



Motivation

Quantum numbers conserved in heavy-ion collisions

– Balance function measures correlations between balancing pairs of hadrons, giving insight into the production of charge, strangeness, baryons, etc., and their transport mechanisms [1].

Previous measurements of charge balance function

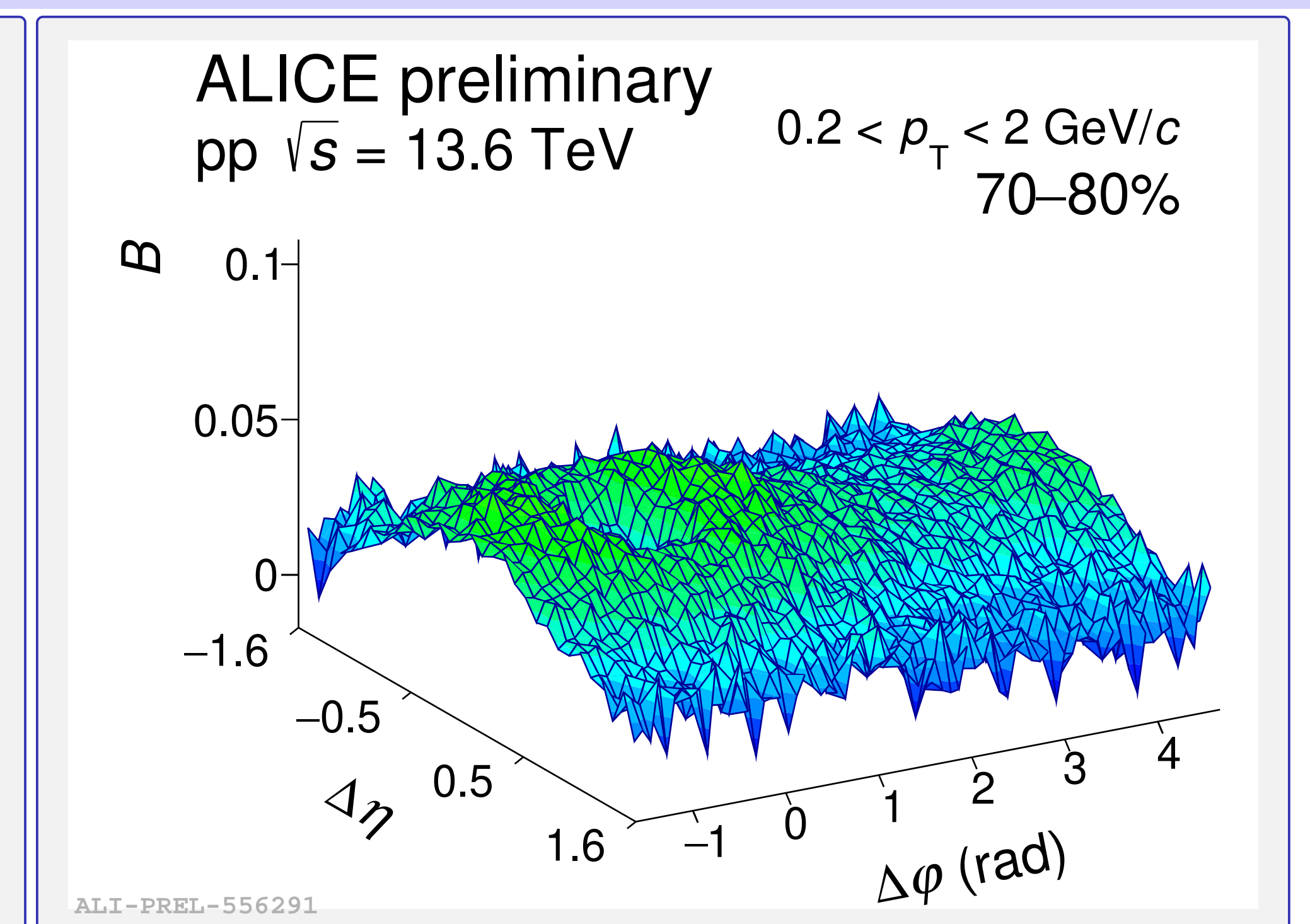
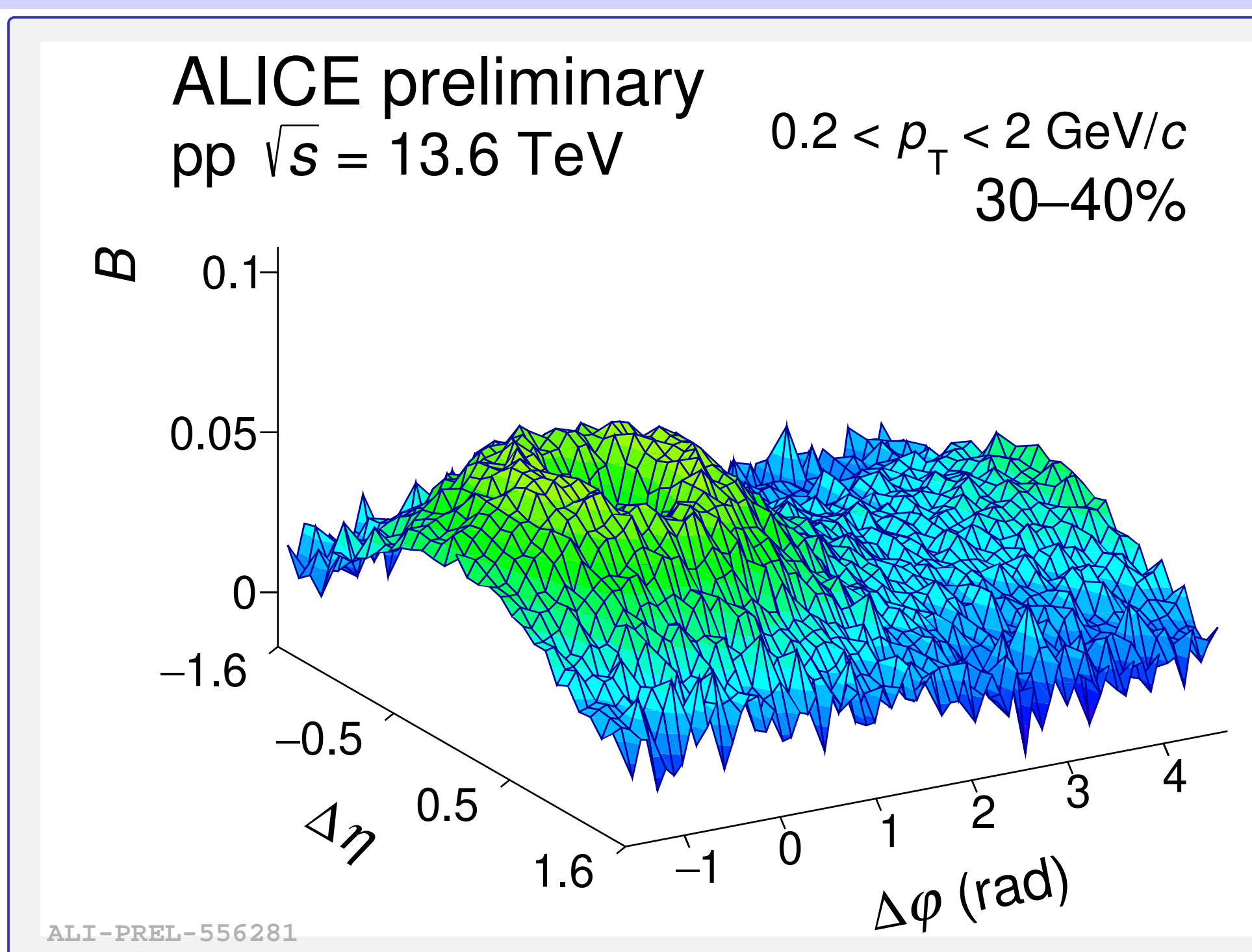
