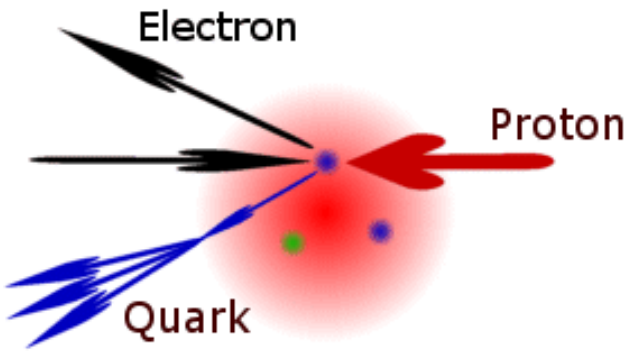


Status of HERA experiments

Publications since last PRC

Beam-helicity asymmetry in associated electroproduction of real photons ep → eγπN in the Δ-resonance region
JHEP01 (2014) 077

Transverse target single-spin asymmetry in inclusive electroproduction of charged pions and kaons
PLB 728 (2014) 183

Reevaluation of the Parton Distribution of Strange Quarks in the Nucleon **DESY-13-246, sub. PR D**

Measurement of Feynman-x Spectra of Photons and Neutrons in the Very Forward Direction in Deep-Inelastic Scattering at HERA **DESY-14-035, sub. EPJ**

Measurement of Inclusive ep Cross Sections at High Q2 at sqrt(s) = 225 and 252 GeV and of the Longitudinal Proton Structure Function FL at HERA **EPJ C74 (2014) 2814**

Deep inelastic cross section measurements at large y with the ZEUS detector at HERA **DESY-14-053**

Measurement of beauty and charm production in deep inelastic scattering at HERA and measurement of the beauty-quark mass (past reading)

Measurement of Neutral Current $e^{\pm}p$ Cross Sections at High Bjorken x with the ZEUS Detector
DESY-13-245, acc. PRD

Photoproduction of Isolated Photons, Inclusively and with a Jet, at HERA **DESY-13-234**

Further studies of the photoproduction of isolated photons with a jet at HERA (past reading, preliminary **ZEUS-prel-13-001**)

Measurement of D^* photoproduction at three different centre-of-mass energies at HERA (past reading, preliminary **ZEUS-prel-13-002**)

Preliminary results since last PRC

Transverse Target Spin-asymmetries of KK Dihadron Production (update)

Search for QCD Instantons using the H1 experiment at HERA **H1prelim-14-031**

Diffractive Dijet Production with Leading Proton in ep Collisions at HERA **H1prelim-14-011**

Dijet production with large rapidity gap in deep-inelastic scattering at HERA **H1prelim-14-014**

Exclusive Photoproduction of Rho Meson with Leading Neutron at HERA **H1prelim-14-013**

Measurement of the cross-section ratio $\sigma_{\psi(2S)}/\sigma_{J/\psi}$ in deep-inelastic exclusive ep scattering at HERA

ZEUS-prel-14-003

Exclusive dijet production in diffractive deep inelastic scattering at HERA (past 1st EB) **ZEUS-prel-14-004**

Combined Measurement of Inclusive e±p Scattering Cross Sections at HERA

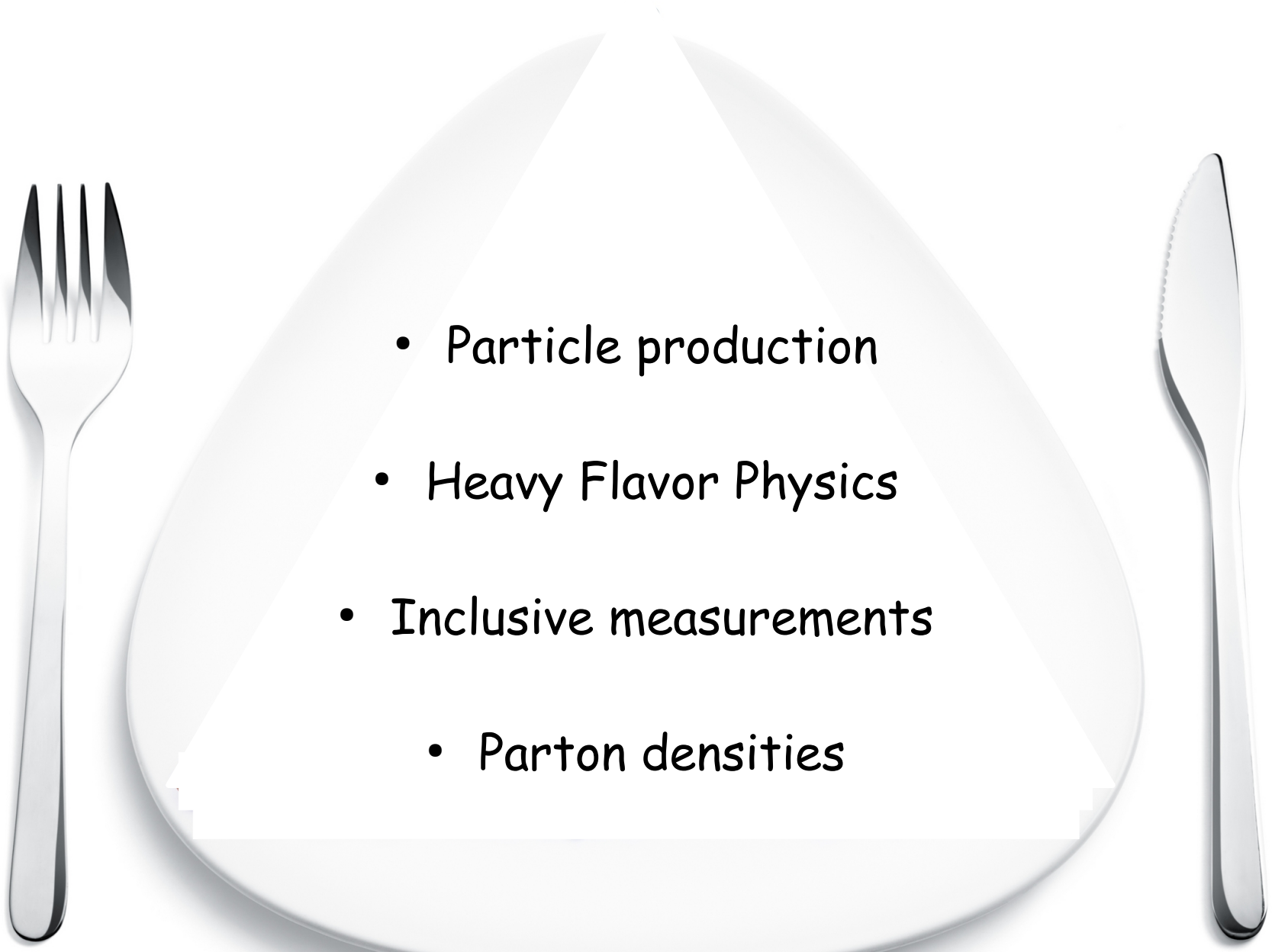
ZEUS-prel-14-005, H1prelim-14-041

QCD Analysis of the Inclusive e±p Scattering Cross Sections at HERA

ZEUS-prel-14-007, H1prelim-14-042

Determination of Charm Mass Running from an Analysis of Combined HERA Charm Data

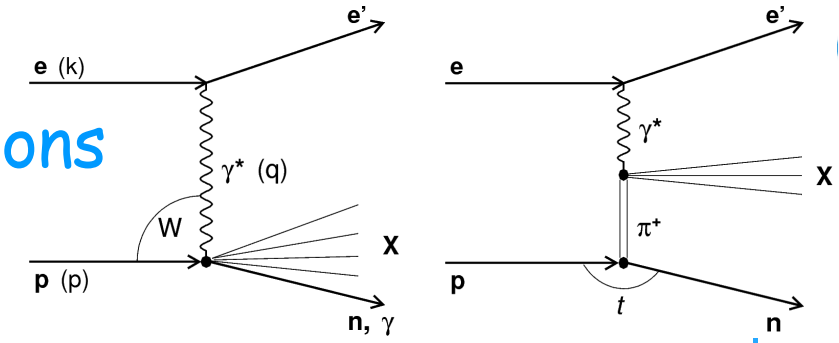
ZEUS-prel-14-006, H1prelim-14-071

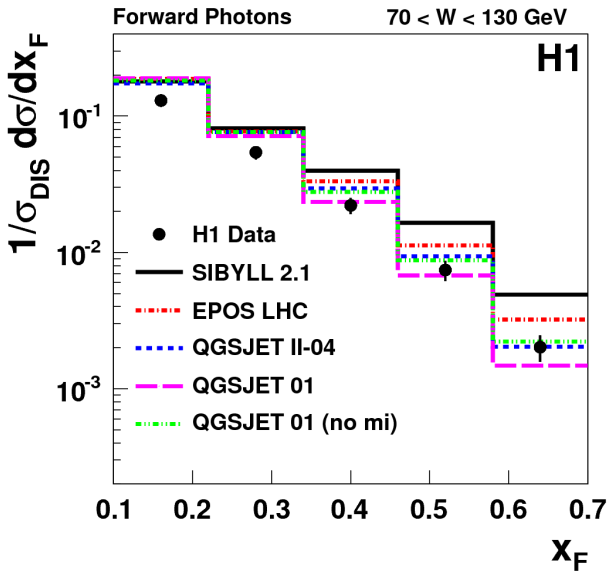


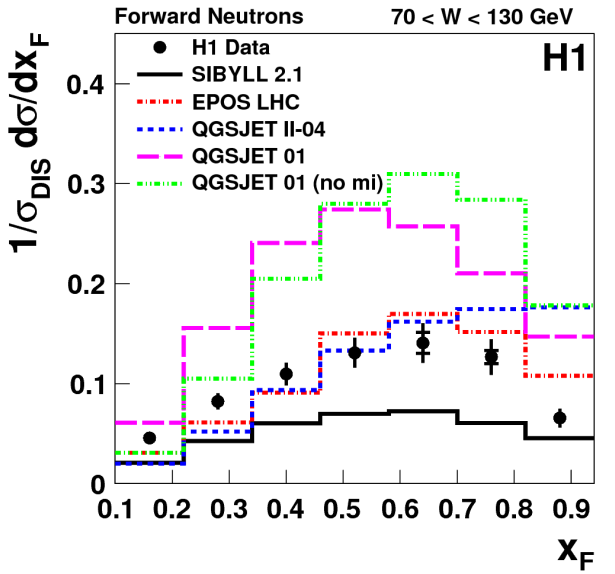
- Particle production
- Heavy Flavor Physics
- Inclusive measurements
- Parton densities

