



Quantifying the underlying event for subtraction in jet measurements with sPHENIX

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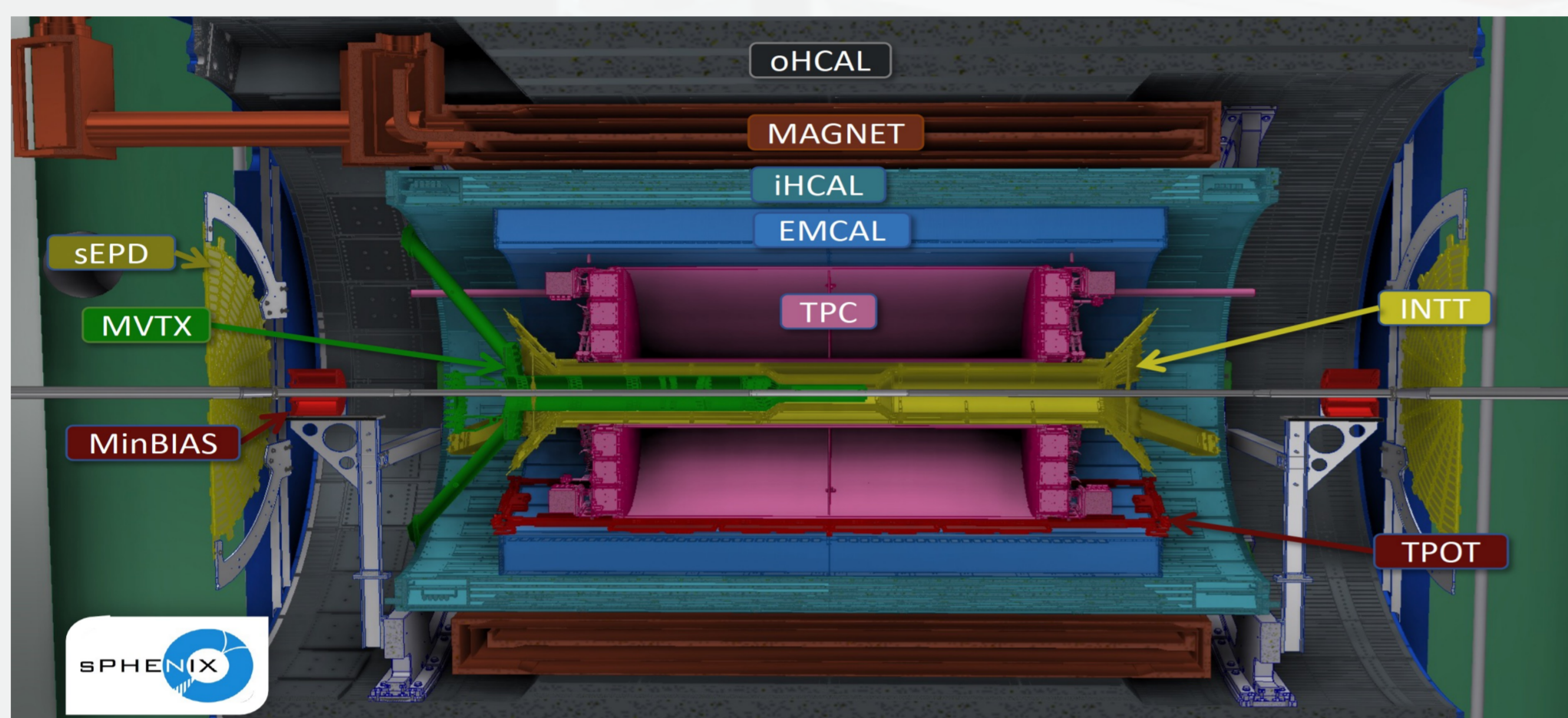


Abstract

The sPHENIX experiment at the Relativistic Heavy Ion Collider (RHIC) is designed to study the properties of quark-gluon plasma (QGP) created in heavy-ion collisions. sPHENIX is equipped with tracking detectors, an electromagnetic calorimeter, and hadronic calorimeters, which allow for the precise measurement of charged particles and the energy and direction of particles produced in the collision and are crucial for reconstructing and determining the energy of jets. High-energy jets produced through hard scatterings in heavy-ion collisions provide valuable insight into how patrons interact and lose energy in the QGP. In sPHENIX, jets are reconstructed by clustering energy from all three layers of the calorimeter. Due to the presence of the underlying event (UE), which refers to all particles produced from sources other than the hard-scattering process, accurate quantification and subtraction of UE from jet measurements are crucial to avoid an overestimation of jet energy and distortion of jet properties. This poster will present the status of sPHENIX event-by-event estimation of the UE as a function of event activity throughout the 2023 data-taking period and plans for extracting measurements with underlying event-subtracted reconstructed jets.

