Hubble Space Telescope
Servicing Mission 4

Lesson Booklet
Teacher's Guide
Grade Levels: 3-5

By Karen Freiboth
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Dark Energy
Dark Matter
Extravehicular Mobility Unit (EMU)
EVA (Spacewalk)
Flight Director (FLIGHT)
Galaxy Evolution
Hubble Space Telescope (HST)
Johnson Space Center (JSC)
NASA
Remote Manipulator System (RMS)
Safety Tethers
Servicing Missions
Space Shuttle
Wide Field Camera 3 (WFC3)
Objective:
To use a visual image to introduce the Hubble Space Telescope Servicing Mission 4.

Hubble’s Servicing Mission 4

Mission Logo

NASA’S
Hubble Space Telescope’s
Final Service Mission
Objective:
To learn about NASA’s space shuttle Atlantis STS-125 astronauts who performed Hubble’s servicing mission 4.

The Mission’s Astronauts

NASA’s Space Shuttle Atlantis STS-125 Astronauts

Michael J. Massimino, Mission Specialist, Spacewalker
Michael T. Good, Mission Specialist, Spacewalker
Gregory C. Johnson, Pilot
Scott D. Altman, Commander
K. Megan McArthur, Mission Specialist, Flight Engineer, Robotic Arm Operator
John M. Grunsfeld, Mission Specialist, Lead Spacewalker
Andrew J. Feustel, Mission Specialist, Spacewalker
Objective:
To use a visual image to introduce the STS-125 Hubble Space Telescope Servicing Mission 4.

The Mission Patch

STS-125 Atlantis Crew
Mission Patch

Pictured to the right is the STS-125 Servicing Mission 4 crew patch which shows the Hubble Space Telescope along with a representation of its many scientific discoveries.

The red border of the patch depicts the:
- Red-shifted glow of the early universe
- Limit of the Hubble Space Telescope’s view into the cosmos

The black background represents the:
- Mysteries of dark-energy and dark matter

The blue portions shows the:
- Overall structure and composition of the universe filled with planets, stars and galaxies
- Soaring by the HST is the Space Shuttle Discovery which, in 1990, first placed the HST into space enabling astronauts to upgrade the HST and greatly contribute to the expansion of our own knowledge of the universe.
Objective:
To use a visual image of the Atlantis STS-125 astronauts before the shuttle launch.

Atlantis STS-125 Launch Day

The STS-125 Astronauts
May 11, 2009

The STS-125 crew members are pictured on their way to the launch pad which is where they will board the Space Shuttle Atlantis to begin their mission.
Objective:
To learn about NASA’s Space Shuttle Atlantis STS-125 Hubble Service Mission 4.

Atlantis STS-125 Launch Day

Atlantis Flight Day 1
May 11, 2009

On May 11, 2009 NASA’s Space Shuttle Atlantis, with its seven member crew, launched to space for the fourth and final Hubble Space Telescope Servicing Mission: Hubble Service Mission 4. The Atlantis STS-125 mission was to make repairs and upgrades to the Hubble Space Telescope, which were needed to extend the life of the Hubble Space Telescope to the year 2020. The mission, which included five spacewalks, lasted for 12 days. The Space Shuttle Atlantis and its crew returned to Earth on May 24, 2009.
Objectives:
To use visual images to show teamwork in the mission control center.
To show that during the Atlantis STS-125 mission, the astronauts were never left alone in space; their teammates on the ground at NASA’s Johnson Space Center were helping them throughout the mission.

Space Shuttle Flight Control Room

Atlantis Flight Day 2
May 12, 2009

Mission Control Center
NASA’s Johnson Space Center

The STS-125 spacecraft communicator (CAPCOM), astronaut Alan Poindexter is pictured on the right as he monitors data at NASA’s Johnson Space Center in Houston, Texas.

STS-125 lead spacewalk officer Tomas Gonzalez-Torres is pictured monitoring data.
Space Shuttle Flight Control Room

Atlantis Flight Day 2
May 12, 2009

Mission Control Center
NASA’s Johnson Space Center

Pictured on the left is flight director Rick LaBrode. Working along side him is flight director Chris Edelen. Together, the two flight directors are monitoring data.

There were a lot of hardworking and dedicated people on the ground during Hubble’s Servicing Mission 4. Hubble’s final service mission took a great deal of teamwork between the Atlantis STS-125 astronauts in space and their STS-125 teammates here on Earth.

