Michael Trott,

Papers discussed:

Espinosa, Muhlleitner, Grojean, Trott arXiv:1202.3697

Espinosa, Muhlleitner, Grojean, Trott arXiv: 1205.6790

Espinosa, Muhlleitner, Grojean, Trott arXiv:1207.1717

Espinosa, Grojean, Sanz, Trott arXiv:1207.7355

Preview:

Espinosa, Muhlleitner, Grojean, Trott ....

Grojean, Jenkins, Manohar,Trott ....

Michael Trott,

Papers discussed:

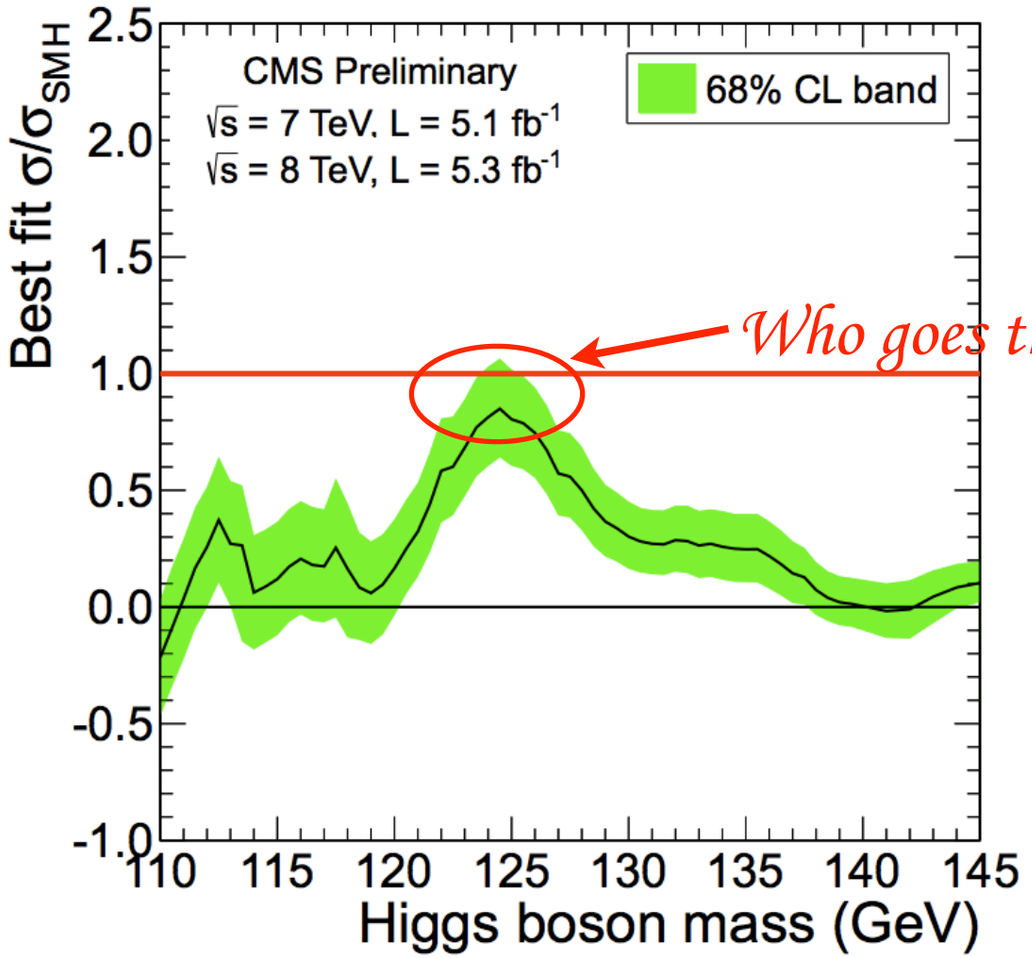
Espinosa, Muhlleitner, Grojean, Trott arXiv:1202.3697	*Basic fit EFT, limits, χ^2, 7 TeV data*
Espinosa, Muhlleitner, Grojean, Trott arXiv: 1205.6790	*Invisible width fits, PDF developments*
Espinosa, Muhlleitner, Grojean, Trott arXiv:1207.1717	*"Tension", ICHEP data (updates)*
Espinosa, Grojean, Sanz, Trott arXiv:1207.7355	*NSUSY*

Preview:

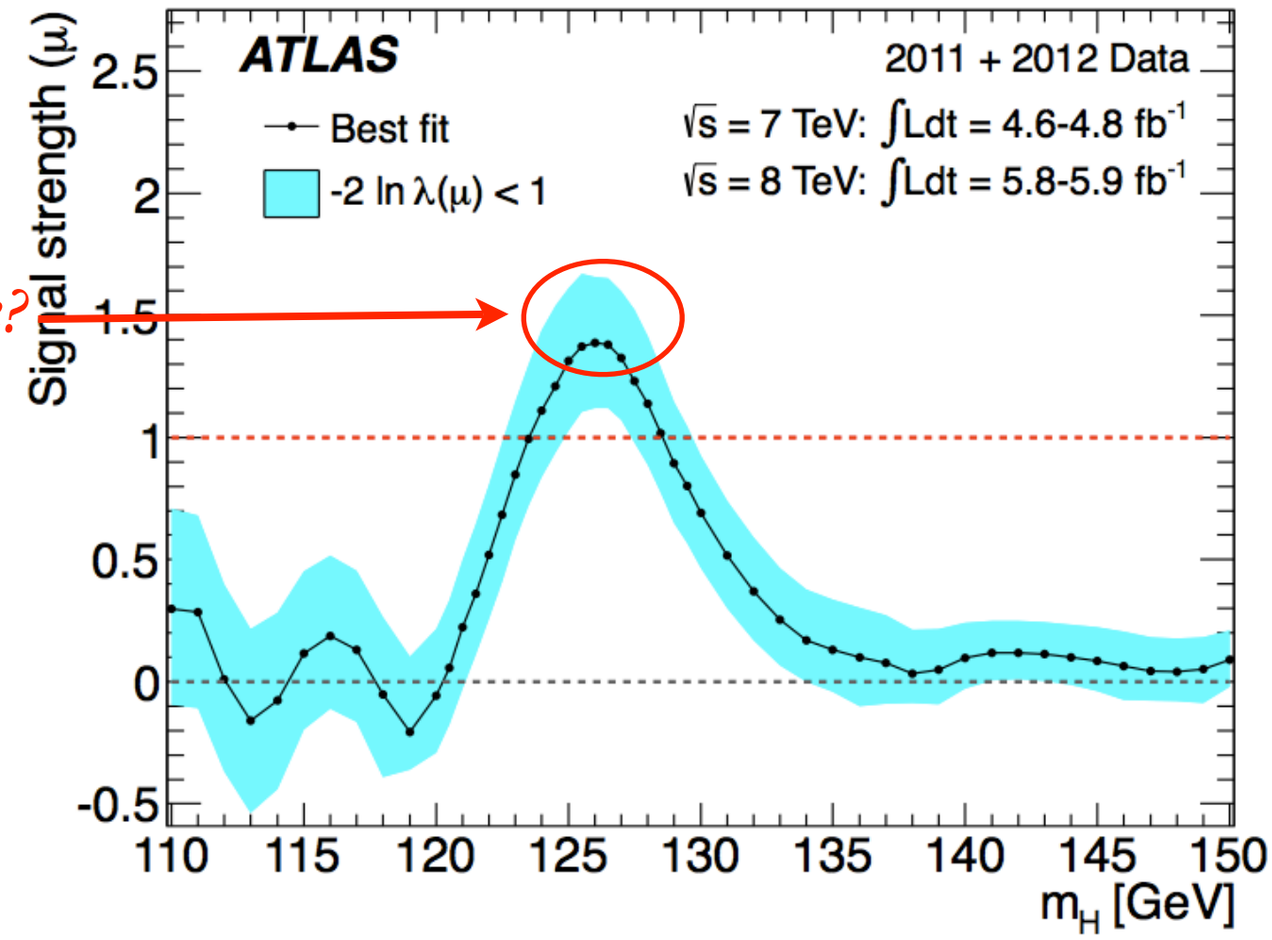
Espinosa, Muhlleitner, Grojean, Trott	*yet more data analysis... soon*
Grojean, Jenkins, Manohar,Trott	*some loops....sooner*

Content (for ref):

Discovery Physics!



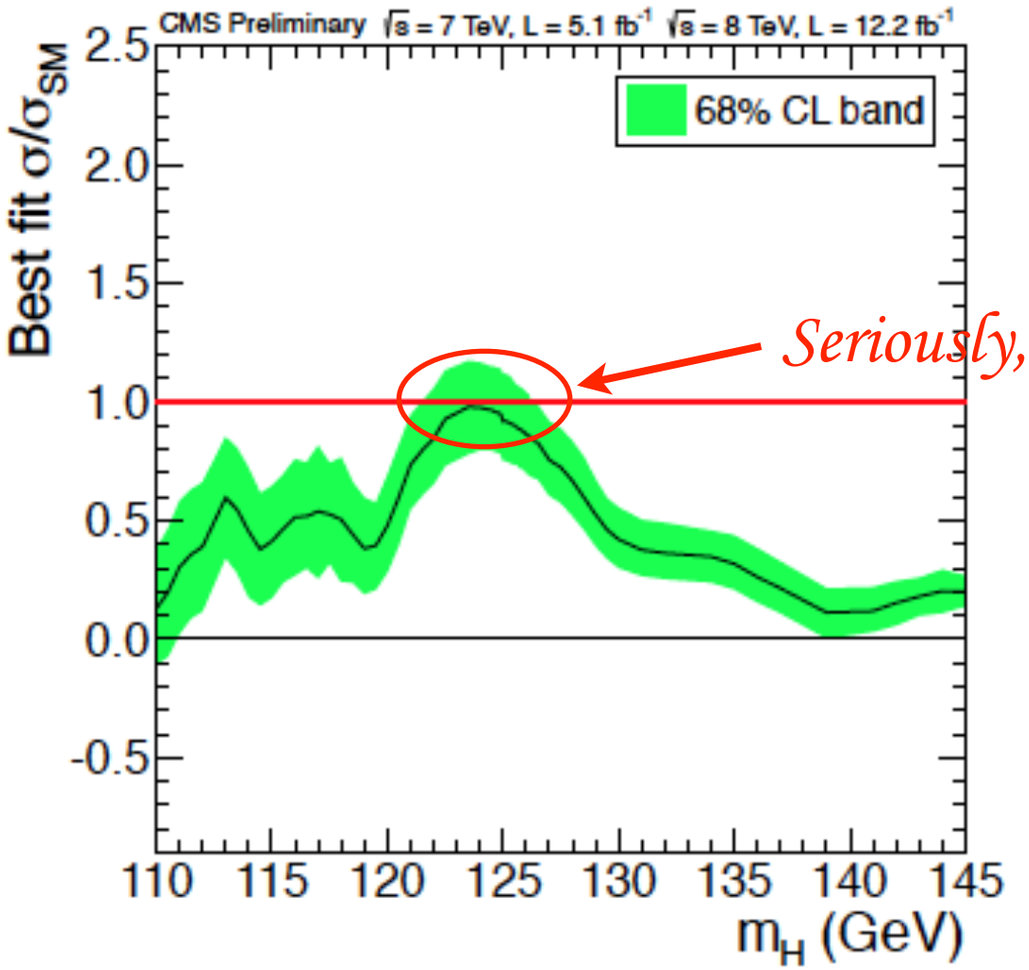
Who goes there?



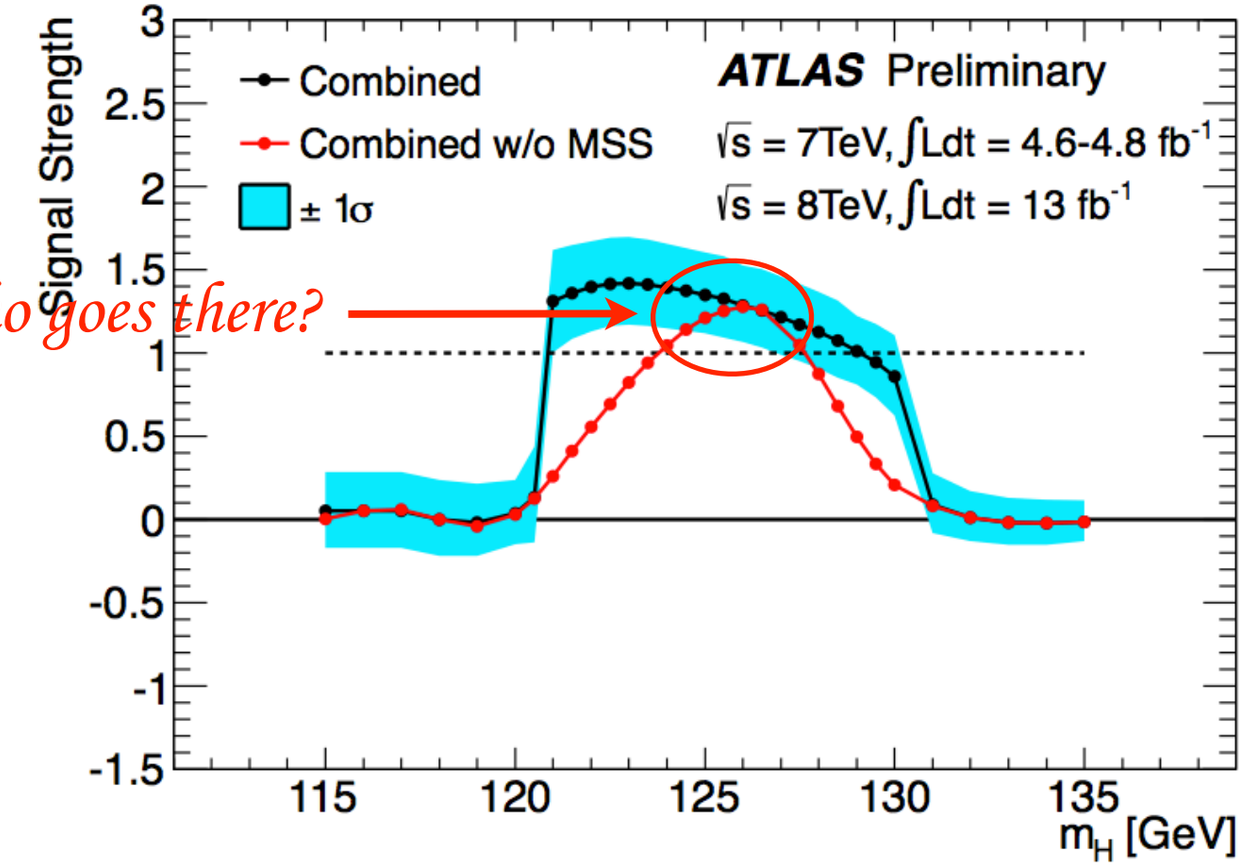
"As a layman, I would say: I think we have it." - the D.G.

Typical theorist mental state then.

Post-Discovery Physics...

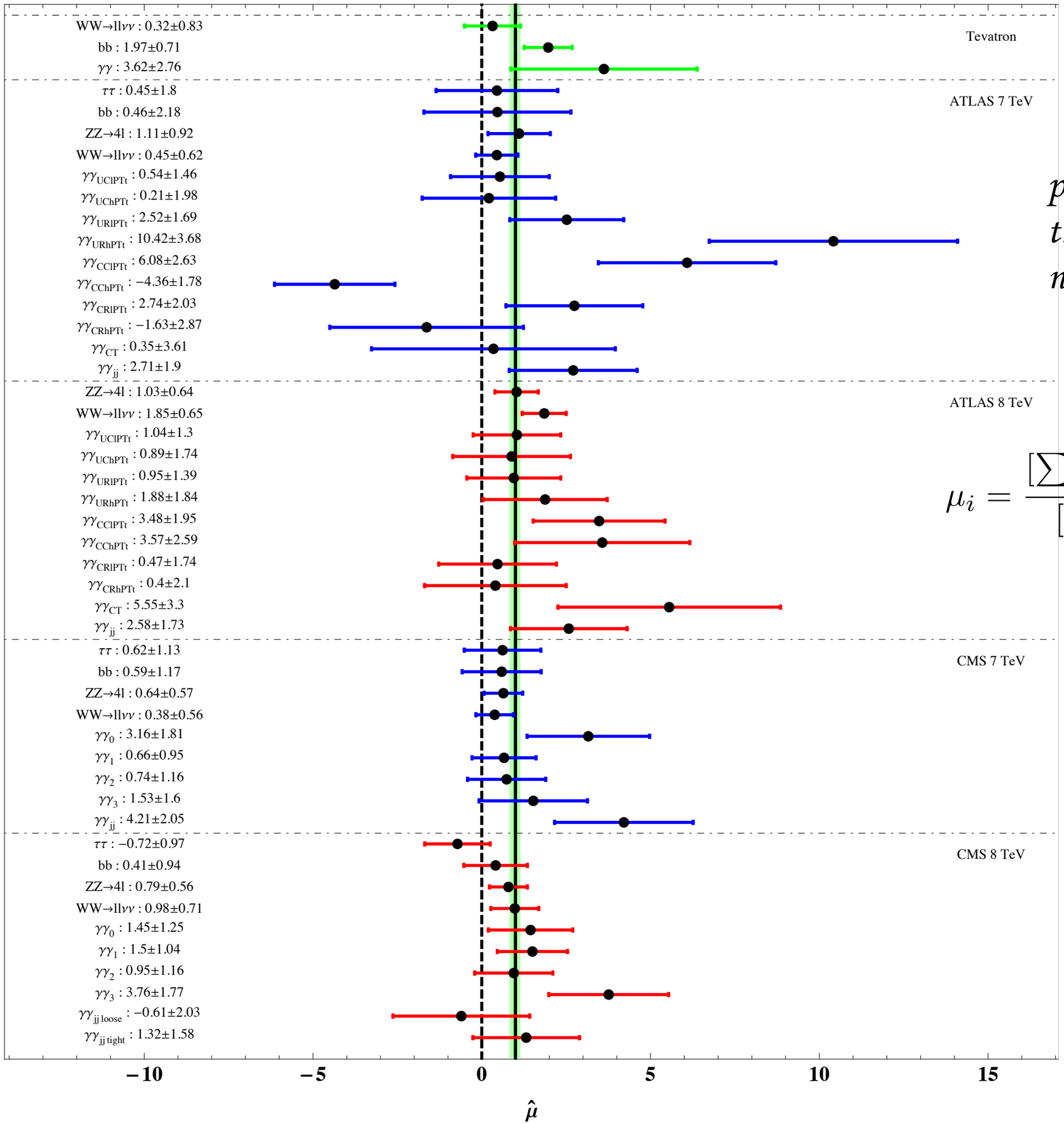


Seriously, who goes there?



"Yeah, yeah, where is SUSY?"

Typical theorist mental state now.



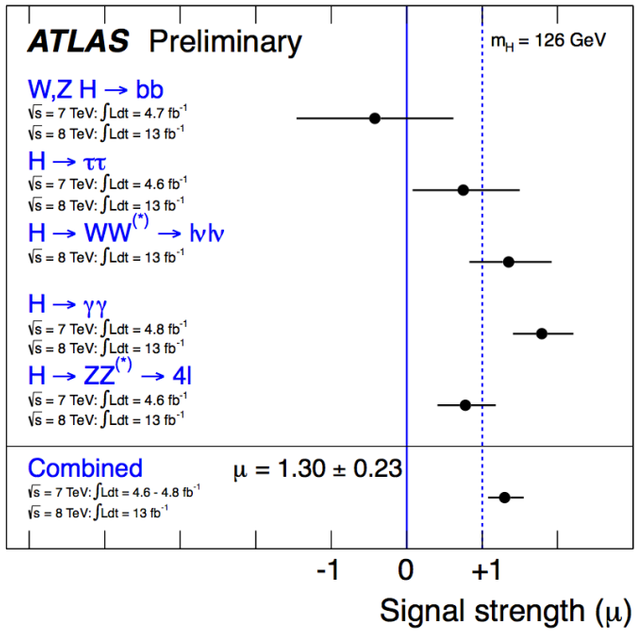
"IT".

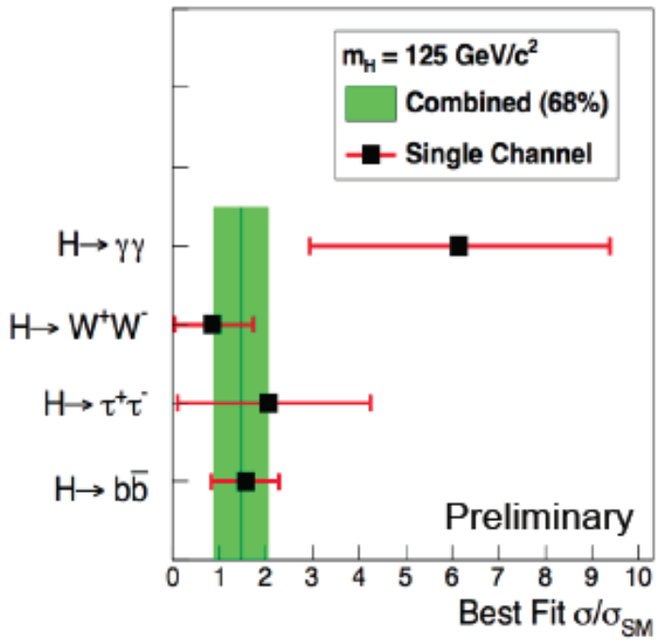
pre-HCP data. Warning the 7 tev has changed in a non public way in some signals.

