Update of the NNLO PDFs in the 3- and 5-flavour schemes

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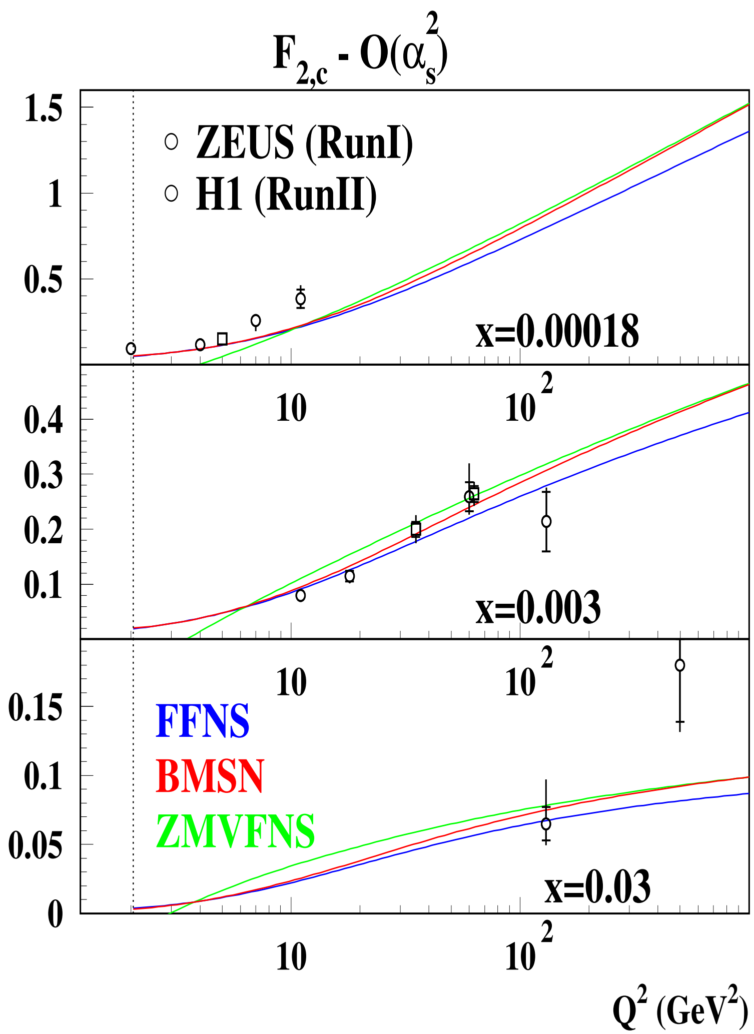
ABKM09 PDFs

(sa-Blümlein-Klein-Moch 09)

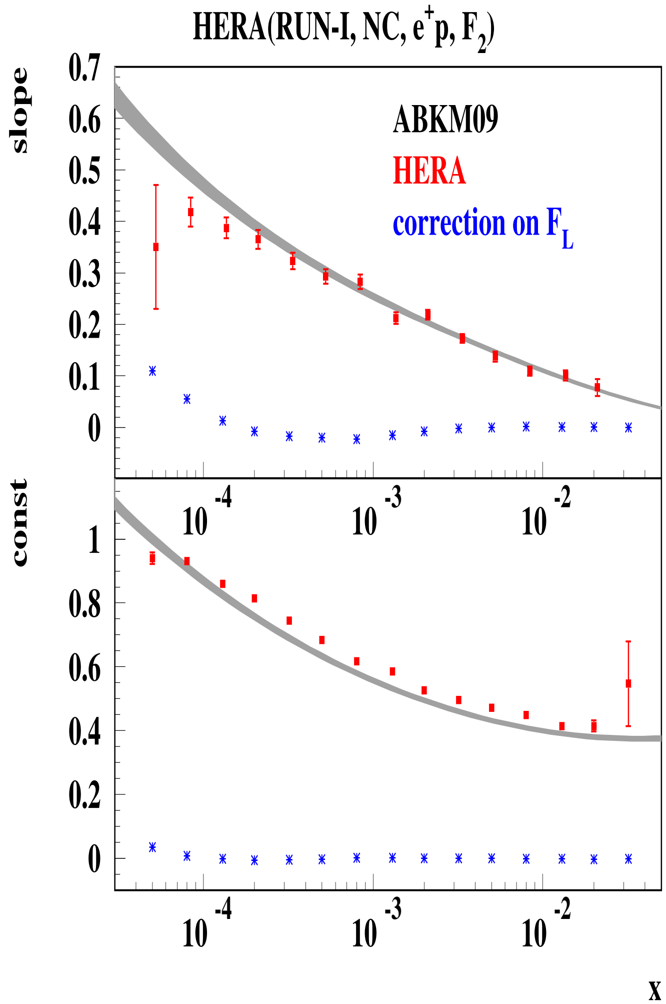
- the inclusive DIS data with the transferred momentum $Q^2 > 2.5$ GeV^2 (SLAC-BCDMS-NMC-H1-ZEUS).
- the fixed target Drell-Yan data by FNAL-E-605 (p Cu) and FNAL-E-866 (pp/pD).
- data on dimuon production in the νN interactions by the CCFR and NuTeV collaborations

