Measurement of Charm Meson Production and Charm Meson Tagged Jets in Heavy-Ion Collisions at STAR

Diptanil Roy and Yuan Su
For the STAR Collaboration

April 22, 2023

1 Abstract

Heavy flavor quarks (charm and bottom), produced in the early stages of the heavy-ion collisions, serve as excellent probes to study the properties of the Quark-Gluon Plasma (QGP). The nuclear modification factors related to the production cross-section of heavy-flavor hadrons can quantify the flavor dependence of the medium induced parton energy loss. In addition, jets tagged with heavy flavor hadrons can shed light on their fragmentation, parton shower, and propagation in the medium.

The transverse momentum fraction of the jet carried by hadrons along the jet axis ($z = p_{\mathrm{T,hadron}}/p_{\mathrm{T,jet}}$) is related to the jet fragmentation function, and connects the production of quarks and gluons in the perturbative regime with the hadronized final state particles in the non-perturbative regime. In the QGP medium, modifications to the fragmentation function compared to that in the vacuum can provide additional insight into the underlying mechanism of the jet quenching.

We report the first measurements of the D^0 meson production at mid-rapidity ($|y| < 1$) in isobar collisions (^{96}Ru + ^{96}Ru and ^{96}Zr + ^{96}Zr) at $\sqrt{s_{\mathrm{NN}}} = 200$ GeV, at the STAR experiment at RHIC. We present the transverse momentum dependent invariant yields of the D^0 meson, along with the centrality-dependent nuclear modification factors, and compare them to the published results from Au+Au collisions at $\sqrt{s_{\mathrm{NN}}} = 200$ GeV.

We complement the D^0 meson studies with measurements of D^0 meson tagged jets in Au+Au collisions at $\sqrt{s_{\mathrm{NN}}} = 200$ GeV. We show the transverse momentum dependent invariant yields, the first measurement of the z distribution, and the nuclear modification factors as a function of $\mathrm{p_T}$ and z for D^0 jets. Additionally, we report the radial profile of the D^0 mesons in these tagged jets. These reported measurements can constrain theoretical calculations of parton flavor and mass dependencies of medium modifications across systems of different sizes.