Update of the ABM PDFs

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- heavy quarks in DIS
- jet Tevatron data

in collaboration with J.Blümlein and S.Moch

PDF4LHC, DESY, 29 Nov 2010

The ABKM fit ingredients

DATA:

- DIS NC inclusive
- DIS μμ CC production
- fixed-target DY
- Tevatron Run II jets

QCD:

- NNLO evolution
- NNLO massless DIS and DY coefficient functions
- NLO+ massive DIS coefficient function - FFNS
- NLO jet production corrections - 5-flavor scheme

Deuteron corrections in DIS:

- Fermi motion
- off-shell effects

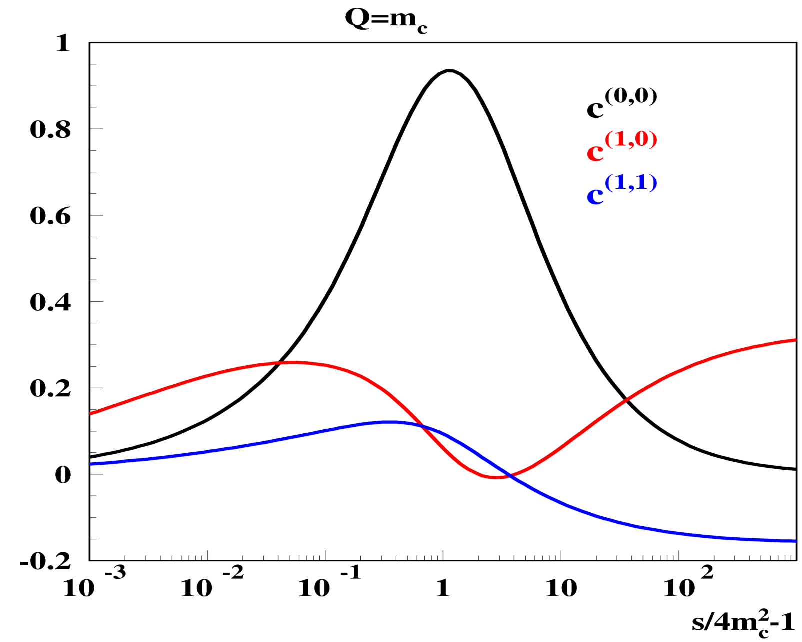
Power corrections in DIS:

- target mass effects
- dynamical twist-4(6) terms

sa, Blümlein, Klein, Moch PRD 81, 014032 (2010)

The heavy-quark electro-production in FFNS

The dominant mechanism is photon-gluon fusion, contributes up to 30% to the inclusive structure functions. The massive coefficient functions are known up to the NLO.



$C^{LO}_{2,g} = c^{(0,0)}$ **Witten NPB 104, 445 (1976)**

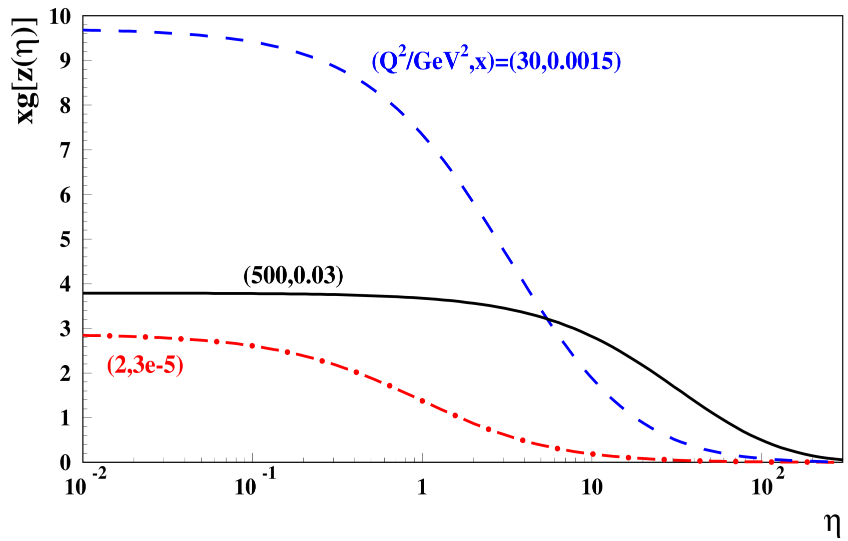
$$C^{NLO}_{2,g} = c^{(1,0)} + c^{(1,1)} \ln(\mu_F^2/m_c^2)$$

Laenen, Riemersma, Smith, van Neerven NPB 392, 162 (1993)

At $Q \gg m_c$ first Mellin NNLO moments NNLO are know, full calculations in progress

Bierenbaum, Blümlein, Klein NPB 829, 417 (2009)

[hep-ph 1008.0792]



- At small x and small Q the main contribution comes from η<1 due to the gluon distribution shape → threshold production, similarly .
- The large logs ~ $\ln^{2n}(\beta)$ can be resummed in all orders, this gives a good approximation to the exact NNLO expression at small β with the tower of large logs.

