Anomalous kaon correlations in Pb–Pb collisions with ALICE at the LHC

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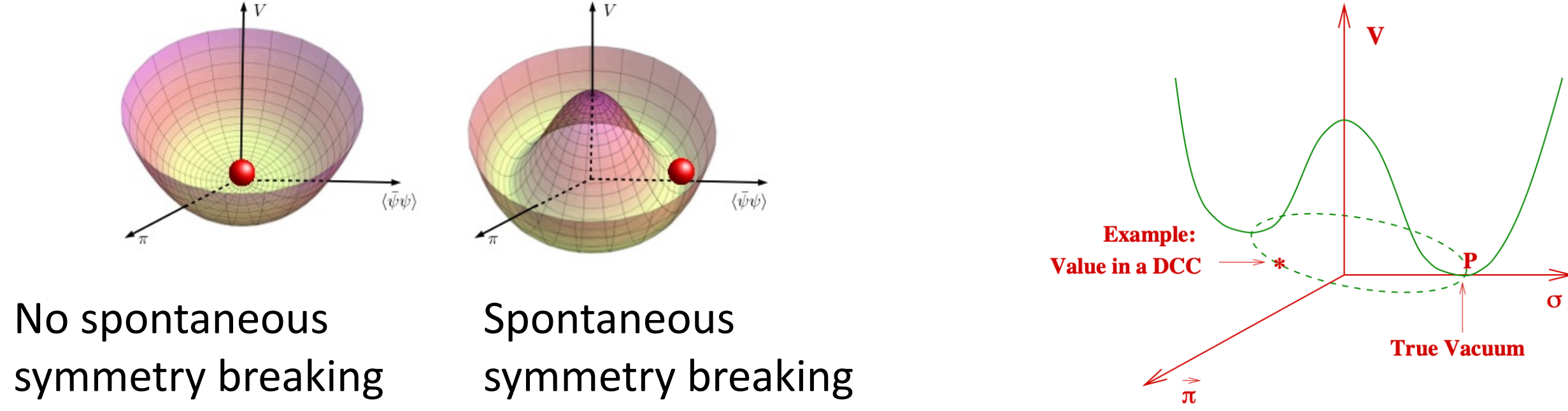[(1)]University of Houston, United States

1. MOTIVATION: THEORY

- ALICE observed unusual behavior in the event-by-event fluctuations in the kaon sector in Pb–Pb collisions. One possible description for this is formation of Disoriented Chiral Condensate (DCC) [1].

- DCC arises from chiral symmetry restoration in the QGP, which breaks during the phase transition to form a condensate which coherently emits hadrons.

