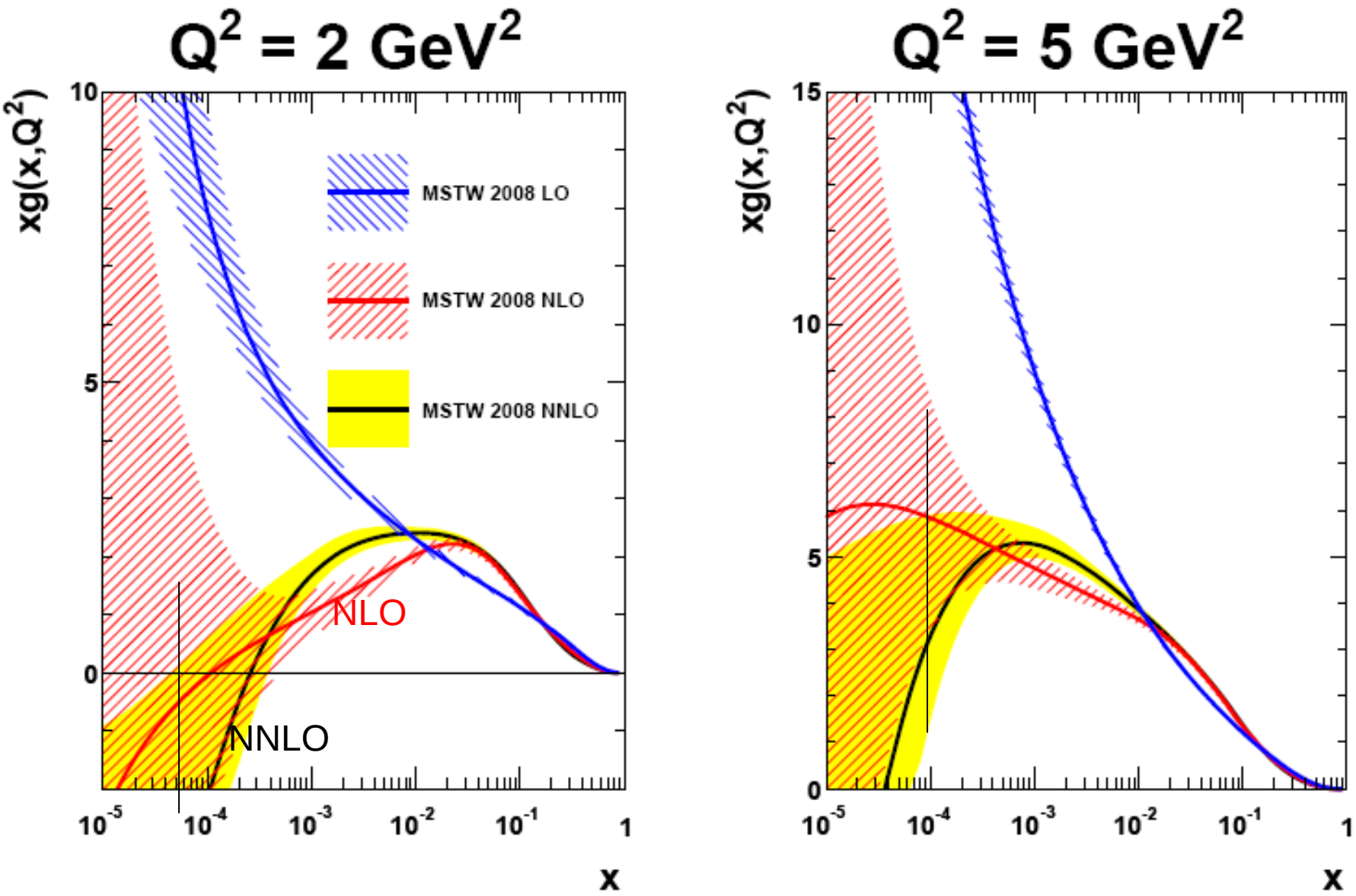
Low x, low Q^2 gluon from MSTW 2008



The low x gluon

Beyond LO the gluon does not have a simple probabilistic interpretation --- and can be negative --- particularly at small x where HO perturbative corrections are large.

At small-x there is large order-by-order change in the splitting functions, particularly P_{qg}, making the evolution of quarks quicker and the NLO, NNLO… gluons smaller (and valence-like). Including higher twists in F_2 gives little change.

