Heavy Quark Interactions with the Medium as Measured with Electron-Hadron Correlations in Au+Au Collisions in STAR

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Abstract

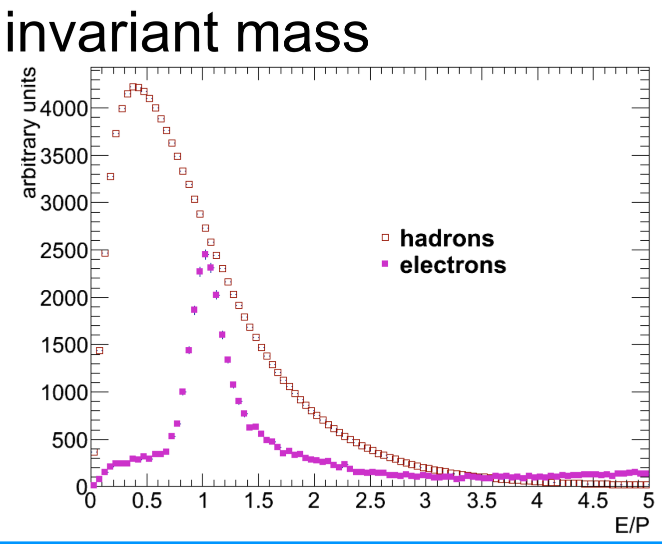
Measurements of heavy flavor R_{AA} have shown a large suppression in central heavy ion collisions, indicating the importance of both gluon radiation and collisional energy loss in models of heavy quark propagation. There is still considerable uncertainty around the energy loss mechanisms of heavy quarks in QGP: the relative contribution of radiative and collisional interactions to the energy loss of heavy quarks as well as the response of the medium to heavy quark propagation are both open questions. Two particle correlations from heavy flavor jets are a unique tool to investigate interactions with QGP, as away side correlations in central events should show modifications as compared to measurements in peripheral bins and p+p collisions. High p_T non-photonic electrons serve as a proxy for heavy flavor mesons coming from heavy ion collisions and allow us to tag heavy flavor jets. These electrons' correlations to associated hadrons could give insight into the interactions between charm and bottom quarks and the medium. The away side will contain information both from the decay of any associated away side meson as well as interaction of the away side jet with the bulk. The high statistics from STAR Run 11 allow us to construct correlations across a range of centralities and particle p_T. We present measurements of correlations of non-photonic electrons to hadrons in high tower triggered $\sqrt{s_{NN}}$ = 200 GeV Au+Au data from STAR, and will show comparisons to theoretical models for heavy quark correlations in QGP.

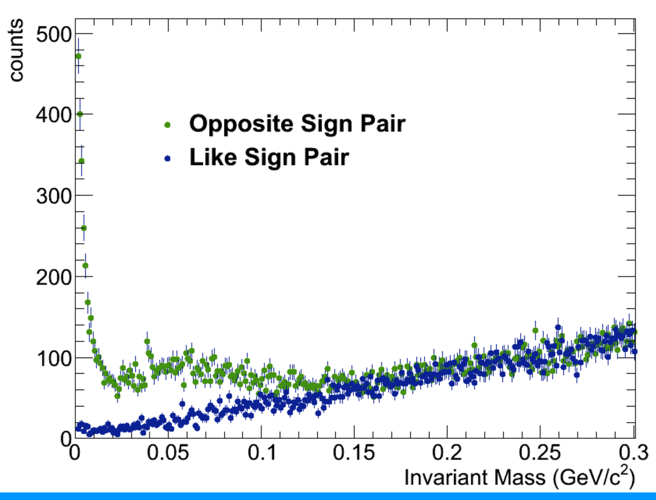
Motivation

- Heavy flavor quarks are produced in early hard processes in heavy ion collisions
- Models of heavy quark energy loss rely on different underlying physical assumptions, additional observables are needed
- Two particle correlations are an additional tool to investigate the interaction of heavy quarks with the medium

