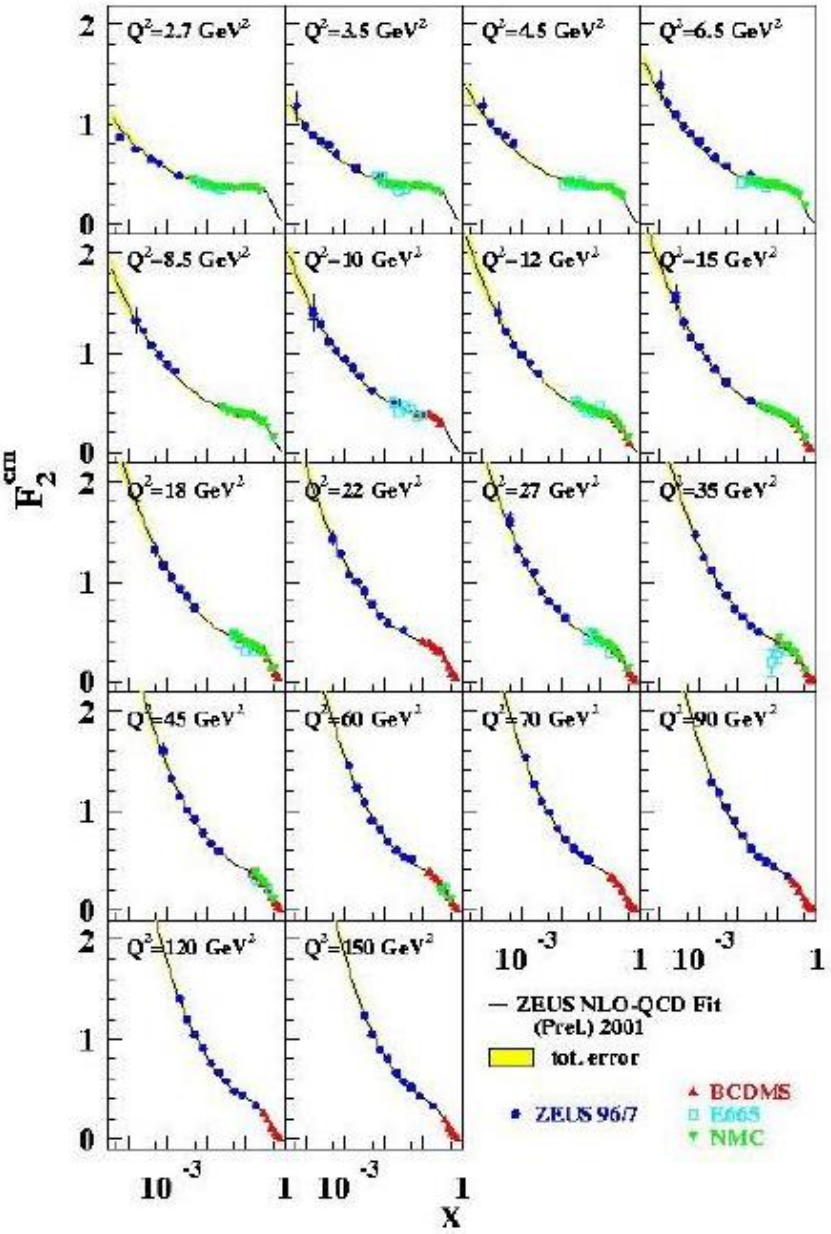
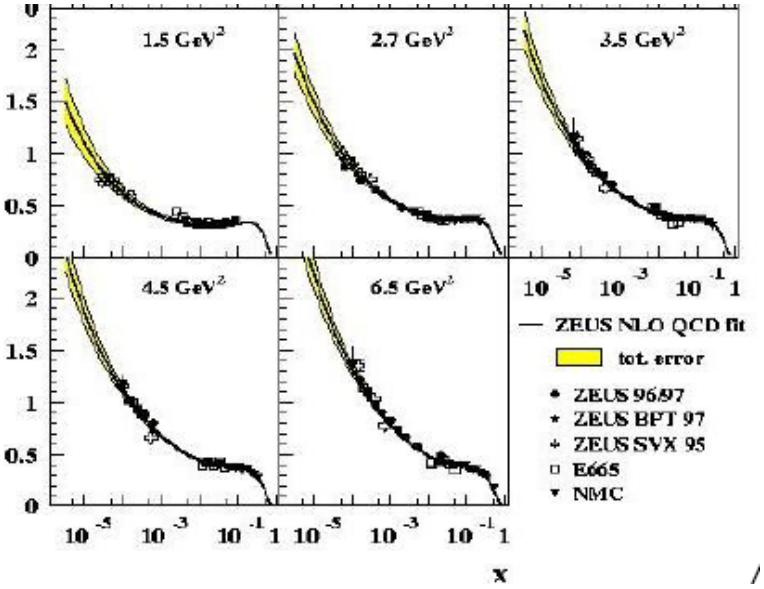
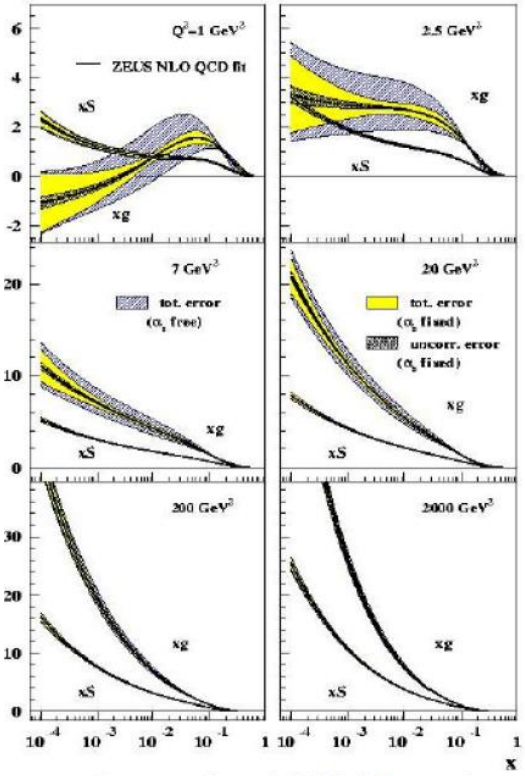
