Single electron yields from semileptonic charm and bottom hadron decays in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV[†]

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The PHENIX experiment measured open heavy flavor production in minimum bias Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV using single electrons from semileptonic decays of charm and bottom hadrons. Previous measurement of electrons from inclusive heavy flavor decays showed strong suppression at high transverse momentum, $p_T > 5$ GeV/c, when compared with that in $p+p$ collisions[1)]. In order to understand the suppression, we installed the silicon vertex tracker (VTX). VTX allows separating the charm and bottom contributions by measuring the distance of the closest approach of electrons to the primary vertex (DCA).

Data analysis was performed in three steps. First, we measured the DCA of inclusive electrons using Au+Au events recorded in 2011. The electrons contain a large amount of backgrounds (BG) that are Dalitz decays of π^0 and η, photon conversions, K_{e3} decays, and $J/\psi \to e^+e^-$ decays. Most of them are rejected based on the requirement of the pair-wise hit in VTX because the pair of hits are created by e^+e^- pairs of BG's, such as $\gamma \to e^+e^-$.

Second, we determined the BG DCA distribution for 1)misidentified hadrons, 2)random matching of electrons with VTX hits, 3) π^0, η, K_{e3}, and J/ψ decays and photon conversions. 1) is evaluated by the event swap method and 2) is evaluated by embedding single simulated electrons into the real events. 3) is estimated using GEANT-based detector simulation with the input of measured spectra. All BG DCA distributions are normalized based on the BG yield obtained in the single electron measurement in 2004[1–3)].

Third, to extract the charm and bottom components, we developed the unfolding method that employs the Bayesian inference technique with the Markov chain Monte Carlo sampler. The method performed simultaneous fitting with the DCA distributions and inclusive heavy flavor electrons yield[1,2)] as a function of p_T.

From the unfolding result, the fraction of bottom electrons to inclusive heavy flavors was shown in Fig. 1. The red line and the pink band represent the center value and the systematic errors, respectively. The gray line is the FONLL prediction in $p+p$ collisions. We found the steeper rise in $2 < p_T < 4$ GeV/c with a possible peak compared with the central FONLL calculations.

The nuclear modification factors R_{AA} of charm and bottom electrons can be calculated separately using this result with additional constraints in $p+p$[4)] and previous Au+Au measurement[1,2)]. Figure 2 indicates that both charm and bottom electrons are strongly suppressed at high p_T, and bottom electrons are less suppressed than charm electrons in $3 < p_T < 4$ GeV/c.

For further improvement, we are analyzing large amounts of the Au+Au and $p+p$ data recorded in 2014 and 2015[5)].

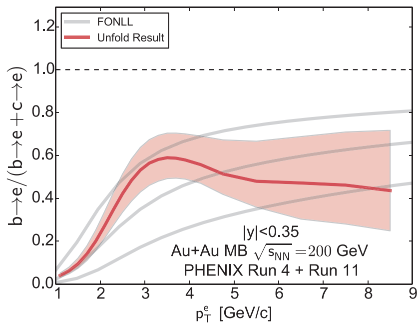

Fig. 1. Bottom electron fraction in minimum bias Au+Au collisions. The FONLL calculations are also shown (gray lines)

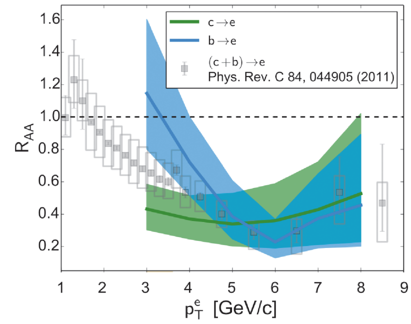

Fig. 2. R_{AA} for charm and bottom electrons as a function of p_T.

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