Objectives:
To use a visual image to show teamwork in the mission control center.
To show that during the Atlantis STS-125 mission, the astronauts were never left alone in space; their teammates on the ground at NASA’s Johnson Space Center were helping them throughout the mission.
Objective:
Using a timeline to outline the Atlantis STS-125 mission to the Hubble Space Telescope.

STS-125 Mission Timeline

Space Shuttle Atlantis
STS-125 Hubble Mission 4 Timeline

Flight Day 1 (May 11, 2009)
- Space Shuttle Atlantis and its STS-125 crew members launch to space from the Kennedy Space Center.

Flight Day 3 (May 13, 2009)
- Space Shuttle Atlantis Captures the Hubble Space Telescope in space.

Flight Day 4 (May 14, 2009)
- Mission specialist and lead spacewalker John M. Grunsfeld and mission specialist and spacewalker Andrew J. Feustel perform the first spacewalk of the mission.

Flight Day 5 (May 15, 2009)
- Mission specialist and spacewalker Michael J. Massimino and mission specialist and spacewalker Michael T. Good perform the second spacewalk of the mission.
Objective:
Using a timeline to outline the Atlantis STS-125 mission to the Hubble Space Telescope.

STS-125 Mission Timeline

**Flight Day 6 (May 16, 2009)**
- Mission specialist and lead spacewalker John M. Grunsfeld and mission specialist and spacewalker Andrew J. Feustel perform the **third spacewalk** of the mission.

**Flight Day 7 (May 17, 2009)**
- Mission specialist and spacewalker Michael J. Massimino and mission specialist and spacewalker Michael T. Good perform the **fourth spacewalk** of the mission.

**Flight Day 8 (May 18, 2009)**
- Mission specialist and lead spacewalker John M. Grunsfeld and mission specialist and spacewalker Andrew J. Feustel perform the **fifth and final spacewalk** of the mission.

**Flight Day 9 (May 19, 2009)**
- Space Shuttle Atlantis releases the Hubble Space Telescope.

**Flight Day 12 (May 22, 2009)**
- Space Shuttle Atlantis and its STS-125 crew members land at the Kennedy Space Center.
Objective:
To use visual images to show the Atlantis as it captured the HST in space.

How Atlantis Captured The Hubble

Atlantis Flight Day 3
May 13, 2009

This picture shows what the Space Shuttle Atlantis crew members saw through the window of the orbiter as they were getting very close to the Hubble in space.

Atlantis’ robotic arm captures the Hubble
Objective:
To use an artist’s depiction to show the Atlantis’ cargo bay, robotic arm, and the positioning of the HST on the orbiter for its upgrades and repairs.

Atlantis After Capturing The Hubble

The Hubble is Ready For Servicing Mission 4

The above artist’s depiction shows the Hubble after the Atlantis successfully captured it in space. The Hubble Space Telescope is now ready for its upgrades and repairs.
A Spacesuit Designed For Spacewalks

A Special Spacesuit Designed For Spacewalks

A spacewalk or EVA (Extravehicular activity) is an activity performed by astronauts in space on the outside of a spacecraft. Hubble Service Mission 4 included five straight back-to-back days of spacewalks to make final repairs and upgrades to the Hubble Space Telescope. The astronauts who perform spacewalks must wear a special spacesuit called the Extravehicular Mobility Unit (EMU). This spacesuit is made to protect and keep them safe while working outside the spacecraft, in space. The astronaut pictured below is the mission’s lead spacewalker John M. Grunsfeld during the first spacewalk of Hubble’s Service Mission 4, which included the removal of the Hubble’s Wide Field Camera 2 and the installation of the telescope’s Wide Field Camera 3.

Mission’s Lead Spacewalker
John M. Grunsfeld wearing his EMU Spacesuit as he is tethered to the HST during the first spacewalk of the mission.
Objective:
To visit an interactive web site to learn about the Extravehicular Mobility Unit (EMU) spacesuit that spacewalkers use for spacewalks.

The Clickable Spacesuit
A Fun Interactive Learning Experience

To learn more about the Extravehicular Mobility Unit (EMU), please visit the following web site for a fun interactive spacesuit experience!

