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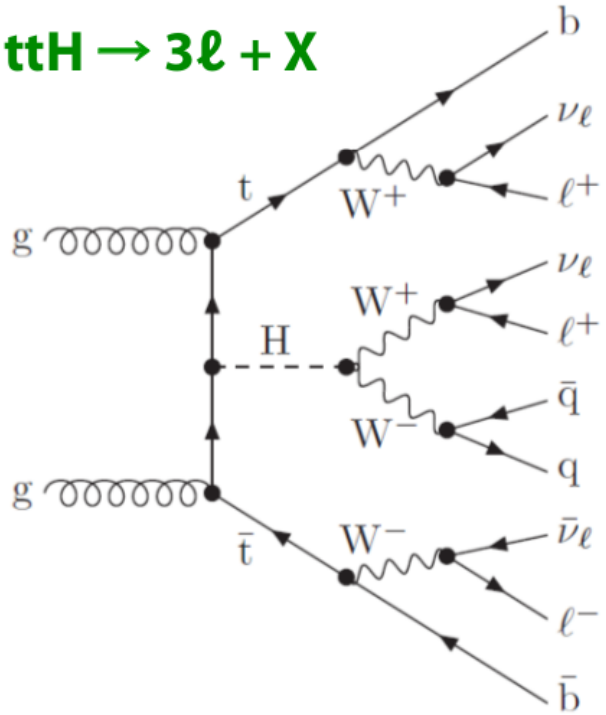
Red LHC Workshop

Status and prospects for $t\bar{t}H$ production in the multilepton and two same-sign lepton channels

INTRODUCTION

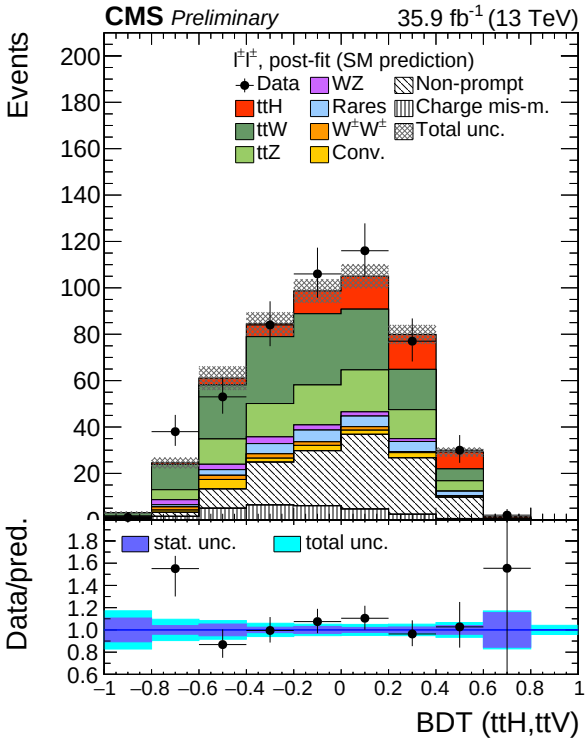


CMS-PAS-HIG-17-004

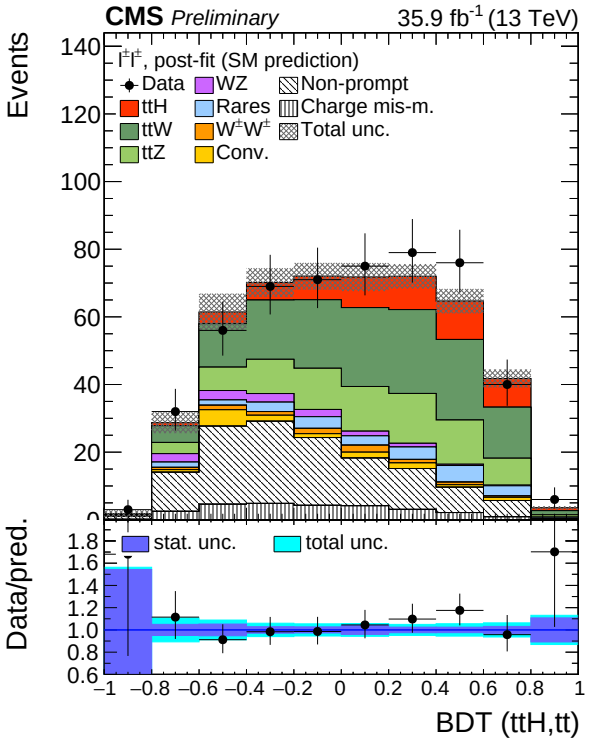
- Oviedo group is contributing to the multilepton and two same-sign leptons channels
- Limited background compared to the $H \to b\bar{b}$ channel
- Higher cross section than the $H \to \gamma\gamma$ channel
- Main background sources are
  - Nonprompt leptons coming from $t\bar{t}$
  - Irreducible backgrounds due to $t\bar{t}W$ and $t\bar{t}Z$ production

