MSTW Update

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Effect of combined HERA data.

Preliminary – have included combined neutral current data from HERA, with errors added in quadrature for the moment (correlated errors now very small and effect of this previously shown to be small).

Also still including separate H1/ZEUS e^+ charged current data. Combination should be similar since statistics dominate. Normalisations related to NC data correctly. Published e^- NC carry extremely little weight.

Fit to data for $Q^2 \geq 2\mathrm{GeV}^2$ but look also at numbers for $Q^2 \geq 3.5\mathrm{GeV}^2$ to compare to HERA fit results.

Fits at NLO

Simply replace old HERA NC data with combined data.

Global fit quality $\sim 2610/2471$. To HERA NC data $\sim 600/553$ ($Q^2 > 2\mathrm{GeV}^2$) and $\sim 530/524$ ($Q^2 > 3.5\mathrm{GeV}^2$). Latter number compared to $483/524$ (A.M. Cooper-Sarkar) for same treatment of errors. Other data in fit stops equivalently good comparison. Normalisation of data down by nearly 2σ.

$\alpha_S(M_Z^2) = 0.1215$ – $1-\sigma$ effect. Quarks generally bigger, sometimes outside $1-\sigma$ band. Gluon not changed much except some decrease at large x.

Also fit fixing $\alpha_S(M_Z^2) = 0.1202$, i.e. MSTW2008 NLO value. Both global and HERA NC data fit ~ 10 higher. PDF change similar.

Fit only HERA NC and CC cross-section data. 25 free parameters, including α_S. Same as in global fit but strange sector fixed. Now get $\sim 515/553$ ($Q^2 > 2\mathrm{GeV}^2$) and $\sim 445/524$ ($Q^2 > 3.5\mathrm{GeV}^2$). Much better than HERA fit.

$\alpha_S(M_Z^2) = 0.123$, high-x gluon much reduced, quark flavours change dramatically. Comparison to Tevatron jet data – $\chi^2 \sim 1.5$ per point, poor, but not terrible. Comparison to data relying on flavour and quark-antiquark details extremely poor.

Fits at NNLO

Standard fit – global fit quality $\sim 2505/2387$. To HERA NC data $\sim 585/553$ ($Q^2 > 2\mathrm{GeV}^2$) and $\sim 535/524$ ($Q^2 > 3.5\mathrm{GeV}^2$). ~ 15 better than NLO for full data but similar for $Q^2 > 3.5\mathrm{GeV}^2$. Normalisation down slightly less than at NLO.

$\alpha_S(M_Z^2) = 0.1178$ – much less than $1-\sigma$ effect. Quarks generally bigger, sometimes outside $1-\sigma$ band, until very low x, then smaller. Gluon not changed much except some decrease at large x, and at lowest x.

Also fit fixing $\alpha_S(M_Z^2) = 0.1171$, i.e. MSTW2008 NNLO value. Both global and HERA NC data fit only $\sim 2-3$ higher. PDF change tiny.

Fit only HERA NC and CC cross-section data. Obtain $\sim 495/553$ ($Q^2 > 2\mathrm{GeV}^2$) and $\sim 465/524$ ($Q^2 > 3.5\mathrm{GeV}^2$). Better than NLO for former, but worse for latter.

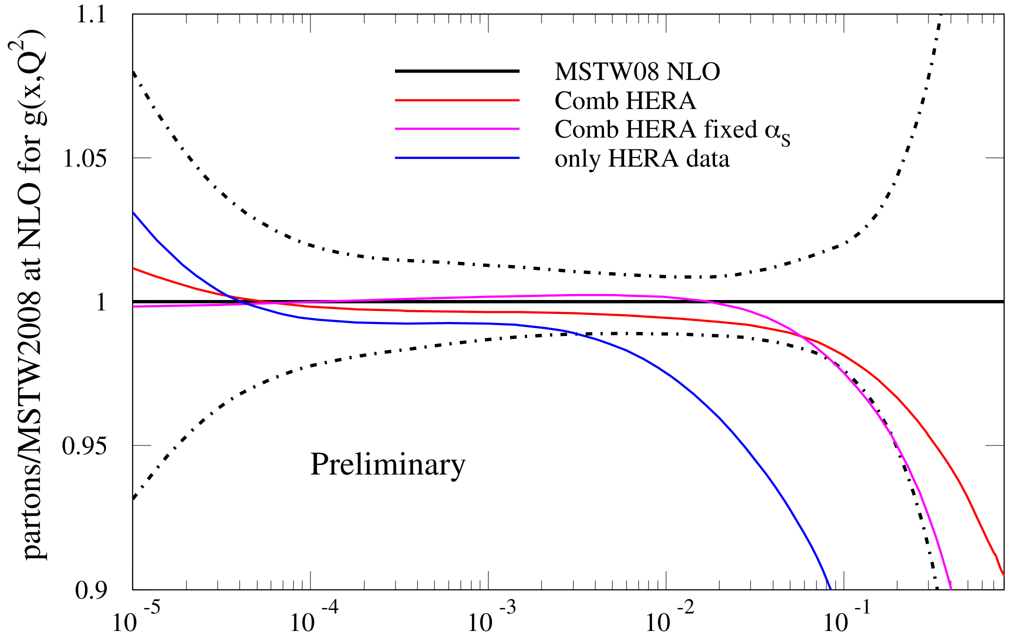
$\alpha_S(M_Z^2) = 0.127$, but sensitivity much lower than global fit. Gluon generally reduced, quark flavours change dramatically. Comparison to all non HERA data extremely poor.

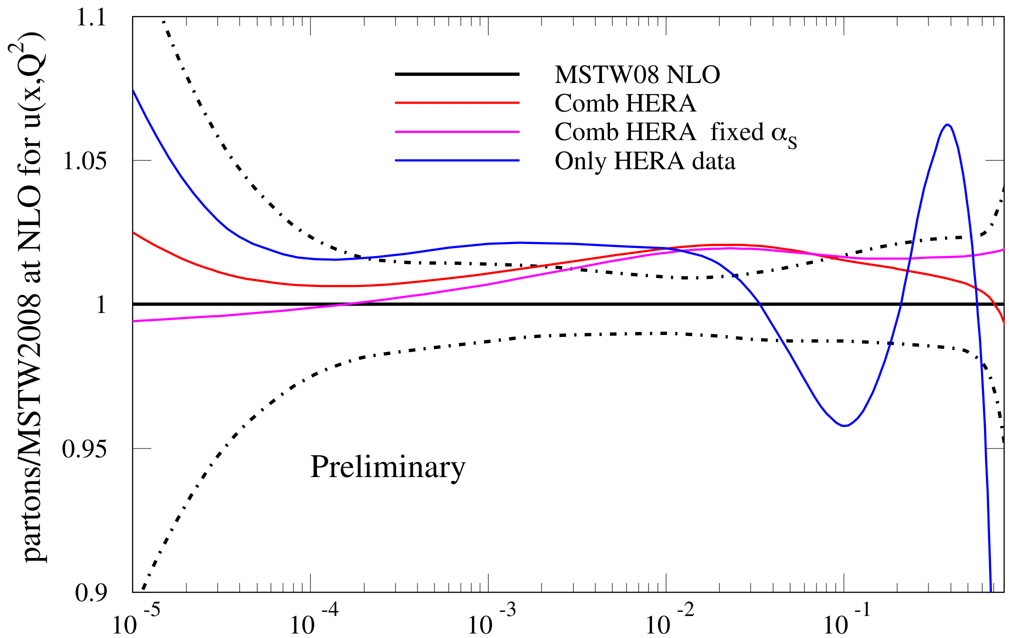
Comparison of gluon and up quark from fits using combined HERA data to MSTW2008 NLO versions with $1-\sigma$, uncertainty shown.

Significant effect in places, but generally not actually bigger than potential effects from variation of GM-VFNS (except for fit to HERA data only).

Most dramatic for quark at about $x = 0.01$, also noticed by NNPDF (Forte).

Only very rough indications of effect on uncertainty. Dynamical tolerance procedure yet to be applied.

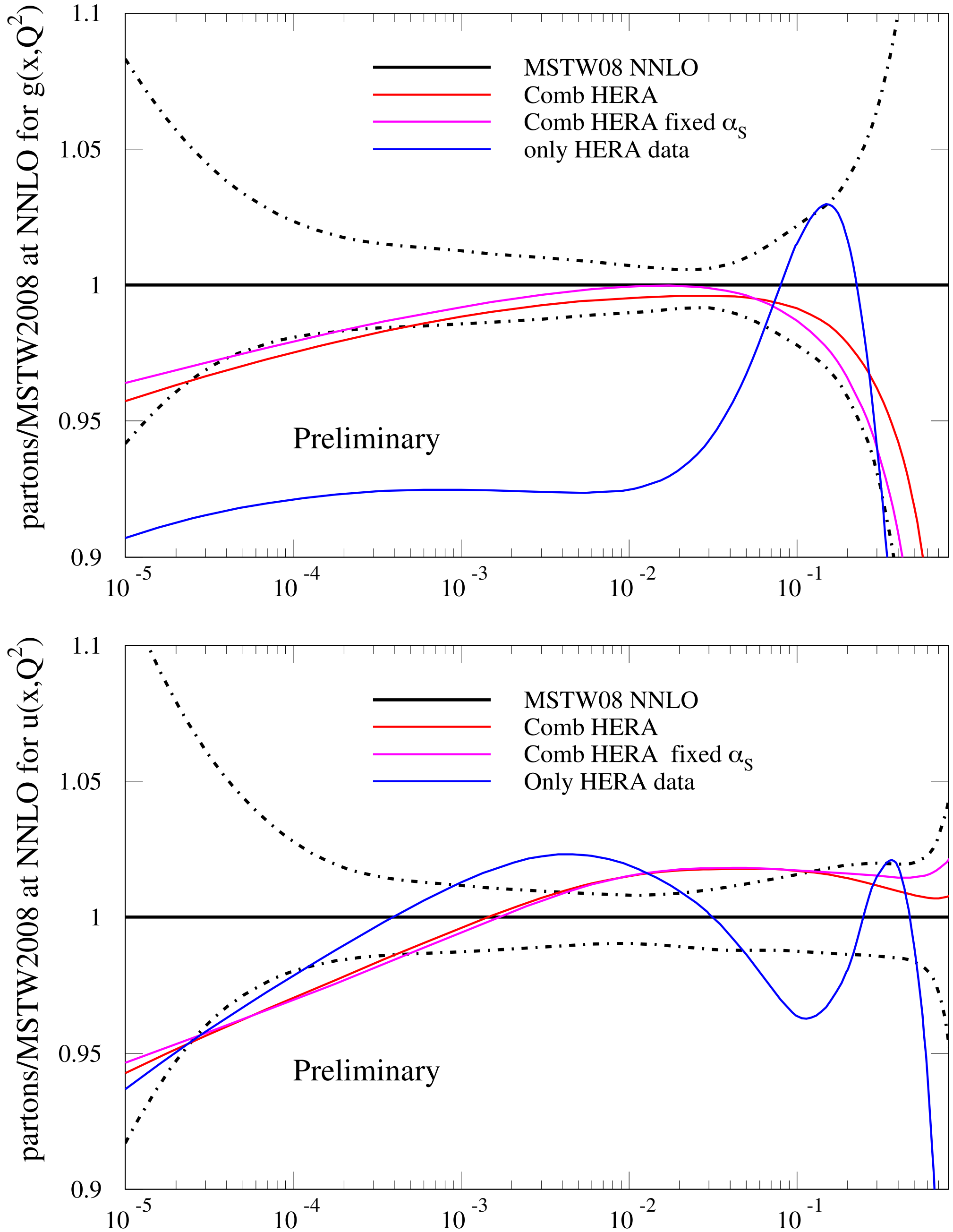




Comparison of gluon and up quark from fits using combined HERA data to MSTW2008 NNLO versions with $1-\sigma$, uncertainty shown.

Significant effect in places. Very little dependence on whether α_S left free.

Most dramatic for quark at about $x = 0.01$, and PDFs at about $x \sim 0.0001$.



Impact on Cross Sections - NLO.

The values of the predicted cross-sections at NLO for Z and a 120 GeV Higgs boson at the Tevatron and the LHC (latter for 14 TeV centre of mass energy).

PDF set	$B_{l^+l^-} \cdot \sigma_Z$(nb)TeV	σ_H(pb)TeV	$B_{l^+l^-} \cdot \sigma_Z$(nb)LHC	σ_H(pb)LHC
MSTW08	0.2426	0.7462	2.001	40.69
Comb HERA	0.250	0.741	2.05	41.2
fixed $\alpha_S(M_Z^2)$	0.250	0.717	2.04	40.4
only HERA	0.280	0.632	2.21	39.7

For new global fits $2-3\%$ effect on Z (and W) cross sections. Marginally bigger at Tevatron. Similar to $1-\sigma$ uncertainty (including $\alpha_S(M_Z^2)$ variations).

Maximum of little more than 1% for Higgs. Small compared to uncertainties.

HERA-only fit much higher for Z and lower for Higgs though decreasing effect in latter case as sampled x becomes smaller.

Impact on Cross Sections - NNLO.

The values of the predicted cross-sections at NNLO for Z and a 120 GeV Higgs boson at the Tevatron and the LHC (latter for 14 TeV centre of mass energy).

PDF set	$B_{l^+l^-}\cdot\sigma_Z$(nb)TeV	σ_H(pb)TeV	$B_{l^+l^-}\cdot\sigma_Z$(nb)LHC	σ_H(pb)LHC
MSTW08	0.2507	0.9549	2.051	50.51
Comb HERA	0.258	0.954	2.07	50.7
fixed $\alpha_S(M_Z^2)$	0.258	0.931	2.06	50.0
only HERA	0.280	1.12	2.24	55.5

For new global fits $2-3\%$ effect on Z (and W) cross sections at Tevatron, but small change at LHC. Similar to $1-\sigma$ uncertainty in former case.

