H1 status report

Ringailė Plačakytė

Universität Hamburg

70th PRC meeting, DESY Zeuthen
14-15 October 2010

Outline:

- Recent results from H1
- Computing and software
- Summary

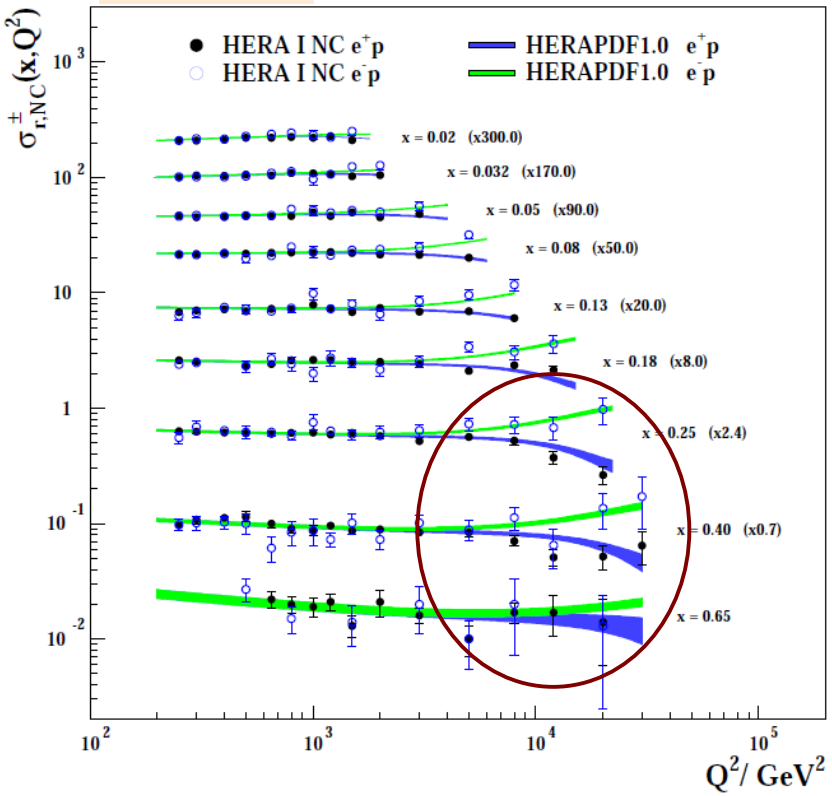
Recent H1 results (since last PRC meeting)

Proton Structure	H1prelim-10-142 ZEUS-prel-10-018	PDF fits including HERA II high Q^2 data
	H1prelim-10-143 ZEUS-prel-10-019	The Role of the Charm Mass Parameter in the QCD Analysis of the Combined HERA Data and Implications for the LHC
Searches	H1prelim-10-161	Search for new Physics in ep Contact interactions at HERA
Jets & HFS	H1prelim-10-131	Measurement of the Azimuthal Correlation between the Scattered Electron and the most Forward Jet in DIS at HERA
Heavy Flavour	DESY-10-083	Measurement of Charm and Beauty Jets in DIS at HERA
	H1prelim-10-172	D* production at low Q^2 in an extended phase space
Diffraction	DESY-10-095	Measurement of the Diffractive DIS Cross Section with Leading Proton at HERA
	H1prelim-10-113	Measurement of Leading Neutron x_L and p_T^2 Double Differential Cross Sections in DIS at HERA

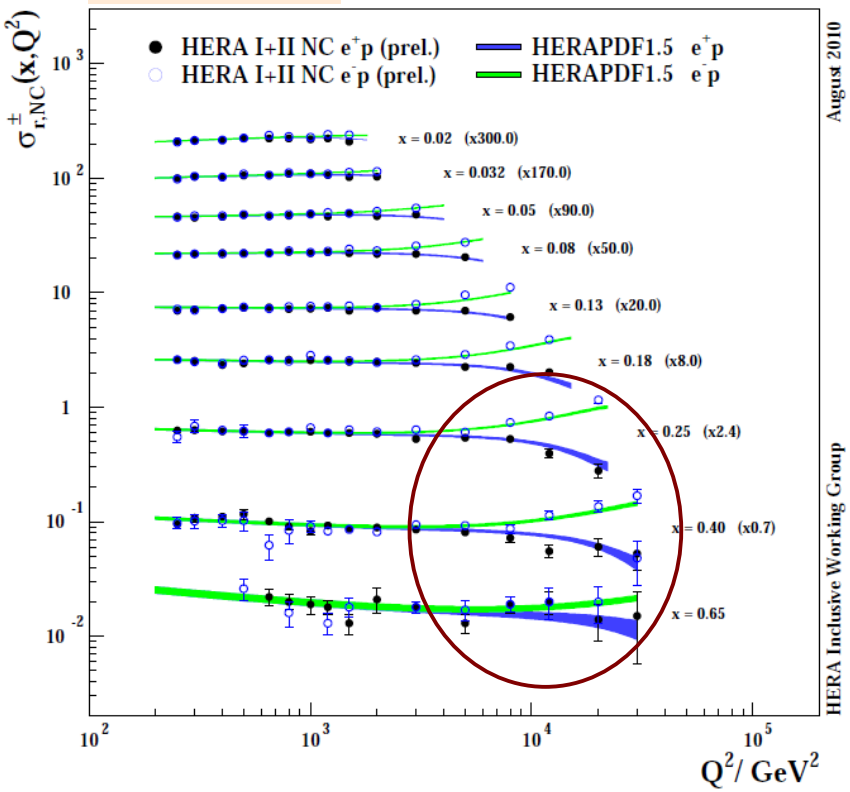
Fits to new combined HERA data: HERAPDF1.5

HERAPDF1.0: combined inclusive HERA I arXiv:0911.0884[hep-ex]
HERAPDF1.5: combined inclusive HERA I and HERA II data

HERA I H1 and ZEUS HERAPDF1.0



+ HERA II H1 and ZEUS HERAPDF1.5



Improved data precision → Improved PDFs

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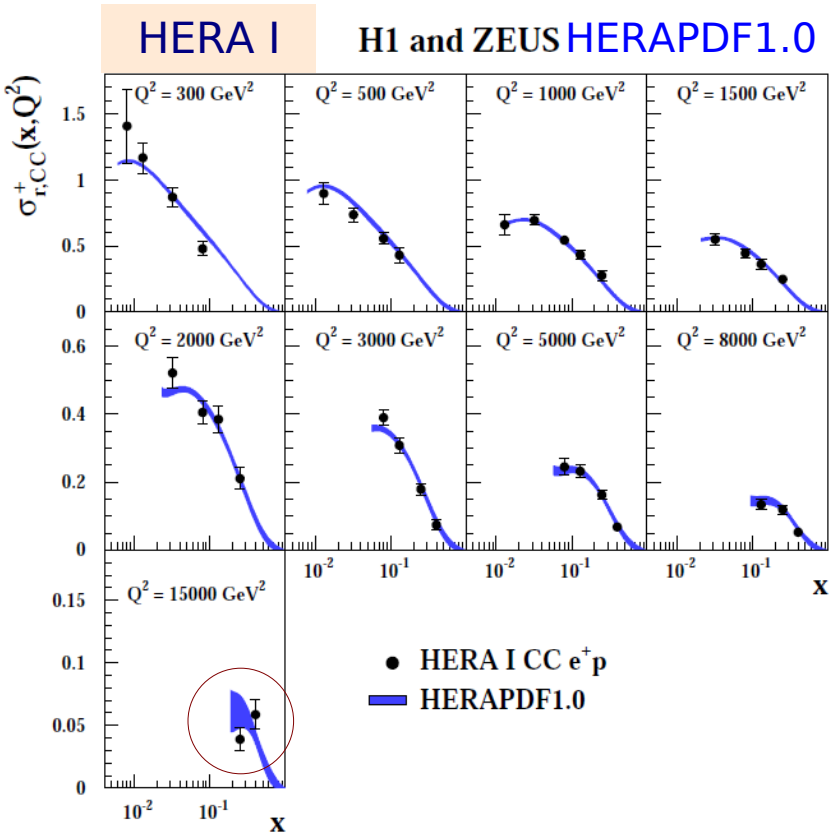

