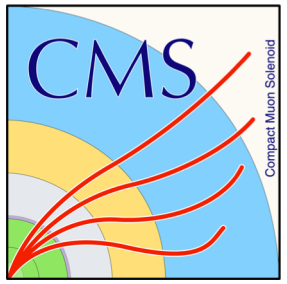


Higgs: Experimental Status

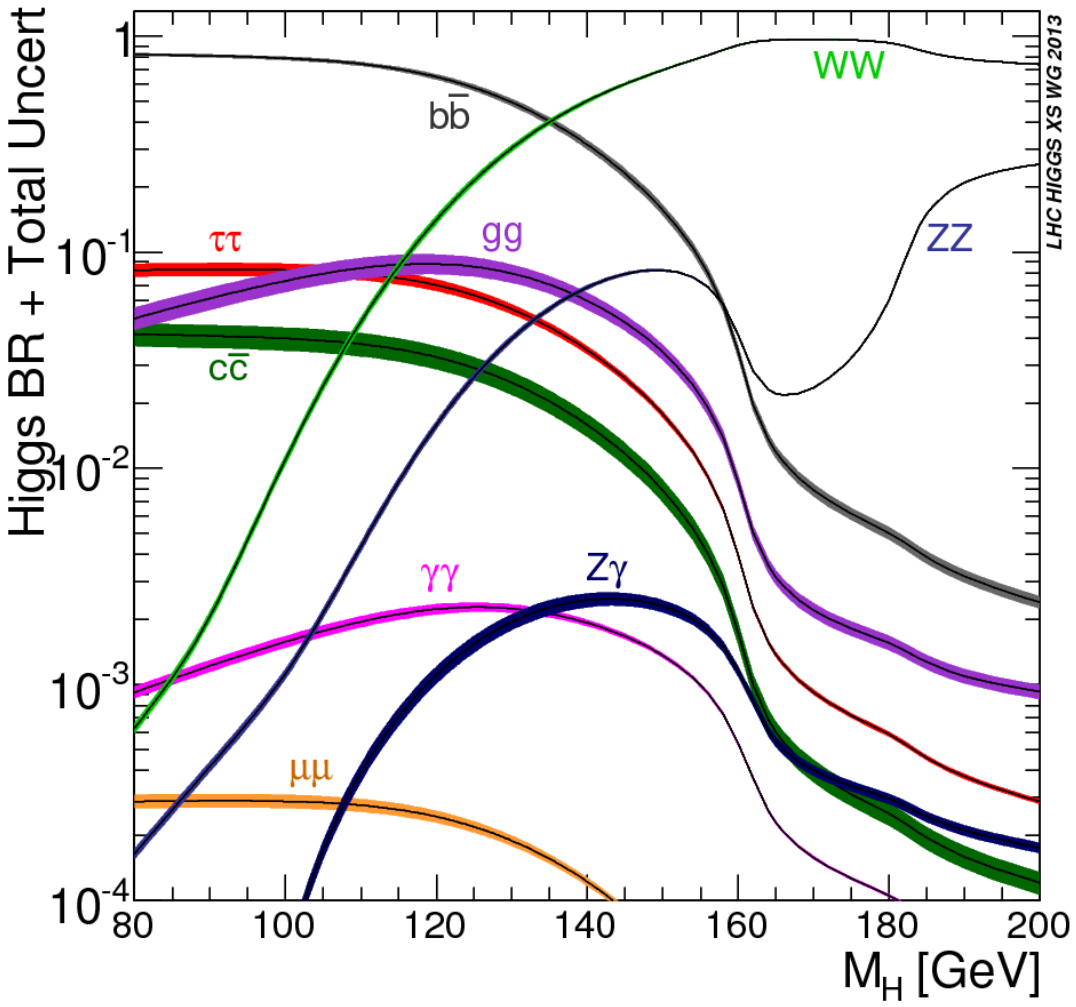
PEDRO MERCADANTE

Why measure Higgs properties ?

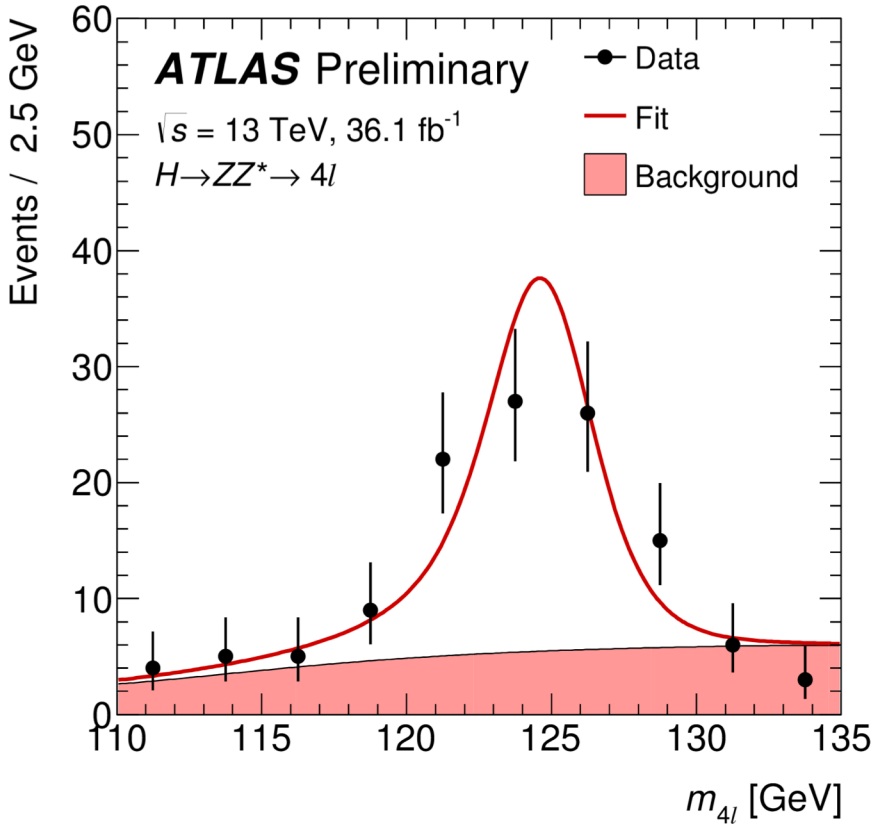
" this theory is sometimes dignified with the title `the minimal standard model´, but its is not really a model at all "

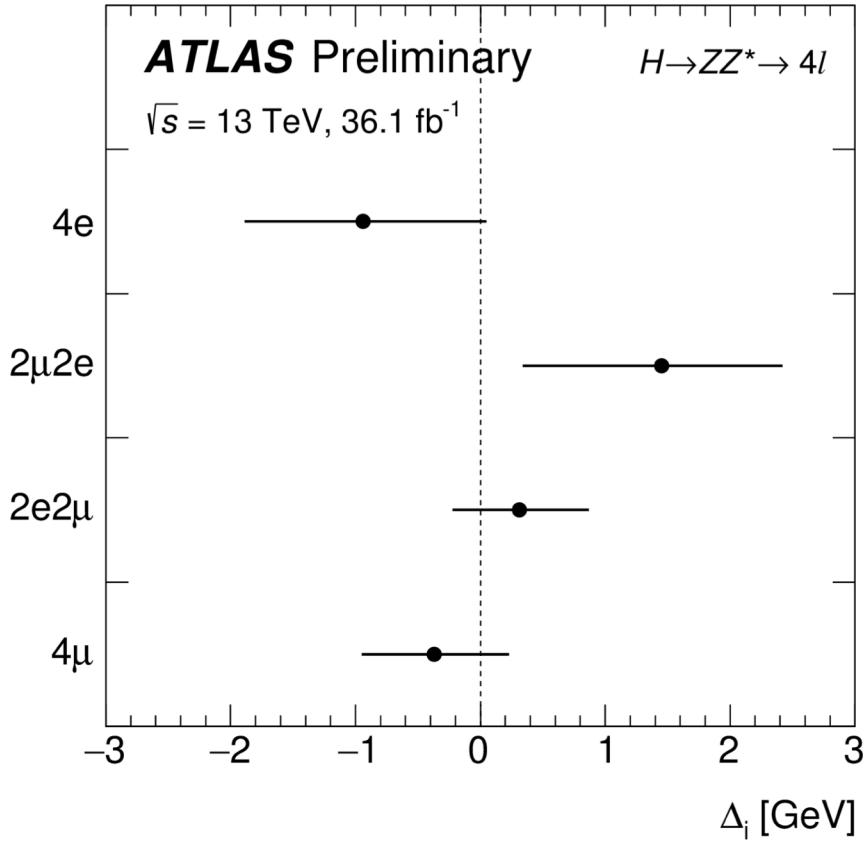
Murayama and Peskin

(hep-ex/9606003)



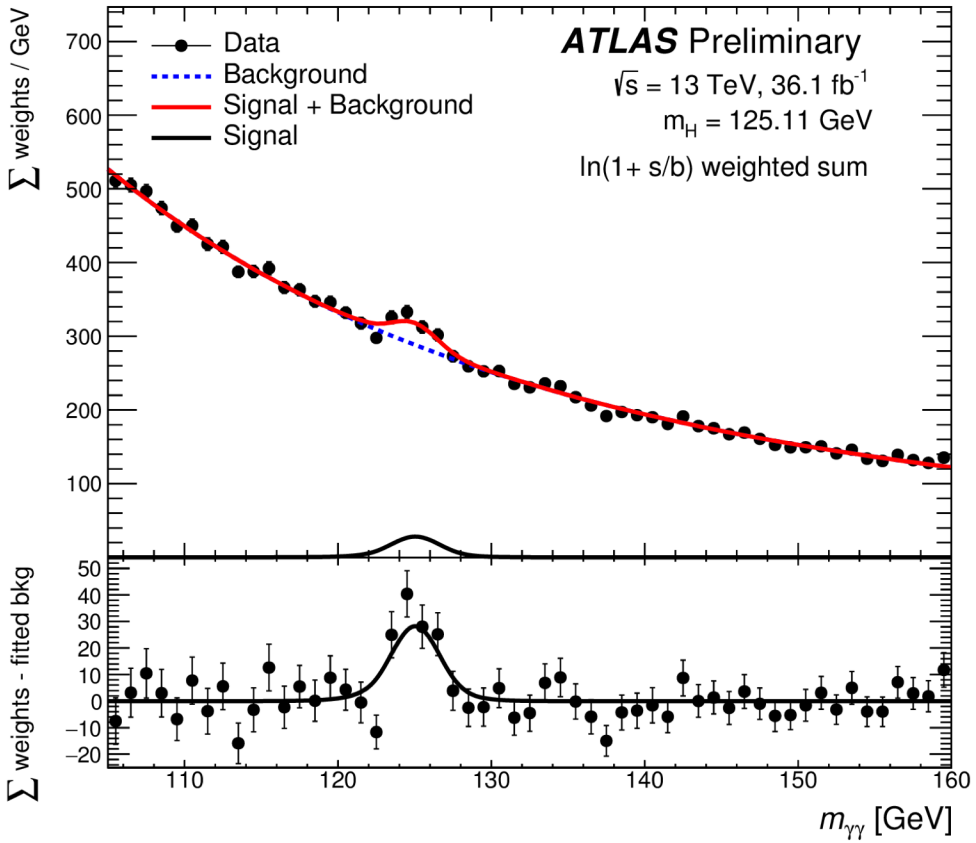
Mass Measurement (ATLAS)

