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

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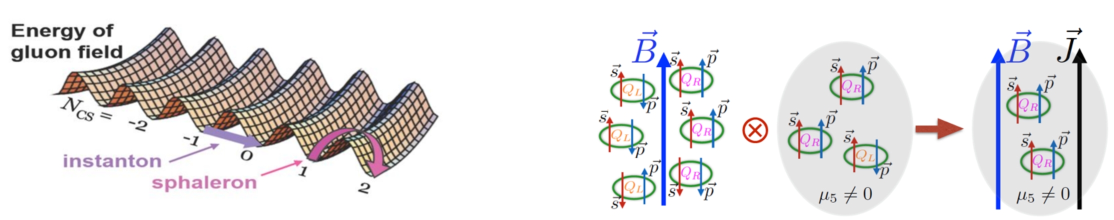
High-energy heavy-ion collisions can create a hot and dense nuclear medium in which local domains could obtain a chirality imbalance. The chirality imbalance, together with a strong magnetic field, can induce an electric charge separation along the magnetic field direction, owing to the chiral magnetic effect (CME) [1]. The γ correlator measures the two-particle azimuthal correlations relative to the reaction plane, and provides a probe to the electric charge separation due to the CME. However, the γ correlator contains short-range correlations caused by other physics mechanisms, such as quantum effects, Coulomb interaction and resonance decays. In this poster, we decompose the γ correlator into two parts, along and across the reaction plane, respectively, and 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 on 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

γ and δ definition

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

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

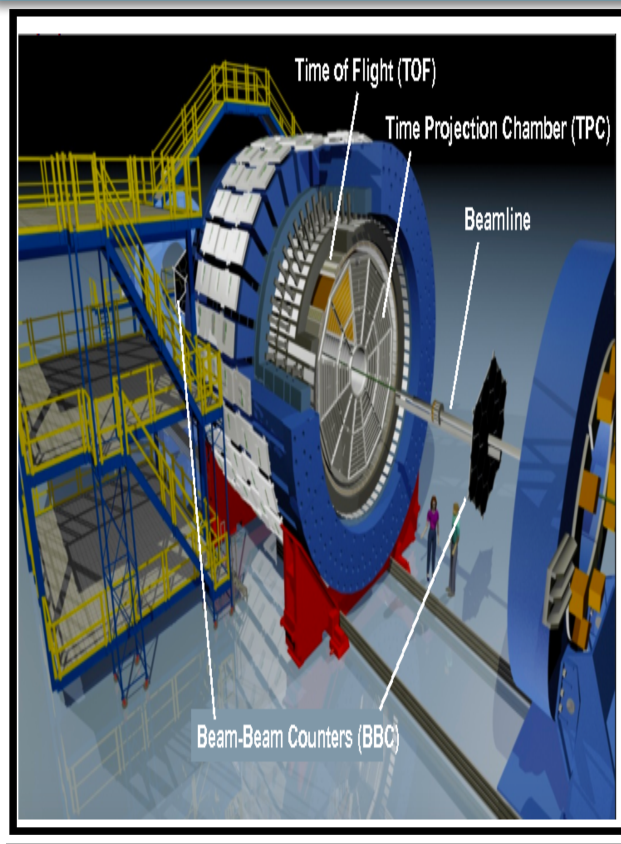
the sinsin and coscos terms as functions of Δη can be described by 3 Gaussian peaks and a pedestal.

