

April 13 2018

NMSSM Subgroup of LHC HXSWG3 meeting

ATLAS feedback for NMSSM

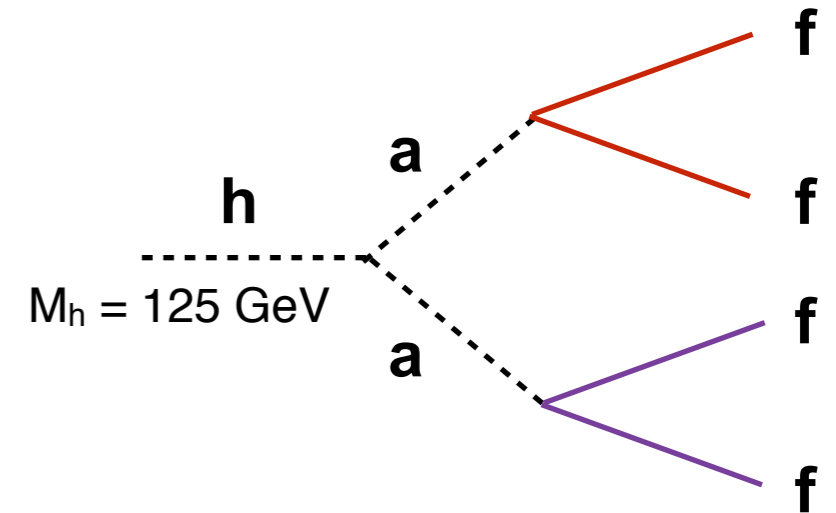
Roger Caminal Armadans, Massachusetts University

Eric Feng, CERN

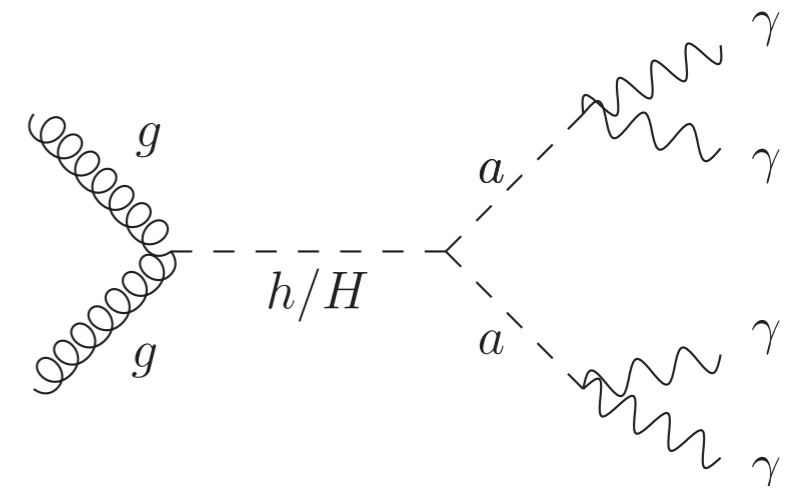
Ljiljana Morvaj, Stony Brook
on behalf of ATLAS analyzers



