



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

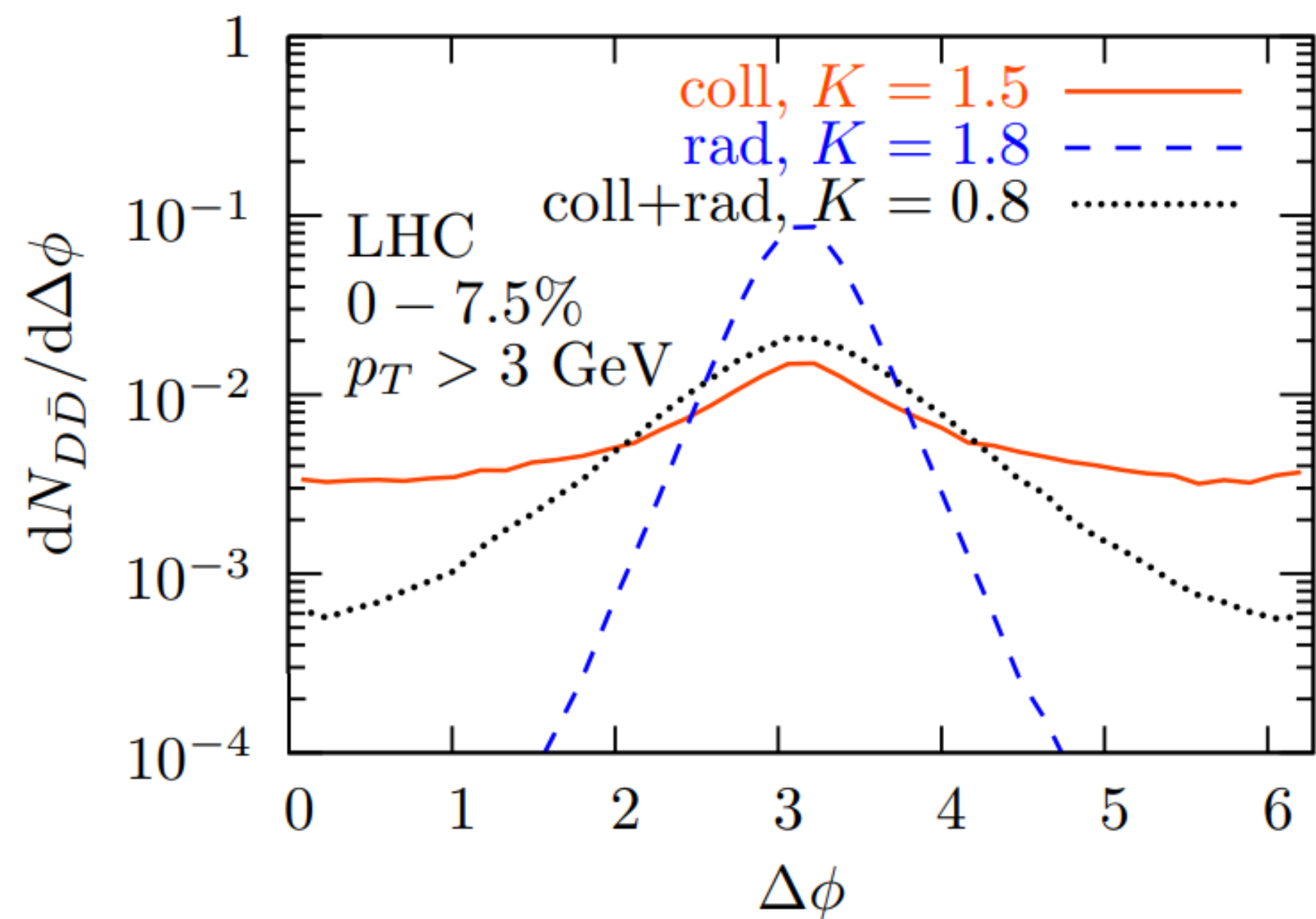


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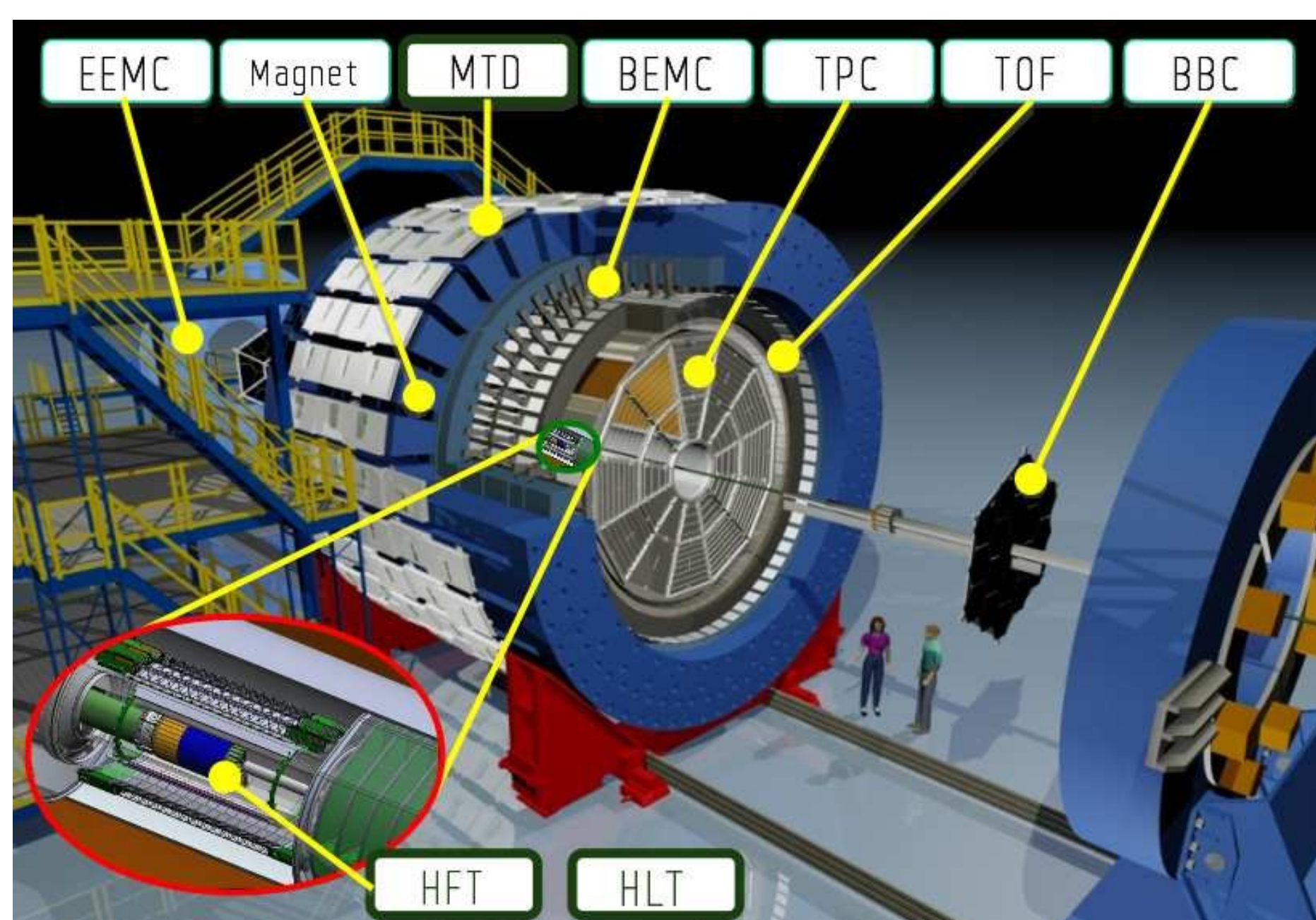
Motivations

- Heavy quarks produced at the very early stage of heavy-ion collisions (before the QGP phase).
- Large elliptic flow and nuclear modification factor of D^0 at RHIC indicate 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)

