

## Higgs Report

# Live Higgs Report on July 4, 2012 & Congratulations - It's a Boson

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### Abstract

This is a live Higgs report from the webcast of CERN Announcement on July 4, 2012 plus viXra unofficial Higgs combinations and my analysis after the announcement. As expected, CERN has happily announced the arrival of a new Boson. The facts are that the boson discovered with a mass of about 125 GeV or 126 GeV interacts with a wide range of particles in exactly the way the Higgs boson should. Its decay modes to Z, W, b and tau have just the right ratios and its production has also been tested in different ways confirming indirectly that its coupling to the top quark is also about right. Its spin could be 0 or 2 but 0 is much more likely. All these features point to the standard model Higgs boson. The only fly in the ointment is its decay rate to two photons. This is nearly twice as large as expected. The significance of the discrepancy with the standard model is about 2.5 sigma.

**Key Words:** Higgs live, Higgs discovery, July 4<sup>th</sup>, 2012, CERN, LHC, ATLAS, CME, viXra combination.

## Higgs Live plus viXra Combinations

A year ago I started to [get fired up](#) about the prospects for the Higgs boson discovery as it became clear that the Large Hadron Collider was performing so well that they would either find it, or prove that it does not exist, at least not in the form most expected. We had three major progress updates from the LHC last year with the amount of data being analysed doubling each time bringing better and better signs that a signal was emerging from the noise. At first the heavier ranges for its mass were ruled out. Then, in December the last major announcement left many theorists such as myself cautiously optimistic that the Higgs boson has finally been glimpsed in its last refuge at a mass of about 125 GeV. Officially the physicists who speak for the experiments have remained cautious but now they have enough data to settle the matter conclusively. This years initial runs of the proton accelerator have already delivered as much collision data as it produced last year, and CERN has announced another meeting to update the figures once again.

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Rumours have spread that the new data contains the same signal seen before by both the large detectors CMS and ATLAS that have been searching for the Higgs boson at the collision points of the Large Hadron Collider. If this is true then it is just possible that either or both of the teams that run the detectors will be able to tell us that they have seen a signal with the 5 sigma significance required to claim a discovery. If they don't reach that goal individually, the combination of the two almost certainly will.

As I write the auditorium at CERN is letting in the physicists who have been queueing all night for their place. Several will be live blogging from there but I will be reporting from home using the [live webcast](#).

### **Is 5-sigma necessary for a discovery?**

We have been assuming that a discovery announcement would require a level of significance of 5 sigma equivalent to a one in 3 million chance of the signal happening as just a background fluctuation is there is really nothing there. This morning some of the live bloggers are playing down this requirement which suggests that they might not reach 5 sigma but that the overall levels of significance could be considered sufficient. We will see what they actually say shortly.

