74th PRC meeting, DESY,Zeuthen
8-9 November 2012

H1 Status Report

Armen Buniatyan

- Organisational matters
- Recent physics highlights
- Publication plan
- Computing

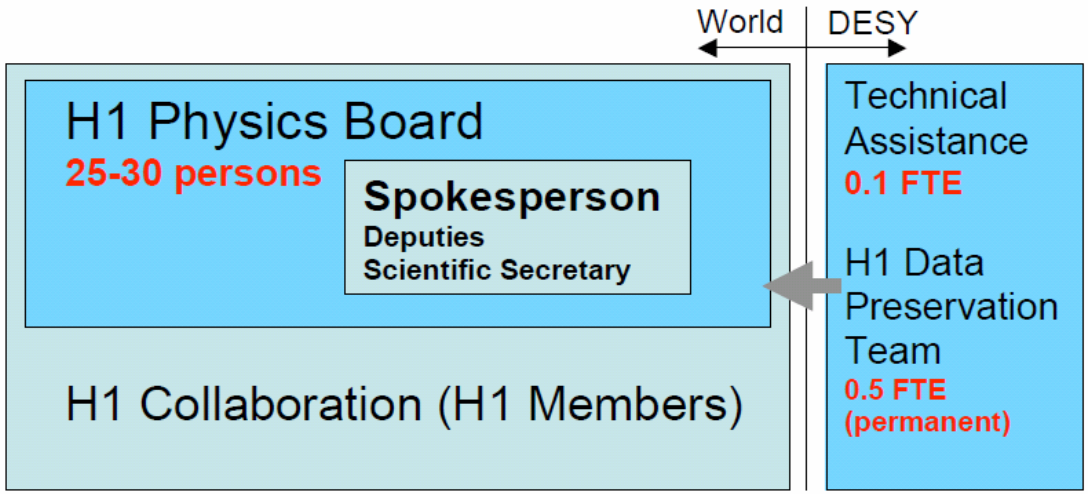
H1 organisational changes

H1 management since July 2012:

- Stefan Schmitt [Spokesperson]
- Armen Buniatyan [Deputy Spokesperson]
- Karin Daum [Physics Coordinator]
- Katja Krüger [Physics Coordinator (until end of 2012)]
- Michael Steder [Computing Coordinator/Data preservation]

New organisational structure:

the H1 Collaboration Board (institute's representatives) is replaced by the H1 Physics Board



Recent H1 physics results

News since the last PRC:

Publications:

DESY-12-072 Measurement of Beauty Photoproduction near Threshold using Di-electron Events with the H1 Detector at HERA

DESY-12-100 (H1/ZEUS) Combined Inclusive Diffractive Cross Sections Measured with Forward Proton Spectrometers in DIS at HERA
(details in Katarzyna Wichmann's report)

DESY-12-107 Inclusive Deep Inelastic Scattering at High Q^2 with Longitudinally Polarised Lepton Beams at HERA

DESY-12-172 (H1/ZEUS) Combination and QCD Analysis of Charm Production Cross Section Measurements in DIS at HERA

Preliminary result:

H1prelim-12-111 Analysis of Feynman Scaling with Photon Production in the Very Forward Direction in DIS at HERA

Inclusive DIS cross sections at high Q^2 (DESY-12-107)

Final measurement of inclusive NC/CC cross sections at $\sqrt{s}$=319 GeV with H1 detector

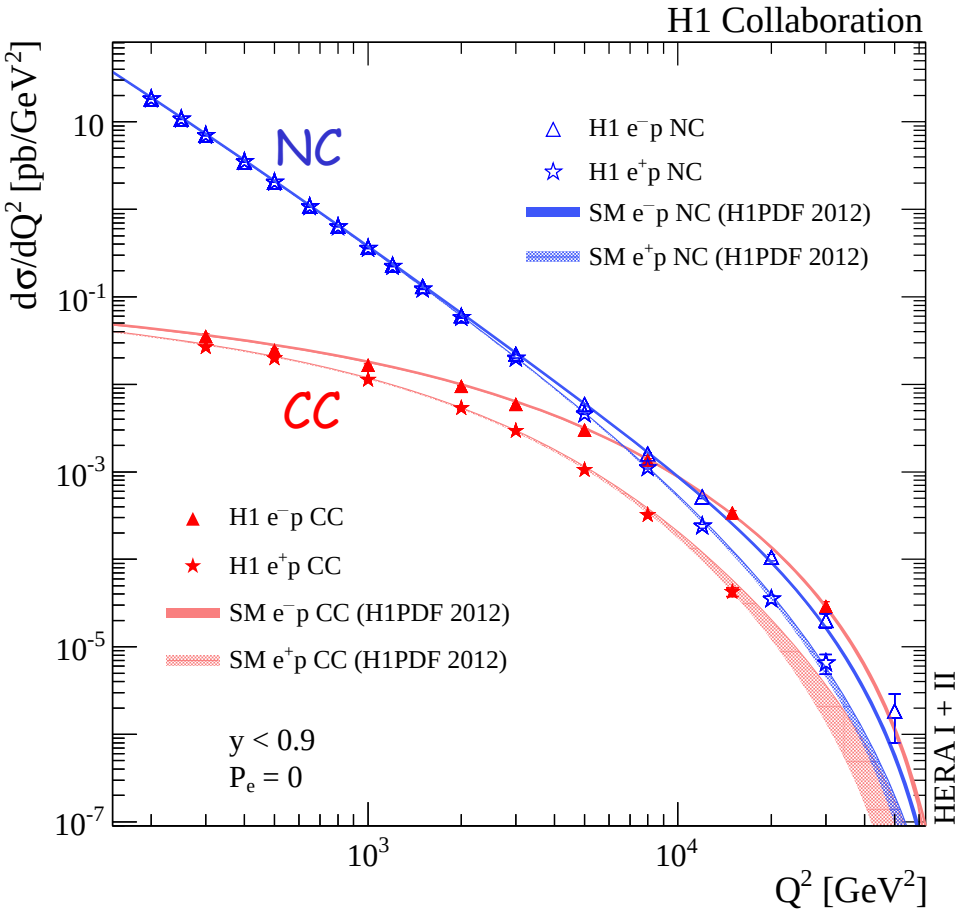
Data: e^-p and e^+p polarized $e^\pm$ beams
→4 distinct data sets
(all HERA-2 data at Ep=920 GeV)

	R	L
e^-p	$\mathcal{L} = 47.3\,\mathrm{pb}^{-1}$ $P_e = (+36.0 \pm 1.0)\%$	$\mathcal{L} = 104.4\,\mathrm{pb}^{-1}$ $P_e = (-25.8 \pm 0.7)\%$
e^+p	$\mathcal{L} = 101.3\,\mathrm{pb}^{-1}$ $P_e = (+32.5 \pm 0.7)\%$	$\mathcal{L} = 80.7\,\mathrm{pb}^{-1}$ $P_e = (-37.0 \pm 0.7)\%$

