

# Search and studies of $H \rightarrow ZZ(*) \rightarrow 4l$ with the ATLAS detector

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National and Kapodistrian  
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*HEP 2014*  
*Genesis@LHC*



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# July 2012 Announcement of new Higgs-like boson discovery

Within 2013 -2014

## ➤ Properties measurement

- Measurement of Higgs mass
- Measurement of Higgs couplings
- Measurement of Higgs spin-CP properties

In parallel

- Lepton reconstruction and identification criteria improved
- Event selection criteria optimized
- Systematic uncertainties extensively studied
- Improved background estimation techniques incorporated

**See talks by K. Nikolopoulos and E. Mountricha in this conference**



## Thalis Genesis@LHC contribution to Higgs discovery and properties study in 2013-14

- Participation in data challenges
- Data-driven estimations for background rejection criteria
- Design and application of data-driven method for the estimation of the reducible Z+jets and ttbar backgrounds
- Participation in the event selection criteria for the categorization of the events according to the Higgs production mechanism
- Determination of the reducible background magnitude in these categories

**Phys. Lett. B 726 (2013), pp. 88-119**

**ATLAS-CONF-2013-013**

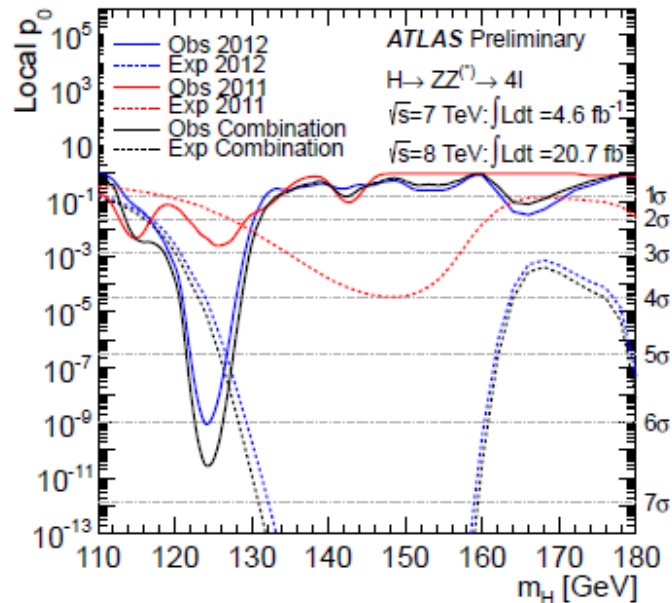
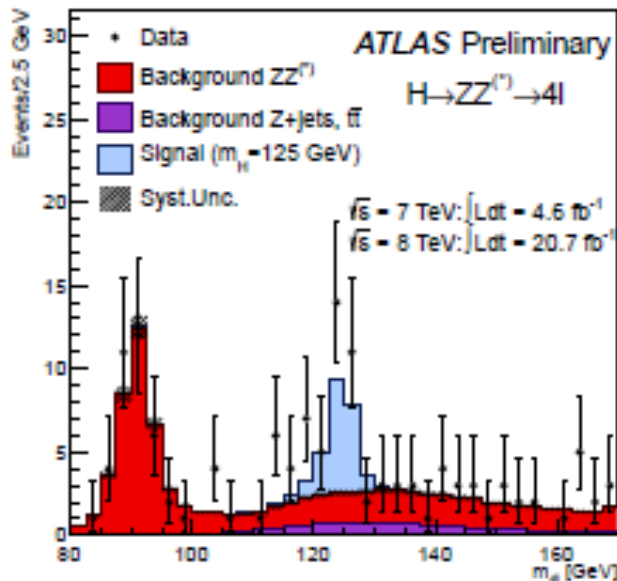
**Publication for Run I data in final stage**

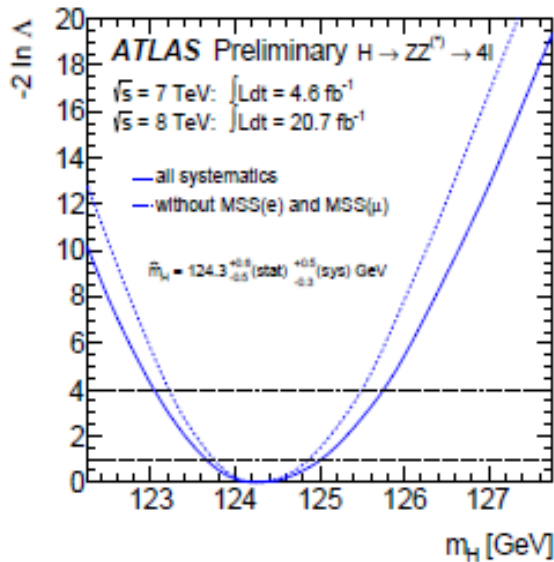
**More than 15 internal presentations in ATLAS WGs**