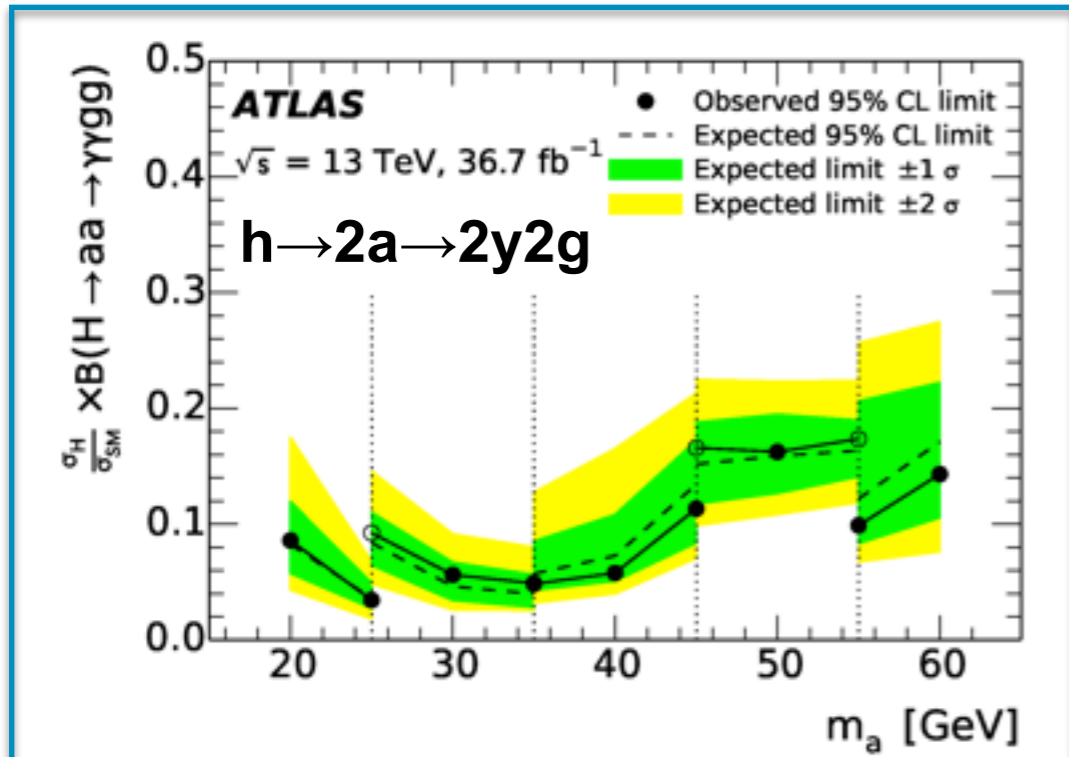
- $h(125) \rightarrow aa$ group of searches motivated by 2HDM+S
- $\text{Br}(h \rightarrow aa)$ can be significant in NMSSM
- Existing ATLAS searches listed in the table
- **Many searches in new final states coming out soon/end of Run 2**



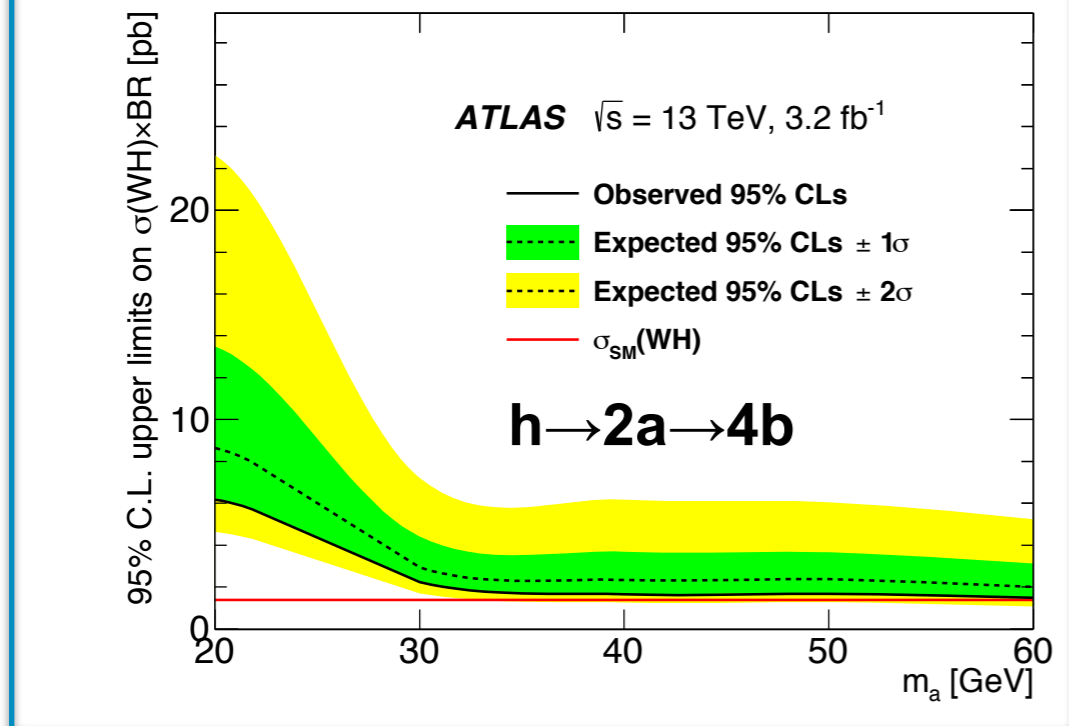
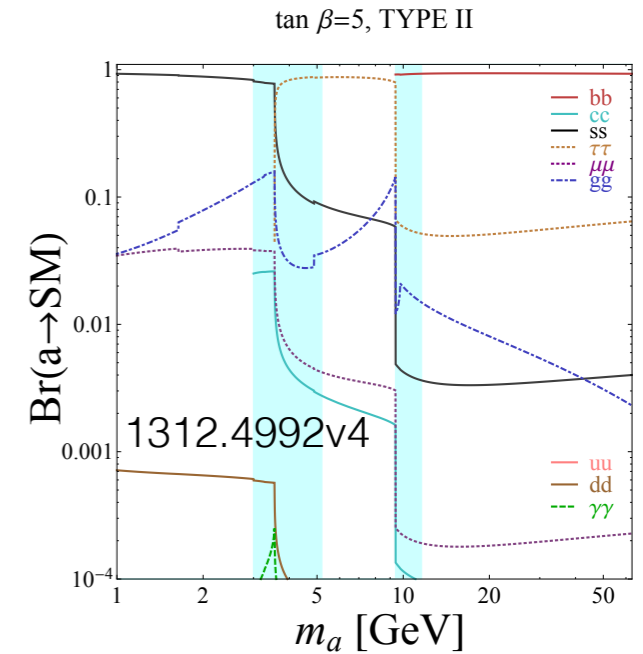
Process	Run 1	Run 2
$h \rightarrow 2a \rightarrow 2j2\gamma$ (VBF)		<u>1803.11145</u>
$h \rightarrow 2a \rightarrow 4b$ (Wh)		<u>1606.08391</u>
$h \rightarrow 2a \rightarrow 2\tau 2\mu$	<u>1505.01609</u>	
$h \rightarrow 2a / 2Z_d / ZZ_d \rightarrow 4\ell$	<u>1505.07645</u>	<u>1802.03388</u>
$h \rightarrow 2a \rightarrow 4\gamma$	<u>1509.05051</u>	



