Elliptic flow of electrons from heavy-flavor decays in 54.4 GeV Au+Au collisions from the STAR experiment

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Abstract

Measurements of heavy-flavor hadron production and elliptic flow (v_2) provide unique and indispensable information for understanding the properties of the QGP. Recent STAR measurements indicate that in Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV D^0 mesons develop large large elliptic flow v_2 similarly as light-favor hadrons, implying that charm quarks interact strongly with the thermalized medium at the RHIC top energy. STAR has also published results on v_2 of electrons from heavy-flavor decays at $\sqrt{s_{NN}}$ = 62.4 and 39 GeV, where the central v_2 values of such electrons seem to be lower than those of light-flavor hadrons. However, the precision of these results did not allow for firm conclusions.

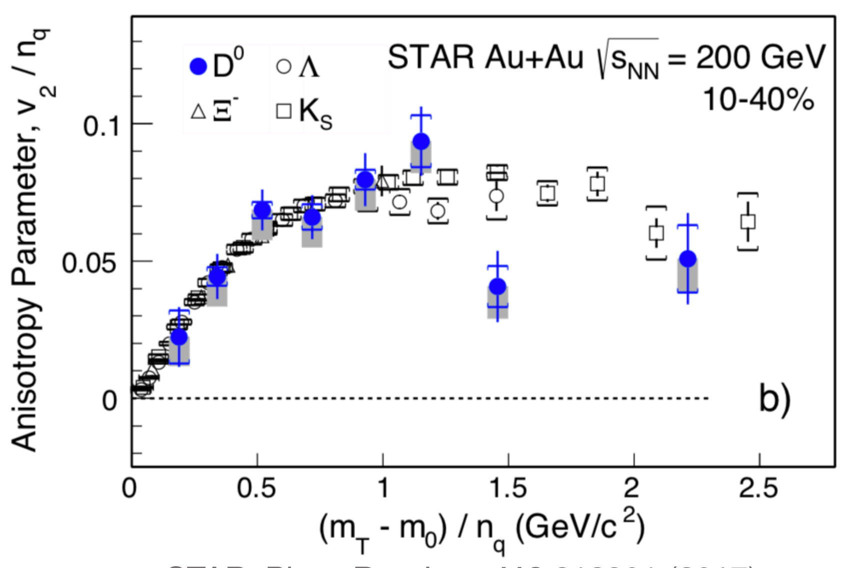
Thanks to the large data samples recorded by STAR in 2017, we are now able to perform more precise measurements of the elliptic flow of electrons from heavy-flavor decays in Au+Au collisions at $\sqrt{s_{NN}}$ = 54.4 GeV. The data sample size is more than 15 times larger than that of $\sqrt{s_{NN}}$ = 62.4 GeV taken in 2010. In this poster, we present new results from the STAR experiment on the v_2 of electrons from heavy-flavor decays, at $\sqrt{s_{NN}}$ = 54.4 GeV, as a function of electron transverse momentum.

Motivation

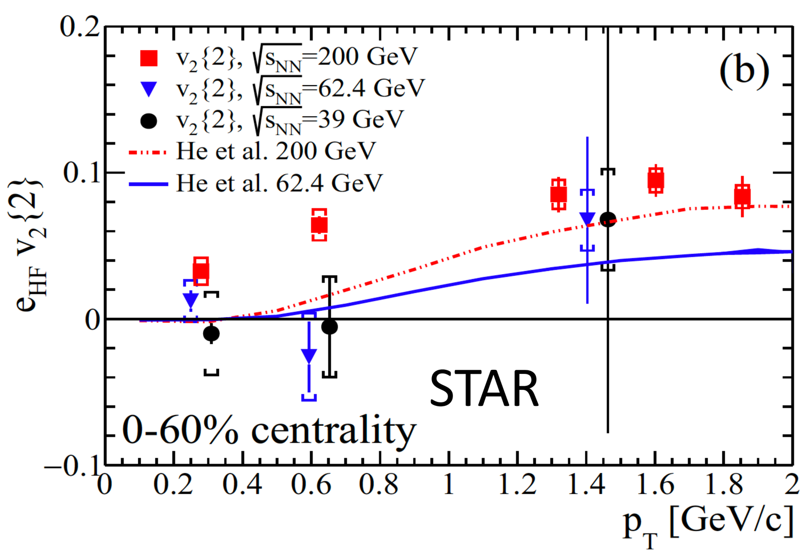
- Charm hadron v_2 – sensitive probe to charm quark transport in QGP
- Energy dependence – probing different temperature regions
- Charm hadrons exhibit in 200 GeV Au+Au collisions the same strong collective behavior as light-flavor hadrons.
- Study the energy dependence of the heavy quark interactions with QGP.
  - 2017 54.4 GeV dataset: 15×statistics of 2010 62.4 GeV dataset

