Measurements of charge-dependent correlations with CMS

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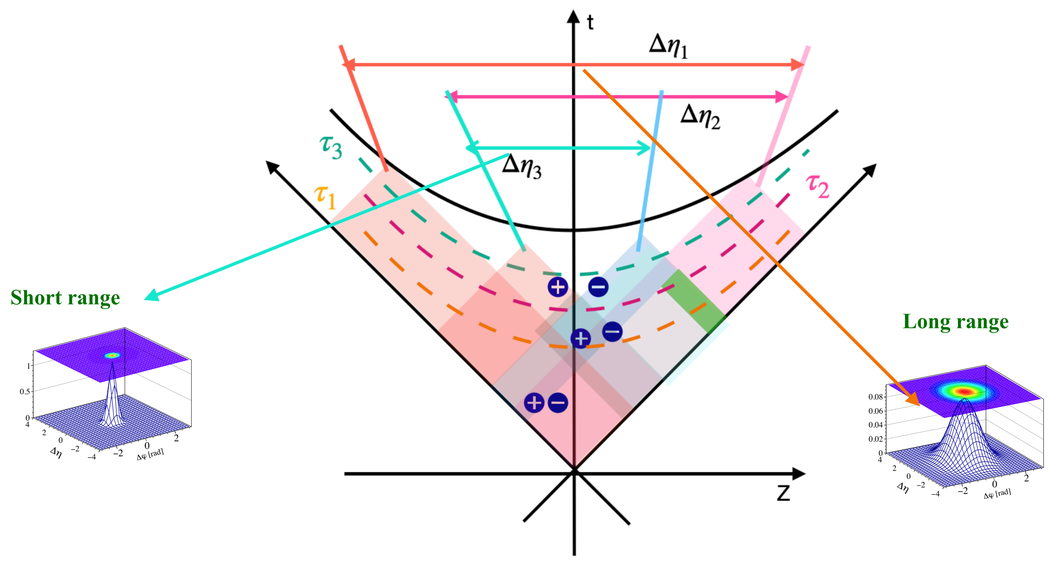
Introduction

- Law of nature "charge is conserved"
- The longitudinal width of the correlation is related to time the correlation is established.
- Early time charge separation ⟶ should be long range in $\Delta\eta$



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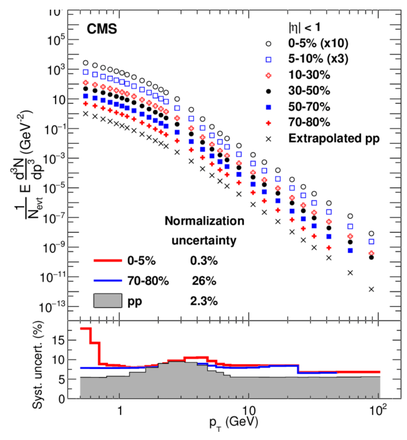
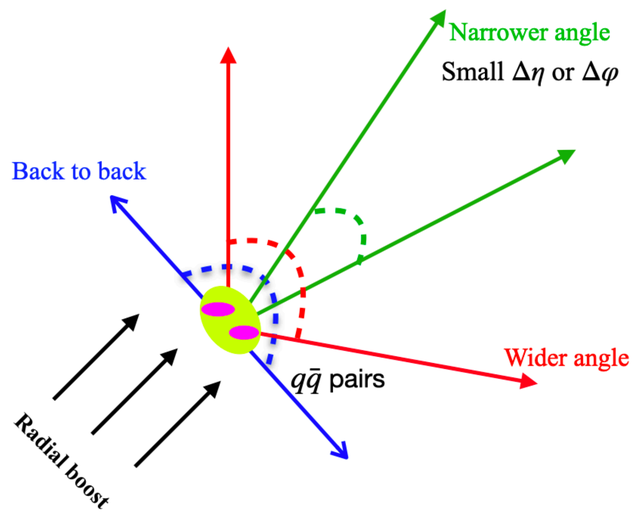




- Radial flow : $\Delta p_z = m_T . sinh(\Delta y) \approx m_T . \Delta y$
- Increasing the centrality and the transverse momentum decreases the width of balance function due to the radial flow

