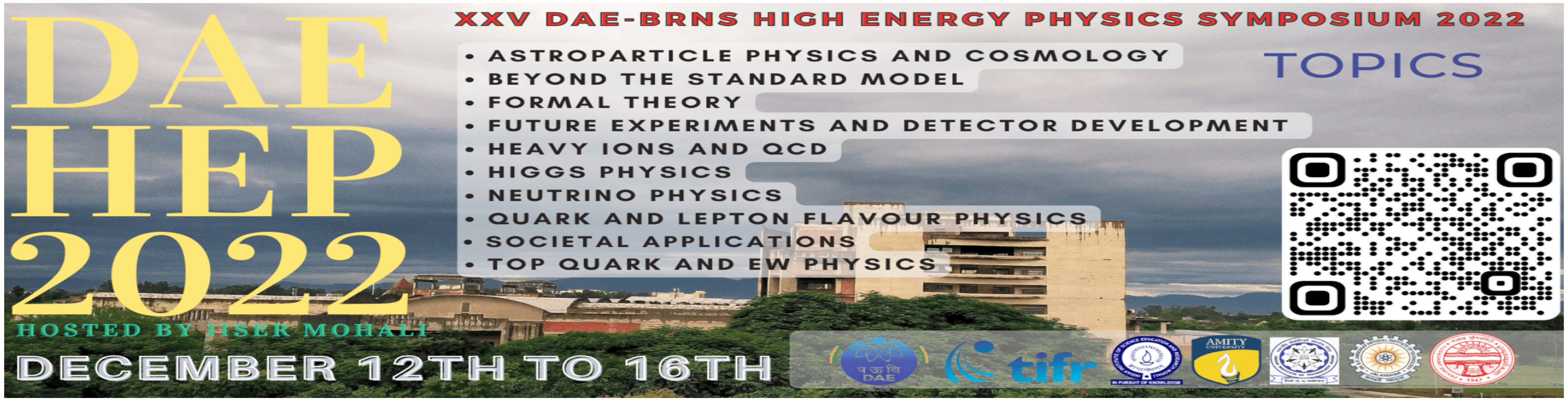

CME search in isobar ($^{96}_{44}Ru +^{96}_{44} Ru$ and $^{96}_{40}Zr +^{96}_{40} Zr$) collisions at $\sqrt{s_{NN}}$ = 200 GeV using SDM at RHIC

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

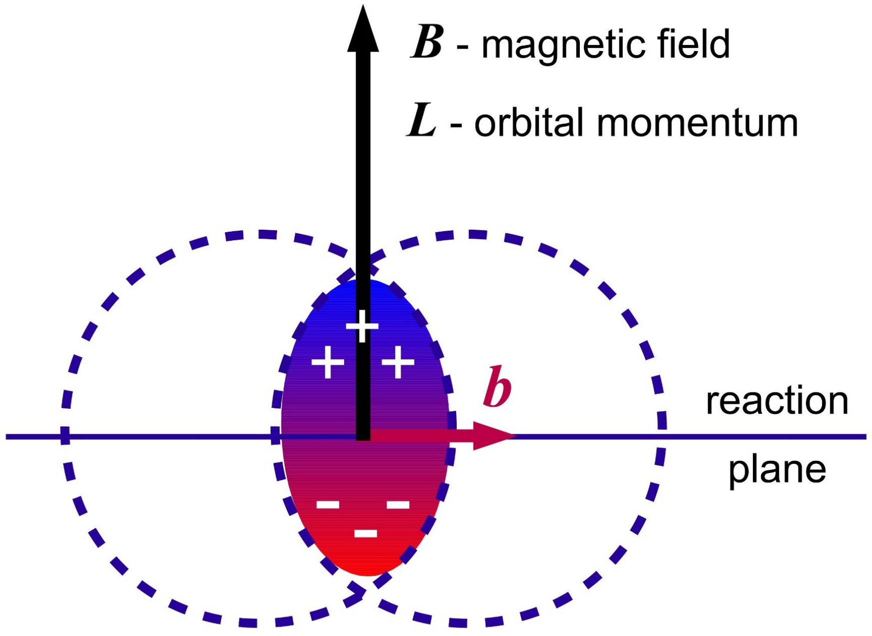
Outline

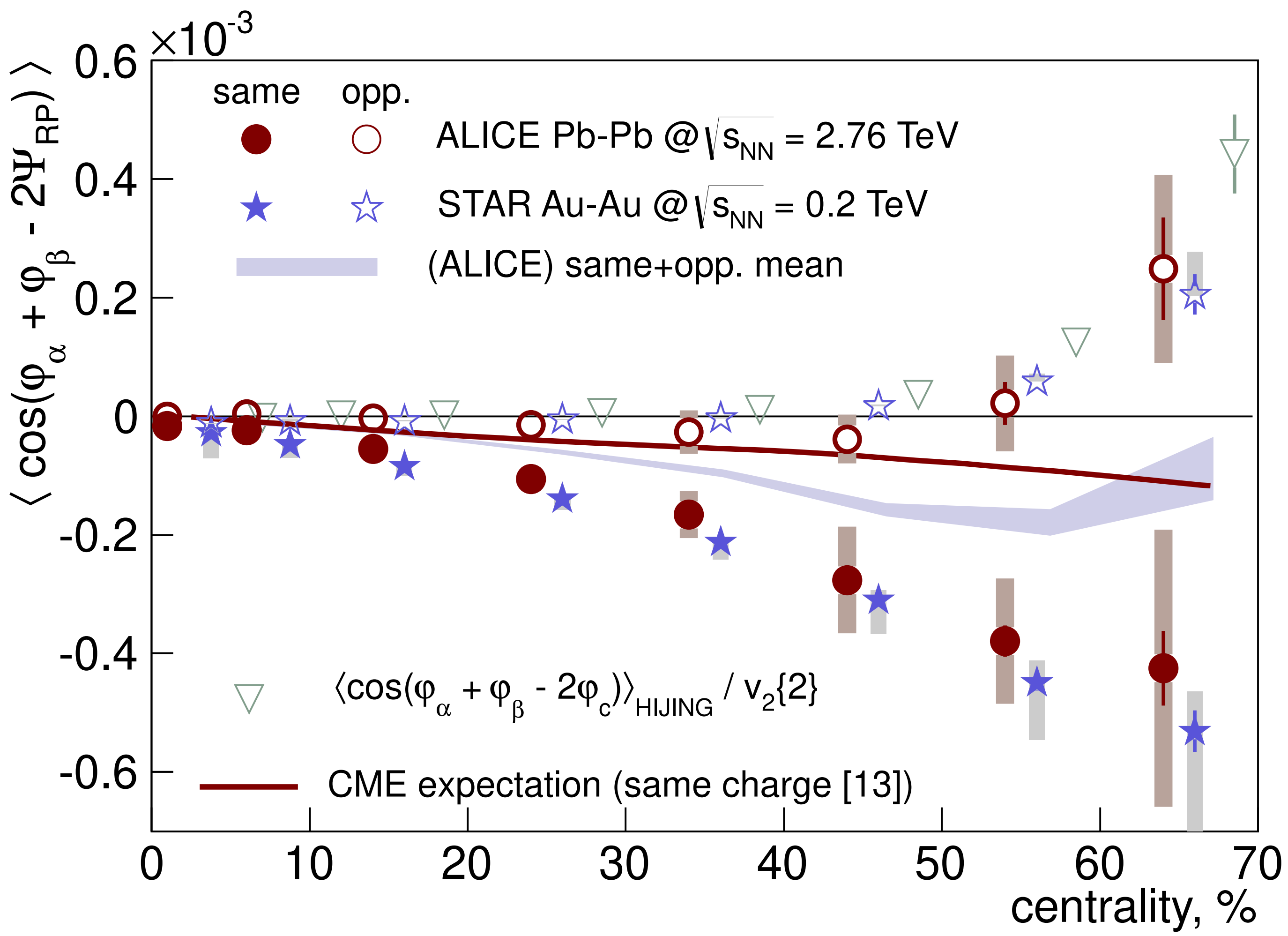
- Introduction
- STAR Experiment
- Analysis Details
- Results
- Summary

Introduction

Chiral Magnetic Effect?