Why HF electrons?

- larger branching ratios compared to typical hadronic channels
  - c→e + anything (B.R. 9.6%), b→e + anything (B.R. 10.86%).



STAR, Phys. Rev. Lett. **118** 212301 (2017)



STAR, Phys. Rev. C **95**, 034907 (2017)

Electron identification and background subtraction

- **Inclusive electron**

PID: Time of flight + TPC (dE/dx)

- **Photonic electron yield extraction**

Invariant mass method

- **Background: photonic electrons**

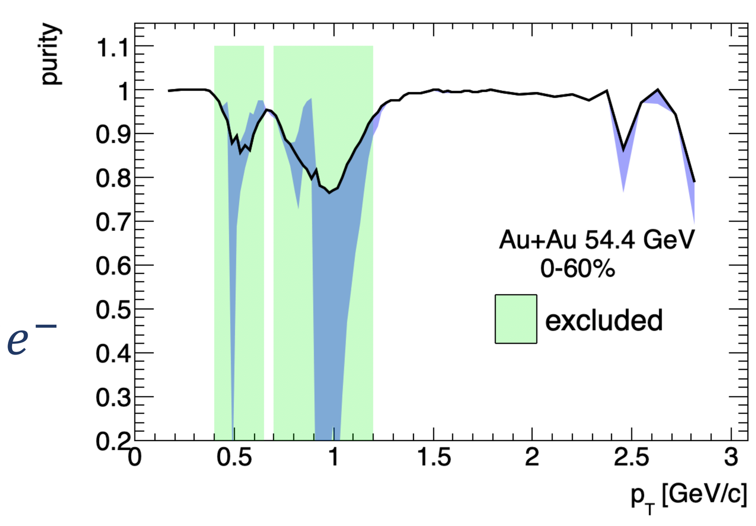
From photon conversion and Dalitz decays:
$\pi^0/\eta \to \gamma\gamma, \pi^0/\eta \to e^+e^-\gamma$, Direct $\gamma \to e^+e^-$

- **Non-photonic electron yield**

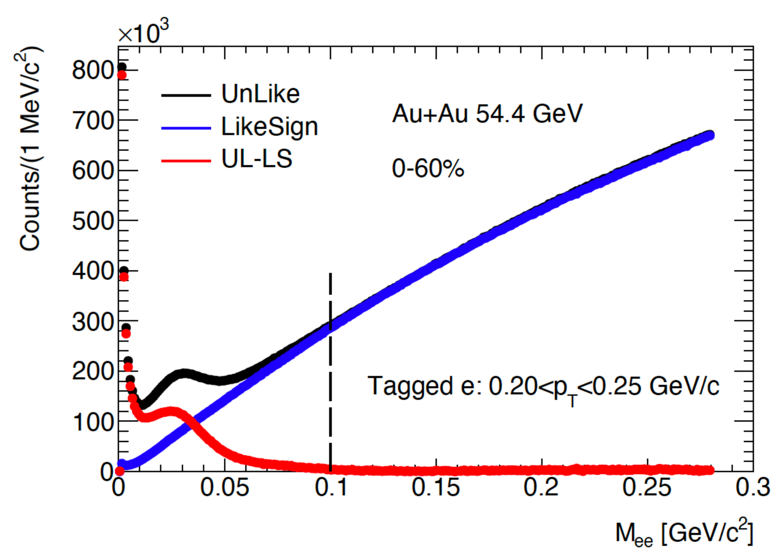
$$N^{NPE} = (p \times N^{inc} - N^{pho}/\epsilon_{reco})$$

