PDF4LHC

Jan 29th 2010

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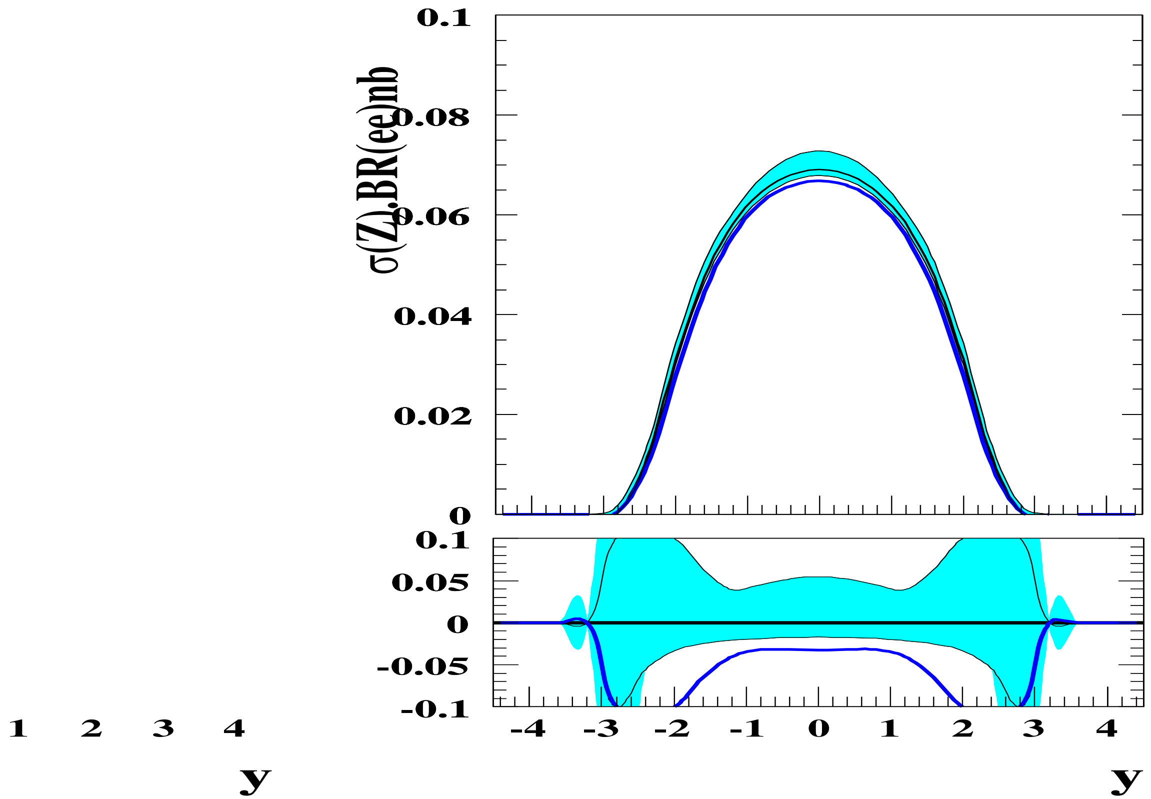
Comparing HERAPDF to Tevatron data for fun

Z-rapidity, W asymmetry, jets

Fitting F2charm HERA combined data- TRVFN and FFN fits

Comparing HERAPDF1.0 to Tevatron data

I am always predicting for the LHC, why not for Tevatron Run-II



These are the predictions Z0 production at 1.96 TeV. Compared to MSTW08. The Z0 data are actually closer to the HERAPDF -BUT NOTE although data errors are ~1.5% that's not counting the normalisation of 6%, so both PDFs describe it fine.

CDF Z/γ* (66-116 GeV) rapidity spectrum from 2.1 fb-1
May 2009 – also 6% normalisation error

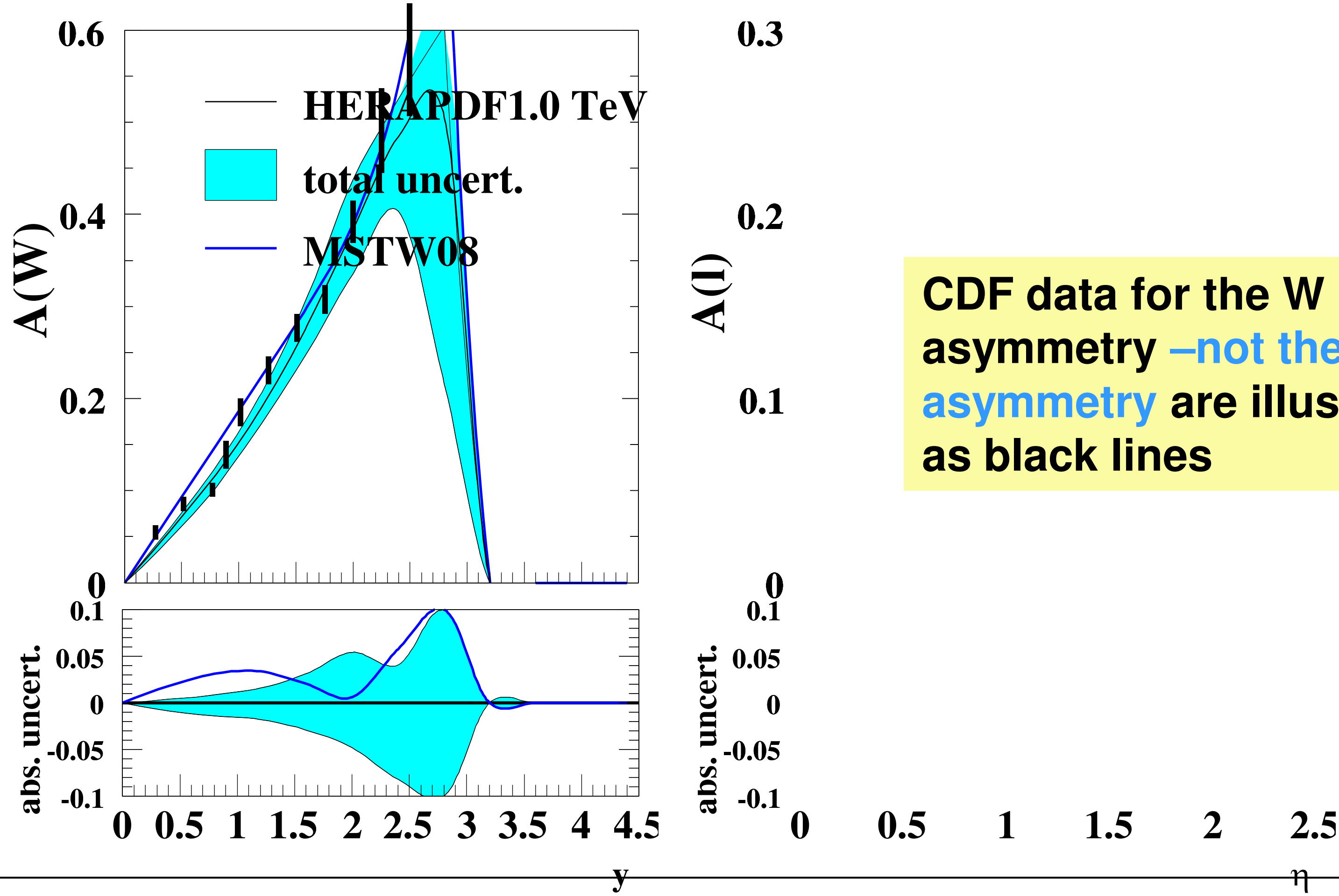
y	$d\sigma/dy[pb]$	y	$d\sigma/dy[pb]$
0.05	$69.41 \pm 0.73 \pm 0.49$	1.55	$49.91 \pm 0.62 \pm 0.37$
0.15	$70.94 \pm 0.74 \pm 0.49$	1.65	$46.48 \pm 0.60 \pm 0.35$
0.25	$70.86 \pm 0.73 \pm 0.49$	1.75	$40.83 \pm 0.58 \pm 0.33$
0.35	$69.68 \pm 0.72 \pm 0.48$	1.85	$37.03 \pm 0.56 \pm 0.32$
0.45	$67.62 \pm 0.70 \pm 0.47$	1.95	$33.21 \pm 0.55 \pm 0.31$
0.55	$67.79 \pm 0.70 \pm 0.47$	2.05	$28.05 \pm 0.53 \pm 0.25$
0.65	$66.07 \pm 0.69 \pm 0.47$	2.15	$22.43 \pm 0.51 \pm 0.24$
0.75	$66.19 \pm 0.69 \pm 0.48$	2.25	$19.07 \pm 0.51 \pm 0.21$
0.85	$64.31 \pm 0.68 \pm 0.49$	2.35	$14.85 \pm 0.52 \pm 0.18$
0.95	$63.88 \pm 0.68 \pm 0.49$	2.45	$9.40 \pm 0.48 \pm 0.11$
1.05	$61.91 \pm 0.66 \pm 0.50$	2.55	$6.16 \pm 0.48 \pm 0.10$
1.15	$61.27 \pm 0.65 \pm 0.49$	2.65	$3.27 \pm 0.46 \pm 0.17$
1.25	$58.21 \pm 0.65 \pm 0.47$	2.75	$1.48 \pm 0.41 \pm 0.07$
1.35	$55.59 \pm 0.64 \pm 0.42$	2.85	$0.96 \pm 0.57 \pm 0.09$
1.45	$53.11 \pm 0.63 \pm 0.40$	2.95	–

