Measurements of $D_{S}^{\pm}$ - meson production in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV in STAR

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Outline

• Motivation
• STAR detector and analysis details
• $p_T$ spectra, particle ratio and $R_{AA}$
• Elliptic flow ($v_2$) of $D_S$
• Summary
Why Study $D_S^{\pm}$?

- $D_S$ meson: one charm and one strange quark

- Strangeness enhancement due to QGP is expected to affect the yield of $D_S$
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Ref: M. He et al., PRL 110, 112301 (2013)
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- $R_{CP}$ or $R_{AA}$ of $D_S > D^0$ predicted
- Elliptic flow of $D_S < D^0$ is expected due to earlier freeze out of $D_S$

**Good Probe to study the hadronization and strangeness enhancement**

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STAR Detector in Year 2014

- Full $2\pi$ coverage
- Pseudorapidity coverage $\sim \pm 1$ unit
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For Details about HFT: See talk by G. Contin (Tuesday, 3.00 PM, Futute Exp. Fac. Upgr.)
Analysis Details

- Au+Au at $\sqrt{s_{NN}} = 200$ GeV in 2014
- 750 M minimum bias events analyzed (70% of collected data)
- $|Vz| \leq 6$ cm
- Centrality using raw charged particle measured in TPC and Glauber Model

- Decay Channel : $D_s^\pm \rightarrow \phi (\rightarrow K^+K^-) + \pi^\pm$
- Branching Ratio: $2.32 \pm 0.14 \%$
- Decay Length : $150 \pm 2$ $\mu$m
- Mass : $1968.47 \pm 0.33$ MeV/c$^2$

Secondary Vertex :
Using HFT

$D_s \rightarrow K^* \rightarrow K^+ + K$ decay channel:
See Poster by L. Zhou (ID:336)
Particle Identification

TPC PID: Using $dE/dx$

TOF PID: Using Time of Flight ($\beta$)*

*TOF PID has been applied only when $\beta$ information is available.
Particle Identification

TPC PID: Using $dE/dx$  

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• First measurement of $D_S$ meson at RHIC.
• We will present $D_S$ spectra for 10-40% centrality and for $2.5 < p_T < 5.0 \text{ GeV/c}$.
• Lower $p_T$ and more peripheral collisions studies are underway.
Mass and width

Mass is consistent with PDG value
Width is consistent with the results from detector simulations.
The $R_{AA}$ of $D_S$ is higher than unity but statistically not significant.

$R_{AA} = \frac{1}{N_{\text{Bin}}} \times \frac{dN_{\text{AA}}^{\text{pp}}}{dp_T} \frac{dN_{\text{pp}}^{\text{pp}}}{dp_T}$

$D_S$ spectra for $p+p$ collision has been calculated from measured charm cross-section in STAR. Fragmentation factor from charm to $D_S$ is $0.09 \pm 0.01$.

The ratio $D_S/D^0$ is less than unity and seems to be higher than prediction for $p+p$ collision from PYTHIA.
Invariant Yield and $D_S/D^0$

STAR and ALICE data are consistent with large uncertainties.
Elliptic Flow Analysis

\[ v_2 = < \cos(2(\phi - \psi_2)) > \times R^{-1} \]

**Method:** Full Event Plane

**Event Plane:** Using TPC tracks

**Resolution:** Using Eta sub-event

\[ D_s v_2 : \]

*By fitting Yield vs. (\( \phi - \psi_2 \)) with function p0(1 + 2 v_{2raw} \cos(2(\phi - \psi_2)))*

![Graph](image-url)
Elliptic Flow of $D_S$

First measurement of $D_S v_2$ in heavy-ion experiment. Need more statistics.

For $D^0 v_2$:
See talk by M. Lomnitz
(Tuesday, 9 AM, Collective Dynamics)

$\phi$-meson $v_2$
e-Print :1507.05247
• We have observed a clear signal of $D_s$ at RHIC for the first time
• $D_s$ in Au+Au 200 GeV for 10-40% central collisions:
  - $D_s/D^0$ seems to be higher than p+p prediction (from PYTHIA 6.4) at $p_T = 2.8$ and 3.9 GeV/c
  - $R_{AA} = 2.1^{+0.5}_{-0.7}$ and $1.7^{+0.4}_{-0.7}$ at $p_T = 2.8$ and 3.9 GeV/c, respectively
• First measurement of elliptic flow of $D_s$ is presented
• Stay tuned for Run 16 Data with increased statistics and improved detector performance

Thank You
Back-up
$R_{AA}$

$D_s$ (Au+Au 200 GeV, 10-40%)
$D_s$ (Pb+Pb 2.76 TeV, 20-50%)
$D^0$ (Au+Au 200 GeV, 10-40%)

STAR Preliminary

$D_s$ Pb+Pb (ALICE: arXiv:1509.07287)
$D^0$Au+Au (STAR: PRL 113 (2014) 142301)
φ-meson signal

![Graph showing the number of entries versus the invariant mass of the K⁺K⁻ pair.](image-url)