Quantitative impact of LHC measurements on PDF determination

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Motivation: The data from hadron collisions provide unique information for the PDFs and the LHC measurements could be especially useful for putting constraints on the PDFs due to wide kinematical coverage and large mass scales.

Problem: Presumably, the LHC data alone will not allow to completely disentangle the PDFs in the whole kinematical region.

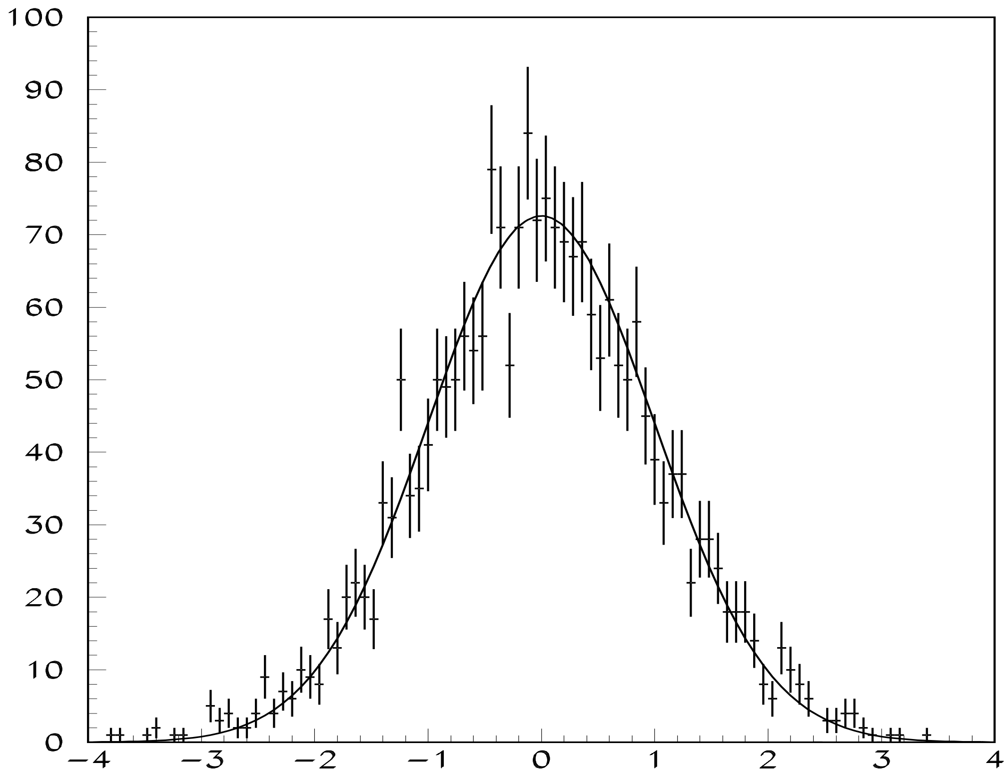
Strategy: Combine the MC generated LHC "measurements" with the existing data and estimate improvement in the PDFs errors (in particular, the fit of PDFs to the global DIS data will be used as a starting point).

The PDFs used (A02)

- extracted from the SLAC-BCDMS-NMC-H1-ZEUS proton and deuteron data on c.s.(F_2 and $F_{\rm L}$)
- $\alpha_{\rm s}$ is fitted simultaneously with the dynamical twist-4 contribution $H(x)$ is parameterized in model-independent form, $F^{\rm LT}$ are defined by the fitted parton distributions
- the QCD corrections up to the NNLO are accounted
- account of the target mass and the nuclear correction
- account of all experimental errors (statistical, point-to point correlated systematical, normalization) with rigorous treatment of the confidence intervals