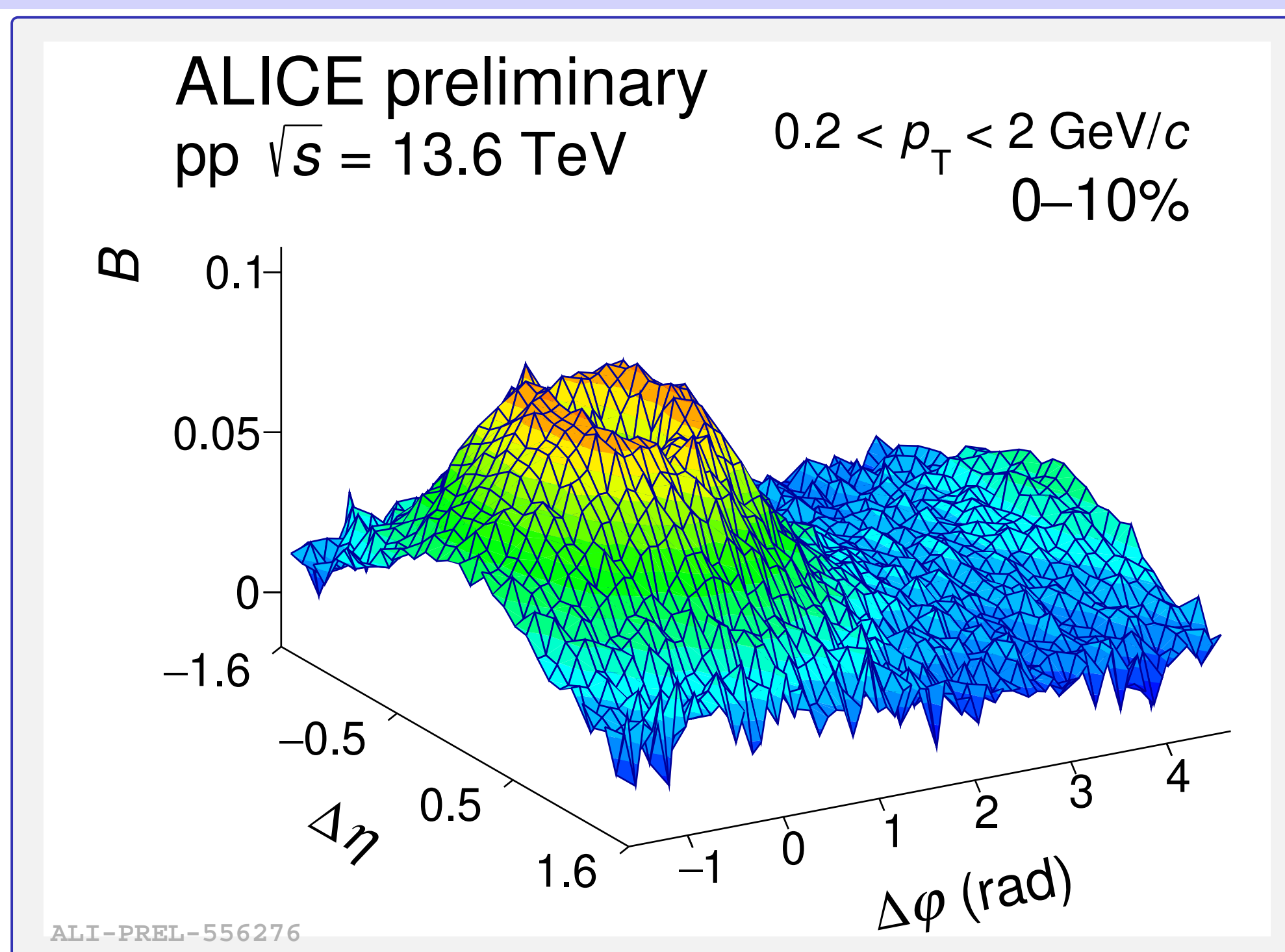
– Balance function is sensitive to delayed hadronization and two stages of quark production, the diffusivity of light quarks, and the charge susceptibility of QGP [2].
– Balance function longitudinal and azimuthal widths and their integrals evolve with collision energy, system size, and multiplicity [3, 4].

