NASA

Despite the request by a National Research Council committee that NASA keep open the option of a shuttle visit to *Hubble*, no money has been set aside for it.

instruments to the telescope, build expertise for a potential robotic service mission, and "take no actions that would preclude a space shuttle servicing mission."

While the NRC was debating the merits of various *HST* options, NASA was quietly evaluating just one approach: a robotic rescue mission. Since March, NASA has been testing the Canadian-built special purpose dexterous manipulator (Dextre)—a plug-in device for a robotic arm on the International Space Station.

NASA's Goddard Space Flight Center, which is carrying out the tests, gave Dextre high marks. On a mock-up of the *HST*, the robot was able to disconnect and reconnect power cables and remove and replace science instruments—albeit 10 times slower than an astronaut. The servicing would be the most complex space mission yet given to a robot. With new batteries, gyroscopes, and a pair of new science instruments, the 14-year-old telescope could remain functional to 2013.

Robotic surprise

On 9 August, O'Keefe announced to Goddard staff that NASA would ask Congress for additional resources in the 2005 budget to pay for a robotic service mission to the *HST*. It was his strongest endorsement to date for keeping the telescope alive, and it caught many by surprise—including Al Diaz, newly appointed NASA associate administrator for science, who hastily organized a telephone conference with reporters.

"I would feel more comfortable if NASA were actively keeping open both options—a shuttle servicing mission and a robotic servicing mission—as recommended by the NRC committee," says John Bahcall of the Institute for Advanced Study in Princeton, New Jersey. But, adds Bahcall, who served last year on a NASA committee on extending the *HST*'s life, "if successful, [a robotic mission] would be very good for the nation, providing not only servicing of the *Hubble* but also giving the US an important technology that has many other potential important applications."

While NASA's plans for a rescue mission were progressing, the *HST* was showing signs of old age. Most of the gyroscopes for positioning the telescope are already dead. The space telescope imaging spectrograph died on 3 August, and engineers are becoming increasingly concerned that the *HST*'s batteries may fail in 2007. STIS had unique spectroscopic capabilities for studying supermassive black holes and was one of the few space-borne instruments sensitive to UV light.

Robotic compromise

Under time pressure to service the *HST*, NASA approached industry for off-the-shelf ideas, says Paul Cooper, vice president for R&D at MD Robotics, the Brampton, Ontario, builders of Dextre. Of the 26 proposals sent to NASA over the past year, two close contenders—Robonaut by the Johnson Space Center and the University of Maryland's Ranger system—were ruled out because they are several years away from being flight-ready.

NASA will have to solve many problems if a mission using Dextre is to succeed. One unknown is how Dextre would rendezvous with and dock to the *HST*. But the greatest challenge for the robot is one of the simplest tasks for an astronaut: closing the instrument bay doors on the telescope after installing new equipment.

Congress has given no indication that NASA's funding request will be approved during this, an election year. The final tab, estimated at $1 billion to $1.6 billion for a robotic service mission, is higher than the cost for a space shuttle flight. Only $300 million, for the *HST* de-orbiting module, is currently in NASA's budget—which is being increasingly squeezed because of the president's plan to send manned missions to the Moon and Mars.

Although it's a compromise, astronomers are relieved that NASA is considering a robotic servicing mission rather than letting the *HST* die. "It's technically feasible but more risky [in terms of fixing unexpected problems during the service mission] than using the shuttle," says Steven Beckwith, director of the Space Telescope Science Institute in Baltimore, Maryland, which schedules observing time on the *HST*.

Bahcall is confident that the telescope can be rescued. "We have had more near-fatal situations than a department full of hospital heart patients, but somehow the ingenuity of the engineers, the originality of the scientists, and the strong backing of Congress and the general public have kept [the *HST*] alive. I hope it will continue to bring us beautiful and inspiring pictures of the universe for another 10 years."

Paul Guinnessy

Panel Chooses Superconducting Option for the International Linear Collider

The international particle physics community is almost unanimous in its desire for a TeV electron–positron linear collider. Such a facility would be at least 30 km long and cost $5–7 billion. But for more than a decade, competing international collaborations have devoted intensive R&D to two different RF accelerating technologies for the collider (see PHYSICS TODAY, September 2004, page 49). Now, at last, the community has settled on one of the competing technologies.

