Centrality and p_T dependence of D^0 triangular flow in Au+Au collisions at $\sqrt{s_{NN}}$=200 GeV

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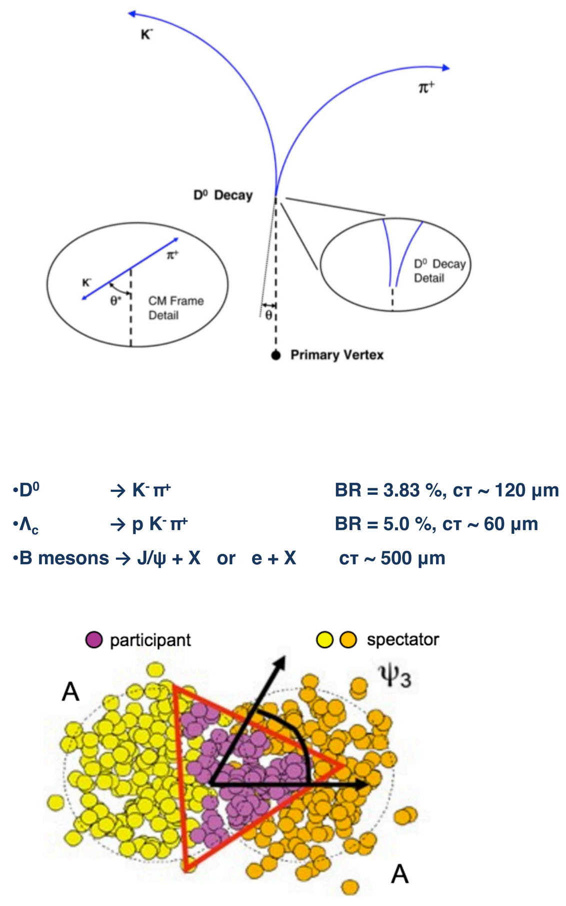
Abstract: Heavy quarks are produced through initial hard scatterings in heavy-ion collisions, and are affected by the hot and dense medium throughout its evolution when propagating in the medium. Several models have predicted that fluctuations in the initial conditions, together with frequent interactions with the QGP medium could lead to a finite triangular flow (v_3) for the D^0 meson.

We present the first measurement of the D^0 triangular flow using data taken with the STAR Heavy Flavor Tracker in Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV. The D^0 v_3 will be compared to light hadron measurements as well as theoretical calculations. Physics implications on the charm-medium interactions as well as the QGP medium properties will be discussed.

Motivation

- Some models [1] predict that fluctuations in initial conditions and interactions between D^0 and the medium could lead to a finite D^0 v_3.
- Models suggest that a QGP with higher temperature/ larger volume will transfer more bulk flow to heavy quarks.
- This trend will be observable in comparing the centrality dependence of v_3/ε between light and heavy quarks.
- The Heavy Flavor Tracker (HFT) was designed to detect heavy flavor particles through direct topological reconstruction of displaced vertices.

