Heavy Flavor Electron azimuthal anisotropy v_2 from 2- and 4-particle correlations in Au+Au collisions at $\sqrt{s_{NN}} = 200, 62$ and 39 GeV at STAR

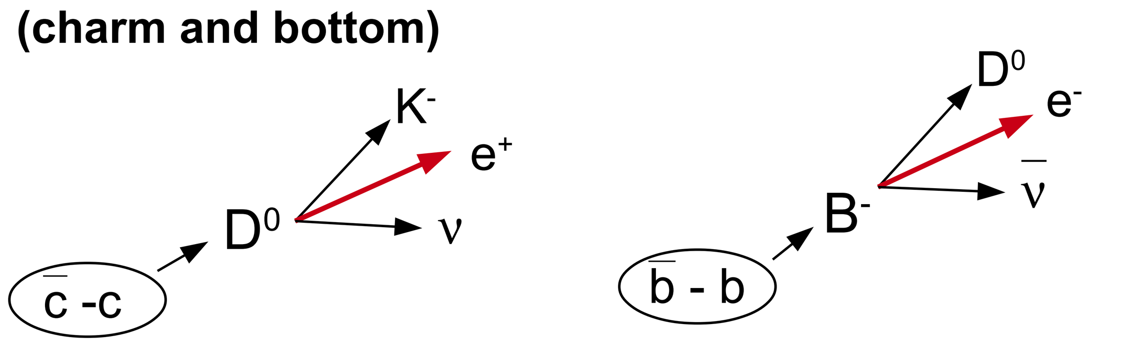
Daniel Kikoła for the STAR collaboration

Heavy quarks (charm and bottom) are produced early in the collisions and therefore are important probes of the hot and dense matter created in the reactions at RHIC energies. Electrons from semileptonic decays of heavy flavor mesons (non-photonic electrons, NPE) are the most feasible tool so far for studying heavy quarks in-medium interactions. NPE azimuthal anisotropy (v_2) is of particular interest because it provides insights into thermalization of heavy quarks and additional means to discriminate between models which describe heavy quark in-medium interactions.

We report the v_2 measurements using 2- and 4-particle correlations, $v_2\{2\}$ and $v_2\{4\}$, at $\sqrt{s_{NN}}$ = 200, 62 and 39 GeV at STAR. NPE azimuthal anisotropy at $\sqrt{s_{NN}}$ = 62 and 39 GeV is consistent with zero which might suggest that heavy quarks are not fully thermalized at those energies. At $\sqrt{s_{NN}}$ = 200, NPE v_2 is finite at high-p_T and seems to increase with p_T which indicates that path length dependence of heavy quark energy loss and/or jet-like correlations are the dominant source of NPE azimuthal anisotropy at high-p_T.