NASA’s The Clickable Spacesuit Interactive Spacesuit Experience
http://www.nasa.gov/audience/foreducators/spacesuits/home/clickable_suit.html

Teacher
Stop Lesson Here
To Have Students Visit the Web Site
Objective:
To use a visual image to show how the STS-125 spacewalkers used still cameras during their space walk

First Spacewalk of the Mission

Atlantis Flight Day 4
May 14, 2009

This picture has been enlarged from its original form. It has been enlarged so that it is easier for you to see. What you are seeing is a reflection inside of a photograph; this reflection shows the Earth behind STS-125 spacewalker Andrew J. Feustal. Look closely at the picture to see Feustal using a still camera to take a picture. The picture that he took is shown on the next page.
Objective:
To use a visual image taken by a STS-125 space walker to show how photography is used in space.

First Spacewalk of the Mission

Atlantis Flight Day 4
May 14, 2009

This is the picture from page 14 in its original form. Spacewalker Andrew J. Feustal took this picture of spacewalker John M. Grunsfeld during the first spacewalk of the mission. Look closely at Grunsfeld’s extravehicular visor on his helmet to see the incredible reflection of the Earth and his crewmate Feustal.
Objective:
To introduce the Hubble telescope’s new wide field camera 3 and its significance to astronomers.

First Spacewalk of the Mission
Atlantis Flight Day 4
May 14, 2009

During the first spacewalk of the mission, spacewalkers John M. Grunsfeld and Andrew J. Feustal removed the Hubble Space Telescope’s Wide Field Planetary Camera 2 and installed the telescope’s Wide Field Camera 3.

Wide Field Camera 3 will enable astronomers to make better observations of:

- Galaxy evolution
- Dark matter
- Dark energy
Objective:
To use an artist’s depiction of the HST to show the placement of Wide Field Camera 3 on the telescope.

First Spacewalk of the Mission

Artist’s Depiction of Wide Field Camera 3

This is an artist's depiction of the Hubble Space Telescope showing the Wide Field Camera 3 and the location on the telescope where spacewalkers John M. Grunsfeld and Andrew J. Feustal installed the camera.
Objective:
To use a visual image to show how a STS-125 space walker worked in the cargo bay of the Atlantis.

Second Spacewalk of the Mission

Atlantis Flight Day 5
May 15, 2009

Spacewalker Michael T. Good is pictured in Atlantis’ cargo bay working with the Hubble Space Telescope during the second spacewalk of the mission.
Objective:
To use a visual image to show how a STS-125 spacewalker worked in the cargo bay of the Atlantis.

Second Spacewalk of the Mission

Atlantis Flight Day 5
May 15, 2009

Spacewalker Michael J. Massimino is pictured in Atlantis’ cargo bay during the second spacewalk of the mission.
Objective:
To use a visual image to show STS-125 spacewalkers working on the telescope during a spacewalk.

Third Spacewalk of the Mission

Atlantis Flight Day 6
May 16, 2009

Spacewalker Andrew J. Feustel

Spacewalker Andrew J. Feustel is pictured during the third spacewalk of the mission, navigating on the end of the remote manipulator system arm, by the Hubble Space Telescope. Spacewalker John M. Grunsfeld, is pictured signaling to Feustel. During the spacewalk, STS-125 astronauts controlled the remote manipulator arm from inside of the Space Shuttle Atlantis’ crew cabin.
Objective:
To use a visual image to show a STS-125 space walker as he is about to attach a safety tether.

Third Spacewalk of the Mission

Atlantis Flight Day 6
May 16, 2009

Spacewalker John M. Grunsfeld is pictured during the third spacewalk of the mission, as he is about to attach a safety tether so that he can work on the Hubble Space Telescope.
Fourth Spacewalk of the Mission

Atlantis Flight Day 7
May 17, 2009

Objective:
To use visual images of STS-125 astronauts showing how it took teamwork to suit up the spacewalker.

Astronauts Scott D. Altman, John M. Grunsfeld, and Gregory C. Johnson are pictured on Atlantis’ middeck helping Michael T. Good suit up in his Extravehicular Mobility Unit (EMU) for the fourth spacewalk of the mission.
Spacewalker Michael J. Massimino is pictured in the Atlantis’ airlock, fully suited in his EMU, before beginning the mission’s fourth spacewalk.

Spacewalkers Michael T. Good (left) and Michael J. Massimino working in and near the HST.
Objective:
To use a visual image to show how a spacewalker uses a safety tether during a HST spacewalker.