Forward Photons and Neutrons

DESY-14-035







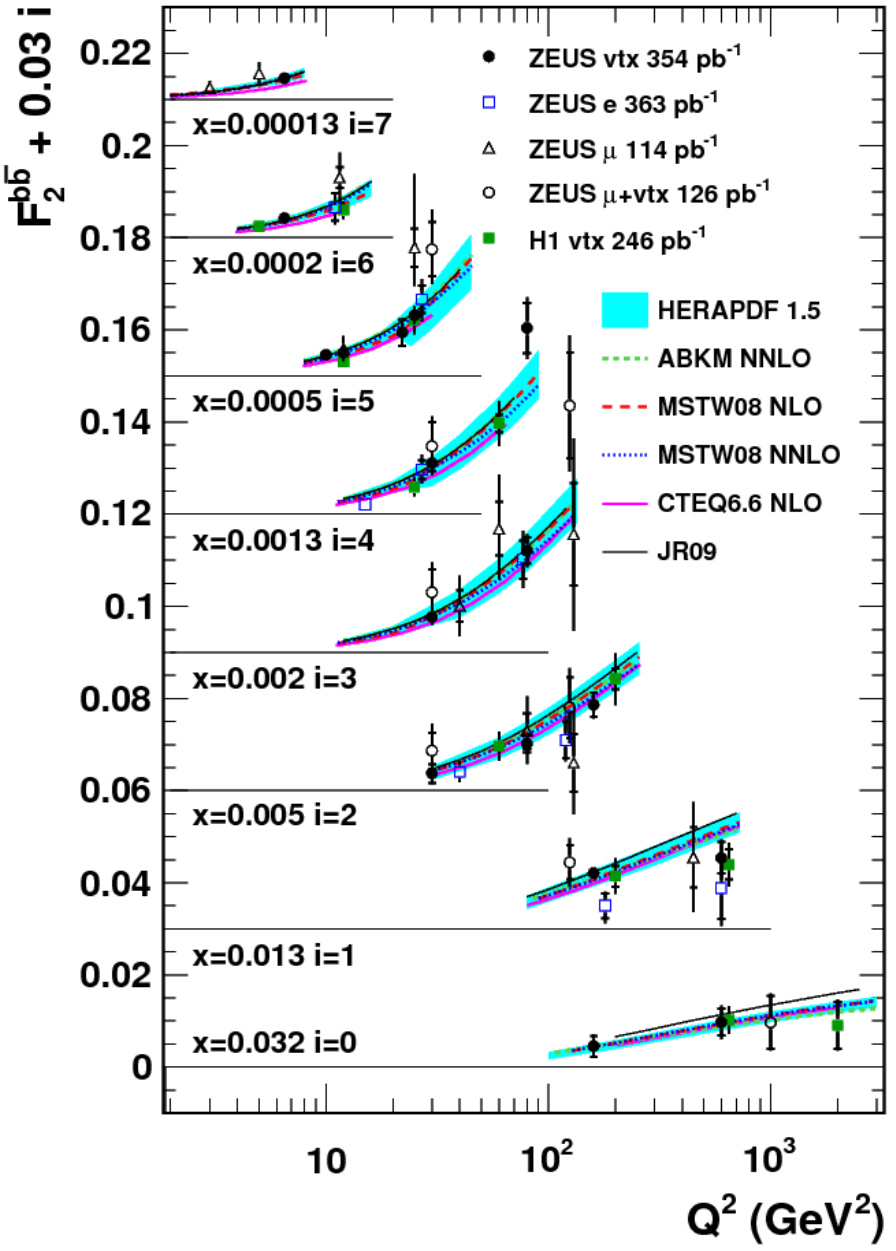
- Very forward particle production measured by H1
  - Constrains for proton fragmentation theory
  - **Constrains for high energy cosmic rays models**
- Feynman scaling hypothesis tested: particle production independent of CME in terms of x_F
  - First test of Feynman scaling for very forward γs and neutrons
- **Feynman scaling confirmed for 70<W<245 GeV**
  - Results compared to cosmic ray models
  - No model describes photon and neutron data simultaneously well

Insight into proton fragmentation at colliders and cosmic ray experiments

Structure function measurements

$$\sigma^{\pm}_{r,\mathrm{NC}} = \frac{\mathrm{d}^2\sigma^{e^{\pm}p}_{\mathrm{NC}}}{\mathrm{d}x\mathrm{d}Q^2} \cdot \frac{Q^4 x}{2\pi\alpha^2 Y_+} = \tilde{F}_2 \mp \frac{Y_-}{Y_+} x\tilde{F}_3 - \frac{y^2}{Y_+}\tilde{F}_L$$

F_2^{cc} and F_2^{bb} structure functions



- ZEUS measured beauty- and charm-jet production in DIS
  - Long lifetimes and large masses exploited
- Structure function F_2^{cc} and F_2^{bb} extracted
  - Good agreements with other results
- Various NLO and NNLO predictions provide reasonable description of data

In wide Q^2 range most precise determination of F_2^{bb}

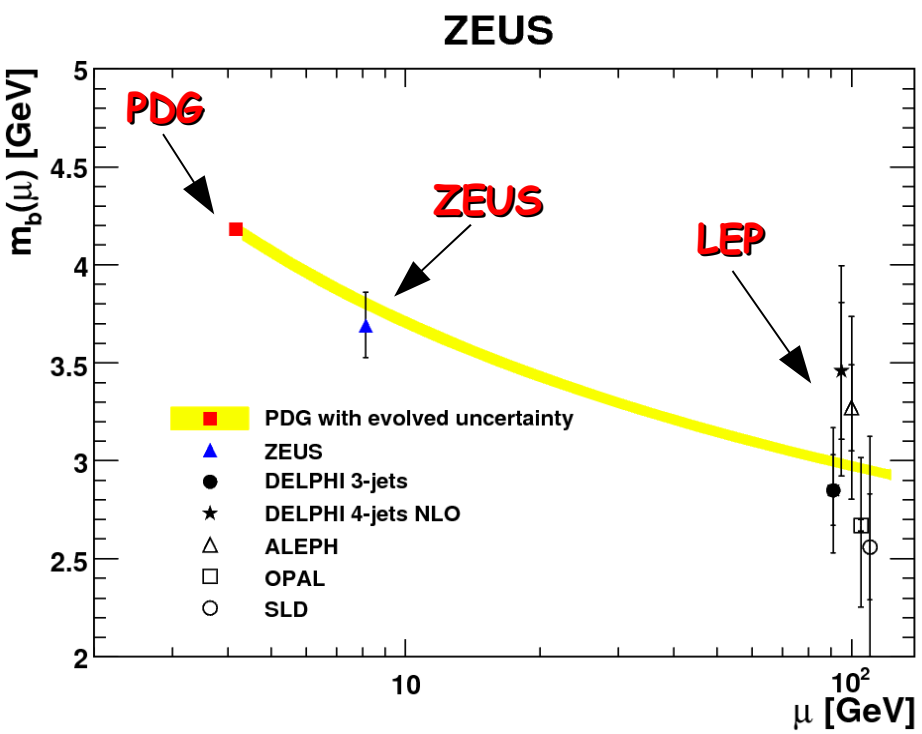
Used to determine b mass

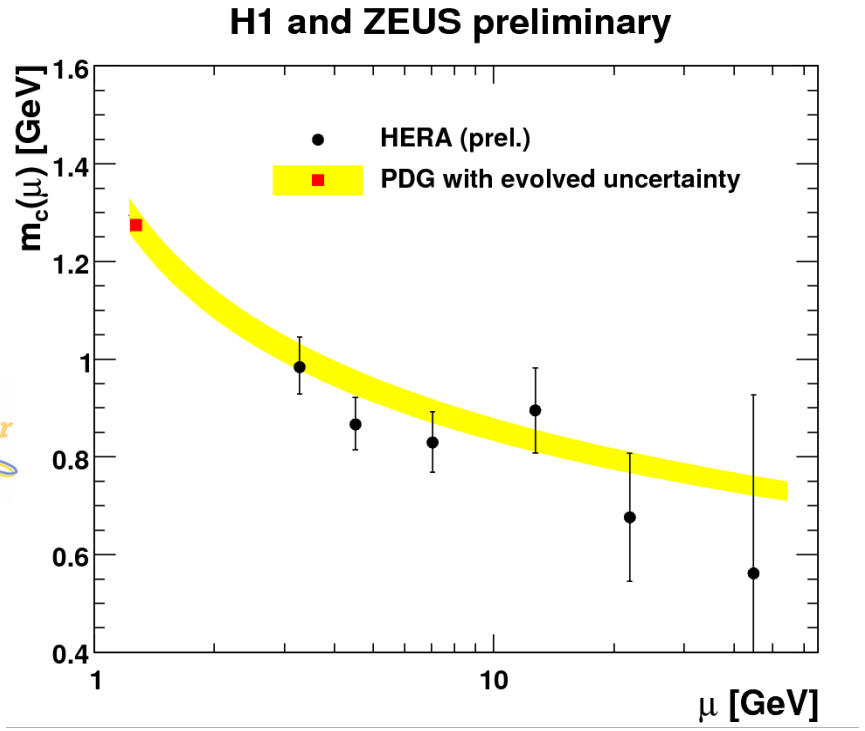
Heavy quarks mass running

- Beauty mass extracted by ZEUS, for the first time from hadron collider data, from QCD fit from reduced b cross sections and inclusive data @ NLO

$$m_b(m_b) = 4.07 \pm 0.14\,(\text{fit})^{+0.01}_{-0.07}\,(\text{mod.})^{+0.05}_{-0.00}\,(\text{param.})^{+0.08}_{-0.05}\,(\text{theo.})\ \text{GeV}$$

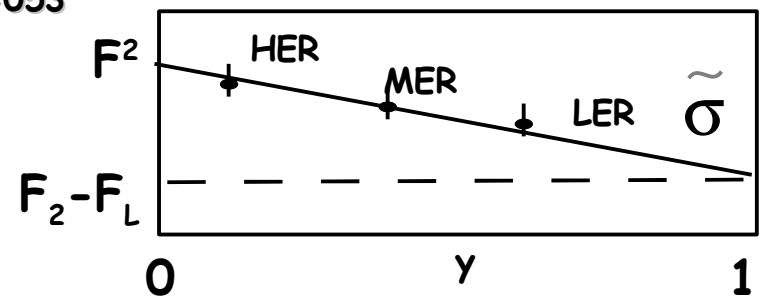
- Charm mass running in MS scheme measured for a first time from combined HERA charm reduced cross sections





