Status of π^0 pair A_{LL} analysis in RHIC-PHENIX experiment

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1 Introduction

The proton has a spin of 1/2 that originates from internal quarks and gluons. Results from deep inelastic scattering (DIS) experiments[1] show that the quark spin contribution to the proton spin is only about 25% . In the PHENIX experiment, the gluon-spin contribution to the proton spin has been studied for more than 10 years. In recent years, double helicity asymmetries, A_{LL}, have been measured in several types production ($\pi^0, \pi^{\pm}$, direct photon, etc). In the case of single inclusive π^0 production, A_{LL} is defined as follow:

$$A_{LL}^{\pi^0} \equiv \frac{\sum_{a,b,c} \Delta f_a \Delta f_b \hat{\sigma}^{ab\to cX} \hat{a}_{LL}^{ab\to cX} D_c^{\pi^0}}{\sum_{a,b,c} f_a f_b \hat{\sigma}^{ab\to cX} D_c^{\pi^0}} \quad (1)$$

where $f_{a,b}$ represent unpolarized parton distribution functions (PDFs) of partons a and b and $\Delta f_{a,b}$ represent polarized PDFs, $D_c^{\pi^0}$ is a fragmentation function (FF) of parton c to π^0, $\hat{\sigma}^{ab\to cX}$ and $\hat{a}_{LL}^{ab\to cX}$ denote the cross section and A_{LL} of the partonic subprocess $ab \to cX$ respectively.

Experimentally, the A_{LL} for π^0 production is determined as

$$A_{LL}^{\pi^0} = \frac{1}{< P_B P_Y >} \frac{N_{++} - RN_{+-}}{N_{++} + RN_{+-}}; R = \frac{L_{++}}{L_{+-}} \quad (2)$$

where $N_{++(+-)}$ is the number of π^0s and R is the relative luminosity between bunches with the same and opposite helicities. $< P_B P_Y >$ are the averaged beam polarizations.

2 Simulation study on kinematics coverage

Bjorken-x is a fraction of a proton's longitudinal momentum. Let us imagine a reaction parton a interacting with parton b and producing jets(or partons) c and d: $parton(a)+parton(b) \to jet(c)+jet(d)$. In this case, Bjorken-x can be determined by using pseudorapidity and the transverse momentum of scatterted partons c and d

$$x_1 = \frac{1}{\sqrt{s}}(p_{T,c}e^{\eta_c} + p_{T,d}e^{\eta_d}) \quad (3)$$

$$x_2 = \frac{1}{\sqrt{s}}(p_{T,c}e^{-\eta_c} + p_{T,d}e^{-\eta_d}) \quad (4)$$

If both partons c and d are produced in the mid-rapidity region, $e^{\eta_{c,d}}$ and $e^{-\eta_{c,d}}$ are similar. Hence, x_1 and x_2 of the dijet production at the mid-rapidity region have a similar value. We can not mesure total energy of scattered partons. We measured the π^0 pair instead of the dijet(or partons). If we select back-to-back hadron pair production at the mid-rapidity region, the Bjorken-x of two incoming partons should be almost balanced. If values of two Bjorken x are not balanced, the produced particles system is boosted, and these particles should move to the exterior of the PHENIX central arm acceptance, where the rapidity region is $|\Delta\eta| < 0.35$. Figure 1 is a result of PYTHIA6.4 simulation. The vertical the horizontal axes are the log of Bjorken-x distribution. The colors denote the number of events. We accepted all events in which the pt of π^0, which decays gamma fire trigger is up to 2.0 GeV and in which the pt of π^0, which is produced in the opposite direction of the triggered π^0 is up to 1.5 GeV. The events in which two Bjorken-x's are similar are selected. The selection of back-to-back hadron pair production at a mid-rapidity region can suppress events in which two Bjorken-x's are Bjorken-x1>>Bjorken-x2 or Bjorken-x1<<Bjorken-x2.

3 Current status of this study

We calculated A_{LL} as well as A_L for π^0 pair production , A_{LL} for the single inclusive π^0 production etc, for cross checking. We determined te our analysis passed these tests. We are also checking for consistency in statistics between experimental data and simulated data with the PYTHIA 6.4 event generator.

This analysis is being preformed at RIKEN-CCJ[2], and we are grateful for its smooth operation.

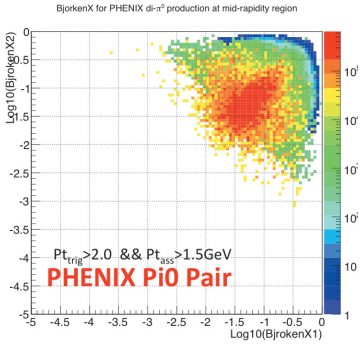

Fig. 1. Bjorken-x distribution for the π^0 pair production.

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References
1) http://arxiv.org/abs/hep-ph/0101224v1
2) http://ccjsun.riken.jp/