MSTW PDFs – Impact of NMC data/treatment

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July 5th, 2011

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In their 1997 measurement of structure functions NMC obtained $R(x,Q^2) = F_L(x,Q^2)/(F_2(x,Q^2) - F_L(x,Q^2))$ for a few points directly by investigating cross-section measurement at common x and Q^2 but different y from different beam energy runs.

In previous measurements 1995 had not done this but assumed SLAC parameterisation $R_{1990}(x,Q^2)$.

Sensitivity to $R(x,Q^2)$ in relationship between $F_2(x,Q^2)$ and cross section.

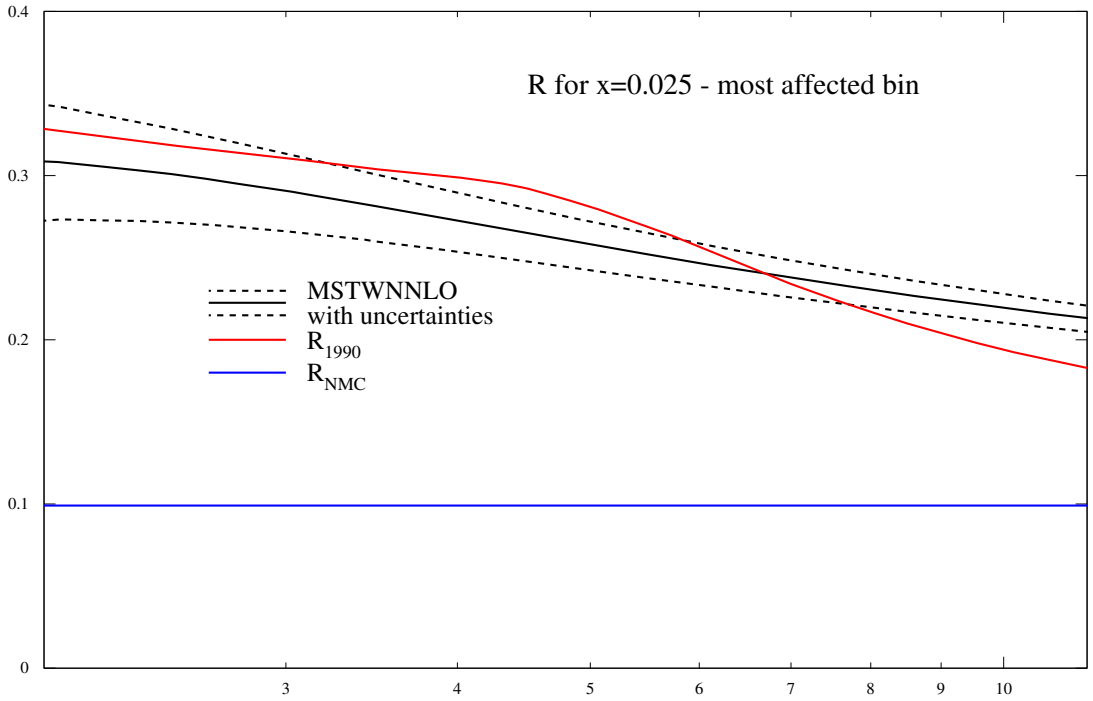
$$\frac{d^2\sigma}{dxdQ^2} = \frac{4\pi\alpha^2}{xQ^4}\left[1 - y + \frac{y^2/2}{1+R(x,Q^2)}\right]F_2(x,Q^2)$$

In 1997 results used direct measurement of $R_{\rm NMC}(x)$ in x bins for $x \leq 0.12$ (only one for each x bin) to obtain $F_2(x,Q^2)$.

Using $R(x,Q^2)$ too small, as $R_{\rm NMC}$ often is, leads to a smaller $F_2(x,Q^2)$, if y is large.

