D^0 production in U+U collisions at $\sqrt{s_{NN}} = 193$ GeV at the STAR experiment

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Abstract

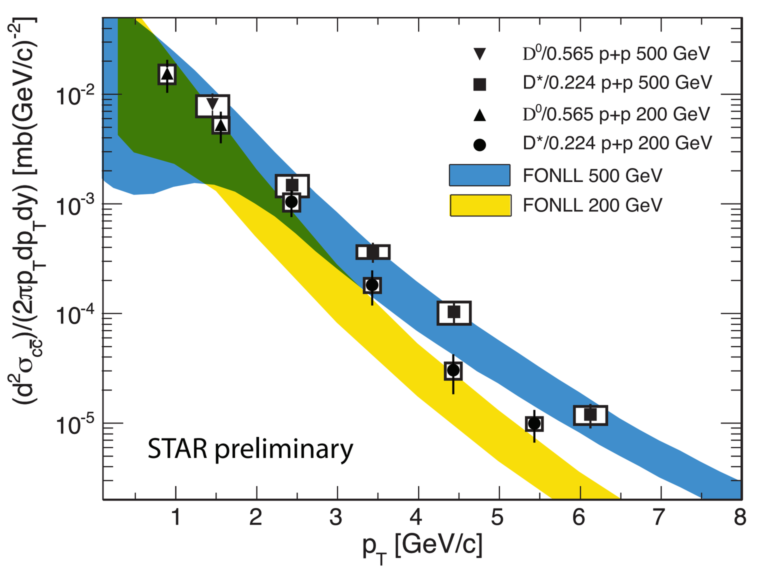
The relativistic heavy-ion collisions at RHIC in Brookhaven National Laboratory allow to produce a hot and dense nuclear matter - the Quark-Gluon Plasma (QGP). During the initial phase of the collision, enough energy is released from the hard scattering to produce the heavy quarks such as charm and bottom. The measurement of the production of mesons containing heavy quarks, such as D^0, in heavy ion collision is important to understand the properties of QGP. Due to their large mass, heavy quarks are expected to interact differently with QGP than light quarks.

The STAR experiment previously measured the production of charm mesons via hadronic channels in p+p, d+Au and Au+Au collisions. Charm quarks were observed to be strongly suppressed in Au+Au at high p_T. As U+U collision should produce even higher energy density, new information on heavy quark energy loss could be acquired. In this poster, the status of D^0 measurement in U+U collisions at $\sqrt{s_{NN}} = 193$ GeV via hadronic decay channel $D^0 \longrightarrow \pi^+ + K^-$ and $\overline{D^0} \longrightarrow \pi^- + K^+$ performed by STAR experiment is presented.

Previous D^0 Measurements at STAR

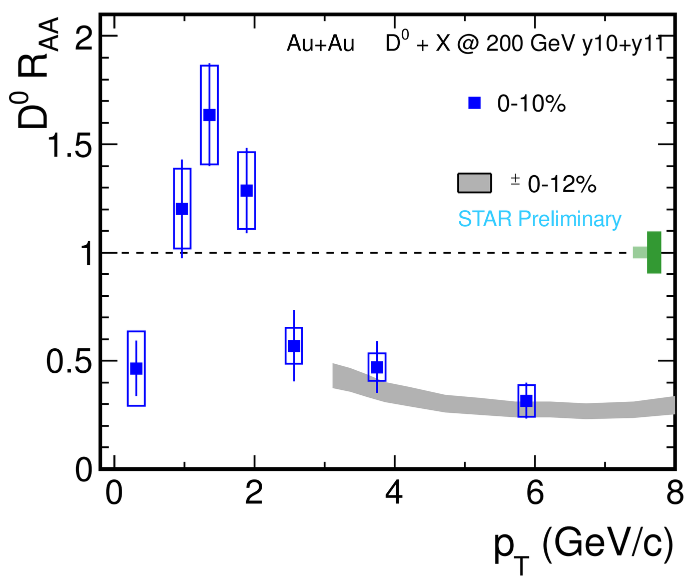
The D^0 meson: $(c\bar{u})$, $c\tau = 123$ μm, $m_D = 1.865$ GeV/c^2. STAR measured open charm mesons via hadronic decay $D^0 \longrightarrow \pi^+ + K^-$ and $\overline{D^0} \longrightarrow \pi^- + K^+$ with branching ratio BR = 3.89 %. Reconstruction of the hadronic mode enables a **direct identification**. However, the channel suffers from a **large combinatorial background** due to lack of precise secondary vertex measurement in STAR.

