tW production in run 2 of the LHC with ATLAS

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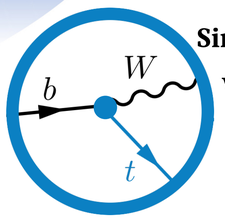
Two measurements of *tW* production in the **dilepton** channel are presented using **13 TeV** ATLAS pp collisions



Single top production is a **weak** process (cf. top pair)

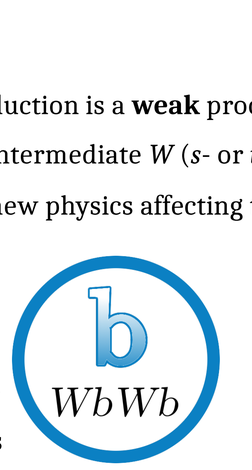
Virtual/real intermediate *W* (*s*- or *t*-chnanel) or *tW*

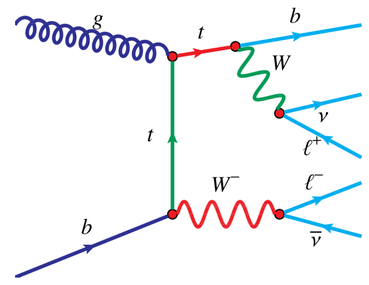
Sensitive to new physics affecting the *tWb* vertex, $|V_{tb}|$

tW at NLO and $t\bar{t}$ at LO interfere in 5-flavour scheme

Full picture: a unified *WbWb* process in 4-flavour scheme

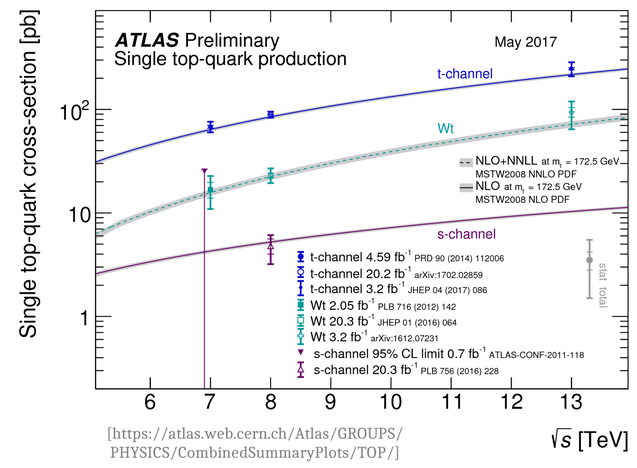
Modelling of the interference is important, e.g. in searches





tW dilepton channel

- Cleaner channel with less jet activity
- Kinematically under-constrained; difficult to reconstruct the *tW* system



[https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/CombinedSummaryPlots/TOP/]

Differential *tW*

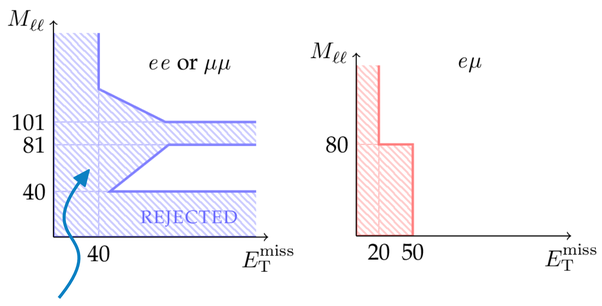
36.1 fb^{-1} (2015-2016)

[Eur. Phys. J. C 78 (2018) 186]

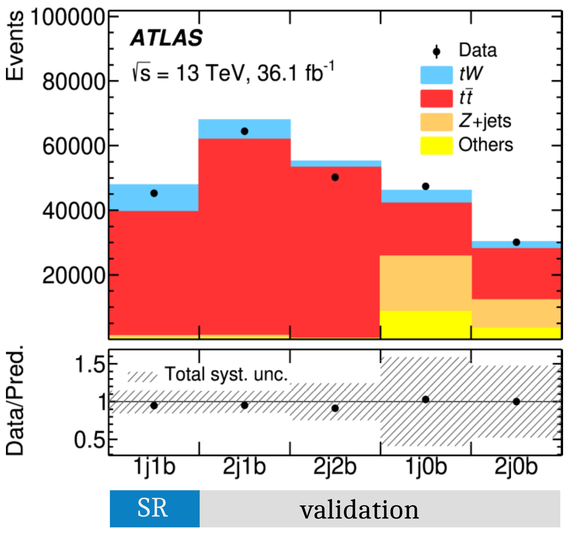
First differential measurements of *tW* production at ATLAS

