Higgs coupling measurements in the $H \rightarrow WW^*$ channel in pp collisions at $\sqrt{s}=13$ TeV with the ATLAS detector

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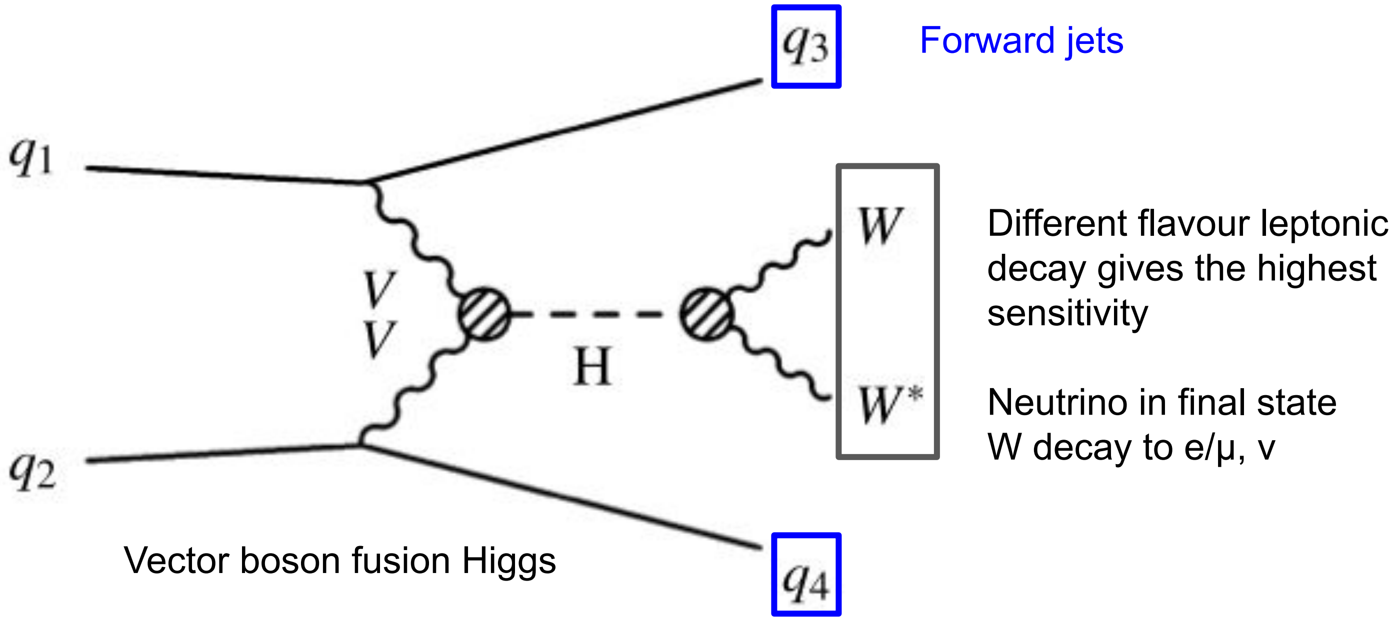
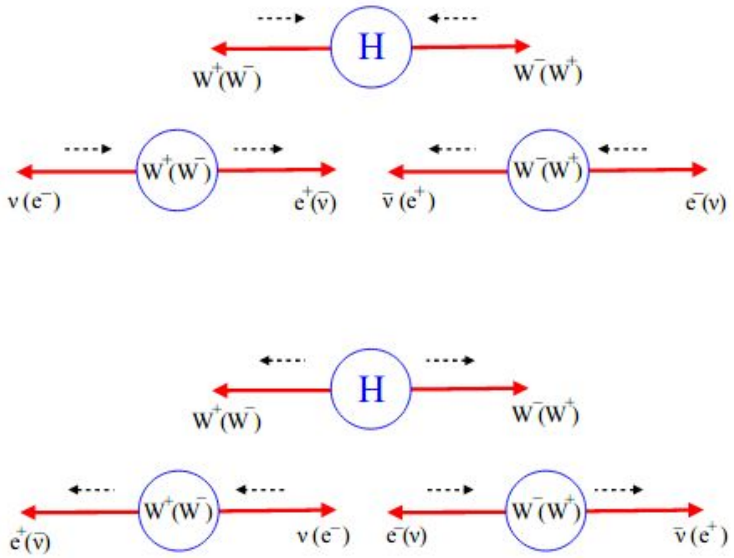
Motivation