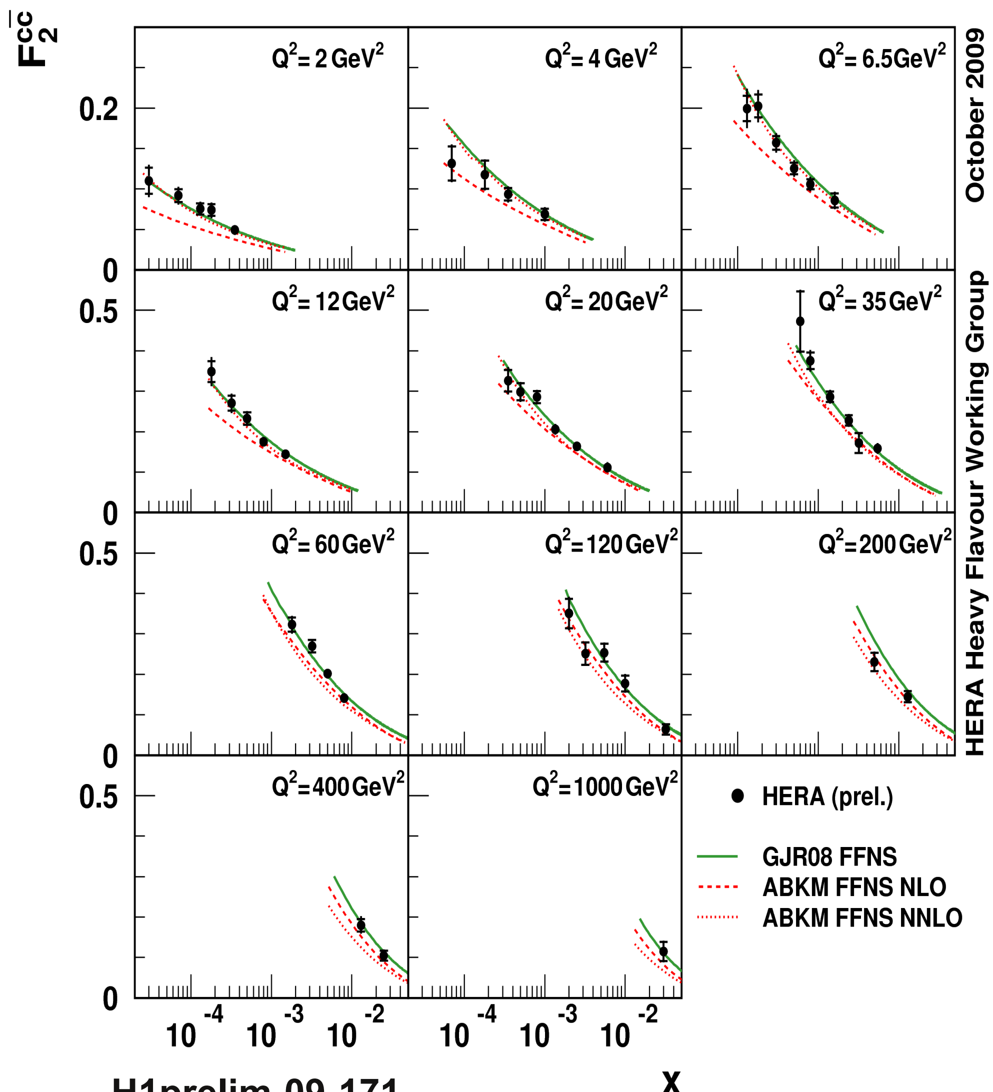
$\beta=\sqrt{1-4m^2/s}$

Laenen, Moch PRD 59, 034027 (1999)

sa, Moch PLB 672, 166 (2009)

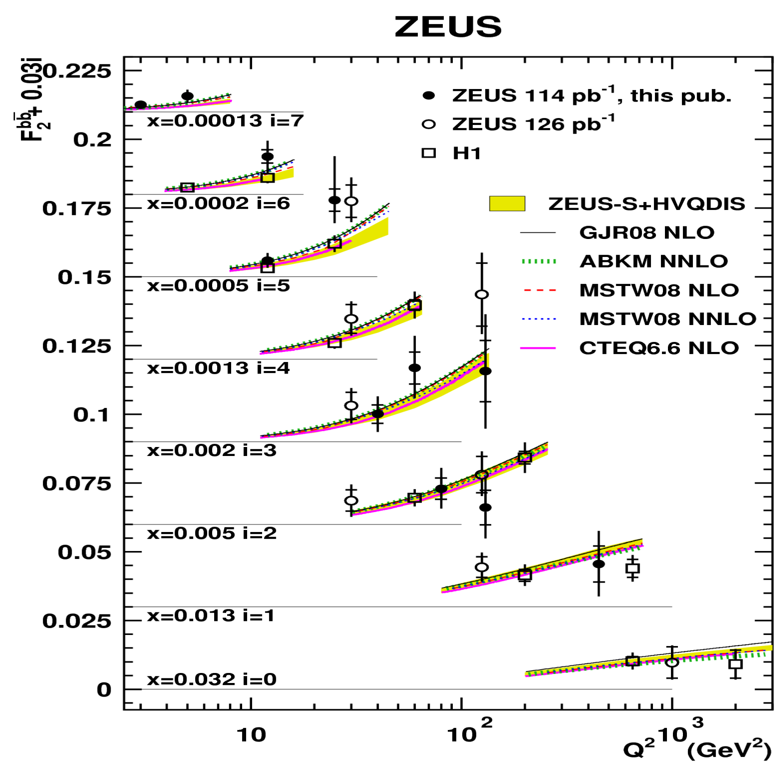
FFNS versus semi-inclusive HERA data

- The FFNS predictions with account of the threshold NNLO corrections are in a good agreement with the charm-production HERA data at small and moderate *Q*.
- For the b-quark production agreement is even better, the threshold approximation is applicable for wider kinematics.



