PDF ISSUES FOR HIGGS PHYSICS

STEFANO FORTE
UNIVERSITÀ DI MILANO & INFN

UNIVERSITÀ DEGLI STUDI DI MILANO
DIPARTIMENTO DI FISICA

INFN Istituto Nazionale di Fisica Nucleare

HIGGS WORKING GROUP

BNL, MAY 5, 2011

SUMMARY

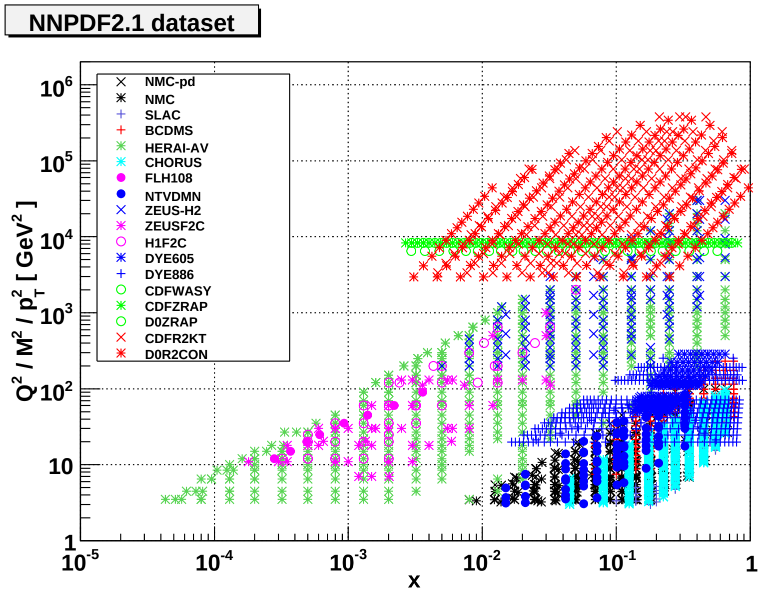
- PROGRESS
  - NLO STATUS
  - NLO PROGRESS
  - NNLO
- ISSUES
  - PDF UNCERTAINTIES
  - DATA CONSISTENCY
  - FIXED-TARGET DATA
  - α_s
- OUTLOOK
  - PRACTICAL PRESCRIPTIONS
  - TOWARDS COLLIDER-ONLY FITS

STATUS & PROGRESS

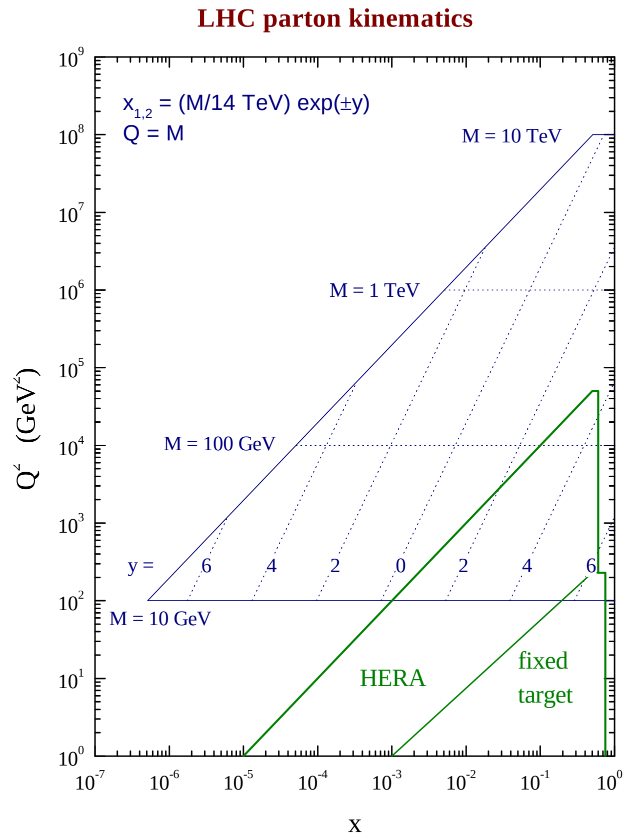
CURRENT PDF SETS

$$\sigma_X(s, M_X^2) = \sum_{a,b} \int_{x_{\min}}^{1} dx_1\, dx_2\, f_{a/h_1}(x_1) f_{b/h_2}(x_2) \hat{\sigma}_{q_a q_b \to X}\left(x_1 x_2 s, M_X^2\right)$$

data in global fits



LHC kinematics



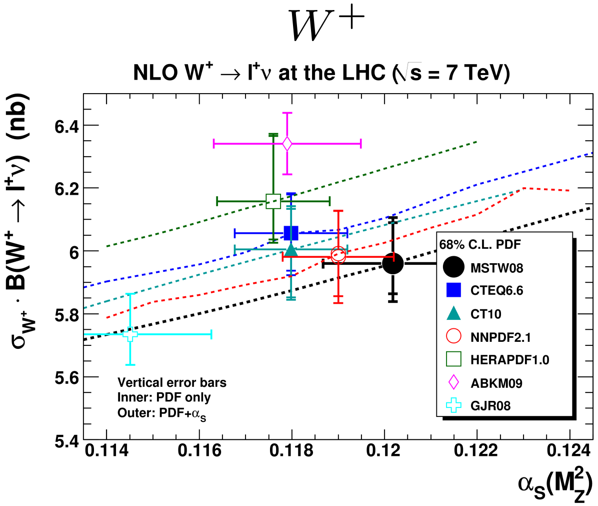
- CT10: GLOBAL, NLO, SEVERAL α_s VALUES, VFN
- MSTW08: GLOBAL, NLO & NNLO, SEVERAL α_s VALUES, VFN
- NNPDF2.1: GLOBAL, NLO, SEVERAL α_s VALUES, VFN
- ALEKHIN ABKM: DIS+SOME DY, NLO & NNLO, SINGLE α_s VALUE, FFN
- HERAPDF1.0: HERA DIS, NLO, SEVERAL α_s VALS, VFN
- SETS BASED ON MODEL ASSUMPTIONS (GRV/GJR, STATISTICAL PDFS,...)

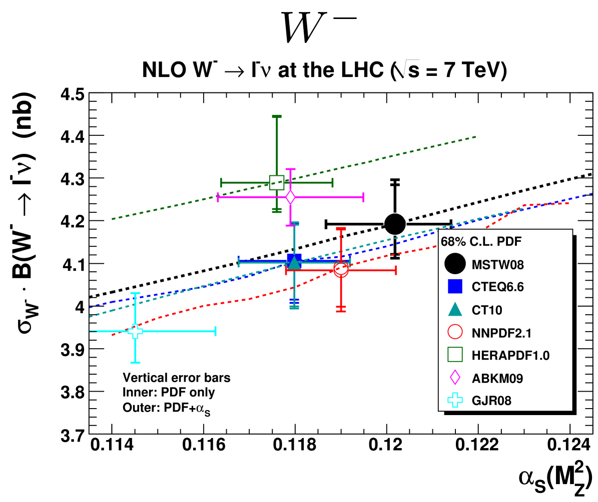
FEATURES, TRADEOFFS AND CHOICES

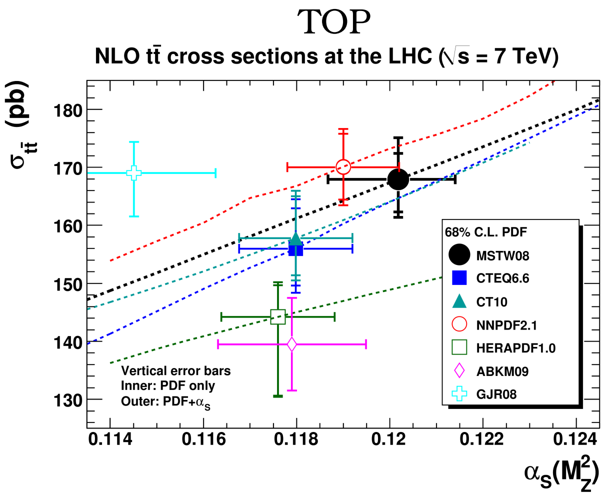
- DATASET: CTEQ, MSTW, NNPDF FIXED TARGET AND COLLIDER, eP AND $\bar{P}P$ DATA; ABKM, GJR GLOBAL DIS+ FIXET-TARGET DY; HERAPDF: HERA DIS ONLY
- STATISTICAL TREATMENT: CTEQ, MSTW HESSIAN WITH DYNAMICAL TOLERANCE; HERAPDF, STANDARD HESSIAN+PARM. ERROR ANALYSIS; GJR, HESSIAN WITH FIXED TOLERANCE; ABKM STANDARD HESSIAN; NNPDF MONTE CARLO (ALSO STUDIED BY HERAPDF)
- PARTON PARAMETRIZATION: CTEQ, MSTW, HERAPDF $x^{\alpha}(1-x)^{\beta}\times$ POLYNOMIALS; GJR: DITTO + VALENCELIKE ASSUMPTION; NNPDF NEURAL NETS; CHEBYSHEV POLYNOMIALS STUDIED BY HERAPDF;
- α_s VALUE: CTEQ, NNPDF: EXTERNAL PARAMETER, SEVERAL VALUES AVAILABLE; MSTW: FITTED, BUT ALSO VARIABLE AS EXT.PARAMETER; ABKM, GJR: FITTED, NOT VARIABLE AS EXT. PARAMETER
- PERTURBATIVE ORDER: CTEQ: NLO, BUT DY LO WITH K-FACTORS; MSTW: NNLO, BUT DY LO WITH K-FACTORS; NNPDF FULL NLO, NNLO DIS; ABKM, HERAPDF, GJR: NNLO
- HEAVY QUARKS: CTEQ: GM-VFN (SACOT-χ SCHEME); MSTW: GM-VFN (ACOT+TR' SCHEME); NNPDF: GM-VFN (FONLL SCHEME); ABKM: FFN ($N_f = 3, 4$ MATCHED WITH BMSN SCHEME); GJR: FFN ($N_f = 3$)

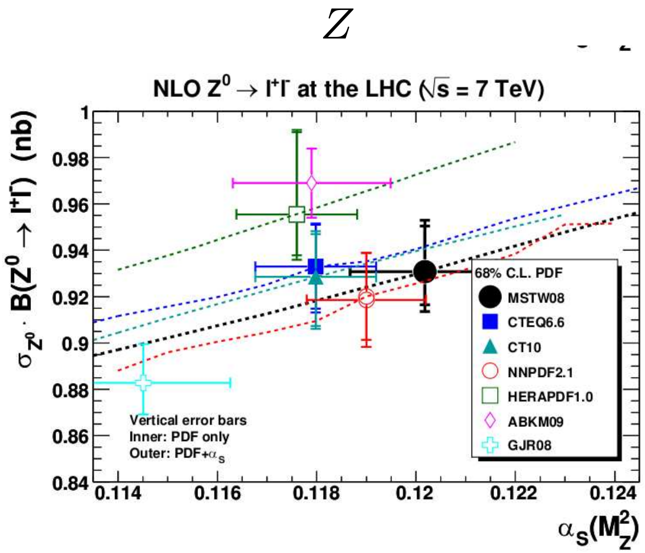
STATUS

LHC STANDARD CANDLES







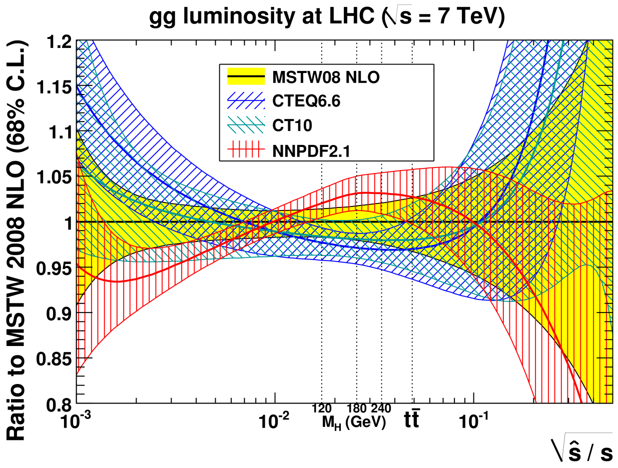


(G. Watt, 2011)

