PROCEEDINGS OF SCIENCE

Production of D$^{\pm}$ mesons in Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV at the STAR experiment

Jan Vanek ***for the STAR Collaboration***[a,b,*]

[a] *Nuclear Physics Institute of the Czech Academy of Sciences, Husinec - Řež 130, Řež, Czech Republic*

[b] *Faculty of Nuclear Sciences and Physical Engineering, Czech Technical University in Prague, Břehová 78/7, 115 19 Staré Město, Prague, Czech Republic*

E-mail: vanek@ujf.cas.cz

Charm quarks are an excellent probe of the quark-gluon plasma created in heavy-ion collisions as they are produced at a very early stage of such collisions and subsequently experience the whole evolution of the system. At the STAR experiment, charm quark production can be measured by direct topological reconstruction of open-charm hadrons thanks to the exceptional spatial resolution of the Heavy Flavor Tracker detector. In these proceedings, we present a measurement of D$^{\pm}$ meson production in Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV by the STAR experiment using data collected in 2014 and 2016. Supervised machine-learning techniques were used to maximize signal significance in raw yield extraction from the three-body hadronic decay channel $D^{\pm} \rightarrow K^{\mp}\pi^{\pm}\pi^{\pm}$. The D$^{\pm}$ invariant spectra were then obtained in 0-10%, 10-40%, and 40-80% Au+Au collisions. The measured nuclear modification factor $R_{AA}(p_T)$ reveals a significant suppression of high-p_T D$^{\pm}$ mesons in central (0-10%) Au+Au collisions with respect to p+p collisions. The $(D^+ + D^-)/(D^0 + \overline{D^0})$ yield ratio has also been extracted and compared to that from PYTHIA calculations.

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*Speaker

STAR is a versatile experiment which studies a variety of physics phenomena observed in high energy p+p and heavy-ion collisions. One of the main goals of the STAR experiment is to study properties of a hot and dense medium called the Quark-Gluon Plasma (QPG) created in heavy-ion collisions. The charm and bottom quarks are an excellent probe of the QGP as they are produced at very early stages of the heavy-ion collisions which means that they experience the whole evolution of the system. One way to access information about the charm quark production in heavy-ion collisions is through reconstruction of open-charm hadrons. From year 2014 to 2016, STAR was equipped with the Heavy Flavor Tracker (HFT) [1] which allowed direct topological reconstruction of decays of the open-charm hadrons.

In these proceedings, we present recent results from measurement of $D^{\pm}$ mesons in Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV. One key difference between the $D^{\pm}$ and D^0 measurements is that D^0 mesons are reconstructed in two-body hadronic decay channel ($D^0 \to K^- \pi^+$, and its charge conjugate), but $D^{\pm}$ mesons are accessed through three-body hadronic decay ($D^{\pm} \to K^{\mp}\pi^{\pm}\pi^{\pm}$). This is possible because of the excellent track pointing resolution provided by the HFT. The measurement of $D^{\pm}$ mesons serves as an independent check for the open-charm suppression and will also play an important role in measuring total charm cross section in heavy-ion collisions.

The invariant yields of $D^{\pm}$ mesons as a function of transverse momentum (p_T) have been measured in three centrality classes (0-10%, 10-40%, and 40-80%) of Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV. The methods for signal reconstruction and reconstruction efficiency correction are analogous to those used for D^0 and described in detail in Ref. [2]. The p_T spectra are used to calculate the nuclear modification factor (R_{AA}) and the $(D^+ + D^-)/(D^0 + \overline{D^0})$ yield ratio.

The R_{AA} of $D^{\pm}$ mesons as a function of p_T is shown in Fig. 1 for 0-10% and 10-40% central Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV. The R_{AA} of D^0 mesons is plotted for comparison [2]. As expected, the level of suppression for $D^{\pm}$ and D^0 mesons is comparable and the larger suppression for 0-10% central Au+Au collisions suggests stronger interactions of the charm quarks with the QGP compared to 10-40% centrality class.

