



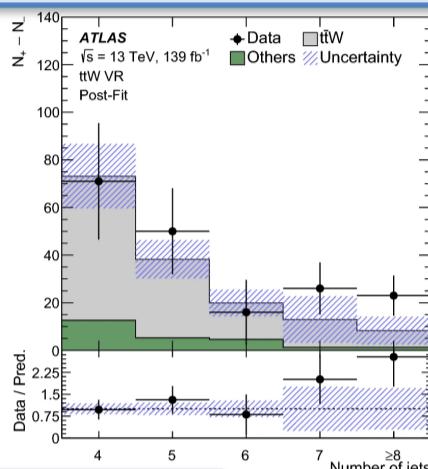
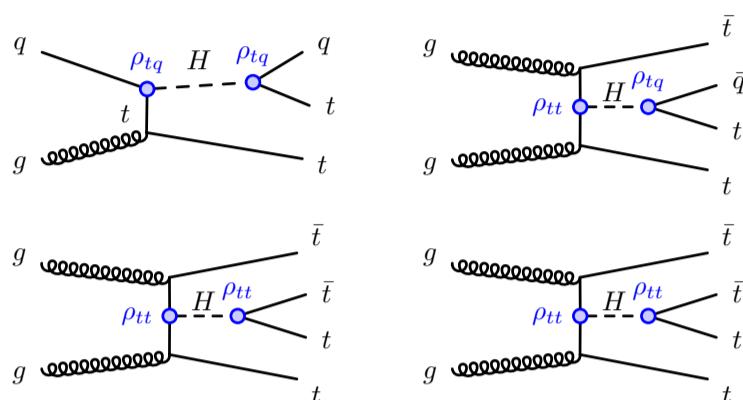
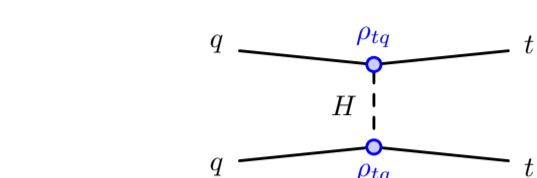
Search for heavy Higgs bosons from a g2HDM in multilepton plus b -jets final states in pp collisions at 13 TeV with the ATLAS detector

Merve Nazlim Agaras on behalf of the ATLAS collaboration | ICHEP 2022

Introduction

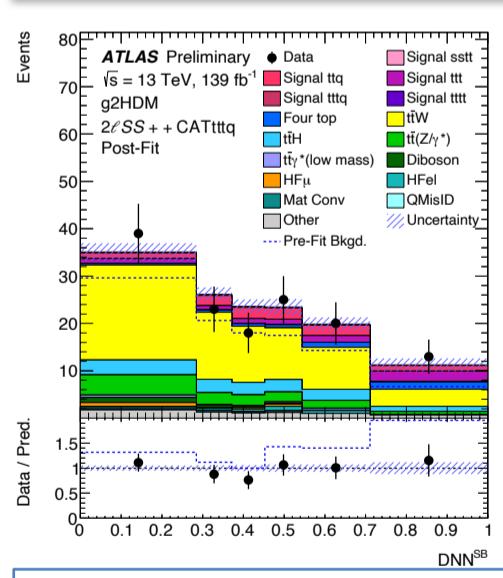
general 2HDM: including off-diagonal Yukawa couplings for the second doublet in the alignment limit while dropping discrete symmetry (Z_2) which will allow for FCNH

- Extra **sub-TeV** Higgs bosons (H^0, A^0) with extra Yukawa couplings: $\rho_{tt}, \rho_{tw}, \rho_{tc}$
 - Satisfy existing experimental constraints (Higgs coupling measurements, flavour physics, etc.), and can address several shortcomings of the SM: electroweak baryogenesis, strong CP problem, flavour problem, etc
 - Production modes with tH and ttH and resulting processes $sstt, ttq, ttt, tttq, tttt$ are studied
 - Final states with multiple leptons ($2\ell SS, 3\ell, 4\ell$) and b-jets studied (expect lepton charge asymmetry)

