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Clocking the particle production and tracking radial flow effects at top LHC Run 3 energy with ALICE





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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

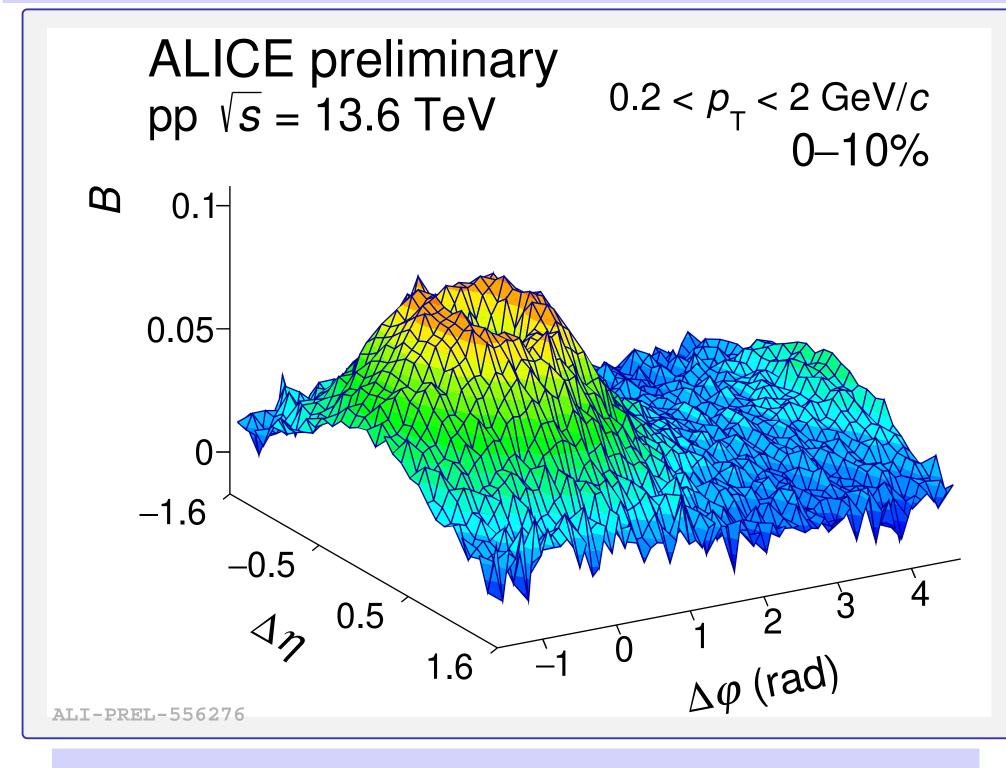
- Balance function is sensitive to delayed hadronization and two stages of quark production, the diffusivity of light quarks, and the charge susceptibility of QGP [2].
- Balance function longitudinal and azimuthal widths and their integrals evolve with collision energy, system size, and multiplicity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