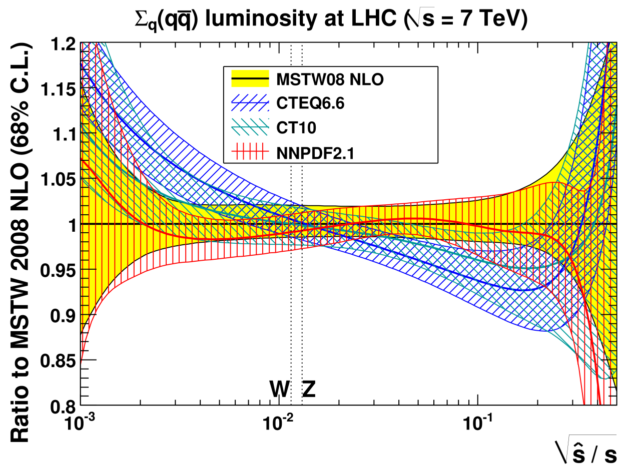
- FITS WITH WIDEST DATASET IN GOOD MUTUAL AGREEMENT
- CHOICE OF α_s VALUE IMPORTANT

STATUS
PARTON LUMINOSITIES

GLUON-GLUON

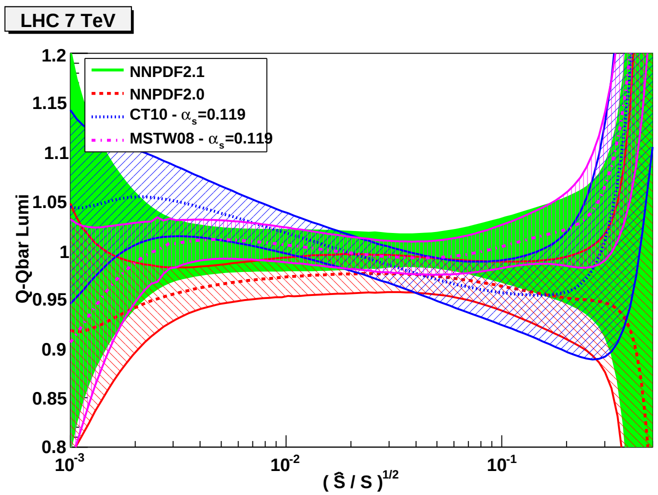


QUARK-QUARK

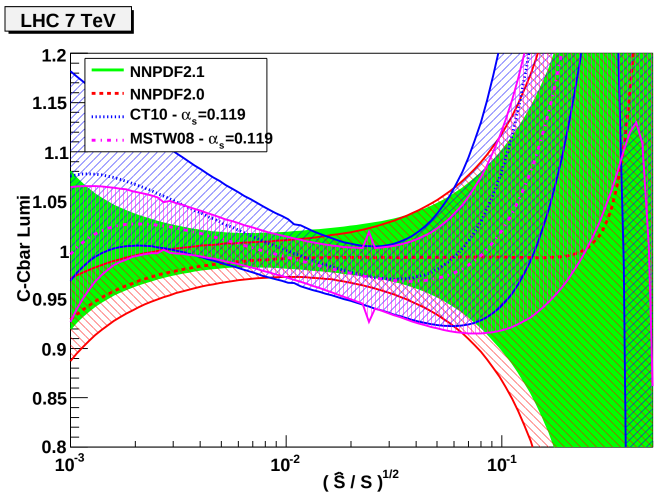


(G. Watt, 2011)

QUARK-GLUON



CHARM-CHARM



(NNPDF, 2011)

PROGRESSS

SINCE LAST WG MEETING

- NNPDF2.0 $\rightarrow$ NNPDF2.1
  - INCLUSION OF HQ MASSES (FONLL-A)
  - F_2^c DATA INCLUDED
- CTEQ6.6 $\rightarrow$ CT10
  - IMPROVED STATISTICS (SIMILAR TO DYNAMICAL TOLERANCE)
  - MORE FLEXIBLE d_v, GLUON, STRANGENESS (BUT STILL $s = \bar{s}$)
  - COMBINED HERA DATA, RUN II JETS, W ASYM, Z RAPIDITY DISTN.

ANNOUNCED AND/OR PRESENTED IN PRELIMINARY FORM

(BUT NOT YET ON LHAPDF)

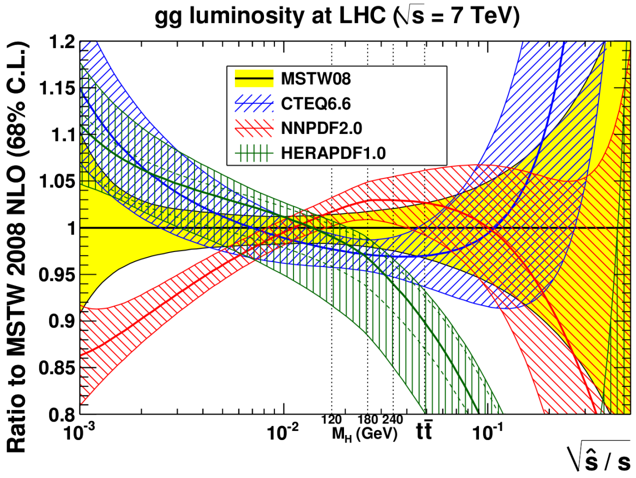
- CTEQ: NNLO
- NNPDF: NNLO (& LO) (2.1); INCLUSION OF LHC W ASYM DATA (2.2)
- HERAPDF: NNLO (1.0); INCLUSION OF HERAII AND HERA JET DATA (1.5)
- ABKM: INCLUSION OF JET DATA

PROGRESS

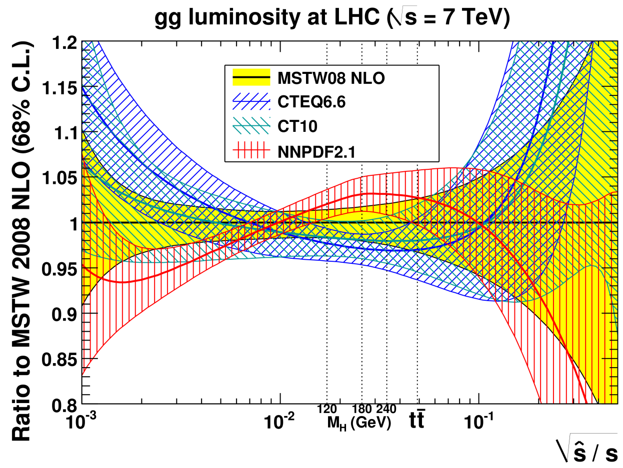
PARTON LUMINOSITIES

GLUON-GLUON

2010

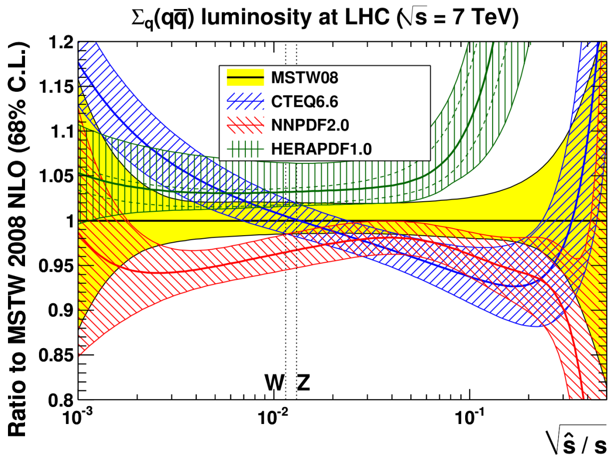


2011

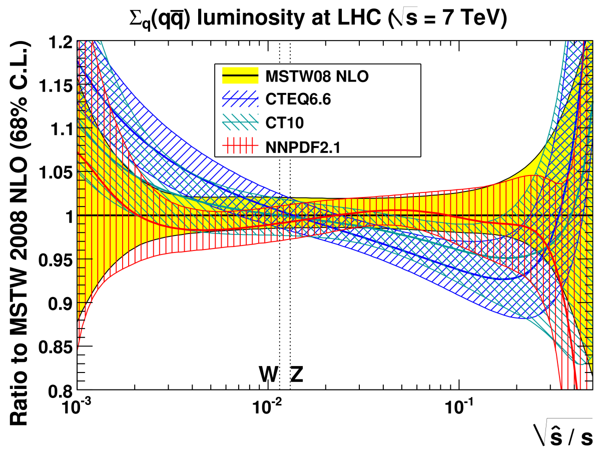


QUARK-QUARK

2010



2011



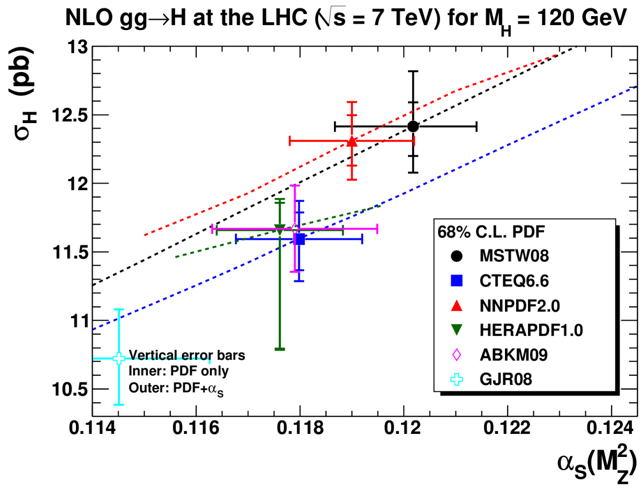
(G. Watt, 2011)

CONSIDERABLY IMPROVED AGREEMENT!

