More thoughts on parton distributions: why do pdf sets differ?

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Why do ‘best fit’ pdfs differ?

- different data sets in fit
  - different sub-selection of data
  - different treatment of exp. sys. errors
- different choice of
  - factorisation/renormalisation scheme/scale
  - Q_0^2
  - parametric form $Ax^a(1-x)^b[..]$ etc
  - α_S
  - treatment of heavy flavours
  - theoretical assumptions about $x \to 0,1$ behaviour
  - theoretical assumptions about sea flavour symmetry
  - evolution and cross section codes (removable differences!)

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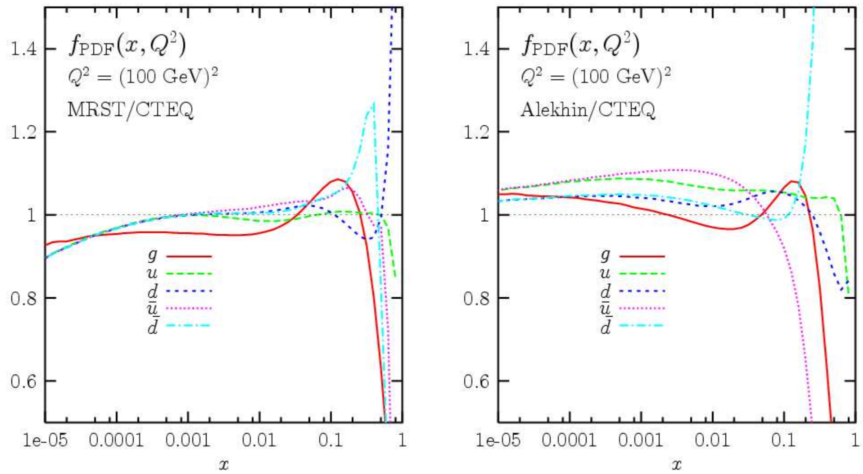
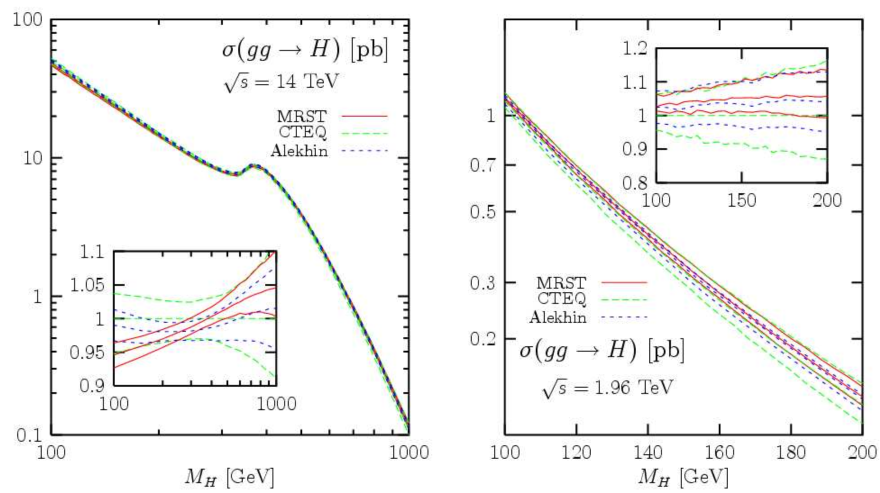


