# Studying Geometric Bias for Jet-Hadron Correlations with Monte Carlo Models

Michael Oliver, Kirill Lapidus

## Motivation

- A key topic in heavy ion collisions is investigating the path-length dependence of jet energy loss and broadening.
- The path length through the medium is determined entirely by the geometry, but the experimental observability of path length dependence is impacted by fluctuations in the jet-medium interactions.

## Models

- **JEWEL**: Explicit pQCD treatment of hard parton $2 \rightarrow 2$ scatterings with partons sampled from a simple medium model [1]. JEWEL has two modes:
  - No Recoils: the sampled scattering centers are not kept or included in the hadronization phase.
  - Keep Recoils: the scattered partons from the medium are kept and included in the hadronization phase. An issue with this model is the added thermal energy of the scattering centers and the partial background these particles create.

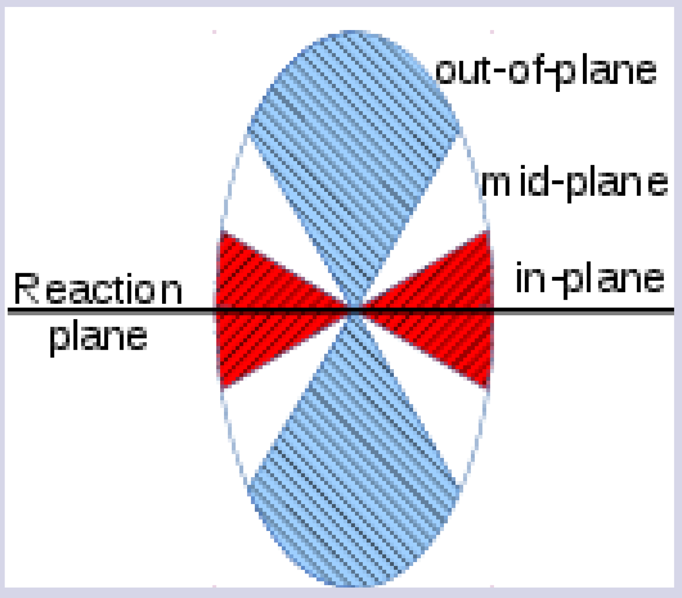
## Geometry Bias

### Trigger Surface Bias

- Intuitively, the leading jet in a dijet pair in a heavy ion collision will have lost less energy, and is often assumed to originate nearer to the surface, implying the other jet traverses more of the medium.
- However, experimental observations of dijet asymmetry can be explained in JEWEL by fluctuations in the interaction with the medium and not the path-length [2].

### Event Plane Dependence

- In non-central collisions, the traversed path-length varies with angle relative to the event plane.
- We can try examining path-length dependence by measuring jets in different angles relative to the event plane. Define three regions:
  - In-plane: $|\phi_{jet} - \Psi_{EP}| < \pi/6$
  - Mid-plane: $\pi/6 < |\phi_{jet} - \Psi_{EP}| < \pi/3$
  - Out-of-plane: $|\phi_{jet} - \Psi_{EP}| > \pi/3$




## Jet-Hadron Correlations

- By measuring jet-hadron correlations, we aim to study how jets are modified by the presence of a Quark-Gluon Plasma, especially by looking at energy loss and broadening from gluon bremsstrahlung and collisions.
- Trigger on an anti-$k_t$ jet, collect correlations with hadrons in the event in $\Delta\eta, \Delta\phi$.