Motivation

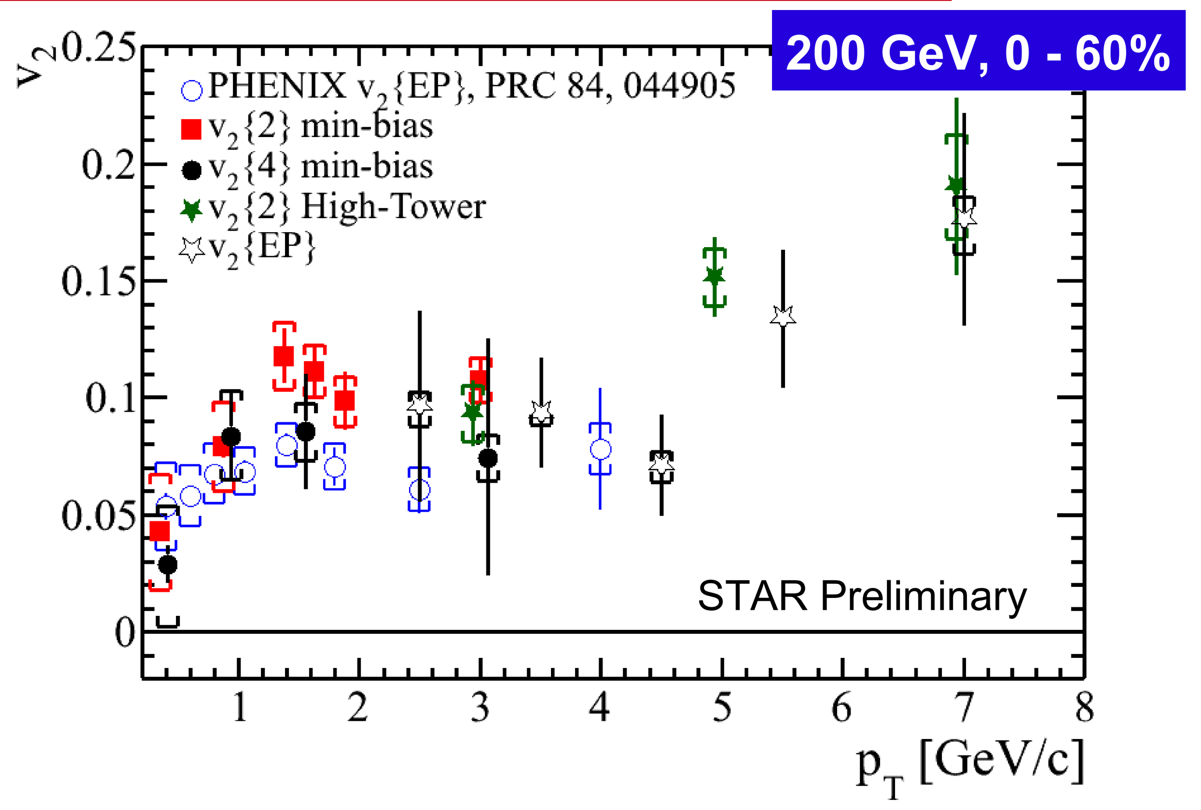
Non-photonic electrons → proxies for heavy quarks (charm and bottom)

