Hadronic backgrounds pattern study for $W^{\pm} \rightarrow \mu^{\pm}$ analysis in PHENIX

C. Kim,[*1,*2] Y. Goto,[*2] S. Caussin,[*2,*3] S. Han,[*2,*4] M. Kim,[*2,*5] T. Moon,[*2,*6] T. Murakami,[*7] J. Murata,[*8] T. Nagashima,[*2,*8] I. Nakagawa,[*2] S. Park,[*2,*5] R. Seidl,[*2] W. Saito,[*2,*8] K. Tanida,[*2,*5] and I. Yoon[*2,*5]

The ongoing $W^{\pm} \rightarrow l^{\pm}$ analysis at PHENIX aims to precisely constrain the sea quark spin contribution to the proton spin of 1/2. The main observable of this analysis is single longitudinal spin asymmetry among muons (A_L), which directly decayed from W boson[1].

To measure the desired asymmetry precisely S/BG needs to be estimated as accurately as possible. However, observing a distinct Jacobian peak in $W^{\pm} \rightarrow \mu^{\pm}$ is not expected due to the large momentum and charge smearing in the muon reconstruction in addition to dominant backgrounds from various sources. As a result, conventional S/BG estimation is not available; thus, we use a partially indirect method based on likelihood to the W (Wness), which is calculated by using NLO level signal Monte Carlo (MC) and data itself.

In an actual S/BG estimation, we perform an unbinned maximum likelihood fit (UMLF) by using six probability density functions (PDFs) from a pair of kinematic variables (η (pseudorapidity) and $dw23$ (reduced azimuthal bending)) and three processes (signal, muonic BG, and hadronic BG).

Among these PDFs, the hadronic BG process is modeled from the data itself owing to the difficulty in hadronic MC production. To obtain the expected hadronic distribution among the final muon candidates, we modeled each kinematic variable's distribution from the BG dominant region in the data ($0.1 <$ Wness < 0.9), and then extrapolated it into the signal dominant region (Wness > 0.9). For the validity of the method, each variable's distribution along Wness should be understood precisely. However, as there exists a serious Wness dependence of $dw23$ (Fig. 1) unlike η, a specific pattern study was required to reflect its shape along Wness.

A typical $dw23$ in a certain Wness range (ex. $0.1 <$ Wness < 0.2) can be described by a stack of two Gaussians. To understand its development along Wness, we collected $dw23$ over a certain Wness range, performed a fit using two Gaussians, and then parameterized each Gaussian's parameters (maximum, center, and FWHM) along Wness. Then we fed it back during the hadronic BG $dw23$ modeling process as explained above.

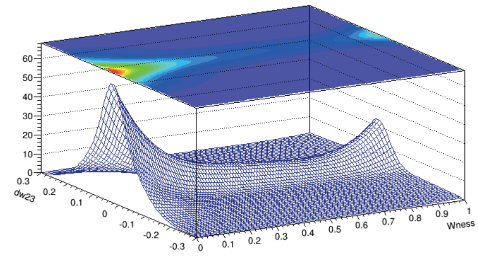

Fig. 1. An example of dw23 vs. Wness.

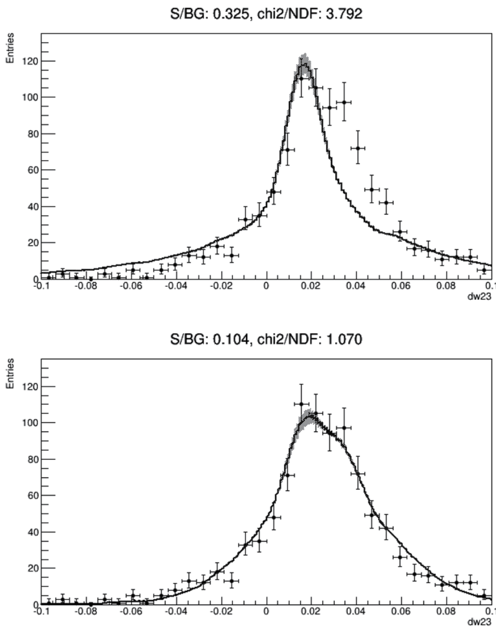

Fig. 2. Comparison between fit results before (top) and after (bottom) the pattern study for $W^{+} \rightarrow \mu^{+}$ measured in the North muon arm. The gray-hatched area of the solid line indicates the uncertainty of the final PDF itself.

Figure 2 shows the results of a 2D UMLF projection onto $dw23$ in the final sample before and after the pattern study. A noticeable improvement was observed in the fit's χ^2, and we plan to apply the pattern study in $W^{\pm} \rightarrow \mu^{\pm}$ analysis for both the 2012 and 2013 datasets.

*1 Department of Physics, Korea University
*2 RIKEN Nishina Center
*3 Department of Physics, ENSICAEN
*4 Department of Physics, Ewha Womans Univeristy
*5 Department of Physics, Seoul National University
*6 Department of Physics, Yonsei University
*7 Department of Physics, Kyoto University
*8 Department of Physics, Rikkyo University

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