Measurement of Higgs properties and Higgs LFV decay search at LHC

Conference on Flavor Physics and CP Violation
FPCP 2021
Shangai June 7-11, 2021

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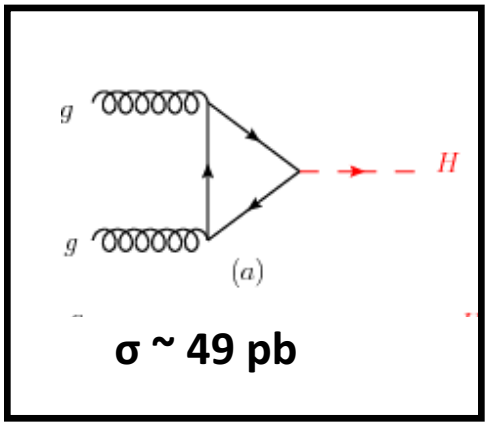
Probing the Higgs boson at the LHC

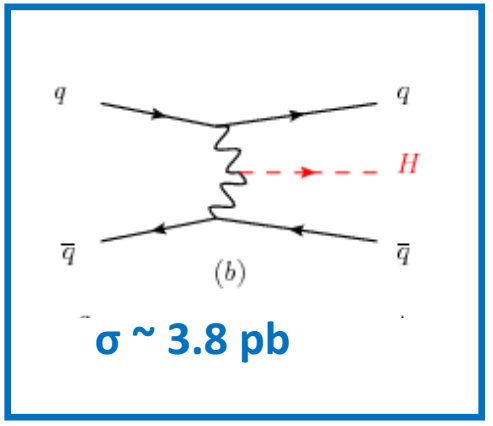
Main **production processes** at the LHC (cross sections at √s=13TeV for mH=125GeV**)**

Gluon fusion



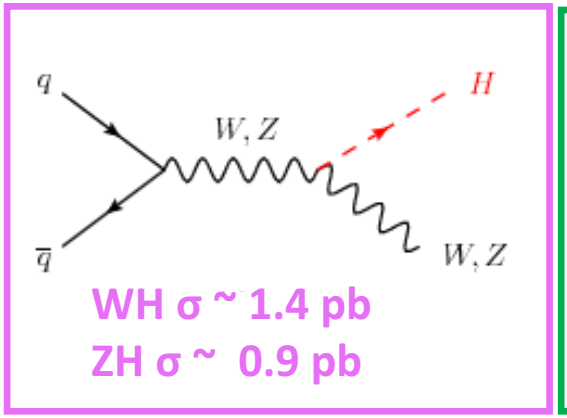
σ ~ 49 pb

Vector boson Fusion



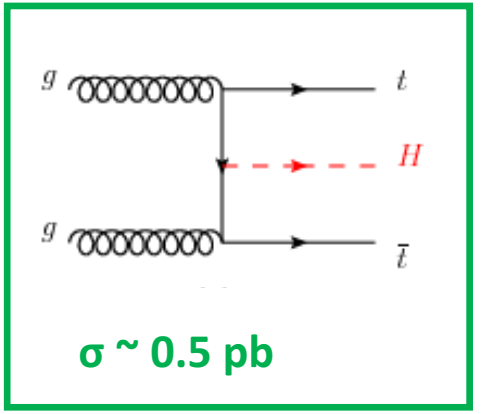
σ ~ 3.8 pb

W/Z Higgsstrahlung



WH σ ~ 1.4 pb
ZH σ ~ 0.9 pb

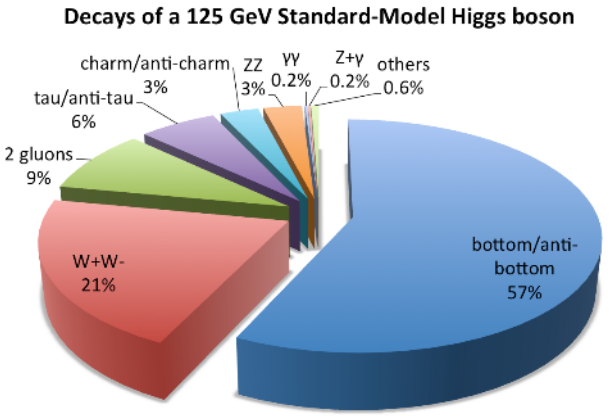
Associated tt production



σ ~ 0.5 pb

Theory pred: **N3LO** / NNLO/ NNLO/ NLO QCD for **ggF** / **VBF, VH**/ ttH; NLO EW accuracies for all

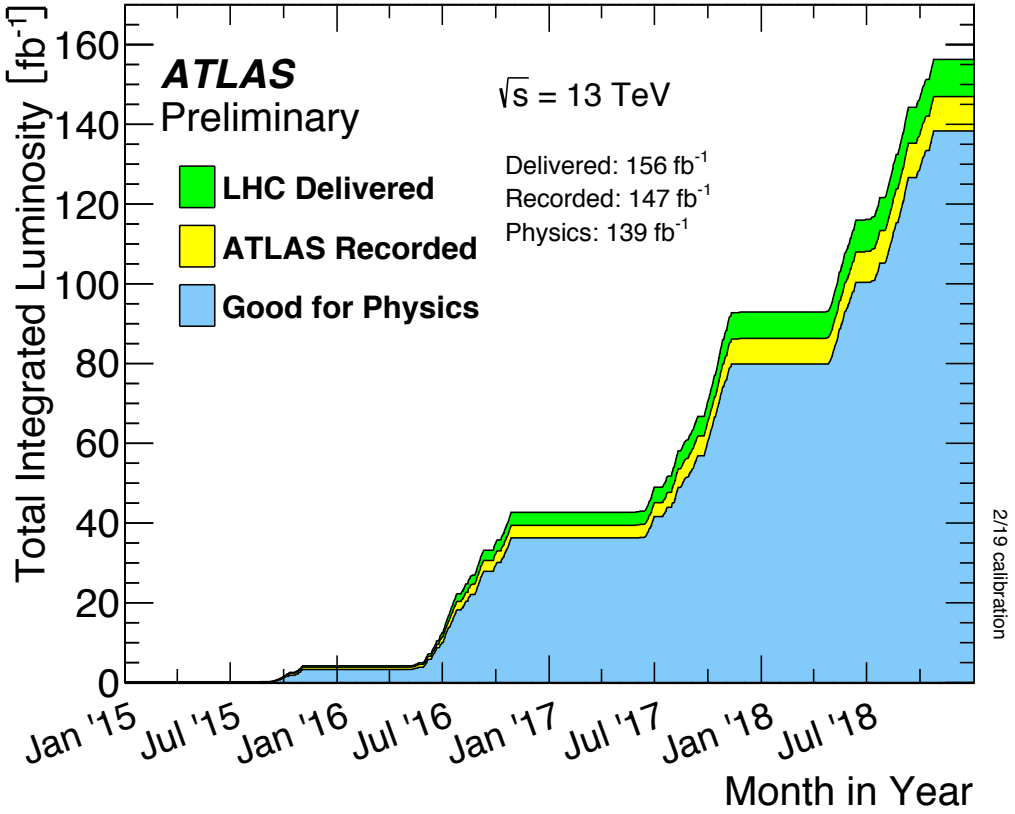
- **Decay modes**
  - Large BR for **H→bb, H→WW*, H→ττ**
    - poor mass resolution
      - due to Neutrino (WW*), objection resolution (bb, ττ)
    - background contamination
- Small BR for **H→ZZ*** and **H→γγ**;
  - high mass resolution
  - small background contamination

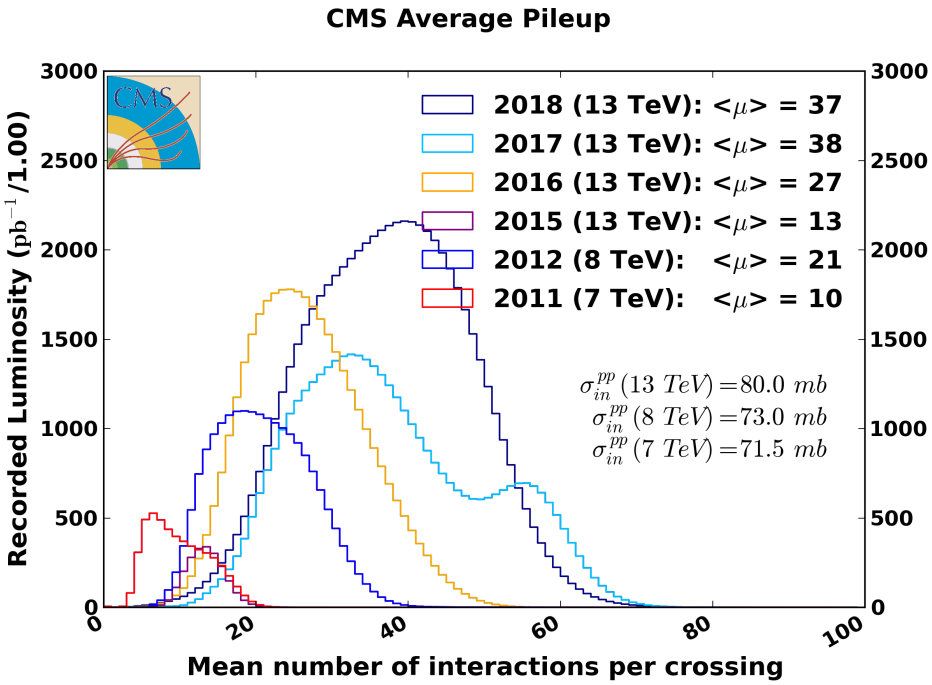


LHC performance

- LHC **Run2** finished in 2018 collecting almost **140 fb-1** of good-quality pp collisions per experiment at √s=13TeV→ excellent LHC performance

- Increasing pile-up conditions, up to a mean of ~37 p-p collisions per bunch crossing
  - steady improvement in the offline reconstruction and trigger





Most of results in this talk based on 140 fb^{-1}

Status of Higgs properties

- **Observation** of all main **production** processes:
  - ggF, VBF, **WH,ZH, ttH**

During Run2
Observation/
Evidence

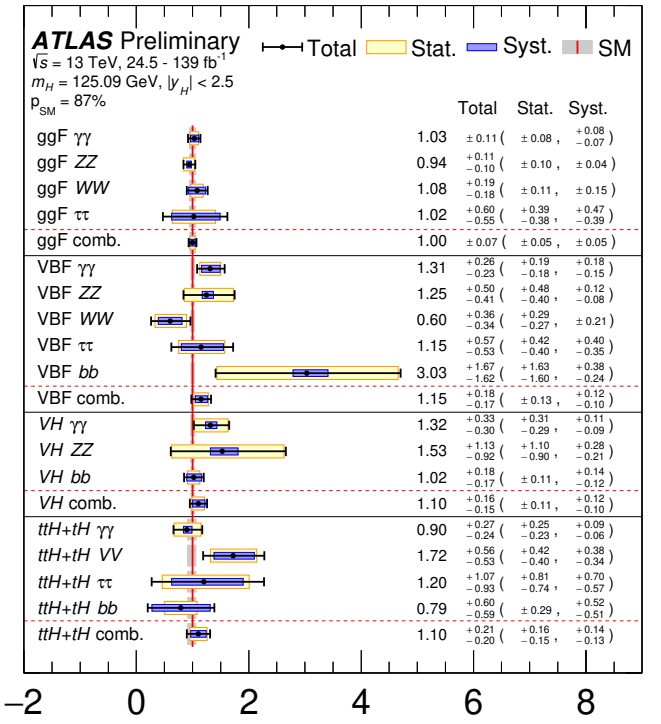
- **Observation** of most of the **bosonic** and **fermionic** decay modes H→ZZ,γγ,WW, **H→bb,H→ττ**

- Evidence for **H→μμ** and **rare** H→llγ decay

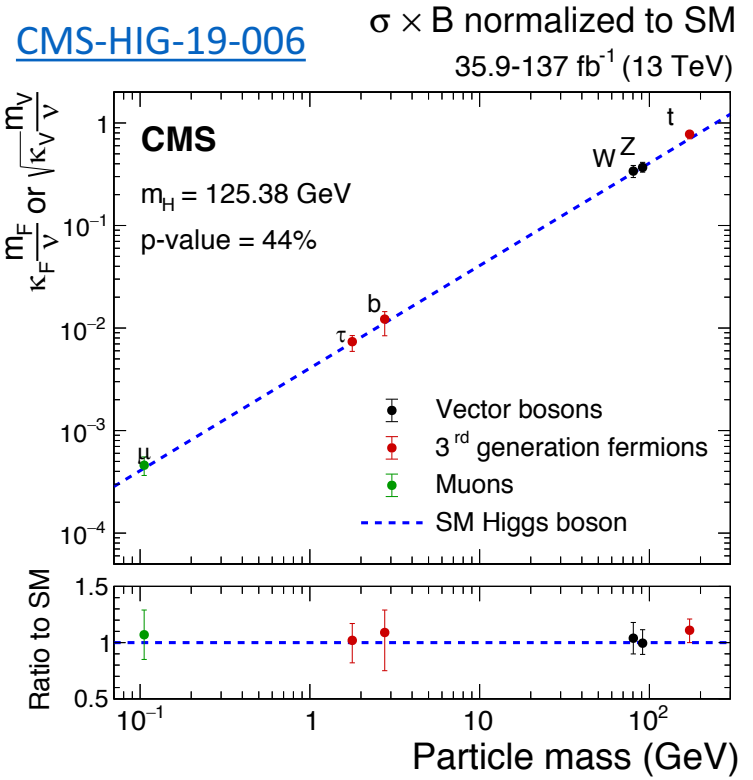
- Measurement of **mass**, **CP**, constraints on **width**

- Experimental systematic and theory uncertainties comparable to statistic uncertainties
- All measurements in **agreement** with the **SM** predictions

ATLAS-CONF-2020-027



CMS-HIG-19-006



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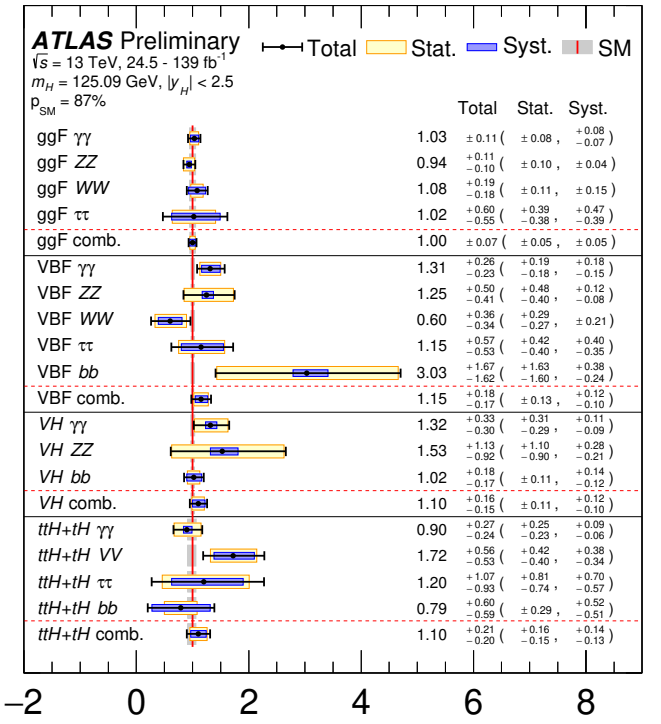
During Run2 Observation/ Evidence

The characterization of the Higgs sector is steadily **improving**:

- Inclusive σ → **differential σ** measurements in **multiple** kinematic regions
- Search for **rare** decays, **BSM** effects, including **Lepton Violating decays**
- **CP** in fermionic decays, ..

ATLAS-CONF-2020-027



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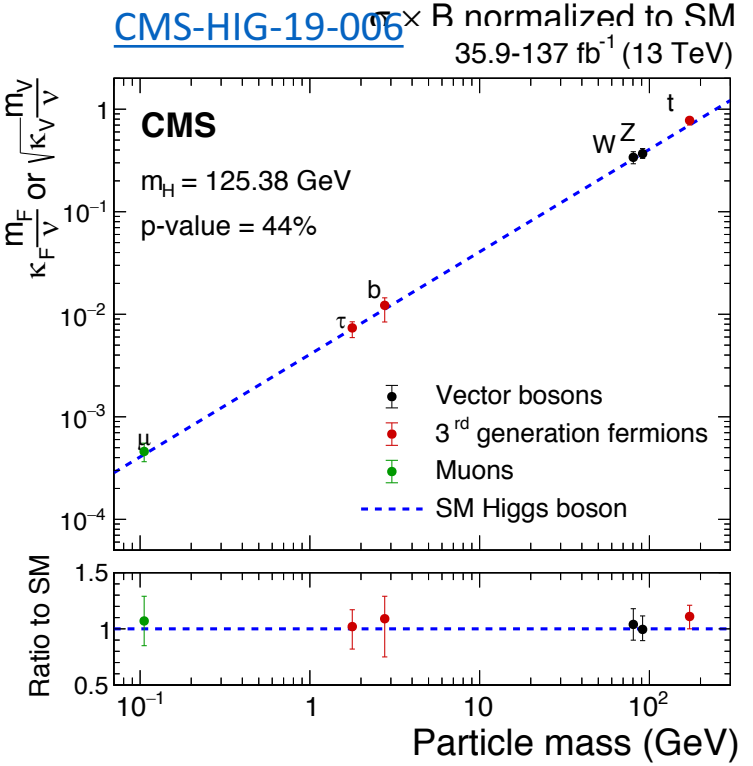


κ-framework

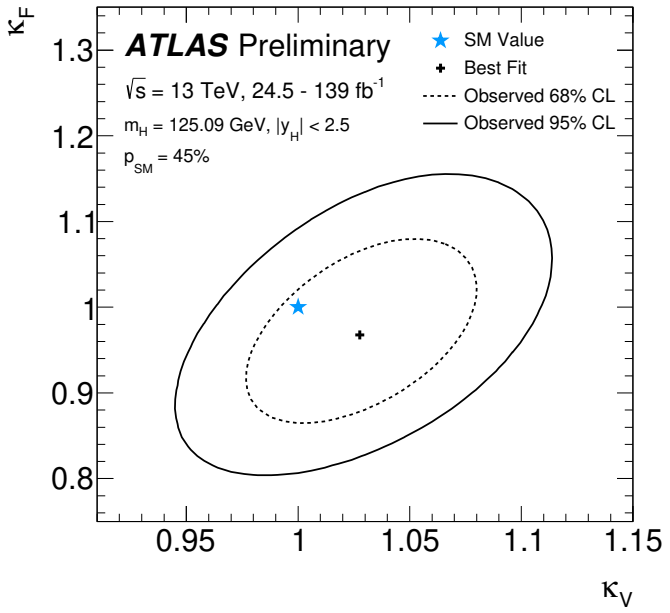
$$(\sigma_i \times B_f) = k_i^2 \sigma_i^{SM} \frac{k_f^2 \Gamma_f^{SM}}{k_H^2 \Gamma_H^{SM}}$$

- **Leading order** tree level motivated framework
- **Coupling strength modifiers** κ to study SM deviations couplings ; $\kappa^2_i = \sigma_i / \sigma_i^{SM}$; $\kappa^2_f = \Gamma_f / \Gamma^{SM}$
- **BSM** contribution in invisible (B_i) or undetected (B_u) decays affecting the width Γ_H