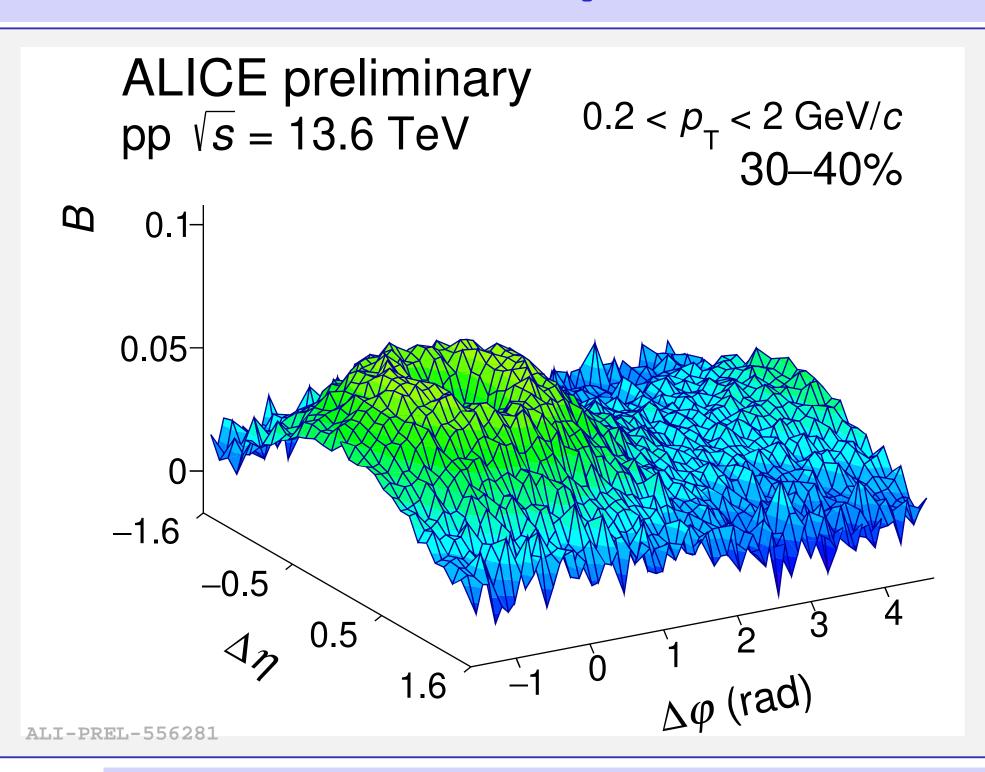
Balance function

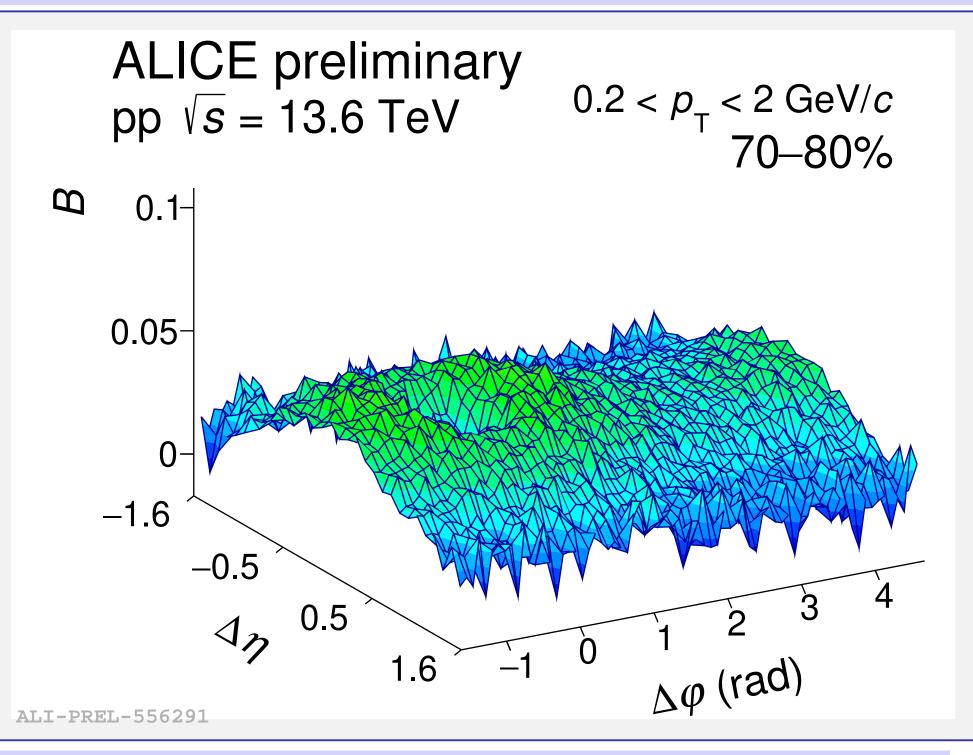
$$B^{lphaeta}\left(\Delta\eta,\Deltaarphi
ight)=rac{1}{2}\left\{
ho_{1}^{ar{eta}}\left[R_{2}^{lphaar{eta}}-R_{2}^{ar{lpha}ar{eta}}
ight]+
ho_{1}^{eta}\left[R_{2}^{ar{lpha}eta}-R_{2}^{lphaeta}
ight]
ight\}$$

$$R_2^{lphaeta} = rac{
ho_2^{lphaeta}}{
ho_1^{lpha}
ho_1^{eta}} - 1 \qquad \left\{egin{array}{c}
ho_2^{lphaeta} = rac{\mathrm{d}^2N^{lphaeta}}{\mathrm{d}\Delta\eta\,\mathrm{d}\Deltaarphi} \
ho_1^{lpha} = rac{\mathrm{d}^2N^{lpha}}{\mathrm{d}\eta\,\mathrm{d}arphi} \end{array}
ight.$$

