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A short FUSE

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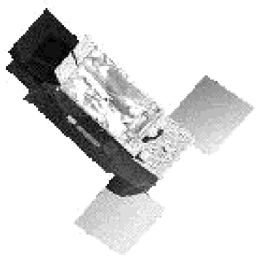
As space-walking astronauts preformed surgery on NASA's Hubble Space Telescope this week, an international team of astronomers and engineers was celebrating an even more remarkable space repair job.



Far Ultraviolet Spectroscopic Explorer, known as FUSE

Without ever leaving the ground they have revived a spacecraft that had been proclaimed dead by some in December.

"Instead of astronauts in spacesuits, we've got backroom guys and computer geeks in dark corners," says John Hutchings, at the National Research Council observatory in Victoria, B.C., whose team has been working overtime to repair the Far Ultraviolet Spectroscopic Explorer, known as FUSE.

The spacecraft, that circles the Earth 14 times a day at a height of about 750 kilometres, was launched in 1999 on a mission financed by NASA, the Canadian Space Agency and French Centre National d'ftudes Spatiales.

FUSE carries sensitive instruments that can peer through space to probe everything from black holes to the universe's structure. It was designed to last at least three years and expected to function far beyond that. But two years into the mission, the spacecraft started "creaking and failing," says Hutchings, the Canadian project scientist for the mission.

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The gyroscopes meant to steady the craft began to malfunction. And tape, used to prevent rattling during the spacecraft's launch, is thought to have become tangled with the reaction wheels that help guide the craft as it moves through space.

Hutchings says an investigation is underway to find out why the tape was ever used. It appears the tape became "so clogged up" with the machinery that two of the four reaction wheels had seized up by December and stopped spinning. When this occurred, FUSE automatically switched into a pre-programmed "safe mode" to prevent it from pointing directly at the sun, which would have fried the sensitive astronomical equipment on board. It also put an end to the observations FUSE had been making for astronomers.

Things looked bleak, so the engineers and scientists who had designed the craft decided to try some drastic rescue measures.

It dawned on them that the sophisticated Canadian-made camera on board the craft, designed to provide the extremely accurate pointing needed for astronomical measurements, could do extra duty on the navigational and stabilization front. And the long, thin magnets known as torquer bars on the spacecraft could be used to create a new guidance system.

The scientists scrambled to test their ideas on computers and lab simulators. Then, in recent weeks they been relaying new commands and programs to the spacecraft.

To the researchers' astonishment, the new guidance system actually works.

"There was a lot of jumping around in the corridors," says Hutchings, who was at FUSE mission headquarters at Johns Hopkins University in Baltimore, when the first components of the new guidance system were switched on a few weeks ago.

"We could scarcely believe our eyes," says Jeff Kruk, deputy chief of observatory operations at Hopkins.

Dr. Paul Hertz, FUSE program executive at NASA headquarters in Washington, says he would have "bet good money that it was end of life for the mission" when they lost two reaction wheels in December. "I am thrilled that the FUSE team pulled off a miracle and proved me wrong," he said in statement released this week.

In their desperation, the scientists have created a new breed of spacecraft that can operate without the finicky reaction wheels that are standard on most satellites and spacecraft, and malfunctioned so badly on FUSE.

At the heart of the new system is a technique that uses the push and pull of the Earth's magnetic field for steering. The FUSE scientists reprogrammed their spacecraft so electric currents could run through the craft's three torquer bars, which had initially served as part of FUSE's compass, to generate magnetic fields.

"By actively changing the electricity flow to the torquer bars with revised software, we can use the Earth's magnetic field to help point the satellite," says Bill Blair, chief of FUSE observatory operations at Johns Hopkins. "The control aspects come from the interplay between these locally generated magnetic fields and the magnetic field of the Earth."

With the navigation problems sorted out, FUSE is back in operation. And the scientific instruments on board are still in perfect condition. "There's been no degradation," Hutchings says.

Hutchings and his Canadian colleagues are now working to reprogram the Canadian-made camera on board the craft to do the job of the failing gyroscopes that are meant to keep FUSE steady in space. The camera is being reprogrammed to become multi-tasking, calculating the craft's drift rate and locking onto guide stars as part of the new guidance system.

Final computer programming and simulations are underway in Victoria, and Hutchings says the overhaul should be completed by the end of March.

The international team operating FUSE now hopes to get another two years of observing time from their repaired craft. Before FUSE ran into trouble it gave scientists a much better picture of the fierce stellar winds that blow through the heavens generated by massive stars that are so bright they are blowing themselves apart, says Hutchings. FUSE has also provided a detailed look at the bizarre reality of black holes; one of the black holes they are studying is in the process of swallowing up a neighbouring star.

In addition, FUSE, which cost about US$120-million, has given the astronomical community its best glimpse yet of the "ghostly cobweb" of helium gas left over from the Big Bang, which underlies the universe's structure.

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