Fifth Spacewalk of the Mission
Atlantis Flight Day 8
May 18, 2009

Spacewalker John M. Grunsfeld is being lowered into Atlantis’ cargo bay during the fifth and final spacewalk of the mission. Look closely at Grunsfeld’s waist. Spacewalkers attach safety tethers to the spacecraft and pieces of equipment to prevent themselves from floating away.
Objective:
To use a visual image to show a STS-125 space walker during a spacewalk.

Fifth Spacewalk of the Mission

Atlantis Flight Day 8
May 18, 2009

Spacewalker Andrew J. Feustel is pictured during the final spacewalk of the mission, as he is getting equipment from the shuttle bay of the Atlantis.
Objective: To use a visual image to show how the RMS is used by a spacewalker to work on the HST.

Fifth Spacewalk of the Mission

Atlantis Flight Day 8
May 18, 2009

Shown in the left side of this picture is Spacewalker John M. Grunsfeld during the final spacewalk of the mission. He is positioned on a foot restraint on the end of Atlantis’ Remote Manipulator System (RMS). Astronaut K. Megan McArthur controlled the RMS from inside of the Atlantis orbiter.
Objective:
To use a visual image to show the STS-125 astronaut as she operates the RMS.

Fifth Spacewalk of the Mission

Atlantis Flight Day 8
May 18, 2009

Astronaut K. Megan McArthur is shown operating the controls of the RMS from inside of the Atlantis orbiter during the final spacewalk of the mission.
Objective:
To use a visual image to show how astronaut McArthur used the Atlantis’ RMS to release the Hubble.

How Atlantis Released The Hubble

Atlantis Flight Day 9
May 19, 2009

The Atlantis released the HST on May 19, 2009. This picture shows how STS-125 Astronaut K. Megan McArthur operated Atlantis’ robotic arm to reach out, grab hold of and fasten onto the HST. Once she had hold of the Hubble, McArthur lifted it out of Atlantis’ cargo bay and then she moved it over the edge of the shuttle.

The Hubble Telescope measures:
43.5 ft. in length
14 ft. in diameter
25,500 lbs. in weight
**Objective:**
To use visual images taken by STS-125 astronauts to show how the HST looked as it was being released.

**Atlantis Releases The Hubble**

**Atlantis Flight Day 9**
**May 19, 2009**

The Hubble Space Telescope as it is being released back into orbit by the Atlantis.
Objective:
To use visual images to show how astronauts used still cameras (photography) to capture images of the HST.

Photographing Hubble After its Release

Atlantis Flight Day 9
May 19, 2009

Astronaut
John M. Grunsfeld

Astronauts photographing the Hubble Space Telescope after its release from the Atlantis.

Astronaut Michael T. Good
Objective:
To use a visual image of the HST after its release from the Atlantis to show how the STS-125 astronauts used still cameras (photography) to capture this photograph of the HST.

The Hubble After its Release

Atlantis Flight Day 9
May 19, 2009

This magnificent picture of the Hubble Space Telescope was taken by one of the STS-125 astronauts after it was released back into orbit from the Space Shuttle Atlantis.
Objectives:
- To use visual image to show the Atlantis and its STS-125 crew members as they returned to Earth at the completion of their mission.
- To use a visual image to show the Atlantis STS-125 Crew after their Hubble mission.

Atlantis Lands Ending Hubble Mission 4

Atlantis Returns To Earth

Atlantis STS-125 Crew After Mission
Objective:
To identify the upgrades and repairs made to the HST.

Upgrades and Repairs to the Hubble

The STS-125 Hubble Service Mission 4

The upgrades and repairs made to the Hubble Space Telescope during Atlantis STS-125 Hubble Service Mission 4 are listed below.

Upgrades and Repairs Made to the HST:

- **Installed** the Wide Field Camera 3
- **Installed** the Cosmic Origins Spectrograph
- **Repaired** the Advanced Camera for Surveys
- **Repaired** the Space Telescope Imaging Spectrograph
- **Replaced** the Science Instrument Command and Data Handling System
- **Replaced** the Fine Guidance Sensor 2
- **Installed** Rate Sensor Units
- **Replaced** the Battery Module Units
Objective: To list Hubble’s significance to Science.

Hubble’s Impact on Science

Hubble’s Accomplishments

Since its launch into space in 1990, the scientific images taken by the Hubble Space Telescope have greatly improved astronomers understanding of the Universe. The orbiting Hubble Space Telescope has captured billions of extraordinary images of stars, planets and other celestial objects. Most of all, the large space telescope’s pictures have provided astronomers and other scientists with better knowledge of the expanding Universe. The Hubble Telescope’s images have helped the study of astronomy by showing how the expanding Universe of galaxies has changed over billions of years of cosmic time.
Objective:
To engage students in a whole-group class discussion of material from this lesson booklet.

