IDENTIFIED PARTICLE CORRELATIONS AT RHIC: MEDIUM INTERACTIONS AND MODIFIED FRAGMENTATION*

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Azimuthal angle two particle correlations have been shown to be a powerful probe for extracting novel features of jet induced correlations produced in Au+Au collisions at RHIC. At intermediate $p_{\rm T}$, 2–5GeV/c, the jets have been shown to be significantly modified in both their particle composition and their angular distribution compared to p+p collisions. Two-particle angular correlations with identified particles provide sensitive probes of both the interactions between hard scattered partons and the medium. The systematics of these correlations are essential to understanding the physics of intermediate $p_{\rm T}$ in heavy ion collisions.

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In p+p collisions at $\sqrt{s} = 200$ GeV a hard scattering picture has been found to well describe single particle spectra of both pions [1, 2] and p and $\bar{p}$ at $p_{\rm T}$ as low as 2 GeV/c. In heavy ion collisions at the same energy, it is known from direct photon data [3] that the initial hard parton–parton collisions scale as expected from p+p by the number of binary nucleon–nucleon collisions. There is also evidence that the soft physics region extends higher in $p_{\rm T}$. The baryon to meson ratios are increased by ≈ 3 in central Au+Au collisions compared to p+p collisions for $2 < p_{\rm T} < 5$ GeV/c [4] and a quark number scaling of v_2 has been found to extend to $\approx$ 4–6 GeV/c [5].

Because of this overlap, intermediate $p_{\rm T}$ is well suited to studying the interaction between the calibrated hard probes and the strongly interacting medium. Jet-induced two particle correlations have been used extensively to probe this physics, and have led to many unexpected results at RHIC such as jet-like structure of the intermediate $p_{\rm T}$ baryon excess [6] and the away

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side jet shape has a peak displaced from azimuthal angular difference, $\Delta\phi$, of π [7]. We present results which exploit the high statistics and particle identification capabilities of RHIC detectors.

Due to the large energy loss, at high $p_{\rm T}$ the hard scattered partons are expected to emerge from near the surface of the interaction region and fragment in vacuum [8]. Fig. 1 (left) [9] shows near side, small $\Delta\phi$, I_{AA} for trigger π^0 and lower $p_{\rm T}$ associated hadrons as a function of the number of participating nucleons, $N_{\rm part}$. I_{AA} is the yield of associated hadrons per trigger in Cu+Cu collisions divided by that in p+p collisions. In the absence of nuclear effects I_{AA} will be 1. The near side I_{AA} is consistent with 1 within systematics at all centralities. A more differential look at the fragmentation differences between Cu+Cu and p+p can be obtained by looking at the yield as a function of $p_{\rm out} = p_{\rm T,assoc}\sin(\Delta\phi)$, Fig. 1 (right) [10]. Though I_{AA}, dominated by small $p_{\rm out}$, shows no significant nuclear effects, the $p_{\rm out}$ distributions are much harder for Cu+Cu collisions. These two plots show the need for sensitive observables to measure subtle changes to jet fragmentation.

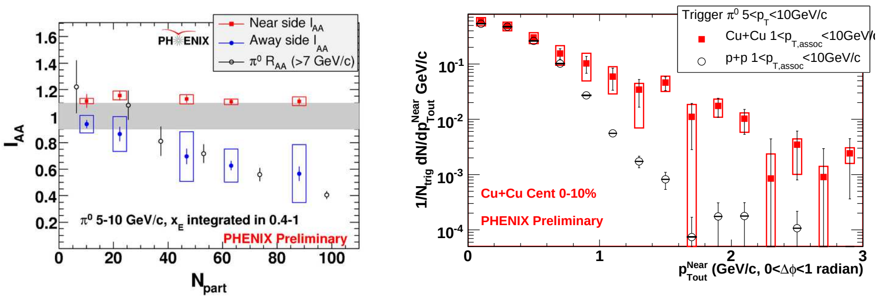

Fig. 1. Left: I_{AA} as a function of $N_{\rm part}$ for π^0-hadron correlations in Cu+Cu collisions. Right: $p_{\rm out}$ distribution for central Cu+Cu and p+p π^0-hadron correlations. In both panels trigger π^0 are $5 < p_{\rm T} < 10\,{\rm GeV}/c$.

At lower $p_{\rm T}$ where there are known modifications to particle production via vacuum fragmentation [6, 11, 12], conditional yield measurements as a function of $N_{\rm part}$ can be used along with single particle spectra measurements to constrain the modifications. Fig. 2 (left) shows correlations between two p or $\bar{p}$ [13]. In the case of minimal nuclear effects, $N_{\rm part} = 15$, the conditional yield for opposite sign pairs is independent of whether the trigger is a p or $\bar{p}$ and the conditional yield for same sign pairs is consistent with zero. Both features remain at all centralities, however, the yield of opposite sign pairs increases slightly from peripheral collisions.

