B-Jet Projection Study with Pythia Simulation

Yaping Wang (CCNU)
Zhenyu Ye (UIC)

Outline

- B-tagged Jet Physics
- MC simulation for B-tagged jet
- Conclusion

Puzzle:

(1) pQCD predicts: jets from heavy quarks lose energy less than ones from light quarks due to “dead-cone effect”.

(2) But the mechanism for in-medium partonic energy loss are still constrained?

Via b-tagged jet measurements:

(1) Determine b-quark production rate via the measurement of b-tagged jets.

(2) Quantify mass and color charge dependence of parton energy loss in a Quark-Gluon Plasma (QGP).

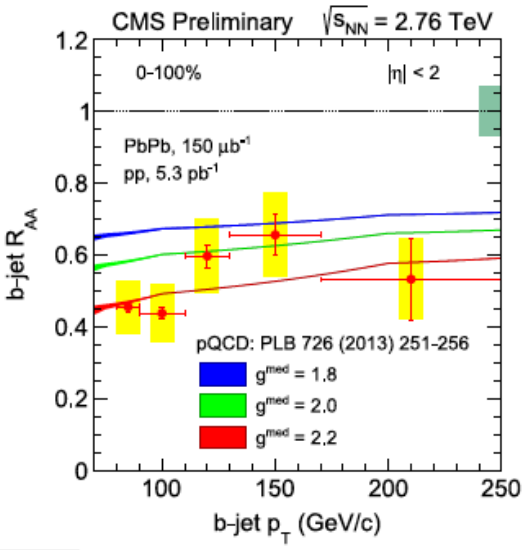
(3) Complement the measurements of electrons, D mesons and J/psi from bottom hadron decays at lower p_T.

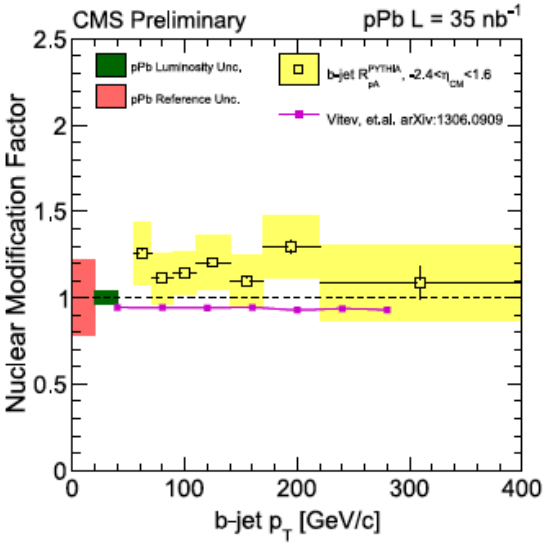
B-tagged Jet Physics -- Results from HIC experiments

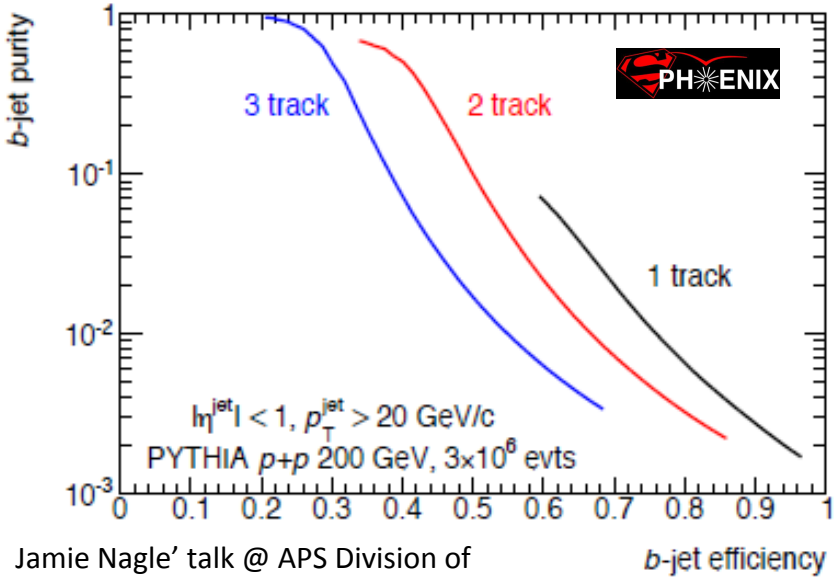
Results from CMS:

- B-jets in PbPb are found to be suppressed over a wide range of p_T, from 80-250 GeV/c.
- The b-jets observed in pPb show no suppression effects, but a small enhancement.

http://dx.doi.org/10.1016/j.nuclphysa.2014.09.086



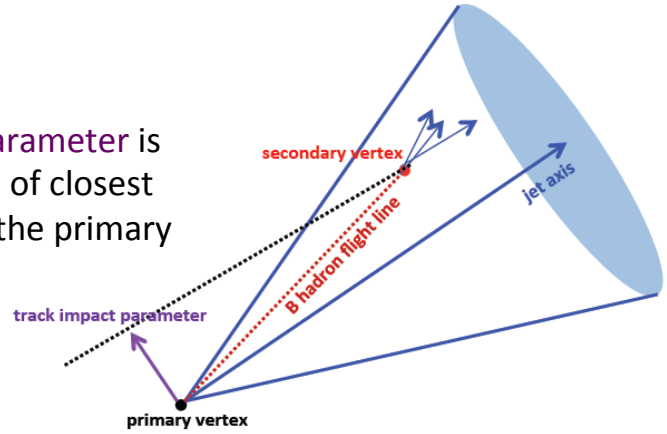




Jamie Nagle' talk @ APS Division of Nuclear Physics: 2014 Long-range plan

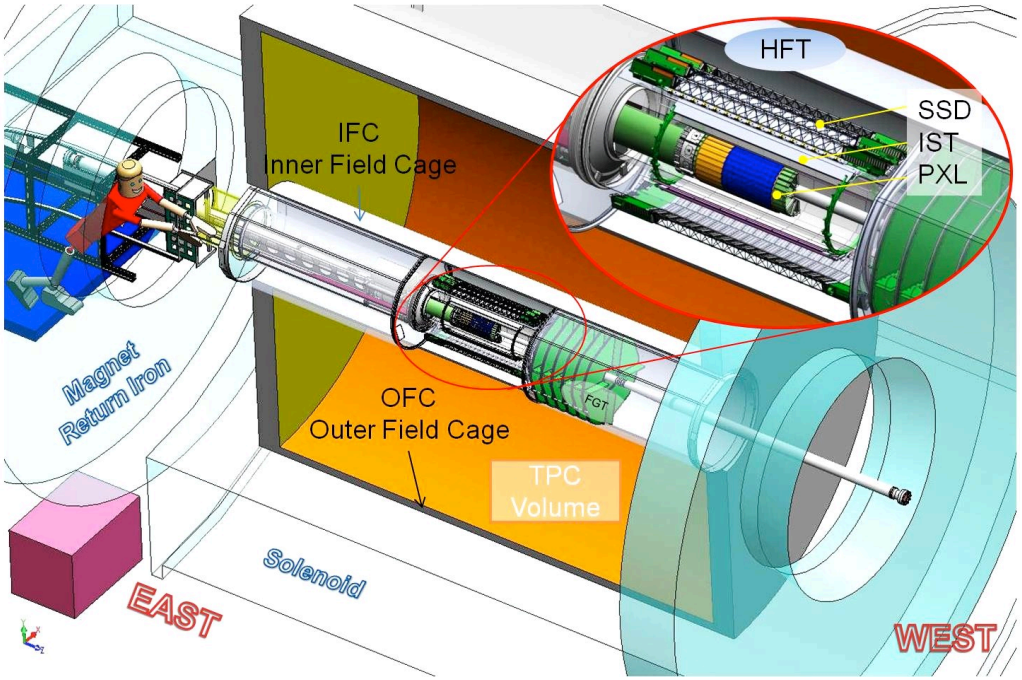
Variety of proven techniques: soft lepton tagging, track counting, secondary vertex reconstruction.

