Low-cost EUV satellite shut down

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University of California, Berkeley, scientists quietly switched off one of the campus's working satellites last month, ending a 10-year series of ups and downs for NASA's first and only low-cost, university-class Explorer spacecraft.

The Cosmic Hot Interstellar Plasma Spectrometer satellite (CHIPSat), funded by NASA in 1998, was designed to look for extreme ultraviolet (EUV) emissions from the bubble of hot gas that envelops our solar system out to a distance of several hundred light years.

Five years later, after two cancellations and anxious scrambling for launch space by Mark Hurwitz, the UC Berkeley physicist who shepherded the satellite from its original concept, CHIPSat was launched on Jan. 12, 2003. The total cost was $14.5 million. The only other university-class Explorer (UNEX) mission approved never made it to launch.

On April 11, 2008, not long after its fifth anniversary in orbit, CHIPSat was essentially told not to call home anymore.

"It is sad and liberating," said Hurwitz, who, during CHIPSat's lifetime transitioned from a data-crunching research astronomer to a high school physics teacher at Lick-Wilmerding High School in San Francisco. "It's been lucky that the project has gone on as long as it has, and it has been very cool."

Although the team needed only about $100,000 to operate the satellite

through the rest of 2008, Hurwitz said the budget climate is tight and that NASA personnel do not have the discretion they had in past years. According to Patrick Crouse, project manager for space science mission operations at NASA's Goddard Space Flight Center, CHIPSat is one of five satellites turned off since last fall, and only two of them had become inoperable.

"Typically, missions just kept getting extended, but we're now reaching the end of diminishing returns on some of these small satellites," said Crouse, who still oversees about 20 other satellites for Goddard.

The CHIPS instrument never did detect EUV radiation from the hot interstellar gas, which may be cooler or hotter than the million-degree Kelvin temperatures expected, or else theories of what makes up the sparse material between stars are incomplete. After about three years of operation, Hurwitz concluded from CHIPS measurements that the EUV glow of the local interstellar medium was less than one-thirtieth expected, and redirected the satellite to look at EUV emissions from the sun.

Hurwitz and colleagues at UC Berkeley's Space Sciences Laboratory had hoped that NASA would be interested in such studies, since they complement the observations of other satellites studying the sun's ultraviolet emissions.

"CHIPSat's instruments can provide a high-resolution solar spectrum that can help us learn about the temperature distribution in the sun's chromosphere and corona and the EUV input to the photochemistry in Earth's upper atmosphere," Hurwitz said.

Additionally, from an altitude of 575 kilometers, CHIPSat was observing the so-called "ultraviolet sunset" in the tenuous outer layers of Earth's atmosphere, probing the distribution of nitrogen and oxygen high above

the surface of the earth. Unfortunately, NASA turned down two proposals to support such studies.

Hurwitz reminisced about the hurdles he had to overcome to get the CHIPS instrument launched in the first place. Though the original proposal called for attaching an extreme ultraviolet spectrograph to a commercial communications satellite to be launched aboard a Russian rocket, the U.S. government killed that idea when it unexpectedly applied to the CHIPS instrument a policy designed to prevent the launch of government-funded satellites aboard foreign launch vehicles.

"After the Russian rocket fiasco, we pounded the pavement for months, looking for any way to get our small instrument into space," recounted Hurwitz. "At the end of the day, we would have done just as well to stand on the side of the road near the Kennedy Space Center and stick out a thumb."

An offer to piggy-back aboard the launch of a global positioning satellite (GPS) made Hurwitz and his team scramble to build an independent satellite, CHIPSat, instead of a ride-along experiment, but that fell through in 1999. Finally, NASA switched CHIPSat into a Delta rocket to replace a satellite having problems, and the mini-satellite was launched in 2003.

"Many people at NASA and elsewhere assigned us a low probability of success," Hurwitz said. The satellite and instrument had been built on a shoestring, and without the parts qualification and test programs that the larger projects use. But both the satellite, built by SpaceDev Inc. of Poway, Calif., and the EUV spectrometer, built at UC Berkeley's Space Sciences Laboratory (SSL), performed beyond all expectations, he said.

"The operations team at UC Berkeley, led by Mark Lewis and Manfred Bester, has done a fantastic job over the years keeping an increasingly

temperamental satellite healthy and productive," he said.

CHIPSat has also been productive from an engineering perspective. It was NASA's first mission to communicate via IP (Internet protocol), and it was used by NASA's Exploration Initiative to test scheduling systems software in orbit. A small satellite group at the Ames Research Center in Mountain View, Calif., used CHIPSat to study real-time data during ground station passes.

"The design life was 18 months because, beyond that, the cumulative effects of radiation and thermal cycling had a good chance of causing component failure," said Michael Sholl, CHIPS project manager at the SSL. "But as happened with some other low-cost missions, once the CHIPS instrument survived the first few months, it proved to be sufficiently robust for long-term operations."

The SSL team and NASA both are still open to reviving CHIPSat if the need arises. Crouse noted that the SWAS (Submillimeter Wave Astronomy Satellite) spacecraft, which was turned off at the end of January, had been revived several times previously to make observations of comets and to view the Deep Impact collision.

"Turning it off does not mean it's unrecoverable," Crouse said. "These missions were designed so that someone could not accidentally shut them down forever, so the flip side of that is, it is hard to shut them down forever. We leave them in a pacified state but, if it was in the interests of the agency, we could try to recover them and bring them back."

That would have to happen before CHIPS falls from orbit and burns up in a fiery plunge through the atmosphere.

"The satellite could last five years or longer in orbit, and if NASA wants to turn it on again, I'd be happy to support that work," Hurwitz said.

Source: University of California, Berkeley