- Strong magnetic field created by the fast-moving spectator protons causes the charge separation perpendicular to the reaction plane, known as the CME [1].





B. Abelev et al., (ALICE Collaboration), PRL 110, 012301 (2013)

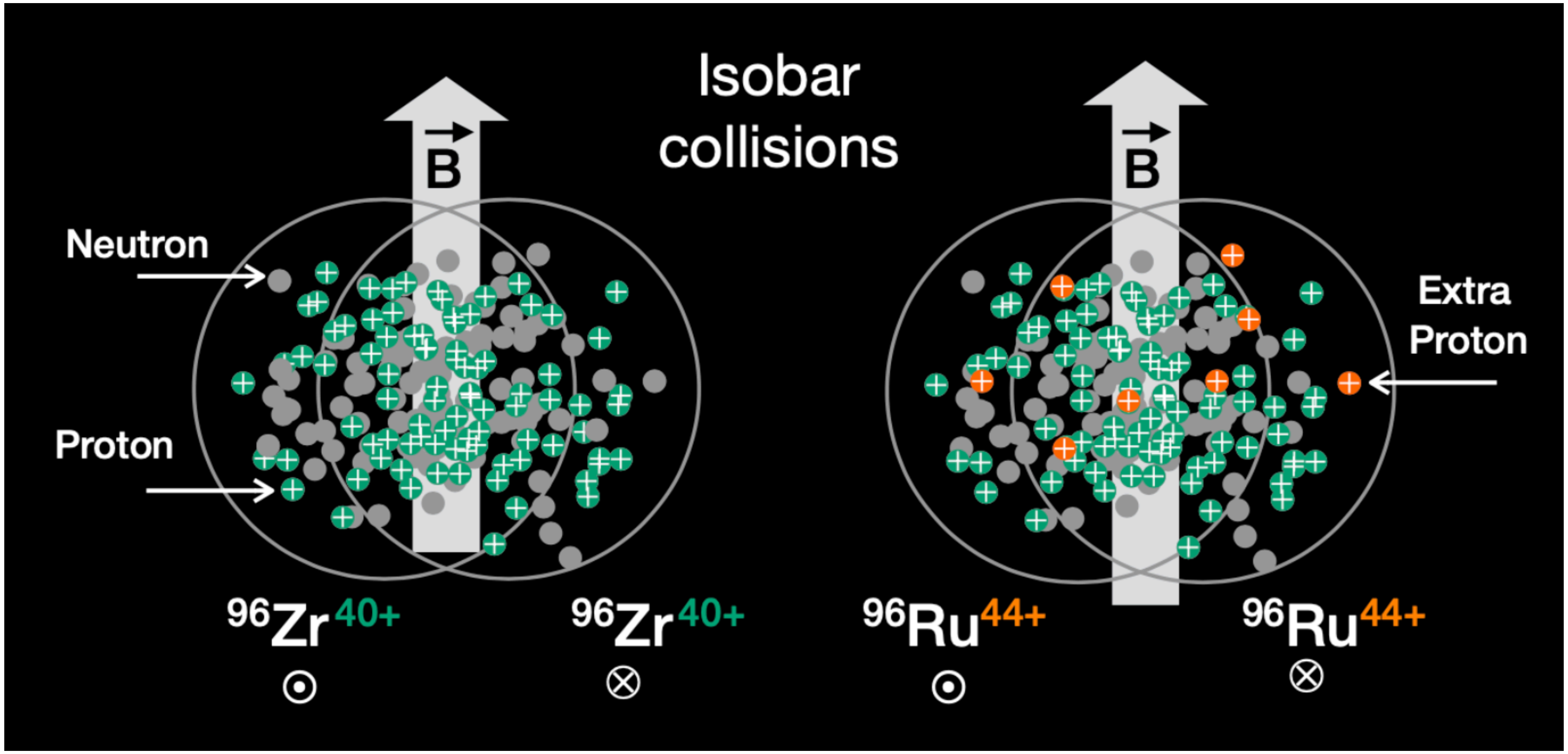
- The STAR at RHIC and the ALICE at the LHC have studied the CME by measuring the γ-correlator ($\gamma = \langle cos(\phi_a + \phi_b - 2\Psi_{RP}) \rangle$) [2].

[1] K. Fukushima, D. E. Kharzeev and H. J. Warringa, Phys. Rev. D 78, 074033 (2008).
[2] S. Voloshin, Phys. Rev. C70, 057901 (2004).

Introduction

Isobar Collisions

- Expected enhanced CME effect in Ru+Ru collisions than Zr+Zr collisions.
- The magnetic field is ~10-18% larger in Ru+Ru collisions



P. Tribedy, Free meson seminar, TIFR, Oct 7th, 2021

STAR Experiment

Two main detectors used in STAR for particle identification:

- **Time Projection Chamber (TPC)**
- **Time of Flight (TOF)**

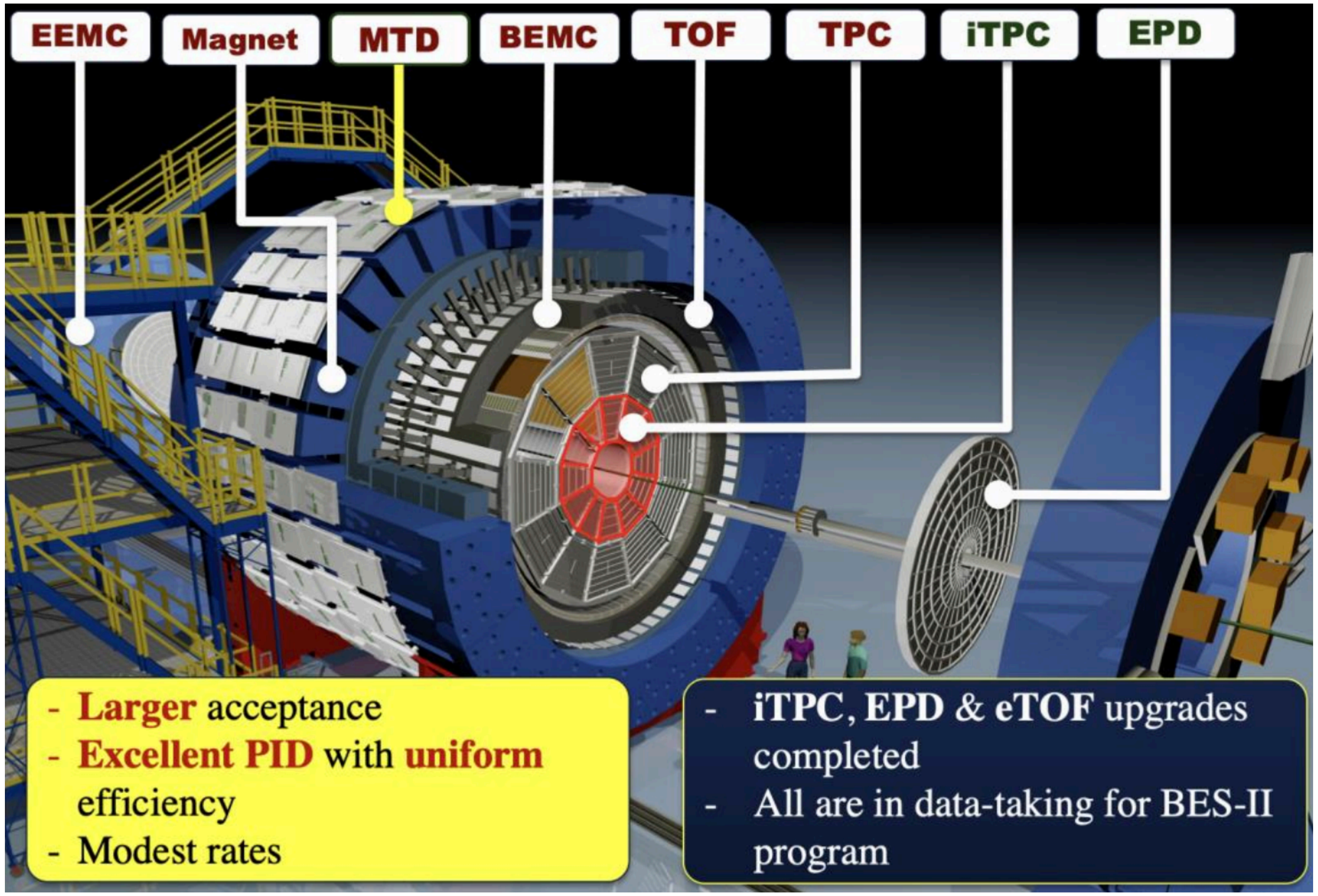
The main characteristics of the STAR:

- Large coverage i.e., $\phi(0,2\pi)$ and $\eta(-1,1)$
- Excellent particle identification at low p_T using TPC and at intermediate p_T using TOF

Data Set: Isobaric Collisions (Ru+Ru & Zr+Zr) at 200 GeV (~50% of the available data).

Event and Track selection cuts:

- $-35 < V_z < 25$ cm
- $|\eta| < 1$
- $0.2 < p_t < 2.0 GeV/c$
- DCA < 3 cm



STAR (Solenoidal Tracker at RHIC)

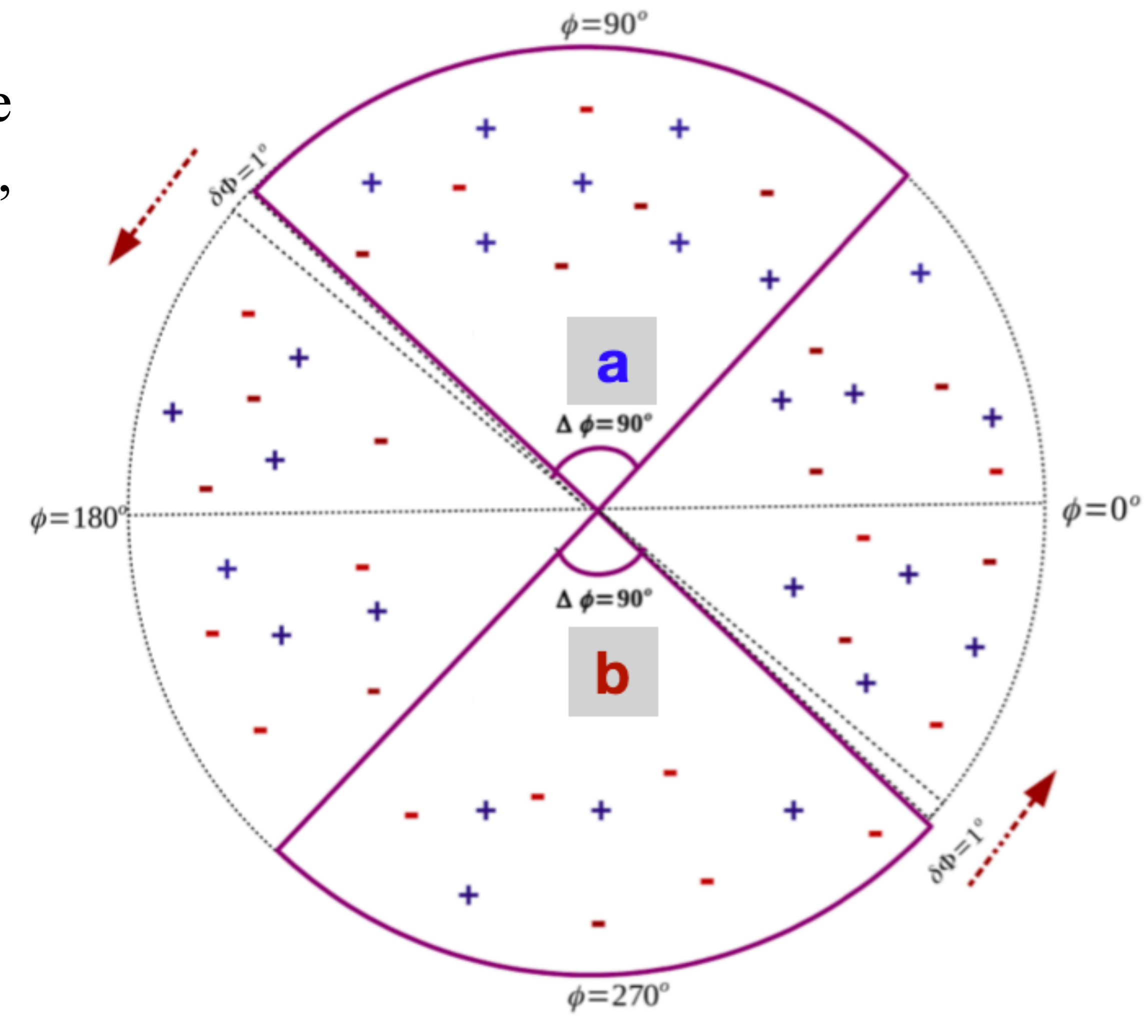
Analysis Details

Sliding Dumbbell Method

- The azimuthal plane in each event is scanned by sliding the dumbbell of $\Delta\phi = 90^\circ$ in steps of $\delta\phi = 1^\circ$ while calculating, Db_{+-} for each region to obtain maximum values of Db_{+-} (Db_{+-}^{max}) in each event.

$$Db_{+-} = \frac{n_+^a}{(n_+^a + n_-^a)} + \frac{n_-^b}{(n_+^b + n_-^b)}$$

Where, n_+^a *and* n_-^a (n_+^b *and* n_-^b), the number of positive and negative charged particles on "a"("b") side of the dumbbell



- Fractional Charge separation (f_{DbCS}) across the dumbbell in each event is defined as :

$$f_{DbCS} = Db_{+-}^{max} - 1$$

- f_{DbCS} distributions are obtained for different collision centralities and divided into 10-percentile bins.