Djouadi & Ferrag, hep-ph/0310209



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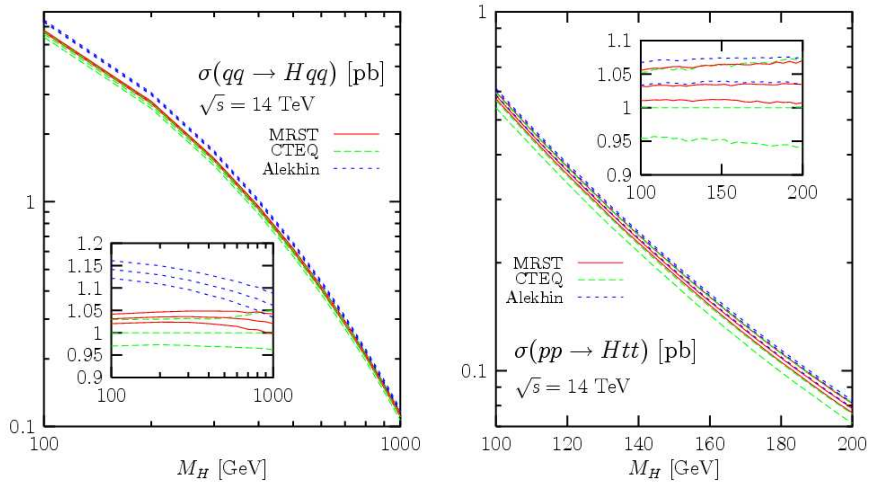


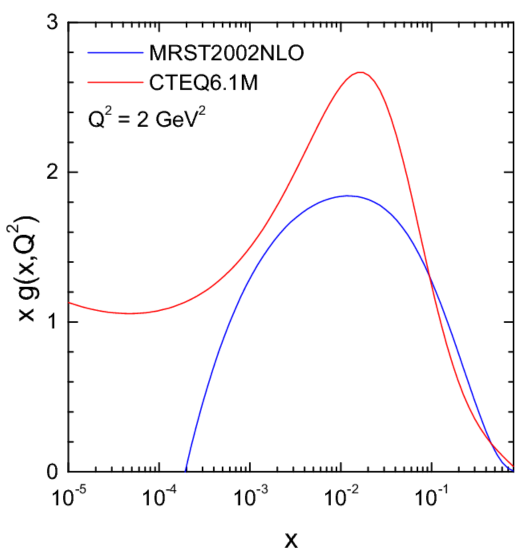
Djouadi & Ferrag, hep-ph/0310209

- MRST: $Q_0^2 = 1$ GeV^2

$$xg = Ax^a(1-x)^b(1+Cx^{0.5}+Dx) - Ex^c(1-x)^d$$

- CTEQ6: $Q_0^2 = 1.69$ GeV^2

$$xg = Ax^a(1-x)^b e^{cx}(1+Cx)^d$$



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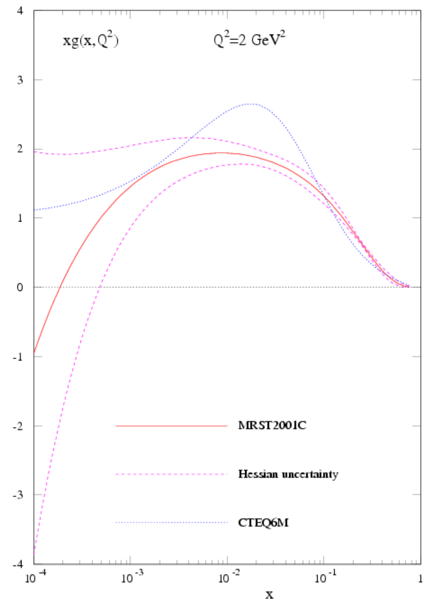

