HiggsBounds: confronting arbitrary Higgs sectors with exclusion bounds from LEP & the Tevatron

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[see arXiv:0811.4169 [hep-ph] and try it out at `www.ippp.dur.ac.uk/HiggsBounds/`]

outline :

- motivation
  - Higgs search
  - Why HiggsBounds ?
- implementation
  - basic idea
  - LEP analyses
  - Tevatron analyses
- usage and applications
  - usage
  - applications

- motivation

– Higgs search

- The **search for Higgs bosons** is a major cornerstone in the effort to unravel the **nature of electroweak symmetry breaking**.

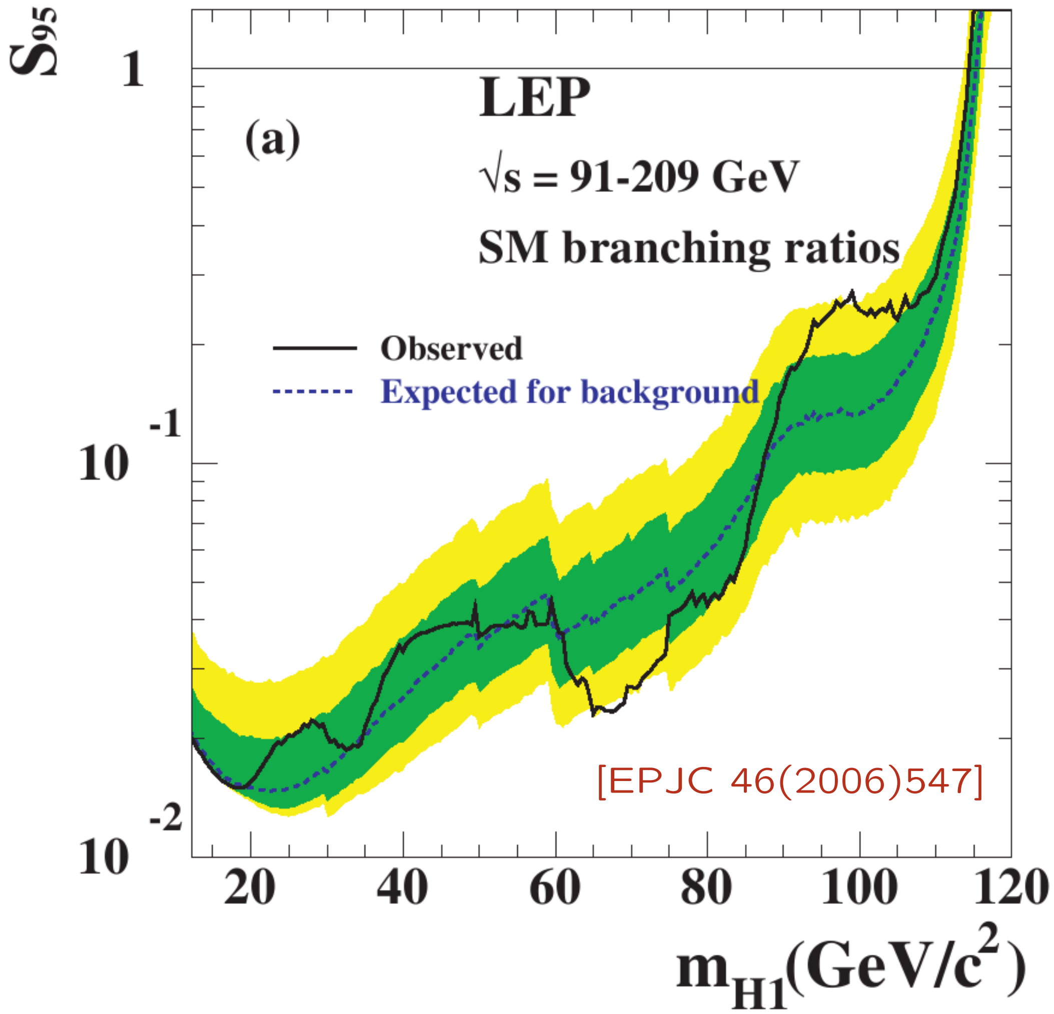
- So far: no Higgs signals.
  - LEP searched for them.
  - Tevatron is currently searching for them.

- Tevatron and LEP turn(ed) the non-observation of Higgs signals into 95% C.L. limits on rates/cross sections of ...

  a) ... individual signal topologies,
  e.g. $e^+e^- \to h_i Z \to b\bar{b}Z$, $p\bar{p} \to h_i \to W^+W^-$,

  b) ... combinations of signal topologies
  e.g. SM, MSSM combined limits.

example 1: LEP SM combined limit



$$S_{95}(m_{H1}) := \frac{\sigma_{\text{max}}}{\sigma_{\text{SM}}}(m_{H1})$$

where $\sigma_{\text{max}}(m_{H1})$ is the maximal Higgs production cross section compatible with the background-only hypothesis at 95% C.L.

A SM-like model with

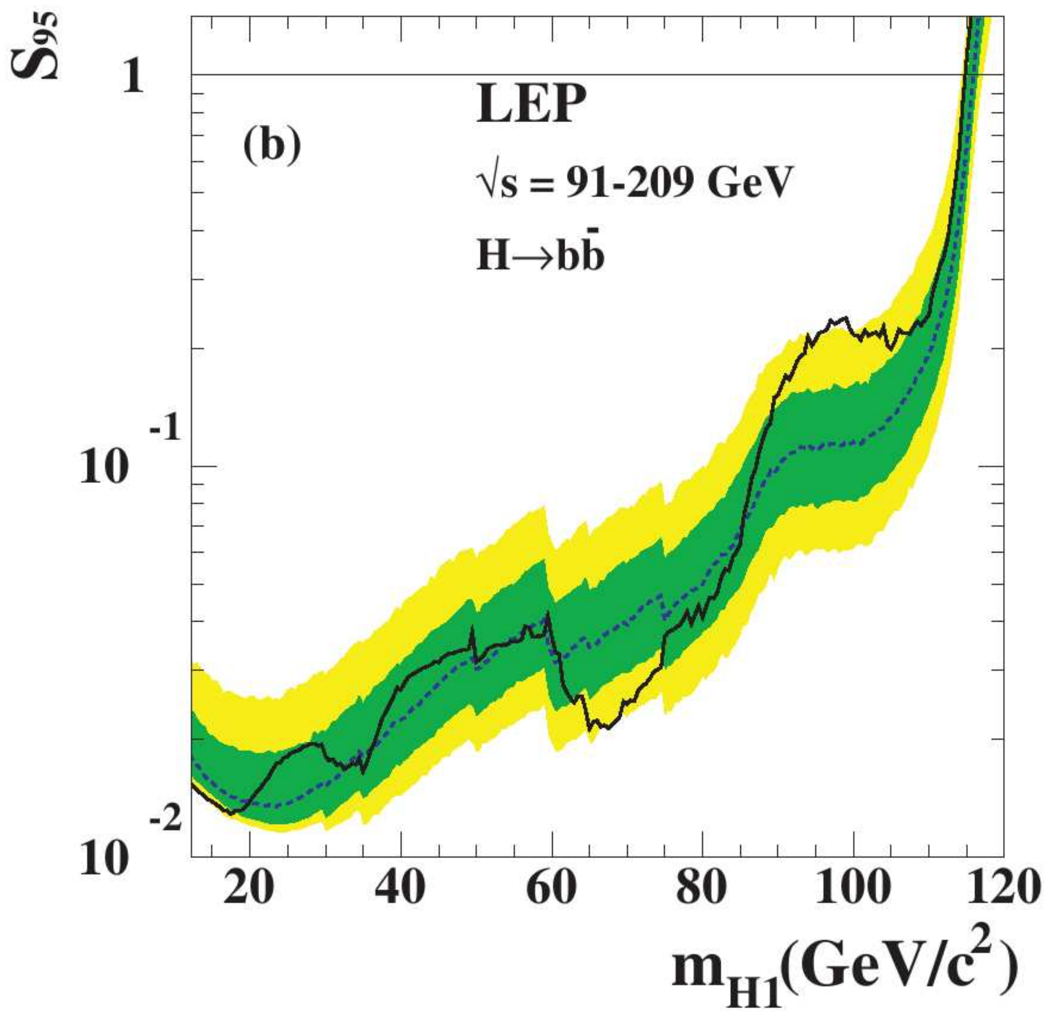
$$\sigma_{\text{model}}(m_{H1}) > \sigma_{\text{max}}(m_{H1})$$