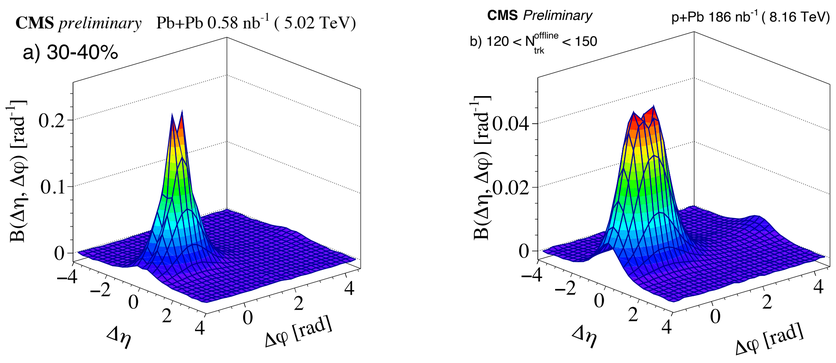
Balance function

$$B(\Delta\eta, \Delta\varphi) = \frac{1}{2}[C(+,-) + (C-,+) - C(-,-) - C(+,+)]$$

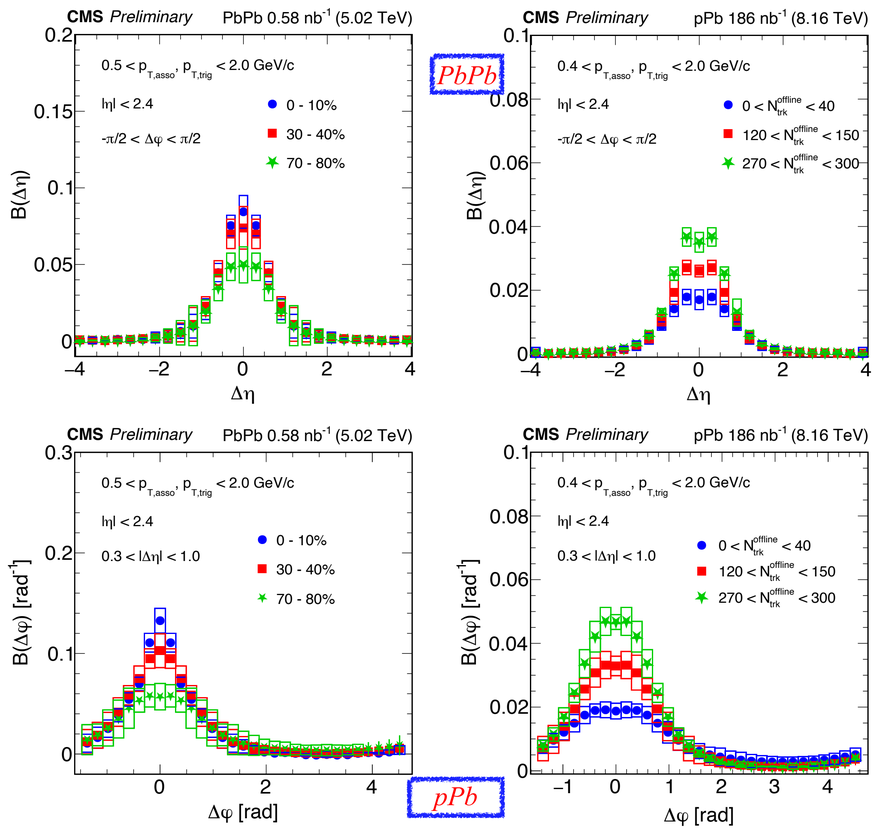
$$\frac{1}{N_{trig}} \frac{d^2N^{pair}}{d\Delta\eta d\Delta\varphi} = C = M(0,0) \frac{S(\Delta\eta, \Delta\varphi)}{M(\Delta\eta, \Delta\varphi)},$$

$$S(\Delta\eta, \Delta\varphi) = \frac{1}{N_{trig}} \frac{d^2N^{same}}{d\Delta\eta d\Delta\varphi},$$ ⟶ Particles paired from same events

$$M(\Delta\eta, \Delta\varphi) = \frac{1}{N_{trig}} \frac{d^2N^{mix}}{d\Delta\eta d\Delta\varphi},$$ ⟶ Particles paired from two different events



