

WEBSITE: TAKING AT CLOSER LOOK AT LHC

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LHC ends 2009 run on a high note. “Council is extremely pleased and impressed by the way the LHC, the experiments and the computing Grid have operated this year,” said President of Council Torsten Åkesson. “So far, it is all systems go for the LHC,” said CERN Director General Rolf Heuer. “This first running period has served its purpose fully: testing all the LHC’s systems, providing calibration data for the experiments and showing what needs to be done to prepare the machine for a sustained period of running at higher energy. We could not have asked for a better way to bring 2009 to a close.” This was the last Council meeting to be chaired by Professor Åkesson, who hands over the Council’s Presidency to Professor Michel Spiro, Director of the French National Institute of Nuclear and Particle Physics (CNRS/IN2P3).

[CERN PRESS RELEASE DECEMBER 2009.](#)

LHC: progress in commissioning proton beams. After becoming the world’s highest energy particle accelerator, the LHC is now making progress in commissioning stable beams and providing more collisions at the four points for several hours at a time. For the first time, beams have circulated with more than one bunch of protons, thus increasing the intensity. On the evening of Tuesday, 8 December, two bunches per beam circulated for the first time at 1.18 TeV for a short period and ATLAS recorded its first collisions at the record energy of 2.36 TeV (centre of mass). [CERN – THE BULLETIN December 2009.](#)

LHC sets new world record. CERN’s Large Hadron Collider has today become the world’s highest energy particle accelerator, having accelerated its twin beams of protons to an energy of 1.18 TeV in the early hours of the morning. This exceeds the previous world record of 0.98 TeV, which had been held by the US Fermi National Accelerator Laboratory’s Tevatron collider since 2001. It marks another important milestone on the road to first physics at the LHC in 2010. [CERN PRESS RELEASE, November 2009.](#)

The LHC is back. Particle beams are once again circulating in the world’s most powerful particle accelerator, CERN’s Large Hadron Collider (LHC). This news comes after the machine was handed over for operation on Wednesday morning. A clockwise circulating beam was established at ten o’clock this evening. This is an important milestone on the road towards first physics at the LHC, expected in 2010. [CERN PRESS RELEASE, November 20, 2009.](#)

Half way round the LHC. Particles are smoothly making their way around the 27 km circumference of the LHC. Last weekend (7-8 November), the first bunches of injection energy protons completed their journey (anti-clockwise) through three octants of the LHC’s circumference and were dumped in a collimator just before entering the CMS cavern. Six of the eight sectors of the LHC have now been hardware commissioned to allow the passage of beams at 1.2 TeV. The remaining two (Sectors 3-4 and 8-1) will be powered up in the coming week. If all goes well, in just over one week from now, the beams could circulate in both pipes of the LHC. The first low-energy collisions should follow shortly after. [CERN Bulletin November 2009.](#)

...while the LHC gets colder and colder. The cool-down and commissioning of the LHC continues to progress well. Six of the eight sectors were at a nominal temperature of 1.9 K by the end of the first week of October, and the final two sectors, 3-4 and 6-7, were on course to be fully cold two weeks later. Teams are starting to power the magnets as each sector reaches 1.9 K, so the machine should be fully powered soon after the cool-down is completed. Repairs are thus continuing towards the planned restart, with the injection of the first bunches of protons into the machine scheduled for mid-November. The procedure will be to establish stable beam initially in each direction, clockwise and anticlockwise. This will be followed by a short period of collisions at the injection energy of 450 GeV per beam. Commissioning will then begin on ramping the energy to 3.5 TeV, again working first with each beam in turn. After this, LHC physics will finally begin with collisions at this energy. [CERN Courier, October 30, 2009.](#)

Towards the big chill. During the weekend of 25-29 September, particles (protons and ions) were injected into the transfer lines that link the SPS to the LHC. These crucial tests showed that the whole injection chain is ready. Furthermore, six out of the eight LHC sectors are at operating temperature. And the new Quench Detection System and the energy extraction system have both been tested and are performing well. [CERN Bulletin, October 2009.](#)