Background reduction

- BDT is used to discriminate between:
  - prompt leptons, coming from leptonic W, Z and τ decays
  - leptons coming from other sources: misidentified jets, b quark decays



- BDTs in order to discriminate between $t\bar{t}H$, $t\bar{t}$ and $t\bar{t}V$
- Trained using kinematic variables of the objects, matrix element weights, BDTs targeting top and Higgs decays

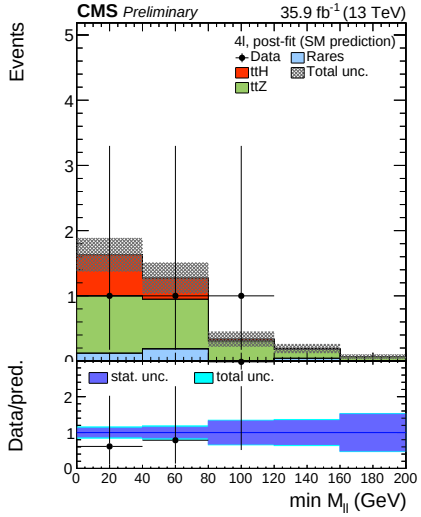


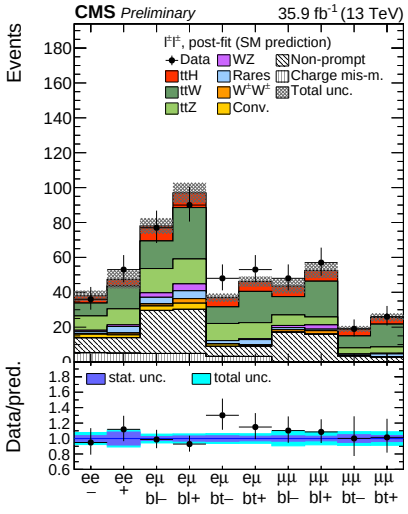
Background estimation

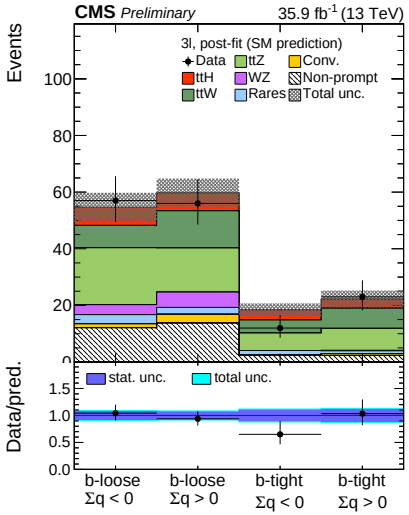
- Background due to nonprompt and charge misidentified leptons estimated using data-driven methods
- Nonprompt is estimated from control regions with loose lepton identification criteria
- Charge misidentificationis estimated from control regions with two opposite-sign dilepton
- Contribution from $t\bar{t}W$ and $t\bar{t}Z$ estimated using MonteCarlo simulation
- Estimation validated in dedicated control regions