or $\frac{\sigma_{\text{model}}(m_{H1})}{\sigma_{\text{max}}(m_{H1})} > 1$

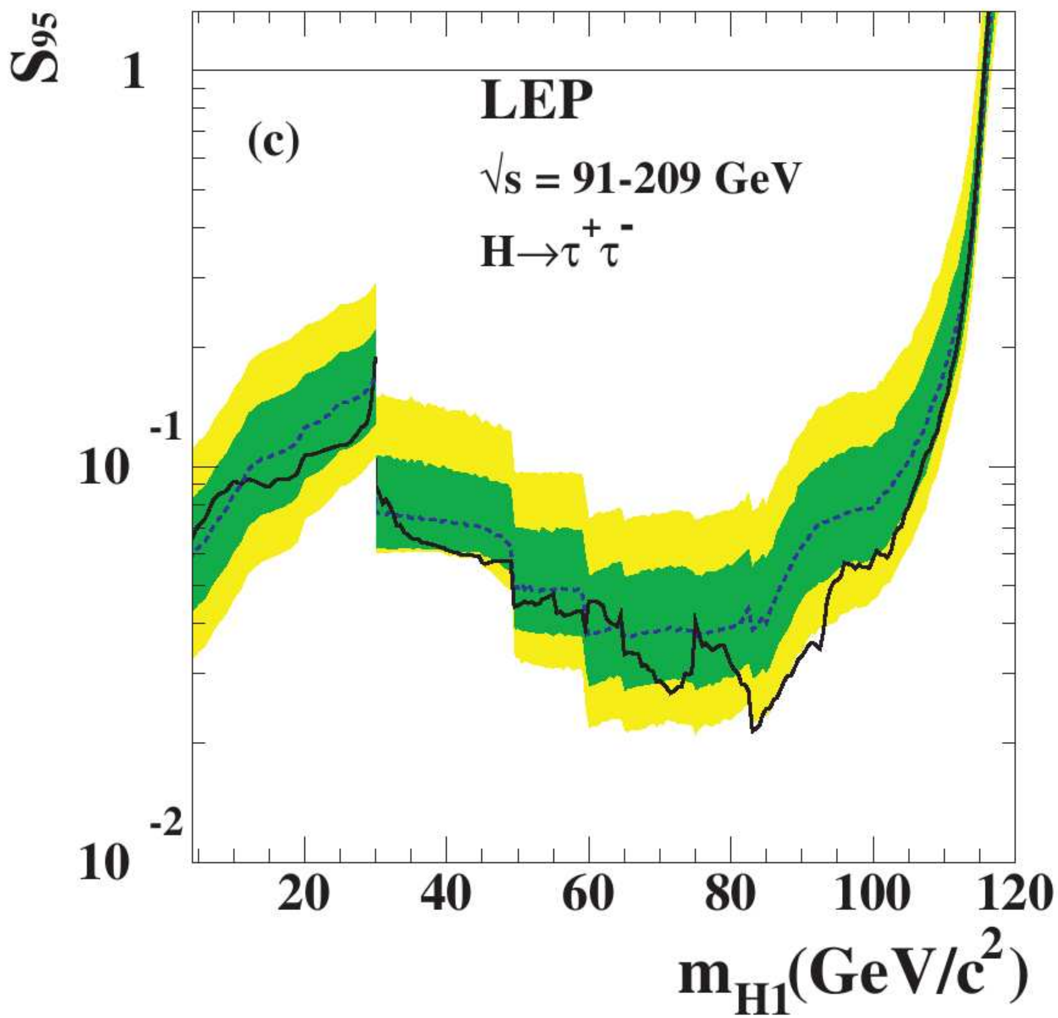
is said to be excluded at the 95% C.L.

example 2: LEP single topology limits, assuming HZ production and ...

a) ... BR($H \to b\bar{b}$)=1



b) ... BR($H \to \tau^+\tau^-$)=1

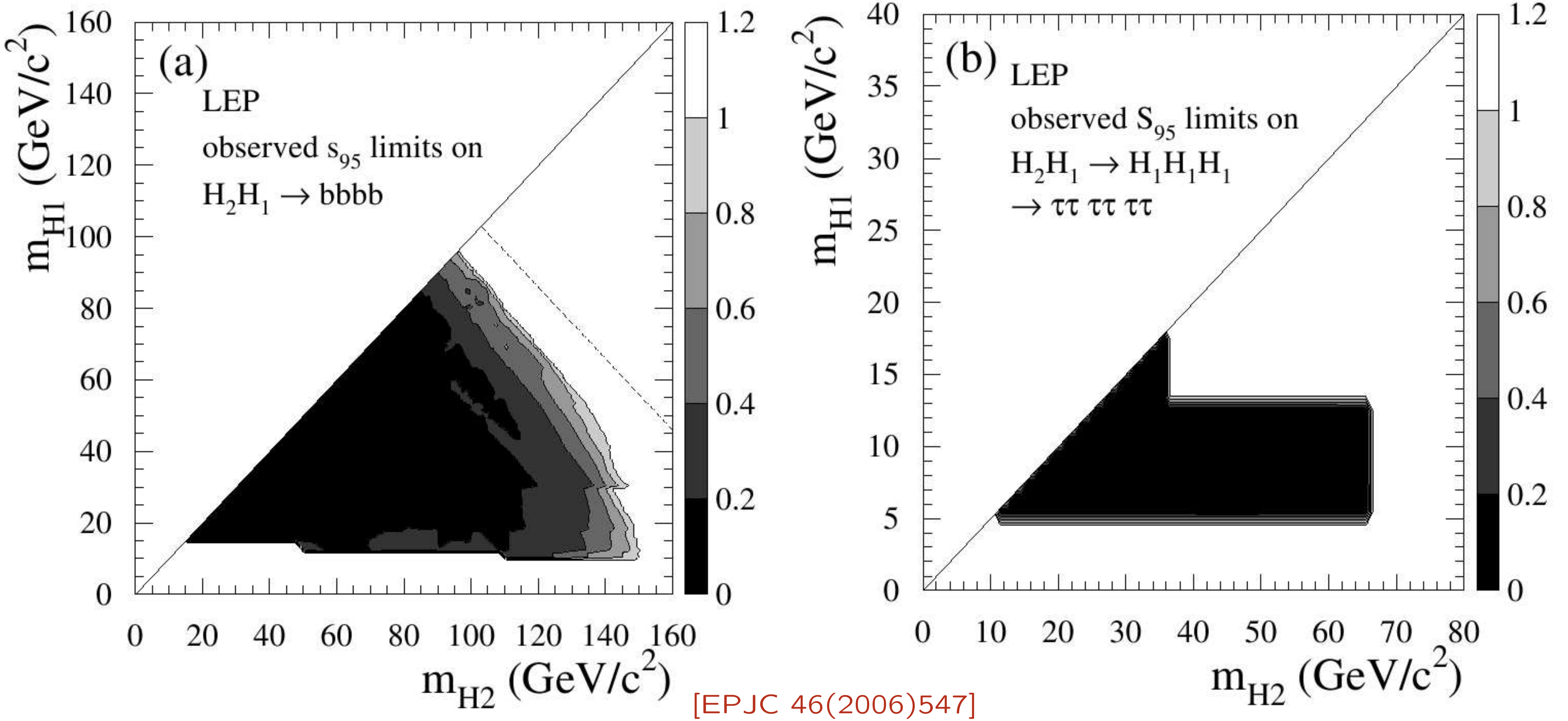


[EPJC 46(2006)547]

example 3: LEP single topology limits, assuming ...

