Production of $D_s^{\pm}$ mesons in Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV

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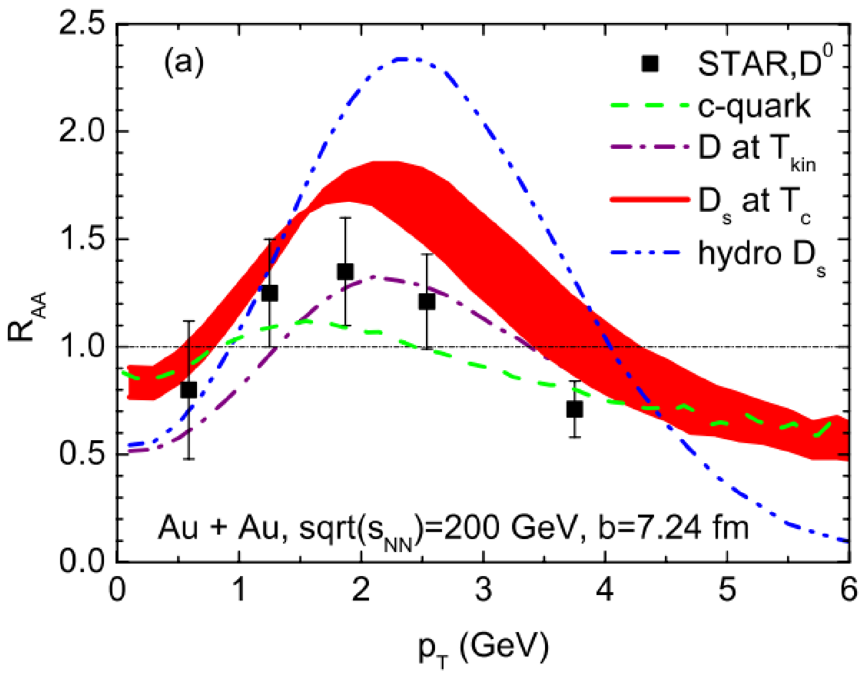
Outline

- Motivation
- STAR detector
- $D_s^{\pm}$ reconstruction
- Results and comparisons
- Conclusion and outlook

Why study $D_s^{\pm}$?



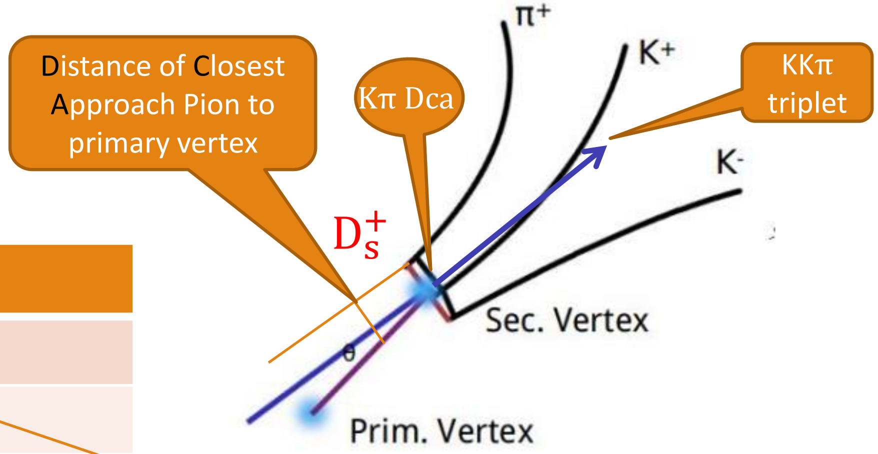
Ref: M. He et al., PRL 110, 112301 (2013)

Charm quarks are excellent probes of properties of Quark-Gluon Plasma (QGP).

Charm quark coalescence hadronization + strangeness enhancement -> R_{AA} ($D_s^{\pm}$) > R_{AA} (D^0) .

