Boosting the reconstruction efficiency of low momentum Charmed Mesons using their back-to-back decay property

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Introduction

The energy loss measurement of heavy quarks are a unique probe of the hot and dense medium created in the heavy ion collisions at RHIC [1]. Most of the heavy flavour measurements at RHIC are done through the semileptonic decay channel. Both bottom and charm contribute to the non-photonic decay channel and there is ambiguity in their relative contribution to the total yield. A direct measurement of charm is thus imperative to solve this.

The work presented here is based on a microvertexing method for the direct reconstruction of the $D^0(\bar{D}^0)$ meson through the decay channel $D^0(\bar{D}^0) \longrightarrow K^{\mp}\pi^{\pm}$ using STAR silicon vertex detectors [2] . This method uses a kinematically constrained decay vertex fit to reduce combinatorial background. But the reconstruction efficiency is poor when the momentum of D^0 particles is low. **We device a method to boost the reconstruction efficiency in the low momentum region by utilising the back-to-back correlation of the daughters of such events. The method is applied to find signal in $D^0(\bar{D}^0)$ embeddded $Au + Au$ data at $\sqrt{s_{NN}} = 200GeV$, and the results are presented.**

STAR Experiment

The STAR Experiment is a large detector placed at the six O' clock collision point of RHIC. STAR has used in the past a silicon detector ensemble, consisting of 3 layers of Silicon Vertex Detectors (SVT) using silicon drift sensors and one layer of double sided microstrip sensor, Silicon Strip Detector (SSD). This was designed mainly to improve strange particle measurement. Later, this was used to study decays of charmed mesons. The hit information from the silicon detectors (SVT, SSD) and TPC is crucial for the pointing resolution needed for such analyses. At 1 GeV, the resolution to the interaction point is $\sim 250\mu m$ with hits on all four silicon layers.

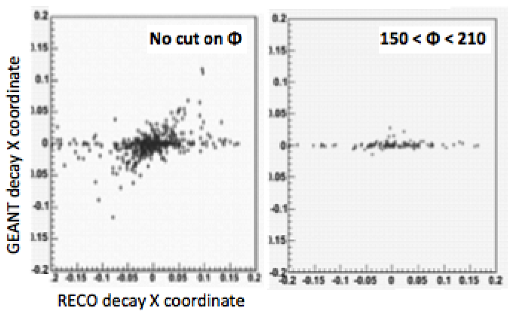

FIG. 1: Decay vertex x-coordinate, Reconstructed Vs GEANT. Without any cut on ϕ(Left) and with the cut $150 < \phi < 210$(Right)

Analysis Technique and Results

Since the decay of D^0 ($c\tau \sim 123\mu m$) occurs before the tracking detectors, it has to be done using the identified daughter tracks (K and π). The microvertexing method reconstructs the decay vertex and calculates associated quantities. A plot of the GEANT versus reconstructed decay vertex coordinates in Monte carlo signal events shows a clear correlation as can be seen from Fig. 1(Left plot). There are some uncorrelated entries as well, which corresponds to the low momentum D^0 particles. This can be understood from the

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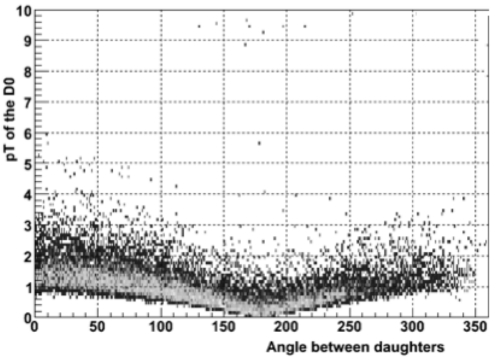

FIG. 2: Transverse momentum(p_T) Vs ϕ of the D^0 particles

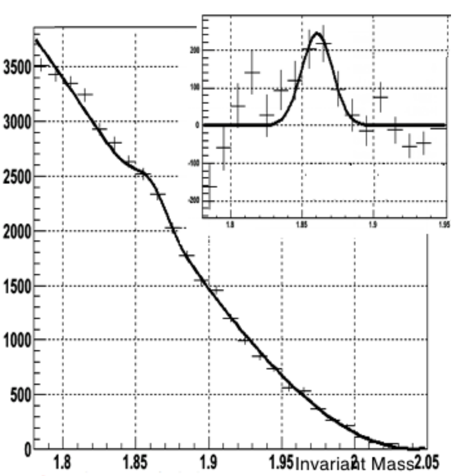

FIG. 3: Invariant mass distribution from D^0 embedded $Au+Au$ data, before background subtraction and after background subtraction(inset)

right plot, which is obtained when we require the opening angle between daughters (ϕ) to be between 180 ± 30.

The low momentum D^0 particles are almost at rest in the lab frame. So, the daughter tracks decay back to back according to momentum conservation. The parallelism of the tracks undermines the microvertexing method because it tries to find a minima between the daughter tracks. Thus there is poor resolution in the low momentum region. Here, we exploit the back-to-back correlation between daughter tracks to find signal in the low momentum region. Requirement on their decay angle $150 < \phi < 210$ indeed selects these candidates as can be seen from Fig. 2. The low momentum D^0 candidates cannot be simply discarded since they contribute significantly to the D^0 statistics.

This method was tested in Monte Carlo data and then extended to D^0 embedded Au+Au data. Fig. 3 shows the invariant mass plots obtained from 4.8K events. The distribution shows a clear peak corresponding to the D^0 mass 1.864 GeV/c^2. The background is subtracted off from this plot by fitting with a third degree polynomial. The invariant mass distribution after background subtraction is also shown in the inset. The method successfully finds the signal candidates with low momentum and can be applied to real data.

Future in STAR

The future upgrade to STAR, Heavy Flavor Tracker (HFT) is designed to precisely measure charmed particles. It is a micro vertexing detector using active pixel sensors and silicon strip technology. The HFT will replace the decommissioned SVT with active pixel technology. It consists of two subdetectors: a silicon pixel detector (PIXEL) and an intermediate silicon tracker (IST). Both these detectors lie inside the radial location of the SSD. The SSD-IST-PIXEL detector serves the purpose of graded resolution from the TPC to the interaction point. It can extend the pT reach and measure spectra and cross section with great accuracy[3].

References

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