# The Higgs sector at the LHC: from triumph to nightmare?

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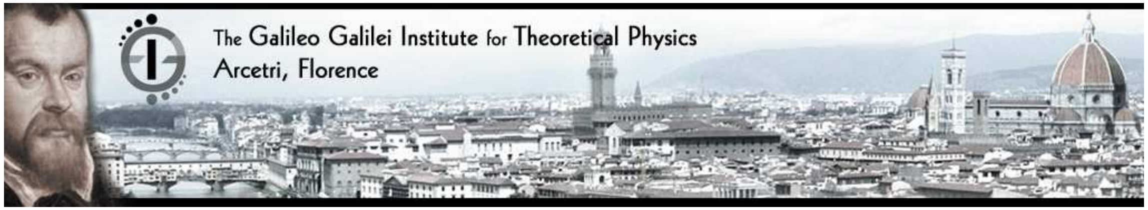
1. Standardissimo?
2. Constraints on new physics: MSSM case
3. Deeper probe of the Higgs sector
4. An example: $\mathrm{D}_{\gamma\gamma}$
5. Conclusion

**I am supposed to briefly summarize the activities on Higgs at:**

Welcome to the:




"Collider Physics and the Cosmos"

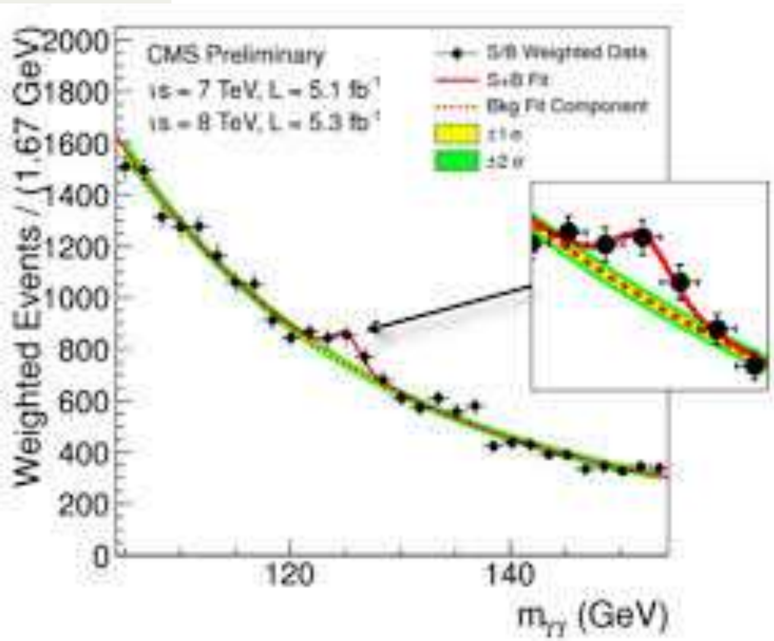
**Week Schedule – September 11-15, 2017**

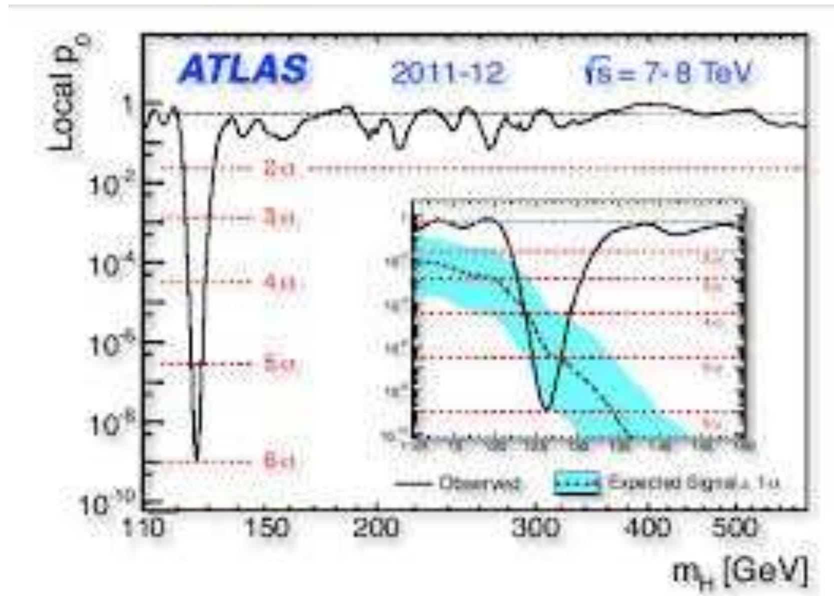
| Day | Time | Room | Speaker | Title |
|---|---|---|---|---|
| **Monday 11** | 15.00<br>16.00 | B | Abdelhak Djouadi<br>all | *Status of the Higgs Sector*<br>*Discussion Session* |
| **Tuesday 12** | 11.00<br>15.00<br>16.00<br>16.30 | B | Howard Haber<br>Jan Henryk Kalinowski<br>Andreas Goudelis<br>all | *Extended Higgs Sectors*<br>*Extended Higgs Sectors*<br>*Extended Higgs Sector and DM*<br>*Discussion Session* |
| **Wednesday 13** | 11.00<br>16.00<br>16.30 | B | Karim Benakli<br>Satoshi Shirai<br>all | *Naturalness*<br>*Naturalness*<br>*Discussion Session* |
| **Thursday 14** | 11.00<br>15.15<br>16.00<br>16.30 | B | Alexander Kusenko<br>Antonio Padilla<br>Luca Marzola<br>all | *Scalar fields in cosmology*<br>*Cosmological Constant*<br>*Higgs and Inflation*<br>*Discussion Session* |
| **Friday 15** | 10.00<br>12.00 | | | ***Round Table Session at VILLA IL GIOIELLO***<br>***Refreshments and Light Lunch*** |

**and short presentations by E.J. Chun, Tania Robens, Nazilla Mahmoudi, ...**
**I do it in a kind of personal way leaving aside some subjects to be discus**
**vaccum stability (Strumia), Inflation (Bezrukov, Hill), Baryogenesis (Lee), ... .**

# 1. Standardissimo?

he Higgs discovery in July 2012: a triumph for high-energy physics.




A very non–trivial check of the SM: test at the quantum/permile level:

– constraints from data: $\mathrm{M_H} = 92^{+34}_{-26}$ GeV $\lesssim 160$ GeV at 95% CL

– experimentally found to be: $\mathrm{M_H} = 125.1 \pm 0.24$ GeV (ie within $1\sigma$..)

In addition, it looks as it has the properties of the SM Higgs state:

he triumph of the SM model of particle physics or Standarissimo?!

# 1. Standardissimo?

**Triumph of the Medici's in the clouds of Mount Olympus, Luca Giordano, fresco in the Palazzo Medici-Riccardi, 1686**

# 1. Standardissimo?

**We have a theory for the strong+electroweak forces, the SM, that is:**

- a relativistic quantum field theory based on a gauge symmetry,
- renormalisable as proved by 't Hooft and Veltman for SEWSB,
- unitary as we have now a Higgs and its mass is rather small,
- perturbative up to the Planck scale as again the Higgs is light,
- leads to a (meta)stable electroweak vacuum up to high scales,
- compatible with (almost) all precision data available to date...

**Is the SM the "theory of everything" and should we be satisfied with it?**

No! Low energy manifestation of a fundamental theory that solves:

- "Esthetical" problems with e.g. multiple and arbitrary parameters; gauge coupling unification: $3 \neq g_i$ which do not meet a high scale.
- "Experimental" problems as it does not explain all seen phenomena: $\nu$ masses/mixing, dark matter, baryon asymmetry in the universe ....
(Note: SO(10) at intermediate $Q = 10^{11}$GeV and axions cure these pbs)
- "Theory" (or consistency) problem: the hierarchy/naturalness pbs.
$\Delta M_H^2 \propto \Lambda^2 \approx (10^{18}\ \mathrm{GeV})^2$: $M_H$ not stable against high scales.

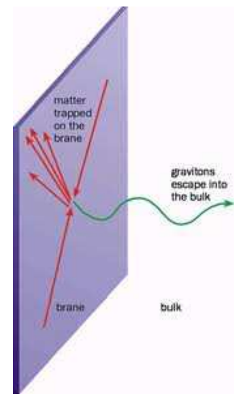
**All these indicate that there is beyond the Standard Model!**

# 1. Standardissimo?

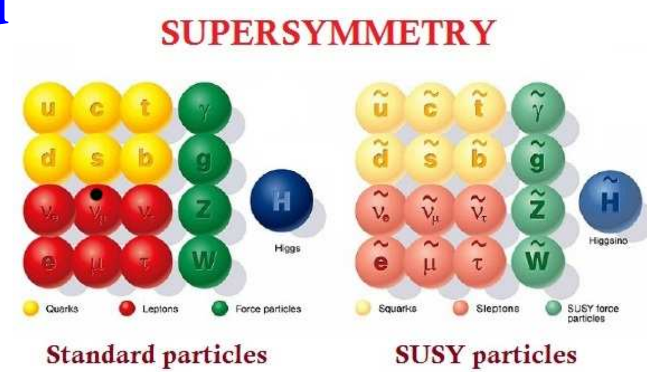
**Three main avenues for solving the hierarchy or naturalness problems**
**Discussed (in day 3) of this meeting: K. Benakli, S. Shirai, ....**

**I. Compositeness/substructure:**
All particles are composite: Technicolor
$\Rightarrow$ H bound state of two fermions
(no more spin–0 fundamental state).

**II. Extra space–time dimensions**
where at least s=2 gravitons propagate.
$\Rightarrow$ effective gravity scale $\Lambda \approx$ 1 TeV.
EWSB mechanism needed: H or not H!




