Measuring the groomed shared momentum fraction (z_g) in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV at STAR using a semi-inclusive approach

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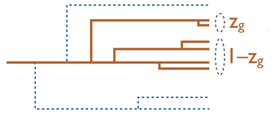
Abstract: This poster presents an ongoing analysis of measuring the jet substructure observable z_g, which probes the physics of the first hard splitting of a hard-scattered parton, in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV. This analysis employs a semi-inclusive approach, selecting candidate jets found within the recoil region of high transverse momentum trigger particles. Contributions from combinatorial jets due to the large fluctuating background is subtracted at the ensemble level using a mixed-event technique.

Groomed Shared Momentum Fraction z_g

- z_g is the momentum fraction of the subleading subjet groomed using SoftDrop [1] (defined here with $z_{cut} = 0.1, \beta = 0$)

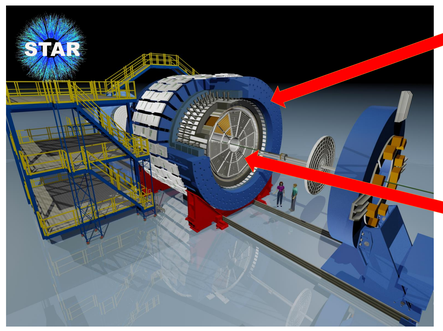
$$z_g = \frac{\mathrm{Min}(p_{T,1}, p_{T,2})}{p_{T,1}+p_{T,2}} > 0.1$$



J. Thaler, Alice Workshop 2015 (figure) Larkoski et al., PRD 91, 111501 (2015)

- Previously measured in STAR for Au+Au collisions [2] using a HardCore selection of dijets to eliminate combinatorial jets
  - No modification of z_g found compared to p+p embedded into Au+Au
  - Requiring a high-p_T particle in jets can induce surface bias
- Is there a different selection of jets in Au+Au collisions at RHIC energies in which z_g is modified?

The STAR Detector



BEMC
Barrel Electromagnetic Calorimeter
- $|\eta| < 1$
- $0 < \varphi < 2\pi$
- Triggering

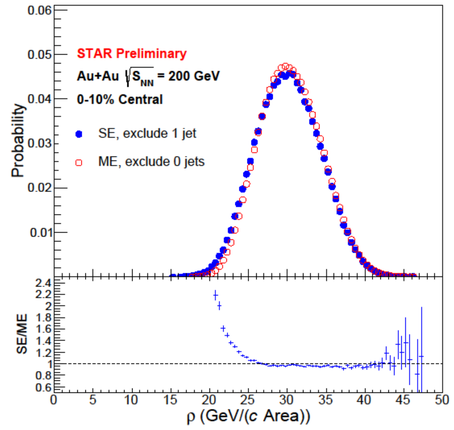
TPC
Time Projection Chamber
- $|\eta| < 1$
- $0 < \varphi < 2\pi$
- Charged particles for jet analyses

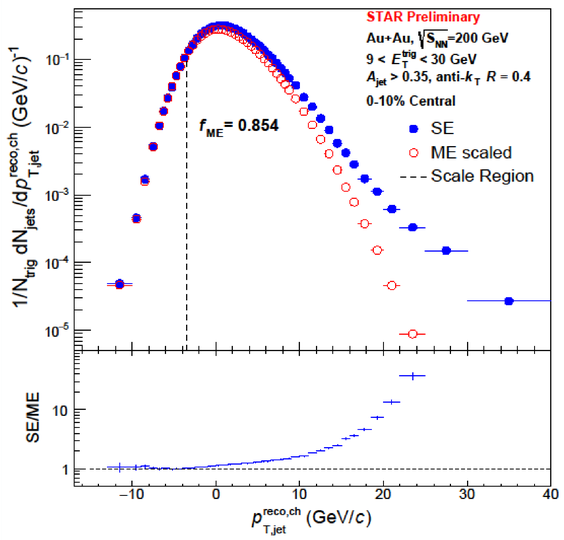
The Semi-inclusive Approach [3]

- Select events with high-E_T trigger, selecting surface-biased high-Q^2
- Reconstruct recoil jets (anti-k_T, R=0.4), biased towards having longer path-length in medium
- Minimal discrimination of combinatorial jets at the jet-level, avoiding surface and fragmentation biases of measured jets
- Subtract combinatorial jets at the ensemble level using mixed events, done in bins of centrality