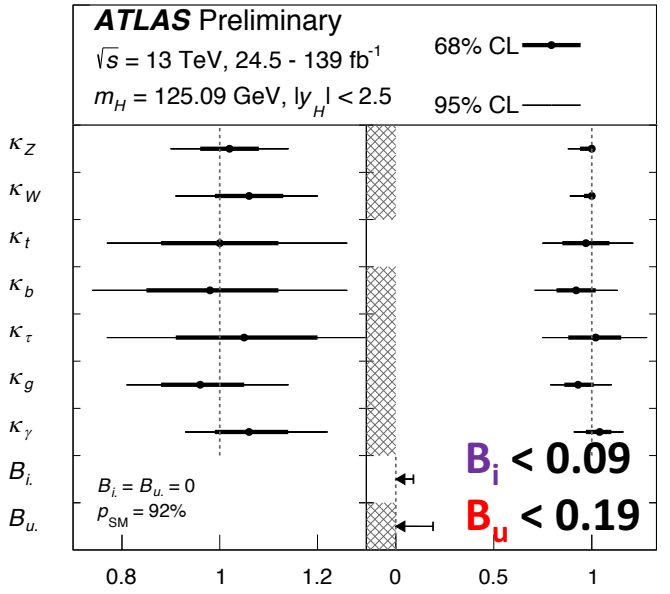
$$\kappa_H^2(\kappa, B_{i.}, B_{u.}) = \frac{\sum_j B_j^{SM} \kappa_j^2}{(1 - B_{i.} - B_{u.})}.$$

Probing universal fermion and boson coupling modifiers

- $\kappa_V = \kappa_{W,Z}$; $\kappa_f = \kappa_{t,b,\tau,\mu}$
- Hgg and Hγγ loops function of $\kappa_{f,V}$
- $B_i = B_u = 0$



Probing model allowing new particles in the gluon fusion loop and decays w/ and w/o BSM in the invisible (B_i) and undetected (B_u) decays affecting the width Γ_H



Room for NP in decays

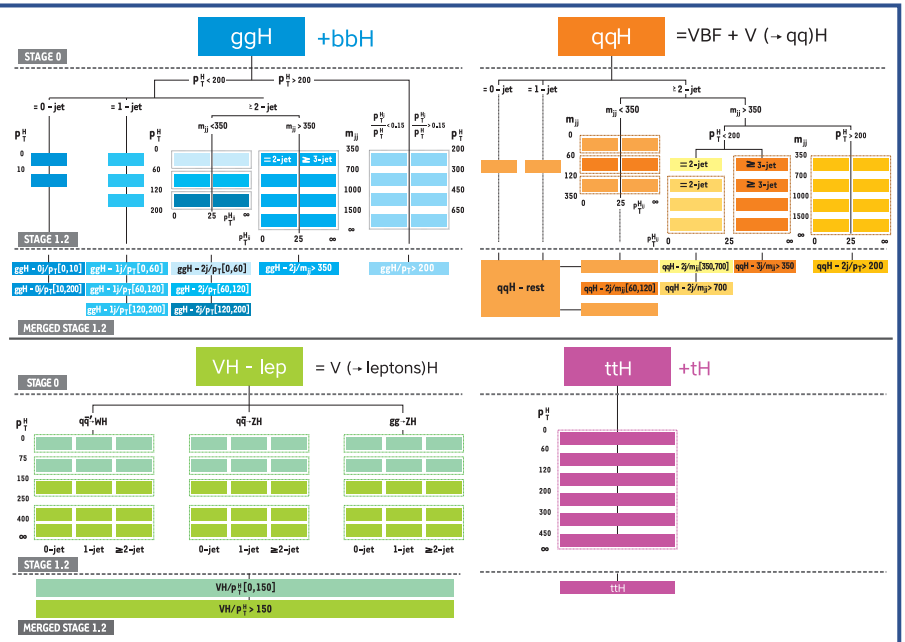
[ATLAS-CONF-2020-027]

Latest properties measurements

STXS and differential cross sections

Simplified Template Cross Sections (STXS)

- Measure production modes separately
- Categories using bin of (truth) quantities (p_T^H, Njets, m_{jj}) optimized to
  - reduce the **theoretical uncertainties**
  - best signal / new physics **sensitivity**
- Framework provided in different stages with increasing granularity
- Inclusive in decay mode: well-suited for combinations



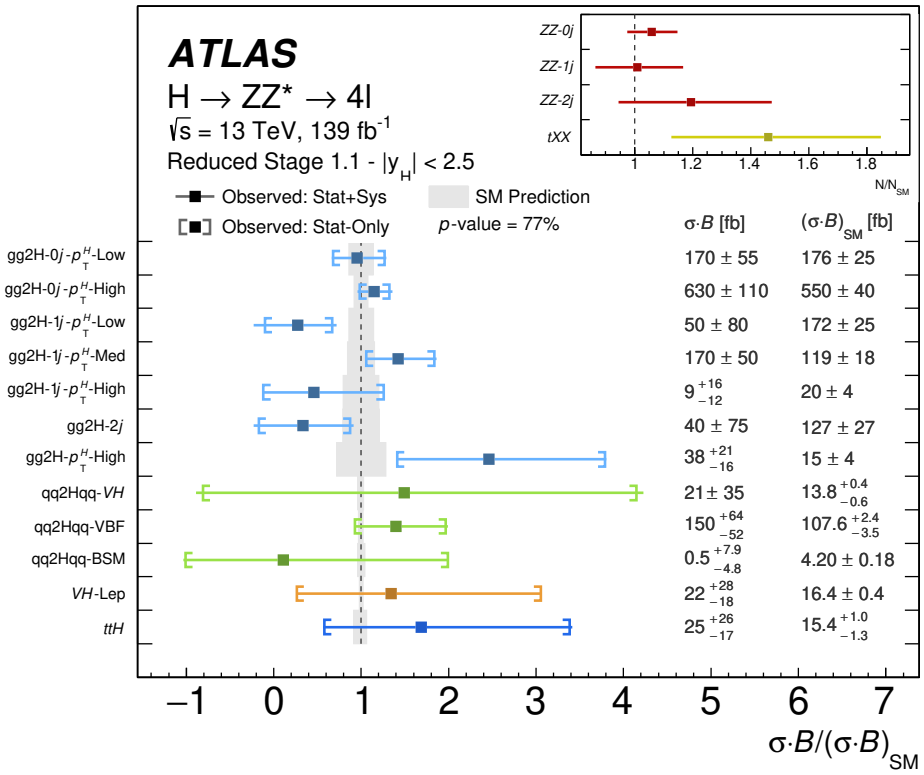
Stage 1.2

Fiducial Cross section

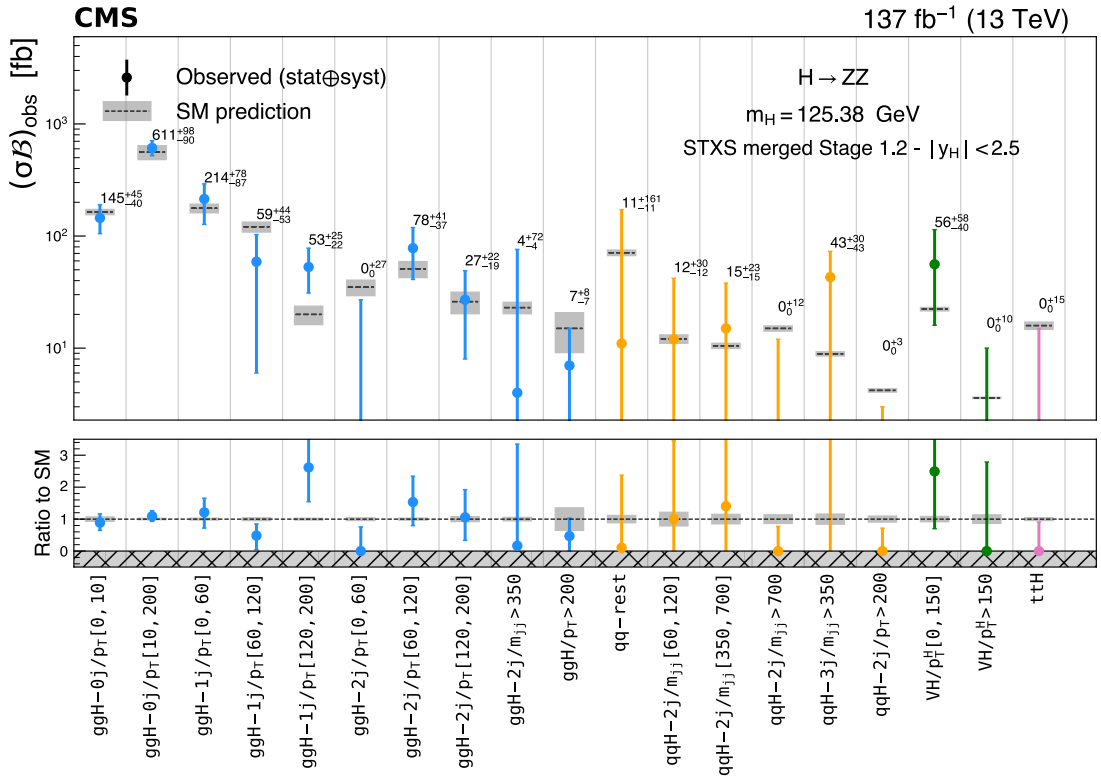
- More **model independent** than STXS
- Definition of the fiducial phase space based also on the Higgs decay products
- Unfold to truth level correcting for detector effects
- **Differential** distributions in kinematic variables chosen to be sensitive to signal modeling and BSM effects

H→ZZ*→4l STXS

HIGG-2018-28



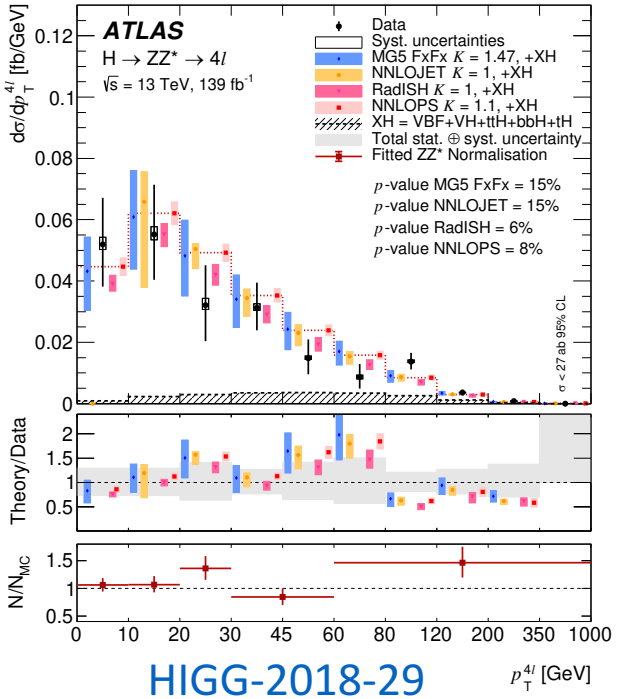
HIG-19-001



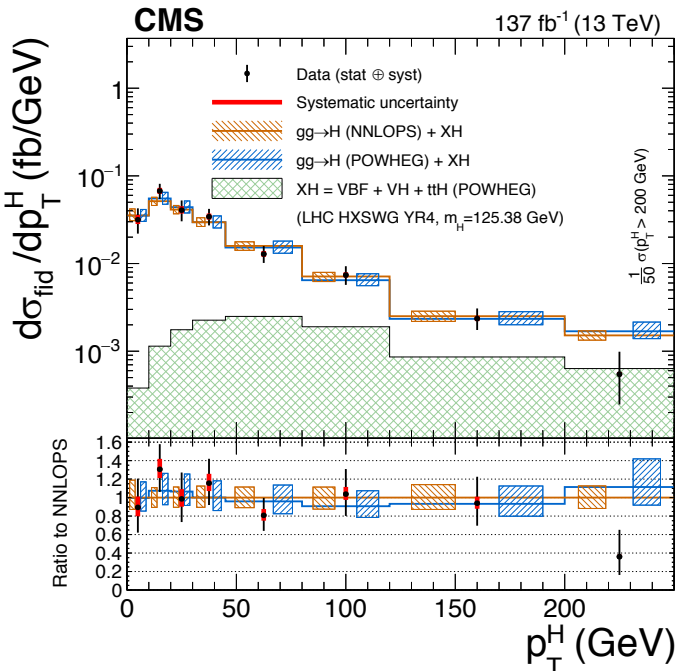
- High S/B and clean signature with fully reconstructed final state
- Several bins measured for **ggH** and **qqH**
- NN-based categorization either to define the categories (CMS) or as observable for fit (ATLAS)
- **Agreement with SM predictions**

Fiducial x-section H→ZZ*→4l

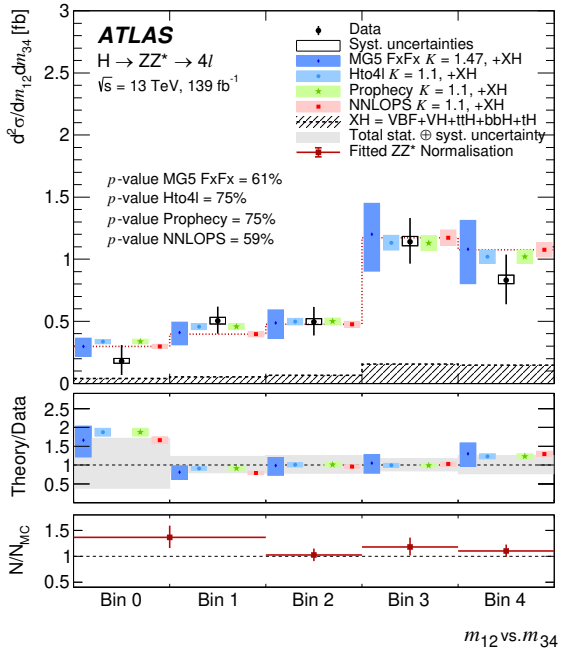
- Differential cross section vs
  - Higgs kinematics
  - Jet activity
  - dilepton invariant masses
- NNLOPSandMadGraph5_aMC @NLO-FxFx used
  - also NNLOJET and RadISH (Hto4l and Prophecy4) for Higgs production (decays) measurements
- Limited by statistical uncertainty
- **Good agreement with SM predictions**

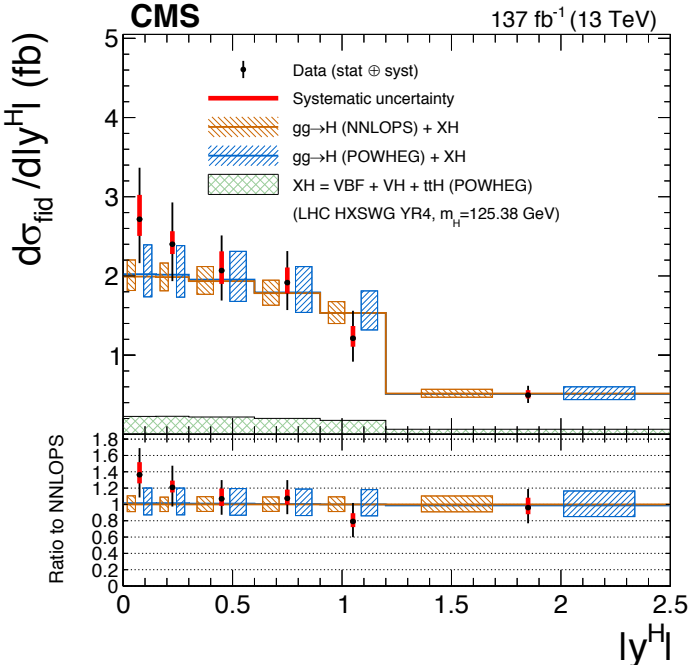


HIGG-2018-29



CMS-PAS-HIG-19-001



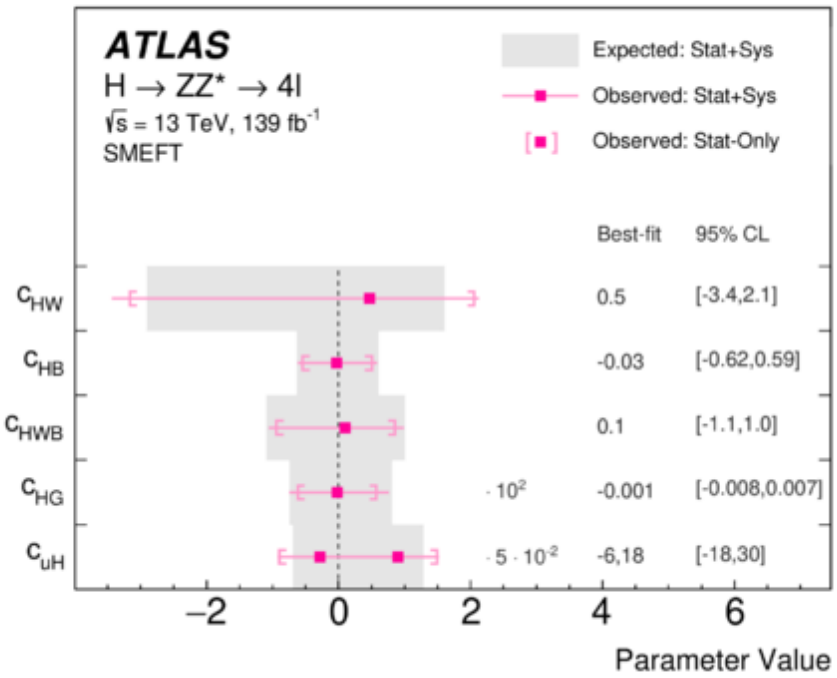


Effective Field Theory (EFT) interpretation H→ZZ*→4l

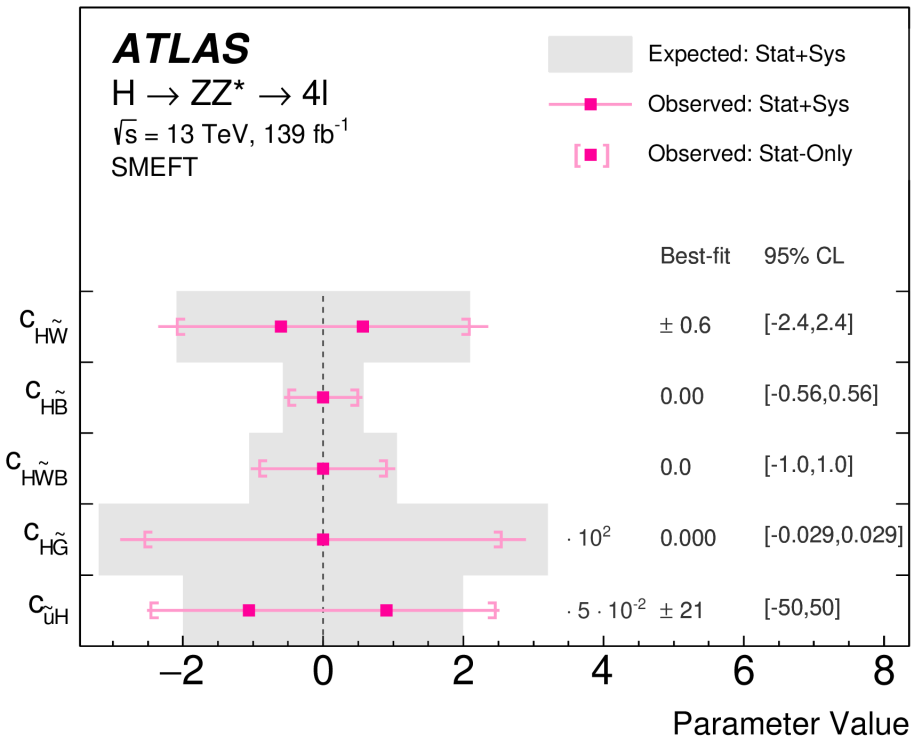
- **EFT** framework to probe BSM effects in tensor structure of Higgs couplings
- Probe **CP even** and **CP-odd** operators in interactions between Higgs and gluons, top and vector bosons

$$\mathcal{L}_{\text{EFT}} = \mathcal{L}_{\text{SM}} + \sum_i \frac{C_i^{(d)}}{\Lambda^{(d-4)}} O_i^{(d)} \quad \text{for } d > 4.$$

