NSF Eyes New South Pole Station

Scientists are rushing to capitalize on unique opportunities for research at the South Pole just as the 20-year-old U.S. station is on its last legs. But can NSF afford a $175-million facility?

The first time astrophysicist Tony Stark went to the U.S. station at the South Pole to set up an experiment with Mark Dragovan and colleagues from AT&T Bell Laboratories, it was strictly do-it-yourself. The team commandeered two wooden structures left over from a previous experiment, unpacked the pieces of a small telescope designed to study cosmic microwave background radiation, and plunged ahead. "We had to stiffen the floor so things wouldn't bounce around, we built our own computer table, and the base technicians made a sort of sun deck for the telescope," recalls Stark, now at the Harvard-Smithsonian Center for Astrophysics. "Then we stood outside, in minus-50-degree weather, making adjustments so we could take some readings. It's not impossible to do, but boy, it gets pretty cold." At the end of the short austral summer, they packed everything up and went home.

Stark's experience, in 1985, is typical of a generation of researchers who have shrugged off primitive conditions as the price of working at the South Pole. But if officials at the National Science Foundation (NSF) get their way, future scientific explorers will find life at the bottom of the world a bit more agreeable: NSF is weighing a plan to construct a $175-million station at the South Pole that would transform the current Amundsen-Scott Station, last rebuilt in 1975, into a larger and more functional facility. NSF officials believe the unique conditions at the pole—including its tranquility, low temperatures, arid climate, pristine air, and 3000-meter-thick ice sheet—provide a rare opportunity to do frontier research in a range of fields spanning the physical sciences.

A key step in the effort to secure funding for the new base was taken this week, when a blue-ribbon panel of outside scientists and government officials was scheduled to meet for 2 days across the street from the agency's new home in Arlington, Virginia, to review the scientific justification for the proposed station as well as the architectural and engineering plans (see box). If all goes as NSF officials hope, the panel, chaired by former NSF director H. Guyford Stever, will submit a report to NSF's governing body, the National Science Board, in time for its August meeting. If the board gives its approval, NSF officials want to insert an opening bid for as much as $47 million into the agency's 1996 budget request, which will be submitted to the White House in September.

But even if NSF builds a consensus around the impressive scientific opportunities at the pole, it will be faced with a tough selling job. The proposed new station, which would take 8 years to build, would represent a major new commitment at a time when federal spending is flat and the NSF budget is struggling to keep up with inflation. Moreover, the proposal is being floated just as the Navy, which has long provided logistical support for NSF's polar programs, is trying to abandon this role and leave NSF to make other arrangements. Antarctic researchers, well aware of the political hurdles they face, have already begun to enlist help from some key members of Congress.

RICHARD A. CHAMBERLIN

CARA

Polar vision. CARA's South Pole observatory *(below)*, which already includes a microwave instrument, foreground, and an infrared telescope, on roof, awaits the arrival of a submillimeter telescope *(left)*.

Scientific promise

NSF's chief argument is that a new South Pole station is needed to support what it hopes will become a world-class astronomical observatory, equaling or surpassing Hawaii's Mauna Kea and other sites that have attracted a horde of sky-gazing instruments. The low levels of water vapor in the polar atmosphere allow measurements at infrared and millimeter wavelengths that are absorbed at other sites, and the location allows astronomers to observe much of the Southern sky for 24 hours a day. "It's not as good as getting into space," says Nobel laureate physicist Charles Townes of the University of California, Berkeley, a member of the NSF panel, "but it's much better than anything else on the ground."

Indeed, the scientific world has already begun beating a path to the South Pole. The discovery of a hole in the ozone layer over Antarctica brought atmospheric chemists running to the frozen continent in the 1980s, soon to be joined by researchers eager to explore the continent's unique impact on global climate change. Long a popular site for upper-atmospheric balloon launches, the pole has more recently been coveted by astrophysicists, who are using its ice to track the elusive neutrino (*Science*, 7 January, p. 28). In addition to NSF-funded work in aeronomy, astronomy, and astrophysics, there is a clean-air station operated by the National Atmospheric and Oceanic Administration and a seismic station run by the Incorporated Research Institutions for Seismology, each a key element in a global monitoring network of Earth's geophysical well-being.