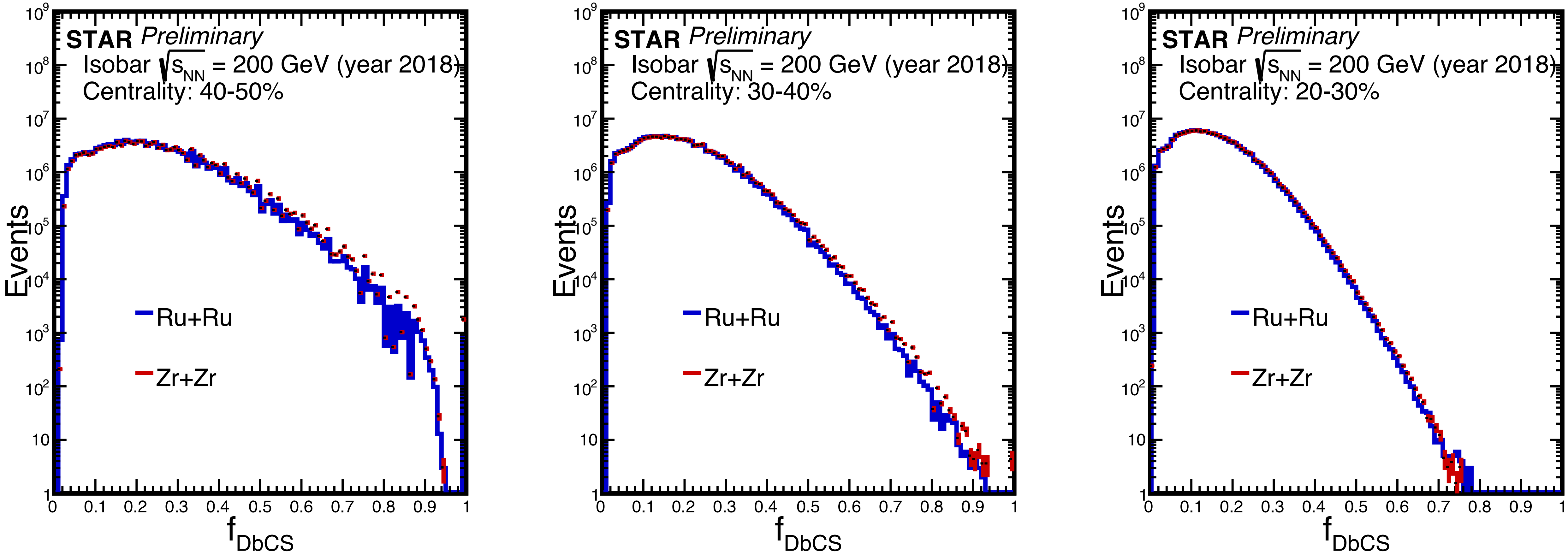
Jagbir Singh, Anjali Attri, and Madan M. Aggarwal, DAE Symp. Nucl. Phys. 64, 830, (2019).

Background Estimation

- **Charge Shuffle (ChS)**: The charges of particles in each event are shuffled randomly to destroy the charge-dependent correlations amongst charged particles but keeping θ and ϕ of each particle unchanged in an event.

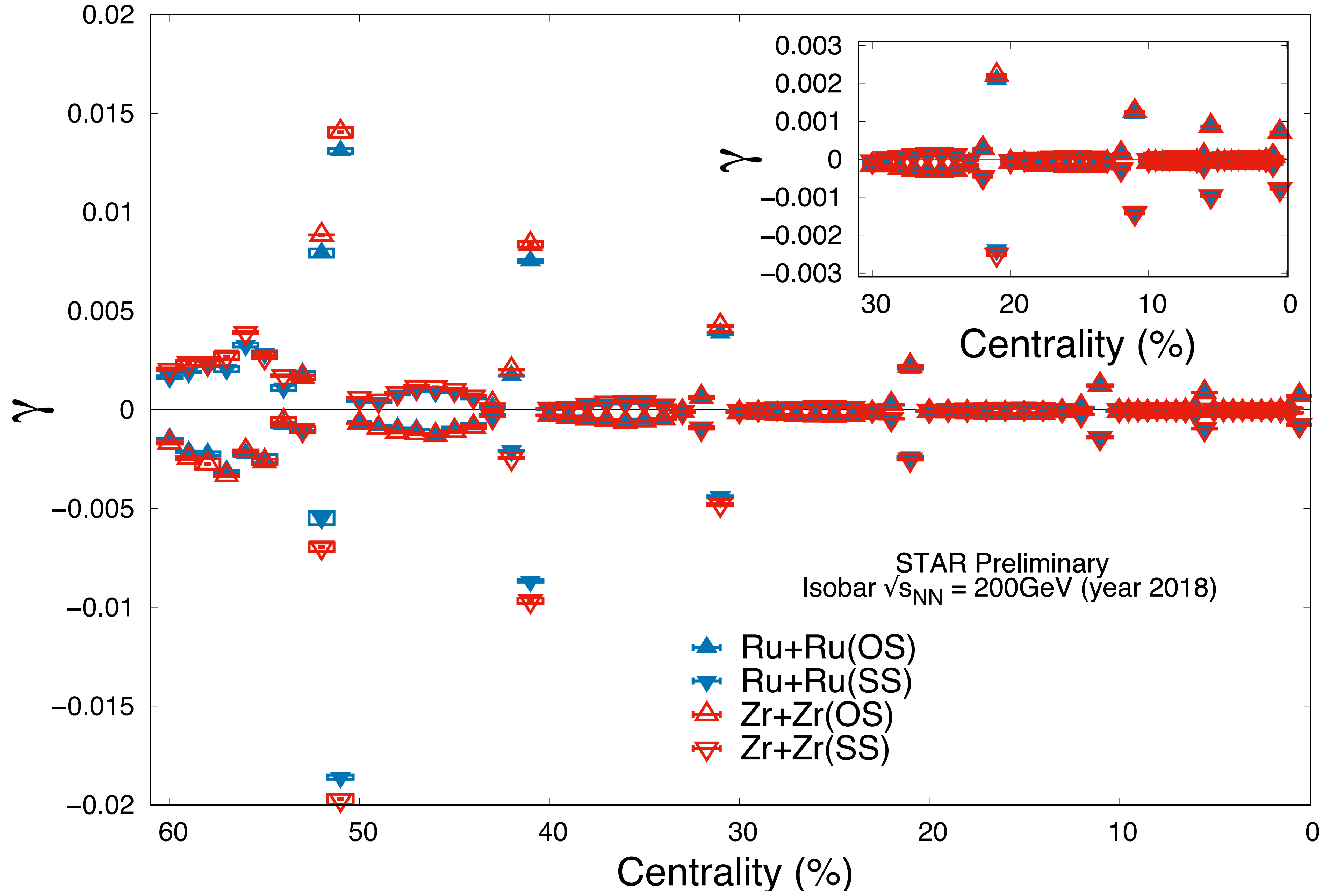
- **Correlated (Corr.) Background**: The shuffling of charges of particles in an event keeping the flow in, kills not only the CME-like correlations but also correlations amongst produced particles in an event. Correlations amongst particles that were destroyed during charge shuffling were recovered from the corresponding original events in a particular f_{DbCS} bin. This is termed as the correlated background.