Balance function

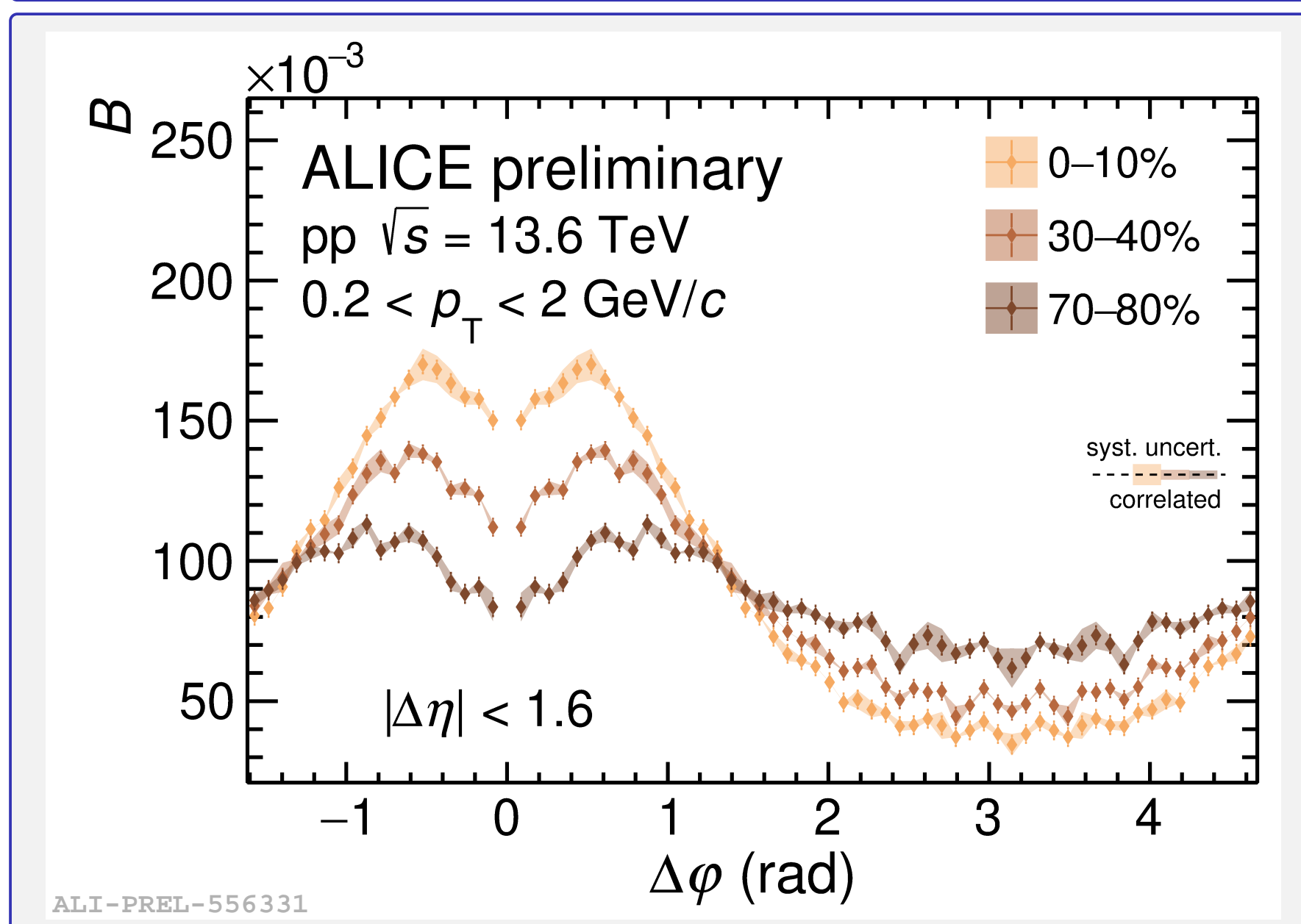
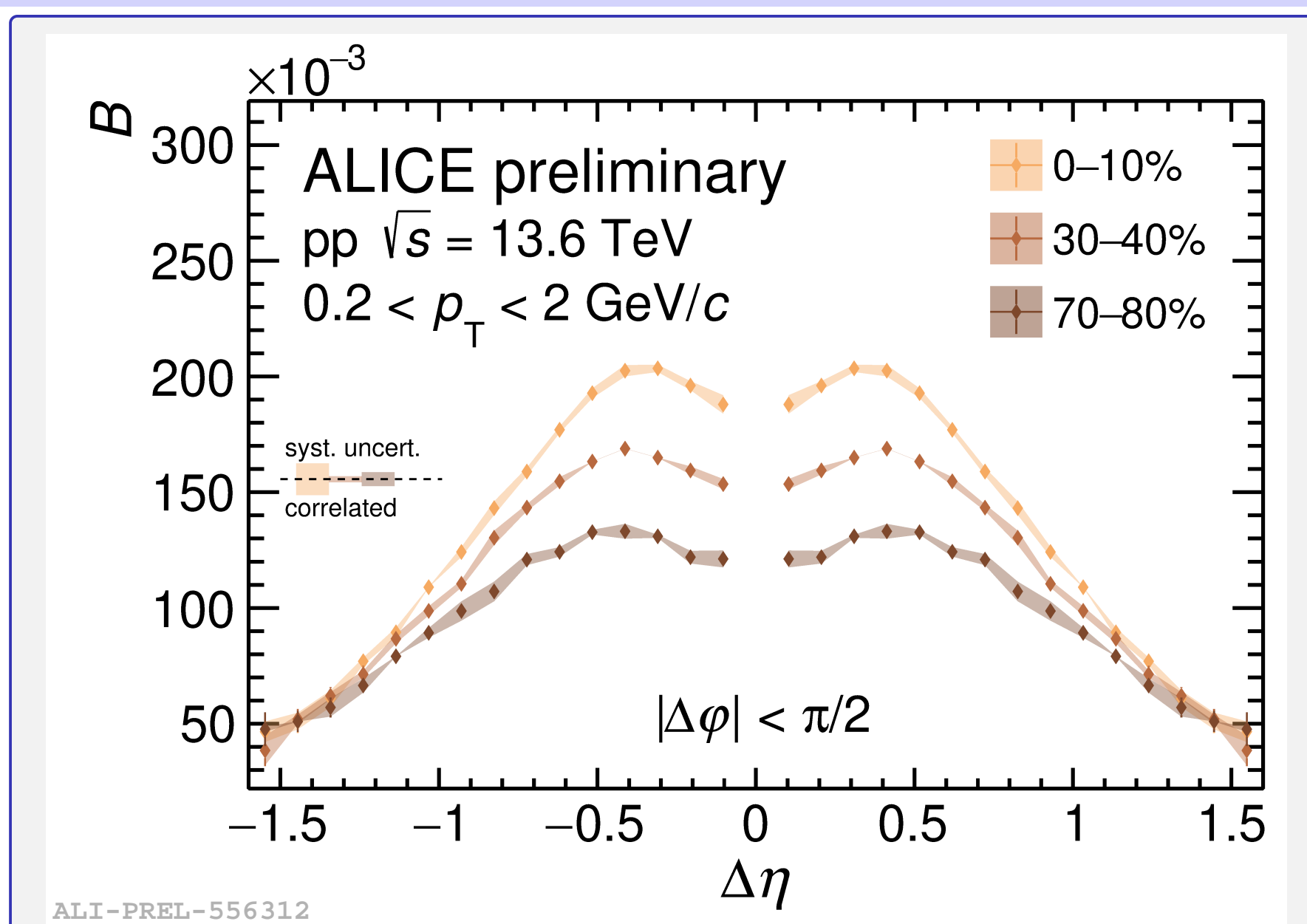
$$B^{\alpha\beta}(\Delta\eta, \Delta\varphi) = \frac{1}{2} \left\{ \rho_1^{\bar{\beta}} \left[R_2^{\alpha\bar{\beta}} - R_2^{\bar{\alpha}\bar{\beta}} \right] + \rho_1^{\beta} \left[R_2^{\bar{\alpha}\beta} - R_2^{\alpha\beta} \right] \right\}$$

$$R_2^{\alpha\beta} = \frac{\rho_2^{\alpha\beta}}{\rho_1^{\alpha} \rho_1^{\beta}} - 1 \quad \left\{ \begin{array}{l} \rho_2^{\alpha\beta} = \frac{d^2 N^{\alpha\beta}}{d\Delta\eta d\Delta\varphi} \\ \rho_1^{\alpha} = \frac{d^2 N^{\alpha}}{d\eta d\varphi} \end{array} \right.$$

