

Searching for lepton-flavour-violating decays of the Higgs boson with the ATLAS detector



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## Motivation

Lepton flavour violation (LFV) is **not allowed** in the Standard Model. However, the observation of neutrino oscillations indicates that LFV occurs in nature.

How about in the charged sector? One possibility would be LFV Higgs boson decays:

#### $H \rightarrow \tau e, H \rightarrow \tau \mu, H \rightarrow e \mu^*$

There are many BSM models predicting it: supersymmetry, composite Higgs models, more than one Higgs doublet models, Randall– Sundrum models, and more.

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# Channels and Bkgs

We search for **H→τe** and **H→τµ** (separately) using data collected by ATLAS in 2015-2016, **36 fb<sup>-1</sup>** 

Channels: Depending on the tau decay mode, leptonically or hadronically, we have two channels, ℓτ<sub>lep</sub> and ℓτ<sub>had</sub>

## Event selection and signal regions

 $\ell \tau_{lep}$ : exactly 2 light-leptons of different flavour and opposite charge  $\ell \tau_{had}$ : exactly 1  $\tau_{had}$  and 1 light-lepton, with opposite charge

**Baseline:**  $n_{b-jets} = 0$  (suppress Top bkg), **VBF region:**  $n_{jets (pT>30 \text{ GeV})} \ge 2$ ,  $m_{jj}>400 \text{ GeV}$ and  $|\Delta \eta_{jj}|>3$ , **nonVBF region:** fails VBF selection



Bkgs: From simulation: Z→ττ (main in both channels), Top (2nd for ℓτ<sub>lep</sub>), Diboson, H→ττ and Z→ℓℓ.
From data: Fake bkg, jets mis-id as τ<sub>had</sub> or ℓ (2nd for ℓτ<sub>had</sub>), calculated using transfer factors derived in control regions.

### Multivariate Analysis

We used **BDTs** to separate signal from background. One BDT trained per channel and per signal region. Input variables are combination of low and high level kinematics. VBFexclusive variables used in VBF region training. BDT parameters are optimised for discovery.

#### Re<u>sults</u>

No significant excess over the SM bkg is found. Observed (expected) upper limits at 95% CL are set:

BR( $H \rightarrow \tau e$ )<0.47% (0.34<sup>+0.13</sup>-0.10 %), BR( $H \rightarrow \tau \mu$ )<0.28% (0.37<sup>+0.14</sup>-0.10 %) These limits can be converted to limits on off-diagonal Yukawa coupling matrix elements:



Limits on the individual coupling matrix elements  $|Y\tau \ell|$  and  $|Y\ell\tau|$  together with the limits from the ATLAS Run 1 analysis and from  $\tau \rightarrow \ell\gamma$  searches

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