Snapshots from the HERAPDf1.0 prediction

y	dσ/dy	y	dσ/dy
0.00	69.10 + 4.1-1.4	1.60	47.6 + 3.6-1.4
0.40	68.00 + 3.7-1.7	2.00	31.0 + 3.1-1.2
0.80	64.62 + 3.2-1.8	2.40	11.4 + 1.7-0.9
1.20	58.27 + 2.3-1.5		

These are the latest data

Input of this data to the fit would improve uncertainties

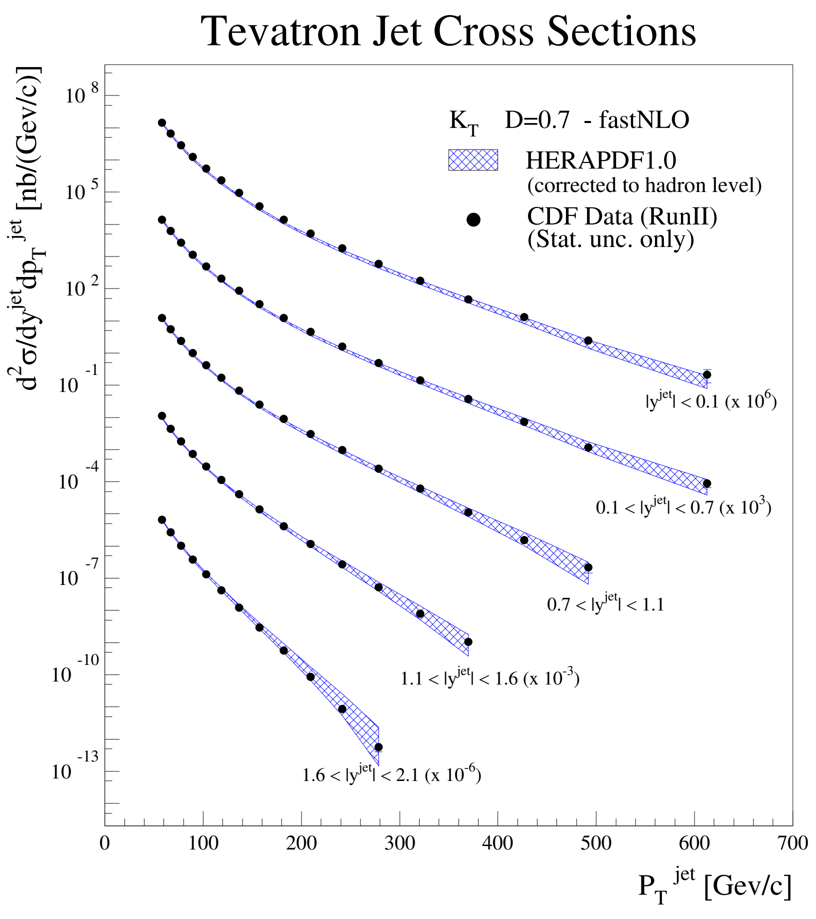


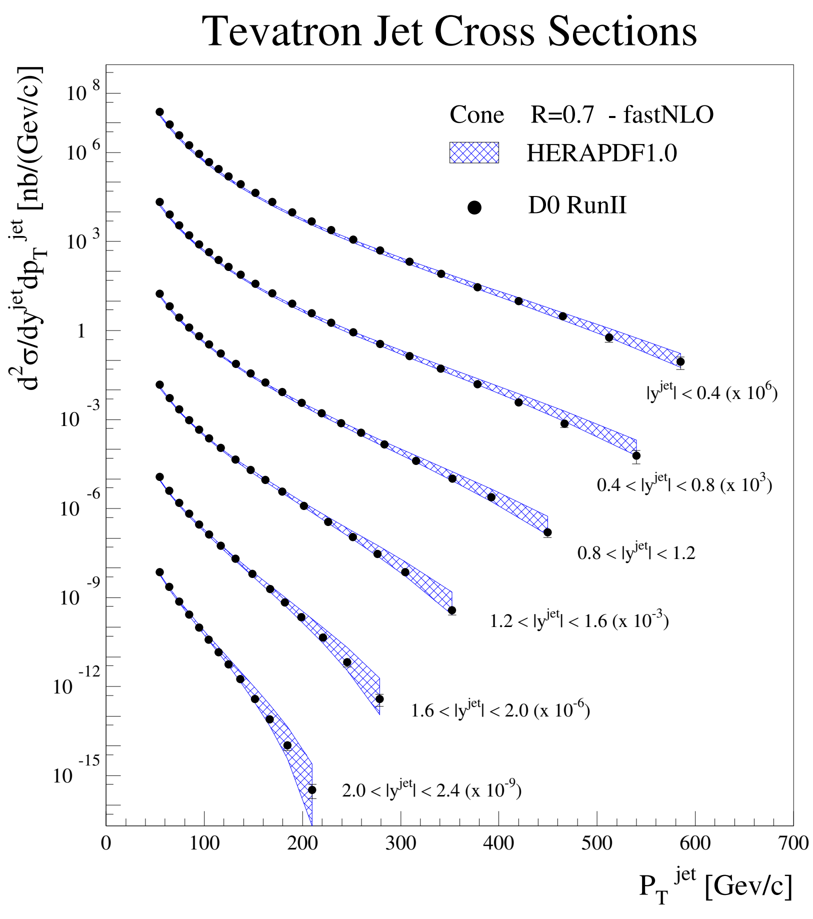
CDF data for the W asymmetry –not the lepton asymmetry are illustrated as black lines