a) ... H_2H_1 production and $\text{BR}(H_i \to b\bar{b}) = 1$

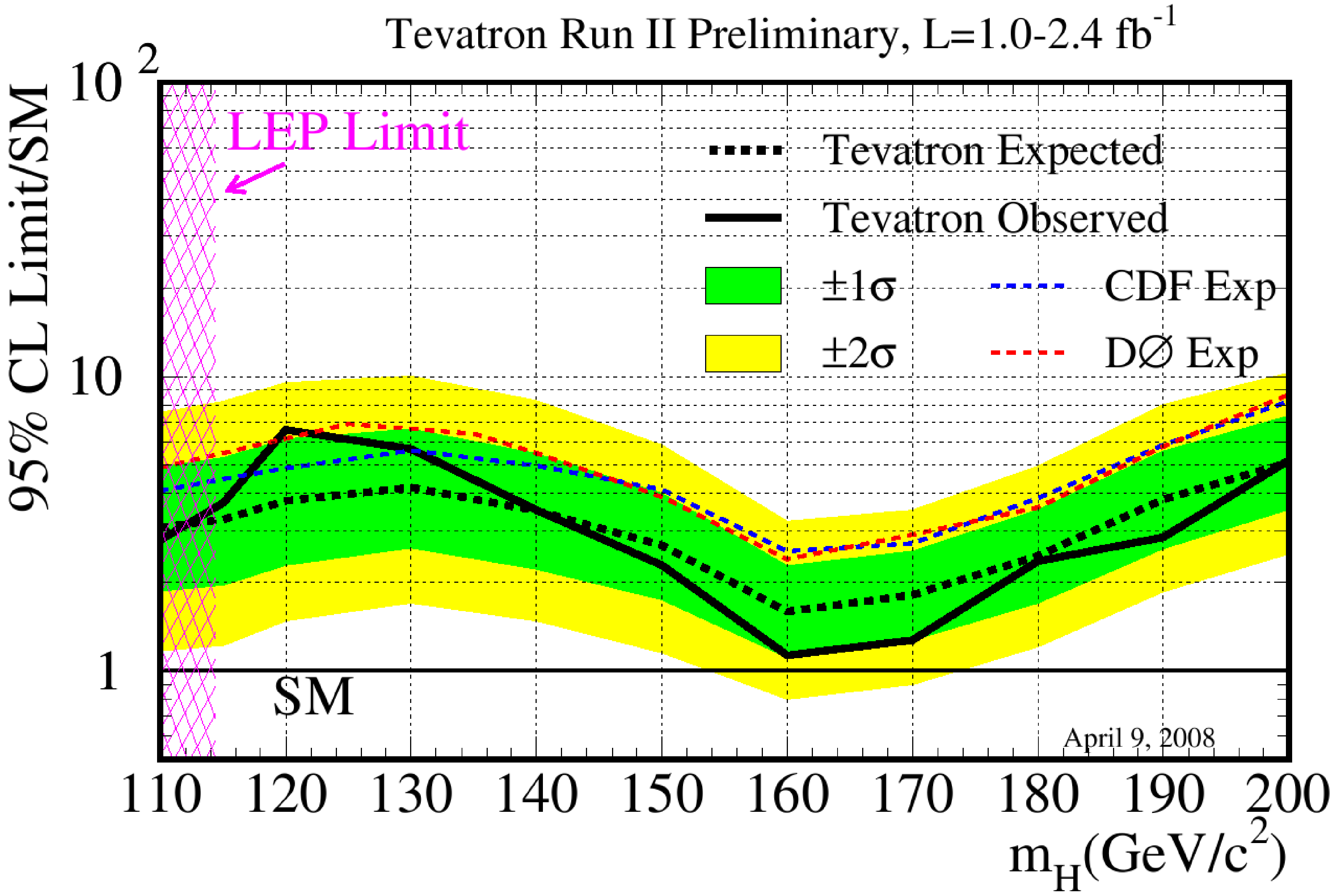
b) ... H_2H_1 production and $\text{BR}(H_i \to \tau^+\tau^-) = \text{BR}(H_2 \to H_1H_1) = 1$



[EPJC 46(2006)547]

here: $S_{95}(m_{H1}, m_{H2}) := \frac{\sigma_{\text{max}}}{\sigma_{\text{ref}}}(m_{H1}, m_{H2})$ with a reference $\sigma_{\text{ref}}(m_{H1}, m_{H2})$

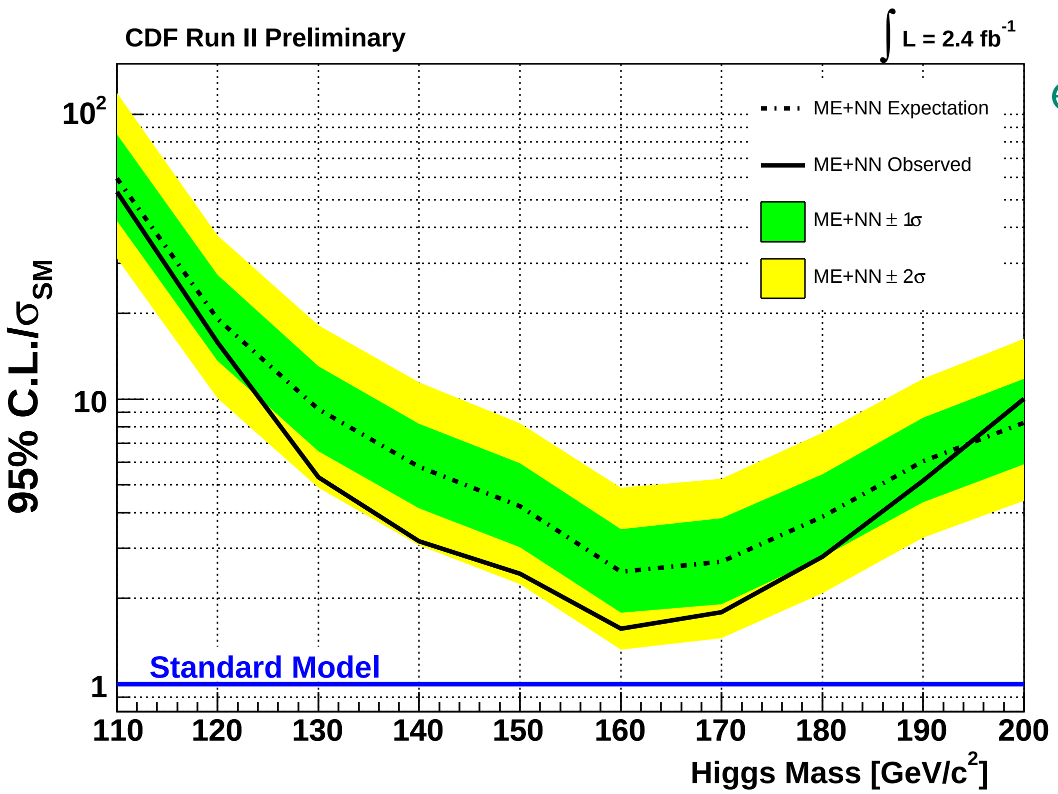
example 4: Tevatron SM combined limit



example 5: Tevatron single topology limits

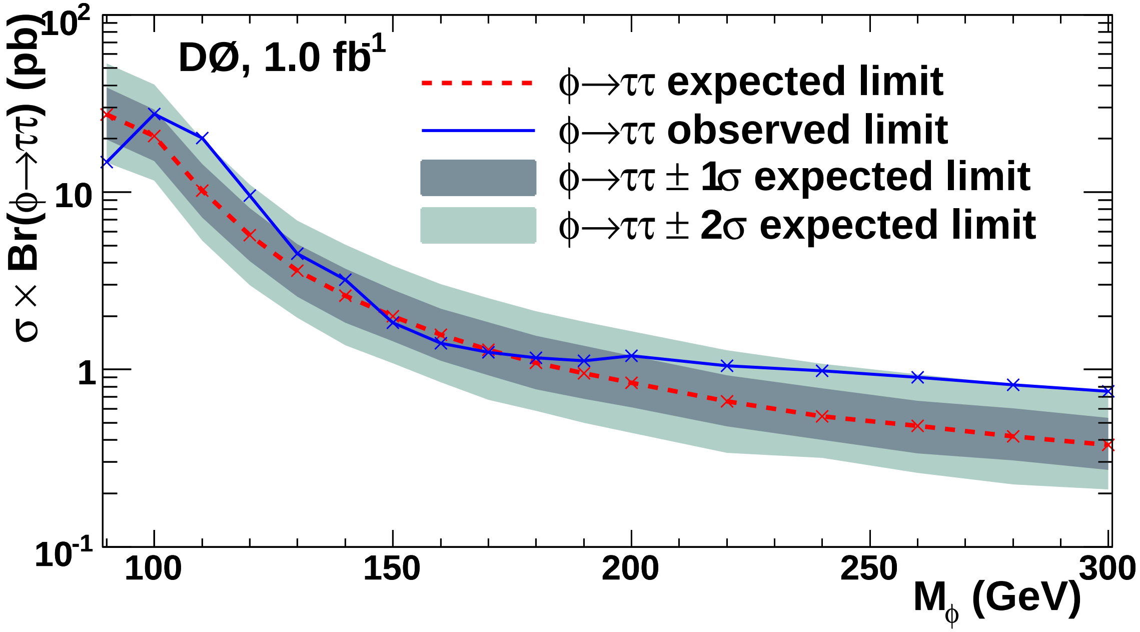
a) $p\bar{p} \to H \to WW^\star$ using 1.9 fb^{-1}
[CDF note 8958]

cross section ratio limit



b) $p\bar{p} \to H \to \tau^+\tau^-$ using 1 fb^{-1}
[DØ hep-ex/0805.2491]

absolute cross section limit



– Why HiggsBounds ?

- Many limits on individual topologies (from LEP/Tevatron) and combined results available, more to be expected from the Tevatron and the LHC (hopefully not for too long).

- In general, BSM models contribute to individual Higgs signal topologies in different proportions than in the SM.
  → SM combined analyses cannot be used

- To test such models against LEP and Tevatron results:
  check model predictions for cross sections
  of individual search topologies
  against the experimental limits.

HiggsBounds:

Test theoretical predictions of models with arbitrary Higgs sectors against exclusion bounds obtained from Higgs searches at LEP and the Tevatron.

- Easy access to all relevant Higgs exclusion limits

- Applicable to models with arbitrary Higgs sectors

  HiggsBounds Input: the predictions of the model for:

  # of Higgs bosons h_i , m_{h_i}, $\Gamma_{\text{tot}}(h_i)$, BR($h_i \to \ldots$),
  production cross section ratios (wrt reference values)

- Possibility to combine results from LEP and Tevatron

- implementation

• implementation

– basic idea

- Evaluate model prediction Q_{model} for cross section times BR (normalised to a reference value or not) of all search channels X for given Higgs masses and deviations from the SM and compare to experimental limit.