Maximum of 1% for Higgs, less when α_S changes. Small effect.

HERA-only fit much higher for Z and for Higgs due to very large coupling.

Dependence on m_c (pole mass) at NLO in 2008 fits.

m_c (GeV)	χ^2_{global} 2699 pts	$\chi^2_{F_2^c}$ 83 pts	$\alpha_s(M_Z^2)$
1.1	2728	263	0.1182
1.2	2625	188	0.1188
1.3	2563	134	0.1195
1.4	2543	107	0.1202
1.45	2541	100	0.1205
1.5	2545	97	0.1209
1.6	2574	104	0.1216
1.7	2627	128	0.1223

Clear correlation between m_c and $\alpha_S(M_Z^2)$.

For low m_c overshoot low Q^2 medium x data badly.

Preference for $m_c = 1.45\mathrm{GeV}$. Relevance for pole mass determinations later.

BCDMS and NMC data prefer lower m_c, lower α_S and quicker threshold evolution respectively.

Dependence on m_c at NNLO in 2008 fits.

m_c (GeV)	χ^2_{global} 2615 pts	$\chi^2_{F_2^c}$ 83 pts	$\alpha_s(M_Z^2)$
1.1	2499	114	0.1158
1.2	2463	88	0.1162
1.26	2546	82	0.1165
1.3	2457	82	0.1166
1.4	2480	95	0.1171
1.5	2527	125	0.1175
1.6	2589	167	0.1180
1.7	2666	217	0.1184

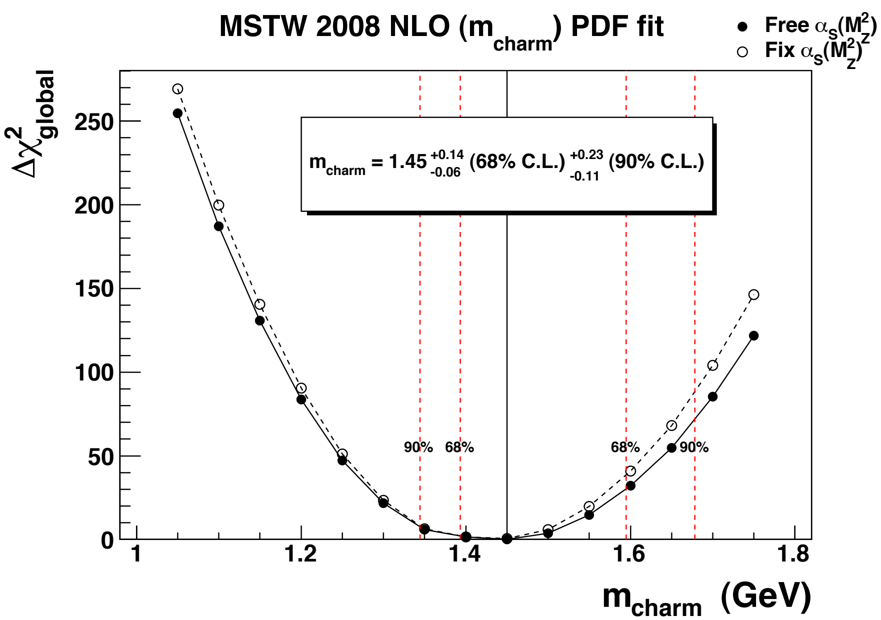
Less correlation between m_c and $\alpha_S(M_Z^2)$.

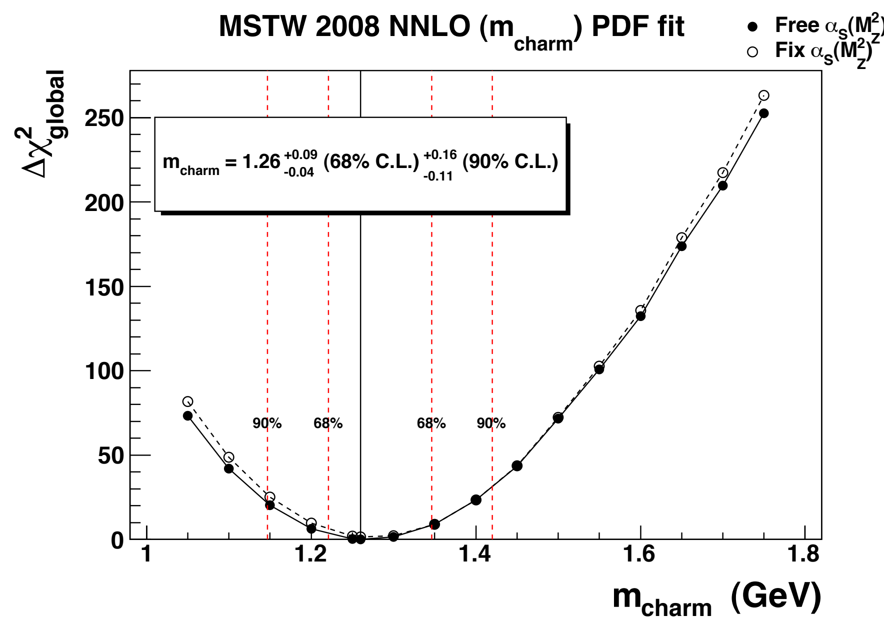
For high m_c undershoot moderate Q^2 data badly.

Preference for low value of $m_c = 1.26\text{GeV}$. Definitely on low side.

Despite correlation with α_S little tightening in χ^2 if it is kept fixed at best fit value.

Another example of gluon-α_S compensation for fits to small-x data.

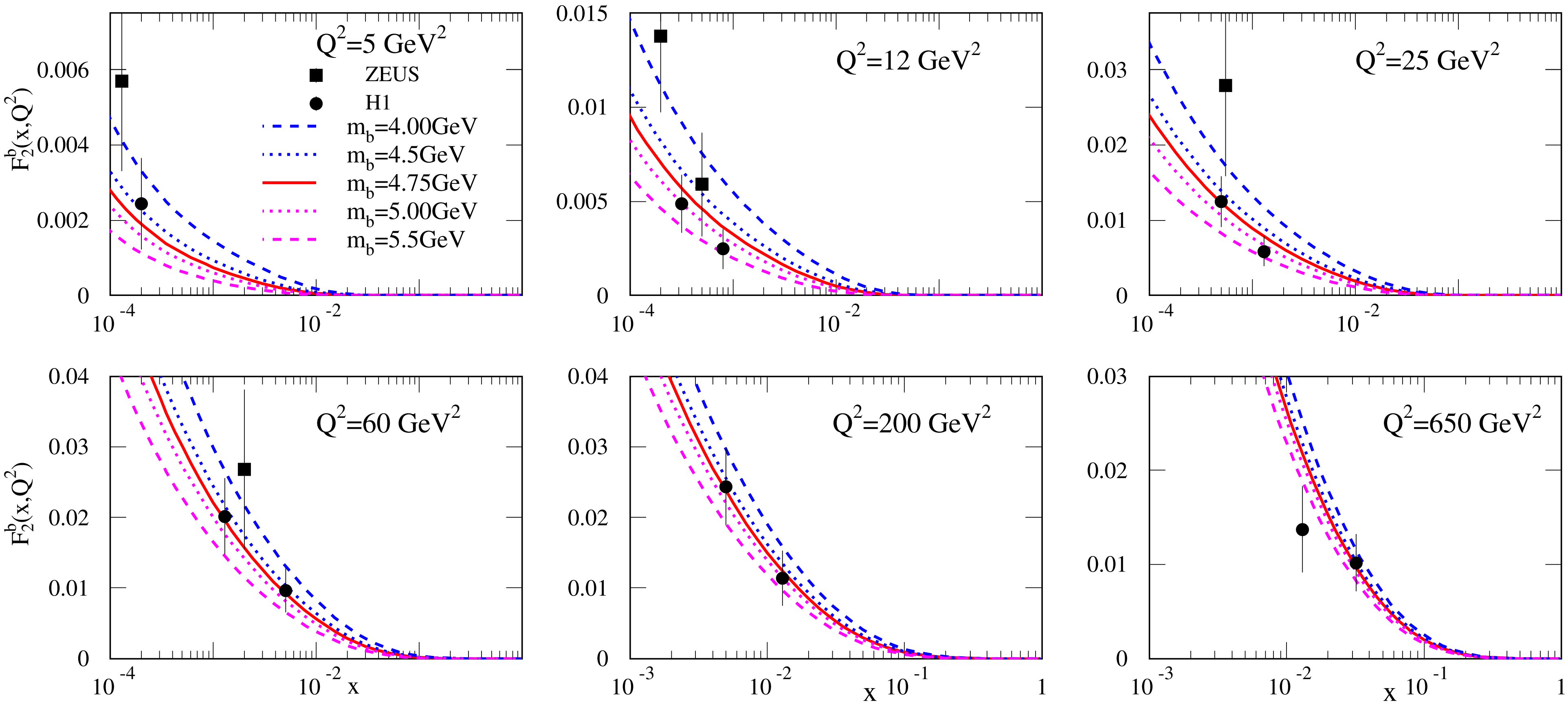




Just about consistency between NLO and NNLO values.

Newer combined data seem to prefer higher mass (largely because the data in Eur.Phys.J.C38:447-459,2005 not released in structure function form).

NNLO comparisons to Beauty data (not in global fit) for varying m_b



Distinct preference for $m_b \approx 5\mathrm{GeV}$.

Very similar at NLO.

Dependence on m_b at NNLO in 2008 fits.

Vary m_b in steps of $0.25\mathrm{GeV}$.

m_b (GeV)	χ^2_{global} 2615 pts	$\chi^2_{F_2^b}$ 12 pts	χ^2_{tot} 2627 pts	$\alpha_s(M_Z^2)$
4.00	2477	21	2498	0.1201
4.25	2478	15	2493	0.1202
4.50	2478	11	2489	0.1202
4.75	2480	8.8	2489	0.1202
5.00	2481	6.9	2488	0.1201
5.25	2483	7.7	2491	0.1201
5.50	2485	7.9	2493	0.1200

For non-F_2^b data fairly flat all the way down to $m_b = 3\mathrm{GeV}$.

For lower m_b marginally better fit to HERA data, including $F_2^c(x, Q^2)$.

Similar at NLO, but with slightly bigger change in χ^2.

Overall global fit, even including current beauty data, would prefer fairly near current default $= 4.75\mathrm{GeV}$.

Other constraints on Masses

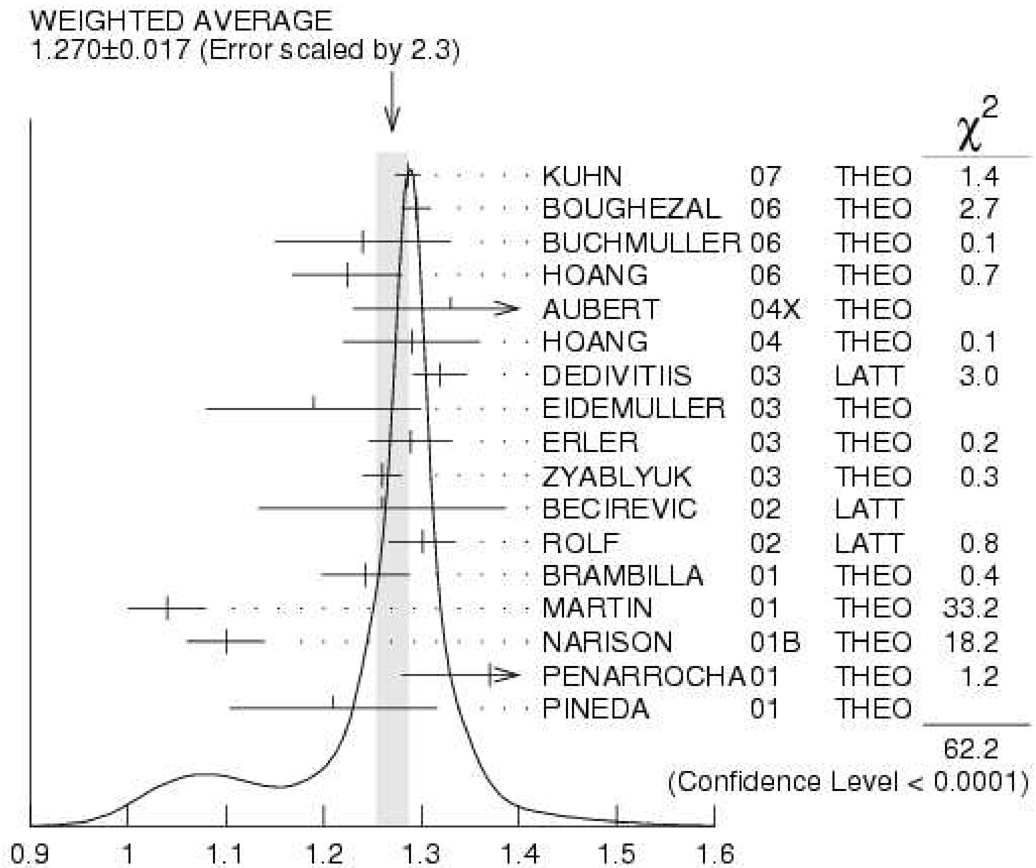
We use pole mass definition since the perturbative transition matrix elements $A_{ij}(\mu^2/m_h^2)$ (Buzu *et al*, Blümlein *et al*) which give boundary conditions for evolution and coefficient functions $C_{ij}^{FFNS}(z,m_h^2)$ (Laenen *et al*) used in definition of GM-VFNS defined in "on mass-shell"" renormalization scheme.

Could convert to other schemes, but not aware that anyone does. Would lose very convenient decoupling properties.

