Physics = economic vitality

Leading-edge research means a big boost to northeastern Minnesota's economy.

Today's physics is about more than Newton's laws of gravity or Einstein's theory of relativity. Scientists are searching for information about the most basic particles of nature, which may provide clues to how the universe was created.

Some of the most advanced research takes place right here. The Soudan Underground Lab in Soudan, Minn., is a particle physics laboratory developed by the University of Minnesota physics department. The facility is located within the Soudan Underground State Park and is one of only 10 underground physics research labs in the world.

Soudan-2, the lab's first project, was constructed in the mid-1980s to try to detect a very rare event called proton decay, in which the proton of an atom releases most of its energy and becomes another sub-atomic particle. Although proton decay was never detected at the lab – or anywhere else in the world – data from the proton decay project led scientists to study neutrinos and develop the MINOS detector in use at the lab today.

Why do they do it?

The question visitors to the Soudan Underground Laboratory ask most often is...Why?

Why are scientists working on these projects? Why are these projects important? How will these projects make my life – or the lives of people in general – better?

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One of the most important differences between the projects at the lab and other types of scientific projects is that MINOS and CDMS II are what scientists call "basic research." The purpose of basic research is to help scientists understand how something works. MINOS and CDMS II are helping scientists understand how the universe works.

Because scientists who do basic research are trying to learn how something works, basic research projects are not usually focused on a certain result, such as better medicine or new machines. This does not mean, however, that basic research does not produce results. Projects like MINOS and CDMS II help train the next generation of scientists, engineers and doctors – some of whom may go on to make important inventions or discoveries.

In addition, the understanding scientists have gained from projects done years ago form the foundation of many of today's most advanced technologies. Magnetic resonance imaging, new cancer therapy, faster computers, and the World Wide Web (or internet) all can trace their roots to particle physics projects.

Only time will tell how scientists' work at the Soudan Underground Laboratory on MINOS or CDMS II projects, or any other basic research on particle physics, may play an important role in helping future generations lead healthier, more efficient and productive lives.

Local long-term benefits

The lab will inject $24 million into the local economy:

Project	Annual operating cost	Yrs. of op'n.	Total impact
SOUDAN-2	$450,000	1987-2000	$6.3 million
MINOS			
• pre-construction	$375,000	1998-1999	$0.8 million
• construction	$3.3 million	1999-2000	$6.9 million
• installation	$1.3 million	2001-2003	$3.9 million
• standard operations	$900,000	2004-2009	$4.5 million
• visiting scientists	$25,000	1987-2009	$0.5 million
CDMS II	$225,000	1999-2005	$1.14 million
TOTAL		**1987-2009**	**$24.0 million**

- Lab staff was increased from 6 to 32 full-time positions at peak installation.
- 10 -25 skilled construction workers and local contractors were hired during MINOS cavern excavation and outfitting.
- The state park has added 6 permanent positions since lab opened
- On a typical day, 15 visiting physicists from around the world are working at the Soudan Underground Laboratory.

To learn more...

For more information about the Soudan Underground Laboratory, visit any of the following web sites:

http://www.soudan.umn.edu
Soudan Underground Lab site

http://www-numi.fnal.gov
MINOS/NuMI web site

http://www.fnal.gov
Fermilab web site

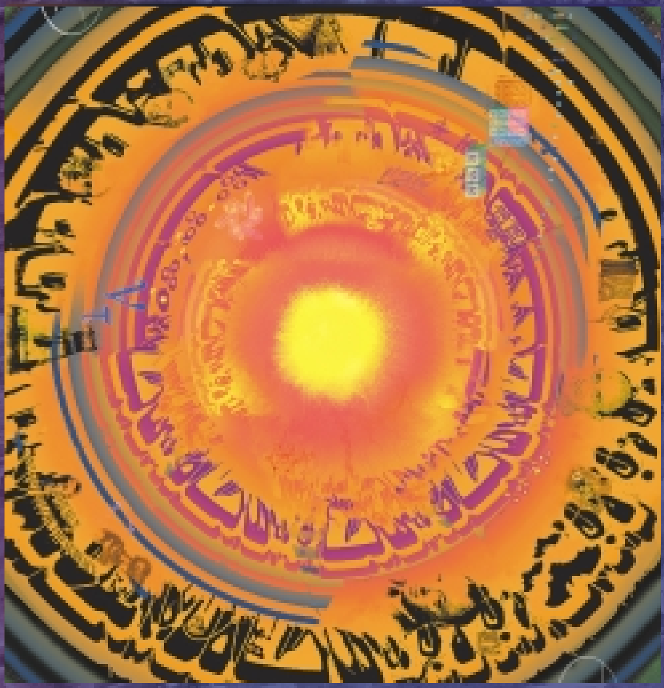
http://cdms.berkeley.edu/
CDMS II web site