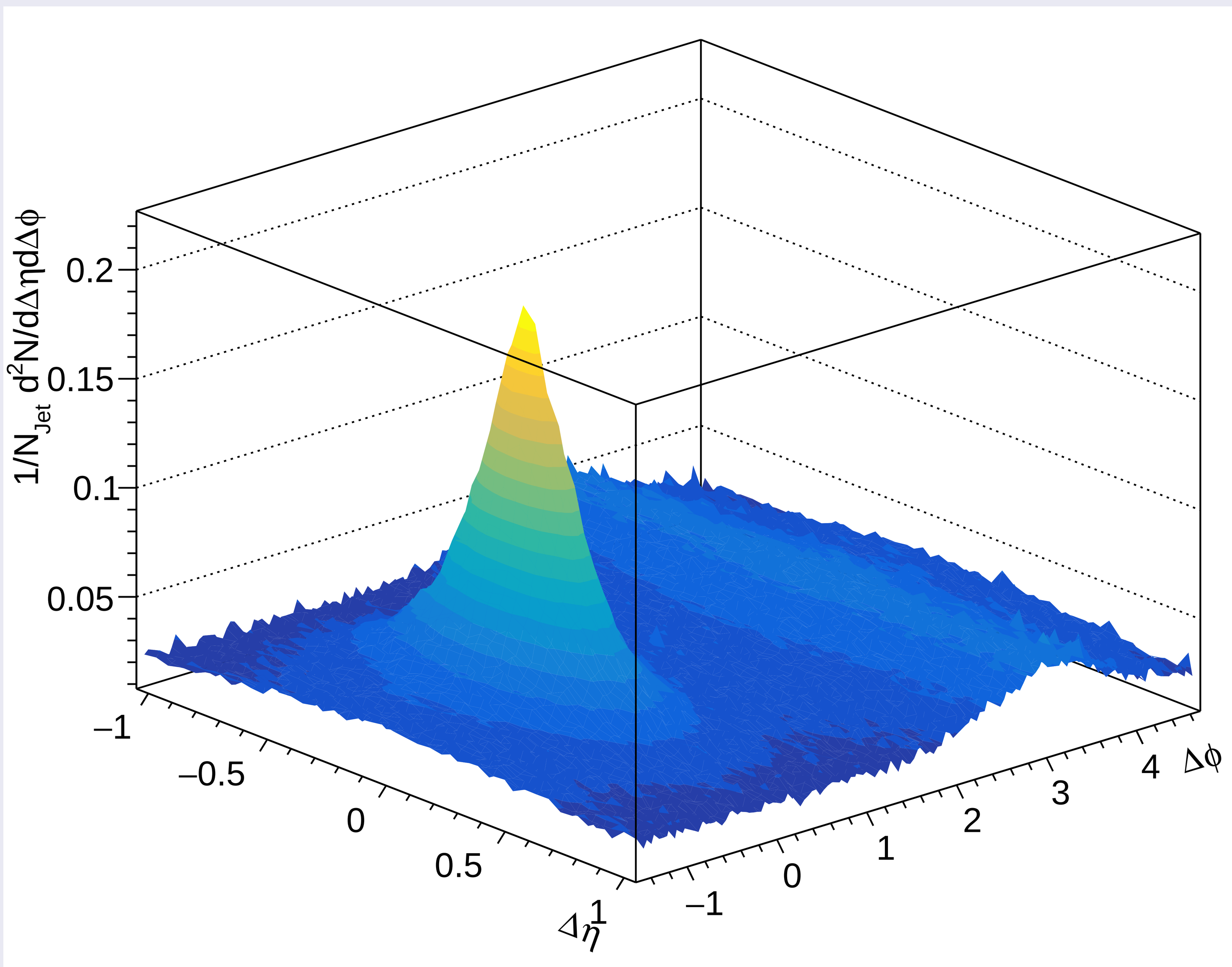
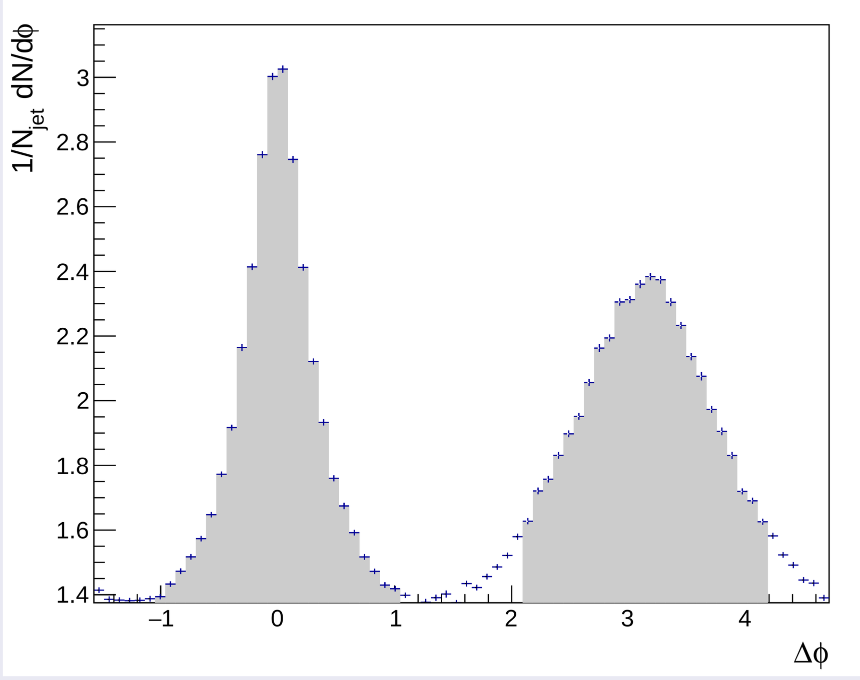



Figure: Jet-Hadron Correlations for $20 < p_T^{jet} < 40$ GeV/c, $1 < p_T^{hadron} < 1.5$ GeV/c, JEWEL PbPb, Keep Recoils