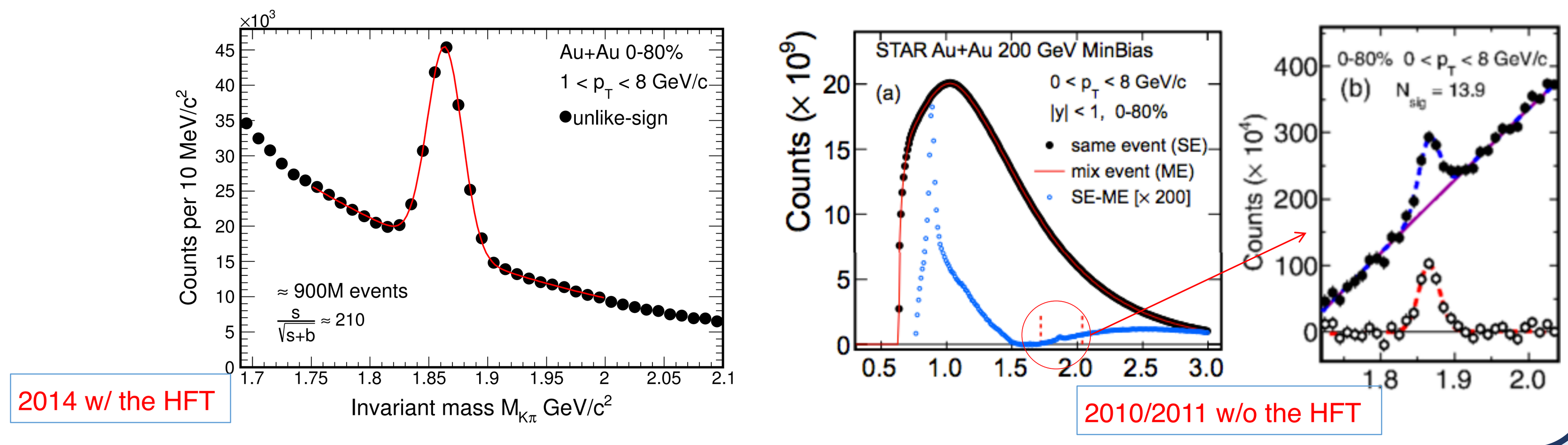


B. Alver, G. Roland, PRC81 (2010) 054905

D^0 Signal

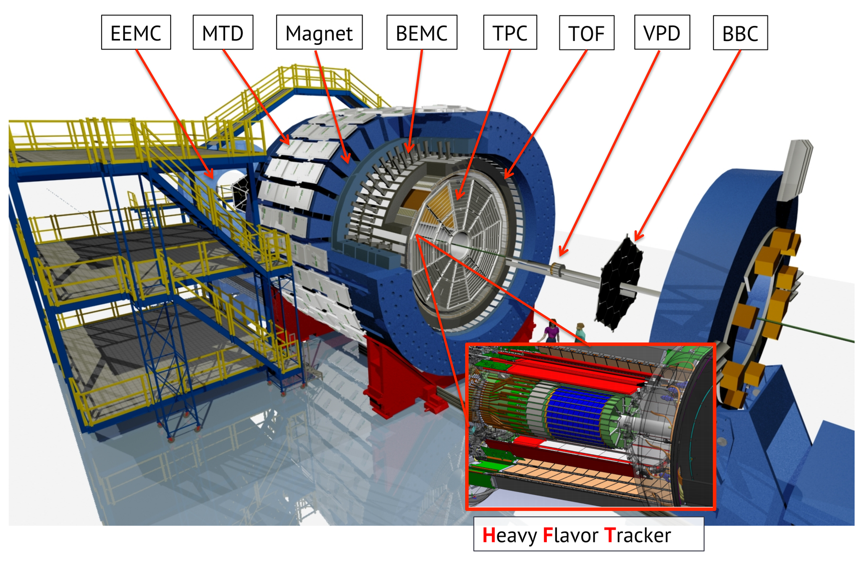
- Using the HFT drastically reduces the combinatorial background by imposing cuts on the decay topology, e.g. the decay length and distance of closest approach (DCA) to the primary vertex.
- Over an order of magnitude improvement in measured D^0 signal significance compared to 2010/11 results using only the TPC [3].
- With this improvement, the 2014 dataset is equivalent to roughly 200 billion events without the HFT.

	w/o HFT	w HFT
	2010 + 2011	2014
# events(MB) analyzed	1.1 B	~900M
Significance per billion events	13	~220



STAR Heavy Flavor Tracker

Detector	Radius (cm)	Hit Resolution R/φ - Z (μm - μm)	Radiation length
SSD	22	20 / 740	1% X_0
IST	14	170 / 1800	<1.5 %X_0
PIXEL	8	12/ 12	~0.5 %X_0
	2.8	8 / 8	~0.5% X_0