- Depending on the way the exclusion result (table) for a particular search channel (topology) has been published (relative or absolute limit), we evaluate

$$Q_{\text{model}} = \frac{[\sigma \times \text{BR}]_{\text{model}}}{[\sigma \times \text{BR}]_{\text{ref}}} \quad \text{or} \quad [\sigma \times \text{BR}]_{\text{model}}.$$

- From the experimental results we read off the value $Q_{\text{observed}}(X)$ corresponding to the observed 95% C.L. limit.

- If $\frac{Q_{\text{model}}(X)}{Q_{\text{observed}}(X)} > 1$ the model is excluded by this channel at 95% C.L.

→ Problem : how to combine channels without losing the 95% C.L. ?

Answer: We can't do that.

Only a dedicated experimental analysis can do that.

However: we can always use the channel of highest statistical sensitivity.

How to preserve the 95% C.L. limit:

- Determine for each search channel X the experimental expected limit $Q_{\text{expected}}(X)$.

- Determine the channel X_0 with the highest sensitivity for the signal, i.e. of all channels X find the channel X_0 where $\frac{Q_{\text{model}}(X)}{Q_{\text{expected}}(X)}$ is maximal.

- If for this channel $\frac{Q_{\text{model}}(X_0)}{Q_{\text{observed}}(X_0)} > 1$ the model is excluded at 95% C.L. by the corresponding experimental analysis for the search channel X_0.

– LEP analyses

We include expected and observed S_{95} values for the following search channels [EPJC 46(2006)547]

1. $e^+e^- \to (h_k)Z \to (b\bar{b})Z$,
2. $e^+e^- \to (h_k)Z \to (\tau^+\tau^-)Z$,
3. $e^+e^- \to (h_k \to h_i h_i)Z \to (b\bar{b}b\bar{b})Z$,
4. $e^+e^- \to (h_k \to h_i h_i)Z \to (\tau^+\tau^-\tau^+\tau^-)Z$,
5. $e^+e^- \to (h_k h_i) \to (b\bar{b}b\bar{b})$,
6. $e^+e^- \to (h_k h_i) \to (\tau^+\tau^-\tau^+\tau^-)$,
7. $e^+e^- \to (h_k \to h_i h_i)h_i \to (b\bar{b}b\bar{b})b\bar{b}$,
8. $e^+e^- \to (h_k \to h_i h_i)h_i \to (\tau^+\tau^-\tau^+\tau^-)\tau^+\tau^-$,
9. $e^+e^- \to (h_k \to h_i h_i)Z \to (b\bar{b})(\tau^+\tau^-)Z$,
10. $e^+e^- \to (h_k \to b\bar{b})(h_i \to \tau^+\tau^-)$,
11. $e^+e^- \to (h_k \to \tau^+\tau^-)(h_i \to b\bar{b})$,

Inclusion of additional channels, e.g. with $h_k \to$ invisible, is work in progress.

LEP input (Input Option `part/hadr`)

masses: m_{h_k} ,

branching ratios:

$$\mathrm{BR}_{\mathrm{model}}(h_i \to b\bar{b})\,, \qquad \mathrm{BR}_{\mathrm{model}}(h_i \to \tau^+\tau^-)\,, \qquad \mathrm{BR}_{\mathrm{model}}(h_k \to h_i h_i)\,,$$

ratios of cross sections:

$$\frac{\sigma_{\mathrm{model}}(e^+e^- \to h_k Z)}{\sigma_{\mathrm{ref}}(e^+e^- \to HZ)}\,, \qquad \frac{\sigma_{\mathrm{model}}(e^+e^- \to h_k h_i)}{\sigma_{\mathrm{ref}}(e^+e^- \to H'H)}\,,$$

with $m_{H'} = m_{h_k}$ and $m_H = m_{h_i}$ and for $k, i \in \{1, \ldots, n_{\mathrm{Higgs}}\}$.

With this input, we can evaluate S_{model} to compare with S_{95} as e.g.

$$S_{\mathrm{model}}\left[(h_1)Z \to (b\bar{b})Z\right] = \frac{\sigma_{\mathrm{model}}(h_1 Z)}{\sigma_{\mathrm{ref}}(HZ)}\mathrm{BR}_{\mathrm{model}}(h_1 \to b\bar{b})\,,$$

$$S_{\mathrm{model}}\left[(h_2 \to h_1 h_1)Z \to (b\bar{b}b\bar{b})Z\right] = \frac{\sigma_{\mathrm{model}}(h_2 Z)}{\sigma_{\mathrm{ref}}(HZ)}\mathrm{BR}_{\mathrm{model}}(h_2 \to h_1 h_1)\mathrm{BR}_{\mathrm{model}}(h_1 \to b\bar{b})^2$$

LEP input (Input Option `effC`)

masses: m_{h_k},

total widths: $\Gamma_{\text{tot}}(h_k)$,

normalised squared effective couplings:

$$\left(\frac{g^{\text{model}}_{h_k ZZ}}{g^{\text{SM}}_{HZZ}}\right)^2, \qquad \left(\frac{g^{\text{model}}_{h_k h_i Z}}{g^{\text{ref}}_{H'HZ}}\right)^2, \qquad \left(\frac{g^{\text{model}}_{h_k f\bar{f},\text{eff}}}{g^{\text{SM}}_{Hf\bar{f}}}\right)^2,$$

branching ratios: $\text{BR}_{\text{model}}(h_k \to h_i h_i)$,

for $k, i \in \{1, \ldots, n_{\text{Higgs}}\}$ and $f \in \{b, \tau\}$.

Relation to Input Option `part/hadr` quantities:

$$\frac{\sigma_{\text{model}}(e^+e^- \to h_k Z)}{\sigma_{\text{ref}}(e^+e^- \to HZ)} = \left(\frac{g^{\text{model}}_{h_k ZZ}}{g^{\text{SM}}_{HZZ}}\right)^2, \quad \frac{\sigma_{\text{model}}(e^+e^- \to h_k h_i)}{\sigma_{\text{ref}}(e^+e^- \to h_k h_i)} = \left(\frac{g^{\text{model}}_{H'HZ}}{g^{\text{ref}}_{H'HZ}}\right)^2,$$

$$\text{BR}_{\text{model}}(h_k \to f\bar{f}) = \text{BR}_{\text{SM}}(H \to f\bar{f})(m_H)\, \frac{\Gamma^{\text{SM}}_{\text{tot}}(m_H)}{\Gamma_{\text{tot}}(h_k)}\bigg|_{m_H = m_{h_k}} \left(\frac{g^{\text{model}}_{h_k f\bar{f},\text{eff}}}{g^{\text{SM}}_{Hf\bar{f}}}\right)^2.$$

– Tevatron analyses

At the moment, the following analyses of Higgs production signatures by CDF and DØ have been included in HiggsBounds:

search topology X (analysis)	reference ($\star$=published)
$p\bar{p} \to ZH \to l^+l^-b\bar{b}$ (CDF with 1.0 fb^{-1})	CDF'08*
$p\bar{p} \to ZH \to l^+l^-b\bar{b}$ (CDF with 2.4 fb^{-1})	CDF note 9475
$p\bar{p} \to ZH \to l^+l^-b\bar{b}$ (DØ with 2.3 fb^{-1})	DØ note 5570
$p\bar{p} \to WH \to l\nu b\bar{b}$ (DØ with 1.7 fb^{-1})	DØ note 5472
$p\bar{p} \to WH \to l\nu b\bar{b}$ (CDF with 2.7 fb^{-1})	CDF note 9463
$p\bar{p} \to WH \to W^+W^-W^\pm$ (DØ with 1.0 fb^{-1})	DØ note 5485
$p\bar{p} \to WH \to W^+W^-W^\pm$ (CDF with 1.9 fb^{-1})	CDF note 7307
$p\bar{p} \to H \to W^+W^- \to l^+l'^-$ (DØ with 3.0 fb^{-1})	DØ note 5757
$p\bar{p} \to H \to W^+W^- \to l^+l'^-$ (CDF with 3.0 fb^{-1})	CDF'08*
$p\bar{p} \to H \to \gamma\gamma$ (DØ with 1.1 fb^{-1})	DØ '08*
$p\bar{p} \to H \to \gamma\gamma$ (DØ with 2.68 fb^{-1})	DØ note 5737
$p\bar{p} \to H \to \tau^+\tau^-$ (DØ with 1.0 fb^{-1})	DØ '08*
$p\bar{p} \to H \to \tau^+\tau^-$ (CDF with 1.8 fb^{-1})	CDF note 9071
$p\bar{p} \to bH, H \to b\bar{b}$ (CDF with 1.9 fb^{-1})	CDF note 9284
$p\bar{p} \to bH, H \to b\bar{b}$ (DØ with 1.0 fb^{-1})	DØ '08*
$p\bar{p} \to bH, H \to b\bar{b}$ (DØ with 2.6 fb^{-1})	DØ note 5726

Evaluation of model predictions Q_{model}: similar to LEP case.

