

Summary of WG3 Discussions

16th Higgs Cross Section Working Group General Meeting

Oct. 18th 2019

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SM-like Cross Sections for BSM Higgs

- Cross sections for the production of a SM-like Higgs boson with mass heavier than 125 GeV have been provided by WG1:

<https://twiki.cern.ch/twiki/bin/view/LHCPhysics/CERNYellowReportPageBSMAAt13TeV>

- **Gluon Fusion**

- Two sets are made available: NNLO+NNLL, and N3LO with infinite top mass. Which set should be used in BSM analyses based on SM-like cross sections with rescaled Higgs couplings?
- N3LO with infinite top mass is by no means "SM-like" for a heavy Higgs.
- An analysis based on rescaled SM-like cross sections should use the NNLO+NNLL numbers, which include full top-mass effects up to NLO.
- The two set of numbers describe very different physical scenarios and should not be presented side-by-side to avoid confusion.
- Also, contributions proportional to different Higgs couplings should be given separately.

- **VBF**

- ggH numbers go up to 5 TeV but VBF stops at 3 TeV
- Depending on model, VBF cross section could be important at high mass
- Would ask WG1 to extend VBF numbers to the same range as ggH

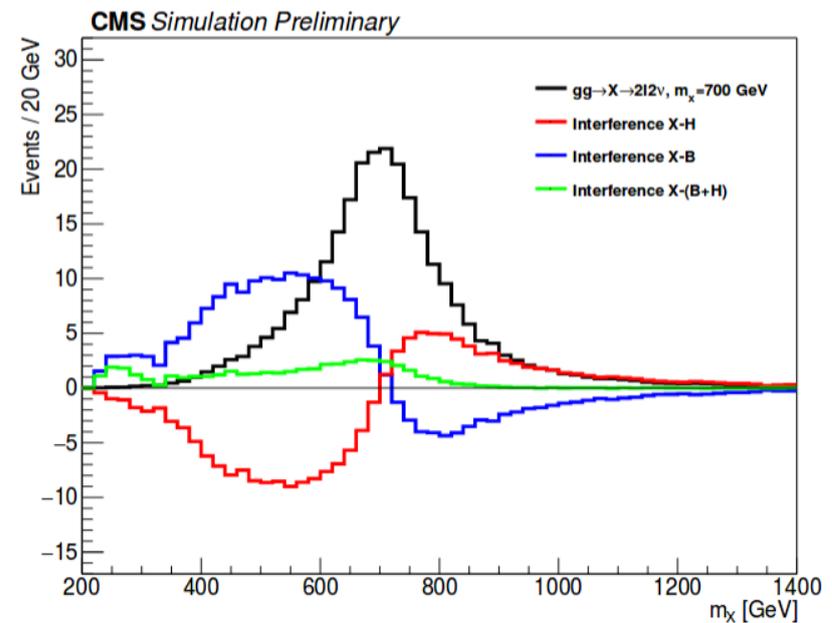
SM-like Cross Sections for BSM Higgs

- Cross sections so far have been provided in the NWA
 - Should have multi-dimensional tables of cross sections vs. mass, width, and coupling
- Interference effects are of course important and affect the signal lineshape
 - Longer term, not only cross sections should be provided but also reference lineshape per final state
 - Overlap with offshell group in the case of $H \rightarrow VV$
- Accounted for in the experiments, although not always fully parametrized
 - Could (should?) provide/standardize tools/instructions, not just numbers

ggF and VBF $H \rightarrow WW$ generated with POWHEG+JHUGen
Assume SM Width up to 1 TeV

Approximation above 1 TeV : Width = $0.5 * m_X$

Interference with WW continuum and $h(125)$ considered
(Estimated with MELA reweighting of signal)

