Full speed ahead for cosmic ray project

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This is one of many sets of mirrors, covered by protective cloth, being installed in the Black Rock Mesa fluorescence detector building, one of three such facilities under construction as part of the $17 million Telescope Array cosmic ray observatory being built in Utah by scientists from the University of Tokyo, the University of Utah and other institutions. The fluorescence detector mirrors will scan the sky for faint ultraviolet flashes that occur when cosmic rays from space hit nitrogen gas molecules in the atmosphere. Credit: Robert Cady, University of Utah.

Construction is accelerating on a $17 million cosmic ray observatory west of Delta, Utah, thanks to two U.S. agencies: the Bureau of Land Management issued a permit, and the National Science Foundation approved a $2.4 million grant.

Known as the Telescope Array, the observatory "will be 10 times more

sensitive than previous experiments, and we hope it will allow us to finally resolve the mystery of the origin of these ultrahigh-energy particles [cosmic rays] that are bombarding the Earth," says Pierre Sokolsky, professor and chair of physics at the University of Utah.

"We'll have the most powerful cosmic ray detector in the Northern Hemisphere," says Charlie Jui (pronounced Ray), a University of Utah professor of physics.

Sokolsky says the new observatory should begin test runs in late spring 2007, start full operation by late summer 2007 and then conduct research for up to 10 years.

Some 250 scintillation detectors sit in a field in Delta, Utah, while awaiting installation as part of the Telescope Array, a $17 million cosmic ray observatory under construction in the desert of western Utah. The observatory will include 564 scintillation detectors placed in a grid pattern over an 18-mile-by-22-mile area, as well as three buildings containing mirrors known as fluorescence detectors. Credit: Robert Cady, University of Utah.

So far, the Telescope Array has been funded by $14.4 million from

Japan's government. The three-year, $2.4 million grant from the National Science Foundation will let University of Utah physicists relocate equipment to the new facility from their aging High-Resolution Fly's Eye cosmic ray observatory on the U.S. Army's Dugway Proving Ground.

Structures and roads will occupy only 50 acres of the 400-square-mile experiment site, although the Bureau of Land Management permit allows the use of 374 acres.

At three locations on Utah school trust land, buildings will house "fluorescence detectors," which are sets of mirrors and recording instruments that peer into the night sky for faint ultraviolet flashes that occur when incoming cosmic rays hit atoms of nitrogen, the most abundant gas in Earth's atmosphere. Each of the three sites will be about 25 miles from the others. A "central laser facility" building, located between the three fluorescence detector sites, will send laser beams skyward when the mirrors and recorders need to be calibrated.

The other major component of the observatory is a "ground array" of 564 table-shaped scintillation detectors, each about 3 feet tall and 6-by-10-feet wide. The devices will measure "air showers," which are cascades of subatomic particles that fall to Earth when cosmic rays slam into nitrogen in the atmosphere.

The scintillation detectors will be spread in a grid over an 18-mile-by-22-mile area west of Delta. The Bureau of Land Management "right-of-way grant/temporary use permit" will allow scientists to build the central laser facility and install 460 of the scintillation detectors on BLM land, which covers 80 percent of the observatory site. Permission to install the other 104 scintillation detectors already was obtained from the State of Utah and private landowners. They own the remaining 20 percent of the sprawling site.

Scientists Cooperate Instead of 'Duking it Out'

The new cosmic ray observatory will seek to answer one of the most perplexing mysteries in physics: What is the source of ultrahigh-energy cosmic rays, which are subatomic particles that come screaming into Earth's atmosphere with incredible energy?

Cosmic rays are atomic nuclei – atoms stripped of their electrons – of chemical elements, mainly hydrogen and helium. The atmosphere prevents them from hitting Earth, and even if they could, they would zip through a person unnoticed. But if a single ultrahigh-energy cosmic ray could hit your head, it would feel like a fast-pitched baseball.

