For the first time the LHC reaches temperatures colder than outer space

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Geneva, 10 April 2007. The first sector of CERN's Large Hadron Collider (LHC) to be cooled down has reached a temperature of 1.9 K (-271°C), colder than deep outer space.

Although just one-eighth of the LHC ring, this sector is the world's largest superconducting installation. The entire 27-kilometre LHC ring needs to be cooled down to this temperature in order for the superconducting magnets that guide and focus the proton beams to remain in a superconductive state. Such a state allows the current to flow without resistance, creating a dense, powerful magnetic field in relatively small magnets. Guiding the two proton beams as they travel at nearly the speed of light, curving around the accelerator ring and focusing them at the collision points is no easy task.

A total of 1650 main magnets need to be operated in a superconductive state, which presents a huge technical challenge. "This is the first major step in the technical validation of a full-scale portion of the LHC," explained LHC project leader, Lyn Evans.

There are three parts to the cool down process, with many tests and intense checking in between. During the first phase, a sector is cooled down to 80 K, slightly above the temperature of liquid nitrogen. At this temperature the material will have seen 90% of its final thermal contraction, a 3 millimetre per metre shrinkage of the steel structures. Each of the eight sectors is about 3.3 kilometres long, which means shrinkage of 9.9 metres. To deal with this amount of shrinkage, specific places have been designed to compensate, including expansion bellows for piping elements and cabling with some slack. Tests are done to make sure no hardware breaks as the machinery is cooled.

The second phase brings the sector to 4.5 K using enormous refrigerators. Each sector has its own refrigerator and each of the main magnets is filled with liquid helium, the coolant of choice for the LHC because it is the only element to be in a liquid state at such a low temperature.

The final phase requires a sophisticated pumping system to help bring down the pressure on the boiling Helium and cool the magnets to 1.9 K. To achieve a pressure of 15 millibars, the system uses both hydrodynamic centrifugal compressors operating at low temperature and positive-displacement compressors operating at room temperature. Cooling down to 1.9 K provides greater efficiency for the superconducting material and for the helium's cooling capacity. At this low temperature helium becomes superfluid, flowing with virtually no viscosity and allowing greater heat transfer capacity.

"It's exciting because for more than ten years people have been designing, building and testing separately each part of this sector separately and now we have a chance to test it all together for the first time," said Serge Claudet, head of the Cryogenic Operation Team. For more information and to see regular updates, see http://lhc.web.cern.ch/lhc/.

The conditions are now established to allow testing of all magnets in this sector to their ultimate performance.

Source: CERN