$60 < Q^2 < 50.000\ \mathrm{GeV}^2$, $0.0008 < x_{Bj} < 0.65$

Typical precision:
NC e^+ ~1.5% ; e^- ~2.0%
CC $e^\pm$ ~4%

$d\sigma/dQ^2$ cross sections of CC and NC

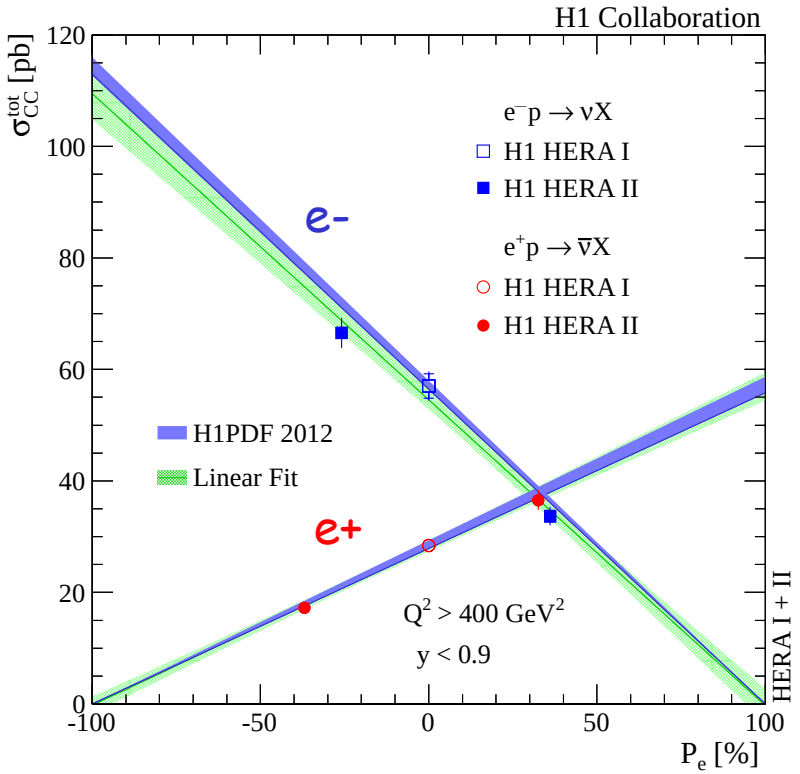


Text-book plot illustrating electroweak unification

Inclusive DIS cross sections at high Q^2 (DESY-12-107)

Polarisation dependence of total CC cross sections

SM: $\sigma^{\pm}_{CC}(P_e) = (1 \pm P_e)\sigma^{\pm}_{CC}(0)$



Linear scaling with P_e

Extrapolated cross sections ≈ 0
- at Pe=+1 for e-
- at Pe=-1 for e+

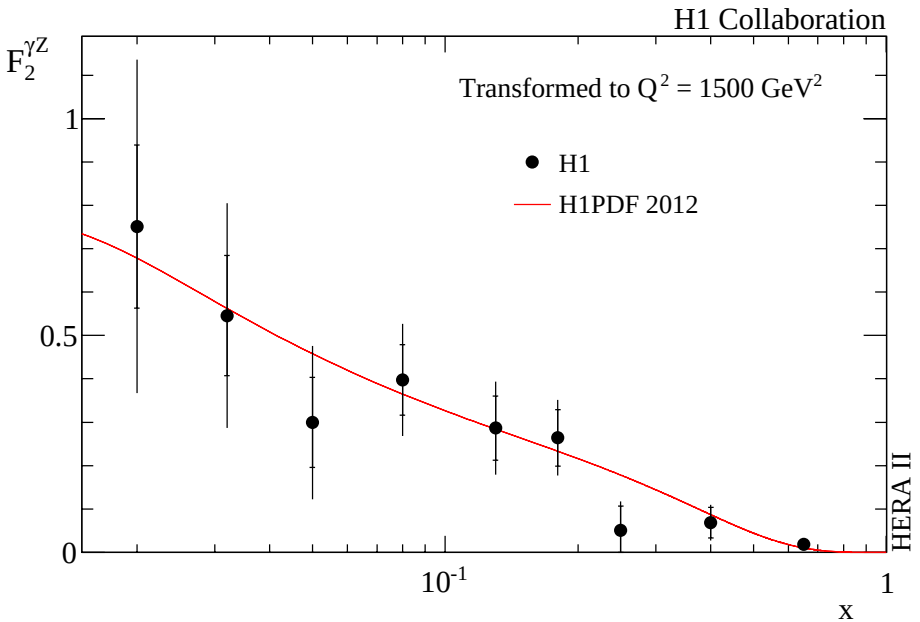
➔ Demonstration of the absence of right handed weak current

NC polarisation asymmetry

SM: difference in the σ_{NC} for leptons with different helicity states (due to chiral structure of the neutral EW exchange)

Polarisation asymmetry of NC cross section is sensitive to γZ interference terms of structure functions

$$F_2^{\gamma Z} \sim [\sigma^-(P_L) - \sigma^-(P_R)] - [\sigma^+(P_L) - \sigma^+(P_R)]$$