## Analysis

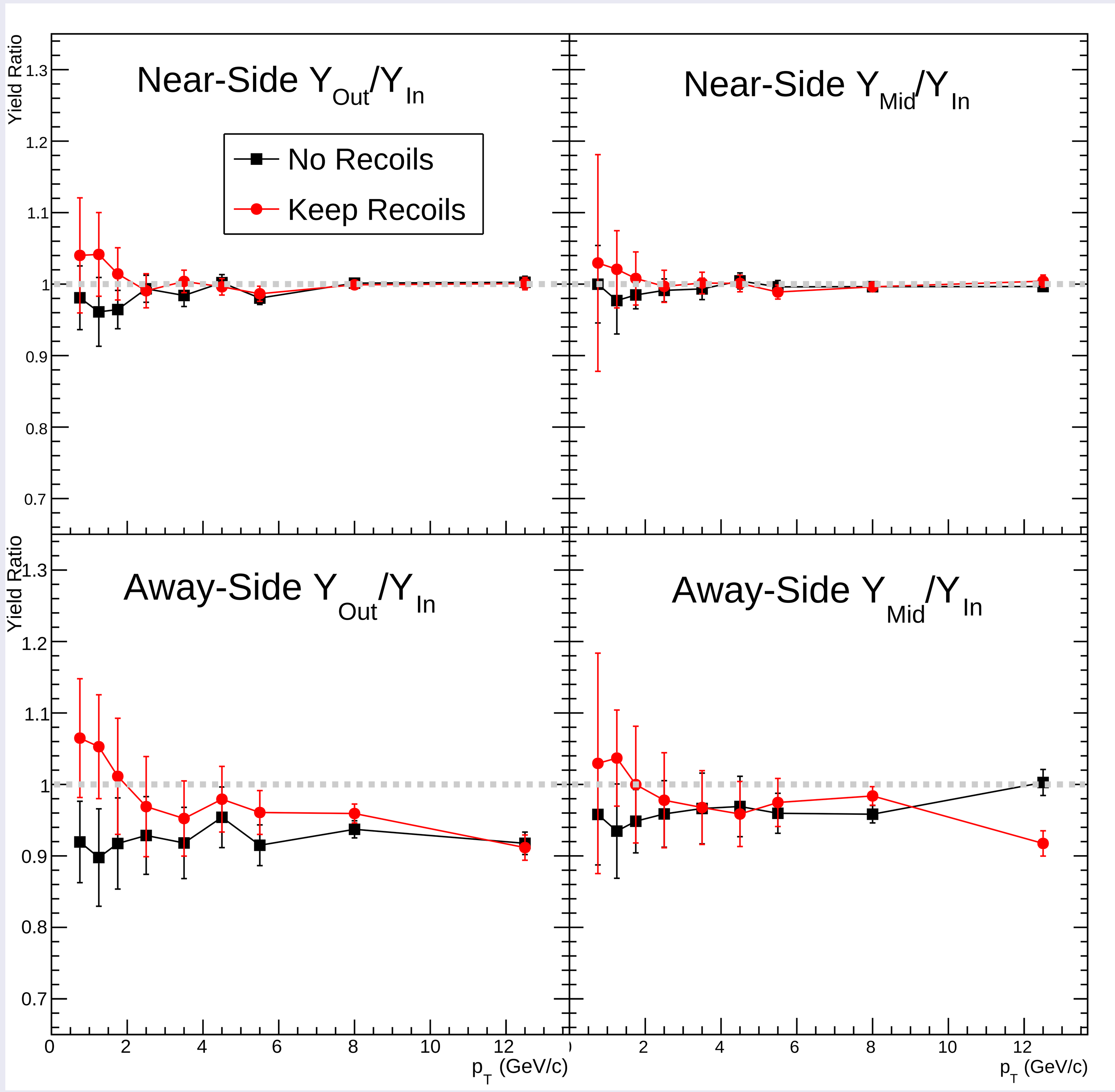
- Use same cuts, parameters as used in ALICE experimental analysis (See Talk by Joel Mazer on Tues. for ALICE experimental results)
  - Trigger on full anti-$k_T$ (R=0.2) jets with constituents $p_T > 3$ GeV/c
  - Rapidity Cuts: $|\eta^{jet}| < 0.5$, $|\eta^{assoc}| < 0.9$
- Correct $\Delta\eta, \Delta\phi$ Correlations for finite acceptance.
- We calculate the yields of particles correlated with the trigger jet on the near-side ($\Delta\phi \approx 0$) and on the away-side ($\Delta\phi \approx \pi$)
  - Subtract constant background (assume Zero Yield at Minimum (ZYAM))
  - Direct integral over $|\Delta\phi| < 1.047$ for near-side and $|\Delta\phi - \pi| < 1.047$ for awayside




- To estimate systematic error from background subtraction, use three different fit functions to estimate constant background term.

## Event Plane Predictions

- Examine path-length dependence by comparing yields of associated particles for each peak in different event plane bins.
- Shown are the peak integrals for the peaks in out- and mid-plane bins divided by the near-side bin, for $20 < p_T^{jet} < 40$ GeV/c. Error bars include estimated systematic uncertainty from the yield calculations.




## Summary and Outlook

- JEWEL predicts weak observable path-length dependence through event plane binning on yields in jet-hadron correlations, and only in the away side yields.
- We will examine other models that have less dependence on fluctuations (YaJEM [3]) to compare.

## References and Acknowledgements

[1] K. Zapp *et al.* JHEP 1303 (2013) 080, EPJC C60 (2009) 617.

[2] J. Milhano, K. Zapp. EPJC C76 (2016) 288.

[3] T. Renk, Phys. Rev. C 84 (2011) 067902.

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