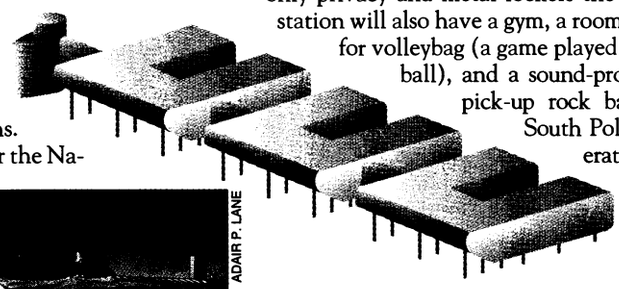
"I don't see any way the South Pole can avoid becoming a premier research facility," says Steven Barwick, an associate professor of physics at the University of California, Irvine, and a collaborator on the Antarctic Muon and Neutrino Detector Array (AMANDA), a $1-million, NSF-funded project to spot neutrino decay 1000 meters or more under the ice. "There's just too many opportunities there to do world-class science."

So many astronomers already want to take advantage of those opportunities that in 1991 NSF created the Center for Astrophysical Research in Antarctica (CARA), run by the University of Chicago and directed by Doyal Harper of the university's Yerkes Observatory in Williams Bay, Wisconsin. Last fall CARA received its second award, a 5-year, $20-million grant. Although CARA's presence actually augments the strain on the existing station by increasing maintenance needs and adding as many as a half-dozen

A Design for Life in the Freezer

For an architect, drawing up a blueprint for a new station at the South Pole is about as tough a challenge as terrestrial design gets. Eight inches of snow accumulates every year and never melts. A steady wind creates drifts that can bury low-lying buildings in months. Temperatures routinely hit minus 100 degrees Fahrenheit. The "ground" itself—really a glacier almost 2 miles deep—slides an average of 33 feet toward the sea each year, and adjacent spots can move at different speeds, ripping apart structures. And then there's the task of designing facilities that will help the station's two dozen or so winter inhabitants endure near-total isolation from the outside world during 6 sunless months.

Given those challenges, it's no wonder the National Science Foundation (NSF) has spent 4 years chewing over more than a dozen different configurations to replace the current station, built in 1975. Proposals, fluctuating between the aesthetic and the practical, have ranged from half-buried mounds to a globe on stilts. But the first solid design is finally emerging from the cloud of half-formed ideas.



ADAIR P. LANE

(N)ice and comfortable. The proposed South Pole station *(right)* would result in more science with less maintenance than the current structure *(above)*.

SOURCE: FERRARO, CHOI & ASSOCIATES

This week, NSF is expected to propose a structure consisting of three horizontal U-shaped modules on stilts, connected by flexible enclosed walkways. Each of the elevated modules will have two floors; some will contain sleeping and personal space, others will have lab areas, recreational rooms, a cafeteria, and conference rooms. At 120,000 square feet, the new station will be some 33,000 square feet larger than the existing dome and underground arches that comprise the current station. It will be able to house 150 people in summer—25 more than the current overcrowded accommodations—and 50 in winter, compared with the current overcapacity of 29. But the biggest difference is in the way each person will be housed: Individual rooms and workspaces, windows, and a mix of common and team space will allow for efficient working conditions even during the depths of winter.

The design is dominated by the need to prevent the relentless drifts from burying the station. Today, bulldozer crews spend nearly the entire summer digging the current dome out from its winter accumulation; to avoid a "bowl" effect, they now have to push the snow nearly a mile away. The new station will be almost maintenance free, with each module perched on legs above the ice. The raised modules will have their leading edges sloped to deflect a nearly constant 10- to 15-mph wind and accelerate it underneath the structure, thereby reducing the accumulation of snow. Because some drifting is inevitable, the modules are designed to be raised when the "ground" gets too close. Likewise, because the ice sheet on which the new station will be built is moving, the walkways that connect the modules are flexible.

