

DIS 2010

<http://www.fi.infn.it/dis10>

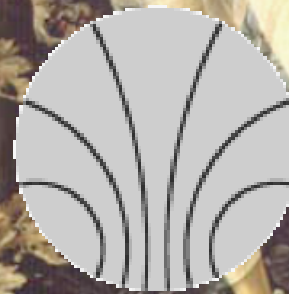
XVIII INTERNATIONAL
WORKSHOP ON DEEP
INELASTIC SCATTERING
AND RELATED SUBJECTS

Recent Results from the H1 Experiment



Katja Krüger

Kirchhoff-Institut für Physik,
Uni Heidelberg

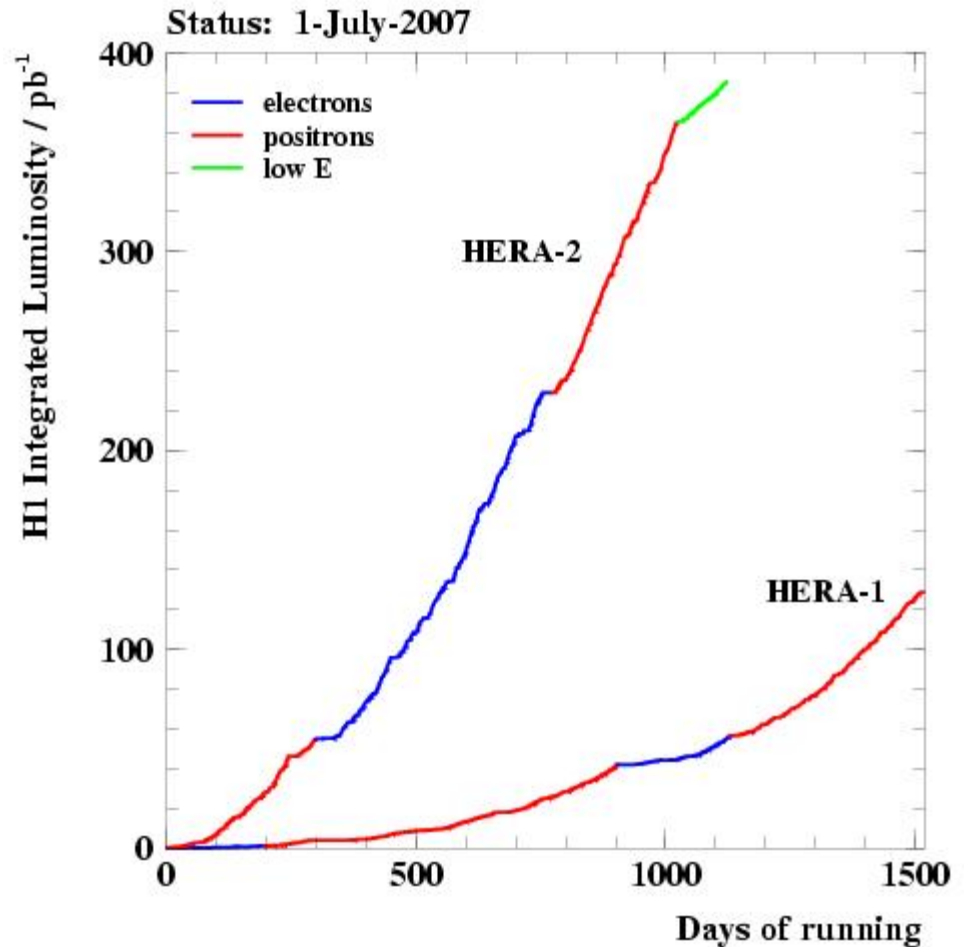


19-23 April 2010, Convitto della Calza, Firenze



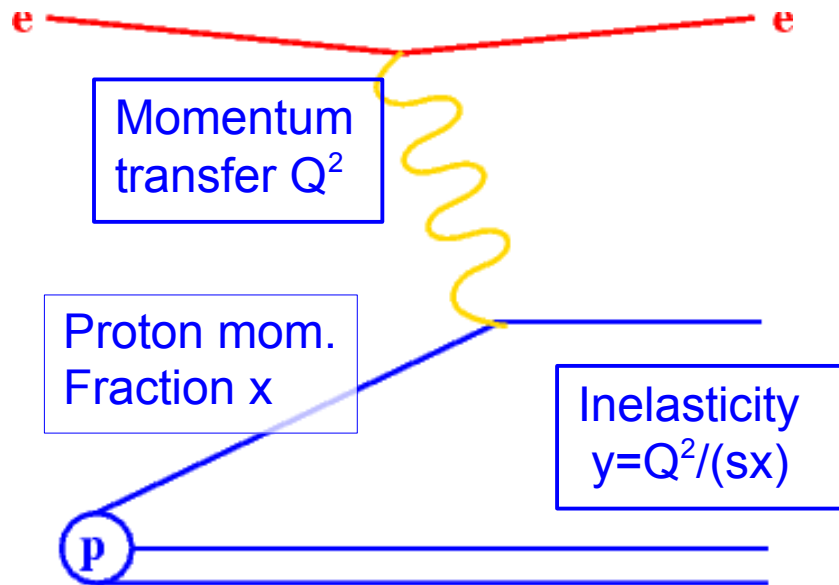
Physics Program

- Structure of the Proton
- QCD tests with the hadronic final state
- Diffraction
- Searches





Structure of the Proton



$Q^2 \gtrsim 2 \text{ GeV}^2$:
perturbative QCD
DGLAP Evolution

Reduced Cross Section:

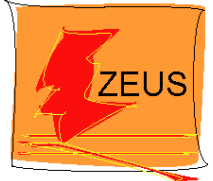
$$\sigma_r \propto F_2 - \frac{y^2}{1+(1-y)^2} F_L$$

Structure functions F_2 and F_L :

- F_2 : valence and sea quarks
gluon visible in scaling violations
- F_L : directly sensitive to gluon
suppressed by helicity factor

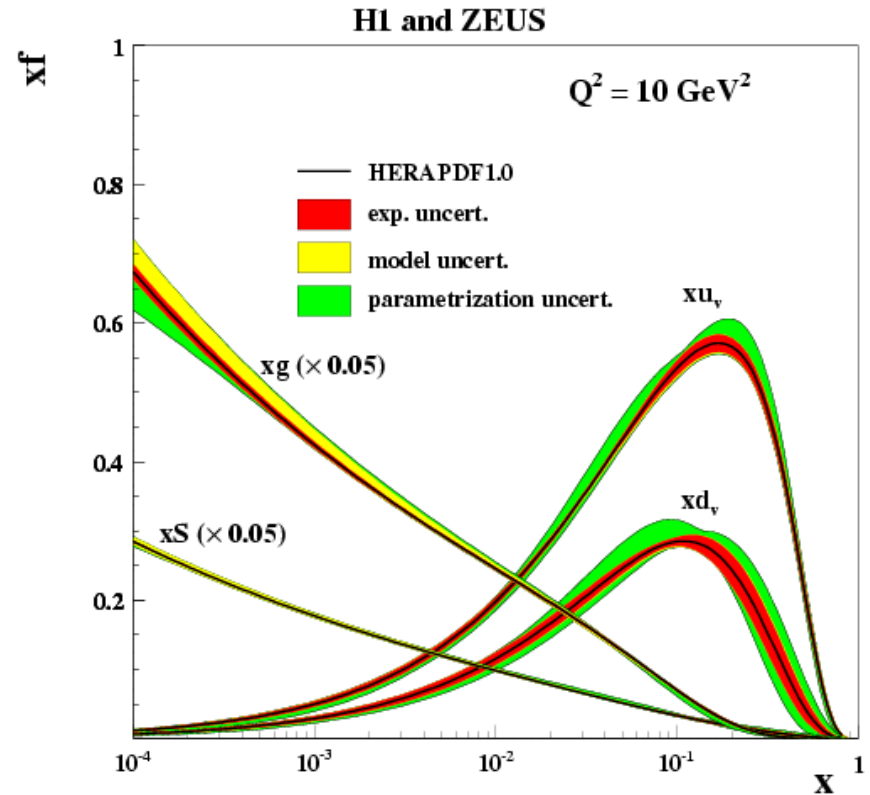
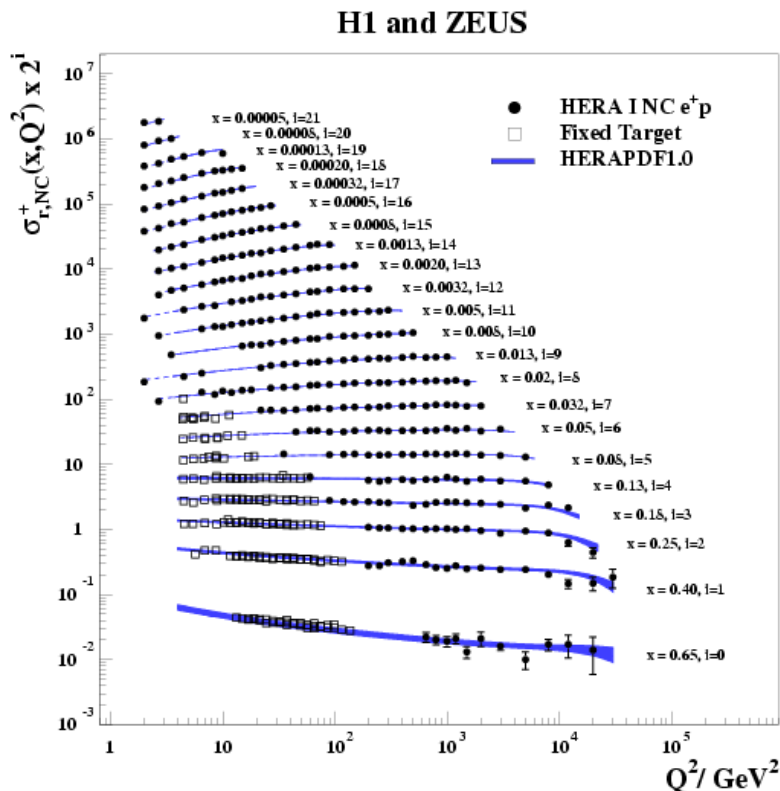


Incl. HERA I data and PDF fit



- complete HERA I combined incl. cross sections
- O(1%) precision for $10 < Q^2 < 100 \text{ GeV}^2$
- sole input for HERAPDF1.0
- precise PDFs in the region relevant for LHC

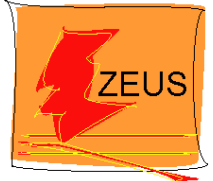
JHEP 1001:109,2010
→ S. Habib [169]



available since LHAPDF 5.8.1



Incl. HERA I data and PDF fit

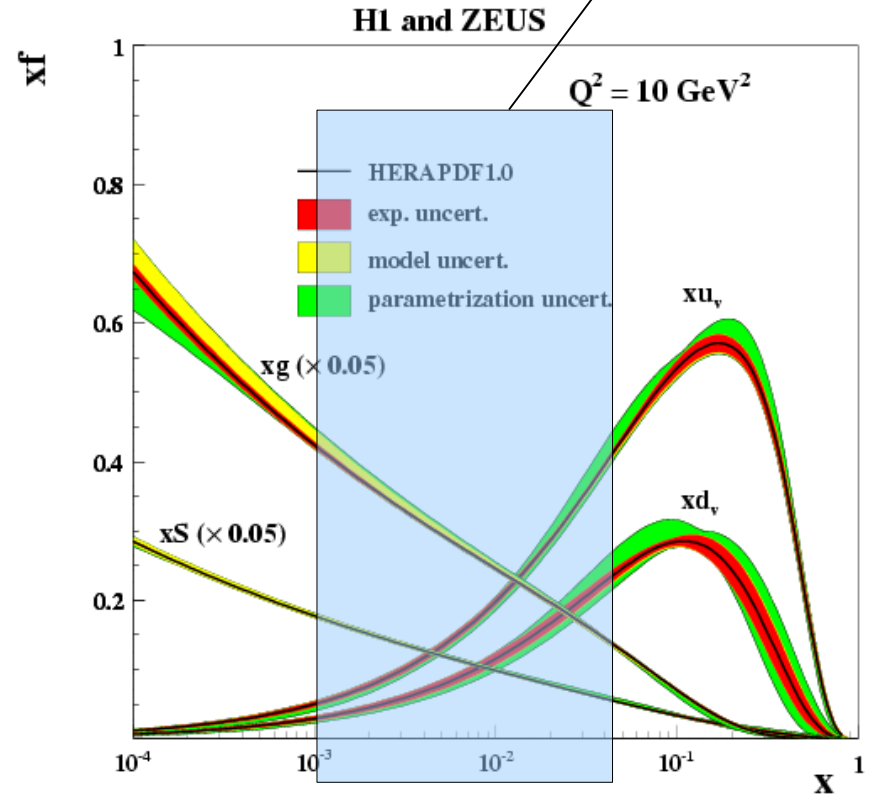
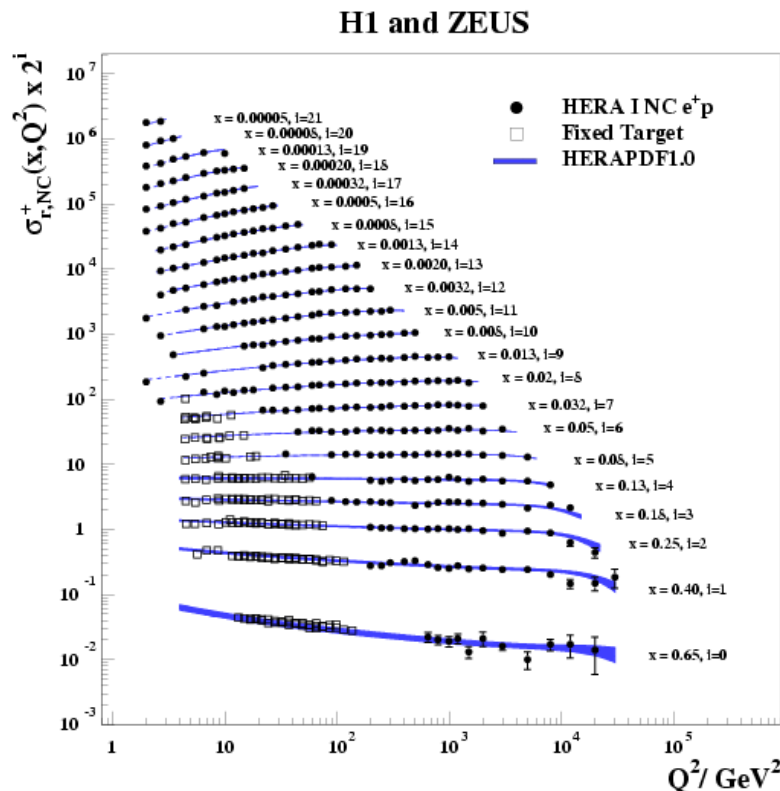


- complete HERA I combined incl. cross sections
- O(1%) precision for $10 < Q^2 < 100 \text{ GeV}^2$
- sole input for HERAPDF1.0
- precise PDFs in the region relevant for LHC

JHEP 1001:109,2010

→ S. Habib [169]