1D projection of balance function

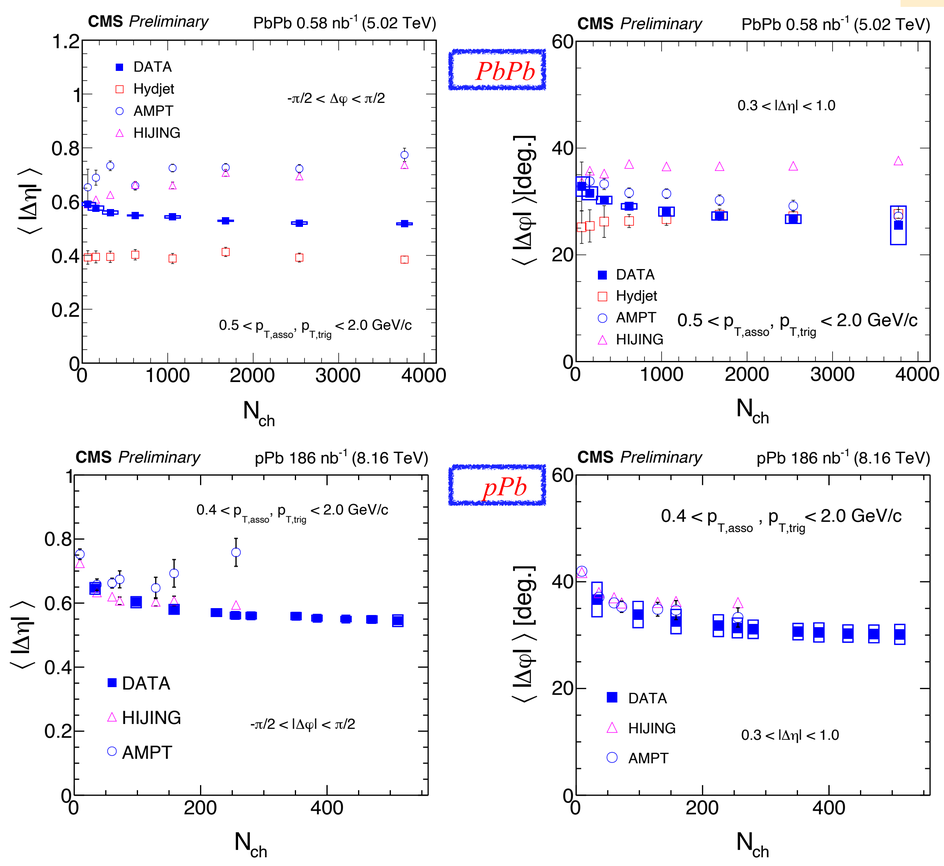


◉ Narrowing of the balance function is observed from high to low track multiplicity collisions.

Average width estimation

$\langle|\Delta\eta|\rangle$ and $\langle|\Delta\varphi|\rangle$ Vs multiplicity

$$\langle|\Delta\eta|\rangle = \frac{\sum_i B(\Delta\eta_i)|\Delta\eta_i|}{\sum_i B(\Delta\eta_i)} \qquad \langle|\Delta\varphi|\rangle = \frac{\sum_i B(\Delta\varphi_i)|\Delta\varphi_i|}{\sum_i B(\Delta\varphi_i)}$$

