Identification of the Higgs boson produced in association with top quark pairs in proton–proton collisions: an analysis of the final state containing three leptons with the ATLAS detector

Valentina Vecchio, on behalf of the ATLAS collaboration

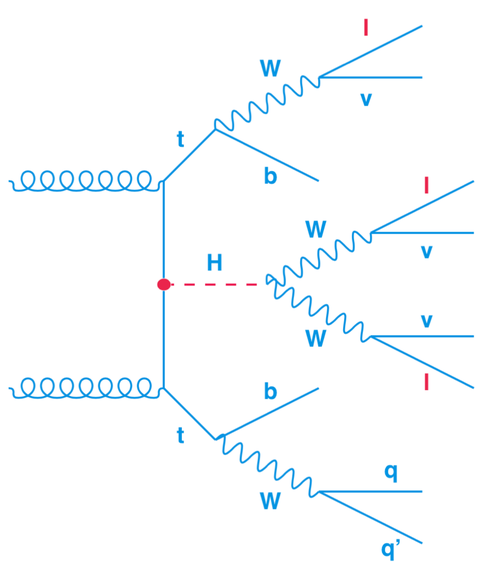
ATLAS
RUN II DATA
$\sqrt{s}$ = 13 TeV
Integrated $\mathcal{L}$ = 13.2 fb^{-1}

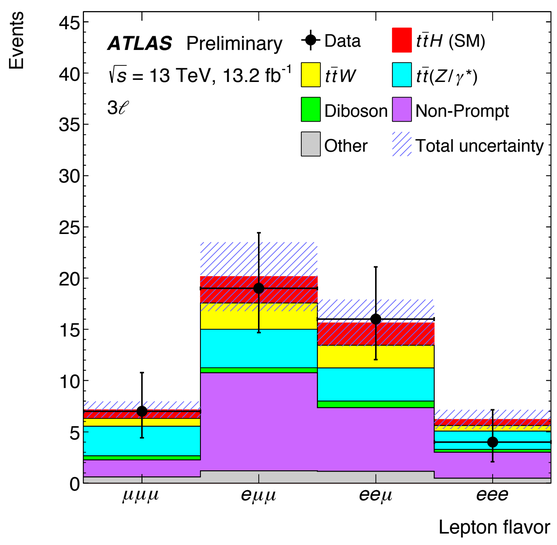
MOTIVATION

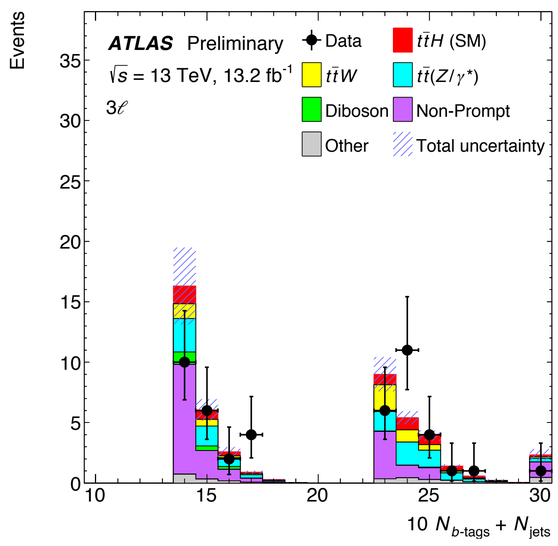
- The associated production of the Higgs boson with top quark pairs permits to measure directly the top Yukawa coupling
- The Higgs decaying in WW, ZZ and ττ make multi lepton analyses less sensitive to QCD modeling than H →bb
- The three lepton final state is mostly sensitive to the H → WW* decay (74% from simulation)
- Results are combined with the other multilepton channel considered by ATLAS

EVENT SELECTION

- Single lepton trigger
- Three prompt and isolated leptons (e/μ)
- Total lepton charge ± 1
- Jet requirement:
  - at least 4 of which 1 b-tagged OR
  - exactly 3 of which at least 2 b-tagged
- Lepton pairs having the invariant mass compatible with the Z boson within 10 GeV are vetoed





