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

Laurynas Mince on behalf of the ATLAS collaboration

14th International Workshop on Top-Quark Physics

15/09/2021

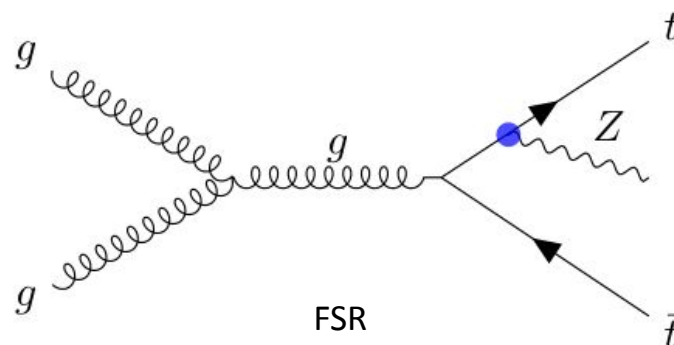
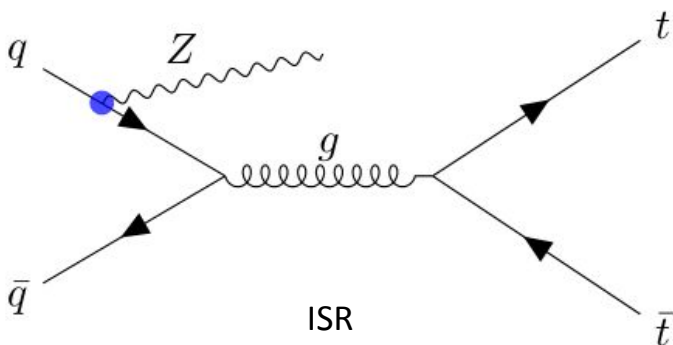
The **first inclusive measurement** of the **ttZ process** using **full Run 2 data** with  $\mathcal{L} = 139 \text{ fb}^{-1}$ .

[Eur. Phys. J. C 81 \(2021\) 737](#)

Differential measurements  
presented by Dominik @ [YSF](#).

- A **rare SM process** produced at the LHC.
- A direct probe of the **top-quark coupling to the Z boson**.
- An **irreducible background** in **BSM searches** and measurements of **SM processes with multi-lepton final states**.

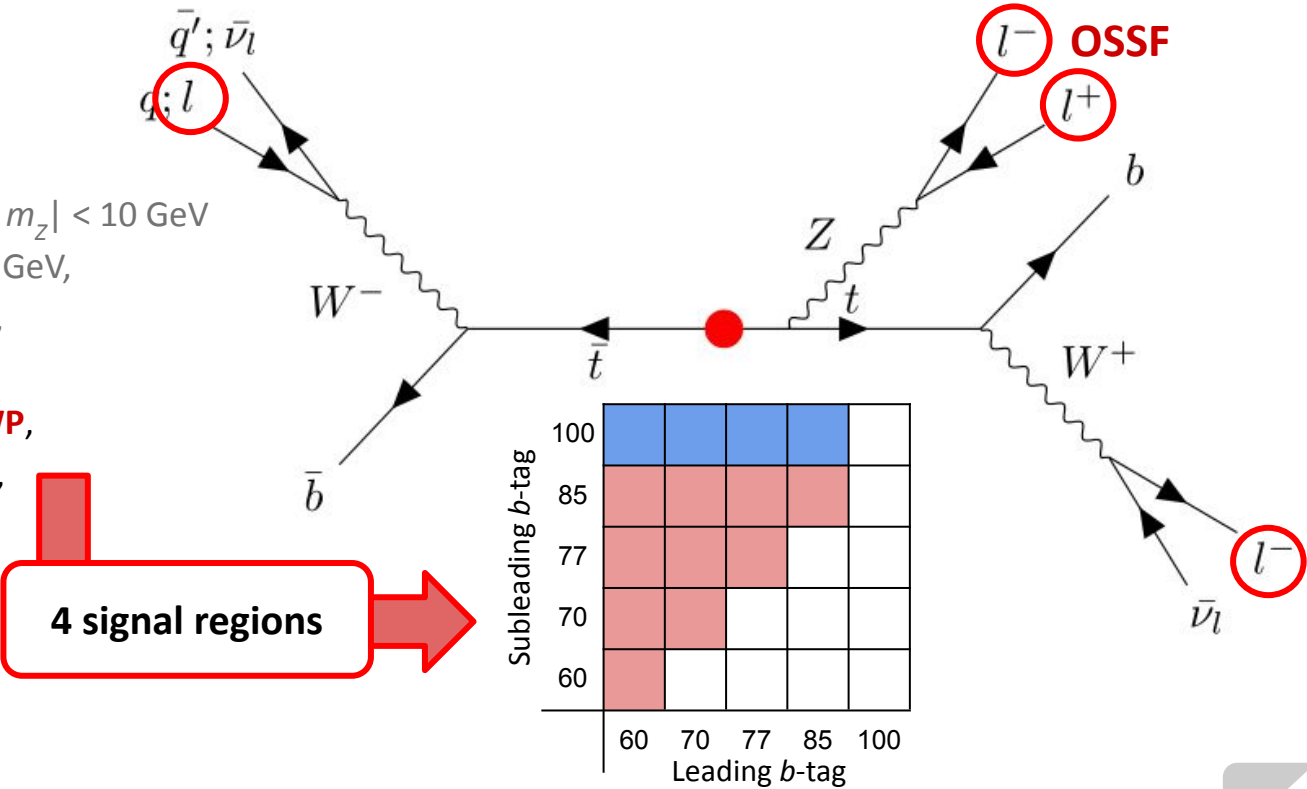
A **top-quark-antiquark pair** is produced **in association with a Z boson** from the **initial or final state radiation**.