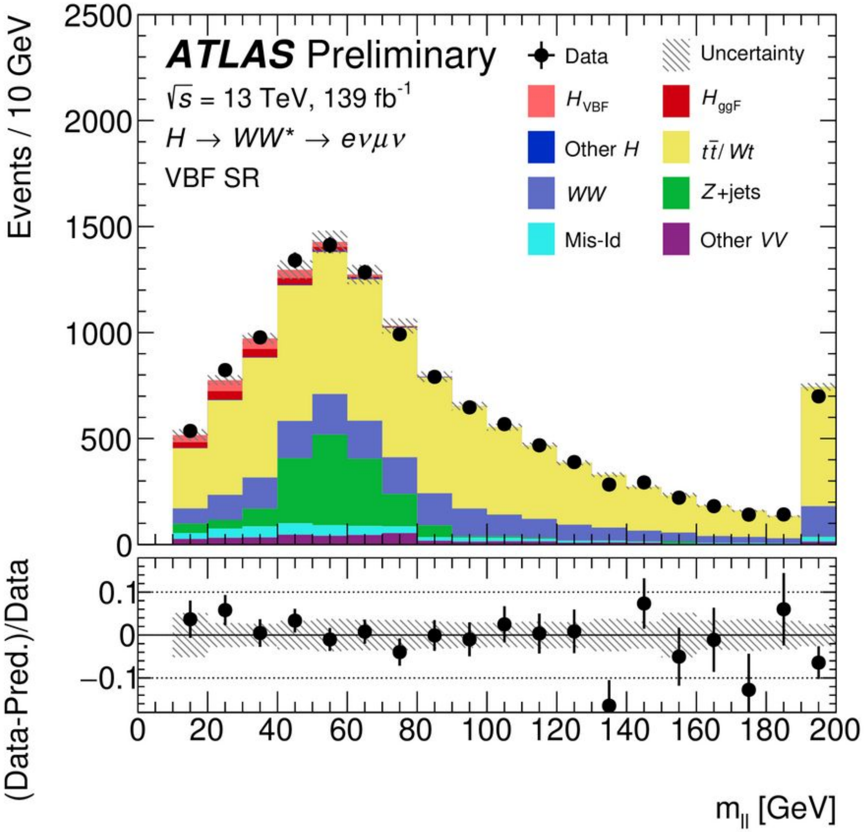
- H->WW*: second highest branching ratio at 125 GeV
  - H->WW 22% (H->bb 57% , H->ττ 6.2%, H->ZZ 2.8%, H->γγ 0.23%)
  - One of the most sensitive channel in Higgs discovery
- Focus on recent observation of vector-boson-fusion production of Higgs bosons with full Run-2(2015-2018) data with ATLAS detector
  - First experimental observation of VBF H->WW*



General analysis strategy

- Top : events without b jets
- $Z_{\tau\tau}$: events outside $M_{\tau\tau}$ mass window
- Non- resonant WW

