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Abstract

The new sPHENIX detector at Brookhaven's National Laboratory's Relativistic Heavy Ion Collider (RHIC) was designed to significantly further the study of the nature of hot nuclear matter. The use of jets as a probe in p+A and A+A collisions allows access to the interaction of the hard-scattered partons with the nuclear environment and is sensitive to a wide range of scales. Using calorimetric jets constructed from the electromagnetic and hadronic calorimeters, the hadronic being first of its kind at midrapidity at RHIC, we can study their substructure to learn more about the properties of the Quark Gluon Plasma (QGP) produced during heavy ion collisions. This poster will outline the method used to construct purely calorimetric jets from underlying event subtracted calorimeter towers, by first clustering calorimeter towers into anti- k_t $R = 0.2$ "subjets" and then clustering the subjets into larger R jets for substructure study. We will show the status towards measuring such jet substructure observables as a function of centrality for use in future sPHENIX runs.

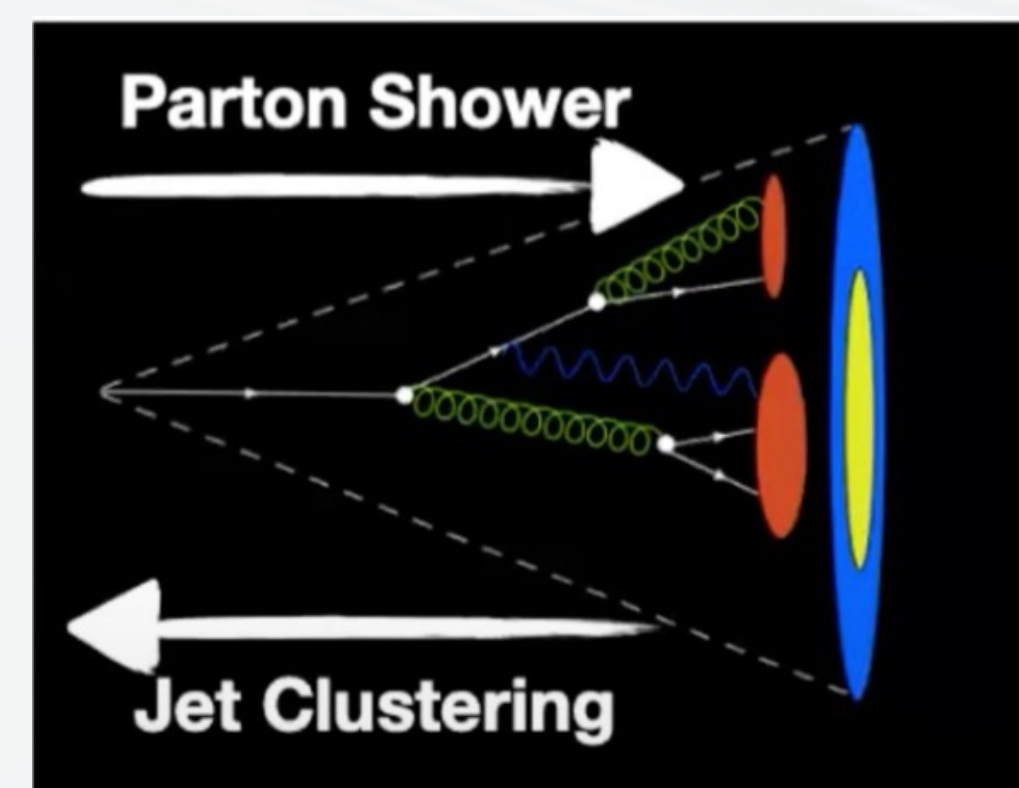
Purpose and Measuring Jets

Jets serve as proxies for the partons produced during a collision, defined using an algorithm and resolution parameter R . For this study, the use of an anti- k_t clustering scheme is used, which clusters using distances between constituents and distance to the beam weighted by the transverse momentum of the constituent as shown below. Jet types in simulation can then be compared through matching in rapidity-azimuthal space, (η, ϕ) , to test reconstruction performance in preparation of applying to data.