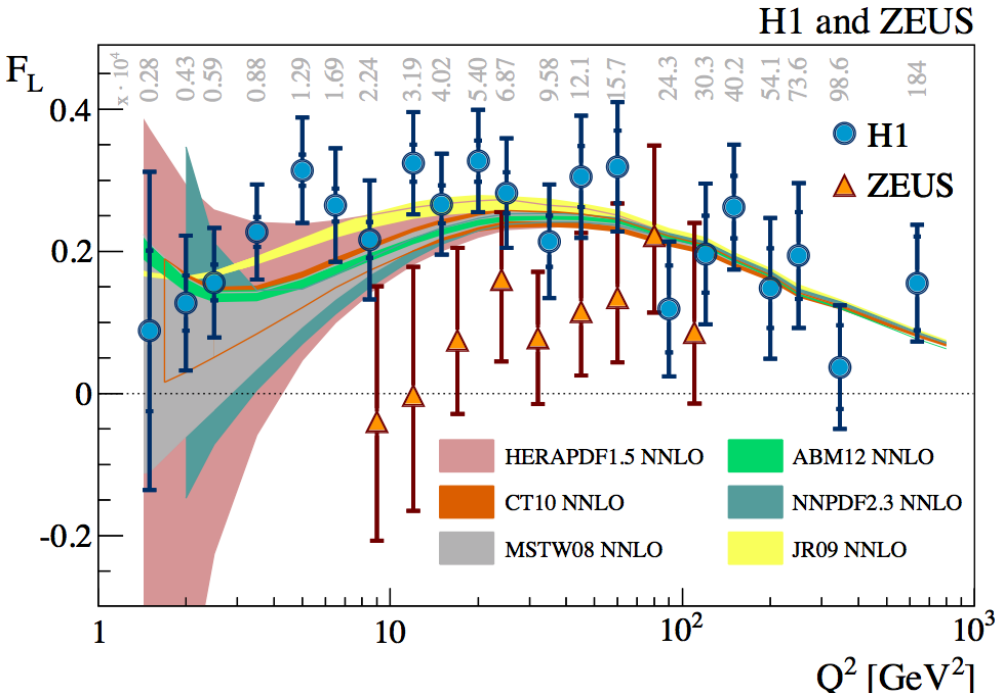
Results consistent with QCD expectation

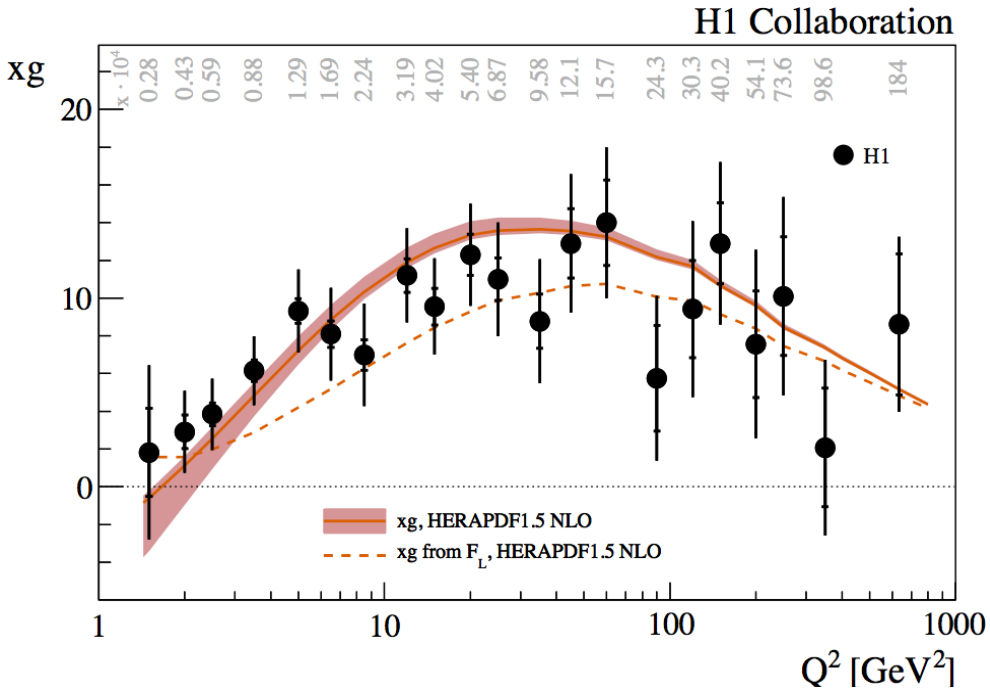
EPJ C74 (2014) 2814



F_L structure function

- H1 and ZEUS published final F_L measurements using low-energy data
- H1 performed extraction of gluon density from F_L measurement @NLO





Consistent within ~ 1.5 sigma

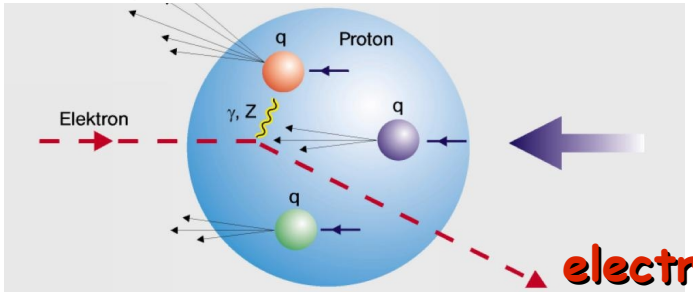
(sizeable point-to-point correlated uncertainties)

Gluon approximated from F_L agrees with gluon determined from scaling violations

All H1 and ZEUS inclusive measurements FINAL

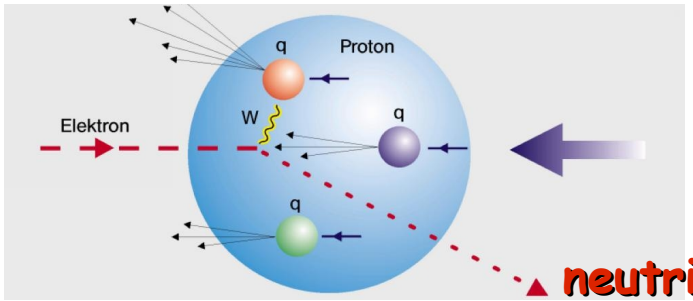
time to combine them

Combined inclusive DIS



← Neutral Current (NC)

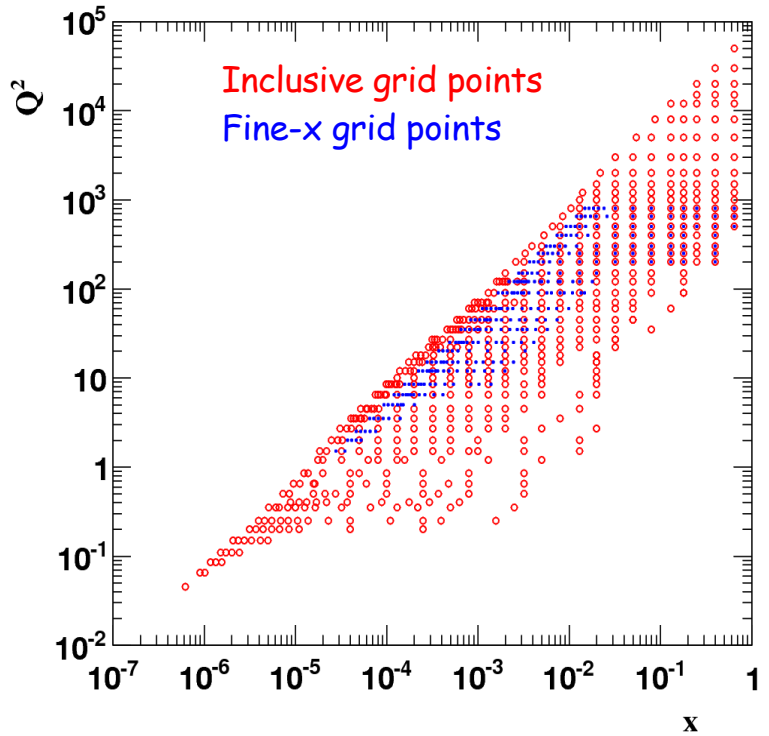
γ, Z^0 exchange



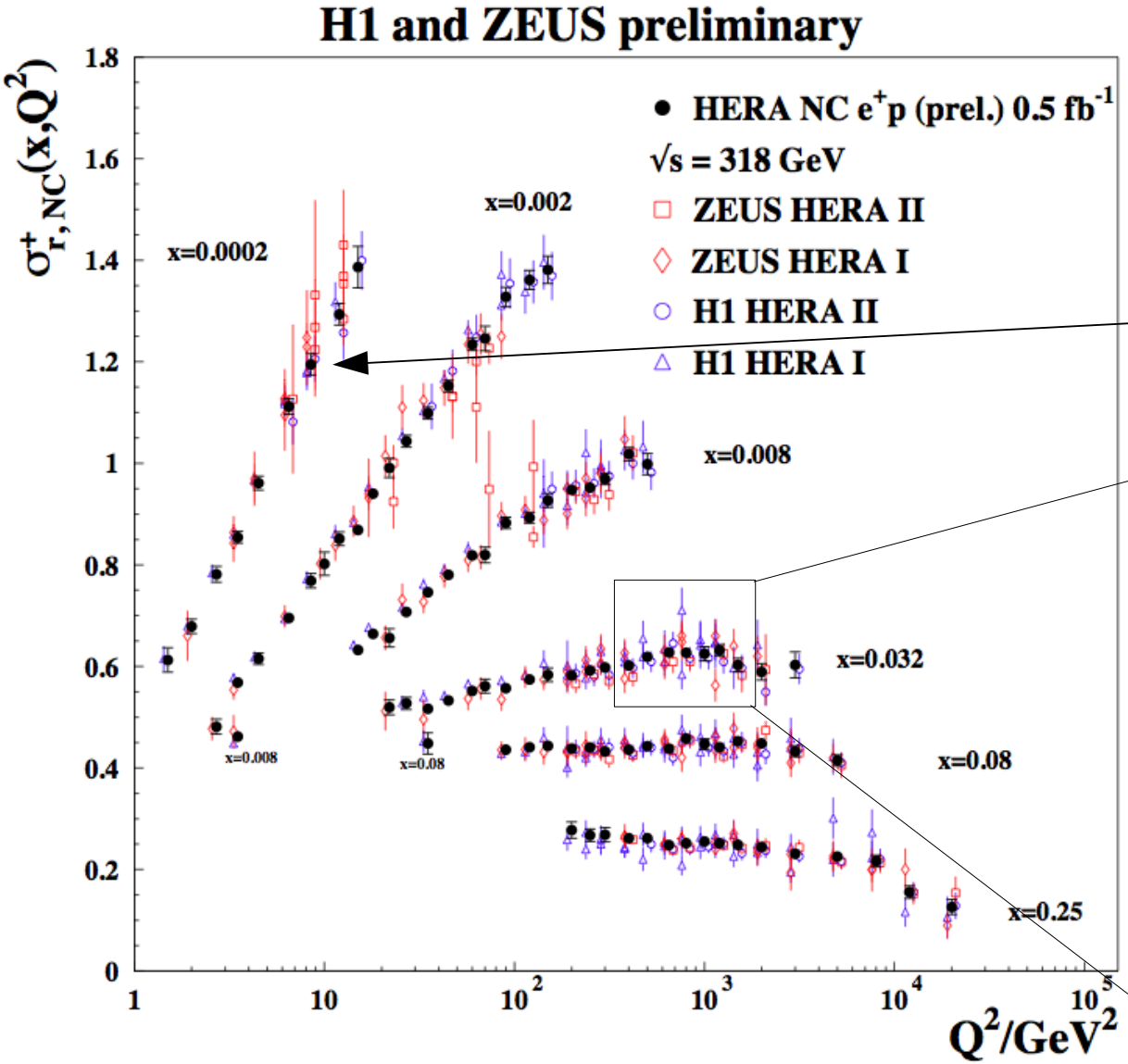
← Charged Current (CC)