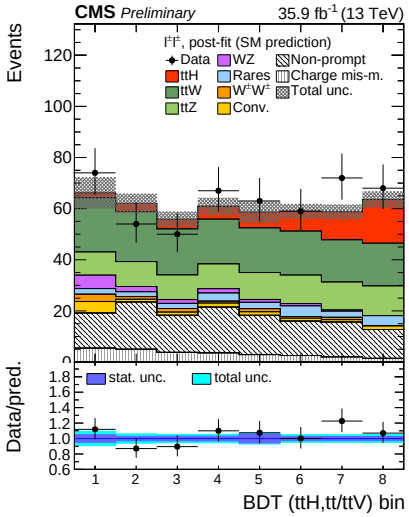
CATEGORIZATION AND SIGNAL EXTRACTION

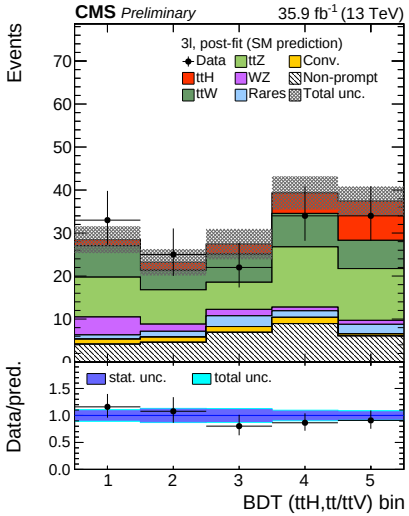
- Events are further categorized
  - dilepton, three lepton and four lepton channel
  - charge, lepton flavor (2l) and presence of tighter b-jets
  - likelihood ratio score using BDTs output as an input



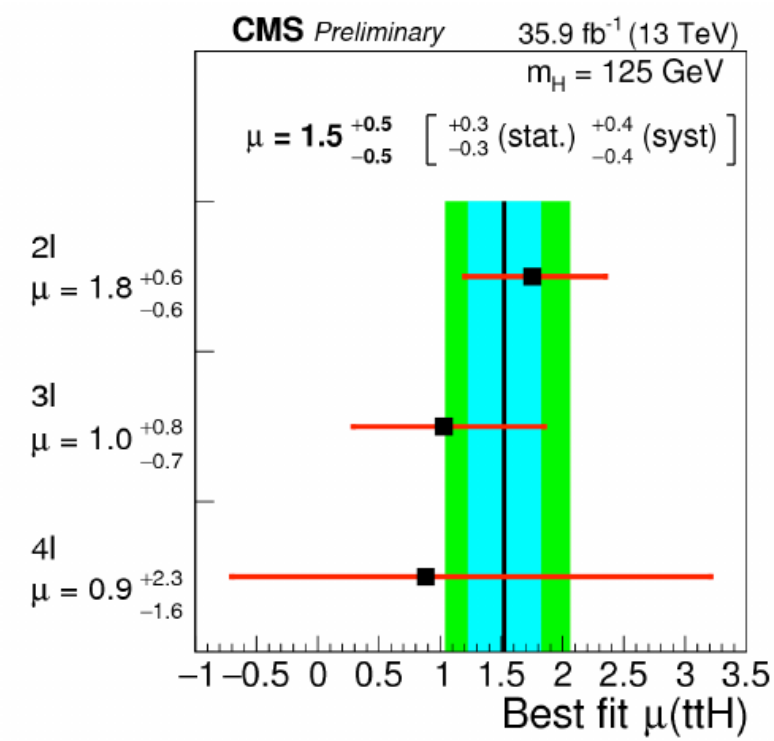








RESULTS



- Measurement of the $t\bar{t}H$ production cross-section of a 50% uncertainty
- Observed (expected) significance w.r.t. $\mu(t\bar{t}H) = 0$ hypothesis: 3.3 (2.4) σ

Challenges for the future

- Analysis very optimized for the current detector conditions
  - Using elaborate data-analysis techniques (BDT + likelihood discriminator)
  - ...trained with non-trivial variables (matrix elements, BDTs)
  - Using data-driven techniques for many of the main backgrounds
- ...leading us to a result of 3-σ-sensitivity analysis

- However this might not be enough to drive us to a 5-σ observation with higher luminosity
- Simpler cut-and-count analysis might be more suitable to use for recast or reinterpretations

Thanks for your attention!
Questions?