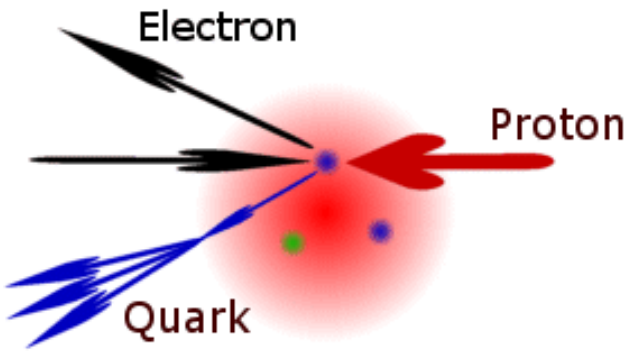
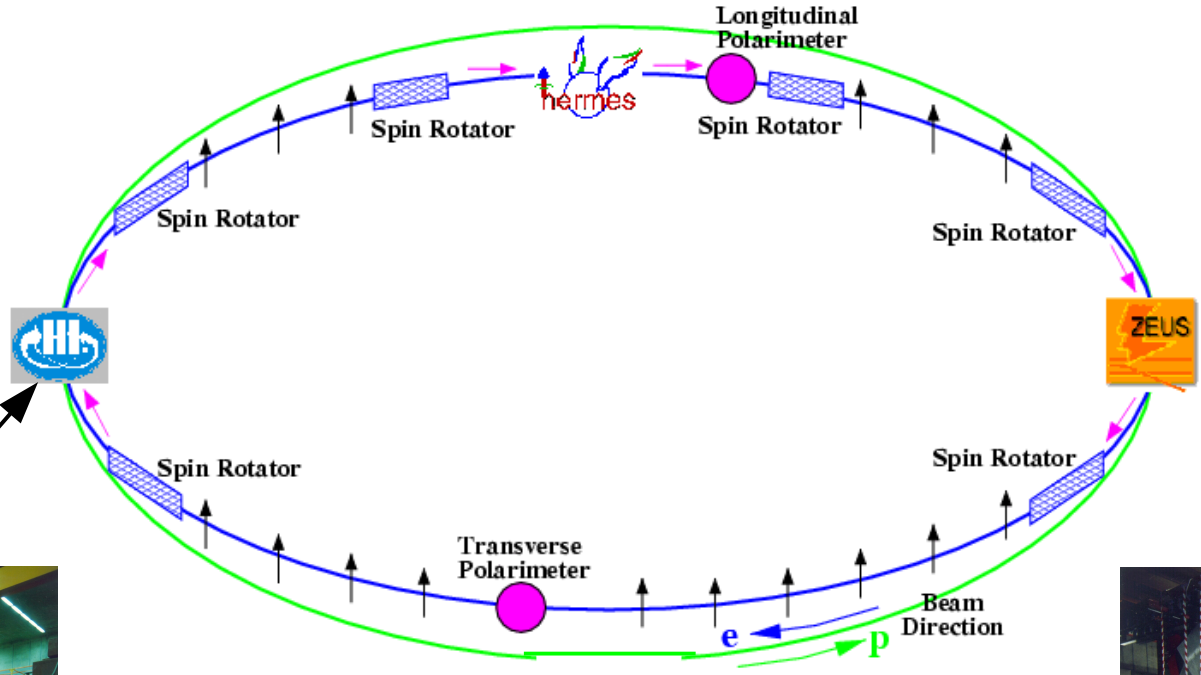
High-Q^2 Neutral Current and Charge Current Cross Sections at HERA

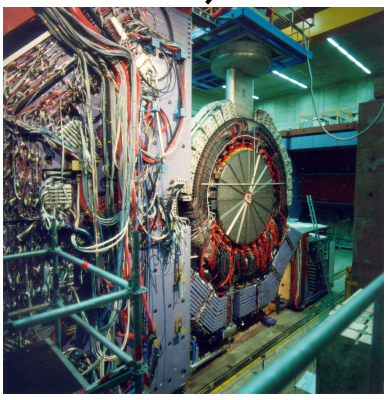
Katarzyna Wichmann
on behalf of
H1 and ZEUS Collaborations

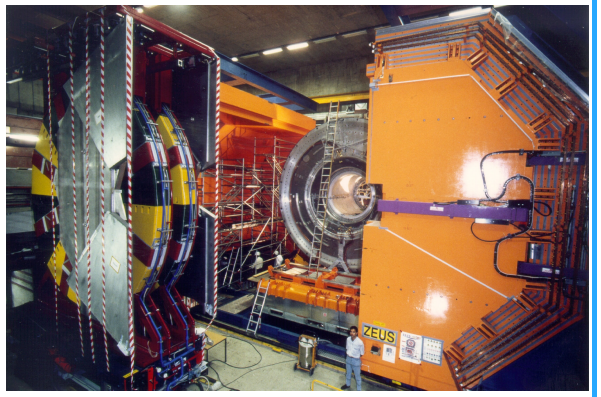
HERA Accelerator



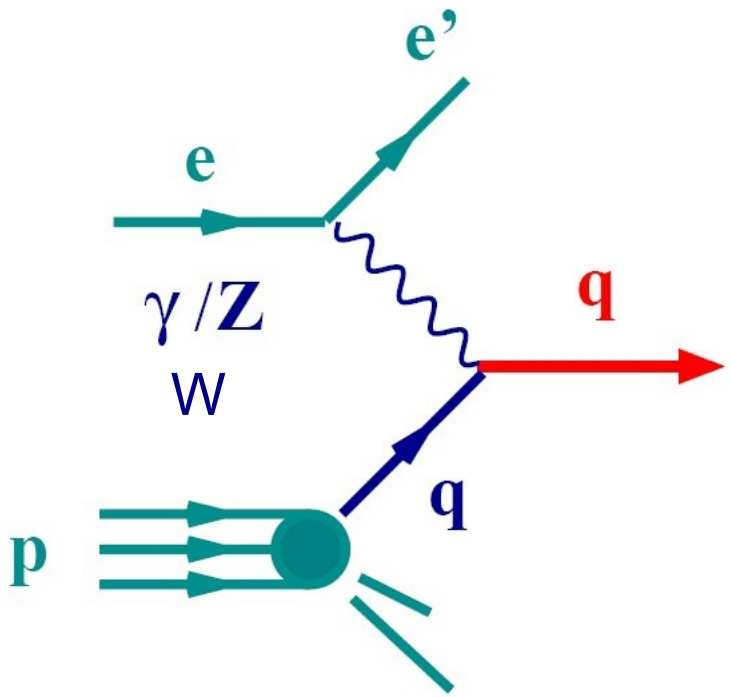
- HERA: ep collider, $\sqrt{s}$ = 320 GeV
- From 2003 polarised lepton beam
- 2 colliding beams experiments: H1 & ZEUS
- collected 0.5 fb^{-1}/exp of luminosity in 1992-2007