**III. Supersymmetry: doubling the world**
– links s=$\frac{1}{2}$ fermions to s=1 bosons,
– links internal/space-time symmetries,
– if made local, provides link to gravity,
– natural $\mu^2 < 0$: radiative EWSB,
$\Rightarrow$ sparticle loops cancel $\Lambda^2$ behavior




**Extend H sector! Haber, Kalinowksi, Goudelis, Chun, Robens, Mahmoudi, ...**

# 1. Standardissimo?

**Are we in in the nightmare scenario or else, in Dante Alighieri's Inferno?**

**Mosaic (detail) of the Satan in the Last Judgment on the ceiling of the Florence Baptistry San Giovanni (13th century).**

# 1. Standardissimo?

**The problem is that (as discussed in first day of the meeting:**

**A) we observe a Higgs with a mass of 125 GeV and no other Higgs:**

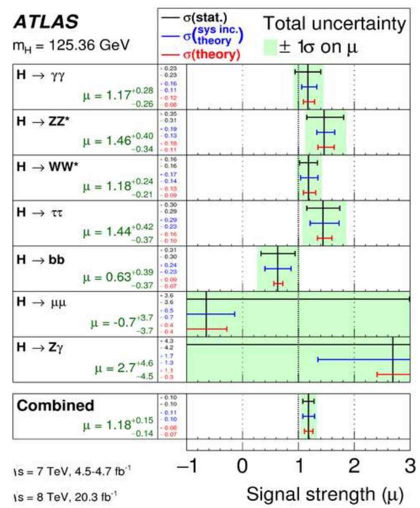
**$\sigma\times$BR rates compatible with those expected in the SM**

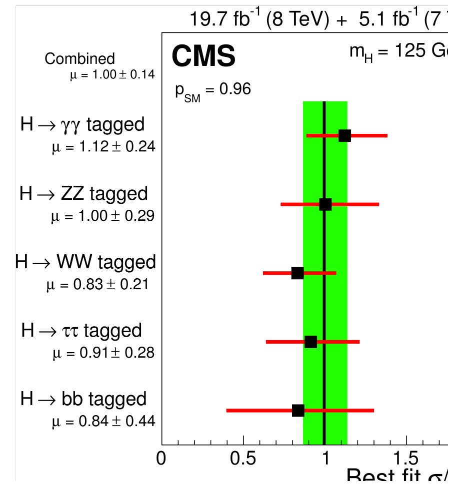
**Fit of all LHC Higgs data $\Rightarrow$ agreement at 15–30% level**

**Results from the LHC 7–8 TeV campaign already give us:**

$$\mu_{\rm tot}^{\rm ATLAS} = 1.18 \pm 0.15$$

$$\mu_{\rm tot}^{\rm CMS} = 1.00 \pm 0.14$$




**we do not observe any new particle beyond those of SM with Higgs:**

**profound implications for most discussed BSM scenarios; they are in:**

- **“Mortuary”: Higgsless, 4th generation, fermio or gauge-phobic..**
- **“Hospital”: Technicolor, composite models (but some loopholes) ....**
- **“Trouble” and strongly constrained: extra-dimensions, SUSY, ...**

**As an example, let us see what it implies for SUSY and the MSSM.**

## 2. Constraints on new physics: MSSM

In the MSSM we need two doublets of complex scalar fields $H_1$ and $H_2$
(2HDM of type II: talks H. Haber, J. Kalinowski, A. Goudelis, EJ Chun..)
After EWSB, three dof for $W^\pm_L, Z_L \Rightarrow$ 5 physical states: $h, H, A, H^\pm$.
Only two free parameters at tree-level to describe the system $\tan\beta, M_A$

$$M^2_{h,H} = \frac{1}{2}\left\{M_A^2 + M_Z^2 \mp \left[(M_A^2+M_Z^2)^2 - 4M_A^2 M_Z^2 \cos^2 2\beta\right]^{1/2}\right\}$$

$$M^2_{H^\pm} = M_A^2 + M_W^2$$

$$\tan 2\alpha = \frac{-(M_A^2+M_Z^2)\sin 2\beta}{(M_Z^2-M_A^2)\cos 2\beta} = \tan 2\beta \, \frac{M_A^2+M_Z^2}{M_A^2-M_Z^2} \quad \left(-\frac{\pi}{2} \le \alpha \le 0\right)$$

$M_h \lesssim M_Z|\cos 2\beta| + RC \lesssim 130$ GeV , $M_H \approx M_A \approx M_{H^\pm} \lesssim M_{EWSB}$.

- Couplings of $h, H$ to VV are suppressed; no AVV couplings (CP).
- For $\tan\beta \gg 1$: couplings to b (t) quarks enhanced (suppressed).

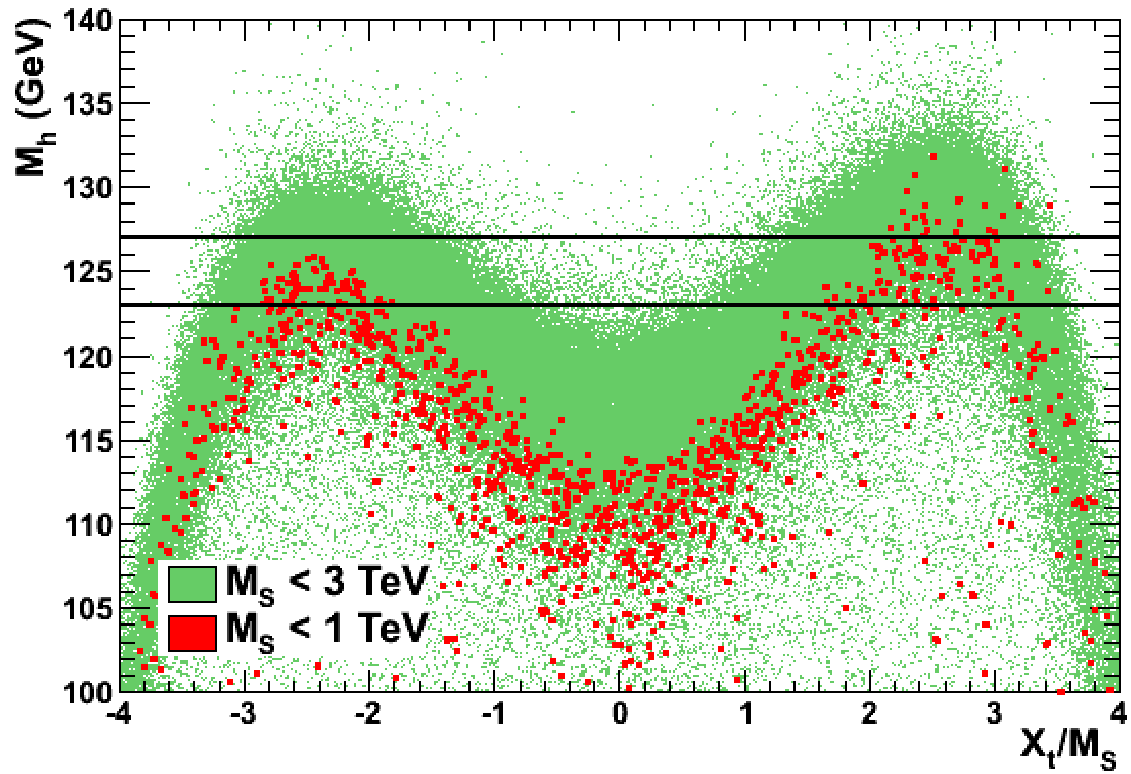
| $\Phi$ | $g_{\Phi\bar{u}u}$ | $g_{\Phi\bar{d}d}$ | $g_{\Phi VV}$ |
|---|---|---|---|
| $h$ | $\frac{\cos\alpha}{\sin\beta} \to 1$ | $\frac{\sin\alpha}{\cos\beta} \to 1$ | $\sin(\beta-\alpha) \to 1$ |
| $H$ | $\frac{\sin\alpha}{\sin\beta} \to 1/\tan\beta$ | $\frac{\cos\alpha}{\cos\beta} \to \tan\beta$ | $\cos(\beta-\alpha) \to 0$ |
| $A$ | $1/\tan\beta$ | $\tan\beta$ | $0$ |

In decoupling limit: MSSM Higgs sector reduces to SM with a light h.

# 2. Constraints on new physics: MSSM

**There is first direct implication from the measurement $M_h = 125\text{GeV}$...**

$$M_h^2 \xrightarrow{M_A \gg M_Z} M_Z^2 \cos^2 2\beta + \frac{3\bar{m}_t^4}{2\pi^2 v^2 \sin^2\beta}\left[\log\frac{M_S^2}{\bar{m}_t^2} + \frac{X_t^2}{M_S^2}\left(1 - \frac{X_t^2}{12 M_S^2}\right)\right] = (125)^2$$