The CDF extraction of the lepton asymmetry has a model dependence on the PDF used to extract it (CTEQ6.1)- which is included in its error bars

NOT clear hat this data would improve PDf uncertainties- error bars are of ~ same size as uncertainties

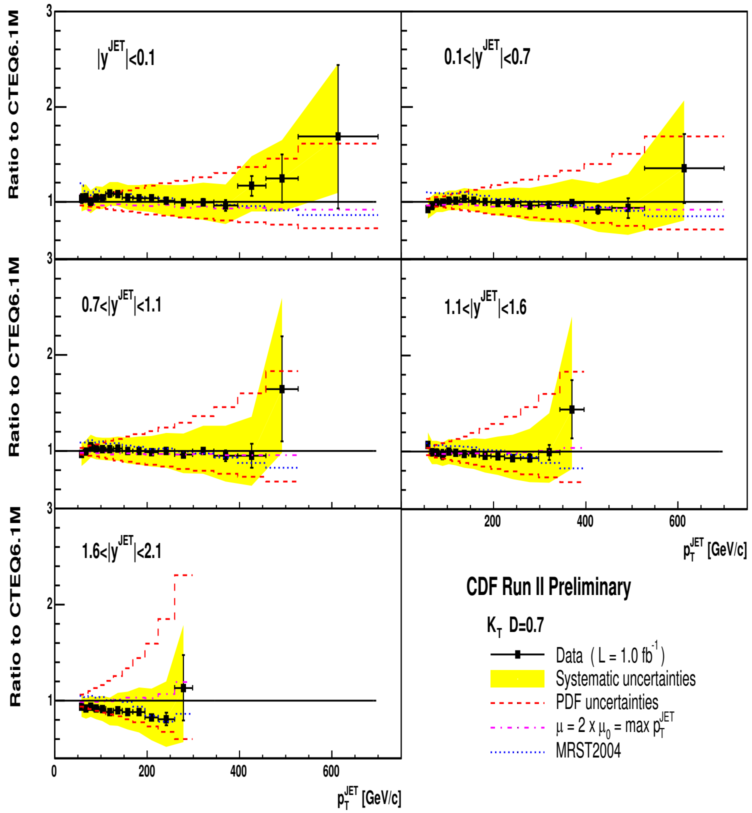
CDF and D0 Run-II jet data compared to HERAPDF1.0

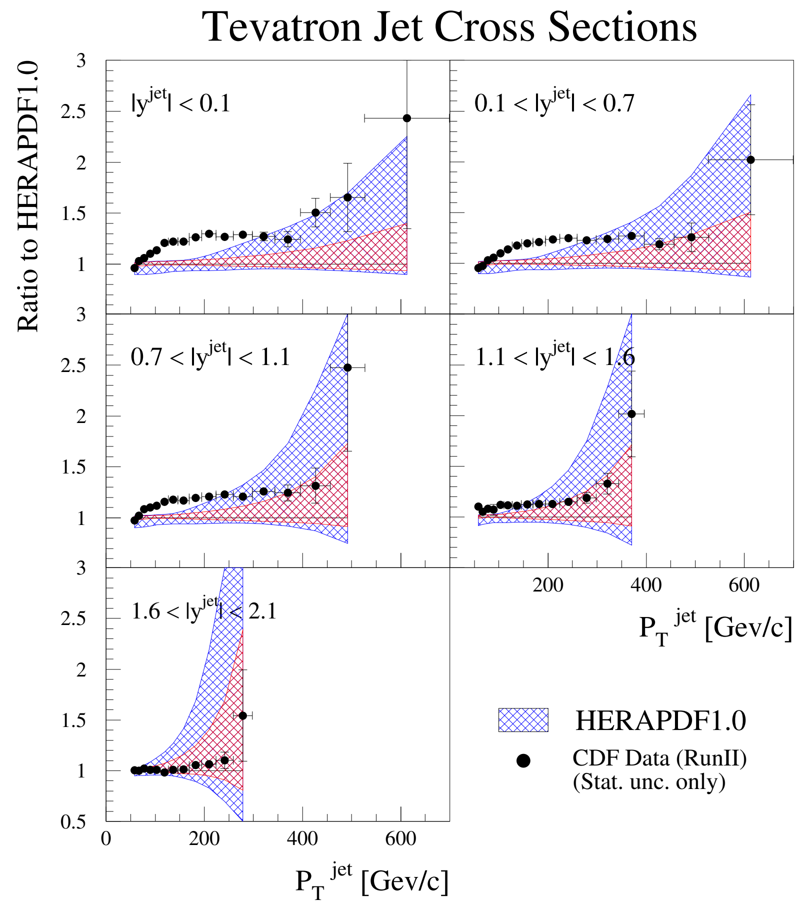




Run-II jet data seem to be less hard than Run-I

It is Not true that a fit using HERA data alone cannot give a hard enough high-x gluon to describe these data

