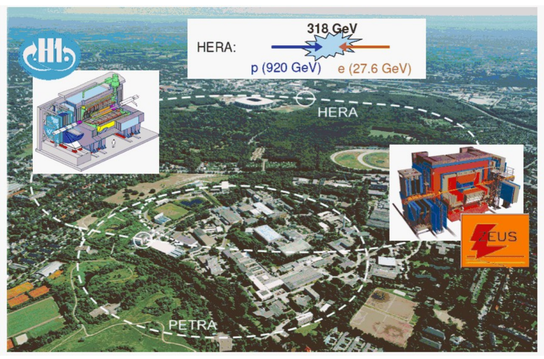
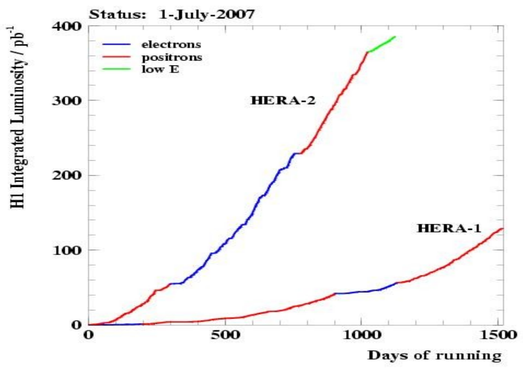
New Results from the H1 Experiment at HERA

Voica Radescu on behalf of the H1 collaboration





HERA 1: 1994-2000
Integrated luminosity: e^-p ~ 14 pb^{-1}
e^+p ~ 106 pb^{-1}

HERA 2: 2003-2007
Integrated luminosity: e^-p ~ 184 pb^{-1}
e^+p ~ 294 pb^{-1}

Polarized $e^\pm$ beams in both left-hand and right-hand modes

March 20, 2007: Start of Low Energy Run:
Ep = 460 GeV: 12.5 pb^-1
Ep = 575 GeV; 6.5 pb^-1

June 30, 2007: HERA shut down

Direct measurement of F_L will provide new constraint on gluon density.

DIS kinematics:

$Q^2 = -q^2 = -(k-k')^2$

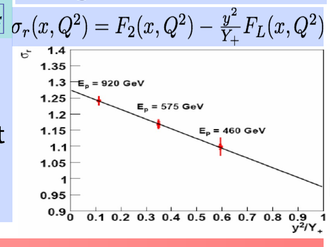
$x = \frac{Q^2}{2p\cdot q}$ $y = \frac{p\cdot q}{p\cdot k}$

$s = (p+k)^2$ $Q^2 = x\cdot y\cdot s$

$Y_\pm = 1 \pm (1-y)^2$

F_L can be obtained by measuring σ_r at the same x, Q^2 for different beam energies.

$\sigma_r(x,Q^2) = F_2(x,Q^2) - \frac{y^2}{Y_+}F_L(x,Q^2)$



Inclusive Measurements: Neutral Current cross section, electroweak parameters

Neutral Current Cross Section:

$$\frac{\sigma^2_{NC}(e^\pm p)}{dxdQ^2} = \frac{2\pi\alpha^2}{xQ^4}Y_+\underbrace{\left(\tilde{F}_2 - \frac{y^2}{Y_+}\tilde{F}_L \mp \frac{Y_-}{Y_+}x\tilde{F}_3\right)}_{\sigma_r^{NC}(x,Q^2)}$$

$\sigma_r^{NC}(x,Q^2)$ → NC reduced cross section

$\tilde{F}_2$: Dominant contribution; $\frac{y^2}{Y_+}\tilde{F}_L$: Sizable at high y; $\frac{Y_-}{Y_+}x\tilde{F}_3$: Contributes only at high Q^2

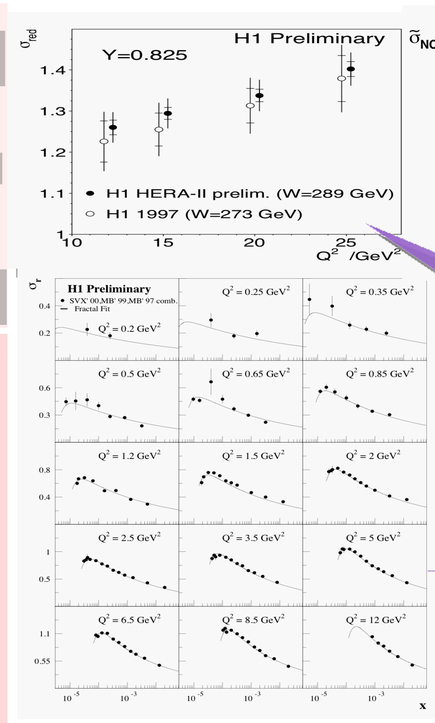
Charged Current Cross Section:

$$\frac{\sigma^2_{CC}(e^\pm p)}{dxdQ^2} = \frac{G_F^2}{2\pi x}\frac{M_W^4}{Q^2+M_W^2}\underbrace{\left(Y_+W_2 - y^2W_L \mp Y_-xW_3\right)}_{\sigma_r^{CC}(x,Q^2)}$$