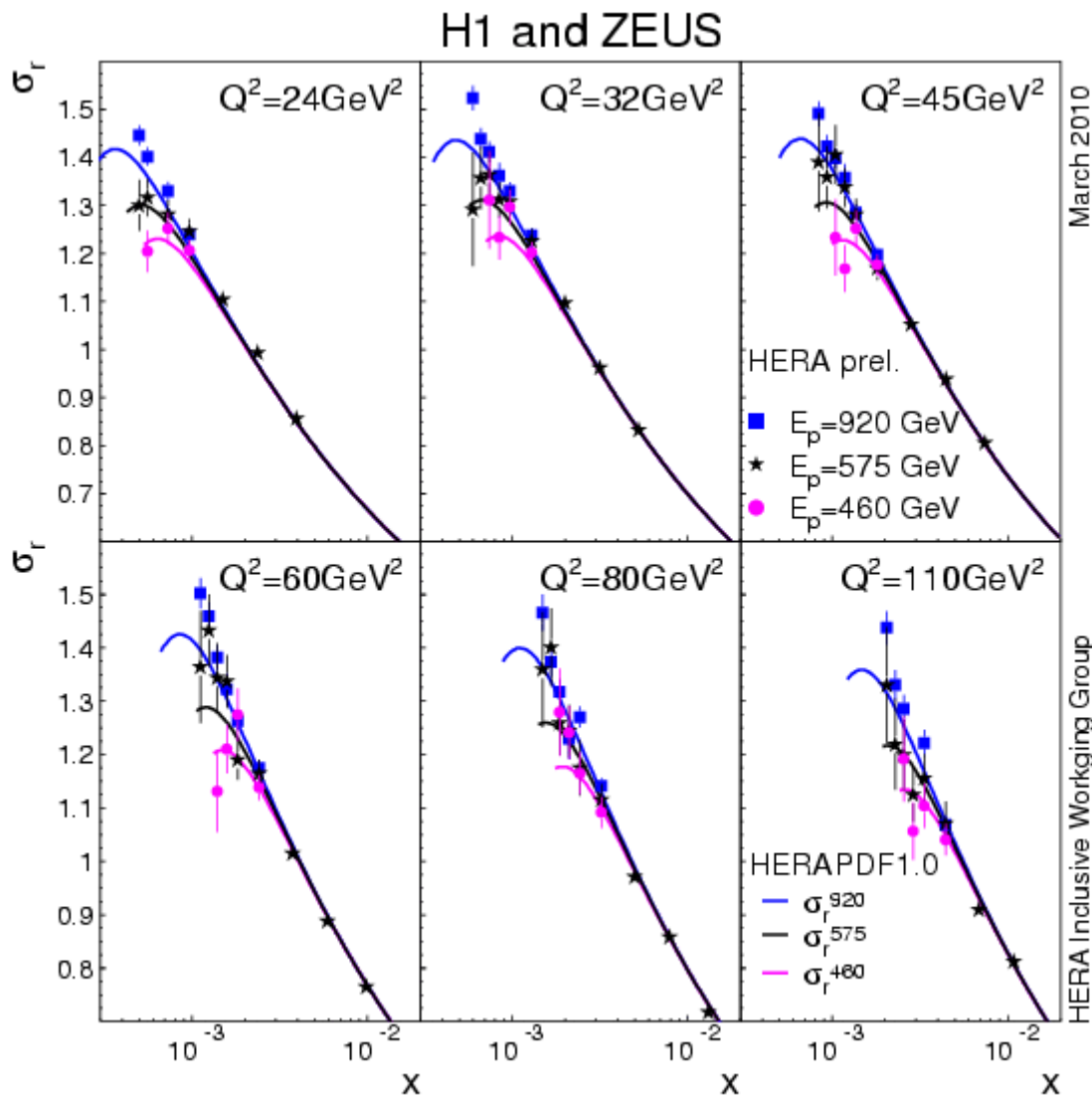
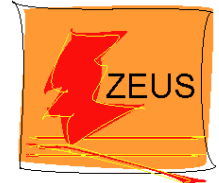
x range for central 100 GeV particle



available since LHAPDF 5.8.1



Incl. Cross Section at low E_p , F_L



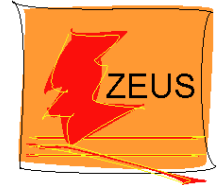
H1prelim-10-043
ZEUS-prel-10-001

→ J. Grebenyuk [170]

- combined H1+ZEUS inclusive NC cross sections with reduced proton beam energy
- extraction of a combined F_L with improved precision
- use in PDF fit

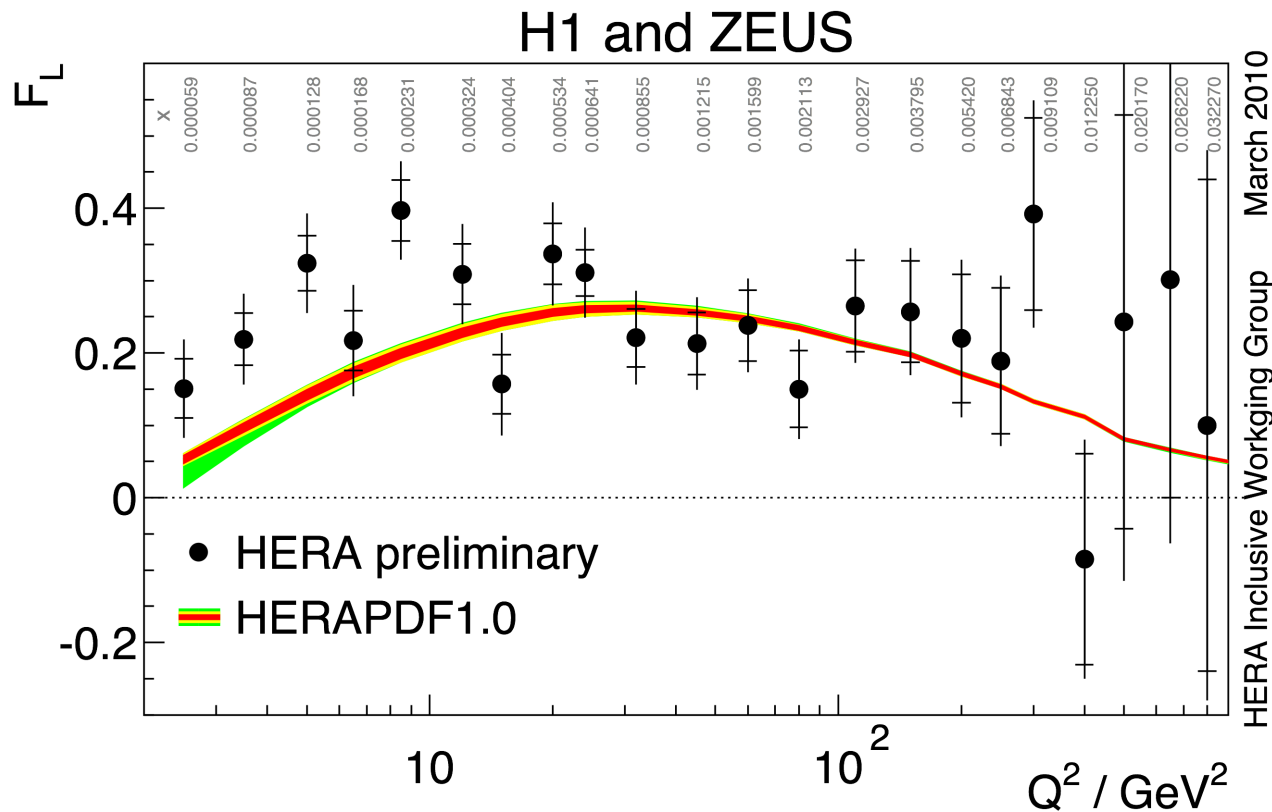


Incl. Cross Section at low E_P , F_L



H1prelim-10-043
ZEUS-prel-10-001

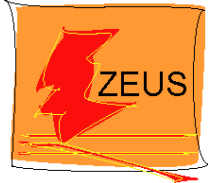
→ J. Grebenyuk [170]



- combined H1+ZEUS F_L
- tension to HERAPDF1.0 at low Q^2

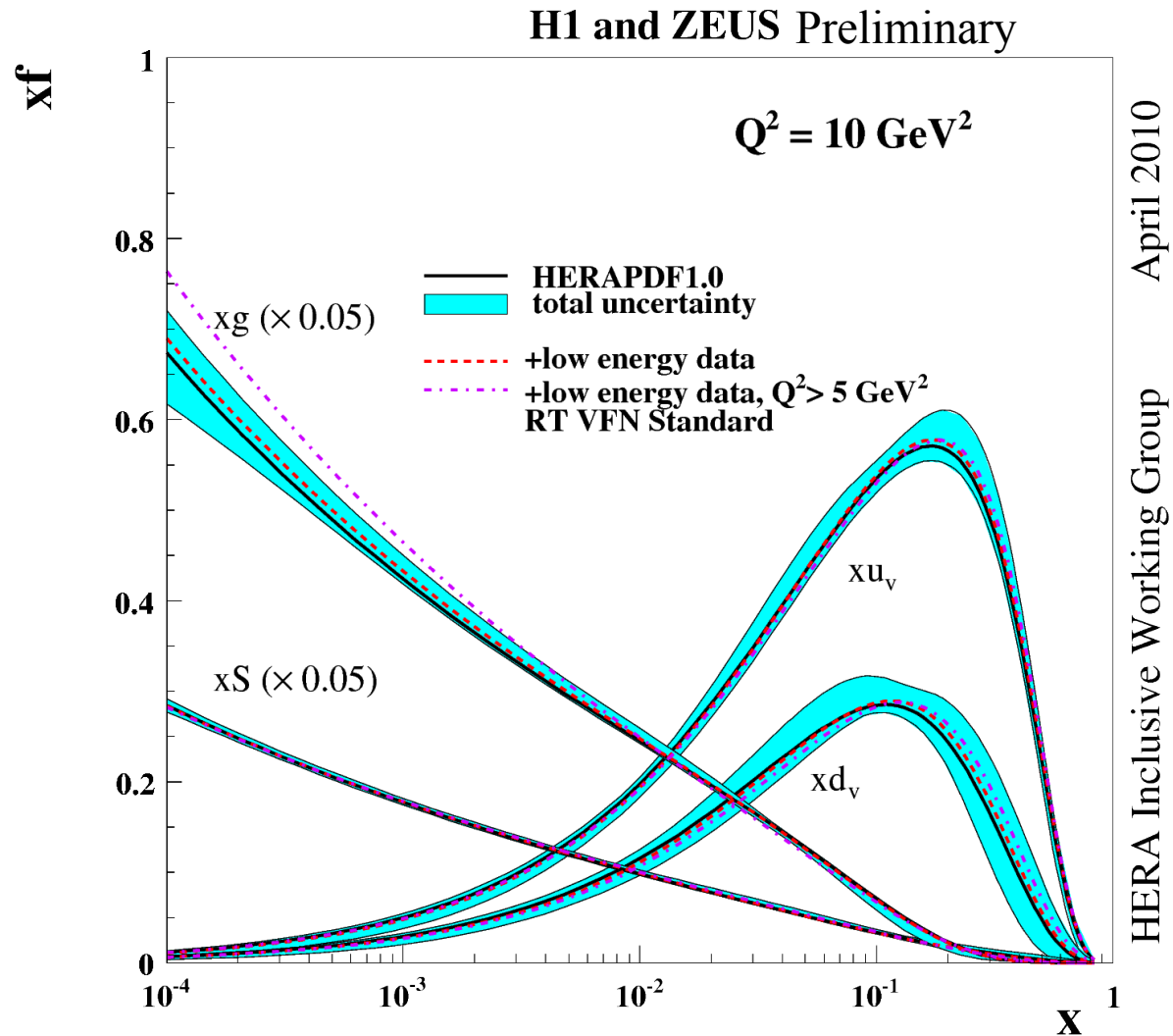


PDF fit including low E_p data



H1prelim-10-044
ZEUS-prel-10-008

→ V. Radescu [318]



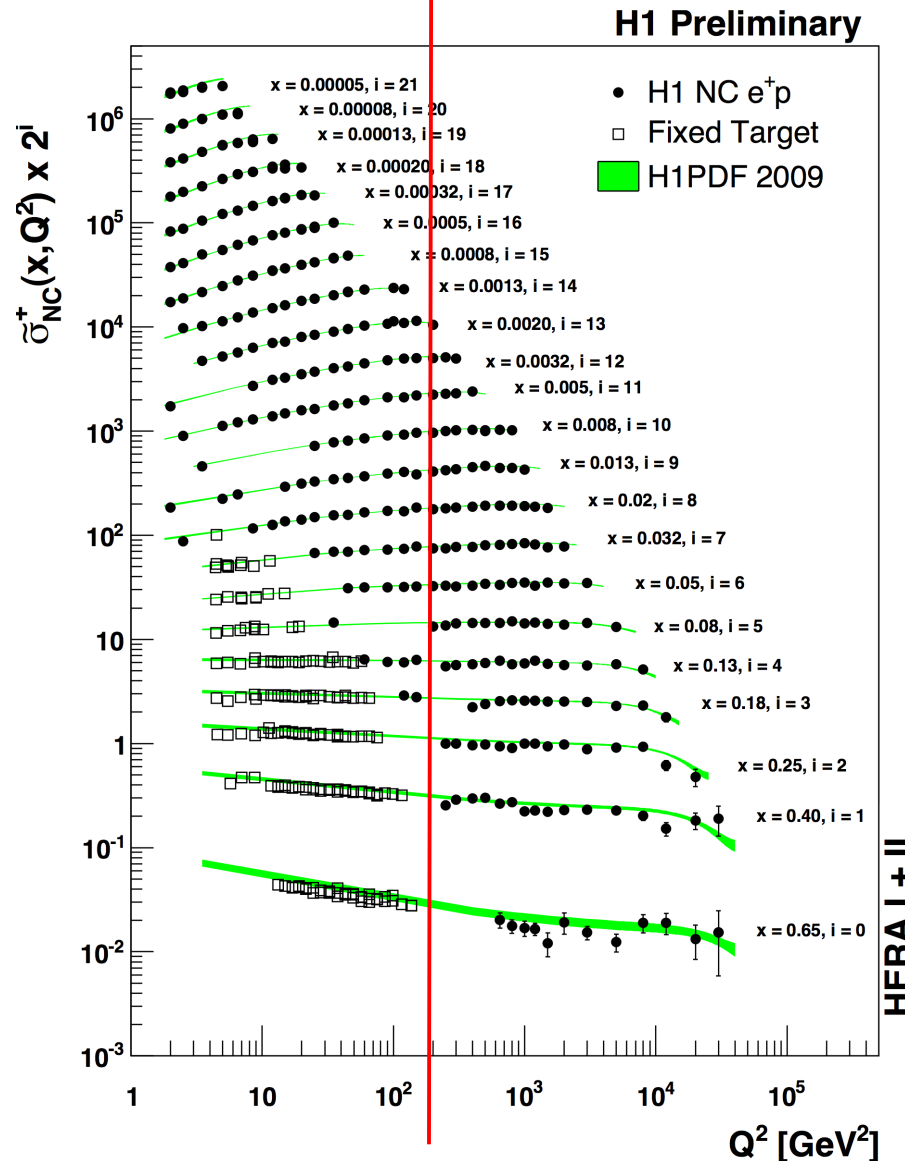
- inclusion of low energy data leads to PDFs consistent with HERAPDF1.0
- fit only data $Q^2 > 5 \text{ GeV}^2$: higher gluon



High Q^2 NC & CC

H1prelim-09-042

→ V. Chekelian [350]



High Q^2 inclusive cross sections with full HERA II data:

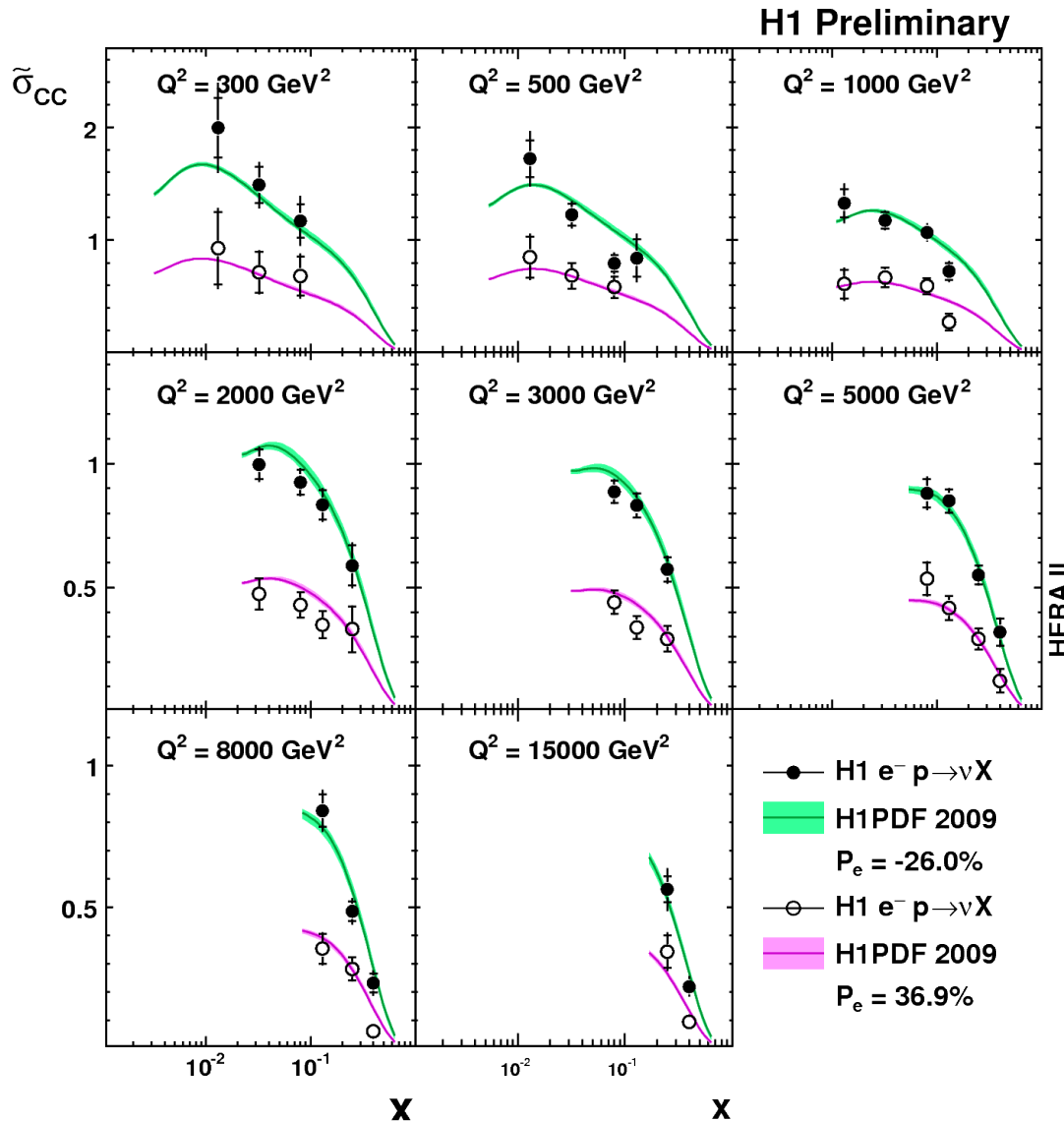
- NC ($Q^2 > 200 \text{ GeV}^2$) and CC ($Q^2 > 400 \text{ GeV}^2$)
- e^+ and e^- data
- righthanded and lefthanded data
- 46 to 103 pb^{-1}



