Measurement of $D^0 - \bar{D}^0$ azimuthal correlations in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV at STAR

Katarzyna Gwiździel[1] on behalf of the STAR Collaboration

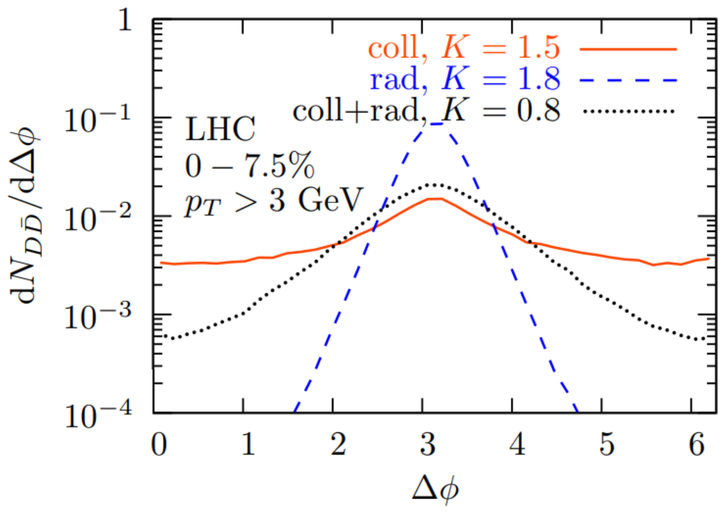
[1] Warsaw University of Technology, Faculty of Physics, ul. Koszykowa 75, 00-662 Warszawa, Poland

Motivations

• Heavy quarks produced at the very early stage of heavy-ion collisions.

• Large elliptic flow and nuclear modification factor of D^0 at RHIC $\rightarrow$ strong interactions between charm quarks and the QGP.

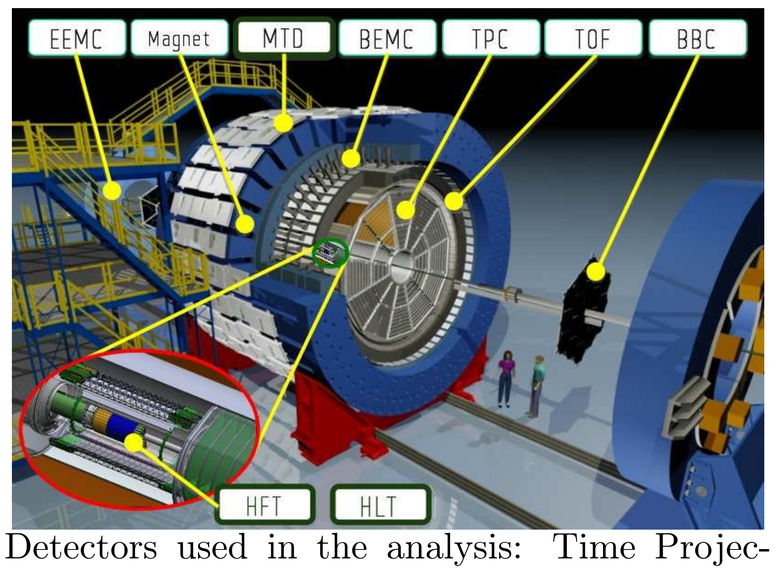
• Azimuthal correlations of D mesons can help to pin down the relative role of radiative and collisional energy losses, and the level of thermalization of charm quarks.



M. Nahrgang et al., J. Phys. Conf. Ser.509, 012047 (2014)

Note: The femtoscopic correlations are shown on the poster number 770 presented by Priyanka Roy Chowdhury.

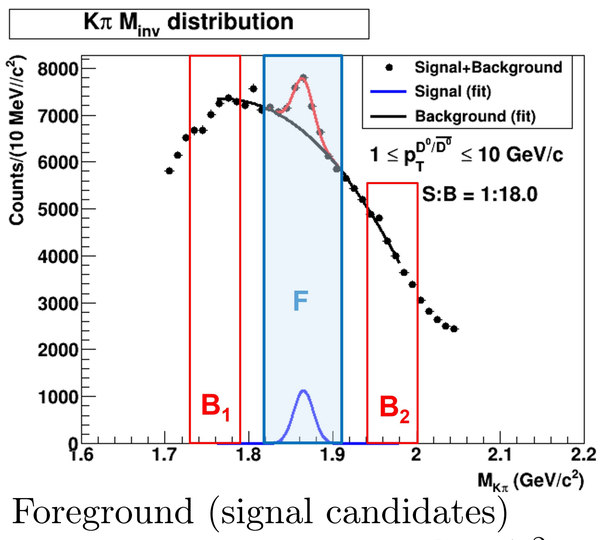
The STAR experiment



Detectors used in the analysis: Time Projection Chamber (TPC), Time-of-Flight (ToF) and Heavy Flavor Tracker (HFT)