Questions For Discussion

1) Would you recommend the Clickable Spacesuit website to a friend? Why or why not?
   Answers will vary

2) What was the purpose of Hubble’s servicing missions?
   To perform upgrades and repairs to the Hubble Space Telescope; for maintenance to keep the telescope operating to collect data to transmit back to astronomers and other scientists on the ground to study.

3) How does the HST help astronomers and other scientists?
   It helps in understanding the Universe: what is out in space, how far away celestial objects are located, and how the Universe has changed over billions of years.

4) Do you think that astronomers would know less or more about the Universe, if the HST did not exist?
   Answers will vary

5) Would you consider becoming an astronomer? Why or why not?
   Answers will vary

6) If you had the opportunity to go to space and see the Hubble Space Telescope in person, would you? Why or why not?
   Answers will vary
Objective:
To use a NASA video to gain a visual and audio understanding of the last servicing mission to the HST.

To Learn More About the Mission

Video
The Last Mission to Hubble

To Watch The Video

Step 1:
Visit the following web site:

NASA
Mission to Hubble
Making Hubble More Powerful Than Ever

Step 2:
To watch the video
Click on the Link Titled:

The Last Mission to Hubble
View This Video
Video Duration is: 4 minutes and 47 seconds
Objective:
To introduce students to NASA web sites that teach about Hubble Space Telescope careers.

Hubble Careers

To Learn About Some of the Fun and Exciting Hubble Careers Please Visit the Following Web site:

Hubble Careers in Action
http://www.nasa.gov/audience/foreducators/hubble-careers.html
Objective:
To introduce students to NASA web sites that teach about Hubble Space Telescope careers.

Hubble Careers

Goddard Engineers and Divers
Multi-Task for Hubble

Did you ever wonder how NASA astronauts prepare for Hubble Space Telescope servicing missions?

This picture shows **Servicing Mission 4 astronauts practice on a Hubble model underwater** at the Neutral Buoyancy Lab in Houston under the watchful eyes of NASA engineers and safety divers.

To learn more please visit this website:
Objective:
To introduce students to NASA web sites that teach about Hubble Space Telescope careers.

Hubble Careers

Thermal Blanket Fabricators

Learn why the Hubble needs thermal blankets and what skills and materials are needed to make them.

Pictured above is technician Brenda Estavia cutting a piece of aluminum kapton film that will become part of a thermal blanket.

To learn more please visit this website:
Objective:
To introduce students to NASA web sites that teach about Hubble Space Telescope careers.

Hubble Careers

Flight Controllers
in the Hubble Operations Center

The Hubble would not be able to do what it does without the help of a small group of dedicated engineers and technicians at NASA’s Goddard Space Flight Center in Greenbelt, Md.

This picture shows engineers at Goddard's Space Telescope Operations Control Center monitoring the Hubble Space Telescope around the clock.

To learn more please visit this website:
Objective:
To introduce students to NASA web sites that teach about Hubble Space Telescope careers.

Hubble Careers

Specialized Tool Developers

A team at NASA's Goddard Space Flight Center designs and builds the special tools and aids astronauts need when they service the Hubble Space Telescope.

In this picture Servicing Mission 4 astronaut Andrew Feustel trains with fellow astronauts and Hubble engineers in the clean room at NASA’s Goddard Space Flight Center. Feustel is using a computer-controlled power tool, called the Pistol Grip Tool, to install the Wide Field Camera 3 into a high-fidelity Hubble model.

To learn more please visit this website:

Karen Freiboth
NASA Top Stars, 2009
Glossary
Dark Energy
- A mysterious force that seems to work opposite to that of gravity and makes the universe expand at a faster pace.

Dark Matter
- Matter that is too dim to be detected by telescopes. Astronomers infer its existence by measuring its gravitational influence. Dark matter makes up most of the total mass of the universe.

Extravehicular Mobility Unit (EMU)
- The current spacesuit is a complex garment. Not only does it protect from the extreme conditions of space, it is in itself a mobile life support system with an oxygen supply, electrical power, water-cooling equipment, ventilating fan, and an in-suit drink bag. This section of the Suited for Spacewalking Educator Guide describes the components of the current extravehicular mobility unit, or EMU.