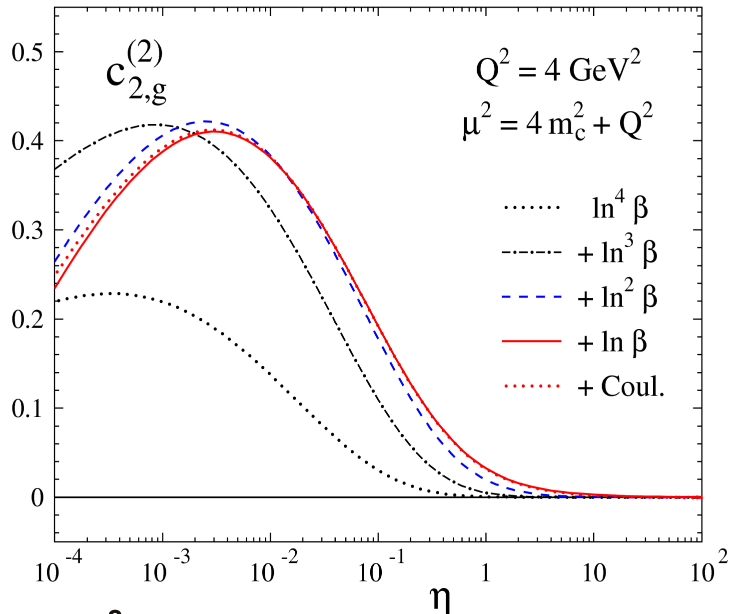
H1prelim-09-171

ZEUS-prel-09-015



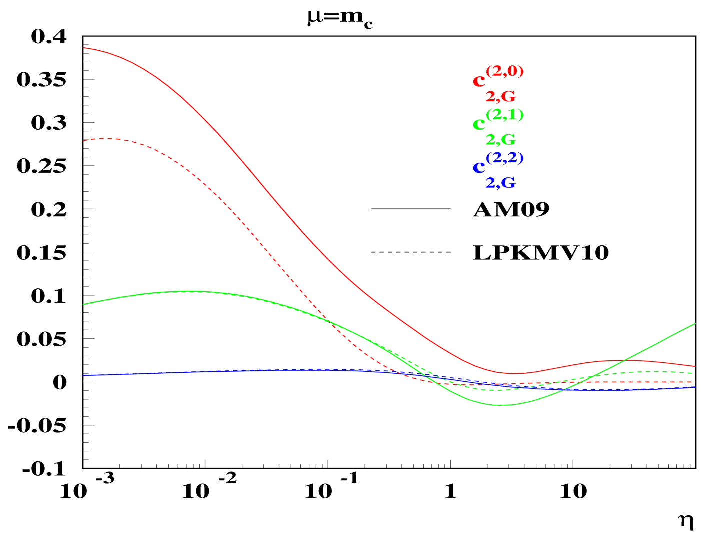
DESY-10-047

Updated treatment of the heavy quarks in DIS



$\eta = s/4m^2 - 1$

Lo Presti, Kawamura, Moch, Vogt [hep-ph 1008.0951]



F_2^c gets somewhat lower at small Q and somewhat higher at large Q

The running mass values from our fit (cf. talk by Sven afternoon)

sa, Moch [hep-ph 1011.xxxx]

$m_c(m_c)$=1.01±0.09 GeV (NLO),

$m_c(m_c)$=1.01±0.09 GeV (NNLO approx.)

$m_c(m_c)$=1.01±0.08 GeV (PDG '10)

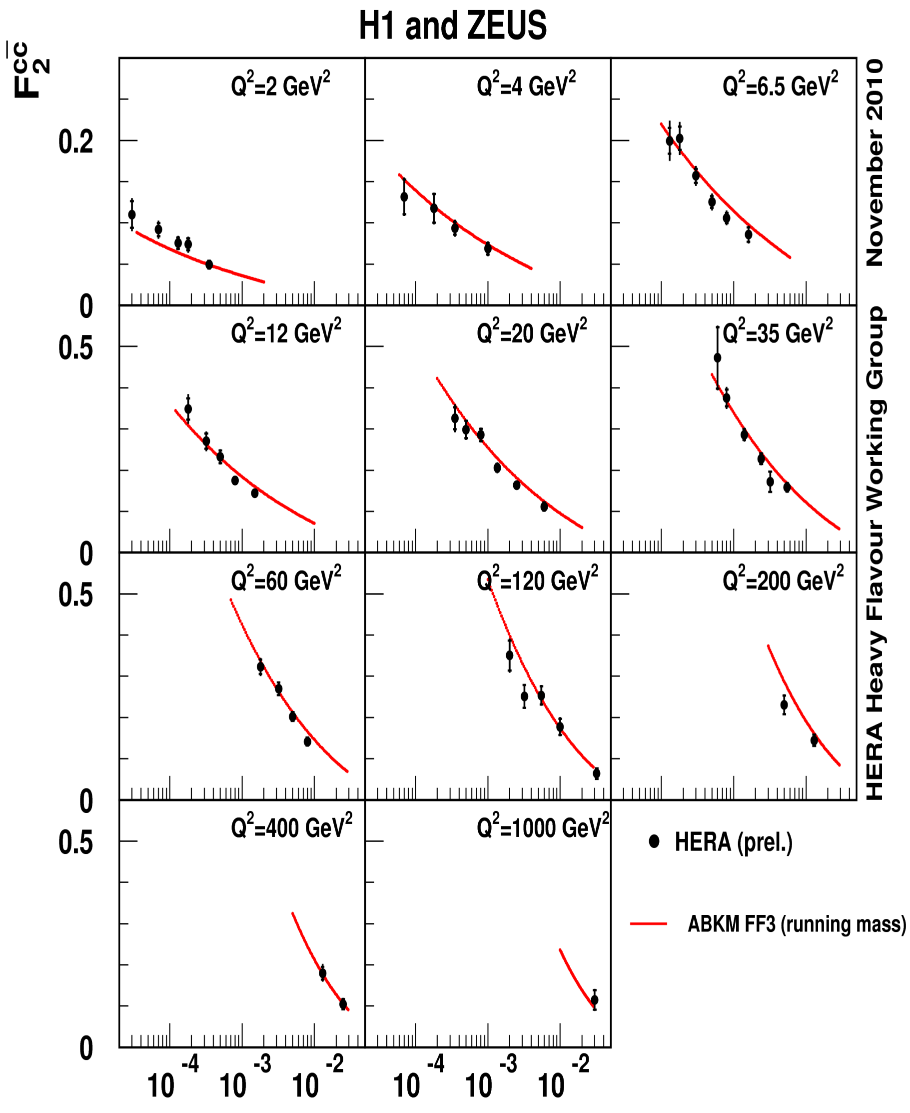
$m_c(m_c)$=1.18±0.06 GeV (NNLO, +PDG)