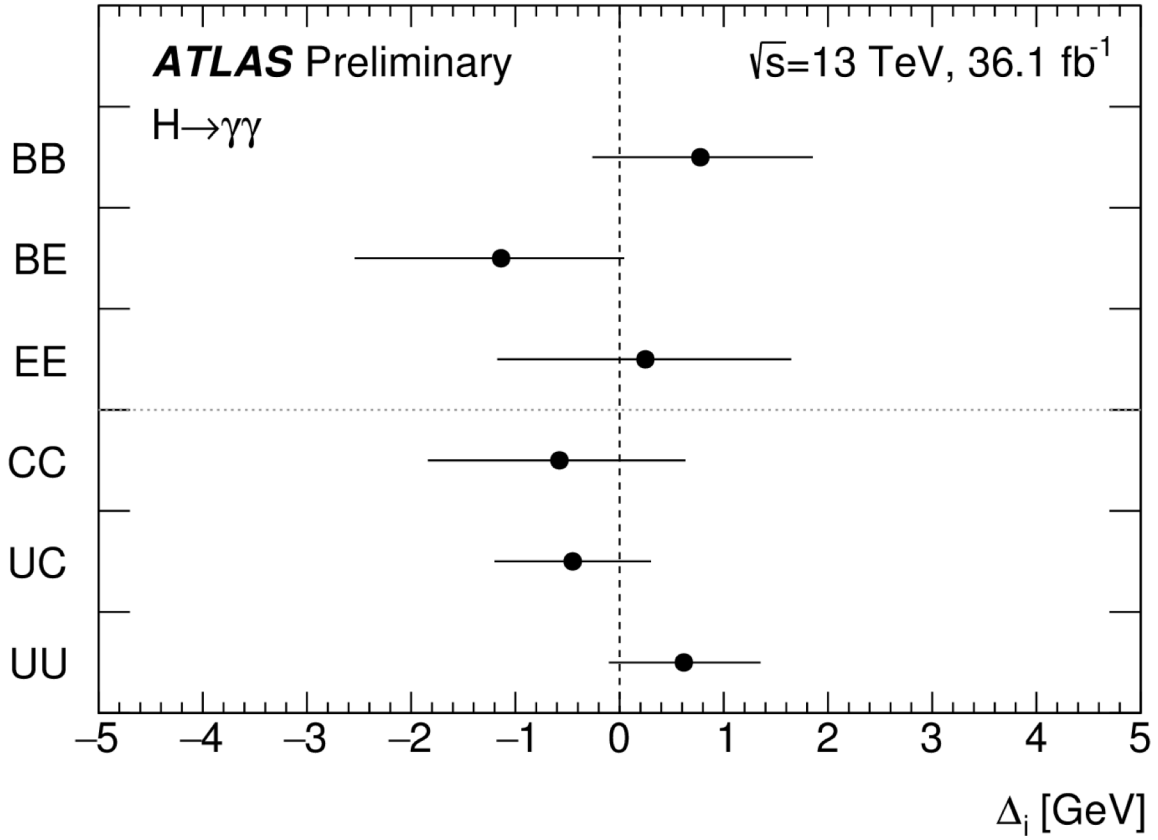




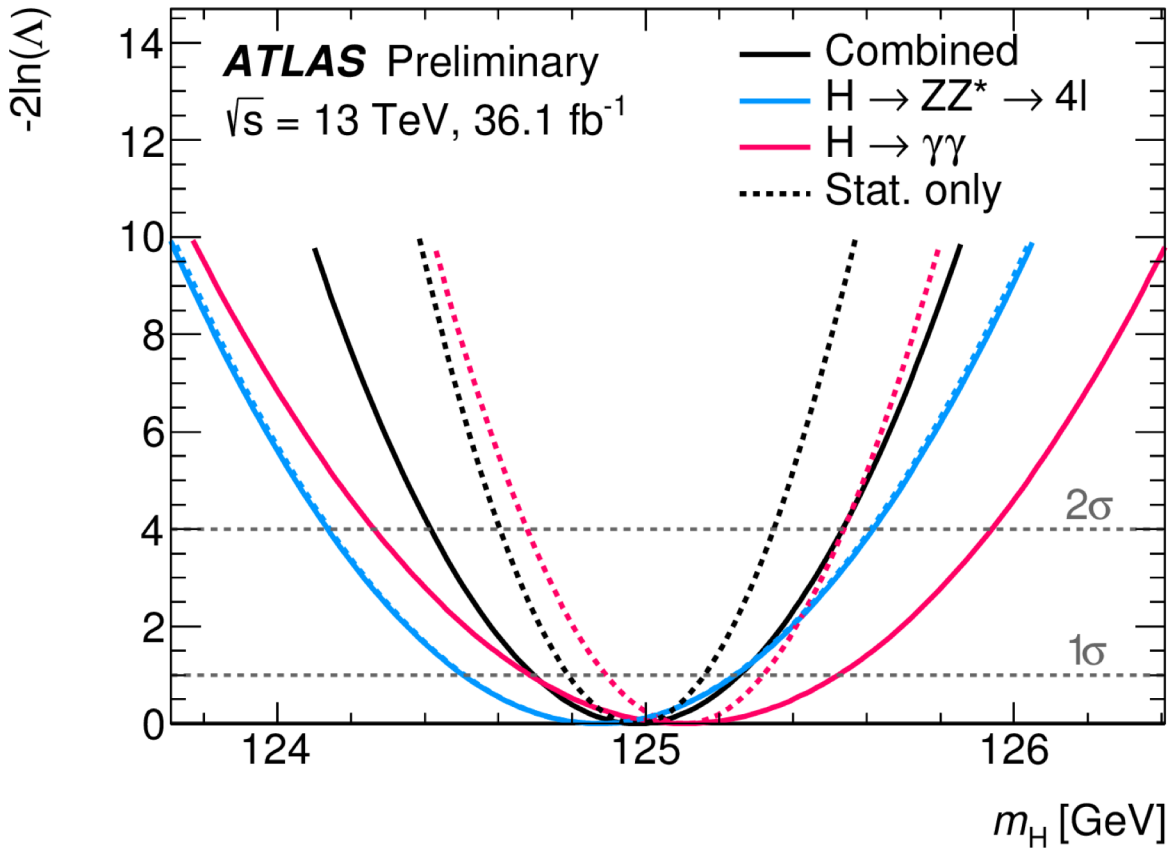
ATLAS-CONF-2017-046

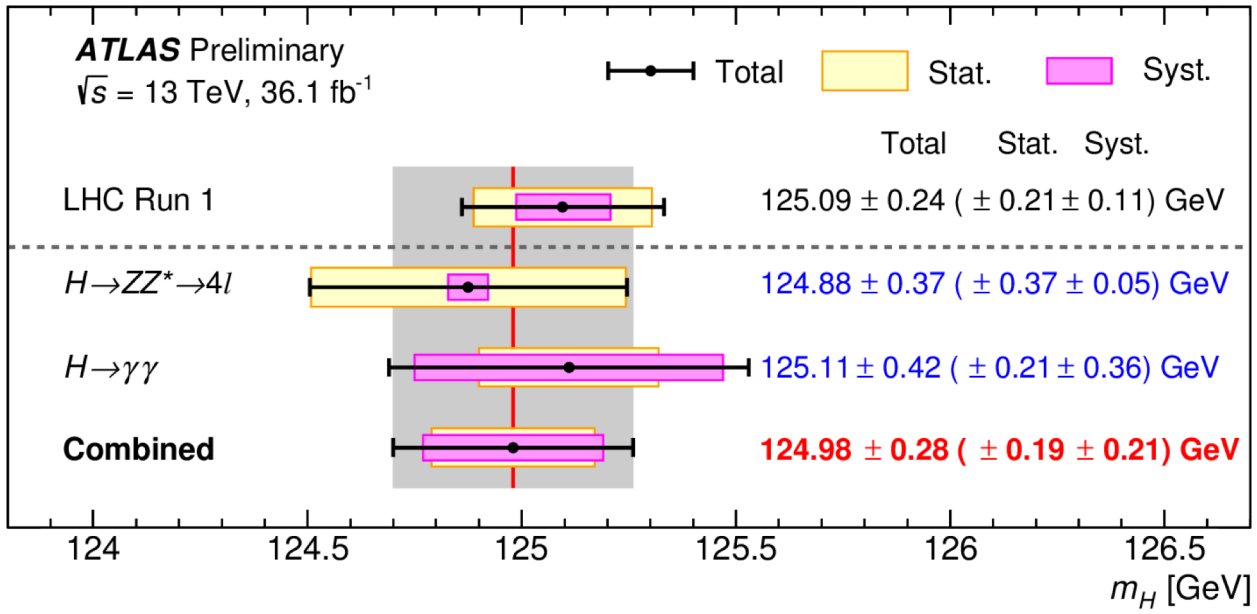
Photon Channel



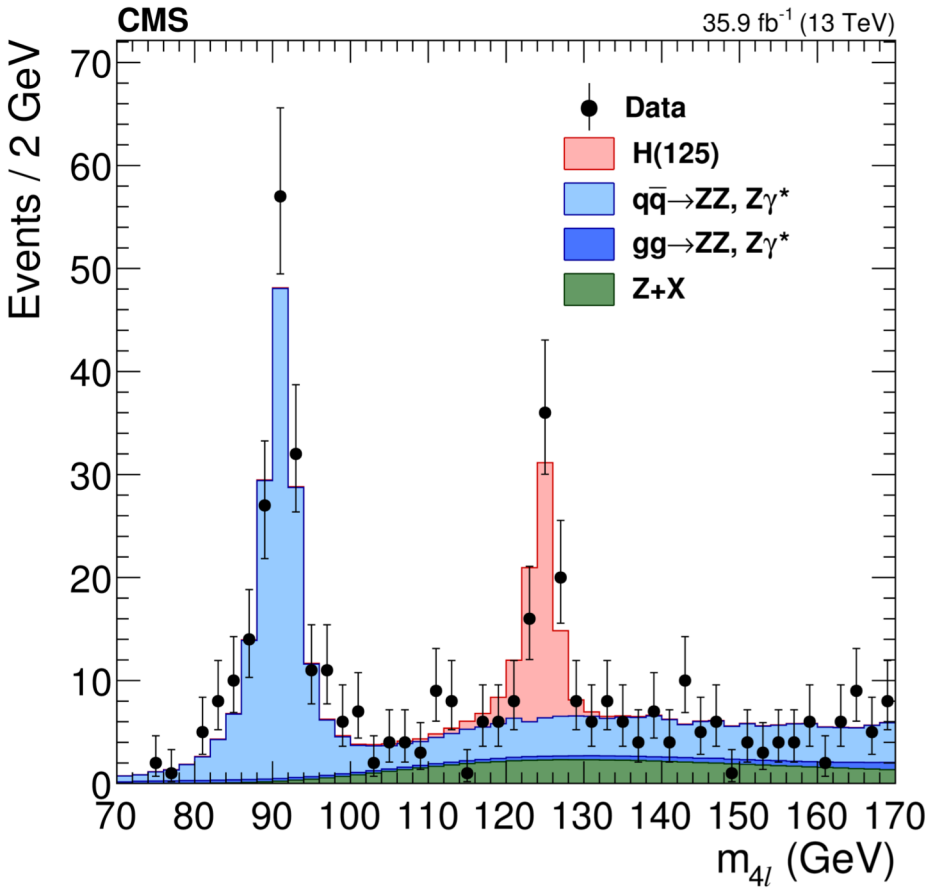


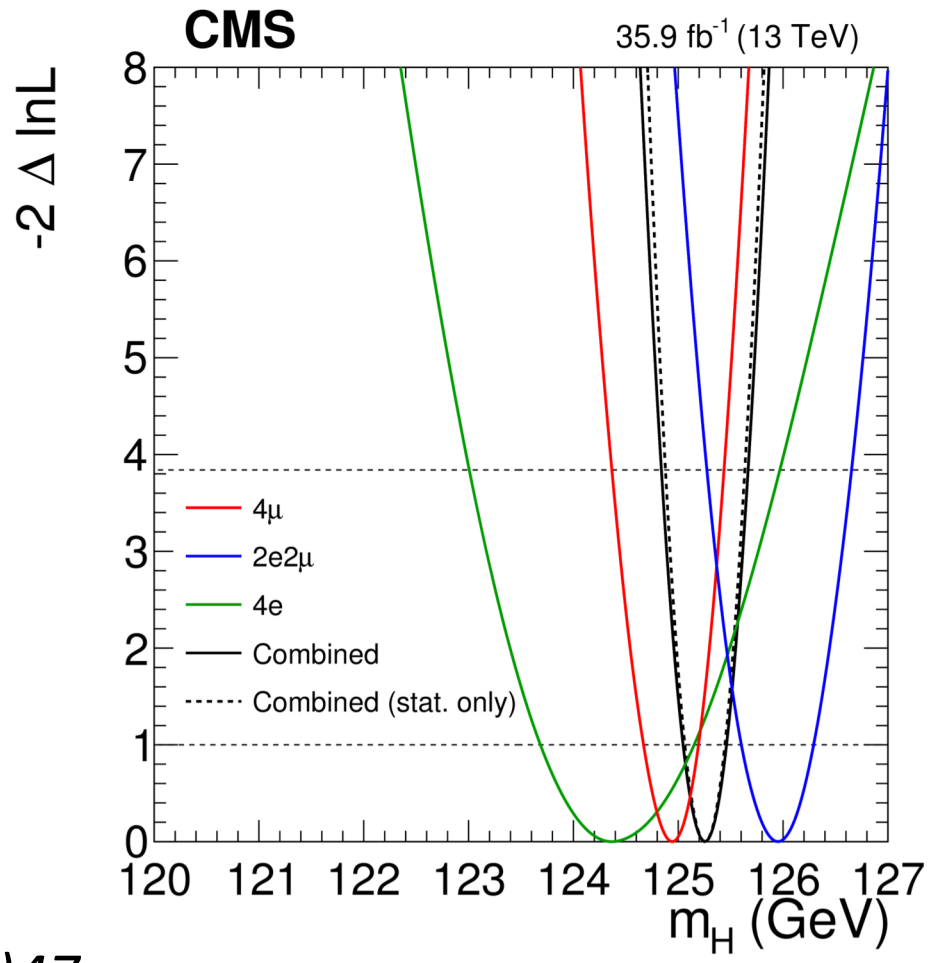
Combination





Mass Measurement (CMS)





