Measurement of Azimuthal Anisotropy of Electrons from Semi-leptonic Decays of Open Heavy Flavor Mesons in Au+Au Collisions at $\sqrt{s_{NN}}$ = 200 GeV by the PHENIX Experiment

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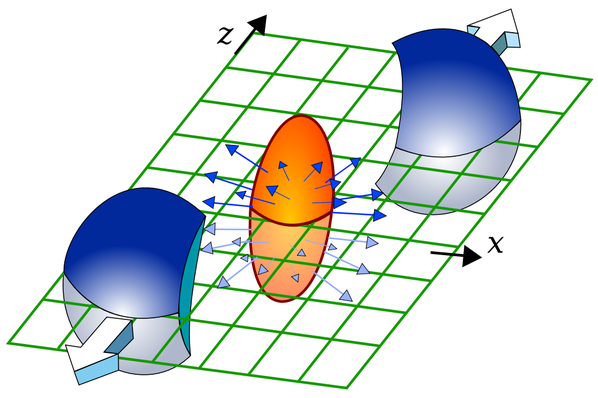
Elliptic Flow of Charm

Incomplete overlap of nuclei is not azimuthally symmetric



Collective behavior can lead to pressure gradients and azimuthal anisotropy in particle distributions.

Elliptic flow is characterized by the second Fourier coefficient of the azimuthal distribution of particles with respect to the reaction plane:

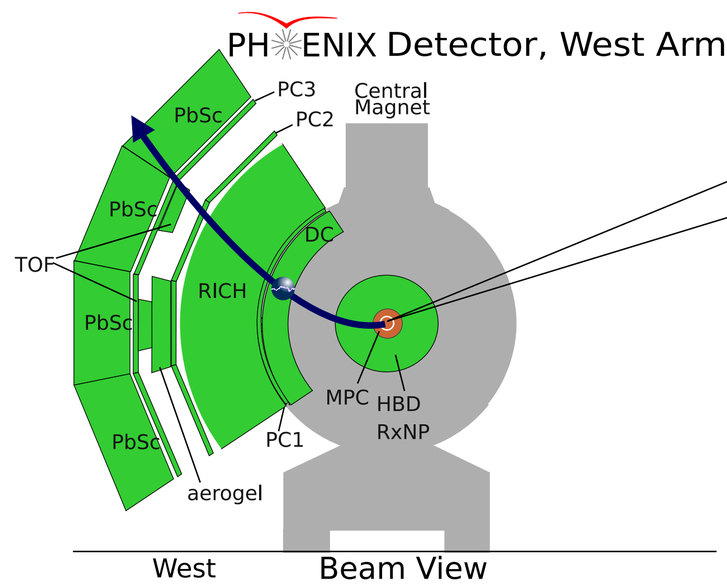
$$\frac{dN}{d(\phi-\Psi)} = N_0\left[1+2v_2\cos\left(2\left(\phi-\Psi\right)\right)\right]$$

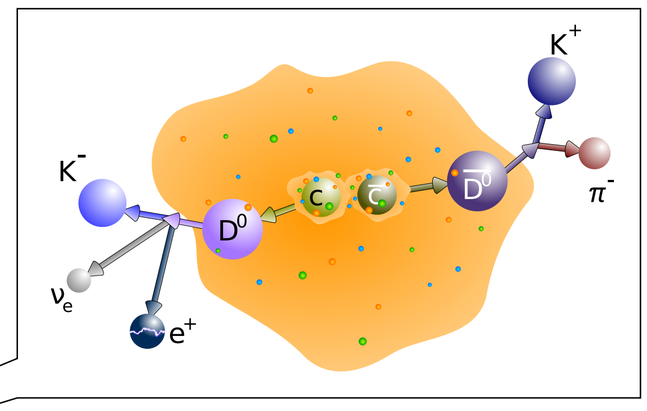
v_2 for light hadrons is as large as predicted by ideal hydrodynamics.

Charm quarks are produced in the initial hard scatterings, and probe the early stages of the medium. Do charm quarks flow?
Charm quark flow indicates strong coupling and thermalization. It also provides information about the transport coefficients of the medium.

Experimental Approach

Measure the azimuthal anisotropy of charm mesons through the azimuthal anisotropy of semi-leptonic decays into electrons and positrons.