Is a *pseudo*-physical definition since it is not dependent on order of perturbation series or scale, but suffers from fact that there are no free quarks.

Latter point leads to significant power corrections – $\Lambda^2_{\rm QCD}/m_h^2$ and higher powers, i.e. leading twist definitions/determinations contaminated by renormalon ambiguities.

Accurate determinations of m_c and m_b nearly always given using $\overline{MS}$ definition – good apparent perturbative stability. However, even this gives individual determinations with much greater spread than quoted uncertainties, e.g. from 2008 PDG



PDG quotes $m_c(\mu = m_c) = 1.27^{+0.07}_{-0.11}$ and $m_b(\mu = m_b) = 4.20^{+0.17}_{-0.07}$.

In principle know the conversion from $\overline{MS}$ definition to pole mass to $\mathcal{O}(\alpha_S^3)$ (Chetyrkin and Steinhauser, Melnikov and van Ritbergen).

Using MSTW NNLO α_S value for bottom

$$m_b^{\rm pole} = m_b^{\overline{MS}}(\mu = m_b) * (1 + 0.095 + 0.045 + 0.035 + \cdots) = 4.9 {\rm GeV}$$

with moderate convergence of the series.

For charm the equation is

$$m_c^{\rm pole} = m_c^{\overline{MS}}(\mu = m_c) * (1 + 0.16 + 0.14 + 0.18 + \cdots)$$

So no apparent convergence at all due to larger coupling and less gluon-light-quark loop cancellation in coefficients (naively get $1.88 {\rm GeV}$).

Conversion severely renormalon contaminated. For bottom assume $\mathcal{O}(\alpha_S^3)$ is smallest term in series so is the point where the series is truncated and this term is the approx. size of power correction

$$\rightarrow m_b^{\rm pole} = 4.9{\rm GeV} \pm 0.15{\rm GeV}$$

Uncertainty similar to renormalon calculation estimate Beneke and Braun – 1994.

Not even clear where series for m_c starts to diverge (immediately?).

However, conversion for $m_b - m_c$ has cancellation of leading power correction, and $m_c - m_b = 3.4{\rm GeV}$ with very small error (Hoang and Manohar). Using this

$$m_c^{\rm pole} = 1.5{\rm GeV} \pm 0.17{\rm GeV}$$

Considering these constraints together with our fit results we suggest using

$m_c = 1.4{\rm GeV}$ with uncertainty $0.15{\rm GeV}$ for 68% C.L or $0.25{\rm GeV}$ for 90% C.L

$m_b = 4.75$ with uncertainty $0.25{\rm GeV}$ for 68% C.L or $0.5{\rm GeV}$ for 90% C.L (in latter case take round value for convenience).

Variation in cross sections with m_c – fixed α_S.

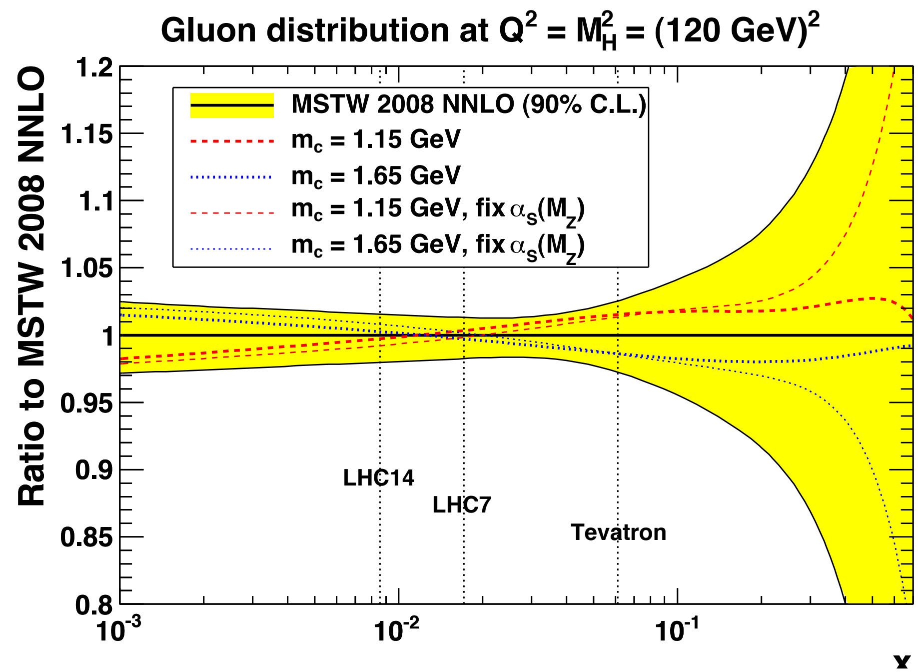
m_c [GeV]	$\delta\sigma_Z$(Tev)	$\delta\sigma_H$(TeV)	$\delta\sigma_Z$(LHC)	$\delta\sigma_H$(LHC)
1.15	−1.4	2.7	−2.4	0.0
1.20	−1.1	2.2	−1.9	0.0
1.25	−0.8	1.6	−1.4	0.0
1.30	−0.5	1.1	−1.0	0.0
1.35	−0.3	0.5	−0.5	0.0
1.40	0.0	0.0	0.0	0.0
1.45	0.2	−0.6	0.5	0.0
1.50	0.4	−1.2	0.9	0.0
1.55	0.7	−1.7	1.4	0.0
1.60	0.8	−2.3	1.8	0.0
1.65	1.1	−2.9	2.7	−0.1

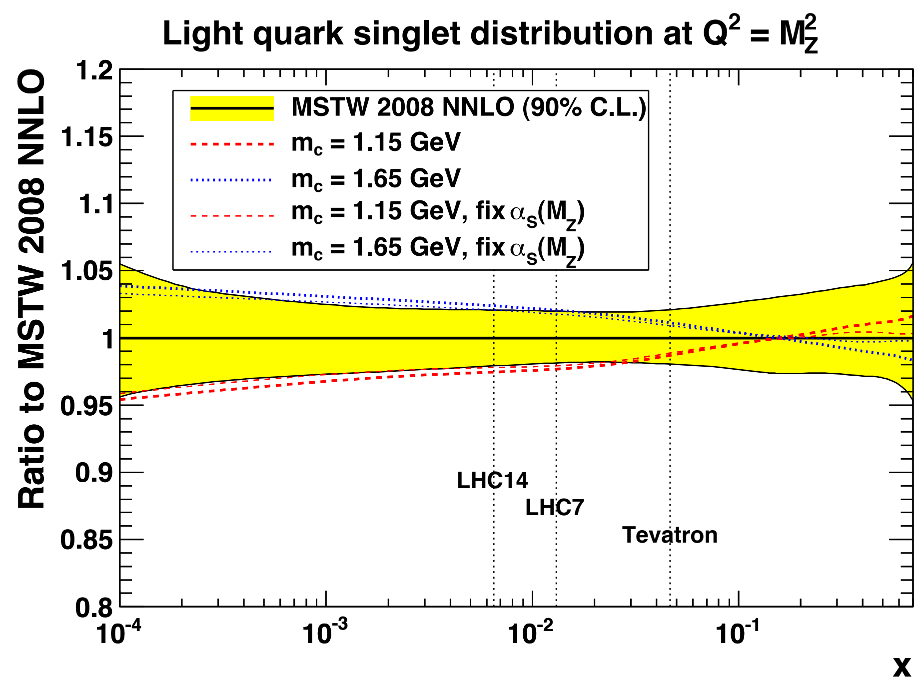
Variation in cross sections at NNLO. About $15 - 20\%$ bigger at NLO in general.

For quarks bigger when probing lower x. For Higgs coincidentally at fixed point in x for $120\mathrm{GeV}$ Higgs at $7\mathrm{TeV}$.

$0.15\mathrm{GeV}$ change in m_c can give 1.5% changes. Similar to PDF uncertainty (and similar to HERAPDF results). Suggest adding in quadrature.

Ratio of partons when m_c is varied either with or without varying α_S





Variation in cross sections with m_b – varying α_S.

Changes much smaller for inclusive quantities for variation in m_b, even with varying α_S (though variations tiny).

m_b [GeV]	$\delta\sigma_Z$(Tev)	$\delta\sigma_H$(TeV)	$\delta\sigma_Z$(LHC)	$\delta\sigma_H$(LHC)
4.25	-0.1	-0.1	0.0	-0.3
4.75	0.0	0.0	0.0	0.0
5.25	0.0	0.1	0.0	0.2

Would be more significant if sensitive to bottom quarks in final state.

3- and 4 Flavour Sets

Will be providing both 3- and 4-flavour sets for a wide variety of charm and bottom quark masses.

As argued in previous MRT paper on subject (2006) and in RT, Tung summary article for HERA-LHC workshop will be basing these on input for GM-VFNS fit.

Full global fit not possible while keeping number of flavours fixed at 3 or 4 due to lack of coefficient functions for many processes.

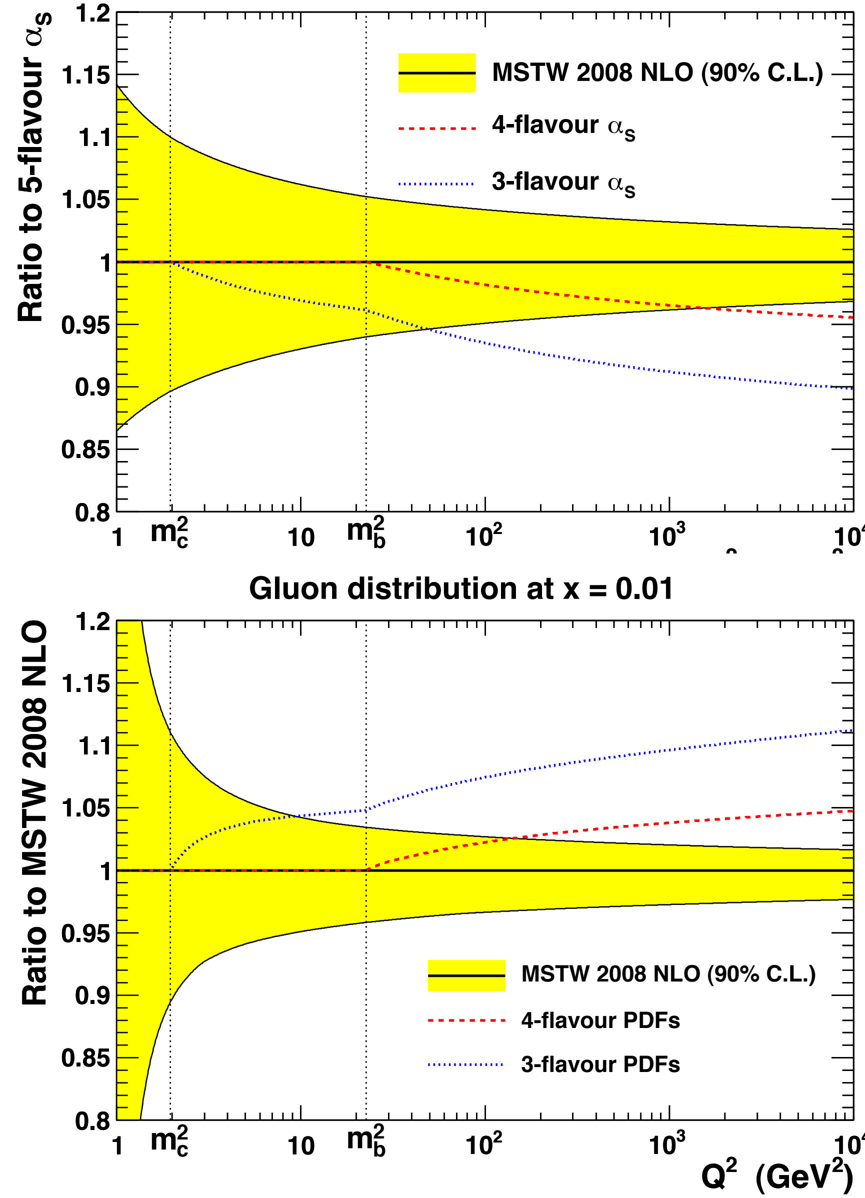
Argued in previous article that lack of accuracy from this procedure is questionable.

Use appropriate number of flavour in coupling for standard definition of FFNS coefficient functions (depends on renormalisation scheme one defines), i.e. same number as in PDFs at all times.

Doing this decrease in coupling compared to variable flavour, larger β-function.

Also increase in gluon compared to variable flavour, no splitting to heavy quarks.

To lowest order good compensation between two. Leads to invariance of quantities $\propto \alpha_S g(x, Q^2)$, e.g. light flavour evolution, Higgs cross-section.



Conclusions

Have looked at effect on central fits when including new combined HERA neutral current data. In some places alters partons, and $\alpha_S(M_Z^2)$, by $1-\sigma$ or a bit more.

Total fit better at NNLO. Global fit worse than HERA fit. Can do better than HERA fit when only fitting HERA data. Big decrease in χ^2 when other data removed.

Can be a $1-\sigma$ effect on Z and W cross-sections, more so at Tevatron. Less for Higgs cross sections. More variation at NLO than at NNLO.

Have investigated dependence of global fits on heavy quark pole masses. Fits prefer $m_c = 1.45\text{GeV}$ at NLO and $m_c = 1.26\text{GeV}$ at NNLO with nominal current uncertainty about $0.1GeV$ in each. Marginal consistency, use 1.4GeV.