$W^{\pm}$ exchange

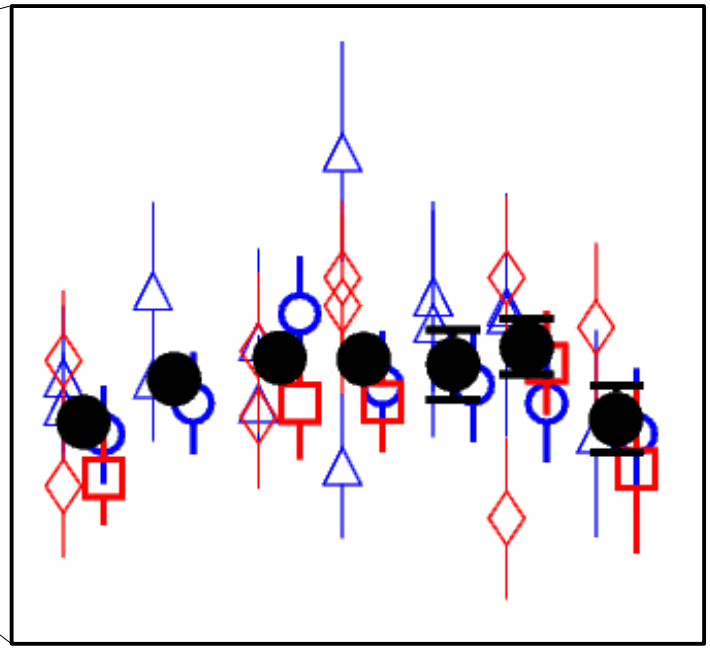
- H1 and ZEUS published all HERA inclusive DIS measurements – 1 fb^{-1}
- **Now we combine these measurements**
- 2927 data points combined into 1307
  - $0.045 < Q^2 < 50000\ GeV^2$
  - $6 \times 10^{-07} < x < 0.65$
- Low energy running data included
- HERAverager & HERAFitter used
  - Swimming done using our own full data



Impressive amount of data points combined



- 2927 data points combined to 1307
- 162 correlated systematic uncertainties
- Up to 6-8 data points combined to 1

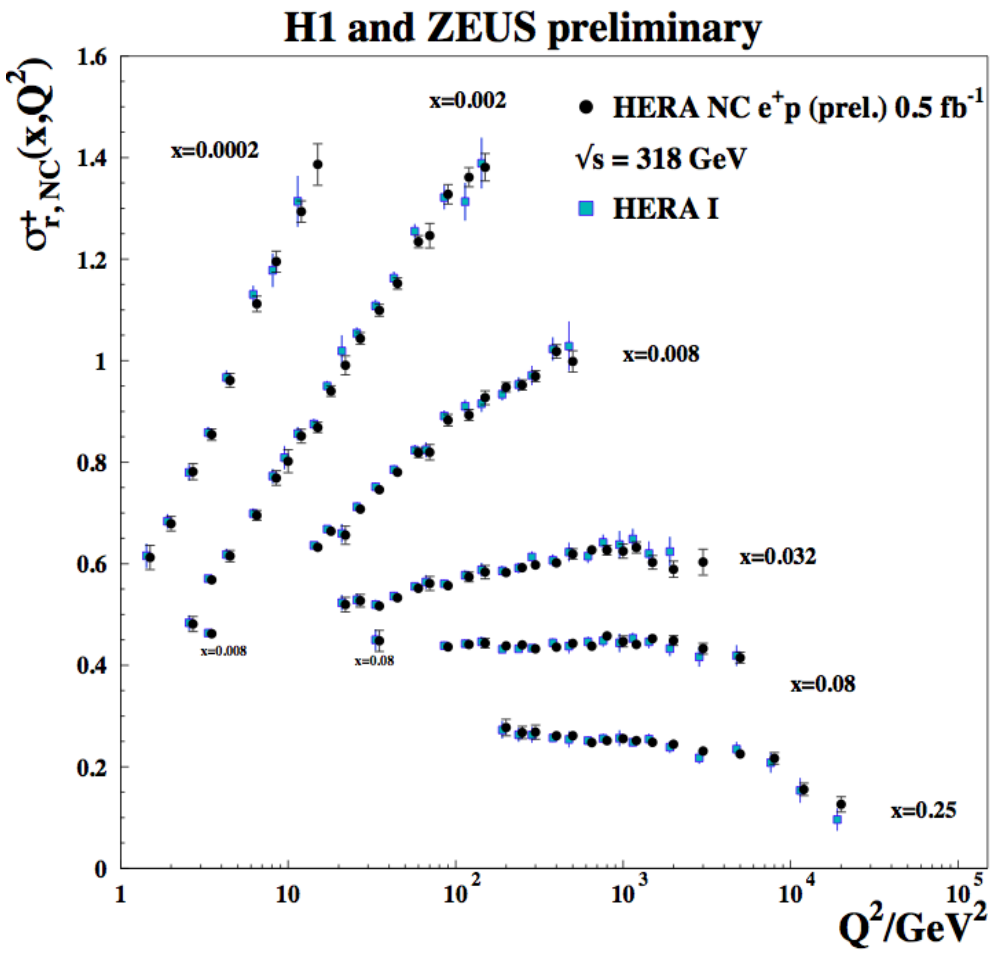


Good consistency: χ^2/dof = 1685/1620

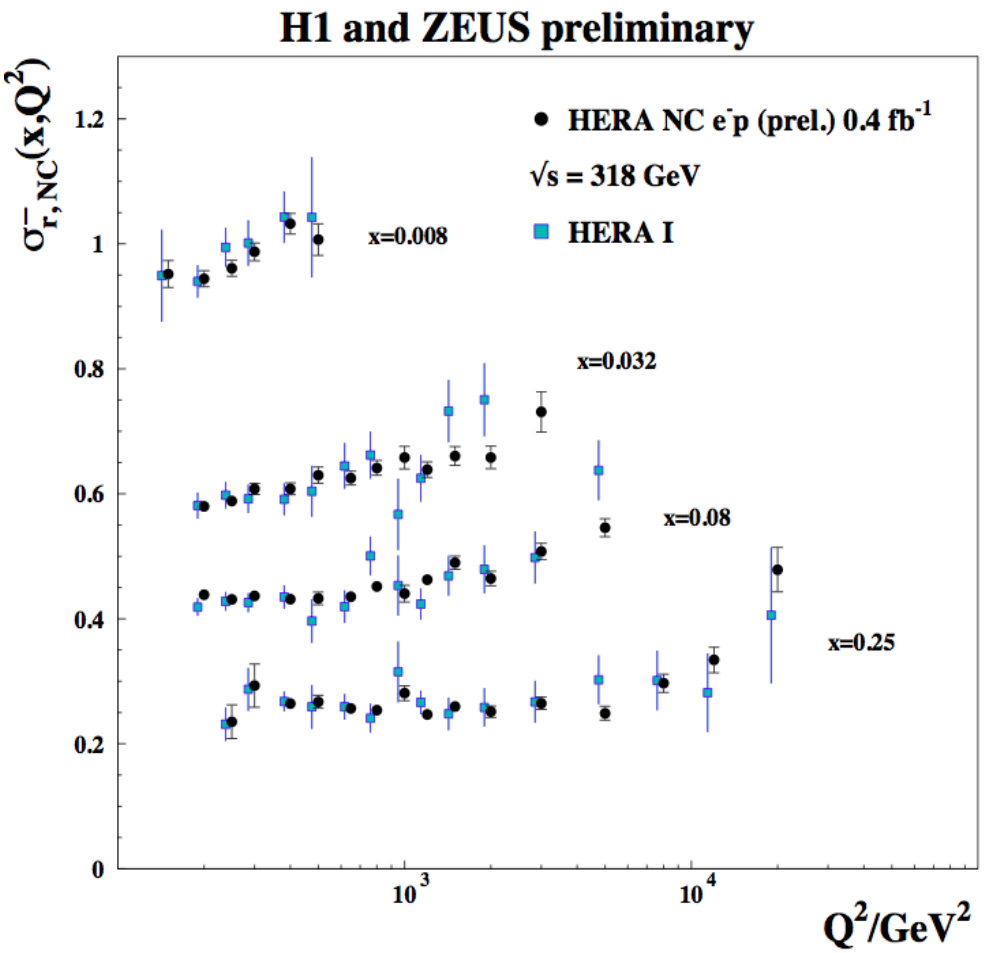
Comparison with HERAI combination

- Significant reduction of systematic uncertainties
- Significant increase of statistics

