

Higgs@HL-LHC

Status report : May 2018

S. Jezequel, M. Kado, M. Testa

Introduction

- Analysis wish list for Yellow Report 2018
- PUB notes to be public before end summer
- Some results combined with CMS (= extrapolated to 6 ab⁻¹)

	CMS	ATLAS	LHCb
Couplings Studies	✓✓★	✓✓★	
Differential CrossSections	✓★	✓★	
Width		✓	
CPV	✓★	✓	
Rare Decays	μμ, cc	Zγ, J/ψγ, FCNC μμ, ργ, cc	Hcc/Hbb
Exotic Decays	LFV; Invisible, DarkSusy; 4jets		
DiHiggs	✓✓★	✓✓★	
Additional Scalars	A->Zh, high mass ττ, low mass γγ	μμ, ZZ, A->Zh, ττ, WW	

Legend: Past Studies, 2017 TDRs, Wishlist for 2018

Higgs coupling @ HL-LHC: Overview

- Extrapolation from Run2 results
 - Scaling cross sections and luminosity
 - So far, baseline scenario: same Run2 systematic uncertainties
 - Then, improved scenario(s) with reduced experimental, theory and modeling systematic uncertainties
 - need common ATLAS-CMS definition
- Major channels should be combined over summer (at least with baseline scenario)
- Interpretation within kappa framework

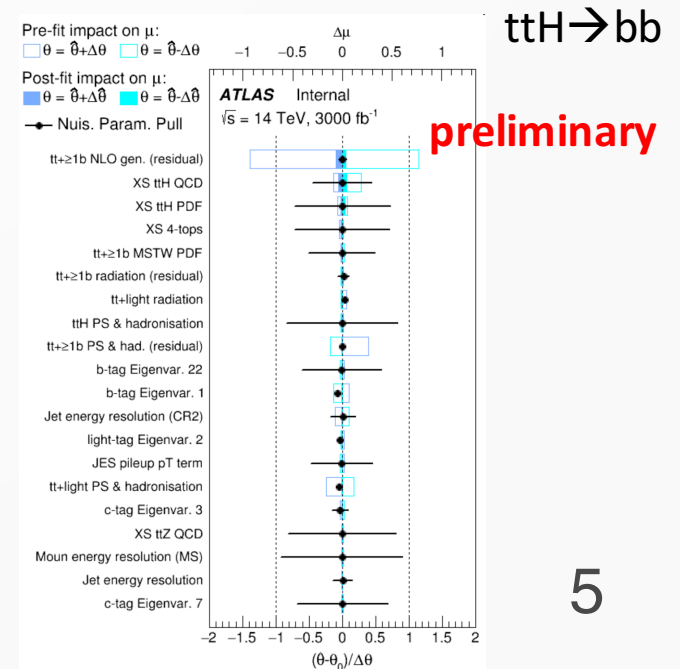
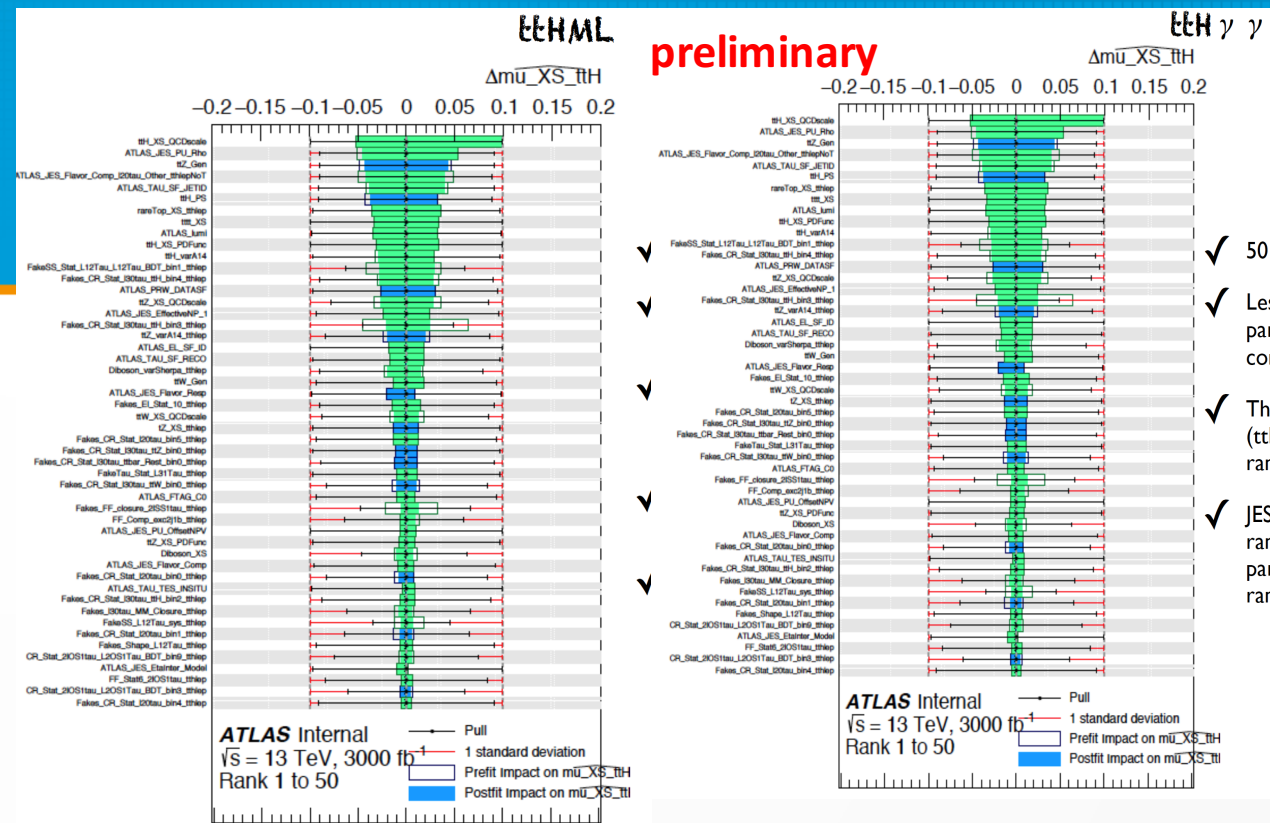
Higgs coupling @ HL-LHC: Overview

