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The Antarctic Sun

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IceCube turns up the heat

Project team to end season with eight new sensor strands complete and 71 more to go

By Steven Profaizer
Sun staff

Construction on the six-year, $272-million IceCube project continues to accelerate. But with nine holes almost complete and 71 remaining, crews know there is a lot of work to be done before the world's largest neutrino telescope is fully operational.

The device will be an array of sensors placed between 1,400 and 2,400 meters beneath the surface of the South Pole. The sensors are called digital optical modules, or DOMs.

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The science behind the construction, page 16
IceTop enhances IceCube from the surface, page 17

Steven Profaizer / *The Antarctic Sun*

Jim Latshaw guides a logger into a newly drilled IceCube hole Jan. 17. The device reports the angle and width of the hole back to the surface.

Ice conditions send penguins packing

By Emily Stone
Sun staff

To the uninitiated, it looks like there are a whole lot of penguins at the Cape Royds Adélie colony. The cacophony of their collective calls sounds something like a car engine turning over. Their pungent scent hits you hard when you get close. The smell corresponds to the ground that has gone from black to a yellowish grey.

But to penguin researcher David Ainley, the group looks tiny. With 1,200 breeding pairs there in mid-January, the colony is only 25 percent its normal size. The colony started the season at about twice that size, but declined through the summer as adults left because their chicks died. A few years ago, there would be 4,000 pairs there to mate and hatch their chicks.

The culprit is 80 kilometers of sea ice between the colony and open water, which the birds must cross in order to feed. Normally, the ocean would be lapping

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Emily Stone / *The Antarctic Sun*

Two penguin chicks stare out from their parent's shelter. The chicks at Cape Royds are not doing well this year because the adults must go so far across the sea ice to get food.

Quote of the Week

"I'm not a trained monkey! I can't just spit out a quote for you."

— Man after being asked for a Quote of the Week submission

INSIDE

Boxing it up

Emily Stone / *The Antarctic Sun*

Bryan Fanning carries boxes to the window of the McMurdo post office on Jan. 28, the last day that residents could mail packages home.
The summer season is drawing to an end, as people begin leaving station and the winter crew arrives for both McMurdo and South Pole. The bulk of the summer workers will leave in mid-February, with the last flight out of McMurdo planned for between Feb. 26 and March 1, just after the sun has set for the first time since October.

Cold, hard facts

Lowdown on the lab

Name: The **Albert P. Crary Science and Engineering Center**, usually called the Crary Lab.

What: McMurdo Station's **main science building**

Named for: Glaciologist **Albert P. Crary**, the first person to set foot on both poles.

Completed: **Nov. 5, 1991**

Cost: **$23 million**

Size: **4,300 square meters**

Cool fact: Crary has an additional reverse osmosis **water purifying system** that makes the water so pure that it can leach the calcium from teeth and bones. Used for experiments — not for drinking.

Source: Barbara Wood, Crary administrative coordinator

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Level 1 Comix **Matt Davidson**

Fuel prices drive need for alternatives

By Peter Rejcek
Sun staff

Consumers in the United States aren't the only ones feeling the pinch of rising fuel prices.

When the transport tanker *Lawrence H. Gianella* arrives at McMurdo Station this month, the 42 million liters of fuel it's carrying will cost the National Science Foundation (NSF) far more than last year.

"In our budget, we anticipated a 50 percent increase in fuel prices," said Erick Chiang, head of the NSF Polar Research Support Section. "We'll pay for it this fiscal year when it comes off the tanker."

That 50 percent hike represents a $9 million hit to the Antarctic program. The total NSF budget request for the 2006 fiscal year is about $5.6 billion, but the Office of Polar Programs, which oversees the Arctic and Antarctic programs, is a small piece of that pie, with about $386 million proposed. Money is tight, so the shortfall caused by higher prices must be recouped in other ways, according to Chiang.

"What it means is that money goes to fuel rather than to facility improvements or new construction," he said.

Ironically, one high-priority project that NSF will try to preserve is the construction of new tanks to double fuel storage at McMurdo Station. Added storage would serve as a contingency should the fuel tanker be unable to reach the station. That's been a problem in recent years thanks to the thick, multi-year ice in McMurdo Sound.

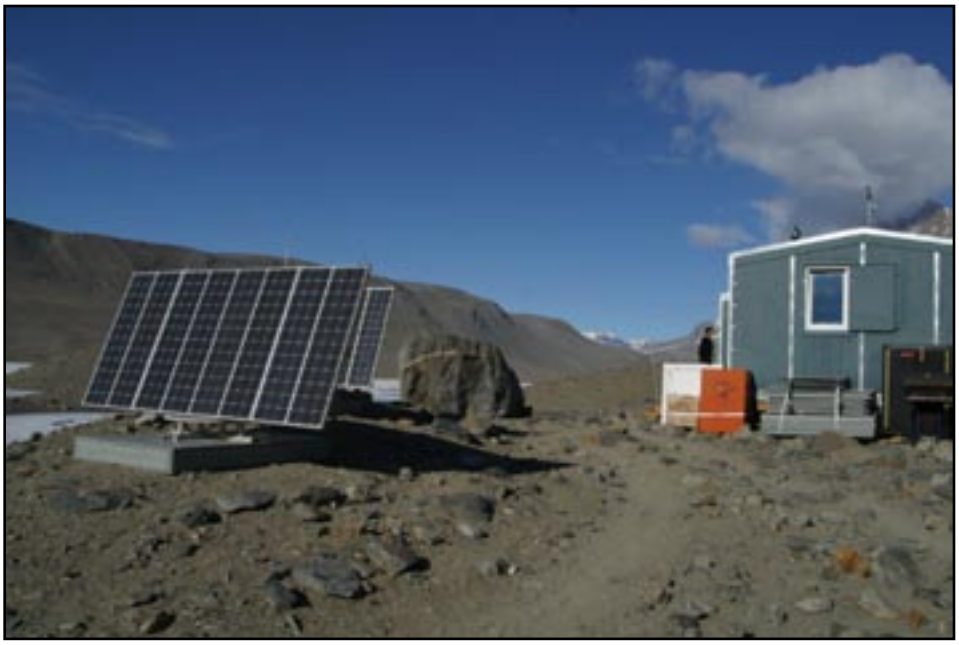
The second phase of construction on the science support center at McMurdo Station is also being pushed back because of financial constraints, Chiang added.

Conservation is one way to make fuel stretch as far as possible. Weaning the program off of fossil fuels and onto renewable energy as much as possible is another prevalent strategy.

> "There's a whole cultural change that we have to bring into the Antarctic ... ideas from around the world."
>
> *— Erick Chiang, NSF Polar Research Support Section head*

For more than a decade, the science support department has been at the forefront of alternative energy. Most, if not all science field camps, use solar panels to turn sunlight into power. Lake Hoare, the crossroads for science groups operating in the McMurdo Dry Valleys, was the first permanent camp to receive a solar panel array, according to Andy Young, manager of science field support for Raytheon Polar Services Co.

These days the diesel generator is rarely used, he said. "We haven't fueled that generator in three years," Young noted.



Peter Rejcek / *The Antarctic Sun*

Photovoltaic cells at the Lake Hoare field camp in the McMurdo Dry Valleys are the primary source for power. Lake Hoare was the first permanent camp to get a solar panel array.

The sun, wind or both now power four other Dry Valleys camps: New Harbor, Lake Bonney, Lake Fryxell and F-6. Another permanent camp at Cape Crozier and temporary camps at Cape Royds and Penguin Ranch on the sea ice also have solar or wind power to supplement fuel-powered generators. A hybrid power system that combines wind turbines and photovoltaic cells, backed up by diesel generators, has powered telecommunications equipment on Black Island for years.

Chiang said the goal, if feasible, is to have all field camps free of fossil fuels. He also set goals of a 10 percent reduction in fossil fuel use at both McMurdo and South Pole stations. He said South Pole would be more challenging, particularly this year, as construction continues on the new station. And while the buildings under the Dome are scheduled to go cold this winter and the new elevated station is more efficient, its sheer size will require more fuel to heat and power.

The Dome, completed in 1975, was originally designed to house 33 people (eventually 40 with the addition of the annex), while the new station will hold 154, he said.

"The total fuel we're going to use at Pole is greater," Chiang said.

Wind may prove to be stronger than the sun when it comes to a long-term solution for supplementing power at all three U.S. Antarctic Program stations. Peter Somers, Raytheon energy engineer, said one of the ideas is to purchase wind turbines for McMurdo, South Pole and Palmer stations.

The idea would be to install ten 100-kilowatt turbines at McMurdo and another 10 at South Pole, according to Somers.

The turbine rotors are about 19 meters in diameter, and would sit on towers about 25 meters tall, Somers said. The rotors at Pole could be slightly longer because the maximum wind speed is less there than at McMurdo, he added.

