Workshop on high-precision α_s measurements: from LHC to FCC-ee
CERN, 13 October 2015

α_s from σ(ttbar): preliminary new results

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state of art: CMS extraction

arXiv:1307.1907 (7 TeV)

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sigma(ttbar) = 161.9pb ± 6.7 (stat+syst+lumi) ± 2.9 (Ebeam) pb
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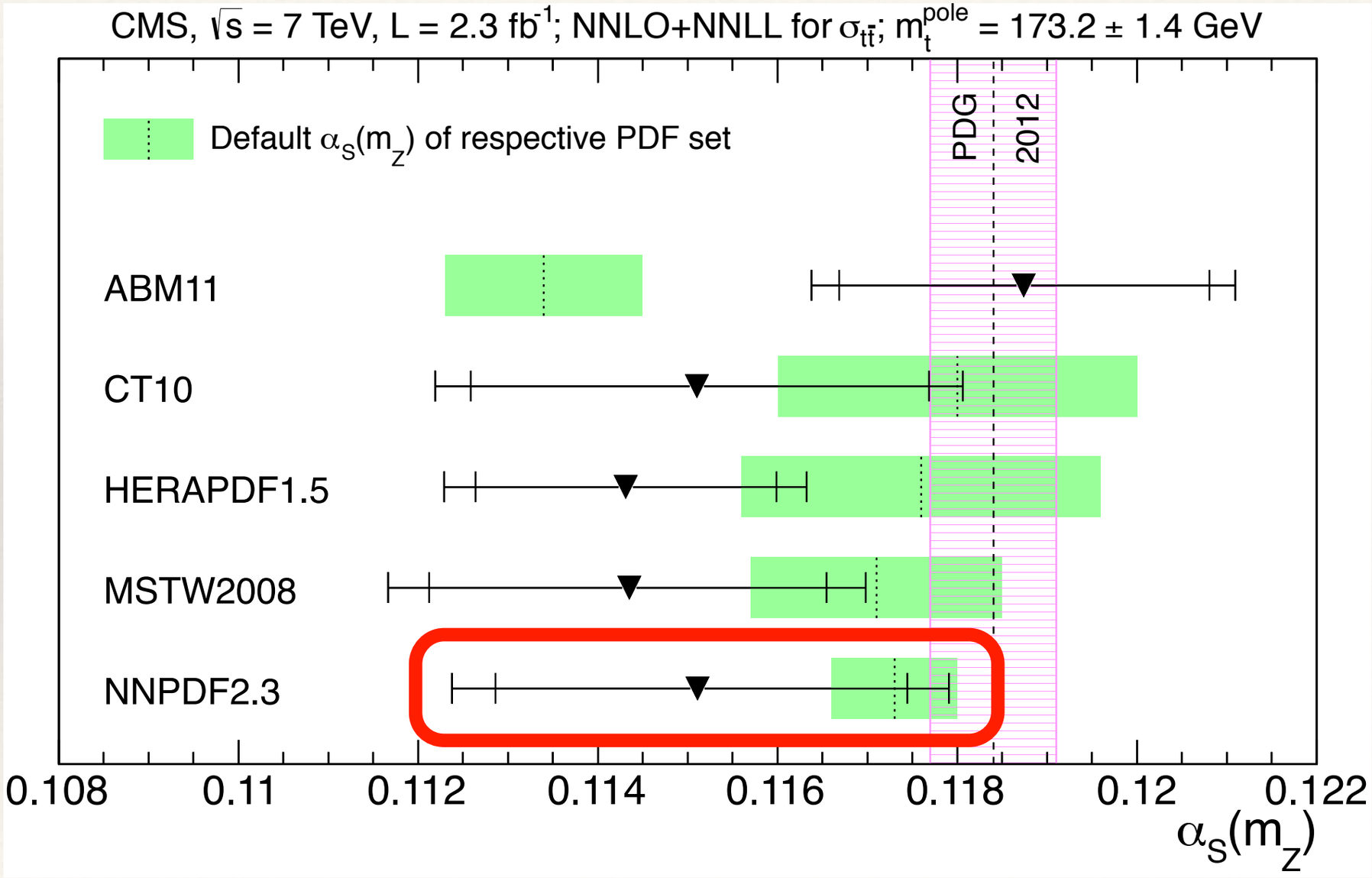

$$\alpha_S(m_Z) = 0.1151^{+0.0028}_{-0.0027}$$

Why update? New data

Original cross section measurement used by CMS (7TeV)

