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Elusive subatomic particle captured

By **Joseph B. Verrengia**

Associated Press

After a two-decade search, scientists have found the first direct evidence of one of the most elusive and ghostly subatomic particles in nature -- the tau neutrino.

The breakthrough, announced on Thursday, was achieved by scientists at the Fermi National Accelerator Laboratory outside Chicago.

It wasn't clear Thursday how the breakthrough would affect a planned \$146 million search for neutrino mass involving the Soudan (Minn.) Underground Mine State Park scheduled to begin in 2002.

University of Minnesota researchers planned to seek the elusive neutrino by beaming subatomic particles underground from the Fermi lab to Soudan.

The tau is one of the fundamental building blocks of all matter. It is the last of the impossibly tiny particles described in the Standard Model of Particle Physics to be confirmed in experiments.

"It's a tremendous milestone," said Stanford University physicist and Nobel Prize winner Martin Perl of the tau's discovery. Perl theorized the existence of the tau neutrino in 1978. "Now it has been seen, and it behaves in the way we expected," he said.

Neutrinos are hurtling everywhere and all the time at the speed of light. Trillions pass through all of us every second. Yet they are among the shiest of all subatomic particles, carrying no electrical charge and virtually no mass -- perhaps one-millionth that of an electron.

Fifty-four scientists from the United States, Japan, Korea and Greece collaborated on tracking down tau neutrinos since 1997 at the Fermilab.

"We finally have direct evidence that the tau neutrino is one of the





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...many have great hopes that the tau neutrino is one of the building blocks of nature," said Byron Lundberg, a physicist and spokesman for the international team. "It is one thing to think there are tau neutrinos out there. But it is a hard experiment to do."

The tau neutrino is the third and perhaps final type of neutrino to be found. The first two types -- electron neutrinos and muon neutrinos -- were discovered in 1956 and 1962.

In 1978, tests by Perl and others at Stanford discovered the existence of another class of subatomic particle, the tau lepton. This suggested there would be a tau neutrino, too, because neutrinos are precursors to leptons.

Finding the tau neutrino was more difficult.

In 1997, scientists using the ring-shaped particle accelerator at Fermilab fired an intense neutrino beam into a 50-foot detector composed of iron plates coated with an emulsion. Then the scientists analyzed the 6 millions impressions left on the coating.

The researchers used computer-assisted video cameras to create 3-D images of the particle tracks. They narrowed down the field and found four clear tracks of a tau lepton that scientists say were caused by tau neutrino collisions.

"Because neutrinos have no charge, you can never detect them directly," Perl said. "Tau neutrinos make tau leptons, which decay very quickly. Their signature is what you detect."

The findings are being prepared for publication in a scientific journal.

The tau's discovery could affect planned research in the abandoned Soudan mine, which houses a particle research facility operated by several institutions, including the University of Minnesota, Oxford University in Cambridge, England, and the Argonne National Laboratory in Illinois.

Those institutions were among the nearly 200 physicists from 16 other research universities investigating the neutrino through the Fermi labs.

The 2002 Soudan experiment, led by U of M researchers, would beam almost pure streams of muon neutrinos through a half-mile-long steel pipe from the Fermilab toward Soudan at the speed of light. Since neutrinos have little, if any mass, they pass easily through the 445 miles of dirt and rock between Chicago and the mine.

Inside the mine, neutrinos would hit a 6,000-ton steel barrier resembling a set of 550 giant office hanging folders, then bounce off plastic sheets sandwiched between the steel.

If the muons transformed into taus, they would show up on the plastic sheets.

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