Somers said the wind power proposal is only one of about 400 projects being considered to help improve energy efficiency and move away from fossil fuels. A lot of the work is not necessarily high profile, like the installation of motion sensors on lights or putting meters on buildings to track electrical use.

"If you can't monitor it, you can't manage it," Somers said.

Chiang said the challenge to conserve energy in the program is really a reflection of what's going on in the United States. The European model of conservation that emphasizes more efficient appliances and equipment is one that will eventually need to be adopted.

"There's a whole cultural change that we have to bring into the Antarctic ... ideas from around the world," he said.

Ship Shape Vessels help keep Antarctic program afloat

Layout by
Peter Rejcek


RV Laurence M. Gould

Kurtis Burmeister / Special to *The Antarctic Sun*


RV Nathaniel B. Palmer

Al Hickey / Special to *The Antarctic Sun*


MV American Tern

Kristan Hutchison / *The Antarctic Sun*

Ships currently supporting USAP

STATS	*Gould*	*Palmer*	*Krasin*	*Polar Star*	*Gianella*	*Tern*
Type	Research	Research	Icebreaker	Icebreaker	Tanker	Cargo
Length	70.2m	93.9m	134.8m	121.6m	187.5m	158.8m
Year Built	1997	1992	1976	1976*	1986*	1990
A key feature to note	Supplies Palmer Station.	Capable of breaking ice.	Flies the Russian flag.	Breaks two meters of ice at three knots.	Can carry 237,766 barrels of oil fuel.	Carries 655 milvans on main deck.

** First year of service.*
Sources: U.S. Antarctic Program, U.S. Coast Guard and U.S. Navy Web sites.


Krasin

Peter Rejcek / *The Antarctic Sun*


MV Lawrence N. Gianella

Kris Kuenning / *The Antarctic Sun*


USCGC Polar Star

Kristan Hutchison / *The Antarctic Sun*

around the continent

PALMER

Ship visits

By Kerry Kells
Palmer Correspondent

Last week, Palmer Station hosted three yachts and two cruise ships with one offshore lecture. The beautifully designed yacht *Onora* rested in Hero inlet, and the impressive, three-masted Canadian schooner the *Sedna IV* anchored in Arthur Harbor. The yacht *Spirit of Sydney* also stopped by, and its Swiss and Australian passengers got a tour of station.

The *Onora* is a 19-meter cutter captained by Jim and Jean Foley of Chicago. They started in New Zealand and sailed across the South Pacific to Chile, then across the Drake Passage to King George Island and the South Shetland Islands. They spent New Year's at Bellinghausen, the Russian Station, and have visited two Chilean stations and one British station.

The *Sedna IV* yacht, a 51-meter, three-masted, steel-hulled sailing schooner, was constructed as a North Sea trawler in 1957, according to its Web site. The yacht was completely rebuilt in 1992 in Germany and acquired in 2001 by a group of Canadians. Now the yacht is "a seagoing studio," according to the Web site.

A Canadian film crew is sailing on the *Sedna IV*, with mission leader and producer/director Jean LeMire and director Caroline Underwood. Onboard are ship staff and engineers, as well as scientists, cinematographers and editors. They hope to publicize and educate with their environmental documentaries.

Their journey to the Antarctic follows a trip to film a documentary in the Arctic. They will join several Palmer science groups in their field studies to showcase the "Antarctic Mission," which will be broadcast in several countries, including on the Discovery channel in the United States. Some of the crew will spend the winter at Argentina's Melchior Station.

The team showed short film clips of the king penguin colony on South Georgia Island, and the albatross and fur seals on Bird Island. After that, scientist Pascale Otis, an animal physiologist, gave a presentation on her research: "Cold Adaptations in Birds," with a focus on "Staying Warm vs. Saving Energy."

She concentrated on snow geese and Canada geese and their goslings, studying how much energy they expend in Arctic conditions. Her research required studying the same goslings over time, and the birds became imprinted on her and her colleagues, believing that the humans were their parents.

In further research, she studied the geese's feet to determine how the birds avoid frostbite. She found that geese can alternate blood flow to one leg, then the other and change their rate of heat loss.

She also wanted to know why their skin tissues do not freeze at such low temperatures. She discovered that there is an antifreeze protein in the webbed skin of their feet, and that penguins also have high concentrations of antifreeze protein in their feet. She explained that there are many types of this antifreeze protein. While Arctic birds have the protein in the winter, penguins are likely to have the protein year-round. With infrared surface measurements, she found that the penguins could regulate one foot at 31 degrees Celsius and the other foot at 9.3 degrees Celsius.

Much more study is required as these antifreeze proteins have not been found before in warm-blooded animals. She hopes to further her research on the antifreeze proteins and possibly study the physiology of seals in cold weather temperatures as well.

Palmer Station experienced near-record-breaking temperatures of 10.6 degrees Celsius and a two-minute wind speed average of 98 kph, with wind gusts up to 119 kph on Jan. 23. The winds threw ice from the Marrs Ice Piedmont glacier into Arthur Harbor and finally pushed our nearby icebergs out to sea.

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Cara Sucher / Special to *The Antarctic Sun*

The Canadian yacht Sedna IV *sits in Arthur Harbor during a visit to Palmer Station.*

the week in weather

McMurdo Station
High: 39F / 4C
Low: 16F / -9C
Max. sustained wind: 35mph / 56kph
Windchill: -24F / -31C

Palmer Station
High: 51F / 11C
Low: 30F / -1C
Max. sustained wind: 61mph / 98kph
Precipitation: 6mm

South Pole Station
High: -14F / -26C
Low: -31F / -35C
Peak wind: 14mph / 22kph
Max. physio-altitude: 3,168m

Continent

From page 5

SOUTH POLE

A busy end of summer

By Amnesty Kochanowski and Liesl Schernthanner
South Pole correspondents

The summer season at South Pole Station is at peak production.

On Jan. 23, the first wave of summer people headed north. Most others not staying for winter will trickle out of South Pole Station on or before Feb. 15. A small number of workers not part of the winter crew will stay to manage flight operations as late as Feb. 24, depending on temperatures. As of Jan. 25, there have been 262 flights to the Pole. The season's goal was to get over 3.9 million kilograms of cargo to Pole this year — an expected 333 flights.

The temperature has been falling to around negative 32 degrees Celsius, but it has been a pleasant week with little wind.

The biomed arch was totally cleared and moved for the construction of footers and knee-walls for its eventual elevation. The cryogenic facility assembly continues, and the transition of science equipment to the elevated station and the Atmospheric Research Observatory was completed.

IceCube drillers finished their seventh hole, and telescopes are being prepared for winter observations.

It's also been a busy week for visitors. Representatives from Raytheon Polar Services Co., the National Science Foundation, Support Forces Antarctica, the Spanish media, and the U.S. Embassy in New Zealand, among others, came to tour the facilities. In addition, the design team is on site to review new construction and provide occupancy permits.

On Jan. 21, we had a poker tournament and the third annual South Pole International Film Festival. For the film fest, the dining area was darkened and transformed by fake palm trees, as 21 films were presented to a full house at the premier. There was a second showing to accommodate swing and night shift workers. Quite a few people stayed up to see the films a second time.

Amateur filmmakers have been working on their projects all season during their free time. Films were generally short and comical. Topics included: the two-minute shower police; a South Pole television show; people lip-syncing and acting to songs; a monster that lives in the ice tunnels; pirates at Pole; a spoof on the "priceless" MasterCard commercial; and many other creative topics. Tony Morgan designed the 2006 logo. Philip Clark and Nathan Bahls were masters of ceremony.

The winners of the Christmas Day "Race Around the World" traveled to McMurdo Station to run in the Scott's Hut Race. South Pole is proud of Joey Hockett and Michael Rehm, who finished in second and fourth place, respectively, for the men, and Sara Boaz, who took second in the women's division.

SHIPS

LMG

Compiled from reports by Andrew Nunn
Marine Projects coordinator

We exchanged equipment with Palmer Station in the middle of the night on Jan. 14 via Zodiac and then began multiple instrument deployments along the testing grid for the Long Term Ecological Research Project.

We completed testing at 13 water sampling stations over the next three days. On the 18th, the sea bird researchers went ashore to do some diet sampling on two islands that they were unable to visit on the previous trip due to ice.

Operations continued to run smoothly until the 21st, when bad weather forced us to stop sampling for about six hours during the peak of the storm. Work continued after the storm, and testing went well for the next few days.

NBP

Compiled by reports by Harold "Skip" Owen
Marine Projects coordinator

We reached the fuel tanker *Lawrence Gianella* and the icebreaker *Krasin* on Jan. 17. After some initial issues adapting the hoses, we began transferring fuel. The process took about 10 hours, and we departed the area at 3:30 a.m. on the 18th.

Later that day, we met up with the Italian research ship, *Italica*, and exchanged people between the ships via Zodiac. We then conducted a conductivity, temperature and depth cast in sync with the Italians to calibrate our instruments.