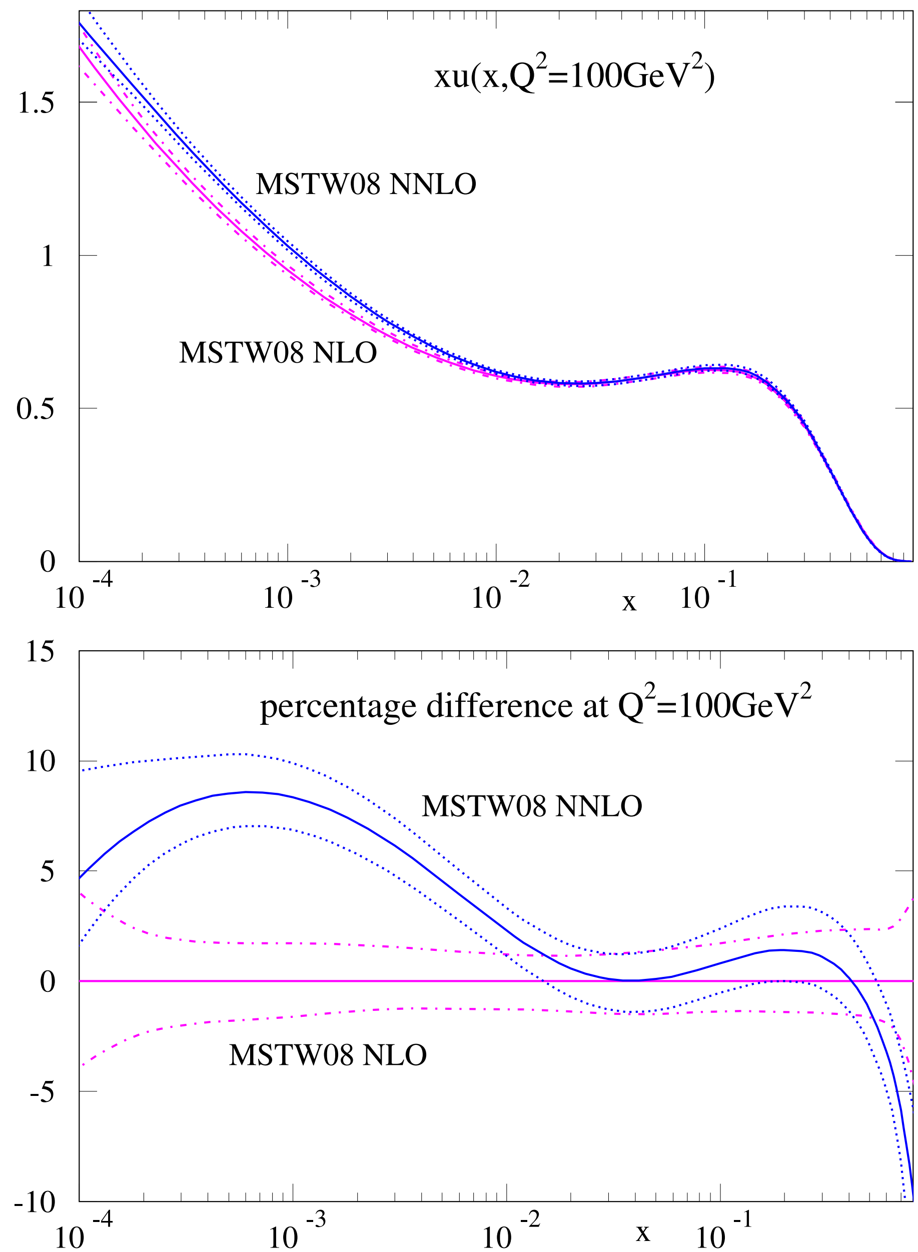
Fit happy with $m_b = 4.75\text{GeV}$ with big uncertainty.

Alternative constraints a bit higher (1.5GeV and 4.9GeV), but with intrinsic uncertainty in conversion from $\overline{MS}$ definition to pole mass. We suggest $1.4 \pm 0.15\text{GeV}\ (m_c)$ and $4.75 \pm 0.25\text{GeV}\ (m_b)$.

Can lead to changes comparable to PDF uncertainties. Suggest adding in quadrature.

Sets with varying masses and 3 and 4 light flavours available imminently.

An illustration of how a PDF can be different when defined and extracted at different orders of perturbation theory.



Effect of new Tevatron lepton/W asymmetry.

In MSTW08 fit include D0 muon asymmetry data from 0.3fb^{-1} and $p_T > 20\text{GeV}$ and CDF electron asymmetry from 170pb^{-1} in bins of $25 < p_T < 35\text{GeV}$ and $35 < p_T < 45\text{GeV}$

Use the FEWZ code (Melnikov and Petriello) for NLO QCD with the width of the W taken into account. Have checked fully that this gives very similar results to use of MCFM and even RESBOS.

Is main constraint in one direction on 3 eigenvectors at NLO (5 at NNLO). Mainly constrains d quark distribution since u well known from DIS.

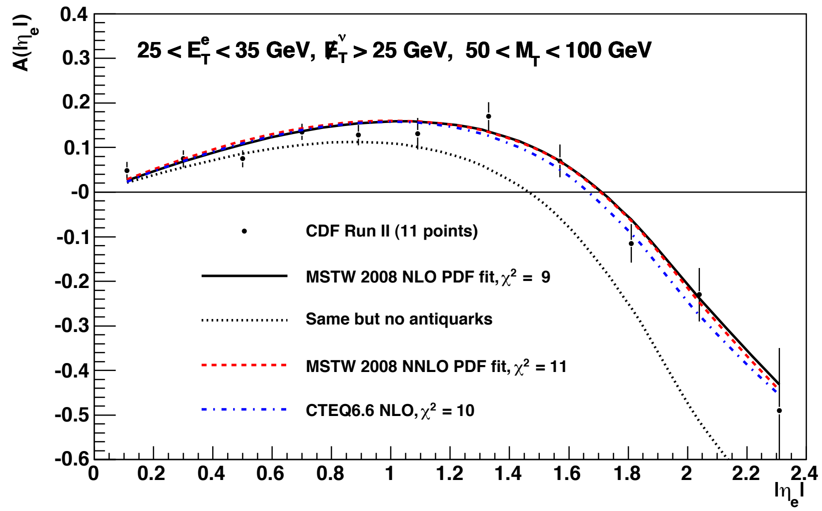
Main d constraint from deuterium DIS subject to uncertainty from nuclear corrections. Currently the uncertainties due to these corrections not accounted for.

In both cases fit is not very good, particularly for D0. At NLO $\chi^2 = 25/10$ for D0 data and $\chi^2 = 29/22$ for CDF data.

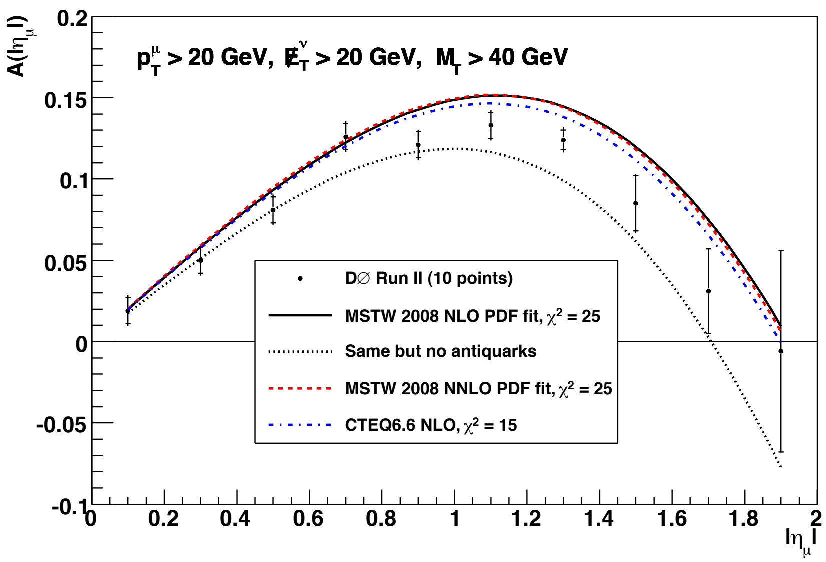
Left out D0 data on electron asymmetry in two p_t bins with 0.75fb^{-1} since fit $163/24$ in p_T bins or $116/12$ for $p_T > 25\text{GeV}$ combined data.

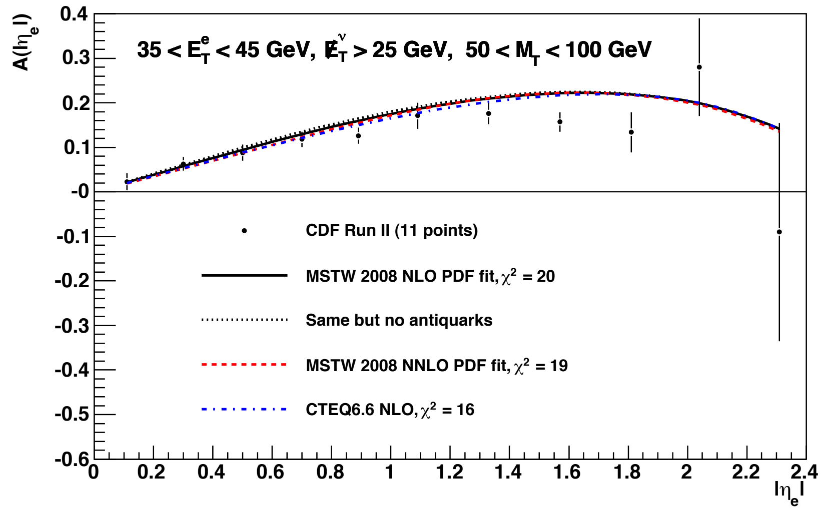
Comparison to prelim CDF W-asymmetry data about $28/13$ (depending on details), i.e. ok but needs tuning.

CDF data on lepton charge asymmetry from W→eν decays



DØ data on lepton charge asymmetry from W→μν decays





Standard fits give very poor comparison to both D0 electron data from $0.75\mathrm{fb}^{-1}$ and D0 muon data from $4.9\mathrm{fb}^{-1}$.

Try a wide variety of alternative fits first by weighting asymmetry data and/or making cuts on other data fit.

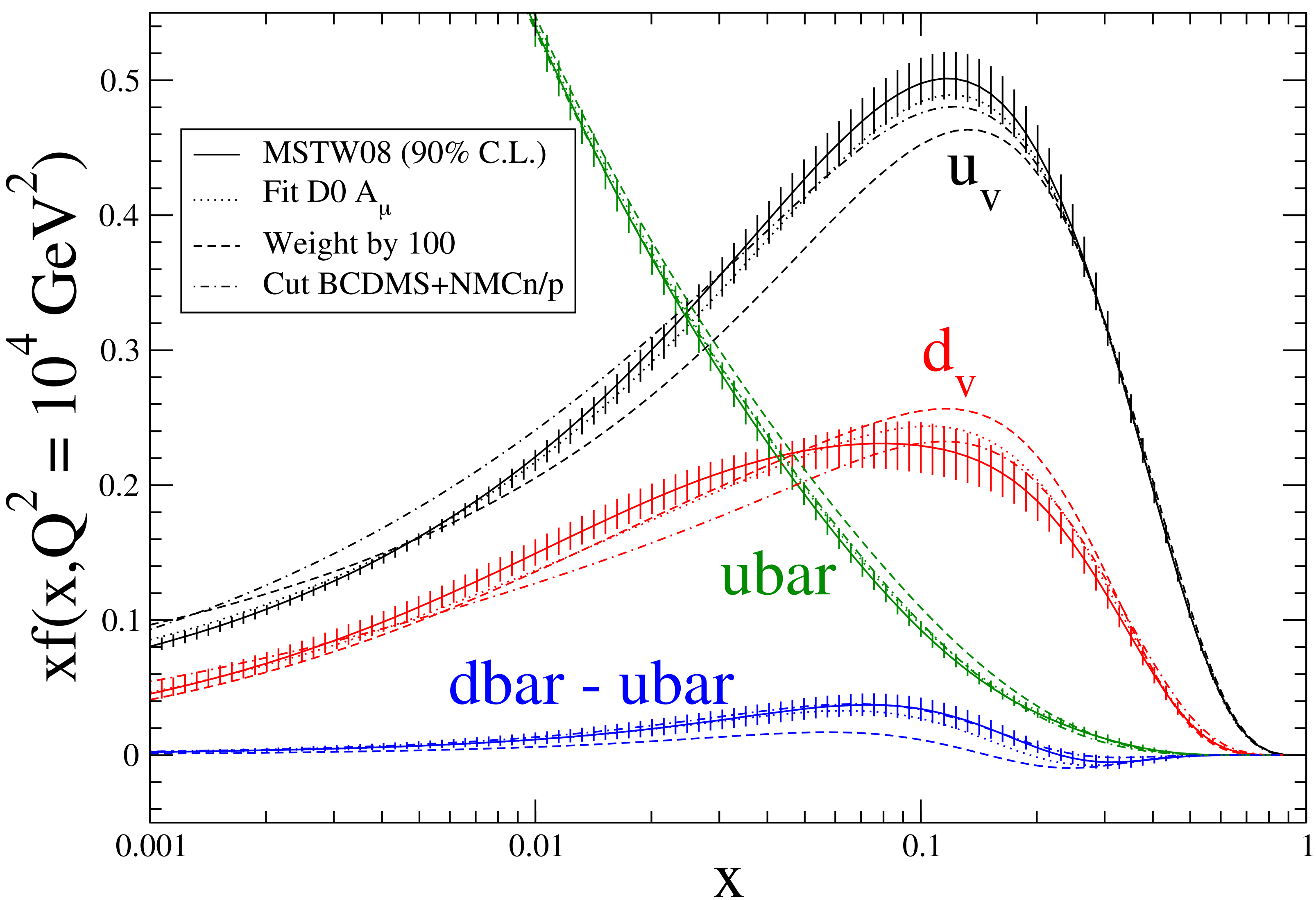
Fit to D0 e and μ data and other data. w denotes high weight D0 data set.

Cut – omit BCDMS, NMCn/p from fit.

