RECENT RESULTS OF INCLUSIVE JET PRODUCTION IN AU+AU COLLISIONS AT $\sqrt{s_{\rm NN}} = 200$ GEV BY THE STAR EXPERIMENT

R. Licenik (for the STAR Collaboration), licenik@ujf.cas.cz, Nuclear Physics Institute of the Czech Academy of Sciences

INTRODUCTION

Jets are an excellent probe of the Quark-Gluon Plasma (QGP) - an exotic state of matter created in high-energy nucleus-nucleus collisions. They are created at the very early stage in the collision during hard parton-parton scatterings, which means that they experience the entire evolution of the system. In addition, their production cross section in proton-proton collisions is calculable by perturbative Quantum Chromodynamics. The modification of jet production as the result of parton interactions with the QGP medium (jet quenching) was first studied via suppression of high-transverse momentum (high-$p_{\rm T}$) hadrons [1], which provided a clear evidence of QGP formation in Au+Au collisions at top RHIC energies. Since then, detailed measurements with reconstructed jets have been carried out in Pb+Pb collisions at the LHC [2, 3, 4]. These proceedings focus on the recently reported results of inclusive charged-particle jet production in Au+Au collisions at $\sqrt{s_{\rm NN}} = 200$ GeV by the STAR experiment at RHIC [5] and also on the ongoing analysis of fully-reconstructed jets, which is expected to bring extended kinematic reach and improved precision.

DATASET AND ANALYSIS

The analysis uses the STAR detector [6], a multi-purpose large-acceptance system utilizing a solenoidal magnetic field. Charged-particle tracks and their momenta are reconstructed in the Time Projection Chamber (TPC) [7]. The Barrel Electromagnetic Calorimeter [8] is used to measure the energy deposited by neutral particles and also provides online triggers. The STAR detector offers a full azimuthal coverage within pseudorapidity range $|\eta| < 1$. The dataset for the charged-particle jet analysis amounts to ~ 6 μb^{-1} of Au+Au collisions at $\sqrt{s_{\rm NN}} = 200$ GeV recorded with the minimum-bias trigger in year 2011, while the fully-reconstructed jet analysis uses a 5.2 nb^{-1} dataset of Au+Au collisions at the same energy recorded in 2014 using the High-Tower trigger, requiring a signal threshold of ~ 4 GeV in a single BEMC tower. Charged-particle jets are reconstructed from TPC tracks (see [5] for analysis details), while fully-reconstructed jets also include the energy from BEMC clusters (3×3 towers), corrected for hadronic energy deposition. The clusters' transverse energy was limited to $0.2 < E_{\rm T} < 30.0$ GeV. Jets are reconstructed using the anti-$k_{\rm T}$ algorithm [9] with resolution parameters $R = 0.2, 0.3, 0.4$. The combinatorial-jet background in both analyses is suppressed by imposing a cut on the transverse momentum of the hardest particle ($p_{\rm T,lead}$) in a jet. However, this cut also introduces a bias into the fragmentation of the surviving jet population. This bias is estimated by varying the $p_{\rm T,lead}$ cut and physics results are discussed in the unbiased region.

