Hubble Facts

National Aeronautics and Space Administration

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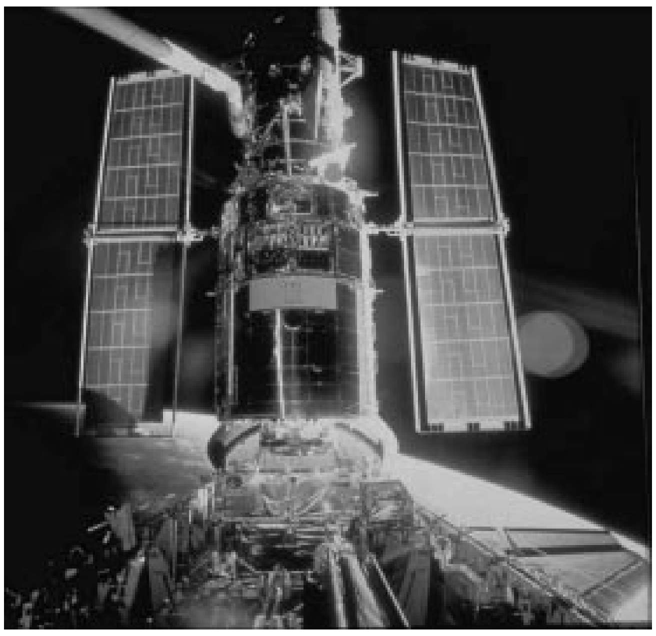
The Hubble Space Telescope Second Servicing Mission (SM-2)

NASA PREPARES FOR 1997 MISSION: EXTENSIVE PLANNING AND TRAINING UNDERWAY

Floating high above Earth's atmosphere, the astronaut team made it look easy, even graceful as they repaired the Hubble Space Telescope in late 1993. It wasn't easy. The successful rendezvous was the result of years-long planning and preparation.



NASA is approaching its second rendezvous with the telescope in February 1997 as it did the first—with optimism, backed up by extensive planning and training. By the time astronauts install two state-of-the-art science instruments and replace components, they and their colleagues on the ground will have spent hundreds of thousands of hours planning and practicing for their date with Hubble.

Given NASA's previous success, one might reasonably ask 'why the fuss'?

"We set a very high standard for ourselves," explains Project Manager John Campbell, who oversees the preparations from Goddard Space Flight Center in Greenbelt, MD. "And although we know space servicing is doable, human space flight is inherently risky. Along with ensuring the safety of our astronauts, we must make sure we do no harm to the telescope."

Indeed, one seemingly tiny servicing mistake could spell trouble for Hubble. A mishandled tool or bolt could damage the telescope's sophisticated instruments, crippling their ability to return valuable science data. And if one considers all that the telescope has accomplished since its deployment six years ago, an accident would be tragic.

As far as NASA is concerned too much is at stake to approach the mission in any other way.

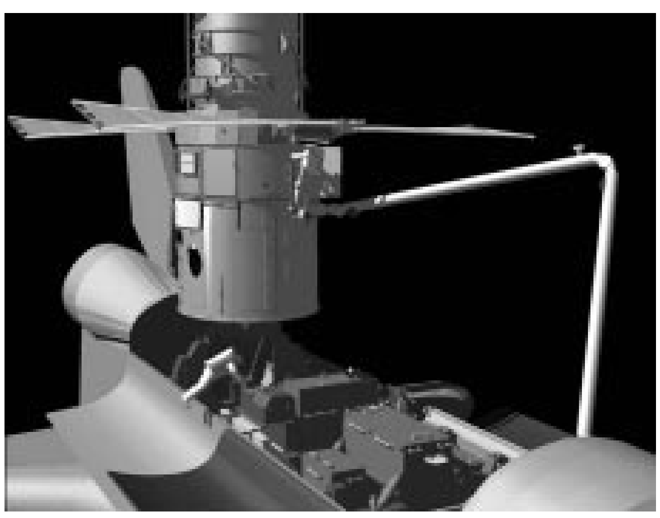
Why Service Hubble?

NASA decided early in the telescope's development to design the observatory for on-orbit servicing. Instruments were designed as modular units, comparable to dresser drawers that could be easily removed and replaced. In addition, designers equipped the telescope with handholds and other special features to make servicing tasks less difficult for astronauts wearing bulky spacesuits.

By periodically upgrading the science instruments, NASA also reasoned that it could provide the science community worldwide with state-of-the-art technology that took advantage of Hubble's unique position high above Earth's obscuring atmosphere.