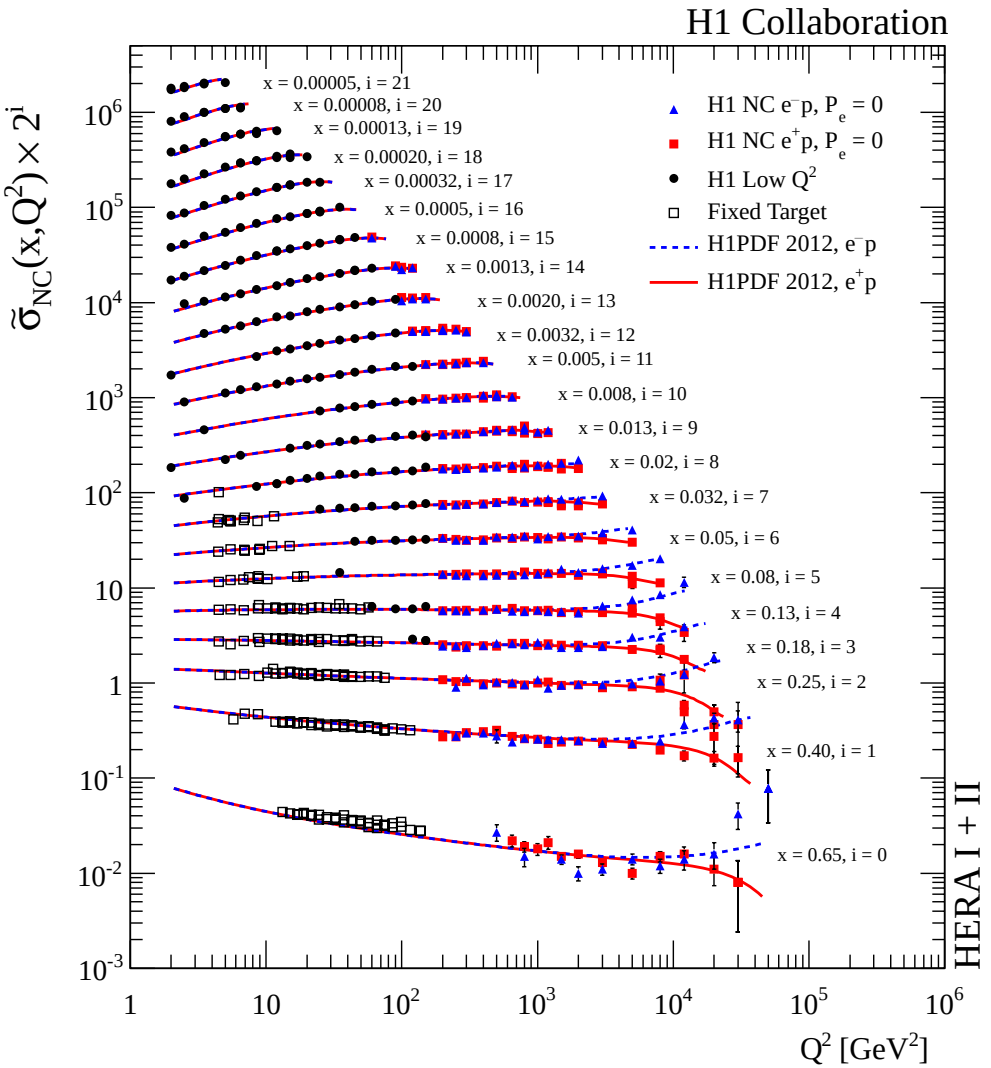


First measurement of $F_2^{\gamma Z}$ structure function ever

Inclusive DIS cross sections at high Q^2 (DESY-12-107)

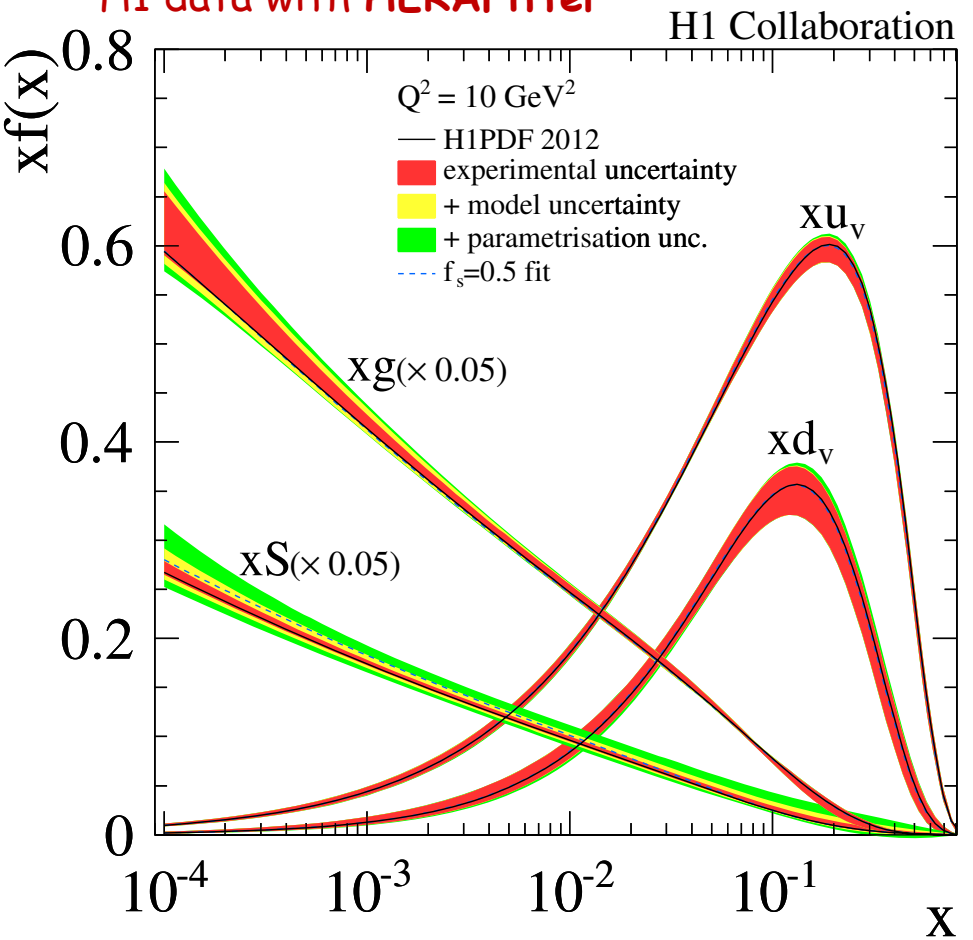
unpolarised NC cross e^-p and e^+p reduced cross sections

$$\tilde{\sigma}^{\pm}_{\rm NC}(x,Q^2) \equiv \frac{{\rm d}^2\sigma^{\pm}_{\rm NC}}{{\rm d}x{\rm d}Q^2}\frac{xQ^4}{2\pi\alpha^2}\frac{1}{Y_+} = \left(\tilde{F}_2^{\pm} \mp \frac{Y_-}{Y_+}x\tilde{F}_3^{\pm} - \frac{y^2}{Y_+}\tilde{F}_L^{\pm}\right)(1+\Delta_{\rm NC}^{\rm weak}) \qquad Y_{\pm} = 1 \pm (1-y)^2$$



Combined H1 data probe the proton over nearly 5 orders of magnitude

NLO QCD fit to all published NC and CC H1 data with **HERAFitter**

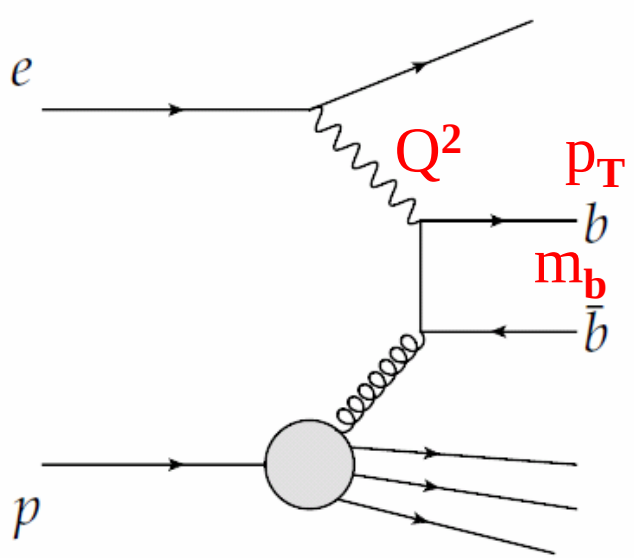


➔ H1PDF 2012

➔ Improvement in precision for all PDFs in the full x range

Beauty photoproduction near threshold using di-electrons (DESY-12-072)

Measure process $ep \to eb\bar{b}X$ in the range $Q^2<1$ GeV^2, $0.05<y<0.65$, $|\eta(b,\bar{b})|<2$



b-quarks are mainly produced in photon-gluon fusion
- sensitive to the gluon in the proton
- hard scales for pQCD: m_b, p_T, Q^2

→ check consistency of QCD calculations

- identify $b\bar{b}$→ eeX' by the semi-leptonic decays of b-quarks to electrons
- low p_T(b) momentum
- extract *b*-cross-section from two low p_T-electrons
- identification of low momentum electrons (P_T(e)>1 GeV) in the trigger

