PROCEEDINGS OF SCIENCE

Measurement of inclusive jet production in Au+Au collisions at $\sqrt{s_{\mathrm{NN}}}$ = 200 GeV by the STAR experiment

Robert Licenik (for the STAR Collaboration)[a,*]

[a] *Nuclear Physics Institute, Czech Academy of Sciences, 250 68, Rez, Czech Republic*

E-mail: licenik@ujf.cas.cz

The STAR Collaboration reports the measurement of inclusive jet production in central (0-10%) and peripheral (60-80%) Au+Au collisions at $\sqrt{s_{\mathrm{NN}}}$ = 200 GeV, using both charged-particle and fully-reconstructed jets. Jet reconstruction is carried out using the anti-k_{T} algorithm with resolution parameters R = 0.2, 0.3 and 0.4. Yield suppression of charged-particle jets is observed for central Au+Au collisions relative to both peripheral Au+Au collisions and a vacuum baseline utilizing PYTHIA 6 simulations. The magnitude of the suppression is similar to that measured at the LHC and can be described by theoretical calculations. No evidence of significant medium-induced jet broadening is observed, based on comparison of jet spectra at varying R. The yield suppression, when expressed as the jet transverse momentum shift corresponding to energy loss, is consistent in magnitude with coincidence measurements at RHIC based on direct-photon and hadron triggers. There is an indication of larger energy loss observed at the LHC.

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The Quark-Gluon Plasma (QGP) created in high-energy heavy-ion collisions is opaque to jets (jet quenching) [1], a phenomenon that was first observed at RHIC via suppression of high transverse momentum (p_{T}) hadron yields and correlations [2]. Such measurements only provide limited insight into jet quenching mechanisms and dynamics, and more detailed measurements with reconstructed jets are required. While charged-particle and fully-reconstructed inclusive jet productions have been extensively studied in Pb+Pb collisions at the LHC ([3–5]), these proceedings focus on inclusive jet production in heavy-ion collisions at RHIC. We discuss recently reported measurements of charged-particle jets in Au+Au collisions by the STAR Collaboration [6], together with a new analysis to measure fully-reconstructed jets which is expected to have greater kinematic reach and improved systematic precision. The analysis uses data from the STAR detector [7], a large-acceptance system utilizing a solenoidal magnetic field, a Time Projection Chamber (TPC) [8] for charged-particle tracking and momentum reconstruction, and the Barrel Electromagnetic Calorimeter (BEMC) [9], which measures energy deposited by neutral particles and provides online triggers. STAR offers a full azimuthal coverage within pseudorapidity acceptance $|\eta| < 1$. The charged-jet analysis utilizes a dataset for Au+Au collisions at $\sqrt{s_{\mathrm{NN}}}$ = 200 GeV with L_{int} = 70 μb^{-1}, recorded in 2011 with a Minimum-Bias trigger. The fully-reconstructed jet analysis uses Au+Au collisions at $\sqrt{s_{\mathrm{NN}}}$ = 200 GeV recorded in 2014 using a High-Tower trigger, which requires at least ~ 4 GeV in one BEMC tower.

Details of the charged-particle jet analysis, based on charged-particle tracks measured in the TPC, are found in [6]. The fully-reconstructed jet analysis also utilizes BEMC clusters (3x3 adjacent towers), corrected for hadronic energy deposition. The cluster transverse energy is limited to $0.2 < E_{\mathrm{T}} < 30.0$ GeV. The combinatorial background in both analyses is removed by imposing a cut on the leading hadron transverse momentum $p_{\mathrm{T,lead}}$. However, this cut also biases the fragmentation of the surviving jet population. This bias is measured by varying the $p_{\mathrm{T,lead}}$ cut and results are presented for the unbiased region.

Figure 1 shows charged-particle (left) and fully-reconstructed (right) jet distributions as a function of $p_{\mathrm{T,jet}}^{\mathrm{reco}}$ ($= p_{\mathrm{T,jet}}^{\mathrm{raw}} - \rho \cdot A$, where A is the jet area and ρ is the median background energy density, calculated event-wise) for $R = 0.4$ and various values of the $p_{\mathrm{T,lead}}$ cut in central Au+Au collisions at $\sqrt{s_{\mathrm{NN}}}$ = 200 GeV. It can be seen that the $p_{\mathrm{T,lead}}$ cut significantly suppresses the combinatorial background, especially at low $p_{\mathrm{T,jet}}^{\mathrm{reco}}$. The distributions from the fully-reconstructed-jet analysis also indicate its extended kinematic reach, but corrected results are a work in progress. In the following we only show corrected results from the charged-particle jet analysis. Corrections are applied for the smearing effects of combinatorial background and instrumental effects using the SVD and Bayesian unfolding methods (details in [6]).

