Global Higgs Fits

and implications for extended Higgs sectors

Sabine Kraml
LPSC Grenoble

Based on work with
G. Belanger, B. Dumont, U. Ellwanger, J.F. Gunion, et al.

outline

- Introduction & motivation
- Using the experimental results
  - Disentangling production modes
  - Combined signal strengths
- Global coupling fits
  - constraints on reduced couplings
  - constraints on invisible/unseen decays
  - interplay with dark matter searches
- Implications for specific models
  - 2HDM, inert Higgs, triplets, SUSY
- Conclusions

“On the presentation of the LHC Higgs results,” **arXiv:1307.5865**

“Global fit to Higgs signal strengths and couplings and implications for extended Higgs sectors,” **arXiv:1306.2941**

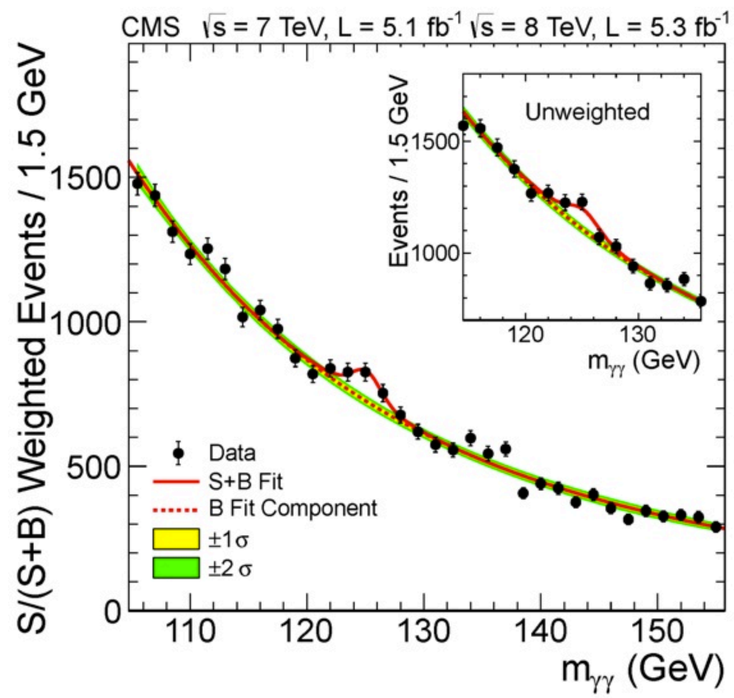
“Status of invisible Higgs decays,” **arXiv:1302.5694**

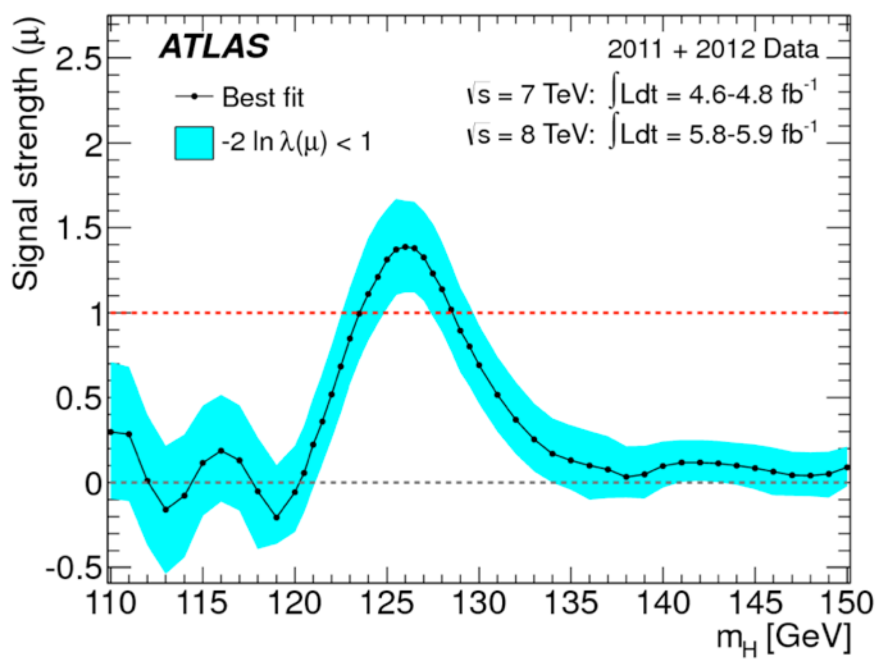
“LHC constraint on light neutralino dark matter in the MSSM,” **arXiv:1308.3735**

and work in progress ....

motivation

- The 2012 discovery of a SM-like Higgs at a mass around 125 GeV is a first triumph for the LHC physics program.
- The data collected at $\sqrt{s}$ = 7 and 8 TeV already provide quite a comprehensive picture of the production and decay properties of the 125 GeV Higgs boson
- However, while the Higgs completes our picture of the SM, it still leaves many fundamental questions open (naturalness, hierarchy problem)
  → new physics beyond the SM ?
- Given the absence of direct signals for BSM at the LHC, the Higgs data and their interpretation currently provide the crucial guidelines for BSM theories.





The Higgs as guide to BSM ?

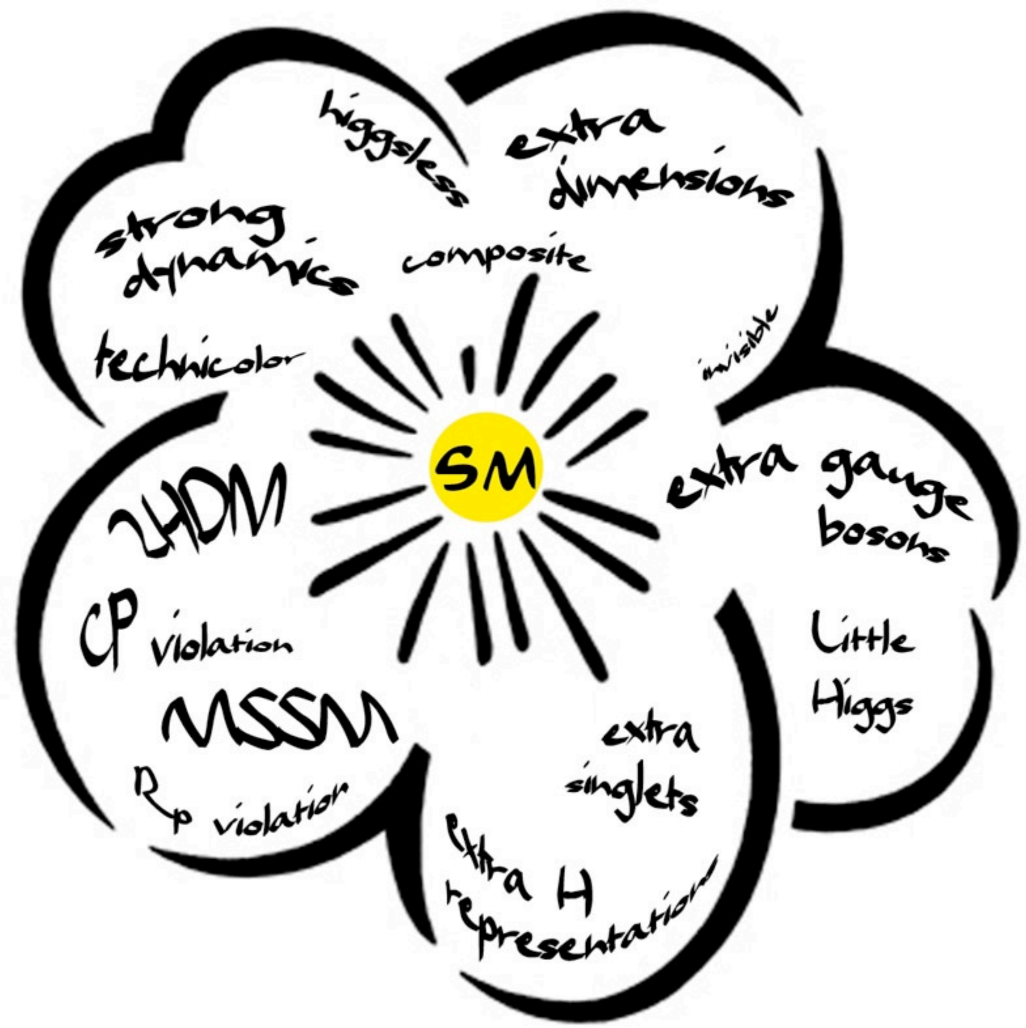
- In BSM theories, the Higgs production cross sections, decay branching ratios, kinematic distributions, and even the number of Higgs particles may differ from SM predictions.

- Have to distinguish between two classes of models by whether or not the selection efficiencies and detector acceptances for the various channels are independent of the model parameters.

- In the former case, SM-like tensor structure of the 125 GeV Higgs
  → signal strength modifiers

- Otherwise perform MC simulation, apply cuts, compare with exp. data
  → ideally want fiducial cross sections

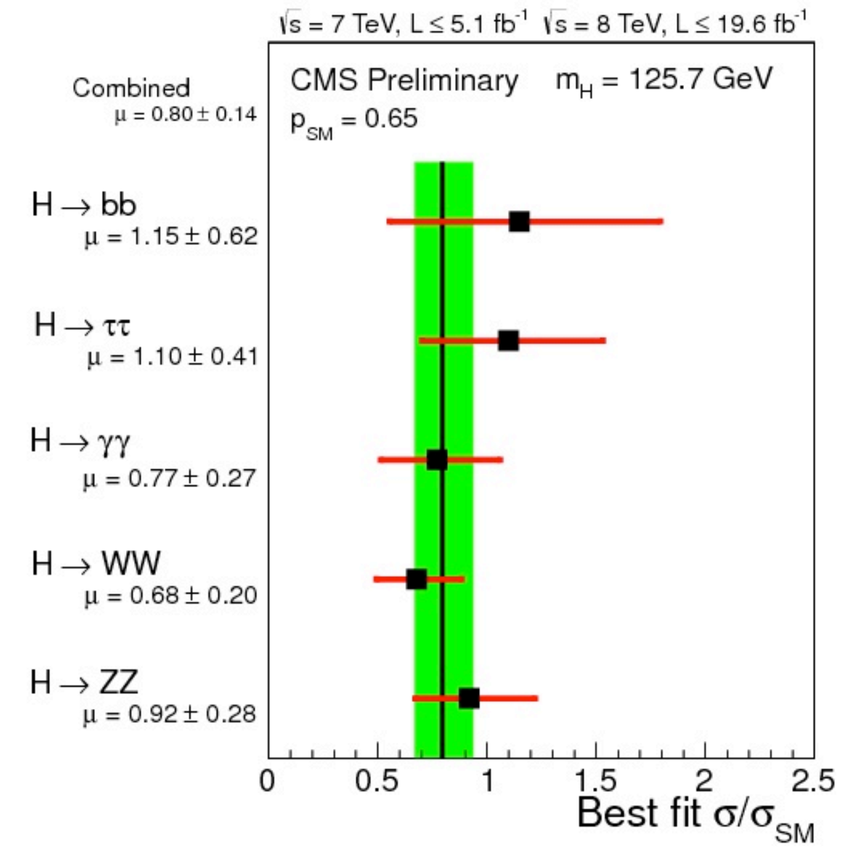
- See suggestions "On the presentation of the LHC Higgs results" in **1307.5865**.

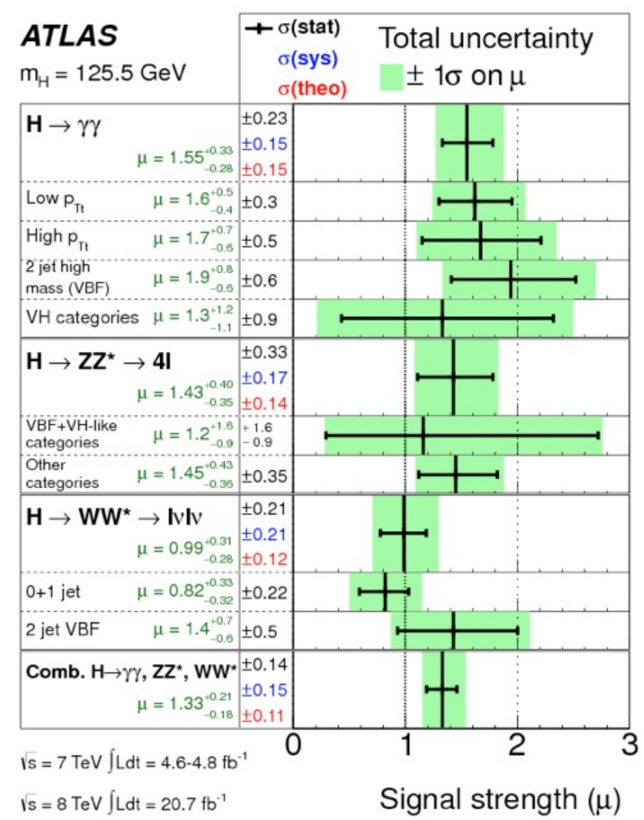


using the experimental results

signal strengths

- Presenting results in terms of $\mu=\sigma/\sigma_{SM}$ is a very convenient way to quantify agreement with SM expectations.
- BSM contributions affect production as well as decay rates → detailed breakdown in terms of production×decay modes needed to test (B)SM.
- Experimental practice: data related to a single decay mode H→Y are divided into categories (or "sub-channels") I, in order to improve sensitivity or discrimination among the production mechanisms.
- Need to interpret this in terms of "pure" production modes: ggF, VBF, VH, ttH → need efficiencies!



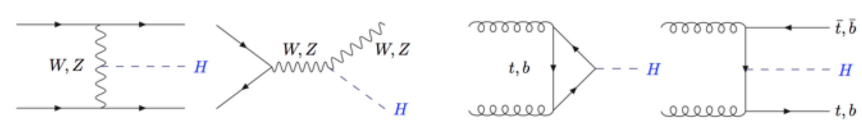


signal strengths in “theory space”

decay mode ($\gamma\gamma$, WW, ZZ, bb, $\tau\tau$, ...)

$$\mu(X,Y) \equiv \frac{\sigma(X)\,\mathrm{BR}(H \to Y)}{\sigma(X_{\mathrm{SM}})\,\mathrm{BR}(H_{\mathrm{SM}} \to Y)}$$

fundamental production mode such as gg fusion (ggF), VBF, etc.



The likelihood in terms of μ(X,Y) allows for reinterpretation of the results in models where the efficiency and acceptance for each (X,Y) is approximately unchanged with respect to the SM.

using sub-channel information

- The likelihood in terms of μ(X,Y) can be approximately recomputed combining the χ^2 of all categories I using an efficiency-weighted sum:

$$\mu_I(Y) = \sum_X \mu(X,Y)\, T(I,X)\, \sigma(X_{\rm SM})\, {\rm BR}(H_{\rm SM} \to Y)$$

selection efficiencies for each production mode, normalized to one.

Jack calls this the "transfer matrix".

- It is critical that for each of the categories I the selection efficiencies (and uncertainties thereon) be provided for all production modes. Unfortunately this is not yet done in a systematic way :-(

- NB important correlations may be missed in this approach, e.g., from migration of events between categories.

using sub-channel information

- The likelihood in terms of μ(X,Y) can be approximately recomputed combining the χ^2 of all categories $\boldsymbol{I}$ using an efficiency-weighted sum:

$$\mu_I(Y) = \sum_X \mu(X,Y) T(I,X) \sigma(X_{\rm SM})\,{\rm BR}(H_{\rm SM} \to Y)$$

crucial !

selection efficiencies for each production mode, normalized to one.

