Impact of the jet data on the Higgs production rate

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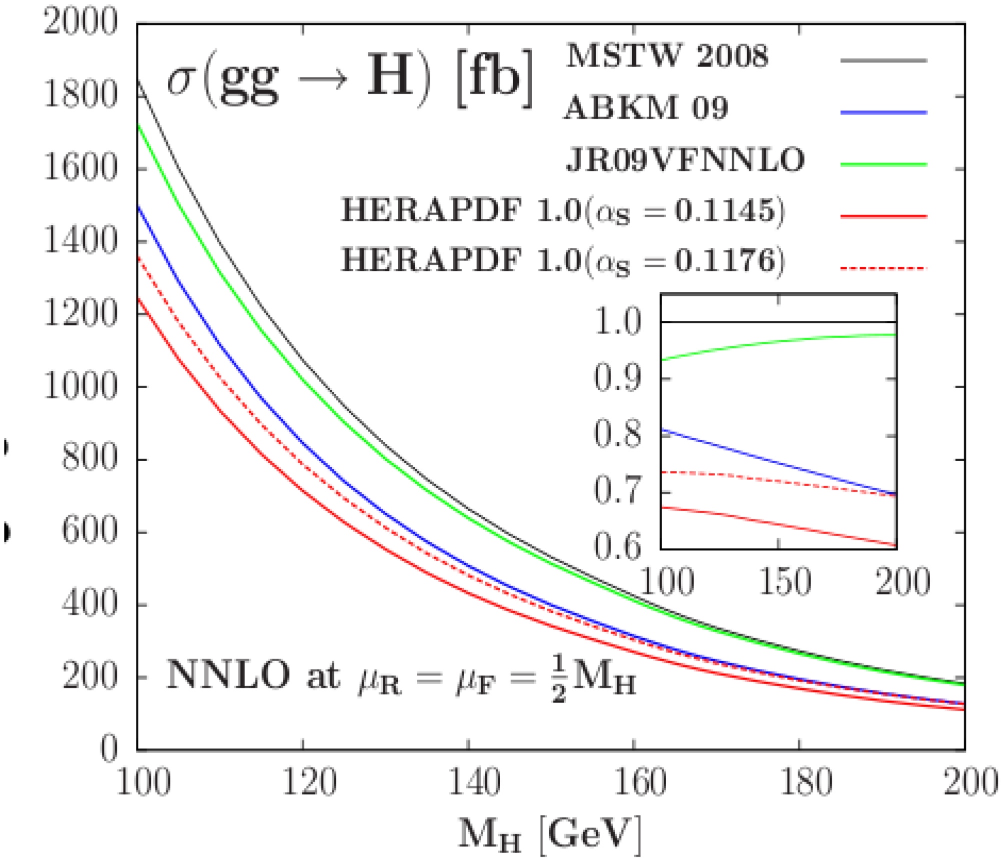
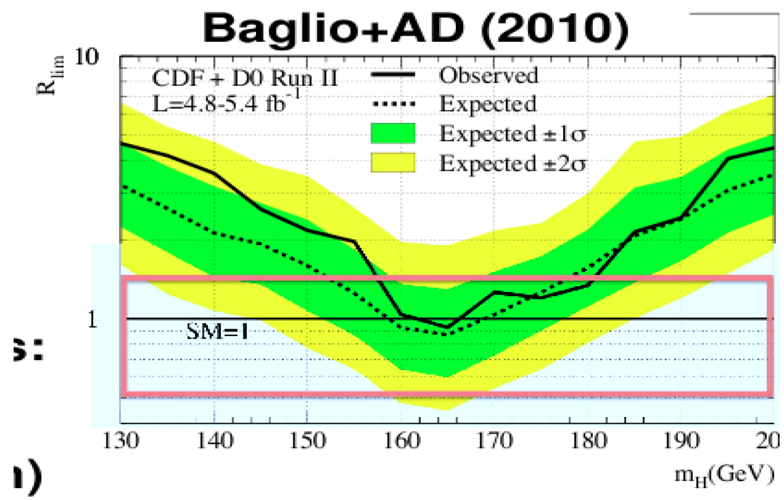
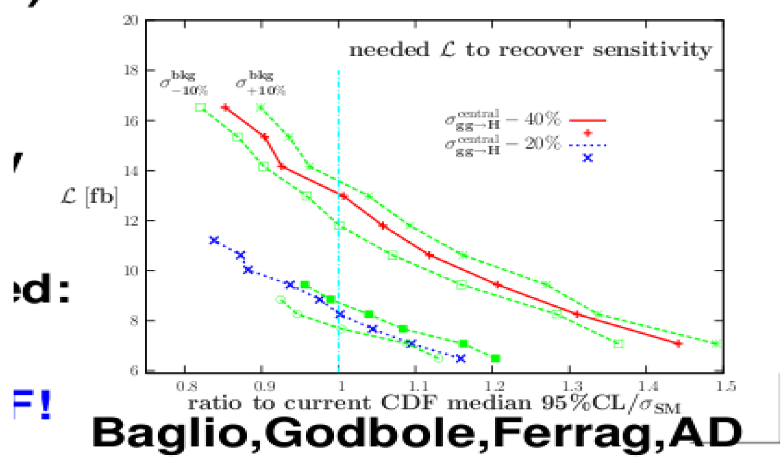
sa, Blümlein, Moch [hep-ph 1105.5349]

St.Andrews, 25 Aug 2011

Higgs discovery limit







The spread in the c.s. due to the choice of PDFs is sizable $\rightarrow$ bottleneck for the discovery limit. For the solid exclusion of the Higgs at Tevatron twice bigger statistics is necessary

Baglio, Djouadi [hep-ph 1003.4266]

Validation of gluons and/or α_s is necessary

The ABM fit ingredients

DATA:

- DIS NC inclusive (new HERA data)
- 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 functions
  - (NLO + NNLO threshold corrections, running mass)
- NLO jet production corrections

Deuteron corrections in DIS:

- Fermi motion
- off-shell effects

Power corrections in DIS:

- target mass effects
- *dynamical twist-4 terms*

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.