EVA (Spacewalk)
- Extra Vehicular Activity - Outside the spacecraft; activity in space conducted by suited astronauts, also known as a spacewalk.

Flight Director (FLIGHT)
- Flight serves as leader of the flight control team, and is responsible for overall shuttle mission and payload operations and all decisions regarding safe, successful flight conduct.

Galaxy Evolution
- The study of the birth of galaxies and how they change and develop over time.
Hubble Space Telescope (HST)
- Hubble orbits 600 kilometers (375 miles) above Earth, using excellent pointing precision, powerful optics, and state-of-the-art instruments to provide stunning views of the Universe that cannot be made using ground-based telescopes or other satellites. Hubble was originally designed in the 1970s and launched in 1990. Designed to be serviced in orbit, there have been five servicing missions. The fifth and last servicing mission, SM4, was in 2009.

Johnson Space Center (JSC)
- Johnson Space Center, Houston Texas, established in 1961 as the Manned Spacecraft Center. In 1973, the Center was renamed in honor of the late President and Texas native, Lyndon B. Johnson. JSC is home to the NASA astronaut corps. The Mission Control Center (MCC) at JSC directs all space shuttle missions and also manages all activity onboard the international space station. JSC is the home of the Neutral Bouyance Lab.

NASA
- The NATIONAL AERONAUTICS AND SPACE ADMINISTRATION which is in charge of all public space programs of the United States.

Remote Manipulator System (RMS)
- The shuttle robotic arm, about the size of a Greyhound bus - 15.2-meter (50-foot) long articulating arm remotely controlled from the flight deck of the Orbiter.

Safety Tethers
- One end of these straps is attached to the spacewalker. The other end is connected to the vehicle. The safety tethers keep the astronauts from drifting away into space.
**Servicing Missions**
- Hubble was the first space telescope designed to be serviced in space. Scientists believed that periodic servicing missions would extend Hubble’s operating life and keep the observatory up-to-date. Astronauts have visited Hubble five times. The first servicing mission was in December 1993 and the second in February 1997. The third mission was split into two visits. Part A took place in December 1999 and part B in March 2002. The final servicing mission visit occurred in May 2009.

**Space Shuttle**
- A reusable U.S. spacecraft operated by astronauts and used to transport cargo, such as satellites, into space. The spacecraft uses rockets to launch into space, but it lands like an airplane. A space shuttle carried the Hubble Space Telescope into space in 1990. Astronauts aboard subsequent space shuttles have visited the telescope to service it.

**Wide Field Camera 3 (WFC3)**
- This new camera replaced the Wide Field and Planetary Camera 2 during Servicing Mission 4. WFC3 has the latest CCD (charge-coupled device) technology and optical coatings which provide a broader range of colors, spanning ultraviolet, visible, and near-infrared wavelengths. WFC3 will greatly enhance Hubble’s observational capabilities by studying a diverse range of objects and phenomena, from early and distant galaxy formation to nearby planetary nebulae, and finally our own backyard — the planets and other bodies of our solar system.
Credits
&
Photo Credits
SPACE EDUCATORS’ HANDBOOK
THE SPACESUIT
Suiting Up
http://er.jsc.nasa.gov/SEH/suitnasa.html

HUBBLESITE
THE TELESCOPE
Team Hubble: Servicing Missions
NASA
Space Telescope Science Institute (STScI)
http://hubblesite.org/the_telescope/team_hubble/
servicing_missions.php
http://hubblesite.org/the_telescope/team_hubble/
servicing_missions.php#sm4

NASA
HUMANSPACEFLIGHT
Mission Control Center
April 24, 2005
Spacecraft Communicator (CAPCOM)
http://spaceflight.nasa.gov/shuttle/reference/mcc/shuttle_mcc.html

NASA
Spacesuits and Spacewalks
Learn About Spacesuits
Safety Tethers
November 13, 2008
http://www.nasa.gov/audience/foreducators/spacesuits/home/
clickable_suit_nf.html
This image depicts space shuttle Atlantis capturing the Hubble Space Telescope.