Using Mixed Events to Remove Combinatorial Jets

- Same Events (SE) require a BEMC tower with $E_T > 9$ GeV
- Mixed Events (ME) are minimum-bias (MB) events with charged tracks mixed such that particle correlations are destroyed
- Events binned and sampled in classes of event vertex position along the beam direction, luminosity, event-plane angle and charged track multiplicity
- Event mixing and combinatorial jet subtraction independently done for 0-10% and 10-20% centrality
- Unlike SE, no jets excluded when calculating ME ρ, the event-wise background density



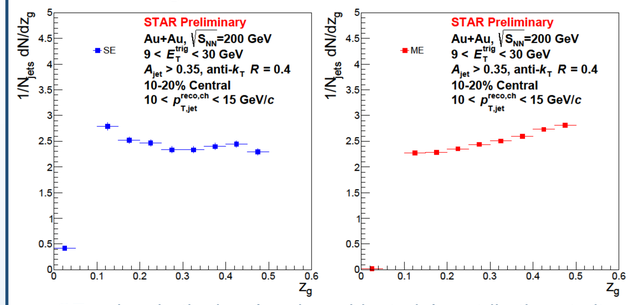


- Jets reconstructed in SE and ME in the recoil range of the trigger object of the SE $|\varphi_{jet} - \varphi_{trig}| > \pi - \pi/4$
- Jets' p_T are shifted using area-based subtraction:

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

- The total per-trigger yield of jets within the recoil range is approximately the same for both ME and SE,
- Before scaling, lack of signal yield at high $p_{T,jet}$ in ME enhances the ME yield at low $p_{T,jet}$
- Most negative $p_{T,jet}$ region expected to have same per-trigger yields, ME scaled down by factor f_{ME} to compensate

SE and ME z_g Distributions

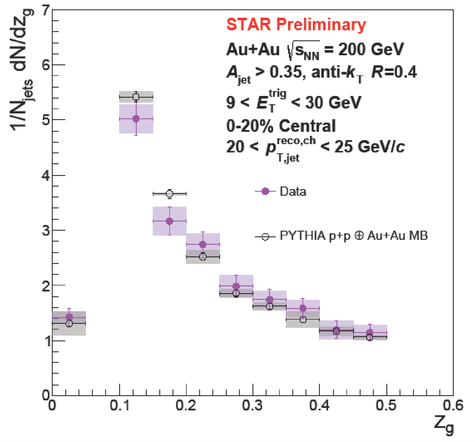


- SE z_g has both signal and combinatorial contributions to its distribution
- ME z_g consists of purely combinatorial contributions

- Both event classes are background subtracted using Constituent Subtraction [4] at the jet-level
- Zero bin filled by jets which do not pass the SoftDrop criterion
- SE and ME z_g have distinct shapes, especially important at low $p_{T,jet}$ where combinatorial jet contribution is significant

Combinatorial-subtracted z_g

- Combined **0-20%** centrality detector level jets with $20 < p_{T,jet}^{reco,ch} < 25$ GeV/c
- Insensitive to details of combinatorial subtraction in this p_T range (~5% combinatorial jets in SE for 0-10% central, less for 10-20% central)
- Comparison to smeared PYTHIA-6 embedded into MB 0-20% Au+Au events
- No significant modification found in this $p_{T,jet}$ bin compared to PYTHIA-6



Summary and Outlook

- Measured z_g for 0-20% central events within $20 < p_{T,jet}^{reco,ch} < 25$ GeV/c bin which is insensitive to details of combinatorial subtraction
- No clear z_g modification observed for $20 < p_{T,jet}^{reco,ch} < 25$ GeV/c compared to smeared PYTHIA-6 baseline embedded into Au+Au events
- Plan to utilize this semi-inclusive approach to measure z_g down to lower jet p_T without inducing a strong surface or fragmentation bias

References

[1] A. J. Larkoski, S. Marzani, G. Soyez, J. Thaler, "Soft Drop", JHEP 05 (2014) 146
[2] STAR Collaboration, "Measurement of shared momentum fraction z_g", arXiv:1703.10933
[3] STAR Collaboration, "Semi-inclusive hadron+jet distributions", Phys. Rev. C 96 (2017) 24905
[4] Berta,P., Spousta, M., Miller, D.W. *et al.* "Particle-level pileup subtraction", JHEP 1405(2014) 92

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