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

NLO evolution + NLO coefs
- consistent fit
- QCD evolution is inaccurate

NNLO evolution + NLO coefs
- the PDF evolution more accurate
- the PDFs ready for the HO calculations

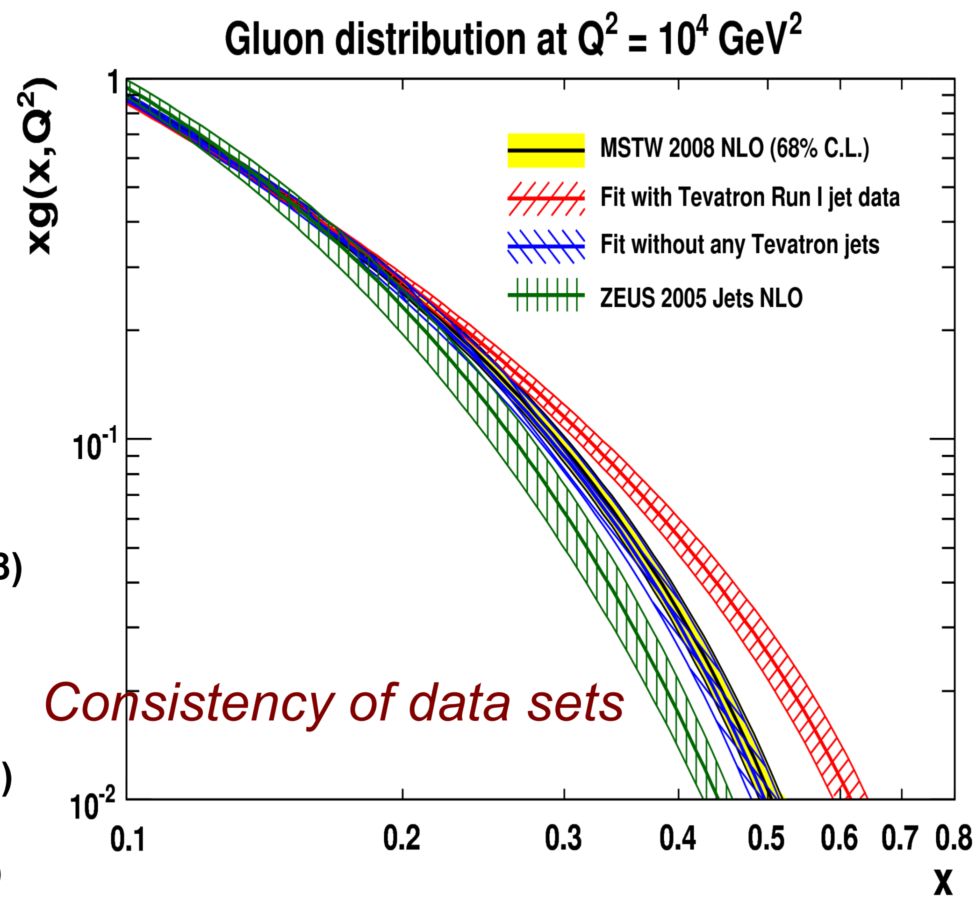
RunII Tevatron data checked wrt ABKM09:

D0 midpoint inclusive (R=0.7)
PRL101, 062001 (2008)

D0 midpoint di-jet (R=0.7)
PLB 693, 531 (2010)

CDF K_T inclusive (D=0.7)
PRD 75, 092006 (2007)

CDF midpoint inclusive (R=0.7)
PRD 78, 052006 (2008)

