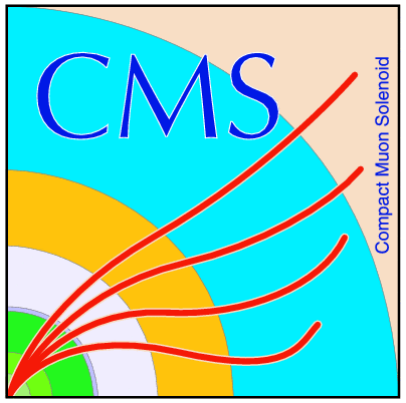
ttH measurement in final states with multileptons using data taken during the Run 2 of the LHC with CMS

ICHEP

30 July 2020



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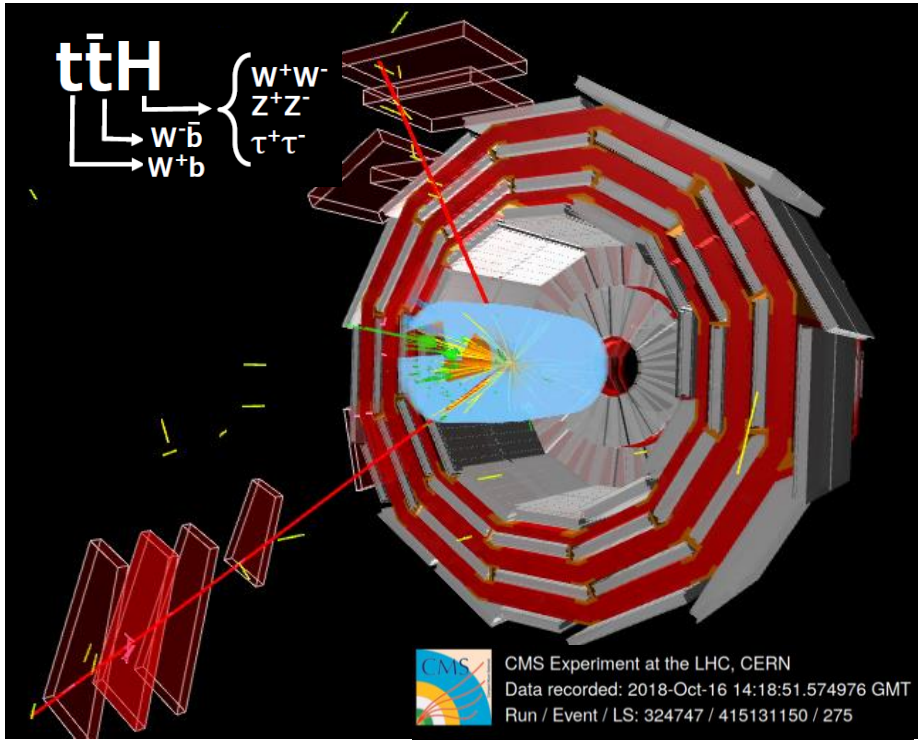
Introduction

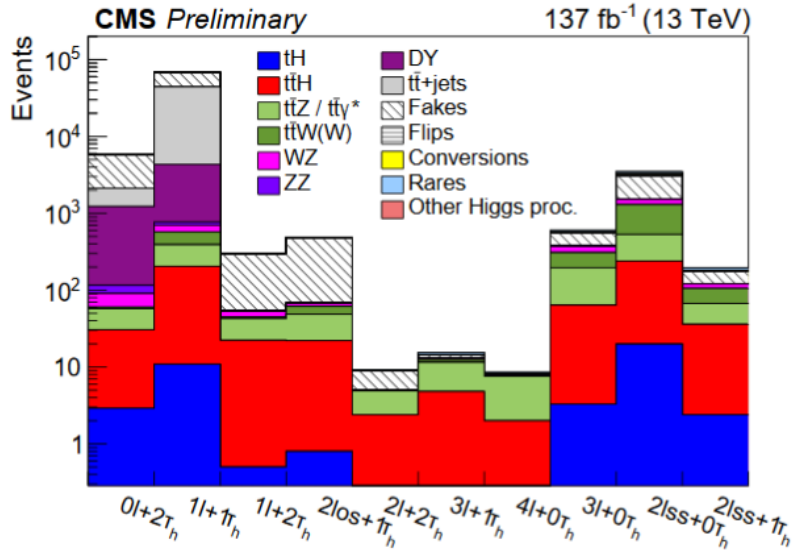
- Measurement of the top quark pair production in association with a Higgs boson in **final states with multiple leptons** (e,μ,τ)
- Data taken by the CMS experiment at 13 TeV during Run 2 (137 fb^{-1}).
- ttH and tH processes provide **the most precise model-independent determination of the Yukawa coupling** of the Higgs to the top quark (yt).
- More information about this analysis **here**
- Report number: **CMS-HIG-19-008**