Identification of Non-photonic Electrons

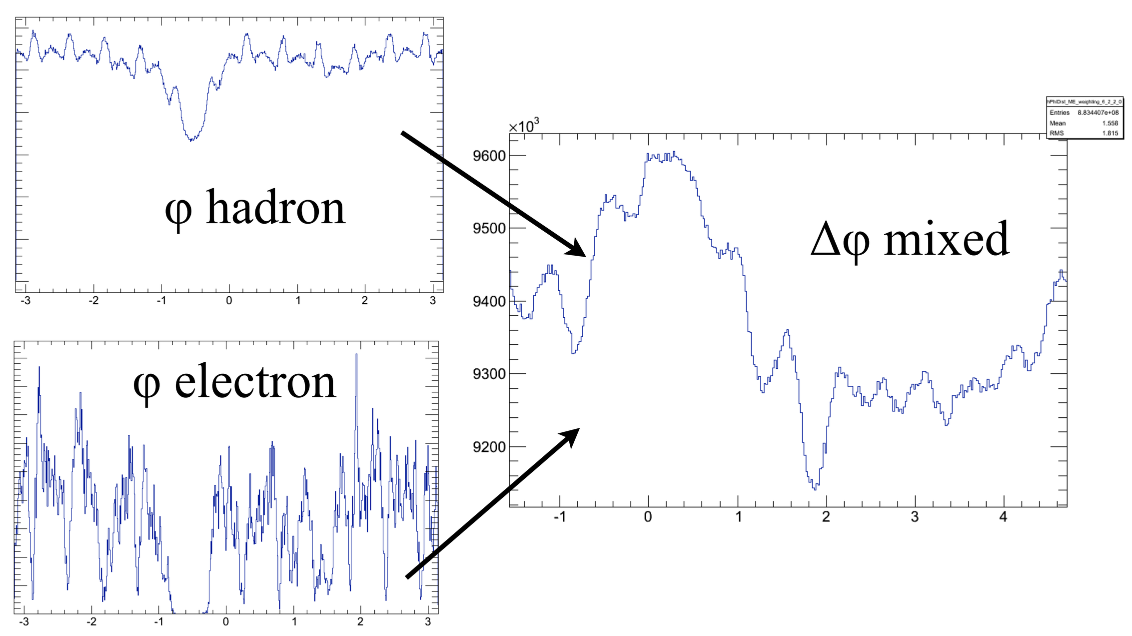
- Electrons identified from high p_T electron triggered events
- PID performed with dE/dx in TPC and E/p and shower width in barrel EMC
- For electron p_T > 2GeV/c there is high correlation between the direction of the electron and the parent meson
- Main background is from photon conversions and Dalitz decays (photonic electrons)
- Photonic background identified by searching for partner tracks with small opening angle and low invariant mass





Analysis

Non-uniformity in detector acceptance needs to be corrected for any correlation analysis, this is done by applying weights to flatten the single hadron distribution and by correcting the electron hadron correlation by a factor calculated from mixed event correlations



NPE-hadron correlation is constructed from three terms:

$$\frac{dN_{NPE-h}}{d\Delta\phi} = \frac{dN_{semi}}{d\Delta\phi} - \left(\frac{1}{\epsilon_\gamma} - 1\right)\frac{dN_{photonic}}{d\Delta\phi} + \frac{dN_{same-sign}}{d\Delta\phi}$$

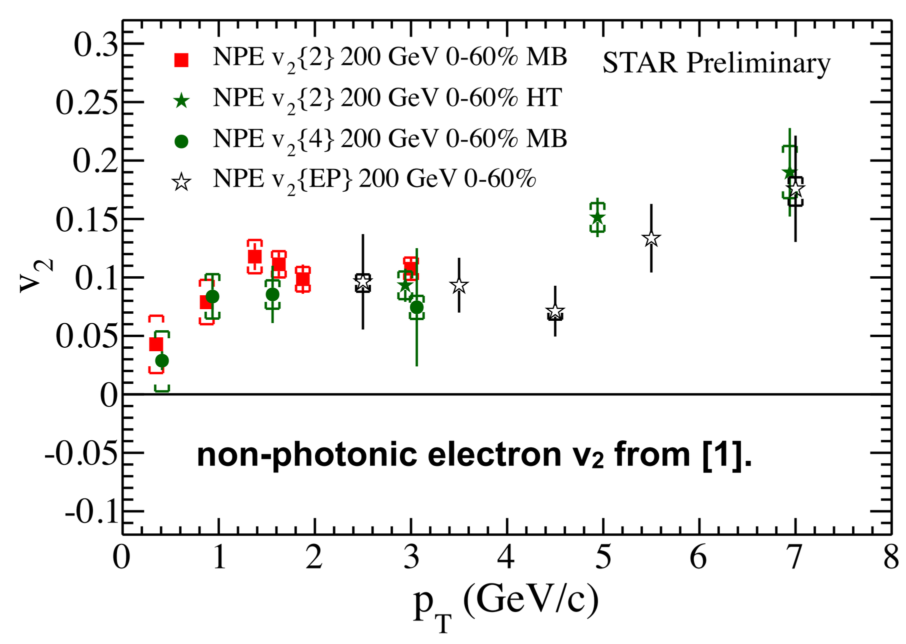
Semi-inclusive electrons: Inclusive electrons with identified photonic electrons removed.

