Fermilab and LHC: A Major Stakeholder

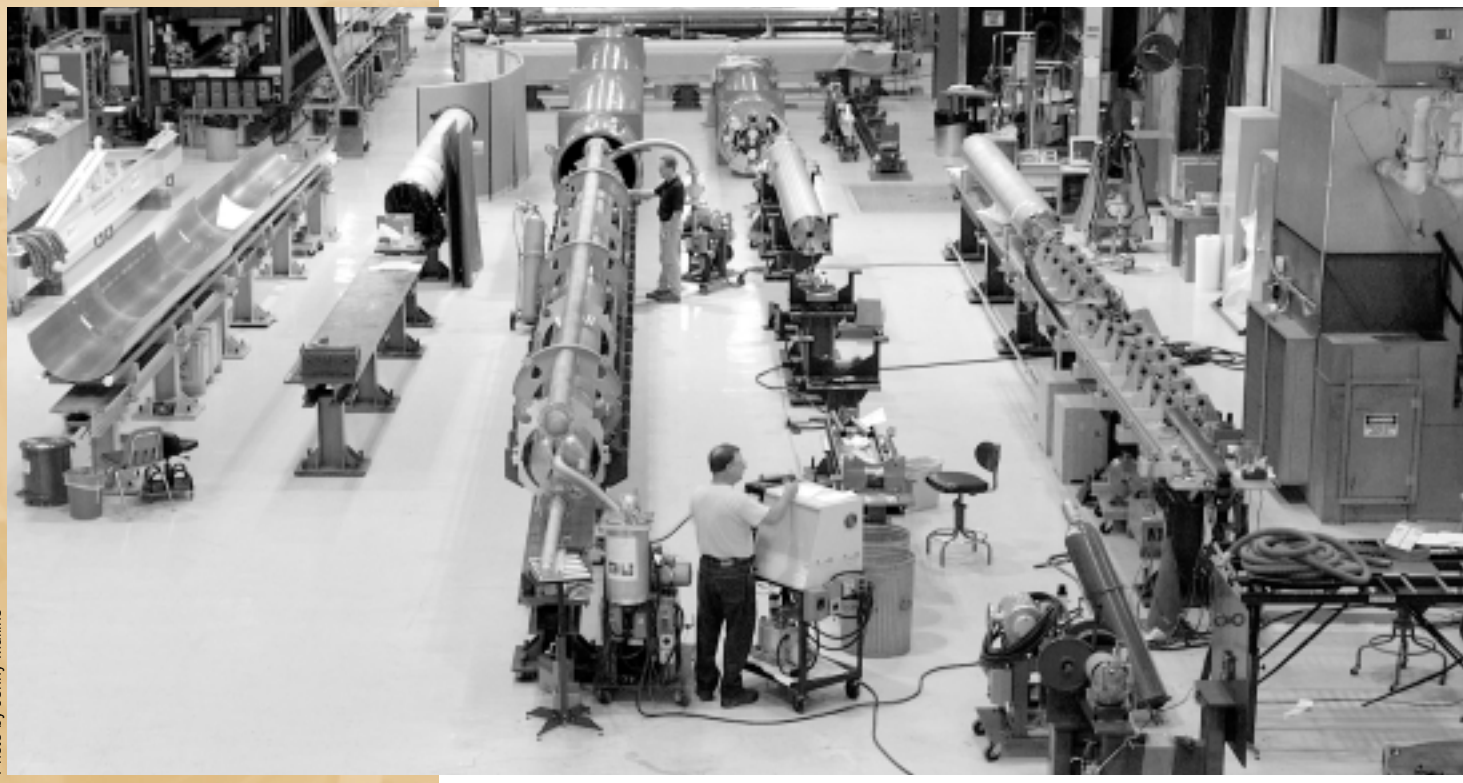


Photo by Jenny Mullins

The magnet test area at Fermilab with the first quadrupole-corrector magnet assembly, consisting of two Fermilab quadrupoles and a CERN correction coil. Denny Gaw (foreground) and Jan Szal perform a leak check before the assembly is inserted into its cryostat vessel.

by Jim Strait
Project Manager, US LHC Accelerator Project

The United States has a $531 million commitment to provide accelerator and detector components for the Large Hadron Collider, which is under construction at CERN, the European Particle Physics Laboratory in Geneva, Switzerland, and which will begin operations later this decade. With a major role in construction of the LHC accelerator and the CMS detector, Fermilab will be positioned for a major role in the emergent physics when LHC begins operating later this decade.

The US LHC Accelerator Project is led by Fermilab and executed by three U.S. national laboratories: Fermilab, Brookhaven National Laboratory (BNL) and Lawrence Berkeley National Laboratory (LBNL). The project focuses on the four interaction regions (IRs) and the radio-frequency straight section of the LHC Accelerator, testing of superconducting cable for the main LHC magnets, and accelerator physics calculations. Fermilab, in collaboration with LBNL and BNL, is responsible for providing CERN with integrated inner triplet magnet systems for the IRs, which focus and bring the two proton beams into collision at the interaction points.