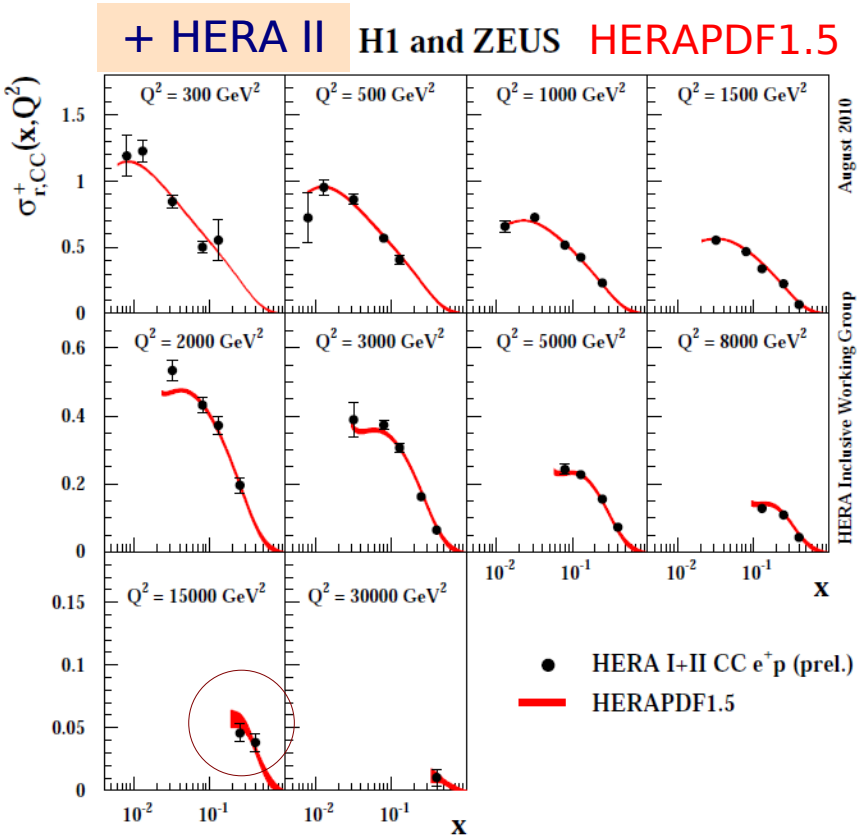

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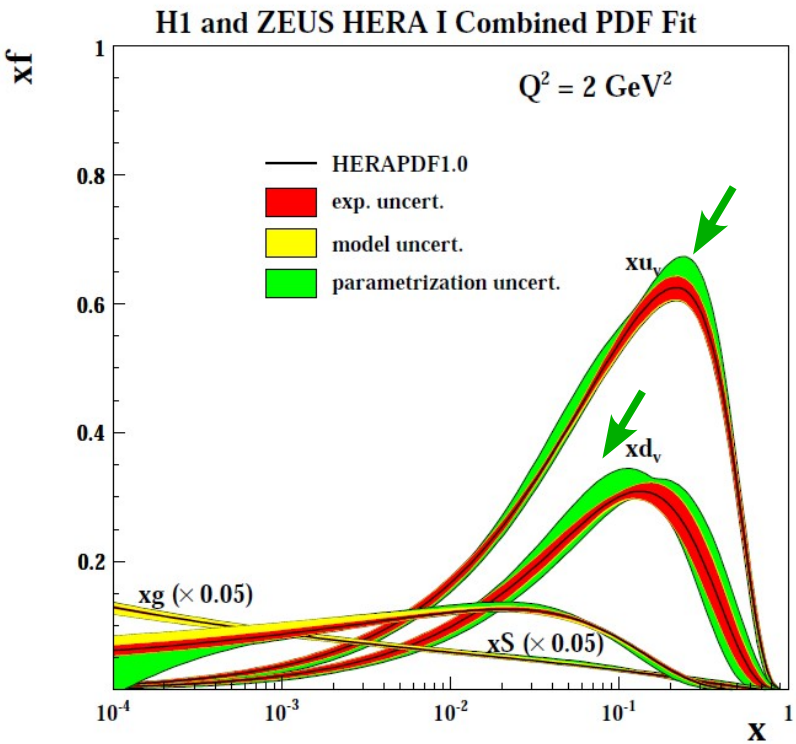
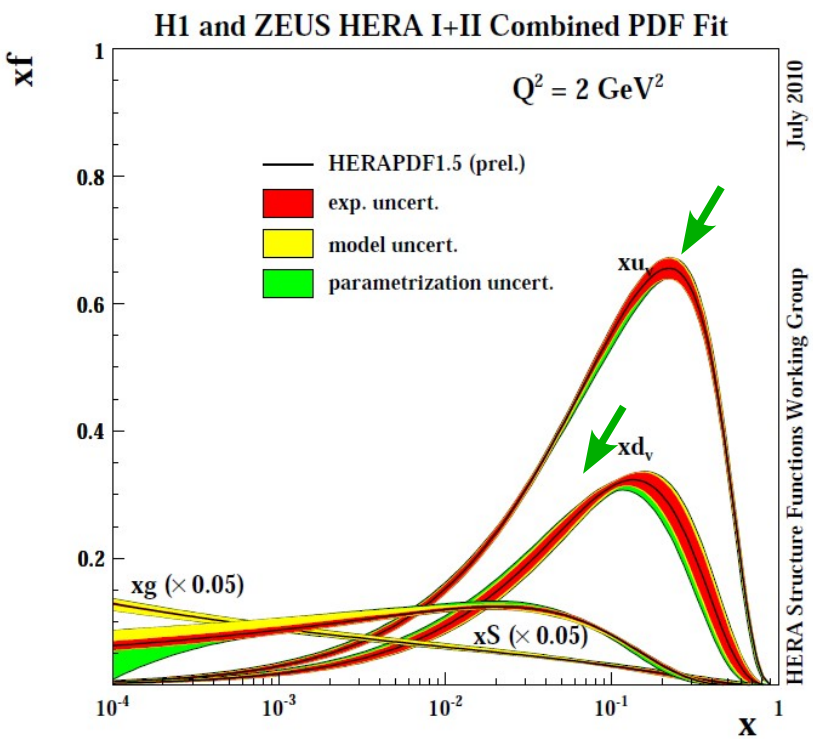
HERAPDF1.0



HERAPDF1.5

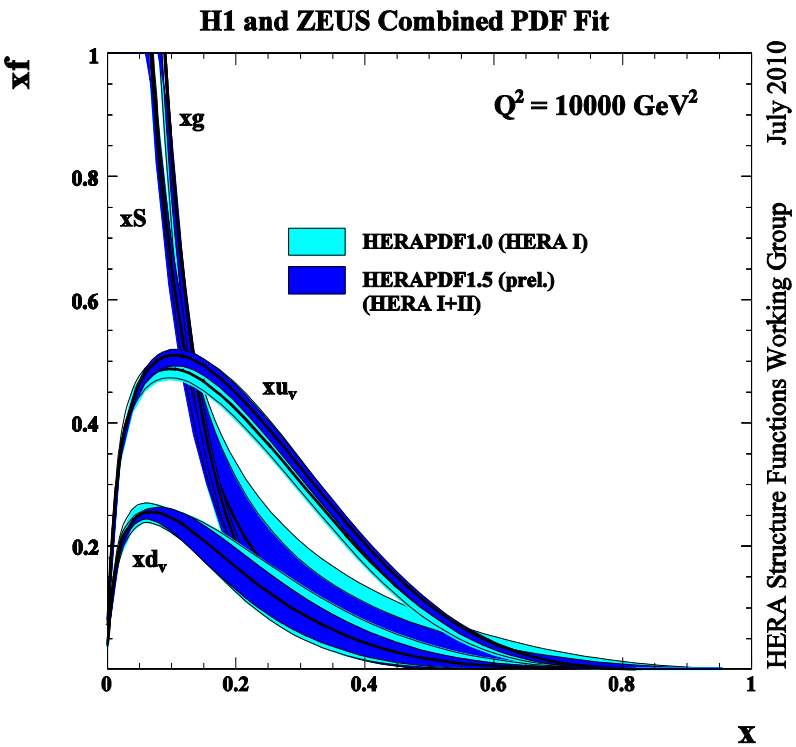


Better constrained valence quarks

Reduced experimental and parametrisation uncertainties

Fits to new combined HERA data: HERAPDF1.5

Linear x scale

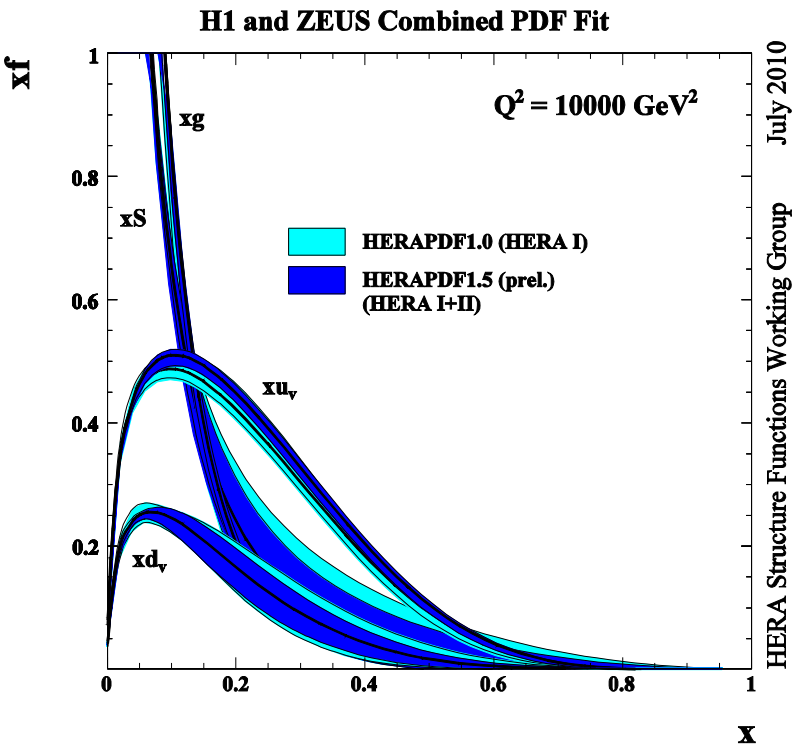


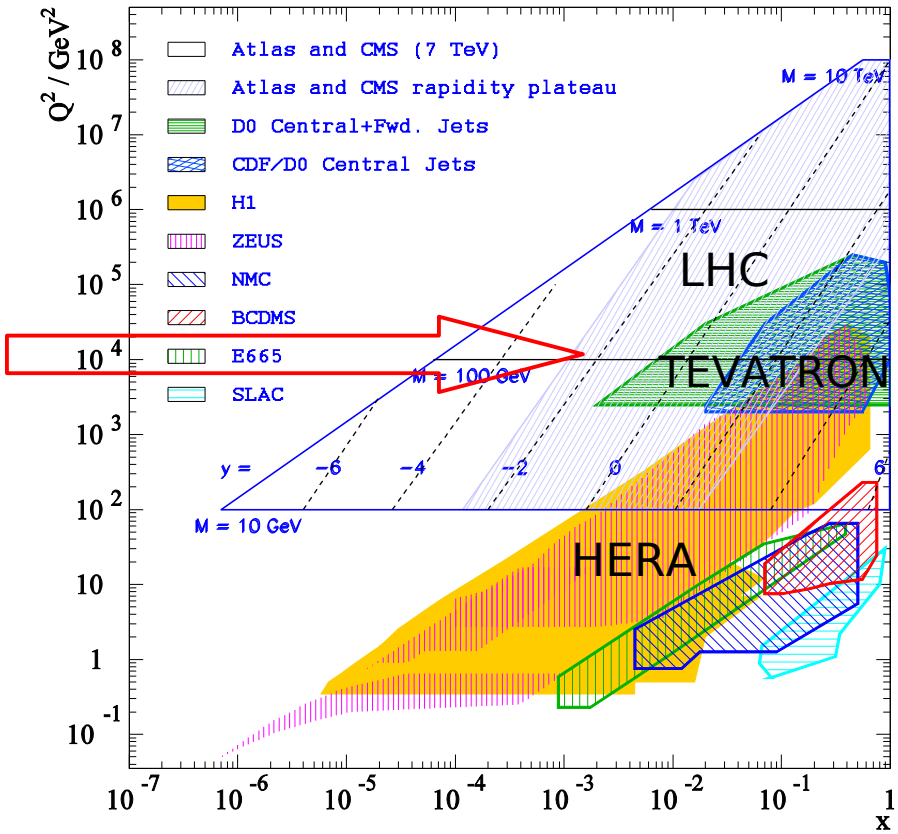
HERAPDF1.5: smaller uncertainties for all PDFs at high *x*

