PROCEEDINGS OF SCIENCE

# Dihadron correlations in pp and pPb collisions with LHCb

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Small systems such as p+Nucleus and pp collisions were assumed to be free from the effects of hot nuclear matter unlike the heavy ion collisions. Recently long-range (large rapidity gap) near-side (same azimuthal angle) dihadron correlations, revealing azimuthal anisotropies in the event shape have been seen, challenging this assumption. This phenomenon is known as the ridge structure. The ridge in a small system have been understood to be a result from the collective behaviour of emitted particles in the collisions, which can be described by hydrodynamic models. This talk presented the recent results of two particle angular correlation in the LHCb experiment at LHC using pPb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV and pp collisions at $\sqrt{s}$ = 13 TeV.

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## 1. Introduction

The ridge structure in long range angular correlations were first measured in heavy ion collisions by the STAR experiment [1] and the PHOBOS experiment [2] at the Relativistic Heavy Ion Collider (RHIC). Dihadron angular correlation functions in a large rapidity gap $\Delta\eta$ can be decomposed into cosine Fourier component amplitudes, $v_{n,n}(p_T^a, p_T^b) = v_n(p_T^a)v_n(p_T^b)$ where the $v_{n,n}(p_T^a, p_T^b)$ is the anisotropy pair factor that is parametrized by product of two single particle azimuthal anisotropies $v_n$ [3]. Especially, $v_2(p_T^b)$, the so-called elliptic flow, in heavy ion collisions is important to understand the high-temperature quark gluon plasma (QGP) created in the collision. The $v_n$ are measured to be of a similar size in 2.76TeV PbPb collisions at the Large Hadron Collider (LHC) at CERN and in Au+Au collisions $\sqrt{s_{NN}}$ = 200 GeV at RHIC. These anisotropies are well described by the hydrodynamic model [4]. On the other hand, there are alternative theories to explain these anistropies, such as initial-state gluon saturation [5], the color glass condensate (CGC) [6], which suggested underlying processes. Since ridge is observed in long-range $\Delta\eta$ dihadron correlations in 7 TeV pp collisions [7], it raises the question whether ridge in small system are produced by the same processes as in heavy ion collisions. This proceeding presents the recent results of dihadron angular correlations in the LHCb experiment at LHC using pPb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV and pp collisions at $\sqrt{s}$ = 13 TeV. The dihadron angular correlation in the forward region is a unique capability of the LHCb facility. Firstly, the pPb measurements are presented, followed by pp results.

## 2. Dihadron angular correlation

Dihadron angular correlation functions in the pPb configuration are presented in Figure 1 [8]. The correlation for particles with $1 < p_T < 2$ GeV/c is shown for the 0-3 % event activity class, corresponding to the highest event activity. One can distinguish three features in the figure. First, a near side jet peak around $(\Delta\varphi, \Delta\eta) \cong (0,0)$ which is due to correlations of particles originating from the same jet-like objects. For better visualisation of additional structures, in all histograms the jet peak is truncated. The second prominent feature is visible on the away side jet in $\Delta\varphi \cong \pi$ over a long range $\Delta\eta$ and combines near side jet and (potential) ridge contributions. Ridge structure is in long range $\Delta\eta$ centred at $\Delta\varphi = 0$. This ridge is elongated over the full measured $\Delta\eta$ range of 2.9 units in forward rapidities, 2.0< $\eta$ <4.9.

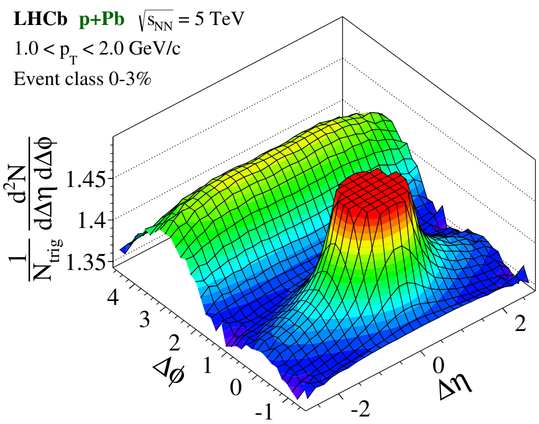
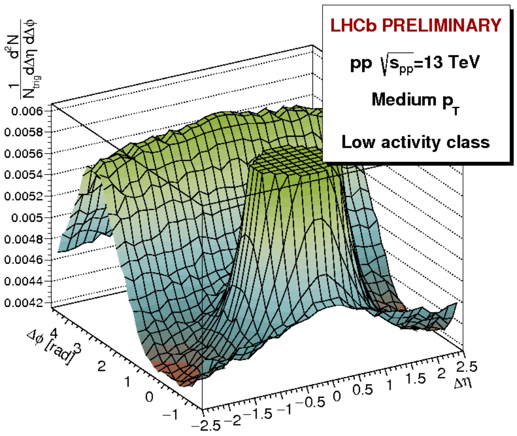


