A Supersymmetric Explanation for the Excess of Higgs–Like Events at the LHC and at LEP

Manuel Drees

Bonn University & Bethe Center for Theoretical Physics

universitätbonn

Bethe Center for Theoretical Physics

Contents

Contents

Contents

Contents

Contents

Contents

Discovery of a “Higgs–Like Particle”

Announced at CERN on July 4, 2012!

Discovery of a “Higgs–Like Particle”

Announced at CERN on July 4, 2012!

Expectations for 125 GeV SM Higgs:

- Produced mostly in gluon fusion (90%, via t, b loops); vector boson fusion ($qq \to qqH_{\rm SM}$) subdominant

Discovery of a “Higgs–Like Particle”

Announced at CERN on July 4, 2012!

Expectations for 125 GeV SM Higgs:

- Produced mostly in gluon fusion (90%, via t, b loops); vector boson fusion ($qq \to qqH_{\rm SM}$) subdominant
- Main decay modes: $H_{\rm SM} \to b\bar{b},\ WW^*$

Discovery of a “Higgs–Like Particle”

Announced at CERN on July 4, 2012!

Expectations for 125 GeV SM Higgs:

- Produced mostly in gluon fusion (90%, via t, b loops); vector boson fusion ($qq \rightarrow qqH_{\rm SM}$) subdominant
- Main decay modes: $H_{\rm SM} \rightarrow b\bar{b},\ WW^*$
- Biggest significance in $H_{\rm SM} \rightarrow \gamma\gamma$ (via $W^\pm, t, b$ loops), $H_{\rm SM} \rightarrow ZZ^* \rightarrow 4\ell$

Discovery of a “Higgs–Like Particle”

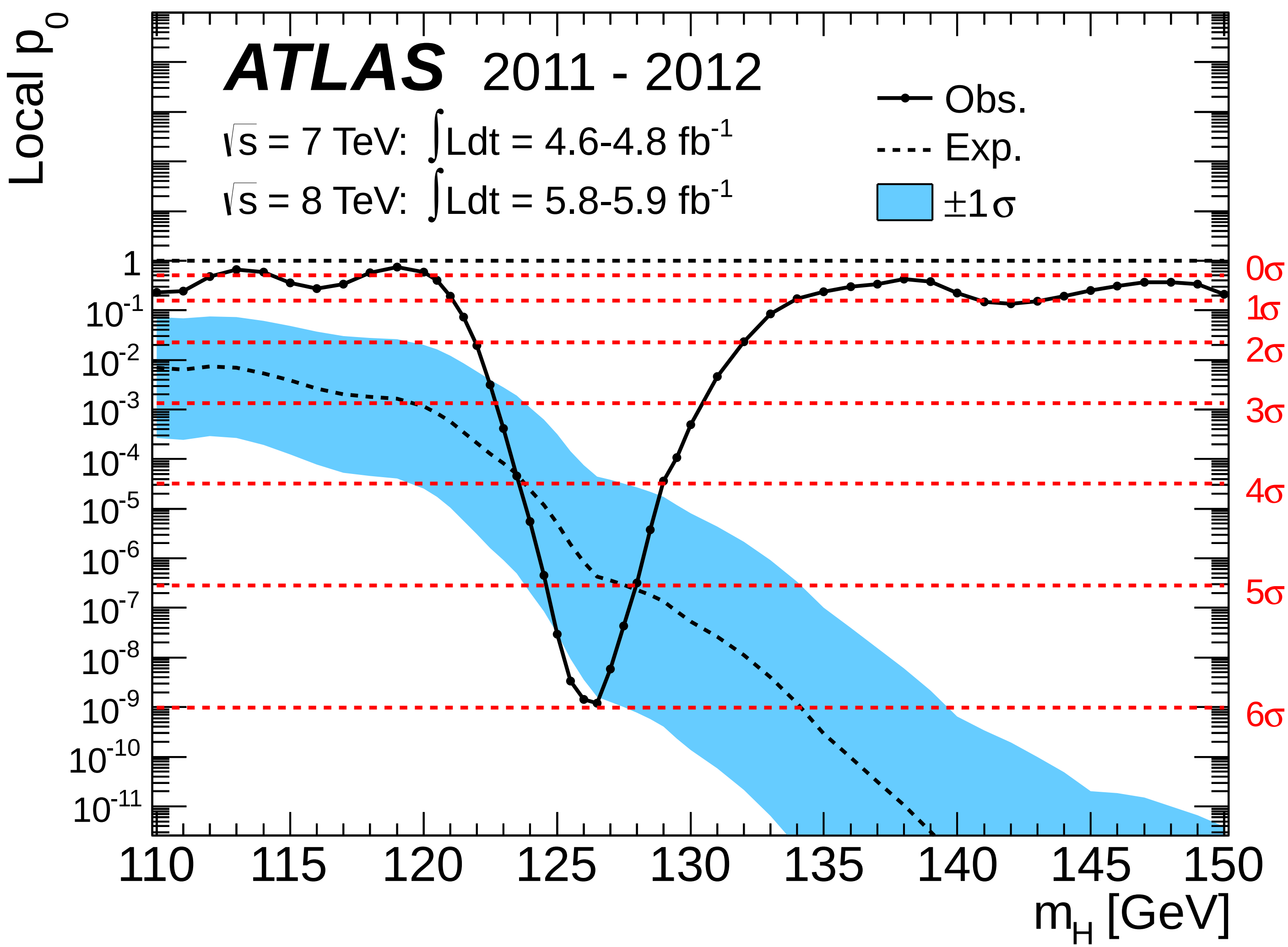
Announced at CERN on July 4, 2012!

Expectations for 125 GeV SM Higgs:

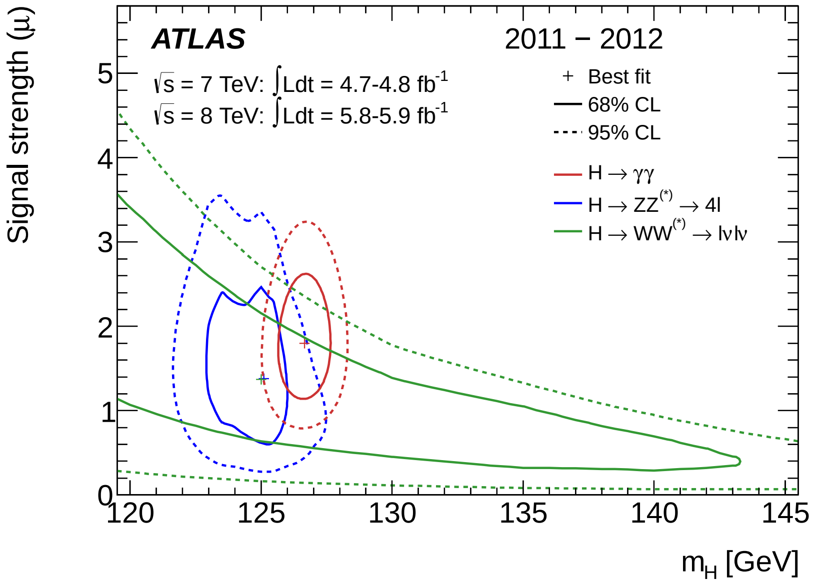
- Produced mostly in gluon fusion (90%, via t, b loops); vector boson fusion ($qq \to qqH_{\rm SM}$) subdominant
- Main decay modes: $H_{\rm SM} \to b\bar{b},\ WW^*$
- Biggest significance in $H_{\rm SM} \to \gamma\gamma$ (via $W^\pm, t, b$ loops), $H_{\rm SM} \to ZZ^* \to 4\ell$

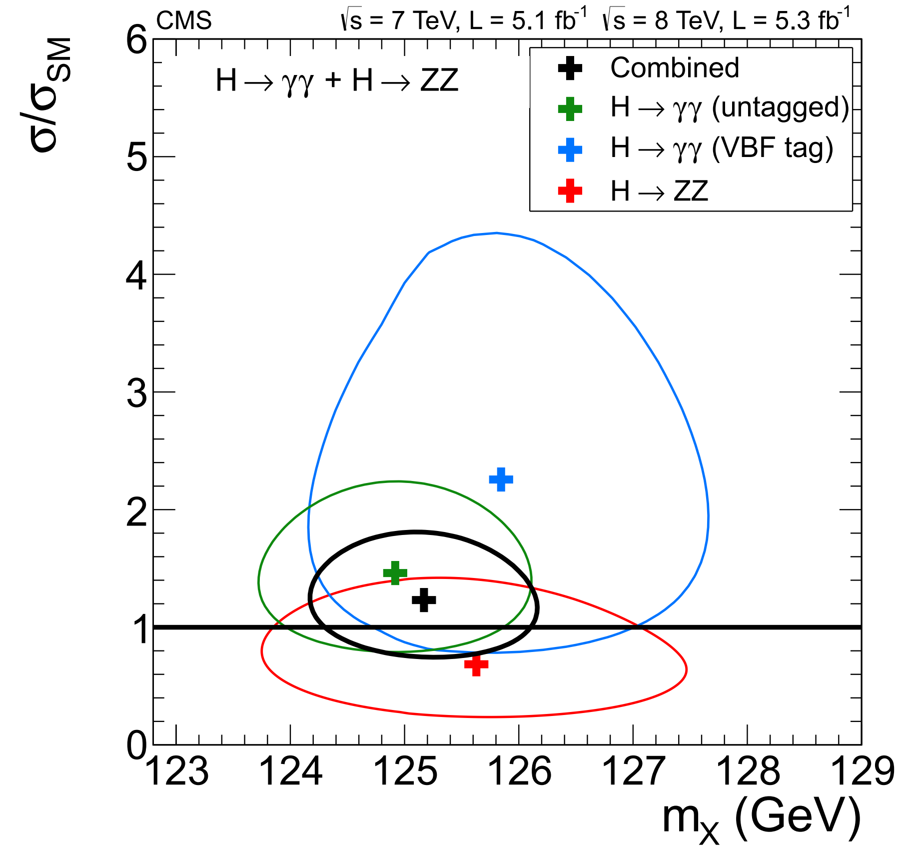
Agrees with observations!

