# Drama in space: GRO gets much-needed boost

After two years of unsuccessful maneuvers and anxious analyses, NASA engineers last month boosted the Compton Gamma Ray Observatory (GRO) back to a higher-altitude Earth orbit, averting a potential disaster. Had the craft continued to descend, the space agency would have lost control of it this April, forfeiting the ability to determine where large chunks of the 17-ton observatory would have struck Earth early next summer, NASA scientists say.

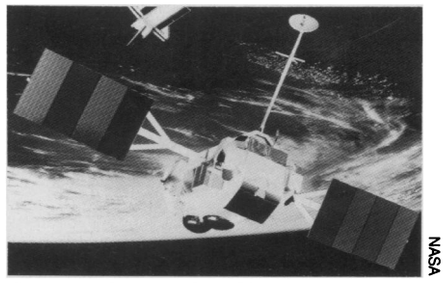
Long before NASA launched GRO in April 1991, the agency knew that the craft — the heaviest science payload ever launched by a space shuttle — would require a boost to counter the effects of solar activity, which gradually push the satellite into a lower orbit. The boost had to occur before the craft descended below 290 kilometers. At that altitude, GRO would lose stability and plunge uncontrollably into Earth's atmosphere, increasing the risk that GRO debris not burned up in the atmosphere would fall on populated areas.

Engineers at NASA and TRW Systems of Redondo Beach, Calif., the company that built GRO, believed that the boost would go smoothly. But they hadn't fully accounted for the complexities of GRO's propulsion system, which features long, wide-diameter fuel lines that can accelerate fuel to high velocity and sometimes give rise to surges in pressure.

"What it amounts to is this: Something was overlooked in the design of the [propulsion] system," says Joseph A. Wonsever, a NASA program manager for flight assurance in Washington, D.C., who participated in a review of the GRO difficulties. "We hadn't [launched] any spacecraft of that size, and therefore we didn't have a history of a spacecraft with long propulsion lines."

A key problem emerged soon after the observatory's launch, notes Thomas LaVigna of NASA's Goddard Space Flight Center in Greenbelt, Md., who supervised efforts to boost GRO. After ground controllers commanded the craft to inject high-pressure propellant from a fuel tank into a pipe leading to the observatory's thrusters, they noticed several things amiss. Two valves in the fuel line flipped positions, and a device to measure pressure went off the scale.

It appeared that a high-pressure surge had damaged the valves. Studies indicated that the seeds of this problem may have been sown during inadequate ground testing, says Dennis I. Asato of the Goddard Space Flight Center. Scientists believe that just before launch, large bubbles of nitrogen gas became trapped in the lower-pressure fuel downstream of the fuel tanks. These gas pockets would create an empty space for the rushing propellant to fill, fostering the pressure surge.



NASA

*Compton Gamma Ray Observatory.*

Concerned about damage to that fuel line, engineers turned to GRO's redundant fuel line and set of thrusters to raise the craft's orbit. To avoid another pressure surge, engineers devised a method of opening fuel valves for just a few hundredths of a second at a time, allowing the high-pressure fuel to trickle down the pipe. That strategy proved a success, but another problem soon developed. During an attempted orbital boost in June 1993, one of the smaller thrusters failed to fire reliably, causing the observatory to tumble.

Engineers quickly regained control of the craft and, by firing GRO's large thrusters only for short intervals, circumvented the need for the stabilizing force of the small thrusters. On Dec. 17, NASA completed the operation, taking GRO to an orbit 452 kilometers above Earth and lengthening the craft's life by an estimated five years. Well before the craft descends to 290 kilometers, ground controllers will take steps to ensure that debris from the observatory strikes uninhabited parts of Earth, LaVigna says.

Wonsever says he knows of no other NASA spacecraft that are likely to suffer similar propulsion problems. Nonetheless, propulsion systems may continue to fuel headlines. Next week, the space agency plans to release a report on the loss of the Mars Observer spacecraft. The report's contents are not known, but some scientists have speculated that the fuel system aboard the Observer — though markedly different from the one on GRO — may have played a role in the craft's demise (SN: 9/4/93, p.149).

*— R. Cowen*

# Gun blasts naked-DNA vaccine into cells

After a decade of ever more elaborate genetic engineering procedures — snipping, stitching, and packaging DNA — some vaccine researchers are finding that the simplest method works best. Just administer plain DNA to mice, they recommend, and the animals will muster an immune response strong enough to protect them from an otherwise lethal virus.

A research team led by Harriet Robinson of the University of Massachusetts Medical School in Worcester inoculated mice with purified DNA, which encodes a protein of the influenza virus. Between 67 and 95 percent of these test animals developed flu symptoms and then recovered, whereas 87 percent of the control animals, which had not been vaccinated, died.

Five different routes of inoculation conferred immunity, but by far the most efficient was to shoot DNA into the mice's skin with a gene gun. The scientists describe their study in the Dec. 15 PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES.

"I think this is a powerful new technique," Robinson says. "It will allow us to make vaccines for diseases that we did not previously have vaccines for."

"It is a revolutionary approach in the sense of using DNA as a vaccine," comments Dominick Iacuzio, who directs the influenza program at the National Institute for Allergy and Infectious Diseases in Bethesda, Md.

At this time, though, the technique remains an experimental concept, both researchers caution. "It's promising but too early to tell how these animal results will relate to a possible vaccine for humans," Iacuzio says.

A vaccine provokes the body's immune system to prepare for a later attack of a pathogen. Traditional vaccines consist of live, weakened viruses, dead viruses, or purified proteins. Live viruses carry the risk of reverting to a more active form, and dead viruses and proteins do not always achieve lasting immunity. With pure DNA, however, "you get the advantages of a [weakened] virus without the risk of [that] virus actually growing out," Robinson says.

That was not the mainstream opinion until now. "The whole idea of injecting DNA as a vaccine is contrary to anything that was previously envisioned or even allowed by the Food and Drug Administration," Iacuzio explains.

Besides safety concerns, researchers doubted whether DNA could enter cells in amounts sufficient to trigger a strong immune reaction.

Host cells take up very little DNA, Robinson acknowledges, but she suggests that immunity depends on quality, not quantity. Cells read the DNA and produce proteins that touch off a cascade of cellular interactions leading to stable immunity. The technique is so effective because the immune system recognizes a viral protein manufactured by the body much better than one made outside, she adds.

Moreover, the skin and the linings of the nose and trachea possess unique patrol systems of lymphoid cells that detect foreign proteins when they enter the body and promptly inform the im-