Reduced uncertainty for LHC predictions

Fits to new combined HERA data: HERAPDF1.5

Linear x scale



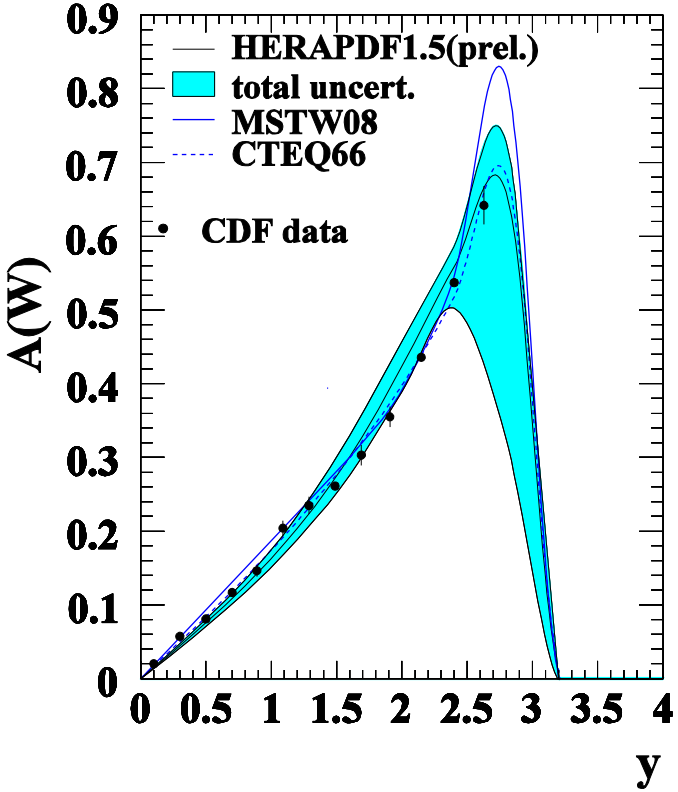


HERAPDF1.5: smaller uncertainties for all PDFs at high *x*

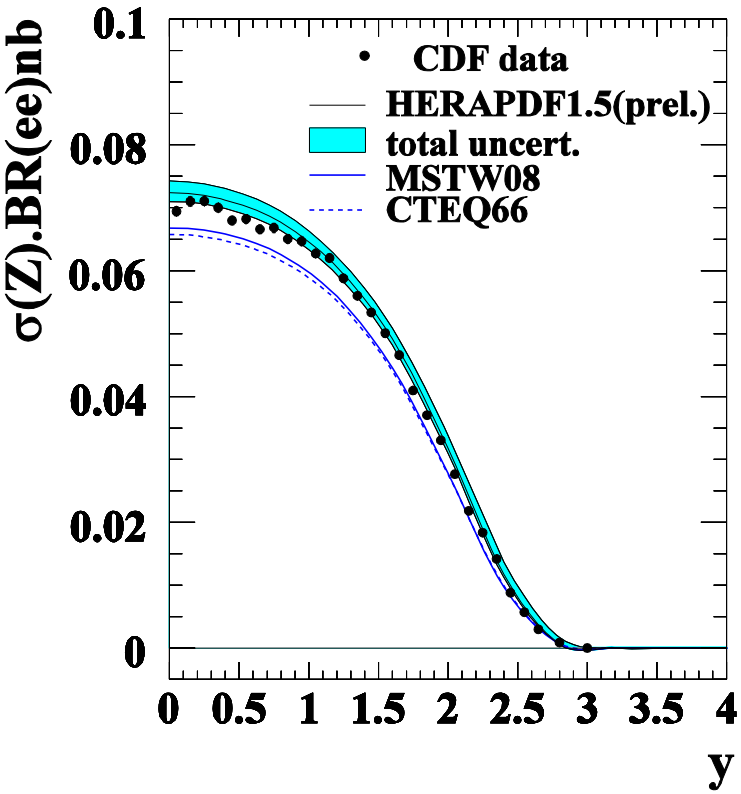
Reduced uncertainty for LHC predictions

HERAPDF1.5: predictions for TEVATRON

W asymmetry



Z Production



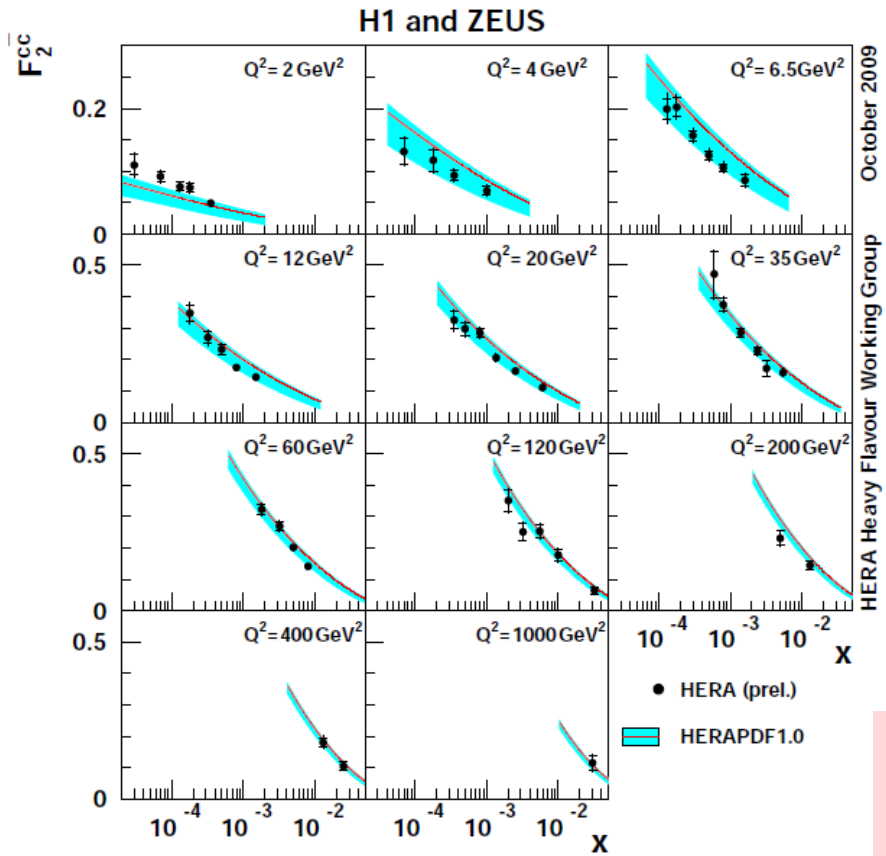
Prediction based on HERAPDF1.5 agrees well with Tevatron data

QCD analysis of combined HERA charm data

Charm contribution to total DIS significant (~ 30% at high Q^2)

Understanding of charm important for PDF, different HF schemes exist

→ Include HERA charm data in QCD analysis



F_2^{cc} vs. HERAPDF1.0 prediction:

Band: PDF uncertainty due to variation of m_C^{model} in PDF:

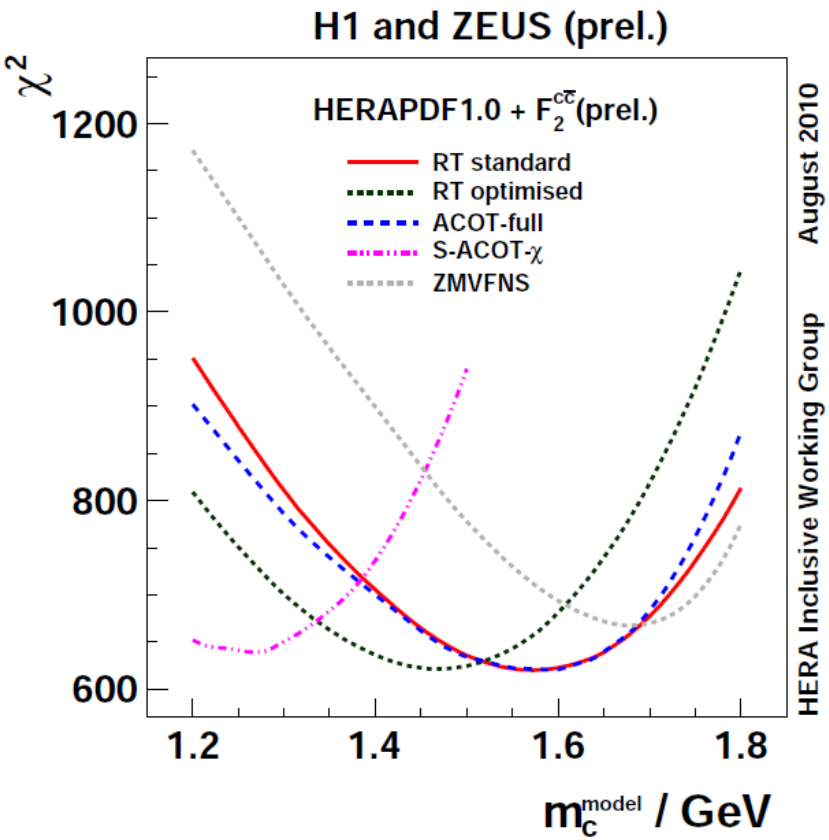
$1.35 < m_C^{model} < 1.65$ GeV

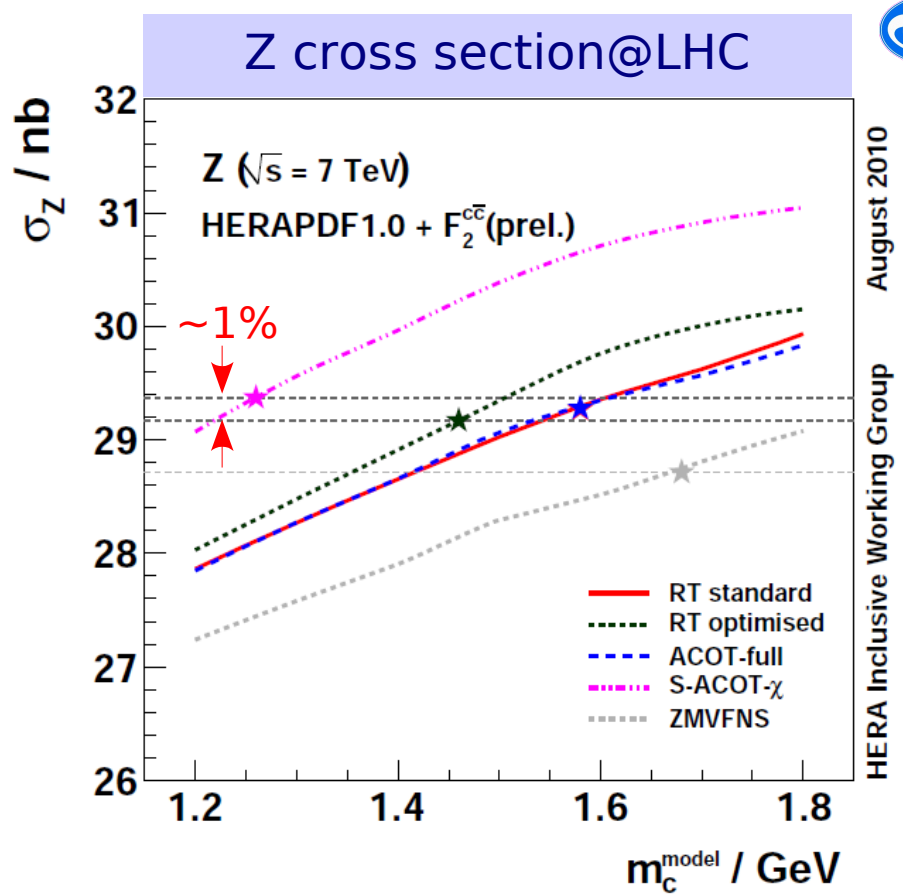
Predictions consistent with data

Data help constraining m_C^{model} for the PDFs

Use F_2^{cc} to determine optimal m_C^{model} as a PDF parameter for different HF schemes

m_c^{model} scan in different heavy flavour schemes





Different schemes prefer different m_c^{model}

Variation between schemes ~7%
Significantly reduced at m_c^{model} (opt) (★)

