Multiple parton interaction in jets from forward-backward multiplicity correlations

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Introduction

One of the first results in $\mathrm{p+p}$ collisions on the Forward-Backward $(\mathrm{F-B})$ multiplicity correlations was from the Intersecting Storage Ring (ISR) at CERN at $\sqrt{s} = 52.6$ GeV [1], finding positive values for the correlations.

Experimental studies of long-range rapidity correlations can give us the information about the initial stage of the hadronic interactions at high energies. It has been proposed that the study of the long-range $\mathrm{F-B}$ multiplicity correlations between two separated rapidity windows can provide a signature of the string fusion and percolation model in ultrarelativistic heavy ion collisions [2]. **Recent studies show the possibility of extracting the number of multiple parton interaction (nMPI) [3]. In this work, we extend these studies to jet event classes, taking into account color reconnection(CR).**

Jet Study

A reconstructed jet is a narrow cone of hadrons created by the hadronization of a quark or gluon produced in hadron-hadron or heavy ion collisions.

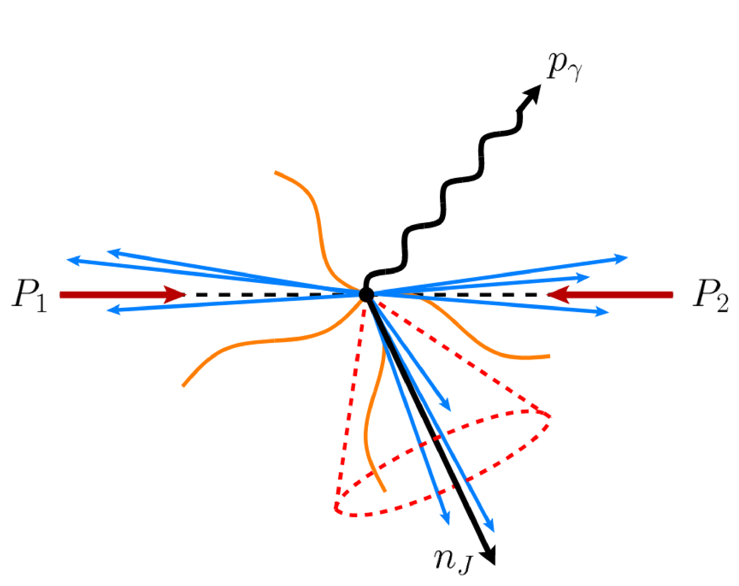

Figure 1:Jet cono topology: $R = \sqrt{\Delta\eta + \Delta\phi}$

The present analysis generates Soft QCD events and use jet finder SlowJet from PYTHIA 8.2 [4] event generator.

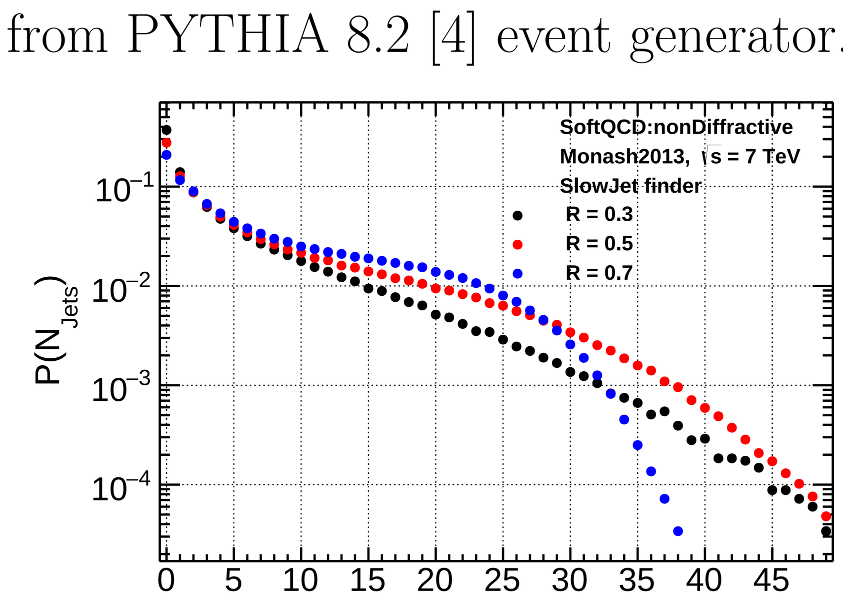

Figure 2:Probability distribution for the number of jets for different values of the R.