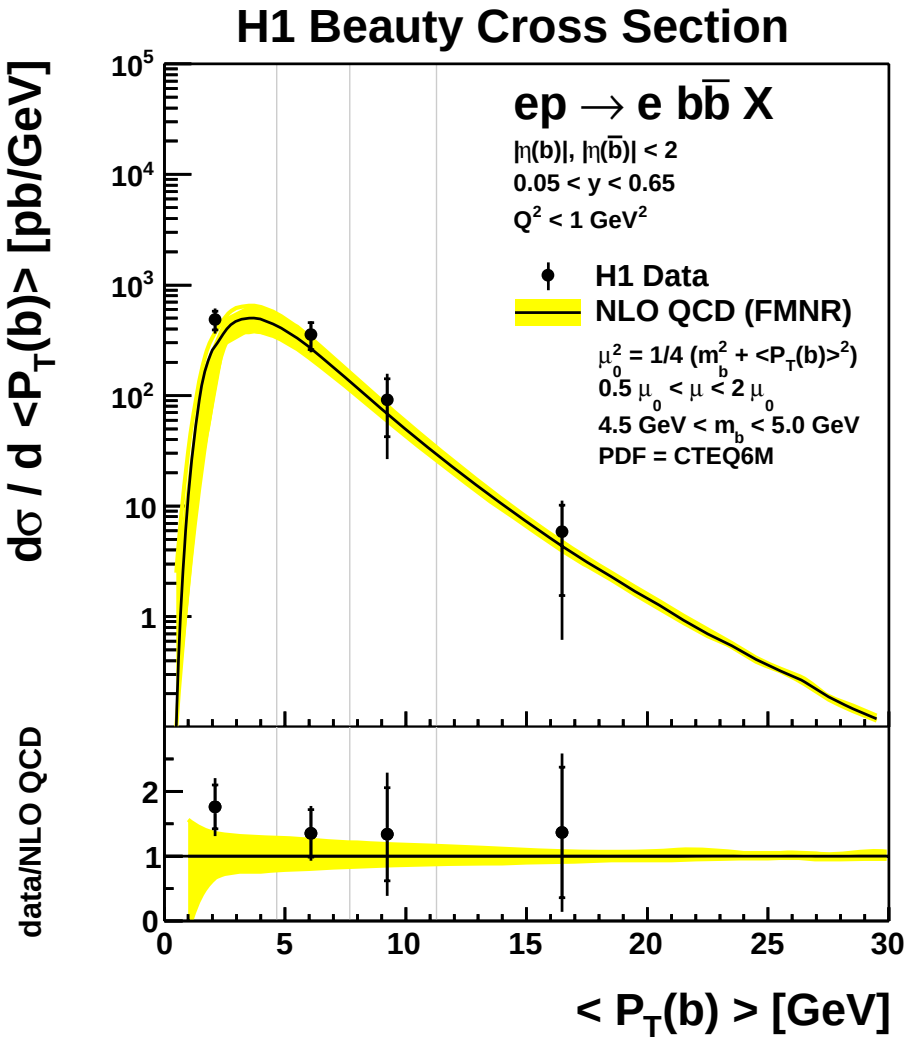
(measurement became possible because of Fast-Track-Trigger and Jet-Trigger)

Differential beauty cross section as a function of the mean *b* quark momentum

- Access to lowest $p_T(b)$ values ever measured in ep

Previously unexplored region near production threshold
→ *b*-quark mass is the only hard scale
→ less theoretical uncertainties for pQCD

- Good agreement with NLO calculation



$$\sigma\left(ep \to ebb\bar{b}X\right) = 3.79 \pm 0.53\left(stat.\right) \pm 0.58\left(sys.\right)\ nb$$

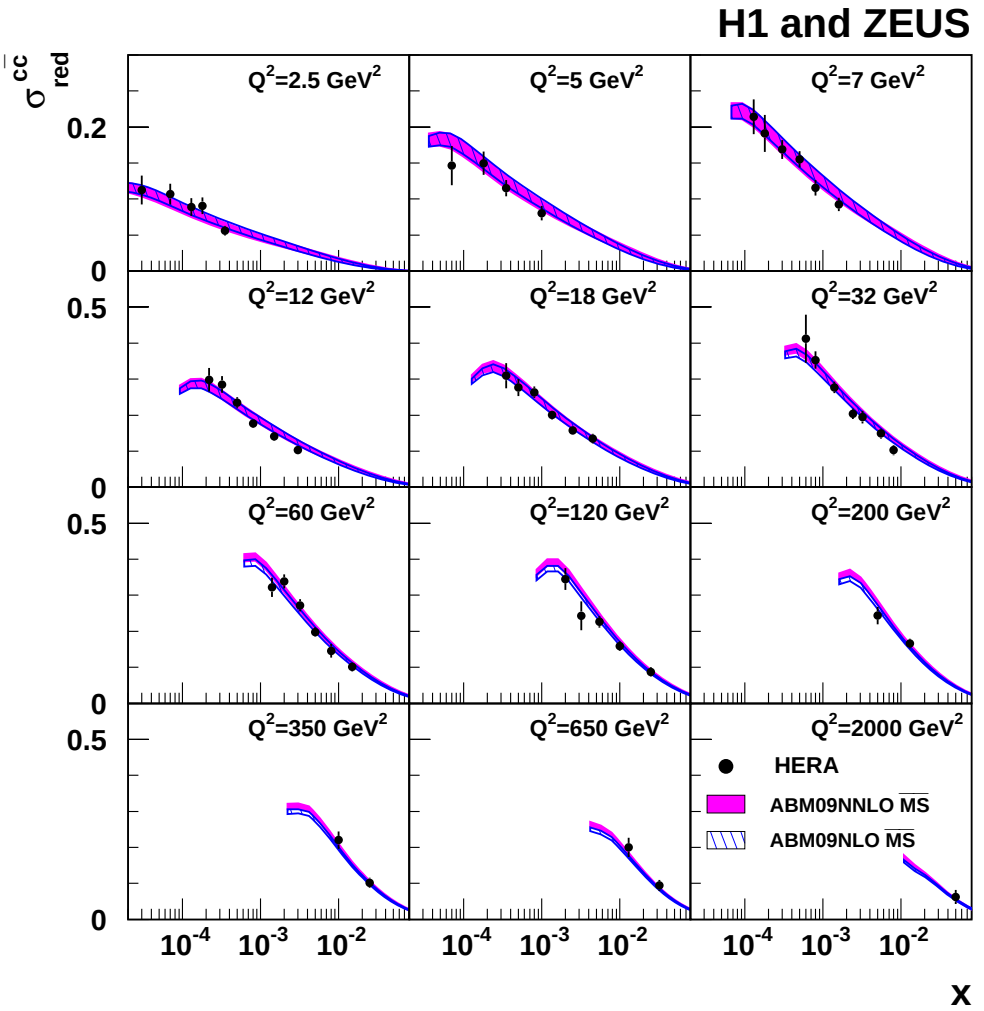
H1/ZEUS combined charm cross sections (DESY 12-172)