The International Committee for Future Accelerators has endorsed the recommendation of the 12-member International Technology Recommendation Panel (ITRP) that the RF accelerating cavities be made of superconducting niobium operating at 2 K rather than copper at room temperature (see http://www.ligo.caltech.edu/~skammer/ITRP_Home.htm). Although the superconducting technology was championed by DESY, the German Electron Synchrotron laboratory in Hamburg, the choice does not imply a specific site for the collider, nor does it imply DESY's detailed TESLA design. "We've chosen a technology, not a specific design," says ITRP chair Barry Barish of Caltech. The principal laboratories developing the "warm" copper alternative have been SLAC in California and KEK in Japan.

Germany, Japan, and the US are the chief competitors for hosting the collider. It may be another four years before the physicists and governments settle on a site for what is envisioned as a fully international facility—assuming, of course, that the necessary funding is forthcoming.

After seven months of investigation and deliberation, the ITRP concluded that both the cold and warm RF technologies have proven themselves suitable for the demands of a TeV e^+e^- collider. But this “embarrassment of riches,” as Barish calls it, could not continue. “It’s too wasteful to continue pursuing both technologies,” he says. “We can now concentrate the talent, experience, and resources of both teams on the goal of realizing the superconducting machine.”

The ITRP had to weigh a long list of relative strengths and risks. The critical magnetic field intensity above which niobium stops superconducting limits the cold cavity’s accelerating gradient to about two-thirds that of the copper alternative. Thus the cold option requires a total length of 40 km to reach the ultimate goal of two 500-GeV beams colliding head-on. The warm design could do it in 33 km.

On the other hand, the cold option gains several advantages because its

Physicists Get First Take at Science Fiction Film

It is not uncommon for an unknown director to win an award at the Sundance Film Festival. But it is uncommon for a prize to go to a complex, low-budget science fiction thriller. And *Primer*, which was named this year’s dramatic award winner, may be the first film to be marketed through physics conferences.


SHANE CARRUTH

Shane Carruth (right) with actor David Sullivan.

Primer is about two young engineers conducting experiments on themselves with a time machine they build, and the unexpected personal consequences. The film was written and directed by Shane Carruth, a 27-year-old former mathematician and engineer, who also stars in the movie. Carruth wrote the screenplay, he says, because he “wanted to see a story play out that was more in line with the way real innovation takes place than I had seen on film before.”

Participants at semiconductor conferences at the University of California, Santa Barbara, and Northern Arizona University had an opportunity to watch *Primer* this summer. The film’s distributors say marketing to physicists is a cost-effective way of testing the movie with an international and technically savvy audience. “Nearly 300 physicists saw the movie [in Santa Barbara] and stayed late into the night discussing it,” says UCSB physicist David Awschalom. The screening was organized by the university’s Professional Artists Lab, a forum within which artists develop new works for theater, film, and television. Screenings at other physics meetings are scheduled for later this year.

“In general,” says Carruth, “the response from scientists has been encouraging, although I’ve already had one complaint about using the term ‘pulling voltage’ instead of ‘drawing current.’ ” *Primer* will be released in selected markets later this month.

Paul Guinnessy

RF wavelength, 23 cm, is nine times longer than that of the higher-frequency copper alternative. That makes for larger accelerating cavities less sensitive to small misalignments, seismic ground motion, and the disruptive effects of wake fields on the bunches of beam particles. The copper scheme would require a large number of devices, called SLEDs, to boost accelerating power by temporally compressing the RF pulses coming out of the klystron tubes. A downside of the superconducting scheme's longer wavelength is that it requires much larger damping rings—that is, storage rings in which synchrotron radiation reduces the phase-space spread of the beams.

A superconducting linac will consume less electric power and require far fewer klystrons than its warm alternative. The klystrons in the warm scheme would also have to be quite close to the accelerating cavities, thus necessitating a second tunnel running alongside the beam tunnel. The superconducting scheme has the option of conveying the RF power to the underground beam tunnel from klystron buildings every few kilometers on the surface. For reasons of safety and access, however, the second tunnel remains under consideration.

An important consideration for the ITRP was that industrialization of the superconducting linac's major components is already under way. That's partly because the German government last year approved the construction of the 1.4-km XFEL coherent x-ray light source at DESY (see PHYSICS TODAY, April 2003, page 35). The XFEL will have essentially the same superconducting accelerating structure as the TESLA design. "Aside from the XFEL," says Barish, "the early involvement of industry in large-scale scientific proposals is more common in Germany than in the US." Overall, the ITRP report concludes, "The main linac and RF systems [of the superconducting technology] are of comparatively lower risk."