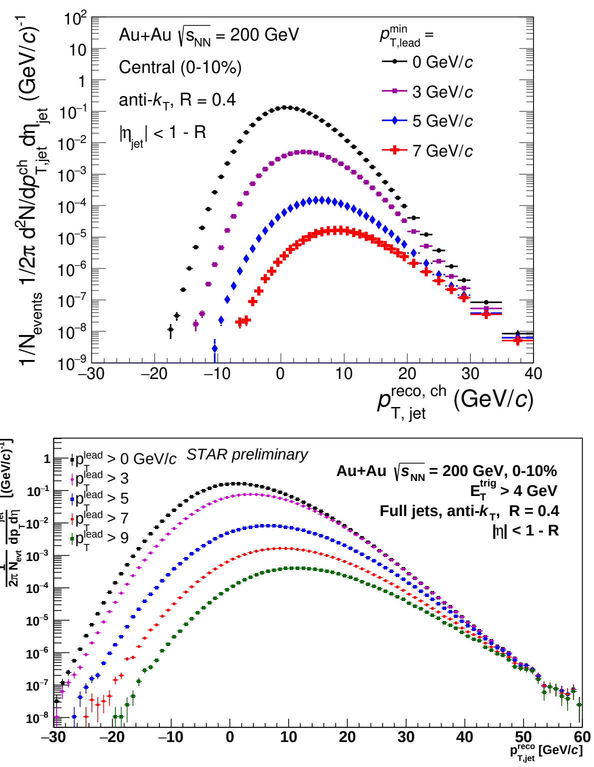

Fig. 1. Uncorrected distributions of charged-particle [5] (top) and fully-reconstructed (bottom) jets as a function of $p^{\rm reco}_{\rm T,jet}$ in 0-10 % Au+Au collisions at $\sqrt{s_{\rm NN}} = 200$ GeV. Different colors represent different values of $p_{\rm T,lead}$.

RESULTS

Figure 1 shows the charged-particle (top) and fully-reconstructed (bottom) jet distributions as a function of $p^{\rm reco}_{\rm T,jet} = p^{\rm raw}_{\rm T,jet} - \rho \cdot A$, where $p^{\rm raw}_{\rm T,jet}$ is the raw jet $p_{\rm T}$ given by the jet finder, A is the jet area and ρ is the median background energy density (calculated event-wise), for $R = 0.4$ in central Au+Au collisions. It can be seen that the $p_{\rm T,lead}$ cut significantly reduces the combinatorial background, especially at low $p^{\rm reco}_{\rm T,jet}$. The distributions also indicate the extended kinematic reach of the fully-reconstructed-jet analysis. However, since this analysis is a work in progress, we only show corrected results from the charged-particle jet analysis. Corrections are applied for the smearing effects of the high-multiplicity environment and instrumental effects using the SVD and Bayesian unfolding methods (details in [5]).

Figure 2 shows charged-particle jet $R_{\rm CP}$, the scaled ratio of yields in central to peripheral collisions, which exhibits a similar level of suppression as charged hadrons at RHIC [10] and LHC energies [11] and as charged-particle jets at the LHC at higher $p^{\rm ch}_{\rm T,jet}$ [2], with weak $p^{\rm ch}_{\rm T,jet}$ dependence. Figure 3 shows charged-

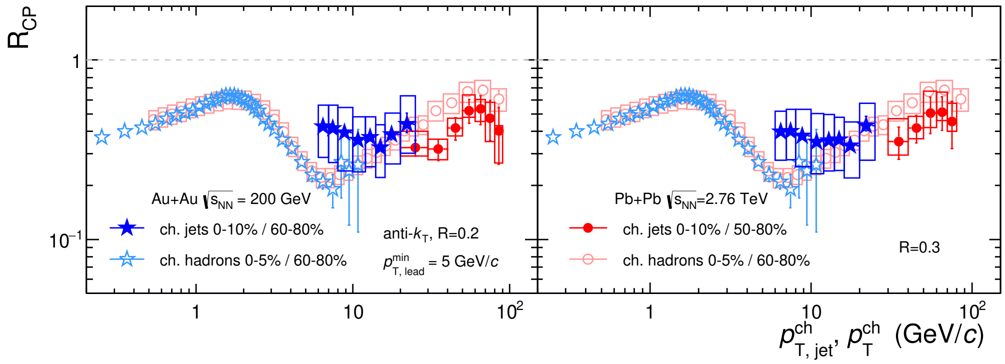

Fig. 2. R_{CP} of charged-particle jets reconstructed with $R = 0.2$ (left) and 0.3 (right) and $p_{\mathrm{T,lead}} > 5$ GeV/c (solid stars) [5]. Also shown are measurements of R_{CP} for charged-particle jets at the LHC (solid circles) [2] and inclusive charged hadrons at RHIC (open stars) [10] and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