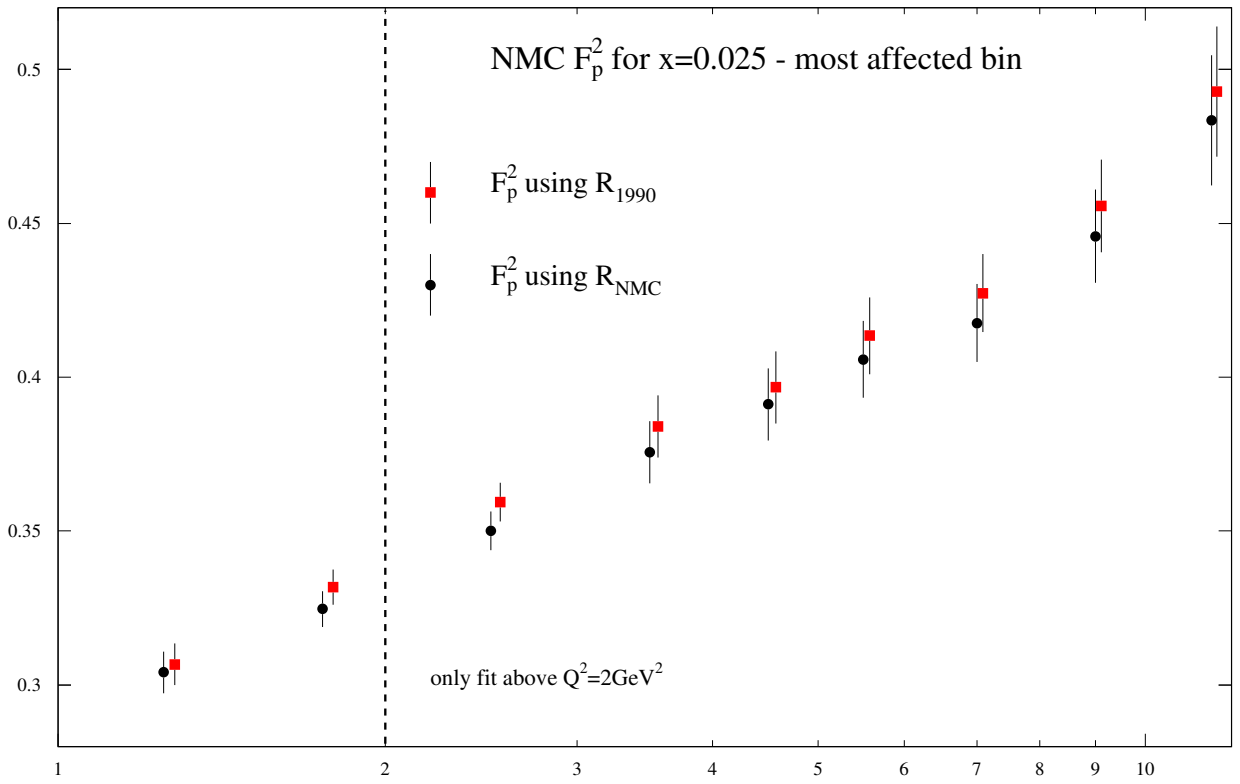
(Remember switch between 1995 and 1997 measurements when preparing MRST98 PDFs, and no real effect noticed).

Big different between $R_{\rm NMC}(x,Q^2)$ and $R_{1990}(x,Q^2)$ and $R_{\rm MSTW}(x,Q^2)$ in some bins



Most consistent to fit to $d^2\sigma/dxdQ^2$.

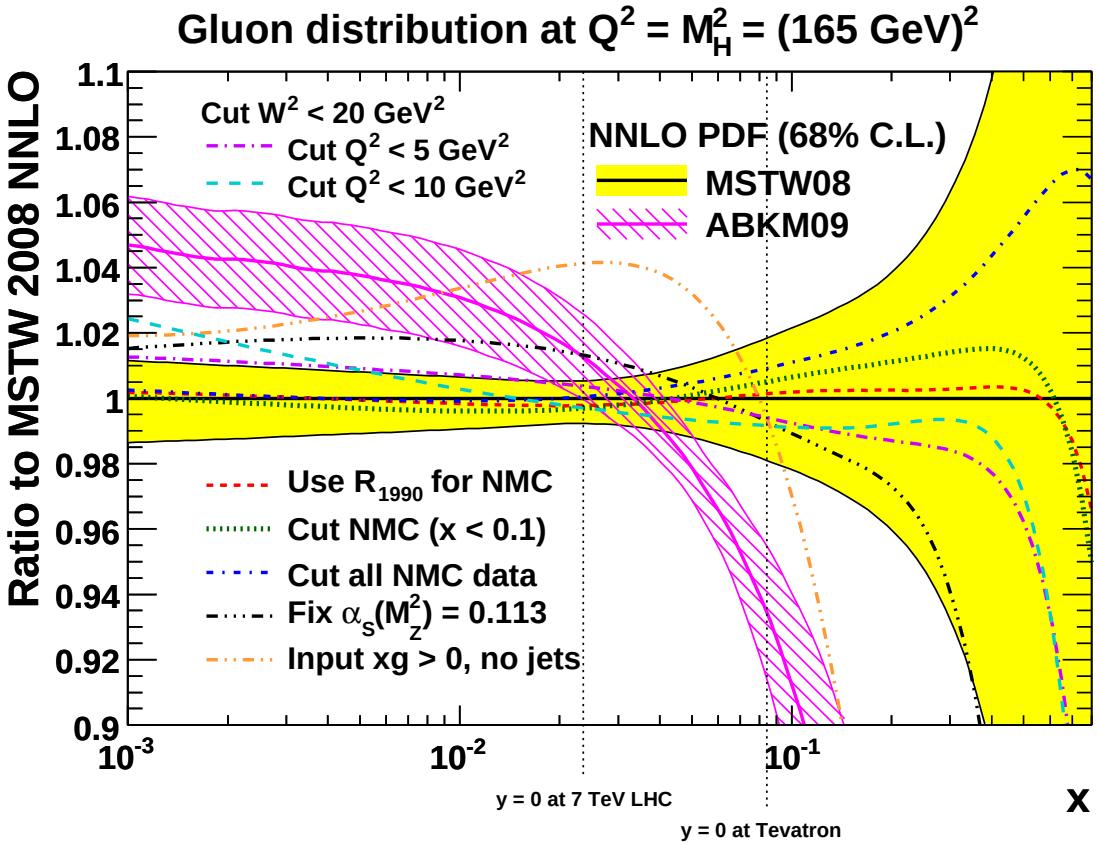
However, at NNLO, $R_{\rm MSTW}(x,Q^2) \approx R_{1990}(x,Q^2)$ so using $F_2(x,Q^2)$ extracted using $R_{1990}(x,Q^2)$ very similar indeed.