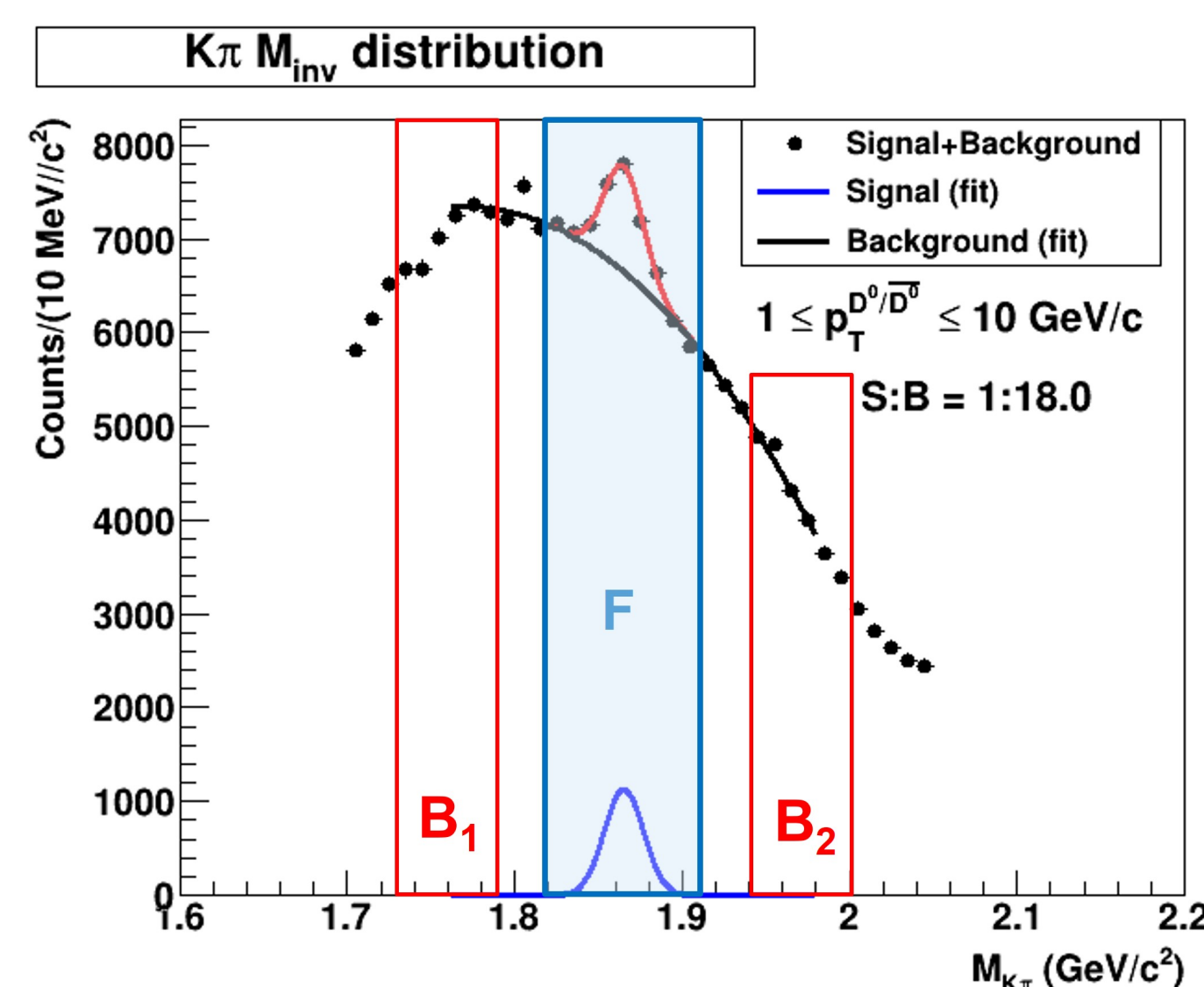
The STAR experiment



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/\bar{D}^0 mesons for run 2014 data ($1 < p_T^{D^0} < 10$ GeV/c).