Deep Inelastic Scattering @ HERA



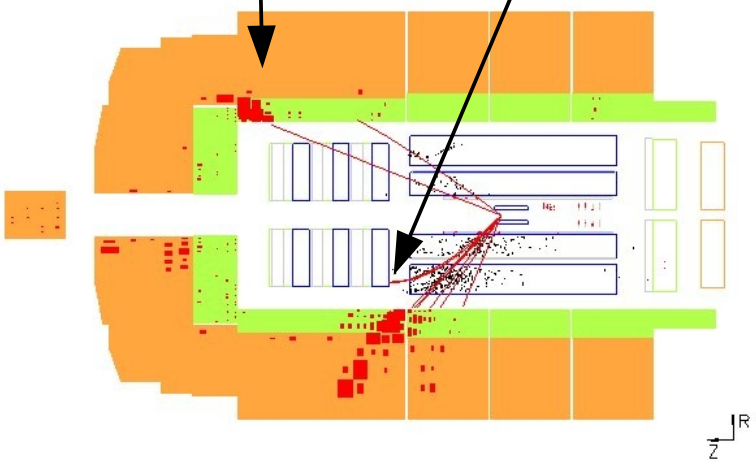
$$Q^2 = -q^2 = -(k - k')^2$$

$$x = \frac{Q^2}{2p \cdot q} \qquad y = \frac{p \cdot q}{p \cdot k}$$

$$s = (p + k)^2 \qquad Q^2 = x \cdot y \cdot s$$

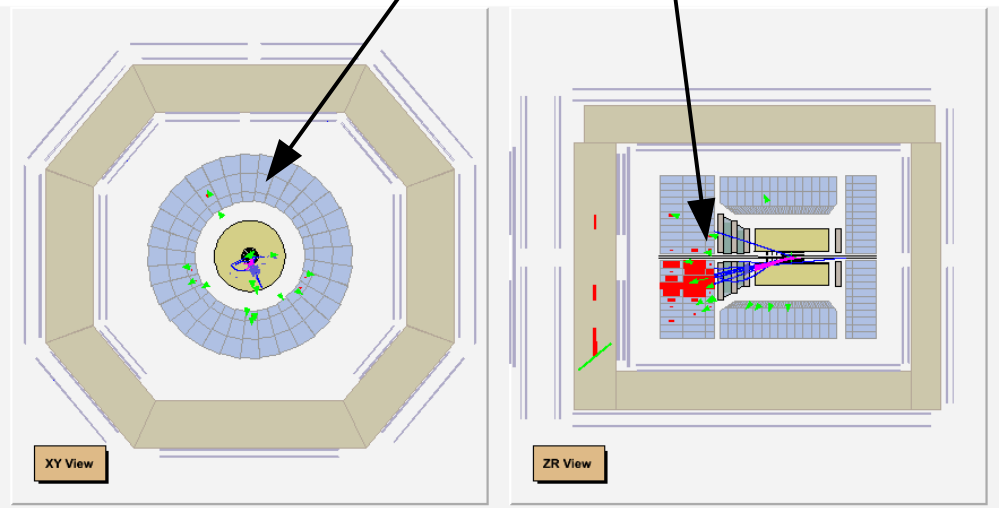
Neutral Current (NC): g, Z exchange

electron + jet



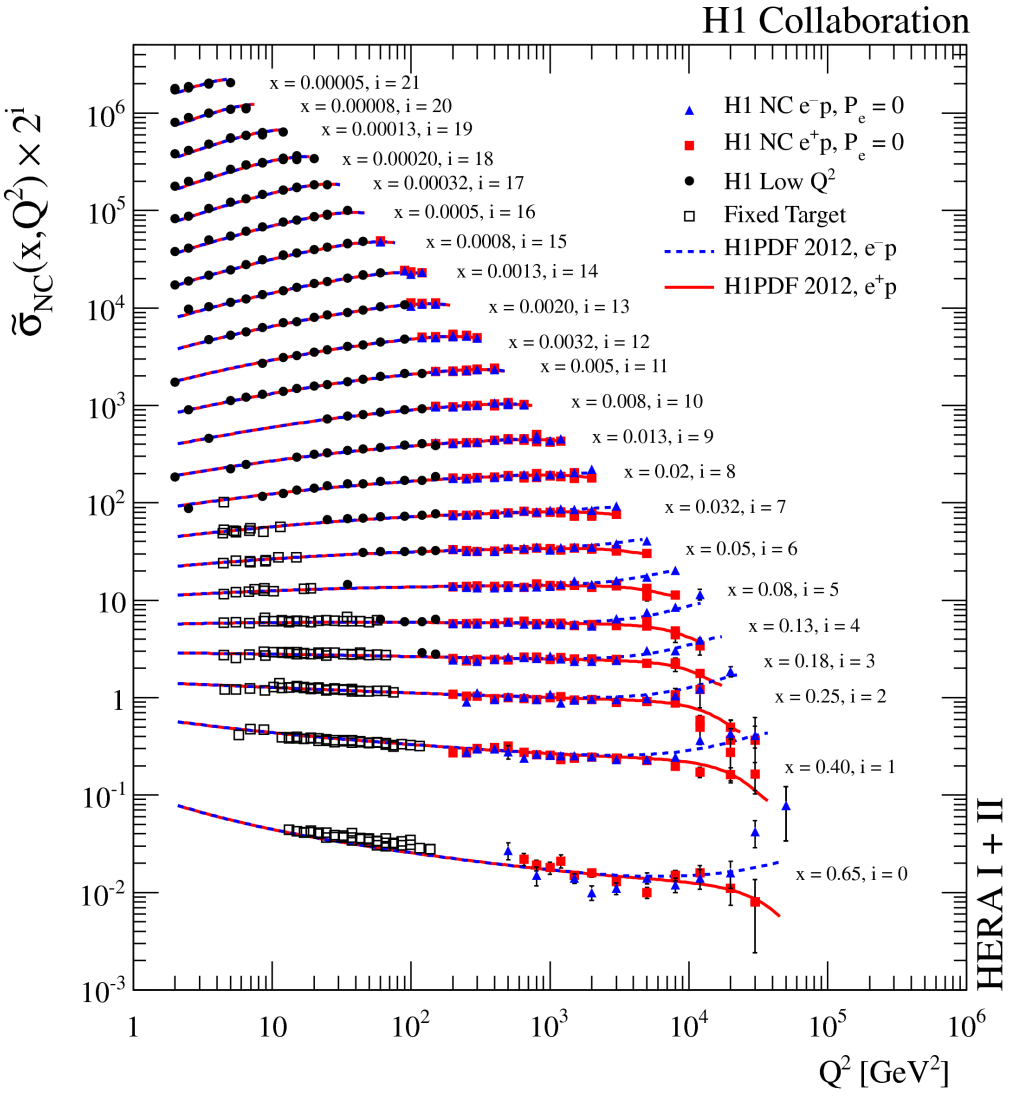
Charge Current (CC): W exchange

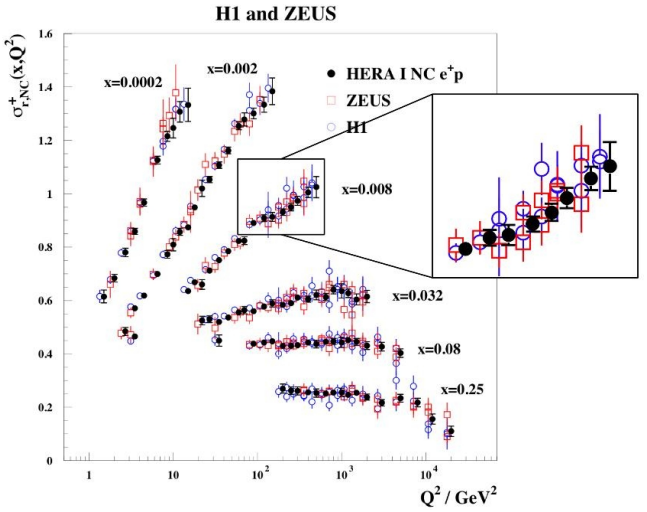
missing p_T + jet

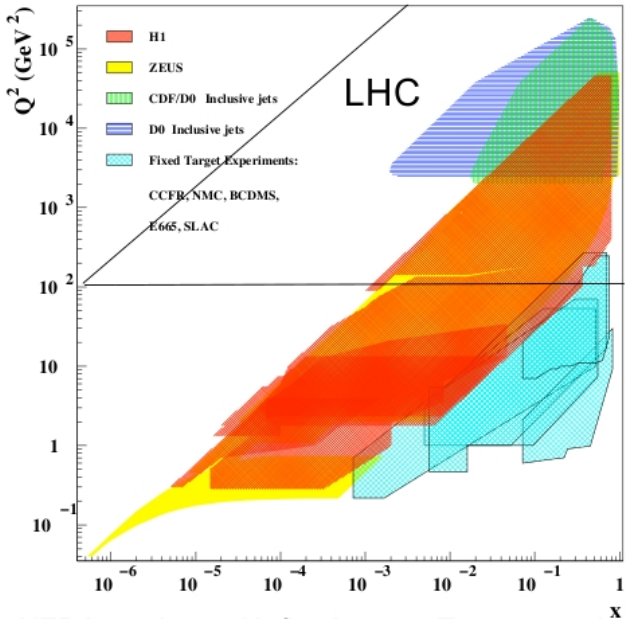


HERA High-Precision DIS Data

- Precise data, room for improvement (combination of H1+ZEUS results)
- Wide kinematic plane, intersecting with Tevatron and LHC







HERA Check List

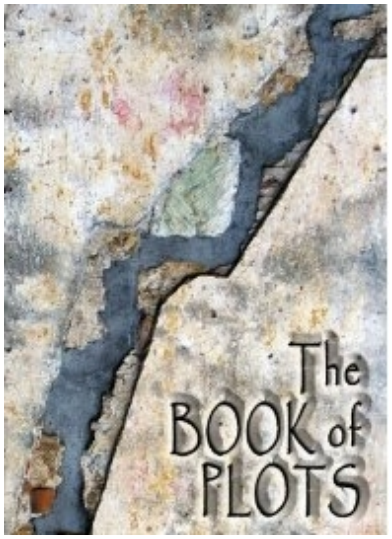
- Precise measurements of high-Q^2 DIS at HERA open fantastic opportunities
  - Checking consistency of Standard Model
  - Constraining and/or extracting parameters (for example PDFs)
  - Detailed comparison with both electroweak and QCD predictions
  - Looking for physics Beyond Standard Model
  - And more...