No spontaneous symmetry breaking

Spontaneous symmetry breaking

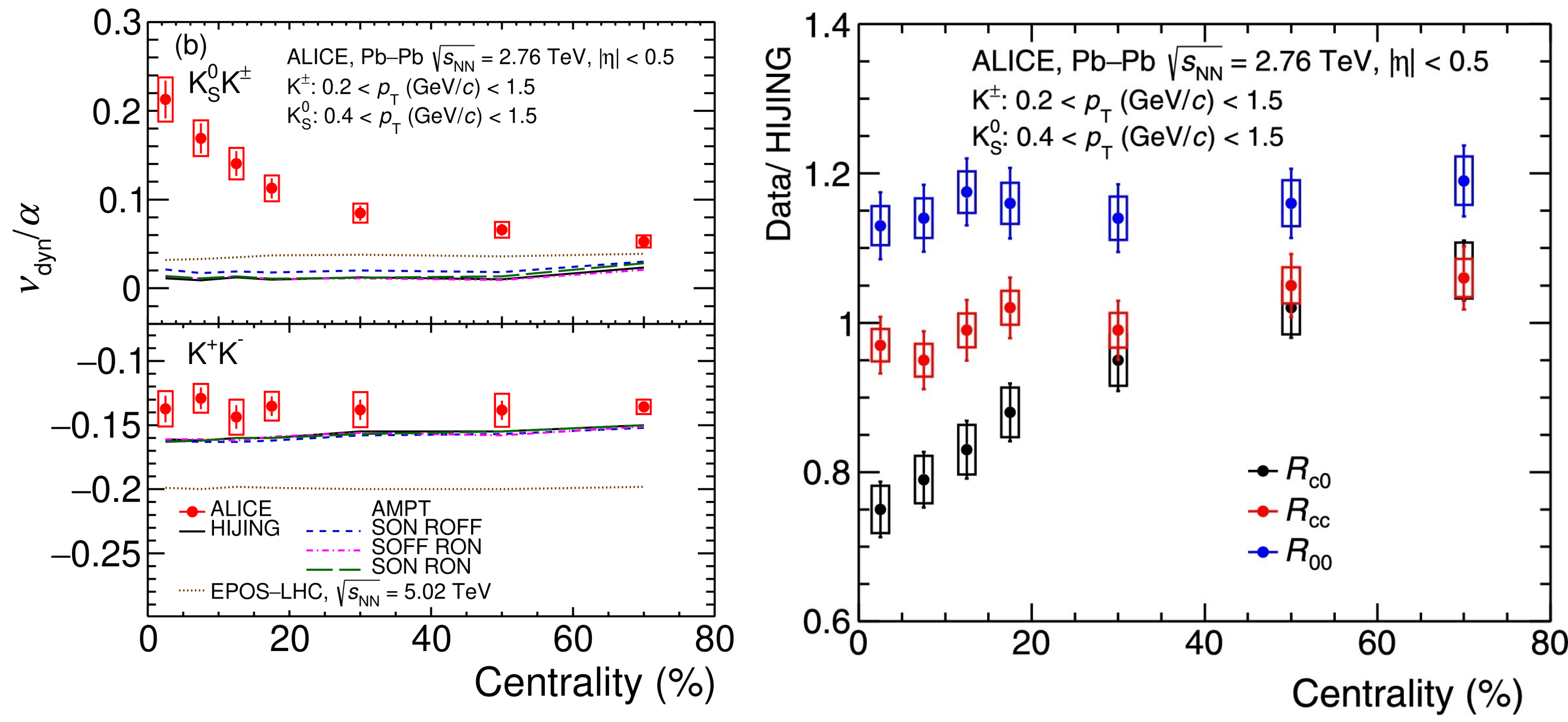Example: Value in a DCC

True Vacuum

2. MOTIVATION: EXPERIMENT

- The fluctuations of relative yields of kaons were measured using the robust fluctuation correlator, ν_{dyn} [2].

$$\nu_{dyn} = R_{cc} + R_{00} - 2R_{c0}.$$

$$R_{aa} = \frac{<N_a^2> - <N_a>^2 - <N_a>}{<N_a>^2} \qquad R_{c0} = \frac{<N_c N_0> - <N_c><N_0>}{<N_c><N_0>}$$

$$\alpha \equiv (\langle K_S^0 \rangle^{-1} + \langle K^{\pm} \rangle^{-1})$$


- Unlike the data, the scaled values of ν_{dyn} predicted by the models are essentially invariant with collision centrality.
- R_{c0} shows significant dependence on centrality.

3. ANALYSIS STRATEGY

- The correlation function is defined as the ratio of signal and background distributions.
- **Signal**: Distribution of correlated pairs of particles from the same events.
- **Background**: Reference distribution constructed by the event-mixing procedure using uncorrelated particle pairs.