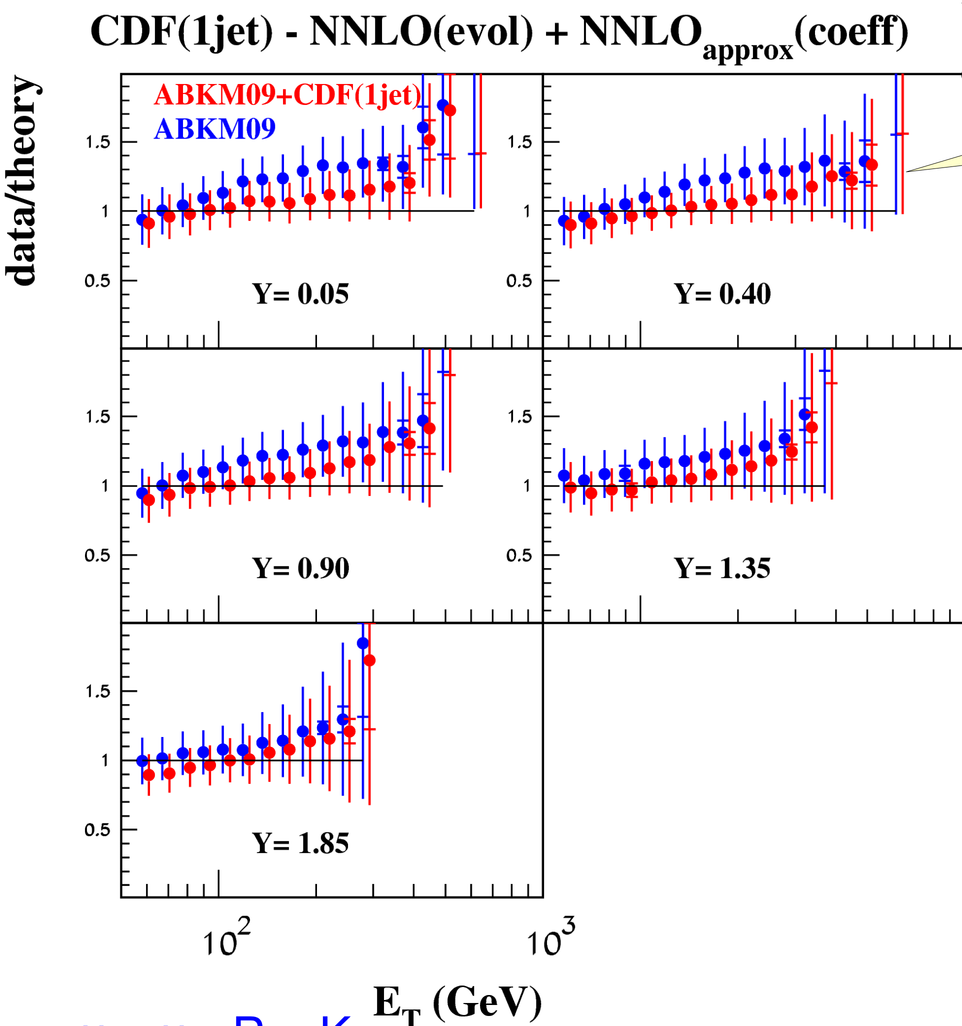


MSTW Collaboration EPJC 63, 189 (2009)

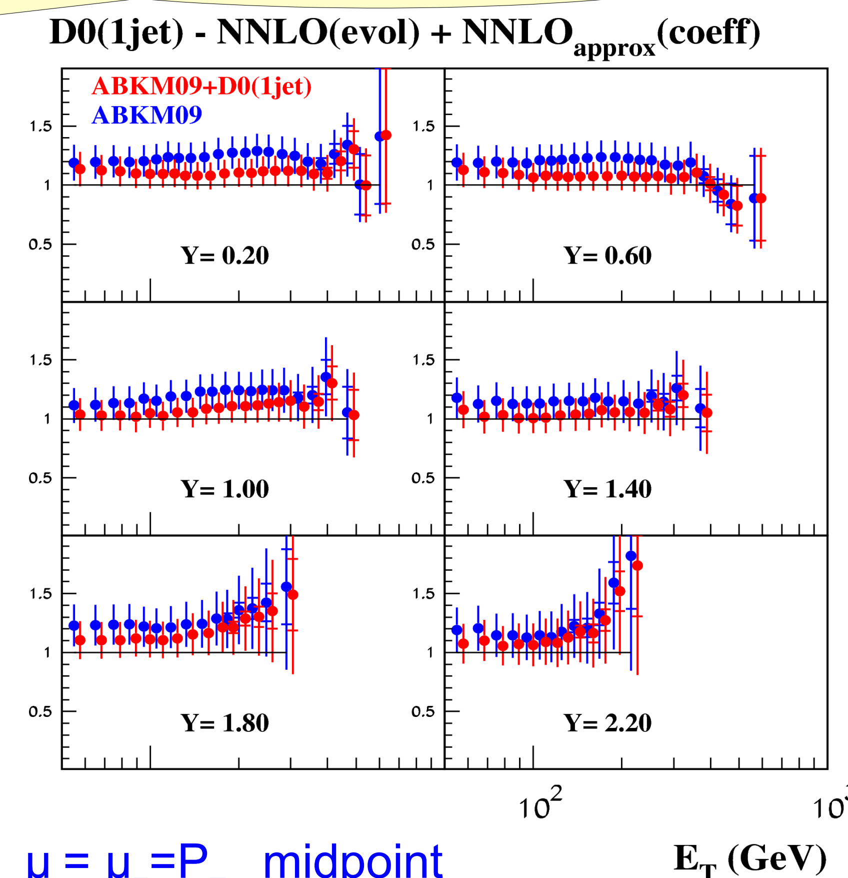
FastNLO is used to employ NLO corrections.

Kluge, Rabberitz, Wobbisch [hep-ph 0609285]

