Measurements of D^0 and D* production in p+p collisions at $\sqrt{s}$ = 510 GeV in STAR experiment

Subhadip Pal, for the STAR collaboration
Czech Technical University in Prague

Supported in part by U.S. DEPARTMENT OF ENERGY

CTU CZECH TECHNICAL UNIVERSITY IN PRAGUE

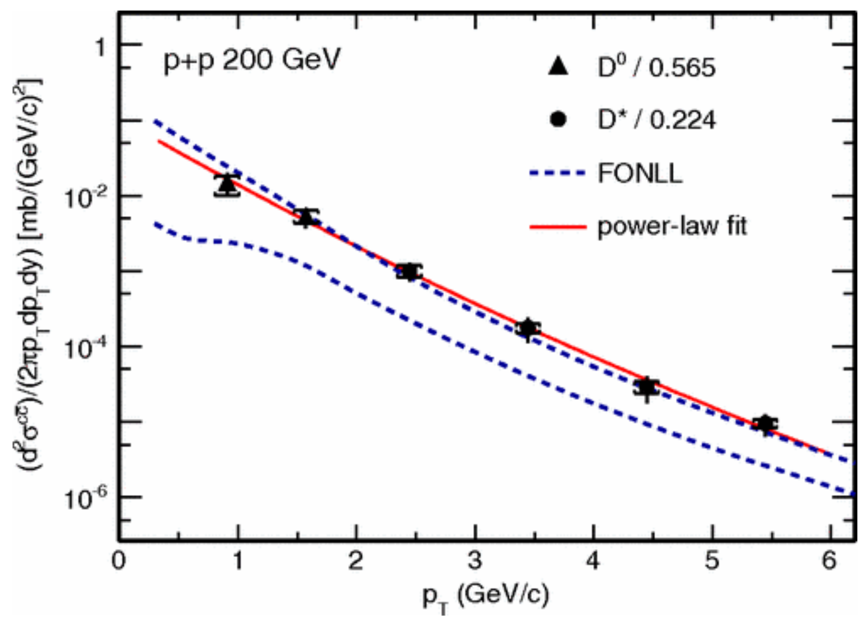
STAR

Introduction

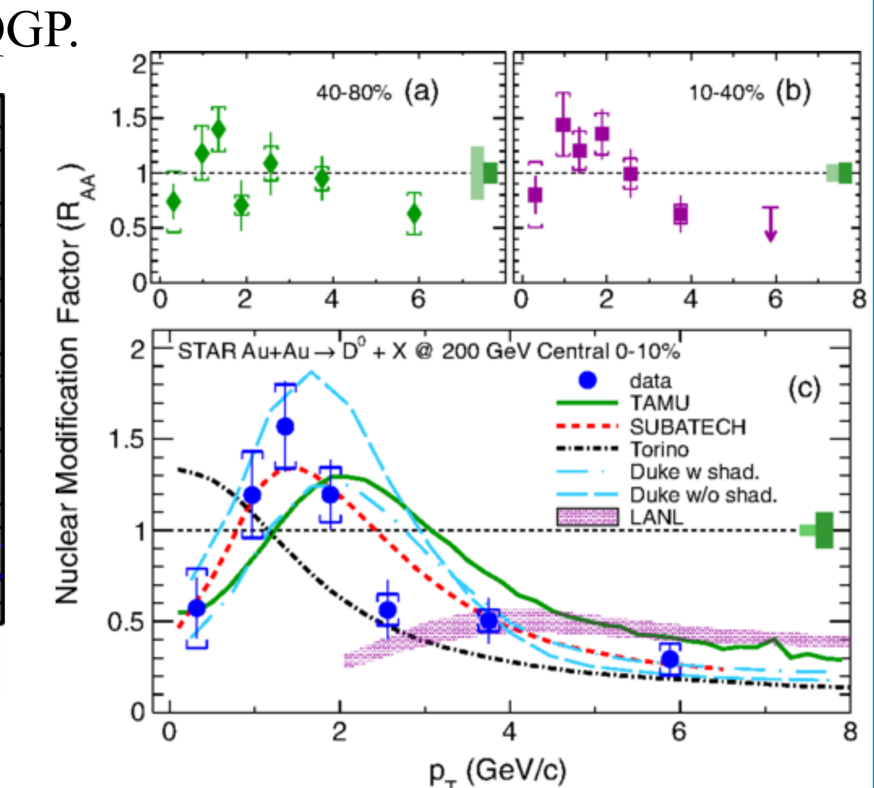
This poster is centered around an investigation into the production of D^0 and D* mesons as a function of transverse momentum (p_T) in proton-proton (p+p) collisions at a center-of-mass energy of $\sqrt{s}$ = 510 GeV conducted within the STAR experiment at the Relativistic Heavy Ion Collider (RHIC). The results of this analysis will serve to constrain the charm-anticharm production mechanisms in p+p collisions. We present the ongoing signal extractions of the D^0 and D* mesons from the minimum bias events recorded during the p+p collisions at $\sqrt{s}$ = 510 GeV at STAR in 2017.