The track impact parameter is the track's distance of closest approach (DCA) to the primary vertex

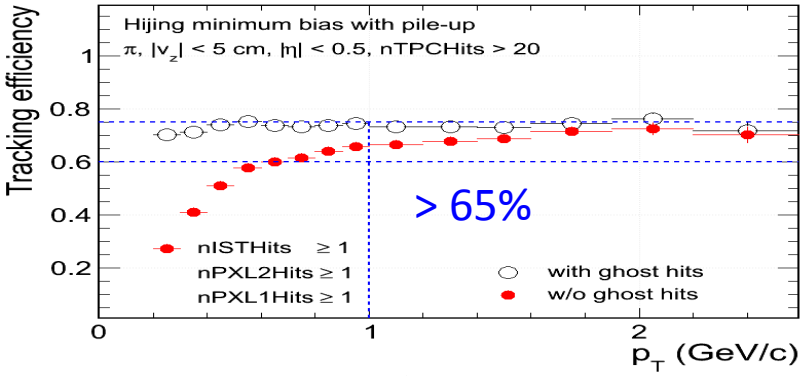


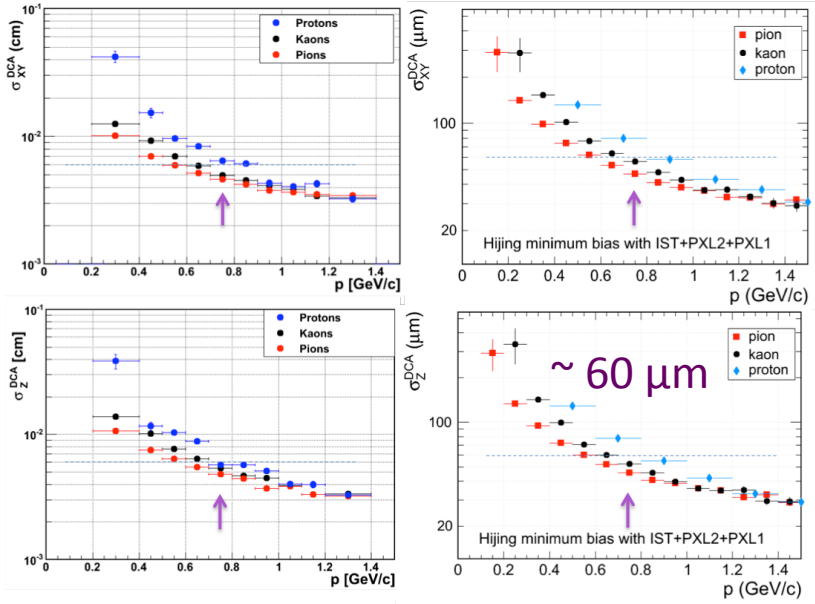
B-tagged Jet Physics -- Prospects with STAR-HFT

Heavy Flavor Tracker (HFT) will greatly enhance the capability of STAR for heavy flavor studies (energy loss mechanism, partonic thermalization), allowing identification of displaced vertices and direct topological reconstruction of open charm hadrons.



The HFT and the TPC are used for tracking and secondary vertex reconstruction in STAR.





HF-tagged jet study with PYTHIA -- setup

Pythia8176 setting:

3 processes: (1) hardQCD:all; (2) hardQCD:hardccbar; (3) hardQCD:hardbbbar

Each case was run in 7 partonic p_T ranges (CKIN3, CKIN4): 3-5, 5-10, 10-20, 20-40, 40-60, 60-80, 80-100.

Jet reconstruction:

anti_kT algorithm (fastJet 3.1.0)

jet cone size: 0.3

minimum p_T of jet: 5.0 GeV/c

$|\eta_{jet}| \leq 0.6$

Tagging:

$\sqrt{(\Delta\eta^2+\Delta\phi^2)} < 0.3$ (distance between the tagging particle to jet axis)

HF-Jet was tagged with heavy hadrons(B-Hadron /C-Hadron)

Statistics:

Simulated events: 5×10^6 events

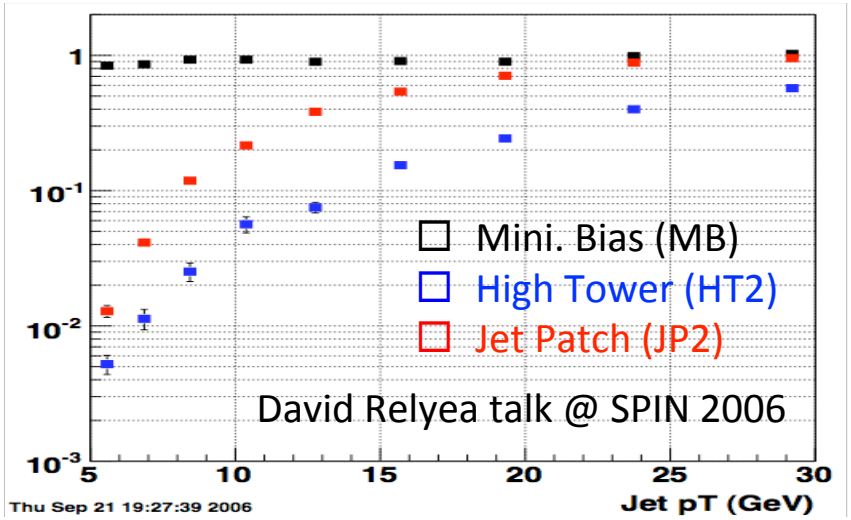
Normalized to integrated luminosity: 10 pb^{-1}

MC Simulation -- Description

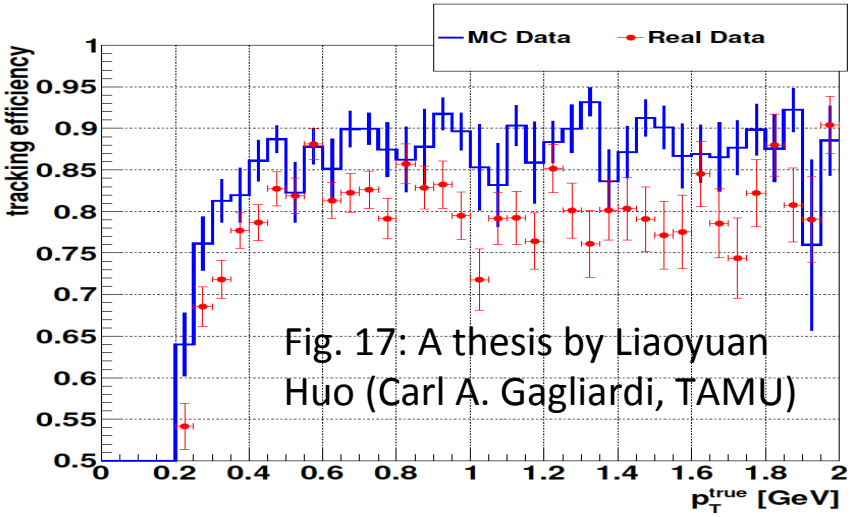
- Jet flavor defined via the leading (highest p_T) hadron in the jet cone.
- Reconstruct jet (R_{cone}=0.3, $|\eta_{jet}|$<0.6) starting from charged tracks and neutral energy.
- Reconstructed jet yield was corrected by the STAR jet trigger efficiencies for HT2 trigger only in this study.
- TPC and HFT tracking efficiencies are taken into account in counting the number of reconstructed tracks.
- DCA of MC tracks were smeared to take into account the HFT pointing resolution.

