Finding the Higgs Boson

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Presentation in RLM 13.202

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ATLAS EXPERIMENT http://atlas.ch

What is the Higgs boson?

The Higgs boson is a particle manifestation of the Higgs *field*, like a photon (a particle of light) is a particle of electric and magnetic fields. In our theory of the universe, the Higgs field is necessary to give mass to subatomic particles. This field completely fills the universe, and its size determines particle masses.
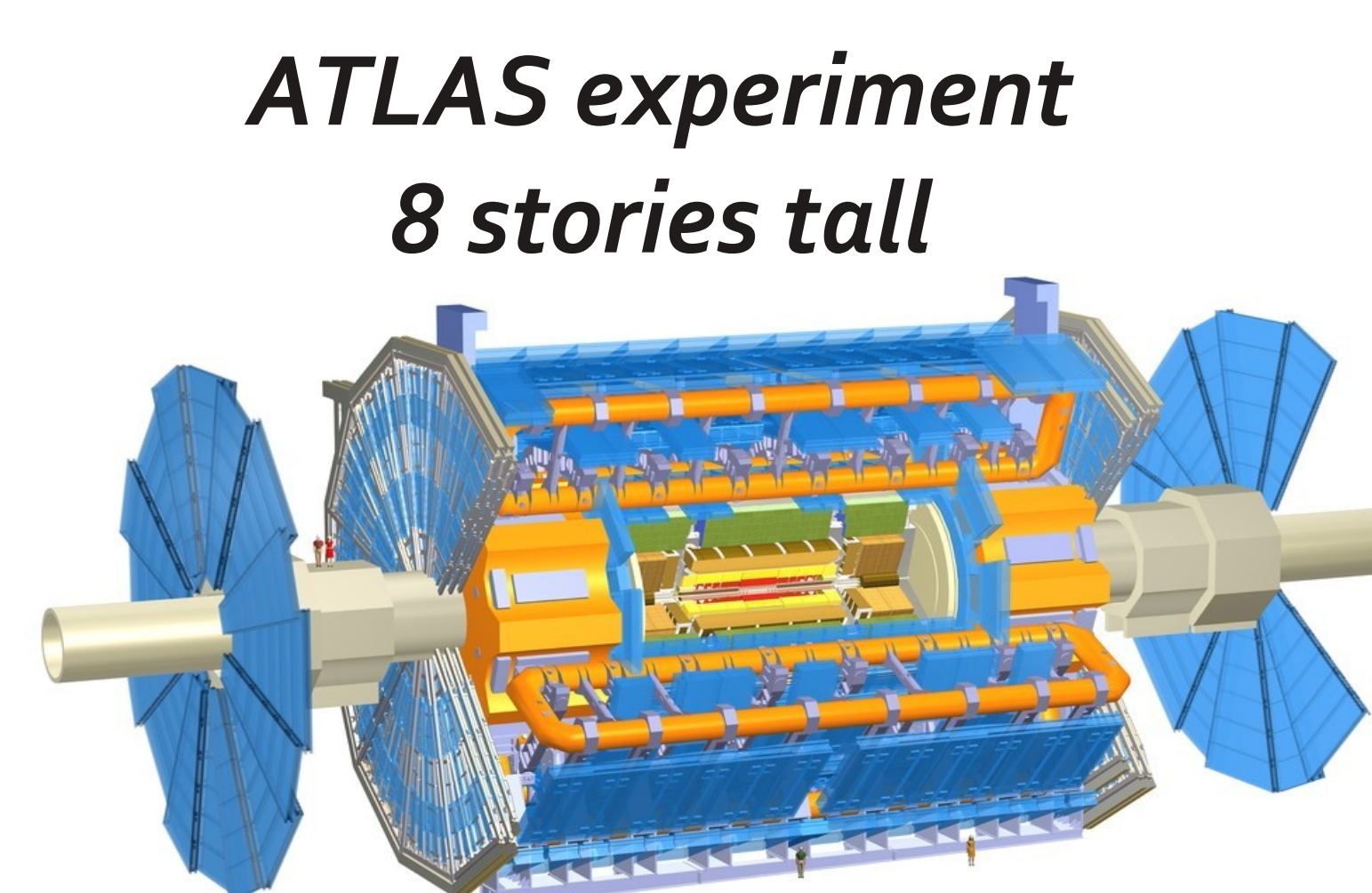
If electrons were massless, atoms would fly apart. The Higgs field literally makes our existence possible.