Early next year, the steering committee for the International Linear Collider (ILC), as it will now be called, hopes to appoint a director for the project and set up design and testing teams in Europe, Asia, and the Americas. A site-independent conceptual design should be completed by 2006—after which, work on the detailed engineering design is scheduled to begin, probably even before a site has been chosen.

After final approval by the relevant governments, digging and component manufacturing could begin as early as 2009. By then, first results from the Large Hadron Collider at CERN will have revealed first glimpses of the terra incognita into which both accelerators are to make their complementary forays. For governments not completely convinced by the theoretical arguments that important new physics is bound to show up at LHC and ILC energies, disappointing early LHC results would provide what has been called a last-minute off-ramp.

Bertram Schwarzschild

Japan Funds New Cosmic-Ray Detector in Utah

The new Telescope Array (TA) in Utah will combine fluorescence and scintillation detection methods used in earlier experiments to resolve a discrepancy in the observed rates of ultrahigh-energy cosmic rays. "Looking with both methods simultaneously should settle this," says the University of Utah's Pierre Sokolsky, a spokesman for the US–Japan collaboration. "If there's no cutoff in the energy, there will be quite a lot of excitement. If there is, then we have some understanding. It's been a burning question in cosmic-ray physics for 30 years." (See Sokolsky's article in PHYSICS TODAY, January 1998, page 31.)

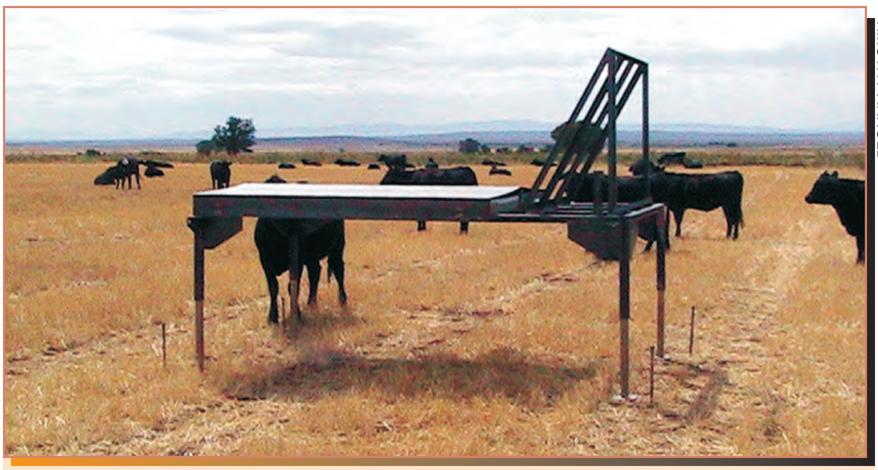
Ground was broken in late August for the first of TA's three fluorescence detectors. Fluorescence from atmospheric nitrogen relaxing to the ground state is used to reconstruct the energy and directional origin of incident cosmic rays as a function of atmospheric depth.

In addition to the fluorescence detectors, which are scheduled to be up and running next year, TA will have 576 scintillation detectors spaced at three-quarter-mile intervals. The scintillators record charged particles produced by cosmic-ray showers and are similar to those used in Japan's now defunct AGASA experiment. The fluorescence detectors are based on the High Resolution Fly's Eye (HiRes), located on the US Army's Dugway Proving Ground, about 90 km north of TA.

TA is designed to record cosmic rays with energies of 3×10^{18} eV and higher. Over times normalized for the experiments' sizes, AGASA scientists recorded 12 events above 10^{20} eV, whereas HiRes spotted only 2. "This is statistics of small numbers, so the overall discrepancy is nothing to talk about. Yet if it's true, these 12 events would tell us something is wrong with our understanding of how the physics works," says Utah physicist Kai Martens. "In any case, we don't know the sources [of the highest-energy particles]."

The TA team needs permission from the federal Bureau of Land Management to place the scintillators on government land. Another hurdle is money. Japan has committed $12 million, but the University of Utah and other US partners are still trying to rustle up an additional $6 million. TA is being built in Utah because it's high, dry, and dark. Japan is too humid and crowded for the experiment, says TA cospokesman Masaki Fukushima, a physicist at the University of Tokyo's Institute for Cosmic Ray Research.

Scientifically, TA overlaps with the much larger Pierre Auger Observatory. Also a hybrid, Auger couples fluorescence detection with an array of water



TIMOTHY ARNOLD

Solar-powered scintillators for the Telescope Array will sit on platforms scattered around the central Utah desert.