Electron Identification

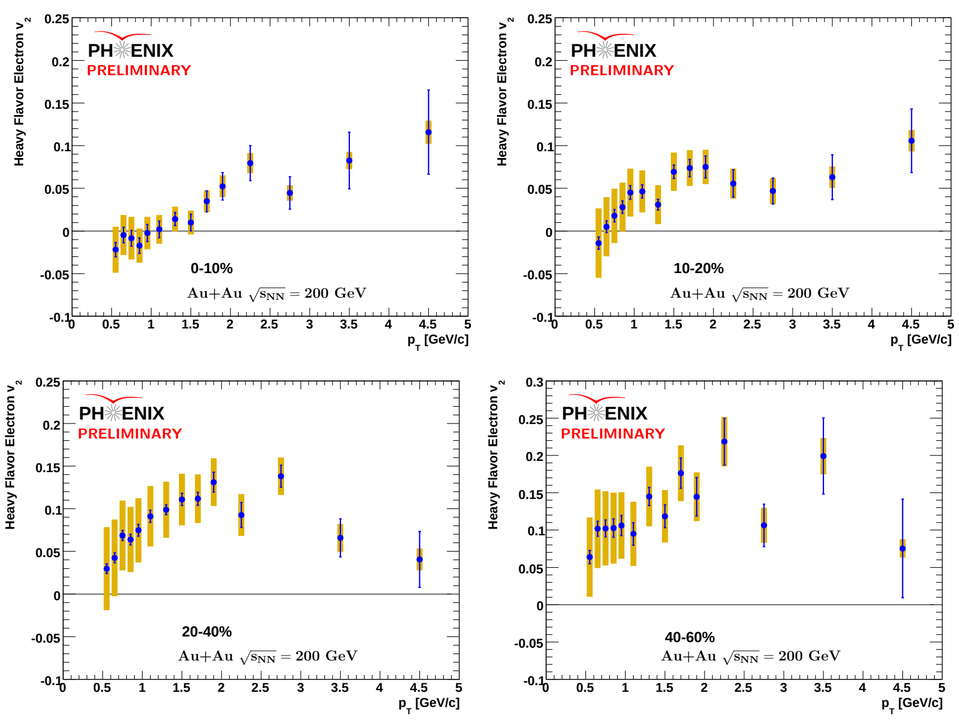
Tracking with drift chamber

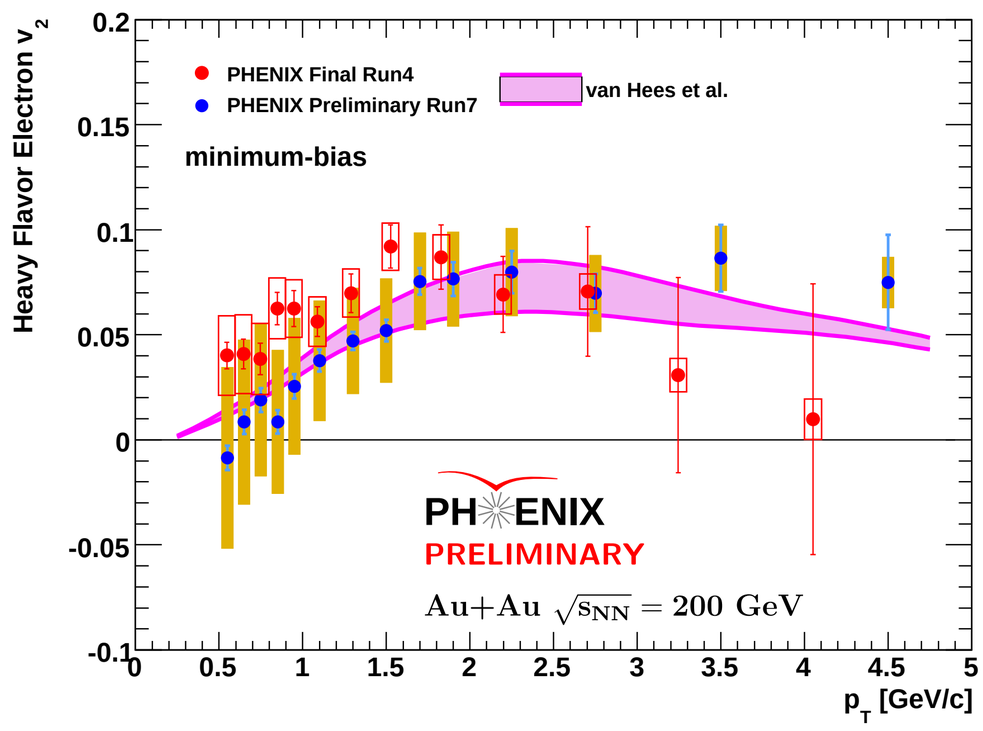
Electrons tagged by Ring-Imaging Cherenkov Detector and Electromagnetic Calorimeter

Estimate v_2 of photonic electrons from v_2 of π^0 and a decay generator. The yield of photonic electrons is estimated from the yield of light hadrons, the dalitz decay branching ratio, and the rate of photon conversions in PHENIX as determined by a GEANT-based simulation. Given this information, and the v_2 of inclusive electrons, we can determine the v_2 of electrons from heavy flavor decays.