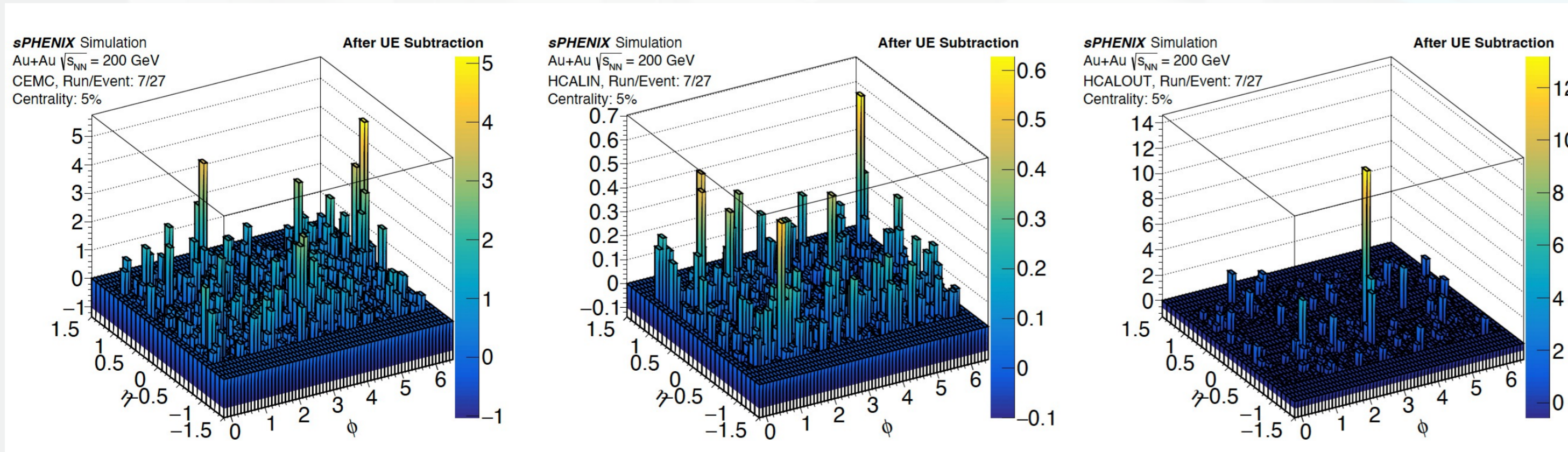
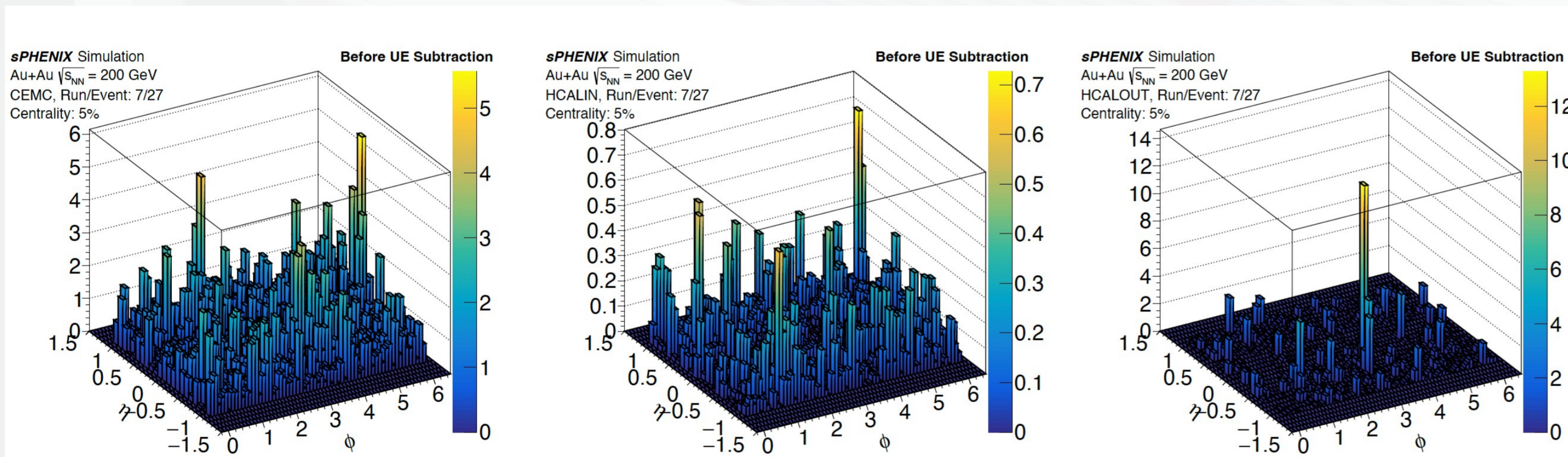
The sPHENIX Detector