http://sirius.ihep.su/~alekhin/pdfa02/

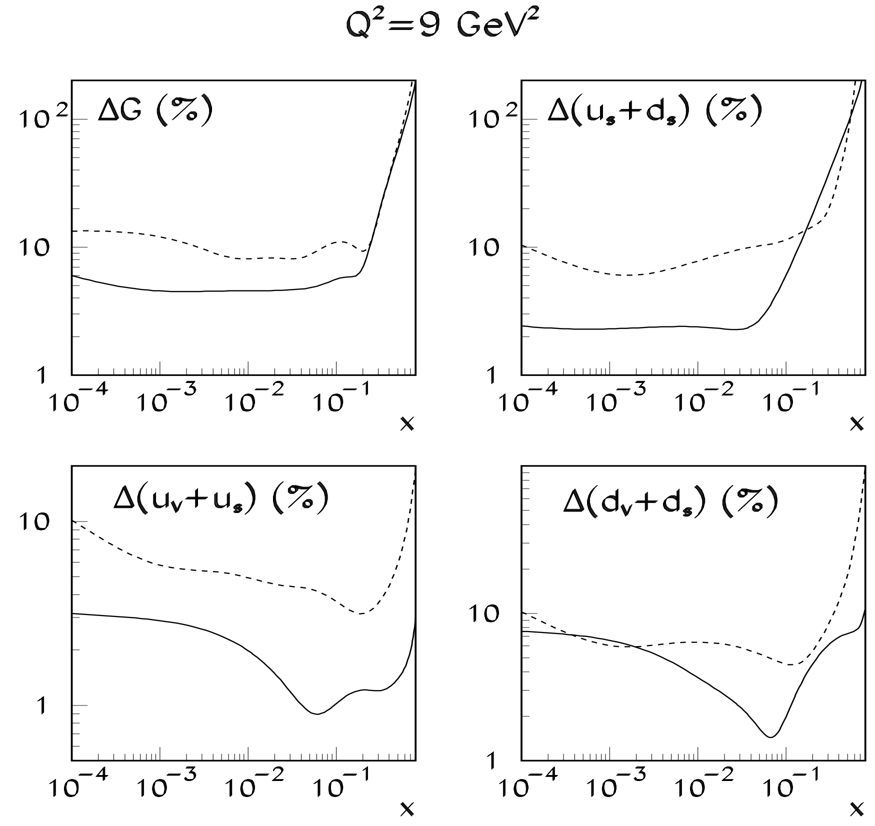
Quality of the fit



Points: (data-theory)/theory, curve: normal distribution.