**08:55** Higgs applauded as he takes his seat

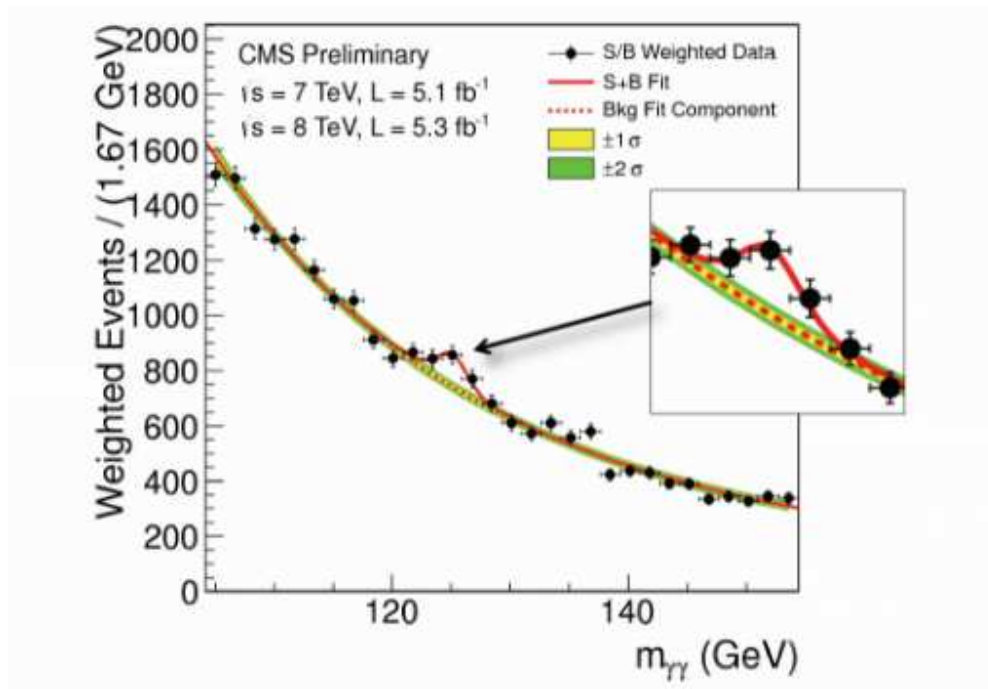
**09:00** DG opens the meeting



Incandela, CMS spokesman starts with pile-up slide. Pile-up could be an excuse for any anomalies.

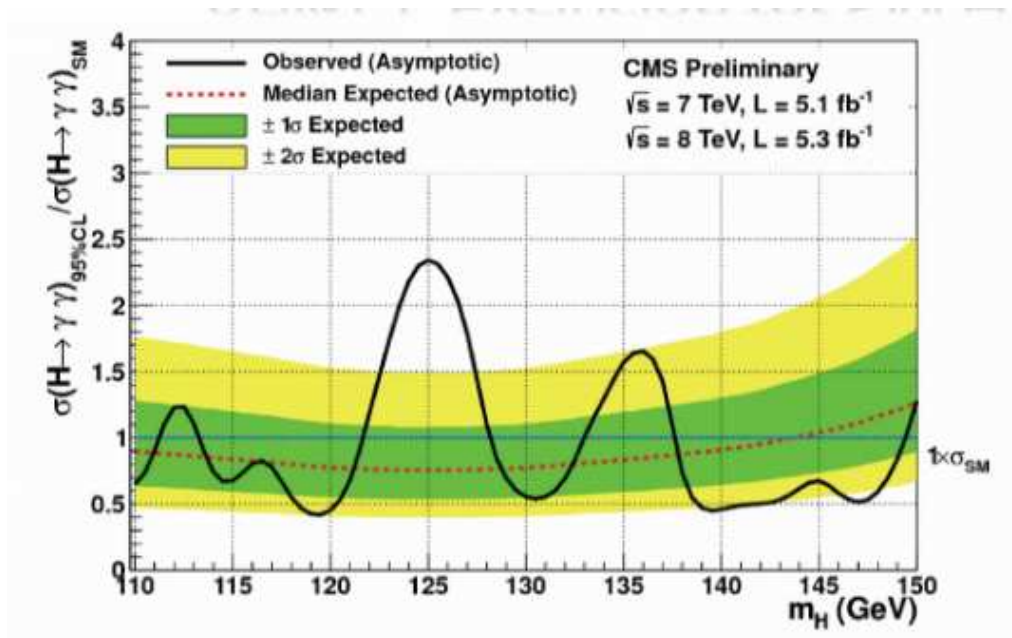
**8:24** Far too much detail for time allowed.