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

VSR:very-short-range SR: short-range IR: 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

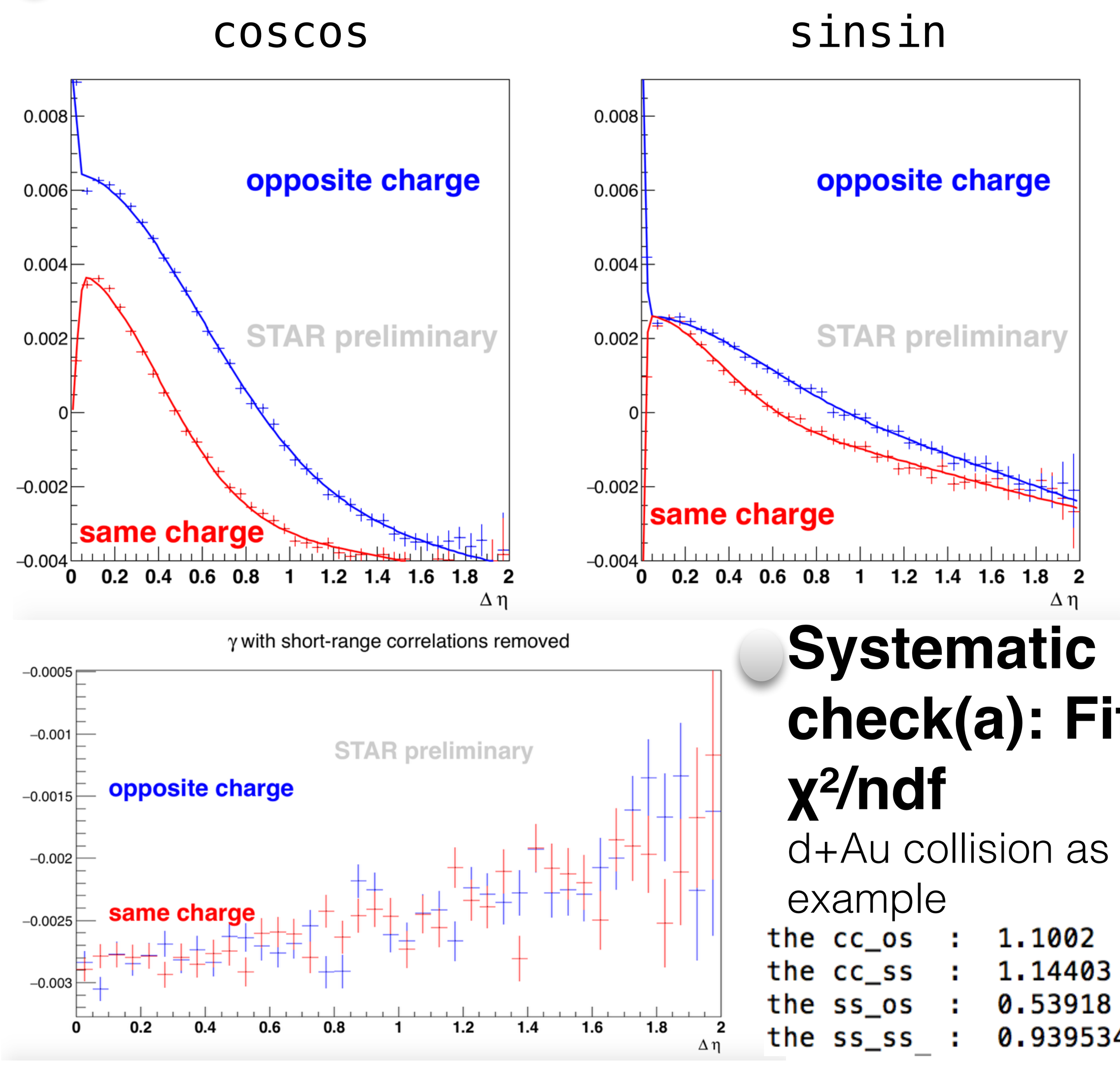


Event cuts and track cuts:

|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



Systematic check(a): Fit and χ^2/ndf

d+Au collision as an example

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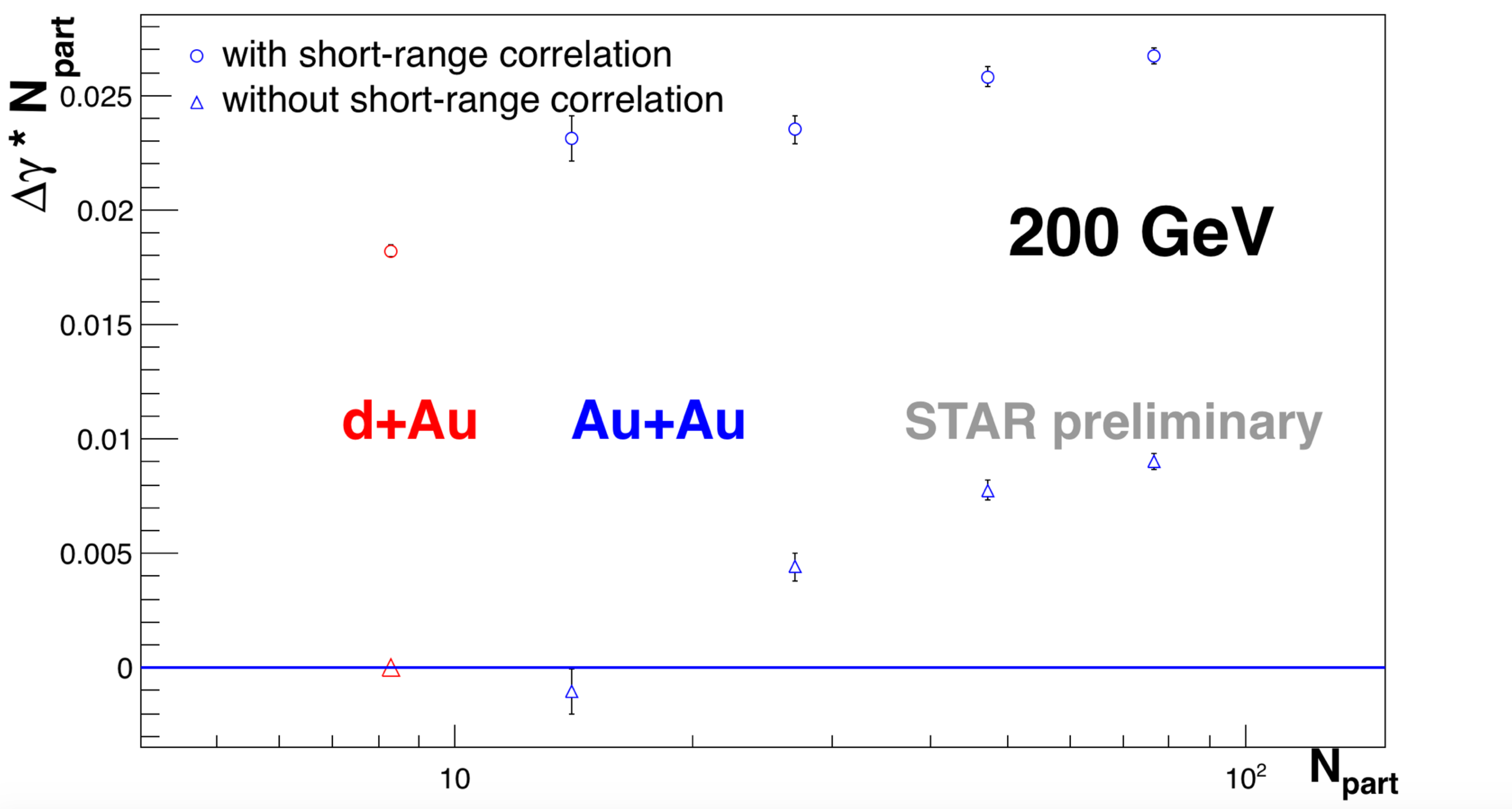
Results