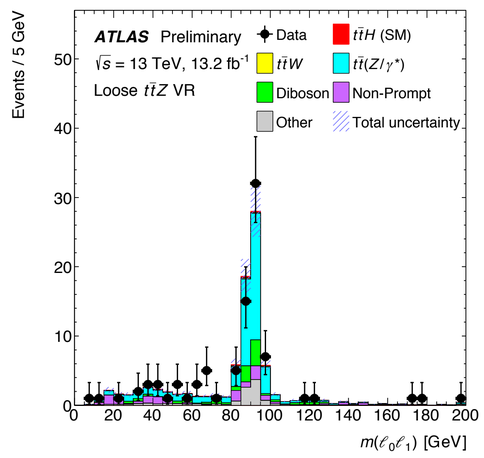


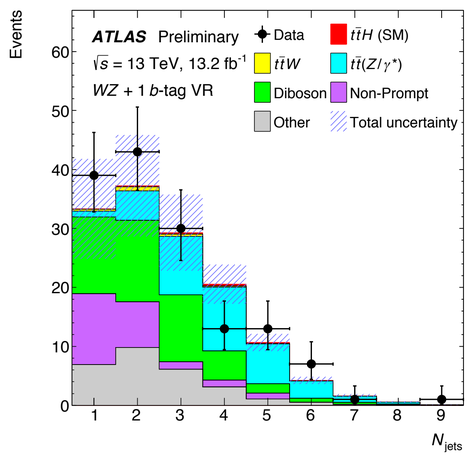
BACKGROUNDS

- The main background is the production of fake and non-prompt leptons, especially from ttbar→lvlvbb events. This background is estimated with a data driven method using a transfer factor from anti-tight leptons
- Irreducible backgrounds are the production of vector bosons in association with top quark pairs ttV (V = Z/W). These two processes are estimated from simulation and validated against data in enriched ttV regions.
- A small contribution coming from WZ production is also validated using data events

VALIDATION PLOTS

Validation plots for ttZ and WZ backgrounds





SYSTEMATIC UNCERTAINTIES

Systematic uncertainties arise from:

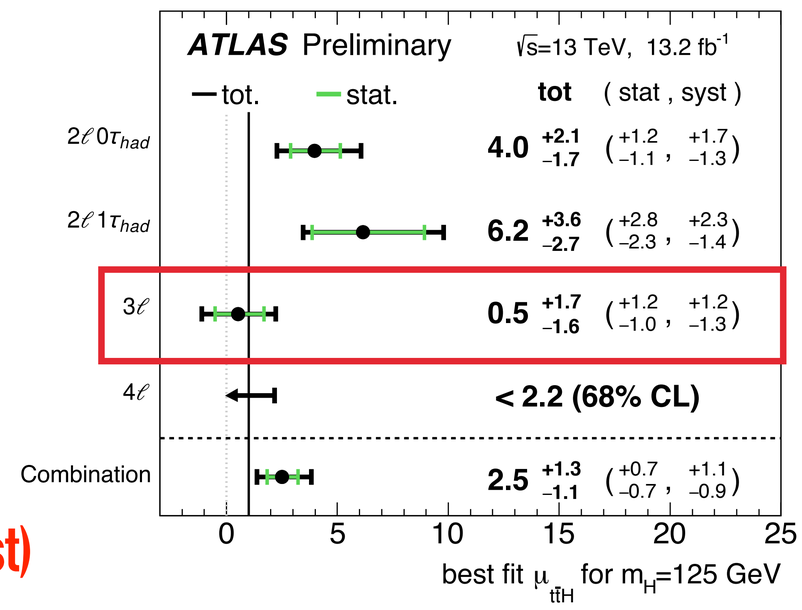
- Theoretical predictions
- Detector-related effects
  - JVT systematic is ranked as second contribution

Uncertainty Source	$\Delta\mu$	
Non-prompt leptons and charge misreconstruction	+0.56	−0.64
Jet-vertex association, pileup modeling	+0.48	−0.36
$t\bar{t}W$ modeling	+0.29	−0.31
$t\bar{t}H$ modeling	+0.31	−0.15
Jet energy scale and resolution	+0.22	−0.18
$t\bar{t}Z$ modeling	+0.19	−0.19
Luminosity	+0.19	−0.15
Diboson modeling	+0.15	−0.14
Jet flavor tagging	+0.15	−0.12
Light lepton (e, μ) and τ_{had} ID, isolation, trigger	+0.12	−0.10
Other background modeling	+0.11	−0.11
Total systematic uncertainty	+1.1	−0.9

RESULTS *ATLAS-CONF-2016-058

Expected yields, observed data and best fit value of the signal strength using a maximum likelihood fit

	3ℓ
$t\bar{t}W$	6.1 ± 1.3
$t\bar{t}(Z/\gamma^*)$	11.5 ± 2.0
Diboson	1.8 ± 1.0
Non-prompt leptons	20 ± 6
Charge misreconstruction	—
Other	3.3 ± 0.8
Total background	43 ± 7
$t\bar{t}H$ (SM)	6.2 ± 1.1
Data	46



Best fit $\mu_{3l} = 0.5 \pm 1.1(\text{stat})^{+1.2}_{-1.3}$ (syst)