Discovery Plot (ATLAS)

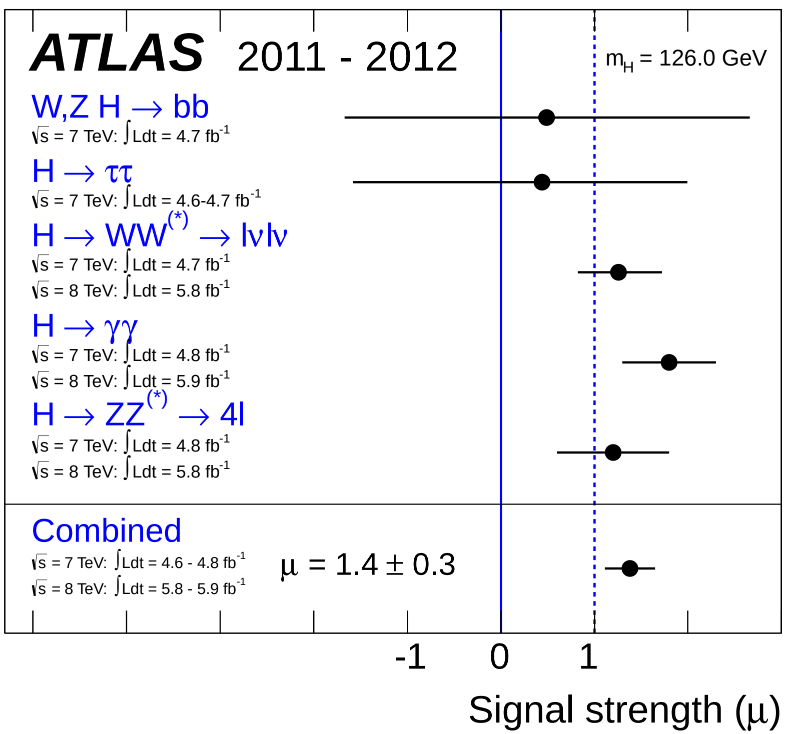


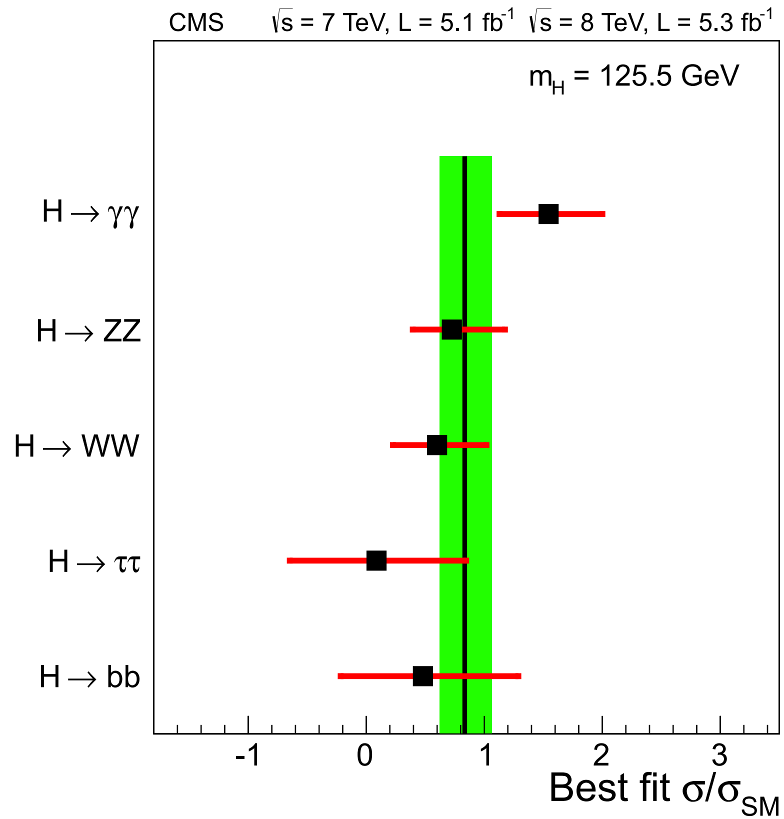
Mass Determination



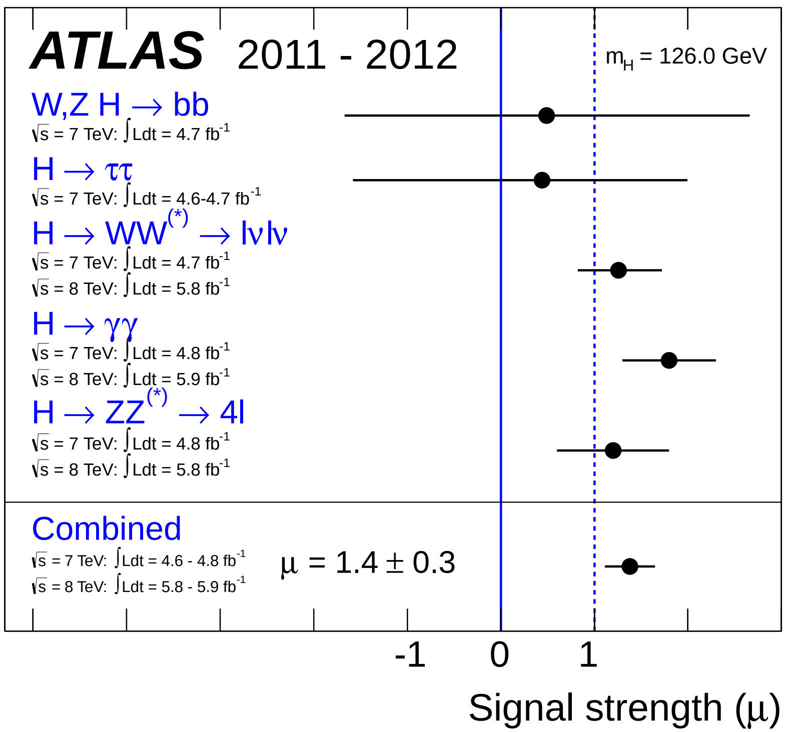


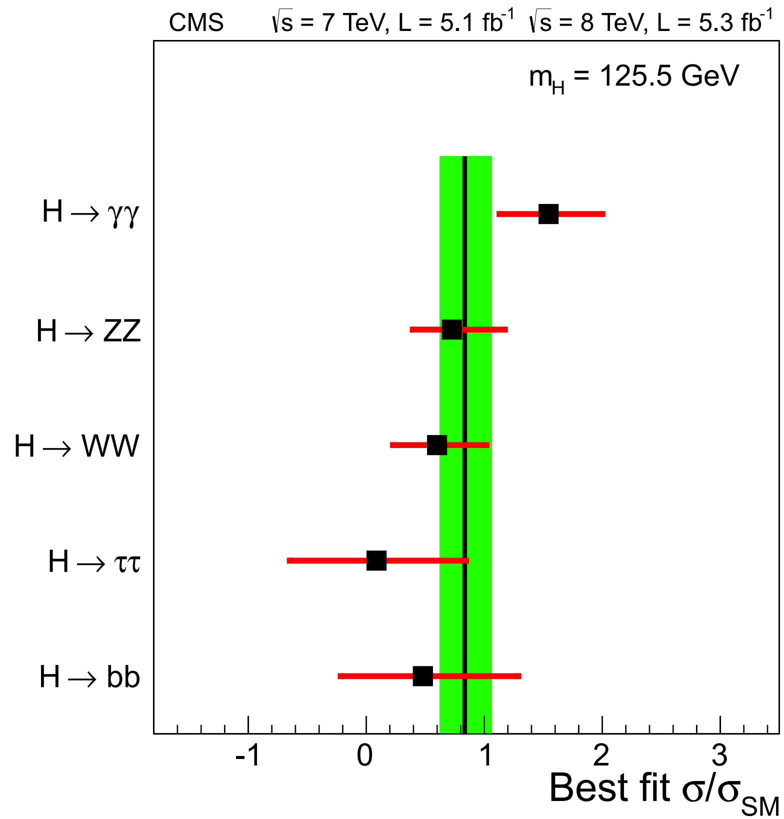
Signal Strengths Relative to SM





Signal Strengths Relative to SM





Here: interpret this in context of SUSY!

Motivation for Supersymmetry

- Stabilizes the hierarchy. No quadratic divergences!

Motivation for Supersymmetry

- Stabilizes the hierarchy. No quadratic divergences!
- Allows for Grand Unification of SM gauge couplings by *automatically* providing just the right additional fields

Motivation for Supersymmetry

- Stabilizes the hierarchy. No quadratic divergences!
- Allows for Grand Unification of SM gauge couplings by *automatically* providing just the right additional fields
- Naturally includes viable Dark Matter candidate which might even be detectable

The MSSM

- Is the simplest potentially realistic SUSY model.

  Straightforward supersymmetrization of SM.

The MSSM

- Is the simplest potentially realistic SUSY model.

  Straightforward supersymmetrization of SM.

- Predicts a superpartner for each SM particle, with $m_{\mathrm{SUSY}} \lesssim 1$ TeV: testable at the LHC!

The MSSM

- Is the simplest potentially realistic SUSY model.

  Straightforward supersymmetrization of SM.

- Predicts a superpartner for each SM particle, with $m_{\mathrm{SUSY}} \lesssim 1$ TeV: testable at the LHC!

- Predicts the existence of 2nd Higgs doublet. To cancel higgsino contribution to anomalies, and to give masses to all quarks.

The MSSM Higgs sector

- Two doublets H_u, H_d with opposite hypercharge
  ($Y(H_u) = +1/2$)

The MSSM Higgs sector

- Two doublets H_u, H_d with opposite hypercharge
  ($Y(H_u) = +1/2$)
- Important parameter: $\tan\beta \equiv \frac{\langle H_u^0 \rangle}{\langle H_d^0 \rangle}$; expect
  $1 \lesssim \tan\beta \lesssim 60$.

The MSSM Higgs sector

- Two doublets H_u, H_d with opposite hypercharge
  ($Y(H_u) = +1/2$)
- Important parameter: $\tan\beta \equiv \frac{\langle H_u^0 \rangle}{\langle H_d^0 \rangle}$; expect
  $1 \lesssim \tan\beta \lesssim 60$.
- 8 d.o.f. $\Longrightarrow$ 5 physical Higgs bosons after elw symmetry breaking:
  h, H: neutral, CP–even ($m_h < m_H$); A: neutral, CP–odd;
  $H^\pm$: charged

  Assumes CP conservation in Higgs–sfermion sector.