Some highlights & newest results shown in this talk :)

Bibliography

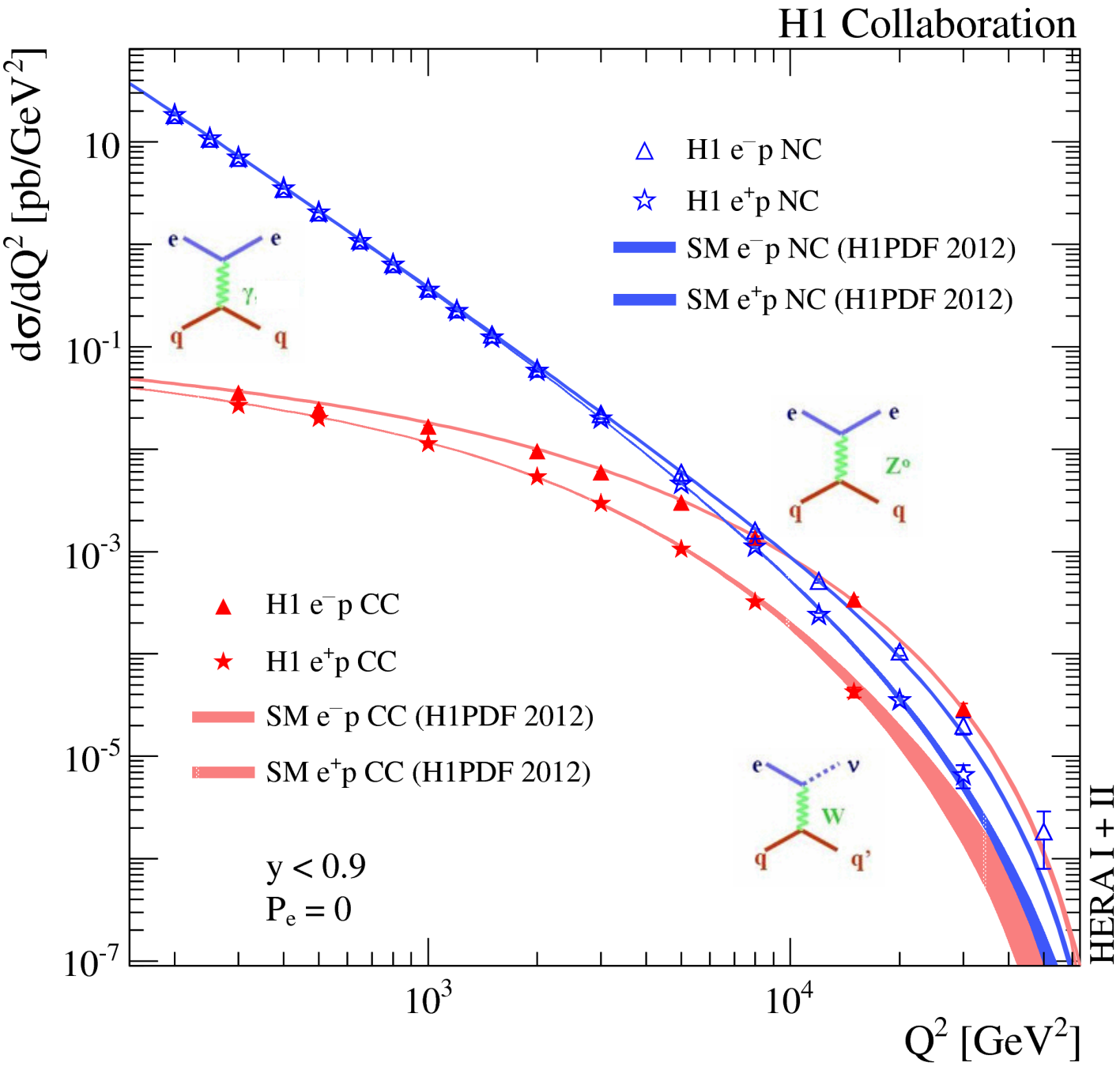
Results Shown Here

- H1 Collaboration, "Inclusive deep inelastic scattering at High Q2 with longitudinally polarised lepton beams at HERA", DESY-12-107, arXiv:1206.7007
- ZEUS Collaboration, "Measurement of high-Q2 neutral current deep inelastic e+p scattering cross sections with a longitudinally polarised positron beam at HERA", DESY-12-145, arXiv:1208.6138
- H1 Collaboration, "Search for First Generation Leptoquarks in ep Collisions at HERA", DESY-11-123, Phys. Lett. B704 (2011) 388
- H1 Collaboration, "Search for Contact Interactions in ep Collisions at HERA", DESY-11-114, Phys. Lett. B705 (2011) 52
- QCD Fit HERAPDF1.5 (Preliminary), H1prelim-10-142, ZEUS-prel-10-018

