

# Measurement of the $t\bar{t}$ production cross-section

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# Event selection

## Dilepton preselection

- $e\mu$  channel.
- Muon selection:
  - Tight muons (POG)
  - $p_T > 20.0\text{GeV}$
- Electron selection:
  - Tight electron (POG)
  - $p_T > 20.0\text{GeV}$

## Jet selection

- No direct constrain is applied to the number of jets in the event.
- Events are required to have 1 or 2 b-tagged jets ( $E_T > 30.0\text{GeV}$ ).

# Calculation of the cross-section

$$N_1 = L\sigma_{t\bar{t}}\epsilon_{e\mu}\epsilon_b(1 - C_b\epsilon_b) + N_1^{bkg} \quad (1)$$

$$N_2 = L\sigma_{t\bar{t}}\epsilon_{e\mu}\epsilon_b^2 + N_2^{bkg} \quad (2)$$

- $N_1$  ( $N_2$ ): number of events with one (two) b-jets.
- $N_1^{bkg}$  ( $N_2^{bkg}$ ): number of background events with one (two) b-jets.
- $\epsilon_{e\mu}$ : efficiency for a  $t\bar{t}$  event to pass the  $e\mu$  preselection.
- $\epsilon_b$ : b-tagging efficiency.
- $C_b = \epsilon_{bb}/\epsilon_b^2$ , being  $\epsilon_{bb}$  the probability of b-tagging both b-jets.

## Estimation of parameters

- $N_1^{bkg}$ ,  $N_2^{bkg}$  and  $\epsilon_{e\mu}$  are estimated with MC and DD techniques
- $C_b$  is estimated using MC and

$$C_b = \frac{4N_{e\mu}^{t\bar{t}} N_2^{t\bar{t}}}{(N_1^{t\bar{t}} + 2N_2^{t\bar{t}})^2} \quad (3)$$

where:

- $N_{e\mu}^{t\bar{t}}$  is the number of  $t\bar{t}$  events passing the  $e\mu$  preselection.
- $N_1^{t\bar{t}}$  ( $N_2^{t\bar{t}}$ ) is the number of  $t\bar{t}$  passing the  $e\mu$  with one (two) b-tagged jets.

## Cross-section/B-tag efficiency

$\sigma_{t\bar{t}}$  and  $\epsilon_b$  can be obtained combining (1) and (2)

## Data-driven

- Non W/Z leptons and DY background estimated with DD techniques as in the C&C analysis
- Other background sources are estimated using MC samples

	$N_1$	$N_2$
Data	24231	10023
Signal	21290	9312
Stop	2018	246
DY	302	15
Rare	195	84
Non W/Z	237	33
Diboson	163	8

## Cross-section estimation

$$\sigma_{t\bar{t}} = 245.62 \pm 9.20 \text{ (sys.)} \pm 6.56 \text{ (lumi.)} \pm 1.89 \text{ (stat.) (pb)}$$

# Systematics estimation

Source	$\Delta\sigma_{t\bar{t}}[pb(\%)]$
Trigger Efficiencies	2.49 ( 1.0 %)
Lepton Energy Scale	0.33 ( 0.1 %)
Lepton Efficiencies	3.56 ( 1.4 %)
Jet Energy Scale	0.67 ( 0.3 %)
Jet Energy Resolution	0.39 ( 0.2 %)
Single top modelling (MC) ( 30 % ) / ( 30 % ) <sup>1</sup>	7.47 ( 3.0 %)
Single top modelling (MC) ( 5 % ) / ( 20 % ) (ATLAS) <sup>2</sup>	1.28 (0.5 %)
DY modelling (DD) ( 15 % ) / ( 15 %)	0.55 ( 0.2 %)
Rare modelling (MC) ( 30 % ) / ( 30 %)	0.74 ( 0.3 %)
Non W/Z (DD) ( 30 % ) / ( 30 %)	0.87 ( 0.4 %)
Diboson modelling (MC) ( 20 % ) / ( 20 %)	0.40 ( 0.2 %)
B-tagging	1.10 ( 0.4 %)
Mis-tagging	0.25 ( 0.1 %)
Pile-up	0.19 ( 0.1 %)
Top Pt	0.25 ( 0.1 %)
Matching partons	0.93 ( 0.4 %)
QCD Scale	2.64 ( 1.1 %)
PDF Uncertainty	2.68 ( 1.1 %)
Total systematics	9.20 ( 3.7 %)
Lumi	6.56 ( 2.7 %)
Statistical	1.89 ( 0.8 %)
Total uncertainty	11.46 ( 4.7 %)

<sup>1</sup>Uncertainty in each b-tag bin

<sup>2</sup>ATLAS's uncertainty (not propagated)