HERA charm measurements help to reduce uncertainties of predictions for the LHC

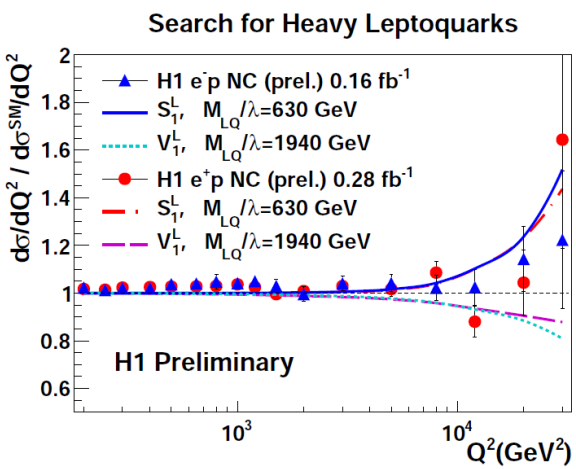
Search for Contact Interactions at HERA

Deviations in the NC DIS at high Q^2 may indicate new physics
can appear like effective four fermion contact interaction (CI)

full HERA data

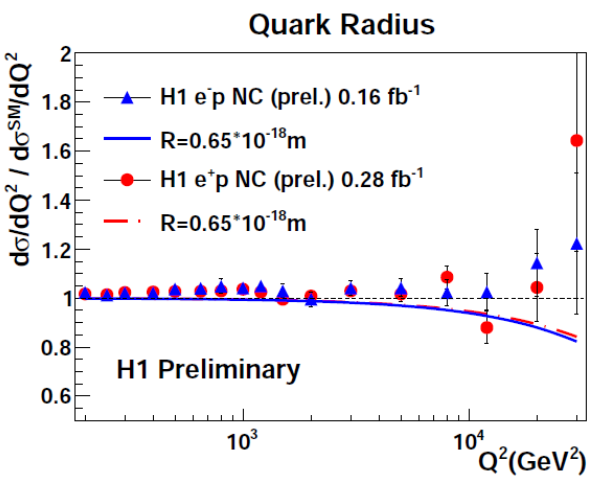
Leptoquarks

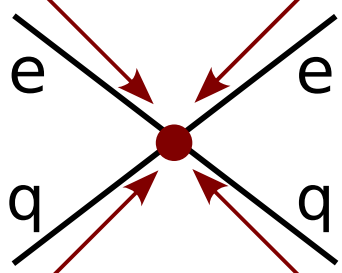
$M_{LQ} / \lambda > 0.4 - 1.94$ TeV



Quark Form Factor

$R_q < 0.65 \cdot 10^{-18}$ m





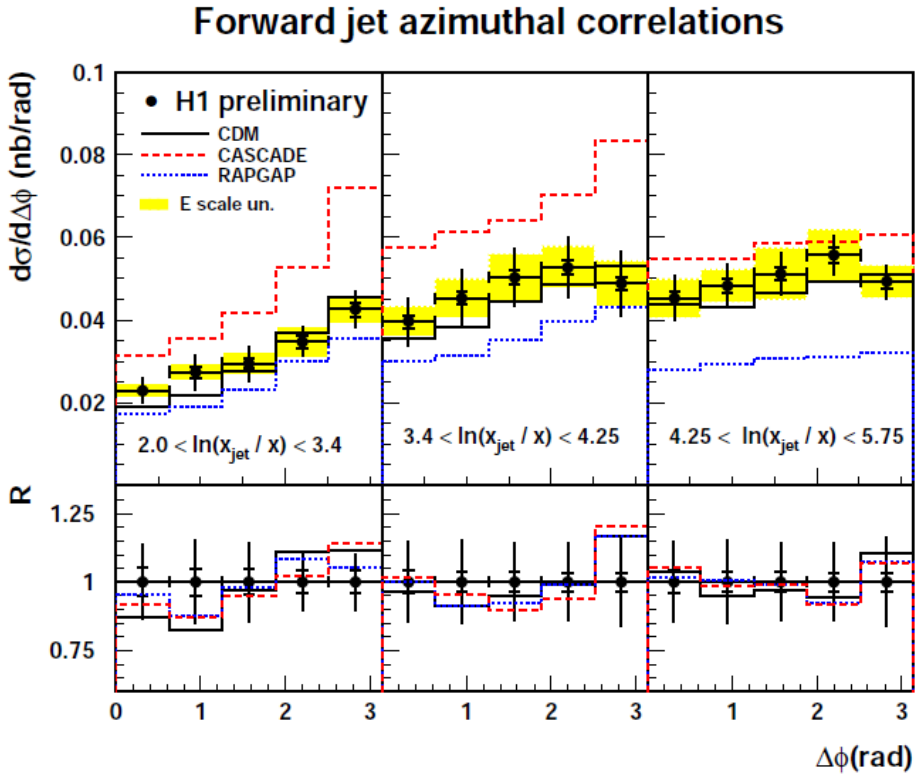
Compositeness

$\Lambda^{\pm} > 3.7 - 7.4$ TeV

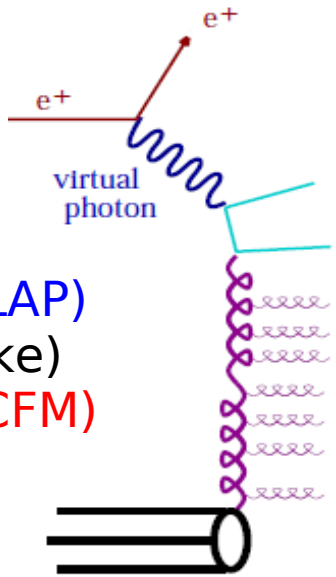
Extra Dimensions

$M_S > 0.9 - 0.91$ TeV

Azimuthal Correlation between Scattered e and Forward Jet in DIS



Probing different ordering models:

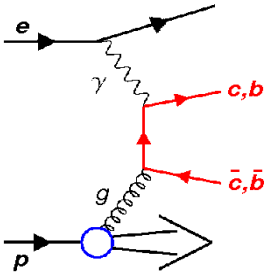


RAPGAP (DGLAP)
CDM (BFKL-like)
CASCADE (CCFM)

$\Delta\phi$: azimuthal difference between scattered electron and forward jet
Measure in three (rapidity separation) regions of $ln(x_{jet}/x)$ to study correlations

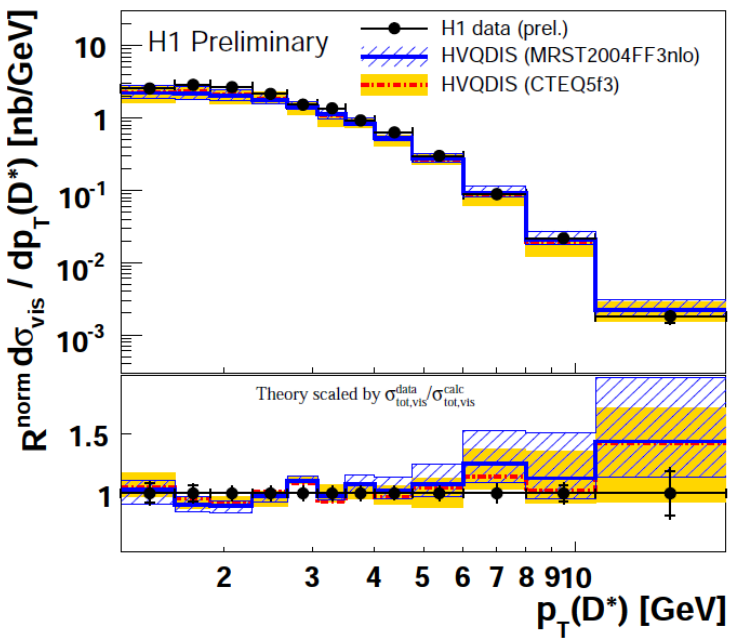
Significant differences between models in normalisation
All models predict similar shapes and are consistent with data

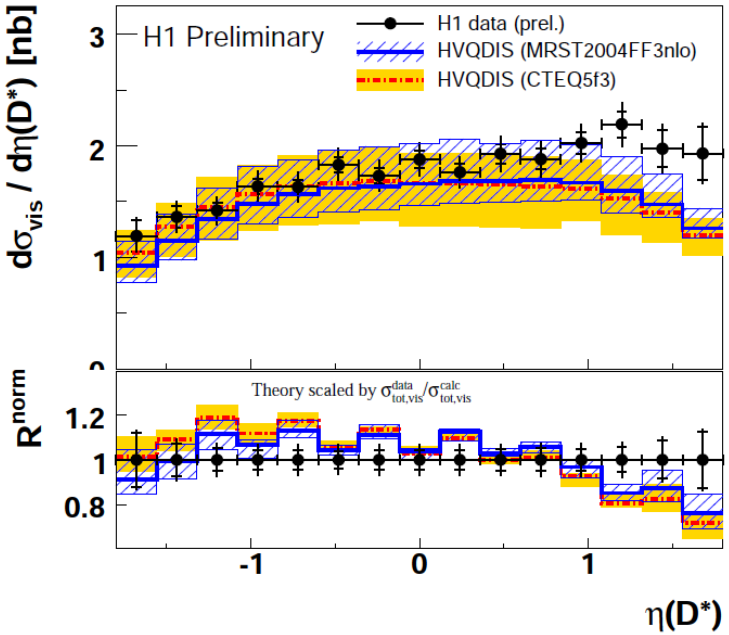
D* Cross Sections in DIS and F_2^{cc} at medium Q^2



Heavy quarks at HERA produced in boson-gluon fusion
Test of pQCD, access to the gluon

H1 preliminary: HERA II data, $5<Q^2<100$ GeV^2, $0.02<y<0.7$, $p_T(D^*)>1.25$ GeV, $|\eta(D^*)|<1.8$ largest D* phase space at HERA





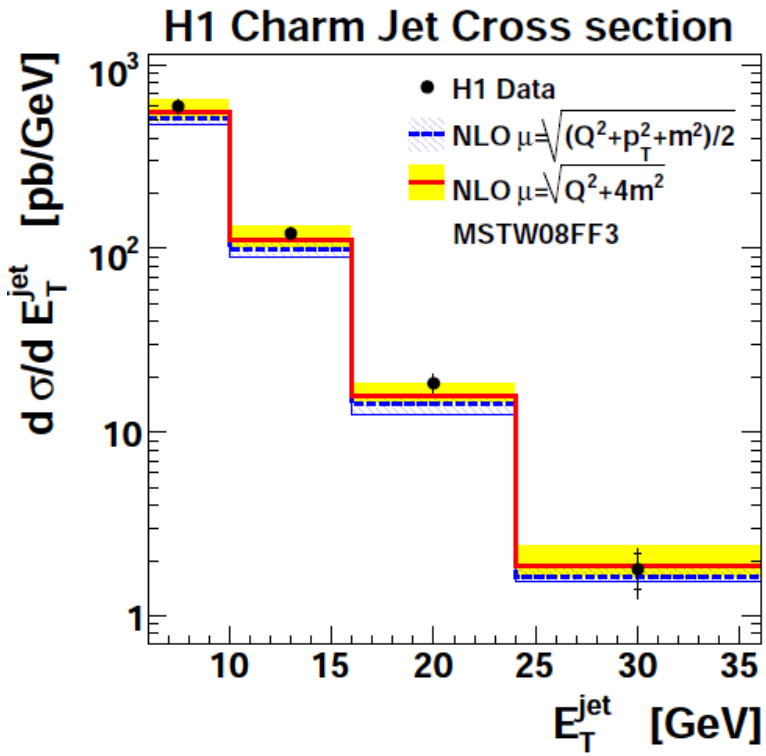
Reasonable agreement with NLO QCD → used to extract F_2^{cc}
Most precise measurement in the combined HERA F_2^{cc}

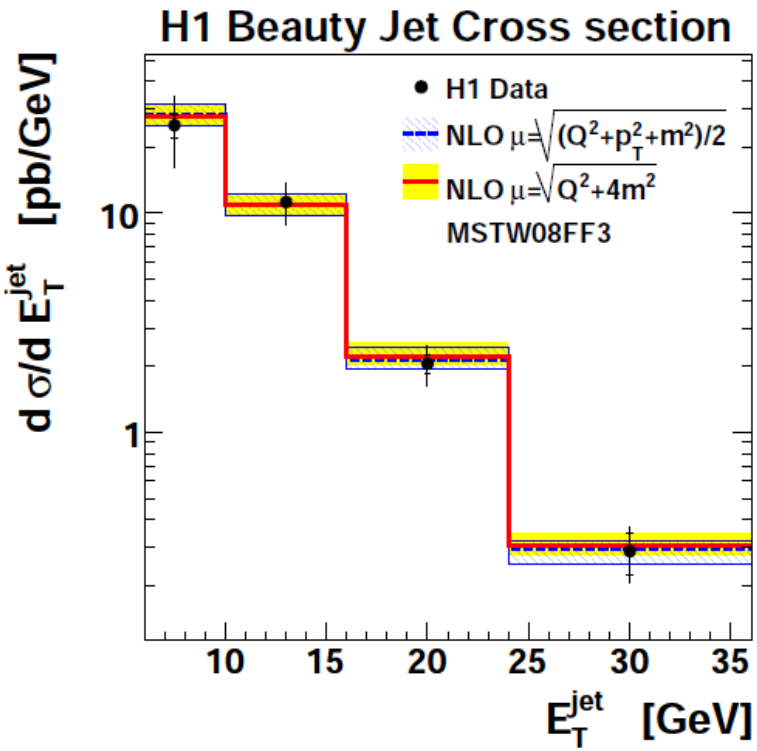
Measurement of Charm and Beauty Jets in DIS

arXiv:1008.1731[hep-ex]

H1 Vertex detector (CST)

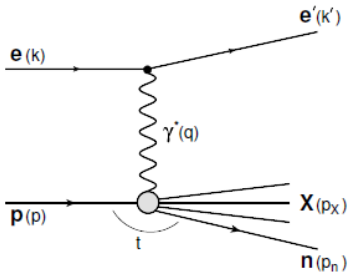
Full HERA II data with CST



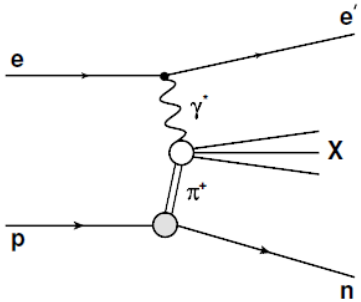


Charm and beauty jet cross sections described by NLO QCD

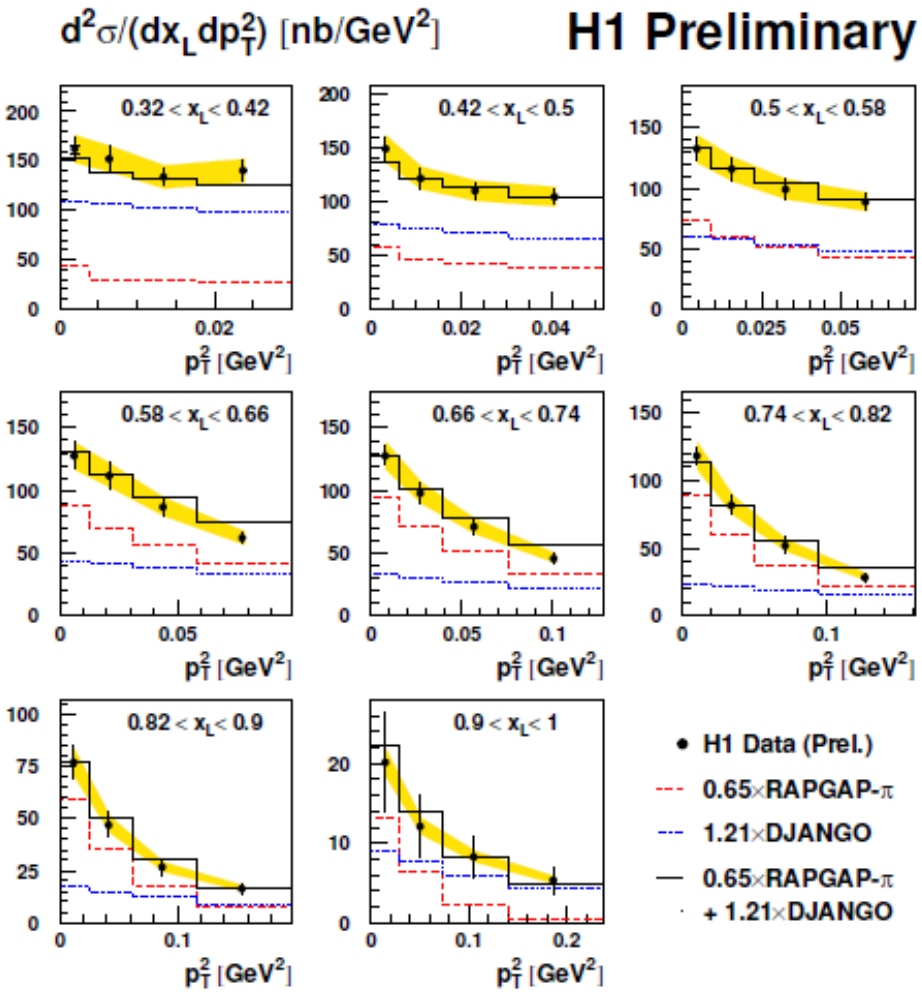
Leading Neutron x_L and p_T^2 cross sections



fragmentation



π^+-exchange



Double differential DIS cross section for leading n production

$6<Q^2<100$ GeV^2, $0.05<y<0.6$

2006-07 e^+p data

Cross sections well described by mixed MC with standard fragmentation and π –exchange

H1 Analyses Status and Prospects

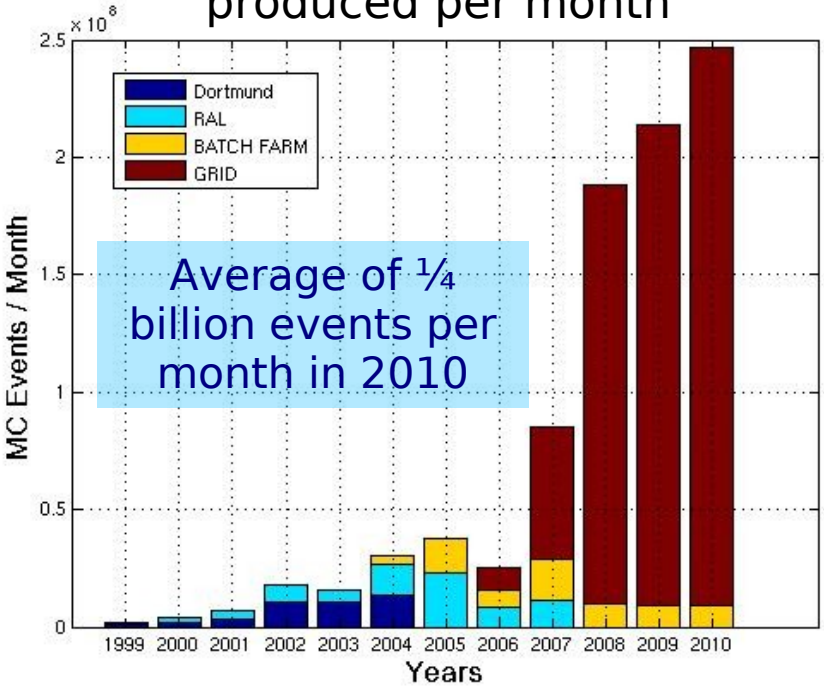
Most important and closest future plans:

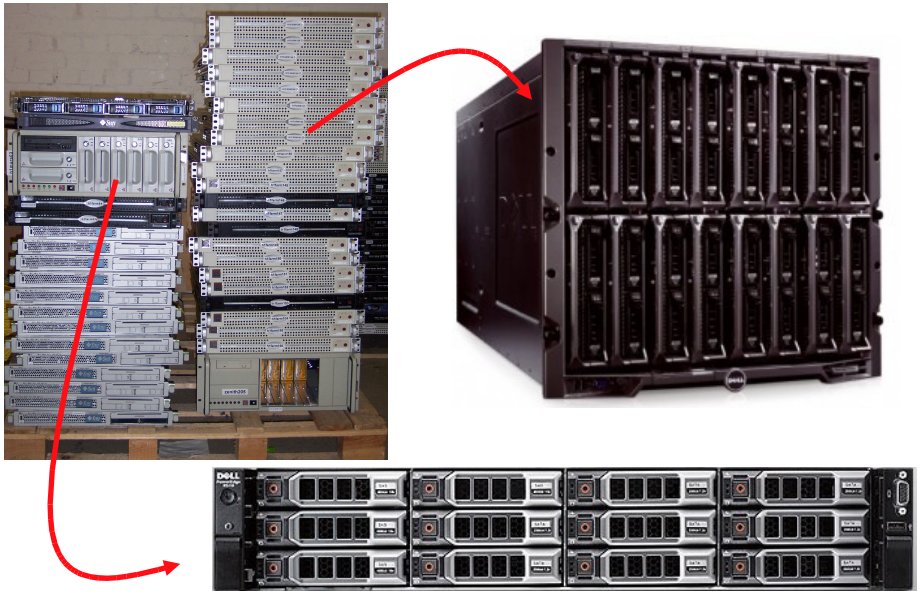
Proton Structure	Publication of inclusive high Q^2 measurements H1 and ZEUS combination $\rightarrow$ HERAPDF2.0
Searches	Finalising analyses
Jets & HFS	Jets: fully exploit HERA II at high/low Q^2 Particles: profit from improved reconstruction (DST7)
Heavy Flavour	Publication of H1 and ZEUS F_2^{cc} combination
Diffraction	Diffractive structure functions (FPS, LRG, VFPS) $\rightarrow$ HERADPDF

The publication plan includes 25 more papers

H1 Computing and Software

Average number of MC events produced per month





Hardware renewal programme, saving space and improving analysis efficiency

- DST 7 / H1OO 4.0 analysis software used by most H1 analyses
  HERA I DST7 production starts next week → coherent H1 96-07 data
- H1 hardware surveyed and updated
  Local batch farm in good shape and regularly in full use (836 job slots)

Data analysis in H1 still needs constant, reliable computing +large scale MC production