We spent the next four days sampling for the CORSACS project in warmer waters in Terra Nova Bay. CORSACS stands for Controls on Ross Sea Algal Community Structure and is a project studying what controls phytoplankton dynamics.

We finished up our science by the 23rd and began preparations for the end of the cruise and our journey to McMurdo Station in the ice channel. Updates from McMurdo on the state of the channel are somewhat discouraging, but we planned to head in for a firsthand look the following evening.

The 24th was spent collecting final underway data, and packing and breaking down the labs. We entered the ice channel heading towards McMurdo, and we'll see how things go over the next day or so.

Continental Drift

What's your favorite Antarctic vehicle and why?

"Hagglands — they look like they belong on Mars."

Patrick Parkinson, McMurdo janitor from Santa Barbara, Calif., second season

"The [*Laurence M.] Gould,* because it's my transportation home."

Dave Ensworth, Palmer power and water plant mechanic from Vancouver, Wash., fifth season

"Mary Lou — the D-8R delivered by the traverse — is my favorite vehicle, even though she's broke, because we have the same middle name. And so does Judy Goldberry's twin sister!"

Katie Hess, South Pole communications coordinator from Randolph, N.H., fourth season

Peter Rejcek / *The Antarctic Sun*

Doug Forsythe's carpenter crew is making its "last stand" in the B4 wing of the new elevated station, which consists mainly of the gym and is the last area for major interior construction. A weight room will be located above the gym floor behind a wire cage.

Station construction in final stages

By Peter Rejcek
Sun staff

Doug "Dog" Forsythe is starting to run out of places to store construction materials in the new elevated station at South Pole. That's a good thing.

It means that some six years of station construction is finally ending. Forsythe, a construction supervisor with Raytheon Polar Services Co., estimates most of the interior work on the roughly 6,100-square-meter building will be done at the end of the summer season in mid-February. He's been with the $140-million South Pole Station Modernization project since the beginning, playing a big part in procuring building materials for the new station as well as overseeing summer construction.

"It's kind of neat to see the start and finish," he said during an interview in a newly built second-floor conference room. A large audio and visual screen, intended for video teleconferences, dominates one end of the room.

It's up to Forsythe to sweat the details. For instance, he's counted and recounted the dwindling supply of pre-fabricated concrete flooring about a half-dozen times. There's just enough of the heavy slabs to cover the last swath of naked floor in the final wing under major construction, which includes a gym and weight room.

"It's going right down to the end," he said of the supplies.

The construction crew is also running out of space to stage materials and tools. The door and back wall leading to a snow ramp outside the B4 wing is intentionally being left undone so materials can continue to be shuttled in and out. The weight room that overlooks the gym serves as the crew's tool and break room.

"We call it our last stand," Forsythe said. "We always had an extra wing to move into. Now everything is getting pushed out."

The push to finish the station for a dedication ceremony next summer season will continue through the winter months. When completed, the two-story elevated station will be able to house 154 people. At one end of the modular building is the shiny, unheated vertical tower, with its 96 steps and cargo elevator. The building itself stands more than three meters above the compacted ice foundation to alleviate the sort of snow drifting that has buried the Dome.

Inside are all the amenities one could ask for so far from civilization. There's a large dining hall and kitchen, a hydropon-

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Fate of Dome still under study

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ics growth chamber, store, computer room, coat rooms, hobby room, reading lounge, recreational lounges and a gym. A suite of modern offices and conference rooms are located upstairs in the B3 operations wing. An emergency power plant is located on the first floor of the B1 berthing wing, which doubles as a survival pod in case of a major disaster. The new science wing is humming with activity.

Two of the three berthing wings, A1 and B1, are occupied this summer, with the station population expected to reach a record crescendo this month with as many as 270 people. The population surge is not just because of the station construction. It's also due to numerous science projects emerging in anticipation of the station's completion next summer season.

"We can't build it fast enough," remarked Jerry Marty, the National Science Foundation representative at South Pole. He said it's truly a case of "build it and they will come.

"They're on our doorstep," he added, referring to science construction juggernauts like IceCube, a neutrino observatory that comes with its own construction crew and a price tag of $272 million.

More than two dozen carpenters and about another dozen plumbers and electricians are dedicated to the station construction effort alone this season. The interior work is coming along even faster than expected because of a delay in getting materials to install the outer aluminum shell of the building. Some of those workers, dubbed the panel crew, were moved inside to help finish the interior.

The panel project was delayed after an infrared camera noted some air leaks in the building's shell. Commercial grade Tyvek, a fibrous paper, arrived at the station just before Christmas. It will be laid underneath the panels, which are now going up, to act as a vapor barrier to prevent heat loss.

There's more than 12,350 square meters of area to cover with the panels. Forsythe said the panel crew would get a good start this season and finish the job at the beginning of next summer.

"I guarantee we'll hit it hard," he said.

They'll have to. The formal dedication of the new station is tentatively scheduled for January 2007, according to Marty. He said the ideal date would be Jan. 9, the same day the Dome was dedicated 32 years ago. Next year is also the 50th anniversary when the first South Pole station was built for the International Geophysical Year.

Steven Profaizer/ *The Antarctic Sun*

Peter Rejcek / *The Antarctic Sun*

Peter Rejcek / *The Antarctic Sun*

Top, the gunmetal gray siding is rapidly going up on the outside of the elevated station despite a late start on the project.

Above, plaques and signs await installation throughout the elevated station.

Left, a South Pole carpenter screws down the concrete board flooring for the new gym.

The Dome

In many ways, the new building is already the de facto station. Only a few offices are still occupied under the Dome, and just a handful of people still live there — likely the last occupants. The Dome, completed in 1975, can only house about 40 personnel. It's well past its prime, having been originally designed to last no more than 20 years.

"We've been keeping that thing alive with band aids and duct tape for at least 15 years," said Carlton Walker, the South Pole facilities, engineering, maintenance and construction manager.

"It has served its purpose," he said of the Dome. "It has done its job admirably. But it's time to go."

The final resting place for the iconic structure is still undecided, though there's been discussion of removing and reassembling it at the Seabee Museum in Port Hueneme, Calif. The Seabees, also known as Naval Mobile Construction Battalions, built the original Dome. Marty said the Seabees already have a baseball field-size area set aside for a Dome museum.

"They want to include an Antarctic exhibition exhibit area … along with all these other areas of Seabee tradition," he said. "There's a very keen interest in more South Pole/Antarctic memorabilia."

Marty said the Dome's fate will depend on how economically and logistically feasible it will be to remove. He said the NSF is committed to staying within its remediation budget, which includes removal of the Dome, its buildings and ancillary structures

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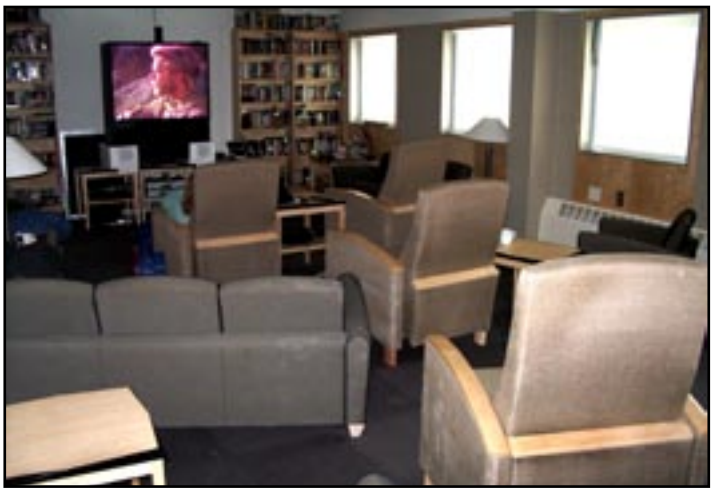
The new game room in the elevated station boasts pool and ping-pong tables, along with a kitchen and library.



Photos by Peter Rejcek / *The Antarctic Sun*

The new television room is located next to the game room in the B4 wing of the elevated station.

Science construction keeps crews busy

From page 8

like the old power plant. Whether the Dome, in part or as a whole, can be removed and rebuilt in Port Hueneme at the Seabee base should be decided before next fiscal year.

"I'm a strong, strong advocate of save the Dome, bring the Dome home," Marty said. "It's part of U.S. history. It's part of Antarctic history."

The Dome is scheduled to go in 2009 regardless of whether it's turned into a museum or recycled into aluminum cans.

The winter construction crew, expected to number about 35, will spend part of the season doing interior demolition work on the Dome's remaining buildings. The old dining hall and medical buildings have already been removed. Walker said how the Dome is eventually dismantled will be dependent upon its final fate.

"You take things apart a lot differently when you plan on reusing them than you do when you don't plan on reusing them," he noted.

While not overly sentimental about abandoning the Dome, Walker said it's disquieting to see it slowly disappear and shut down.

"It's still bizarre to me to walk into the Dome, because for so many years it was the heart and soul of this place," said Walker, a 15-year veteran of the U.S. Antarctic Program. "Walking by the old power plant and not hearing any noise come from it still bothers me."