However, for the cross section input of each search channel X, ratios of hadronic cross sections are needed (Input Option `hadr`):

$$Q_{\text{model}}(X, m_H) = \frac{\sigma_{\text{model}}(X, m_H)}{\sigma_{\text{SM}}(X, m_H)} = \left(\frac{\sigma_{\text{model}}(P)}{\sigma_{\text{SM}}(P)}\right)\left(\frac{\text{BR}_{\text{model}}(H \to F)}{\text{BR}_{\text{SM}}(H \to F)}\right)$$

However, it can be rather inconvenient for the user.

The user input can also be ratios of partonic cross sections and the ratios of hadronic cross sections are calculated from it (Input Option `part`).

$$\left(\frac{\sigma_{\text{model}}(P)}{\sigma_{\text{SM}}(P)}\right) \approx \sum_{\{n,m\}} R_{nm}^{H+y}(\hat{s}_{\text{thr.}}, m_H) \frac{\sigma_{\text{SM}}(p\bar{p} \to nm \to H + y, m_H)}{\sigma_{\text{SM}}(p\bar{p} \to H + y, m_H)},$$

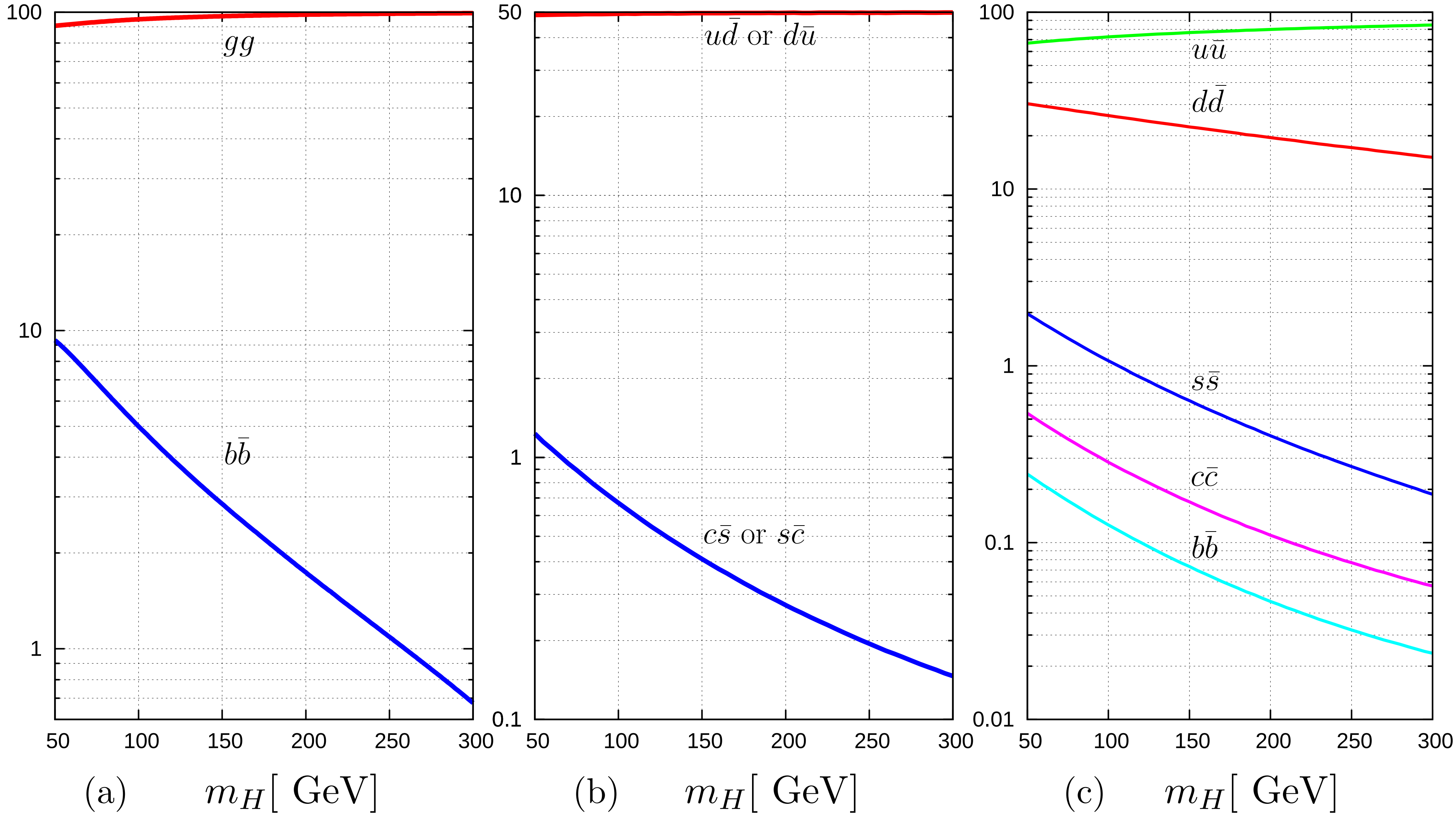
with

$$R_{nm}^{H+y}(\hat{s}, m_H) := \frac{\hat{\sigma}^{\text{model}}_{nm \to H+y}(\hat{s}, m_H)}{\hat{\sigma}^{\text{SM}}_{nm \to H+y}(\hat{s}, m_H)}.$$

These ratios can usually be expressed in terms of ratios of effective Higgs couplings (Input Option `effC`).

SM cross section fractions in % (using MRST 2006 NNLO PFDs)

$\frac{\sigma_{\mathrm{SM}}(p\bar{p}\to nm\to H)}{\sigma_{\mathrm{SM}}(p\bar{p}\to H)}$ $\frac{\sigma_{\mathrm{SM}}(p\bar{p}\to nm\to HW^{+/-})}{\sigma_{\mathrm{SM}}(p\bar{p}\to HW^{\pm})}$ $\frac{\sigma_{\mathrm{SM}}(p\bar{p}\to nm\to HZ)}{\sigma_{\mathrm{SM}}(p\bar{p}\to HZ)}$



Tevatron input (Input Option `hadr`)

masses: m_{h_k},

branching ratios:

$$\mathrm{BR}_{\text{model}}(h_k \to b\bar{b}), \qquad \mathrm{BR}_{\text{model}}(h_k \to \tau^+\tau^-),$$
$$\mathrm{BR}_{\text{model}}(h_k \to W^+W^-), \qquad \mathrm{BR}_{\text{model}}(h_k \to \gamma\gamma),$$

ratios of the hadronic cross sections:

$$\frac{\sigma_{\text{model}}(p\bar{p} \to h_k Z)}{\sigma_{\text{SM}}(p\bar{p} \to HZ)}, \quad \frac{\sigma_{\text{model}}(p\bar{p} \to h_k W^\pm)}{\sigma_{\text{SM}}(p\bar{p} \to HW^\pm)}, \quad \frac{\sigma_{\text{model}}(p\bar{p} \to h_k \text{ via VBF})}{\sigma_{\text{SM}}(p\bar{p} \to H \text{ via VBF})},$$
$$\frac{\sigma_{\text{model}}(p\bar{p} \to h_k)}{\sigma_{\text{SM}}(p\bar{p} \to H)}, \quad \frac{\sigma_{\text{model}}(p\bar{p} \to h_k b)}{\sigma_{\text{SM}}(p\bar{p} \to Hb)},$$

for $k \in \{1, \ldots, n_{\text{Higgs}}\}$.

Tevatron input (Input Option `part`)

masses: m_{h_k} ,

branching ratios:

$$\mathrm{BR}_{\mathrm{model}}(h_k \to b\bar{b})\,, \qquad \mathrm{BR}_{\mathrm{model}}(h_k \to \tau^+\tau^-)\,,$$
$$\mathrm{BR}_{\mathrm{model}}(h_k \to W^+W^-)\,, \qquad \mathrm{BR}_{\mathrm{model}}(h_k \to \gamma\gamma)\,,$$

ratios of partonic cross sections ($\hat{s} = \hat{s}_{\mathrm{threshold}}$):

$$\frac{\hat{\sigma}_{\mathrm{model}}(gg \to h_k)}{\hat{\sigma}_{\mathrm{SM}}(gg \to H)}\,, \qquad \frac{\hat{\sigma}_{\mathrm{model}}(b\bar{b} \to h_k)}{\hat{\sigma}_{\mathrm{SM}}(b\bar{b} \to H)}\,, \qquad \frac{\hat{\sigma}_{\mathrm{model}}(bg \to h_k b)}{\hat{\sigma}_{\mathrm{SM}}(bg \to Hb)}\,,$$
$$\frac{\hat{\sigma}_{\mathrm{model}}(q\bar{q}' \to h_k W^+)}{\hat{\sigma}_{\mathrm{SM}}(q\bar{q}' \to HW^+)}\,, \qquad \frac{\hat{\sigma}_{\mathrm{model}}(q'\bar{q} \to h_k W^-)}{\hat{\sigma}_{\mathrm{SM}}(q'\bar{q} \to HW^-)}\,, \qquad (q, q') \in \{(u, d), (c, s)\}\,,$$
$$\frac{\hat{\sigma}_{\mathrm{model}}(q\bar{q} \to h_k Z)}{\hat{\sigma}_{\mathrm{SM}}(q\bar{q} \to HZ)}\,, \qquad q \in \{u, d, c, s, b\}\,,$$

and the hadronic cross section ratio:

$$\frac{\sigma_{\mathrm{model}}(p\bar{p} \to h_k \text{ via VBF})}{\sigma_{\mathrm{SM}}(p\bar{p} \to H \text{ via VBF})}\,,$$

for $k \in \{1, \ldots, n_{\mathrm{Higgs}}\}$.

