Charged Particle Pseudorapidity Distributions in Au+Au, Cu+Au, and U+U Collisions.

Zachary Rowan of the City University of New York Graduate School and Baruch College for the PHENIX Collaboration

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Abstract

In light of the recently realized possibility of hydrodynamic flow in small systems, we aim to study, as a function of centrality, very peripheral to semi-central collisions. In this transition region, which has not yet been carefully mapped out, we will study charged particle multiplicity as a function of pseudorapidity. Such pseudorapidity distributions are important for characterizing collision dynamics of relativistic heavy ions. Comparisons will be made of systems with different collision geometries; including Au+Au, Cu+Au, and U+U at top RHIC energy. Measurements will be made with the PHENIX silicon vertex detector in the pseudorapidity range $|\eta| \leq 2.8$.

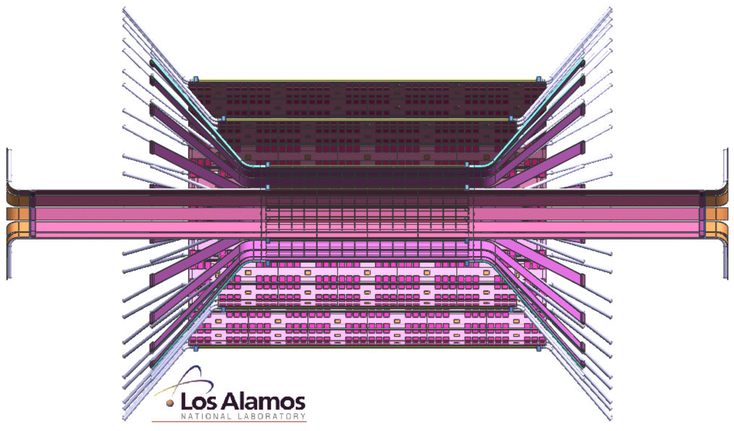

Figure 1: Cutaway view of the half-VTX at PHENIX.

Silicon Vertex Detector (VTX)

- The VTX consists of two inner pixel and two outer stripixel cylindrical layers.
- Tracks of particles from collisions at the center of the detector can be efficiently reconstructed in the pseudorapidity range $|\eta| \leq 1.2$.
- Charged particle multiplicities can be efficiently studied in the $|\eta| \leq 2.8$ when allowing the collision vertex to vary up to around $\pm 30cm$

Approach

All data is taken with the PHENIX magnet off so that straight line tracks may be assumed and low p_T particles can successfully be detected. At the moment only Au+Au collisions with centralities $< 50\%$ are examined. After perfecting it, this technique will be applied to the other RHIC systems with varying centralities. Multiplicities are measured in two separate ways: with multi-layer tracklets and single layer clusters. A cluster is a group of pixels hit by a single particle.

Clusters

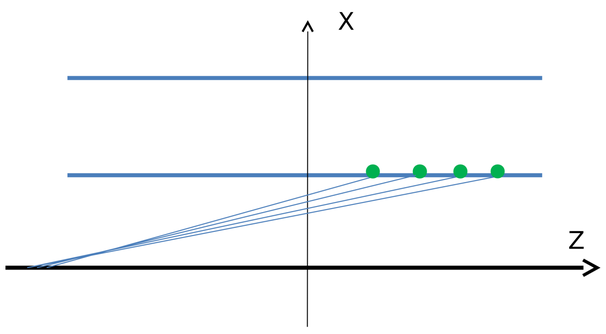

Figure 2: Cluster positions, from a single pixel layer, and the event vertex, as determined by the Beam Beam Counters (BBCs), are used to determine the η for an event

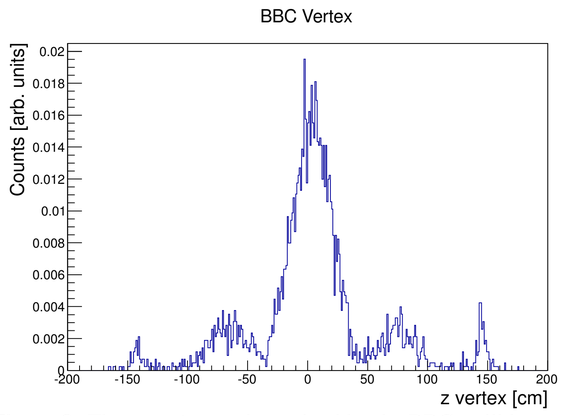

Figure 3: The $z\ vertex$ as determined by the BBCs will be used with VTX cluster positions to determine particle pseudorapidities.

