Deciphering the Charge Production Dynamics with General Charge Balance Functions at $\sqrt{s_{NN}}$ = 2.76 TeV at ALICE

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Abstract: *The two-wave quark production scenario can be investigated experimentally by measurements of balance functions of identified particle pairs[1]. In this scenario, quark-antiquark pairs produced in the earlier stages of the collision are pulled apart due to collective effects, while pairs produced during hadronization are unlikely to separate. We present measurements of such balance functions based on an analysis of data acquired at the Large Hadron Collider (LHC) by the ALICE detector. Balance functions have been measured for identified charged-pion pairs in Pb-Pb collisions at $\sqrt{s_{NN}}$ = 2.76 TeV. These balance functions are presented in relative rapidity Δy and relative azimuthal angle Δφ. We observe that charged-pion balance function widths in terms of Δy and Δφ are narrower in central Pb-Pb collisions compared to peripheral collisions. In addition, a comparison between the balance functions of charged-pions and unidentified charged particles will be shown.*

Methodology for determination of Balance Functions Observable

The BF is defined as the difference of the correlation function of oppositely and same charged particles normalised to the total number of trigger particles. The balance function is defined as

$$B = \frac{1}{2}\left[\frac{\langle N_{(a,b)}\rangle - \langle N_{(a,a)}\rangle}{\langle N_a\rangle} + \frac{\langle N_{(b,a)}\rangle - \langle N_{(b,b)}\rangle}{\langle N_b\rangle}\right]$$ where a and b could be different kinds of particles.

- Here $N_{i,j}$ counts pairs within opposite charge that satisfy the criteria that their relative rapidity(pseudo-rapidity) or azimuthal angle is within some range
- N_i is the number of positive or negative particles in the same interval. Here the angular bracket represents averaging over the events..
- Balance Functions definition reads.

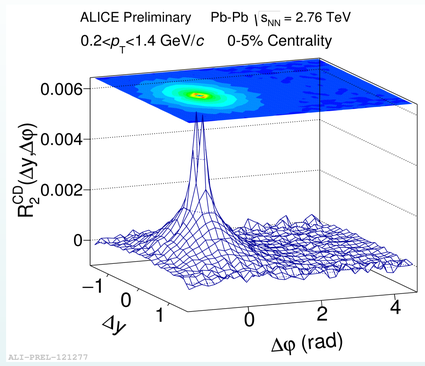
$$B(\Delta\eta, \Delta\varphi, p_{\mathrm{T,trig}}, p_{\mathrm{T,assoc}}) = C_{+,-}(\Delta\eta, \Delta\varphi, p_{\mathrm{T,trig}}, p_{\mathrm{T,assoc}}) + C_{-,+} - C_{+,+} - C_{-,-}$$

Where C is defined as $$C_{a,b}(\Delta\eta, \Delta\varphi) = \frac{\langle N^{corr}_{(a,b)}(\Delta\eta, \Delta\varphi)\rangle}{\langle N^{corr}_{a}(p_{\mathrm{T,trig}})\rangle}$$

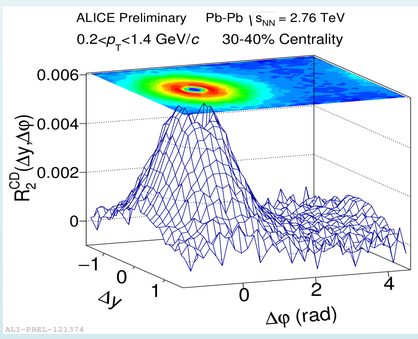
- each of the terms of above equation is corrected for single particle inefficiencies on a track-by-track basis extracted from Monte Carlo simulations

