Abstract

The forward proton spectrometer of H1, comprising two stations 81 and 90 m downstream the interaction point, was operated for the first time in 1995 with full instrumentation. An integrated luminosity of 2.4 pb^{-1} has been collected.

Due to the known deflection in the magnets of the HERA machine a measurement of a scattered proton's trajectory with respect to the circulating beam allows to reconstruct its energy E'_p and scattering angle θ at the interaction point. The global uncertainty of the energy measurement amounts to 8 GeV. Offset and tilt of the beam are derived from the data by a calibration procedure.

In this thesis deep inelastic ep–scattering with forward scattered protons in the energy range between 580 and 740 GeV and transverse momenta $p_\perp < 200\,MeV$ has been studied for the first time in H1. The triple differential cross section $\frac{\mathrm{d}^3\sigma\,(ep\to e'p'X)}{\mathrm{d}x\,\mathrm{d}Q^2\,\mathrm{d}x_{\mathbb{P}}}$ has been measured and parametrized with the structure function $F_2^{LP\,(3)}$ ($x_{\mathbb{P}} = 1 - E'_p/E_p$ is the fraction of the proton's momentum that enters the ep scattering process).

In the region $0.1 < x_{\mathbb{P}} < 0.3$ covered by the measurement the events under study can be interpreted as electron scattering off the proton's pion cloud. A factorisation of the form $F_2^{LP(3)}\,(\beta,\, Q^2,\, x_{\mathbb{P}}) = f_{\pi^0/p}\,(x_{\mathbb{P}}) \cdot F_2^{\pi^0}\,(\beta,\, Q^2)$ is expected to hold, where $f_{\pi^0/p}$ describes the flux of virtual pions and $F_2^{\pi^0}\,(\beta,\, Q^2)$ their structure; $\beta = x/x_{\mathbb{P}}$ is the momentum fraction carried by the interacting quark in the pion. The data are well described by this ansatz and are compatible with the parametrization of the pion structure function by Glück, Reya, and Vogt. In the region $3.7\cdot10^{-4} < \beta < 2.7\cdot10^{-2}$ and $2.6\,\mathrm{GeV}^2 < Q^2 < 28.6\,\mathrm{GeV}^2$ covered by this analysis a rise of $F_2^{LP\,(3)}$ with $\log Q^2$ and towards low β is observed. The Monte Carlo generator RAPGAP implements a π^0 exchange model; it describes the shape of $x, Q^2, x_{\mathbb{P}}$–distribution of the data well, the pedicted cross section is, however, low by a factor of 1.85.

In models not based on meson exchange like the soft colour interaction model β is not necessarily the appropriate scaling variable. It is observed that a factorization of the form $F_2^{LP(3)}\,(x,\, Q^2,\, x_{\mathbb{P}}) = f\,(x_{\mathbb{P}}) \cdot F\,(x,\, Q^2)$ is compatible with the data as well (x being the proton's momentum fraction carried by the quark). A proportionality of $F_2^{LP(3)}\,(x,\, Q^2,\, x_{\mathbb{P}})$ with the proton structure function $F_2\,(x,\, Q^2)$ is, however, excluded at 99 % confidence level.

The soft colour interaction model as implemented in the Monte Carlo generator LEPTO predicts the size of the cross section at small Q^2 correctly but underestimates the rise of $F_2^{LP\,(3)}$ with Q^2.