d/u and tbar/t in the ABM fit

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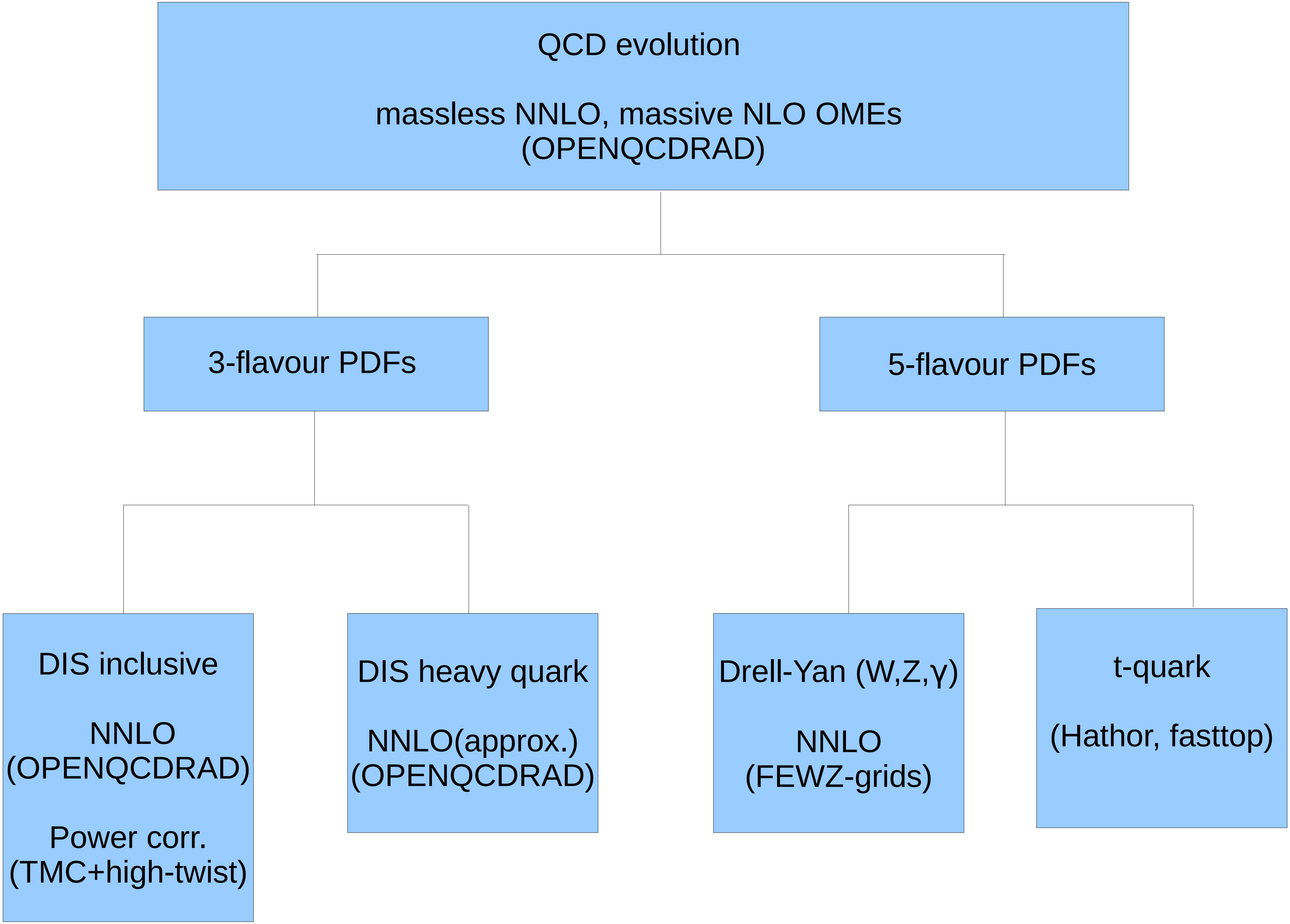
sa, Blümlein, Moch, Plačakytė PRD 96, 014011 (2017)
sa, Blümlein, Moch PLB 777, 134 (2018)
sa, Blümlein, Moch EPJC 78, 477 (2018)
sa, Kulagin, Blümlein, Moch, Petti hep-ph/1808.06871
sa, Blümlein, Moch hep-ph/1808.08404

5th CMS single-top workshop, Oviedo, 29 Nov 2018

PDF fit framework



DY data in the ABMP16 fit

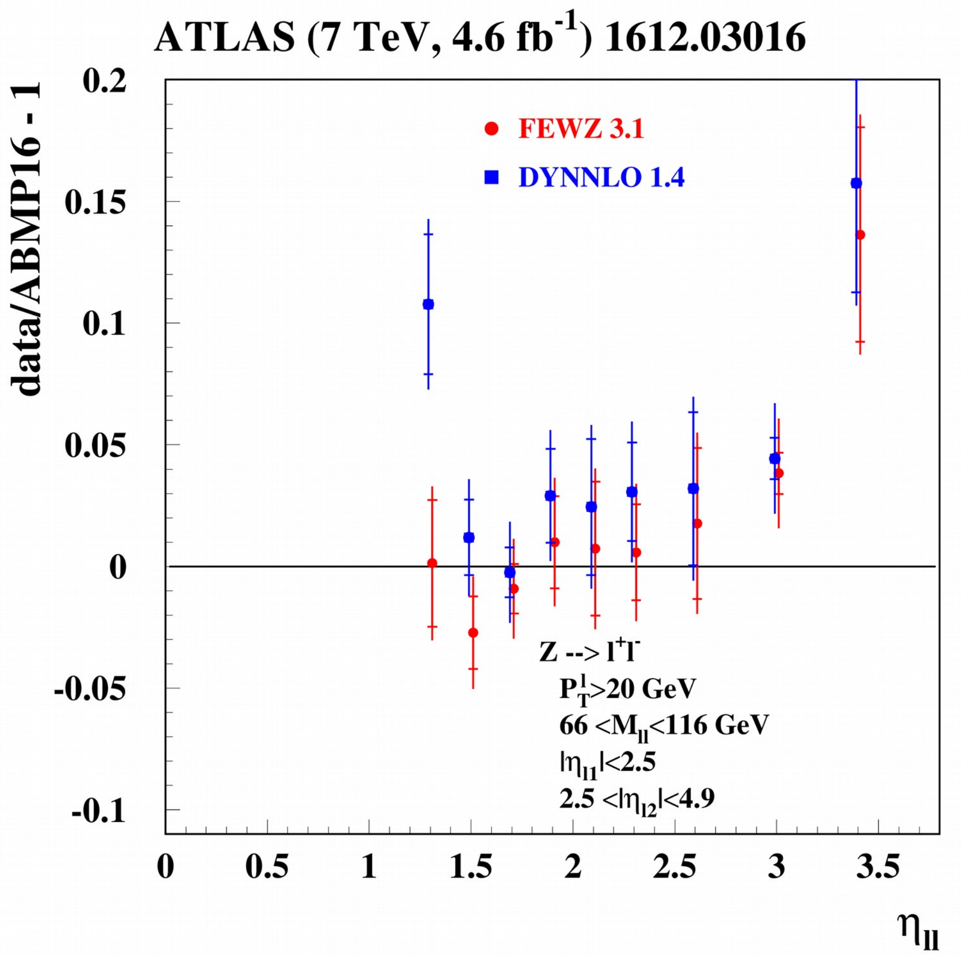
Experiment	ATLAS		CMS		DØ		LHCb		
$\sqrt{s}$ (TeV)	7	13	7	8	1.96		7	8	
Final states	$W^+ \to l^+\nu$ $W^- \to l^-\nu$ $Z \to l^+l^-$	$W^+ \to l^+\nu$ $W^- \to l^-\nu$ $Z \to l^+l^-$	$W^+ \to \mu^+\nu$ $W^- \to \mu^-\nu$ (asym)	$W^+ \to \mu^+\nu$ $W^- \to \mu^-\nu$	$W^+ \to \mu^+\nu$ $W^- \to \mu^-\nu$ (asym)	$W^+ \to e^+\nu$ $W^- \to e^-\nu$ (asym)	$W^+ \to \mu^+\nu$ $W^- \to \mu^-\nu$ $Z \to \mu^+\mu^-$	$Z \to e^+e^-$	$W^+ \to \mu^+\nu$ $W^- \to \mu^-\nu$ $Z \to \mu^+\mu^-$
Cut on the lepton P_T	$P_T^l > 20$ GeV	$P_T^e > 25$ GeV	$P_T^\mu > 25$ GeV	$P_T^\mu > 25$ GeV	$P_T^\mu > 25$ GeV	$P_T^e > 25$ GeV	$P_T^\mu > 20$ GeV	$P_T^e > 20$ GeV	$P_T^\mu > 20$ GeV
Luminosity (1/fb)	0.035	0.081	4.7	18.8	7.3	9.7	1	2	2.9
NDP	30	6	11	22	10	13	31(33) [a]	17	32(34)
ABMP16	31.0	9.2	22.4	16.5	17.6	19.0	45.1(54.4)	21.7	40.0(59.2)
CJ15	–	–	–	–	20	29	–	–	–
CT14	42	–	– [b]	–	–	34.7	–	–	–
`HERAFitter`	–	–	–	–	13	19	–	–	–
MMHT16	39 [c]	–	–	21	21 [c]	26	(43)	29	(59)
NNPDF3.1	29	–	19	–	16	35	(59)	19	(47)

