

Search for ttH production in multileptons final states at 13 TeV

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Introduction

A measurement of the ttH production in final states with electrons, muons or hadronic au

The ttH production process is one of the only handles available to measure the y_t coupling

- \triangleright Only probe of the y_t coupling at tree level
- Very low cross-section at 13 TeV
- Rich variety of final states given by the various decays of the Higgs boson The process was first observed by CMS combining different final states [1].

Event selection and main backgrounds

- Very reduce signal compared to other SM processes with leptons in the final state
- \triangleright 6 categories are defined depending on the number of light leptons (ℓ) and hadronic τ_h
- $\triangleright 1\ell + 2\tau_h$

- > 3ℓ
- \triangleright 2 ℓ ss (two same-sign leptons) \triangleright 3 ℓ + 1 τ_h
- \triangleright 2ℓ ss + 1 au_h
- ▶ Lepton identification is performed using a BDT discrimant to reject non-prompt leptons
- \triangleright Additional jet and b-jet multiplicity requirements are applied in the different categories
- Main backgrounds are
 - > ttZ and ttW production: estimated with MC simulations
 - ▶ Mis-identified leptons: estimated with data-driven methods
 - Using a loose-to-tight method
 - ► Transfer factors derived in data control region

Signal extraction

- Signal is further discriminated from background using MVA techniques
- ightharpoonup Separate BDT discriminants are trained in each region against $t\bar{t}$ and ttZ and ttW separately
- Input variables are
 - Multivariate hadronic top decay and Higgs decay taggers
 - Matrix element techniques
 - Other kinematic variables
- Discriminators against $t\overline{t}$ and ttZ+ttW combined into a single score using a likelihood discriminator
- Optimal choice of bin multiplicity obtained with a recursive application of the k-means algorithm