High Q^2 NC & CC

H1prelim-09-043

→ S. Shushkevich [348]



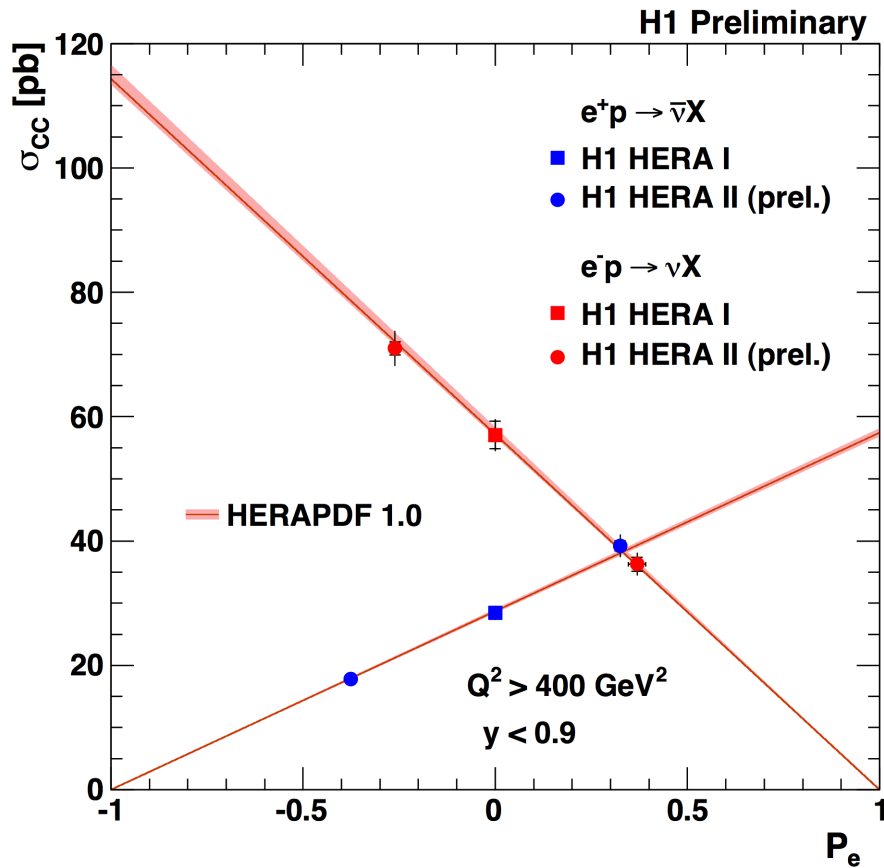
High Q^2 inclusive cross sections with full HERA II data:

- NC ($Q^2 > 200 \text{ GeV}^2$) and CC ($Q^2 > 400 \text{ GeV}^2$)
- e^+ and e^- data
- righthanded and lefthanded data
- 46 to 103 pb^{-1}



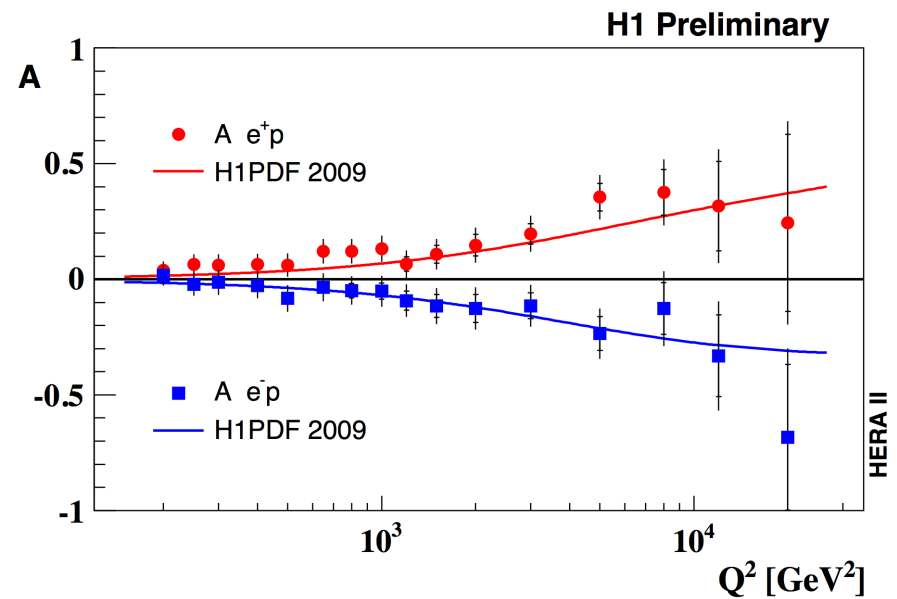
High Q^2 NC & CC: Polarization

- no hint for right-handed CC



$$\text{CC: } \sigma_r^\pm \propto (1 \pm P_e) W_2^\pm$$

- NC: polarization asymmetry due to γZ -interference

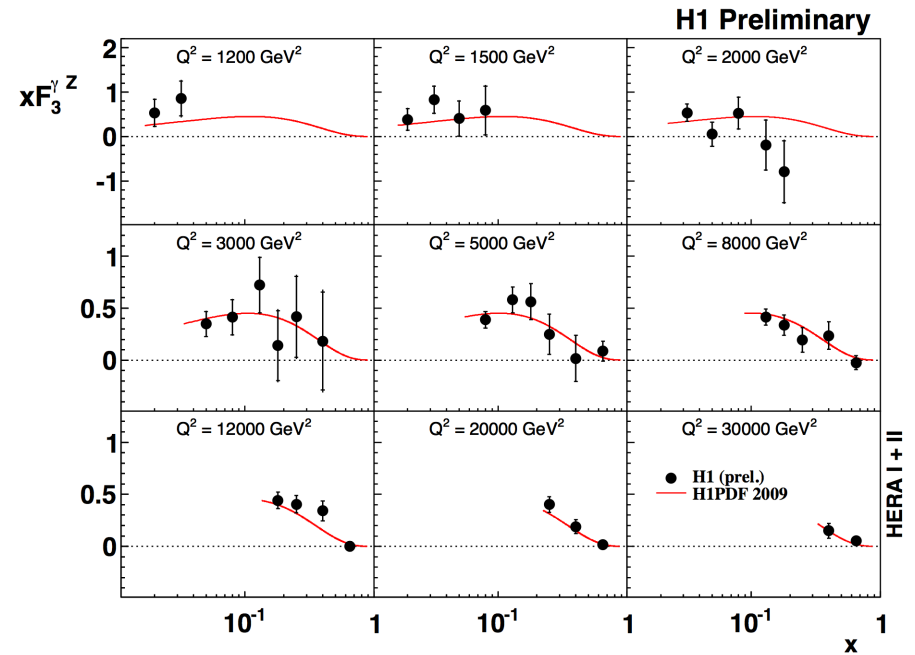
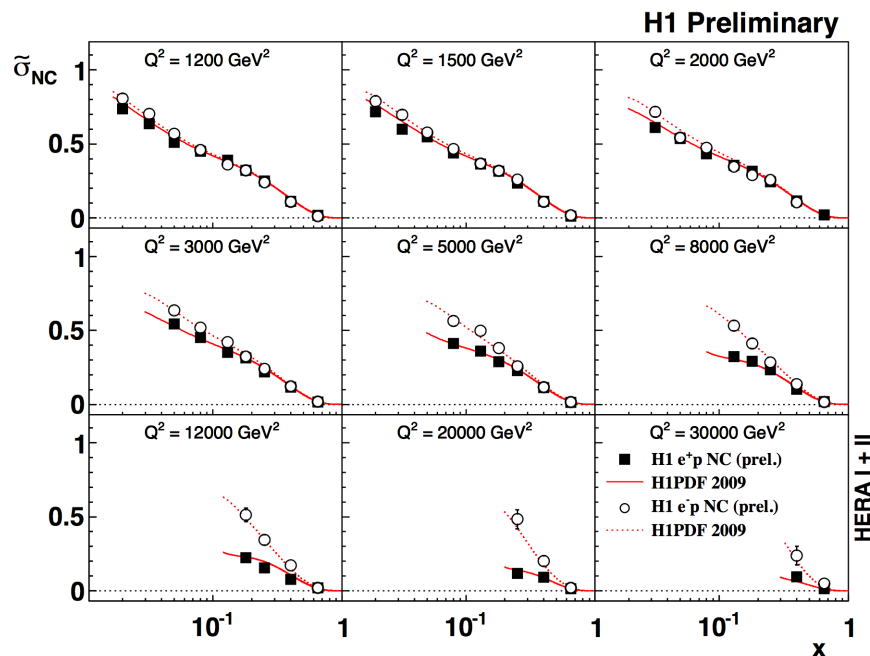


$$A = \frac{2}{P_R - P_L} \frac{\sigma^\pm(P_R) - \sigma^\pm(P_L)}{\sigma^\pm(P_R) + \sigma^\pm(P_L)}$$



High Q^2 NC & CC

- determination of cross sections for $P_e=0$, combination with HERA I data



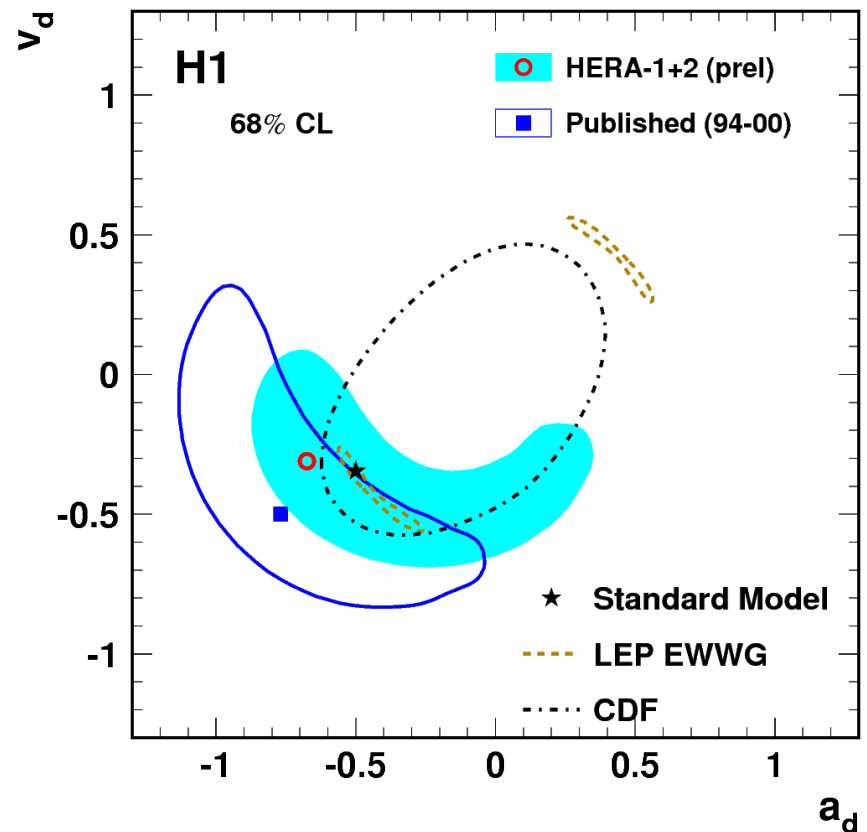
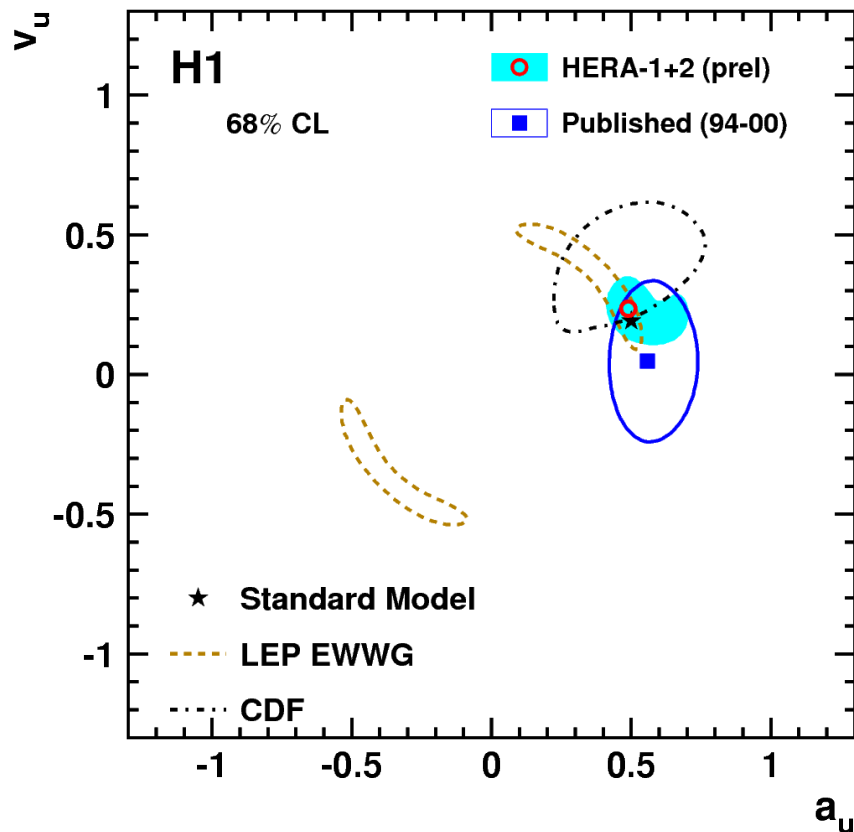
- extraction of xF_3 from charge asymmetry



Electroweak Fit to NC and CC data

H1prelim-10-042
→Z. Zhang [351]

- determination of u and d couplings to Z boson, simultaneously with PDF fit
- improved sensitivity due to polarization dependence





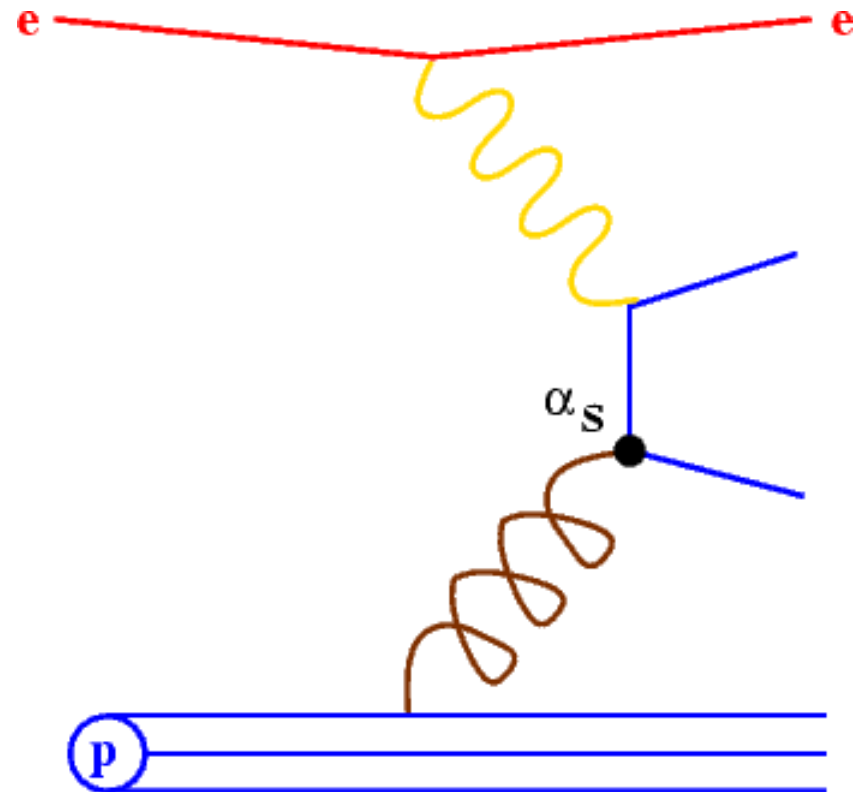
QCD tests with HFS

hadronic final states:

- jets
- heavy flavours
- particle spectra

topics:

- determination of α_s
- information on the gluon density in the proton
- information on parton evolution





Jet Production in DIS and α_s

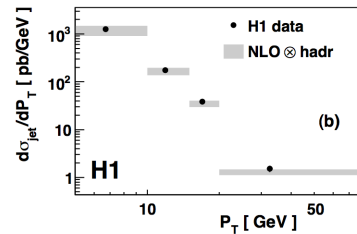
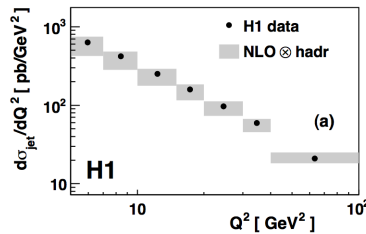
- inclusive, 2 and 3 jet cross sections
- $5 < Q^2 < 100 \text{ GeV}^2$ and $Q^2 > 150 \text{ GeV}^2$
- running of α_s , agreement of $\alpha_s(M_Z)$ in whole Q^2 range

Eur.Phys.J.C65 (2010) 363
 DESY-09-162, acc. by EPJC

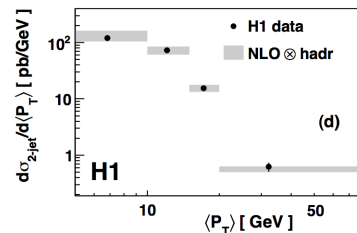
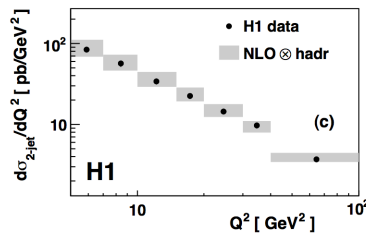
→ R. Kogler [160]

Inclusive Jet, 2-Jet and 3-Jet Cross Sections

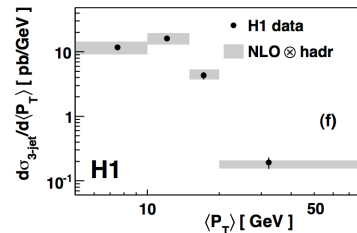
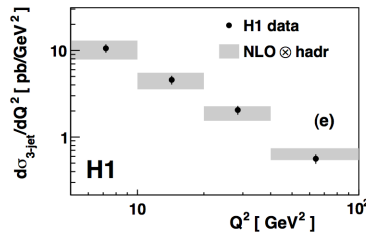
incl.
jet



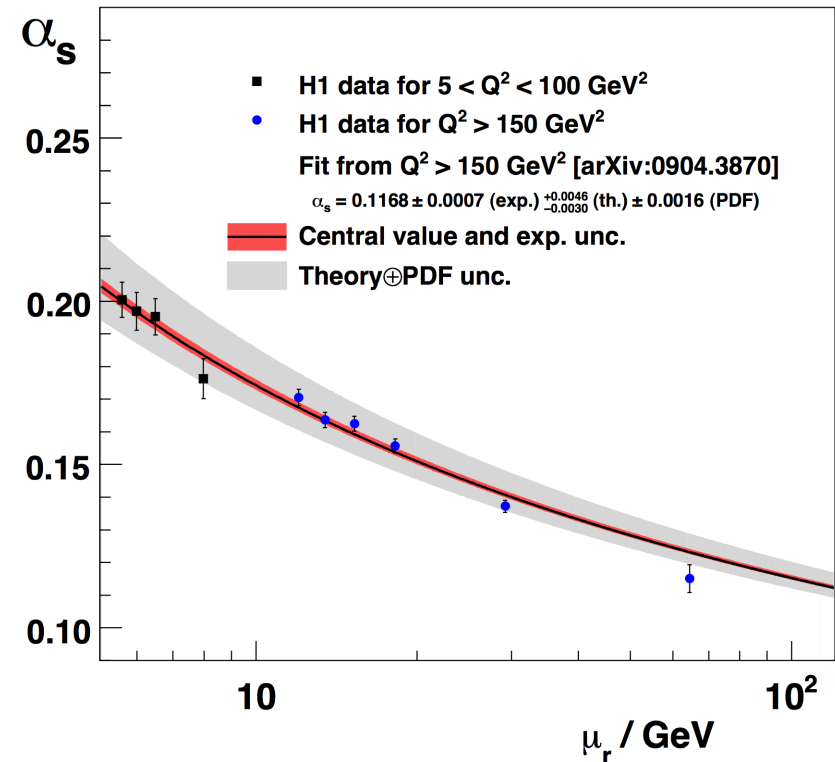
2 jet



3 jet



α_s from Jet Cross Sections in DIS

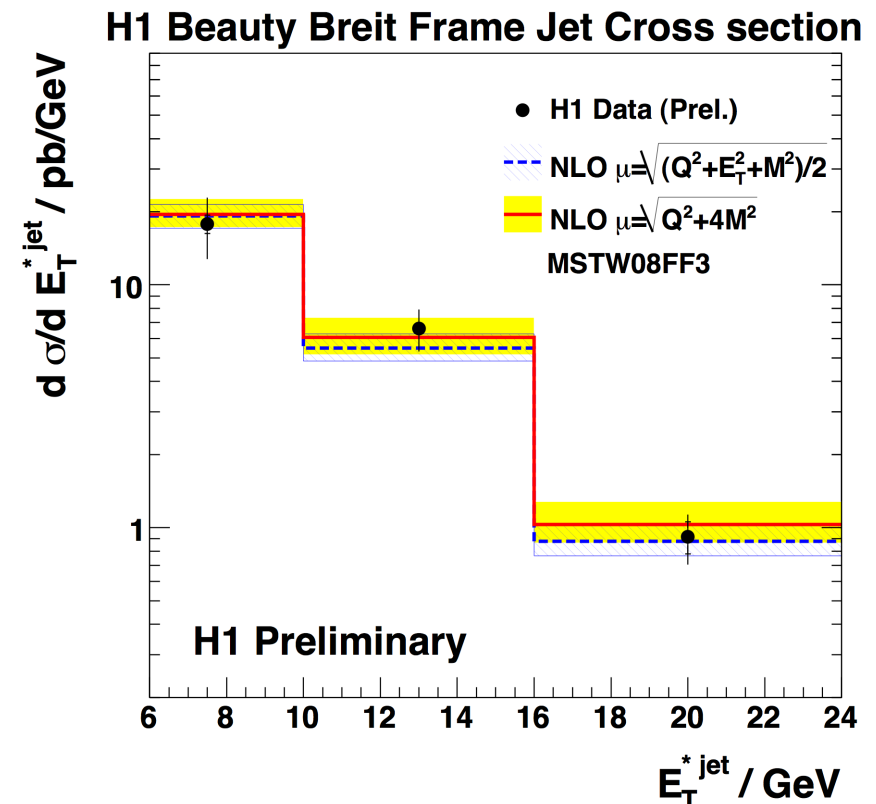
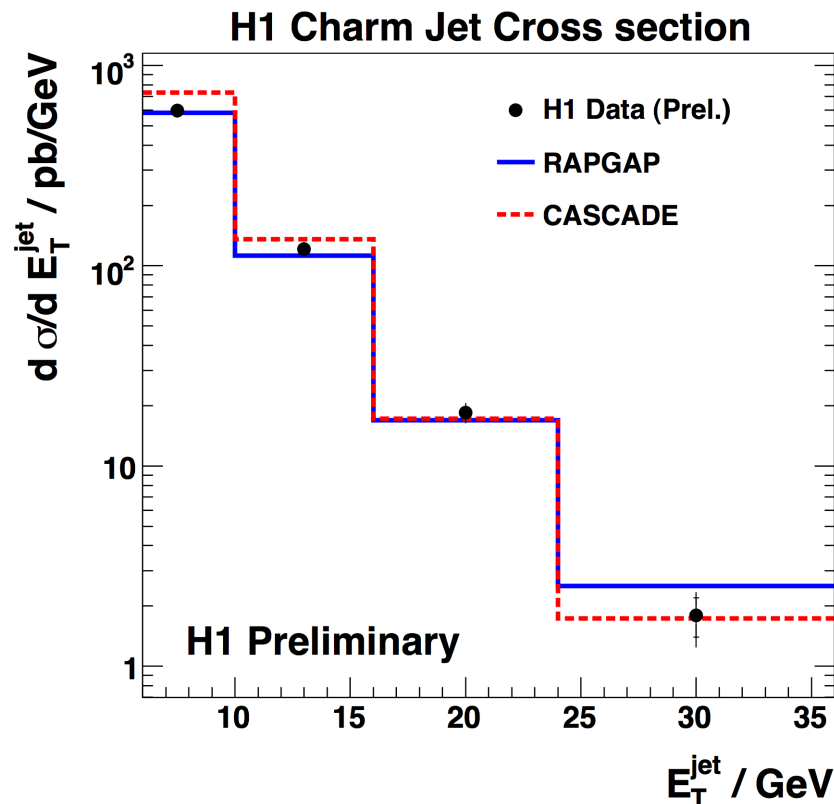




Charm and Beauty Jets

H1prelim-10-073

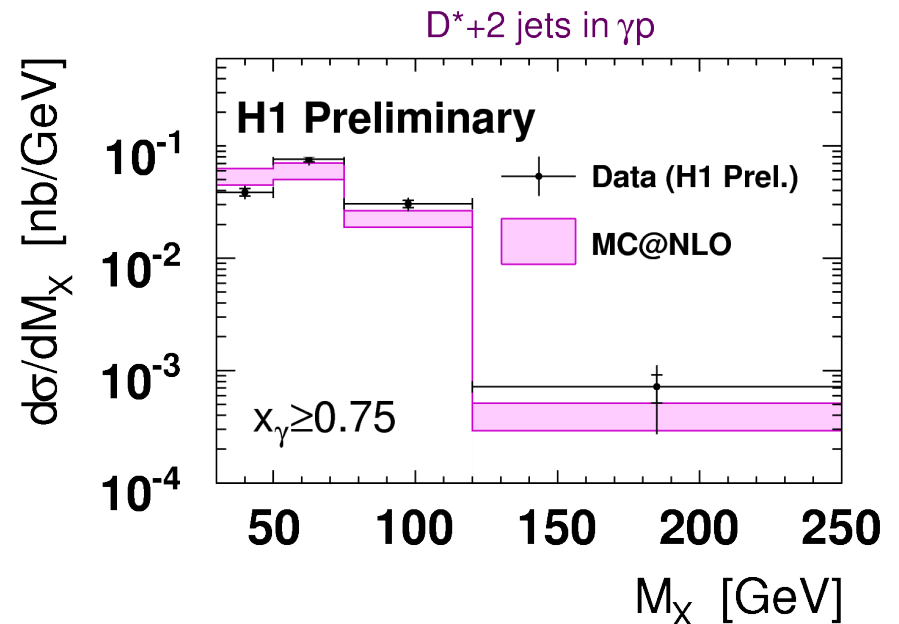
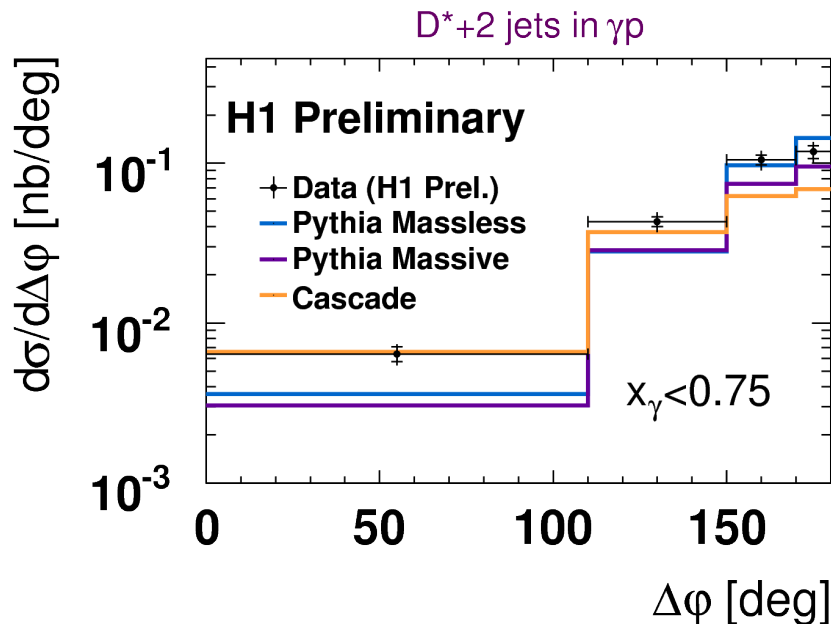
- complete HERA II data
 - use lifetime technique to tag events with c and b jets
 - cross sections in lab and Breit frame
 - comparison to LO ME+PS MC and NLO predictions
- P. Thompson [19]





D* and jets in Photoproduction

- untagged photoproduction, HERA II data H1prelim-10-072
→ Z. Staykova [89]
- D* meson and 2 jets, one of them containing the D*
- study variables sensitive to parton dynamics in x_γ regions enriched by direct / resolved photon processes
- comparison to LO ME+PS MCs and to MC@NLO

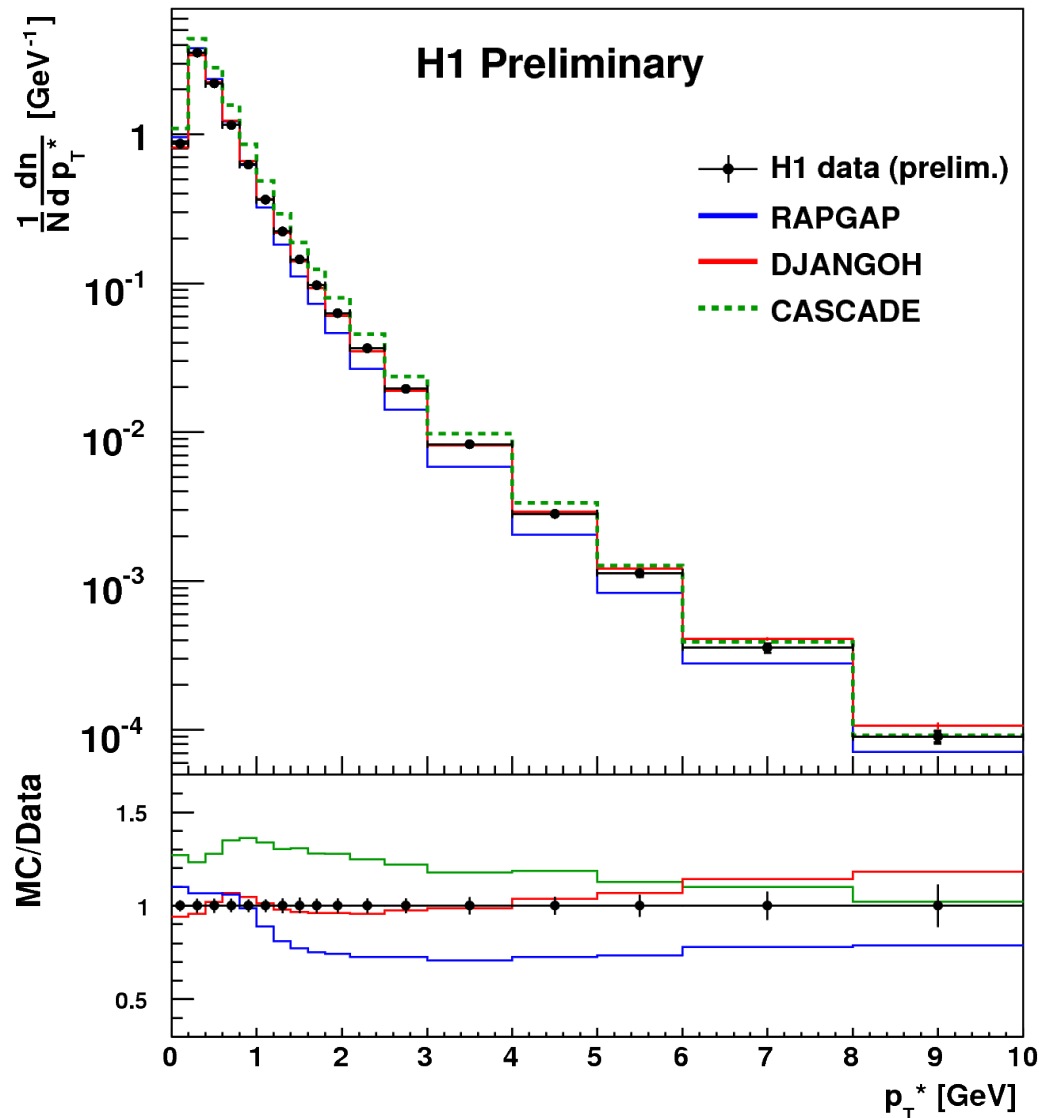




Charged Particle Spectra

H1prelim-10-035

→A. Grebenyuk [151]