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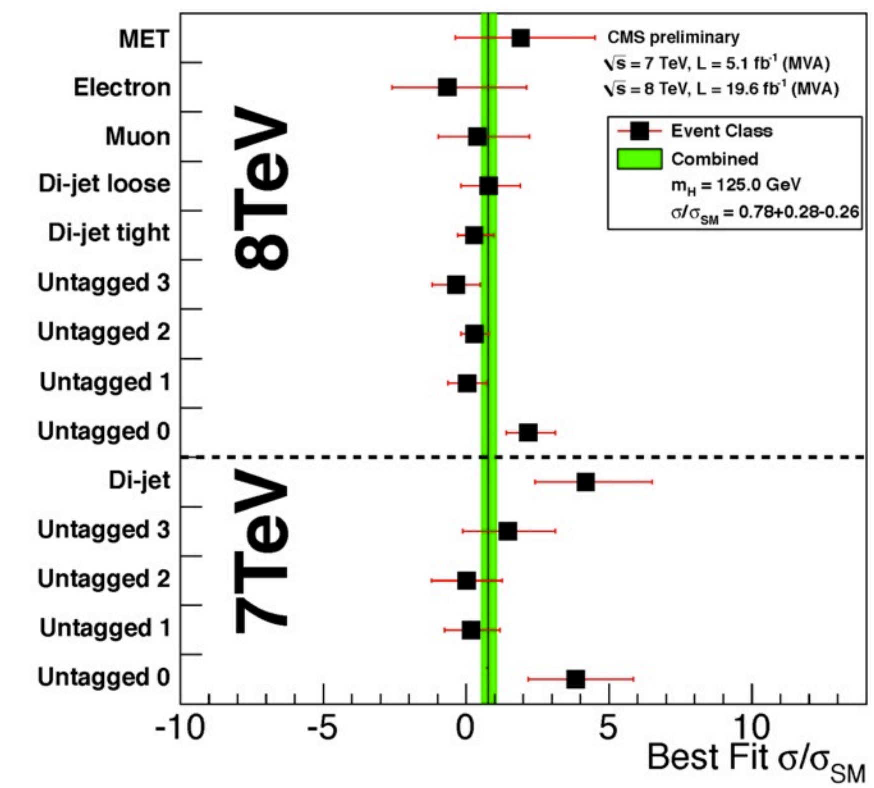
- It is critical that for each of the categories $\boldsymbol{I}$ the selection efficiencies (and uncertainties thereon) be provided for all production modes. Unfortunately this is not yet done in a systematic way :-(

- NB important correlations may be missed in this approach, e.g., from migration of events between categories.

T(I,X) .... a good example

Expected signal and estimated background

Event classes		SM Higgs boson expected signal (m_H=125 GeV) Total	ggH	VBF	VH	ttH	σ_{eff} (GeV)	FWHM/2.35 (GeV)
7 TeV 5.1 fb^{-1}	Untagged 0	3.2	61.4%	16.8%	18.7%	3.1%	1.21	1.14
	Untagged 1	16.3	87.6%	6.2%	5.6%	0.5%	1.26	1.08
	Untagged 2	21.5	91.3%	4.4%	3.9%	0.3%	1.59	1.32
	Untagged 3	32.8	91.3%	4.4%	4.1%	0.2%	2.47	2.07
	Dijet tag	2.9	26.8%	72.5%	0.6%	–	1.73	1.37
8 TeV 19.6 fb^{-1}	Untagged 0	17.0	72.9%	11.6%	12.9%	2.6%	1.36	1.27
	Untagged 1	37.8	83.5%	8.4%	7.1%	1.0%	1.50	1.39
	Untagged 2	150.2	91.6%	4.5%	3.6%	0.4%	1.77	1.54
	Untagged 3	159.9	92.5%	3.9%	3.3%	0.3%	2.61	2.14
	Dijet tight	9.2	20.7%	78.9%	0.3%	0.1%	1.79	1.50
	Dijet loose	11.5	47.0%	50.9%	1.7%	0.5%	1.87	1.60
	Muon tag	1.4	0.0%	0.2%	79.0%	20.8%	1.85	1.52
	Electron tag	0.9	1.1%	0.4%	78.7%	19.8%	1.88	1.54
	E_T^{miss} tag	1.7	22.0%	2.6%	63.7%	11.7%	1.79	1.64

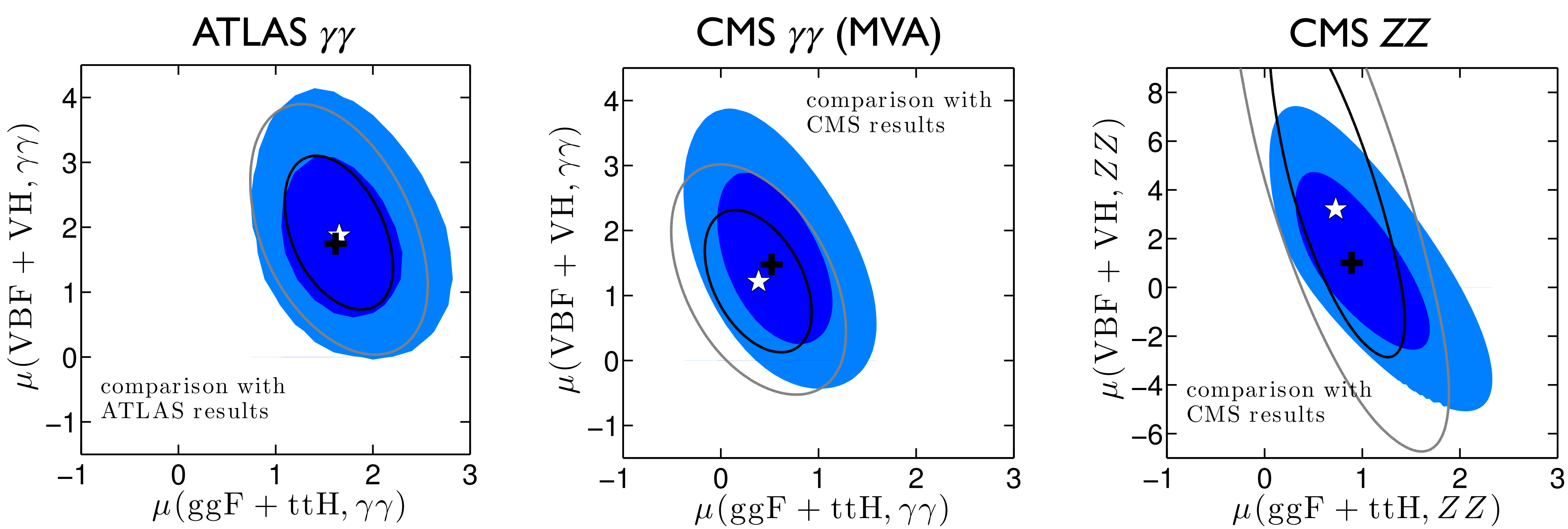


from CMS-PAS-HIG-13-001 (H→$\gamma\gamma$, mass-fit MVA analysis)

but unfortunately not yet available for all channels from both ATLAS and CMS
(also not for CMS H→$\gamma\gamma$ CiC analysis)

using sub-channel information

- Reconstruction of 68 and 95% CL contours from sub-channel info (black/grey) and comparison to official ATLAS/CMS results (blue)



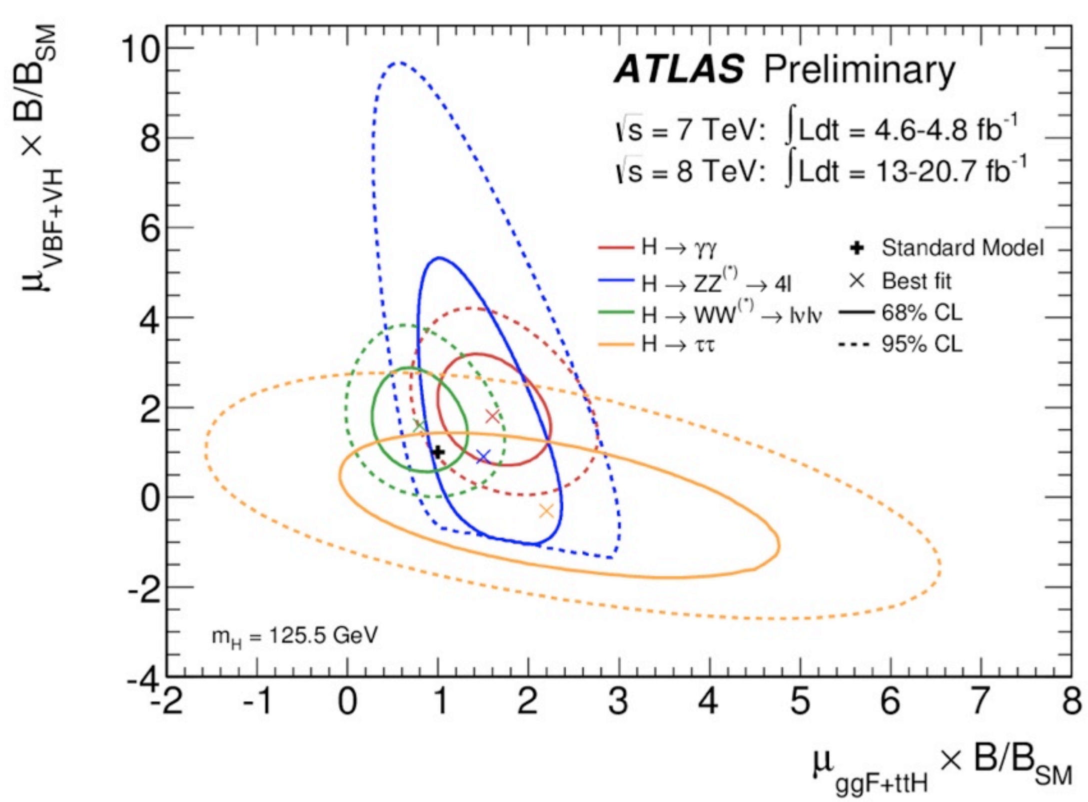
arXiv:1307.5865

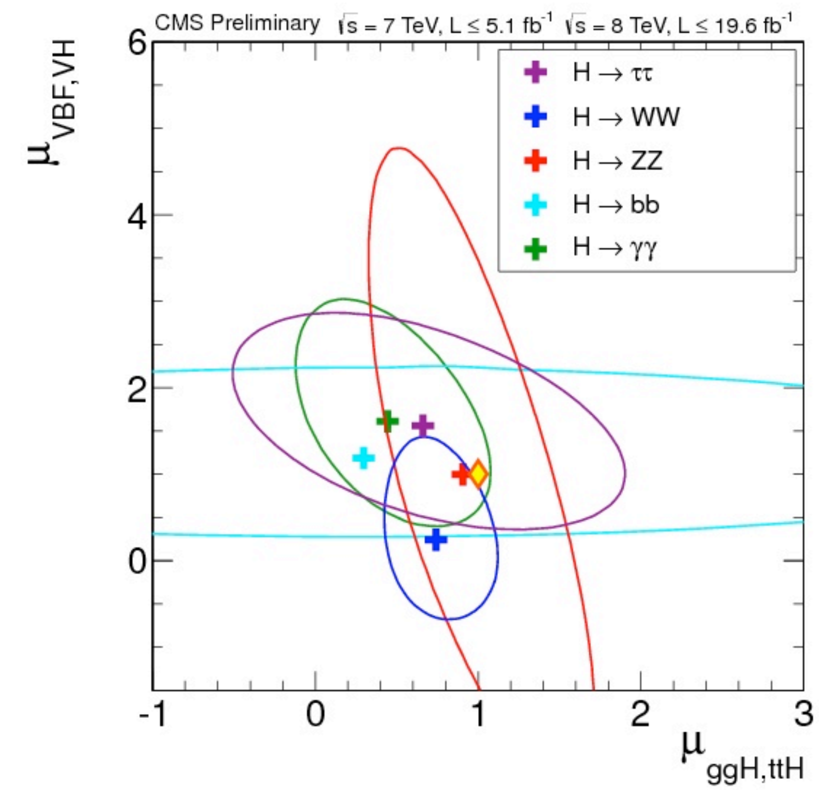
- NB important correlations may be missed in this approach. In particular, some systematic uncertainties lead to migration of events between categories, and these uncertainties can dominate over the statistical ones.

μ(ggF+ttH) vs μ(VBF+VH) plots

- It has become standard that for each decay mode the experiments present 68% and 95% CL contours in the μ(ggF+ttH) versus μ(VBF+VH) plane:

VH=WH+ZH



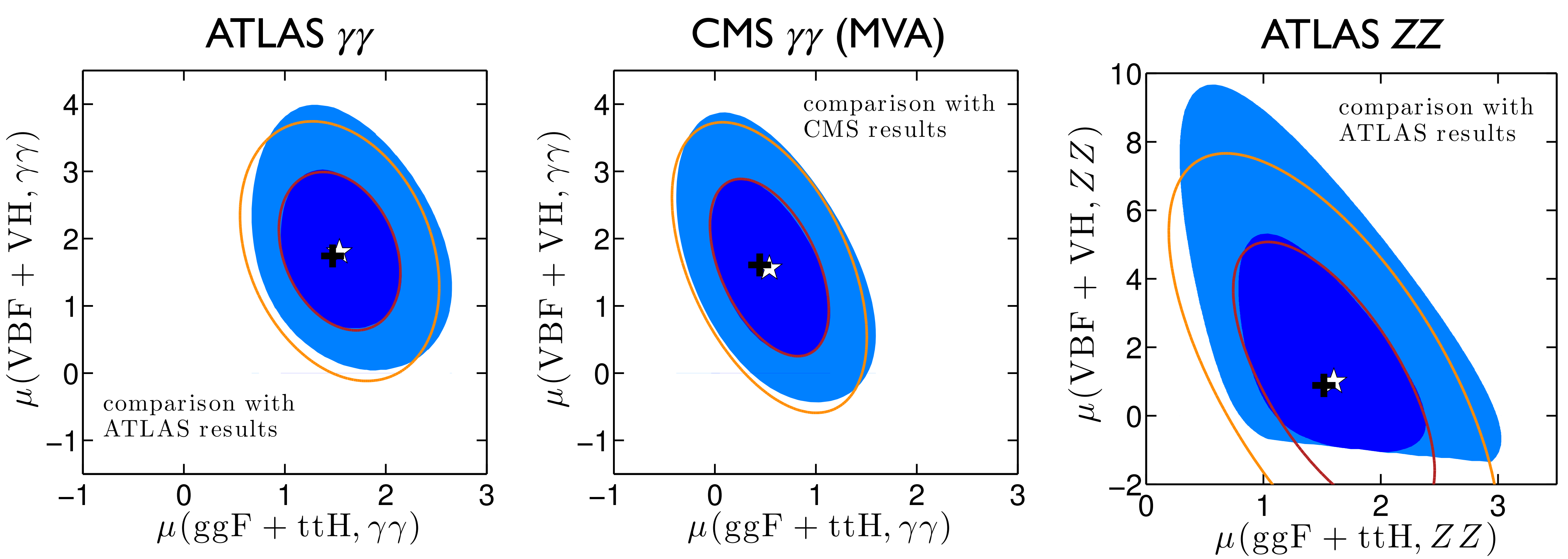


- This is a boon for interpretation studies because the fundamental production modes are already "unfolded" from the experimental categories.
- Could be extended to other μ(X,Y) vs μ(X',Y') combinations, e.g. WH, ZH for H→bb

