PROCEEDINGS OF SCIENCE

Probing Phenomenological Models Implemented in PYTHIA8

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PYTHIA is a highly successful and well established Monte Carlo event generator, different options of selected physics models offered by PYTHIA8 are investigated using the Minimum Bias published data by ATLAS. These models include a new scenario for Multiparton Interactions (MPI), impact parameter dependence, and color reconnection choices. MPI should be switched on to get reasonable results for hadron-hadron collision data. It is observed that the double Gaussian option in impact parameter dependence is favored by data as compared to other options provided by PYTHIA8. Without the color reconnection model, the Pt spectrum is too soft. This study is quite intriguing to observe the impact of different model options on the description of selected observables.

The Tenth Annual Conference on Large Hadron Collider Physics - LHCP2022
16-20 May 2022
online

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PoS(LHCP2022)262

1. Introduction

Monte Carlo event generators like PYTHIA8 combines theory with phenomenological models to describe a number of physics processes, including hard and soft interactions, initial state parton showers, final state parton showers, multiple parton interactions, fragmentation and decay [8]. In this work we studied different Physics models given by PYTHIA8 [1] to describe their behavior at high energies. PYTHIA offers variety of Physics models which can be selected by so called switches. Each model is defined by certain parameters which are mostly free and need to be tuned [6]. We investigated selected models keeping their free parameter values at default [5] using published data from ATLAS experiment at 7TeV [3]. The choice of models as well as their combinations are totally arbitrary [7] and shown in Figure 1, we investigated different models option for three most sensitive models to the selected data employed in PYTHIA8: Multiple Parton Interactions (MPI) model,five scenarios of Impact-parameter dependence and three models for Color Reconnections. All comparison plots presented in this study are produces by using Rivet toolkit [2]. Minimum bias published data from ATLAS Collaboration at 7TeV were used in this study.

2. MPI Treatment

Since the proton or any other hadron is a composite object, in a head on collision of two hadron there is a probability that more than one pair of partons undergo scatterings, resulting in a higher multiplicity compared to events with only one strong interaction. PYTHIA8 offers this model [4], [9] with switch for multiparton interactions; on/off = true/false

flag PartonLevel:MPI (default = on)

Studies (Figure 2) of the average particle transverse momentum, pT , as a function of the events charged particle multiplicity, charged particle Nch demonstrate that models fail to describe the data if the possibility of multiple parton interactions is neglected. This observable is sensitive to the presence of MPI since a higher multiplicity, which is a result of MPI, result in a lower average pT. In the absence of MPI the average pT shows harder spectrum. The low activity can also be seen in the multiplicity distribution.

3. Impact Parameters Dependence Treatment

We considered five models for this study :

mode MultipartonInteractions:bProfile (default = 3)

Option 0 : no impact parameter dependence at all.

Option 1 : a simple Gaussian matter distribution with no free parameters option.

Option 2 : a double Gaussian matter distribution, with the two free parameters.

Option 3 : an overlap function, the convolution of the matter distributions of the two incoming hadrons.

Option 4 : a Gaussian matter distribution with a width that varies according to the selected x value of an interaction.

Figure 3 shows Data / MC comparison plots for above mentioned five options it is clear that double Gaussian matter overlap describe data better than other models.