The NNLO approximation for the PDFs evolution and the light-parton coefficient functions is employed. The heavy quark contribution to the charged-lepton DIS is calculated in the 3-flavour scheme with account of the corrections up to $O(\alpha_s^2)$ (NLO).



- At small Q the 3-flavour FFNS is well justified. At large Q the existing data are not sensitive to the difference between 3-flavour FFNS and the zero-mass VFNS in $O(\alpha_s^2)$.
- The remaining discrepancies with the data at small Q can be cured rather by the $O(\alpha_s^3)$ corrections than by the VFNS, provided the latter is smoothly matched to the VFNS at small Q.

(sa-Moch 09)



- The data on F_2 at $Q^2 < 100$ GeV^2 can be described by a simple model-independent, polynomial in $\ln(Q)$.
- With(out) account of the correlated uncertainties (114 sources) for the most precise part of the NC e^+p data the value of χ^2/NDF=153/134=1.14 (123/134=0.9).
- The Q-slope of the combined data on F_2 is very well reproduced by the ABKM09 PDFs; The constant term is systematically lower.

The PDFs shape modification

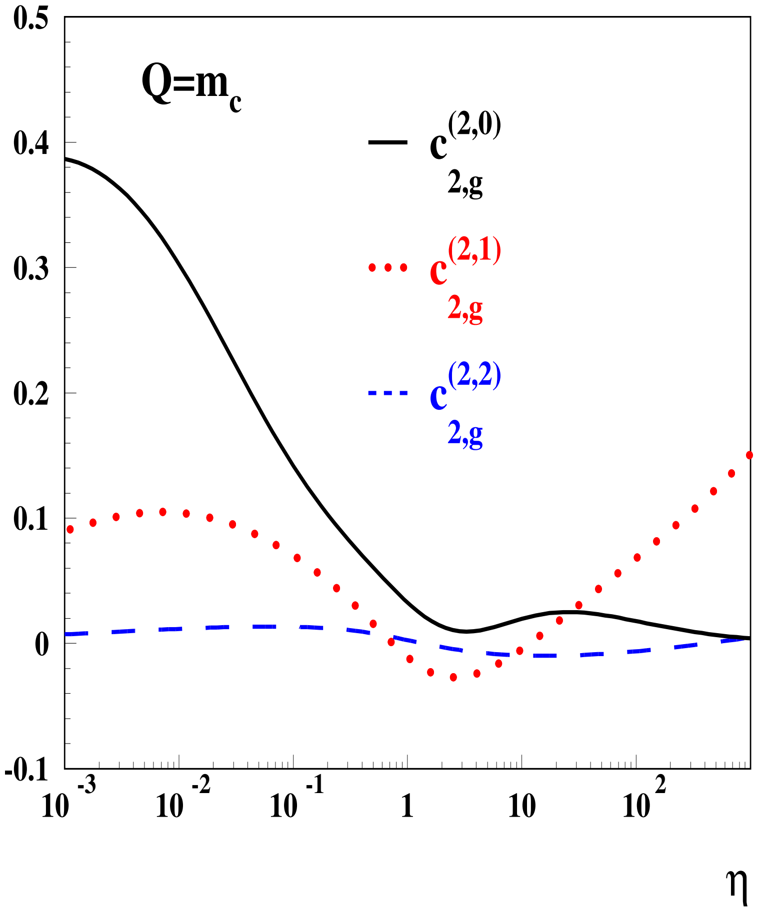
The general functional form of the PDFs employed in the QCD fit