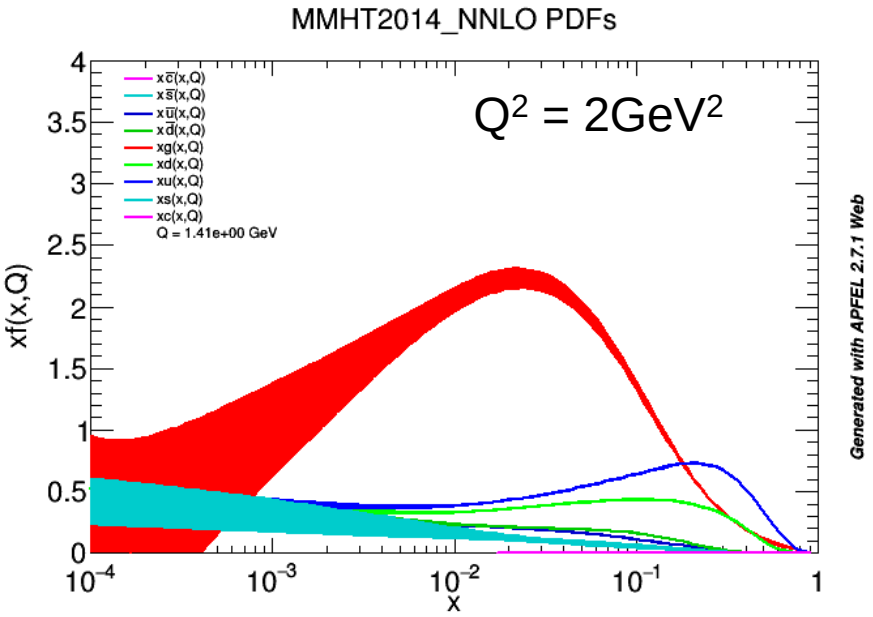
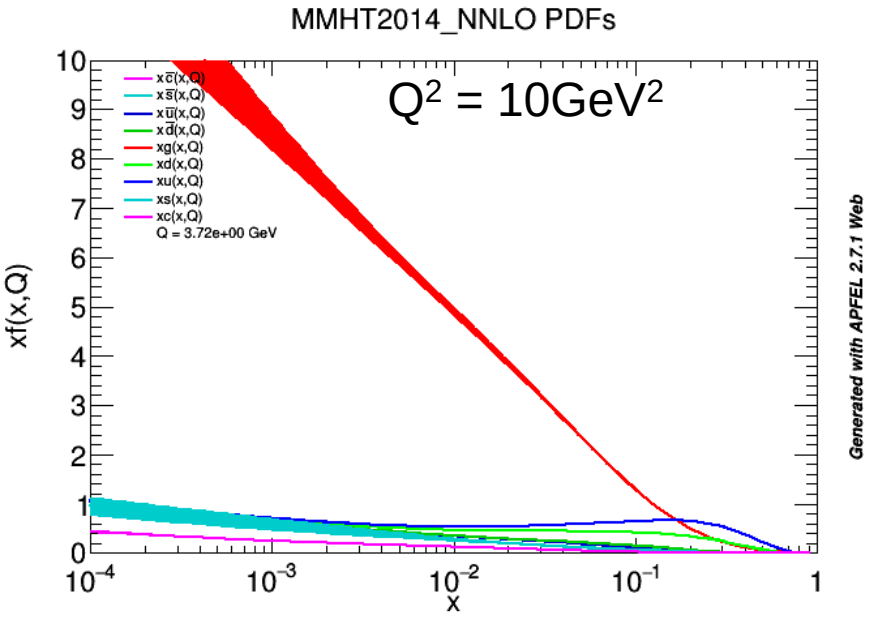