	LO	NLO	NNLO
χ^2/NDP	1.20	1.11	1.11

Comparison of the errors in DIS PDFs with ones in the global PDFs

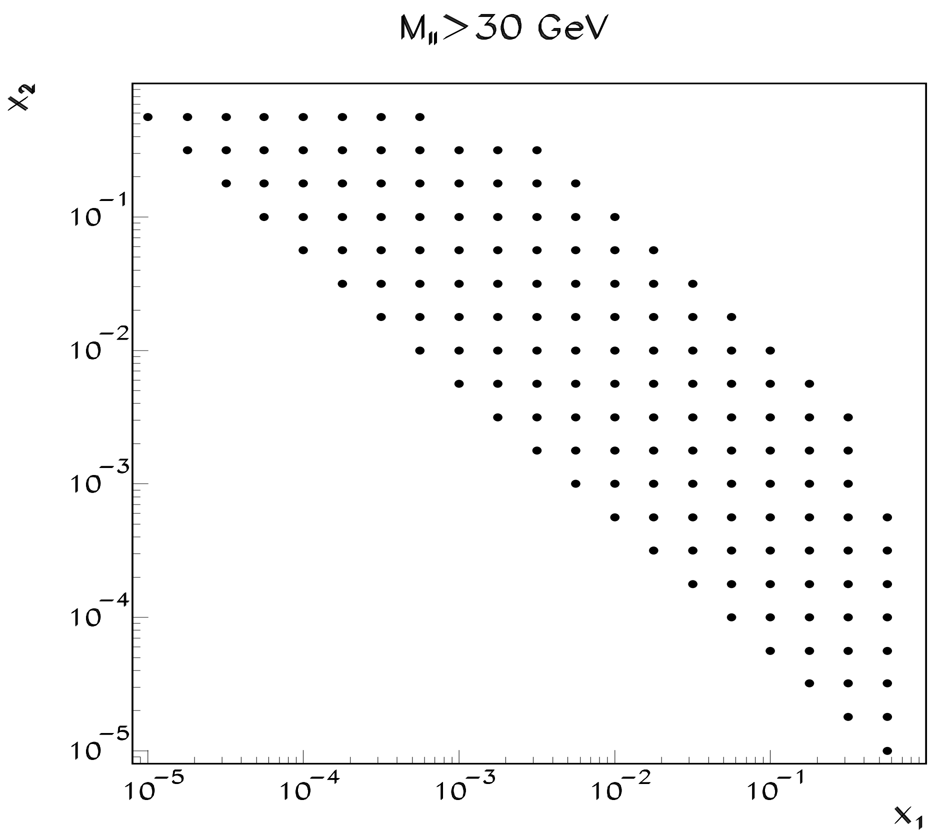


Solid lines: A02, dashes: CTEQ6

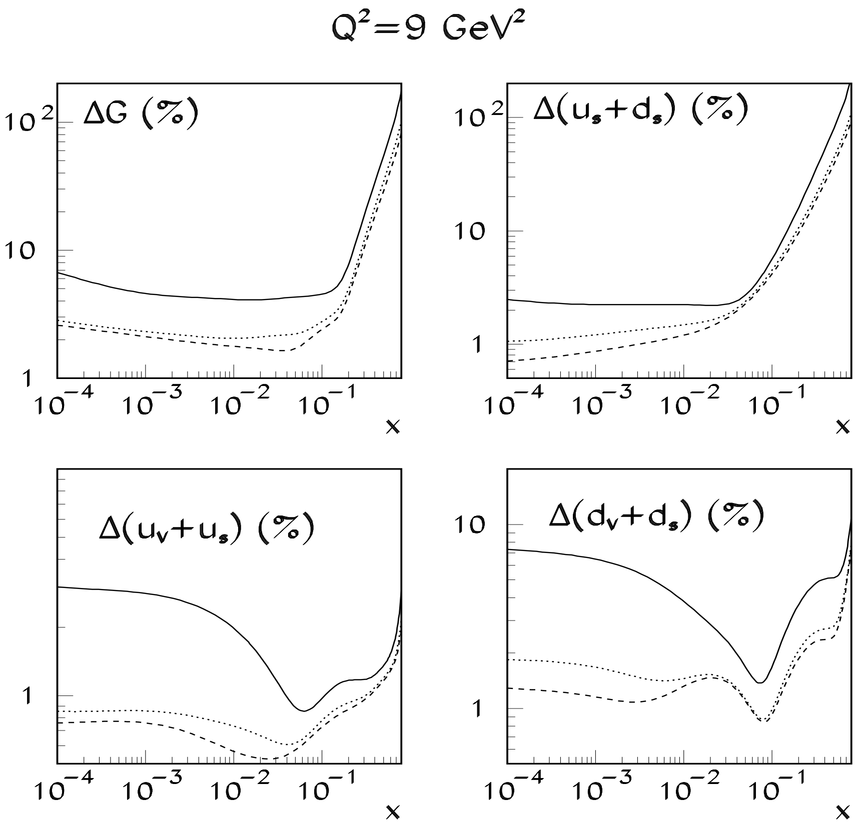
The DIS PDFs are not less precise than the global PDFs due to better compatibility of the data sets.

Impact of the Drell-Yan data on PDFs

- define the grid in $x_{1,2}$-space with $x_{1,2} = 10^{-5} \div 1$ and with 20×20 bins in $\log(x_{1,2})$.
- calculate the DY cross section at the center of each bin.
- get the number of DY events for the integral luminosity 10 fb^{-1} and estimate statistical errors of “measurements”.
- add 5% normalization error
- drop the bins with number of events less than 100.
- add the obtained “data” to the global DIS set and re-extract PDFs