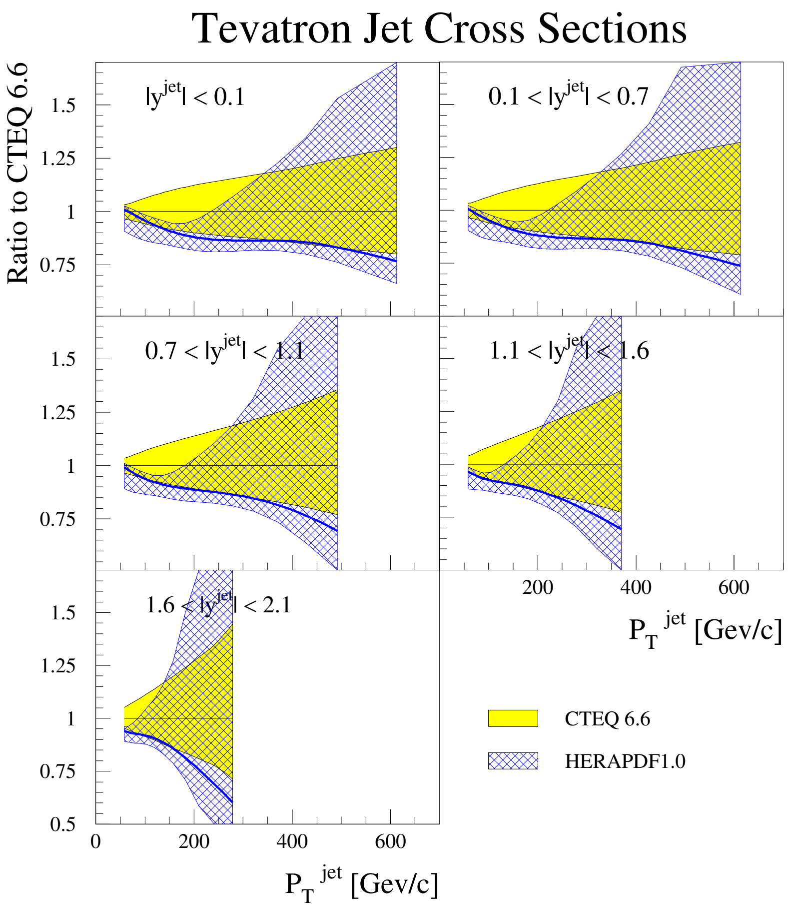


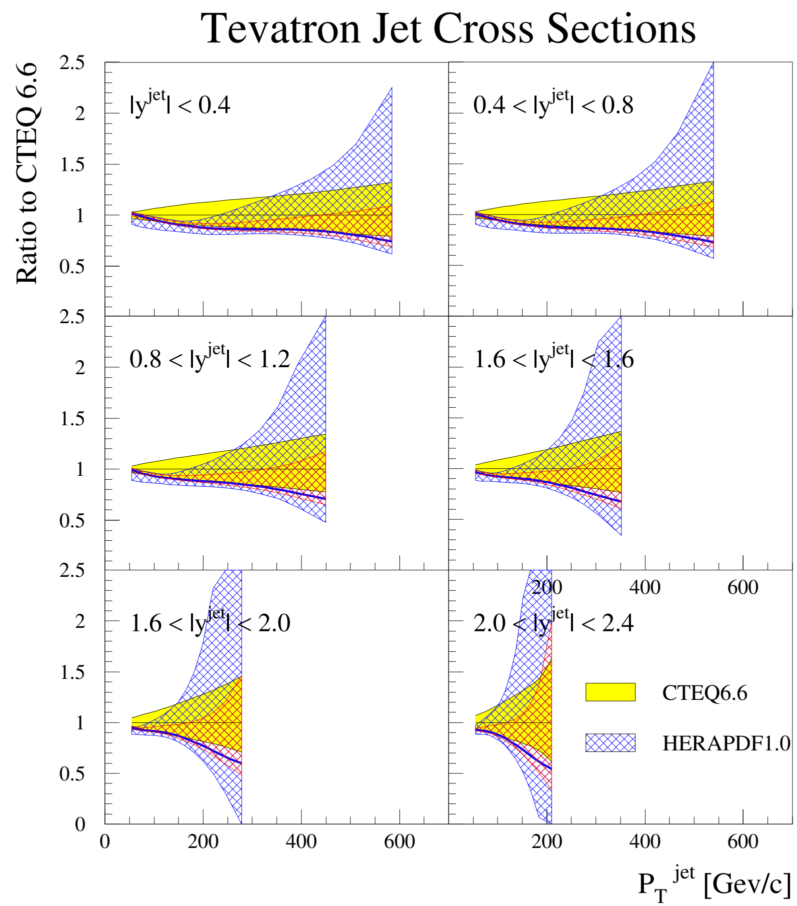


CDF data systematic uncertainties are large-see yellow band

Hence not clear that input of this data would improve PDF uncertainties much

CTEQ66 and HERAPDF1.0 predictions compared

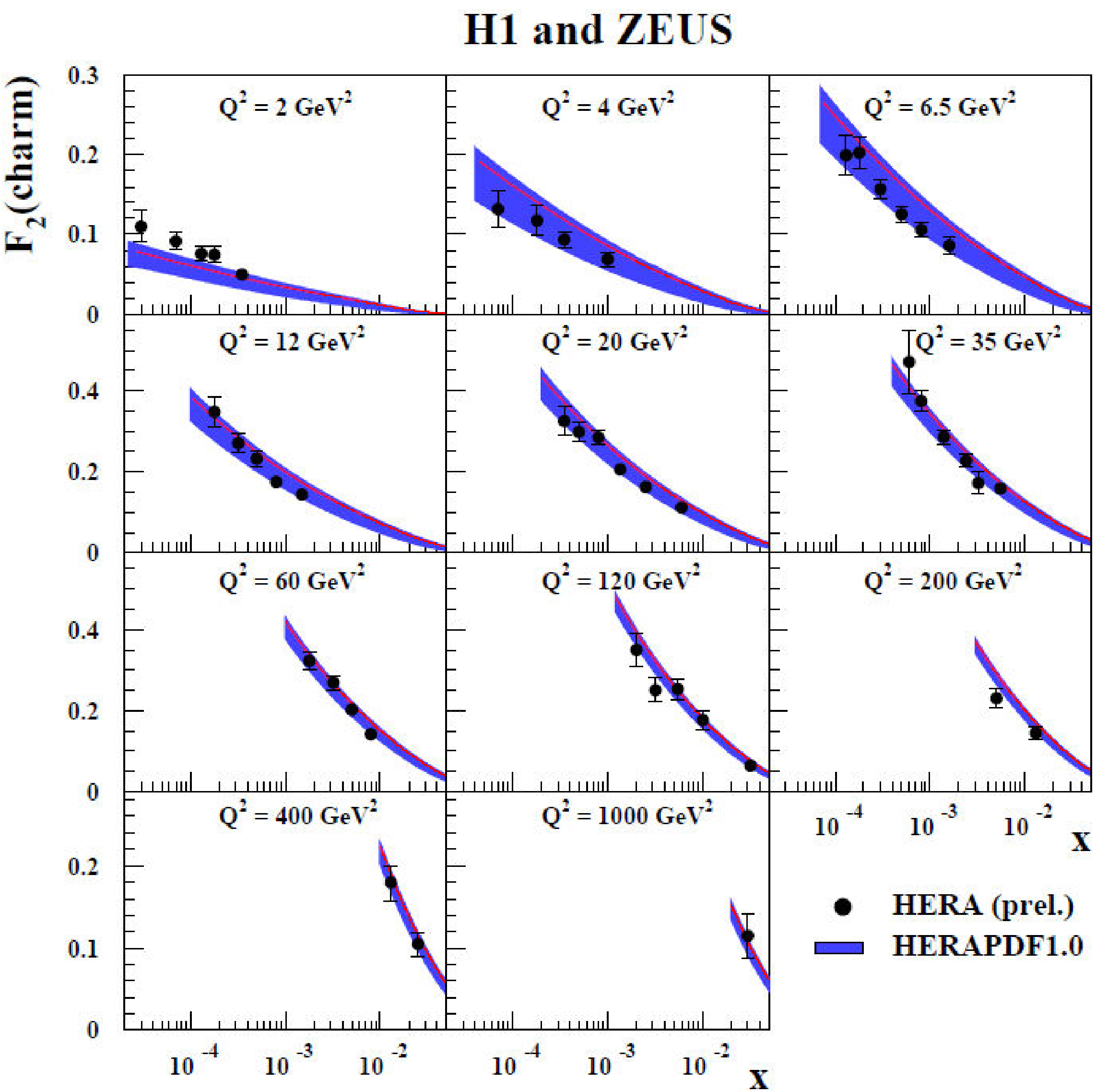




General message is that HERAPDF is compatible with TEVatron measurements used in CTEQ/MSTW and now NNPDF fits, but rather than using these data we

look forward to improving high-x uncertainties with HERA-II data

Fitting HERA combined F2charm data



In the standard HERAPDF1.0fit charm mass varies between mc=1.35 (top of error band) and mc=1.65 (bottom of error band)