Motivation

- ❑ Studying charm meson production allows for comparisons between experimental results and theoretical models (e.g., perturbative QCD, factorization frameworks).
- ❑ Modifications of the charm meson production in heavy-ion collisions with respect to p+p provide insights into QGP.



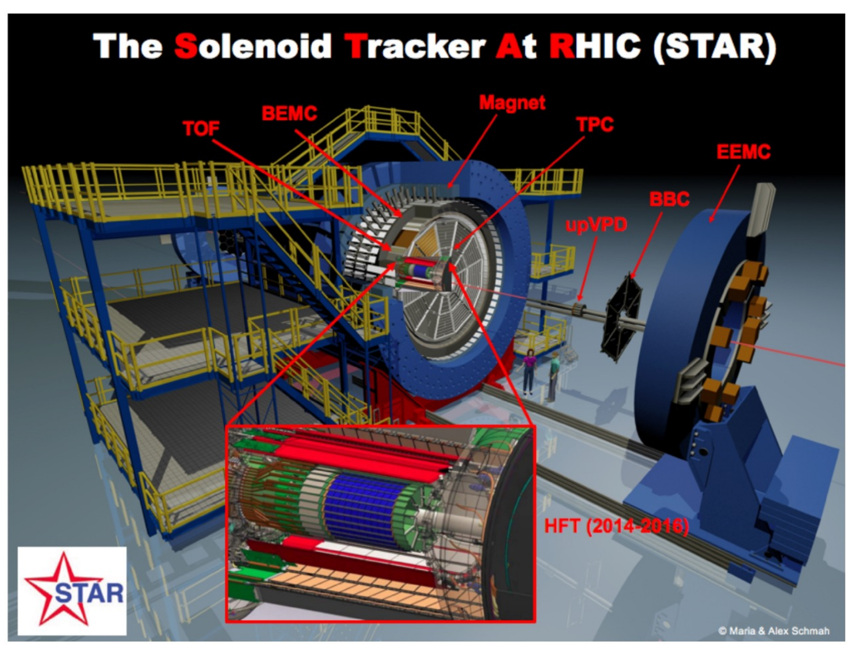
p_T-differential $c\bar{c}$ production cross sections compared with FONLL pQCD calculations [1]



D^0 meson nuclear modification factor R_{AA} [2]

STAR Detector

- ❑ The STAR detector is excellent in tracking and identifying charged particles at mid-rapidity ($|\eta| < 1$), while providing complete azimuthal coverage.
- ❑ The majority of the subsystems are situated within a solenoidal magnetic field of 0.5 T.



- ❑ Vertex Position Detector (VPD) to trigger minimum bias events and removing pileup vertices.
- ❑ Time Projection Chamber (TPC): main tracking detector, momentum determination, particle identification via ionization energy loss (dE/dx).
- ❑ Time Of Flight (TOF): particle identification via velocity (β).

Analysis Method

- ❑ About 1.11 billion minimum bias p+p events at $\sqrt{s}$ = 510 GeV recorded in 2017 are used in this analysis.
- ❑ Hadronic decay channels are used to reconstruct D^0 and D*.

$$D^0(\bar{D}^0) \xrightarrow{B.R.=3.947\%} K^{\mp}\pi^{\pm} \quad ; \quad D^{*\pm} \xrightarrow{B.R.=67.7\%} D^0(\bar{D}^0)\pi_s^{\pm} \xrightarrow{B.R.=3.947\%} K^{\mp}\pi^{\pm}\pi_s^{\pm}$$

❑ Event Selection

$\lvert V_{z[TPC]} - V_{z[VPD]} \rvert$	< 4.0 cm
$V_{z[TPC]}$	< 60 cm
$V_{x[TPC]}$	(–0.3, 0.14) cm
$V_{y[TPC]}$	(–0.26, 0.02) cm