Results



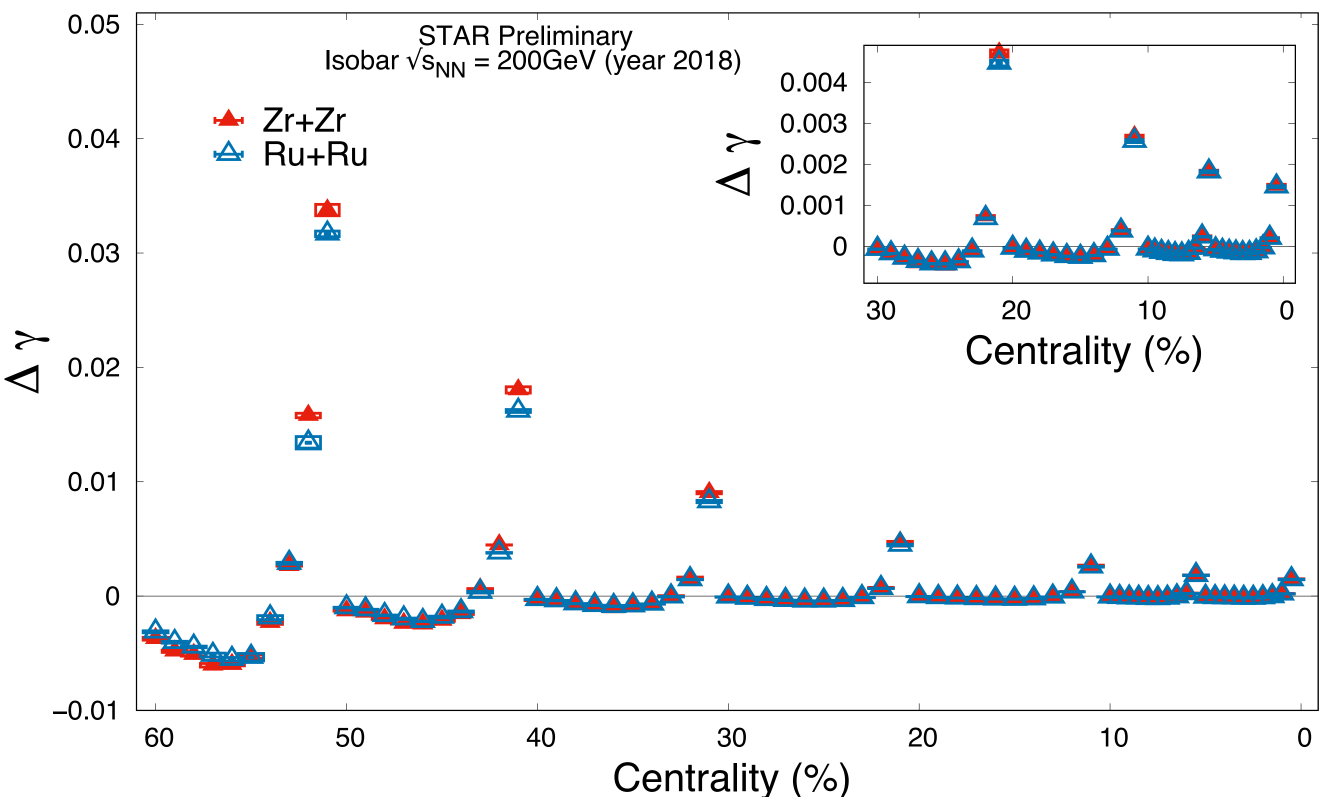
- Charge separation (f_{DbCS}) distributions extend towards higher f_{DbCS} values with decreasing collision centrality.

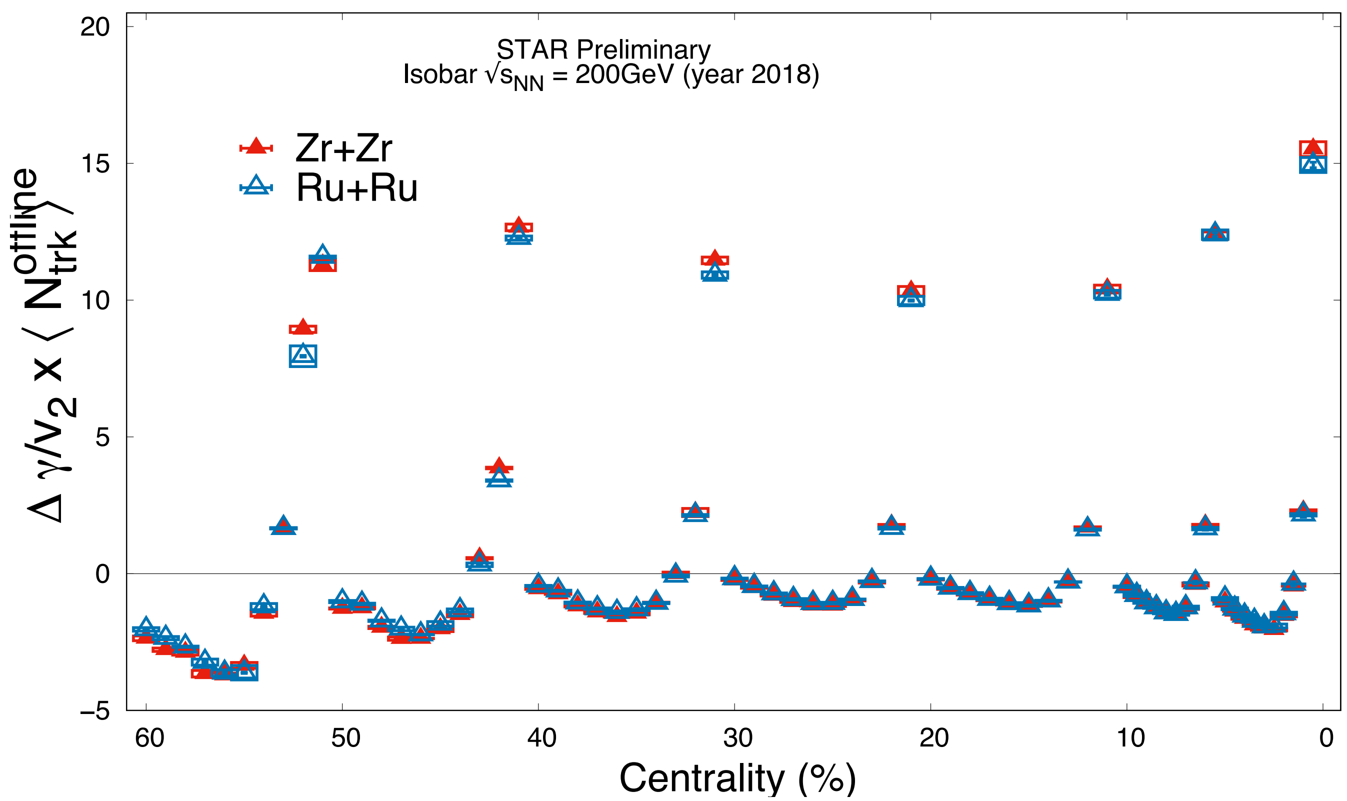
Results



- For top f_{DbCS} bins (0-20%), $\gamma_{OS} > 0$ *and* $\gamma_{SS} < 0$.