Why did we look for it?

The theory could have been wrong! There was no direct evidence for the Higgs field, the linchpin of the model. If there is a Higgs field, there must be a Higgs boson. Not finding the Higgs boson would have meant a complete rethink of our theories of fundamental particles.

Geneva, Switzerland

ATLAS experiment 8 stories tall

Large Hadron Collider 17 mile circumference

"Bumps" with more Higgs boson candidates than expected from "noise" Evidence for a new particle

How did we look for it?

We used the Large Hadron Collider, the most powerful particle accelerator ("atom smasher") in the world, located on the French/Swiss border. This device gives protons lots of kinetic energy, which is turned into mass via Einstein's $E = mc^2$. We needed lots of energy to make a particle as heavy as the Higgs boson.

Two particle detector experiments (ATLAS and CMS) searched through the traces of nearly a million billion collisions to find a few hundred possible Higgs bosons in the debris.
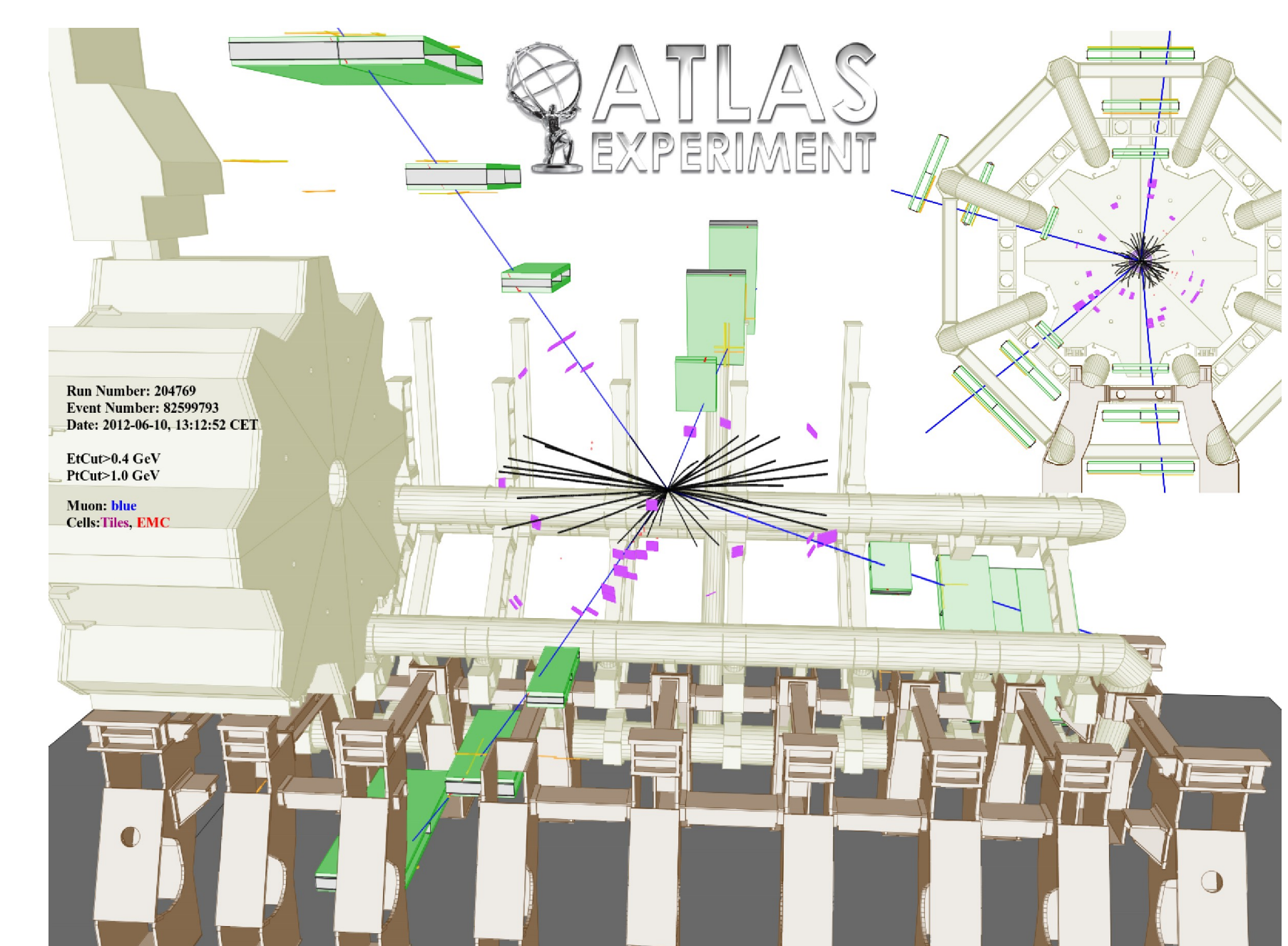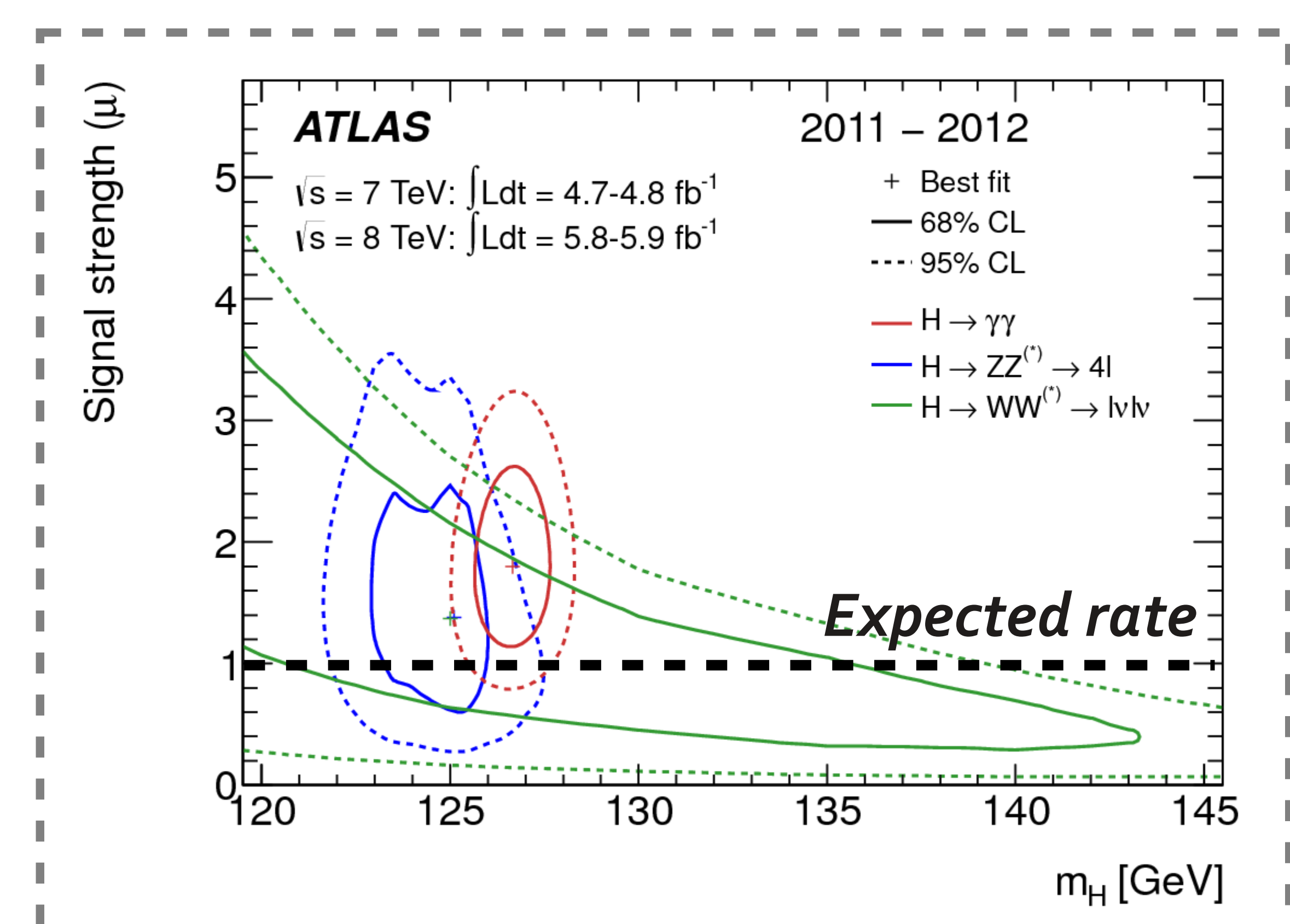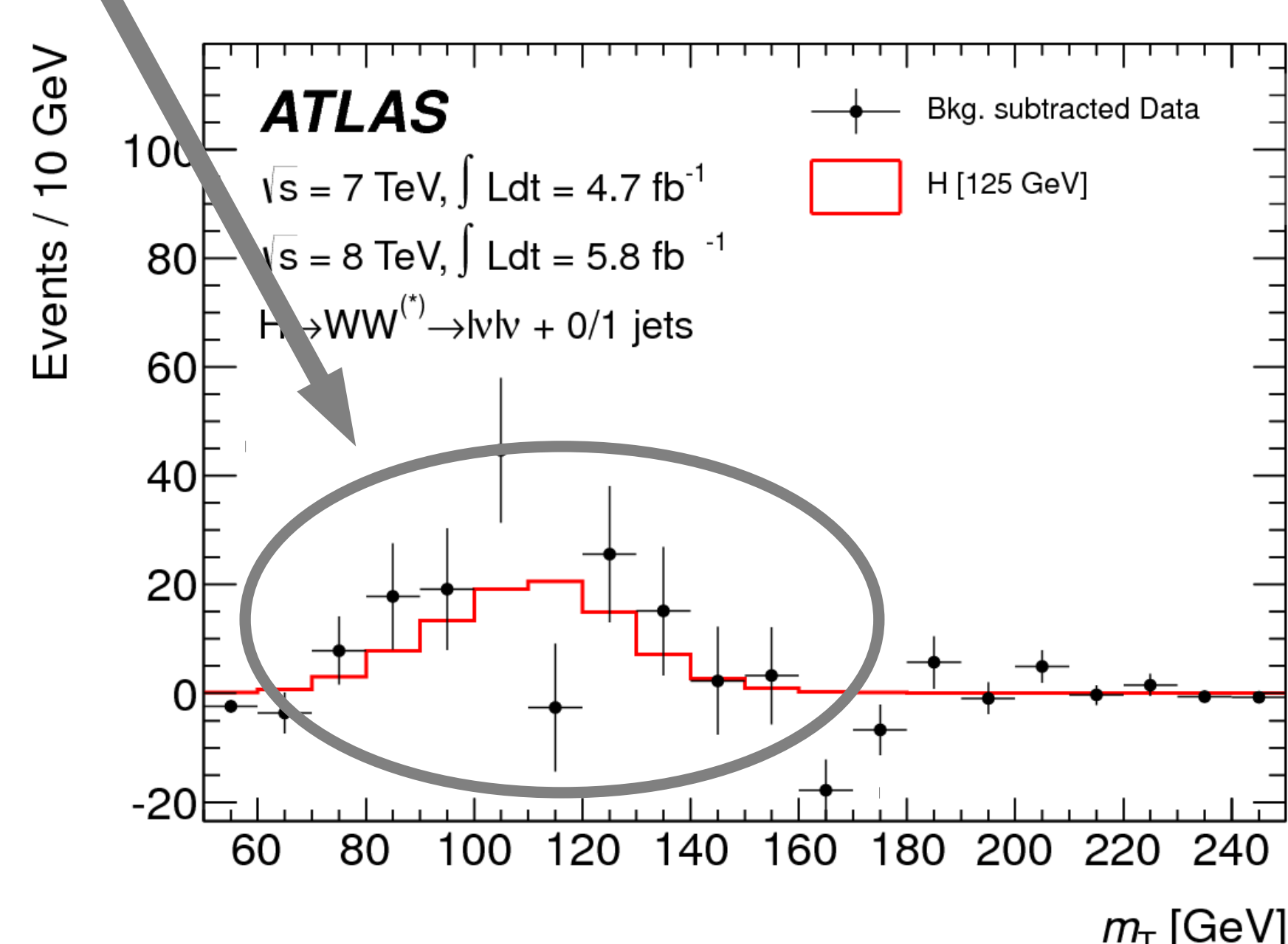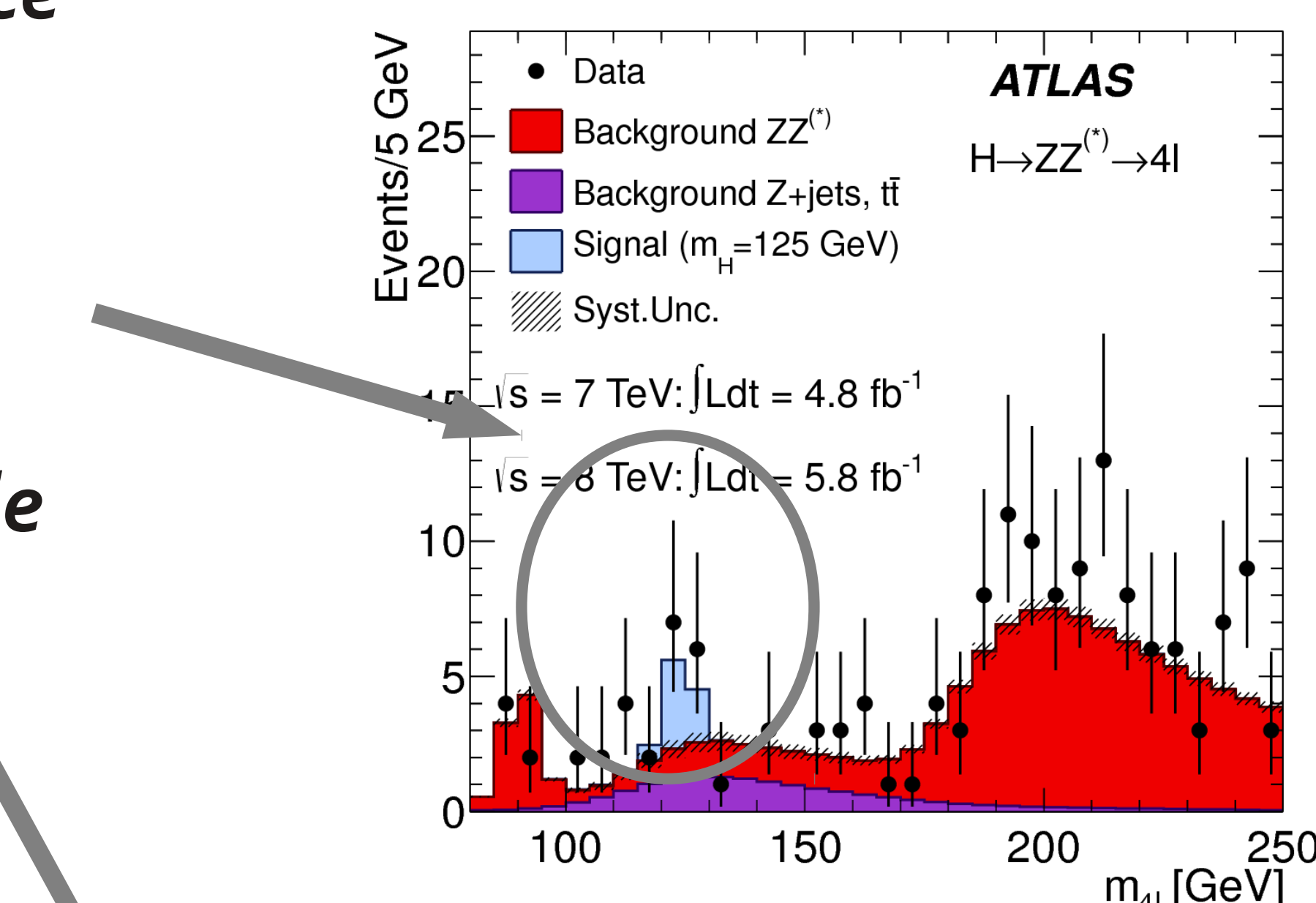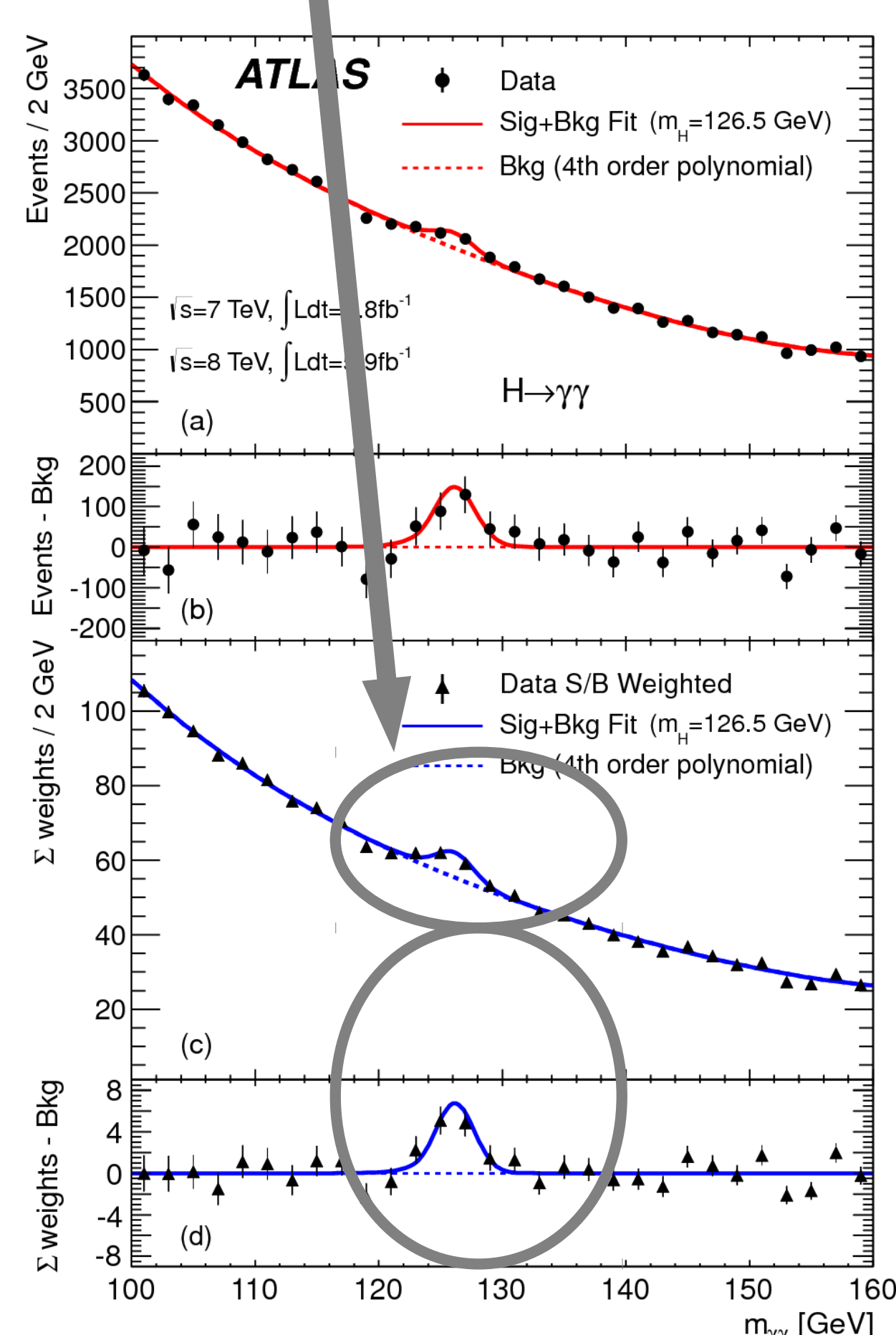

A collision likely to have made a Higgs boson

What did we find?

Both experiments have definitely seen a new particle (the p-value for ATLAS alone is 1.7×10^{-9}). We see evidence for it three different ways, all compatible with what theory predicts for the simplest Higgs model. This is already a strong constraint on extensions of the theory.

What's next?

We need to further study the particle's properties. This will let us know whether our theory needs to be extended, and will help us understand the implications of the model.