μ(ggF+ttH) vs. μ(VBF+VH): limitations

- μ(VBF+VH) assumes custodial symmetry.
- If only 68% and 95% CL contours are given, one first needs to reconstruct the likelihood. Simplest solution is fitting a 2D Gaussian:

arXiv:1307.5865

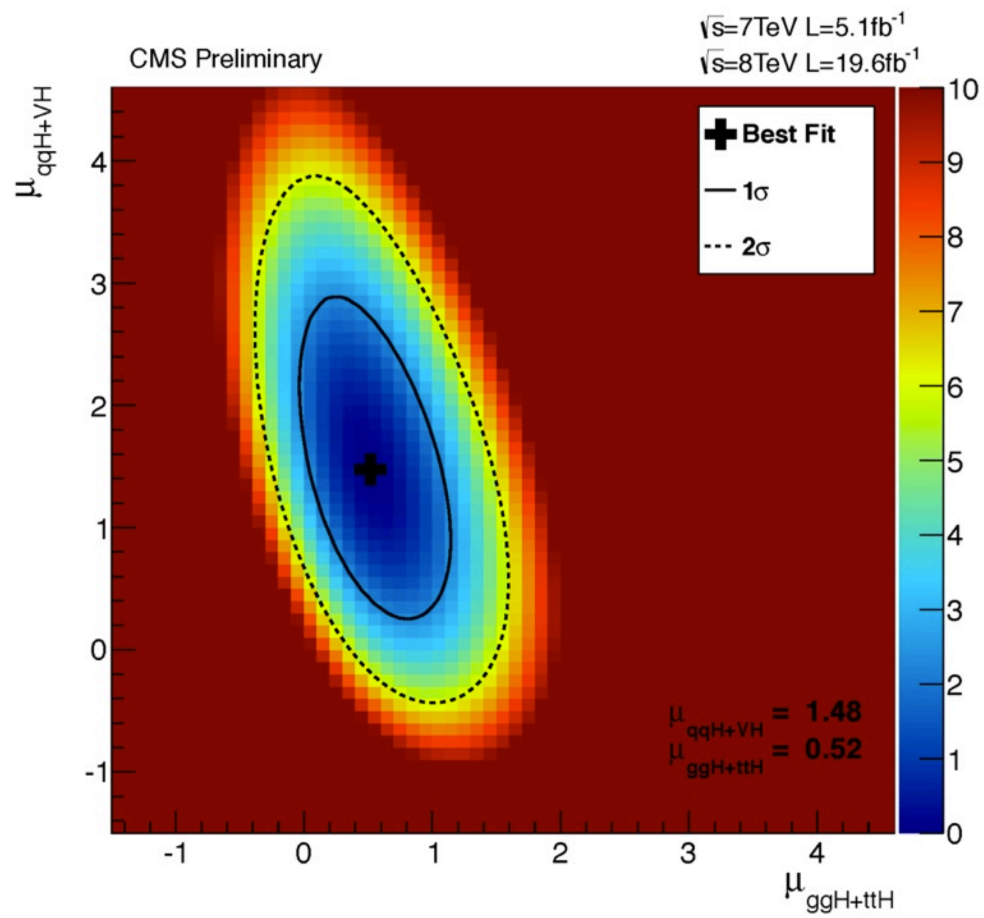


Gaussian fits (red/orange contours) to signal strengths in the μ(ggF+ttH) vs μ(VBF+VH) plane and comparison to official ATLAS and CMS results (in blue).

In each case, we approximately reconstruct the likelihood by fitting a bivariate normal distribution to the 68% CL contour given by the collaboration

arXiv:1307.5865

- It would be of great advantage to have the full likelihood information in the μ(ggF+ttH) vs μ(VBF+VH) plane ... or other relevant planes

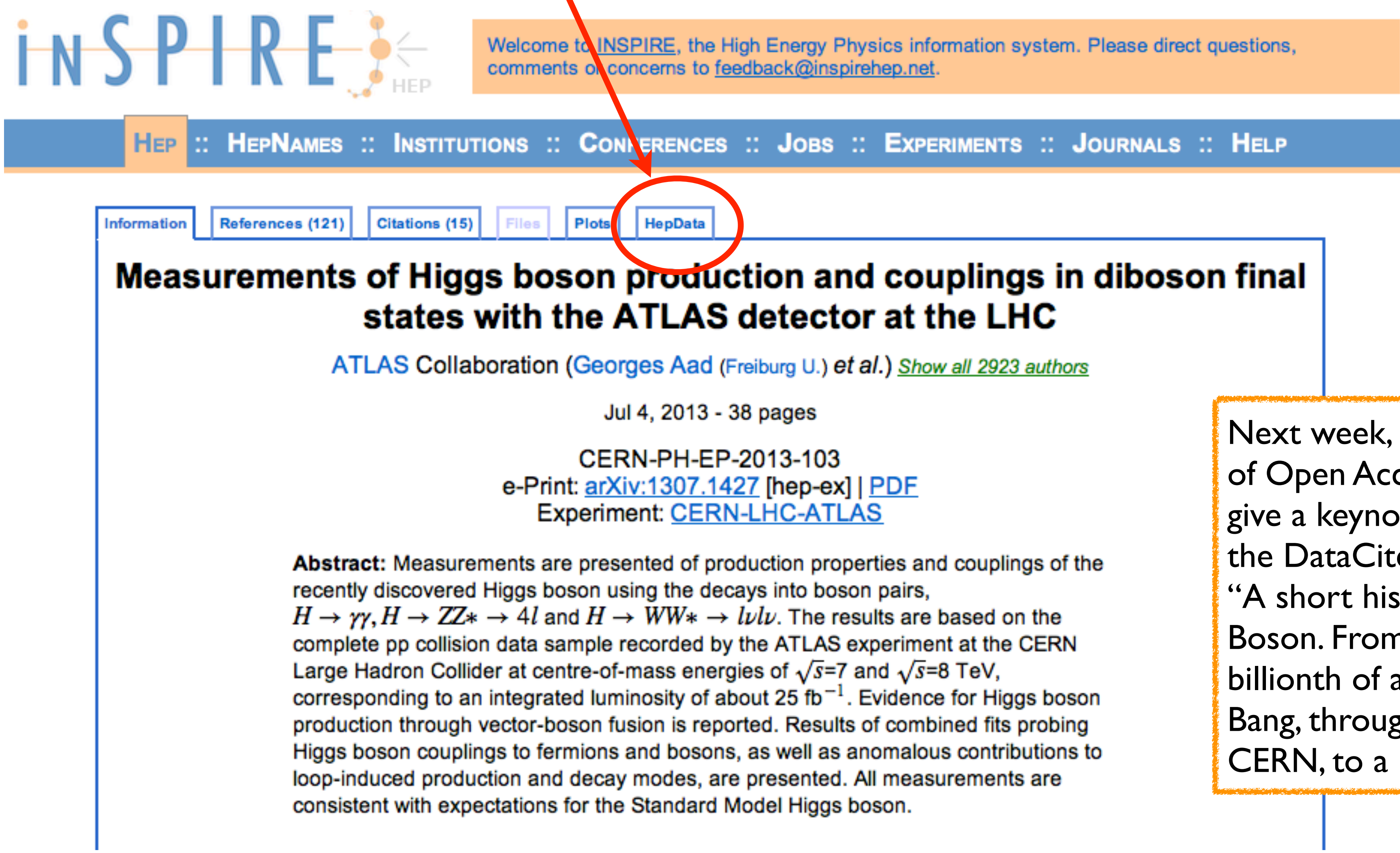


from CMS-PAS-HIG-13-001 ($H \rightarrow \gamma\gamma$)

- Preferably this information should be directly available in numerical form (via INSPIRE → DOI → searchable and citable)

a big step forward

This week the ATLAS collaboration has taken an important step forward by making the likelihood function for three key measurements about the Higgs available to the world digitally. [K. Cranmer, QuantumDiaries, 12-Sep-2013]



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Measurements of Higgs boson production and couplings in diboson final states with the ATLAS detector at the LHC

ATLAS Collaboration (Georges Aad (Freiburg U.) *et al.*) *Show all 2923 authors*

Jul 4, 2013 - 38 pages

CERN-PH-EP-2013-103
e-Print: arXiv:1307.1427 [hep-ex] | PDF
Experiment: CERN-LHC-ATLAS

Abstract: Measurements are presented of production properties and couplings of the recently discovered Higgs boson using the decays into boson pairs, $H\to\gamma\gamma, H\to ZZ*\to 4l$ and $H\to WW*\to l\nu l\nu$. The results are based on the complete pp collision data sample recorded by the ATLAS experiment at the CERN Large Hadron Collider at centre-of-mass energies of $\sqrt{s}$=7 and $\sqrt{s}$=8 TeV, corresponding to an integrated luminosity of about 25 fb^{-1}. Evidence for Higgs boson production through vector-boson fusion is reported. Results of combined fits probing Higgs boson couplings to fermions and bosons, as well as anomalous contributions to loop-induced production and decay modes, are presented. All measurements are consistent with expectations for the Standard Model Higgs boson.

Next week, Salvatore Mele, head of Open Access at CERN, will give a keynote presentation to the DataCite conference entitled "A short history of the Higgs Boson. From a tenth of a billionth of a second after the Big Bang, through the discovery at CERN, to a DataCite DOI".

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Information | Files

Data from Figure 7 from: Measurements of Higgs boson production and couplings in diboson final states with the ATLAS detector at the LHC

ATLAS Collaboration (Aad, Georges (Freiburg U.) [...]) *Show all 2923 authors*

Cite as: ATLAS Collaboration (2013) HepData, http://doi.org/10.7484/INSPIREHEP.DATA.A78C.HK44

Description: -2 log Likelihood for the H → γγ channel in the (μ_ggF+ttH * B/BSM, μ_VBF+VH * B/BSM) plane for a Higgs boson mass mH = 125.5 GeV.

Preview not available

Note: * Temporary entry *

This dataset complements the following publication:
Measurements of Higgs boson production and couplings in diboson final states wi
ATLAS detector at the LHC

Record created 2013-09-11, last modified 2013-09-11

Figure 7

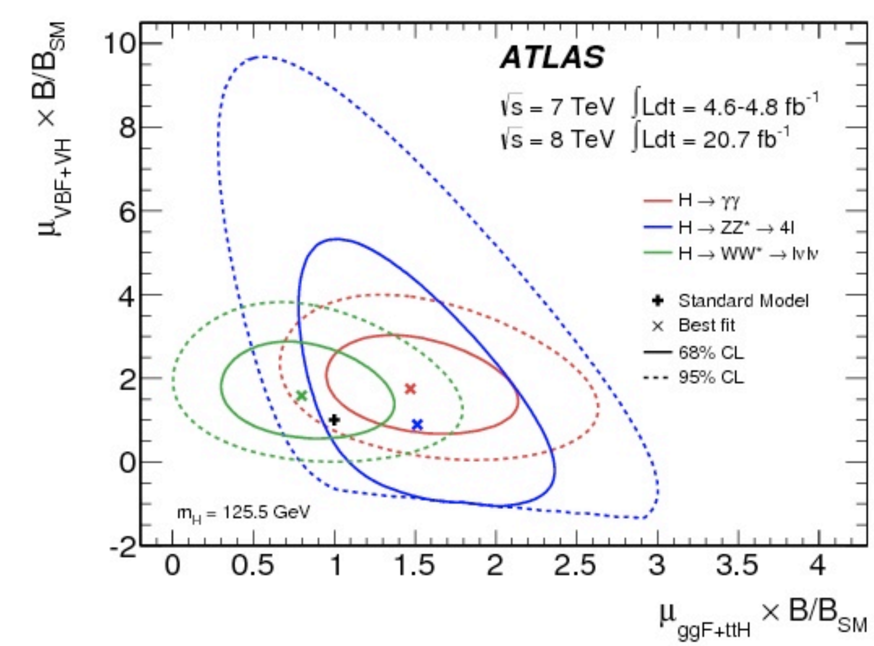

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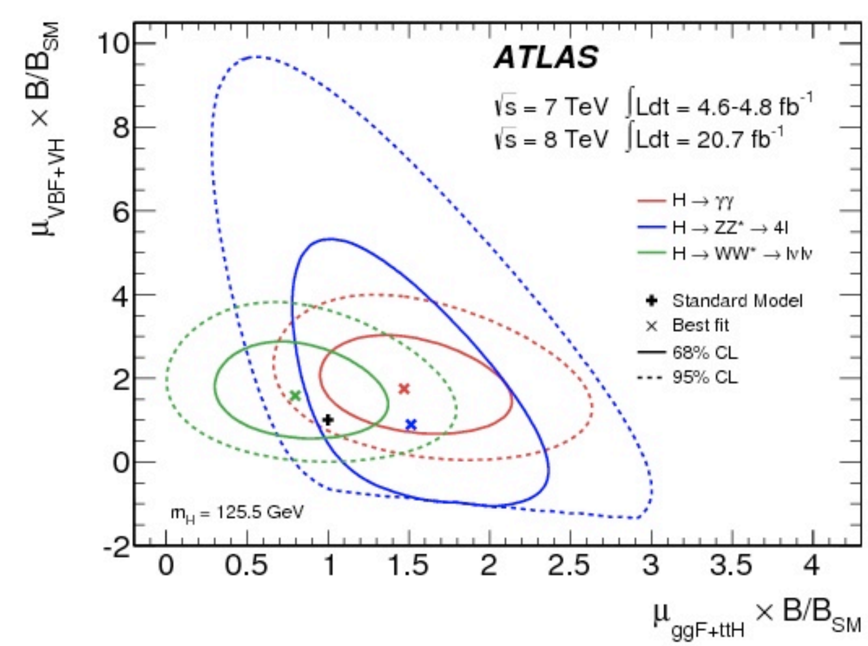
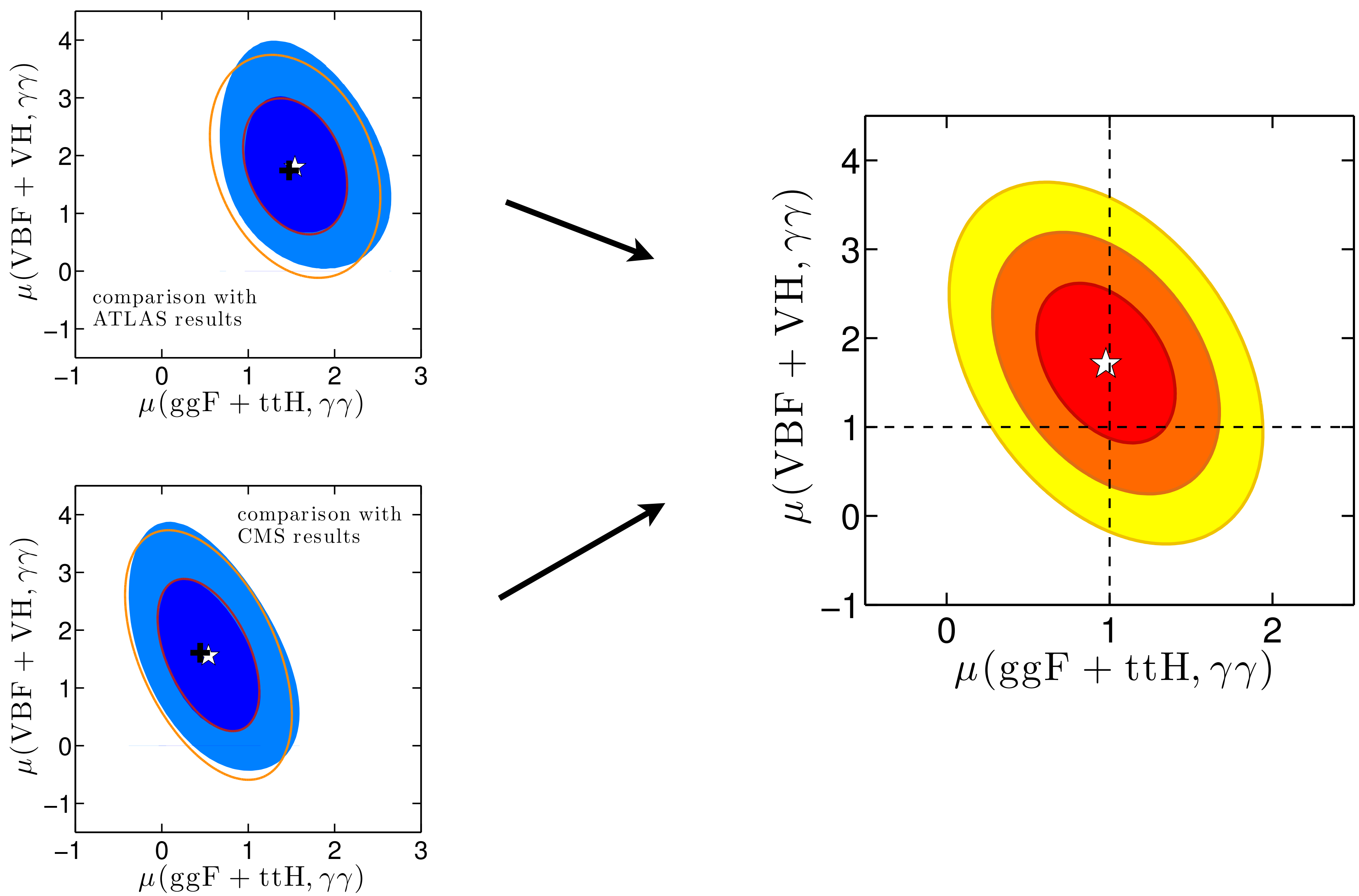
Figure 7