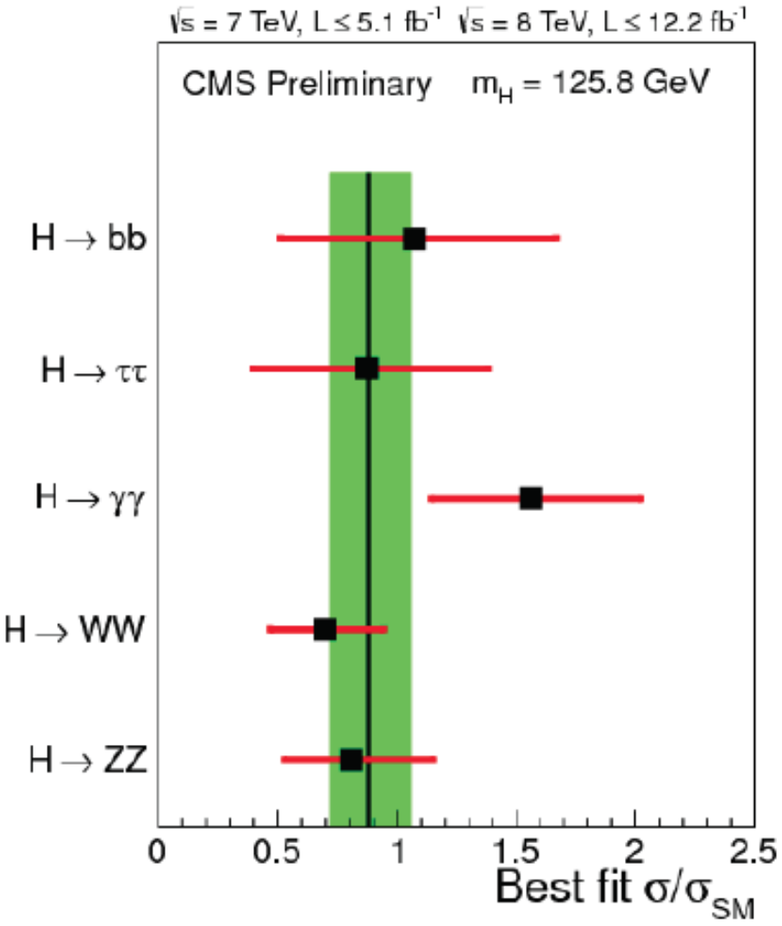
Signal Strengths.

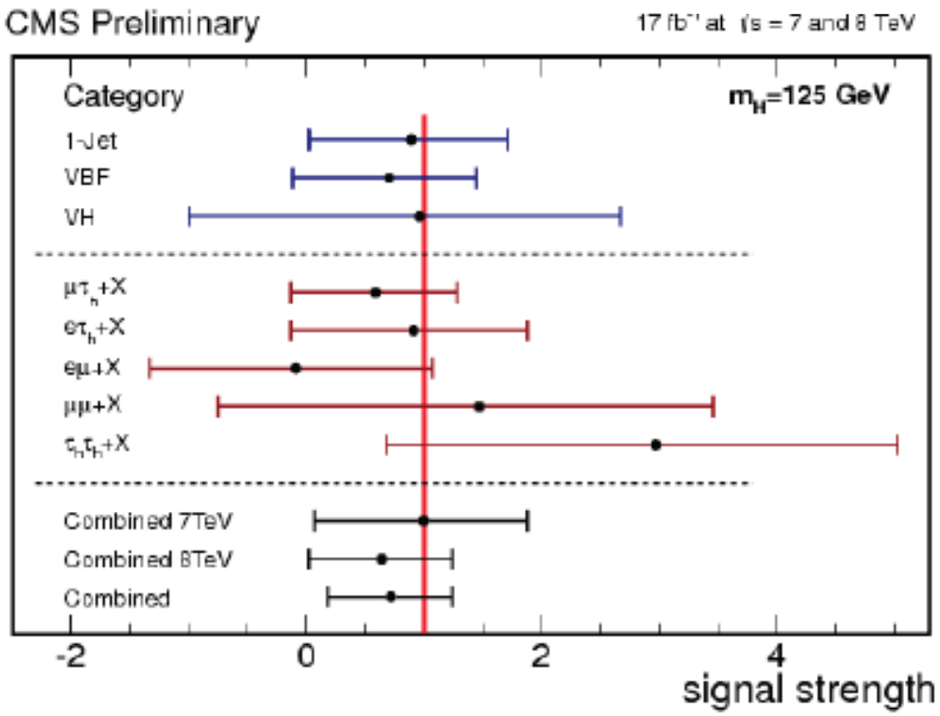
$$\mu_i = \frac{[\sum_j \sigma_{j\to h} \times \mathrm{Br}(h \to i)]_{observed}}{[\sum_j \sigma_{j\to h} \times \mathrm{Br}(h \to i)]_{SM}},$$

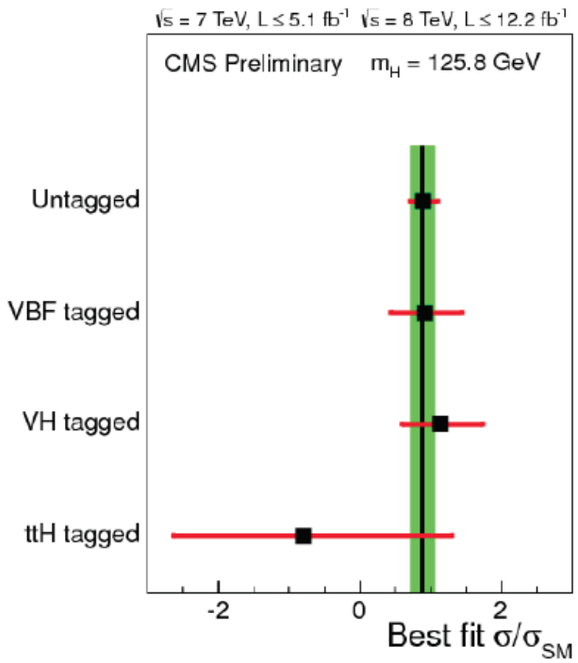
More on "IT".


ATLAS Preliminary
m_H = 126 GeV
W,Z H → bb
√s = 7 TeV: ∫Ldt = 4.7 fb⁻¹
√s = 8 TeV: ∫Ldt = 13 fb⁻¹
H → ττ
√s = 7 TeV: ∫Ldt = 4.6 fb⁻¹
√s = 8 TeV: ∫Ldt = 13 fb⁻¹
H → WW(*) → lνlν
√s = 8 TeV: ∫Ldt = 13 fb⁻¹
H → γγ
√s = 7 TeV: ∫Ldt = 4.8 fb⁻¹
√s = 8 TeV: ∫Ldt = 13 fb⁻¹
H → ZZ(*) → 4l
√s = 7 TeV: ∫Ldt = 4.6 fb⁻¹
√s = 8 TeV: ∫Ldt = 13 fb⁻¹
Combined
μ = 1.30 ± 0.23
√s = 7 TeV: ∫Ldt = 4.6 - 4.8 fb⁻¹
√s = 8 TeV: ∫Ldt = 13 fb⁻¹
-1
0
+1
Signal strength (μ)


m_H = 125 GeV/c²
Combined (68%)
Single Channel
H→ γγ
H→ W⁺W⁻
H→ τ⁺τ⁻
H→ bb̄
Preliminary
0 1 2 3 4 5 6 7 8 9 10
Best Fit σ/σ_SM

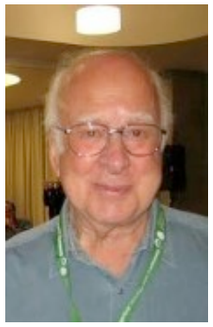

√s = 7 TeV, L ≤ 5.1 fb⁻¹ √s = 8 TeV, L ≤ 12.2 fb⁻¹
CMS Preliminary m_H = 125.8 GeV
H → bb
H → ττ
H → γγ
H → WW
H → ZZ
0 0.5 1 1.5 2 2.5
Best fit σ/σ_SM

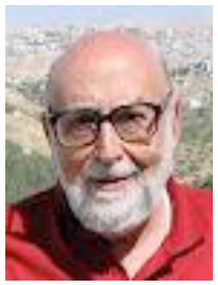

CMS Preliminary
17 fb⁻¹ at √s = 7 and 8 TeV
Category
m_H=125 GeV
1-Jet
VBF
VH
μτ_h+X
eτ_h+X
eμ+X
μμ+X
τ_hτ_h+X
Combined 7TeV
Combined 8TeV
Combined
-2 0 2 4
signal strength


√s = 7 TeV, L ≤ 5.1 fb⁻¹ √s = 8 TeV, L ≤ 12.2 fb⁻¹
CMS Preliminary m_H = 125.8 GeV
Untagged
VBF tagged
VH tagged
ttH tagged
-2 0 2
Best fit σ/σ_SM

WHAT IS "IT"?

Is it a SM "Higgs"?

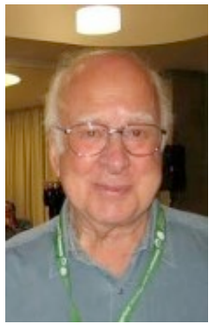


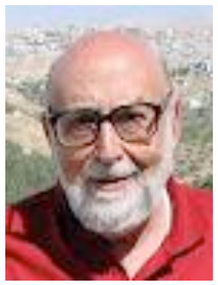




Good luck sorting the credit out noble committee!

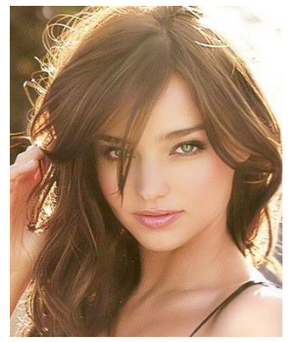
WHAT IS "IT"?

Is it a SM "Higgs"?





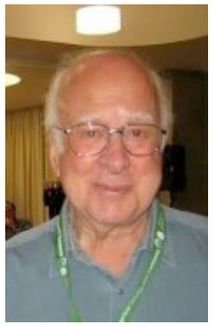


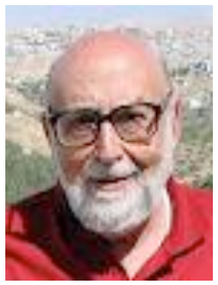
Good luck sorting the credit out noble committee!

Is it a SM "Higgs" and the impact of NP? A 2 for 1?

WHAT IS "IT"?

Is it a SM "Higgs"?





Good luck sorting the credit out noble committee!

Is it a SM "Higgs" and the impact of NP?

Have to assume something. - assume a scalar field - Consider more exotic possibilities AFTER broad scalar EFT attempts fail.

Consistency Problems requiring some New Physics

A scalar field is already strongly implied by the problem to solve.
The massive W,Z indicate that there is a consistency issue at high energies:

$$\mathcal{L}_{eff} = m_W^2\, W^+\, W^- + \frac{m_Z^2}{2}\, Z\, Z + \cdots$$

$$W_L^+\, W_L^- \to W_L^+\, W_L^- : \quad A \propto \frac{s}{v^2}$$

$$\psi\, \bar{\psi} \to W_L^+\, W_L^- : \; A \propto \frac{s}{v^2}$$

The way to think of the theory we have actually been probing till now is:

$$\mathcal{L} = m_W^2 W\, W + \frac{m_z^2}{2}\, Z\, Z = \frac{v^2}{4} \mathrm{Tr}\left(D^\mu \Sigma^\dagger D_\mu\, \Sigma\right)$$

Goldstones of broken $\mathrm{SU}_L(2) \times \mathrm{SU}_R(2)/\mathrm{SU}_V(2)$ *give mass the to W and Z*

grouped in the nonlinear chiral EW Lagrangian as $\Sigma = \exp(i\, \sigma_a\, \pi^a / v)$

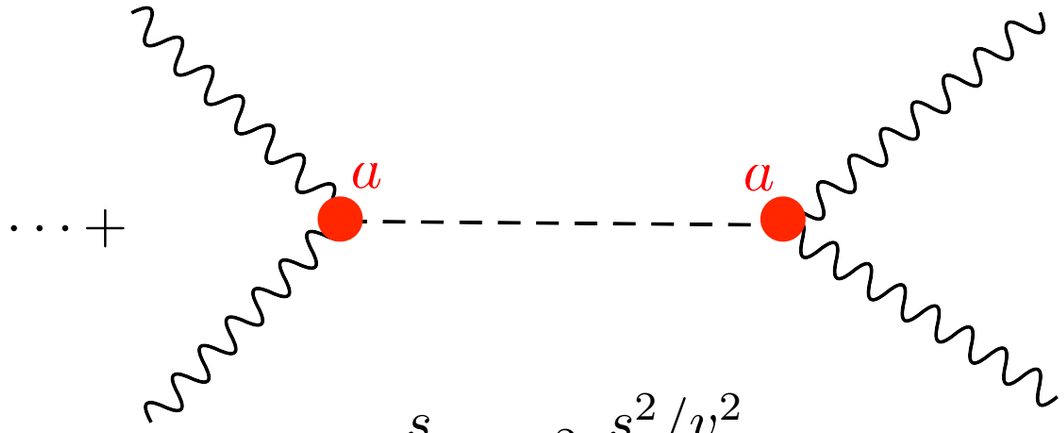
Consistency Problems requiring some New Physics

A scalar field is already strongly implied by the problem to solve.
The massive W,Z indicate that there is a consistency issue at high energies:

$$\mathcal{L}_{eff} = m_W^2\, W^+\, W^- + \frac{m_Z^2}{2}\, Z\, Z + \cdots$$

$$W_L^+\, W_L^- \to W_L^+\, W_L^- : \quad A \propto \frac{s}{v^2}$$

$$\psi\, \bar{\psi} \to W_L^+\, W_L^- : \; A \propto \frac{s}{v^2}$$



$$\mathcal{A} = \frac{s}{v^2} - a^2 \frac{s^2/v^2}{s - m_h^2}$$

Couplings within 10% of the SM, cut off scale 7 tev...

Cut off scale of the EFT: $\Lambda = 4\, v\, \pi$ *..raised to...* $\Lambda = 4\, v\, \pi / \sqrt{|1 - a^2|}$

Fairly suggestive that a scalar field of some form will be involved in the UV completion.

Nonlinear Chiral EW Lagrangian + scalar

Leading terms in the EFT, there is a systematic derivative expansion to exploit:

$$\begin{aligned}
\mathcal{L} &= \frac{1}{2}(\partial_\mu h)^2 - V(h) + \frac{v^2}{4}\mathrm{Tr}(D_\mu \Sigma^\dagger\, D^\mu \Sigma)\left[1 + 2\,a_{W,Z}\,\frac{h}{v} + b_{Z,W}\,\frac{h^2}{v^2} + b_{3,Z,W}\,\frac{h^3}{v^3} + \cdots\right], \\
&\quad -\frac{v}{\sqrt{2}}\,(\bar{u}^i_L \bar{d}^i_L)\,\Sigma\left[1 + c_i^{u,d}\,\frac{h}{v} + c_{2,j}^{u,d}\,\frac{h^2}{v^2} + \cdots\right]\begin{pmatrix} y^u_{ij}\,u^j_R \\ y^d_{ij}\,d^j_R \end{pmatrix} + h.c., \\
V(h) &= \frac{1}{2}\,m_h^2\,h^2 + \frac{d_3}{6}\left(\frac{3\,m_h^2}{v}\right)h^3 + \frac{d_4}{24}\left(\frac{3m_h^2}{v^2}\right)h^4 + \cdots\,.
\end{aligned}$$

Also higher dimensional operators: (hats -dual fields)

$$\begin{aligned}
\mathcal{L}^5_{HD} &= -\frac{c_g\,g_3^2}{32\,\pi^2\,v}\,h\,G^A_{\mu\,\nu}G^{A\,\mu\,\nu} - \frac{c_W\,g_2^2}{32\,\pi^2\,v}\,h\,W^a_{\mu\,\nu}W^{a\,\mu\,\nu} - \frac{c_B\,g_1^2}{32\,\pi^2\,v}\,h\,B_{\mu\,\nu}B^{\mu\,\nu} \\
&\quad -\frac{\hat{c}_g\,g_3^2}{32\,\pi^2\,v}\,h\,\hat{G}^A_{\mu\,\nu}G^{A\,\mu\,\nu} - \frac{\hat{c}_W\,g_2^2}{32\,\pi^2\,v}\,h\,\hat{W}^a_{\mu\,\nu}W^{a\,\mu\,\nu} - \frac{\hat{c}_B\,g_1^2}{32\,\pi^2\,v}\,h\,\hat{B}_{\mu\,\nu}B^{\mu\,\nu} + \mathcal{O}(h^2)
\end{aligned}$$

Also higher dimensional derivative operators in the chiral EFT...

TOO MANY DAMN PARAMETERS!

Nonlinear Chiral EW Lagrangian + scalar

EFT gives model independence & is a systematically improvable Lagrangian approach . ALSO LETS ONE USE SYMMETRY TO REDUCE PARAMETERS.

Assuming custodial sym breaking as in the SM and consistent with MFV:

$$\mathcal{L} = \frac{1}{2}(\partial_\mu h)^2 + \frac{v^2}{4}\mathrm{Tr}(D_\mu \Sigma^\dagger D^\mu \Sigma)\left[1 + 2\,a\,\frac{h}{v}\right] - \frac{v}{\sqrt{2}}\,(\bar{u}^i_L \bar{d}^i_L)\,\Sigma\left[1 + c^{u,d}\,\frac{h}{v}\right]\begin{pmatrix} y^u_{ij}\,u^j_R \\ y^d_{ij}\,d^j_R \end{pmatrix} + h.c.,$$

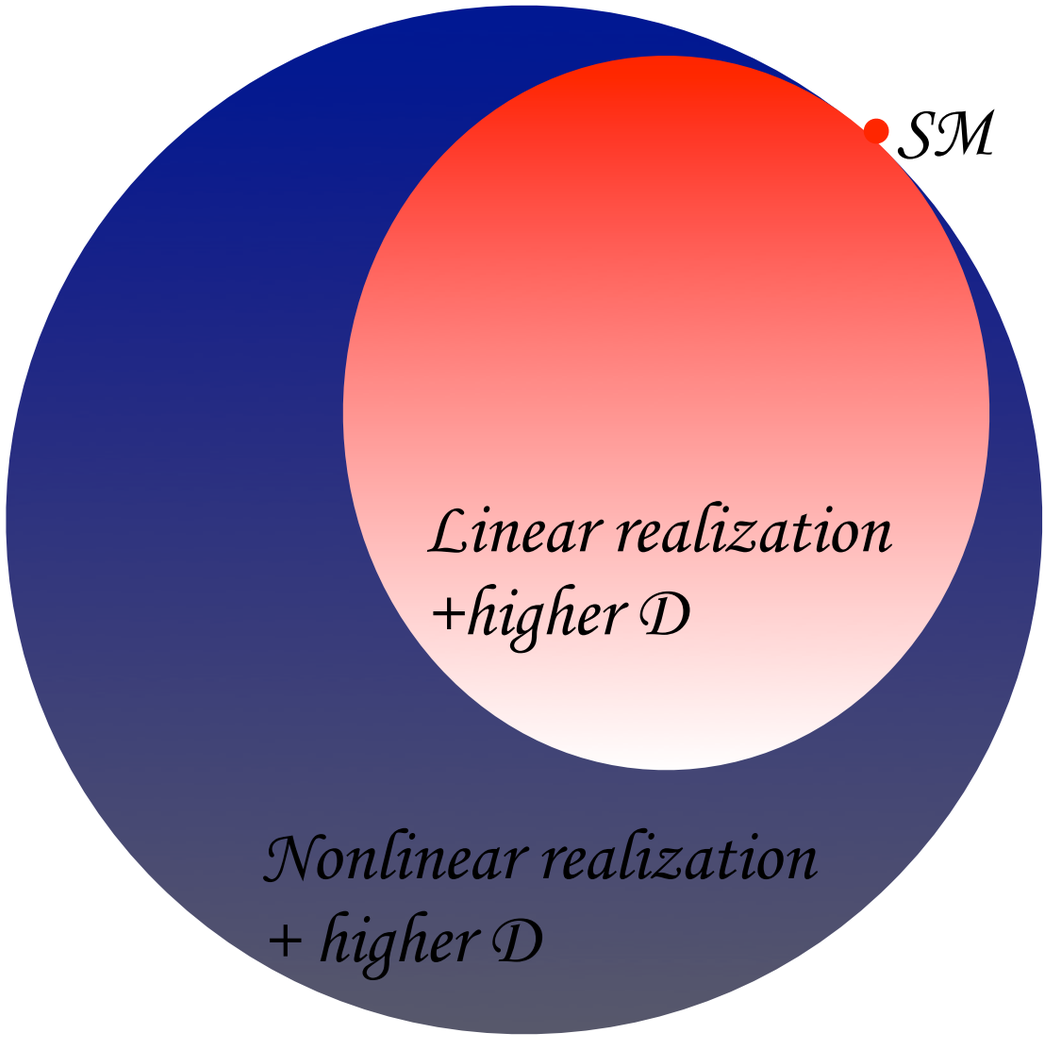
Also higher dimensional operators: - assuming no large BSM CP violation

$$\mathcal{L}^5_{HD} = -\frac{c_g\,g_3^2}{32\,\pi^2\,v}\,h\,G^A_{\mu\,\nu}G^{A\,\mu\,\nu} - \frac{c_W\,g_2^2}{32\,\pi^2\,v}\,h\,W^a_{\mu\,\nu}W^{a\,\mu\,\nu} - \frac{c_B\,g_1^2}{32\,\pi^2\,v}\,h\,B_{\mu\,\nu}B^{\mu\,\nu}$$

Reasonable coupling space, can draw physical conclusions for sym theories with current data. Still have degeneracies. **ONLY THE START OF THIS PROGRAM.**

What is the right approach to use?

It is obvious that we will be doing Higgs Effective Field theory for LHC and linear colliders. But WHICH EFT to use?



We want a robust field theory generalization of the SM scalar predictions to use to prove FROM THE DATA (not our brains or guts) that the SM is preferred.