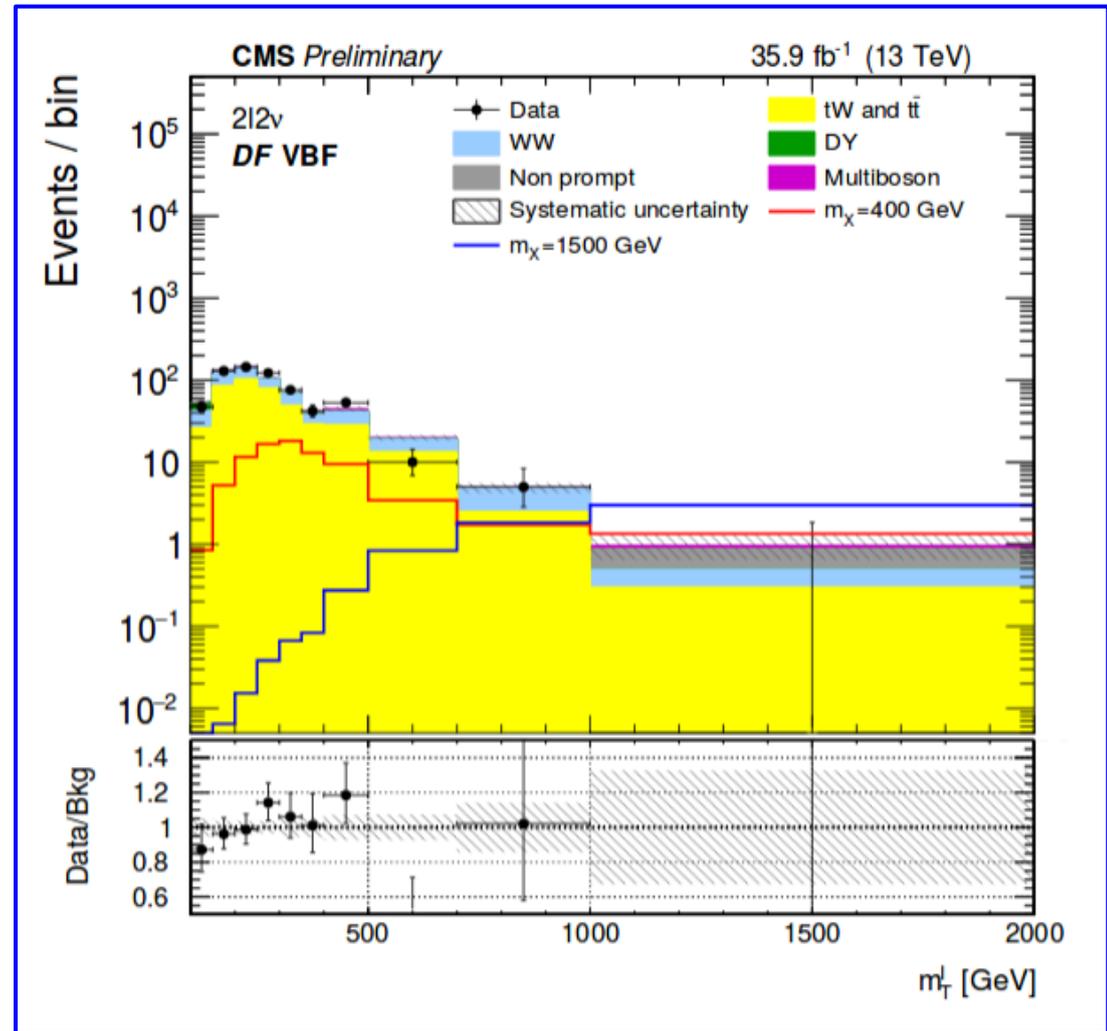


Physics model : Yield = $\mu * \mathbf{S} + \sqrt{\mu} * \mathbf{I} + \mathbf{B}$

Dermot Moran (CIEMAT)

