Constraints on Higgs boson properties using $WW^*(\rightarrow e\nu\mu\nu)jj$ production in 36.1fb^{-1} of $\sqrt{s}$ =13TeV pp collisions with the ATLAS detector

ATLAS Paper Draft
HIGG-2017-13
Version 1.0
Target journal: Eur. Phys. J. C

Comments are due by: 29th September 2020

Analysis Team

[*email:* atlas-HIGG-2017-13-editors@cern.ch]

K. Becker, L. Brenner, L. Bruni, C. Burgard, R. Castelijn, D. Duda, P. Ferrari, F. Filthaut, R. Gugel, K. Lohwasser, Y.J. Lu, K. Koeneke, F. Pasquali, D. Shope, E. Sidebo, M. Slawinska, J. Strandberg

Editorial Board

[*email:* atlas-HIGG-2017-13-editorial-board@cern.ch]

Chris Hays (chair)
Andrew Pilkington
Zhiqing Zhang

paper draft in CDS:
https://cds.cern.ch/record/2730830

supporting note:
https://cds.cern.ch/record/2291365

Magdalena Sławińska (IFJ PAN)
on behalf of the analysis team

Atlas Weekly, 22/09/2020

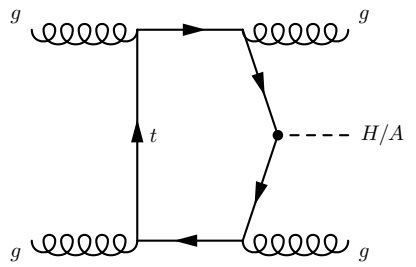
Motivation

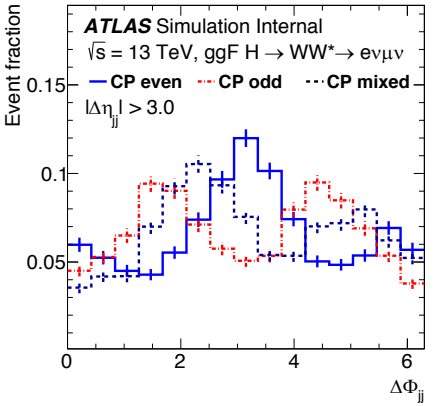
Common final state $WW^*(\rightarrow e\nu\mu\nu)\,jj$, two Higgs production mechanisms:

- ggf category
  - CP properties of the top Yukawa coupling and new particles in the gluon fusion loop probed with:

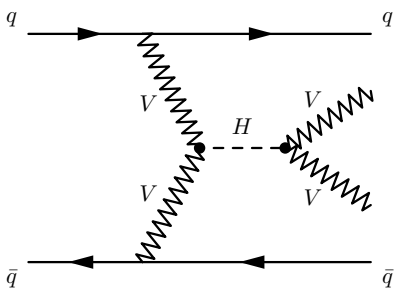
    1D fits to $\kappa_{Agg}/\kappa_{Hgg} \cdot \tan\alpha$ and

    2D fit of CP-even and CP-odd couplings κ_{Hgg} and κ_{Agg} with the mixing angle $\tan\alpha = 1$
  - Measurement of μ_{ggf+2j}

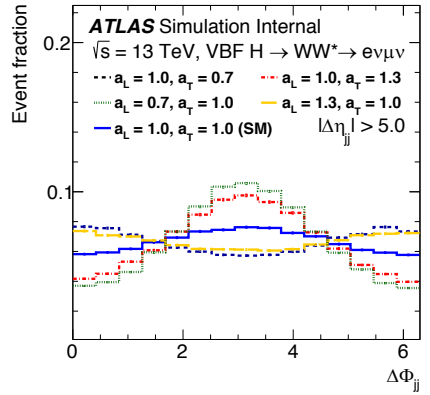




- VBF category
  - Search for BSM physics in Higgs boson individual couplings to longitudinally and transversely polarised W and Z bosons
  - Measurement of $\sigma_{VBF} \cdot Br(H \rightarrow WW^*)$ in Phys. Lett. B789 (2019) 508 in agreement with the SM, while HV_LV_L and HV_TV_T not measured
  - Fits to $a_L(=g_{HVLVL}/g_{HVV})$ and $a_T(=g_{HVTVT}/g_{HVV})$ and Pseudo Observables κ_{VV} and ε_{VV}, where the other parameter is fixed or profiled



