Particle Composition at High p_T in Au+Au Collisions at $\sqrt{s_{NN}}$ = 200 GeV

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Abstract. We report the recent results of proton and anti-proton yields as a function of centrality and p_T in Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV, measured by the PHENIX experiment at RHIC. In central collisions at intermediate transverse momenta ($1.5 < p_T < 4.5$ GeV/c) a significant fraction of all produced particles is protons and anti-protons. They show a different scaling behavior from that of pions. The $\overline{p}/\pi$ and p/π ratios are enhanced compared to peripheral Au+Au, p+p and e^+e^- collisions. This enhancement is limited to $p_T < 5$ GeV/c as deduced from the ratio of charged hadrons to π^0 measured in the range $1.5 < p_T < 9$ GeV/c.

Heavy-ion collisions at RHIC energies allow us to study the properties of nuclear matter at extreme energy densities. High p_T hadrons production originating in the fragmentation of partons with a large momentum transfer (hard processes) are sensitive probes of the hottest and densest stage of the collision. One of the most significant results from the first year of RHIC run was the suppression of yields both for charged and π^0 at high p_T in central Au+Au with respect to the number of nucleon-nucleon collisions (N_{coll}) [1, 2]. Moreover, it was found that π^0 yields are more strongly suppressed than for charged hadrons [1], and the yields of p and $\overline{p}$ near 2 GeV/c in central collisions are comparable to the yield of pions [3]. These observations suggest that a significant fraction of all particle yields is p and $\overline{p}$ at the intermediate p_T in central Au+Au collisions. We present here the results of p and $\overline{p}$ yields including their scaling properties and ratios of p/π, $\overline{p}/\pi$ as a function of centrality in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV measured by the PHENIX experiment [4]. The detailed analysis methods and results are found in references [5, 6] for identified charged hadrons, in reference [7] for π^0, and in reference [8] for inclusive charged hadrons.

Figure 1 shows the p/π and $\overline{p}/\pi$ ratios as a function of p_T measured at mid-rapidity in central (0–10%), mid-central (20–30%), and peripheral (60–92%) Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV. For all centralities the ratios rise steeply at low p_T and then, at a value of p_T which increases from peripheral to central collisions, level off. In central collisions the ratios are a factor of ~ 3 larger than in peripheral events. At $p_T > 2$ GeV/c the peripheral Au+Au data agree well with the ratios observed in $p+p$ collisions at lower energies [9]. Above 3 GeV/c the p/π, $\overline{p}/\pi$ ratios in peripheral collisions are also consistent with gluon and quark jet fragmentation [10]. Deviations from jet fragmentation below 3 GeV/c indicate the absence of soft hadron production in the e^+e^- data. In Figure 2, we compare the N_{coll} scaled central to peripheral yield ratios, $R_{\rm CP}$, for $(p+\overline{p})/2$ and π^0. In the p_T range from 1.5 to 4.5 GeV/c, p and $\overline{p}$ are not suppressed in

