

Updated reference x-sections ttH status report

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WG activities (besides sects)

- ttbb meeting (July 22)
<https://indico.cern.ch/event/1165637/>
- ttW meeting (December 22)
<https://indico.cern.ch/event/1219500/>
- Studies on ttbb modelling (to be restarted)
- Studies on ttW modelling (in contact with MC developers)



WG activities (I)

- Signal: provide new reference cross sections, including all relevant theory progress. For the moment, we will aim at the restricted (energy, mass) range
- ttH: NNLO QCD + NNLL soft + complete NLO EW. First individual results available
 - I [Broggio et al, 1907.04343](#);
 - II [Kulesza et al, 2001.03030 I](#);
 - III [Catani et al, 2210.07846](#)
- tH (various channels) NLO QCD, with FS-uncertainties for t-channel (YR4). EW corrections are known ($\sim -3\%$, [Pagani et al, 2006.10086](#)), but cannot be broken down in t/s/tW channel. Numbers ready (reduced set of mass/energies)

ttH numbers

\sqrt{s} [TeV]	m_H [GeV]	σ [fb]			$\delta_\mu (+\delta_{\text{ThU}})$			δ_{PDF}			δ_{α_s}		
		I	II	III	I	II	III	I	II	III	I	III	
13.0	124.60	504.7	509.5	528.8	+7.8 -5.9	+5.4 -6.1	+3.2 -3.2	± 0.7	2.3	2.2	2.3	0.0	1.5 1.7
13.0	125.00	499.9	505.1	524.6	+7.8 -5.9	+5.4 -6.1	+3.2 -3.2	± 0.7	2.3	2.2	2.3	0.0	1.5 1.7
13.0	125.09	499.0	503.1	523.0	+7.9 -5.9	+5.4 -6.0	+3.2 -3.2	± 0.7	2.3	2.2	2.3	0.0	1.5 1.7
13.0	125.38	495.5	500.6	518.9	+7.9 -5.9	+5.4 -6.1	+3.1 -3.1	± 0.7	2.3	2.2	2.3	0.0	1.5 1.7
13.0	125.60	493.4	497.9	517.0	+7.8 -5.9	+5.4 -6.1	+3.2 -3.2	± 0.7	2.3	2.2	2.3	0.0	1.5 1.7
13.0	126.00	488.7	493.7	511.6	+7.8 -5.9	+5.3 -6.1	+3.1 -3.1	± 0.7	2.3	2.2	2.3	0.0	1.5 1.7
13.6	124.60	565.4	570.9	592.8	+7.8 -5.9	+5.5 -6.1	+3.0 -3.0	± 0.6	2.2	2.1	2.2	0.0	1.5 1.6
13.6	125.00	560.4	566.6	586.3	+7.9 -5.9	+5.4 -6.1	+3.0 -3.0	± 0.7	2.2	2.1	2.2	0.0	1.5 1.6
13.6	125.09	559.4	564.3	585.7	+7.9 -5.9	+5.5 -6.1	+3.0 -3.0	± 0.7	2.2	2.1	2.2	0.0	1.5 1.6
13.6	125.38	556.0	561.5	581.7	+7.9 -5.9	+5.4 -6.1	+3.0 -3.0	± 0.7	2.2	2.1	2.2	0.0	1.5 1.6
13.6	125.60	552.8	558.7	579.8	+8.1 -5.9	+5.4 -6.1	+3.1 -3.1	± 0.7	2.2	2.1	2.2	0.0	1.5 1.7
13.6	126.00	548.2	553.2	573.8	+7.9 -6.0	+5.4 -6.1	+3.1 -3.1	± 0.7	2.2	2.1	2.2	0.0	1.5 1.7
14.0	124.60	608.6	614.7	636.2	+8.0 -5.9	+5.5 -6.2	+2.9 -2.9	± 0.6	2.2	2.1	2.2	0.0	1.5 1.6
14.0	125.00	603.2	609.2	632.3	+8.0 -5.9	+5.4 -6.1	+3.0 -3.0	± 0.6	2.2	2.1	2.2	0.0	1.5 1.6
14.0	125.09	601.7	607.7	628.9	+7.9 -6.0	+5.5 -6.2	+2.9 -2.9	± 0.6	2.2	2.1	2.2	0.0	1.5 1.6
14.0	125.38	598.4	603.0	628.2	+7.9 -6.0	+5.5 -6.1	+3.1 -3.1	± 0.6	2.2	2.1	2.2	0.0	1.5 1.6
14.0	125.60	595.6	600.0	623.8	+7.9 -6.0	+5.5 -6.1	+3.0 -3.0	± 0.6	2.2	2.1	2.2	0.0	1.5 1.6
14.0	126.00	589.5	595.2	616.6	+7.9 -6.0	+5.4 -6.1	+3.0 -3.0	± 0.7	2.2	2.1	2.2	0.0	1.5 1.6

Table 1: Predictions for the process $t\bar{t}H$.

