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Long-range correlations in high-multiplicity proton–proton collisions at $\sqrt{s}$ = 13 TeV

Abstract

1 Introduction

Collective effect is one of key probes to explore evolution of the hot and dense matter as consequence of heavy ion collisions at high energy. The enhancement in the production of two-particle correlations at small relative azimuthal angle($\Delta\varphi$) that extends over a long-range of relative pseudorapidity($\Delta\eta$) is often referred to as the “ridge”, which is one crucial observables of the collective effect. In recent years, many results of unexpected observation of ridge in small systems, like proton-proton(pp) collisions and proton-nucleus(pA) collisions, has been reported, showing similar features to those in heavy ion collisions, where the volume and lifetime of the medium produced are expected to be to small to form Quark Gluon Plasma(QGP) thought to play a important and dominant role in formation of the ridge in heavy ion collisions. There are many theoretical trials to interpret the ridge considering hydrodynamics, saturation or other mechanisms, not demonstrating measured data fully, because the sources of the ridge is not understood quantitatively. The understanding of possible origins of the ridge in small systems may provide a hint to distinguish the mechanism of formation of ridges in large systems and small systems.

2 Experimental setup

Collisions of proton and proton were provided by the LHC for a few years from 2015 to 2018 with various energy during Run2 period. The used beam energies were 6.5 TeV for both protons so that center-of-mass energy is 13 TeV. Among data from pp collisions at 13 TeV, This paper shows the results with 2016 to 2017 data set whose total cross section corresponds to xxx. Subsystems mainly used in the present analysis, VZERO detector, Inner Tracking System(ITS) and Time Projection Chamber(TPC), are mainly discussed in the paper while the whole ALICE detector is well described in Ref(?). The VZERO is separated into two plates, VZERO-A and VZERO-C, consisting of two arrays of 32 scintillator tiles each, covering the full azimuthal angle within 2.8< η <5.1 and -3.7< η <-1.7 respectively. The VZERO provides trigger and event characterization with respect to particle-multiplicity. The ITS is composed of three subsystem, Silicon Pixel Detector(SPD), Silicon DriftDetector (SDD) and Silicon Strip Detector(SSD). Each subsystem consists of two layers with an acceptance of $|\eta|$ <1.95, $|\eta|$ <1.xx and $|\eta|$ <1.xx. The TPC, which is operated inside a solenoidal magnetic field of 0.5 T, have an acceptance of $|\eta|$ <0.9 for tracks reaching the outer radius of the TPC. In pp collisions, trigger requirement is fulfilled by the combination of SPD, VZERO-A or VZERO-C.

3 Event and track selection

Several event selections have been applied to the data set to reject bad signals. Multiple collisions in the same time(¡100 ns) is tagged as ”Pileup”, which is detected by SPD. The Pileup events have been rejected from the present analysis. Primary vertex range has been chosen as $|z_{\mathrm{vtx}}|$ <8 cm to keep higher tracking efficiency in large η region. The event classes are separated through charged particle-multiplicity using VZERO. The analysis uses ITS and TPC to reconstruct the track of the charged particle. The reconstructed tracks have been selected with $|\eta|$ <0.9 and p_{T} >0.2 GeV/c. The efficiency of track reconstructed has been estimated from a Monte Carlo(MC) simulation using PYTHIA event generator.

4 Analysis

The two-particle angular correlation between trigger particle and associated particle has been measured as function of relative pseudo-rapidity versus relative azimuthal angle. Two particles constructing the correlation are defined as the trigger particle and the associated particle by considering magnitude of transverse momentum of two particles to be $p_{\mathrm{T}}^{\mathrm{trig}} > p_{\mathrm{T}}^{\mathrm{assoc}}$. The correlation takes the number of the trigger particles into its denominator to make the correlation present the associated yield.

5 Results

6 Conclusions