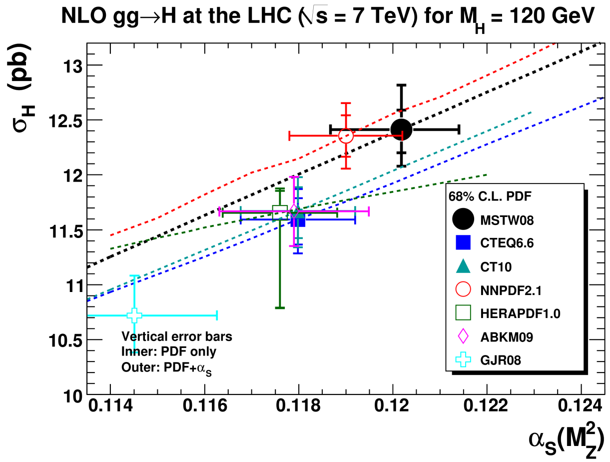
PROGRESS

THE HIGGS CROSS SECTION

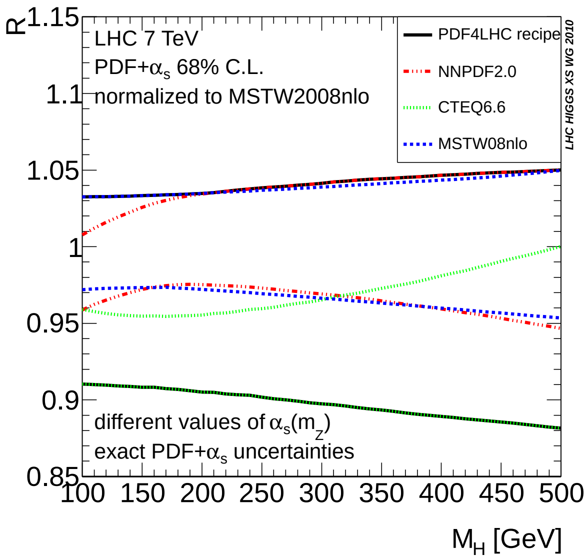
$m_H = 120$ GeV: 2010



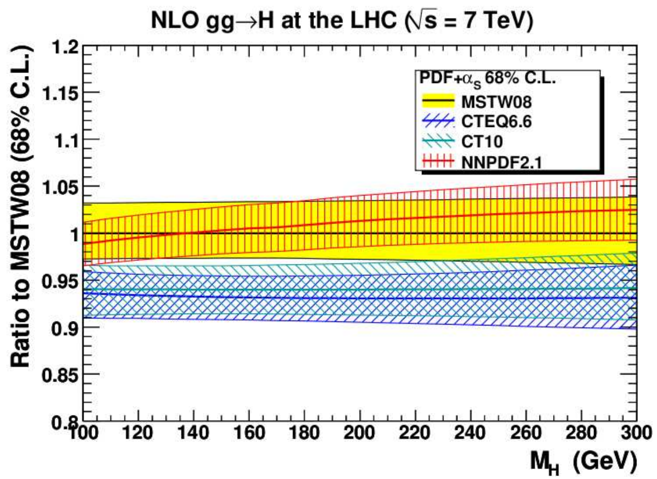
$m_H = 120$ GeV: 2011



(G. Watt)



(Higgs WG)



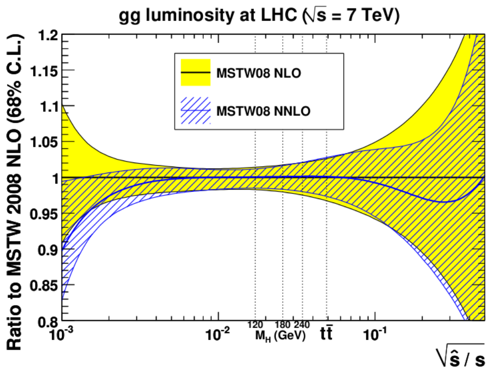
(G. Watt)

- (SMALL) IMPROVEMENT, MOSTLY CTEQ AND @ LARGE M_H

NNLO STATUS

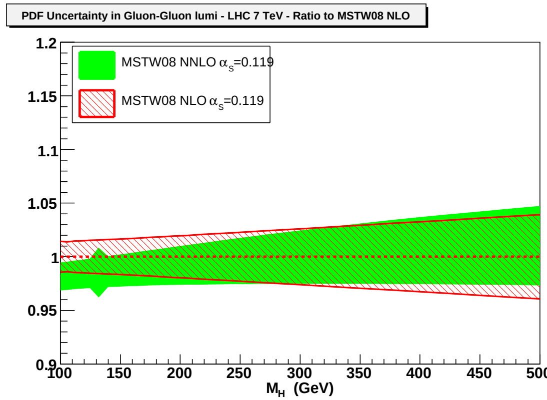
GLUON-GLUON PARTON LUMINOSITY

MSTW NNLO/NLO
best fit α_s



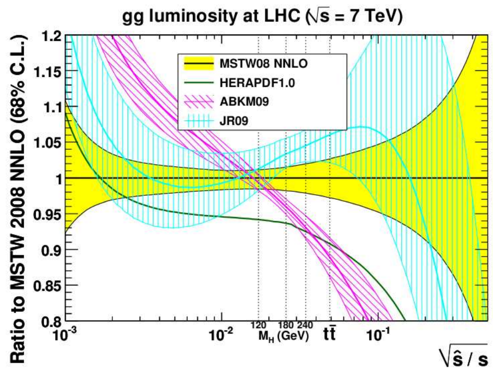
(G. Watt, 2011)

MSTW NNLO/NLO
fixed α_s



(J. Rojo, 2011)

LESS GLOBAL VS MSTW
.



(G. Watt, 2011)

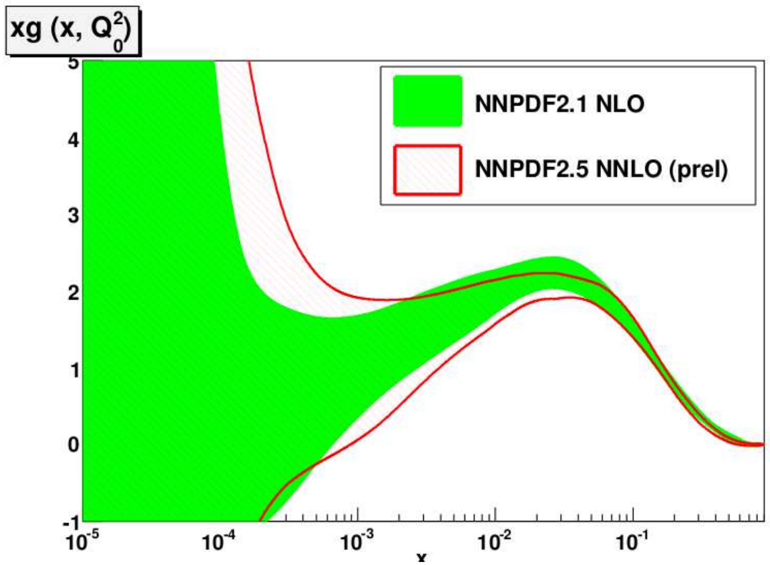
- NLO VS NNLO MSTW LUMINOSITIES QUITE CLOSE
  ... BUT PARTLY DUE TO LOWER NNLO α_s (0.117 VS 0.120)
- DIFFERENCES AS DATASED VARIED MUCH LARGER
  ... BUT IN SOME CASE ALSO α_s QUITE DIFFERENT (ABKM: 0.113)

NNLO PROGRESS

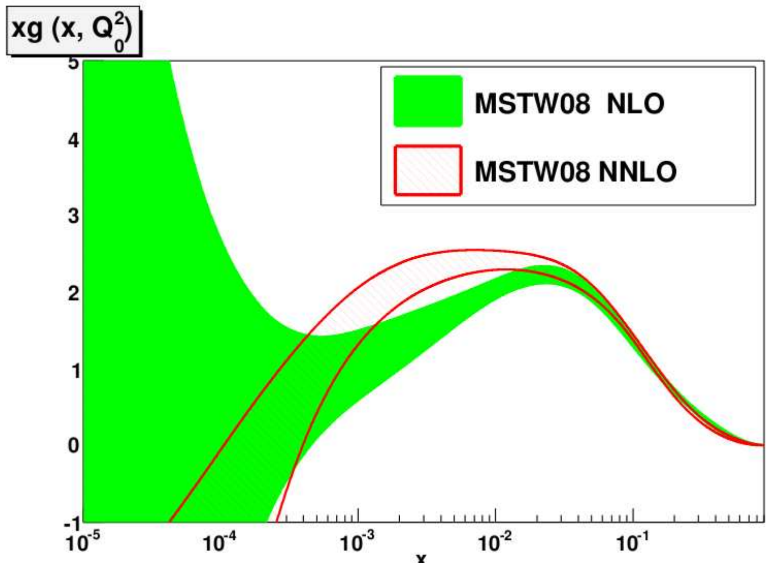
- CTEQ NNLO in preparation
- NNPDF NNLO presented in prelim. form (DIS only at NNLO, full NNLO in preparation)
  - gluon similar to MSTW, but no small x instability

gluon PDF: NLO vs NNLO

NNPDF



MSTW

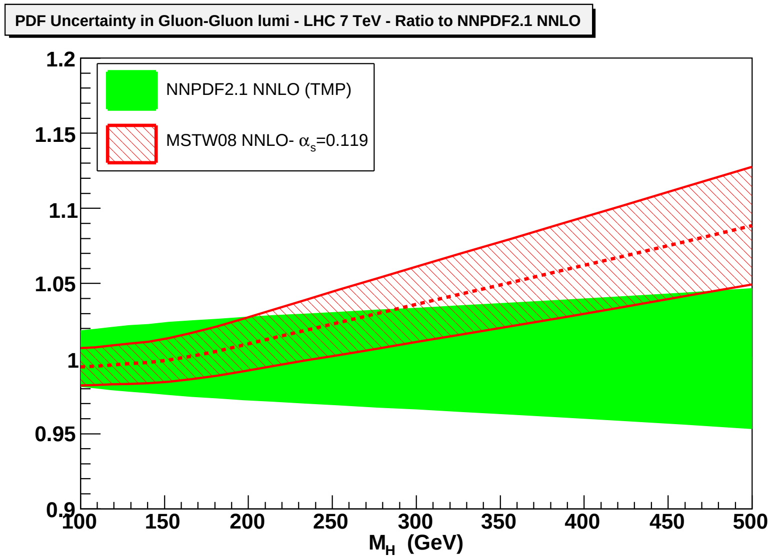


NNLO PROGRESS

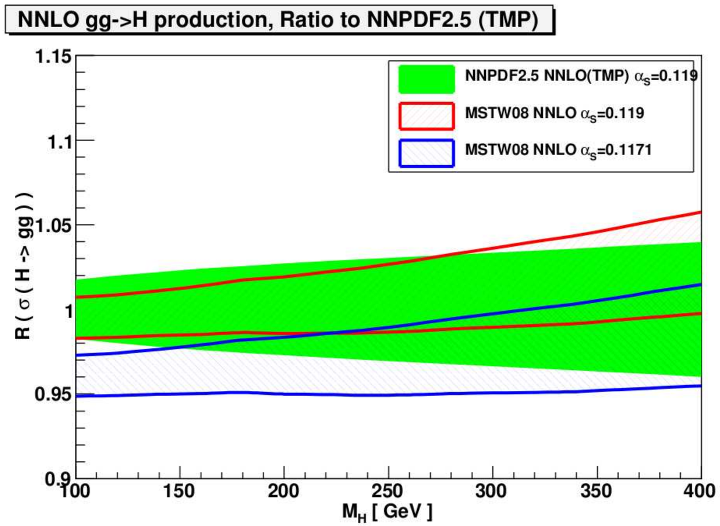
- CTEQ NNLO IN PREPARATION
- NNPDF NNLO PRESENTED IN PRELIM. FORM (DIS ONLY AT NNLO, FULL NNLO IN PREPARATION)
  - GLUON SIMILAR TO MSTW, BUT NO SMALL x INSTABILITY
  - LUMINOSITY & HIGGS XSECT QUITE CLOSE TO MSTW
    ... PROVIDED SAME α_s USED

GLUON LUMI & HIGGS XSECT: NNPDF VS MSTW

GLUON LUMI



HIGGS XSECT.



ISSUES

PDF UNCERTAINTIES:
DO THEY HAVE A STATISTICAL MEANING?

SOMETIMES STATED THAT "PDF UNCERTAINTIES ARE THEORETICAL UNCERTAINTIES" (THUS DEVOID OF STATISTICAL MEANING) IS IT TRUE?

PDF UNCERTAINTIES: DO THEY HAVE A STATISTICAL MEANING?

SOMETIMES STATED THAT "PDF UNCERTAINTIES ARE THEORETICAL UNCERTAINTIES" (THUS DEVOID OF STATISTICAL MEANING) IS IT TRUE?