**8:30** Amazing signal from combining 7 TeV + 8 TeV in diphoton channel for CMS

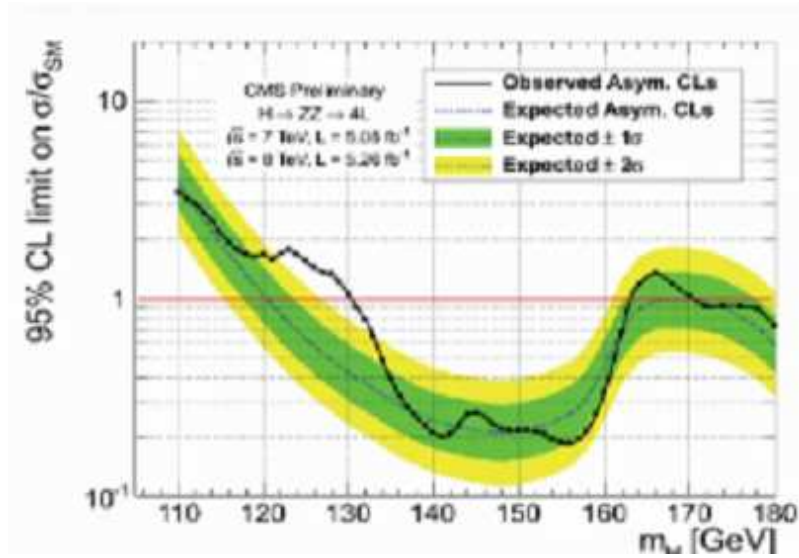


They have used 5.5/fb from 2012 data.

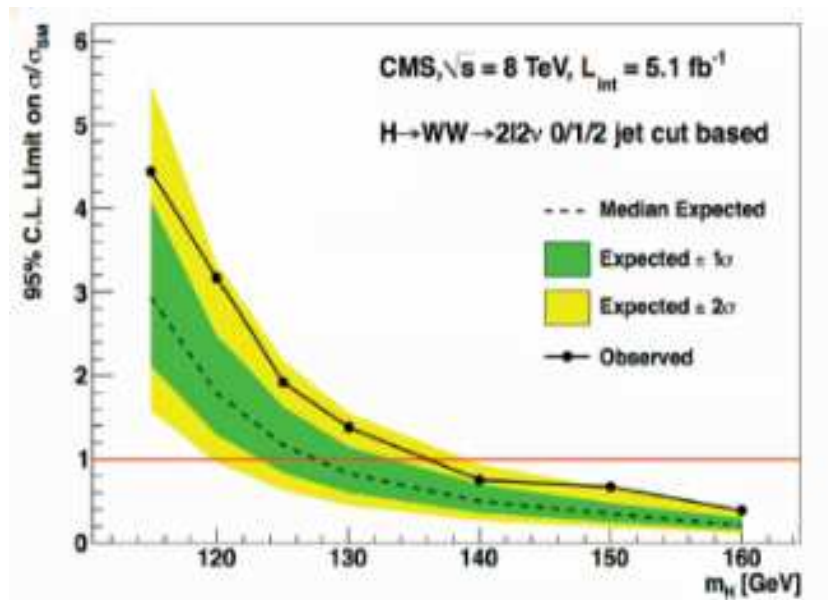
Here is the exclusion plot



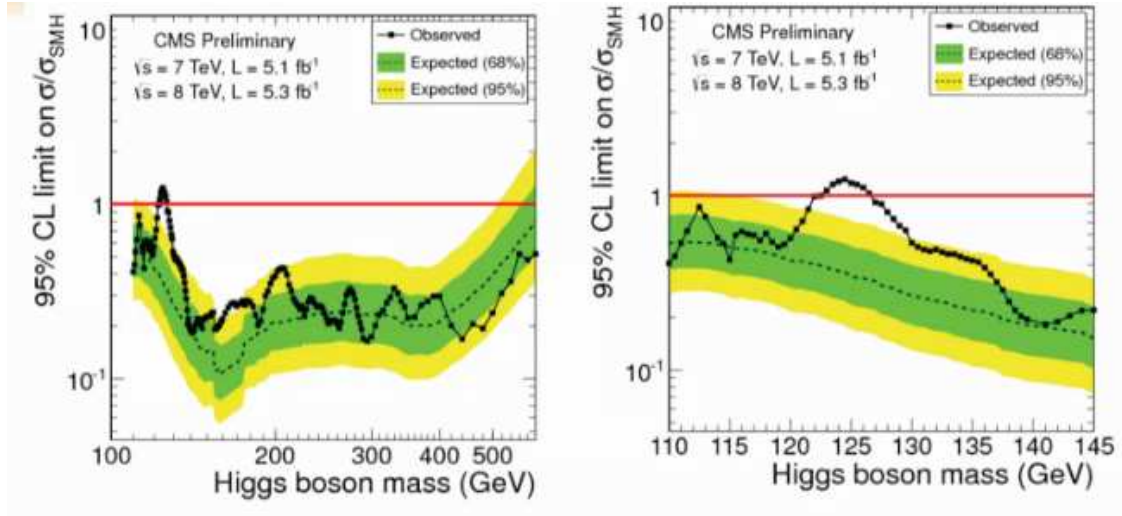
4lepton also looks good. Combined significance is 5 sigma! = Discovery