MC Simulation -- Corrections with STAR-HFT KPP

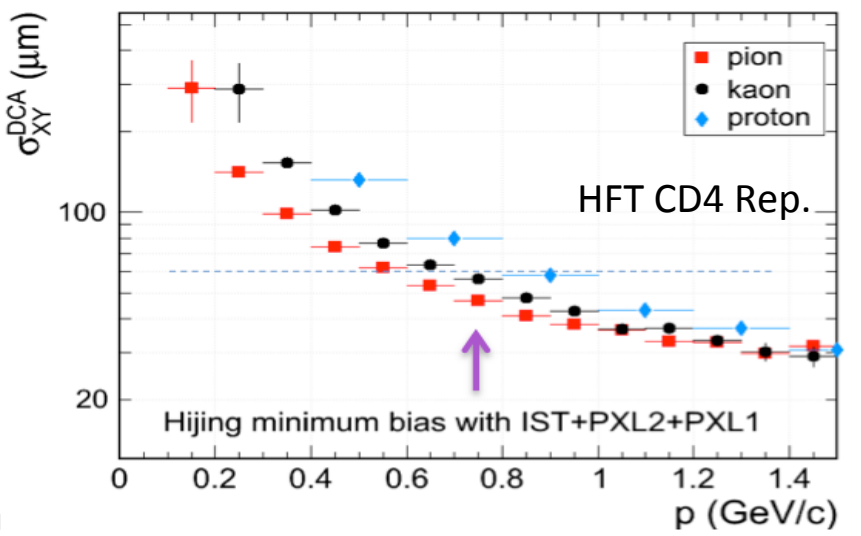
1. Jet trigger efficiency in PP @ STAR (MC):



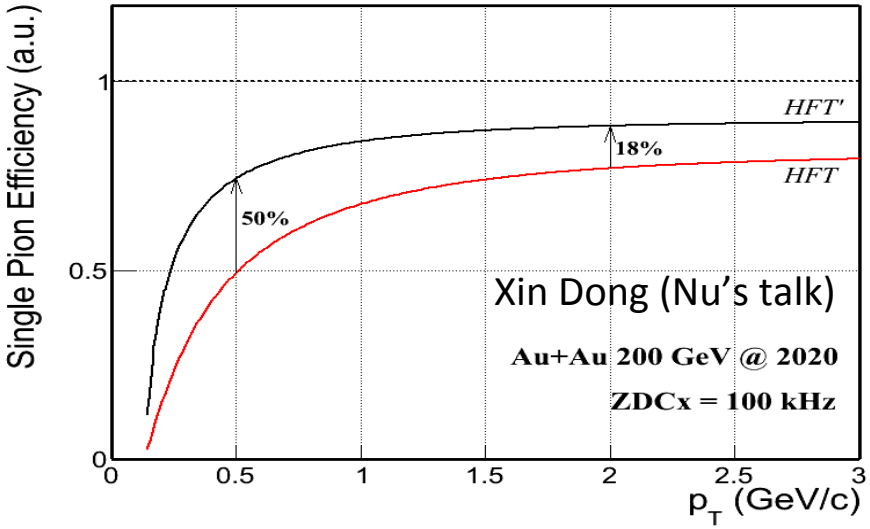
2. In-jet cone TPC tracking efficiency in PP:



3. HFT DCA resolution smearing:

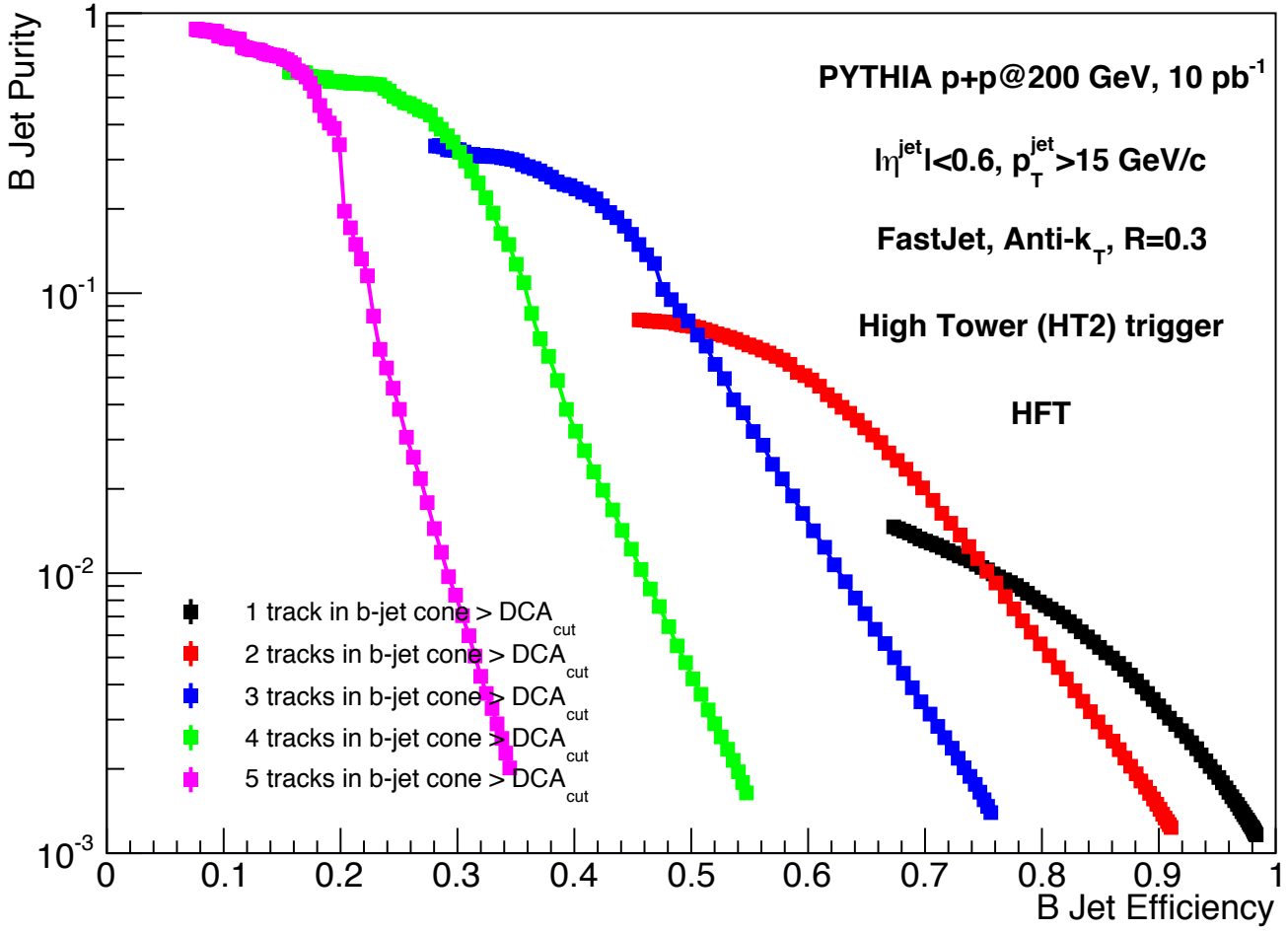


4. HFT/HFT+ tracking efficiency correction:



MC Simulation -- HF-Jet tagging efficiency vs. purity

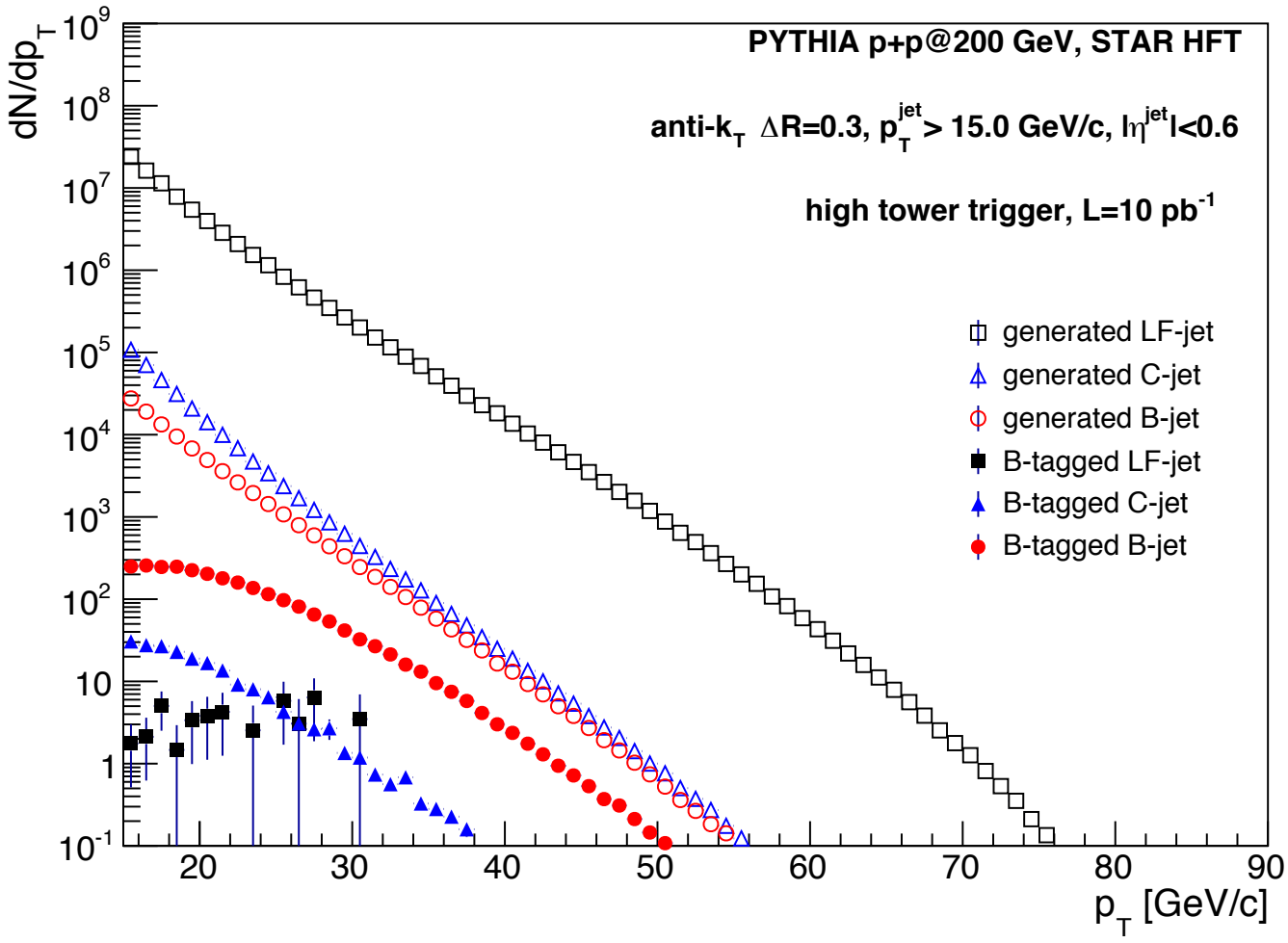
B jet tagging: based on counting the number of tracks with large impact parameters within jet cone.



