Upgrades yield increased cryogenic power at Large Hadron Collider

October 20 2020, by Anaïs Schaeffer

The cold box located on the surface is approximately 6 metres long and 3 metres in diameter. All the elements are vacuum insulated to limit thermal radiation. Credit: CERN

The Large Hadron Collider (LHC) is one of the coldest places on Earth. The 1.9 K (-271.3 °C) operating temperature of its main magnets is even

lower than the 2.7 K (-270.5 °C) of outer space. To get the LHC to this temperature, 120 tons of liquid helium flow around a closed circuit in the veins of the accelerator.

The LHC cooling system is made up of cryogenic islands with eight helium refrigerators in total. Each even-numbered point on the accelerator (Points 2, 4, 6 and 8) has two refrigerators, one dating from the LEP (Large Electron-Positron Collider) era, and another newer refrigerator dating from the start-up of the LHC. The LEP refrigerator is composed of two cold boxes—one on the surface and the other downstream in the tunnel, which cool the helium from room temperature to 20 K (-253.15 °C) and from 20 K to 4.5 K respectively—and a unit located in a cavern generating superfluid helium at 1.9 K.

"These refrigerators date back to 1994, but they have undergone a number of upgrades since then, in particular in preparation for the LHC in 2006," says Emmanuel Monneret, an engineer from the TE-CRG group working on the refrigeration project. "On that occasion, their cooling power was increased from 12 to 16 kW at 4.5 K."

During LS2, further upgrades have been carried out on the LEP refrigerator at Point 4, increasing its cooling power to 18 kW at 4.5 K, in preparation for the HL-LHC (High-Luminosity LHC): "The Point 4 refrigerators are crucial for the HL-LHC, because as well as cooling sectors 3-4 and 4-5, they must also cool the sections where the radiofrequency cavities are installed, which require a considerable amount of cooling," continues Emmanuel Monneret.


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The new turbines and their heat exchangers, recently installed in the lower cold box at Point 4. The turbines are mounted on an interface that was specially developed to allow them to be installed from outside the cold box. Credit: CERN

To achieve this important extra 2 kW, the four turbines and heat exchangers in each of the cold boxes at Point 4 have been replaced with higher-performing equivalents. This task was relatively straightforward to carry out for the cold box at the surface, which is easily accessible to workers (see photo 1), but more arduous for the cold box in the tunnel. "We had not anticipated that it would be impossible to get inside the tunnel cold box, which is much more compact than the one on the surface," Emmanuel Monneret explains. "Working in close collaboration with the manufacturer, we eventually found a solution to allow us to replace the turbines and exchangers from the outside."

Thanks to a new interface (see photo 2) developed by the manufacturer in just a few months, the team in charge of the project was able to install the turbines and exchangers without having to connect them from inside the cold box. This new equipment, which has just been commissioned, will be operational by the end of the month.

The LHC has started cool-down

The post-LS2 cool-down of the LHC began on 5 October in sector 4-5. Cool-down is carried out in three stages: from room temperature to 80 K, from 80 K to 4.5 K, and finally from 4.5 K to 1.9 K. It takes around seven weeks for a sector to be cooled to 1.9 K, including checks and adjustments of the instrumentation and the process control systems. The sectors are cooled gradually, one after another. The LHC should therefore reach its nominal temperature in spring 2021.

Provided by CERN

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