Final states with **three (3 $\ell$ )** or **four (4 $\ell$ )** isolated leptons (e or  $\mu$ ) are considered in the analysis.

**4 $\ell$**

- = 4 leptons (e or  $\mu$ )
- $\geq 1$  OSSF lepton pair with  $|m_{\ell\ell} - m_Z| < 10$  GeV
- $\nabla$  OSSF lepton pairs  $m_{\text{OSSF}} > 10$  GeV,
- $p_T(\ell_1, \ell_2, \ell_3, \ell_4) > 27, 20, 10, 7$  GeV,
- $N_{\text{jets}} \geq 2$ ,
- $N_{b\text{-jets}} = 1$  or  $\geq 2$  @ 85%  $b$ -tag WP,
- **Non-Z lepton flavours, SF & DF,**
- $E_T^{\text{miss}}$  cuts to reduce the ZZ+jets background.

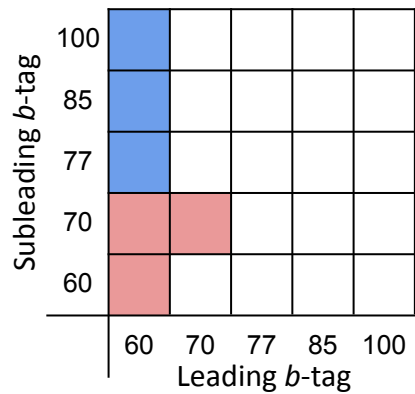
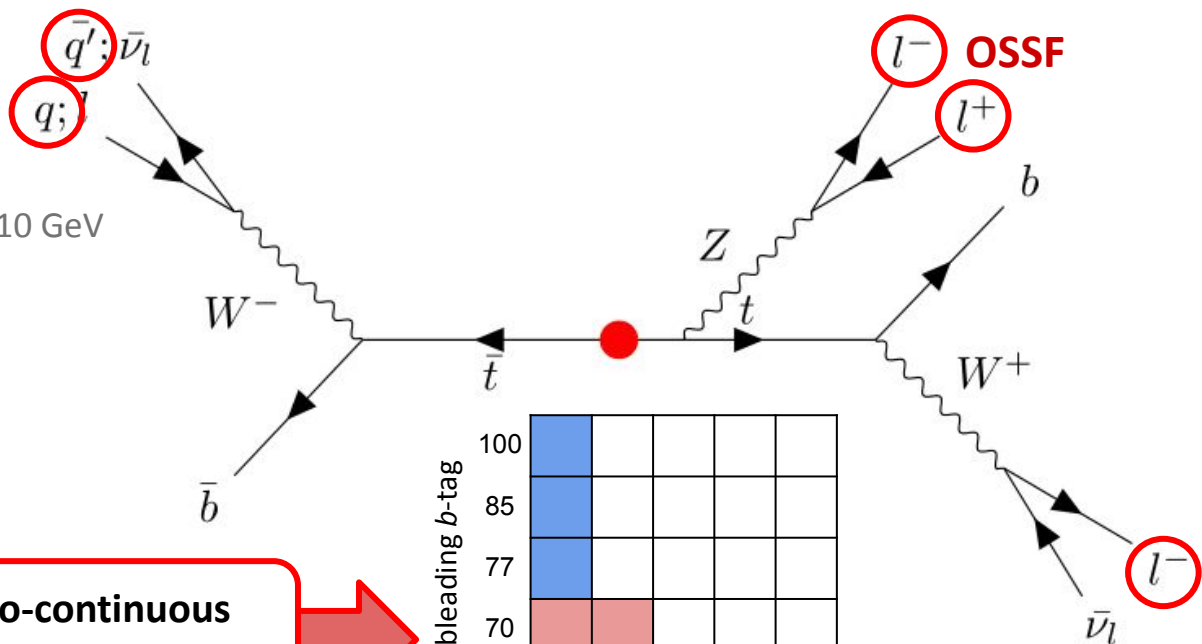


Final states with **three (3 $\ell$ )** or **four (4 $\ell$ )** isolated leptons (e or  $\mu$ ) are considered in the analysis.