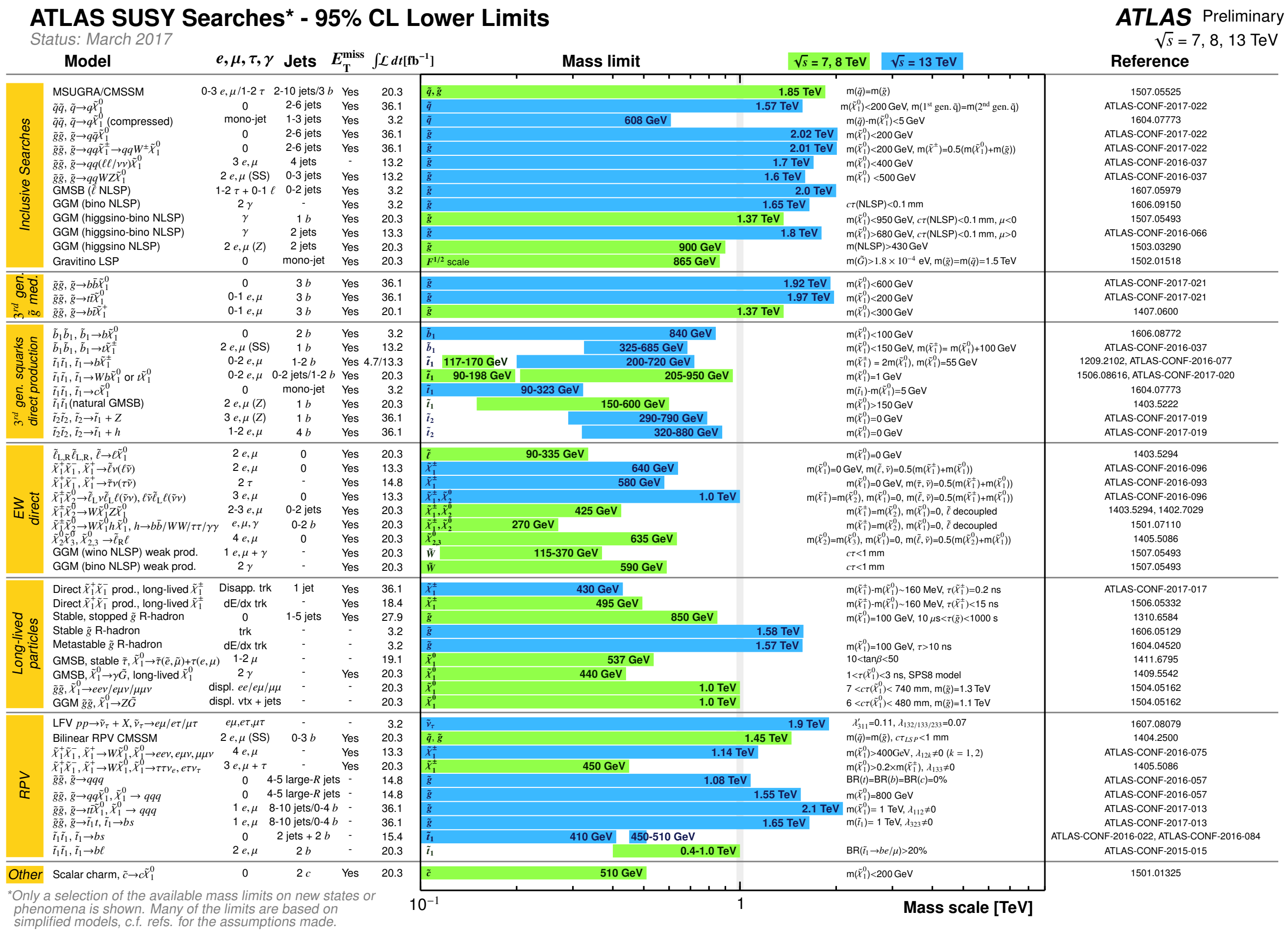

Arbey, Battaglia, AD, Mahmoudi, Quevillon (2012)

**$M_{SUSY} \gtrsim 1\text{TeV}$ in general MSSM and higher in constrained models.**

# 2. Constraints on new physics: MSSM

**This is backed up by direct searches of SUSY particles at the LHC:**

**the SUSY scale $M_{\rm SUSY} \gtrsim \mathcal{O}(1~{\rm TeV})$ in most experimental searches..**




**⇒ ATLAS/CMS depressing tables ....**

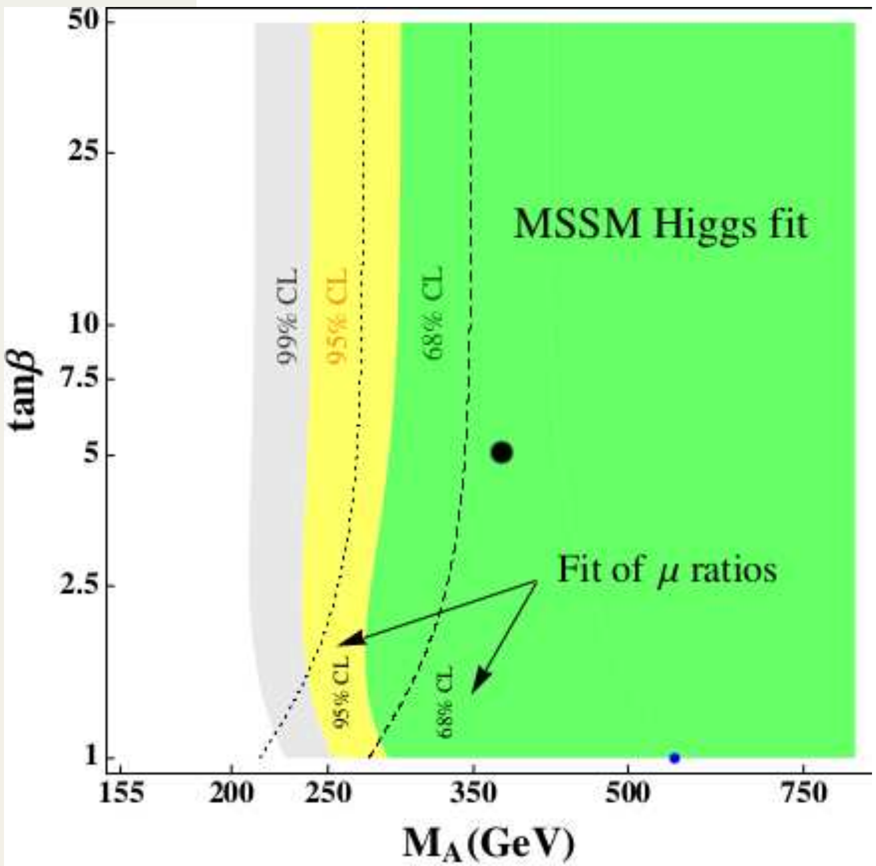
# 2. Constraints on new physics: MSSM

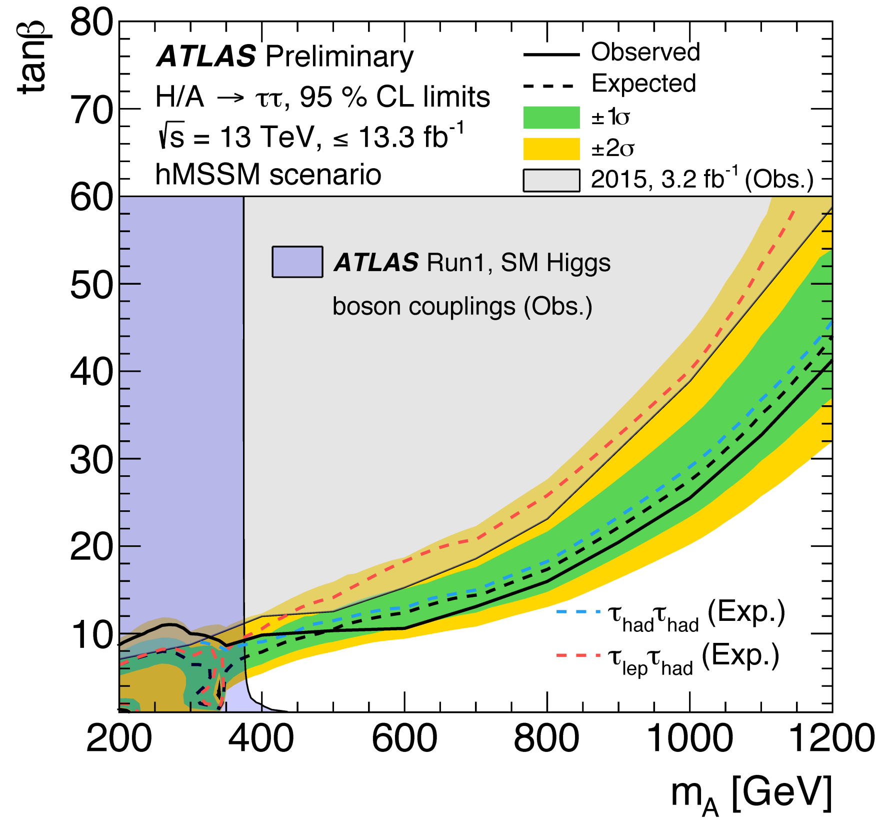
**Also backed up indirectly by the measurement of the Higgs properties:**

**fits of the h couplings ⇒ constraints on the MSSM $[M_A, \tan\beta]$ plane:**

**MSSM:** $g_{ht\bar{t}} = \cos\alpha / \sin\beta$, $g_{hb\bar{b}} = \cos\alpha / \sin\beta$, $g_{hVV} = \sin(\beta - \alpha)$

**Global fit of H couplings (2013)** | **Direct search for pp→H,A**



# 3. Deeper probe of the Higgs sector

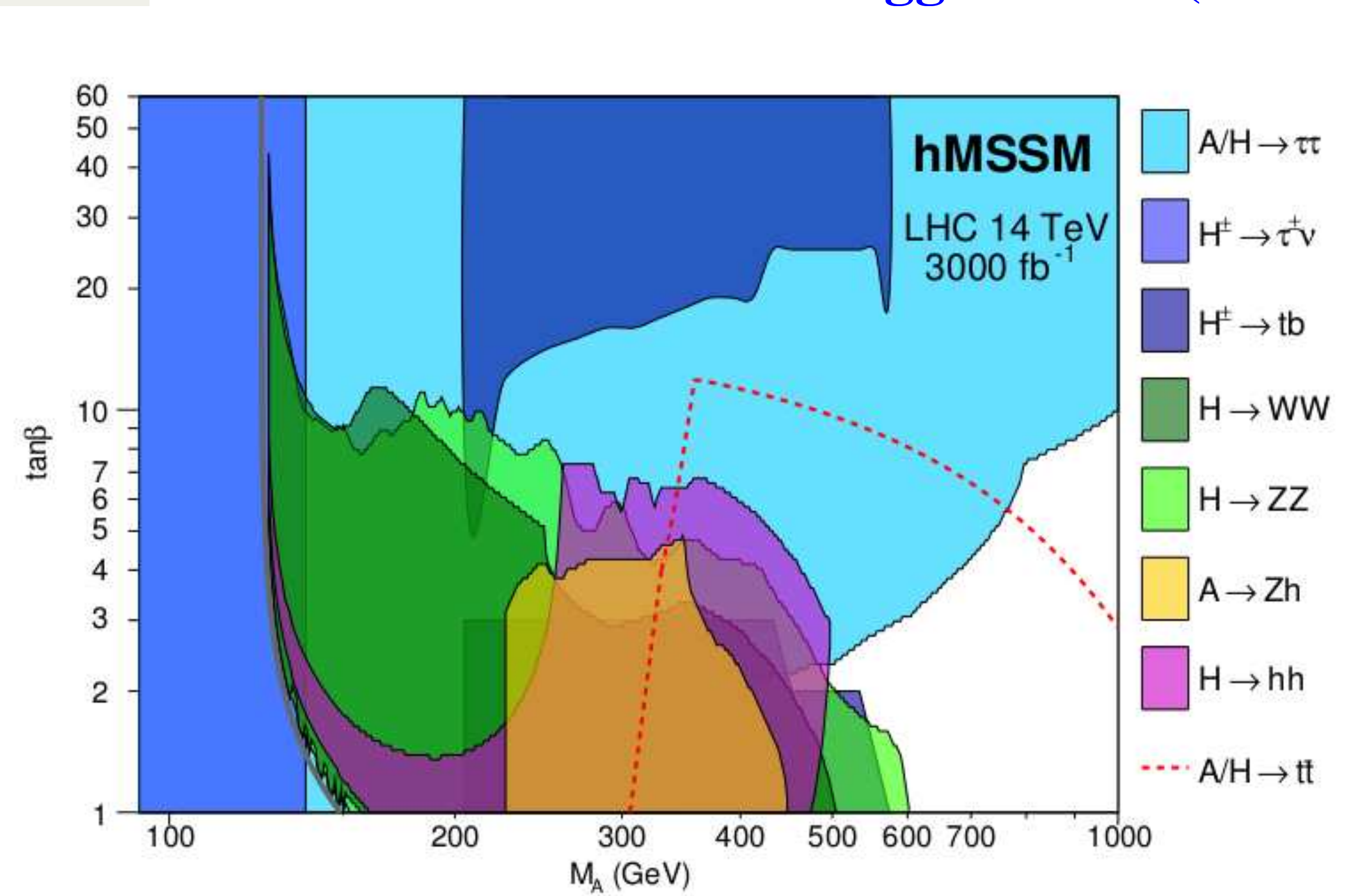
**he question is: Particle Physics "closed" and we should all go home?**