NCe⁺p: 3 times HERAI luminosity

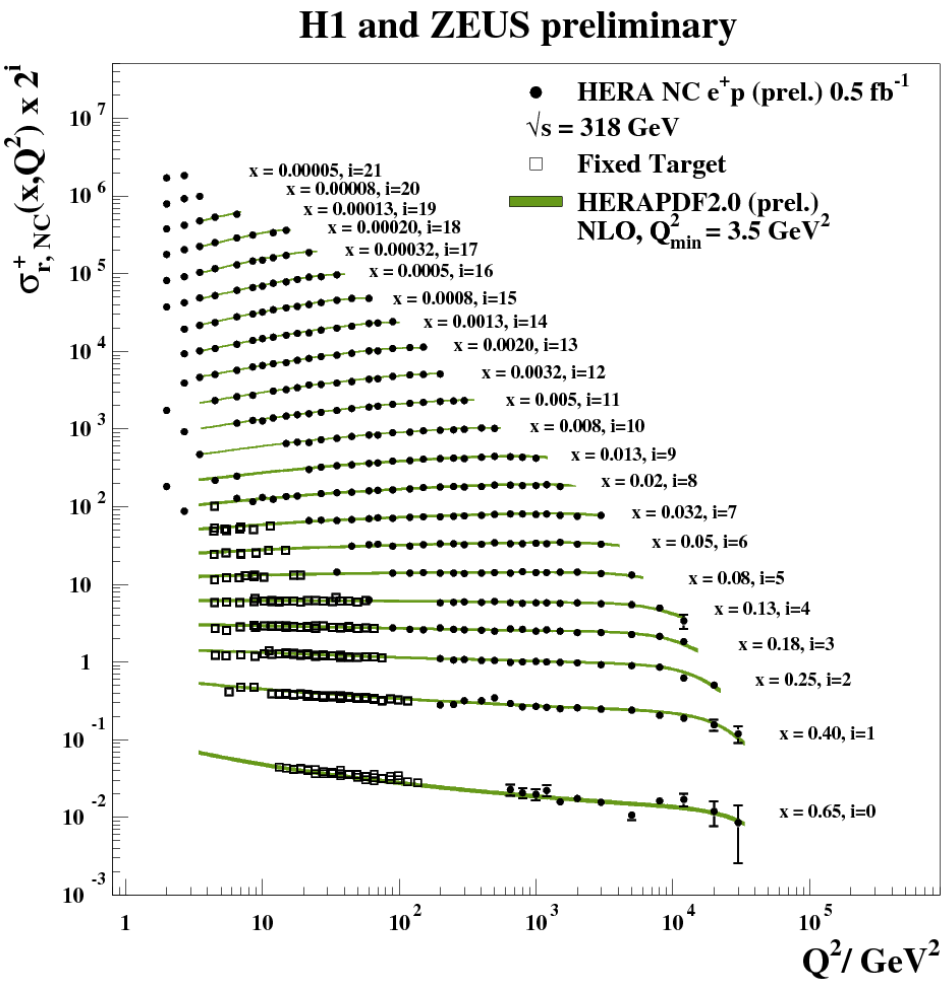


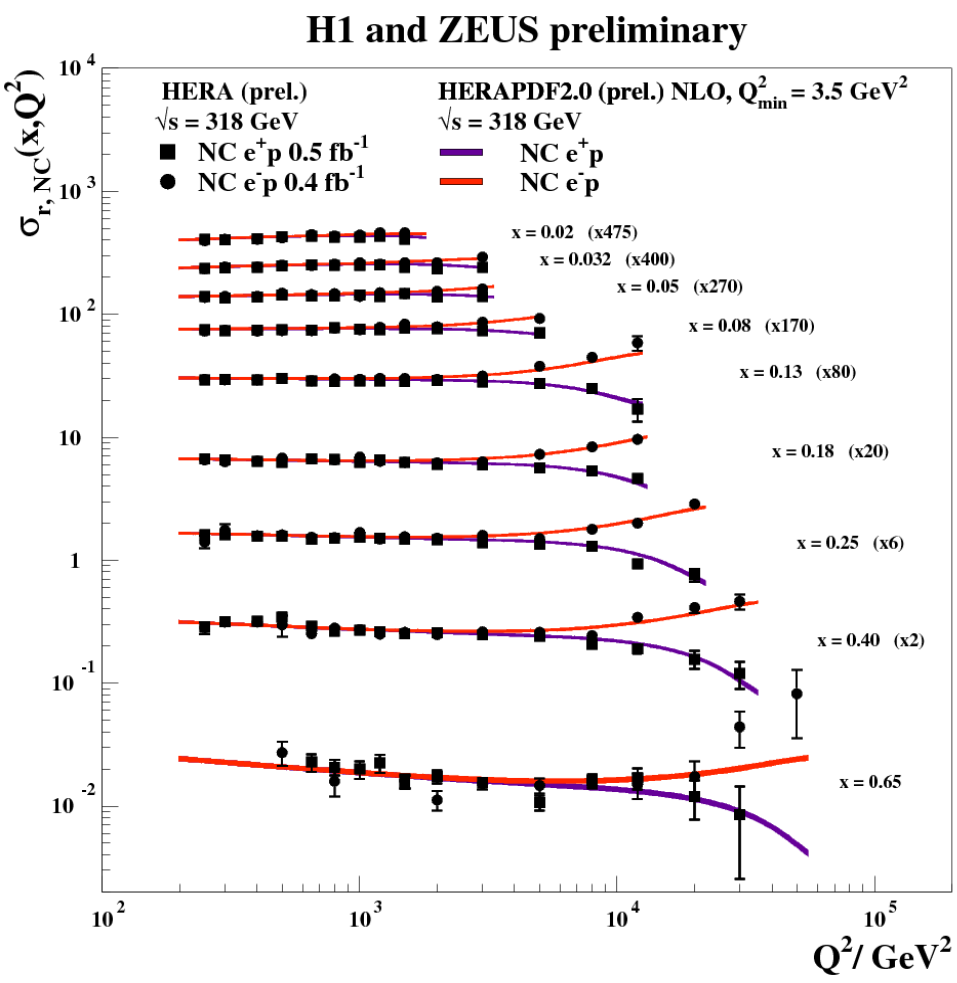
NCe⁻p: 10 times HERAI luminosity



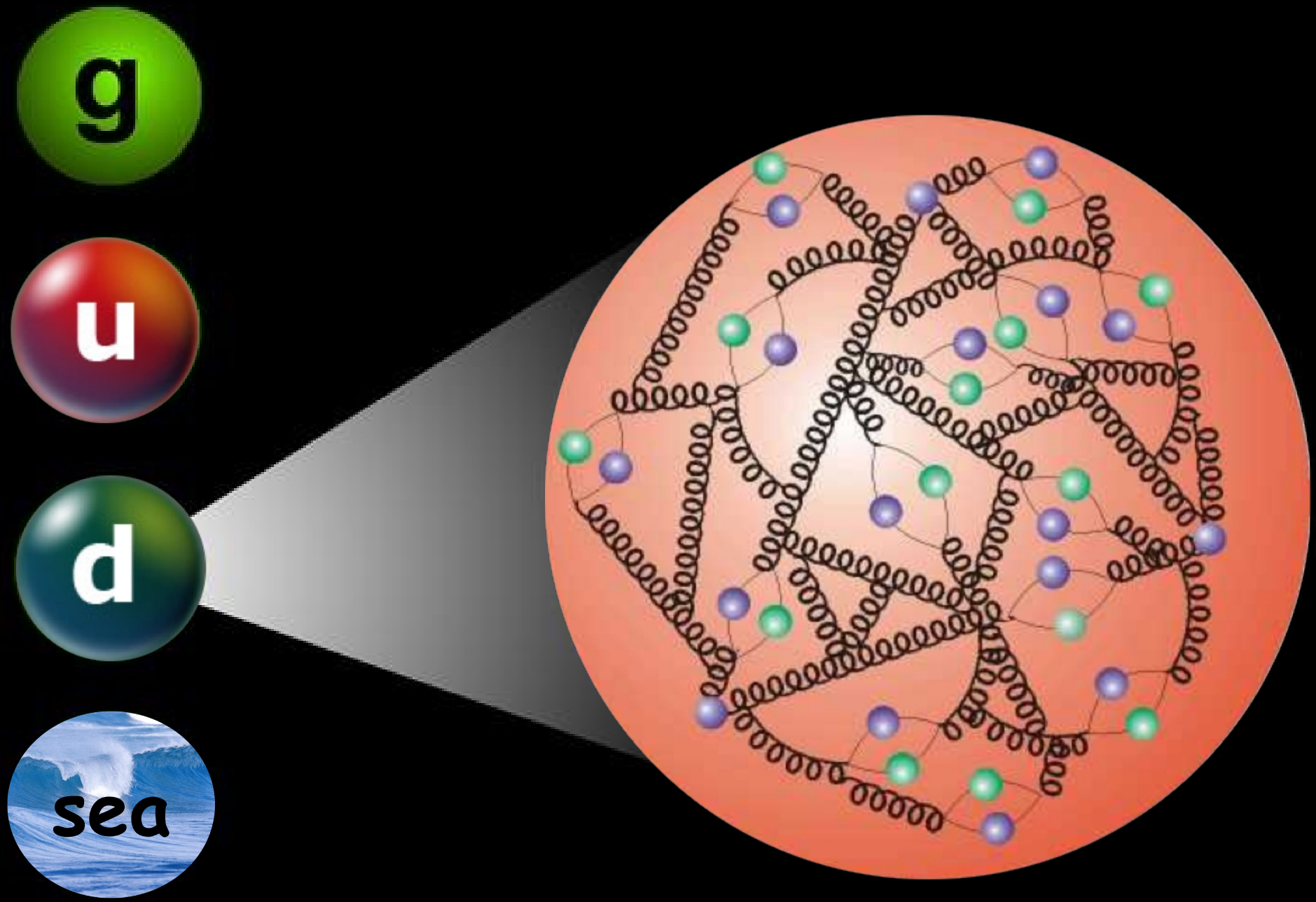
Large gain in precision

QCD scaling and EW effects beautifully seen





This data (exclusively!) used as input to global QCD fit HERAPDF2.0 (prel.)