WW looks OK too, only 8 TeV not combined with 7 TeV



Mass of Higgs is  $125.3 \pm 0.6$  GeV, combined significance 4.9 sigma

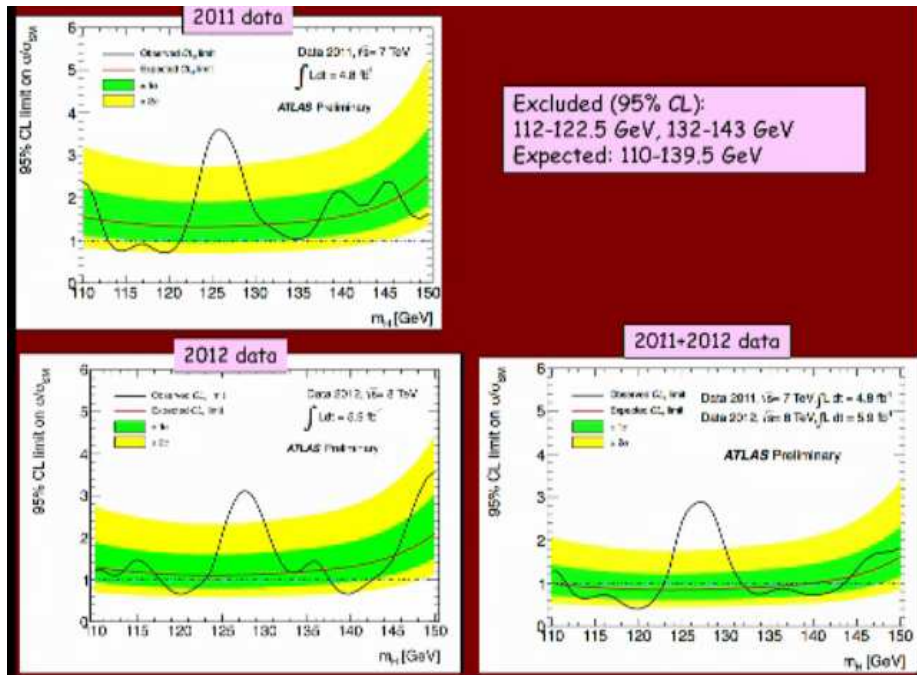


All channels consistent with SM but diphoton a little enhanced

**8:53:** Now starting the ATLAS presentation

Diphoton channel for ATLAS also showing a distinct signal. They get 4.5 sigma combining 2011 with 2012, used 5.9 sigma

Signal is nearly twice the standard model



Even in the 4-lepton channel the signal looks clear on the evnt plots

3.6 sigma in this channel

In combined channels ATLAS reach 5 sigma at 126.5 GeV = discovery!

Interesting that the mass value is still a little inconsistent with CMS.