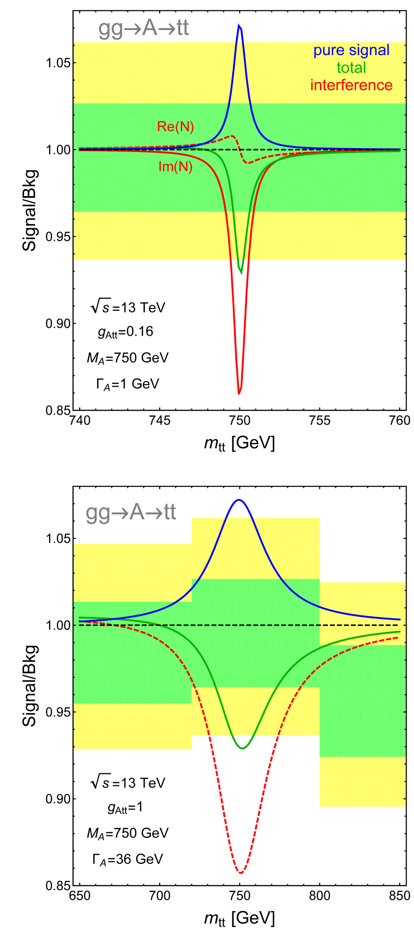
**Triumph of Death (detail), Buonamico Buffalmacco de Firenze (F. Traini?)**
**Fresco at Camposanto Monumentale in Pisa, Italy, 1350.**

# 3. Deeper probe of the Higgs sector

**The answer is of course: No!**

**1) Fully probe the TeV scale that is relevant for the hierarchy problem**
**⇒ continue to search for heavier Higgs bosons (and superparticles).**

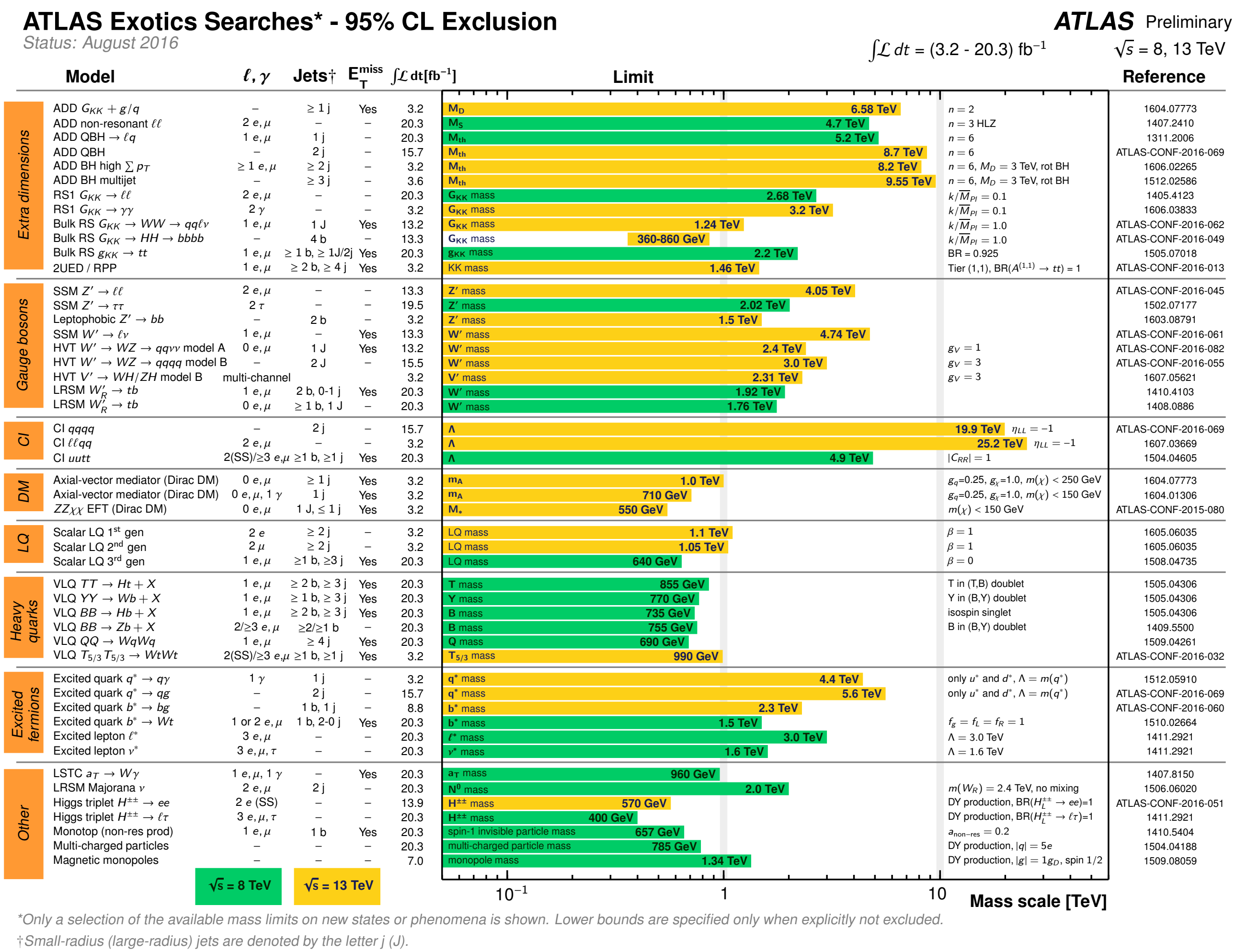



**AD, Maiani,Quevillon, Polosa,Riquer...** **AD, Ellis,Quevillon**

# 3. Deeper probe of the Higgs sector

## Continue searches for exotic particles in all possible channels.




**Should be continued, extended, refined:**

**new states are simply around the corner and can be found tomorrow!**

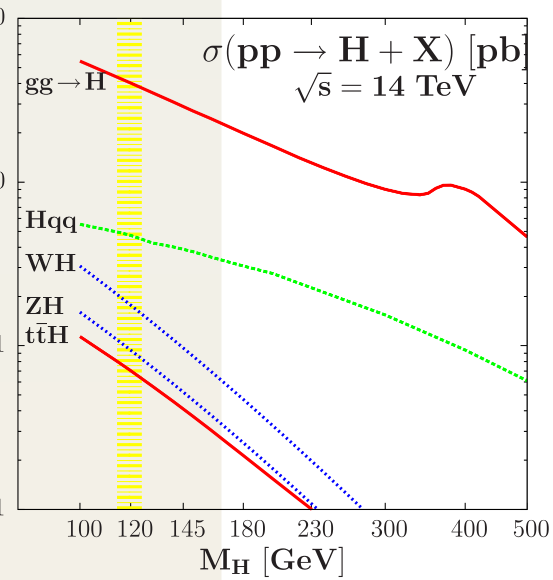
# 3. Deeper probe of the Higgs sector

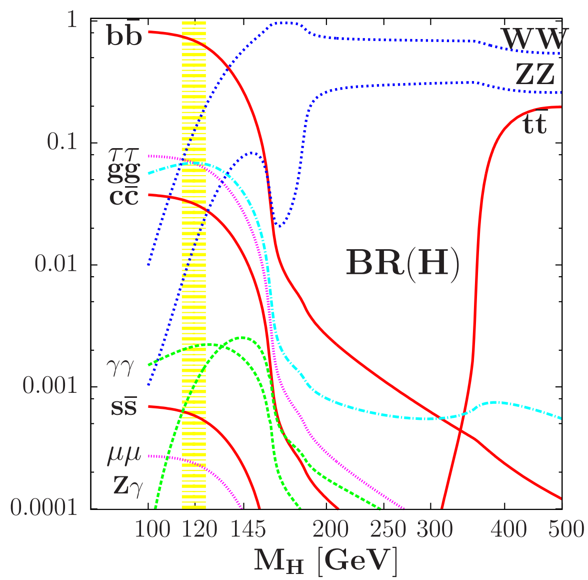
he next question is then: "is Particle Physics closed"? Answer is no!

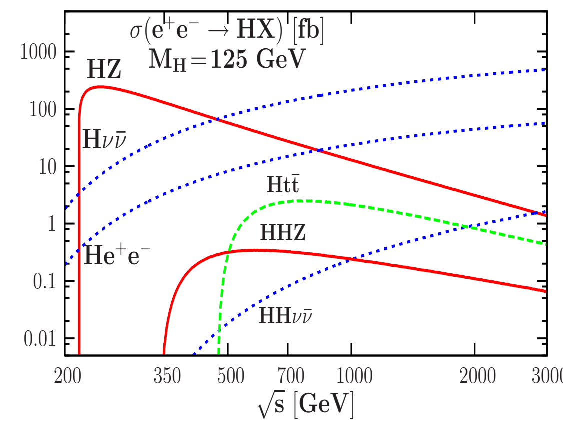
2) Need to check that H is indeed responsible of EWSB (and SM-like?)
⇒ measure its fundamental properties in the most precise way:

- its mass and total decay width (invisible width due to dark matter?),
- its spin–parity quantum numbers (CP violation for baryogenesis?),
- its couplings to fermions and gauge bosons and check if they are only proportional to particle masses (no new physics contributions?),
- its self-couplings to reconstruct the potential $V_S$ that makes EWSB.