g
u
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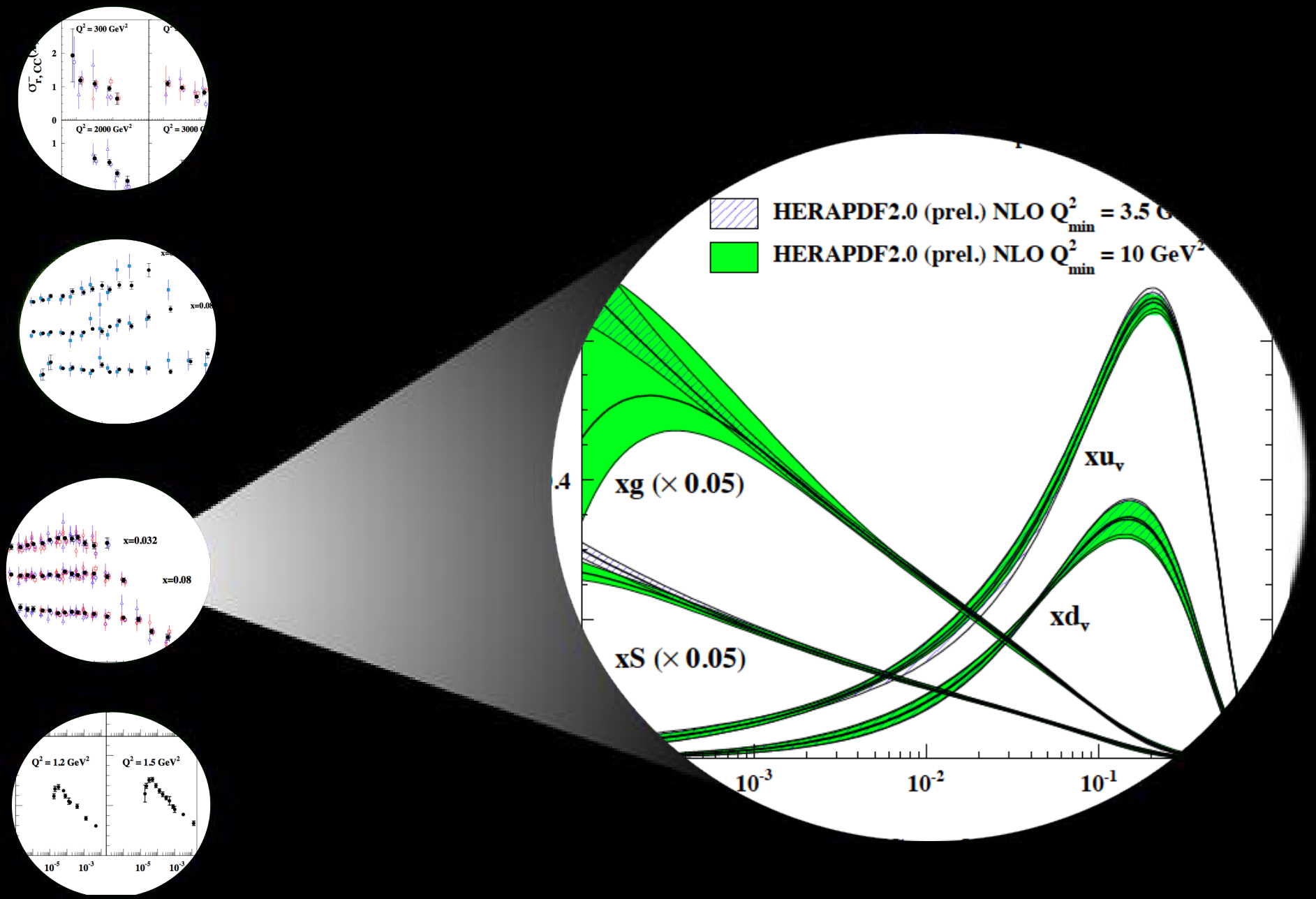
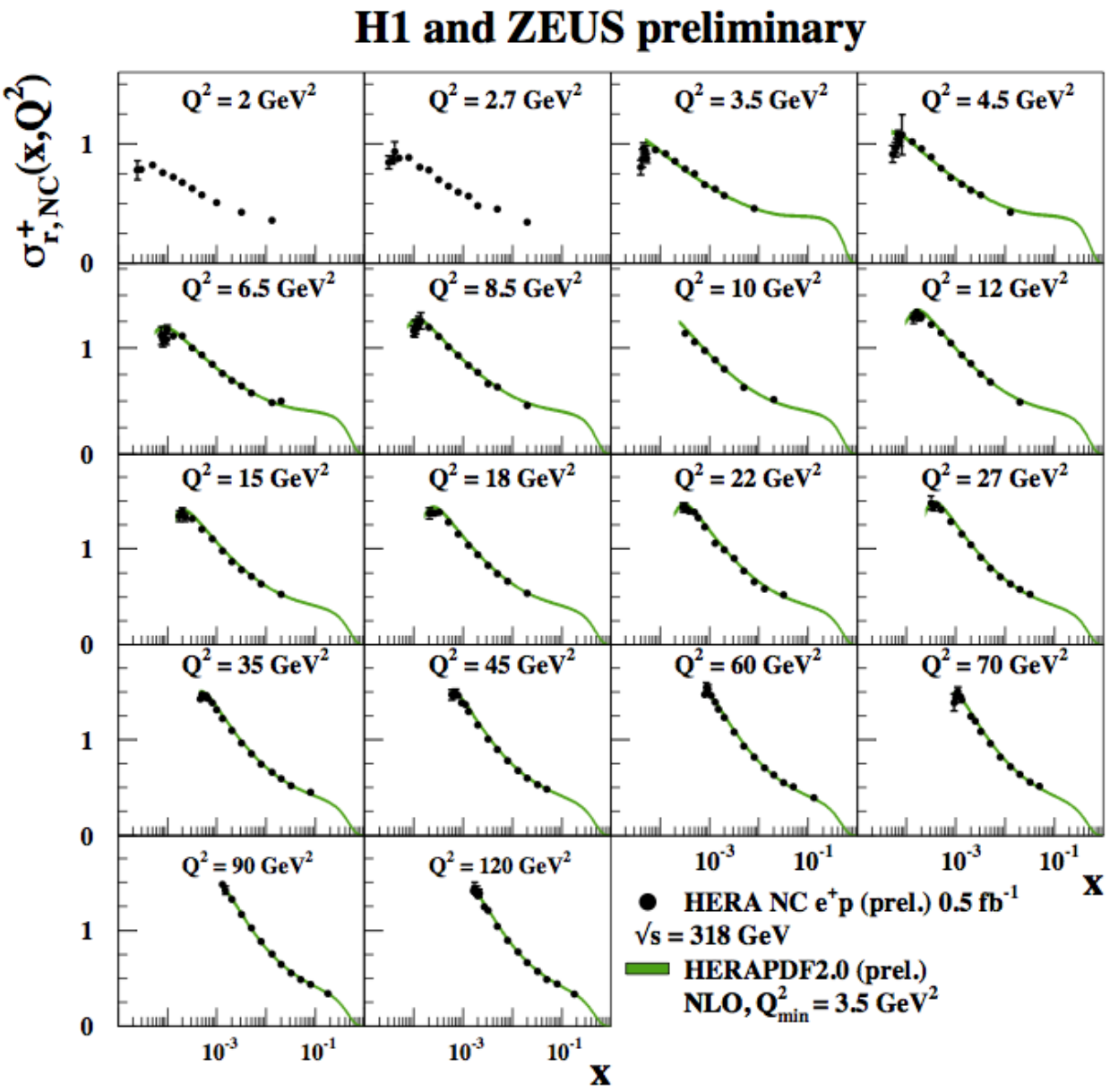

Q^2 = 300 GeV^2
Q^2 = 2000 GeV^2
x=0.08
x=0.032
x=0.08
Q^2 = 1.2 GeV^2
Q^2 = 1.5 GeV^2
HERAPDF2.0 (prel.) NLO Q^2_{min} = 10 GeV^2
xg (× 0.05)
xS (× 0.05)
xu_v
xd_v
10^{-3}
10^{-2}
10^{-1}