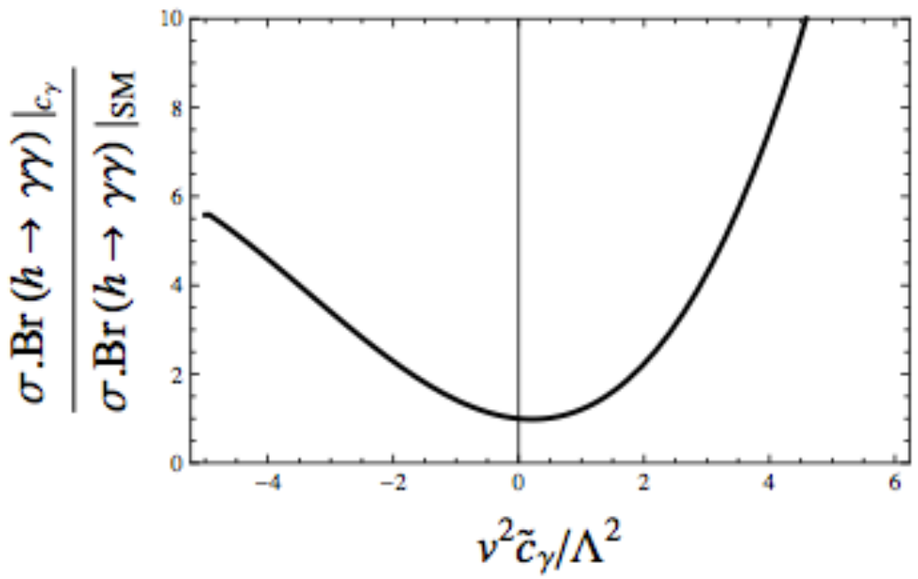
What is the right approach to use?

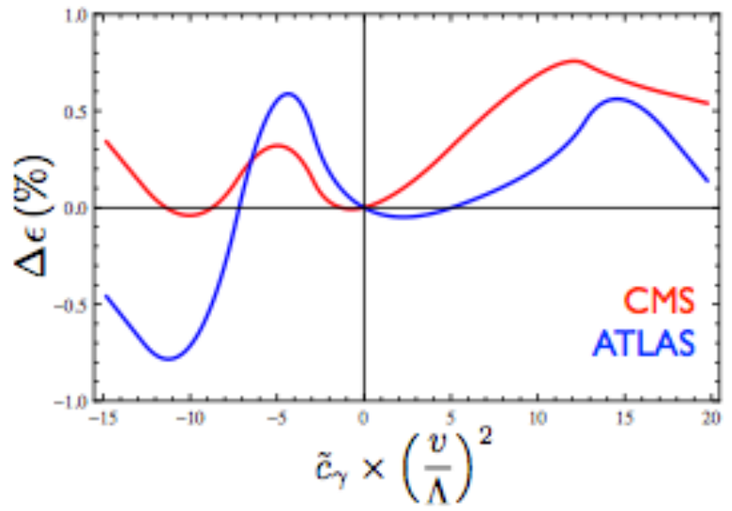
This is the framework that leads to generalizing the SM predictions with tree level rescalings of the cross section and branching ratios:

$$\mu_i = \frac{[\sum_j \sigma_{j\to h} \times \mathrm{Br}(h \to i)]_{observed}}{[\sum_j \sigma_{j\to h} \times \mathrm{Br}(h \to i)]_{SM}} \ , \qquad \chi^2(\mu_i) = \sum_{i=1}^{N_{ch}} \frac{(\mu_i - \hat{\mu}_i)^2}{\sigma_i^2}$$

This modifies $\mu^i_{SM} \to \mu^i(a, c)$ *but what about efficiency corrections?*

Event rates will only change if a kinematic distribution is changed significantly
we have checked that in a number of cases as well eff corrections can be safely neglected:





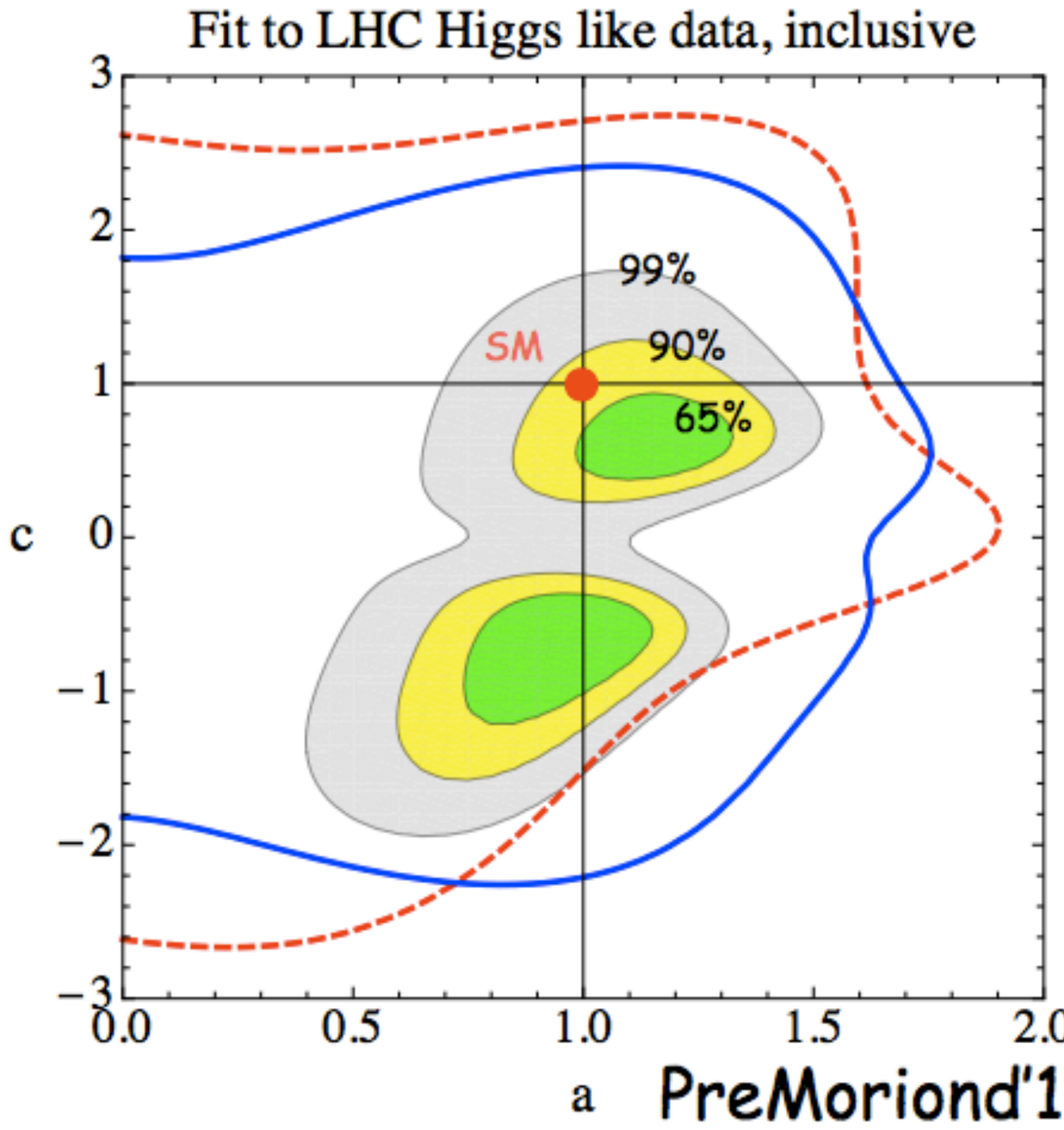
History of a discovery in Fit space

SM 82%CL
away from
best fit point

Two minima:

(a,c)=(1.13,0.58)
χ^2=2.86

(a,c)=(0.96,-0.64)
χ^2=1.96



65% CL

90% CL

99% CL

Atlas 95%CL exclusion

CMS 95%CL exclusion

Tevatron 95%CL exclusion

combined 95%CL exclusion

Espinosa,Grojean,Muhlleitner,Trott
JHEP 1205 (2012) 097 arxiv:1202.3697

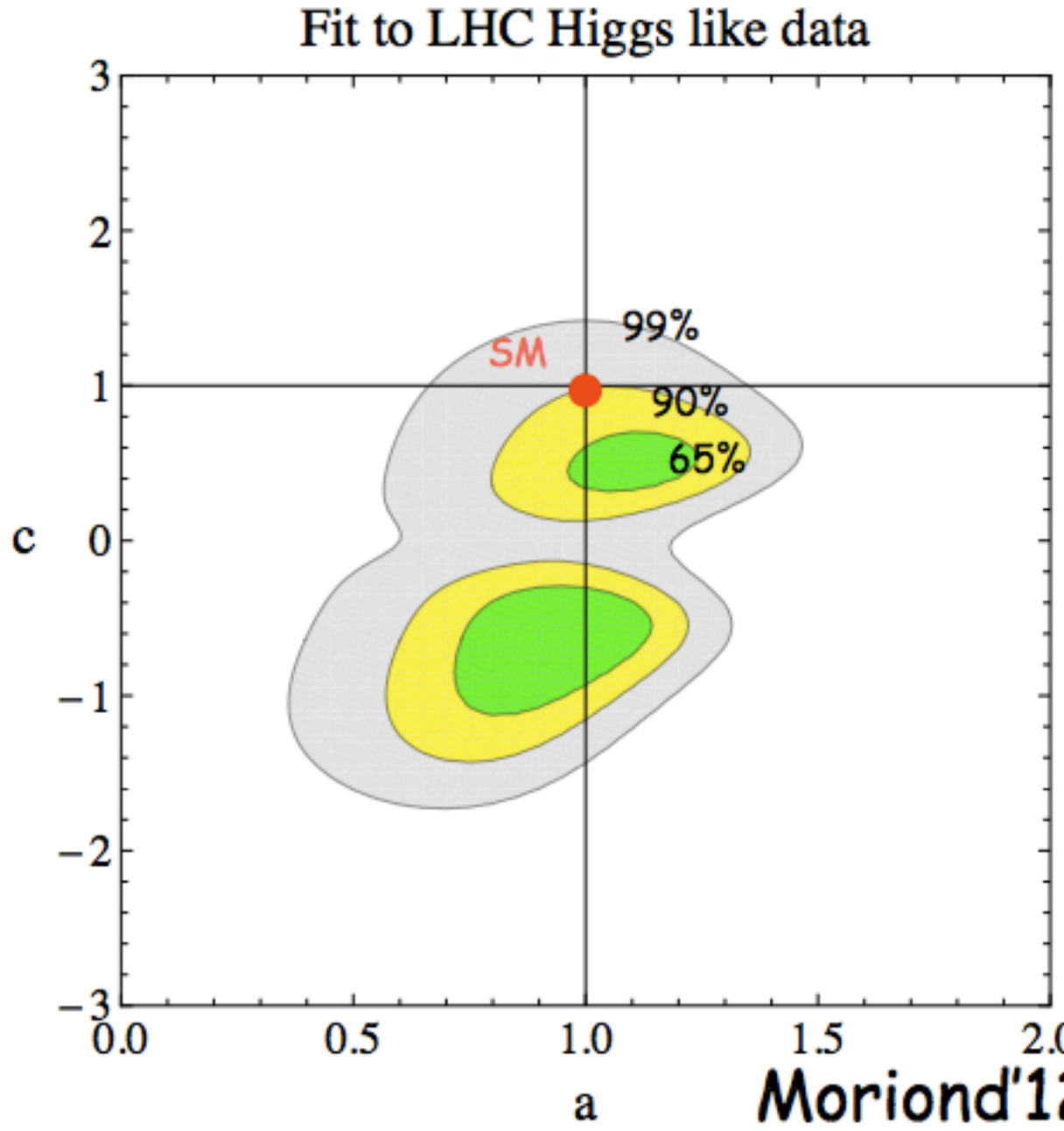
History of a discovery in Fit space

SM 88%CL
away from
best fit point
(~2σ)

Two minima:

(a,c)=(1.18,0.55)
χ^2=7.5

(a,c)=(0.99,-0.64)
χ^2=6.3



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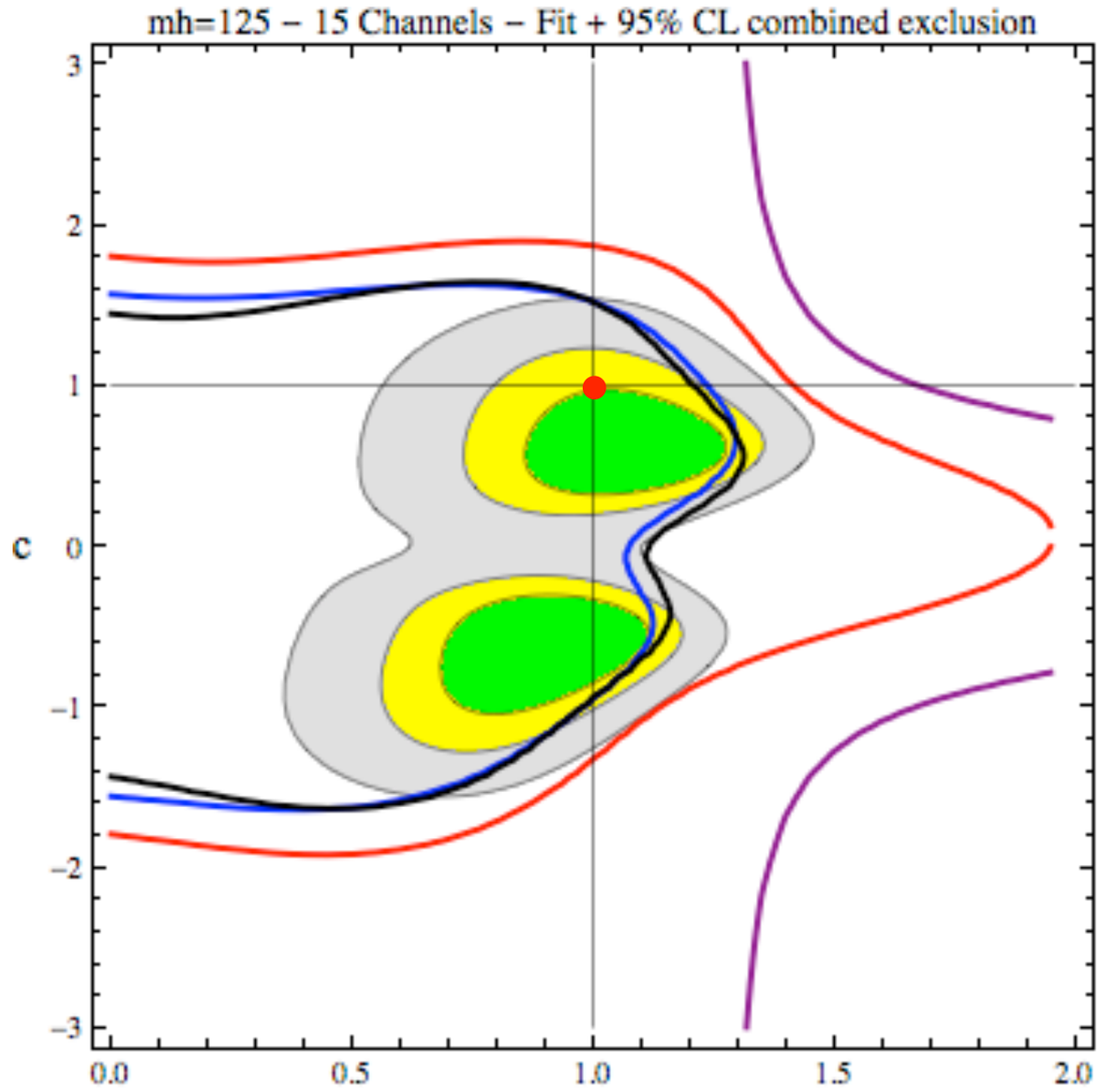

65% CL

90% CL

99% CL

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Post-Moriond/Pre-ICHEP

Espinosa,Grojean,Muhlleitner,Trott
JHEP 1205 (2012) 097 arxiv:1202.3697

History of a discovery in Fit space

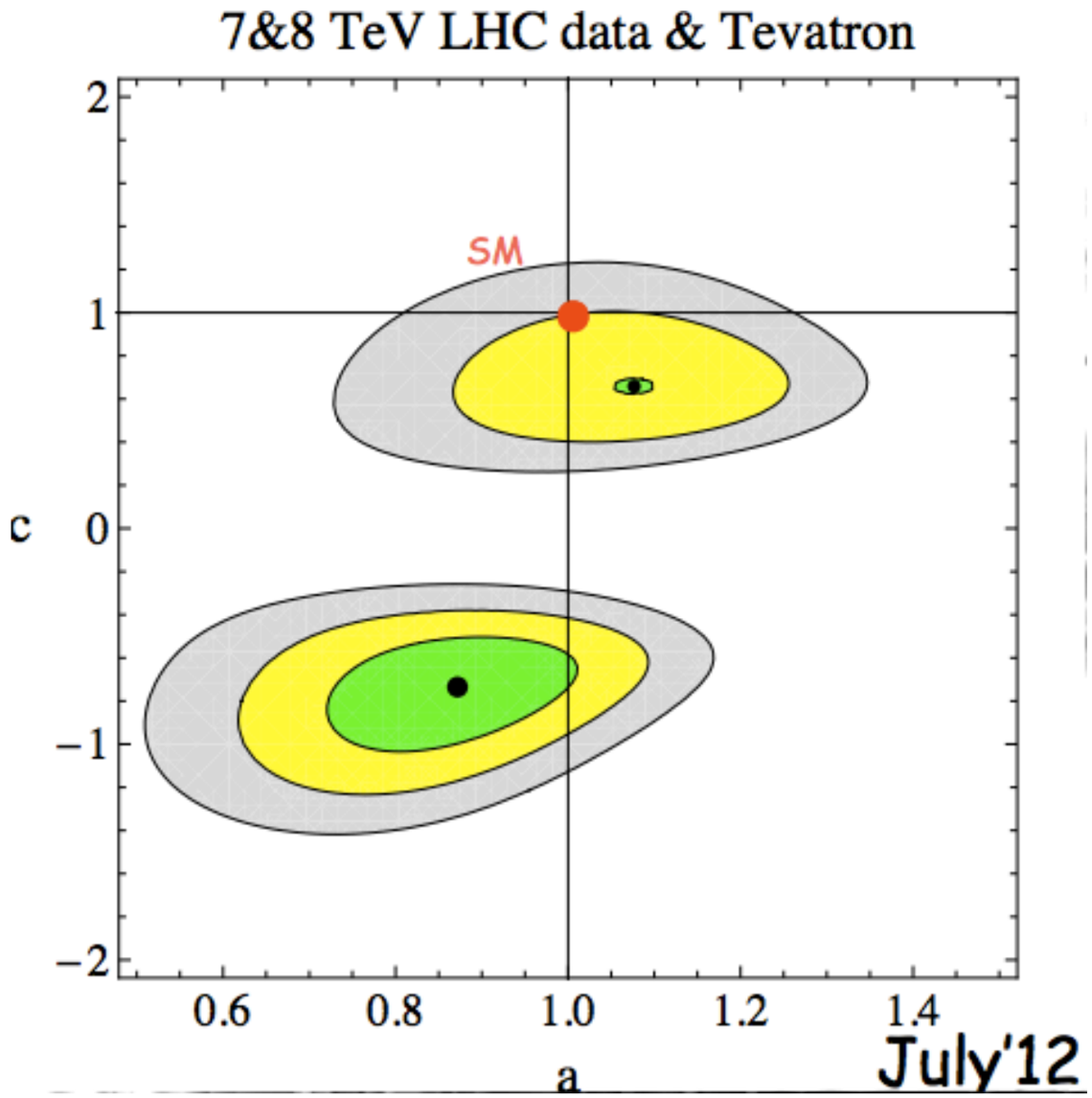
Notice scale change, errors coming down!

SM 93%CL away from best fit point (~1.8σ)

Two minima:

(a,c)=(0.86,-0.64)
χ^2=41

(a,c)=(1.05,0.63)
χ^2=41.4



$1\,\sigma$

$2\,\sigma$

$3\,\sigma$

Need to rescale 7, 8 TeV data independently.

Data released day of largely 7+8 TeV combinations.

Atlas 95%CL exclusion

CMS 95%CL exclusion

Tevatron 95%CL exclusion

combined 95%CL exclusion

Data day of discovery (released).

Espinosa,Grojean,Muhlleitner,Trott
JHEP 1205 (2012) 097 arxiv:1207.1717

History of a discovery in Fit space

Notice scale change, errors coming down!

