Distance of closest approach analysis with VTX at RHIC-PHENIX

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Heavy quark production is being studied via a PHENIX experiment by measuring of electrons from semi-leptonic decays of hadrons containing charm and bottom quarks. A large suppression and strong elliptic flow of single electron heavy flavor has been observed in Au+Au collisions at $\sqrt{s} = 200$ GeV[1]. In past measurement, PHENIX was unable to distinguish electrons from charm and bottom quarks.

In order to understand the medium effects in more detail, the Silicon Vertex Tracker (VTX) was developed and installed in year 2011 in the RHIC-PHENIX experiment. The VTX can measure charm and bottom separately using the distance of closest approach (DCA) to the primary vertex. After the preliminary result of the fraction of $b \rightarrow e/(b \rightarrow e + c \rightarrow e)$ in Au+Au collision was reported[2], we improved the DCA analysis to obtain the final result.

(i) In the high multiplicity environment, hits on the VTX can be associated with uncorrelated tracks. They are one of the main sources of background of DCA distribution. We studied the chi-square distribution of track fitting using real data and a Monte Carlo simulation. We determined the threshold of the chi-square value of tracks to reject random association candidates as much as possible. The real tracks are expected to be removed around 5% from the simulation study.

(ii) Electrons from photon conversion and Dalitz decay of neutral mesons are also the background source in the electron DCA measurement. We identify e^+, e^- pairs by VTX and removed these pairs from the DCA distribution. The tagging efficiency of the conversion and the Dalitz decay are estimated thorough the simulation. The yield of the remaining electrons and the shape of the DCA distribution from conversions and Dalitz decays are also estimated using the past measurement data[1] and the simulation.

(iii) Electrons from J/ψ and Kaon also cause small background noise. The yield of these electrons and the shape of DCA distribution are estimated using the past measurement data and the simulation.

After completing the study, we decomposed electron DCA distribution. In Fig. 1, the shape of each component is obtained through the simulation and each component is overlaid on the DCA distribution of real data. Currently, the ratio of charm and bottom quarks are based on theoretical prediction. The fraction of each DCA background (conversion, Dalitz, Kaon, J/ψ...) is obtained from (ii) and (iii). The sum of those DCA distribution values describes the shape of the electron DCA distribution in real data very well.

To obtain the precise ratio of $b \rightarrow e/(b \rightarrow e + c \rightarrow e)$ as a function of transverse momentum and momentum distribution of parent mesons (D and B mesons) from DCA measurement, an invariant yield of heavy flavor electrons and DCA distribution are being analyzed simultaneously. The results will be published soon.

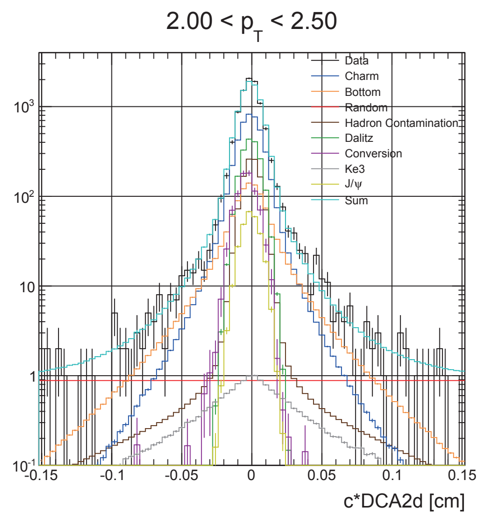

Fig. 1. Electron DCA distribution at 2.0-2.5 GeV/c. Charm (blue) and bottom (yellow) are signal. The other components are backgrounds. The sum of the signals and backgrounds (light blue) obtained through the simulation is consistent with data (black).

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References

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