High-purity ttW measurement feasibility study

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This is a simple feasibility study for measuring ttW production in a high-purity (but low-branching) channel,

$$t\bar{t}W^{\pm} \to \ell^{\pm}\ell^{\pm}\ell'^{\mp}b\bar{b} + \text{neutrinos}$$

Strategy

Estimate the yields after a simple signal selection using MC for the known processes that can contribute without a misidentified lepton (including charge mismeasurement). Only MC16e samples are run (corresponding to 2018 data) to speed things up, although the other subcampaigns can be added quite quickly.

`AnalysisTop 21.2.90` is used.

Event selection

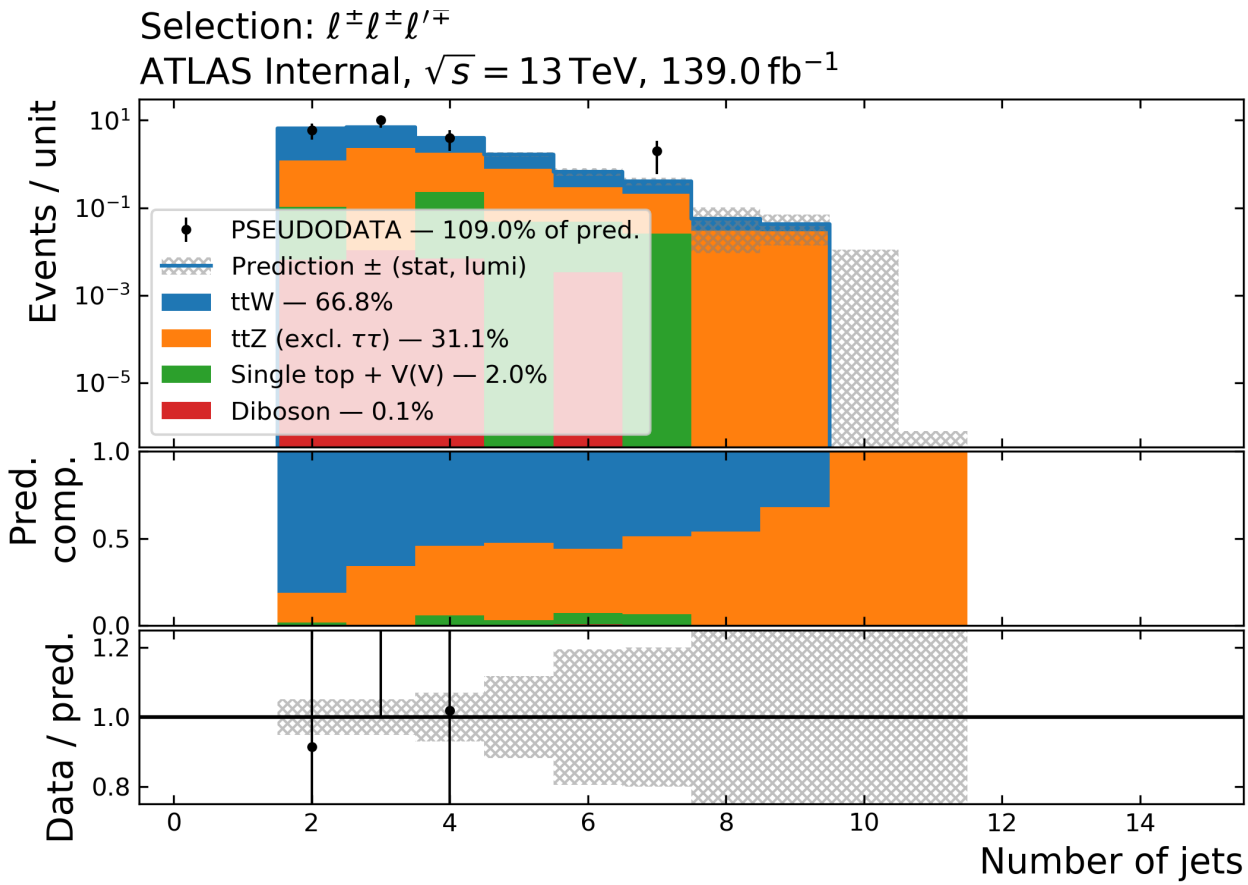
- Exactly two tight leptons with $p_{\mathrm{T}} > 27$ GeV of the same flavour (e or μ) with the same charge ($\pm$)
- Exactly one tight lepton with $p_{\mathrm{T}} > 27$ GeV of the other flavour (μ or e) with the opposite charge ($\mp$)
- Two or more jets with $p_{\mathrm{T}} > 27$ GeV
- Both jets b-tagged (77% efficiency working point)