Cut data have $\chi^2 = 1222/462$. Other (not D0$_\mu$) data $\chi^2 = 48$ lower (mainly Drell-Yan and F_2^d).

fit	$\chi^2/12$ D0$_e$ $p_T > 25$	$\chi^2/12$ D0$_e$ $25 < p_T < 35$	$\chi^2/12$ D0$_e$ $35 < p_T < 45$	$\chi^2/2689$ non-D0	$\chi^2/16$ D0$_\mu$ both p_T
Standard MSTW08	116	19	144	2518	542
fit D0$_e$	71	23	81	2551	358
fit D0$_e$ (w)	25	10	23	2942	183
fit D0$_\mu$	26	55	88	2640	119
fit D0$_\mu$ (w)	33	79	88	3131	10
fit D0$_\mu$ (w) cut	33	52	55	3190	26

Change in PDFs when fitting W -> μν data with 4.9 fb^{-1} from D0



Change in partons for good fits much larger than uncertainties.

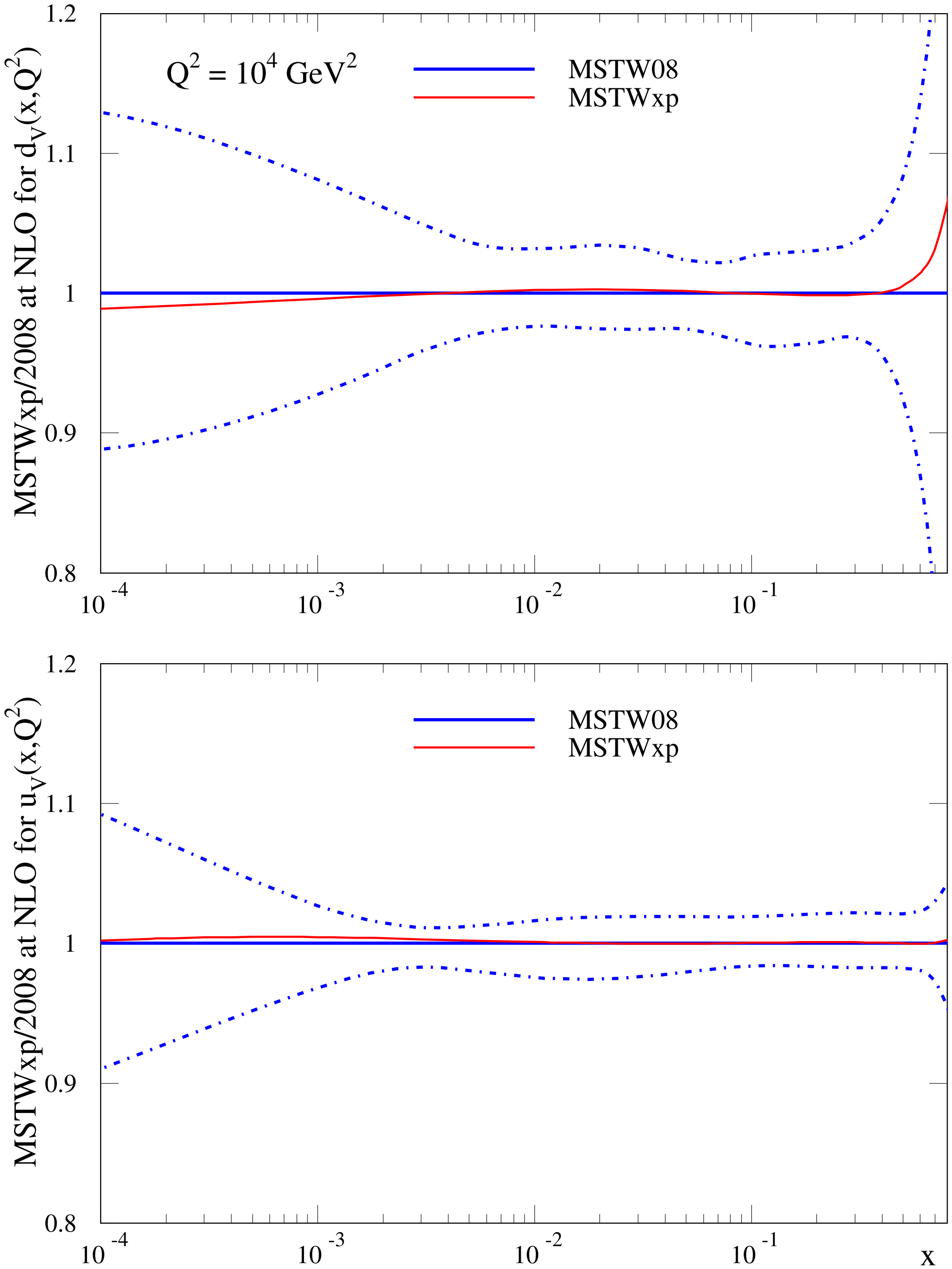
Previously tried adding x^2 terms to standard $(1+\epsilon x^{0.5}+\gamma x)$ polynomial multiplying $A_V(1-x)^\eta x^\delta$ in two valence parameterisations.

Fit quality improved by 2 units.

Change in partons negligible.

Tried also in fits with new asymmetry data.

Again very little effect indeed.



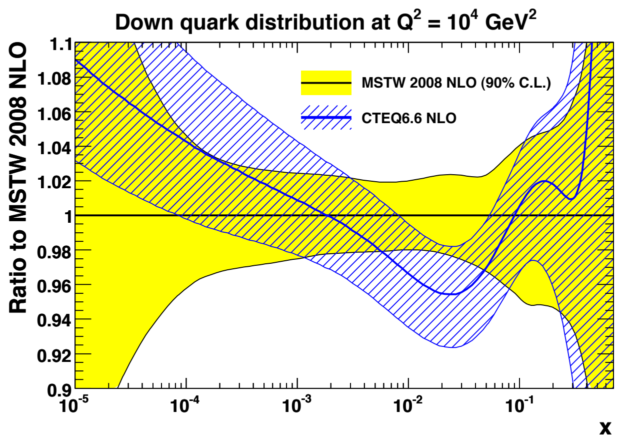
In standard fit data corrected for shadowing at small-x, but not for any high-x effects.

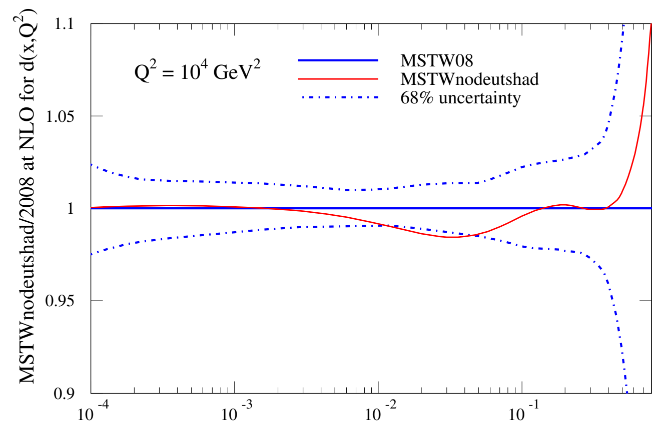
CTEQ apply no corrections. Leads to slightly better comparison to asymmetry data when we try this, (smaller $d(x)$ at $x \sim 0.01$) but quite small effect.

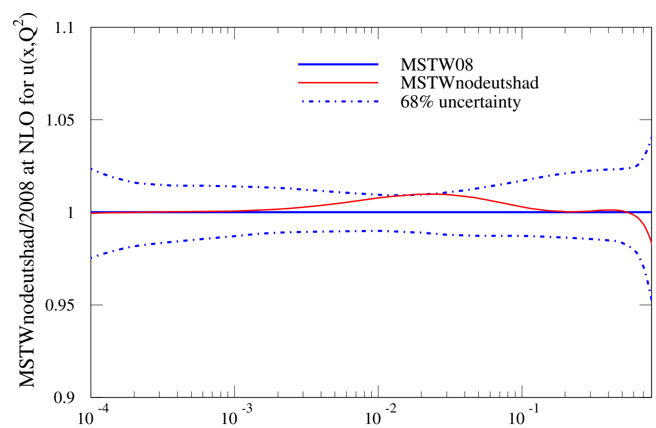
Using standard MSTW08 data $\chi^2 = 19/10$ (from $\chi^2 = 25/10$) for D0 data and $\chi^2 = 25/22$ (from $\chi^2 = 29/22$) for CDF data.

Partons only change by fairly small amounts, but can approach 68% uncertainty band for $u(x,Q^2)$ and $d(x,Q^2)$ in expected region $0.01 < x < 0.1$.

Dip in $d(x,Q^2)$ indeed reminiscent of comparison to CTEQ, but smaller. (Effect on this in recent Pumplin paper arXiv:0909.5176.)







Also try more sophisticated approach to corrections for deuterium data.

Try alternative Q^2-independent deuterium corrections for all x applied to theory corrected by means of a smooth function with 4 free parameters.

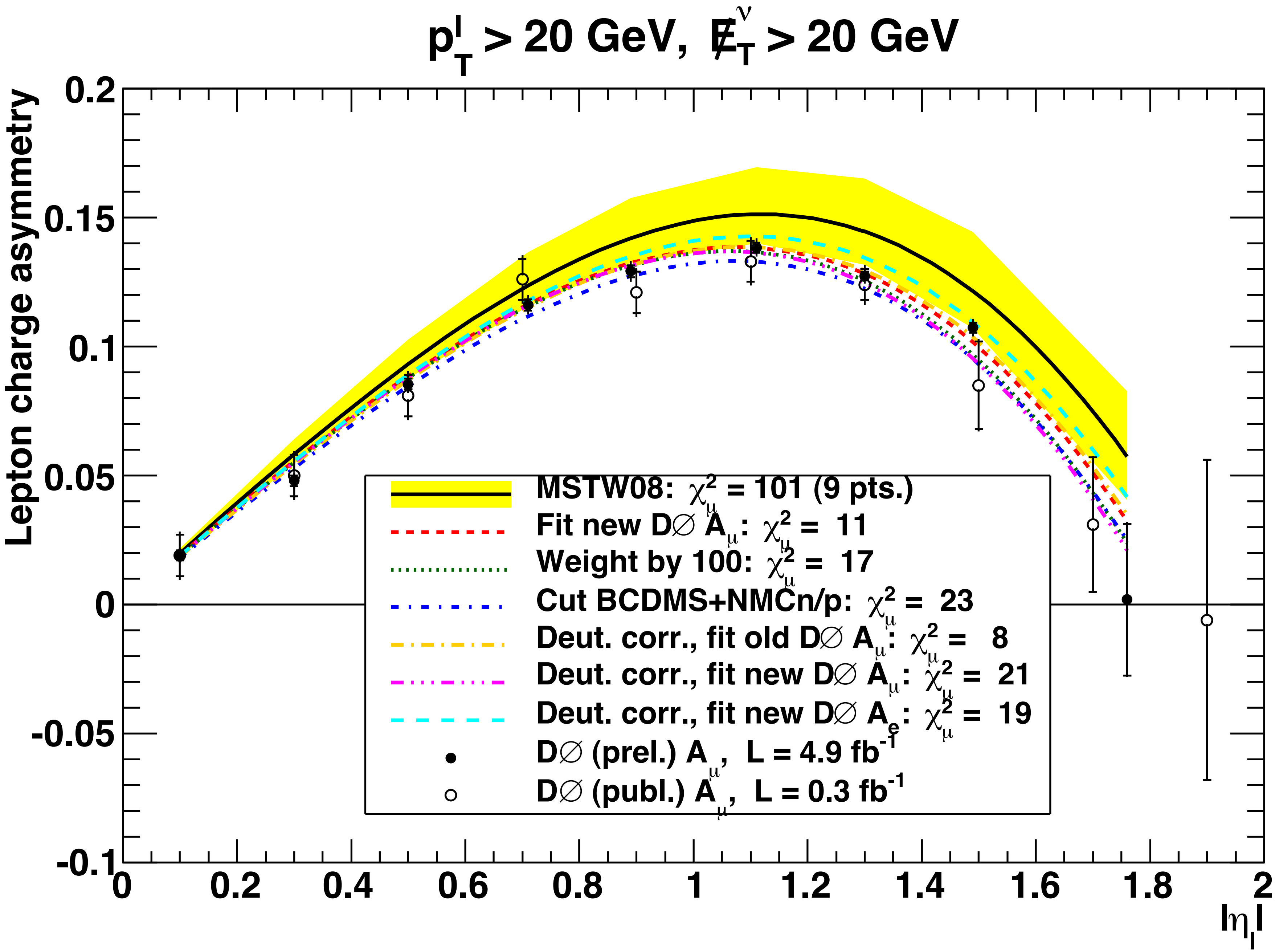
Improves quality of fit to non-asymmetry data significantly. Also ...

Using standard MSTW08 data $\chi^2 = 6/10$ (from $\chi^2 = 25/10$) for D0 (PRD 77) data and $\chi^2 = 21/22$ (from $\chi^2 = 29/22$) for CDF data (PRD 71).