The MSSM Higgs sector (cont.'d)

- At tree level:

The MSSM Higgs sector (cont.'d)

- At tree level:
  - $m_h < \min(M_Z, m_A)$

The MSSM Higgs sector (cont.'d)

- At tree level:
  - $m_h < \min(M_Z, m_A)$
  - $m_H > \max(M_Z, m_A)$

The MSSM Higgs sector (cont.'d)

- At tree level:
  - $m_h < \min(M_Z, m_A)$
  - $m_H > \max(M_Z, m_A)$
  - $m_{H^\pm}^2 = m_A^2 + M_W^2$

The MSSM Higgs sector (cont.'d)

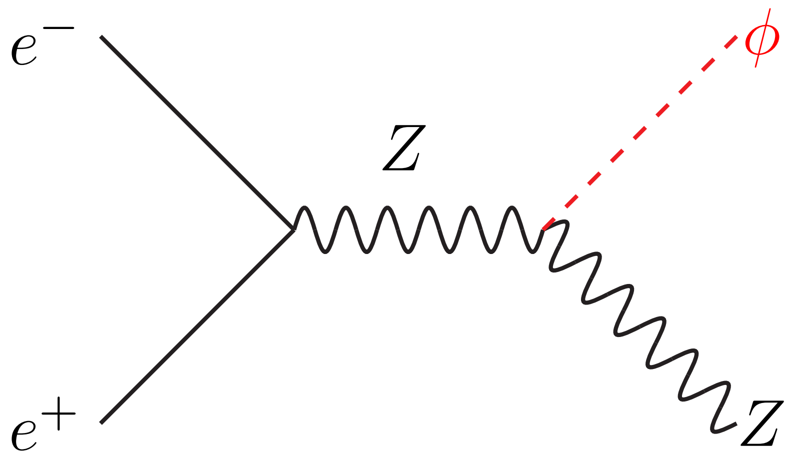
- At tree level:
  - $m_h < \min(M_Z, m_A)$
  - $m_H > \max(M_Z, m_A)$
  - $m^2_{H^\pm} = m^2_A + M^2_W$
- After loop corrections (mostly stop): $m_h \lesssim 135$ GeV, $m_h > m_A$ possible; $m_{H^\pm}$ changed significantly only for large $\tan\beta$.

The MSSM Higgs sector (cont.'d)

- At tree level:
  - $m_h < \min(M_Z, m_A)$
  - $m_H > \max(M_Z, m_A)$
  - $m_{H^\pm}^2 = m_A^2 + M_W^2$
- After loop corrections (mostly stop): $m_h \lesssim 135$ GeV, $m_h > m_A$ possible; $m_{H^\pm}$ changed significantly only for large $\tan\beta$.
- h, H have same quantum numbers as SM Higgs boson, but in general different couplings

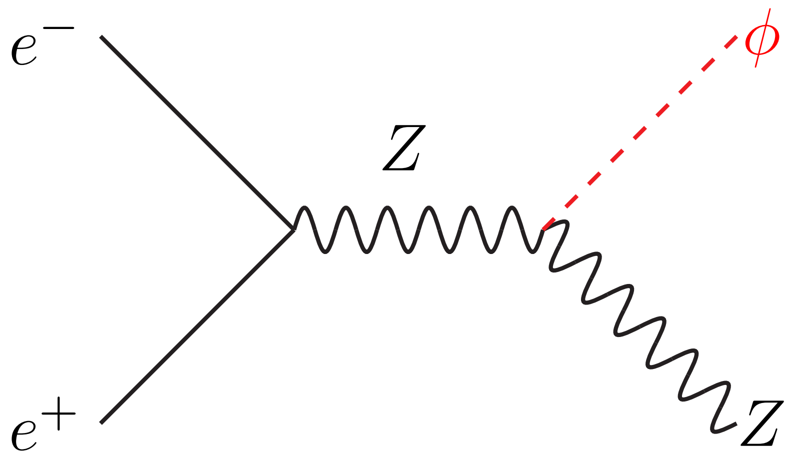
Excess of Higgs–like events at LEP

LEP searches for SM Higgs boson:



Excess of Higgs–like events at LEP

LEP searches for SM Higgs boson:

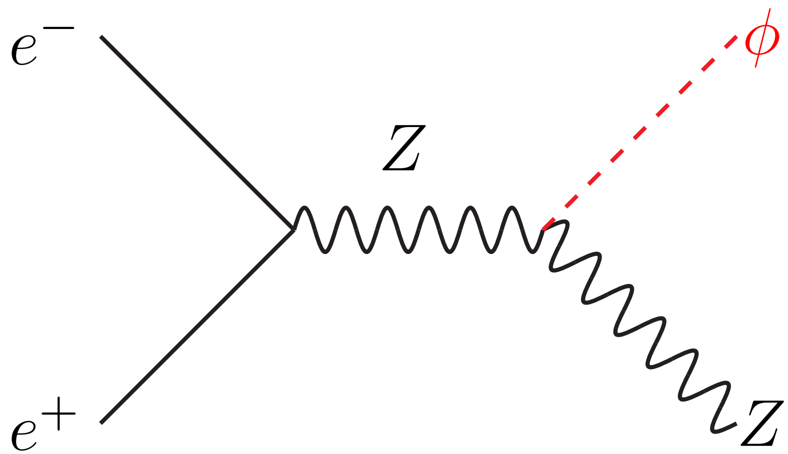


In SM: $H_{\rm SM} \to b\bar{b}$ ($\simeq 92\%$) or $\tau^+\tau^-$ ($\simeq 7\%$)

$Z \to q\bar{q}$ ($\simeq 73\%$); $\nu\bar{\nu}$ ($\simeq 18\%$); $\ell^+\ell^-$ ($\simeq 6\%$); $\tau^+\tau^-$ ($\simeq 3\%$)

Excess of Higgs–like events at LEP

LEP searches for SM Higgs boson:



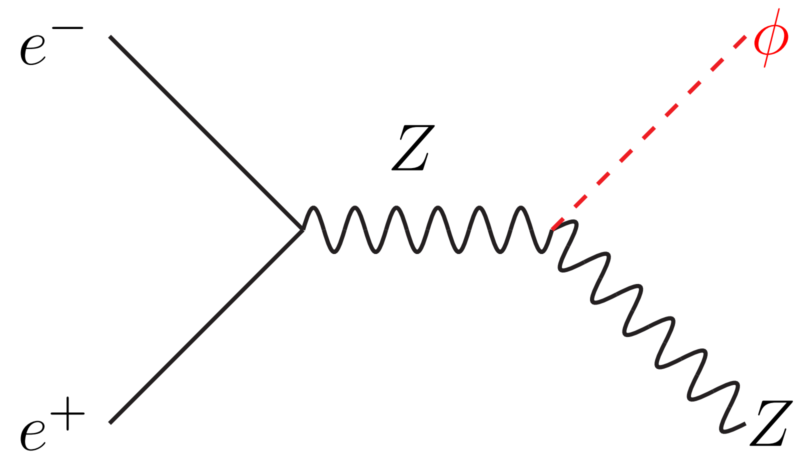
In SM: $H_{\rm SM} \to b\bar{b}$ $(\simeq 92\%)$ or $\tau^+\tau^-$ $(\simeq 7\%)$

$Z \to q\bar{q}$ $(\simeq 73\%)$; $\nu\bar{\nu}$ $(\simeq 18\%)$; $\ell^+\ell^-$ $(\simeq 6\%)$; $\tau^+\tau^-$ $(\simeq 3\%)$

Final states: 4 jet $(\simeq 67\%)$; $b\bar{b}\nu\bar{\nu}$; $b\bar{b}\ell^+\ell^-$; $\tau^+\tau^- jj$

Excess of Higgs–like events at LEP

LEP searches for SM Higgs boson:

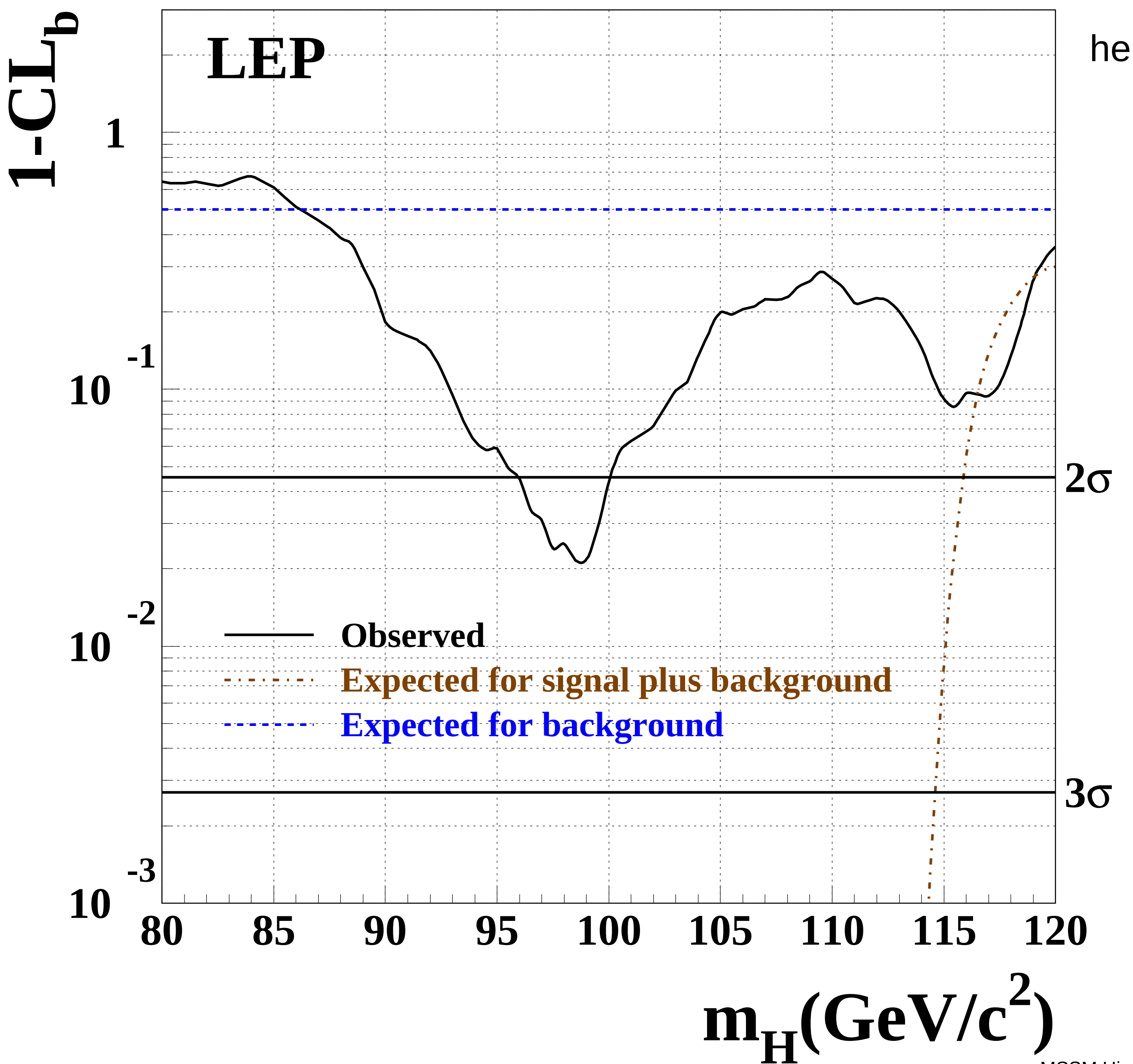


In SM: $H_{\rm SM} \to b\bar{b}$ $(\simeq 92\%)$ or $\tau^+\tau^-$ $(\simeq 7\%)$
$Z \to q\bar{q}$ $(\simeq 73\%)$; $\nu\bar{\nu}$ $(\simeq 18\%)$; $\ell^+\ell^-$ $(\simeq 6\%)$; $\tau^+\tau^-$ $(\simeq 3\%)$

