

# **Hubble Space Telescope Servicing Missions: An Astronaut's Perspective**

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## **Introduction**

A cornerstone to the success of the Hubble Space Telescope program has been the ability to reinvent the telescope through servicing of the spacecraft by astronauts. Since the installation of the corrective optics by the crew of the first servicing mission in 1993, three Space Shuttle crews have visited and vastly improved the science capability of the Hubble Space Telescope. These servicing missions have brought together the best of the NASA Space Science and Human Spaceflight programs. The result is that the Hubble Space Telescope is regarded as the most significant and productive scientific instrument ever crafted by humans. The mission of NASA can be described as one of exploration, discovery and inspiration. It is in part to enable great scientific discoveries in the exploration of the universe that as astronauts we are willing to risk our lives.

## **Astronaut Servicing of the Hubble Space Telescope**

The Hubble Space Telescope servicing missions have helped to define the capabilities of humans working in a vacuum. The demands of working on a large optical system in space have pushed the design of space tools and techniques, which have proved invaluable for the Hubble missions, and for the assembly of the International Space Station.

These Hubble servicing missions have allowed the scientific capability of the telescope to keep up with modern advances in instruments and avionics. As a result the discovery potential of the system has increased by much more than an order of magnitude since launch, and will benefit from further enhancements after the next servicing mission currently scheduled in 2005.

While the Hubble Space Telescope was designed to be serviced on orbit, the motivated and clever scientists and engineers of the extended Hubble team have enabled the telescope to take advantage of advances in technology never imagined when the telescope was designed. These include the addition of new rigid and more powerful solar arrays that allow multiple axial instruments to operate simultaneously, and a novel mechanical cooling system to improve the performance of the scientific instruments. As well, the combined experience of the servicing missions has allowed for the replacement of failed items that were not designed for change-out on orbit, including a failed transmitter and the main power control unit.

On three of the four Hubble Space Telescope servicing missions the astronauts performed five spacewalks to upgrade and service the telescope, and three spacewalks on the mission in 1999 December which was cut short due to Y2K issues. On the most recent servicing mission in 2002 March the total spacewalking time set a duration record for the most time that humans have worked in space at vacuum on a single mission. The tasks that are performed on Hubble missions are considered as some of the most precise and difficult in the space program. It is

often said that teams perform at their best when presented with high performance challenges. For this reason and because of the clear scientific drivers the Hubble Space Telescope servicing missions are highly coveted assignments in the astronaut community.

### **Observations of an Astronomer/Astronaut**

Going into space to do any mission carries with it a fixed and somewhat indeterminate risk. The tragic loss of the Space Shuttle *Columbia* and her crew is a potent reminder of the risks of space flight. The Hubble missions do not add significantly to the risk to human life over other types of missions.

For all of my adult life I have worked in the field of experimental astrophysics to build instruments and operate them in and out of the atmosphere. Since becoming an astronaut my primary role has been to help enable great scientific discovery through the NASA space flight program. When I reflect on my years of training in astrophysics, electronics, experiment design, construction and my astronaut training, I feel as if all those experiences were focused on preparing me to execute the difficult tasks in servicing the Hubble Space Telescope. I have had the privilege to participate with the outstanding teams on the last two Hubble Servicing Missions (SM-3A, and SM3B as Payload Commander). As an astronomer visiting the Hubble in orbit, I can only describe the experience as breathtaking and magical. Looking back on these servicing missions I feel that playing a part in the success and scientific return from the Hubble Space Telescope is the most important and significant achievement in my life. I can say without hesitation that traveling to space to upgrade the instruments and ensure the future of the Hubble Space Telescope was worth the potential risk to my life.

### **Future Visits to Service Hubble**

If astronauts are going to risk their lives to service the Hubble Space Telescope, we should do it in order to enable great science. For the upcoming SM4 mission the Astronaut Office has signed up for and is excited about the prospects of sending a team up to Hubble to install the Cosmic Origins Spectrograph, the Wide Field-3 Camera, and replace the gyros, batteries, and install the Aft-shroud Cooling System. The Space Shuttle Program is aggressively working towards improving the safety of the Shuttle system and to provide solutions to the tile issues, brought to light by the *Columbia* accident, which will enable an SM4 mission to the Hubble.

If there were to be a mission after the SM4 for the purpose of returning Hubble to earth in the Shuttle Payload bay, the Astronaut Office would have reservations supporting the mission. Initial analysis shows that perhaps four spacewalks are required, significant hardware would have to be jettisoned, and a heavyweight return through the atmosphere would have to be performed. In a sense this mission would be risking human lives, and a unique national resource (the Space Shuttle), for the purpose of disabling great science, albeit due to necessity at end-of-life. For this reason the Astronaut Office favors the alternate approaches being investigated by the Office of Space Science, including an autonomously installed propulsion module mission, or a Shuttle based combined servicing/propulsion module installation mission.

### **Conclusion**

As astronauts we place our trust in the astronomical community, the NASA Office of Space Science, and the Office of Space Flight to examine the end-of-life options for the Hubble Space Telescope. And if it is determined that the science case drives an additional Hubble servicing mission, the astronauts will be there to help enable the scientific exploration of the Cosmos.