http://www.nasa.gov/pdf/331922main_sts125_presskit_050609.pdf

NASA
THE HUBBLE PROJECT
Servicing Mission 3B
Kennedy Launch Site - Part 1 of 2
Kennedy Launch Site - Part 2 of 2
VAB Vertical Assembly Building Booster Rocket
Booster Rocket
GODDARD SPACE FLIGHT CENTER
October 24, 2005

http://sm3b.gsfc.nasa.gov/launch-info/kennedy-part2.html
http://sm3b.gsfc.nasa.gov/launch-info/kennedy-part2.html#VAB
NASA
HUMANSPACEFLIGHT
STS-125 Shuttle Mission Imagery
June 1, 2009


NASA
SERVICING MISSION 4
THE HUBBLE PROGRAM
SM4 MULTIMEDIA
SM4 MISSION - PRE-SM4
Pre-SM4 Photo Images
Pre-SM4 Videos
July 2, 2009
http://sm4.gsfc.nasa.gov/multimedia/gallery10_pre.php

STS-125 Mission Patch (High Resolution)

http://sm4.gsfc.nasa.gov/art/overview/sts125-patch-hi.jpg
SM4 Mission Logo (High Resolution)

http://sm4.gsfc.nasa.gov/art/overview/SM4_Logo_hi.jpg

Return to Hubble-Yes We Can, America (Pre-SM4 Videos)

http://sm4.gsfc.nasa.gov/multimedia/gallery10_pre.php
NASA
SM4 MULTIMEDIA
SM4 MISSION - PRE-SM4
Wide Field Camera 3 (WFC3)
WFC3 Graphic Images
June 15, 2009
http://sm4.gsfc.nasa.gov/multimedia/gallery1_wfc3.php#graphics

WFC3 Logo

http://sm4.gsfc.nasa.gov/multimedia/gallery1_wfc3.php#graphics

Hubble with WFC3

http://sm4.gsfc.nasa.gov/art/graphics/inst_hub_wfc3.gif

NASA
Spacesuits and Spacewalks
The Clickable Spacesuit -- An Interactive Spacesuit Experience
NASA's Extravehicular Mobility Unit, or EMU, is like a personal mini-spacecraft. Mouse over the parts of the spacesuit and learn why each piece is important.
Learn about spacesuits with this interactive feature. Image Credit: NASA
October 6, 2009

http://www.nasa.gov/audience/foreducators/spacesuits/home/index.html
Tomas Gonzalez-Torres, STS-125 lead spacewalk officer, monitors data at his console in the space shuttle flight control room in the Mission Control Center (MCC) at NASA's Johnson Space Center (JSC).

Astronaut Alan Poindexter, STS-125 spacecraft communicator (CAPCOM), monitors data at his console in the space shuttle flight control room in the MCC at JSC.

Flight directors Rick LaBrode (left) and Chris Edelen monitor data at their console in the space shuttle flight control room in the MCC at JSC.
NASA
SERVICING MISSION 4
THE HUBBLE PROGRAM
SM4 MULTIMEDIA
SM4 MISSION - FLIGHT DAY 3 - 05.13.2009
Flight Day 3 Photo Images
June 22, 2009
http://sm4.gsfc.nasa.gov/multimedia/gallery10_space-day3.php

Hubble has been captured

http://sm4.gsfc.nasa.gov/art/
day3/345874main_hubble_grapple3.jpg

Still photo of the Hubble Space Telescope as Atlantis approaches

http://sm4.gsfc.nasa.gov/art/day3/s125e006922.jpg

NASA
SERVICING MISSION 4
THE HUBBLE PROGRAM
SM4 MULTIMEDIA
SM4 MISSION - FLIGHT DAY 4 - 05.14.2009
Flight Day 4 Photo Images
June 22, 2009
http://sm4.gsfc.nasa.gov/multimedia/gallery10_space-day4.php

Close-up of John Grunsfeld performing a spacewalk

http://sm4.gsfc.nasa.gov/art/day4/s125e007493.jpg
John Grunsfeld performs work on the HST.

http://sm4.gsfc.nasa.gov/art/day4/s125e007225.jpg

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Michael Good works with the HST in the cargo bay of Atlantis.

http://sm4.gsfc.nasa.gov/art/day5/s125e007555.jpg

Mike Massimino in Atlantis' cargo bay.

http://sm4.gsfc.nasa.gov/art/day5/s125e007537.jpg
Andrew Feustel navigates near the HST on the end of the remote manipulator system arm.

http://sm4.gsfc.nasa.gov/art/day6/s125e007853.jpg
Mike Massimino attired in his EMU spacesuit, is pictured in the Atlantis' airlock prior to the start of the mission's fourth EVA.