C=1 : No Correlation
C>1 : Correlation
C<1 : Anti-correlation

$$S(\Delta\eta, \Delta\varphi) = \frac{1}{N_{pairs}^{signal}} \frac{d^2 N_{pairs}^{signal}}{d\Delta\eta \, d\Delta\varphi}, \qquad B(\Delta\eta, \Delta\varphi) = \frac{1}{N_{pairs}^{mixed}} \frac{d^2 N_{pairs}^{mixed}}{d\Delta\eta \, d\Delta\varphi}, \qquad C(\Delta\eta, \Delta\varphi) = \frac{S(\Delta\eta, \Delta\varphi)}{B(\Delta\eta, \Delta\varphi)},$$
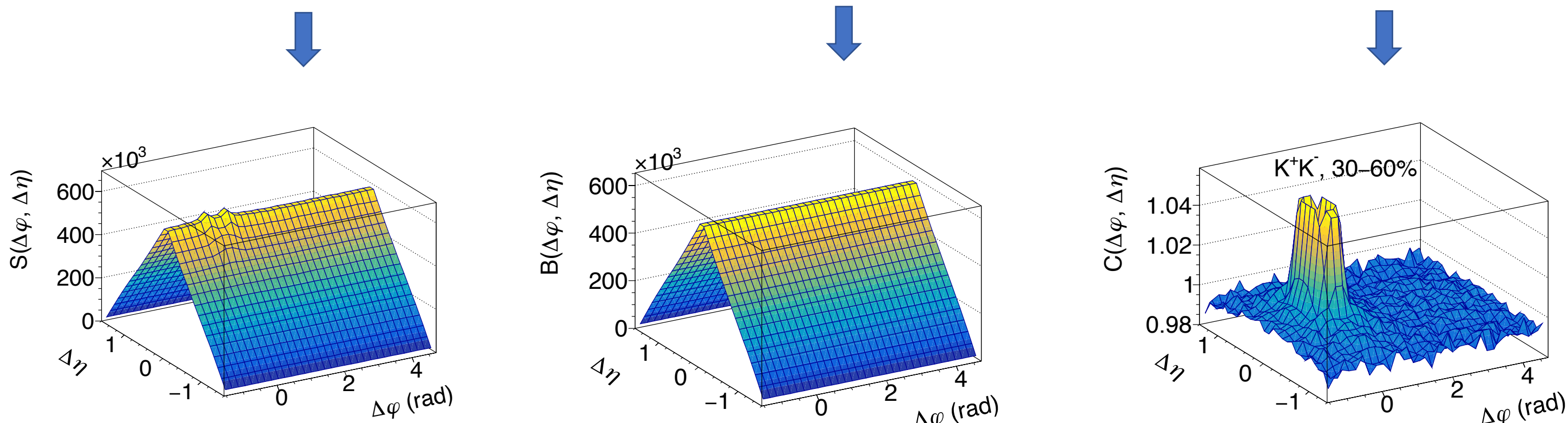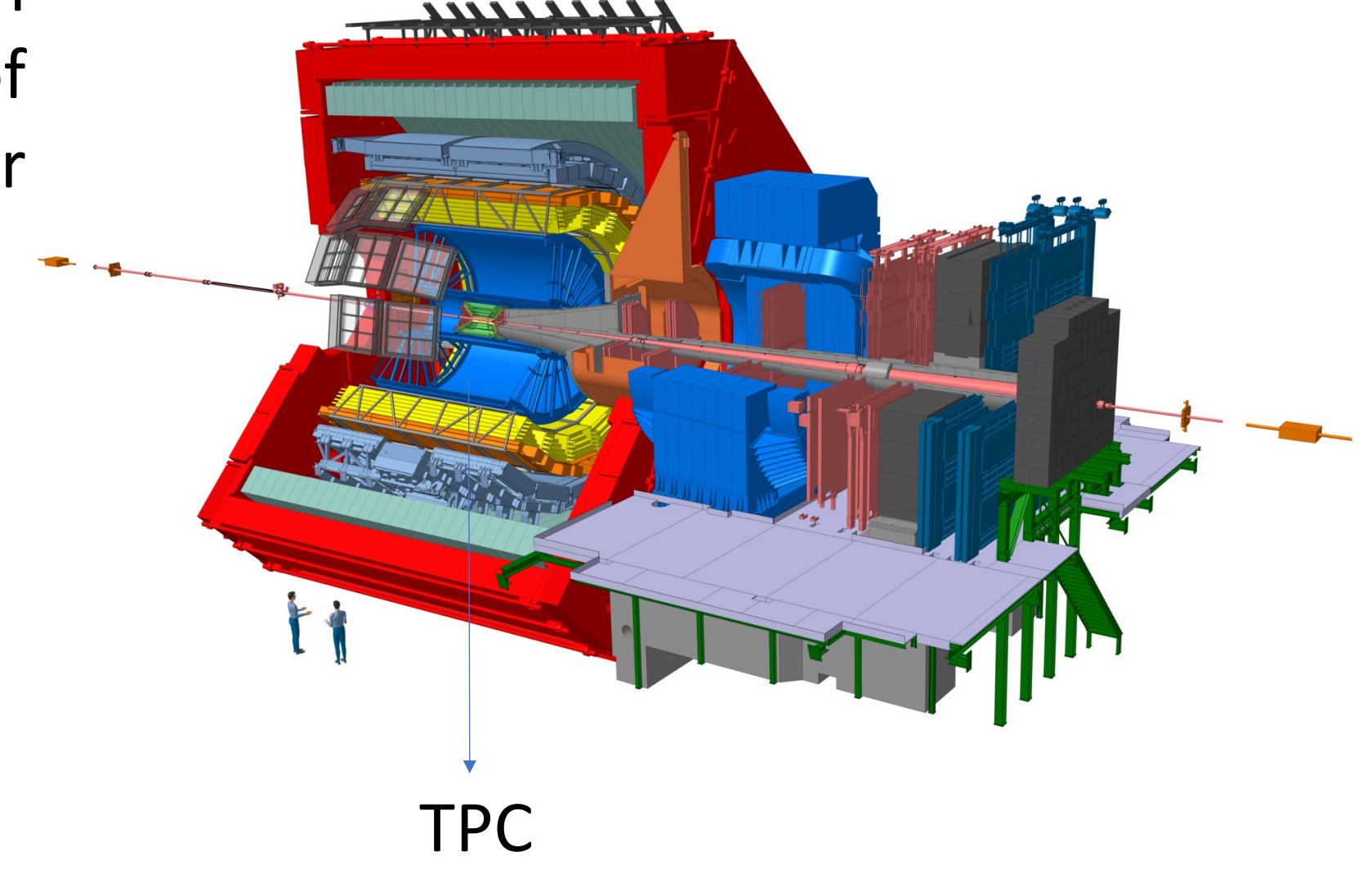