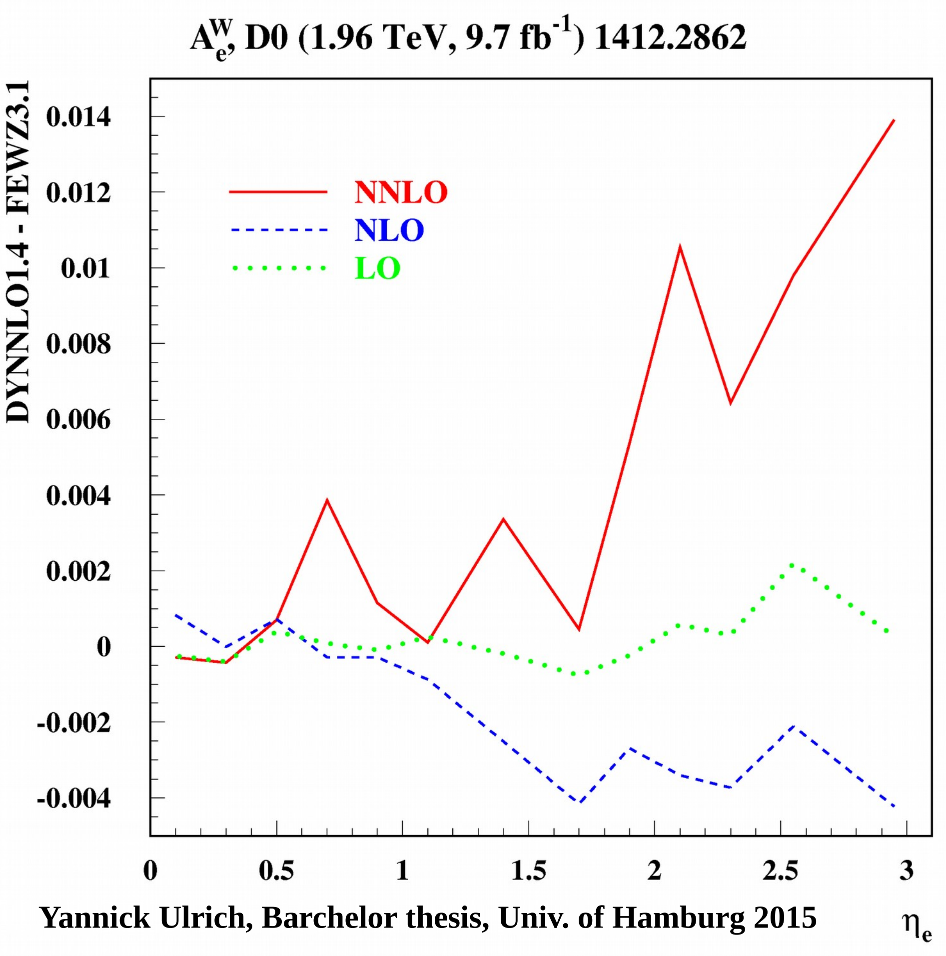
[a] The values of NDP and χ^2 correspond to the unfiltered samples.
[b] For the statistically less significant data with the cut of $P_T^\mu > 35$ GeV the value of $\chi^2 = 12.1$ was obtained.
[c] The value obtained in MMHT14 fit.

Good overall agreement; some tension between D0 and LHCb data

Experiment	NDP	χ^2 after the data sets excuded				
		–	ATLAS	CMS	DØ	LHCb
ATLAS	36	37.7	–	37.0	38.3	39.6
CMS	33	26.6	25.6	–	26.0	23.5
DØ	23	48.5	48.1	47.7	–	**44.2**
LHCb	80	98.2	100.2	97.4	**78.8**	–