So what happens if we actually fit the charm data?

First with the RT-VFN formalism

With scales all Q2 as appropriate to that scheme

Use the usual cuts i.e. only data Q2 > 3.5, so 41 F2c data points

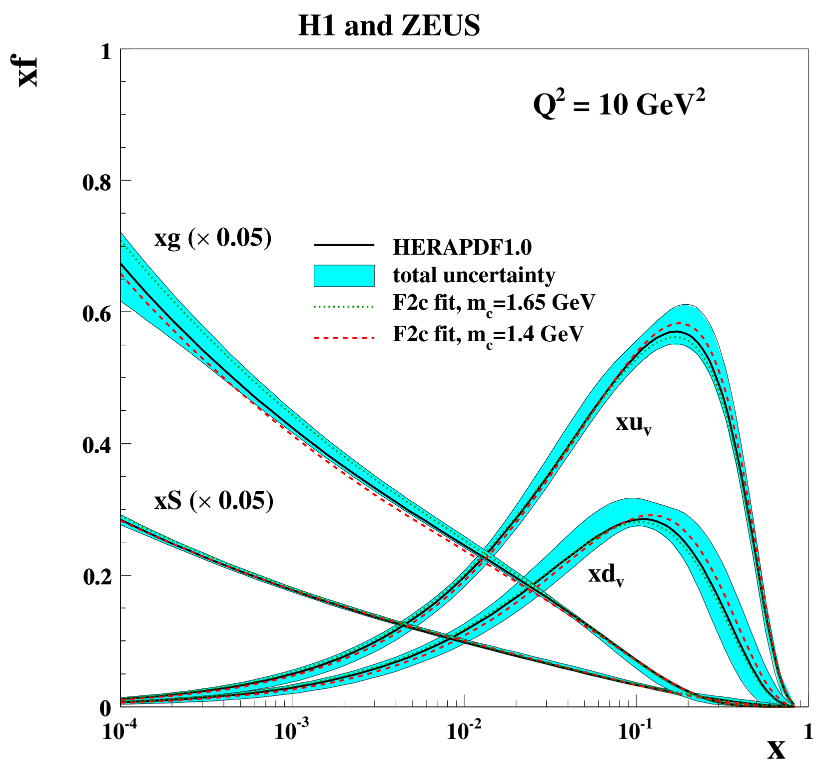
Obtain a good fit for mc=1.65GeV

χ2/ndp =627.6/633 for HERA_I combined 584/592 for F2c 43/41

Mc=1.4 gives a very poor fit to the charm data 135/41

Can also let mc be a free parameter
mc=1.54 ± 0.09

The summary plot illustrates the two fits which include F2c data using mc=1.4 and mc=1.65 compared to the HERAPDF1.0



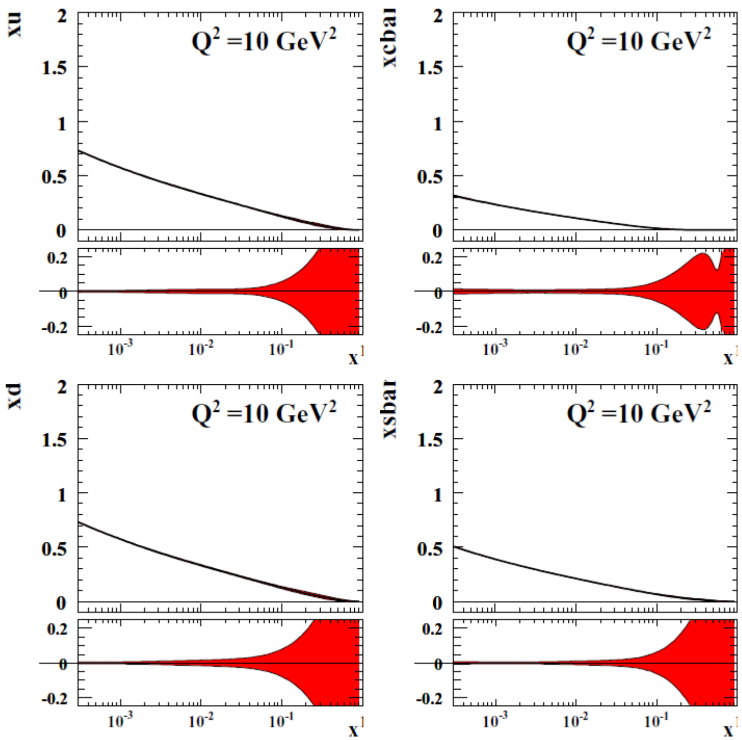
Higher charm mass gives suppressed F2c but enhanced gluon at low-x

Adding in the charm data barely changes the other PDFs..