HERAPDF2.0 (prel.) @ NLO



- NLO fit for Q^2_{min} = 3.5 GeV^2

  χ^2/dof = 1386/1130

- Additional fit performed with Q^2_{min} = 10 GeV^2

  χ^2/dof = 1156/1003

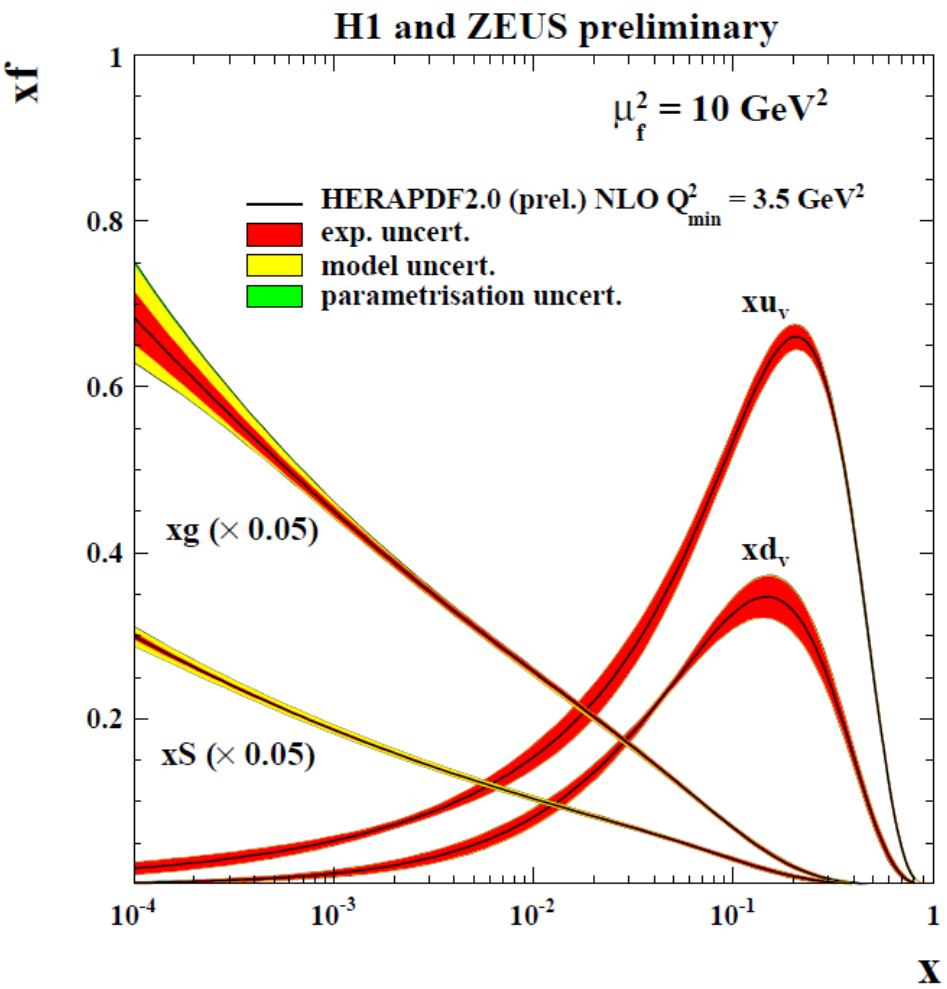
Situation somewhat improved

- **Similar results for NNLO**

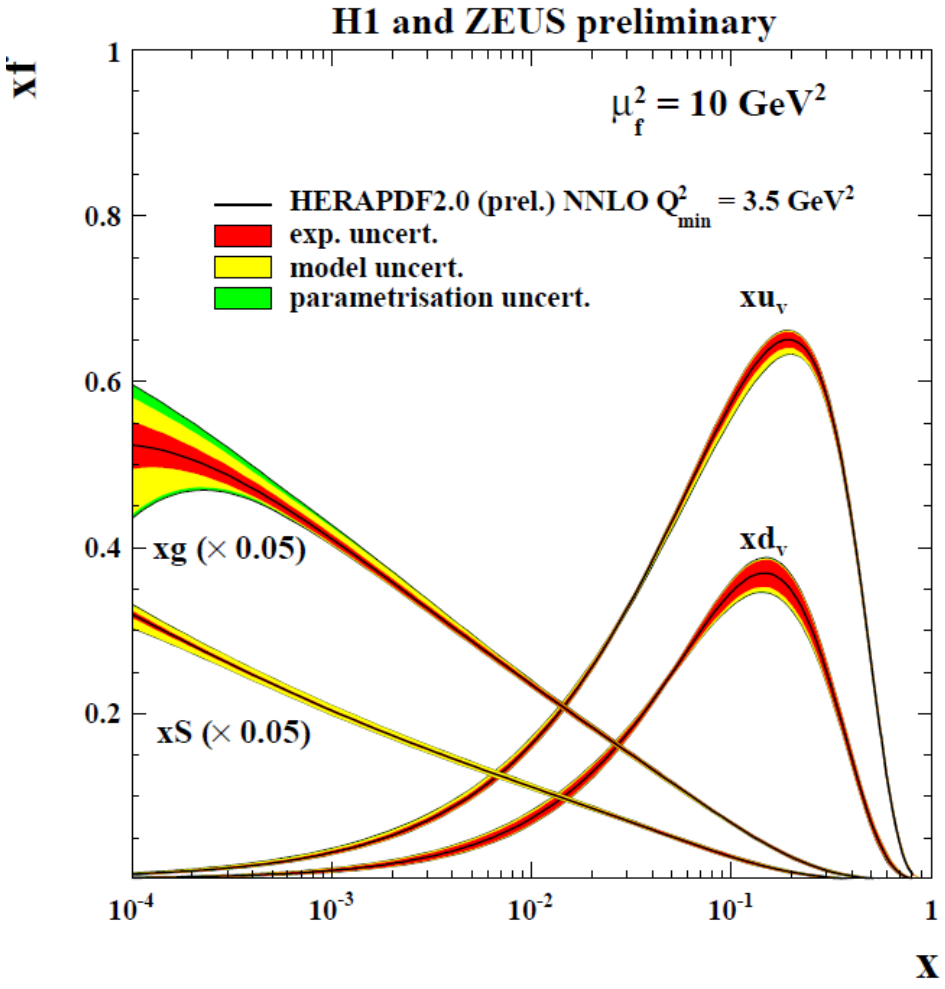
Reasonable description of NC, CC and low energy data for NLO and NNLO

NLO & NNLO parton densities

NLO



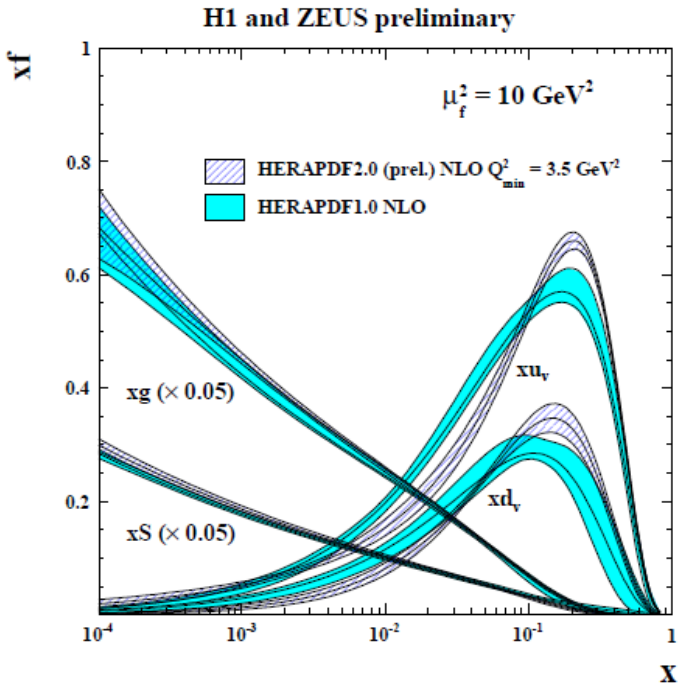
NNLO

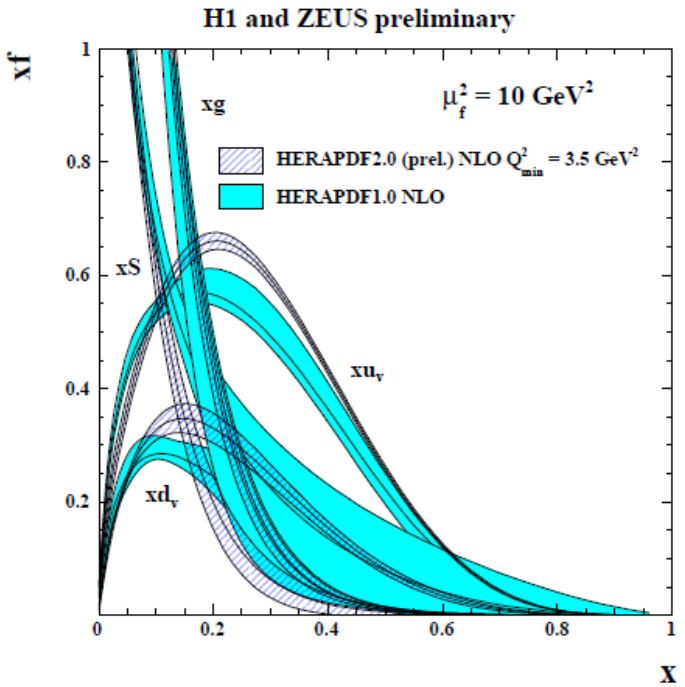


HERAPDF2.0 (prel.) extracted

with experimental, model and parametrization uncertainties

Parton distribution from inclusive data

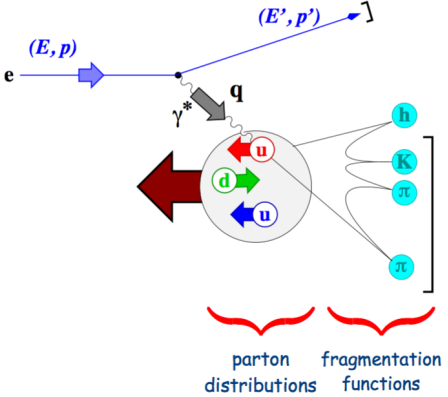




- Considerable decrease in uncertainty
  - Particularly in high-x sea
- Shapes of PDF changed
  - Valence shape changed due to considerable increase of high-x data
  - High-x sea becomes softer

- Strange contribution to sea cannot be constraint by inclusive data
- Direct measurements of strange particles can help constraining sea
  - Strangeness tagging via kaons promising
- Exploited by HERMES at LO

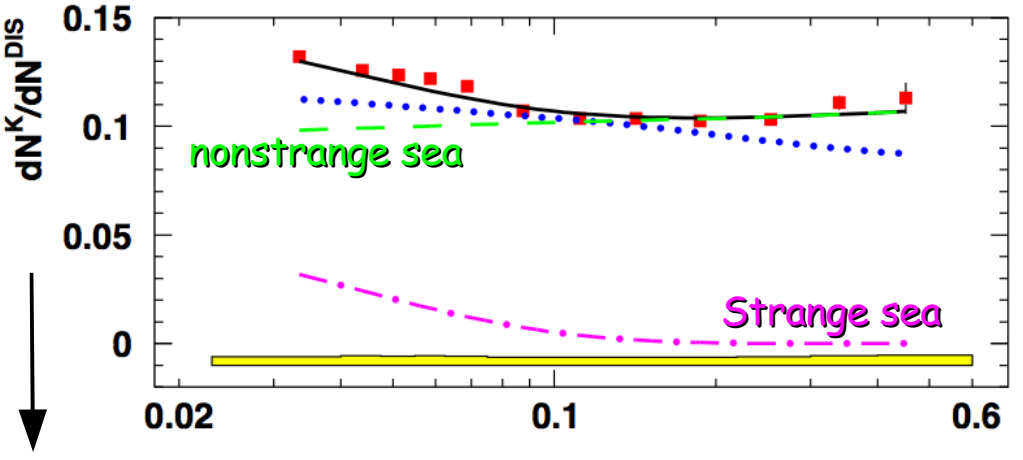
PDF determination @ HERMES



- Extract <u>strange quark distribution</u> @ LO

  using HERMES data (PL B666, 466 (2008), 100+ cit.)

  - Newest K^+K^- multiplicities on deuteron used: PR **D87**, 074029 (2013)

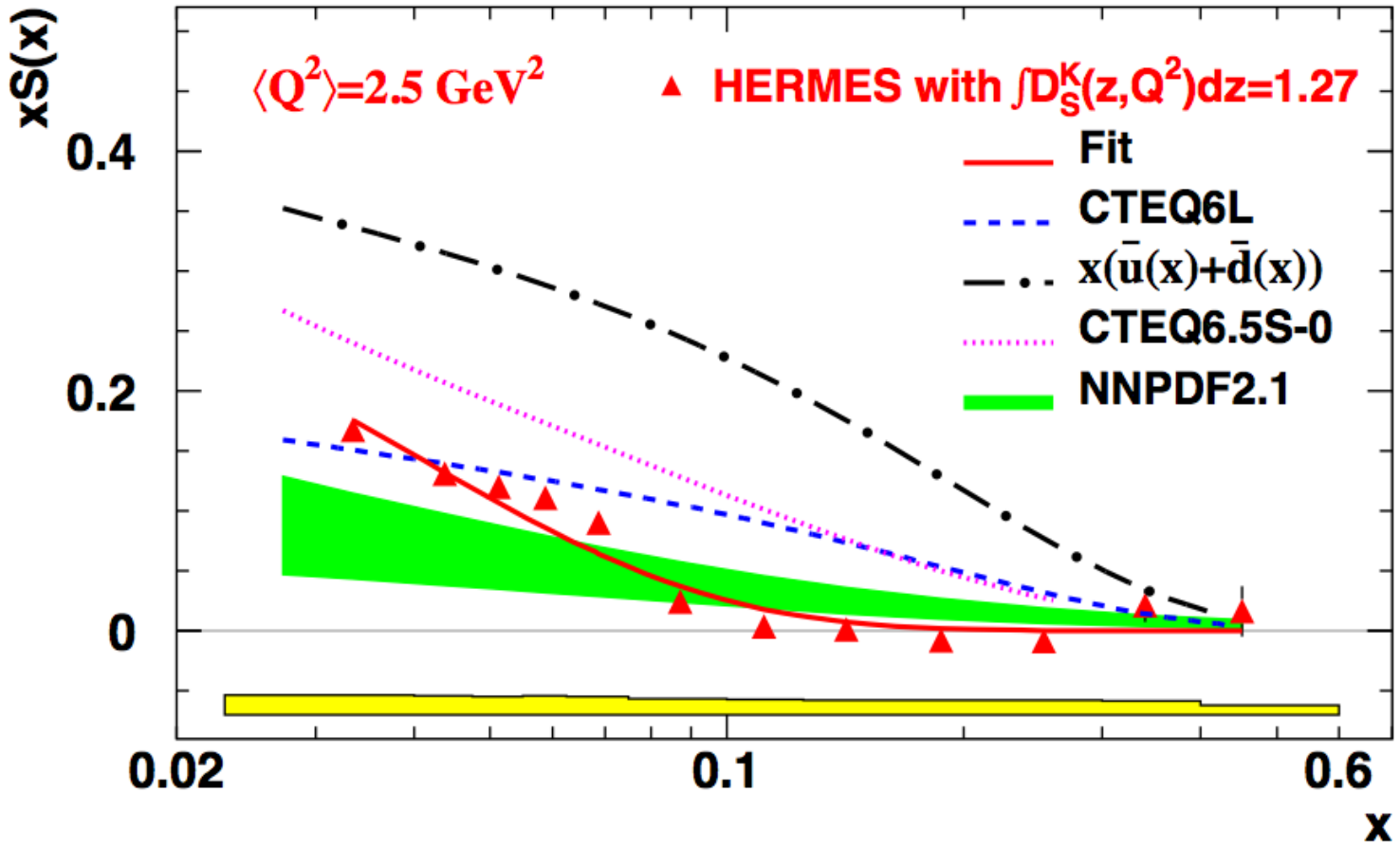


$$s(x) + \bar{s}(x) = S(x) \int \mathcal{D}_S^K(z)\,dz \simeq Q(x)\left[5\frac{d^2N^K(x)}{d^2N^{DIS}(x)} - \int \mathcal{D}_Q^K(z)\,dz\right]$$