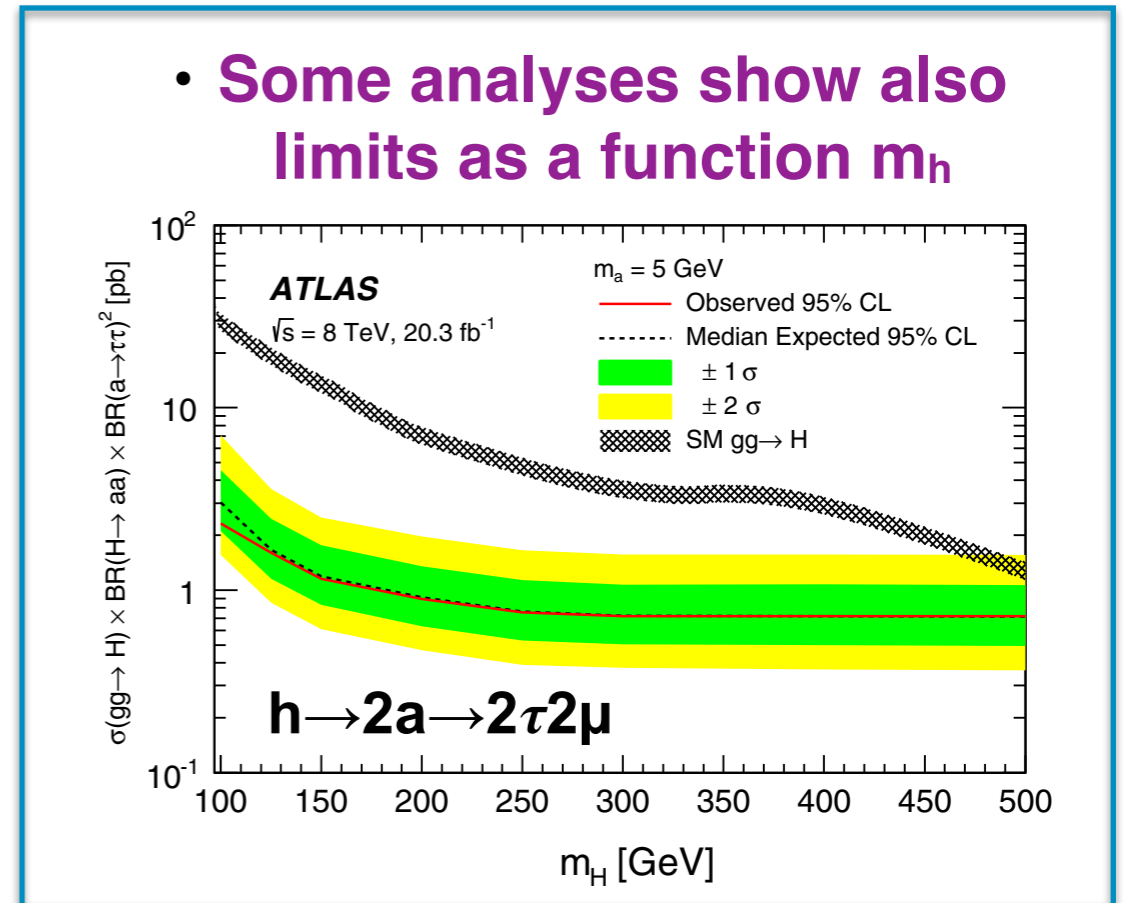
- Quote limits on $\text{Br}(h \rightarrow aa \rightarrow xxyy)$ as a function of m_a