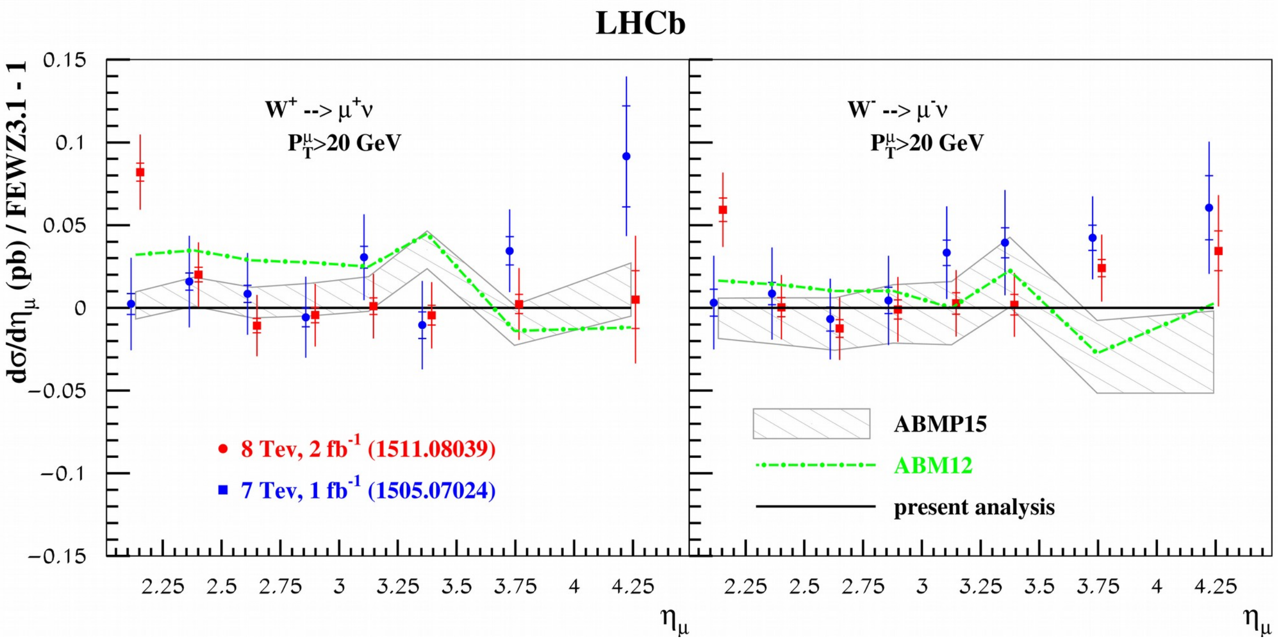
NNLO tools benchmarking

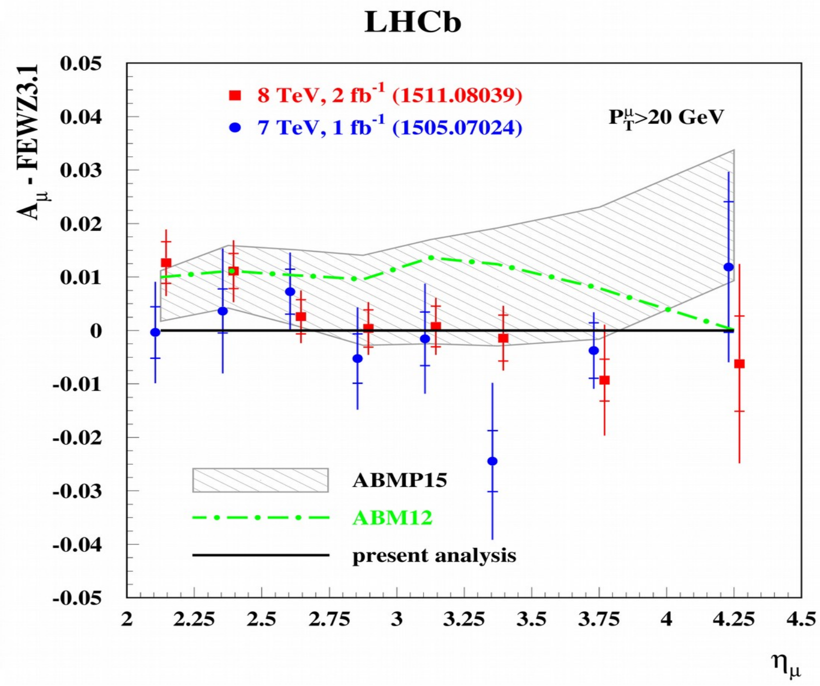


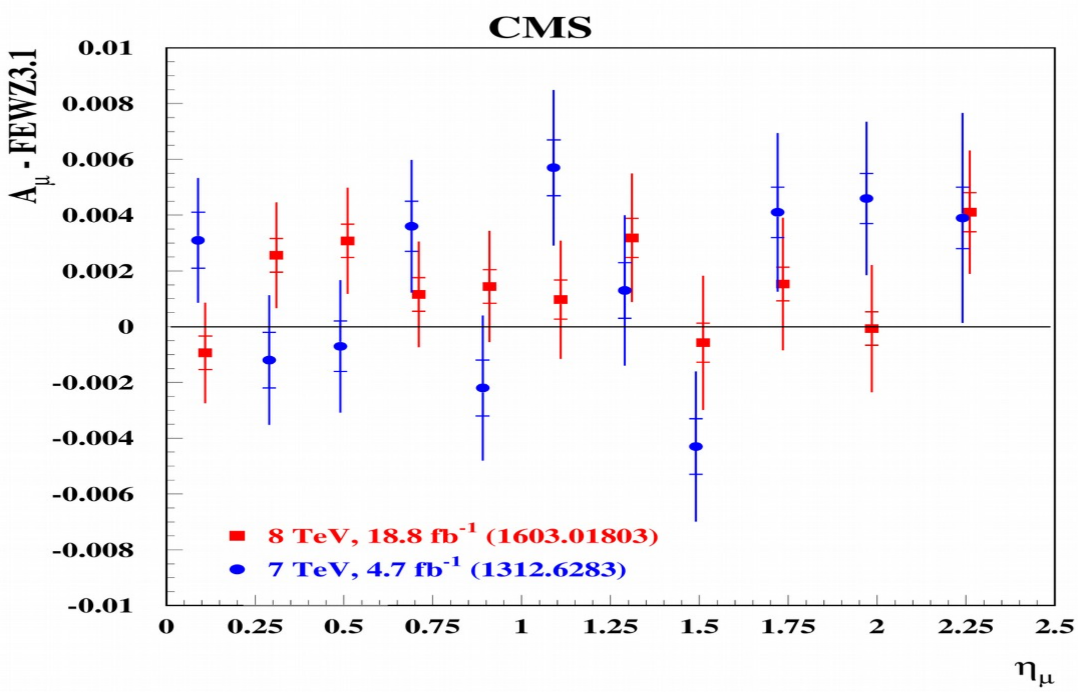


DYNNLO-FEWZ difference not fully understood; further benchmarking is needed

Recent DY inputs







Filtering of the LHCb data has been performed:

– a bump at 7 Tev and Y=3.275

(not confirmed by the LHCb data at 8 TeV)

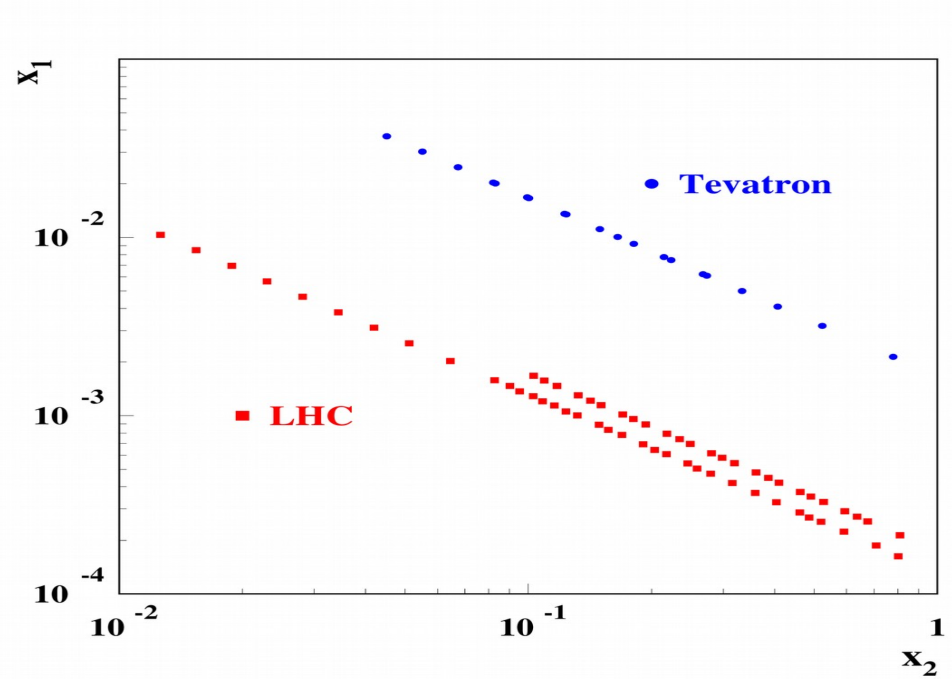
– and excess at 8 TeV and Y=2.125

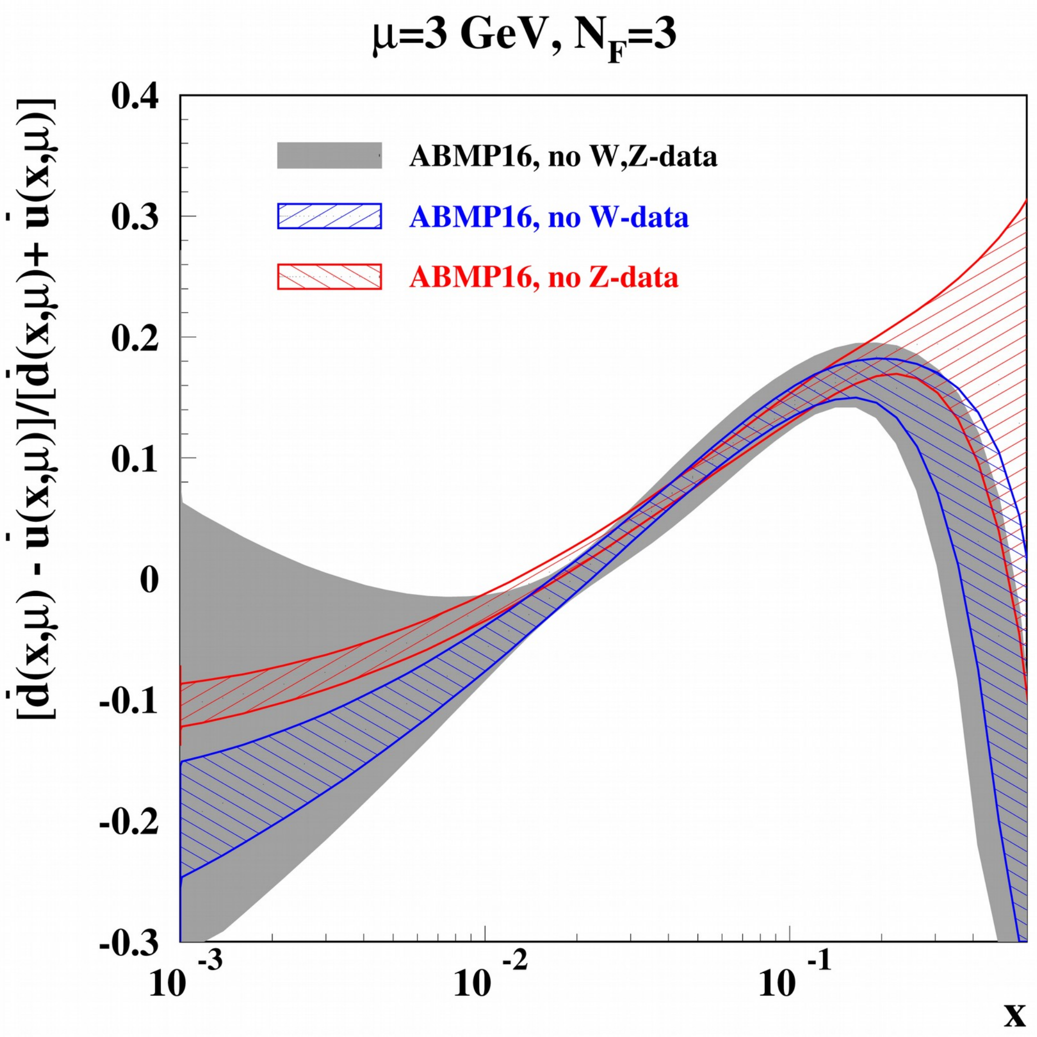
(not confirmed by the CMS data at 8 TeV)