Tracklets

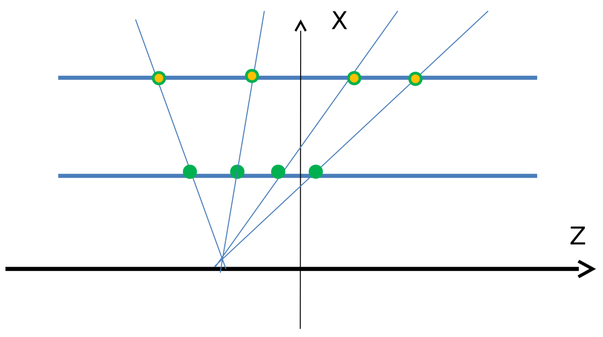

Figure 4: Tracklets are formed by connecting clusters from the two innermost pixel layers with straight lines.

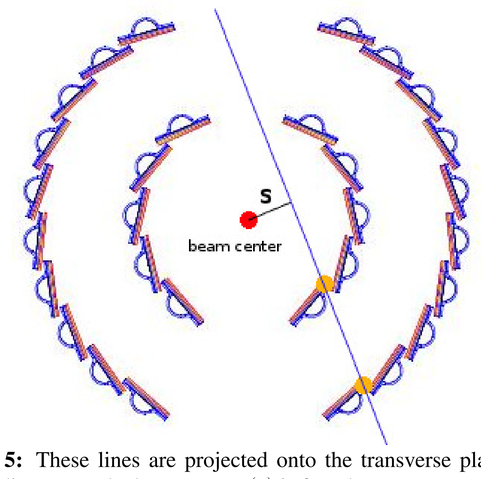

Figure 5: These lines are projected onto the transverse plane. The closest distance to the beam center (s) is found.

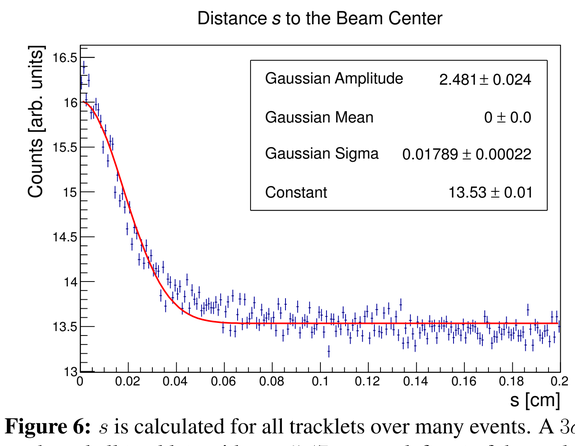

Figure 6: s is calculated for all tracklets over many events. A 3σ cut is made and all tracklets with $s > 5.47mm$ are left out of the analysis.

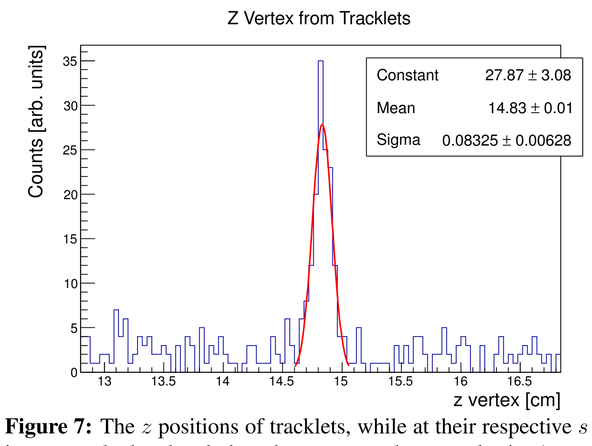

Figure 7: The z positions of tracklets, while at their respective s minima, are calculated and plotted on an event-by-event basis. A $z\ vertex$ is then found.

Results

Pseudorapidity distributions from Au+Au collisions with centralities $< 50\%$ have been found using the VTX. Two separate methods, using clusters and tracklets, have been explored. For all results background, occupancy, and acceptance factors have not been applied.