# ATLAS-CONF-2013-013

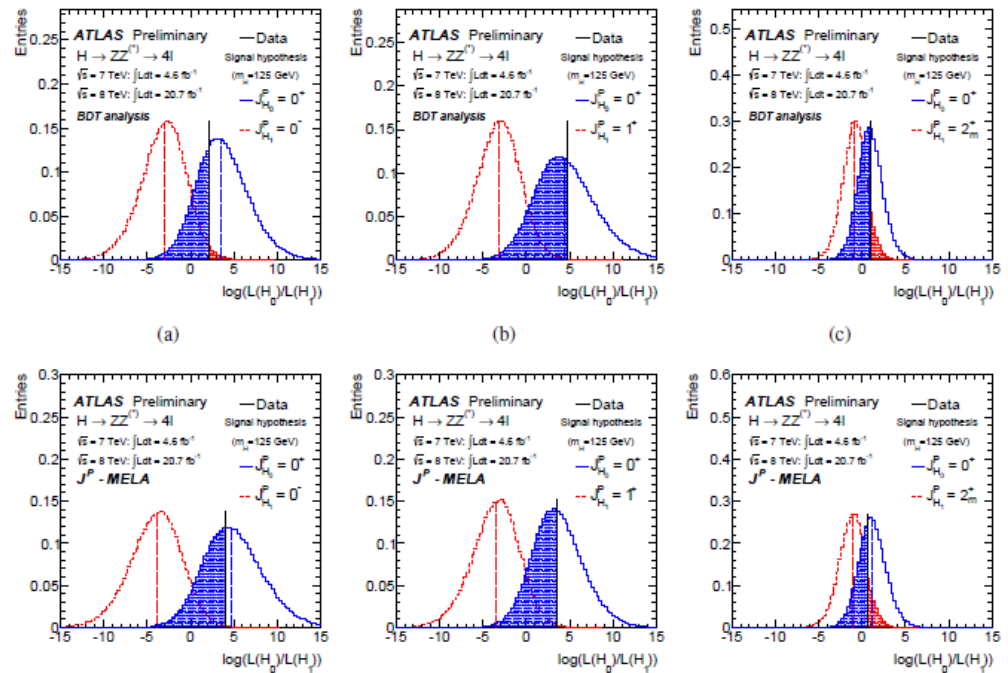
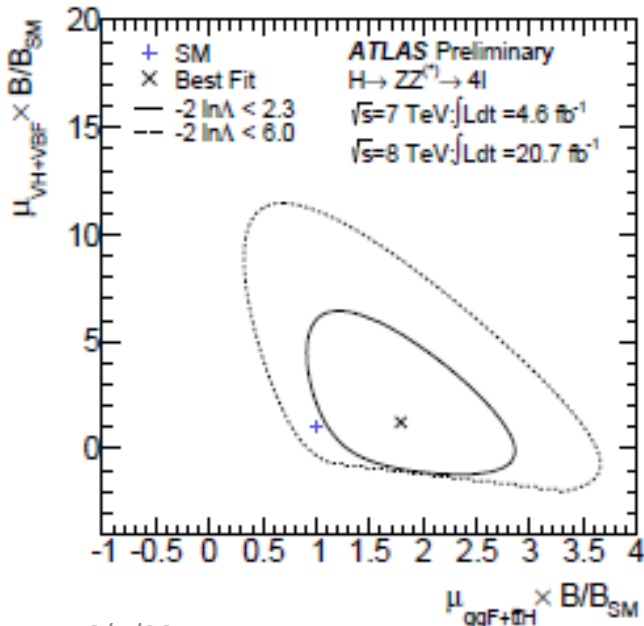
## Reducible background estimation

method	estimate at $\sqrt{s} = 8$ TeV	estimate at $\sqrt{s} = 7$ TeV
	$4\mu$	$4\mu$
$m_{12}$ fit: $Z$ + jets contribution	$2.4 \pm 0.5 \pm 0.6^\dagger$	$0.22 \pm 0.07 \pm 0.02^\dagger$
$m_{12}$ fit: $t\bar{t}$ contribution	$0.14 \pm 0.03 \pm 0.03^\dagger$	$0.03 \pm 0.01 \pm 0.01^\dagger$
$t\bar{t}$ from $e\mu + \mu\mu$	$0.10 \pm 0.05 \pm 0.004$	-
	$2e2\mu$	$2e2\mu$
$m_{12}$ fit: $Z$ + jets contribution	$2.5 \pm 0.5 \pm 0.6^\dagger$	$0.19 \pm 0.06 \pm 0.02^\dagger$
$m_{12}$ fit: $t\bar{t}$ contribution	$0.10 \pm 0.02 \pm 0.02^\dagger$	$0.03 \pm 0.01 \pm 0.01^\dagger$
$t\bar{t}$ from $e\mu + \mu\mu$	$0.12 \pm 0.07 \pm 0.005$	-