Tevatron input (Input Option `part`)

Example: evaluation of the model cross section
for the search channel $X = p\bar{p} \to H \to W^+W^- \to l^+l'^-$
normalised to the SM cross section:

$$Q_{\text{model}}(X) = \left\{ \left(\frac{\hat{\sigma}^{\text{model}}_{gg\to h_k}(\hat{s}_{\text{thr.}}, m_{h_k})}{\hat{\sigma}^{\text{SM}}_{gg\to h_k}(\hat{s}_{\text{thr.}}, m_H)} \frac{\sigma_{\text{SM}}(p\bar{p} \to gg \to H, m_H)}{\sigma_{\text{SM}}(p\bar{p} \to H, m_H)} + \frac{\hat{\sigma}^{\text{model}}_{b\bar{b}\to h_k}(\hat{s}_{\text{thr.}}, m_{h_k})}{\hat{\sigma}^{\text{SM}}_{b\bar{b}\to h_k}(\hat{s}_{\text{thr.}}, m_H)} \frac{\sigma_{\text{SM}}(p\bar{p} \to b\bar{b} \to H, m_H)}{\sigma_{\text{SM}}(p\bar{p} \to H, m_H)} \right) \times \frac{\text{BR}^{\text{model}}_{h_k\to W^+W^-}(m_{h_k})}{\text{BR}^{\text{SM}}_{H\to W^+W^-}(m_H)} \right\} \Bigg|_{m_H = m_{h_k}} .$$

(green: input, purple: provided functions)

For the SM normalisation, HiggsBounds provides also predicitons for SM branching ratios using HDECAY 3.303 [Djouadi et al.'98] and SM Higgs production processs using the compilation of the TEV4LHC Working Group [Aglietti et al.'06].

Tevatron input (Input Option `effC`)

masses: m_{h_k} ,

total widths: $\Gamma_{\text{tot}}(h_k)$,

normalised squared effective couplings:

$$\left(\frac{g^{\text{model}}_{h_k ZZ}}{g^{\text{SM}}_{HZZ}}\right)^2, \quad \left(\frac{g^{\text{model}}_{h_k h_i Z}}{g^{\text{ref}}_{H'HZ}}\right)^2, \quad \left(\frac{g^{\text{model}}_{h_k f\bar{f},\text{eff}}}{g^{\text{SM}}_{Hf\bar{f}}}\right)^2,$$

$$\left(\frac{g^{\text{model}}_{h_k gg}}{g^{\text{SM}}_{Hgg}}\right)^2, \quad \left(\frac{g^{\text{model}}_{h_k \gamma\gamma}}{g^{\text{ref}}_{H\gamma\gamma}}\right)^2, \quad \left(\frac{g^{\text{model}}_{h_k W^+W^-}}{g^{\text{SM}}_{HW^+W^-}}\right)^2,$$

for $k \in \{1, \ldots, n_{\text{Higgs}}\}$ and $f \in \{b, \tau\}$.

From this input, all quantities required in Input Option `part` can be calculated in the effective coupling approximation.

- usage and applications

– usage

Command-line version:

Command:

```
HiggsBounds <analyses to use> <input mode> <number of Higgses> [<fileprefix>]
```

with

```
<analyses to use>     :  LandT (LEP and Tevatron)
                      :  onlyT (only Tevatron)
                      :  onlyL (only LEP)
                      :  singH (only analyses involving one Higgs)
<input mode>          :  part (partonic CS ratios)
                      :  hadr (hadronic CS ratios)
                      :  effC (effective couplings)
<number of Higgses>   :  1 to 9 (extendable)
<fileprefix>          :  prefix for input files (optional,
                         can also be a subdirectory)
```

The command-line version works on a set of input files.
Which set depends on the selected analyses and input mode.

Sample output file (written to <prefix>HiggsBounds_Results.dat)

```
# generated with HiggsBounds on 31.10.2008 at 11:18
# settings: LandT, effC
#
# column abbreviations
#   n          : line id of input
#   Mh(i)      : Higgs boson masses
#   HBresult   : scenario allowed flag (1: allowed, 0: excluded, -1: unphysical)
#   chan       : most sensitive channel (see below). chan=0 if no channel applies
#   obsratio   : ratio [sig x BR]_model/[sig x BR]_limit (<1: allowed, >1: excluded)
#   ncomb      : number of Higgs bosons combined in most sensitive channel
#   additional : optional additional data stored in <prefix>additional.dat (e.g. tan beta)
#
# channel numbers used in this file
#          3 : (ee)->(h3)Z->(b b)Z   (LEP table 14b)
#          4 : (ee)->(h1)Z->(tau tau)Z   (LEP table 14c)
#        124 : (pp)->W(h1)->l nu (b b)   (CDF Note 9463)
#        134 : (pp)->h2->tau tau   (arXiv:0805.2491)
#        157 : (pp)->h1+... where h1 is SM-like  (arXiv:0804.3423 [hep-ex])
# (for full list of processes, see Key.dat)
#
#cols: n    Mh(1)     Mh(2)     Mh(3)    HBresult  chan    obsratio     ncomb  additional(1)
#
       1   359.121   271.963   134.929         1   134    0.212206E-03     1    0.246862
       2   75.0123   92.8677   71.9716         1     4    0.306172E-01     1    0.714964
       3   136.293   345.483   330.026         1   124    0.640713E-01     1    0.434594
       4   111.377   220.765   51.7469         1     3    0.162811         1    0.727173
       5   186.131   355.002   146.448         0   157     15.2354         1    0.230522
```

WWW version:

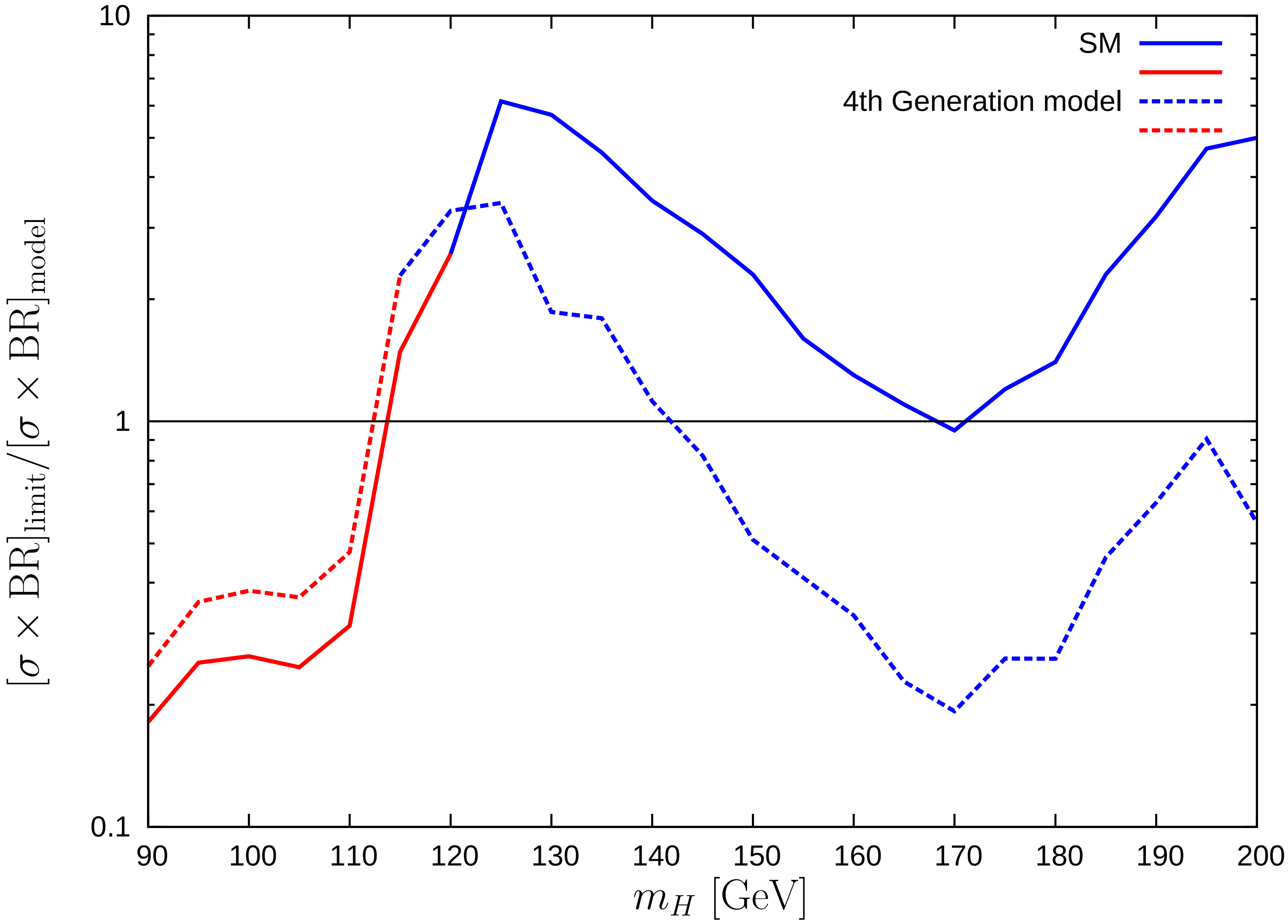
options similar to command-line version, pointwise input only

