Saving Solar Max: Satellite rescue effort by shuttle renewed

One of the most highly touted examples of the space shuttle's potential has been that of retrieving ailing satellites from orbit for repair, either aboard the shuttle itself or by bringing them back to earth. Multi-million-dollar satellites have been known to succumb to maladies as technically trivial as blown fuses, but the shuttle offers the promise of being able to simply replace the faulty parts, particularly if the satellites are designed with plug-in modules to make it easy.

The only such satellite yet flown is the Solar Maximum Mission spacecraft, designed to study the sun during the most active part of its 11-year cycle. It was launched on Feb. 14, 1980, and 10 months later suffered just such a frustrating malfunction: The fuses blew in its primary attitude-control system, leaving three of the craft's seven scientific instruments virtually useless for want of accurate aiming. "Solar Max" seemed a natural candidate for a rescue mission by the shuttle, and last spring, the National Aeronautics and Space Administration studied the prospect in detail (SN: 5/23/81, p. 324). An apparent problem turned up, however, when analysis showed that getting the shuttle to Solar Max's altitude (expected to be about 270 nautical miles instead of the shuttle's usual 160) would require either launching the vehicle empty, thereby wasting payload capacity, or equipping it with an expensive auxiliary fuel kit for its orbital-maneuvering engines. With such a choice, NASA's associate administrator for space transportation operations, Stanley Weiss, called the rescue mission only "a remote possibility" (SN: 6/27/81, p. 406).

Now the agency would like to attempt the mission after all. More recent analyses of the shuttle's performance, says Don Turner, the rescue plan's program manager, indicate not only that the auxiliary kit could be dispensed with, but that the shuttle could deliver a substantial payload into orbit during the ascent. NASA estimates that the effort would cost about $22 million and is hoping that Congress will grant permission to get $18 million of that by reprograming funds from the agency's FY 1982 budget.

Besides restoring the usefulness of the three crippled sensors, says NASA, the revitalized attitude-control system could extend Solar Max's orbital lifetime by two years or more. Futhermore, Weiss notes, the in-orbit servicing would serve as a "pilot project" for the upcoming Space Telescope, scheduled for launch in January 1985 and which will need periodic refurbishment during its envisioned 20-year lifetime. The Defense Department, too, is interested in the technique.

The leading candidate for the rescue mission, says Turner, is the shuttle's 13th flight, targeted for March 1984. It had been estimated that an unrepaired Solar Max would burn up in the atmosphere later that year, he says, but early 1985 now appears likelier from recent analyses of solar-activity data — including some from Solar Max itself. Says Turner, "It's helping to predict its own reentry." The flight would also be used to deploy NASA's Long-Duration Exposure Facility, a large framework carrying numerous test materials for a months-long evaluation of their responses to space conditions. (Left in orbit, LDEF would be retrieved during the same shuttle mission that had first deployed the Space Telescope.)

The rescue plan calls for the shuttle to approach Solar Max, after which a spacesuited astronaut would jet over to it using a backpack. Using a grappling device to grasp one of the satellite's fittings (provided for just such purposes), he would then use the backpack's cold-gas jets as a stabilization system to halt Solar Max's slow turning. The other astronaut would then guide the shuttle's long maneuvering arm to take the satellite in tow, return it to the payload bay and mount it on a servicing rack where the repairs would be accomplished. Besides installing a new attitude-control module (using a spare component from Landsat D, which was also designed with the plug-in system). NASA hopes to use the opportunity for some repairs to the probe's sensors: sticking a new thermal cover over a Hard X-Ray Imaging Spectrometer, installing a ring-seal around a vent from an X-ray Polychromator and swapping an electronic box on a Coronagraph/Polarimeter.

—*J. Eberhart*

New microscopy: An ion road to crystalline contrast

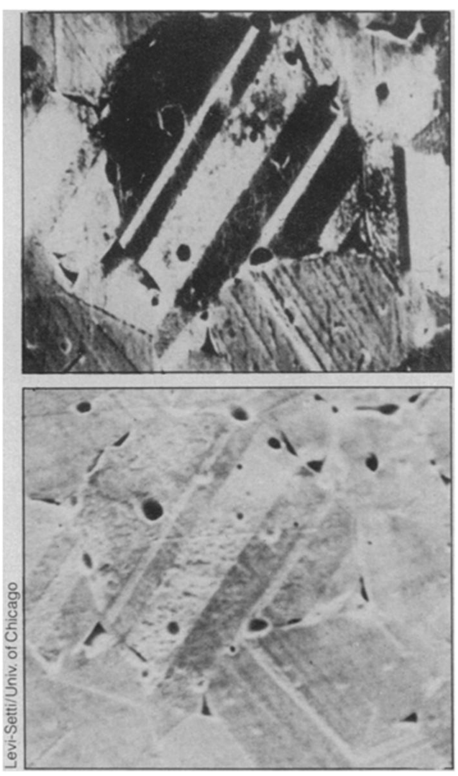
Impurities and minute structural defects in crystals seem to show up more clearly when microscopes use heavy-metal ions instead of electrons. A scanning ion microscope also allows microanalysis of a sample, while it produces images of the sample as it erodes away.

Physicist Riccardo Levi-Setti at the University of Chicago is working with the Hughes Research Laboratory to produce two new ion microscopes that will improve resolution to 100 angstroms or less, using gallium ions as a source. Levi-Setti says ions can initiate many unique phenomena that electrons cannot, and these provide information and contrast not otherwise available.

In the scanning ion microscope, an electric field of 1 to 2 volts per angstrom pulls gallium ions from the tip of a tungsten needle wetted with gallium, which is a liquid at room temperature. A system of electrostatic lenses and magnetic fields accelerate, focus and select the metal ions. When the beam hits the target, the ions cause the surface to sputter by emitting secondary ions and electrons, which are detected and form the image.

"In principle, the ions are causing damage, and you're taking advantage of it," says Levi-Setti. For example, the secondary ions sputtered from a surface can be collected and used with techniques like secondary ion mass spectrometry (SN: 10/24/81, p. 265) for doing microanalysis at high spatial resolution. "You can effectively look at some subsurface features," Levi-Setti says. "You sequentially peel off layers and see what's inside. One of the prime goals of a high-resolution, heavy-ion probe is that of using it as a milling tool for microfabrication in microelectronics applications."

Levi-Setti says, "It's a very practical diagnostic tool without being particularly fancy." □



Levi-Setti/Univ. of Chicago

A scanning ion microscope photograph, top, of recrystallized, polished brass shows more detail than a comparable scanning electron micrograph because channeling of ions into properly oriented crystals creates greater contrast. In the ion photograph, the broad white band that bisects the large central crystallite contains dark details that may arise from defects or impurities within the crystal.