D0 and CDF inclusive data



dominated by quark-quark scattering



$\mu_r = \mu_F = P_T$ K_T

17 sources of systematics

χ^2/NDP=60/76

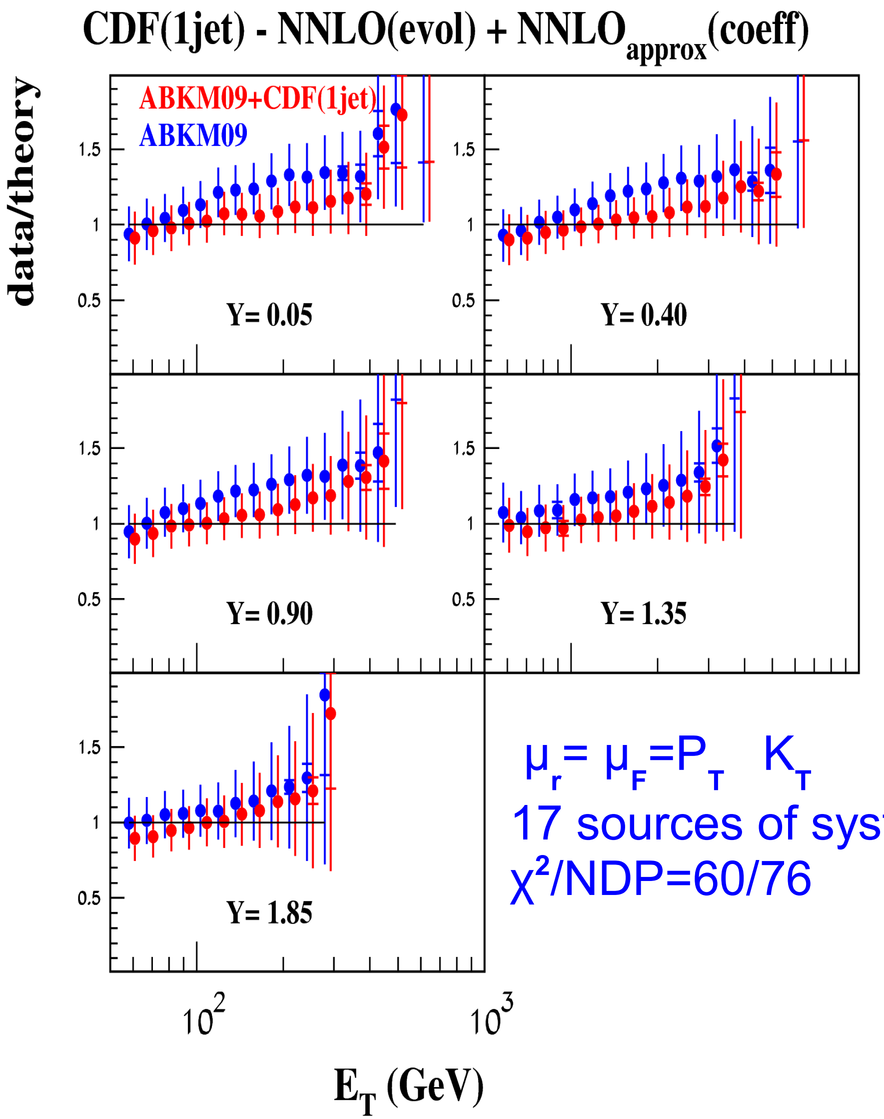
$\mu_r = \mu_F = P_T$ midpoint

24 sources of systematics

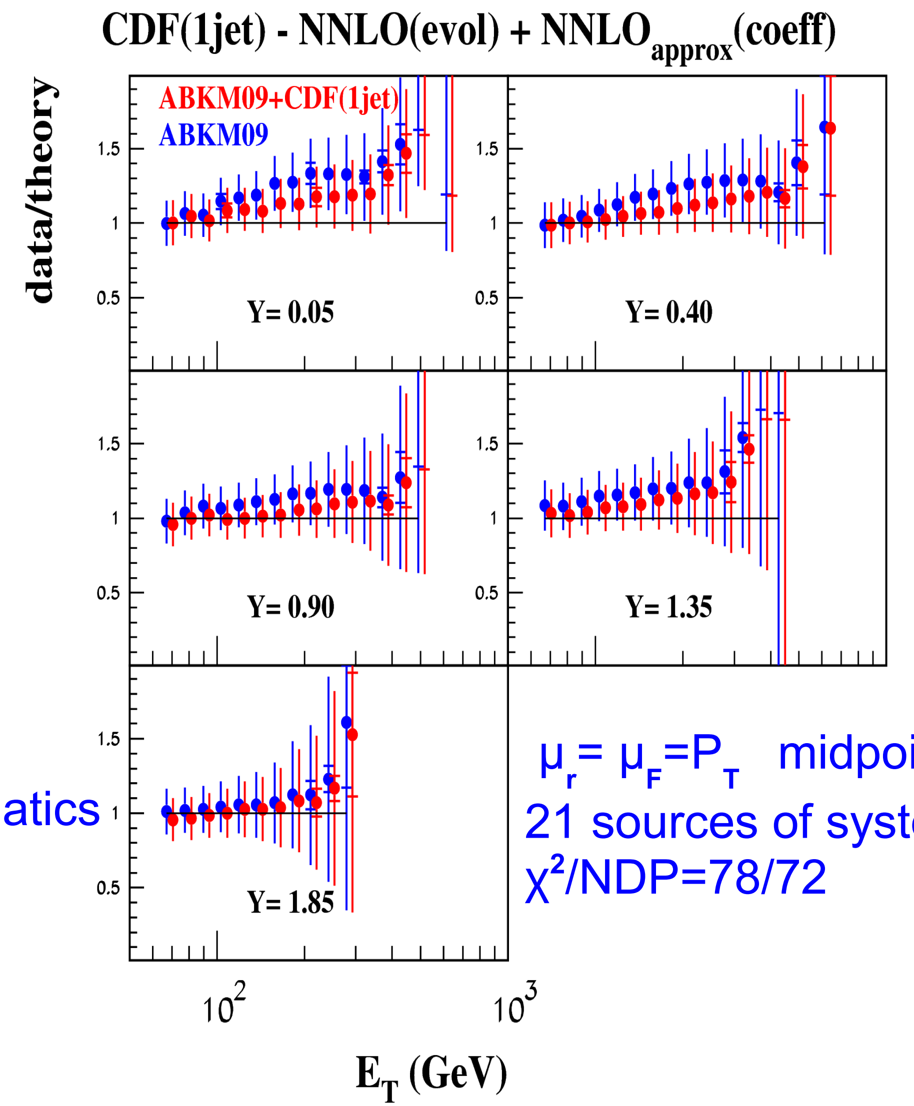
χ^2/NDP=103/110

For the D0 data the discrepancy with the ABKM predictions can be explained by the missing NNLO K-factor of 20-30%. For the CDF data the slope in data is different; the agreement at large E_T can be hardly improved.

