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EVENT SHAPES IN DIS AT H1

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We report preliminary results on differential distributions of event shape variables in deep-inelastic ep scattering, taken with the H1 detector at HERA. We also compare the results on two-jet event shapes with resummed NLO perturbative QCD predictions and power law hadronization corrections. Three-jet event shapes and jet rates are compared to predictions obtained with the RAPGAP Monte Carlo generator.

1 Introduction

Hadronic final states in deep-inelastic ep scattering (DIS) provide an ideal environment to study perturbative QCD predictions and non-perturbative hadronization contributions over a wide range of momentum transfer Q in a single experiment. The study of event shape variables in DIS allows for a determination of the strong coupling constant α_s and a test of power corrections for the non-perturbative contributions [1]. The H1 Collaboration already published an analysis of mean event shape variables in [2]. In this talk, we emphasize the analysis of differential distributions of event shapes in DIS. The analysis is based on an integrated luminosity of 112 pb^{-1} taken with H1 detector [3] in the years 1995-2000. The data cover the phase space $14\,\mathrm{GeV} < Q < 200\,\mathrm{GeV}$ in momentum transfer and $0.1 < y < 0.7$ in inelasticity. More details on this analysis can be found in [4].

In the hadronic final state of a DIS event, there is the remnant of the initial proton, i.e. the proton constituents that did not participate in the hard scattering. We have to separate the proton remnant from the particles originating from the hard scattered parton. As a convenient method, the results are reported in the Breit frame of reference, where the proton remnant is maximally separated from the scattered quark or gluon. The current hemisphere of the Breit frame is analogous to a single hemisphere in e^+e^- annihilation [1,2].

The theory calculations for the event shapes are performed to NLO in α_s, are resummed to NLL and are matched to power corrections. They are taken from [5]. The power corrections result in a shift for the differential distribution

$$\frac{d\sigma(F)}{dF} = \frac{d\sigma^{pQCD}(F - a_F\mathcal{P})}{dF}, \qquad (1)$$

where a_F can be calculated perturbatively. The power correction term $\mathcal{P}$ is assumed to be universal for the observable and the process, and to have only two free parameters: $\alpha_s(Q)$ and $\bar{\alpha}_0(\mu_I = 2\,\mathrm{GeV})$.

2 2-jet Event Shape Variables

The studied 2-jet event shape variables are two kinds of thrust, τ and τ_C, the jet broadening B, the jet mass ρ and the C-parameter. These are defined for the particles in the current hemisphere (CH) alone, and the formulae are shown in table 1. More details can be found in [2,4].

2-jet event shape variable		Definition
Thrust	τ	$1-(\sum_h \lvert p_{zh}\rvert)/(\sum_h \lvert p_h\rvert)$
Thrust related to the thrust axis	τ_C	$1-(\sum_h \lvert p_h \cdot n_T\rvert)(\sum_h \lvert p_h\rvert)$
Jet broadening	B	$(\sum_h \lvert p_{\perp h}\rvert)(\sum_h \lvert p_h\rvert)$
Jet Mass (massless in the p-scheme)	ρ	$(\sum_h p_h)^2/(2\sum_h \lvert p_h\rvert)^2)$
C-parameter	C	$(3\sum_{h,i} \lvert p_h\rvert\lvert p_i\rvert \sin^2\theta_{hi})/(2(\sum_h \lvert p_h\rvert)^2)$

Table 1. The definitions for the five 2-jet event shape variables

We show the measured distributions for thrust (τ and τ_C) in figures 1, where the experiment data are compared with the results of a fit based on NLO QCD including resummation and power corrections. The predictions are shown with dashed lines for those data points which were not included in the fit. A good description of the data by the QCD prediction is evident for higher Q, while for lower Q the distributions are not always well described. The measured jet broadening, jet mass and the C-parameter (not shown here) also prove the same conclusion [4].

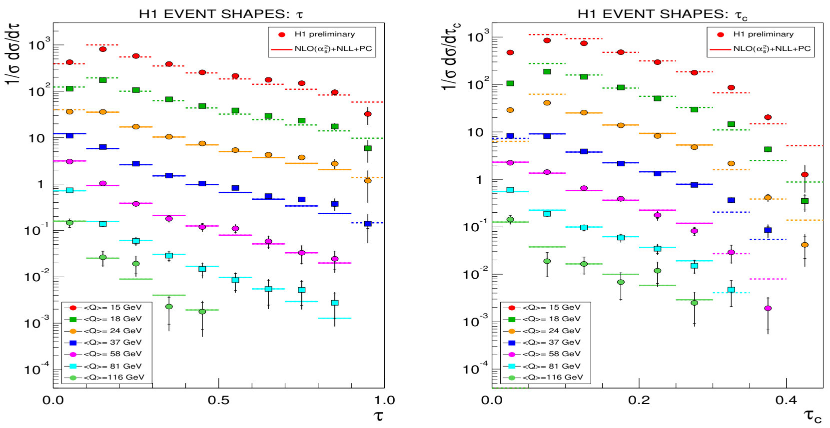

Figure 1. The distributions for two different definitions of thrust

The fitted results for the parameters $\alpha_s(m_Z)$ and $\bar{\alpha}_0(\mu_I = 2\,\mathrm{GeV})$ in the form of 1σ contours are shown in figure 2. The world average of α_s [6] is shown as a band for comparison. A negative correlation coefficient between α_s and $\bar{\alpha}_0$ is observed for all five 2-jet event shape variables. The value of $\bar{\alpha}_0(\mu_I = 2\,\mathrm{GeV})$ is found to be 0.5 with uncertainties of around 10%, in agreement with a previous analysis [2]. The fitted value of α_s is also consistent with the world average of α_s.