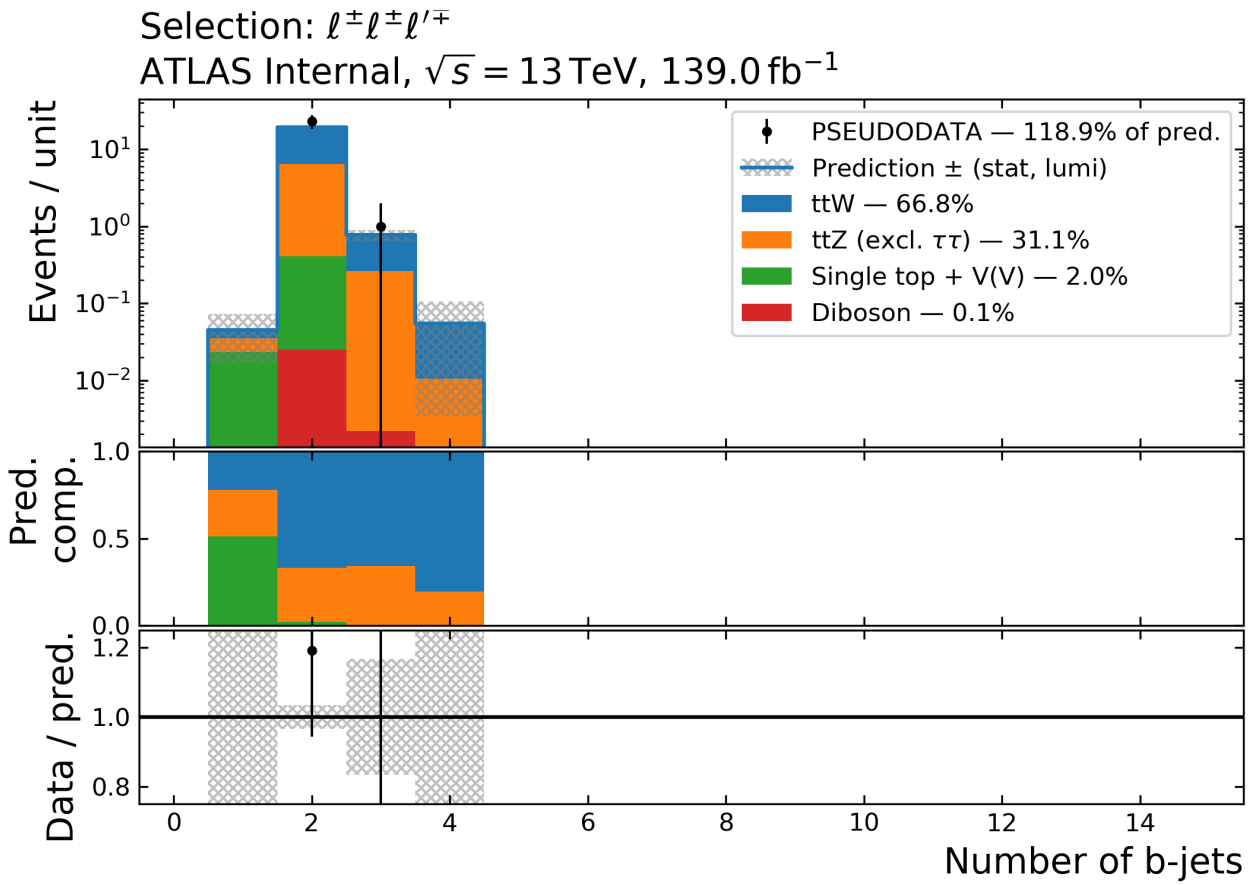
There is no requirement on jets. This has the advantage of keeping the experimental uncertainties much smaller.