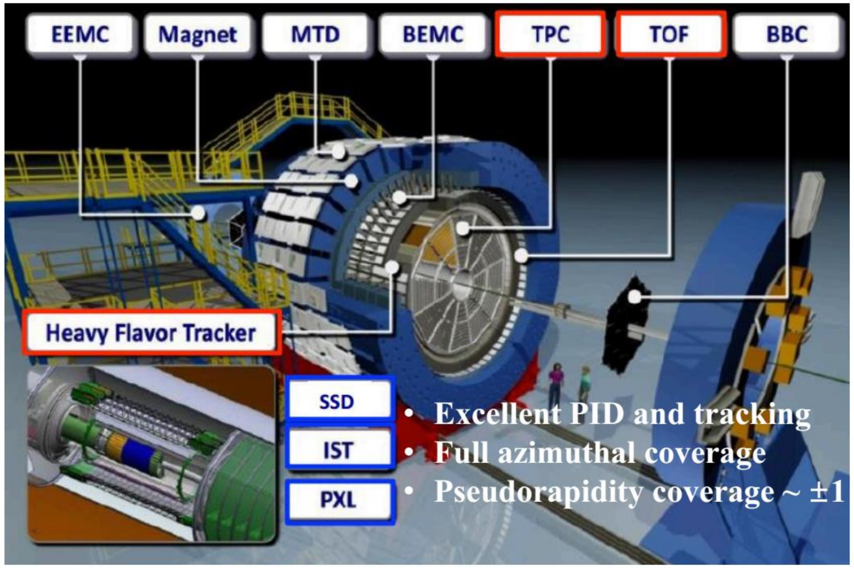
How to measure $D_s^{\pm}$?

$D_s^{\pm}$	
Quark constituent	$c\bar{s}$ ($\bar{c}s$)
Branching ratio	2.27 %
$c\tau$	150 μm
Rest mass	1967 MeV/c^2

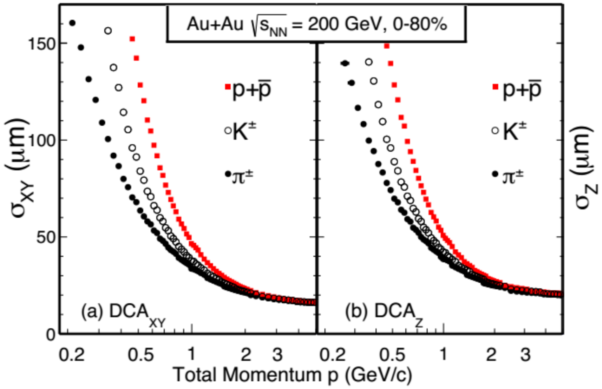


$$D_s^{\pm} \rightarrow \phi + \pi^{\pm} \rightarrow K^{+} + K^{-} + \pi^{\pm}$$
$$c\tau(\phi) = 4.65 \times 10^{-8}\mu m$$