SM-like Cross Sections for BSM Higgs

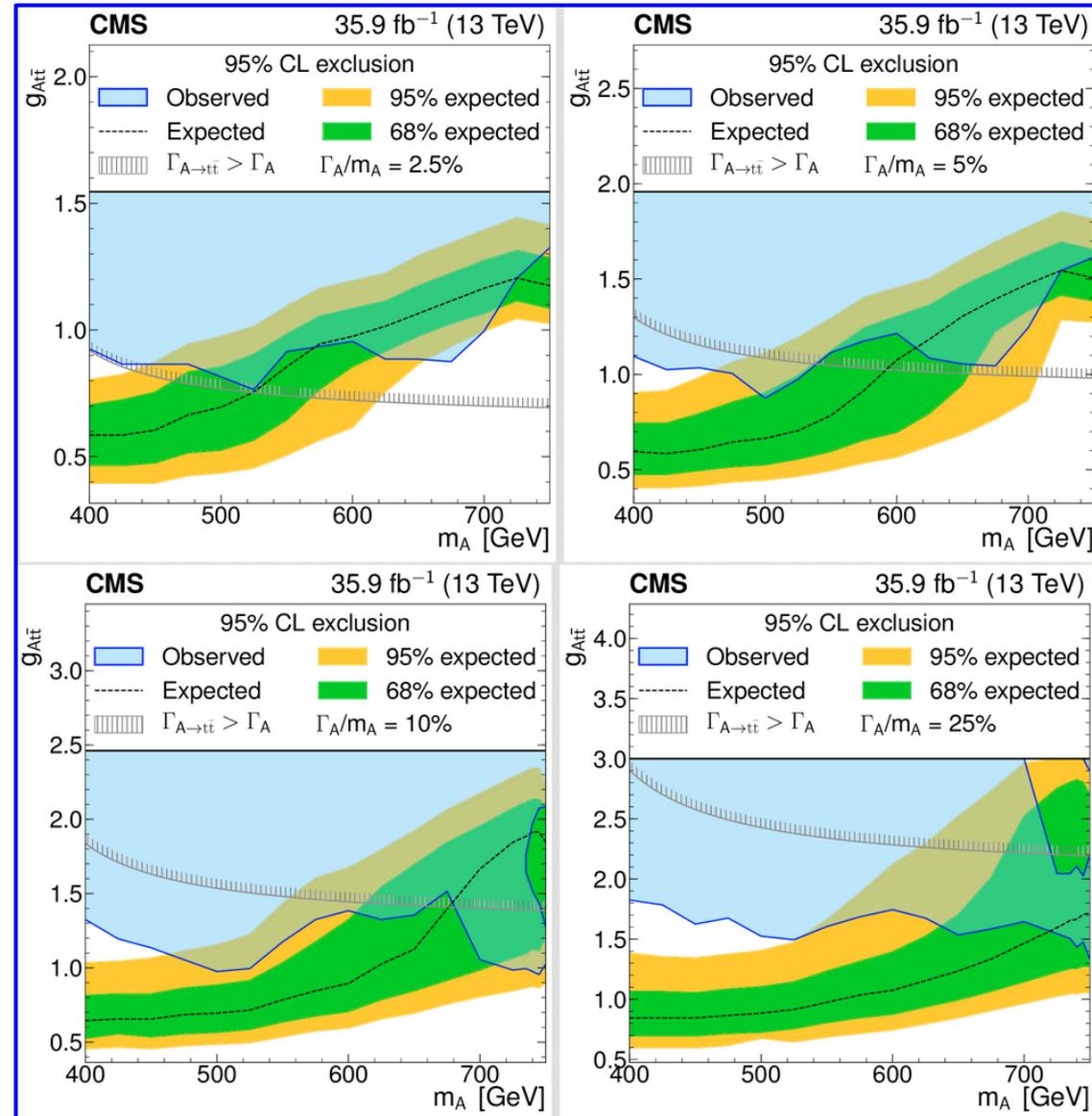
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