The CMS data at 8 TeV are much smoother than the ones at 7 TeV:

χ^2=17/22 versus 22/11

Impact of the W-, Z-data





In the forward region $x_2 >> x_1$

$\sigma(W^+) \sim u(x_2)$ dbar (x_1)

$\sigma(W^-) \sim d(x_2)$ ubar(x_1)

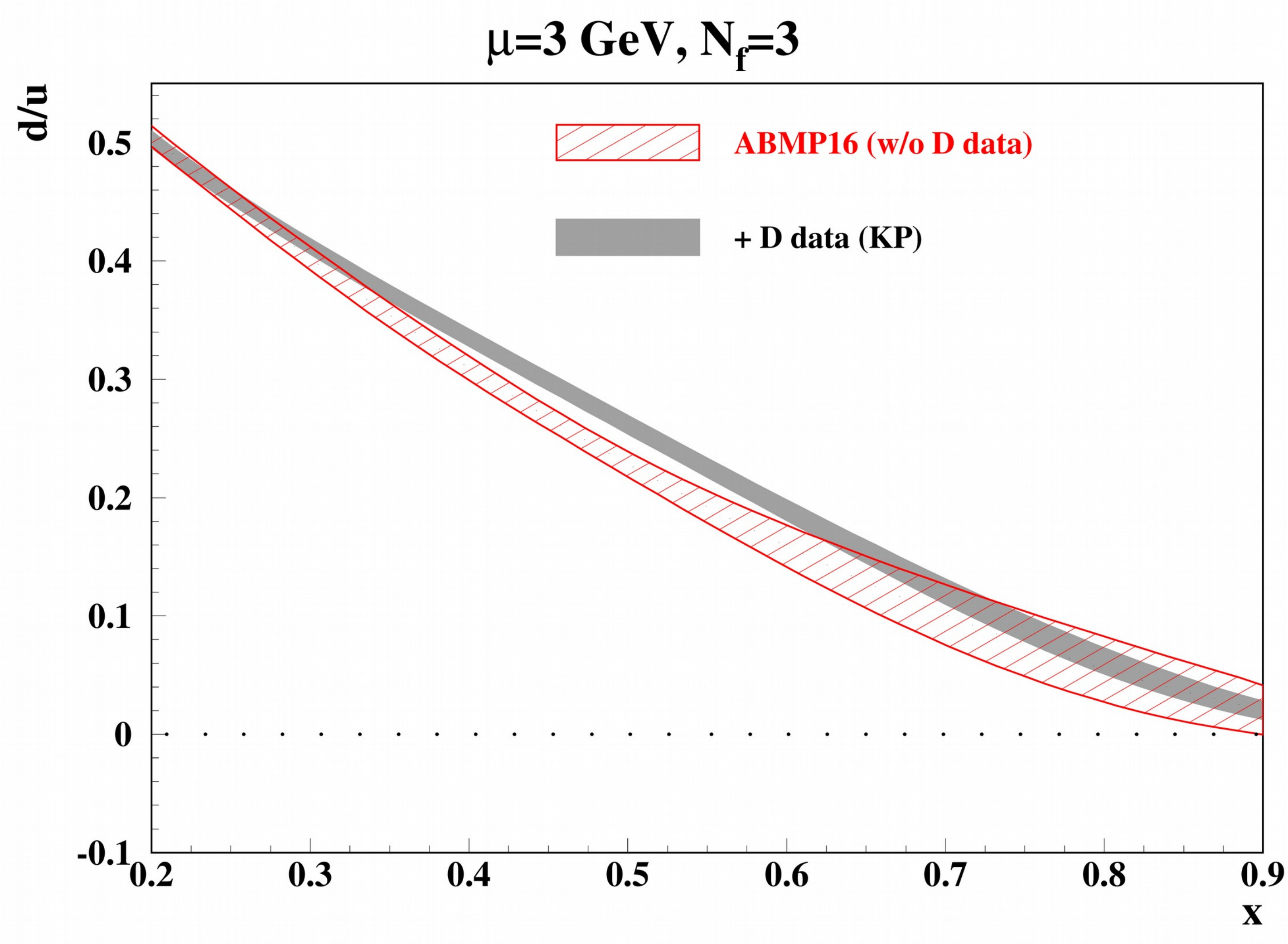
$\sigma(Z) \sim Q_U^2 u(x_2)$ ubar $(x_1)+ Q_D^2 d(x_2)$ dbar(x_1)

$\sigma(DIS) \sim q_u^2 u(x_2) + q_d^2 d(x_2)$

- *Forward W&Z production probes small/large x and is complementary to the DIS ⇒ good quark disentangling; W-, Z-data control quark distributions at small x*

- *Good u- and d- separation at moderate x ⇒ deuteron data can be dropped*

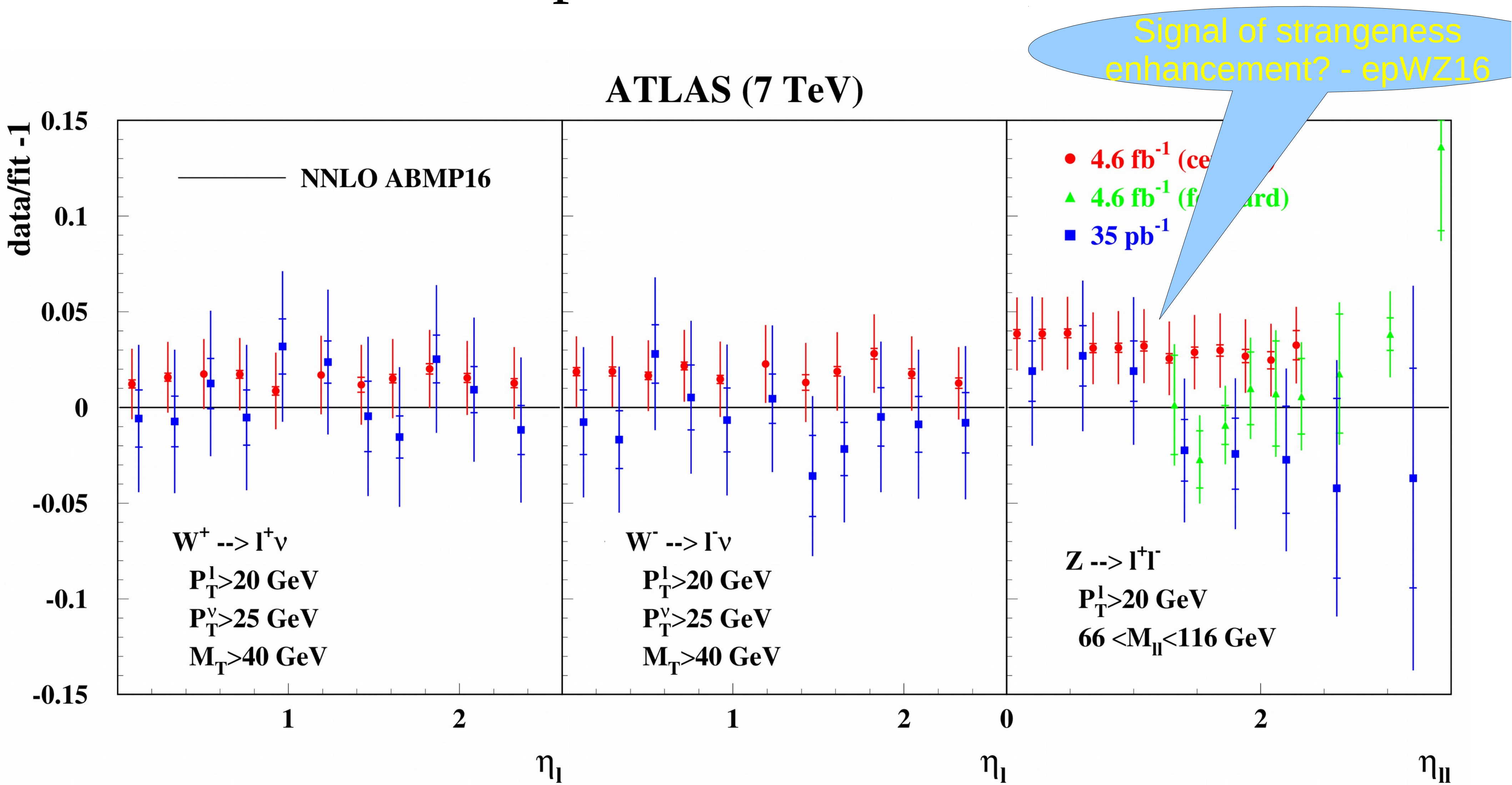
Deuteron effects in the PDF fits



Spread between different deuteron models O(%); sizable for the precision measurements