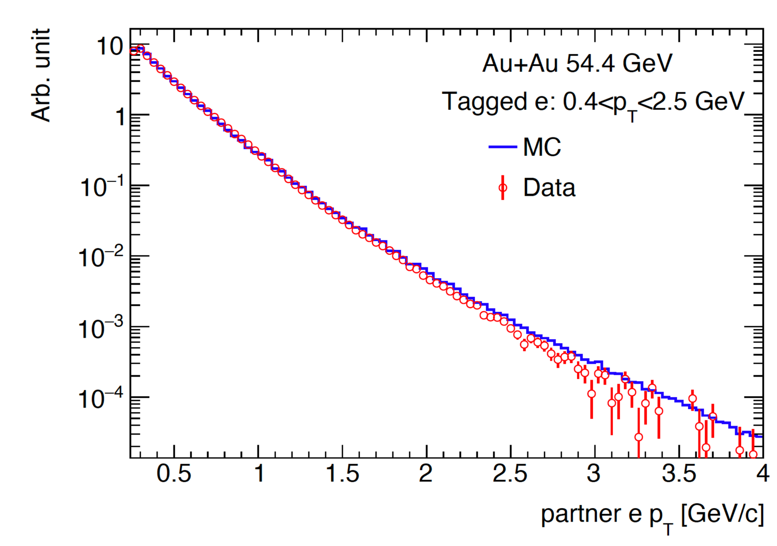
N^{NPE}: num of non-photonic electrons
N^{pho}: num of photonic electrons
p : electron purity
ϵ_{reco}: e^{pho} reconstruction efficiency