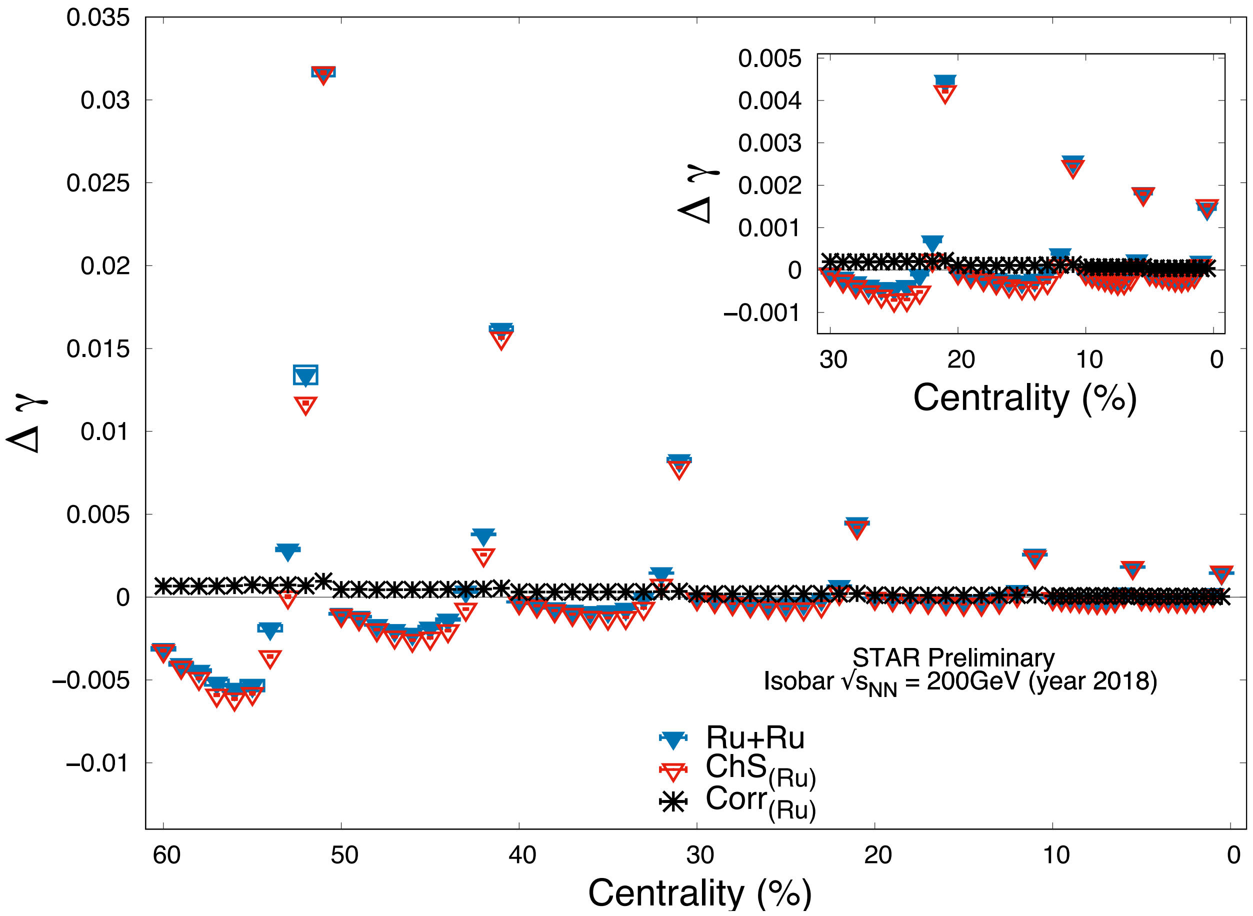
Results

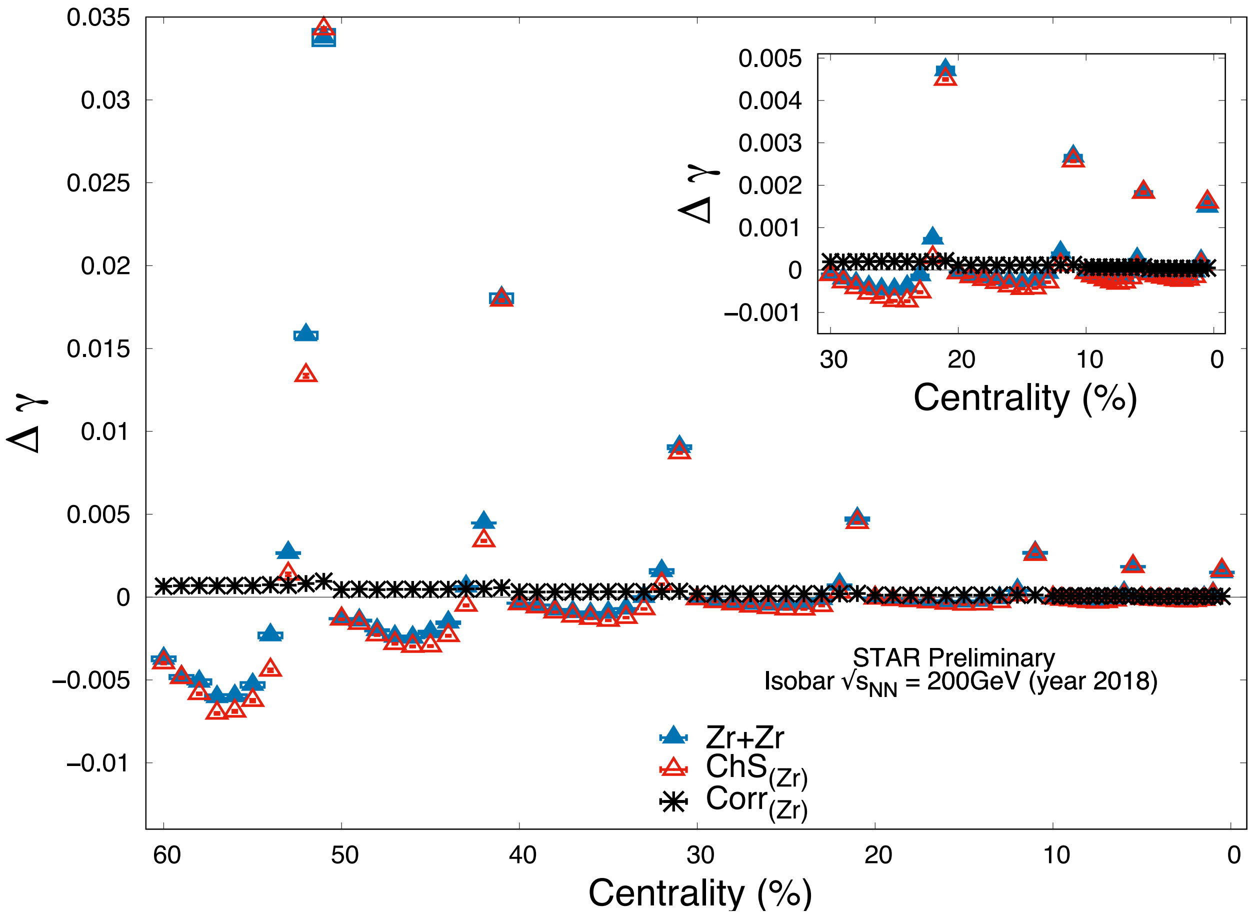




- $\Delta\gamma\ (=\gamma_{OS}-\gamma_{SS})$ is positive for the top 20%(30%) f_{DbCS}.
- $\Delta\gamma$ is smaller for Ru than those of Zr.
- Δγ scaled with $\langle N_{trk}^{offline}\rangle/v_2$ (Left figure).