The 1997 mission is being conducted with these original objectives in mind. The mission is aimed at improving Hubble's science capabilities and ensuring that it continues to operate effectively. Having taken every precaution in its original design and now in servicing preparations, the benefit of installing upgraded instruments outweighs the risk.

"Over the past two-and-a-half years, the public has seen the power of the Hubble Space Telescope," says GSFC Project Scientist David Leckrone. "They haven't seen anything yet. We're opening the doors for more discoveries."



Servicing Tasks and Mission Objectives

Once the crew captures the observatory in orbit and berths it in the Shuttle cargo bay, four mission specialists, working in pairs on alternating days, will begin four days of spacewalks to replace instruments and install other components critical to Hubble's continued success. An additional day of spacewalks is scheduled should astronauts require the contingency time.

The primary objective is to replace the Goddard High Resolution Spectrograph and the Faint Object Spectrograph with two dramatically improved instruments—the Near Infrared Camera and Multi-Object Spectrometer (NICMOS) and the Space Telescope Imaging Spectrograph (STIS).

Astronauts also will replace a Fine Guidance Sensor needed to point the telescope at celestial objects; a tape recorder used to record data; an electronics package that drives the telescope's solar arrays; and a communications unit that translates ground-based commands and relays the information to onboard instruments and systems. In addition, astronauts plan to install a new solid-state data recorder, which is important because the two new science instruments are expected to gather enormous quantities of data.

Replacement Instruments

Planning and construction of both replacement instruments began in the early 1990s. Built by Ball Aerospace in Boulder, CO, the instruments contain corrective optics to compensate for the telescope's flawed primary mirror. Once installed, they will dramatically improve Hubble's capabilities, giving scientists more detailed information needed to answer some of the most fundamental questions in astrophysics today.

NICMOS and the Near Infrared

NICMOS will see the universe at near infrared wavelengths more sensitively and in sharper detail than any other existing or planned telescope. What does that mean to astronomers?

Infrared light, which falls between visible and radio waves on the electromagnetic spectrum, isn't absorbed or scattered like visual light by the clouds of gas and dust found abundantly in the universe. Therefore, astronomers will be able to see newly forming stars and possibly measure the properties of the disks of dust particles believed to give birth to planetary systems. They will be able to peer into the centers of galaxies, including our Milky Way, to study quasars and other exotic objects. And they will be able to observe some of the universe's oldest and most distant objects, studies that could someday answer questions about the size, structure and future of the universe.

NICMOS Instrument

STIS Instrument

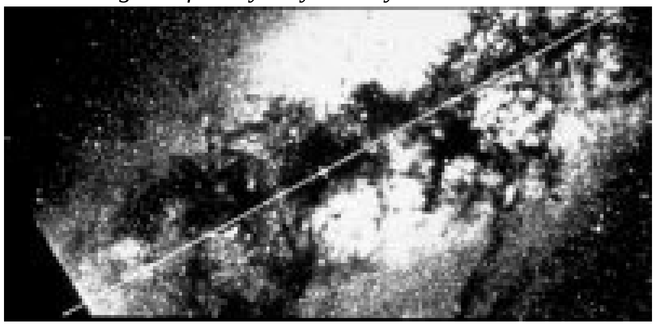
The instrument is a system of three cryogenically cooled cameras that operate independently and simultaneously but with different fields of view. The NICMOS camera detectors are key to the mission because they perform a thousand times better than previous infrared detectors. University of Arizona Professor Rodger Thompson and a 16-member science team developed the instrument.

STIS and the Ultraviolet

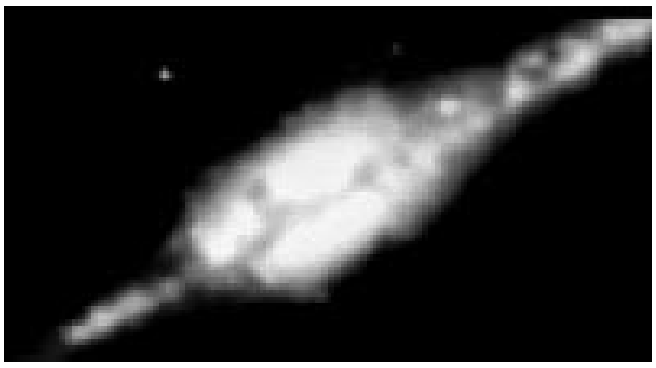
STIS separates ultraviolet and optical light into its component colors, thereby giving scientists critical diagnostic information about an object's composition, temperature, motion and other chemical and physical properties. It, too, represents a major breakthrough in technology development.