Combine all open charm HERA data

	Data set	Tagging method	Q^2 range [GeV^2]	N	$\mathcal{L}$ [pb^{-1}]
1	H1 VTX [14]	Inclusive track lifetime	5 – 2000	29	245
2	H1 D^* HERA-I [10]	D^{*+}	2 – 100	17	47
3	H1 D^* HERA-II [18]	D^{*+}	5 – 100	25	348
4	H1 D^* HERA-II [15]	D^{*+}	100 – 1000	6	351
5	ZEUS D^* (96-97) [4]	D^{*+}	1 – 200	21	37
6	ZEUS D^* (98-00) [6]	D^{*+}	1.5 – 1000	31	82
7	ZEUS D^0 [12]	$D^{0,\mathrm{no}D^{*+}}$	5 – 1000	9	134
8	ZEUS D^+ [12]	D^+	5 – 1000	9	134
9	ZEUS μ [13]	μ	20 – 10000	8	126

Measurements use different charm tagging techniques → different systematics

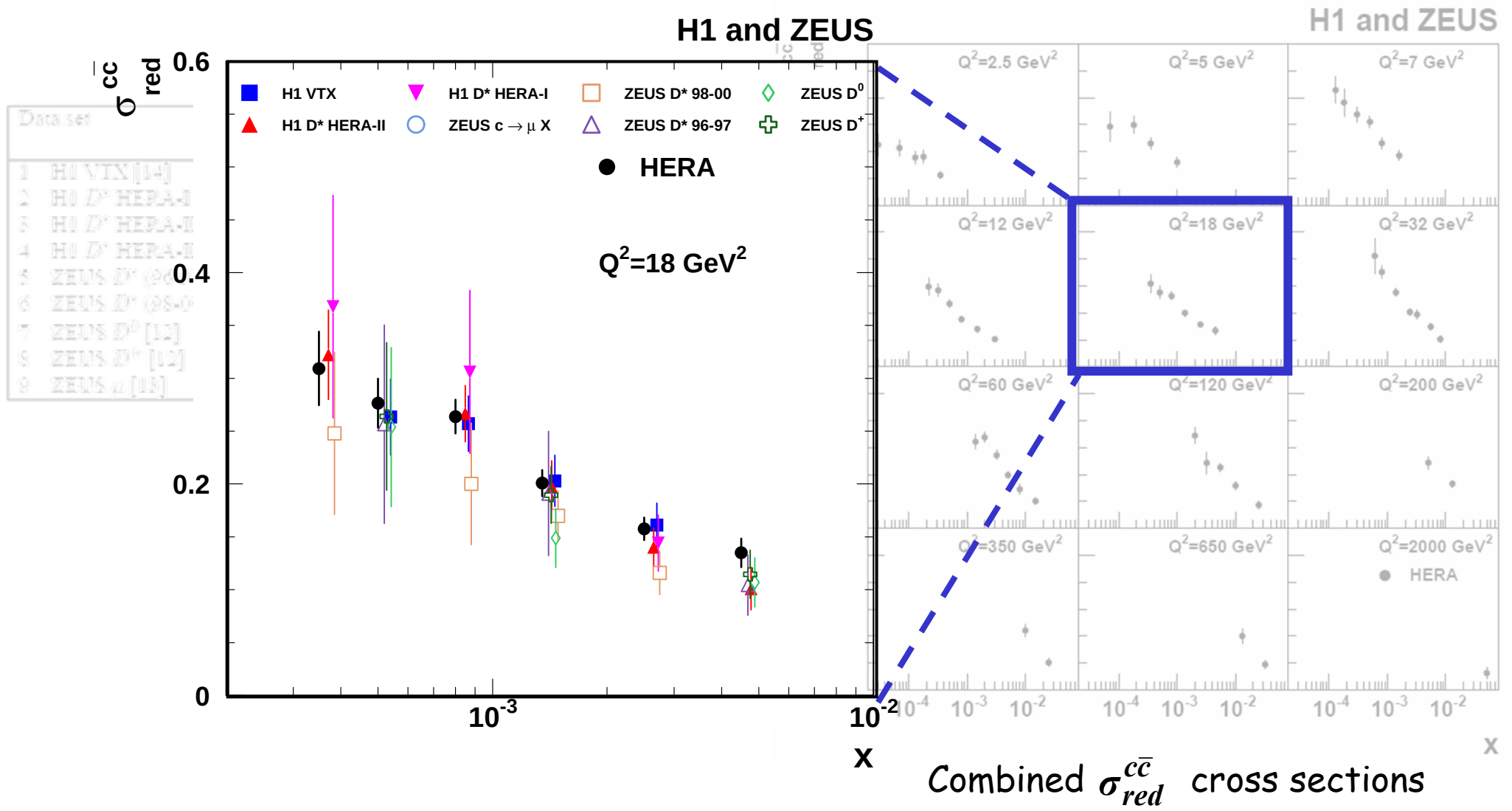
Total of 155 measurements with 48 sources of correlated systematic uncertainty from 9 publications are combined to 52 cross-section measurements



Combined $\sigma_{red}^{c\bar{c}}$ cross sections

Good description by pQCD predictions

H1/ZEUS combined charm cross sections (DESY 12-172)



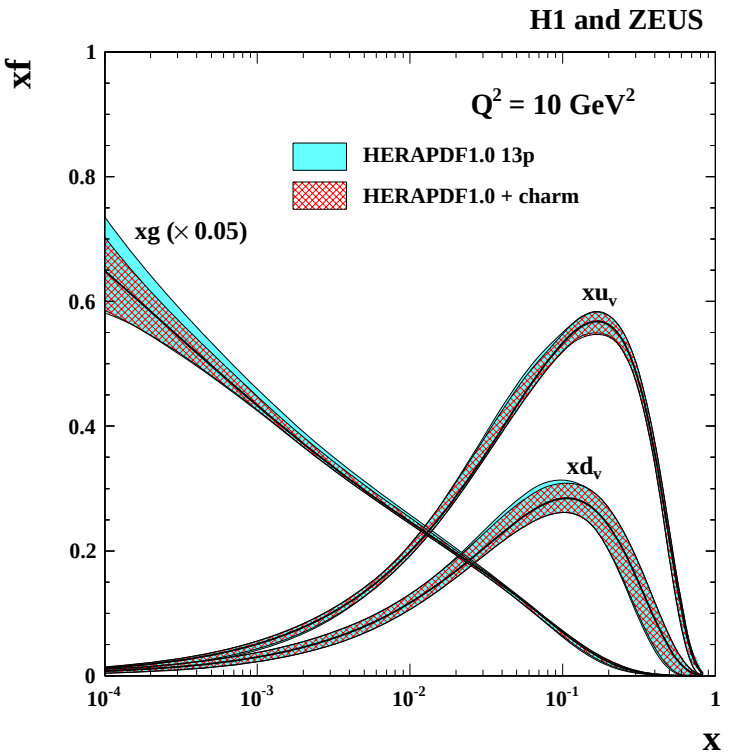
Combined $\sigma_{red}^{c\bar{c}}$ cross sections

