

Angular correlations of π , K , p , Λ

Eur.Phys.J. C77 (2017) 569

ALICE results in pp collisions at $\sqrt{s} = 7\text{TeV}$,

- ▶ $(\Delta\eta, \Delta\varphi)$ correlations of π , K , p , Λ
- ▶ $p_T < 2.5\text{ GeV}/c$, $|\eta| < 0.8$
- ▶ track reconstruction by ITS & TPC
- ▶ particle identification by TPC & TOF for π , K , p and by topological cuts for Λ ; purity above 95% for all samples.
- ▶ separately for like- and unlike-sign pairs

Construction of correlation function

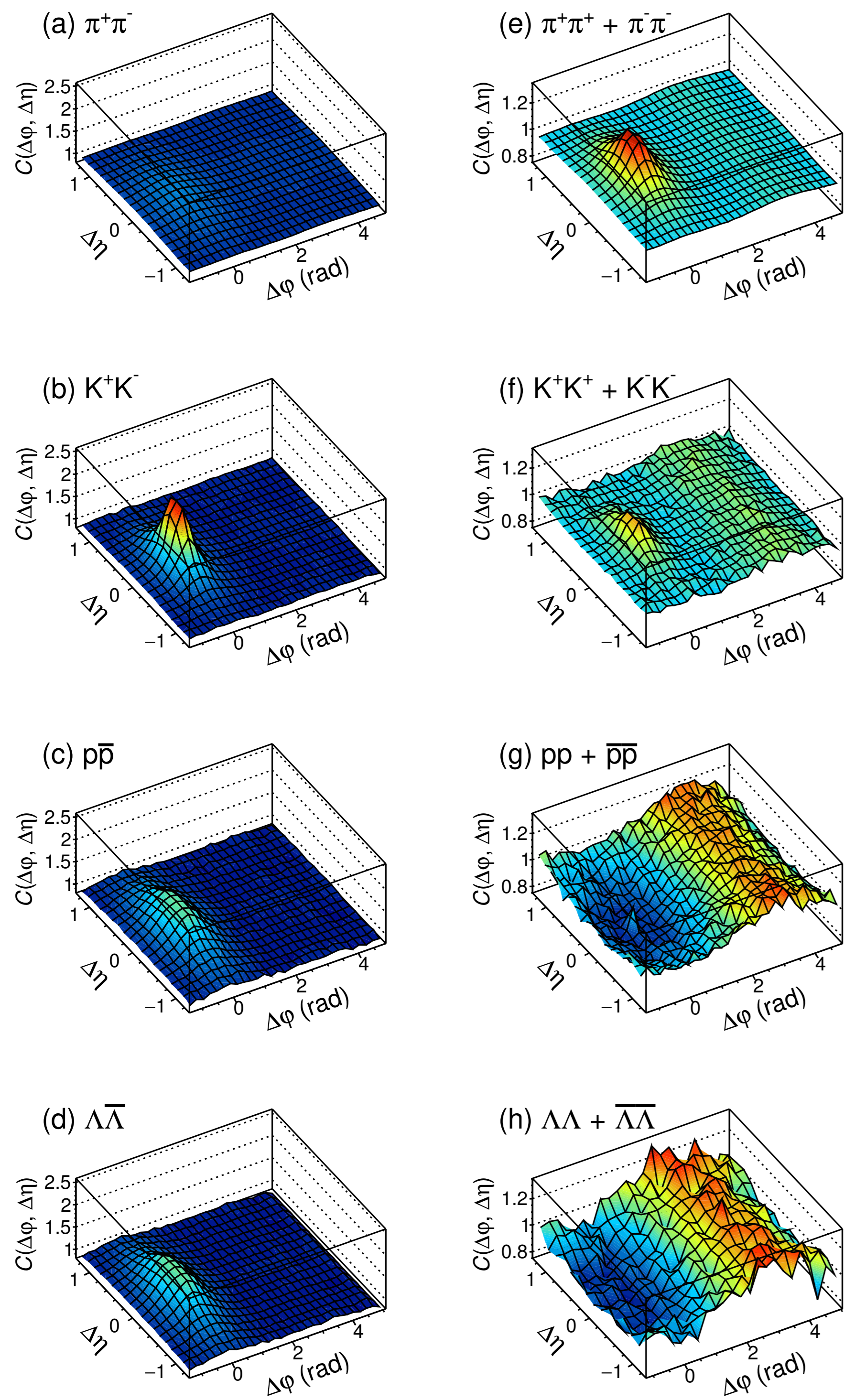
The correlation function C is defined experimentally as:

