$D_s^{\pm}$ meson production in Au+Au collisions at $\sqrt{s_{NN}}$ = 200GeV in STAR

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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 $D_s(c\bar{s}/\bar{c}s)$ 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 by the topological reconstruction of displaced decay vertices. It provides a unique opportunity for precise measurement of the D_s meson production.

We will present an independent study of D_s meson production via two decay channels $D_s \rightarrow \phi(1020) + \pi$, and $D_s \rightarrow K + K^*(892)$ in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV. Multivariate Data Analysis used to obtain D_s signal will also be presented.

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.

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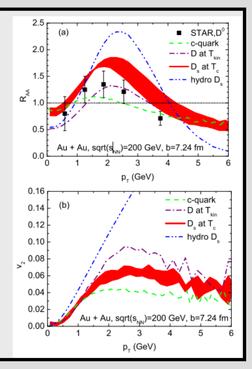


Experimental Setup

Vertex Position Detector (VPD)

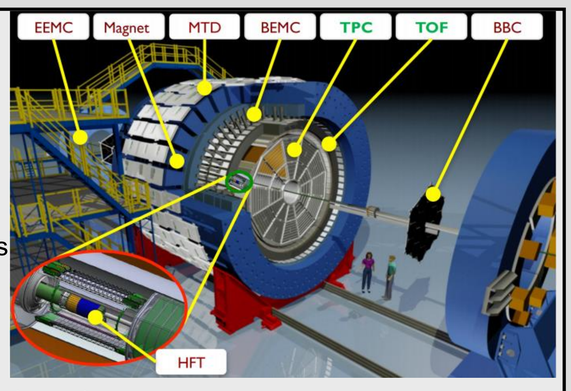
Time of Flight (TOF)

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 750 MeV/c kaons)



Decay Channels Investigated

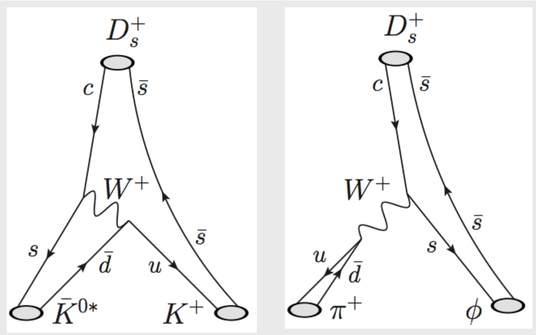
$D_s^+ \rightarrow \phi(1020) + \pi^+ \rightarrow k^+ + k^- + \pi^+$

BR:2.32 %

$D_s^+ \rightarrow k^+ + \overline{k^{*0}}(892) \rightarrow k^+ + k^- + \pi^+$

BR : 2.60 %

D_s : $c\tau = 149.9$um

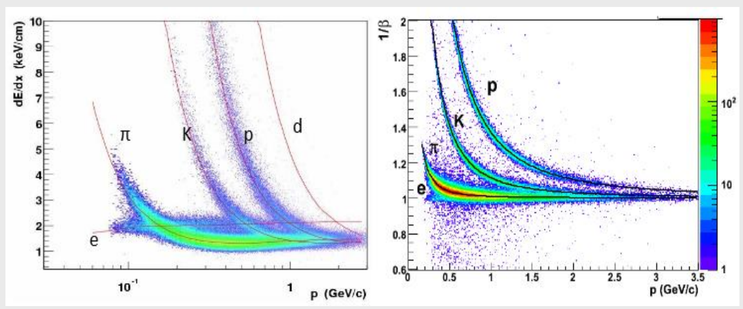


Particle Identification

All tracks are required :

- p_T>0.6 GeV/c
- TPC dE/dx
  - Kaon : $|n\sigma_k|$<3
  - Pion : $|n\sigma_\pi| < 2$
- if TOF is available
  - Kaon: $|1/\beta - 1/\beta_k|$<0.04
  - Pion: $|1/\beta - 1/\beta_\pi|$<0.04