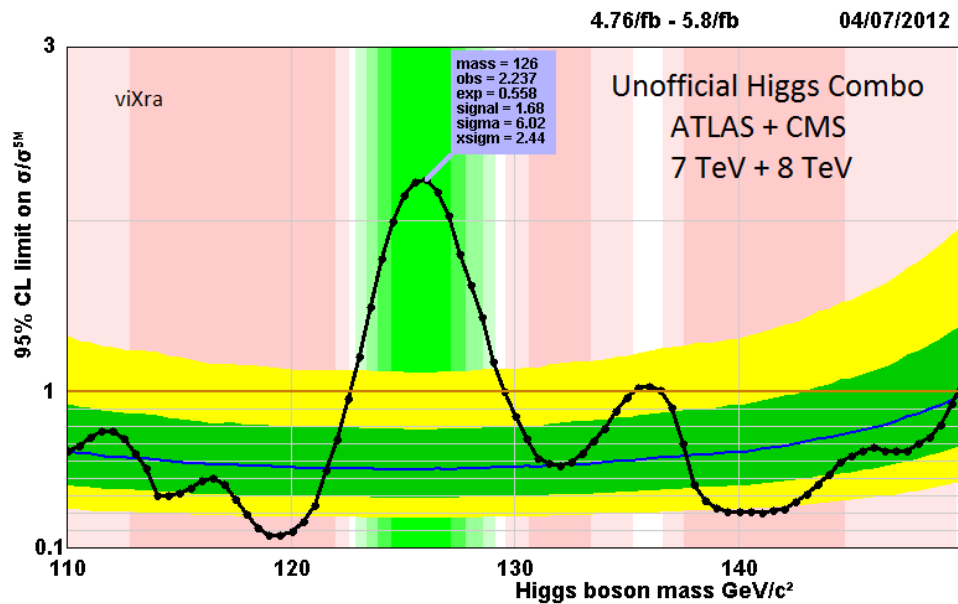
Both experiments are showing excess above standard model in diphoton channel. This is even more exciting than the discovery

DG says "I think we have it, do you agree?"

"We have a discovery, a particle consistent with the Higgs boson"

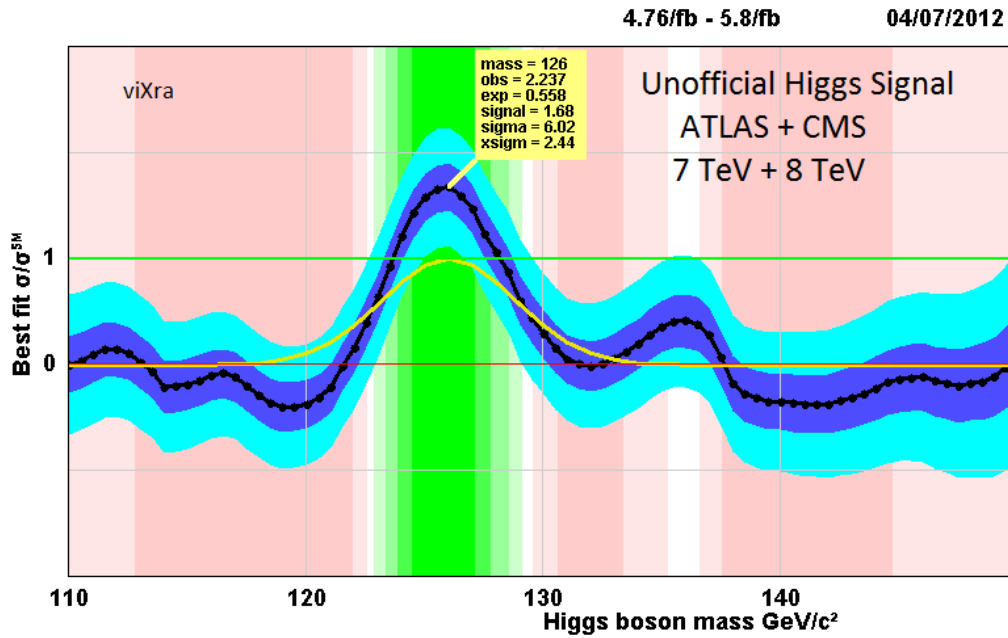
Now I have to combine those diphoton channels to see how significant the excess really is, BRB

11:47 This is what DG warned you against...