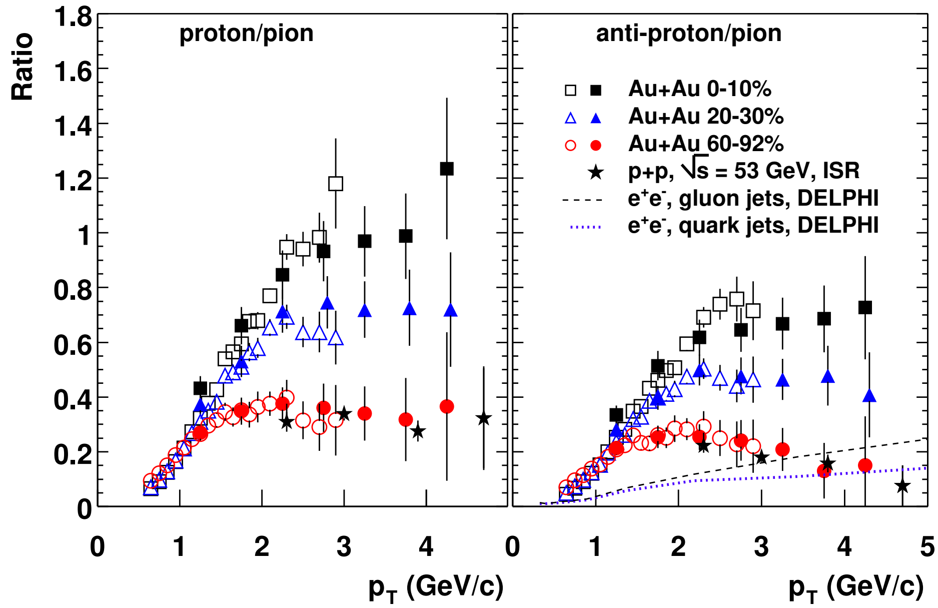

FIGURE 1. p/π (left) and $\overline{p}/\pi$ ratios for central(0-10%), mid-central(20-30%) and peripheral (60-92%) Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV [5, 6]. Open (filled) points are for charged (neutral) pions, respectively. Data from $\sqrt{s} = 53$ GeV $p+p$ collisions [9] are shown with stars. The dashed and dotted lines are $(\overline{p}+p)/(\pi^+ + \pi^-)$ ratio in gluon and in quark jets [10].

contrast to π^0 which are largely suppressed by a factor of 2-3. Moreover, this behavior holds for all centralities (see references [5, 6]), while the suppression in the π^0 yields increases from peripheral to central collisions [7].

It is interesting why the suppression for p and $\overline{p}$ is absent in central Au+Au collisions. Recently the observed abundance of protons yields relative to pions in central collisions has been attributed to the recombination of quarks, rather than fragmentation [11]. In this model, recombination for p and $\overline{p}$ is effective up to $p_T \simeq 5$ GeV above which fragmentation dominates for all particle species. Another explanation of the observed large baryon content invokes a topological gluon configuration: the baryon junction [12]. A centrality dependence, which is in qualitative agreement with the results presented here, has been predicted [13]. In both theoretical models, the baryon/meson enhancement is limited to $p_T < 5$–6 GeV/c. In order to test these theoretical predictions, we measure charged hadrons to π^0 measured in $1.5 < p_T < 9$ GeV/c (see references [5, 8]). It is found that in central collisions for $1 < p_T < 4.5$ GeV/c, h/π^0 ratio is enhanced by as much as 50% above the $p+p$ value. Above $p_T \simeq 5$ GeV/c, the particle composition is consistent with that measured in $p+p$ collisions. This indicates that the scaling of the proton yields should become consistent with that of pions at $p_T > 5$ GeV/c. Similar limiting behavior of baryon/meson enhancement is observed in Λ and K_S^0 by the STAR collaboration [14]. It is possible that nuclear effects such as the "Cronin effect" [15] contribute to the observed large (anti)proton/pion ratios. The recent results of inclusive charged hadrons and π^0 in d+Au at $\sqrt{s_{NN}} = 200$ GeV suggest that the Cronin effect in baryons is different from that in mesons [16]. Detailed studies of particle composition in d+Au collisions will help our understanding of the baryon production at the intermediate p_T region at

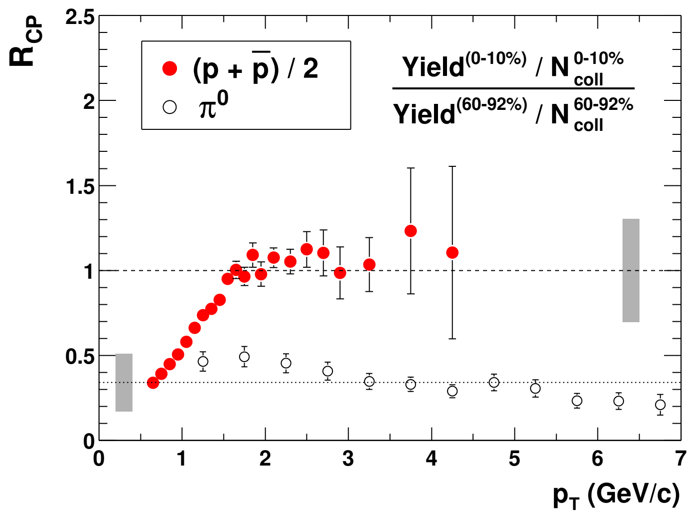

FIGURE 2. Nuclear modification factor R_{CP} for $(p+\overline{p})/2$ (filled circles) and π^0 [5, 6]. Dashed and dotted lines indicate N_{coll} and N_{part} (number of participant nucleons) scaling; the shaded bars show the systematic errors on these quantities.

RHIC.

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