$n\sigma_k$ and $n\sigma_\pi$ are normalized dE/dx



Ds Meson Reconstruction

Event selection

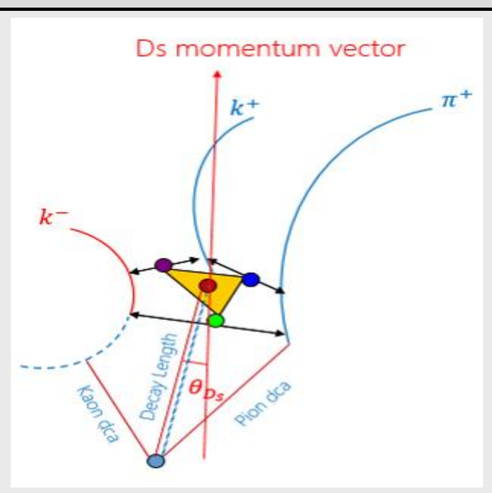
- Minimum bias trigger
- $|V_z|$<6 cm
- $|V_z - V_{z\_vpd}|$<3 cm

Topological cuts

- dca_k dca_π : kaon and pion Dca (Distance of Closest Approach) to the primary vertex.
- $dca_{\pi kk\_max}$: the maximum pair Dca in three combination pairs .
- $\cos(\theta_{point})$: 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
- decayLenght: D_s meson candidate flight length.
- v0diff : The maximum distance between three combination pairs

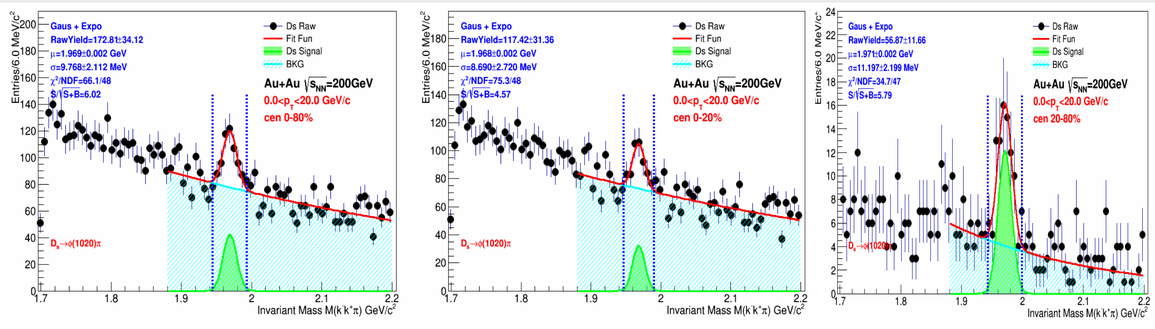
The cuts used for D_s candidates with p_T of 2.5 GeV/c – 4.5 GeV/c

dca_k	dca_π	$dca_{\pi kk\_max}$	$\cos(\theta_{point})$	**v0diff**
>100um	>70um	<60um	>0.995	<400um