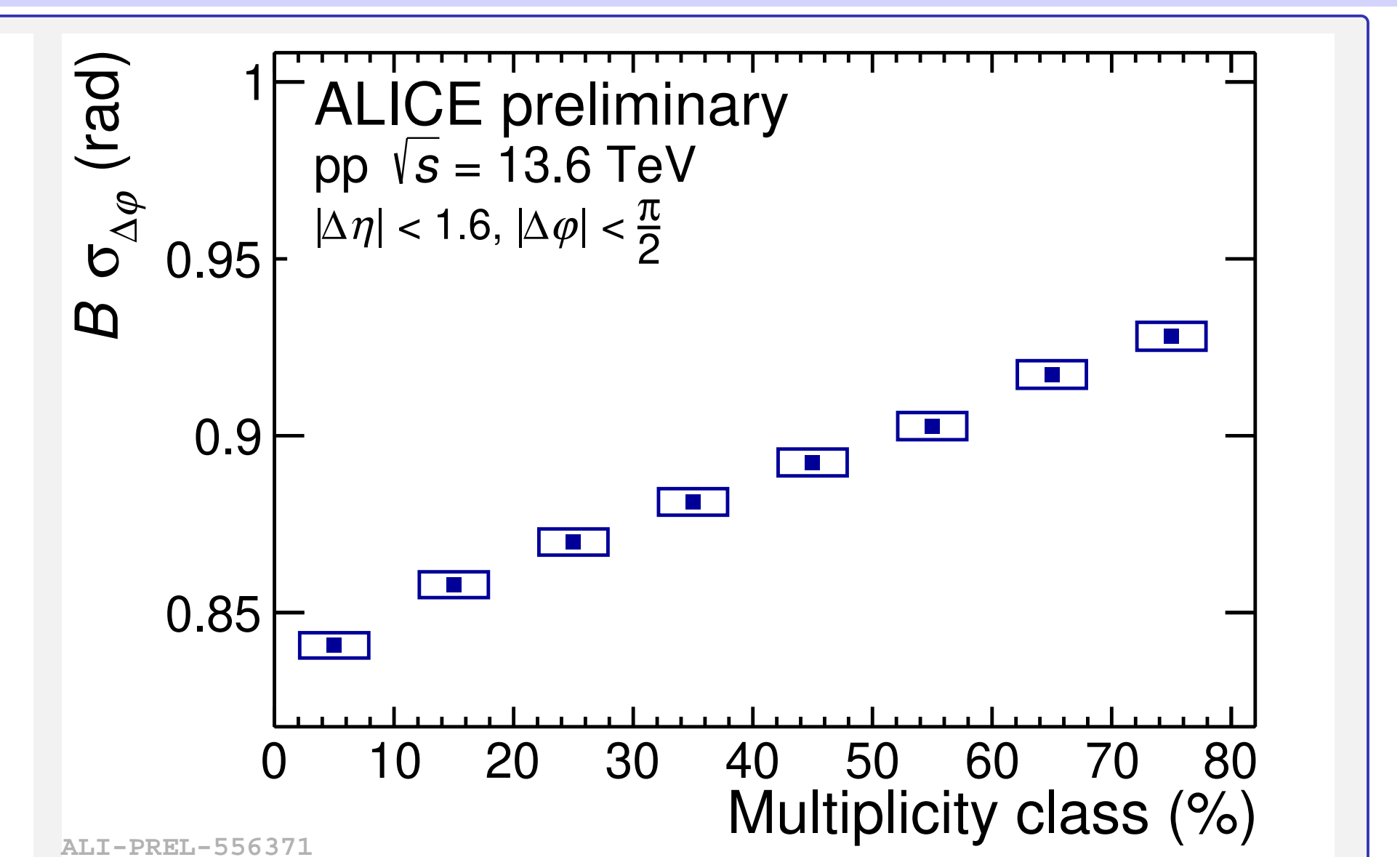
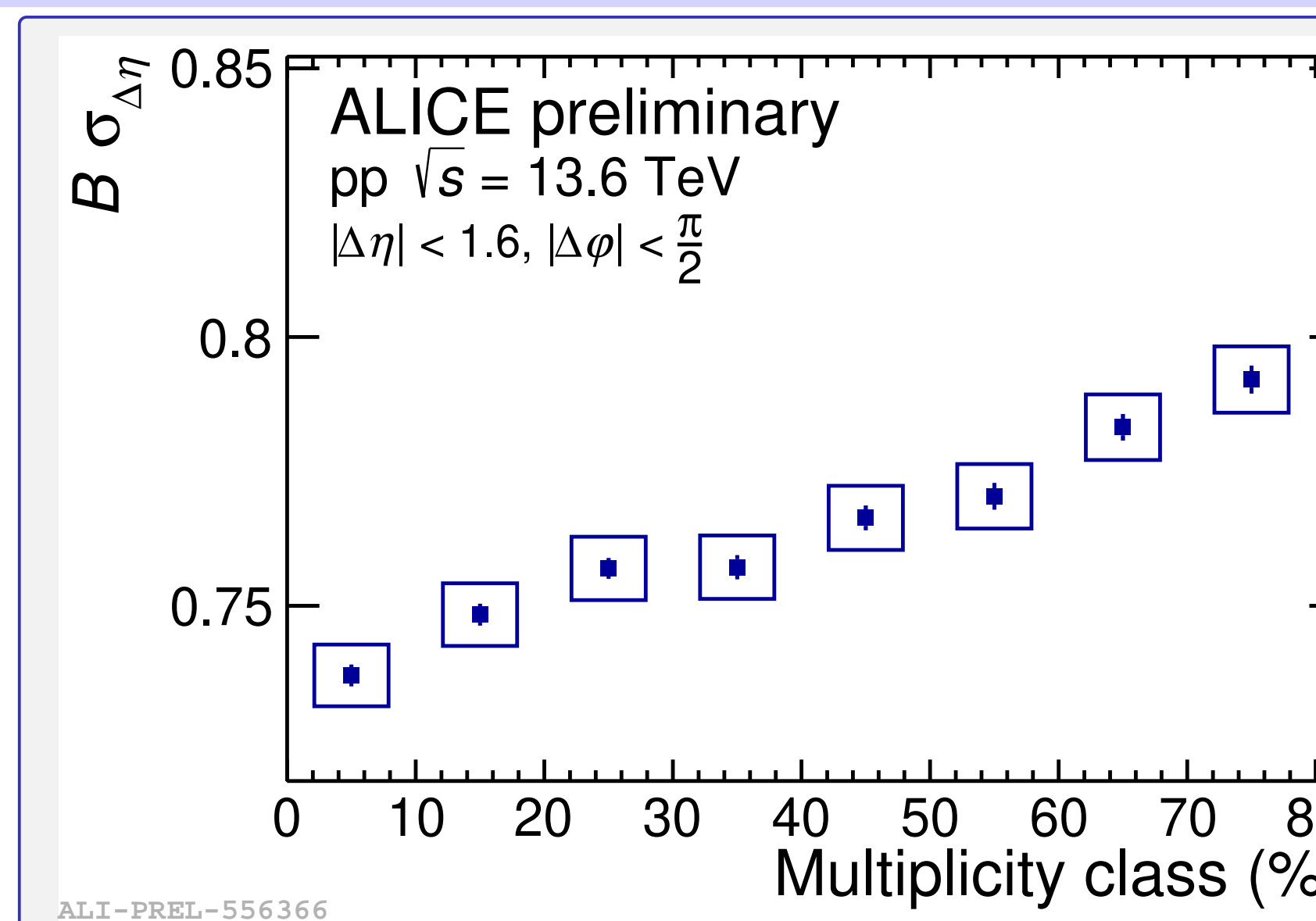
Charge balance function B of unidentified particles



