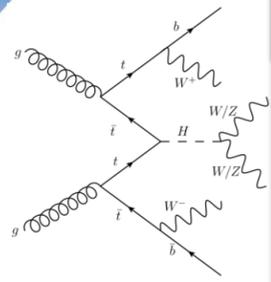


Search for $t\bar{t}H$ production in multilepton final states with the ATLAS experiment

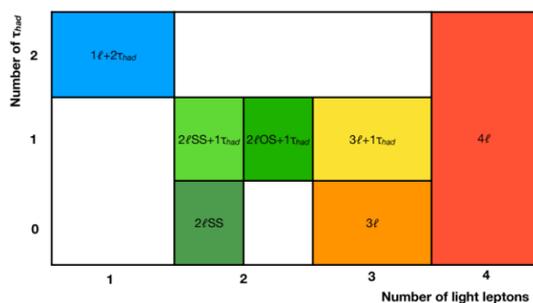


Introduction

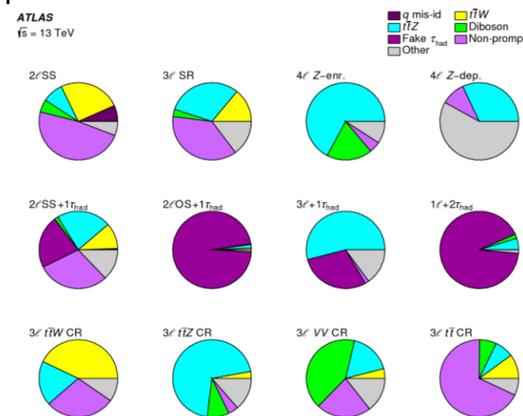
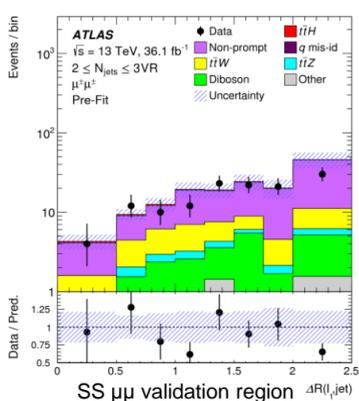
- Provides direct measurement of the Higgs boson's Yukawa coupling (y_t) to the top quark in a tree level process
- $y_t \sim 1$ in the Standard Model (SM). Any deviation in the measurement of this parameter could indicate effects beyond the SM
- ATLAS experiment performed search for this process with 36.1 fb^{-1} of data collected in 2015-16 at $\sqrt{s} = 13 \text{ TeV}$

Overview

- Targets $H \rightarrow WW^*$, $H \rightarrow \tau^+\tau^-$ and $H \rightarrow ZZ^*$ decay modes
- Based on the number and flavor of charged leptons in the final state, analysis is optimized in seven different channels

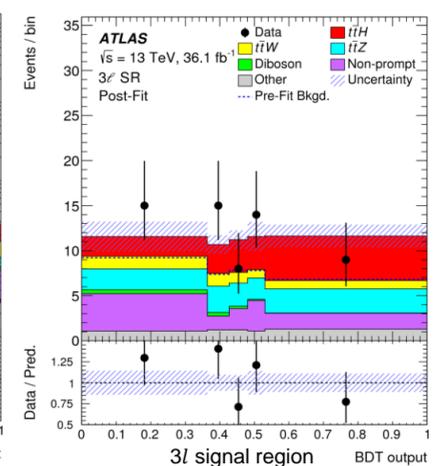
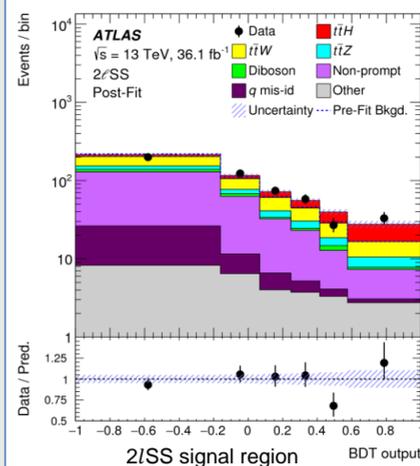