CP-even



CP-odd



No deviation from SM predictions

HIGG-2018-28

H→γγ STXS

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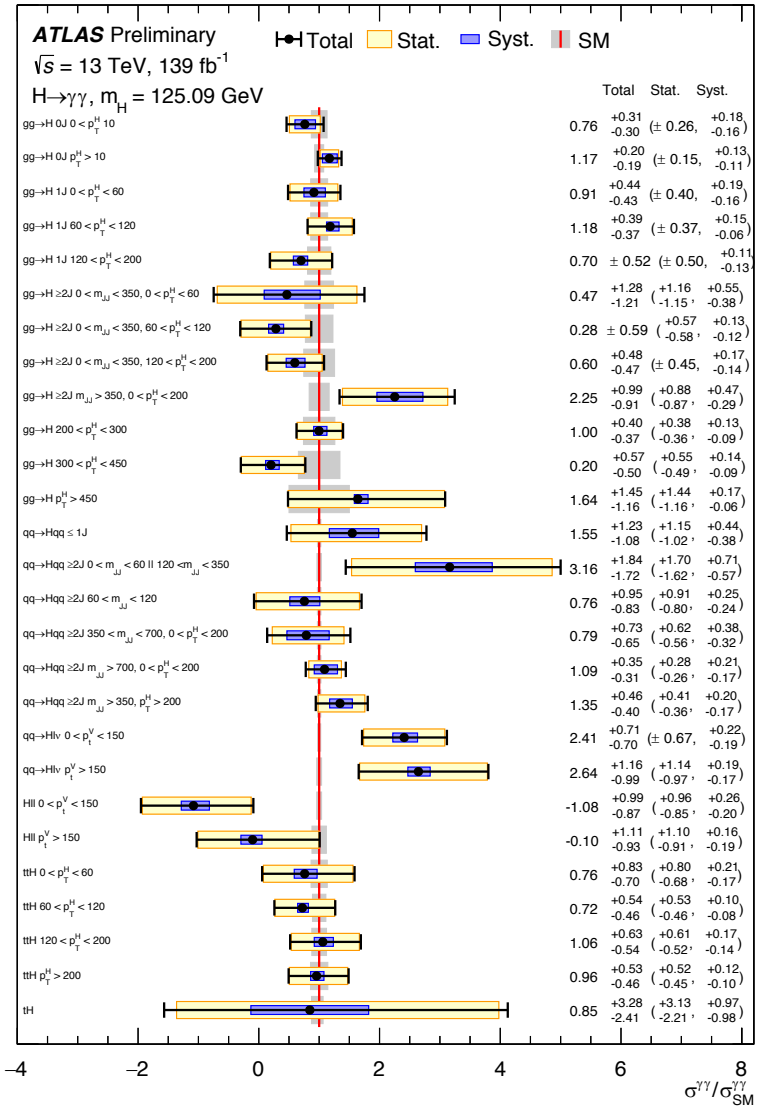
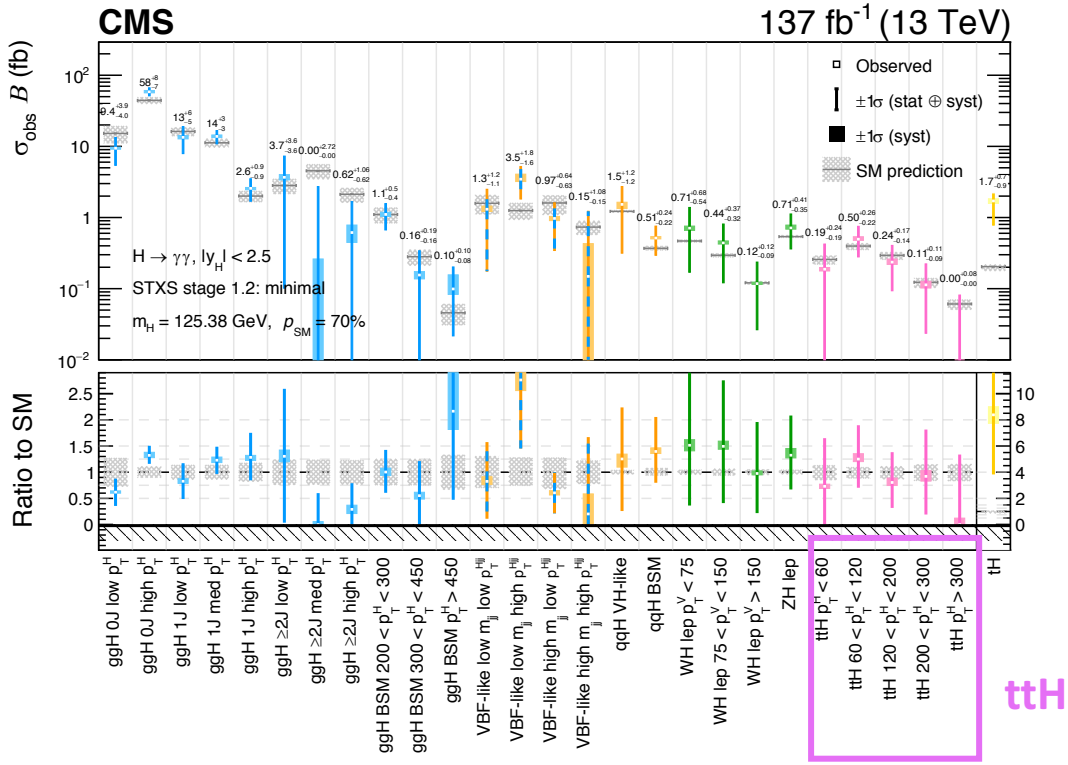


CMS-HIG-19-015

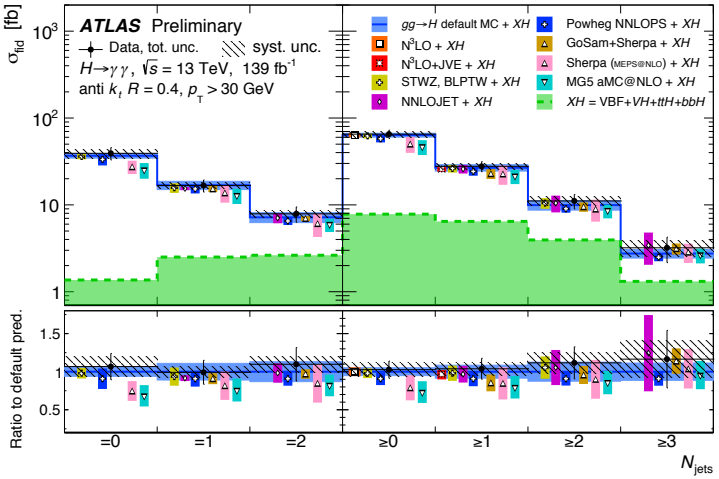


- First channel to perform **ttH** measurement differentially
- Event categorization through multiclass BDT for both ATLAS and CMS
- Dominated by statistical uncertainty
- **Compatible with SM predictions**

Fiducial x-section H→γγ

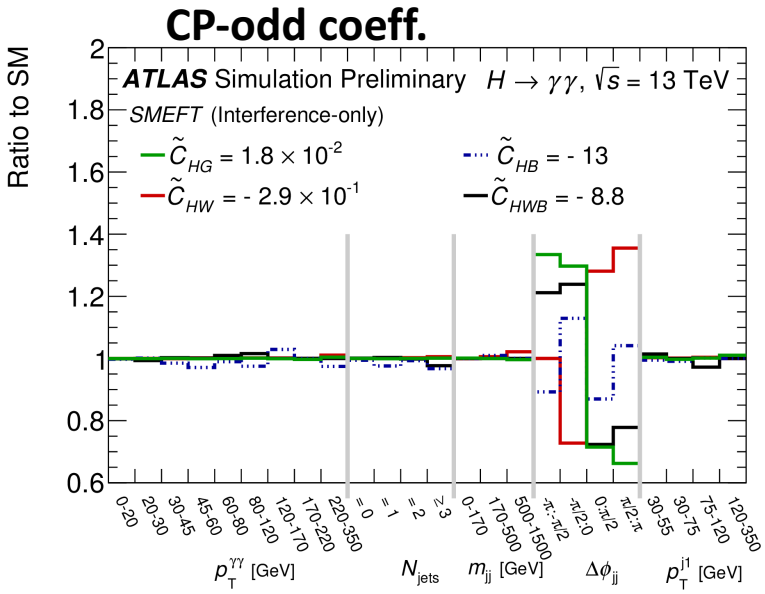
- Differential cross section vs Higgs kinematics, jet activities
- Limited by stat. uncertainty
- **Good agreement with SM predictions**

ATLAS-CONF-2019-029

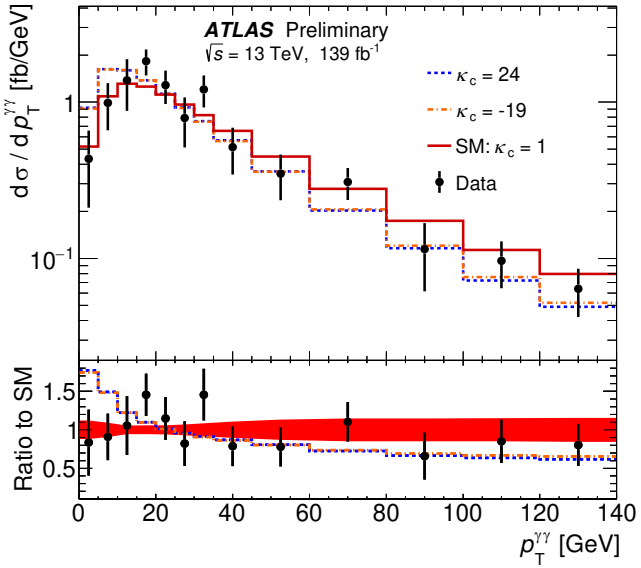


Interpretations:

- SM **Effective Field Theory** to probe additional CP-even and CP-odd interactions

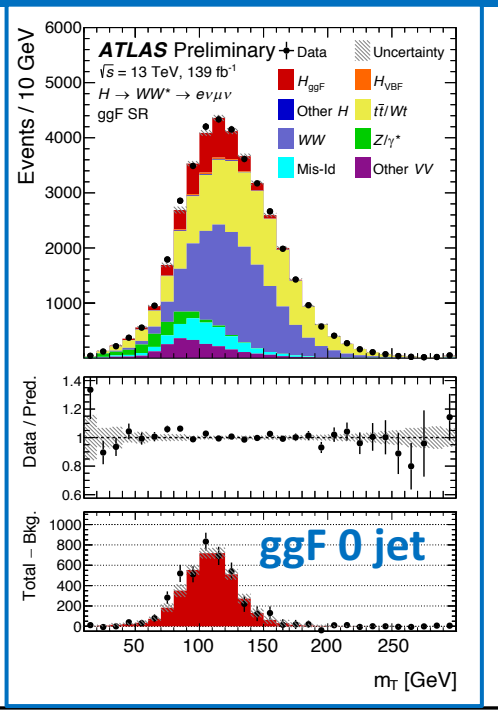


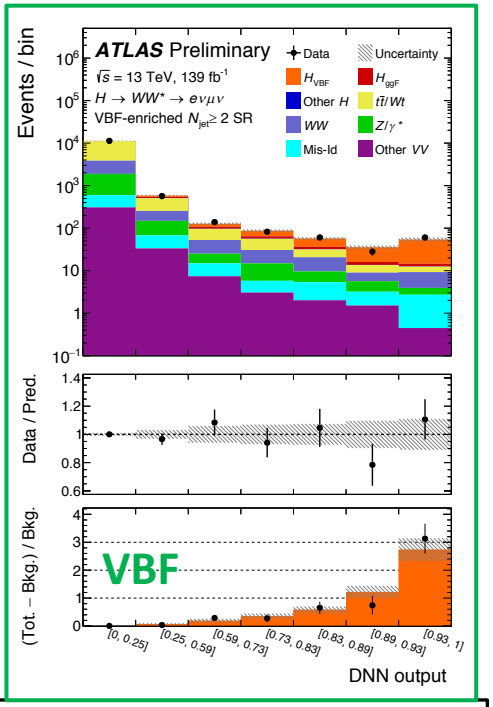
- **pT $^{\gamma\gamma}$** sensitive to the Yukawa coupling of the Higgs boson to the **charm quark**.:-19 <κ_c< 24



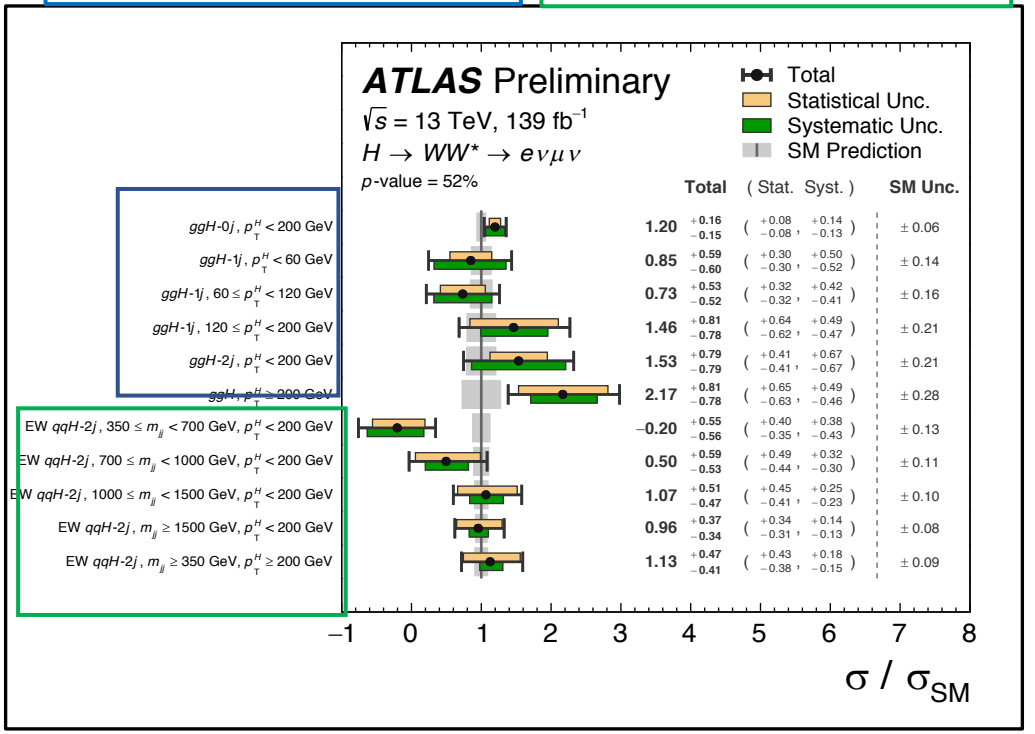
H→WW* →eν μν STXS

- Targets **ggF** and **VBF** production modes
- Larger BR of H→ WW* wrt ZZ* / γγ
- Fit variables: m_T (DNN) for ggF (VBF)





- **ggH** uncertainties limited by both stat. + syst.
- **VBF** uncertainties limited by statistics at high mjj /pT
- **Results compatible with SM**



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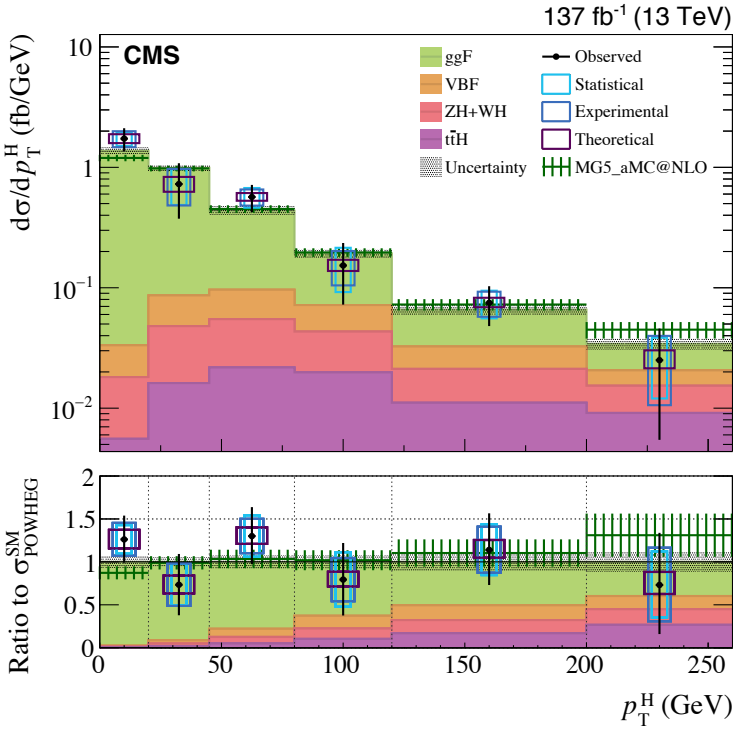
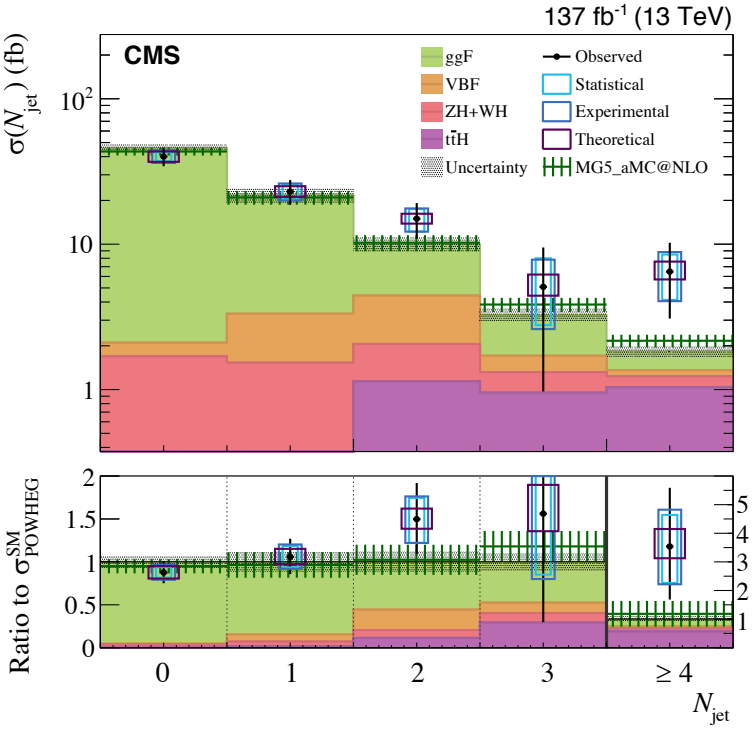
Differential distribution : H→WW* →eν μν