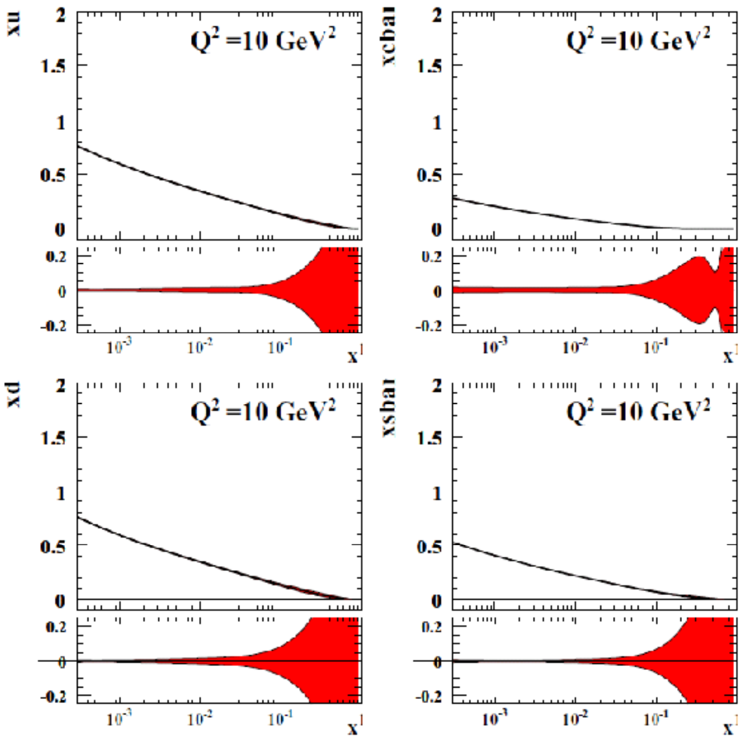
the value of mc affects only the fit to the charm data- and the predictions for F2c are almost the same whether the F2c data is included in the fit or not.

Does the F2charm data improved the uncertainties on the PDFs?

Compare experimental PDF uncertainty bands. I can see a marginal decrease in the size of the cbar uncertainty- encouraging



HERAPDF1.0



HERAPDF1.0 plus F2charm

It is a separate question whether the input of this data restricts parametrisation dependence- much more work!

However it is clear that the model uncertainty due to variation of charm mass can be reduced

Fixed Flavour Number fits in QCDNUM17beta.06

CANNOT deal with CC data – no readily usable NLO coefficient functions for F2 or xF3, and this DOES matter because although the scale is high ZMVFN cannot be used sensibly- the problem is that the process W+c →s is missing and no coefficient function is making up for this!

SO leave CC data out: 633 data points down to 565

(Could also restrict $Q^2 < 3000$ GeV^2 because not resumming $\ln(Q^2/mc^2)$-but this makes little difference)

Fit σ NC e+ (379), NCe-(145) and F2c (41)

Hence FIX valence parameters

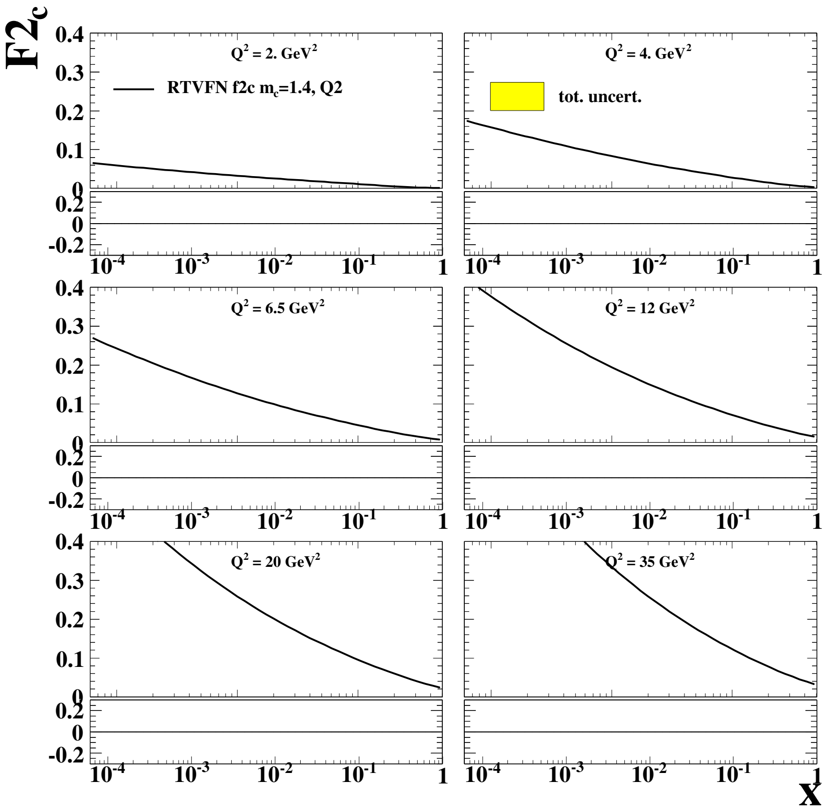
Make the heavy quark factorisation scale Q^2+4mc^2 (but using Q^2 makes little difference)

3-flavour $\alpha_S(Q^2)$ so $\alpha_S(M_z^2)$ must be set low (0.105) so that it is not too high at low energy

