Special Report

Moriond Higgs Update, Animated Higgs from ATLAS, & Higgs Spin from CMS & ATLAS

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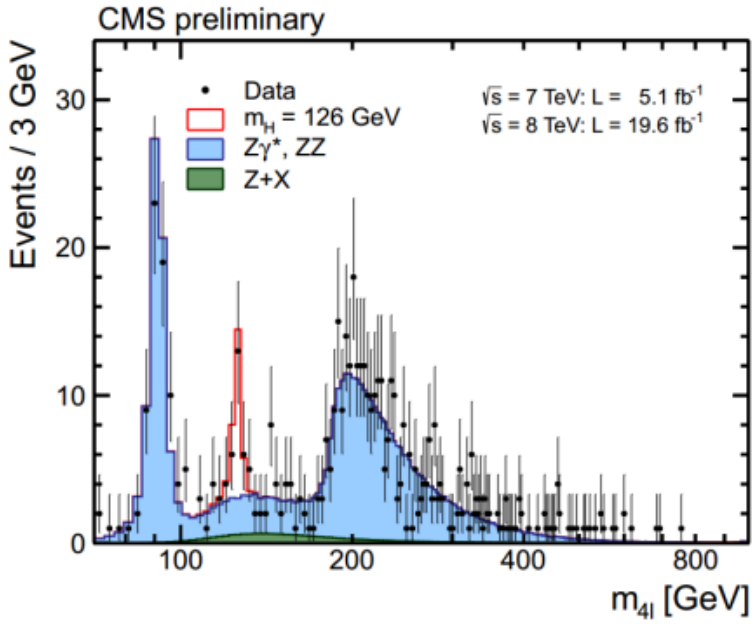
Abstract

The latest Higgs updates have been presented at Moriond. The full LHC run 1 dataset is now being used including 19.6/fb at 8 TeV. The things that CERN has decided are crucial for determining that this is a Higgs boson are thankfully exactly the things that can be determined from run 1 but there are plenty of other observations to keep them busy for run 2 and beyond.

Key Words: Higgs update, Moriond, animated Higgs, Higgs spin, CERN, LHC, CMS, ATLAS.

Moriond Higgs Update (March 6, 2013)

The latest Higgs updates are now being presented at Moriond. CMS have kicked off the morning with a presentation of bosonic decays including WW and ZZ but still not including the important diphoton channel. The full LHC run 1 dataset is now being used including 19.6/fb at 8 TeV. In ZZ they get a very clear signal on the event plot.



