Toward understanding relativistic heavy-ion collisions with the STAR detector using photon-jet correlations

A. Hamed, S. Mioduszewski, and the STAR Collaboration

The γ-jet analysis was suggested as a means to study energy loss in a dense medium [1] because the photon trigger energy is known (since it escapes the medium with negligible interaction). The photon does not interact via the strong force, so it essentially escapes the medium unmodified; while the jet produced from the parton scattered into the opposite direction of the photon exhibits the effects of the dense medium. The analysis is performed through a correlation measurement, where the hadrons correlated to a direct photon trigger are studied in p+p collisions (no medium) and central Au+Au collisions (dense medium).

We have finalized this analysis from the Run-7 Au+Au and Run-8 p+p data and documented the results in a paper [2] for the STAR Collaboration. We submitted the manuscript of these results for publication in December of 2009, and recently resubmitted it with modifications to address comments by the referees. Two of the main plots from the paper are shown in Figs. 1 and 2. Figure 1 shows the yields

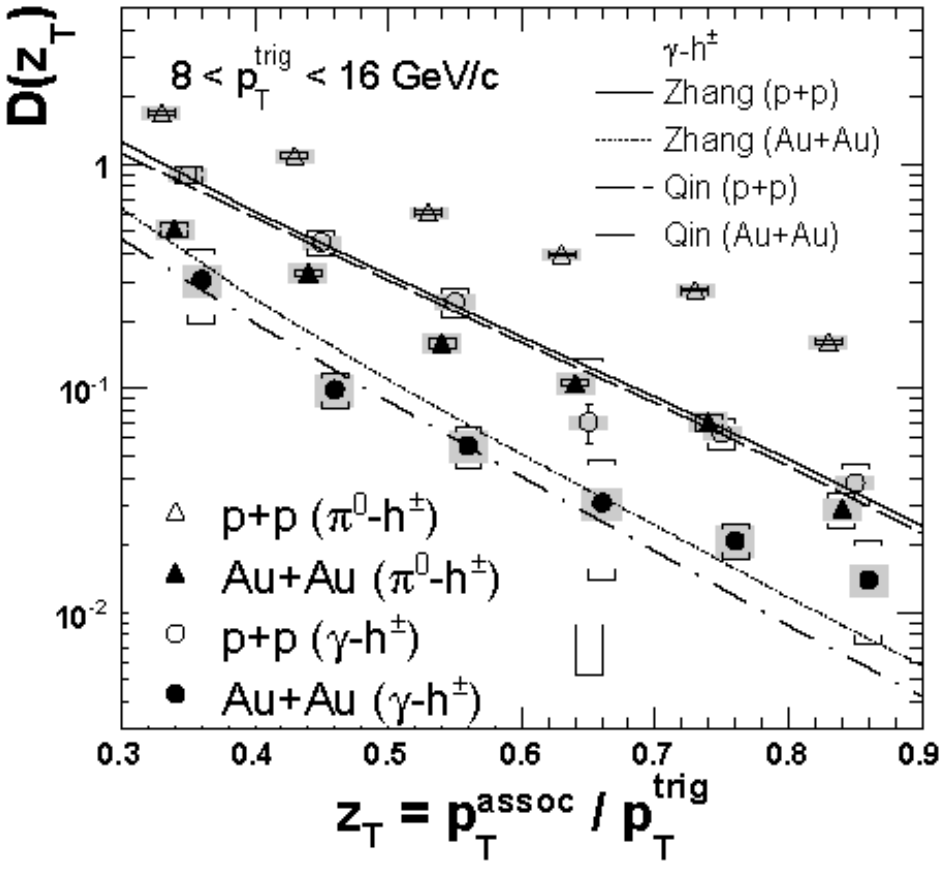

FIG. 1. Associated yields of hadrons correlated with a high-p_T direct γ (circles) or π^0 (triangles) trigger, as a function of z_T ($=p_T^{assoc}/p_T^{trig}$) for 0-10% central Au+Au collisions and p+p collisions.

associated with hadron (π^0) triggers compared to the yields associated with direct photon triggers for both p+p collisions and central Au+Au collisions, as a function of $z_T = p_T^{assoc}/p_T^{trig}$. Also shown are comparisons to theoretical calculations [3, 4]. The difference in yields for π^0 vs. direct-γ triggers is expected, even in p+p collisions, because hadrons originate from a fragmentation process and thus from a higher energy parton than the energy of the direct photon (which does not originate from fragmentation). The effect of the medium is seen by taking the ratio of yields in central Au+Au collisions to those in p+p collisions (Fig. 2). The surprising result is that the effect of the medium on hadron (π^0)-triggered yields is very similar to the effect on direct photon-triggered yields. Since direct photons are not expected to be