Final states: 4 jet ($\simeq 67\%$); $b\bar{b}\nu\bar{\nu}$; $b\bar{b}\ell^+\ell^-$; $\tau^+\tau^- jj$

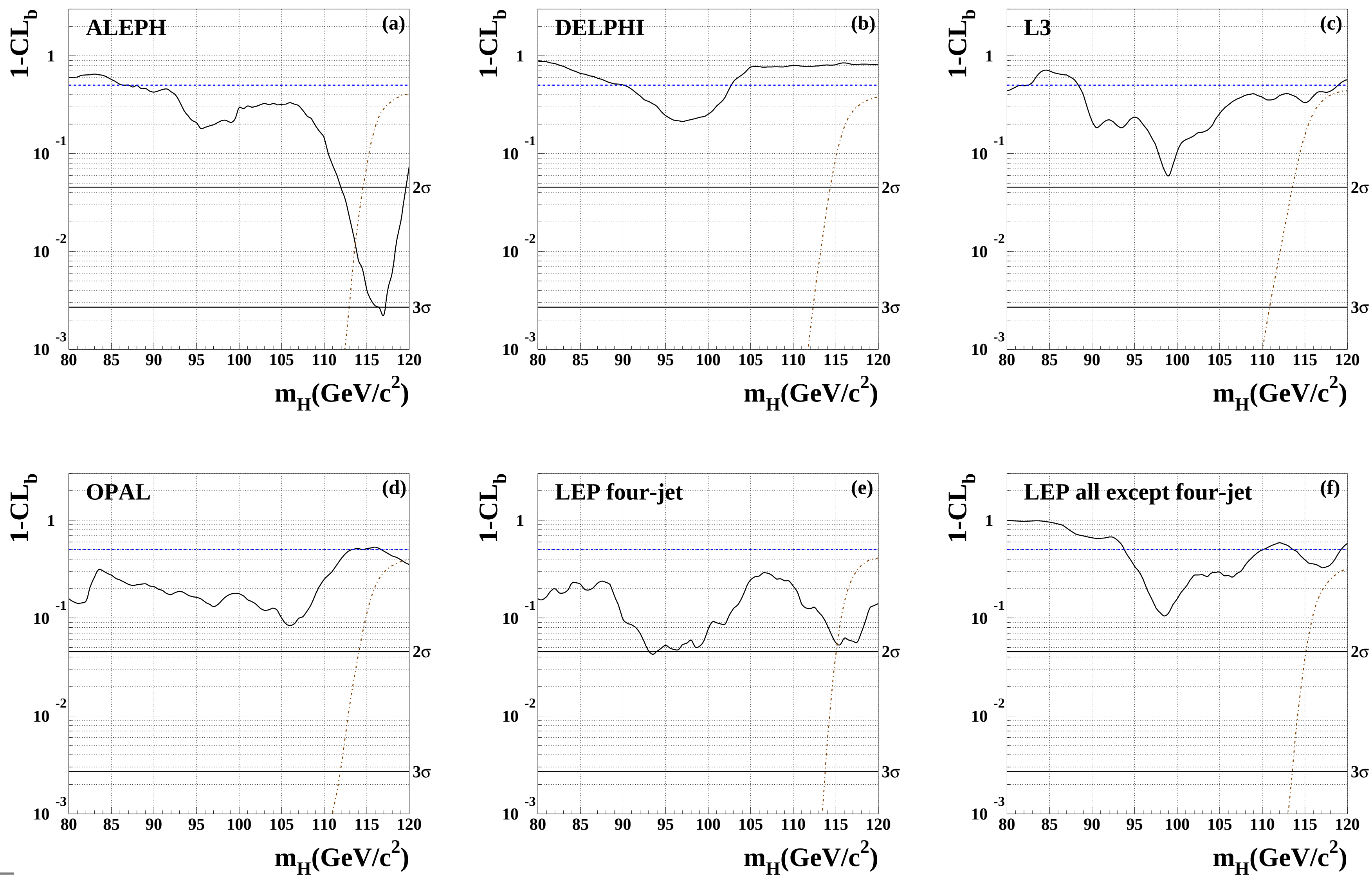
Result: Some evidence for excess events near $m_\phi = 98$ GeV ($\sim 2.3\sigma$) and $m_\phi = 115$ GeV ($\sim 1.7\sigma$)

LEP summary



hep-ex/0306033

In more detail



Excess near 98 GeV

- Has larger significance than the one near 115 GeV

Excess near 98 GeV

- Has larger significance than the one near 115 GeV
- Distributed over all experiments and several final states

Excess near 98 GeV

- Has larger significance than the one near 115 GeV
- Distributed over all experiments and several final states
- Is about 10 times weaker than signal for 98 GeV Higgs in SM

The explanation

- SM needs Supersymmetry to be natural: MSSM!

The explanation

- SM needs Supersymmetry to be natural: MSSM!
- MSSM contains two CP–even Higgs bosons h, H $(m_h < m_H)$

The explanation

- SM needs Supersymmetry to be natural: MSSM!
- MSSM contains two CP–even Higgs bosons h, H ($m_h < m_H$)
- Couplings: $g_{hZZ} = g_{H_{\rm SM}ZZ} \sin(\alpha - \beta)$
  $g_{HZZ} = g_{H_{\rm SM}ZZ} \cos(\alpha - \beta)$

The explanation

- SM needs Supersymmetry to be natural: MSSM!
- MSSM contains two CP–even Higgs bosons h, H ($m_h < m_H$)
- Couplings: $g_{hZZ} = g_{H_{\rm SM}ZZ} \sin(\alpha - \beta)$
  $g_{HZZ} = g_{H_{\rm SM}ZZ} \cos(\alpha - \beta)$
- To explain excess near 98 GeV as Zh production:

$$\begin{aligned} 0.056 &\leq \sin^2(\alpha - \beta) &\leq 0.144 \\ 95 \text{ GeV} &\leq \quad m_h &\leq 101 \text{ GeV} \end{aligned}$$

First range from statistics, second range guessed

The explanation

- SM needs Supersymmetry to be natural: MSSM!
- MSSM contains two CP–even Higgs bosons h, H ($m_h < m_H$)
- Couplings: $g_{hZZ} = g_{H_{\rm SM}ZZ} \sin(\alpha - \beta)$
  $g_{HZZ} = g_{H_{\rm SM}ZZ} \cos(\alpha - \beta)$
- To explain excess near 98 GeV as Zh production:

$$
\begin{aligned}
0.056 &\leq \sin^2(\alpha - \beta) &\leq 0.144 \\
95 \text{ GeV} &\leq \quad m_h &\leq 101 \text{ GeV}
\end{aligned}
$$

First range from statistics, second range guessed

- By itself implied that H should be discovered at LHC, with $115 \text{ GeV} \leq m_H \leq 140 \text{ GeV}$: prediction from 2005!

MD, hep-ph/0502075

Explanation (cont'd)

If in addition LHC discovery is to be explained by H production: need

$$123 \text{ GeV} \leq m_H \leq 128 \text{ GeV}$$

Explanation (cont'd)

If in addition LHC discovery is to be explained by H production: need

$$123 \text{ GeV} \leq m_H \leq 128 \text{ GeV}$$

To get approximately correct signal strengths, require:

$$0.5 \leq R_H^{VV} \leq 2.0 \quad (V = W, Z)\,;$$
$$0.5 \leq R_H^{\gamma\gamma}\,.$$

with

$$R_H^{XX} \equiv \frac{\Gamma(H \to gg)}{\Gamma(H_{\rm SM} \to gg)} \cdot \frac{\Gamma(H \to XX)}{\Gamma(H_{\rm SM} \to XX)} \cdot \frac{\Gamma(H_{\rm SM,\,tot})}{\Gamma(H_{\rm tot})}$$

Details of the Analysis

- At tree level, MSSM Higgs spectrum determined by $m_A, \tan\beta$

Details of the Analysis

- At tree level, MSSM Higgs spectrum determined by $m_A, \tan\beta$
- At loop level, also need to fix parameters of stop (1–loop) and gluino (2–loop) sectors; sbottom for $(H,h)b\bar{b}$ couplings; stau for $H \to \gamma\gamma$

Details of the Analysis

- At tree level, MSSM Higgs spectrum determined by $m_A, \tan\beta$
- At loop level, also need to fix parameters of stop (1–loop) and gluino (2–loop) sectors; sbottom for $(H, h)b\bar{b}$ couplings; stau for $H \to \gamma\gamma$
- Perform random scan over parameters, look for extrema of observables such that constraints on the Higgs sector are satisfied

Details of the Analysis

- At tree level, MSSM Higgs spectrum determined by $m_A, \tan\beta$
- At loop level, also need to fix parameters of stop (1–loop) and gluino (2–loop) sectors; sbottom for $(H,h)b\bar{b}$ couplings; stau for $H \to \gamma\gamma$
- Perform random scan over parameters, look for extrema of observables such that constraints on the Higgs sector are satisfied
- For simplicity: take same soft breaking parameters in $\tilde{b}$, $\tilde{t}$ sectors.

Details of the Analysis

- At tree level, MSSM Higgs spectrum determined by m_A, $\tan\beta$
- At loop level, also need to fix parameters of stop (1–loop) and gluino (2–loop) sectors; sbottom for $(H,h)b\bar{b}$ couplings; stau for $H \to \gamma\gamma$
- Perform random scan over parameters, look for extrema of observables such that constraints on the Higgs sector are satisfied
- For simplicity: take same soft breaking parameters in $\tilde{b}$, $\tilde{t}$ sectors.
- All parameters varied directly at weak scale: pMSSM!