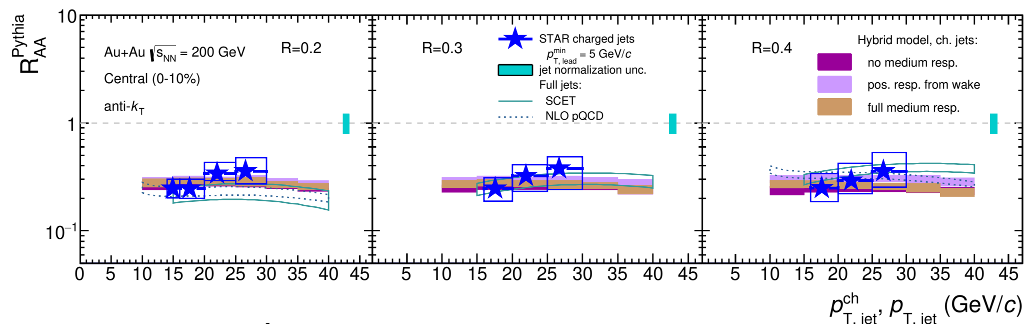

Fig. 3. $R_{\mathrm{AA}}^{\mathrm{PYTHIA}}$ as a function of $p_{\mathrm{T,jet}}^{\mathrm{ch}}$ for charged-particle jets at STAR reconstructed with $R = 0.2$ (left), 0.3 (middle) and 0.4 (right), and $p_{\mathrm{T,lead}} > 5$ GeV/c [5]. Bands represent theory calculations [13, 14, 15, 16].

particle jet $R_{\mathrm{AA}}^{\mathrm{PYTHIA}}$, which measures the yield suppression for central Au+Au collisions compared to p+p baseline calculated by PYTHIA 6 (Perugia 2012, further tuned by STAR [12]). Calculations based on jet quenching models are largely consistent with the measured value of $R_{\mathrm{AA}}^{\mathrm{PYTHIA}}$ within uncertainties, which motivates more precise measurements to distinguish among them.

CONCLUSIONS

We have discussed the recently reported results of charged-particle jet production in Au+Au collisions at $\sqrt{s_{\mathrm{NN}}} = 200$ GeV by the STAR experiment. The R_{CP} shows large suppression, consistent with similar measurement at the LHC and also with charged hadron results at RHIC and the LHC. The $R_{\mathrm{AA}}^{\mathrm{PYTHIA}}$ also shows large suppression consistent with models incorporating jet-quenching mechanisms. The ongoing fully-reconstructed jet analysis is expected to increase the kinematic reach and precision of STAR inclusive jet measurements.

ACKNOWLEDGMENT: This work is supported by the project LTT18002 of the Ministry of Education, Youth and Sport of the Czech Republic.

REFERENCES

1. STAR Collaboration, Phys. Rev. Lett. 91 (2003) 072304.
2. ALICE Collaboration, J. High Energy Phys. 30 (2014) 013.
3. ATLAS Collaboration, Phys. Lett. B 790 (2019) 108-128.
4. CMS Collaboration, Phys. Rev. C 96 (2017) 015202.
5. STAR Collaboration, arXiv:2006.00582 [nucl-ex].
6. K. Ackermann *et al.*, Nucl. Instrum. Meth. A 499 (2003) 624.
7. M. Anderson *et al.*, Nucl. Instrum. Meth. A 499 (2003) 659.
8. M. Beddo *et al.* Nucl. Instrum. Meth. A 499 (2003) 725.
9. M. Cacciari *et al.*, J. High Energy Phys. 04 (2008) 063.
10. STAR Collaboration, Phys. Rev. Lett. 91 (2003) 172302.
11. ATLAS Collaboration, J. High Energy Phys. 09 (2015) 050.
12. STAR Collaboration, Phys. Rev. D 100 (2019) 052005.
13. I. Vitev, B.-W. Zhang, Phys. Rev. Lett. 104 (2010) 132001.
14. Y.-T. Chien *et al.*, Phys. Rev. D 93 (2016) 074030.
15. Y.-T. Chien, I. Vitev, J. High Energy Phys. 05 (2016) 023.
16. J. Casalderrey-Solana *et al.*, J. High Energy Phys. 03 (2017) 135.