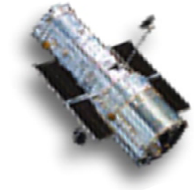
Hubble Facts



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Hubble Space Telescope

Degradation of HST's Primary Optics

To date no evidence has been found of measurable degradation of the primary and secondary mirrors of the HST's Optical Telescope Assembly since observations were first taken with the telescope and its instruments in 1990. Two types of degradation are of concern. Thin deposits of molecular contaminants would be made evident by loss of sensitivity at ultraviolet wavelengths, particularly below 200nm. Physical degradation of the mirror surfaces, e.g. pitting or deposits of dust would be evident in changes over time in the properties of the images of stars or other point sources. It is not possible to measure independently the properties of the in-orbit primary optics. Instead we have to rely on measurements taken with the on-board scientific instruments. Consequently, it is not possible to disentangle variations in reflectivity of the telescope optics from changes in the throughput of the instruments. However, measurements with the instruments allow us to place upper bounds on changes in the telescope.

The primary and secondary mirrors are ultralow-expansion glass, coated with aluminum and over-coated with magnesium fluoride. Magnesium fluoride is inert to atomic oxygen, so that pointing the HST aperture into the ram direction should not result in erosion of that coating.

A 1994 evaluation of far-ultraviolet spectroscopic data obtained with the Goddard High Resolution Spectrograph (GHRS), one of the instruments originally launched on Hubble in 1990, concluded that there was no evidence for a change of sensitivity at 120 nm at the level of 1% per year over 2.5 years. The Wide Field and Planetary Camera 2 (WFPC2), inserted into the observatory during the first servicing mission in 1993, has seen no evidence for a permanent change in sensitivity through far-ultraviolet filters (160 nm and 170 nm) from 1993 through 2003. Upper bounds of 3% change at 170 nm and 5% at 160 nm correspond to the measurement uncertainties. In fact in the Planetary Camera mode of WFPC2, throughput has actually risen over time, possibly as a consequence of the slow removal of contaminants. The Space Telescope Imaging Spectrograph, inserted into Hubble in 1997, has seen a decline of ~ 5-10% in far-ultraviolet throughput over a period of five years. This decline has a well-defined wavelength dependence; the largest drop is ~14% at about 160 nm. The wavelength dependence of the drop is generally consistent with pre-launch expectations based on the wavelength-dependent sensitivity of the STIS mirror coatings to contaminants. Neither WFPC2 nor STIS has exhibited losses of sensitivity as the result of servicing, with an upper bound of 1.5% in STIS and about 5% in WFPC2; for the latter long-term trending provides a stronger upper limit of 3-5%.

In summary, there is no evidence of degradation of the performance of the HST optics in the far ultraviolet at the 3-5% level over 13 years and across four servicing missions. The far-ultraviolet throughput of STIS is degrading slowly, at a rate of 1-2% per year, likely due to contamination of its internal optics by sources within the instrument itself.

As to the surface roughness of the primary optics, subtractions of point-source images taken years apart with WFPC2 for purposes of high-contrast imaging science (e.g., studies of circumstellar disks) would be sensitive to changes in the large-angle scattering pattern caused, for example, by pitting of the telescope's optical surfaces. HST observers have seen no evidence of such problems.