REFERENCES

[1] J. I. Kapusta, S. Pratt and M. Singh, Phys. Rev. C 107, no.1, 014913 (2023)
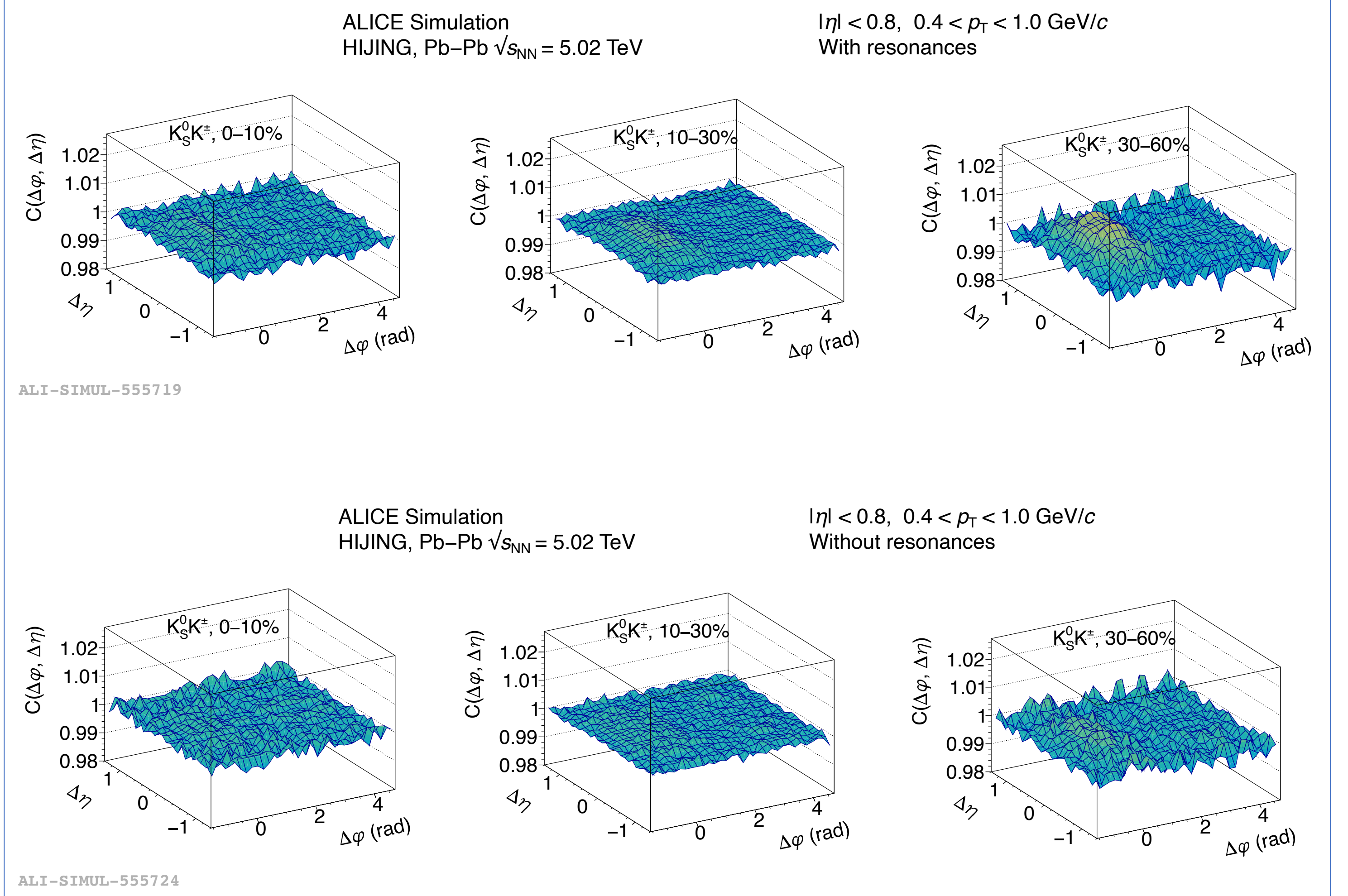[2] S. Acharya et al. (ALICE), Phys. Lett. B 832, 137242 (2022)

4. ALICE DETECTOR

- The experimental acceptance used in this analysis is based on the geometrical acceptance of the Time Projection Chamber (TPC) at low p_{T}.