- sPHENIX is a new experiment at RHIC
- Equipped with calorimeters and tracking detectors
- sPHENIX is designed to measure jets, collimated sprays of particles from hard scatterings used to study partonic energy loss in the Quark Gluon Plasma
- Jets studies presented here are reconstructed with the anti- k_T algorithm using towers from the sPHENIX calorimeters (EMCAL, iHCAL and oHCAL)
- sPHENIX HCAL is the first hadronic calorimeter at mid-rapidity at RHIC



Underlying Event Subtraction

- Particles produced in heavy-ion collision not associated with the hard scattering are collectively called the underlying event (UE)
- Need to subtract the contribution of these particles from the jet energy
- UE is measured in η slices that exclude jets
- The UE contribution is subtracted from each layer of the calorimeter
- Jets are reconstructed from the subtracted towers
- The goal is to obtain precise measurements of jet properties like energy, momentum, and substructure
- Presented studies use PYTHIA 8 embedded in HIJING

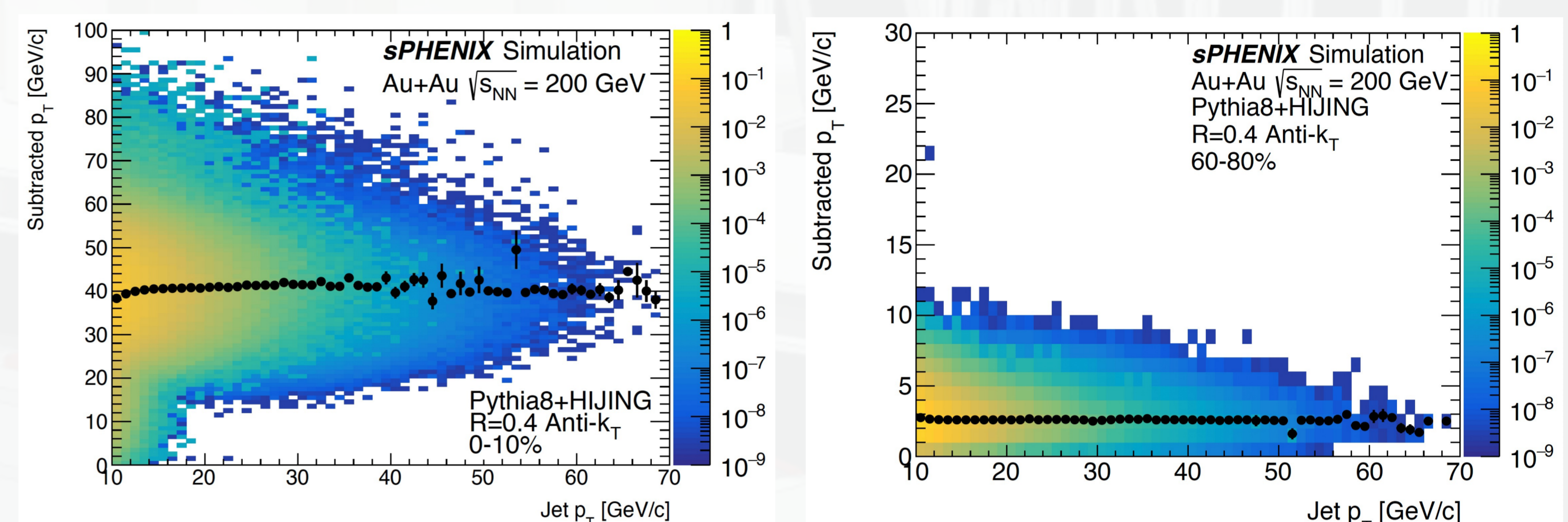


Raw tower energies for each layer of the calorimeter system before (top) and after (bottom) UE subtraction

Acknowledgment

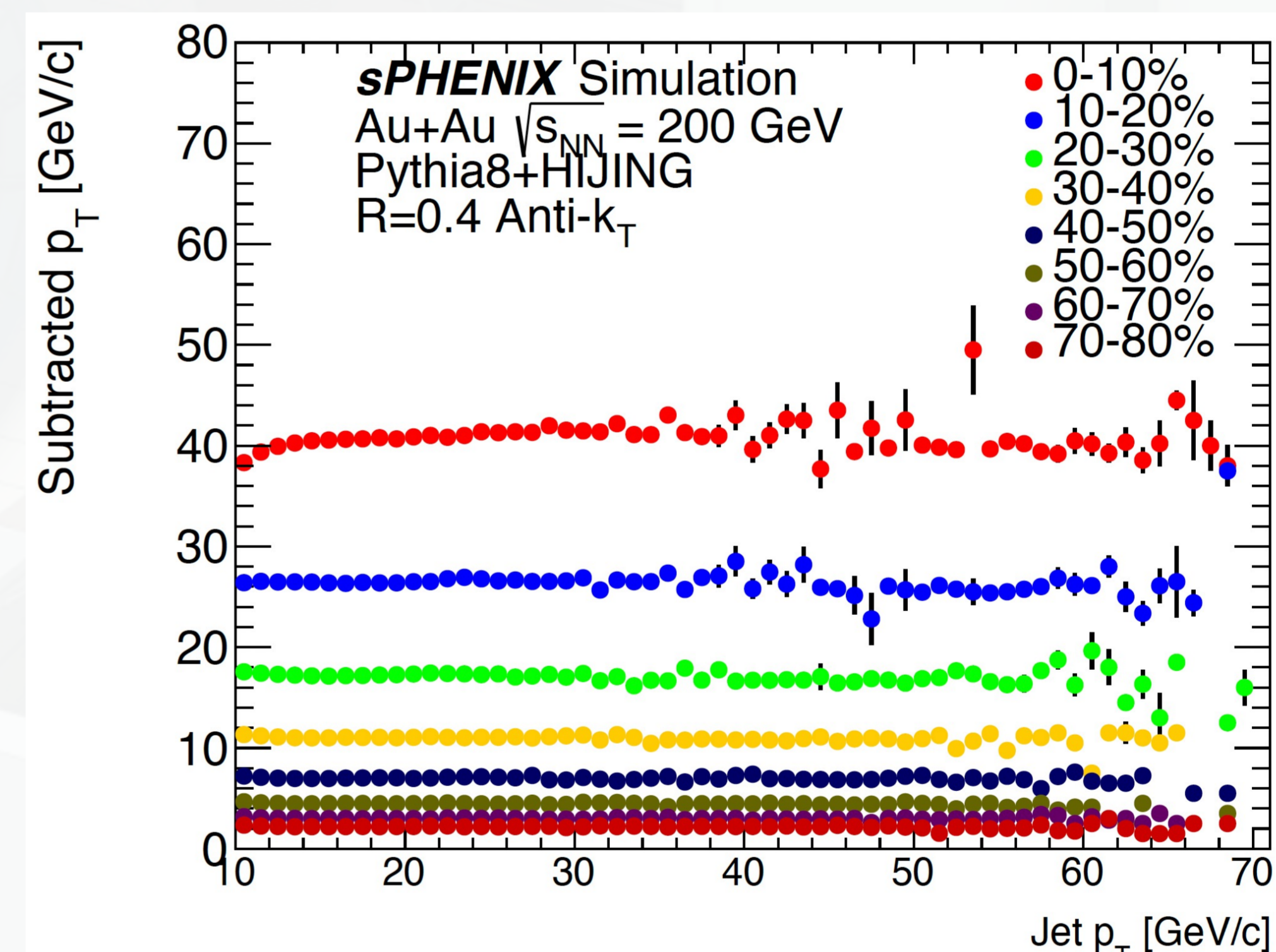
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Centrality Dependence of Underlying Event