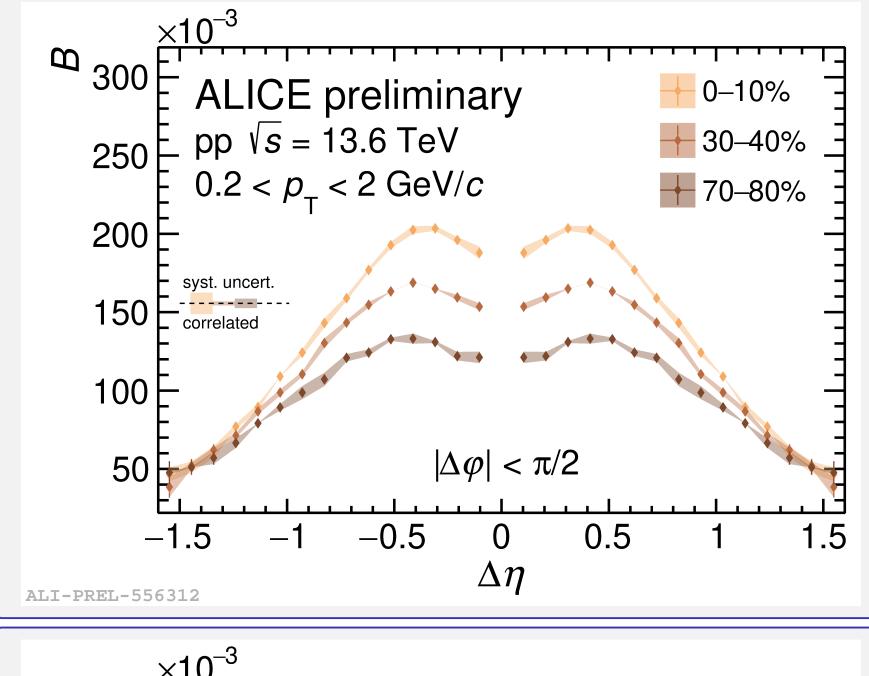
Charge balance function \boldsymbol{B} of unidentified particles