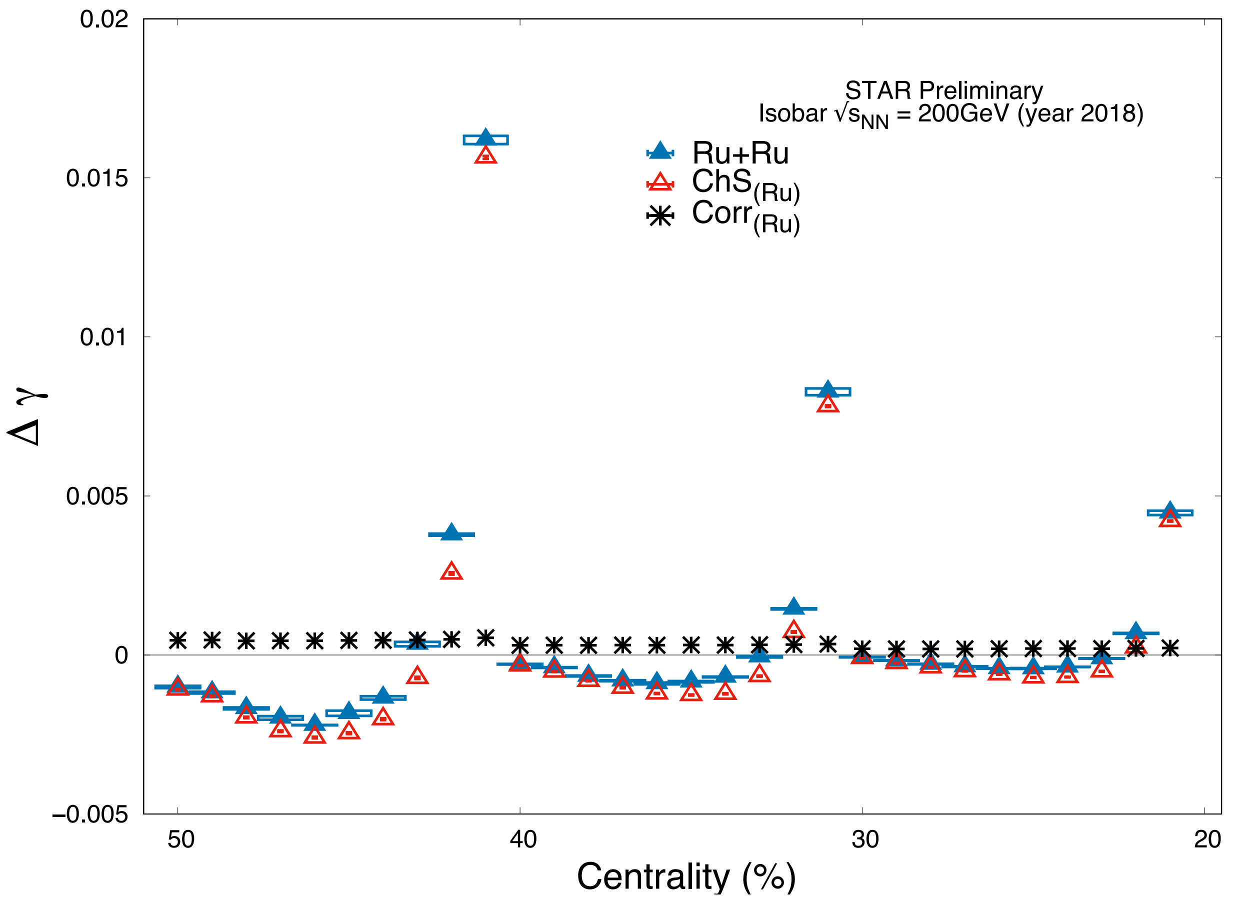
Results

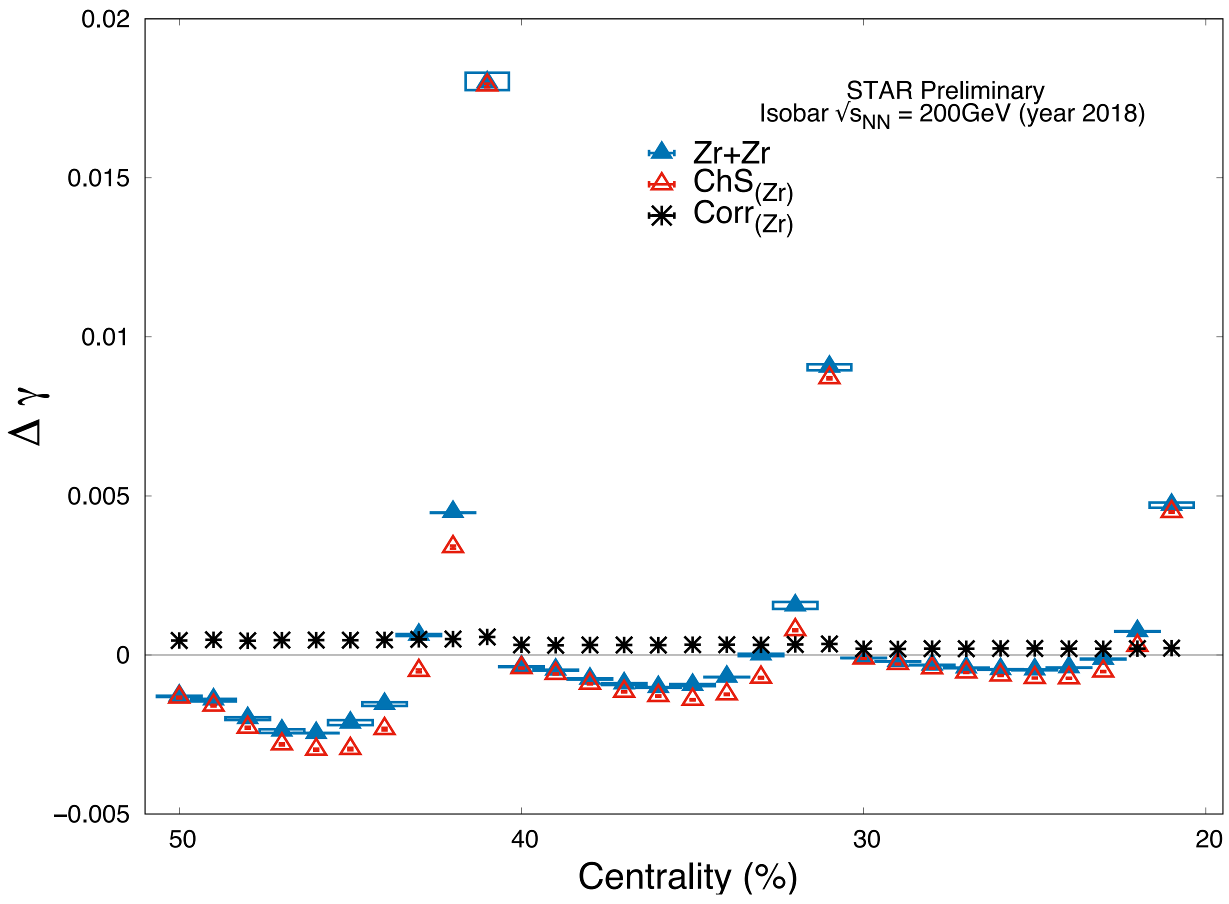




- $\Delta\gamma$ for Ru+Ru and Zr+Zr collisions are compared with their respective backgrounds for each f_{DbCS} bin.