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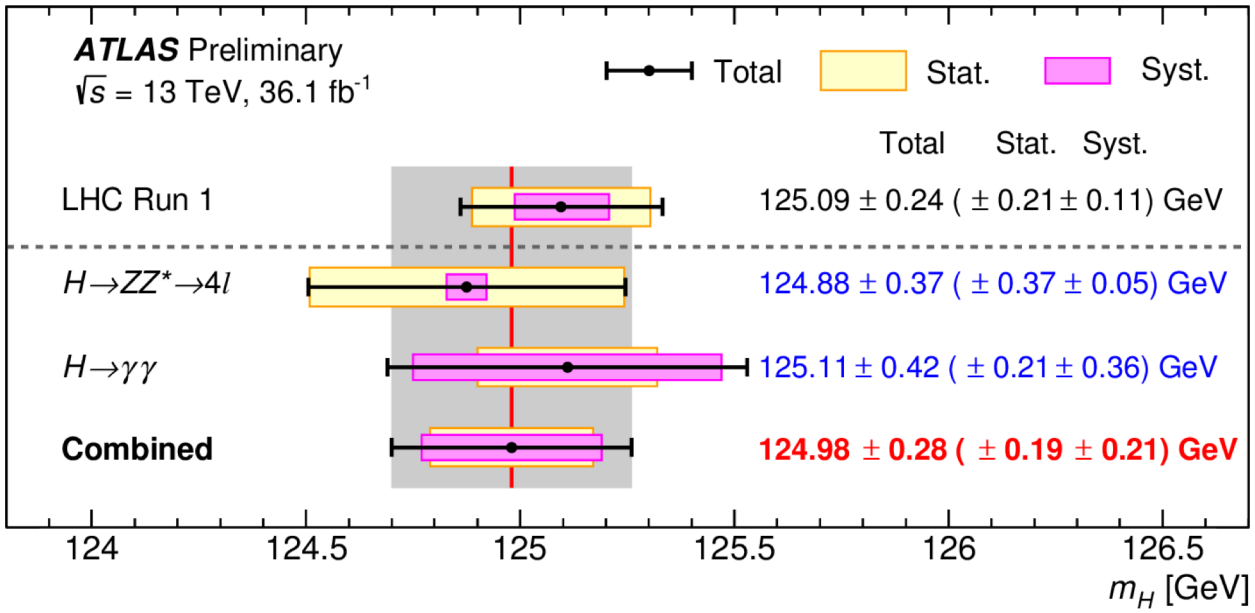
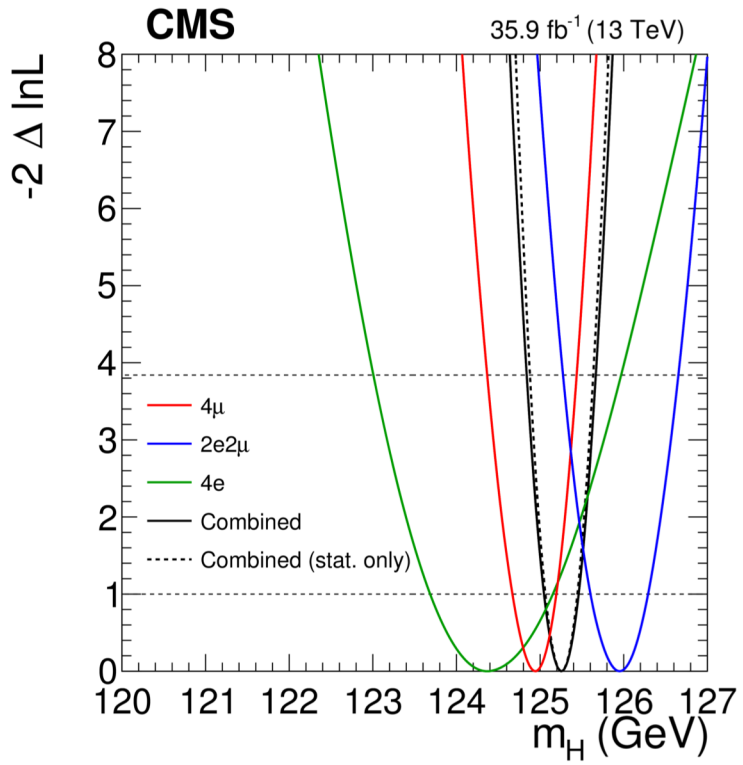
Mass Measurement

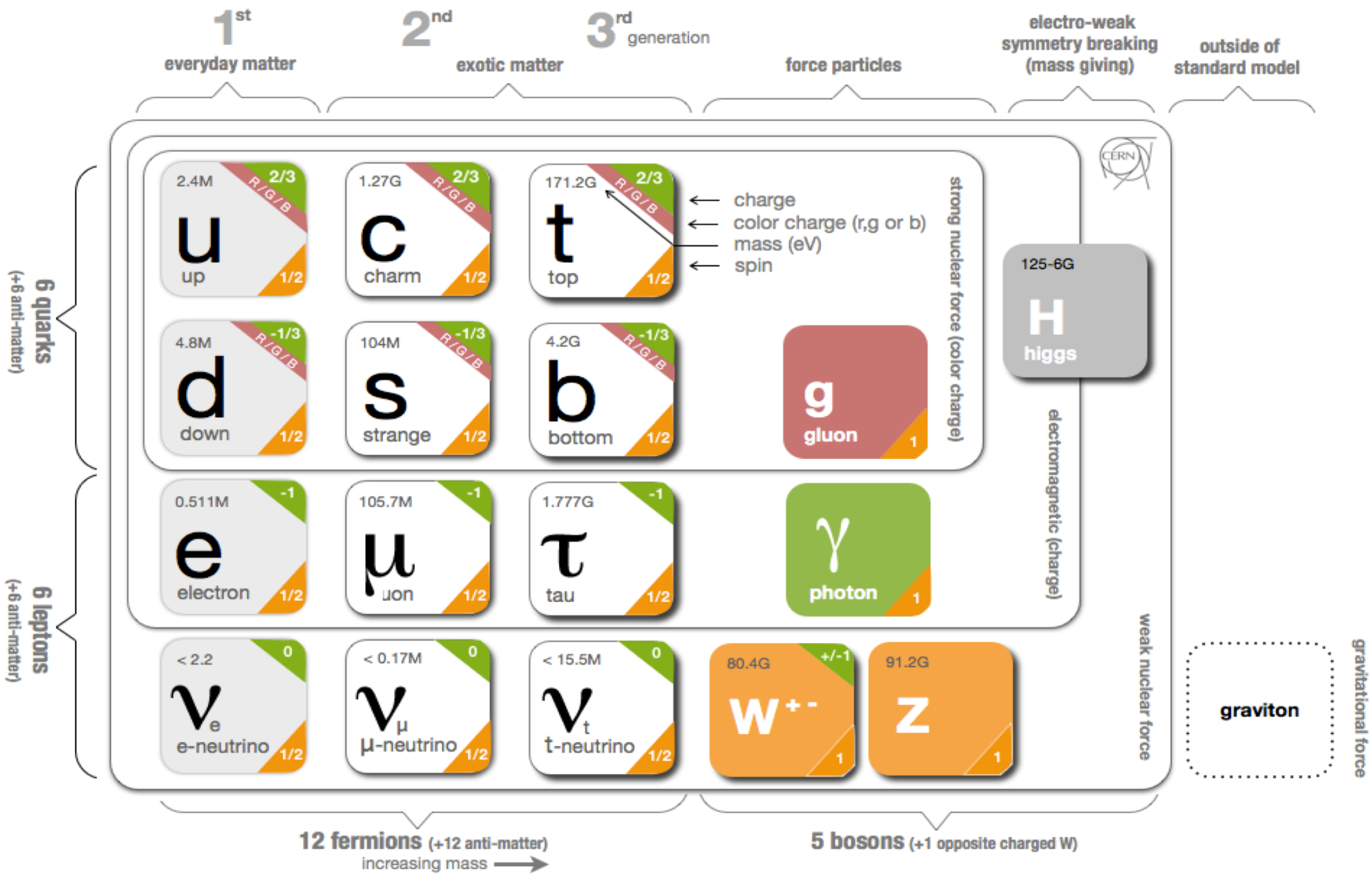




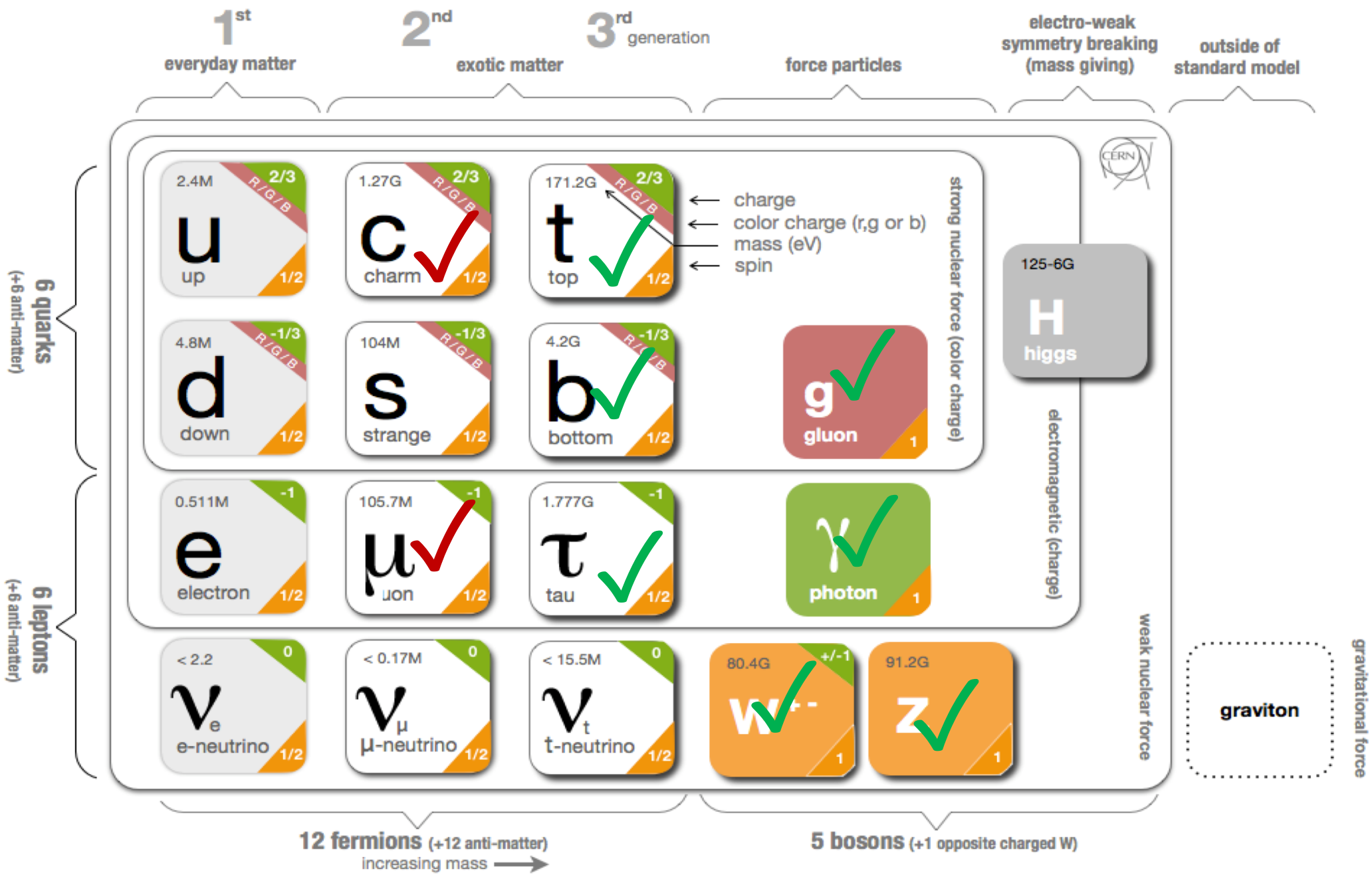
$$M_H = 124.98 \pm 0.28\ (\pm 0.19 \pm 0.21)$$

$$M_H = 125.26 \pm 0.21\ (\pm 0.20 \pm 0.08)$$

Higgs Boson Couplings

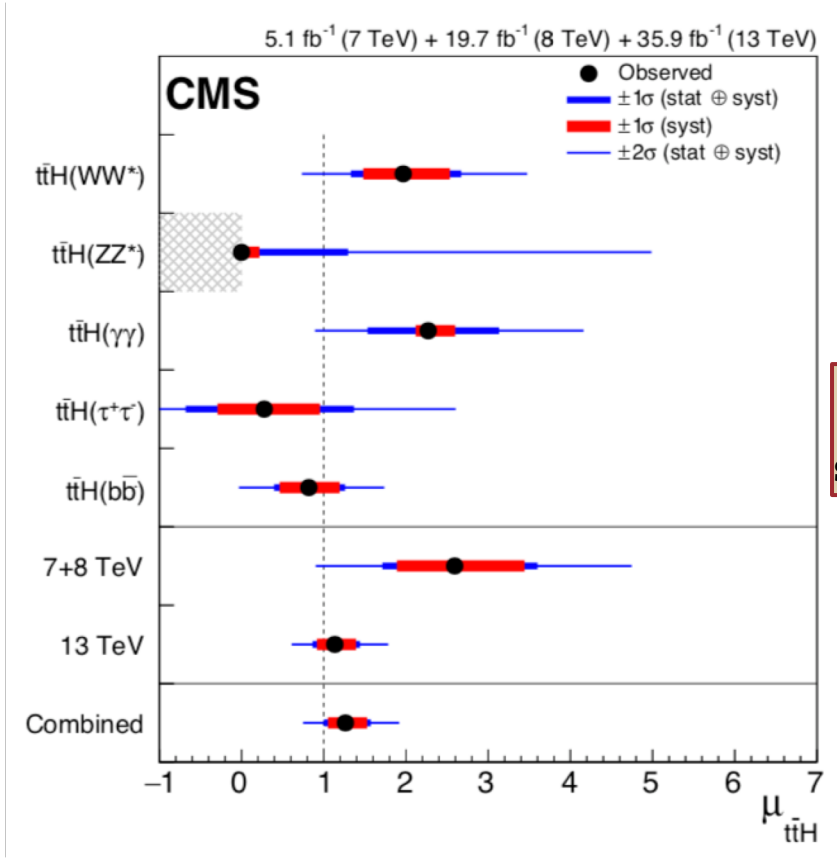


Higgs Boson Couplings



Observation of ttH production (1804.02610)

