Identification of jet-like events in forward rapidities using Photon Multiplicity Detector at LHC energies

R. Singh[1],* B. Mohanty[2], and Y.P. Viyogi[2]
[1] *Department of Physics, University of Jammu, Jammu 180006, India and*
[2] *Variable Energy Cyclotron Centre, Kolkata 700064, India*

Introduction

At Large Hadron Collider (LHC), with the large center-of-mass (CM) energy, multi-jet events may be produced with measurable cross-section in forward rapidities [1]. Typical 3-jets events arising from $qg \rightarrow qgg$: $gg \rightarrow gg$ should appear in the ratio of 0.3:1 as discussed in [2]. If the CM system has a boost either in +ve or in the -ve z-direction, the jets might be directed in the forward rapidity. For the partonic interaction of a low "x" gluon and the high "x" quark will lead to a jet in forward direction, where x is the fraction of momentum carried by the partons.

In *pp* collisions, dijet events will appear with jets lying back to back in azimuthal angle. In ALICE experiment these may be easily studied using the central barrel detectors. However one may encounter events where the barrel detectors see two of more than two jets where the toplogy may suggest a missing jet which may be in other part of the phase space. If even the direction of such a missing jet can be found, more physics can be extracted from such an event.

Jets in general produce particles which are confined to a cone and hence the spatial particle density within the jet region is expected to be very diferent compared to a normal event in *pp* collisions. The aim of the present work is to explore if this disticntion can be exploited successfully to predict the jet direction.

In the forward region of ALICE on the +ve z-side there are a set of charged particle detectors and a photon multiplicity detector (PMD) [3]. The PMD is a preshower detector for measuring the spatial distribution of photons event-by-event in the forward rapidity($2.3 < \eta < 3.9$) with full azimuthal coverage. It consists of two planes, one is the Charged Particle Veto (CPV) and other is a Preshower plane with a lead converter sandwiched between the two planes. The CPV plane in general measures the charged particle multiplicity. We present here preliminary results of our investigation using the PMD for detecting jets in *pp* collisions.

Jet events for PMD

We have used PYTHIA6.4 [4] in order to generate events with and without jets. The produced particles are tracked through the ALICE geometry using GEANT simulation. The basic aim is to study the signals of the jet-events in PMD to find if there is any basic difference in the structure of events with and without jets in PMD.

We have presently used a study containing di-jets without any initial and final state radiations and one of the jets is in the PMD η - coverage. The jet transverse energy is taken as $E_T > 20GeV$. A typical distribution in (η, ϕ) plane of particles from a jet event after putting a p_T threshold of $2GeV$ is displayed in fig. 1.

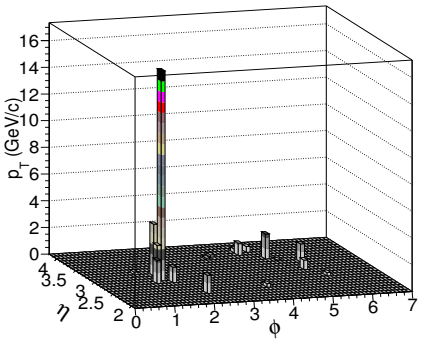

FIG. 1: A typical PYTHIA simulated jet event falling on PMD region in *pp* collisions at $\sqrt{s}_{NN} = 7$ TeV.

Fig. 2 shows particle density distribution for minimum bias (MB) and jet events in PMD η - coverage. The multiplicity distribution for jets is fitted with double Negative Binomial Distribution (NBD) function and that for minimum bias is single NBD fit which is as expected. Also with a large differences in multiplicities, the cut on par-

*Electronic address: ransinghep@gmail.com

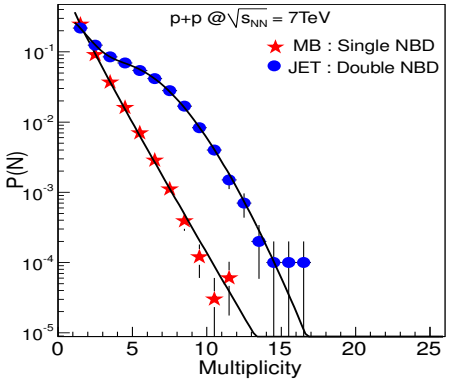

FIG. 2: Multiplicity distribution for minimum bias and jet events in *pp* collisions at $\sqrt{s}_{NN}$ = 7 TeV.

ticle multiplicity can be used as a tool to make jet rich event samples.

Wavelet Analysis and Detector Response

In the present work we have used a multiresolution 1D wavelet transformation using D4 basis as a technique to identify the jet-like events. The basic idea behind the wavelet analysis is that if there is a jet production in forward rapidities and it is falling on PMD then the multiplicity distribution will be localised in small $\eta-\phi$ region. With the help of wavelets, we can differentiate the jet-like region from a uniformaly distributed non-jet events. The output of the wavelet transformation are called as the Father Function Coefficients (FFCs). These are obtained for non-jet or minimum bias(MB) and mixed jet events for different scales. The results for scale J=2 is shown in fig. 3. It is observed that FFCs distribution width increases as the percentage of jet-like events in the sample increases.

To quantify the results, we introduced a strength parameter ξ, given by $\xi = \frac{\sigma^2_{jet}-\sigma^2_{mb}}{\sigma_{mb}}$, where σ_{jet} and σ_{mb} are widths of the FFCs distrbutions for jets and MB events respectively. In fig. 4 variation of ξ with scale parameter J for event samples with different jet percentage is shown. The ξ values are higher at $J = 2$ which tells the jet spread on the detector.

Summary

We have presented a study based on a multiresolution analysis technique to identify jet-like

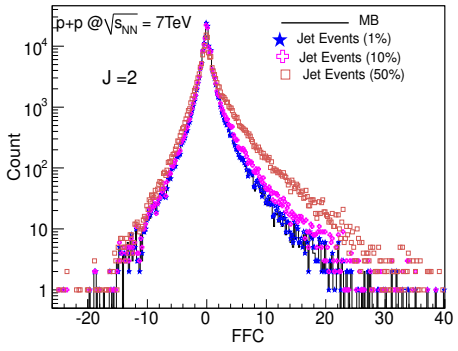

FIG. 3: FFCs distribution for sclae $J = 2$ at $\sqrt{s}_{NN}$ = 7TeV.

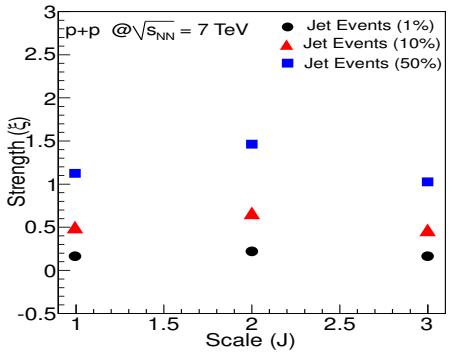

FIG. 4: Strength vs. scale parameter with different jet percentage at $\sqrt{s}_{NN}$ = 7TeV.

events in a multiplicity detector like PMD at LHC energies. The obsevation of jet-like events in PMD can be used to tag 3-jet events in ALICE at LHC. Our preliminary study shows the good sensitivity of strength parameter. The value of ξ is greater than zero for event sample with 1% jet-like events. Further study is underway to improve the sensitivity of the probe.

References

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