The combined diphoton plot gives a 6 sigma signal. It is 2.4 sigma stronger than the standard model.

This is what the signal plot looks like. Remember the green line is the standard model level, red line is background level

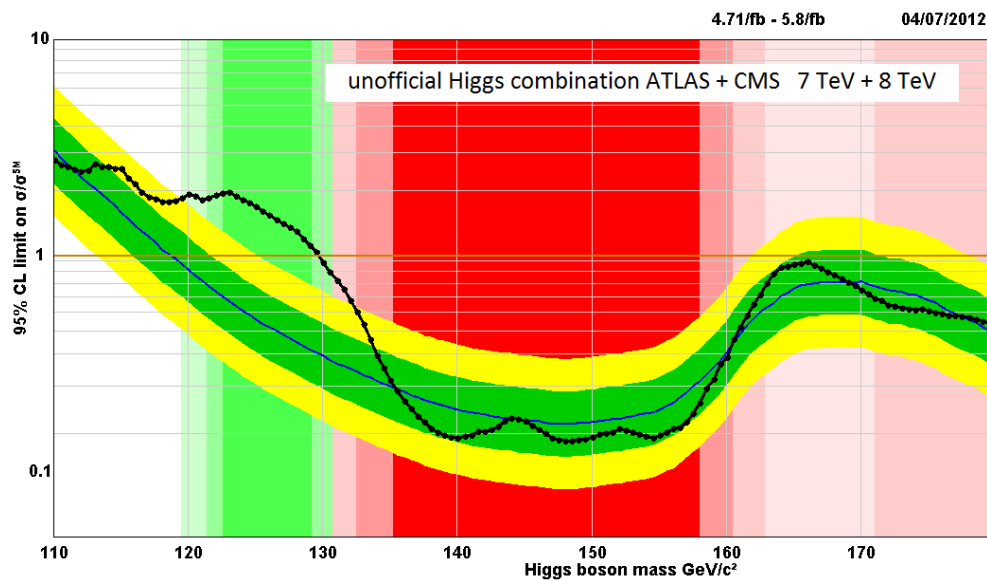


I will refine these when I have clearer plots to work from

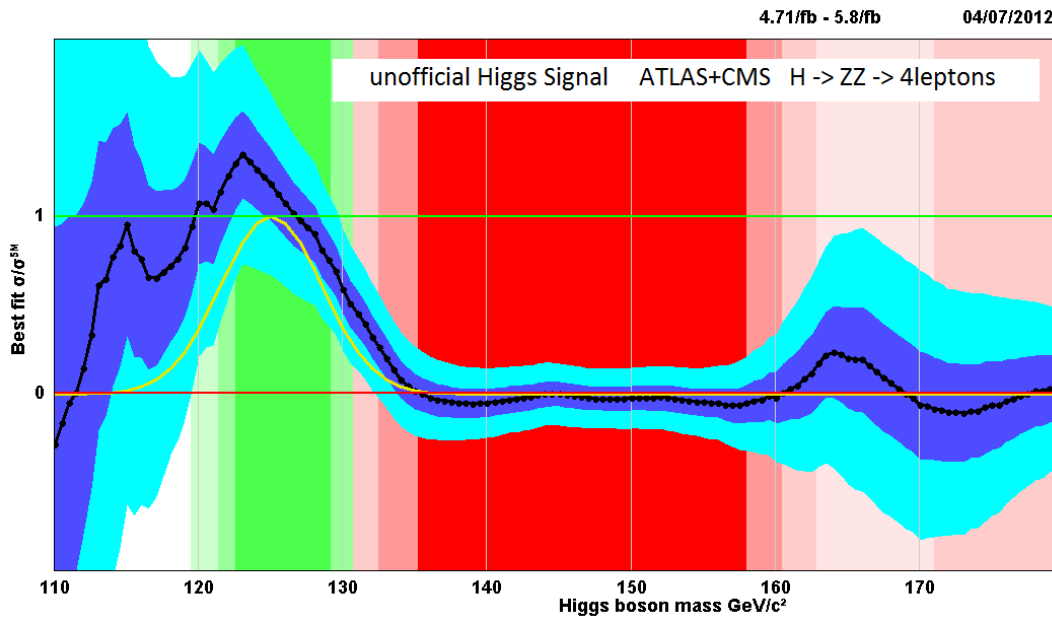
The slides are [now online](#).