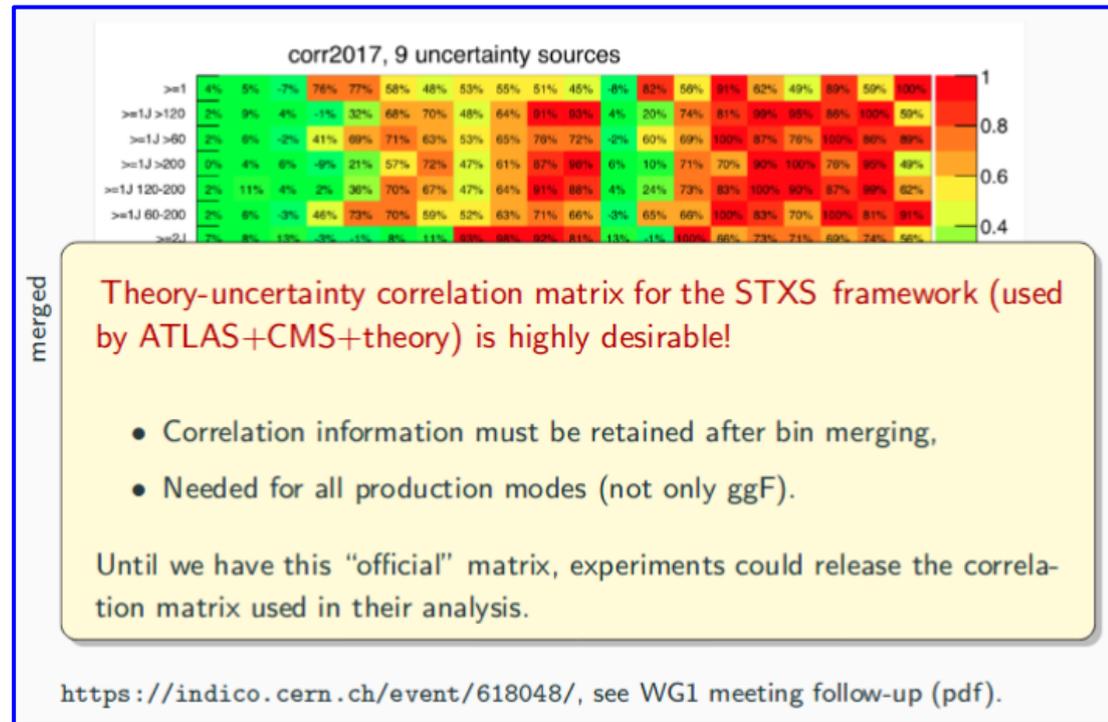
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arXiv:1908.01115

