

SETI IS DEAD

LONG LIVE SETI

The closure of the Allen Telescope Array shifts the search for extraterrestrial intelligence away from big science.

BY M. MITCHELL WALDROP

Out where the Hat Creek Valley twists among the ancient lava fields north of California's Lassen Peak, the only sounds are the wind and the lowing of distant cattle. The soft growl of antenna motors has long since fallen silent; all 42 radio dishes of the Allen Telescope Array stand motionless in the hot summer sun, staring blindly at the mountains on the southern horizon.

The grass growing around their mounts — its neatness once a point of pride for observatory staff — is getting shaggy. The two caretakers still on site at the Hat Creek Radio Observatory don't have the resources to keep it trimmed. For nearly four years, these dishes listened for radio signals from an alien civilization. But since April, when the state's budget crisis forced the University of California, Berkeley, to suspend operations at the observatory, the world's largest instrument dedicated to the search for extraterrestrial intelligence (SETI) has been left in limbo. If the money cannot be found to reopen the array, the 6-metre antennas will have to be dismantled and removed.

The melancholy vista at Hat Creek makes it easy to entertain equally melancholy thoughts about the SETI enterprise itself. It's the ultimate in high-risk, high-payoff science, pursued by only a handful of passionate researchers. In 50 years of searching, they have turned up nothing — and they can't quite shake an association in the public mind with flying-saucer sightings and Hollywood science fiction, all of which is so easy for cost-cutting politicians to ridicule that any substantial federal funding for SETI is impossible. Private support for the search is getting tighter because of the global recession. And many of the pioneers who have championed the search are now well into their 60s, 70s or 80s.

Given all that, what kind of future can SETI have? Quite a vigorous one, insist the SETI researchers. By nature they are an optimistic lot, given to taking the long view. "I'm a Pollyanna" about raising the money to restart the Allen array, declares Jill Tarter, head of the search programme at the SETI Institute in Mountain View, California — the nonprofit research organization that conceived the array, operated it in partnership with astronomers at Berkeley and is now seeking the funds to resurrect it. Besides, the array is only one SETI initiative among many.

"If it closes I'll be sad for my colleagues at the SETI Institute," says Daniel Werthimer, a radio astronomer at Berkeley who runs several



S. SHOSTAK/SPL

The 42 antennas of the Allen Telescope Array in California listened for alien radio signals for four years, until lack of funding forced the array's closure in April.

SETI surveys using data from the 305-metre radio dish at the Arecibo Observatory in Puerto Rico, “but that’s not going to affect us here.” Or elsewhere: smaller, cheaper SETI searches are currently being conducted on telescopes around the world (see ‘Search engines’). Some are seeking alien radio beacons, whereas others are looking for the flicker of interstellar communication lasers. Some projects are looking at specific stars that seem likely to host Earth-like planets; others are doing a less sensitive but broader scan of the entire sky in the hope of catching signals of a type not yet conceived.

The reason to keep going is in that plethora of projects, says Frank Drake, an early pioneer of SETI studies and now an 81-year-old emeritus professor at the University of California, Santa Cruz. Our Galaxy is vast. The fraction searched so far is tiny. And the conceivable modes of alien communication are myriad. So there are always new possibilities to explore. Or, as Tarter likes to put it, giving up now would be like dipping a cup into the Pacific Ocean, finding nothing but clear water and declaring, ‘the oceans have no fish’.

INTELLIGENCE TEST

From this wider perspective, the closing of the Allen array would mark the end of a ‘big science’ approach to SETI, but not of SETI itself. And, as the array’s creators ruefully admit, even that approach might have succeeded — if it were not for their own early miscalculations.

Like every modern SETI effort, the Allen array follows the path blazed by Drake in 1960, when he was a staff astronomer at the National Radio Astronomy Observatory in Green Bank, West Virginia, and managed to wangle 200 hours of telescope time to mount the first search for alien signals. Focusing on just two of the closest Sun-like stars, Tau Ceti and Epsilon Eridani, his Project Ozma yielded nothing but static. But Drake’s effort got some prestigious support from physicists Giuseppe Cocconi and Philip Morrison of Cornell University in Ithaca, New York, who had independently come to the same conclusion he had: that massive new radio telescopes like the ones at Green Bank could detect potential alien signals across interstellar distances (G. Cocconi and P. Morrison *Nature* **184**, 844–846; 1959).

Between Drake, Cocconi and Morrison, SETI gained instant scientific credibility, which began to draw other scientists into the field. “I realized I was part of the first generation that didn’t have to ask a priest the ‘Are we alone?’ question,” says Tarter, who committed her career to SETI in 1971 at the age of 27, after reading NASA’s first major report on the subject.