CMS-HIG-19-002

- Inclusive in production modes
- Differential cross section vs p_T^H and Njet

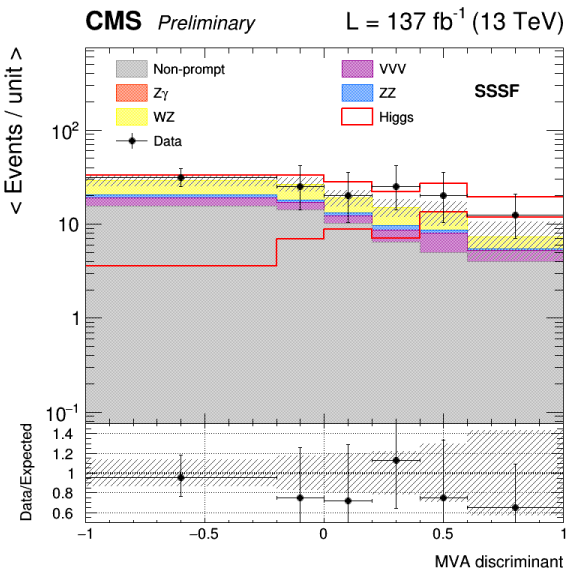




No significant deviation from the SM

VH→WW →2l2ν

- Targets **ZH** and **WH** production modes
- Final states with 2,3,4 leptons
- Categories based on charge and flavour of leptons
- Signal fit: BDT discriminants in WH(3l) and ZH(4l), $m_T(H)$ in ZH(3l)
- Observed significance of 4.7σ w.r.t. b-only for incl. Xsec
- Syst uncertainties ~ stat. uncertainties
- **Results compatible with SM**



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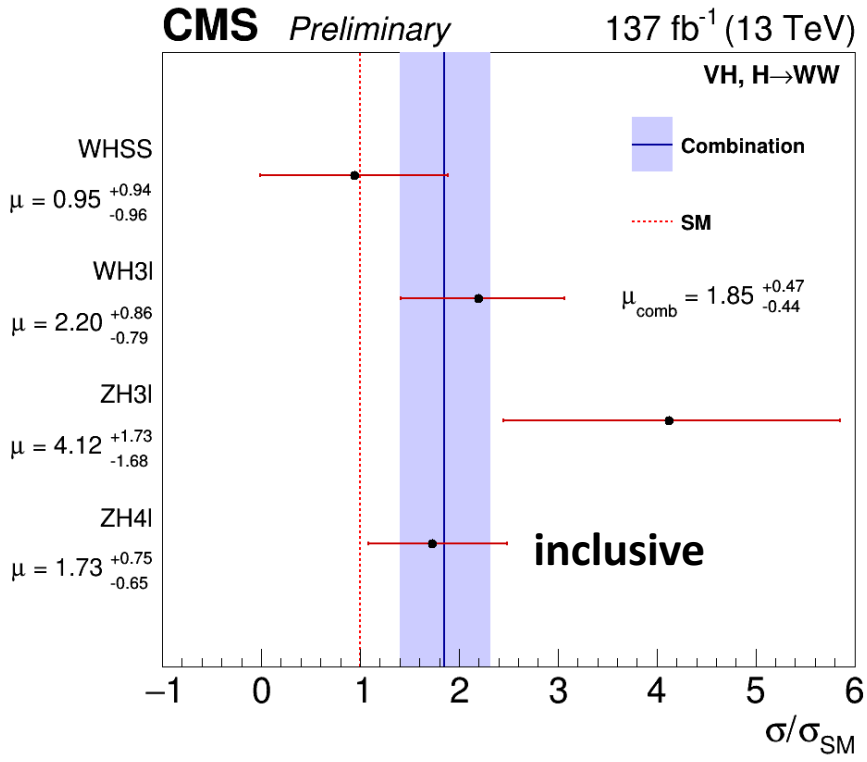
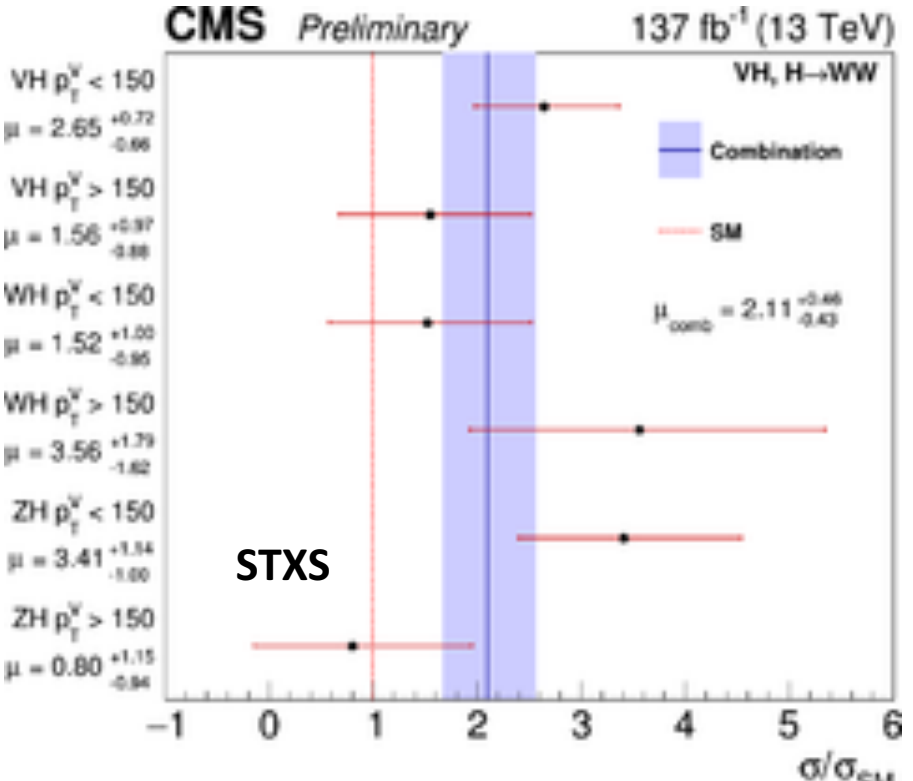
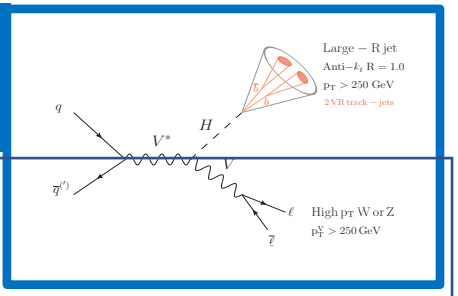


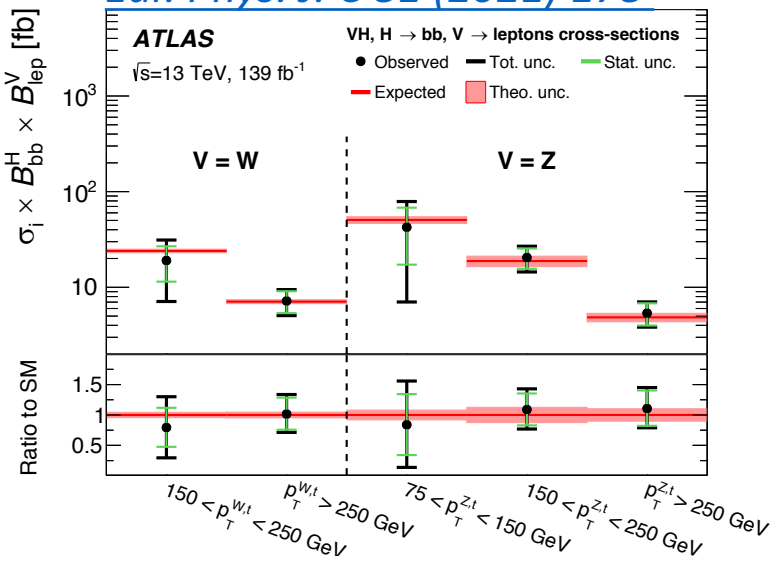


H→bb STXS



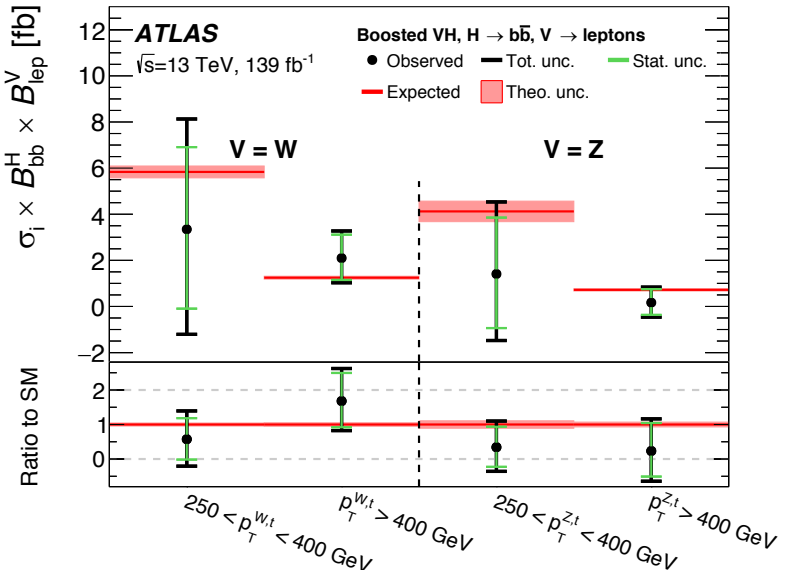
- **VH resolved / boosted**
  - bb pair reconstructed as **two separate** jets / **single large-radius** jet
  - Single STXS bin for **p_T^V > 250 GeV** / probing phase space **p_T^V > 400 GeV**
  - Stat. limited at high p_T / overall

Eur. Phys. J. C 81 (2021) 178

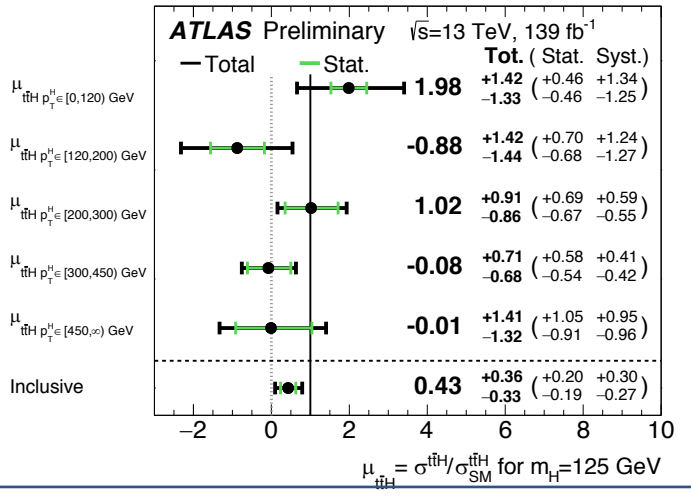


Compatible with SM prediction

Phys. Lett. B 816 (2021) 136204



- **ttH**
  - First differential measurement in H→bb
  - **Compatible with SM prediction**



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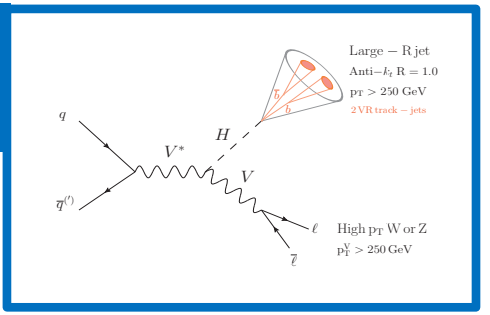
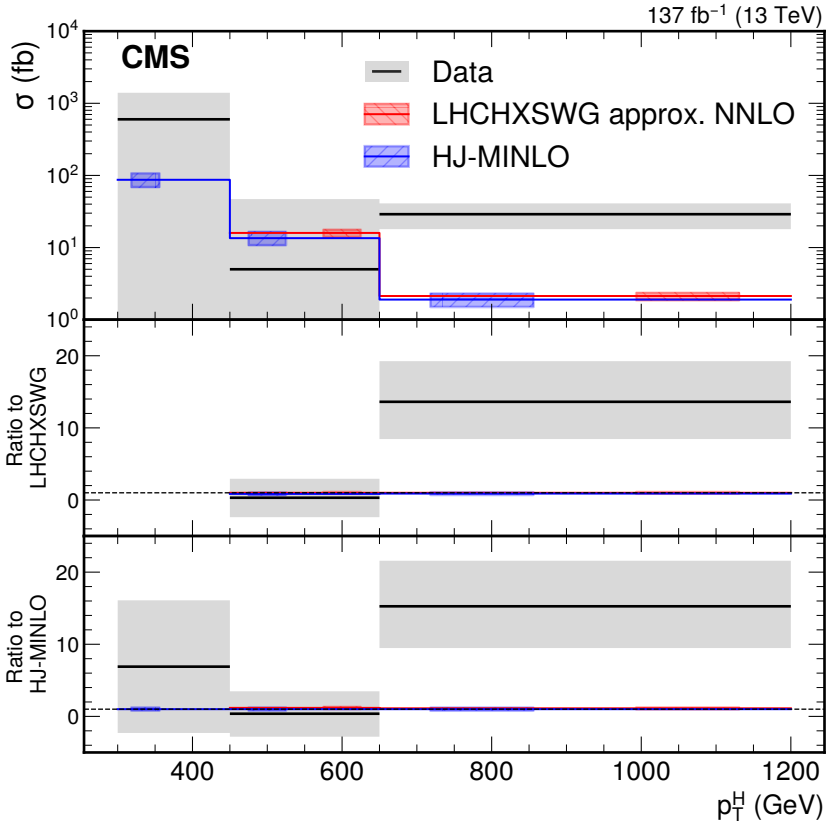
Differential H→bb



Use **boosted** H->bb category to reach **large p_T^H**

JHEP 12 (2020) 085



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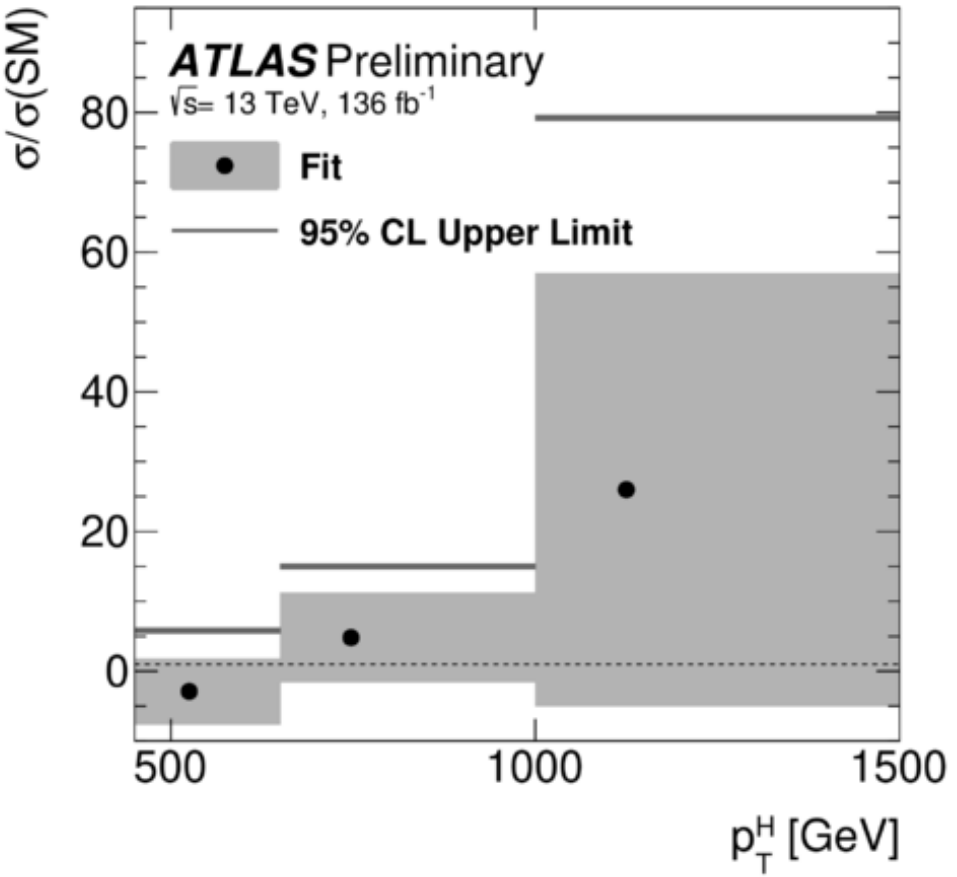
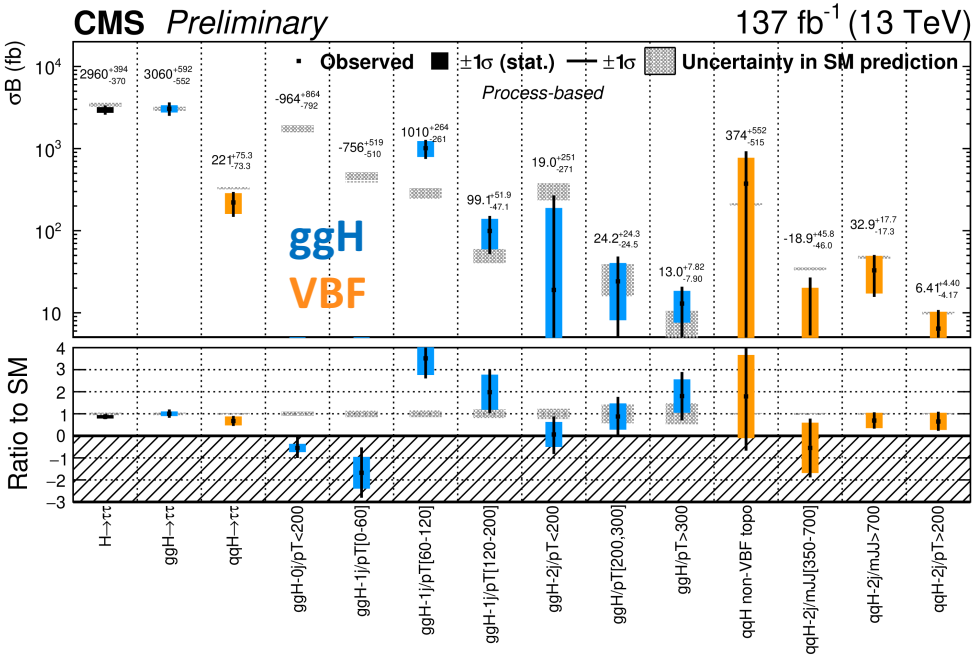


