

Production of D^\pm Mesons in Au+Au Collisions at $\sqrt{s_{NN}} = 200$ GeV

at the STAR Experiment

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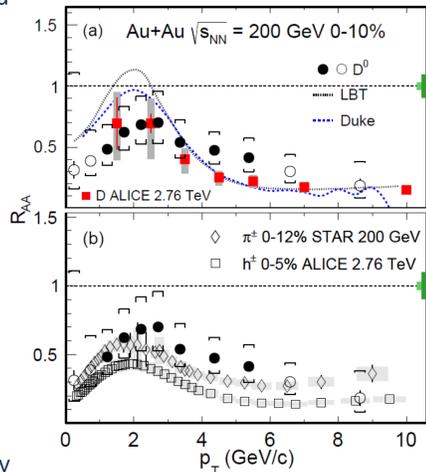
Abstract

Charm quarks are a unique probe of the Quark Gluon Plasma (QGP) created in heavy-ion collisions as they are produced at very early stages of these collisions and subsequently experience the whole evolution of the system. Information on charm quark production and dynamics in the QGP medium can be accessed through open charm hadrons. At STAR, measurements of open charm hadrons are enabled by the Heavy Flavor Tracker (HFT), thanks to its excellent track pointing resolution, through direct topological reconstruction. In this poster, we present measurements of D^\pm meson production in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV by the STAR detector using data collected in years 2014 and 2016. In particular, we focus on invariant spectra and nuclear modification factors (R_{AA}) of D^\pm mesons measured in three centrality classes of Au+Au collisions. Both D^\pm and D^0 R_{AA} show significant suppression in central Au+Au collisions for transverse momentum (p_T) above 4 GeV/c. We also report a measurement of D^\pm/D^0 yield ratio which turns out to be in agreement with the PYTHIA 8 calculation, suggesting no modification of the ratio in Au+Au collisions with respect to p+p collisions.

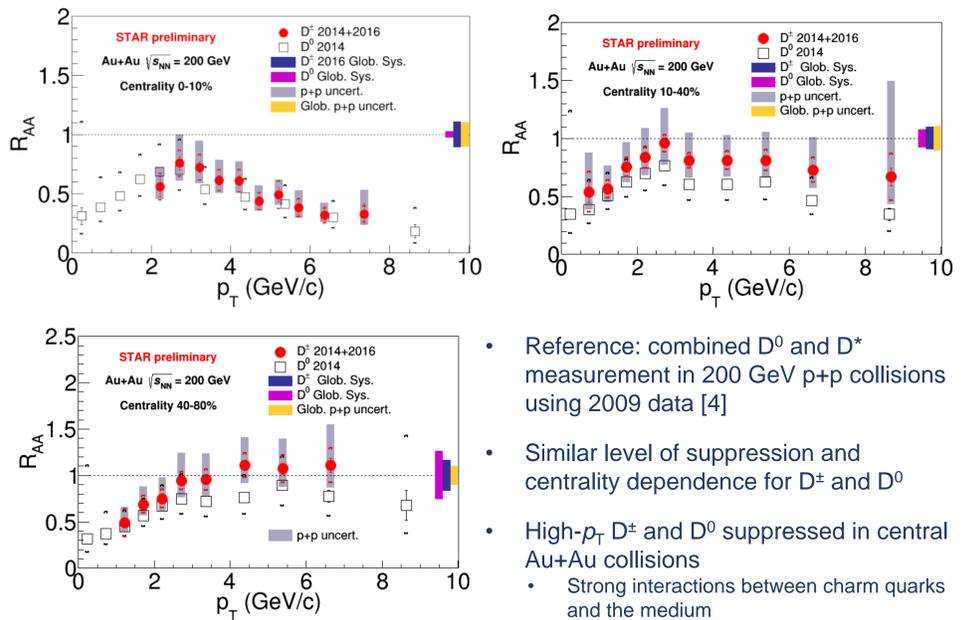
Physics Motivation

- At RHIC energies, charm quarks are produced predominantly through hard partonic scatterings at early stages of Au+Au collisions, making them excellent probe of the QGP
- Suppression of high- p_T D^0 is observed in central Au+Au collisions and is comparable to that of pions and models incorporating both radiative and collisional energy losses, and collective flow [1]
- The HFT allows direct topological reconstruction of three body decay $D^\pm \rightarrow K^\mp \pi^\pm \pi^\pm$ at mid-rapidity
 - $BR = (8.98 \pm 0.28)\%$, $ct = (311.8 \pm 2.1) \mu\text{m}$
- The study of D^\pm production is complementary to that of D^0 and also provides constraints on the total charm cross-section in heavy-ion collisions