$$d_{ij} = \min(k_{t,i}^{2p}, k_{t,j}^{2p}) \frac{dR_{ij}^{2p}}{R^2} \quad d_{iB} = k_{t,i}^{2p}$$

$$dR_{ij}^2 = (\phi_i - \phi_j)^2 + (\eta_i - \eta_j)^2$$

$$p = -1$$

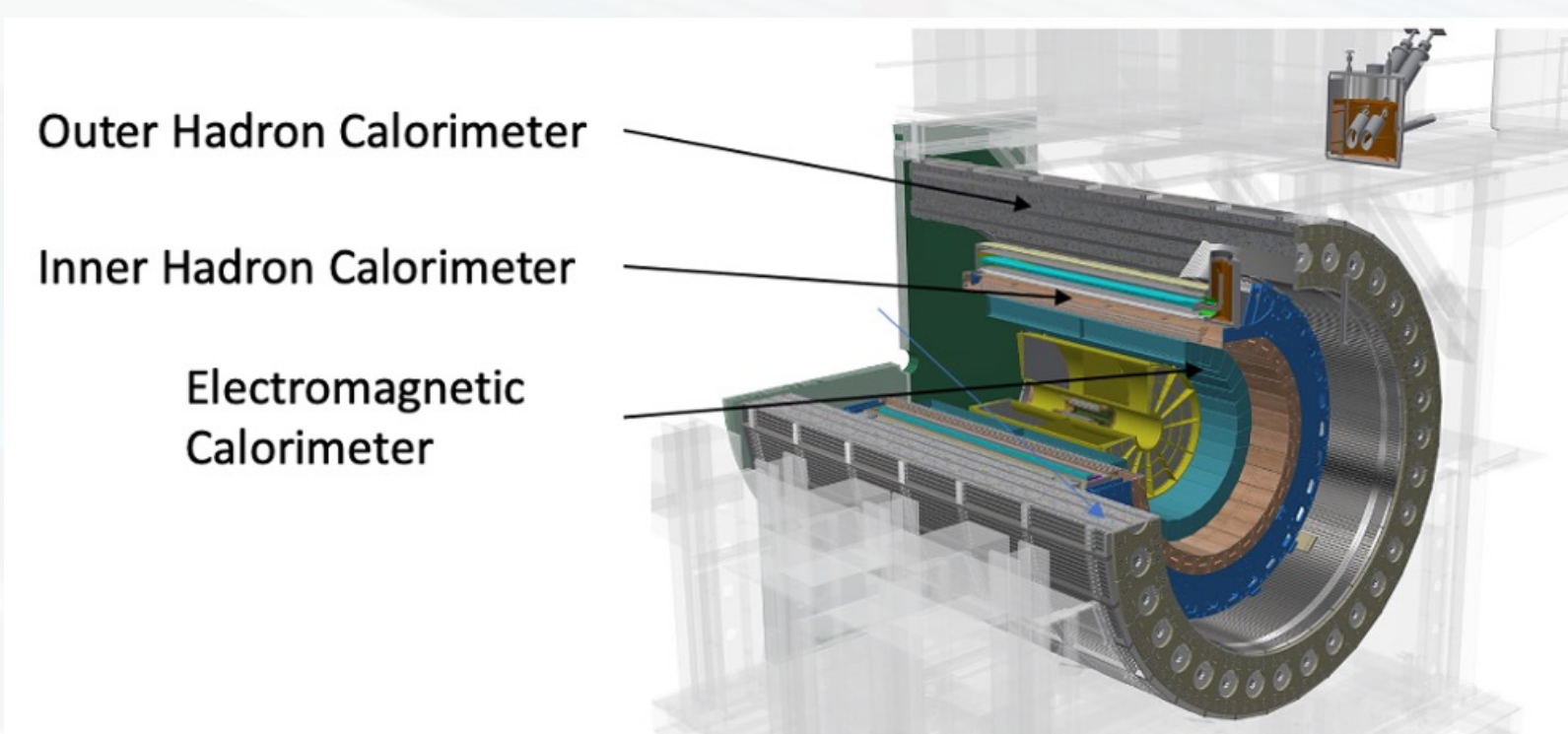


Jet Reconstruction Method

This study performs jet reconstruction in two stages, first clustering to anti- k_t $R = 0.2$ "constituent" jets which are then reclustered to anti- k_t $R = 0.4$ for substructure study. In simulation three types of jets are constructed,

- "Truth Particle Jets" – Anti- k_t $R = 0.4$ jets directly clustered from particles.
- "Truth R=0.2 Constituent Jet" – Anti- k_t $R = 0.4$ jets clustered from $R = 0.2$ constituent jets which are clustered from particles.
- "Reco Jets" – Anti- k_t $R = 0.4$ jets clustered from $R = 0.2$ constituent jets which are clustered from calorimeter towers.

Reco jets are intended for use in data, with the particle jets used for additional simulation studies.