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sigma(ttbar) = 161.9pb ± 6.7 (stat+syst+lumi) ± 2.9 (Ebeam) pb
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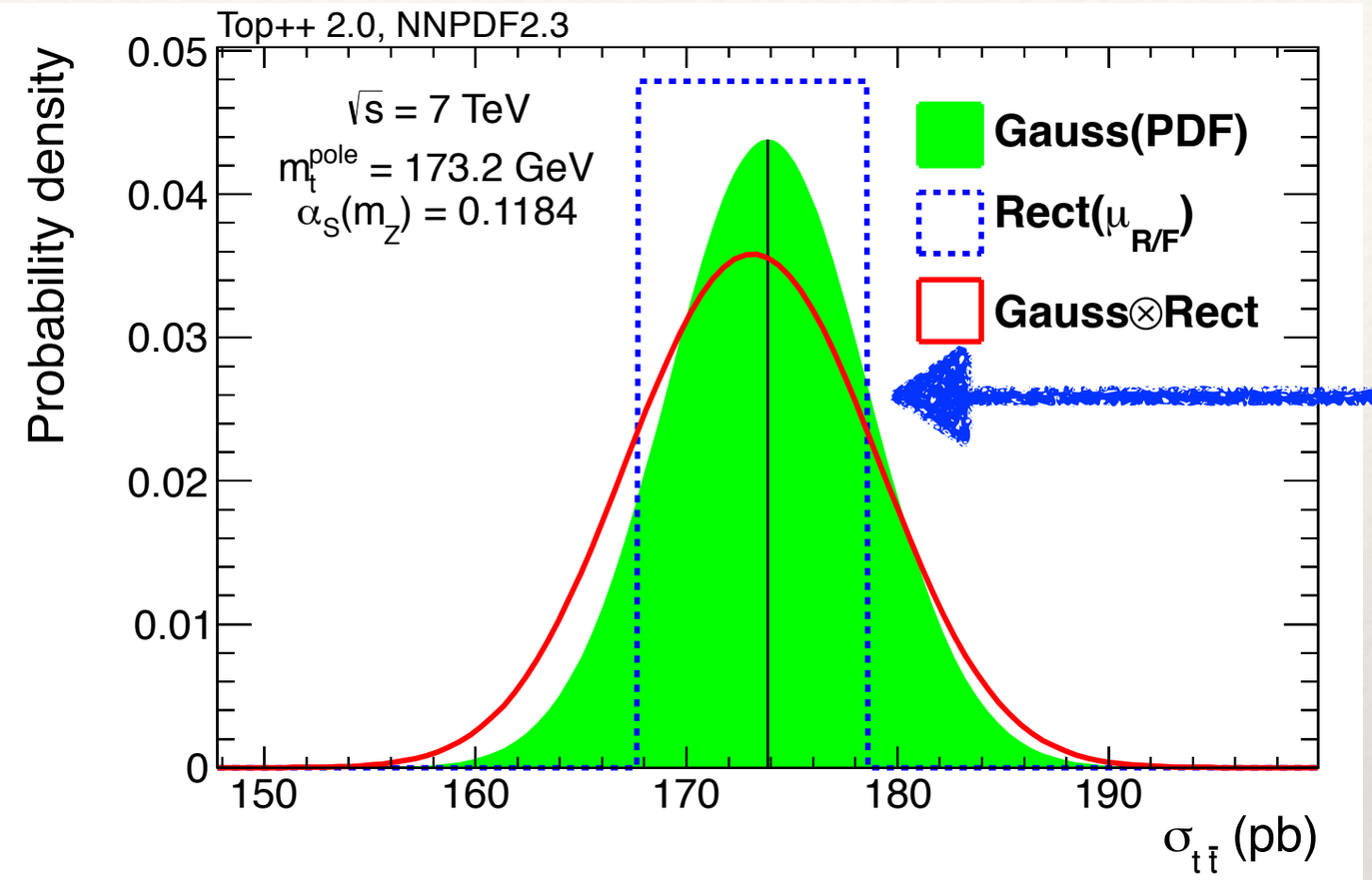
J. High Energy Phys. 11 (2012) 067

