Forward-backward multiplicity correlations with strongly intensive observables in pp collisions simulated in PYTHIA

Andrey Erokhin

Saint Petersburg State University

Introduction

Strongly intensive observables do not depend on volume and volume fluctuations in the model of independent sources (*1*). One of the observables proposed in that paper, together with the normalization introduced in (*2*), was used to measure forward-backward charged particles multiplicity correlations produced in pp collisions simulated in PYTHIA 8 (*3*):

$$\Sigma\left[n_{\mathsf{F}}, n_{\mathsf{B}}\right] = \frac{1}{\langle n_{\mathsf{F}}\rangle + \langle n_{\mathsf{B}}\rangle}\left[\langle n_{\mathsf{B}}\rangle\omega[n_{\mathsf{F}}] + \langle n_{\mathsf{F}}\rangle\omega[n_{\mathsf{B}}] - 2\operatorname{cov}\left(n_{\mathsf{F}}, n_{\mathsf{B}}\right)\right] ,$$

where n_{F} and n_{B} are multiplicities, and $\omega[n] \equiv \frac{\langle n^2\rangle - \langle n\rangle^2}{\langle n\rangle}$. With this normalization, $\Sigma\left[n_{\mathsf{F}}, n_{\mathsf{B}}\right] = 1$ in the model of independent particle production.

Analysis method

Monash 2013 (*4*) PYTHIA tune was used. Charged particles with transverse momentum $p_{\mathsf{T}} \in (0.2, 2.0)$ GeV/c within $|\eta| < 0.8$ interval were selected.

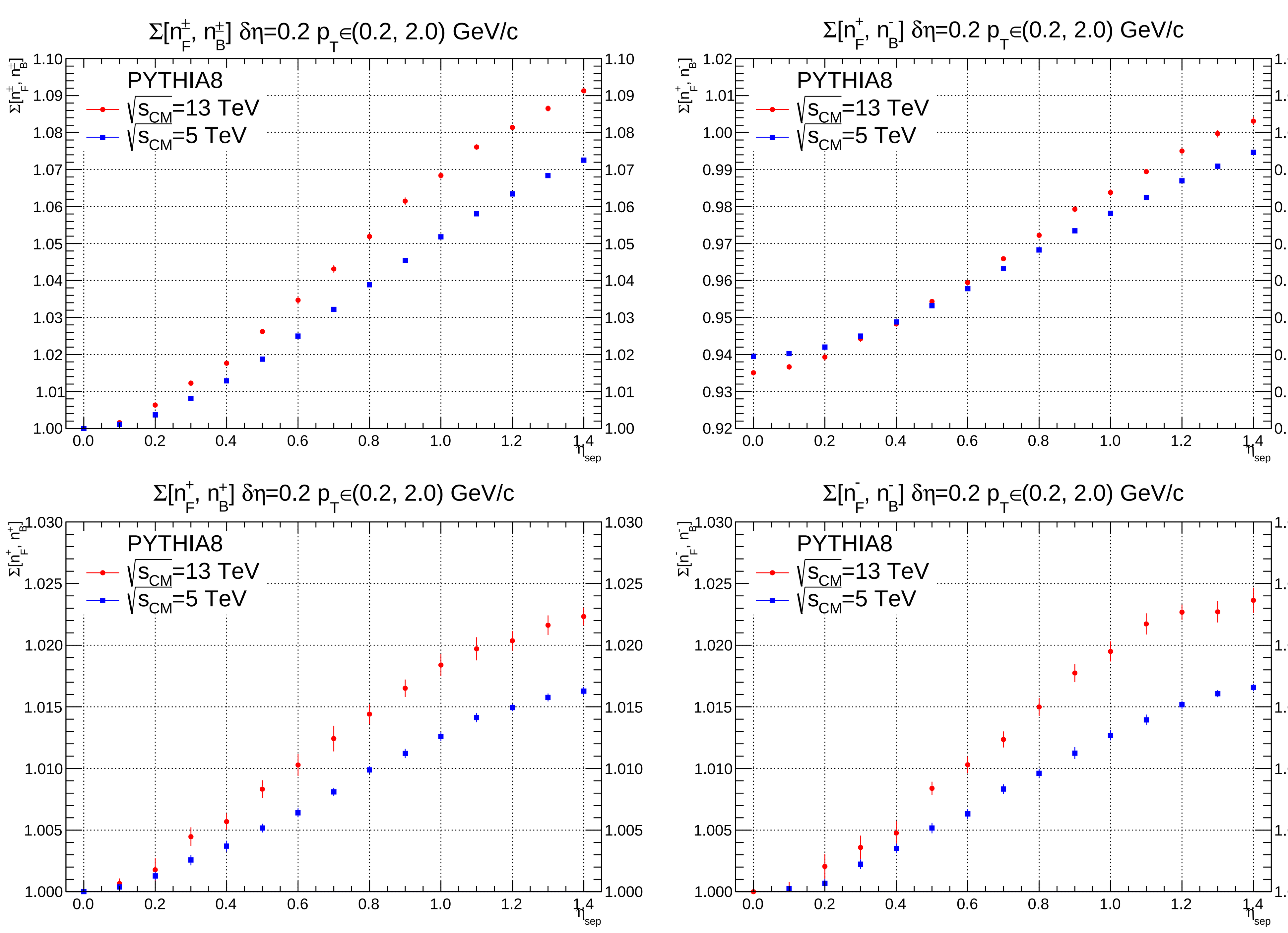
Forward-backward correlations were measured between particles in two phase-space windows of size $\delta\eta = 0.2$ $\delta\varphi = 2\pi$ as a function of η_{sep} – the distance between the centers of the windows placed symmetrically around $\eta = 0$, and in windows of size $\delta\eta = 0.2$ $\delta\varphi = \pi/4$ as a function of η_{sep} and φ_{sep} – the azimuthal distance between the centers of the windows.