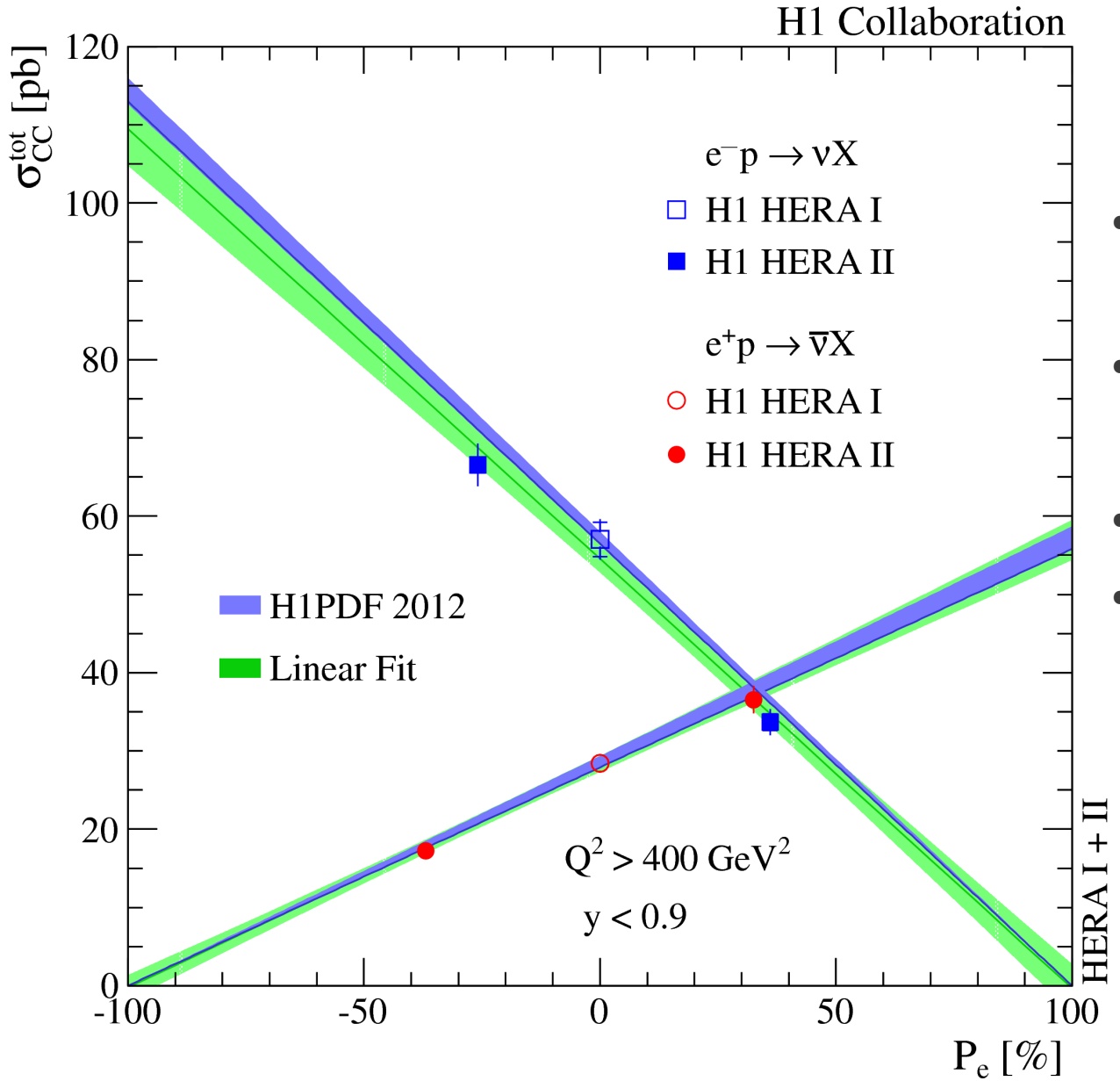


Textbook Plots

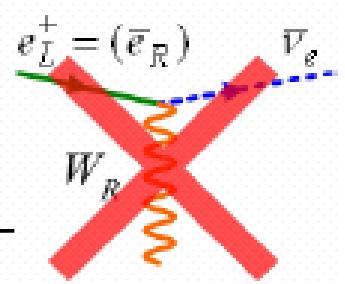
Electroweak Unification



Parity Violation in CC DIS

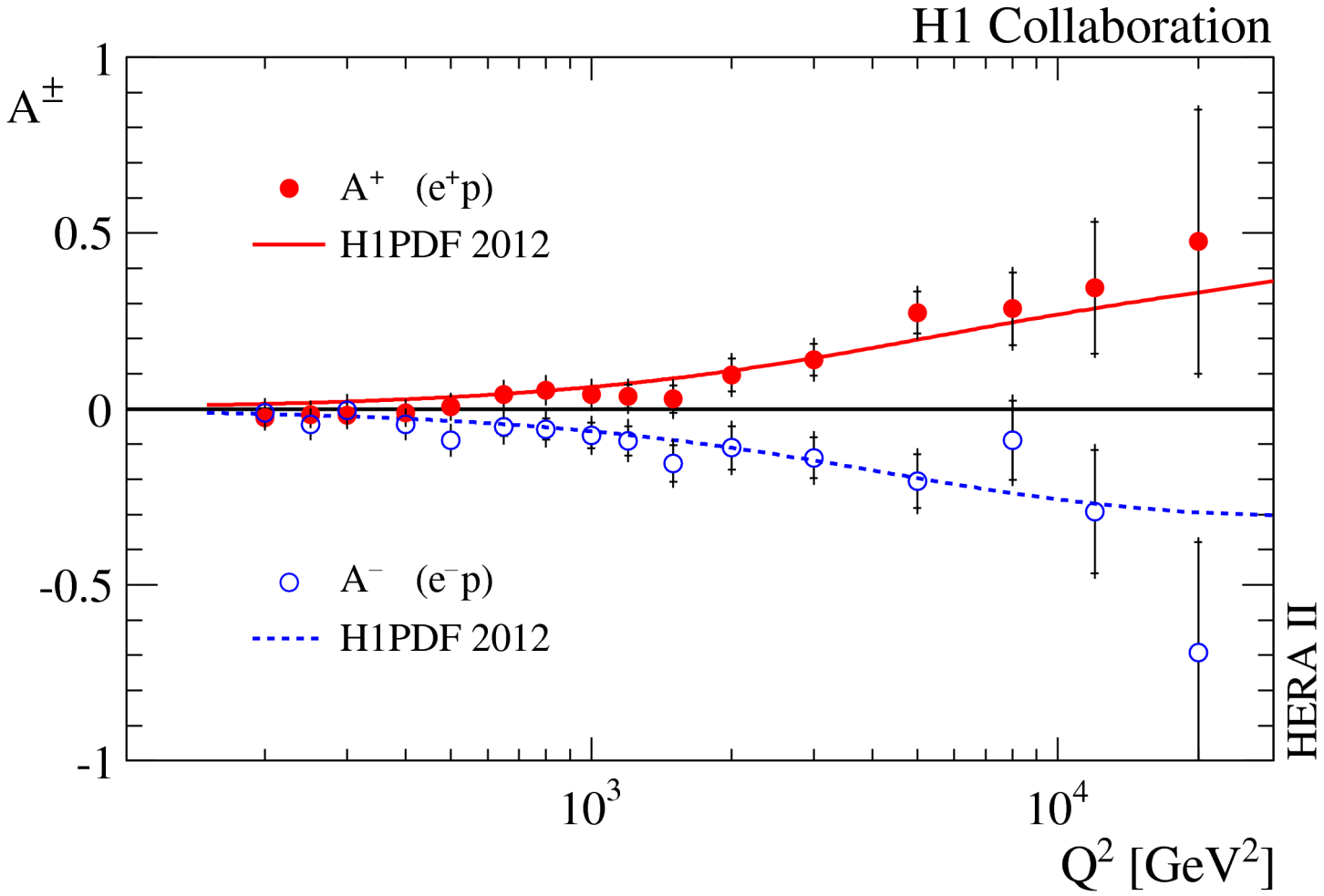


- Chiral structure of EW interactions probed
- SM CC:
  $\sigma_{cc}^{\pm}(P_e) = (1 \pm P_e)\sigma_{cc}^{\pm}(0)$
- Agrees with theory
- Rules out $W_R < 200$ GeV

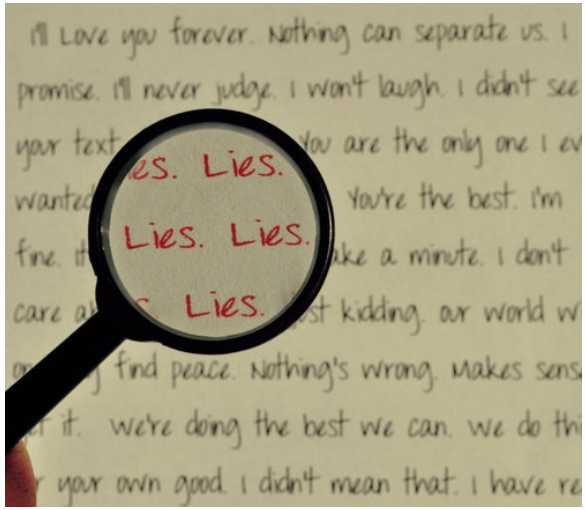


Parity Violation in NC DIS

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



Direct measure of parity violation effect in NC DIS

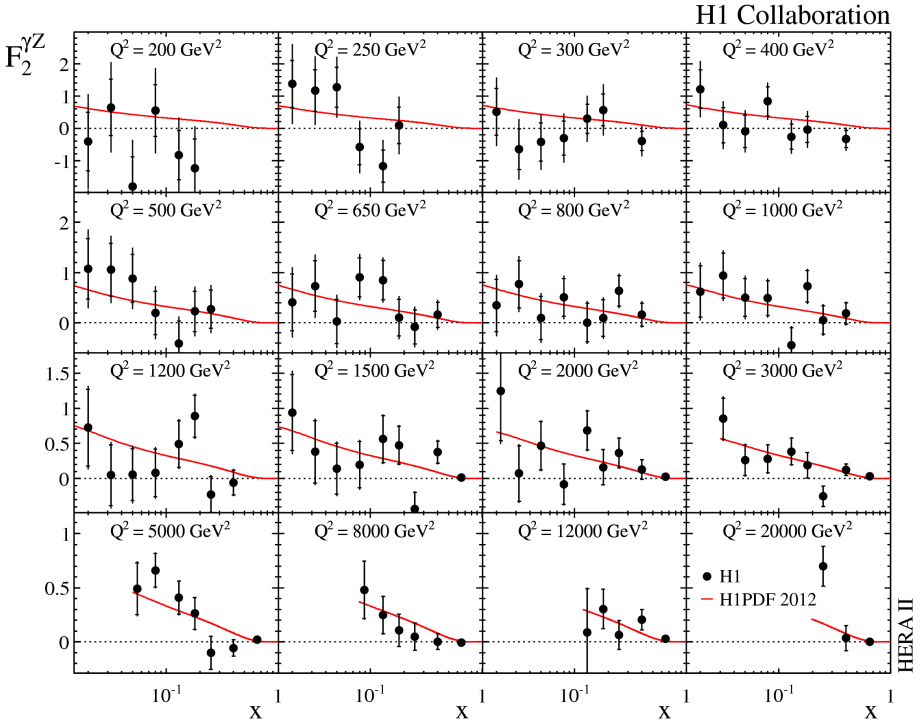

I'll Love you forever. Nothing can separate us. I
promise. I'll never judge. I won't laugh. I didn't see
your text
You are the only one I ev
wanted
You're the best. I'm
fine. I
Lies. Lies.
like a minute. I don't
care a
Lies.
st kidding. our world w
find peace. Nothing's wrong. Makes sens
it. We're doing the best we can. We do thi
your own good. I didn't mean that. I have re