$$R_{AA}(p_T) = \frac{dN^{AA}/dp_T}{\langle N_{coll} \rangle dN^{pp}/dp_T}$$



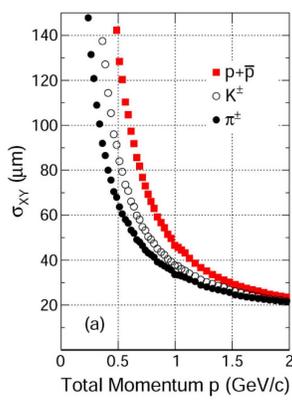
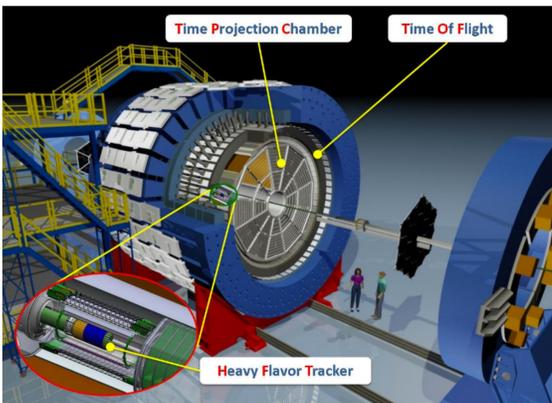
D^\pm Nuclear Modification Factor



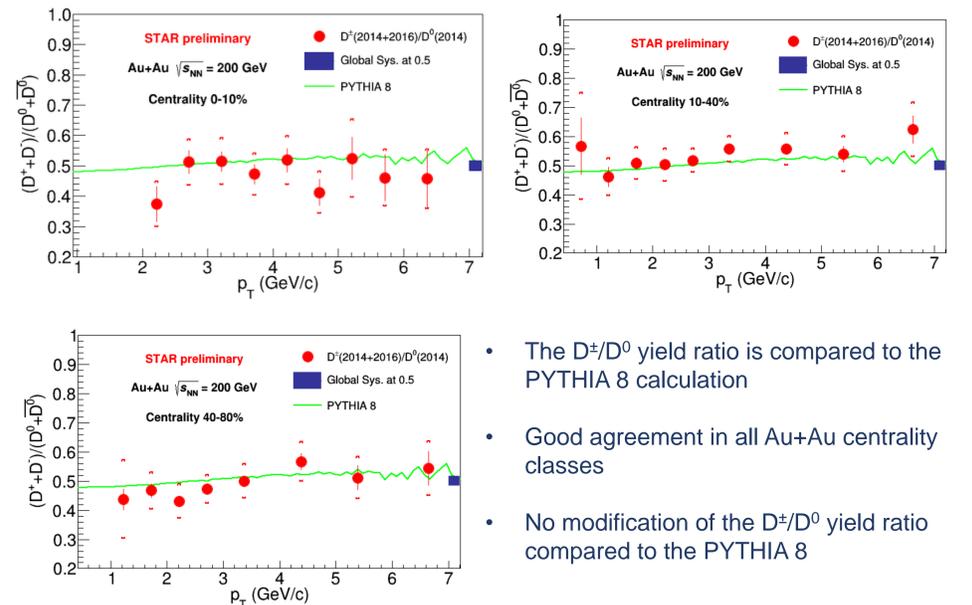
- Reference: combined D^0 and D^\pm measurement in 200 GeV p+p collisions using 2009 data [4]
- Similar level of suppression and centrality dependence for D^\pm and D^0
- High- p_T D^\pm and D^0 suppressed in central Au+Au collisions
 - Strong interactions between charm quarks and the medium