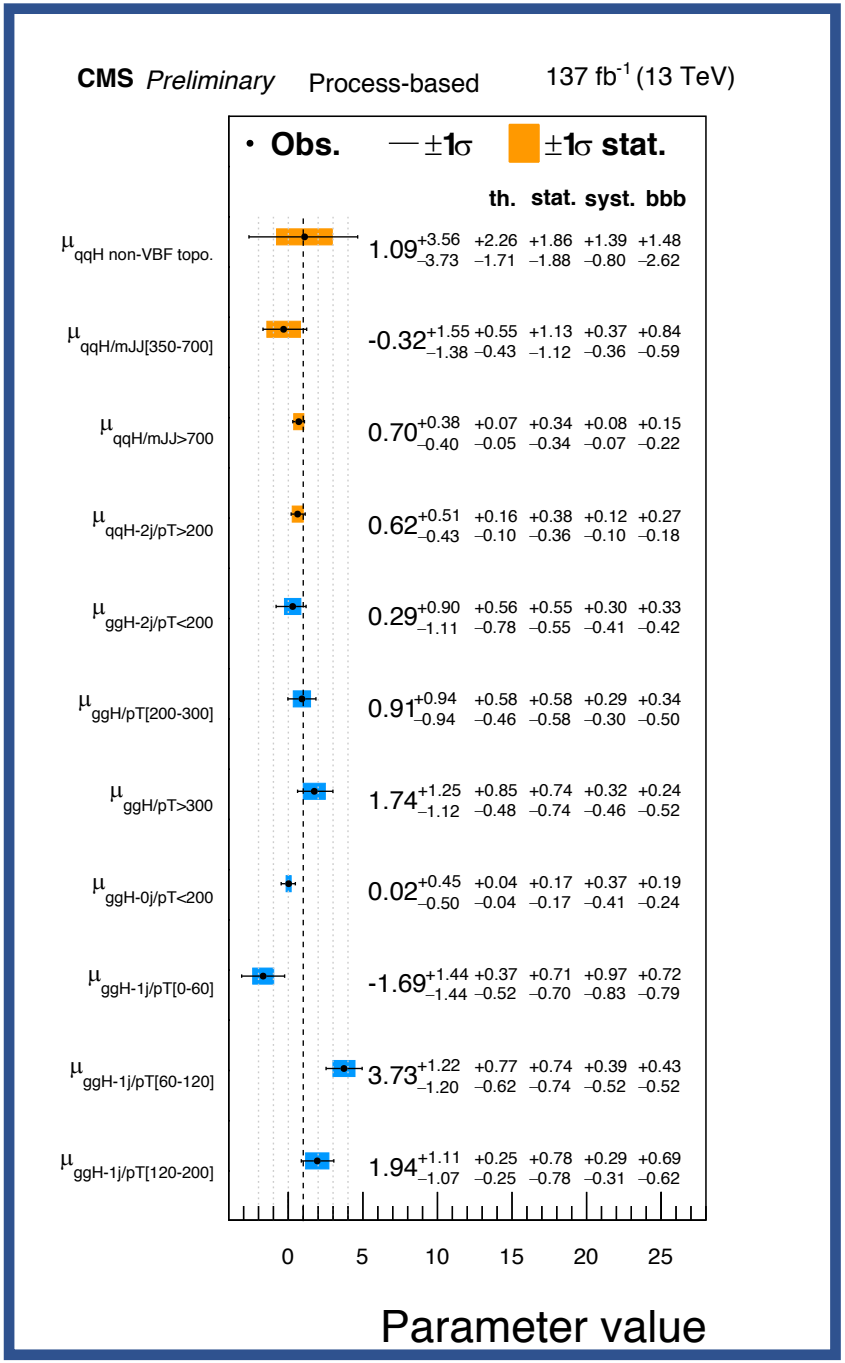
- CMS
  - local significance of 2.6 σ w.r.t. SM for p_T^H > 640 GeV
    - 1.9 σ when considering all 3 bins simultaneously
- ATLAS
  - Up to p_T^H > 1 TeV
  - Results **compatible with SM expectation** within uncertainties

H→ ττ STXS

- Targets **ggF** and **VBF** production modes
- Tau embedding for precise estimate of Z background
- 2D fit in each category: $m_{\tau\tau}$ and observable discriminating STXS process (eg mjj for VBF)
- **Results compatible with SM**

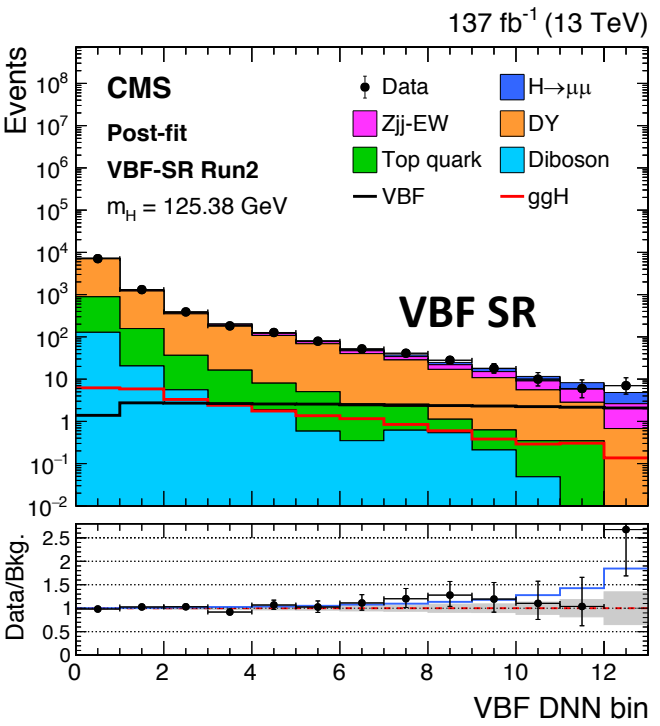


CMS-PAS-HIG-19-010

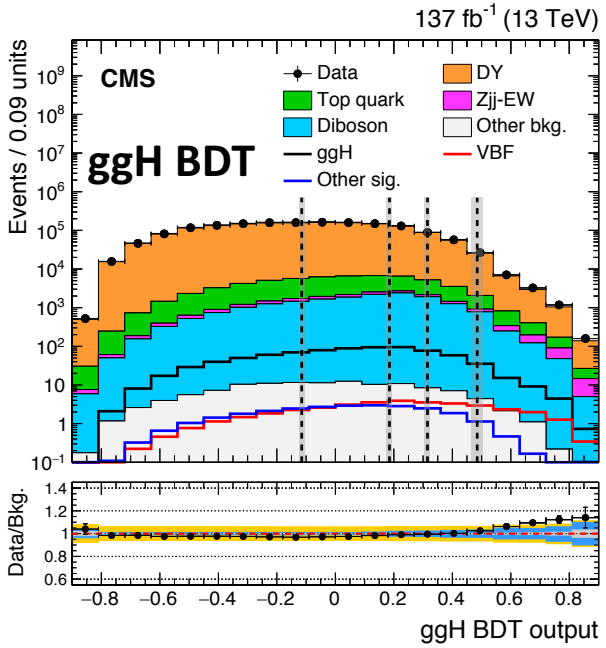


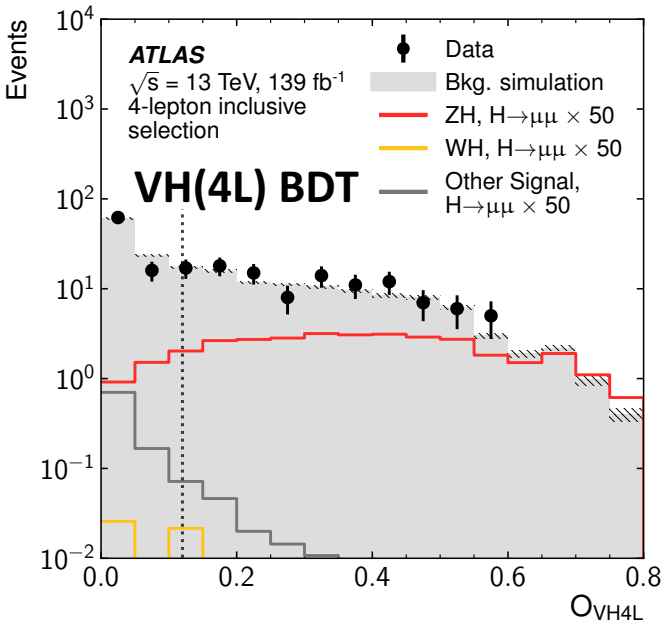
H→μμ

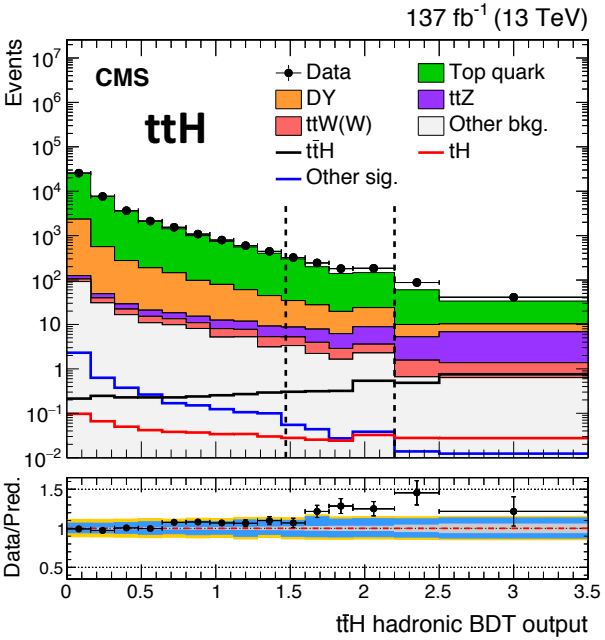
- **Motivation**:
  - Probing Higgs couplings to fermions of **2nd generation**
- **Strategy**:
  - ggH, VBF, VH, and ttH production modes probed
  - Event categories based on Nlep, Nbjet, and VBF-jets
  - BDTs used to suppress backgrounds in each category
  - Signal extracted from fits to m(μμ) with functions
    - High m_H resolution but low S/B due to mainly Z+jets background
  - For VBF CMS uses DNN to extract signal



JHEP01(2021)148
Phys.Lett.B.7812.135980

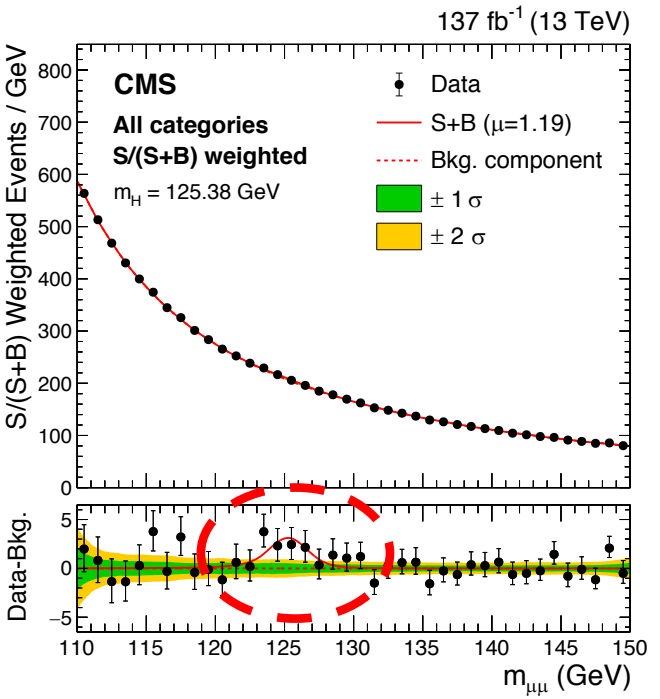




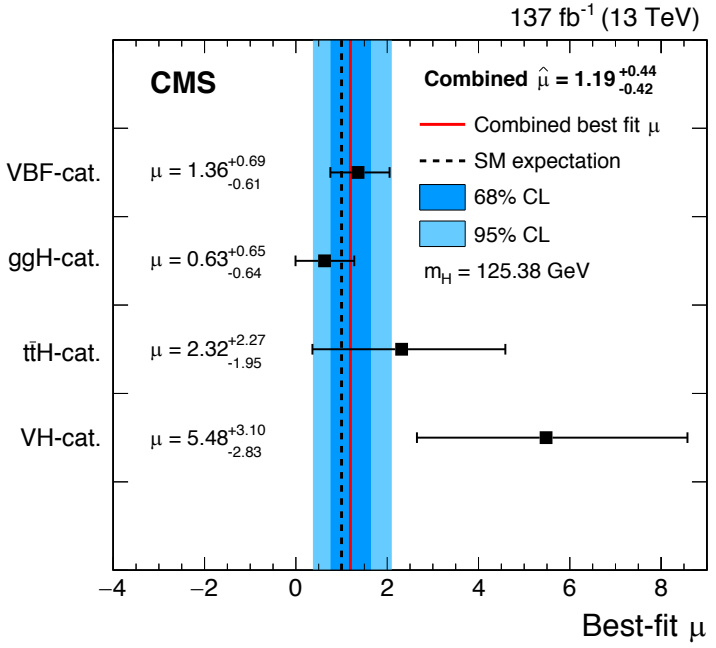


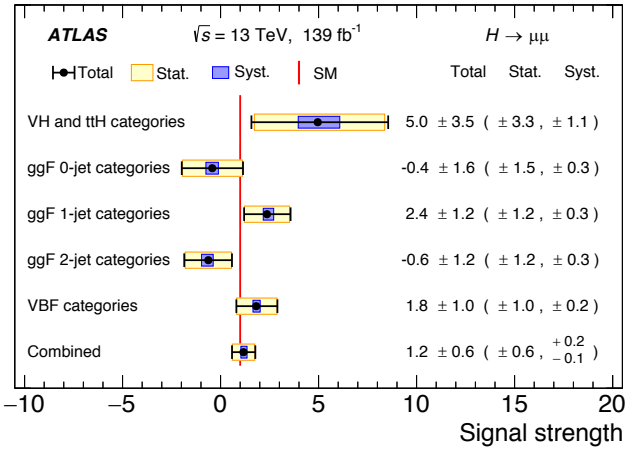
H→μμ

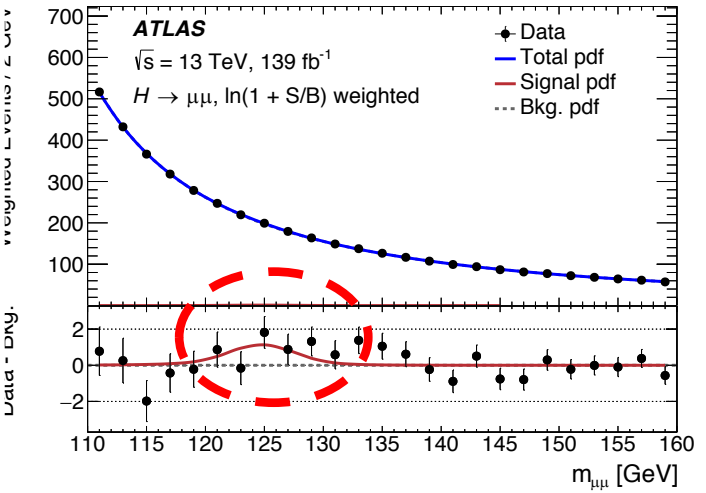
- **Excess observed** in data w.r.t b-only ~125 GeV by both experiments
- **CMS** result: obs. (exp.) significance **3.0σ** (2.5σ)
- **ATLAS** result: obs. (exp.) significance **2.0σ** (1.7σ)
- Results are both **compatible with SM** expectations in each mode
- Performance limited by statistical uncertainty



Evidence for H→μμ decays







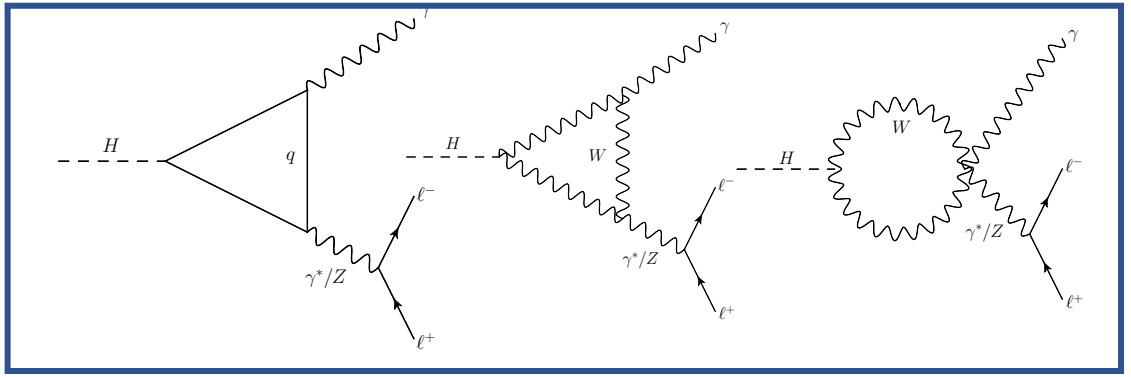
Phys.Lett.B.7812.135980

JHEP01(2021)148

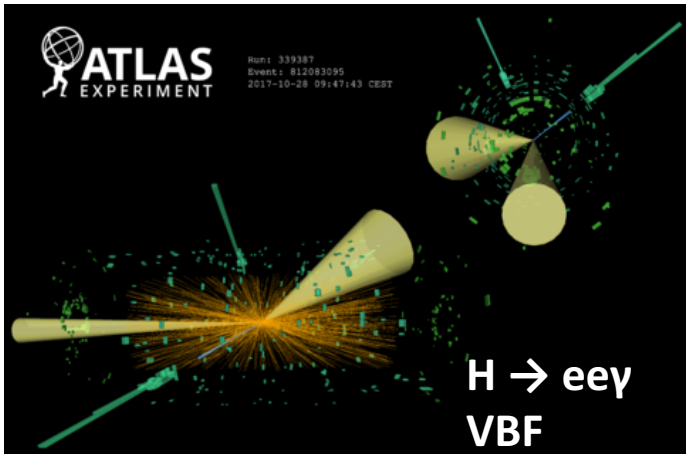
Rare H→llγ decay

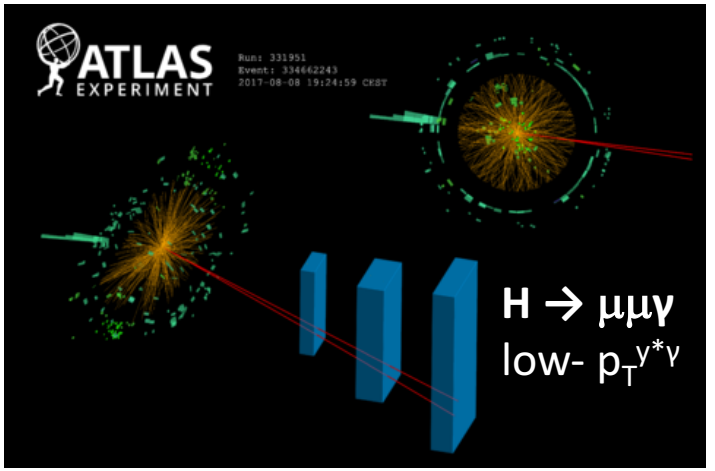
- **Rare** decays through loop diagrams
  - sensitive to **BSM** effects
  - SM pred.: BR $(1.54 \pm 0.09) \times 10^{-3}$

- Previous result for H→γ*γ→μμγ:
  by CMS: σ×BR < **4.0**× **SM** σ×BR
  w/ 36 fb^{-1} JHEP11(2018)152



- **Strategy:**
  - m_{ll}<30GeV
  - Decays predominantly through virtual photon: H→γ*γ→llγ (l=e,μ) →leptons are collimated
  - Dedicated electron trigger & ID
  - Categories to separate VBF-like events and high $p_T^{\gamma^*\gamma}$ events
  - Analytic functions to describe mllγ distributions for signal and the bkg