Future of the H1 Collaboration

Define the end of the H1 Collaboration in the present form

06/2013 defined by the common funding

Adopt long term organisation scheme

H1 Physics committee overview the operations

Data access should remain possible in the next period

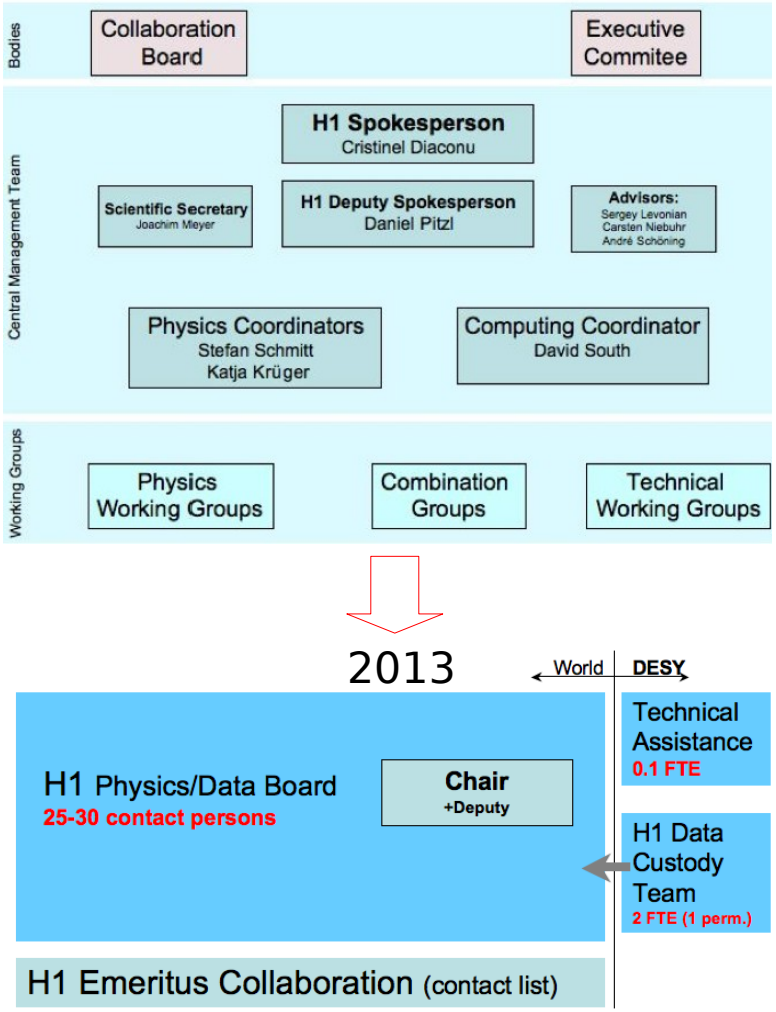
Consolidate the analysis environment and the hardware in the present configuration

H1 plays a major role in DPHEP

Close connection with DESY/IT, ZEUS, HERMES

→ see Dave South talk on data preservation

H1 Collaboration organisation



Summary

Many new H1 results with final HERA precision

in different physics areas:

Proton structure, Searches, Jets&Final States, Heavy Flavours, Diffraction

~25 papers expected to come in 2011/2

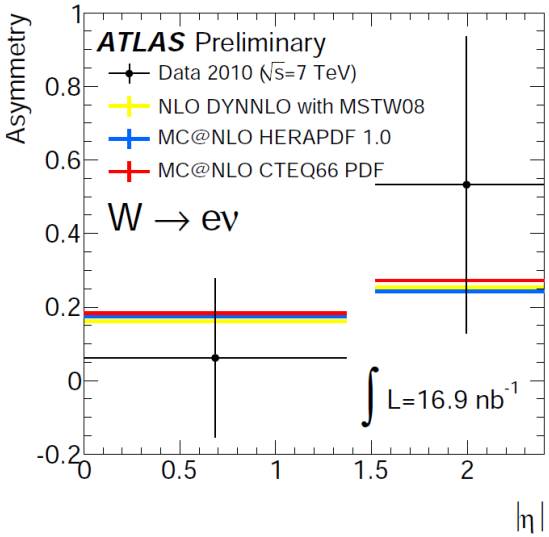
Computing and software at H1 in excellent shape, still vital to analysis

H1 also involved in the data preservation effort at DESY

H1 decided on the long term organisation (after 2013)

Further improved HERA precision with combined H1 and ZEUS results, smaller PDFs uncertainties

Essential for LHC predictions

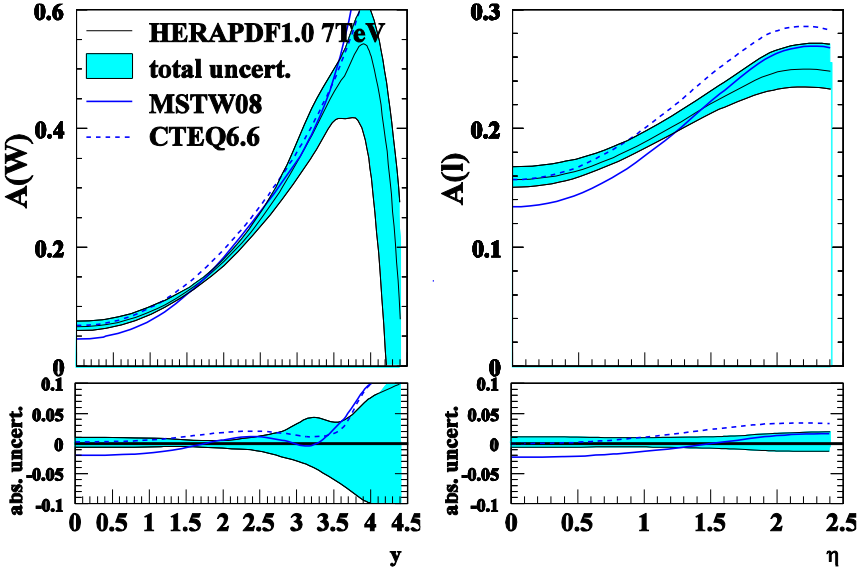


Back-up slides

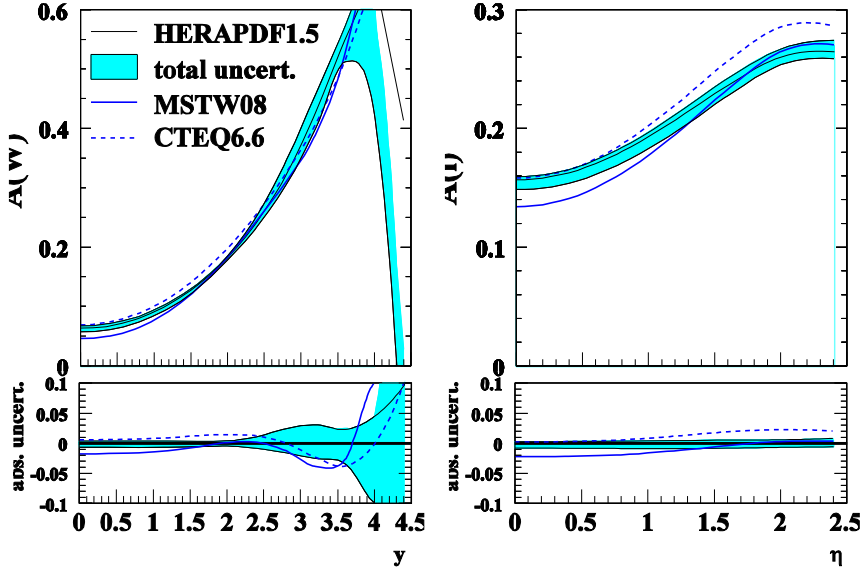
HERAPDF1.5: impact for LHC

Predictions for W and lepton asymmetries at LHC

HERAPDF1.0

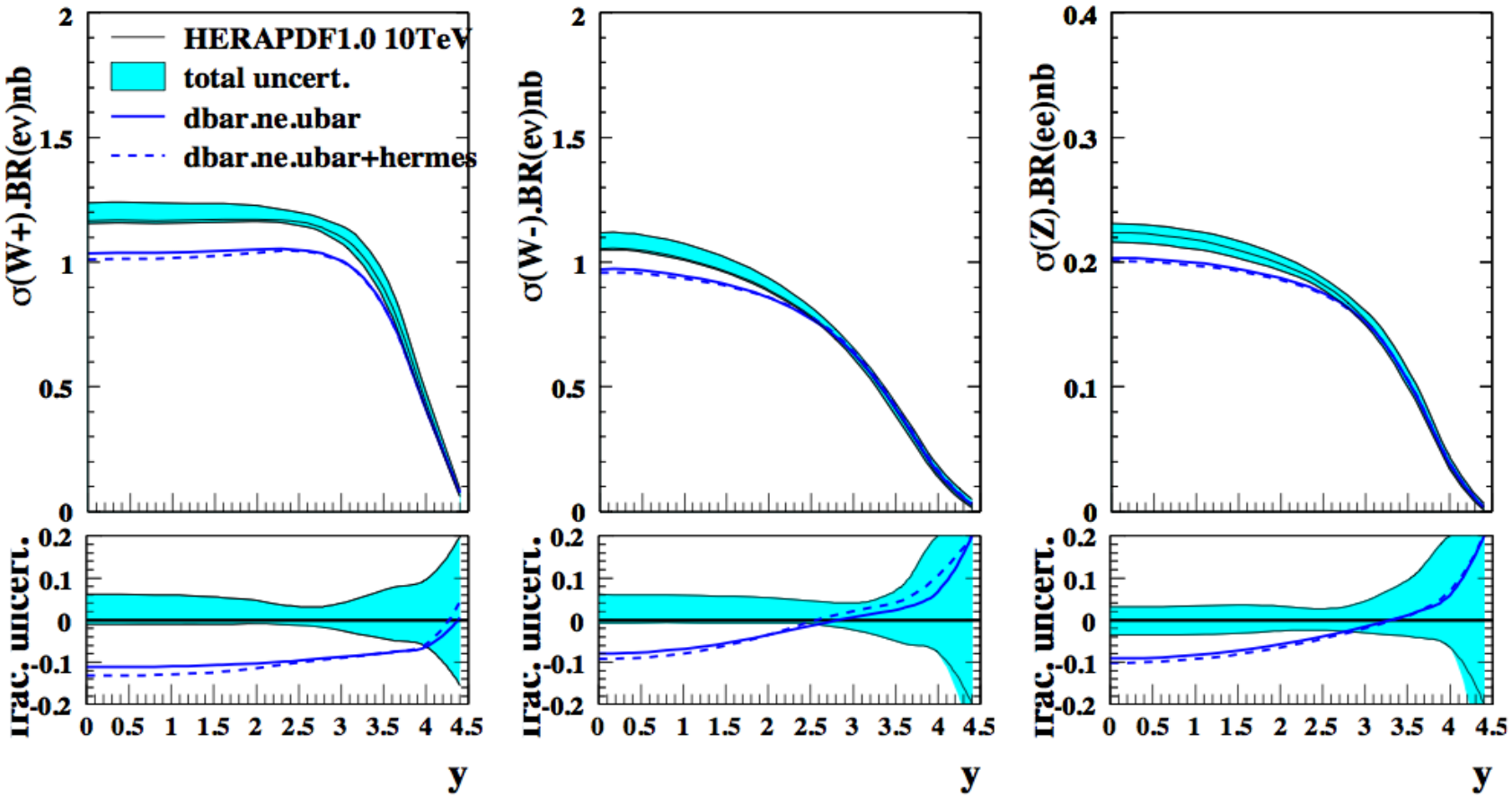


HERAPDF1.5



- reduced uncertainties with HERAPDF1.5 compare to HERAPDF1.0

HERAPDF1.0u (with unconstrained low x sea)