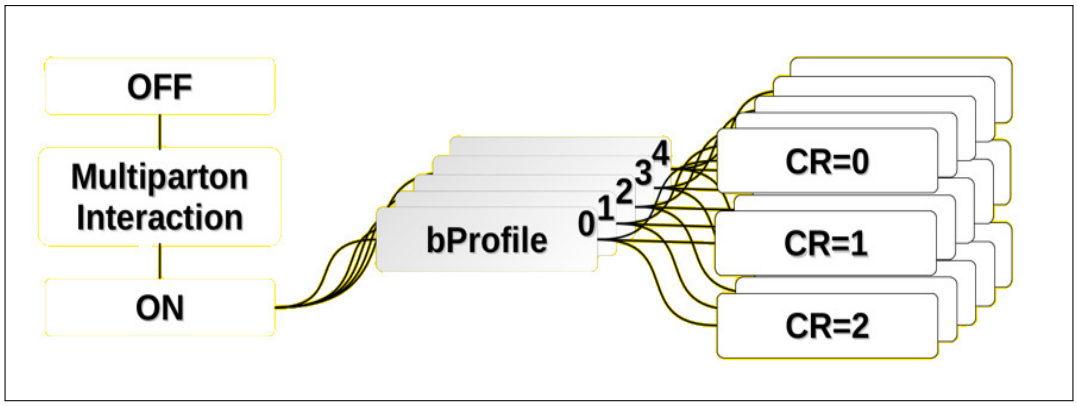

Figure 1: Flow diagram showing selected combination of different models implemented in PYTHIA8 framework

4. Color Reconnection Treatment

The colour flows in the separate subprocesses defined in the multiparton-interactions scenario are tied together via the assignment of colour flow in the beam remnant.
flag ColourReconnection:reconnect (default = on)
Allow or not a system to be merged with another one.
mode ColourReconnection:mode (default = 0; minimum = 0; maximum = 4)
Determine which model is used for colour reconnection. Beware that some settings may need to be changed to match the model selected.
Option 0 : The MPI-based original Pythia 8 scheme.
Option 1 : The new more QCD based scheme. Should be combined with BeamRemnants:remnantMode = 1.
Option 2 : The new gluon-move model.

Figure 4 shows the charged pt distribution and average pt vs charged multiplicity (Nch) appears to be sensitive to the color structure of the events, within the framework of the PYTHIA8 modeling. It is clear from data/MC comparison that to describe data CR should be switched on [7]. Figure 4 shows Data / MC comparison plots using three CR models for all five matter overlap distributions. It is shown that MPI based scheme is more mature and describe data better than other options.

5. Conclusion

Different options of selected physics models offered by PYTHIA8 are investigated using ATLAS Minimum Bias data at 7TeV. New scenario for MPI model should be switched on to get reasonable results for hadron hadron collision data. The matter overlap distribution option with double Gaussian distribution is favored by data as compare to the other options, though the difference is not much but visible at low PT and also at low multiplicity. Without the color reconnection model the Pt spectrum is too soft. The MPI based model provides good results,the other two options for CR model do not show significant differences in the predictions.

References

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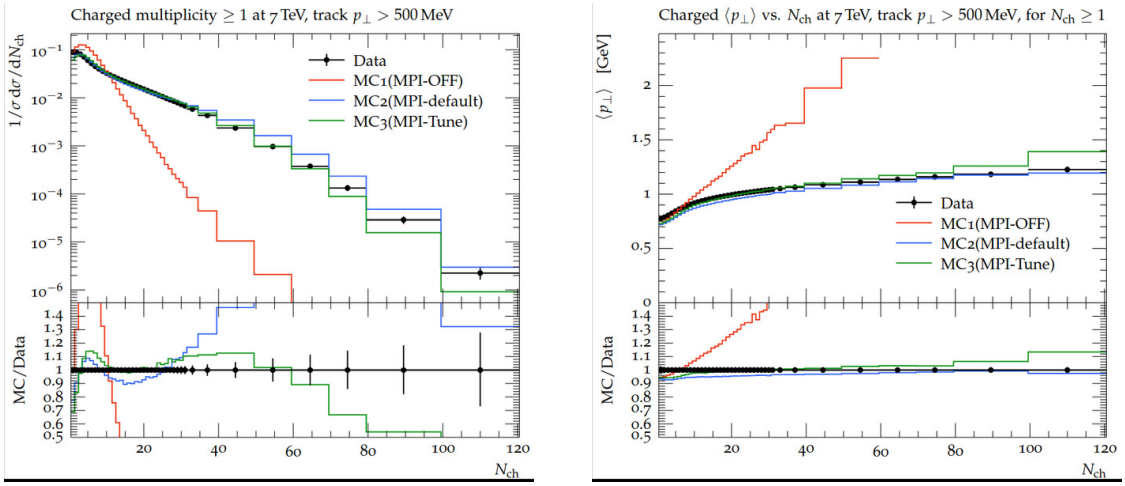