**13:44** I have been occupied with other things but will add some more combos later. There are lots of plots to digitise,

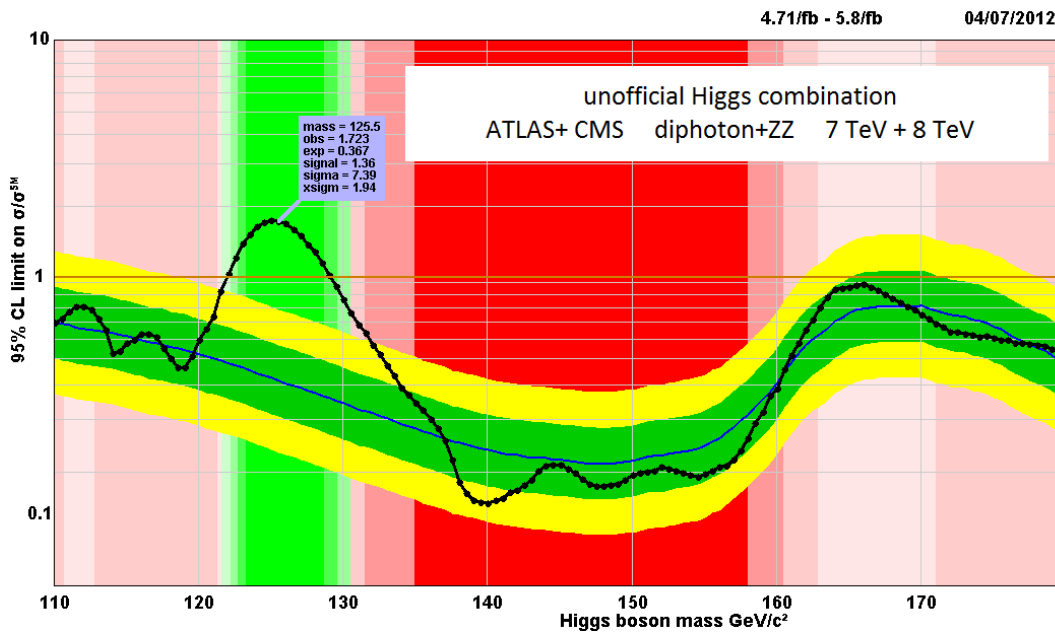
**14:10** For those patiently waiting here is the unofficial combination for ZZ to four leptons. Significance is an impressive 4.6 sigma



The signal plot shows that in this channel it matches perfectly the standard model Higgs



For completeness here is the combination of the two low resolution channels across ATLAS+CMS. This one gives 7.4 sigma





Notice that we have now eliminated any possibility of a second boson nearby, unless they are too close to separate.

### **Congratulations, It's a Boson**

Congratulations, It is a Boson. Have you thought of a name yet?

