Extra data bolster top quark discovery

The top quark's true identity is beginning to emerge from the debris of trillions of high-energy collisions between protons and their antimatter counterparts.

Last year, physicists at the Fermi National Accelerator Laboratory (Fermilab) in Batavia, Ill., presented the first direct experimental evidence for the existence of the long-sought top quark (SN: 4/30/94, p.276). But significant uncertainties in the limited data available rendered the results suspect.

Now, after acquiring and sifting through three times as much data, Fermilab researchers are confident that they have indeed discovered the top quark. Moreover, teams using two different detectors have observed traces of this elusive subatomic particle. A year ago, only the group using the Collider Detector at Fermilab (CDF) claimed any sightings.

At that time, researchers at the rival DZero detector "just did not have enough events to make a statement about the top quark's existence, but now, with a larger data sample, the signal is clear," says Paul D. Grannis of the State University of New York at Stony Brook, a DZero team member.

Representatives of the CDF and DZero teams reported their findings at a seminar held last week at Fermilab.

According to the standard model of particle physics, quarks come in six varieties. Two kinds of quarks — known as up and down quarks — combine to create the protons and neutrons of everyday matter. Three other types of quarks — strange, charm, and bottom — have been found using particle accelerators. The newly discovered top quark completes the family.

Created as quark-antiquark pairs in collisions between protons and antiprotons moving at nearly the speed of light, top quarks disintegrate almost immediately to create characteristic showers of other particles that physicists can then detect. However, because decays of other subatomic particles can mimic those postulated for the top quark, researchers must take care to distinguish these "background" events from genuine top quark decays.

Out of trillions of collisions, the CDF team identified about 40 events as top quark candidates, significantly more than the 12 events expected as background. From these data, the physicists calculated that the top quark has a mass (expressed in energy units) of 176 billion electronvolts (GeV), with an uncertainty of 13 GeV.

"The new mass estimate closely matched our previous measurement," says Paul Tipton of the University of Rochester and a member of the CDF group. "This was very reassuring and made us believe the result that much more."

The DZero group has found about 17 candidate events, leading to a mass estimate for the top quark of 199 GeV, with an uncertainty of 30 GeV. "There's a good overlap between the measurements," Tipton says.

"The detectors are vastly different, and what you record is very different, but the physics of producing the particles and what those particles do in the detectors is the same," adds DZero team member Andrew R. Baden of the University of Maryland in College Park. "I think it's pretty clear now that [both detectors] are looking at the same phenomenon."

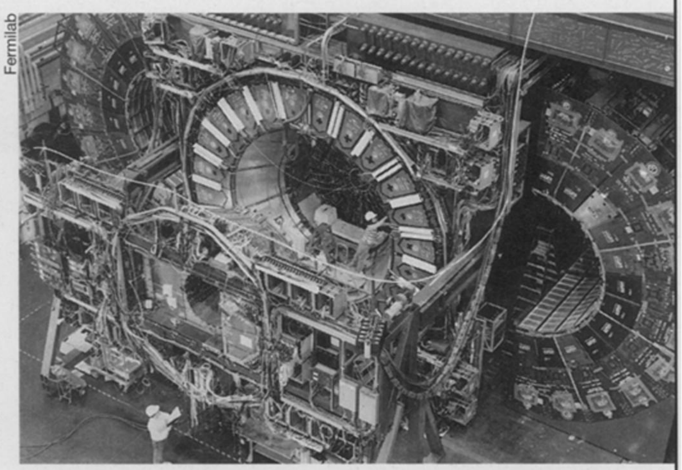
The two teams plan to continue collecting data until the end of the year. "By then, we'll have twice the data we have now," Baden says.

Much effort will go into reducing the uncertainty in the top quark mass. As the number of candidate events increases, researchers will also begin to study other characteristics of the top quark.

"We have this new particle, and we're the only people in the world who have what is, in effect, a new laboratory," Tipton says. "There are possibilities for observing new physics in both how the top is produced and how it decays."

— *I. Peterson*

Fermilab



The massive Collider Detector at Fermilab (CDF) dwarfs its human operators.

Seizing two genes for fast heartbeat

Researchers say they have fingered two genes underlying a lethal heart rhythm abnormality that can strike young, healthy people without warning. The finding, reported this week, may pave the way for early diagnosis and treatment of individuals who have inherited this condition, which occurs in about 1 in 10,000 individuals. More than 300,000 people in the United States die suddenly each year; in many cases the underlying cause may be an aberrant cardiac rhythm.

The disorder is called long QT syndrome for the abnormally long wave it may produce on an electrocardiogram, a tracing of the electrical activity of the heart. The first indication of trouble may surface suddenly, in the form of an episode of rapid, irregular heartbeat. That ineffective heart rhythm can lead to blackout spells and even death.

Mark T. Keating of the Howard Hughes Medical Institute at the University of Utah Health Sciences Center in Salt Lake City and his colleagues had previously reported that certain regions of chromosomes 7, 3, and 11 appear to contain genes responsible for this deadly syndrome.

They also knew of the discovery by another research team of a gene on chromosome 7 believed to contain the blueprint for an ion channel, a protein embedded in the surface of cells. Certain ion channels keep the heart beating rhythmically. Keating's group speculated that this gene, called HERG, plays a role in long QT syndrome.

To test that theory, they first demonstrated that HERG lies within the expected region of chromosome 7. "That's when it became a really exciting candidate," Keating says, although he ruefully acknowledges that other promising genes have not panned out.

Further research suggested that while HERG's protein product turns up on other cells of the body, it is usually found on the surface of heart cells.

Finally, the researchers identified HERG mutations in six families with long QT syndrome. They describe their results in the March 10 CELL.

The researchers believe that a flaw in HERG leads to a faulty potassium ion channel. Normally, this protein acts as a switch that turns contracting heart cells off. Without a functional potassium channel, these cells lack one of several "brakes" that keep the heartbeat under control. If another factor, such as stress or medication, knocks out the remaining brakes, the heart begins to race too fast to pump blood effectively.

"The engine of the heart goes galloping out of control," Keating says.