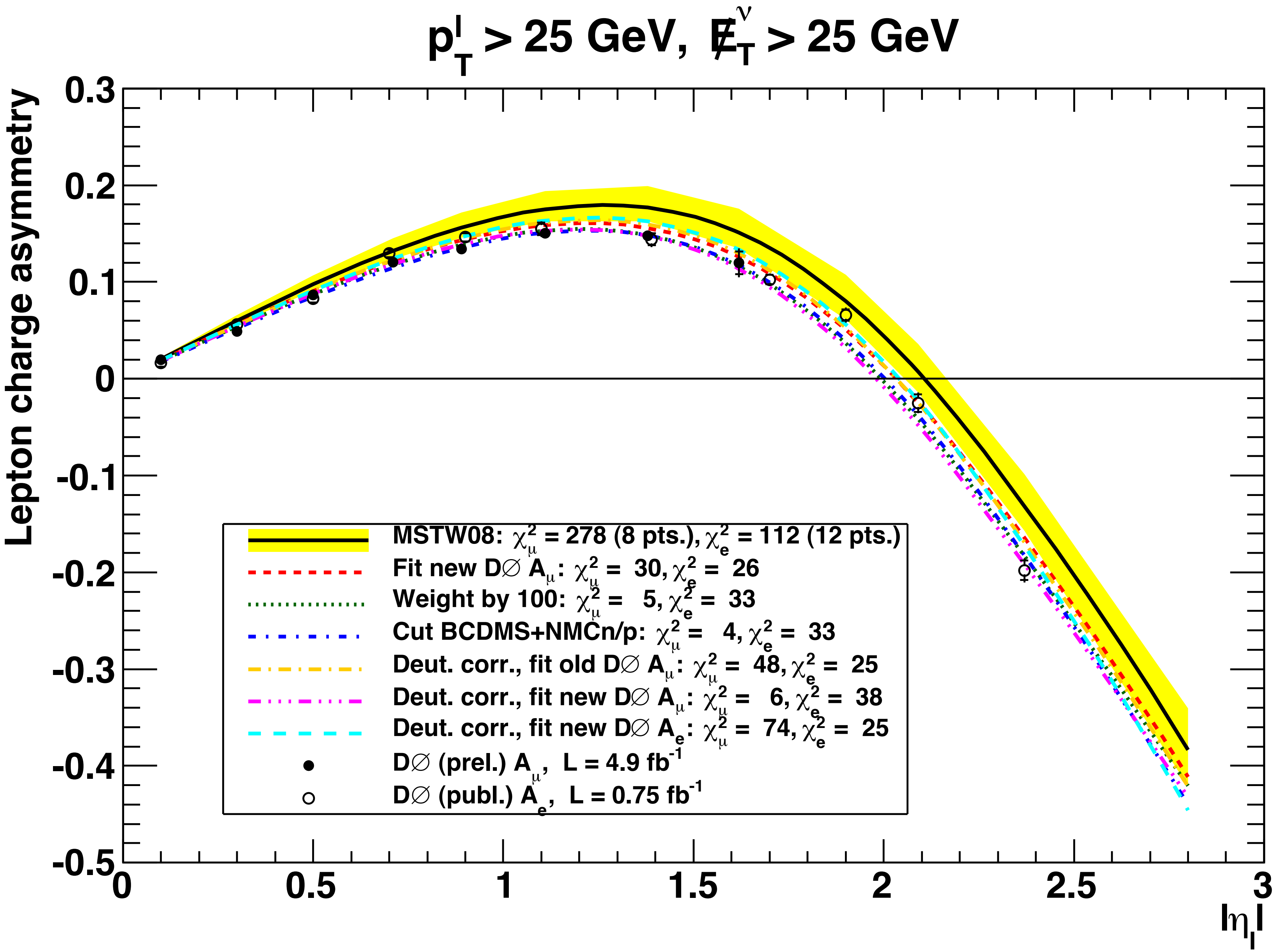
Fit to D0 e and μ data and other data. w denotes high weight D0 set.

fit	$\chi^2/12$ D0$_e$ $p_T > 25$	$\chi^2/12$ D0$_e$ $25 < p_T < 35$	$\chi^2/12$ D0$_e$ $35 < p_T < 45$	$\chi^2/2689$ non-D0	$\chi^2/16$ D0$_\mu$ both p_T
Deut. Corr.					
MSTW08 data	25	32	42	2455	140
fit D0$_e$ (w)	25	9	23	2551	192
fit D0$_\mu$ (w)	38	67	75	2649	11
fit D0$_{e+\mu}$ (w)	24	16	40	2848	42
fit D0$_e$ $p_T > 25$	23	38	32	2454	229

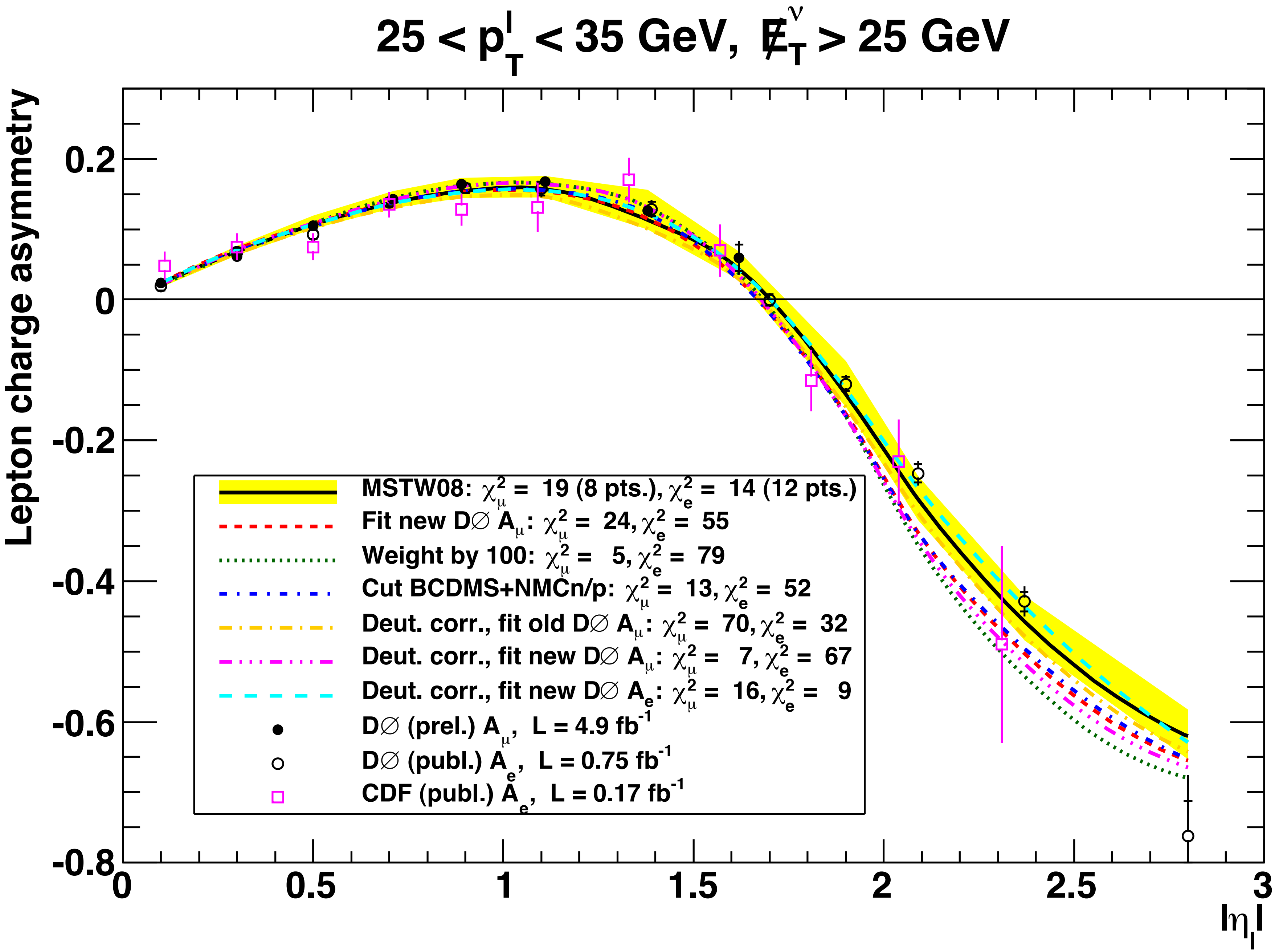
Deuterium corrections help significantly.



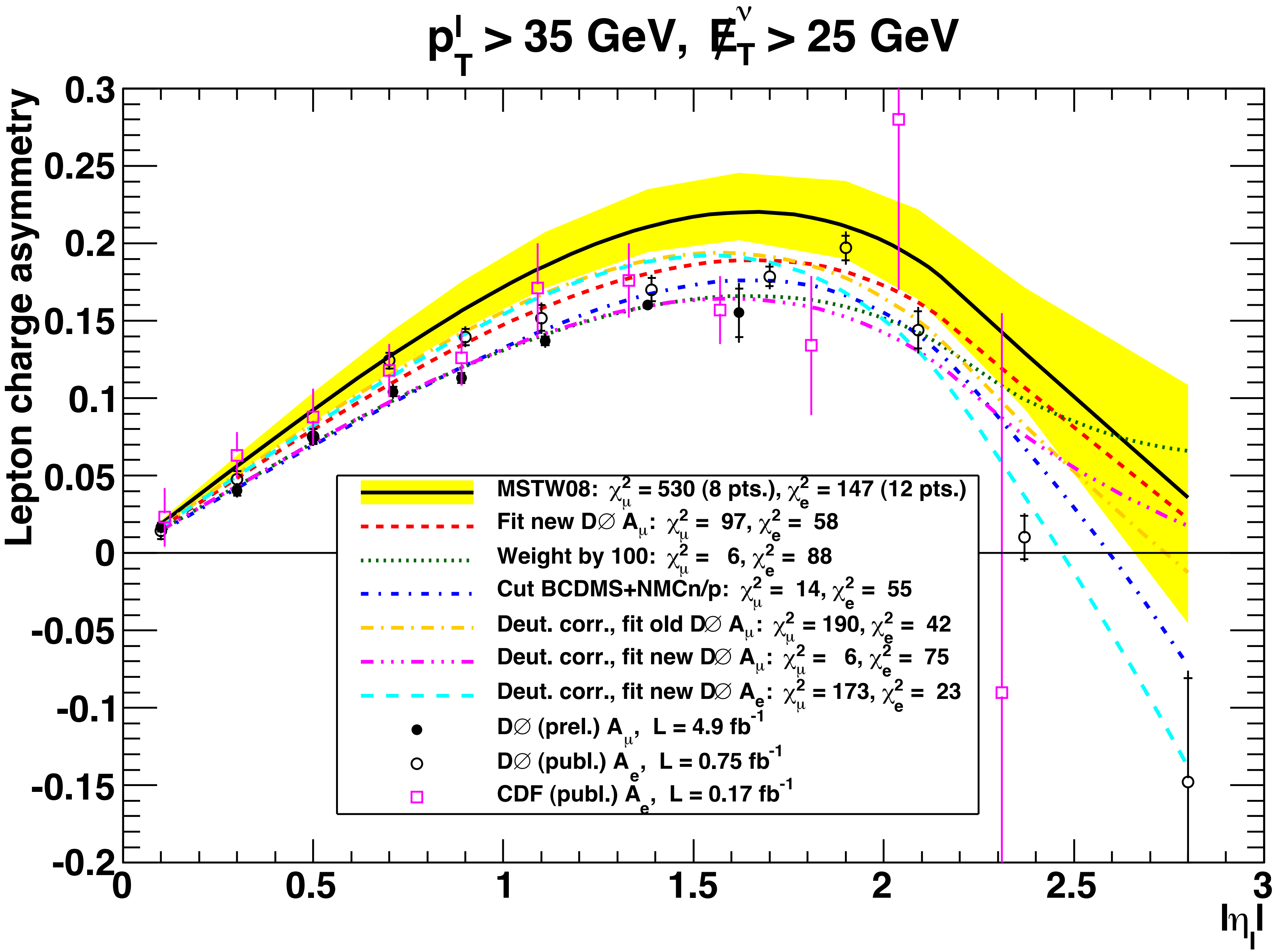
p_T^l > 20 GeV, $\not{E}_T^\nu$ > 20 GeV
Lepton charge asymmetry
0.2
0.15
0.1
0.05
0
-0.05
-0.1
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
$|\eta_l|$
MSTW08: χ^2_μ = 101 (9 pts.)
Fit new D∅ A_μ: χ^2_μ = 11
Weight by 100: χ^2_μ = 17
Cut BCDMS+NMCn/p: χ^2_μ = 23
Deut. corr., fit old D∅ A_μ: χ^2_μ = 8
Deut. corr., fit new D∅ A_μ: χ^2_μ = 21
Deut. corr., fit new D∅ A_e: χ^2_μ = 19
D∅ (prel.) A_μ, L = 4.9 fb^{-1}
D∅ (publ.) A_μ, L = 0.3 fb^{-1}



p_T^l > 25 GeV, E̸_T^ν > 25 GeV
Lepton charge asymmetry
|η_l|
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
0
0.5
1
1.5
2
2.5
3
MSTW08: χ²_μ = 278 (8 pts.), χ²_e = 112 (12 pts.)
Fit new D∅ A_μ: χ²_μ = 30, χ²_e = 26
Weight by 100: χ²_μ = 5, χ²_e = 33
Cut BCDMS+NMCn/p: χ²_μ = 4, χ²_e = 33
Deut. corr., fit old D∅ A_μ: χ²_μ = 48, χ²_e = 25
Deut. corr., fit new D∅ A_μ: χ²_μ = 6, χ²_e = 38
Deut. corr., fit new D∅ A_e: χ²_μ = 74, χ²_e = 25
D∅ (prel.) A_μ, L = 4.9 fb⁻¹
D∅ (publ.) A_e, L = 0.75 fb⁻¹