- Requiring 5 tracks in jet cone with DCA > 200 microns, the b-jet purity can be ~ 91.2%

MC Simulation -- Inclusive jet yield estimations

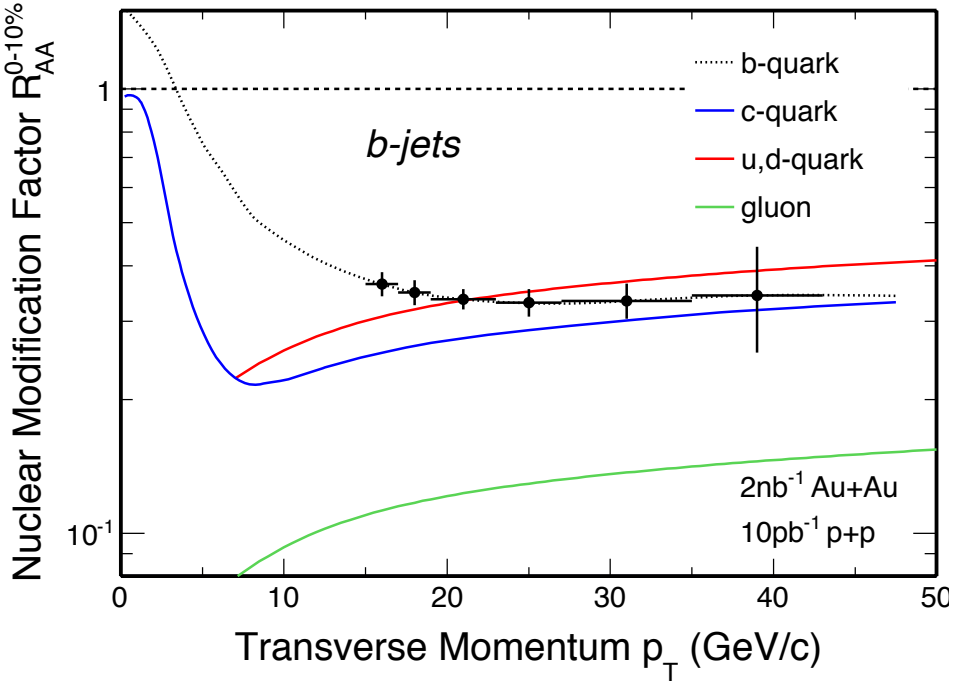
Based on the counting method, the b-jets can be identified over the b-jets enriched samples.