Color reconnection

Hadronization process which contribute to the hadrons production, is implement in terms of interaction probability between partons, from lowest to highest p_T, a reconnection probability is given by $P_{rec}(p_T)$:

$$P_{rec}(p_T) = \frac{(R_{rec}\, p_{T0})^2}{(R_{rec}\, p_{T0})^2 + p_T^2} \qquad (1)$$

where the range of CR, $0 \leq R_{rec} \leq 10$, is a phenomenological parameter and p_{T0} is and energy dependent parameter used to damp the low p_T divergence of the $2 \to 2$ QCD cross section.

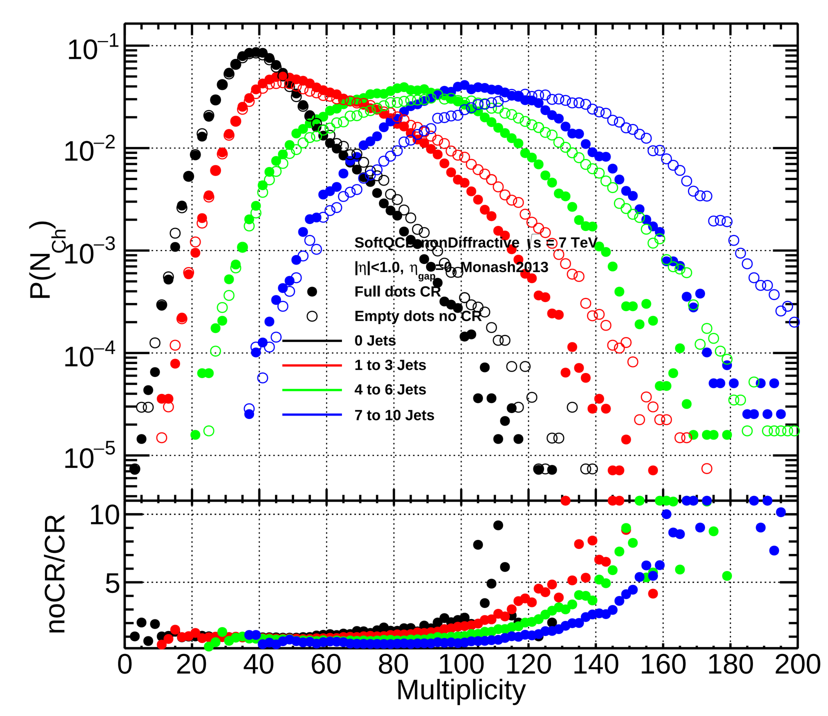

Figure 3:Multiplicity distribution with and without CR as a function of number of jets

Multiple Parton interactions

The Number of Multiple Parton Interaction indicates how many collisions between partons occur in an event as a function of p_T. An average nMPI per event is related to the cross section given by:

$$\langle n_{MPI}(p_{T,min})\rangle = \frac{\sigma_{int}(p_{T,min})}{\sigma_{nd}} \qquad (2)$$

where σ_{nd} and $\sigma_{int}(p_{T,min})$ correspond to cross section for non diffractive events and the integrated one.