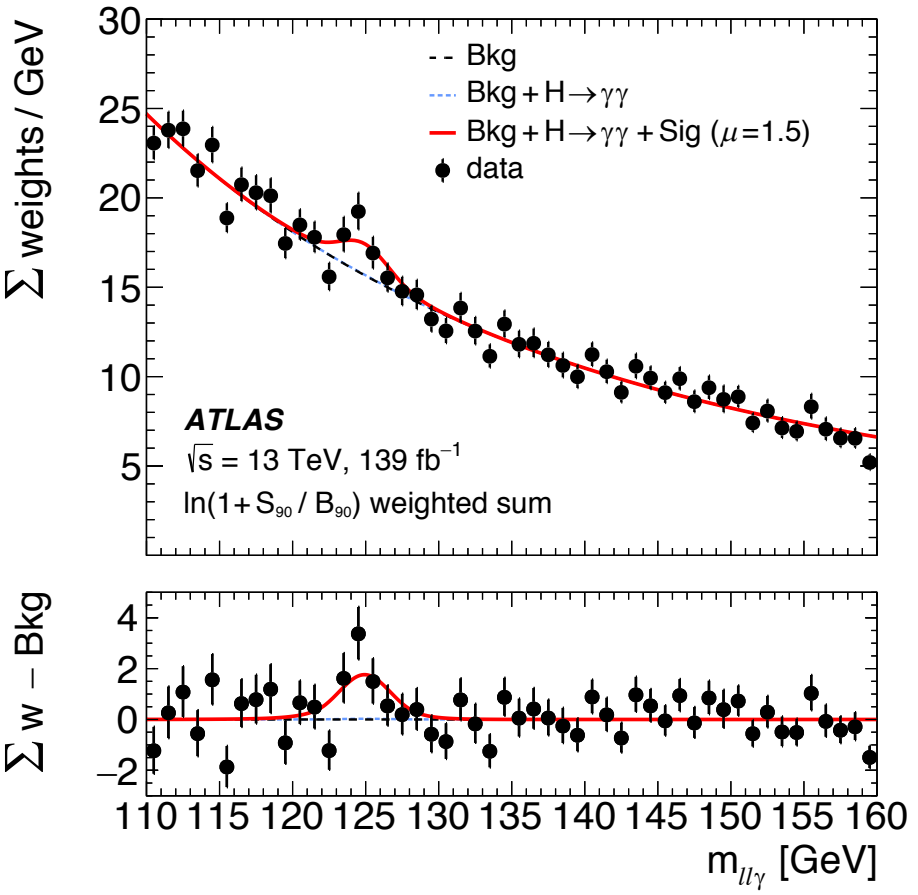
HIGG-2018-43

Evidence for H→llγ

HIGG-2018-43

- **Observed**(exp) significance: **3.2** (2.1) σ
- Best-fit signal strength: **1.5 ± 0.5** times **SM**
- Cross-section times BR for m_{ll}<30 GeV: $8.7\ ^{+2.8}_{-2.7}$ fb
- Limited by statistical uncertainty

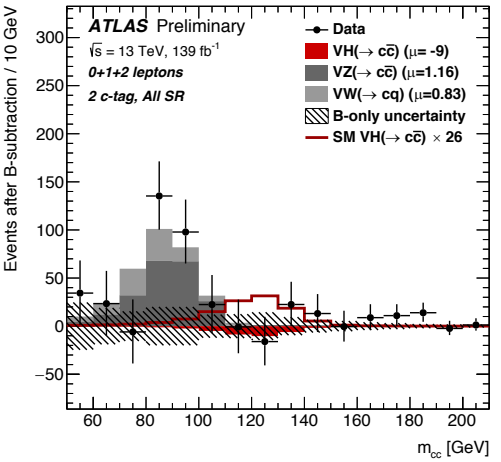
First evidence for the decay of the Higgs boson into a pair of leptons and a photon

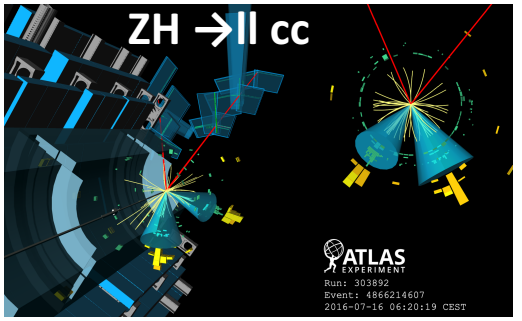


VH,H→cc

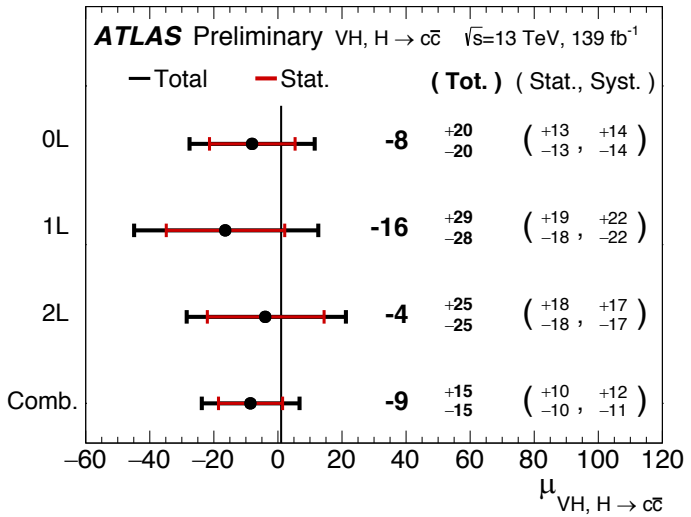
NEW

- Probe Higgs coupling to **second quark generation**
- SM expectation = BR(H→cc) = 2.9%
- Previous analysis with 36 fb^{-1}
  μ/μ_{SM}< 110/70 with ATLAS/CMS
- ZH → vv(ll)cc, WH →vcc with 0,1,2 leptons
- Categories in p_T^V and N_{jets}
- Fit mcc distribution
- **No excess observed**

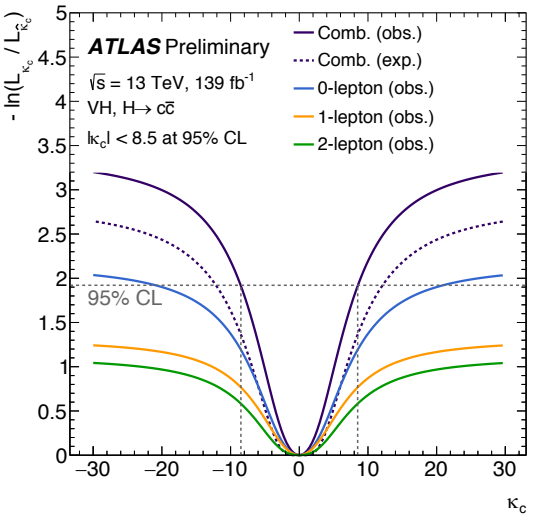




c-tagger key ingredient



$\mu = (\sigma \times BR)/(\sigma \times BR_{SM}) < 26\ (31)$ at 95%CL



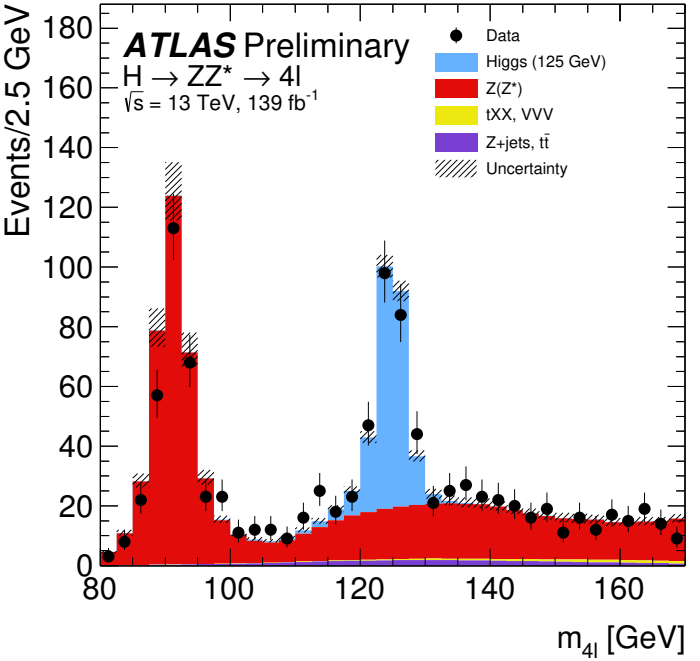
- Yukawa coupling modifier strength
  |κ c |<8.5 at 95% CL
- most stringent constraint to date

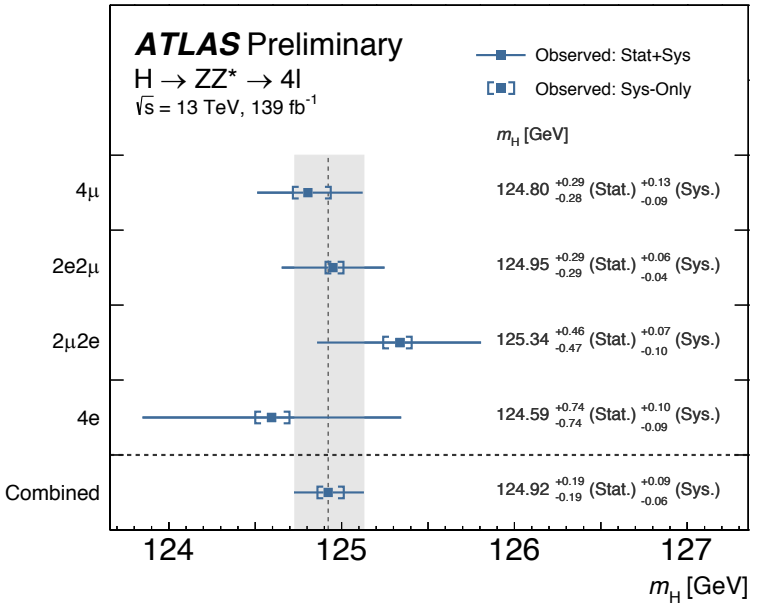
Higgs mass

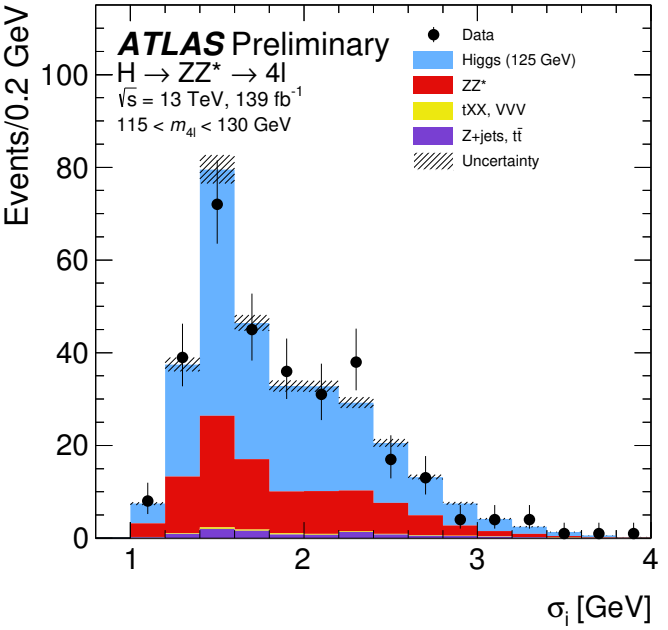
- Previous measurement with Run1 + 36 fb^{-1}:
  - ATLAS: 124.97 ± 0.24 GeV CMS: 125.38 ± 0.14 GeV
  - Use invariant mass of H→ZZ→4l and H→γγ

- Recent ATLAS measurement using **H→ZZ*→4l** .
  - Combined fit to the **m4l** and its predicted **resolution**
    - described through analytical model per event
  - Main **systematic** uncertainty:
    - μ momentum and *e* energy scale

$m_H = 124.92 \pm 0.19(\text{stat.})^{+0.09}_{-0.06}(\text{syst})$ GeV



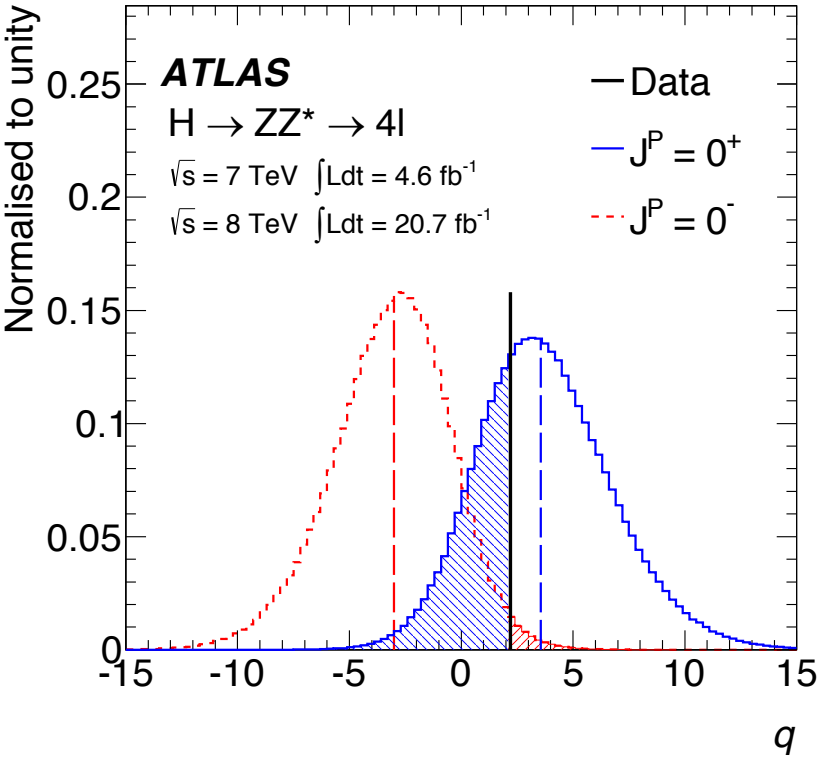




ATLAS-CONF-2020-005

Spin CP

- SM expectation Higgs $J^{CP} = 0^{++}$
- Measurement from bosonic decays consistent with SM
- Mix of scalar and pseudoscalar state not excluded
- Fermionic decays are now scrutinized
- Fermionic **Yukawa couplings**



$$\mathcal{L} = -\frac{m_t}{v}\left\{\bar{\psi}_t \kappa_t \left[\cos(\alpha) + i\sin(\alpha)\gamma_5\right]\psi_t\right\} H$$

- $\alpha = 0$ scalar (SM)
- $\alpha = \pi/2$ pseudoscalar
- $0 < \alpha < \pi/2$ mixed state with CP violation → maximal violation for $\pi/4$

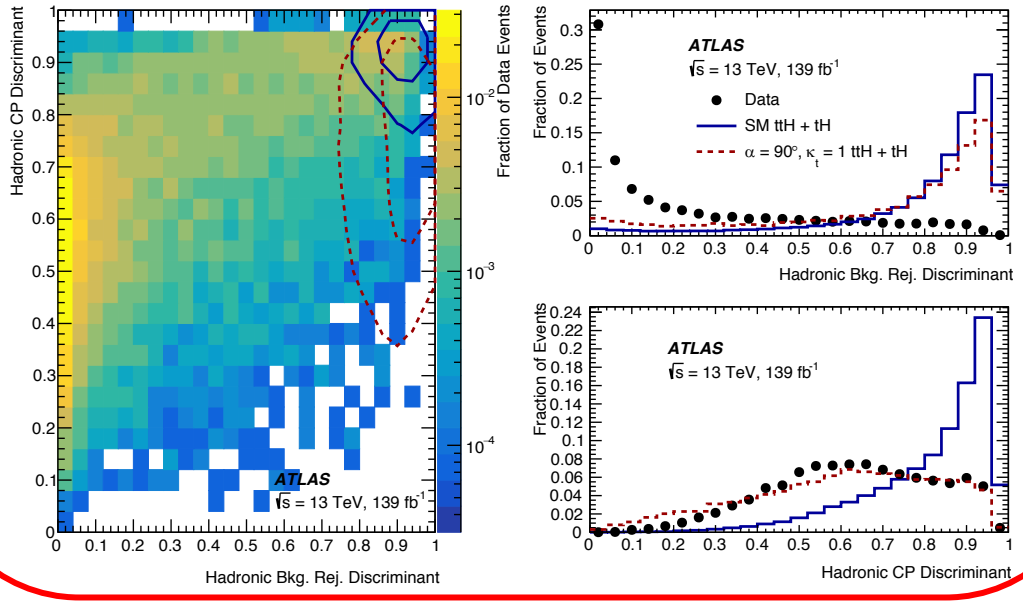
CP structure of ttH vertex

- Probe **CP** structure of **ttH** vertex in **ttH/tH, H→γγ**
- Strategy: two BDTs used to reject background and to distinguish CP-odd from CP-even contributions

A CP-odd coupling is excluded at 3.9σ (3.2σ) for ATLAS(CMS)

$$\mathcal{L} = -\frac{m_t}{v}\left\{\bar{\psi}_t \kappa_t \left[\cos(\alpha) + i\sin(\alpha)\gamma_5\right]\psi_t\right\} H$$

$|\alpha|>43^{o}$ excluded at 95% CL

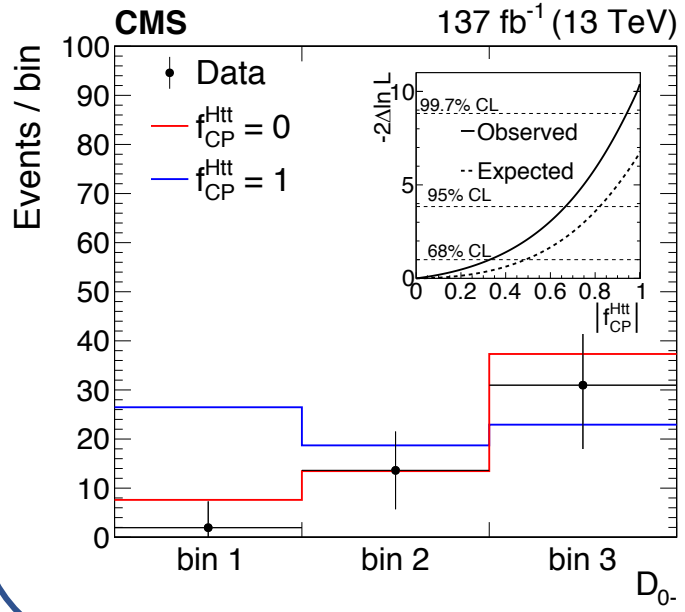


[Phys.Rev.Leett.125 (2020) 061802]

$$\mathcal{A}(\mathrm{Htt}) = -\frac{m_t}{v}\bar{\psi}_t\left(\kappa_t + i\tilde{\kappa}_t\gamma_5\right)\psi_t,$$

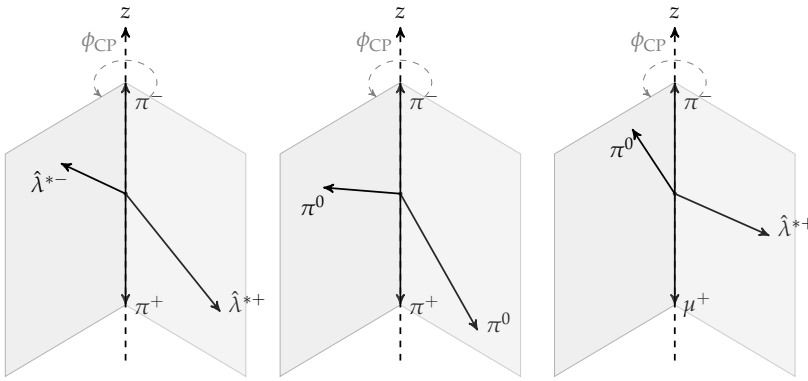
$$f_{CP}^{\mathrm{Htt}} = \frac{|\tilde{\kappa}_t|^2}{|\kappa_t|^2 + |\tilde{\kappa}_t|^2}\,\mathrm{sign}(\tilde{\kappa}_t/\kappa_t).$$

$|fH^{tt}_{CP}| < 0.82$ at 95% CL



[Phys. Rev. Lett.125 (2020) 061802]

