

Implications of LHC Results for TeV-Scale Physics

WG1 (Signals of Electroweak Symmetry Breaking): Towards the Final Document

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on behalf of *Andreas, Chiara, Georg, Marumi*

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From the charge:

- “. . . to evaluating the implications of recent results from the LHC, and elsewhere, for TeV-scale physics, and to discuss the impact of these results on the future strategy for particle physics.”
- **WG1: Signals of electroweak symmetry breaking**
- The task of the working groups is to assess the possible interpretations of the experimental results in view of their implications for the future strategy of particle physics.
- First general meeting: **08/2011 @ CERN** ⇒ initial ideas, discussions
Intermediate WG1 meeting: **11/2011 @ Orsay** ⇒ “unclear” situation
- final document will be ready in time for the Orsay-type meeting of the European Strategy update
⇒ **31.07.2012**

Towards the final document

Keep in mind:

- a) How well do the observed signatures in the early LHC data **constrain the possible physics scenario?**
- b) What could be the impact of early LHC results on the **choice of the next facility** and its (ultimate) energy reach and luminosity?
- c) What would be the possible implications for the **machine and the detector design?**

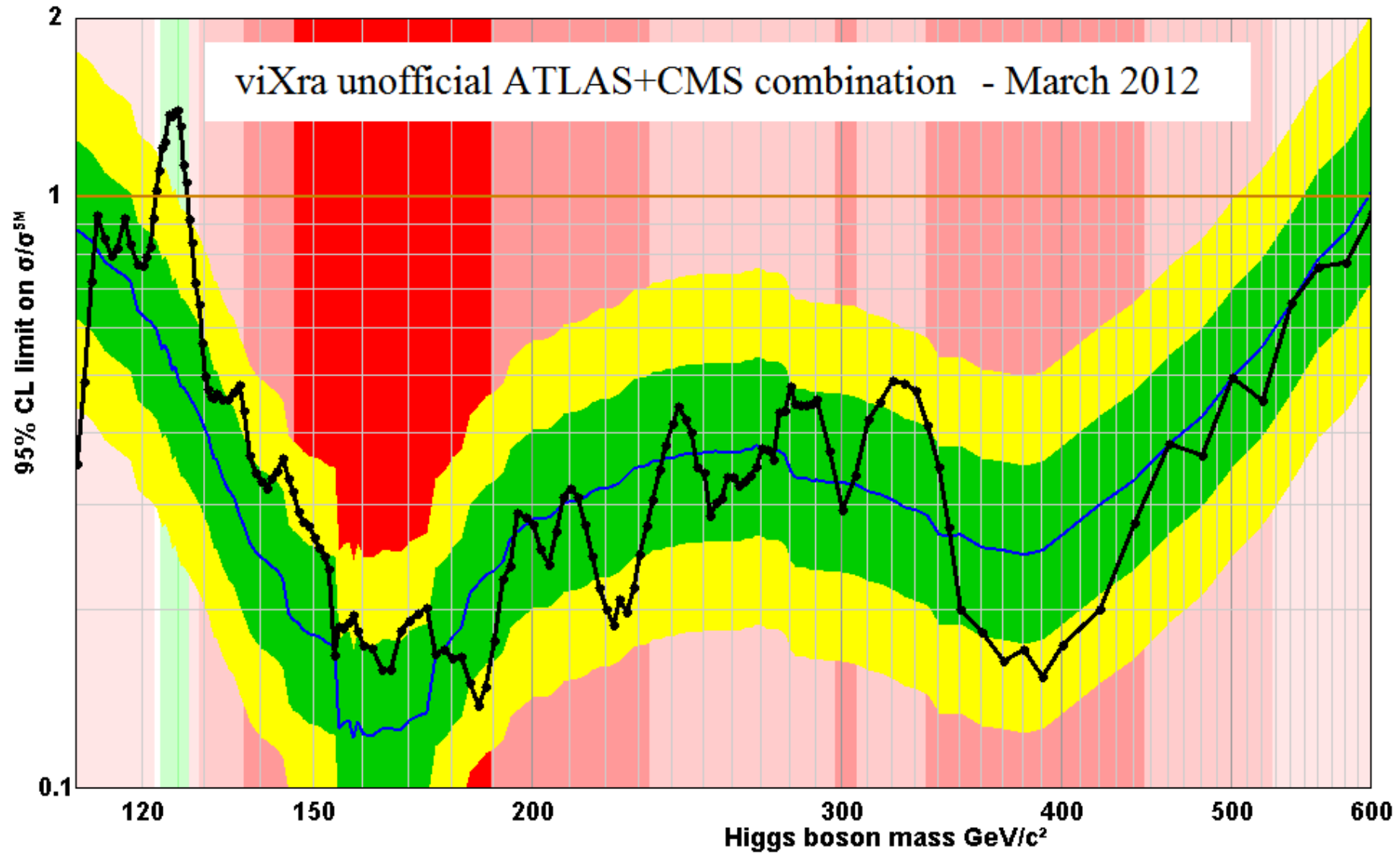
⇒ **draft very soon** (pre-draft exists already :-)

(“dry run”: take a look at LHC2FC report!)

The situation changed dramatically since Orsay . . .