Inside the station, quarters will seem luxurious compared to the existing berths, where welders' curtains often provide the only privacy and metal lockers the only personal storage. The station will also have a gym, a room with a ceiling high enough for volleybag (a game played with a beanbag instead of a ball), and a sound-proofed practice room for the pick-up rock bands that have become a South Pole tradition. NSF's polar operations manager, Erick Chiang, hopes the new station will feel "like a reasonably good motel," with at least one special feature: a 3000-square-foot area in which treated sewage fertilizes vegetables and perhaps some fruit.

As for working conditions, laboratory space will consist mostly of flexible work stations, open areas, and a machine shop. Power will be provided initially by the same sort of diesel-electric power plants that provide heat and electricity for the current station. But NSF is also planning on some passive solar heating—during the summer months, the pole is the sunniest spot on Earth—as well as exploring photovoltaics and wind turbines for supplemental power. To ease fuel consumption, the new station will be insulated to a value nearly five times that of the average U.S. residence.

Outside, the surrounding ice will be divided into science sectors: "Dark" for astrophysics; "Quiet" for seismology; "Clean air" for atmospheric sampling; and perhaps a balloon launch sector as well. A fifth sector is the actual pole, a significant geopolitical feature as well as a tourist attraction.

Symbolism is important when redesigning South Pole station, says Joseph Ferraro, with the Honolulu firm of Ferraro, Choi & Associates, Ltd., the proposed new station's chief architect. "NSF wants a really impressive shape," he says, as well as a way to clean up the surrounding area, now littered with crates and temporary scientific structures. One option would give the station the look of a wing by connecting the modules with a flexible mesh.

One symbol that is not expected to survive the redesign is the familiar dome. Although the dome will be used to house the estimated 80 workers and their equipment during the 8 years of construction, it will be taken down when the new station is finished. Not only would the dome continue to present a drifting problem, says Chiang, but "we just didn't feel it would be right to turn this symbol into a shed."

–Christopher Anderson

people to the winter-over crew, it provides better working conditions for scientists affiliated with the center. As a consequence, when Stark makes his fourth visit to the pole in November, he'll be stepping into comparative luxury. Instead of lugging a low-budget prototype with him, he'll meet up with a $3-million, 10,000-pound Antarctic Submillimeter Telescope and Remote Observatory (AST/RO), which was built, assembled, and calibrated in Boston and shipped across the Pacific by boat. Instead of toiling outside, Stark will use the telescope to map star-forming regions of the galaxy from inside a well-heated building. And when the austral summer ends, AST/RO will be tended by a graduate student who will winter over and operate the observatory until Stark returns in November 1995.

This fall, construction crews will complete work on a second building that will be a permanent home for two other CARA instruments currently occupying AST/RO's quarters. One, called Python, is a microwave telescope measuring the temperature of the early universe (*Science*, 25 March, p. 1683). It's operated by a team led by Dragovan, who's in the process of moving to Yerkes from Princeton University. The second, called SPIREX (South Pole Infrared Ex-

plorer telescope), is looking at the evolution of distant galaxies. A fourth CARA team, led by John Bally at the University of Colorado, is already drawing up plans for a second generation of larger and more sophisticated instruments for each team. Bally's group is also gathering data on the characteristics of the pole as an observatory and sketching out plans for a training center on a peak in the Colorado Rockies that would be a test bed for staff and equipment headed to the pole.

CARA scientists aren't the only ones thinking big. Last week, a group of high-energy physicists, including NSF advisory panel member astrophysicist P. Buford Price of the University of California, Berkeley, met with Representative George Brown (D–CA), chairman of the House Science, Space and Technology Committee, in his district to describe a follow-up project to AMANDA, costing upwards of $50 million, that would place several thousand photo tubes down hundreds of holes in a region 1 kilometer across and more than a kilometer down into the Antarctic ice. "We don't have a concrete plan yet for the next detector," explains Ben Shen, a professor of physics at the University of California, Riverside, which is in Brown's district. "But people felt it was important to educate Congress as early as possible and to ask Mr. Brown for advice on the best way to proceed."

But unfortunately for researchers, the present Amundsen-Scott Station is coming to the end of its useful life just as scientific opportunities are burgeoning. "The aging facilities are already at capacity," says Cornelius Sullivan, director of NSF's office of polar programs. "And in less than 10 years they won't even be habitable."