The STAR previously investigated $D^0 \longrightarrow \pi^+ + K^-$ and $\overline{D^0} \longrightarrow \pi^- + K^+$ channels in p+p ($\sqrt{s} = 200$ and 500 GeV) [1,2], d+Au ($\sqrt{s_{NN}} = 200$ GeV) [3] and Au+Au ($\sqrt{s_{NN}} = 200$ GeV) [2] systems.

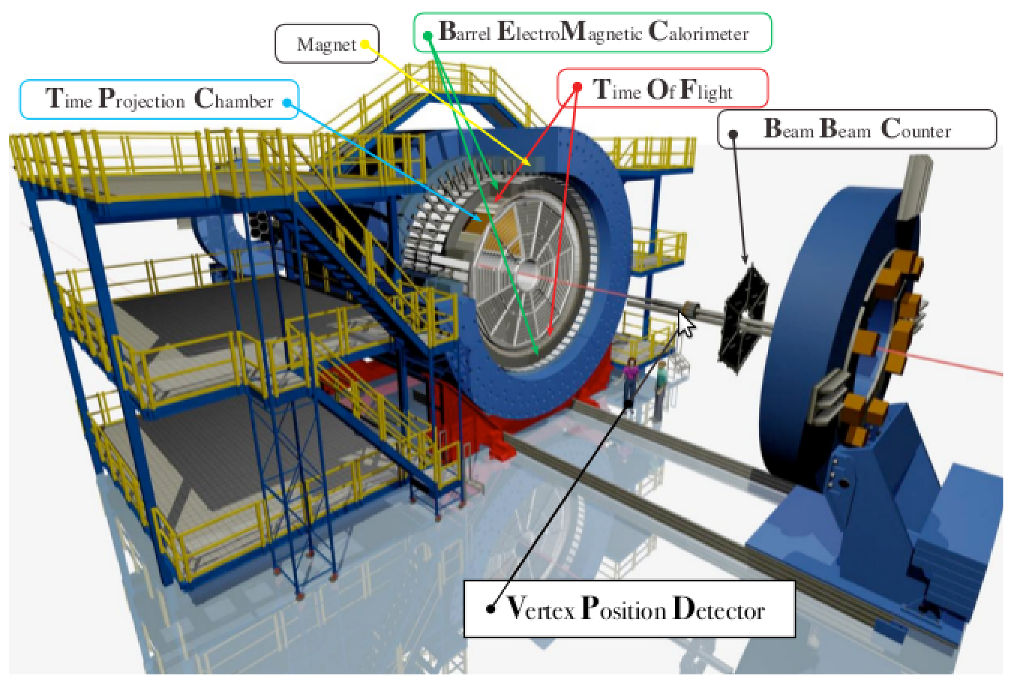


Left: The invariant differential charm cross-sections [2]. The data are compared to FONLL pQCD calculations [4]. The FONLL upper limit describes the data well.

Right: Nuclear modification factor (R_{AA}) in Au+Au 200 GeV [2]. The D^0 meson production is suppressed at high-p_T similarly as light hadrons.



STAR detector



In current analysis, TPC and TOF subdetectors were used. Charged tracks were accepted from region:

$$-1 < \eta < 1 \qquad -\pi < \Delta\phi < \pi.$$

Data Analysis

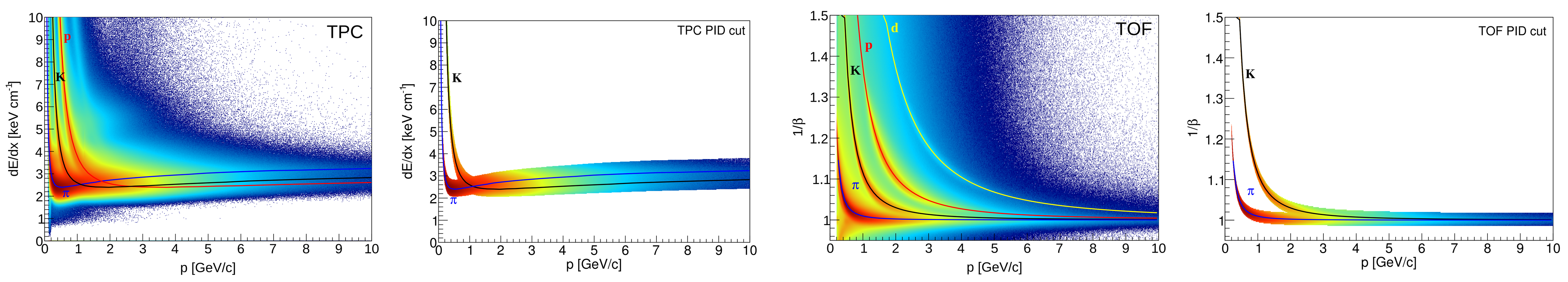
Data: 320 millions of minimum-bias events collected in Year 2012 for U+U collisions at $\sqrt{s_{NN}} = 193$ GeV. D^0 and $\overline{D^0}$ reconstructed in $D^0 \longrightarrow \pi^+ + K^-$ and $\overline{D^0} \longrightarrow \pi^- + K^+$ channel, no secondary vertex information. Decay products were identified using a combination of TPC and TOF subsystems.

