DIFFERENTIAL CHARGED CURRENT CROSS-SECTIONS AT HERA

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H1 COLLABORATION

Recent results on high Q^2 Charged Current interactions obtained by the H1 and ZEUS Collaborations are reported, using e^-proton and e^+proton interaction data collected in 1993, 1994 and 1995 at the HERA collider. The M_W propagator mass is extracted from the Q^2 dependence of the cross-sections. The differential cross-sections as function of the Bjorken variables x and y behave as expected from the standard model when comparing either the e^+p and e^-p data, or the valence and sea dominated regions.

1 Theoretical aspects

Within the parton model, the differential Charged Current (CC) cross-section has three main components: the Fermi coupling constant G_F, the propagator term, and the quark densities within the proton. The second term is sensitive to the W mass. The third one gives access to the quark/antiquark flavours and to the V-A helicity structure of the weak interaction, manifest in a different behaviour as function of y of the quark and anti-quarks components.

$$\frac{d^2\sigma(e^-p)}{dxdQ^2} = \frac{G_F^2}{2\pi}\left(\frac{1}{1+Q^2/M_W^2}\right)^2 \left[\ (u+c) + \ (1-y)^2(\bar{d}+\bar{s})\ \right] \tag{1}$$

$$\frac{d^2\sigma(e^+p)}{dxdQ^2} = \frac{G_F^2}{2\pi}\left(\frac{1}{1+Q^2/M_W^2}\right)^2 \left[\ (\bar{u}+\bar{c}) \ + \ (1-y)^2(d+s)\ \right] \tag{2}$$

2 Experimental aspects: Detectors and Selections

The results presented here are based on data collected in 1993 (e^-proton collisions), 1994 (e^-proton followed by e^+proton collisions) and 1995 (e^+proton collisions, shown as preliminary results by H1 only). A detailed description of the H1 and ZEUS detectors can be found in [1] and [2] respectively.

The selection of the high Q^2 CC candidates relies on two main criteria : a vertex formed by the tracks of the outgoing jet(s) and a large missing transverse momentum, $\not{P}_t$, due to the unobserved outgoing neutrino. Since the hadronic information is the only one available, the Jacquet-Blondel [3] method is used to compute the kinematical variables from the calorimeter cells (Liquid Argon for H1 and compensating Uranium Scintillator for ZEUS). The high $\not{P}_t$ cut required by the two experiments reduces the photoproduction background induced by events with high energy jets measured as unbalanced in P_t. H1 chooses a cut at $\not{P}_t > 25$ GeV. ZEUS reduces this value to 11 GeV adding another cut based on the hadronic system topology: $\frac{P_t}{E_t} > 0.4$. Both experiments remove cosmic and halo muons induced background using timing information (from central trackers and Liquid Argon trigger for H1, from scintillators for ZEUS) and topological patterns. The remaining background is discarded by visual scanning.

The final CC samples are corrected for trigger and selection efficiencies as calculated from Neutral Current data and/or Monte-Carlo simulations. The differential cross-sections are unfolded for experimental effects, using detailed simulations of the detector response.

3 Results and interpretation

The final sample statistics (still preliminary for 1995) is summarized in table 1.

Table 1: Luminosity and Number of CC's selected by the H1 and ZEUS experiments.

		e^- 93 + 94	e^+ 94	e^+ (prel.) 95
$\mathcal{L}$	H1	0.7	2.7	3.7
(pb^{-1})	ZEUS	0.8	2.9	-
Nb of	H1	25	47	58
CC's	ZEUS	30	56	-

3.1 Propagator mass

At high Q^2, the CC cross-sections measured by H1[5] and ZEUS[6] are about a factor 3 higher for e^-p interactions compared to e^+p interactions. This is in agreement with the excess of u quarks over d quarks within the proton, together with the different helicity sensitivity of the e^+p and e^-p weak interactions (equations (1) and (2)).

Using Log-likelihood fits with M_W as a free parameter, both experiment extract the propagator mass M_W from the shapes and normalizations of the differential Q^2 cross-sections in e^+p and e^-p collisions. The combined result yields :

$$m_W^{HERA} = 82^{+6+3}_{-5-3} \text{ GeV}$$

where the errors from both experiments are added in quadrature, the first error being statistical and the second one systematical.

The mass of the propagator corresponds to the on-shell W mass measured[4] at the Tevatron : 80.22 ± 0.26 GeV.