Because we use data averaged over energy bins effect not actually so large since y is never large in all bins.

Show easily worst x bin, i.e. $R_{\rm MSTW}(x,Q^2)$ and $R_{\rm NMC}(x,Q^2)$ very different, many points high y and quite a lot of points survive cut of $Q^2 \geq 2{\rm GeV}^2, W^2 \geq 15{\rm GeV}^2$.

Not much difference and we get $\Delta\alpha_S(M_Z^2) = 0.0012$ from a fit to 2500 other data points.



Repeat global fit at NNLO changing the $F_2(x, Q^2)$ from NMC to that using $R_{1990}(x, Q^2)$, cutting NMC data sensitive to the change, cutting all NMC data changing Q^2_{cut} up from $2\mathrm{GeV}^2$ (and losing much of the NMC data along with sensitivity to higher twist). None causes much change in the gluon.

Use the MSTW08 fit with $\alpha_S(M_Z^2) = 0.113$. More similar to ABKM09 gluon, but not all the way. Most similar, remove jet data from fit and use simpler gluon parameterisation (4 parameters) with one small-x power.

NNLO PDF	$\alpha_S(M_Z^2)$	σ_H Tevatron	σ_H LHC (7 TeV)
MSTW08	**0.1171**	**0.342 pb**	**7.91 pb**
Use R_{1990} for NMC	0.1167	-0.7%	-0.9%
Cut NMC ($x < 0.1$)	0.1162	-1.2%	-2.1%
Cut all NMC data	0.1158	-0.7%	-2.1%
Cut $Q^2 < 5$ GeV^2, $W^2 < 20$ GeV^2	0.1171	-1.2%	$+0.4\%$
Cut $Q^2 < 10$ GeV^2, $W^2 < 20$ GeV^2	0.1164	-3.0%	-1.7%
Fix $\alpha_S(M_Z^2)$	0.1130	-11%	-7.6%
Input $xg > 0$, no jets	0.1139	-17%	-4.9%
ABKM09	0.1135	-26%	-11%

Change in $\alpha_S(M_Z^2)$ and Higgs production ($m_H = 165\text{GeV}$) cross sections with fits outlined.

Only the imposition of $\alpha_S(M_Z^2) = 0.113$, and even more-so the fit with no jets and restricted parameterisation (which automatically gives $\alpha_S(M_Z^2) = 0.1139$) move much towards the ABKM09 values.

Some observations.

NMC analysis in region of higher twist. Have shown insensitivity to this.

Change in α_S with treatment of correlated errors in HERA data questioned. In MRST2001 fit checked this has $\Delta\alpha_S(M_Z^2) = -0.0003$ effect. Includes most of HERA data in MSTW2008 fit.

First HERA-LHC benchmark study of PDFs – treatment without correlated errors gave $\Delta\alpha_S(M_Z^2)$ of over 0.002 lower.

Use of combined HERA data with reduced effect of correlated errors pushes $\alpha_S(M_Z^2)$ up about 0.001.

Note that slope of $F_2^c(x, Q^2)$ varies quite a lot at low Q^2 between NLO and NNLO. Use NLO $F_2^c(x, Q^2)$ in ABKM09 fit. Improved since.