Opinion: We need to talk about the Higgs

July 6 2018, by Tim Gershon

François Englert (left) and Peter Higgs at CERN on 4 July 2012, on the occasion of the announcement of the discovery of a Higgs boson. Credit: Maximilien Brice/CERN

It is six years ago that the discovery of the Higgs boson was announced, to great fanfare in the world's media, as a crowning success of CERN's Large Hadron Collider (LHC). The excitement of those days now seems

a distant memory, replaced by a growing sense of disappointment at the lack of any major discovery thereafter.

While there are valid reasons to feel less than delighted by the null results of searches for physics beyond the Standard Model (SM), this does not justify a mood of despondency. A particular concern is that, in today's hyper-connected world, apparently harmless academic discussions risk evolving into a negative outlook for the field in broader society. For example, a recent news article in Natureled on the LHC's "failure to detect new particles beyond the Higgs," while The Economistreported that "Fundamental physics is frustrating physicists." Equally worryingly, the situation in particle physics is sometimes negatively contrasted with that for gravitational waves: while the latter is, quite rightly, heralded as the start of a new era of exploration, the discovery of the Higgs is often described as the end of a long effort to complete the SM.

Let's look at things more positively. The Higgs boson is a totally new type of fundamental particle that allows unprecedented tests of electroweak symmetry breaking. It thus provides us with a novel microscope with which to probe the universe at the smallest scales, in analogy with the prospects for new gravitational-wave telescopes that will study the largest scales. There is a clear need to measure its couplings to other particles – especially its coupling with itself – and to explore potential connections between the Higgs and hidden or dark sectors. These arguments alone provide ample motivation for the next generation of colliders including and beyond the high-luminosity LHC upgrade.

So far the Higgs boson indeed looks SM-like, but some perspective is necessary. It took more than 40 years from the discovery of the neutrino to the realisation that it is not massless and therefore not SM-like; addressing this mystery is now a key component of the global particle-

physics programme. Turning to my own main research area, the beauty quark – which reached its 40th birthday last year – is another example of a long-established particle that is now providing exciting hints of new phenomena (see Beauty quarks test lepton universality). One thrilling scenario, if these deviations from the SM are confirmed, is that the new physics landscape can be explored through both the b and Higgs microscopes. Let's call it "multi-messenger particle physics."

How the results of our research are communicated to the public has never been more important. We must be honest about the lack of new physics that we all hoped would be found in early LHC data, yet to characterise this as a "failure" is absurd. If anything, the LHC has been more successful than expected, leaving its experiments struggling to keep up with the astonishing rates of delivered data. Particle physics is, after all, about exploring the unknown; the analysis of LHC data has led to thousands of publications and a wealth of new knowledge, and there is every possibility that there are big discoveries waiting to be made with further data and more innovative analyses. We also should not overlook the returns to society that the LHC has brought, from technology developments with associated spin-offs to the training of thousands of highly skilled young researchers.

The level of expectation that has been heaped on the LHC seems unprecedented in the history of physics. Has any other facility been considered to have produced disappointing results because only one Nobel-prize winning discovery was made in its first few years of operation? Perhaps this reflects that the LHC is simply the right machine at the right time, but that time is not over: our new microscope is set to run for the next two decades and bring physics at the TeV scale into clear focus. The more we talk about that, the better our long-term chances of success.

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