F_L

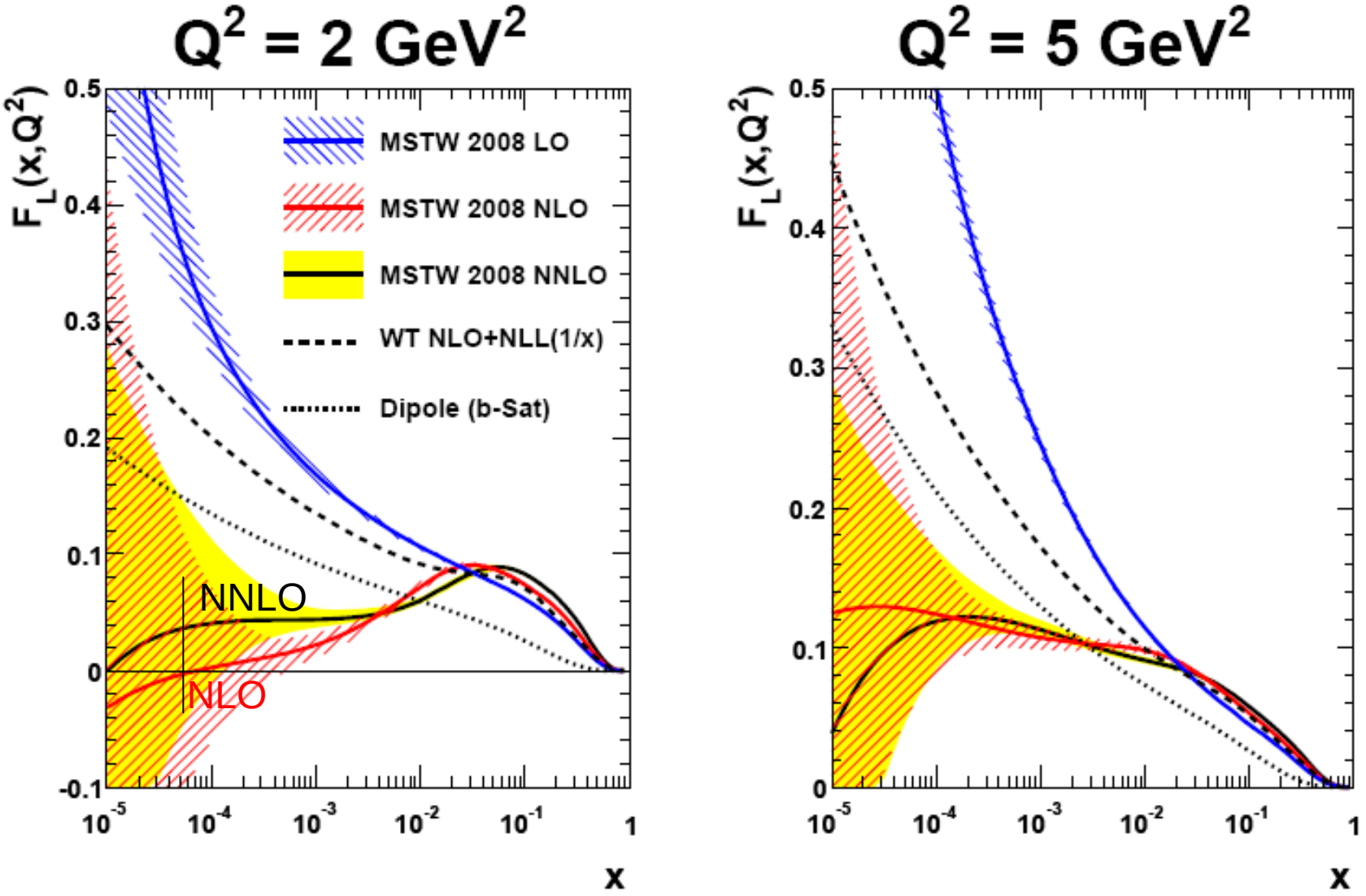
The coeff. fn. $C_{L,g}^{NNLO}$ gives a large positive contribution to F_L and counters the decrease in the small-x gluon.

