Study of the dimuon process for PHENIX $W^{\pm} \to \mu^{\pm}$ analysis using 2012 data

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Using the parity violation of weak interactions, we measured the single spin asymmetry of W production in longitudinally polarized p+p collisions. This enables us to access the flavor-separated sea quark polarization in protons[1]. PHENIX measured the single spin asymmetry A_L^W via lepton decays of W bosons, $W^{\pm} \to e^{\pm}$ at midrapidity ($|\eta| < 0.35$) and $W^{\pm} \to \mu^{\pm}$ ($1.2 < |\eta| < 2.2$) at the center of mass energy $\sqrt{s} =$ 510 GeV at RHIC. After the first measurement in 2011 for the $W^{\pm} \to \mu^{\pm}$ channel, PHENIX collected data at an integrated luminosity of 50 pb^{-1} in 2012 with fully upgraded detectors and a trigger system.[2]. The preliminary result of A_L obtained using the 2012 data is shown in Fig. 1. The measured asymmetries are consistent with theory models within large uncertainty ranges.

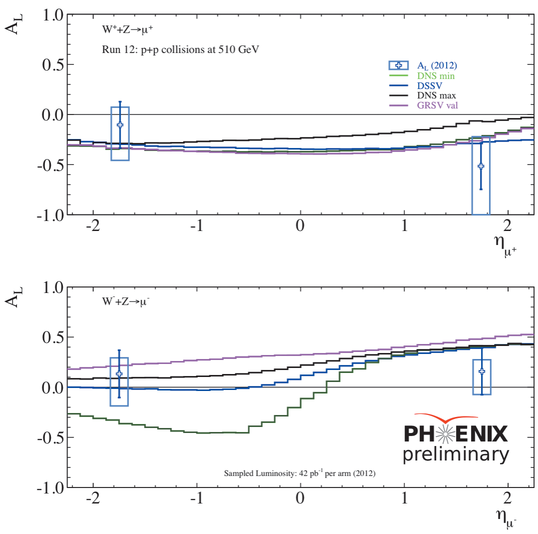

Fig. 1. Preliminary result of A_L for W^+(top) and W^-(bottom) at forward/backward rapidity region with various theoritical predictions.

After the preliminary result was obtained, there have been efforts toward the finalization of the 2012 data analysis. Understanding the background of the W→ μ analysis is one of the most important goals. The major background source is coming from decays of kaons and pions to muons in flight. In addition to this hadron background, there are muon backgrounds from the dimuon process that are open heavy flavor, quarkonia, and Drell-Yan process. Estimating the muon background is one of the essential steps to extract the signal-to-background ratio accurately. We simulate the dimuon processes using the PYTHIA event generator and GEANT4 detector simulation. The cross section of each process can be estimated by comparing the simulated dimuon yield to data. Fig. 2 shows the invariant mass spectrum of dimuon events in the 2012 data. We select unlike-sign muon pairs that travel to the same side of the PHENIX muon arm spectrometer. The discrepancy in the mass spectrum of the two muon arms reflects the difference in trigger efficiency. The simulated dimuon yields that take the trigger efficiency into account are used to extract analytical functions for each process. The scale factor of analytical functions for each process that contributes to the dimuon yields are then determined through simultaneous fit to the data. Currently, the simultaneous fit is being performed, and the result will be finalized shortly.

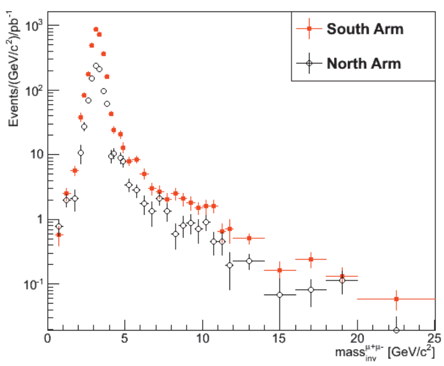

Fig. 2. Invariant mass distributions of dimuon events from data for south (red) and north (black) muon arms.

In addition to the dimuon study, dedicated analysis work is in progress on different fronts. Evaluation of the trigger efficiency and systematic uncertainty estimation are some of the tasks to be carried out. Furthermore, the signal-to-background ratio is expected to be improved through a review of the hadron background.

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References

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2) S. Park et. al, RIKEN Accel. Prog. Rep. 46, 63 (2013)