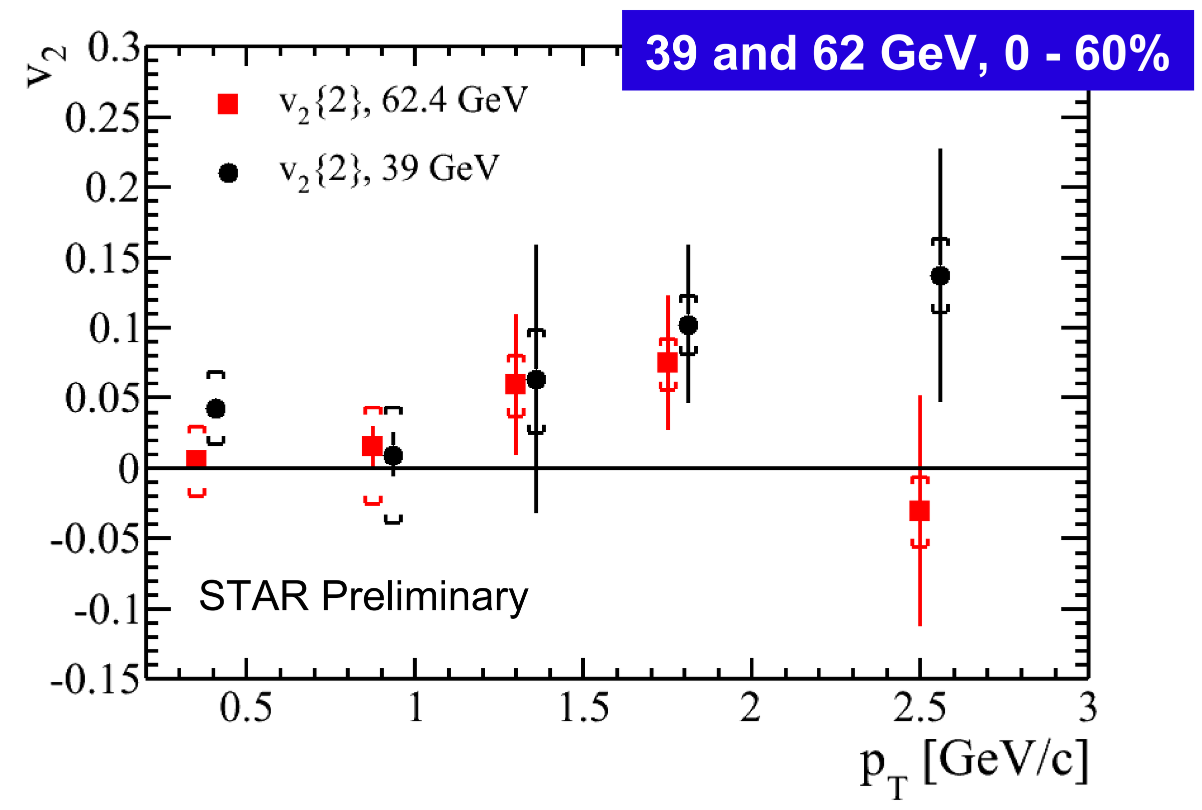


Bottom/charm ratio at 62 and 39 GeV is reduced compared to $\sqrt{s_{NN}}$ = 200 GeV → v_2 at low p_T at 62 and 39 GeV reflects charm v_2 better than at 200 GeV

$v_2\{2\}$ and $v_2\{4\}$ have different sensitivity to the nonflow and flow fluctuations → upper and lower limits on elliptic flow of heavy flavor electrons

Results and Conclusions





– v_2 seems to increases with p_T → v_2 at high p_T dominated by path length dependence of heavy quark energy loss and/or jet-like correlations

– $v_2\{2\}$ and $v_2\{4\}$ consistent with event plane results

39 and 62 GeV: $v_2\{2\}$ consistent with zero → heavy quarks might not flow strongly at 39 and 62 GeV

Heavy Flavor electron yield analysis

Electron identification:

p_T < 1.5 GeV/c: Time-of-Flight + TPC (dE/dx)

p_T > 1.5 GeV/c: Barrel Electromagnetic Calorimeter + Shower Max Detector

Acceptance:

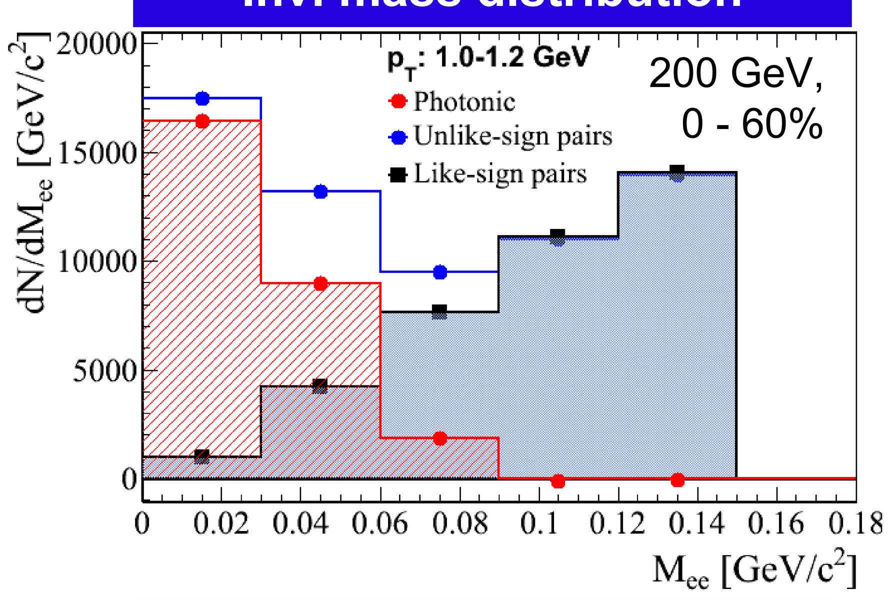
p_T > 0.5 GeV/c: $|\eta|$ < 0.7

p_T < 0.5 GeV/c: 0 < η < 0.7

Photonic electron identification → invariant mass method

Non-photonic electron yield: $N^{\text{NPE}} = N^I p - N^{\text{Pho}} = N^I p - (N^{\text{UL}} - N^{\text{LS}})/\epsilon$

Inv. mass distribution

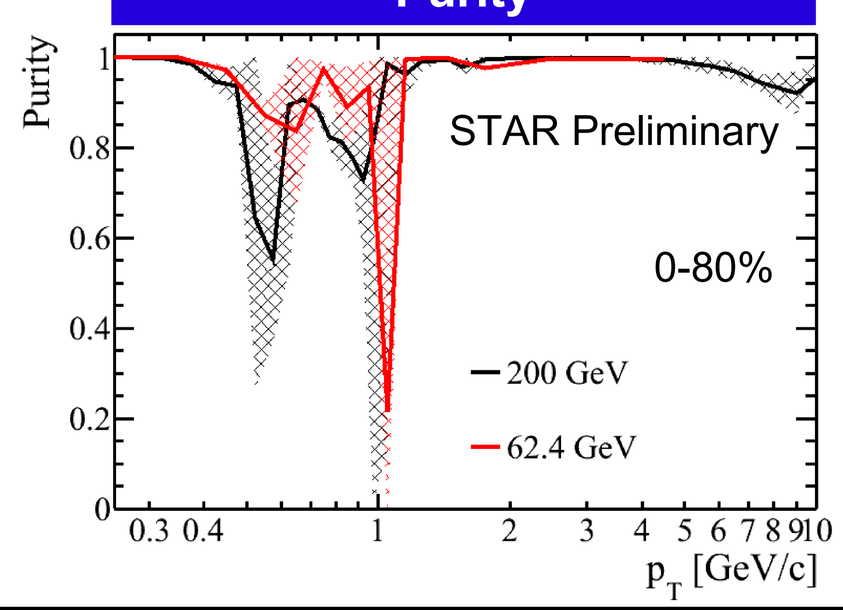


p – purity, ε - photonic. electron reconstruction efficiency (from simulations)
N^I - inclusive electron yield, N^{Pho} – photonic electron yield

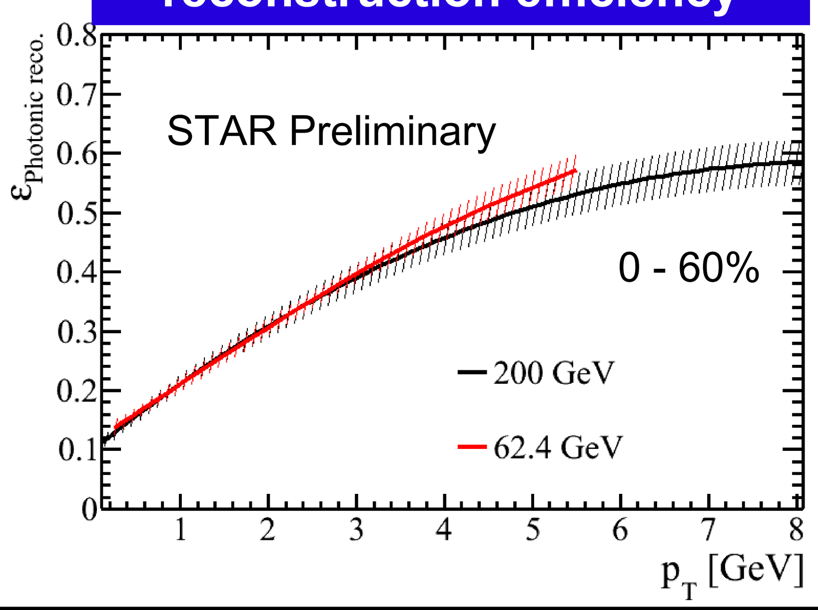
Main background sources:
– $\pi^0 \to e^+e^-\gamma$ and $\gamma \to e^+e^-$