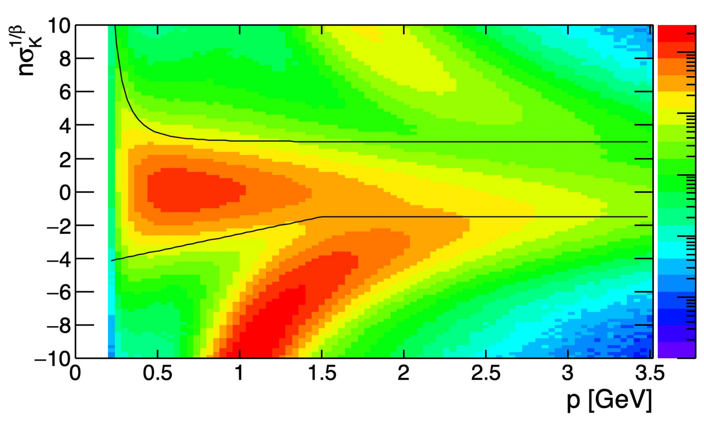
❑ Track Quality Cuts

number of TPC fit points	> 18
$\frac{\text{number of TPC fit points}}{\text{number of max possible TPC fit points}}$	> 0.52
global DCA	< 1.5 cm
p_T	> 0.2 GeV/c
$\lvert\eta\rvert$	< 1

❑ PID

	$p_T \le 1.6$ GeV/c	$p_T > 1.6$ GeV/c
Kaons	$-2.5 < n\sigma_K^{dE/dx} < 3.0$ p dependent cut on $n\sigma_K^{1/\beta}$	$-2.5 < n\sigma_K^{dE/dx} < 3.0$ p dependent cut on $n\sigma_K^{1/\beta}$
Pions	$-3.0 < n\sigma_\pi^{dE/dx} < 3.0$ p dependent cut on $n\sigma_\pi^{1/\beta}$	$-3.0 < n\sigma_\pi^{dE/dx} < 3.0$ if TOF matched p dependent cut on $n\sigma_\pi^{1/\beta}$ if TOF matched $-2.5 < n\sigma_\pi^{dE/dx} < 2.5$ if no TOF info

D^0 daughter Kaon and Pion PID Cuts



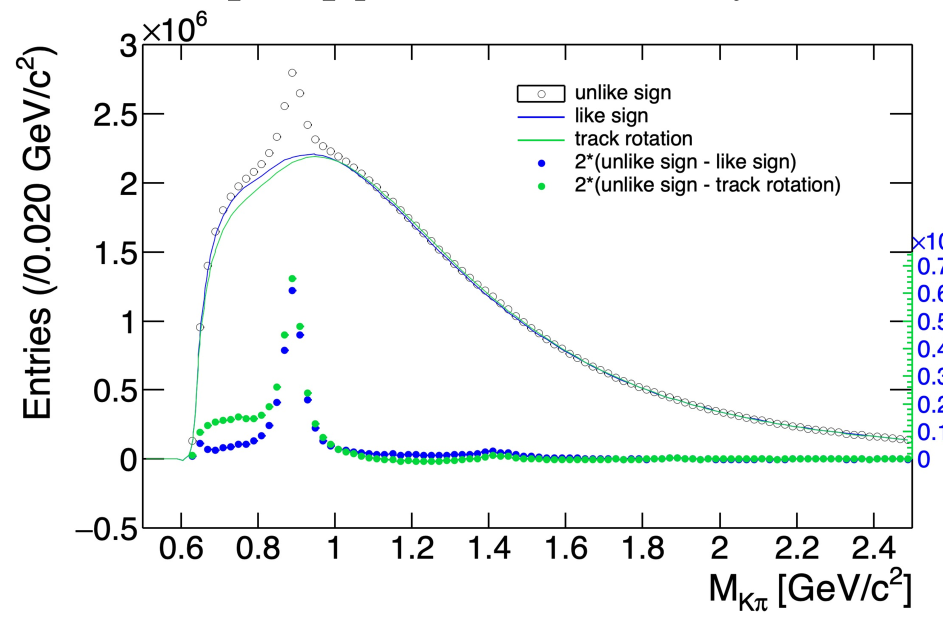
For Soft Pion (π_s) identification, TOF pion cut was loosened for p < 1.6 GeV/c to select more low momentum tracks.