DY data help to keep accuracy of the PDF determination avoiding uncertainty due to the modeling of nuclear effects

New input: ATLAS at 7 TeV



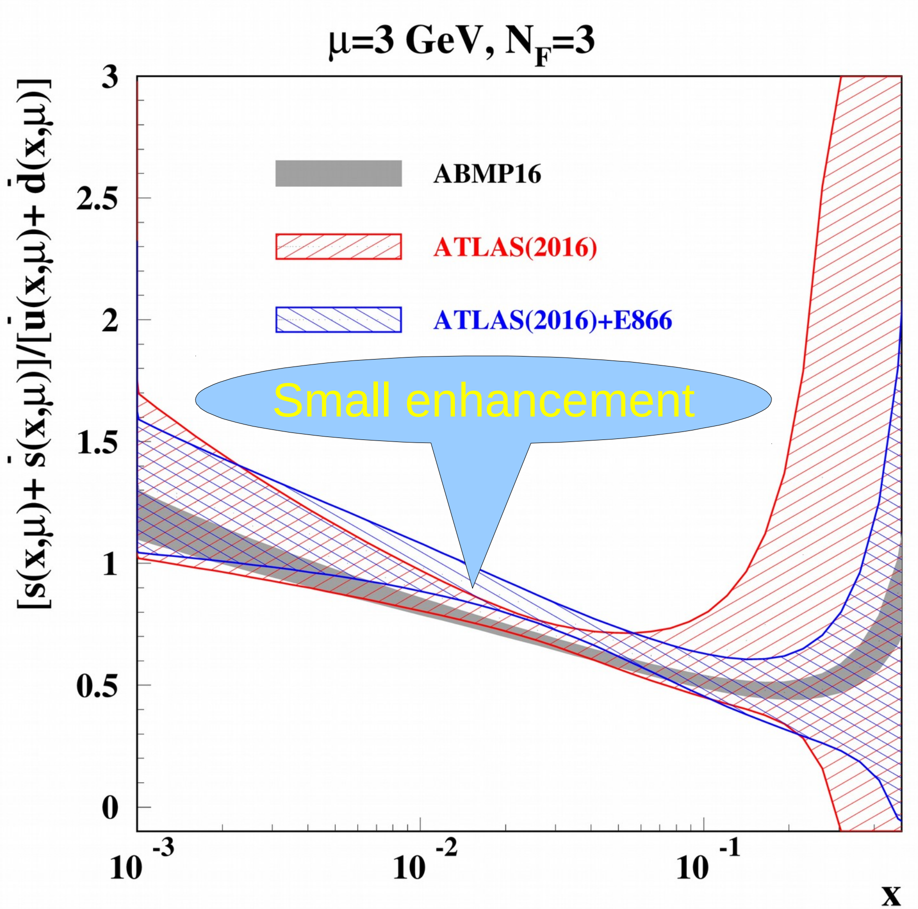
- *Good agreement with W data*
- *Undershooting Z-boson data*
- *Different trends for the central and forward Z-boson data*

Impact of ATLAS data on strangeness

	$\kappa_s(\mu^2=20\ \mathrm{GeV}^2)$
HERA+ATLAS	0.81(18)
HERA+ATLAS+E866	0.72(8)
ABMP16(incl. NOMAD)	0.66(3)

κ_s is integral strange sea suppression factor:

$$\kappa_s(\mu^2) = \frac{\int_0^1 x[s(x,\mu^2)+\bar{s}(x,\mu^2)]dx}{\int_0^1 x[\bar{u}(x,\mu^2)+\bar{d}(x,\mu^2)]dx},$$



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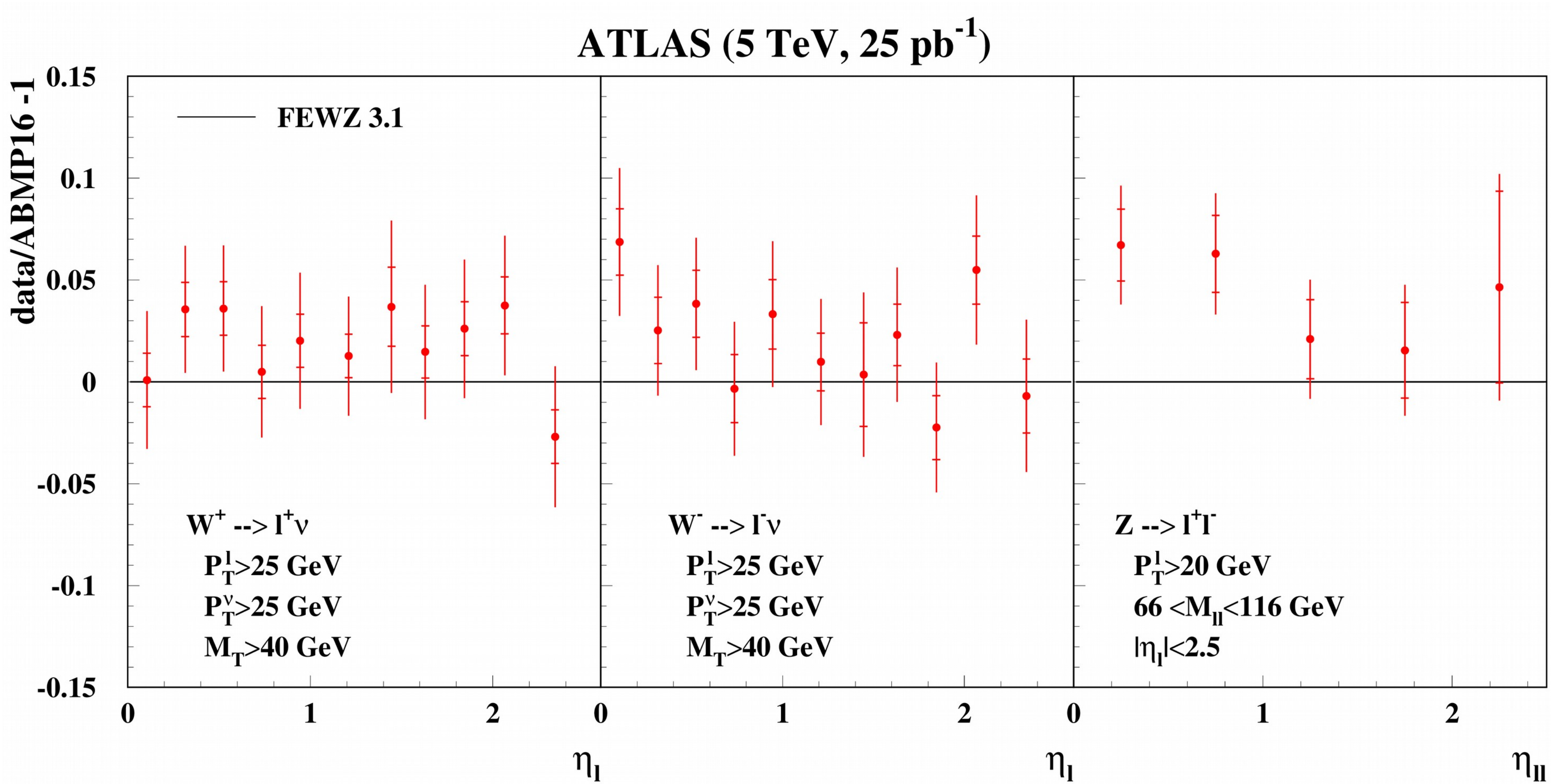
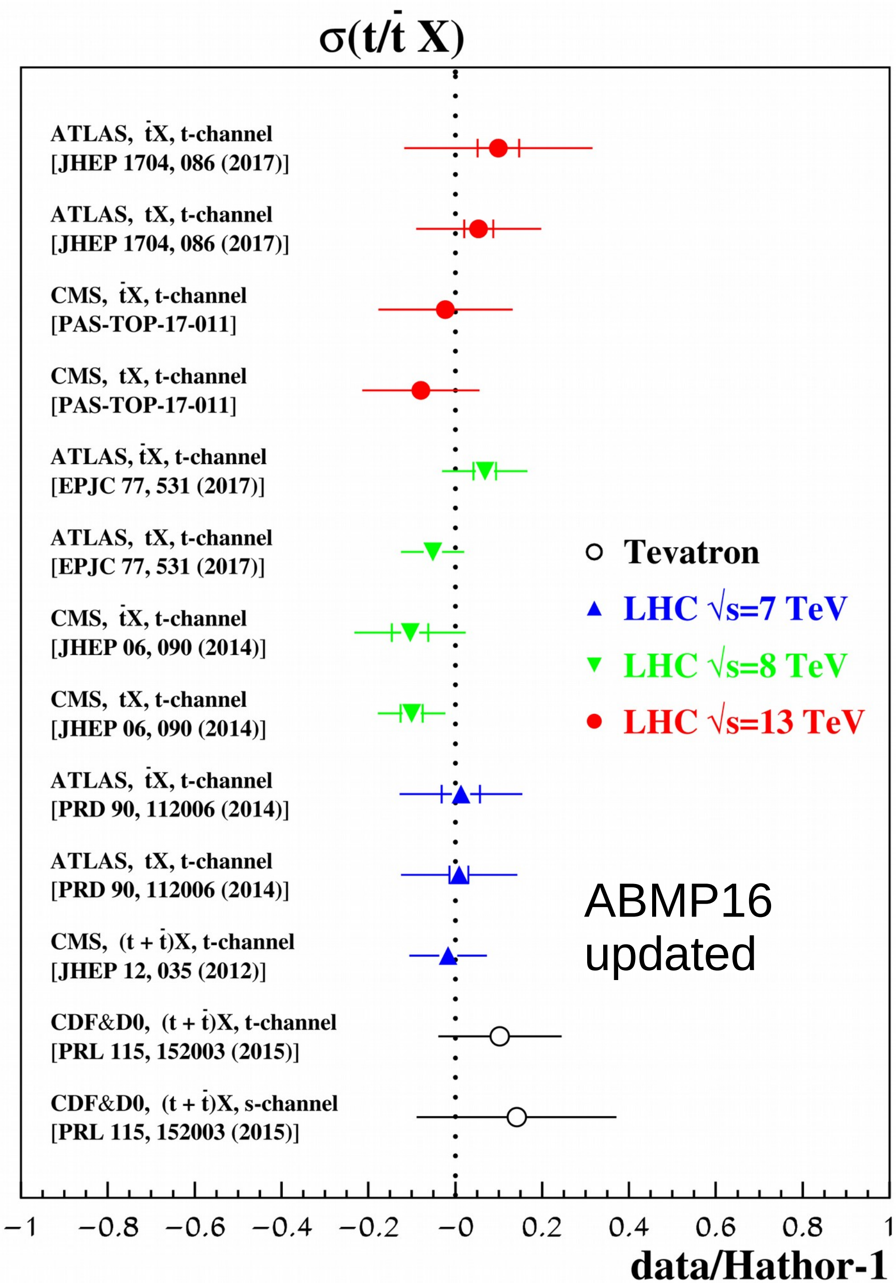
- The strangeness is in a broad agreement with the one extracted from the dimuon data
- The E866 data are consistent with the ATLAS(2016) central data: χ^2/NDP=48/39 and 40/34, respectively.