Scan Range

Scanned over range:

$$
\begin{aligned}
|\mu|,\, m_{\tilde{t}_R},\, m_{\tilde{t}_L},\, m_{\tilde{g}},\, m_{\tilde{\tau}_L},\, m_{\tilde{\tau}_R} &\le 5\ \mathrm{TeV};\\
|\mu|,\, m_{\tilde{t}_1},\, m_{\tilde{b}_1},\, m_{\tilde{\tau}_1} &\ge 100\ \mathrm{GeV};\\
|m_{\tilde{t}_1} - m_{\tilde{b}_1}| &\le 50\ \mathrm{GeV}\ \text{or}\ \max(m_{\tilde{t}_1}, m_{\tilde{b}_1}) > 300\ \mathrm{GeV};\\
m_{\tilde{g}} &\ge 600\ \mathrm{GeV};\\
|A_t|, |\mu| &\le 1.5 \left(m_{\tilde{t}_R} + m_{\tilde{t}_L}\right);\\
|A_\tau|, |\mu| &\le 1.5 \left(m_{\tilde{\tau}_R} + m_{\tilde{\tau}_L}\right);\\
\delta\rho_{\tilde{t}\tilde{b}} &\le 2 \cdot 10^{-3}
\end{aligned}
$$

Scan Range

Scanned over range:

$$|\mu|,\ m_{\tilde{t}_R},\ m_{\tilde{t}_L},\ m_{\tilde{g}},\ m_{\tilde{\tau}_L},\ m_{\tilde{\tau}_R} \leq 5\ \mathrm{TeV};$$

$$|\mu|,\ m_{\tilde{t}_1},\ m_{\tilde{b}_1},\ m_{\tilde{\tau}_1} \geq 100\ \mathrm{GeV};$$

$$|m_{\tilde{t}_1} - m_{\tilde{b}_1}| \leq 50\ \mathrm{GeV\ or}\ \max(m_{\tilde{t}_1}, m_{\tilde{b}_1}) > 300\ \mathrm{GeV};$$

$$m_{\tilde{g}} \geq 600\ \mathrm{GeV};$$

$$|A_t|, |\mu| \leq 1.5\left(m_{\tilde{t}_R} + m_{\tilde{t}_L}\right);$$

$$|A_\tau|, |\mu| \leq 1.5\left(m_{\tilde{\tau}_R} + m_{\tilde{\tau}_L}\right);$$

$$\delta\rho_{\tilde{t}\tilde{b}} \leq 2 \cdot 10^{-3}$$

Additional constraints: ATLAS $t \to H^+ b$ search;
CMS $A,\ H,\ h \to \tau^+\tau^-$ search

Results: Bounds on Observables

Scenario is viable!

Results: Bounds on Observables

Scenario is viable!

$$120 \text{ GeV} \leq m_{H^\pm} \leq 170 \text{ GeV}$$
$$96 \text{ GeV} \leq m_A \leq 152 \text{ GeV}$$

To saturate upper bound: need very large μ, large $-A_t$, large $\tilde{t}_L - \tilde{t}_R$ mass splitting, $\tan\beta \simeq 6$

Results: Bounds on Observables

Scenario is viable!

$$120 \text{ GeV} \leq m_{H^\pm} \leq 170 \text{ GeV}$$
$$96 \text{ GeV} \leq m_A \leq 152 \text{ GeV}$$

To saturate upper bound: need very large μ, large $-A_t$, large $\tilde{t}_L - \tilde{t}_R$ mass splitting, $\tan\beta \simeq 6$

$$5.5 \leq \tan\beta \leq 12.5$$

Lower bound from ATLAS $t \to H^+ b$ searches, upper bound from CMS di–tau searches

Results: Bounds on Observables

Scenario is viable!

$$120 \text{ GeV} \leq m_{H^\pm} \leq 170 \text{ GeV}$$
$$96 \text{ GeV} \leq m_A \leq 152 \text{ GeV}$$

To saturate upper bound: need very large μ, large $-A_t$, large $\tilde{t}_L - \tilde{t}_R$ mass splitting, $\tan\beta \simeq 6$

$$5.5 \leq \tan\beta \leq 12.5$$

Lower bound from ATLAS $t \to H^+ b$ searches, upper bound from CMS di–tau searches

$0.2 \leq R_H^{\tau\tau} \leq 5.7$: Large deviation from SM possible!

Results: Bounds on Observables

Scenario is viable!

$$120\ \mathrm{GeV} \leq m_{H^\pm} \leq 170\ \mathrm{GeV}$$
$$96\ \mathrm{GeV} \leq m_A \leq 152\ \mathrm{GeV}$$

To saturate upper bound: need very large μ, large $-A_t$, large $\tilde{t}_L - \tilde{t}_R$ mass splitting, $\tan\beta \simeq 6$

$$5.5 \leq \tan\beta \leq 12.5$$

Lower bound from ATLAS $t \to H^+ b$ searches, upper bound from CMS di–tau searches

$0.2 \leq R_H^{\tau\tau} \leq 5.7$: Large deviation from SM possible!

$0.66 \leq \frac{R_H^{\gamma\gamma}}{R_H^{VV}} \leq 1.3$: quite SM–like

Bounds on Observables (cont.d)

$0.12 \leq R_h^{\tau\tau} \leq 3.4$: Probably difficult to detect, since $m_h - M_Z \leq 7$ GeV!

Bounds on Observables (cont.d)

$0.12 \leq R_h^{\tau\tau} \leq 3.4$: Probably difficult to detect, since $m_h - M_Z \leq 7$ GeV!

$|A_t| + |\mu| \geq 2$ TeV; $m_{\tilde{t}_1} + m_{\tilde{t}_2} \geq 900$ GeV: needs some finetuning!

Increasing the $\gamma\gamma$ Signal

- Increase production rate $\propto \Gamma(H \to gg)$: Also increases VV^*, $\tau^+\tau^-$ signals

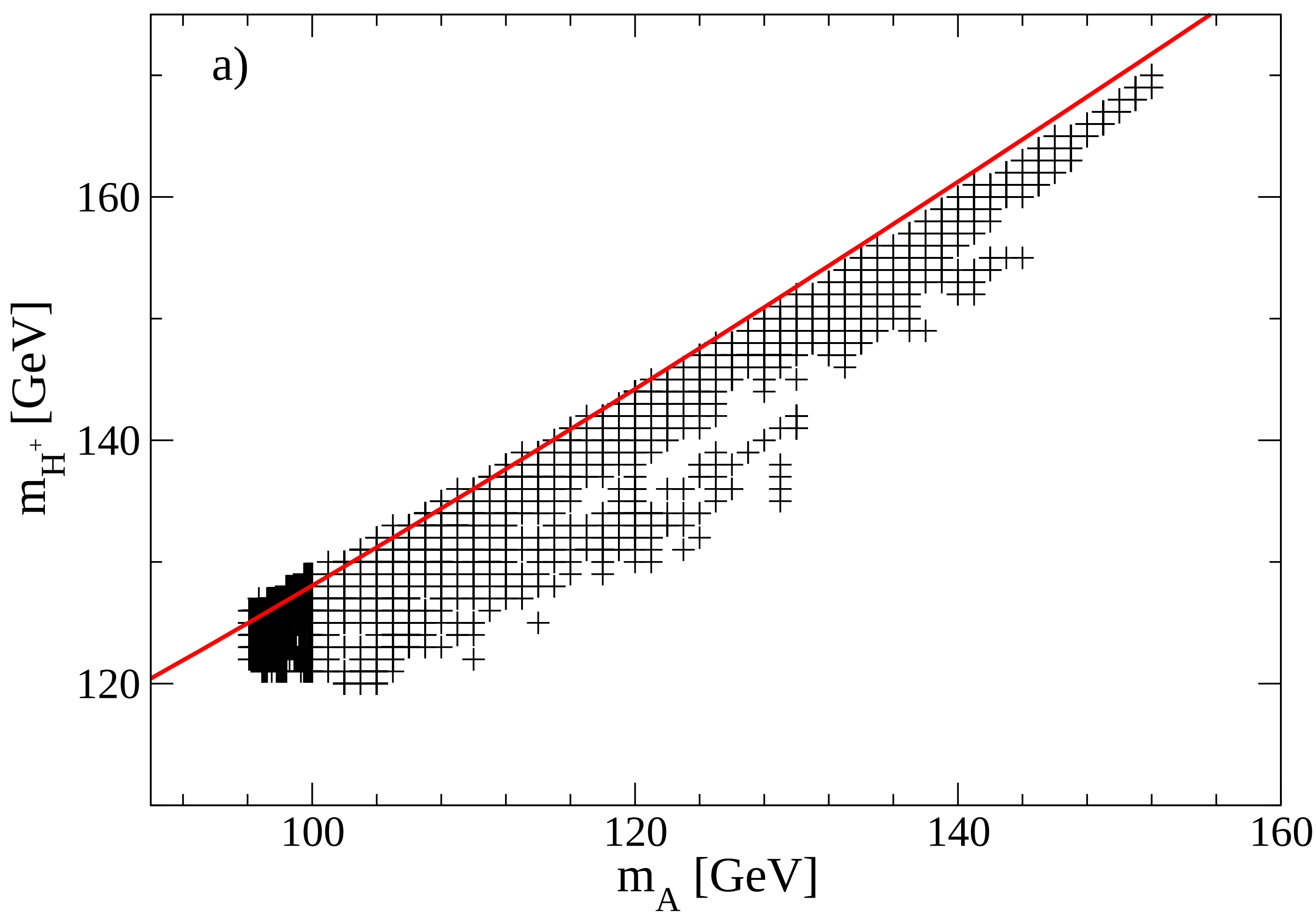
Increasing the $\gamma\gamma$ Signal

- Increase production rate $\propto \Gamma(H \to gg)$: Also increases VV^*, $\tau^+\tau^-$ signals
- Reduce $\Gamma_{\rm tot}(H)$: Also increases VV^* signals, since $\Gamma(H \to VV^*) \propto \cos^2(\alpha - \beta)$ is basically fixed