25 < p$_T^l$ < 35 GeV, $\not{E}_T^\nu$ > 25 GeV
Lepton charge asymmetry
0.2
0
-0.2
-0.4
-0.6
-0.8
0
0.5
1
1.5
2
2.5
3
$|\eta_l|$
MSTW08: χ^2_μ = 19 (8 pts.), χ^2_e = 14 (12 pts.)
Fit new D∅ A_μ: χ^2_μ = 24, χ^2_e = 55
Weight by 100: χ^2_μ = 5, χ^2_e = 79
Cut BCDMS+NMCn/p: χ^2_μ = 13, χ^2_e = 52
Deut. corr., fit old D∅ A_μ: χ^2_μ = 70, χ^2_e = 32
Deut. corr., fit new D∅ A_μ: χ^2_μ = 7, χ^2_e = 67
Deut. corr., fit new D∅ A_e: χ^2_μ = 16, χ^2_e = 9
D∅ (prel.) A_μ, L = 4.9 fb^{-1}
D∅ (publ.) A_e, L = 0.75 fb^{-1}
CDF (publ.) A_e, L = 0.17 fb^{-1}



p_T^l > 35 GeV, $\not{E}_T^{\nu}$ > 25 GeV
Lepton charge asymmetry
0.3
0.25
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
0
0.5
1
1.5
2
2.5
3
$|\eta_l|$
MSTW08: χ^2_μ = 530 (8 pts.), χ^2_e = 147 (12 pts.)
Fit new DØ A_μ: χ^2_μ = 97, χ^2_e = 58
Weight by 100: χ^2_μ = 6, χ^2_e = 88
Cut BCDMS+NMCn/p: χ^2_μ = 14, χ^2_e = 55
Deut. corr., fit old DØ A_μ: χ^2_μ = 190, χ^2_e = 42
Deut. corr., fit new DØ A_μ: χ^2_μ = 6, χ^2_e = 75
Deut. corr., fit new DØ A_e: χ^2_μ = 173, χ^2_e = 23
DØ (prel.) A_μ, L = 4.9 fb^{-1}
DØ (publ.) A_e, L = 0.75 fb^{-1}
CDF (publ.) A_e, L = 0.17 fb^{-1}

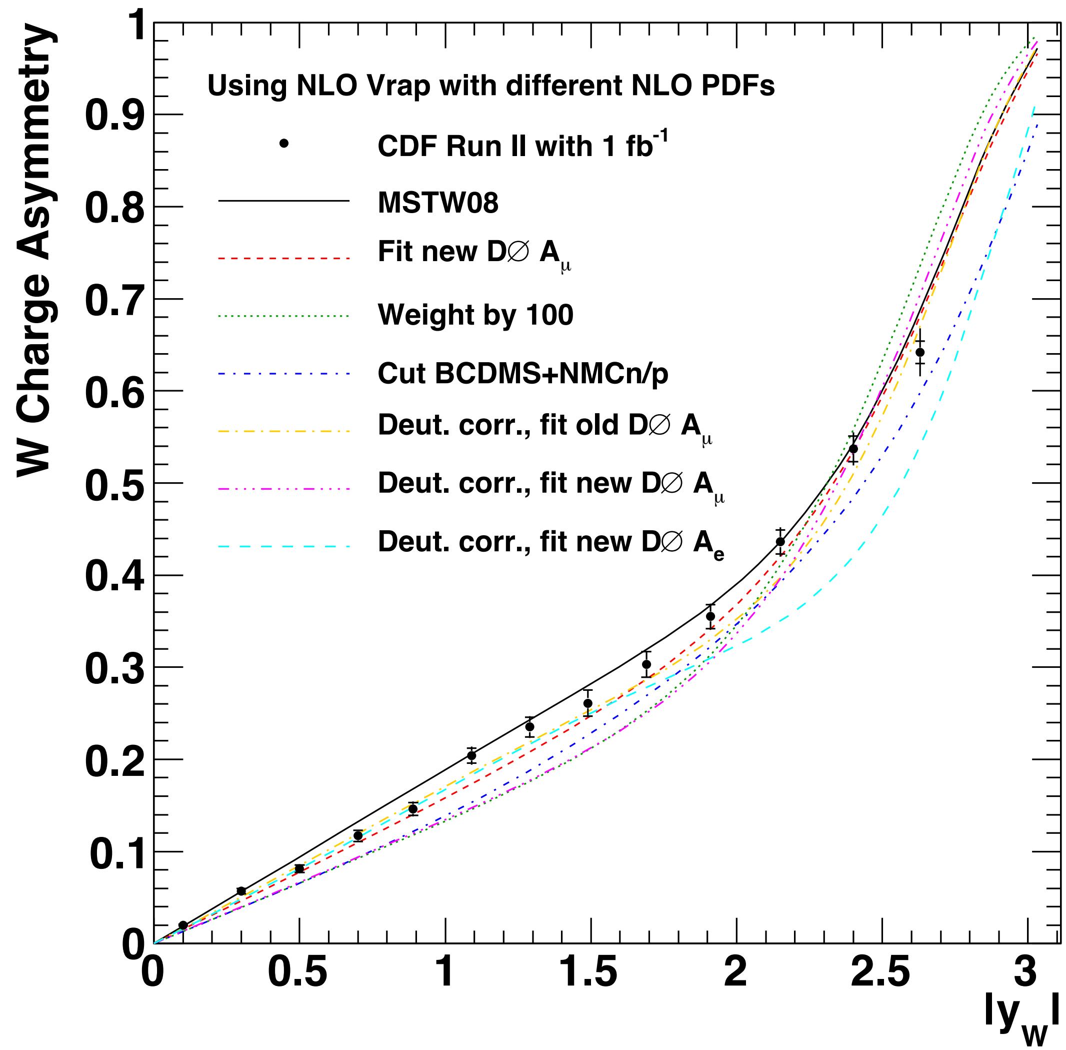
Compare various MSTW predictions to the published CDF data on W-asymmetry.

Standard MSTW fit gives reasonable comparison as does standard fit with allowed deuterium corrections.

Approx χ^2 is $28/13$ and $24/13$ respectively.

Only unweighted (and poor) fit to $D0_\mu$ data is at all similar. All others $\chi^2 > 100$.

All others show some region of clearly too much suppression for some region of rapidity.

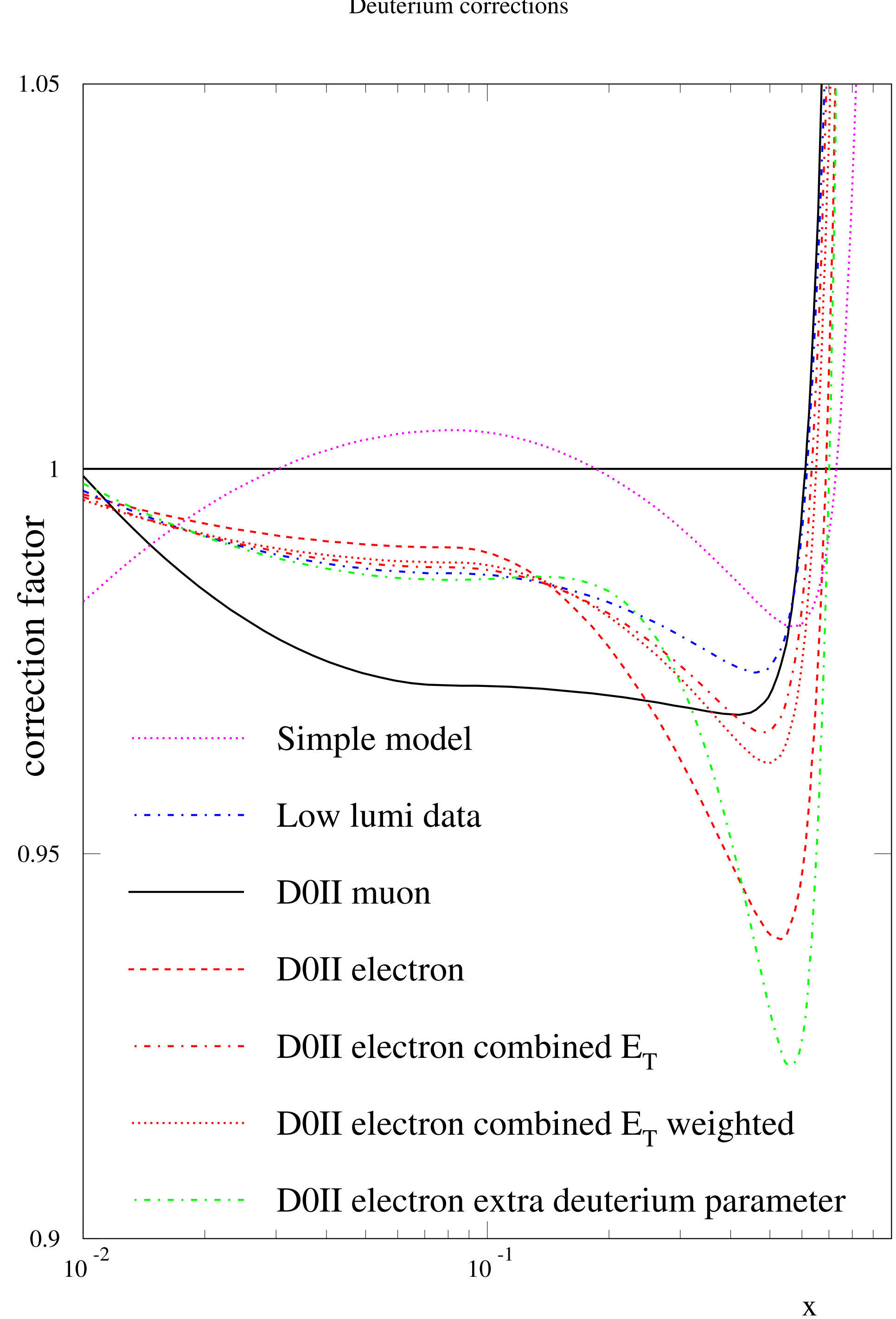


Deuterium corrections help significantly but are very large/unusual for best fits to muon or electron asymmetry in both p_T bins.

All dip at $x \sim 0.6$ (binding effects) and rise quickly at very high x (Fermi motion), but dips to less than ~ 0.97 not expected.

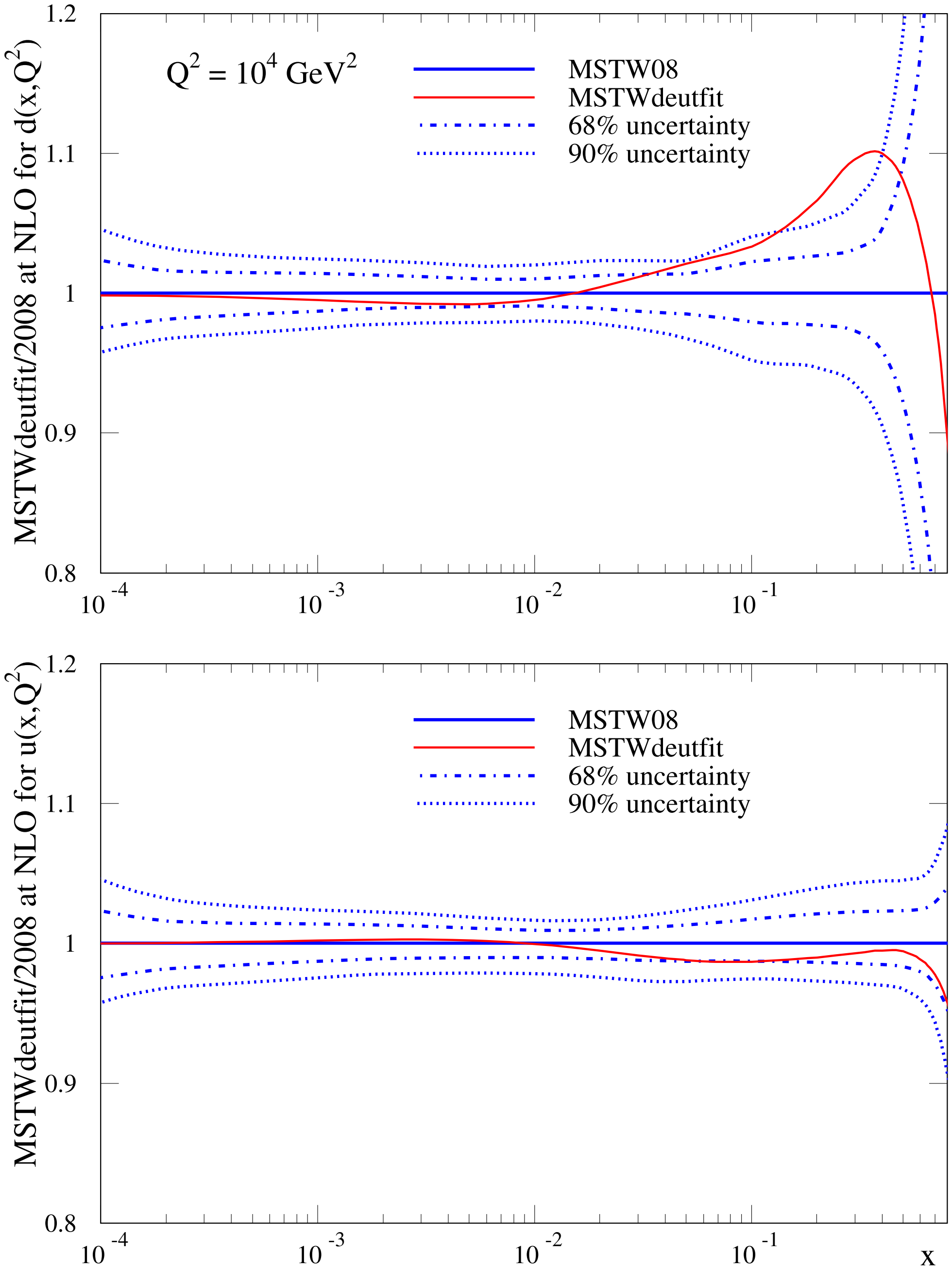
Tendency to rise (and go above 1 for $x < 0.01$) for lowest x not strong, and driven by deuterium data rater than asymmetry data, so low x shadowing corrections roughly consistent with expected shadowing.

