Azimuthally-differential two-pion femtoscopy in Zr+Zr and Ru+Ru collisions at $\sqrt{s_{NN}} = 200$ GeV using the UrQMD model

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Abstract

Correlation femtoscopy allows one to estimate the spatial and temporal characteristics of the particle-emitting region formed in the relativistic heavy-ion collisions. Azimuthally-differential analysis is used to study shape and orientation of the source. In this work, collisions of isobaric nuclei Ru+Ru and Zr+Zr at $\sqrt{s_{NN}} = 200$ GeV are calculated using the UrQMD (Ultrarelativistic Quantum Molecular Dynamics) model [1-2] and the azimuthally-differential two-pion femtoscopy relative to the second- and third-order event plane are performed. The extracted characteristics of the emission source are presented as a function of the pair transverse momentum, k_T, collision centrality and the pair emission angle. In the future, the obtained results can be compared with the STAR experimental data.

Correlation femtoscopy

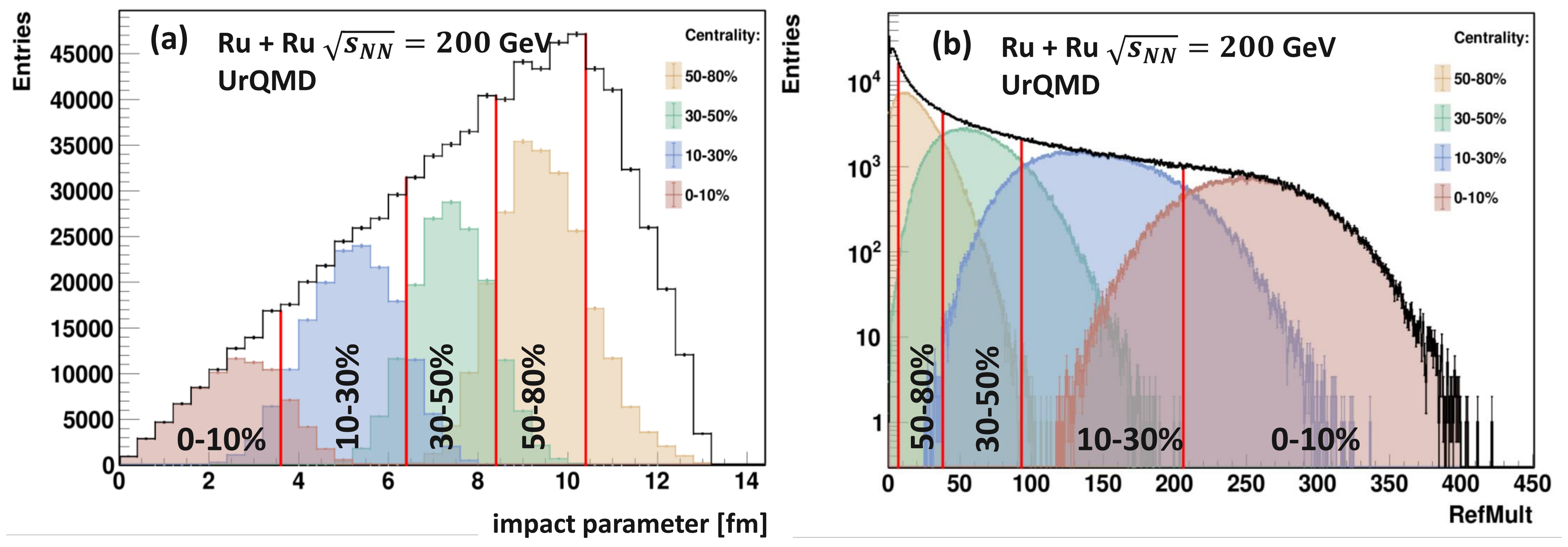
The two-particle correlation function is constructed as follows: $C(\vec{q}) = A(\vec{q})/B(\vec{q})$, where $A(\vec{q})$ is the relative momentum ($\vec{q} = \vec{p_1} - \vec{p_2}$) distribution for pairs of particles from the same event and $B(\vec{q})$ is the relative momentum for particle pairs from the different event. The relative momentum $\vec{q}$ is decomposed using the Pratt-Bertsch parametrization.

