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The measurement of non-photonic electrons in STAR

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The measurements of non-photonic electrons, produced by semileptonic decays of D and B mesons, provide information on heavy quarks production in the hot and dense nuclear matter created in relativistic heavy ion collisions. In this proceedings we present the recent measurements of centrality dependence of non-photonic electron p_T distributions, its nuclear modification factor and elliptic flow v_2 in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV.

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1. Introduction

The properties of strongly interacting Quark-Gluon Plasma can be studied using heavy quarks, such as charm and bottom. Due to their large masses, heavy quarks are produced mainly during initial parton-parton interaction at RHIC, before the QGP phase, and their production rates can be calculable by pQCD. Thus they are good probes to study the QCD matter [1]. They are expected to interact with the medium differently than the light quarks. Hot and cold nuclear matter effects, which affect the heavy quark production in heavy ion collisions, could be quantified with nuclear modification factor (R_{AA}, R_{dA}) where result from $p + p$ collisions serves as a baseline. At RHIC, heavy quarks could be studied by measuring non-photonic electrons (NPE) which are produced from semi-leptonic heavy flavor decays [2] or by study of D mesons production [3]. Measurements of NPE nuclear modification factor, together with the NPE elliptic flow, are necessary to distinguish between different energy loss scenarios. Elliptic flow measurement can be a good proxy to reveal heavy flavor collectivity, which can improve our understanding of the medium thermalization.

2. Analysis

Data reported in this proceedings were collected in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV in the year 2010 with Minimum Bias Trigger and High Tower Triggers, where minimum bias triggered data are used for $p_T < 2$ GeV/c results while High Tower triggered data are used for $p_T > 2$ GeV/c results.

Main detectors used in presented measurements are the Time Projection Chamber (TPC), the main charged particle tracking device in the STAR detector used for particle identification and momentum determination, the Barrel Electromagnetic Calorimeter (BEMC), used for deposited energy measurement and for online trigger, and the Barrel Shower Maximum Detector (BSMD). Hadron contamination at low p_T is minimized using information from Time Of Flight (TOF) detector. At low-p_T, electron candidates are identified via specific ionization energy loss from the TPC combined with ToF information. Electrons at high-p_T are selected using the ratio of track momentum and the energy deposited in the BEMC, the BSMD shower profile, and the distance between TPC track projected position at BEMC and reconstructed BEMC cluster position. The obtained inclusive electron sample includes non-photonic electrons, photonic electrons background, and hadron contamination. Non-photonic electrons yield is calculated as: $N_{NPE} = N_{Inclusive} * \varepsilon_{purity} - N_{PHE}/\varepsilon_{photonic}$, where N_{NPE} is non-photonic electrons yield, $N_{Inclusive}$ represents all electron candidates yield, ε_{purity} is a purity of inclusive electron sample, N_{PHE} is yield of reconstructed photonic electron background, which mainly originates from photon conversion in the detector material and from Dalitz decay of π^0 and η mesons, and $\varepsilon_{photonic}$ is photonic electron reconstruction efficiency. This efficiency is determined by embedding simulated gammas and π^0 into real data. Finally, NPE yield is corrected by reconstruction and electron identification efficiency.

3. Results

The recent results of non-photonic electron measurements in Au+Au collisions at $\sqrt{s_{NN}}$=200 GeV from the year 2010 are shown in Fig. 1 and 2. Figure 1 shows NPE invariant yield in five

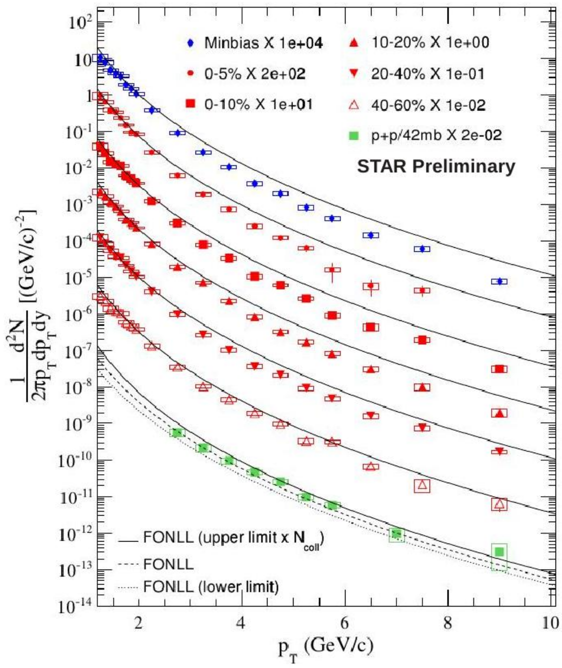

Figure 1: Non-photonic electrons p_T spectra in Au+Au collisions at $\sqrt{s_{NN}}$=200 GeV. Spectrum is divided into 5 centrality bins which are plotted separately. Solid lines represent FONLL calculations scaled by number of binary collisions [4]. Green color represents result from p+p collisions at $\sqrt{s_{NN}}$=200 GeV.

centrality bins compared with Fixed Order plus Next-to-Leading Logarithms (FONLL) calculation scaled by number of binary collisions which correspond to the given centrality bin. In central and semicentral collisions we observed the suppresion of NPE compared to the FONLL calculation [4]. The invariant yield of combined non-photonic electron production in p+p collisions from the year 2005 and year 2008 is shown as well and this result could be very good described by FONLL calculation [2].