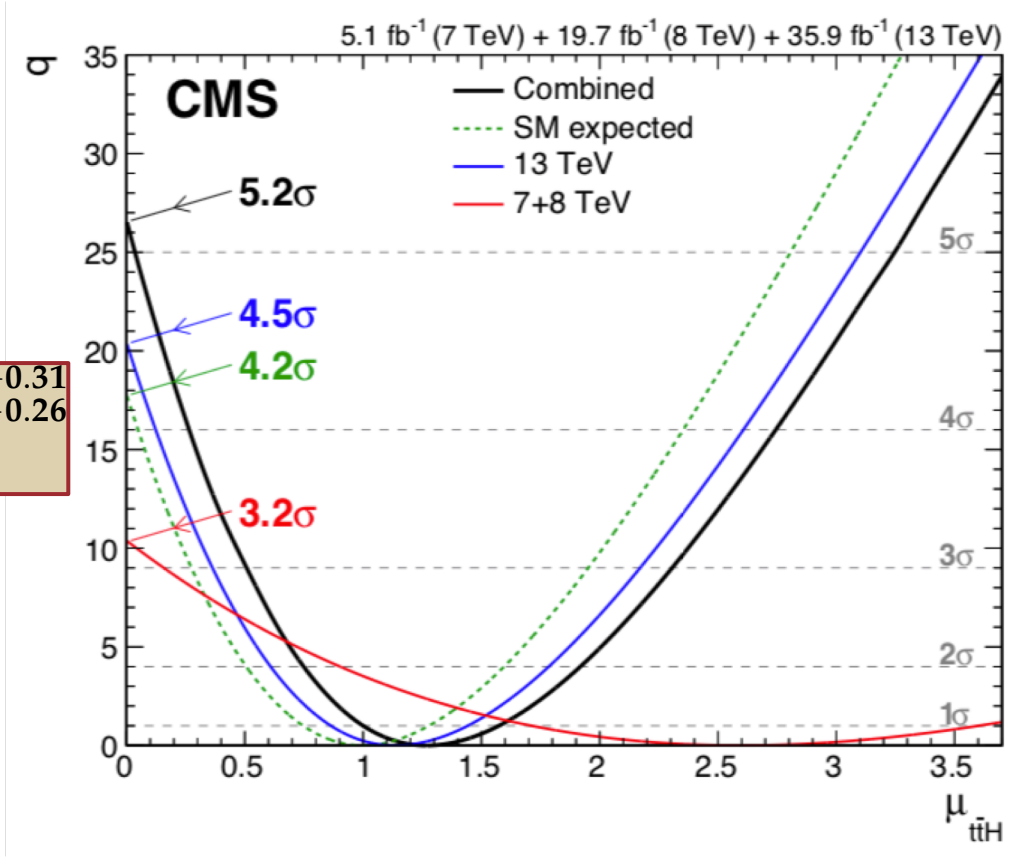
Best fit value for ttH signal strength



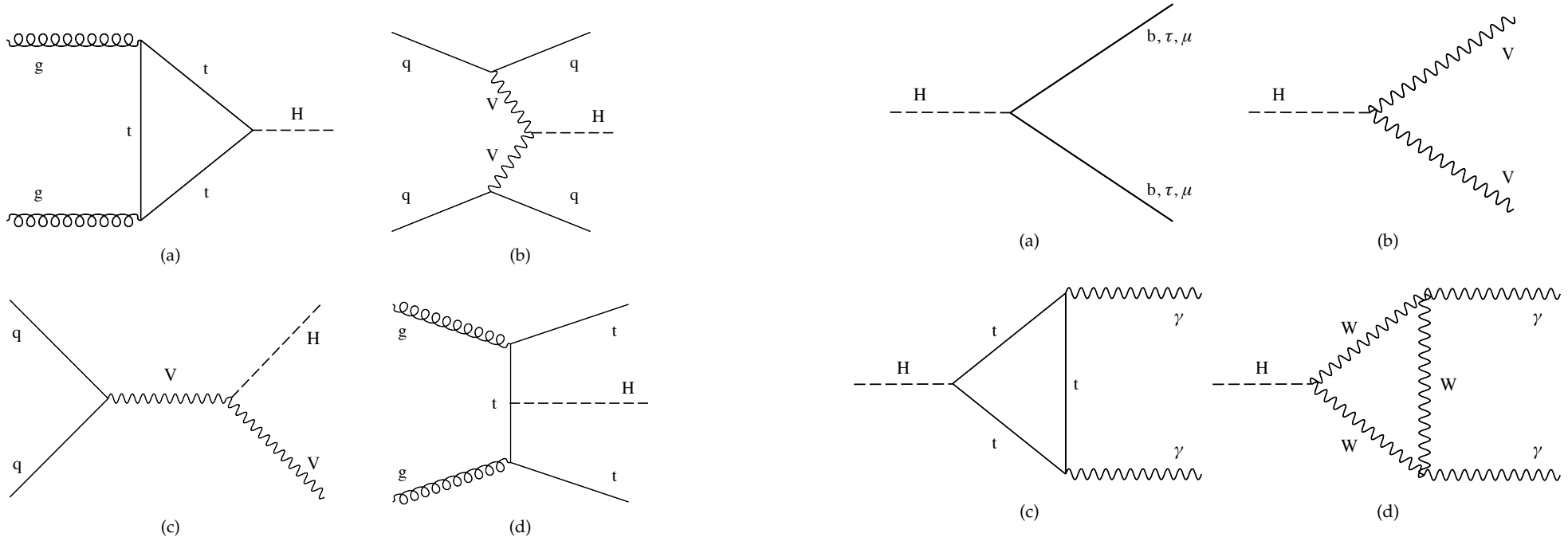
$$\mu = 1.26^{+0.31}_{-0.26}$$

$$\text{signif.} = 5.2\ \sigma$$

Test statistic -2 log-likelihood ratio



Combined Measurements of the Higgs Boson Couplings at 13 TeV (CMS)



CMS–PAS-HIG-17-031

Signal Strengths and Cross Sections

Experimentally, for i -> H -> f, we can extract:

$$\mu_i^f = \frac{\sigma_i \cdot \mathrm{BR}^f}{(\sigma_i)_{\mathrm{SM}} \cdot (\mathrm{BR}^f)_{\mathrm{SM}}} = \mu_i \times \mu^f$$

Several parametrizations with different assumptions leads to constrains

Global fit from all analysis, with one single parameter:

$$\mu = 1.17^{+0.10}_{-0.10}$$

Cross Sections and BR

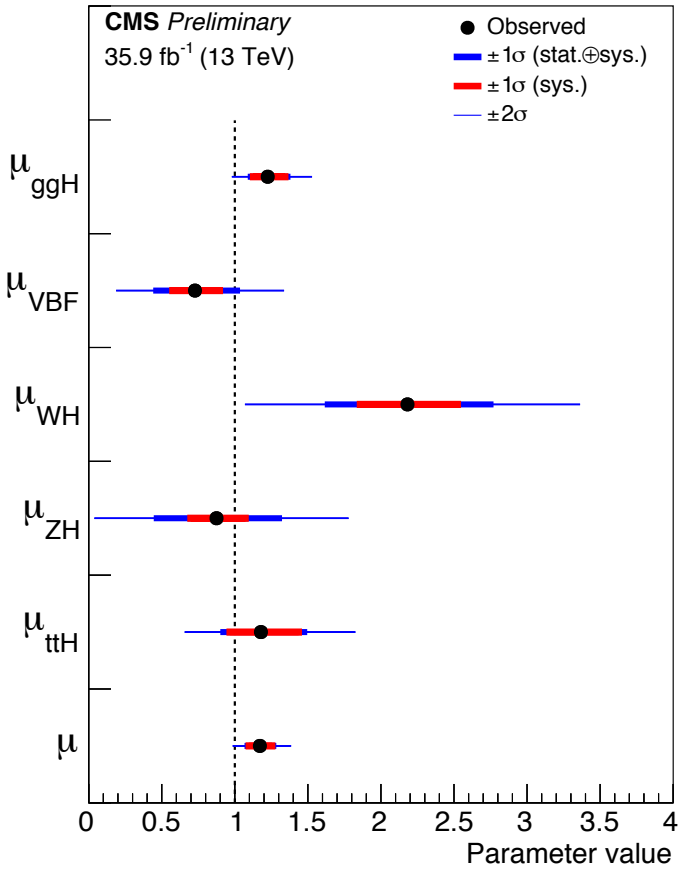
Relax assumption on common production mode

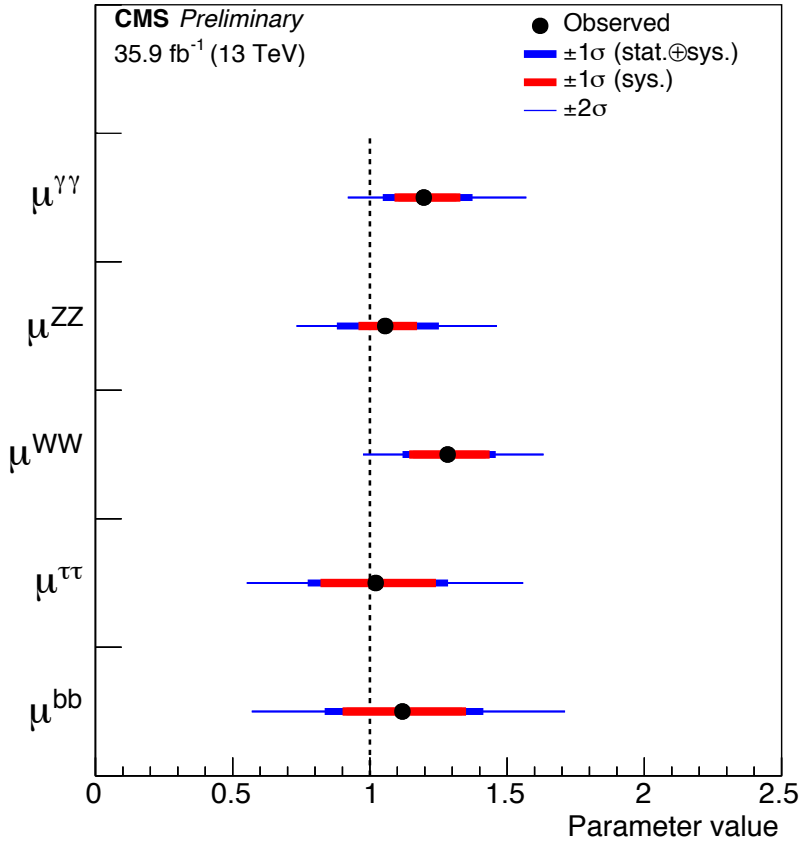
- 5 production strength

Relax common decay mode

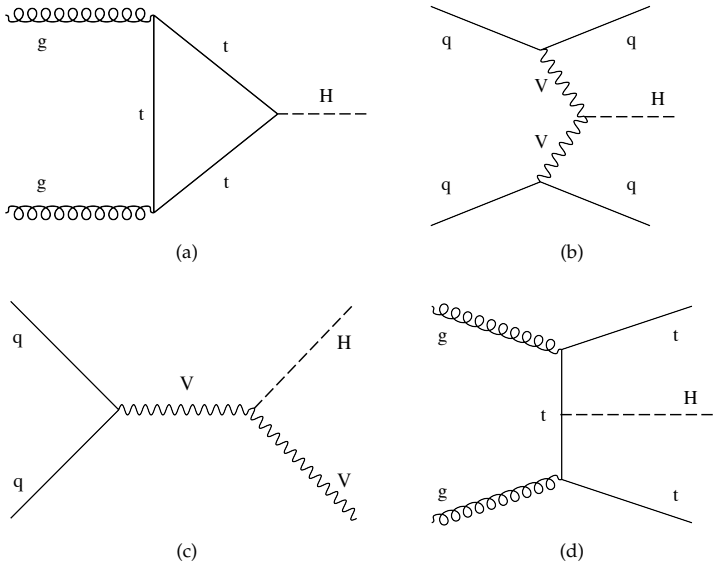
- 5 decay process strength

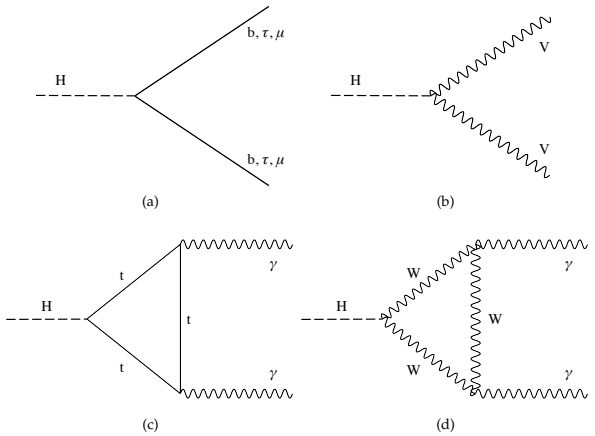
Improvement of about 20 to 50% on the precision from 7-8 TeV results

