Sea quark polarization measurement by $W^{\pm} \to \mu^{\pm}$ in PHENIX 2012

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The leptonic decayed $W^{\pm}$ bosons measurement at RHIC aims to achieve precise constraint of each flvaor-decomposed sea quark's spin contribution to the whole proton spin $\frac{1}{2}$.

The $W^{\pm} \to \mu^{\pm}$ analysis by using the dataset of year 2012 shares the basic strategy set in the 2011 analysis[1)], but also has several advantages such as enhanced statistics and upgraded W trigger for data acquisition. Table 1 shows a few key features of the recent longitudinally polarized pp collisions.

Table 1. Results of recent polarized pp collisions in PHENIX Muon Arms.

Year	$\sqrt{s}$	L (pb^{-1})	P (%)	FoM (LP^2)
2009	500	8.6	39.0	1.3
2011	500	16.7	48.0	3.8
2012	510	31.5	51.9	8.5
2013	510	146.0	55	44.2

The main observable in this analysis is the single spin asymmetry (A_L) calculated by muons decayed from desired W bosons.

The major background source is muons from in-flight decayed low p_T ($p_T \leq 3$ GeV/c) hadrons, which mimic high p_T muons as well as various irreducible muonic backgrounds. Owing to the dominance of these backgrounds in addition to smearing in momentum and charge determination, observing distinct Jacobian peak in $W^{\pm} \to \mu^{\pm}$ measurement in forward rapidity is not expected, unlike the $W^{\pm} \to e^{\pm}$ measurement in mid-rapidity. Therefore, accurate estimation of the S/BG ratio plays an essential role in a reliable signal extraction process.

Table 2. S/BG ratio in Run 12 (preliminary).

Channel	n_{sig}	n_{μ}	n_{had}	S/BG
South μ^-	$88.87^{+16.97}_{-16.28}$	44.42	$177.77^{+19.60}_{-18.60}$	$0.40^{+0.12}_{-0.10}$
South μ^+	$92.48^{+20.55}_{-19.91}$	44.88	$258.74^{+24.38}_{-23.31}$	$0.30^{+0.10}_{-0.08}$
North μ^-	$38.95^{+11.90}_{-11.15}$	42.71	$139.78^{+15.45}_{-14.56}$	$0.21^{+0.09}_{-0.07}$
North μ^+	$72.37^{+15.75}_{-15.04}$	38.67	$185.69^{+18.93}_{-17.98}$	$0.32^{+0.10}_{-0.09}$

To estimate the S/BG ratio properly, we use a partially indirect approach by using likelihood to the W. The procedure for the estimation is as follows. First, calculate the W likelihood by using the data and NLO level Monte Carlo sample. Second, construct the overall probability density function (PDF) for signal and backgrounds by using three types of component PDFs based on W likelihood. Each component PDF corresponds to a signal, muonic backgrounds, and hadronic backgrounds, respectively. Finally, estimate the S/BG ratio via the overall PDF and unbinned max. likelihood fit technique. The estimated S/BG ratio in the preliminary condition is summarized in Table 2. Also, A_L calculated by applying the above S/BG ratio can be seen in figure 1.

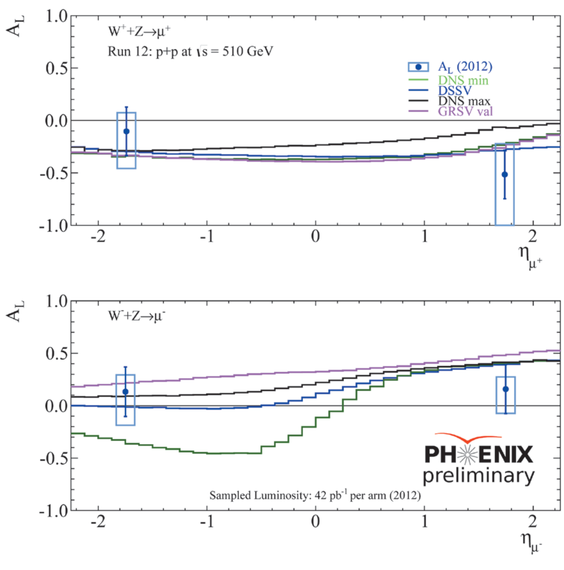

Fig. 1. A_L in Run 12 (preliminary). Empty squared box indicates systematic error by dilution factor.

After the preliminary, various refinements have been made or are underway, such as inclusion of kinematic variables from the Forward Silicon Vertex Detector (FVTX), applying overall trigger efficiency, update in detector efficiency, and further fine tune of hadronic PDF. Among them, inclusion of FVTX variables and fine tune of hadronic PDF are expected to play a significant role in improving statistics in the region of interest (W likelihood ≥ 0.92) as well as reduced errors, which will enable better estimation of the S/BG ratio and A_L.

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