

# $t\bar{t}H$ Measurements CMS

Higgs@HL/HE-LHC — Autumn WG2 Meeting

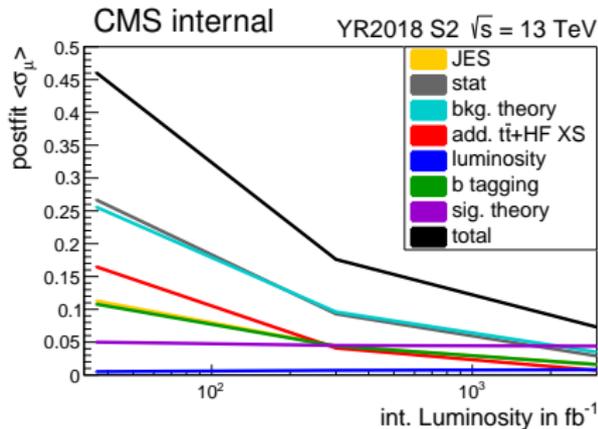
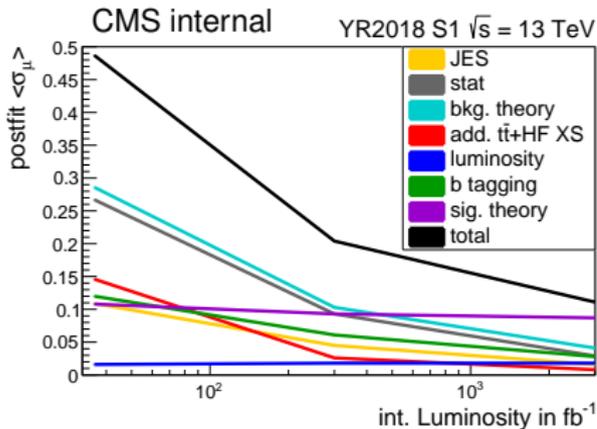
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- $t\bar{t}H$  production: **direct measurement of top-Higgs Yukawa coupling**
- **Search in  $H(b\bar{b})$  channel** considered for dedicated projection analysis
- $t\bar{t}H(b\bar{b})$  result with  $36 \text{ fb}^{-1}$ : 1.6 obs. (2.2 exp.)  $\sigma$  significance
  - Requires heavy use of multivariate techniques (BDT, DNN, MEM) to define signal and control regions and construct sensitive variables
  - Challenge:  $t\bar{t} + \text{HF background}$ ; modelled assigning essentially large rate uncertainties per  $t\bar{t} + X$  process (+smaller shape uncertainties)
  - Dominant uncertainties:  $t\bar{t} + \text{HF}$  modelling, b tagging
- **Projection: expect observation of  $t\bar{t}H(b\bar{b})$  with  $300 \text{ fb}^{-1}$** 
  - Significance  $\approx 6\sigma$

# $t\bar{t}H(\text{b}\bar{\text{b}})$ : Projected Uncertainties



- Total uncertainty on signal strength  $\mu$  reduced to 0.11/0.07 at 3000  $\text{fb}^{-1}$
- Experimental uncertainties become sub-dominant
- Signal theory starts to dominate
  - Can be reduced when measuring cross-section instead of  $\mu$

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Source	S1			S2		
	35.9 fb <sup>-1</sup>	300.0 fb <sup>-1</sup>	3000.0 fb <sup>-1</sup>	35.9 fb <sup>-1</sup>	300.0 fb <sup>-1</sup>	3000.0 fb <sup>-1</sup>
stat	0.267	0.093	0.029	0.267	0.093	0.029
luminosity	0.016	0.018	0.018	0.005	0.007	0.008
bkg. theory	0.286	0.103	0.041	0.256	0.096	0.035
add. tt+HF XS	0.146	0.026	0.008	0.165	0.041	0.007
JES	0.109	0.045	0.016	0.113	0.044	0.016
b tagging	0.120	0.061	0.028	0.108	0.044	0.016
sig. theory	0.108	0.093	0.087	0.050	0.045	0.044
total	0.487	0.204	0.111	0.461	0.176	0.073

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- While actual model would likely have more degrees of freedom, one can conclude: statistical power of 3000 fb<sup>-1</sup> of data can be used to obtain much information about the  $t\bar{t} + HF$  processes
- Observed constraints tell the level at which we will be able to discriminate between different models

- Projection of  $t\bar{t}H(b\bar{b})$  results
- Strong constraints of background modelling uncertainties observed: indicates that we will be able to discriminate different models with good precision and/or essentially measure background from data
  - Different background modelling in ATLAS and CMS: different approaches to assess future performance
  - Consistent treatment between ATLAS+CMS to account for recommended  $t\bar{t} + HF$  uncertainty reduction in combination
- $H(b\bar{b})$  channel has high potential, similar sensitivity to other channels