Closer Look

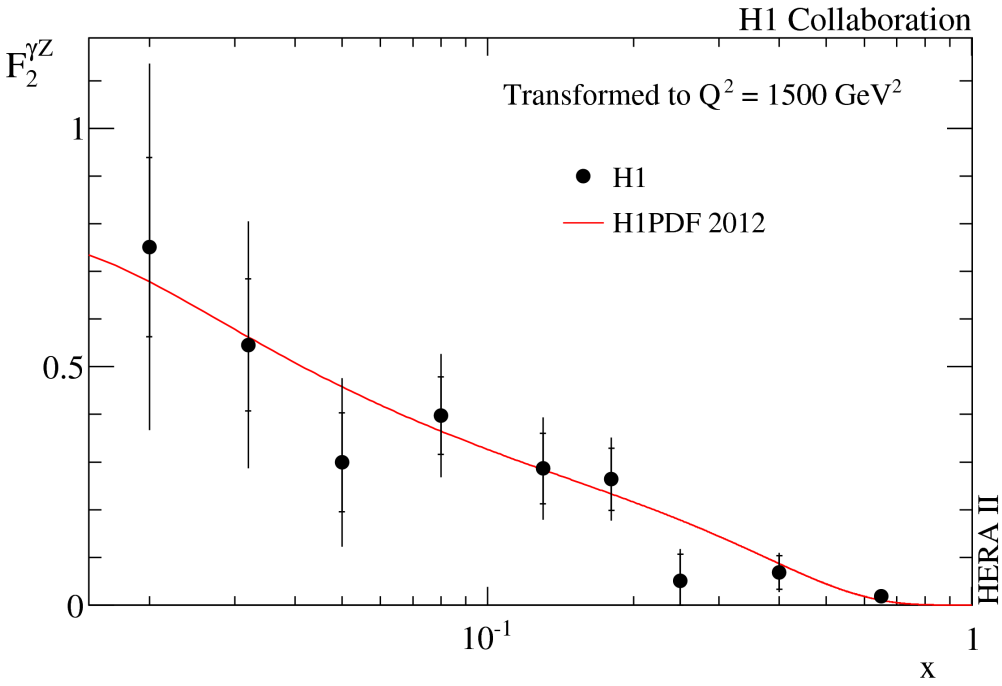
Quark-Antiquark Distribution

$$\frac{\sigma^{\pm}(P_L^{\pm}) - \sigma^{\pm}(P_R^{\pm})}{P_L^{\pm} - P_R^{\pm}} = \frac{\kappa Q^2}{Q^2 + M_Z^2}\left[\mp a_e F_2^{\gamma Z} + \frac{Y_-}{Y_+} v_e x F_3^{\gamma Z} - \frac{Y_-}{Y_+}\frac{\kappa Q^2}{Q^2 + M_Z^2}(v_e^2 + a_e^2) x F_3^Z\right]$$

Parity violating structure function $F_2^{\gamma Z}$ extracted from polarized NC cross sections