$\sigma_r^{CC}(x,Q^2)$ → CC reduced cross section

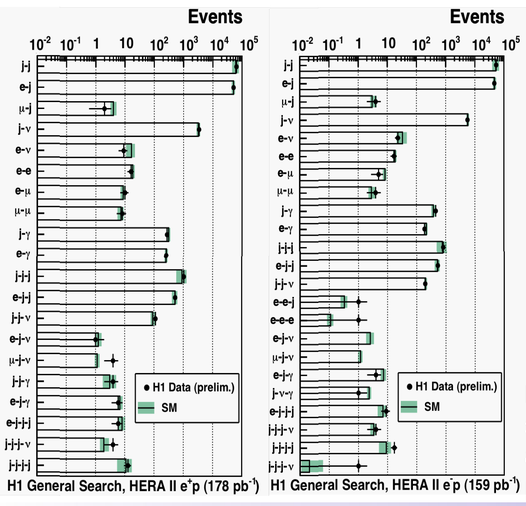
A wealth of new precision measurements (HERA II) covering the (x,Q^2) kinematic plane were performed:

(a) At very low Q^2<10 GeV².
(b) At high y (y>0.6) and low Q^2: sensitivity to F_L.
(c) At high y (y>0.6) and medium Q^2: sensitivity to F_L.
(d) Combined H1 and ZEUS measurement of $xF_3^{\gamma Z}$ compared to NLO QCD fits to H1 inclusive data and to inclusive jet ZEUS data.
(e) First observation of parity violation in γ-Z interference in NC $e^\pm p$ data at R down to 10^{-18} m (at high Q^2).
(f) The high Q^2 $e^\pm p$ H1 data are used to extract the axial and vector weak couplings of u and d quarks to the Z boson.
(g) The NC cross section at high Q^2 is measured using full $e^\pm p$ H1 data.

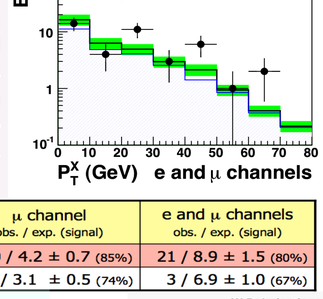


Rare Processes and Searches: Isolated leptons with high P_T, W polarisation, General searches, Multileptons, Single Top production

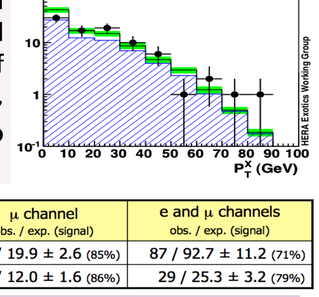
A general search of all classes containing at least two objects such as: e, μ, γ, jet, ν, over phase space: P_T>20GeV, 10<θ<140 was performed at H1. Very good agreement with SM was found.



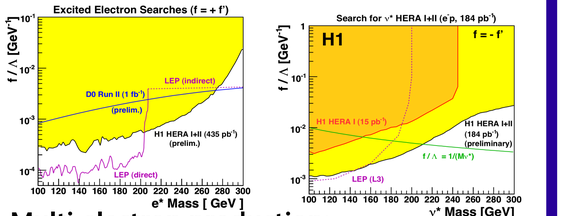
Events containing isolated leptons (e,μ) and missing transverse momentum (P_T) are observed by H1 in the full $e^\pm p$ data sample (1994-2007). Agreement between data and the SM is seen in the e^-p data, but a 3σ excess of data events over the SM prediction at large hadronic P_T is seen in the e^+p data - an observation not confirmed by ZEUS.



A combined H1 and ZEUS analysis is performed over a common phase space. A total of 87 events are observed compared to SM prediction of 92.7±11.2. At large P_T>25 GeV, 23 events are observed in e^+p data compared to 14 by SM.



