Overall trigger efficiency estimation for W analysis at PHENIX

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The large uncertainty of flavor-separated spin contributions of anti-quarks to the spin 1/2 can be constrained using W analysis at PHENIX. The observable is a single longitudinal spin asymmetry (A_L), originating from parity-violating W production calculated by collecting single muons from W bosons. The muons were collected via multiple muon sensitive Global Level 1 (GL1) triggers from 2011 to 2013 during data recording periods. Owing to the heavy Monte-Carlo simulation dependence and necessity of precise W cross-section measurement, precise estimation of the trigger efficiency is essential.

However, there are a few difficulties to overcome in actual trigger efficiency estimation.

First, owing to the use of multiple triggers (e.g., 13 for 2013 data), more than 1 trigger can be fired in a given muon event. Though the probabilty of multiple triggers fired for an event drops following a Poisson distribution, it is important to know the number of fired triggers as well as their combination. Therefore, we investigated all possible trigger combinations and yields in the data, and then obtained a list of highly contributing combinations. By measuring these combinations' relative fraction in the data and their efficiency, the overall efficiency of all muon triggers in the data can be estimated. The top plot in Fig. 1 shows a fraction of 77 trigger combinations in the final data. Note that each trigger combination's fraction was measured in a certain pseudorapidity (η) window to take into account its η dependence.

Second, there exists a linear correlation between the trigger efficiency and the W signal likelihood ($Wness$). The $Wness$ is a key parameter of the analysis; it is a probability that indicates how close an event is to the W signal. The higher the $Wness$ ($\to 1$), more likely the event is the W signal. In this analysis, only a very small fraction of the data with a high $Wness$ (≥ 0.92) is used as the final candidates for the evaluation and we need to know the average trigger efficiency of the fraction. It is appropriate to measure the trigger efficiency with these candidates however, owing to the scarcity of high-$Wness$ candidates, statistical uncertainty dominates if we directly measure the efficiency with these candidates only. Therefore, we separate the data into a few $Wness$ windows (e.g., $0.1 < Wness < 0.2$), estimate each efficiency separately, and then extrapolate the efficiency from low $Wness$ to high $Wness$ for the average efficiency in the high-$Wness$ region. The bottom plot of Fig. 1 shows each trigger combination's extrapolated efficiency in the high-$Wness$ region.

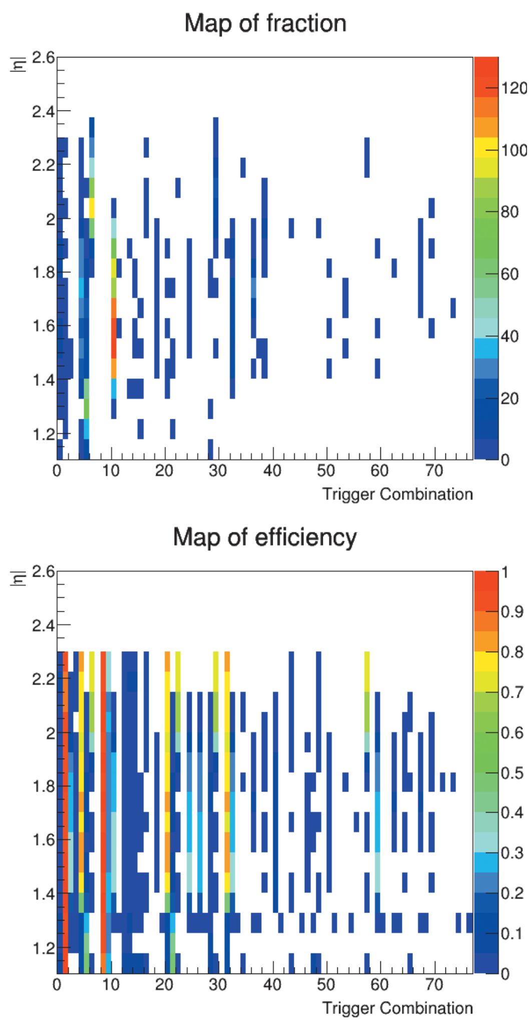

Fig. 1. Map of specific trigger combination fractions in the data (top) and their efficiency (bottom).

The combination of triggers, their relative fractions, and extrapolated efficiencies are currently being cross-checked using multiple analyzers to obtain the final asymmetry result.

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