further analysis.[140] On 14 March 2013, CERN announced confirmation that the observed particle was indeed the predicted Higgs Boson.[141]

On 8 November 2012, the LHCb team reported on an experiment seen as a "golden" test of supersymmetry theories in physics,[120] by measuring the very rare decay of the B_s meson into two muons ($B^0_s \to \mu^+\mu^-$). The results, which match those predicted by the non-supersymmetrical Standard Model rather than the predictions of many branches of supersymmetry, show the decays are less common than some forms of supersymmetry predict, though could still match the predictions of other versions of supersymmetry theory. The results as initially drafted are stated to be short of proof but at a relatively high 3.5 sigma level of significance.[142] The result was later confirmed by the CMS collaboration.[143]

In August 2013, the LHCb team revealed an anomaly in the angular distribution of B meson decay products which could not be predicted by the Standard Model; this anomaly had a statistical certainty of 4.5 sigma, just short of the 5 sigma needed to be officially recognized as a discovery. It is unknown what the cause of this anomaly would be, although the Z' boson has been suggested as a possible candidate.[144]

On 19 November 2014, the LHCb experiment announced the discovery of two new heavy subatomic particles, Ξ'^-_b and Ξ^{*-}_b. Both of them are baryons that are composed of one bottom, one down, and one strange quark. They are excited states of the bottom Xi baryon.[145][146]

The LHCb collaboration has observed multiple exotic hadrons, possibly pentaquarks or tetraquarks, in the Run 1 data. On 4 April 2014, the collaboration confirmed the existence of the tetraquark candidate Z(4430) with a significance of over 13.9 sigma.[147][148] On 13 July 2015, results consistent with pentaquark states in the decay of bottom Lambda baryons (Λ^0_b) were reported.[149][150][151]

On 28 June 2016, the collaboration announced four tetraquark-like particles decaying into a J/ψ and a φ meson, only one of which was well established before (X(4274), X(4500) and X(4700) and X(4140)).[152][153]

In December 2016, ATLAS presented a measurement of the W boson mass, researching the precision of analyses done at the Tevatron.[154]

Second run (2015-2018)

At the conference EPS-HEP 2015 in July, the collaborations presented first cross-section measurements of several particles at the higher collision energy.

On 15 December 2015, the ATLAS and CMS experiments both reported a number of preliminary results for Higgs physics, supersymmetry (SUSY) searches and exotics searches using 13 TeV proton collision data. Both experiments saw a moderate excess around 750 GeV in the two-photon invariant mass spectrum,[155][156][157] but the experiments did not confirm the existence of the hypothetical particle in an August 2016 report.[158][159][160]

In July 2017, many analyses based on the large dataset collected in 2016 were shown. The properties of the Higgs boson were studied in more detail and the precision of many other results was improved.[161]

Planned "high-luminosity" upgrade

After some years of running, any particle physics experiment typically begins to suffer from diminishing returns: as the key results reachable by the device begin to be completed, later years of operation discover proportionately less than earlier years. A common response is to upgrade the devices involved, typically in