- Improved constraint om m_c, → improved accuracy of the c-quark distribution

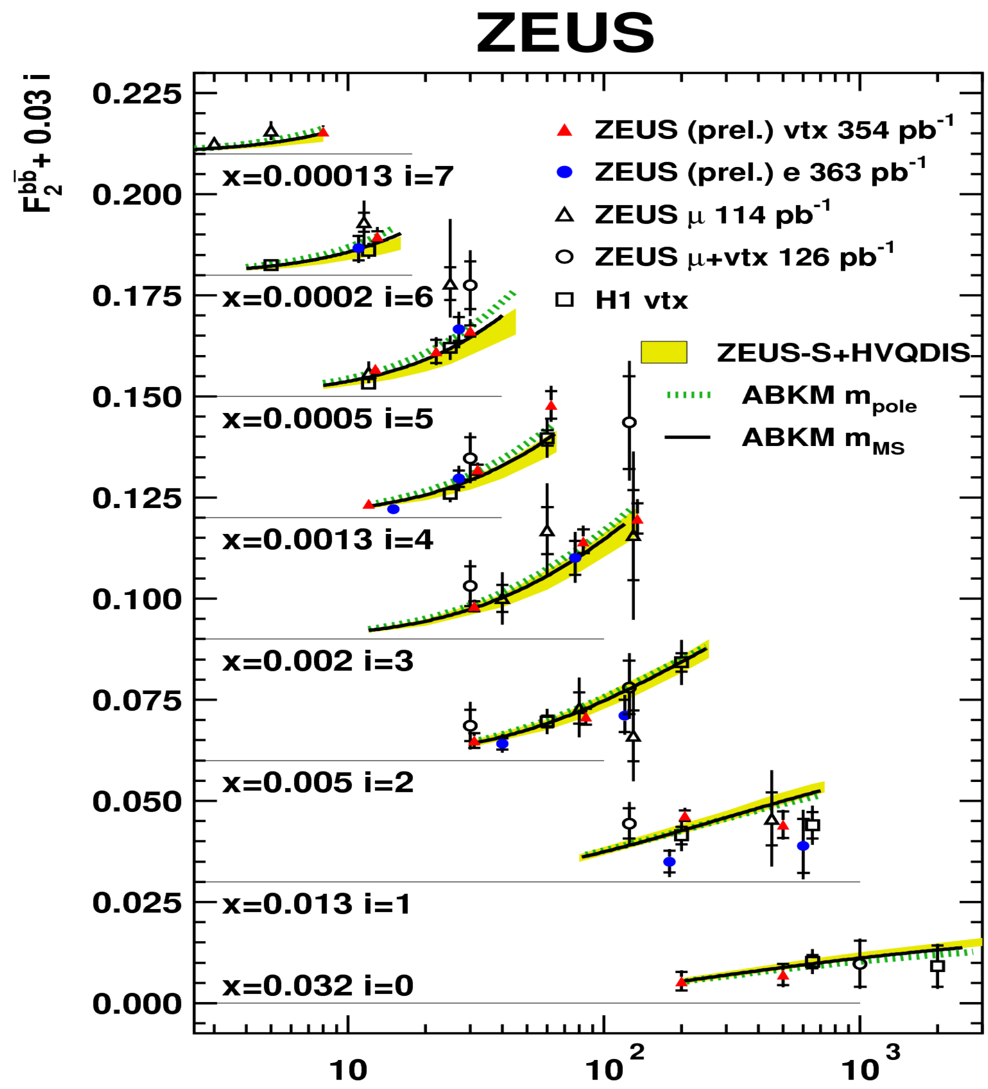
sa, Moch, in preparation

- no sensitivity to m_b, fixed at the PDF value

http://www-zeuthen.desy.de/~alekhin/OPENQCDRAD/



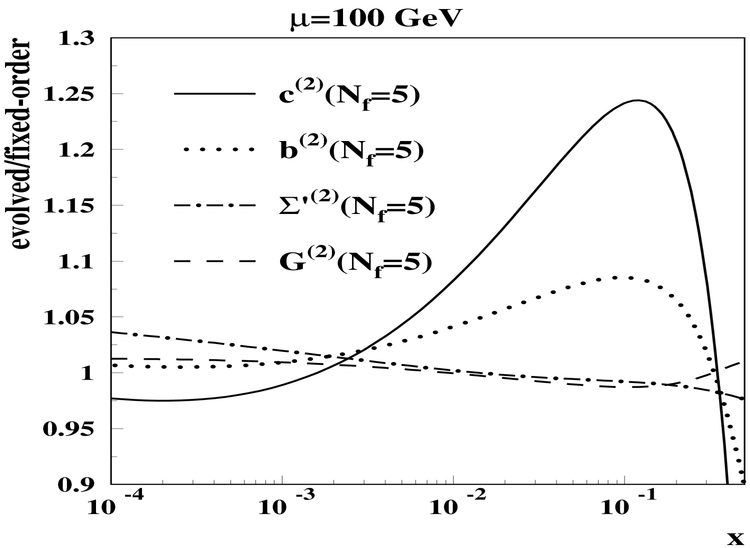
(courtesy of K.Lipka)



(courtesy of A.Geiser and P.Roloff)

The NNLO(approx.) FFNS ABM *predictions* based on the running mass definition are In nice agreement to the HERA data → a room for the VFN schemes?

Collider data in the ABM fit



sa, Blümlein, Klein, Moch PRD 81, 014032 (2010)