$$q(x) = exp\left[a \ln x(1 + \beta \ln x)(1 + \gamma_1 x + \gamma_2 x^2 + \gamma_3 x^3)\right](1 - x)^b.$$

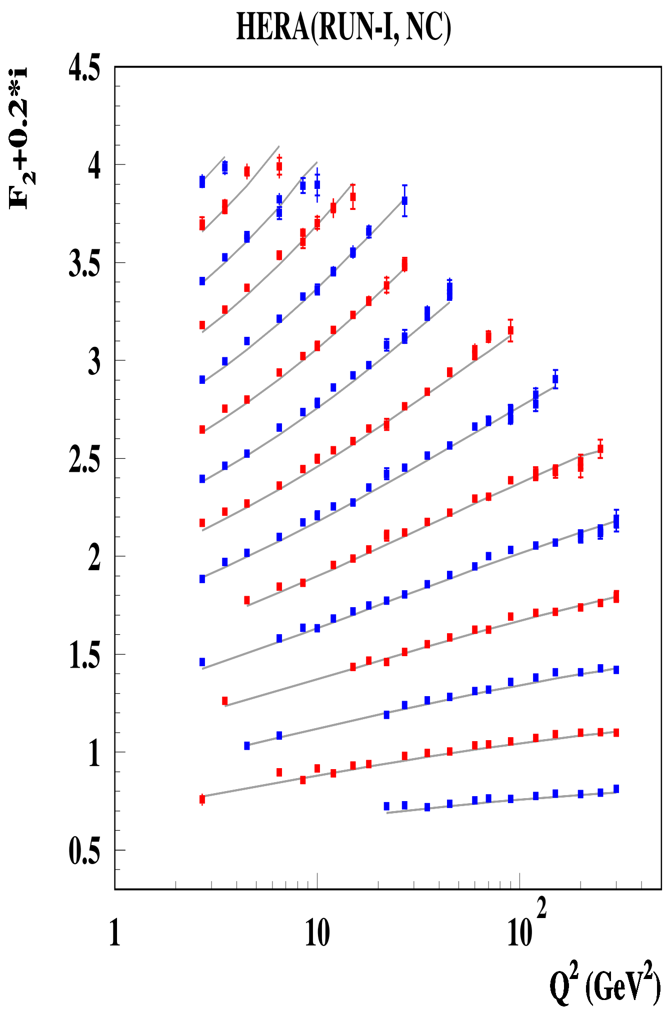
At $\beta = \gamma = 0$ it reproduces a conventional shape $q(x) = x^a(1 - x)^b$. The coefficients γ allow additional flexibility at $x \gtrsim 0.1$ and the coefficients β – at $x \lesssim 0.1$.

In the version of fit, which include the combined HERA data, we add coefficients γ_3 for the valence u-quark and the coefficient β to the isosinglet sea distributions. We also tried the coefficient γ for d-quarks and coefficient β for gluons, it turned out unnecessary.

