January 17, 2011

Recalling a Fallen Star's Legacy in High-Energy Particle Physics

By DENNIS OVERBYE

The machine known as the Tevatron is four miles around. Bison graze nearby on the 6,800 acres of former farmland occupied by the Fermi National Accelerator Laboratory in Batavia, Ill. Occasionally, physicists run races around the top of it.

It was turned on in 1983 to the sound of protesters who worried that its high-energy collisions between protons and antiprotons could bring about the end of the world or perhaps the whole universe.

For the next three decades it reigned as a symbol of human curiosity and of American technological might, becoming the biggest, grandest, most violent physics experiment of its time, devouring a small city's worth of electricity to collide subatomic particles with energies of up to a trillion electron volts apiece in an effort to retrieve forces and laws that prevailed during the Big Bang.

The world as a whole never did end, but for American physicists a small piece of it has now. Last Monday the Department of Energy, which runs Fermilab, as it is known, announced that despite last-minute appeals by physicists, the Tevatron will shut down as scheduled in September.

The news disappointed American physicists who had hoped that three more years of running might give them a glimpse of as yet unobserved phenomena like the Higgs boson, a storied particle said to imbue other particles with mass.

"It's a shame to shut it down," said Lisa Randall, a Harvard physicist, who says she thinks the physics community gave up too easily. Dr. Randall organized a bunch of some 40 theorists to write a letter to the Department of Energy last summer urging them to keep the machine running. A message on her new Twitter account last week broke the news of the decision to shut down the Tevatron.

That leaves the field of future discovery free for the Large Hadron Collider, which started up a year ago outside Geneva at CERN, the European Organization for Nuclear Research, and is now the world champion. The collider is 17 miles around and capable eventually, CERN says, of producing 7 trillion-electron-volt protons. Hobbled with bad electrical connections, it ran at half

that energy in 2010.

"How are we going to feel if they find it at the LHC?" Dr. Randall said. "The Tevatron had the capacity to give us complementary information."

This moment has been coming ever since 1993, when Congress canceled the Superconducting Supercollider, a physics machine in Texas that would have been the biggest, most powerful machine on the planet. CERN's collider is expected to dominate physics for the next 20 years.

The impending death of the Tevatron adds to a gloomy time for American science, coming as it does just as NASA has announced that its flagship project, the James Webb Space Telescope, is $1.6 billion over budget and will be years late, knocking the pins out from under hopes of mounting a mission anytime soon to investigate the dark energy that is boosting the expansion of the universe.

Michael Turner, a cosmologist at the University of Chicago and vice president of the American Physical Society, said American scientists were struggling to adjust to a world in which Europe and Asia are attaining parity with the United States. "We are used to dominating in science," Dr. Turner said. "We seem to be unable to make decisions, and instead continue to chase every opportunity, in the end doing nothing."

For the last year the Tevatron and the CERN collider have been engaged in a race to discover, among other things, the Higgs. By all accounts the Tevatron, with a 20-year head start, was ahead. Moreover, CERN had been scheduled to shut down for a year in 2012 to fix their machine and bring it up to par. In response to the prospect of the Tevatron extending its run, CERN had been talking recently about postponing its own shutdown for a year.

But the squeeze is on science budgets, and the continuation of the Tevatron was not to be. "Unfortunately the current budgetary climate is very challenging and additional funding has not been identified," William Brinkman, director of the office of science at the Department of Energy, said in a letter to the High Energy Physics Advisory Panel on Jan. 6.

The Tevatron will be remembered scientifically for the discovery of the top quark, the last missing part of the ensemble that makes up ordinary matter, in 1995, and a host of other intriguing results like the controversial discovery last summer of a particle that goes back and forth between being itself and its evil-twin antiparticle a little faster in one direction than the other, providing a possible clue to why the universe is now made of matter and not antimatter.

Physicists will be analyzing and studying the data from its two big detectors, DZero and the Collider Detector at Fermilab, CDF, for years.

It will also be remembered as a fount of technological development whose influence spread far

beyond high-energy physics. The development, in partnership with industry, of superconducting magnets for Fermilab's machine, said Young-Kee Kim, deputy director of the lab, helped pave the way for cheap M.R.I. machines for hospitals.

Although it is the end for the Tevatron, it is not the end for Fermilab, which helped build the Large Hadron Collider and which hosts a control room for one of that accelerator's gigantic particle detectors, and is also home to a thriving cosmology program. The lab has bet its long-term future on a new-generation accelerator program called Project X which would produce intense proton beams for producing and scrutinizing other particles like neutrinos.

Robert Roser, a Fermilab physicist, said, "I always knew it would be a long shot to run three additional years." He credited the competition with Fermilab with spurring on the Europeans.

"I believe they made machine progress more rapidly than they would have had we not been part of the landscape in the coming years," Dr. Roser wrote in an e-mail message. He and others pointed out that the machines were complementary — the Tevatron collides protons and their opposites, antiprotrons, while the CERN collider bangs together protons and thus produces slightly different fireballs with different mixtures of particles and radiation coming out of them. Without the Tevatron's data, Dr. Roser said, it would take the CERN longer to confirm the Higgs when and if they finally find it.

Physicists are trained to be unsentimental about facts, theories and machines, but the rest of us are not obliged to be so unsentimental about the Tevatron and what it meant for American science. Robert Wilson, Fermilab's founding director, was an artist as well as physicist, and he took pains to ensure that the lab's physical presence was as elegant as the ideas it was built to explore. The Tevatron was buried underground, to shield the world from the radiation of its beams, but Dr. Wilson had a circular berm built over it, so that the ring would be visible. From high in the sky the berm and the roads that circle it make a pattern that might intrigue an alien civilization that had sufficiently acute vision and lure them in.

Some day alien archaeologists could excavate the tunnel in which giant machines replayed the Big Bang and wonder what happened to the people who built it, and what they thought about their place in the universe.