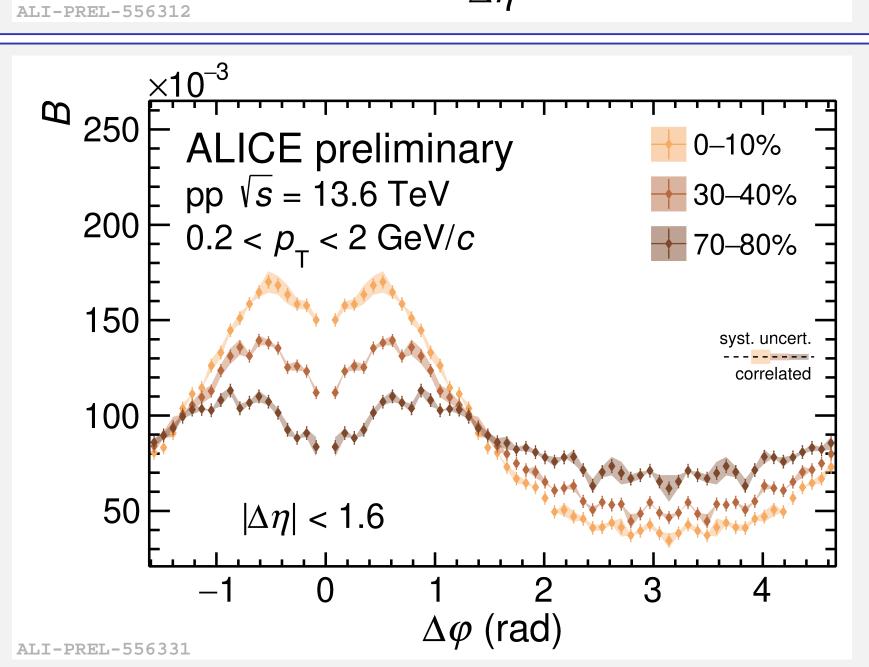




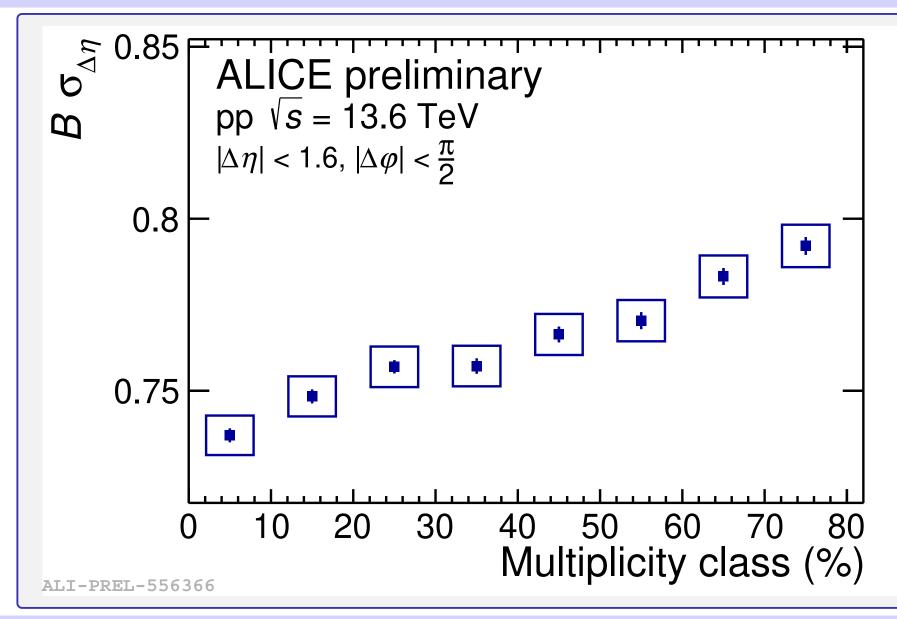


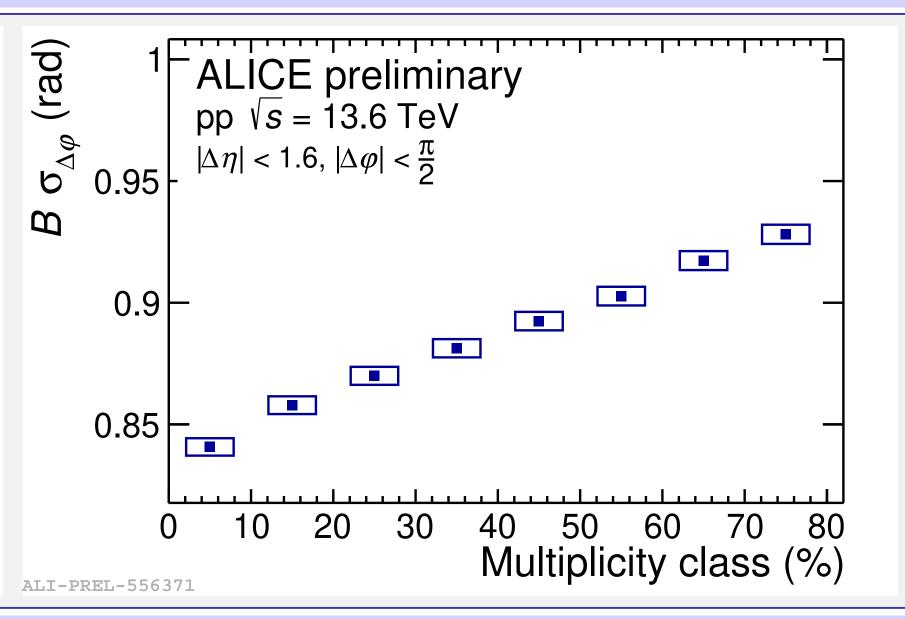
$oldsymbol{B}$ evolution



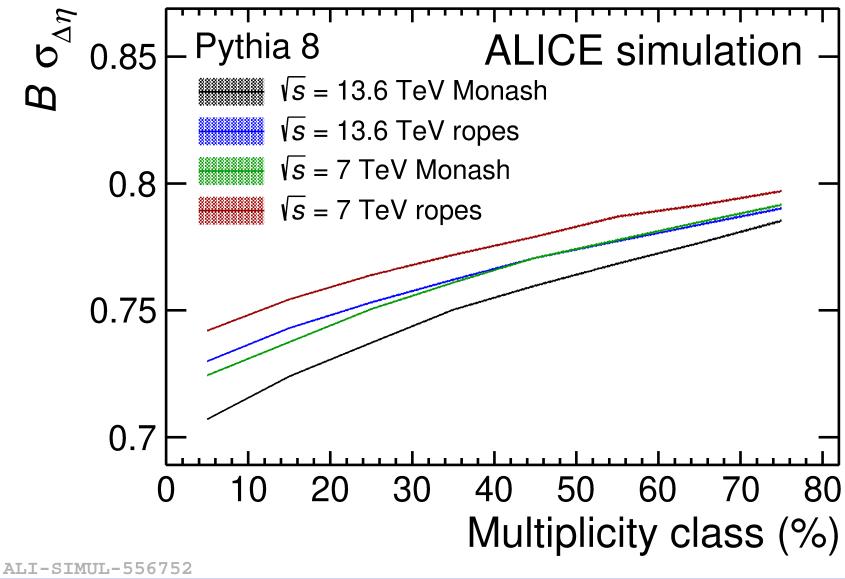


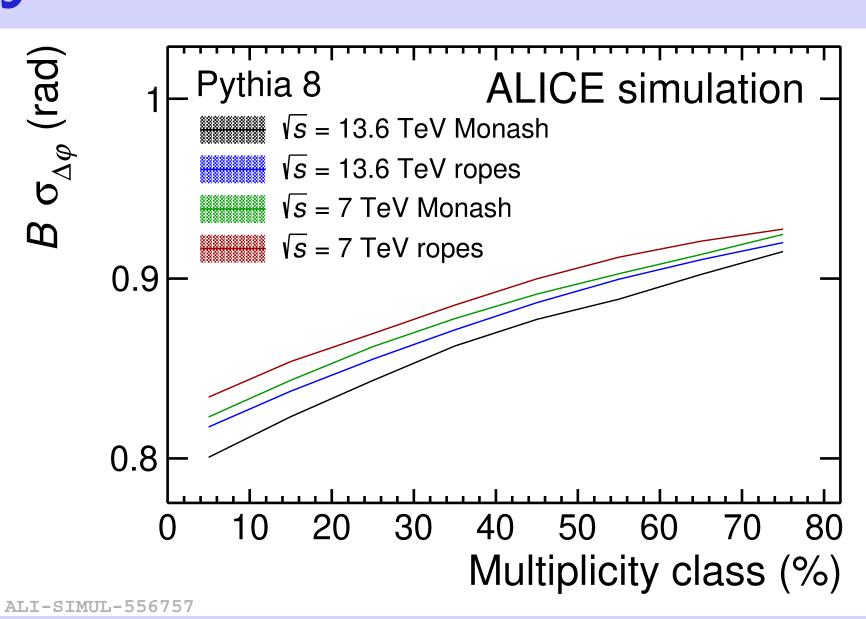