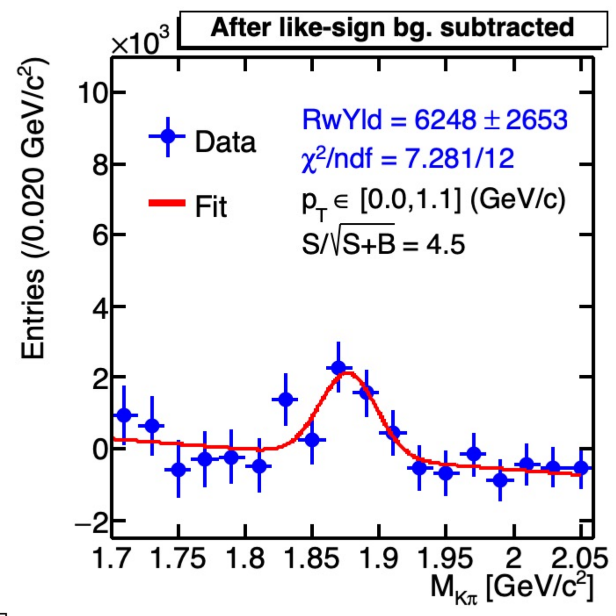
References

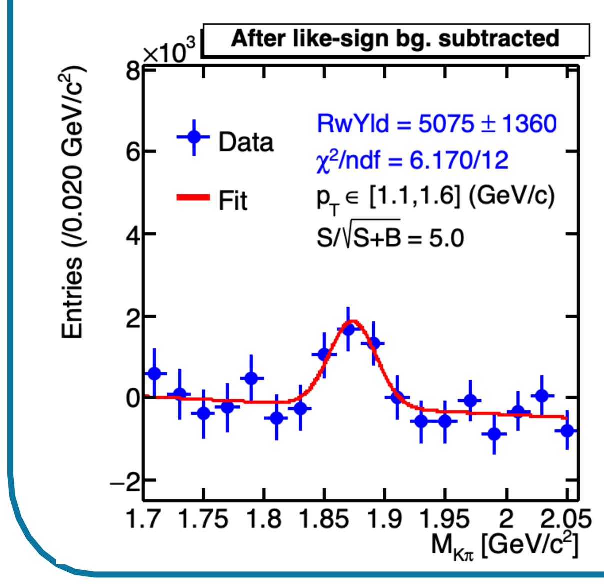
1. L. Adamczyk et. al. (STAR Collaboration), 2012, Phys. Rev. D 86, 072013.
2. L. Adamczyk et. at. (STAR Collaboration), 2014, Phys. Rev. Lett. 113, 142301

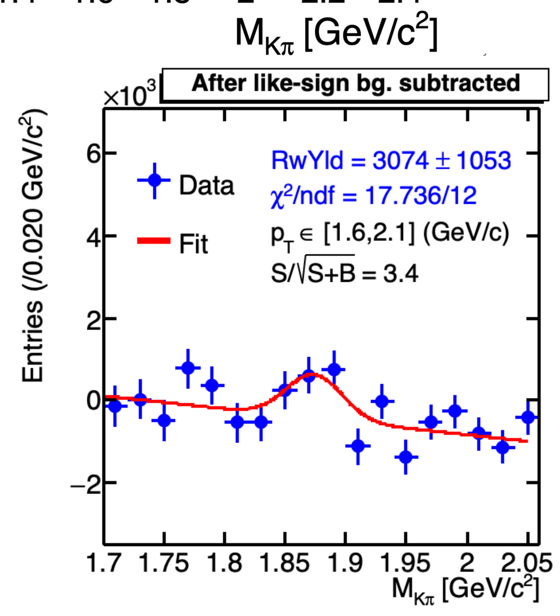
D^0 Signal Extraction

- ❑ Unlike-sign pions and kaons were paired [K$^-\pi^+$, K$^+\pi^-$].
- ❑ Two independent background estimation methods were deployed for D^0 signal extraction :
  - like-sign pairs [K$^-\pi^-$, K$^+\pi^+$]
  - track-rotation method [pion tracks are paired with kaon tracks with reversed 3-momentum (180^o rotation)]
- ❑ Intervals of pair p_T used for the analysis: 0-1.1, 1.1-1.6, 1.6-2.1 GeV/c.