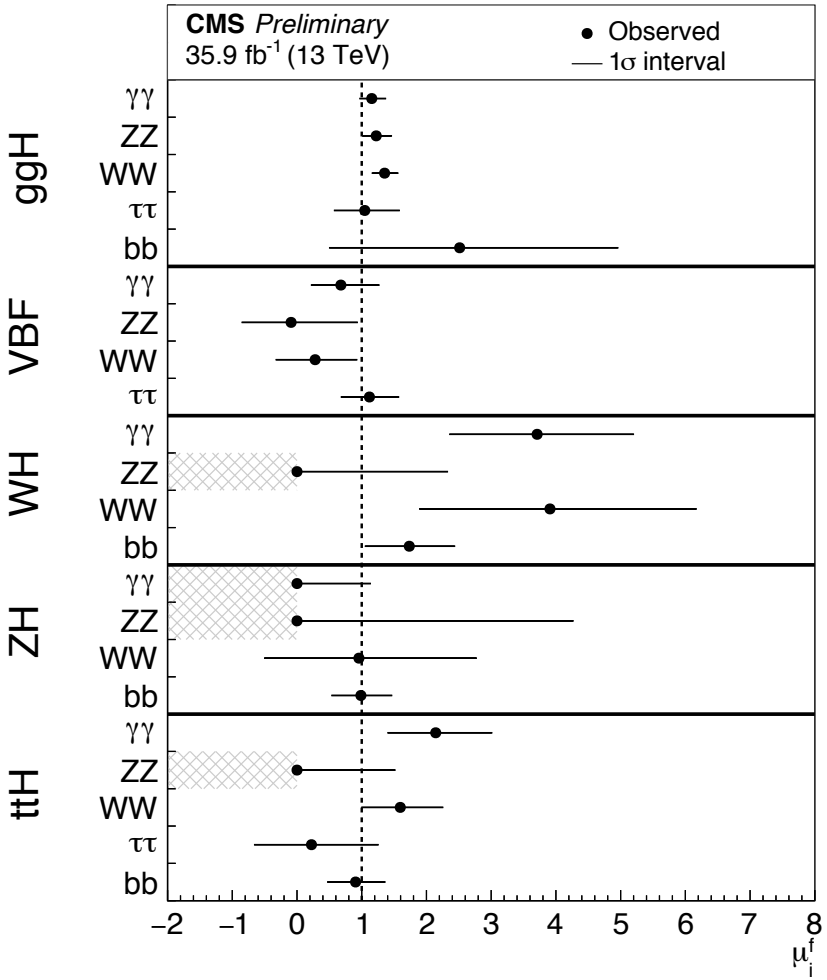




All possible channels







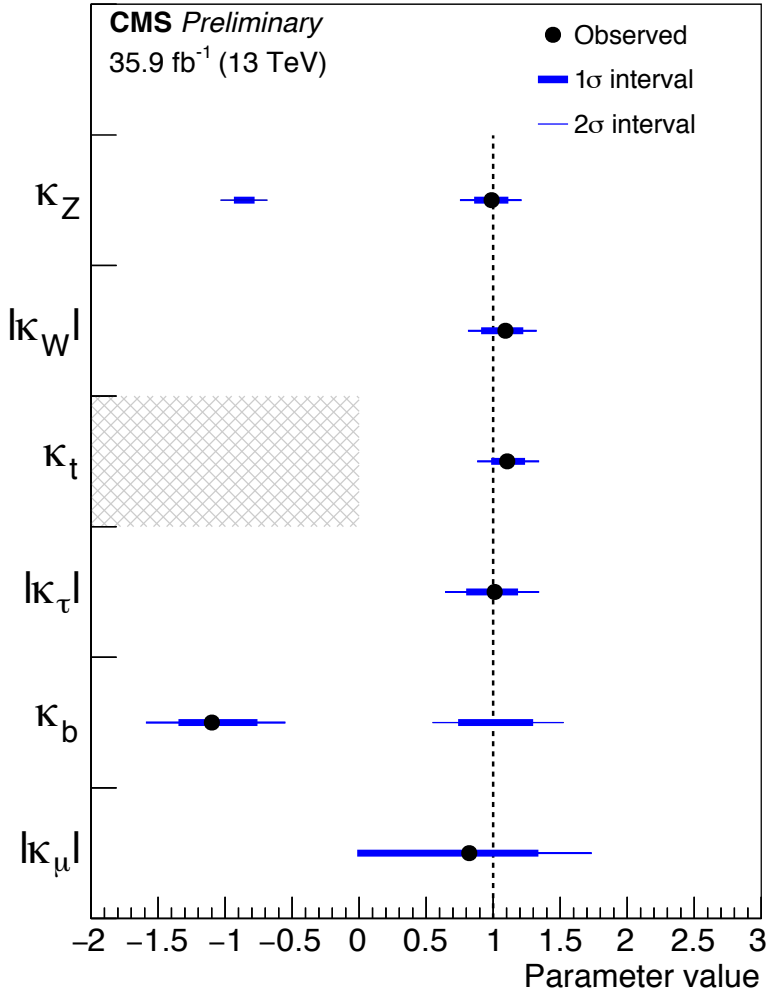
Measuring Couplings – Resolved Loops

K-framework

Coupling modifiers introduced

$$\sigma_i \cdot \mathrm{BR}^f = \frac{\sigma_i(\vec{\kappa}) \cdot \Gamma^f(\vec{\kappa})}{\Gamma_\mathrm{H}}$$

$$\kappa_j^2 = \sigma_j / \sigma_j^{\mathrm{SM}} \quad \text{or} \quad \kappa_j^2 = \Gamma^j / \Gamma_{\mathrm{SM}}^j$$

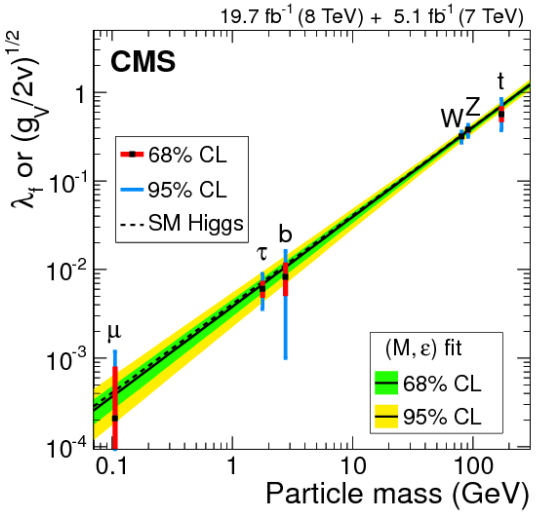


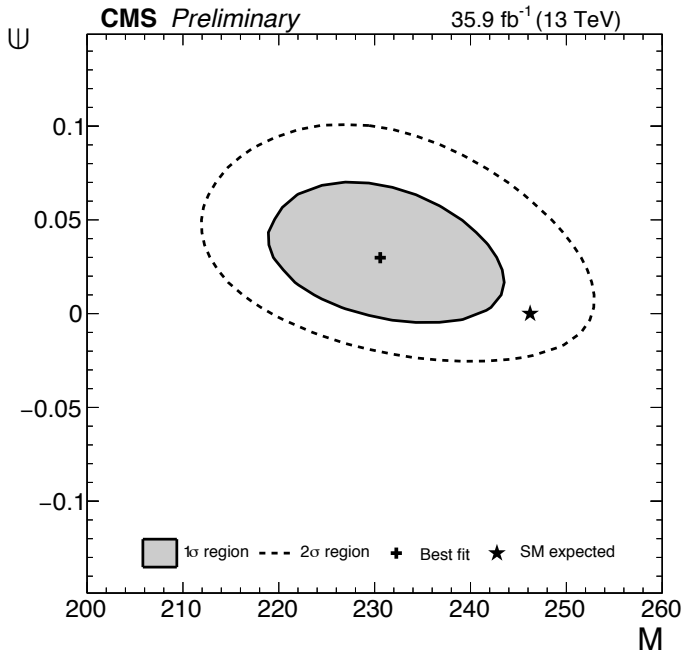
Resolved Loops

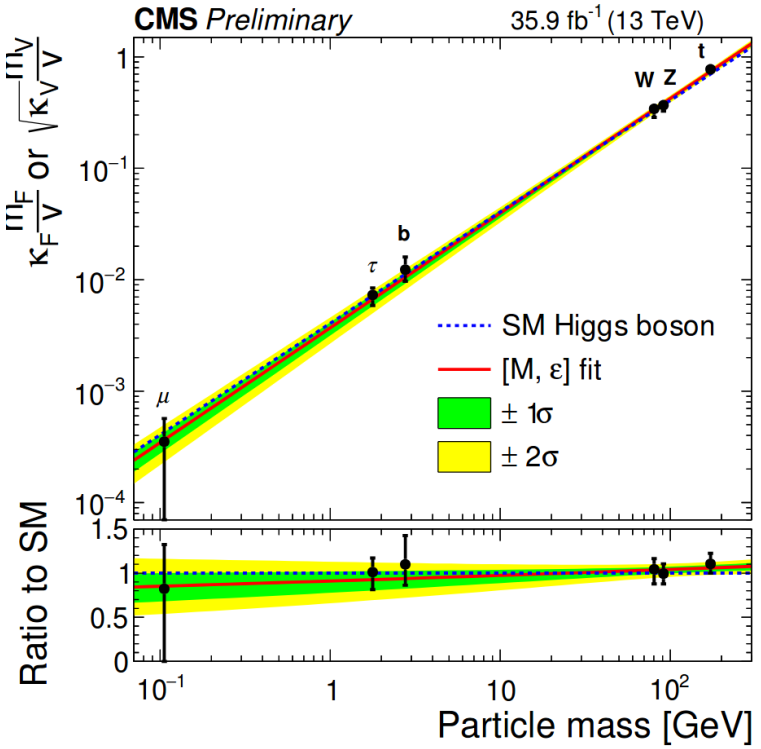
Fit relating fermions and vector bosons couplings with its mass:

$$\kappa_F = v\ m_{\mathrm{f}}^{\epsilon}/\mathrm{M}^{1+\epsilon}$$

$$\kappa_V = v\ m_{\mathrm{V}}^{2\epsilon}/\mathrm{M}^{1+2\epsilon}$$

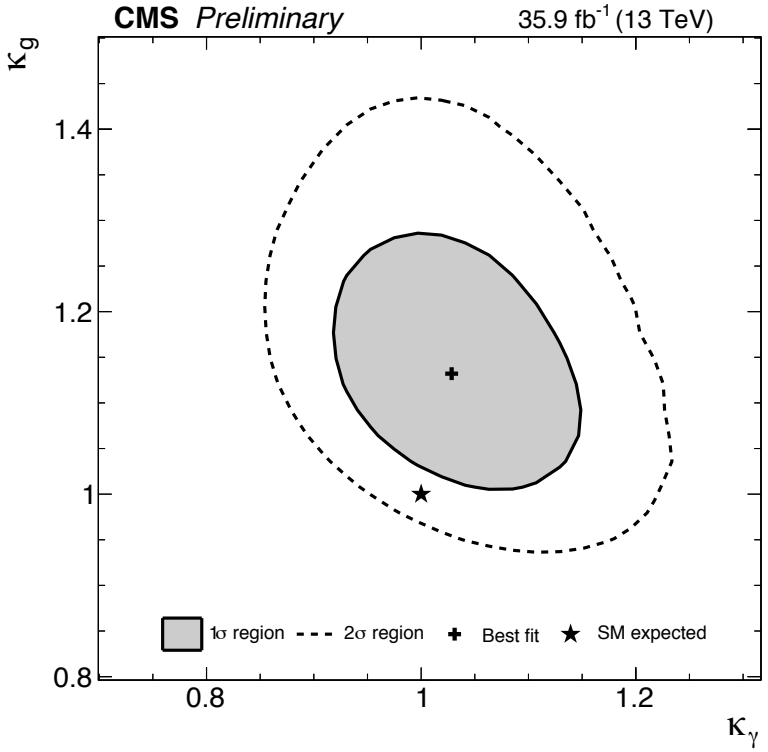




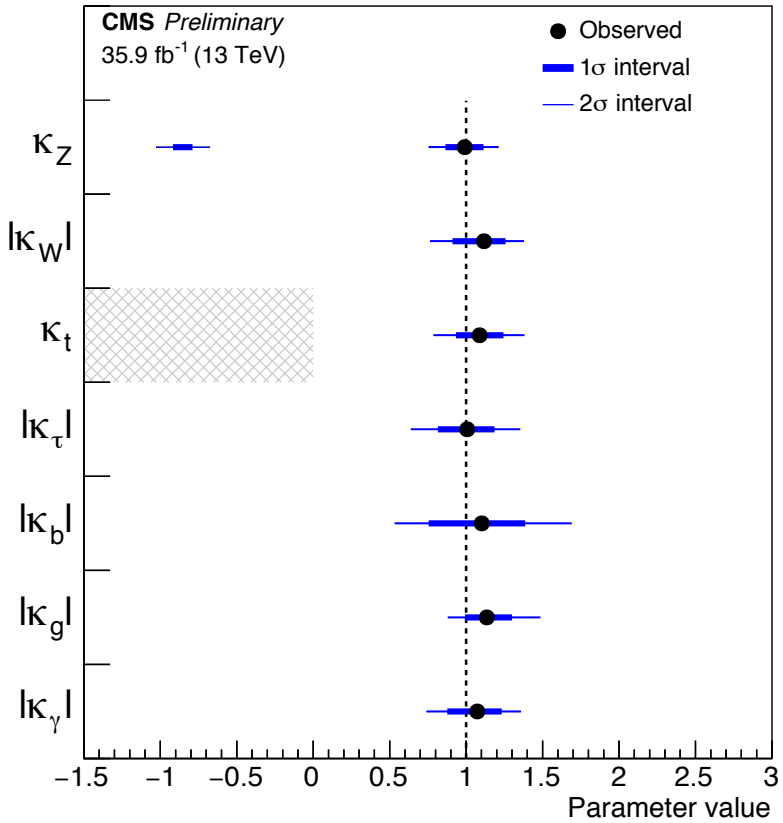


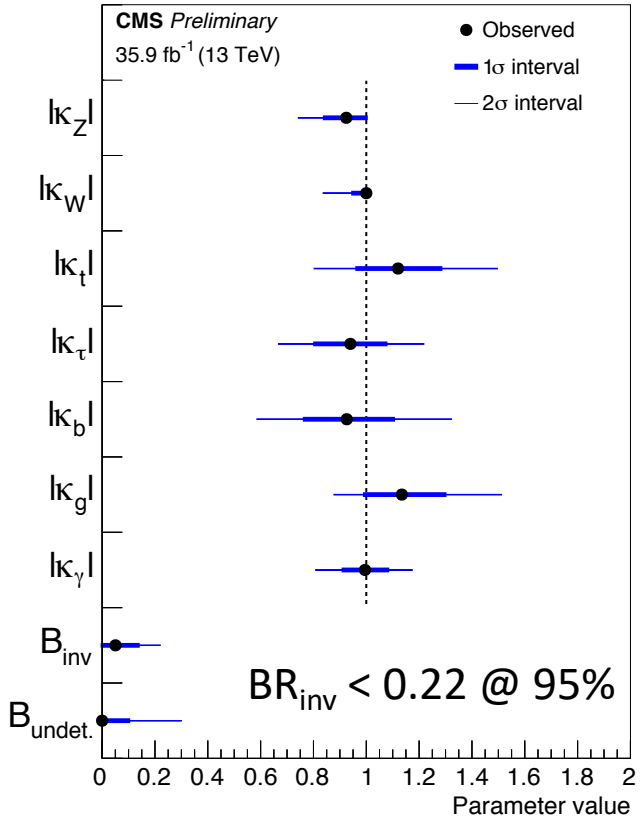
Effective Loops

Coupling to gluon and foton are parametrized

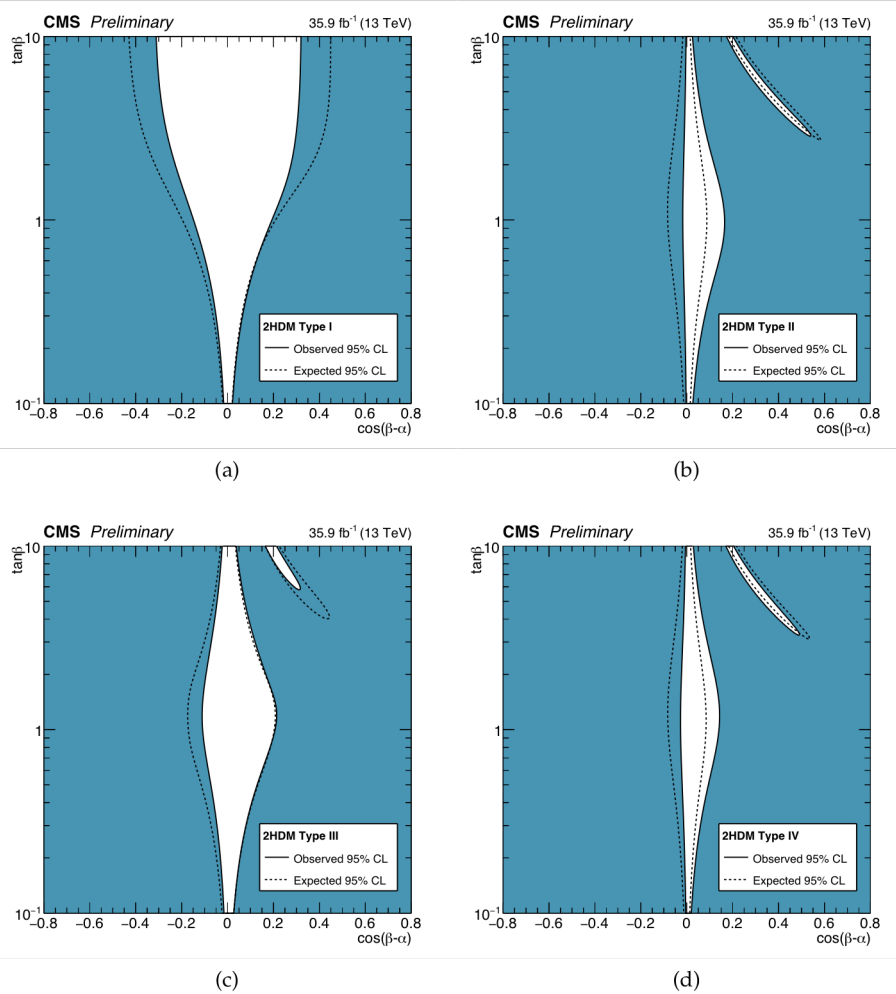


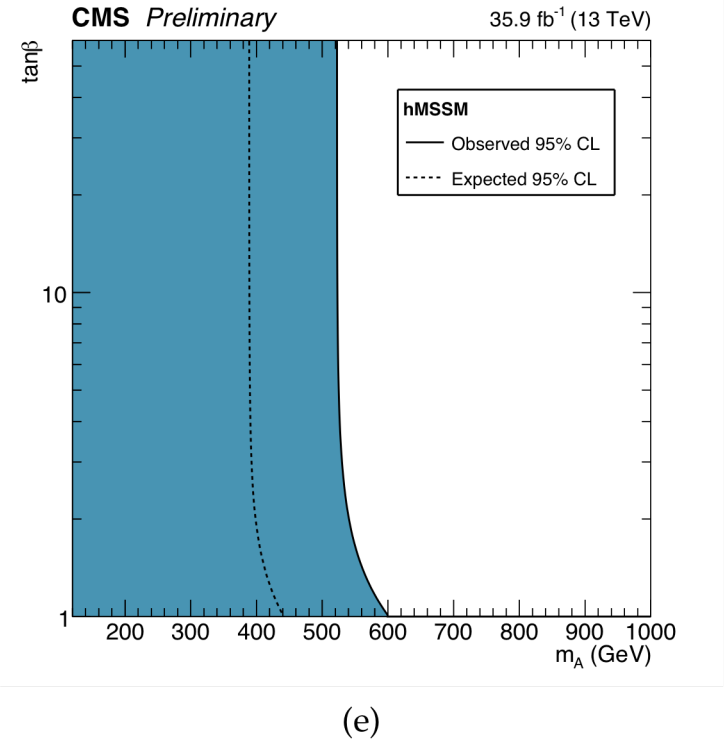
$BR_{BSM}=0$



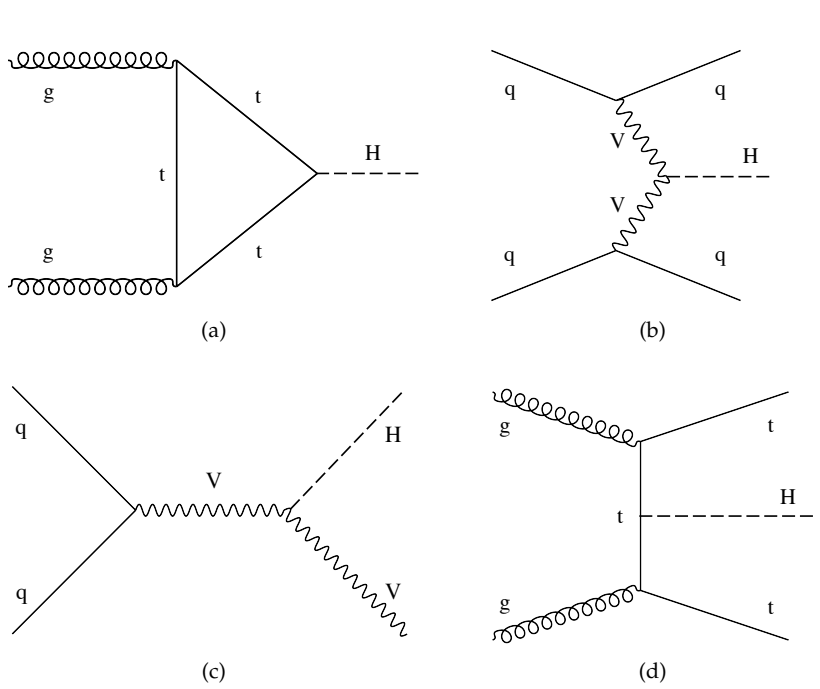


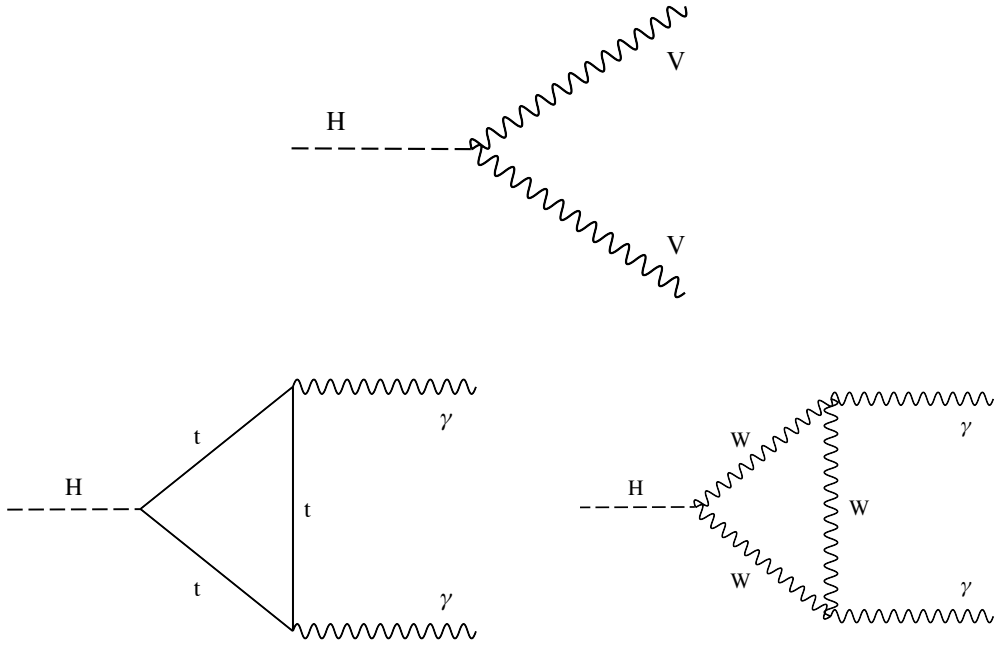
2HDM Constrains





Combined Measurement of Higgs Boson Production and Decay using 13 TeV data at ATLAS Experiment