Event selection

single ℓ trigger	high-p_T, isolated
at least 1 anti-k_t jet	$p_T > 25$ GeV, $\|\eta\| < 2.5$, $R = 0.4$
exactly 2 OS ℓ	$p_T > 20$ GeV, $\|\eta\| < 2.5$
at least 1 high-p_T ℓ	$p_T > 27$ GeV



Veto the *Z* mass peak and *Z*-enriched region

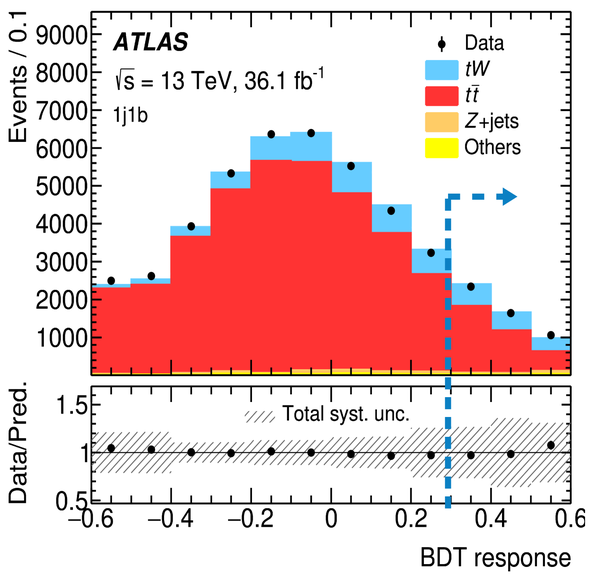


Only 1j1b SR used in the measurement

1j1b = 1 jet of which 1 is *b*-tagged, etc.

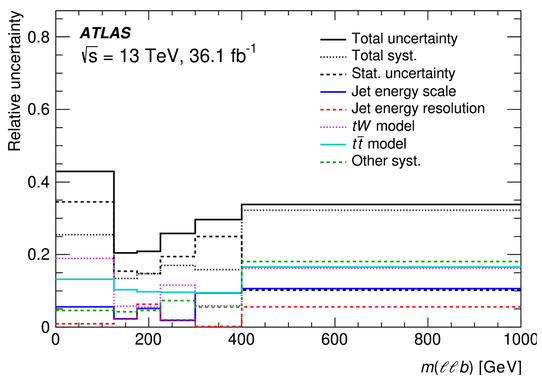
Background separation

- **Boosted decision trees** (BDTs) trained to separate *tW* signal from $t\bar{t}$ background
- A cut on the response is used to isolate a ***tW*-enriched sample**
- S/B ~0.5 after BDT cut