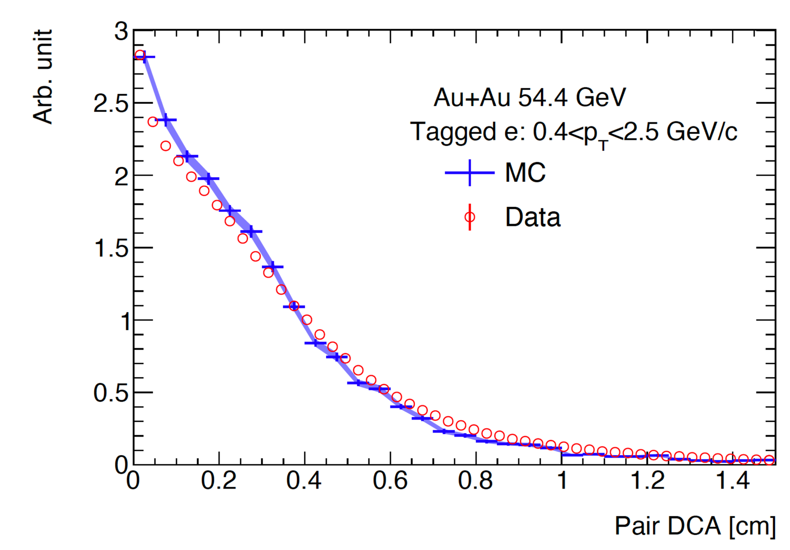
Electron purity

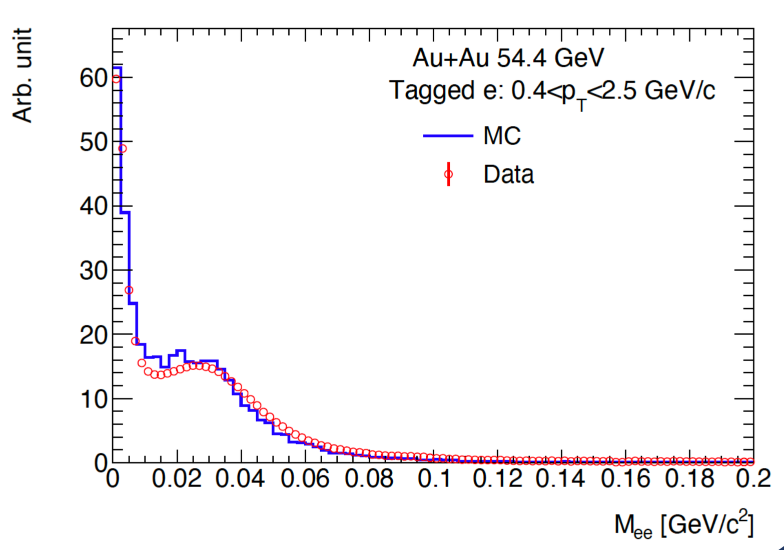


Inv. mass distribution of di-electrons



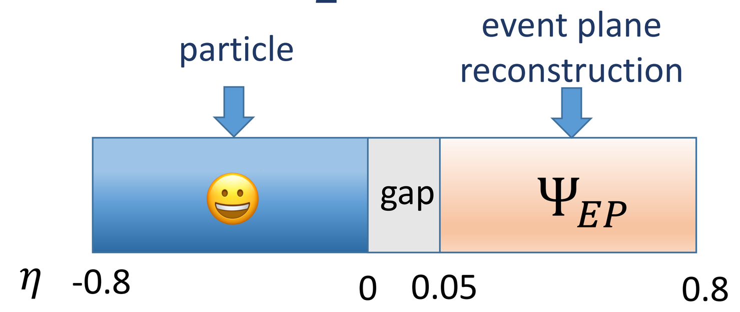






- Good agreement between data and embedding

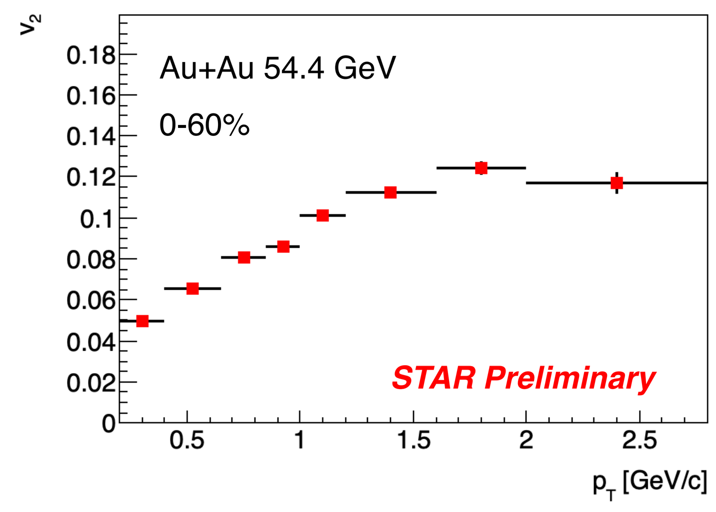
Electron v_2 reconstruction



Event plane η-sub method

$$v_2 = \left\langle \frac{\cos 2(\phi - \Psi_{EP})}{R} \right\rangle$$

R: event plane resolution

