Interference effects in $H^{\pm}$ production at the LHC

D. Azevedo, R. Santos, S. Moretti, P. Sharma,
R. Benbrik, A. Arhrib, R. Patrick

Departamento de Física
Universidade de Lisboa

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Outline

Introduction

Study of $pp \rightarrow tH^{-} \rightarrow tW^{-}b\bar{b}$ events, under 2HDM framework, has shown large interference effects between signal and background. arXiv:1712.0501

- Interference of $\mathcal{O}(100\%)$ remains even after selection cuts, mostly negative.
- Kinematical distributions alike for signal and interference.
- LHC searches should require "inclusive" rescaling of the event yield.

Current project focus on the Minimal Supersymmetric Model (MSSM) in $2 \rightarrow 3$ events, namely $pp \rightarrow t\bar{b}H^{-}$ and $pp \rightarrow \bar{t}bH^{+}$.

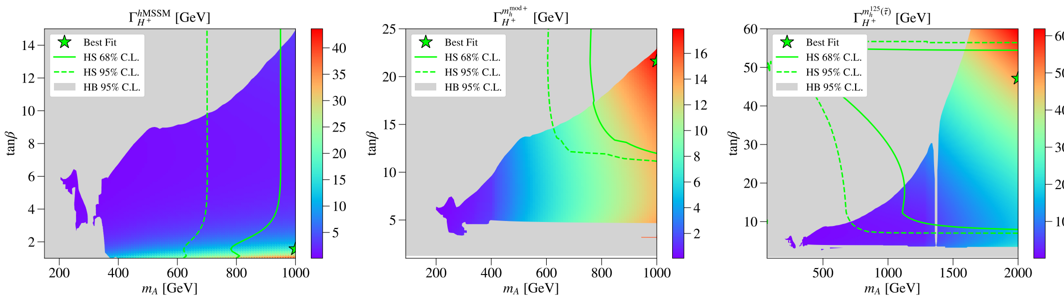

Figure: Benchmarks comparisons: $tan\beta$ vs. m_{A^0} with Γ_{H^+} as color code. Left to right: hMSSM, $m_h^{\text{mod}+}$ and $m_h^{125}(\tilde{\tau})$.

Benchmark cross-sections

→ Benchmarks points are chosen where there is a large charged Higgs width and smallest m_A^0:

Parameters	**hMSSM**	$\mathbf{m_h^{mod+}}$	$\mathbf{m_h^{125}}(\tilde{\tau})$
μ (GeV)	200	200	1000
$\tan\beta$	1.01	14.576	3.191
m_{H^+} (GeV)	633.91	628.5	628.08
Γ_{H^+} (GeV)	27.777	6.991	2.677

Production cross-sections:

Benchmark	Signal (pb)	Background (pb)
hMSSM	$(3.243 \pm 0.001) \times 10^{-2}$	13.078 ± 0.004
m_h^{mod+}	$(4.2312 \pm 0.0006) \times 10^{-4}$	13.03 ± 0.04
$m_h^{125}(\tilde{\tau})$	$(1.6805 \pm 0.0006) \times 10^{-2}$	13.183 ± 0.047

Benchmark	Signal+Background (pb)	**Interference** (pb)
hMSSM	13.140 ± 0.004	$(3.0 \pm 0.8) \times 10^{-2}$
m_h^{mod+}	13.0513 ± 0.0057	$(2.09 \pm 4.56) \times 10^{-2}$
$m_h^{125}(\tilde{\tau})$	13.189 ± 0.005	$(-1.1 \pm 0.7) \times 10^{-2}$

Where

$$(S+B)^2 = S^2 + B^2 + \text{Interference} \quad (1)$$

→ Still large errors but interferences seem to be present.

Some kinematic distributions 1/2

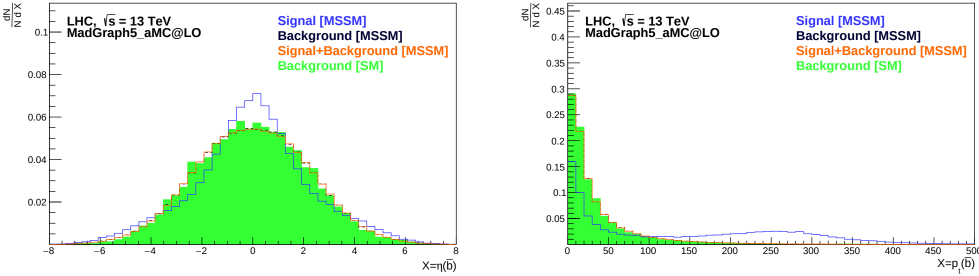

Figure: hMSSM: Antibottom quark η (left) and p_t (right) distributions.