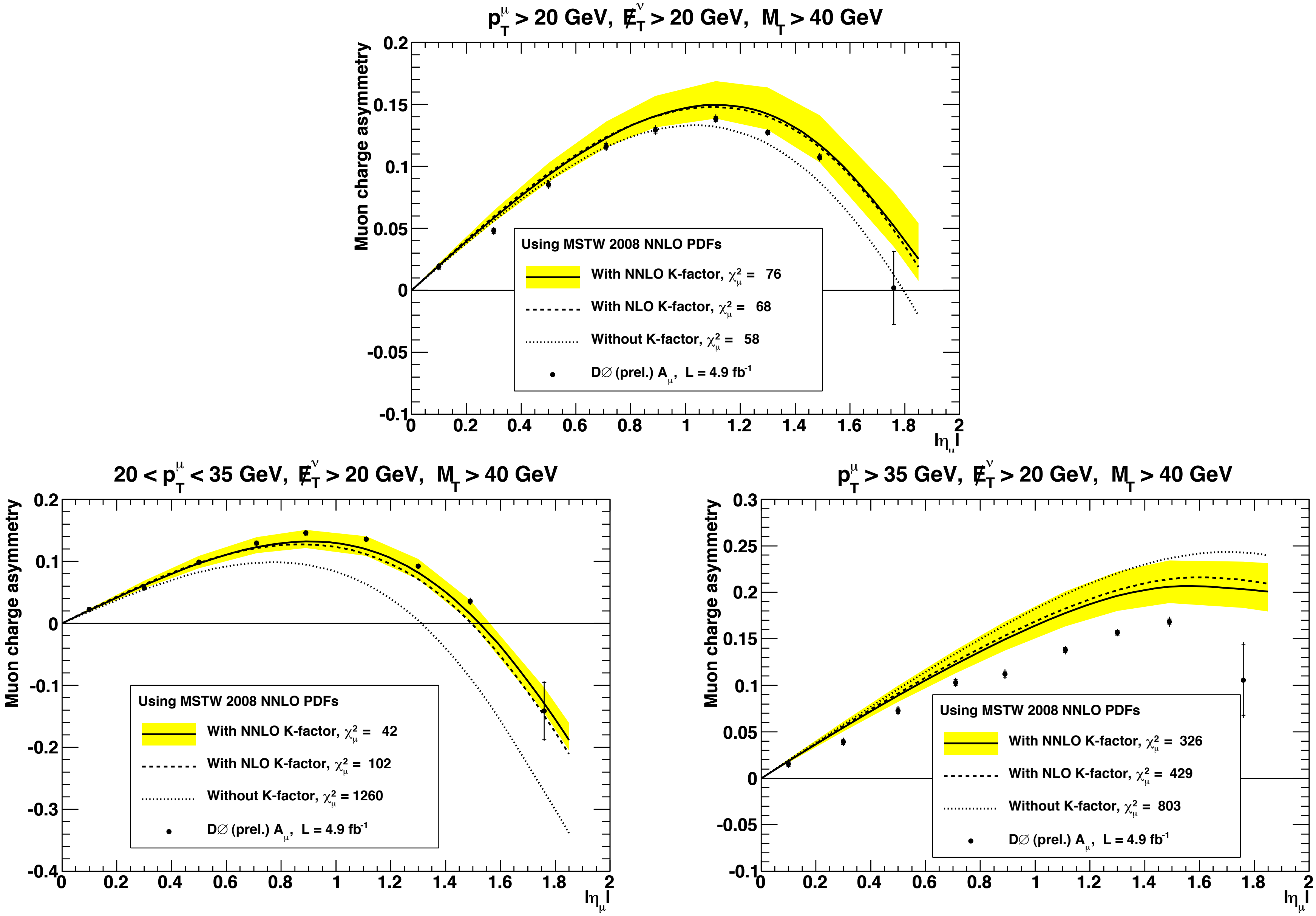
Suppression even at $x \sim 0.1$ (anti-shadowing region) unexpected. Particularly needed for $D0_\mu$ data.



Refit with free deuterium corrections results in a change of the PDFs often at the level of the 68% uncertainty band.

For $d(x, Q^2)$ for $0.2 < x < 0.4$ can even be outside 90% uncertainty.





NNLO corrections (Grazzini et al) are in the correct direction to help resolve discrepancies with D0 data but are too small to fully account for them.

Observation on Relationship Between Gluon and $\alpha_S(M_Z^2)$

In study of α_S within global fit noticed that within full fit HERA cross-section data prefer large $\alpha_S(M_Z^2) \approx 0.125$ at NLO (0.121 at NNLO). Due to presence of other data?

Fitting only to these data using NLO find $\alpha_S(M_Z^2) = 0.127 \pm 0.005$ (using $\Delta\chi^2 = 1$) and $\chi^2 = 57$ lower than in global fit for 839 points.

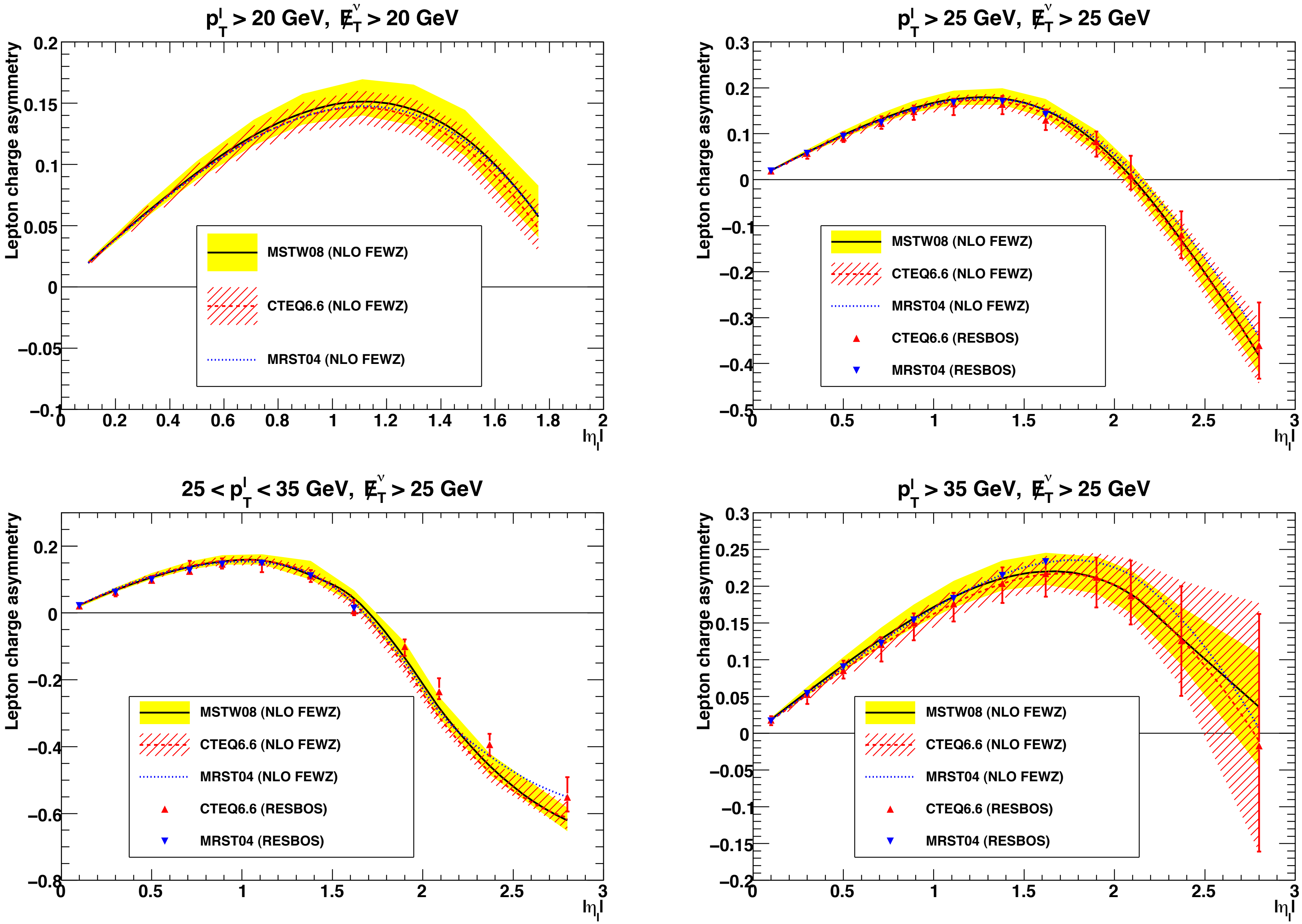
However, repeated fit removing second term from

$$xg(x, Q_0^2 = 1\mathrm{GeV}^2) = A_g(1-x)^{\eta_g}(1+\epsilon_g x^{0.5} + \gamma_g x)x^{\delta_g} + A_{g'}(1-x)^{\eta_{g'}} x^{\delta_{g'}}.$$

Obtain instead $\alpha_S(M_Z^2) = 0.110 \pm 0.002$ with χ^2 now 17 higher.

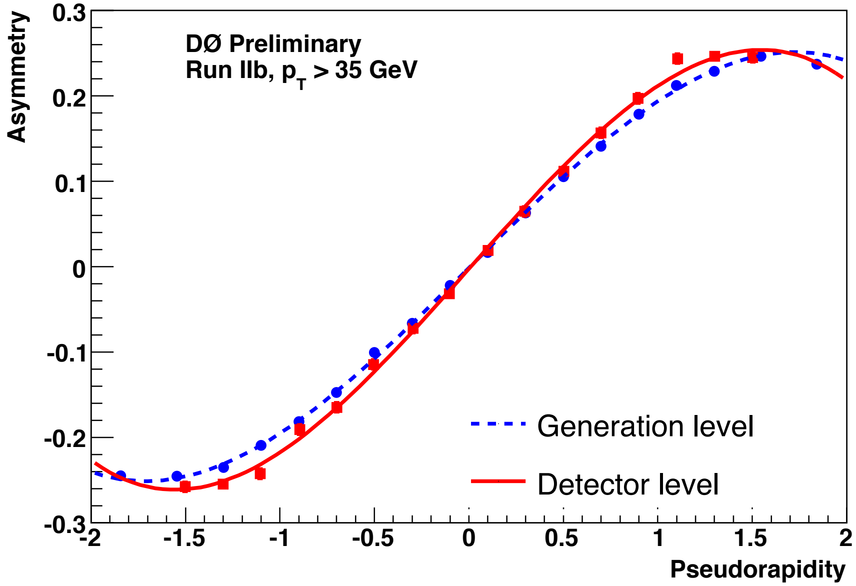
Use restricted parameterisation at $Q_0^2 = 1.5\mathrm{GeV}^2$. Now χ^2 only 4 higher than best fit. Data *happy* with positive input gluon - similar to other single power gluon fits? Obtain $\alpha_S(M_Z^2) = 0.117 \pm 0.0025$. (Find $\alpha_S(M_Z^2) = 0.132 \pm 0.006$ with free parameterisation.)

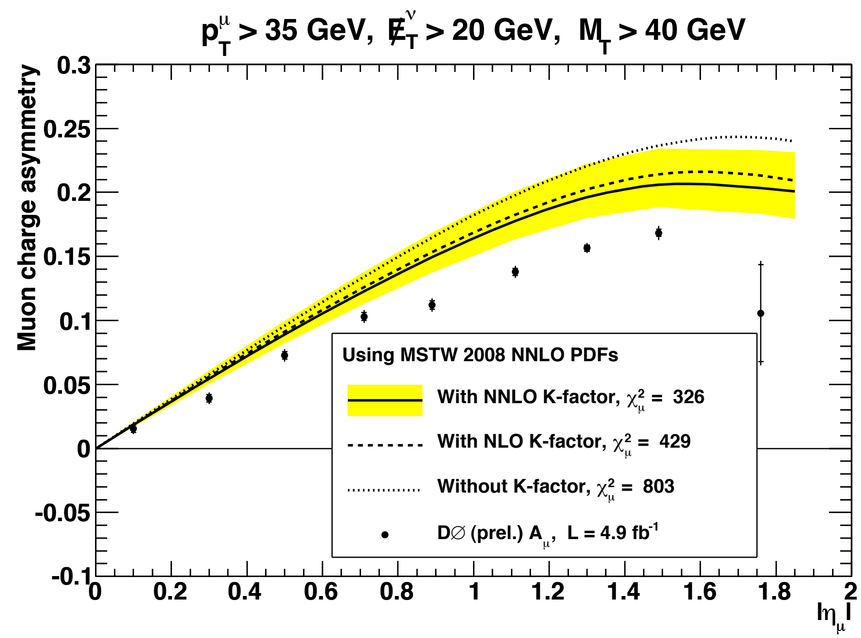
Both extracted $\alpha_S(M_Z^2)$ and its uncertainty (obtained from careful scan - higher value otherwise) sensitive to limited gluon parameterisation. Both become lower.



Comparison between use of FEWZ and RESBOS for CTEQ6.6 and MRST04

Notice that Monte Carlo for D0 muon data (fig. 2 of D0 note 5976-CONF) much bigger than data, particularly for high p_T. Influence on detector corrections?





Monte Carlo data more than 50% greater than actual data.

Effect on size of detector corrections?

Have difficulty fitting some recent lepton/boson asymmetry data at NLO. NNLO seems to help, but not very much. Deuterium corrections help, both with normal fit and asymmetry data. Improve asymmetry data fit in MSTW08 a lot.

Without deuterium corrections reasonable fit to CDF W-asymmetry possible without high penalty. All D0 sets bad.

With deuterium corrections can fit CDF W-asymmetry and D0 electron asymmetry for combined p_T with no problems. D0 electron asymmetry for separate p_T not too bad, but large deuterium assumption. **D0 muon data impossible without high penalty.**

Maximally self consistent sets seem to be CDF W-asymmetry and D0 electron asymmetry for combined p_T.