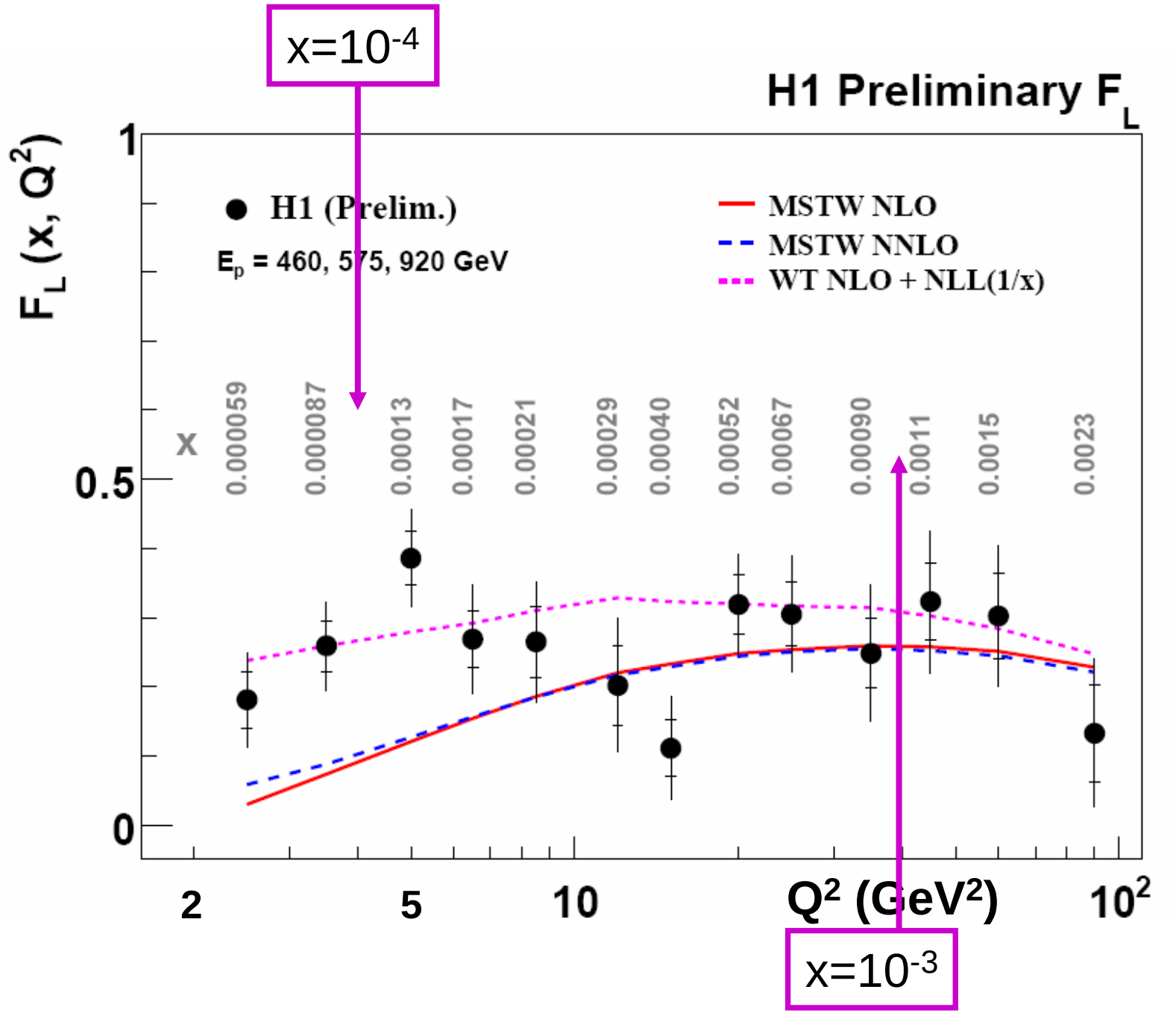
The lack of perturbative stability of F_L may be due to HT contributions from renormalons in the quark sector (TW):