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- $\nabla$  OSSF lepton pairs  $m_{\text{OSSF}} > 10$  GeV,
- $p_T(\ell_1, \ell_2, \ell_3) > 27, 20, 20$  GeV,
- $N_{\text{jets}} \geq 4$  if  $N_{b\text{-jets}} \geq 1$  @ 60% b-tag WP
- $N_{\text{jets}} \geq 3$  if  $N_{b\text{-jets}} \geq 2$  @ 70% b-tag WP.

**Pseudo-continuous b-tagging**



The **measured inclusive cross-section** is in **good agreement** with the **SM theory predictions**.

**NLO + NNLL SM prediction:**

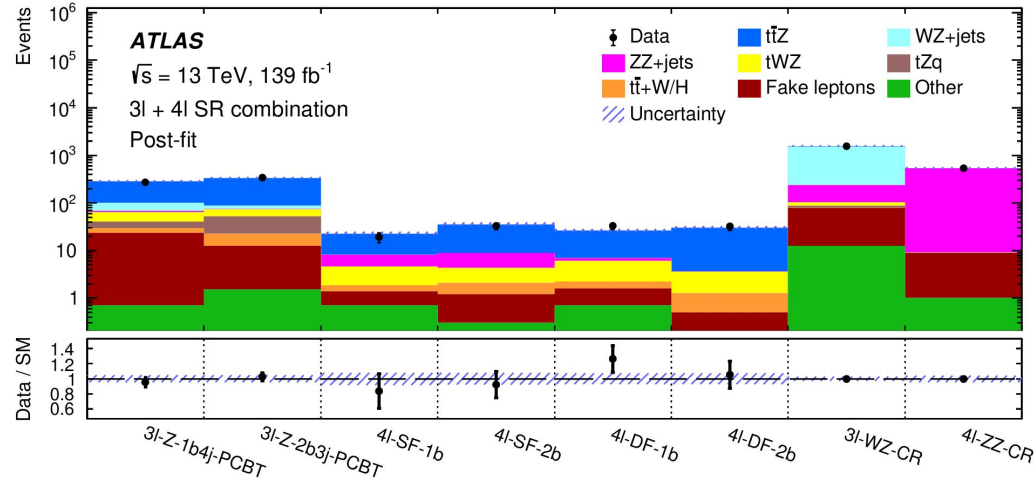
$$\sigma_{t\bar{t}Z}^{\text{SM}} = 0.86_{-0.08}^{+0.07}(\text{scale}) \pm 0.02(\text{PDF}) \text{ pb}$$

**Profile-likelihood fits w.r.t. the NLO (QCD+EW) SM prediction:**

Channel	$\mu_{t\bar{t}Z}$	$\frac{\sigma_{\text{obs}}}{\sigma_{\text{SM}}}$
Trilepton	$1.17 \pm 0.07$ (stat.)	$+0.12$ (syst.) $-0.11$
Tetralepton	$1.21 \pm 0.15$ (stat.)	$+0.11$ (syst.) $-0.10$
<b>Combination (3l + 4l)</b>	<b><math>1.19 \pm 0.06</math> (stat.)</b>	<b><math>\pm 0.10</math> (syst.)</b>

↑ Simultaneous fit to the **6 SRs & 2 CRs** is used to extract the **cross-section**

$$\sigma(pp \rightarrow t\bar{t}Z) = 0.99 \pm 0.05 \text{ (stat.)} \pm 0.08 \text{ (syst.) pb}$$



**Dominant sources of systematic uncertainty:**

1. **ttZ parton-shower modelling,**
2. **tWZ modelling,**
3. **Jet flavour-tagging.**

The **measured inclusive cross-section** is in **good agreement**  
with the **SM theory predictions**.

- The full Run 2  $pp$  collisions at  $\sqrt{s} = 13$  TeV data set collected by the ATLAS detector.
- Only final states with three or four isolated leptons.

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- The dominant sources of systematic uncertainty:
  - ttZ parton-shower modelling,
  - tWZ background modelling,
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**Thank you for the attention!**