PHENIX measurements of charged hadron and heavy flavor v_2 at forward/backward rapidity in d+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV

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Motivation

Recent measurements at both RHIC and the LHC continue to indicate that particles produced in small collision systems exhibit collective behavior similar to those observed in large collision systems. The PHENIX experiment has measured substantial v_2 and v_3 in $p/d/^3$He+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV [1], as shown in Fig. 1. These measurements indicate that the v_n is strongly coupled to the initial collision geometry and are in good agreement with hydrodynamic calculations which include a QGP phase.

PHENIX has also measured strong rapidity and p_T dependent modification of leptons from heavy flavor decays in d+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV [2, 3]. In order to further investigate the origin of these modifications, as well as the potential for QGP formation even in small collision systems, we present measurements of the $v_2(p_T)$ of muons from open heavy flavor decays at forward (d-going) and backward (Au-going) rapidities in d+Au collisions.

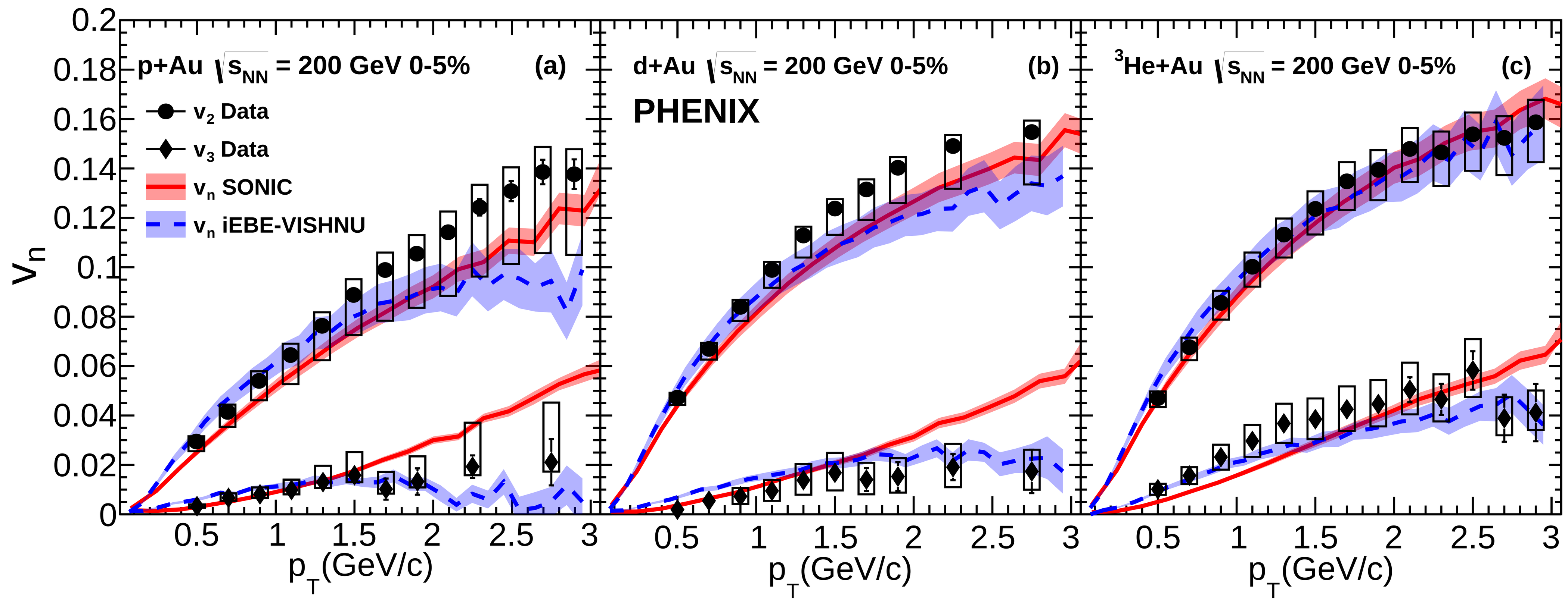

Figure 1: The $v_n(p_T)$ at mid pseudorapidity in 0-5% central p+Au (a), d+Au (b), and ^{3}He+Au (c) collisions at $\sqrt{s_{NN}}$ = 200 GeV. Black circles are v_2, black diamonds are v_3. The red (blue) curves are hydrodynamic predictions of v_n from SONIC [4] (iEBE-VISHNU [5]).

Heavy flavor muon extraction

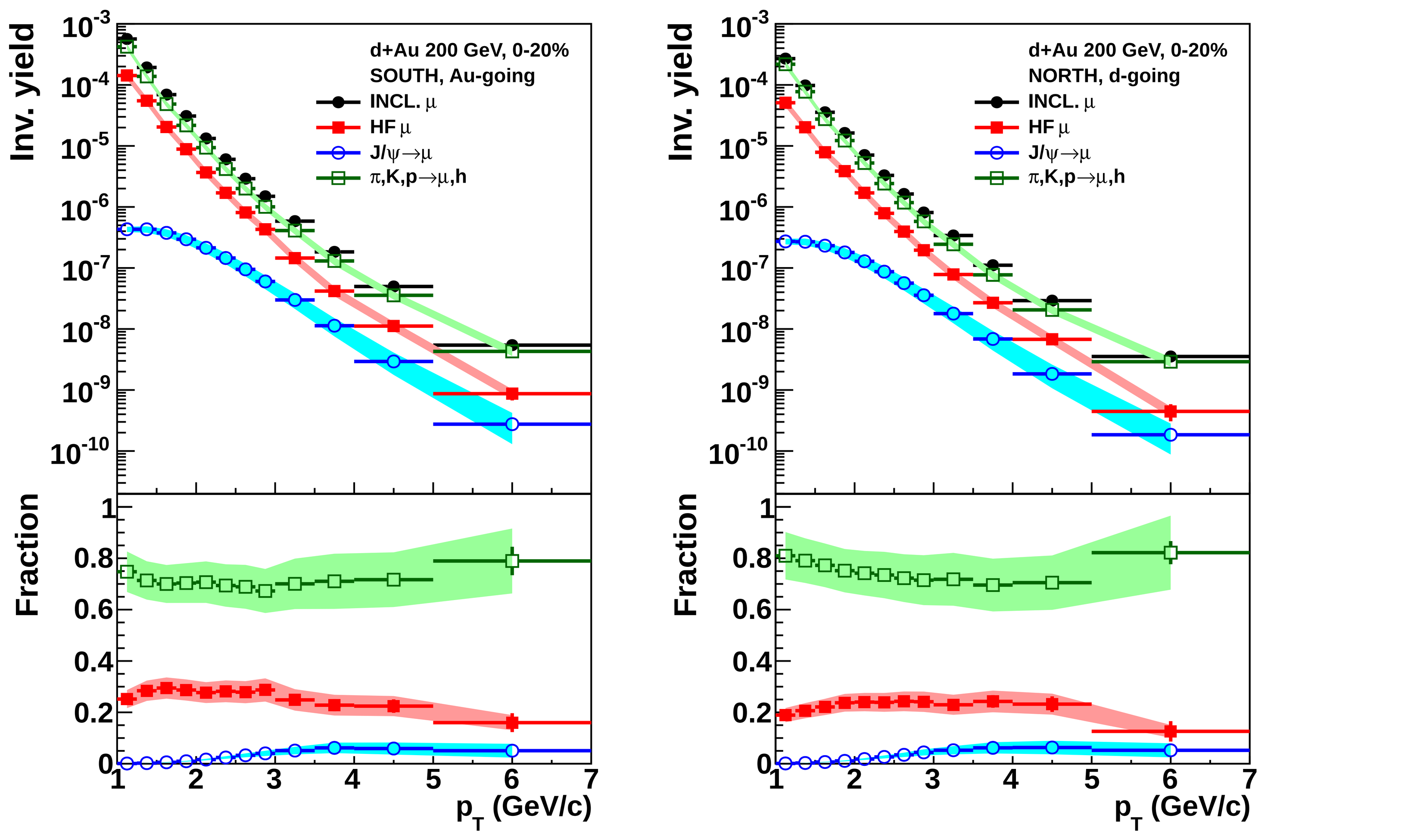

Figure 2: The invariant yield of inclusive muons and various components at backward (Left) and forward (Right) pseudorapidities in 0-20% central d+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV [3].

Inclusive muons are measured in the two PHENIX muon arms covering $-2.2 < \eta < -1.2$ and $1.2 < \eta < 2.2$ respectively. They are identified by tracks which penetrate to the last gap of the muon identifier (MuID), through 19 cm of copper and 60 cm of iron absorbers. The inclusive track sample is dominated by four main sources: 1) muons from decays of light-flavor mesons, 2) hadrons which reach the final MuID gap, referred to as "punch-through hadrons", 3) muons from heavy flavor resonance (J/ψ and Υ) decays, and 4) muons from open heavy flavor decays. We group the contributions from 1) and 2) and show the various contributions to the inclusive track sample in Fig. 2. The fraction of muons from heavy flavor decays is > 20% for $1 < p_T$ [GeV/c] < 3.

Heavy flavor lepton nuclear modification

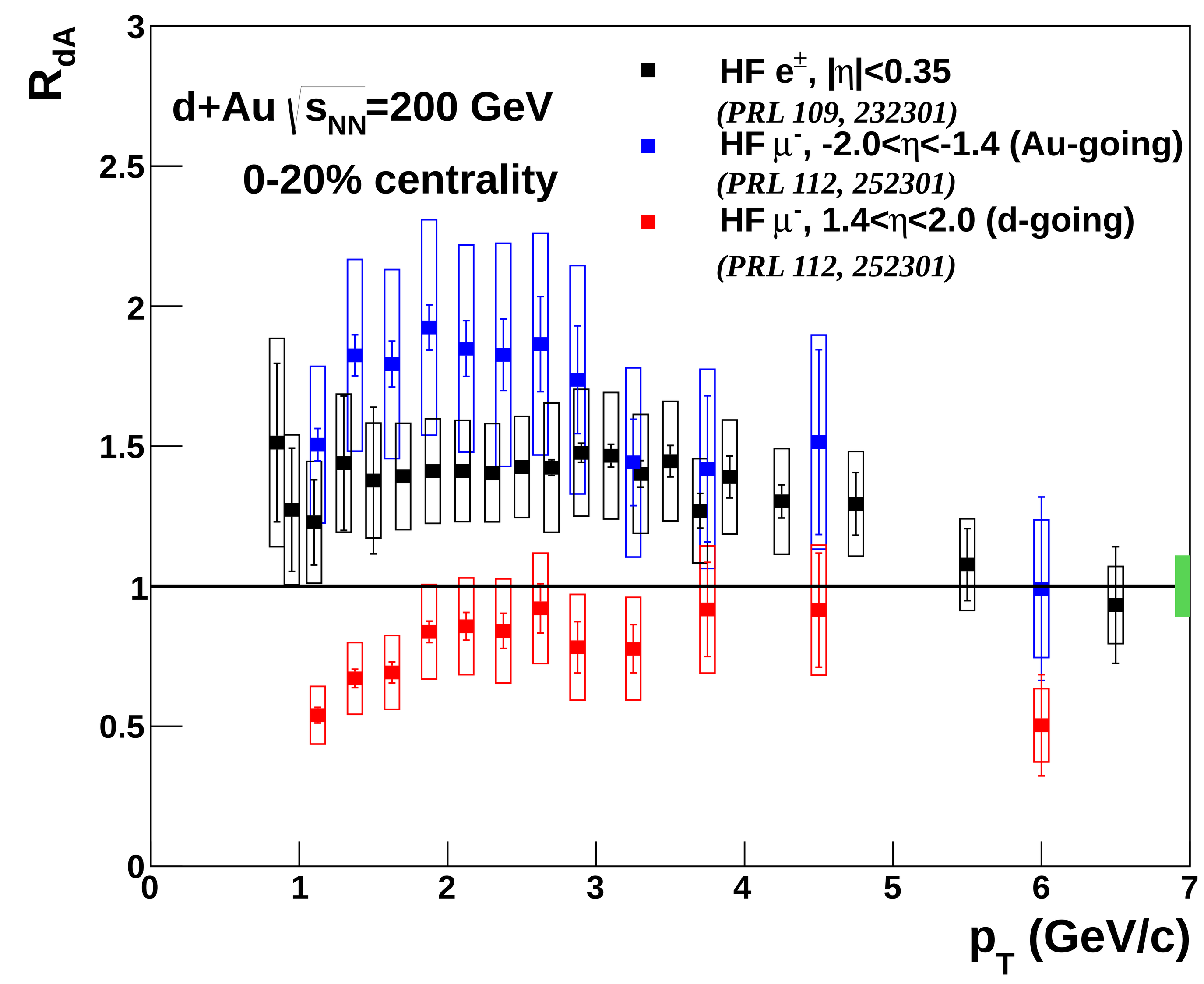

Figure 3: The R_{dA} as a function of p_T for electrons and muons from open heavy flavor decays in 0-20% central d+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV [2, 3].

The nuclear modification factor, R_{dA}, for leptons from heavy flavor decays at backward, mid, and forward rapidities in 0-20% d+Au collisions is shown in Fig. 3. An enhancement is seen at backward and mid rapidities, which has generally been interpreted as arising from nuclear-p_T broadening. At forward rapidity, a suppression of leptons from heavy flavor decays is observed, which has been interpreted as arising from gluon shadowing or parton energy loss.

Heavy flavor muon v_2

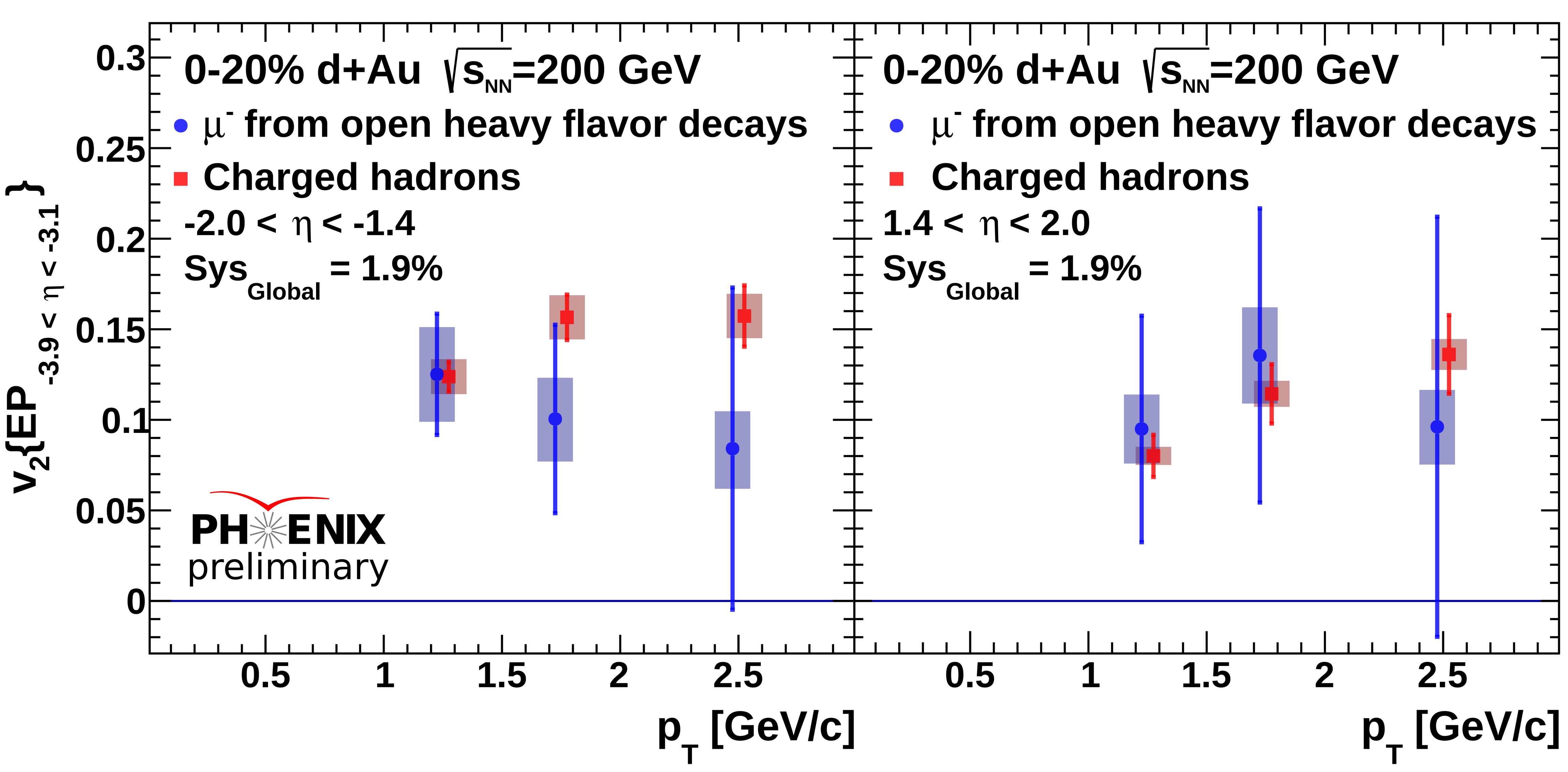

Figure 4: The v_2 of charged hadrons and muons from open heavy flavor decays as a function of p_T at backward (Left) and forward (Right) pseudorapidities in 0-20% central d+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV.

The v_2 of heavy flavor muons is calculated using the inclusive muon track sample (v_2^{incl}), the fraction of heavy flavor muons (F_{HF}) shown in Fig. 2, and the v_2 of charged hadrons (v_2^{chhd}) as

$$v_2^{HF} = \frac{1}{F_{HF}}\left(v_2^{incl} - (1 - F_{HF})v_2^{chhd}\right). \quad (1)$$

The resulting v_2^{HF} is shown in Fig. 4 compared to the v_2^{chhd}.

We observe a heavy flavor muon v_2 which is non-zero and consistent with the v_2 of charged hadrons. While the charged hadrons show a larger v_2 at backward rapidity compared to forward rapidity, it is unclear if the heavy flavor v_2 shows the same trend given the large statistical uncertainties. While the uncertainties on the measurement are large, we calculate a confidence level for $v_2^{HF} > 0$ integrated from $1.0 < p_T$ [GeV/c] < 3.0 of

$$-2.0 < \eta < -1.4 : 99.93\%, \quad (2)$$

$$1.4 < \eta < 2.0 : 98.61\%. \quad (3)$$

References

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Acknowledgments

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