- assume $S(x,Q^2)$ -> 0 at high x → extract non-strange fragmentation
- Strange fragmentation measured before (PR D75,114010 (2007)) → **extract xS(x)**

Strange sea @ LO from HERMES

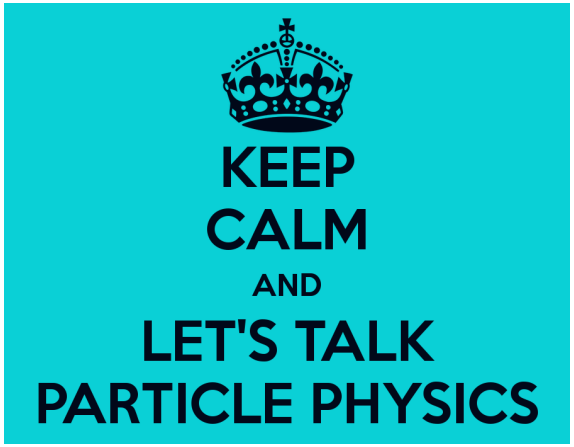
- xS(x;Q2) shape
  - strikingly different from CTEQ6L and other global LO PDFs
  - At high x consistent with NNPDF
  - absence of strength above x ~ 0.1 discrepant with CTEQ6L



Distribution softer than that determined by other analysis

Talks

- Collaborations and resources are shrinking
  - Sometimes problems with finding speakers
- HERA results visible at major HEP conferences
  - Up to now ~70 talks already for this year
  - 27 DIS14 talks
  - Many invited talks on other conferences



We need to secure our data for future analyses

Data Preservation @ HERA

- 2014 is a crucial year for the HERA experiments, must complete the transition to DESY-IT central services
  - Movement of DPHEP-data from the old HERA dCache to dedicated storage on the DESY-SE has almost been completed (online and archival parts)
  - Analysis jobs successfully running on the Bird batch system
  - Implementation of further validation tests within `sp-system` planned, after the movement to common resources based on SLD6 / Bird / nfs4.1 is completed
- New person-power appointed within the IT division for two years to work closely with the experiments to ensure the DPHEP-data are secure and available for analysis
  - The position is also vital to success of the `sp-system`
- DESY, together with CERN and IN2P3, will meet next week to finalise the DPHEP Collaboration Agreement in view to sign it as founding partners
  - Other candidate partners from the DPHEP Study Group expected to follow

Summary

- HERA diet is well balanced, diversified and tasty
  - New interesting measurements in every field
  - Three new combined H1-ZEUS results

- We have plenty
  - 11 publications and 10 preliminary results since last PRC
- We share with pleasure
  - All experiments well visible at HEP and DPHEP conferences
- Data preservation project essential for continuation of HERA experiments efforts

Additional material

Changes in managements

HERMES management changes:

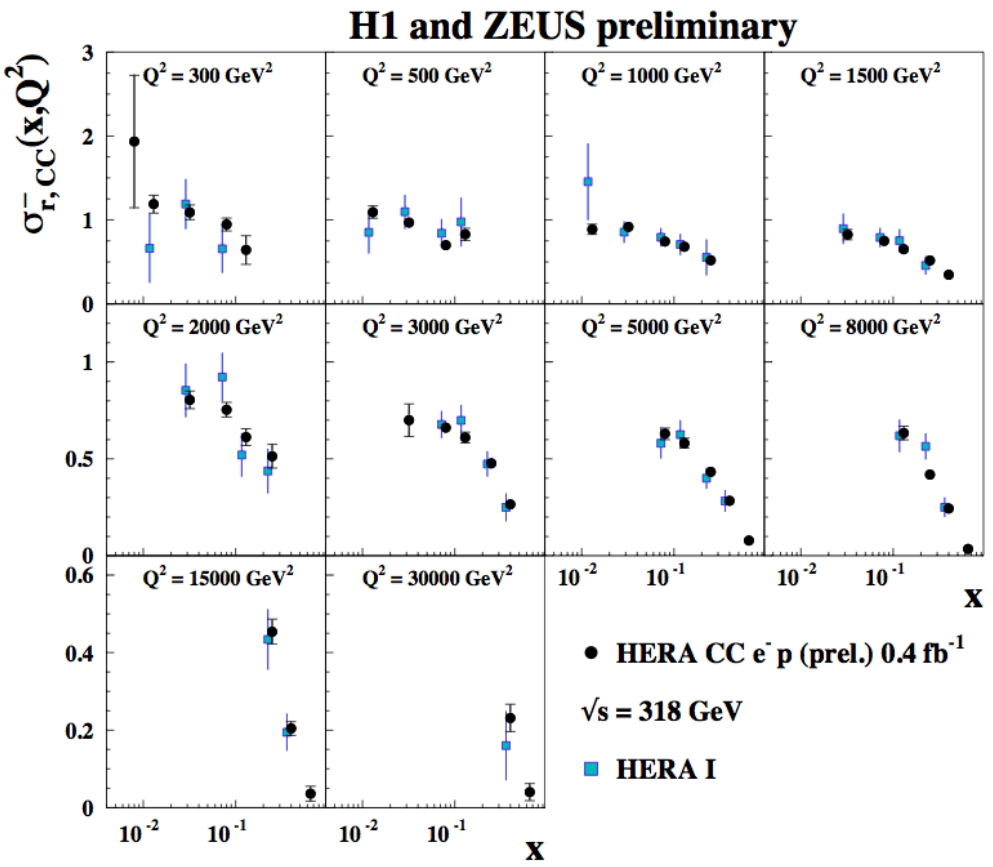
- New analysis coordinator: Charlotte Van Hulse
- New deputy analysis coordinator: TBA

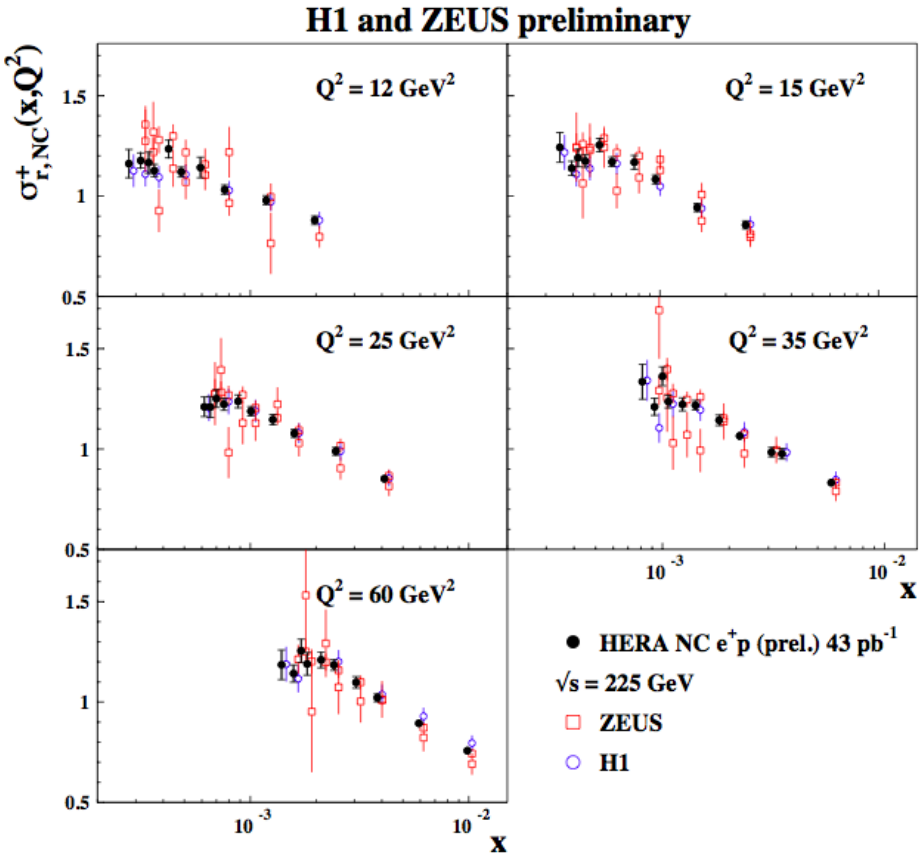
ZEUS management addition:

- Olaf Behnke has join physics coordinators as QCD expert

New kinematic ranges explored

- Kinematic range extended for existing data samples
- Low energies added: CME = 225 GeV and 251 GeV





HERAPDF2.0 (prel.)

$$
\begin{aligned}
xg(x) &= A_g x^{B_g}(1-x)^{C_g} - A'_g x^{B'_g}(1-x)^{C'_g}, \\
xu_v(x) &= A_{u_v} x^{B_{u_v}}(1-x)^{C_{u_v}}\left(1 + D_{u_v}x + E_{u_v}x^2\right), \\
xd_v(x) &= A_{d_v} x^{B_{d_v}}(1-x)^{C_{d_v}}, \\
x\bar{U}(x) &= A_{\bar{U}} x^{B_{\bar{U}}}(1-x)^{C_{\bar{U}}}\left(1 + D_{\bar{U}}x\right), \\
x\bar{D}(x) &= A_{\bar{D}} x^{B_{\bar{D}}}(1-x)^{C_{\bar{D}}}.
\end{aligned}
$$

HERAPDF2.0 (prel.) @ NNLO

- High-Q^2 region well described for NCep and CCep and low energy data for NLO and NNLO