- $VH \rightarrow bb$ and ttH provided work spaces to Higgs combination
- $H \rightarrow gg$ / $H \rightarrow ZZ$ / $H \rightarrow \tau\tau$: Under study
- $H \rightarrow WW$, $H \rightarrow Z\gamma$ and $H \rightarrow \mu\mu$: No identified contribution yet
- Main systematics : signal/background modeling, theory, JES/JER, b-tagging
 - Challenge : Understanding of experimental/theory systematic uncertainties over-constraints with very high statistics

Higgs coupling @ HL-LHC: ttH

- ttH ML and ttH → γγ:
 - signal theory uncertainties highly ranked for ML and γγ
 - Important to get guesses on improvements from theorists
 - common ATLAS-CMS scenario(s)

- ttH → bb:
 - tt + ≥1b modeling and theory (signal and background) highly ranked
 - tt + ≥1b modeling strongly over-constrained
 - Nice to have a common ATLAS-CMS treatment on this for the projection



Differential cross-section $H \rightarrow \gamma\gamma$ and ZZ

- Extrapolation from Run2
- First presentation recently in Higgs prospect
- Quickly progressing
 - Try to extrapolate to higher p_T bins
- anomalous coupling Interpretation

HH production / Higgs self-coupling

- Channels :
- 4b : Results published in Pixel TDR:
 - Run2 analysis limited by systematic uncertainty from multi jet rate and shape
- $bb\tau\tau$: Cross-section in Pixel TDR and coupling being evaluated
 - Run2 analysis limited by systematic uncertainty from fake taus
- $bb\gamma\gamma$: Analysis being finalised
 - still statistics limited at HL-LHC
- Combination to be done
 - Should be ready over summer
- Possible naive extrapolation to HE-LHC for $bb\gamma\gamma$

$V(\rightarrow II)H (\rightarrow cc)$

- Extrapolation from Run2
- Validated in Higgs approval meeting and requested modifications implemented
- Next step : Nomination of readers
- Publication expected for June

H \rightarrow $\tau\tau$ (ggF + VBF) smearing functions

- Initiated for forward tracking and HGTD performance studies and tau ID performance with ITK
 - Based on smearing functions
- Benchmark for signal strength for VBF channel
- complementary to Run2 extrapolation

- Framework is available (smearing function + weighting method) and many presentations

- Should be ready over summer

VBF H \rightarrow $\gamma\gamma$ smearing functions

- Initiated for forward tracking and HGTD performance studies
- Based on smearing functions
- Benchmark on VBF signal strength
- complementary to Run2 extrapolation
- Already many presentations
- Should be ready over summer

CPV $H \rightarrow \tau\tau$

- Channels : $\tau \rightarrow \rho^- (\rightarrow \pi^- \pi^0) \nu_\tau$ and $\tau \rightarrow \pi^- \nu_\tau$,
- Sensitivity to CP through angular distributions
- Based on smearing function
- Should be statistics limited
- Analysis just starting
- Target : October 2018

BSM A/H \rightarrow $\tau\tau$

- ggH and bbH production modes
- Extrapolation from Run2
- First results presented in Higgs prospect
- Should be ready over summer

BSM Heavy $H \rightarrow WW \rightarrow l\nu l\nu$

- Analysis initiated for HGTD gain studies but also aims to provide expected significance
- Based on smearing functions
- Should converge on PUB note before summer

Thoughts

- For the middle June HL(HE)-LHC WS useful to show to the theory community the impact of theory uncertainties on the individual channels for Higgs couplings
- Keep discussion for a common methodology on experimental and modeling uncertainty