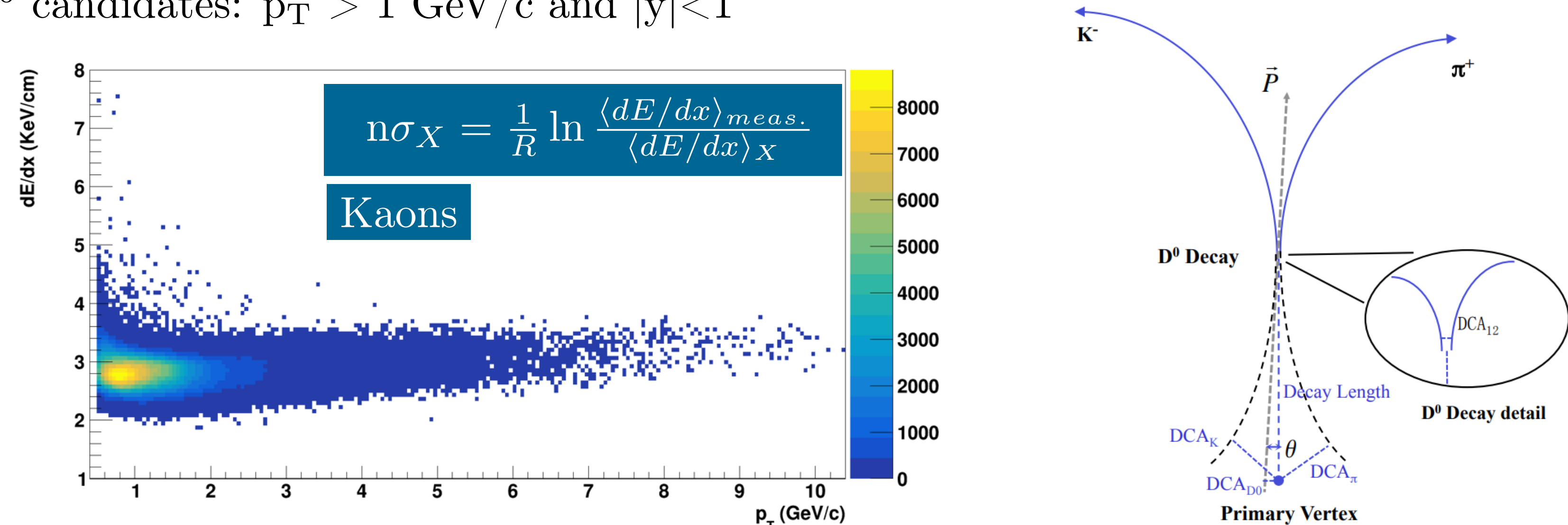
- Foreground (signal candidates)
 - F: $1.82 < M < 1.91$ GeV/c²
- Side-band background:
 - B₁: $1.73 < M < 1.79$ GeV/c²
 - B₂: $1.94 < M < 2.00$ GeV/c²
- Fit: Gaussian function + polynomial

References

- ¹L. 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).
- ²J. Bellm et al., “Herwig 7.0/Herwig++ 3.0 release note”, Eur. Phys. J. C **76**, 196 (2016).

Data selection

- Data set: Au+Au at $\sqrt{s_{NN}} = 200$ GeV data collected in 2014 and 2016, minimum bias events
- Number of events: 855 M (run 2014) and 1.34 B (run 2016), overall 2.2 B good events
- D^0 daughter cuts: $n_{\text{Hits}} > 20$, $|n\sigma_K| < 2.0$, $|n\sigma_\pi| < 3.0$, $p_T > 0.5$ GeV/c, $|\eta| < 1.0$, $|\Delta 1/\beta| < 0.03$
- Topological cuts for D^0/\bar{D}^0 mesons selection: $DCA_\pi, DCA_K, DCA_{\text{daughters}}$, decay length
- D^0 candidates: $p_T > 1$ GeV/c and $|y| < 1$



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Azimuthal correlations of D^0 and \bar{D}^0 mesons