3.2 Differential cross-sections : $\frac{d\sigma}{dx}$ and $\frac{d\sigma}{dy}$

The ZEUS Collaboration extracts the differential x cross-section for both e^+p and e^-p data (Figure 1). At low x ($x \leq 0.02$), e^+p and e^-p cross-sections are of comparable magnitude, as expected from the domination of the sea component, for which e^+ and e^-'s have the same sensitivity. At higher x, there is evidence for a faster decrease of the e^+p cross-section compared to the e^-p cross-section, due to the excess of u over d valence quarks within the proton. The measured x-distributions are in agreement with the MRSA parametrisation shown in Figure 1.

Both experiments also measure the differential y cross-sections. Figure 2 shows the preliminary result obtained by the H1 Collaboration, combining e^+p data collected in 1994 and 1995. The distribution shows the expected rise at low y, due to the helicity sensitivity of the dominating d-quark contribution (equation (2)).

The different helicity sensitivity of the quark and anti-quark components can be used to extract their relative contributions. The potential of this method is illustrated in figure 3, which shows the raw y distributions (not unfolded for detector response) obtained by the H1 Collaboration in 2 x-domains. As expected from equation (2), the y distribution is steeper in the valence dominated region ($x > 0.1$) than in the sea domain ($x < 0.1$).

References

1. H1 Collab. , DESY H1-96-01, (1996).
2. ZEUS Collab., *Phys. Lett.* B **293**, 465 (1992).
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4. L. Montanet *et al.*, *Phys. Rev.* D **50**, 1173 (1994)
5. H1 collab., DESY 96-046, (1996).
6. ZEUS Collab., DESY 96-104, (1996).

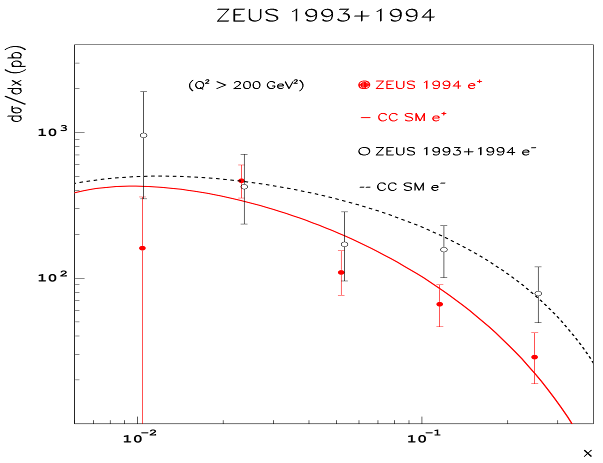

Figure 1: ZEUS differential CC cross-sections as function of x for e^+p and e^-p interactions.

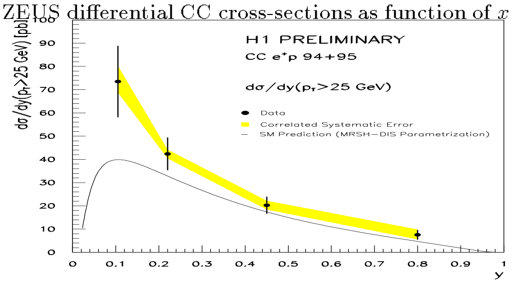

Figure 2: Preliminary H1 e^+p differential CC cross-section as function of y (not bin-center corrected).

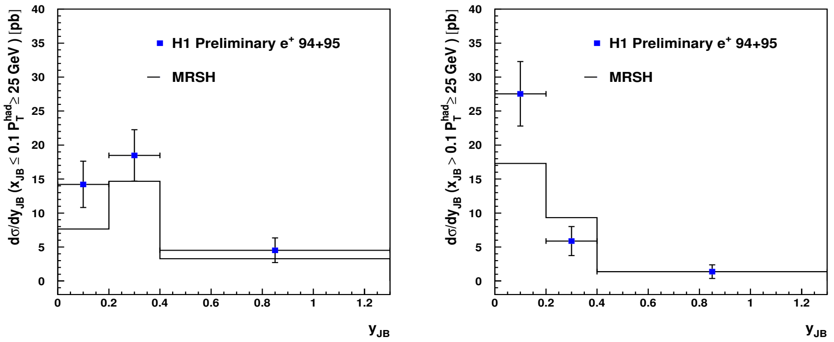

Figure 3: Preliminary H1 e^+p differential CC cross-sections as function of the measured y_{JB} (not unfolded for detector response) for $x_{JB} < 0.1$ and $x_{JB} > 0.1$.