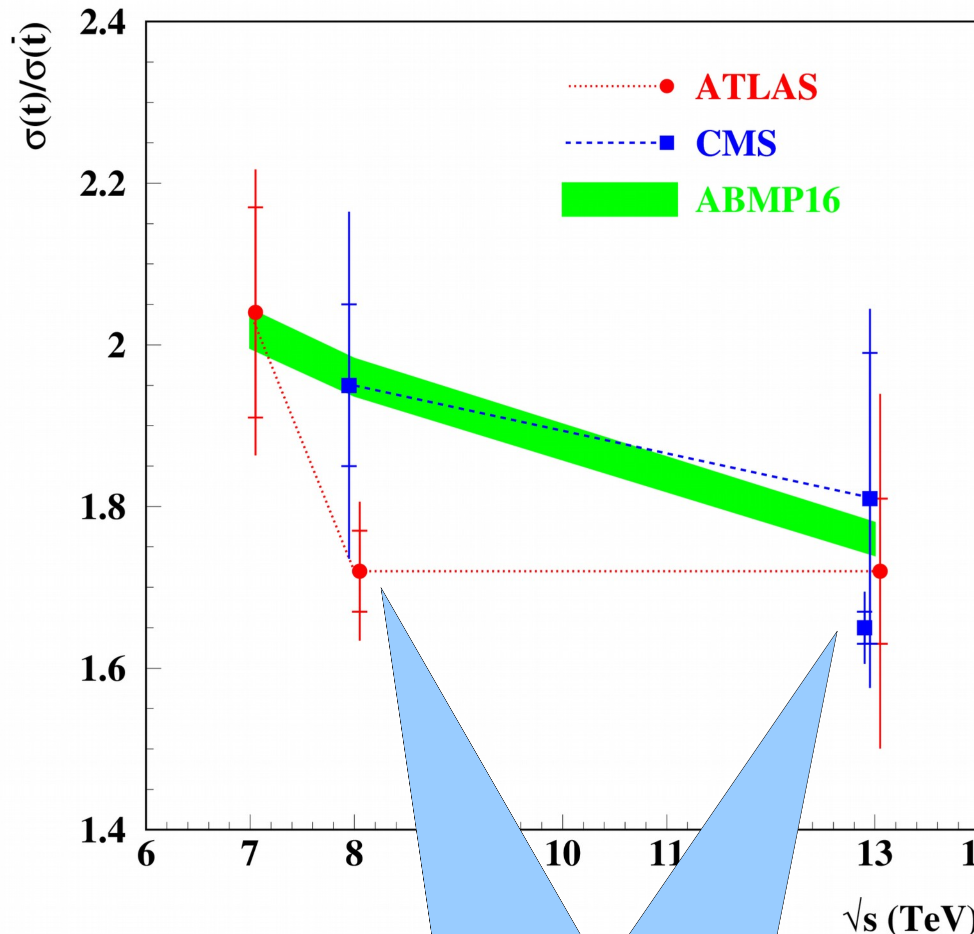
Very new input: ATLAS at 5 TeV



Good overall agreement; some undershooting of the Z-boson part ⇒ some strangeness enhancement should be expected, similarly to the 7-TeV ATLAS sample.

Single-top data



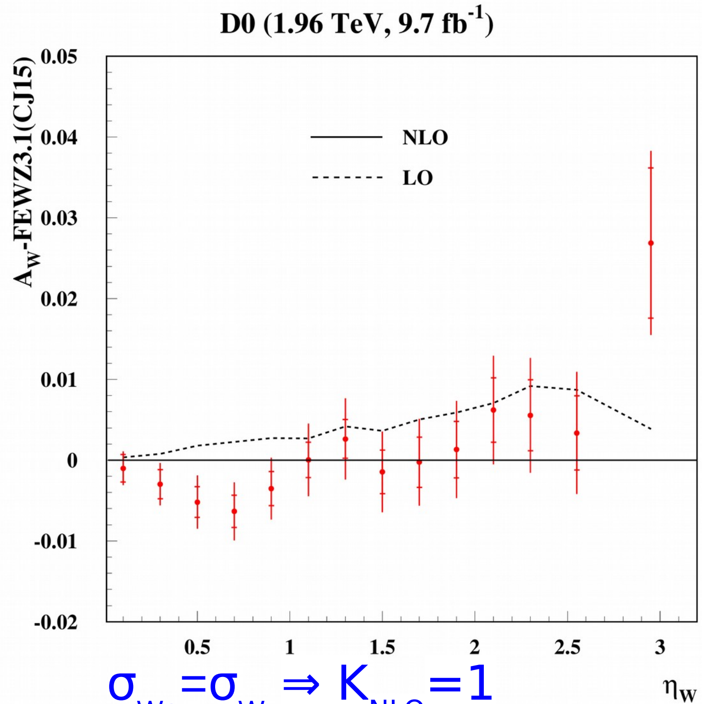


Small errors due to cancellation of theor. unc. in case the MC version is fixed; they are much larger if different MCs are considered

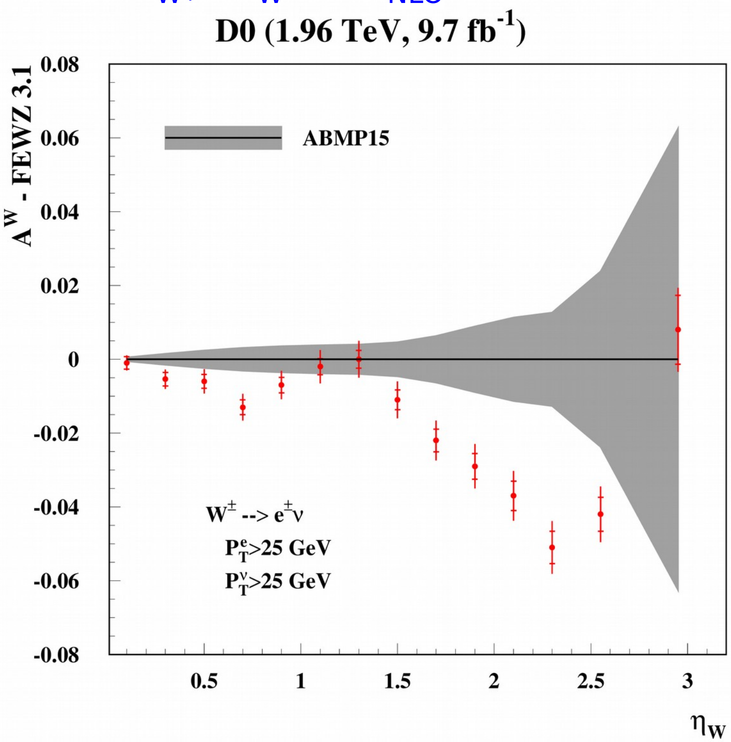
Summary

- Steady improvement in the quark PDFs' determination due to DY LHC data
  - disentangling d- and u-quark distributions at small x
  - competitive constraint on d/u at moderate x w/o using deuteron data
  - somewhat enhanced strange distribution at small x due to ATLAS data, still consistent with "standard" strangeness suppression of ~0.5
- Recent single-top can potentially somewhat improve d/u at moderate x, however, clarification of systematic effects in data is desirable

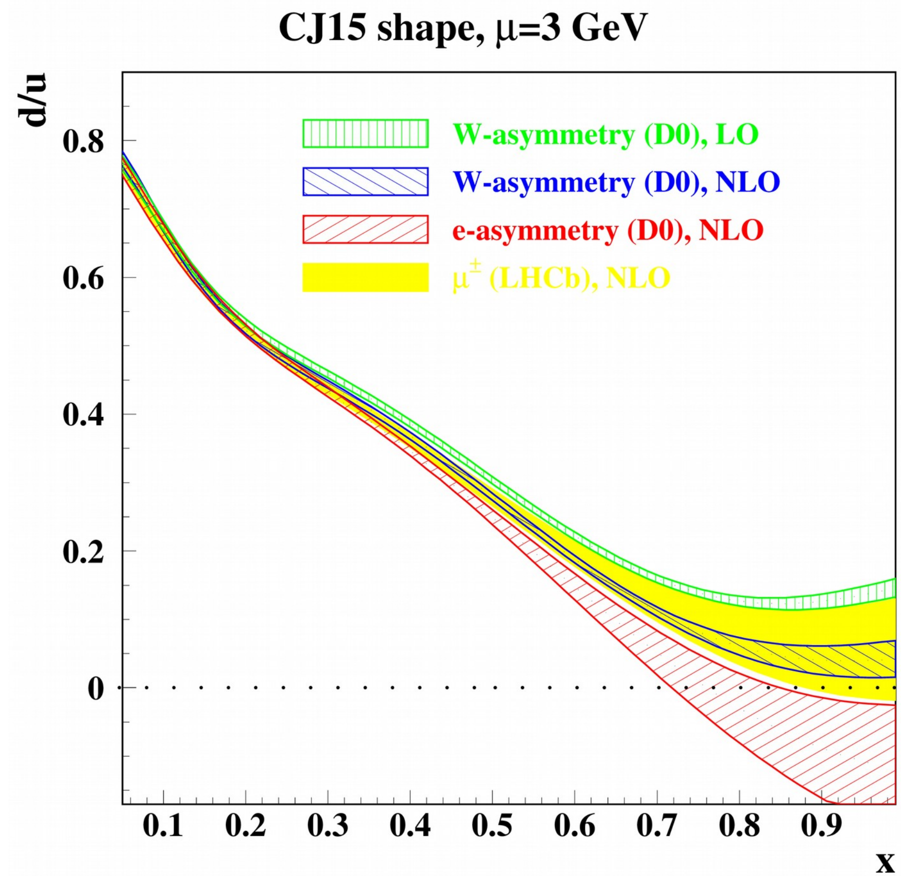
EXTRAS



$\sigma_{W+} = \sigma_{W-} \Rightarrow K_{NLO} = 1$



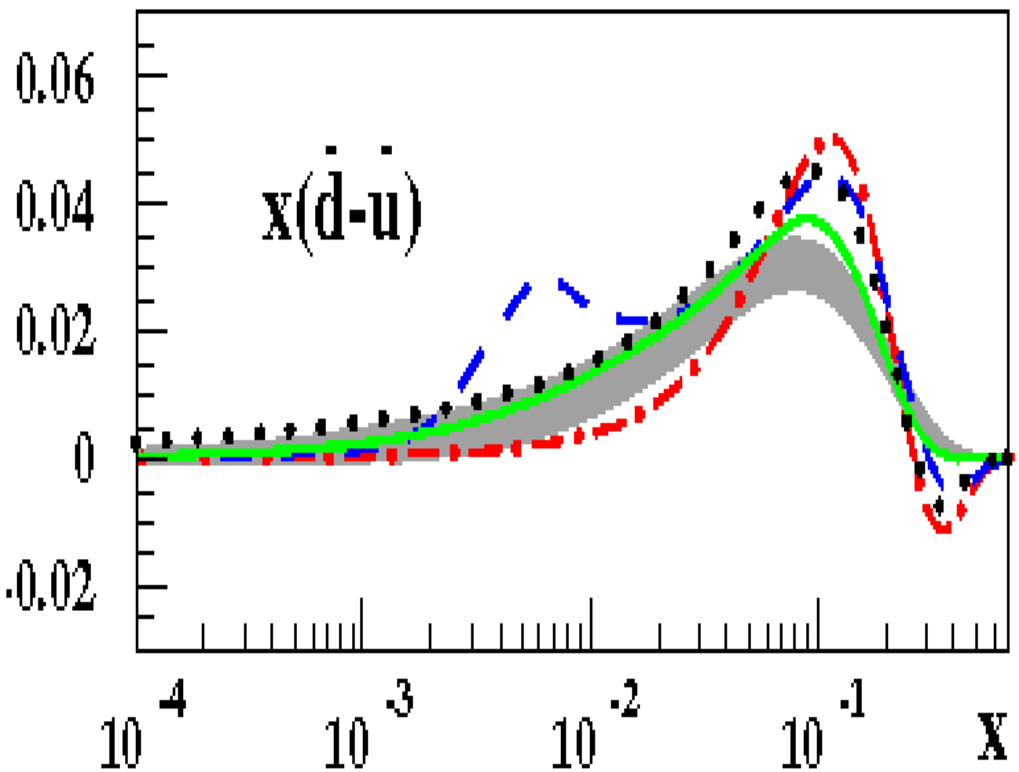
W-asymmetry data go lower that predictions based on the e-asymmetry