Other construction

Walker and his 120 employees have little time to reminisce these days. Besides finishing the station, there are a number of ongoing construction projects, including several science-related ones such as the South Pole 10-Meter and BICEP telescopes. Crews are also assisting with the IceCube neutrino detector work and excavating the biomedical arch.

"We're just scattered all over," Walker noted.

All the equipment for the 10-meter telescope construction is at the station, according to Walker. The base for the telescope is already done. The $18 million telescope is designed to conduct some of the largest and deepest sky surveys of the universe as it searches for galaxy clusters, among other goals.

The project is led by the University of Chicago in collaboration with four other academic organizations. January 2007 is the target date for completion.

The shield for the new Background Imaging of Cosmic Extragalactic Polarization (BICEP) telescope is also finished. The BICEP telescope was built by the California Institute of Technology to measure the polarization of the cosmic microwave background in order to search for answers to the beginning of the universe. Al Baker, the Raytheon science support coordinator, said BICEP should be running this winter.

Heavy equipment operators have dug out the biomed arch, which will be raised and eventually aligned with the old power plant and garage arches. The three will become the new cargo arch as part of the South Pole Station Modernization project.

A large construction crew is still planned for the winter, with interior work on the new cryogenics and the 10-meter telescope facilities. A lot of demolition is also scheduled. Besides the Dome buildings, the old power plant will be gutted.

"We'll have a busy winter," Walker said.

Like an old photo, life under the South Pole Dome is slowly but surely fading away as construction of the new elevated station wraps up.

CREAM payload successfully recovered

By Steven Profaizer
Sun staff

The CREAM payload is back at McMurdo Station after a 28-day journey in the stratosphere connected to a balloon made of 64,750 square meters of fabric. The payload was part of NASA's long duration balloon project and spent the journey taking measurements high above Antarctica.

Each year, the National Science Balloon Facility (NSBF) provides the balloon platform for projects chosen by NASA. This includes the launch, monitoring, termination and recovery of the instrument-laden payload.

Using long-duration balloons gives scientists an opportunity to study things that can only otherwise be observed from space.

"Compared to rockets, this is dirt cheap," said David Sullivan, the head of NSBF operations in Antarctica.

CREAM, Cosmic Ray Energetics and Mass, is a project designed to study ultra-high-energy cosmic rays.

Balloons follow the stratospheric air stream in a circle over the continent. When the CREAM balloon came back around to the McMurdo area, Sullivan honed in on its every movement and waited until it was at a safe place close enough to McMurdo to ensure the recovery would be possible.

On Jan. 13, NSBF members loaded into a C-130 aircraft and flew out to meet the balloon near Terra Nova Bay. The team brought along the remote for the payload — a black box a little larger than a dorm refrigerator with a laptop-style computer mounted to the top. The device needs a line of sight in order to give instructions to the balloon.

Courtesy of David Sullivan / Special to *The Antarctic Sun*

The ATIC payload, from one of NASA's long duration balloons, sits by a Twin Otter airplane on Dec. 20. A team flew out to recover the payload after the balloon's flight was terminated early due to an unknown equipment malfunction. An investigative team is currently working to identify the problem.

"A lot of people don't realize how complicated this device is. ...There's not just a terminate button."

— David Sullivan, head of the National Science Balloon Facility's operations in Antarctica, on activating the device that cuts a balloon payload.

"A lot of people don't realize how complicated this device is," Sullivan said while flipping through pages of commands. "There's not just a terminate button."

When the balloon received the instruction, it went out with a bang. A small explosion separated the connection between the payload and the balloon, and a cord connecting the payload to the balloon ripped away a huge section, allowing the helium to escape and bringing the balloon to the ground.

A parachute delivered the 4,530-kilogram payload safely down to a location about 160 kilometers inland from the bay.

Part of the team returned the following two days by Twin Otter to break the payload down and fly it back to McMurdo in the aircrafts.

"We have to break it down extensively for it to fit," Sullivan said. "People are always impressed by how big the payloads we fly are. I'm always thinking, 'Oh geez, how's that going to fit in a Twin Otter?'"

Bursting their balloon

The termination of the CREAM payload marks the end of the NSBF's season in Antarctica, but it wasn't supposed to. The Antarctic sky was one NSBF balloon short this season.

Another payload called ATIC, Advanced Thin Ionization Calorimeter, was scheduled to study cosmic ray proton and helium spectra. The balloon was launched Dec.19, but its short flight only lasted about four hours before the team had to terminate it due to a yet unknown problem with the balloon.

"We knew almost immediately that something was wrong," Sullivan said. "But once you let it go, it's gone."

It was a tense few hours as the NASA science team and NSBF support team gathered around computer screens to watch the data come in as the balloon climbed — 60,000 feet … 70,000 … 80,000 … 80,000 … 80,000 …

"The balloon just didn't get above 80,000 feet," Sullivan said about the balloon that stopped far short of the target 120,000 feet. "We're not yet sure what happened. We have an investigation team reviewing video, photographs and paperwork to determine what went wrong."

The payload landed about 140 kilometers away from McMurdo, just off the edge of Ross Island, and a recovery team made it to the site about a week later in hopes of recovering and re-launching the equipment.

"Unfortunately, there was enough damage to the payload that it was unable to be re-flown," Sullivan said. "We had an extra balloon and extra gas. We think we could have re-flown it if it had not been so damaged."

This was the ATIC team's last of three flights over the last three years.

"It was a bit hard to take," Sullivan said. "It was really difficult on the science team because it was their last one, but we don't take a failure lightly either."

Better safe than sorry

The extra balloon and helium were part of the many back-up systems in place for all NSBF flights.

See RECOVERING on page 11

Icebergs draw life to nearby waters

By Emily Stone
Sun staff

In his 20 years studying the Southern Ocean, Ken Smith heard many stories about how seabirds flock to icebergs.

His theory was that free-drifting icebergs created an area of nutrient-rich water around them, thus drawing phytoplankton, krill and the larger animals that feed on them. Smith, of the Scripps Institute of Oceanography, set out last month on a cruise with five collaborators in the Weddell Sea to see if he was right.

He was. The iceberg team discovered significantly higher levels of nutrients and organisms around the two icebergs they studied. The bergs created a "halo effect," as Smith calls it, where the waters around the icebergs contained much more life than the water several kilometers away.

The information is important because rising global temperatures are creating more icebergs off the Antarctic Peninsula, which is the warmest part of the continent. Those icebergs, it seems, will create more nutrient-rich areas in the oceans with increased primary productivity that can increase the amount of carbon dioxide being taken from the atmosphere.

These preliminary findings are another example of how global warming is altering the ecosystem, Smith said.

The group spent 17 days on the *Laurence M. Gould* studying two tabular icebergs, the larger A-52 and smaller W-86. They deployed a series of instruments to test the water and trawl for samples, and used a remotely operated vehicle to peer at the underwater portion of the berg.

In addition to observing much more life in the surrounding water, the group also found something new — algae growing on submerged rock particles embedded in the bergs 60 meters underwater.

"To our knowledge, it's never been seen before (on free-drifting icebergs)," Smith said.

Part of the reason is that virtually no one has studied free-floating icebergs from a chemical and biological perspective before, Smith said. He got interested in the project both because of the curious number of birds flying around, and because he'd had enough encounters with icebergs during his studies of the ocean's ecology to understand their influence.

"Icebergs have polished off a lot of my (bottom-moored) instruments," he said. "I figured if I can't fight them, I'll join them."

The icebergs churn up the water around them, creating a stew of nutrient-rich water. This generates an entire food chain from phytoplankton up to top predators, like seabirds.

Smith's group of 18 did some analysis on the ship, but will do more work with the data now that they're back home. Even without the final numbers, he said it was clear that there were more things living near the bergs. Simply counting the seabirds showed this.

"Their numbers were significantly higher … adjacent to the iceberg," he said.

NSF-funded research in this story: Ken Smith, Scripps Institute of Oceanography.

Henry Ruhl / Special to *The Antarctic Sun*

The W-86 iceberg in the Weddell Sea was one of two icebergs that Ken Smith's science group studied to see if the waters near icebergs create more nutrients and draw more organisms.

Recovering payloads can be a tricky endeavor

Continued from page 10

"Just about everything in this business uses redundancy," said Jim Humphrey, NSBF electrician.

The ATIC balloon was terminated using one of those redundancies. If a flight needs to be ended at a time when an aircraft trip is not an option, a signal can be sent from the NSBF facility in Texas via satellite connection.

This signal immediately activates the payload and parachute separation, giving the group little control over where it lands and an inability to know the condition of the payload until it's recovered.

"Having an aircraft fly out to the balloon gives us a great advantage," Sullivan said. "We get to see it on the ground and know that it's safe."

If the team gets to take a plane out to terminate the flight, it needs to make sure it can complete the mission. Part of the reason for the large size of the remote the group uses to issue balloon commands from the plane is because it contains a backup of every piece of equipment needed.