(see www.ippp.dur.ac.uk/HiggsBounds/)

Fortran subroutine version: e.g. for effective couplings input

```
call run_HiggsBounds_effC(nH,<analyses to use>,
&    Mh,GammaTotal,
&    g2hjbb,g2hjtautau,g2hjWW,g2hjZZ,
&    g2hjgaga,g2hjgg,g2hjhiZ,
&    BR_hjhihi,
&    HBresult,chan,
&    obsratio, ncombined )
```

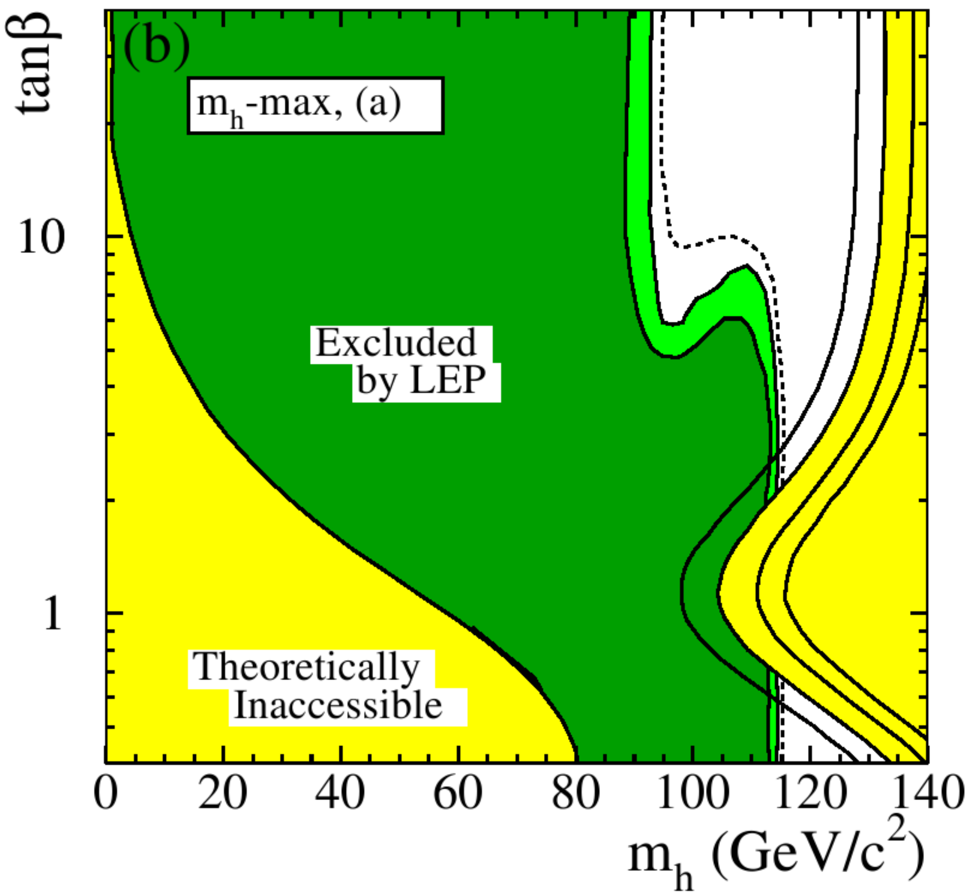
application 1: SM versus Fourth Generation Model exclusion

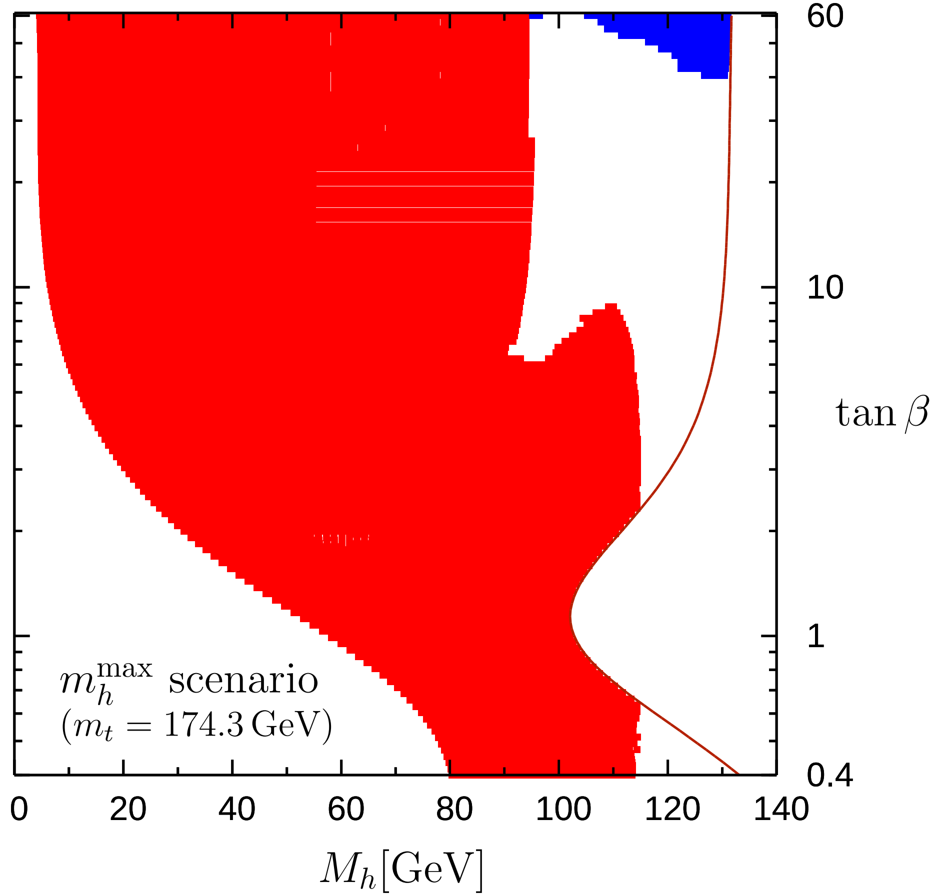


application 2: MSSM benchmark scenarios, exclusion update

a) [EPJC 46(2006)547]

b) HiggsBounds
with: new m_t,
impoved m_h prediction,
Tevatron data included

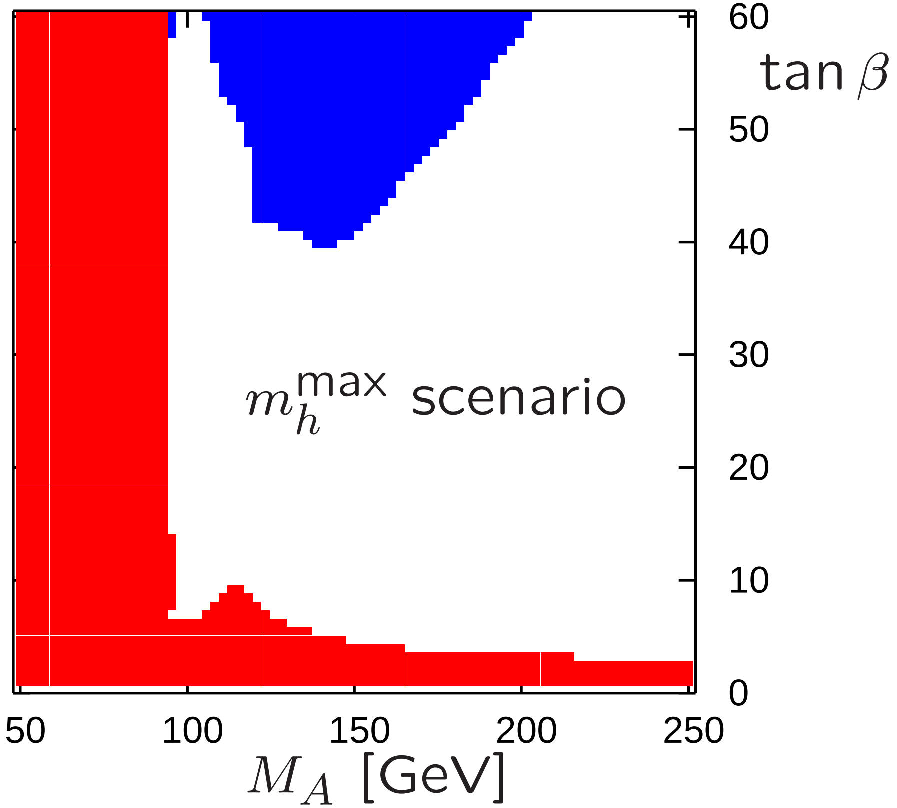




[usage and applications, applications]