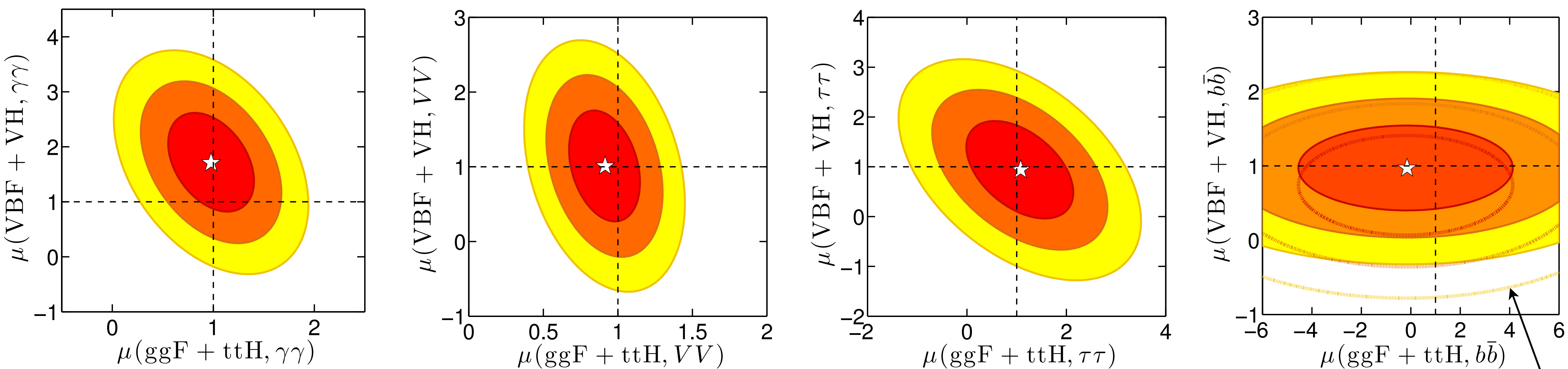
combined signal strengths

Combining ATLAS, CMS and Tevatron results

Fitting 2D Gaussians to the 68% CL contours from the experiments, we construct a combined likelihood in the (ggF+ttH, VBF+VH) plane for each final state:

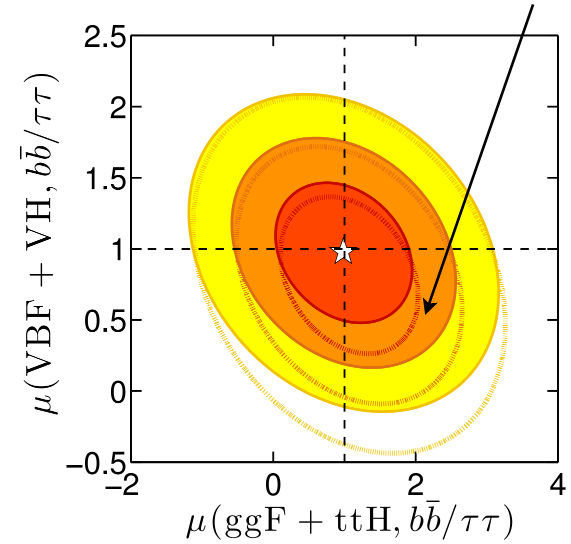


Combined μ’s



w/o Tevatron

	$\hat{\mu}(\mathrm{ggF+ttH})$	$\hat{\mu}(\mathrm{VBF+VH})$	ρ
$\gamma\gamma$	0.98 ± 0.28	1.72 ± 0.59	-0.38
VV	0.91 ± 0.16	1.01 ± 0.49	-0.30
$b\bar{b}/\tau\tau$	0.98 ± 0.63	0.97 ± 0.32	-0.25
$\tau\tau$	1.07 ± 0.71	0.94 ± 0.65	-0.47
$b\bar{b}$	-0.23 ± 2.86	0.97 ± 0.38	0



Agrees frustratingly well with SM :-(
but, there’s still room for sizable deviations …

global fits

Coupling Fits

- Need to specify the Lagrangian

$$\mathcal{L} = g\left[C_V\left(M_W W_\mu W^\mu + \frac{M_Z}{\cos\theta_W} Z_\mu Z^\mu\right) - C_U \frac{m_t}{2M_W}\bar{t}t - C_D \frac{m_b}{2M_W}\bar{b}b - C_D \frac{m_\tau}{2M_W}\bar{\tau}\tau\right] H\,.$$

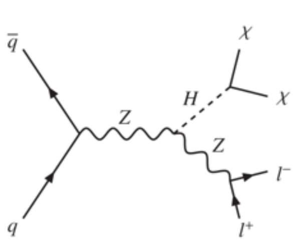
C's scale couplings relative to SM ones; $C_U=C_D=C_V=1$ is SM.

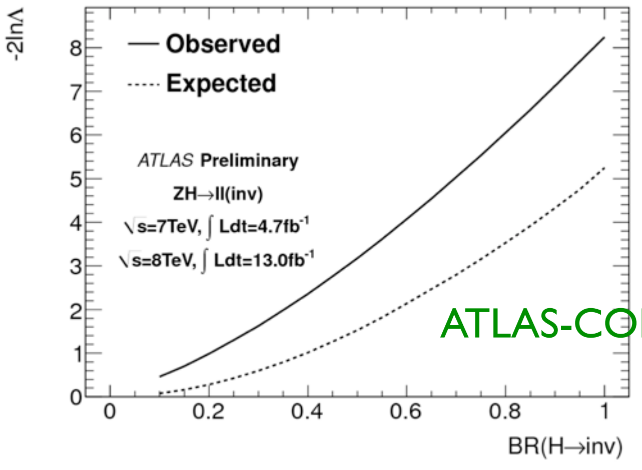
- Couplings to gluons and photons: we compute $\overline{C}_g$ and $\overline{C}_\gamma$ from C_U, C_D, C_V; we also allow additional loop contributions ΔC_g and ΔC_γ from new particles $\rightarrow$ $C_g = \overline{C}_g + \Delta C_g$ and $C_\gamma = \overline{C}_\gamma + \Delta C_\gamma$

- Calculation of σ×BR following the recommendations of the LHC Higgs Cross Section Working Group, arXiv:1209.0040

- Fit includes ATLAS, CMS and Tevatron results from Moriond and LHCP 2013.

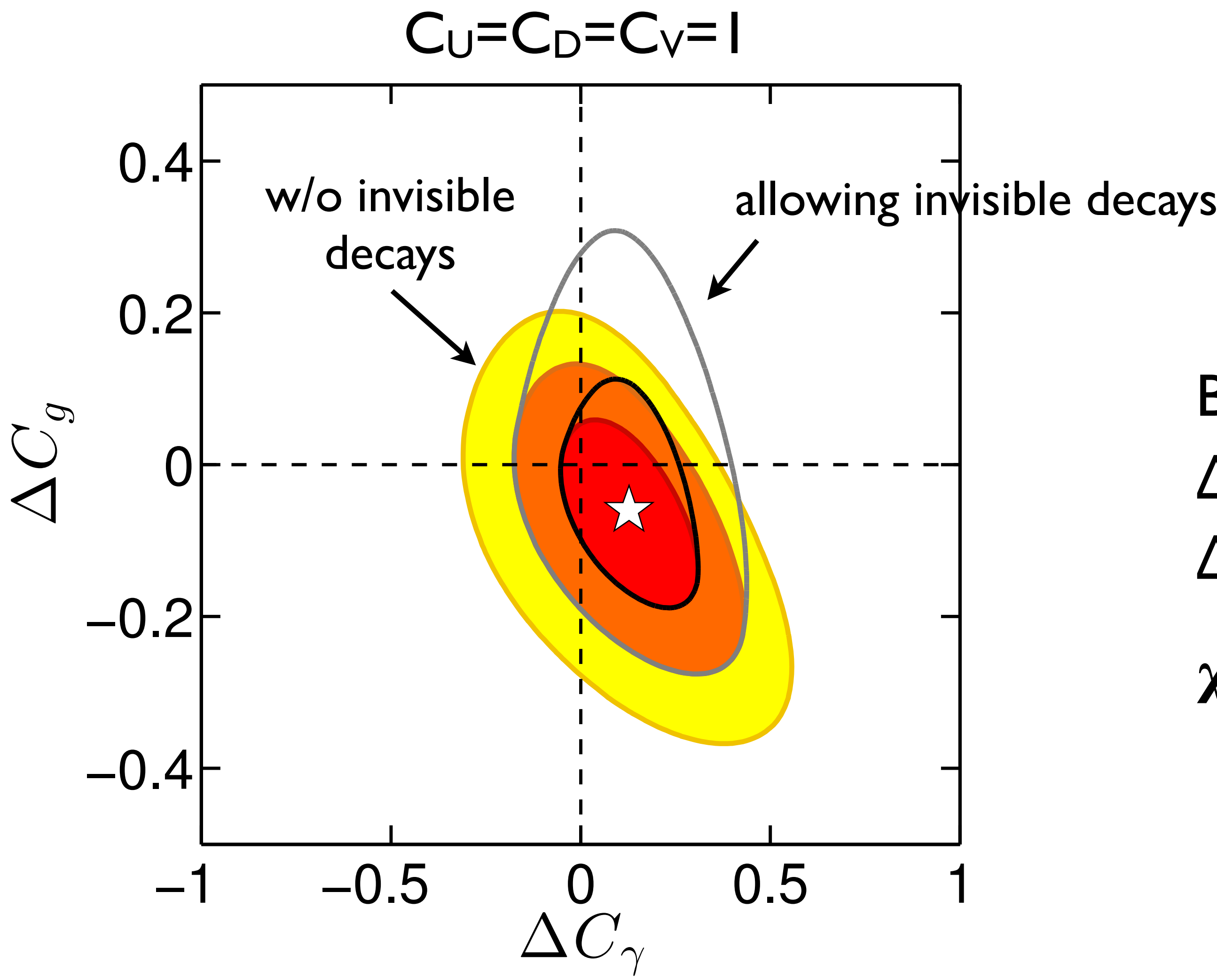
- NB when relevant we also include searches for invisible decays. In particular ATLAS ZH→ll+MET gives B(inv)<0.65 at 95% CL.





ATLAS-CONF-2013-011

ΔC_g, ΔC_γ Fit



68%, 95% and 99.7% CL contours

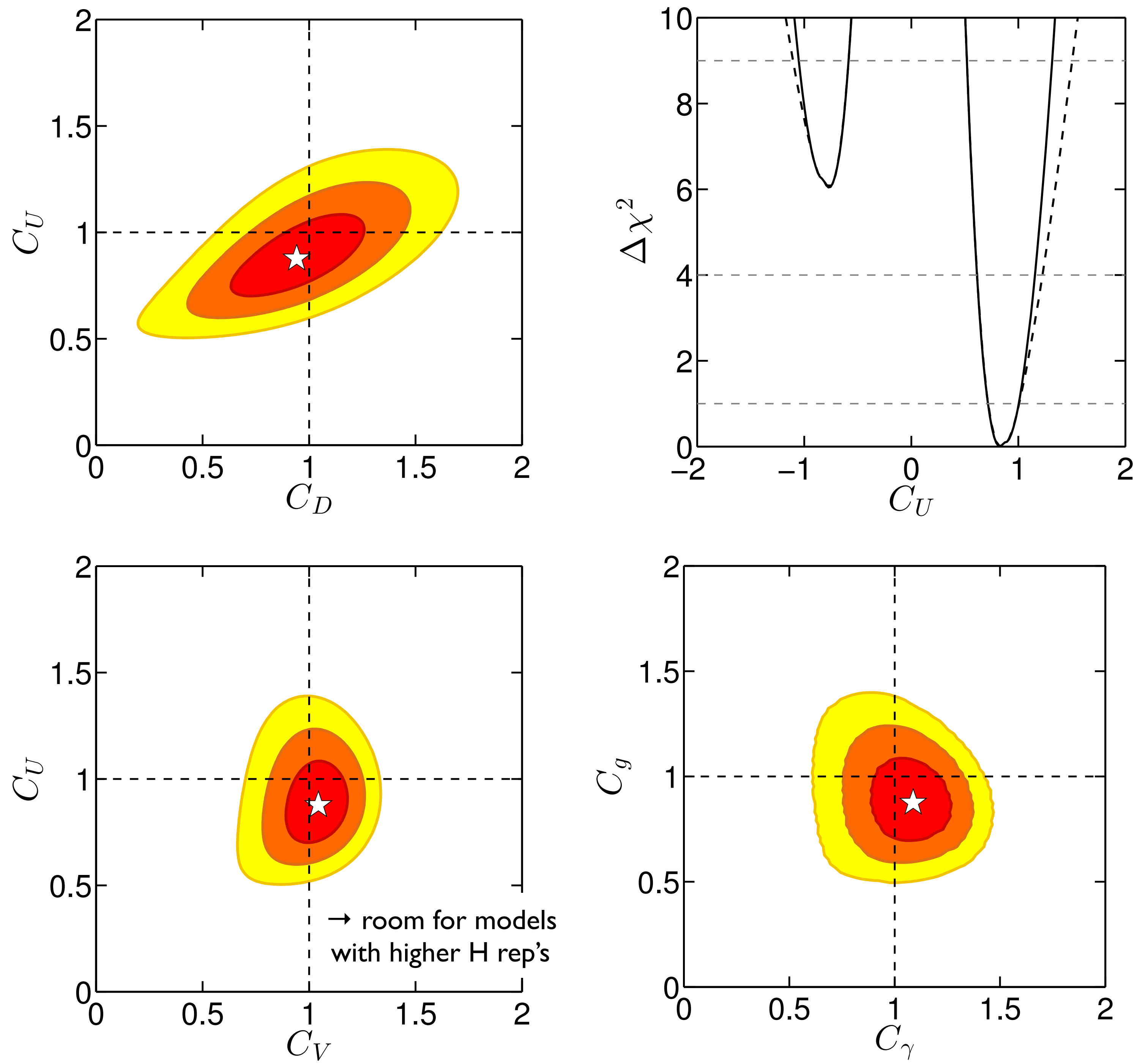
Best fit:

ΔC_g = -0.06

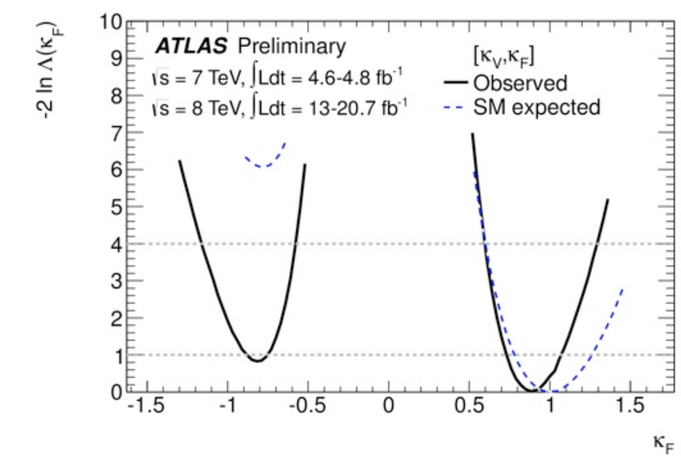
ΔC_γ = 0.13

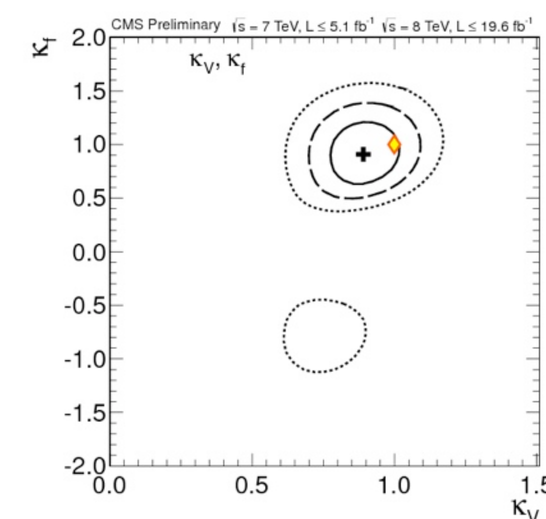
χ^2_{min}/dof = 0.84 (SM: 0.82)

C_U, C_D, C_V Fit ($\Delta C_g = \Delta C_\gamma = 0$)



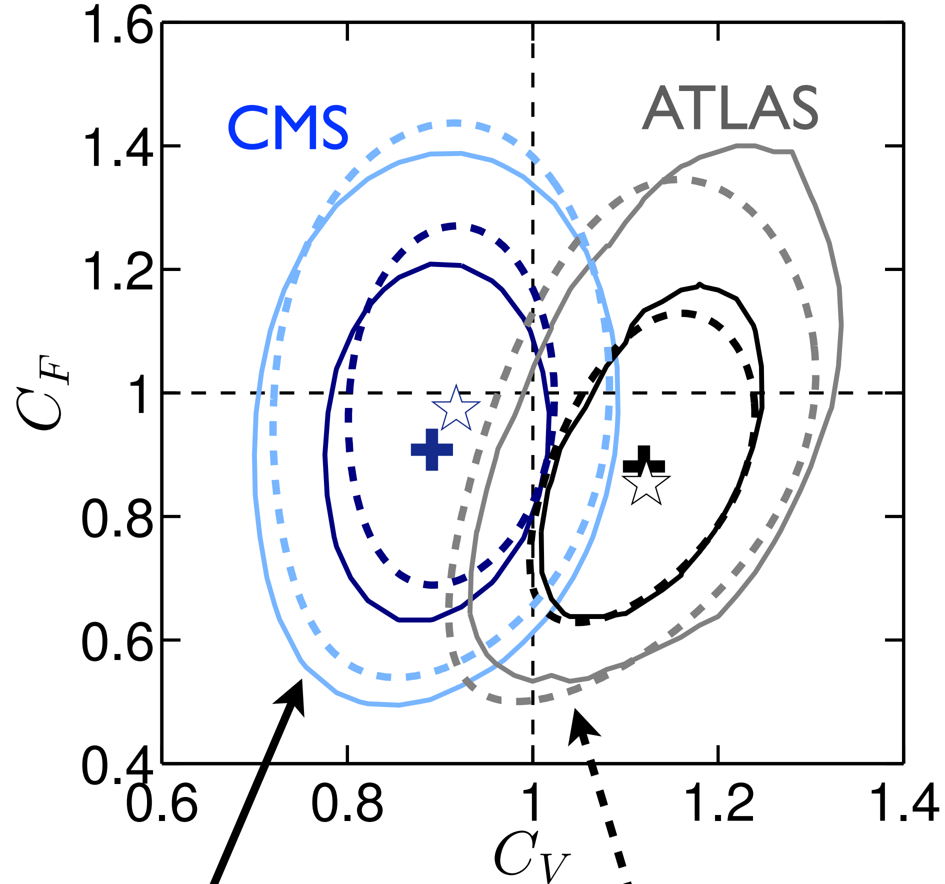
C_U<1 disfavored by our fit
(sign ambiguity in C_D remains)





Comparison with ATLAS and CMS coupling fits

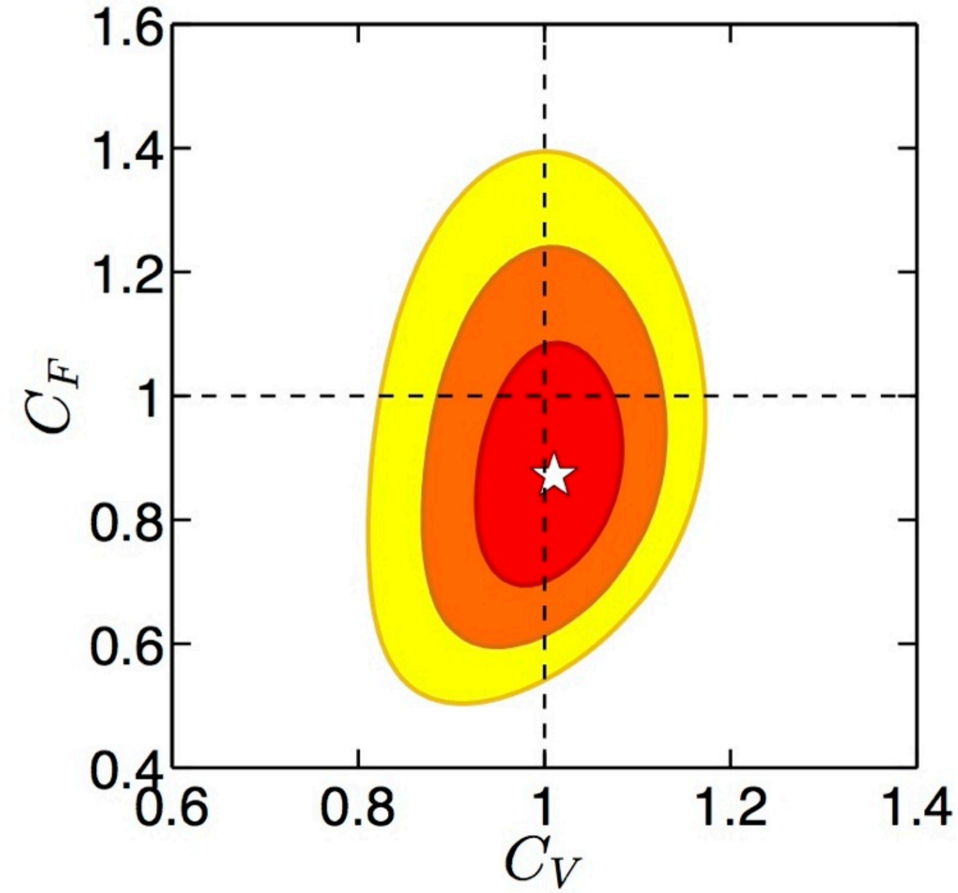
ATLAS/CMS individually



solid contours:
official results

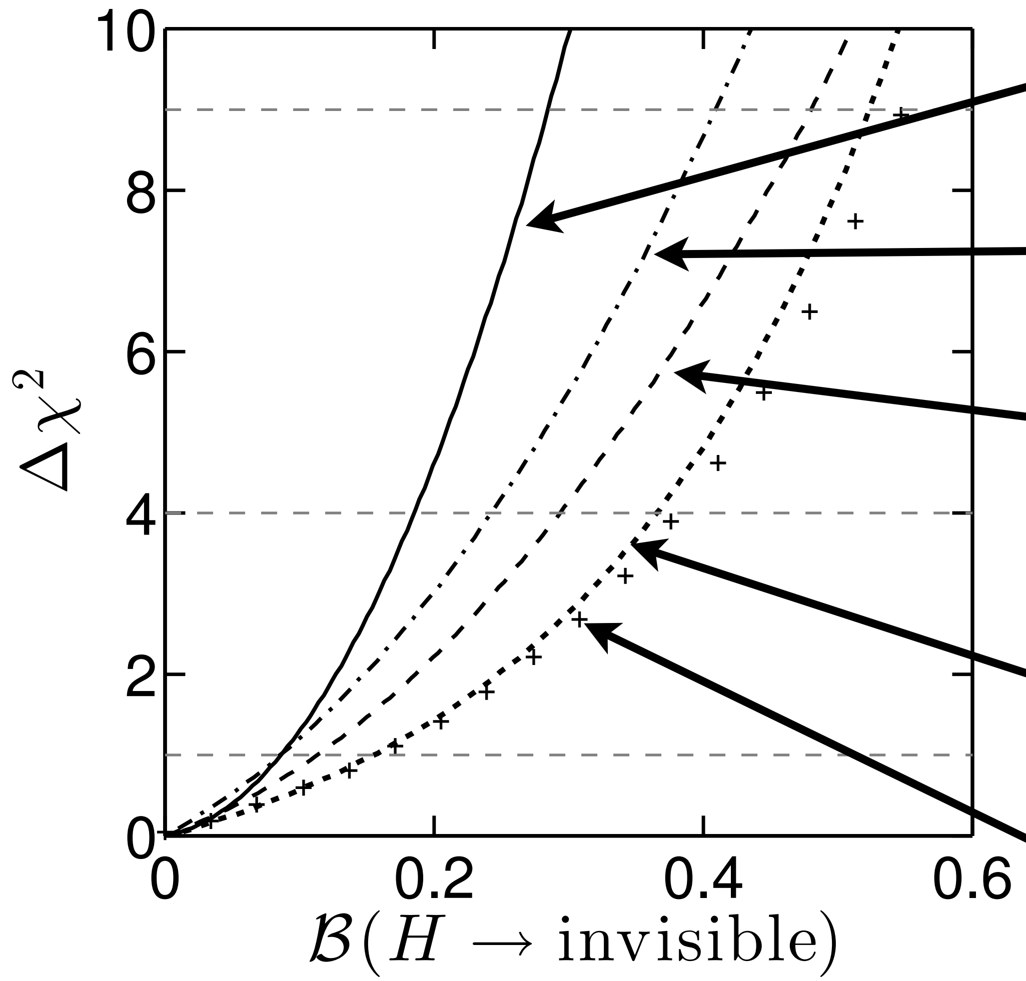
dashed: our fit

combined fit



applicable, e.g., to 2HDM type-I or
Georgi-Machacek triplet Higgs model

invisible decays



SM+invisible
$\mathcal{B}(H \to \text{inv.}) < 0.19$ at 95% CL

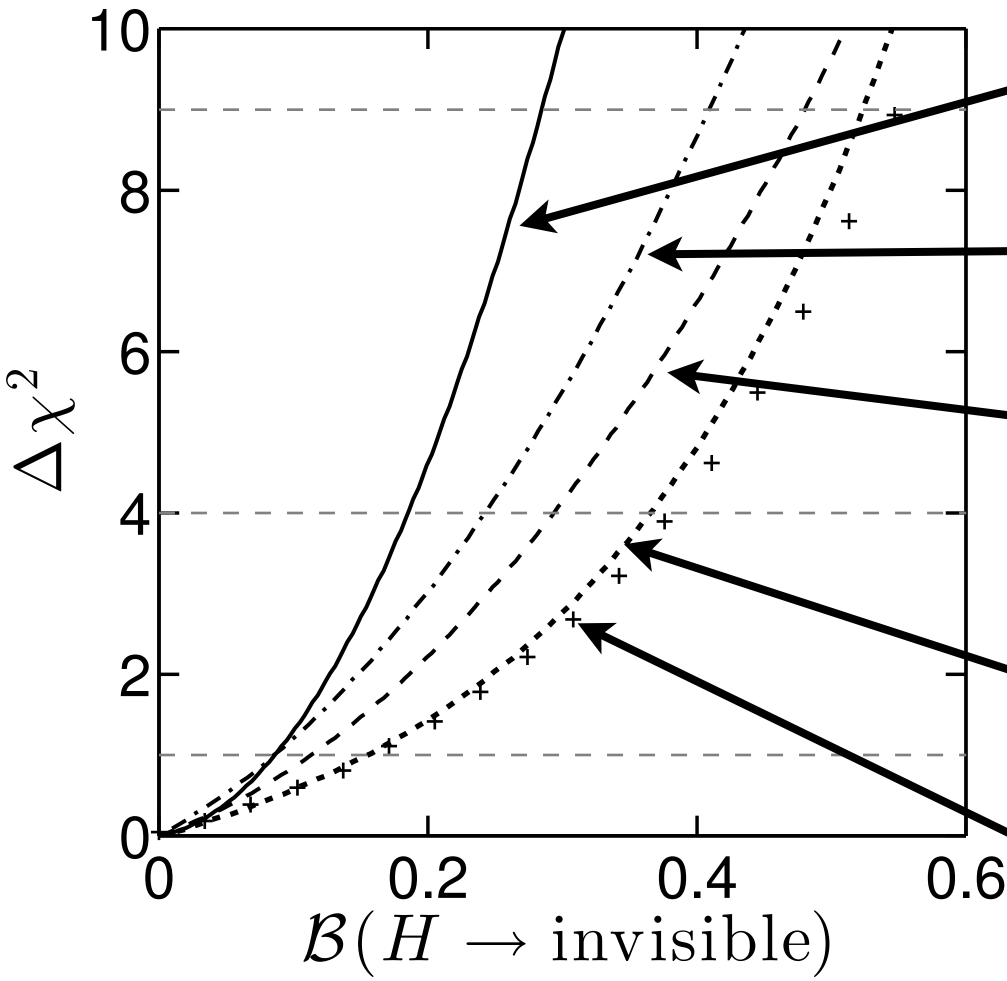
$C_U + C_D + (C_V \leq 1)$+invisible
$\mathcal{B}(H \to \text{inv.}) < 0.24$ at 95% CL