Figure 2 shows charged-particle jet R_{CP}, the scaled ratio of yields in central to peripheral collisions, which exhibits a similar level of suppression to charged hadrons at RHIC [10] and LHC energies [11] and to charged-particle jets at the LHC at higher $p_{\mathrm{T,jet}}$ [3], with weak $p_{\mathrm{T,jet}}^{\mathrm{ch}}$ dependence. Figure 3 shows charged-particle jet $R_{\mathrm{AA}}^{\mathrm{PYTHIA}}$, the yield suppression for central Au+Au collisions compared to pp baseline calculated by PYTHIA 6 (Perugia 2012, further tuned by STAR [12]). Calculations based on jet quenching models [13–16], shown in the various colored lines and shaded regions, are consistent with the measured value of $R_{\mathrm{AA}}^{\mathrm{PYTHIA}}$.

Figure 4 shows the transverse momentum shift $-\Delta p_{\mathrm{T,jet}}$, corresponding to yield suppression

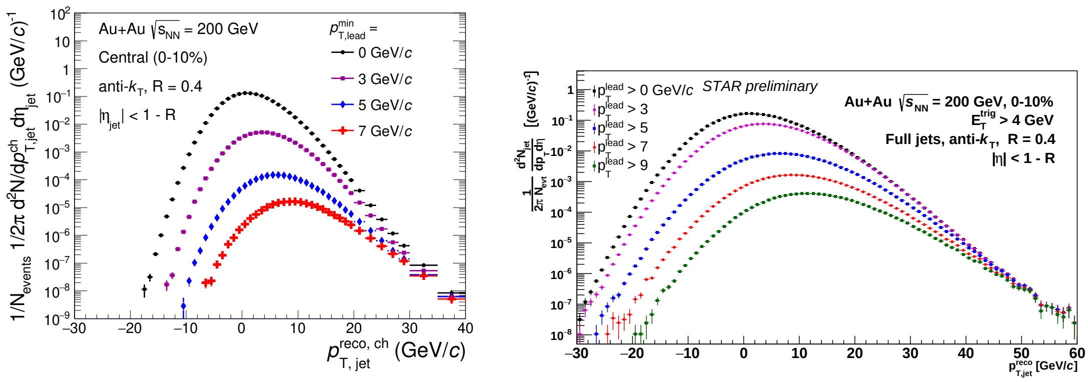

Figure 1: Uncorrected distribution of charged-particle [6] (left) and fully-reconstructed (right) jets as a function of $p_{\mathrm{T,jet}}^{\mathrm{reco}}$ in 0-10% Au+Au collisions at $\sqrt{s_{\mathrm{NN}}}$ = 200 GeV. Different colors represent different values of the $p_{\mathrm{T,lead}}$ cut.

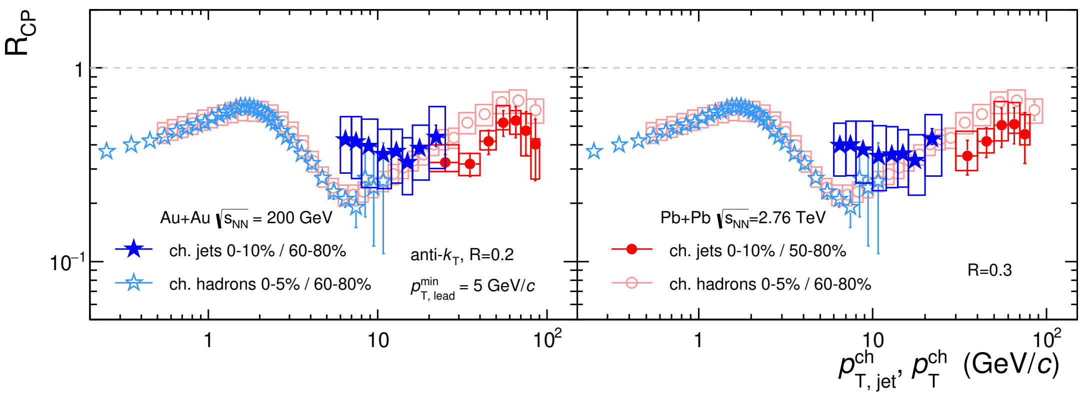

Figure 2: R_{CP} of charged-particle jets reconstructed with R = 0.2 and 0.3 and $p_{\mathrm{T,lead}}$ > 5 GeV/c (solid stars) [6]. Also shown are similar suppression measurements with jets at the LHC [3] and inclusive charged hadrons at RHIC [10] and the LHC [11].

