optimal orbit—geostationary or higher—thereby doubling or even tripling its productivity. And each replacement would serve as a backup for the telescope before it. As Giacconi points out, "Right now, ST is a single point failure—if it should fail early, we have no backup."

Brown and Giacconi's message is definitely being heard in the astronomical community. This past spring, for example, the science working group for another upcoming telescope mission, the Space Infrared Telescope Facility (SIRTF), strongly recommended that the agency forget about servicing the spacecraft and instead place it in a very high orbit some 100,000 kilometers out. NASA space science director Lennard Fisk accepted the recommendation immediately.

However, NASA is by no means ready to give up on servicing entirely. The AXAF x-ray satellite, for example, is being designed from scratch to be as robust as possible, so that it can last out its 15-year life with an absolute minimum of servicing. But it is still going to go into that 600-kilometer shuttle-compatable orbit.

"I think servicing gets a bad rap," declares astrophysics chief Pellerin. Servicing Space Telescope, he maintains, is worth it because the astronauts will not just repair the thing. They will upgrade the instruments. "I see the life of Hubble as three 5-year epochs," he says—the first featuring its current suite of optical and ultraviolet instruments; the second featuring a new set of powerful infrared cameras; and the third featuring a new generation of ultraviolet imaging arrays. "You couldn't even think of doing that without servicing," says Pellerin.

Pellerin also has little patience with Brown and Giacconi's vision of expendable telescopes. "I wonder if people would have even done Hubble without servicing," he says. "Would they have invested in that superb optical system, just to throw it away?"

And indeed, Giacconi is the first to admit that the main argument against their idea of disposable telescopes is political. "Congress' reaction is 'Look, we just *bought* you a telescope. Why do you want another one?'—even though the two may cost the same as one!"

The answer, Giacconi says, is that each telescope would build on the one that went before. So instead of spending money on sterile upkeep, says Giacconi, you could spend it on improving the instrumentation, advancing the technology, and getting new generations of students involved in the discipline—"the activities that provide a better benefit to the nation."

■ M. MITCHELL WALDROP

Plea to Bromley: Save Our Neutrons

Presidential science adviser Allan Bromley and a dozen other government officials got a sharp message this week from researchers who do neutron scattering experiments. A petition signed by about 100 scientists warns that U.S. research in materials science, which many see as a key to continued economic growth in the 1990s, could be seriously hampered unless a commitment is made to increase funding for the nation's handful of aging neutron scattering facilities.

Neutron scattering is becoming an increasingly important technique in areas vital to the U.S. technological future. In the study of high-temperature superconductors, for instance, neutron scattering has provided vital information on structure and magnetic properties. Because neutrons are more sensitive to light elements than x-rays, they are able to pinpoint the exact locations of the all-important oxygen atoms in crystals of the copper-oxide superconductors, whereas x-ray diffraction cannot. And because neutrons have a spin, or magnetic moment, they can probe superconductors' magnetic properties, which many scientists feel hold the key to why these materials become superconducting at such high temperatures.

Moreover, neutrons can see deeper into an object than can x-rays, and they are nondestructive, which makes them ideal for such tasks as checking residual stress in cast metal parts. Residual stress is an internal stress left over from the manufacturing process, and it can cause a part—a turbine blade in a jet engine, for example—to fail under applied stresses much less than it was engineered to withstand.

"There isn't any competition [to neutron analysis] if you want a nondestructive method of looking at industrial parts," says John Hayter, a solid-state physicist at Oak Ridge National Laboratory. But researchers like Hayter are becoming increasingly frustrated with delays and outdated equipment at U.S. neutron scattering facilities.

The immediate problem, says Stephen Shapiro of Brookhaven National Laboratory, is that safety concerns have shut down the two most powerful research reactors in this country, putting much of the neutron work on hold. Brookhaven's High Beam Flux Reactor was closed in April for a safety review, and the High Flux Isotope Reactor at Oak Ridge has been out of commission since November 1986. The latter reactor was originally shut down because routine testing revealed possible radiation damage to its pressure vessel. Although that problem was resolved in August 1987, the restart was delayed while various committees studied safety procedures with an eye toward guaranteeing that no possible accident could cause a release of radioactivity.

The shutdowns have forced researchers such as Brookhaven's John Tranquada, who uses neutrons to study high-temperature superconductors, to "try to get time at other facilities outside the country," he says. That has slowed his research considerably, he notes.

Tranquada and his colleagues are looking forward to the new year when both reactors are expected to be restarted. But they're still worried about the future. "The bigger problem is the perception that there's no support [for neutron scattering] in the long term," Hayter says. Few young researchers in the United States are going into the field at this point, he says, because they worry they will not have the necessary facilities to do their work.

Hayter echoes sentiments expressed in the petition, which was passed around at a neutron scattering session at the fall meeting of the Materials Research Society, held in Boston from 27 November to 2 December. The petition points out that many of the nation's neutron facilities are 20 to 25 years old, and increased safety costs have reduced the money available for both upgrading them and doing research. It adds that safety concerns have "seriously impeded the design of the Advanced Neutron Source," a planned state-of-the-art research reactor that researchers hope will be available by the turn of the century. "It becomes costlier and costlier to run [reactors] when these things are included," says Simon Moss, a physicist at the University of Houston. "Then you have safety for something that you can't [afford to] run."

Safety is less of an issue at pulsed neutron facilities, which employ a particle accelerator instead of a nuclear reactor to produce neutrons. But even there, funds have not kept pace with the increasing operating costs, such as electricity bills. The result is that the two major pulsed neutron facilities are kept open for less time now than 2 years ago.

■ ROBERT POOL

Plea to Bromley: Save Our Neutrons

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