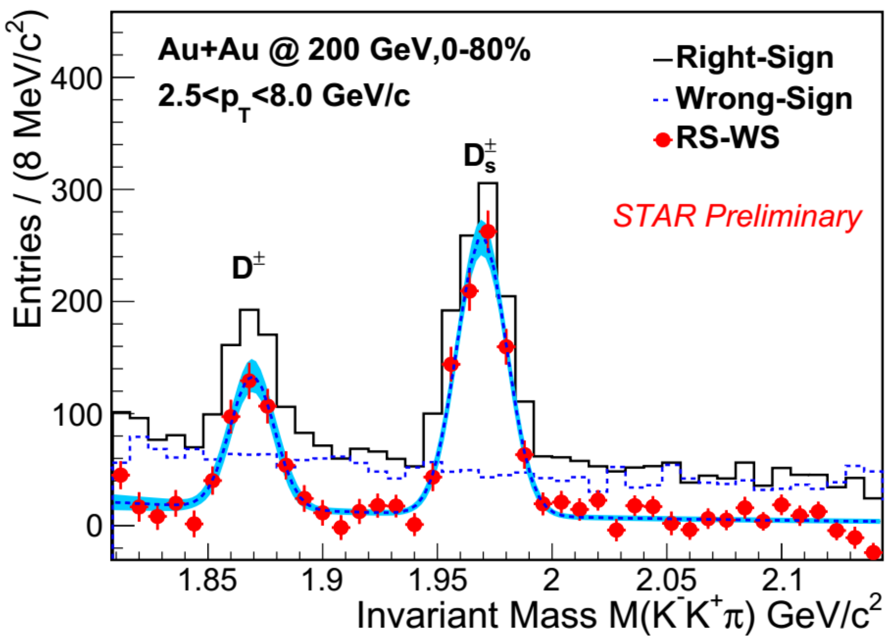
STAR detector



Heavy Flavor Tracker (HFT, 2014-2016):
Four-layer silicon detector.
Excellent resolution of Distance of Closest Approach (DCA).



Invariant mass distribution

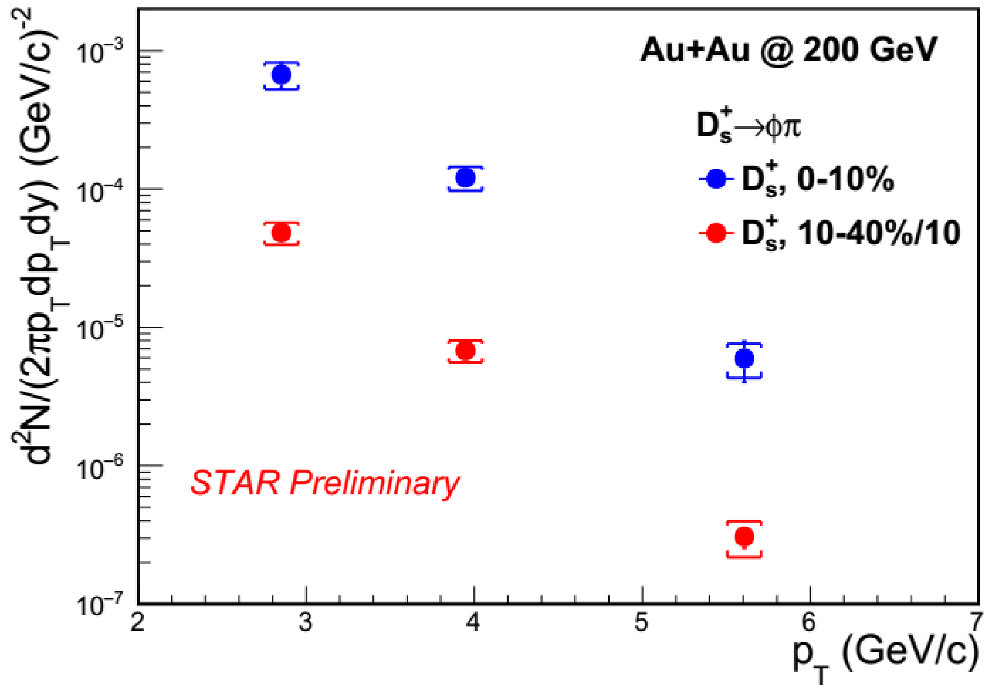


- 2014 data

- Rectangular Cut method from the Toolkit for MultiVariate Analysis is used to reconstruct $D_s^{\pm}$.

- The RC method optimizes straight cuts on input topological variables in order to maximize signal significance.

