# D-meson reconstructions with STAR HFT at RHIC

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In high-energy nuclear collisions, heavy quarks are believed to be produced at early stages via initial gluon fusion and their production cross-section can be estimated by perturbative QCD[1]. Due to their high mass and small interaction cross-section, the strength of elliptic flow of heavy flavor hadrons might test thermalization at partonic stage. Charm quarks are predicted to lose less energy than light quarks in the hot-dense matter due to the "dead-cone" effect [2].

Recently, both STAR and PHENIX results show that the open charm production cross-sections are consistent with binary collision scaling with large systematical uncertainties, and their total yields are larger than NLO pQCD calculation [3, 4]. In the non-photonic electron $R_{AA}$, which is suppressed as strong as light hadrons, and non-zero $v_2$ with large uncertainties, both contributions from charm and bottom are mixed together [5, 6]. Since the correlation of momentum between leptons and their parent D-mesons is weak, these indirect measurements through semileptonic decay channel are not sufficient [7]. Due to large combinatorial background in Au+Au collisions, STAR directly measured $D^0$ with large error bars and in small momentum coverage [8].

The Heavy Flavor Tracker is designed for direct D-meson reconstruction and for clarification of these discrepancies. To demonstrate the capability of the HFT, we have simulated several specific charm meson decay channels, including $D^0 \to K^-\pi^+$, $D_s^+ \to K^-\pi^+K^+$ and $D^+ \to K^-\pi^+\pi^+$. A vertex position resolution of 8 $\mu m$ was achieved for the highest multiplicity events. As an example, the $D^+$ direct reconstruction, which was simulated with a conservative vertex position resolution of 20 $\mu m$, will be reported. Signal and background events are generated separately. The signal consists of one $D^+$ per event. The transverse momentum ($p_T$) distribution of the charmed hadrons follows a Boltzman distribution which reproduces the $\langle p_T \rangle$ of D-mesons as measured by STAR at 200 GeV $d$+Au collisions [9] and the rapidity distribution suggested by PYTHIA. The background is simulated using the MevSim event generator parameterized to reproduce the measured particle multiplicities at 200 GeV Au+Au collisions. The distributions of reconstructed D-meson signal and background were scaled to match the predicted D-meson production per central Au+Au collision, *e.g.* there are $\sim 20$ $c\bar{c}$ pairs per central event. The cross-section for $c \to D^+$ is 0.21 and the branching ratio for $D^+ \to K\pi\pi$ is 0.092 [10]. So the signal should be scaled by $20 \times 0.21 \times 0.092 = 0.39$. The daughter particles are identified as originating from a vertex displaced ($V_0$) from the primary vertex. For three-body decay, the $V_0$ is determined by the average of three displaced vertices of each two daughters. The track helices are constrained by refitting with 2 HFT hits. The invariant mass of the parent particle is then calculated from the kinematics of the daughters. Some topology cuts are applied to reject background and to increase signal to noise, such as the distance-of-closest-approach (DCA) to primary vertex $\gtrsim 100\mu m$, DCA to $V_0 \lesssim 100\mu m$, decay length $\gtrsim 150\mu m$, $cos\theta > 0.85$, etc. The reconstruction efficiency was derived from the comparison of the signal after these cuts applied to input, which is shown in Fig. 1. It is used to estimate the expected rate for detecting D-mesons. The simulated efficiencies show that with about 40 M events, D-meson $R_{AA}$ will be measurable up to $p_T \sim 8\text{GeV}/c$, and with 200 M events, D-meson $v_2$ up to $p_T \sim 3\text{GeV}/c$. In addition, the lowest charmed baryon $\Lambda_c$ ($c_\tau \sim 60\mu m$) can also be reconstructed with an efficiency similar to $D^+$, which provide a chance to reveal the difference between charmed meson and charmed baryon. This might allow to understand hadro-chemistry and hadronization involving heavy-flavors.

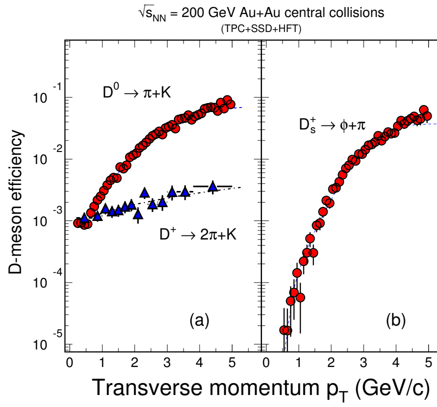


FIG. 1: D-meson efficiencies as a function of transverse momentum, together with fits. to the distributions.

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