Increasing the $\gamma\gamma$ Signal

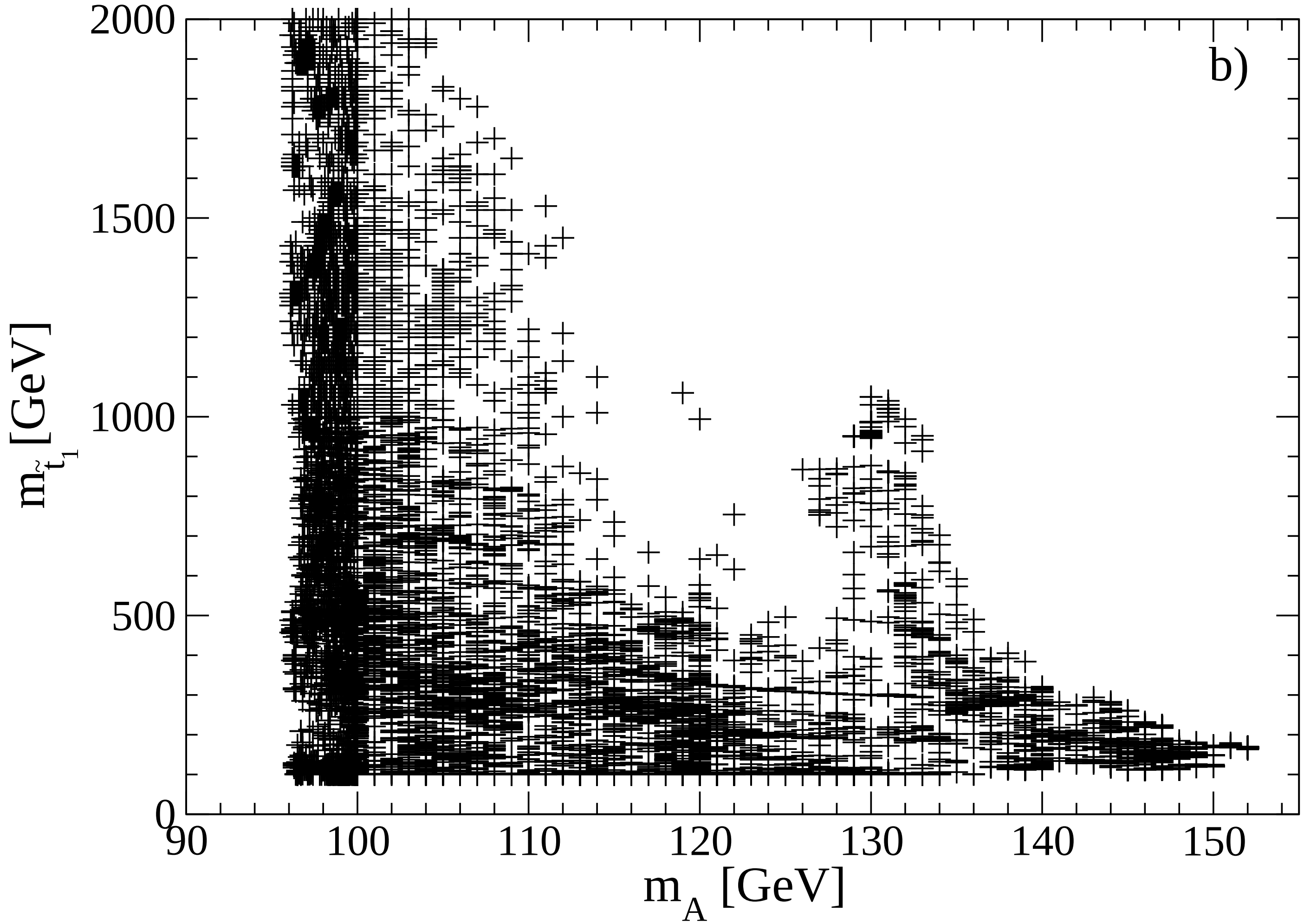
- Increase production rate $\propto \Gamma(H \to gg)$: Also increases VV^*, $\tau^+\tau^-$ signals
- Reduce $\Gamma_{\rm tot}(H)$: Also increases VV^* signals, since $\Gamma(H \to VV^*) \propto \cos^2(\alpha - \beta)$ is basically fixed
- Increase $\Gamma(H \to \gamma\gamma)$: Difficult to do in the MSSM, since W loops are dominant.

Correlations between parameters



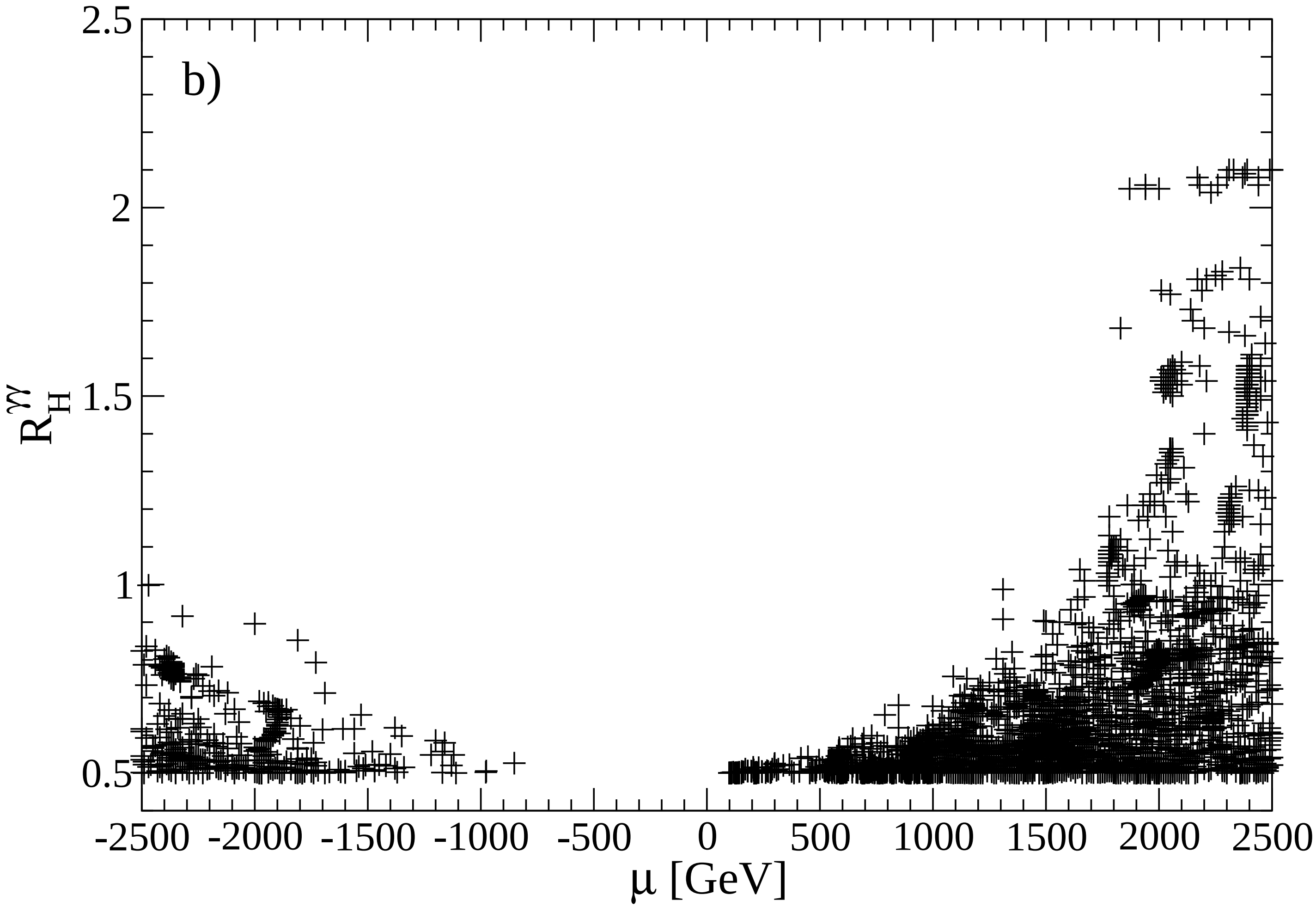
Modest radiative corrections due to bounds on $A_t/m_{\tilde{t}}, \mu/m_{\tilde{t}}$.

Correlations (cont.d)



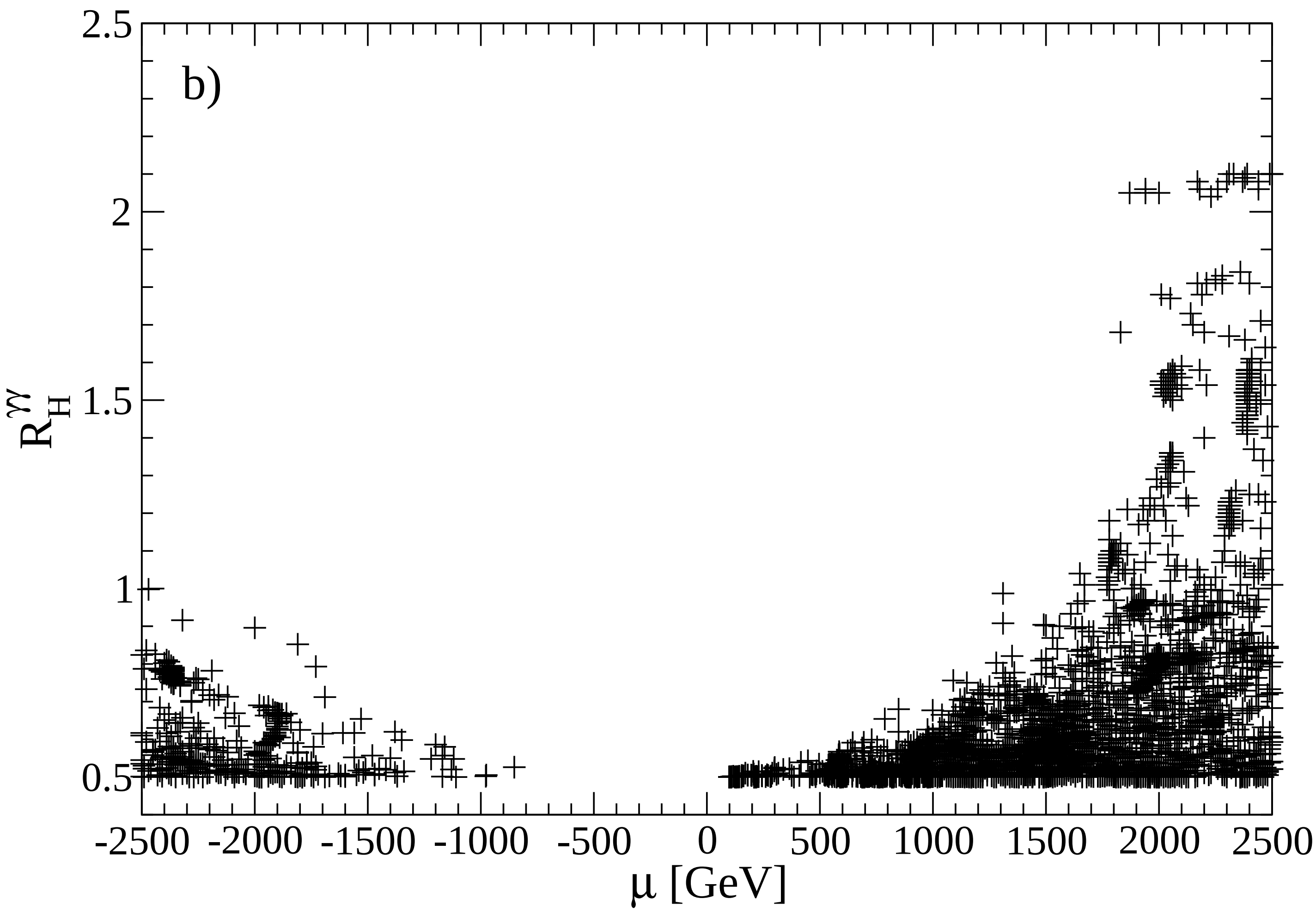
Upper bound on $m_{\tilde{t}_1}$ if $m_A > 110$ GeV

Correlations (cont.d)



