

Hubble space telescope

Every delay has a silver lining*Baltimore, Maryland*

THAT the launch of the Hubble Space Telescope seems likely to be delayed until 1989 may yet turn out to be a blessing in disguise. Many project scientists believe that the three-year delay, caused by the Challenger space shuttle accident, will give time to make the telescope more



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effective – provided the National Aeronautics and Space Administration (NASA) can avoid making major cutbacks.

Samuel Keller, deputy associate administrator of NASA's Office of Space Science and Applications, says the agency hopes to avoid redundancies at the Space Telescope Science Institute (STSI) in Baltimore, but that a 10–20 per cent fall in staff numbers is likely, due to natural wastage. No new staff are being taken on. At Marshall Space Flight Center in Alabama, staff reductions have taken effect. As Keller points out, NASA has to comply with levels of funding and directives imposed by Congress.

The telescope's large size (43 ft) and weight (around 24,000 lb) mean that only the shuttle could put it into space. NASA recently announced that the shuttle will not fly before 1988, but Dr Riccardo Giacconi, director of STSI, believes it "still reasonable" to hope for launch during 1988. Giacconi thinks the telescope could be the third to the fifth payload in line once flights resume. The first will probably be military, and the second a tracking and data relay satellite to replace that lost with Challenger (one such satellite is now in operation for dual military and civilian use, but at least two are needed for safe control of the telescope).

Keeping the telescope waiting is not likely to cause problems. But the delay will necessarily mean large cost increases at Lockheed Missiles and Space Corporation in California, where about 150 people are testing the telescope. NASA has considered stopping work until close to launch, but it would still be necessary to keep an experienced engineering team together for pre-flight tests. Giacconi now thinks he has NASA's support for keeping the telescope accessible for testing until launch, but major reductions in the

Lockheed workforce are still likely.

There is clearly still much to do. The main controlling system, the space operations ground system, is installed in a basic form, but the final version will not be delivered by TRW Inc. until the end of the year because of development delays. In its present form, the system could not, for example, control the telescope so as to track moving targets such as planetary moons. Other systems, such as that which will calculate optimal timing of observations, are still in development. Some upgrading of hardware at STSI is also now thought to be necessary, but their cost, though counted in hundreds of thousands of dollars, is small compared with the software. All agree that it will be easier to complete installation and testing of complicated control systems with the instrument still on the ground.

Giacconi also wants to use the delayed deadline to allow institute astronomers to catch up on their own research and to foster a "more academic atmosphere". Although the official target for institute staff has always been that they would

Weight problems

IMPROVEMENTS to the shuttle recommended by the Rogers commission investigation of the Challenger accident will add weight and could impair the shuttle's ability to put the massive Hubble Space Telescope into a high enough orbit. Although the ideal height would be 360 nautical miles or more, even the unmodified shuttle is unlikely to manage 320 nautical miles.

At this height, atmospheric drag would gradually bring the telescope down: the plan was that a shuttle flight two years or so after launch would boost the telescope up to the desired 360 miles. (Some point out that if NASA by then has an operational orbiter transfer vehicle — at present still on the drawing board — the telescope may even be taken up to 400 nautical miles, where it would be stable indefinitely.) But if the modified shuttle is incapable of getting close to 320 nautical miles, there may be problems caused by orbital decay and atmospheric interference.

NASA officials Fred Wojtalik of Marshall and Frank Carr of Goddard Space Flight Center do not expect there will be problems, however. Keller, at NASA headquarters, points out that the weight of improvements to the shuttle has not yet been determined and thinks the rumoured figure of 12,000 lb may be pessimistic. The more modest weight increases he thinks likely would, he estimates, result in an orbit only 10–15 miles lower than that now planned.

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spend 50 per cent of their time on research, in February the figure was still less than 25 per cent. Proposals for guest astronomers will not now be taken until March 1987 to take account of the launch delay.

Last June, the telescope successfully completed its first major test: a thermal vacuum test which used a simulated solar source to investigate heating effects, and other calibrated light sources for basic checks of the major instruments. Although many minor problems were found, none require extensive redesign or rebuilding. The test did, however, indicate that the telescope takes longer than expected to reach thermal equilibrium, necessary to avoid structural distortion. Among solutions being considered are extra insulating material and more solar cells to make more use of heating elements. The thermal vacuum test also included the first end-to-end test of the telescope's science operations and data analysis system.

Commands were successfully sent from STSI via Goddard through a simulated tracking and data relay satellite to the instrument itself. Although STSI sees the test as a major success, it is only a beginning. Just three of the main instruments were tested, and because of the incomplete control system and software incompatibilities with Lockheed, many of the commands had to be translated manually.

STSI has in the past been criticized for failure to control its budget. But Giacconi says that earlier antagonism between the institute and NASA has now disappeared, as "they recognize a competent group when they see one". Independent consultants agree that the institute has performed impressively in a task whose immensity was not fully realized at the outset. One example: software for the telescope is expected to be 1.5 million lines of code, 10 per cent of that thought necessary for the Strategic Defense Initiative.

Much of the work outside the basic control system has been done in-house at STSI, which is managed independently of NASA. STSI is particularly proud of its guidestar selection catalogue, which contains the coordinates of 40 million celestial sources to unprecedented accuracy. Giacconi claims that running a project at a single institute is often more cost-effective than use of external contractors, and criticizes NASA for wanting to contract out development of the telescope's embryonic data archiving system at a cost he estimates at \$20 million. Giacconi claims STSI can develop a basic but operable system for \$0.5 million, and unfavourably compares NASA's decision to the procurement style of the Department of Defense. But he believes STSI has proved itself and speculates that it will be in business in 20 years' time "for son of the Hubble Space Telescope". **Tim Beardsley**