Presentation of H(125) Results for BSM Interpretations

- Authors of different codes (HiggsSignals, Lilith) had similar recommendations
- Correlations in experimental analyses (including theory uncertainties) should be made public
 - For certain types of measurements (e.g. signal strengths) they already are made public, though “closure tests” are not perfect
- Converging on an “official” theory correlation scheme is difficult
- Experimentalists agreed (in principle) to provide the THU corr. scheme they used
 - Although all agreed that better would be for theorists to talk between themselves without having to go through the experiments

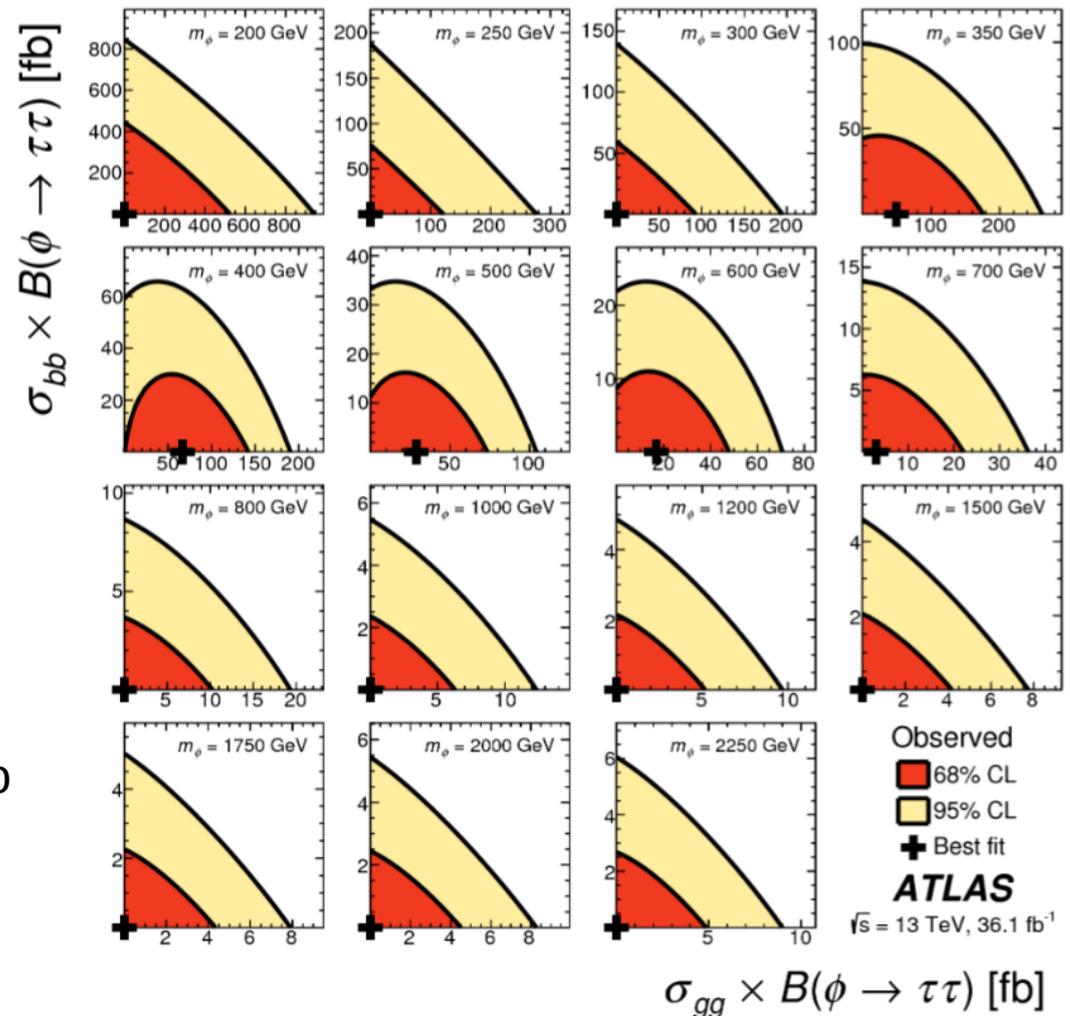


S. Heinemeyer/T. Stefaniak (CSIC/DESY)

Presentation of BSM Higgs Results for Reinterpretations

- Theory colleagues would like to have the full profiled likelihood scan as a function of all of the relevant POIs
- This is important when including the BSM higgs search result in a global fit
- This was already provided for $\Phi \rightarrow \tau\tau$ searches in both CMS and ATLAS
- In some cases this can be a pretty high dimensional space
- Mass(es), width(s), multiple cross sections and BRs
- Its a lot of work for experimentalists, so would be nice to ensure the original data is always being cited