SM *88* %CL
away from
best fit point

Two minima:

(a,c)=(*1.07*, *0.68*)
χ^2= *43.6*

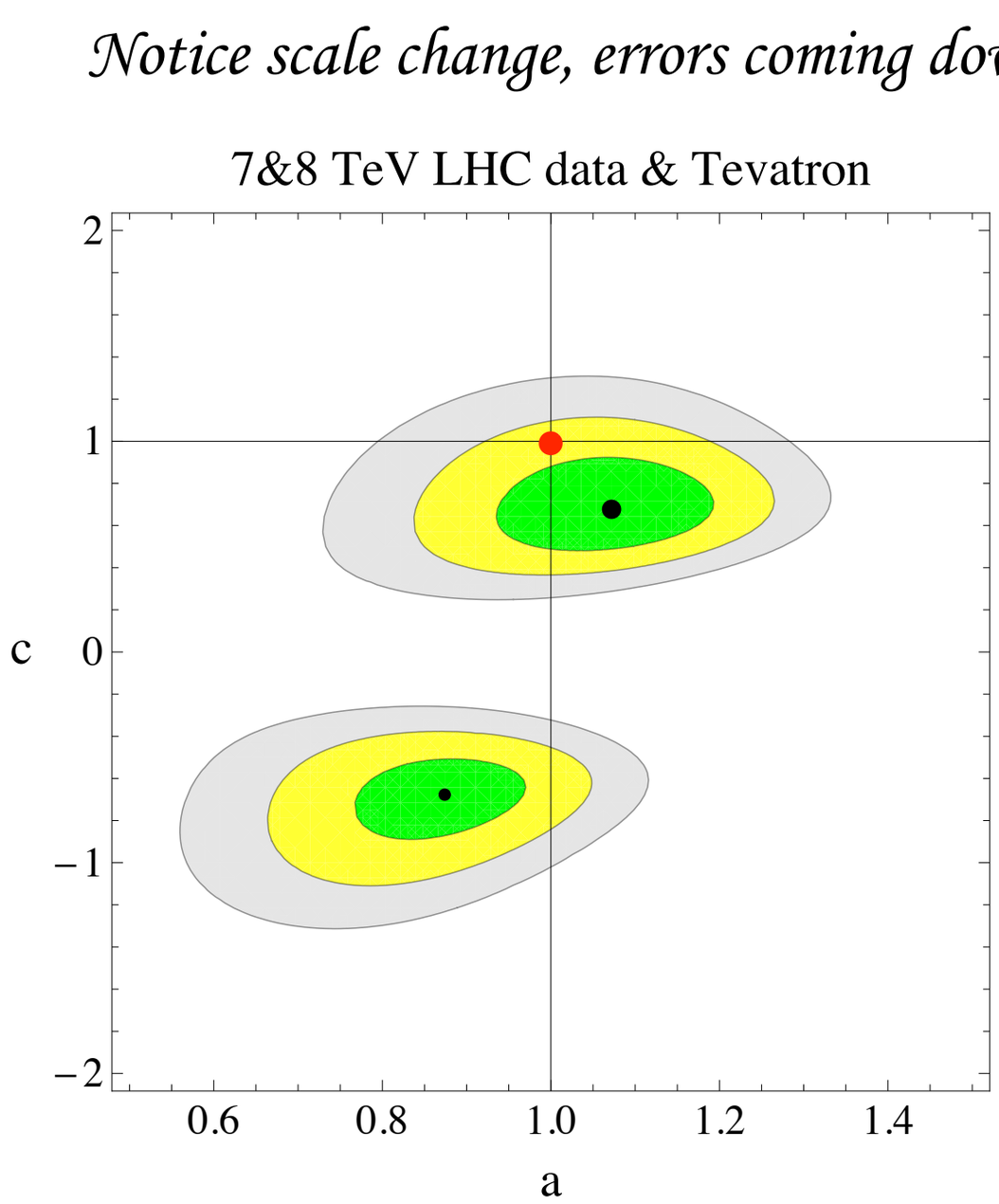
(a,c)=(*0.87*,-*0.68*)
χ^2= *44.3*

Atlas 95%CL exclusion

CMS 95%CL exclusion

Tevatron 95%CL exclusion

combined 95%CL exclusion



$1\,\sigma$

$2\,\sigma$

$3\,\sigma$

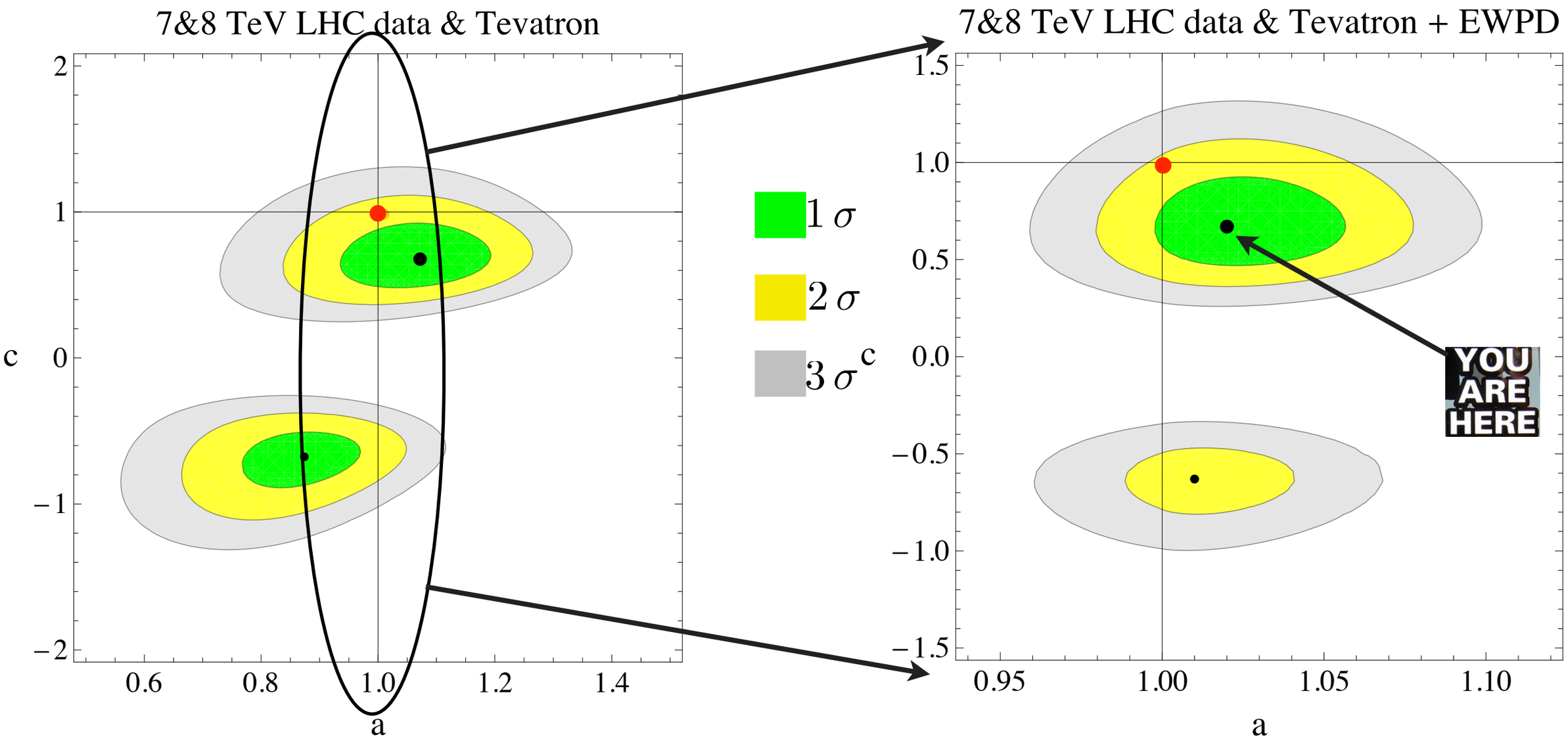
Most 7,8 data now split.

Atlas photon subcategories and WW largest changes.

Post ICHEP Data - no HCP.

Espinosa,Grojean,Muhlleitner,Trott
JHEP 1205 (2012) 097 arxiv:1207.1717

Add in EWPD to the Fit



Espinosa,Grojean,Muhlleitner,Trott
JHEP 1205 (2012) 097 arxiv:1207.1717

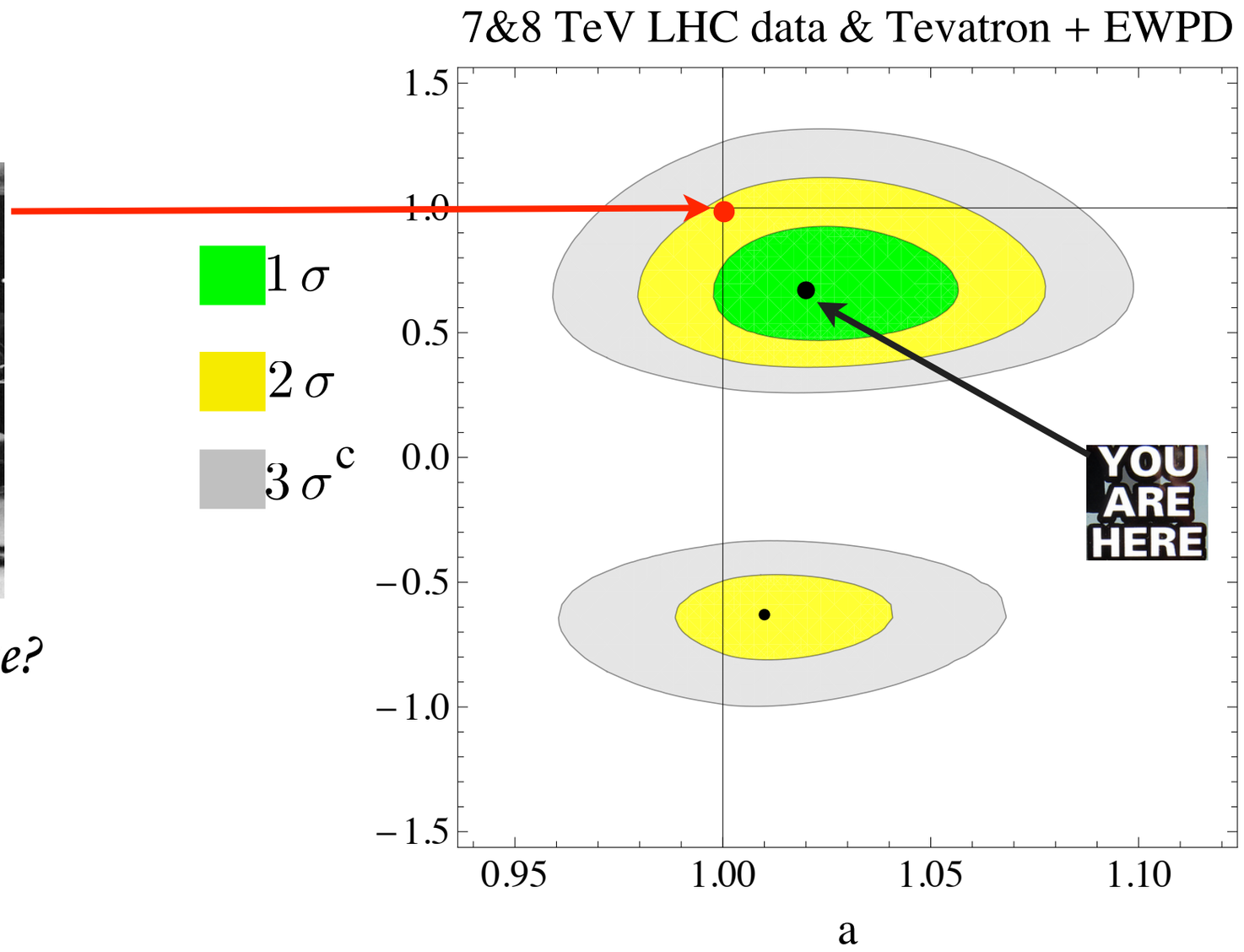
Notice "a" scale changed significantly

Here we use the log dependence on a not 1 in EWPD determined in

Barbieri, Bellazzini, Rychkov, Varagnolo **arXiv:0706.0432**

Add in EWPD to the Fit

GWS is here, will we converge?



Notice "a" scale changed significantly

Here we use the log dependence on a not 1 in EWPD determined in

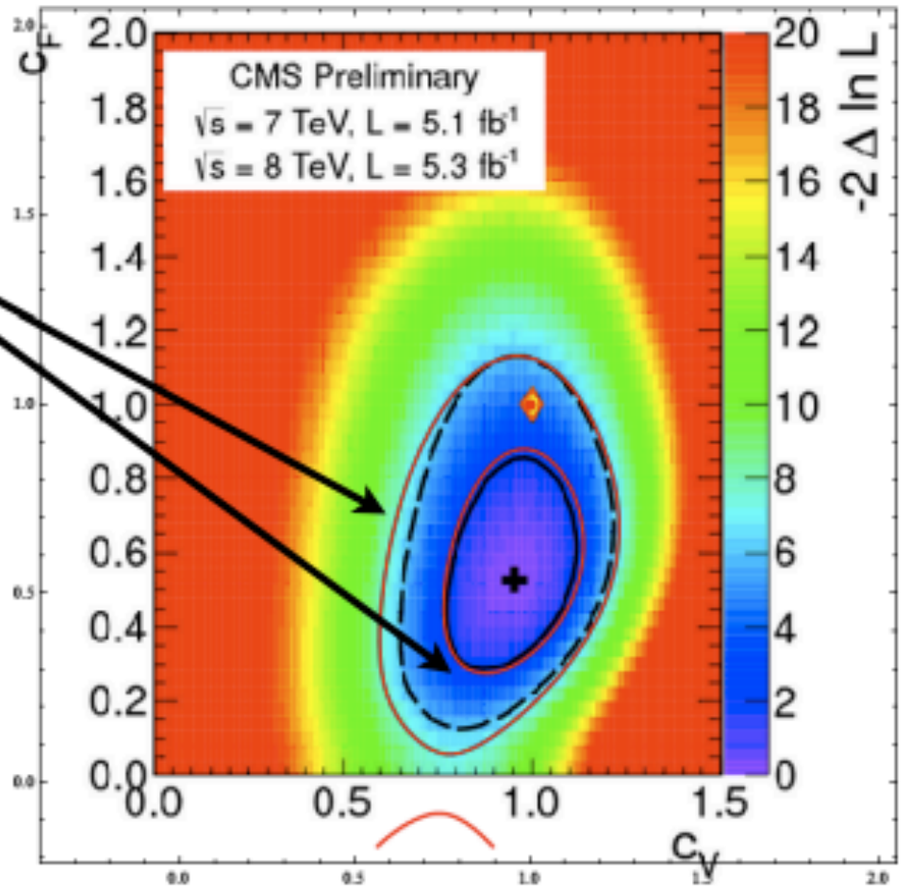
Barbieri, Bellazzini, Rychkov, Varagnolo **arXiv:0706.0432**

Can you trust a theorist to do this?

Comparison with CMS "official" fit

CMS imposed a prior $c > 0$
(it doesn't affect χ^2, but it modifies $\Delta\chi^2$)

Our contours



Your χ^2 is too damn good !
-our friendly competition

This means that:

a) We are not badly screwing up.

b) correlations do not matter (summer)

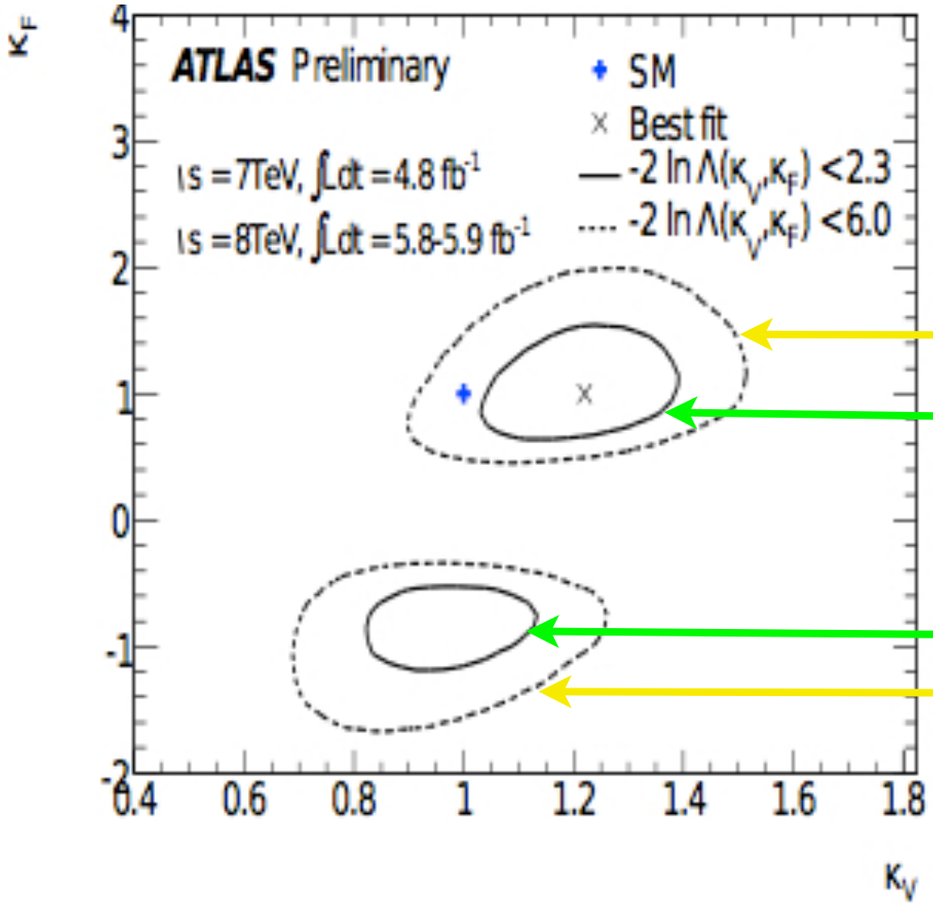
or

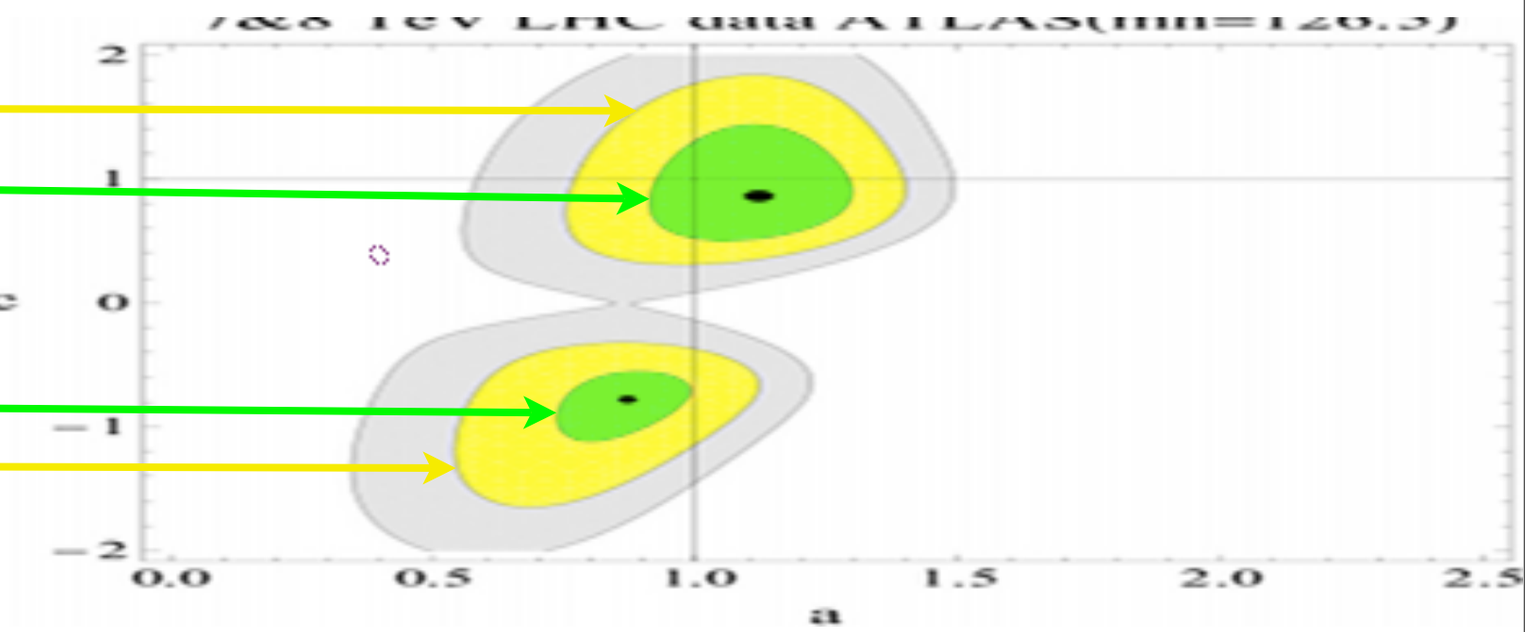
b) they do matter but CMS is as lost on estimating them correctly as we are.

Conclusion: You can trust some theorists to do this (for now).

More Movement by Atlas and CMS in this direction

Atlas Comparison





The contours of comparison are pretty good. However, more of a shift than CMS.

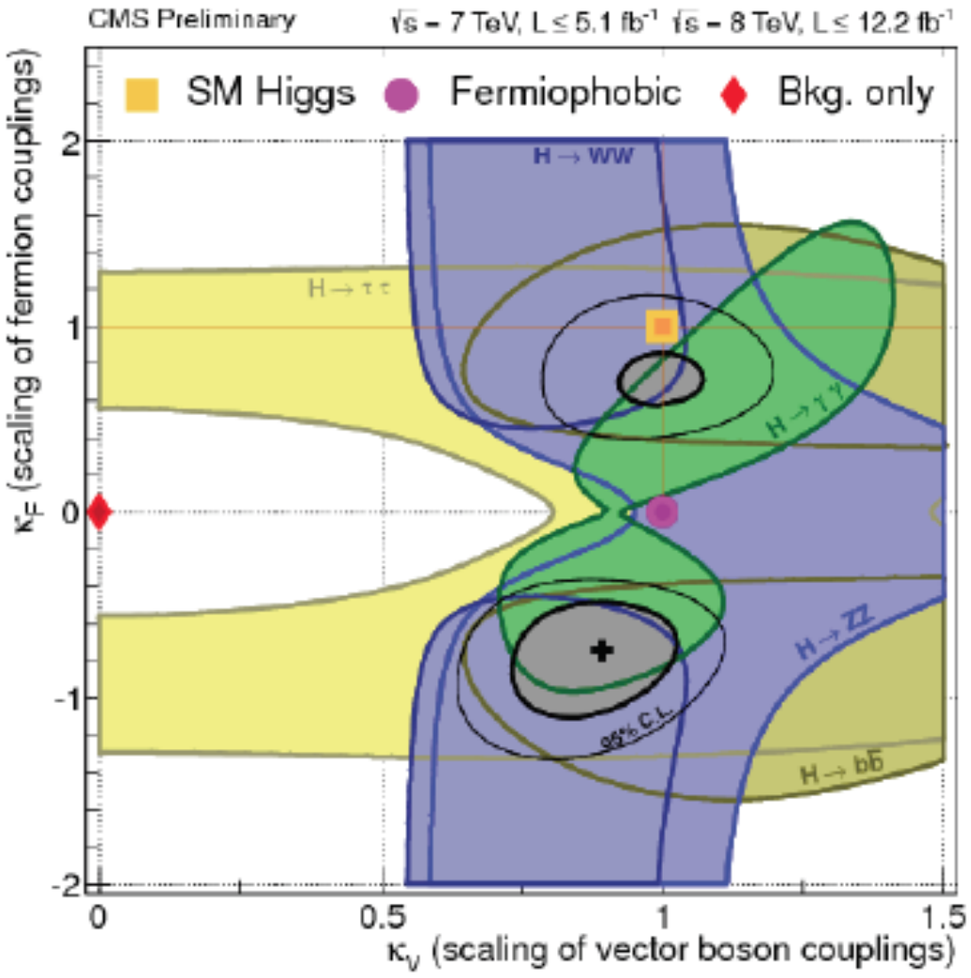
1) WW (0,1,2 jet) sub-channel treatment, they have more info, can use the sub-channels.

