Universe

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nomical phenomena that gave them birth.

Now, in the same way that UW-Madison biologists have staked their claim to the science of human embryonic stem cells, physicists here have cornered the market on the study of the enigmatic neutrino.

They've done it by turning the crystalline ice beneath the South Pole into a massive neutrino detector, burying glass-globed sensors the size of basketballs on 1½-mile-long strings, 60 sensors per string, in 80 deep holes beneath the polar surface.

Dubbed "IceCube," the $270 million international effort (more than 20 collaborators are working with UW-Madison) is currently less a science experiment than the coldest and most demanding construction project in the world.

But even though it is still about four years from completion, the neutrino detector is already causing a buzz in the world of particle physics and of science in general.

This month, the project made the cover of the journal Science, a spot reserved for the world's most select scientific endeavors. Francis Halzen, a UW-Madison physicist and director of IceCube, wrote an update of work on the project for the magazine.

Halzen, who just returned to Madison from teaching in Spain, said he is very pleased with the progress made on IceCube this season.

Workers, he said, have installed eight of the detector strings in their 1½-mile holes and hope to have buried a total of 12 strings by the end of January, the end of the Antarctic summer and the construction season at the Pole.

That would bring the total number of strings to 22, about a quarter of the total.

"It's going very well," Halzen said of the work. "And this is such a delicate operation. You always live on the edge with this project. It's like driving a race car; you never know when you're going to go off the road."

Light signatures

While most attention has been focused on construction of the ice-bound detector, the instrument is already capturing the ghostly light trails of traveling neutrinos, according to Halzen. The detectors don't actually see the passing neutrinos.

Instead, they see particles called muons that are flung from the neutrino's collision with an atom within the ice. The movement of the muons away from the collision leaves patterns of light and that light holds the clues sought by the researchers.

The data from those light signatures — the very beginnings of a library of information from distant space — is stored right here in Madison, in a bank of air-conditioned computers at the IceCube offices at 222 W. Washington Ave. How that data gets there speaks to the scale of the science being done.

Halzen said the information already being collected from the working detectors deep beneath the Pole is fed to a computer laboratory that is nearing completion atop the ice. During an eight-hour window each day, that data is uploaded to an old military satellite that the researchers converted to their use. From the satellite, the data is beamed to a ground station in Mexico and from there to the computers in Madison.

This early data is reassuring to Halzen and the other scientists who have staked reputations on the project.

It shows that the detector works, for one thing. And it also allows the scientists to calibrate the instrument, to learn how to read and interpret these messages from outer space.

As the detector begins to do what it was meant to do, it also means the scientists involved in the project, including many particle physicists such as Halzen, can begin to think less about construction woes and more about the space science that is ahead.

Cold, isolated work

Whether it is a traditional telescope or a giant, land-based collider, such large-scale instruments require patience because it takes so many years to build them — and so many years of fretting over budgets and work crews instead of actually doing science.

"It's really difficult," Halzen said. "Right now, I'm sitting at my computer looking at drill data. I'm not thinking about the universe."

It has been frustrating, also, for Robert Paulos, who is the project manager and is overseeing many of the nuts-and-bolts details of construction.

He just returned from the Pole where his concerns had less to do with black holes than with overseeing crews that were dragging the drilling rig over the frozen landscape.

The work being done at the Pole would be difficult even if it were undertaken on a continent with more normal conditions.

But at the IceCube construction site, workers have to deal with deadly cold and isolation, in addition to all the challenges of a major construction job.

To imagine what they're doing, think about an ice-fisherman dragging his augur out onto Lake Mendota during a blizzard.

But replace the augur with a giant drill that pumps 200 gallons per minute of 190-degree water under 1,000 pounds per square inch of pressure to bore a hole 1½-miles into the ice. Now add in temperatures that can drop to 35- or 40-below zero in an instant.

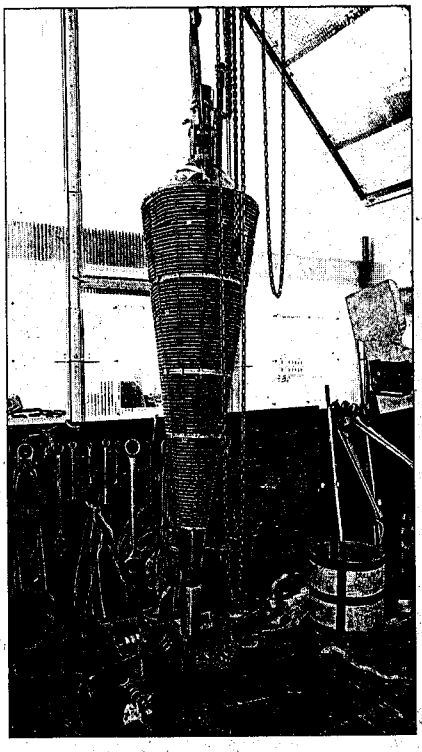
No matter, the work has to get done, Paulos said.

"If it's minus-25 and windy, too bad," Paulos said. "We're moving hose that day."

On the rare day off, Paulos added, crew members are generally so tired that they do laundry and sleep.

Still, every once in a while, Paulos added, he pauses to realize where he is — in a place that has only been visited through all of history by fewer than 200,000 people. And he remembers what he is doing — building one of the most fascinating instruments science has ever concocted.

And he says to himself, "Oh, yeah, I'm here where the sun is always up and I'm going to work. On a snowmobile."



UW-Madison

A specialized hot water drill, created here at UW-Madison, bores the deep holes into which the strings of detectors are lowered. This is the drill head, known as a firn drill, that workers use to melt through snow near the surface. A different drill head is used to work through the deeper ice.

Neutrino trivia

A few fun facts about the IceCube neutrino project and Antarctica:

- It takes 4,800 gallons of jet fuel to drill each of the 1½-mile deep holes in which the IceCube detectors are buried.
- The amount of ice melted per hole is about 200,000 gallons.
- The water for the giant ice drill is heated with 36 converted car wash heaters.
- It takes 48 hours to travel from Los Angeles to the work site at the South Pole.
- Average summer temperature at the South Pole is around -35 degrees Fahrenheit.
- The world's lowest temperature of -128 degrees Fahrenheit was recorded at the Russia Vostok Station in Antarctica.
- The temperature in Antarctica once dropped 65 degrees in 12 minutes.
- There are at least two active volcanoes in Antarctica, one of which has a permanent molten lava lake.
- Dogs have been banned from Antarctica to protect the seal population.
- The center of Antarctica is the largest desert in the world.

Source: UW-Madison