Possible for $M_H \approx 125$ GeV as all production/decay channels useful.



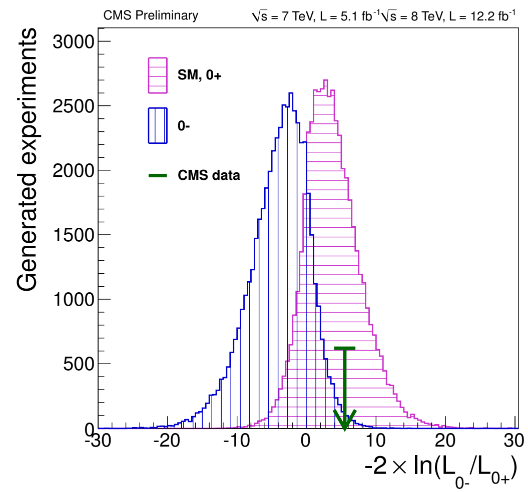



# 3. Deeper probe of the Higgs sector

**A check of spin–parity quantum numbers.**

**Spin: clear situation (no suspense) as the new state decays into $\gamma\gamma$**
**$\Rightarrow$ not s=1 from Landau–Yang and s=2 (KK graviton?) unlikely..**

**CP numbers: CP-even, CP-odd, or mixture?**
**(more important issue: CPV in Higgs sector.)**
**ATLAS and CMS MELA analyses for pure CP**
**$\Rightarrow$ pure CP-even favored at $\gtrsim 3\sigma$ level.**
**But problems with this (too simple) picture:**
**pure CP–odd does not couple to VV@tree-level;**
**in $H \to ZZ^*$ only CP-even part is projected out.**




- **Direct probe:** **via production/decays in extensions like C2HDM:**

**Ex: Undoubtable signs of CP-violation in Higgs decays at LHC run 2**
**combined searches of $h_i \to h_j Z$ and $h_i \to ZZ$ with $i,j = 1,2,3$.**

- **Indirect probe:** **$g_{Hff}$ more democratic $\Rightarrow$ fermionic decays.**

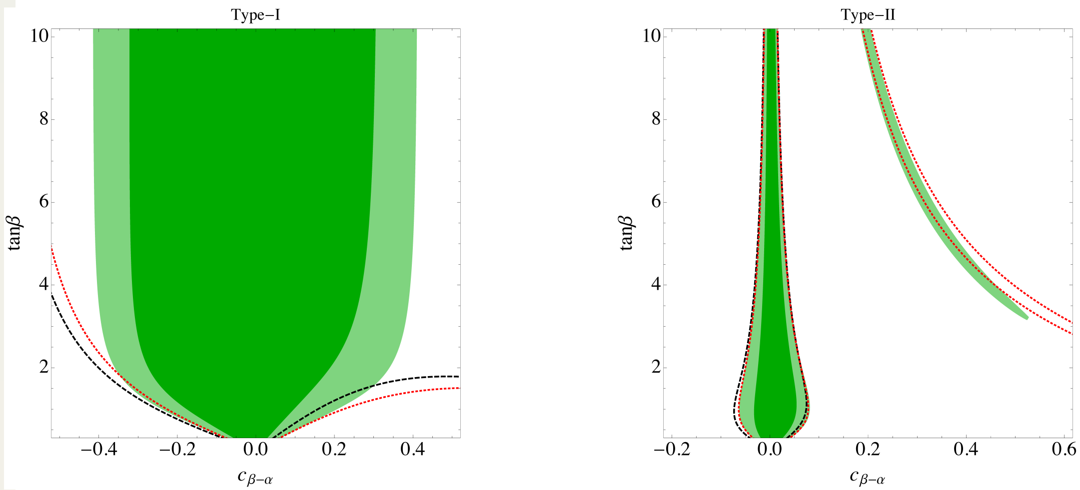
**Ex: spin-correlations in $q\bar{q} \to HZ \to b\bar{b}ll$ or $q\bar{q}/gg \to Ht\bar{t} \to b\bar{b}t\bar{t}$.**

**Need to be lucky or is very challenging even at the HL–LHC...**

# 3. Deeper probe of the Higgs sector

**Perform a much more precise measurement of the Higgs couplings**
$\Rightarrow$ **would allow a better sensitivity to new physics virtual effects.**

**• In standard production+decay channels as gg $\rightarrow$ H $\rightarrow$ ZZ, WW, $\gamma\gamma$**
**Presently sensitivity is low in many cases as 2HDM of type I and II:**
**still large theoretical+experimental errors of about 15–20% each**




**Falkowski**

**Fontes**

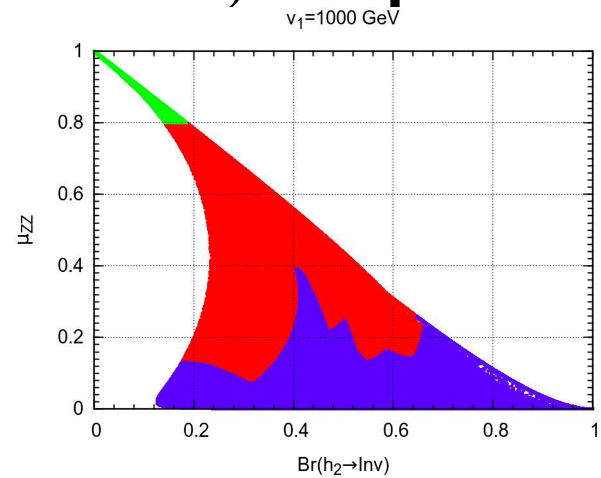
**Romao**

**Silva...**

**• In very rare decays that allow additional/unknown information:**
**– H $\rightarrow \mu^+\mu^-$ to probe second generation fermion couplings**
**– H $\rightarrow \Upsilon\gamma$ to probe the sign of some fermionic couplings (here b's).**
**– H $\rightarrow Z\gamma$ with information that is complementary to H $\rightarrow \gamma\gamma$**
**But will this be sufficient to probe BSM physics? (see later....)**

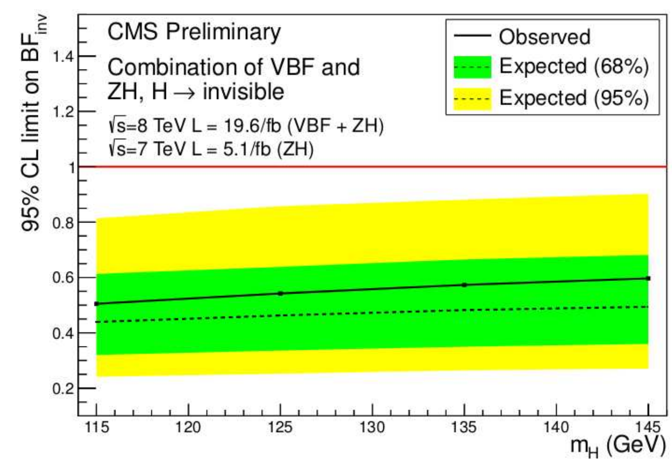
# 3. Deeper probe of the Higgs sector

• **Total width**: $\Gamma_H = 4$ MeV, too small to be resolved experimentally.
– very loose bound from interference gg→ZZ (a factor 2–5 at most).
– no way to access it indirectly (via production rates) in a precise way.




Bonilla. Romao. Valle

• **Invisible decay width: DM connection!**
Higgs portal to DM particles scenario:
discussed thoroughly at this meeting:
day 3: Goudelis, Kim, Kusenko, Roben,...
Best probe so far: the HZ channel:
$q\bar{q} \to HZ$ with $Z \to ll, H \to$ invisible
similar $E\!\!\!/_T$ analyses in VBF channels
and also recently in gg→Higgs+jet.
Combined HZ+VBF search from CMS
$BR_{inv} \lesssim$ 50%@95%CL for SM Higgs
Improvement in future: 10%@HL–LHC?



# 3. Deeper probe of the Higgs sector

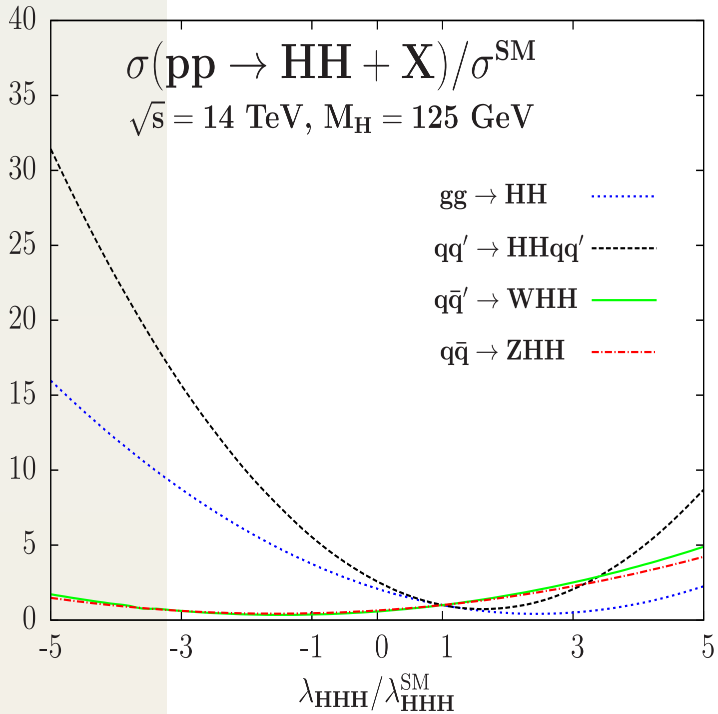
**Important challenge: measure Higgs self-couplings and access to $V_H$.**

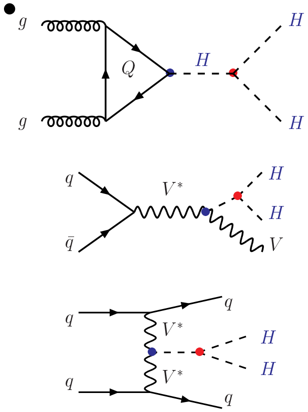
**$g_{H^3}$ from $pp \to HH + X$ $\Rightarrow$**

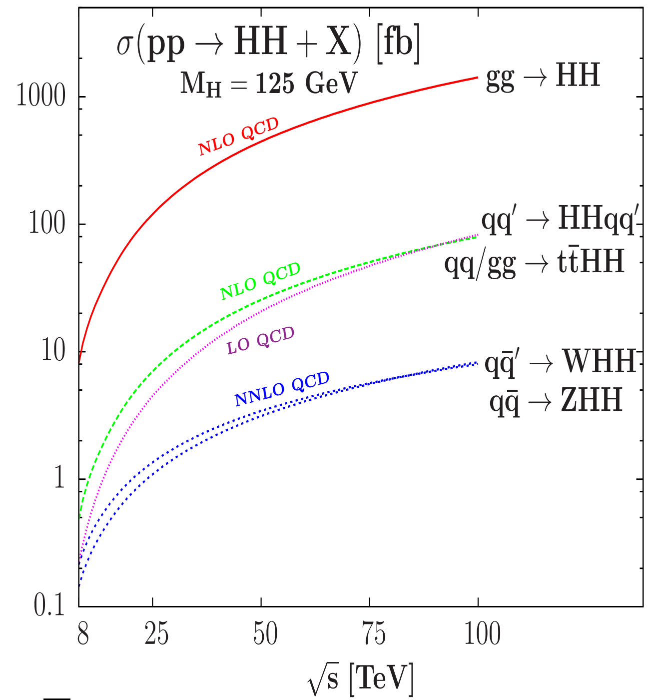
**$g_{H^4}$ from pp→3H+X, hopeless.**

**arious processes for HH prod:**

**nly gg $\to$ HHX relevant...**






- **$H \to b\bar{b}$ decay alone not clean**
- **$H \to \gamma\gamma$ decay very rare,**
- **$H \to \tau\tau$ would be possible?**
- **$H \to WW$ not useful?**

**$bb\tau\tau$, $bb\gamma\gamma$ viable? Maybe...**
**but needs very large luminosity.**

**Baglio, Spira et al., 2012**

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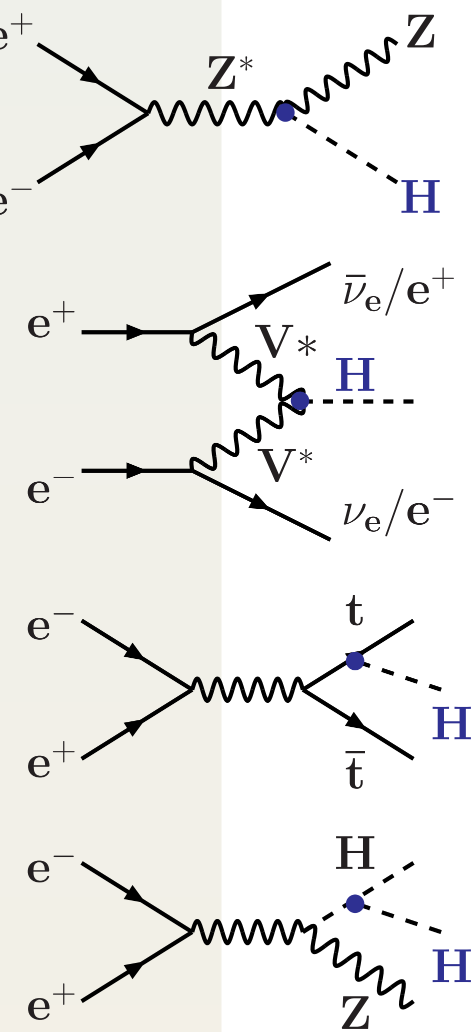
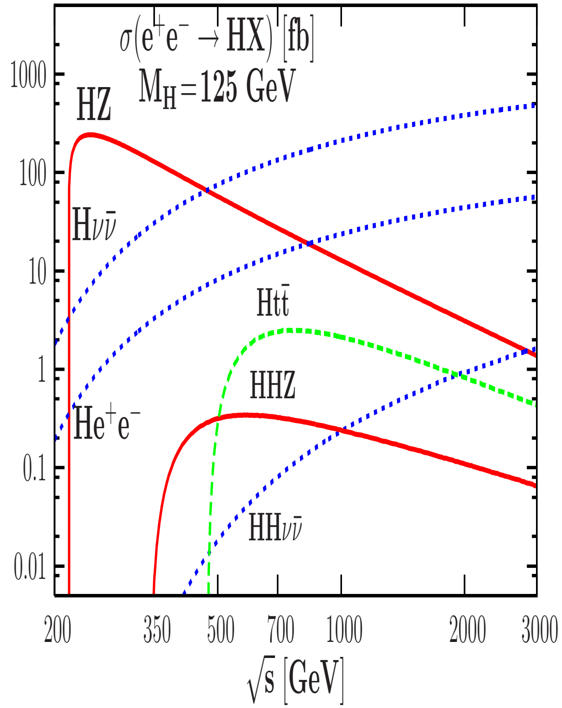
# 3. Deeper probe of the Higgs sector




**Very precise measurements mostly at $\sqrt{s} \lesssim$ 500 GeV and mainly in $e^+e^- \to ZH$ (with $\sigma \propto 1/s$) and ZHH, ttH**

| | |
|---|---|
| $g_{HWW}$ | $\pm 0.012$ |
| $g_{HZZ}$ | $\pm 0.012$ |
| $g_{Hbb}$ | $\pm 0.022$ |
| $g_{Hcc}$ | $\pm 0.037$ |
| $g_{H\tau\tau}$ | $\pm 0.033$ |
| $g_{Htt}$ | $\pm 0.030$ |
| $\lambda_{HHH}$ | $\pm 0.22$ |
| $M_H$ | $\pm 0.0004$ |
| $\Gamma_H$ | $\pm 0.061$ |
| CP | $\pm 0.038$ |

$\Rightarrow$ **difficult to be beaten by anything else for $\approx$ 125 GeV Higgs**

**But let's get back to the near future: what can we do at HL-LHC?**

# 4. Example: $D_{\gamma\gamma}$

nother way to search for New Physics: high precision measurements.
Example: Higgs couplings in cleanest channels: $H \to \gamma\gamma$, $H \to 4\ell^{\pm}$

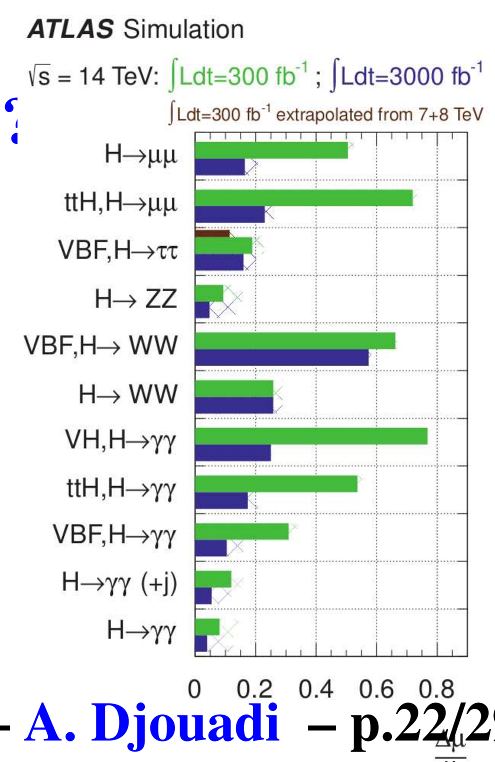
| channel | atlas | cms |
|---|---|---|
| $\mu_{\gamma\gamma}$ | $1.17\ ^{+0.23}_{-0.23}\ ^{+0.16}_{-0.11}\ \left(^{+0.12}_{-0.08}\right)$ | $1.14\ ^{+0.21}_{-0.21}\ ^{+0.16}_{-0.10}\ \left(^{+0.09}_{-0.05}\right)$ |
| $\mu_{ZZ}$ | $1.46\ ^{+0.35}_{-0.31}\ ^{+0.19}_{-0.13}\ \left(^{+0.18}_{-0.11}\right)$ | $0.93\ ^{+0.26}_{-0.23}\ ^{+0.13}_{-0.09}$ |

**Is this enough to probe effects of new physics or BSM?**

ot in the case of weakly interacting theories like 2HDM, SUSY, etc...

expect effects at $\approx \frac{C_{new}\alpha_W}{\pi} \approx \frac{M_h^2}{M_{new}^2} \approx 1\%$;

Is 1% accuracy achievable at HL-LHC ($3ab^{-1}$)?




- Statistical error: $20\%/\sqrt{3 \times 100} \lesssim$ 1–2%
(projection OK with ATLAS+CMS combo)
- Systematical error: can be made $\lesssim 1\%$ ?
some errors are common (luminosity, etc....).
- Theoretical uncertainty (if it is $\gg 1\%$):
will be then by far the crucial/limiting issue!

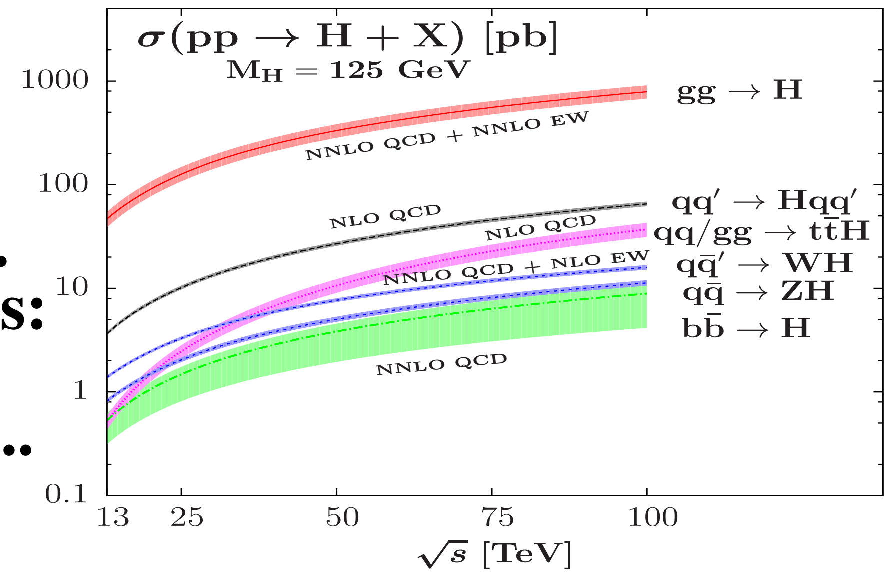
$\Rightarrow$ How big is it? Can it be reduced? Removed?