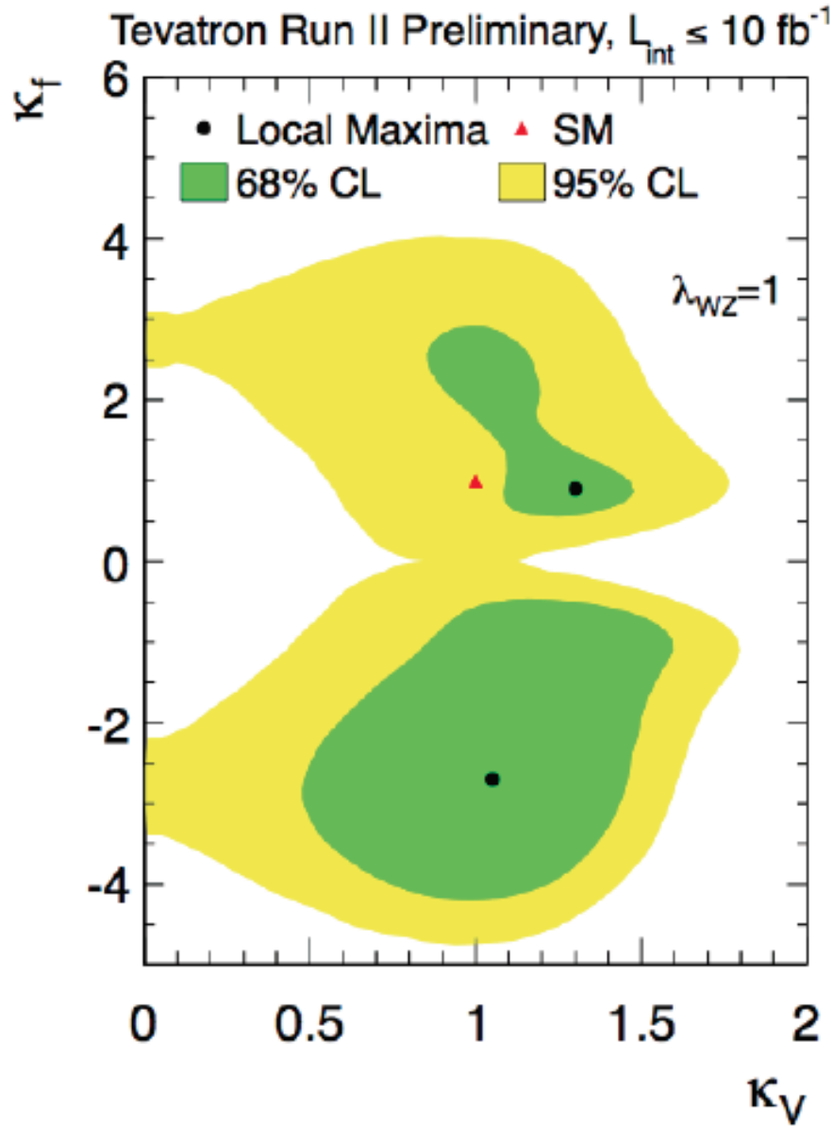
2) gamma gamma correlations might matter here due to the way the data was sliced up

Need more info from ATLAS for a more direct comparison.

The hand off...

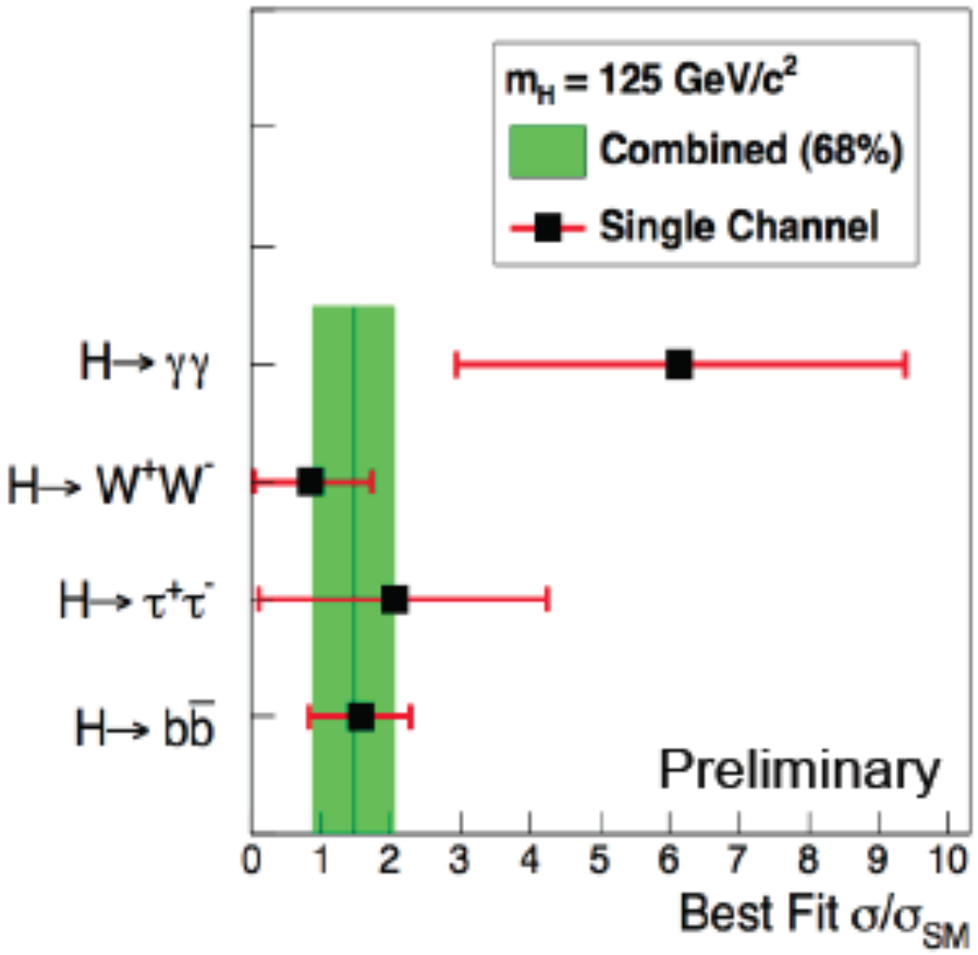
"Via con Dios" experimental fitters...

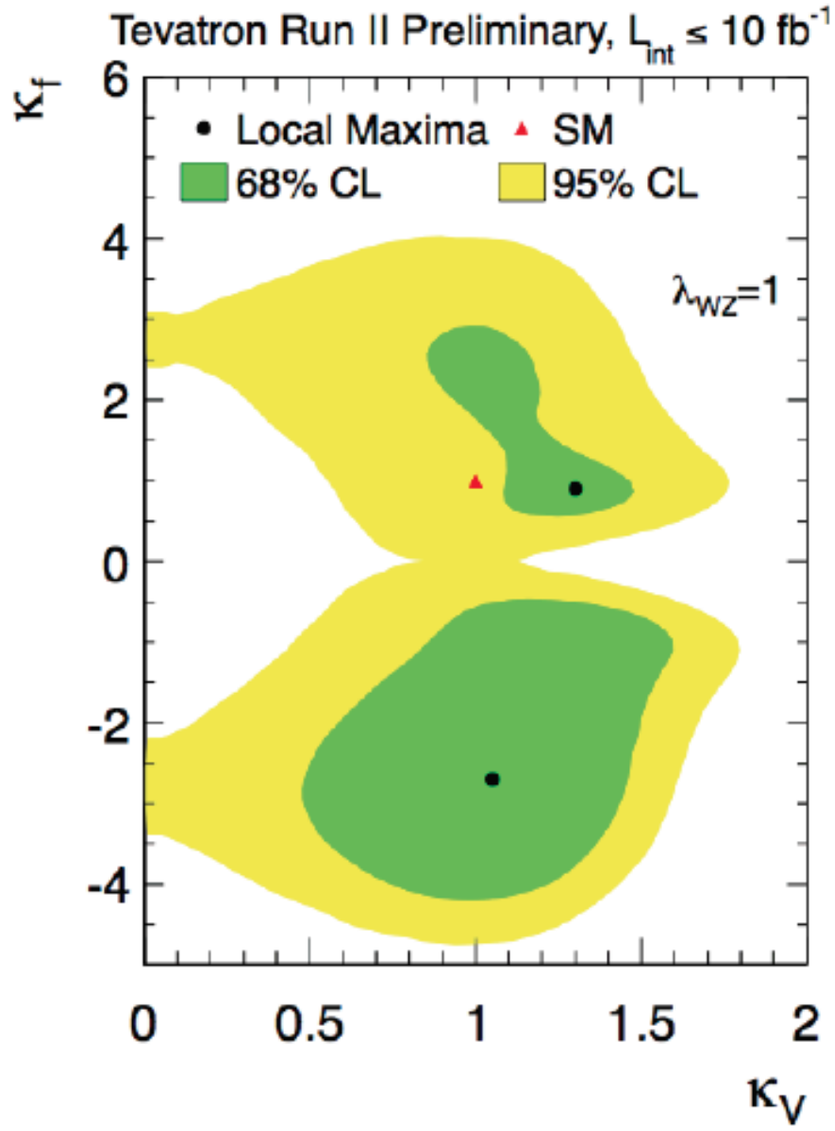




Wait a minute...

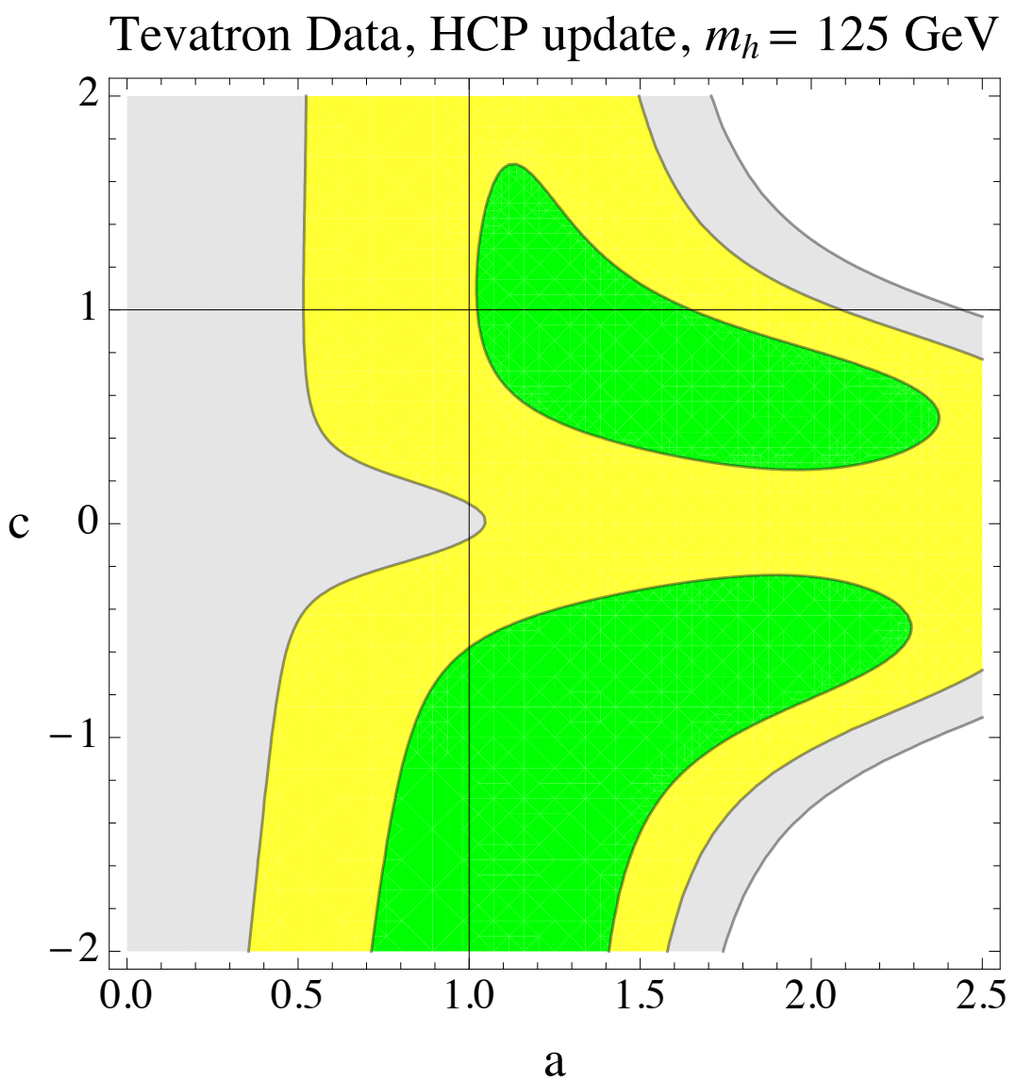
Public Tevatron data:

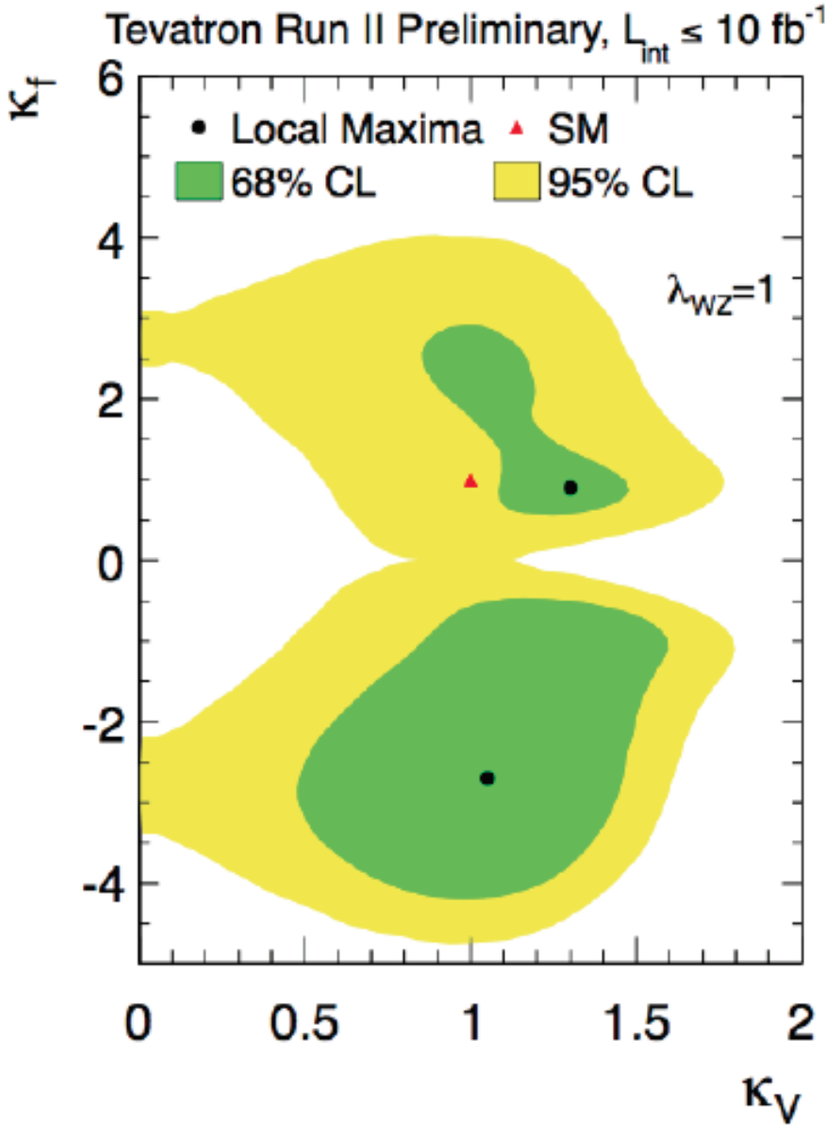




Wait a minute...

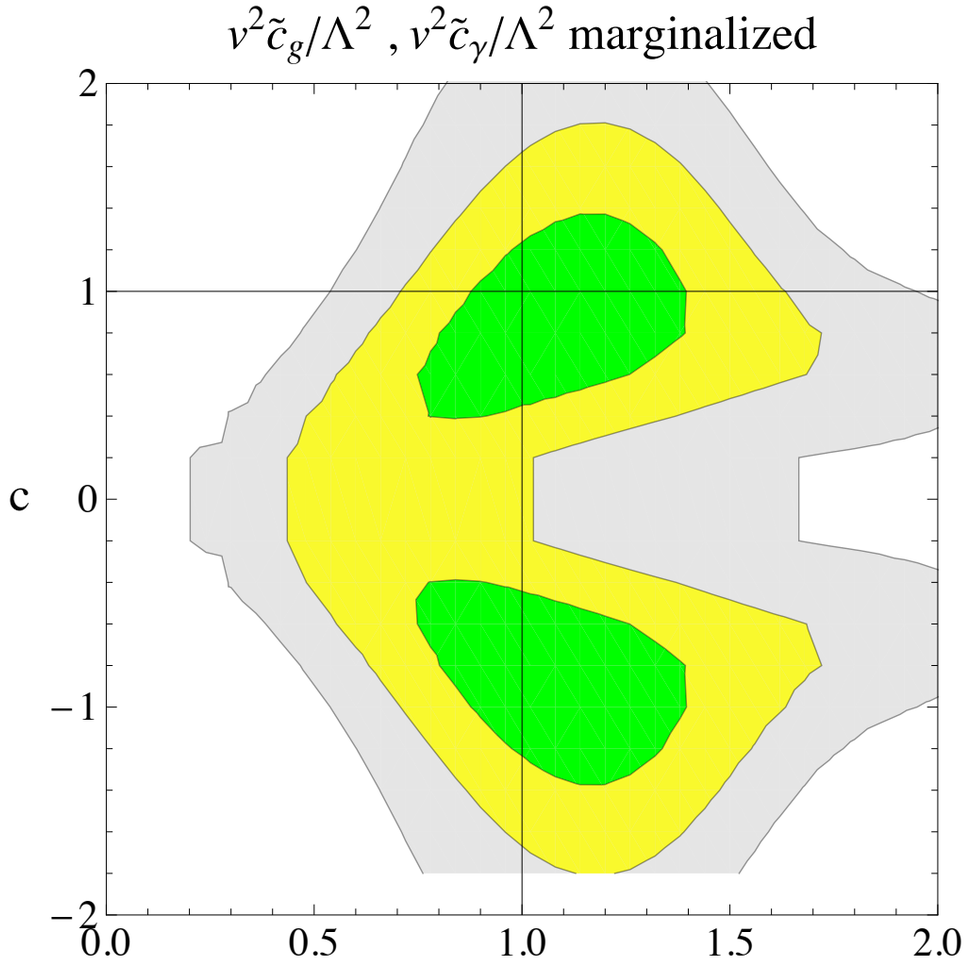
Public Tevatron data, gives:

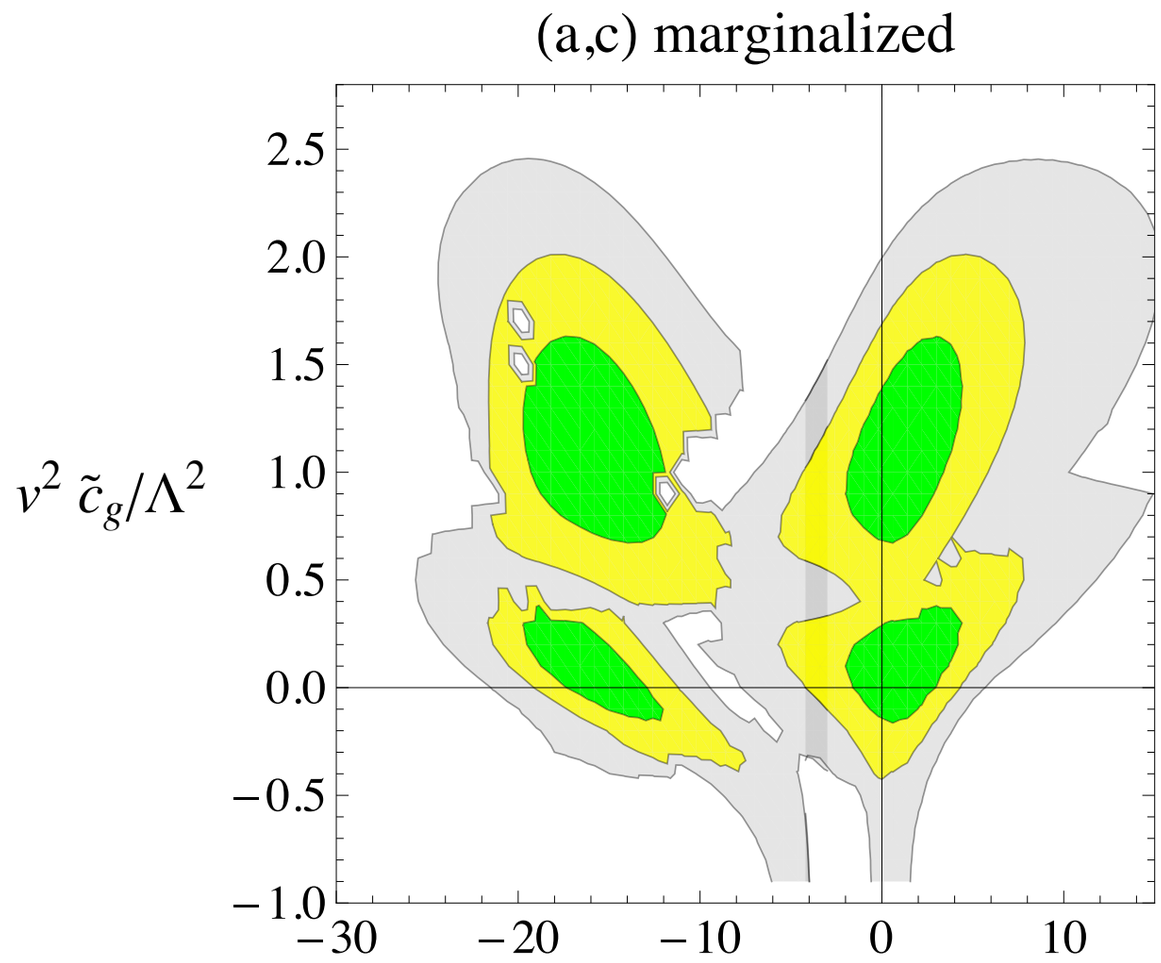




.....different scales....but still the public info not sufficient. Info will have to be further resolved so that broad physics conclusions can be drawn by theorists from Higgs data.