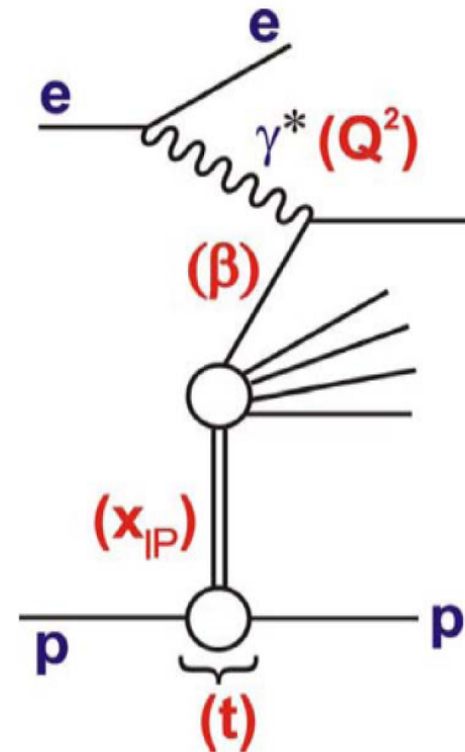


- p_T spectrum in HCM frame at large p_T sensitive to parton evolution
- less well described by RAPGAP (DGLAP) than by DJANGO (CDM)



Diffraction

- access to the structure of the colour-singlet exchange
- experimental methods:
 - rapidity gaps
 - leading proton

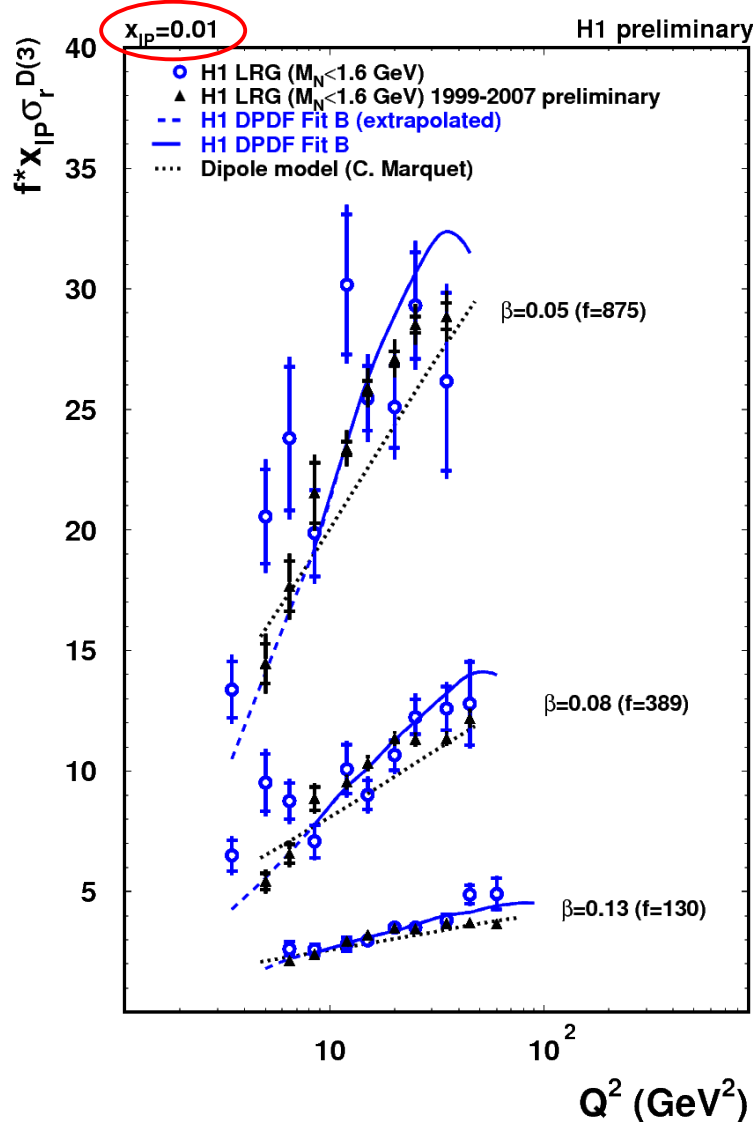




$F_2^{D(3)}$ with Rapidity Gaps

H1prelim-10-011

→ P. Laycock [249]



- full HERA II statistics
- inclusive cross section as function of Q^2 , β and x_{IP}
- good agreement with HERA I data and DPDF fit
- combination with HERA I data

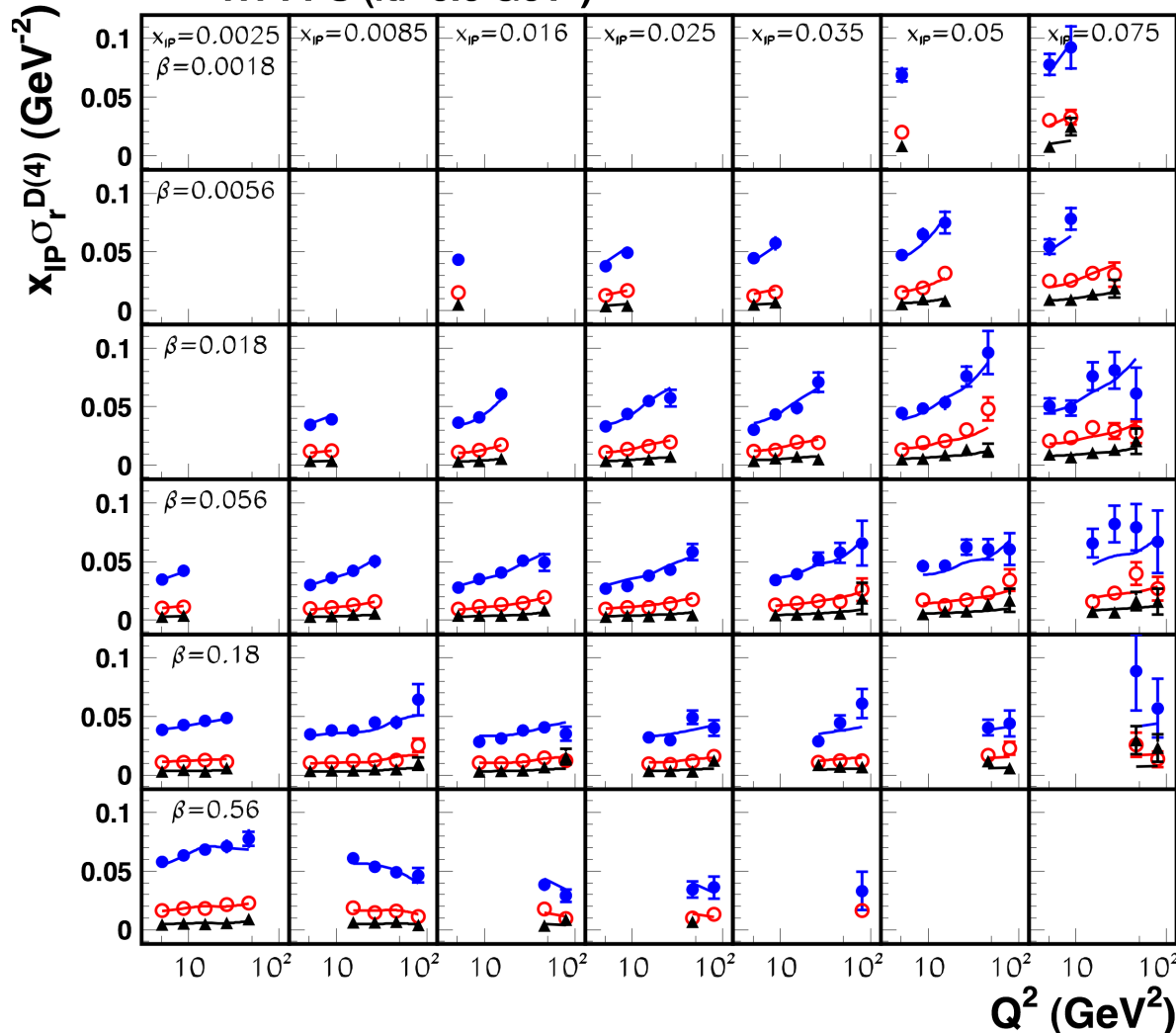


$F_2^{D(4)}$ with Proton in FPS

- H1 FPS ($|t|=0.2 \text{ GeV}^2$)
- H1 FPS ($|t|=0.4 \text{ GeV}^2$)
- ▲ H1 FPS ($|t|=0.6 \text{ GeV}^2$)

H1 Preliminary
— Regge fit IP+IR

H1prelim-10-012
→ M. Kapishin [270]



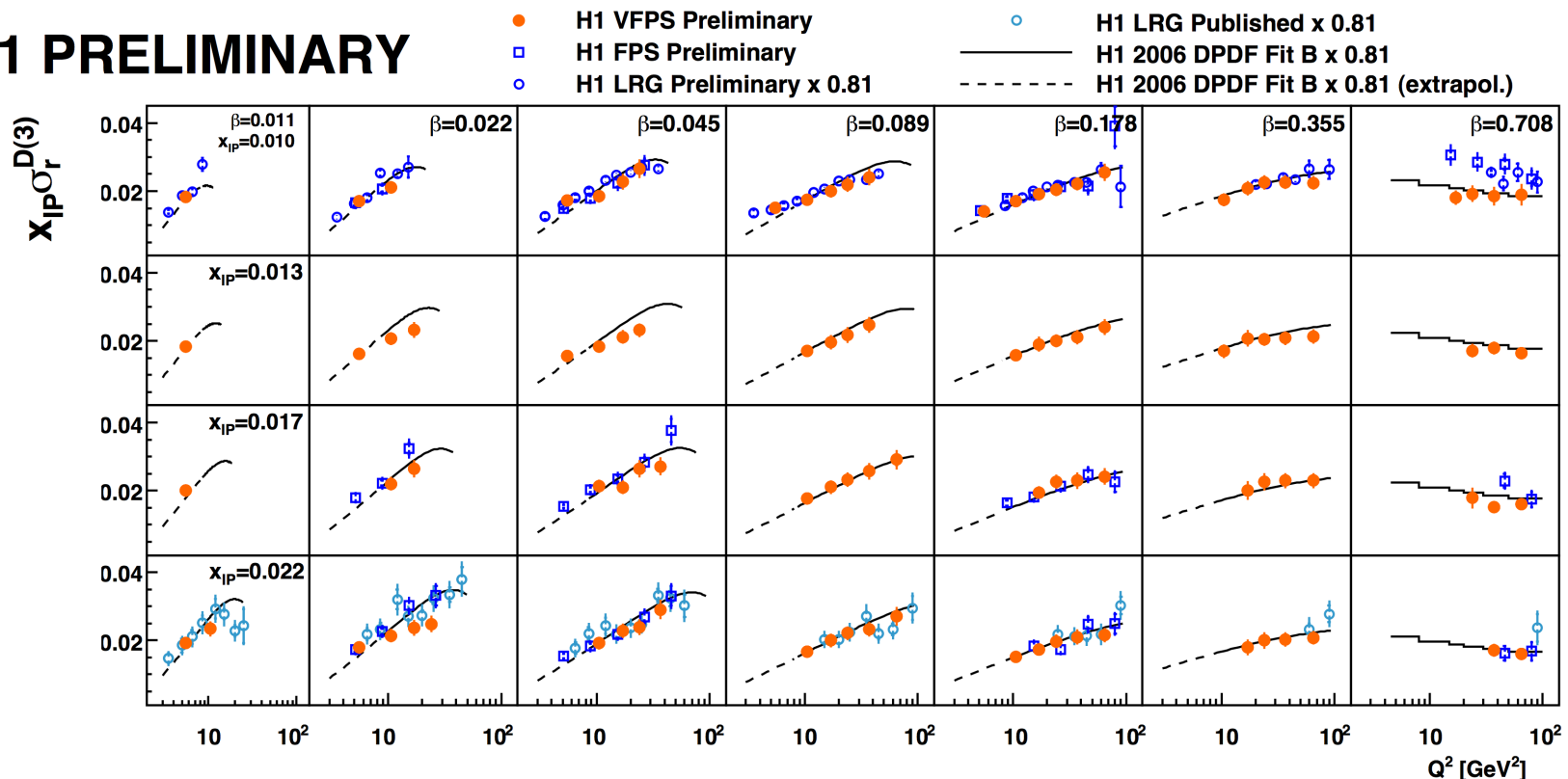
- full HERA II statistics
- t dependence
- Regge fit to data



$F_2^{D(3)}$ with Proton in VFPS

- VFPS: new device in HERA II, 220m away from H1 H1prelim-10-014 → T. Hreus [271]
- high acceptance for $|t| < 0.25 \text{ GeV}^2$, $0.009 < x_{\text{IP}} < 0.026$
- precise reconstruction of β and x_{IP}
- good agreement between rap. gap, FPS and VFPS measurements