Soudan Underground State Park
Contact Info:
(218) 753-2245 voice
(218) 753-2246 fax
http://www.dnr.state.mn.us
soudanmine@dnr.state.mn.us

For more information about other economic development projects and opportunities in northeastern Minnesota, contact:

Jack LaVoy
IRRB
Highway 53 South
Eveleth, MN 55734
Phone: 218-744-7400

Discover
a new Range of science

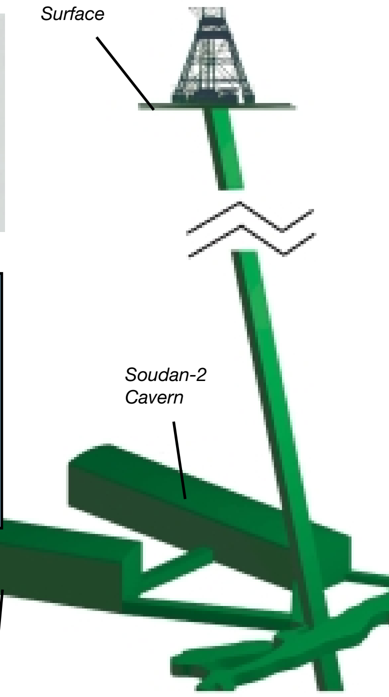


Mural by Joseph Giammetti

Physics research at the Soudan Underground Laboratory located at the Soudan Underground Mine State Park

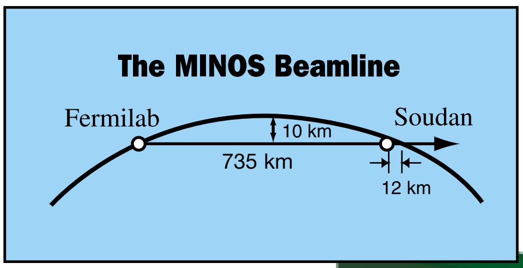
The high-tech study of elementary particles

Physicists and engineers at the Soudan Underground Lab have built the most advanced instruments available to study elementary particles, the smallest known particles of the universe. MINOS and CDMS II, the two projects at the lab, are designed to study neutrinos and dark matter, which are very small and hard to see. Both could help scientists unlock some of today's biggest questions about how the universe works.



A half-mile below the surface, local contractors have built a second, larger cavern to house the MINOS project.

MINOS
(Main Injector Neutrino Oscillation Search)



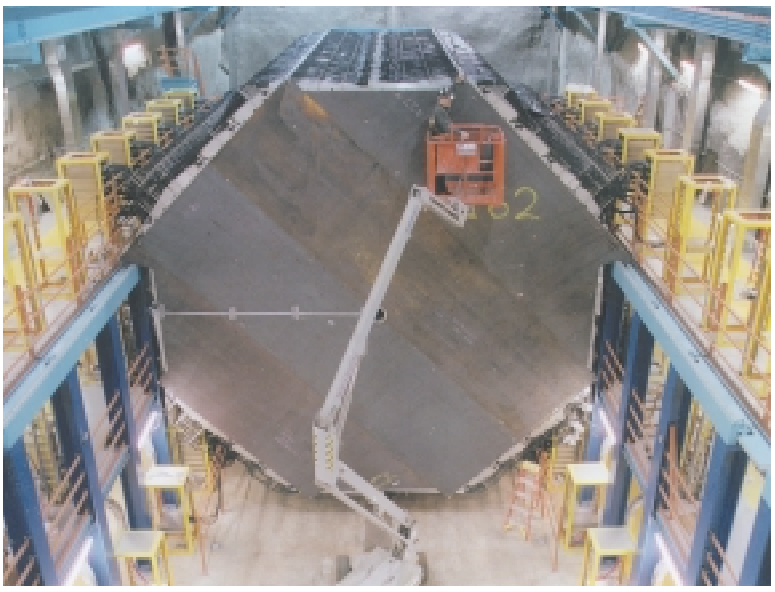
This $46 million project is a partnership between the University of Minnesota (U of M), 30 other institutions and Fermilab, a national physics lab run by the U.S. Department of Energy.