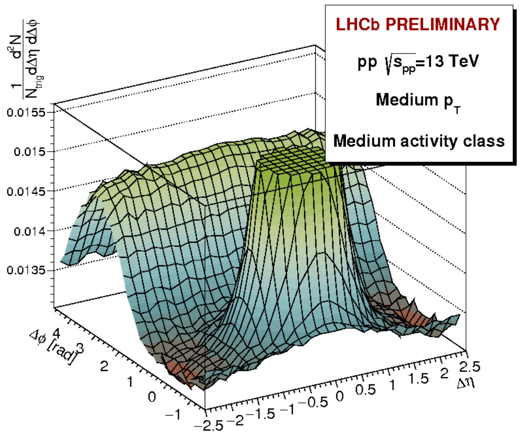

Figure 1: Dihadron correlation function in the pPb configuration in the high event-activity classes for $p_T$ range of $1 < p_T < 2$ GeV/c is shown.

Dihadron correlation function are also performed in pp collisions at $\sqrt{s}$ = 13 TeV [9]. Event activity classes dependence in medium $p_T$ are shown in Figure 2a, Figure 2b and Figure 2d. As increasing event activity class, particle yields are increasing. Especially in the high activity class shown in Figure 2d, the enhanced structure is observed at $\Delta\varphi \cong 0$ in long range $\Delta\eta$. While in low and medium activity classes, correlations are shown as hollow or flat shape.

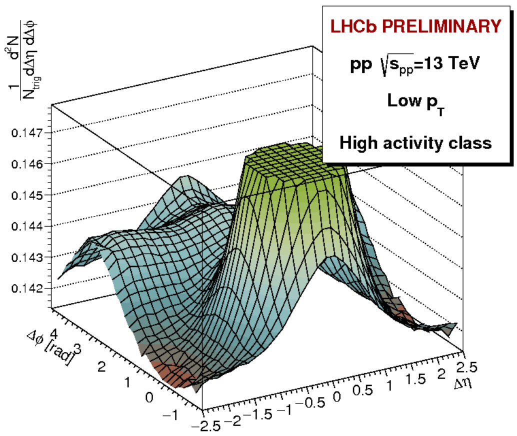
The $p_T$ dependence of dihadron correlation can be seen comparing Figure 2c and Figure 2d. The observed event activity and $p_T$ dependence agree well with other experimental result.



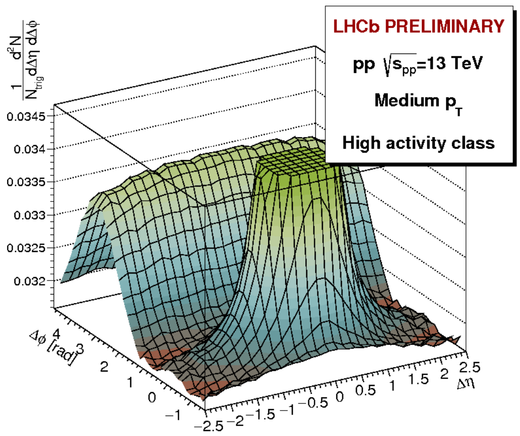

(a) The low activity class in medium $p_T$ class.




(b) The medium activity class in medium $p_T$ class.




(c) The high activity class in low $p_T$ class.




(d) The high activity class in medium $p_T$ class.

Figure 2: Event activity class dependence of dihadron correlation in p+p are shown in (a), (b) and (d). And $p_T$ dependence are shown in (c) and (d).

## 3. Summary

Dihadron angular correlations between prompt charged particles produced in pPb collisions at $\sqrt{s_{NN}}$ = 5 TeV and pp collisions at $\sqrt{s}$ = 13 TeV have been measured for the forward region in the pseudorapidity range $2.0 < \eta < 4.9$ over the full range of azimuthal angles, probing particle correlations in different common $p_T$ intervals, using the LHCb detector. For events with high event activity a long range $\Delta\eta$ correlation in $\Delta\varphi \cong 0$ (the ridge) is observed in both pPb and pp. The correlation structures on the near side and on the away side both grow stronger with increasing event activity. The ridge is most pronounced for particles of higher transverse momentum.

## References

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