CP structure of H→ττ vertex

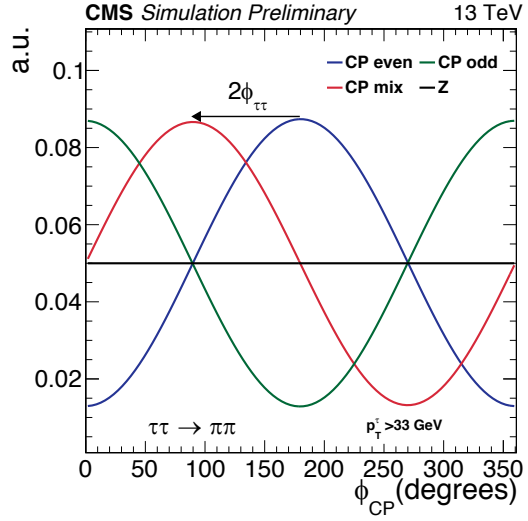


- Strategy : measure the ϕ_{CP} between planes formed by the charged particle direction and the τ impact parameter vector
- Sensitive to mixing angle $\phi_{\tau\tau}$ for the **Hττ coupling**

$$L_Y = -g_\tau(\cos(\phi_{\tau\tau})\bar{\tau}\tau + \sin(\phi_{\tau\tau})\bar{\tau}i\gamma_5\tau)h$$

- Use $\tau_h\tau_h$ and $\tau_h\tau_l$ channels
- Most sensitive channels: ρρ,πρ,μρ

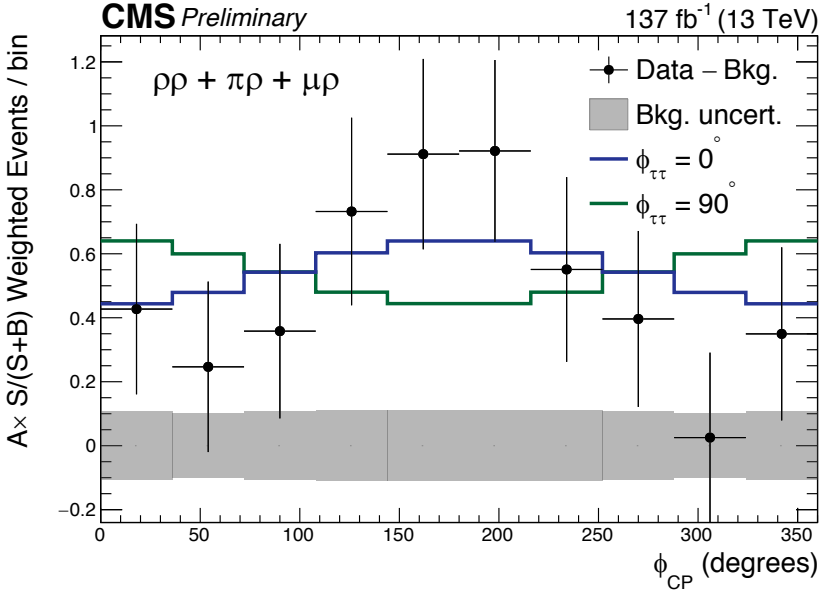
CMS-HIG-20-006-pas



- Results:
- **$\phi_{\tau\tau}$=4°±17°(stat)±2°(bin−by−bin)±1°(syst) ±1°(theory)**

- Pure CP-odd pseudoscalar boson rejected with 3.2σ (2.3) observed (expected)

- **Consistent with SM expectation**



CP structure of Hgg vertex

- Test **CP** structure of effective Higgs coupling to **gluons** using **H→ZZ*→4l** CMS-PAS-HIG-19-009
- **Amplitude** describing the interaction of a **spin-0** particle and **two spin-one gauge** bosons: ZZ, Zγ,γγ, WW, **gg**:

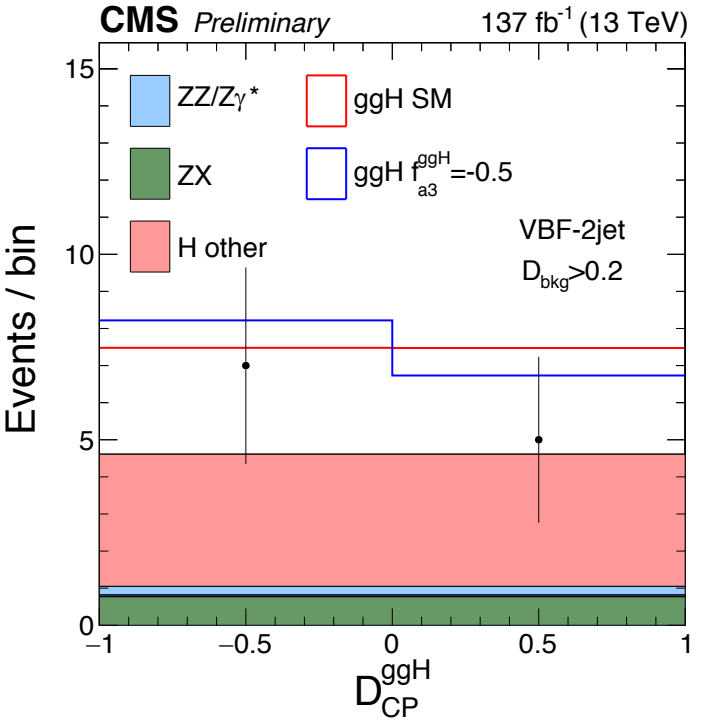
$$A(\mathrm{HVV}) = \frac{1}{v}\left[a_1^{\mathrm{VV}} + \frac{\kappa_1^{\mathrm{VV}} q_{\mathrm{V1}}^2 + \kappa_2^{\mathrm{VV}} q_{\mathrm{V2}}^2}{\left(\Lambda_1^{\mathrm{VV}}\right)^2} + \frac{\kappa_3^{\mathrm{VV}} (q_{\mathrm{V1}} + q_{\mathrm{V2}})^2}{\left(\Lambda_{\mathrm{Q}}^{\mathrm{VV}}\right)^2}\right] m_{\mathrm{V1}}^2 \epsilon_{\mathrm{V1}}^* \epsilon_{\mathrm{V2}}^* + \frac{1}{v} a_2^{\mathrm{VV}} f_{\mu\nu}^{*(1)} f^{*(2),\mu\nu} + \frac{1}{v} a_3^{\mathrm{VV}} f_{\mu\nu}^{*(1)} \tilde{f}^{*(2),\mu\nu},$$

$a_3^{gg}(a_2^{gg})$ ***CP-odd***(*CP-even*)

- Use discriminant variable based on matrix elements both for separating signal from background events, and CP-even from CP-odd events.
- Extract:

$$f_{a3}^{ggH} = \frac{|a_3^{gg}|^2}{|a_2^{gg}|^2 + |a_3^{gg}|^2} \,\mathrm{sign}\left(\frac{a_3^{gg}}{a_2^{gg}}\right).$$

$f^{ggH}_{a3} = -0.53\ ^{+0.51}_{-0.47}$ **Consistent with SM**

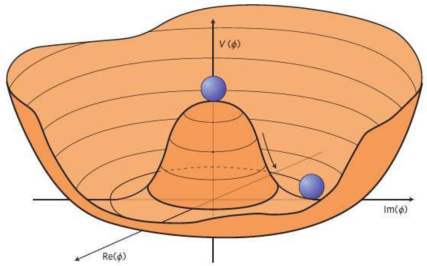


First direct test of CP violation effects in the Hgg coupling

Higgs-self coupling at LHC

- Motivation for **Higgs-self coupling**
  - Shape of Higgs potential
  - Probe EW Symmetry Breaking mechanism
  - Probe new physics
  - Not yet measured experimentally

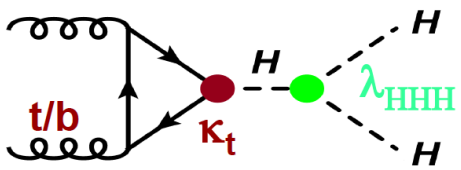
$$V(\Phi^\dagger\Phi) = -\mu\Phi^\dagger\Phi + \lambda(\Phi^\dagger\Phi)^2$$



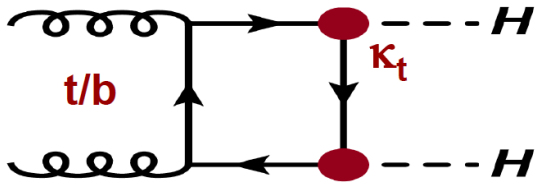
$\lambda = m_H^2/2v^2 \sim 0.13$

- **Non-resonant HH production** sensitive to λ:
  - **rare** process of the SM:
    $\sigma(gg\rightarrow HH) \approx 0.1\% * \sigma(gg\rightarrow H)$
    destructive interference between box and triangle diagram

Triangle diagram



Box diagram

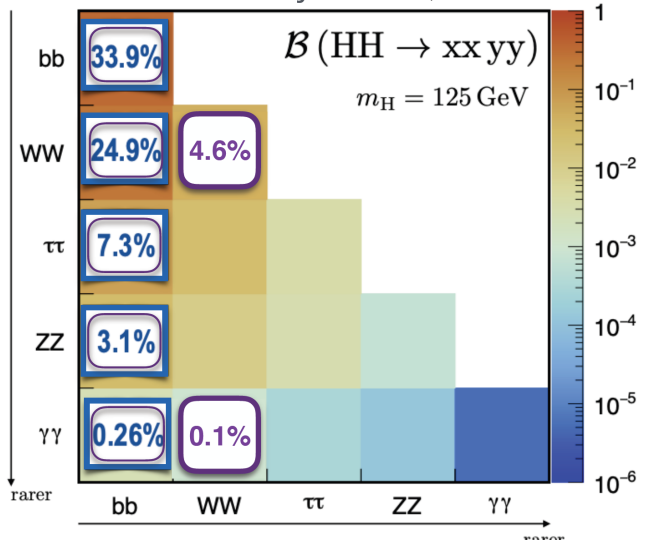


- Run1 36 fb^{-1} for ATLAS / CMS
  - $\sigma/\sigma_{SM} <$ 6.9 (22) at 95% CL
  - -5 (-12) < k_λ < 12 (19)

CMS-HIG-17-030
HDBS-2018-58

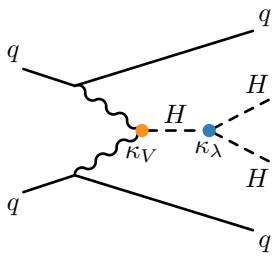
- New set of measurements with 140 fb^{-1} of Run2

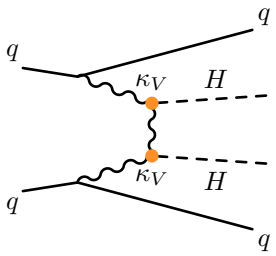
Published by CMS, ATLAS

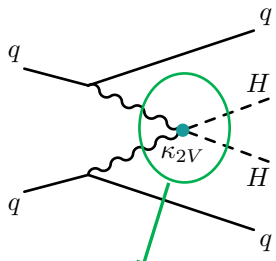


VBF HH→bbbb

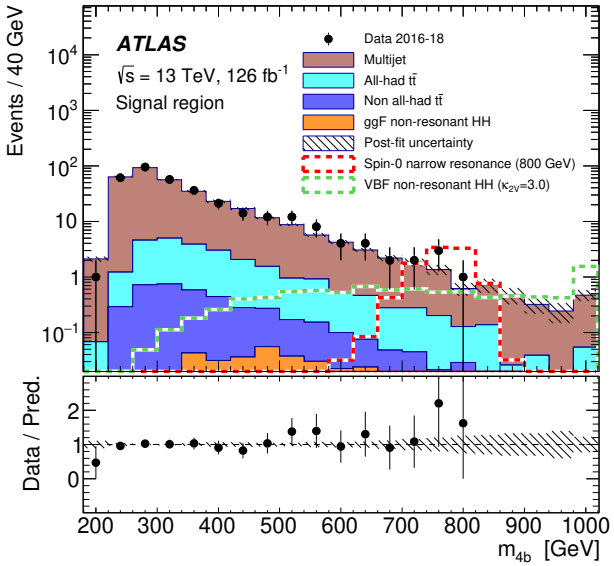
- Production mode sensitive to c_{2V} coupling unique to HH







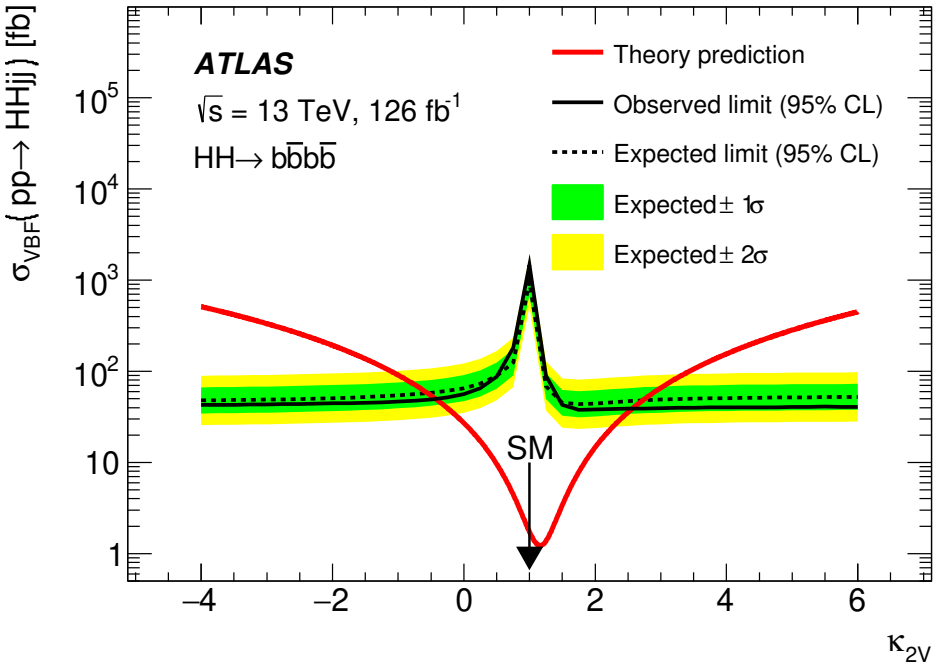
$\kappa_{2V} = c_{2V} / c_{2V\,SM}$



- Main challenge: multijet bkg, data-driven estimate
- Fit m4b to extract presence of signal

Observed (expected) :

- **$\sigma_{VBF}/\sigma_{VBF\,SM}$ < 840(550) at 95%CL**
- **-0.43 (-0.55) < κ_{2V} < 2.56 (2.72)**

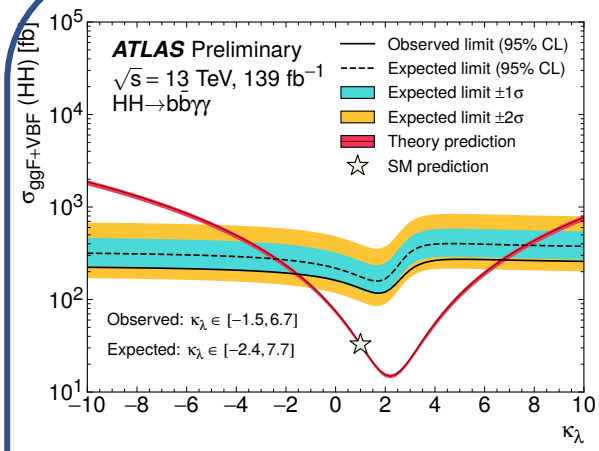


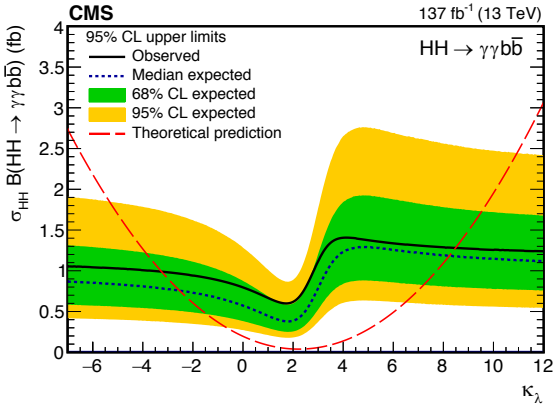
HDBS-2018-18

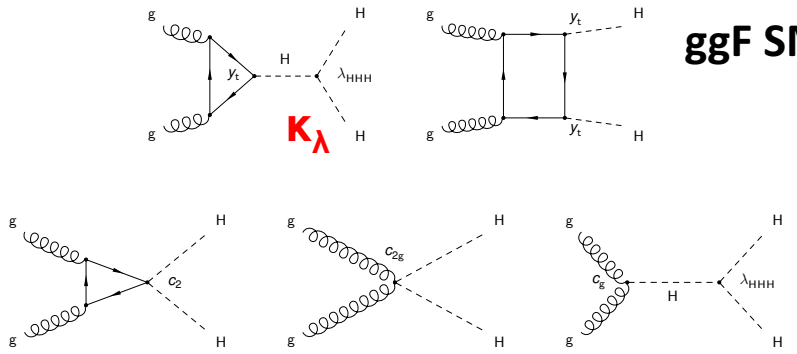
HH→bbγγ

- Both **ggF** and **VBF** production modes
- $\sigma_{SM\ HH}$ and anomalous values of κ_λ; CMS also $\sigma_{SM\ HH\ VBF}$ and κ_{2V},

JHEP 03 (2021) 257
ATLAS-CONF-2021-016



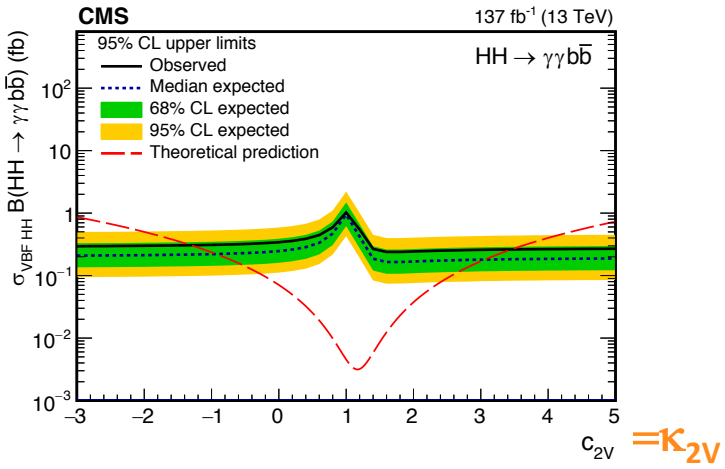


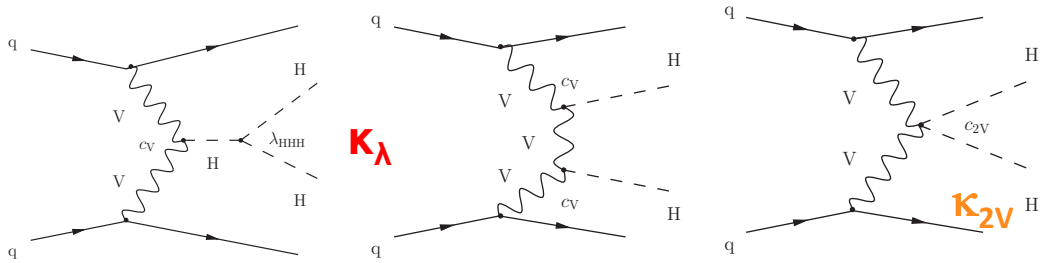


Inclusive HH, driven by ggF categories

CMS: **σ/σ_{SM} < 7.7(5.2) , -3.3 (-2.5) < κ_λ < 8.5(8.2) Obs. (Exp)**

ATLAS: **σ/σ_{SM} < 4.1(5.5), -1.5 (-2.4) < κ_λ < 6.7(7.7) Obs. (Exp)**





VBF HH

CMS: **$\sigma_{VBF}/\sigma_{VBF\ SM}$ < 225(208)**

-1.3 (-0.9) < κ_{2V} < 3.5 (3.0) Obs. (Exp)