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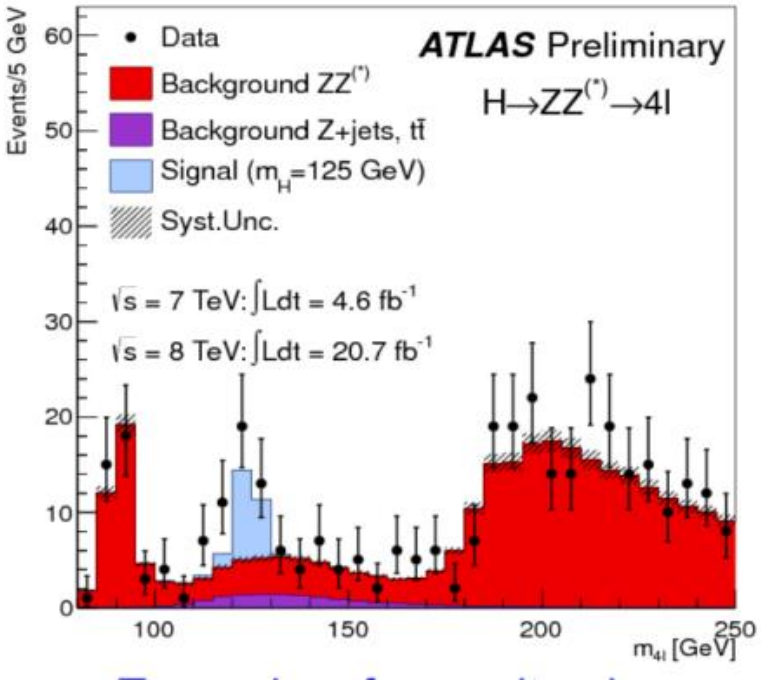
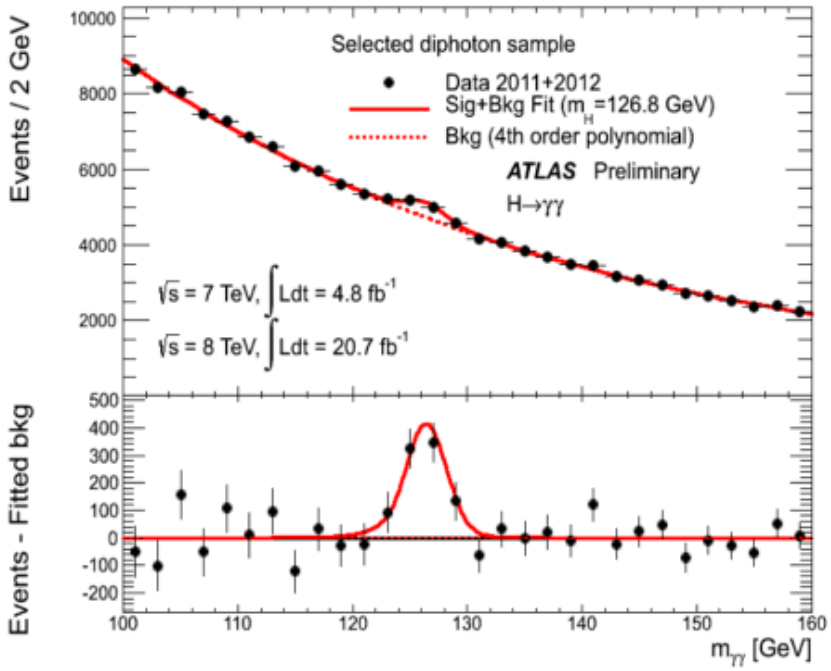
Higgs Mass from ZZ is 125.8 +- 0.5(stat) +- 0.2(Syst). The cross section relative to standard model is 0.91 +- 0.27; ATLAS also updated ZZ with 20.7/fb at 8 TeV to produce a similarly impressive plot



Higgs mass for ZZ from ATLAS is 124.3 +- 0.6(stat) +- 0.4(syst) cross-section 1.7 +- 0.5. Unlike CMS, ATLAS have presented their diphoton results giving a mass estimate of 126.8 +- 0.2(stat) +- 0.7(stat)

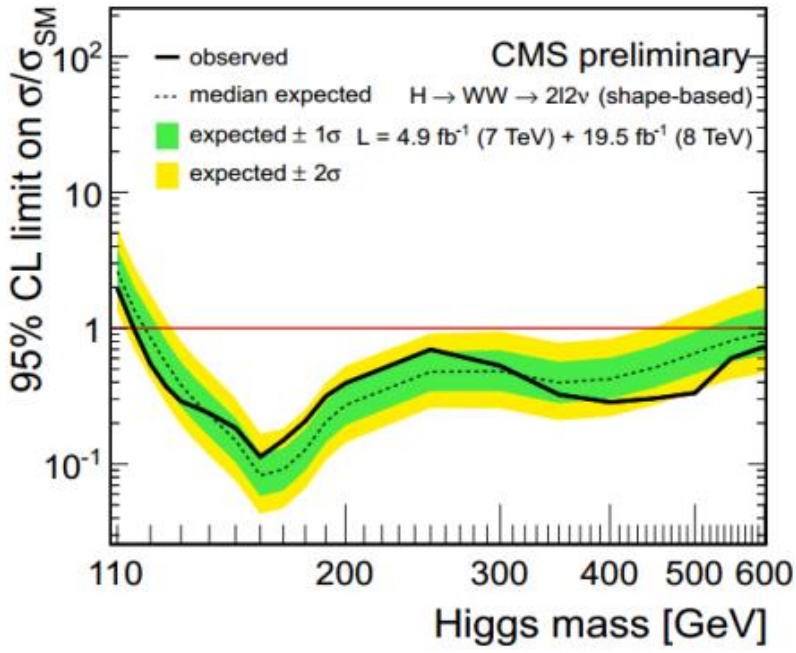


diphoton cross-section is 1.65 +- 0.24(stat) +- 0.21(syst). Rumour puts the CMS diphoton excess at 1.0 +- 0.2, to be shown at Moriond QCD next week perhaps (via Jester on twitter).