Scientists are trying to verify whether neutrinos – one of the least understood elementary particles – have mass. If they do, they could account for a small fraction of the mass in the universe.

Scientists will try to measure a neutrino's mass not by weighing it, but by observing whether neutrino oscillations occur over long distances.

In the MINOS experiment, Fermilab's new Main Injector, a special particle accelerator located near Chicago, will send a beam of muon neutrinos 450 miles (735 kilometers) through the ground to the Soudan lab, a trip that will take .0025 seconds.

At the lab, the beam will pass through 2 detector units called supermodules. Each unit will weigh 3,000 tons. Inside each unit, 243 steel planes that are approximately 26 feet across and 1 inch thick will alternate with layers of 192 custom-built plastic strips that house fiber-optic cable about the width of fishing line. Light generated by neutrino interactions would travel along the fiber-optic cable to photo-sensitive detectors, then on to computers. Scientists will analyze the patterns of light to see if the muon neutrinos that left Chicago arrive as muon neutrinos or if they change to other types of neutrinos during their journey.



The two supermodules that will detect neutrinos arriving at the lab weigh 6,000 tons, equivalent to a total of about 5,820 Ford Taurus cars. Iron ore for the 486 steel planes inside the detectors comes from Hibbing Taconite.

CDMS II
(Cryogenic Dark Matter Search)

This $16 million project looks for particles called WIMPs: Weakly-Interacting Massive Particles.

Like neutrinos, WIMPs easily pass through ordinary matter and are difficult to detect. CDMS II searches for WIMPs that were produced in particle collisions that took place during the hot conditions of the early universe, just moments after the Big Bang.

Scientists think WIMPs could be one type of the so-called "dark matter" that makes up most of the matter in the universe today. Based on astronomical evidence from observations of stars and galaxies, these scientists think most of the "dark matter" in the universe cannot be seen directly in telescopes. Instead, it must be observed indirectly through its gravitational pull on objects we can see.

Detecting WIMPs is challenging not only because their interactions between each other and with other objects are weak, but also because they only move at 1/1,000th of the speed of light. In comparison, the neutrinos produced at Fermilab's particle accelerator for the MINOS project move at speeds very close to the speed of light.

Because WIMPs move so slowly, scientists use devices that detect extremely small amounts of energy to detect them. These devices are called "cryogenic" detectors because they are very cold and must be operated in refrigerators cooled with liquid helium, like the one installed in the Soudan Underground Lab. When complete, CDMS II will consist of 7 stacks of 6 detectors made from germanium and silicon, housed in a copper holder.

Although its detector is small compared to MINOS, CDMS II is a complex experiment that requires the expertise of many research groups that work together. Groups from all over the United States come to Soudan to take advantage of the unique conditions available in the mine.

The headframe that caps the mine shaft is one of the most distinctive features of the Soudan Underground Mine State Park – home to Minnesota's oldest and deepest iron mining site.

Soudan Underground Mine State Park

Rock is what makes northeastern Minnesota an ideal location for particle physics reasearch. The 3.6 billion year-old greenstone in the region emits virtually no radioactive particles that could interfere with the experiments. The dense rock also shields the lab from cosmic rays and other high-energy interference that is common at the Earth's surface.

The Soudan Underground Mine State Park – a registered National Historic Landmark – is where Minnesota iron mining began in 1883. More than 17 million tons of iron were removed from the Soudan Mine during its 78 years of operation. Since 1965, the Minnesota Department of Natural Resources has preserved and operated the mine as a state park open to the public. So far, more than 1 million visitors have experienced the mine's underground environment firsthand.

By preserving the mine, the park was able to provide a site for the U of M's physics experiments in a safe underground facility. This unique partnership between the DNR and the U of M creates opportunities for physicists from around the world to work in the Soudan Underground Lab, while the park preserves the unique features and facilities of this National Historical Landmark.

Tours of the historic mine and the Soudan Underground Lab are conducted from Memorial Day weekend through the end of September, and by special arrangement for groups in the off-season.