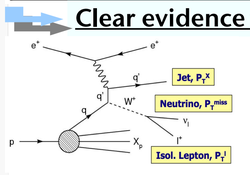
Searches for e^* (left) and ν^* (right) are performed using the full H1 data sets. Mass dependent exclusion limits are determined for the ratio of the coupling to the compositeness scale, f/Λ.



H1 HERA I+II P_T^X > 25 GeV	e channel obs. / exp. (signal)	μ channel obs. / exp. (signal)	e and μ channels obs. / exp. (signal)
e^+p data (294 pb^{-1})	11 / 4.7 ± 0.9 (75%)	10 / 4.2 ± 0.7 (85%)	21 / 8.9 ± 1.5 (80%)
e^-p data (184 pb^{-1})	3 / 3.8 ± 0.6 (61%)	0 / 3.1 ± 0.5 (74%)	3 / 6.9 ± 1.0 (67%)

H1+ZEUS $e^\pm p$ data HERA I+II (0.97 fb^{-1})	e channel obs. / exp. (signal)	μ channel obs. / exp. (signal)	e and μ channels obs. / exp. (signal)
Full sample	64 / 72.9 ± 8.9 (67%)	23 / 19.9 ± 2.6 (85%)	87 / 92.7 ± 11.2 (71%)
P_T^X > 25 GeV	16 / 13.3 ± 1.7 (73%)	13 / 12.0 ± 1.6 (86%)	29 / 25.3 ± 3.2 (79%)

Clear evidence for W production

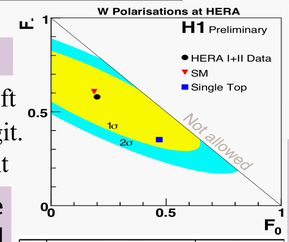


Measured W cross sections are in good agreement with SM predictions.

W polarisation fractions:

$$\frac{dN}{d\cos\theta^*} \propto (1-F_- - F_0)\cdot\frac{3}{8}(1+\cos\theta^*)^2 \text{ left}$$
$$+ F_0\cdot\frac{3}{4}(1-\cos^2\theta^*) \text{ longit.}$$
$$+ F_-\cdot\frac{3}{8}(1-\cos\theta^*)^2. \text{ right}$$

Polarisation fractions are in agreement with SM predictions.

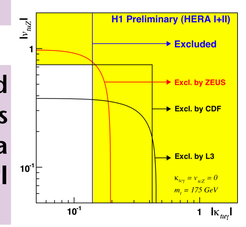


H1	HERA I+II Data	SM
F_-	0.58 ± 0.15 (stat) ± 0.12 (sys)	0.61 ± 0.01 (stat)
F_0	0.15 ± 0.21 (stat) ± 0.09 (sys)	0.19 ± 0.01 (stat)

A search for single top production was performed at H1. An upper limit on the cross section is found to be :

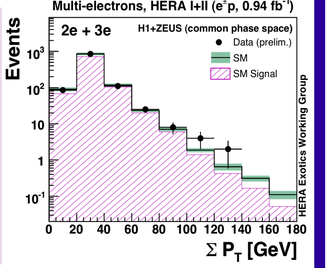
$\sigma_{ep\to etX} < 0.16$ pb, $\kappa_{tu\gamma} < 0.14$,

(at 95% CL). Investigated model considers anomalous prediction of top quarks in a Flavour Changing Neutral Current process.

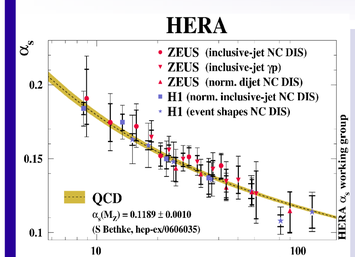


Multi-electron production:

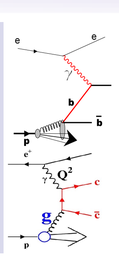
Yields of ee and eee events are measured by H1 and ZEUS. A good agreement is found with the Standard Model (SM) predictions.



