

# THE NEW MILLENNIUM: SPACECRAFT THE SIZE OF TOASTER OVENS AND PAYLOADS THE SIZE OF SUGAR CUBES

By Karen Lustgarten

In the wake of federal government downsizing and budget cutbacks, NASA got the message that in order to stay in business, it must build "smaller, faster, cheaper" spacecraft. The space agency has responded with the New Millennium Program, managed by the Jet Propulsion Laboratory (JPL) in Pasadena, Calif. To support New Millennium missions, scientists at JPL's Center for Space Microelectronics Technology (CSMT) are developing motherships the size of toaster ovens that will carry even tinier microspacecraft known as "spaceships-on-a-chip." They'll be used to gather data on Mars, asteroids and the outer solar system.

Standing amid prototypes of miniature spacecraft systems, instruments and sensors bound for future missions, CSMT director Carl Kukkonen says the New Millennium Program "will validate the microtechnology in risky demonstration missions, such as the Mars program." CSMT conducts research and development in sensors, microelectronics and advanced computing for NASA, the Ballistic



Accelerometer

Missile Defense Organization and other Department of Defense agencies.

Spacecraft miniaturization is made possible by electron beam (E-beam) lithography, which etches circuits onto a silicon chip so small, they can only be read with an electron microscope. Kukkonen demonstrates the results of E-beam lithography by showing visitors a wall with pictures of 20 spacecraft and a plaque inscribed with the names of 7,600 JPL employees. In the middle of the wall you can look into a small hole and see a pinpoint of reflected light the size of a grain of salt. This light is actually an image written by the ultra-fine E-

beam of all the names and photos on the wall.

The equipment and technology used to miniaturize scientific instruments for smaller, faster, cheaper spacecraft are housed in the Microdevices Laboratory's \$3 million E-beam lithography clean room. It filters the air down from 10 million parts of dust per cubic foot (standard Los Angeles conditions) to no more than 10 parts per cubic foot.

## MICRO-INVADERS HIT MARS

Projects at JPL's Microdevices Laboratory deal with low-cost planetary surface exploration. The New Millennium Program is designed to test advanced technologies, miniature science instruments and operations systems developed by the lab and its partners. The Mars Exploration Program will then use the technology in a series of small missions launched every 12-18 months that will study martian weather, seismic activity and geochemistry, as well as search for signs of life. "In the next decade, samples from Mars will be collected and returned to Earth for study in