- Major backgrounds: $t\bar{t}Z$, $t\bar{t}W$, VV and other processes with non-prompt leptons or charge mis-identified electrons
- Backgrounds with non-prompt light leptons and fake hadronic taus are estimated from data



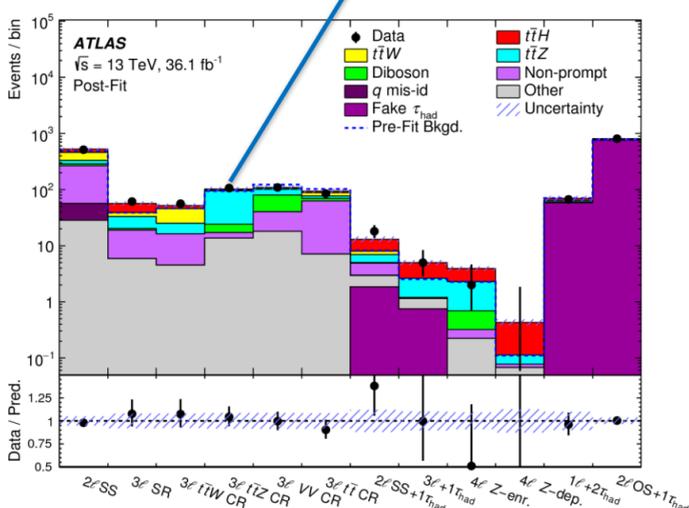
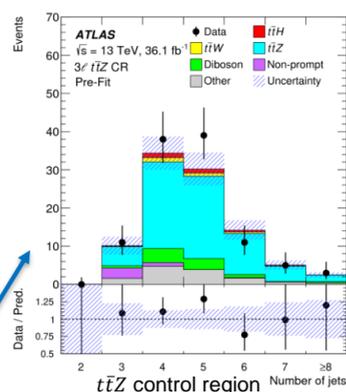
Analysis strategy

- To separate background events from signal events, Multivariate Analysis (MVA) techniques based on boosted decision trees have been used for all channels except $3l+1\tau_{had}$ channel
- Kinematic and topological aspects of events are used for training these MVAs
- Output gives the likelihood of the event to be signal
- MVA techniques have been cross-checked with cut-and-count categorization analyses in most sensitive $2lSS$, $3l$ and $2lSS+1\tau_{had}$ channels



Observed data & predicted yields

- Estimates of all major backgrounds have been validated in background-enriched control regions before looking into signal regions



Results and conclusions

- A maximum likelihood fit to data is performed simultaneously for all signal and control regions

$$\mu_{t\bar{t}H} = \frac{\sigma_{obs}^{t\bar{t}H}}{\sigma_{SM}^{t\bar{t}H}} = 1.6_{-0.3}^{+0.3}(\text{stat.})_{-0.3}^{+0.4}(\text{syst.}) = 1.6_{-0.4}^{+0.5}$$

- $\sigma^{t\bar{t}H} = 790_{-210}^{+230} \text{ fb}$ (SM prediction = $507_{-50}^{+35} \text{ fb}$)
- Leading systematic uncertainties on the $\mu_{t\bar{t}H}$ measurement: $t\bar{t}H$ modelling, jet energy scale and resolution, non-prompt light-lepton estimates
- Observed significance 4.1σ (expected significance 2.8σ)

Combination of ATLAS $t\bar{t}H$ searches

The combination of this result with other $t\bar{t}H$ analyses ($b\bar{b}$, $\gamma\gamma$, ZZ^*) performed by the ATLAS collaboration gives

- $\mu_{t\bar{t}H} = 1.2_{-0.3}^{+0.3}$
- Observed significance 4.2σ (expected significance 3.8σ)
- This provides evidence for the $t\bar{t}H$ production mode