ON THE WEB:

The US LHC Collaboration
www-td.fnal.gov/LHC/USLHC.html

The LHC Project
lhc.web.cern.ch/lhc/general/gen_info.htm

The inner triplet systems consist of high-gradient quadrupoles provided both by Fermilab and KEK, the High Energy Accelerator Research Organization in Japan, correction coils provided by CERN, dipole magnets provided by BNL, cryogenic feedboxes provided by LBNL, and absorbers provided by LBNL to protect the superconducting magnets from collision debris. In addition to building half of the quadrupoles, Fermilab is responsible for the integration of the Fermilab-, KEK- and CERN-provided magnets into three different types of quadrupole-corrector assemblies, insertion of these into cryostats, and the final measurements and tests of these assemblies.

The superconducting quadrupole magnets, which provide final focusing of the LHC beams at the interaction points, are among the most challenging components of the machine. They must provide a field gradient of up to 215 Tesla/meter over a 70 mm aperture. They operate at 1.9 K, under heavy heat load due to secondary particles from beam-beam collisions. The LHC performance depends critically on their field quality. Following an intensive R&D program, in which nine model magnets and one full-scale prototype were built and tested, the inner triplet quadrupoles for the LHC are now in production at Fermilab. Four of the 18 quadrupoles that Fermilab will build are complete and two more are in production. The first KEK- and CERN-provided magnets have arrived at Fermilab.

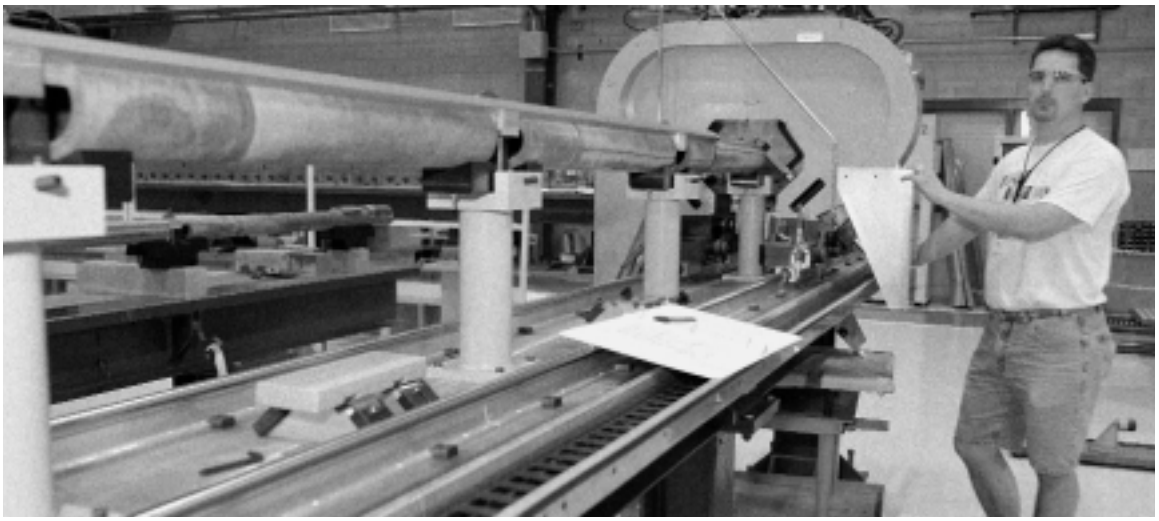
The first quadrupole-corrector assembly, consisting of two Fermilab quadrupoles with a CERN correction coil, is being readied for insertion into its cryostat and will be tested by the end of the summer. Production and testing of the quadrupoles will continue for the next two and one-half years, and all inner triplet quadrupoles will be delivered to CERN for installation in LHC by the end of 2004. The US LHC Accelerator Project is more than 75 percent complete and is proceeding on schedule.

The development, construction and testing of these very challenging magnets for LHC helps to ensure that Fermilab and the US High Energy Physics program remain at the cutting edge of superconducting magnet technology. Our work with CERN (and KEK) on the construction of the LHC accelerator is an important step forward in international collaboration in large science projects, which will be crucial for the construction of future large accelerator facilities.

We are now preparing to extend this collaboration into the commissioning and operational periods of the LHC and are beginning work with CERN to increase the luminosity of the LHC in order to extend its scientific reach. The US LHC Accelerator Research Program, which will be carried out by the same three US national laboratories under Fermilab's leadership, will focus on the commissioning of the LHC, accelerator physics experiments and calculations, R&D for quadrupoles of even higher performance than those now under construction for the inner triplet systems, and the development of advanced beam instrumentation and diagnostics.

The US LHC Accelerator Research Program will further develop the US laboratories' capabilities, so that the US can be the leader in the next generation of hadron colliders; it will serve as a vehicle for US accelerator specialists to pursue their research; and it will train future generations of physicists on some of the most advanced problems in accelerator physics.

Using a stretched-wire field measurement system, Steve Gould verifies the magnetic alignment of a quadrupole magnet.



Photos by Reidar Hahn

To steer particles moving at nearly the speed of light, physicists rely on magnets manufactured with extreme precision. Here Fermilab technician Wayne Schewe measures the size of a magnet coil to few-micron accuracy.