Forward-Backward Multiplicity Correlations in pp collisions at LHC energies

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Correlations amongst the relativistic particles produced in relativistic and ultra-relativistic hadronic and heavy-ion (AA) collisions are regarded as a powerful tool for understanding the underlying mechanism of multiparticle production. It has been reported[1] that the inclusive two particle correlations have two components: the short-range correlations (SRC) and the long-range correlations (LRC)[1, 2]. The SRC have been observed to be localized over a region, $\eta \pm 1.0$ unit around mid-rapidity. They are expected to arise from the decay of resonances and (or) clusters and jet/mini-jet induced correlations[2]. LRC, on the other hand are expected to extend over a relatively longer range(>2 units of η). These correlations are envisaged to arise from the fluctuations in the number and properties of emitting sources, like clusters, strings, mini-jets, etc[1]. Numerous attempts have been made to study the forward-backward (FB) multiplicity correlations in e^+e^-, μ^+p, $p(\bar{p})p$ and AA collisions at widely different energies[1–4]. Strong FB correlations were observed in $p(\bar{p})p$ collisions at ISR and at SPS energies[2, 3]. It has also been observed that the strength of FB correlations increases with increasing beam energy[2]. After the availability of the experimental data from the LHC, attempts were made to examine the particle correlations at LHC energies[2]. These results have also raised considerable theoretical interest to provide a qualitative description of soft process. A comparison of these available results with the predictions of various Monte Carlo models would provide interesting conclusions regarding the particle production. It was therefore considered worthwhile to undertake a study of FB correlations by analyzing the Monte Carlo events simulated in the framework of HIJING and AMPT models. For this purpose 10^5 events corresponding to *pp* collisions at energies $\sqrt{s}$ = 0.9, 2.76, 7.0 and 13.0 TeV are simulated using the codes HIJING-1.35 and AMPT-v1.21-v2.21. FB correlations are generally investigated[4] by studying the dependence of mean charged multiplicity in the backward (B) hemisphere, $< n_b >$, on the charge particle multiplicity in the forward (F) hemisphere, n_f, of the form, $< n_b >=a+bn_f$. For symmetric F and B regions, b is often referred to as the correlation strength and is expressed as, $b = {D_{bf}}^2/{D_{ff}}^2$, where D_{ff} and D_{bf} respectively denote the forward-forward and backward-forward dispersions.

η distribution of relativistic charged particles is divided into two parts with respect to its center of symmetry, η_c. The region with values of $\eta > \eta_c$ is referred to as the F region, while that with $\eta < \eta_c$ is termed as the B region. The numbers of charged particles in F and B regions, n_f and n_b are counted on event-by-event (ebe) basis. A 2-dimensional distribution (n_f,n_b) for AMPT data at 13.0 TeV and variations of $< n_b >$ with n_f for various data sets at different energies is displayed in Fig.1. It may be noted from Fig.1.(b) that $< n_b >$ increases linearly with n_f. The values of correlation strength b are estimated and presented in Table 1. It may be noted from the table that the values of b increases with increasing beam energy. However, HIJING gives somewhat smaller values of b as compared to those predicted by AMPT. A deviation from the linearity for higher n_f values is also observed for HIJING events. Similar deviations were observed[2] for *pp* data at $\sqrt{s}$ = 7.0 TeV.

In order to check the presence of LRC, if any, contribution arising from SRC to be eliminated. For this purpose, windows of fixed equal width, $\Delta\eta$ are placed in F and B regions such that they are separated by equal distances η_{gap}, (in η units) with respect to η_c. Multiplicities, n_f and n_b are counted by changing the η_{gap} from 0 to 3.0 on each

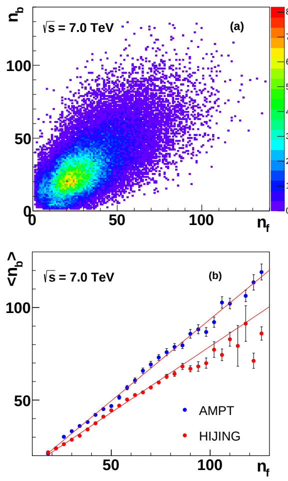

FIG. 1: (a) n_b versus n_f 2-dimensional plot and (b) dependence of $< n_b >$ on n_f.

side η_c. The values of b for each η_{gap} are computed and the variations of b with η_{gap} for AMPT data seta at different energies are plotted in Fig.2 for the window widths = 0.25 and 0.50. It may be observed from Fig.2 that (1) values of b slowly decrease with increasing η_{gap}, (2) for a given η_{gap} values of b are higher for larger $\Delta\eta$ values and (3) for a given η_w and η_{gap}, b increases with increasing incident energy.

Similar trends of variations of b with η_{gap} are also observed with the HIJING stimulated events at different energies. These findings are similar to those observed[2] with the real data at $\sqrt{s}$ = 0.9, 2.76 and 7 TeV. However, in order to check whether the findings based on the real data, reported earlier[2] agree with predictions of AMPT and HIJING, geometrical acceptance of the detector and also the p_T cuts applied to the real data are to be taken into account. Results based on the analysis with these cuts will be presented. Furthermore, the analysis will be extended by keeping the η_{gap} fixed and increasing the window width in steps until the limit of the geometrical acceptance of the detector. The findings based on these work may lead to draw some useful conclusions.

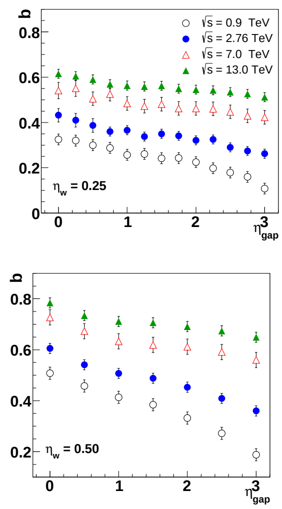

FIG. 2: Dependence of correlation strength, b on η_{gap} between two windows for AMPT at $\sqrt{s}$ = 0.9, 2.76, 7.0 and 13.0 TeV.

Table 1: Values of parameter b for various data sets

Energy (TeV)	b			
	0.9	2.76	7.0	13.0
AMPT	0.70±0.01	0.79±0.01	0.88±0.01	0.90±0.01
HIJING	0.62±0.01	0.66±0.01	0.71±0.01	0.73±0.01

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