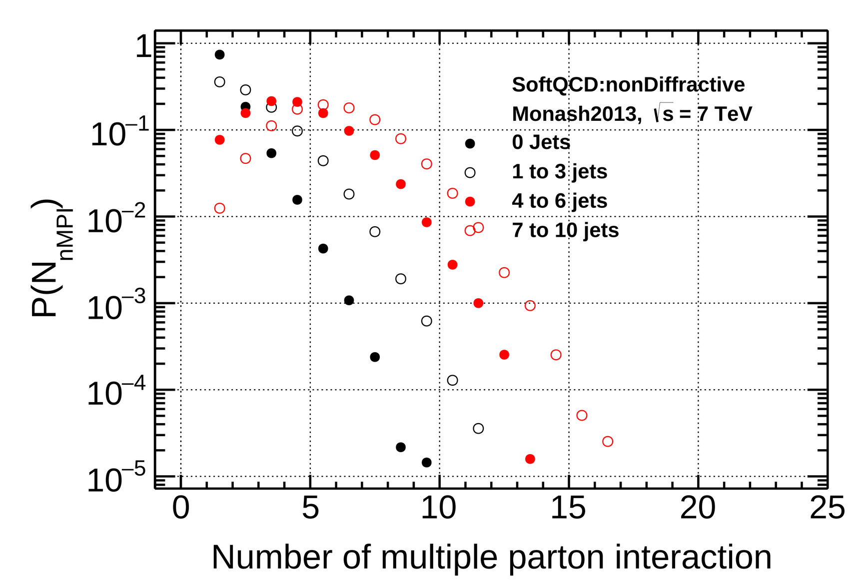

Figure 4:Multiple parton interaction distributions on terms of average number of jets per event.

F-B multiplicity correlation, b_{Corr}

Multiplicity fluctuation show a $\mathrm{F-B}$ correlations defined by

$$b_{Corr}(\delta\eta) = \frac{\langle \mathrm{n_F n_B}\rangle - \langle \mathrm{n_F}\rangle\langle \mathrm{n_B}\rangle}{\langle \mathrm{n_F^2}\rangle - \langle \mathrm{n_F}\rangle^2}, \qquad (3)$$

where n_F and n_B are the charged multiplicity in two symmetrically window width $\delta\eta$, separated by a central pseudorapidity gap, $\Delta\eta$.

b_{Corr} and CR

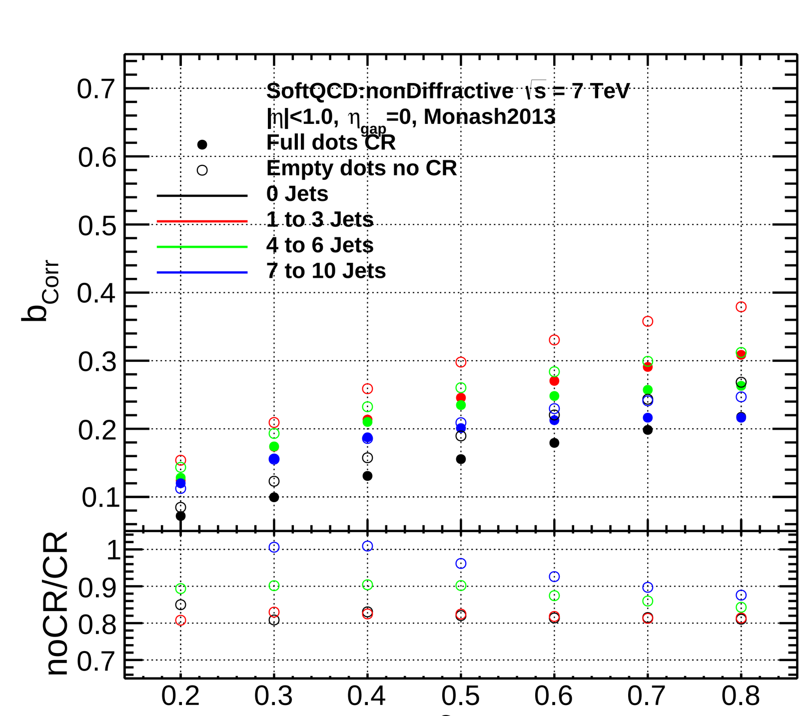

Figure 5:b_{Corr} for ranges of the number of jets with and without CR

Selecting event classes with a higher range on the number of jets, we observe a lower distribution of b_{Corr}. This tendency is more pronounced at higher values of $\delta\eta$.