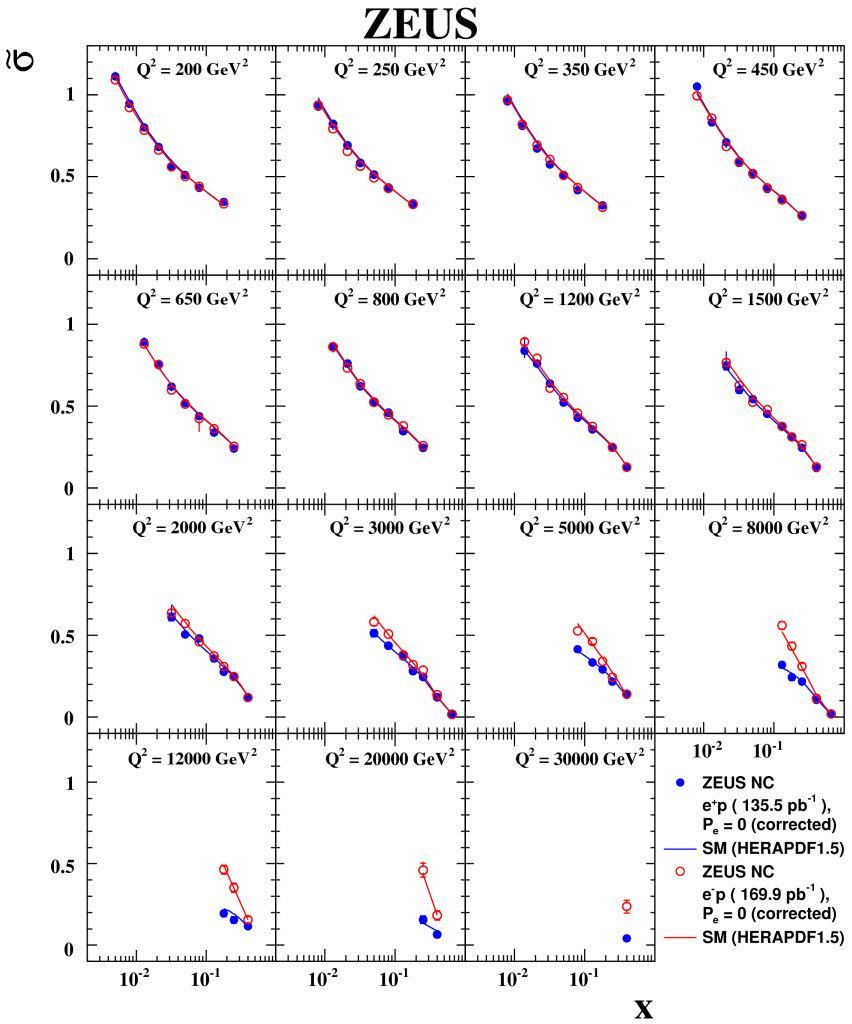
$F_2^{\gamma Z} \sim$ q+qbar



First measurement of $F_2^{\gamma Z}$

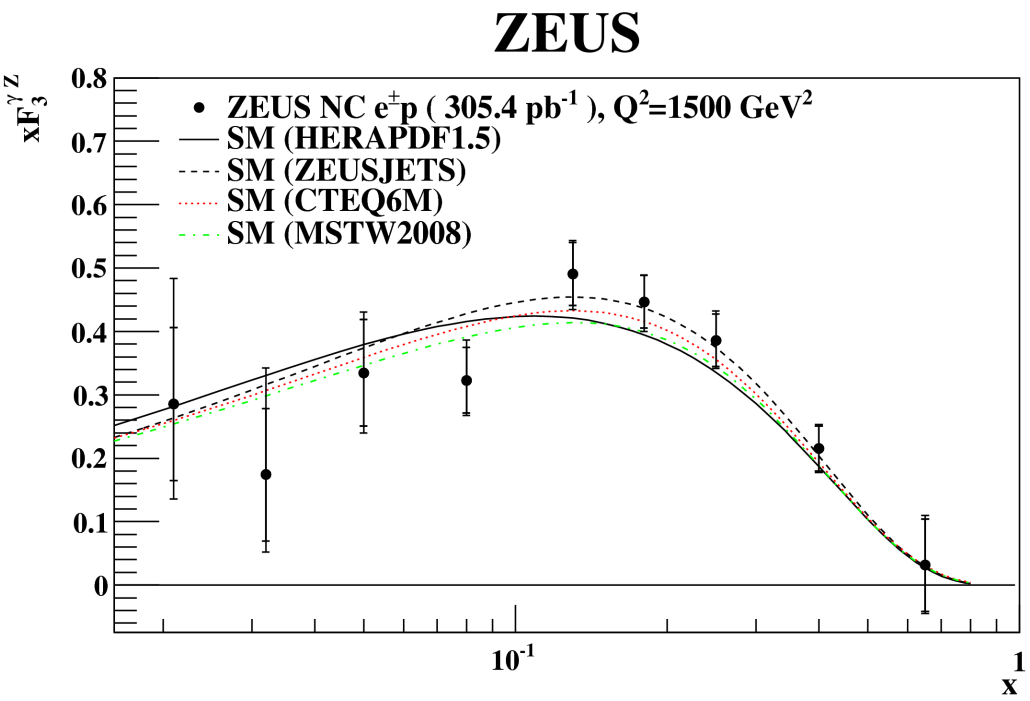
Valence Distribution

Difference in NC e^+p and e^-p used to extract $xF_3^{\gamma Z}$



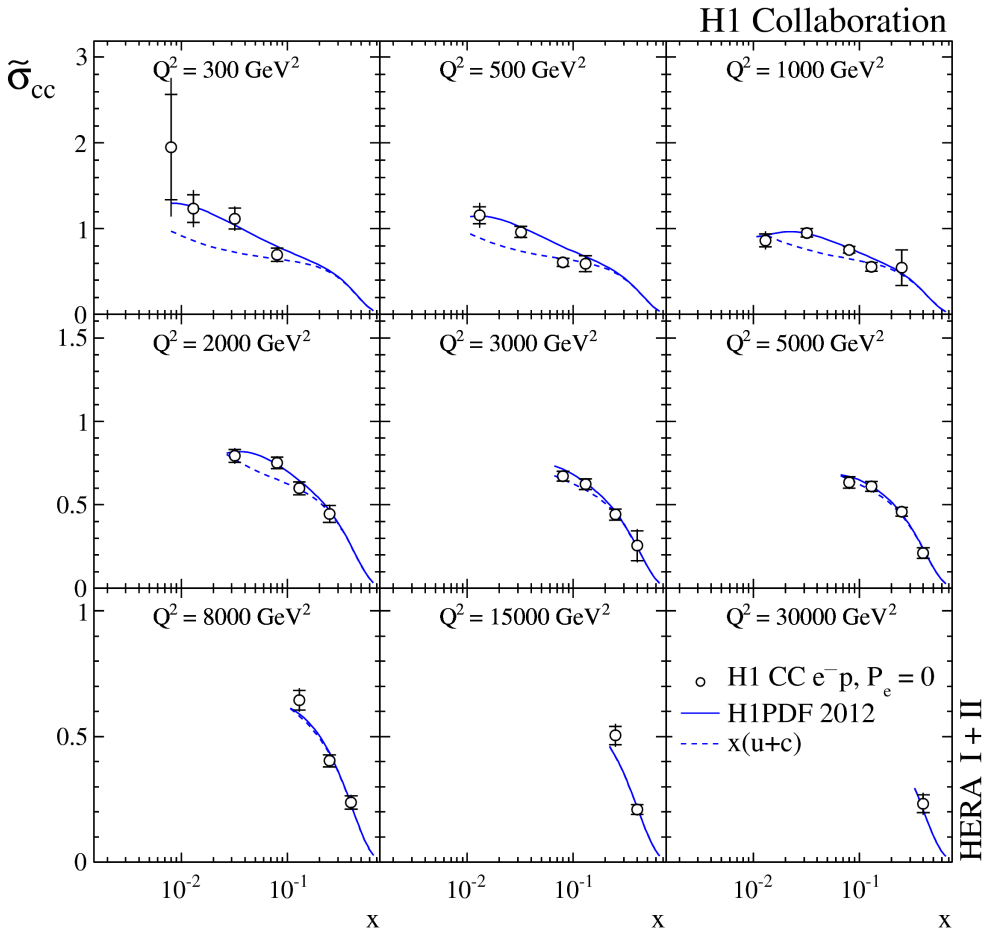
x dependence of $xF_3^{\gamma Z}$ reflects parton composition

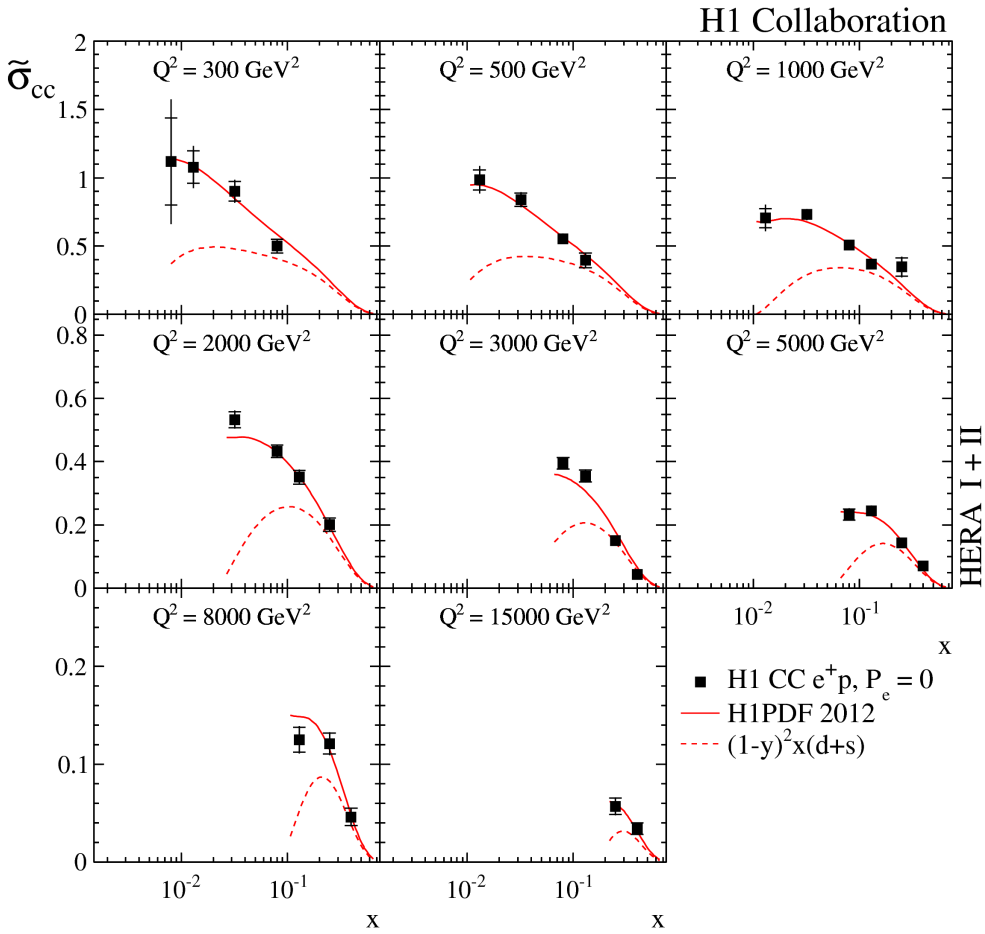
$xF_3^{\gamma Z} \sim xq_v$



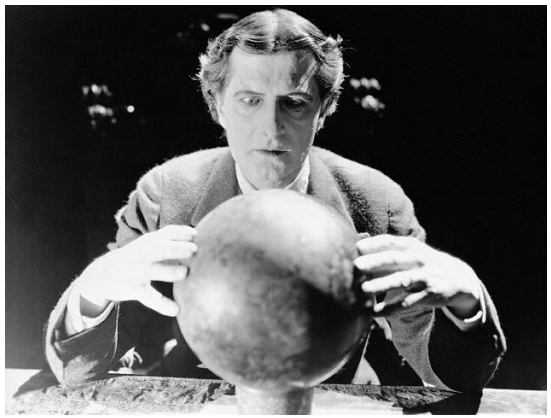
Good description by various PDFs

Up/Down Quark Separation





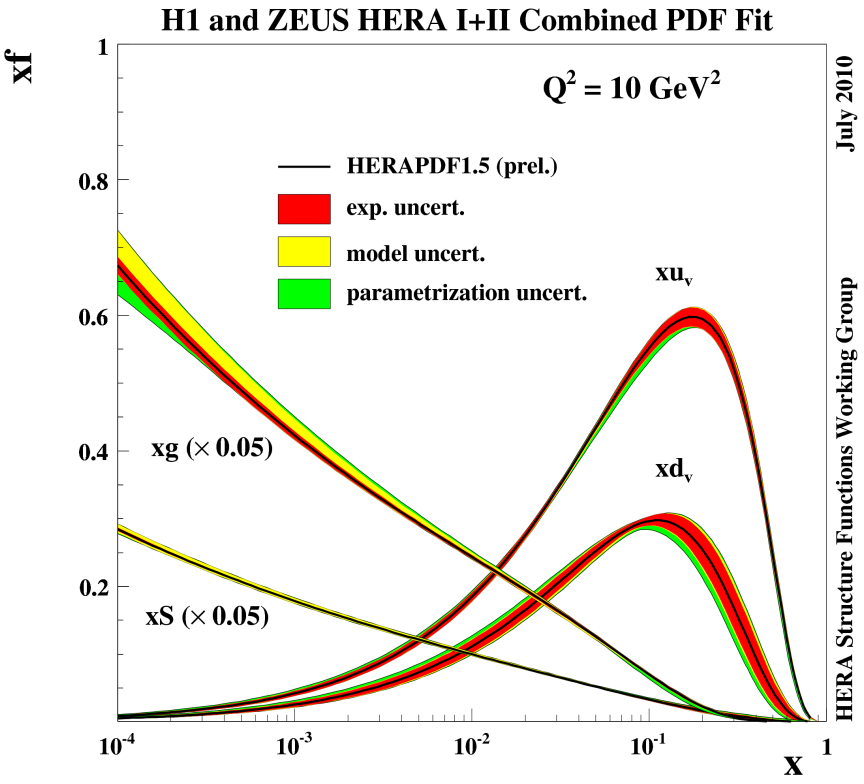
CC data can be used to separate up/down distributions in proton