# 4. Example: $D_{\gamma\gamma}$

**Production cross sections**

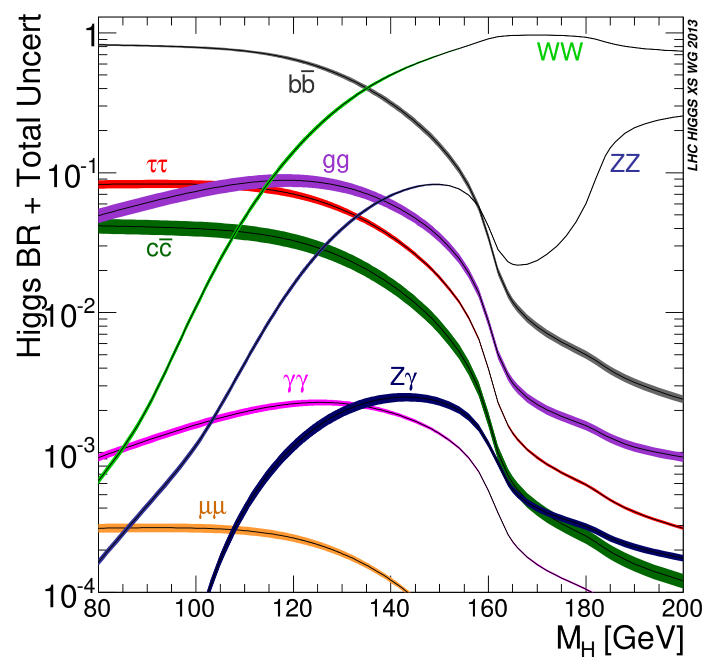
**gg→ H by far dominant process**
**(≈ 85% of the events before cuts)**
**⇒ O(10%) total TH uncertainty .....**
**followed by cleaner VBF+VH modes:**
**only $\lesssim$ 15% of rate before cuts...**
**smaller TH error only for inclusive...**
**⇒ O(10%) for total uncertainty?**

**LHCXSWG (2011), Baglio et al (2015)**




**Decay branching ratios**

**Dominant decay $H \to b\bar{b} \approx 60\%$**
**Affected by QCD+parametric errors:**
**from $m_b$ and $\alpha_s$ only, a few % ⇒**
**migrate to O(5%) error in other modes**
**such as $H \to \gamma\gamma, ZZ, WW, \tau\tau$**
**(partial widths very precise $\lesssim$ 1%).**
**⇒ too large theory uncertainties**
**(even if reduced by a factor of 2)...**




**LHCXSWG + Denner et al. (2011)**

# 4. Example: $D_{\gamma\gamma}$

**Best way to eliminate theory uncertainty: use ratios of signal rates.**

**H→VV with V→ℓ as reference and H→XX with H produced in p:**

$$D_{XX} = \sigma^{p}(pp \to H \to XX)/\sigma^{p}(pp \to H \to VV)$$
$$= \sigma^{p}(pp \to H) \times BR(H \to XX)/\sigma^{p}(pp \to H) \times BR(H \to VV)$$
$$= BR(H \to XX)/BR(H \to VV) = \Gamma(H \to XX)/\Gamma(H \to VV)$$

**To first approximation:** $D_{XX} = c_X^2/c_V^2$

**Works only if one selects exactly same kinematical configuration (i.e. same "fiducial cross sections") for the two channels X and V!**

- **the theoretical uncertainties from the cross sections drop out;**
- **the parametric uncertainties from the branching ratios drop out;**
- **the theoretical ambiguities in the Higgs total width also drop out;**

⇒ $D_{XX}$ **measures only the ratio of partial decay widths.**

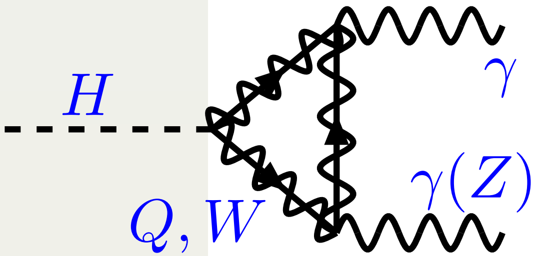
- **Extremely clean theoretically, although some information will be lost.**
- **And maybe it has also some advantages from the experimental side?**

**Best probe by far is $D_{\gamma\gamma}$ which measures deviations of the $\gamma\gamma$ loop**

$$D_{\gamma\gamma} = \frac{\sigma(pp \to H \to \gamma\gamma)}{\sigma(pp \to H \to VV)} = \frac{\Gamma(H \to \gamma\gamma)}{\Gamma(H \to VV)} = d_{\gamma\gamma} c_\gamma^2/c_V^2$$

**AD (2012)**

# 4. Example: $D_{\gamma\gamma}$




$$\Gamma = \frac{G_\mu\, \alpha^2\, M_H^3}{128\, \sqrt{2}\, \pi^3} \left| \sum_f N_c e_f^2 A_{\frac{1}{2}}^H(\tau_f) + A_1^H(\tau_W) \right|^2$$

$$A_{1/2}^H(\tau) = 2[\tau + (\tau - 1) f(\tau)]\, \tau^{-2}$$

$$A_1^H(\tau) = -[2\tau^2 + 3\tau + 3(2\tau - 1) f(\tau)]\, \tau^{-2}$$

- Loop decay. In SM: only W- and top-loops are relevant (others small)
- For $m_i \to \infty \Rightarrow A_{1/2} = \frac{4}{3}$ and $A_1 = -7$: W loop dominating!

$\gamma\gamma$ width counts the number of charged particles coupling to Higgs!

Contribution $A_s^p$ of particle p of spin s with Higgs coupling $g_{Hpp}$:

$$A_0^p = -\tfrac{1}{3} g_{Hpp}^2/m_P^2,\ A_{1/2}^p = +\tfrac{4}{3} g_{Hpp}^2/m_P^2,\ A_1^p = -7 g_{Hpp}^2/m_P^2,$$

If $g_{Hpp} \propto m_p \Rightarrow A_0^p \to +\frac{1}{3}, A_{1/2}^p \to -\frac{4}{3}, A_1^p \to +7.$

Small/calculated QCD and EW corrections: only of order of percent.

+Spira+Zerwas, Vicini et al., AD+Gambino, Actis et al., (ZZ: Denner et al.)

In SM with W,t loops: $c_\gamma \approx 1.26 \times |c_W - 0.21\, c_t|$

Assuming custodial symmetry $g_{HZZ} = g_{HWW} = c_V$, $D_{\gamma\gamma} = c_\gamma^2/c_V^2$ is

$$c_\gamma^2/c_V^2 \approx 6.5 \times |1 - \tfrac{1}{5} c_t/c_V|^2$$

with $c_V = c_t = 1$ in SM. Any new physics effects will alter this value.

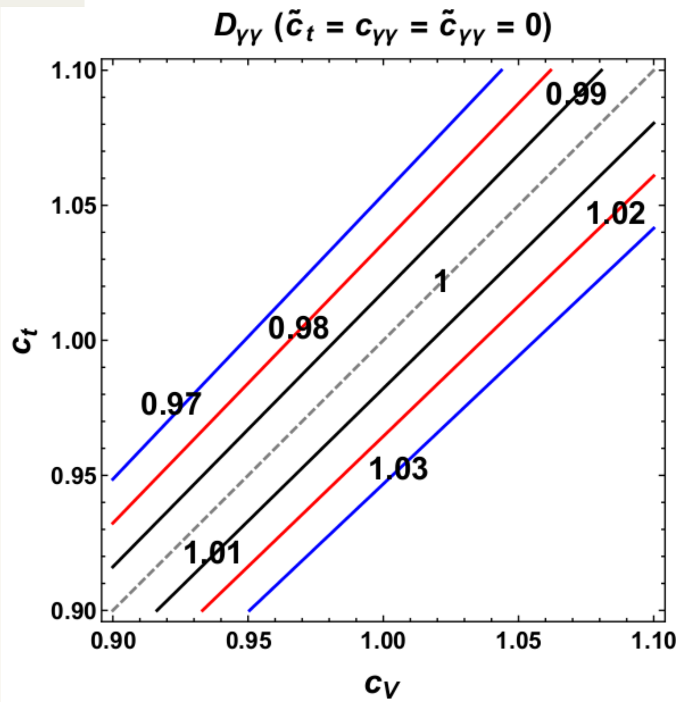
# 4. Example: $D_{\gamma\gamma}$

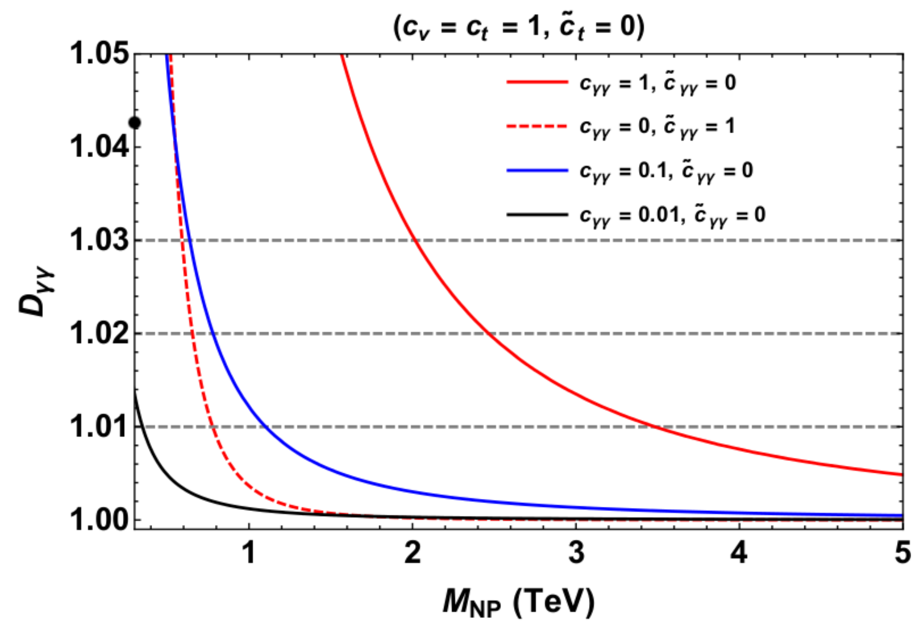
**Will $D_{\gamma\gamma}$ be the g-2 of the LHC? Yes, if measured at 1% level!**