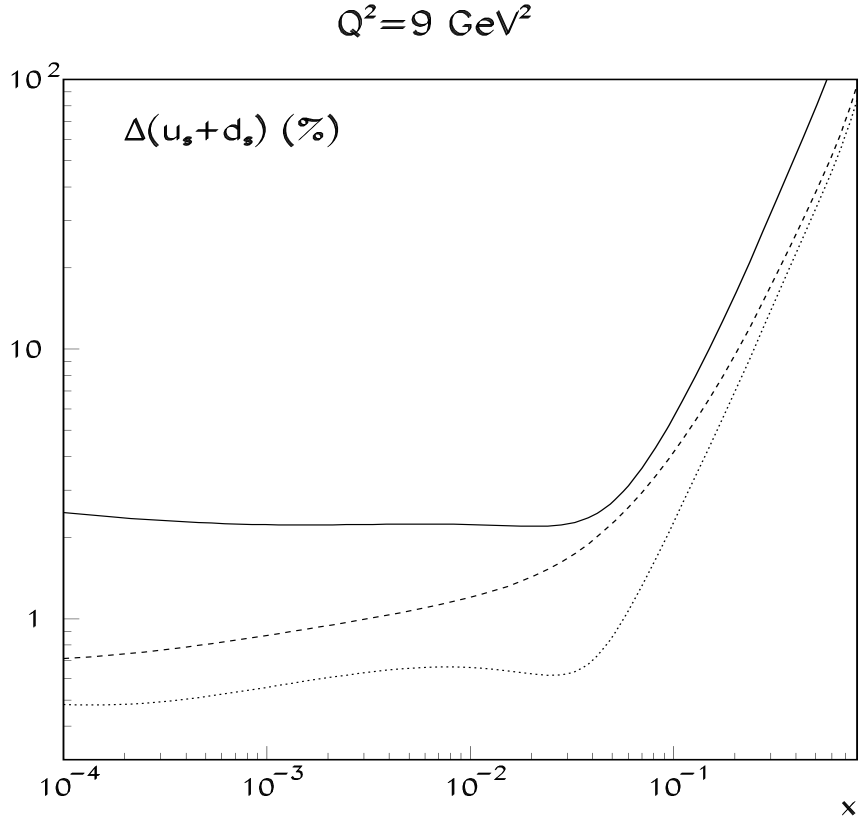


M_ll>30 GeV
x_2
10^-1
10^-2
10^-3
10^-4
10^-5
10^-5
10^-4
10^-3
10^-2
10^-1
x_1



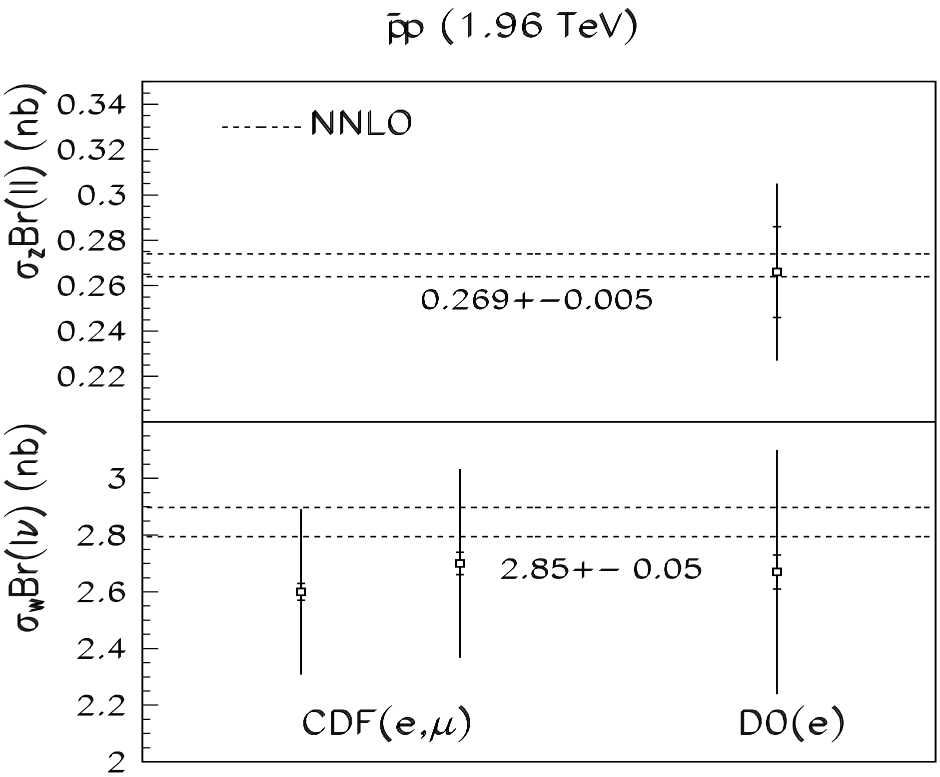
Solid lines: A02; dashes: DY data with $M_{ll} >$ 15 GeV added; dots: DY data with $M_{ll} >$ 30 GeV added.