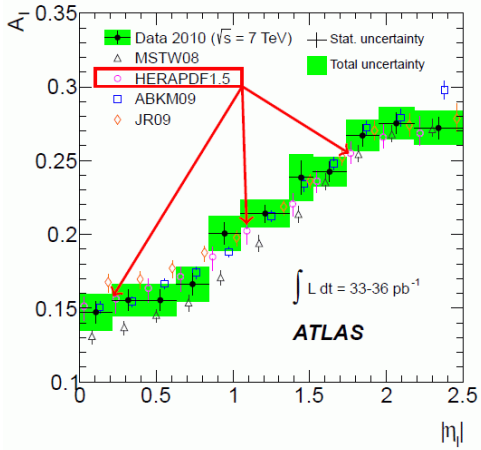


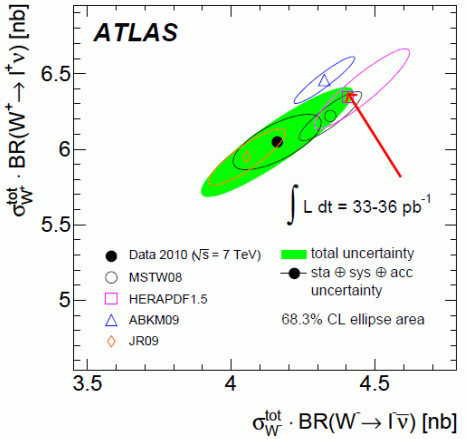
Predictive Power

HERAPDF → Future

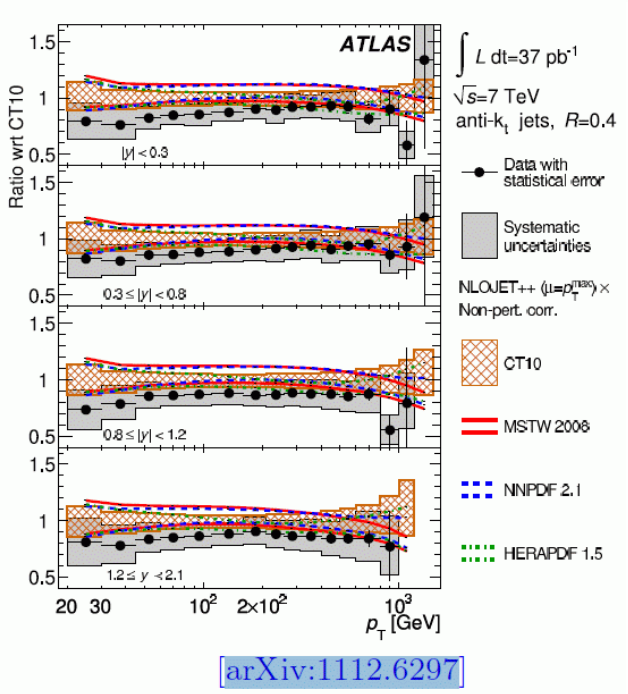
- H1-ZEUS NC, CC, e^+p, e^-p data used in global fits: HERAPDFs
  → Talk by P. Belov







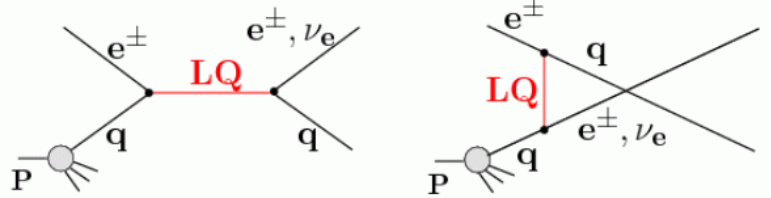
[CERN-PH-EP-2011-143]



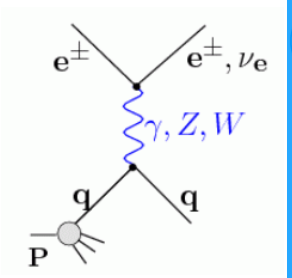
[arXiv:1112.6297]

PDFs extracted from HERA alone provide good description of LHC data

Exploring Unknown



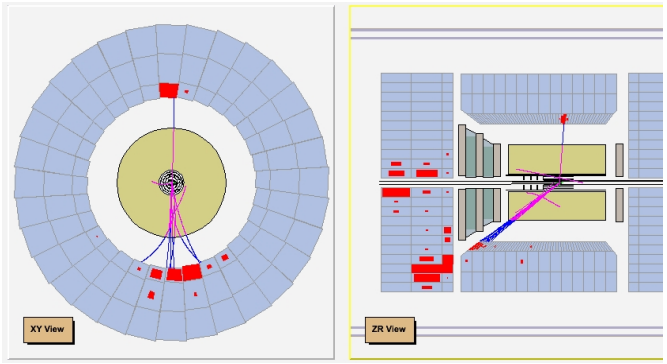
Leptoquarks @ HERA



LQs @ HERA have the same initial and final state as NC/CC DIS

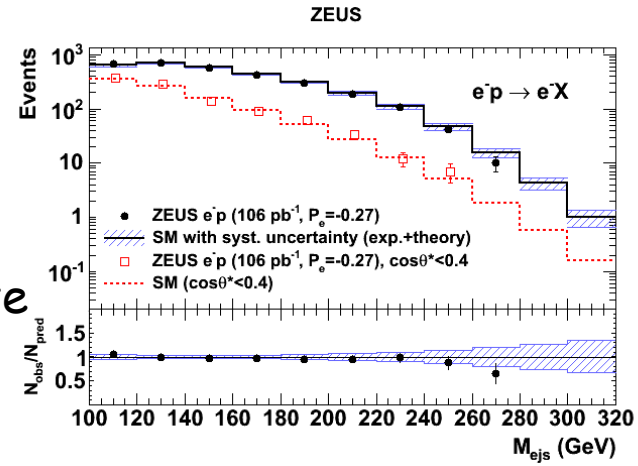
→ Look for LQ-deviations from SM in NC & CC distributions