Marginalization Games





Espinosa,Grojean,Muhlleitner,Trott
JHEP 1205 (2012) 097 arxiv:1207.1717

Very interesting that the SM higgs hypothesis test is improved in the context of NP in this way. Need more data.

A way of seeing that the existence of the $\gamma\gamma$ "excess" depends upon the Yukawa couplings being SM - like. Need more data.

Limit/Tension Methodology:

What is this statistics #$@!*$ in your paper, it is just equivalent to a damn χ^2 as far as i am concerned! *-another charitable physicist.*

Each signal strength measurement can be approx:

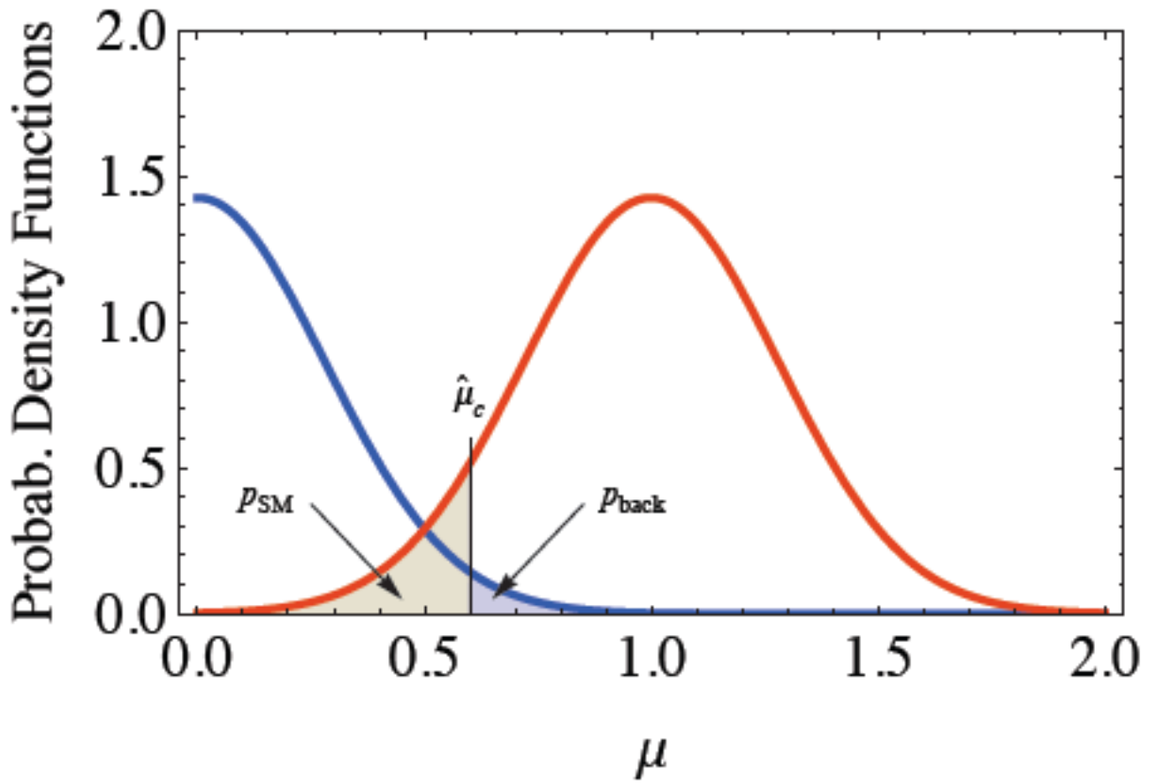
$$pdf_i(\mu, \hat{\mu}_i, \sigma_i) \approx e^{-(\mu-\hat{\mu}_i)^2/(2\sigma_i^2)}$$

The PDF's can be combined to get global PDF's

$$pdf(\mu, \hat{\mu}_c, \sigma_c) \propto \prod_i^{N_{ch}} pdf_i(\mu, \hat{\mu}_i, \sigma_i) = \mathcal{N}_c\, e^{-(\mu-\hat{\mu}_c)^2/(2\,\sigma_c^2)}$$

Where you have the combination variables:

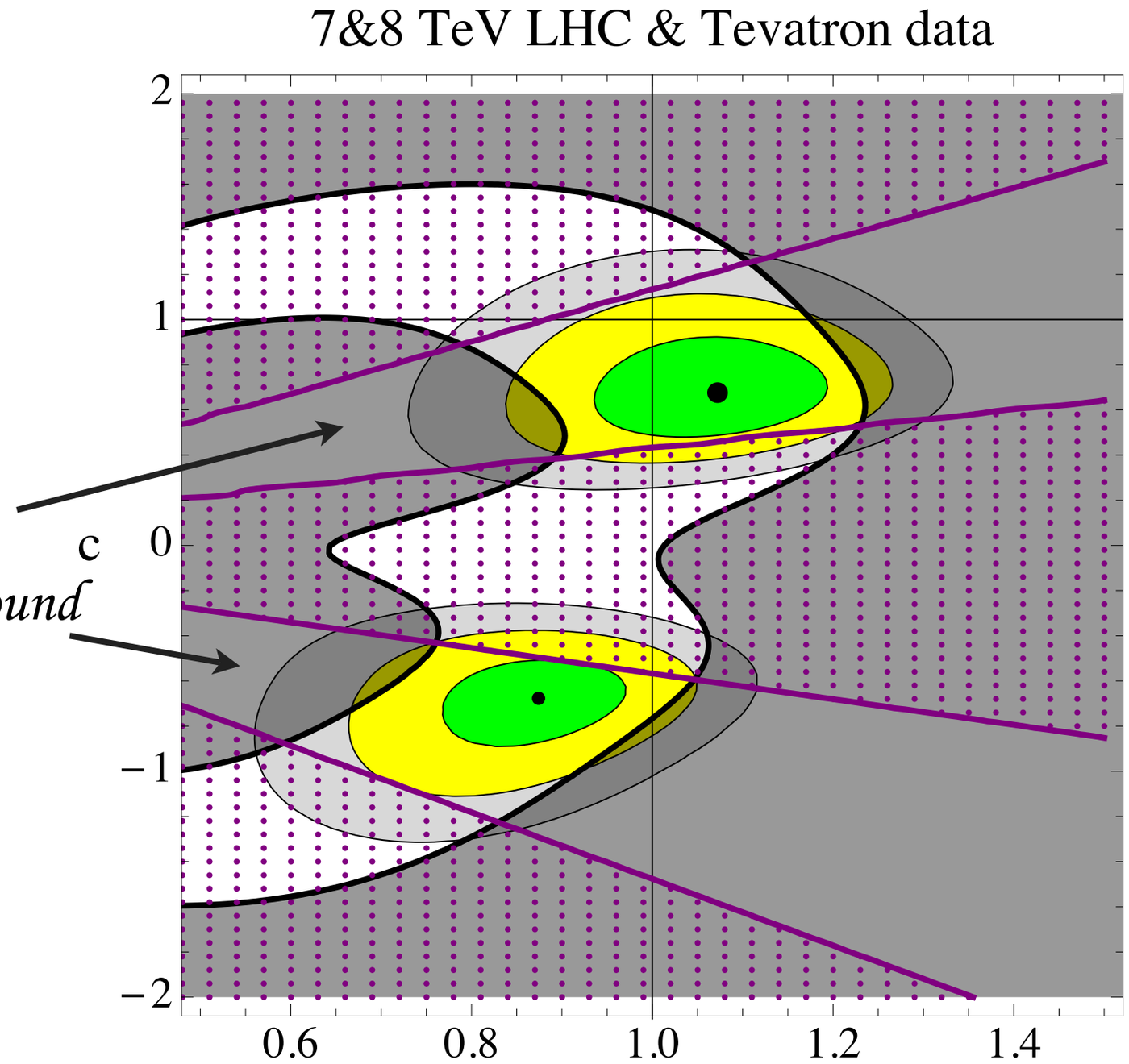
$$\frac{1}{\sigma_c^2} = \sum_i^{N_{ch}} \frac{1}{\sigma_i^2}, \qquad \frac{\hat{\mu}_c}{\sigma_c^2} = \sum_i^{N_{ch}} \frac{\hat{\mu}_i}{\sigma_i^2}\ .$$



(note: correlations neglected here)

PDF's make clear one can set upper, lower and consistency limits on signal strength values.

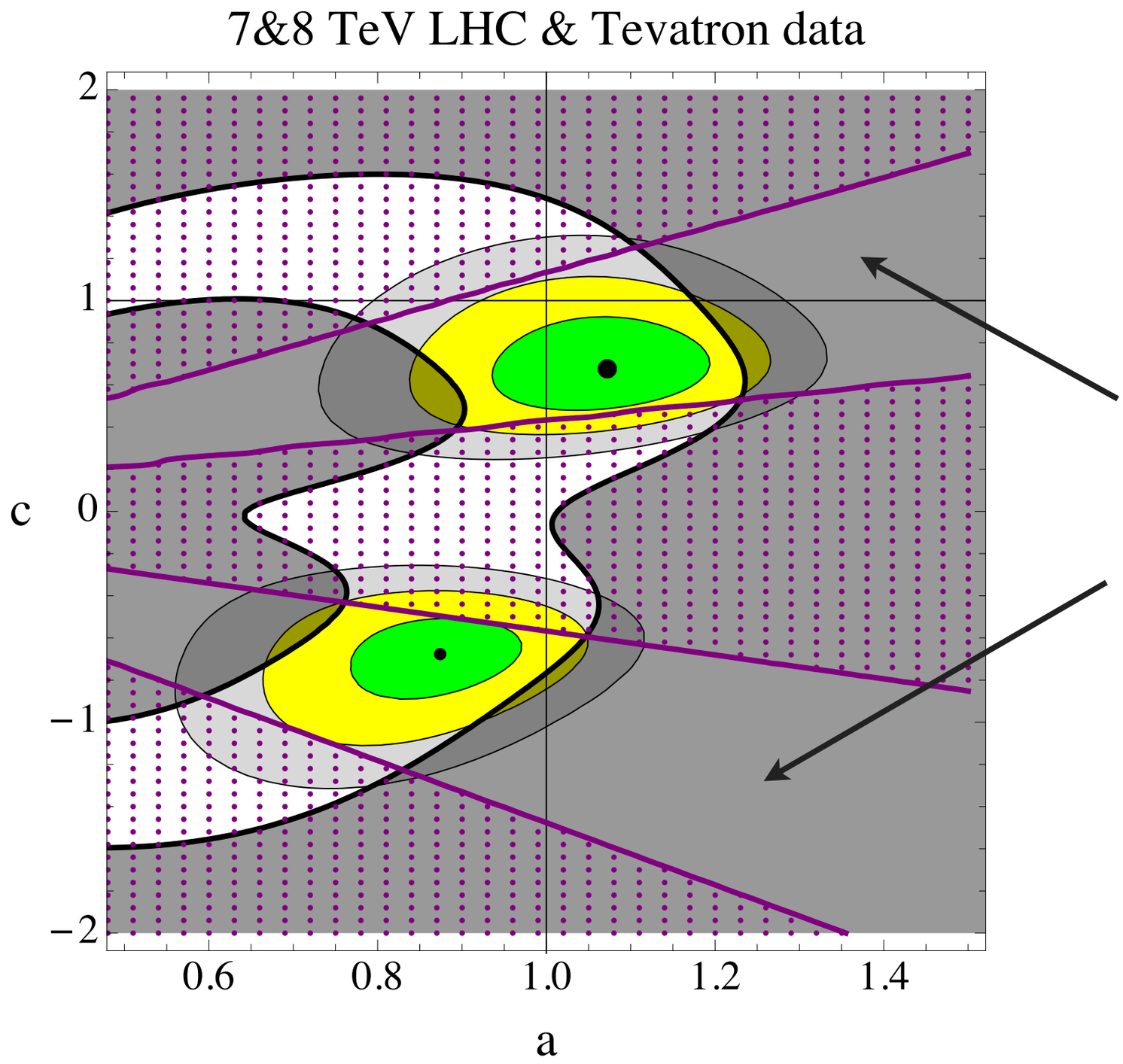
Ultimate PDF usage to check the data set



Too few events
95%CL lower bound

Espinosa,Grojean,Muhlleitner,Trott
JHEP 1205 (2012) 097 arxiv:1207.1717

Ultimate PDF usage to check the data set

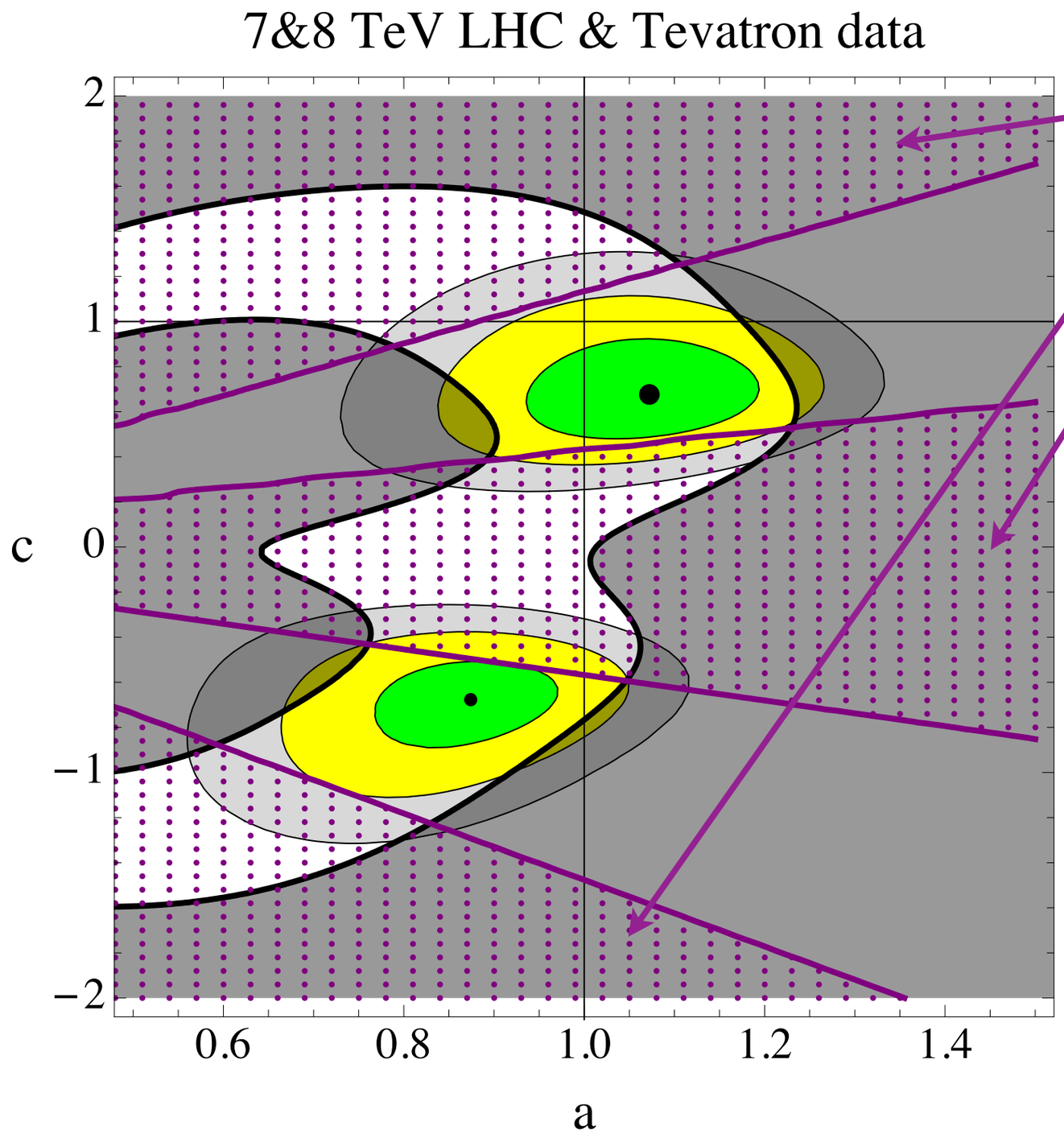


Too few events expected 95%CL

Too many events expected 95%CL

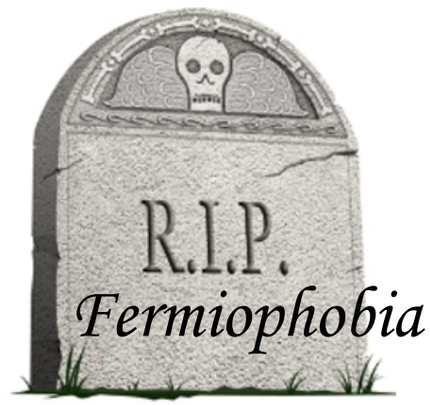
Ultimate PDF usage to check the data set

Too few events expected 95%CL



Inconsistencies driven by individual channels (2 sigma)

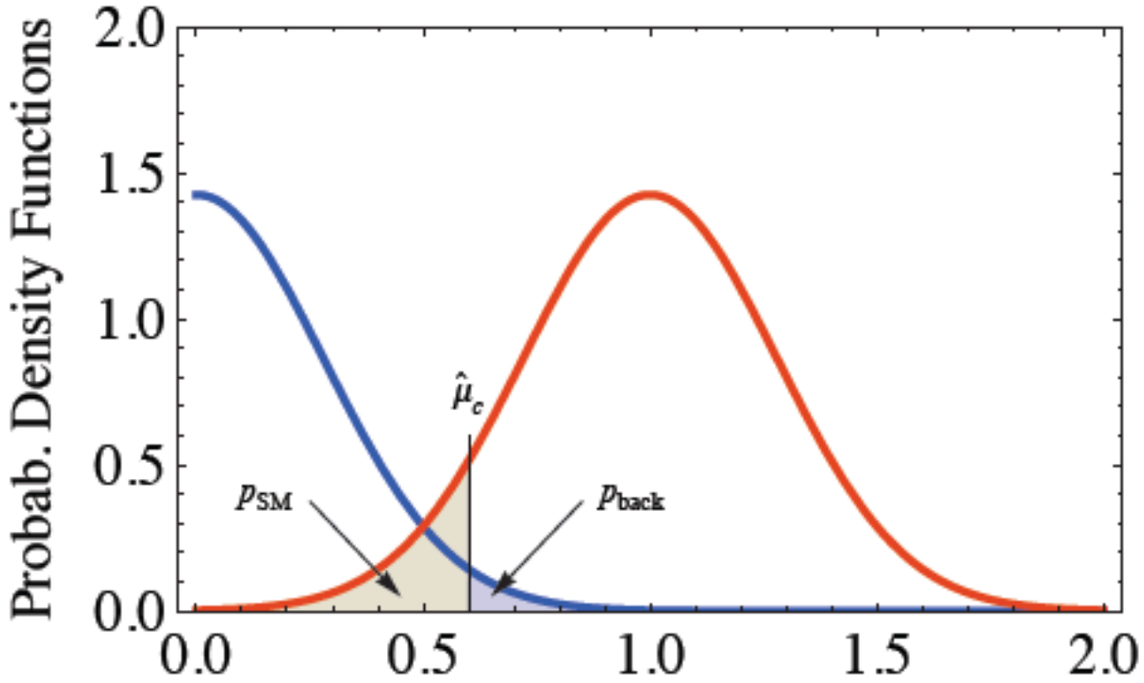
Too many events expected 95%CL



Branching Ratio Invisible

The invisible branching ratio is great as it is a universal shift on signal strengths.

$$\mathrm{Br}(h \to f) \equiv \frac{\Gamma(h \to f)}{\Gamma_{\mathrm{SM}} + \Gamma_{inv}} = (1 - \mathrm{Br}_{inv}) \times \mathrm{Br}_{SM}(h \to f).$$



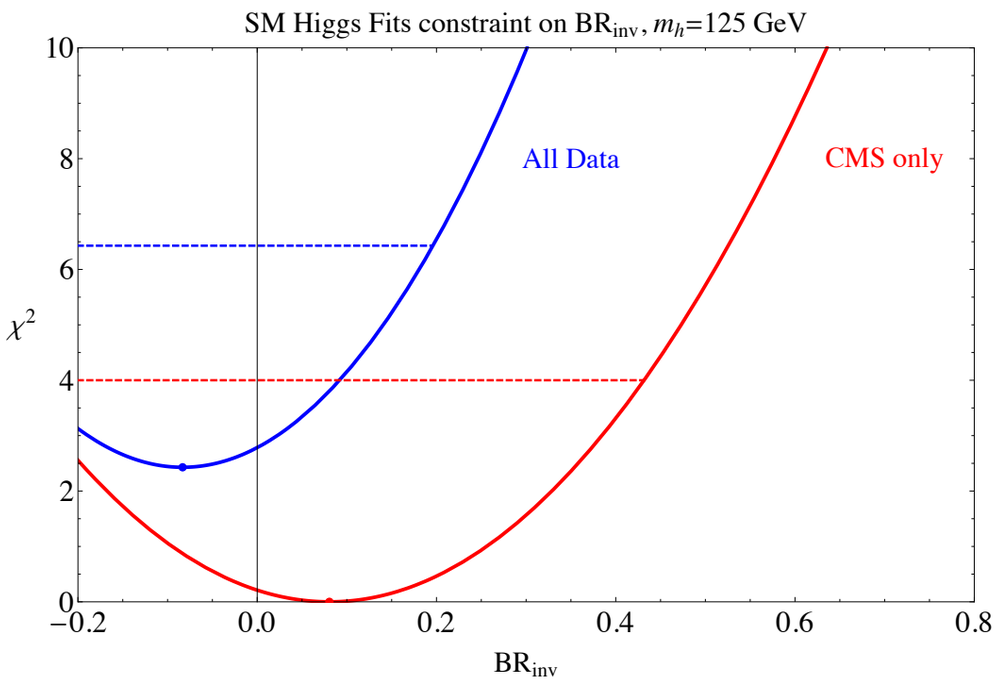
In terms of the gaussian combination variables

$$\frac{1}{\sigma_c^2} = \sum_i^{N_{ch}} \frac{1}{\sigma_i^2}, \qquad \frac{\hat{\mu}_c}{\sigma_c^2} = \sum_i^{N_{ch}} \frac{\hat{\mu}_i}{\sigma_i^2}.$$