Energy dependence

Energy dependence was measured for correlations between all charged particles in two windows, between particles of the same positive or negative charge, and between particles of the opposite charges.

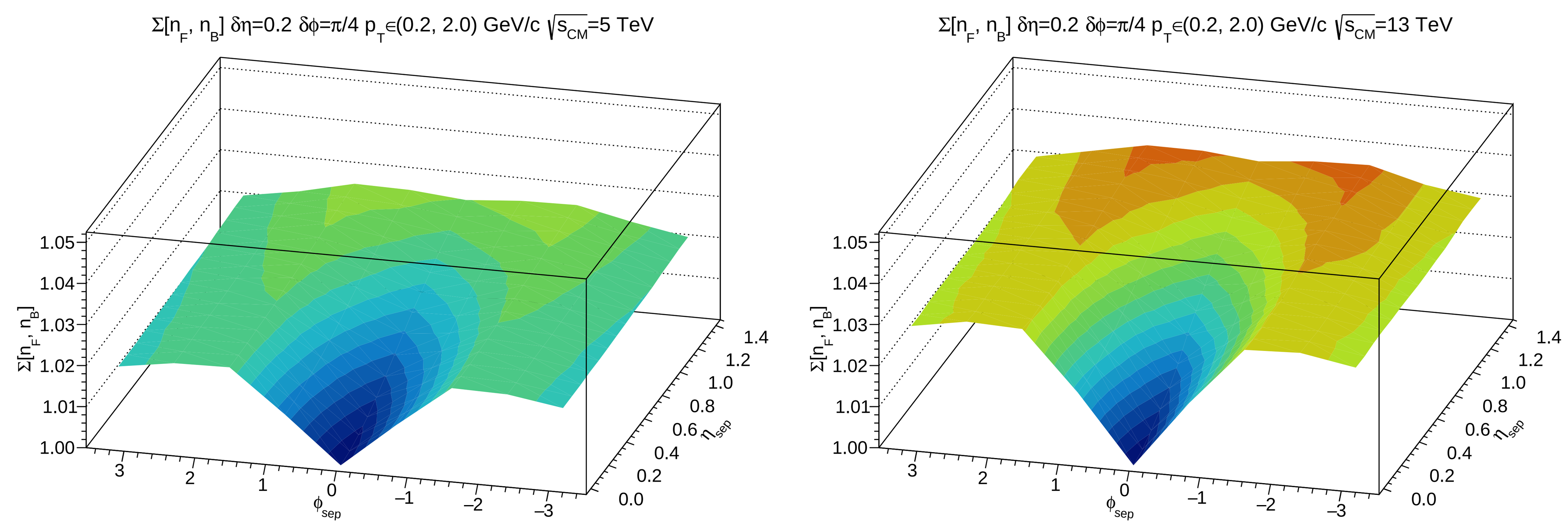
The strongly intensive quantity $\Sigma\left[n_{\mathsf{F}}, n_{\mathsf{B}}\right]$ grows with energy for all charge combinations at large η_{sep}, but for correlations between particles of the opposite charges, it decreases near $\eta_{\mathsf{sep}} = 0$.