In order to extract femtoscopic parameters, the correlation function is fitted to the following:

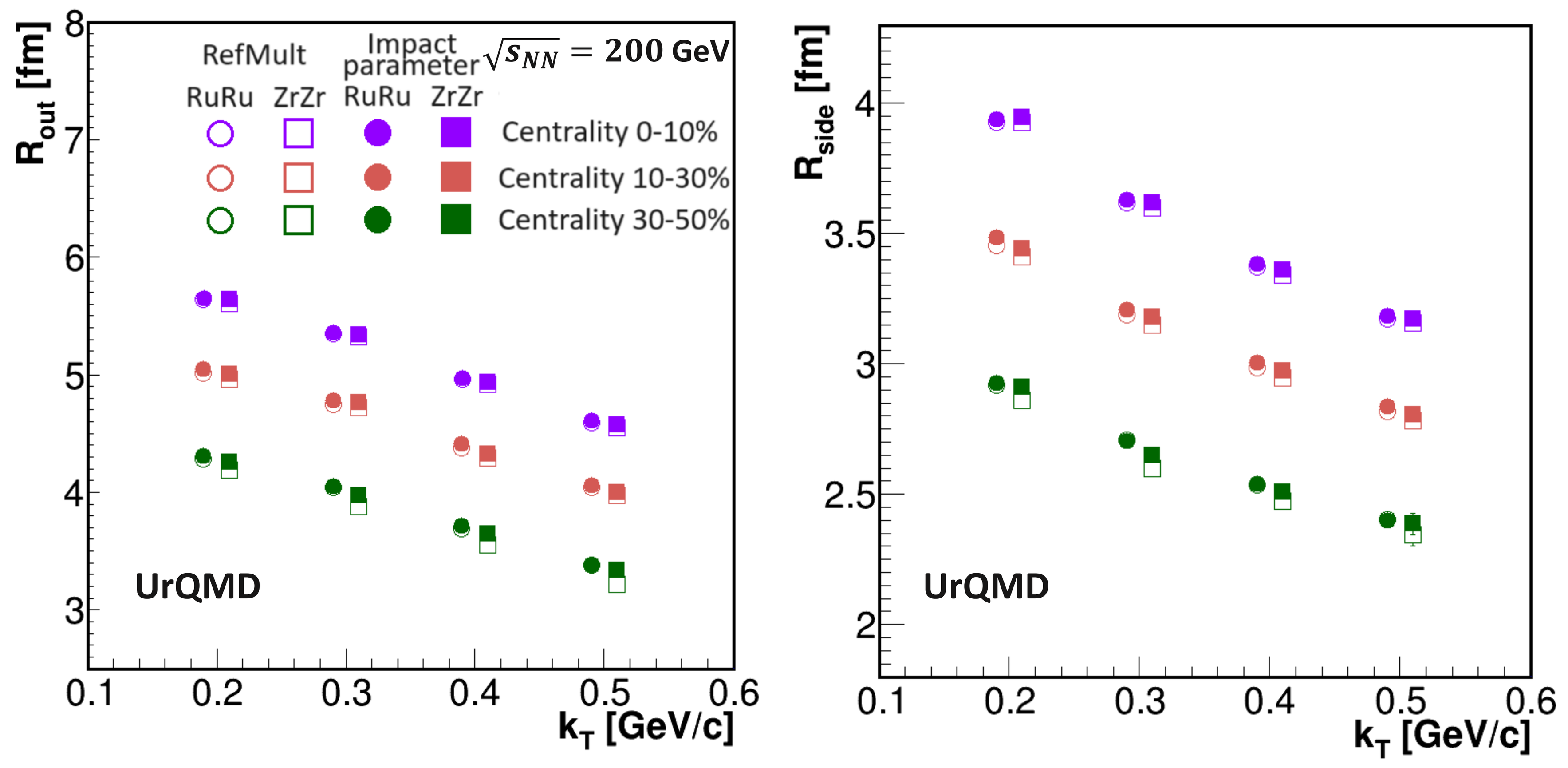
$$C(q_o, q_s, q_l) = N\left(1 + \lambda \cdot \exp\left[-q_o^2 R_o^2 - q_s^2 R_s^2 - q_l^2 R_l^2 - 2 q_o q_s R_{os}^2\right]\right)$$

