Charged Hadron Suppression at High p_T in AuAu Collisions at 200 GeV

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Motivation

The nuclear modification factor of single hadrons still provides one of the strongest constraints on energy loss mechanisms in the Quark-Gluon Plasma. Currently the best measurement at RHIC is made with neutral pions. Charged hadrons have independent sources of systematic uncertainty and thus can provide additional constraints. In PHENIX, the background from conversions and weak decays mimicking high p_T particles dominate the spectrum above $p_T > 6$ GeV/c and have limited the measurement of charged hadrons to $p_T < 10$ GeV/c.

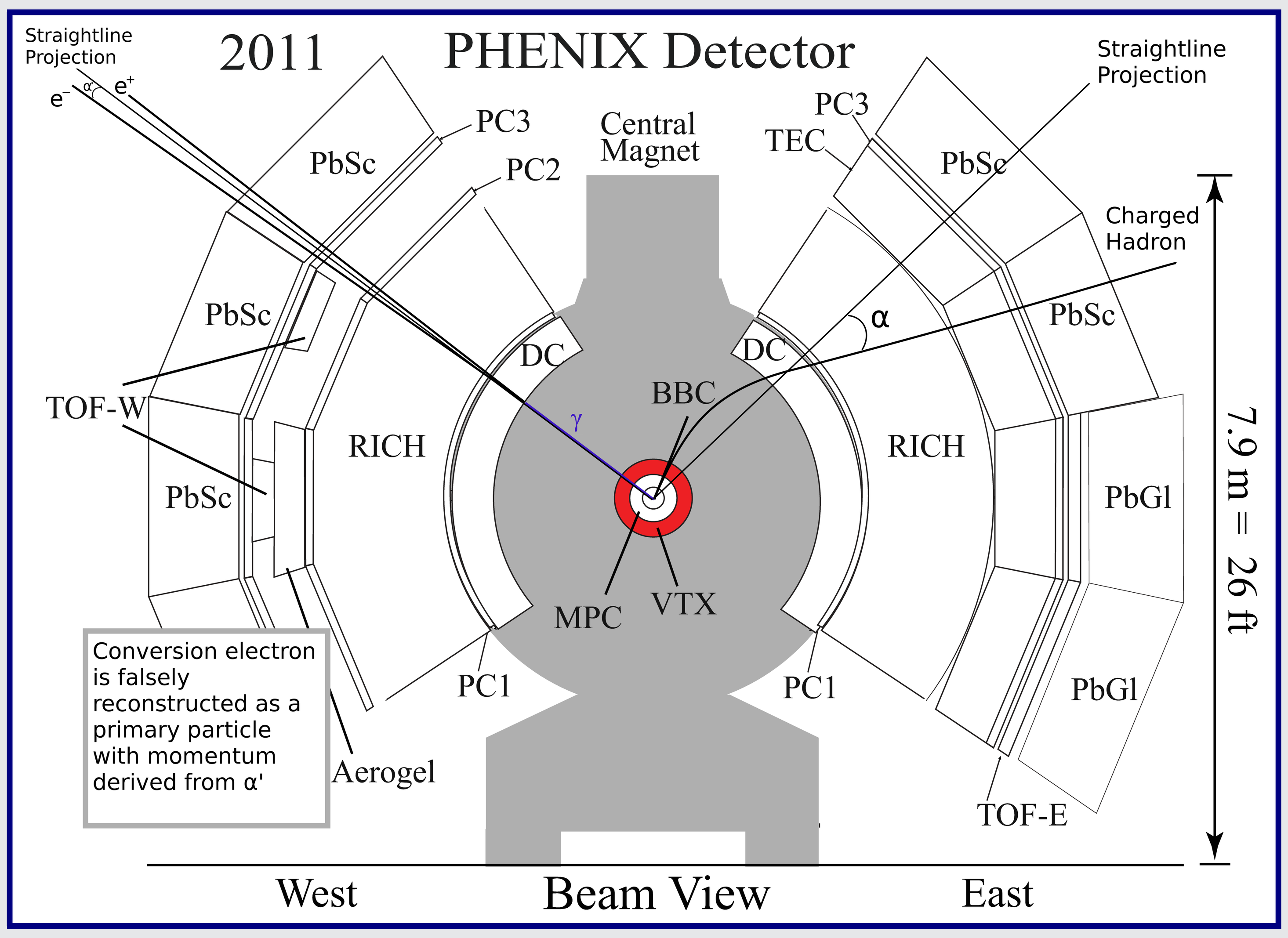

Figure 1: The PHENIX detector as configured in 2011. A signal particle is pictured on the right. The drift chamber measures momentum by calculating the difference in angle between a particle's track and a straightline projection to the collision vertex α. As seen on the left the angle α' calculated for conversion or a secondary particle may result in a different momentum than its parent particle.