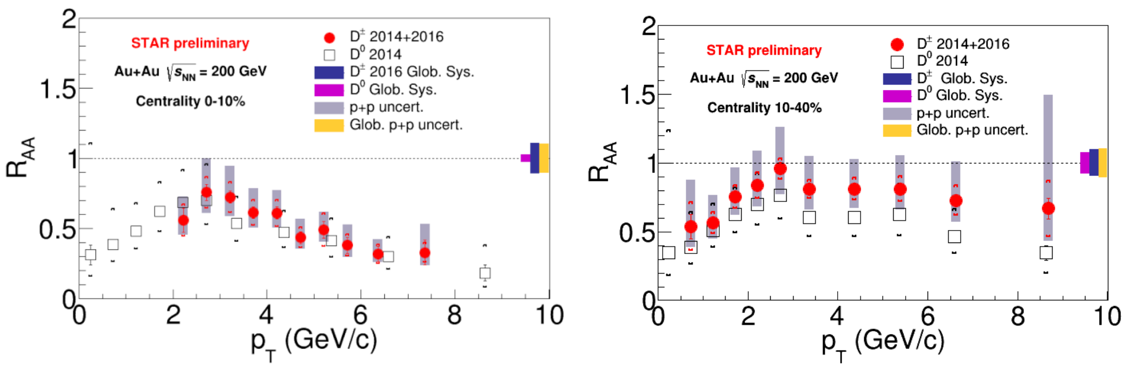

Figure 1: R_{AA} of D^0 [2] and $D^{\pm}$ mesons as a function of p_T measured in 0-10% (left) and 10-40% (right) central Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV.

The $(D^+ + D^-)/(D^0 + \overline{D^0})$ yield ratios are shown in Fig. 2 for 0-10% and 10-40% central Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV. The data are in agreement with PYTHIA 8 calculations which suggests that no modification of the ratio is observed in Au+Au collisions with respect to p+p collisions. The agreement is observed in all studied centrality classes which means that the ratio has no or very week centrality dependence.

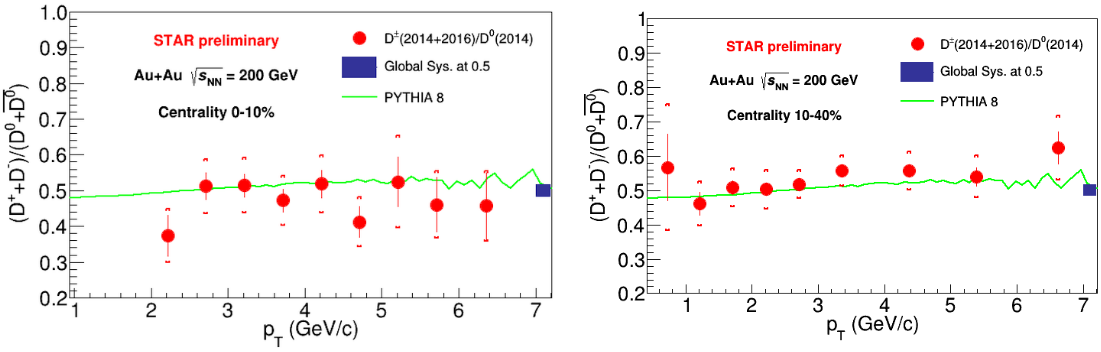

Figure 2: $(D^+ + D^-)/(D^0 + \overline{D^0})$ yield ratio measured as a function of p_{T} by STAR in 0-10% and 10-40% central Au+Au collisions at $\sqrt{s_{\mathrm{NN}}}$ = 200 GeV. Data are compared to PYTHIA 8 calculation.

Summary

The STAR experiment has extensively studied production of open-charm hadrons in heavy-ion collisions utilizing the HFT which allows direct topological reconstruction of hadronic decays of these hadrons. The invariant yields of $D^{\pm}$ mesons have been measured for three centrality classes (0-10%, 10-40%, and 40-80%) of Au+Au collisions at $\sqrt{s_{\mathrm{NN}}}$ = 200 GeV and were subsequently used to calculate the R_{AA} and $(D^+ + D^-)/(D^0 + \overline{D^0})$ yield ratio. The R_{AA} of $D^{\pm}$ mesons reveals a significant suppression at high p_{T}, similar to that observed for D^0 mesons, which suggests that charm quarks strongly interact with the QGP. The $(D^+ + D^-)/(D^0 + \overline{D^0})$ yield ratio is consistent with a PYTHIA 8 model calculation which means that no modification of the ratio is observed in Au+Au collisions with respect to the p+p collisions. The $D^{\pm}$ measurement will help to constrain the total charm quark cross section in Au+Au collisions at $\sqrt{s_{\mathrm{NN}}}$ = 200 GeV.

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