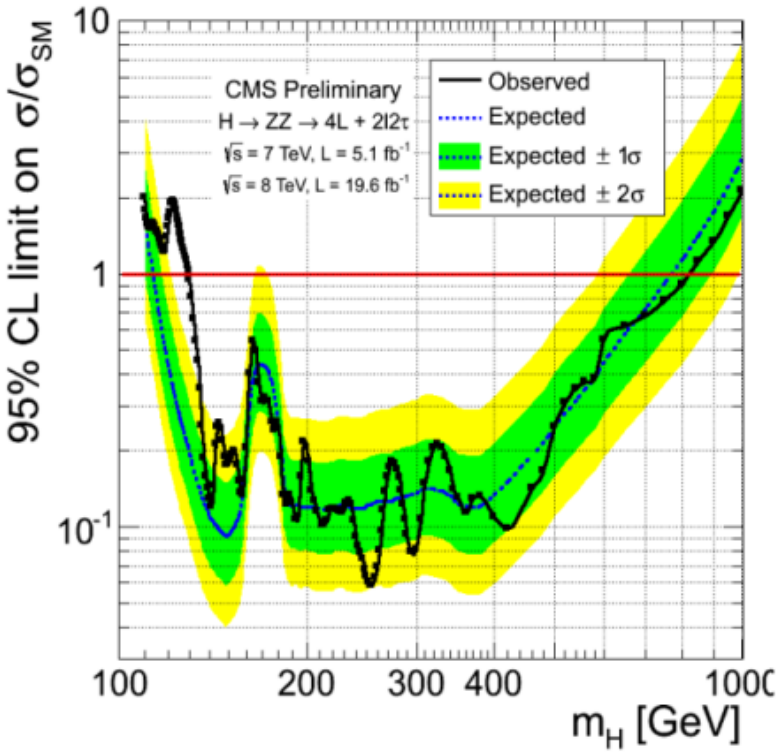
The excess over the standard model remains high but its significance has not increased because the value has gone down as more data has been added. When we first saw this excess a year ago we were excited that it may be real physics and we hoped that by this time we would have a truely significant effect. This has not happened. We still need to wait for CMS to show their diphoton results before we can draw any conclusion but rumours are that their overexcess has fallen even more dramatically. This means that expectations of significant BSM effects from run 1 are now lower.

CMS also gave us a plot of excesses in the WW channel over the standard model with Higgs at 125 GeV. In other words this plot should only show any excesses attributed to any other Higgs like particles. They said they are now doing this analysis for all the high mass searches which is a good move.

The WW cross-section from CMS is 0.76 +- 0.21



This shows that there are not yet any signs of higher mass Higgs particles as would be expected in Higgs multiplet models. If they exist then they must be quite well decoupled from the observed Higgs boson. The usual combined ZZ channel plot tells a similar story with no significant excesses beyond the known Higgs.



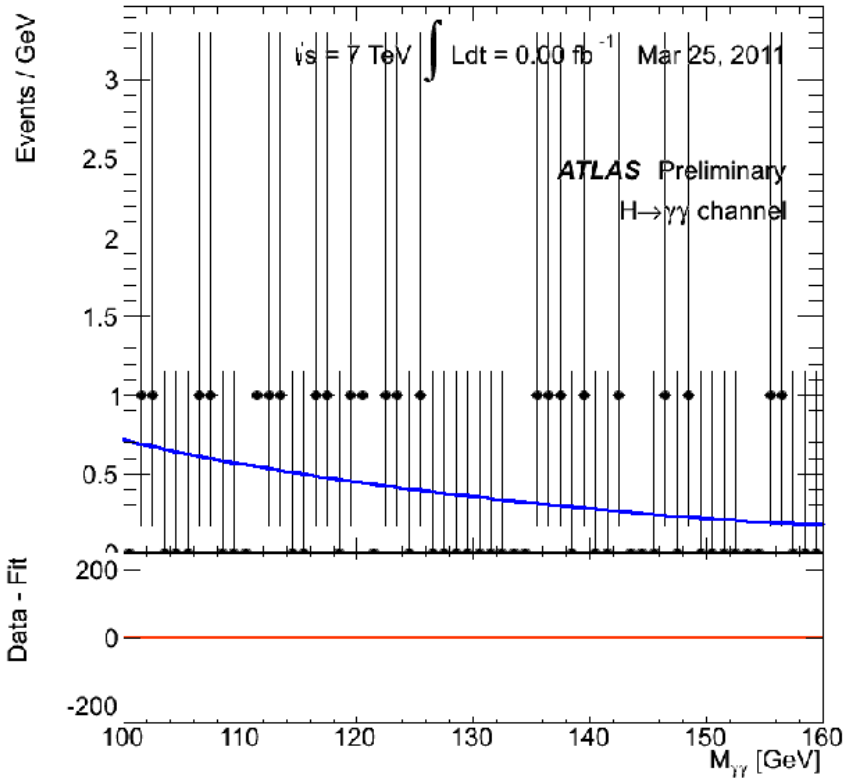
By the way, we are still waiting for the AMS-02 results due out soon. They had hoped to reveal them yesterday at Moriond but approval was not ready in time. Next oportunity could be the Moriond Cosmology conference next week.