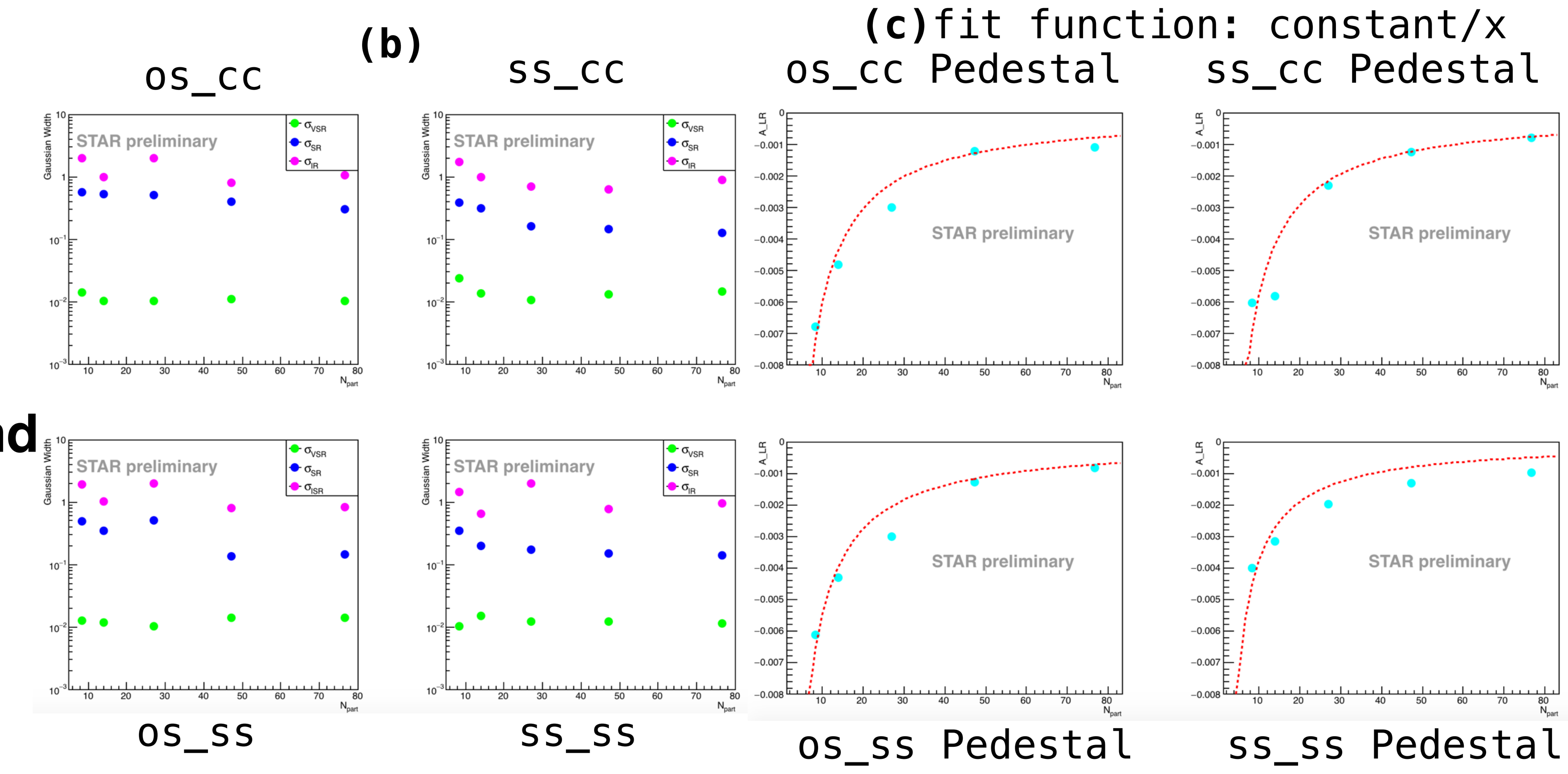
Δγ with and without short-range correlation

statistical errors only



Systematic check(b): Gaussian peak

Systematic check(c): Pedestal



Summary

- The short-range correlations have significant contributions to the γ correlations,especially in the small systems.
- Finite observables in more central collisions could still come from other backgrounds, which is under investigation.

Acknowledge

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Reference

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

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