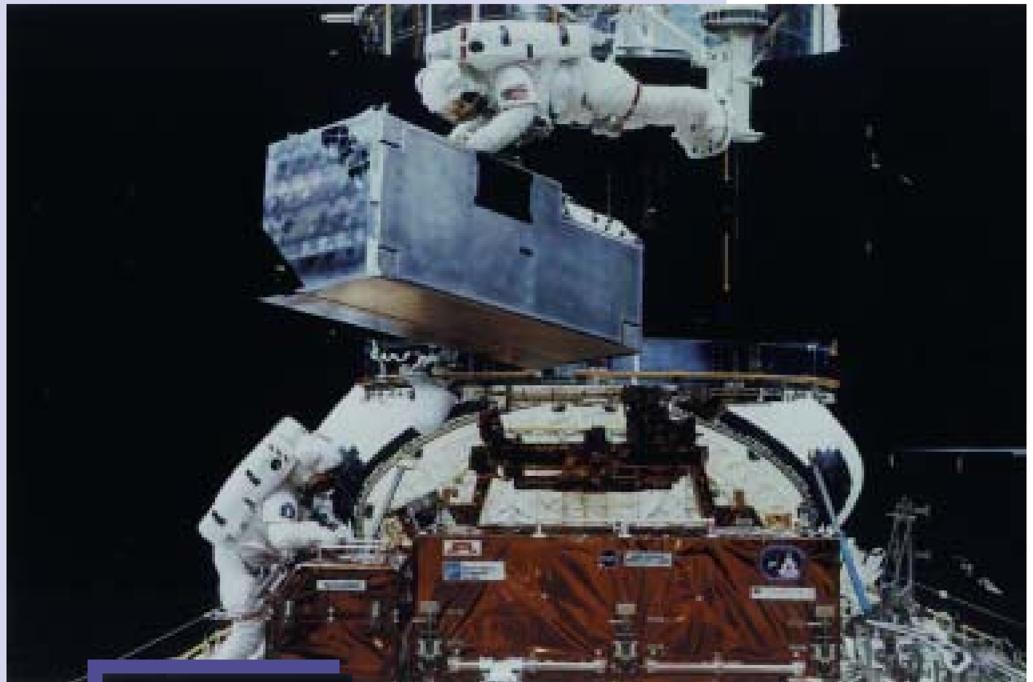
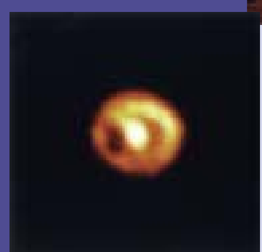
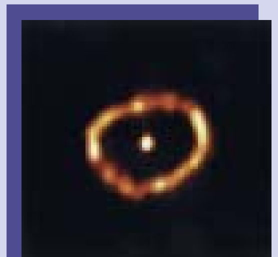


Corrective Optics Space Telescope Axial Replacement

Installed in 1993, the Corrective Optics Space Telescope Axial Replacement (COSTAR) successfully corrected the aberrated light from the Hubble primary mirror going to three science instruments. The imaging performance of the telescope is now close to the theoretical optimum, allowing observations to be made with the full sensitivity and resolution for which Hubble was designed.



Mission Specialist Kathy Thornton maneuvers COSTAR into the base of the Hubble Space Telescope.



Before COSTAR (top), and after COSTAR (bottom).

Since Hubble's servicing mission in 2002, COSTAR's mission is complete, with all new instruments incorporating an internal correcting optical system based on the successful design of COSTAR. The COSTAR instrument will be removed from Hubble during the 2004 servicing mission.

