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Multivariate techniques for identifying diffractive interactions at the LHC

Close to one half of the LHC events are expected to be due to elastic or inelastic diffractive scattering. Still, predictions based on extrapolations of experimental data at lower energies differ by large factors in estimating the relative rate of diffractive event categories at the LHC energies.

Measurement of inelastic activity, such as multiplicity and energy flows, in forward and central detector systems can be used to efficiently classify proton–proton collisions. In combination with a powerful multivariate classification algorithm, the measurements will allow the first estimates of the single diffractive, double diffractive, central diffractive and non-diffractive cross sections at the LHC. With such a multivariate approach, one is not dependent on any specific rapidity gap definition of diffraction. Instead, optimal characteristics of each event class are found automatically while training the algorithms with Monte Carlo data.

In this talk, we present two different approaches for an event-by-event classification of forward physics processes at the LHC. We first show that hard classification where each event is unambiguously assigned to a single physics process can efficiently identify diffraction within a large sample of simulated proton–proton scattering events. We compare the performance of neural networks, gene expression programming and support vector machines in hard classification and show that neural networks are able to identify diffraction with the highest accuracy.

In the second part of the talk, we develop a soft classifier for diffraction. In this scheme, each event is assigned to a given class with a certain probability. The estimated class probabilities can then be used to weigh event contributions to physical observables. This approach is more consistent with probabilistic quantum mechanics and ensures the correct treatment of events lying in areas of the data space where different classes are overlapping.

Primary authors: Mr MALMI, Eric (Helsinki Institute of Physics); Mr KUUSELA, Mikael (Helsinki Institute of Physics); Mr ORAVA, Risto (Helsinki Institute of Physics); Mr VATANEN, Tommi (Helsinki Institute of Physics)

Co-authors: Mr LÄMSÄ, Jerry W. (Helsinki Institute of Physics); Mr MEHTÄLÄ, Petteri (Helsinki Institute of Physics)

Presenter: Mr KUUSELA, Mikael (Helsinki Institute of Physics)

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