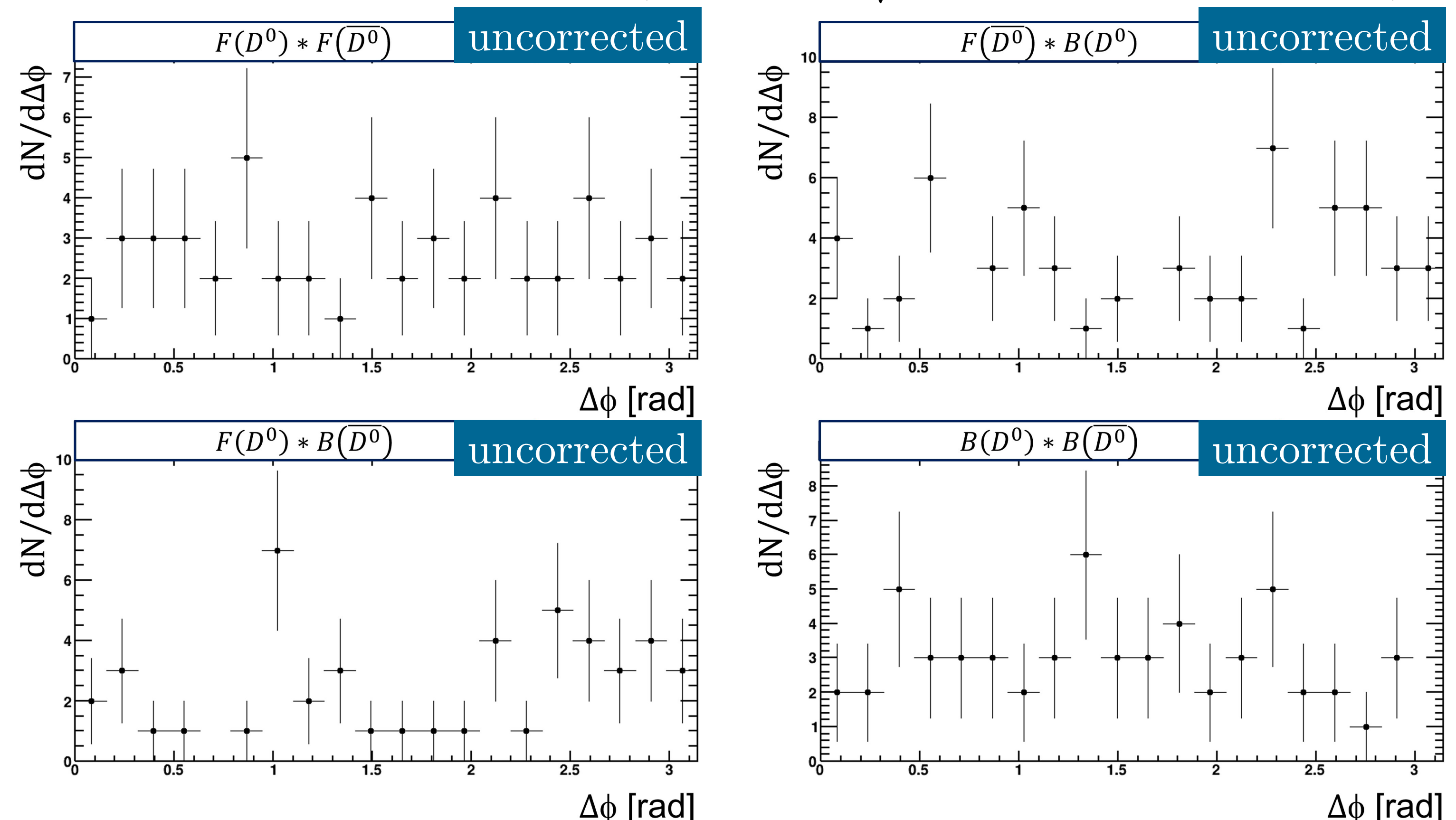
We obtained the azimuthal correlations for D^0 and \bar{D}^0 mesons following Ref. [1]. The correlation function was calculated as the convolution of background and foreground counts:

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

We used the following experimental formula:

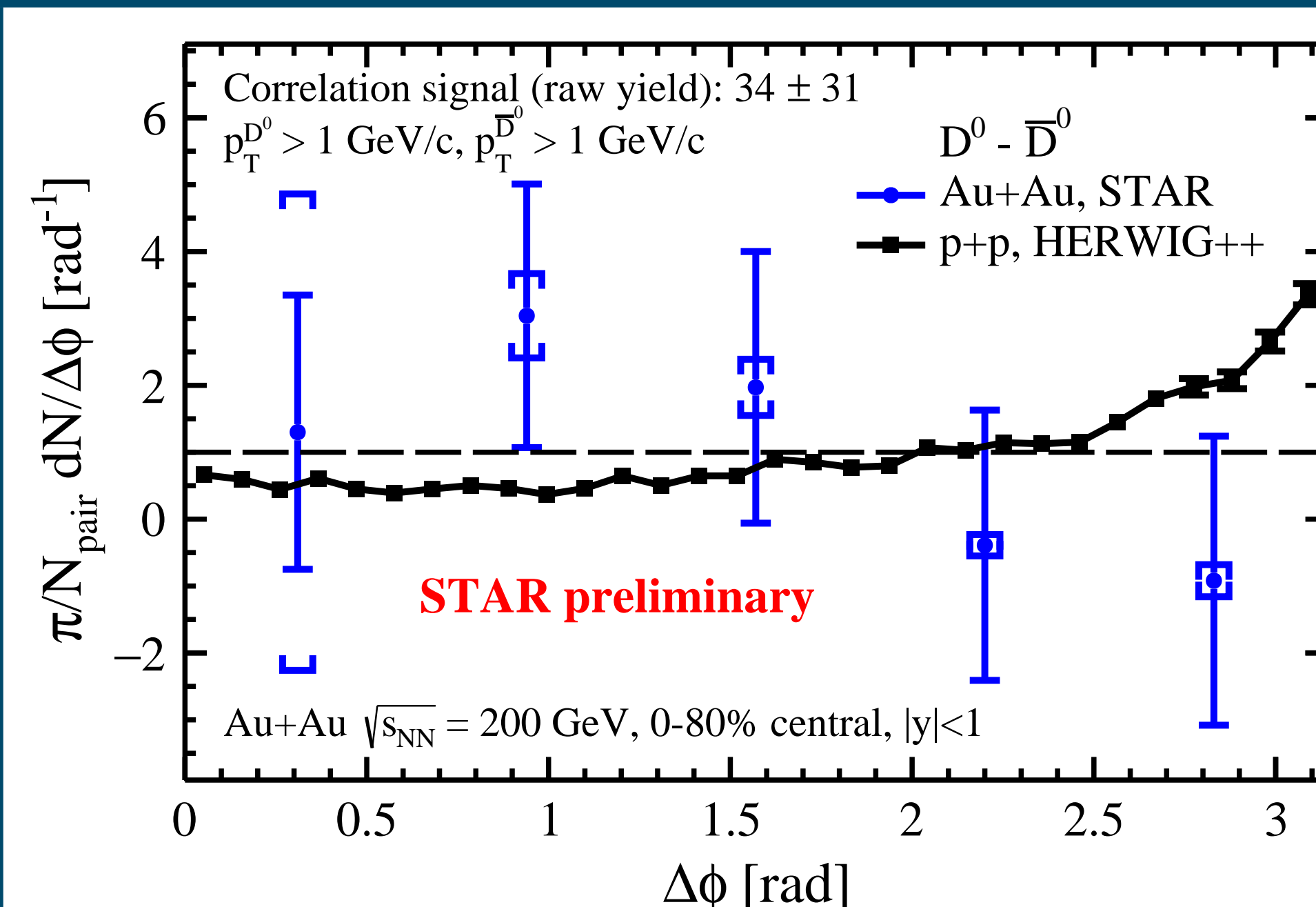
$$S(D^0) * S(\bar{D}^0) = F(D^0) * F(\bar{D}^0) - f * F(D^0) * B(\bar{D}^0) - f * F(\bar{D}^0) * B(D^0) + f^2 * B(D^0) * B(\bar{D}^0),$$

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



The raw distributions were corrected for non-uniform detector acceptance. Then, we calculated the azimuthal correlation $S(D^0) * S(\bar{D}^0)$ and combined the results from Run 2014 and 2016.

Results



Azimuthal correlation function for $D^0 - \bar{D}^0$ 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 $D^0 - \bar{D}^0$ azimuthal correlations at RHIC.
- With available statistic, we do not observe an azimuthal correlation signal for $D^0 - \bar{D}^0$ 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 collisions at $\sqrt{s} = 500$ GeV collected in 2017 and 2022

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