The reaction plane is measured by the Reaction Plane Detector (RxNP), a scintillating paddle counter.

Analysis Results

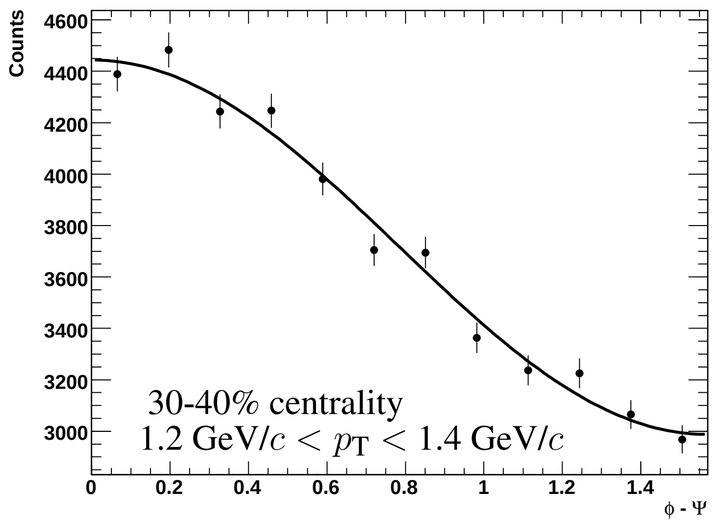


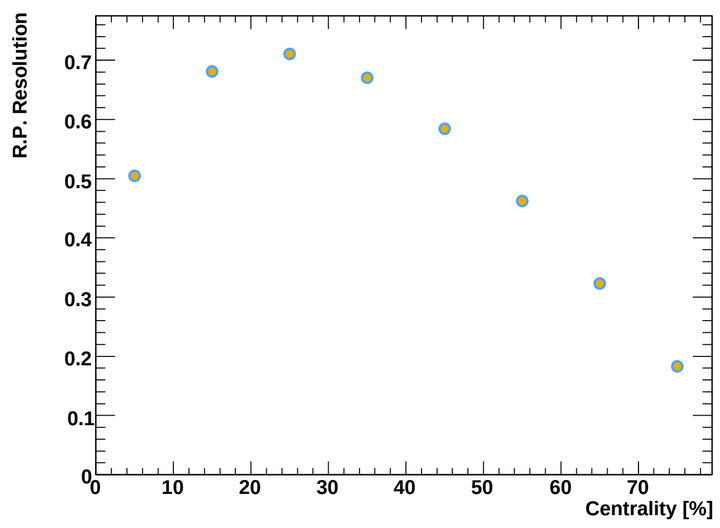


The plot on the left shows the heavy flavor electron v_2 compared to a model calculation (H. van Hees, V. Greco, R. Rapp, Phys. Rev. C73, 034913 (2006)) which contains contributions from both bottom and charm quarks.

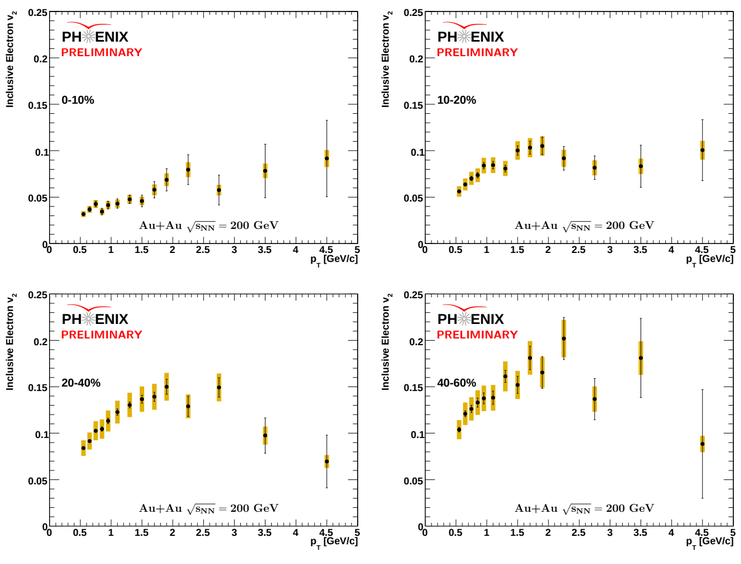
There is evidence that charm quarks flow as much as light quarks!