For advocates, the obvious next step was a large-scale, federally funded effort to listen for aliens in as much of the Galaxy as technology allowed. This was a tough sell in Congress, says Drake. “Their first question is, ‘How long will it take?’, and you can’t tell them.” Then they ask how much it will cost — and that depends on how long it takes. “So you can’t guarantee success,” says Drake, “and you’re asking them for a blank cheque.”

But the SETI advocates persevered, and in October 1992 the first phase of NASA’s US\$12-million-per-year SETI search, dubbed the High Resolution Microwave Survey (HRMS), got under way at Arecibo, targeted at the 1,000 nearest Sun-like stars.

A year later it was dead: Senator Richard Bryan (Democrat, Nevada) engineered a bill cancelling the HRMS as an utter waste of taxpayers’ money. “The Great Martian Chase may finally come to an end,” he proclaimed. From then on, says Tarter, “we became the 4-letter ‘S-word’ at NASA headquarters”.

The SETI Institute moved quickly to pick up the pieces. It had been founded in 1984 by scientists from NASA’s Ames Research Center in Moffett Field, California, and had been managing the first phase of the HRMS under contract to Ames. So it had no problem hiring many of the NASA employees who had been working on the programme, and arranging to use the custom-built signal analysers that NASA had already paid for. (These devices were designed to scan radio-telescope data for extremely narrow-band

emissions, which were presumed to be the technological signature of an alien civilization; all known natural radio sources have a much broader bandwidth.)

“We sponsored a big series of workshops between 1997 and 1999 on what the future of SETI ought to be,” says Drake, who served as the first chairman of the SETI Institute’s board of trustees, and is still a board member. One of the prime recommendations was the construction of a large array of small, high-quality radio telescopes that could be dedicated full-time to SETI surveys. As in any radio array, the signals from all the antennas could be combined to look as though they came from a single antenna covering the same area — in this case, spanning 10,000 square metres, or one hectare. The One Hectare Telescope, as it was then known, became the SETI Institute’s top priority.

To help create it, the institute enlisted the telescope-building expertise of the Radio Astronomy Laboratory at Berkeley, where researchers were interested in using the array for conventional surveys of galactic and extragalactic radio sources in parallel with SETI. The partners agreed that the institute would raise the money to build the array, and that Berkeley would design it and pay for 20 years of operation at Hat Creek.

And that, looking back, was when the miscalculations started. “The Allen array was born in a time of irrational exuberance, and ended in the great recession,” says Geoffrey Bower, a radio astronomer at Berkeley who was deeply involved in designing the array. “Those two play a big role in how it was imagined, and now how it’s coming to an end.”

A prime example of over-optimism was the antenna design. The original concept, proposed by Drake, was to use commercial satellite-television dishes as a way to keep the initial antenna cost to an absolute

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minimum. He had been inspired by a 3-metre dish that he had bought and assembled himself for \$600, and that still stands behind his house in the hills near Santa Cruz. “It has receivers on it as good as any radio telescope,” he says. For the array, which was intended to have 350 antennas, Drake found a commercial manufacturer in Wisconsin that would sell him 4.2-metre dishes — good enough, he felt — for about \$1,100 apiece.

But that plan was quickly set aside as the Berkeley team came up with multiple innovations for optimizing performance. Less noise in the receivers. A wider frequency range. More-sensitive measurements of the radio waves’ polarization. More sophisticated electronics.

Tarter and her colleagues at the SETI Institute endorsed these design decisions. But the attempt to do so many new things inevitably led to overruns and delays. The result, despite other innovations to minimize the price tag, was a design for 6-metre antennas that would cost at least \$200,000 apiece. “If we had just reduced the technical complexity of the telescopes early in the project,” says Bower, “we could have built hundreds of them.”

They might have been able to do so anyway — except that the SETI Institute was beginning to realize that it might not have been such a good idea to start the project without getting all the money up front. “We’re scientists,” sighs Tarter. “What did we know?”

The first \$25 million was easy enough to raise through the institute’s contacts in the computer industry. Paul Allen, co-founder of the software powerhouse Microsoft, promised to contribute that much towards design and construction, and the facility was renamed the Allen Telescope Array. But by the time Allen’s first instalment of funds arrived in 2001, the industry was reeling from the collapse of the dot-com boom, making further donations harder to come by. And those computer-industry philanthropists who were still giving, preferred to fund projects

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SEARCH ENGINES

With the US\$50-million Allen Telescope Array shuttered, the search for extraterrestrial intelligence (SETI) is now sustained by 'small-science' efforts that use borrowed telescope time and inexpensive detectors to seek radio and optical signals from aliens.

RADIO SETI



SETI AT BERKELEY

Analyses data from the Arecibo radio telescope in Puerto Rico and includes SETI@home, which uses processing power donated by home computers.