V=W, Z



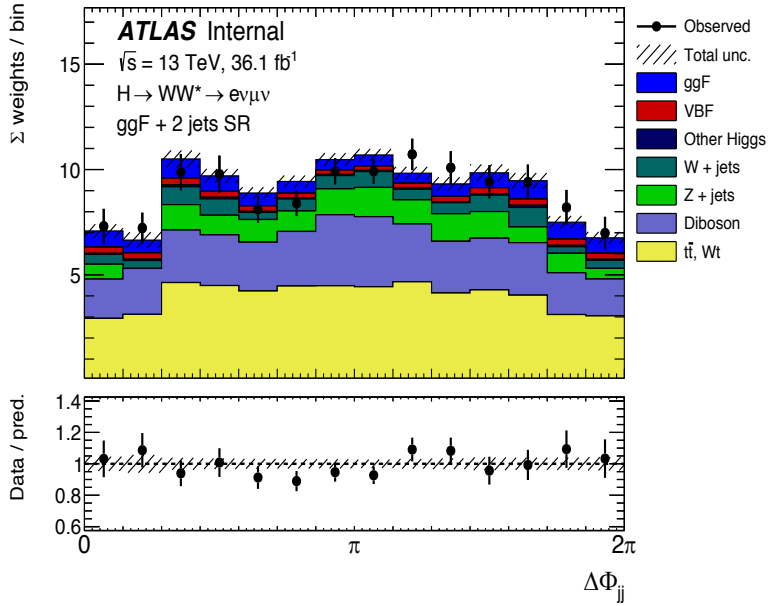
Methodology

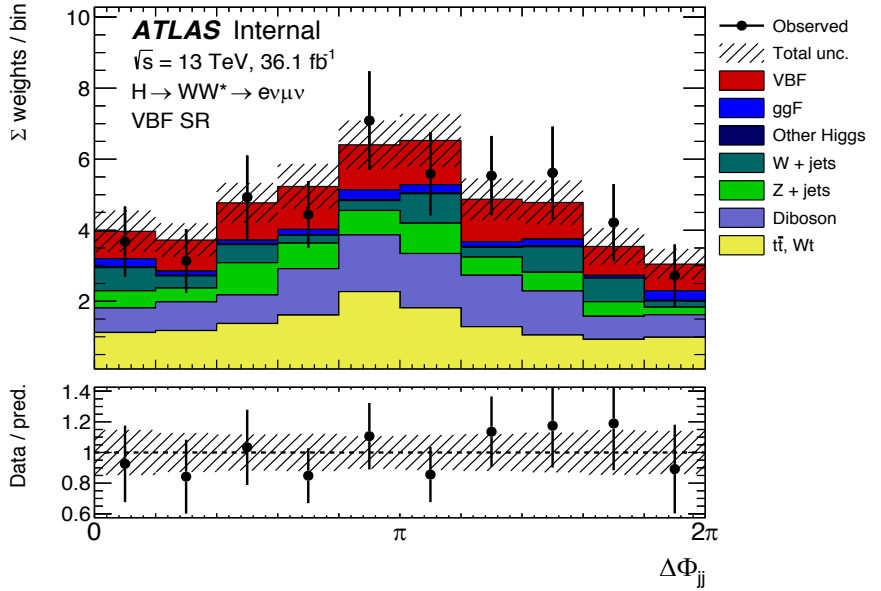
Signature: two (forward) jets, two different flavor opposite sign leptons, no b-quarks
Main backgrounds: double and single top, Z+2jets, WW and other dibosons
Signal optimisation: several signal categories, separately for each analysis using BDTs

To measure properties of the Higgs production vertex the shape of the distribution of the azimuthal angle between two tagging jets $\Delta\Phi_{jj}$ is used. Additionally, in selected fits, $\sigma \cdot Br(H \rightarrow WW^*)$ information is employed.