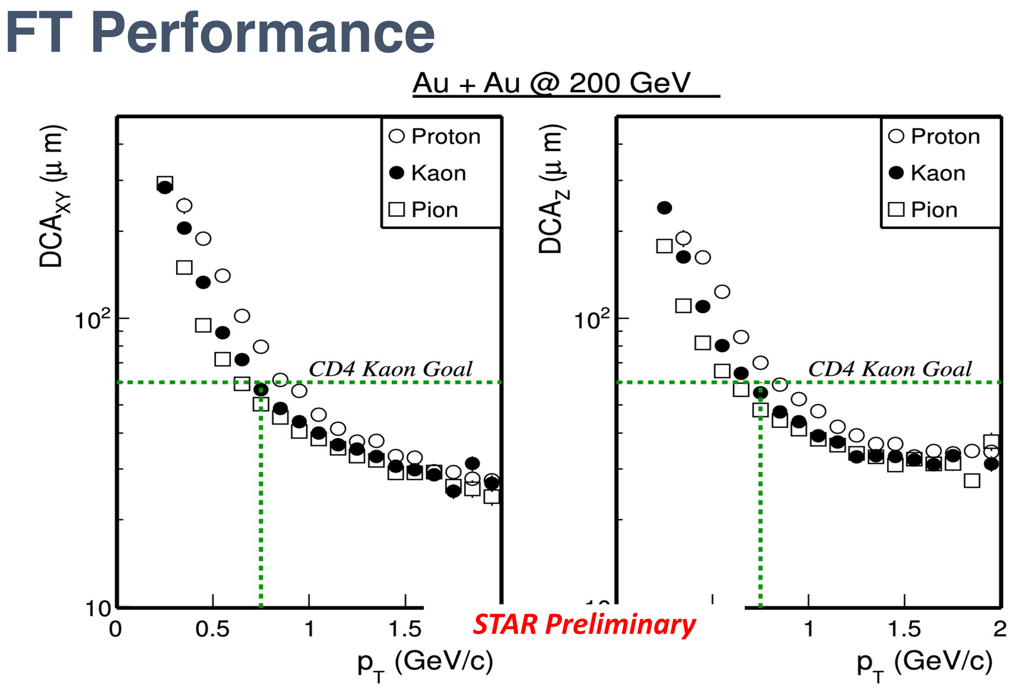


The STAR HFT consists of three subassemblies with the purpose of gradually improving the track pointing resolution to be able to distinguish decay vertices.

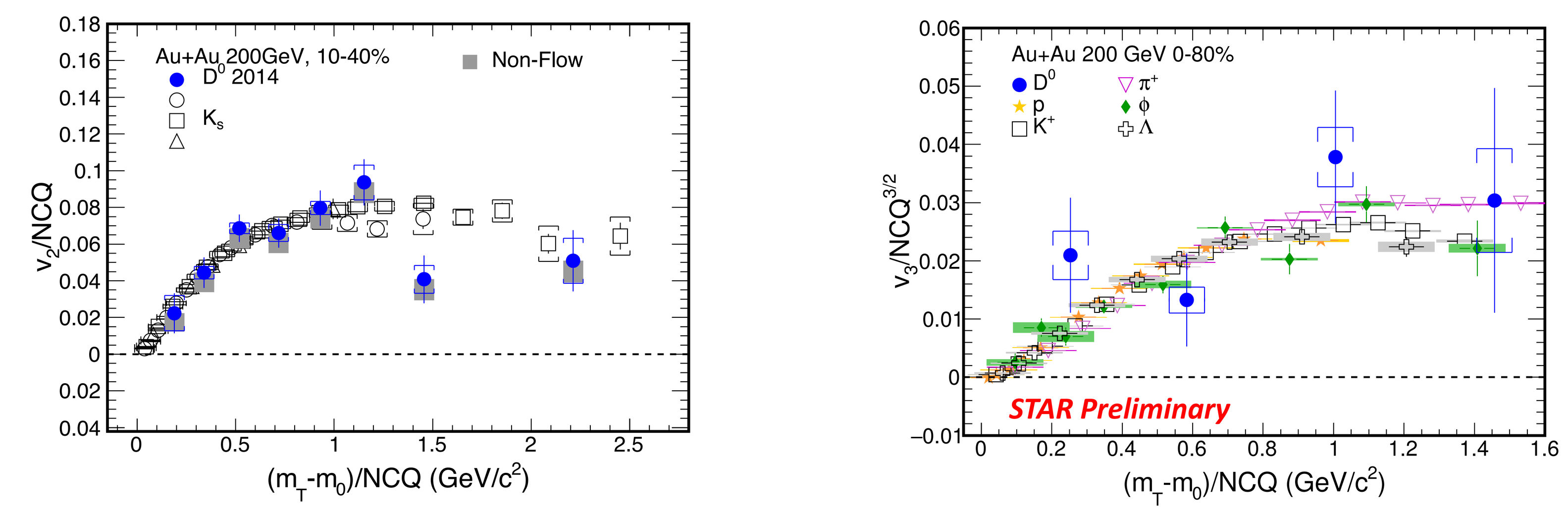
- **SSD**: the Silicon Strip Detector consists of a single layer of double-sided silicon strips sensors. Existing detector with new, faster electronics (200 Hz --> 1 kHz).
- **IST**: the Intermediate Silicon Tracker consists of a single layer of single-sided silicon pad sensors. Like the SSD, it guides tracks from the TPC to the PiXeL detector.
- **PiXeL** detector: the heart of this upgrade. The goal of this detector is to measure hit points with great accuracy to find secondary decays. It is made by 2 layers of 20.7 μm x 20.7 μm CMOS Monolithic Active PiXeL sensors [2].