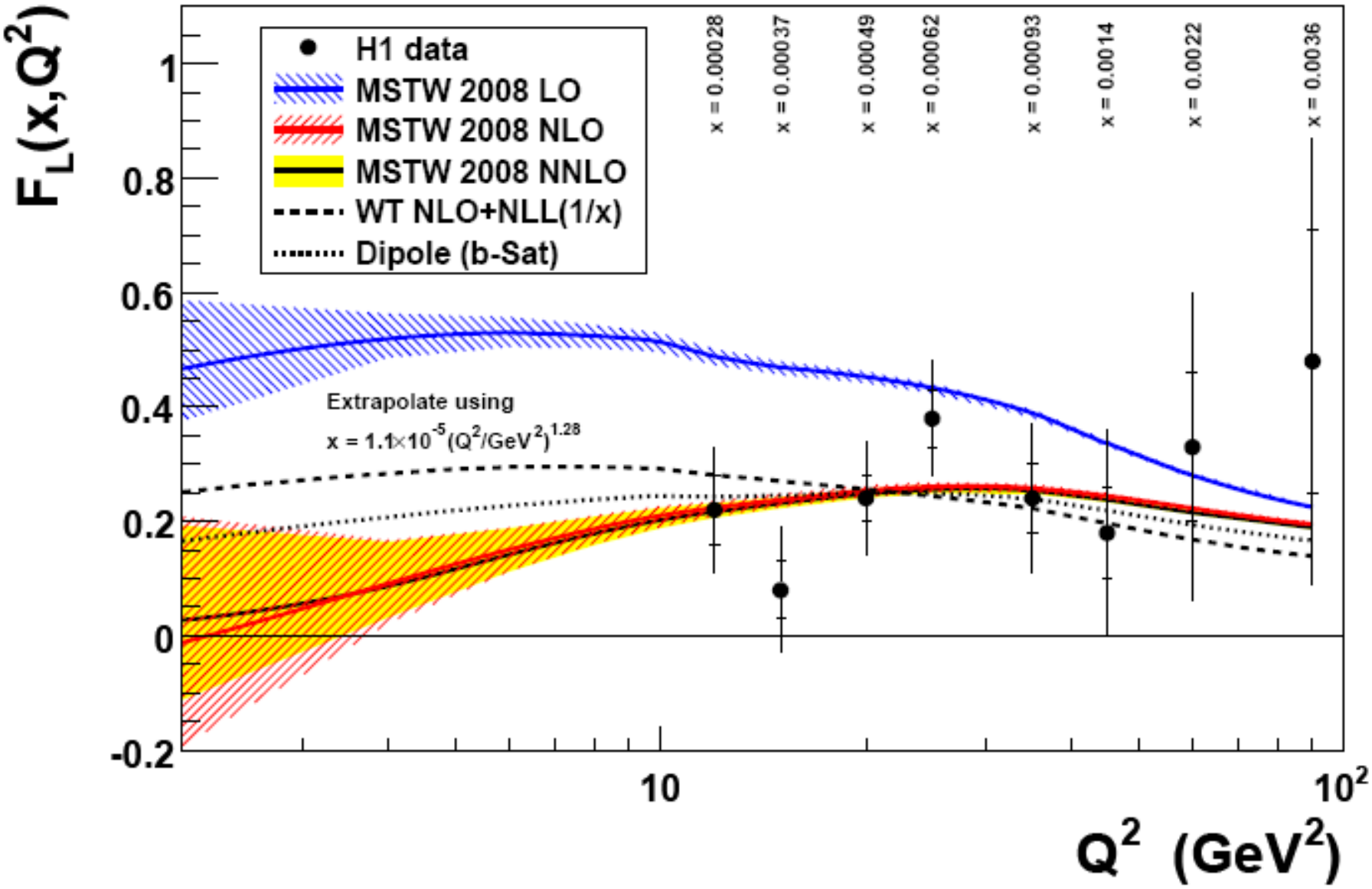
$F_L^{HT} \sim AF_2/Q^2$, e.g. ~0.1 for $x=10^{-4}$ and $Q^2=2$ GeV^2.

