Associated Higgs Boson Top-Quark production channel $t\bar{t}H \rightarrow l^{\pm}l^{\pm} + 1\tau_{had}$ at $\sqrt{13}$ TeV with the ATLAS experiment

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Higgs decay mode in $2l + 1\tau_{had}$ SR

$\tau\tau$	WW^*	ZZ^*	Other
51%	46%	2%	1%

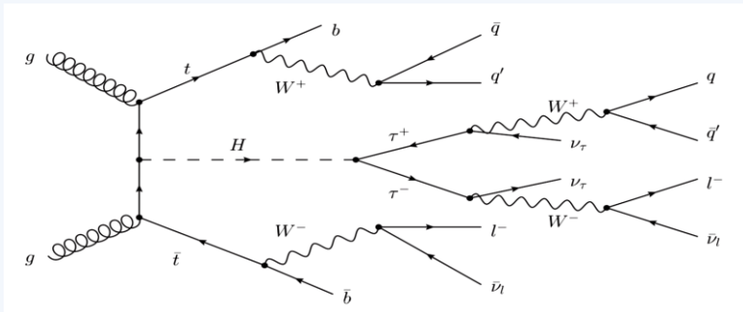
Motivation

- $t\bar{t}H$ production allows direct measurement of Yukawa coupling of the top quark.
- The $2l + 1\tau_{had}$ channel sensitive to $t\bar{t}H$ via $H \rightarrow \tau\tau, WW^*, ZZ^*$.
- Luminosity presented is $13.2\ \mathrm{fb}^{-1}$ at $\sqrt{13}$ TeV recorded by the ATLAS experiment during 2015 and 2016.

$t\bar{t}H \rightarrow 2l + 1\tau_{had}$ channel

The final state is selected by the following requirements:

- Two light leptons (electrons or muons) of same charge.
- One hadronically decaying τ, opposite charge to leptons.
- At least 4 jets of which at least one b-tagged jet.

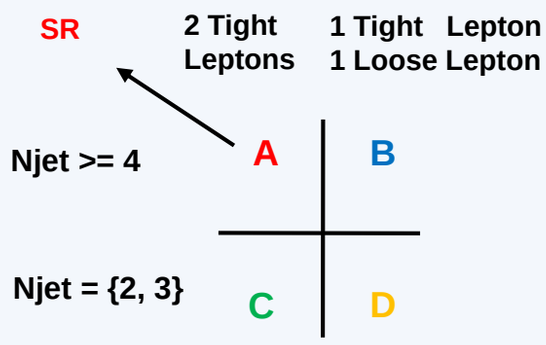


Main backgrounds:

- Irreducible: $t\bar{t}V, VV$; produce real, isolated same-sign leptons.
- Reducible: $t\bar{t}$ produces at least one fake or non-prompt lepton.

Fake background estimation

- A two-dimensional side-band data-driven method. **(ABCD method)**



- The events with non-prompt or fake objects in the signal region (SR) is estimated from data yields in region B, C and D as:

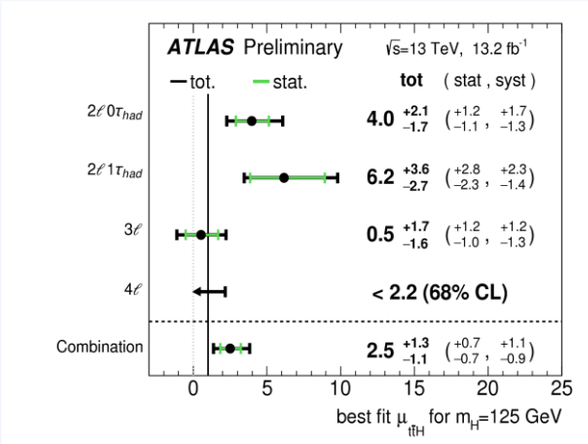
$$N^{A}_{fake} = \frac{N^{C}_{Data-MC}}{N^{D}_{Data-MC}} N^{B}_{Data-MC}$$

Results

- The expected signal, background yields and observed data.