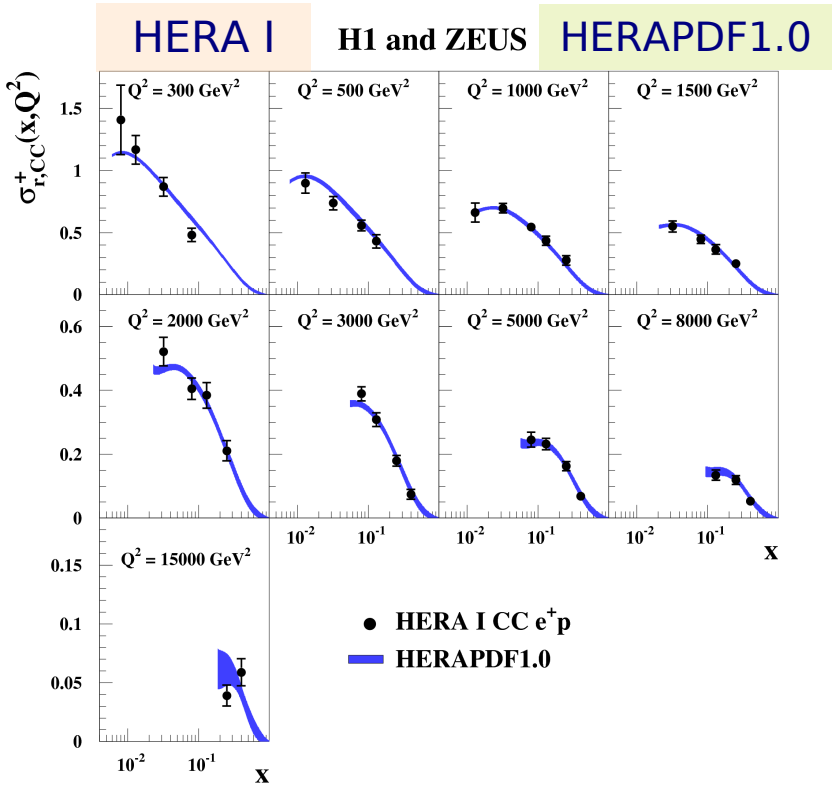
- using unconstrained PDFs Z/W cross sections decrease compare to standard HERAPDF1.0
  - up to 10% in the central region
- HERAPDF1.0u are available in the LHAPDF format

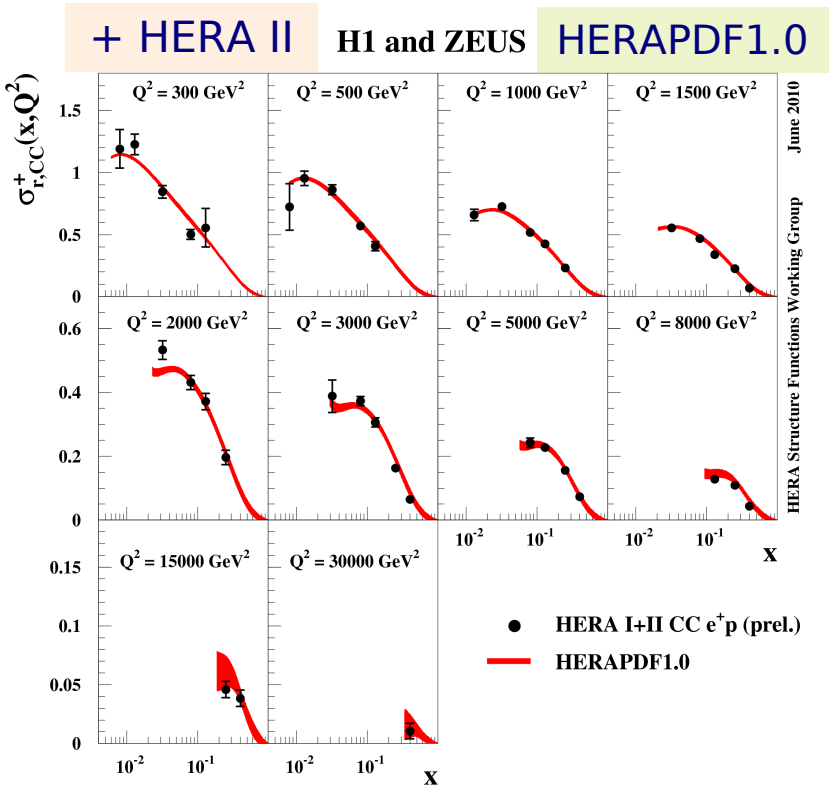
Fits to new combined HERA data: HERAPDF1.5

Preliminary HERA II high Q^2 inclusive data available

HERAPDF1.0: combined inclusive HERA I arXiv:0911.0884[hep-ex]

HERAPDF1.5: combined inclusive HERA I and part of HERA II data



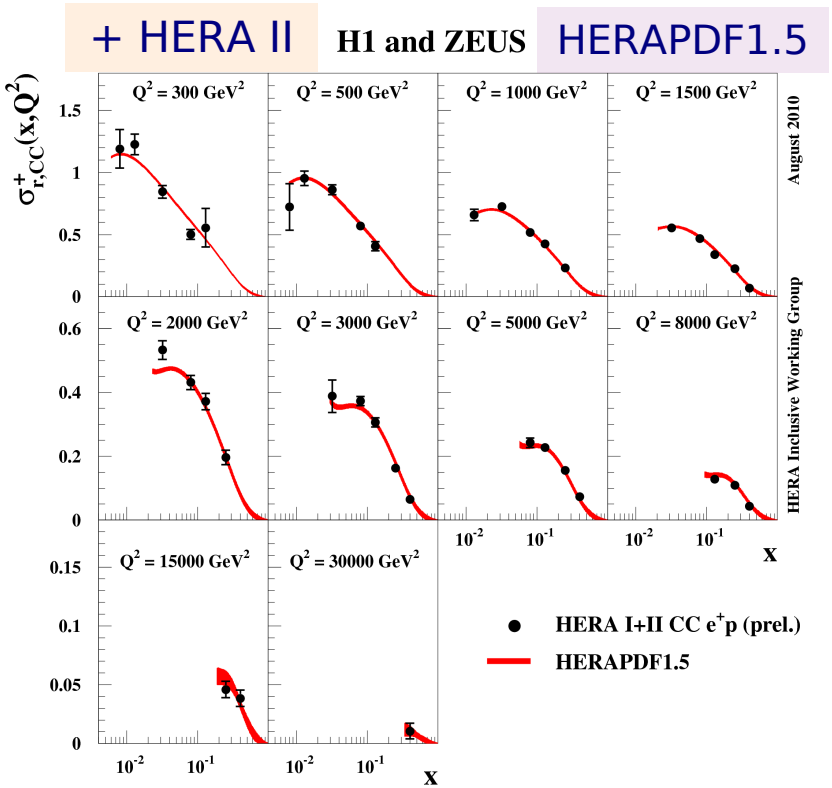


Better precision in charged current measurement

Fits to new combined HERA data: HERAPDF1.5

HERAPDF1.5: combined inclusive HERA I and part of HERA II data

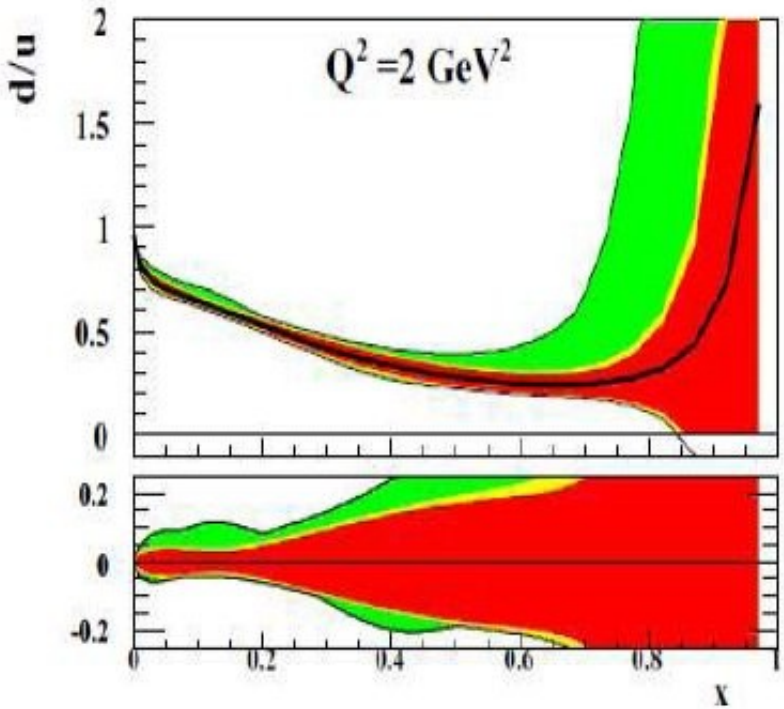
- Data described by HERAPDF1.5



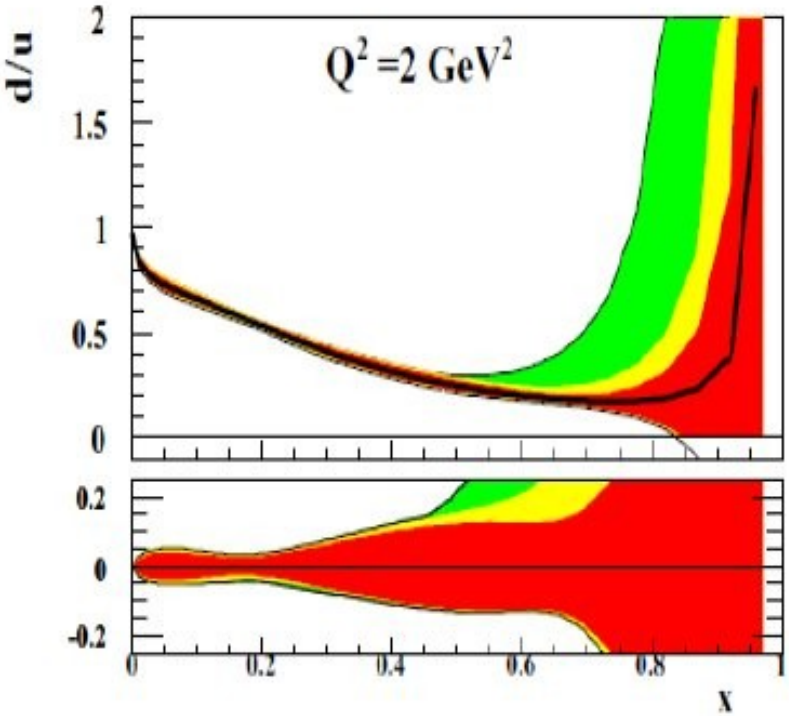
- Improved precision in HERAPDF1.5 compared to HERAPDF1.0

