Latest results from the LHC experiments are presented in Vienna

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Credit: CERN

The world particle-physics community has convened in Vienna for the 2015 European Physical Society Conference on High Energy Physics (EPS-HEP2015), where the latest results in the field are being presented and discussed. These include the first results from Run 2 of the Large Hadron Collider (LHC) at CERN, which are being presented for the very first time, less than two months after the experiments started to take data at the unprecedented energy of 13 TeV, following a two-year long

shutdown.

"It is much too early to expect any discovery, we will have to be patient," said CERN Director General Rolf Heuer. "Nevertheless, the LHC experiments have already recorded 100 times more data for the summer conferences this year than they had around the same time after the LHC started up at 7 TeV in 2010. We can sense a fantastic pioneering spirit as the physicists are looking at completely new data at an unexplored energy."

As for any machine exploring a new energy frontier, operators at the LHC face many challenges on a daily basis. Since the start of Run 2, they have been gradually increasing the intensity of the LHC's two beams, which travel in opposite directions around the 27-kilometre ring at almost the speed of light. The LHC has run at the record high energy with each beam containing up to 476 bunches of 100 billion protons, delivering collisions every 50 nanoseconds. In the coming days, the intensity should increase further with a new rhythm of 25 nanoseconds. After a planned technical stop in early September, the teams will also be able to increase the number of bunches with the goal of reaching more than 2000 bunches per beam by the end of 2015.

"During the hardware-commissioning phase, we have learnt to manage carefully the huge energy stored in the magnets. Now with beam commissioning we have to learn progressively how to store and handle the beam energy," said CERN Director of Accelerators and Technology Frédérick Bordry. "Our goal for 2015 is to reach the nominal performance of the LHC at 13 TeV so as to exploit its potential from 2016 to 2018."

The LHC has already delivered over 10 thousand billion collisions to the large experiments since the start of Run 2. This has allowed the LHC collaborations to measure a full suite of detector performance

parameters that demonstrate the readiness of the experiments for discovery physics and precision measurements. The next step was to confirm the Standard Model at the new energy of 13 TeV. After only a few weeks of data taking, the experiments have now "rediscovered" all of the known fundamental particles, apart from the so-called Higgs boson, for which more data are still required. The collaborations are thus ready to test the Standard Model at 13 TeV and the hope is to find evidence of new physics beyond this well-established theory.

At the EPS-HEP2015 conference, the ATLAS and CMS collaborations presented the first measurements at 13 TeV on the production of charged strongly-interacting particles (hadrons). CMS has already submitted this result for publication – the first for the new energy region. Such measurements are important in understanding the basic production mechanism for hadrons.

The LHC experiments have also made the first measurements of cross-sections at 13 TeV. Cross-sections are quantities related to the probability for particles to interact, and their measurement is essential for identifying any new phenomena. For example, ATLAS has measured the cross-section for the production of pairs of top quarks and antiquarks, which is some three times higher at 13 TeV than at the energy of Run 1.

In addition, the conference is providing the opportunity for all of the LHC experiments to present many new or final results from the first run at the LHC. These include searches for dark matter, supersymmetric and other exotic particles, as well as new precision measurements of Standard Model processes.

In this respect, one highlight in Vienna is the presentation for the first time at an international conference of the recent discovery by the LHCb experiment of a new class of particles known as pentaquarks (see press

release). LHCb also published today in *Nature Physics* a result confirming that a certain decay involving the weak force happens with beauty quarks having a "left-handed" spin. This result is consistent with the Standard Model, in contrast with previous measurements that allowed for a right-handed contribution.

In other highlights from Run 1, the ALICE and LHCb experiments have new results on long-range correlations in proton–lead collisions. The latest measurements show that the so-called "ridges" seen in the most violent collisions span across even larger longitudinal distances. In Run 2 data, ATLAS reported that the near-side ridge is seen in 13 TeV proton–proton collisions, with characteristics very similar to those observed by CMS in Run 1.

More information: "Determination of the quark coupling strength $|V_{ub}|$ using baryonic decays." *Nature Physics* (2015) DOI: 10.1038/nphys3415

"Pseudorapidity distribution of charged hadrons in proton-proton collisions at sqrt(s) = 13 TeV." arxiv.org/abs/1507.05915

Provided by CERN

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