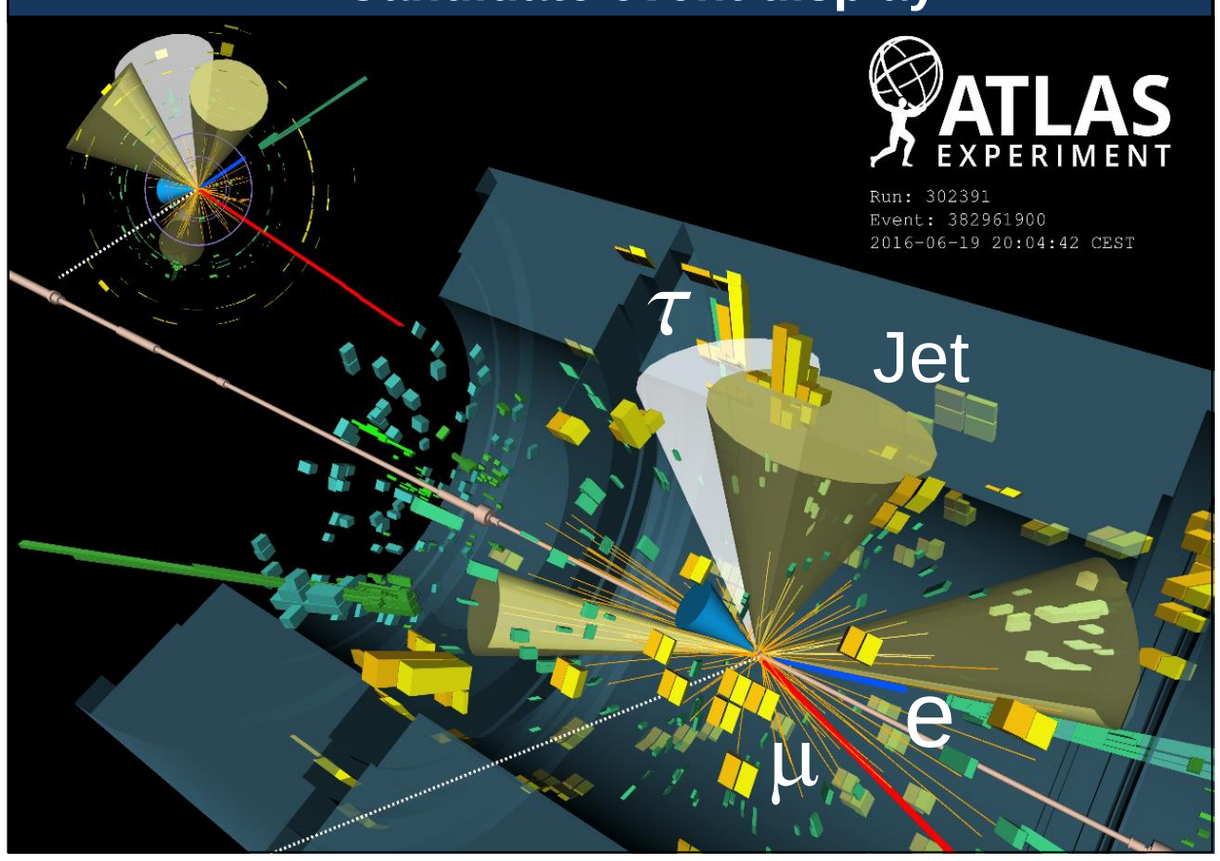
	$2\ell 1\tau_{had}$
$t\bar{t}W$	0.8 ± 0.4
$t\bar{t}(Z/\gamma^*)$	1.6 ± 0.4
Diboson	0.20 ± 0.15
Non-prompt leptons	1.3 ± 1.2
Charge misreconstruction	0.24 ± 0.03
Other	0.63 ± 0.15
Total background	4.8 ± 1.4
$t\bar{t}H$ (SM)	1.43 ± 0.31
Data	14

- The best fit value of $t\bar{t}H$ signal, using maximum likelihood fit to observed data.



