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

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Abstract

The HFT, a new inner tracking detector for STAR, aims to measure the charmed hadron nuclear modification factor as well as their elliptic flow to the low p_T region (~0.5 GeV/c) by measuring the displaced vertices of charmed particles.

1. Introduction

Due to their large masses, heavy flavor (c and b) quarks are produced in the early stages of heavy ion collisions [1]. A precise measurement of heavy flavor production could be achieved by identifying the decay of charmed mesons using direct topological reconstruction and thus disentangling the c and b contributions. The HFT has the necessary resolution for such a measurement that requires high precision. It is the assembly of the existing Silicon Strip Detector (SSD) and 2 new detecting devices: the Intermediate Silicon Tracker (IST) and the PIXEL detector. The PIXEL is composed by 2 layers of monolithic CMOS Active Pixel sensors [2] which measure with great accuracy the position of a particle within a few centimeters of the interaction region. These very thin layers minimize the multiple coulomb scaterring. The intermediate tracking system is made by the IST and the existing SSD (Table 1). The purpose of the IST and the SSD is to link tracks found in the STAR Time Projection Chamber (TPC) to the PIXEL detector.

Table 1: Characteristics of each silicon layer of the HFT

Detector	Radius (cm)	Technology	Si thickness (μm)	Hit resolution R/$\phi - Z$ (μm - μm)	Material Budget in radiation length X_0
SSD	23	double sided strips	300	30 - 857	1%
IST	14	Si Strip Pad sensors	300	170 -1700	1.2%
PIXEL	2.5, 8	Active Pixels	50	8.6 - 8.6	0.37%

2. Simulation details

Simulations presented in this proceedings were performed using the full STAR geometry package with 10k AuAu HIJING central events at $\sqrt{s_{NN}}$ = 200 GeV embedded with D^0 and

Λ_c particles, forced to decay to their hadronic channels ($D^0 \to K^- \pi^+$, $\Lambda_c \to K^- \pi^+ p$). Their reconstruction efficiencies are based on particle identification of daughter particles provided by the TPC and extended to higher p_T with the Time of Flight detector (TOF) : K-π and (K+π)-p separations were done up to $p_T \leq 1.6$ GeV/c and $p_T \leq 3$ GeV/c, respectively. Topological cuts have been also applied to the D^0 candidates. The effect of *out of time* events is included in the PIXEL simulation at a rate corresponding to RHIC-II luminosity.

3. Estimated D^0 and Λ_c reconstruction performances

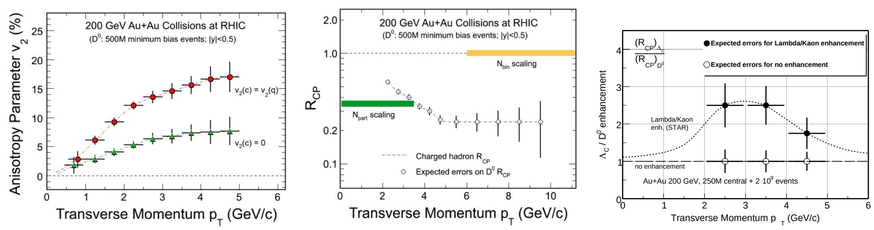

Figure 1: Projections of key measurements with HFT

Figures 1 show the statistical error projections for the key measurements with the HFT in 500 M minimum bias AuAu collisions. Fig. 1(left) is the flow parameter v_2, shown for two extreme scenarios [charm quark flow equal to light quark flow (red circles) and charm quark does not flow (green triangles)]. The HFT will be able to distinguish with great accuracy these 2 cases. Figure 1(middle) shows the suppression factor R_{CP} of D^0: the HFT will be able to measure it directly for $p_T \leq 10$ GeV/c via the hadronic channel thus avoiding the indirect method using non-photonic electrons. A measurement of Λ_c is important to perform since the Λ_c/D^0 ratio may be enhanced, indicating a similar pattern to the baryon/meson ratio involving light quarks in the intermediate p_T region [3]. Two scenarios are investigated for the Λ_c/D^0 ratio [4] : no enhancement and same enhancement as Λ/K_s^0. We see from Fig. 1(right) that the statistical errors are sufficiently small, making a measurement of baryon/meson ratio in charm sector with good precision in heavy ion collisions.

4. Summary

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

References

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