Near-side peak widths evolution



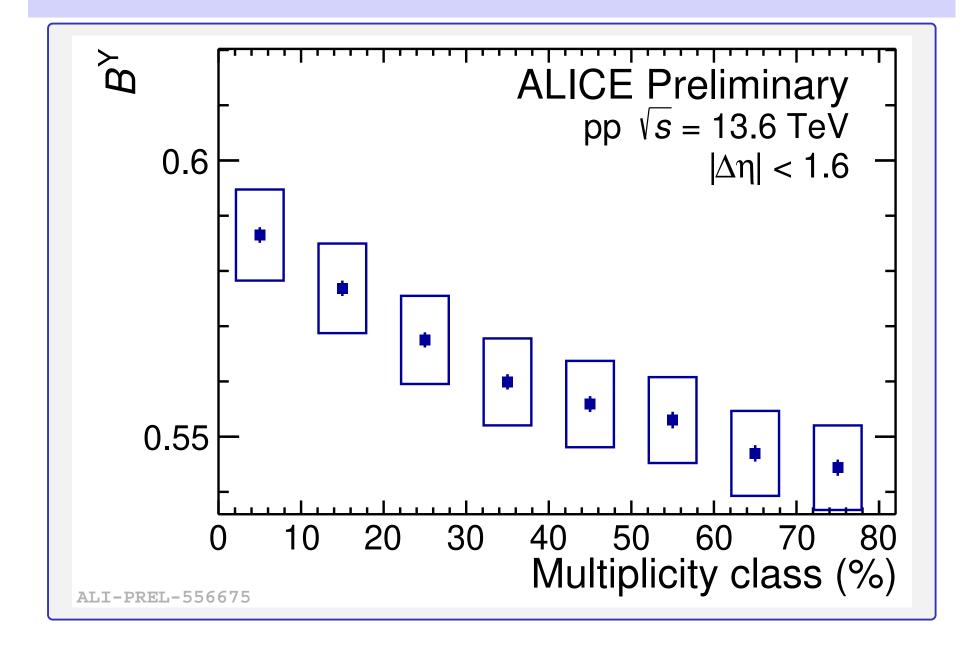


Widths evolution from Pythia 8





\boldsymbol{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 $\sqrt{s_{\mathrm{NN}}} = 2.76$ TeV. *Phys. Lett. B*, 833:137338, 2022.