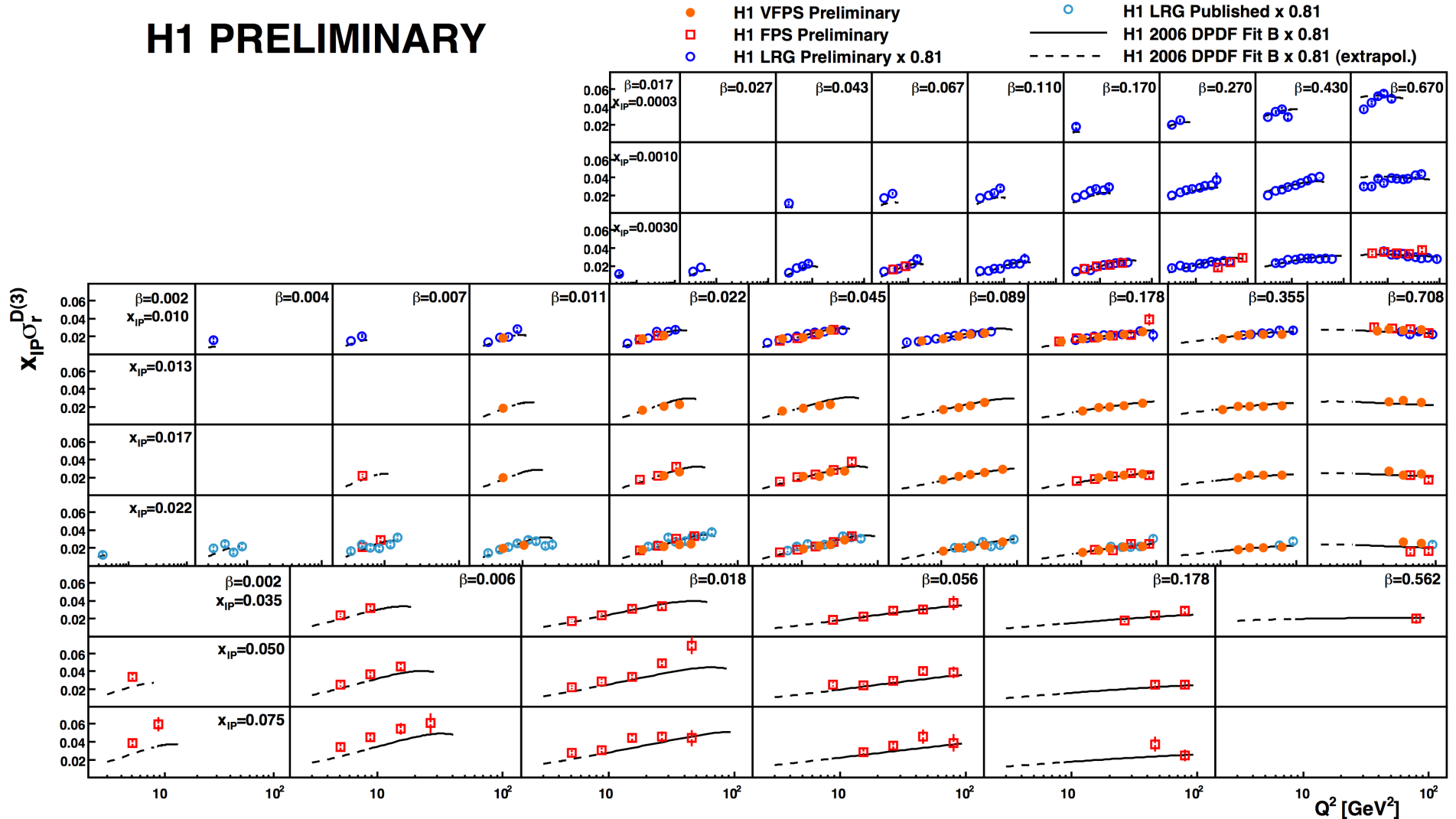
H1 PRELIMINARY





$F_2^{D(3)}$ Comparison

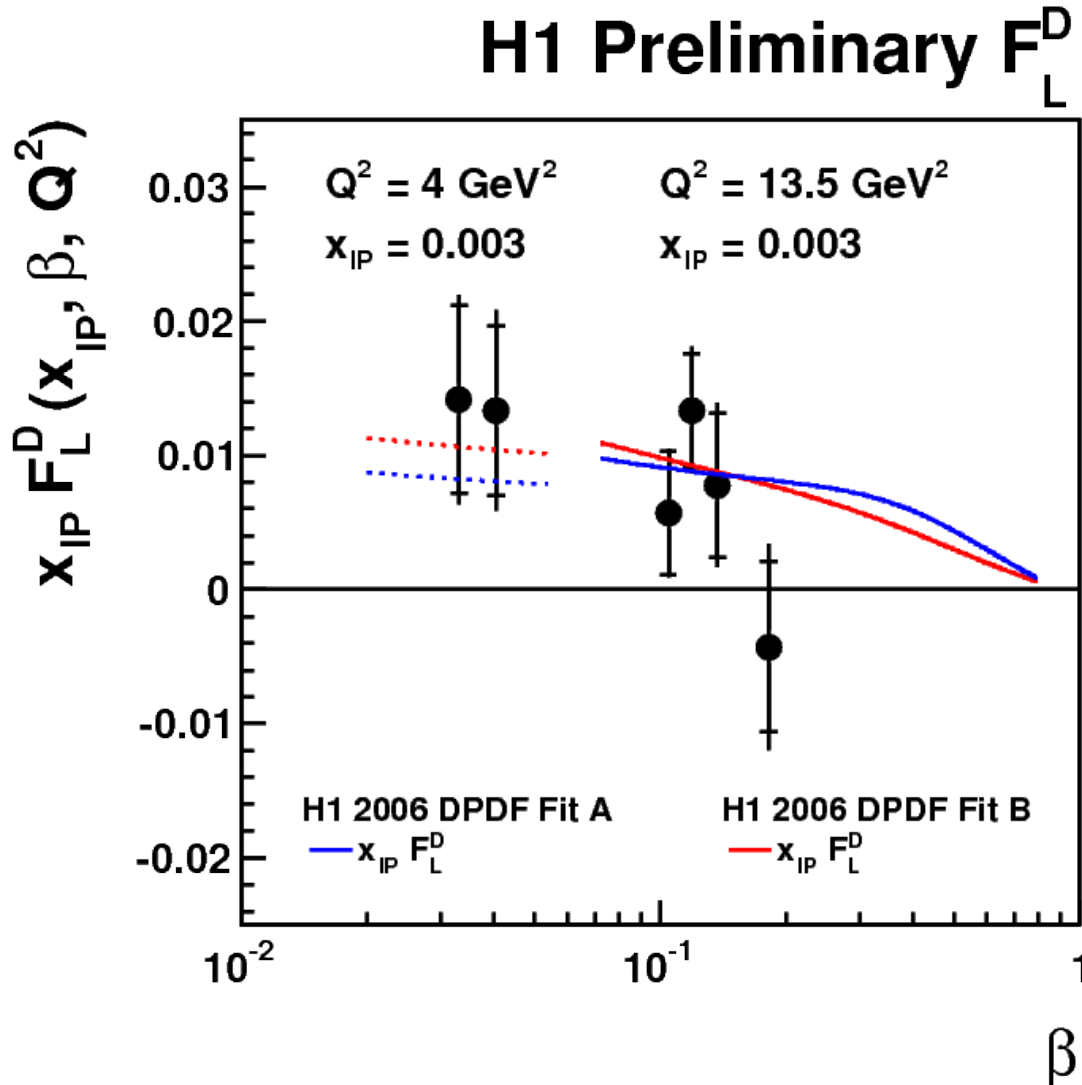
H1 PRELIMINARY





F_L^D in extended Q^2 range

H1prelim-10-017
 → P. Laycock [249]



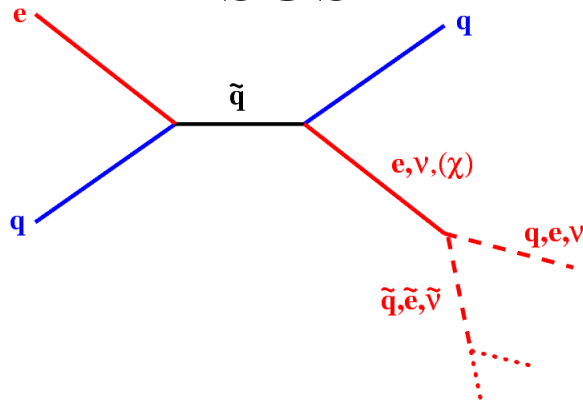
$$\sigma_r^D \propto F_2^D - \frac{y^2}{1+(1-y)^2} F_L^D$$

- rapidity gap in low E_p running
- extend measurement to lower Q^2
- non-zero F_L^D

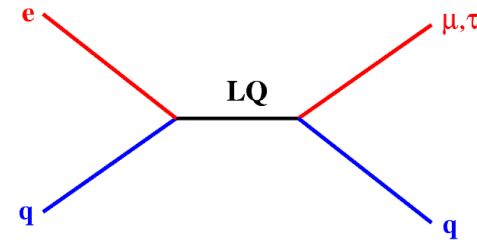


Searches

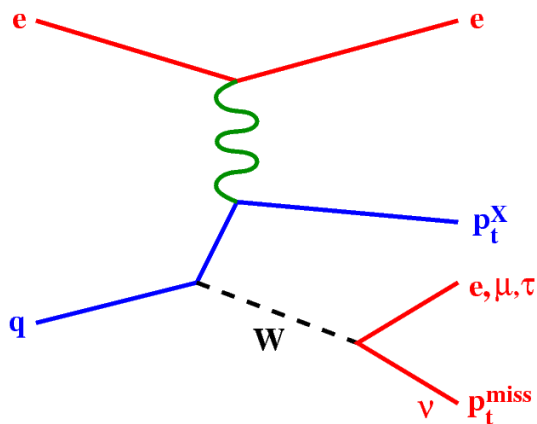
R-Parity violating SUSY



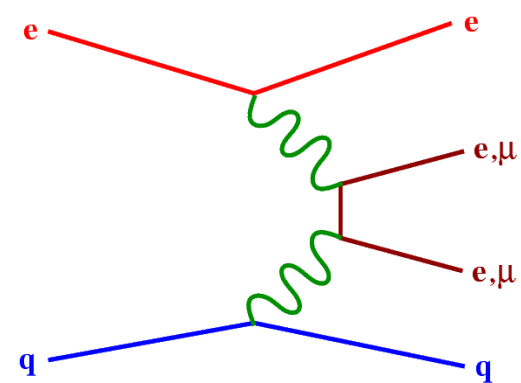
Leptoquarks with Lepton Flavour Violation



Isolated Leptons & W



Multi-Leptons

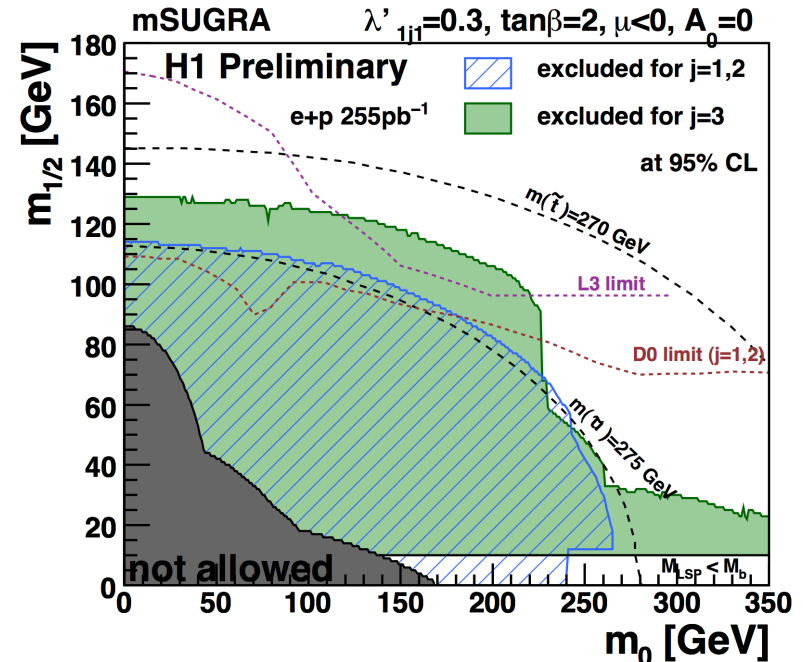
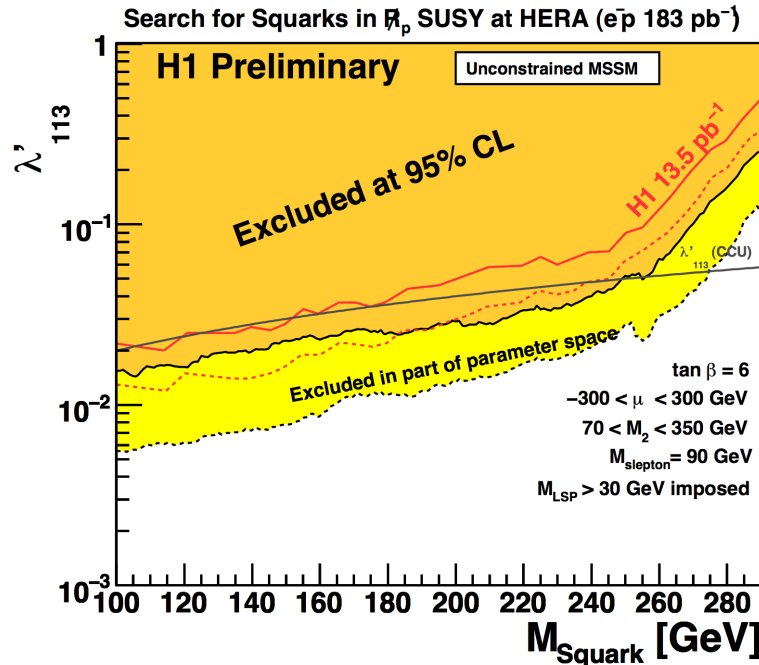
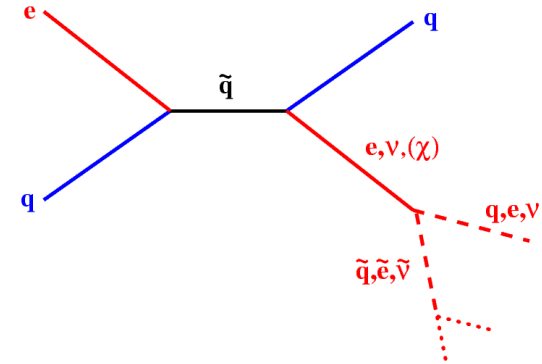




R-Parity violating SUSY

- many different decay topologies
- complete HERA I+II data
- limits for all 3 generations in unconstrained MSSM and mSUGRA

H1prelim-10-063
→ M. Herbst [74]

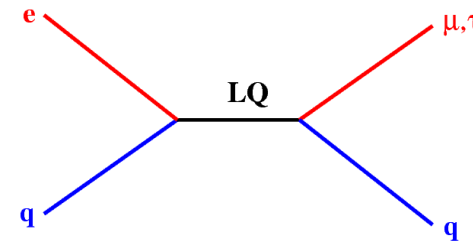




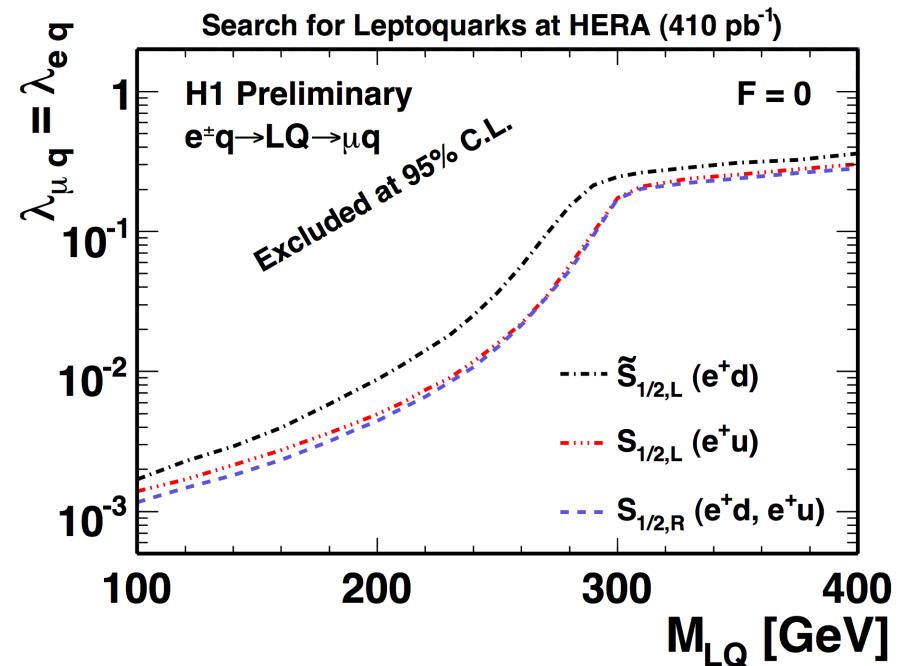
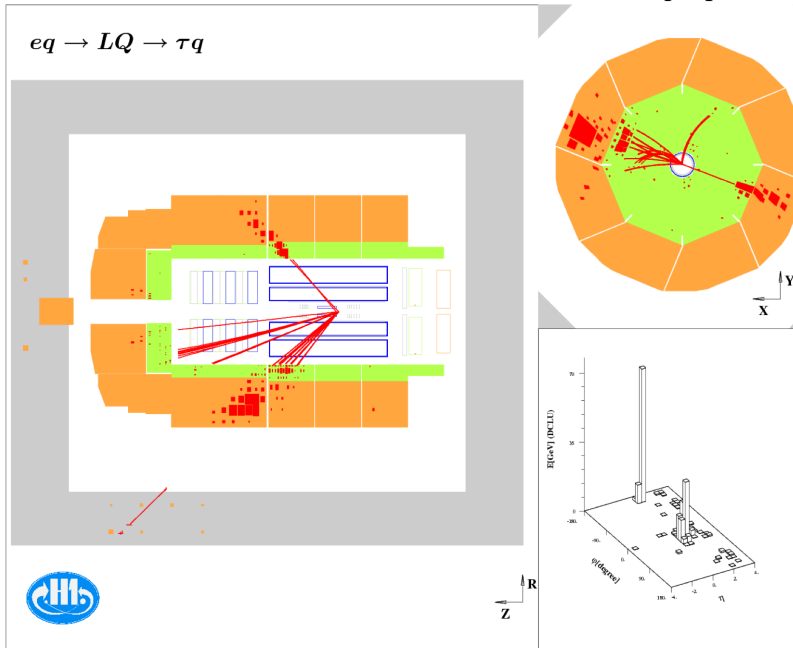
Leptoquarks with Lepton Flavour Violation

- decay via LFV coupling
 $e q \rightarrow LQ \rightarrow \mu q$ or τq
- complete HERA I+II data
- for $\lambda=0.3$ masses $<272-530$ GeV excluded

H1prelim-10-061
 → I. Panagoulas [75]

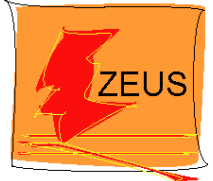


H1 Candidate Event in the Search for Third Generation Leptoquarks





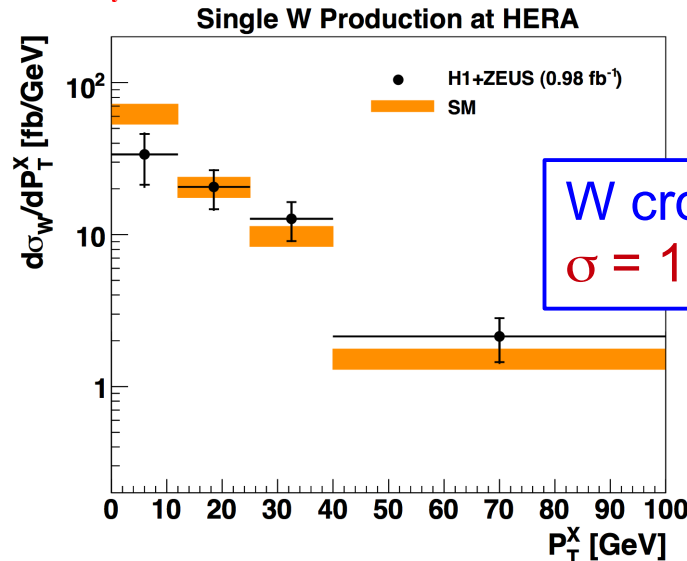
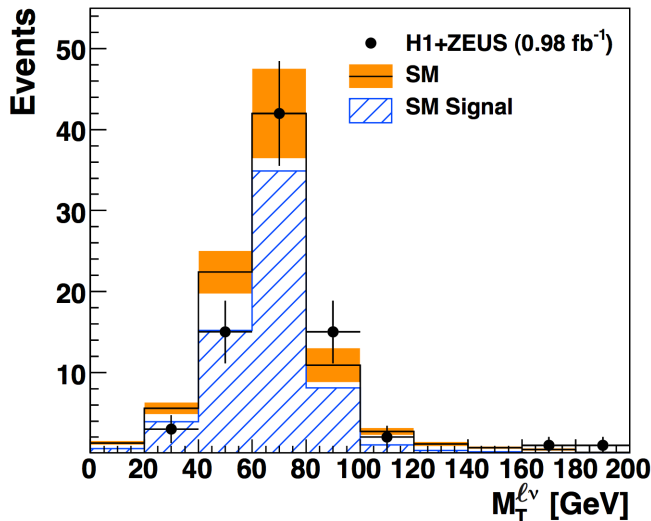
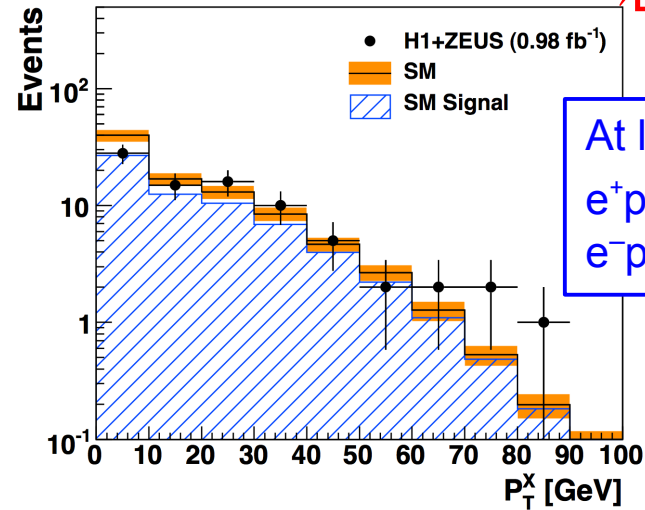
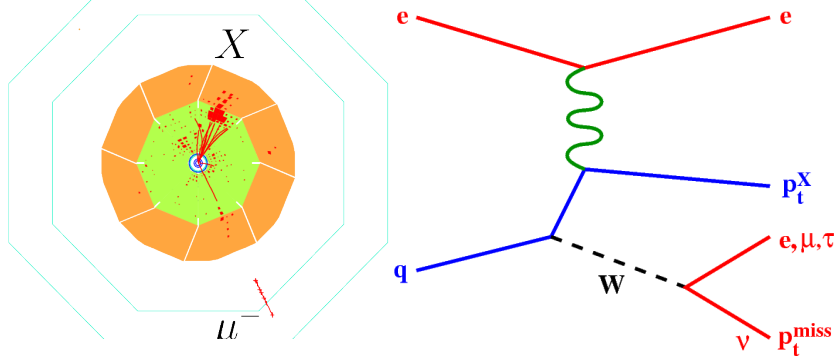
Isolated Leptons & W production



- $\ell=e,\mu$ and ν with high P_T
- complete HERA data, $\sim 1 \text{ fb}^{-1}$
- combine W cross sections

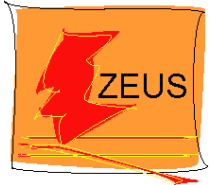
JHEP 1003:035,2010

→ D. South [67]





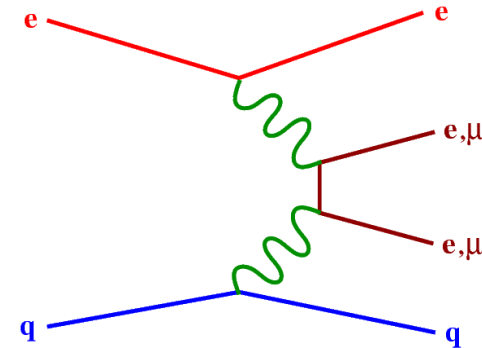
Multi-Leptons



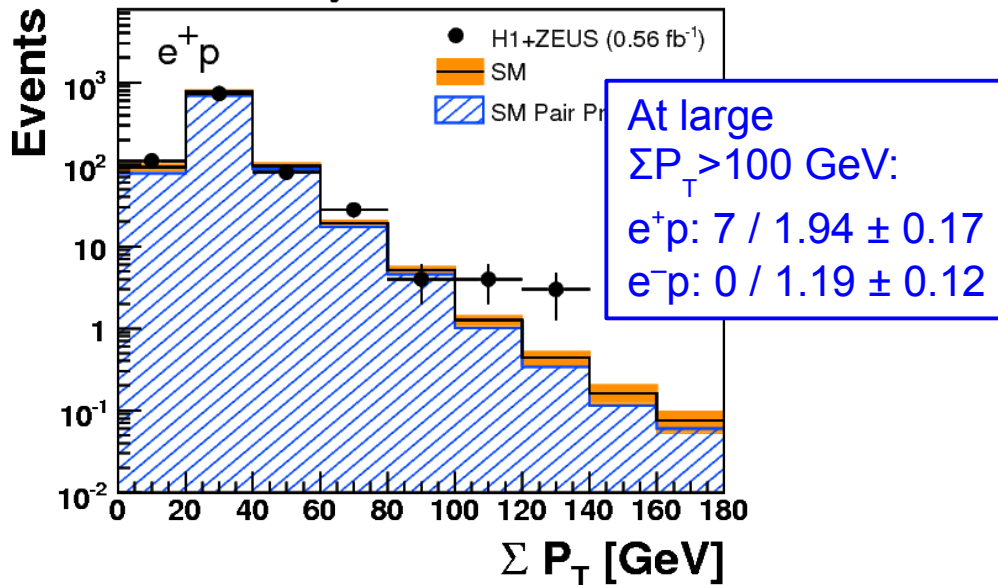
first publication by “The H1 and ZEUS Collaborations”

JHEP 0910:013,2009
→A. Parenti [84]

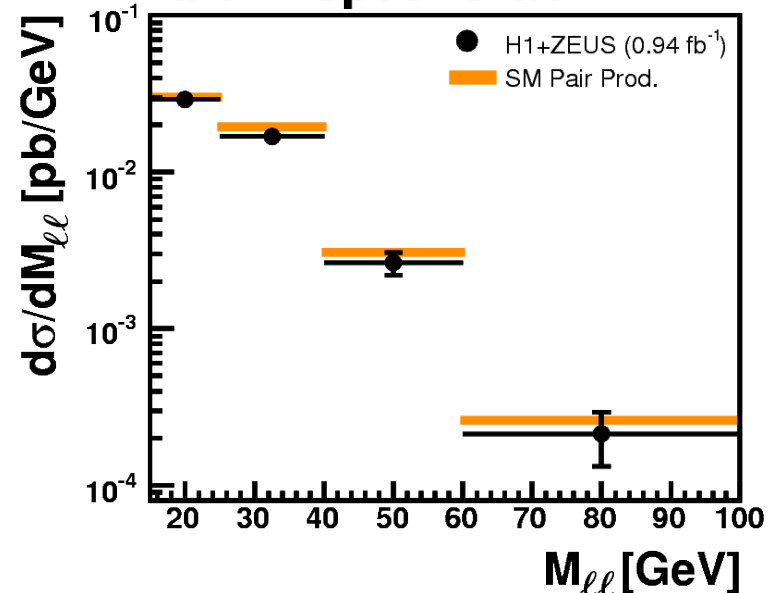
- 2 or 3 high P_T leptons: $\ell=e,\mu$
- complete HERA data, $\sim 1 \text{ fb}^{-1}$
- cross section for $\gamma\gamma \rightarrow \ell^+ \ell^-$



Multi-Leptons at HERA







Multi-Leptons at HERA





New H1 Results at DIS2010

Structure Functions & PDFs

- Incl. HERA I medium Q^2 →M. Klein [171]
- Incl. HERA I low Q^2 →A. Glazov [172]
-  • Incl. HERA I & HERAPDF1.0 →S. Habib [169]
-  • combined F_L →J. Grebenyuk [170]
-  • PDF fit including F_L →V. Radescu [318]
-  • PDF fit including F_2^c →A. Cooper-Sarkar [31]
- High Q^2 NC HERA II →V. Chekelian [350]
- High Q^2 CC HERA II →S. Shushkevich [348]


Diffraction

- F_L^D →P. Laycock [249]
- F_2^{LN} →A. Bunyatyan [272]
- F_2^D wit rap.gap →P. Laycock [249]
- F_2^D with proton in FPS →M. Kapishin [270]
- F_2^D with proton in VFPS →T. Hreus [271]
- Jets with proton in FPS →R. Polifka [274]
- DVCS →L. Favart [263]
- ρ and ϕ in DIS →X. Janssen [265]



QCD Final States

- Jets at high Q^2 and α_s →R. Kogler [160]
- Jet at low Q^2 and α_s →R. Kogler [160]
- Prompt Photons in γp →D. Saxon [331]
- HFS charge asymmetry →D. Traynor [145]
- Charged Particle Spectra →A. Grebenyuk [151]
- Strangeness at high Q^2 →J. Ruiz Tabasco [157]

Heavy Flavour

- D^* and F_2^c at high Q^2 →M. Brinkmann [28]
- F_2^b and F_2^c with Vertex Det. →P. Thompson [19]
- c and b jets with Vertex Det. →P. Thompson [19]
-  • Combined F_2^c →K. Daum [30]
- Inelastic J/ψ →M. Steder [85]
- D^* and jets in γp →Z. Staykova [89]

EW and Searches

-  • Multi-Leptons →A. Parenti [84]
-  • Isolated Lepton and W →D. South [67]
- R-Parity Violating SUSY →M. Herbst [74]
- LFV Leptoquarks →I. Panagoulas [75]
- EW and QCD Fit →Z. Zhang [351]



Summary

Many new results in key areas of H1 physics program:

- combined NC and CC HERA I data → [HERAPDF1.0](#)
- high Q^2 NC and CC HERA II data
- running of α_s from low to high Q^2
- inclusive diffractive scattering (first VFPS measurement)
- finalization of searches

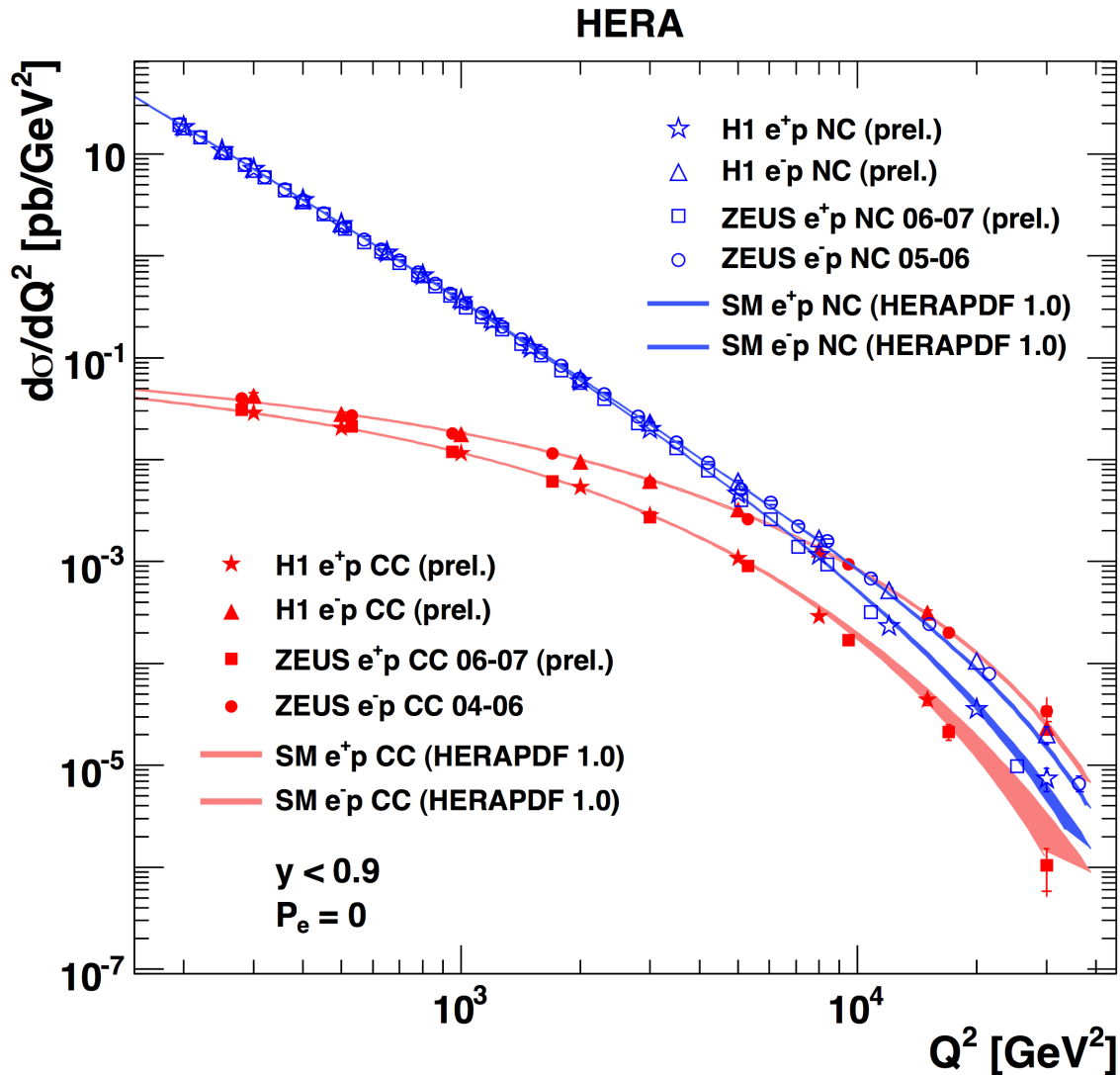
In the process of harvesting the HERA II precision now