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Unofficial(!) LHC combination for SM-like Higgs searches:



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- SM-like Higgs excluded for $M_H \lesssim 120$ GeV
 - SM-like Higgs excluded for 130 GeV $\lesssim M_H \lesssim 500$ GeV
 - large regions excluded beyond the 99% CL limit
 - large regions excluded for a Higgs with strongly reduced couplings
 - “tantalizing hints” observed for 122 GeV $\leq M_H \leq 128$ GeV
 - ATLAS: 2.5σ (local, with 2.8σ expected): $\gamma\gamma$ (+ ZZ)
 - CMS: 2.8σ (local, with 2.8σ expected): $\gamma\gamma$
 - Tevatron: 2.7σ (local, with 1.5σ expected): $b\bar{b}$ (+ $l\nu l\nu$)
- ⇒ parallel sessions on 125 GeV implications ...
- ⇒ impressively coherent picture

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Do not forget: SM-fit prefers low M_H

MSSM predicted M_h around this range for decades!

Our “final” data set: everything presented at ICHEP 2012

For our analysis/write-up: $\mathcal{L} \lesssim 3 - 7 \text{ fb}^{-1}$ @ 8 TeV

- collaboration internal combination :-) sufficient for 5σ ???
- combination of ATLAS and CMS? :-((

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Possible scenarios: (things can change rapidly!)

observation of a state compatible with

A: SM-like Higgs with $M_H \approx 125 \text{ GeV}$

B: non-SM-like Higgs with $M_H \approx 125 \text{ GeV}$

C: something inconclusive

D: “nothing” Is this possible with “our” data set?

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A: SM-like Higgs with $M_H \approx 125 \text{ GeV}$

- mass measurement to $\pm?$ GeV
- μ values (“signal strength”) for various channels
- very rough coupling measurement ($\sim 50\%$ level $\sim 20\%$ level??)
(ATLAS? CMS? SFitter!, \mathcal{L}_{eff} fitters!)
- quantum numbers: J^{PC} , ...

\Rightarrow parallel session on 125 GeV implications ...

\Rightarrow parallel session on coupling determination

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For our analysis/write-up: $\mathcal{L} \lesssim 3 - 7 \text{ fb}^{-1} @ 8 \text{ TeV}$

- collaboration internal combination :-)
- combination of ATLAS and CMS? :-)

sufficient for 5σ ???

B: non-SM-like Higgs with $M_H \approx 125 \text{ GeV}$

- mass measurement to $\pm?$ GeV
- μ values (“signal strength”) for various channels
 \Rightarrow deviation from SM?
- very rough coupling measurement ($\sim 50\%$ level!! $\sim 20\%$ level??)
(ATLAS? CMS? SFitter!, \mathcal{L}_{eff} fitters!)
- quantum numbers: J^{PC}, \dots

\Rightarrow parallel session on 125 GeV implications ...

\Rightarrow parallel session on coupling determination

Our “final” data set: everything presented at ICHEP 2012

For our analysis/write-up: $\mathcal{L} \lesssim 3 - 7 \text{ fb}^{-1}$ @ 8 TeV

- collaboration internal combination :-)
 - combination of ATLAS and CMS? :-)
- sufficient for 5σ ???

C: something inconclusive

- unclear
- how to prepare??
- update with more data!!

⇒ parallel session on alternatives

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- combination of ATLAS and CMS? :-)

D: “nothing”

- VV scattering will not say anything yet ...
- VV scattering will be interesting/relevant in any scenario!
(i.e. also in A, B, C)

⇒ parallel session on VV scattering

General strategy:

Work out/summarize what a future facility

- HL-LHC
- HE-LHC
- ILC
- CLIC
- LEP3
- LHeC
- μC
- ...

will add in that scenario to

what we will learn at the LHC with $\sim 300 \text{ fb}^{-1}$

A: SM-like Higgs with $M_H \approx 125$ GeV

Measurement of mass, (self-)couplings, quantum numbers, tensor structures at LHC(300) vs.

- HL-LHC
- HE-LHC
- ILC
- CLIC
- LEP3
- LHeC
- ...

B: non-SM-like Higgs with $M_H \approx 125$ GeV

Measurement of mass, (self-)couplings, quantum numbers, tensor structures at LHC(300) vs.

- HL-LHC
- HE-LHC
- ILC
- CLIC
- LEP3
- LHeC
- ...

C: something inconclusive (also: hints at 125 GeV + something inconclusive)

D: “nothing”

We have to further probe the entire mass range (also below 114 GeV!!)

- Higgs with strongly suppressed couplings?
- Heavy Higgs (+ something else)
- VV scattering
- something else

Compare LHC(300) to

- HL-LHC
- HE-LHC
- ILC
- CLIC
- LEP3
- LHeC
- ...

What is missing?

How will it work?

- the convenors will ask for special contributions (fits, numbers, ...)
 - the convenors will (the sooner the better) prepare a draft (pre-draft exists already :-)
 - the draft will be circulated pre-ICHEP
 - comments to be sent to the convenors
 - the draft will be updated after ICHEP and circulated on a very short time scale!
 - document ready by 31.07. latest
- ⇒ all in coordination with other WG's

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After Moriond 2013 prepare the really final document