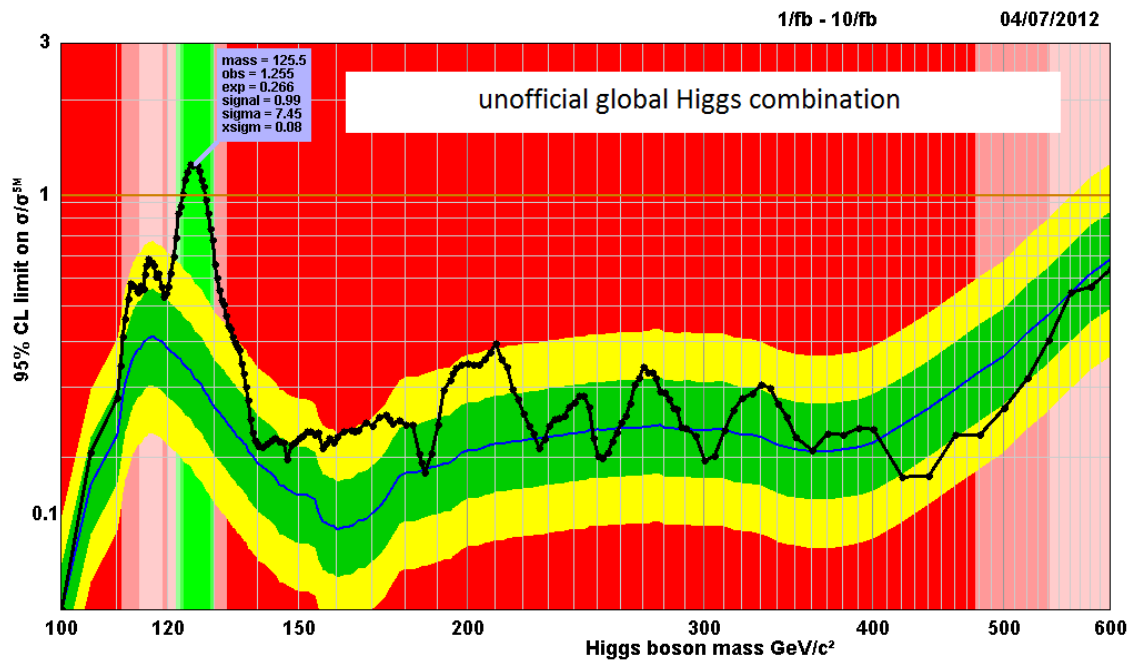
CERN have happily announced the arrival of a new Boson but so far are being a bit cagey about what to call it. Is it the Higgs? Their caution as experimenters is perfectly laudable. They should show that they are keeping an open mind, but theorists are independent of the process of discovery and do not need to be so reticent.

The facts are that the boson discovered with a mass of about 125 GeV or 126 GeV interacts with a wide range of particles in exactly the way the Higgs boson should. Its decay modes to Z, W, b and tau have just the right ratios and its production has also been tested in different ways confirming indirectly that its coupling to the top quark is also about right. Its spin could be 0 or 2 but 0 is much more likely. All these features point to the standard model Higgs boson.

The only fly in the ointment is its decay rate to two photons. This is nearly twice as large as expected. The significance of the discrepancy with the standard model is about 2.5 sigma. It could be a fluke. We have learnt to show some healthy skepticism when it comes to observations of physics beyond the standard model. However it is also consistent with an enhancement due to the presence of another charged boson. If that boson exists it must have a mass at least a bit larger than the W otherwise the Higgs would decay to this particle in pairs and we would see the effect on the other decay rates. It can't be too massive otherwise it would not enhance the diphoton rate enough. But it is likely to be possible to find a range of masses and properties that is consistent with all the observations.

So it is not necessary to invoke any properties for the observed boson that are any different from the standard model. Separate new physics will suffice. So the observed boson passes several tests required by the Higgs and I think that it is reasonable to assume that is indeed the Higgs boson until some observation suggests otherwise. It will always be possible to think of other models that could fit the facts, but they are not likely to be quite as economical as the standard model. It would be a disservice to the theorists who provided the theory 50 years ago if we continue to refuse to acknowledge the clear nature of this discovery when there is no evidence to the contrary. They predicted it would be just like this and It is the Higgs boson. Congratulations to all the experimenters and theorists who made this dream come to life.

**Update:** Here is the global Higgs combination. Is that conclusive enough now?



## References

1. <http://blog.vixra.org/2012/07/04/higgs-live-vixra-combinations/>
2. <http://blog.vixra.org/2012/07/04/congratulations-its-a-boson/>