MINOS Neutrino Experiment Launched

March 4 2005

Scientists are working to solve a 50-year-old question: Can neutrinos – a particle that is relatively massless, has no electric charge yet is fundamental to the make-up of the universe – transform from one type to another?
Officials at the Department of Energy's Fermi National Accelerator Laboratory today dedicated the MINOS experiment and the beam that will send subatomic particles called neutrinos from Fermilab, near Chicago, to a particle detector in Minnesota. The Honorable J. Dennis Hastert Jr., Speaker of the U.S. House of Representatives, and Dr. Raymond L. Orbach, Director of the DOE Office of Science, officially inaugurated the Main Injector Neutrino Oscillation Search (MINOS) experiment. The Speaker unveiled the beam to send the first pulses of neutrinos on a path through the earth from Fermilab to a detector located 450 miles away, a half-mile underground in the historic Soudan iron mine in northeastern of Minnesota.

"With the MINOS experiment, Fermilab again demonstrates its position as the world's premier facility to conduct particle physics research," Rep. Hastert said. "With the new knowledge it generates on neutrinos, Fermilab will expand the frontiers of understanding about our universe and the way it works, and build on a reputation established over 30 years of outstanding science and discovery."

Scientists will seek to discover how neutrinos "change flavors." Neutrinos come in three "flavors:" electron, muon and tau. Each is related to a charged particle, which gives the corresponding neutrino its name. Neutrinos are extremely difficult to detect because they rarely

interact with anything. Though they can easily pass through a planet, solid walls and even a human hand, they rarely leave a trace of their existence.

The Neutrinos at the Main Injector (NuMI) project, with the MINOS experiment, includes over 200 scientists, engineers, technical specialists and students from 32 institutions in 6 countries, including Brazil, France, Greece, Russia, the United Kingdom and the United States. The institutions include universities and national laboratories. The U.S. Department of Energy provides the major share of the funding, with additional funding from the U.S. National Science Foundation and from the United Kingdom's Particle Physics and Astronomy Research Council.

"Fermilab's MINOS experiment is the newest and most powerful tool in investigating the properties of the neutrino," said Secretary of Energy Samuel W. Bodman. "This research may lead to new insights into the early history and evolution of the universe. We eagerly look forward to the new knowledge generated by the MINOS experiment."

The MINOS experiment will use a neutrino beam produced at Fermilab's Main Injector accelerator to probe the secrets of these elusive subatomic particles: where do they come from, what are their masses and how do they change from one kind to another? In Minnesota, a 6,000-ton particle detector will search for neutrinos that may have changed from one kind to another during the 2.5-millisecond trip. Trillions of lab-created neutrinos will pass through the MINOS detector each year. But because neutrinos interact so rarely, only about 1,500 of them each year will collide with atoms inside the detector. The rest pass right through with no effect. MINOS scientists will use the change from one type of neutrino to another as the key to discovering neutrinos' secrets.

"In time, the MINOS project will be viewed as a landmark event in the

history of physics. This world-class research is a bold, visionary initiative which will have profound implications for our understanding of the structure and evolution of the universe," said Congressman James L. Oberstar, whose Minnesota district includes the Soudan site. "The billion-year-old rock formations in the Soudan Underground mine, which is located in my congressional district, have provided some of the world's richest iron ore. Now the mine may help unlock mysteries about the origins of the universe. I congratulate Dr. Earl Peterson, Director of the Soudan Underground Laboratory; the University of Minnesota; Fermilab, and the U.S. Department of Energy for being at the forefront of scientific research and discovery."

Generating the neutrinos destined for Minnesota required building a beamline housed underground at Fermilab. The beamline is a 4,000-foot tunnel, whose direction, roughly north and slightly down, points from Fermilab to Soudan. The beamline tunnel holds the components which generate the neutrinos from protons accelerated by Fermilab's Main Injector. Then comes the MINOS Hall, a 120-foot-long cavern located 350 feet below the surface of the lab campus, with access by an elevator traveling the equivalent of a 30-story building. The MINOS Hall holds the near detector, a smaller version of the MINOS detector at Soudan, which is used to measure the properties of the neutrinos at the start of their trip to northern Minnesota.

"Physicists from around the world are trying to understand what these mysterious neutrinos are telling us," said Fermilab director Michael Witherell. "Today, we are embarking on a journey of exploration using the most powerful neutrino facility in the world. I am extremely proud of what the people of Fermilab have accomplished in completing the NuMI project. I would like to thank the American people and the federal government for making the necessary commitment to support great science."

Prof. Ian Halliday, CEO of the UK's Particle Physics and Astronomy Research Council, anticipates the revelations from the experiment's precision measurements.

"The mysteries of the elusive neutrino are about to be unveiled," Halliday said. "For the very first time we will be able to investigate the changing state of this bizarre particle to an unprecedented accuracy of a few percent in a controlled beam of neutrinos created in the laboratory. I'm extremely proud that UK scientists have played a key role in bringing this experiment to fruition and, in collaboration with their international colleagues, will be amongst the first in the world to study its unique characteristics."

The MINOS far detector is located in the Soudan Underground Mine State Park, operated by the Minnesota Department of Natural Resources. As the first iron mine in Minnesota, the Soudan mine is a registered national historic site. Market forces brought operations to a close in 1962. Before expansion to allow for the MINOS detector and the Fermilab Cryogenic Dark Matter Search experiment, the Soudan underground laboratory was home to the Soudan 2 detector experiment, searching for decays of protons, the charged components of the atomic nucleus. Park staff now provide public tours underground for 30,000 to 40,000 visitors annually, viewing both the mine area and MINOS detector hall in the underground laboratory. An added attraction is a 60-foot mural, painted on the wall of the cavern by Minneapolis artist Joe Giannetti.

Michael Turner, the National Science Foundation's Assistant Director for Mathematics and the Physical Sciences, believes the neutrinos' infinitesimal mass belies their significant and ubiquitous impact.

"Neutrinos are always referred to as ghostly particles, as if they are of little interest and have to be apologized for," Turner said. "Nothing could

be further from the truth. Neutrinos account for as much of the mass of the universe as do stars, they play a crucial role in the production of the chemical elements in the explosions of stars, and they may well explain the origin of the neutrons, protons and electrons that are the building blocks of all the atoms in the universe. MINOS will help us better understand how neutrinos shaped the universe we live in."

Source: Fermi National Accelerator Laboratory and Lawrence Livermore National Laboratory