Reconstruction of Neutral-Triggered Full Recoil Jets in $\sqrt{s} = 200$ GeV p+p Collisions at the STAR Experiment

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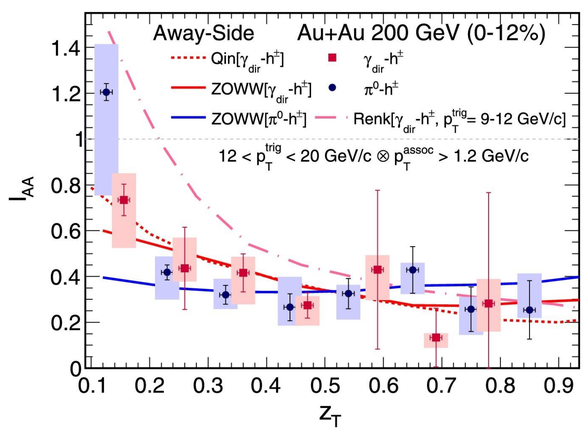
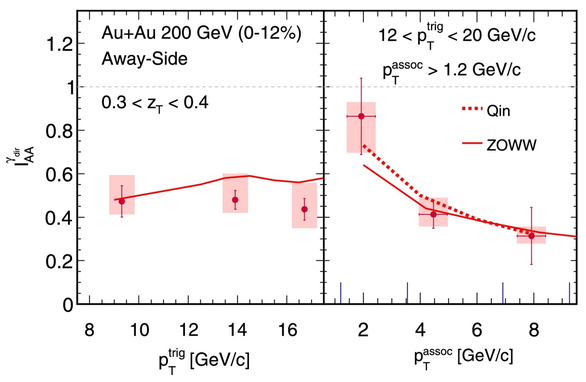
Abstract

In heavy-ion collisions, the study of recoil jets tagged by high transverse-momentum "direct photons" (γ_{dir}) provides a calibrated probe of partonic energy loss in the hot, dense medium produced in such collisions. Since a γ_{dir} does not interact strongly with the medium, it closely approximates the initial energy of the recoiling parton. Moreover, the comparison of γ_{dir} -tagged recoil jets to π^0-tagged recoil jets may shed light on the path-length and color-factor dependence of in-medium partonic energy loss. To establish a vacuum fragmentation reference, we present the measurement of the yields of full recoil jets (recoil jets consisting of both charged and neutral particles) in p+p collisions. Jets are reconstructed using the STAR Time Projection Chamber and Barrel Electromagnetic Calorimeter in p+p collisions at $\sqrt{s} = 200$ GeV tagged by neutral-particle triggers recorded during the running year 2009. To assay the effect of reconstructing full jets versus charged-only jets in such studies, the yields of charged recoil-jets are compared to the yields of full recoil-jets.

Motivation

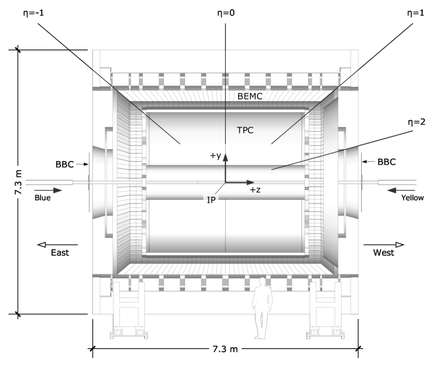
- Direct photons (γ_{dir}) offer a channel to study medium-induced energy loss [1]
  - To leading order, γ_{dir} do not interact strongly with medium
  - Measured energy of a γ_{dir} closely approximates E_0 of recoiling parton
- Comparing the quenching of jets recoiling from γ_{dir} to those recoiling from energetic π^0
  - π^0 biased towards surface emission while γ_{dir} have no such bias [2]
  - π^0 mostly recoil from gluon jets [3, 4]
  - γ_{dir} mostly recoil from quark jets
  - ∴ On average, jets recoiling from γ_{dir} should **be less quenched** than those recoiling from energetic π^0
- Recent measurement of I_{AA} by the STAR collaboration [5]
  - Difference **not observed within uncertainty!**
- Now pursuing full jet reconstruction of jets recoiling from γ_{dir} and energetic π^0 in Au+Au collisions
  - p+p collisions serve as control in which no medium is produced