SM+$\Delta C_g + \Delta C_\gamma$+invisible
$\mathcal{B}(H \to \text{inv.}) < 0.29$ at 95% CL

$C_U + C_D + C_V$+invisible
$\mathcal{B}(H \to \text{inv.}) < 0.36$ at 95% CL

$C_U + C_D + C_V + \Delta C_g + \Delta C_\gamma$+invisible
$\mathcal{B}(H \to \text{inv.}) < 0.38$ at 95% CL

invisible decays



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mainly from global μ fit

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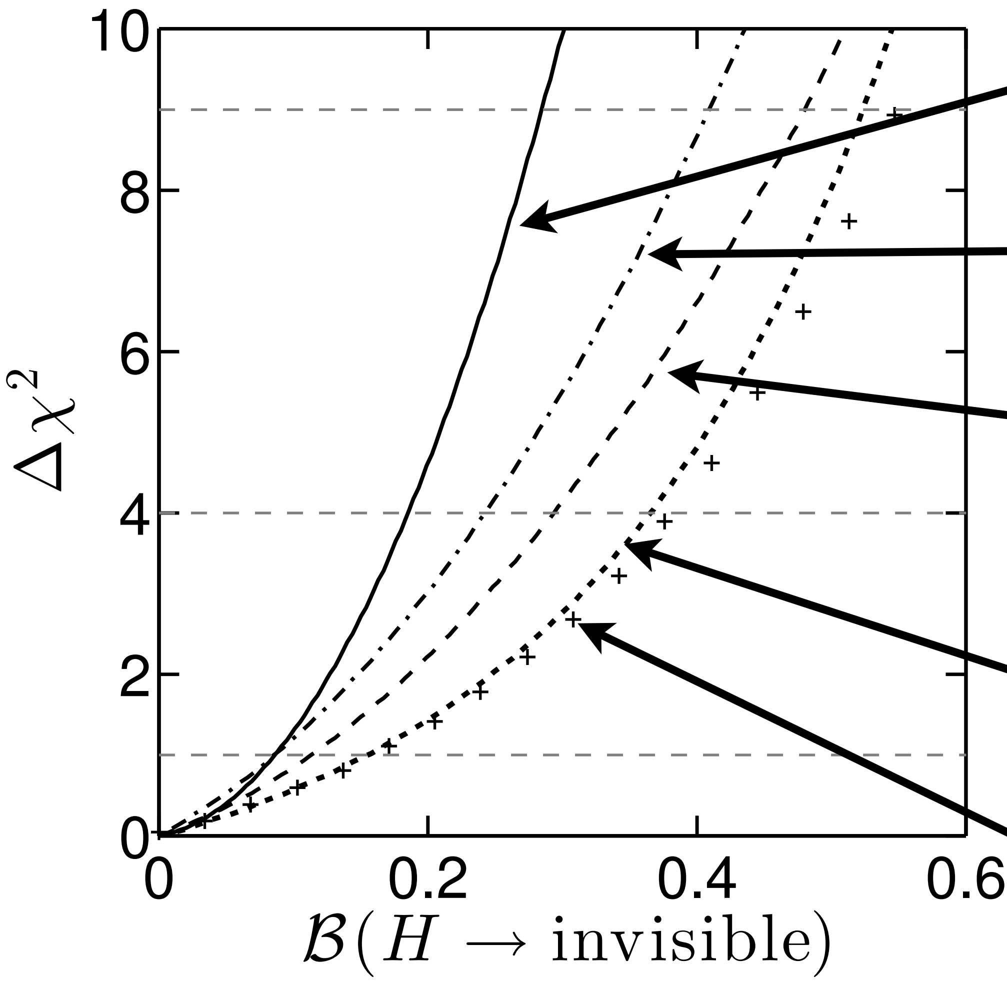
invisible decays



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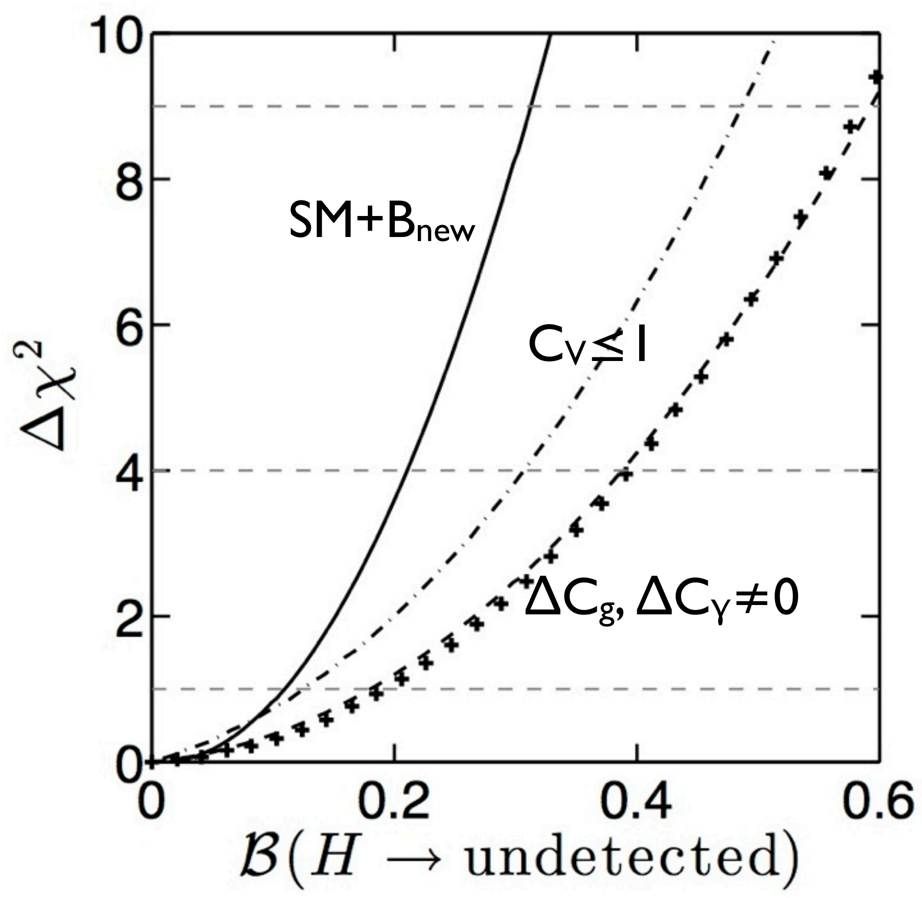
constrained by searches for invisible H

unseen decays



- In principle all the Higgs production*decay rates can be kept fixed by scaling up the C's while adding a new, unseen decay mode with branching ratio B_{new}.

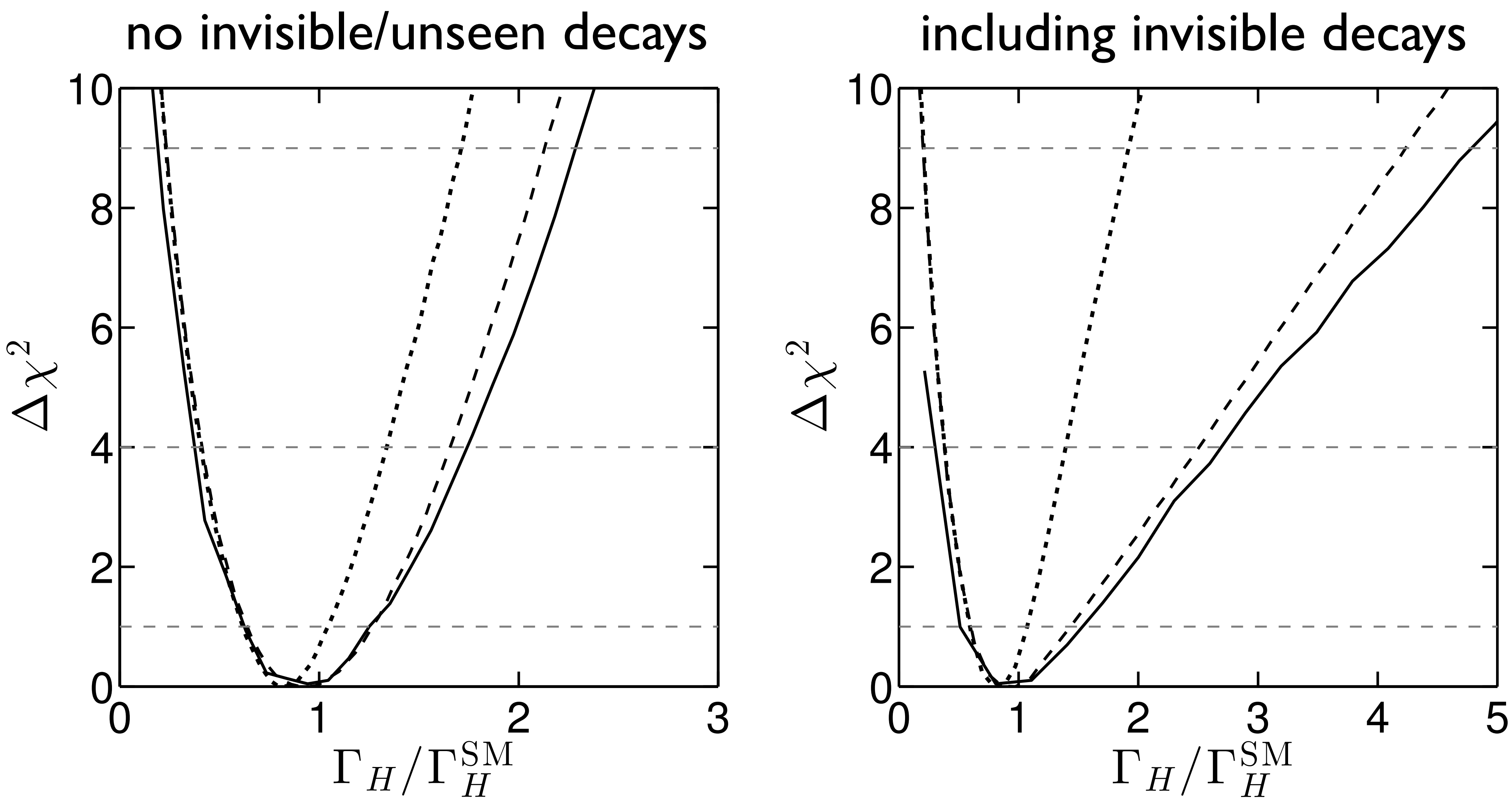
- For $C \equiv C_U = C_D = C_V$: $C^2 = 1/(1 - B_{new})$

D. Zeppenfeld et al, hep-ph/0002036
A. Djouadi et al, hep-ph/0002258
M. Duhrssen et al, hep-ph/0406323

- This gives a flat direction in C_U, C_D, C_V. For $C_V \leq 1$ however, we can still get a strong constraint on B_{new} similar to the case of invisible decays. At 95% CL:

i) $\mathcal{B}_{\rm new} < 0.21$ for a SM Higgs with allowance for unseen decays;
ii) $\mathcal{B}_{\rm new} < 0.31$ for C_U, C_D free, $C_V \leq 1$ and $\Delta C_\gamma = \Delta C_g = 0$; and
iii) $\mathcal{B}_{\rm new} < 0.39$ for $C_U = C_D = C_V = 1$ but $\Delta C_\gamma, \Delta C_g \neq 0$ allowed for.

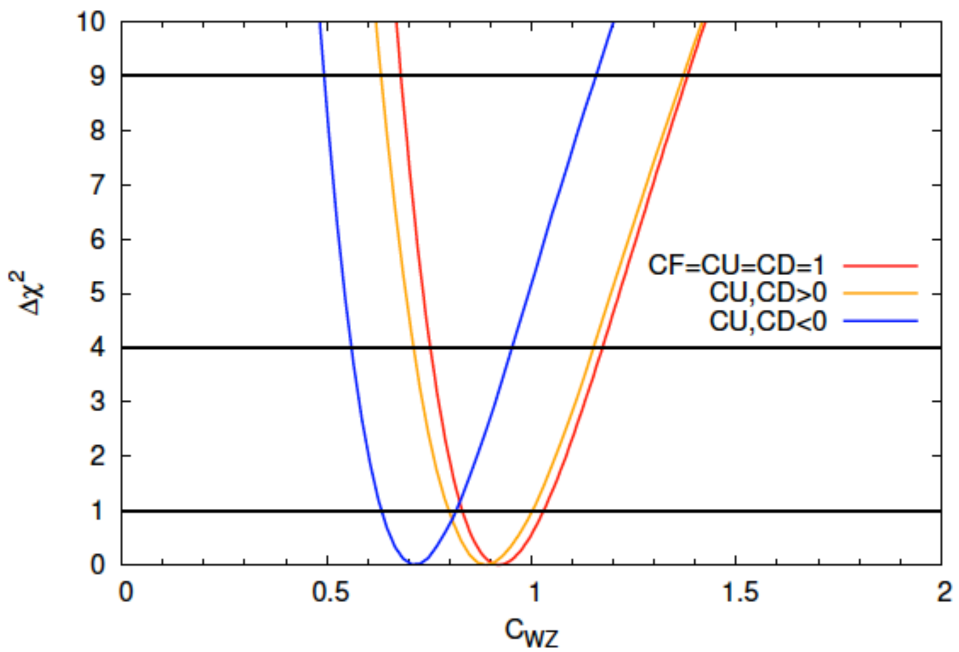
total width

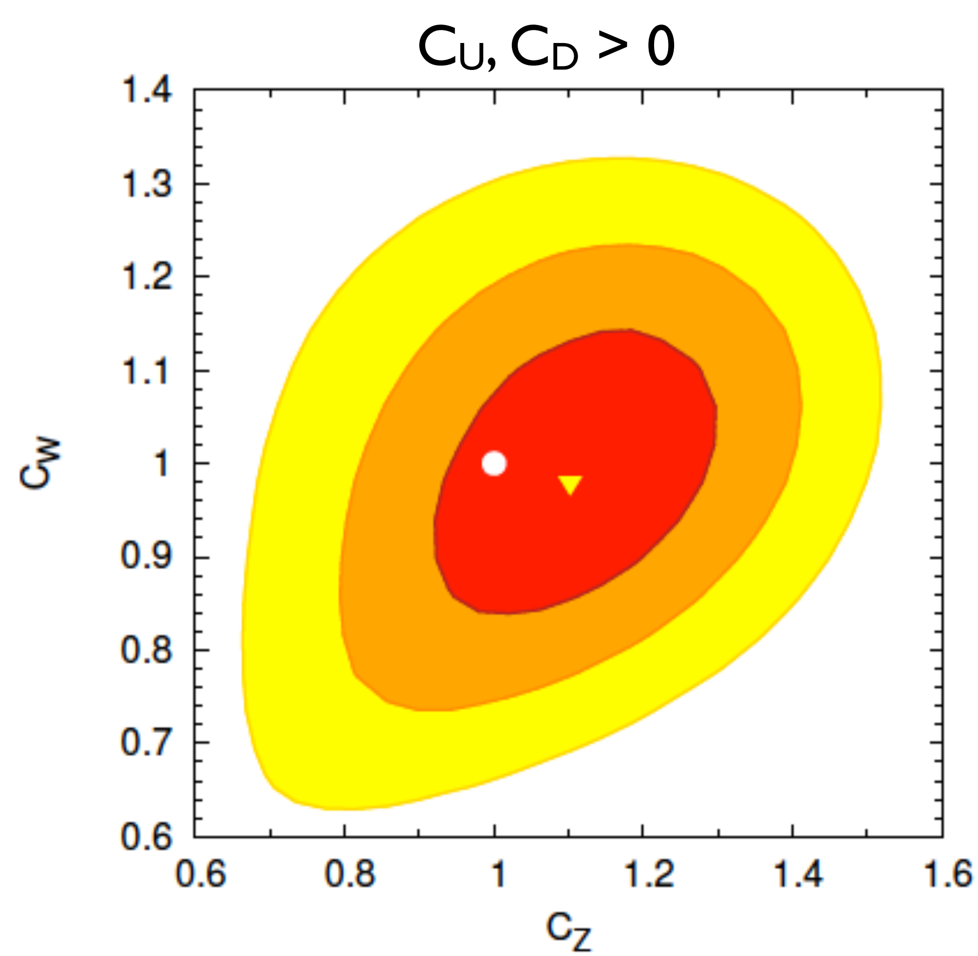


dotted: C_U, C_D, $C_V \leq 1$
dashed: C_U, C_D, C_V
solid: C_U, C_D, C_V, ΔC_g, ΔC_γ

testing custodial symmetry

Fit to ATLAS and CMS results as in arXiv:1306.2941 but taking C_W and C_Z as independent parameters. $C_{WZ} = C_W / C_Z$