The spectrograph employs two-dimensional detectors that allow the instrument to gather either 30 times more spectral data than the first-generation Hubble spectrographs or up to 500 times more spatial data during a single exposure. The advantages are obvious. Astronomers can point the telescope at a star and measure its spectrum 30 times more rapidly than the first-generation Hubble spectrographs, or they can observe a galaxy or nebula and gather spectral data from different neighboring regions—up to 500 positions—simultaneously. The first-generation spectrographs could look at only one place at a time.

Central Region of Milky Way Galaxy



Visible Light Shows Dust-Shrouded Region



Infrared Light Reveals Structure Behind the Dust Clouds

"It's a fantastic tool for the astronomers," Leckrone says. "It makes things possible that were hopelessly inefficient or impossible before."

One of the greatest advantages to using STIS is in the study of supermassive black holes in the center of galaxies. To really determine the velocities at which stars and gas orbit around these exotic objects, scientists need to take measurements at no fewer than 10 different locations across the galaxy's nucleus. Given STIS's dramatically enhanced data gathering capabilities, scientists will be able to not only locate supermassive black holes, but begin to survey differences in their characteristics from galaxy to galaxy. It's no longer a question of whether supermassive black holes exist, but rather a question of under which conditions they exist and how they differ from one another.

The instrument is being developed by Goddard's Laboratory for Astronomy and Solar Physics. The principal investigator is Dr. Bruce E. Woodgate.

Training and Preparation

For this mission, NASA has selected a highly experienced astronaut crew. Astronaut Gregory Harbaugh was a back-up crewperson and Pilot Kenneth Bowersox flew as pilot during the first servicing mission. Astronaut Steven Hawley, who will operate the Shuttle's 50-foot robot arm during the mission, flew the Hubble deployment mission in 1990.

The other astronauts include: Scott "Doc" Horowitz, who served as a pilot on STS-75, which featured the second deployment of the Tethered Satellite System; Mark Lee, who in 1994 deployed and retrieved a solar science satellite and conducted the first untethered spacewalk; Joseph R. Tanner, who flew a mission in 1994 designed to study the Earth's atmosphere; and Steven Smith, who flew STS-68 during which the crew studied the Earth's surface and atmosphere, creating radar images and mapping global carbon monoxide pollution.

The team is training in NASA's deep water buoyancy tanks, which simulate the weightlessness of space, and practicing procedures using tools specifically designed for the mission. Astronaut Story Musgrave, a mission specialist on the first servicing mission, also is helping with the training to make sure the procedures and equipment work properly.

Future Servicing Missions

The third servicing mission is planned for 1999. The primary objective will be to install a next-generation instrument called the Advanced Camera for Surveys (ACS) and to reboost the telescope into a higher orbit to compensate for the atmospheric drag that is slowly degrading the telescope's altitude.

The Advanced Camera for Surveys will supersede the existing Wide Field Planetary Camera 2 (WFPC2), and dramatically improve Hubble's imaging capabilities. The new instrument, which will occupy the slot

now housing the Faint Object Camera, contains detectors that are 80 percent more efficient than those on WFPC2. With its enlarged field of view, the instrument is well-suited for sky surveys and studying very faint objects.

An additional servicing will occur in 2002. NASA has released an "Announcement of Opportunity" for the next-generation instrument that will be deployed during that servicing.

Summary

With its spectacular view some 320 nautical miles above Earth's atmosphere, the Hubble Space Telescope has a resolving power that is about 10 times better than any Earthbound telescope. Over its six-year history, it has produced an impressive string of discoveries that should continue as NASA's team of experienced and dedicated professionals refurbish the telescope and fit it with new and more powerful instruments—instruments designed to help astronomers unlock the mysteries surrounding the birth and evolution of our universe

Servicing Mission At-A-Glance
Date: February 1997

Orbiter: Discovery

Astronauts: Kenneth Bowersox, Mission Commander
Scott "Doc" Horowitz, Pilot
Steven Hawley, Mission Specialist (Robot Arm Operator)
Mark Lee, Mission Specialist (Payload Commander)
Gregory Harbaugh, Mission Specialist
Joseph R. Tanner, Mission Specialist
Steven Smith, Mission Specialist

Payload: Near Infrared Camera and Multi-Object Spectrometer (NICMOS)
Space Telescope Imaging Spectrograph (STIS)
Fine Guidance Sensor-2
Engineering/Science Tape Recorder-2
Data Interface Unit-2
Solid State Recorder
Solar Array Drive Electronics

Number of Spacewalks: 4 (Additional day planned, if needed).

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