Anyone who's been there can recite a list of hardships endured, including sleeping in Korean-era canvas tents and walking 50 to 100 feet to toilets that are simply holes in the ice. But there are also more serious problems. A few years ago, NSF was compelled to repair structural breaks in a portion of the station caused by the weight of drifting snow, a problem that requires 24-hour attention during the summer months. Much of the insulation has become water-soaked and ineffective, driving up the cost of heating the station. There's also the growing need to give researchers enough working space, electrical power, and computer networks to do what attracted them to the bottom of the world. "We could keep the current facility open indefinitely," says polar operations manager Erick Chiang, "but we'd have to devote almost all our resources to simply maintaining a presence. There wouldn't be any capacity to do science."

Although building a larger and more modern station that can withstand the elements is, by itself, an enormous challenge, the biggest hurdles to NSF's plans for expansion at the South Pole are likely to be political and financial rather than technical. NSF officials and science board members say they are awaiting the report of the advisory panel before deciding on a course of action. But Sullivan and others have already laid some political groundwork, discussing the need for a new station "with anyone who would listen"—including then-Senator (now Vice President) Al Gore during a 1988 visit to the South Pole. NSF has even carved out a new budget category for the station, a large facilities account to separate big-ticket items within the physical sciences from the stiff competition for funds within its regular research programs. If approved, the new station would join two existing construction projects in this category, the laser interferometer gravity wave observatory (LIGO) and the twin, 8-meter telescopes (GEMINI).

One challenge for NSF is finding the proper niche for Antarctic science in a changing world. For nearly 4 decades, science has piggybacked on military efforts to combat the threat from the Soviet Union. The United States established a military presence at McMurdo Sound in 1955, followed by the first South Pole station in 1956, and science grew strong on the back of the perceived need to maintain what a presidential executive order describes as an "active and influential presence" in Antarctica. A small biological station was built in 1965 on the western peninsula to study the continent's living organisms. Indeed, the perceived military threat has been a boon to U.S. researchers: The Defense Department contributes $62 million to NSF's current $195-million budget for Antarctica in the form of a 700-person force to handle ground and air operations, an amount double NSF's budget for science alone.

PHOTOS BY STEVEN BARWICK

Taking the plunge. Team scientists *(inset)* help as a crane lowers part of the Antarctic Muon and Neutrino Detector Array down a 1-kilometer tunnel in the ice pack.

NSF officials are hoping that the end of the Cold War won't destroy that close and beneficial relationship. However, cracks are already appearing, the most worrisome of them being the Navy's eagerness to get out of the business of providing logistical support for science—a mission that now falls outside its military responsibilities. NSF is confident that it can find civilian contractors to do some of the Navy's work, but military personnel are uniquely qualified to fly NSF's seven LC-130 transport planes, which can land almost anywhere on the Antarctic ice. Officials from several federal agencies with a stake in Antarctica have been meeting for 2 years to resolve the issue without unintentionally weakening the U.S. presence on the continent.

Science for its own sake

The advisory panel, on the eve of its meeting, seems favorably disposed to NSF's plans for expansion. Two of its 10 members—Berkeley's Price and atmospheric scientist Chester Gardner of the University of Illinois—are currently doing NSF-funded research at the pole, and two more—NASA chief scientist France Cordova and National Weather Service deputy director Robert Landis—work for federal agencies who support research there. Gardner, for one, thinks it's time the country embraced the scientific opportunities afforded by the pole for their own sake, rather than as an adjunct to national security. "What we're seeing is a shift from justifying our presence by doing science to focusing on some of the most crucial scientific issues of the day," says Gardner, whose team uses a lidar—the laser equivalent of radar—to take detailed atmospheric measurements over the pole.

Whether or not NSF's plans for a new station become reality next year, a growing number of scientists are deciding that the South Pole is the place they want to be. "I've been thinking of doing work at the pole since I was a graduate student, more than 20 years ago," says CARA's Harper. "But for a long time, there were always interesting things that I could do elsewhere. Now the most interesting things in my field are being done at the pole, and I think other people are coming around to that view, too."

–Jeffrey Mervis