$$C(\Delta\eta, \Delta\varphi) = \frac{S(\Delta\eta, \Delta\varphi)}{B(\Delta\eta, \Delta\varphi)} \quad (1)$$

- ▶ S (signal) - composed of particle pairs from the same event
- ▶ B (background) - composed of uncorrelated particles; constructed using "mixing" method, normalized to the number of pairs

Correlation functions

ALICE pp $\sqrt{s} = 7\text{TeV}$



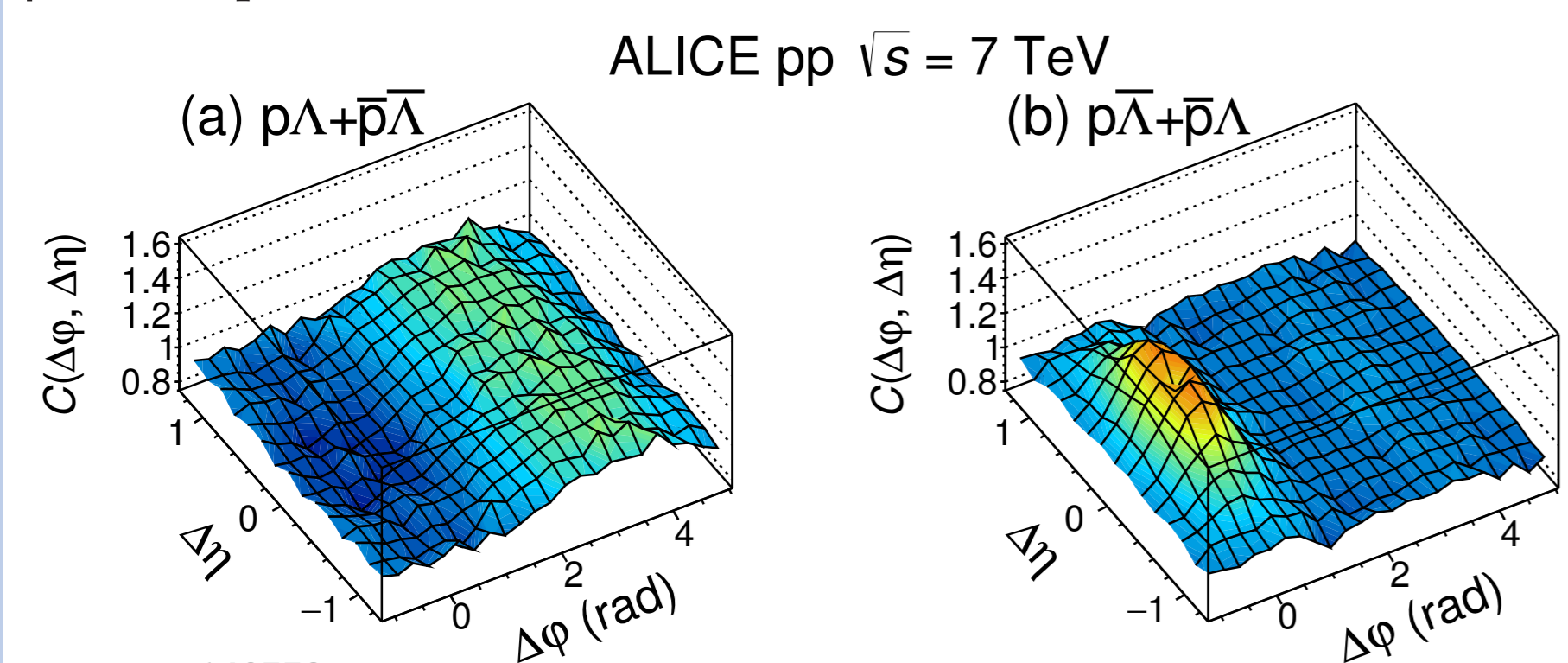
ALI-PUB-140768

Observations

- ▶ Surprising anti-correlation shape in the near-side region for the correlation functions of pairs of baryons with the same baryon number (pp , $p\bar{p}$, $\Lambda\Lambda$, $\Lambda\bar{\Lambda}$).