Background Limitations

- Conversions and weak decay products can mimic high p_T particles
- Since momentum is calculated by projecting tracks from the drift chamber back to the collision vertex, it will be miscalculated for tracks not originating from the vertex
- For example, a photon originating from an heavy ion collision could convert into an e^+e^- pair on the entrance window of the drift chamber (Fig. 1)
- Weakly decaying particles may also decay before reaching the drift chamber and be assigned an incorrect momentum
- These background tracks can be rejected by the silicon vertex tracking detector

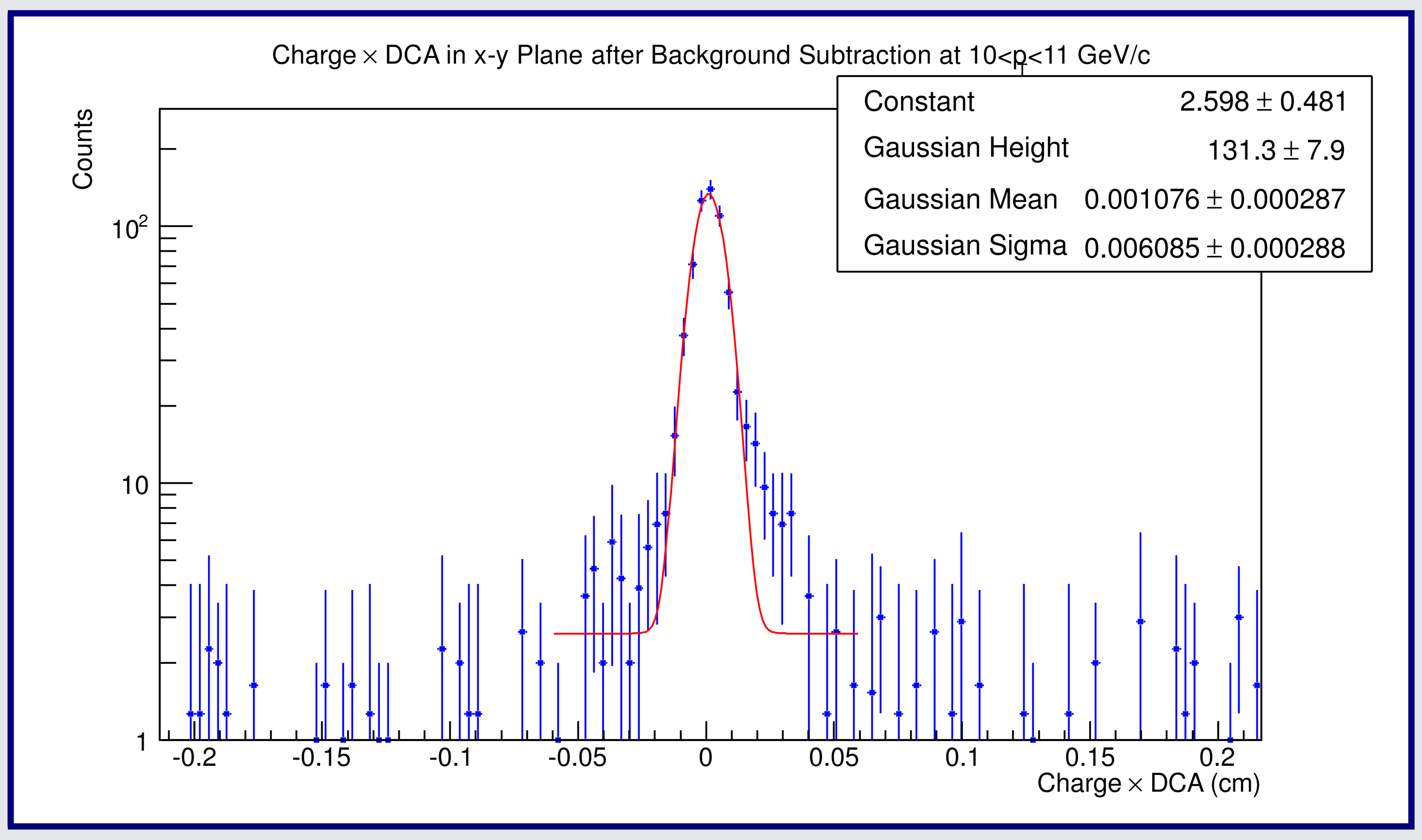

Figure 2: Charge × Distance of closest approach (DCA) in the transverse plane after tracks with a large DCA in the longitudinal direction have been subtracted for $10 < p_T < 11$ GeV/c. Final DCA is fit to a Gaussian and integrated over ± 3 sigma.

