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As LHC Draws Nigh, Nobelists Outline Dreams--And Nightmares

Run-up to activation of world's biggest science experiment later this summer

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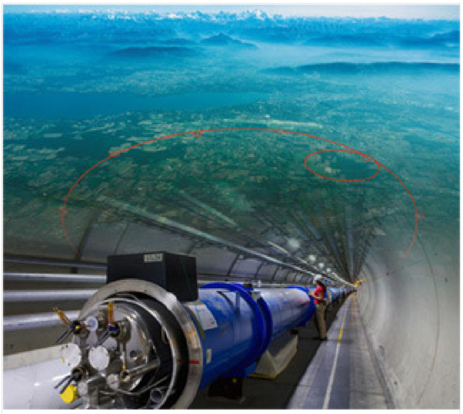

LARGE HADRON COLLIDER: One of the LHC's superconducting magnets is shown here [*inset*] superimposed on an aerial view of CERN's accelerator complex near Geneva with the path of the LHC marked in red.
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The number 14 turns up conspicuously in discussions of the Large Hadron Collider (LHC), the soon-to-be world's biggest particle accelerator. Construction of its underground, 17-mile (27-kilometer) ring on a site near Geneva, Switzerland, has taken 14 years. It is designed to reach energies of 14 tera- (trillion) electron volts (TeV), or about seven times that of the Tevatron, the world's currently reigning accelerator at Fermi National Accelerator Laboratory in Illinois.

And project leaders at the European Organization for Nuclear Research (CERN) announced today that next month workers should be done chilling the machine's 50,000 tons of magnets to temperatures colder than deep space—a bracing –456.3 degrees Fahrenheit (1.9 kelvins)—making them ready to whip opposing beams of protons to near light speed and collide them so researchers can pick over the debris.

The expected cool-down date? The week of July 14.

Needless to say, switching on the largest, most complex science experiment ever constructed will be a drawn-out process. "There's no red button to press," James Gillies, a CERN spokesperson, said during a news conference yesterday Web cast from the CERN Control Center in Pr√©vessin, France. The lab plans to send the first protons through the ring in mid-August, then spend a couple of months ramping them up to high energies. Ideally, the LHC's massive particle detectors should be ready for action at around the same time.

In anticipation of the start-up, CERN convened a panel of five Nobel Prize‚Äìwinning physicists to give their thoughts on the project. The LHC was built first and foremost to seek out a subatomic particle called the Higgs boson, which solves the conundrum of why the photon (the particle that conveys the force of electromagnetism) has no mass, whereas its counterparts, the W and Z bosons (the operative particles in the weak nuclear force that causes radioactive decay), do.

Physicists believe that the Higgs breaks a symmetry between these forces, similar to the way Earth's gravity makes it appear that space has an up and a down. It does so by acting like molasses that other particles have to plow through. The end result is mass as we know it.

Most of the panelists said they were confident that the LHC would uncover the Higgs, because its presence (or at least something like it) is so strongly implied by the standard model of particle physics, which describes the three forces that hold atoms together. (In addition to electromagnetism and the weak force is the strong nuclear force that keeps individual protons and neutrons from dissolving into more basic particles called quarks.)

Discovering the Higgs would close a three-decade-long chapter in the history of physics. "We are all enormously excited that the LHC is about to turn on," said David Gross of the University of California, Santa Barbara, co-winner of a 2004 Nobel for elucidating the strong nuclear force.

Part of the enthusiasm stems from the fact that the standard model was so successful that physicists have no firm clues on how to proceed beyond it. Even more interesting than the Higgs, panel members said, would be the discovery of particles responsible for dark matter as well as an explanation of why the universe has a preponderance of matter over antimatter, either of which would break new ground in fundamental physics.

And then there's the far-out stuff: George Smoot of the University of California, Berkeley, who shared the 2006 Nobel Prize in Physics for mapping the faint cosmic microwave background radiation that gave evidence of the big bang, mentioned the prospect of finding signs of extra dimensions of space implied by string theory. "I have really high hopes,Äîperhaps too high," he said.

Gross, who described himself as more conservative, said he expected the LHC to reveal supersymmetry, a proposed theory in which each particle has a heavier counterpart; such a discovery could explain the existence of dark matter as well as solve some lingering coincidences in particle physics known as unification and the hierarchy problem, which have to do with why the forces appear so different from one another.

Of course, nature might throw researchers a curveball. Martinus Veltman of the University of Michigan at Ann Arbor (Nobelist in 1999 with Gerard 't Hooft of Utrecht University in the Netherlands for work on the weak force that paved the way for the Higgs) suggested a gloomy but speculative scenario in which Higgs exists but fails to show up at the LHC. If that happens, he predicted, "it will probably be the end of particle physics."

Gross said that such a result, going against the standard model, would itself be "enormously exciting." What worried him was finding the Higgs and nothing else, because then it would be impossible to persuade world governments to fund future machines such as the proposed International Linear Collider, which took a hit in December when Congress yanked 2008 funding for the U.S. share of R&D on the project.

Without some hints from nature, physicists would not even know how big to build their machines to try to make new discoveries, Gross said. "My nightmare is we find the Higgs and nothing else," he said. "I have a lot of confidence that we won't, but that is a nightmare."

't Hooft, the fifth panelist, who shared his prize with Veltman, said even if the LHC turned up nothing but the Higgs, physicists would still keep the machine busy studying the way it interacts with other particles. Prior particle accelerators were considered successes for doing essentially the same thing, he said.

The discussion touched at least one laureate's nerves. Theoreticians "have too much time to think" sometimes, Carlo Rubbia (awarded half the 1984 physics prize for experiments that led to the discovery of the W and Z bosons) charged. Rubbia, a former director general of CERN who is considered the father of the LHC for his early work on the project and now holds scientific advisory positions at several European institutions, asked if Veltman would return his share of the Nobel Prize money in the event the LHC found no sign of the Higgs. (Veltman replied that he had already spent it.)

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