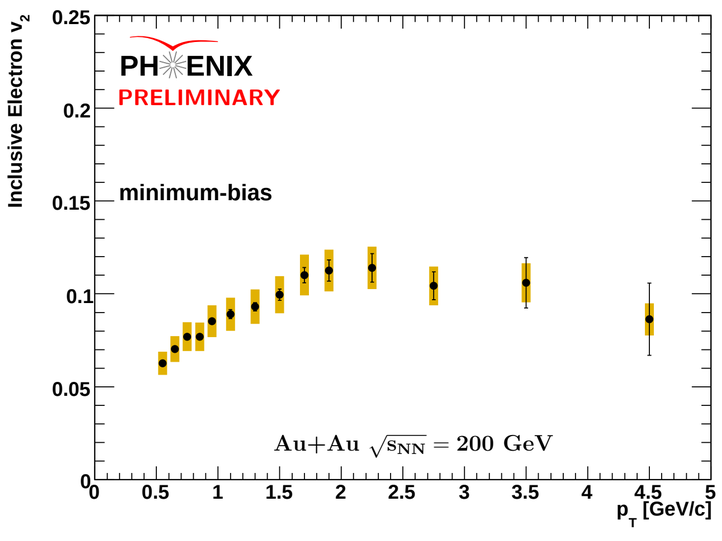
Measuring v_2



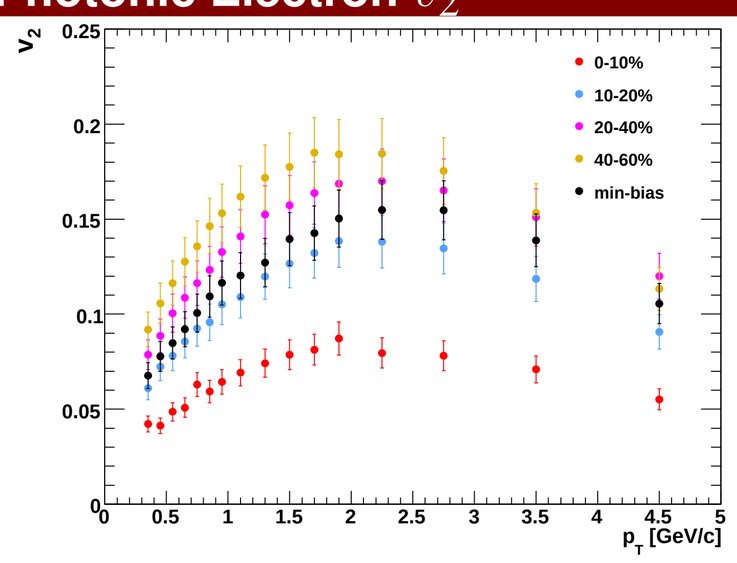
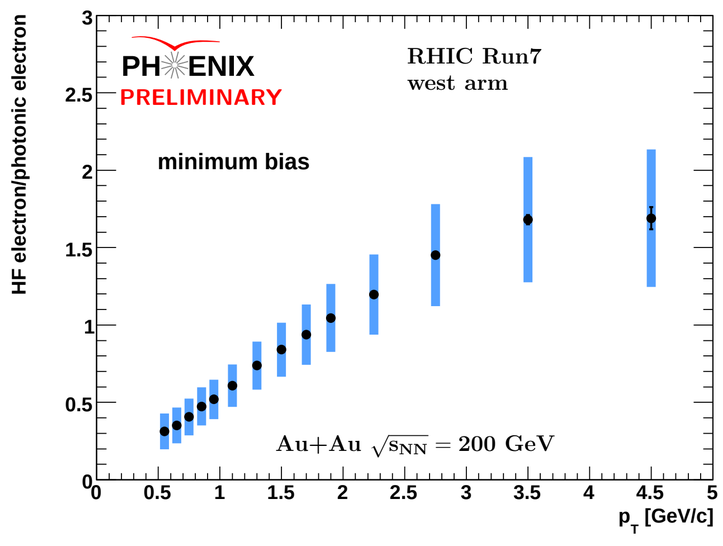


We obtain v_2 of the inclusive electrons by fitting the azimuthal distribution to the form above. Since we don't know the orientation of the reaction plane precisely, the v_2 which we measure is smaller than the true v_2. We correct for this by dividing by the reaction plane resolution, which depends on the centrality of the collision. The smaller the centrality, the more head-on the collision.





Photonic Electron v_2



The v_2 of photonic electrons is shown above. The "photonic" electrons include Dalitz decays, photon conversions, weak Kaon decays, and vector meson decays. Any excess electrons are attributed to heavy flavor decays. The ratio of heavy flavor electrons to photonic electrons is shown below.