

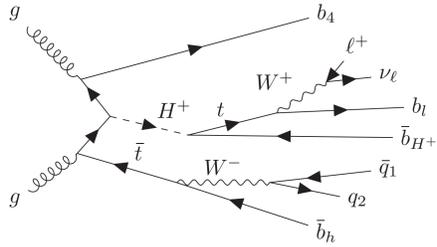
New results of the $H^+ \rightarrow tb$ search using full Run-2 data with the ATLAS detector



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Motivation

- Charged Higgs Bosons predicted by several BSM theories like 2HDM and MSSM
- These models predict 5 Higgs bosons: h, H, A, H^+, H^-
- Production depends on $m(H^+)$ and mixing angles α, β
- When $m(H^+) > m(t)$ dominant production is $pp \rightarrow tbH^+$
- Dominant decay $H^\pm \rightarrow tb$ for $m(H^\pm) > 200$ GeV

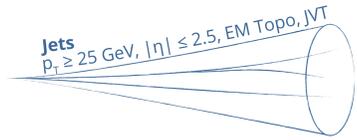


Analysis Overview

- Use LHC Run-2 139 fb⁻¹ pp collisions at $\sqrt{s} = 13$ TeV recorded with the ATLAS detector
- Search in the 200 - 2000 GeV mass range
- Focus on the single lepton final state
- Previous analysis with 36 fb⁻¹
[10.1007/JHEP11\(2018\)085](https://arxiv.org/abs/10.1007/JHEP11(2018)085)

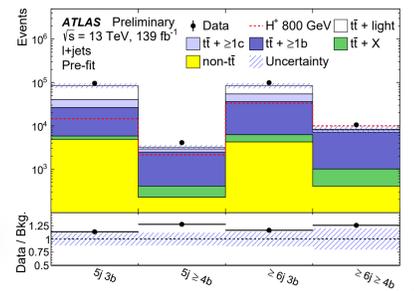
Object selection

Single lepton trigger: e^+ or μ^+ ≥ 5 jets, ≥ 2 b-tagged at 70% efficiency



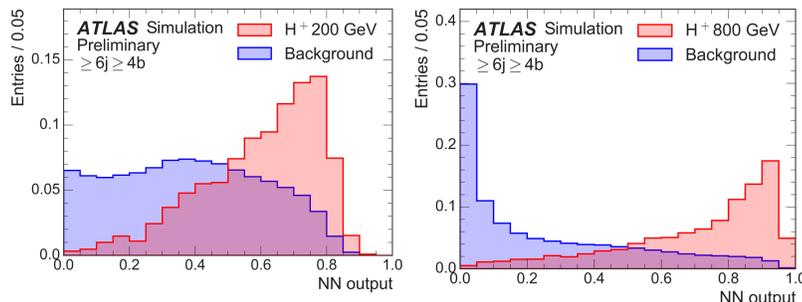
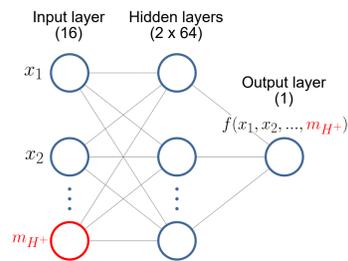
Event selection

- Select single lepton events (e^\pm, μ^\pm)
- Four signal regions (SR): 5j3b, 5j≥4b, ≥6j3b, ≥6j≥4b
- $t\bar{t}$ +jets main background
- Four regions to correct the $t\bar{t}$ +jets modelling by data-based reweighting: 5j2b, 6j2b, 7j2b, ≥8j2b



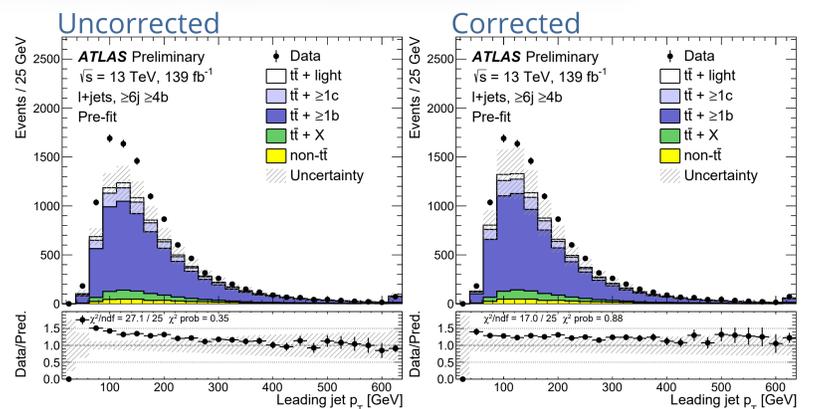
Mass-parameterised Neural Network

- Trained every signal region (SR) using 14-16 variables
 - H^+ mass as input parameter
 - All H^+ masses included in the training
- Mass-parameterisation allows to train with more statistics for signal and the possibility of evaluating intermediate mass points efficiently
- More S/B separation at higher masses



Correcting $t\bar{t}$ +jets MC

- Correct NN pre-fit distributions to mitigate $t\bar{t}$ +jets mismodelling
- Data/MC-based factors extracted from the 2b regions sequentially:
 1. Correct the 2b jet multiplicity distribution
 2. Correct the 2b H_T^{all} distribution for each jet multiplicity and fit to a curve
- Correction factors applied appropriately to the SRs



Fit results and exclusion limits

- Simultaneous binned profile likelihood fit to data in the four SR NN outputs
- One fit for each masspoint
- No significant signal observed
- Model independent $\sigma \times \text{BR}$ limits produced

- $\tan\beta$ exclusion limits considered for different benchmarks
 - hMSSM
 - $M_h^{125}, M_h^{125}(\tilde{\chi}), M_h^{125}(\tilde{\tau})$
- Exclusion limits improved especially at high H^+ masses
- Systematics-limited at low H^+ masses