Only TPC: p_T range of $0.2 - 0.6$ GeV/c and > 3.0 GeV/c.

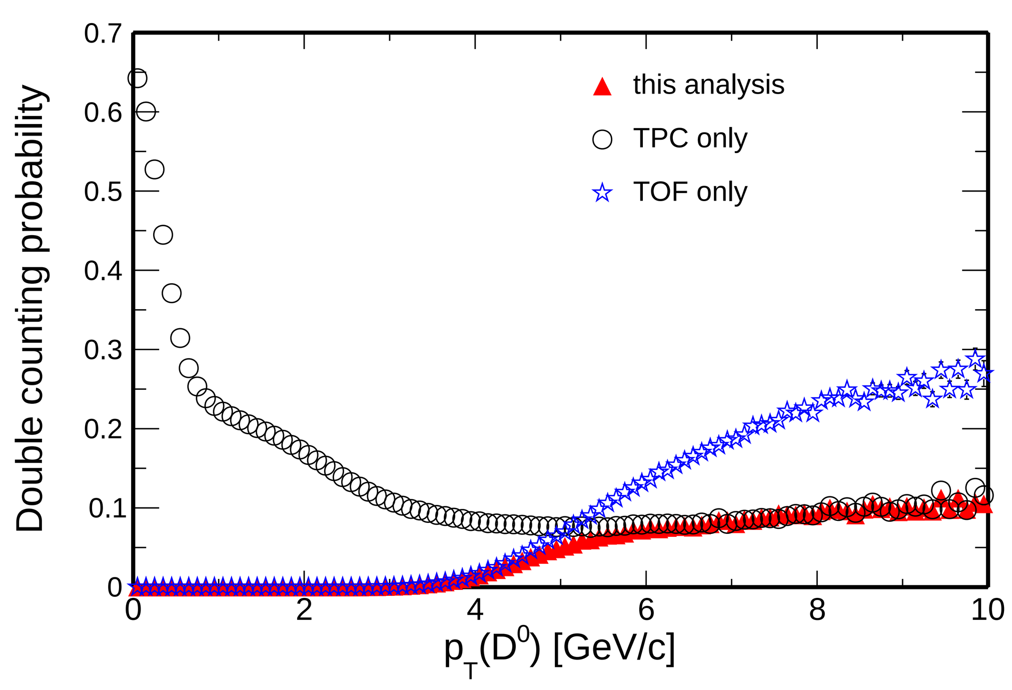
- $n\sigma = (\ln dE/dx - \ln dE/dx_{meas})/R$
- $|n\sigma_K| < 2$ and $|n\sigma_\pi| < 2$

Only TOF: p_T range of $0.6 - 3.0$ GeV/c.

- $1/\beta \in \left[\sqrt{\frac{m^2}{p^2}+1} - 2\sigma; \sqrt{\frac{m^2}{p^2}+1} + 2\sigma\right]$
- $\sigma_\pi = 0.0075$
- $\sigma_K(p) = 0.0076 + 0.0014/(1.89^{1.758p} - 1.152^{1.57})$