The team also brings a black case with them, which contains a third copy of everything in the tower.

"All the electronics can be torn apart and rebuilt in the air, if it's needed," Humphrey said.

There is also a fail-safe in the event of a problem with the explosive coupling that frees the payload. If it fails to fire, the team turns to the bolt holding the whole thing together. This isn't a bolt you can find in your local hardware store; it is an explosive bolt packed with gunpowder.

"One way or another, it's coming down," Sullivan said.

The National Science Foundation provides logistical support for NASA's long-duration balloon projects in Antarctica.

Penguins, bergs provide natural experiment

From page 1

against the shores of the colony at this time of year. The giant icebergs that calved off the Ross Ice Shelf in 2000 and calm winds this past winter have prevented the sea ice in McMurdo Sound from blowing out.

"The system is supposed to cooperate, and the ice is supposed to go away," said Ainley, an ecological consultant with H.T. Harvey & Associates in San Jose, Calif.

The icebergs have created a natural experiment for Ainley and co-principal investigators Grant Ballard and Katie Dugger by allowing them to watch what the penguins do when their colonies become either inaccessible or undesirable. Penguins are extremely loyal to their birth colonies — a phenomenon called philopatry — so changes in home base have previously been considered highly unusual.

The bergs also appear to have answered a question about penguin patterns in the past. DNA from isolated colonies along the Ross Sea coast is very similar despite the fact that the penguins from separate colonies don't normally interbreed. Scientists believe that giant icebergs that calve off the ice shelf once or twice every century have caused enough scrambling of isolated penguin populations to explain this.

Ainley's group, along with LandCare Research in New Zealand, is studying the penguin colonies at Cape Royds, Cape Bird, Beaufort Island and Cape Crozier. Cape Royds is the smallest of the colonies. Cape Bird and Beaufort Island each have about 40,000 breeding pairs, and the massive community at Cape Crozier has about 150,000 breeding pairs.

The project began 10 years ago, before the icebergs appeared. The original goal was to investigate why these colonies were such dramatically different sizes, why their populations were increasing, and to see how the colony size affected the penguins' quality of life. The group tags and weighs the birds, and uses tracking devices to gauge this.

Ten years ago, the researchers had noticed that Royds was growing by about 10 to 15 percent a year, which was much faster than the increases at the other colonies.

"The expectation was that we'd be studying why this colony was expanding," Ainley said. "The icebergs came and just reversed everything."

Iceberg issues

The Cape Royds birds are having the most trouble coping with the extra sea ice because they are the farthest south.

In a normal year, more than 99 percent of penguins will return to the colony where they were born, Ainley said. This year, the scientists saw more Cape Royds birds breeding at other colonies than at Royds.

"This is totally contrary to the rules of penguindom," he said.

The group tracks the birds by tagging about 1,000 each year at Cape Bird and Cape Crozier, and 400 each year at both Cape Royds and Beaufort Island. The researchers spend much of their time in the field scanning the colony with binoculars to see which birds are there and entering that information into a database.

The birds that did return to Royds are finding it tough. The feeding grounds are so far away that parents are unable to make the 80-kilometer trip back home with enough food and quickly enough to feed their chicks. They're getting back too late to feed their chicks, so the chicks are scrawny and slowly starving.

The ice that's been causing problems at Royds has been a boon for Beaufort Island — although a temporary one.

The ice has blocked the ocean waves that would normally wash across the island's beaches this time of year, making it a safe place for penguins to live for the time being. An additional 5,000 to 10,000 pairs, including some from Royds, have taken up residence there, Ainley said.

"There are going to be thousands of (Beaufort) penguins looking for a place to live," once the ice leaves, Ainley said.

There's a delayed effect from all these natural changes. Adélie penguins wait five years before returning to their colony to breed, so the scientists are only now starting to see the results of the icebergs arrival in 2001.

For example, Cape Crozier had a banner year six years ago. So the scientists have seen more penguins there than ever before in the past two years.

"It's real complex what's going on," Ainley said.

Scrambled genes

That complexity has helped explain why the different Ross Island penguins have remarkably similar DNA.

A recent paper by the group and other New Zealand collaborators in the

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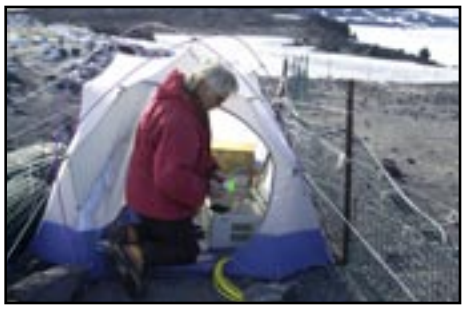
Photos by Emily Stone / *The Antarctic Sun*



Above, the Cape Royds Adélie penguin colony sits next to Pony Lake on a small peninsula on Ross Island. Researchers have been studying the penguins there and at three other Ross Sea colonies to learn why they choose to live in colonies that vary greatly in size.

Left, penguin researcher David Ainley explains the equipment used to weigh penguins as they go to and from their nests. The birds are weighed on a scale each time they enter or leave their nest area, and the information is stored on a computer in the tent.

Icebergs stir the Adélie gene pool

From page 12

Proceedings of the National Academy of Sciences compared the DNA from penguins today to DNA retrieved from 6,000-year-old penguin remains that were preserved by Antarctica's dry climate. The paper showed that microevolution was occurring and that the DNA of modern penguins living at the same colony had changed slightly over time.

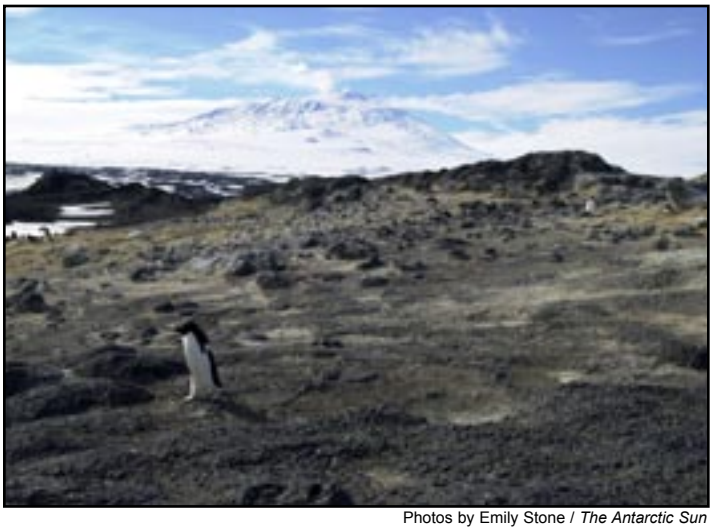
It would seem to follow, that the DNA of penguins from different colonies would have changed in slightly different ways since penguins aren't supposed to mix between colonies. However, this is not the case. The DNA from modern penguins from different colonies is remarkably similar.

Ainley and the other scientists hypothesize that this is because of occasional iceberg events that force the penguins to find new homes.

The scientists saw almost no intermingling between the colonies before the icebergs, Ainley said. Since then, they've witnessed the scrambling of populations.

"These penguins aren't dumb," he said. "They're starting to move."

Once they switch colonies, they aren't picky about the background of the penguins whom they breed with. So a Royds bird might pick a Crozier mate and so on.



Photos by Emily Stone / *The Antarctic Sun*

Penguins at the Cape Royds Adélie colony wander around as Mount Erebus looms in the background. There are about a quarter as many penguins at the colony this year than in years past because of difficult sea ice conditions.

Original study

This unexpected natural experiment hasn't prevented the scientists from continuing with their original work — tracking the differences between the penguin colonies and how healthy the parents are.

The scientists fenced in an area that held a similar number of nests at Cape Crozier, Cape Bird and Cape Royds. An open gate allows the birds access to their nests. But to walk through the gate the birds must cross a highly sensitive scale. The scientists have implanted a Rice Krispie-sized sensor in the birds that live inside the corrals. The scale reads that sensor and transmits the information to a computer that records which bird was just weighed and whether it was arriving or departing the area.

The chicks are also weighed at each colony. Normally the Royds chicks are the butterballs since their parents have the easiest access to a bounty of food. Because there are so few birds there and the ocean is normally next door, it only takes a few hours for a Cape Royds parent to forage for food. Cape Crozier birds, by contrast, sometimes need two or three days to get far enough away so that all 300,000 of them can find food. The penguins, along with whales, have depleted the food closer to the colony.

The Crozier chicks are normally "mean and lean," Ainley said. That's not the case so far this year. The Royds chicks are weighing in most recently at an average of 350 grams compared to the 800-gram Crozier chicks. Beaufort's chicks, whose parents have a 10-kilometer walk to open water, are in the middle at 650 grams.

The scientists, with help from NASA, have started using satellite tracking tags to monitor the birds on foraging trips, and other tags to track their winter voyage away from the colony. The penguins follow the sea ice edge north in the winter in order to stay near food and in partial daylight.