A WAY OF TESTING:
NEW DATA ⇒ BAYES' THEOREM

$$\langle \mathcal{O} \rangle_{\text{new}} = \int \mathcal{O}[f]\, \mathcal{P}_{\text{new}}(f)\, Df, = \mathcal{N}_\chi \int \mathcal{O}[f]\, \mathcal{P}(\chi^2|f)\mathcal{P}_{\text{old}}(f)\, Df,$$

IN A MONTE CARLO APPROACH...

$$\langle \mathcal{O} \rangle_{\text{new}} = \frac{1}{N_{\text{rep}}} \sum_{k=1}^{N_{\text{rep}}} \mathcal{N}_\chi \mathcal{P}(\chi^2|f_k)\mathcal{O}[f_k] = \frac{1}{N_{\text{rep}}} \sum_{k=1}^{N_{\text{rep}}} w_k\, \mathcal{O}[f_k], \quad w_k = \mathcal{N}(\chi^2_k)^{n/2-1} e^{-\frac{1}{2}\chi^2_k}$$

⇒ EFFECT OF NEW DATA IS ACCOUNTED FOR BY REWEIGHTING MONTE CARLO AVERAGES

(CAN ALSO BE IMPLEMENTED IN HESSIAN FRAMEWORK (de Lorenzi, McNulty, 2010-2011))

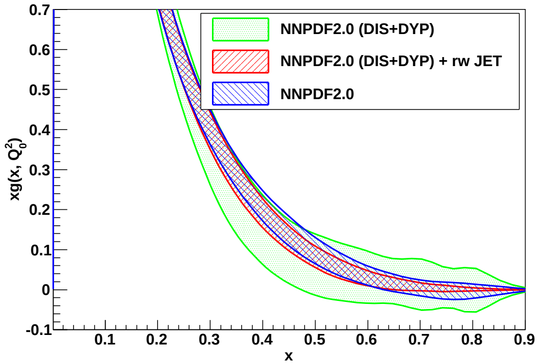
- DETERMINE PDFS INCLUDING SOME DATA BY BAYES' THEOREM (REWEIGHTING)
- DETERMINE PDFS BY ENLARGING THE DATASET TO THE NEW DATA (REFITTING)
- COMPARE RESULTS ⇒ IF THEY AGREE, PDFS DO HAVE A STATISTICAL INTERPRETATIONS ALRIGHT!

RUNNING THE TEST

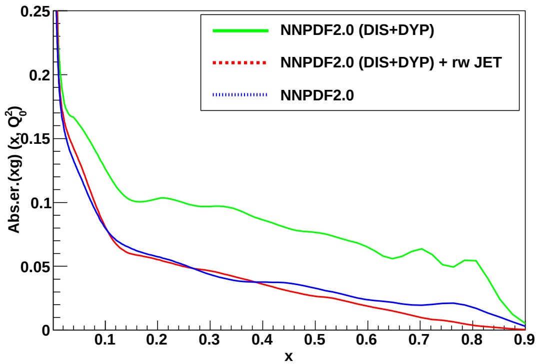
INCLUSION OF JET DATA: REWEIGHTING VS. REFITTING

NNPDF2.0DIS+DY VS. NNPDF2.0FULL

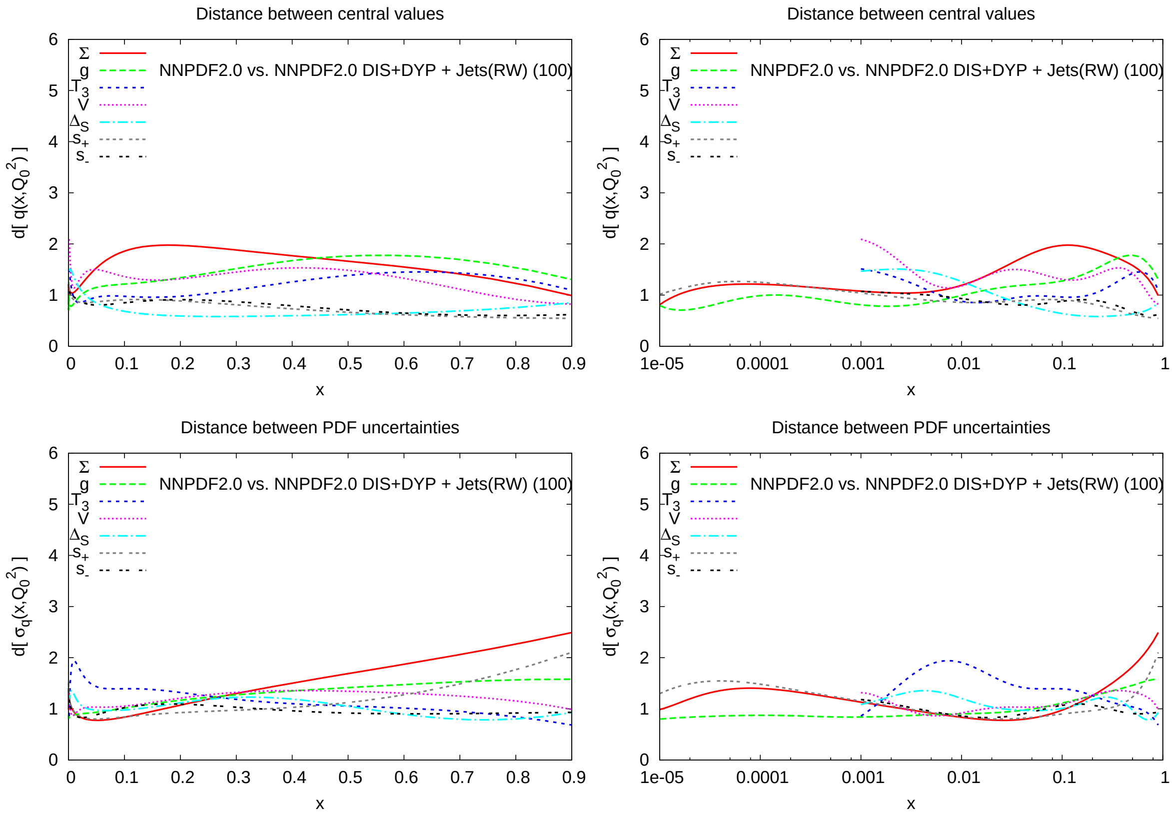
GLUON



GLUON UNCERTAINTY



DISTANCES



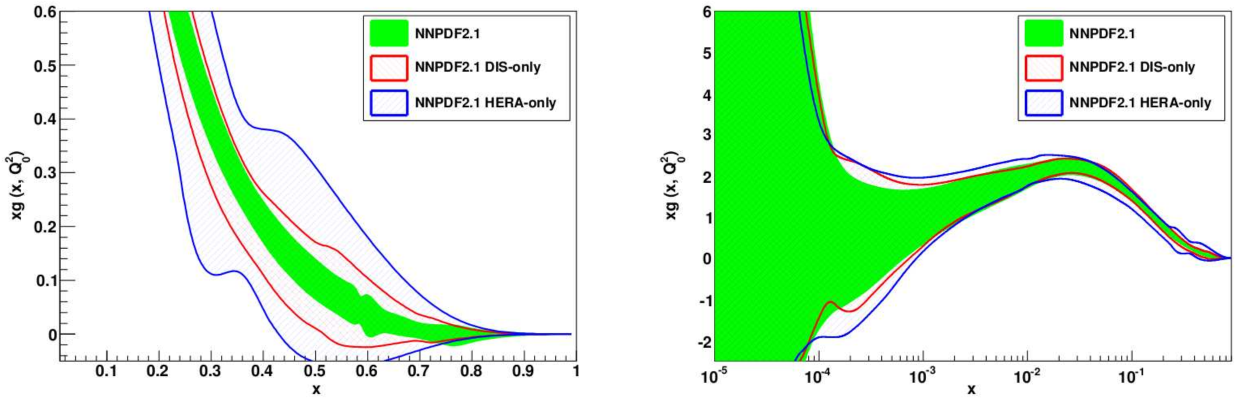
$d \sim 1 \Rightarrow$ STATISTICAL EQUIVALENCE

STATISTICAL INTERPRETATION VALIDATED

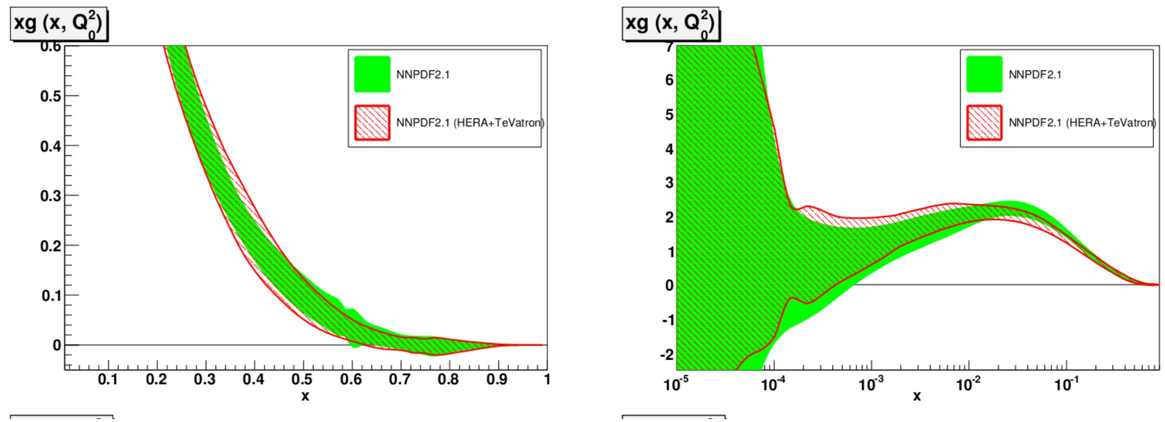
DATA CONSISTENCY: WHY WE NEED IT

- DIS only fit ⇒ significant loss in accuracy for gluon (& other PDFs)
- HERA only even worse
- but collider only (HERA+Tevatron) close to global fit (for gluon, though not for valence)

the gluon: global vs DIS vs HERA



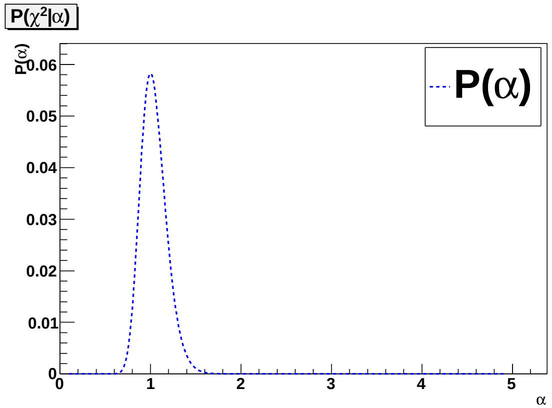
the gluon: global vs collider only



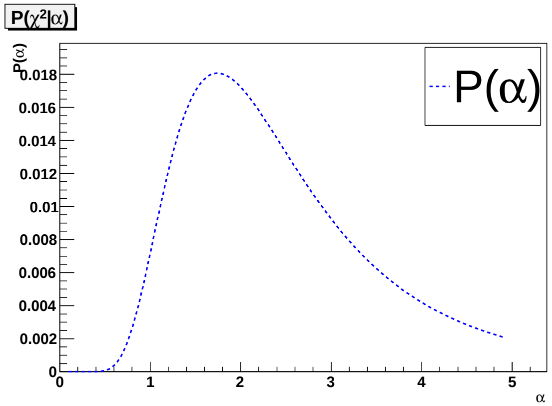
DATA CONSISTENCY: HOW TO TEST FOR IT

- INCONSISTENT DATA $\Leftrightarrow$ UNDERESTIMATED UNCERTAINTIES
- RESCALE ALL UNCERTAINTIES IN A GIVEN EXPERIMENT BY SOME FACTOR α: $\chi^2_\alpha = \chi^2/\alpha$ (TOLERANCE)
- DETERMINE PROBABILITY DISTRIBUTION OF α VALUES BY BAYES' THEOREM $\Rightarrow$ REWEIGHTING: $\mathcal{P}(\alpha) = \frac{\mathcal{N}}{\alpha} \sum_{k=1}^{N} w_k w_k(\alpha)$.