Results





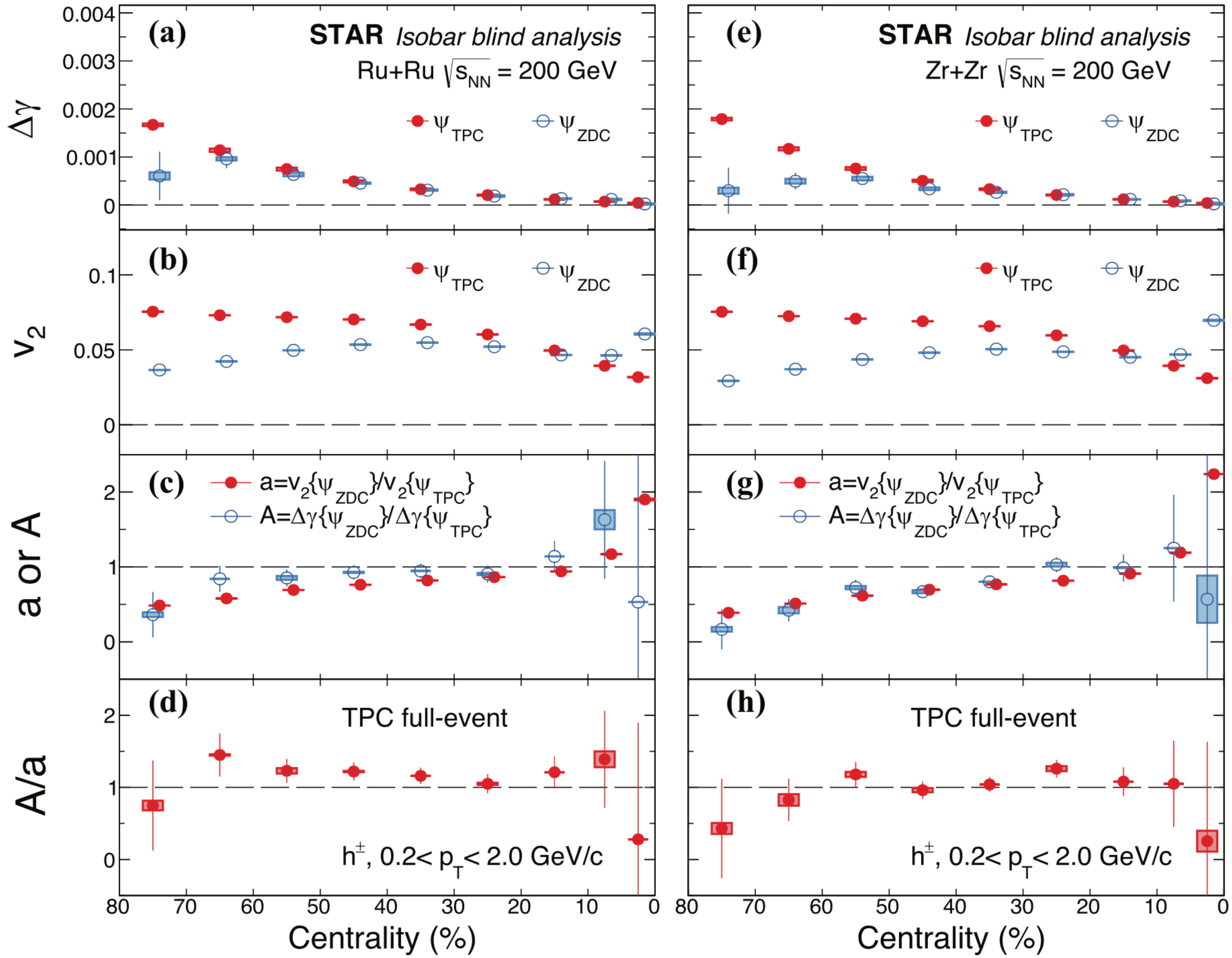
- The data points for the top 20% f_{DbCS} bins look higher than the total background (ChS+Corr) for the 30-50% collision centralities.

Summary

- The charge separation (f_{DbCS}) distribution extends towards higher f_{DbCS} values with decreasing collision centrality.
- It is seen that $\gamma_{OS} > 0$ *and* $\gamma_{SS} < 0$ for the top 20%(30%) f_{DbCS} bins for 0-40% (40-60%) centralities.
- It can be seen that $\Delta\gamma$ are smaller for Ru than those of Zr for the top 10% (top 20%) f_{DbCS} bins for 20-40% (40-60%) centralities. However, the difference between them decreases if $\Delta\gamma$ is scaled with $\langle N_{trk}^{offline} \rangle / v_2$.
- $\Delta\gamma$ for Ru+Ru and Zr+Zr are compared with their respective backgrounds (i.e., Charge shuffled (ChS) and Correlated (Corr)) for 0-60% collision centralities.
- The data points for the top 20% f_{DbCS} bins look higher than the total background (ChS+Corr) for both Ru and Zr for the 30-50% collision centralities. We are analyzing the full available data set to get a detailed comparison.

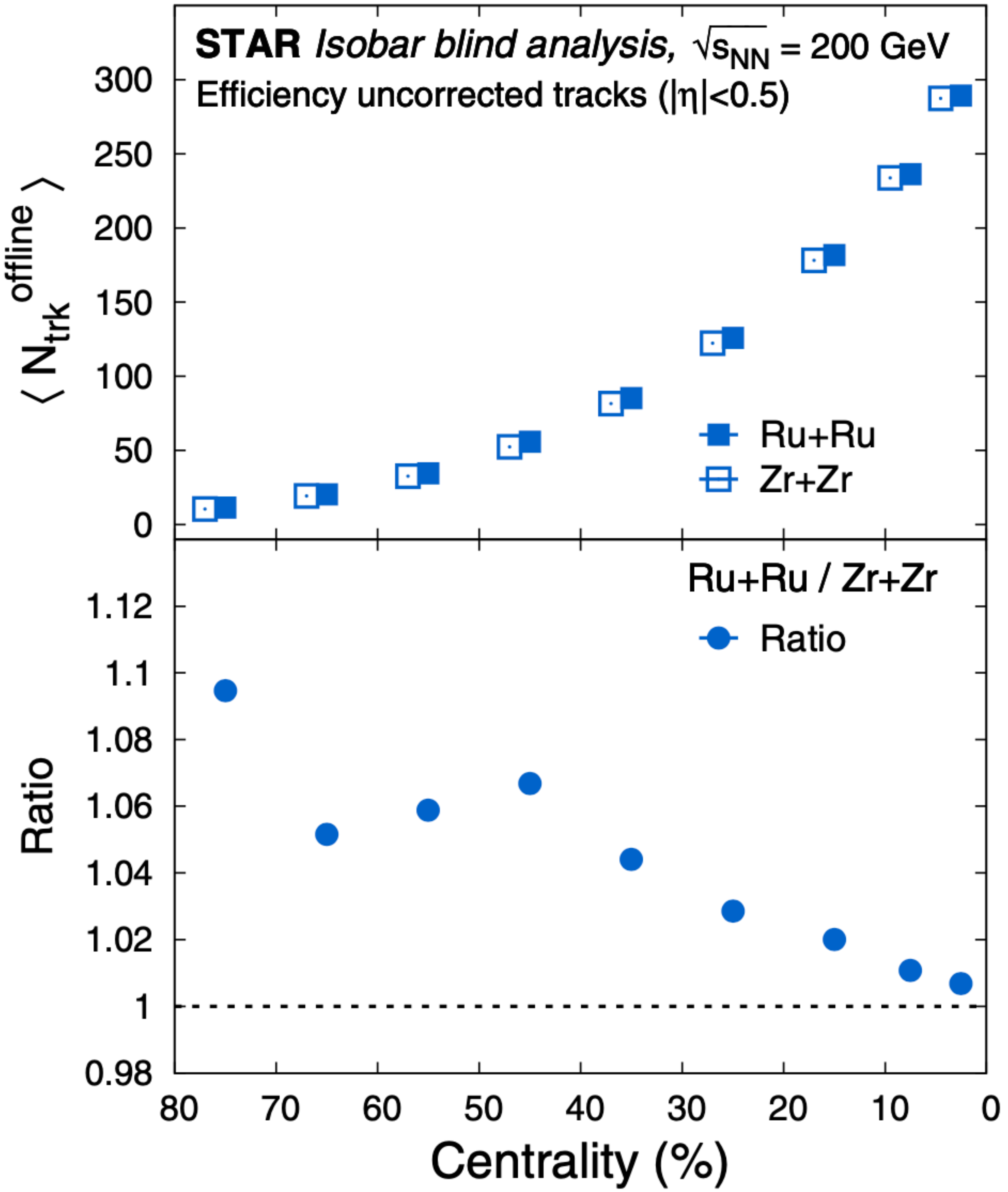
Thank you for your attention!!

Backup



M. S. Abdallah *et al.,* Phys. Rev. C 105, 014901 (2022).

Backup



M. S. Abdallah *et al.*, Phys. Rev. C 105, 014901 (2022).