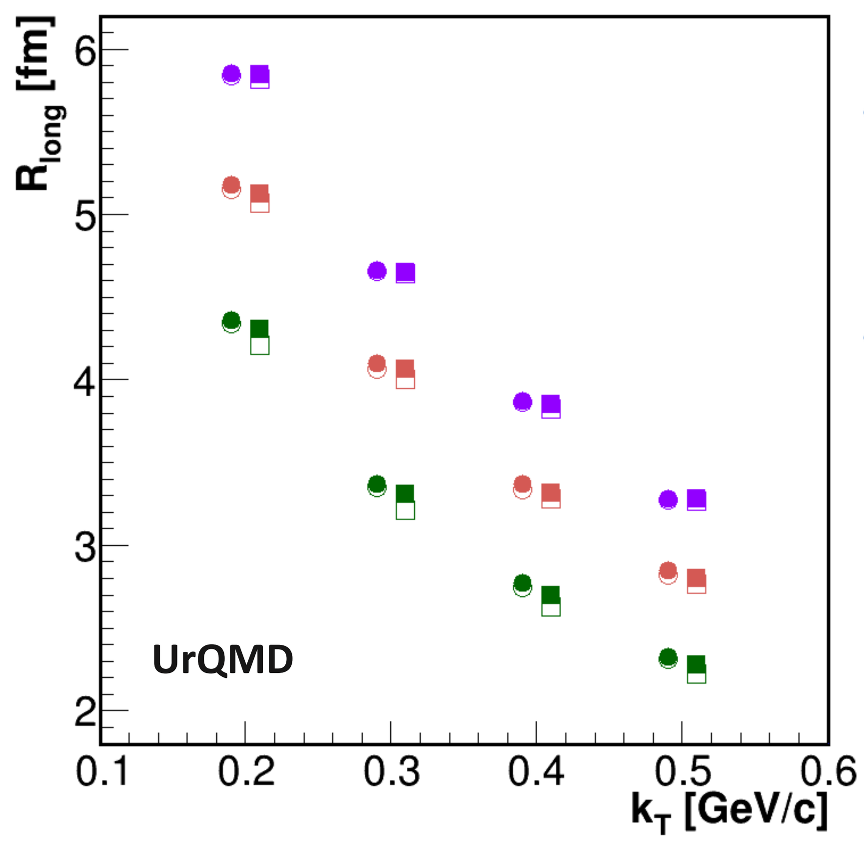
The impact of the centrality determination technique on femtoscopic parameters

The collision centrality is estimated by: the impact parameter (a) and reference multiplicity (b) distributions [3].



The analysis is performed in three centrality (0 – 10%, 10 – 30% and 30 – 50%) and four k_T (0.15 – 0.25 GeV/c, 0.25 – 0.35 GeV/c, 0.35 – 0.45 GeV/c and 0.45 – 0.55 GeV/c) ranges.





- The femtoscopic radii decreases with increasing collision centrality and k_T.
- The difference between the parameters extracted from correlation functions for RefMult and impact parameter centrality analyses is smaller then 1%.

