Heavy Flavor Tracker (HFT) : a new inner tracking device at STAR

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Abstract. Due to their large masses, heavy flavor (c and b quarks) are produced in the early stages of heavy ion collision[1]. The measurement of charm meson nuclear modification factor R_{AA}, as well as their flow velocity will be investigated by the HFT. A precise measurement of heavy flavor production could be achieved by identifying the decay of charm meson using direct topological reconstruction and thus disentangling the b and c quarks. The HFT is a proposed new inner tracking detector for STAR. It is composed by the existing Silicon Strip Detector (SSD) and by 2 new detecting devices : the Intermediate Silicon Tracker (IST) and the PIXEL detector. We report recent results about the Λ_c reconstruction, using a full GEANT simulation of STAR detectors.

1. Technical design

The HFT is an assembly of 3 sub-systems, made of different technologies. It is composed by 2 layers of monolithic CMOS Active Pixel sensors[2] which measure with great accuracy the track pointing resolution and to find secondary decays. These very thin layers (50μm width) minimize the multiple coulomb scaterring (MCS), dominant at this location close to the beam pipe (see Table 1). The mid-rapidity tracking system is made by the IST and the existing SSD ; these detectors allow to guide the reconstructed tracks in the STAR Time Projection Chamber to the PIXEL detector. (plot of STAR detector?).

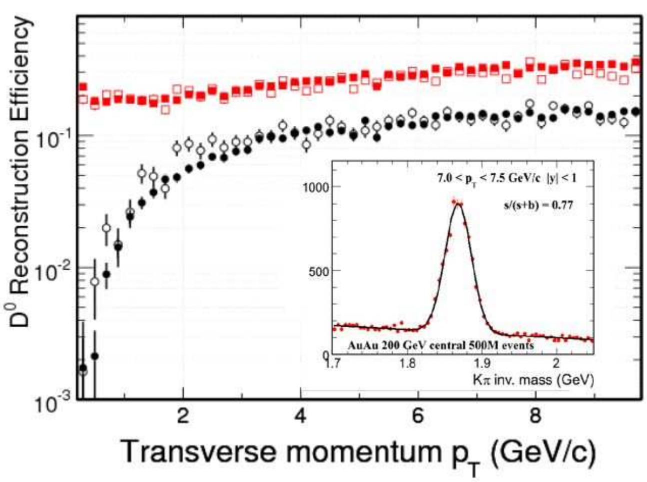
2. Performances : single track and D^0 reconstruction efficiency

Simulations were performed using full STAR geometry package with 10k Au+Au events at $\sqrt{s}$=200 GeV embedded with D^0, D_s, D_s^+ and Λ_c. Pseudo-random hits (pileup) effect is taken into account in the PIXEL detector, corresponding to MinBias collision rate of 80 kHz. It has

Table 1. Characteristics of each silicon layer of the HFT

Detector	Radius (cm)	Technology	Thickness (μm)	Hit resolution R-ϕ (μm - μm)	Radiation Length
SSD	23	double sided strips	300	30 - 857	1% X_0
IST	14	Silicon Strip Pad sensors	300	170 -1700	1.2% X_0
PIXEL	2.5 - 8	Active Pixels	50	8.6 - 8.6	0.3% X_0

been shown that the pointing resolution for single track is in agreement which the detector design : the distance of closest approach (DCA) of correctly reconstructing tracks‡ to the primary vertex (PV) reaches a value of 30μm for momentum of 1 GeV and degrades when pileup increases due to ghosting (probabilty of not assigning the correct MonteCarlo hit) (plot of DCA resolution?). The D^0 efficiency is based on particle identification (PID) of daughter particles provided by the TPC and extended to higher p_T with the time of flight (TOF). Topological cuts have been applied to the D^0 candidates. Fig. 2 shows the good signal significance achievable over a wide range



Fraction of reconstructable D^0 before (red markers) and after (black markers) optimization with a set of cuts based on DCA of its daughters to the PV, isolation cut on cos(θ)(θ being the angle between the D^0 momentum and the vector joining the PV to the secondary vertex). Inserted : example of D^0 invariant mass for 7.0<$D^0 p_T$<7.5 GeV/c

Figure 1. Invariant mass (left) of D^0 and its reconstructed yield as a function of its transverse momentum p_T

of transverse momentum values and the errors extrapolated to 2-3 months of RHIC running time (using 20-40% duty factor in data taking). Fig. 3 show the key measurements for the HFT : on the left the flow parameter v_2 shown for 2 extreme scenarios (charm quark flow equal to light