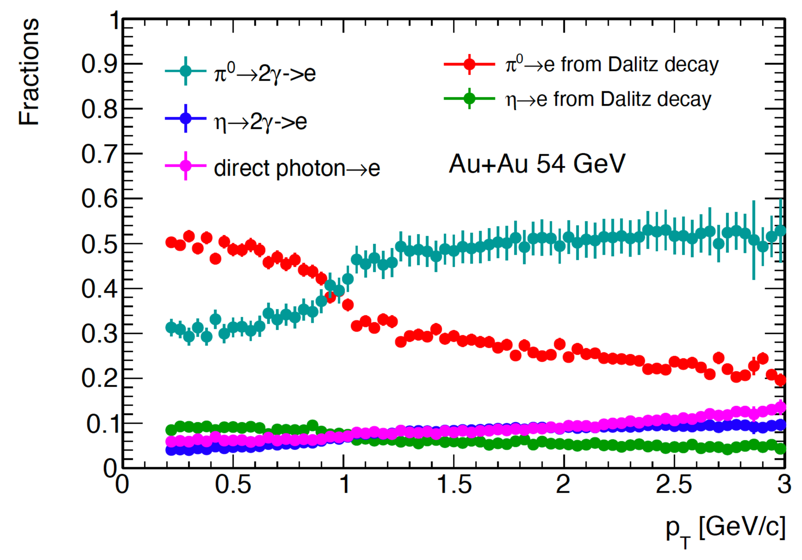


Inclusive electron v_2^{inc}

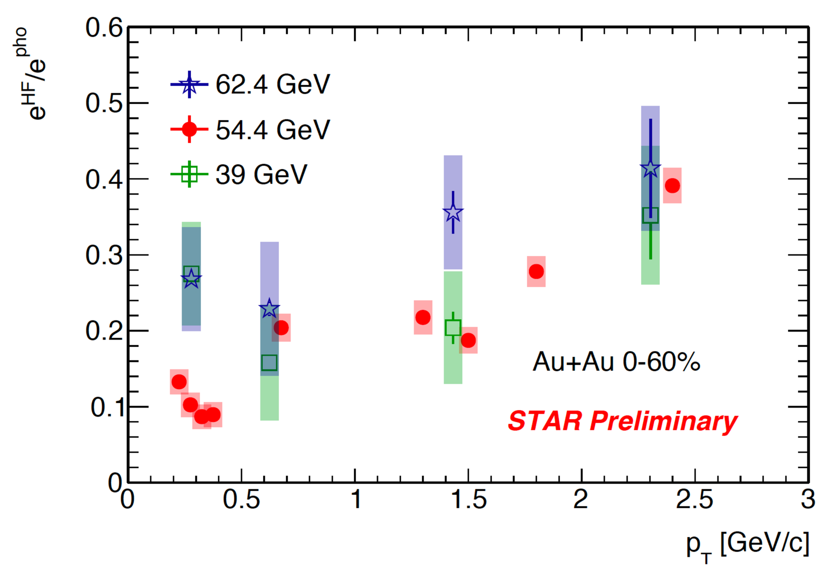
Photonic electron reconstruction efficiency and v_2

Embedding simulated π^0, η, γ into experimental data of Au+Au collisions to calculate the photonic electron reconstruction efficiency

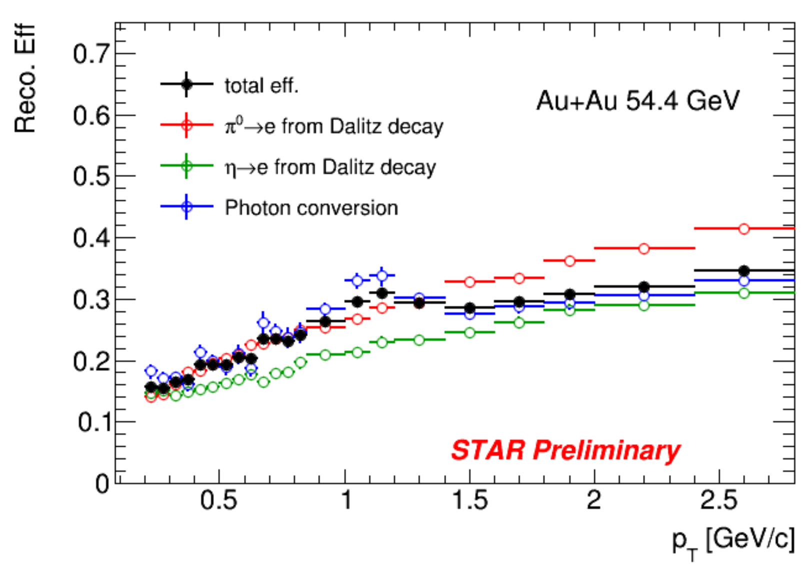
- p_T and ϕ weights set according to parent particle spectra and v_2



