Soft and Hard Multiple Parton Interactions

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In the years '80, the evidence for Double Scattering (DS) phenomena in the high-p$_T$ phenomenology of hadron colliders suggests the extension of the same perturbative picture to the soft regime, giving rise to the first implementation of the Multiple Parton Interaction (MPI) processes in a QCD Monte Carlo model by T.Sj $o$strand and M.van Zijl. Such model turns out to be very successful in reproducing the UA5 charged multiplicity distributions and in accounting for the violation of the sensitive Koba Nielsen Olesen scaling violation at increasing center of mass energies.

The implementation of the MPI in the QCD Monte Carlo models is quickly proceeding through an increasing level of sophistication and complexity, still leaving room for different approaches and further improvements like the introduction of a dynamical quantum description of the interacting hadrons providing a modeling of the diffractive interactions in the same context. See the detailed discussion in the introduction of Section IV.

As deeply discussed both in Section I and Section II, considerable progress in the phenomenological study of the Underlying Event (UE) in jet events is achieved by the CDF experiment at the Tevatron collider, with a variety of redundant measurements relying both on charged tracks and calorimetric clusters, the former being intrinsically free from the pile-up effects and achieving a better sensitivity at low p$_T$. Challenging tests to the universality features of the models are provided by the extension of the UE measurement to the Drell Yan topologies and by the additional complementary measurements on MB events dealing with the correlations between charged multiplicity and average charged momentum.

While preparing the ground for the traditional Minimum Bias (MB),Underlying Event (UE) and Double Scattering (DS) measurements at the LHC along the precious Tevatron experience also complemented with the recent UE HERA results, new feasibility studies are proposed which in perspective will constitute a challenge to the predictivity and to the consistency of the models: the usage of jet clustering algorithms providing an automated estimation of the UE activity, the measurement of large pseudo-rapidity activity correlations, the investigation of the mini-jet structure of the MB events, the evaluation of the impact of the MPI on the total cross section.

With the LHC data taking period approaching, the experiments put a lot of emphasis on the physics validation and tuning of the models, in particular for what concerns the energy dependency of the parameters. The tune of the MPI parameters is a very delicate issue which has impact on the calibration of major physics tools like the vertex reconstruction and the isolation techniques.

A significant fraction of the early measurements of ALICE, ATLAS, CMS, LHCb and TOTEM will be affected by the MPI, with most of the LHC feasibility studies shown in these proceedings turned into physics publications in a reasonably short time scale. In other words the MPI will be one of the first features of the LHC physics which will be deeply tested with an high degree of complementarity and redundancy, and we should be ready for possible surprises!