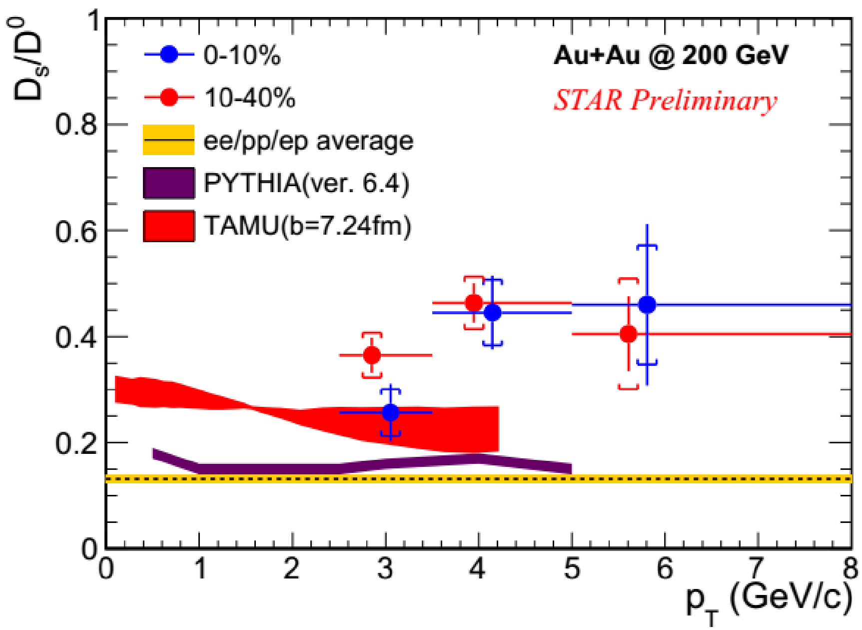
$D_s^{\pm}$ p_T spectrum



$D_s^{\pm}$ p_T spectra are measured for two centrality bins (0-10% and 10-40%)

$$\frac{1}{2\pi p_T}\frac{d^2N}{dp_T dy} = \frac{N(D_s^+ + D_s^-)}{4\pi.\, p_T.\, \Delta p_T \Delta y.\, BR.\, N_{evt}.\, Eff_{rec}}$$

$D_s^{\pm}/D^0$ ratio



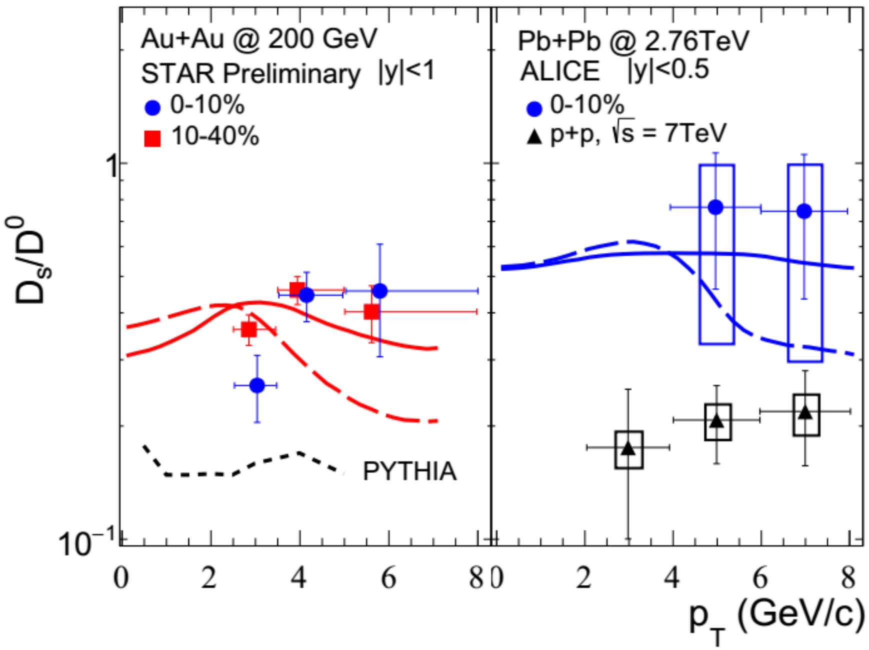
- No clear centrality dependence is seen in $D_s^{\pm}/D^0$ ratio.

- $D_s^{\pm}/D^0$ ratio in Au+Au collisions is significantly higher than that predicted by PYTHIA for p+p collisions -> charm quark coalescence hadronization + strangeness enhancement[1]
- TAMU model calculation in the 10-40% centrality bin is systemically below data.