**Slightly different scale setting for III;
combination TBD**

tH numbers (t/s-ch)

\sqrt{s} [TeV]	m_H [GeV]	σ [fb]	δ_μ	δ_{PDF}	δ_{α_s}
13.0	124.60	76.17	$^{+6.5}_{-15.0}$	1.8	1.2
13.0	125.00	76.04	$^{+6.4}_{-15.9}$	1.8	1.2
13.0	125.09	75.99	$^{+6.4}_{-16.1}$	1.8	1.2
13.0	125.38	75.79	$^{+6.4}_{-15.1}$	1.8	1.2
13.0	125.60	75.67	$^{+6.4}_{-15.8}$	1.8	1.2
13.0	126.00	75.53	$^{+6.4}_{-15.5}$	1.8	1.2
13.6	124.60	85.79	$^{+6.4}_{-16.4}$	1.7	1.2
13.6	125.00	85.38	$^{+6.4}_{-15.5}$	1.7	1.2
13.6	125.09	85.34	$^{+6.3}_{-15.5}$	1.7	1.2
13.6	125.38	85.10	$^{+6.3}_{-15.6}$	1.7	1.2
13.6	125.60	85.00	$^{+6.3}_{-16.0}$	1.7	1.2
13.6	126.00	84.86	$^{+6.3}_{-15.8}$	1.7	1.2
14.0	124.60	92.22	$^{+6.3}_{-15.8}$	1.7	1.2
14.0	125.00	92.02	$^{+6.3}_{-15.0}$	1.7	1.2
14.0	125.09	91.89	$^{+6.3}_{-14.9}$	1.7	1.2
14.0	125.38	91.72	$^{+6.3}_{-16.2}$	1.7	1.2
14.0	125.60	91.75	$^{+6.3}_{-16.0}$	1.7	1.2
14.0	126.00	91.32	$^{+6.3}_{-15.4}$	1.7	1.2

Table 2: Predictions for the process $tH + \bar{t}H$, t -channel.

\sqrt{s} [TeV]	m_H [GeV]	σ [fb]	δ_μ	δ_{PDF}	δ_{α_s}
13.0	124.60	2.95	$^{+2.4}_{-1.9}$	2.4	0.2
13.0	125.00	2.93	$^{+2.4}_{-1.9}$	2.4	0.2
13.0	125.09	2.92	$^{+2.4}_{-1.8}$	2.4	0.2
13.0	125.38	2.90	$^{+2.4}_{-1.9}$	2.4	0.2
13.0	125.60	2.89	$^{+2.4}_{-1.8}$	2.4	0.2
13.0	126.00	2.87	$^{+2.5}_{-1.9}$	2.4	0.2
13.6	124.60	3.18	$^{+2.4}_{-1.8}$	2.3	0.2
13.6	125.00	3.15	$^{+2.4}_{-1.8}$	2.3	0.2
13.6	125.09	3.14	$^{+2.4}_{-1.8}$	2.3	0.2
13.6	125.38	3.13	$^{+2.4}_{-1.8}$	2.3	0.2
13.6	125.60	3.12	$^{+2.4}_{-1.8}$	2.3	0.2
13.6	126.00	3.10	$^{+2.4}_{-1.8}$	2.3	0.2
14.0	124.60	3.33	$^{+2.4}_{-1.8}$	2.3	0.3
14.0	125.00	3.30	$^{+2.4}_{-1.8}$	2.3	0.3
14.0	125.09	3.30	$^{+2.4}_{-1.8}$	2.3	0.3
14.0	125.38	3.29	$^{+2.4}_{-1.8}$	2.3	0.3
14.0	125.60	3.27	$^{+2.4}_{-1.8}$	2.3	0.3
14.0	126.00	3.24	$^{+2.4}_{-1.8}$	2.3	0.3

Table 5: Predictions for the process $tH + \bar{t}H$, s -channel.

Numbers available also for tH and txH separately



$t\bar{t}WH$ numbers

\sqrt{s} [TeV]	m_H [GeV]	σ [fb]	δ_μ	δ_{PDF}	δ_{α_s}
13.0	124.60	15.52	$+4.6$ -6.2	3.1	2.3
13.0	125.00	15.47	$+4.6$ -6.1	3.1	2.3
13.0	125.09	15.41	$+4.6$ -6.2	3.1	2.2
13.0	125.38	15.29	$+4.7$ -6.3	3.1	2.3
13.0	125.60	15.13	$+4.8$ -6.6	3.1	2.3
13.0	126.00	15.06	$+4.7$ -6.4	3.1	2.3
13.6	124.60	17.54	$+4.6$ -6.3	3.0	2.2
13.6	125.00	17.40	$+4.7$ -6.4	3.0	2.2
13.6	125.09	17.37	$+4.7$ -6.4	3.0	2.2
13.6	125.38	17.33	$+4.7$ -6.3	3.0	2.2
13.6	125.60	17.24	$+4.8$ -6.4	3.0	2.2
13.6	126.00	17.07	$+4.7$ -6.3	3.0	2.2
14.0	124.60	18.98	$+4.8$ -6.5	2.9	2.2
14.0	125.00	18.86	$+4.7$ -6.3	2.9	2.2
14.0	125.09	18.76	$+4.7$ -6.4	2.9	2.2
14.0	125.38	18.63	$+4.8$ -6.6	2.9	2.2
14.0	125.60	18.61	$+4.7$ -6.4	2.9	2.2
14.0	126.00	18.45	$+4.8$ -6.5	2.9	2.2

Table 8: Predictions for the process $tHW^- + \bar{t}HW^+$ (with DR2). The rate of each of the two processes taken alone is half of the rate of their sum.

