Current status of bottom and charm measurements using VTX at RHIC-PHENIX

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One of the most noteworthy results at RHIC was the strong suppression of inclusive open heavy quarks (bottoms and charms) at high p_T in central Au+Au collisions[1)]. It was expected that heavy quarks would be less suppressed due to their large mass. However, the results showed that the suppression was comparably strong with pions. In order to study the suppression in detail, we developed a silicon vertex tracker (VTX) at PHENIX. VTX can measure bottom and charm separately using the distance of closest approach (DCA) to the primary vertex.

We reported the preliminary result of the fraction of $(b \to e)/(b \to e + c \to e)$ using VTX in Au+Au collisions[2)]. Numerous improvements of the analysis for the final result are underway. Here, we have listed a few of these improvements:

(1) Rejecting photon conversions and Dalitz decays: Photon conversions and Dalitz decays of light neutral mesons are the main background sources in single electron measurement. Electron pairs from the backgrounds are generated with small opening angles and the pair makes correlated hits in VTX. Therefore, VTX can significantly reject the backgrounds by requiring pair-wise hits in VTX. On the other hand, heavy flavor electrons ($b \to e$ and $c \to e$) rarely make the correlated hits. Figure 1 shows the fraction of heavy flavor electrons to inclusive electrons. The open and closed circles correspond to the result before and after VTX installation, respectively. This plot indicates that VTX could reject the background effectively and provide a good signal to noise ratio.

(2) Unfolding of DCA distribution:
We developed an unfolding method to decompose bottom and charm contributions[3)]. The method is a Bayesian approach using the Markov chain Monte Carlo sampler[4)]. Using this method, the bottom and charm yields are obtained by fitting both the DCA and the p_T distribution of heavy flavor electrons simultaneously. The DCA shape is correlated with the p_T distribution of the parent B and D mesons because the DCA is determined by the convolution of two effects: the decay length of the parent particle and the decay p_T kick relative to the parent momentum. As a consistency test, we verified if the known input can be reproduced using a simulation[3)].

(3) Detector efficiency:
The detector efficiency was determined by full GEANT simulation with the actual dead map. The raw p_T spectrum of heavy flavor electrons was corrected using the efficiency, and the corrected spectrum is consistent with the published data[5)]

(4) DCA smearing by random association
The DCA shape is smeared and modified by the random association of electron tracks with VTX. The smearing effect was studied by embedding simulated electron tracks into real events. Then, we found that the unphysically large DCA tail in the data was explained by the smearing effect.

The current analysis of Au+Au data will be completed for publication soon. We took 20 billion Au+Au data in year 2014, which is 20 times larger statistics. This new dataset will be analyzed. The alignment calibration of the dataset was completed[6)] and the data production was started.

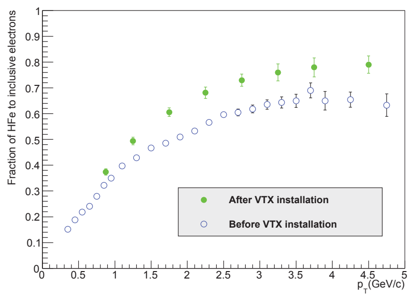

Fig. 1. Fraction of heavy flavor electrons to inclusive electrons before (closed) and after (open) the VTX installation.

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References
1) A. Adare et al: Phy. Rev. Lett. **98**, 172301 (2007).
2) R. Akimoto et al.: RIKEN Accel. Prog. Rep. 46, 60 (2013).
3) A. Adare et al.: Quark Matter 2014 poster.
4) G. Choudalakis.: arXiv:1201.4612v4
5) H. Asano at al.: In this report.
6) T. Moon at al.: In this report.