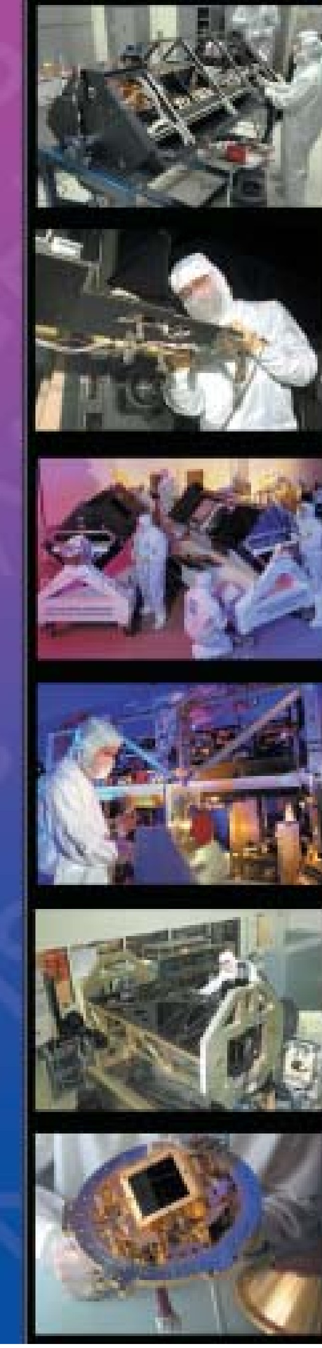
Goddard High Resolution Spectrograph

The Goddard High Resolution Spectrograph (GHRS) was specifically designed to detect and disperse ultraviolet light, which is emitted by all stars, planets and galaxies.

GHRS observations are contributing to the study of the conditions during the first moments of our universe, providing information about the structure and composition of galaxies. Using GHRS, astronomers are making significant observations of stars, interstellar gas, planets and comets.

GHRS was on board Hubble when it was launched in 1990 and was removed from Hubble during the second servicing mission in 1997, after a very successful seven-year mission.

The Ball Aerospace-built GHRS provided higher quality UV spectroscopic data than any previous space instrument.



Hubble Space Telescope Instruments

Ball Aerospace & Technologies Corp. is playing a major scientific role in the Hubble Space Telescope, the on-orbit astronomical observatory that is revolutionizing understanding of the contents of our universe. Across the spectrum from ultraviolet to visible to infrared, Ball Aerospace-built imagers and spectrographs are making significant contributions to our knowledge about the universe. By the final servicing mission, scheduled for 2004, Ball Aerospace will have produced seven science instruments for Hubble.

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Wide Field Camera 3

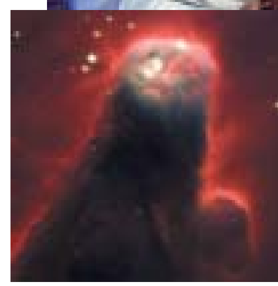
Wide Field Camera 3 (WFC3) is a next-generation imaging instrument for Hubble. Building on the history of previous Wide Field and Planetary Cameras (WF/PC1 and 2), the Near Infrared Camera and Multi-Object Spectrometer, and Advanced Camera for Surveys, WFC3 employs existing designs and parts from its predecessors and effectively blends them with new technology. Ball Aerospace is developing the optical assembly, instrument electronics and software for WFC3. These elements will be integrated with a modified external enclosure and radiator from WF/PC1 at NASA's Goddard Space Flight Center.

WFC3 will improve Hubble's imaging capability by providing an expansive field of view, high sensitivity and wide spectral coverage. WFC3's two channels will allow imaging from the near-ultraviolet to the near-infrared. WFC3 will provide eight-times better discovery efficiency (the product of the field of view times optical throughput) in the near-ultraviolet than previous Hubble instruments, and about 15-times better discovery efficiency in the near-infrared.

WFC3's ability to capture a large field of view over a wide spectral range will offer astronomers an unprecedented opportunity to efficiently gather information on the universe.

WFC3 will be installed in the Hubble during Servicing Mission 4 in 2004. The instrument is designed to ensure that the superb imaging performance of Hubble is maintained through the end of its mission in 2010.

Ball Aerospace is developing the optical assembly, instrument electronics and software for WFC3.



ACS was installed on Hubble's servicing mission in 2002. Among the ACS photographs that demonstrate the camera's capabilities is the Cone Nebula, a craggy looking mountaintop of cold gas and dust.

Cosmic Origins Spectrograph

The Cosmic Origins Spectrograph (COS) is scheduled for installation in Hubble during the final servicing mission in 2004. Compared to previous UV spectrographs on Hubble with comparable spectral resolutions, COS will be nearly 20 times more sensitive in the far-ultraviolet and will observe distant quasars too faint for previous spectrographs.

With increased sensitivity, COS will study fundamental problems in cosmology and astrophysics. Its science objectives address core issues of NASA's Origins Program, specifically:

- The origin of large-scale structure and intergalactic medium.
- The formation, evolution and ages of galaxies.
- Stellar and planetary origins and the cold interstellar medium.