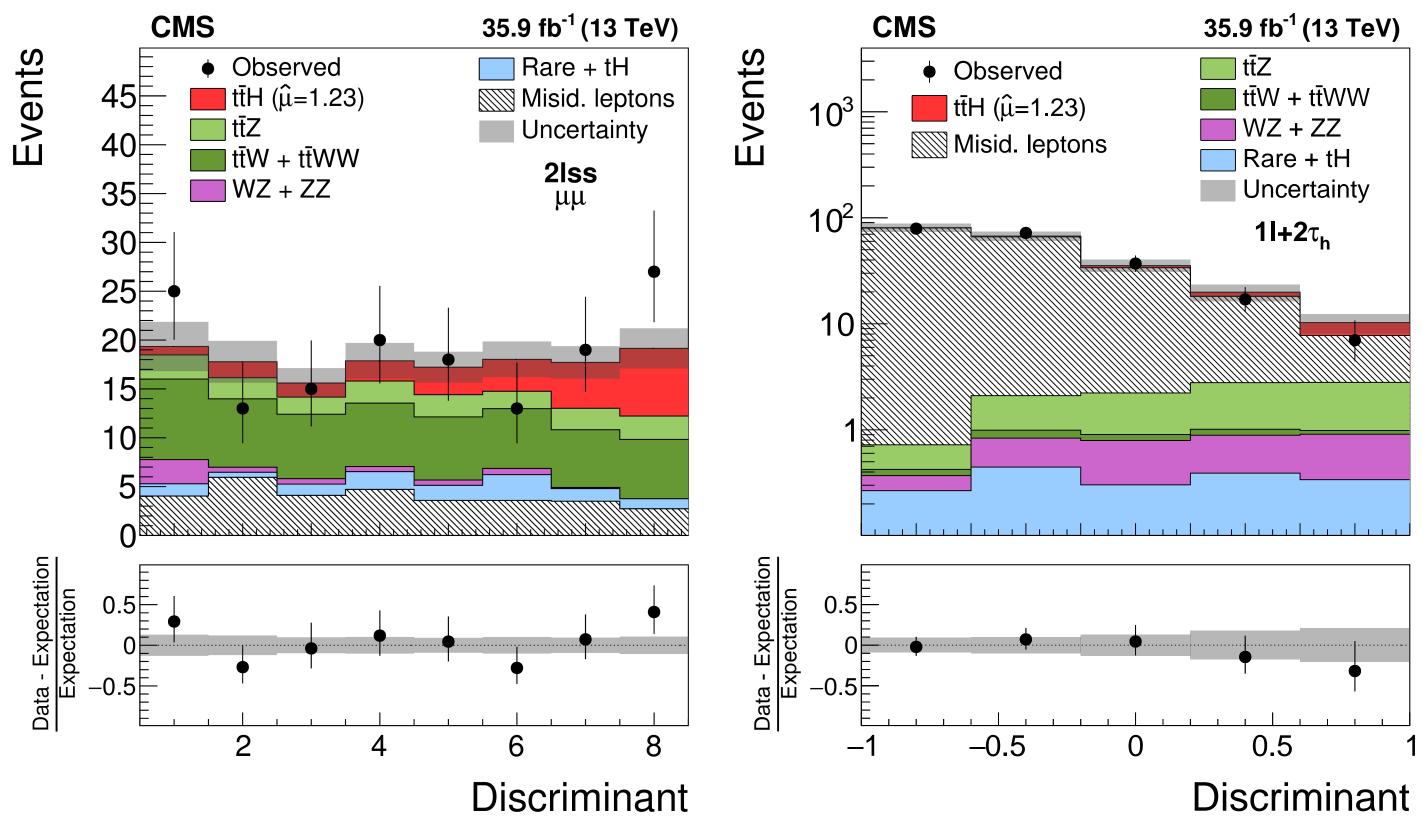


Figure: Distribution of multivariate discriminants used in the $\mu^+\mu^-$ (left) and $1\ell+2 au_h$ for the signal extraction.

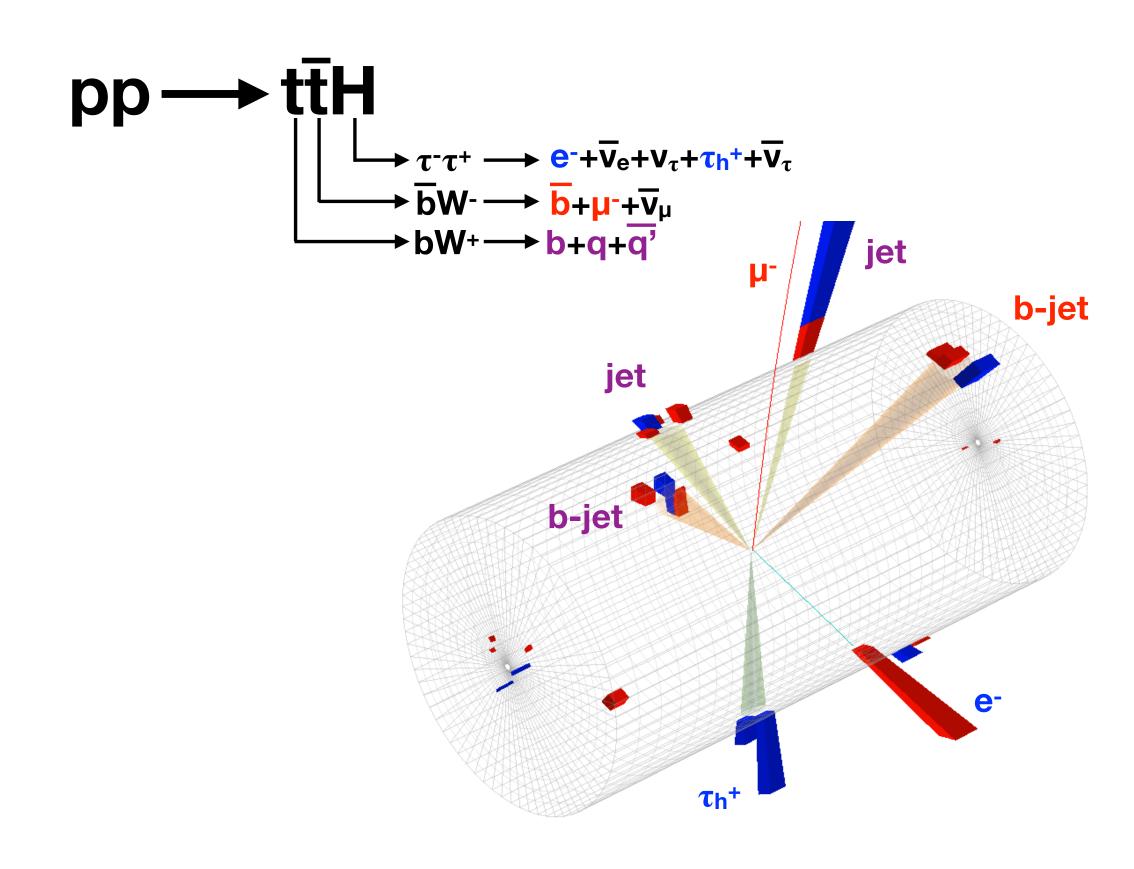


Figure: Event display of a ttH production event candidate in one of the targeted final states.

Event categorization

- Further categorization in 2ℓ ss and 3ℓ regions
- Categories are built in lepton flavor, charge and b-jet multiplicity

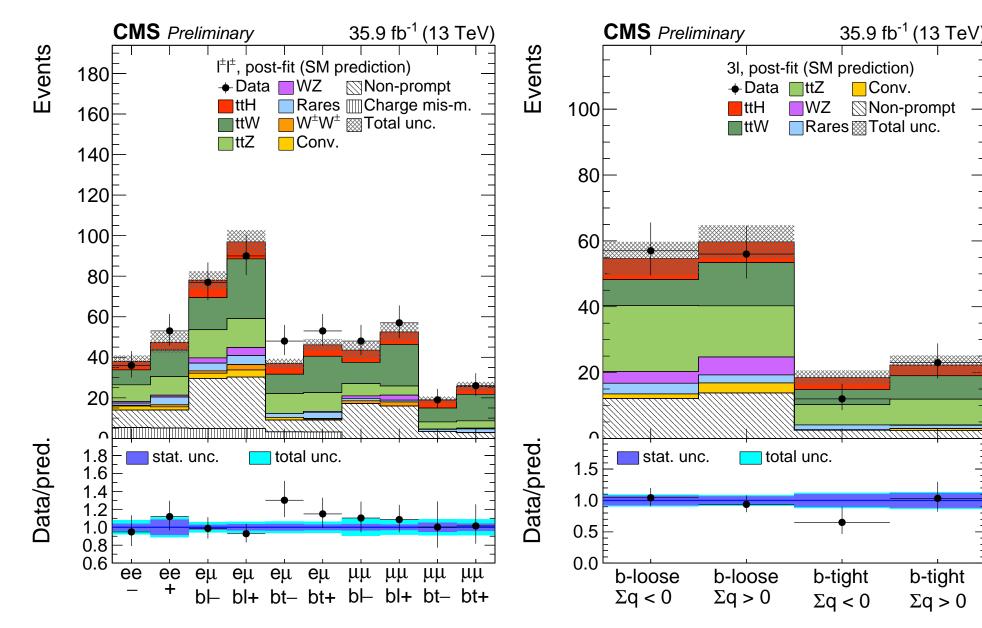


Figure: Categories in the 2ℓ ss and 3ℓ regions.

Results and conclusions

- Results show evidence for ttH production in multilepton final states
- Measured signal strength of

$$\mu = 1.23^{+0.45}_{-0.43}$$

corresponding to 3.2σ above the background-only hypothesis

Result in agreement with SM expectations

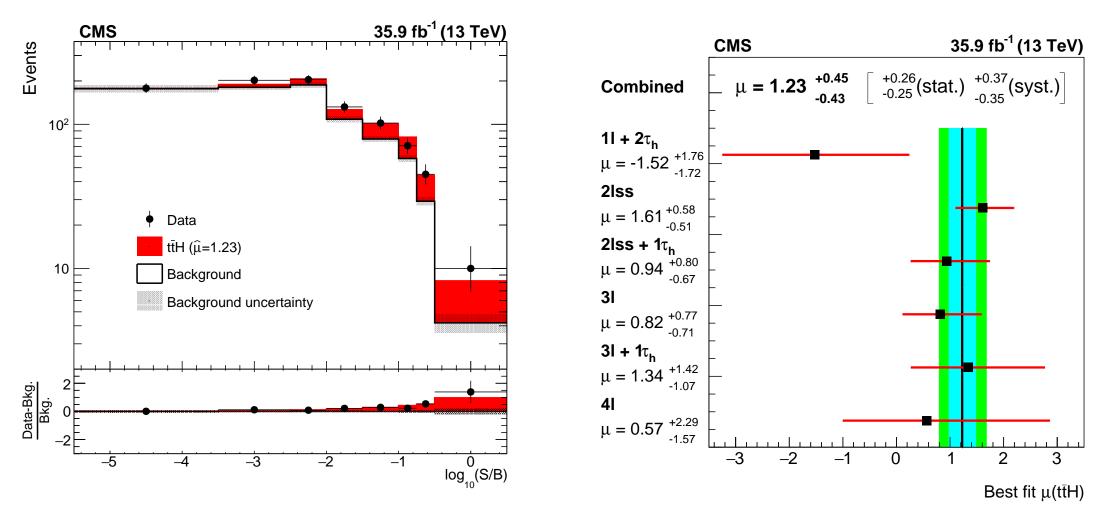


Figure: Decimal logarithm of the ratio between expected signal and expected background in each bin of the distribution used for signal extraction (left) and signal strength measured in each of the categories individually (rigth).

References



[1] Evidence for associated production of a Higgs boson with a top quark pair in final states with electrons, muons, and hadronically decaying τ leptons at $\sqrt{s}=13$ TeV. arXiv:1803.05485



[2] Observation of ttH Production. Phys. Rev. Lett. 120, 231801