More recent determinations at LHC (dilepton) and Tevatron

(NB: 7 TeV results 8-13% higher than in original CMS extraction)

Experiment	E_{CM}	σ [pb]	Exp err. [pb]	Ebeam [pb]	
ATLAS	7000 GeV	182.9	± 6.3	± 3.3	Eur.Phys.J. C74 (2014) 3109
CMS	7000 GeV	174.5	± 6.1	± 2.9	CMS-PAS-TOP-13-004
ATLAS	8000 GeV	242.4	± 9.5	± 4.2	Eur.Phys.J. C74 (2014) 3109
CMS	8000 GeV	245.6	± 9.0	± 4.1	CMS-PAS-TOP-13-004
CDF&D0	1960 GeV	7.6	± 0.41		Phys.Rev. D89 (2014) 072001

Theory uncertainty



CMS procedure

Take theory uncertainty as top-hat within scale variation range (100%cl)

Widespread alternative

Treat scale uncertainty as if it were ±1σ (i.e. 68%cl)

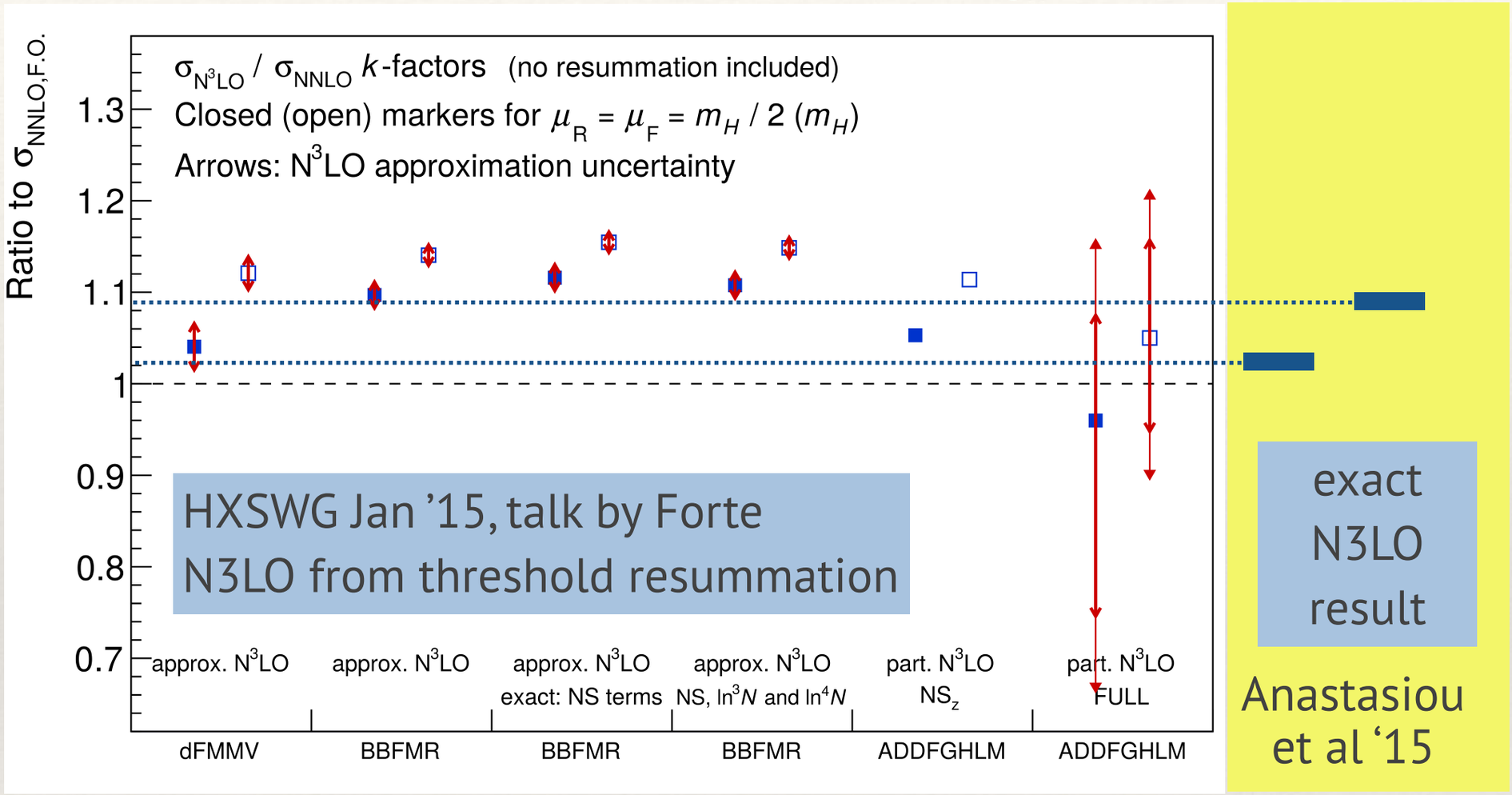
[After convolution with other uncertainties]