Invariant mass of D^0 mesons

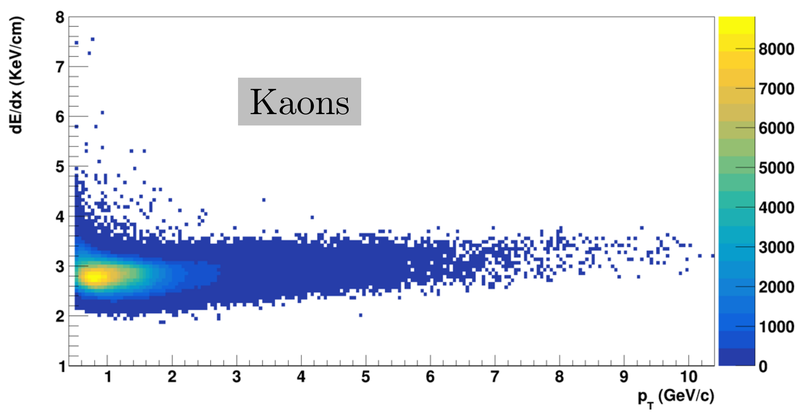
Example of the invariant mass of the $D^0/\overline{D^0}$ mesons for run 2014 data ($1 < p_T^{D^0} < 10$ GeV/c).

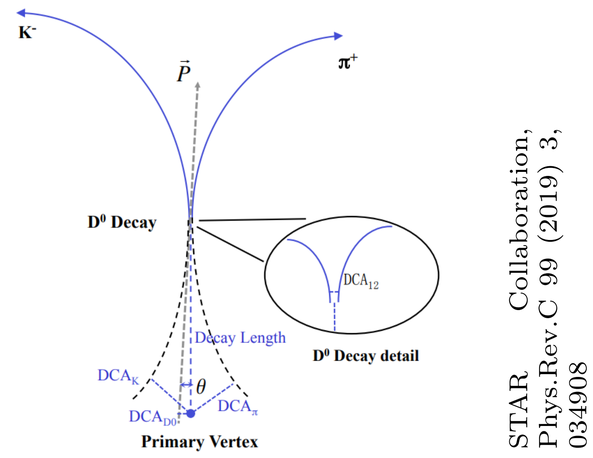


- Foreground (signal candidates)
  - F: $1.82 < M < 1.91$ GeV/c^2
- Side-band background:
  - B_1: $1.73 < M < 1.79$ GeV/c^2
  - B_2: $1.94 < M < 2.00$ GeV/c^2

Data selection

- Data set: Au+Au $\sqrt{s_{NN}} = 200$ GeV data collected in 2014 and 2016
- Event selection: centrality: $0 - 80\%$, $|V_z| < 6$ cm, $|V_Z - V_z^{VPD}| < 3$ cm, $|V_{Transverse}| < 2$ cm
- Number of events: 855 M (run 2014) and 1.34 B (run 2016), overall 2.2 B good events
- D^0 daughter cuts: nHits > 20, $|n\sigma_K| < 2.0$, $|n\sigma_\pi| < 3.0$, $p_T > 0.5$ GeV/c, $|\eta| < 1.0$, $|\Delta 1/\beta| < 0.03$
- Topological cuts for $D^0/\overline{D^0}$ mesons selection: $DCA_\pi, DCA_K, DCA_{daughters}$, decay length
- D^0 candidates: $p_T > 1$ GeV/c and $|y|<1$





STAR Collaboration, Phys.Rev.C 99 (2019) 3, 034908

Azimuthal correlations of D^0 and $\overline{D^0}$ mesons

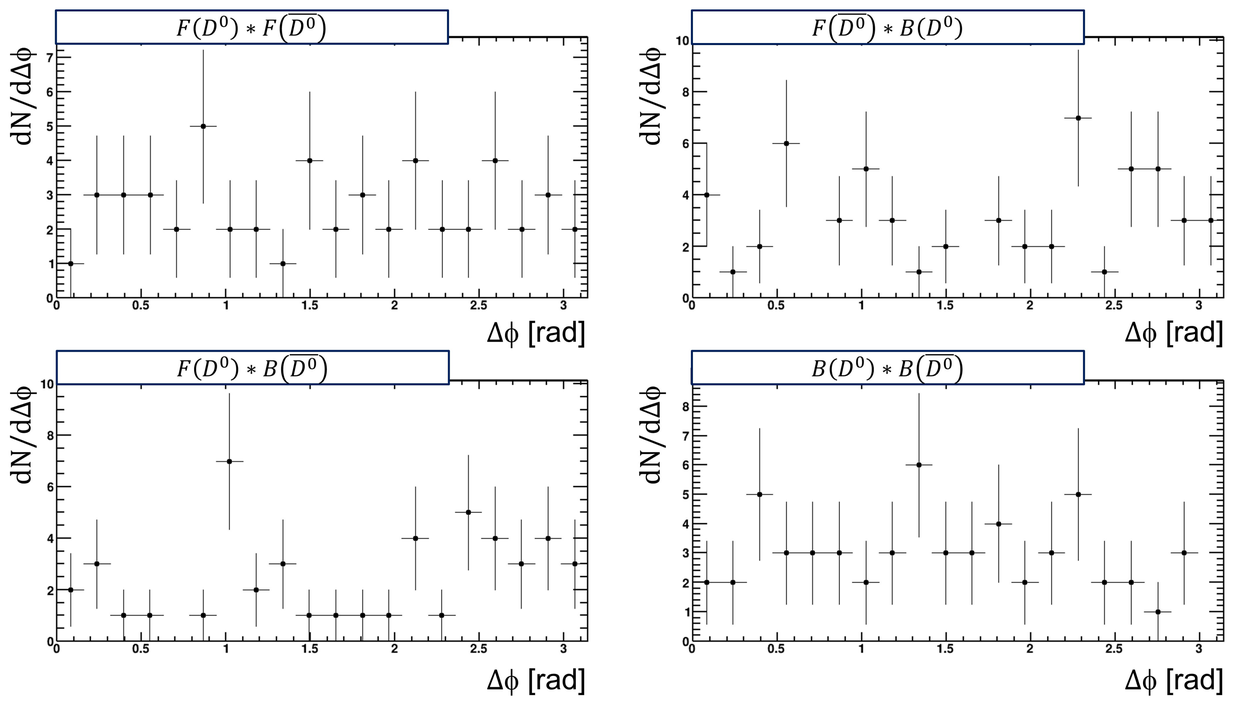
We obtained the azmiuthal correlations for D^0 and $\overline{D^0}$ mesons following Ref. [1]. The correlation function was calculated as the convolution of background and foreground counts:

$$S(D^0) * S(\overline{D^0}) = [F(D^0) - B(D^0)] * [F(\overline{D^0}) - B(\overline{D^0})].$$

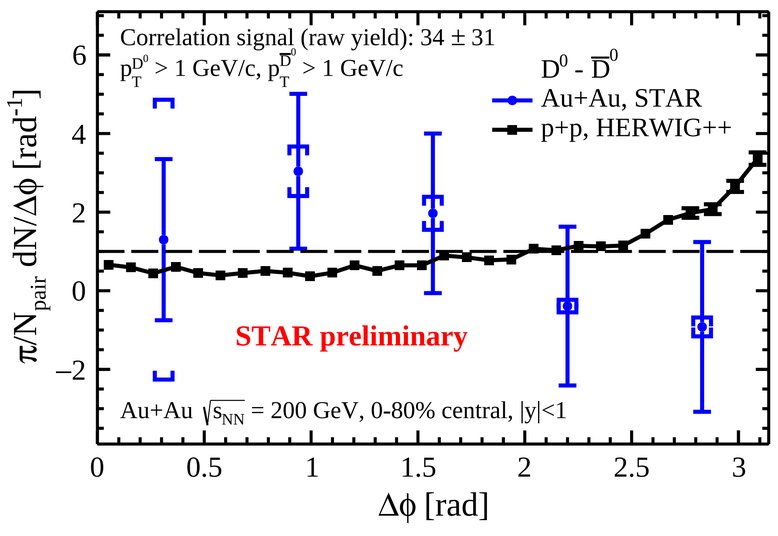
We use the following experimental formula:

$$S(D^0) * S(\overline{D^0}) = F(D^0) * F(\overline{D^0}) - f \times F(D^0) * B(\overline{D^0}) - f \times F(\overline{D^0}) * B(D^0) + f^2 \times B(D^0) * B(\overline{D^0}),$$

where $F(D^0)$, $B(D^0)$: foreground and background D^0 candidates (similarly for $\overline{D^0}$ mesons), f: a scaling factory to convert side-band background to background B in the D^0 mass range. The raw azimuthal correlation distributions (Au+Au $\sqrt{s_{NN}} = 200$ GeV, run 2014):



Results



Azimuthal correlation function for $D^0 - \overline{D^0}$ pairs in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV. The acceptance corrections were included. The result is compared to the p+p baseline using the Herwig++ model [2].

Conclusions

• We present the first measurement of $D^0 - \overline{D^0}$ azimuthal correlations at RHIC.

• With available statistic, we do not observe an azimuthal correlation signal for $D^0 - \overline{D^0}$ pairs in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV.

• Possible explanations: correlation effect smaller than available precision and/or there is a decorrelation due to charm interactions within the QGP.

• While the measurement in heavy-ion collisions is challenging, STAR should be able to study charmed meson correlations in p+p $\sqrt{s} = 500$ GeV collected in 2017 and 2022

This research was partially funded by: U.S. DEPARTMENT OF ENERGY | Office of Science and National Science Centre, Poland, grant no. 2018/30/E/ST2/0008

[1] L. Ma (STAR), "Measurement of D^*-meson triggered correlations in p+p collisions at RHIC", Nucl. Part. Phys. Proc. **289-290**, edited by G.-Y. Qin, X.-N. Wang, Y.-P. Wang, B.-W. Zhang, and D.-C. Zhou, 329–332 (2017).

[2] J. Bellm et al., "Herwig 7.0/Herwig++ 3.0 release note", Eur. Phys. J. C **76**, 196 (2016).

The STAR Collaboration, `https://drupal.star.bnl.gov/STAR/presentations`