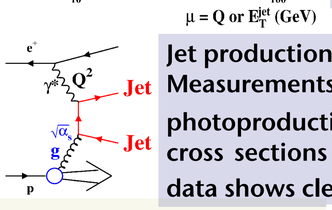
Hadronic Final States: Jet and Event Shapes, Heavy Quark Production



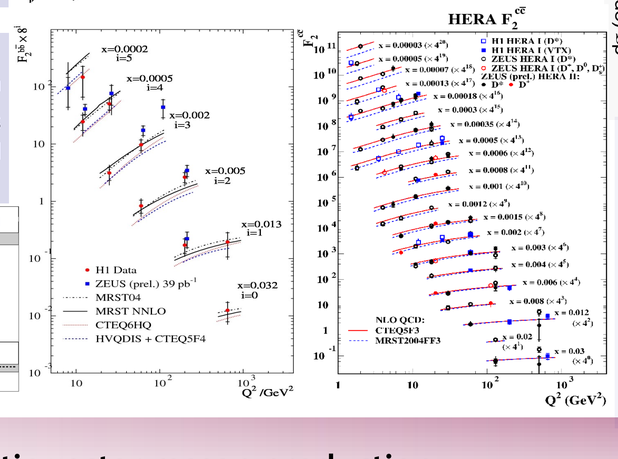
Most precise H1 and ZEUS combined α_S determination using recent inclusive-jet cross-section measurements in NC DIS at high Q^2. The average value is found to be: $\alpha_S(M_Z)$=0.1198±0.0032.

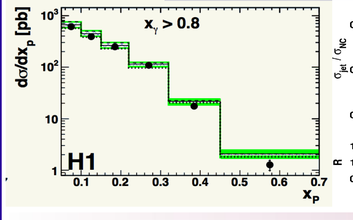


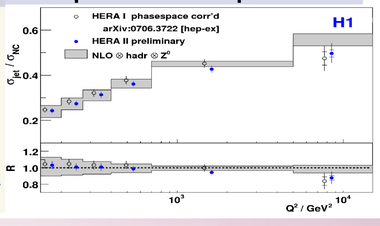
Measurement of F_2^{bb} and F_2^{cc} at H1:
are performed for a wide range in Q^2 and x using the impact parameters of track from decays of long lived b and c hadrons as reconstructed from the vertex detector. The results agree with QCD predictions.



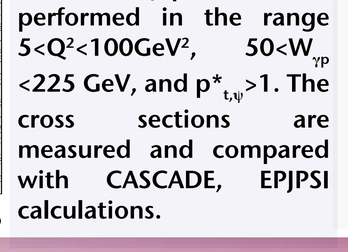
Jet production in DIS at HERA:
Measurements of high P_T dijets in photoproduction (HERA I) and Inclusive jets cross sections at high E_T using full HERA II data shows clear improvement in precision.



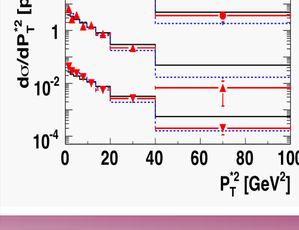


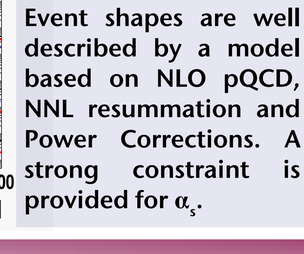


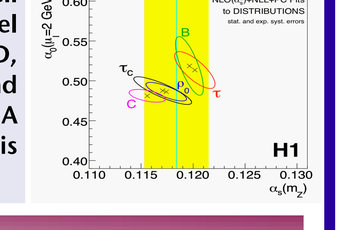
A measurement of inelastic J/ψ production is performed in the range $5<Q^2<100$GeV², $50<W_{\gamma p}<225$ GeV, and $p^*_{t,\psi}>1$. The cross sections are measured and compared with CASCADE, EPJPSI calculations.



Inclusive production of D* mesons is studied in DIS. The visible range for the D* is $P_t(D^*)$>1.5 GeV and $|\eta(D^*)|$ <1.5. Cross-sections are compared to predictions from NLO HVQDIS and LO RAPGAP and CASCADE calculations.

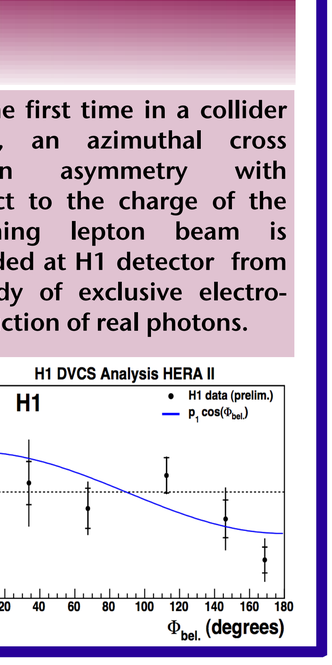




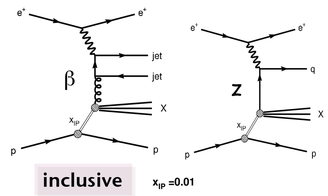


It broadly supports qua fragmentation universality between e^+e^- and ep.