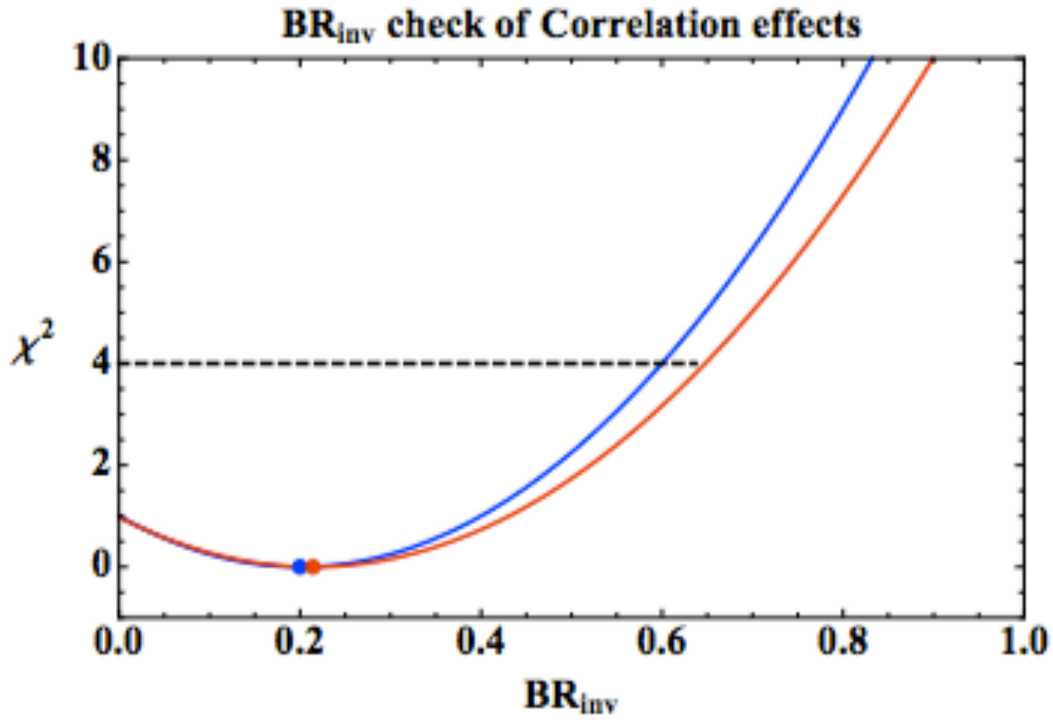
The invisible branching ratio is expressed as: $\mathrm{Br}_{inv} = 1 - \hat{\mu}_c.$

One can fit to it using the SUPPLIED COMBINED SIGNAL STRENGTHS

Branching Ratio Invisible - latest data

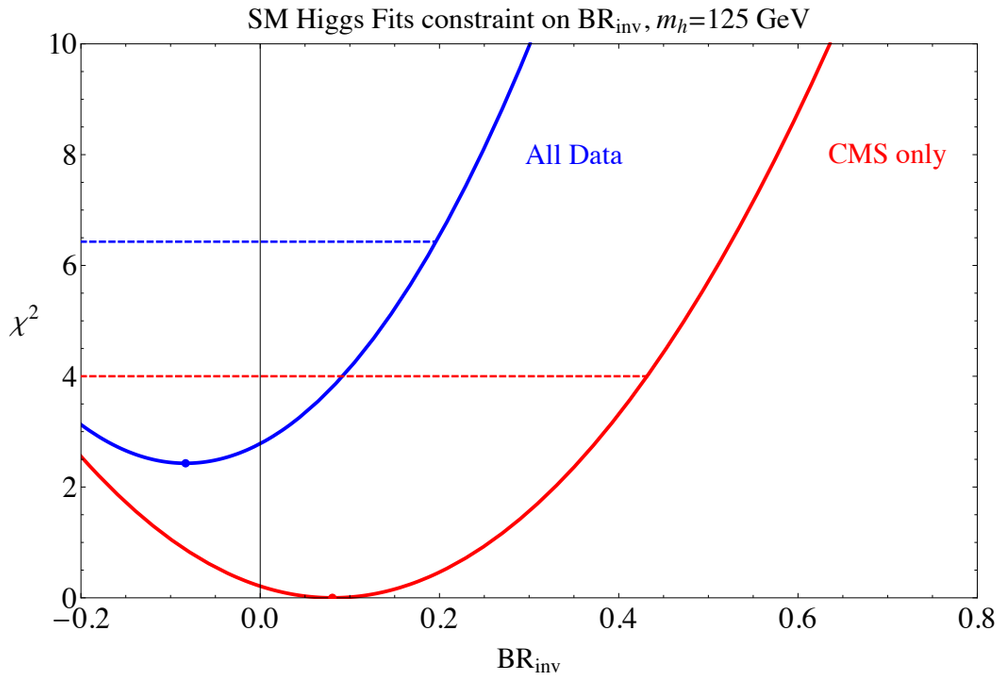


Any global evidence of Brinv?
Nope.

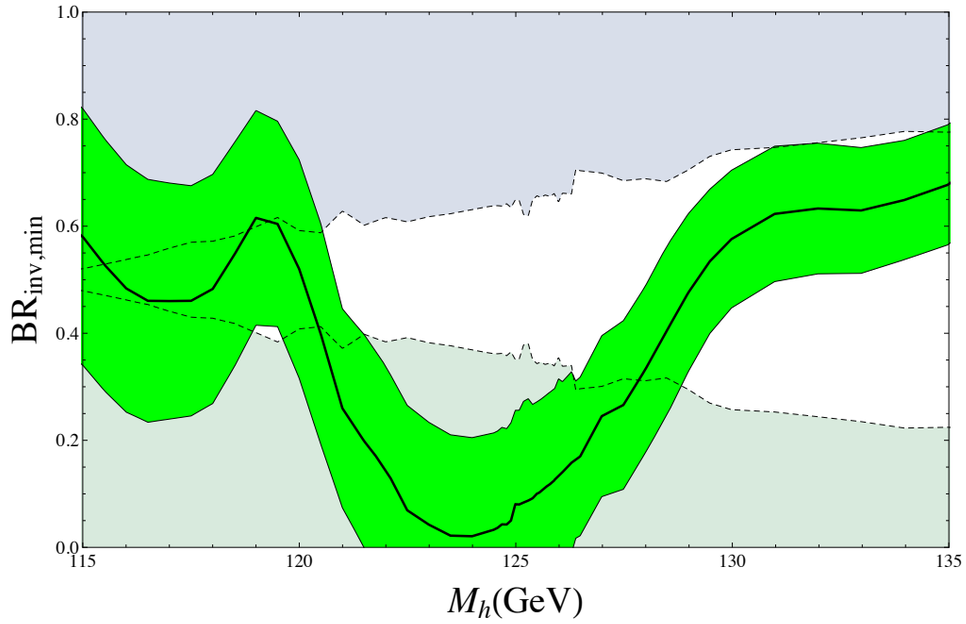


Any global evidence that correlations are so important that we are full of it?
Nope.

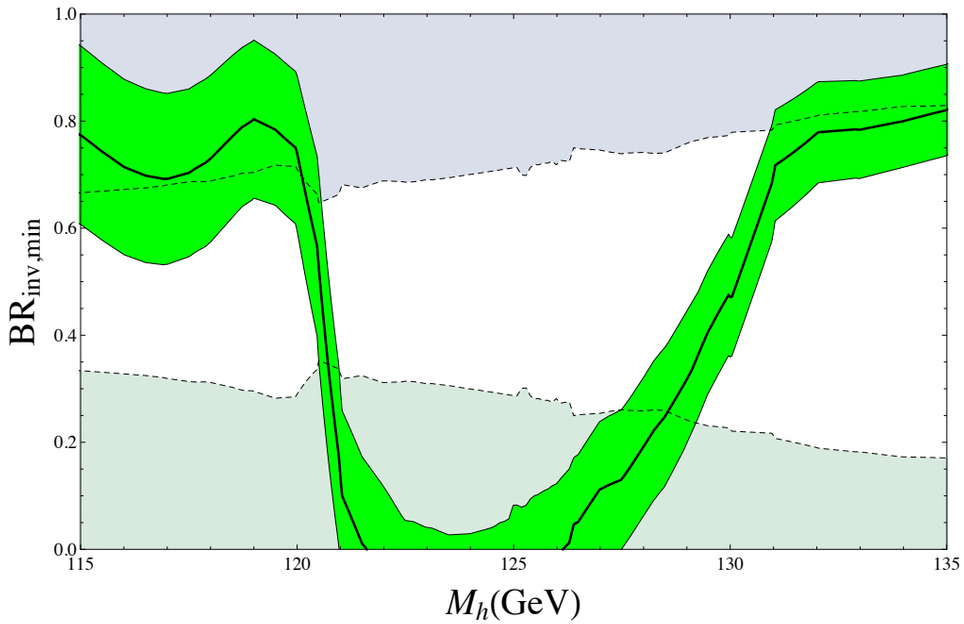
Branching Ratio Invisible - latest data



CMS



CMS + ATLAS



Current data on supplied combined signal strengths, so all correlations included.

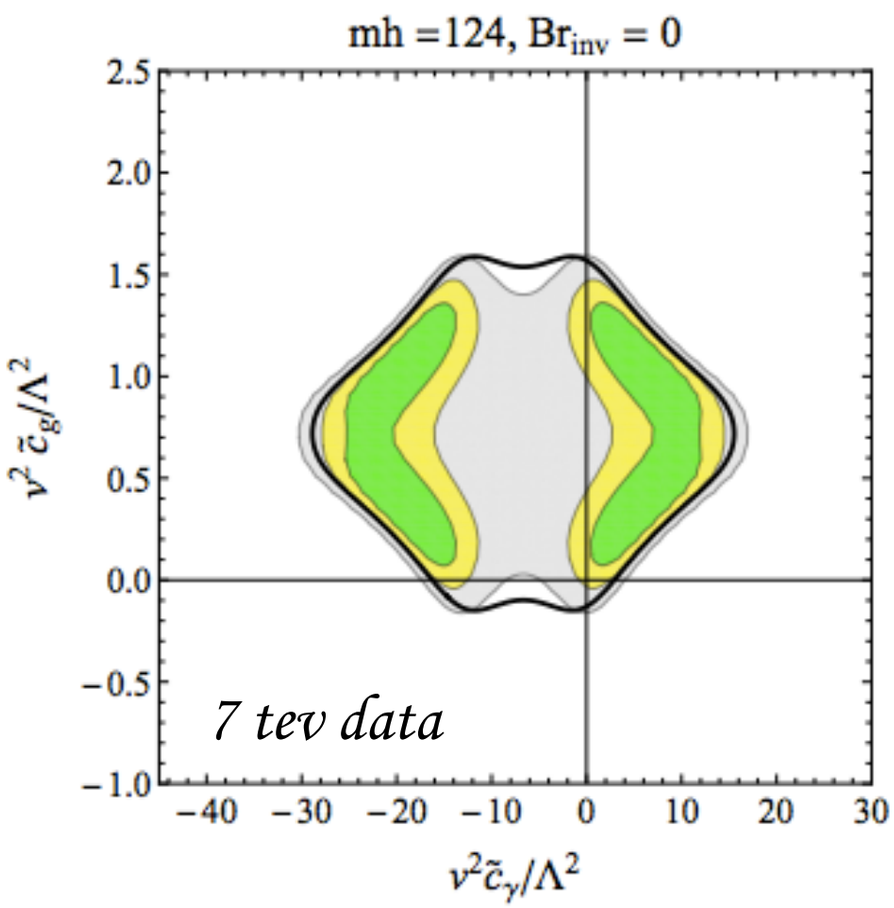
CMS is still low on the combined signal strength.

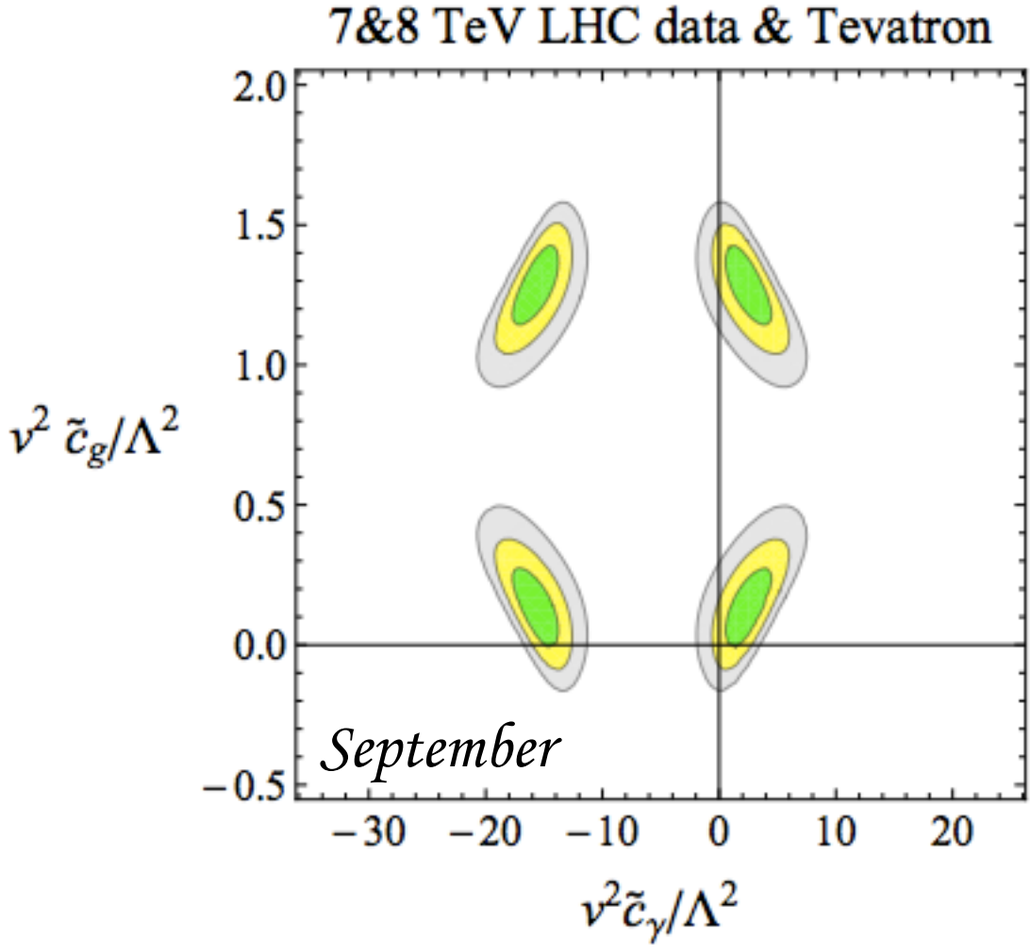
No Smoking gun for dark mater as yet.

Constraints are scaling.

If this is the right effective Lagrangian, we are learning a lot!

$$\mathcal{L}_{HD} = -\frac{c_g\, g_3^2}{2\,\Lambda^2}\, H^\dagger H\, G^A_{\mu\nu} G^{A\mu\nu} - \frac{c_W\, g_2^2}{2\,\Lambda^2}\, H^\dagger H\, W^a_{\mu\nu} W^{a\mu\nu} - \frac{c_B\, g_1^2}{2\,\Lambda^2}\, H^\dagger H\, B_{\mu\nu} B^{\mu\nu} - \frac{c_{WB}\, g_1\, g_2}{2\,\Lambda^2}\, H^\dagger \tau^a H\, B_{\mu\nu} W^{a\mu\nu}\,,$$





Natural Susy

Consider minimal spectrum of stops, left handed sbottom, charginos and neutralinos with large guagino mass.

Stop contributions to Higgs production:

$$\frac{\sigma(gg \to h)}{\sigma^{SM}(gg \to h)} \simeq \frac{\Gamma(h \to gg)}{\Gamma^{SM}(h \to gg)} \simeq |1 + r_g|^2 \qquad r_g = \frac{C_g(\alpha_s) F_g(m_{\tilde{t}_1}, m_{\tilde{t}_2}, \theta_{\tilde{t}})}{F_g^{SM}(m_t, m_b \cdots)}$$

QCD squark matching correction

Stop contributions to interesting decays:

$$\frac{\Gamma(h \to \gamma\gamma)}{\Gamma^{SM}(h \to \gamma\gamma)} \simeq |1 + r_\gamma|^2 , \qquad r_\gamma = \frac{N_c Q_{\tilde{t}}^2 C_\gamma(\alpha_s) F_g(m_{\tilde{t}_1}, m_{\tilde{t}_2}, \theta_{\tilde{t}})}{F_\gamma^{SM}(m_t, W, m_b \cdots)}$$

Same loop functions, non abelian nature of QCD irrelevant at leading order in matching.

Natural Susy

Consider minimal spectrum of stops, left handed sbottom, charginos and neutralinos with large guagino mass.

Stop contributions to Higgs production, In terms of operators:

$$\sigma_{gg\to h} \approx \sigma^{SM}_{gg\to h} \left| 1 + \frac{2}{F_g^{SM}} \frac{v^2\,\tilde{c}_g}{\Lambda^2} \right|^2, \quad \Gamma_{h\to\gamma\,\gamma} \approx \Gamma^{SM}_{h\to\gamma\,\gamma} \left| 1 + \frac{1}{F_\gamma^{SM}} \frac{v^2\,\tilde{c}_\gamma}{\Lambda^2} \right|^2 .$$

Matching with no running:

$$\frac{v^2\,\tilde{c}_g}{\Lambda^2} \simeq C_g(\alpha_s)\,\frac{F_g}{2}, \qquad \frac{v^2\,\tilde{c}_\gamma}{\Lambda^2} \simeq N_c\,Q_{\tilde{t}}^2\,C_\gamma(\alpha_s)\,F_g$$

$$C_g(\alpha_s) = 1 + \frac{25\,\alpha_s}{6\,\pi}, \qquad C_\gamma(\alpha_s) = 1 + \frac{8\,\alpha_s}{3\,\pi}.$$

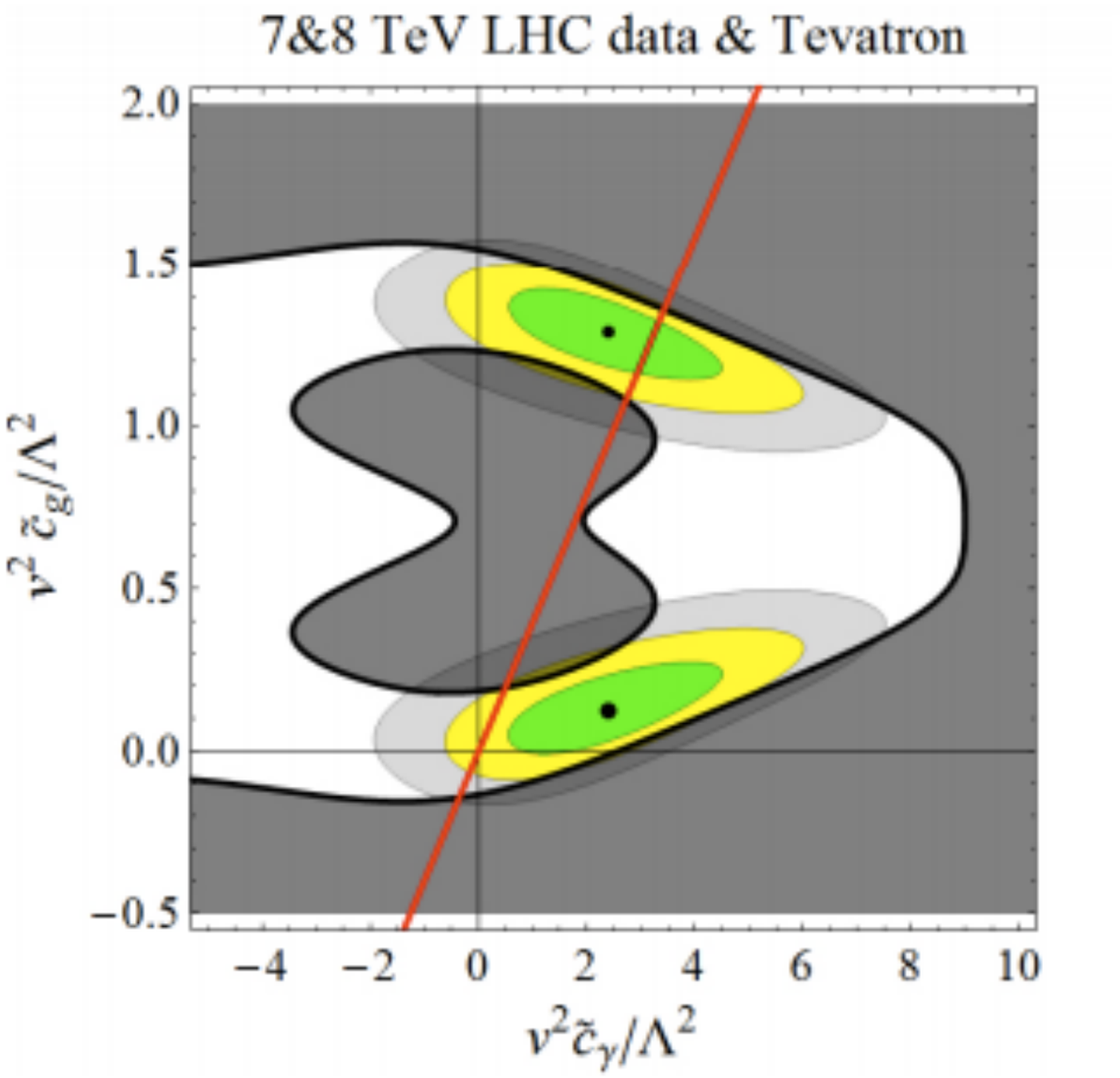
This is a predictive scenario for the wilson coefficients of the higher d ops:

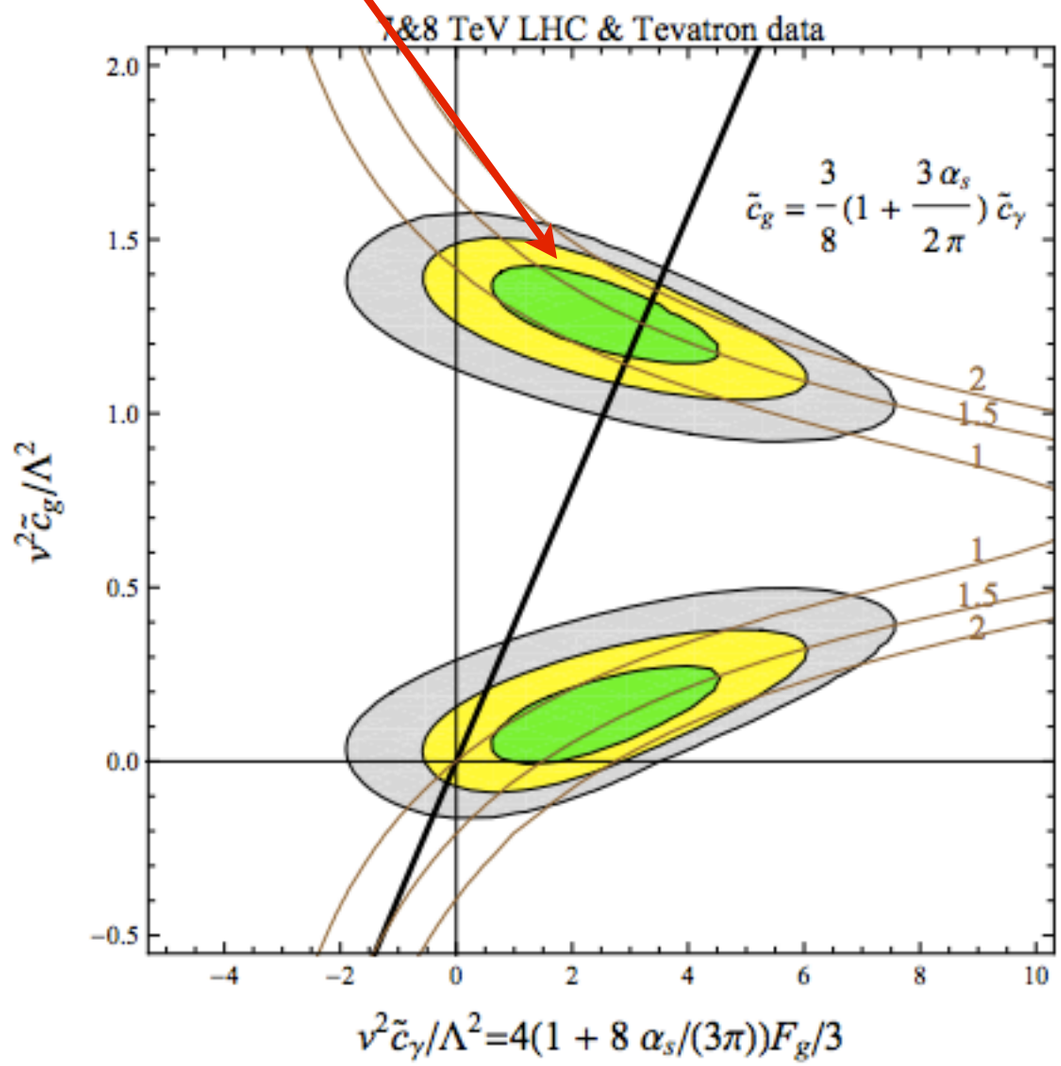
$$\frac{\tilde{c}_g}{\tilde{c}_\gamma} = \frac{1}{2N_cQ_{\tilde{t}}^2}\frac{C_g(\alpha_s)}{C_\gamma(\alpha_s)} = \frac{3}{8}\left(1 + \frac{3\,\alpha_s}{2\,\pi}\right)$$

Natural Susy

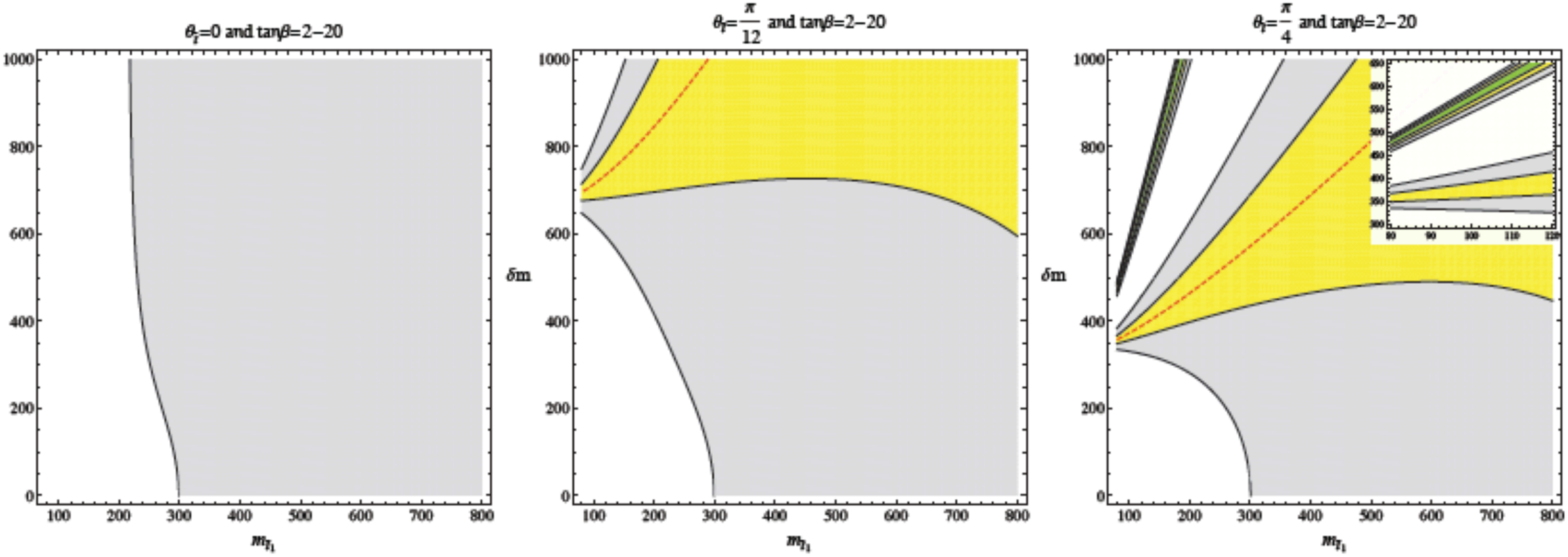
This is a predictive scenario for the wilson coefficients of the higher d ops:

monophoton missing Et exclusions
limit parameter space, ttbar spin correlations, etc
sanz et al. arXiv:1205.1463





Translate to stop space



$1\,\sigma$

$2\,\sigma$

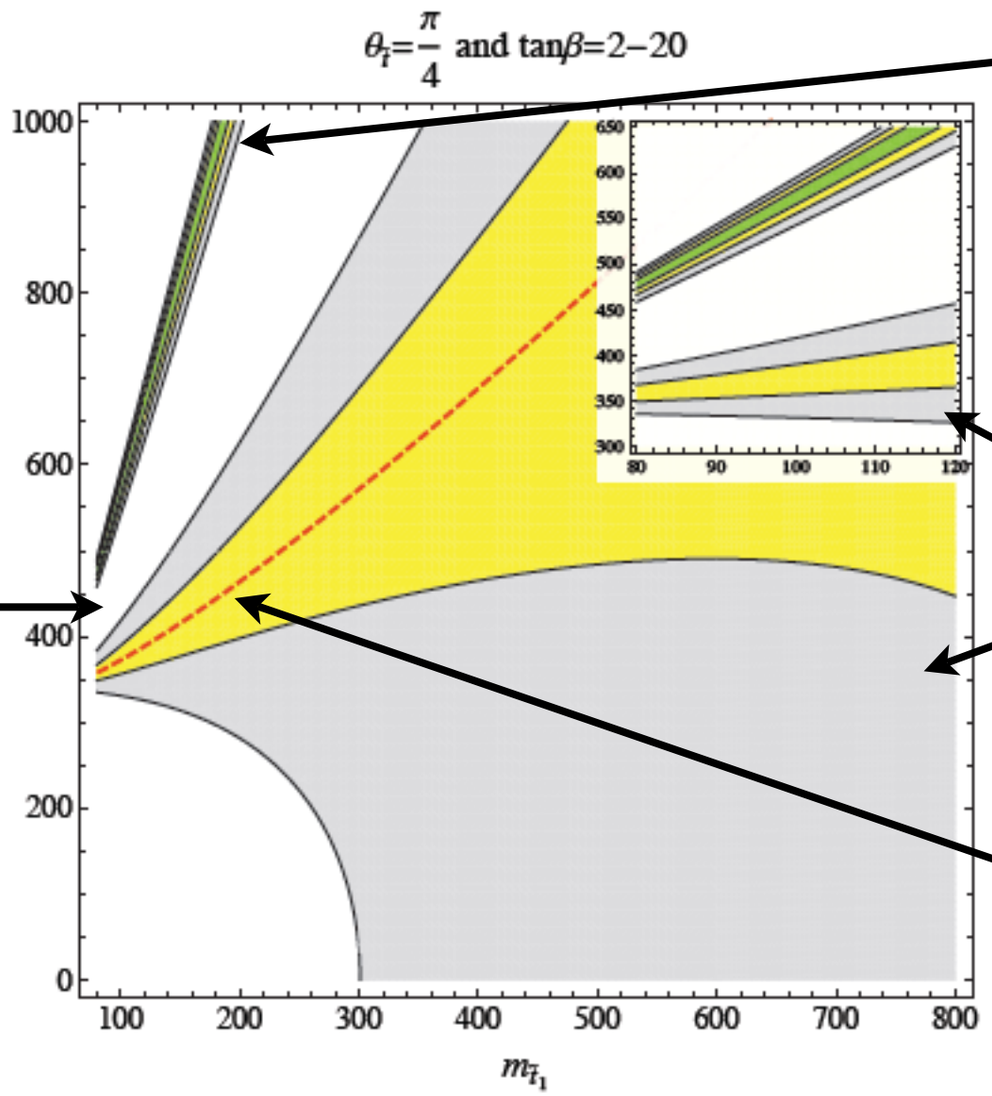
$3\,\sigma$

Map to stop space:

$$F_g = -\frac{1}{3}\left[\frac{m_t^2}{m_{\tilde{t}_1}^2} + \frac{m_t^2}{m_{\tilde{t}_2}^2} - \frac{1}{4}\sin^2(2\,\theta_t)\,\frac{\delta m^4}{m_{\tilde{t}_1}^2\, m_{\tilde{t}_2}^2}\right]$$

Light unmixed stops in bad shape, large mixing preferred in the data.

Translate to stop space



Right through the best fit region

funnel region

Decoupling solution

Second minimum

$1\,\sigma$

$2\,\sigma$

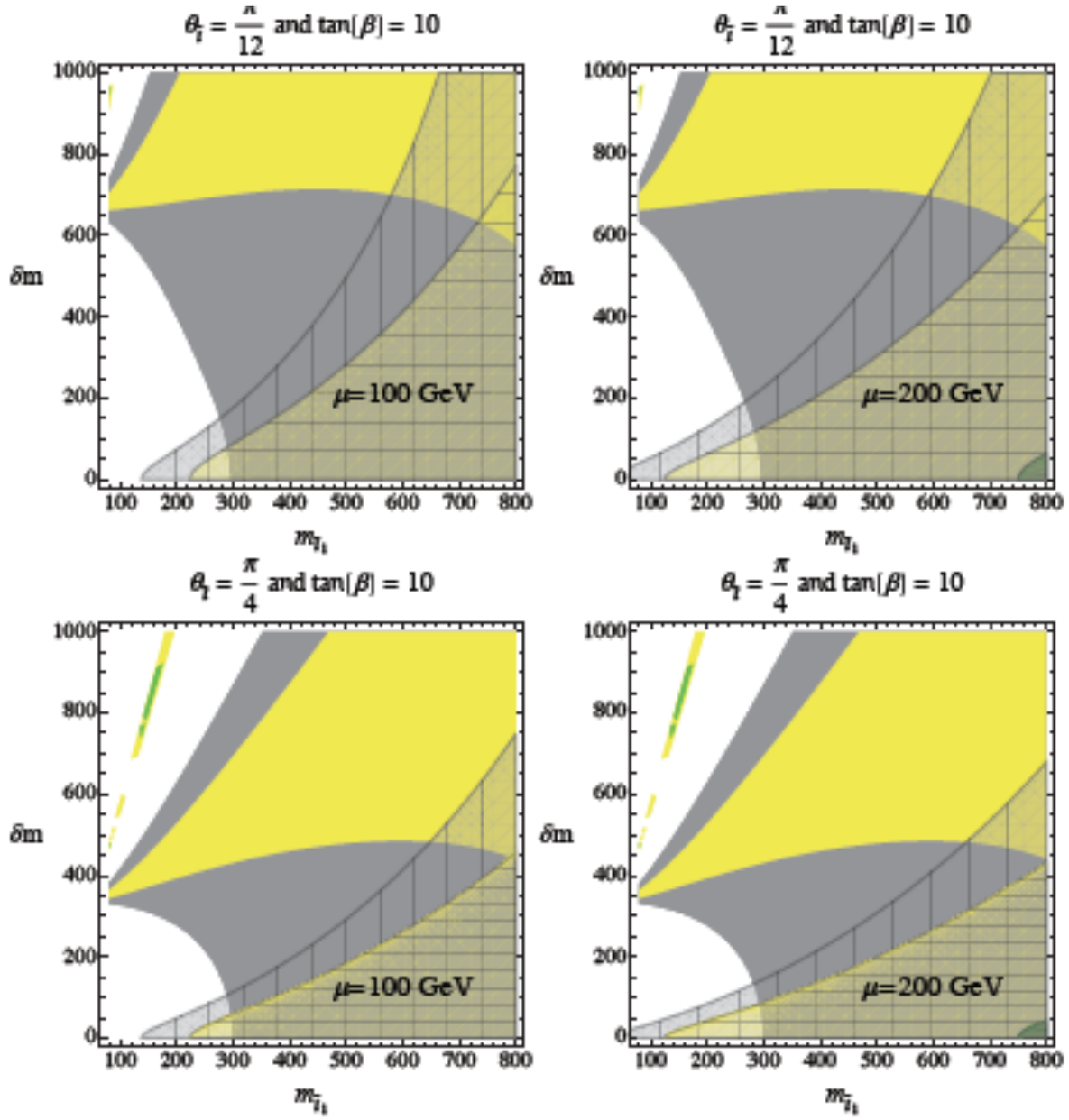
$3\,\sigma$

Map to stop space:

$$F_g = -\frac{1}{3}\left[\frac{m_t^2}{m_{\tilde{t}_1}^2} + \frac{m_t^2}{m_{\tilde{t}_2}^2} - \frac{1}{4}\sin^2(2\,\theta_t)\,\frac{\delta m^4}{m_{\tilde{t}_1}^2\, m_{\tilde{t}_2}^2}\right]$$

Light unmixed stops in bad shape, large mixing preferred in the data.

Consistency of B to s gamma



Not so good news...

μ dependance as the light chargino contributes here in NSUSY

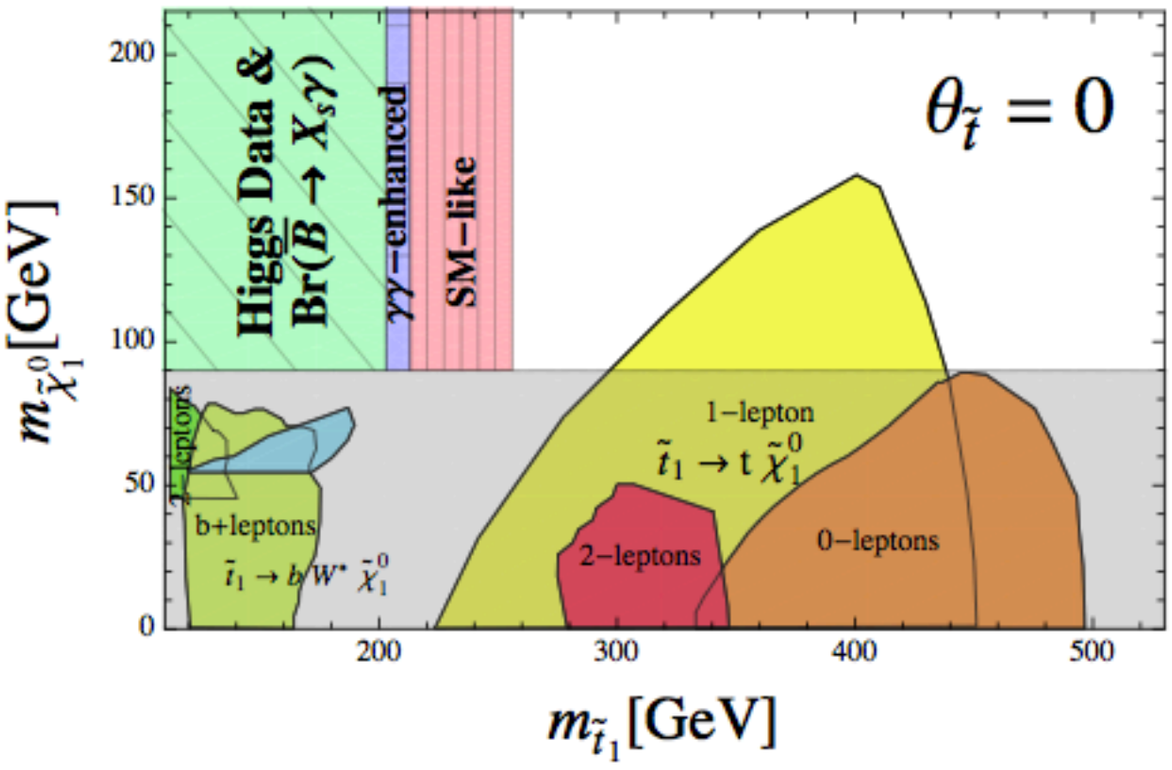
$\mathrm{Br}(\bar{B} \to X_s\,\gamma)$ *basically wants degenerate stops in NSUSY spectrum we consider*

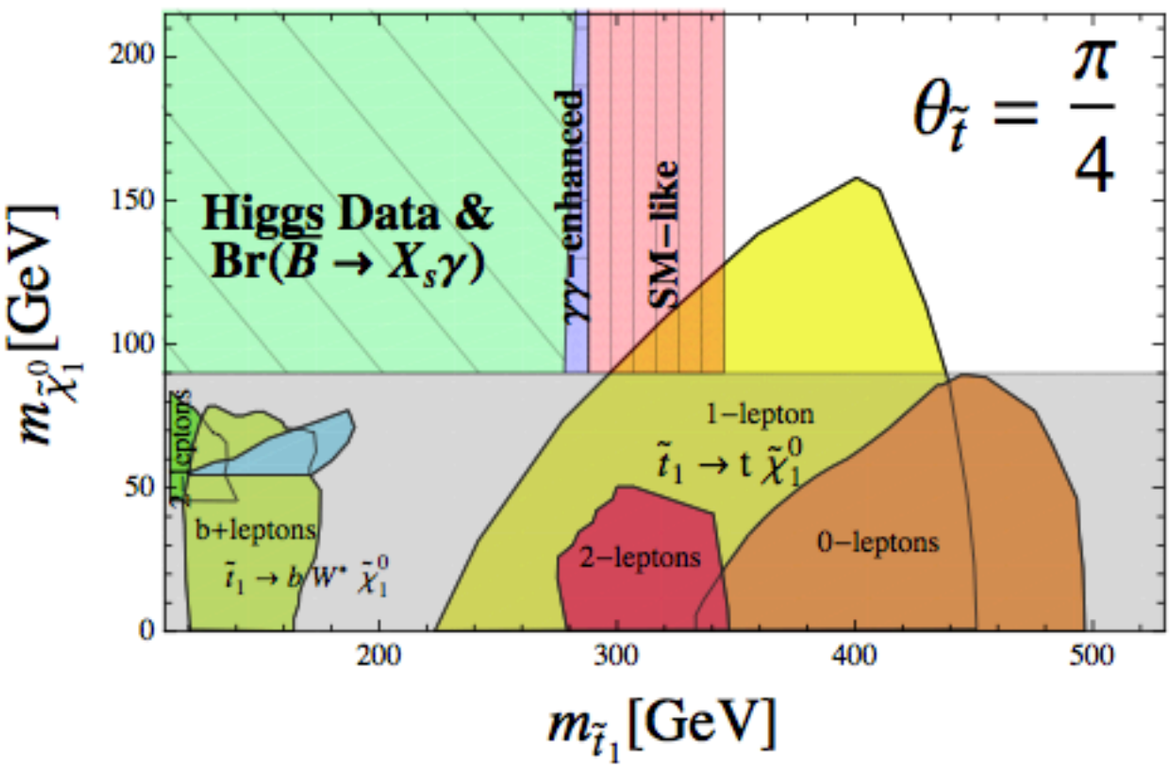
$$\mathrm{BR}(\bar{B} \to X_s\,\gamma)_{E_\gamma > 1.6\,\mathrm{GeV}} = [(3.15 \pm 0.23) - 8.0\,\Delta C_7(\mu_0) - 1.9\,\Delta C_8(\mu_0)] \times 10^{-4}$$

Theory prediction: B. Grzadkowski and M. Misiak, Phys. Rev. D **78**, 077501 (2008) [hep-ph/0802.1413].

$$\mathrm{BR}(\bar{B} \to X_s\,\gamma)_{E_\gamma > 1.6\,\mathrm{GeV}} = [3.43 \pm 0.21 \pm 0.07] \times 10^{-4},$$ *Latest HFAG combo number*

Indirect Exclusion currently and prospects for stops





Combined exclusion with demand that the higgs properties 95 % CL exclude and $\mathrm{Br}(\bar{B} \to X_s\,\gamma)$ *be within 2 sigma of its experimental value*

Interpret with caution!

Indirect probes for stops are powerful tools. Dedicated experimental study warranted and underway now in ATLAS

Conclusions

Need more data.