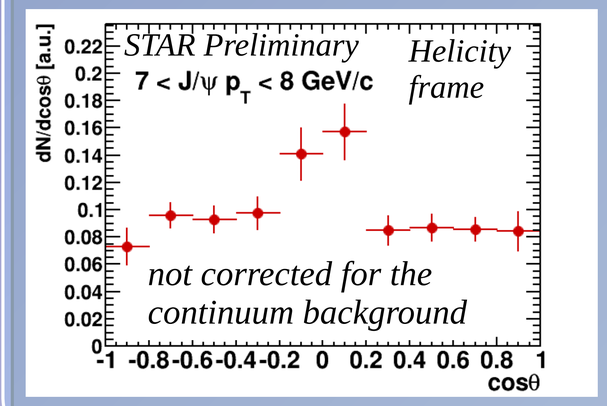
J/ψ corrections obtained using MC simulations.

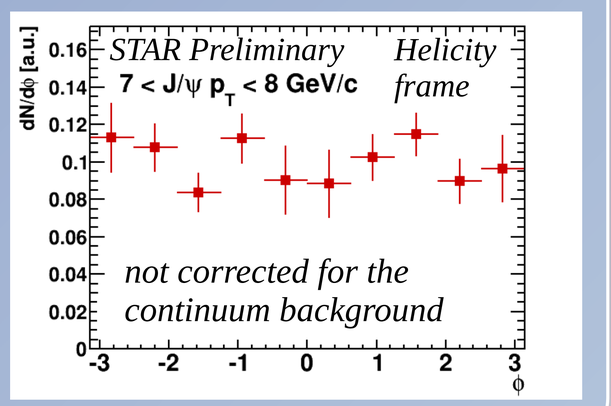




Corrections include:
Acceptance, tracking efficiency, BEMC and TOF electron identification efficiency and the trigger efficiency.

Example of ***Corrected cosθ and φ distributions,*** *Helicity frame*





Statistical uncertainties only

Summary

- First J/ψ polarization measurement at √s = 500 GeV from STAR in progress.
- J/ψ signal up to p_T ~ 15 GeV/c, can be divided into several p_T bins.
- Reconstruction of both θ and φ angles.

Outlook

- Polarization of the correlated background needs to be subtracted.
- Full decay angular distribution analysis of λ_θ and λ_φ parameters as a function of J/ψ p_T.

References
[1] L.Adamczyk *et al.* (STAR Collaboration), arxiv:1311.1621.
[2] P. Faccioli, C. Laorenco, J. Seixas, H.K. Wohri, Eur. Phys. J. C 69, 657 (2010).

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