Making more space for more people. The upcoming operation of the LHC is attracting and will continue to attract more and more researchers. To ensure that we are able to cope with this influx, our technical services have been busy increasing the office space available on the CERN site. On 9 September, an important milestone in this process was

passed when we laid the foundation stone of Building 42, which will provide 300 additional workstations for scientists analysing the LHC data, in addition to the 800 already available in the adjoining Building 40. [CERN BULLETIN September 2009.](#)

The Latest from the LHC: Switching on the magnets. The architecture of the LHC, which is partitioned into eight cryogenically and electrically independent sectors, allows the commissioning of the machine on a sector-by-sector basis. When a sector reaches nominal cryogenic conditions ($-271.3\text{ }^{\circ}\text{C}$ or 1.9 K), and provided that the control systems (Quench Detection System and Powering Interlock Controllers) work correctly and give the clearance, powering tests can be performed on the magnets. Currently, three sectors are at nominal cryogenic temperature and powering tests are being carried out in all three of them. Current began to flow in the magnets of Sector 1-2 at the end of August. This week, the sector was the first to be powered with the new, recently installed Quench Detection System (QDS). Magnet powering tests have also started in two other sectors, namely Sectors 5-6 and 7-8, where the new QDS is being installed. The two sectors are now ready for tests with higher current – the so-called Powering Phase II. [CERN BULLETIN September 2009.](#)

LHC to run at 3.5 TeV for early part of 2009-2010 run rising later. Large Hadron Collider will initially run at an energy of 3.5 TeV per beam. The LHC will run at 3.5 TeV per beam, when it starts up in November this year, until a significant data sample has been collected and the operations team has gained experience in running the machine. Thereafter, with the benefit of that experience, the energy will be taken towards 5 TeV per beam. At the end of 2010, the LHC will be run with lead ions for the first time. After that, the LHC will shut down and work will begin on moving the machine towards 7 TeV per beam. [CERN Press Release, August 2009.](#)

ALICE & LHCb: refinements for the restart. Following the previous issue, the Bulletin (CERN) continues its series to find out what the six LHC experiments have been up to since last September, and how they are preparing for the restart. Previously we looked at CMS and ATLAS; this issue we will round up the past 10 months of activity at ALICE and LHCb. [CERN Bulletin, August 3rd 2009.](#)

Not a moment to lose at the LHC. But even with the accelerator shut down, there has been no time to relax. Physicists not involved in major repairs to the collider have been busy upgrading both equipment and software, making minor fixes that originally had been scheduled for the LHC's first winter shutdown, and repairing nagging problems that cropped up during years of construction. [Symmetry, August 2009.](#)

LHCb have a new [brochure](#). July 2009.

Knocking on the door again. The LHC's anti-clockwise beam transfer system was tested on 6 and 7 June. Particle bunches were sent from the SPS through the 2.8 km transfer line towards the LHC where it intersects just before the LHCb cavern. The beam went down the transfer line and stopped just before reaching the LHC tunnel, where a beam stopper – 4 m of graphite – is physically placed in the beam line to prevent the beam from taking the last step into the LHC. Part of the LHCb detector was turned on during the beam test, allowing the reconstruction of tracks through the Vertex Locator. [CERN Courier, July 2009.](#)

LHC Experiments: refinements for the restart. As the LHC restart draws closer, the Bulletin will be taking a look at how the six LHC experiments are preparing and what they have been up to since last September. In this issue we start with a roundup of the past 10 months of activity at CMS and ATLAS, both technical work and outreach activities. [CERN Bulletin, July 20th 2009.](#)

All repairs in Sector 3-4 completed. All repairs in Sector 3-4, the sector damaged during the incident last September, have been completed and the sector has been closed up. After the last electrical interconnection was brazed, the final 'W bellow' - the large accordion-shaped sleeve that covers the interconnections between two magnets - was closed on 23 June. The teams have now started to pump the air out in order to leak-test the insulation vacuum. Once all the vacuum tests and electrical tests have been completed the sector will be ready to start the cool-down process. [The Bulletin \(CERN\) June 2009.](#)