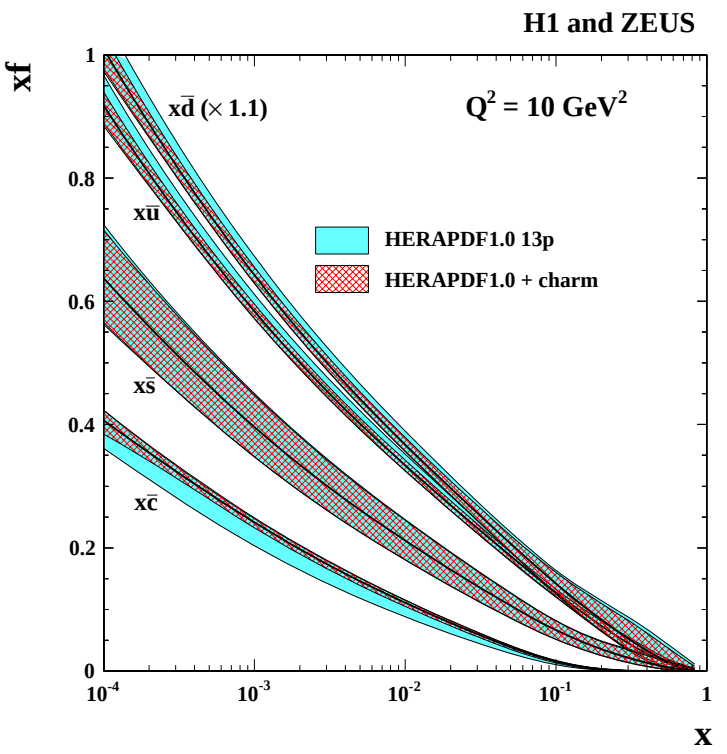
Significant improvement in precision: 10% on average, 6% at low x and medium Q^2 ; uncertainties lower by ~ factor 2 compared to individual measurements

Expect large impact on theory

H1/ZEUS combined charm cross sections (DESY 12-172)

QCD analysis of combined HERA inclusive and charm data - made with **HERAFitter**



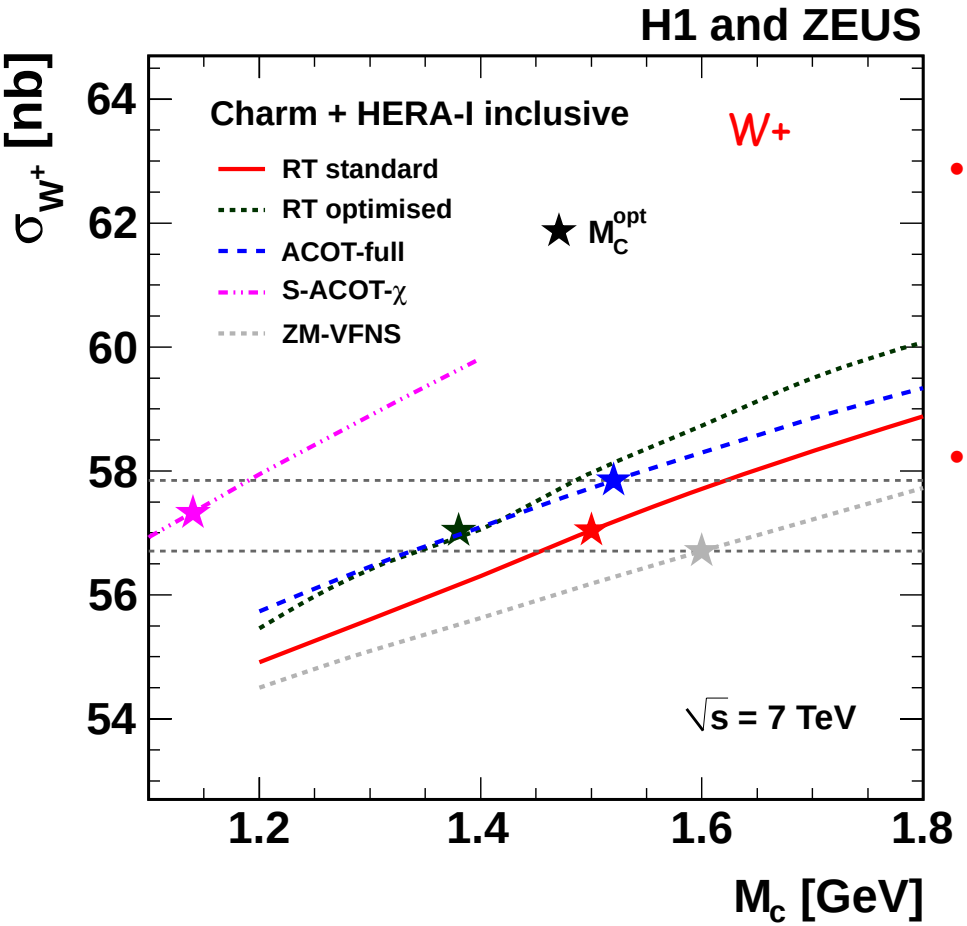


PDFs from the combined QCD analysis of inclusive DIS and charm data
→ Significant reduction of uncertainties for sea quarks and gluons

Measurement of the $\overline{\text{MS}}$ running charm mass $m_c(m_c)$ in FFNS at NLO

$$m_c(m_c) = 1.26 \pm 0.05_{\text{exp.}} \pm 0.03_{\text{model}} \pm 0.02_{\text{param.}} \pm 0.02_{\alpha_s} \text{ GeV}$$

→ consistent with the world average (1.275 ± 0.025) GeV



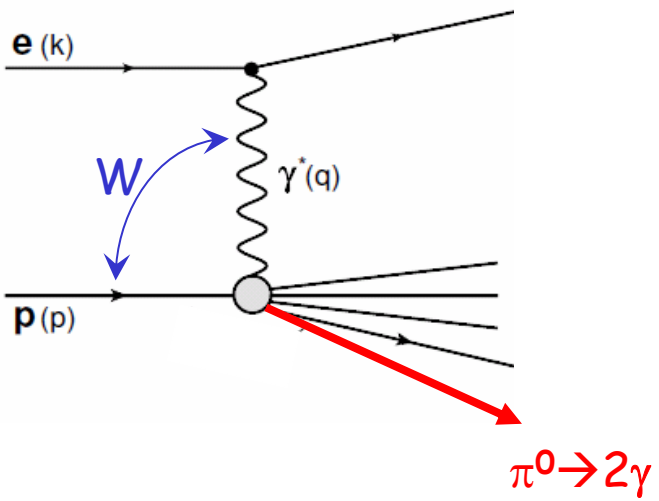
Impact on the LHC predictions for $W^{\pm}$ and Z

- The predictions for $W^{\pm}$, Z inclusive production cross sections vary as a function of charm mass M_c for a given model and for fixed M_c from one model to another.
- Using charm mass values obtained from the fits to HERA data (for each model) reduces the uncertainties of predictions due to M_c

