Status of Jet Reconstruction in Cu+Au collisions at 200 GeV from PHENIX

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1. Why are jets interesting in Cu+Au?

Jet reconstruction in heavy ion collisions is a vital tool to explore medium effects, including energy loss and modification of parton fragmentation functions. Studying reconstructed jets in collisions of asymmetric heavy ions is crucial in understanding the interplay between collision geometry and initial and final state effects. In central Cu+Au collisions, the Cu nucleus is completely embedded within the Au nucleus. The study of Cu+Au collisions as a function of centrality can help disentangle the 'core' of the collision region, characterized by a large energy density, and the outer 'corona' region.

In this poster, we discuss two major challenges in jet reconstruction:

- Control over the effects of underlying event
- Control over the effects of mis-reconstructed high p_T conversions

We conclude that jet reconstruction in Cu+Au looks feasible and promising without an overwhelming background from underlying event or mis-reconstructed high pT conversions.

2. PHENIX detector

PHENIX central arm (Figure 1):

- $|\eta| < 0.35$
- $\Delta\phi = \pi$

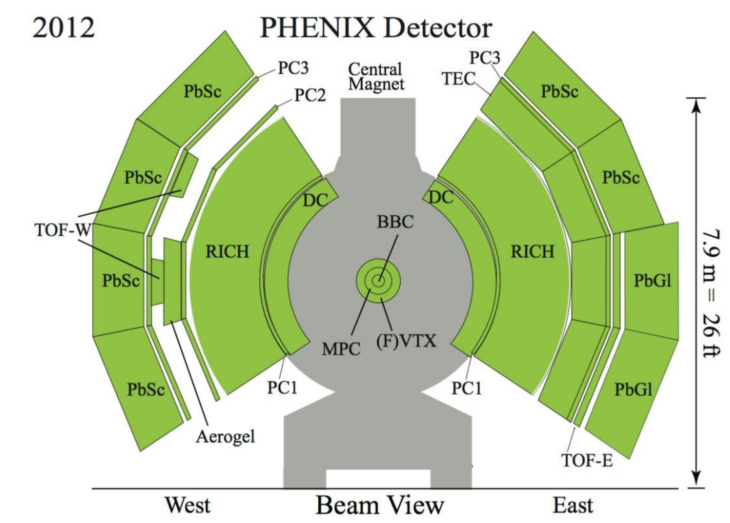

Figure 1: 2012 PHENIX detector configuration

3. Dataset

- **Cu+Au @ 200 GeV, MB**
  - MB trigger requires at least one hit per beam crossings in each of the two BBCs
- **p+p @ 200 GeV, ERT**
  - EMCal-RICH-Trigger (ERT) requires minimum energy of 1.6 GeV in 4x4 group of EMCal towers

- Charged particle tracks are reconstructed using the Drift Chamber (DC), the Pad Chamber (PC) and the collision point
- Neutral clusters are measured in the Electromagnetic Calorimeter (EMCal). EMCal measures π^0, γ, and some hadrons (with lower efficiency)
- The Beam Beam Counters (BBCs) are used as the minimum bias (MB) trigger and for determining the collision vertex (z) position

4. Tracks and clusters selection

- Track selection criteria: $p_T > 500$ MeV/c + various cuts optimized to reject high p_T background
- Cluster selection criteria: Energy > 500 MeV + require cluster to be not (and not around) hot, dead or uncalibrated towers
- Track/cluster association cut: Discard any cluster which is associated with a track

The selected tracks and clusters are used as input for Anti-k_t algorithm[1].

5. Control over the effects of underlying event

Nomenclature:

- **Number of constituents (nc)**

$$nc = \sum_{particle} 1 \times \theta\left(R - \sqrt{\Delta\eta^2_{jet,\ particle} + \Delta\phi^2_{jet,\ particle}}\right)$$

Choice of R parameter

PYTHIA[2] events (p+p @ 200 GeV) for 2->2 QCD processes were embedded in the MB HIJING[3] events. The reconstructed jets (nc>=3) were 'matched' if the jet axis was within $\Delta R = \sqrt{\Delta\eta^2 + \Delta\phi^2} < 0.25$ of the true (PYTHIA) jet.