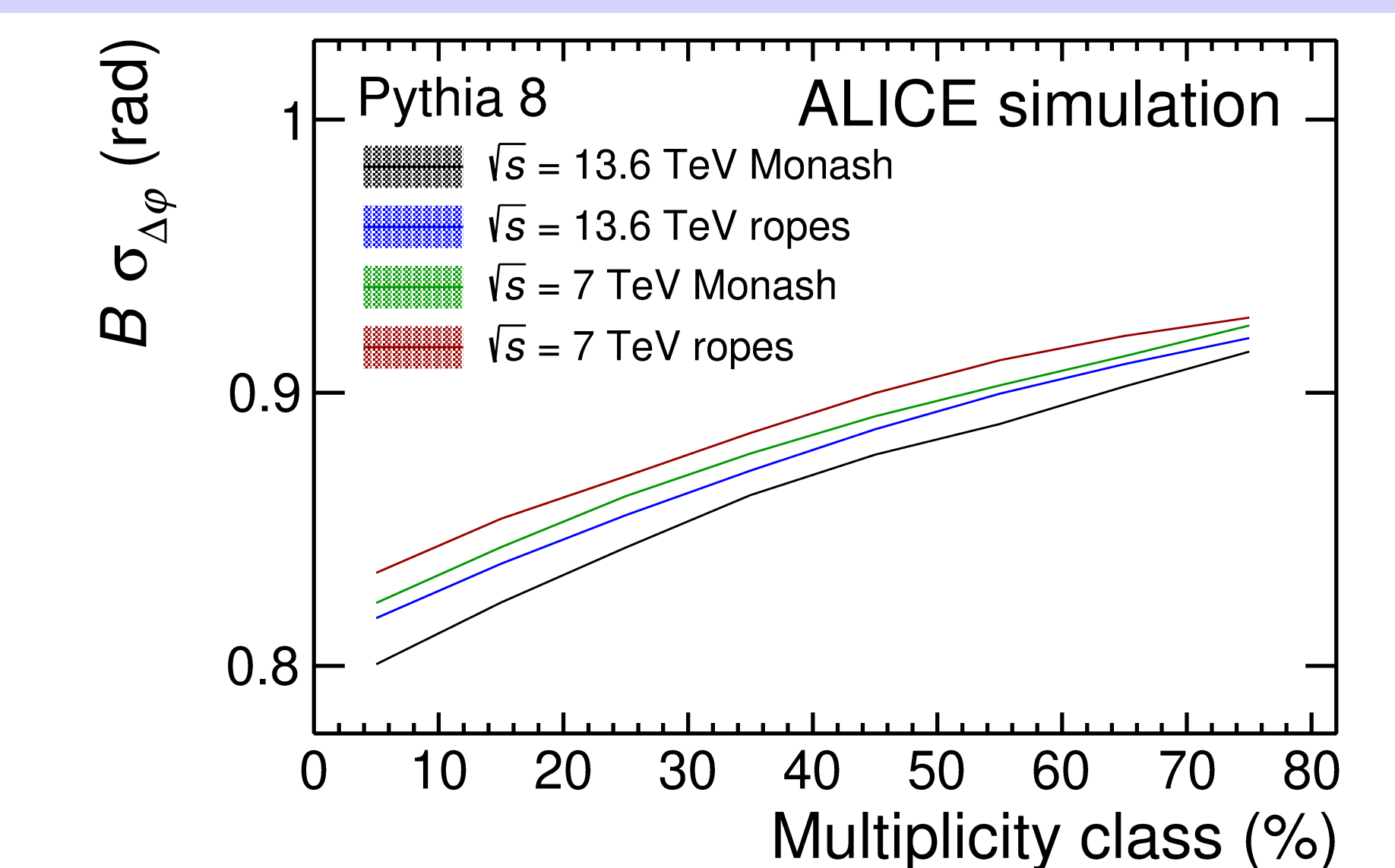
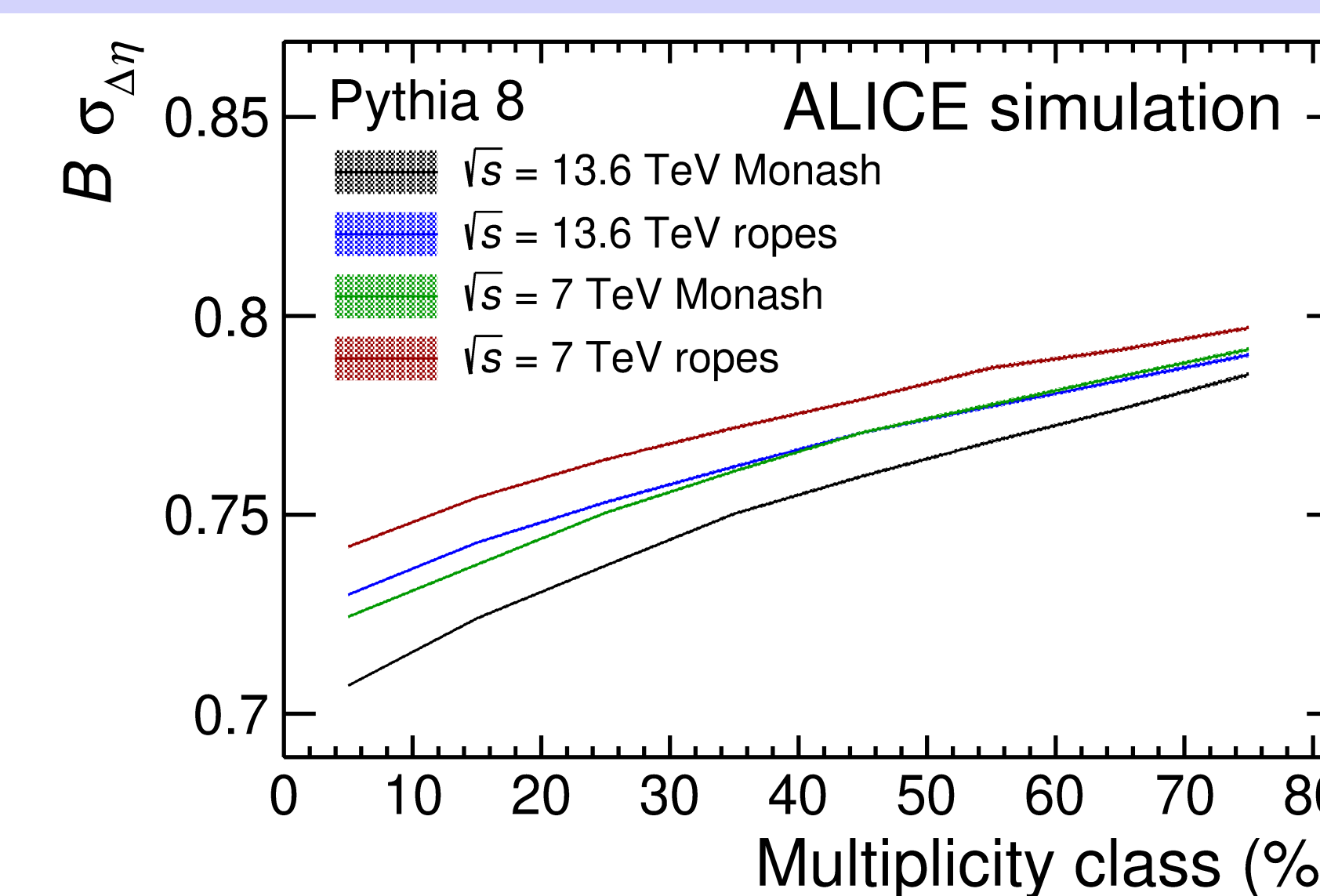
B evolution