CDF: k_T and cone data



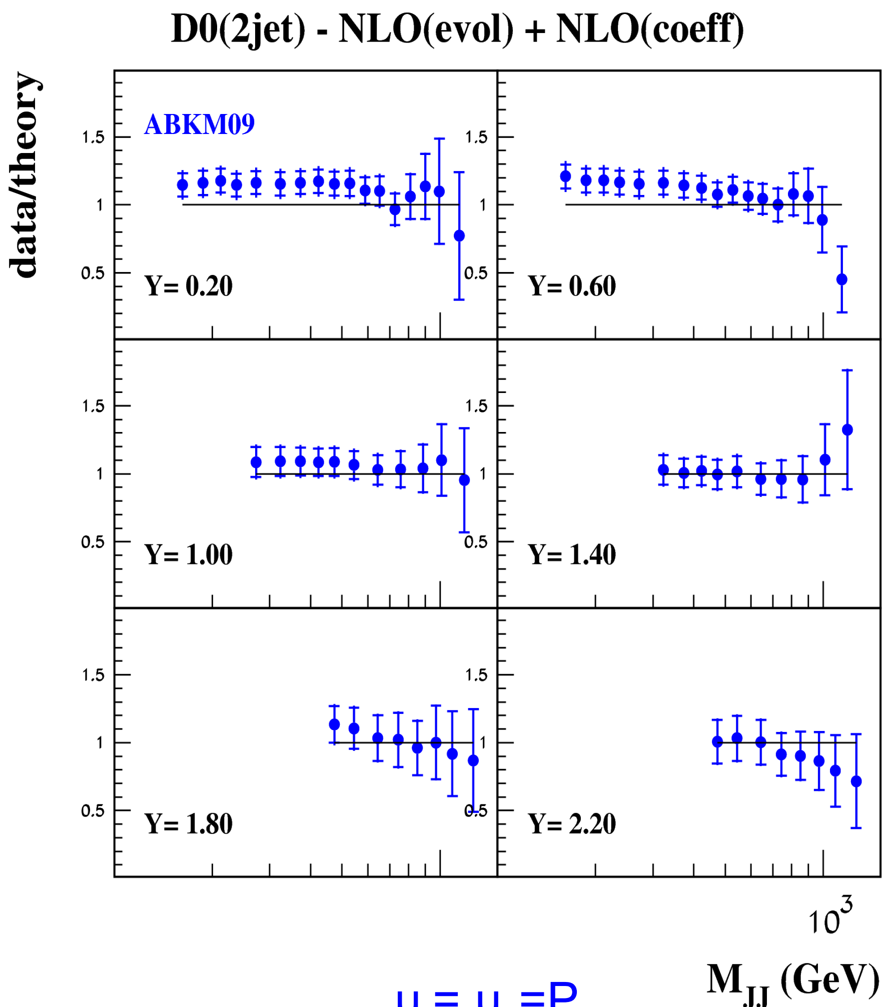
$\mu_r = \mu_F = P_T$ K_T
17 sources of systematics
χ^2/NDP=60/76



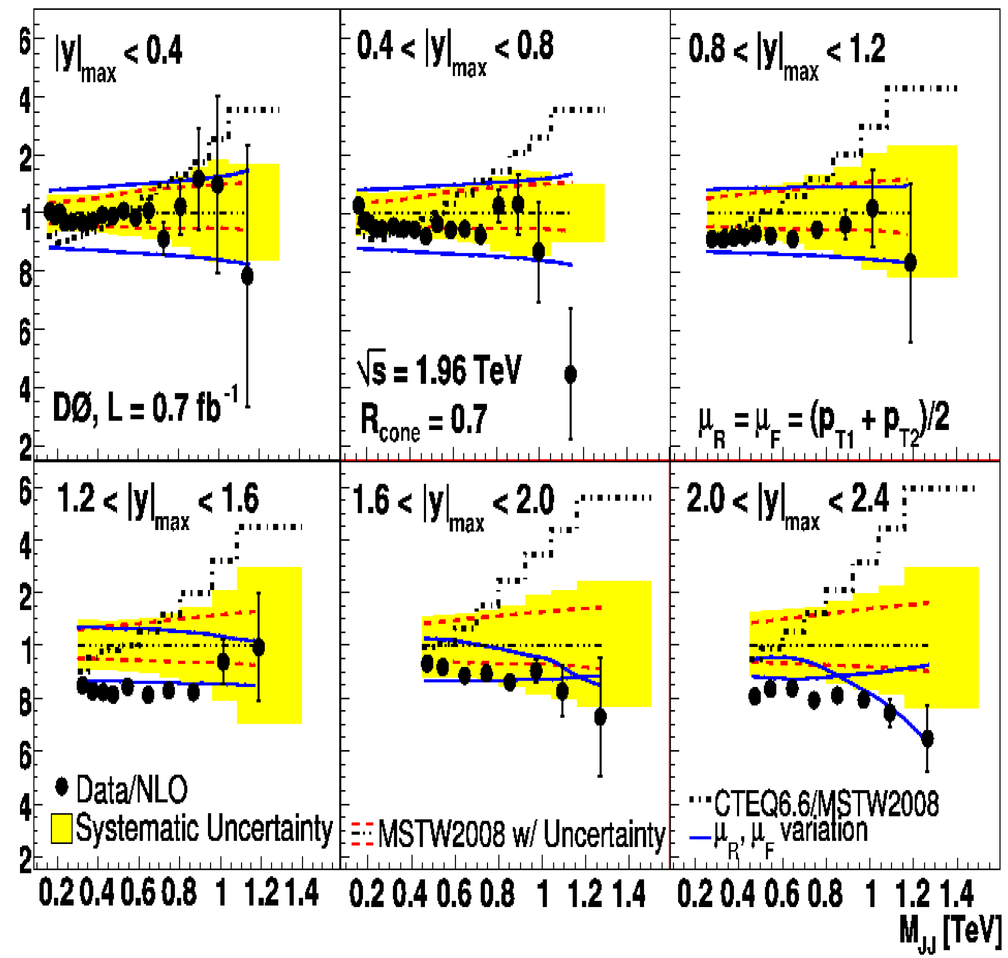
$\mu_r = \mu_F = P_T$ midpoint
21 sources of systematics
χ^2/NDP=78/72

The cone data (predictions) go lower(higher) than the k_T ones → better agreement with the ABKM at low P_T, lower value of α_s is preferred in the combined fit

D0 dijet data in the NLO fits



$\mu_r = \mu_F = P_T$

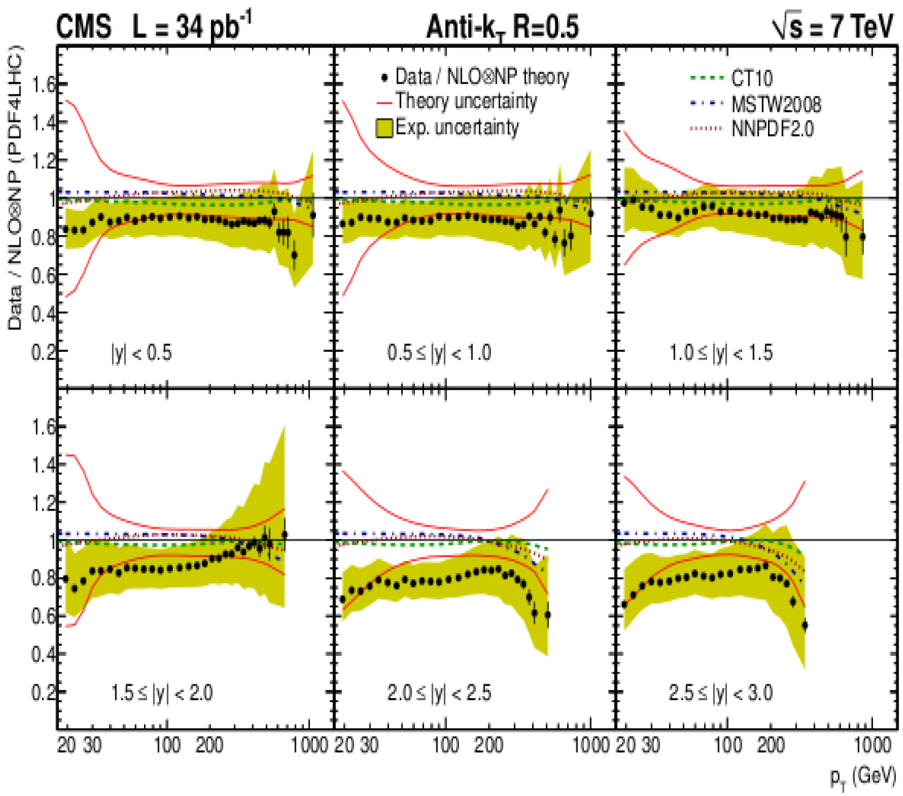


D0 Collaboration PLB 693, 531 (2010)

