Measurement of the Higgs boson production in association with top quarks in final states with multileptons using data taken during the Run 2 of the LHC with CMS

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Introduction:
Measurement of a top quark pair production in association with a Higgs boson in final states with multiple leptons ($\ell\ell\tau\tau$, $\mu\mu\tau\tau$).
- $t\bar{t}H$ and $t\bar{t}$ processes provide the most precise model-independent determination of the Yukawa coupling of the Higgs to the top quark ($\gamma_t$).
- The analysis yields 5.0 sensitivity for $t\bar{t}H$.

Event Selection:
- Small signal compared to other SM processes
- Selected final states target the Higgs boson decays: $H\rightarrow WW$, $H\rightarrow ZZ$ and $H\rightarrow \tau\tau$.
- 10 categories are defined depending on the number of leptons and hadronic $\tau$ in the final state
- Selection:
  - Jet multiplicity requirement according to the number of jets in the final state
  - B jet requirement
  - $Z$ veto and $m_{lep}$ requirements in some categories
- Lepton ID is based on a BDT discriminant to reject non-prompt leptons

Results and conclusions:
- Measured signal strength for $t\bar{t}H$ and $t\bar{t}$ in good agreement with the Standard Model:
  $$\mu_{t\bar{t}H} = 0.92_{-0.23}^{+0.26} \quad \mu_{t\bar{t}} = 5.67_{-4.0}^{+4.1}$$
- Significance:
  - $t\bar{t}H$: $\sigma$ ($4.7\sigma$) expected (observed)
  - $t\bar{t}$: $1.4\sigma$ ($0.3\sigma$) expected (observed)
- $\gamma_t$ constrained to be within $-0.9 < \gamma_t < -0.7$ and $0.7 < \gamma_t < 1.1$ at 95% CL

Acknowledgements

References: