Measurement of ttH and tH production in the H(bb) channel at CMS

NEW full Run 2 data

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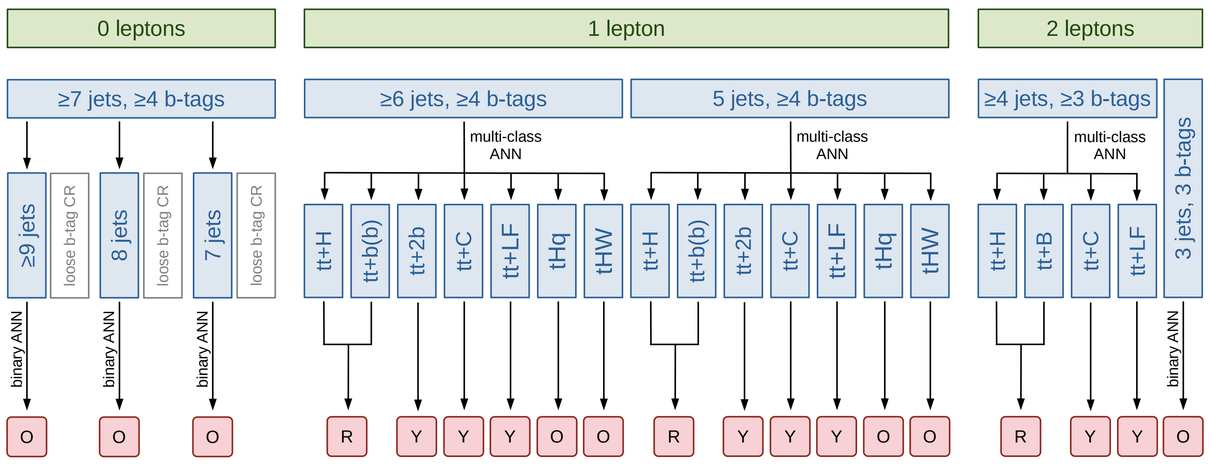
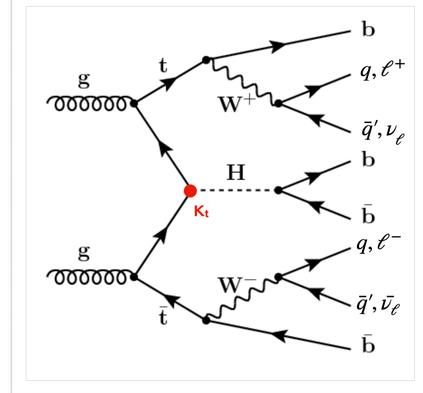
Analysis strategy

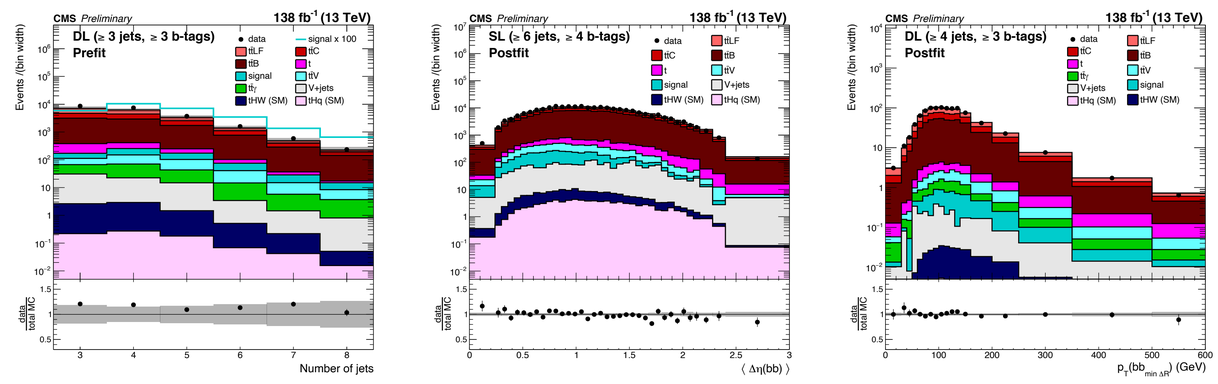


- Direct measurement of the **top-Higgs Yukawa coupling** as crucial test of the Standard Model and indirect probe for new physics
- Categorise events according to **leptons**, **jets**, and **b-tags** multiplicity
- Classify in **signal and bkg like classes** through neural networks (NN)
- **Optimised observables for the fit**
  - *Yield* in control regions
  - *Output* score of NN in less sensitive regions
  - *Likelihood ratio* combining scores from ttB and ttH classes

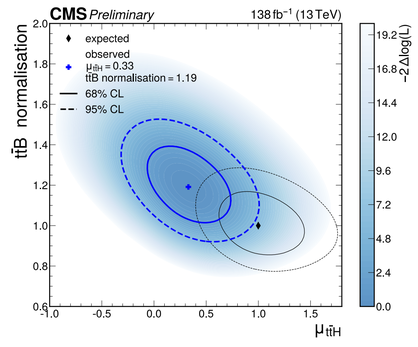


Background modelling (ttbar)

- At particle level, distinguish between ttbar + jets with B, C or light hadrons
- **Simulation for ttB at NLO in 4FS for a better description of kinematics** [1-4]

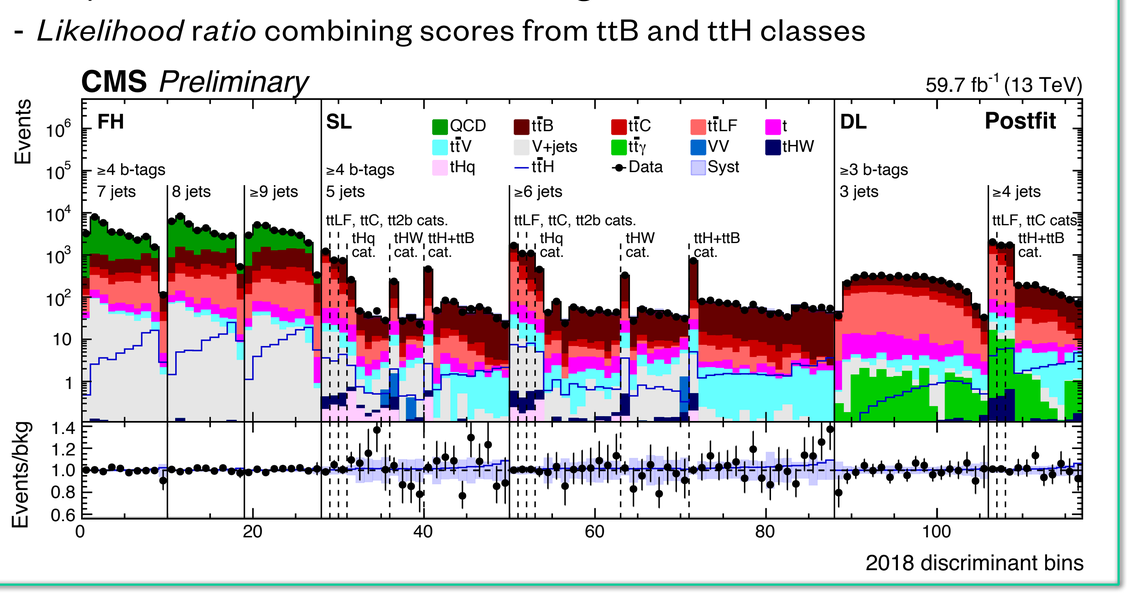


- Conservative **uncertainty (100%) on the tt+2b** component (collinear g → bb splitting)
- **ISR, FSR, μ_R, μ_F scale and PDF** uncertainties decorrelated between ttB and other ttbar events
- **ME-PS uncertainty** decorrelated among ttB, ttC, ttLF
- **Careful validation of the modelling** through:
  - Goodness-of-fit tests
  - Bias tests on the signal strength
  - Pulls and impacts of nuisance parameters
- **Normalisation of ttB and ttC from the final fit to the data**

