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

Michal Svoboda (m.svoboda@ujf.cas.cz), *for the STAR Collaboration*
Nuclear Physics Institute, Czech Academy of Sciences

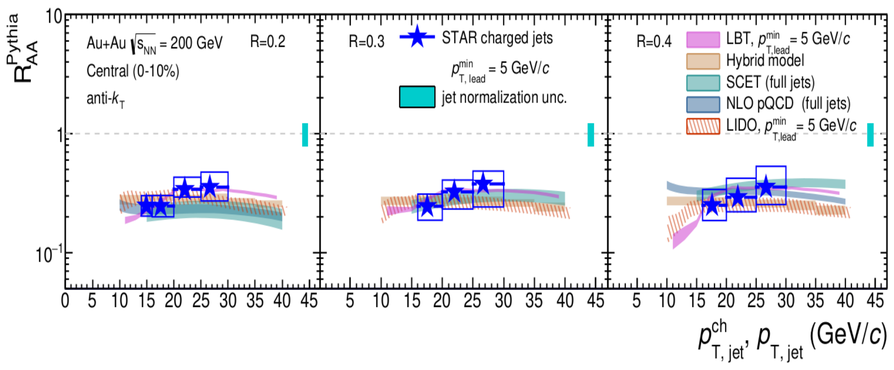
Quark Matter 2025

Abstract

The STAR Collaboration reports the first measurements of the inclusive distribution of fully-reconstructed jets in peripheral (60-80%) and central (0-10%) Au + Au collisions at $\sqrt{s_{NN}}$ = 200 GeV at RHIC, using a dataset with an integrated luminosity of 5.2 nb^{-1}. The data were recorded in 2014 with an online High Tower trigger which requires at least 4.2 GeV energy deposited in one Barrel Electromagnetic Calorimeter (BEMC) tower. Jets are reconstructed from charged-particle tracks in the Time Projection Chamber and neutral energy measured by the BEMC using the anti-k_T algorithm, with resolution parameters R = 0.2, 0.3 and 0.4. The combinatorial jets in heavy-ion collisions are suppressed by requiring a high-transverse-momentum (p_T) leading charged or neutral constituent in accepted jet candidates. The bias imposed by this requirement is assessed by inspecting ratios of jet spectra for different leading constitutent cuts. Background fluctuations and detector effects will be corrected for via unfolding. We expect fully corrected inclusive jet spectrum to reach jet p_T of about 60 GeV/c, extending significantly the kinematic reach of existing measurements with charged-particle jets.

Motivation

- Jets serve as a powerful probe to the properties of the quark-gluon plasma created in heavy-ion collisions.
- Measurement of full jets, utilizing the BEMC trigger, allows to significantly increase the kinematic reach of existing charged particle jet R_{AA} at RHIC [1].

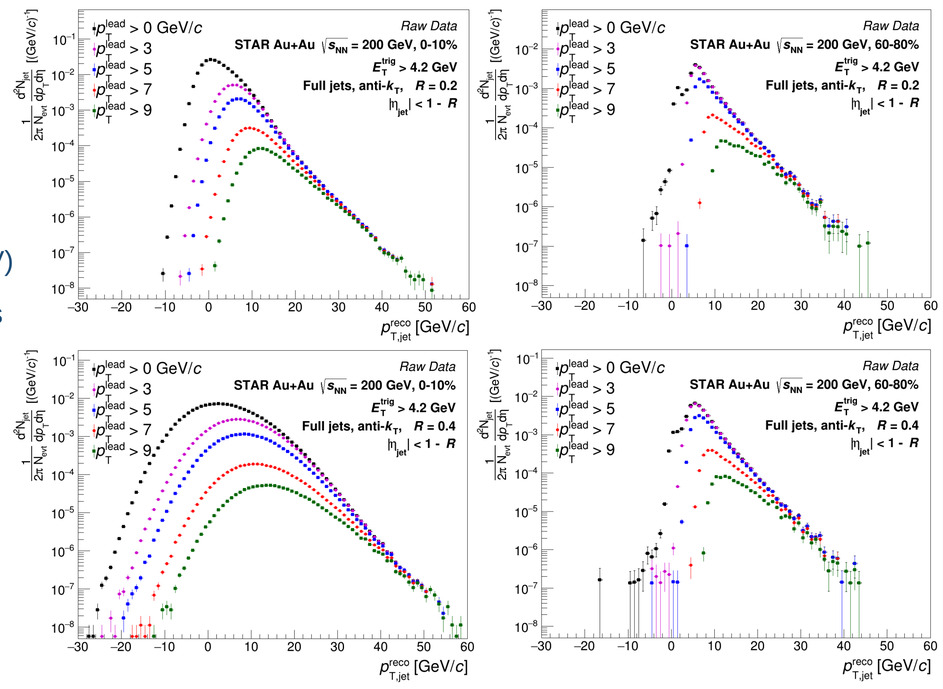


- Aim to measure full jet spectra and R_{AA} in Au + Au collisions at top RHIC energy for low p_T constituents and large R, and up to jet p_T ~ 60 GeV/c.