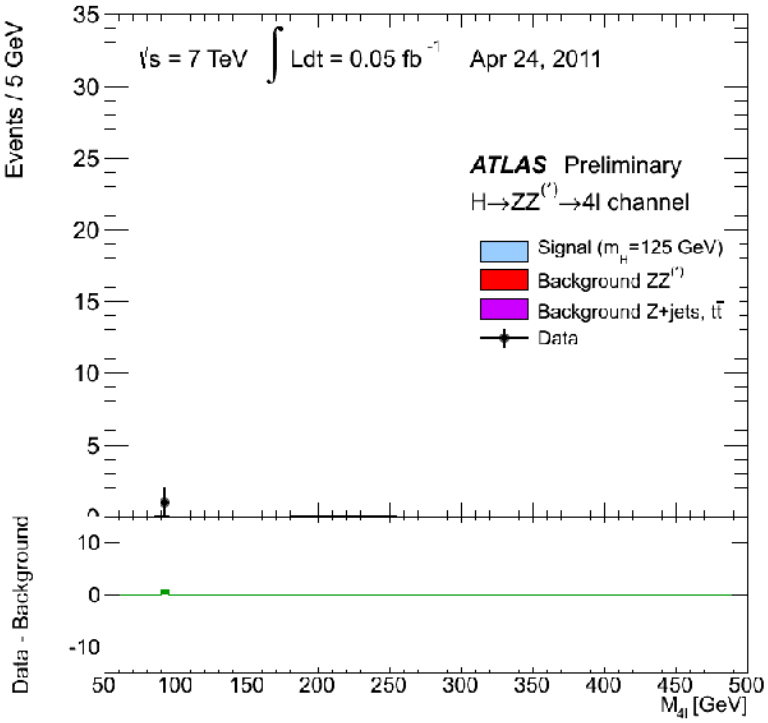
Animated Higgs from ATLAS (March 7, 2013)

ATLAS have provided some animated gifs showing the accumulation of Higgs events over time in the diphoton and four-lepton channels. Enjoy. These don't seem to work in situ on the blog. You need to click on the images to get them to work.

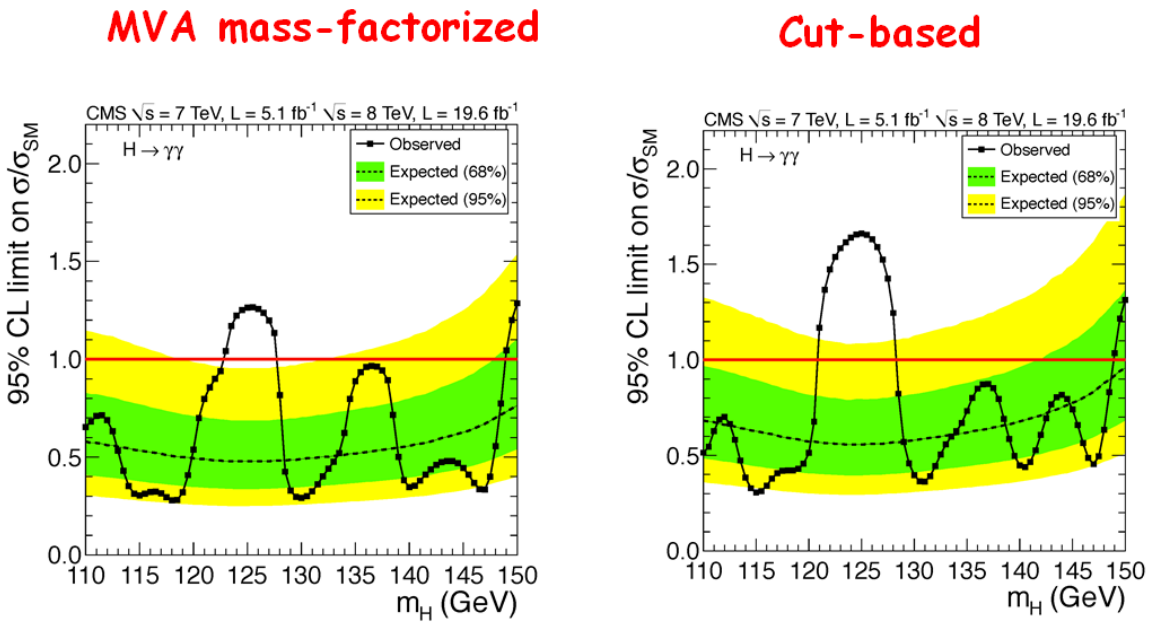
At what date do the Higgs bumps start to look real?