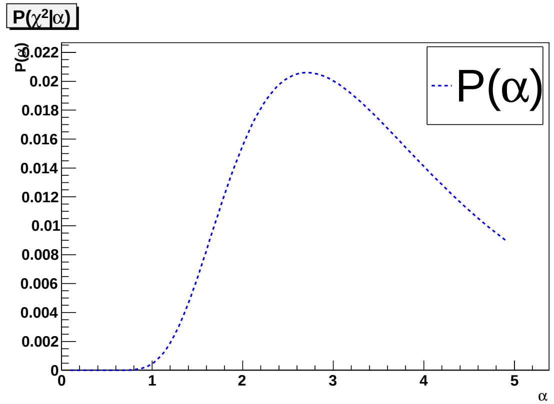
JETS



D0 e INCLUSIVE



D0 e HIGH E_T



- JETS: $\Rightarrow$ CONSISTENT DATA
- $W^\pm$ CHARGE ASYMMETRIES, D0 INCLUSIVE e DATA $\Rightarrow$ UNCERTAINTIES UNDERESTIMATED BY $\sim 30\%$ (PROB. PEAKS AT $\alpha \sim 1.7$)
- $W^\pm$ CHARGE ASYMMETRIES, D0 e DATA WITH $E_T > 35$ GEV $\Rightarrow$ INCONSISTENT DATA

NMC DATA: A PROBLEM?

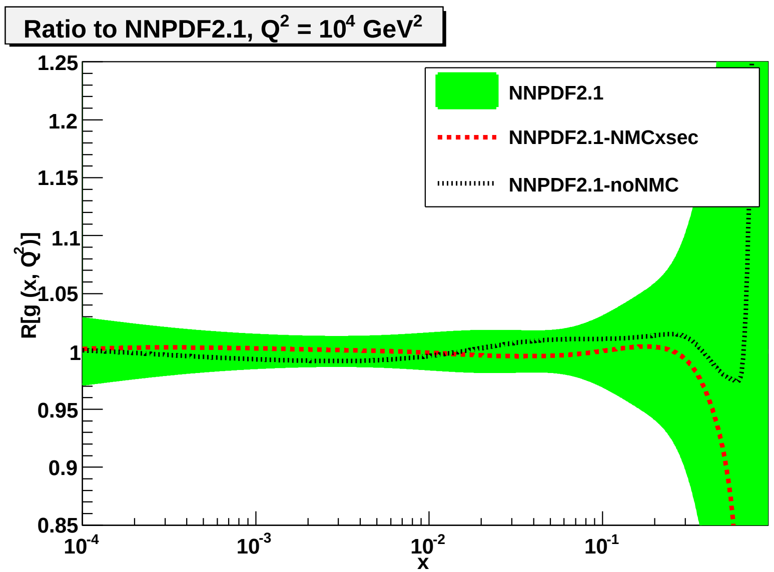
- NMC PROTON AND DEUTERON DATA FOR DIS F_2 STRUCTURE FUNCTION
- F_2STRUCTURE FUNCTION DATA USED IN MSTW, CTEQ, NNPDF FITS,
  WOULD THE USE OF CROSS SECTION DATA MAKE A DIFFERENCE?
  (Alekhin, Blümlein, Moch, 2011)
  $\widetilde{\sigma}(x, y, Q^2) = F_2(x, Q^2)\left(2 - 2y + y^2/[1 + R(x, Q^2)]\right)$

NMC DATA: A PROBLEM?

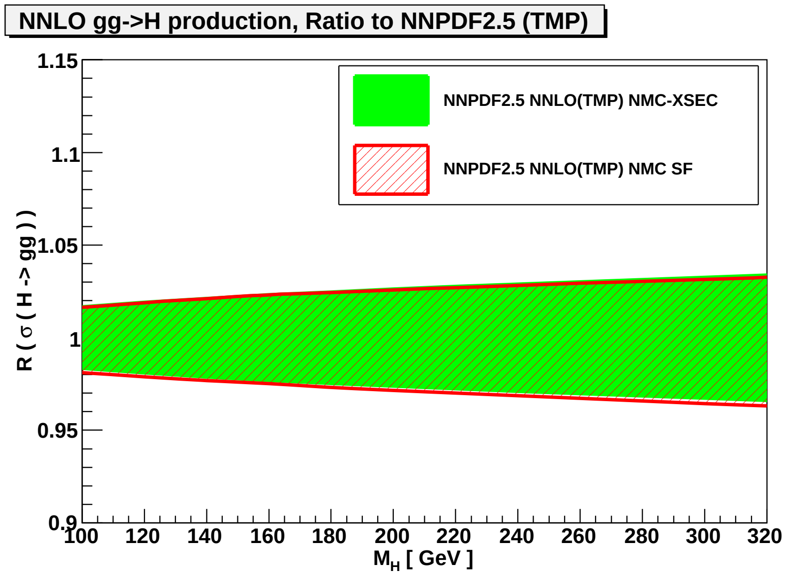
- NMC PROTON AND DEUTERON DATA FOR DIS F_2 STRUCTURE FUNCTION
- F_2STRUCTURE FUNCTION DATA USED IN MSTW, CTEQ, NNPDF FITS, WOULD THE USE OF CROSS SECTION DATA MAKE A DIFFERENCE?
(Alekhin, Blümlein, Moch, 2011)
$\widetilde{\sigma}(x, y, Q^2) = F_2(x, Q^2)\left(2 - 2y + y^2/[1 + R(x, Q^2)]\right)$

NNPDF FIT REPEATED WITH NMC XSECT OR NO NMC
(NLO: arXiv:1102.3182; NNLO: preliminary)

EFFECT ON GLUON



EFFECT ON HIGGS XSECT



NO SIGNIFICANT CHANGE OBSERVED

NMC data: a problem?

A closer look

- Alekhin et al. see large shift in best-fit α_s: from 0.1170 (NMC F_2) to 0.1135 (NMC α_s)
- how much of their change in Higgs xsect ($\sim 8\%$) due to change in α_s?
- based on power counting, expect $2.8\Delta\alpha_s = 8\%$ (!)
- either remove NMC data, or change value of α_s in MSTW fit (Thorne, presented by Watt at PDF4LHC 2011):

NMC DATA: A PROBLEM?
A CLOSER LOOK

- ALEKHIN ET AL. SEE LARGE SHIFT IN BEST-FIT α_s: FROM 0.1170 (NMC F_2) TO 0.1135 (NMC α_s)
- HOW MUCH OF THEIR CHANGE IN HIGGS XSECT ($\sim 8\%$) DUE TO CHANGE IN α_s?
- BASED ON POWER COUNTING, EXPECT $2.8\Delta\alpha_s = 8\%$ (!)
- EITHER REMOVE NMC DATA, OR CHANGE VALUE OF α_s IN MSTW FIT (Thorne, presented by Watt at PDF4LHC 2011):
  - IMPACT OF NMC DATA NEGLIGIBLE
  - IMPACT OF α_s VALUE COMPARABLE (SOMEWHAT SMALLER) TO WHOLE ABKM EFFECT
  - MSTW AND ABKM RESULTS STILL QUITE DIFFERENT EVEN FOR SAME $\alpha_s = 0.113$

NNLO PDF	$\alpha_S(M_Z^2)$	σ_H at Tevatron	σ_H at 7 TeV LHC
MSTW08	**0.1171**	**0.342 pb**	**7.91 pb**
Use R_{1990} for NMC	0.1167	-0.7%	-0.9%
Cut NMC ($x < 0.1$)	0.1162	-1.2%	-2.1%
Cut all NMC data	0.1158	-0.7%	-2.1%
Fix $\alpha_S(M_Z^2)$	0.1130	-11%	-7.6%
ABKM09	0.1135	-26%	-11%

THE VALUE OF α_s

- DEDICATED MUNICH MEETING (FEB 2011):
  S. BETHKE PROPOSES TWO UPDATED VALUES:
  - (1) $\alpha_s = 0.1174 \pm 0.0011$
  - (2) $\alpha_s = 0.1187 \pm 0.0006$
  - BOTH INCLUDE NEW VALUE FROM τ DECAYS $\alpha_s = 0.1213 \pm 0.0014$ (WAS $\alpha_s = 0.1197 \pm 0.0016$)
  - VALUE (1) ALSO INCLUDES NEW SCET VALUE FROM e^+e^- THRUST (Abbate et al., 2010) $\alpha_s = 0.1135 \pm 0.0010$, BUT ALL UNCERTAINTIES RESCALED BY FACTOR 2
  - VALUE (2) EXCLUDES IT
- AVERAGING THE TWO MOST RELIABLE VALUES (GLOBAL EW FIT & τ, BOTH N^3LO, NO DEP. ON HADRON STRUCTURE) GIVES
  $\alpha_s = 0.1209 \pm 0.0013$

THE VALUE OF α_s

- DEDICATED MUNICH MEETING (FEB 2011):
  S. BETHKE PROPOSES TWO UPDATED VALUES:
  - (1) $\alpha_s = 0.1174 \pm 0.0011$
  - (2) $\alpha_s = 0.1187 \pm 0.0006$
  - BOTH INCLUDE NEW VALUE FROM τ DECAYS $\alpha_s = 0.1213 \pm 0.0014$ (WAS $\alpha_s = 0.1197 \pm 0.0016$)
  - VALUE (1) ALSO INCLUDES NEW SCET VALUE FROM e^+e^- THRUST (Abbate et al., 2010)
    $\alpha_s = 0.1135 \pm 0.0010$, BUT ALL UNCERTAINTIES RESCALED BY FACTOR 2
  - VALUE (2) EXCLUDES IT
- AVERAGING THE TWO MOST RELIABLE VALUES (GLOBAL EW FIT & τ, BOTH N^3LO, NO DEP. ON HADRON STRUCTURE) GIVES
  $\alpha_s = 0.1209 \pm 0.0013$
- UNCERTAINTY LARGER THAN 0.002 QUITE UNLIKELY

OUTLOOK

PRACTICAL PRESCRIPTIONS

(no new PDF4LHC guidelines: my suggestion, to start discussion)