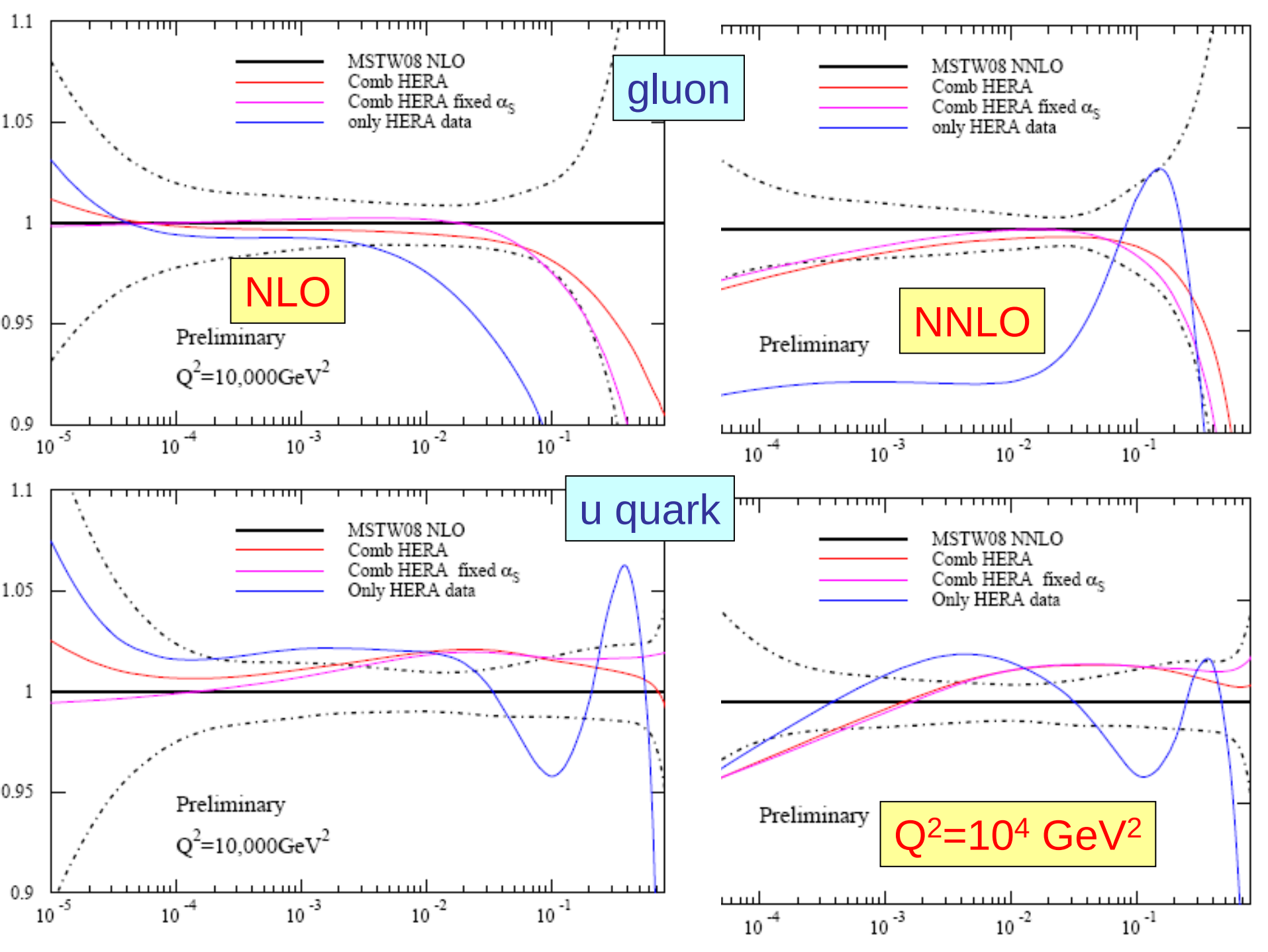
Similar is resum of NLL(1/x). Also, different is dipole picture.