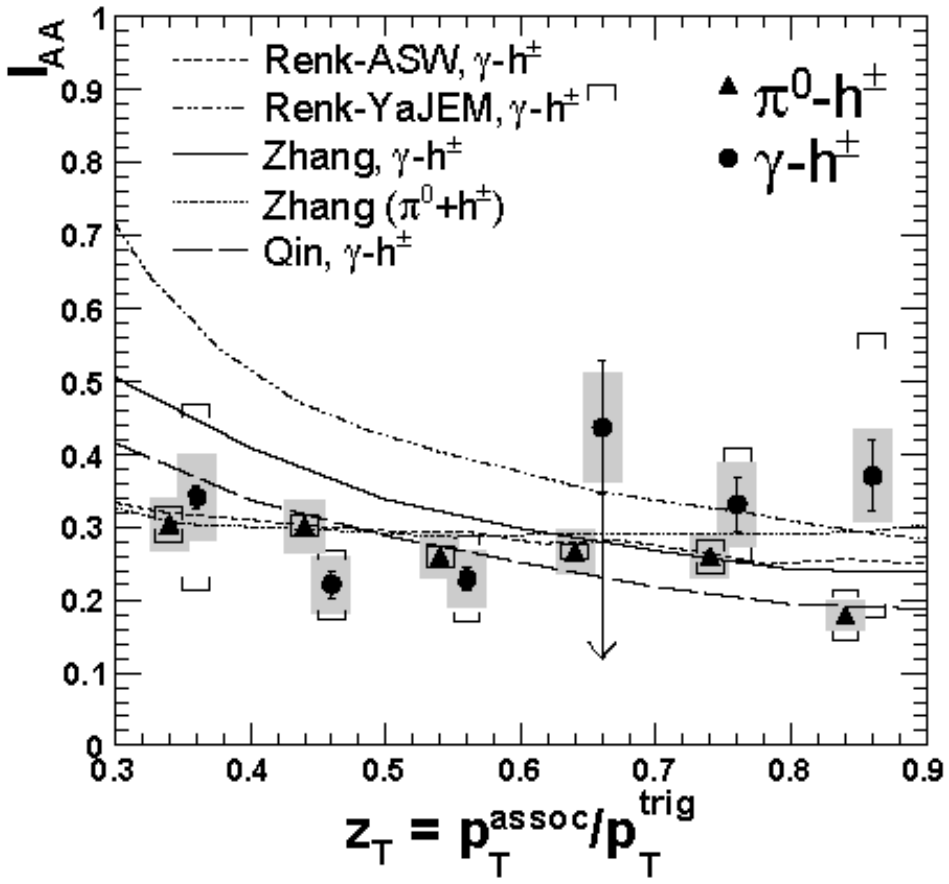

FIG. 2. Ratio of yields measured in central Au+Au to those measured in p+p collisions for direct photon triggers (circles) and π^0 triggers (triangles).

affected by the medium, direct photon triggers can originate from anywhere in the medium, while hadron triggers are biased to originate from the surface. This leads to a larger path length to traverse by the parton opposite to the hadron trigger than for the parton opposite to the direct photon trigger. Some of the model calculations [3-5] shown in Fig. 2 do predict this lack of dependence of the medium effect on the trigger species. In one calculation (Renk-ASW [5]), the explanation is that the fluctuations in energy loss dominate over any effect of geometry. Some of the models predict increased sensitivity to the

trigger species at lower z_T. With the increased statistics of the Run-10 Au+Au data (currently being written to tape), we will be able to extend the trigger p_T to higher values and thus lower the z_T. This will be one focus of future efforts on this topic.

[1] X.-N. Wang, Z. Huang, and I. Sarcevic, Phys. Rev. Lett. **77**, 231 (1996).
[2] B.I. Abelev *et al.* (STAR Collaboration), arXiv:0912.1871 [nucl-ex].
[3] H. Zhang *et al.*, Nucl. Phys. **A830**, 443c (2009).
[4] G.-Y. Qin *et al.*, Phys. Rev. C **80**, 054909 (2009).
[5] T. Renk, Phys. Rev. C **80**, 014901 (2009).