Final magnet for sector 3-4 goes underground. With all of the necessary magnets now underground, work in the tunnel will continue to connect them together. In total 53 magnets were removed from sector 3-4 following the incident on 19 September 2008. Of these, 16 magnets had sustained minimal damage and so were refurbished and put back into the

tunnel; the remaining 37 were replaced by spares, depleting the number of reserve magnets to nearly zero. Work will continue on the surface to repair the remaining damaged magnets to replenish the pool of spares. [CERN Courier. Jun 2009](#)

First sector is closer to cool down. Installation of the new helium pressure-release system for the LHC is progressing well. The first sector to be fully completed is 5-6, with all 168 individual pressure-release ports now in place. These ports will allow a greater rate of helium escape in the event of a sudden increase in temperature. [Cern Courier May 2009](#).

ALICE prepares for jet measurements. The ALICE experiment has reached another milestone with the successful installation of the first two supermodules of the electromagnetic calorimeter (EMCal). ALICE is designed to study matter produced in high-energy nuclear collisions at the LHC, in particular using lead ions. The goal is to investigate thoroughly the characteristics of hot, dense matter as it is thought to have existed in the early universe. [Cern Courier May 2009](#).

LHC consolidation work proceeds apace. The new schedule foresees first beams in the LHC at the end of September 2009, with collisions in late October. A short technical stop has also been foreseen over the Christmas period. The LHC will then run through to the following autumn to ensure that the experiments have adequate data to carry out their first new-physics analyses and have results to announce in 2010. The new schedule also permits the possibility of lead-ion collisions in 2010. [CERN Courier April, 2009](#).

Fermilab Putting the Squeeze on Higgs Boson. Scientists at the Department of Energy's Fermi National Accelerator Laboratory have achieved the world's most precise measurement of the mass of the W boson by a single experiment. Combined with other measurements, a tighter understanding of the W boson mass will also lead researchers closer to the mass of the elusive Higgs boson particle. The territory where the Higgs boson may be found continues to shrink. The latest analysis of data from the CDF and DZero collider experiments at the U.S. Department of Energy's Fermilab now excludes a significant fraction of the allowed Higgs mass range established by earlier measurements. Those experiments predict that the Higgs particle should have a mass between 114 and 185 GeV/c². Now the CDF and DZero results carve out a section in the middle of this range and establish that it cannot have a mass in between 160 and 170 GeV/c². [Read more](#).

CERN launches new youth site on Web's 20th anniversary. Geneva, 13 March 2009. Web veteran Robert Cailliau today launched CERNland, a new website for young people, on the occasion of the Web's 20th anniversary. CERNland has been developed to bring the excitement of CERN's research to a young audience aged 7 to 12 through a range of films, games and multimedia applications. It is available at <http://www.cern.ch/cernland>.

Work continues apace on the repairs at the LHC. The crucial improvement since the incident in sector 3-4 is a new resistance-measurement system which can detect nano-ohm resistances in the joints. This new system would have prevented September's incident and will prevent all imaginable failures of a superconducting joint in the future. For any "unimaginable" failure of a joint, the installation of new pressure-relief valves will reduce the amount of damage that occurs, compared with last year. [CERN Courier March 2009](#)

CERN management confirms new LHC restart schedule. CERN management confirmed the restart schedule for the Large Hadron Collider (LHC) resulting from the recommendations from 2 to 6 February 2009 Chamonix workshop. The new schedule foresees first beams in the LHC at the end of September this year, with collisions following in late October. A short technical stop has also been foreseen over the Christmas period. The LHC will then run through to autumn next year, ensuring that the experiments have adequate data to carry out their first new physics analyses and have results to announce in 2010. The new schedule also permits the possible collisions of lead ions in 2010. [CERN February 2009](#).

Mobilizing for the LHC. Investigations following the incident in Sector 3-4 of the LHC on 19 September have confirmed that the cause was a faulty electrical connection between two magnets. This resulted in mechanical damage and the release of helium from the magnet cold masses. CERN has published two reports on the incident and confirmed that the accelerator will be restarted in summer this year. [CERN Courier January/February Volume 49](#)