Raw Full Jet Spectra

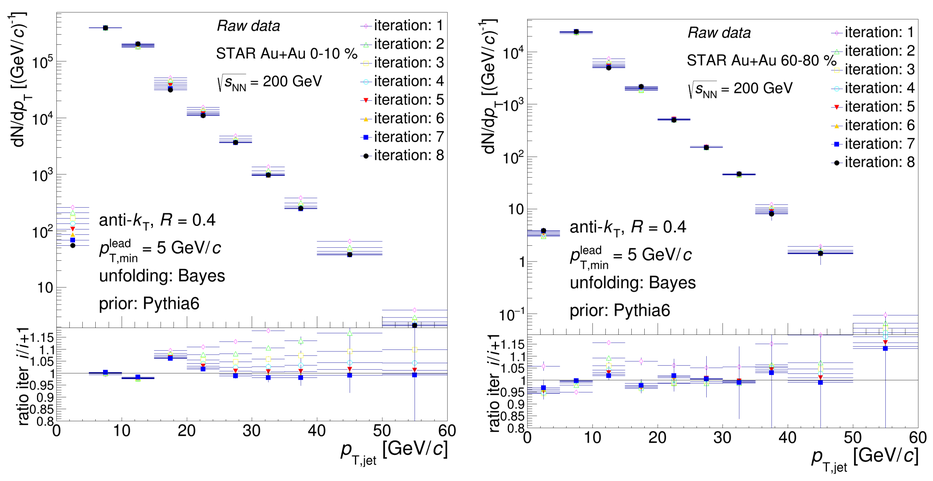
Jet reconstruction:

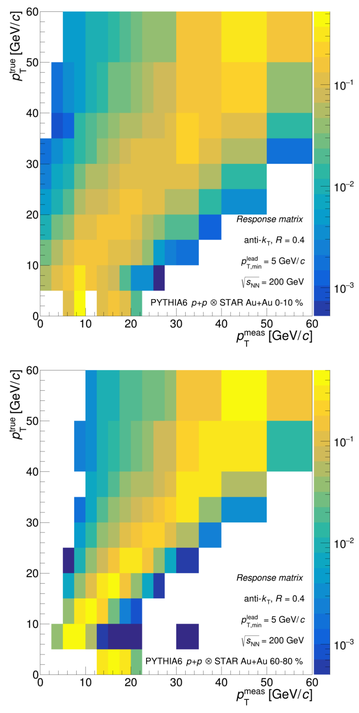
- Anti-k_T algorithm [2] with R = 0.2, 0.3 and 0.4
- Inputs: charged particle tracks in TPC and neutral energy deposited in BEMC
- Low constituent cut: p_T (E_T) > 0.2 GeV/c (GeV)
- Leading particle p_T cut introduced to suppress background
- BEMC trigger tower contained in jet
- Full hadronic correction used to avoid double counting of energy by BEMC and TPC
- Jet area ≥ 0.07, 0.2, 0.4 for R = 0.2, 0.3 and 0.4
- Average background subtraction event-by-event $p_{T,jet}^{reco} = p_{T,jet}^{raw} - \rho A_{jet}$



Unfolding of Jet Spectra

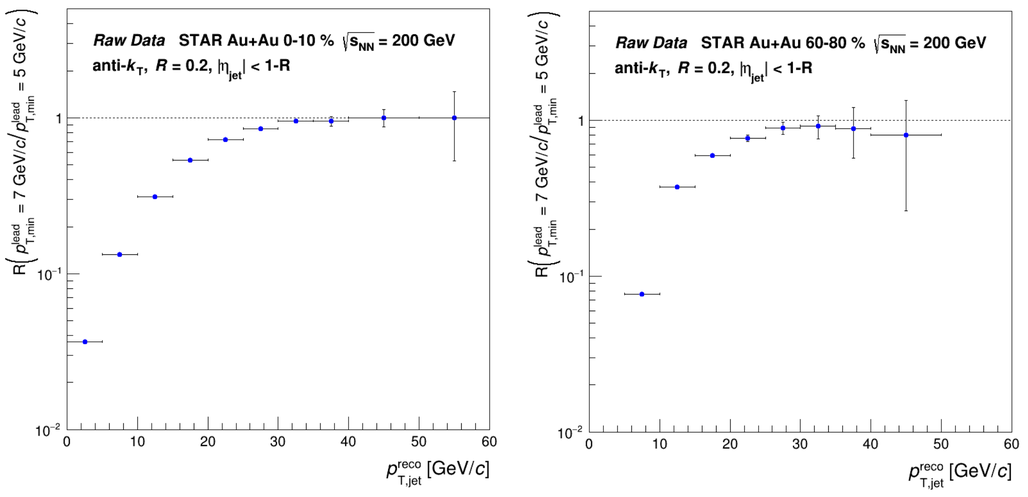
- Bayesian iterative unfolding used [3]
- Good convergence across centralities and jet radii
- Response matrix estimated from PYTHIA dijet events (in p+p) embedded into Au + Au data