http://sm4.gsfc.nasa.gov/art/day7/xs125e009398.jpg

Scott Altman (right) and John Grunsfeld assist Michael Good in the donning of his EMU spacesuit on the middeck.

http://sm4.gsfc.nasa.gov/art/day7/xs125e009404.jpg

Michael Good gets help from John Grunsfeld, Scott Altman, and Gregory C. Johnson in the donning of his EMU spacesuit on the middeck.

http://sm4.gsfc.nasa.gov/art/day7/xs125e009402.jpg

Michael Good (left) and Mike Massimino perform STIS repair.

http://sm4.gsfc.nasa.gov/art/day7/s125e008633.jpg
John Grunsfeld positioned on a foot restraint on the end of Atlantis' RMS as work continues to refurbish and upgrade HST.

http://sm4.gsfc.nasa.gov/art/day8/s125e009612.jpg

John Grunsfeld is tethered to the RMS as he's lowered into the cargo bay.

http://sm4.gsfc.nasa.gov/art/day8/s125e009712.jpg

Megan McArthur works the controls of the RMS.

http://sm4.gsfc.nasa.gov/art/day8/s125e009948.jpg
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http://sm4.gsfc.nasa.gov/multimedia/gallery10_space-day9.php

Michael Good works controls on the aft flight deck.

http://sm4.gsfc.nasa.gov/art/day9/349202main_s125e010161.jpg

Remote manipulator system arm lifts the Hubble Space Telescope from the cargo bay.

http://sm4.gsfc.nasa.gov/art/day9/s125e011766.jpg

John Grunsfeld uses a still camera at an overhead window on the aft flight deck to photograph the Hubble Space Telescope after its release.

http://sm4.gsfc.nasa.gov/art/day9/s125e011919.jpg
Michael Good uses a still camera at an overhead window on the aft flight deck to photograph the Hubble Space Telescope after its release.

http://sm4.gsfc.nasa.gov/art/day9/s125e011921.jpg

A released Hubble

http://sm4.gsfc.nasa.gov/art/day9/s125e012033.jpg

A released Hubble

http://sm4.gsfc.nasa.gov/art/day9/s125e012031.jpg

Hubble begins release

http://sm4.gsfc.nasa.gov/art/day9/s125e011805.jpg

Hubble begins release

http://sm4.gsfc.nasa.gov/art/day9/s125e011810.jpg

A released Hubble

http://sm4.gsfc.nasa.gov/art/day9/s125e011835.jpg

Megan McArthur on the aft flight deck during flight day nine activities.

http://sm4.gsfc.nasa.gov/art/day9/s125e011888.jpg
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Hubble with Earth

http://sm4.gsfc.nasa.gov/art/graphics/hubble_telescope.jpeg

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Flight Day 11
July 16, 2009

STS-125 crew portrait (Pre Launch Photos)
(l to r) Mike Massimino, Mike Good, Greg Johnson, Scott Altman, Megan McArthur, John Grunsfeld, and Andrew Feustel (High Resolution)


STS-125 crew members eagerly stride from the Operations and Checkout Building (Launch Day Photos)


Following the landing the crew of STS-125 gather on the runway at Edwards Air Force Base (Flight Day 11)

http://sm4.gsfc.nasa.gov/art/landing/351413main_crewland_full.jpg
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Mission to Hubble
Making Hubble More Powerful Than Ever
Servicing Mission 4 Videos
May 7, 2009

The Last Mission to Hubble

http://www.nasa.gov/images/content/270621main_overview_video_promo_100x75.jpg

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SM4 Crew Photo Images
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STS-125 Crew Poster

http://sm4.gsfc.nasa.gov/art/multimedia/missionprep/STS125SFAposterhiRes.jpg
Over 3,000 people are currently involved in the servicing mission to Hubble.

Servicing Mission 4 astronauts practice on a Hubble model underwater at the Neutral Buoyancy Lab in Houston under the watchful eyes of NASA engineers and safety divers.
Technician Brenda Estavia cuts a piece of aluminum kapton film that will become part of a thermal blanket.

Engineers at Goddard's Space Telescope Operations Control Center monitor the Hubble Space Telescope around the clock.
Servicing Mission 4 astronaut Drew Feustel trains with fellow astronauts and Hubble engineers in the clean room at NASA's Goddard Space Flight Center. Feustel is using a computer-controlled power tool, called the Pistol Grip Tool, to install the Wide Field Camera 3 into a high-fidelity Hubble model.