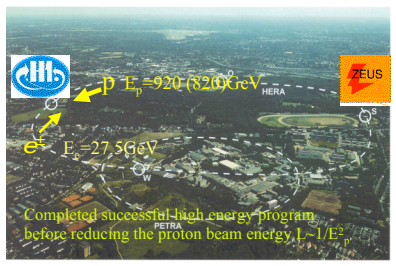
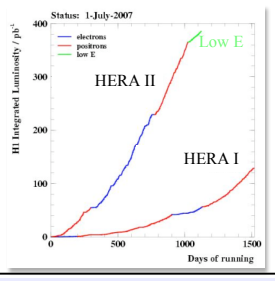
New QCD Results from the H1 Experiment at HERA

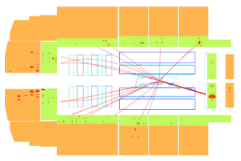
Biljana Antunovic on behalf of the H1 Collaboration



HERA I 1994-2000
integrated luminosity e^-p~14pb^{-1}
e^+p~106pb^{-1}
HERA II 2003-2007
integrated luminosity e^-p~184pb-1
e^+p~294pb-1
March 2007 Start of low energy run e^+p~12.5pb^{-1} (E_p=460 GeV)
(**the F_L measurement**) e^+p~6.5pb^{-1} (E_p=575 GeV)
June 30 2007 HERA Shut down



HERA:
- is a microscope to study the structure of the proton (PDFs) in DIS
- tests pQCD and the validity of the DGLAP evolution at low x and Q^2



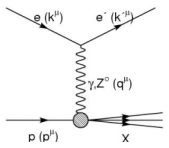
$Q^2 = 4E_eE_e\cos^2\left(\frac{\theta_e}{2}\right)$ (Momentum transfer)^2

$y = 1 - \frac{E_e}{E_e}\sin^2\left(\frac{\theta_e}{2}\right)$ Inelasticity

$x = \frac{Q^2}{sy}$ Bjorken x

$s \approx 4E_eE_p$ Center of mass energy

Inclusive Measurements: Proton Structure Function F_L, Combined Parton Density Functions from HERA



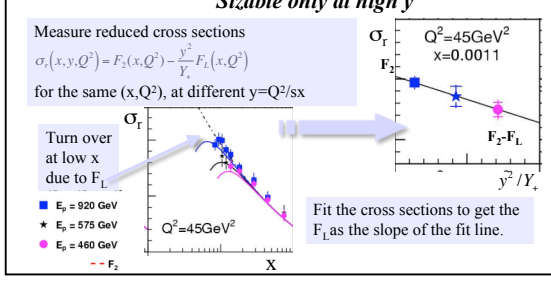
Deep inelastic scattering (DIS) at HERA proceeds via virtual boson exchange in Neutral Current, NC interactions.

$\sigma_r(x,Q^2,y)$ NC reduced cross section

$$\frac{d^2\sigma^{e^+p}}{dxdQ^2} = \frac{Y_+Q^4}{2\pi\alpha^2}\left(F_2(x,Q^2) - \frac{y^2}{Y_+}F_L(x,Q^2) \mp \frac{Y_-}{Y_+}xF_3(x,Q^2)\right)$$

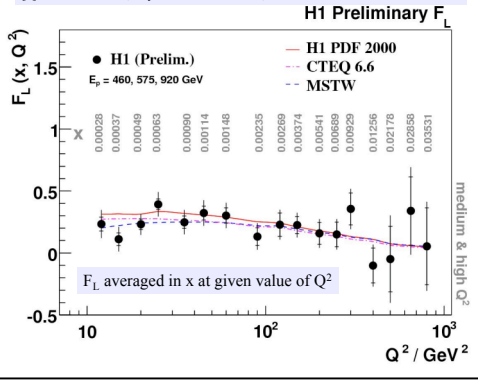
Dominant contribution — *Sizable only at high y* — Contributes at high Q^2