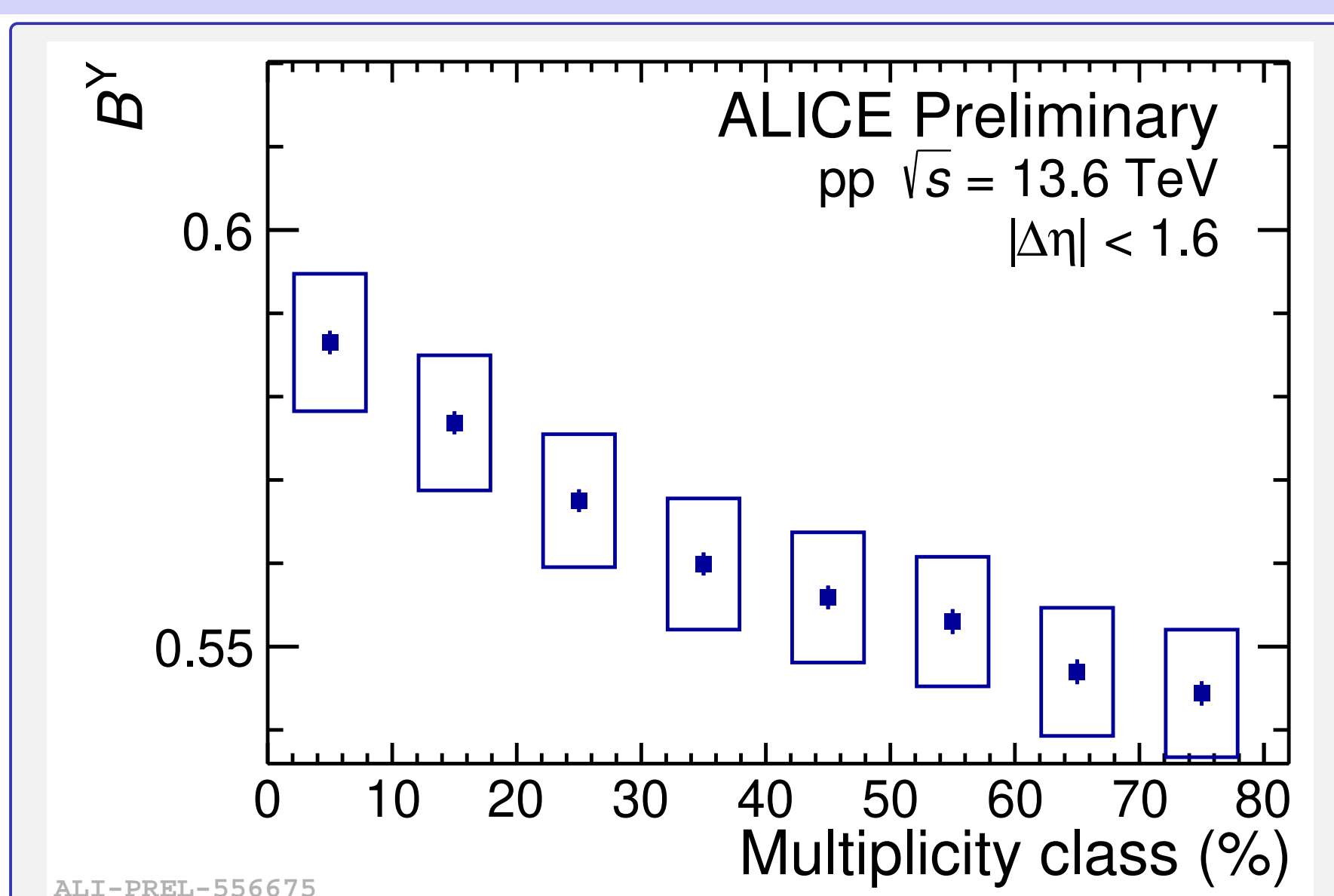
Near-side peak widths evolution



Widths evolution from Pythia 8



B integral



Conclusions

- B narrowing with increasing multiplicity:
 - about 7% along $\Delta\eta$ and 9% along $\Delta\varphi$,
 - consistent with the overall presence of radial flow,
 - trends reproduced by Pythia 8.

- Outlook:
 - balance function of identified particles,
 - charge balance across species,
 - strangeness balance.

Bibliography

- [1] Claude Pruneau, Sumit Basu, Victor Gonzalez, Brian Hanley, Ana Marin, Alexandru F. Dobrin, and Alexandru Manea. Mixed Species Charge and Baryon Balance Functions Studies with PYTHIA. *Accepted by PRC, arXiv:2403.13007*.
- [2] Scott Pratt and Christopher Plumberg. Charge balance functions for heavy-ion collisions at energies available at the CERN Large Hadron Collider. *Phys. Rev. C*, 104(1):014906, 2021.
- [3] ALICE Collaboration. Multiplicity and transverse momentum evolution of charge-dependent correlations in pp, p-Pb, and Pb-Pb collisions at the LHC. *Eur. Phys. J. C*, 76(2):86, 2016.
- [4] ALICE Collaboration. General balance functions of identified charged hadron pairs of (π, K, p) in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV. *Phys. Lett. B*, 833:137338, 2022.