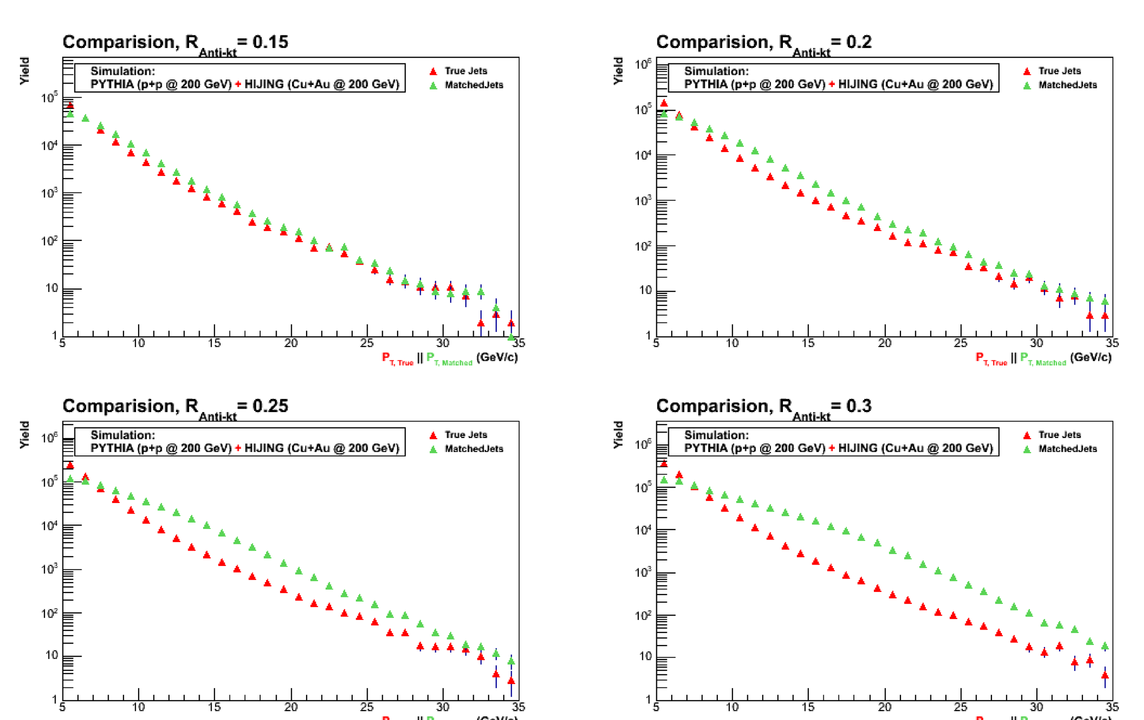

Figure 2: Comparison of $p_{T,\ True}$ and $p_{T,\ Matched}$ for different R parameters

Comparison of $p_{T,\ True}$ and $p_{T,\ Matched}$ (Figure 2) shows that for small R parameter, the underlying event contribution is not overwhelming and will require only smaller corrections to data.

Our choice of R parameter for Cu+Au analysis is 0.2.

Fake jet identification and rejection

After studying performance of various fake jet identification and rejection schemes (for example, Figure 3), for jets reconstructed with R = 0.2, we intend to only consider the $p_{T,\ Reco} > 10$ (GeV/c) part of the spectrum and not implement any fake jet rejection schemes.

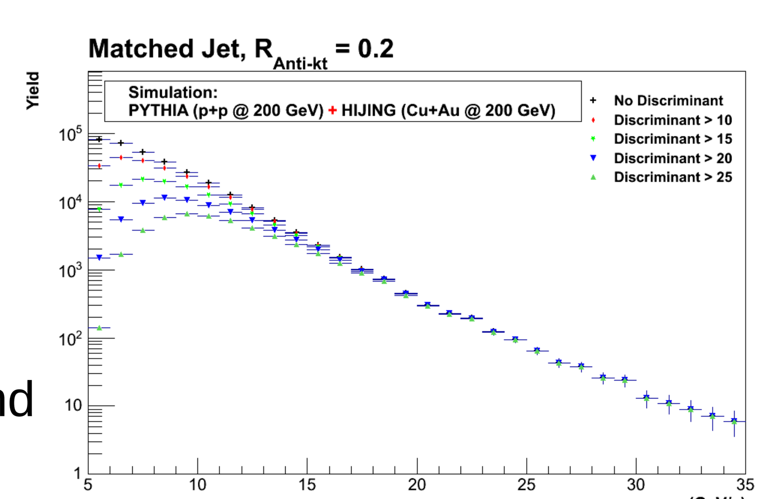

Figure 3: Discriminant cuts applied to matched jet

6. Control over the effects of mis-reconstructed high p_T conversions

Nomenclature:

- **Charged fraction (cf)**

$cf = \frac{1}{p_T^{jet}} \sum p_T^i$, i = Charged constituents

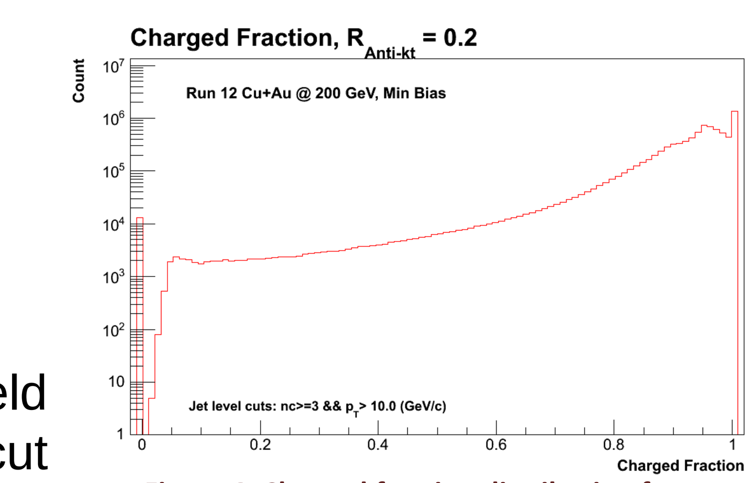

Figure 4: Charged fraction distribution for reconstructed jet (nc>=3 and $p_{T,reco} > 10$ GeV/c)

Charged fraction cut

PHENIX tracking algorithm assumes that all the tracks originate from the collision vertex. Therefore, p_T of conversions (which traverse less magnetic field integral and therefore bend less) will be mis-reconstructed. Charged fraction cut is designed to minimize the contribution of these mis-reconstructed tracks to the reconstructed jet p_T.

Figure 4 shows the charged fraction distribution for reconstructed jets (nc>=3 and $p_{T,reco} > 10$ GeV/c) in the Cu+Au dataset. The rising slope towards cf of 1 is due to the high p_T background.

The effect of cf cut on high pT background can be demonstrated by examining the jet constituent spectra.

Figure 5 shows the change in the constituent spectra shape for various cf cuts. Constituent spectra are for jets (nc>=3 and $p_{T,reco} > 10$ GeV/c) in the Cu+Au dataset.