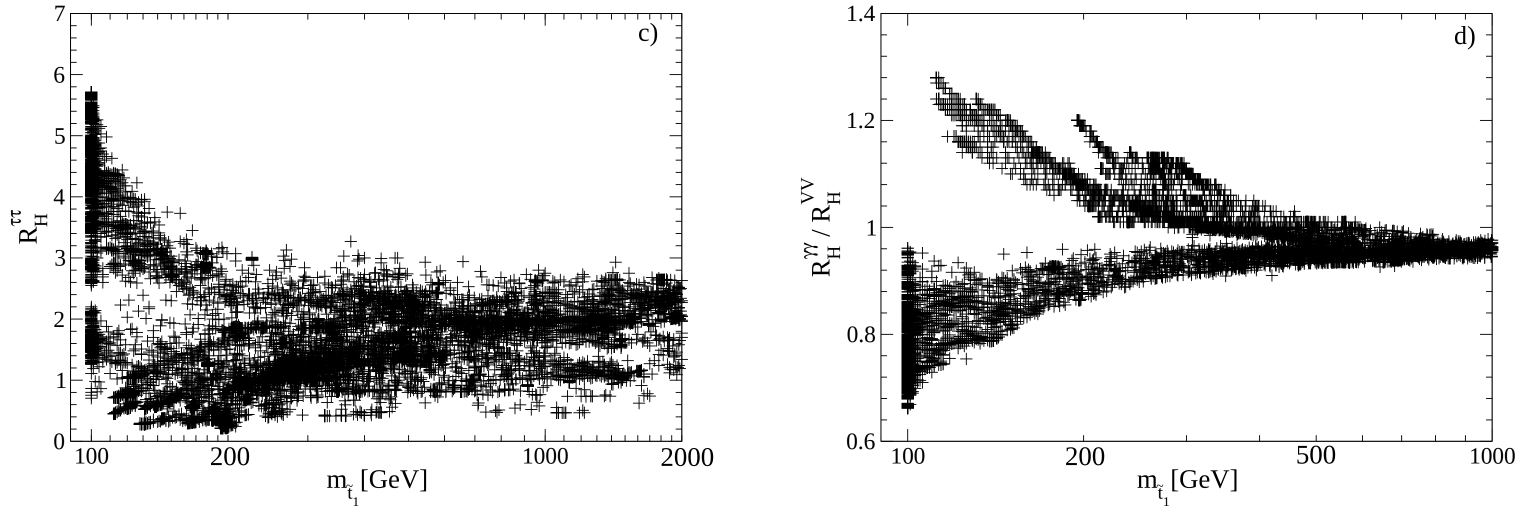
Quite difficult to have $|\mu| < 0.5\ \mathrm{TeV}$;

Correlations (cont.d)



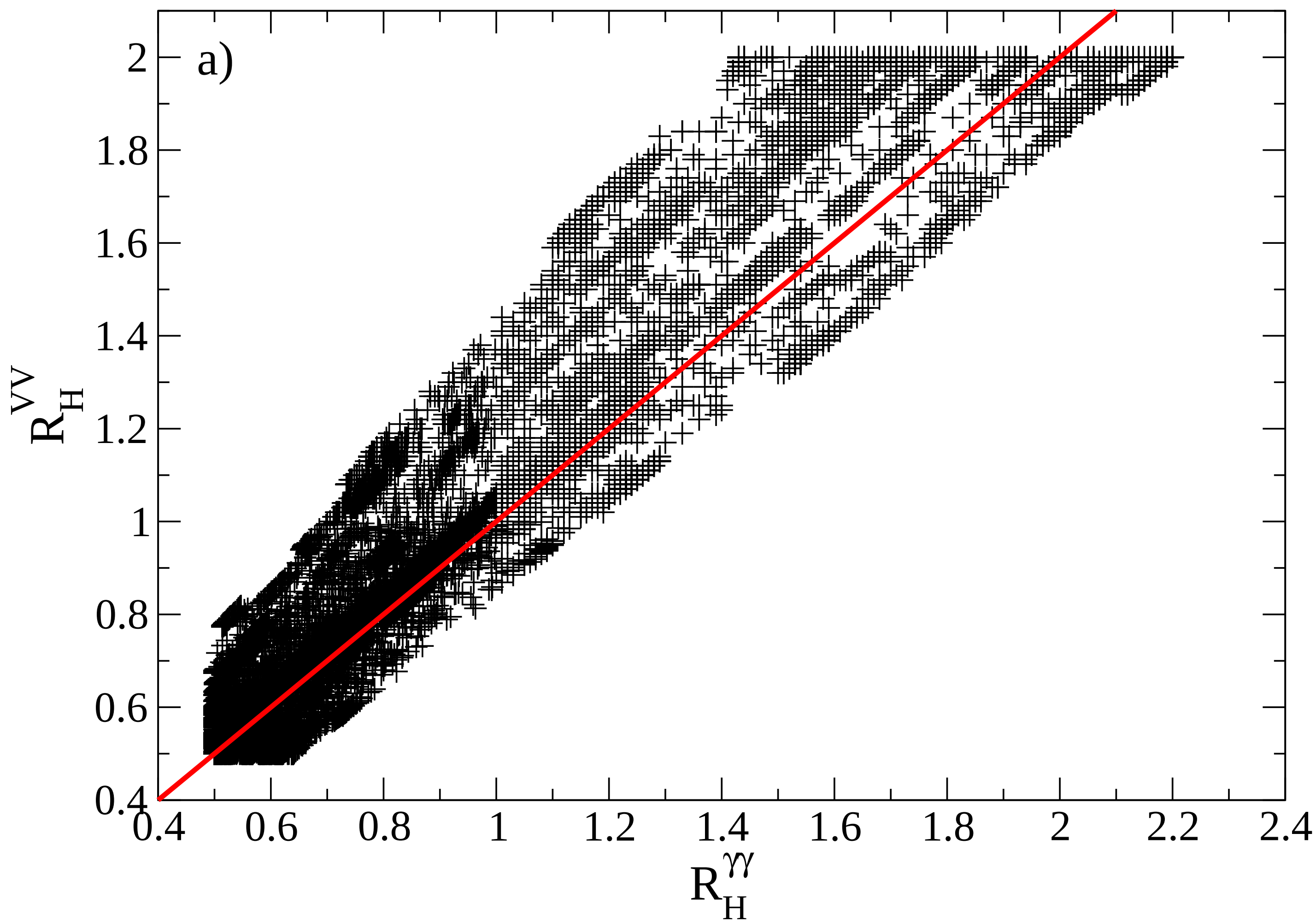
Quite difficult to have $|\mu| < 0.5$ TeV; $R_H^{\gamma\gamma} > 1$ requires $|\mu| > 1$ TeV

Correlations (cont.d)



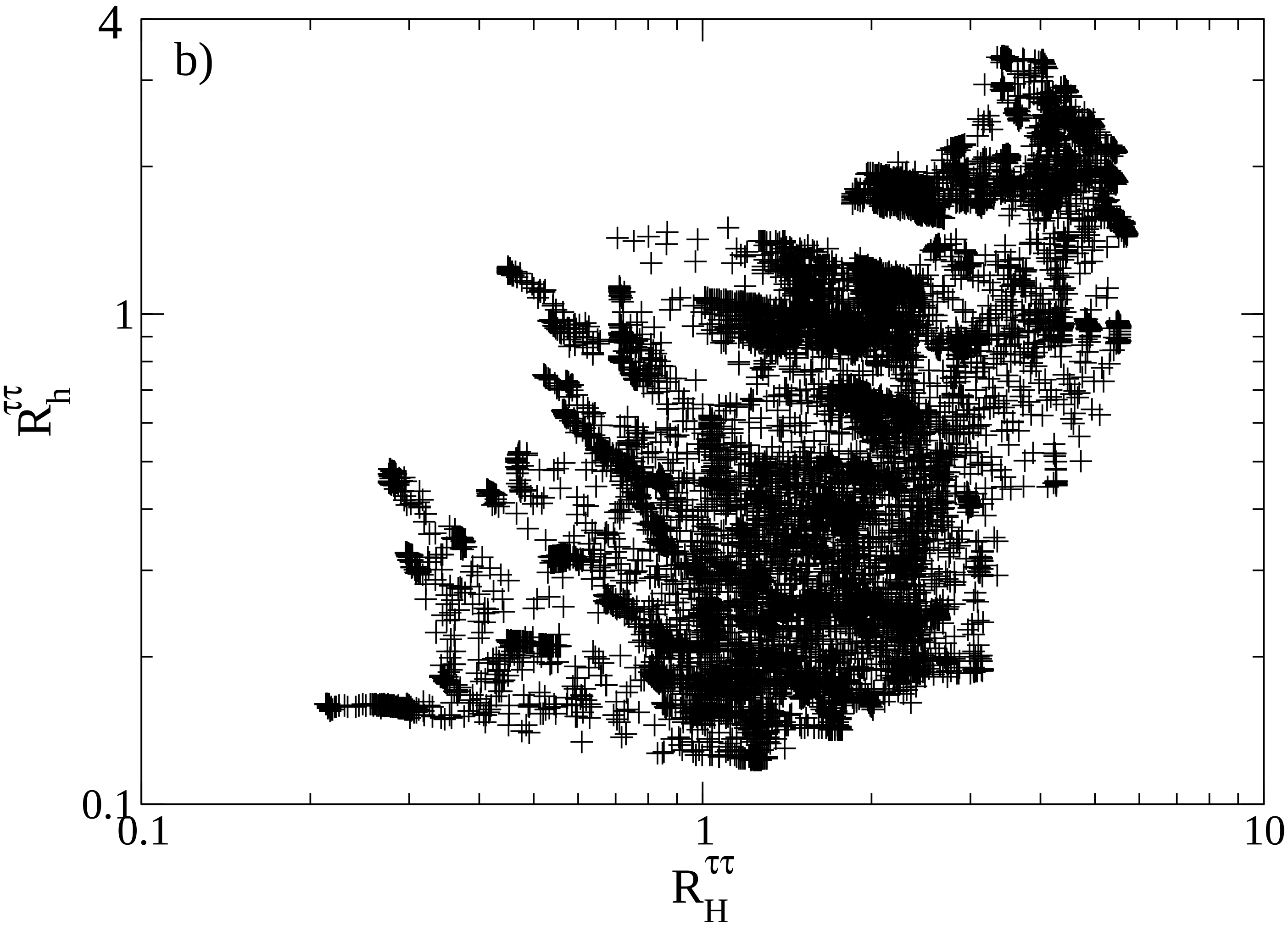
$\tilde{t}, \tilde{b}$ loops affect Higgs partial widths significantly only for $m_{\tilde{q}} \leq 300\ \mathrm{GeV}$ other than through Higgs mixing

Correlations (cont.d)