Estimation of p_T^{lead} Cut Bias

- Ratio of jet spectra for different p_T^{lead} cuts can be used to determine the unbiased region.
- Ratios of raw jet spectra indicate unbiased regions from $p_{T,jet}^{reco}$~ 25 GeV/c, where the ratios saturate.



Systematic Uncertainties

Two categories of systematic uncertainty: correlated uncertainties, which do not change the shape of the distribution, and shape uncertainties.

Correlated uncertainty

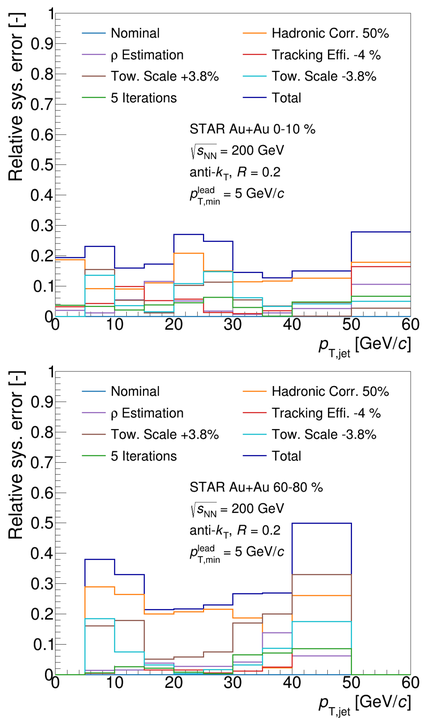
- TPC tracking efficiency
- BEMC tower energy resolution
- Hadronic correction
- ρ estimation

Shape uncertainty

- Change of unfolding iterations

To be done

- Prior dependence of unfolding
- Different unfolding method (SVD)



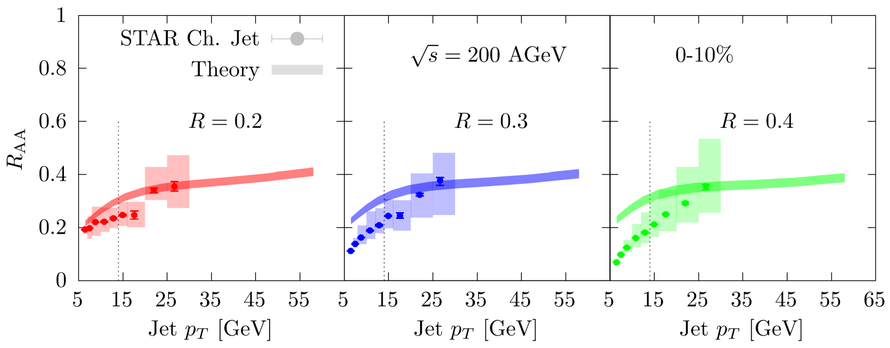
Conclusions and Outlook

We have presented recent progress on the analysis of inclusive full jet spectra in Au + Au collisions at $\sqrt{s_{NN}}$ = 200 GeV measured at STAR.

Next steps:

- Correction for the BEMC trigger efficiency
  → invariant jet yields
- Analysis of reference p+p data
  → calculation of R_{AA}
  → compare to model prediction
- Extension of analysis to larger jet radii using machine-learning methods

Theory Plots [4]*, including comparison to STAR Charged-Jet Data* [1]



References
[1] STAR, PRC 102 (2020) 054913
[2] FastJet, EPJ C 72 (2012) 1896 [arXiv:1111.6097]
[3] G. D'Agostini, Nucl. Instrum. Meth. A 362, 487 (1995)
[4] Y. Mehtar-Tani, D. Pablos, K. Tywoniuk, PRD 110, 014009 (2024)

Supported in part by the U.S. DEPARTMENT OF ENERGY Office of Science

This work was supported by a grant from The Czech Science Foundation (GAČR), grant number: GA23-07499S.

The STAR Collaboration