

Higgs Boson Search Involving Texas A&M Physicists Reveals New Particle



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Physicists at Texas A&M University are celebrating the biggest news out of CERN since the 2008 start-up of the \$9 billion Large Hadron Collider (LHC) – observation of a new particle with boson-like appearances.

After nearly a half-century of searching for the Higgs boson, known as the “God particle” because it is thought to be responsible for generating mass of all visible particles in the universe, data released today from the LHC’s Compact Muon Solenoid (CMS) and ATLAS experiments confirms the presence of a particle consistent with the properties of Higgs boson as predicted by the Standard Model.

The two experiments presented their preliminary results based on data recorded up to June 2012 as part of a joint seminar streamed live today from CERN and at the 2012 International Conference on High Energy Physics held in Melbourne. The CMS collaboration features more than 20 Texas A&M physicists, postdoctoral researchers and graduate students based in College Station as well as at CERN and at Fermi National Accelerator Laboratory (Fermilab), which serves as the United States headquarters for CMS.

“The LHC results indicate what we call a 5-sigma observation of a new particle with a mass of 125 GeV [gigaelectronvolts] and properties consistent with that of a Higgs boson,” says Texas A&M physicist Alexei Safonov. “This is a tremendously important finding made possible by a collaborative effort of several thousand[ⓧ] people from many dozens of institutions working together for more than 15 years to come to this exciting day. It takes that many people to build the detector, commission all systems, get the data out, analyze it and produce physics-quality results. Being part of this amazing effort has been and continues to be both a privilege

and a large responsibility.”

The LHC announcement comes on the heels of Fermilab’s Monday release of Tevatron results demonstrating an excess of data consistent with the elusive Higgs particle using a decade of data (roughly 500 trillion proton-proton collisions).

While Texas A&M physicist David Toback notes the level of affirmation in the Tevatron data is insufficient for the physicists to rule out that the excess is due to chance, he says it is both exciting and encouraging that the excess seen by the Tevatron perfectly agrees with being due to a 125 GeV Higgs-like particle observed at the LHC.

“It provides an independent check and powerful additional confirmation reinforcing the likelihood that it is really a Higgs-like particle that the CERN LHC is seeing,” Toback adds.

Texas A&M physicist Ricardo Eusebi underscores the solidness of the CMS results, which indicate the presence of a new particle, along with roughly 1-in-3-million odds of this observation being due to chance.

“We’ll need much more data to truly understand what kind of particle this is – if it’s a Standard Model Higgs, or a Higgs particle predicted by one of alternative theories such as Supersymmetry, or if it is a Higgs at all,” Eusebi says. “This will give us room for excitement for the next 10 to 15 years, trying to measure and understand the properties of the model we seem to be seeing. We’ll need to have beams with a much higher intensity so we can collect much more data in a shorter period of time.”

Texas A&M physicist Teruki Kamon notes that the LHC data is the result of 350 trillion proton-proton collisions in 2010-11 and another 1,000-to-2,000 trillion in 2012 involving the world’s largest detectors and analyzed by more than 1,700 people from U.S. institutions – including 89 American universities and seven U.S. Department of Energy (DOE) national laboratories – who helped design, build and operate the LHC accelerator and its four particle detectors.

“This result is a triumph of a coherent, united effort in this large-size collaboration,” Kamon says. “Indeed, with more high-quality data, we could chase dark matter at the LHC. It will relate phenomena at a gigantic scale in the universe to the proton-proton collisions at a very small scale – much smaller than a hydrogen atom. This will be the beginning of a long journey to understand the interconnection between particle physics and cosmology.”

Safonov, Toback, Eusebi and Kamon are joined in the CMS collaboration by fellow Texas A&M experimental physicist Peter McIntyre, who helped conceive the original idea for the Tevatron, along with theoretical physicists Dimitri Nanopoulos, Bhaskar Dutta and Richard Arnowitt. They are among the thousands of international scientists whose groundbreaking work has played a part in both breakthrough discoveries, which Safonov says transcend international borders and traditional physics.

“Overall, I think this is something that is very fundamental,” Safonov says. “It has many implications on our understanding of the world and where things started. It has a huge connection to cosmology. You tend to think that what we do is study the smallest particles in the world, which should be something irrelevant to cosmologists, who work with the largest structures in the universe, but they are very closely connected, because it is particle physics that explains things like the origins of the universe and its further evolution. You might say that this is the most fundamental knowledge you can think of. It may not be particle physics that made this world, but it is particle physics that explains why things are the way they are.”

Although understandably not prepared to declare the search for the Higgs over, Kamon says the CMS collaboration is confident the odds are in their favor that the end is now in sight, in light of current LHC data and the Tevatron findings. He notes that, while the first significant indications of a new particle already were evident

in the 2011 data, it is the 2012 dataset that has really made the LHC physicists confident that this is a new particle.

To explain this point, Safonov describes an analogy of the Higgs as a magic treasure chest that may be hidden somewhere on Earth or not exist at all. Although CMS researchers may not know where it is or if it even exists, he says they do know that the place where it is hidden would see rain starting exactly at 12:05 p.m. on the first day of every month.

“If you ask what the odds are that rain would start in a particular town on August 1 at exactly 12:05 p.m., we would say they are tiny,” Safonov says. “However, the chances of that happening in at least one town anywhere on Earth are very high.

“What the LHC experiments did last year is the equivalent of sending its experimenters to all towns on Earth who were checking for rain at that time. The previous year’s data from the LHC is as if these experimentalists found that, during the 12-month period for 2010-2011, only College Station saw rain starting at 12:05 p.m. every first of the month. So if the chest exists, it has to be somewhere in College Station. However, because there are so many towns on Earth, it could still be just a coincidence, even though a very unlikely one. To check their suspicions, the LHC experiments went on and continued monitoring for another 12 months, this time specifically focusing on College Station. The results released today by the LHC are as if the new findings were to show that College Station saw the rain on the first day of every month at 12:05 p.m. in the new data. Odds of that happening by chance are miniscule.”

As for Safonov’s prediction, the best is yet to come, thanks in large part to another important by-product of big-picture worldwide collaborative research – the student scientists who will make the future discoveries.

“What I see as truly inspiring in experimental high energy physics is the people who work in these large collaborations,” Safonov says. “It takes people who are highly dedicated to science to work together, leaving behind and below country borders, national politics and differences, and all the silliness in the world for a common cause. We are also lucky to see new generations of people who are joining this cause, bringing their enthusiasm, energy and idealism.”

Alexx Perloff, a graduate student in Eusebi’s research group whose role in the CMS project is to calibrate jets as part of his Ph.D. dissertation detailing a search for the Higgs in a given channel, says he sought out a known CMS-affiliated adviser while he was an undergraduate based on his desire to go into particle physics. He describes the internationally collaborative experience as nothing short of spectacular and immensely rewarding.

“The amount of guidance and growth that we’ve absorbed in three or four years of doing this is incredible,” Perloff says. “The other week, I needed to create a special analysis tool and emailed a collaborator in Switzerland, and even though it was midnight there, within an hour, we were already working together. We are all working toward the same goal and, for the most part, we don’t let other things get in the way.

“When we work on this project, it’s not just school work, it’s work – it matters. When I sit down to do calibrations for these jets, everyone at CMS uses them. It’s hugely important for us to learn that our work matters. In science, one of the biggest rules is that you need to make sure what you’re doing is right. When you’re put in that position, you understand the thought process and what needs to be done. I think every student needs to get involved in something like this. It doesn’t have to be physics or science, just get involved in a project with academic scope.”