- The 4- and 5-flavor PDFs are generated from the 3-flavor PDFs using the matching conditions. In this way the collider data can be added to the DIS in the PDF fit performed on the FFNS footing
- The 4- and 5-flavor PDFs are evolved starting from the matching scale. Effect is non-negligible at large scales in places → estimate of the high-order corrections to OMEs

The mixed scheme: the choice of PDFs is defined by the relevance for a specific process

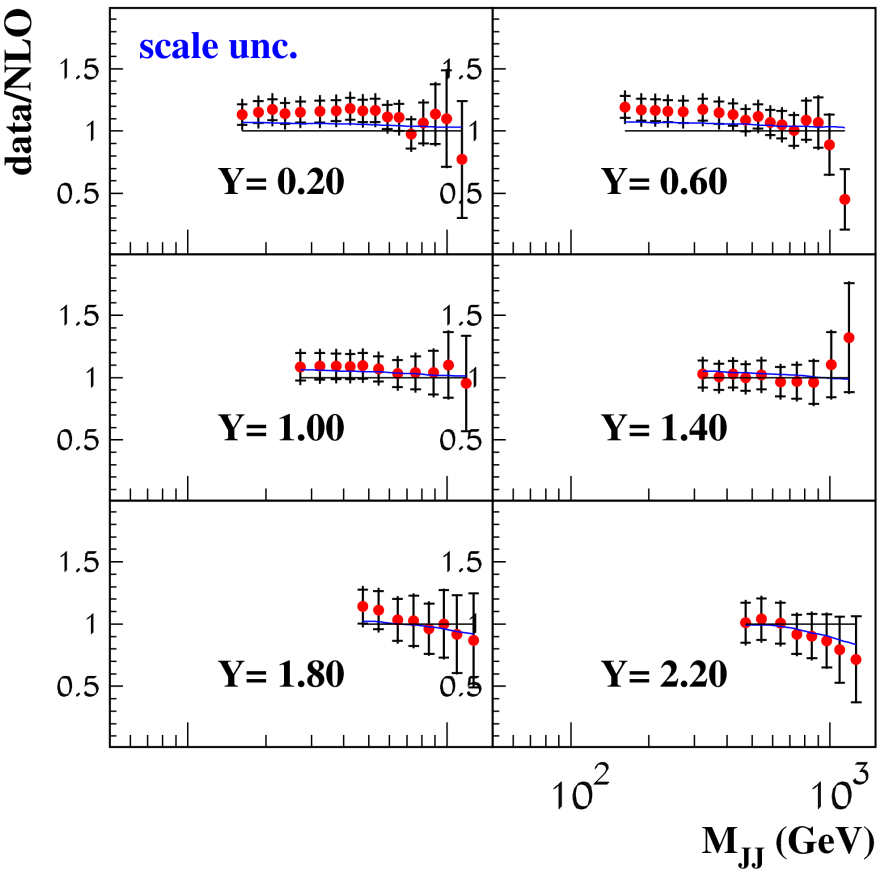
- DIS: 3-flavor
- Fixed-targed Drell-Yan: 5-flavor
- Jets: 5-flavor
- Single-top: 4-flavour