Clusters

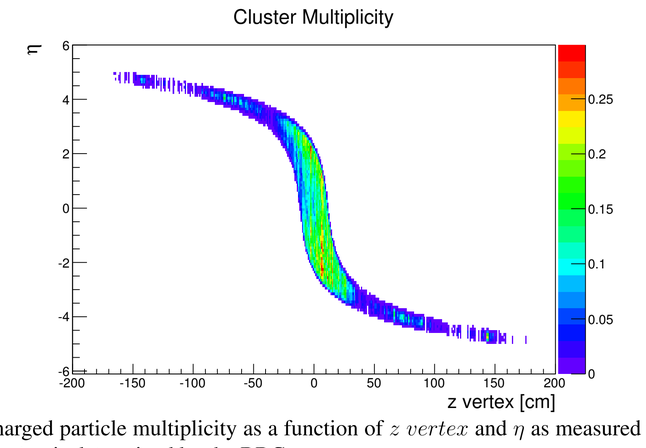

Figure 8: Charged particle multiplicity as a function of $z\ vertex$ and η as measured using clusters. The $z\ vertex$ is determined by the BBCs.

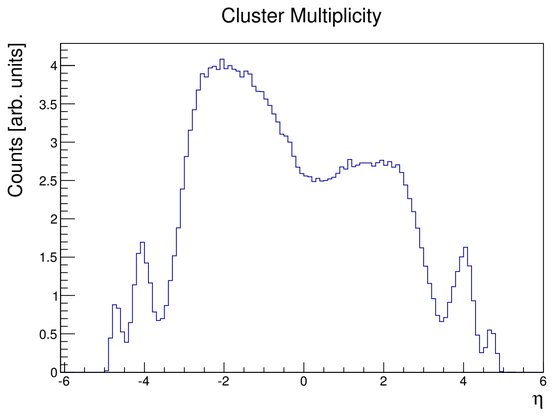

Figure 9: Pseudorapidity distribution of clusters. The heels are caused by the $z\ vertex$ distribution [Fig. 3].

Tracklets

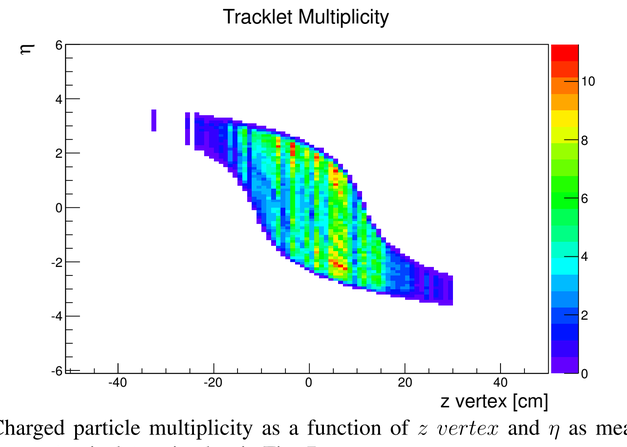

Figure 10: Charged particle multiplicity as a function of $z\ vertex$ and η as measured using tracklets. The $z\ vertex$ is determined as in Fig. 7.

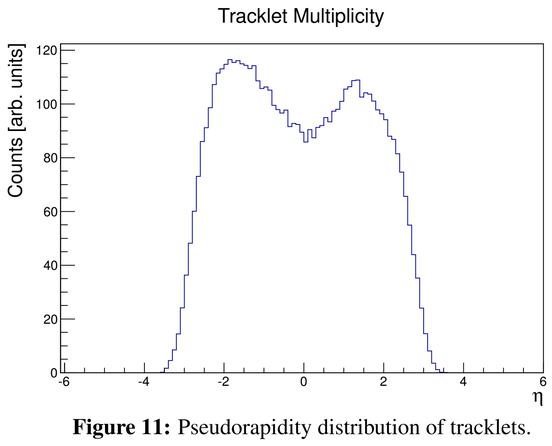

Figure 11: Pseudorapidity distribution of tracklets.

Conclusions

The Silicon Vertex Detector at PHENIX is a suitable detector for measuring charged particle multiplicity as a function of pseudorapidity. The two methods seem promising. However, additional work must be completed. In both methods, backgrounds, acceptances, and occupancies have yet to be fully calculated. We plan to study the relationship between cluster shape/size and pseudorapidity in order to reject more cluster background. Eventually data from the Forward Silicon Vertex Detector (FVTX) will be included to increase our pseudorapidity range.

Contact Information: zrowan@gc.cuny.edu