Structures in purity distributions due to hadrons crossing the electron dE/dx band.

Purity



Photonic electron reconstruction efficiency



Heavy Flavor electron v_2 analysis

$$v_2^{\text{Npe}} = \frac{N^I v_2^I - N^{\text{Pho}} v_2^{\text{Pho}} - N^I(1-p)v_2^H}{N^{\text{Npe}}}$$

v_2^I - inclusive electrons v_2 (v_2 {2} or v_2{4})

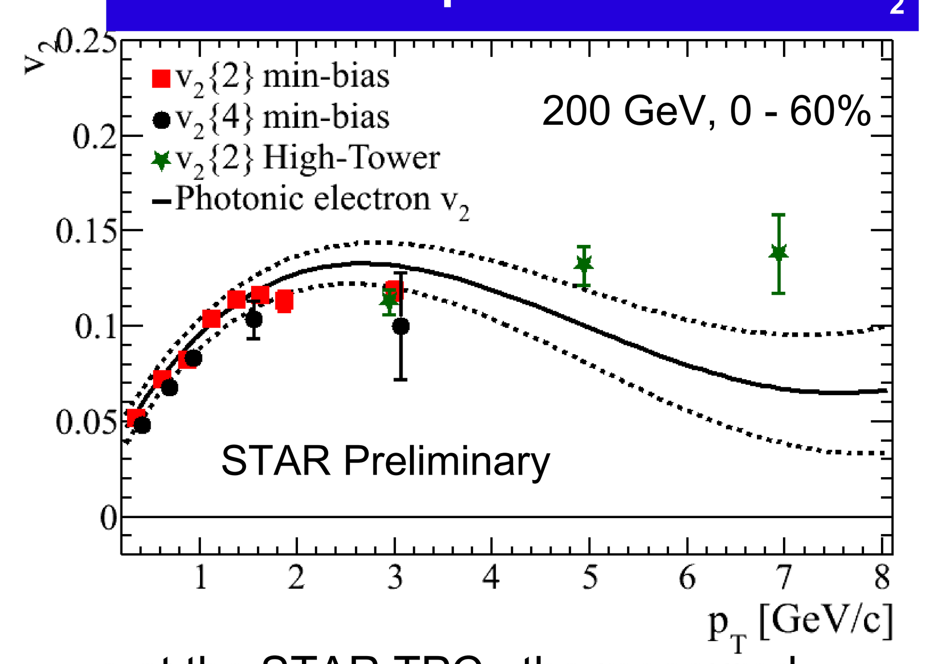
v^{Pho}_2 – photonic electron v_2

v^H_2 – charged hadron v_2 (v_2 {2} or v_2 {4})