Uncertainties

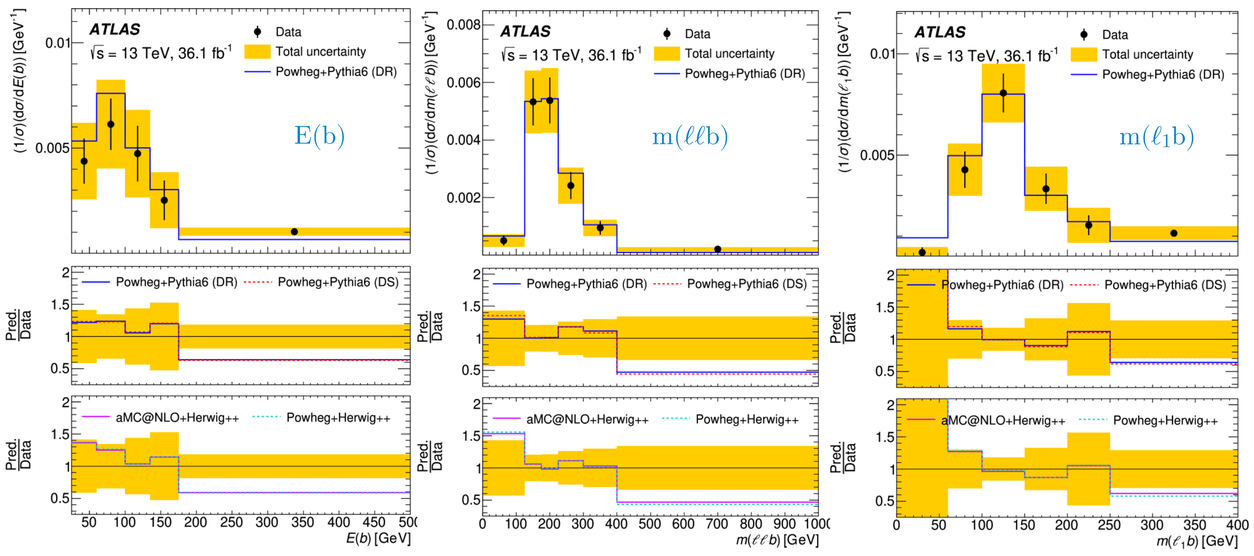
- Some **cancellation** of systematics by normalising the cross-sections
- **Statistical and modelling** uncertainties important in many bins



Correcting for detector effects

- Background-subtracted data are **unfolded to particle level**
- Defined in terms of **stable particles**:
  - Leptons are dressed by nearby photons
  - Remaining particles clustered into jets (*b*-tagging via ghost matching)

Results



tWb interference analysis

36.1 fb^{-1} (2015-2016)

[arXiv:1806.04667, accepted by PRL]

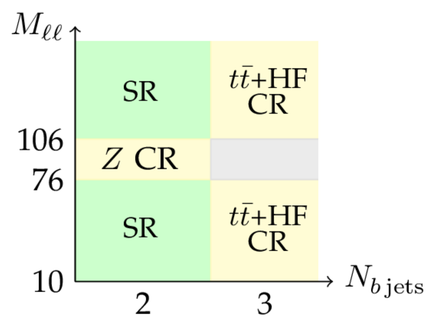
First comparison of ATLAS data to full *WbWb* theoretical predictions

Event selection

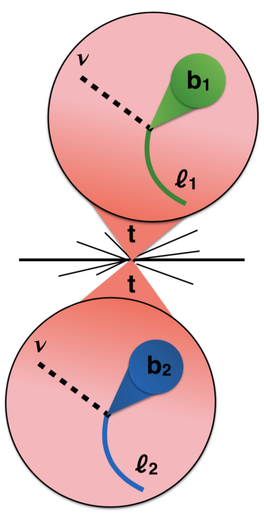
single ℓ trigger	high-p_T, isolated
≥ 2 anti-k_t *b*-jets	$p_T > 25$ GeV, $\|\eta\| < 2.5$, $R = 0.4$
exactly 2 OS ℓ	$p_T > 28$ GeV, $\|\eta\| < 2.5$
veto if any further loose *b*-jet	85% vs 60% eff.

Control regions for major backgrounds

- Use the *Z*-mass for same flavour leptons pairs as a **Z+jets** control region
- Use region with extra b-tagged jet to control for **top-pair plus heavy flavour**



Exploiting *tW* kinematics



2 ways to pair objects:

$m(b_1,\ell_1) \equiv A$ $m(b_2,\ell_2) \equiv a$ WLOG: A>a

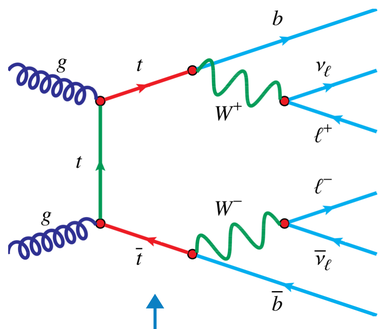
$m(b_1,\ell_2) \equiv B$ $m(b_2,\ell_1) \equiv b$ WLOG: B>b

min-max $m_{bl} \equiv \min(A,B)$

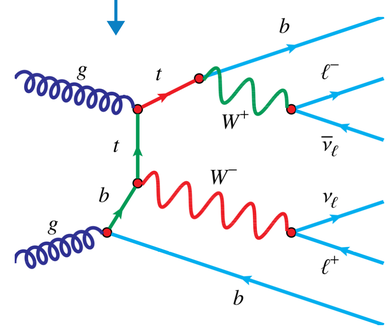
Single variable differential analysis in **maximally interfering** kinematic region

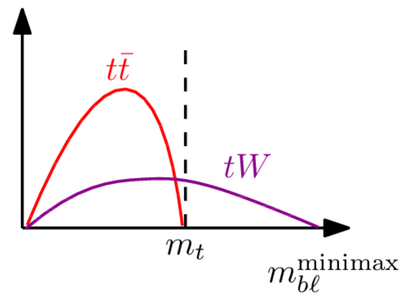
Defining the *tW* process

- Diagram Removal (**DR**) family: remove pure A_{2t} term (DR2) or both A_{2t} terms (DR1)
- Diagram Subtraction (**DS**) family: introduce a gauge-invariant subtraction term
- Both are workarounds attempting to define *tW* as a distinct process
- bb4l: full resonance-aware NLO calculation

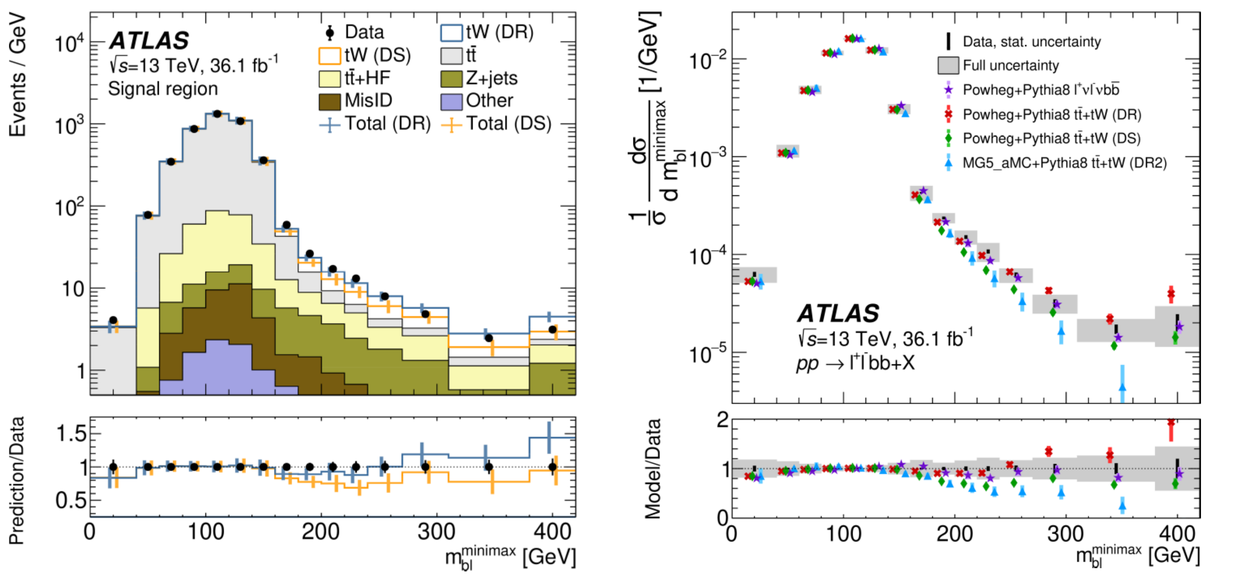


$$|\mathcal{A}_{tWb}|^2 = |\mathcal{A}_{2t}|^2 + |\mathcal{A}_{1t}|^2 + 2\mathrm{Re}(\mathcal{A}_{1t}\mathcal{A}^*_{2t})$$





Results



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