Low x, low Q^2 prediction of F_L from MSTW 2008

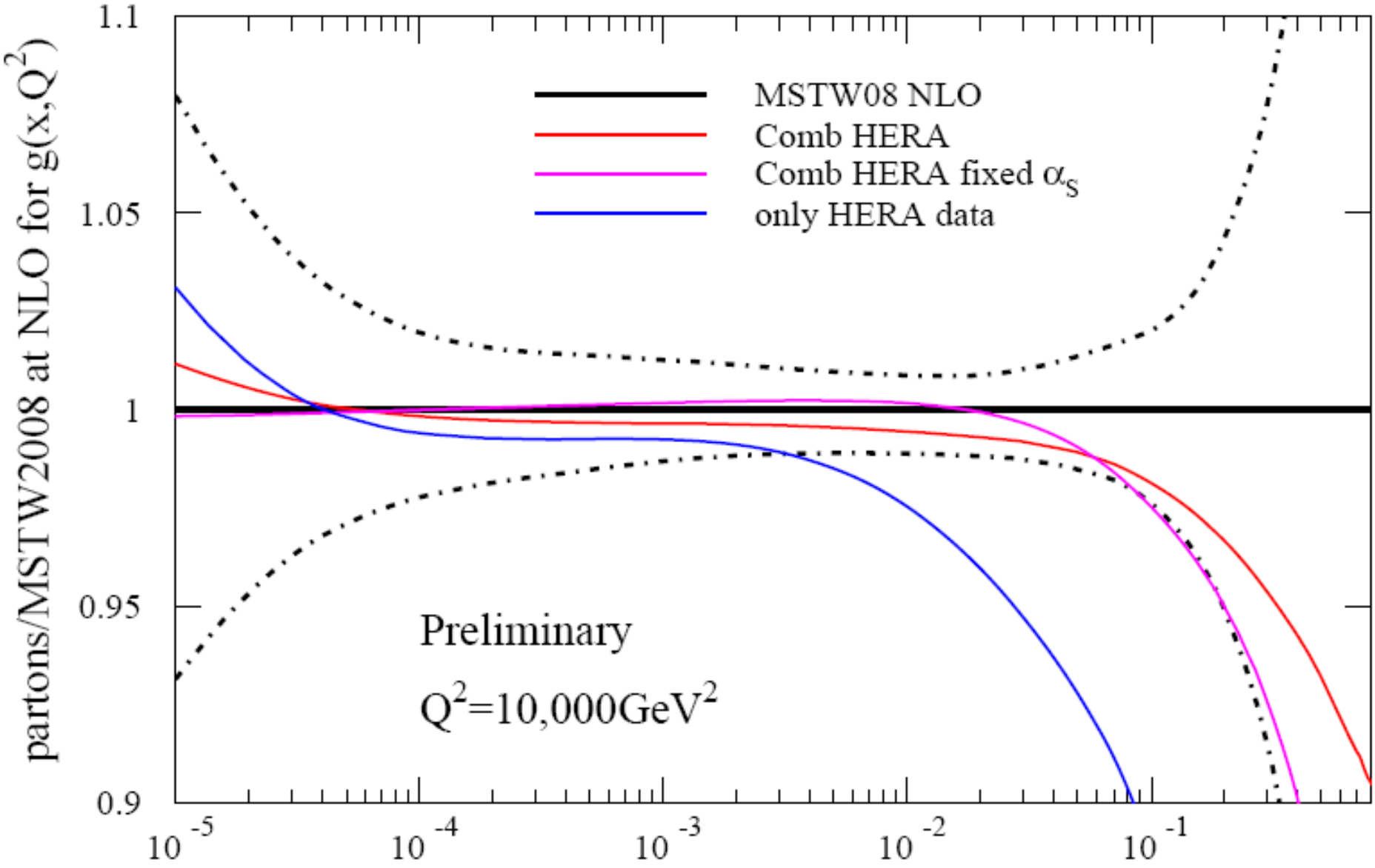



x=10-4
H1 Preliminary FL
FL (x, Q2)
1
0.5
0
H1 (Prelim.)
Ep = 460, 575, 920 GeV
MSTW NLO
MSTW NNLO
WT NLO + NLL(1/x)
x
0.000059
0.000087
0.00013
0.00017
0.00021
0.00029
0.00040
0.00052
0.00067
0.00090
0.0011
0.0015
0.0023
2
5
10
Q2 (GeV2)
10²
x=10-3


$F_L(x,Q^2)$
H1 data
MSTW 2008 LO
MSTW 2008 NLO
MSTW 2008 NNLO
WT NLO+NLL(1/x)
Dipole (b-Sat)
x = 0.00028
x = 0.00037
x = 0.00049
x = 0.00062
x = 0.00093
x = 0.0014
x = 0.0022
x = 0.0036
Extrapolate using
$x = 1.1\times10^{-5}(Q^2/\mathrm{GeV}^2)^{1.28}$
1
0.8
0.6
0.4
0.2
0
-0.2
10
10^2
Q^2 (GeV^2)


gluon
MSTW08 NLO
Comb HERA
Comb HERA fixed α_S
only HERA data
NLO
Preliminary
Q^2=10,000GeV^2
MSTW08 NNLO
Comb HERA
Comb HERA fixed α_S
only HERA data
NNLO
Preliminary
u quark
MSTW08 NLO
Comb HERA
Comb HERA fixed α_S
Only HERA data
Preliminary
Q^2=10,000GeV^2
MSTW08 NNLO
Comb HERA
Comb HERA fixed α_S
Only HERA data
Preliminary
$Q^2=10^4$ GeV^2