Youtube version: https://www.youtube.com/watch?v=Ub1gcQW6rMc


√s = 7 TeV ∫ Ldt = 0.00 fb⁻¹ Mar 25, 2011
ATLAS Preliminary
H→γγ channel
Events / GeV
Data - Fit
M_γγ [GeV]


√s = 7 TeV ∫ Ldt = 0.05 fb⁻¹ Apr 24, 2011
ATLAS Preliminary
H→ZZ(*)→4l channel
Signal (m_H=125 GeV)
Background ZZ(*)
Background Z+jets, tt̄
Data
Events / 5 GeV
Data - Background
M_4l [GeV]

Higgs Spin (Is It really a Higgs then, finally? March 14, 2013**)**



In the press release the CMS and ATLAS spokespeople are quoted as follows:

"*The preliminary results with the full 2012 data set are magnificent and to me it is clear that we are dealing with a Higgs boson though we still have a long way to go to know what kind of Higgs boson it is."* said CMS spokesperson Joe Incandela.

"The beautiful new results represent a huge effort by many dedicated people. They point to the new particle having the spin-parity of a Higgs boson as in the Standard Model. We are now well started on the measurement programme in the Higgs sector," said ATLAS spokesperson Dave Charlton.

So does this mean that they have officially conceded that it really is the Higgs boson and not some Higgs-like imposter? The official line is now that "*they find that the new particle is looking more and more like a Higgs boson, the particle linked to the mechanism that gives mass to elementary particles. It remains an open question, however, whether this is the Higgs boson of the Standard Model of particle physics, or possibly the lightest of several bosons predicted in some theories that go beyond the Standard Model."*

It's a bit meanly mouthed but nevertheless, most commentators are interpreting this to mean that they have agreed that it is a Higgs boson of some sort.

The crux was the spin measurements which both teams agree disfavours spin 2 with positive parity at a 2 to 3 sigma level. The real Higgs boson has spin zero with positive parity and all other spin possibilities are directly ruled out by the fact that it decays to two spin-one photons.

Negative spin zero is not quite so strongly ruled out but this is not being billed as such an important observation.

Particle Property	**Can it be determined with LHC run 1 data?**	**Does CERN think it is deterministic for a Higgs boson?**	**Current Status**
Decay modes	**YES**	**YES**	WW,γγ,ZZ,ττ observed, bb,Zγ,μμ etc ongoing
Other Production modes	**NO**	**NO**	gluon fusion OK, VBF, VH and ttH ongoing
no exotic decay modes	**NO**	**NO**	preliminary results from ATLAS
Spin = 0	**YES**	**YES**	spin zero verified to about 2 or 3 sigma in each experiment
Parity = positive	**NO**	**NO**	negative parity is disfavoured but not ruled out
W fusion	**NO**	**NO**	nothing yet reported
Higgs self-coupling	**NO**	**NO**	nothing yet reported

In summary, the things that CERN has decided are crucial for determining that this is a Higgs boson are thankfully exactly the things that can be determined from run 1 but there are plenty of other observations to keep them busy for run 2 and beyond.

References

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