Measure reduced cross sections
$\sigma_r(x,y,Q^2) = F_2(x,Q^2) - \frac{y^2}{Y_+}F_L(x,Q^2)$
for the same (x,Q^2), at different $y=Q^2/sx$

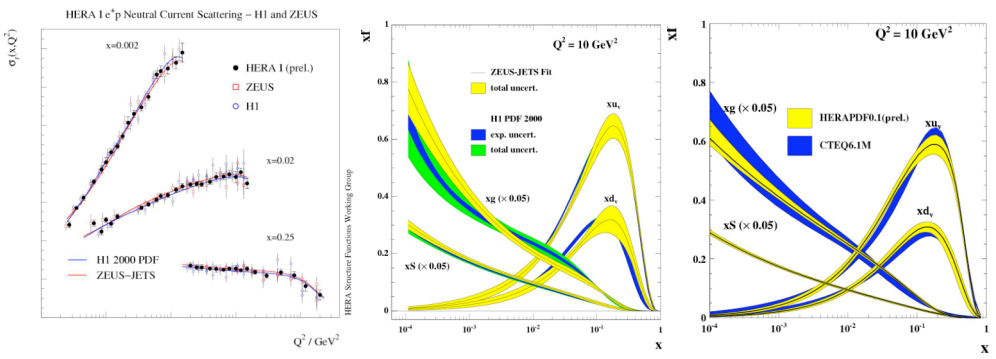


The proton structure function F_L is extracted from the e^+p DIS NC scattering cross section. Measured F_L is consistent with the NLO QCD calculations and prediction of a dominant gluon contribution at low x [1].

[1] H1Collaboration, Phys.Lett.B665:139-146, 2008

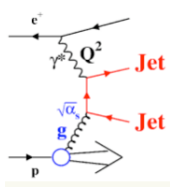


The DIS cross sections from the H1 and ZEUS experiments are combined. This combined HERA data is used to extract the NLO QCD parton distribution functions (PDFs) called HERAPDF0.1.

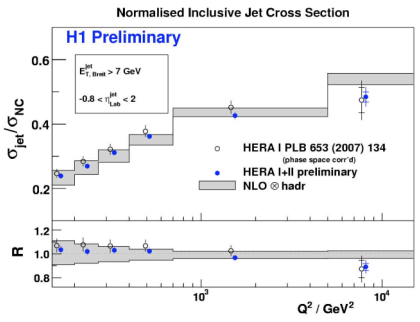


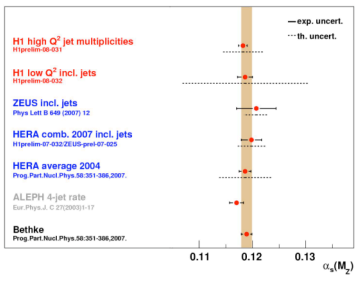
The combined data and resulting HERA PDFs have impressive precision compared to the individual results obtained by the ZEUS and H1 collaborations.

Hadronic Final State: Inclusive and Multi-Jet Production, Strangeness Production, Prompt Photons in Photo-production



The jet production is investigated in DIS NC events for $2<Q^2<100$ GeV^2 and $150<Q^2<1500$ GeV^2. The normalized high inclusive jet cross sections show great **precision** improvement with respect to the HERA I results. The values and evolution of α_s as a function of Q^2 are extracted by fitting the individual normalized inclusive, di-jet, three-jet cross sections and their combination.

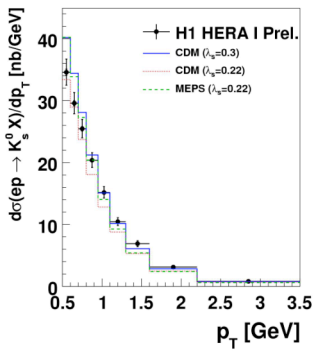


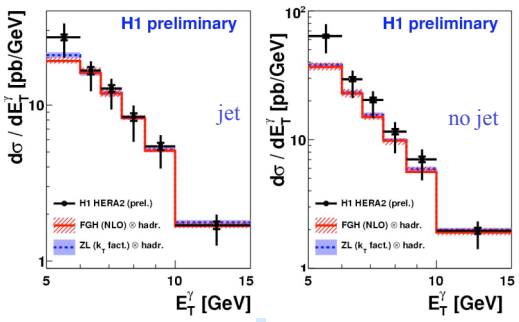


$\alpha_s = 0.1182 \pm 0.0008(\text{exp.})^{0.0041}_{0.0031}(\text{th.}) \pm 0.0018(\text{pdf.})$