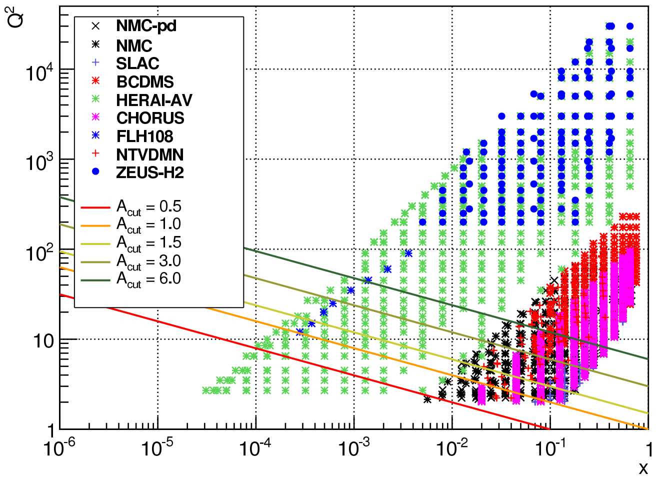
- ISSUES OF α_s UNCERTAINTY & PDF UNCERTAINTY SHOULD NOT BE MIXED: AGREE ON REASONABLE CONSERVATIVE RANGE FOR EITHER
- α_s UNCERTAINTY LARGER THAN $\Delta\alpha_s = 0.002$ DOES NOT SEEM ADVISABLE; ANY OF ABOVE CENTRAL VALUES ACCEPTABLE WITH THIS UNCERTAINTY, BUT AGREE ON ONE
- EVEN AT FIXED α_s, ENVELOPE INCLUDING PDFS W/O HADRONIC DATA NOT ADVISABLE
- IDEALLY, WAIT FOR CTEQ+NNPDF NNLO AND/OR ABKM WITH TEVATRON JETS & VARIOUS α_s VALUES
- IF NOT, JUST UPDATE PDF4LHC NNLO WITH CT10 & NNPDF2.1 (rescale MSTW08 NNLO uncertainty by NLO MSTW/envelope uncertainty ratio)
  MOTIVATION:
  - NNLO VS NLO DIFFERENCES SMALLER THAN DIFFERENCES BETWEEN SETS
  - DIFFERENCES BETWEEN PDFS BASED ON DIFFERENT DATASETS LIKELY TO REFLECT MISSING INFORMATION
  - DIFFERENCES BETWEEN PDFS BASED ON WIDEST DATASET MAY REFLECT GENUINE METHODOLOGICAL UNCERTAINTIES

EXTRAS

THE FUTURE: COLLIDER-ONLY PDFS

- LHC CAN PROVIDE US PRECISION INFORMATION ON PDFS
- TOWARDS A "COLLIDER ONLY" HERA+LHC PDF FIT (TEVATRON DATA MIGHT BE SUPERFLUOUS)
  - MEDIUM & LARGE x GLUON
    - PROMPT PHOTONS AVAILABLE
    - (PRECISION) JETS IN PROGRESS
  - LIGHT FLAVORS AT MEDIUM @ SMALL x, FLAVOR SEPARATION @ SMALL x
    - LOW–MASS DRELL-YAN PRELIM.
    - Z RAPIDITY DISTRIBUTIONS PRELIM.
    - W ASYMMETRIES AVAILABLE
  - STRANGENES & HEAVY FLAVORS
    - STRANGENESS $\Rightarrow W + c$ FUTURE?
    - CHARM $\Rightarrow Z + c$, $\gamma + c$ FUTURE?
    - BOTTOM $Z + b$ IN PROGRESS

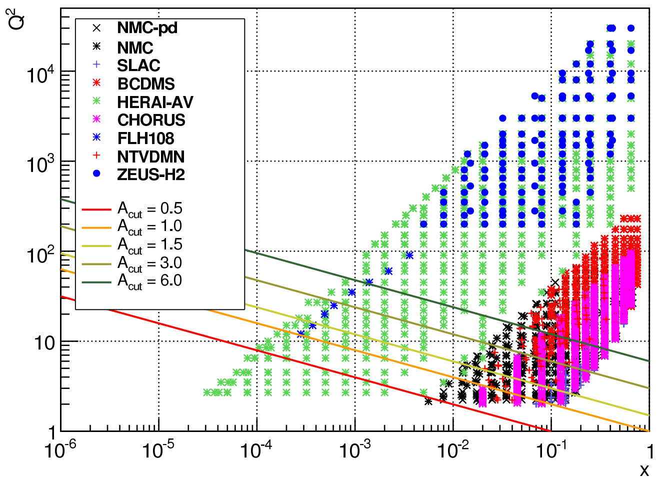
BEYOND DGLAP?
DISCOVERING A NEW QCD EFFECT IN HERA DATA



IDEA: (Gélis, 2008, ⇒ Caola, s.f. ,Rojo 2010)

- CUT OUT DATA IN THE "DANGEROUS" (SMALL x) REGION
- DETERMINE PDFs IN THE "SAFE" (LARGE x AND Q^2) REGION
- EVOLVE BACKWARDS AND COMPARE TO DATA

BEYOND DGLAP?
DISCOVERING A NEW QCD EFFECT IN HERA DATA

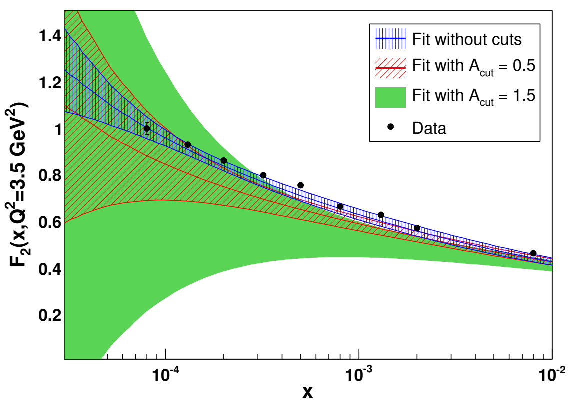


IDEA: (Gélis, 2008, $\Rightarrow$ Caola, s.f. ,Rojo 2010)

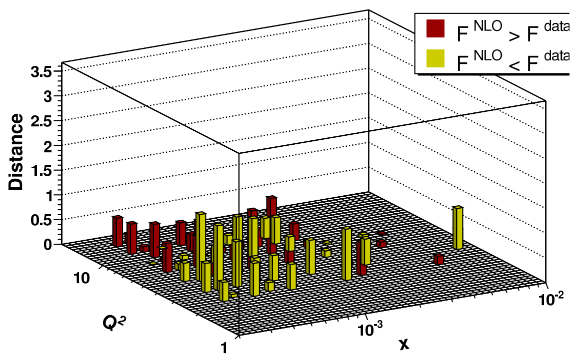
- CUT OUT DATA IN THE “DANGEROUS” (SMALL x) REGION
- DETERMINE PDFs IN THE “SAFE” (LARGE x AND Q^2) REGION
- EVOLVE BACKWARDS AND COMPARE TO DATA

OLD HERA DATA

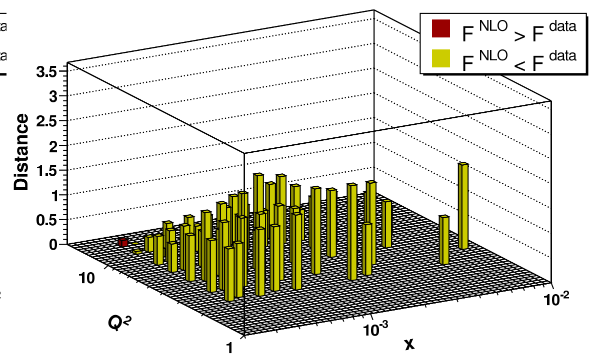
BACKWARD EV. VS DATA



DAT/TH DIST: NO CUT



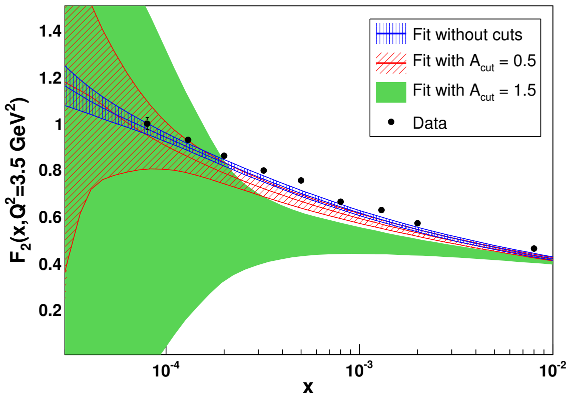
DAT/TH DIST: CUT



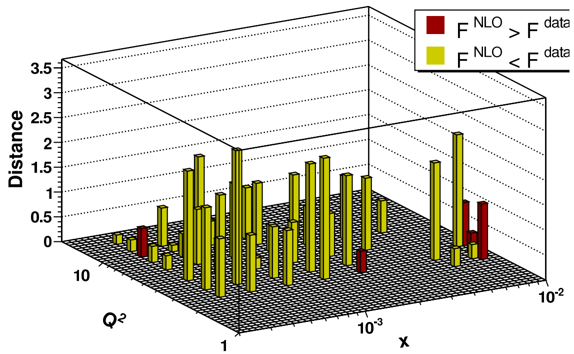
- BACKWARD EVOLVED FIT LIES SYSTEMATICALLY BELOW DATA
- DATA AT LOW x AND Q^2 SHOW LESS EVOLUTION THAN PREDICTED BY NLO DGLAP
- IF LOW x AND Q^2 DATA INCLUDED, THE FIT COMPENSATES READJUSTING PDFs

NEW COMBINED HERA DATA

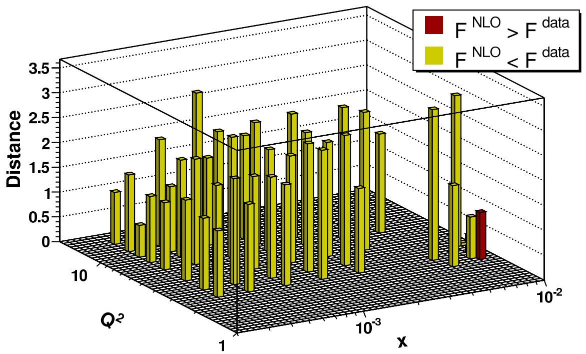
BACKWARD EV. VS DATA



DAT/TH DIST: NO CUT



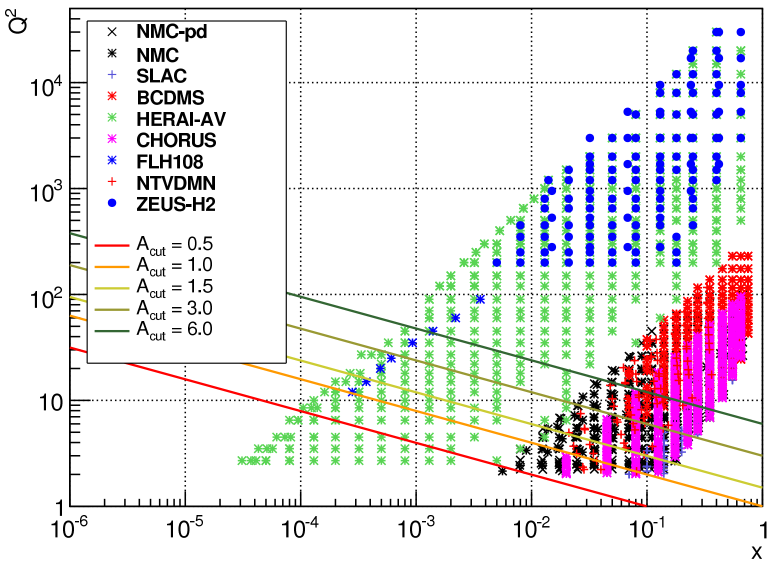
DAT/TH DIST: CUT

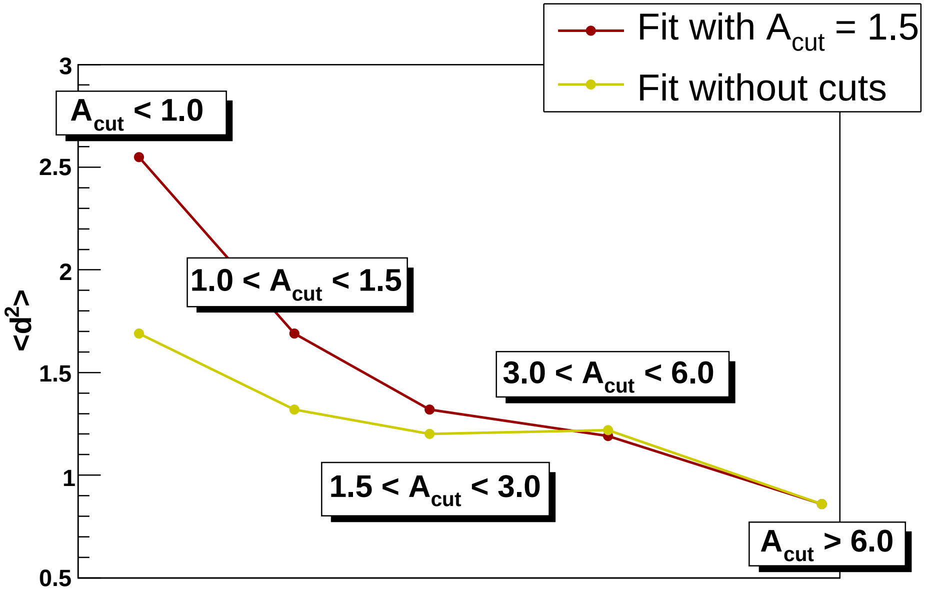


- DATA AT LOW x AND Q^2 SHOW LESS EVOLUTION THAN PREDICTED BY NLO DGLAP
- BACKWARD EVOLVED FIT LIES SYSTEMATICALLY BELOW DATA
- WITH MORE PRECISE DATA, THE FIT NO LONGER MANAGES TO COMPENSATE BY READJUSTING THE PDFS: EVEN FULL FIT LIES BELOW DATA