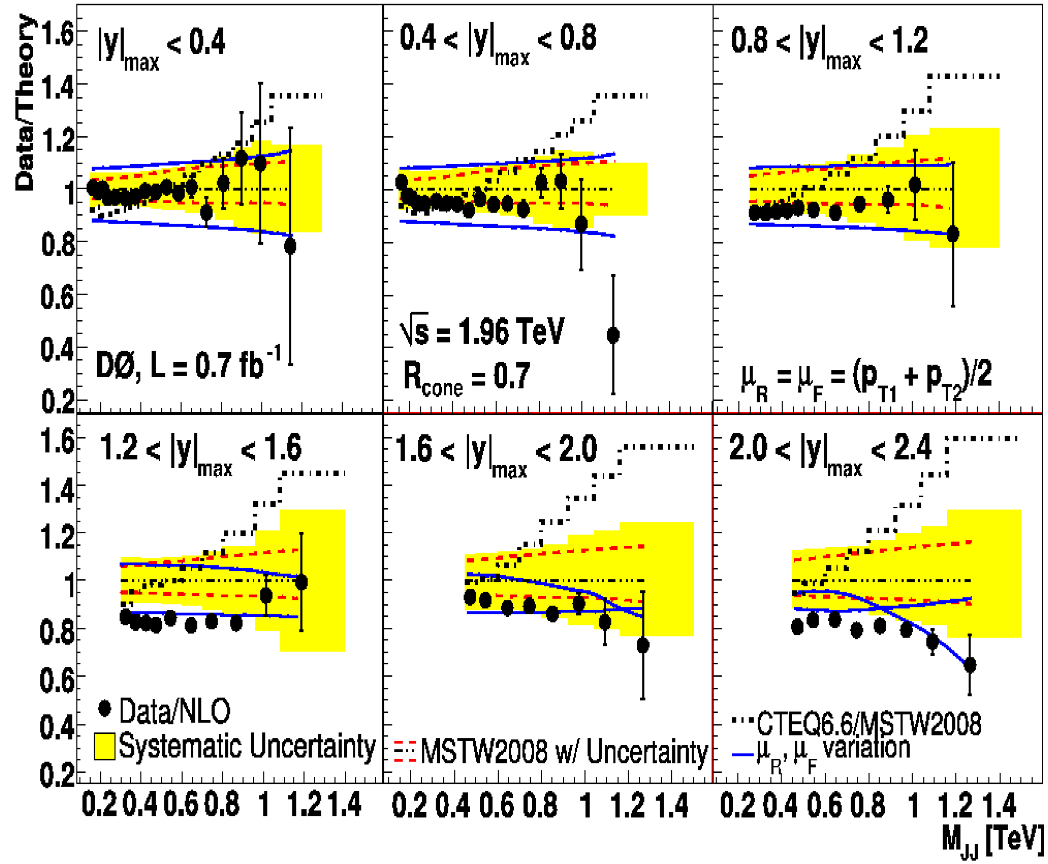
etc

Run II D0 dijet data in the ABKM fit

D0 Collaboration PLB 693, 531 (2010)

ABKM09 (no re-fit)





The NLO ABKM09 **predictions** compared with the D0 Run II dijet data:

FastNLO tool allows to employ the NLO corrections.

$\mu_r = \mu_F = M_{JJ}$

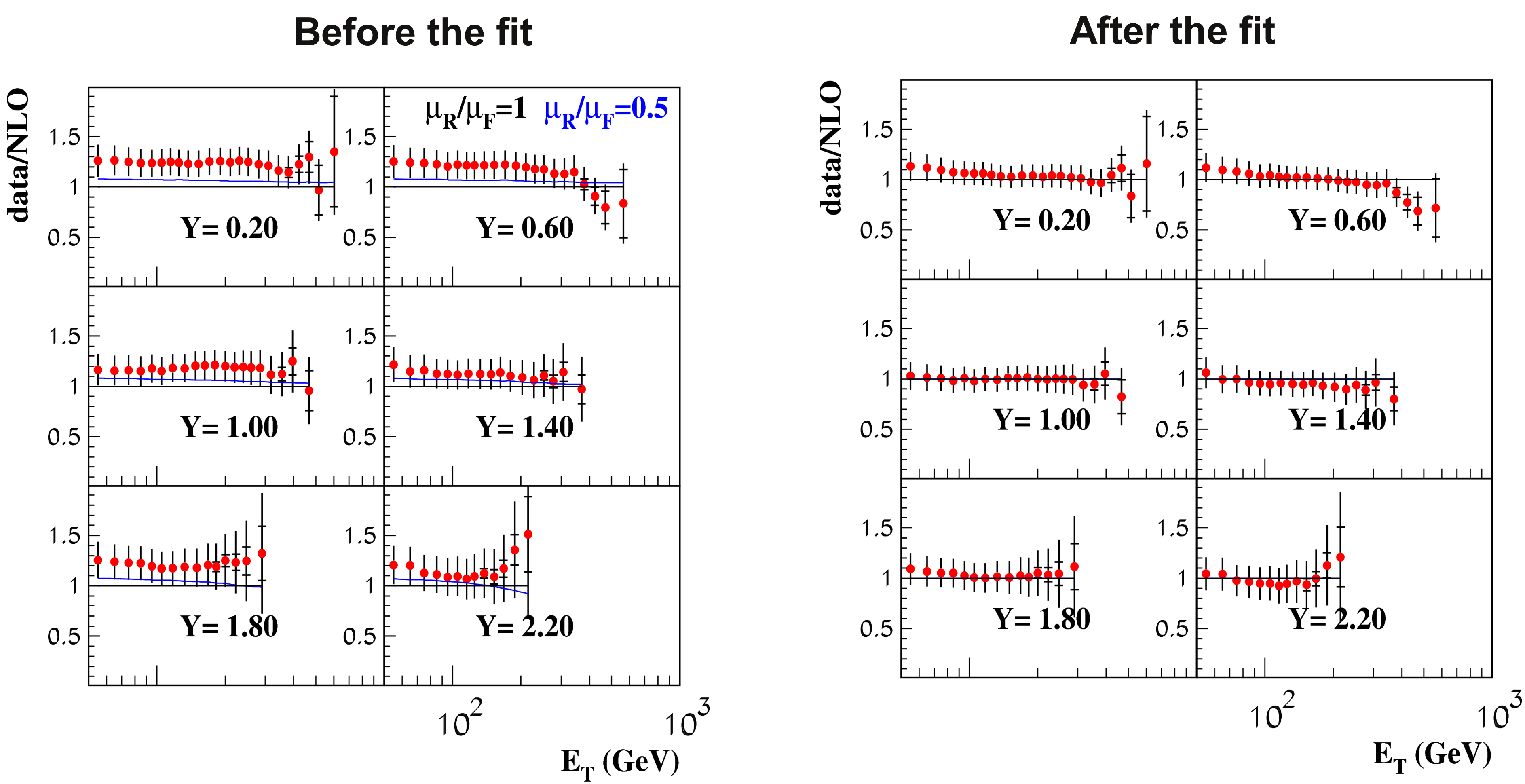
Kluge, Rabberitz, Wobbisch [hep-ph 0609285]