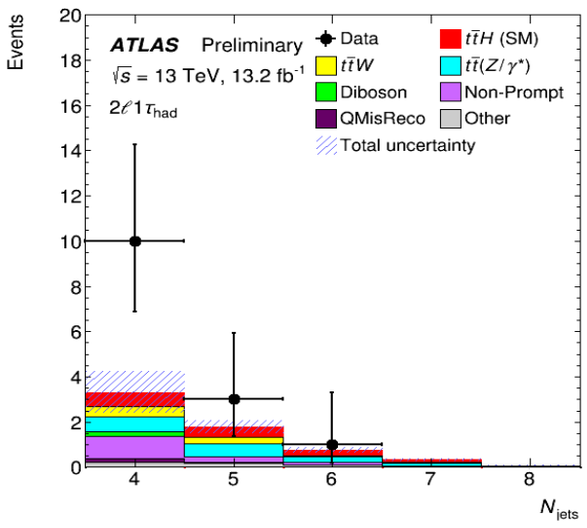
$$\text{Best Fit } \mu = \frac{\sigma^{t\bar{t}H}}{\sigma^{t\bar{t}H}_{SM}} = 2.5^{+1.3}_{-1.1}$$

Candidate event display

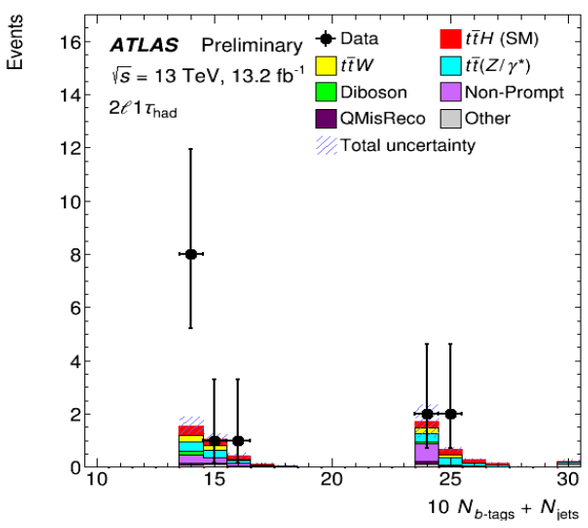


$2l + 1\tau_{had}$ signal region events

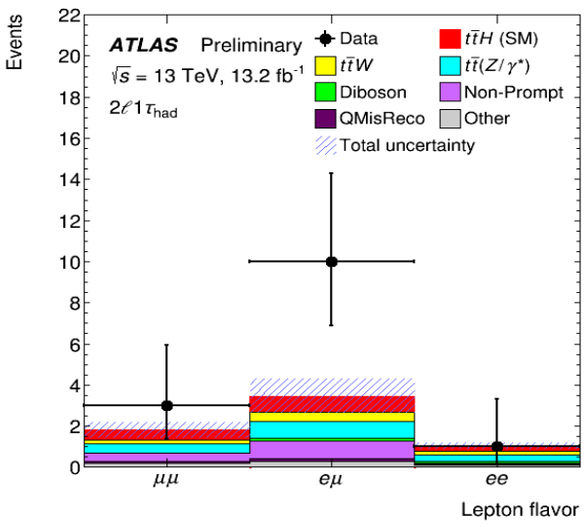
Number of selected jets



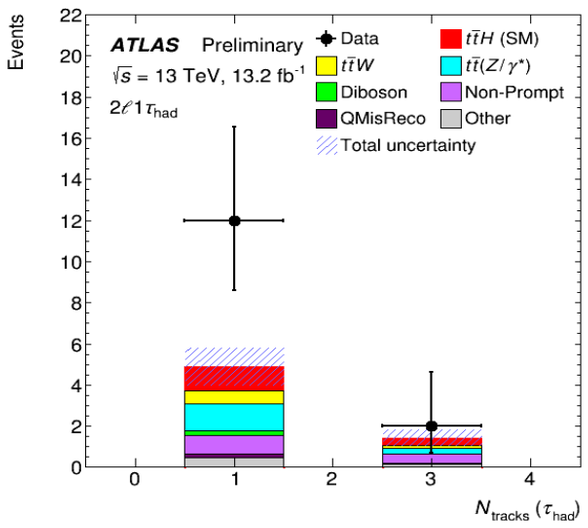
10 × b-tags + selected jets



Lepton flavor composition



τ_{had} number of tracks



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Note: ATLAS-CONF-2016-58