The values of the strong coupling constant compare well with the world average. The relative experimental error is **below 1%,** five times smaller than the theoretical uncertainties.

The production of K_S^0 is investigated by H1 using DIS events in the range of $2<Q^2<100$ GeV^2. The models in general describe the features of the measurements but the data can not be described by an unique strangeness suppression factor.

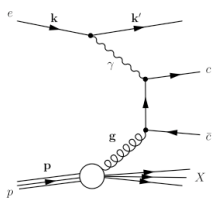




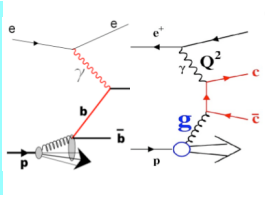
The measurement of the prompt photons in photo-production is performed for final states with or without jets. The differential cross sections are compared to two calculations: based on collinear approach (FGH NLO) [1,2] or k_t factorization (ZL) [3].

[1] M.Fontannaz, J.P.Guillet, G.Heinrich, Eur.Phys.J. C **21** (2001) 303
[2] M.Fontannaz and G.Heinrich, Eur.Phys.J. C **34,** 191 (2004)
[3] A.V.Lipatov, N.P.Zotov, Phys.Rev. D **72** (2005)

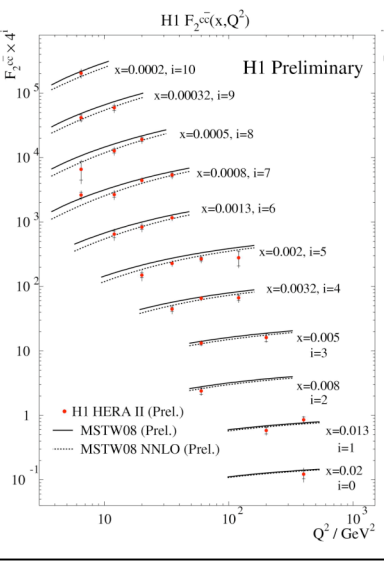
Heavy Flavour: D* Production, Charm and Beauty Production, Beauty Photo-production

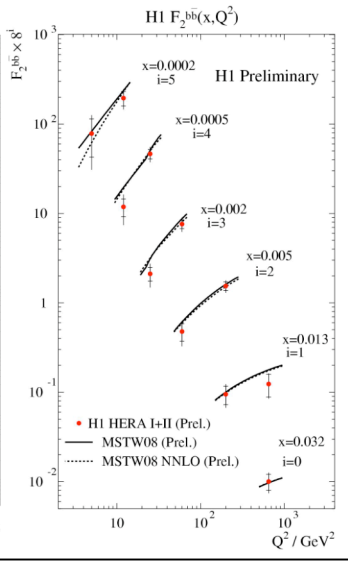


The inclusive production of D* mesons has been measured in photo-production and DIS in a wide range of Q^2. The dominant production mechanism is boson-gluon fusion. The differential cross sections are compared to predictions from the LO MC and the NLO calculations.

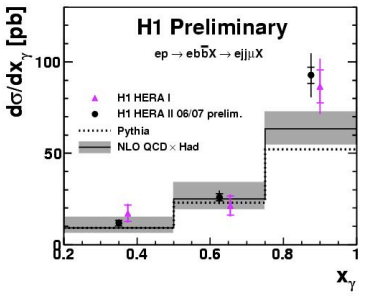


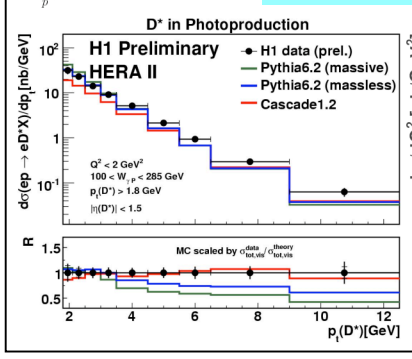
The charm and beauty structure functions are measured in a wide range of Q^2 and x using the lifetime information as reconstructed from the vertex detector. The results agree with the previous measurements, NLO and NNLO QCD predictions.