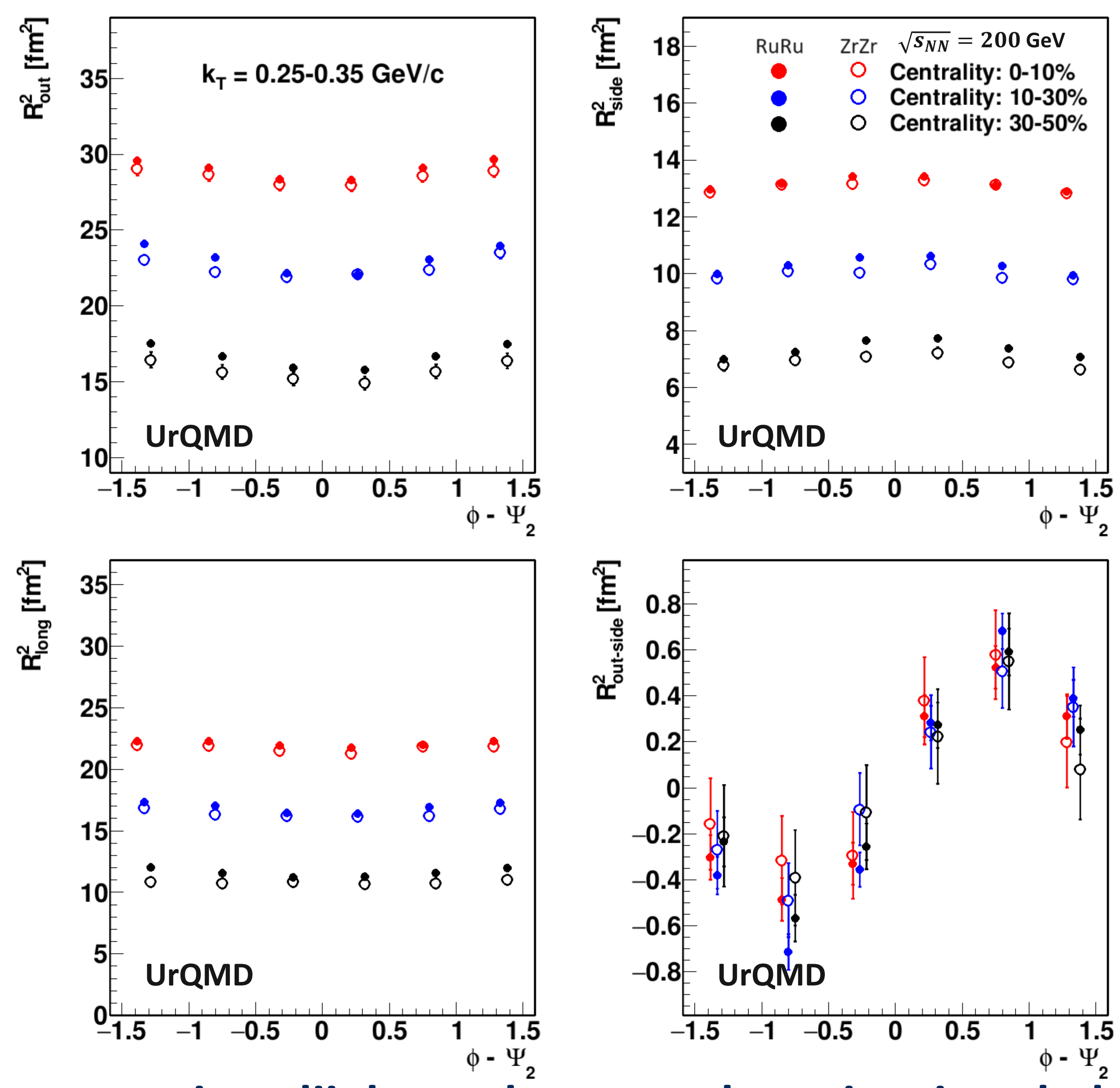
Conclusions

- The Ru+Ru and Zr+Zr collisions at $\sqrt{s_{NN}} = 200$ GeV are simulated using the UrQMD model.
- The femtoscopic radii obtained for Ru+Ru system are larger than those for Zr+Zr. The difference between them is about 1%.
- In the azimuthally-differential analysis relative to the second-order event plane, the radii oscillations is observed.
- In the future work, the deformation of the nuclei will be taken into account. Its impact on femtoscopic radii will be studied.