The total energy of the UE subtracted from the jet is plotted vs the subtracted energy of the jet for central events (left) and peripheral events (right).

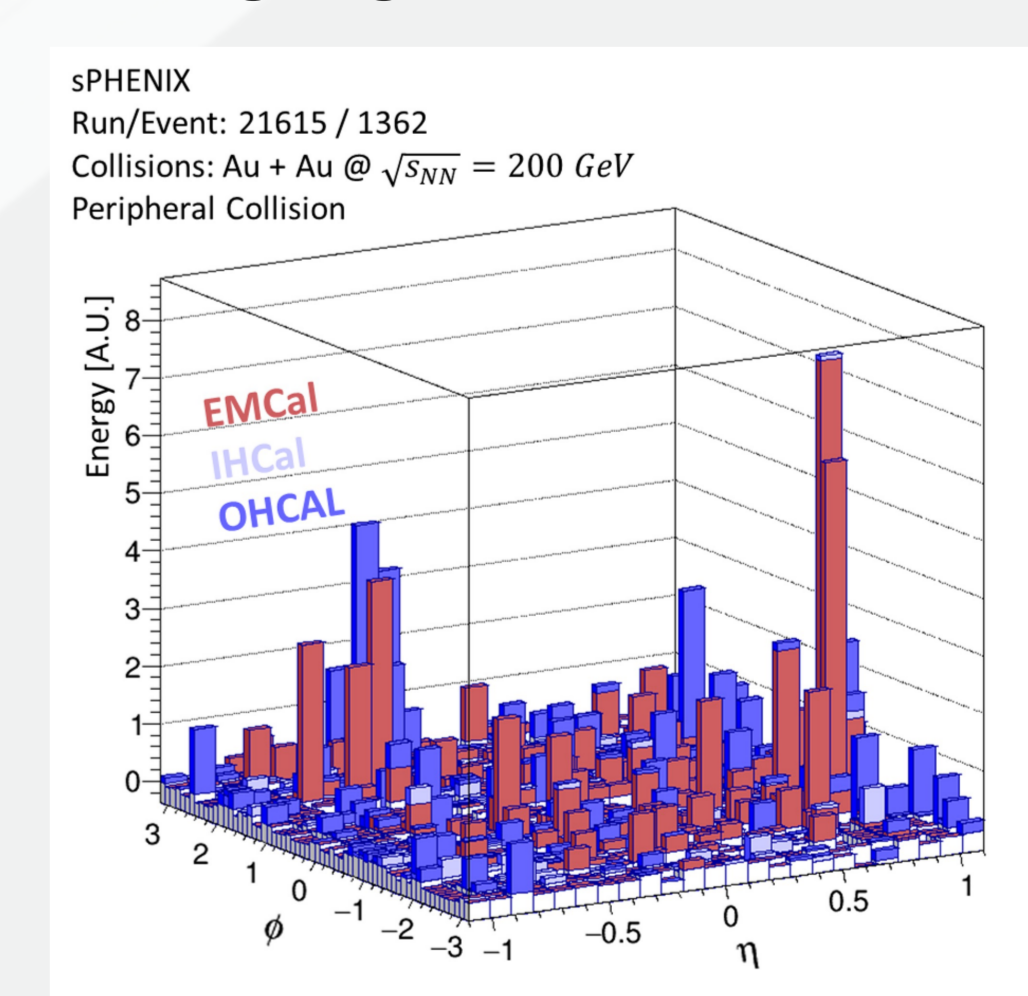
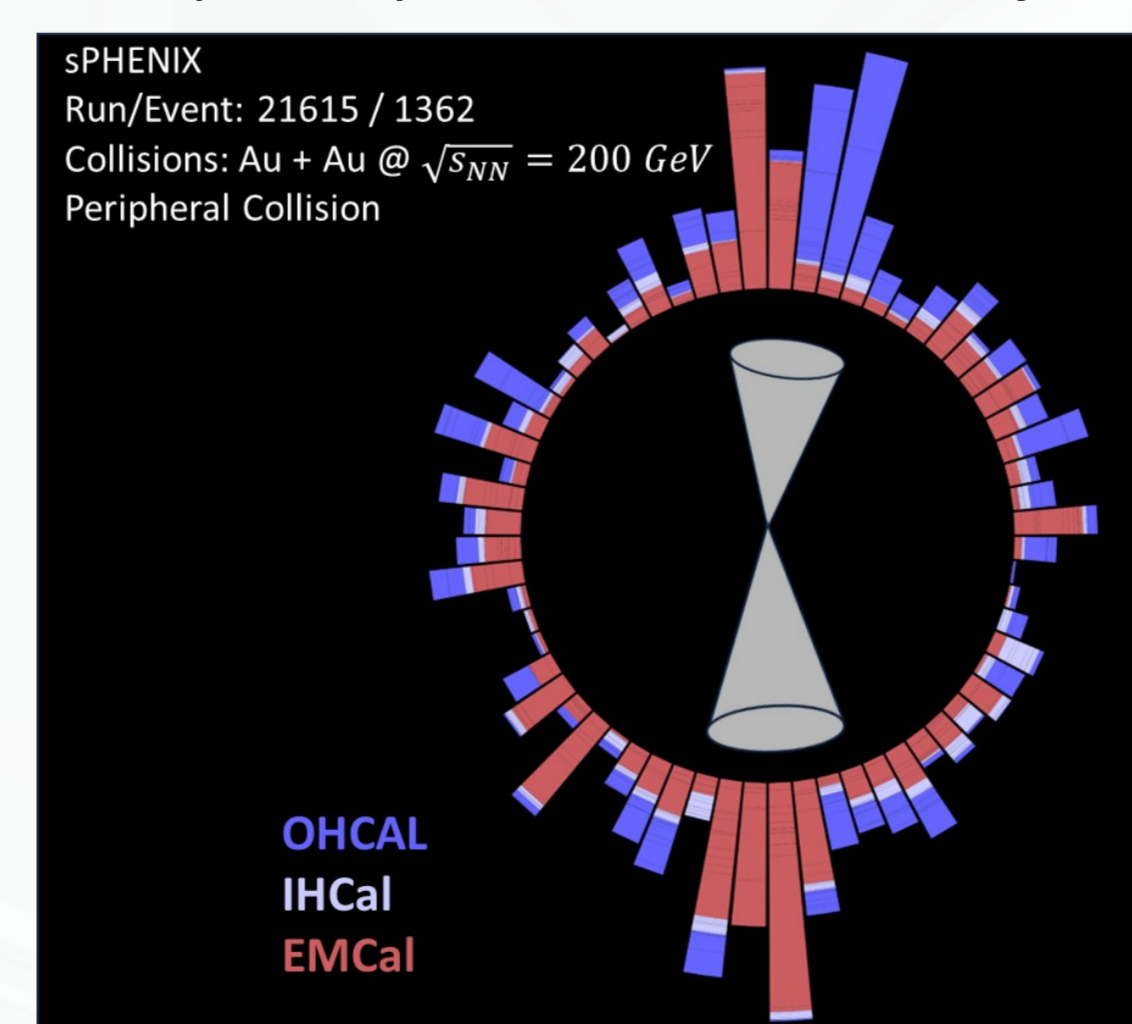
- The average UE subtracted versus jet energy is plotted for PYTHIA8 jets embedded in HIJING.
- The size of the UE increases for more central collisions as expected, providing confidence in the UE subtraction procedure
- For more central events, more UE is subtracted



The total energy of the UE subtracted from the jet is plotted vs the subtracted energy of the jet for each centrality bin as a different color.

Conclusions

- UE subtraction behaving well for simulated Au+Au events
- sPHENIX started collecting data in Spring 2023
- Studies to quantify the UE and extract jets from data are ongoing



First look at jet reconstruction with data from calorimeters in run 2023.