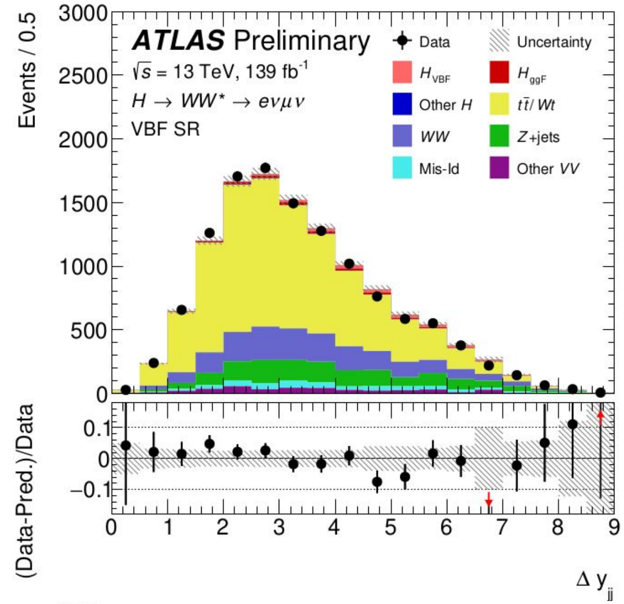


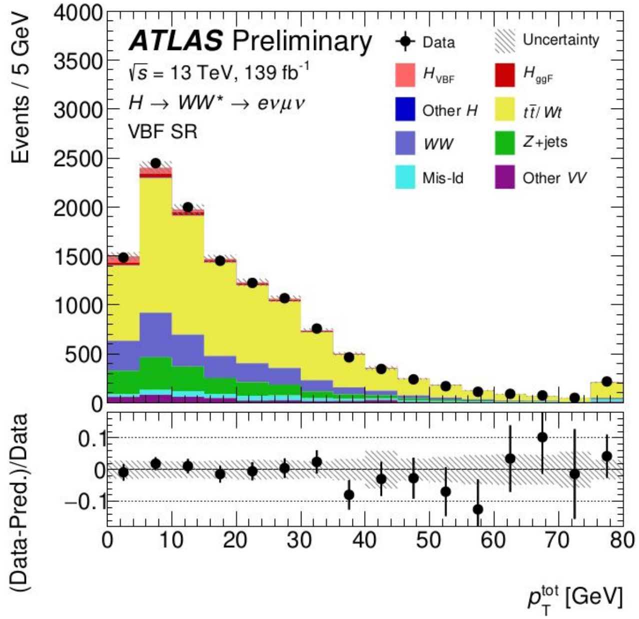


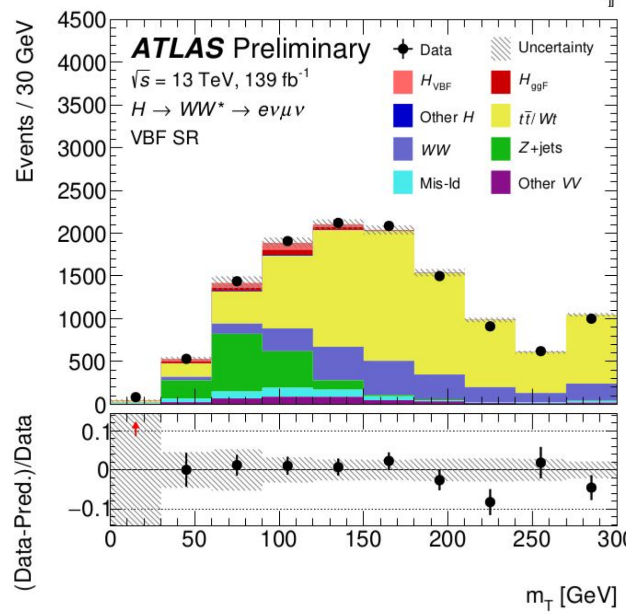
spin 0 Higgs decay: Total angular momentum = 0
V-A structure of W-> lν : decay particle in the direction along the spin

New analysis techniques implemented

- Further signal and background separation use multivariable discriminant
- Direct deploy discriminant can not achieve VBF H->WW* discovery
  - 15 input variables with deep neural network
  - Finer bins allowed. Higher simulation statistics thanks increase computing resources