HFT Performance

- The figure on the right shows the single track pointing resolution in the transverse (xy) and beam directions (z) for three particle species.
- HFT exceeds the design goal (green line), with a track pointing resolution below 55 μm for 750 MeV/c Kaons.



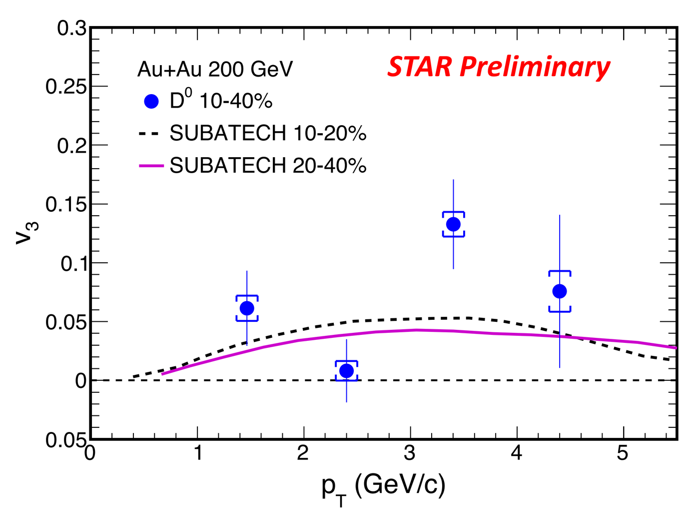
Azimuthal Anisotropy



- D^0 v_2 follows the same Number of Constituent Quark (NCQ) scaling as is observed for light hadrons [5] , indicating that charm quarks have achieved local thermal equilibrium.
- Indication that D^0 v_3 is non-zero at RHIC.
- The right panel shows the v_3/NCQ$^{3/2}$ vs. (m_T-m_0)/NCQ with $m_T = \sqrt{(p_T^2 + m_0^2)}$, as suggested in [4], showing a consistent trend between D^0 and light hadrons.

The right figure shows the measurement of D^0 triangular flow in 10-40% central Au+Au collisions at RHIC.

- The model prediction [1] includes charm interactions with the QGP medium and fluctuations in the initial conditions.
- Measurements in 0-10% and 40-80% centralities are limited by statistics.



Summary and Outlook

- First results of D^0 v_3 using the HFT. Both v_2 and v_3 appear to follow the same NCQ scaling observed for lighter particle species.
- D^0 v_3 is non-zero, suggesting the importance of fluctuations in initial conditions.

Two billion events recorded in 2016 will further improve the precision for D^0 measurements and will allow more thorough studies:

- Centrality dependence of D^0 v_2 and v_3 .
- Studies of other charmed hadrons (Λ_c, D_s, …) and bottom hadron flow

References:
[1] Nahgrang M. et al, *Phys. Rev.* **C91** 014904
[2] E. Anderssen et al. , A Heavy Flavor Tracker for STAR (http://rnc.lbl.gov/hft/docs/hft_final_submission_version.pdf)
[3] L. Adamczyk et al. (STAR Collaboration), *Phys. Rev.* **L113** 142301
[4]: R. Lacey (PHENIX Collaboration), *Journal of Phys.* **G38** 124048
[5]: L. Adamczyk et al. (STAR Collaboration), **arXiv:1701.06060**

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