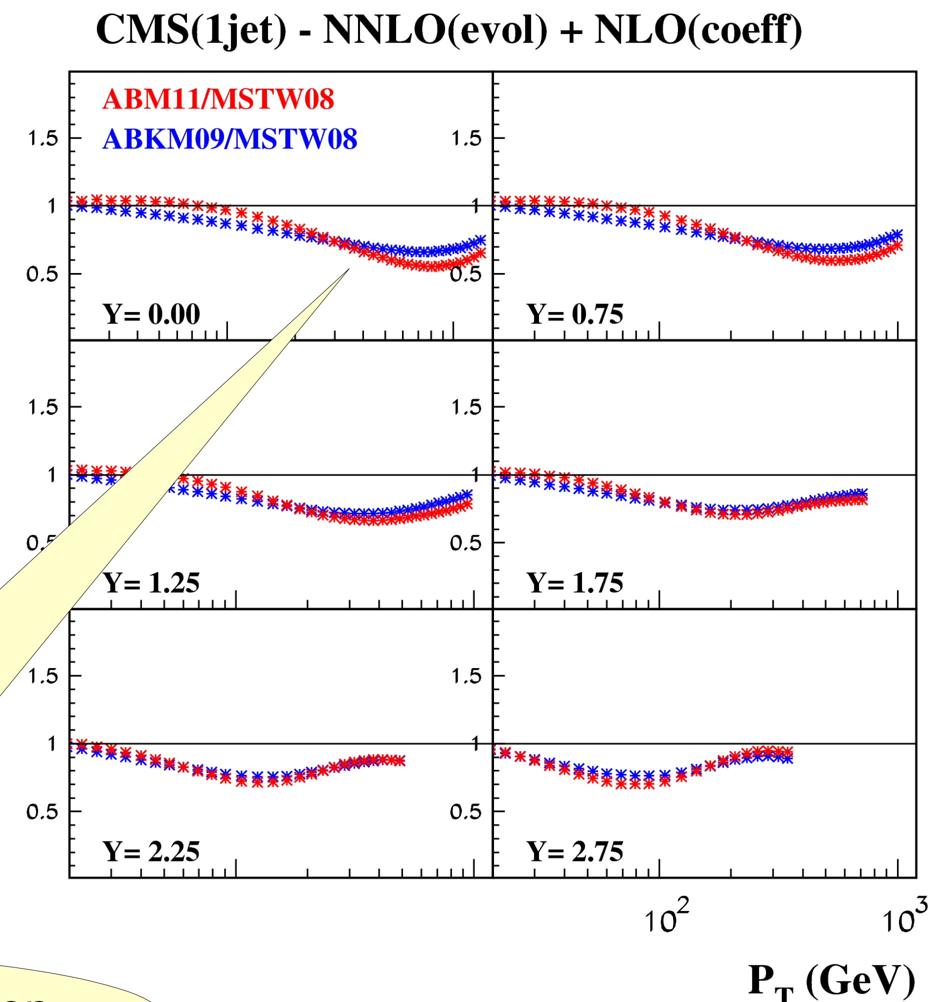
The NLO ABKM09 **predictions** describes jet data better than the fits based on the Tevatron data? → this is not problem of PDFs, rather problem of the data.

The Tevatron jet data are not completely understood

CMS inclusive data (7 TeV, 34 1/pb)



CMS Collaboration [hep-ex/1106.0208]

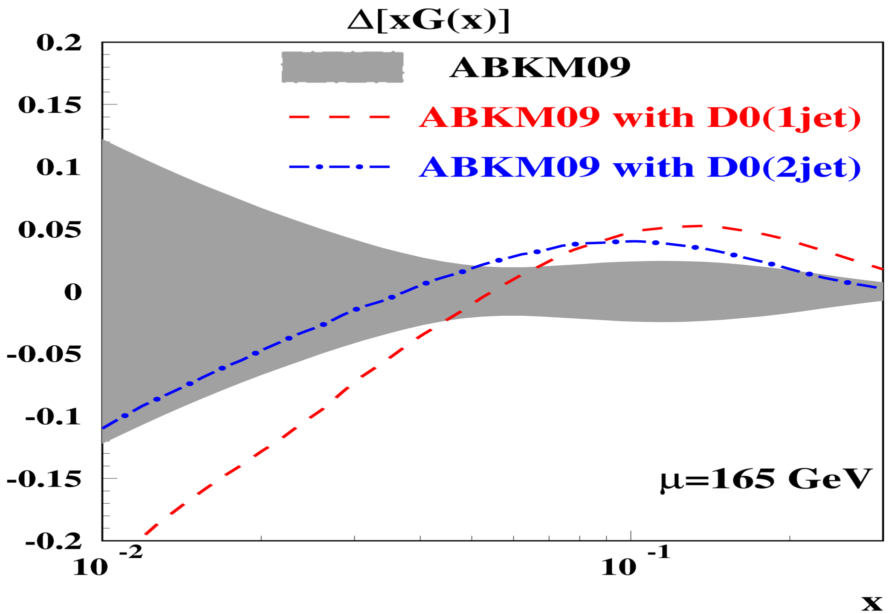


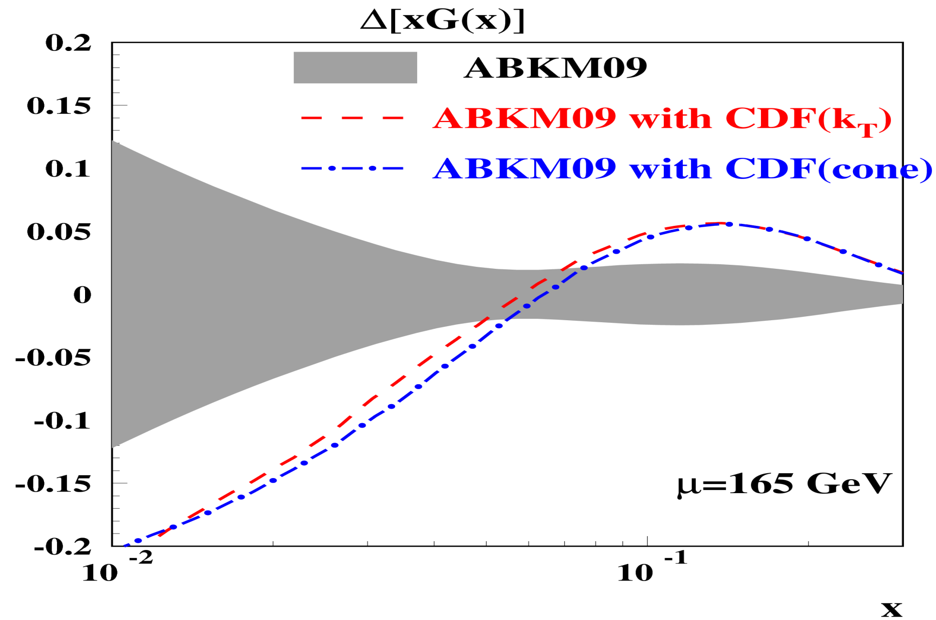
Kinematics for M_H=165 GeV at Tevatron

(FastNLO courtesy of K.Rabberitz)

The CMS data go systematically lower that the predictions based on the PDF fitted to the Tevatron jet data. For the PDF, which do not use the Tevatron jet data, agreement at large P_T is better. At small P_T the PDFs are constrained by the HERA data.