→ combination of H1 and ZEUS data to reach final precision

Backup



High Q^2 NC & CC



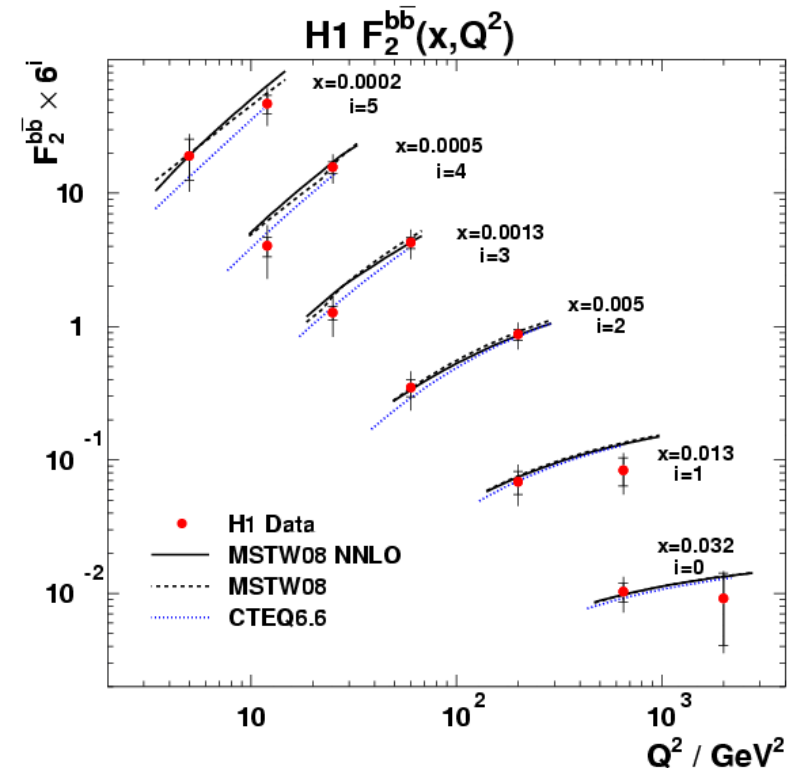
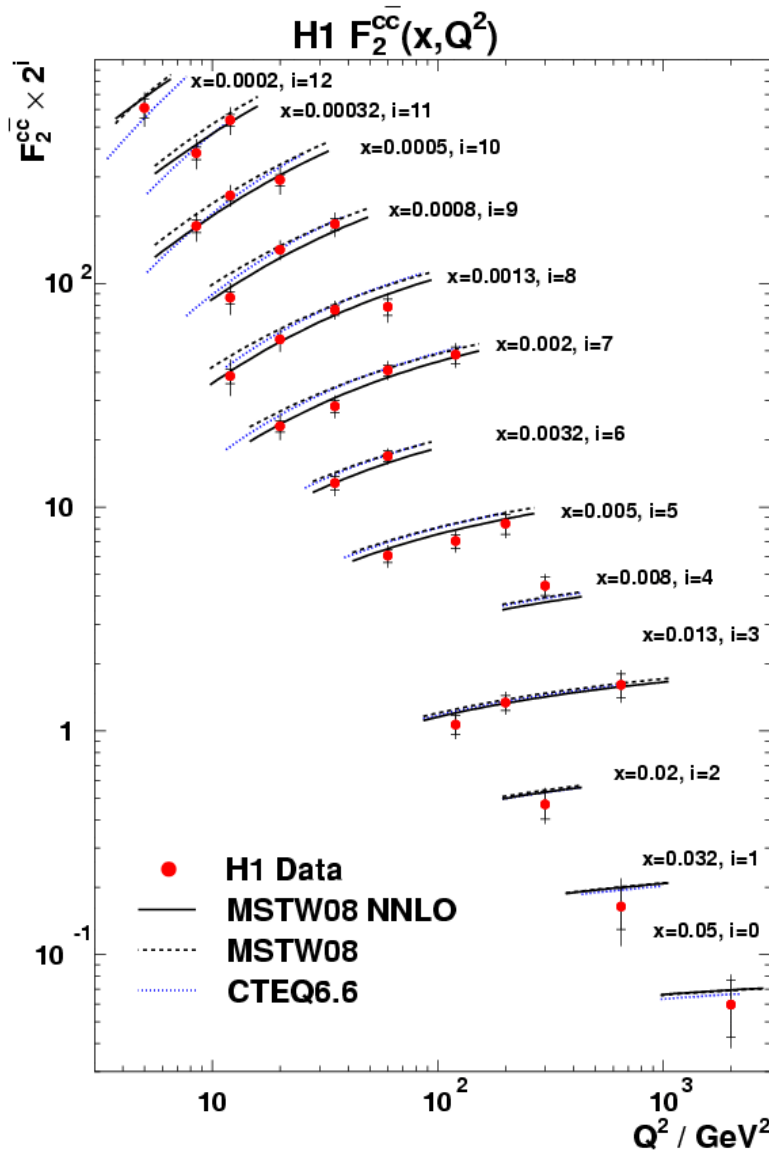
- EW unification plot with complete H1 data



F_2^c and F_2^b with Vertex Detector

Eur.Phys.J. C65 (2010) 89

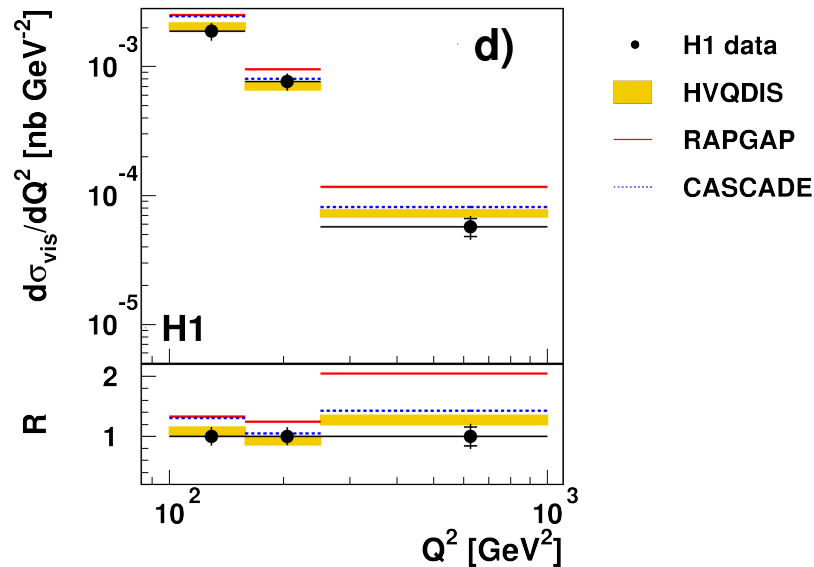
- exploit lifetime of c and b
- combine HERA I & II
- unc. $\sim 10\%$ for c , $\sim 25\%$ for b



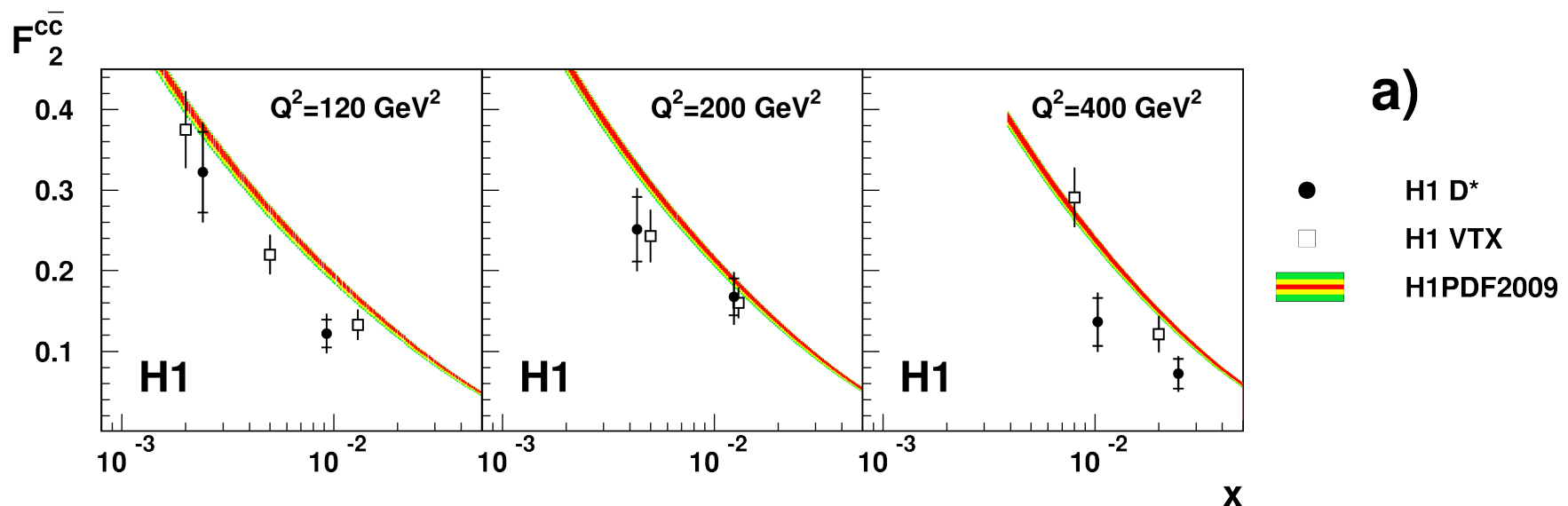


D* and F₂^c at high Q²

Phys.Lett.B686:91,2010



- complete HERA II data
- D* cross sections for 100 < Q² < 1000 GeV²
- c contribution to F₂
- use in F₂^c combination

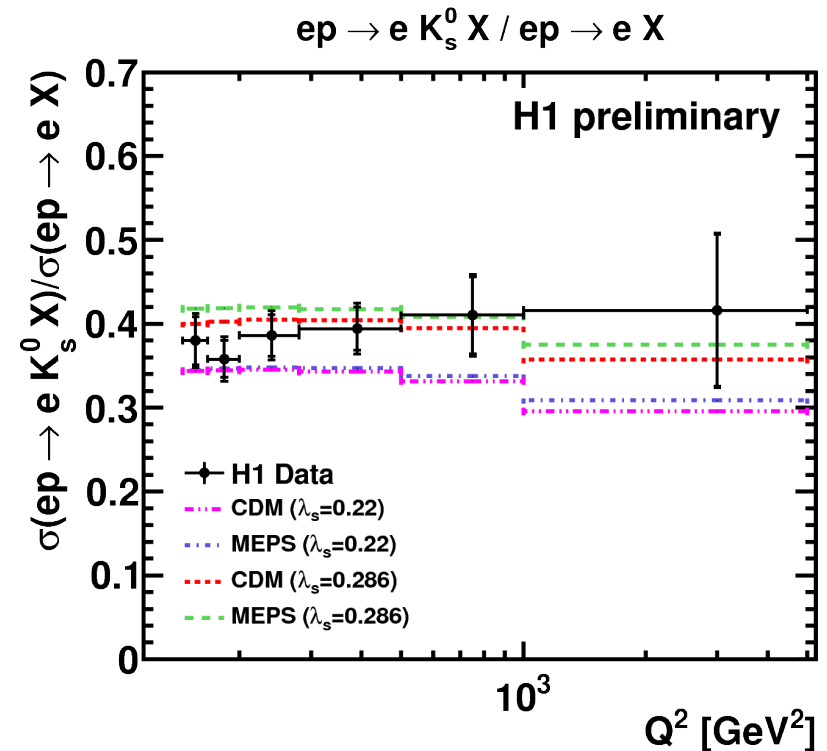
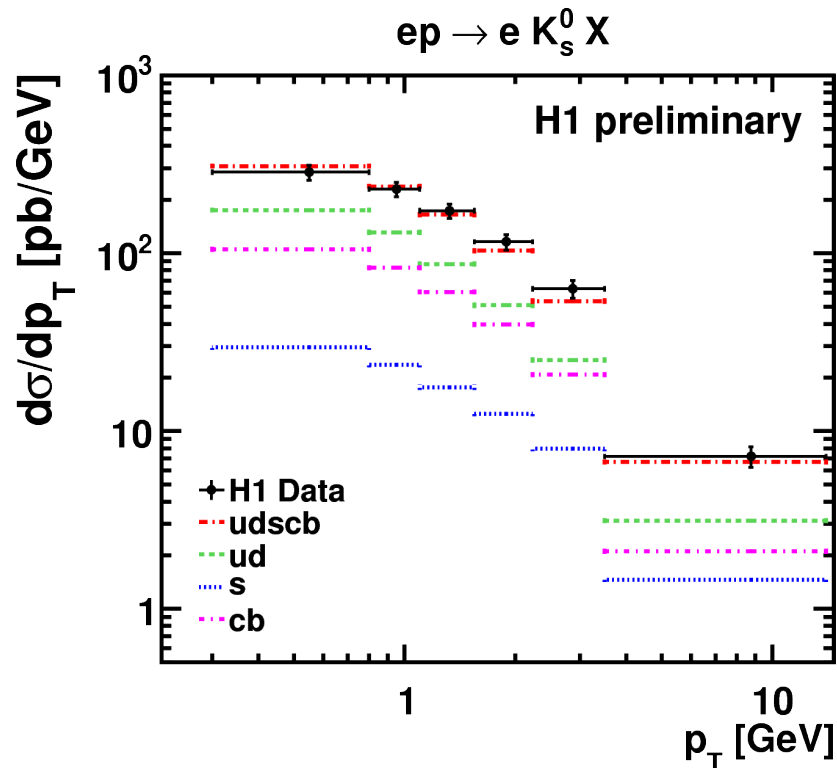




K_S^0 at high Q^2

H1prelim-10-031

- full HERA II statistics
- K_S^0 cross sections in lab and Breit frame, ratio to incl. cross section
- production dominated by fragmentation, $\lambda_s=0.286$ preferred

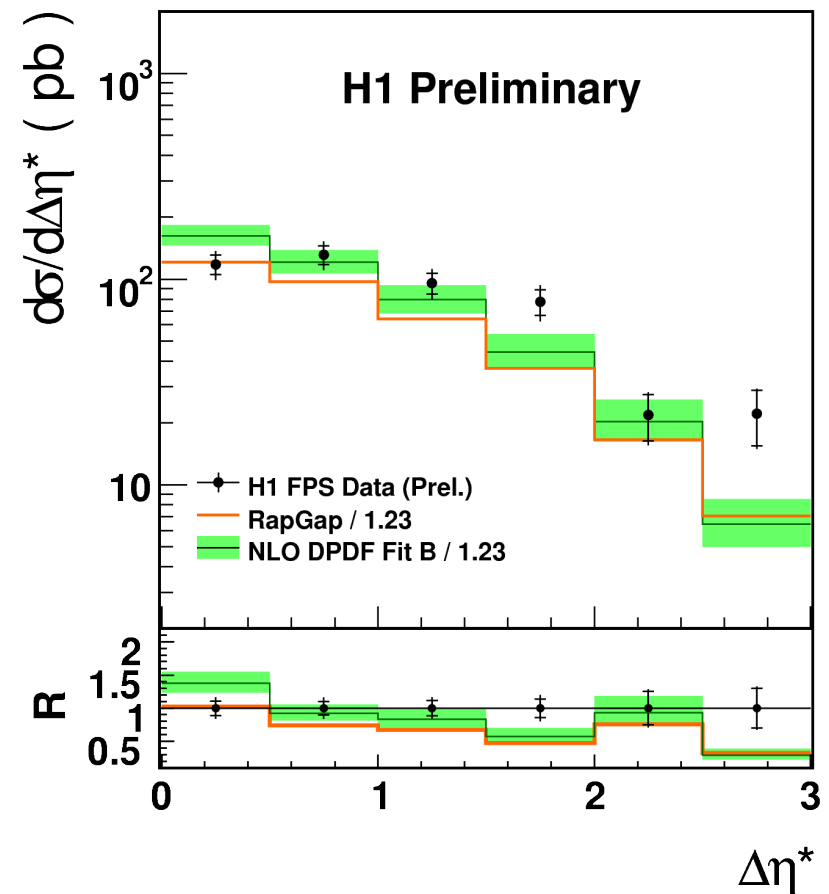
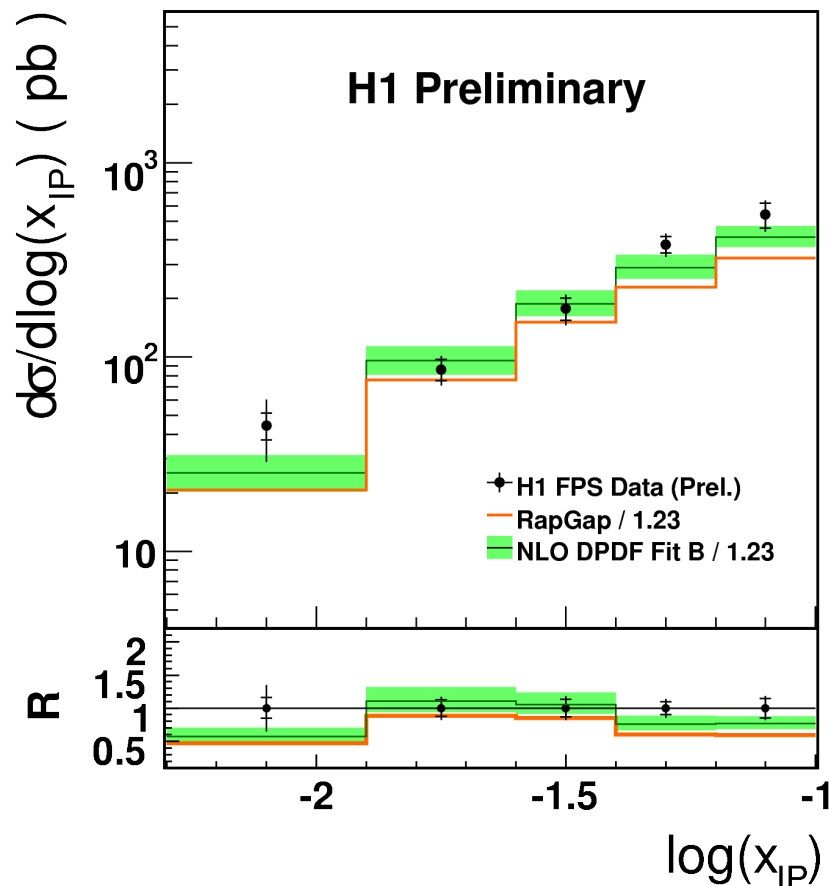




Jets with Proton in FPS

H1prelim-10-013

- 2 jets in the central detector
- access to diffractive jets at large x_{IP}
- comparison to LO ME+PS MC and NLO calculation





Diffractive ρ and ϕ in DIS

DESY 09-093, accepted by JHEP

- comprehensive analysis of elastic and proton-dissociative production of ρ and ϕ mesons in DIS
- measurement of cross sections, spin density matrix elements, longitudinal to transverse ratio
- comparison to other VMs
- comparison to GPD and dipole models