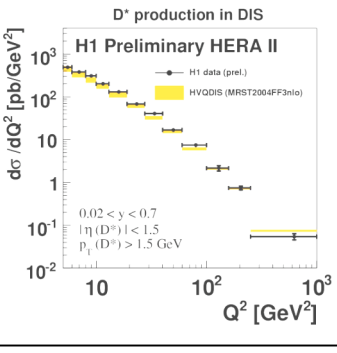




The beauty photo-production is measured using semi-muonic decays and by exploiting beauty lifetime and kinematic information p_t^{rel}. The measurements are well described by the NLO QCD calculations.







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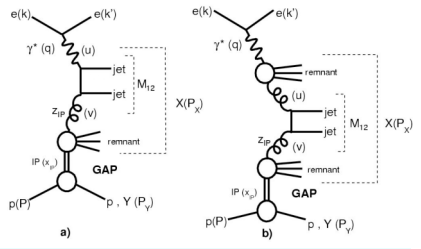
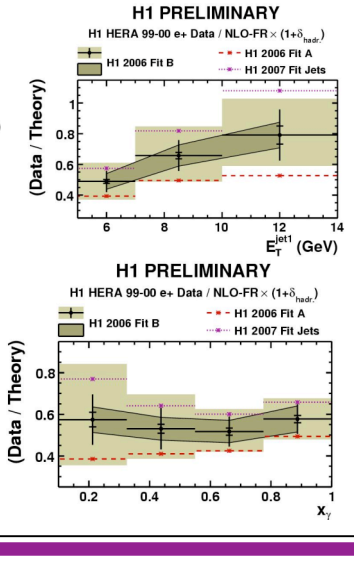
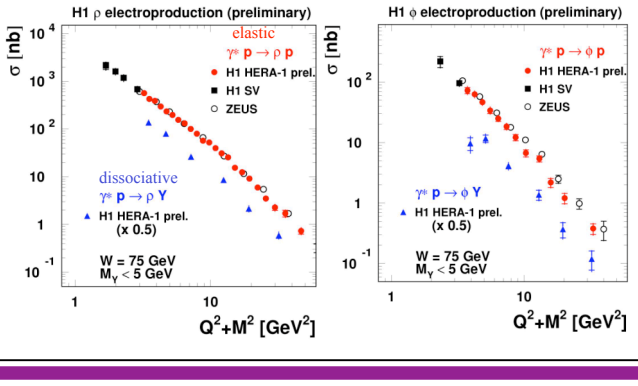
Diffraction: Photo-production of Jets, Meson Production, Leading Neutron Production in DIS



The differential di-jet cross sections in diffractive photo-production are measured in two kinematic regions differing in the requirements on two hardest jets. The di-jet cross sections are compared with the NLO QCD predictions based on recent diffractive parton densities obtained by H1. The data indicate that proton vertex factorization is broken independent on x_γ for both direct and resolved γp collisions.



The diffractive ρ and ϕ production cross section in DIS has been measured in both elastic and proton dissociative channel using HERA I data in region of $2.5<Q^2<100$ GeV^2. The total cross sections for ρ and ϕ production show the same behavior as a function of Q^2+M^2 supporting the factorization of diffractive processes.



The production of highly energetic forward neutrons has been studied in DIS at HERA $p \to n\pi^+$ in order to estimate the structure function of the pion:

$F_2^\pi = F_2^{LN}(x_L)/f_{\pi/p}(x_L)$

The measurement is lower than the predictions indicating large absorption effects.