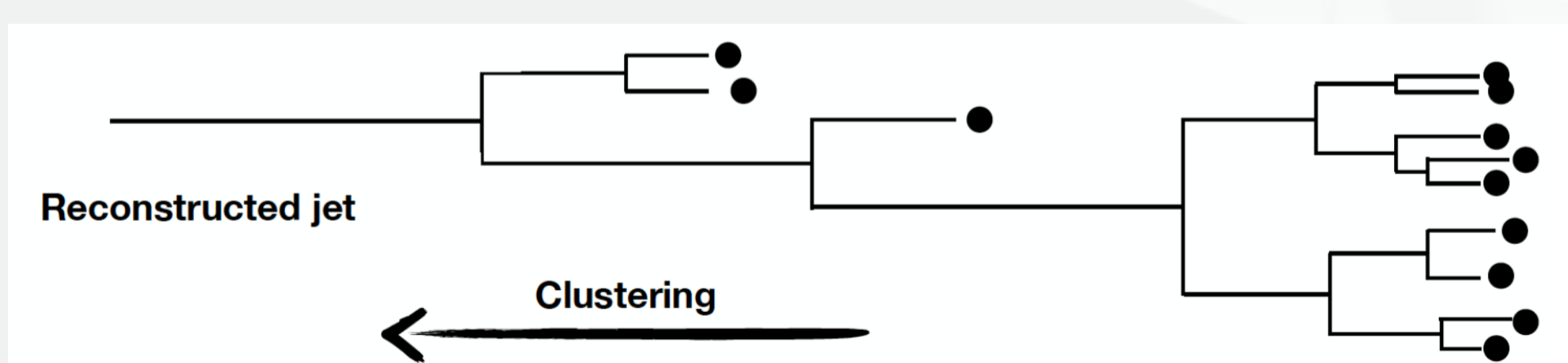


Soft Drop Algorithm

The soft drop algorithm is used to remove soft scattering jets by declustering the jet in 2 constituent increments. This algorithm provides 2 substructure measurements to test jet reconstruction performance,

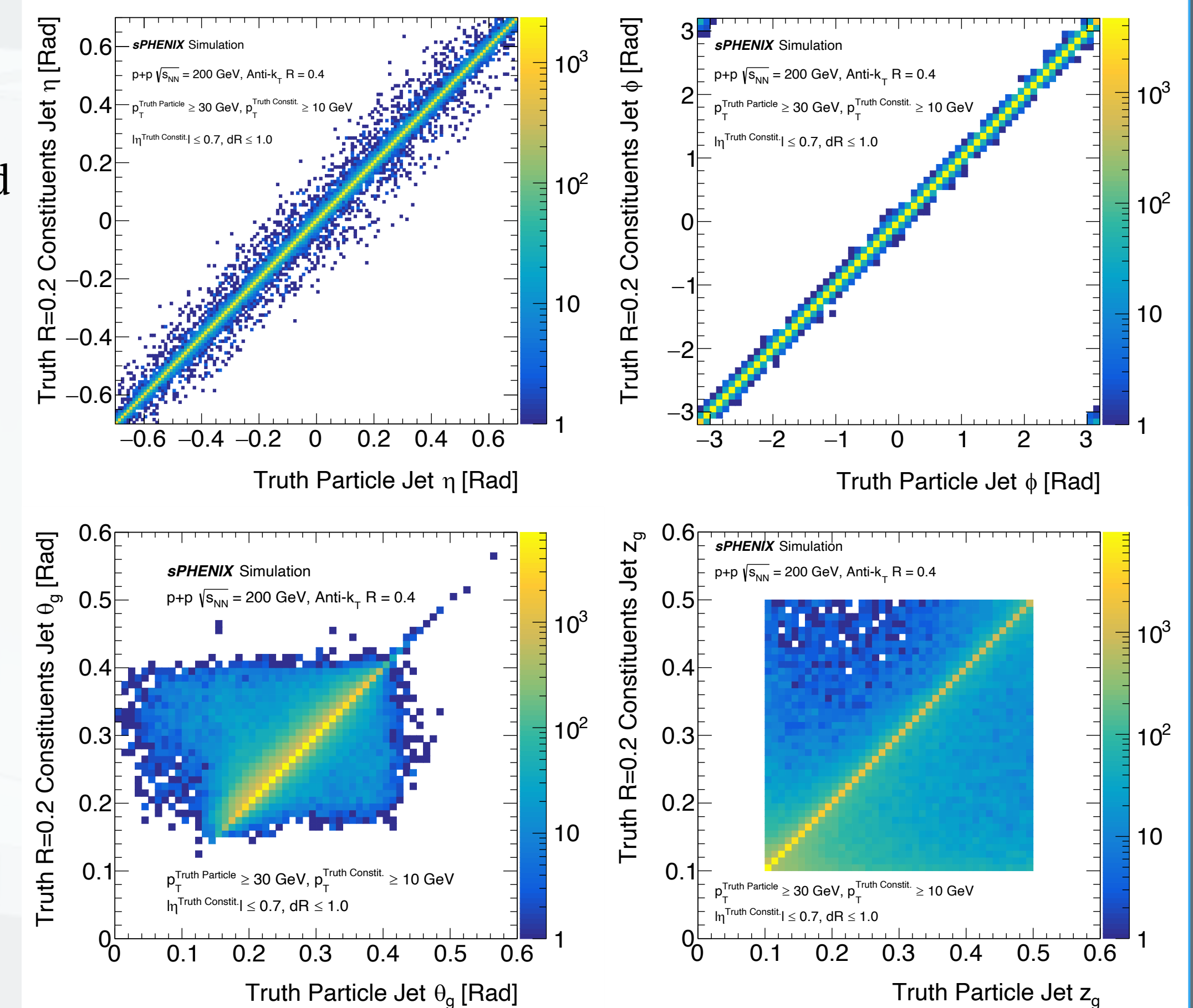
- Groomed Momentum Fraction z_g - The fraction of the jet's transverse momentum carried by the constituent with the lesser transverse momentum.
- Opening Angle θ_g - The distance between the two constituent