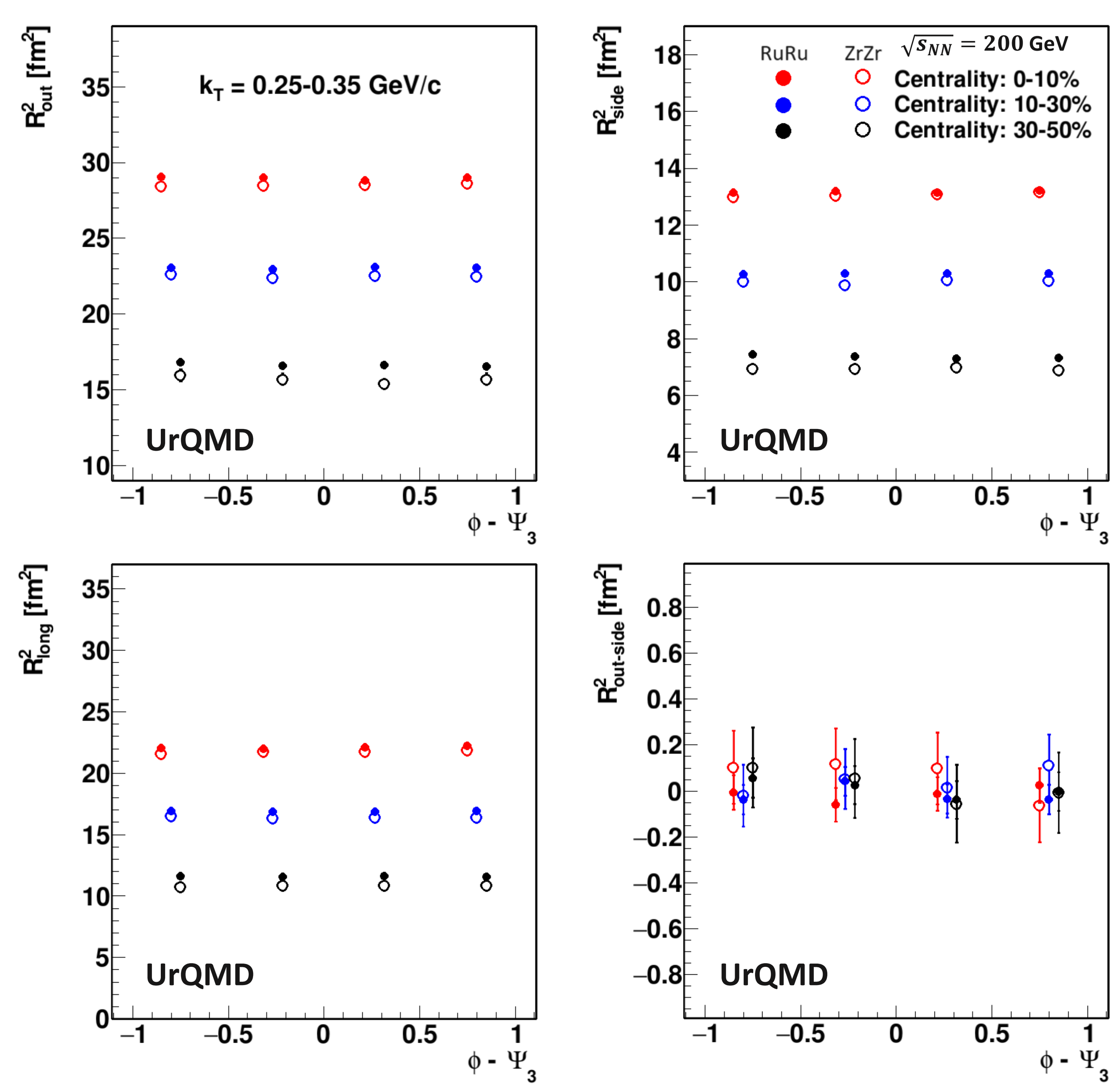
Azimuthally-differential femtoscopy

The event plane is reconstructed following the procedure which is used in the STAR experiment [4-5].

The femtoscopic radii dependence on the pair azimuthal angle



The femtoscopic radii dependence on the pair azimuthal angle relative to the third-order event plane



- The angular oscillations of the femtoscopic radii relative to the second-order event plane is observed.
- The third-order oscillations of the radii is not obtained.
- In the development of this work, the corrections for finit-bin-width and event plane resolution should be applied to these results.

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