TAMU model includes strong charm quark coupling to the QGP and subsequent recombination with equilibrated strange quarks.

[1] G. Agakishiev et al. (STAR Collaboration), PRL 108, 072301 (2012)

$D_s^{\pm}/D^0$ ratio



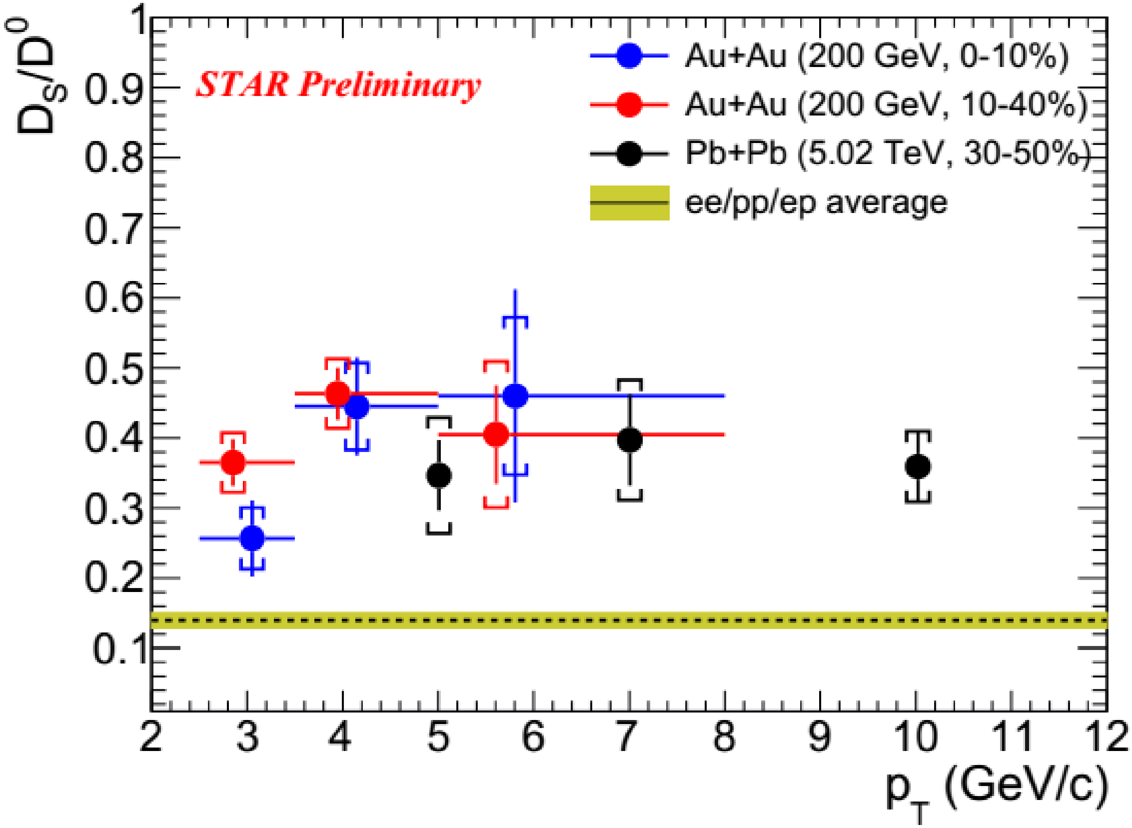
Solid line: sequential coalescence , dash line: simultaneous coalescence (red line is for 10-40% and blue line is for 0-10%).

Data seem to favor sequential coalescence hadronization[1] within 4-8 GeV/c.

- $D_s^{\pm}$ is formed earlier than D^0 .

[1] J.Zhao, S.Shi, N.Xu, P.Zhuang. arXiv:1805.10858v1

Comparison with ALICE result



Our measurement is consistent with ALICE result[1] within uncertainties despite different collision energies and centralities.