The researchers have seen two different patterns emerge in these winter trips. The Cape Crozier birds are making a fairly circular route that runs about 6,500 kilometers. The Cape Royds birds make an out-and-back trip that's about 1,500 kilometers each way.

Ainley attributes this difference to the hatching dates at the two colonies. The Crozier birds hatch earlier, and thus need to travel farther away to find sea ice on which to molt. By the time the Royds birds hatch, it's later in the fall and there's more ice to be found nearby.

Very few, if any, studies have been done on animals that compare different population sizes, Ainley said. Usually a researcher will study one group and extrapolate those findings to the entire species.

"Colony size causes a lot of things to be different," Ainley said while walking among the dwindling Cape Royds colony. "It's a revolutionary idea."

NSF-funded research in this story: David Ainley, H.T. Harvey & Associates; www.penguinscience.com.

Detector a worldwide effort of funding, support

From page 1

They are used to detect light given off by extraterrestrial neutrinos, high-energy but non-charged subatomic particles, streaming through the Earth. Each of the holes will hold one string of 60 DOMs spaced along the cable every 17 meters.

When completed, the 4,800 sensors will form an underground array about one cubic kilometer in size, hence the name IceCube.

Conducting the science behind such a huge project is a difficult task. But drilling holes that are two-thirds of a meter wide to this depth is a challenge in itself.

"We will continue to improve the process as we get more experience with it," said Al Elcheikh, drill team manager.

The team's progress shows that statement in action.

Last season, the team was able to complete one hole. This season, the team has already finished seven holes and hopes to complete another one before it ends its season on Jan. 29, Elcheikh said.

Each hole takes four to five days to complete, which includes melting through the top layer of snow, drilling the hole, and providing one rest day for the current 25-person drilling crew.

The construction is currently scheduled for completion by the end of the 2009-2010 summer season.

They don't grow on trees

IceCube, which will cost about twice as much as the new South Pole Station it sits adjacent to, gets about 90 percent of its construction budget through the National Science Foundation (NSF). The remaining $30 million comes from universities and national laboratories in Sweden, Germany, Belgium and Japan.

IceCube is led by the University of Wisconsin and involves about 25 institutions from around the world, about half of which are based in the United States.

The project is classified as a Major Research Equipment and Facilities Construction (MREFC) and falls outside of NSF's normal budget.

"The idea is that Congress will fund these large-scale projects from time to time when the science merits it," said Bob Paulos, the lead on-site project manager.

In November 1999, the University of Wisconsin submitted a MREFC application, which went through the NSF peer review process to determine if the science merited the money and if the lead organization had the ability to pull off its plan.

The proposal was accepted, the money approved and IceCube was born.

The current funding is for construction only, and the IceCube team will need to submit a separate NSF proposal for maintenance, operation and analysis of the information the array provides.

Photos by Steven Profaizer / The Antarctic Sun

Tom Ham draws his colleagues' attention to data coming back from the logger, a device used to check the success of a newly drilled hole.

The six-meter-long hose reel helps lower the hot water drill into the ice, creating a two-and-a-half-kilometer-deep shaft to hold a string of IceCube's sensors.

Going deep

The team uses a hot water drill that sends hot, high-pressure water to carve out the sensor shaft.

"To core a hole of this diameter [with an ice drill], would take two to three summers," Elcheikh said. "With the hot water drill, we can do it in two days. It's the most feasible way to produce a hole fast enough to make this project viable."

Before the team can use the drill itself, it must first get through the absorbent snow layer.

The team uses a firn drill for this part of the task. This type of drill is also powered by hot water, but it uses considerably less of it. Most of the water it does use goes to heating the copper coils that wind their way around the drill. Like a huge ice cream cone-shaped iron, it uses its weight and heat to melt its way through the snow.

The firn drill is attached to a hose, and the team uses a building-sized winch to control its descent. It's slower than if the group blasted its way through with the hot water drill, but the firn drill has its advantages because of the snow's absorbency.

"It's not as fast as using the hot water drill," said Eleonora Lind, a member of the drilling team. "But it's the more water-saving way."

When the firn drill reaches a depth of about 50 meters, the snow is compacted enough that it will no longer just absorb the water, and the team switches over to the hot water drill.

The drill head is a three-meter-long metal cylinder. A 22-meter weight stack, which makes up the rest of the drill, attaches to the bottom of the drill head and pulls the device straight down through the ice.

"It's pretty simple," Paulos said, "but simple is good."

The water the drill shoots out is 89 to 90 degrees Celsius, just below the boiling point.

"We don't want to get the water too hot," Lind said. "It would cause a lot of steam, a lot of pressure and a lot of problems. Too much heat doesn't help us at all."

The drill acts as far more than a nozzle, however. It serves as a remote monitoring station and reports the water temperature outside the drill, inside the drill, and inside the hose. It is also outfitted with an instrument to measure the tilt of the drill and devices to measure the diameter of the hole.

The drill hangs by a load-bearing power and data cable, as well as the hot water supply hose, which is fed to the drill from a massive hose reel. The six-meter-long reel holds 3,050 meters of thick, black hose and weighs about 45,400 kilograms. The reel also serves more than just its obvious purpose and contains instruments to measure the rate and length of the hose as it comes off the reel.

"It's a sophisticated piece of equipment, not just a dumb garden hose holder," Paulos said.

When the target depth is reached, the drill is hauled back to the surface and a "logger" then makes the 50-minute, two-and-a-half-kilometer journey to the bottom of the new hole. This device logs the width and angle of the shaft as it is pulled back to

See ICECUBE on page 15

IceCube uses ingenuity instead of wasting water

Continued from page 14

the surface over the following two hours.

"It's a good thing to verify the hole is as wide as you think it is before you start putting a $1 million dollar string down there and get it hung up," Paulos said.

Once the group is sure the path is straight and free from obstruction, it begins the 10-hour process of hanging the DOMs down the hole. It is important for the team to immediately begin sensor deployment because the holes start to close up as soon as hot water is no longer being added. In only 36 hours, the holes narrow to the point that the DOMs can no longer be deployed.

The team drills and deploys sensors from inside one of two moveable buildings with holes cut in the floors. When the team is drilling in one, the other is being leapfrogged to the next position so it is ready when the workers are.

"That's a pretty efficient way to get a lot of things done during the short season — just keep moving," Paulos said.

Making holes this size take a lot of water and a lot of heat — two things not found in great quantity at the Pole.

"The drill pumps out up to 200 gallons a minute and brings nothing back," Lind said. "That drains the tanks very quickly."

To deal with this problem, the team uses a pump to draw water back up from the drill hole and into one of two 38,000-liter storage tanks. The water will then be reheated and used again.

Another partial solution to the water problem is a set-up called a Rod well. This type of well uses its own hole in the ice and is the same method employed to deliver drinking water to the South Pole station.

Hot water is continually sprayed down the hole, and a pump brings a mix of the original water and melted ice back up. The device delivers about 91 liters a minute back to the surface and helps to prevent the tanks from running dry.

"It's a constant struggle," Lind said. "At the time when we first start drilling, the tanks go down to about two-thirds empty."

The drilling team needs to constantly monitor the water levels, but the engineers of the equipment anticipated the water supply issue.

"The system and the size of these tanks were designed to handle this problem," Paulos said. "We just can't be too cavalier about it. We've got enough water to drill but not enough to make too many mistakes."

Generating enough heat for the water that feeds the drill is another major challenge. The team has four buildings that are each packed with eight souped-up car wash water heaters that turn aircraft fuel into heat. Each unit has been modified to generate as much heat as possible from every liter of fuel. The fuel consumption concern is due to the expensive transport cost of flying fuel to the Pole.

"Here we are at the South Pole constantly burning fuel. It makes you feel a little guilty," Paulos said. "So we want to do it the most efficient way possible."

As the IceCube team comes to the end of its season, Paulos said he feels it has really hit its stride.

The group has run into a number of mechanical problems, but it has overcome the obstacles and will end the season right about where they wanted to see themselves, Elcheikh said.

The team has also noted a number of improvements it would like to make, including making the building that holds the heaters for the Rod well more spacious.

"When we're down here, we're focused on the drill and keeping it going," Paulos said. "When we're back in the States, we'll have lessons-learned meetings and try to make some improvements for next season."

NSF-funded research in this story: Francis Halzen, University of Wisconsin-Madison; icecube.wisc.edu.

Photos by Steven Profaizer / The Antarctic Sun

Top, wires, cables and hoses connect the movable buildings filled with equipment for heating and recycling IceCube's water supply.

Above, eight souped-up car wash water heaters in four separate buildings, like the ones pictured here, turn aircraft fuel into heat.

Left, steam billows from one of the four buildings holding the water heaters for the hot water drill.

Neutrinos offer a new view of the universe

By Steven Profaizer
Sun staff

Sixty billion neutrinos fly through your thumb every second.