Double Counting



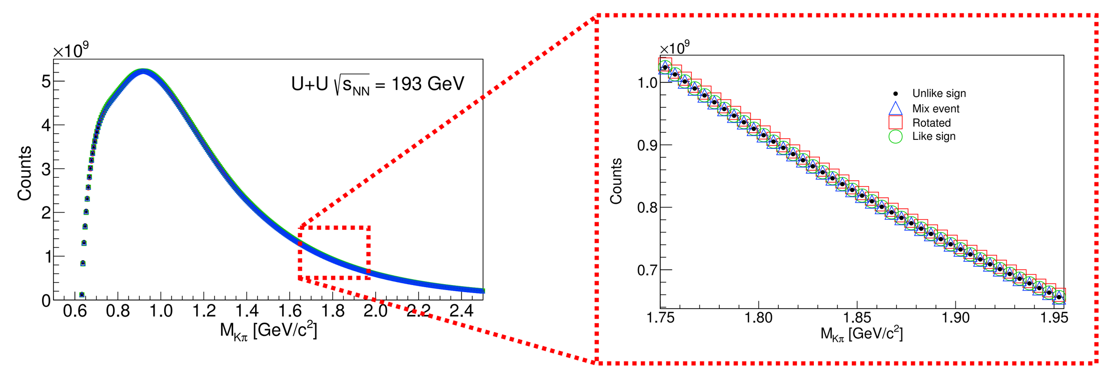
Kaons and pions may be misidentified as pions and kaons respectively. Such pairs then contribute to both D^0 and $\overline{D^0}$ count. Therefore we performed a **double counting** estimation for the analysis here presented.

- simple MC simulation using 500 M events
- misidentification probabilities determined from real data
- TPC gives high double counting in the lower p_T region, works well at $p_T > 3$ GeV/c
- TOF separates K from π very well at lower p_T, however it causes a greater double counting at $p_T > 3$ GeV/c

In the current analysis, the TPC was used at $0.2 - 0.6$ GeV/c and > 3.0 GeV/c. The TOF covers the p_T window $0.6 - 3.0$ GeV/c.

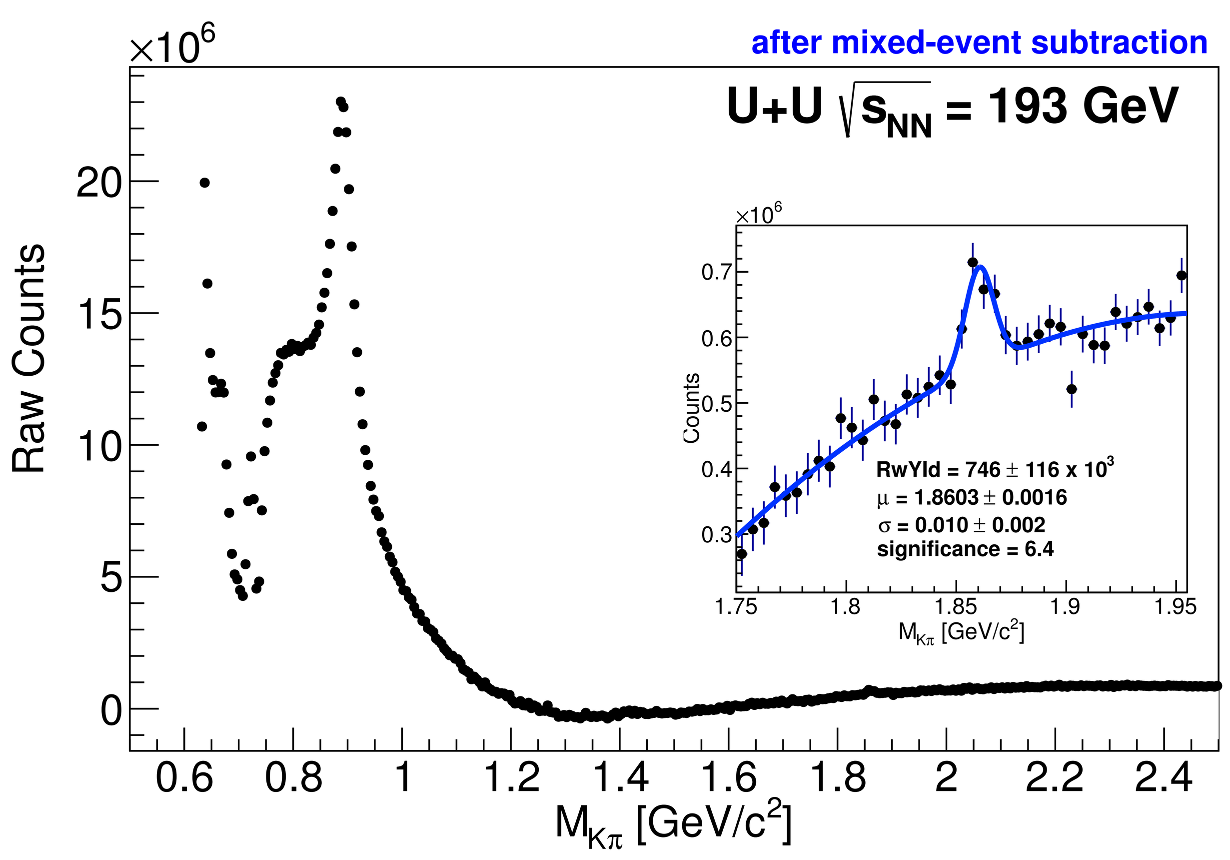
We were able to **correctly identify decay products up to $p_T = 3$ GeV/c**. At higher p_T, the double counting ratio **does not exceed 10%**.