Advanced Camera for Surveys

The Advanced Camera for Surveys (ACS) is a third-generation Hubble instrument that greatly enhances the telescope's imaging capabilities. Shuttle astronauts installed ACS during the 2002 servicing mission, replacing the Faint Object Camera.

The addition of ACS to Hubble has increased Hubble's discovery efficiency tenfold. ACS greatly improves the telescope's productivity, allowing the discovery of celestial objects far beyond the reach of current Hubble instruments and in a fraction of the time.

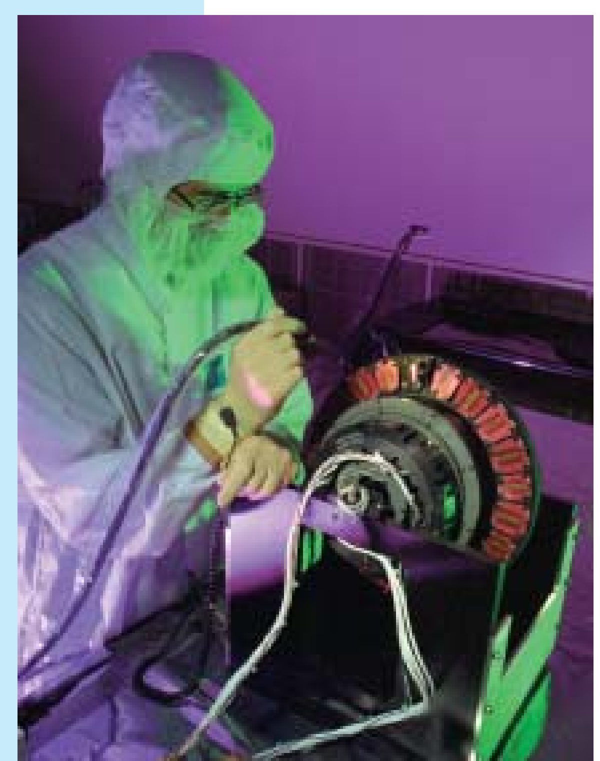
ACS features a wide field of view and high throughput mirrors with higher reflectivity, and it has larger and more sensitive detectors than its Hubble predecessors. This phone booth-sized instrument is sensitive to wavelengths ranging from ultraviolet to the far red (115 to 1050 nanometers). The unique characteristics and dramatically improved technologies of ACS enhance the Hubble science program during its final decade of operations, exploiting the full potential of the telescope to serve the science community.

ACS, as Hubble's new workhorse, surveys far regions of the universe, searches for extrasolar planets and observes weather and other features on planets in our own solar system.

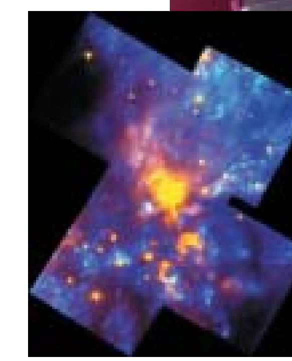
Space Telescope Imaging Spectrograph

The Space Telescope Imaging Spectrograph (STIS) is the second of two axial-replacement instruments installed in the second Hubble servicing mission. STIS was designed to greatly expand on the capabilities of two highly successful first-generation instruments, the Goddard High Resolution Spectrograph and Faint Object Spectrograph, which were replaced by STIS and NICMOS.

STIS is a two-dimensional spectrograph: It images along the entrance slit, which can produce simultaneous spectra for points along a line on the astronomical source.



The STIS optics ring is made up of a selection of mirrored optics, allowing different views of space.



The filter wheel housing of the NICMOS dewar allows scientists to choose different filters for each image.

Observations made by STIS are helping scientists to understand the origins, properties and dynamics of stars as well as planets and their moons.

Near-infrared Camera and Multi-object Spectrometer

The Near-infrared Camera and Multi-object Spectrometer (NICMOS) is one of two axial replacement instruments installed in the second Hubble servicing mission in 1997. NICMOS observes in the near-infrared spectral region with three cameras viewing three adjacent fields of view of different image scales.

NICMOS provides imaging with high-spatial resolution and high sensitivity, along with low-resolution spectroscopy.

Observations have included the discovery of a planet outside our solar system and Hubble Deep Field images containing the farthest and faintest galaxies ever observed.

NICMOS depleted its cryogen after achieving nearly all scientific objectives of the instrument. Ball Aerospace and NASA worked together to return NICMOS to operation using an add-on cryocooler, installed during the 2002 servicing mission.