Best fit: C_Z=1.1, C_W=0.98

[internship J. Bernon]

extended Higgs sectors

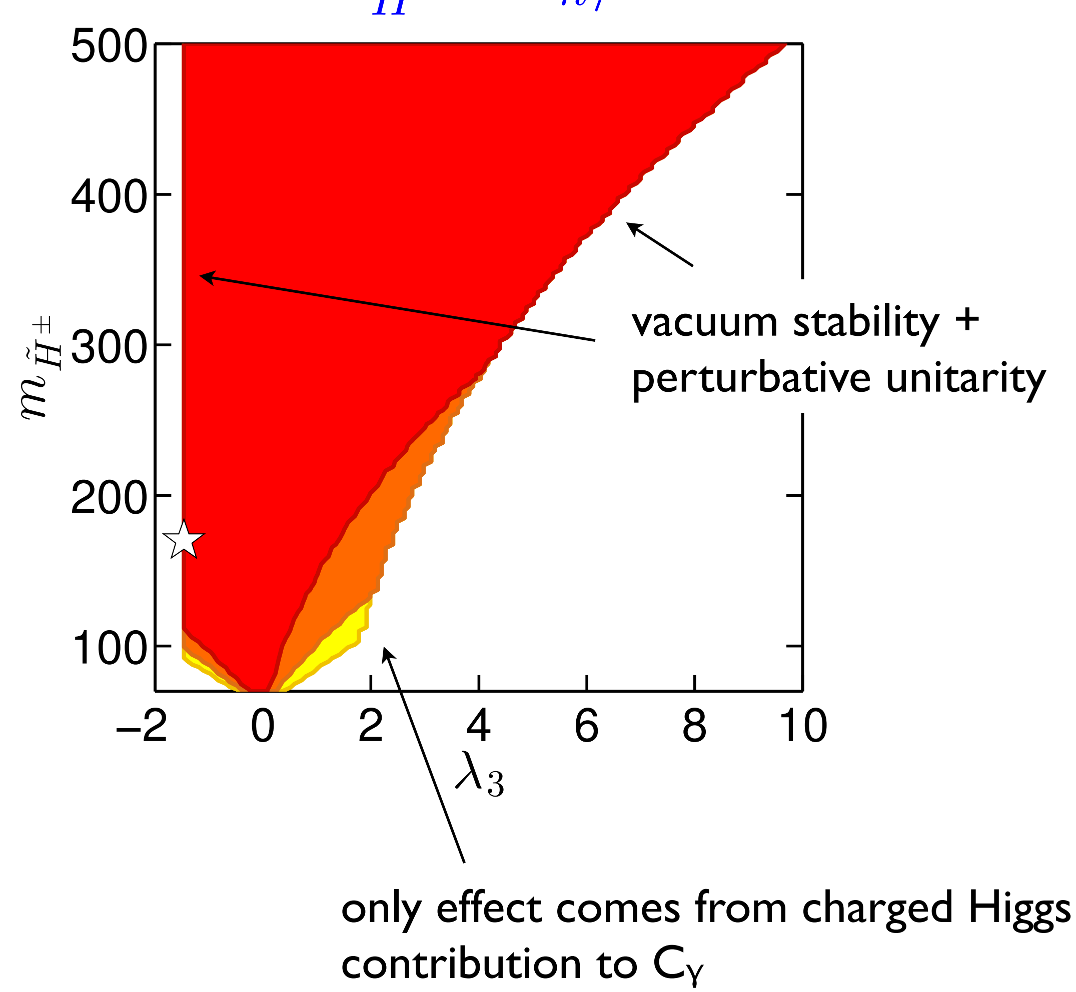
see also B. Swiezewska, 1209.5725
M. Krawczyk et al, 1305.6266

inert doublet model

SM plus a second Higgs doublet $\tilde{H}_2$ which is odd under a Z_2 symmetry → DM

$$V = \mu_1^2|H_1|^2 + \mu_2^2|\tilde{H}_2|^2 + \lambda_1|H_1|^4 + \lambda_2|\tilde{H}_2|^4 + \lambda_3|H_1|^2|\tilde{H}_2|^2 + \lambda_4|H_1^\dagger \tilde{H}_2|^2 + \frac{\lambda_5}{2}\left[\left(H_1^\dagger \tilde{H}_2\right)^2 + \text{h.c.}\right]$$

$m_{\tilde{H}} > m_h/2$



$$\lambda_{L,S} = \frac{1}{2}(\lambda_3 + \lambda_4 \pm \lambda_5)$$

$$\boxed{\begin{aligned} m_h^2 &= \mu_1^2 + 3\lambda_1 v^2, \\ m_{\tilde{H},(\tilde{A})}^2 &= \mu_2^2 + \lambda_{L(S)}\, v^2, \\ m_{\tilde{H}^\pm}^2 &= \mu_2^2 + 0.5\lambda_3 v^2\,. \end{aligned}}$$

$$\frac{\lambda_3}{2} = \frac{1}{v^2}\left(m_{\tilde{H}^+}^2 - m_{\tilde{H}}^2\right) + \lambda_L$$

$$-0.02\ (-0.13) < \Delta C_\gamma < 0.17\ (0.26)\ \text{at}\ 1\sigma\ (2\sigma)$$

see also B. Swiezewska, 1209.5725
M. Krawczyk et al, 1305.6266

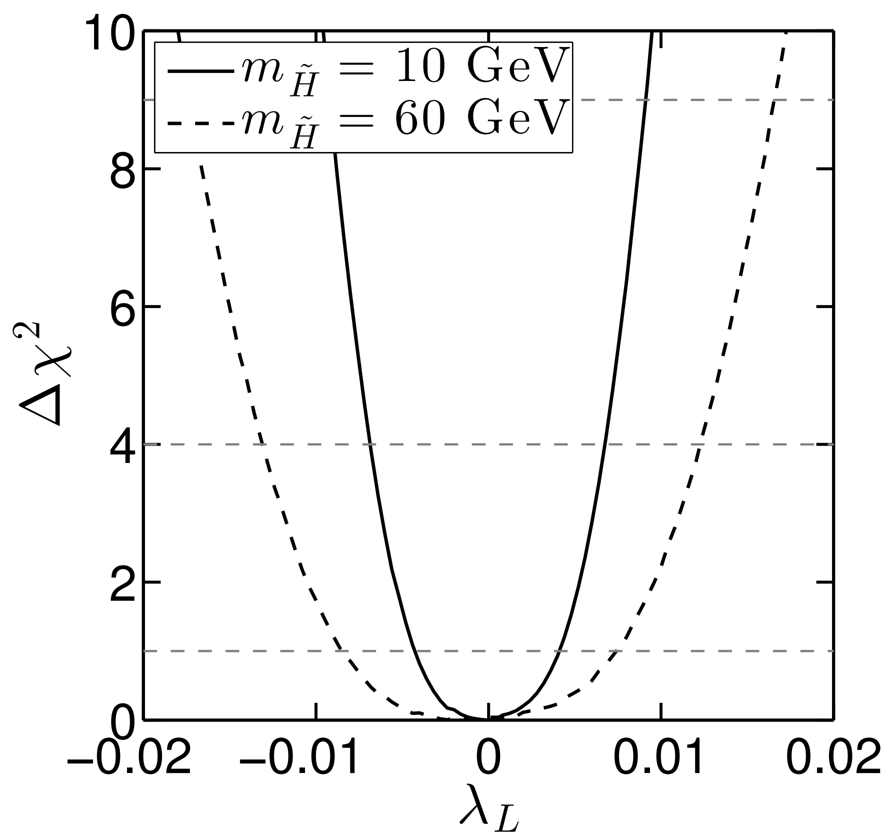
inert doublet model

$$\boxed{m_{\tilde{H}} < m_h/2}$$

$$\mathcal{L} \sim -(2m_W/g)\lambda_3 h\tilde{H}^+\tilde{H}^-$$

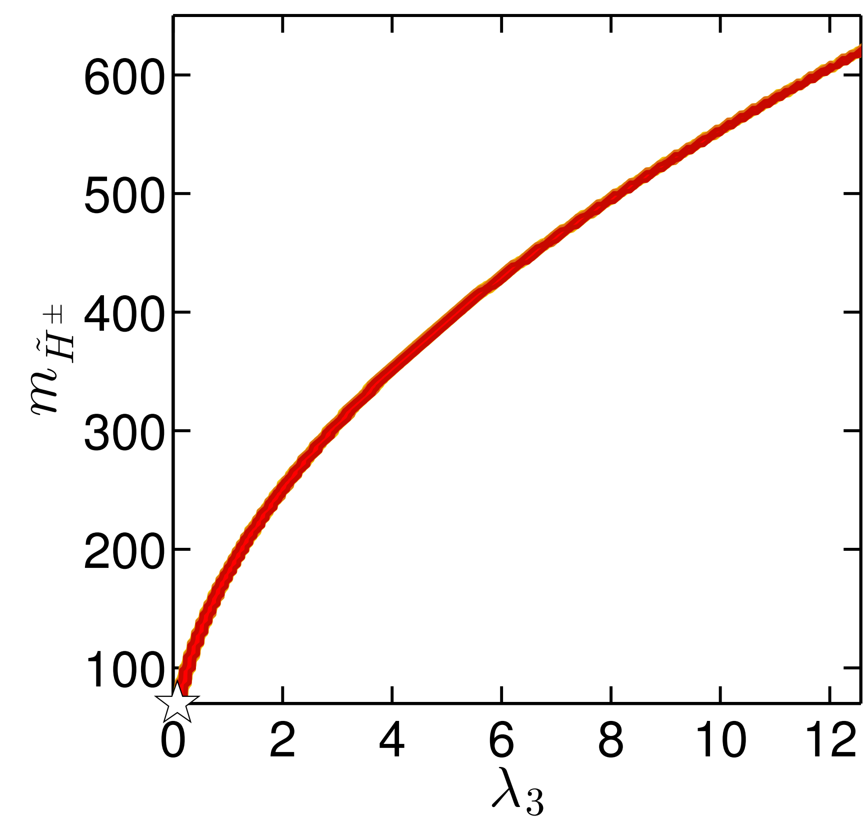
$$\Rightarrow C_\gamma < 1$$

$$g_{h\tilde{H}\tilde{H}} \propto \lambda_L = \frac{1}{2}(\lambda_3 + \lambda_4 + \lambda_5)$$



Invisible h decays strongly constrain $\lambda_L \rightarrow 0$

profiled over $m_{\tilde{H}} = [1, 60]$ GeV



mH+ < 620 GeV from perturbativity

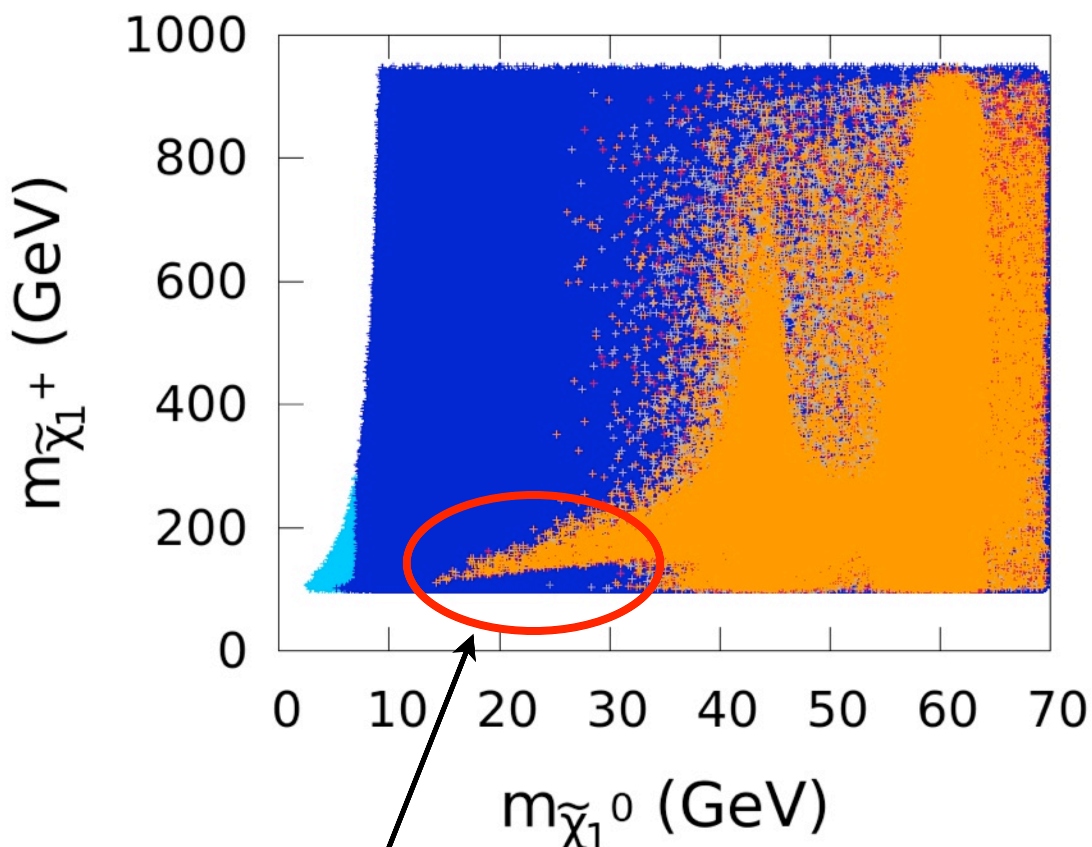
$$\frac{\lambda_3}{2} = \frac{1}{v^2}\left(m^2_{\tilde{H}^+} - m^2_{\tilde{H}}\right) + \cancel{\lambda_L}$$

