Jet and Di-jet Underlying Event in p+Au Collisions at $\sqrt{s_{NN}}$ = 200 GeV at STAR

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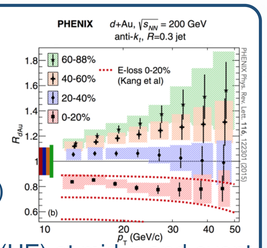
ABSTRACT: In this poster, we present underlying event (UE) measurements and show the trends of UE in relation to event activity (EA) in *p*+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV measured with the STAR detector. We show correlations of backward-rapidity (Au-going) EA with mid-rapidity UE for high-transverse momentum (p_T) jet events vs. di-jet events. Additionally, we study collision kinematics via observables including jet rapidity (η) and jet p_T as a means of investigating the initial hard scattering of partons in these events.

Introduction

- Motivated by unexpected observation of suppression and enhancement of jets as a function of centrality in *d*+Au collisions at PHENIX (R_{dAu})
- How does the hard scattering in an event affect underlying event (UE) at mid-η and event activity (EA) at backward-η (in the Au-going direction)?
- To investigate, we study underlying event differentially as a function of EA, UE η, UE-corrected leading jet p_T, and leading jet η in $\sqrt{s_{NN}}$ = 200 GeV *p*+Au collisions at STAR

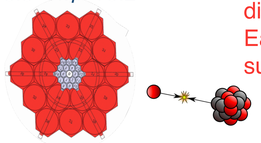


Experiment and Event Activity

Time Projection Chamber (TPC)
- charged tracks, $|\eta| < 1$

Barrel Electromagnetic Calorimeter (BEMC)
- γ, π^0, $e^{\pm}$, … $|\eta| < 1$

Beam Beam Counter (BBC)
- scintillating detector
- East inner BBC (iBBC) $3.3 < |\eta| < 5.2$



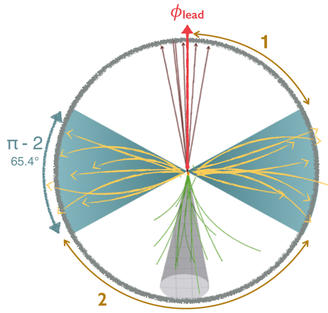
Event Activity is defined by the distribution of the inner BBC East (Au-going direction) signal sum in minimum-bias events
- Low EA: 70-90%
- High EA: 0-30%

Jet and Event Selection

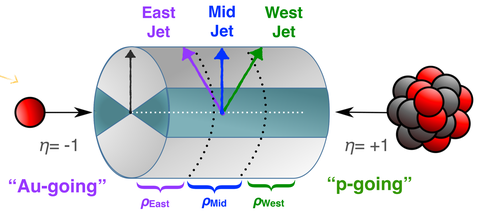
- *R*=0.4 anti-k_T jets Cacciari, M., Salam, G.P., Soyez, G. Fastjet. http://fastjet.fr/
- Charged tracks: $0.2 < p_T < 30.0$ GeV/*c*
- Neutral towers: $0.2 < E_T < 30.0$ GeV
- Leading jet: jet with the highest p_T in an event
- Require a BEMC tower hit with $E_T > 5.4$ GeV within the leading jet radius or the leading jet recoil region $|\phi_{lead} - \phi_{tower}| > \pi - R$
- $p_T^{reco,i} = p_T^{raw,i} - \langle\rho\rangle \cdot A_{jet}^i$ $\langle\rho\rangle = \langle\rho(\eta_{jet}, iBBCEsum)\rangle$
- Events are required to have a leading jet with $|\eta_{lead}| < 1 - R$ and $10 <$ lead $p_T^{reco} < 30$ GeV/*c*

Underlying Event

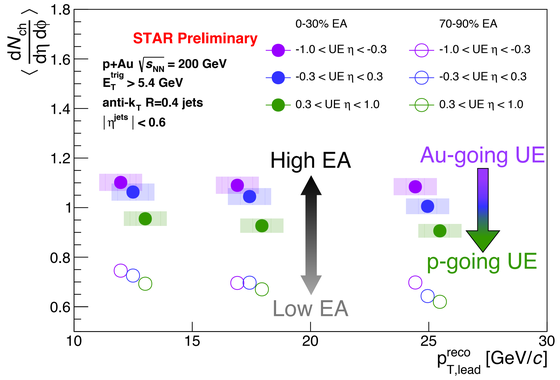
- UE region: $\frac{\pi}{2} \pm (\frac{\pi}{2}\text{-}1)$ from the leading jet axis in ϕ and $|\eta|<1$
- Measurement of charged UE $\langle p_T \rangle$ and $\langle dN_{ch}/d\eta d\phi \rangle$
- Charged UE is corrected for tracking efficiency