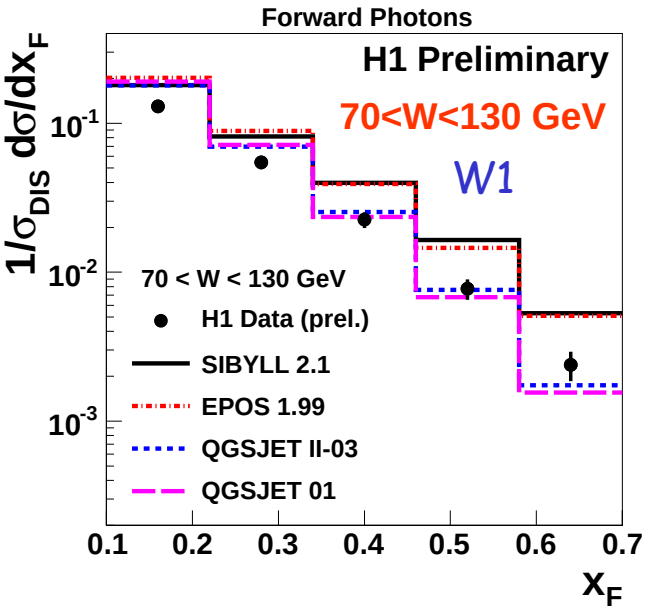
Extension of DESY-11-093 (Measurement of Very Forward Photon production in DIS)

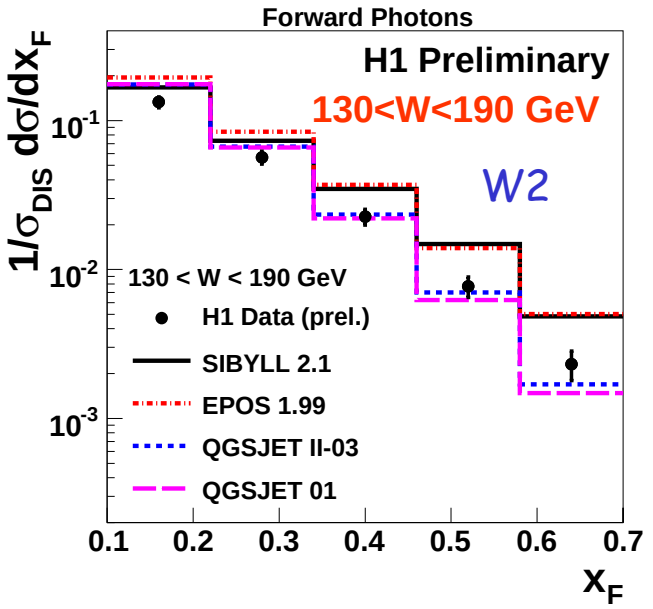
- forward photons (η>7.9) measured in the FNC Calorimeter

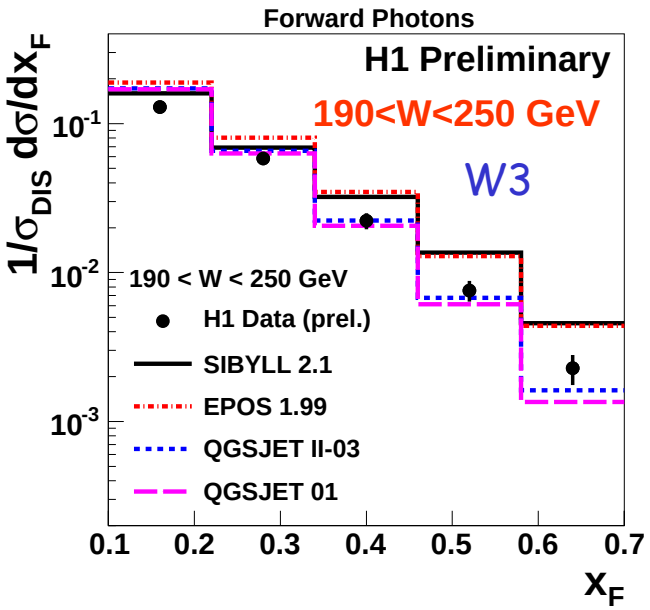
- are mainly from π^0 , produced from the fragmentation of proton remnant



Goal - study the energy (W) dependence of $x_F=2p^*_{||}/W$ distributions → test Feynman scaling
(in particular interesting for tuning of Cosmic Ray hadronic interaction models)



