With a budget of €7.5 billion (approx. $9bn or £6.19bn as of June 2010), the LHC is one of the most expensive scientific instruments[1] ever built.[68] The total cost of the project is expected to be of the order of 4.6bn Swiss francs (SFr) (approx. $4.4bn, €3.1bn, or £2.8bn as of January 2010) for the accelerator and 1.16bn (SFr) (approx. $1.1bn, €0.8bn, or £0.7bn as of January 2010) for the CERN contribution to the experiments.[69]

The construction of LHC was approved in 1995 with a budget of SFr 2.6bn, with another SFr 210M toward the experiments. However, cost overruns, estimated in a major review in 2001 at around SFr 480M for the accelerator, and SFr 50M for the experiments, along with a reduction in CERN's budget, pushed the completion date from 2005 to April 2007.[70] The superconducting magnets were responsible for SFr 180M of the cost increase. There were also further costs and delays owing to engineering difficulties encountered while building the cavern for the Compact Muon Solenoid,[71] and also due to magnet supports which were insufficiently strongly designed and failed their initial testing (2007) and damage from a magnet quench and liquid helium escape (inaugural testing, 2008) *(see: Construction accidents and delays)*.[72] Because electricity costs are lower during the summer, the LHC normally does not operate over the winter months,[73] although exceptions over the 2009/10 and 2012/2013 winters were made to make up for the 2008 start-up delays and to improve precision of measurements of the new particle discovered in 2012, respectively.

Construction accidents and delays

- On 25 October 2005, José Pereira Lages, a technician, was killed in the LHC when a switchgear that was being transported fell on top of him.[74]
- On 27 March 2007, a cryogenic magnet support designed and provided by Fermilab and KEK broke during an initial pressure test involving one of the LHC's inner triplet (focusing quadrupole) magnet assemblies. No one was injured. Fermilab director Pier Oddone stated "In this case we are dumbfounded that we missed some very simple balance of forces". The fault had been present in the original design, and remained during four engineering reviews over the following years.[75] Analysis revealed that its design, made as thin as possible for better insulation, was not strong enough to withstand the forces generated during pressure testing. Details are available in a statement from Fermilab, with which CERN is in agreement.[76][77] Repairing the broken magnet and reinforcing the eight identical assemblies used by LHC delayed the start-up date, then planned for November 2007.
- On 19 September 2008, during initial testing, a faulty electrical connection led to a magnet quench (the sudden loss of a superconducting magnet's superconducting ability owing to warming or electric field effects). Six tonnes of supercooled liquid helium—used to cool the magnets—escaped, with sufficient force to break 10-ton magnets nearby from their mountings, and caused considerable damage and contamination of the vacuum tube *(see 2008 quench incident)*; repairs and safety checks caused a delay of around 14 months.[78][79][80]
- Two vacuum leaks were found in July 2009, and the start of operations was further postponed to mid-November 2009.[81]

Initial lower magnet currents

In both of its runs (2010 to 2012 and 2015), the LHC was initially run at energies below its planned operating energy, and ramped up to just 2 x 4 TeV energy on its first run and 2 x 6.5 TeV on its second run, below the design energy of 2 x 7 TeV. This is because massive superconducting magnets require considerable magnet training to handle the high currents involved without losing their superconducting ability, and the high currents are necessary to allow a high proton energy. The "training" process involves repeatedly running the magnets with lower currents to provoke any quenches or minute movements that may result. It also takes