collapse if HERA is stopped."

Still, HERA-III proponents are not giving up. "Most of us are ready to fight. It would be a real shame to stop," says Kiesling. The accelerator modifications would be relatively minor and participating institutions would foot the bill for the detector. So the main challenges—besides getting the lab's backing—are coming up with funds for a replacement injector plus 150 or so people to run the machine. At the moment, HERA-III proponents are waiting to see if DESY management mentions extending HERA in a five-year plan this fall. Matters are complicated by DESY's having a new oversight agency, the Helmholtz Society, which will review the lab for the first time next year. If HERA-III is not in the plan, says Kiesling, then it would be tough for DESY to go back later to argue for it.

"It seems that the future is sufficiently unclear, with hopes and desperation concerning the HERA-III project intimately mixed," says Kiesling. **Toni Feder**

Astronomers Lobby for New Lease on Hubble's Life

Tight budgets, new rules for space shuttle missions since the Columbia disaster, and plans for the James Webb Space Telescope may stymie efforts to extend the life of the Hubble Space Telescope.

At an all-day public discussion on 31 July about the planned demise of NASA's Hubble Space Telescope, Anne Kinney informed the crowd of NASA's intention: a controlled deorbit of the HST in 2010. This plan would allow NASA to concentrate on the James Webb Space Telescope, the HST's designated successor (see the box on page 30). NASA officials are worried that extending the HST's life would drain funds from the space science budget and delay JWST's launch beyond 2011. "We believe it's a good plan . . . for both the HST and JWST," said Kinney, division director of astronomy and physics at NASA's office of space science.

But by the end of the meeting, which was held at the L'Enfant Plaza Hotel in Washington, DC, most of the 200 astronomers, engineers, and NASA employees in the audience appeared in favor of extending the HST's lifetime. That view was shared by a six-member blue-ribbon panel, which in mid-August recommended to NASA that the HST continue until science operations are no longer possible. That recommendation apparently took NASA by surprise.

The panel, chaired by John Bahcall of the Institute for Advanced Study in Princeton, New Jersey, was convened by Kinney to help address the astronomy community's anxiety about the HST's future. The panel was asked to answer two main questions: Does the existing NASA plan provide for the best scientific use of the HST's unique abilities in the context of the overall NASA program? And is the plan sufficiently flexible to respond to unforeseeable events, such as delays in the JWST program? The panel also discussed how NASA might terminate

the HST. Since the panel convened, it has had discussions with science and engineering experts and been deluged with e-mails and presentations. The issue is a political hot potato, said Bahcall.

Keeping the HST

Originally, the planned launch date for JWST was 2007, which would have provided a three-year overlap with the HST. But, said Kinney, "there has never been a science requirement for an overlap with JWST, and continuing the HST servicing and operations beyond 2010 is not in the NASA budget. . . . We believe the money is better invested in newer facilities." A sixth servicing mission (SM5) to be launched around 2009 would cost at least $700 million and leave NASA to find an additional $120 million per year for HST ground-based support costs.

Moreover, servicing the HST requires a space shuttle. When shuttle missions resume next year, they will operate under a number of restrictions for astronaut safety, including flying a shuttle close to the International Space Station, which could act as an emergency lifeboat. But the HST is at the limit of shuttle capabilities—the telescope has a 600-kilometer-high orbit and is at least 200 kilometers away from the ISS and in a different orbital inclination.

The community's argument for extending the HST's lifetime is the telescope's scientific output. "The HST is the Energizer Bunny® of astronomy—it continues to produce amazing results," said John Huchra, chairman of the board for the Association of Universities for Research in Astronomy. "And AURA strongly supports extending the HST's lifetime to overlap JWST." AURA recently polled its members and found that their number-one priority was UV and optical space-based observatories. The only telescope that currently has these capabilities is the HST.

Losing the HST in 2010 means losing access to a UV space-based observatory for a decade or more, said Huchra. Nearly 40% of US astronomers have used the telescope, and five out of six grant proposals are turned down because of a lack of observing time, he added.

Astronomers are keen to add new instruments to the HST. "If we start an open competition in 2005, I think it's quite clear we could have a set of instruments ready for launch in 2009," said Holland Ford, an astronomer at the Johns Hopkins University in Baltimore, Maryland. "If you're going to have to go anyway [to help deorbit the HST], spending an extra $120 million on new instruments is worth it." US astronaut John Grunsfeld hinted that his colleagues would support such a mission. "The astronaut corps has a tremendous trust in the science community picking missions for the space shuttle that justify the great risks involved," he said.

Killing the HST

"I was a keen proponent of disposing of old telescopes because I thought new techniques would replace them, but I haven't seen it," said Riccardo Giacconi, a winner of the 2002 Nobel Prize in Physics and president of Associated Universities Inc in Washington, DC. "If I were a stellar astronomer, I would be screaming about this plan, and I don't understand why they aren't all here [at the 31 July meeting]."

When the HST first went into orbit in 1990, the plan was to eventually bring it back to Earth for display in a museum. Such a trip is no longer justified, said Kinney. Instead, NASA now wants a shuttle or an unmanned craft to place a propulsion module on the back of the HST. The module would allow a controlled reentry to ensure the safe destruction of the HST.