Gluons at small *x* and Higgs c.s.

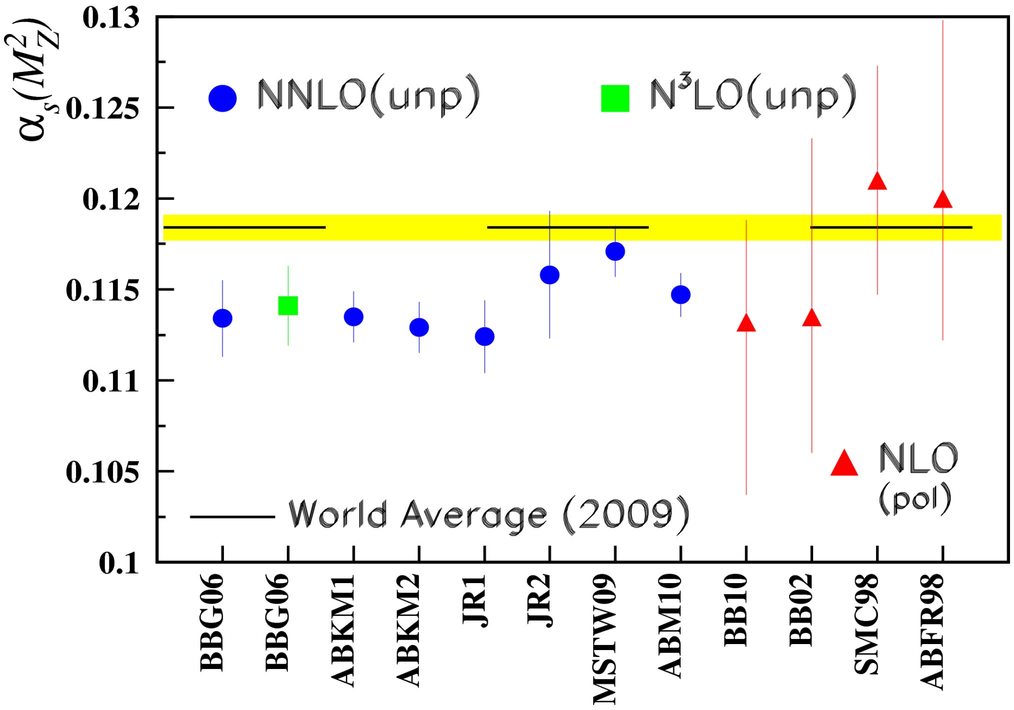




	$\alpha_s(M_Z)$(NNLO)	$\sigma(M_H$=165 GeV) (pb) Tevatron	LHC7
ABKM:	0.1135(14)	0.253(22)	7.05(23)
+ D0(1jet):	0.1149(12)	0.297(12)	7.30(15)
+ D0(2jet):	0.1145(9)	0.281(12)	7.28(14)
+ CDF/k_T	0.1143(9)	0.292(10)	7.18(14)
+ CDF/cone	0.1134(9)	0.283(10)	7.02(14)

- The Tevatron jet data pull the Higgs up by 1-2σ, depending on the data set; the effect must reduce with the NNLO correction to the jet production taken into account
- For the LHC7 relative effect is smaller, than for the Tevatron
- *The value of α_s is still “small”*

PDFs and α_S (Johannes' talk afternoon)



Blümlein, Böttcher NPB 841, 205 (2010)

- Many important hadronic processes i.e. Higgs and top-quark production are $\sim\alpha_s^2$.
- The gluon distribution is correlated with α_s → effect is accumulated.
- The value of α_s from DIS *(mostly defined by the non-singlet part)* is about 3σ lower than the world average of 2009.

Bethke EPJC 64, 689 (2009)

From the Tevatron jet data

$\alpha_s(M_z)$=0.1161±0.0045 (NLO)

D0 Collaboration [hep-ex 1006.2855]

$\alpha_s(M_z)$=0.1135±0.0014 (NNLO)

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

$\alpha_s(M_z)$=0.1171±0.0014 (NNLO)

MSTW Collaboration EPJC 64, 653 (2009)

From the world e+e- data on trust

$\alpha_s(M_z)$=0.1135±0.0002(exp.)±0.0005(had.) ±0.0009(pert..) (NNLO)+*power corr.*

Abbate, Fickinger,Hoang, Mateu, Steward [hep-ph 1006.3080]

Recent results are in nice agreement with the DIS values

The difference in α_s makes difference of 30-40% in the Higgs c.s. at Tevatron

Summary

- The "small" value of the α_s is confirmed in the approximate NNLO fit with the Tevatron jet data included:

  $\alpha_s(M_z)$=0.1135(14) → 0.1134 – 0.1149 (NNLO)

  depending on the data set used

- Due to the Tevatron data the Higgs cross section goes up up by ~1-2σ

  – *scale sensitivity?* → no NNLO corrections

- CMS inclusive jet data prefer small value of the Higgs cross section