The weirdest part is that no one is sure where some of them are coming from.

Neutrinos are subatomic particles that fit into the same general category as protons and electrons. Neutrinos, however, have special characteristics: they have no electrical charge and are almost without mass. This means they are not affected by magnetic fields and are rarely absorbed by matter. With nothing to interfere with them, neutrinos are born, and just keep going in whatever direction their source pushes them. For the most part, they slip straight through anything that gets in their way, shooting across the universe in a straight line from their origin.

But every once in a while, they crash straight into an atom, destroying themselves in the process.

These collisions give scientists a rare opportunity to learn about these abundant yet mysterious particles, which are notoriously difficult to detect because of their benign nature.

Enter IceCube — the monstrous, cubic-kilometer neutrino telescope currently under construction one-and-a-half to two-and-a-half kilometers below the surface of the South Pole. It is designed to observe the result of neutrinos careening across the galaxy, traveling through the earth, and slamming into an atom of ice. The rarity of these occurrences is the reason for IceCube's immensity — the bigger the area of the detector, the better the chance of observing the interaction.

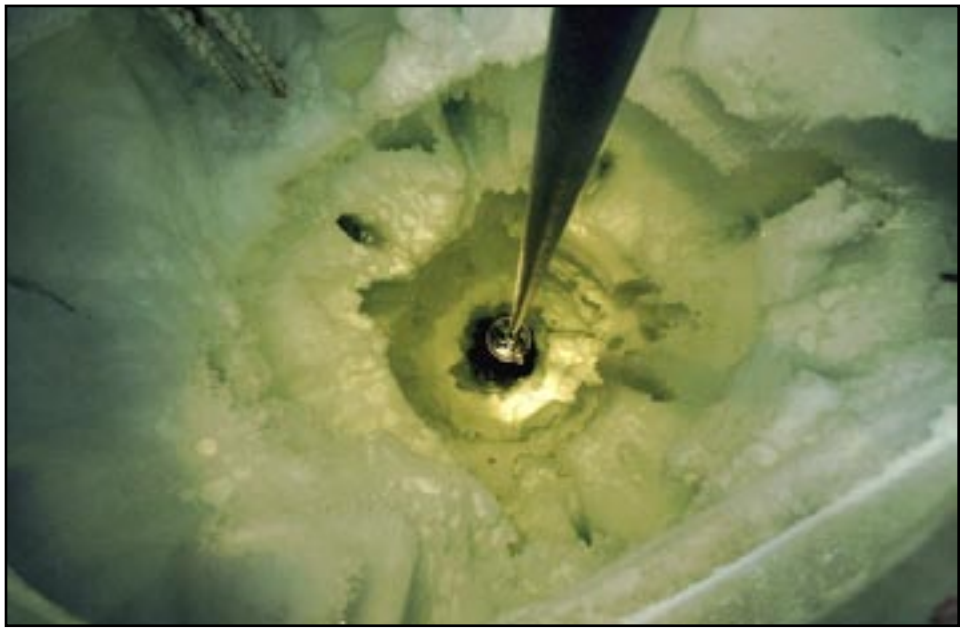
The collision destroys the neutrino but creates a negatively charged particle called a muon, which gives off a blue cone of light as it continues along the path of the neutrino.

This blue luminescence is called Cherenkov radiation. It occurs when a charged particle, like a muon, travels through matter faster than light would through that same substance. And the very large, dark and transparent ice region under the South Pole's surface provides a perfect place for scientists to observe the effect.

IceCube is a sensor array made of digital optical modules, or DOMs. Eighty strands, each with sixty basketball-sized DOMs, will be placed into shafts drilled in the ice. The science team hangs the strands straight down into the holes, and within a month, the ice closes up completely around them.

The ice's grip on the DOMs is hardly a gentle embrace, so their electronic innards are encased in a ball made from glass designed for deep water diving.

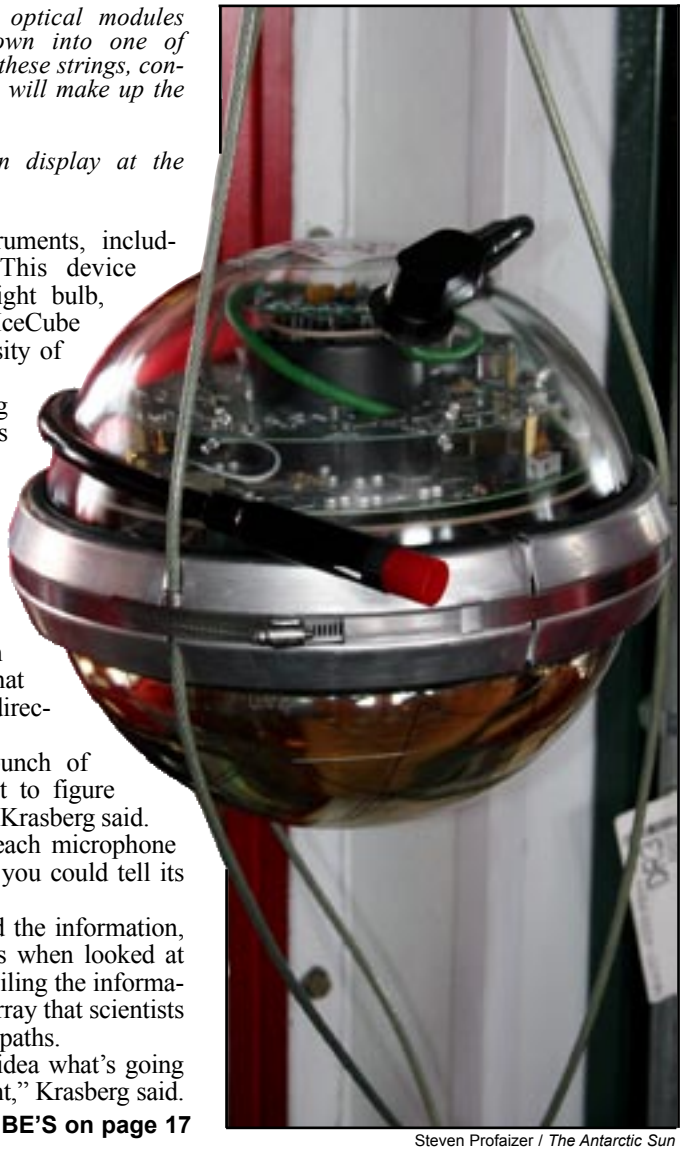
Inside the glass is a minicomputer attached to several instruments, including a photomultiplier. This device works like an inverse light bulb, said Mark Krasberg, an IceCube scientist from the University of Wisconsin.



Courtesy of NSF

Top, a string of digital optical modules (DOMs) are lowered down into one of IceCube's holes. Eighty of these strings, containing 60 DOMs a piece, will make up the IceCube array.

Right, a DOM hangs on display at the IceCube drilling site.



Steven Profaizer / *The Antarctic Sun*

Instead of producing light, it traps light and logs the exact time it registers it — down to five billionths of a second.

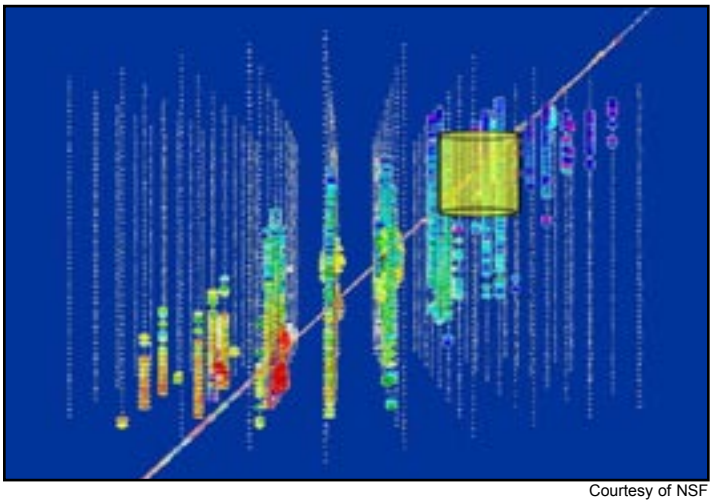
The precision is needed so the scientists can tell the neutrinos apart. Software deduces the exact moment each DOM gets hit and uses that to judge the neutrino's direction and speed.

"It's like putting a bunch of microphones in the street to figure out the direction of a car," Krasberg said. "If you looked at when each microphone recorded the car passing, you could tell its direction."

Each DOM will record the information, but they are fairly useless when looked at individually. It is by compiling the information and using the entire array that scientists can deduce the neutrinos' paths.

"Each module has no idea what's going on, it just gets hit with light," Krasberg said.

See ICECUBE'S on page 17



Courtesy of NSF

IceCube will encompass AMANDA (yellow cylinder). Its much larger size improves its accuracy and capacity to measure paricles' energies. The diagonal line represents a particles' path through the arrays.

IceCube's predecessor incorporated into project

Continued from page 16

The picture constructed from this information will be one that has never been seen by scientists before.