Can easily interpret in different 2HDM scenarios



- Some analyses show also limits as a function m_H



- **Would be nice to reinterpret the existing analyses in other benchmark models**
- Simple reinterpretations (maybe even only at generator level) could serve as an “appetizer” to give a broad sense of sensitivity and motivate a new search
- **List of NMSSM models on the [Twiki](#)**
 - Those involving a light Higgs decaying into two lighter bosons, e.g. BP2_1, could be re-interpreted with the existing analyses
 - Probably not so sensitive to other models since:
 - **The 4-object mass usually constrained to 125 GeV**
 - Can't just reinterpret for high-mass H scenarios, unless the analysis includes that scan
 - **Usually assume 2a of equal masses**
 - ✓ can apply powerful kinematic constraints to reduce backgrounds
 - hard to re-interpret in a1/a2 cases
 - **Some analyses use BDTs dedicated to their signature**

- Lots of interesting signatures to look at and very reduced person power working in this group.
- It is important to “motivate” people to come and join us!
 - ➔ **Have a very explicit and understandable motivation (we are experimentalists 😊) to search for NMSSM**
 - ➔ **Have a list of few models that are most motivated by the current experimental constraints or some kind of “ranking”**
 - ➔ **Do sensitivity studies/provide ideas on how to search for those most motivated models**
- Unexplored cases:
 - $h(125) \rightarrow a1a2 / aa^*$
 - $H(\text{heavy}) \rightarrow aa / a1a2 \implies \text{scan } H/a$
- ➔ **Provide instructions on how to generate MC samples for benchmark models**

- Most recent and future analyses use Powheg + Pythia setup
 - **Use existing LHE files with Powheg generated SM Higgs**
 - **Use Pythia for the $h \rightarrow aa \rightarrow xxyy$ decay and showering**
 - Change pdgId 25(h_0) \rightarrow 35(H_0) to allow the use of “*useBSM*” option in Pythia
 - Then decay to aa setting $\text{Br}(aa \rightarrow xxyy) = 100\%$ for a given xxyy channel
- **Very general setup w/o considering possible model-dependent kinematic changes**
- Ongoing discussion: Are the CP/spin correlations of a-decays conserved in Pythia?
 - Atm. we avoid cutting on CP sensitive variables, but having this implemented correctly would enable us to study e.g. Higgs CP violations

- What would be the best generators to calculate the **effect of SUSY partners, especially light sparticles, on the Higgs sector (both h(125) and H(heavy))**?
 - Production cross-sections, branching ratios & kinematics for various Higgs bosons
 - What order are these calculations valid to
- And similar question for Higgs effects on SUSY rates and kinematics



Would be very helpful if theorist could, along with proposed benchmark models, provide also a correct MC setup

- Very motivated to increase the scope of our searches!
 - **Prioritize best-motivated benchmark models**
 - **Recommendations how to properly generate these signals**
 - Currently using precise calculations for $pp \rightarrow h$ but simplistic models for $h \rightarrow aa \rightarrow xxyy$
 - **Limited by person-power so would benefit greatly from theory guidance & common ATLAS+CMS benchmarks**
- At least three new analyses are currently ramping up and preparing for full Run2 dataset result
 - They would be happy to include some of the interpretations or even have signal regions to probe some of these benchmark points

Backup