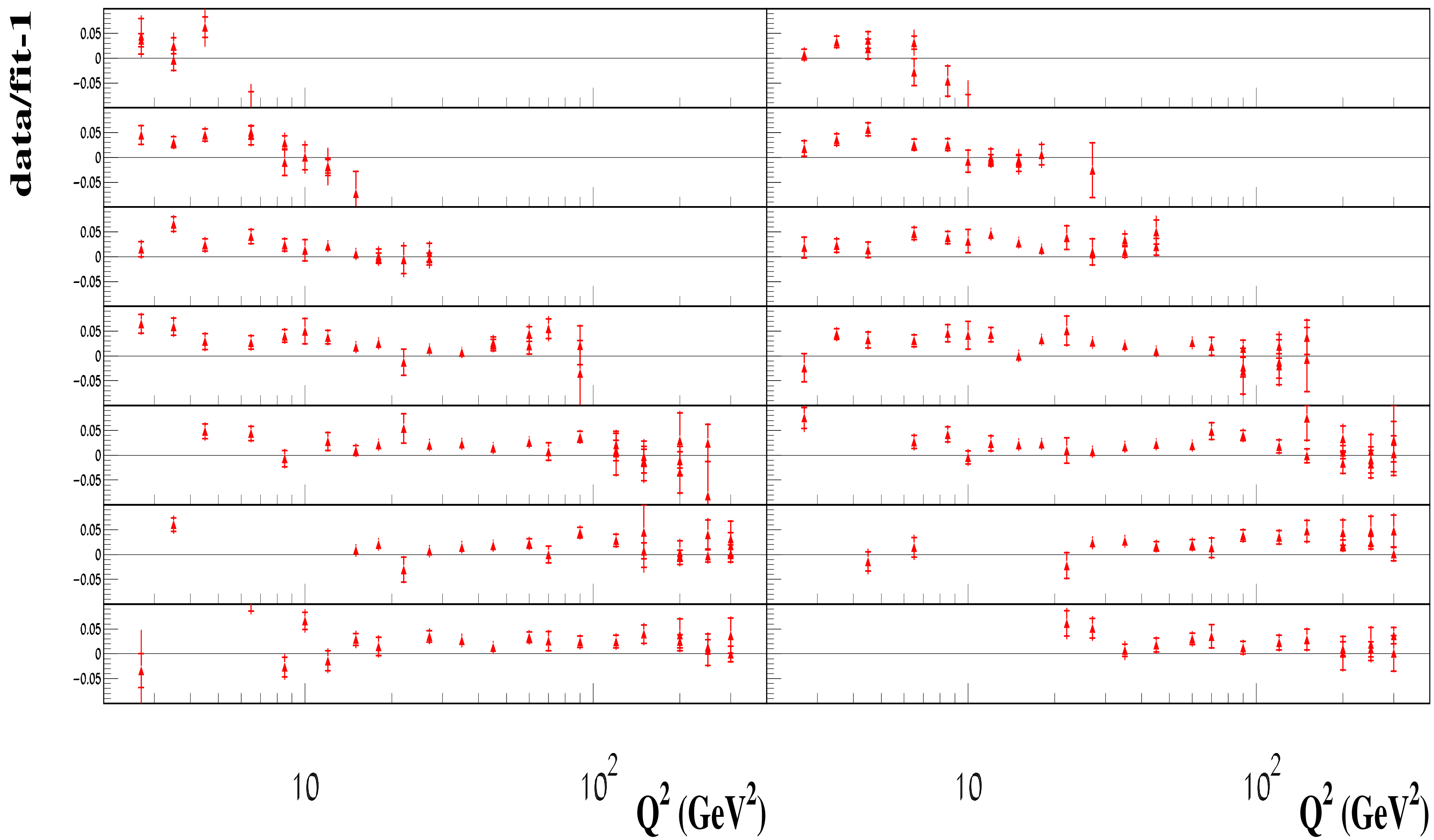
$$C_{2,g}^{\mathrm{NNLO}} = c_{2,g}^{(2,0)} + c_{2,g}^{(2,1)} \ln(\mu^2/m_c^2) + c_{2,g}^{(2,2)} \ln^2(\mu^2/m_c^2)$$