Parameter morphing is used to extrapolate from a small set of BSM coupling benchmarks to a large variety of coupling scenarios.

The final results are obtained by applying a maximum likelihood procedure individually to each coupling parameter hypothesis, where the background prediction is only affected by changes to nuisance parameters in the minimization.



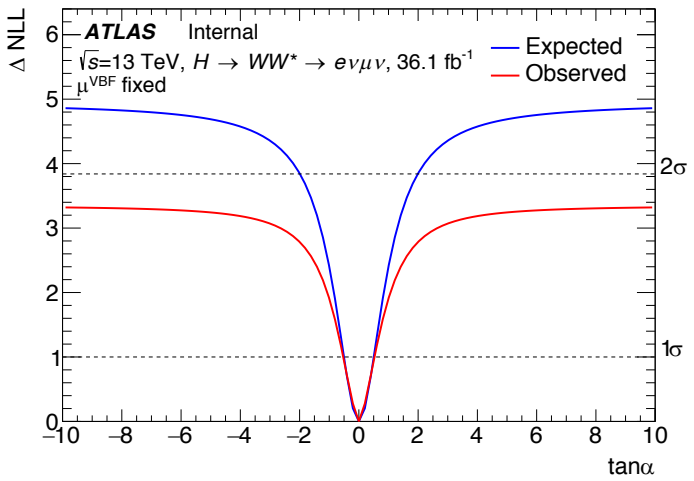


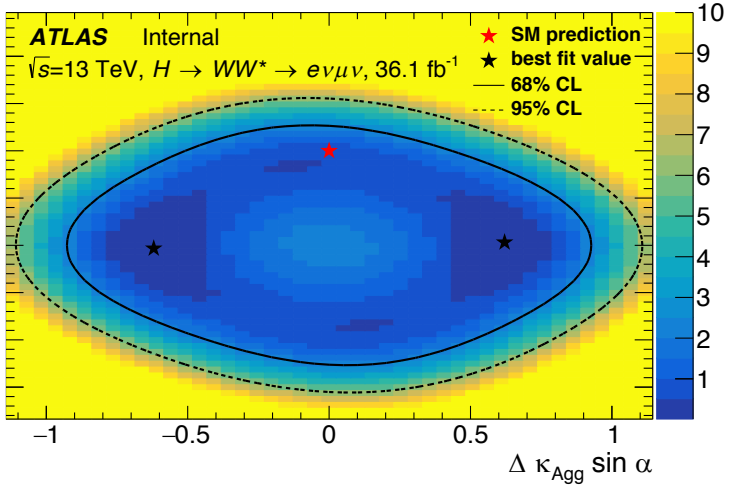
The weighted $\Delta\Phi_{jj}$ distribution in the ggf and VBF signal regions, with signal and background yields fixed from the fits.

Results

ggf

- 68% CL interval of tanα ∈ [−0.5, 0.5], using shape and rate information; shape only fits not yet sensitive
- 68% and 95% CL two-dimensional likelihood contours of the CP-even and CP-odd coupling parameters
- $\mu_{ggF+2j} = 0.7\ ^{+0.8}_{-0.7}$ (syst.) ± 0.4(stat.)





VBF

68% CL intervals using shape and rate information:

- aL ∈ [0.7, 1.0], aT ∈ [0.8, 1.5], (observed) and

  aL ∈ [0.9, 1.1], aT ∈ [0.5, 1.4] (expected)
- κ_{VV} ∈ [0.7, 1.1] , ε_{VV} ∈ [−0.09, 0.24], (observed) and

  κ_{VV} ∈ [0.8, 1.1] , ε_{VV} ∈ [−0.7, 0.20], (expected)

68% CL intervals using only shapes:

- aT ∈ [0.64, 1.78] (observed), aT ∈ [0.40, 1.54] (expected)
- ε_{VV} ∈ [−0.12, 0.55] (observed), ε_{VV} ∈ [−0.7, 0.27] (expected)