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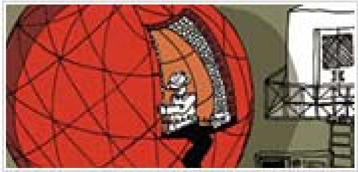

Demystifying the LHC shutdown

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Yesterday the science news media and twitterverse were abuzz following a BBC News article announcing "LHC to shut down for a year to address design faults." Readers – and the news outlets that frantically re-reported the BBC article – assumed that CERN had found a new problem with the LHC and announced an imminent shutdown. Neither is the case. Here, we join our fellow science writers and bloggers in setting the record straight about the LHC's next long shutdown.

The LHC will shut down for about one year – but not until late 2011

What the BBC reported yesterday is true, but is not exactly news. A revised schedule for the LHC's next few years was announced in early February by CERN. According to the revised schedule, the LHC will run at a maximum energy of 3.5 TeV per beam for a period of about 18 months, starting with the first collisions at 3.5 TeV per beam expected to take place at the end of this month. The long run will end in late 2011 or when the LHC experiments have collected a certain quantity of data (one inverse femtobarn in particle-physics parlance), whichever comes first. At the conclusion of this long run, the LHC will shut down for about one year.

The shutdown will be used to fix problems with the LHC and carry out routine maintenance

The long length of the next major LHC shutdown is due to two main factors: the time necessary to fix problems with magnet connections that currently prevent the LHC from running at its full energy; and the time needed to prepare the LHC for routine maintenance and repair work and then restore the LHC to operational status.

Particle accelerators are incredibly complex machines, and, like any complex machine, require regular maintenance to keep their parts running smoothly, repairs when parts wear out or break down, and occasional upgrades to increase the machine's performance. Maintenance, repairs and upgrades to the LHC cannot take place while the machine is running, for two reasons. One, the radiation generated in the immediate vicinity of the LHC while it is operating means that technicians cannot enter the LHC tunnel while the machine is running. Two, the LHC's magnets must be cooled to almost absolute zero to bend high-energy beams of particles, and it takes about one month to warm the accelerator up to room temperature before technicians can access the magnets' innards.

In the past, CERN – like Fermilab near Chicago, which also operates a supercooled particle collider – ran its accelerators on a one-year schedule. The accelerator ran continuously for eight or nine months, followed by a four or five-month shutdown for maintenance, repairs, and upgrades. But the LHC is unique in that it contains 27 kilometers' worth of supercooled machinery. (CERN's previous 27-kilometer-long accelerator wasn't supercooled, and Fermilab's is less than 7 kilometers around.) As the LHC takes at least one month to warm up, and another month to cool down, CERN has decided to move to longer running times followed by longer shutdowns.

But the warm-up and cool-down times aren't the only reason that the LHC's next shutdown will be lengthy.

The 2011-2012 shutdown will also be used to fix problems with the connections between superconducting magnets that prevent the LHC from running at the energies it was designed for. On September 19, 2008, a superconducting connection between two LHC magnets melted, resulting in a chain reaction that damaged more than 50 magnets. The damage took more than one year to fix, and spurred a critical review of the LHC's design. The result was the decision to run the LHC at half design energy – 3.5 TeV per beam – long enough to give the LHC experiments enough data to remain competitive with Fermilab's Tevatron experiments in the hunt for the big physics discoveries. And then take all the time necessary to fix the LHC so that it can finally ramp up to its full energy of 7 TeV per beam in 2013.

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