Cost: ~\$175,000 plus ~\$550,000/year
Funder: Various, including SETI@home participants



SOUTHERN SETI

One of the few Southern Hemisphere SETI projects, this uses two 30-metre antennas at the Argentinian Institute of Radio Astronomy, near Buenos Aires.

Cost: ~\$16,500/year
Funder: The Planetary Society in Pasadena, California



PROJECT ARGUS

Coordinating SETI observations by hobbyist radio astronomers, this project currently comprises 147 home-built dishes.

Cost: ~\$4,000/dish
Funder: Participants

OPTICAL SETI:



SETI AT BERKELEY

A detector on a 0.76-metre telescope at the University of California, Berkeley's Leuschner Observatory searches for nanosecond pulses of laser light.

Cost: ~\$70,000 plus ~\$12,000/year
Funder: The SETI Institute in Mountain View, California, and Planetary Society



SETI OPTICAL TELESCOPE

This 1.8-metre telescope in Harvard, Massachusetts, also looks for nanosecond laser pulses.

Cost: ~\$350,000 plus ~\$20,000/year
Funder: SETI Institute; Planetary Society; and Bosack-Kruger Charitable Foundation in Redmond, Washington



LICK OBSERVATORY OPTICAL SETI

A detector on a 1-metre telescope at Berkeley's Lick Observatory looked for laser pulses in 2000–07. Berkeley is seeking \$100,000 to resume the search.

Cost: ~\$20,000 plus ~\$12,000/year
Funder: SETI Institute and Planetary Society

with a nearer-term, more tangible payoff. "We don't have patients we can cure," says Thomas Pierson, the SETI Institute's chief executive, summing up the problem.

In the end, the institute was able to raise only about \$50 million in total, roughly \$60 million shy of what it would need to pay for all 350 dishes. The array began operations in 2007 with just 42 antennas. This lack of collecting area greatly slowed down the alien-hunting. And worse, it left the array without the sensitivity required for cutting-edge radio astronomy — a fact cited by the National Science Foundation in 2008 when it declined to renew the grant that the university had been using to fund Hat Creek operations. Suddenly, Berkeley had no way to pay the array's \$2.5-million annual operating costs.

The partnership managed to limp along for a few more years. But its increasingly urgent efforts to find a permanent source of funding ran headlong into the worldwide economic downturn and California's resulting budget crisis. On 22 April 2011, Berkeley and the SETI Institute were forced to pull the plug on Hat Creek.

THE SEARCH CONTINUES

Berkeley doesn't hold out much hope of reopening the array, and has started to look at other radio-astronomy projects. "We've poured everything we had into the array," says Bower, "and really hit a wall with it."

The SETI Institute, though, is still trying. In June, it launched an experiment in 'crowd-sourced' funding on a website called SETIstars.org, through which individual supporters can make donations of \$10–1,000. The hope is to raise a few hundred thousand to a million dollars per year that way (the take so far is just over \$100,000). The institute is also in ongoing talks with the US Air Force, which is interested in providing some operations money in return for part-time use of the array to track debris in orbit around Earth.

But if the closure proves to be permanent, say institute officials, their plan B is to fall back on smaller-scale efforts — in effect, turning to the methods that the rest of the SETI community has followed all along. This approach tends to be very ad hoc and informal, says Werthimer. It's done with limited funding, borrowed telescope time and investigators who, like Werthimer himself, do SETI only part-time. "And that's the way it should be," says Werthimer. "It's naive to think that we know what ET, a billion years ahead of us, is going to be doing. So we want to be a small-scale science, trying lots of things."

Data from the Arecibo telescope, for example, are sent to five receivers at once: three doing conventional radio surveys, and two, operated by Werthimer's group, doing SETI. At the Oak Ridge Observatory in Harvard, Massachusetts, Paul Horowitz — a Harvard University astronomer — and his students are searching for extraterrestrial laser pulses with a small optical telescope, built for the search with roughly \$300,000 from nonprofit organizations.

"I see SETI as a terrific thing for a graduate student," says Horowitz. "It's an unploughed field." Students can think up a plausible mode of extraterrestrial communication; design, build and test a detector; analyse the data; and get tangible, hands-on experience. Most students in conventional astronomy just get observation time on a big, institutional telescope. "When I first heard what Dan was doing — wow! I couldn't imagine doing anything else," says Andrew Siemion, who is writing his PhD thesis on SETI instrumentation under Werthimer.

Perhaps this is the lesson from the mothballed array at Hat Creek: the odds against success with SETI are so long that it is best done as a small-science, part-time pursuit. Or perhaps not: the SETI Institute may yet find a way around all the funding woes and political headwinds, and bring the Allen array back to life.

Either way, SETI is not going to disappear. "I went into SETI because it was just too cool not to," says Horowitz. And others will too, he says. "All you need is a university environment, with a few tenured faculty willing to host something wacko. The question is always interesting, and there will always be people willing to take a long shot." ■

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