Correlations of non-identical particles

To compare different configurations of baryon pairs $p\Lambda$, $p\bar{\Lambda}$, $p\bar{\Lambda}$ and $\bar{p}\Lambda$ correlations were measured.



ALI-PUB-140772

- ▶ An anti-correlation is observed for pairs baryon-baryon and anti-baryon-anti-baryon pairs.

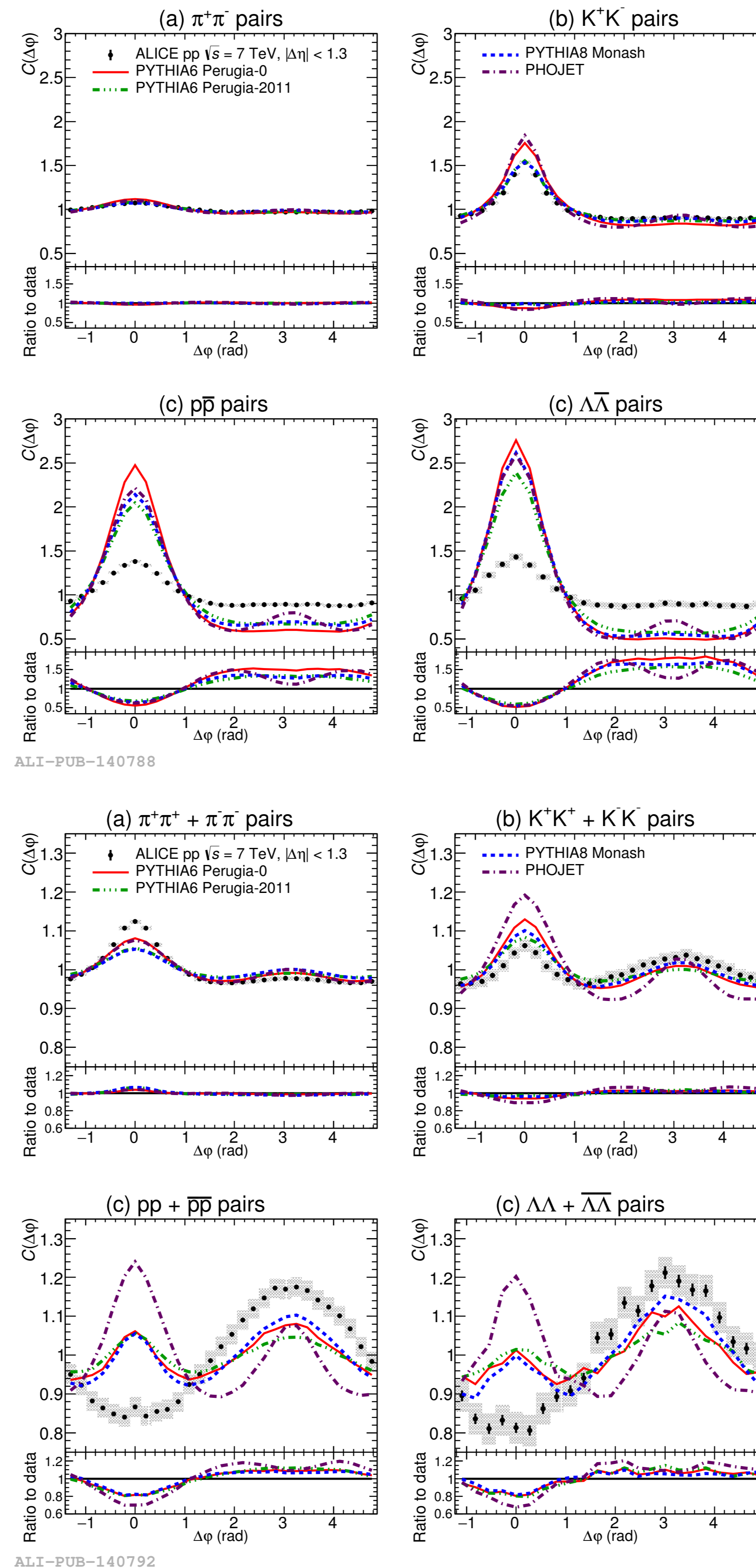
Model comparisons

Studies of Monte Carlo models

The following Monte Carlo models were compared to the ALICE data:

- ▶ Pythia6 Perugia-0, Perugia-2011
- ▶ Pythia8 Monash, 4C
- ▶ PHOJET
- ▶ EPOS-LHC
- ▶ HERWIG
- ▶ Hand-tuning of Pythia6 was also performed

Correlation functions obtained from the Monte Carlo generators are shown below on the projections, overlaid with ALICE data:



ALI-PUB-140788

ALI-PUB-140792

Observations

- ▶ The models reproduce reasonably well the angular correlations for mesons; differences between models and data are well understood (e.g. quantum statistics effects).
- ▶ The models fail to reproduce the results for baryons
- ▶ None of the models reproduce observed anti-correlations.

Bibliography

- ▶ T. Sjöstrand, S. Mrenna, and P.Z. Skands. PYTHIA 6.4 Physics and Manual. *JHEP*, 0605:026, 2006.
- ▶ T. Sjöstrand, S. Mrenna, and P.Z. Skands. A Brief Introduction to PYTHIA 8.1. *Comput. Phys. Commun.*, 178:852-867, 2008.
- ▶ A. Capella, U. Sukhatme, C.I. Tan, and J. Tran Thanh Van. Dual parton model. *Phys.Rept.*, 236:225-329, 1994.
- ▶ T. Pierog, others. EPOS LHC : test of collective hadronization with LHC data. *Phys. Rev. C92*, 034906, 2015.
- ▶ G. Corcella et al. HERWIG 6.5: an event generator for Hadron Emission Reactions With Interfering Gluons. *JHEP*, 01, 010, 2001.

Possible explanations of baryon-baryon anti-correlation

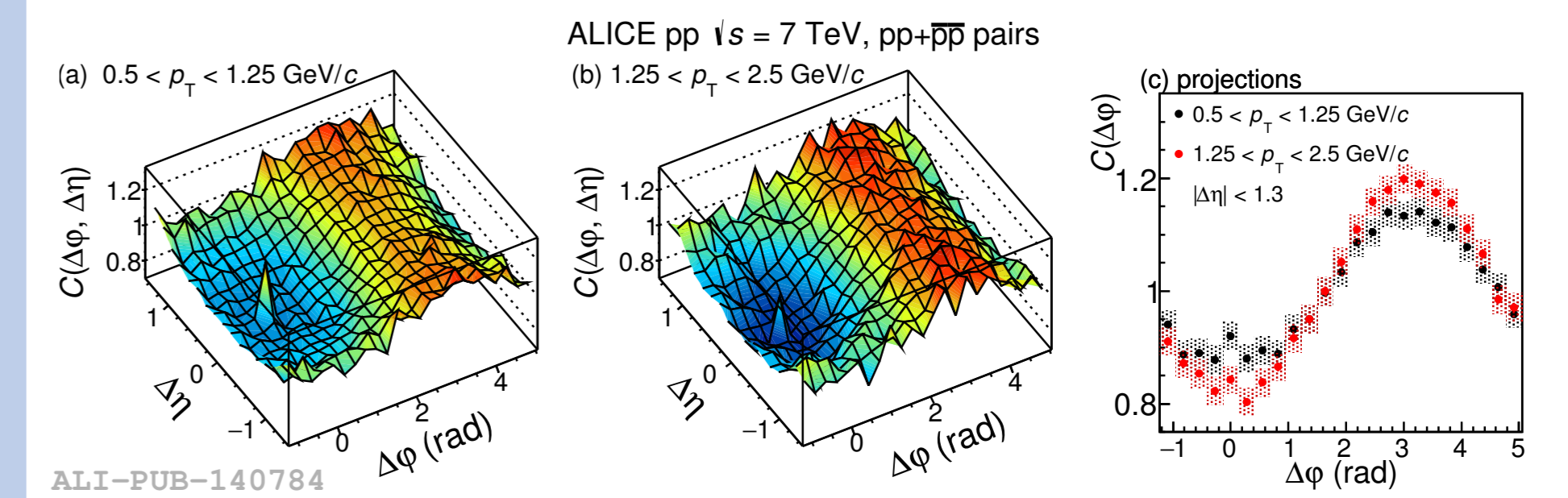
Energy and local baryon-number conservation laws are implemented in all studied models - not enough to explain the anti-correlation observed in experimental data