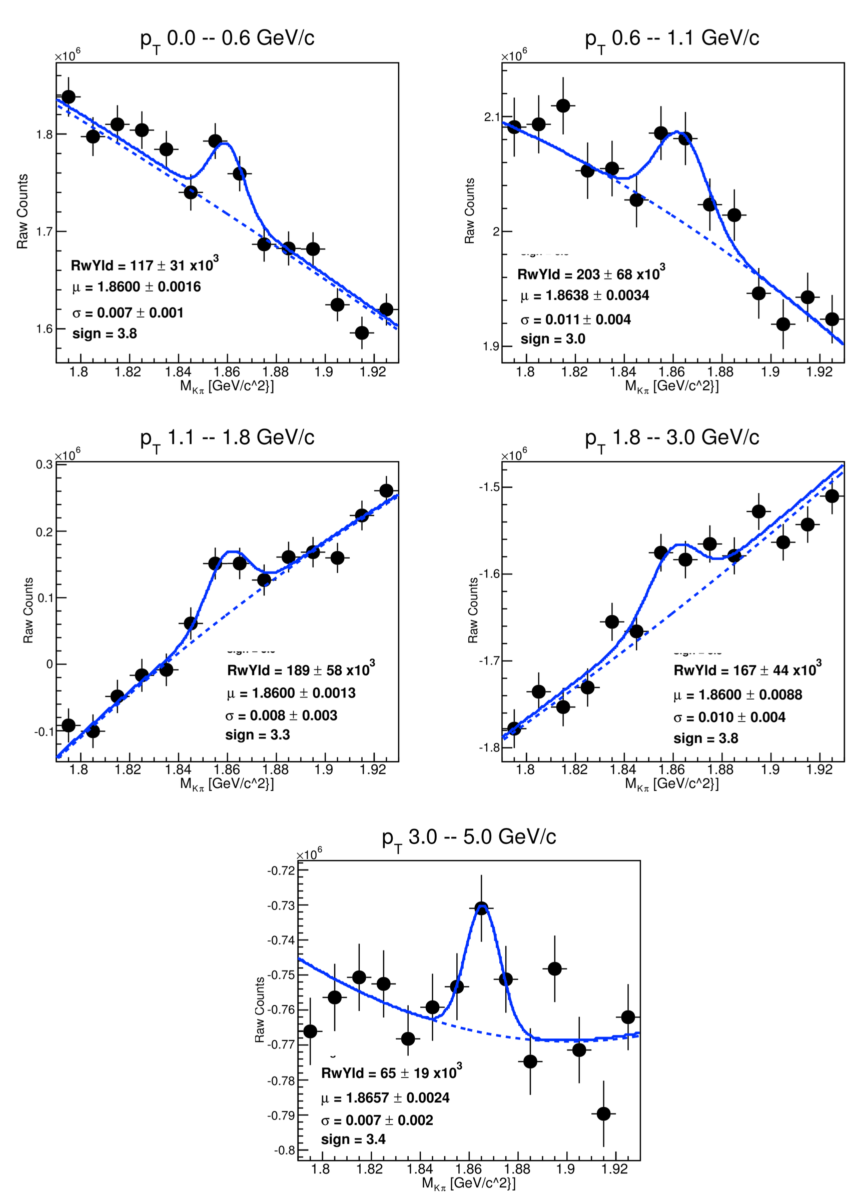
Results



We have investigated the production of D^0 meson in the **transverse momentum range of $0.0 - 5.0$ GeV/c**.

The **mixed-event method** has been used to describe the combinatorial background. This means that the daughter particles are selected from various different events. In this case, each kaon (pion) was combined with pions (kaons) from 5 different events.





The signal was divided into **5 p_T bins**. The significance of signal in each bin was calculated as **significance = $S/\sqrt{S+B}$**

Possible improvements to increase signal significance are being investigated.

References

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Acknowledgement

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