Two-particle short-range correlations relative to the reaction plane in Au+Au collisions at 200 GeV at RHIC/STAR

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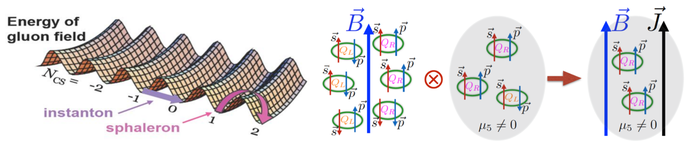
High-energy heavy-ion collisions can create a hot and dense nuclear medium in which local domains could obtain a chirality imbalance. The chirality imbalance, together with a strong magnetic field, can induce an electric charge separation along the magnetic field direction due to the chiral magnetic effect (CME) [1]. A γ correlator measures the two-particle azimuthal correlations relative to the reaction plane, and provides a probe of the electric charge separation due to the CME. However, the γ correlator is sensitive to short-range correlations caused by other physics mechanisms, such as quantum interference, Coulomb interaction, and resonance decays. In this poster, we decompose the γ correlator into two parts, in and perpendicular to the reaction plane, respectively, to separate the contributions of particle pairs with small relative pseudorapidity (short-range). The results will be presented for 200 GeV Au+Au collisions, and the physics implications of the short-range background will be discussed.

Motivation

Chiral Magnetic Effect(CME)



Local domains with chirality imbalance may be created in heavy-ion collisions on an event-by-event basis. A chiral system bears a non-zero axial chemical potential, μ_5.

An electric current will be induced in chiral domains along the B field: **Chiral Magnetic Effect** (CME) $\vec{J_e} \propto \mu_5 \vec{B}$

Observables

The γ definition:

$$\gamma \equiv \langle \cos(\phi_1 + \phi_2 - 2\Psi_{\rm RP}) \rangle = \langle \cos(\phi_1 - \Psi_{\rm RP}) \cos(\phi_2 - \Psi_{\rm RP}) \rangle$$

$$- \langle \sin(\phi_1 - \Psi_{\rm RP}) \sin(\phi_2 - \Psi_{\rm RP}) \rangle = \cos\cos - \sin\sin$$

the sinsin and coscos terms as functions of Δη can be described by 3 Gaussian peaks and a pedestal [2]:

$$f(\Delta\eta) = A_{\rm VSR} e^{-(\Delta\eta)^2/2\sigma^2_{\rm VSR}} + A_{\rm SR} e^{-(\Delta\eta)^2/2\sigma^2_{\rm SR}} + A_{\rm IR} e^{-(\Delta\eta)^2/2\sigma^2_{\rm IR}} + A_{\rm LR}$$

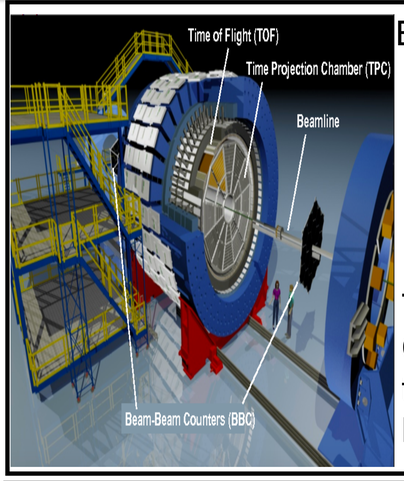
VSR:very-short-range(quantum interference and Coulomb interaction)
SR: short-range(resonance decay)
R: intermediate-range
LR: pedestal

Although there are many contributions to the background, for now, we focus on the short-range correlations.

We fit the sinsin and coscos terms with the multi-Gaussian function, and remove the contributions from the very-short-range and the short-range.

After the removal of the very-short-range and the short-range, we reconstruct γ with the new (coscos - sinsin).

Experiment



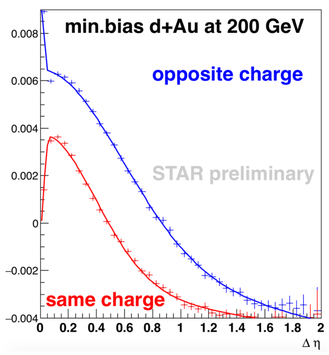
Event and track cuts:

|Vertex Z|< 30 cm
$0.2 < p_T < 2$ GeV/c
|η|<1

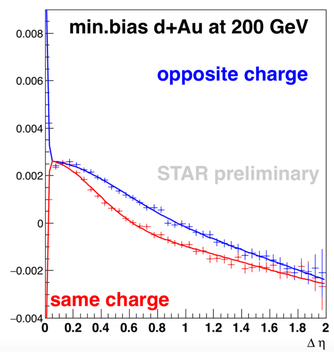
The Time Projection Chamber is used to track charged hadrons.