application 2: MSSM benchmark scenarios, exclusion update

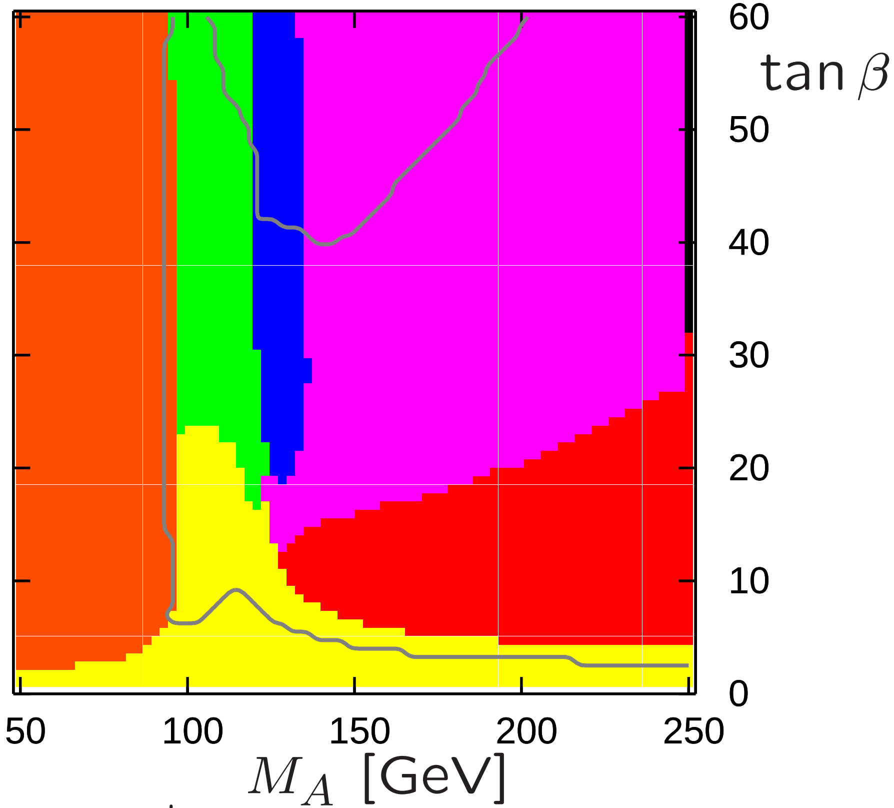
a) LEP and Tevatron exclusion



■ : LEP exclusion

■ : Tevatron exclusion

b) highest sensitivity



■ : $e^+e^- \to hZ, h \to b\bar{b}$

■ : $e^+e^- \to hA \to b\bar{b}b\bar{b}$

■ : $p\bar{p} \to h/A \to \tau^+\tau^-$ [CDF note 9071]

■ : $p\bar{p} \to h/H/A \to \tau^+\tau^-$ [CDF note 9071]

■ : $p\bar{p} \to H/A \to \tau^+\tau^-$ [CDF note 9071]

■ : $p\bar{p} \to hW \to b\bar{b}l\nu$ [CDF note 9463]

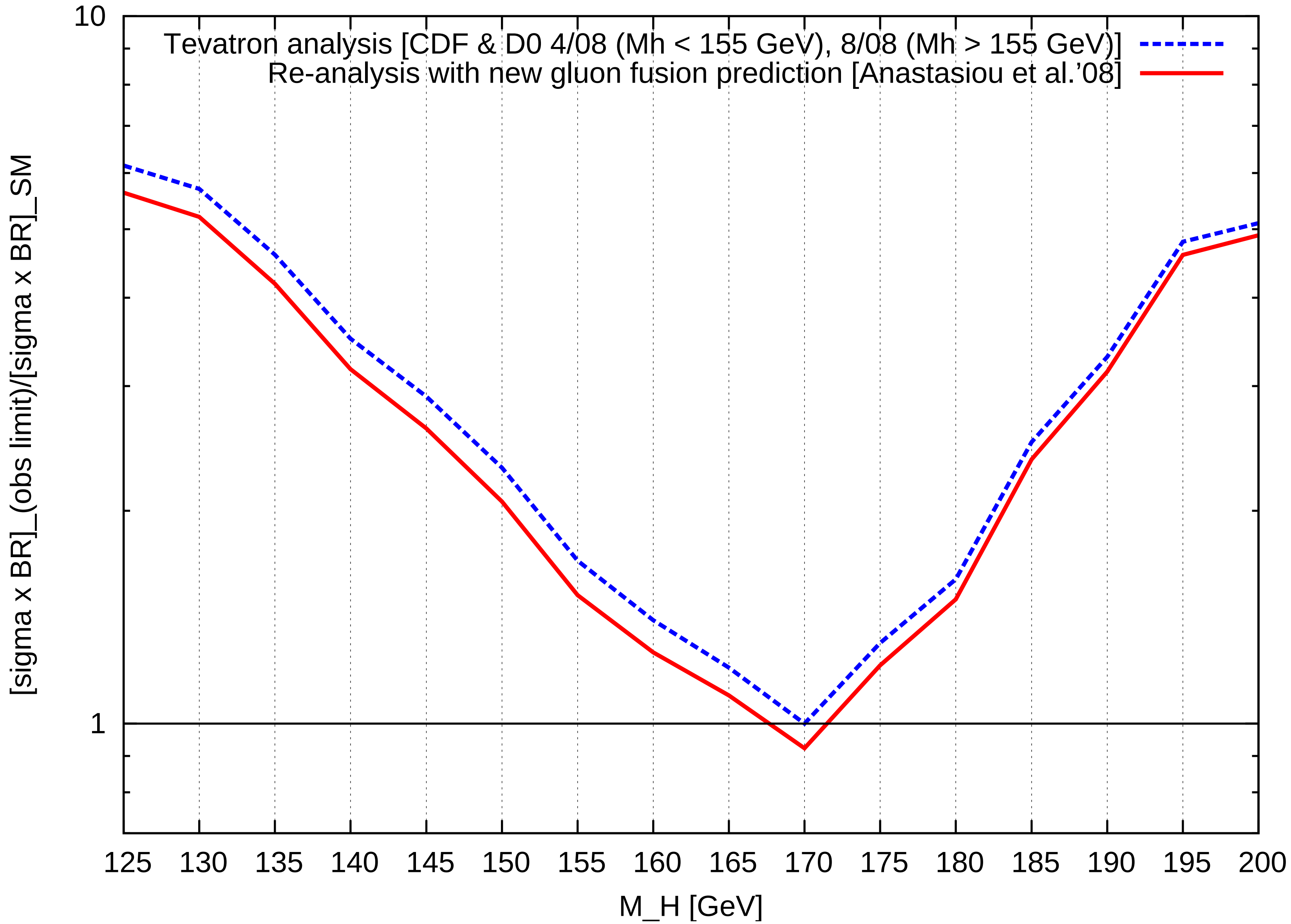
■ : $p\bar{p} \to H/A \to \tau^+\tau^-$ [DØ'08]

application 3: re-evaluation of SM exclusion with improved prediction

This Monday: New SM result for $\sigma(p\bar{p} \to gg \to H)$,
"Mixed QCD-Electroweak corrections to Higgs boson production in gluon fusion"
by Anastasiou, Boughezal, Petriello [arXiv:0811.3458 [hep-ph]]:

"Our results motivate a reconsideration of the Tevatron exclusion limits."

application 3: re-evaluation of SM exclusion with improved prediction



summary

- The Higgs search at Tevatron and LEP turn(ed) out many limits on cross sections of individual and combined signal topologies.

- Those limits are published as figures and tables in many individual papers which don't allow for making use of all of them in a convenient way.

- HiggsBounds offers easy access to a wealth of published limits in form of a FORTRAN program and a web page (`www.ippp.dur.ac.uk/HiggsBounds/`).

- HiggsBounds is a model-independent tool which offers a flexible range of input formats for the necessary model predictions (including the number of neutral Higgs bosons).

The code will be publicly released soon. Please send an e-mail to `oliver.brein@durham.ac.uk` or `k.e.williams@durham.ac.uk` to get notified.