[17], from neutral trigger+jet coincidence measurements at RHIC (red and blue points), inclusive jet measurement (green, this analysis) and charged hadron+jet coincidence measurements at RHIC and the LHC (black points). Results are consistent between channels at RHIC, and indicate smaller jet energy loss at RHIC than at the LHC (though the *relative* shift appears larger at RHIC).

The ratio of inclusive jet cross-sections at different R and fixed $p_{\mathrm{T,jet}}$ measures the jet transverse energy profile. We do not observe any modification of transverse jet profile compared to *pp* collision reference in peripheral or central collisions [6]. Dispersion of the model predictions is larger in this observable than in the $R_{\mathrm{AA}}^{\mathrm{PYTHIA}}$, which implies strong physical motivation to improve systematic uncertainties and study fully-reconstructed jets.

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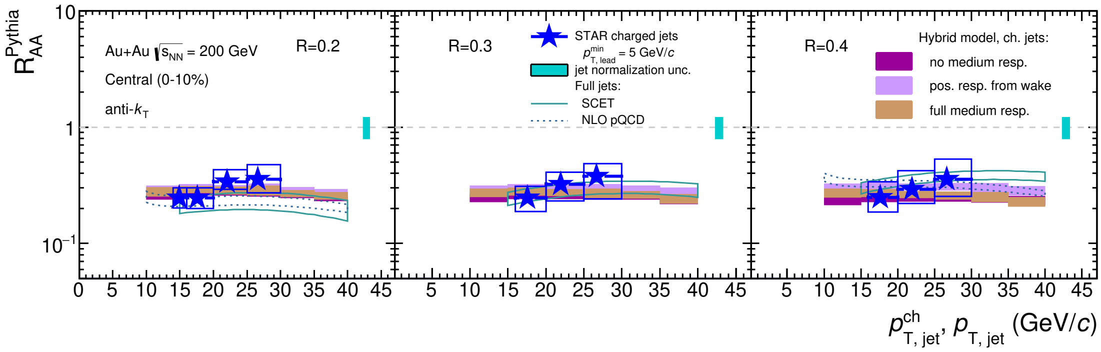

Figure 3: $R_{\mathrm{AA}}^{\mathrm{PYTHIA}}$ as a function $p_{\mathrm{T,jet}}^{\mathrm{ch}}$ of charged-particle jets at STAR reconstructed with R = 0.2, 0.3 and 0.4, and $p_{\mathrm{T,lead}}$ > 5 GeV/c [6]. Bands represent theory predictions.

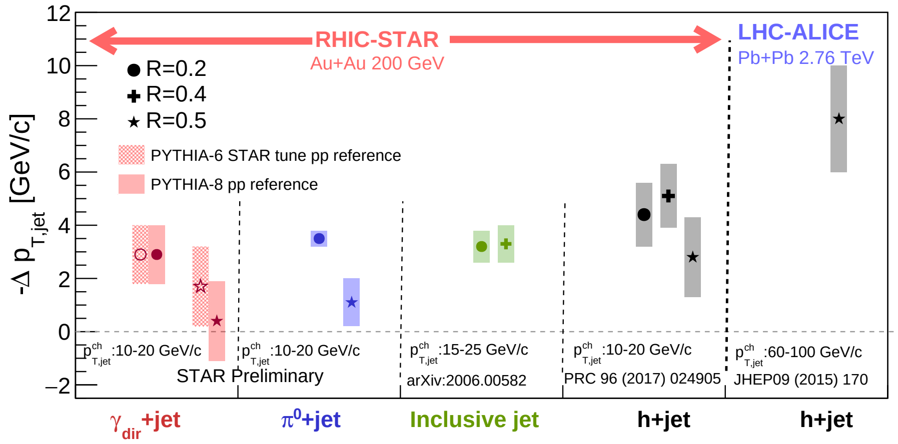

Figure 4: Transverse momentum shift $-\Delta p_{\mathrm{T,jet}}$ from this analysis (middle) compared to various semi-inclusive jet results at RHIC and LHC energies (references in figure).

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