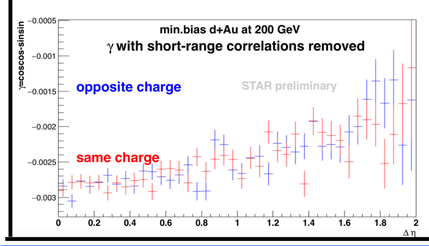
Fit example: d+Au collision at 200 GeV

coscos



sinsin





Fit χ²/ndf

d+Au collision as an example

```
the cc_os  :  1.1002
the cc_ss  :  1.14403
the ss_os  :  0.53918
the ss_ss_ :  0.939534
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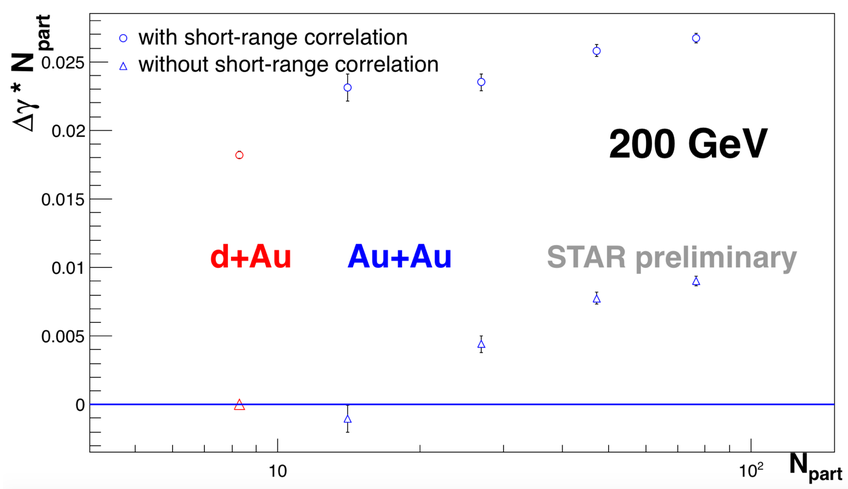
Results

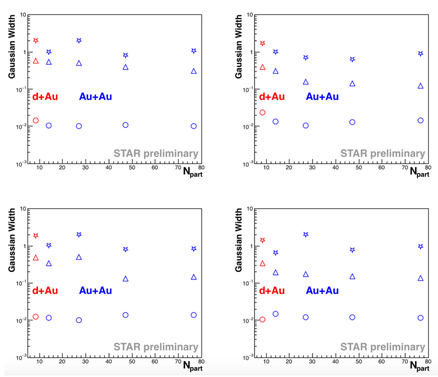
Δγ with and without short-range correlation

statistical errors only



Extracted gaussian widths for different components

os_cc ss_cc

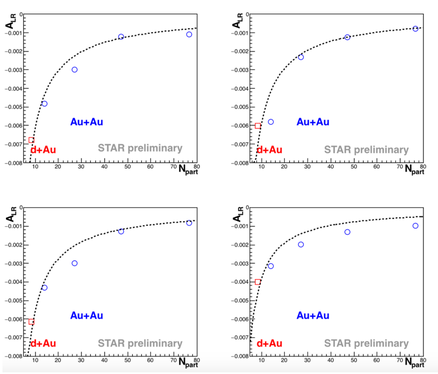


os_ss ss_ss

σ_{VSR} σ_{SR} σ_{IR}

Extracted pedestals

os_cc Pedestal ss_cc Pedestal



os_ss Pedestal ss_ss Pedestal

fit function: constant/x

Summary

The short-range correlations have significant contributions to the γ correlations, especially in small systems.

Finite values of gamma in more central collisions could still come from other backgrounds, which is under investigation.

Acknowledgements

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Reference

[1] D. Kharzeev, Phys. Lett. B 633 (2006) 260

[2] Prithwish Tribedy, for the STAR Collaboration, arXiv:1704.03845.

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