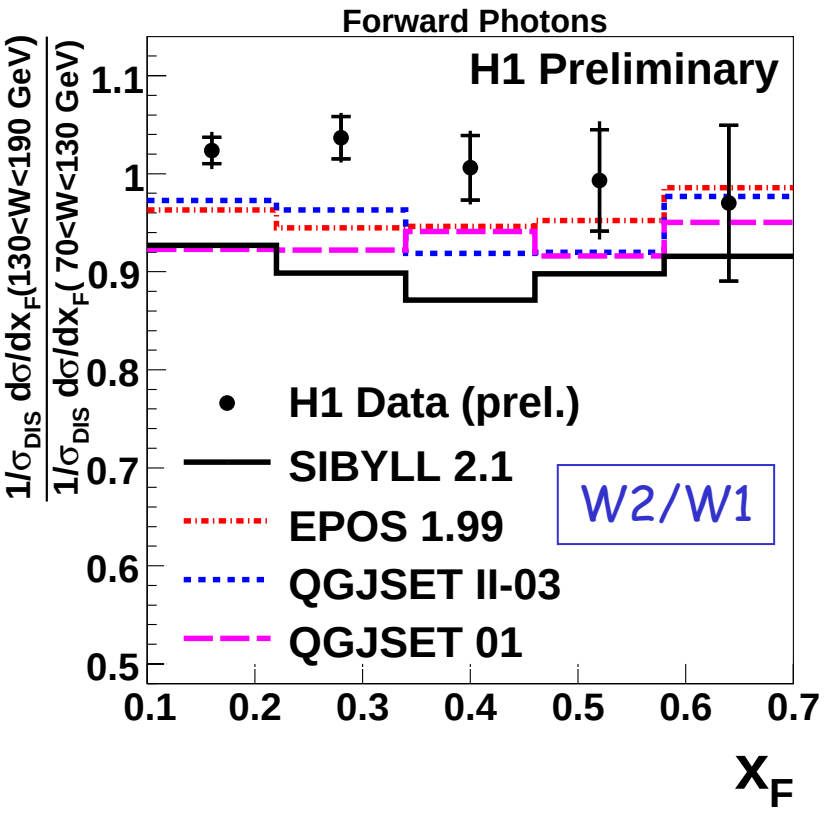




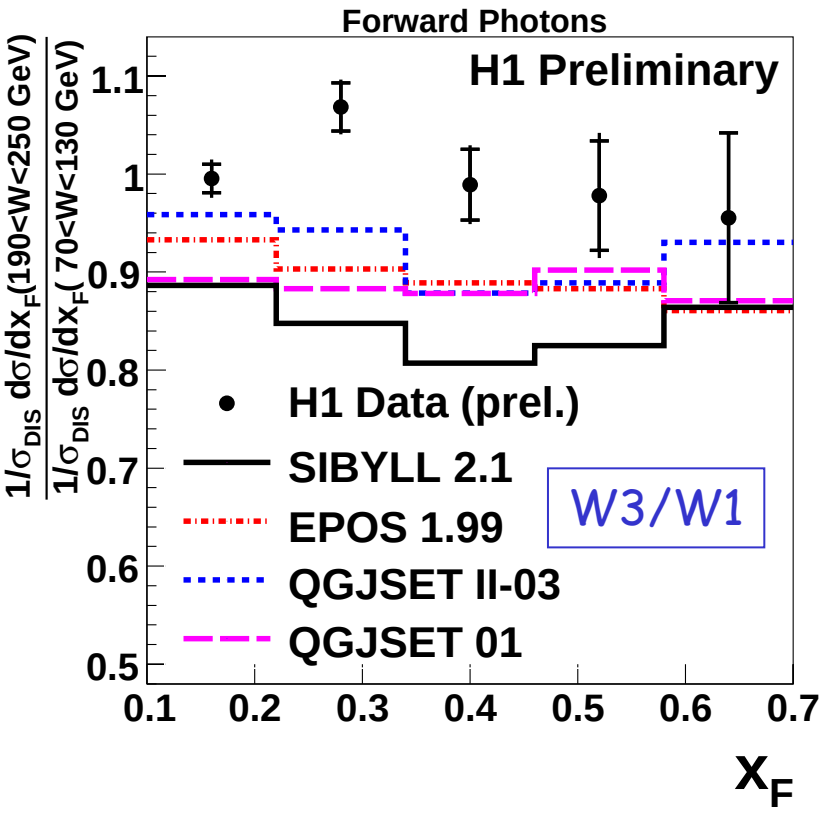
Large differences between the predictions. None of models describes the data well

For W-dependence make ratios of x_F distributions W2/W1 and W3/W1

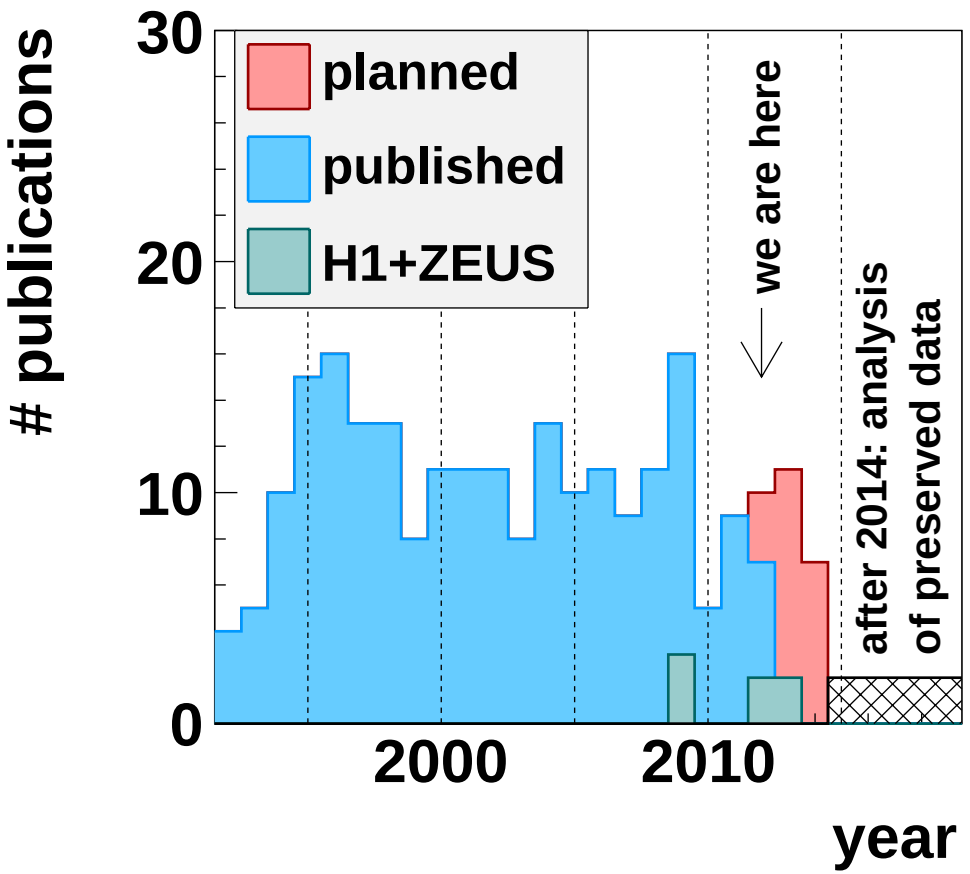
W(130-190 GeV) / W(70-130 GeV)



W(190-250 GeV) / W(70-130 GeV)



- Data show no W dependence of x_F distribution (consistent with Feynman scaling)
- Models indicate deviations from scaling – lower photon rate with increasing W



Publication plan is efficiently realised

7 papers already published in 2012

~20 ongoing analyses, to be finished in 2012-2014

H1 data analyses will continue also after 2014, expect ~1-2 paper/year
→ Data Preservation crucial

H1 computing /data preservation

- Simulation, reconstruction and the analysis framework software - final

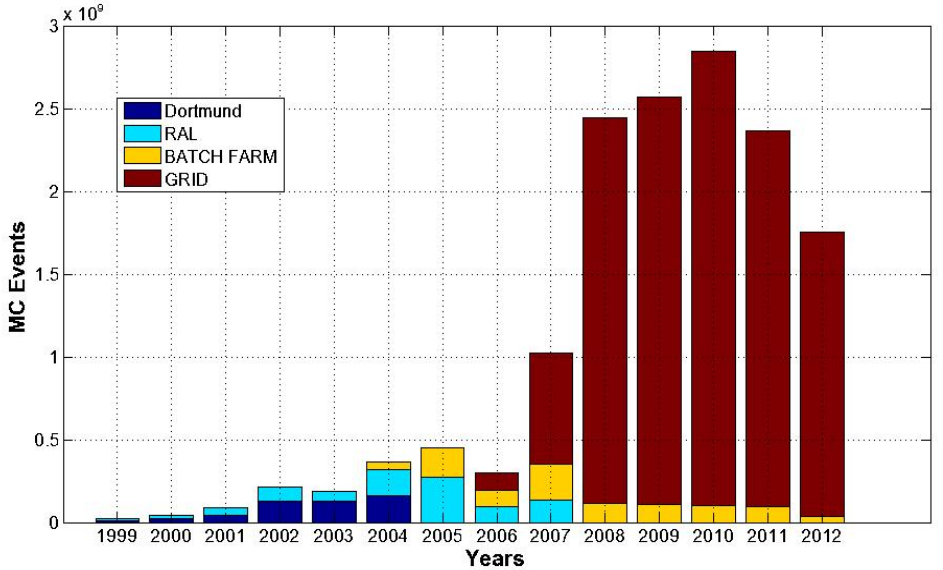
- Final data sets are ready (complete sets of HERA-1 and HERA-2 , fully calibrated)

- Infrastructure stable and reliable. Powerful computing environment for physics analyses guaranteed until end of 2014 (~1000 batch slots)

- Development of validation and archival systems (for data preservation and analyses beyond 2014) close to completion

- Efficient MC production– ~2×10^9events/year

- Anticipate continuous large scale MC production in 2013/2014 for ongoing analyses and for the data preservation



Summary

H1 Collaboration continues to be very active

- 7 papers published so far in 2012, including 2 H1/ZEUS combinations
- ~20 ongoing analyses – planned to be finished during 2012-2014
- Computing (software/hardware) in excellent shape
- Essential contribution to data preservation efforts;

  crucial to ensure that H1 analyses can continue after 2014