It was thought the expected high rate of gluon conversion to $s\bar{s}$ in heavy ion collisions would enhance soft $s\bar{s}$ pairs suppressing jet-like correlations with increasing hadronic strangeness content [14]. Fig. 2 (right) [15] shows no significant difference between the jet-like correlations triggered by Λ, Ξ or Ω. Comparisons to p+p collisions are needed to quantify differences as a function of strangeness in a purely fragmentation system.

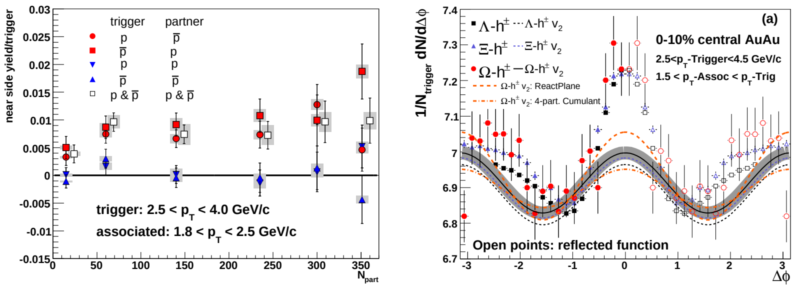

Fig. 2. Left: Near side correlations between two p and $\bar{p}$ as a function of N_{part}. Right: Azimuthal correlations between strange hadron triggers and hadrons. No v_2 subtraction has been done.

Perhaps the most unexpected intermediate p_{T} result is the modified away side shape observed in hadron–hadron, hadron–meson and hadron–baryon azimuthal correlations [12, 16, 17]. Models which include a strong medium response to the recoiling parton, including Mach cones, have been successful in describing the away side shape [7]. Because of the near side surface bias, the away side might be biased toward longer than average medium path lengths, and thus more sensitive to medium effects. Fig. 3 shows the near (left) and away (right) side associated baryon to meson ratios as a function of the associated particle p_{T} for three centralities. Both sides show increasing baryon to meson ratios with centrality, however the increase is much stronger on the away side. The dashed line in Fig. 3 (right) shows the inclusive baryon to meson ratio for 0–20% centrality and p_{T} of 1.85 GeV/c. The

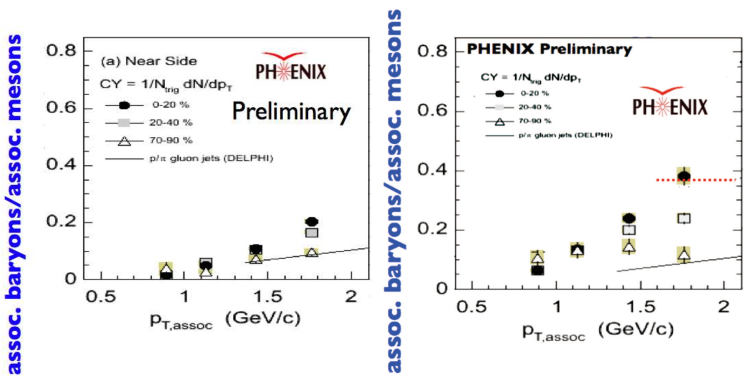

Fig. 3. Associated particle baryon to meson ratios as a function of p_{T}i for near (left) and away (right) side. Trigger particles are hadrons, 2.5< p_{T} <4.0GeV/c.

agreement between the jet associated baryon to meson ratio and the inclusive ratio could indicate that baryons in both cases are enhanced by a common mechanism.

We have presented some recent results of identified particle jet correlations from RHIC. At intermediate $p_{\rm T}$, observations from two particle correlations show features characteristic of both hard and soft physics. Correlations between high $p_{\rm T}$ π^0 and lower $p_{\rm T}$ hadrons are observed to be modified in Cu+Cu collisions from p+p collisions. At intermediate $p_{\rm T}$, correlations between two p and $\bar{p}$ retain the same charge ordering at all centrality, indicating correlated p and $\bar{p}$ production. In central collisions the yield of hadrons associated with strange baryons is independent of the strangeness content. These results suggest that, at least some of, the baryon excess is connected to jet fragmentation in central Au+Au collisions being modified compared to vacuum fragmentation. These observations, along with the quark number scaling observed in elliptic flow measurements in the same $p_{\rm T}$ range could indicate that particle production at intermediate $p_{\rm T}$ is a novel interplay of hard and soft physics. A full understanding of this phenomenology will require models which are able to simultaneously explain single particle yields, elliptic flow and jet correlations.

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