The STAR Experiment

- **Time Projection Chamber (TPC):**
  - Charged particle (track) p_T
- **Barrel Electro-Magnetic Calorimeter (BEMC):**
  - Neutral particle (tower) E_T
  - Used to trigger on p+p collisions containing energetic γ_{dir} or π^0
- Energetic γ_{dir}- and π^0-triggers satisfy:
  - $E_T^{trg} \in (9, 30)$ GeV
  - $|\eta_{trg}| < 0.9$



Neutral Triggers

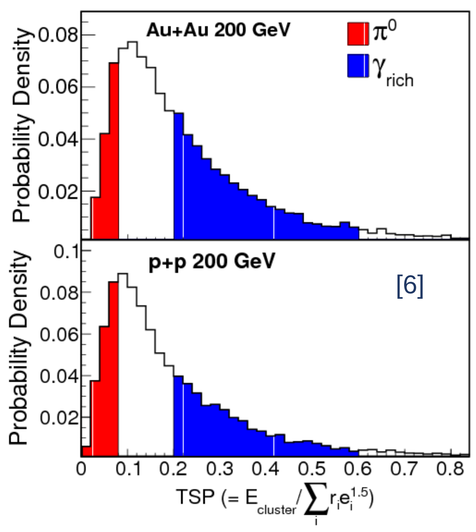
- **Barrel Shower Maximum Detector (BSMD):**
  - Used to distinguish between the γ_{dir} and π^0 via their TSP
- **Transverse Shower Profile (TSP):**

$$TSP = \frac{E_{cluster}}{\sum_i e_i r_i^{1.5}}$$

  - $E_{cluster}$ is total energy of cluster
  - e_i and r_i are energy and distance to cluster center of i[th] BSMD strip
- Data are split into two samples:
  - One a 95% pure sample of π^0 satisfying $TSP \in (0, 0.08)$
  - One with an enhanced fraction of γ_{dir} (γ_{rich}) satisfying $TSP \in (0.2, 0.6)$ [5]:

$$\frac{N^{\gamma_{dir}}}{N^{\gamma_{rich}}} \sim 40\%$$

∴ $\boldsymbol{\gamma_{rich} = 0.4 \cdot \gamma_{dir} + 0.6 \cdot \pi^0}$



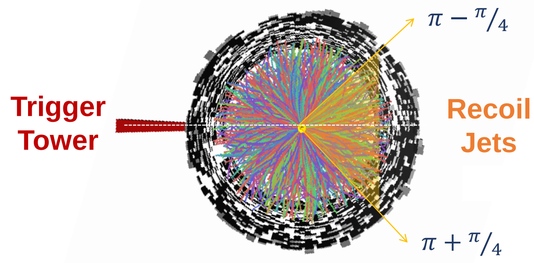
Jet Reconstruction

- Jet reconstructed from
  - TPC tracks with $p_T^{trk} \in (0.2, 30)$ GeV/c and $|\eta_{trk}| < 1$
  - BEMC towers with $E_T^{twr} \in (0.2, 30)$ GeV (after "100% Hadronic Correction") and $|\eta_{twr}| < 1$
- Clustered using FastJet 3.0.6 [7]
- Jet candidates satisfy:
  - $A_{jet} > 0.2$ and $p_{T,jet}^{raw} > 0.2$ GeV/c
  - $|\eta_{jet}| < 1 - R$
- Jet p_T adjusted for background energy density with:

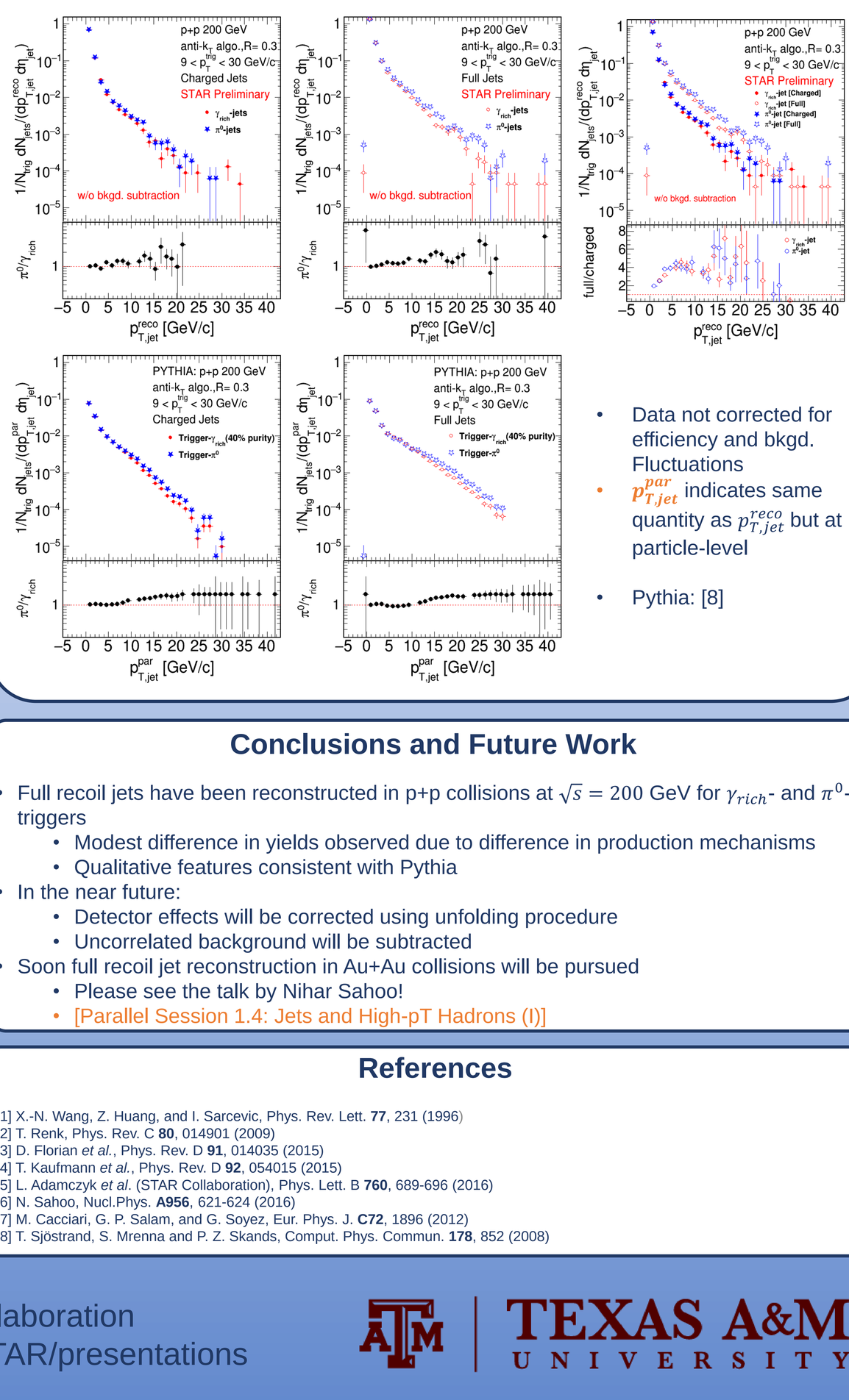
$$\boldsymbol{p_{T,jet}^{reco} = p_{T,jet}^{raw} - \rho \cdot A_{jet}}$$

  - Where

$$\rho \equiv \text{median}\{p_{T,jet}^{raw,i}(k_T)/A_{jet}^{i}(k_T)\}$$



- **Recoil Jet:** any jet satisfying $|\Delta\varphi - \pi| < \pi/4$
- **Charged Jets:** jets composed solely of charged tracks
- **Full Jets:** jets composed of charged tracks and neutral towers



- Data not corrected for efficiency and bkgd. Fluctuations
- $\boldsymbol{p_{T,jet}^{par}}$ indicates same quantity as $p_{T,jet}^{reco}$ but at particle-level
- Pythia: [8]

Conclusions and Future Work

- Full recoil jets have been reconstructed in p+p collisions at $\sqrt{s} = 200$ GeV for γ_{rich}- and π^0-triggers
  - Modest difference in yields observed due to difference in production mechanisms
  - Qualitative features consistent with Pythia
- In the near future:
  - Detector effects will be corrected using unfolding procedure
  - Uncorrelated background will be subtracted
- Soon full recoil jet reconstruction in Au+Au collisions will be pursued
  - Please see the talk by Nihar Sahoo!
  - [Parallel Session 1.4: Jets and High-pT Hadrons (I)]

References

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