**Examples of BSM searches: AD, Quevillon, Vega-Morales, 1509.03913**

**Model independent search through an effective Lagrangian approach.**

$$\mathcal{L} = \frac{H}{v}\Big(c_V(2M_W^2 W_\mu^+ W^{-\mu} + M_Z^2 Z_\mu Z^\mu) - m_t \bar{t}(c_t + i\tilde{c}_t\gamma^5)t + \frac{c_{\gamma\gamma}}{4}F^{\mu\nu}F_{\mu\nu} + \frac{\tilde{c}_{\gamma\gamma}}{4}\tilde{F}^{\mu\nu}F_{\mu\nu}\Big)$$

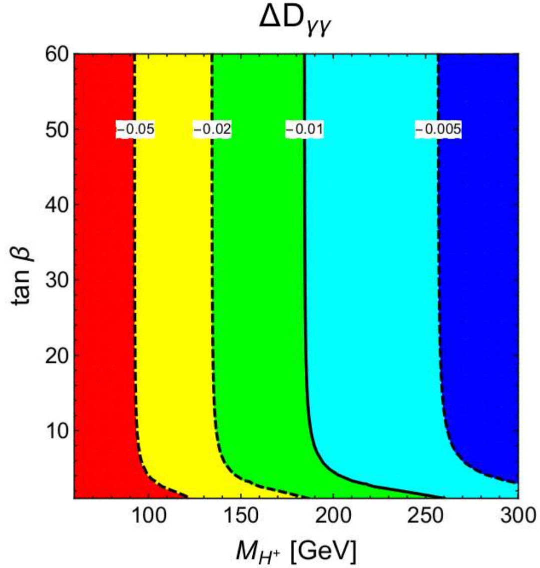


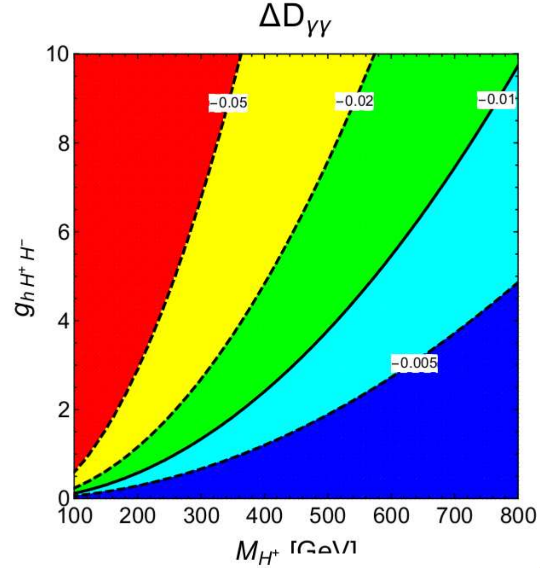



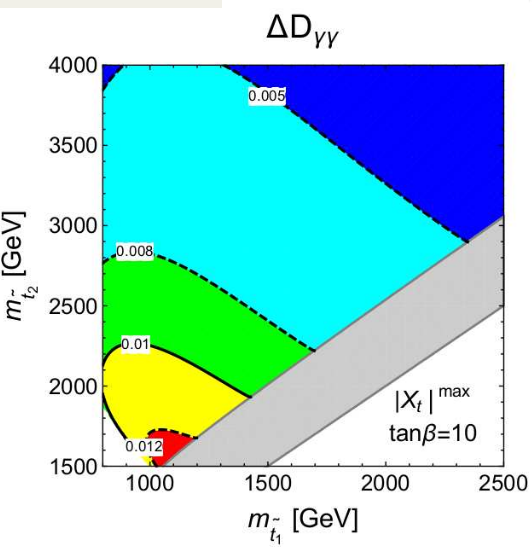
# 4. Example: $D_{\gamma\gamma}$

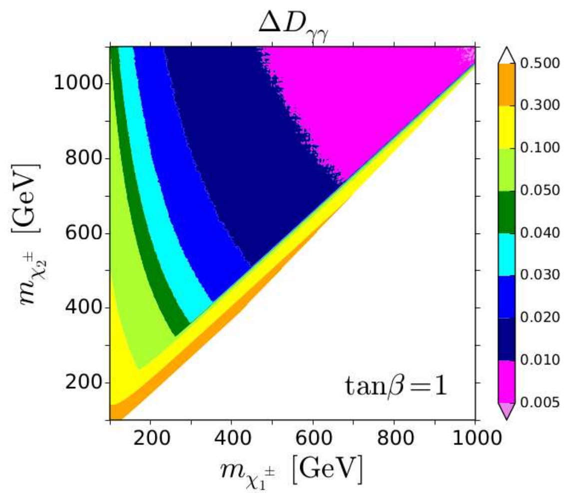
**Will $D_{\gamma\gamma}$ be the g-2 of the LHC? Yes, if measured at 1% level!**

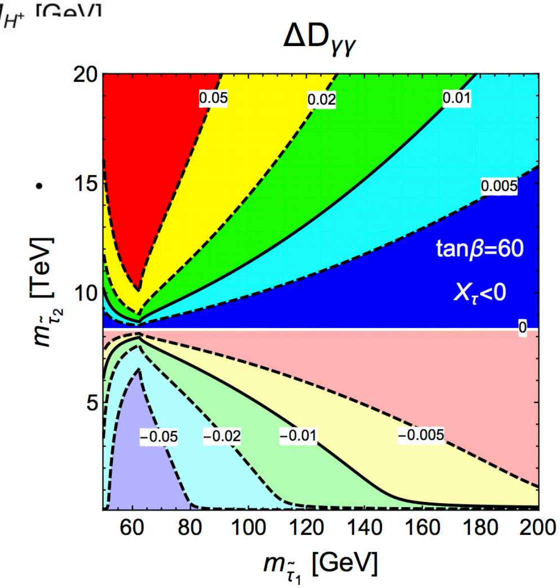
**Example: MSSM searches, AD, Quevillon, Vega-Morales, 1509.03913**



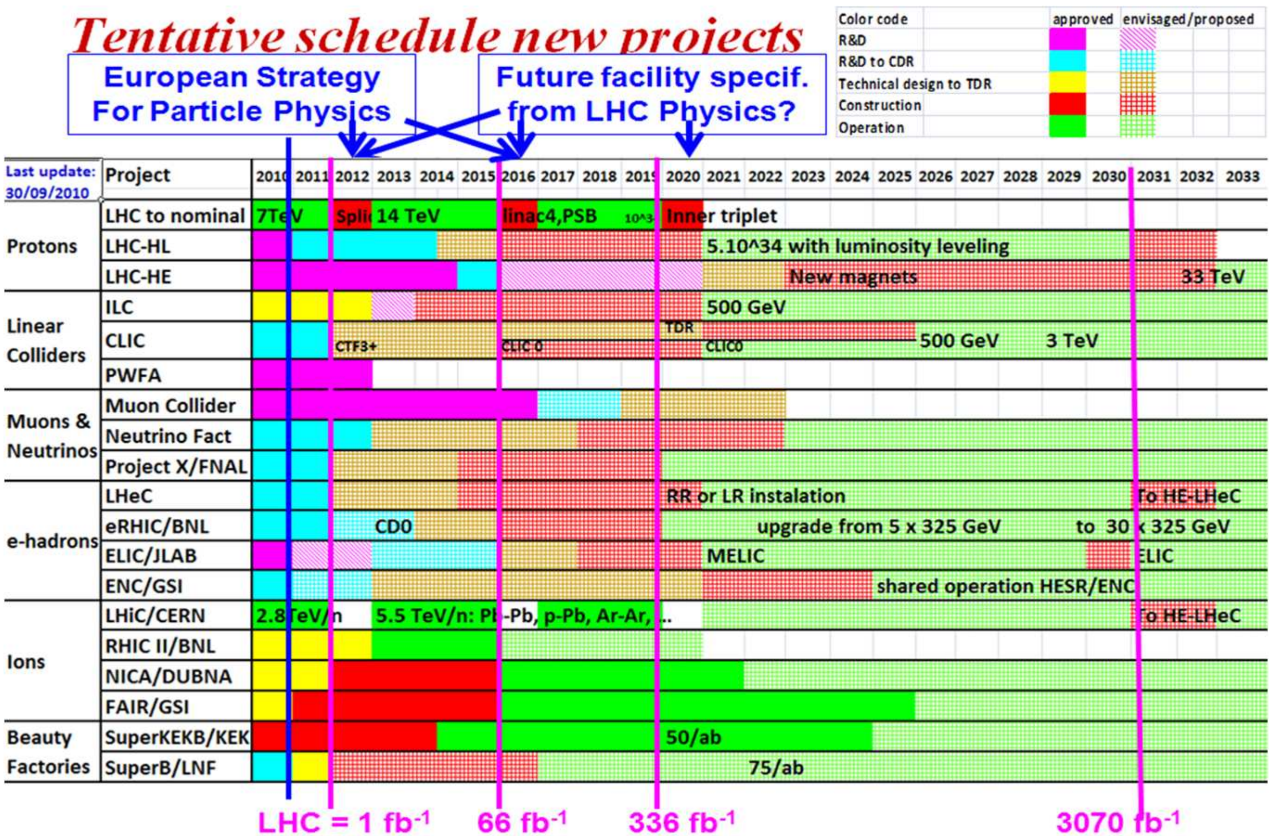



# 5. Conclusion

**We need to continue to search for New Physics and falsify the SM:**

- **directly via new (heavy or light) particle searches with more data.**
- **indirectly via high precision measurements in H/W/Z/top sectors,**



# 1. Standardissimo?

**So let's move forward: it is still action time!**

**Or it is still possible that we go from the Inferno to Paradise...!**

**The last Judgement (detail), Giorgio Vasari (1572-1579)**
**coupole de Santa Maria del Fiore, Florence.**