‡ requires of 15 hits in TPC and 2 hits in PIXEL detector

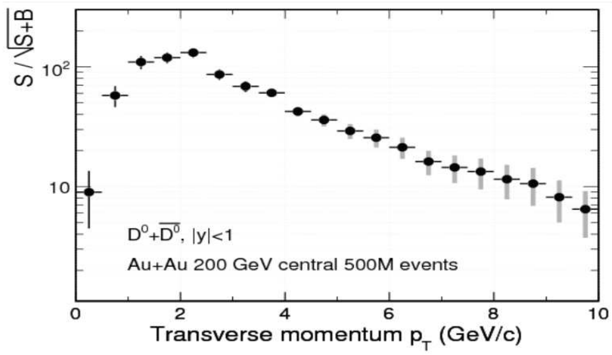


Figure 2. Signal significance of D^0 as a function of transverse momentum p_T

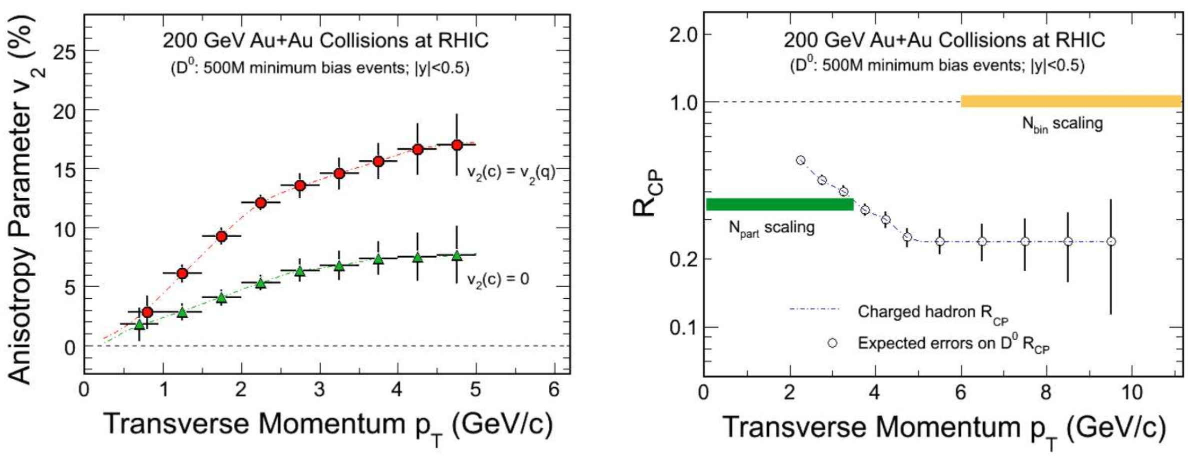


Figure 3. Charm elliptic flow v_2 and R_{cp} with HFT

quark flow (red) and charm quark does not flow (green)). The HFT will be able to distinguish with great accuracy (error bars) these 2 cases. Fig. 3 right shows the flavor suppression factor R_{cp} of D^0: the HFT will be able to measure energy loss directly via hadronic channel thus avoiding indirect method using non photonic electrons.

3. Λ_c reconstruction

A measurement of Λ_c would be useful to perform since the Λ_c/D^0 ratio may be enhanced then indicating a similar pattern as for the baryon/meson ratio in the intermediate p_T region[3]. Details of simulation can be found at [4]. 2 scenarios are investigated for the Λ_c/D^0 ratio : no enhancement and ratio flat equal to 0.2 and an enhancement equal to Λ/K_s^0. We see from Fig. 4 that the statistical errors are well distinguished, making a measurement of baryon/meson ratio in charm sector with good precision in HI collisions.

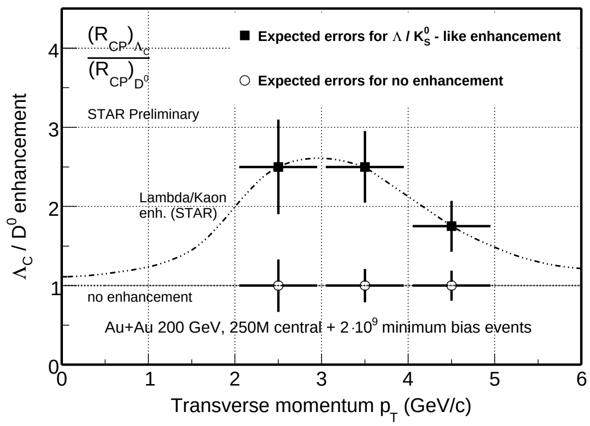


Figure 4. Expected Λ_c/D^0 ratio measurement

4. Summary

The HFT, by using low mass CMOS sensors, will be able to reconstruct direct charm hadrons over a large momentum range thus study flow and energy loss of heavy flavor particles. New measurement such as baryon/meson ratio in the charm sector are also envisaged and have been studied.

References

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