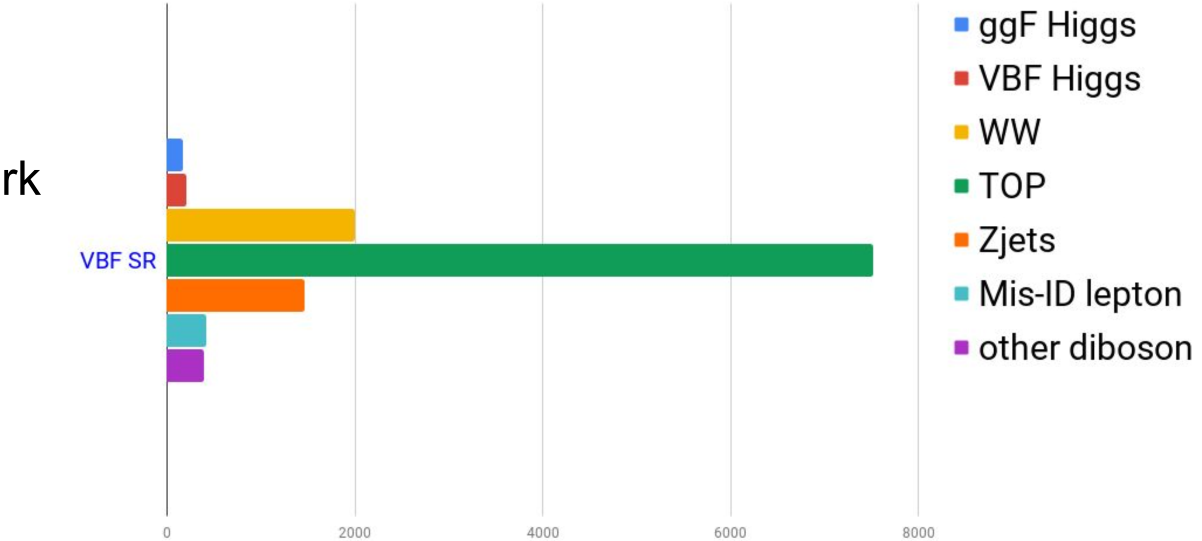




Deep neural network discriminant

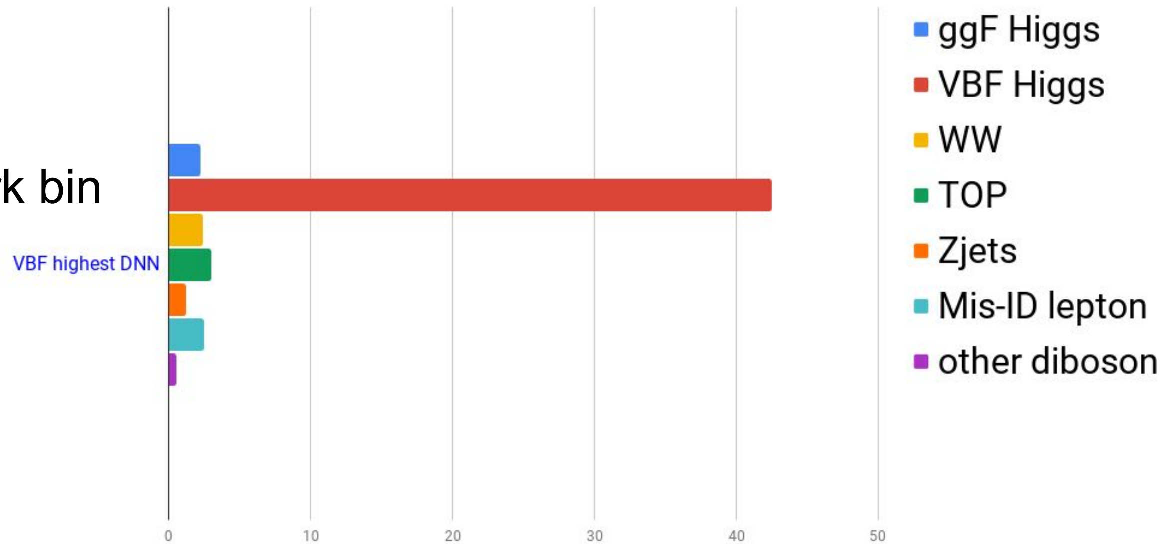
Before deep neural network

Signal fraction = 1.7%



Highest deep neural network bin

Signal fraction = 80%

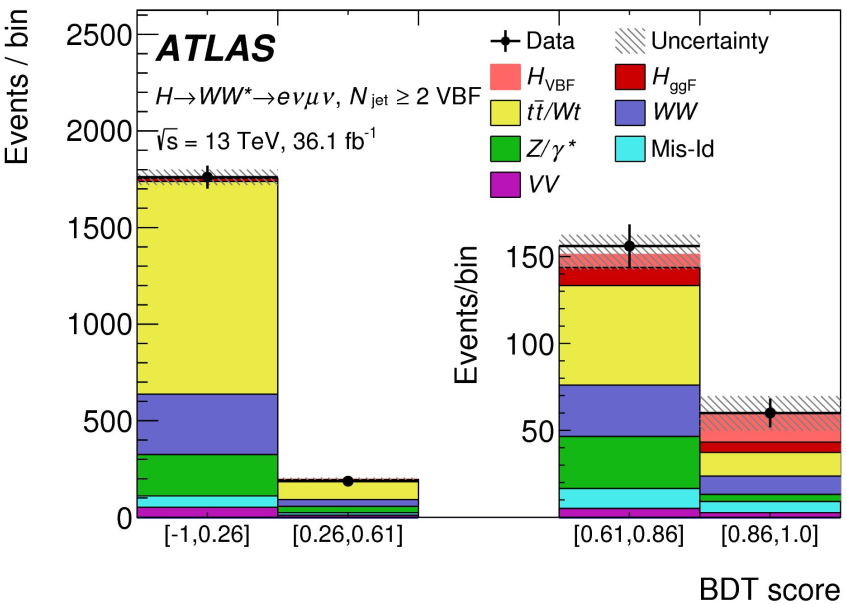


New analysis techniques implemented

2019 publication

Signal fraction: 27 %

$Higgs_{VBF}$:16+-6
$Higgs_{ggF}$:6+-3

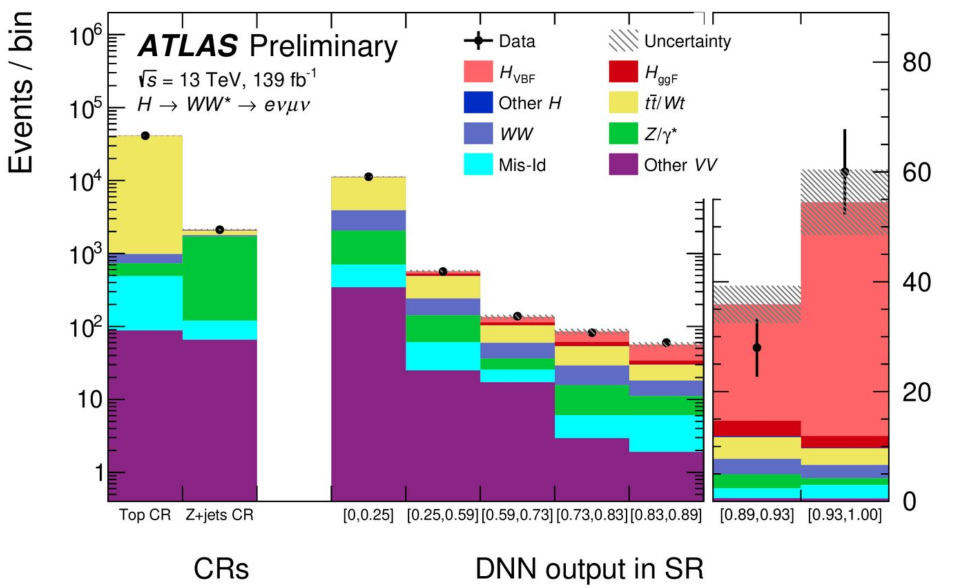


[Phys. Lett. B 789 (2019) 508]

2020 publication

Signal fraction: 80%

$Higgs_{VBF}$:42.6+-6.5
$Higgs_{ggF}$:2.2+-1.5



[ATLAS-CONF-2020-045]

Results

- Observation of VBF signal with observed (expected) significance: 7.0 (6.2)
- Measured signal strength and VBF cross-section x BR(H->WW)

$$\mu_{\mathrm{VBF}} = 1.04\,^{+0.24}_{-0.20}$$
$$= 1.04\,^{+0.13}_{-0.12}\,(\mathrm{stat.})\,^{+0.09}_{-0.08}\,(\mathrm{exp\ syst.})\,^{+0.17}_{-0.12}\,(\mathrm{sig.\ theo.})\,^{+0.08}_{-0.07}\,(\mathrm{bkg.\ theo.})$$

$$\sigma_{\mathrm{VBF}} \cdot \mathcal{B}_{H\to WW^*} = 0.85\,^{+0.20}_{-0.17}\ \mathrm{pb}$$
$$= 0.85 \pm 0.10\,(\mathrm{stat.})\,^{+0.08}_{-0.07}\,(\mathrm{exp\ syst.})\,^{+0.13}_{-0.10}\,(\mathrm{sig.\ theo.})\,^{+0.07}_{-0.06}\,(\mathrm{bkg.\ theo.})\ \mathrm{pb}$$