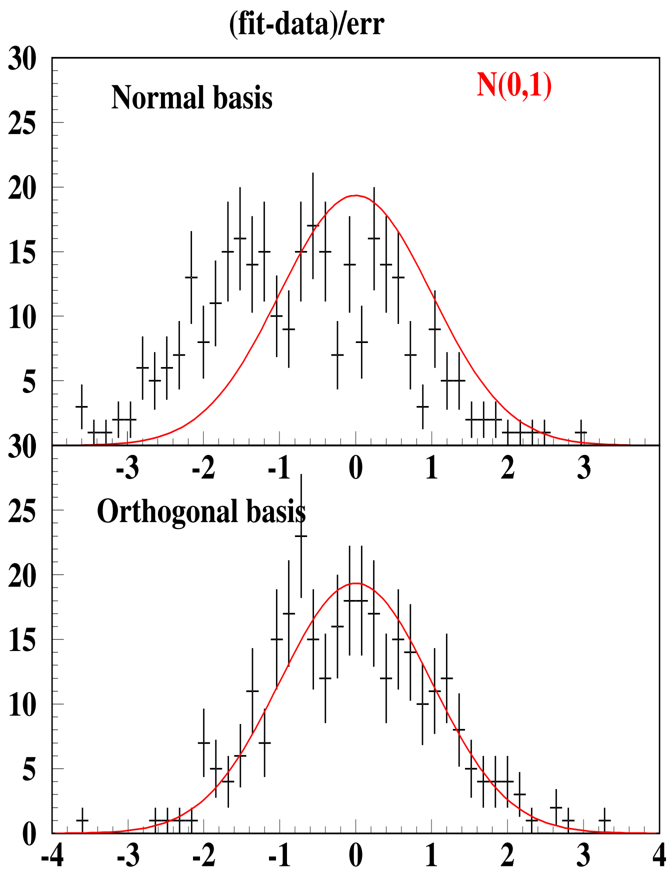


- The coefficients $c_{2,g}^{(2,1)}$ and $c_{2,g}^{(2,2)}$ are known exactly.
- The coefficient $c_{2,g}^{(2,0)}$ can be estimated from the soft-gluon threshold resummation (Laenen-Moch 99). At $\eta = \hat{s}/4m_c^2 - 1 > 1$ this approximation is out of control and are suppressed by factor of $1/\sqrt{1+\eta}$.



The value of χ^2/NDP for the NC HERA data with $Q^2 < 300$ GeV^2 included into the NNLO QCD fit is 365/303=1.20, close to the value of the model independent fit. The fit goes some lower than the data. The average pull of the fit with respect to the data is -0.7. This is not statistically significant since it can be explained by a shift within a systematic uncertainties, however it means the fit prefers lower normalization of the HERA data if it is free.


data/fit-1
0.05
0
-0.05
10
10^2
Q^2 (GeV^2)