The silicon vertex tracker (VTX)

- Consists of 4 concentric cylindrical sections close to the beam pipe
- Sensitive to charged particles
- Provides precision tracking near the collision vertex
- Drift chamber tracks are matched to hits in the VTX and tracks
- Much of the background from conversions and weak decays can be rejected by requiring that tracks have at least 3 associated hits in the VTX
- Further background can be rejected by requiring a small distance of closest approach (DCA)
- DCA is calculated by projecting a track back to the collision vertex and measuring the smallest distance between the vertex and the track
- Real particles originating from the collision are expected to have Gaussian distributed DCA centered around the origin with a sigma of approximately the VTX resolution of $\backsim 70$ microns
- Tracks with a large DCA in the longitudinal direction are removed and the DCA in the transverse plane is fit to a Gaussian and integrated over 3 sigma

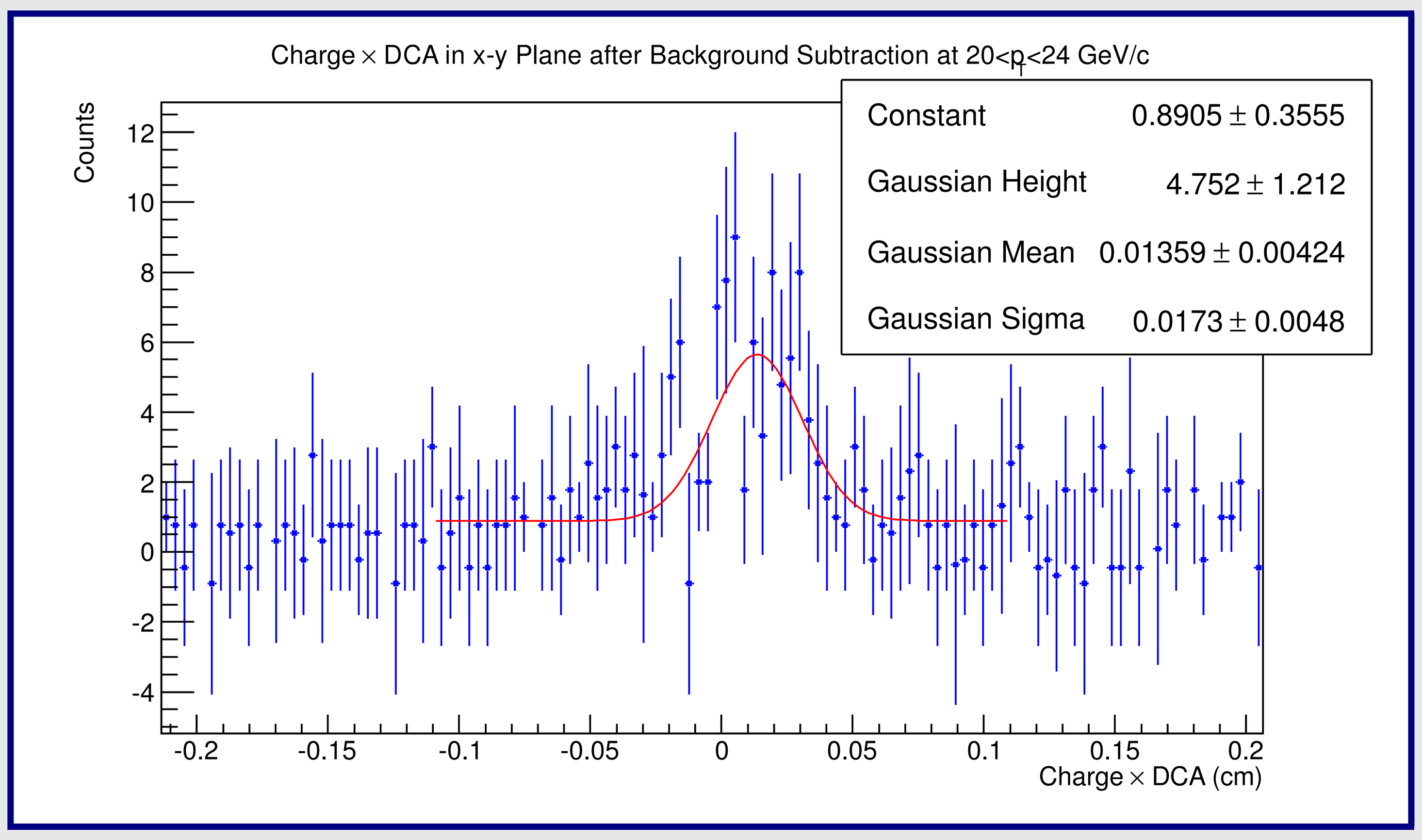

Figure 3: Charge × Distance of closest approach (DCA) in the transverse plane after tracks with a large DCA in the longitudinal direction have been subtracted for $20 < p_T < 24$ GeV/c.