NC

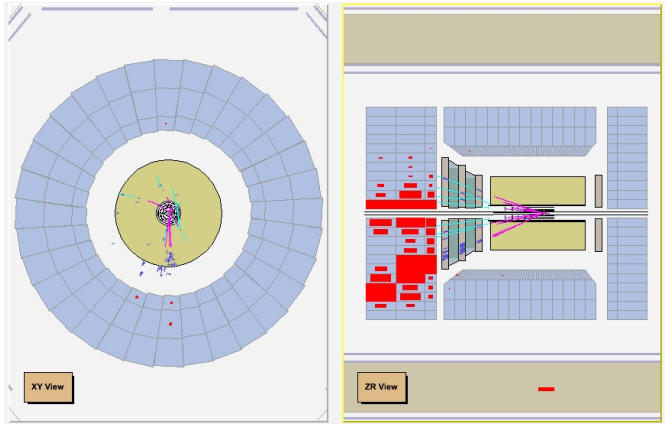


$M_{e\text{-jet}}$

e+jet final state

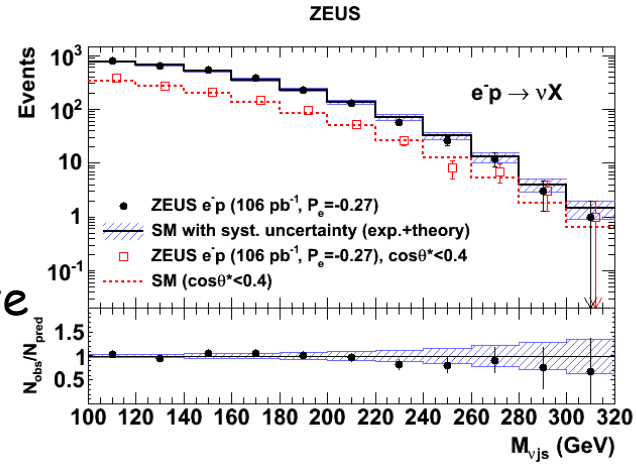


CC



$M_{\upsilon\text{-jet}}$

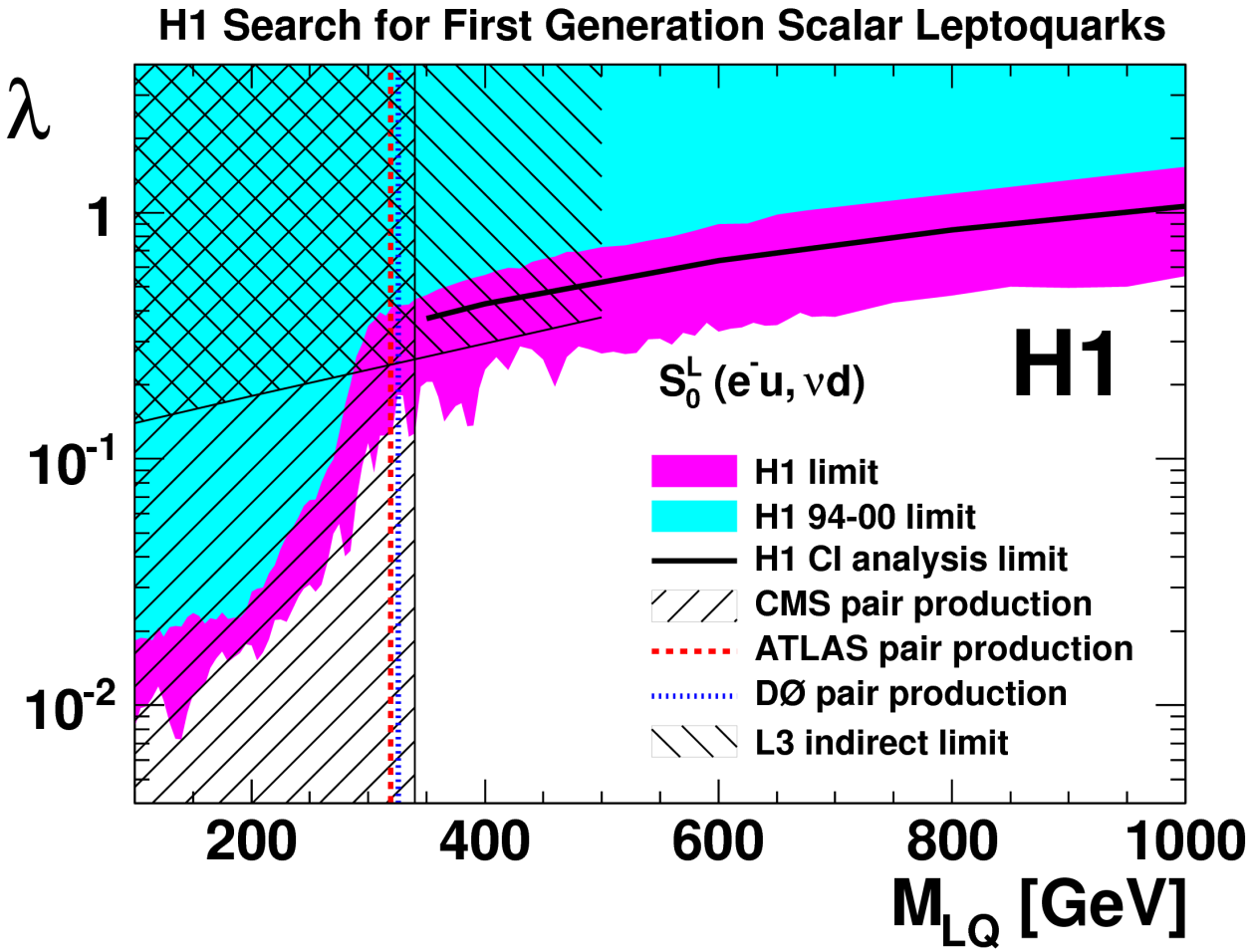
υ+jet final state



Full HERA statistics used for limit setting

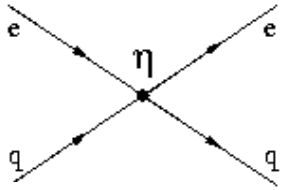
Limits for LQs

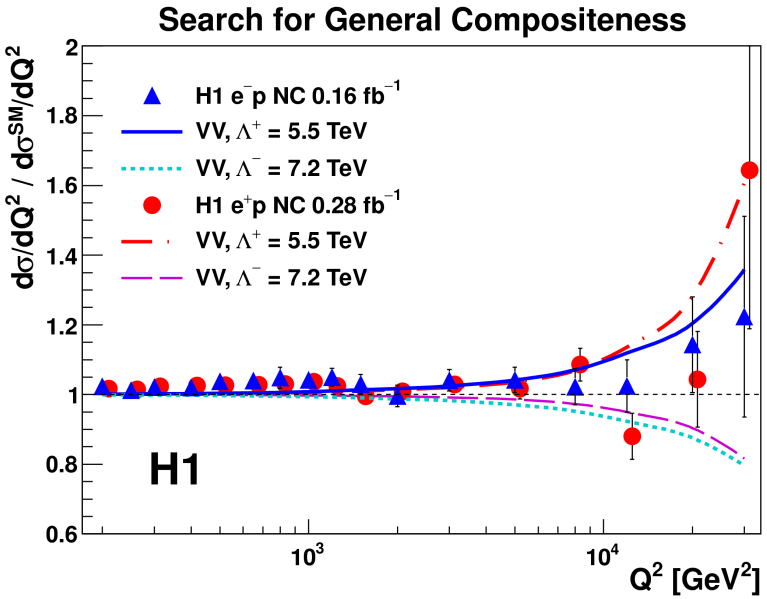
- New results from H1 & ZEUS using full HERA luminosity of 0.5 fb^{-1}
- No evidence of LQs sen → **various limits set as function of LQ mass**

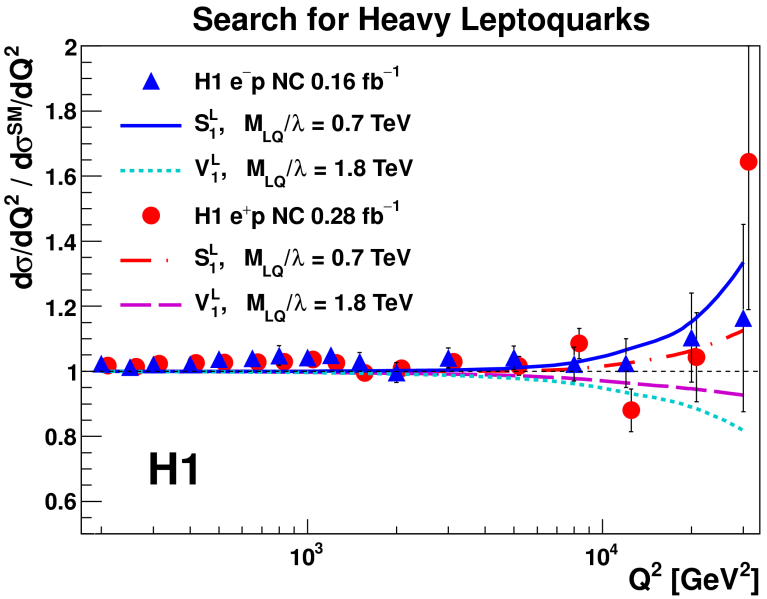


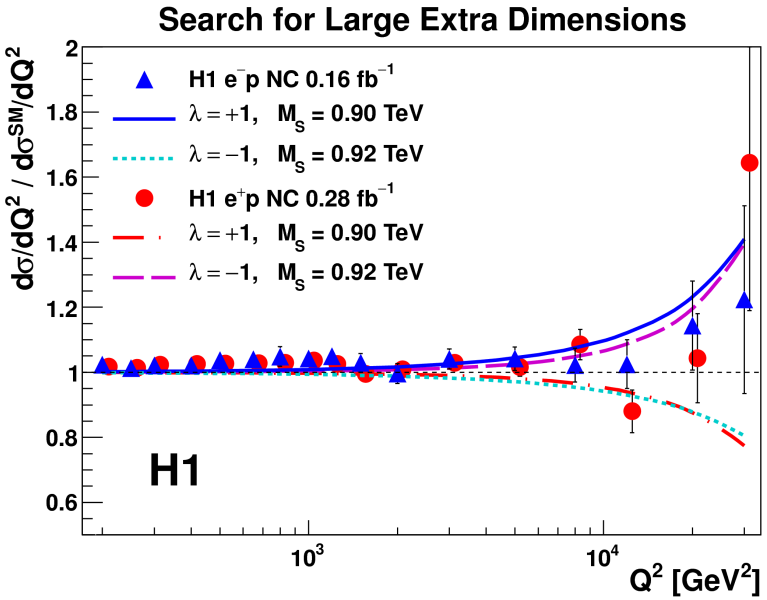
HERA limits are the best to date at high masses

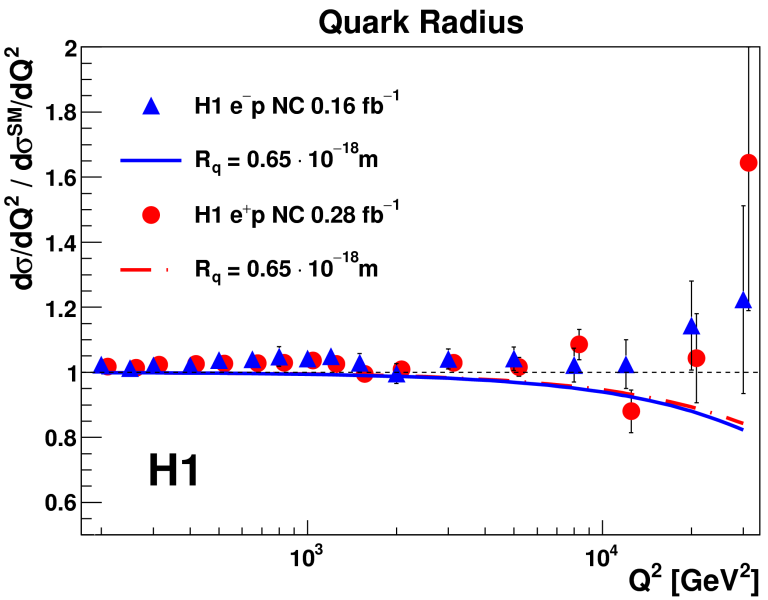
Searches for Contact Interactions











No deviation from SM found – limits set

Summary

HERA keeps delivering high-precision high-Q^2 NC & CC data and keeps exploring it in extensive physics program