time to cool down magnets to their operating temperature of around 1.9 K (close to absolute zero). Over time the magnet "beds in" and ceases to quench at these lesser currents and can handle the full design current without quenching; CERN media describe the magnets as "shaking out" the unavoidable tiny manufacturing imperfections in their crystals and positions that had initially impaired their ability to handle their planned currents. The magnets, over time and with training, gradually become able to handle their full planned currents without quenching.[82][83]

Inaugural tests (2008)

The first beam was circulated through the collider on the morning of 10 September 2008.[46] CERN successfully fired the protons around the tunnel in stages, three kilometres at a time. The particles were fired in a clockwise direction into the accelerator and successfully steered around it at 10:28 local time.[57] The LHC successfully completed its major test: after a series of trial runs, two white dots flashed on a computer screen showing the protons travelled the full length of the collider. It took less than one hour to guide the stream of particles around its inaugural circuit.[84] CERN next successfully sent a beam of protons in an anticlockwise direction, taking slightly longer at one and a half hours owing to a problem with the cryogenics, with the full circuit being completed at 14:59.

Quench incident

On 19 September 2008, a magnet quench occurred in about 100 bending magnets in sectors 3 and 4, where an electrical fault led to a loss of approximately six tonnes of liquid helium (the magnets' cryogenic coolant), which was vented into the tunnel. The escaping vapour expanded with explosive force, damaging a total of 53 superconducting magnets and their mountings, and contaminating the vacuum pipe, which also lost vacuum conditions.[58][59][85]

Shortly after the incident, CERN reported that the most likely cause of the problem was a faulty electrical connection between two magnets, and that – owing to the time needed to warm up the affected sectors and then cool them back down to operating temperature – it would take at least two months to fix.[86] CERN released an interim technical report[85] and preliminary analysis of the incident on 15 and 16 October 2008 respectively,[87] and a more detailed report on 5 December 2008.[79] The analysis of the incident by CERN confirmed that an electrical fault had indeed been the cause. The faulty electrical connection had led (correctly) to a failsafe power abort of the electrical systems powering the superconducting magnets, but had also caused an electric arc (or discharge) which damaged the integrity of the supercooled helium's enclosure and vacuum insulation, causing the coolant's temperature and pressure to rapidly rise beyond the ability of the safety systems to contain it,[85] and leading to a temperature rise of about 100 degrees Celsius in some of the affected magnets. Energy stored in the superconducting magnets and electrical noise induced in other quench detectors also played a role in the rapid heating. Around two tonnes of liquid helium escaped explosively before detectors triggered an emergency stop, and a further four tonnes leaked at lower pressure in the aftermath.[85] A total of 53 magnets were damaged in the incident and were repaired or replaced during the winter shutdown.[88] This accident was thoroughly discussed in a 22 February 2010 *Superconductor Science and Technology* article by CERN physicist Lucio Rossi.[89]

In the original schedule for LHC commissioning, the first "modest" high-energy collisions at a centre-of-mass energy of 900 GeV were expected to take place before the end of September 2008, and the LHC was expected to be operating at 10 TeV by the end of 2008.[90] However, owing to the delay caused by the incident, the collider was not operational until November 2009.[91] Despite the delay, LHC was officially inaugurated on 21 October 2008, in the presence of political leaders, science ministers from CERN's 20 Member States, CERN officials, and members of the worldwide scientific community.[92]

Most of 2009 was spent on repairs and reviews from the damage caused by the quench incident, along with