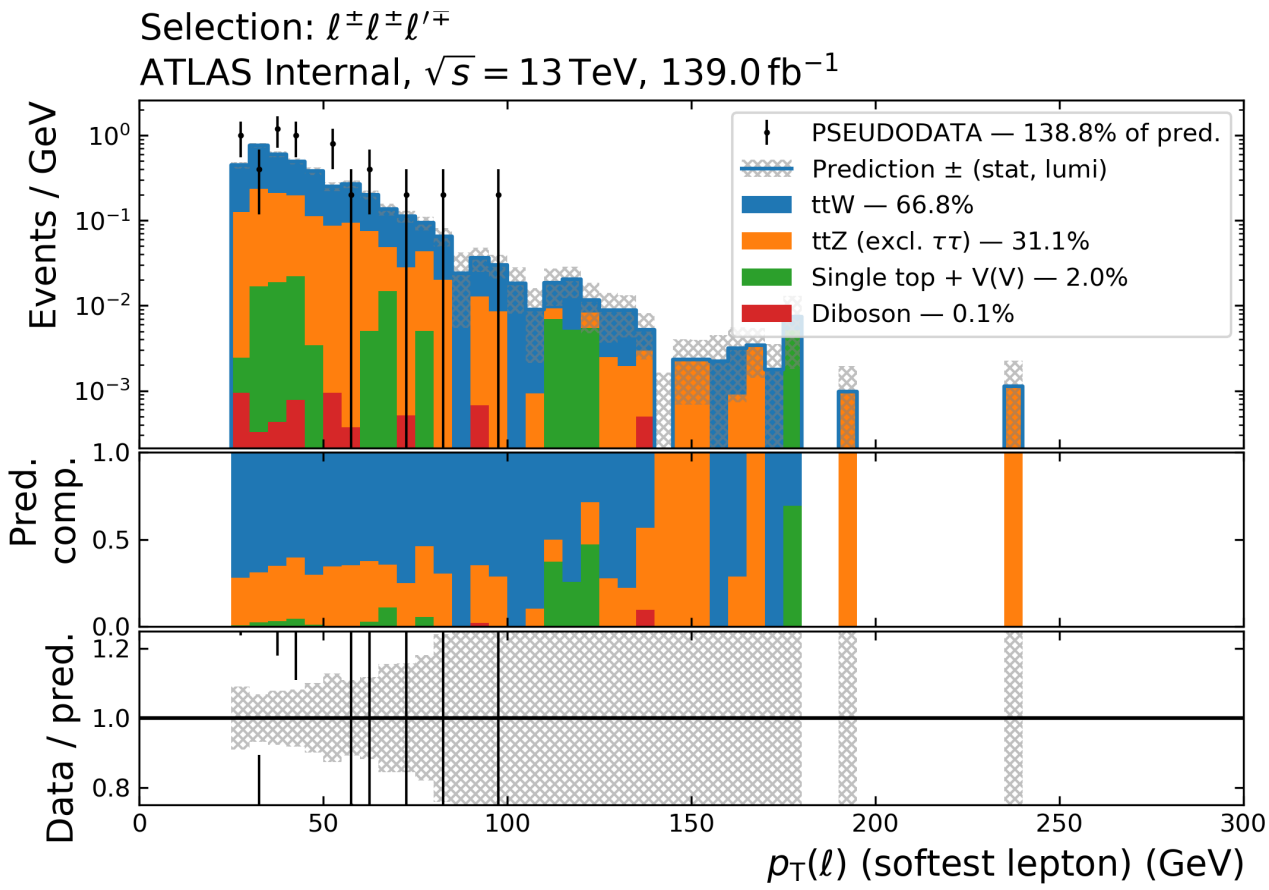
Results

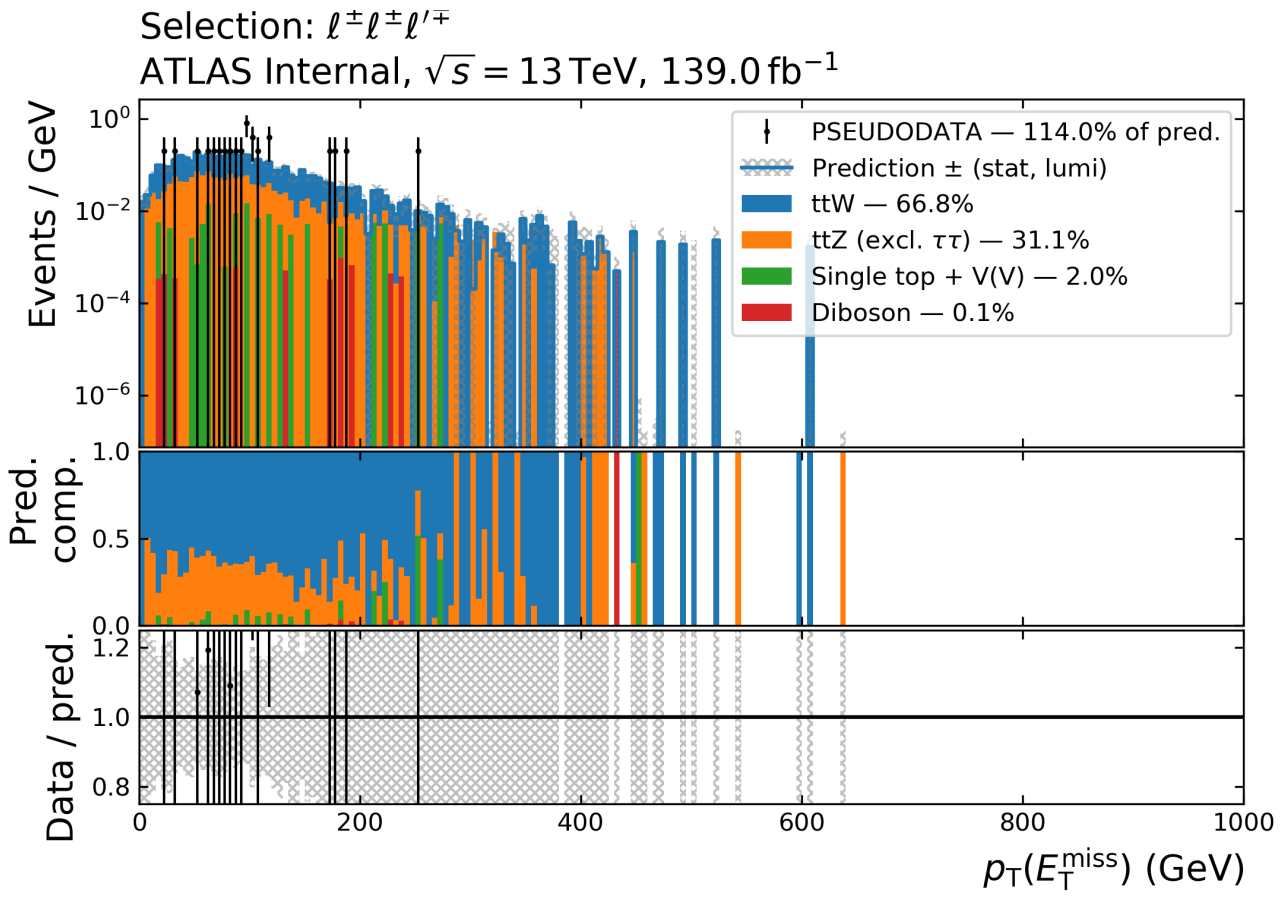
Here are yields predictions and some kinematic distributions, scaled to the total Run 2 luminosity.

Sample	Selection: $\mu^{\pm}\mu^{\pm}e^{\mp}$	Selection: $e^{\pm}e^{\pm}\mu^{\mp}$	Both channels
Total prediction	10.45 ± 0.43	9.7 ± 0.41	20.15 ± 0.59
ttW	7.46 ± 0.35	6.02 ± 0.33	13.48 ± 0.48
ttZ (excl. $\tau\tau$)	2.84 ± 0.19	3.44 ± 0.21	6.28 ± 0.29
Single top + V(V)	0.15 ± 0.13	0.25 ± 0.13	0.4 ± 0.18




Selection: $\ell^{\pm}\ell^{\pm}\ell'^{\mp}$
ATLAS Internal, $\sqrt{s} = 13\,\text{TeV}$, $139.0\,\text{fb}^{-1}$
PSEUDODATA — 118.9% of pred.
Prediction ± (stat, lumi)
ttW — 66.8%
ttZ (excl. ττ) — 31.1%
Single top + V(V) — 2.0%
Diboson — 0.1%
Events / unit
Pred. comp.
Data / pred.
Number of b-jets


Selection: $\ell^{\pm}\ell^{\pm}\ell'^{\mp}$
ATLAS Internal, $\sqrt{s} = 13\,\text{TeV}$, $139.0\,\text{fb}^{-1}$
PSEUDODATA — 138.8% of pred.
Prediction ± (stat, lumi)
ttW — 66.8%
ttZ (excl. ττ) — 31.1%
Single top + V(V) — 2.0%
Diboson — 0.1%
Events / GeV
Pred. comp.
Data / pred.
$p_{\text{T}}(\ell)$ (softest lepton) (GeV)



Discussion

Caveats

Need to add modelling of triboson processes (WWW!) and ttZ($\rightarrow \tau\tau$).

Selection optimisation

- The p_{T} distribution of the softest lepton suggests that not much signal acceptance can be gained by cutting looser on the lepton p_{T}. Still, should try looser cuts
- Probably should use much more loosely identified leptons to enhance the signal acceptance
- Could use charge ID tool to reject electrons with uncertain charge measurement (if the efficiency is high enough).
- Could loosen the cut on the number of b-jets to gain signal acceptance

Conclusion

With looser lepton and (b-)jet cuts, this region could be used for a relatively robust measurement modelling-wise with a large statistical uncertainty of less than 20%. The current selection reaches around 25%.