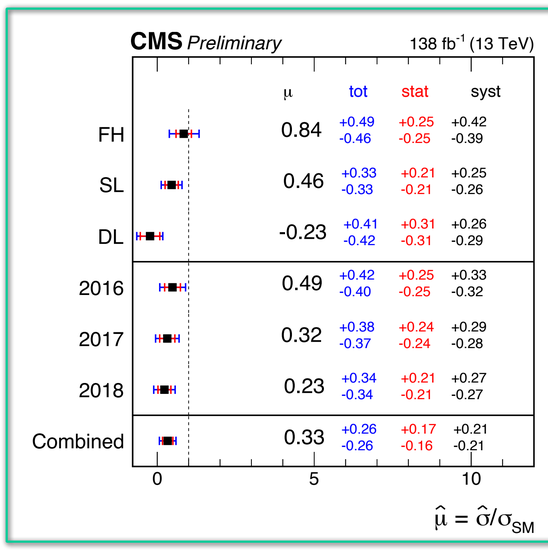


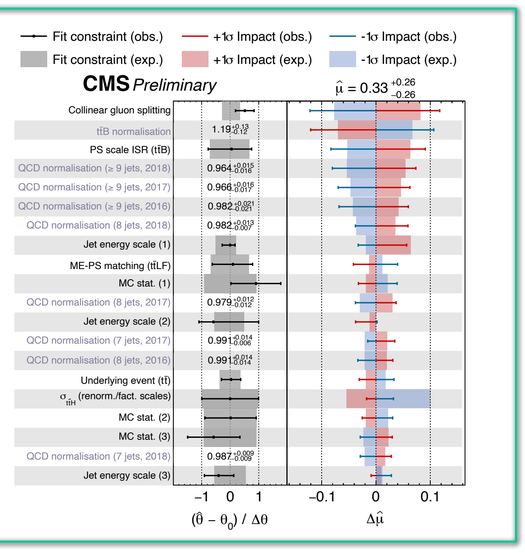
ttB norm : $1.19^{+0.13}_{-0.12}$

ttC norm : $1.07^{+0.20}_{-0.19}$



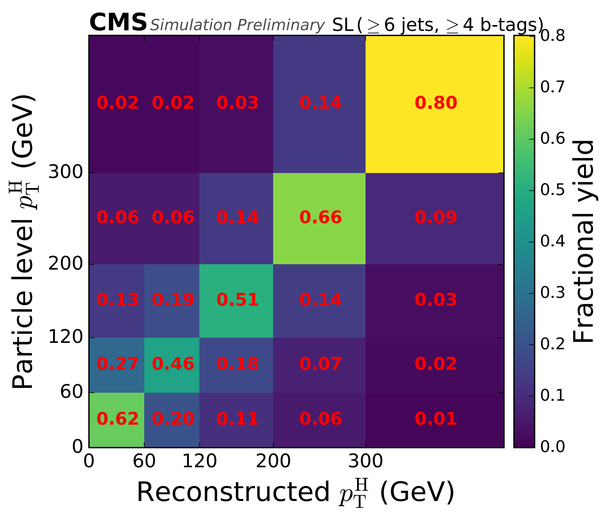
Measurement of ttH production rate (inclusive)



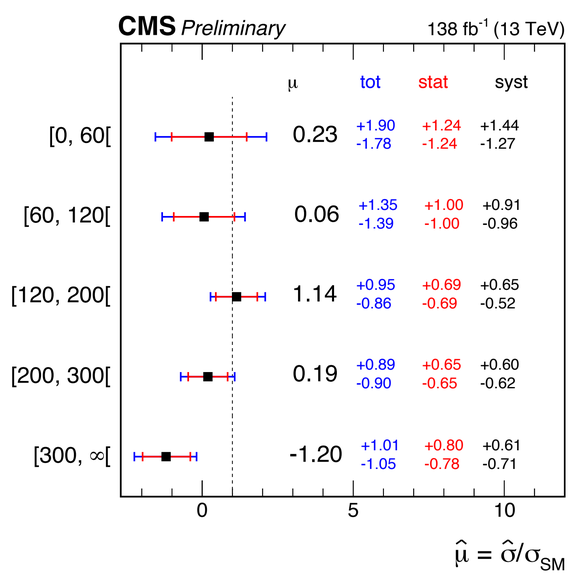


Measurement of ttH in Higgs p_T bins

- Categorisation in p_T bins through a neural network

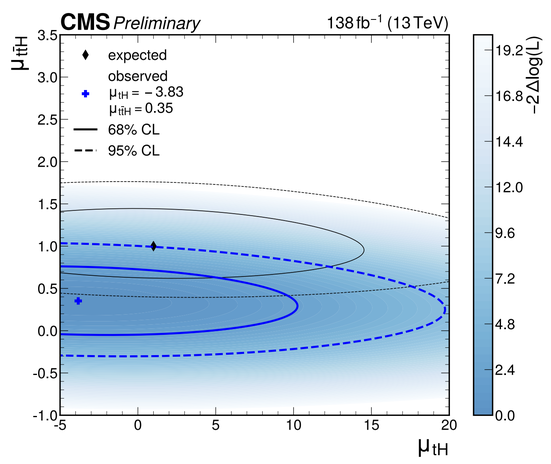


- **Extended uncertainty model**
  - partial decorrelation of ttB normalisation, ISR, FSR, gluon-splitting uncertainties in each p_T bin