Fits to new combined HERA data: HERAPDF1.5

HERAPDF1.0



HERAPDF1.5



Improved precision in HERAPDF1.5 compared to HERAPDF1.0

QCD analysis of F_2^{cc} data

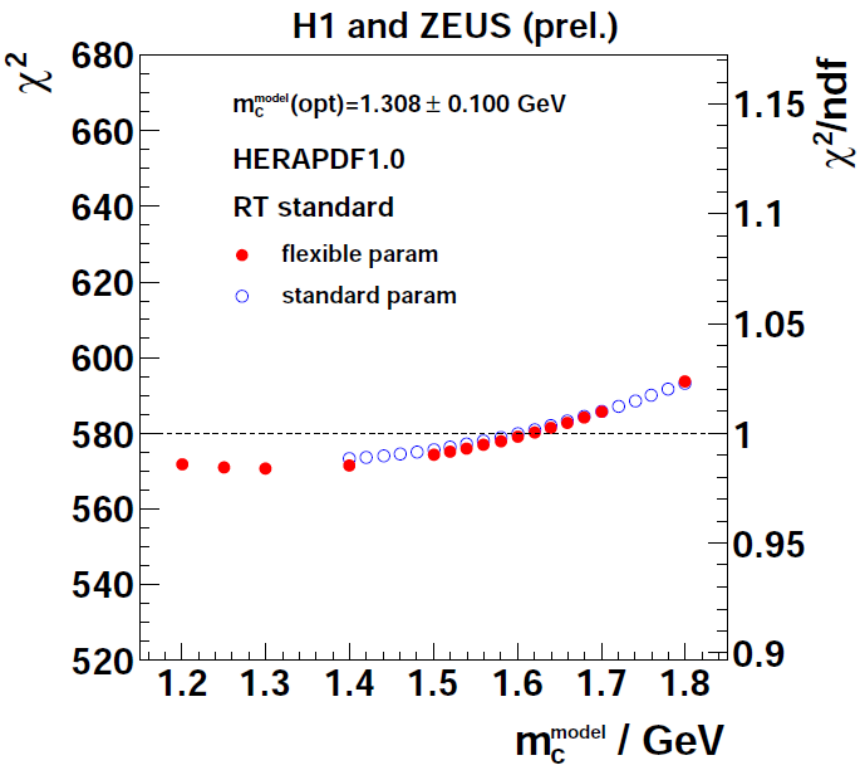
- different implementations of GM-VFN scheme for heavy flavour treatment used in this study:

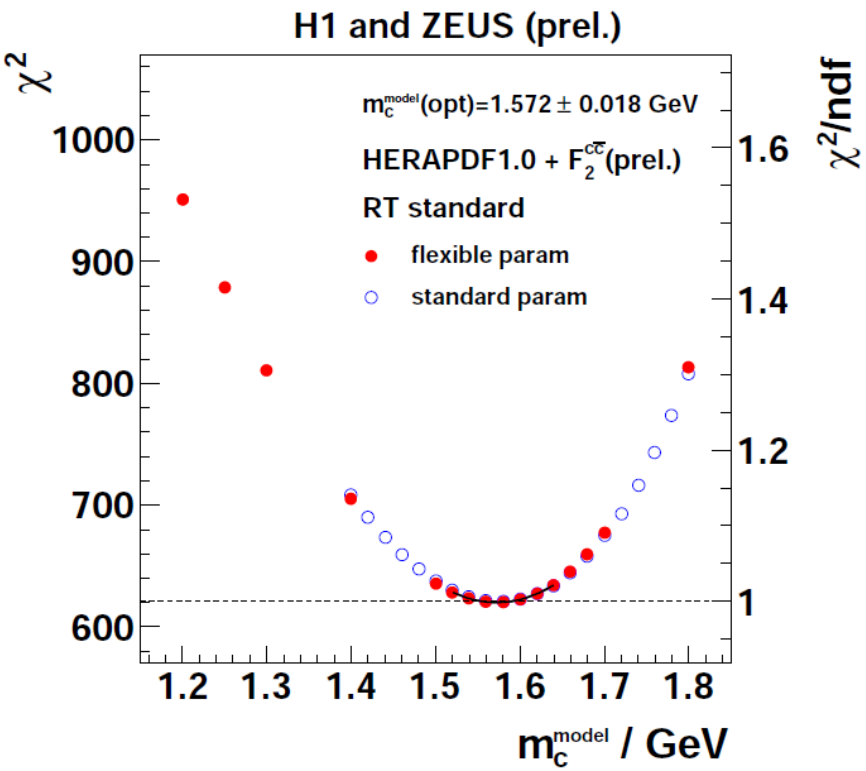
RT standard	used by MSTW08
RT optimised [arXiv:1006.5925]	
ACOT-full	used by CTEQ4,5,6HQ
S-ACOT-χ	used by CTEQ6.5,6.6,CT10
ZMVFNS	used by NNPDF2.0

- the optimal value of parameter m_C^{model} is determined for each of these schemes (m_C^{model}(opt)), which gives the best description of the HERA data

- PDFs are propagated to MCFM to calculate $Z/W^{\pm}$ cross section predictions

m_c^{model} scan: RT





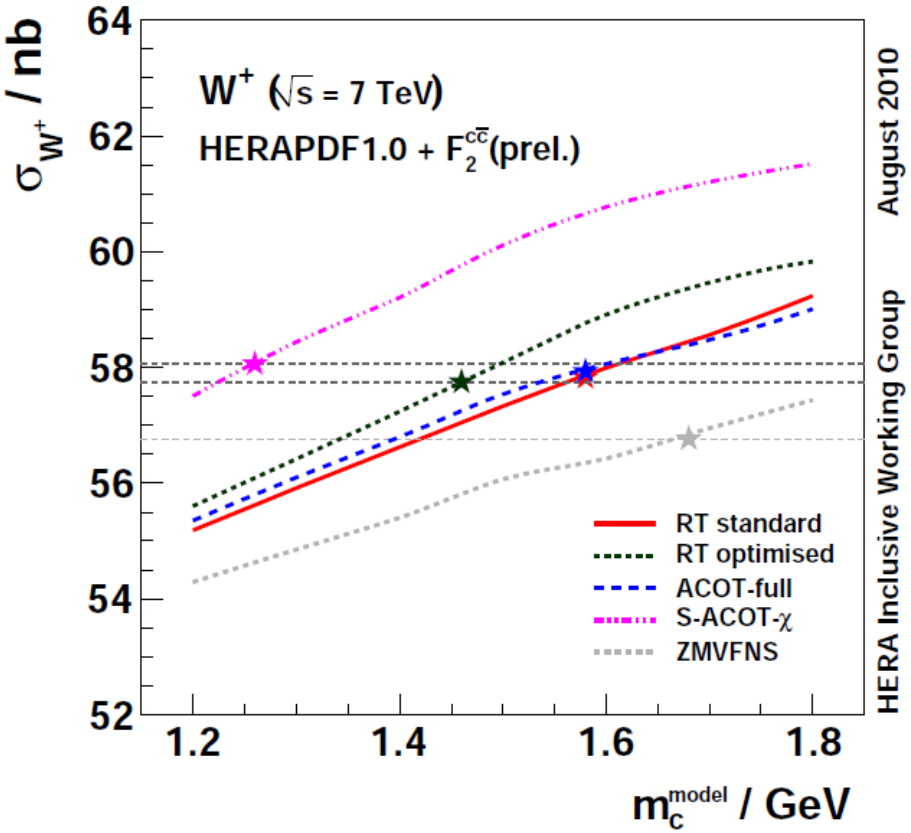
- m_c^{model} (opt) is determined fitting the χ^2 dependance on m_c^{model}:

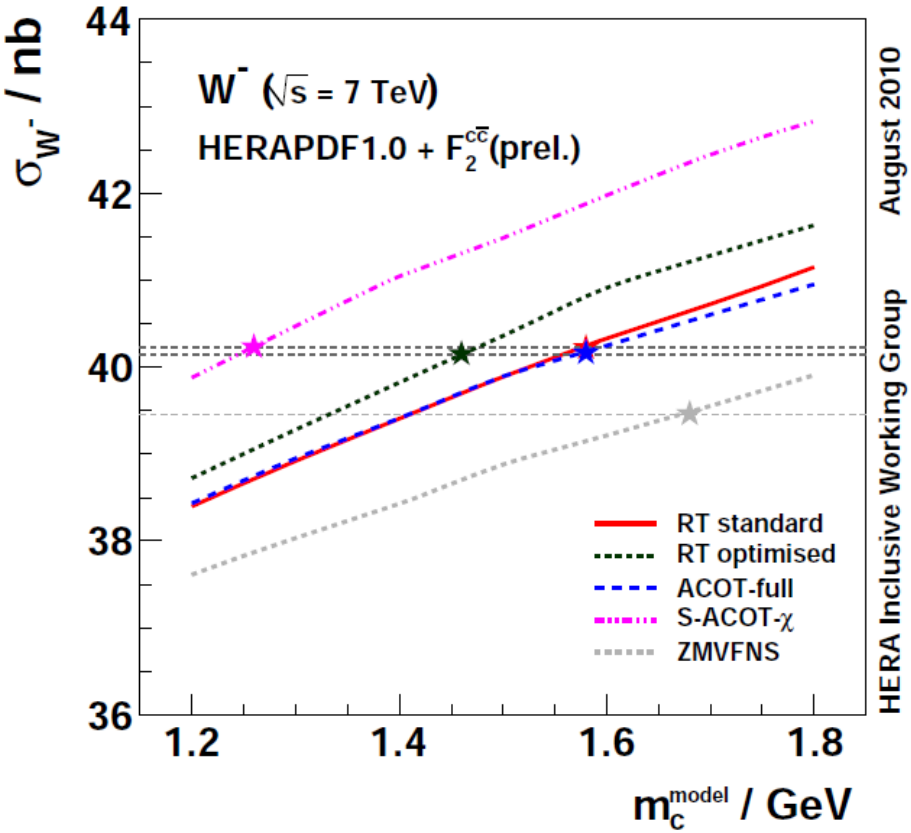
$$\chi^2(m_c^{model}) = \chi^2_{min} + \left(\frac{m_c^{model} - m_c^{model}(opt)}{\Delta_{m_c^{model}}(opt)} \right)^2$$

where Δm_c^{model}(opt) uncertainty assuming $\Delta\chi^2 = 1$

- for inclusive HERA data alone m_c^{model} dependence of χ^2 is very shallow

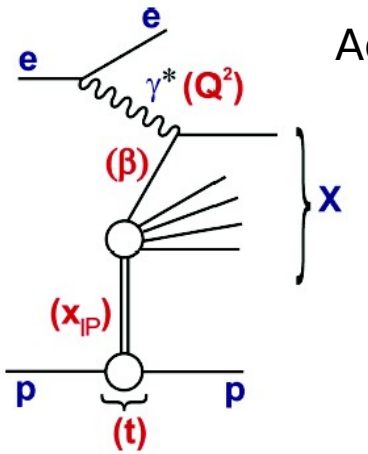
Z/W cross sections at LHC





Measurement of Diffractive DIS Cross Section with Leading Proton at HERA

arXiv:1010.1476[hep-ex]



Additional variables for diffraction:

- t - squared 4-momentum transfer at proton vertex
- $x_{IP} = 1 - x_L$ - fractional momentum loss of proton (IP/p)
- $\beta = x/x_{IP}$ - momentum fraction carried by struck q (q/IP)

Leading proton measured with H1 Forward Proton Spectrometer using HERA II data

(comparable statistics to one using LRG method)

- measurement extended to higher Q^2

- reduced cross section is measured differentially in 4 variables
  - lines represent the Regge fit used to evaluate IP trajectory parameters