Measurement of longitudinal double-spin asymmetries of J/ψ production in polarized p+p collisions at $\sqrt{s}$=500 GeV for 2012 run

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Understanding the contribution of polarized gluons to the proton spin is a key step for resolving the proton-spin puzzle. A number of different channels have been used to study gluon polarization, including final state hadrons[1] and jets[2]. Some rarer process involving direct photons or heavy-flavor production will allow us to measure the gluon contribution at the leading order, but their significantly lower production rates limit their impact on the ΔG constraints. At Relevistic Heavy Ion Collider (RHIC) energies, heavy-quark production is dominated by the gluon–gluon interaction; thus, measurements of the longitudinal double-spin asymmetry in heavy-flavor production in the polarized p+p collisions will allow us to study the polarized gluon distributions. J/ψ is a bound state of a c and $\bar{c}$ pair. Here, we report the status of longitudinal double-spin asymmetries in J/ψ production in polarized p+p collisions in the PHENIX experiment at the RHIC for data collected during 2012.

In the case of the heavy-quark production at RHIC, the asymmetry is proportional to the gluon polarization at the leading order:

$$A_{LL} \sim \frac{\Delta g(x_1)}{g(x_1)} \times \frac{\Delta g(x_2)}{g(x_2)} \times a_{LL}^{gg\to Q\bar{Q}}, \tag{1}$$

where $\Delta g(x)$(g(x)) is the (un)polarized gluon distribution, and $a_{LL}^{gg\to Q\bar{Q}}$ is the partonic asymmetry.

The J/ψ production have been measured by the PHENIX muon spectrometers at forward and backward rapidities ($1.2 < |\eta| < 2.4$), where two muons go into the same arm.

The longitudinal double-spin asymmetry A_{LL} can be measured according to the following equation:

$$A_{LL} = \frac{1}{P_b P_y} \frac{N^{++} - RN^{+-}}{N^{++} + RN^{+-}}, \tag{2}$$

where P_b and P_y are the beam polarizations for blue and yellow beams, respectively; $N^{++}(N^{+-})$ is the J/ψ yield from the same (opposite) helicity beam collisions; and $R = L^{++}/L^{+-}$ is the relative luminosity measured using beam beam counter (BBC) and zero degree calorimeter (ZDC) at very forward rapidity.

The invariant mass distribution of dimuons is shown in Fig. 1. Invariant mass distribution is fitted using a third-order polynomial and two Gaussian functions. The number of J/ψ is calculated on the basis of he fitting with a 2σ cut. The measured inclusive asymmetry

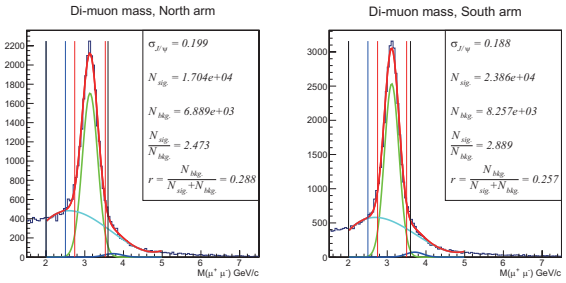

Fig. 1. Invariant mass distribution of dimuons at $\sqrt{s} = 500$ GeV for data obtained during the 2012 run.

A_{LL}^{incl} is related to $A_{LL}^{J/\psi}$ by

$$A_{LL}^{J/\psi} = \frac{A_{LL}^{incl} - r \cdot A_{LL}^{BG}}{1 - r}, \tag{3}$$

$$\delta A_{LL}^{J/\psi} = \frac{\sqrt{(\delta A_{LL}^{incl})^2 + r^2 \cdot (\delta A_{LL}^{BG})^2}}{1 - r}, \tag{4}$$

where r is the background fraction, and A_{LL}^{BG} is the background asymmetry, which is measured using like-sign dimuons under the J/ψ peak and the side-band unlike-sign dimuons.

Fig. 2 shows the sensitivity of J/ψ A_{LL}^{incl} vs. p_T based on data obtained during the 500 GeV polarized p+p run in 2012. The analysis is in progress and we are working towards preliminary results for J/ψ cross section and its longitudinal double-spin asymmetry.

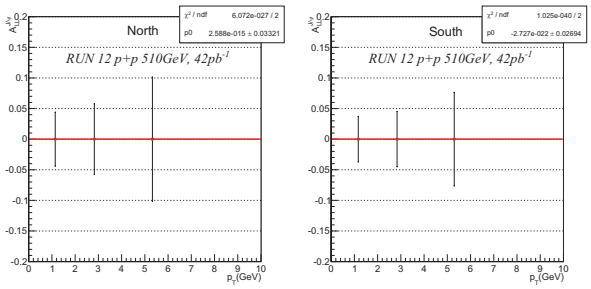

Fig. 2. Sensitivity of A_{LL} vs. p_T in J/ψ production at $\sqrt{s} = 500$GeV for data obtained during 2012.

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References

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