$$m_H = 124.3^{+0.6}_{-0.5}(\text{stat})^{+0.5}_{-0.3}(\text{syst}) \text{ GeV},$$



Mass,  
 Couplings,  
 spin-cp measurements

Results propagated to Combined properties  
 measurements CONF-Notes

## Responsibility for the prospects study of the HL-LHC measurement of the couplings in the $H \rightarrow ZZ(*) \rightarrow 4l$ channel

- Introduction of new event selection category for ttH ( $H \rightarrow ZZ(*)$ )
- Study of the strategy towards Higgs couplings measurement in this channel
- Study of the impact of the extreme pile-up conditions and selection criteria in order to optimize the performance of the measurement.

**ATLAS-CONF-2013-034**

**and supporting internal document**

**8 internal presentations in ATLAS WGs**

# ATL-PHYS-PUB-2013-014

Projections for measurements of Higgs boson cross sections, branching ratios and coupling parameters with the ATLAS detector at a HL-LHC

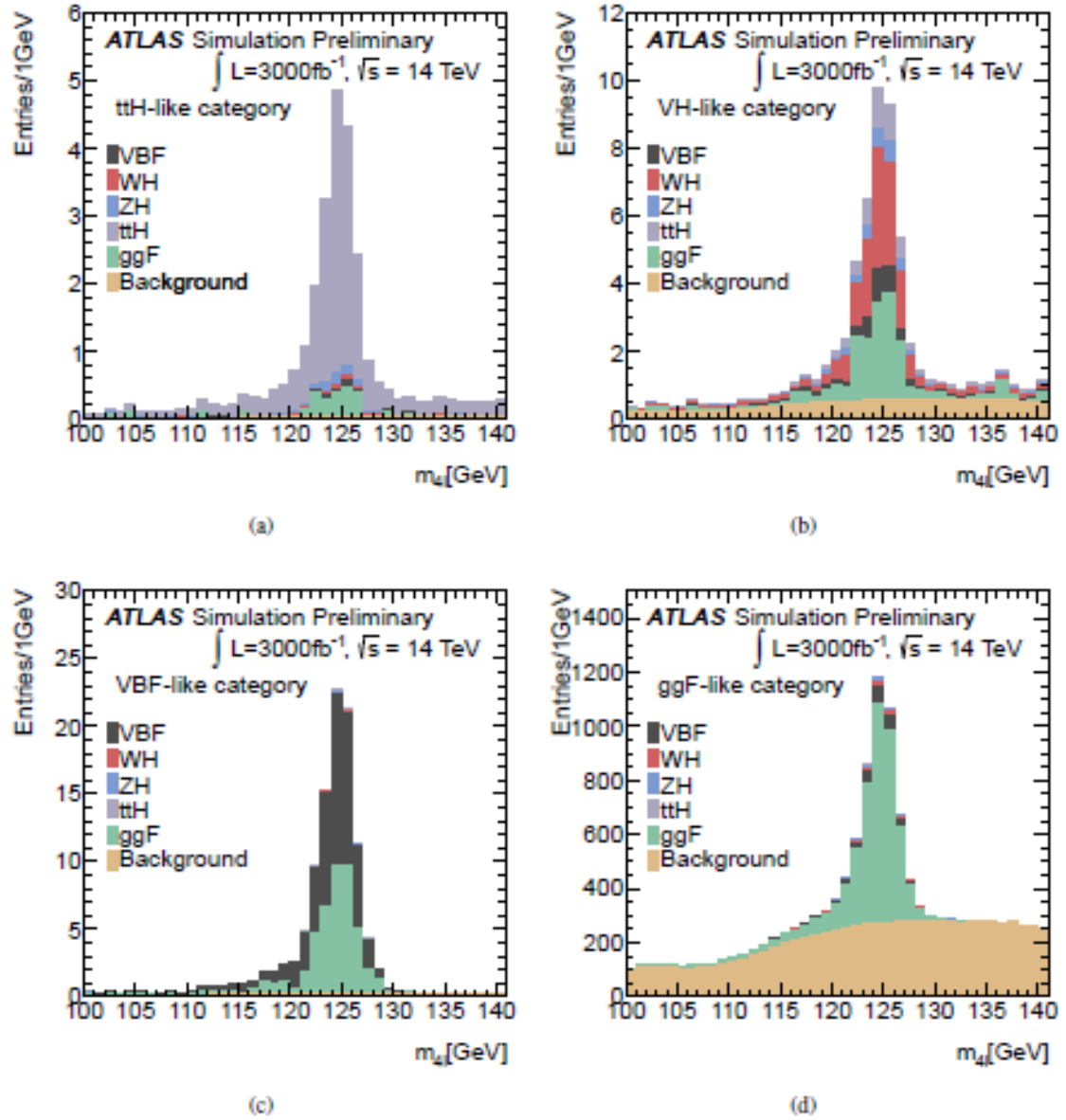


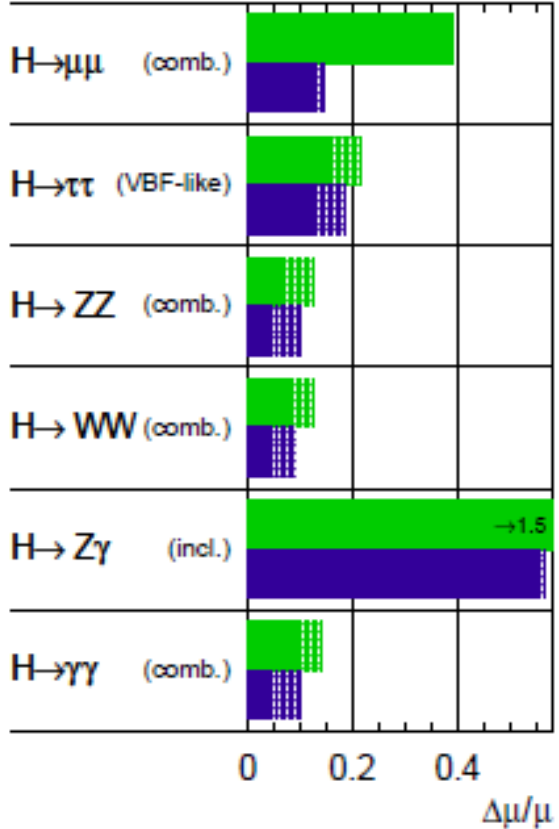
Figure 3: Invariant mass distribution of the 4-lepton system for the  $ttH$ -like (a),  $VH$ -like (b), VBF-like (c) and  $ggF$ -like categories (d).



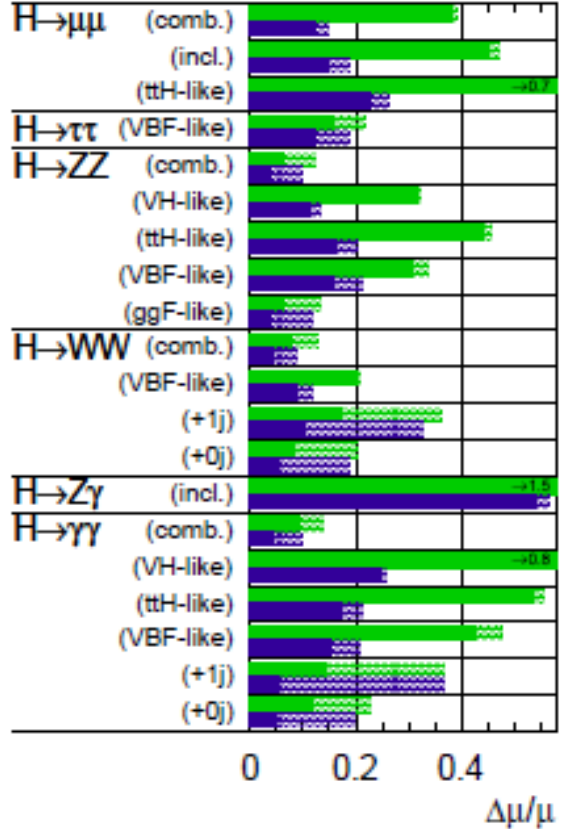
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ATLAS Simulation Preliminary  
 $\sqrt{s} = 14 \text{ TeV}$ :  $\int L dt = 300 \text{ fb}^{-1}$  ;  $\int L dt = 3000 \text{ fb}^{-1}$



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# Conclusions – Further Steps

- Publications of Run I at final stage
- Prospects for HL-LHC have been studied
- Further improvements are studied
- In preparation for Run II
- PhD K. Iordanidou in progress



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