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Addendum

Addendum to 'Measurement of the $t\bar{t}$ production cross-section using $e\mu$ events with b-tagged jets in pp collisions at $\sqrt{s} = 7$ and 8 TeV with the ATLAS detector'

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Abstract The ATLAS measurement of the inclusive top quark pair ($t\bar{t}$) cross-section $\sigma_{t\bar{t}}$ in proton–proton collisions at $\sqrt{s} = 8$ TeV has been updated using the final 2012 luminosity calibration. The updated cross-section result is:

$$\sigma_{t\bar{t}} = 242.9 \pm 1.7 \pm 5.5 \pm 5.1 \pm 4.2\,\text{pb},$$

where the four uncertainties arise from data statistics, experimental and theoretical systematic effects, knowledge of the integrated luminosity and of the LHC beam energy. The result is consistent with theoretical QCD calculations at next-to-next-to-leading order. The measurement of the ratio of $t\bar{t}$ cross-sections at $\sqrt{s} = 8$ TeV and $\sqrt{s} = 7$ TeV, and the $\sqrt{s} = 8$ TeV fiducial measurement corresponding to the experimental acceptance of the leptons, have also been updated.

The most precise measurement of the $t\bar{t}$ cross-section ($\sigma_{t\bar{t}}$) in proton–proton collisions at $\sqrt{s} = 8$ TeV from the ATLAS Collaboration was made using events with an opposite-charge electron–muon pair and one or two b-tagged jets [1], and used a preliminary calibration of the integrated luminosity. The luminosity calibration has been finalised since [2] with a total uncertainty of 1.9%, corresponding to a substantial improvement on the previous uncertainty of 2.8%. Since the uncertainty on the integrated luminosity contributed 3.1% of the total 4.3% uncertainty on the $\sigma_{t\bar{t}}$ measurement reported in [1], a significant improvement in the measurement is possible by using the new luminosity calibration, as documented in this Addendum.

The new calibration corresponds to an integrated luminosity of 20.2 fb^{-1} for the $\sqrt{s} = 8$ TeV sample, a decrease of 0.2%. The cross-section was recomputed taking into account the effects on both the conversion of the $t\bar{t}$ event yield to a cross-section, and the background estimates, giving a result of:

$$\sigma_{t\bar{t}} = 242.9 \pm 1.7 \pm 5.5 \pm 5.1 \pm 4.2\,\text{pb},$$

where the four uncertainties arise from data statistics, experimental and theoretical systematic effects, knowledge of the integrated luminosity, and of the LHC beam energy, giving a total uncertainty of 8.8 pb (3.6%). The result is consistent with the theoretical prediction of $252.9^{+13.3}_{-14.5}$ pb, calculated at next-to-next-to-leading-order with next-to-next-to-leading-logarithmic soft gluon terms with the `top++ 2.0` program [3] as discussed in detail in Ref. [1].

The updated value of the ratio of cross-sections $R_{t\bar{t}} = \sigma_{t\bar{t}}(8\text{ TeV})/\sigma_{t\bar{t}}(7\text{ TeV})$ is:

$$R_{t\bar{t}} = 1.328 \pm 0.024 \pm 0.015 \pm 0.038 \pm 0.001,$$

with uncertainties defined as above, adding in quadrature to a total of 0.047. The largest uncertainty comes from the uncertainties on the integrated luminosities, considered to be uncorrelated between the $\sqrt{s} = 7$ TeV and $\sqrt{s} = 8$ TeV datasets. This result is 2.1σ below the expectation of 1.430 ± 0.013 calculated from `top++ 2.0` as discussed in Ref. [1].

The updated fiducial cross-sections, for a $t\bar{t}$ decay producing an $e\mu$ pair within a given fiducial region, are shown in Table 1, updating Table 5 of Ref. [1]. The results are given both for the analysis requirements of $p_{\text{T}} > 25$ GeV and $|\eta| < 2.5$ for both leptons, and for a reduced acceptance of $p_{\text{T}} > 30$ GeV and $|\eta| < 2.4$. They are given separately for the two cases where events with either one or both leptons coming from $t \to W \to \tau \to \ell$ rather than the direct decay $t \to W \to \ell$ ($\ell = e$ or μ) are included, or where the contributions involving τ decays are subtracted. The results shown for the $\sqrt{s} = 7$ TeV data sample are unchanged with respect to those in Ref. [1]. The results for the top quark pole mass and limits on light supersymmetric top squarks presented in Ref. [1] are derived from $\sqrt{s} = 7$ TeV and $\sqrt{s} = 8$ TeV cross-section measurements taken together, and would be only slightly improved by the luminosity update described here.

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Table 1 Fiducial cross-section measurement results at $\sqrt{s} = 7$ TeV and $\sqrt{s} = 8$ TeV, for different requirements on the minimum lepton p_{T} and maximum lepton $|\eta|$, and with or without the inclusion of leptons from $W \to \tau \to \ell$ decays, with the final 2012 luminosity calibration. In each case, the first uncertainty is statistical, the second due to analysis systematic effects, the third due to the integrated luminosity and the fourth due to the LHC beam energy

p_{T}^{ℓ} (GeV)	$\lvert\eta^{\ell}\rvert$	$W \to \tau \to \ell$	$\sqrt{s} = 7$ TeV (pb)	$\sqrt{s} = 8$ TeV (pb)
>25	<2.5	Yes	$2.615 \pm 0.044 \pm 0.056 \pm 0.052 \pm 0.047$	$3.455 \pm 0.025 \pm 0.070 \pm 0.073 \pm 0.059$
>25	<2.5	No	$2.305 \pm 0.039 \pm 0.049 \pm 0.046 \pm 0.041$	$3.043 \pm 0.022 \pm 0.061 \pm 0.064 \pm 0.052$
>30	<2.4	Yes	$2.029 \pm 0.034 \pm 0.043 \pm 0.040 \pm 0.036$	$2.667 \pm 0.019 \pm 0.054 \pm 0.056 \pm 0.046$
>30	<2.4	No	$1.817 \pm 0.031 \pm 0.039 \pm 0.036 \pm 0.033$	$2.385 \pm 0.017 \pm 0.048 \pm 0.050 \pm 0.041$

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