ment at five sites in the United States and has already received approval to set up its own seismic sensors alongside IRIS equipment at the Blacksburg campus of Virginia Polytechnic Institute and at Albuquerque, New Mexico, 500 miles east of the underground nuclear test site in Nevada, according to Berger.

Within the Soviet Union, one of the first new listening posts will be at Frunze, in Soviet Central Asia, 500 miles from Semipalatinsk, the main Soviet nuclear test site. It is also near what seismologists call a "collision zone" for the immense subterranean tectonic plates that comprise the Indian and Asian subcontinents. Berger says earthquakes in this region occur at unusual depths, complicating previous studies of the processes involved.

Another new post will be in Garni, Armenia, near the site of last December's ruinous earthquakes. U.S. experts believe that a better understanding of the regional seismology will allow the Soviets to construct buildings with improved earthquake resistance.

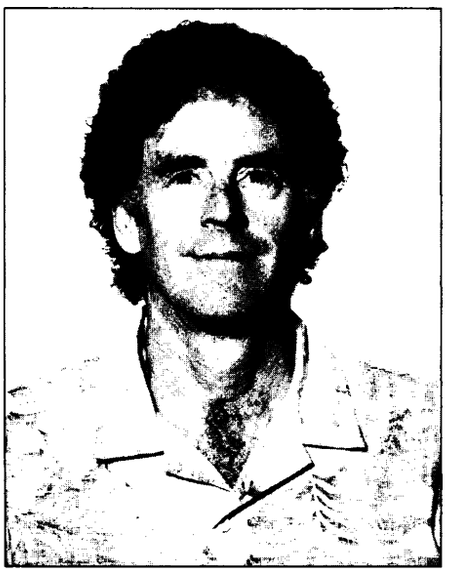
The third new station will be near Irkutsk, near the Mongolian border. Existing stations are located near Moscow, Sverdlovsk, Kislovodsk, and Garm.

Information from monitors at these remote sites may help bring an end to a longstanding dispute about the minimum technical capabilities required to enforce a test ban. A report last year by the Office of Technology Assessment estimated that 15 to 20 seismic listening posts should be installed in the Soviet Union to verify compliance with a ban on nuclear tests of greater than 5 kilotons. Although IRIS is beginning with only seven stations, Berger says that it eventually hopes to install at least twice that many.

Gregory van der Vink, a geophysicist and director of planning at IRIS, explains that debate on this issue "has been unresolved until now because we've been postulating a hypothetical [seismic] network. Now that we have an opportunity to go from modeling to actual experimentation, the uncertainties should diminish."

Milo Nordyke, director of an arms control group at Lawrence Livermore National Laboratory, agrees that the project will "provide a solid base for analyzing" major technical problems associated with future testing limitations. The United States has pledged to consider such limits after Moscow and Washington agree on new verification measures for a 1974 treaty limiting tests to 150 kilotons.

Negotiations on the new measures began in 1987 and the prospects for accord brightened recently when the Soviets agreed to allow on-site inspections of any test expected to exceed 75 kilotons. This meets the position taken by the United States when bilateral negotiations on the issue opened in 1987. Washington subsequently stiffened its demand, asking that all blasts above 50 kilotons be covered.



Seismic diplomat. *Scripps Institution geophysicist Berger helped with negotiations.*

The Soviets originally would allow no more than a few on-site inspections using the laborious U.S. method known as Corrtex, for Continuous Reflectometry for Radius versus Time Experiments. The method involves burying special electronic cables near Soviet nuclear weapons, and it cannot be used to verify compliance with a comprehensive nuclear test ban—a feature that some officials say is the reason Washington has been such a strong advocate of Corrtex.

The Soviets still have not accepted a U.S. demand for a minimum of two inspections each year, even when no high-yield blasts occur, and they are insisting on the right to install a seismic network of their own at the Nevada test site, an unresolved issue.

However, some congressional advocates of a comprehensive ban are encouraged. Senator Edward Kennedy (D–MA), who is pleased with the Pentagon's change of heart about the seismic stations, observes that "too often in the past, opportunities for U.S.–Soviet scientific cooperation to improve verification have been wrongly viewed as undermining short-term negotiating goals."

Advocates of the new Pentagon-funded network also portray it as consistent with the President's highly publicized proposal to conduct trial inspections of weapons that may be limited under a new arms treaty, a proposal the Soviets have informally said they will accept. ■ **R. JEFFREY SMITH**

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Hipparcos: In the Low-Orbit Blues

The European Space Agency's (ESA's) new $300-million Hipparcos astronomy satellite has become a world-class exercise in frustration: after a perfect launch aboard an Ariane 4 rocket on 8 August, it is now functioning beautifully—in the wrong orbit.

The failure lay in the Apogee Boost Motor, a small solid-fueled rocket atop the Ariane that was to have lofted Hipparcos from the low Earth orbit where Ariane left it to the distant geostationary orbit where it was to operate. Although identical boosters have fired successfully on 26 previous missions, this one did nothing: at ESA's first command to ignite shortly after launch and at every urgent attempt thereafter, it has stayed silent.

At ESA's control center in Darmstadt, West Germany, the speculation is that the booster suffers from a short circuit. Whatever the reason, the drama is inexorably coming to a close. Although one last firing attempt was being considered as *Science* went to press, the spacecraft's battery power was running low. If that attempt fails, the controllers would be forced to extend Hipparcos' solar panels, which cannot be refolded. And this means that the booster could no longer be used, even if it did recover: the acceleration would rip the solar panels off and destroy the mission entirely.

Meanwhile, working under the assumption that Hipparcos will be stranded, the science team has been frantically improvising new plans to see what they can salvage of the spacecraft's original mission, which is to map the position of some 120,000 stars to an unprecedented degree of accuracy. Fortunately the picture is not completely bleak. Data-taking should be no problem, since Hipparcos itself is in excellent condition. And its orbit—a highly elliptical path ranging in altitude from 210 kilometers to 3600 kilometers—puts it in no immediate danger of reentering Earth's atmosphere. Indeed, the tentative plan is to raise the low point by several hundred kilometers by firing the spacecraft's tiny hydrazine thrusters, which were intended for keeping it stable. The Hipparcos scientists believe that the resulting orbit, although far from optimal, should allow them to recover a substantial fraction of the science they planned to acquire.

■ **M. MITCHELL WALDROP**