gluon at $Q^2=10^4$ GeV^2 from combined HERA data vs MSTW2008



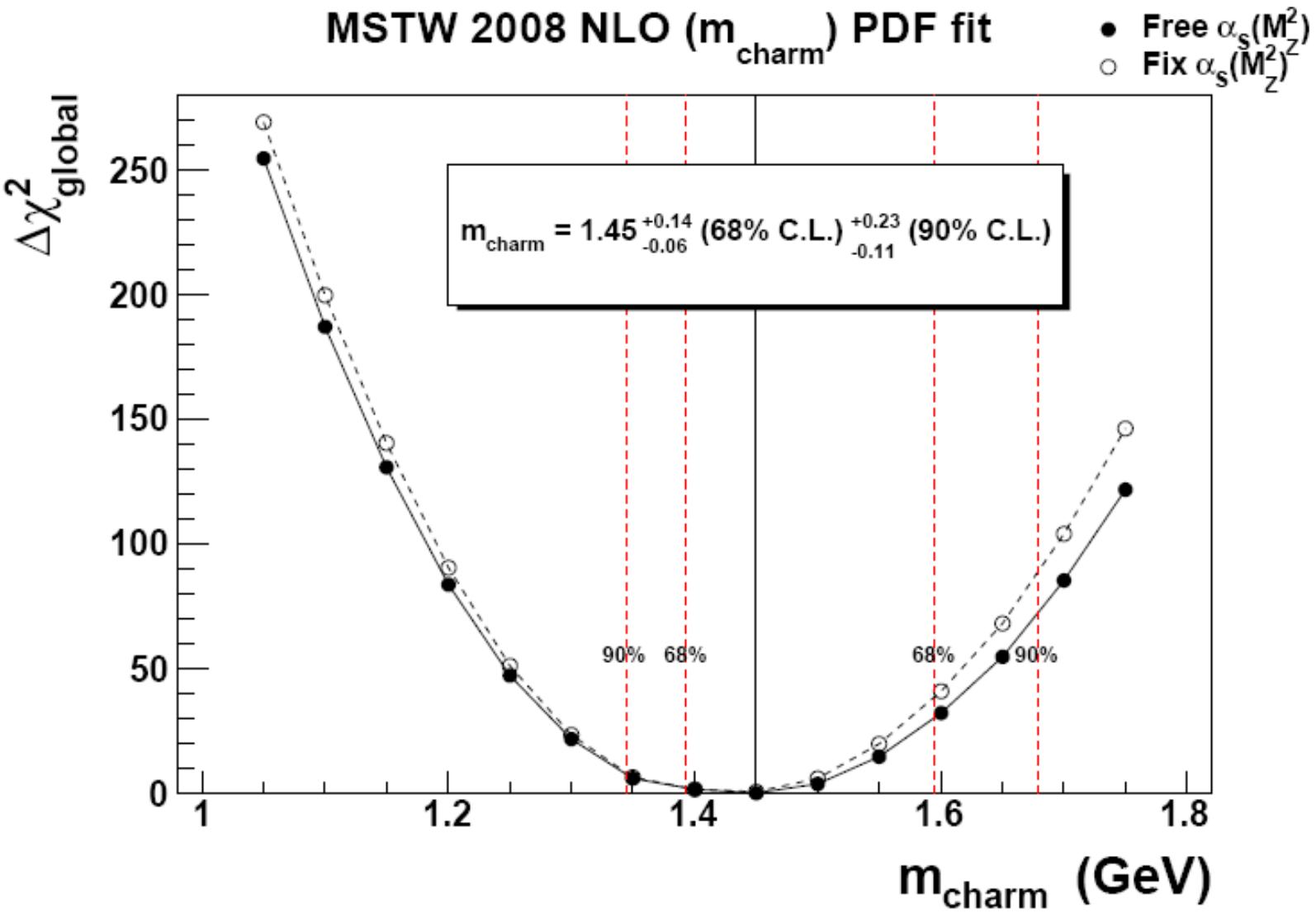
Global fits including the new H1,ZEUS combined data