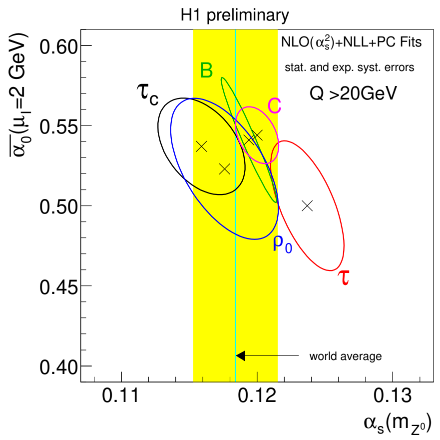

Figure 2. The fitted values of α_s and $\bar{\alpha}_0(\mu_I = 2GeV)$ in form of 1σ contours for the 2-jet event shape differential distributions. The α_s band is taken form [4].

3 3-jet Event Shape Variables

The measured 3-jet event shape variables are the out-of-event-plane momentum $K_{\rm out}$ [7] and the azimuthal correlation χ [8], which have first non-zero contributions at order α_s^2. $K_{\rm out}$ is defined through $K_{\rm out}/Q \equiv 1/Q \sum' |p_h^{\rm out}|$, where $p_h^{\rm out}$ is the out-of-event-plane momentum of hadron h with the event plane formed by the proton momentum in the Breit frame and the thrust major axis. The sum indicated by $\sum'$ extends over all hadrons with pseudo-rapidity less than 3 in the Breit frame. The azimuthal correlation between hadrons h and h' is defined as $\pi - |\phi_h - \phi_{h'}|$, where the observable is constructed by summing over all hadron pairs with a weight $p_{th}p_{th'}/Q^2$. The azimuth of hadron h in the Breit frame is denoted by ϕ_h.

We show the measured distributions of $K_{\rm out}$ and χ in figure 3, together with the RAPGAP Monte Carlo, which uses the LO matrix elements together with parton showers. It is found that $K_{\rm out}$ and χ are well described by RAPGAP.

4 Jet Rates

In the study of jet rates we use the k_t clustering algorithm [9] in its exclusive mode. Here, the jet rate y_n is defined as the value of the cut parameter y_{cut} in the jet finder, at which the transition from $(n+1)$ jets to n jets occurs. Figure 4 shows the distributions of the 2-jet, 3-jet and 4-jet rates. The Monte Carlo program NLOJET++ is able to calculate 2- and 3-jet cross sections at NLO level, and 4-jet cross sections at LO level. We compare the data with NLOJET++ only for y_2 and y_3. NLOJET++ gives a good description of y_2 and y_3 for $Q \geq 24$ GeV. The jet rate y_4 is well described by the RAPGAP Monte Carlo.

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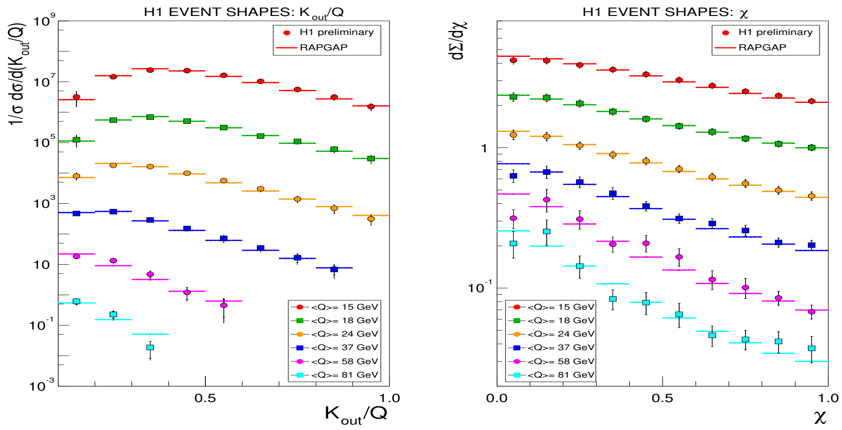

Figure 3. The out-of-event-plane momentum K_{out} and azimuthal correlation χ.

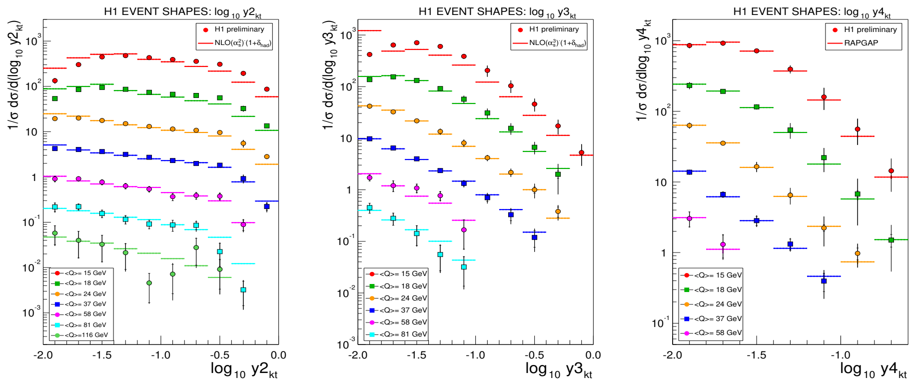

Figure 4. The 2-jet, 3-jet and 4-jet rate

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