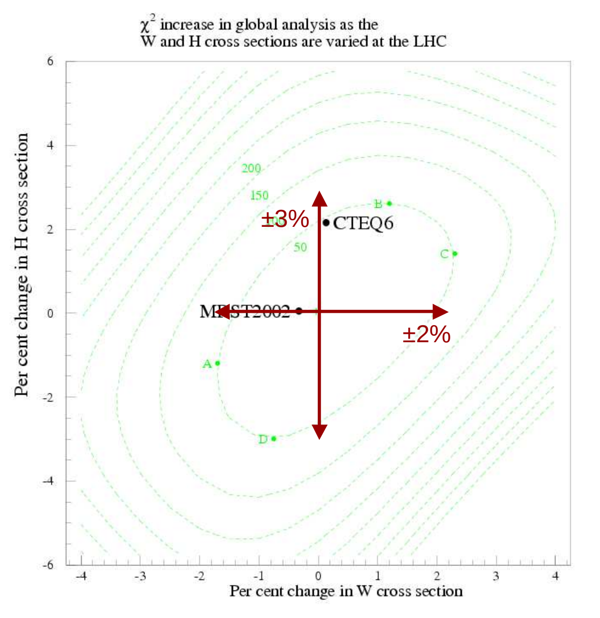

contours correspond to ' experimental' pdf errors only; shift of prediction using CTEQ6 pdfs shows effect of 'theoretical' pdf errors

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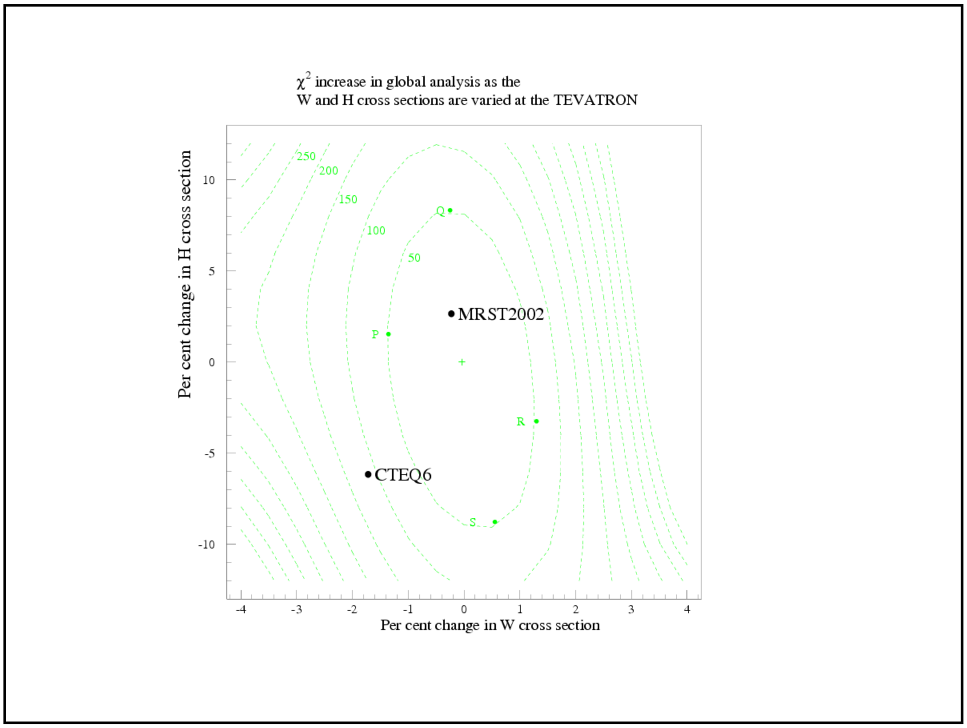