The nuclear modification factor (R_{AA}) for 0-10% most central collisions is plot in Fig. 2. Results are compared to a several theoretical models of energy loss mechanism [5]-[9]. It is seen that gluon radiation scenario alone [5] (dashed green line) fails to explain large NPE suppression which is observed at high p_T. When the collisional energy is added to the the gluon radiative scenario (green line), the model describes data better. The collisional dissociation model [8] (red line) and the AdS/CFT calculation [9] (blue line) describe data also well. The baseline for nuclear modification factor calculation is produced from a combination of non-photonic electrons spectra measured in the years 2005 and 2008 [2].

Measurements of NPE v_2 in Au+Au collisions at $\sqrt{s_{NN}}$=200 GeV is shown in Fig. 3. These results are obtained using 2-particle ($v_2 2$) and 4-particle ($v_2 4$) correlations. These results are compared with theoretical models [10] [11]. Finite v_2 at low p_T indicates strong charm-medium interaction. At high p_T we observe increase of v_2 which can arise from non-flow effects such as jet-like correlations or from path length dependence of heavy quark energy loss.

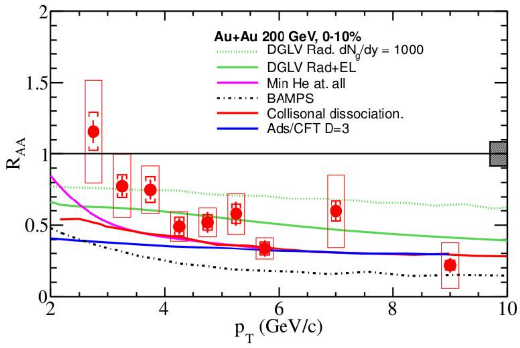

Figure 2: Nuclear modification factor for 0-10% most central collisions in Au+Au at $\sqrt{s_{NN}}$=200 GeV. The results are compared to theoretical models [5]-[9].

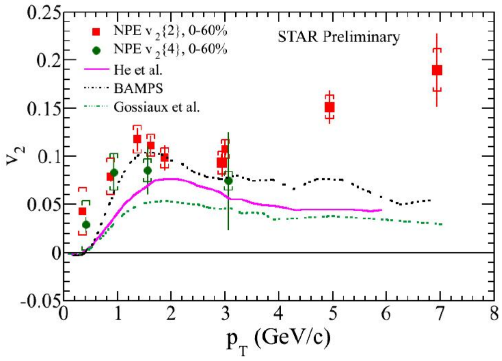

Figure 3: NPE elliptic flow v_2 in Au+Au collisions at $\sqrt{s_{NN}}$=200 GeV.

4. Summary

In this proceedings, results of non-photonic electrons measurements in Au+Au collisions at $\sqrt{s_{NN}}$=200 GeV from STAR are presented. The preliminary results show large suppression of NPE production in central Au+Au collisions. This suppression cannnot be explained by gluon radiation scenario alone. Large NPE v_2 is observed at low p_T which indicates a strong charm-medium interaction.

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References

[1] A. D. Frawley, T. Ullrich, and R. Vogt, Phys. Rept. 462, 125 (2008).

[2] H. Agakishiev et al. [STAR Collaboration], Phys. Rev. D83, 052006,(2011).

[3] L. Adamczyk et al. [STAR Collaboration], arXiv: 1204.4244 (2011).

[4] M. Cacciari, P. Nason and R. Vogt, Phys. Rev. Lett. 95, 122001 (2005).

[5] M. Djordjevic, M. Gyulassy, R. Vogt, and S. Wicks, Phys. Lett. B 632, 81 (2006).

[6] A. Buzzatti, M. Gyulassi, arXiv:1207.6020.

[7] H. Van Hees, M. Mannarelli, V. Greco, and R. Rapp, Phys. Rev. Lett. 100, 192301 (2008).

[8] R. Sharma, I. Vitev, B. Zhang, Phys. Rev. C 80, 054902 (2009).

[9] W. A. Horowitz, J.Phys. G35 044025 (2008).

[10] M. He, R. J. Fries, and R. Rapp, Phys.Rev. C86 014903 (2012).

[11] Gossiaux, J. Aichelin, T. Gousset, and V. Guiho, J.Phys. G37 094019 (2010).