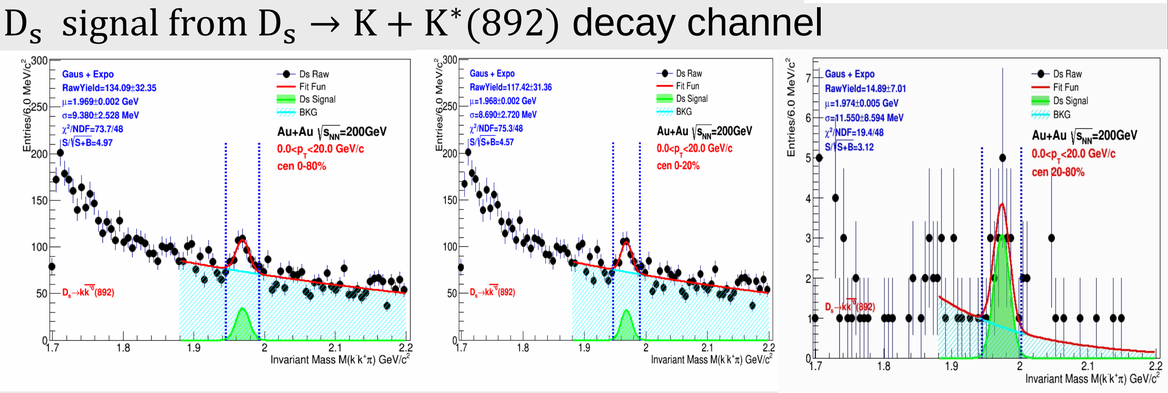


Results

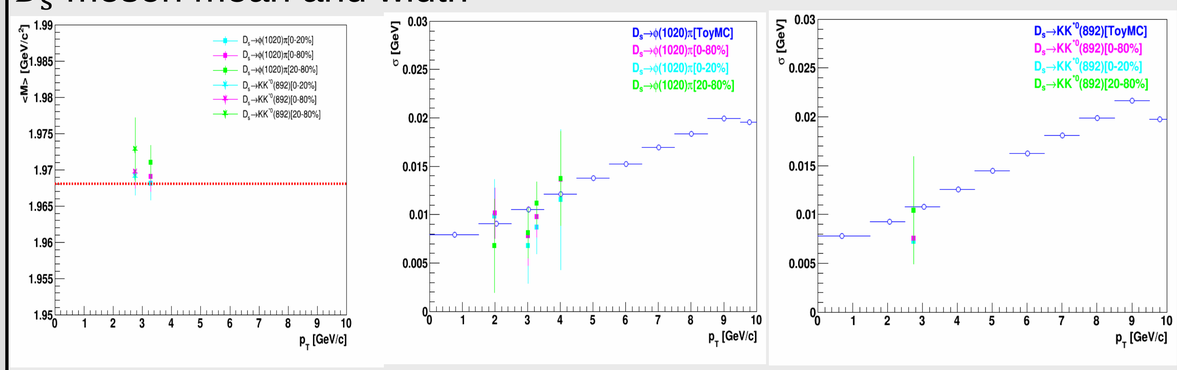
D_s signal from $D_s \rightarrow \pi + \phi(1020)$ decay channel



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



D_s meson mean and width



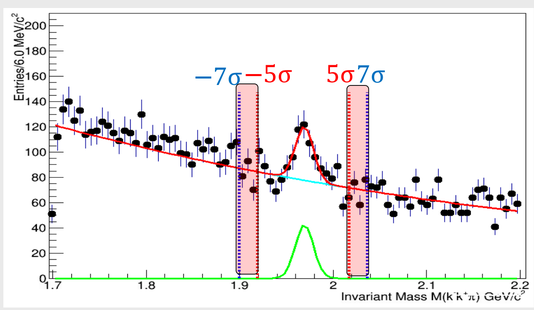
The mean and with are consistent with Toy MC simulation.

TMVA Method

TMVA stands for Toolkit for Multi-Variate Analysis

Signal

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

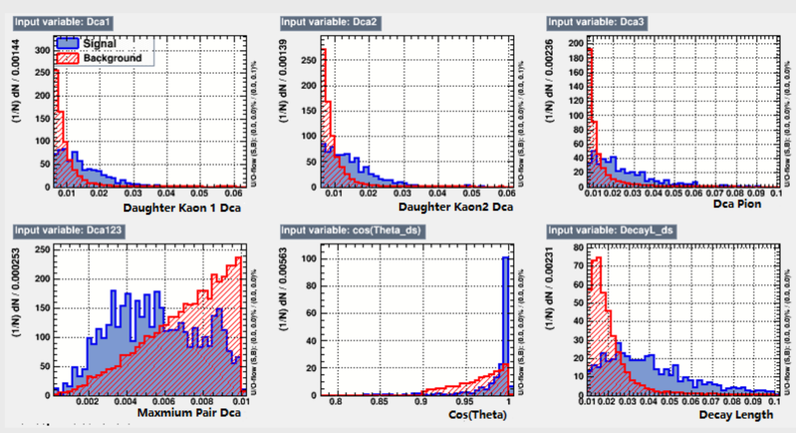


Background

- Side-Band Background
- Mass Window

$|M_\phi - M_\phi^{PDG}| < 8$ MeV

$|M_{Ds} - M_{Ds}^{PDG}|$ in 5σ - 7σ



Ongoing study to optimize the cuts with TMVA.

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.