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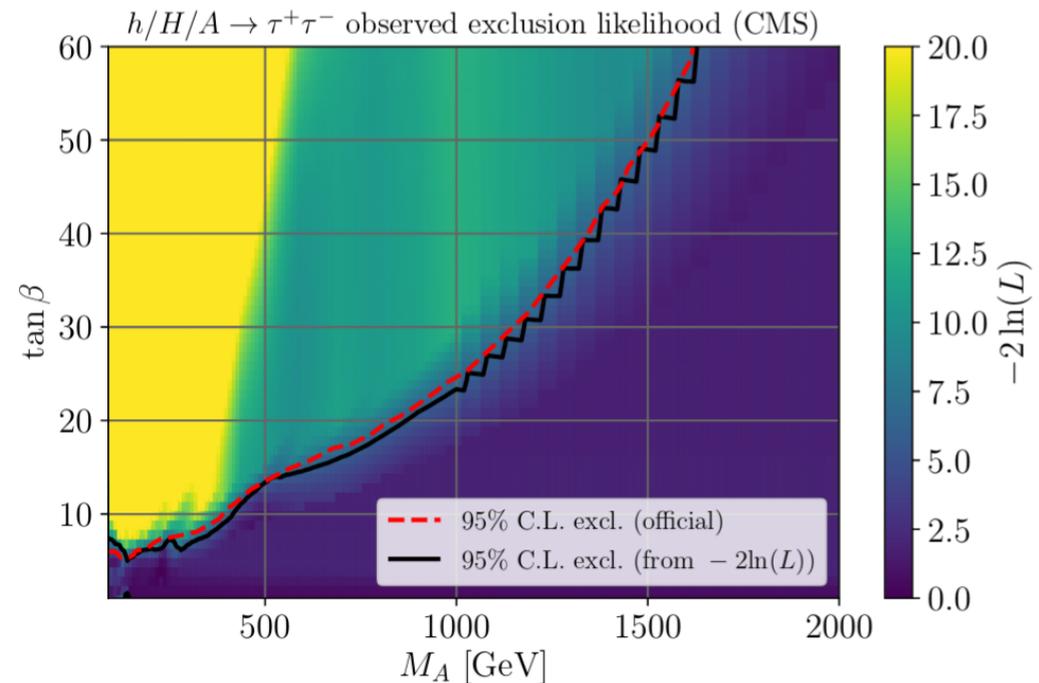


arXiv:1709.07242

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Presentation of BSM Higgs Results for Reinterpretations

- Identified a short list of high priority analyses for BSM fits
- Next steps: identify in these channels which of the relevant parameters are already continuous and which are discrete steps (i.e. what is easy and what is hard), relay information to experiments
- If there are other channels that are important to be used in a fit, model proponents should let it be known

Channel	relevant parameters	BSM model
$pp \rightarrow b\bar{b}\phi, \phi \rightarrow b\bar{b}$	$M_\phi, \sigma(pp \rightarrow \phi), \sigma(pp \rightarrow b\bar{b}\phi)$	MSSM, 2HDM
$pp \rightarrow \phi \rightarrow t\bar{t}$	$M_\phi, g_{Ht\bar{t}}, g_{At\bar{t}}, \Gamma_{\text{tot}}$	MSSM, 2HDM (Also $pp \rightarrow t\bar{t}\Phi^+$)
$pp \rightarrow \phi \rightarrow ZZ, W^+W^-$	$M_\phi, \mu_{pp \rightarrow \phi}, \mu_{\text{VBF}, V\phi}, (\Gamma_{\text{tot}})$	singlet extensions
$pp \rightarrow \phi \rightarrow h_{125}h_{125}$	$M_\phi, \sigma(pp \rightarrow \phi \rightarrow h_{125}h_{125}), (\Gamma_{\text{tot}})$	singlet extensions
$pp \rightarrow \phi_2 \rightarrow Z\phi_1$	$M_{\phi_1}, M_{\phi_2}, \sigma(pp \rightarrow \phi_2 \rightarrow Z\phi_1)$	2HDM
$pp \rightarrow t\bar{b}\phi^\pm, \phi^\pm \rightarrow t\bar{b}$	$M_{\phi^\pm}, \sigma(pp \rightarrow t\bar{b}\phi^\pm \rightarrow t\bar{b}t\bar{b})$	MSSM, 2HDM (Also $\Phi^+ \rightarrow \tau\nu$)
$pp \rightarrow \Phi \rightarrow \tau\tau$	$M(\Phi), \sigma(gg\Phi), \sigma(bb\Phi)$	MSSM, 2HDM ✓
$pp \rightarrow \Phi+X \rightarrow \text{inv}+X$	$M(\Phi), \sigma(\Phi+X)$	DM models ✓ (?)