Some cosmic rays come from stars that explode as supernovas. But ultrahigh-energy cosmic rays are more powerful, and apparently come from distant reaches of the universe. Sokolsky suspects they originate from "active galactic nuclei," which are supermassive black holes formed when about 1 billion collapsed stars amass at the centers of galaxies. Other possible sources include shock waves from colliding galaxies, noisy radio wave-emitting galaxies, exotic sources such as theorized cosmic strings and the decay of massive particles left over from the "big bang" scientists say created the universe about 13 billion years ago.

The Telescope Array will merge two technologies that have counted strikingly different numbers of ultrahigh-energy cosmic rays reaching Earth. Japan's AGASA cosmic ray observatory has detected 10 times more of them than the High-Resolution Fly's Eye. Sokolsky says the large number measured by AGASA implies the source is relatively nearby in the universe, but there are no known astronomical objects that could be the source.

So the Telescope Array will include fluorescence detectors like those

used in the High-Resolution Fly's Eye and scintillation detectors like those used at AGASA.

"This experiment is unique in the sense that it is the union of two initially competing science groups: a Japanese group and an American group which ran two separate experiments for a decade and came up with mutually incompatible results," Sokolsky says. "It is certainly unusual in the history of scientific endeavors like this that, instead of duking it out forever, they decided to join forces and build an experiment together to resolve the differences."

The High-Resolution Fly's Eye and AGASA have reached the end of their useful lives – more powerful instruments are needed – and operation of the High-Resolution Fly's Eye became difficult in the wake of the Sept. 11, 2001, terrorist attacks on New York and Washington. Dugway conducts research on defense against chemical and biological weapons, and tighter restrictions kept the university's foreign graduate students from visiting the site.

BLM: Survey Wildlife, Use Copter to Install Some Equipment

In issuing the permit, the BLM required the University of Utah to conduct surveys for and protect cultural resources, endangered and threatened plants, and wildlife such as kit foxes, burrowing owls and raptors, Sokolsky says.

The observatory builders will use helicopters – not all-terrain vehicles – to install the scintillation detectors, and "we have agreed to maintain them either by foot or by horseback" in places without road access, Sokolsky says. Helicopters will be used if a major problem develops with a detector, but that is expected to be unusual. Scientists also are

required to take digital photos when they visit a detector site and monitor any changes over time.

Here is the status of various components of the Telescope Array:

-- Construction of the observatory began in August 2004 at the first of three fluorescence detector sites, located atop Black Rock Mesa about 13 miles south-southwest of Delta. The building is complete, and many of the mirrors have been installed. The Black Rock fluorescence detector will be finished by the end of this summer.
-- Construction of the second fluorescence detector began in December 2005 at Long Ridge, 30 miles southwest of Delta. The building will be finished by the end of summer, and the mirrors will be installed before winter.
-- Unlike the Black Rock Mesa and Long Ridge detectors, which are being built with Japanese funds, the third fluorescence detector will be built by the University of Utah using the National Science Foundation grant. Named Middle Drum, it is located 25 miles northwest of Delta. Site preparation should start in August, with one or more buildings to hold mirrors complete by December, Sokolsky says. Mirrors and other equipment must be removed from the High-Resolution Fly's Eye at Dugway, cleaned and modified at a Salt Lake City warehouse, and then trucked to the Middle Drum site by next summer.
-- The central laser facility – located equidistant from the three fluorescence detectors – will be built starting in August and should be finished within a month or so.
-- Installation of the scintillation detectors on BLM land is expected to begin in late July or early August once the agency gets results of the required wildlife surveys, says Sokolsky. The first 200 scintillation detectors already have been built, and are stored in a field in Delta, looking "like a giant field full of hospital beds," he adds. They will be trucked to staging areas, and then lifted into position by a helicopter. Sokolsky says the remaining 364 scintillation detectors will be installed

by December.
-- The university has opened the Millard County Cosmic Ray Center in Delta, using $150,000 in state and private funds to buy and equip a building. The scintillation counters are being assembled there and stored in an adjacent, rented field, but the center primarily will house exhibits to educate the public about cosmic ray research.

Source: University of Utah