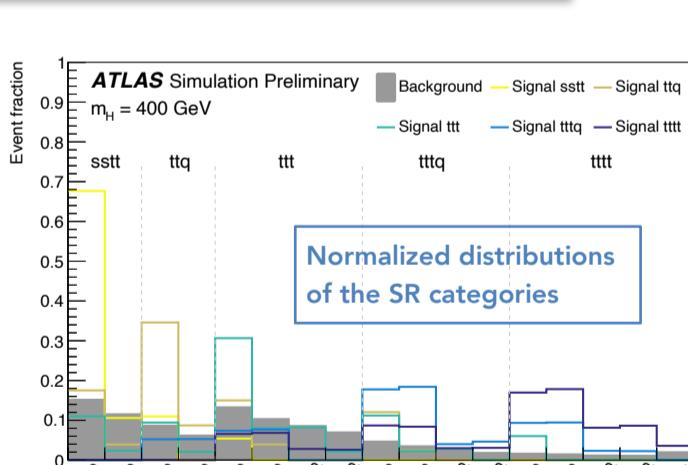


Analysis strategy

- Use **tight lepton definition** to suppress reducible background
 - **Estimate corrections** from data for various non-prompt ℓ (HF, conversions) and irreducible (VV+HF jets, $t\bar{t}Z$, $t\bar{t}W$) backgrounds in simultaneous fit CRs+SRs
 - Multiple **control regions** are defined in order to fit the normalisation of the leading backgrounds
 - Pseudo-continuous (“exclusive”) WPs to build CRs enriched in non-prompt leptons
 - Background from charge-misidentification estimated through a data-driven approach in the 2ℓ SS channel
 - Signal regions
 - Split according to number of leptons, total lepton charge, and a **multi-output deep neural network classifier** (DNN^{CAT}) to categorise the different BSM signals
 - A second **DNN** is trained in a distance correlation (disCo) approach in each CAT to discriminate the signal from the backgrounds (DNN^{SB})
 - Simultaneous profile likelihood fit of CRs+SRs

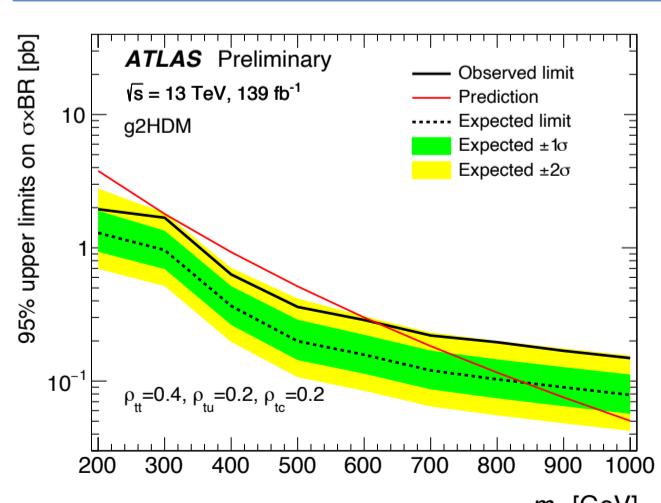


SR with the most significant tension at high DNN^{SB}

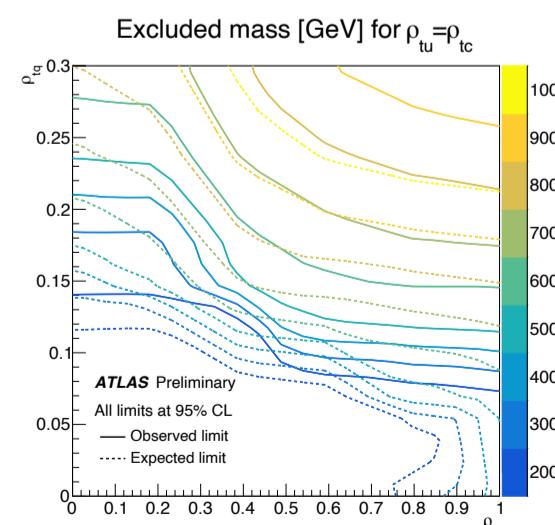


Results

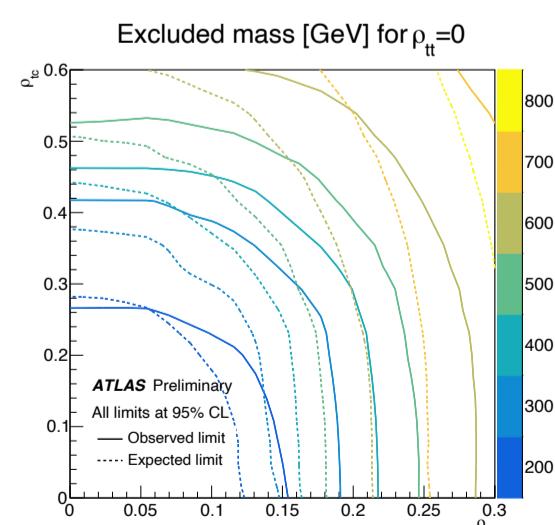
- 95% CL upper limits on the $\sigma \times \text{BR}$ for all the 2HDM signals together across different heavy Higgs masses (from 200 to 1000 GeV)
 - Assuming BSM signal corresponding to benchmark match $t\bar{t}W$ and 4-tops tensions: 400 GeV and $\rho_{tt} = 0.4$, $\rho_{tc} = 0.2$, $\rho_{tu} = 0.2$
 - Assuming $\rho_{tt} = 0$ or $\rho_{tq} = 0$
 - **Scan the full 4D planes of couplings ($\rho_{tt}, \rho_{tu}, \rho_{tc}$) vs mass**
 - **A mild excess is observed** over SM expectation to a local significance of **2.81σ** for a signal with $m_H = 1000 \text{ GeV}$ and ($\rho_{tt} = 0.32$, $\rho_{tc} = 0.05$, $\rho_{tu} = 0.85$)
 - **Bonus:** RPV SUSY interpretation
 - Set limits on wino, higgsino and smuon-bino models with RPV LQD coupling



Observed exclusion limits on the $\sigma \times \text{BR}$ ratio for the benchmark coupling scenario



Observed (solid line) and expected (dashed line) exclusion limits on the scalar mass as a function of the coupling under $\rho_{tc} = \rho_{tu}$



Scan of the couplings at $m_{\tilde{\chi}} = 1 \text{ TeV}$

