Spin Physics in RHICf Experiment

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Transverse single spin asymmetry (A_N) is defined as

$$A_N = \frac{\sigma^{\uparrow} - \sigma^{\downarrow}}{\sigma^{\uparrow} + \sigma^{\downarrow}} \quad (1)$$

where $\uparrow$ and $\downarrow$ denote up and down spins, respectively, of the incident beam. Since the discovery of an unexpectdly large A_N in 1991 from the E704 experiment.[1] A_N values measured from subsequent experiments[2–4] have provided important information to expand QCD application. When we categorize QCD into perturbative QCD (pQCD) and non-perturbative QCD (non-pQCD) according to Q^2, the A_N in the pQCD region can be explained by two kinds of theoretical framworks: twist-3 perturbative QCD and the transverse-momentum-dependent parton distribution function. On the other hand, no general physical framework to calculate A_N in the region of non-pQCD exists. In the case of the inclusive neutron production process, however, A_N can be calculated by the spin-flip one pion exchange (OPE) model and spin-non-flip Reggeon exchange model.[5]

At the Relativistic Heavy Ion Collider (RHIC), the first polarized proton-proton collider, A_N measurement with forward neutrons($8.8> \eta >6.9$) at $\sqrt{s}$ =62 GeV, 200 GeV and 500 GeV has been performed.[6,7] These data have played an important role in testing the explanation based on the OPE model and Regge theory. Nevertheless, more A_N measurements of neutrons with high pseudorapidity and with higher pT are needed for a better understanding of the mechanism in inclusive neutron production and clarification of the relation among A_N, P_T and $\sqrt{s}$.

In the RHICf experiment, we will measure very forward neutral particles ($\eta > 6.9$) by using STAR ZDC and the RHICf detector. ZDC is a sampling type hadron calorimeter that has an energy resolution of 20% for 100 GeV neutrons with a position resolution of 1 cm. The RHICf detector is a sampling type EM calorimeter that has an energy resolution of 40% for 350GeV neutrons with a position resolution of 1 mm.[8]

In addition to the improvement of the position resolution of ZDC and the RHICf detector, we are planning to manipulate the position of the RHICf detector vertically as shown Fig. 1 and use a radial polarized beam during the dedicated beam time for the RHICf experiment.[9] These works will allow more precise measurement and higher p_T (up to 1.5 GeV/C) data. Another challenge in the RHICf experiment is the measurement of A_N with forward π^0; the RHICf detector consists of 2 towers for reconstruction from the detection of 2γ.

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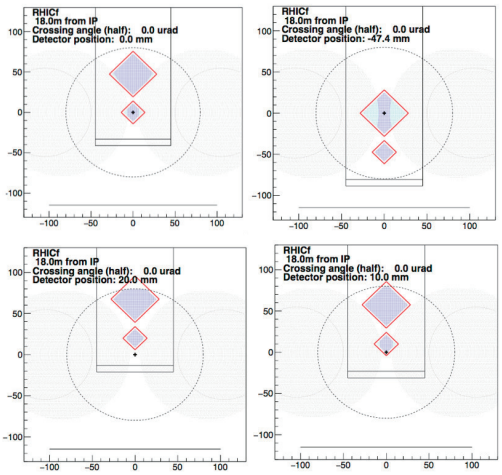

Fig. 1. Various positions of the RHICf detector. The black cross indicates the beam center.

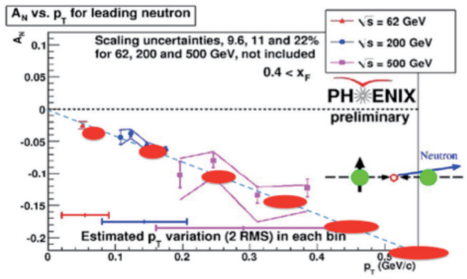

Fig. 2. Relationship between A_N of forward neutrons and pT at various collision energies. Red eclipses show the results expected from RHICf experiment.

References

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