

High mass Higgs searches: diboson decay modes?

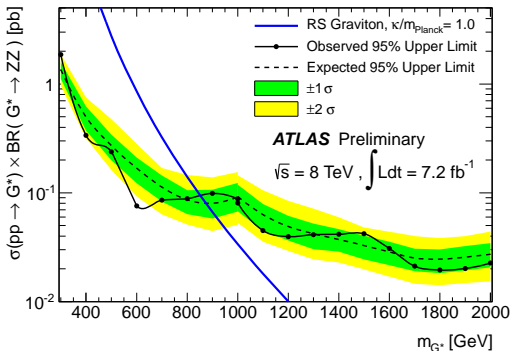
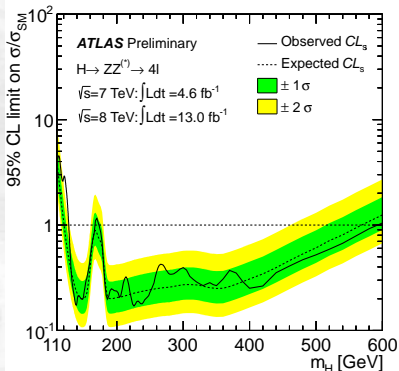
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LHC Higgs x-sec BSM Heavy Higgs, CERN
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- Among many results ATLAS (and CMS) has search for ZZ and WW Higgs decays in the high mass ($m_H > 200/300$ GeV):
 - $H \rightarrow ZZ^{(*)} \rightarrow \ell^+ \ell^- \ell^+ \ell^-$
 - $H \rightarrow ZZ \rightarrow \ell^+ \ell^- \nu \bar{\nu}$
 - $H \rightarrow ZZ \rightarrow \ell^+ \ell^- q \bar{q}$
 - $H \rightarrow W^+ W^- \rightarrow \ell \nu q \bar{q}$
 - $H \rightarrow W^+ W^- \rightarrow \ell^+ \nu \ell^- \bar{\nu}$
- Also exotic searches (typically graviton-like)
 - ZZ decays with leptons (only 1 fb^{-1})
 - $ZZ \rightarrow \ell \ell q \bar{q}$ (7.2 fb^{-1} @ 8 TeV)
 - Also WW, WZ, etc...
- No need to explain here, for a Higgs-like signal theory side two main issues (already solved) impacted these searches:
Line-shape and interference with SM backgrounds.



So far in our results we have been including the famous *ad hoc* $150\% m_H(\text{TeV})^3$ systematic uncertainty.

Interference and Lineshape

I won't list existing calculations/codes since you know them better than me...

- Lineshape:
 - PowHeg box where
 - ComplexPoleScheme included. Both ggF and VBF.
- Interference:
 - Reweight our signals, as we did it in the past using HqT (Higgs p_T)
 - Calculate a systematic uncertainty as function of m_H , as we did with the *ad hoc* $150\%m_H(\text{TeV})^3$

But up to what extend do we actually need all this?

Low mass Higgs boson → interference that changes high end of **VV shapes**,

... but when looking for a “second” Higgs how to consider lineshape (and interference) when coupling strengths are “unknown”???

→ It's all a matter of **width**?

- Ideally we would like to:
 - Have benchmarks models (and MC - prescriptions) where we can test hypotheses.
 - Have a “model independent” strategy to tackle the new know unknowns
 - **Both.**

- if (for the “model independent”?) your answers (to do it the best possible way for a Higgs search) were:
 - *“you can reuse what you have: resimulate changing a parameter in the job option”*
 - *“Just use a generic BW bump search, for interference/and lineshape do this or that”*
 - I know I’m too naive..

 - For a given Higgs mass with different widths:
Interference? Lineshape? Kinematics? jet descriptions? uncertainties? How to combine?
 - What about interferences like:
 $WW \rightarrow \ell\nu\ell\nu$ onto the $H \rightarrow ZZ \rightarrow \ell^+\ell^-\nu\bar{\nu}$
 or $V + qq$ in $H \rightarrow W^+W^- \rightarrow \ell\nu qq / H \rightarrow ZZ \rightarrow \ell^+\ell^-q\bar{q}$