- For the pull average taken in the normal basis,

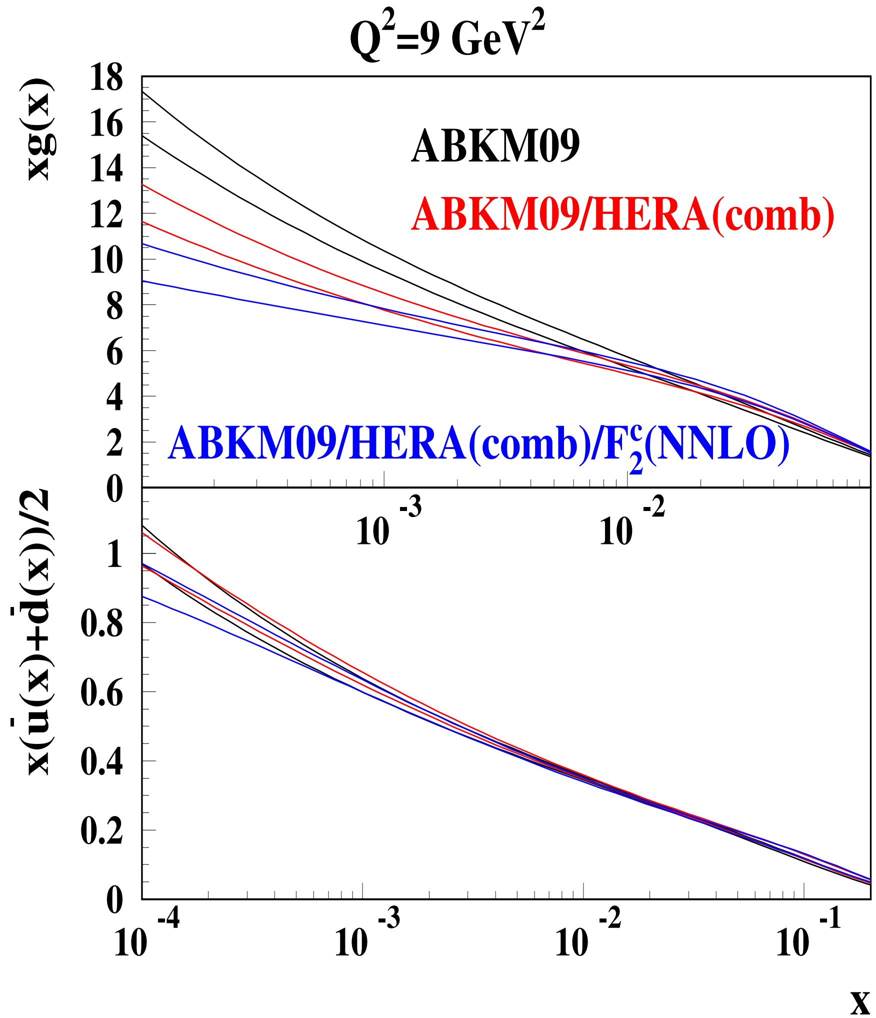
$$< (f_i - y_i)/\sigma_i >= -0.7,$$

it looks like a bias of fit wrt data.

- For the pulls calculated with account of the error correlations, i.e. in the orthogonal basis of the uncertainties

$$< (f_j - y_j)/\sigma_j\sqrt{E}_{ji} >= -0.05,$$

that is $\sim 1\sigma$ for this quantity.



- The gluon distribution at small x goes lower than for the ABKM09 set, however it remains positive down to $\mu^2 \approx 2\ \mathrm{GeV}^2$.
- The value of $\alpha_s(5, M_Z) = 0.1147(12)$. This is somewhat bigger than the value for the ABKM09 fit $\alpha_s(5, M_Z) = 0.1135(14)$. The difference is within 1σ, however it also signals about some tension.

The NNLO rates for the candle processes

	$W^{\pm}$ (nb)	Z (nb)	$t\bar{t}$ (pb)	H (pb) ($M_H = 150$ GeV)
Tevatron				
ABKM09 (Run-I comb)	26.8 ± 0.3	7.88 ± 0.07	6.72 ± 0.12	0.35 ± 0.02
ABKM09	26.2 ± 0.3	7.73 ± 0.08	6.91 ± 0.17	0.36 ± 0.03
LHC (7 TeV)				
ABKM09 (Run-I comb)	100.9 ± 1.3	29.3 ± 0.4	130.3 ± 5.8	9.4 ± 0.2
ABKM09	98.8 ± 1.5	28.6 ± 0.5	131.3 ± 7.5	8.8 ± 0.3

Summary

- In the NNLO QCD fit the combined RUN-I HERA data go slightly above the fit. The discrepancy is within the systematic uncertainties, however anyway the smaller absolute normalization for the HERA data is more preferable for the fit consistency.
- The modifications of the PDFs, which are necessary to accommodate the combined HERA data include release of the valence quarks shape and modification of the sea asymptotic at small x.
- The value of $\alpha_{\rm s}(5, M_{\rm Z}) = 0.1147(12)$ is obtained from the fit.
- Impact of the new data on the candle processes rate is $1 \div 2\sigma$.