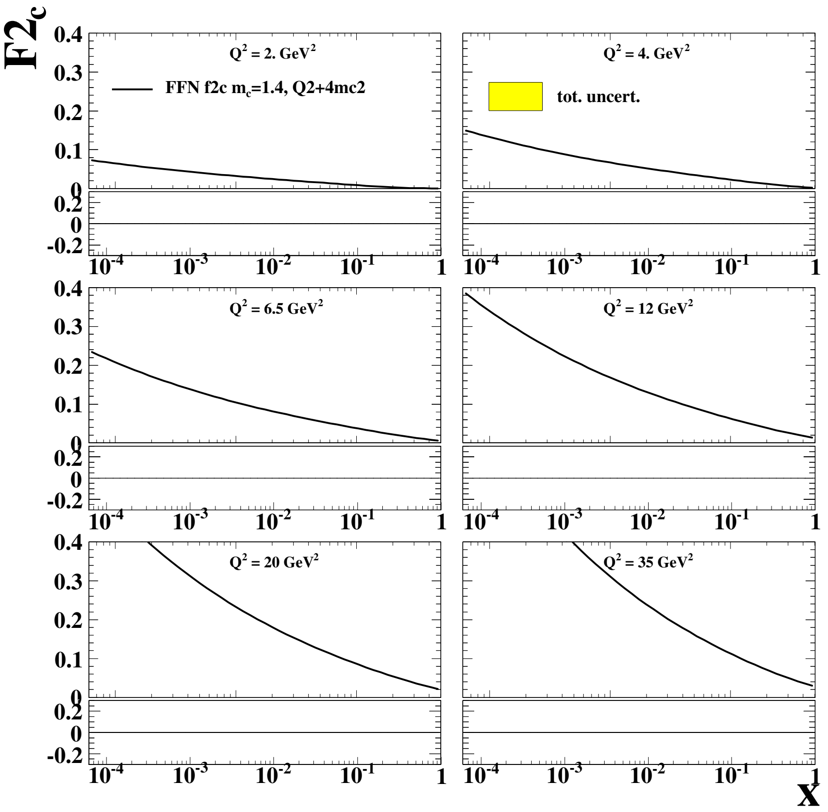
best fits with mc=1.4 GeV NOT mc=1.65

χ2/ndp =567/565 for HERA_I combined 515/524 for F2c 52/41

F2 predictions in various Q2 bins



RTVFN mc=1.4

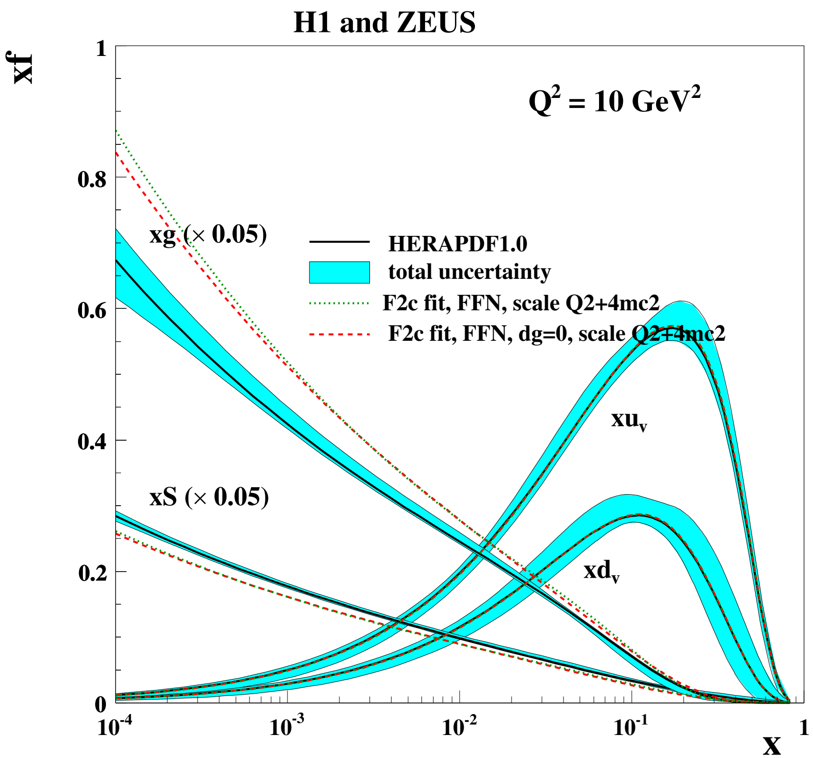


FFN mc=1.4

Compare TRVFN and FFN with same mass mc=1.4 GeV

FFN is relatively suppressed (for Q2> 4)and thus doesn't NEED mc=1.65 to suppress it further to get a good fit

Note that at threshold Q2~2 TRVFN seems surprisingly suppressed?



The FFN/RTVFN change in the gluon is striking ??

(Note the change in the Sea is just the lack of a charm PDF)

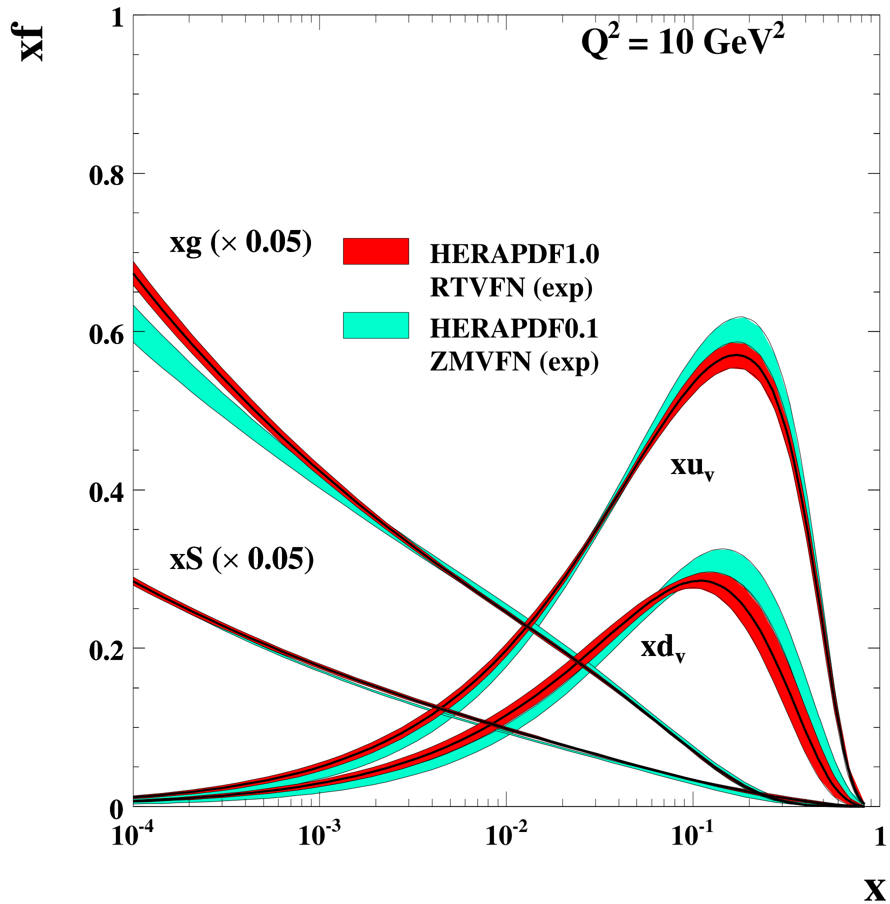
Investigating sensitivity to parametrisation establishes that a $\Delta\chi 2$ improvement of 17 comes from adding an extra parameter to the gluon PDF→Dg ≠ 0