- First experimental observation of VBF H->WW*
  - Result to be included in Higgs combinations
- Full run 2(2015-2018) ggF and simplified template cross section results to come soon

Thank you !

Backup

H->WW* coupling

- Run 2, 2015-2016 coupling (36/fb)

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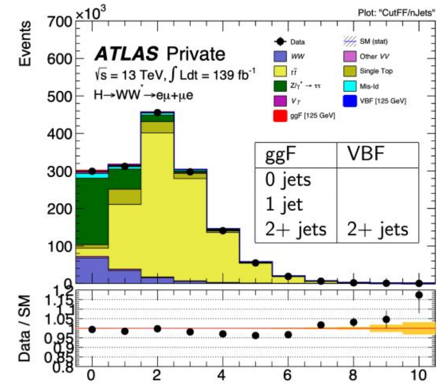
σ	Z_0^{obs}	Z_0^{exp}
ggF	6.0	5.3
VBF	1.8	2.6

$$\mu_{ggF} = 1.10^{+0.10}_{-0.09}(\text{stat.})^{+0.13}_{-0.11}(\text{theo syst.})^{+0.14}_{-0.13}(\text{exp syst.})$$

$$\mu_{VBF} = 0.62^{+0.29}_{-0.27}(\text{stat.})^{+0.12}_{-0.13}(\text{theo syst.}) \pm 0.15(\text{exp syst.})$$

36/fb results included in Higgs combination
Phys. Rev. D 101, 012002



njets

- Analysis overview
  - WW leptonic decay to different flavour : e, μ
    - Largely reduced Z+jets contribution. Best sensitivity among WW decays
  - Analysis is separated into jet multiplicity bins for background estimation

H->WW* Analysis

***Extended to full run 2 dataset**

***HWW VBF observation**

***STXS measurements**

***ggF 0 ,1, >= 2 jet measurements**