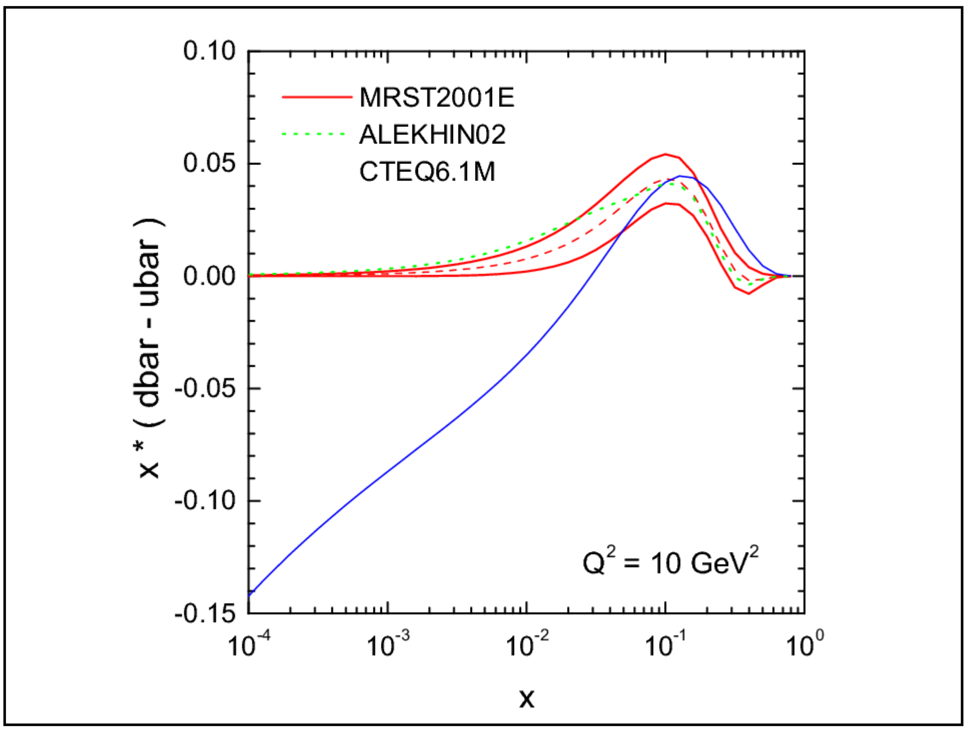

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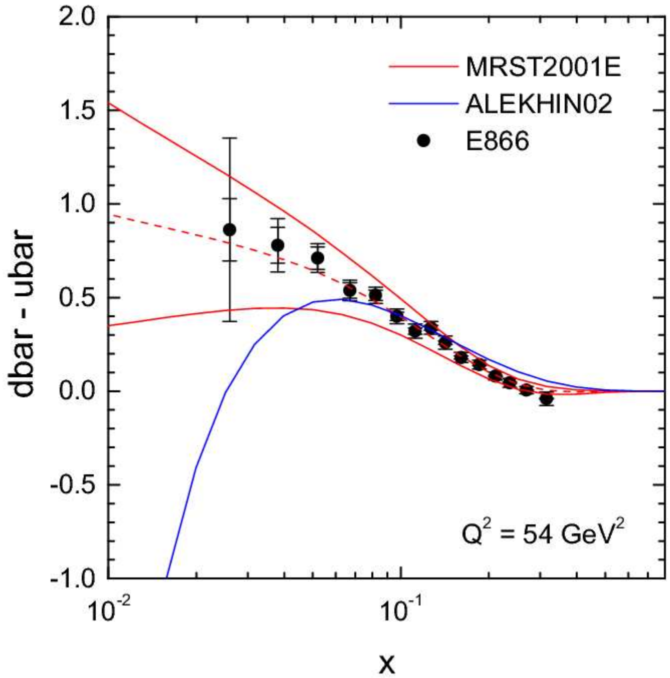
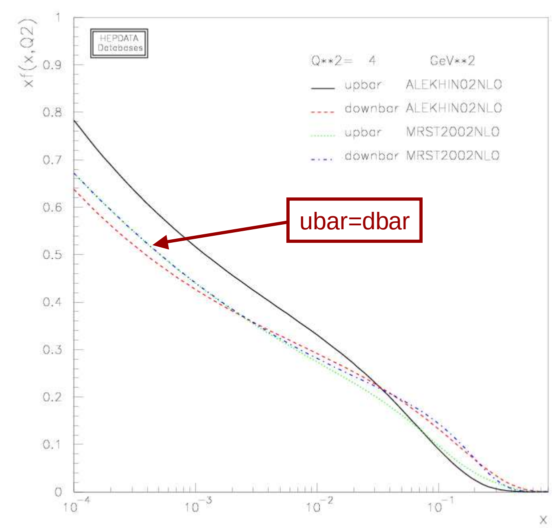


differences between the MRST and Alekhin u and d sea quarks near the starting scale