STAR Experiment

- Heavy Flavor Tracker (HFT)**: 4-layer silicon detector used for precise topological reconstruction of heavy-flavor hadrons, such as D^\pm
 - MAPS-based pixel detectors – 2 layers, Strip detectors – 2 layers
- Time Projection Chamber (TPC) and Time Of Flight (TOF) detector**
 - Particle momentum (TPC) and identification (TPC and TOF)

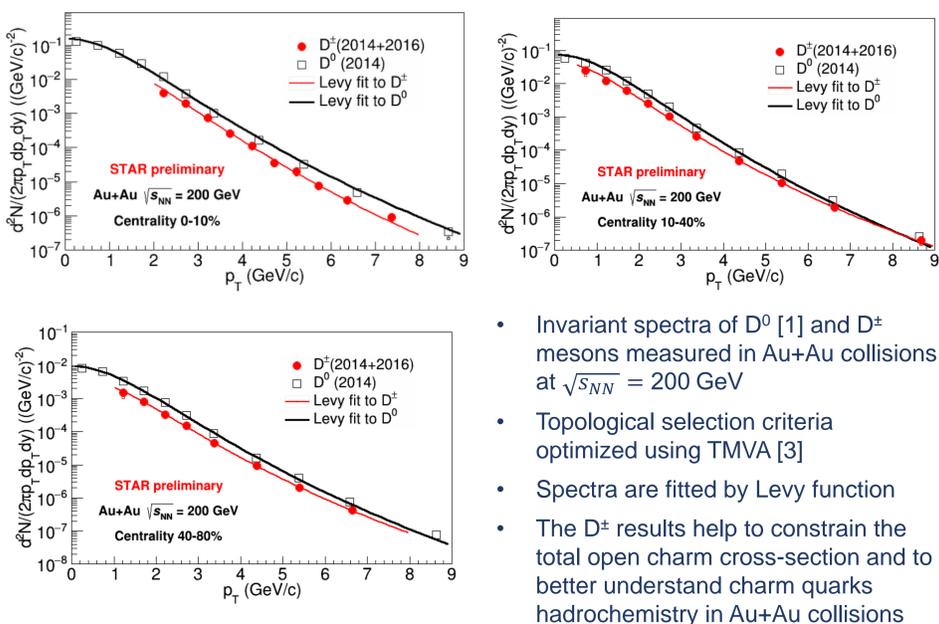


D^\pm/D^0 Yield Ratio



- The D^\pm/D^0 yield ratio is compared to the PYTHIA 8 calculation
- Good agreement in all Au+Au centrality classes
- No modification of the D^\pm/D^0 yield ratio compared to the PYTHIA 8

D^\pm Invariant Spectrum



- Invariant spectra of D^0 [1] and D^\pm mesons measured in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV
- Topological selection criteria optimized using TMVA [3]
- Spectra are fitted by Levy function
- The D^\pm results help to constrain the total open charm cross-section and to better understand charm quarks hadrochemistry in Au+Au collisions

Conclusions

- STAR has extensively studied the production of open-charm mesons in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV utilizing the HFT
- The HFT allows direct topological reconstruction of hadronic decays of open-charm mesons
- D^\pm invariant spectrum measured for three centrality classes of Au+Au collisions
 - 0-10%, 10-40%, 40-80%
- D^\pm nuclear modification factor is consistent with that of D^0
 - D^0 and D^\pm mesons are significantly suppressed at high p_T in central Au+Au collisions
 - Charm quarks interact strongly with the QGP
- D^\pm/D^0 yield ratio agrees with the PYTHIA 8 calculation

References

- [1] Adam J., et al. (STAR), Phys. Rev. C **99**, 034908, (2019).
- [2] Adamczyk L., et al. (STAR), Phys. Rev. Lett. **118**, 212301, (2017).
- [3] TMVA official website: <http://tmva.sourceforge.net>, (October 11, 2019).
- [4] Adamczyk L., et al. (STAR), Phys. Rev. D **86**, 072013, (2012).

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