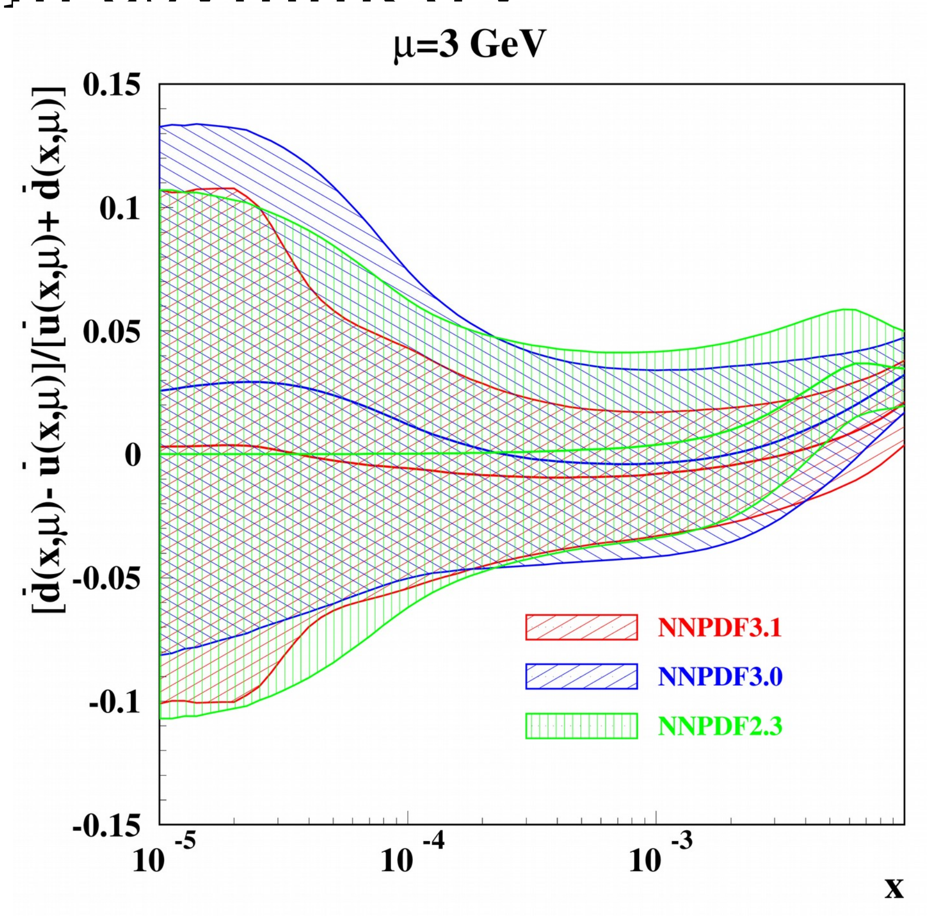
- Account of the NNLO corrections moves large-x d/u downwards
- e-asymmetry data prefer even lower d/u
- Both D0 and LHCb data are consistent with d/u=0 at x → 1.

Non-zero d/u(x=1) can be obtained ony for special selection of data and limited theoretical accuracy

Sea quark iso-spin asymmetry



ABM12 CT10 JR09 MSTW08 NNPDF2.3



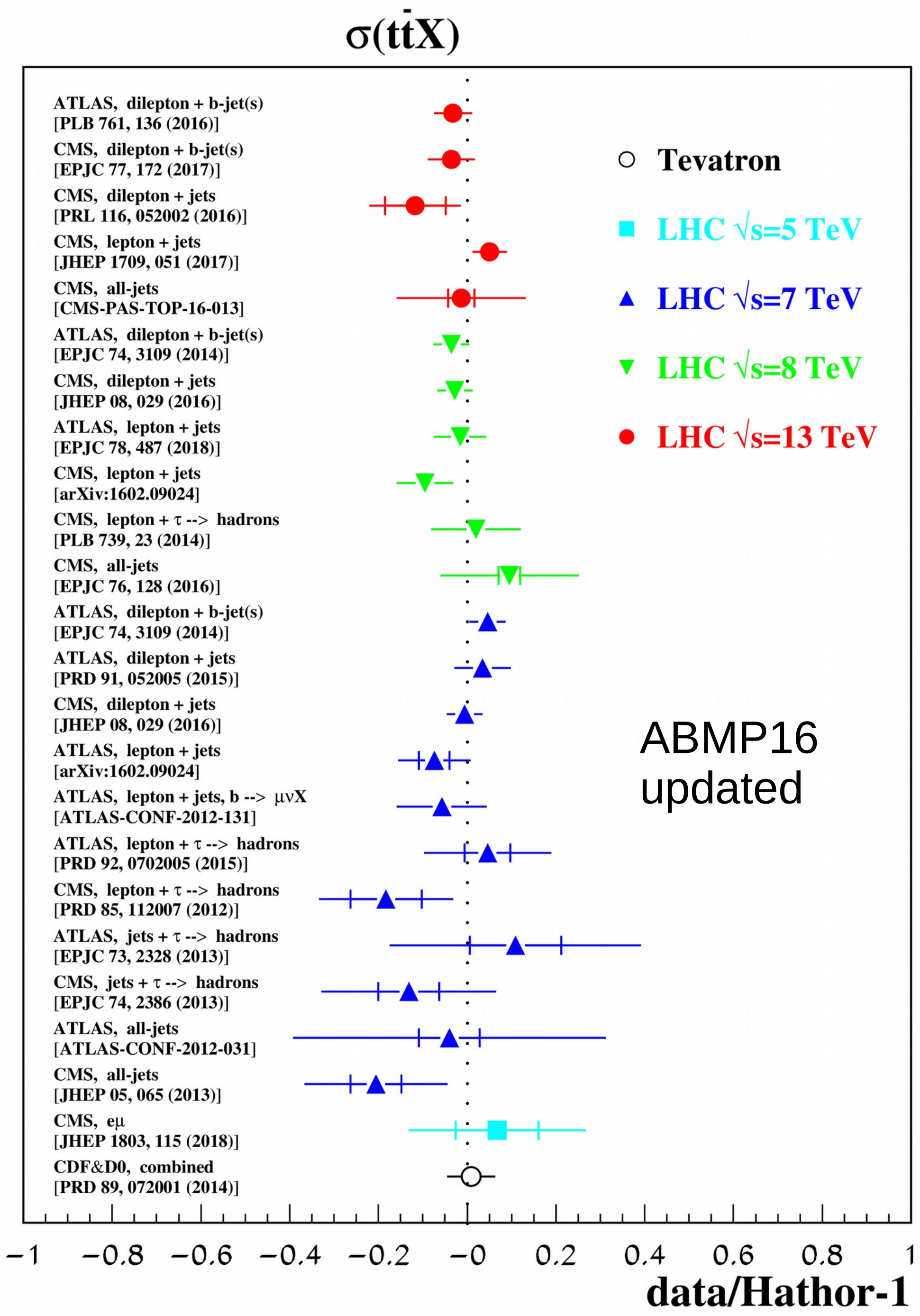
sa, Blümlein, Moch PRD 89, 054028 (2014)

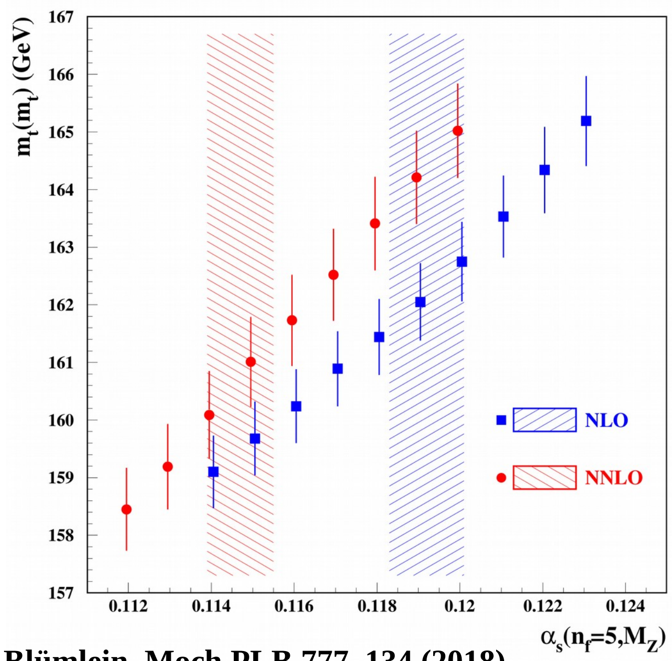
- At x~0.1 the sea quark iso-spin asymmetry is controlled by the fixed-target DY data (E-866), weak constraint from the DIS (NMC)

- At x<0.01 Regge-like constraint like $x^{(a-1)}$, with a close to the meson trajectory intercept; the "unbiased" NNPDF fit follows the same trend

Onset of the Regge asymptotics is out of control

Impact of t-quark data





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- Running t-quark mass can be determined from the world c.s. data

  $m_t(m_t)$= 160.9±1.1 GeV NNLO

  m_t(pole)=170.4±1.2 GeV NNLO

  162.1±1.0 GeV NLO

- Correlation with α_s is important