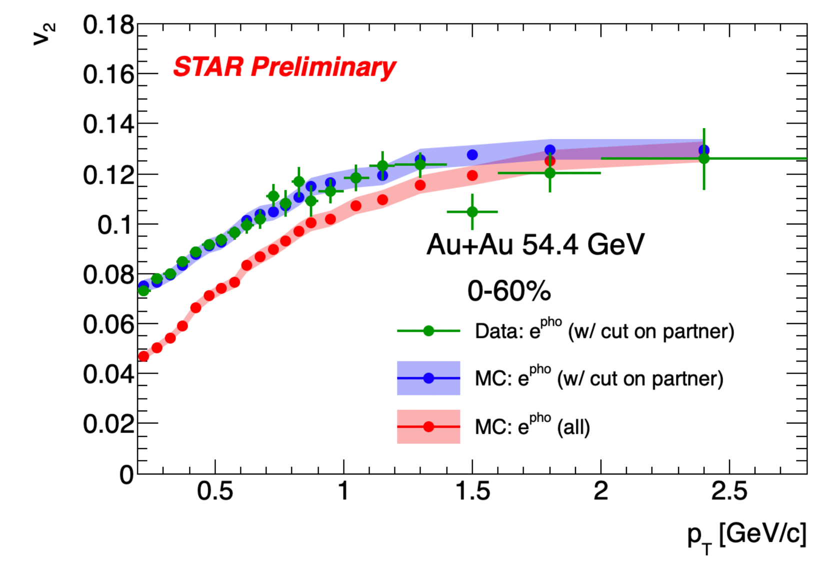
Relative fraction of different photonic electron sources from embedding



Signal (e^{HF}) to photonic background ratio



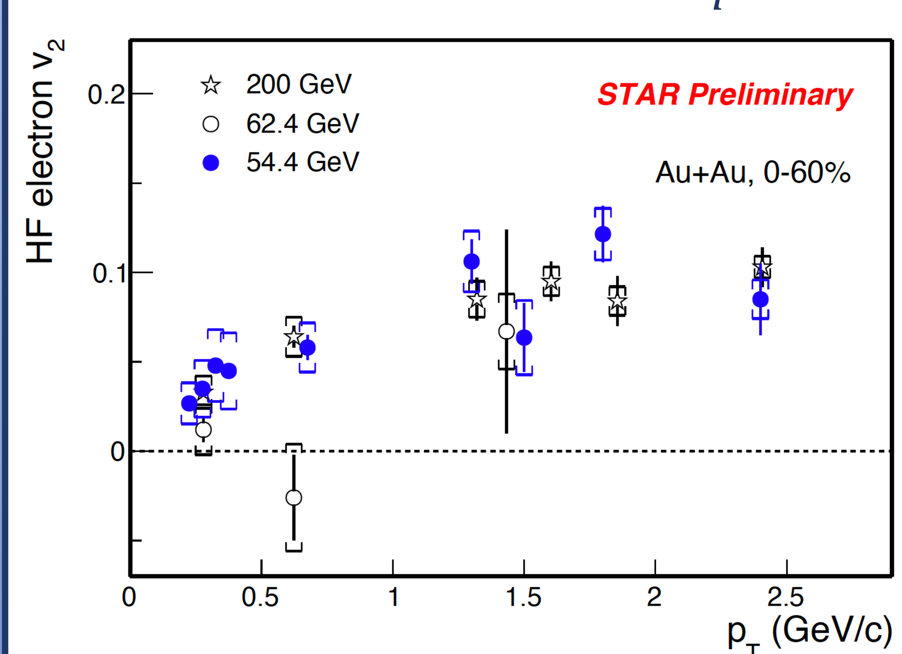
e^{pho} reconstruction efficiency



Photonic electron v_2^{pho} from embedding

Results and discussion

$$v_2^{HF} = \frac{N^{inc} v_2^{inc} - N^{pho} v_2^{pho} - \sum N^h v_2^h}{p \cdot N^{inc} - N^{pho}}$$



N^h : hadron contamination yield;
v_2^h : hadron v_2;
v_2^{pho}: photonic electron v_2;
v_2^{inc} : inclusive electron v_2.

- The precision is significantly improved compared to the published 62.4 GeV result.
- HF electron elliptic flow in Au+Au at 54.4 GeV is comparable to that at 200 GeV.

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The STAR Collaboration
https://drupal.star.bnl.gov/STAR/presentations

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