



Hubble Space Telescope Servicing Mission 4 Wide Field Camera 3

After astronauts install the Wide Field Camera 3 (WFC3) during SM4, it will continue the pioneering tradition of previous Hubble cameras, but with critical improvements to take the telescope on a new voyage of discovery. Together with the new Cosmic Origins Spectrograph (COS), WFC3 will lead the way to many more exciting scientific discoveries.

Instrument Overview

WFC3 will study a diverse range of objects and phenomena, from young and extremely distant galaxies, to much more nearby stellar systems, to objects within our very own solar system. Its key feature is its ability to span the electromagnetic spectrum from the ultraviolet (UV, the kind of radiation that causes sunburn), through visible/optical light (what our eyes can detect), and into the near infrared (NIR, the kind of radiation seen with night-vision goggles). WFC3 extends Hubble's capability not only by seeing deeper into the universe, but also by providing wide-field imagery in all three regions of the spectrum—UV-Visible-NIR. It is this wide-field "panchromatic" coverage of

light that makes WFC3 so unique. As an example, WFC3 will observe young, hot stars (glowing predominantly in UV) and older, cooler stars (glowing predominantly in the red and NIR) in the same galaxy.

Should astronauts successfully repair the Advanced Camera for Surveys (ACS), it will complement the WFC3. ACS was optimized for wide-field imagery in the visible, and although it can detect UV light the field of view is small. ACS also was not designed to go very far into the NIR, a function currently served by the modest field-of-view NICMOS instrument. WFC3 will produce excellent images in the visible, but most importantly it will "fill in" the missing wide-field coverage in the UV and NIR. In short, WFC3 by itself, and especially WFC3 and ACS working in tandem, will create a new golden age of imaging for Hubble. Moreover, WFC3's ability to create crisp images of infrared sources makes it a steppingstone to NASA's James Webb Space Telescope, Hubble's successor planned for launch next decade. The first stars and galaxies to form



in the universe are so old and distant that their light is now relegated to infrared wavelengths. WFC3 could bring us at last to this era.

The Instrument

The WFC3 is configured as a two-channel instrument. Its wide-wavelength coverage with high efficiency is made possible by this dual-channel design using two detector technologies. The incoming light beam from the Hubble telescope is directed into WFC3 using a pick-off mirror, and is directed to either the Ultraviolet-Visible (UVIS) channel or the Near-Infrared (NIR) channel. The light-sensing detectors in both channels are solid-state devices. For the UVIS channel a large format Charge Coupled Device (CCD), similar to those found in digital cameras, is used. In the NIR detector the crystalline photosensitive surface is composed of mercury, cadmium and tellurium (HgCdTe).

The high sensitivity to light of the 16 megapixel UVIS CCD, combined with a wide field of view (160x160 arcseconds), yields about a 35-times improvement in discovery power versus HST's current most sensitive ultraviolet imager, the ACS High Resolution Channel. The NIR channel's HgCdTe detector is a highly advanced and larger (one megapixel) version of the 65,000 pixel detectors in the current near-infrared instrument, NICMOS. The combination of field-of-view, sensitivity, and low detector noise results in a 15-20x enhancement in capability for WFC3 over NICMOS.

An important design innovation for the WFC3 NIR channel results from tailoring its detector to reject infrared light (effectively "heat") longer in wavelength than 1700 nm. In this way it becomes unnecessary to use a cryogen (e.g. liquid or solid nitrogen) to keep it cold. Instead the detector is chilled with an electrical device called a Thermo-Electric Cooler (TEC). This greatly simplifies the design and will give WFC3 a longer operational life.

WFC3 will take the place of Wide Field Planetary Camera 2, which astronauts will bring back to Earth aboard the shuttle.

Selected Science Goals

Galaxy Evolution — Galaxies with new star formation emit most of their light at ultra-violet and visible wavelengths. Looking farther out across the universe and back in time, however, that light shifts toward red and near-infrared wavelengths. A young proto-galaxy in the early universe blazes strongly in ultraviolet. By the time that light has reached us 13 billion years later, its wavelength has been stretched, or red-shifted, by a factor of 6 to 7 or more.

With the WFC3's panchromatic imaging, astronomers will be able to follow galaxy evolution backward in time from our nearest neighboring galaxies to the earliest times when galaxies had just begun to form.

Detailed Studies of Star Populations in Nearby Galaxies —

WFC3's panchromatic coverage, in particular its high UV-blue sensitivity over a wide field, will enable astronomers to sort out in detail the various populations of stars in nearby galaxies to learn when they were formed and what their chemical composition is. Such observations provide clues to the internal history of individual galaxies. They sometimes also reveal a history of collisions and mergers between galaxies.

Dark Energy and Dark Matter — Two mysteries, two approaches. WFC3's mapping of gravitational lenses can help determine the character and distribution of dark matter in galaxy clusters. A gravitational lens is a concentration of mass, such as the galaxies and intergalactic gas in a galaxy cluster, whose gravity bends and focuses light from a more distant object, such as a far-away galaxy, along our line of sight. This phenomenon was predicted by Einstein's General Theory of Relativity and is frequently observed in Hubble images." WFC3 plus ACS could conduct systematic searches for Type Ia supernovae to measure the expansion history of the universe and get a handle on dark energy. The surveys will be 2-3 times more efficient than previous methods using ACS and NICMOS.

WFC3 characteristics	UVIS Channel	NIR Channel
Spectral range (nm)	200-1000	850-1700
Detector type	CCD	HgCdTe
Detector array size (pixels)	4096 x 4096	1024 x 1024
Field of view (arcseconds)	160 x 160	123 x 137
Pixel size (arcsec)	0.04	0.13
Filter complement	62	15
Discovery factor over previous HST instruments	35x over ACS/HRC	15-20x over NICMOS

The Hubble Program at Goddard Space Flight Center jointly developed WFC3 with the Space Telescope Science Institute in Baltimore and Ball Aerospace & Technologies Corporation in Boulder. A community-based Science Oversight Committee, led by Prof. Robert O'Connell of the University of Virginia, provided scientific guidance for its development.

For more information, contact:

Susan Hendrix,
Office of Public Affairs.
301-286-7745

Or visit the Hubble website at:

www.nasa.gov/hubble

National Aeronautics and Space Administration

Goddard Space Flight Center
8800 Greenbelt Road
Greenbelt, MD 20771

www.nasa.gov