The ridges in pp, pPb and PbPb at CMS

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Overview
Long-range near-side dihadron correlations have been extensively studied at RHIC and LHC over the past decade in heavy ion collisions. The ridge revealed the collective behavior of particles produced in such collisions. This behavior mainly comes from hadronic properties of the hot medium created, the so-called Quark and Gluon Plasma. Surprisingly, a few years ago, similar features were discovered in high multiplicity events in a small system such as p-p and p-A. Even if the latter one has already revealed its collective properties, the nature of the ridge in p-p collisions remains unknown. Studying the ridge in small systems is also a good probe to improve our knowledge of initial conditions and its fluctuations. A deeper look into 7 TeV p-p data using CMS detector allowed us to have a better idea about the possible origin of long-range correlations. Furthermore, in light of 13 TeV p-p data this year, we will provide more constraints on potential hadronic properties in small systems. In this poster, results on long-range near-side dihadron correlations are shown at different energies and for different colliding systems using CMS detector. The potential origin of the Ridge in p-p collisions will be discussed.

The ridge observed in Run I – pp, pPb, PbPb

Two-particle correlations & ridge quantification

The ridge is defined by the ratio of signal (same event pairs) and background (pairs from 10 different events).

The integrated yield in Δp is quantified in the long range region 2<Δp<4 (colored), away from jet peak shadowed, then used to extract fast Fourier harmonics:

Hydrodynamical picture of eccentricities (fluctuating initial conditions) and the corresponding flow single particle Fourier harmonics.

Centrality dependence of the PbPb ridge

The dependence on centrality of the Fourier harmonics derived from long range correlations in PbPb collisions at √sNN=2.76 TeV has been investigated over a broad centrality range

(a) ν1 (m=1,…,5) with statistical uncertainties only as a function of pT; strong centrality dependence in ν1, almost none in ν2 to ν5

(b) ν1 (m=1,…,5) shown for ultra-central collisions (0.02%) of similar sizes (within few %) for all m, mostly driven by participant fluctuations (statistical error bars and systematic shaded areas)

(c) consequently, ν1 and ν2 averaged over all pT; comparable within 2%, strong pT dependence: ν1 biggest of all harmonics (pT<1 GeV/c), smaller than ν2 at pT<1 GeV, smaller than even ν4 at pT>3GeV/c

Ridge in pPb and PbPb vs. p_T, multiplicity, η

(1) ridge yield in pPb and PbPb shown for the range 200≤Nch<260

(2) (top) ν1 in pPb (a) and pPb (b) extracted via ν1,2(Δp=2) and four-particle cumulant ν4; (bottom) upper limits on the relative ν1 fluctuations in PbPb (a) and pPb (b)

(3) ν1,2(Δp=2) vs. Nch in pPb (a) and pPb (b) collisions: surprisingly similar ν1 strengths

ν2 and ν3 identified K0_S and Λ in pp, pPb and PbPb

ν2(Δp=2) from long-range correlations in pPb and pPb collisions

mass ordering (top two plots)

apparent scaling of ν1,2 up to KE/Δη = 1 GeV

consistent with hydro picture: ν2 sensitive to initial geometry

ν1,2(Δp=2) vs. ν1(Δp=2) for pPb (pPb collisions)

γ(2,2)cumulant 

as a function of η in the center-of-mass frame. Data normalized, and perhaps less towards the negative side. The

hydrodynamic prediction for

subtracted data (without subtraction)

p dependent (large η gap resulting in denormalized results)

q independent ν1: incohesive

γ(2,2)cumulant 

as a function of η in the center-of-mass frame. Data normalized, and perhaps less towards the negative side. The

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The in pp collisions at 13 TeV

(1) correlated yield quantified by ZYAM by integrating over |Δp|<Δp_{cut}

(2) long-range two-particle correlations in pp collisions at 13 TeV:

(left) ν2(Δp=2) from pp collisions

mass ordering (top) of K0_S, Λ and Λ

apparent scaling of ν1,2 up to KE/Δη = 1 GeV

consistent with hydro picture: ν2 sensitive to initial geometry

(right) onset of associated yield for Nch_{pPb}→40 in pp (at 7 and 13 TeV), pPb (5.02 TeV) and PbPb (2.76 TeV)

strong system size dependence in pp, pPb and PbPb

challenge to models to explain all systems at once

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