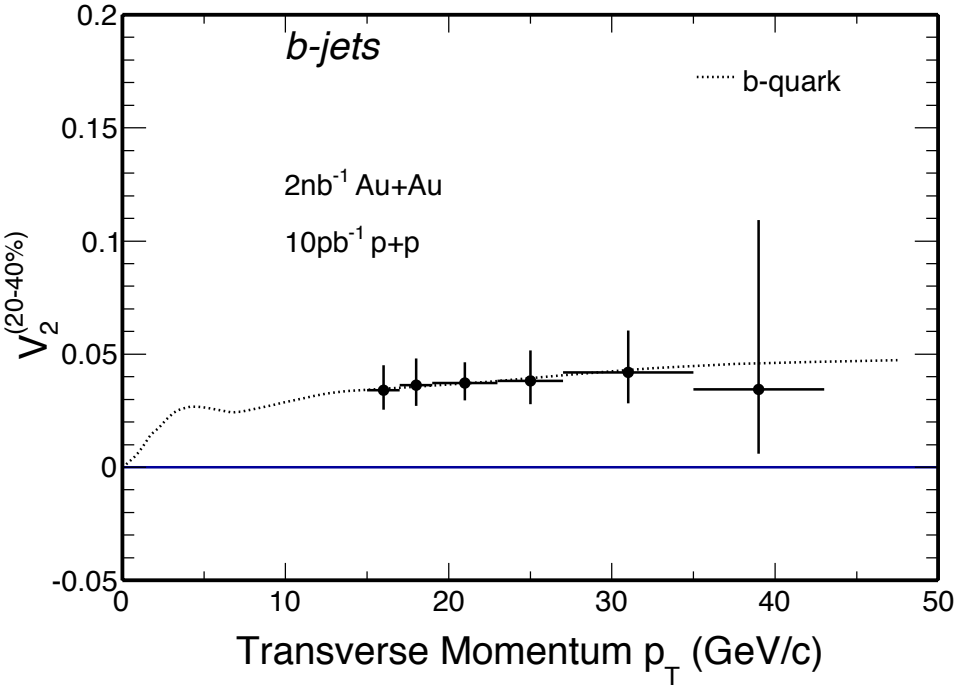
- Requiring 5 tracks in jet cone with DCA > 200 microns, the b-jet purity can be ~ 91.2%

MC Simulation – Projection of R_{AA} and v_2 for b-jets

RHIC R_{AA}



RHIC v_2



CUJET3.0 predictions for R_{AA} and v_2 of D and B flavors, Xu, JL, Gyulassy, arXiv:1411.3673

Conclusion and Discussion

Based on the updated simulation results:

1) With the HFT, statistics from an B-jet enriched sample could be achieved for the B-tagged jet studies.

2) The uncertainty of projected R_{AA} looks acceptable, but the v_2 needs more statistics.

3) Measurements will extend the study of flavor-dependent parton-QGP interactions for p_T up to 40 GeV/c at RHIC energies, thus complement the measurements of electrons, D mesons and J/psi from bottom hadron decays at lower p_T.

4) Projections are based on **10 pb^{-1} of p+p data in Run15 and 2 nb^{-1} of Au+Au data in Run16**, taken with BHT2 trigger with HFT readout within |Vz|<8 cm.

Thanks!