$$z_g = \frac{\min(p_{t1}, p_{t2})}{(p_{t1} + p_{t2})} \geq 0.1 \quad \theta_g = \Delta R_{12}$$

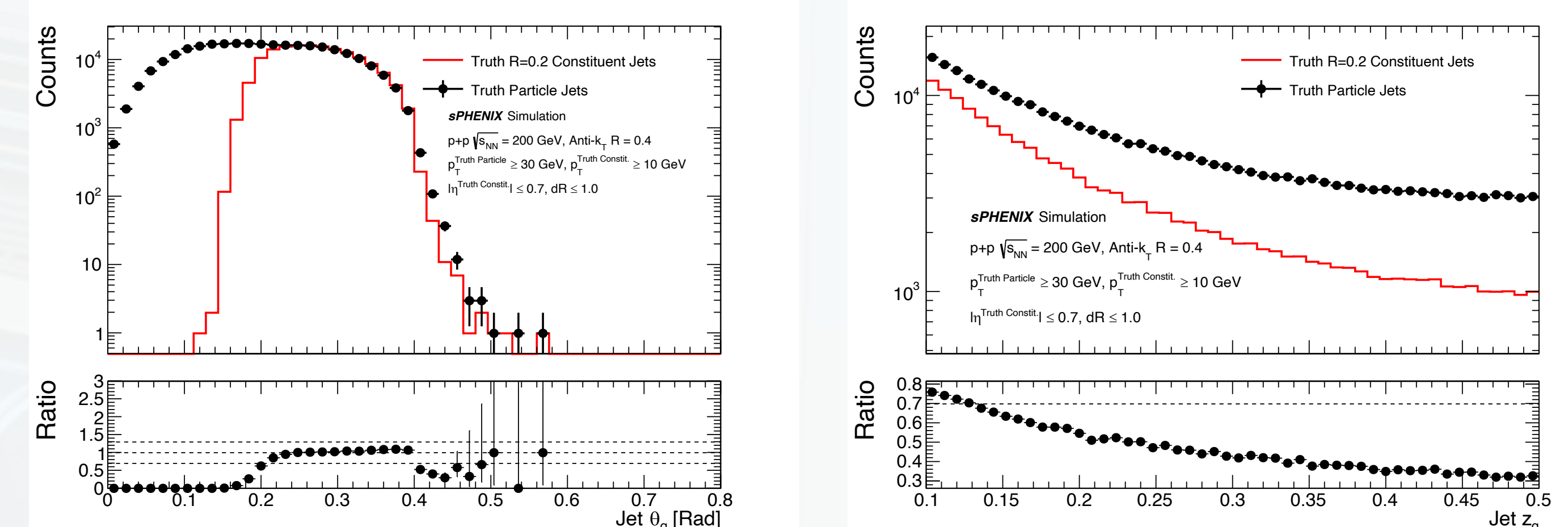


Particle Jet Reconstruction Results

The effect on anti- k_t $R = 0.4$ jet's structure and substructure by reclustering from anti- k_t $R=0.2$ jets was done in simulation using PYTHIA8 p+p. Comparing anti- k_t $R=0.4$ jets clustered directly from particles, "Truth Particle Jets", to jets clustered first into anti- k_t $R=0.2$ constituent jets, "Truth R=0.2 Constituent Jets".