Note the different Y-axis scales!



2D correlation function

On 2D plots it could be seen that $\Sigma\left[n_{\mathsf{F}}, n_{\mathsf{B}}\right]$ grows as a function of η_{sep} for $\varphi_{\mathsf{sep}} \approx 0$ and doesn't depend on η_{sep} for $\varphi_{\mathsf{sep}} \approx \pi$.

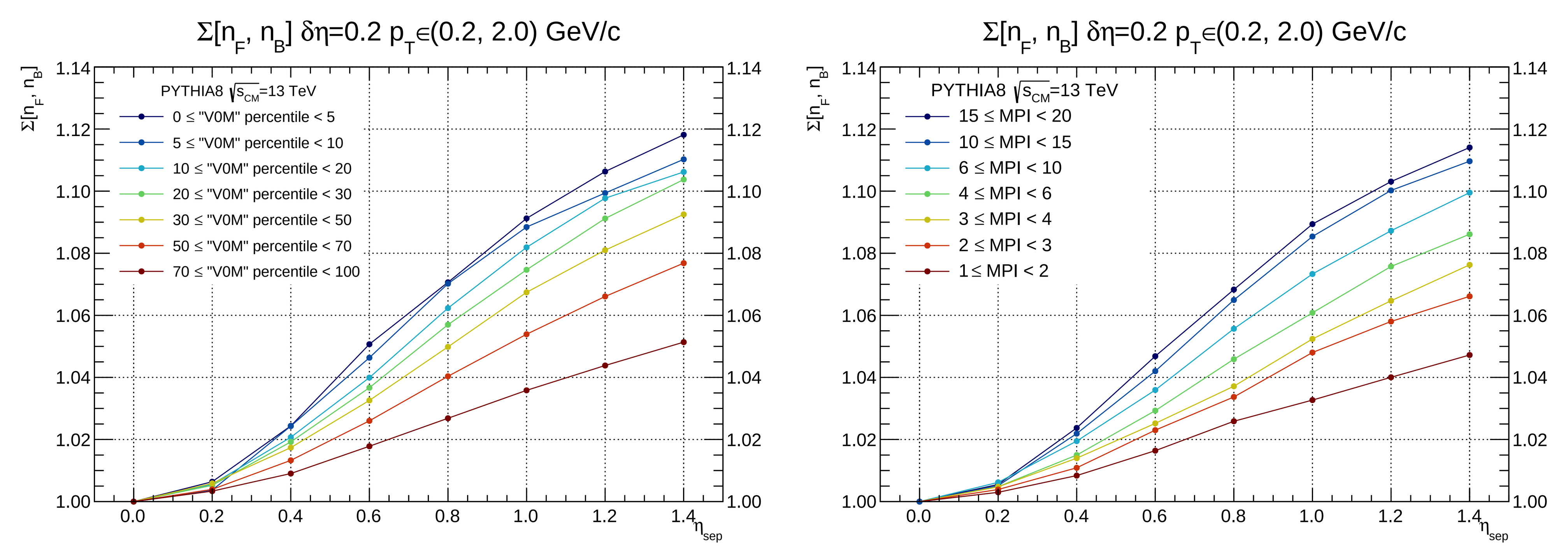


Multiplicity class dependence

Simulated CERN ALICE (*5*) V0 detector's response (denoted by "'V0M' percentile") was used for multiplicity estimations. Basically, this means that the percentiles of the distribution of the number of charged particles produced in forward $(2.8 < \eta < 5.1)$ and backward $(-3.6 < \eta < -1.7)$ regions were used.

The number of multiparton interactions (nMPI) was used as another method to estimate multiplicity. Even though the positive correlation between the number of MPIs and the multiplicity of produced particles is known, parton interactions might be thought of as particle emitting sources, that's why it makes sense to study the dependence on nMPI directly.

The value of $\Sigma\left[n_{\mathsf{F}}, n_{\mathsf{B}}\right]$ depends on the number of sources, which is expected, since the mechanism of colour reconnection in PYTHIA is likely to make the sources dependent.



References

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andrey.erokhin@cern.ch