v_2 analysis: Q-cumulant method

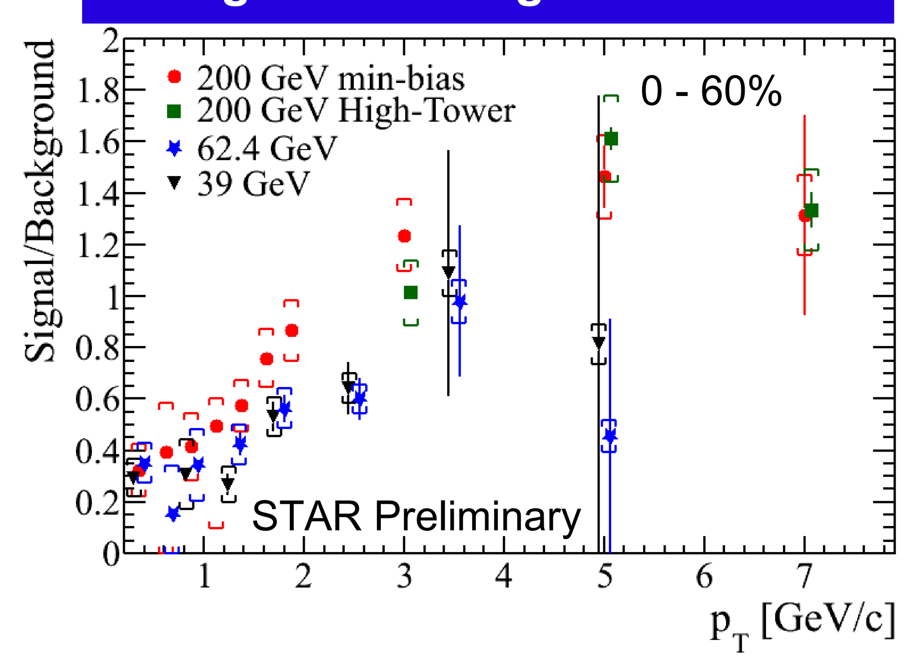
reference flow: charged hadrons, $|\eta|$< 1, 0.2 < p_T< 2 GeV/c

Inclusive and photonic electron v_2

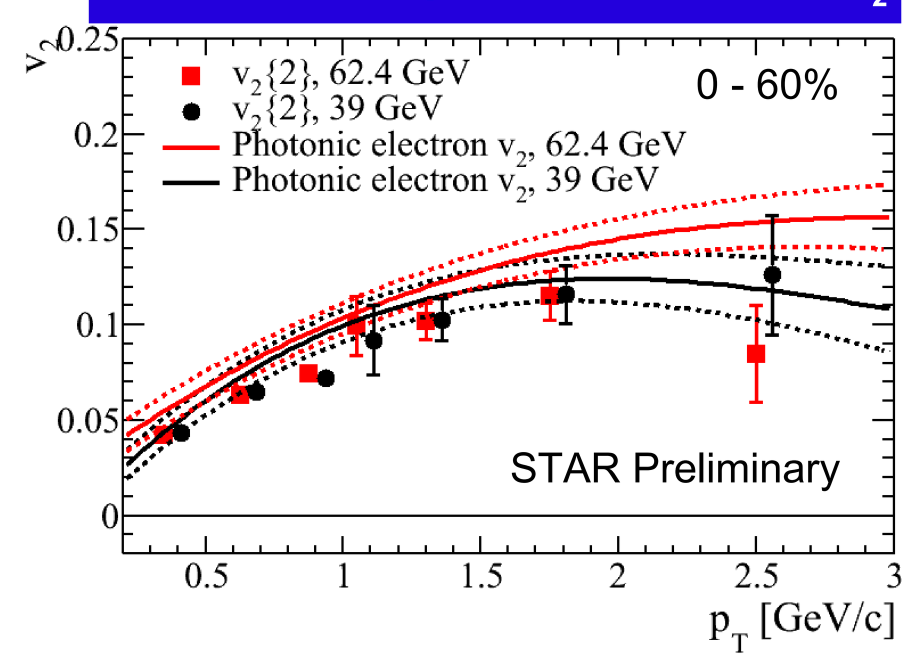


v^{Pho}_2 from simulations of $\pi^0 \to e$ and $\pi^0 \to \gamma \to e$ at the STAR TPC, the measured $v_2(p_T)$ and p_T spectra for π^0 and $\pi^{\pm}$ were used as input for the simulation.

Signal-to-Background ratio



Inclusive and photonic electron v_2



Daniel Kikoła, dkikola@purdue.edu