Analysis strategy

Signal regions and selection:

- 10 event categories built using lepton and τ_h multiplicities
- Jet multiplicity requirement for each category according to the number of jets in the final state
- B jet requirement (all categories)
- Additional Z veto, dilepton masses requirements in some categories



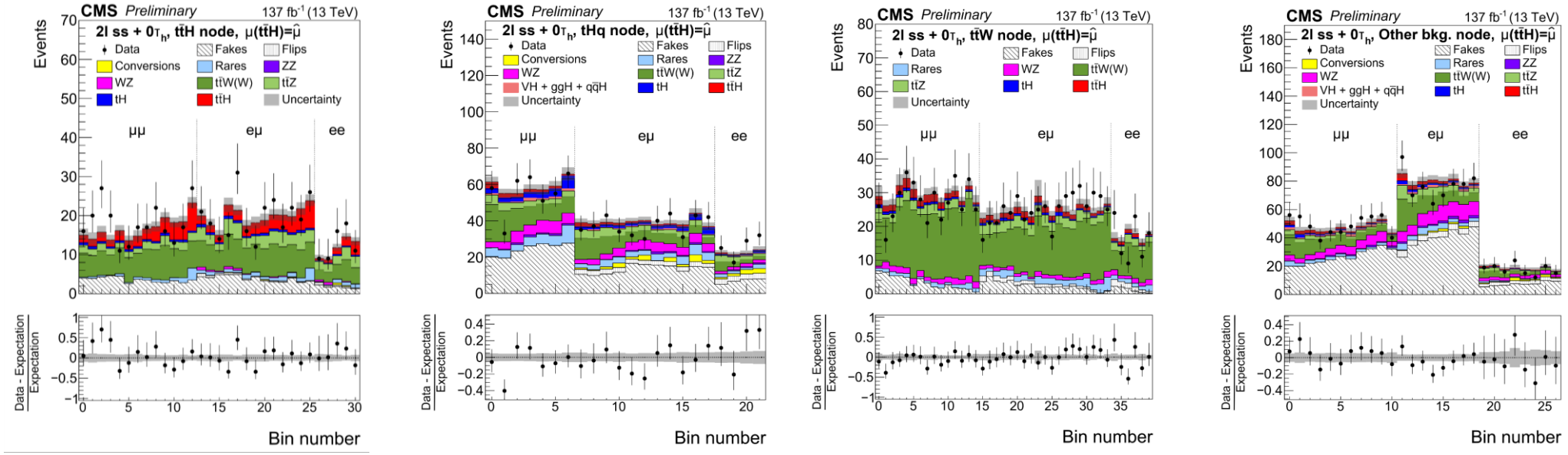
Main backgrounds

- **ttZ** and **ttW** production: estimated with MC simulation
- **Mis-identified leptons**: estimated with data-driven methods. Using **loose-to-tight** methods and deriving factors in data driven control regions.

MVA to enhance background to signal separation:

- multiclass DNNs used in categories with high stats. and sensitive to ttH and tH (2ℓss + $1\tau_h$, 2ℓss+ $0\tau_h$ and 3ℓ +0 τ_h)
- BDTs on categories with lower stats: separate ttH+tH against the backgrounds.
- Inputs: 3-momenta (of leptons, τ_h and jets), angular variables, masses, object multiplicity…

For 2ℓss+ $0\tau_h$ DNN output (4 nodes):



Further categorization in lepton flavour

Results

- A Maximum likelihood fit is performed to extract the signal strength:

$$\mu_{ttH} = 0.92^{+0.26}_{-0.23} \qquad \mu_{tH} = 5.67^{+4.1}_{-4.0}$$

- Above **5σ sensitivity for ttH**, downwards fluctuation yielding **4.7σ observed** significance
- observed tH significance: **1.4σ**

Interpretation in terms of yukawa coupling modifier (κ framework):

- Scan in κ_t κ_V points
- Taking into account: cross section and shape modifications, interference of diagrams with t-H and t-W coupling for tHq and tHW and Higgs BR modifications

κ_t **constrained** to be within **$-0.9 < \kappa_t < -0.7$** and **$0.7 < \kappa_t < 1.1$** at 95% CL