Impact of the data on ABKM PDFs is marginal

ABKM describes jet data better than the “truly global fits” based on the Run II data??

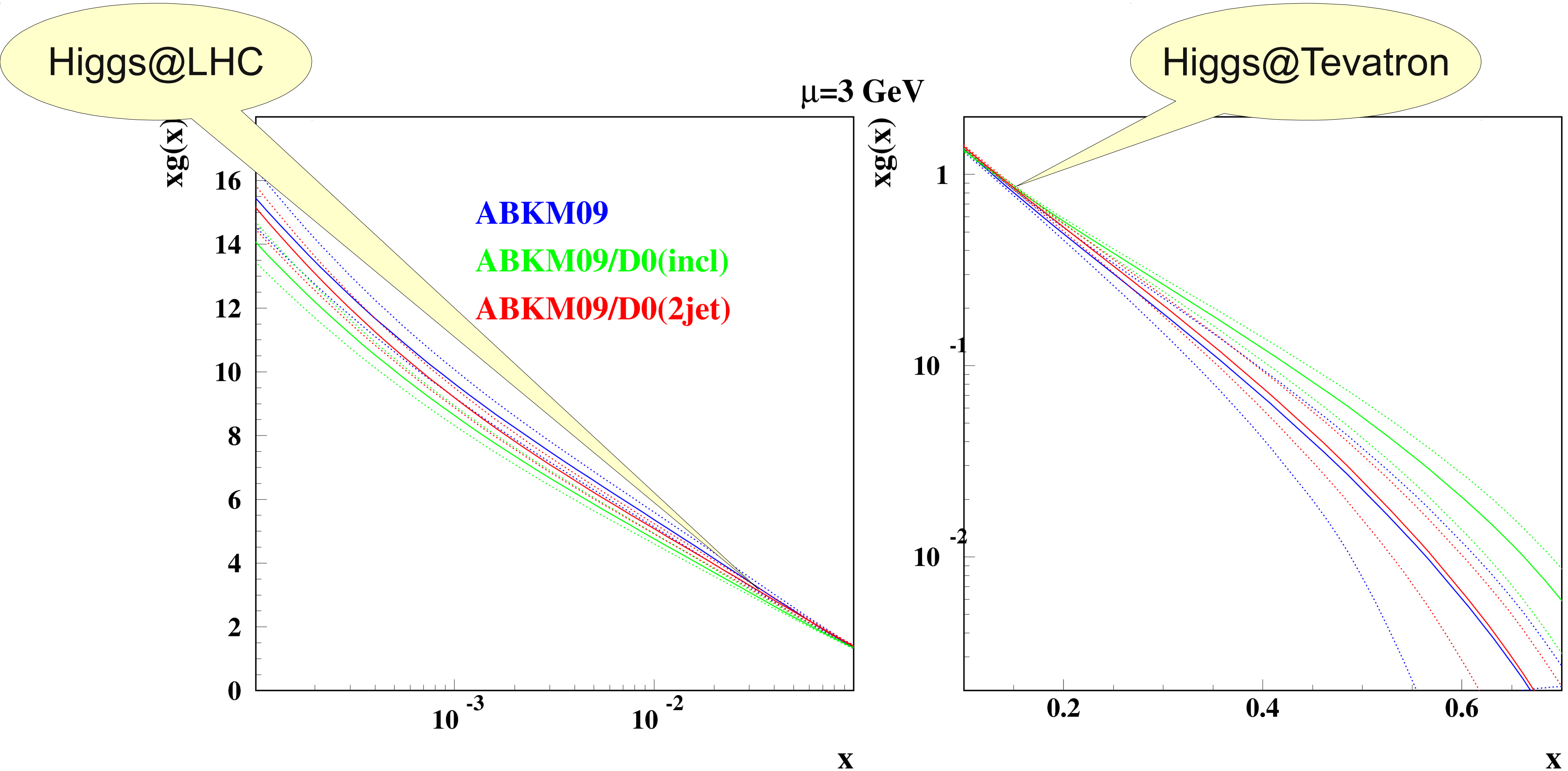
Run II D0 inclusive data in the ABKM fit

D0 Collaboration PRL 101, 062001 (2008)



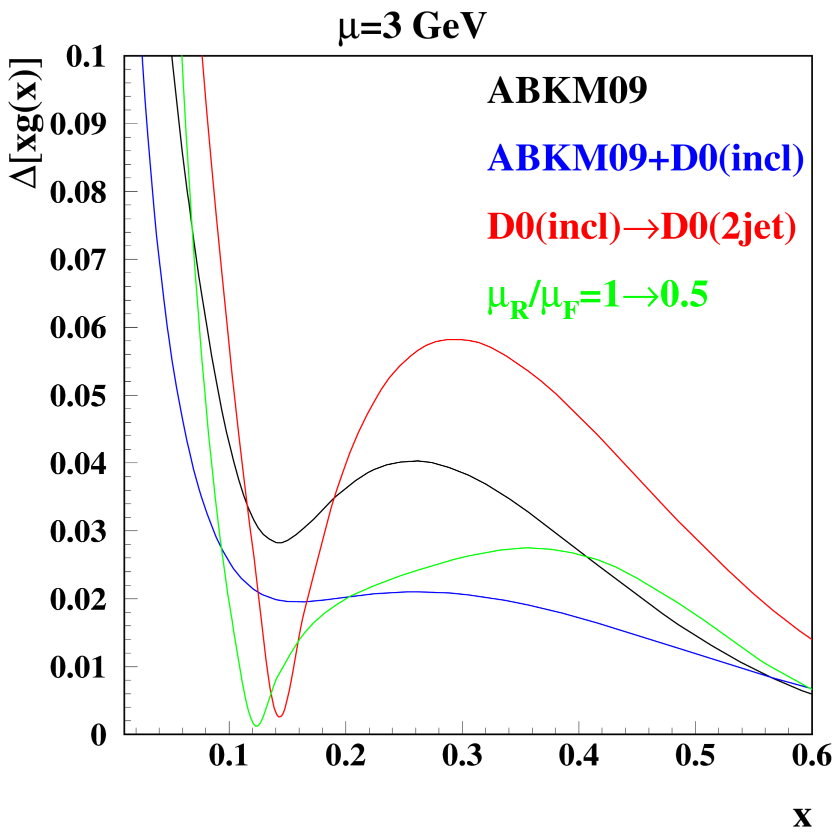
- The NLO variant of the ABKM09 fit with the D0 Run II inclusive midpoint data included
- Mixed scheme: 3-flavor PDFs for the DIS and 5-flavor PDFs for jets, $\mu_F=E_T$
- The value of χ^2 for D0 data is 104/110 → jet data can be easily combined with others

Run II D0 inclusive data in the ABKM fit (cont'd)



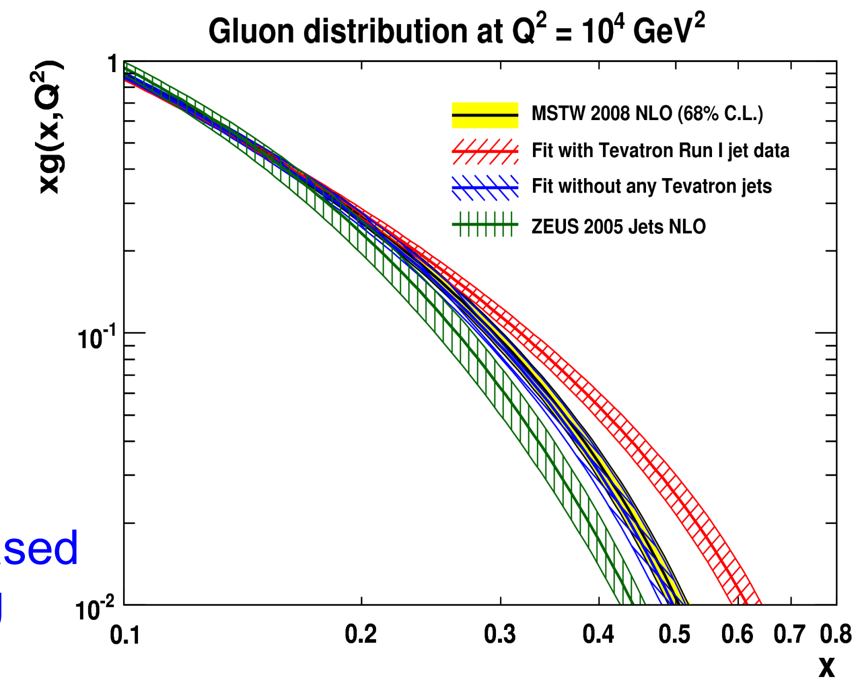
- Impact of the D0 data may be somewhat bigger than 1σ
  what is the proper selection of the jet data? – Run I data give even bigger large-x gluons
- Potential impact of the precise DIS data looks promising → EIC, JLAB@12 and other forthcoming facilities

Impact of the jet data on gluons



- The NNLO corrections to jet production are cumbersome (non-trivial subtraction of the IR singularities), only the e+e- case has been solved recently.

Weinzierl, Gehrmann-De Ridder, Gehrmann, Glower, Heinrich



MSTW EPJC 63, 189 (2009)

- The Tevatron Run I data overshoot the DIS-based predictions → large gluon distributions and big value of strong coupling constant.
- The Run II data go lower → no tension with DIS, impact of the jet data on gluons is greatly reduced.

$\alpha_s(M_z)=0.1161\pm0.0045(\text{exp.})$ (NLO)

D0 Collaboration [hep-ex 1006.2855]

The fragmentation function uncertainties?

Summary

Running mass definition implemented for heavy-quark DIS

- Good agreement to the seiinclusive data → no need for the VFN modeling
- Better constraint on the heavy-qark masses → more precise c-quark distribution

The inclusive Tevatron jet data added to ABKM fit → the "truly global PDFs"

- Moderate impact on the gluons (scale uncertainty)
- Selection of the data is unclear: RunI / RunII / inclusive / dijet → additional uncertainty