Tevatron QCD for Cosmic-Rays

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1. Introduction

The two multi-purpose experiments DØ [1] and CDF [2] are operated at the Tevatron collider, where proton anti-proton collisions take place at a centre of mass energy of 1.96 TeV in Run II. In the kinematic plane of Q^2-scale and (anti-)proton momentum fraction x, Tevatron jet measurements cover a wide range, with phase space regions in common and beyond the HERA ep-collider reach. The kinematic limit of the Auger experiment is given by a centre of mass energy of 100 TeV. Cosmic rays cover a large region of the kinematic phase space at low momenta x, corresponding to forward proton/diffractive physics and also at low scales, corresponding to the hadronisation scale and the underlying event. Therefore of particular interest are exclusive and diffractive measurements as well as underlying event, double parton scattering and minimum bias measurements. The kinematic limit of the Tevatron corresponds to the PeV energy region below the knee of the differential cosmic particle flux energy distribution. The data discussed here are in general corrected for detector effects, such as efficiency and acceptance. Therefore they can be used directly for testing and improving existing event generators and any future calculations/models. Comparisons take place at the hadronic final state (particle level).

2. Exclusive, diffractive and underlying event measurements

In particular for elastic and exclusive production measurements [3][4] forward proton detectors, which cover a pseudorapidity range of up to $|\eta| \lesssim 8$ and momentum fractions of $0.03 < \xi \lesssim 0.10$ are useful, to detect the intact (anti-)proton. Many further analyses of exclusive and diffractive production [5] [6] [7] [8] [9] [10] [11] have been accomplished. Underlying event, double parton scattering and minimum bias studies have been addressed by the measurements [12] [13] [14] [15] [16] and [17]. The studies have been pioneering work in many cases. Methods have been established which are widely used by LHC experiments today. The measurements have provided very important input to theorists, in particular with respect to non-perturbative QCD physics, where phenomenological models are varying considerably. Most prominently the breakdown of factorisation between HERA and Tevatron has been established [7]. The double Pomeron exchange mechanism offers the possibility to study the exclusive Higgs production at the LHC, where predictions did vary by a factor of 1000 before the CDF measurement [7]. Already in Run I CDF has provided useful input for diffractive parton distribution functions.

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