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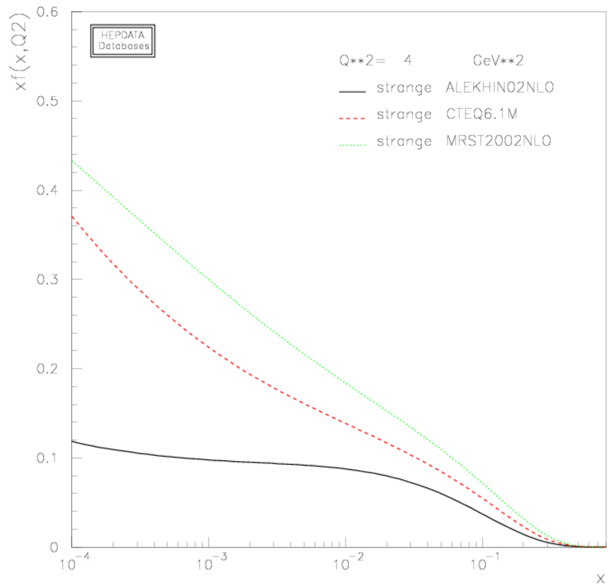
differences between the MRST, CTEQ and Alekhin strange quarks near the starting scale



as small x data are systematically removed from the global fit, the quality of the fit improves until stability is reached at around x ~ 0.005

Δ = improvement in χ^2 to remaining data / # of data points removed

$x_{\rm cut}$:	0	0.0002	0.001	0.0025	0.005	0.01
# data points	2097	2050	1961	1898	1826	1762
$\alpha_S(M_Z^2)$	0.1197	0.1200	0.1196	0.1185	0.1178	0.1180
$\chi^2(x > 0)$	2267					
$\chi^2(x > 0.0002)$	2212	2203				
$\chi^2(x > 0.001)$	2134	2128	2119			
$\chi^2(x > 0.0025)$	2069	2064	2055	2040		
$\chi^2(x > 0.005)$	2024	2019	2012	1993	1973	
$\chi^2(x > 0.01)$	1965	1961	1953	1934	1917	1916
Δ_i^{i+1}		0.19	0.10	0.24	0.28	0.02

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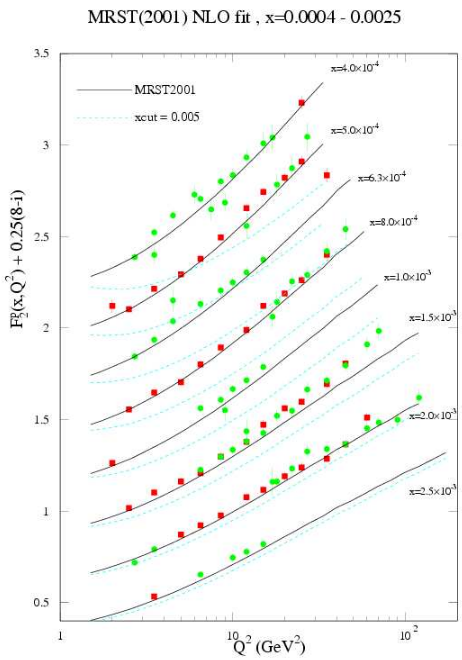
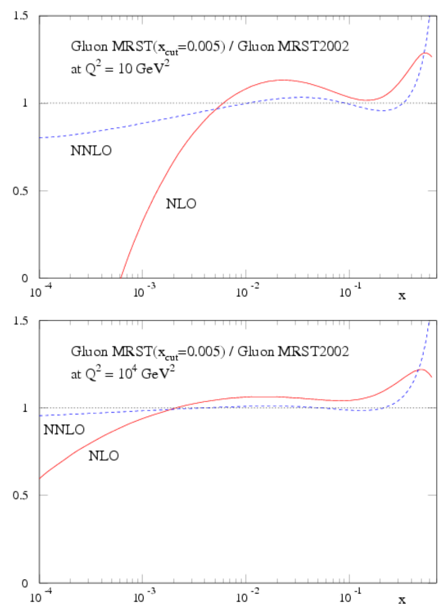
the ‘conservative’ pdfs (blue lines) do not describe the very low-x DIS data not included in the fit