Event shapes are well described by a model based on NLO pQCD, NNL resummation and Power Corrections. A strong constraint is provided for α_s.



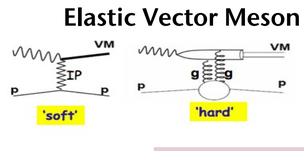
Diffraction: Inclusive dijets, elastic vector meson production



Diffractive PDFs are obtained from NLO fits to the diffractive dijet cross-sections (examples are shown in the left bottom). The extracted diffractive PDF's are dominated by the gluon component.

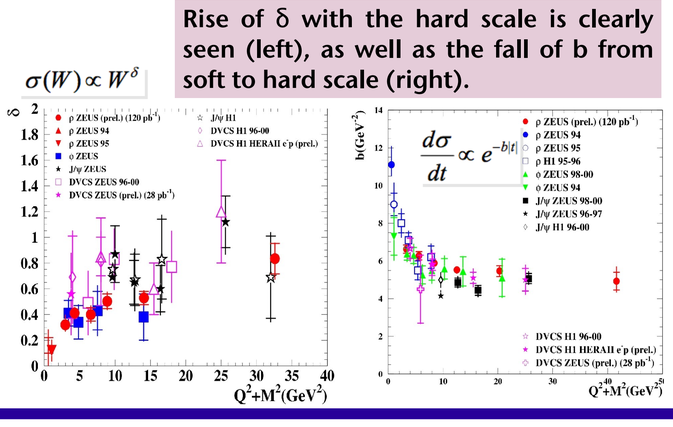
Diffractive scattering is studied in DIS (Q^2>4GeV²) and in photoproduction (Q^2>0.01 GeV²). Dijet production is measured and compared to NLO perturbative QCD calculations which are based on the diffractive proton structure extracted in inclusive diffractive DIS. QCD factorization breaks down in photoproduction where the prediction needs a ~0.5 suppression factor to describe the dijet measurement at H1.

Elastic Vector Meson Production at HERA:

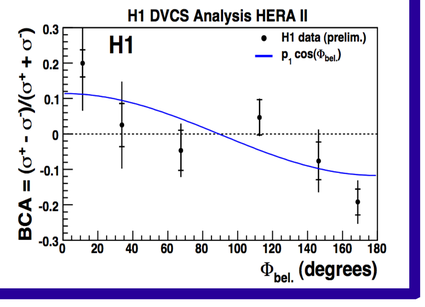


Rise of δ with the hard scale is clearly seen (left), as well as the fall of b from soft to hard scale (right).

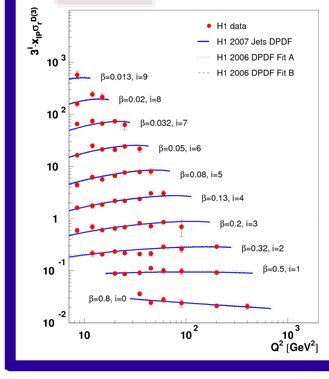
$\sigma(W) \propto W^\delta$



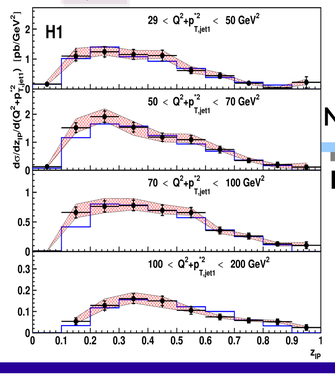
For the first time in a collider mode, an azimuthal cross section asymmetry with respect to the charge of the incoming lepton beam is recorded at H1 detector from a study of exclusive electro-production of real photons.



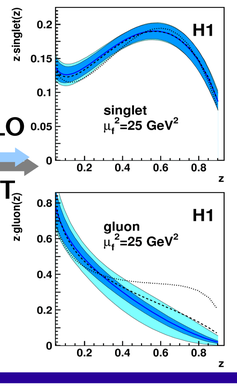
inclusive x_{IP} =0.01

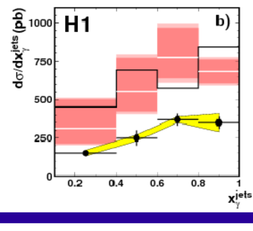


dijet



NLO → FIT





H1 Diffractive Dijet Photoproduction
H1 Data
correlated uncertainty
H1 2006 Fit B DPDF
FR NLO×(1+δ_{had})
FR NLO