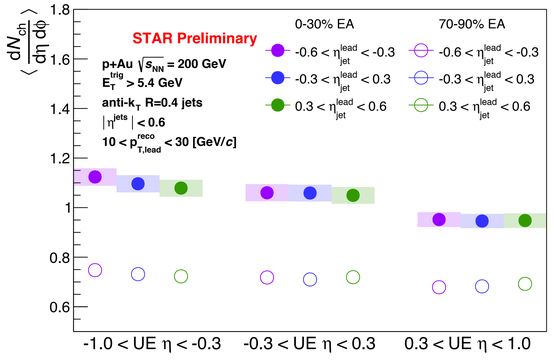


- East UE region: $\eta \in$ (-1.0, -0.3)
- Mid UE region: $\eta \in$ (-0.3, 0.3)
- West UE region: $\eta \in$ (0.3, 1.0)



Differential Study of Underlying Event

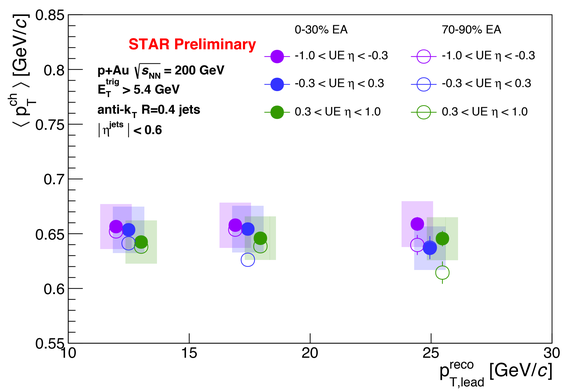




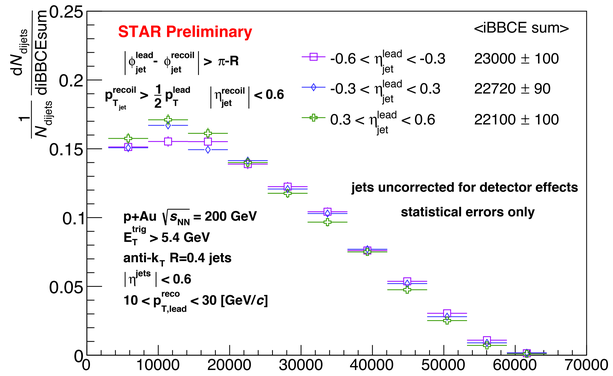
- UE correlated with EA
- $\langle dN_{ch}/d\eta d\phi \rangle$ increases with EA and decreases slightly with leading jet p_T
- $\langle dN_{ch}/d\eta d\phi \rangle$ is independent of leading jet η for UE $\eta > -0.3$
- UE $\langle p_T \rangle$ has no significant dependence on UE region, EA, leading jet p_T (right), or lead jet η (not shown)

Leading jet p_T is corrected for UE but uncorrected for detector effects

Shaded areas indicate mostly correlated systematic uncertainties due to tracking efficiency (±5%)



Di-Jet Correlations with Event Activity



- EA in backward-η depends on the leading jet η in di-jet events requiring a recoil jet within $|\eta|<1$
- $\langle$iBBCEsum$\rangle$ is higher (lower) in events with a Au-going (*p*-going) leading jet
- Additionally, $\langle$iBBCEsum$\rangle$ is lower in events with a larger leading jet p_T (not shown)
- Since there is a negligible probability of recoil jets hitting the iBBC, these trends also persist in inclusive jet events
- The EA in backward-η is dependent on leading jet η while UE at mid-rapidity is independent
- Correlation between hard scattering at mid-η and EA at backward-η—indicates physical mechanism at early times in the collision

Summary

- First differential measurements of UE in *p*+Au events in the presence of jets/di-jets at STAR
- Charged UE particle production is enhanced in the Au-going direction and larger in events with higher EA or lower leading jet p_T
- Jets and UE at mid-rapidity are correlated with EA at backward-rapidity
- Leading jet η influences EA at backward-η but not mid-η UE
- These observations and differential measurements should help constrain models of hard and soft processes in small systems

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The STAR Collaboration
https://drupal.star.bnl.gov/STAR/presentations