ATLAS-CONF-2017-047

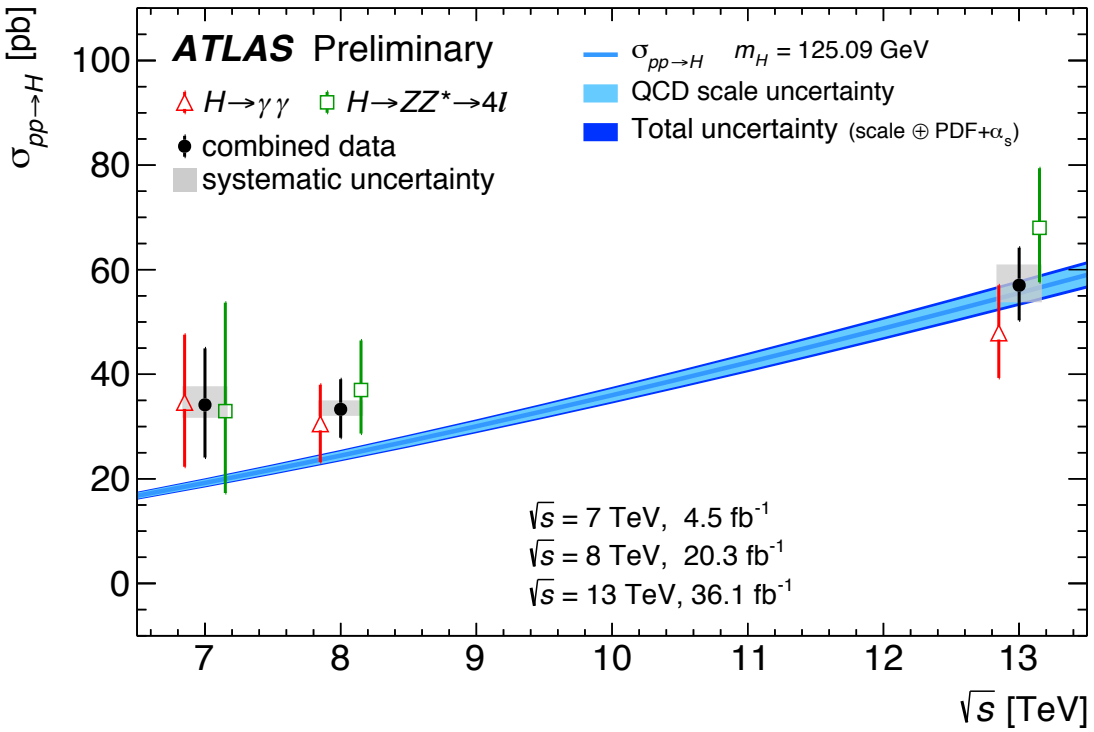
Global Signal Strength

ATLAS result:

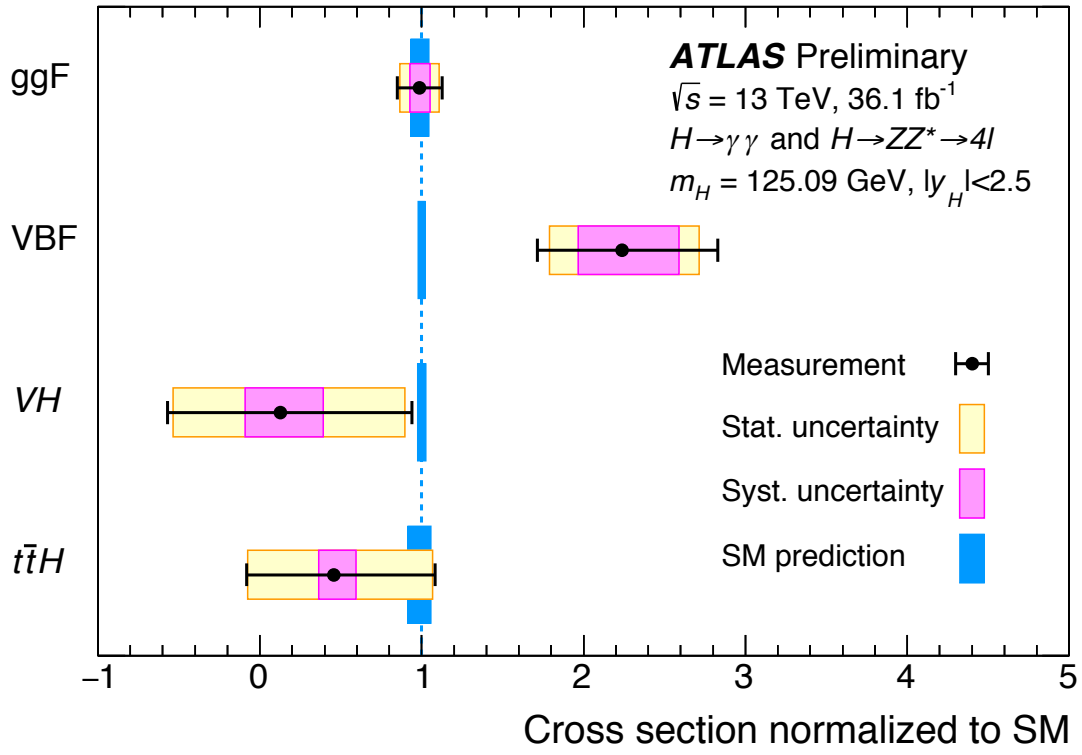
$$\mu = 1.09 \pm 0.12$$

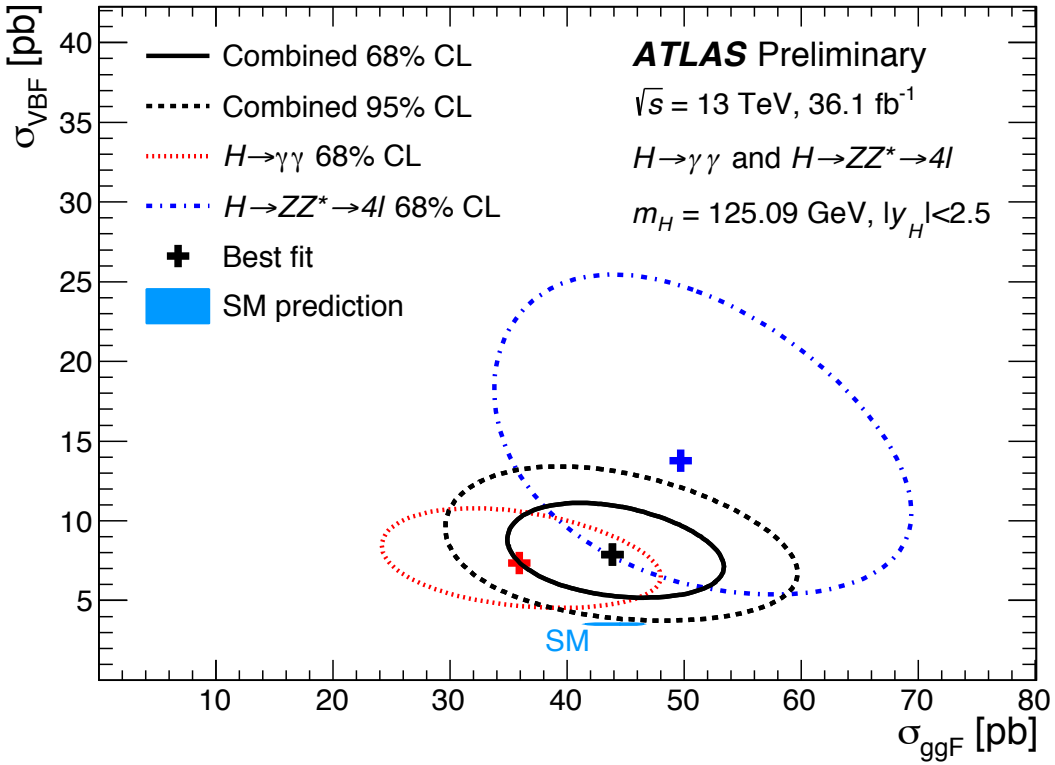
CMS Combination:

$$\mu = 1.17^{+0.10}_{-0.10}$$

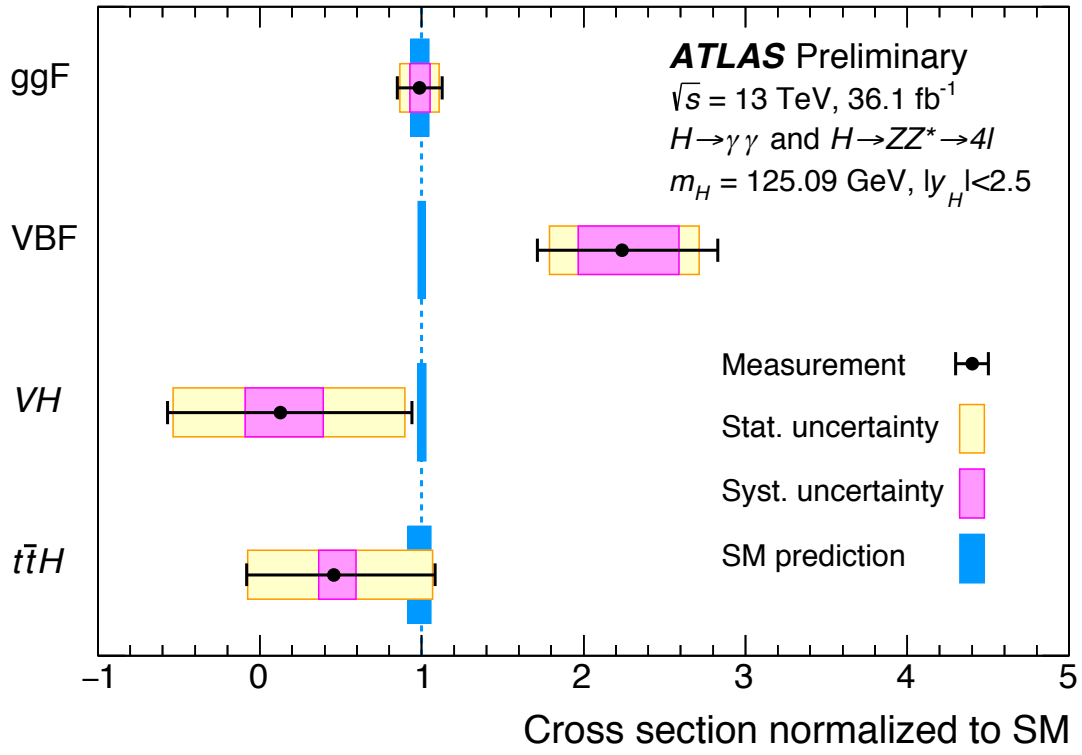


Production Cross Section

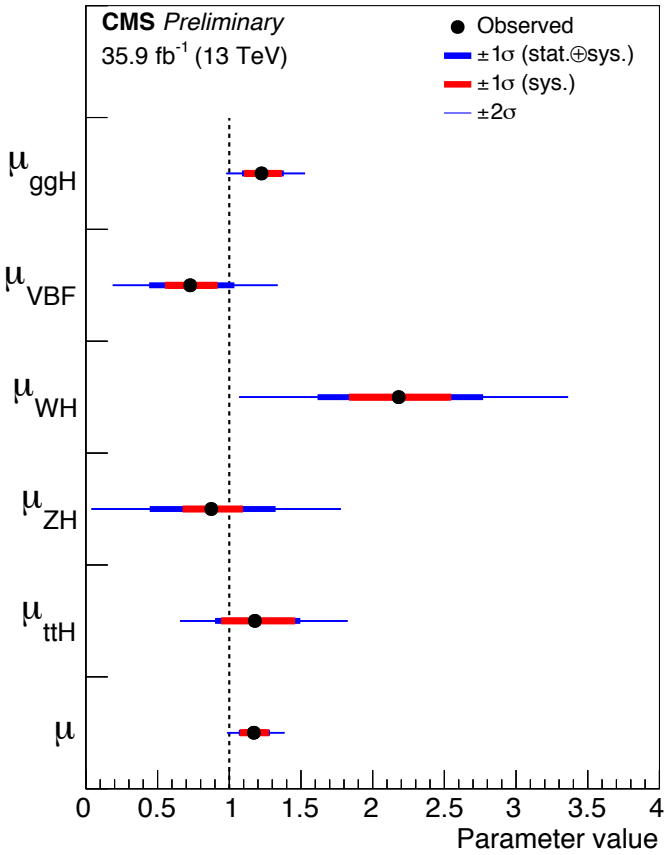




Production Cross Section

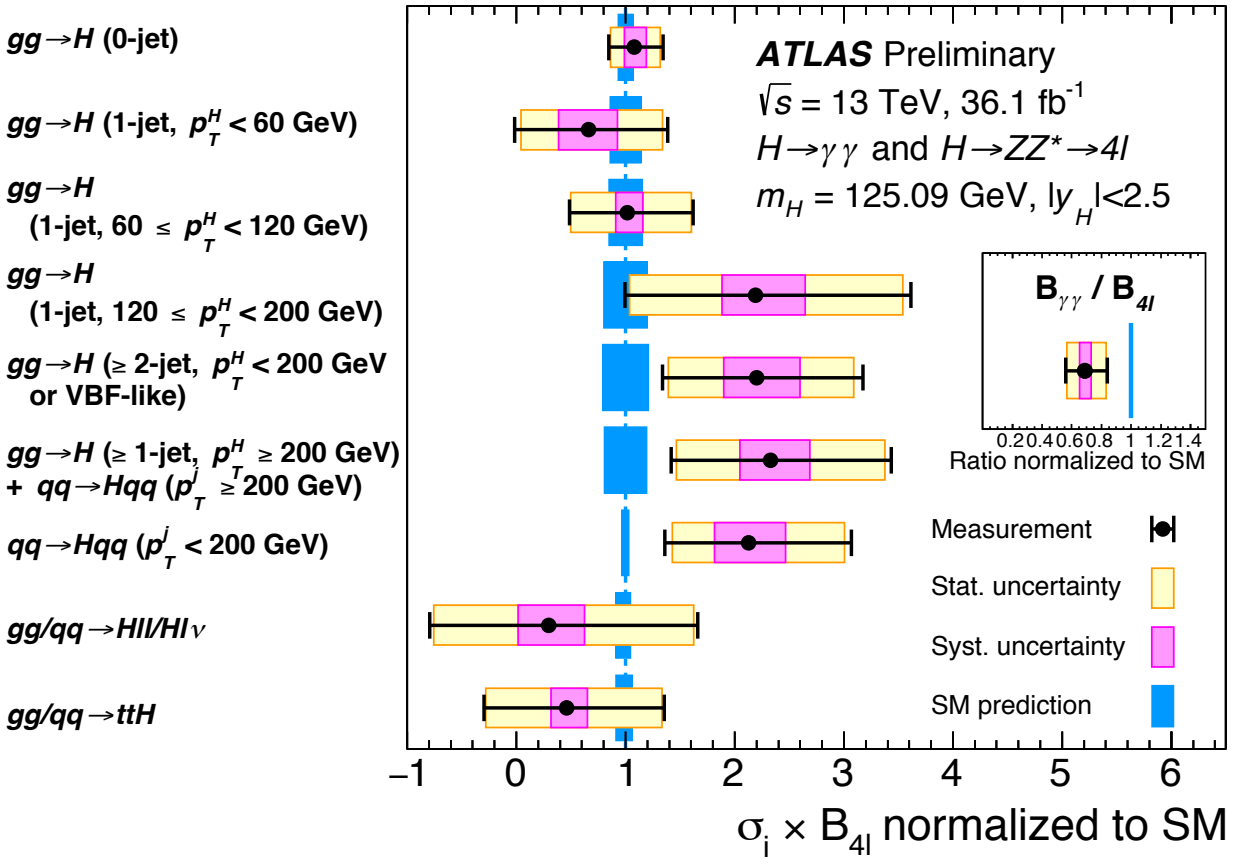


ATLAS-CONF-2017-047



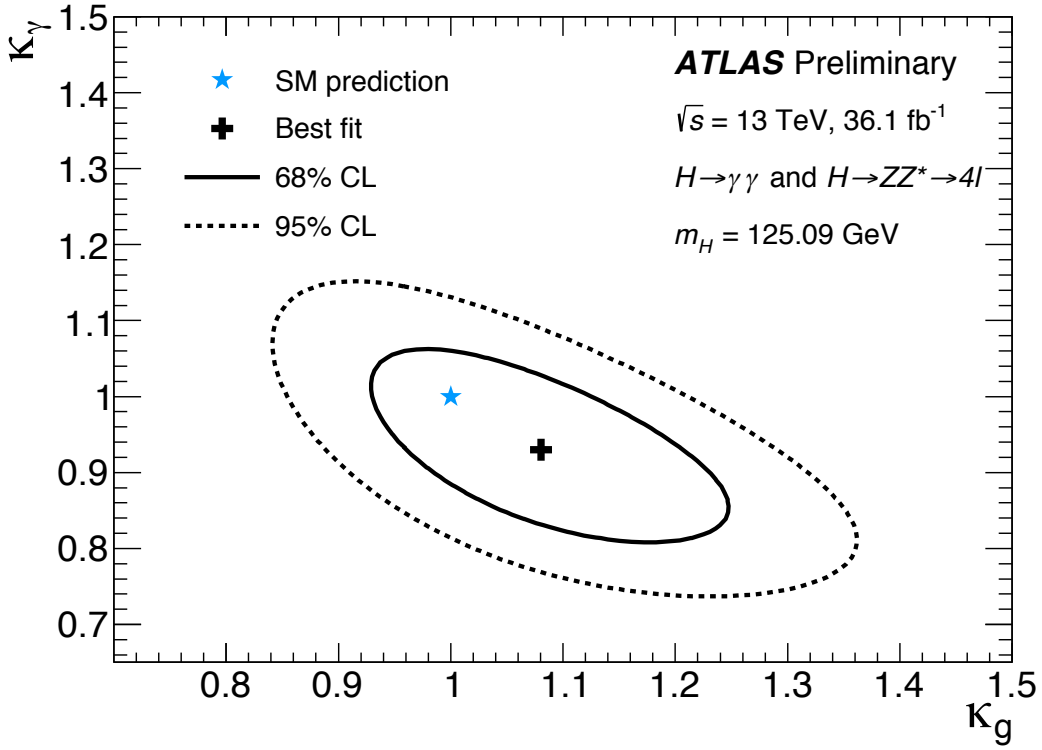
CMS–PAS-HIG-17-031

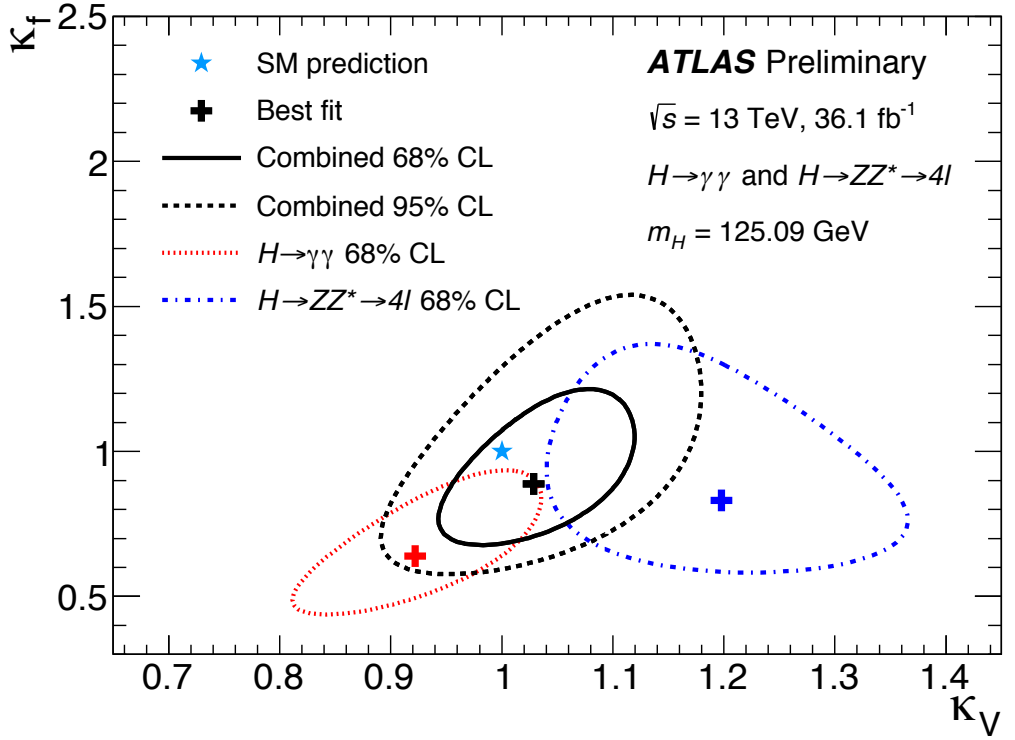
Production Cross Section For Each Channel



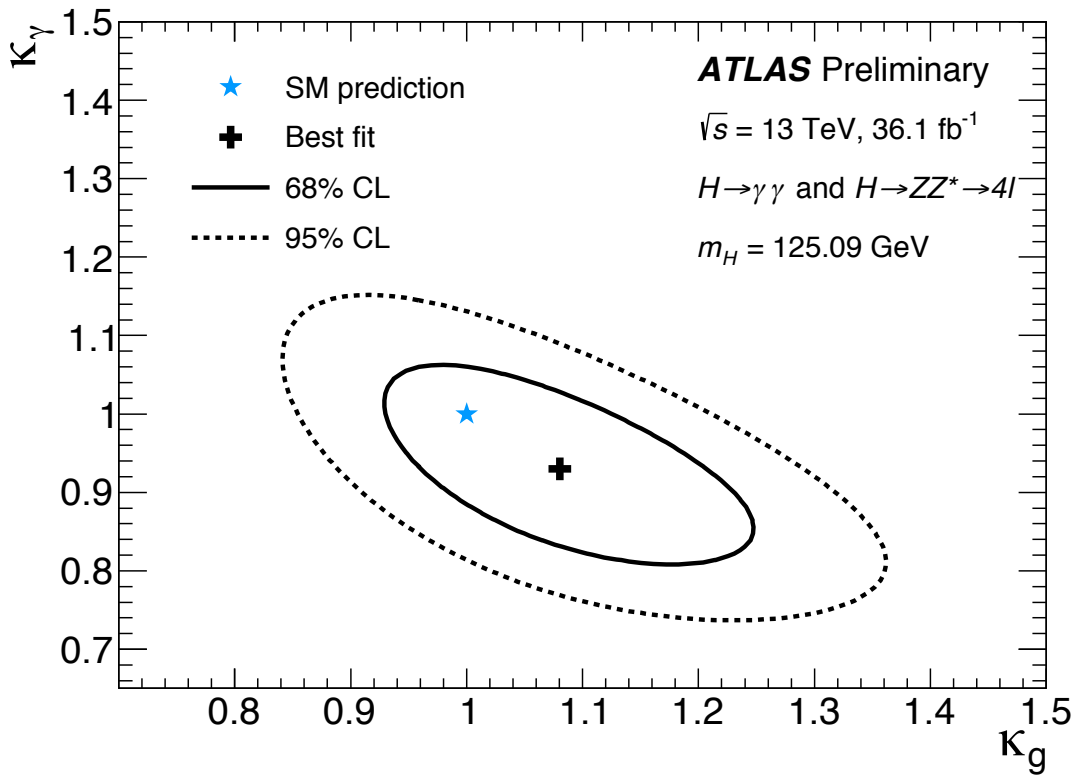
$$y_j = \sum_i A_{ji} \cdot r_i \cdot (\sigma_i \cdot \mathrm{B}_{4\ell})_{\mathrm{SM}} \cdot r_f \cdot \left(\frac{\mathrm{B}_f}{\mathrm{B}_{4\ell}}\right)_{\mathrm{SM}} \cdot \mathcal{L},$$

Results in k-framework

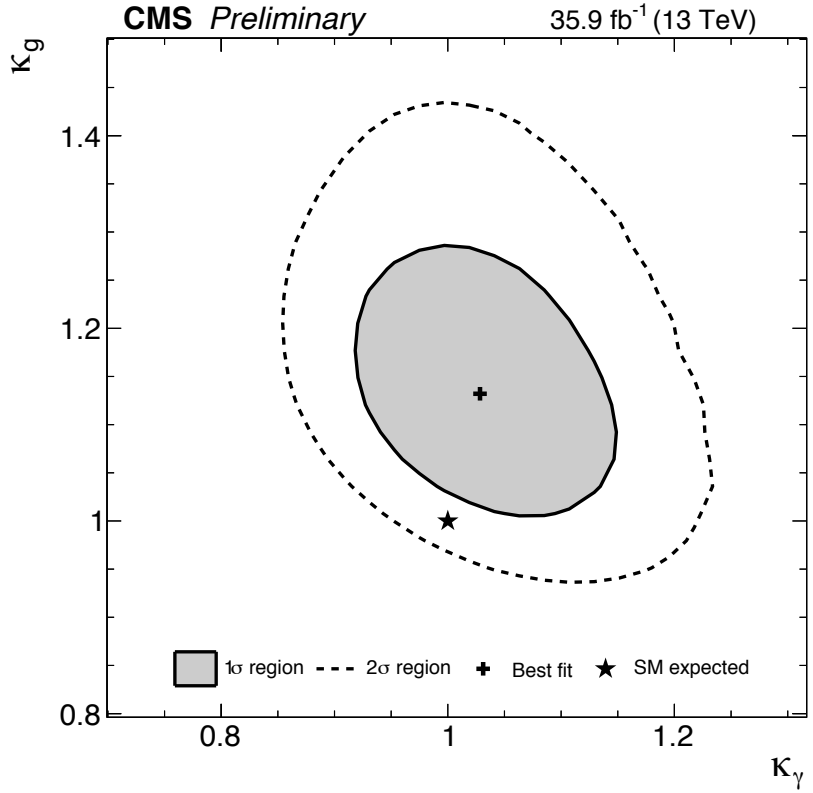




Results in k-framework



K_γ=0.93 (+0.09)(-0.08) k_g=1.08 (+0.11)(-0.10)



K_γ=1.07 (+0.15)(-0.18) k_g=1.14 +(0.15)(-0.13)

Summary

Higgs Boson properties measured in several channels

Up to now: standard model compatible

Higgs mass: 124.98 ± 0.28 (± 0.19 ± 0.21) - ATLAS; 125.26 ± 0.21 (± 0.20 ± 0.08) - CMS

Higgs couplings tested at several different scenarios

- Production mechanism
  - Gluon – loop induced coupling tested
  - VBF – coupling with gauge boson tested
  - tth – top quark coupling tested
- Decay products
  - Photon – loop induced coupling
  - ZZ
  - WW
  - bb, $\tau\tau$, $\mu\mu$ (tested but not yet observed)

References

CMS:

H->$\gamma\gamma$ *CMS–PAS-HIG-16-040*

H->ZZ *JHEP 11(2017),47*

H-> WW *CMS–PAS-HIG-16-042*

H-> $\tau\tau$ *PLB 779 (2018), 283*

VH -> H -> bb 1709.07497

Boosted H->bb *CMS–PAS-HIG-17-010*

ttH *CMS–PAS-HIG-17-026, 17-018*

H -> $\mu\mu$ *CMS–PAS-HIG-17-019*

ATLAS:

H->$\gamma\gamma$ *1802.04146*

H->ZZ *1712.02304*

ttH 1712.08895, 1712.08891

Thank You