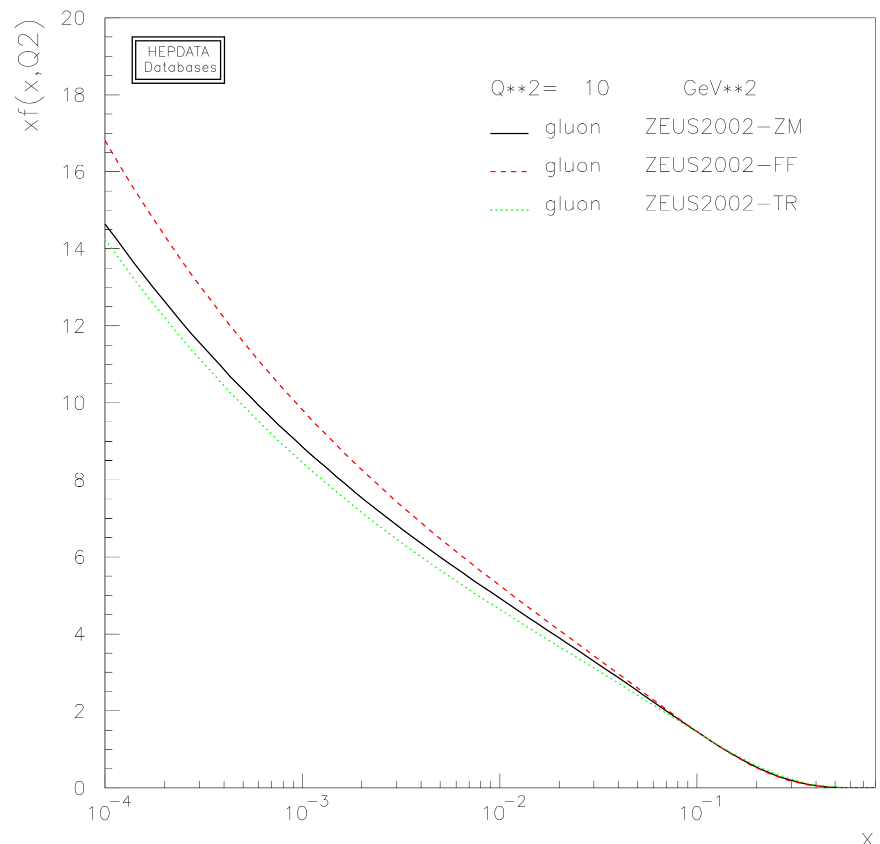
$\chi 2$/ndp =550/565

for HERA_I combined 502/524

for F2c 48/41

No other extra Sea/glue parameters help

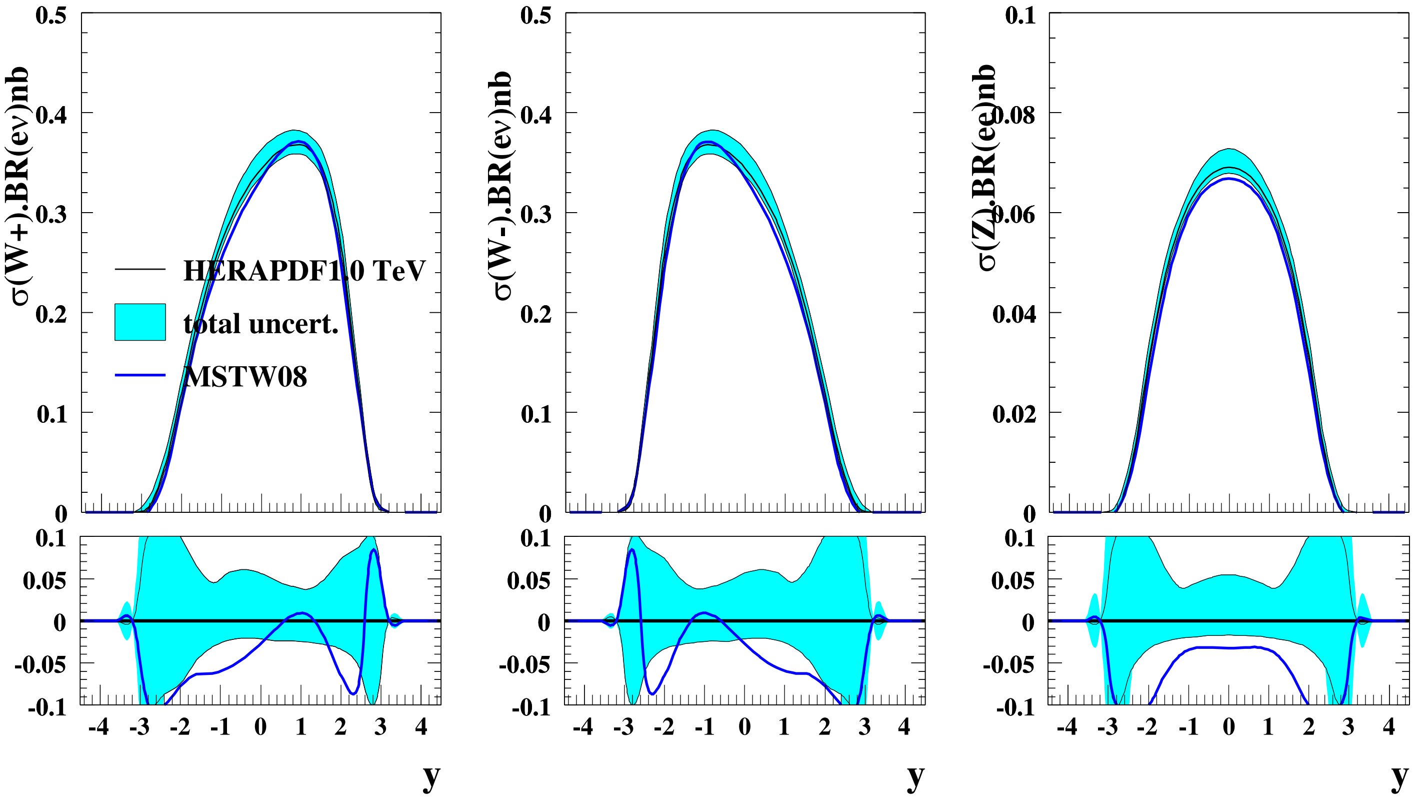




The changes between ZM, TR and FFn in the older ZEUS-S fit are no quite so dramatic- but 3-flavour α_S was not applied

The change from Zero Mass (ZM) to General Mass (TR) VFN was not so dramatic

extras


σ(W+).BR(eν)nb
HERAPDF1.0 TeV
total uncert.
MSTW08
σ(W-).BR(eν)nb
σ(Z).BR(ee)nb
y
y
y

CDF results on the W asymmetry from 1fb-1

Errors from model dependence are larger than this

$\lvert y_W \rvert$	$< \lvert y_W \rvert >_{m_W}$	$A(y_W)$	σ_{sys}	$\sigma_{sys+stat}$
0.0 - 0.2	0.10	0.020	±0.001	±0.003
0.2 - 0.4	0.30	0.057	±0.003	±0.004
0.4 - 0.6	0.50	0.081	±0.004	±0.005
0.6 - 0.8	0.70	0.117	±0.006	±0.006
0.8 - 1.0	0.89	0.146	±0.007	±0.008
1.0 - 1.2	1.09	0.204	±0.008	±0.010
1.2 - 1.4	1.29	0.235	±0.011	±0.012
1.4 - 1.6	1.49	0.261	±0.014	±0.015
1.6 - 1.8	1.69	0.303	±0.014	±0.014
1.8 - 2.05	1.91	0.355	±0.013	±0.014
2.05 - 2.3	2.15	0.436	±0.013	±0.016
2.3 - 2.6	2.40	0.537	±0.014	±0.018
2.6 - 3.0	2.63	0.642	±0.012	±0.026

Snapshots from the HERAPDF1.0 prediction

y_W	$A(y_W)$	
0.40	0.056 ±	0.010
0.80	0.118	0.015
1.20	0.191	0.020
1.60	0.279	0.025
2.00	0.384	0.045
2.40	0.485	0.08