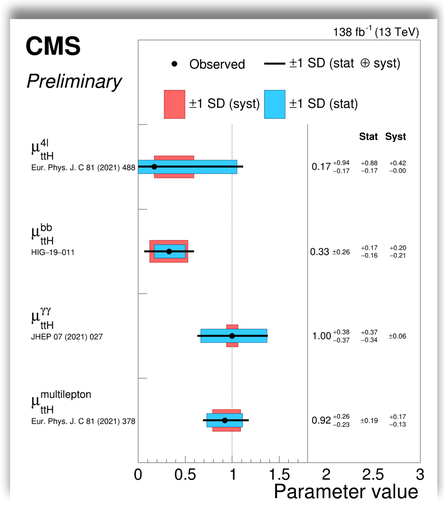


Measurement of tH production rate

- 95% CL limits on μ_{tH}: 14.6 obs. (19.3 exp.)
- Simultaneous fit of tH and ttH signal strengths

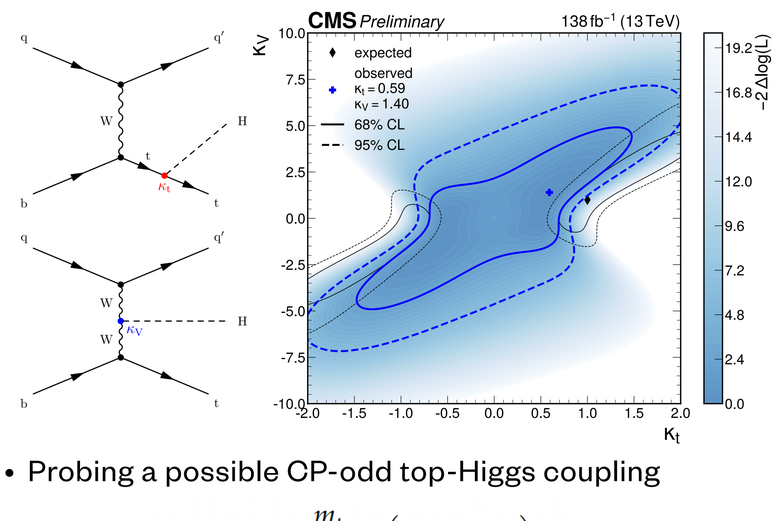


Overview of CMS results on ttH production @ 13 TeV for this conference



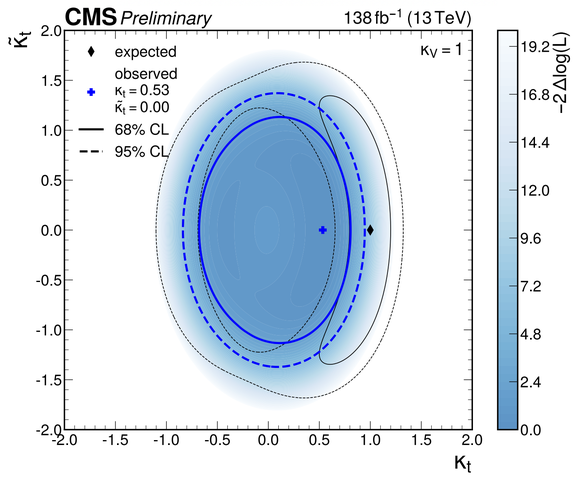
Coupling and CP measurements

- The tH process is sensitive to both κ_t and κ_V



- Probing a possible CP-odd top-Higgs coupling

$$\mathcal{A}(\mathrm{Htt}) = -\frac{m_t}{v}\bar{\psi}_t\left(\kappa_t + i\tilde{\kappa}_t\gamma_5\right)\psi_t$$



CMS Collaboration, "*Measurement of ttH and tH production rates in the H→bb decay channel with 138 fb-1 of proton-proton collision data at √s = 13 TeV*", **CMS-PAS-HIG-19-011**

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[1] T. Jezo et al., "*New NLOPS predictions for tt +b-jet production at the LHC*", Eur. Phys. J. C 78 (2018) 502
[2] F. Buccioni et al., "*OpenLoops 2*", Eur. Phys. J. C 79 (2019) 866
[3] F. Cascioli et al., "*NLO matching for ttbb production with massive b-quarks*", Phys. Lett. B 734 (2014) 210
[4] F. Buccioni et al., "*NLO QCD predictions for ttbb production in association with a light jet at the LHC*", JHEP 12 (2019) 015