DETERIORATION IN FIT QUALITY:

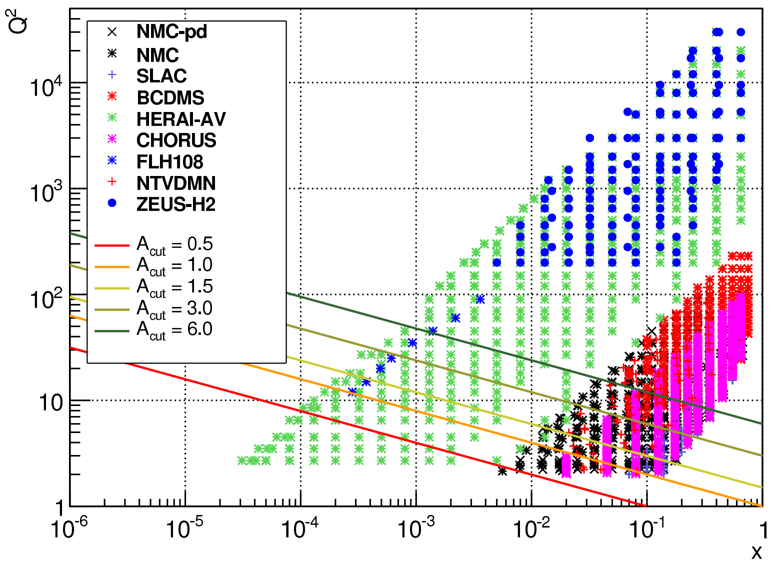
$\langle d^2 \rangle$ VS x SLICES



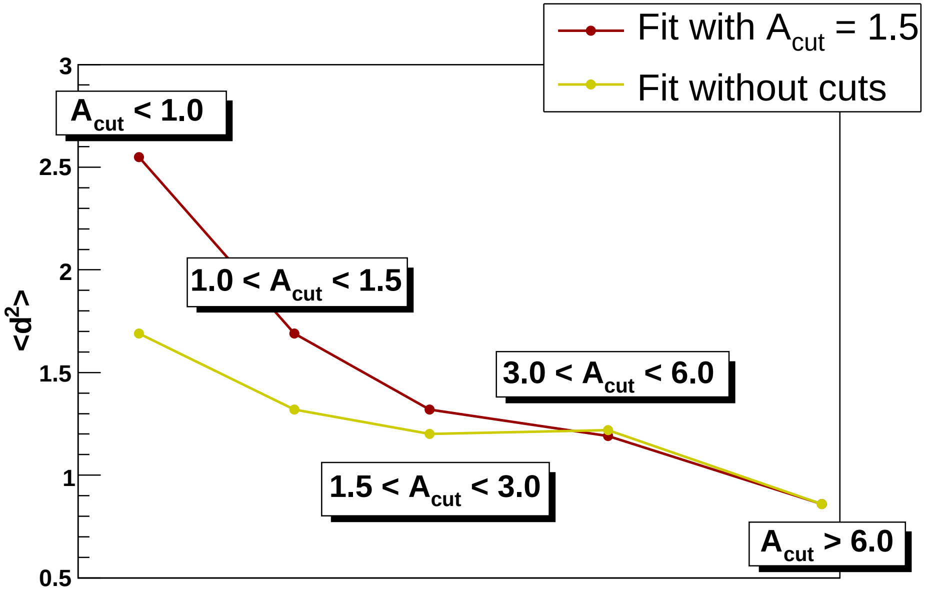


- QUALITY OF UNCUT FIT DETERIORATES IN LOW x REGIONS
- QUALITY OF CUT FIT INCREASINGLY POOR AS x DECREASES
- DISTANCE RISES DESPITE HUGE INCREASE IN UNCERTAINTY

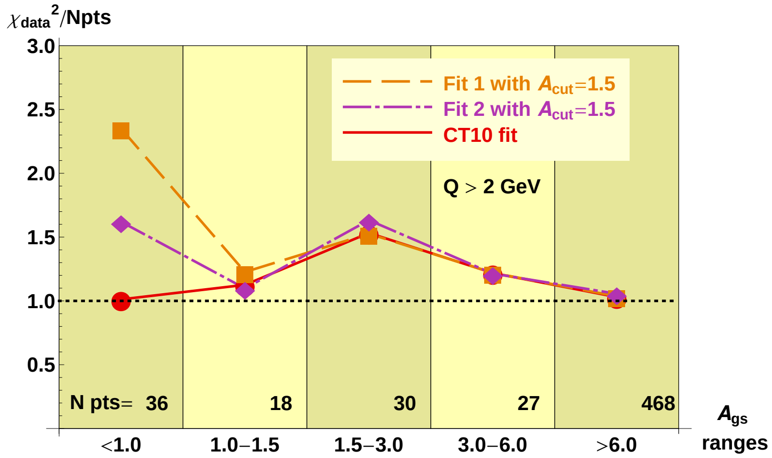
DETERIORATION IN FIT QUALITY:



$\langle d^2 \rangle$ VS x SLICES



χ^2 VS x SLICES FOR CT10



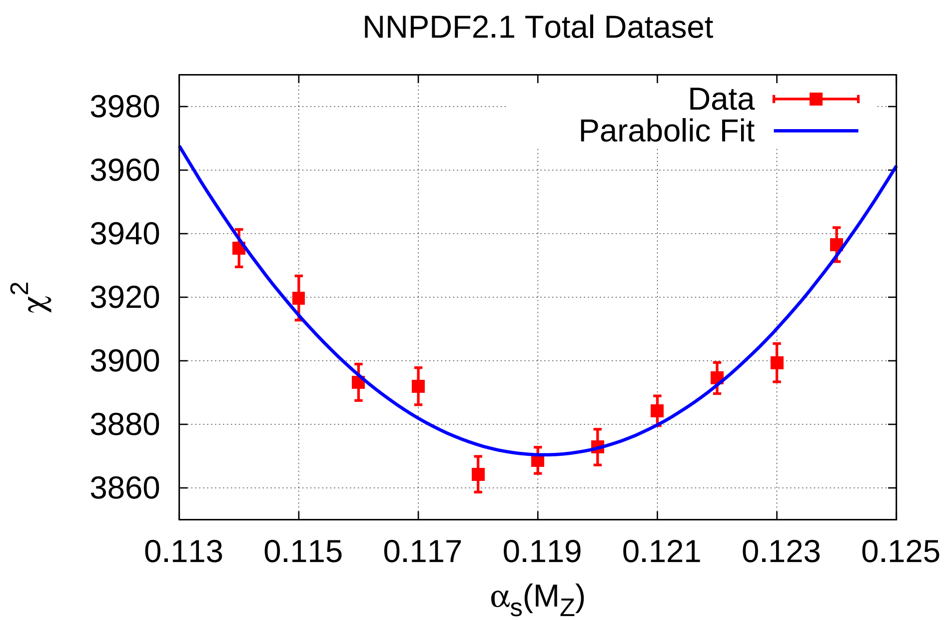
- QUALITY OF UNCUT FIT DETERIORATES IN LOW x REGIONS
- QUALITY OF CUT FIT INCREASINGLY POOR AS x DECREASES
- DISTANCE RISES DESPITE HUGE INCREASE IN UNCERTAINTY
- IN HESSIAN FIT (CTEQ) RESULTS DEPEND ON PARAMETRIZATION $\Rightarrow$ EVIDENCE INCONCLUSIVE

NNPDF α_s

NLO NNPDF2.1 GLOBAL DETERMINATION (ONLY STAT. ERROR KNOWN)

$N_{\rm rep} = 500$ PER VALUE OF α_s

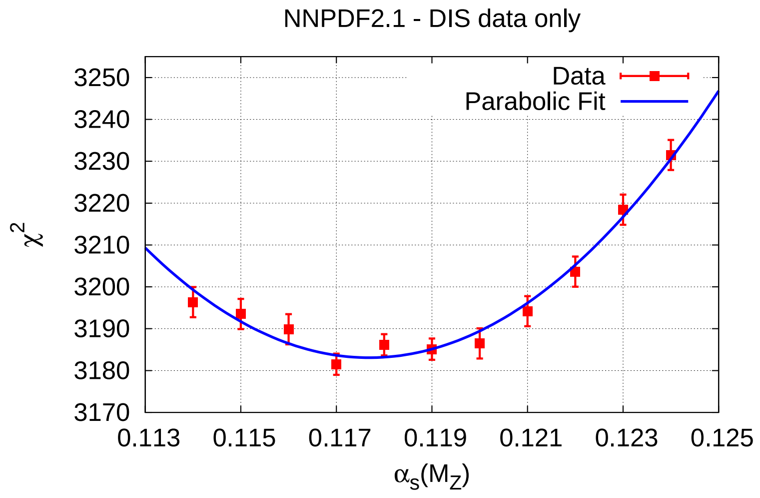
$$\alpha_s(M_z) = 0.1191 \pm 0.0006(\text{stat.}) \pm 0.0001(\text{proc.})$$