α_s	PDF set	$B_{l^+l^-}\cdot\sigma_Z$(nb)	σ_H(pb)	$B_{l^+l^-}\cdot\sigma_Z$(nb)	σ_H(pb)
	NLO	Tevatron		LHC (14 TeV)	
0.1202	MSTW08	$0.243^{+2.4\%}_{-2.0\%}$	$0.746^{+5.0\%}_{-4.4\%}$	$2.00^{+2.1\%}_{-1.8\%}$	$40.7^{+3.0\%}_{-2.7\%}$
0.1215	Comb HERA	$+3.1\%$	-0.7%	$+2.5\%$	$+1.2\%$
	fix $\alpha_S(M_Z^2)$	$+3.0\%$	-4.0%	$+1.8\%$	-0.8%
	NNLO	Tevatron		LHC (14 TeV)	
0.1178	MSTW08	$0.251^{+2.2\%}_{-1.8\%}$	$0.955^{+5.4\%}_{-4.8\%}$	$2.05^{+2.6\%}_{-2.1\%}$	$50.5^{+3.6\%}_{-2.7\%}$
0.1171	Comb HERA	$+3.0\%$	-0.1%	$+0.8\%$	$+0.3\%$
	fix $\alpha_S(M_Z^2)$	$+3.0\%$	-2.5%	$+0.4\%$	-1.1%

If fit to only H1,ZEUS combined data and other CC,NC HERA data, then

0.123 NLO
0.127 NNLO

{ gluon reduced, q's dramatically changed, v.poor description of non-HERA data


MSTW 2008 NLO (m_{charm}) PDF fit
Free $\alpha_s(M_Z^2)$
Fix $\alpha_s(M_Z^2)$
$m_{charm} = 1.45^{+0.14}_{-0.06}$ (68% C.L.) $^{+0.23}_{-0.11}$ (90% C.L.)
$\Delta\chi^2_{global}$
250
200
150
100
50
0
90%
68%
68%
90%
1
1.2
1.4
1.6
1.8
m_{charm} (GeV)

PDG running mass

$$m_c(\mu = m_c) \;=\; 1.27\ ^{+0.07}_{-0.11}\ \ \mathrm{GeV}$$

corresponds to pole mass

$$m_c = 1.27\ \mathrm{GeV} \times 1.3 = 1.65\ \mathrm{GeV}$$

which is in excess of MSTW NLO global fit value of

m_c = 1.45 +0.16 -0.06 GeV

worse agreement at NNLO.

MSTW await combined charm data

Effect of value of m_c on collider cross sections

Variable $\alpha_S(M_Z^2)$		Tevatron ($\sqrt{s} = 1.96$ TeV)			LHC ($\sqrt{s} = 7$ TeV)			LHC ($\sqrt{s} = 14$ TeV)		
m_c (GeV)	m_b (GeV)	$\delta\sigma_W$	$\delta\sigma_Z$	$\delta\sigma_H$	$\delta\sigma_W$	$\delta\sigma_Z$	$\delta\sigma_H$	$\delta\sigma_W$	$\delta\sigma_Z$	$\delta\sigma_H$
1.05		-2.6	-2.8	+0.4	-4.1	-4.6	-2.4	-5.1	-5.5	-3.8
1.10		-2.2	-2.4	+0.2	-3.5	-3.9	-2.1	-4.3	-4.7	-3.3
1.15		-1.8	-1.9	+0.1	-2.9	-3.3	-1.8	-3.6	-3.9	-2.8
1.20		-1.4	-1.5	+0.1	-2.3	-2.6	-1.5	-2.8	-3.1	-2.3
1.25		-1.0	-1.1	0.0	-1.7	-1.9	-1.2	-2.1	-2.3	-1.7
1.30		-0.7	-0.7	0.0	-1.1	-1.3	-0.8	-1.4	-1.5	-1.2
1.35		-0.3	-0.4	0.0	-0.6	-0.6	-0.4	-0.7	-0.8	-0.6
1.40	**4.75**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.45		+0.3	+0.3	0.0	+0.6	+0.6	+0.4	+0.7	+0.8	+0.6
1.50		+0.6	+0.6	0.0	+1.1	+1.3	+0.8	+1.3	+1.5	+1.2
1.55		+0.8	+0.9	+0.1	+1.6	+1.9	+1.2	+2.0	+2.3	+1.8
1.60		+1.1	+1.2	+0.2	+2.1	+2.5	+1.8	+2.6	+3.0	+2.5
1.65		+1.3	+1.5	+0.1	+2.6	+3.0	+2.0	+3.2	+3.7	+2.9
1.70		+1.5	+1.8	+0.2	+3.1	+3.6	+2.5	+3.8	+4.4	+3.6
1.75		+1.8	+2.0	+0.3	+3.5	+4.2	+2.9	+4.3	+5.1	+4.1