Checks considered:

- ▶ p_T regime of the results
- ▶ Coulomb repulsion
- ▶ Fermi-Dirac quantum statistics
- ▶ final state interactions (FSI)

Momentum regime

Does the momentum range influence observed anti-correlation? Analysis was performed for two separate p_T ranges.



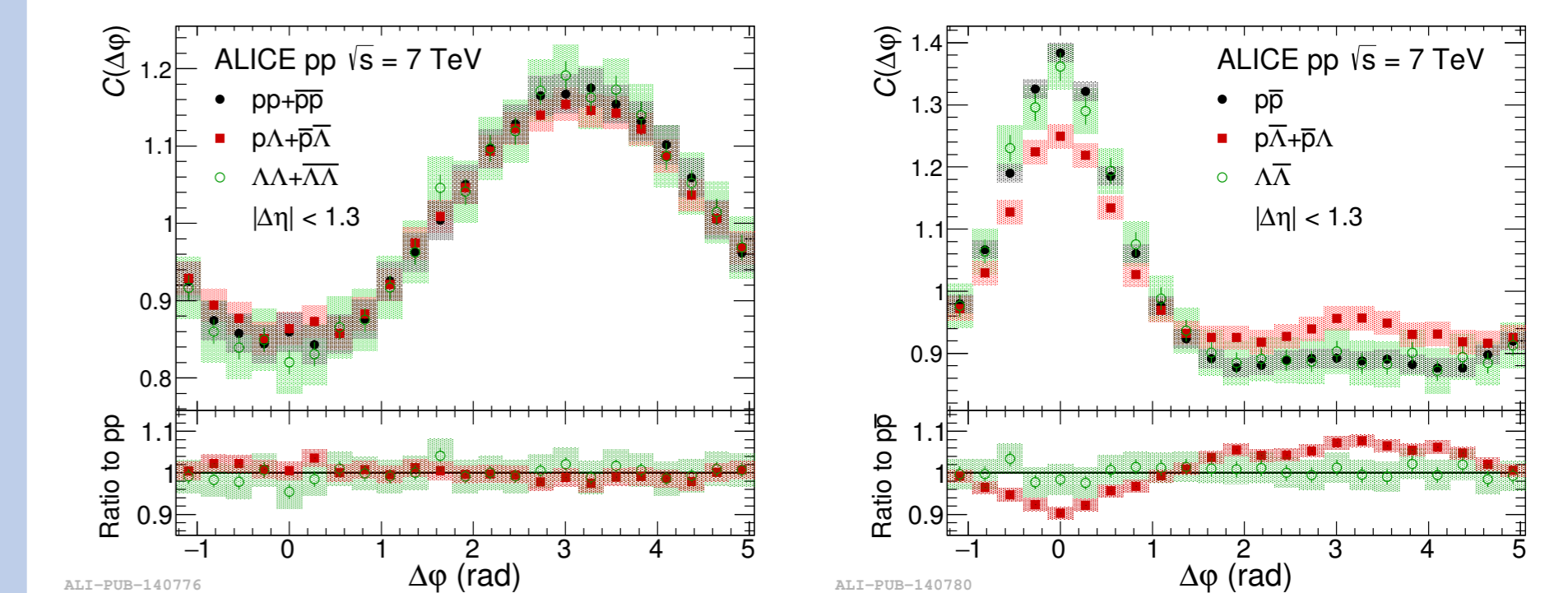
- ▶ Anti-correlation even stronger for higher p_T .