$\chi^2/\text{d.o.f.} = 1.6$ for the parabolic fit

THE RESULT: DIS ONLY
DO DIS DATA PREFER A SMALLER VALUE?
NLO NNPDF2.1 DEEP-INELASTIC DATA
$N_{\rm rep} = 500$ PER VALUE OF α_s

$$\alpha_s(M_z) = 0.1177 \pm 0.0009(\text{stat.}) \pm 0.0002(\text{proc.})$$

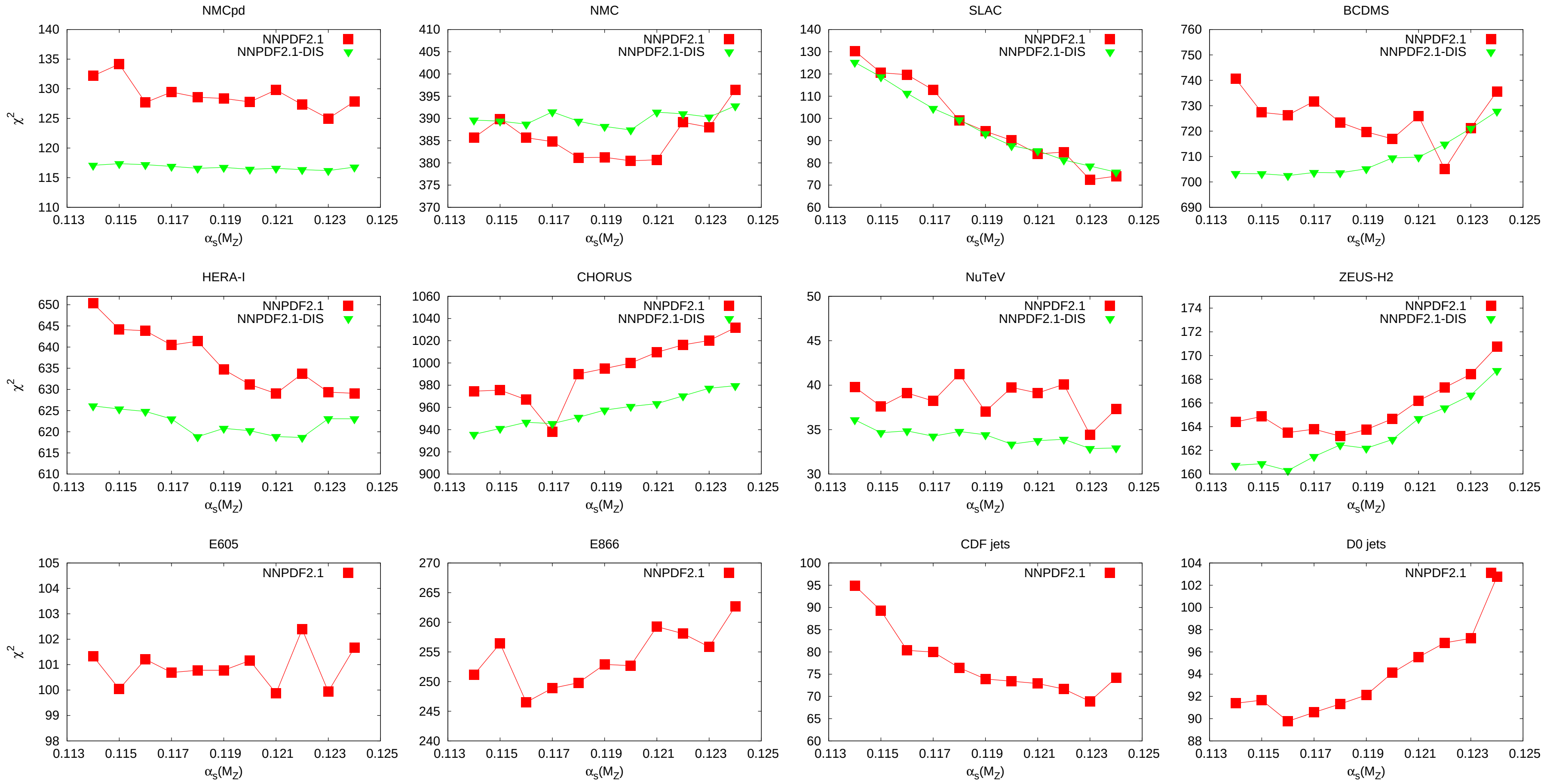


$$\chi^2/\text{d.o.f.} = 0.8 \text{ for the parabolic fit}$$

- YES
- BUT NOT MUCH SMALLER & WITH LARGER UNCERTAINTY (COMPATIBLE WITHIN UNCERTAINTIES, AS IT OUGHT TO)

INDIVIDUAL EXPERIMENTS: WHAT'S GOING ON?

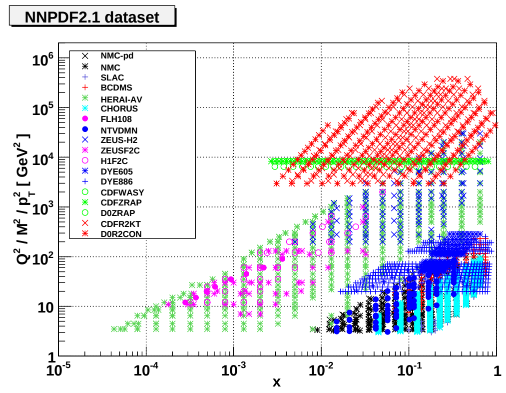
χ^2 PROFILE FOR INDIVIDUAL EXPERIMENTS IN GLOBAL & DIS FITS



- BCDMS SIMILAR TO HERA, NMC PRETTY FLAT
- DIS EXPERIMENTS (BCDMS+HERA) IN DIS FIT HAVE A "RUNAWAY DIRECTION" AT SMALL α_s,
  ABSENT IN GLOBAL FIT
- JET EXPERIMENTS EXCLUDE SMALL α_s

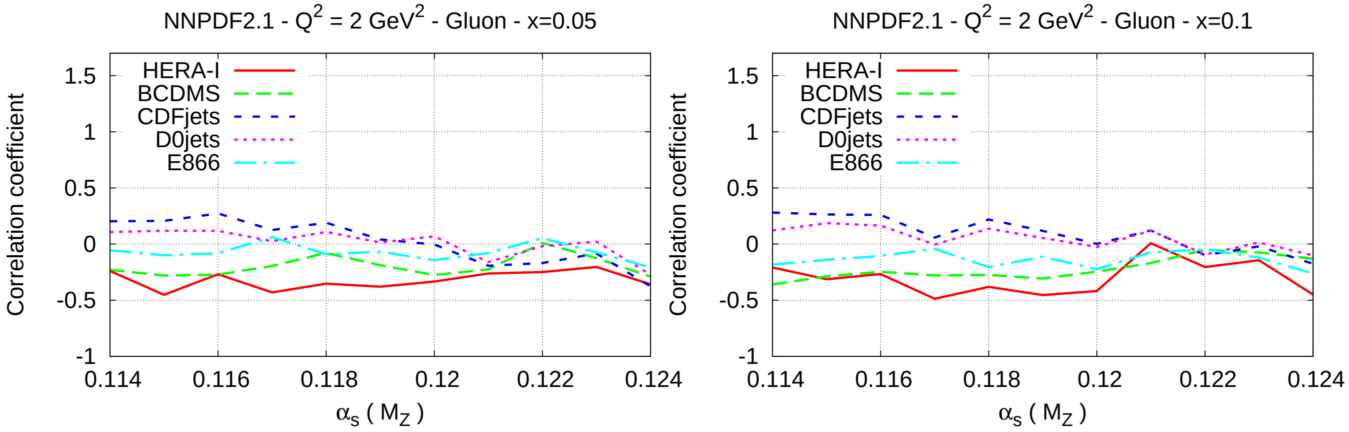
IS THERE A PROBLEM WITH DIS?

CONJECTURE



- IN DIS, GLUON DETERMINED BY SCALING VIOLATIONS $\Rightarrow$ CAN COMPENSATE SMALLER α_s WITH LARGER GLUON (OR CONVERSELY) $\Rightarrow$ RUNAWAY DIRECTIONS POSSIBLE IN DIS FIT
- JET DATA ARE AT MUCH LARGER SCALE, IF α_s TOO SMALL OR LARGE HIGH-SCALE GLUON WILL COME OUT WRONG
$\Rightarrow$ RUNAWAY DIRECTION QUENCHED IN GLOBAL FIT

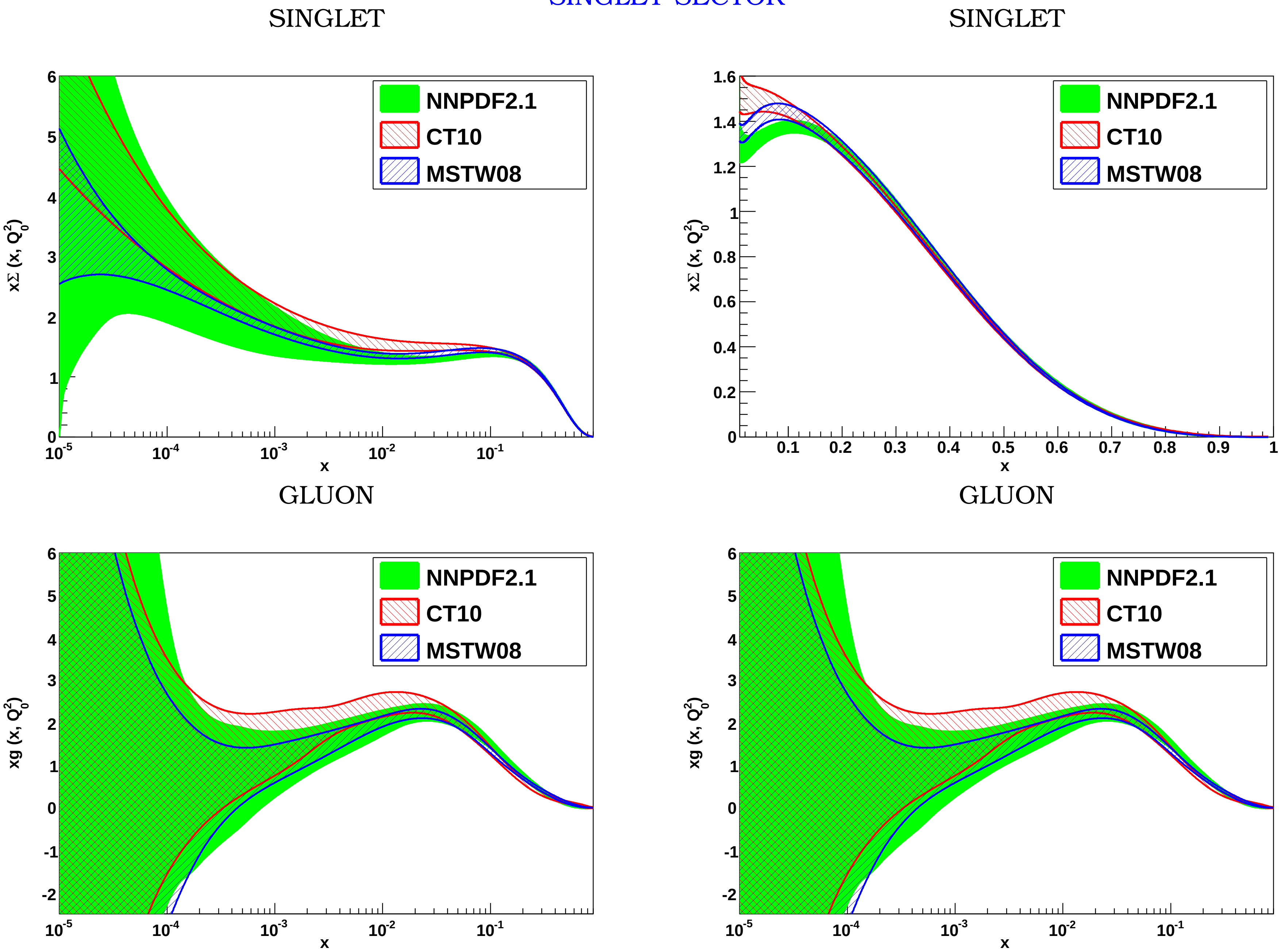
THE EVIDENCE



- COMPUTE THE CORRELATION BETWEEN χ^2 & PDFs AT THE GLOBAL BEST FIT
LARGE (POSITIVE OR NEGATIVE) CORRN. $\Leftrightarrow$ RUNAWAY DIRECTION
- OPPOSITE SIGN CORRELATIONS $\Leftrightarrow$ DATA PULLING IN OPPOSITE DIRECTIONS
- AT LOW $\alpha_s = 0.114$ DIS FIT HAS A RUNAWAY DIRECTION STABILIZED BY JETS
- AT HIGH $\alpha_s = 0.122$ FIT IS GENERALLY STABLE,
THOUGH STILL SOME PULL IN HERA LOW x

NNPDF2.1, MSTW08, CT10 COMPARISON

SINGLET SECTOR



NNPDF2.1, MSTW08, CT10 COMPARISON

NONSINGLET SECTOR