DY data improve u/d separation



Solid line: A02; dashes DY data with normalization error of 5%; dots: DY data with statistical errors only.

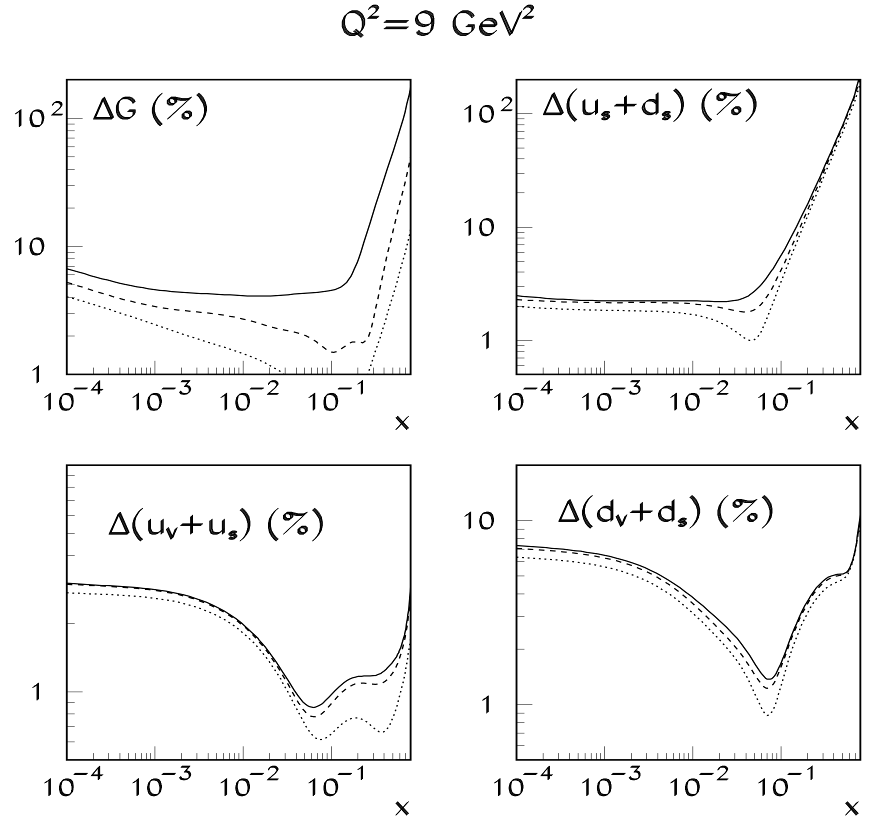
Predictions of the W/Z rates at FNAL and LHC



Predictions are more precise than the measurements and can be used for cross-checks of the collisions luminosity

$$\sigma_{\rm Z}^{\rm LHC} = 60.0 \pm 1.9 \text{ nb}, \quad \sigma_{\rm W}^{\rm LHC} = 204.6 \pm 6.4 \text{ nb}$$

Impact of the jet production data on PDFs



Solid line: A02; dashes: jet data with $P_{\mathrm{T}} >$ 500 GeV added; dashes: jet data with $P_{\mathrm{T}} >$ 1000 GeV added.

Essential improvement of error in the gluon distribution even for very high P_{T}^{min}

Preliminary summary:

- separation of the u- and d-quark distributions at small x can be improved – better determination of the Gottfried integral (complimentary to the HERA runs with deuteron beam).
- dramatic improvement in the precision of the gluon distribution at large x from the jets with very high P_{T} – theoretical uncertainties are suppressed.

Future:

- more realistic cuts and detection efficiency
- additional processes ($p\ p \rightarrow \gamma\ X$, $p\ p \rightarrow Z/\gamma\ jet$, ...) – more input for cross-checks of the PDFs universality.