Coulomb repulsion

Λ baryons are neutral - no Coulomb repulsion

- ▶ Coulomb repulsion plays marginal role in shaping $(\Delta\eta, \Delta\varphi)$ correlation functions.

Fermi-Dirac quantum statistics p and Λ are not identical: no effect from Fermi-Dirac statistics

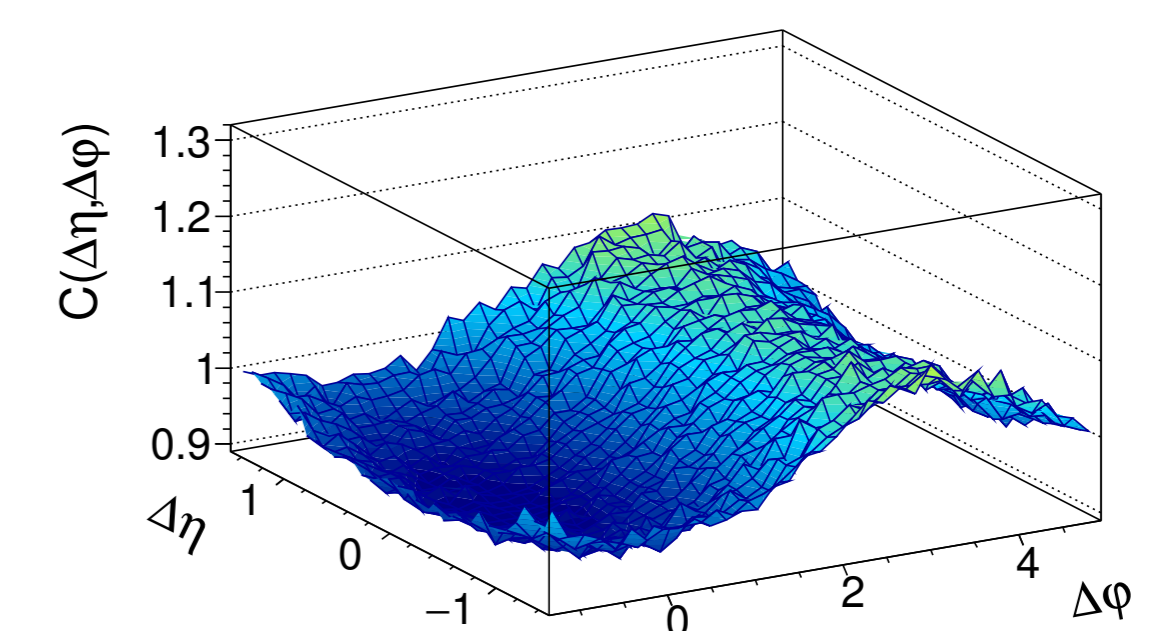


- ▶ All observations from pp and $\Lambda\Lambda$ can be extended to $p\Lambda$
- ▶ Correlation functions for pp , $\Lambda\Lambda$, $p\Lambda$ identical within uncertainties
- ▶ No difference between pp and $p\Lambda$: no strong indication of quantum statistics influence

Final-State Interactions

- ▶ Final-State Interactions (FSI) produce positive correlation
- ▶ Small spike visible in the pp correlation function is the effect coming from FSI

Momentum conservation



- ▶ Correlation function obtained from toy model (including **only** momentum conservation laws) qualitatively reproduces structures observed for like-sign protons in ALICE data

Conclusions

- ▶ Significant depression at $(\Delta\eta, \Delta\varphi) = (0, 0)$ is observed for the baryon-baryon and anti-baryon-anti-baryon pairs, which is not seen for mesons nor for baryon-anti-baryon pairs.
- ▶ This depression is not reproduced by Monte Carlo models.
- ▶ Strong suppression of baryon production in jets?
 - ▶ The fragmentation mechanisms employed in models are incomplete.
 - ▶ This would suggest that some additional, unidentified mechanism must exist; such a mechanism would suppress the production of more than one baryon-anti-baryon pair during a single fragmentation process.