p_T Spectrum

- The uncorrected p_T spectrum is calculated by integrating the Gaussian peaks of the DCA distributions in each p_T bin (Red curve in figure 4)
- Background tracks are expected to have a randomly distributed or flat measured p_T distribution
- Without matching in the VTX, the flat background spectrum seems to dominate after 6 GeV/c (Blue curve in figure 4)
- The spectrum of real tracks matched to the VTX extends to > 20 GeV/c

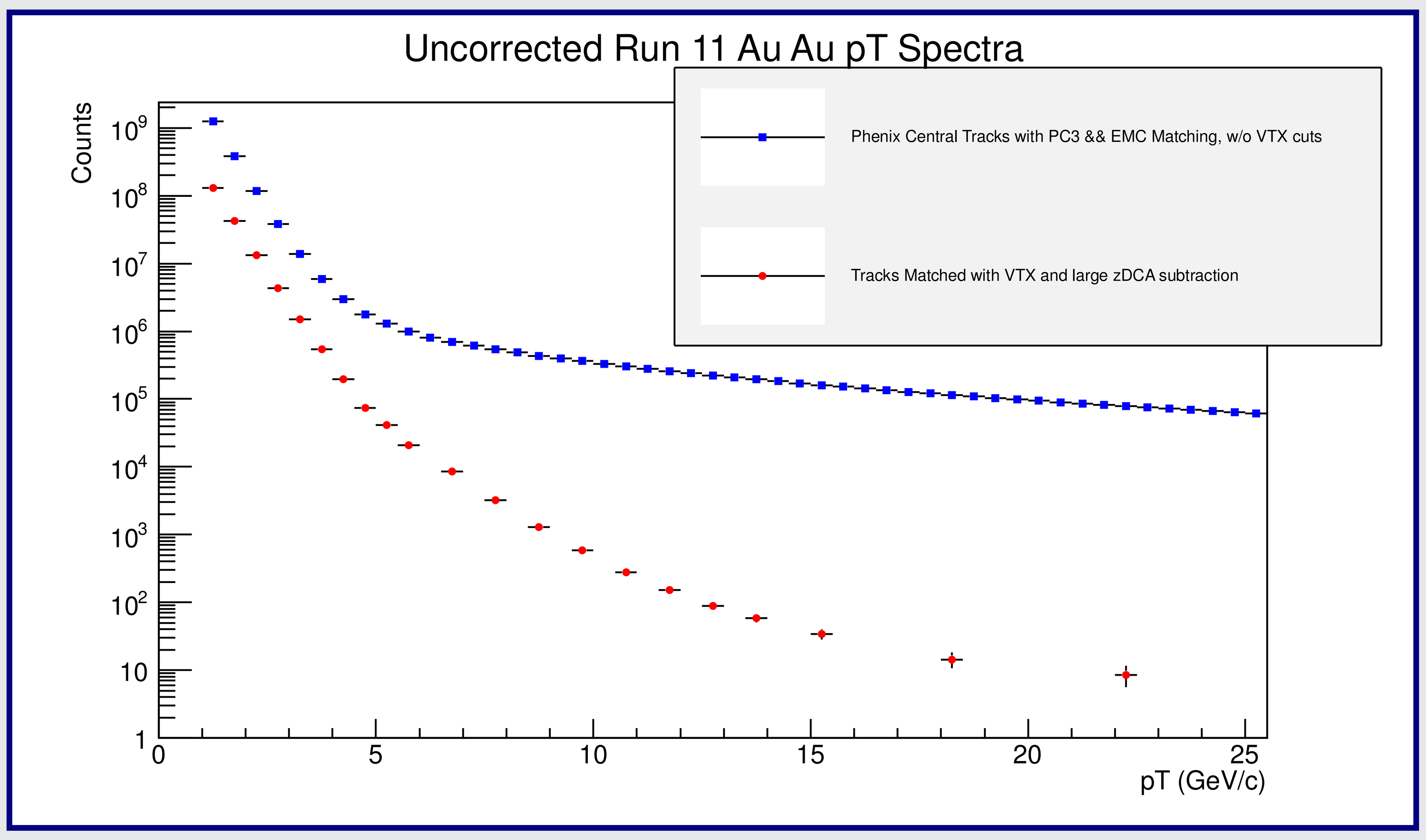

Figure 4: Uncorrected Run-11 AuAu p_T Spectra. The spectrum obtained without matching to the VTX is shown in blue. In red, the spectrum of tracks with associated hits in the VTX and with a low DCA is shown.

Conclusions and Outlook

Most of the background limiting the measurement of charged hadrons in PHENIX is from tracks which do not originate from the collision vertex. Using the VTX detector we can eliminate much of this background. We intend to estimate the number of background particles which do not originate from the collision vertex, but are still accidentally matched to hits in the VTX. In addition, the efficiency of matching tracks to the VTX will be estimated. Finally, we will use this technique to extend the measurement of the nuclear modification factor to higher p_T.