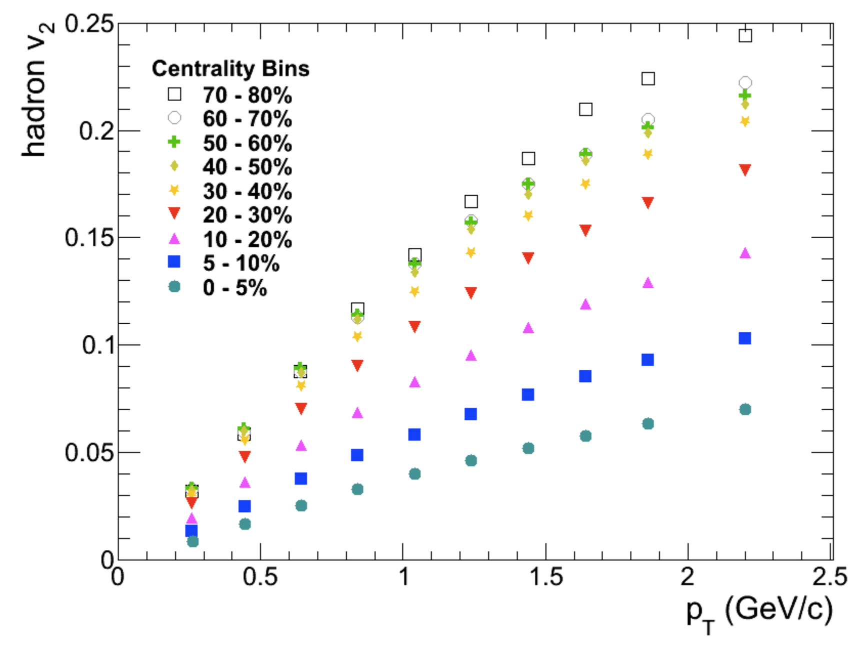
Non-reconstructed photonic electrons: Estimated from identified photonic electrons and reconstruction efficiency ϵ_γ.

Same-sign partners: Triggered electrons for which a like-sign partner track passing photonic electron cuts was found. Added back to account for combinatorially removed pairs.

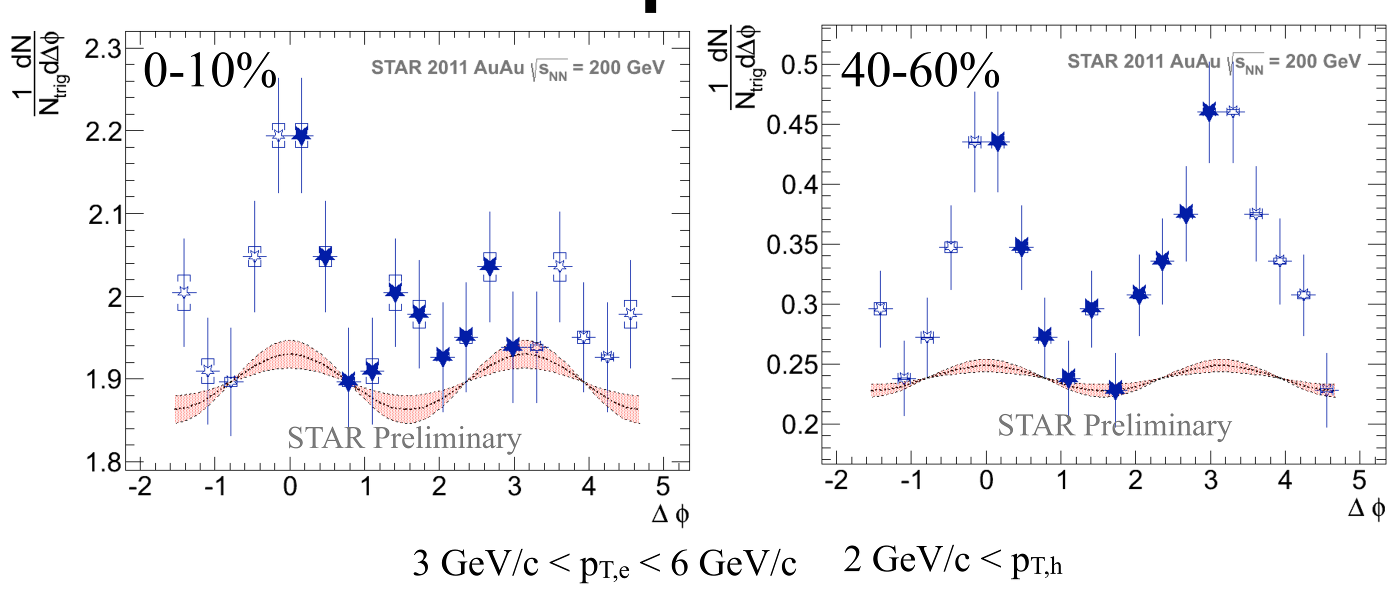
Background from v_2 has the form $1 + 2v_2^h v_2^e \cos(2\Delta\phi)$