top-hat ⇒ theory uncert. that's √3 (1.73) times smaller

We will treat scale uncertainty as ±1σ

NNLO v. NNLL+NNLO?

$\mathrm{N^3LO/NNLO}$ k-FACTOR in gluon fusion → Higgs



In case of Higgs production (only process known at N3LO), threshold approx.for N3LO was off by 2–10%.

We will consider results with and without NNLL

Preliminary results

NNLL + NNLO with NNPDF23

Exp.	E_{CM} [GeV]	$\alpha_s(M_Z)$	Exp.	scale	PDF	m_{top}	E_{beam}	total
ATLAS	7000	0.1207	±0.0017	±0.0014	±0.0014	±0.0018	±0.0009	±0.0033
ATLAS	8000	0.1168	±0.0018	±0.0015	±0.0013	±0.0018	±0.0008	±0.0033
CMS	7000	0.1184	±0.0016	±0.0014	±0.0014	±0.0018	±0.0008	±0.0032
CMS	8000	0.1174	±0.0017	±0.0015	±0.0013	±0.0018	±0.0008	±0.0033
CDF&D0	1960	0.1201	±0.0032	±0.0013	±0.0010	±0.0013	±0.0000	±0.0038
unweigted	**average**	**0.1187**						

Errors symmetrised

m_{top} = 173.2 ± 1.4 GeV

Preliminary results

plain NNLO with NNPDF23

Exp.	E_{CM} [GeV]	$\alpha_s(M_Z)$	Exp.	scale	PDF	m_{top}	E_{beam}	total
ATLAS	7000	0.1223	±0.0018	±0.0025	±0.0014	±0.0018	±0.0009	±0.0040
ATLAS	8000	0.1182	±0.0019	±0.0026	±0.0013	±0.0019	±0.0009	±0.0041
CMS	7000	0.1199	±0.0017	±0.0025	±0.0014	±0.0018	±0.0008	±0.0039
CMS	8000	0.1189	±0.0018	±0.0026	±0.0013	±0.0018	±0.0008	±0.0040
TEV	1960	0.1215	±0.0034	±0.0027	±0.0010	±0.0014	±0.0000	±0.0047
unweigted	**average**	**0.1201**						

Errors symmetrised

m_{top} = 173.2 ± 1.4 GeV

Conclusions

- Newer results point to somewhat larger $\alpha_s(M_Z)$ than earlier CMS extraction (prelim: 0.1187–0.1201 v. 0.1151)

  [NNPDF23 → CT14 reduces α_s by 0.0013]

- Scale uncertainties affected by choice of top-hat v. 1-σ

- Open question of choice of theory: NNLL+NNLO v. NNLO. Latter increases result and uncertainty.

- Ongoing studies:
  - Combination of results
  - PDF choice (get nonsense if PDFs include ttbar data)
  - More sophisticated statistical procedure