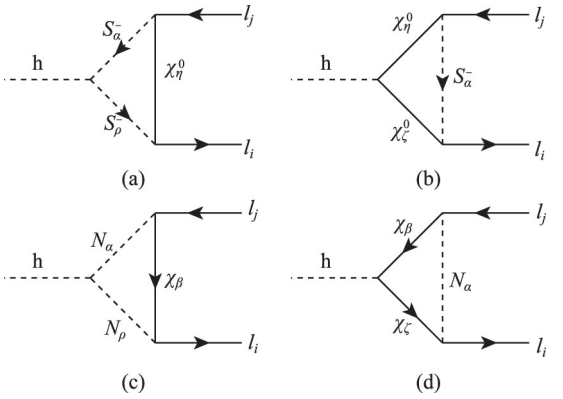
LFV Higgs decays

Higgs → lepton flavor violating

- The LFV decays of **H→eμ,eτ, μτ** are **forbidden** in the **SM**
  → can provide provide possible signatures of **BSM**

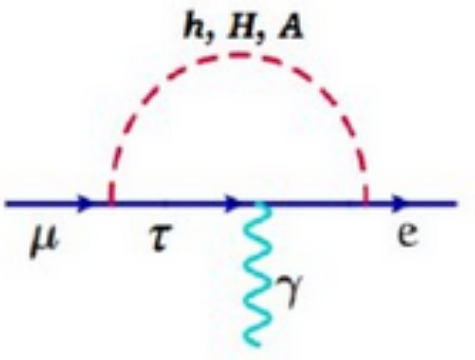
- **Predicted** in models with > 1 Higgs boson doublet,
  SUSY models, composite Higgs models , extra-dimension

- **Experimentally** allowed:
  - From combined fit of Higgs couplings:
  - BR (Higgs→undetected)< 19 % ATLAS-CONF-2020-027



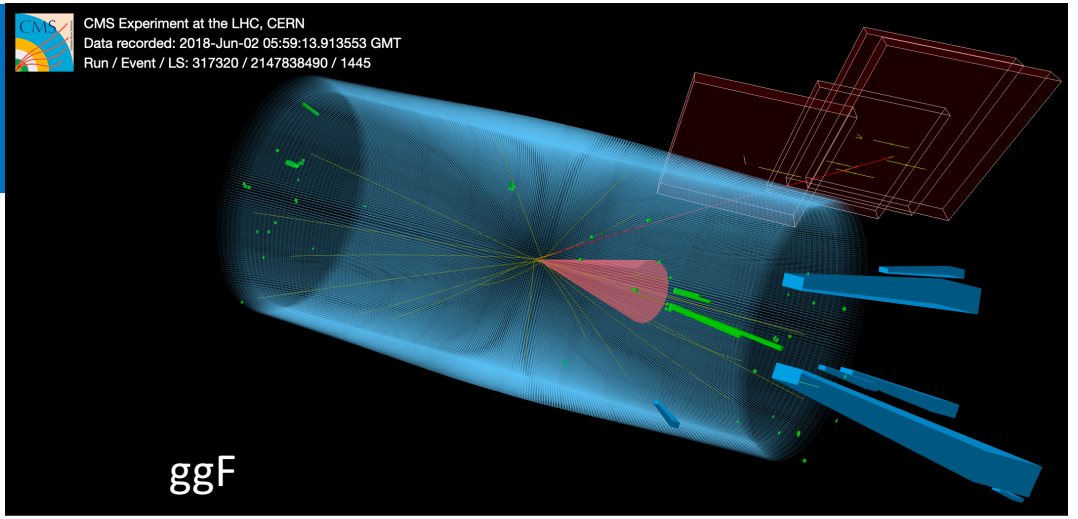
μνSSM

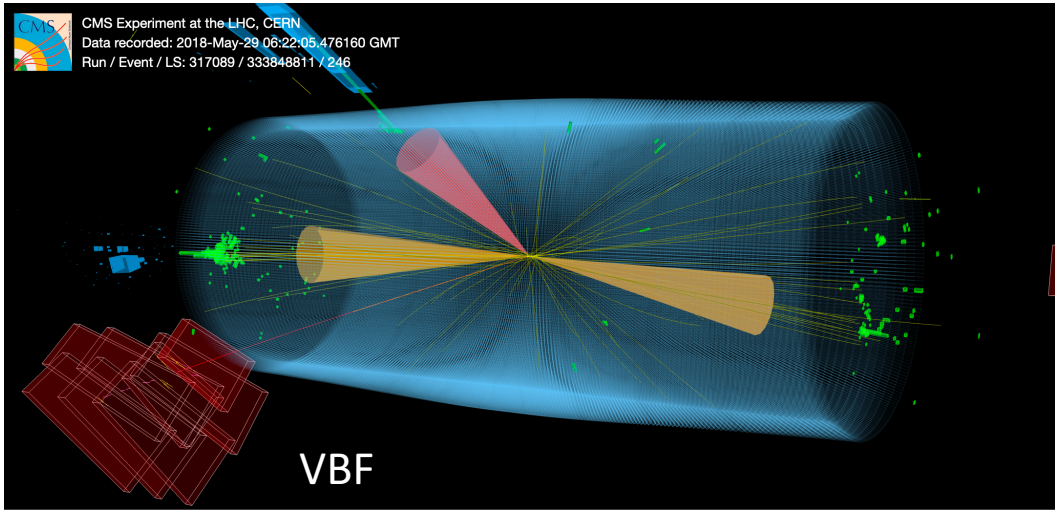
- **Indirect limits**:
  - B(H→eμ) <10^{-8} from the null result for μ→eγ [MEG PRL110(2013)]
  - BR(H→eτ) and B(H→μτ) <10% from searches for rare τ lepton decays , such as τ→eγ and τ→μγ [Phys. Rev. D89(2014)]

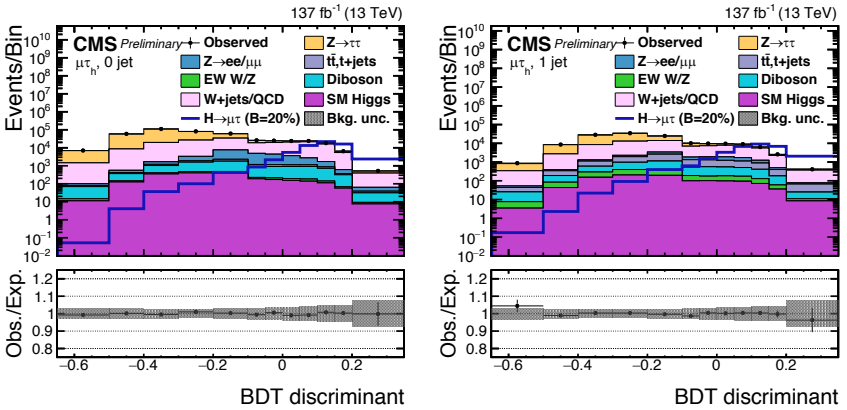


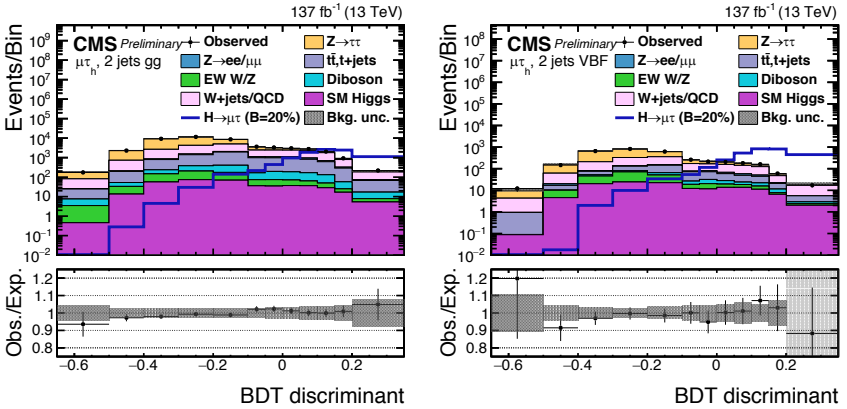
H→e/μ τ

- Four channels: $\mu\tau_h$, $\mu\tau_e$, $e\tau_h$, $e\tau_\mu$
  - divided into event categories targeting Higgs production mechanisms:
    - 0-jet (ggF), 1-jet (ggF + ISR)
    - 2-jet (ggF) , 2-jet (VBF)
- Tau ID based on NN









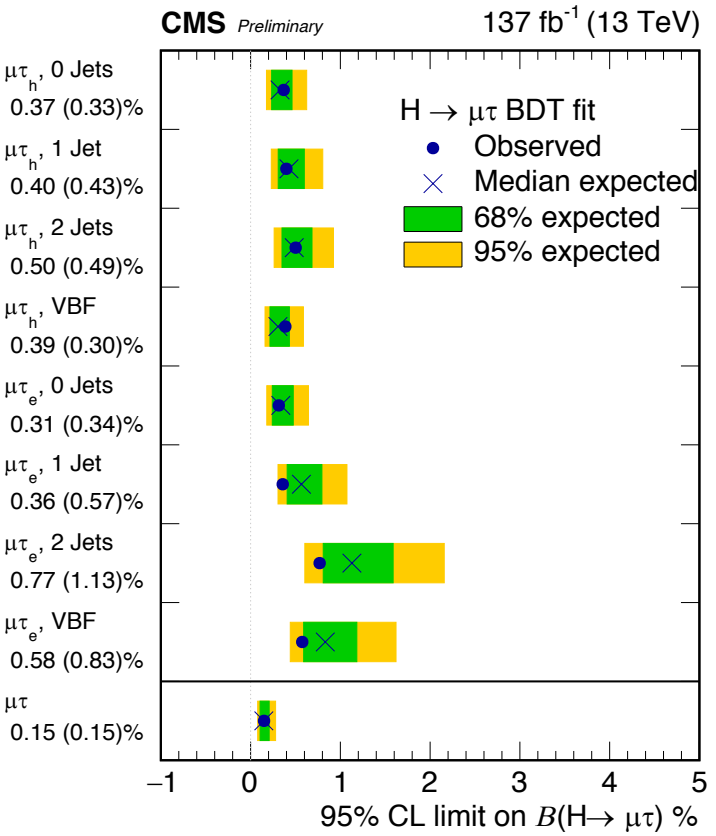
- BDT trained on each channel using kinematic variables
- Fit to BDT distributions performed simultaneously over all channels and categories

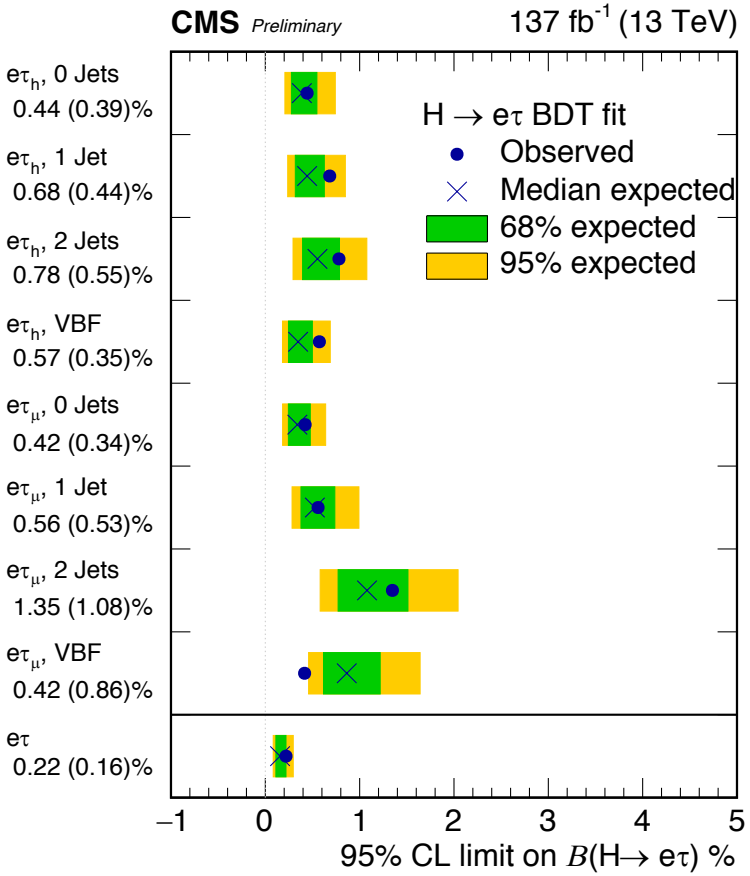
CMS PAS HIG-20-009

H→e/μ τ Results

- **No significant excess has been found**
- Observed (expected) limits at 95 CL:
  - **BR (H→$\mu\tau$)< 0.15% (0.15%) BR (H→$e\tau$)< 0.22% (0.16%)**

CMS PAS HIG-20-009





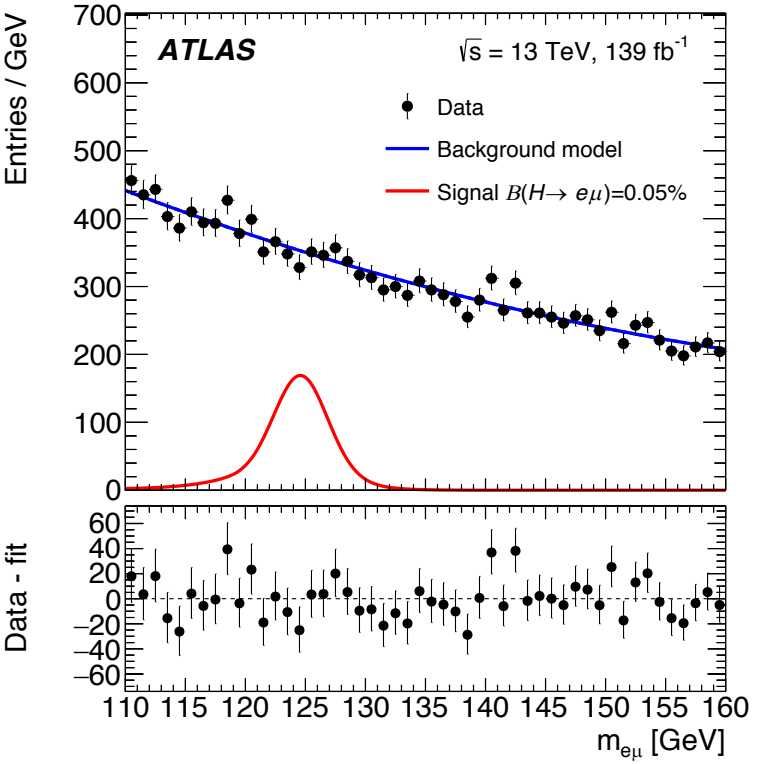
Previous results based on 36 fb^{-1} :
CMS/ATLAS: B(H → $\mu\tau$) < 0.25/0.28 % and B(H→$e\tau$) < 0.37%/0.47%

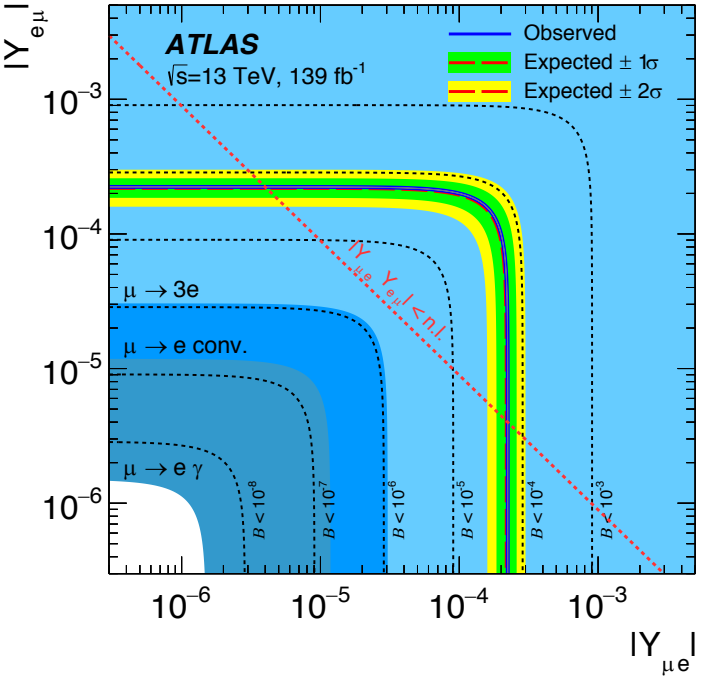
H→e μ , H→e e

- **Motivation**: **BSM** in LFV Higgs decays and coupling to **first-generation** leptons – not yet observed
- Direct limit on **Yeμ/ Yee**
- Indirect constraints on |Yeμ| coupling from limits on the branching fraction of μ→eγ

- **Strategy:**
- Seven (eight) categories for the ee(eμ)channel with different S/B s

- Analytic functions used to describe m_{ll} distributions for signal and the background





No significant excess has been found:

- Observed (expected) limit at 95 CL:
  - **BR (H→eμ) < 6.1×10⁻⁵ (5.8×10⁻⁵)**
- uncertainty dominated by data statistics

HIGG-2018-58

Conclusions

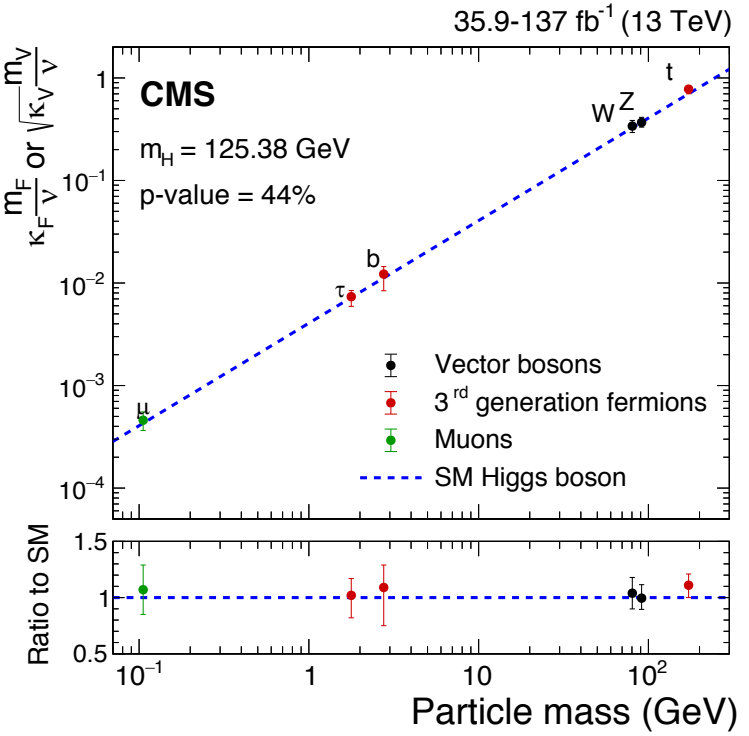
- Most of Higgs measurements now based on full LHC **Run2** data
- Most of Higgs production and decay modes **established**

- **Precision** measurements performed in the high sensitivity channels **H→ZZ, H→WW, and H→γγ**

- Higgs couplings to **3rd generation** firmly **established**

- H(bb) decays used to test **high p_T(H)** phase-space

- **CP**-structure of Yukawa coupling



- **Evidence** for Higgs boson couplings to the **2nd generation** of fermions via the H→μμ decays

- Evidence for Dalitz decays of the Higgs boson in final state H→llγ

- Individual **/ combined legacy measurements** are progressing

- **more data to come**!