Results -- Pion Balance Function

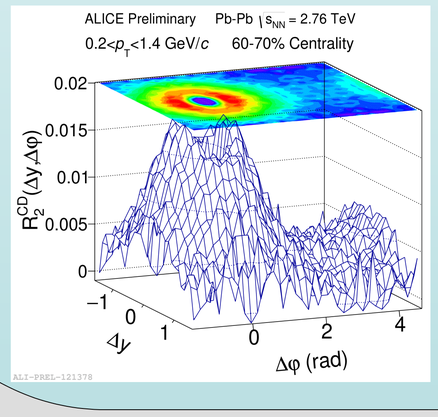
BF 2D Plot : 0-5 % Centrality

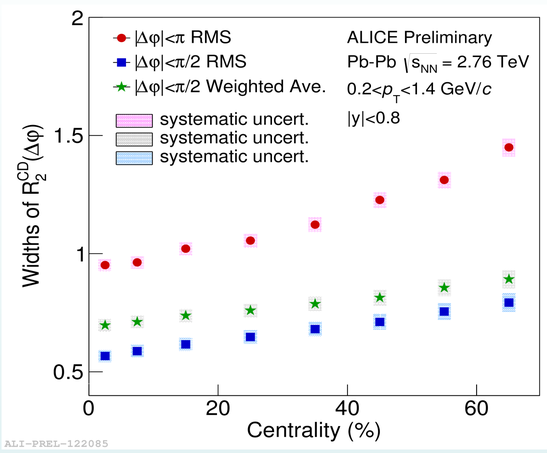


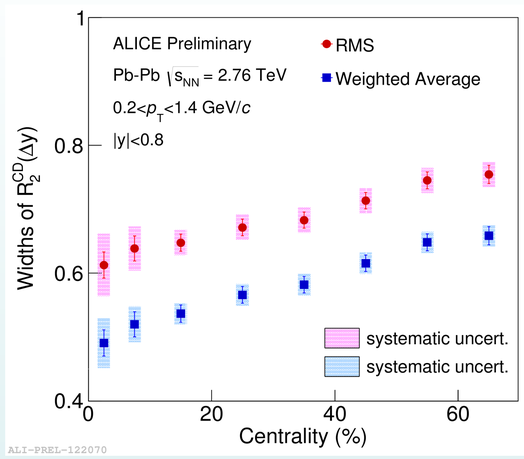
BF 2D Plot : 30-40 % Centrality



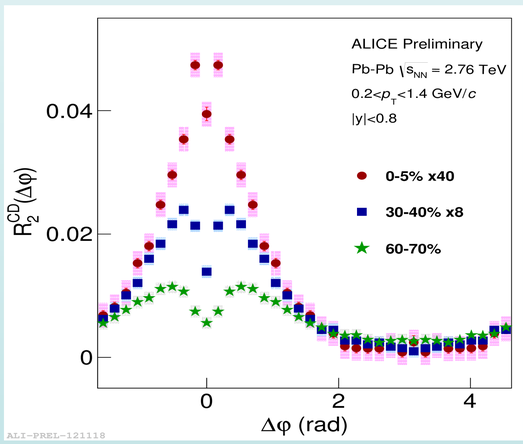
BF 2D Plot : 60-70 % Centrality

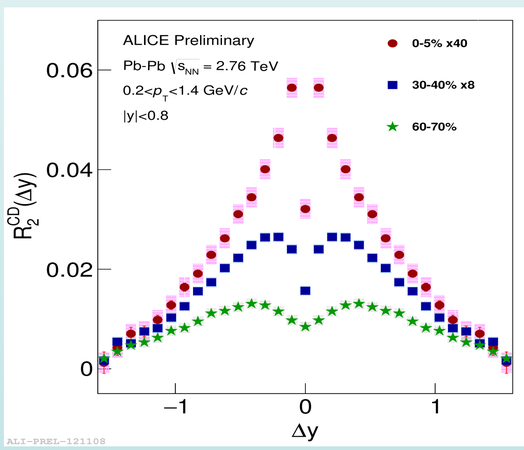






- The centrality dependence of the width of the balance function Δφ(Left Plot) and Δy(Right Plot) for 0.2<p_T< 1.4 GeV/*c*





- Projection of 2D Plots along Δy and Δφ
- Projection along Δy for |Δφ| <π/2
- Projection along Δφ for |Δy| <1.6

Summary and Conclusion

- The widths of the balance functions in Δy and Δφ, are found to decrease when moving from peripheral to central collisions.
- By studying Balance functions of several hadronic species, and calculating width of BF, one can gain insight into the chemical evolution of the QGP and radial flow.
- Detailed model studies of the balance functions of identified particles are ongoing

Reference

[1] Scott Pratt, Phys. Rev. Lett. 108, 212301 (2012); Scott Pratt, Phys. Rev. C 85, 014904 (2012);