Figure 2: Data / MC comparison plots: charged multiplicity and average pt Vs charged multiplicity distributions at 7 TeV

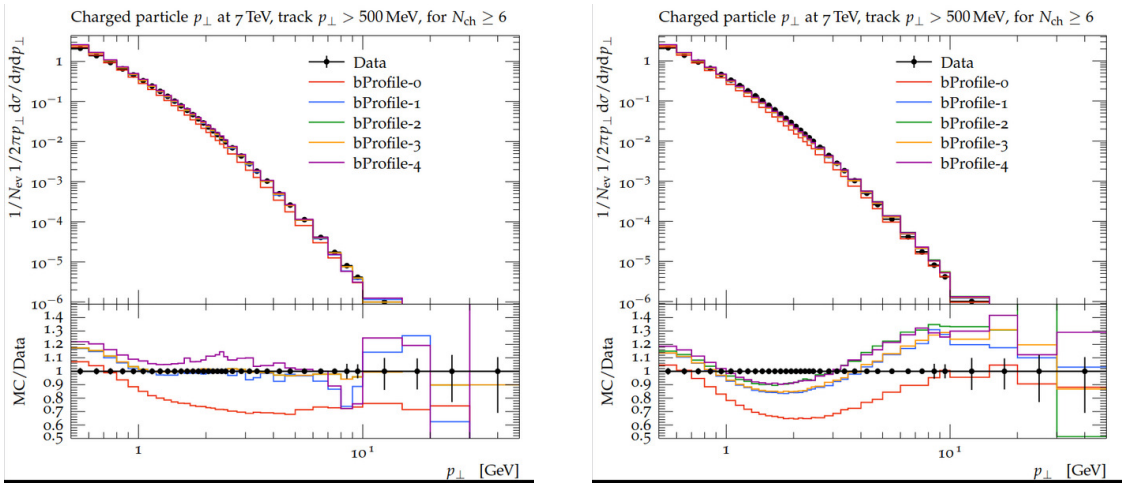

Figure 3: Data / MC comparison plots: Charged pt distributions for different bprofile options at 7 TeV

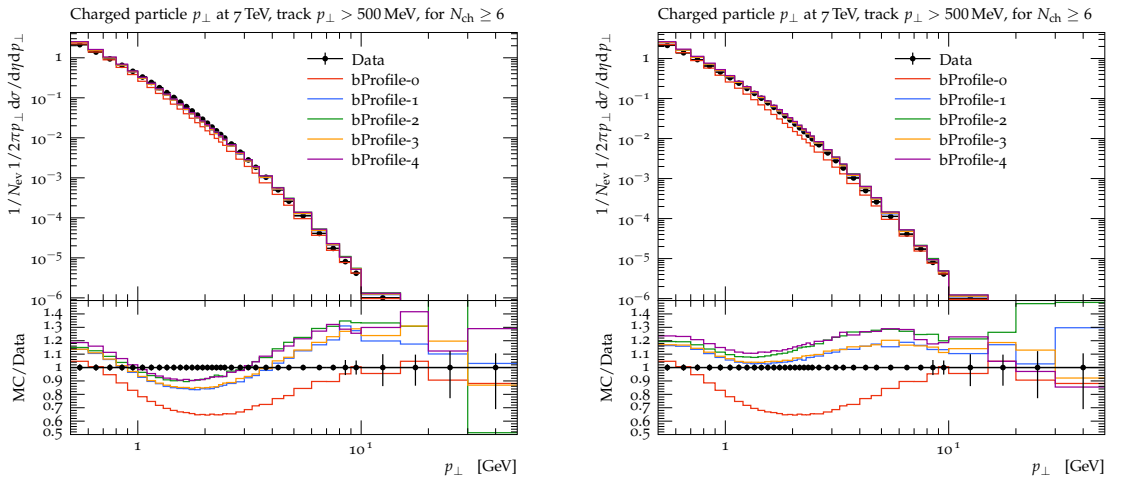

Figure 4: Data / MC comparison plots: charged pt distributions for Color reconnection option 1 and 2 at 7 TeV