Muon g-2 Experiment

By studying the properties of muons, scientists at Fermilab hope to learn whether there are elementary particles beyond the ones we know.

The experiment

Muon g-2 (pronounced gee-minus-two) is an international collaboration between U.S. universities, Fermilab in Illinois, Brookhaven National Laboratory in New York, and nine international labs and universities. It is designed to probe the magnetic property of the muon, a heavy sibling of the electron that lives for about two microseconds, in greater detail than ever before.

The Muon g-2 experiment will study the rotation (wobble) of muons when placed in a magnetic field. Based on what we know about muons and other particles already, scientists should be able to predict the value of the muon's magnetic "wobble." If the experiment comes up with something different, it may mean that our current understanding of physics is incomplete, and could open the door to exciting new realms of science.

A similar experiment at Brookhaven collected data between 1998 and 2001. The margin of error on that experiment provided evidence for—but not definitive proof of—a departure from the expected value of the muons' wobble. That's where the Fermilab Muon g-2 experiment will come in, conducting a next-generation experiment with much greater precision.

A concept drawing of Fermilab's new muon campus, including new buildings to house the Muon g-2 (right) and Mu2e (left) experiments.

What are muons?

Muons are subatomic particles similar to electrons, but 207 times heavier.

They carry the same electrical charge (negative) as an electron.

They exist for only about 2.2 millionths of a second.

They are very easy to make and store at Fermilab.

When placed in a magnetic field, they spin like a gyroscope, and it is this property that the Muon g-2 experiment will measure.

Scientists stand inside the 50-foot-wide muon storage ring at Brookhaven National Laboratory in New York.

The machine

The centerpiece of the Muon g-2 experiment is a particle storage ring made of steel, aluminum and superconducting wire. It measures 50 feet in diameter, and was built at Brookhaven in New York, where it was the heart of the 1990s experiment.

Fermilab has the ability to generate more muons than any other accelerator complex in the United States, and only needed the Brookhaven machine to store and study those muons. Since it is 10 times cheaper to move the existing magnetic ring than it is to build a new one, researchers transported the ring by specially prepared barge and truck from the east coast to Fermilab in summer 2013. The 3,200-mile journey took just over a month to complete. (See the back of this sheet for more.)

Researchers plan to install the massive ring in the laboratory's new muon campus, which begins construction in 2013. The Muon g-2 experiment will begin taking data in 2016.

More information

Muon g-2 project website:
gm2.fnal.gov

If you have questions about this project, please contact:
Fermilab Office of Communication, 630-840-3351.
Or send email to Fermilab@fnal.gov.