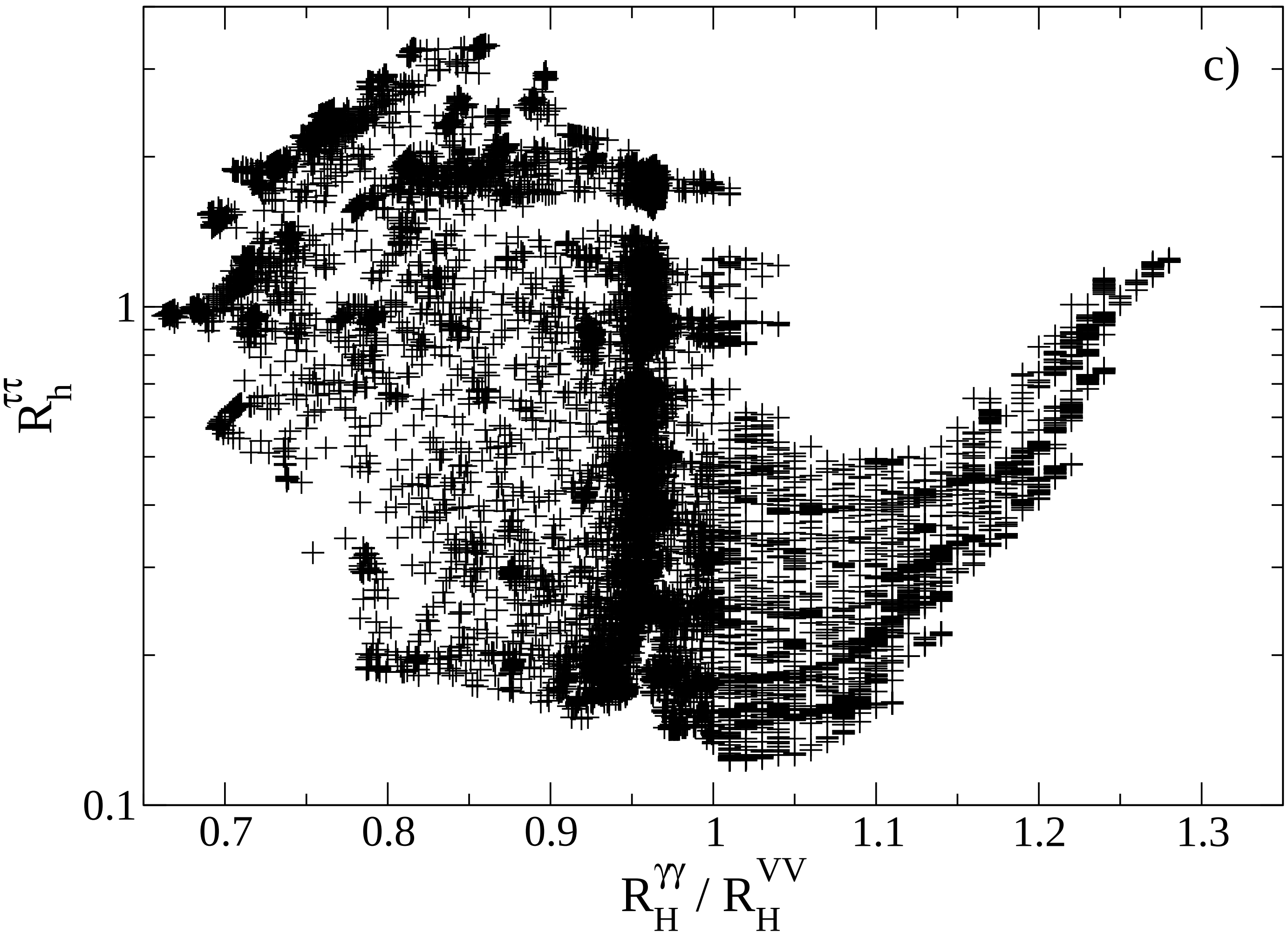
Upper bound on ratio slowly decreases with increasing R_H^{VV}

Correlations (cont.d)



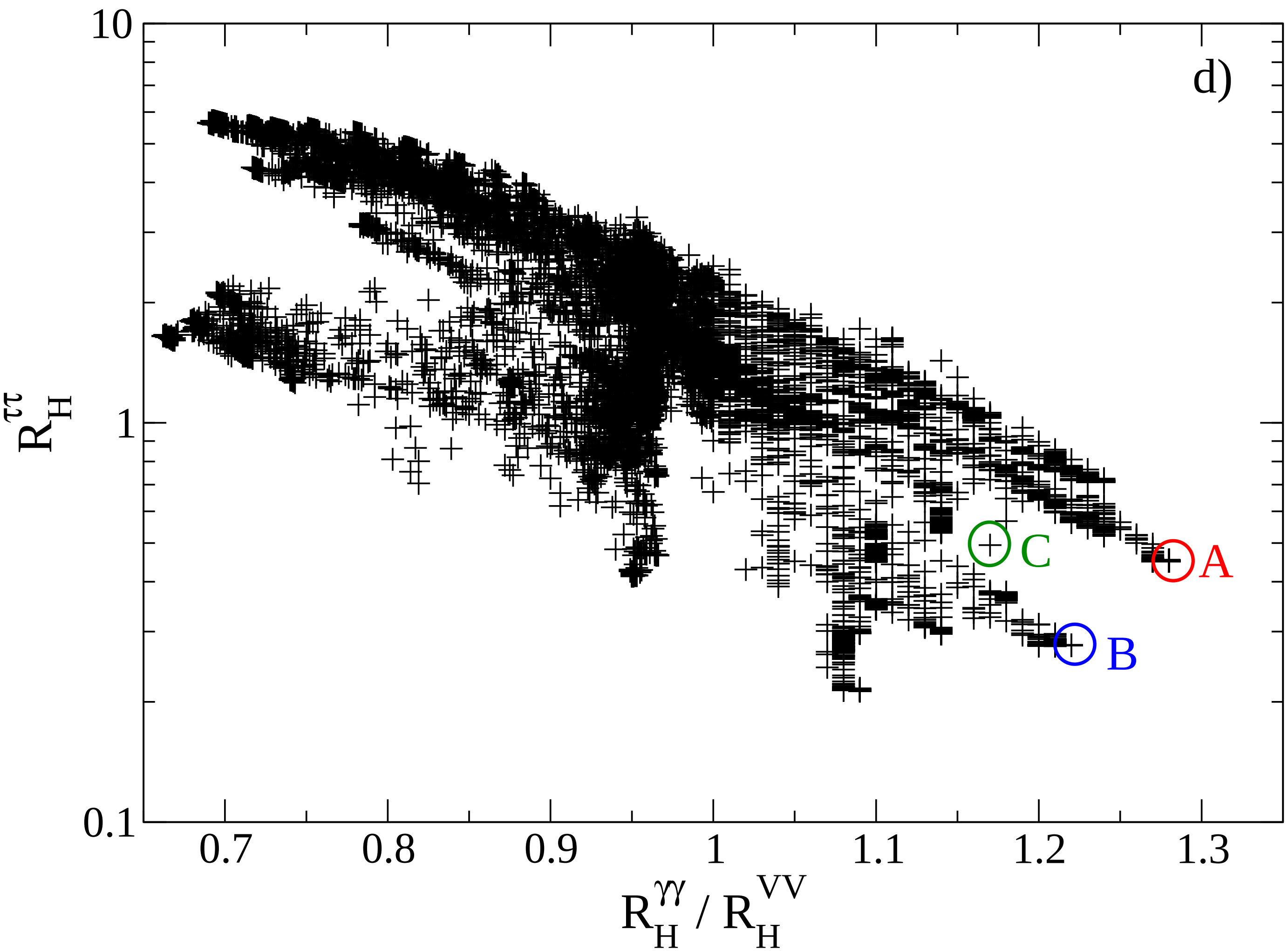
Requiring (e.g.) $R_H^{\tau\tau} < 3$ would further reduce upper bound on $R_h^{\tau\tau}$

Correlations (cont.d)



Imposing a lower bound on the ratio would further reduce upper bound on $R_h^{\tau\tau}$

Correlations (cont.d)



Can simultaneously increase importance of $\gamma\gamma$ signal and reduce size of di–tau signal!

Benchmark Points

quantity	A	B	C
$\tan\beta$	8	7	6
$m_A,\ m_{H^\pm}$ [GeV]	$145,\ 163$	$144,\ 163$	$147,\ 165$
$m_{\tilde{t}_1},\ m_{\tilde{t}_2}$ [GeV]	$112,\ 3002$	$128,\ 3207$	$152,\ 3148$
$\mu,\ A_t$ [TeV]	$4.73,\ -4.26$	$-5.00,\ 4.90$	$5.00,\ -5.01$
$\Gamma(h, H \to VV^*)$ [SM]	$0.056,\ 0.944$	$0.055,\ 0.945$	$0.077,\ 0.923$
$\Gamma(h, H \to \tau^+\tau^-)$ [SM]	$64,\ 0.84$	$50,\ 0.45$	$37,\ 0.49$
$\Gamma(h, H \to b\bar{b})$ [SM]	$40,\ 0.31$	$53,\ 0.68$	$25,\ 0.21$
$\Gamma(h, H \to gg)$ [SM]	$0.76,\ 0.31$	$0.47,\ 0.44$	$0.29,\ 0.52$
$\Gamma(h, H \to \gamma\gamma)$ [SM]	$0.0093,\ 1.20$	$0.021,\ 1.14$	$0.048,\ 1.08$

4 Summary

- MSSM Higgs bosons can simultaneously explain LHC discovery and LEP excess of Higgs–like events!

4 Summary

- MSSM Higgs bosons can simultaneously explain LHC discovery and LEP excess of Higgs–like events!
- Predicts rather light Higgs spectrum ($m_{H^\pm} \leq 170$ GeV): Improved prospects for $t \to H^+ b$ searches!

4 Summary

- MSSM Higgs bosons can simultaneously explain LHC discovery and LEP excess of Higgs–like events!
- Predicts rather light Higgs spectrum ($m_{H^\pm} \leq 170$ GeV): Improved prospects for $t \to H^+ b$ searches!
- Can significantly enhance or suppress various signal strengths; ratio of 4ℓ and $\gamma\gamma$ signals can vary between 0.66 and 1.3.

4 Summary

- MSSM Higgs bosons can simultaneously explain LHC discovery and LEP excess of Higgs–like events!
- Predicts rather light Higgs spectrum ($m_{H^\pm} \leq 170$ GeV): Improved prospects for $t \to H^+ b$ searches!
- Can significantly enhance or suppress various signal strengths; ratio of 4ℓ and $\gamma\gamma$ signals can vary between 0.66 and 1.3.
- Needs large $\tilde{t}$ mass splitting, $|A_t| + |\mu| > 2$ TeV: finetuning!

4 Summary

- MSSM Higgs bosons can simultaneously explain LHC discovery and LEP excess of Higgs–like events!
- Predicts rather light Higgs spectrum ($m_{H^\pm} \leq 170$ GeV): Improved prospects for $t \to H^+ b$ searches!
- Can significantly enhance or suppress various signal strengths; ratio of 4ℓ and $\gamma\gamma$ signals can vary between 0.66 and 1.3.
- Needs large $\tilde{t}$ mass splitting, $|A_t| + |\mu| > 2$ TeV: finetuning!
- For some parts of parameter space, decisive test may need ILC; light h difficult to detect at LHC.