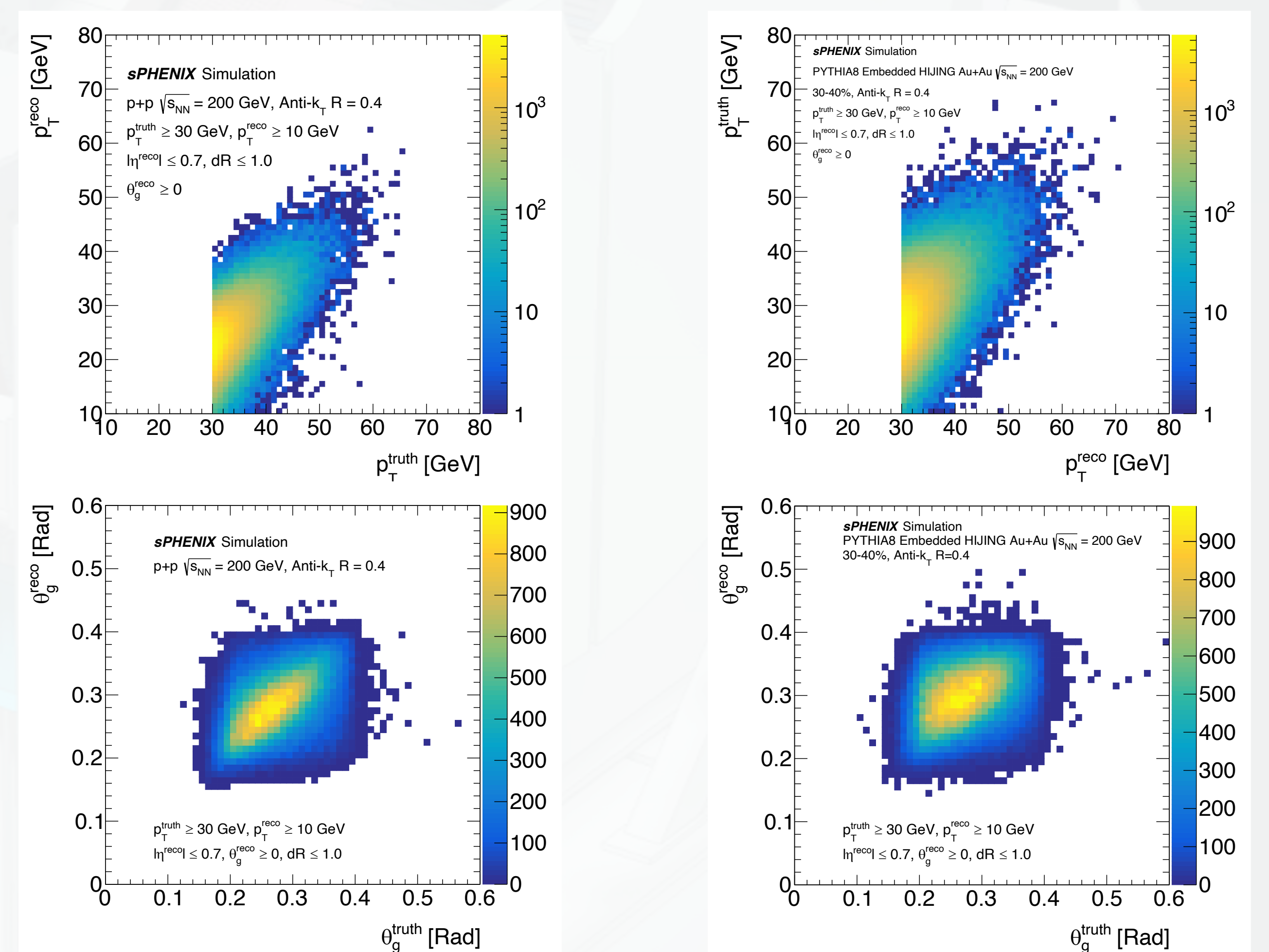


Additional ratio plots as a function of jet substructure quantities were made for further comparison. Reclustering step does limit recovering substructure of jets with θ_g less than R of constituent jet, not an unexpected result.



Calorimeter Jet Reconstruction

Studying matched calorimeter "Reco Jets" and "Truth R = 0.2 Constituent Jets" for both Pythia p+p and Pythia p+p embedded into HIJNING Au+Au.



Correlation found in embedded events; additional selection cuts needed to mitigate impact of underlying event.

Conclusion/Future Work

- Promising results in particle jet comparison showing reclustered jet's substructure is measurable
- Continuing study of reconstruction method in simulated central Au+Au events
- Ongoing studies of $R = 0.2$ constituent jets to define additional/improved selection cuts
- Plan to apply to data in the future