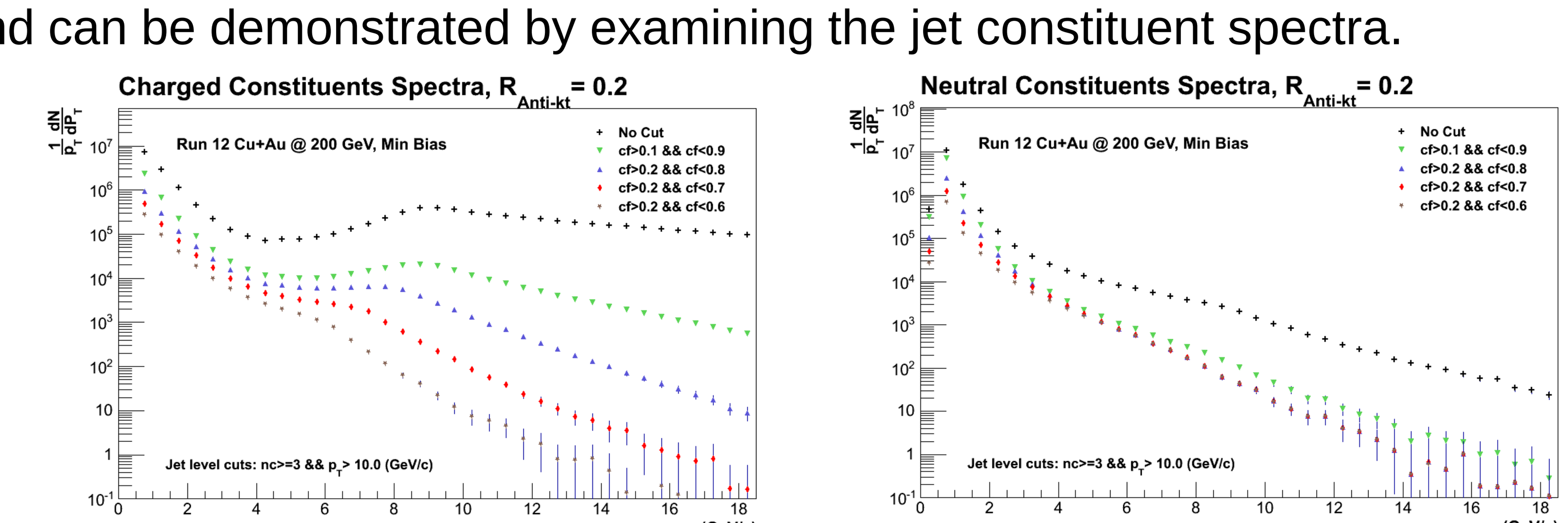

Figure 5: The spectra of charged constituents (left) and neutral constituents (right)

The effect of cf can be quantified by taking the ratio of charged and neutral constituent spectra.

Figure 6 demonstrates the power of cf cut. For cf>0.2 and cf<0.7, the ratio becomes flat and stays flat up to high p_T in both Cu+Au and p+p dataset.

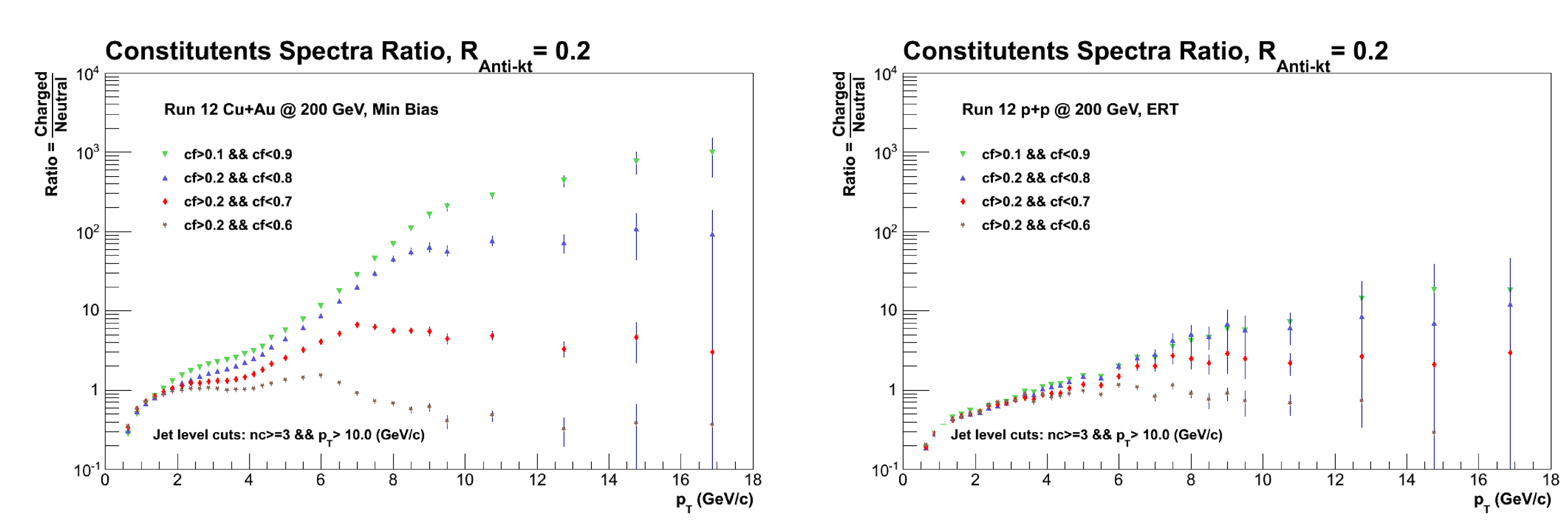

Figure 6: The ratio of charged and neutral spectra for Cu+Au dataset (left) and p+p dataset (right)

References: [1] arXiv:0802.1189v2 [hep-ph] [2] arXiv:hep-ph/0010017v1 [3] arXiv:nucl-th/9502021v1

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