[1] A. Barbano (for the ALICE Collaboration), Nucl. Phys. A 967, 612 (2017)

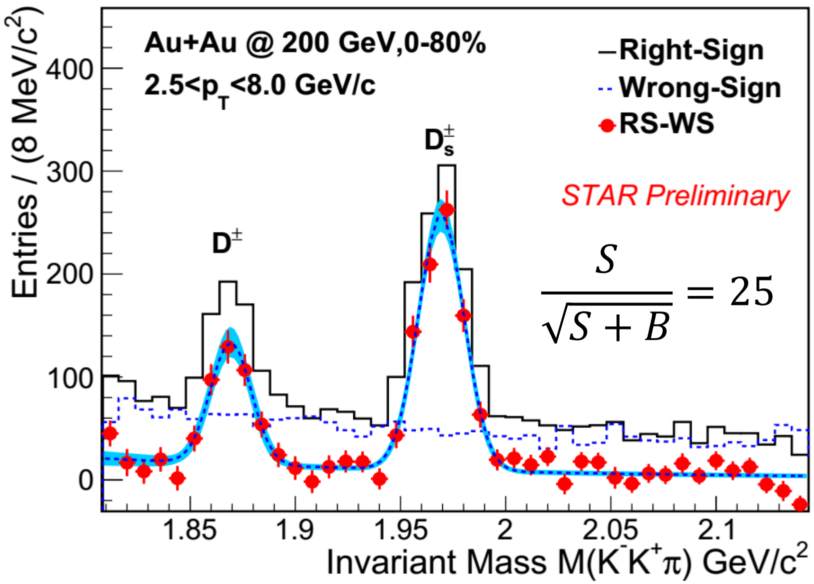
Conclusion

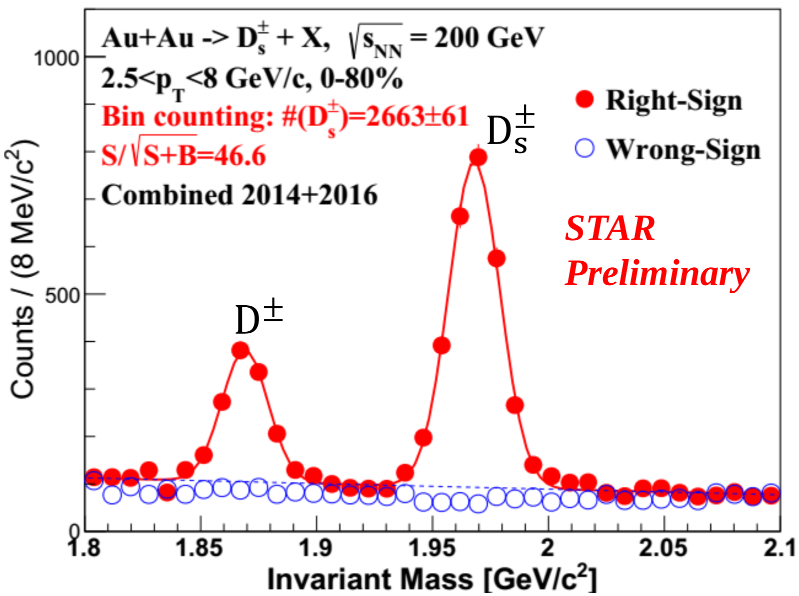
- $D_s^{\pm}$ measurements in Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV enabled by the HFT.
- $D_s^{\pm}/D^0$ enhancement with respect to the fragmentation baseline in 2.5<p_T< 8 GeV/c in central and mid-central Au+Au collisions:

  -Coalescence mechanism for charm quark hadronization + strangeness enhancement.

  - Data seem to favor sequential coalescence hadronization compared to Tsinghua model.

Outlook





Left: 2014 data with Rectangular cut method.

Right: Combined 2014 + 2016 data (2.5x more statistics) with BDT method.

-> significant improvement in $D_s^{\pm}$ signal significance (25->46).