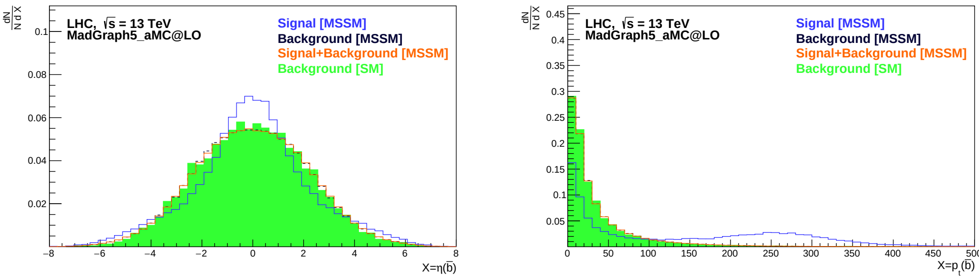

Figure: $\mathbf{m_h^{mod+}}$: Antibottom quark η (left) and p_t (right) distributions.

Some kinematic distributions 2/2

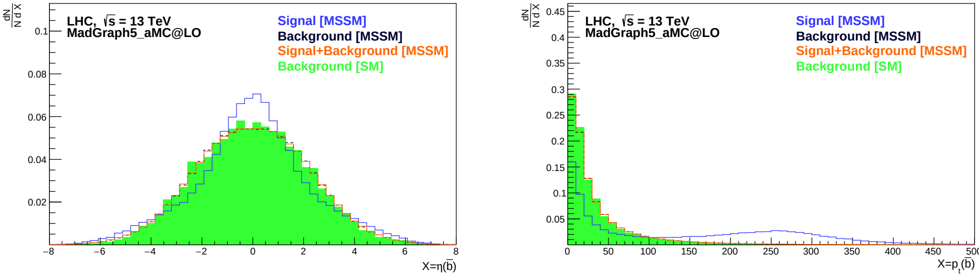

Figure: $\mathbf{m_h^{125}}(\tilde{\tau})$: Antibottom quark η (left) and p_t (right) distributions.

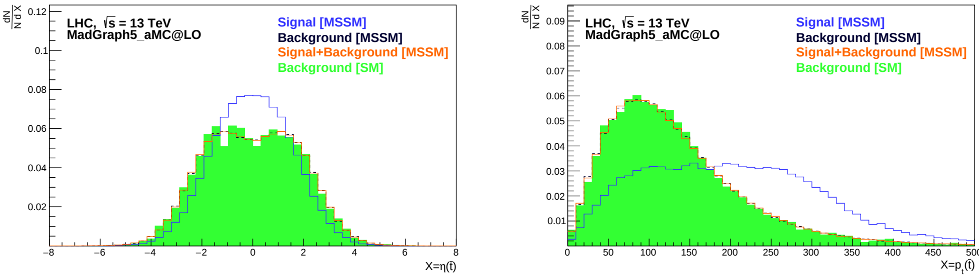

Figure: $\mathbf{m_h^{125}}(\tilde{\tau})$: Antitop quark η (left) and p_t (right) distributions.

Charged Higgs kinematic distributions

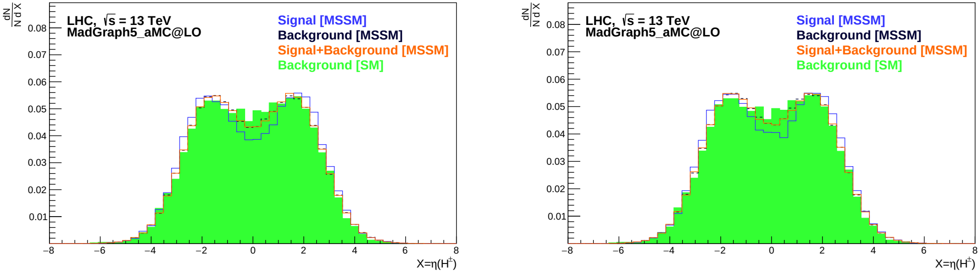

Figure: Charged Higgs η distribution between hMSSM (left) and m_h^{mod+} (right).

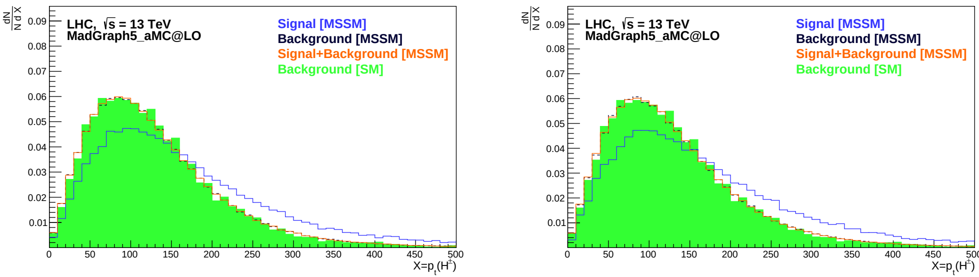

Figure: Charged Higgs p_t distribution between hMSSM (left) and m_h^{mod+} (right).

Conclusions

→MSSM benchmarks scenarios show large interferences as well. Next steps will be

- Analyse the evolution of the interference after showering, reconstruction and selection cuts.
- Check whether established (by ATLAS and CMS) searches can disentangle the MSSM signals when defined as $(S+B)^2 - B^2 = S^2 + 2\Re(SB^*)$.