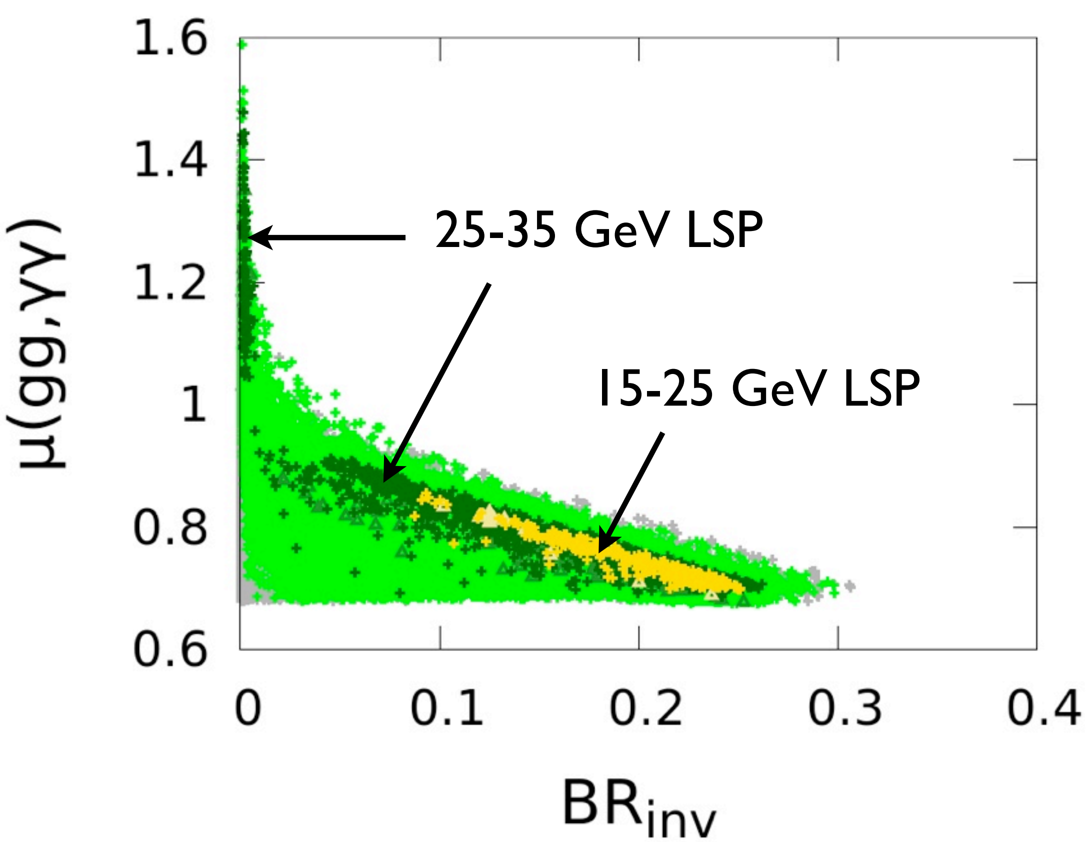
arXiv:1308.3735

mssm with light neutralinos

- Scan over weak-scale MSSM parameter space, requiring consistence at 95% CL with flavor constraints, Higgs mass and h signal strengths in all channels, as well as DM relic density and DM direct searches
- SUSY mass limits from LHC via "SModelS" Simplified Model approach

[SK, Kulkarni, Laa, Lessa, Proschofsky-Spindler, Waltenberger, in preparation]





15-35 GeV neutralino consistent with all constraints

NB $\Omega \lesssim 0.12$ requires light charginos and light staus

conclusions

- mH~125 GeV is quite fortunate: we can detect the Higgs in many different channels.

- ATLAS and CMS measurements already provide quite a comprehensive picture
  → test for deviations from SM predictions
  → constrain models of new physics

- Publication of μ likelihoods by ATLAS is an important step towards maximizing impact and utility of LHC results

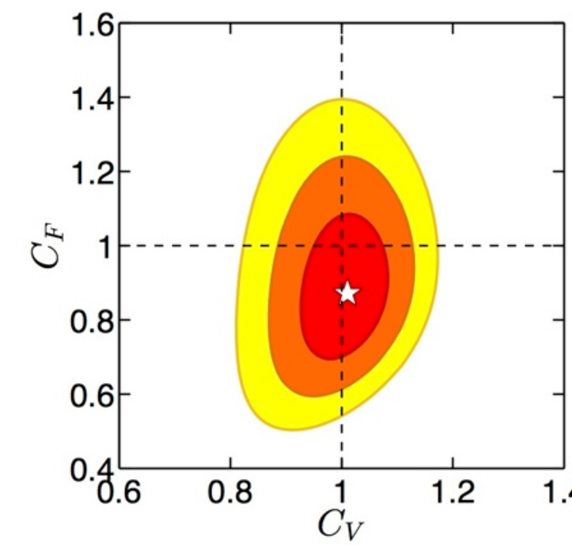
  “I truly hope that this becomes standard practice for the LHC.” (Kyle)

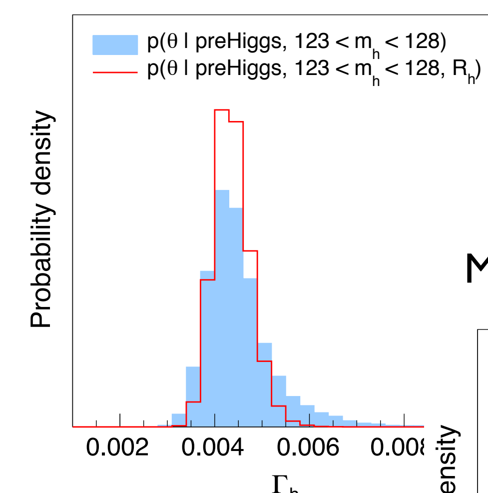
- Eventually we need to go beyond 2D μ’s :

$$\mathcal{L}(m_H, \mu_{\rm ggF}, \mu_{\rm ttH}, \mu_{\rm VBF}, \mu_{\rm ZH}, \mu_{\rm WH})$$

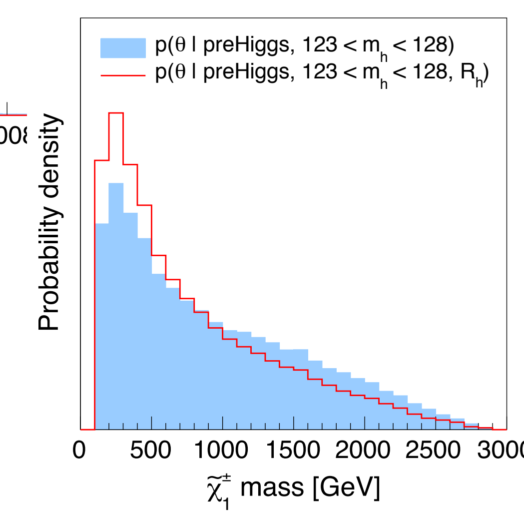
- For testing models with e.g. new tensor structure, we need to go beyond signal strengths → fiducial cross sections

generic coupling fits





MCMC analysis of pMSSM



an exciting way ahead

(to unmapped territory, I hope)

backup

arXiv:1307.5865

On the presentation of the LHC Higgs results

F. Boudjema, G. Cacciapaglia, K. Cranmer, G. Dissertori, A. Deandrea,
G. Drieu la Rochelle, B. Dumont, U. Ellwanger, A. Falkowski, J. Galloway,
R.M. Godbole, J.F. Gunion, A. Korytov, S. Kraml, H.B. Prosper, V. Sanz, S. Sekmen

Abstract:
We put forth conclusions and suggestions regarding the presentation of the LHC Higgs results that may help to maximize their impact and their utility to the whole High Energy Physics community.

Conclusions and suggestions from the workshops
"Likelihoods for the LHC Searches", 21-23 Jan 2013 at CERN,
"Implications of the 125 GeV Higgs Boson", 18-22 March 2013 at LPSC Grenoble,
and from the 2013 Les Houches "Physics at TeV Colliders" workshop.

signal strengths beyond 2D

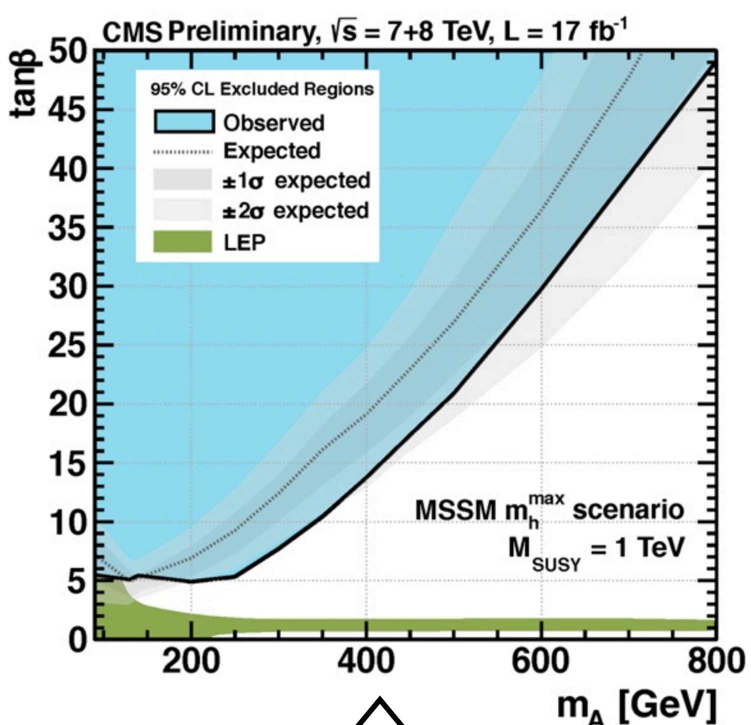
- Eventually, we want to test ggF, ttH, VBF, ZH and WH separately, which means that we need a more detailed break down of the channels beyond 2D plots.
- The optimum would of course be to have the full statistical model available → RooFit workspaces ?
- What we would like to advocate (as a compromise) is that for each final state Y the experiments give the signal strength likelihood in the 6D form

$$\mathcal{L}(m_H, \mu_{\rm ggF}, \mu_{\rm ttH}, \mu_{\rm VBF}, \mu_{\rm ZH}, \mu_{\rm WH})$$

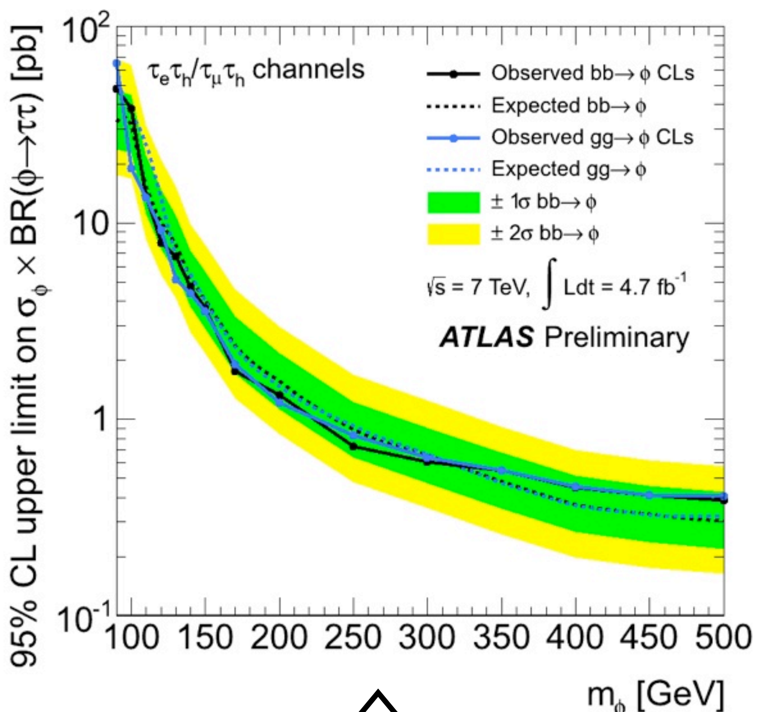
- This way, a significant step could be taken towards a more precise fit in the context of a given BSM theory.
- The likelihood could be communicated either as a standalone computer library or as a large grid data file.
- Open point: final state correlations → covariance matrix ?

additional Higgses

- In searches for additional Higgs states ϕ, the contributions from the SM-like Higgs boson at ~125 GeV should be treated like any other SM background.
- Results should always be reported as bounds on σ×BR for any ϕ !



interesting but not sufficient



we need results (also) in this way

- Degenerate states at ~125 GeV are a special issue → Andrey

summary of recommendations

For each Higgs decay mode Y ($\gamma\gamma$, WW, ZZ, $b\bar{b}$, $\tau\tau$ are currently considered) provide the likelihood $\mathcal{L}$ of the signal strengths in the $(\mu(X,Y), \mu(X',Y))$ plane, as shown in Figure 3. The grouping $X = \mathrm{ggF} + \mathrm{ttH}$, $X' = \mathrm{VBF} + \mathrm{VH}$ is well motivated, but additional choices of X and X' should be considered when appropriate for the given analysis. The content of the plots should *always* be provided also in numerical form, *e.g.*, as a ROOT file or as a simple text file with a grid. In addition to the combined results, results should also be given separately for each $\sqrt{s}$.

To go a step further and overcome the limitations induced by 2D projections and/or combining production modes, provide the signal strength likelihood as a function of m_H, separated into all five production modes ggF, ttH, VBF, ZH and WH; *i.e.* for each decay mode considered give the likelihood in the 6D form $\mathcal{L}(m_H, \mu_{\mathrm{ggF}}, \mu_{\mathrm{ttH}}, \mu_{\mathrm{VBF}}, \mu_{\mathrm{ZH}}, \mu_{\mathrm{WH}})$. Ideally, this should again also be done separately for each $\sqrt{s}$.

summary of recommendations

Whenever possible, provide kinematic event selection criteria that can approximately be reproduced by phenomenologists, *e.g.*, using Monte Carlo event generators.[2] The desired information is: the complete cut flow, estimated number of background events, expected event yields for all the SM Higgs processes, and the observed number of signal events or limits thereon. For MVA-based analyses, it would be of great value if a simplified version of the final MVA could be given.

Concerning searches for additional Higgs-like states with masses above or below 125 GeV, provide the results including the injection of a signal with the properties of a SM-like Higgs boson at 125–126 GeV. Moreover, always present the results as bounds on pure $(\sigma \times \mathcal{B})$ in addition to any model interpretation.

arXiv:1307.5865

summary of recommendations

In addition to direct model-dependent interpretations of data, the long-term goal should be to develop a consistent scheme for publishing fiducial cross sections ($\sigma^{\text{fid}} \times \mathcal{B}$), either measurements or limits for null search results, as done conventionally for SM processes.

We suggest that this supplementary material is made available via INSPIRE [50]. This way the complete set of information will be searchable, citable, and accessible from a single point.

NB the document is open to discussion.
→ your input can help to extend and improve it.