F_2^{em}
Q^2=2.7 GeV^2
Q^2=3.5 GeV^2
Q^2=4.5 GeV^2
Q^2=6.5 GeV^2
Q^2=8.5 GeV^2
Q^2=10 GeV^2
Q^2=12 GeV^2
Q^2=15 GeV^2
Q^2=18 GeV^2
Q^2=22 GeV^2
Q^2=27 GeV^2
Q^2=35 GeV^2
Q^2=45 GeV^2
Q^2=60 GeV^2
Q^2=70 GeV^2
Q^2=90 GeV^2
Q^2=120 GeV^2
Q^2=150 GeV^2
x
— ZEUS NLO-QCD Fit (PreL) 2001
tot. error
ZEUS 96/7
BCDMS
E665
NMC


1.5 GeV^2
2.7 GeV^2
3.5 GeV^2
4.5 GeV^2
6.5 GeV^2
x
— ZEUS NLO QCD fit
tot. error
ZEUS 96/97
ZEUS BPT 97
ZEUS SVX 95
E665
NMC


Q^2=1 GeV^2
— ZEUS NLO QCD fit
2.5 GeV^2
7 GeV^2
tot. error
(α_s free)
20 GeV^2
tot. error
(α_s fixed)
uncorr. error
(α_s fixed)
200 GeV^2
2000 GeV^2
xS
xg
x


MMHT2014_NNLO PDFs
$Q^2 = 2GeV^2$
$x\bar{c}(x,Q)$
$x\bar{s}(x,Q)$
$x\bar{u}(x,Q)$
$x\bar{d}(x,Q)$
xg(x,Q)
xd(x,Q)
xu(x,Q)
xs(x,Q)
xc(x,Q)
Q = 1.41e+00 GeV
xf(x,Q)
x
Generated with APFEL 2.7.1 Web

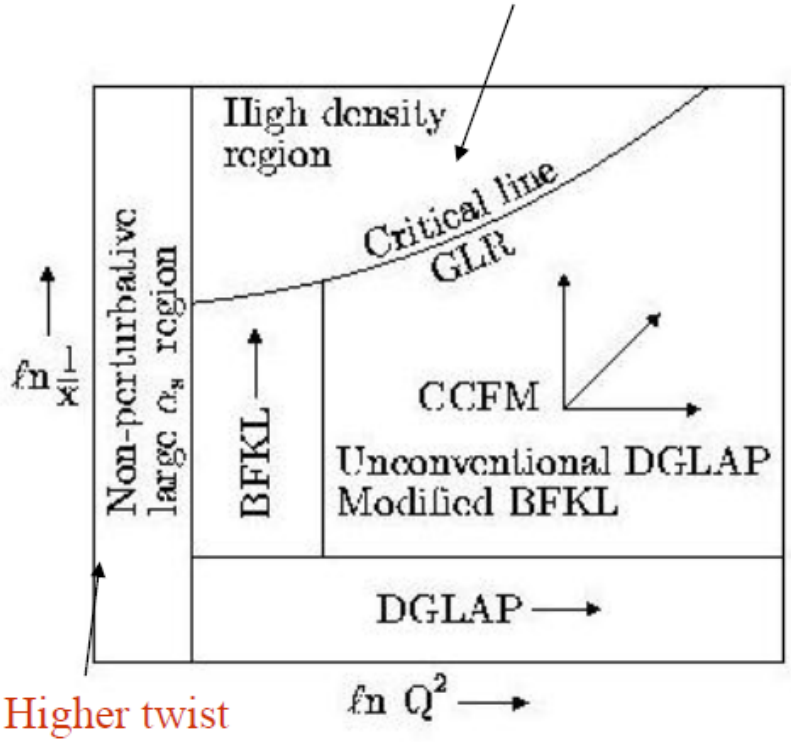

MMHT2014_NNLO PDFs
$Q^2 = 10GeV^2$
$x\bar{c}(x,Q)$
$x\bar{s}(x,Q)$
$x\bar{u}(x,Q)$
$x\bar{d}(x,Q)$
xg(x,Q)
xd(x,Q)
xu(x,Q)
xs(x,Q)
xc(x,Q)
Q = 3.72e+00 GeV
xf(x,Q)
x
Generated with APFEL 2.7.1 Web

There are various reasons to worry that conventional LO and NLO $\ln(Q^2)$ summations – as embodied in the DGLAP equations may be inadequate

It was a surprise to see F_2 steep at small x - even for very very low Q^2, $Q^2 \sim 1$ GeV^2

1. Should perturbative QCD work? α_s is becoming large - α_s at $Q^2 \sim 1$ GeV^2 is ~ 0.4
2. There hasn't been enough lever arm in Q^2 for evolution, but even the starting distribution is steep- **the HUGE rise at low-x makes us think**
3. there **should be** $\ln(1/x)$ resummation (BFKL) as well as the traditional $\ln(Q^2)$ DGLAP resummation- BFKL predicted $F_2(x,Q^2) \sim x^{-\lambda_s}$, with λ_s=0.5, even at low Q^2
4. and/or there should be non-linear high density corrections for $x < 5\ 10^{-3}$

Colour Glass Condensate, JIMWLK, BK



Higher twist

Extending the conventional DGLAP equations across the x, Q2 plane

Plenty of debate about the positions of these lines!