Using an unmanned craft, however, is not without risks. As pointed out by Bruce McCandless II, a retired

Work Progresses on Next-Generation Space Telescope

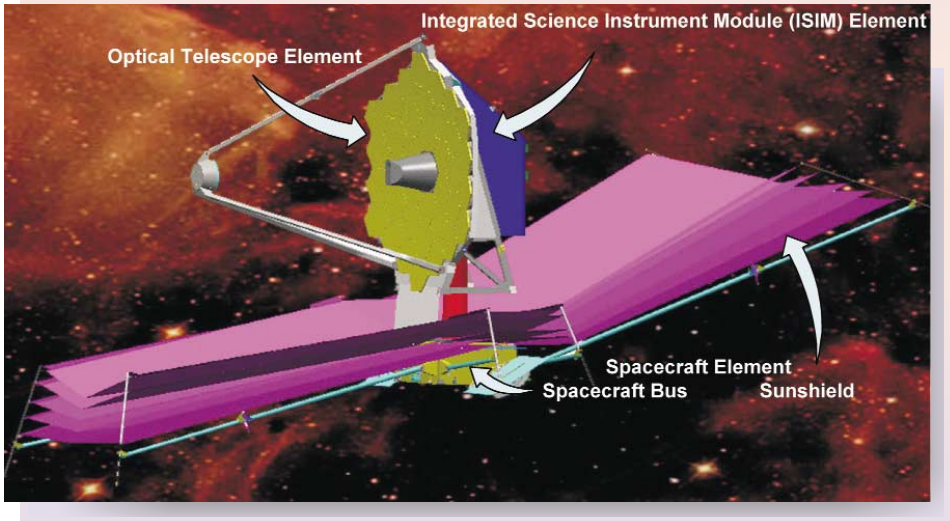
Once technical and financial difficulties are beaten, the James Webb Space Telescope will collect data about galaxy, star, and planetary system formation, and interstellar dust. "Nearly all the construction contracts are signed for JWST and we're now working on the detailed design plans," says John Mather, the telescope's project scientist at NASA's Goddard Space Flight Center in Greenbelt, Maryland (see PHYSICS TODAY, November 2002, page 30).

NASA expects to decide this month which type of mirror to use for observing at wavelengths of 1–5 microns. The choice is between a lightweight beryllium-based mirror, which has good thermal and stiffness properties, and a heavier glass-based mirror, which is cheaper and easier to fabricate. The telescope will be launched from a European Ariane V rocket, which will save NASA roughly $100 million.

Over the past eight years, JWST's budget has ballooned from $600 million to $2.5 billion. Although NASA officials say they are confident that the budget is now under control, to keep JWST on track, the agency will likely cancel the telescope's mid-infrared instrument. That would disappoint members of the Association of Universities for Research in Astronomy, who say maintaining the current JWST design specifications is their second highest priority after UV and optical space-based observatories—in other words, the Hubble Space Telescope (see accompanying story).

Moreover, if cost overruns continue, the planned 2011 launch date may be pushed back. "The average delay from the start of construction for a science mission is 1.8 years, and we're 3 years away from that point," Mather says.

Paul Guinnessy



The James Webb Space Telescope will not be serviced. (Artist's rendition courtesy of Northrop Grumman Space Technology.)

NASA astronaut who helped deploy the HST, "The US does not have the capability to do something like this, and if we used the Russian TORU system [used for docking with the ISS], the spacecraft docking speed [0.6–1 meter per second] is fast enough to severely damage the HST, potentially making it uncontrollable."

If the HST mission is to be continued, the Bahcall panel suggests fitting new instruments in both SM4 (whose launch is planned for 2004 or early 2005) and the later SM5, but only if the SM5 instruments are approved in a peer-reviewed competition. Otherwise, the panel suggests delaying SM4 to 2006 and, if possible, fitting the propulsion module during that flight. If no shuttle servicing missions are available, the panel's last choice is to use an unmanned craft to install the propulsion module.

When Kinney asked the audience at the 31 July meeting which NASA programs they would be willing to eliminate in exchange for extending the HST's lifetime, there was silence. The consensus seemed to be that NASA could approach Congress for more money. But, said Kinney, "Congress can never provide enough money for everything that the science community would like to do. . . . And do you want Congress deciding the science program instead of the science community?"

Paul Guinnessy

Virgo Gears Up to Wait for Gravitational Waves

The latest detector to join the hunt for gravitational waves is the €76 million ($86 million) Virgo, an Italian–French collaboration near Pisa that celebrated its inauguration and started testing at the end of July. "The curious thing is, these detectors do classical physics experiments, yet—as a network—they can get quantum mechanical information about the graviton's spin," says Barry Barish, director of the Laser Interferometer Gravitational Wave Observatory (LIGO), a similar US project (see the article by Barish and Rainer Weiss in PHYSICS TODAY, October 1999, page 44).

Virgo, like LIGO, is a Michelson–Morley interferometer. Virgo's two perpendicular arms are each three kilometers long; LIGO's two interferometers have arms four kilometers long. A laser beam is split and sent down both arms, reflected, and later recombined. An impinging gravitational wave would, by nudging the end mirrors outward and inward, stretch one arm and squeeze the other. The difference in the path lengths introduces a phase shift, which in turn affects the interference pattern and reveals the traces of the gravitational wave.

Gravitational waves are ripples in spacetime caused by accelerating masses. They have never been directly observed but have been inferred from observations of a binary pulsar whose period of rotation is shrinking at a rate consistent with losing energy through gravitational wave radiation. A gravitational wave from a local galactic supernova explosion, for example, might move the Virgo mirrors by 10^{-18} meters, says Adalberto Giazotto, the detector's scientific coordinator. One aim, he says, is to pick up signals from the Virgo cluster of galaxies, which is about 1000 times farther away than the edge of our galaxy.

The experiment's virtue is its isolation from seismic noise: Fancy compound pendulums housed in 10-meter-tall towers isolate Virgo's optical