MRST, hep-ph/0308087



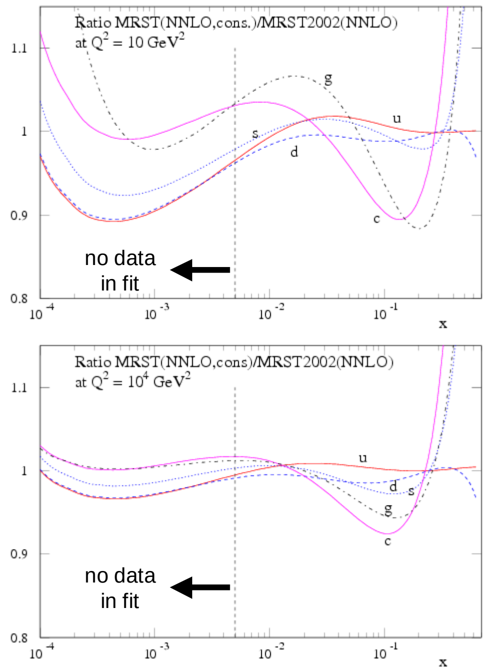
the change in the NLO and NNLO gluons when DIS data with x < 0.005 are removed from the global fit

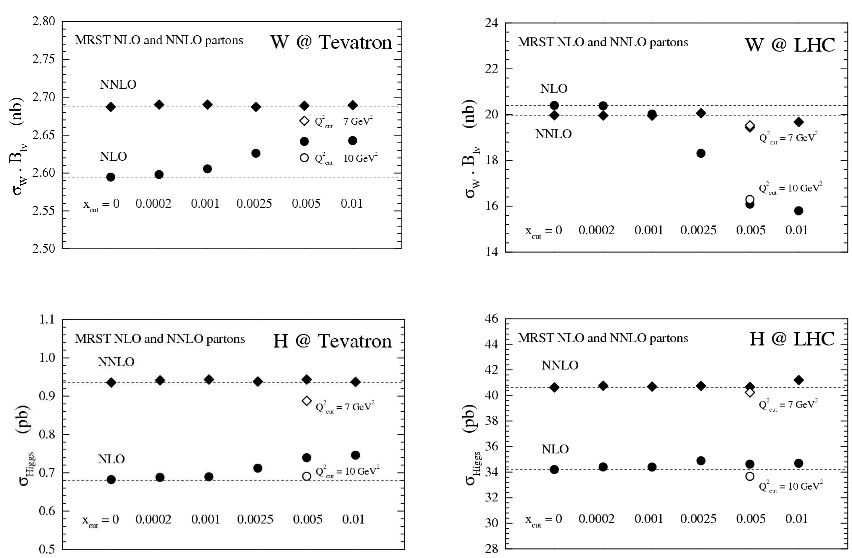
MRST, hep-ph/0308087



comparison of the standard MRST and 'conservative' NNLO pdfs

MRST, hep-ph/0308087





The stability of the small-*x* fit can be recovered by adding to the fit empirical contributions of the form

$$P_{gg} \to P_{gg}^{\mathrm{NLO}} + A\overline{\alpha}_S^4 \left(\frac{\ln^3 1/x}{3!} - \frac{\ln^2 1/x}{2!} \right)$$
$$P_{qg} \to P_{qg}^{\mathrm{NLO}} + B\alpha_S \frac{n_f}{3\pi} \overline{\alpha}_S^4 \left(\frac{\ln^3 1/x}{3!} - \frac{\ln^2 1/x}{2!} \right)$$

... with coefficients *A*, *B* found to be O(1) (and different for the NLO, NNLO fits); the starting gluon is still very negative at small *x* however