Abstract

Heavy quarks, produced in hard scattering processes in the initial stages of the collisions, are considered as excellent probes for the strongly interacting deconfined medium formed in heavy-ion collisions. The $D_s^*(c)/(s)$ production is affected by the strangeness enhancement and the primordial charm quark production in heavy-ion collisions. Thus the modification of the $D_s$ meson spectra in ultra-relativistic heavy-ion collisions provides a new interesting probe to the key properties of the hot nuclear medium.

The Heavy Flavor Tracker, installed in STAR in 2014, has been designed to extend STAR’s capability of measuring heavy flavor production at relativistic energies. The modification of the $D_s$ nuclear modification factor at Ultra-relativistic Heavy Ion Collision is predicted.

Motivation

- Charm hadrons are a powerful tool to study the properties of the QCD medium created in ultra-relativistic heavy-ion collisions.
- The measurement of $D_s$ meson production is of particular interest due to its valence strange quark content.
- A large enhancement of the $D_s$ nuclear modification factor at Ultra-relativistic Heavy Ion Collision is predicted.

Experimental Setup

Vertex Position Detector (VPD)
Time of Flight (TOF)
Time Projection Chamber (TPC)
- Measurement of a charged particle energy loss (dE/dx)
- Tracking and momentum reconstruction
- Heavy Flavor Tracker (HFT)
- Four layer silicon detector, provides high space point resolution (DCA < 50 microns for 700 MeV/c kaons)

Decay Channels Investigated

$D_s^* \rightarrow \phi(1020) + \pi^+$, $D_s^* \rightarrow K^+ + \pi^+$
$D_s^* \rightarrow K^* + K^0(892)$
$D_s^* \rightarrow K^+ + \pi^+$

$D_s$ signal from $D_s \rightarrow \pi \phi(1020)$ decay channel

$D_s$ signal from $D_s \rightarrow K + K^*(892)$ decay channel

$D_s$ meson mean and width

Particle Identification

- All tracks are required:
  - $p_T > 0.6$ GeV/c
  - TPC dE/dx
  - Kaon: $|\Delta m_{KK}| < 3$
  - Pion: $|\Delta m_{KK}| < 2$
  - TOF is available
  - Kaon: $|\Delta \phi| < 0.04$
  - Pion: $|\Delta \phi| < 0.04$
  - $\Delta m_{KK}$ and $\Delta \phi$ are normalized dE/dx

Ds Meson Reconstruction

Event selection

- Minimum bias trigger
- $|\eta|<6$ cm
- $|z_{VC, vpd}|<3$ cm

Topological cuts

- $dca_{kal, pin}$: kaon and pion Dca (Distance of Closest Approach) to the primary vertex.
- $dca_{kal, pin}$: the maximum pair Dca in three combination pairs.
- $\cos(\phi_{kk})$: the angle between $D_s^*$ meson momentum and flight line, which is defined by the positions of the primary and secondary vertices in the laboratory frame
- $\text{decayLength}$: $D_s$ meson candidate flight length.
- $\text{vtdiff}$: The maximum distance between three combination pairs

The cuts used for $D_s$ candidates with $p_T$ of 2.5 GeV/c – 4.5 GeV/c

Summary and To-do

- An independent measurement of $D_s$ meson using STAR Run14 data was presented. Clear $D_s$ signals in 3 centrality bins and 2 decay channels were observed.
- Ongoing study to improve the $D_s$ signal with TMVA method and efficiency correction.

Results

- Ongoing study to optimize the cuts with TMVA.

TMVA Method

- Toy-MC simulation
- Momentum resolution obtained from real data

Background

- Side-Band Background
- Mass Window
  - $|M_{D_s} - M_{D_s}^{MC}| < 8$ MeV
  - $|M_{D_s} - M_{D_s}^{MC}|$ in 5σ - 7σ

Ongoing study to optimize the cuts with TMVA.