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CAMERAS CAPTURE SHUTTLE'S RETURN TO SPACE

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Shuttle's Imaging Network Captures Falling Debris



Discovery launches.



Discovery's cargo bay over Earth's horizon was photographed by one of the seven STS-114 crew members as the astronauts move within 24 hours of docking with the International Space Station. Photo: NASA

NASA's shuttle program grounded after electronic imaging discovers 'debris event.'

By Larry Adams, Editor

The Discovery shuttle launch appeared flawless, but that was what the eye could see. What the eyes could not see was captured by an upgraded network of electronic imaging equipment on the ground, in chaser planes and onboard the craft while the shuttle was in flight.

The expansive imaging system is an interconnected network of cameras, which ranged from the infrared to the handheld digital, image processing tools and data delivery links to NASA computers.

IMPROVING LAUNCH AND DATA IMAGERY

The upgraded Ground Camera Ascent Imagery system did what it was intended to do. A Sony XC-999 camera, one of 107 ground- and aircraft-based cameras that fed back images and data to engineers at three NASA facilities, caught what NASA calls a "debris event."

The camera captured a piece of insulating foam that tore from the external tank about the time of solid rocket booster separation. This was a problem similar to the one that eventually led to the February 2003 destruction of the shuttle Columbia 16 days after takeoff. The chunk did not strike the Discovery, but was nearly as large as the estimated 1.67-pound piece of insulating foam that struck the Columbia.

The electronic imaging network was upgraded to include more cameras taking images from more viewpoints. Also added was high-definition television (HDTV) for quick-look analysis, and mirrored-server capability that allowed engineers at Kennedy Space Center in Florida, Johnson Space Center (Houston) and the Marshall Space Flight Center (Huntsville, AL) to share the images and data.

During the 2003 launch of Columbia in 2003,

- More than 100 cameras captured the launch and landing of the space shuttle Discovery.
- Inflight inspection was conducted with a series of cameras, lasers and data was downlinked to engineers on earth.
- Spacewalkers used a space-hardened digital camera to document damage to the shuttle.



Above Left: STS-114 Mission Specialist Soichi Noguchi gives the camera a quick wave while working on Space Shuttle Discovery's flight deck on Flight Day 1. Flight controllers in the Mission Control Center gave Noguchi the "Electrician of the Day" award for his quick thinking, troubleshooting a problem with the camera. Photo: NASA TV.

Above Right: STS-114 Commander Eileen Collins, right, holds a communicator and grins for the camera on Space Shuttle Discovery's flight deck. Mission Specialist Steve Robinson works behind her. Photo: NASA TV.

Right: Moments after the launch of STS-114 signaled the Space Shuttle's return to flight, Mission Control at the Johnson Space Center in Houston is buzzing with activity. Photo: NASA.



four short-range tracking cameras were used at two sites. These cameras took images of sections of the shuttle and fuel tanks that were later analyzed.

For the Discovery, the number of launch sites was expanded and equipment upgraded at existing sites. Multiple cameras were used at short, medium and long-range camera sites.

The short-range tracking cameras featured 200-millimeter (mm) focal length lenses and were loaded with 400 feet of film, running 100 frames per second (fps). In addition to the cameras around the launch pads, 42 fixed cameras with 16mm motion picture film was used.

Medium-range trackers were located at six sites. Cameras at these sites featured 800mm and greater lenses, running 100 fps. Three of the cameras have 400 feet of film and two have 1,000 feet. The additional tracking cameras have 150-inch lenses, with 1,000 feet of film. Five of six sites also have HDTV video cameras.

Long-range trackers featured cameras with a 400-inch focal length and 100-feet-per-second capability to provide more data points and better tracking of debris.

The onboard imaging systems, dubbed ELVIS, or the Enhanced Launch Vehicle Imaging System, used several new and modified cameras located on the Space Shuttle's solid rockets, external fuel tank and on Discovery. These cameras helped monitor the thermal protection system and the redesigned portions of the external tank. In fact, it was one of these cameras, the Sony XC-999, that was attached to the external tank in its space-hardened housing, that captured the debris event. The event was transmitted to the ground in real-time to the ground communications station at Merritt Is-

land, FL, via antennas located on the tank, almost 180 degrees opposite the camera. The electronics box housed batteries and a 10-watt transmitter.

IN SITU INSPECTION

The astronauts conducted a series of inspections using onboard cameras including handheld digital cameras used to inspect tiles on the Orbital Maneuvering System pods, a robot arm and a new 50-foot boom on the robot arm to inspect the shuttle's wings, nose cap and crew cabin.

The robot arm collected images of the crew cabin and the clearances between the Shuttle's Ku-band dish antenna, which provides high-data rate telemetry and television, and the end of the boom, which was moored to Discovery during launch.

The OBSS was developed by MD Robotics (Brampton, ON, Canada). At one end of the boom, which is called the Canadarm, is a modified electrical grapple fixture, and on the other end are the imagery systems. Electrical and data cables run the length of the boom, providing power for the sensors while allowing images to be transferred through the wiring system to laptop computers and downlink systems in the crew cabin.

The electronic imaging systems on the OBSS included a Laser Dynamic Range Imager (LDRI), a Laser Camera System (LCS) and an Intensified Television Camera (ITVC), which also is used in the shuttle bay. For targeting, the LDRI and ITVC are attached using a pan/tilt unit.

Manufactured by Sandia National Laboratories (Albuquerque, NM), the LDRI has an infrared laser illuminator and an infrared camera receiver. The LDRI can be used

provided 2- and 3-D video imagery data; the two-dimensional imagery was seen by the Shuttle crew on orbit, but the 3-D data was processed by NASA engineers and computers.

The LCS, manufactured by Neptec (Ottawa, ON, Canada), is a scanning laser range finder. The LCS was used as a 3-D camera and to generate computer models of the scanned objects. Unlike the LDRI, the LCS data is not video, but instead are digital files collected on a dedicated laptop.

DOCKING TO THE SPACE STATION

The in-space inspections and repairs were done while the shuttle was docked to the International Space Station (ISS). Prior to docking, the orbiter was maneuvered to expose the underside of the shuttle.

The ISS crew used digital still cameras with 400mm and 800mm lenses and a detailed plan to photographically map the Shuttle's underside for about 90 seconds before it docked to the space station.

A handheld digital camera was used by spacewalkers outside of the vehicle. Previously, the handheld cameras had been film cameras. The new Extravehicular Activity (EVA) camera is a Kodak DCS760, the same camera used for digital imagery inside the Shuttle cabin, with some modifications made to equip it for use in the vacuum and extreme temperatures of space. The modifications included a change of lubricants for the camera and a thermal protective covering.

Digital images taken during a spacewalk were stored in the camera's memory for later download.