"This telescope is a discovery telescope," Krasberg said. "No one has ever looked at large numbers of these neutrinos before. They could show us something amazing. … There's a lot of things we could see, which probably haven't been thought of."

Proven in the past

IceCube is huge in all aspects. It's a cubic kilometer in size; it has a construction budget of $272 million; and there are 25 institutions around the world already involved in the project.

IceCube owes much of this support and interest to AMANDA, which stands for Antarctic Muon and Neutrino Detector Array. It is a 10-year-old array of similar detectors but is fifty times smaller than IceCube. And with 19 strings holding 700 detectors, it only has one-tenth of the instrumentation.

"AMANDA is like a nearsighted person looking at the stars," said Bob Morse, principal investigator of the AMANDA project. "But when IceCube looks at the stars, they will be sharp and twinkling."

Despite being dwarfed by its successor, AMANDA is still contributing to science. The project is now considered part of IceCube, which will eventually encircle AMANDA. Scientists hope the older array will contribute valuable corollary data.

Morse, who is now also IceCube's lead on-site science manager, said he knew AMANDA was a precursor to a larger neutrino telescope. His team even placed three detector strings strands deeper into the ice to test unknown territory for the bigger, better telescope that was yet to come.

"They did little to enhance AMANDA's performance," Morse said, "they were mainly exploratory for IceCube."

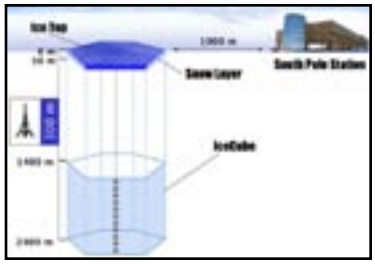
Although it's still years from completion, IceCube probably won't be the last effort to expand and enhance neutrino astronomy at the South Pole, according to Morse.

"I really believe this is just IceCube one," he said.

NSF-funded research in this story: Francis Halzen, University of Wisconsin-Madison, icecube.wisc.edu.

IceTop to augment IceCube's detectors

By Steven Profaizer
Sun staff



Courtesy of NSF

IceTop will sit above IceCube.

There is an inherent oddity to the IceCube project: the blue-light-producing muons it studies are so rare that the array has to cover a cubic kilometer to produce useful data, yet IceCube will detect far more of these interactions than it wants.

What makes this possible? The muons' origin.

Muons can come from many sources, only one of which is the collision of a neutrino with an atom of ice. So just because IceCube registers a muon's blue cone of light shooting across the array, does not necessarily mean it is providing the scientists data on what they are trying to study.

Scientists have come up with a way, however, to use all that extra information — IceTop.

IceTop is considered part of IceCube, but it uses a separate set of the same digital optical modules. These sensors are frozen into 2,300-liter tanks of water and placed in pairs above each string of the IceCube array.

IceTop serves two major functions. The first is to help calibrate and enhance IceCube. The second is to make use of the valuable data that is not directly related to IceCube's goals.

By studying the particles IceCube is not interested in, scientists can get better at eliminating the excess information the particles create in the IceCube array, said Tom Gaisser, principal investigator for IceTop.

If scientists didn't eliminate that interference, it would be like trying to decipher one voice in a stadium filled with screaming fans.

"For every muon generated by a neutrino, there are about a million generated by cosmic rays," Gaisser said.

Scientists can tell muons' sources apart by their trajectory. There are two general directions for muons to move through the array: up and down. The majority of downward-moving neutrinos are from cosmic rays creating showers of subatomic particles as they meet the Earth's atmosphere. But IceCube is designed to look at the muons created by particles moving up through the Earth. Neutrinos are the only muon source that can travel through the entire planet.

"We're looking down through the Earth and using it as a shield," said Mark Krasberg, an IceCube scientist from the University of Wisconsin.

While IceCube is looking through the Earth at the northern sky, IceTop will be looking straight up at the sky over the South Pole.

"We're taking advantage of extra physics that can be done with the background that would otherwise be discarded," Gassier said.

The IceTop team installed eight tanks last summer and completed 24 more this season. Those tanks are still in the process of freezing, but they will be operational in February.

NSF-funded research in this story: Tom Gaisser, University of Delaware, Bartol Research Institute.

Profile

The ride of her life

Peter Rejcek
Sun staff

Liz Kauffman doesn't live her life like the way she works.

As the new helicopter operations supervisor at McMurdo Station, she juggles multiple schedules on a daily basis, making sure people and cargo get from point A to point B. While weather and other intangibles require a degree of flexibility, it's part of her job to make sure everyone adheres to the schedules as much as possible.

But for a cross-country cycling trip from Anacortes, Wash. to Bar Harbor, Maine, the 40-year-old Coloradoan didn't bother much with meticulous timetables or routes. She just had the desire to follow a long-time dream, without really knowing how she would do it.

"I didn't have much of a plan," said Kauffman, who started discussing the idea with an Ice friend, Joe Heil, last summer at McMurdo Station. "He was a big part of the trip just because he pushed me for many months."

Heil, communications supervisor at McMurdo, down played his role in the adventure, saying he told his long-time friend to simply get on her bike and ride. "I thought it was a highly admirable goal," said Heil, himself an avid touring cyclist. "It's the first mile that's the hardest."

By the end of last season, Kauffman said she was ready for a change. She'd been with the U.S. Antarctic Program on and off since 1992, though full time for the last six years, splitting work between the Raytheon Polar Services Co. headquarters in Centennial, Colo. and Antarctica. She started with the program as a general assistant and has worked in most departments over the years.

"I've been with every division except for FEMC," she said, laughing, referring to the department responsible for facilities, engineering, maintenance and construction.

Kauffman said she started telling everybody about how she planned to bike across the northern top of the United States. She was only half-serious, but the more she talked about it, the more it became a reality.

"I just kept saying it over and over," she said. "Suddenly, I had to go."

On May 31, and after only a minimal shakedown of her equipment, she hit the road on her Trek 520 touring bike. The panniers — bags specifically designed for bikes and that ride on either side of the front or rear wheel — were borrowed from another Ice friend, Tom Holford. She had only ridden a fully loaded bike, stuffed with cans to simulate weight, a couple of times around the flatter sections of Denver.

But bike touring doesn't require the sort of preparation you put into a marathon, Kauffman said philosophically.

"I didn't think much about it. … The way I look at it, anybody can ride their bike across the United States — or anywhere," she explained. "It's just a will to do it."

It wasn't long before the road tested her will. Or, rather, her bike pedals did: Her clipless bike shoes kept slipping off the pedals, causing a mental meltdown only about three days into the trip. That was somewhere along about a 50-kilometer uphill on Rainy Pass in the Cascade Range.

The rough beginning was a time of brief reflection, when Kauffman said she wondered what she was getting into.

Fortunately, three other touring cyclists happened to appear in her hour of need and fixed the problem. For the next week, they traveled together until their paths parted. Kauffman said there were many such serendipitous meetings along the 6,000 kilometers she rode — encounters she could only describe as fate.

Shannon Kalsta / Special to *The Antarctic Sun*

Liz Kauffman pauses somewhere along a rural Minnesota road during her bike tour across the United States last summer.

"People came along at exactly the right times that I needed them," she said. "That was a thing that surprised me, too. … It turns out that the people of the United States are just as open and helpful [as people in other countries]. It definitely restored my faith in Americans."

If Kauffman was encouraged by the people she met, the relationship seemed to be reciprocal. She said most people she encountered were interested in her journey and seemed to be inspired that she was following through with a long-held dream.

"You could just see this twinkle in their eye," Kauffman said. "I didn't expect that, that you would inspire so many people. To me, I'm just riding my bike."

What started as a solo adventure was rarely a lonely expedition. Besides hooking up with random touring cyclists on the road, Kauffman was joined by another friend from the Ice, Shannon Kalsta, for more than a month. They traveled together from Whitefish, Mont. to the upper peninsula of Michigan.

It was Kalsta's first bike tour, and she gladly abandoned her own plan to head northwest to Alaska in order to join her former McMurdo roommate.

"She was incredible to ride with," Kalsta said. "She was realizing a dream — and when you're traveling with somebody who is realizing a dream, it's hard not to have a good time."

There's been little respite for Kauffman since she finished the trip in August. She returned to the Denver area from a leave of absence, and she went to work in a new job the day after she flew home from the East Coast. Only a couple of weeks later, she got back in the saddle for a century ride in Grand Junction, Colo.

And now she's on the downhill of another summer season on the Ice. It's been a "sink or swim" experience in helo ops, she said, but one that's particularly interesting because she works so closely with the science groups. The researchers have been very accommodating and appreciative, she added.

"There's something really rewarding in that," Kauffman said.

But after an hour talking with her, one can tell Kauffman's heart is not in the sky but back on the road, where life rolls by at an unexpected pace.

"You just don't know what you're going to run into that day," she said. "Every day is going to be a new experience."