We assume $v_{2,e}$ ~ .1 [1], $v_{2,h}$ is taken from published STAR results [2]. Overall normalization is determined by zero yield at minimum



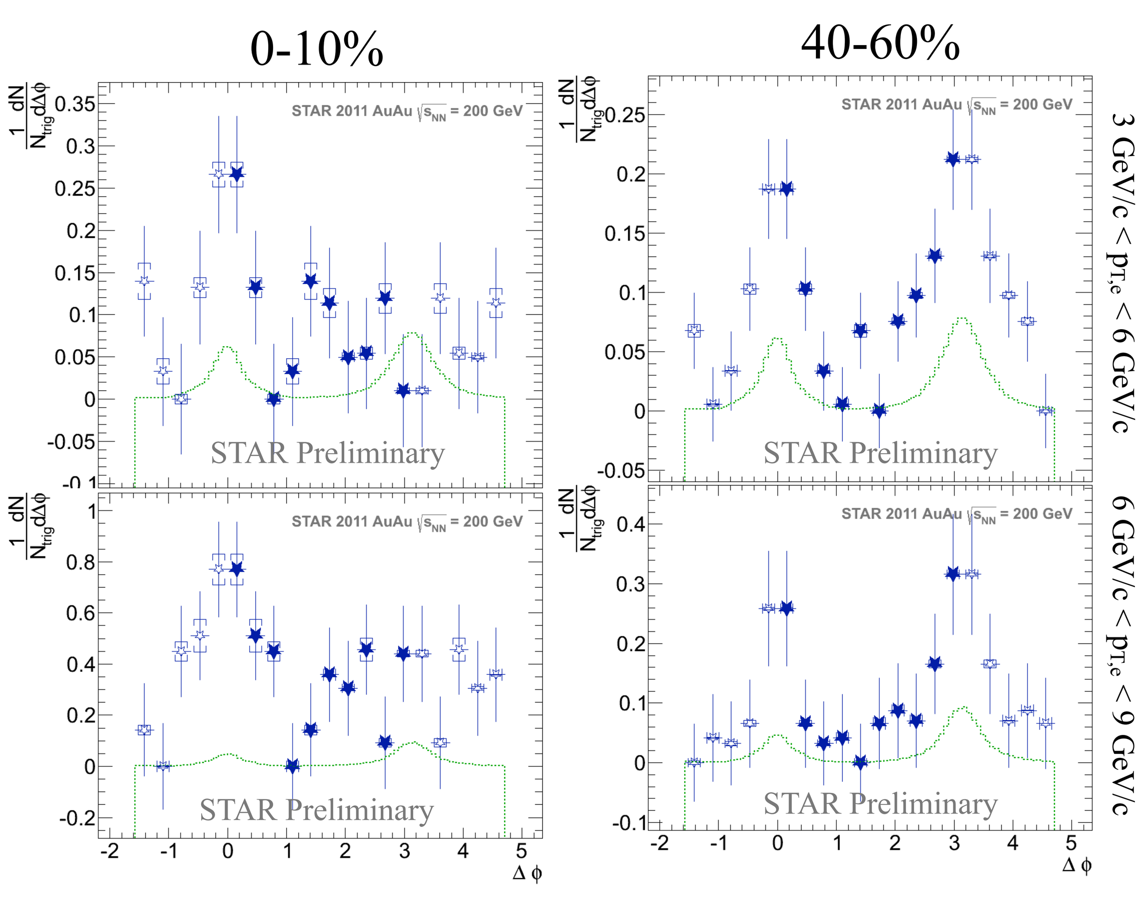


Non-photonic Electron-Hadron Correlations



NPE-h correlations in 200 GeV AuAu collisions. Band in left plots shows background for .5 < $v_{2,e}$ < .15. Systematic errors from photonic electron reconstruction efficiency are also shown. Right plots have v_2 background subtracted and show e-h correlation from PYTHIA simulations normalized per trigger electron and within STAR acceptance.

Similar trend to dihadron correlations; we see larger away side broadening and suppression in central events and at lower trigger p_T.



For all figures $p_{T,h}$ > 2 GeV/c

Summary

- NPE-h correlations in heavy ion collisions are an additional tool to understanding heavy quark interactions in a strongly coupled medium
- Current results have similar features to dihadron correlations
- Systematic uncertainty from background normalization needs to be studied
- In the future we may check the viability of NPE-NPE correlations

References

[1] M. Mustafa for the STAR Collaboration, Nucl Phys A 904-905 (2013) 665c-668c.

[2] STAR Collaboration, Phys Rev C 72, 014904 (2005).