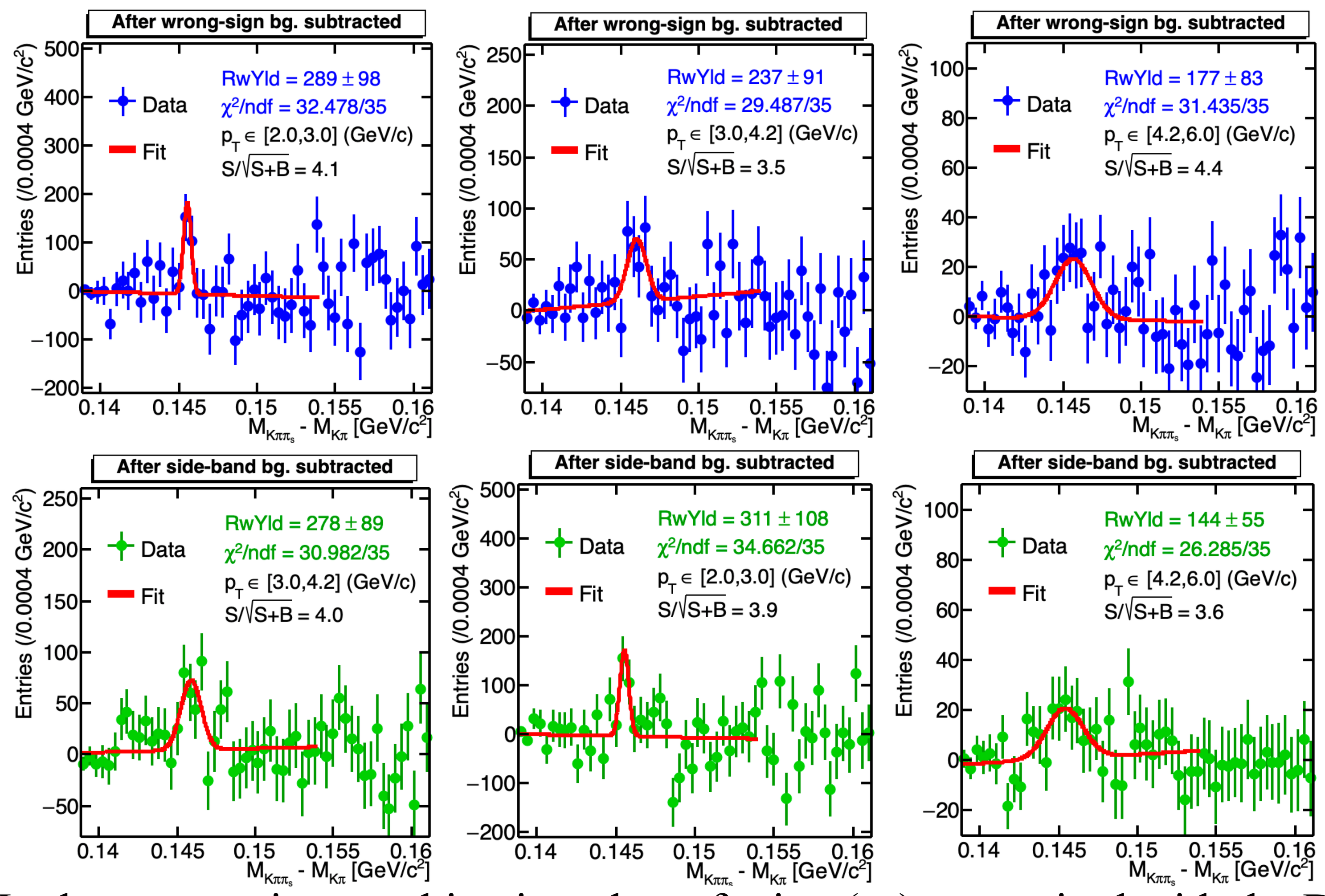




- ❑ Background subtracted data were fitted with Gaussian + linear function.
- ❑ Raw Yield is extracted from the area under the fitted Gaussian.

D* Signal Extraction

- ❑ Histogram was populated with the mass difference $M_{K\pi\pi_s}$ - $M_{K\pi}$.
- ❑ Wrong-sign combination and side-band method were used to reconstruct background to extract the D* signal.
- ❑ Intervals of the triplet p_T used here are: 2-3, 3-4.2, 4.2-6 GeV/c.



- ❑ In the wrong-sign combination, the soft pion (π_s) was paired with the D^0 daughter pion of the opposite charge. In the side-band method, the $M_{K\pi}$ had been lying between two side-bands: 1.64 - 1.74 GeV/c^2 and 2.01 - 2.11 GeV/c^2, i.e. outside the D^0 mass window.

Summary and Outlook

- ❑ D^0 and D* signals were extracted up to p_T of 2.1 GeV/c and 6.0 GeV/c, respectively using Minimum Bias p+p data at 510 GeV.
- ❑ Analyses were performed with two independent background estimation methods.
- ❑ Efficiency and systematic uncertainties to be determined next for cross-section calculation.
- ❑ Barrel High Tower triggered data is also being analyzed currently for raw yield measurements at higher p_T.

Acknowledgement

The work was supported by the Grant Agency of the Czech Technical University in Prague, grant No. SGS22/174/OHK4/3T/14.