b_{Corr} for ALICE and Pythia

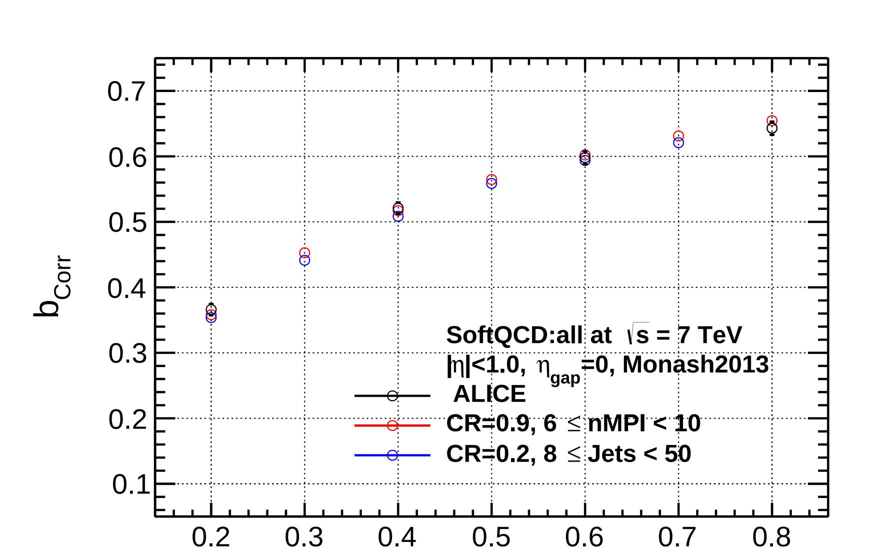

Figure 6:b_{Corr} comparing ALICE data and Pythia with different ranges of nMPI

b_{Corr} shows a clear relationship with ranges of nMPI [3] and the number of jets, this can be interpreted that nMPI is uniform in terms of the correlation.

nMPI versus Jets

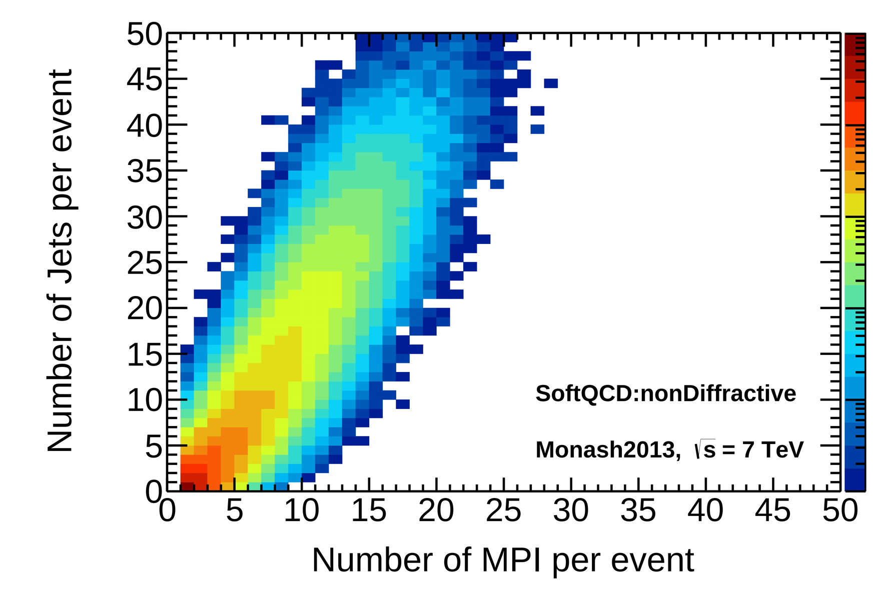

Figure 7:nMPI vs number of jets on the event.

We almost observe a lineal relation between average number of jets and average number of nMPI.

Discussion and conclusion

The hardness of the events can be associated with the number of jets in the event. Large quantities of jets indicate high average multiplicity and imply lower multiplicity correlations. The b_{Corr} multiplicity correlation as a function of the number of jets in an event is similar to those observed when this correlation is analyzed with multiple parton interactions. Therefore it is possible to study the number of multiple parton interactions as a function of the number of jets. Analyzing experimental correlation it is possible to extract the average number of jets as well as the average of nMPI in an event. Moreover, of course, all the analysis is model dependent.

References

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[4] Torbjörn Sjöstrand, Stefan Ask, Jesper R. Christiansen et al Comput. Phys. Commun., 191:159–177, 2015.

Acknowledgments

Partial support was received by DGAPA-PAPIIT IG100219 and CONACyT A1-S-16215 projects.

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