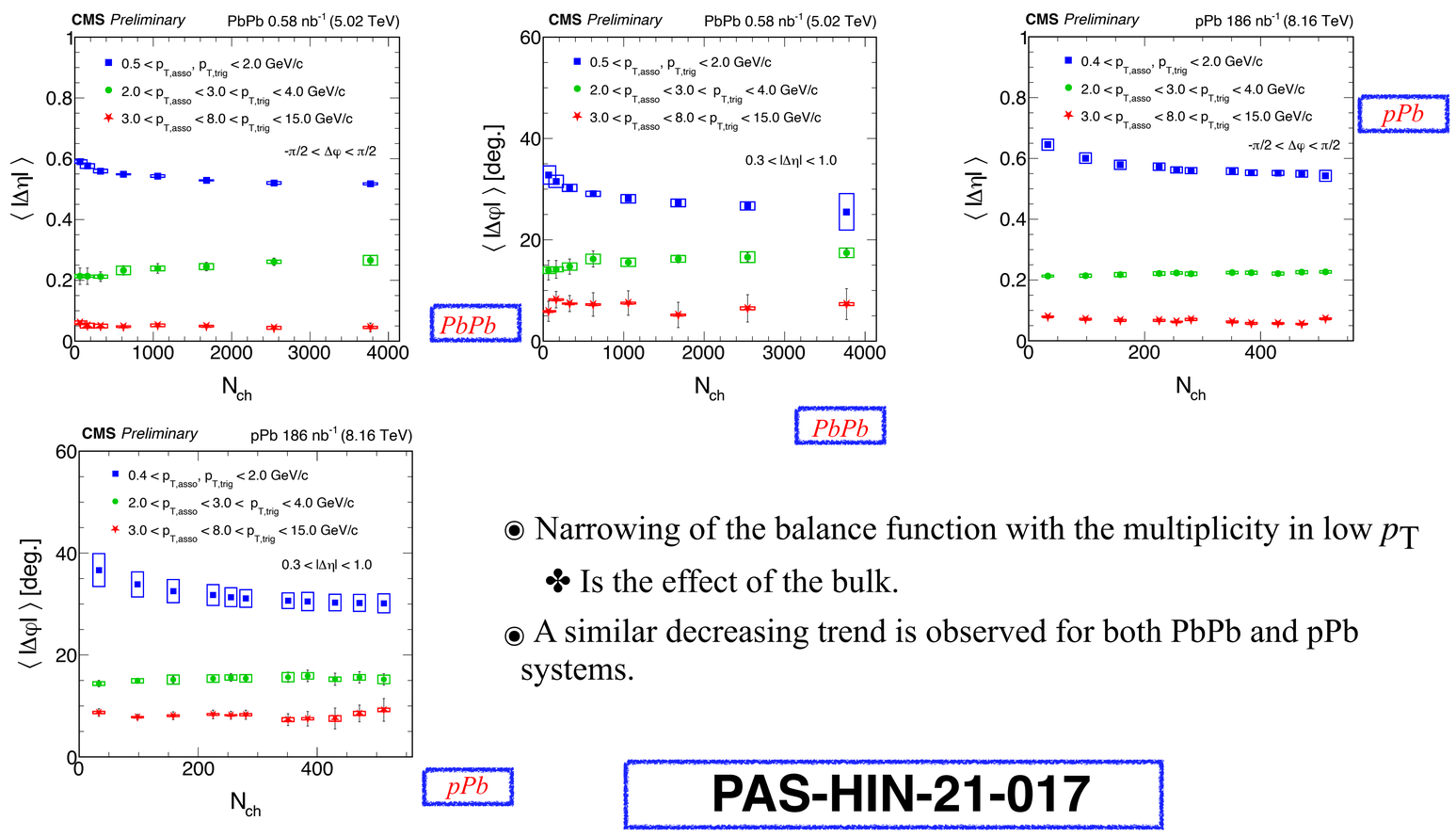


◉ Narrowing of the balance function with increasing multiplicity in $\Delta\eta$ and $\Delta\varphi$.

◉ Data not described by either HYDJET or AMPT or HIJING.

◉ Narrowing in $\Delta\varphi$ qualitatively described by AMPT ➡ connection to radial flow.

$\langle|\Delta\eta|\rangle$ and $\langle|\Delta\varphi|\rangle$ vs multiplicity vs p_T



◉ Narrowing of the balance function with the multiplicity in low p_T

✤ Is the effect of the bulk.

◉ A similar decreasing trend is observed for both PbPb and pPb systems.

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Summary

✦ The balance function width decreases with the increase of charge multiplicity in low p_T (for $p_T < 2.0\ GeV/c$) region.

✦ HIJING, AMPT and HYDJET models can not reproduce the multiplicity dependence of width in $\langle\Delta\eta\rangle$ as compared to PbPb data.

✦ Narrowing in $\Delta\varphi$ of balance function in AMPT shows similar trend as observed in data.

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