- Pseudorapidity: $|\eta| < 0.8$

- Transverse momentum: $0.4 < p_{\mathrm{T}} < 1.0$ GeV/c
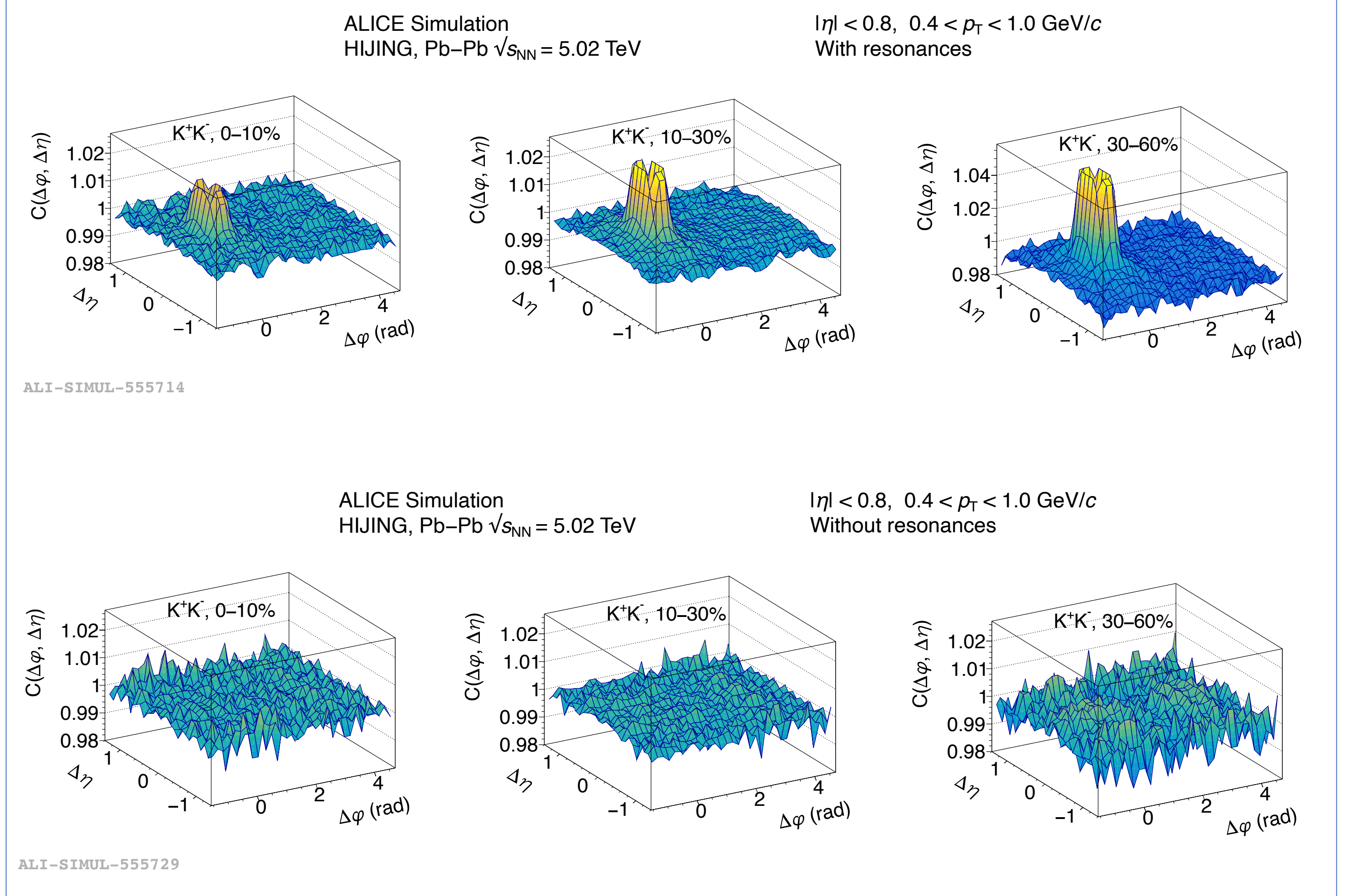

TPC

5. RESULTS

$K^0_S K^{\pm}$ Correlation Function

$K^+ K^-$ Correlation Function

6. CONCLUSIONS

- The $K^0_S K^{\pm}$ and $K^+ K^-$ correlation functions are measured using the HIJING model at the generator level.
- A significant contribution is arising from the resonance decays.
- Isolating the DCC effects requires an understanding of the structures due to other mechanisms such as minijets, fragmentation, etc.
- **Outlook**: Measure these correlations using the high statistics Run 2 Pb–Pb collision data.