Shuttle Press Kit

STS-93

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Download the STS-93 Press Kit in PDF format for printing (2.7 MB).
Requires Adobe Reader 3.0

Columbia OV102
Launch: Tuesday, July 20, 1999
12:36 AM (eastern time)

Mission Objectives

The primary objective of the STS-93 mission is the deployment of the $1.5 billion Chandra X-Ray Observatory, the third in NASA's series of "Great Observatories".

Astronaut Cady Coleman is scheduled to deploy the observatory about seven hours after liftoff. Chandra will spend the next five years in a highly elliptical orbit which will take it one-third of the way to the moon to study invisible and often violent sources of astronomical activity in the distant universe.

Secondary objectives include the firing of Columbia's jet thrusters at various times during the flight to help an Air Force satellite gather data on the characteristics of jet plumes in orbit.

In addition, crew members will operate the Southwest Ultraviolet Imaging System, a small telescope which will be mounted at the side hatch window in Columbia's middeck to collect data on ultraviolet light originating from a variety of planetary bodies.

Pilot Jeff Ashby and Mission Specialists Steve Hawley and Michel Tognini will conduct an in-flight assessment of an exercise system planned for the International Space Station. The on-orbit treadmill, referred to as the Treadmill Vibration Isolation and

Stabilization (TVIS) system, should provide the crew with a reliable exercise device while also meeting International Space Station (ISS) load transmission requirements to avoid disrupting on-orbit experiments.

Crew

Commander:	Eileen M. Collins
Pilot:	Jeffrey S. Ashby
Mission Specialist 1:	Cady G. Coleman
Mission Specialist 2:	Steven A. Hawley
Mission Specialist 3:	Michel Tognini

Launch

Orbiter:	Columbia OV102
Launch Site:	KSC Pad 39-B
Launch Window:	46 minutes
Altitude:	153 nautical miles
Inclination:	28.45 degrees
Duration:	4 Days 22 Hrs. 56 Min.

Vehicle Data

Shuttle Liftoff Weight:	4,524,727 lbs.
Orbiter/Payload Liftoff Weight:	270,142 lbs.
Orbiter/Payload Landing Weight:	219,980 lbs.

Payload Weights

SWUIS	60 lb.
	50,162 lbs.

Software Version: OI-26B

Space Shuttle Main Engines: *(1 MB pdf)*

SSME 1: #2012 **SSME 2:** #2031 **SSME 3:** #2019

External Tank: ET-99

SRB Set: BI-097

Auxiliary Power Units: *(900 KB pdf)*

APU-1: SN 401 **APU-2:** SN 410 **APU-3:** SN 304

Fuel Cells: *(1.4 MB pdf)*

FC-1: SN 113 **FC-2:** SN 125 **FC-3:** SN 115

Shuttle Aborts

Abort Landing Sites

RTLS: Kennedy Space Center
TAL: Banjul (prime); Ben Guerir (alternate)
AOA: Edwards Air Force Base, California

Shuttle Abort History

Landing

Landing Date:	07/24/99
Landing Time:	11:32 PM (eastern time)
Primary Landing Site:	Kennedy Space Center Shuttle Landing Facility

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Payloads

Cargo Bay

Chandra X-Ray Observatory

In-Cabin

Plant Growth Investigations in Microgravity 1
Southwest Ultraviolet Imaging System
Gelation of Sols: Applied Microgravity Research
Space Tissue Loss
Lightweight Flexible Solar Array Hinge
Cell Culture Model, Configuration C
Shuttle Amateur Radio Experiment II
Commercial Generic Bioprocessing Apparatus
Micro-Electromechanical Systems
Biological Research in Canisters

Editorial/Technical Comments: ShuttlePresskit

Mission Overview

STS-93 MISSION MARKS MILESTONES IN SPACE FLIGHT HISTORY

NASA will mark milestones in both human space flight history and astronomy on the 95th Space Shuttle mission with the launch of the first female Shuttle Commander and the Chandra X-Ray Observatory.

Columbia is scheduled to liftoff at 12:36 a.m. EDT from Launch Pad 39-B at the Kennedy Space Center on July 20 on the STS-93 mission, carrying Chandra to orbit to join the Hubble Space Telescope and the Compton Gamma Ray Observatory as the next in NASA's series of "Great Observatories".

Chandra will spend at least five years in a highly elliptical orbit which will carry it one-third of the way to the moon to observe invisible and often violent realms of the cosmos containing some of the most intriguing mysteries in astronomy ranging from comets in our solar system to quasars at the edge of the universe. At 50,162 pounds, Chandra, along with its two-stage, solid-fuel Inertial Upper Stage booster and associated cargo bay equipment is the heaviest payload ever launched on the Shuttle. Chandra is named after the famed Nobel Laureate astrophysicist, Dr. Subrahmanyan Chandrasekhar.

Columbia's 26th flight is led by Air Force Col. Eileen Collins, who will become the first woman to command a Space Shuttle mission following two previous flights as Pilot. Collins, 42, flew to the Mir Space Station on STS-63 in 1995 in the first Shuttle rendezvous with the Russian space outpost and revisited Mir during the STS-84 mission in 1997.

Her Pilot is Navy Captain Jeff Ashby, 45, who will be making his first flight into space.

Air Force Lt. Col. Catherine "Cady" Coleman, 38, will be responsible for the deployment of the Chandra X-Ray Observatory in this, her second flight into space. Steven A. Hawley, Ph.D., 47, who deployed the Hubble Space Telescope nine years ago, will be the flight engineer during launch and landing and will be responsible for many secondary experiments, including operation of the Southwest Ultraviolet Imaging System, a small telescope which will be mounted in the middeck of Columbia. This is Hawley's fifth flight. French Air Force Col. Michel Tognini, 49, of CNES, the French Space Agency, rounds out the crew. Tognini is making his second trip into space after spending two weeks on the Mir Space Station as a visiting cosmonaut in 1992.

Columbia's planned five-day mission is scheduled to end with a night landing at the Kennedy Space Center just after 11:30 p.m. EDT on July 24 to wrap up the second Shuttle flight of the year.

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Updated: 07/07/1999

Flight Plan

STS-93

- Launch Countdown
- Overview Time Line (*175.2 KB pdf*).
  PDF requires Adobe Reader 3.0
- Flight Day Summary
- Detailed Flight Plan (*262.2 KB pdf*).
  PDF requires Adobe Reader 3.0

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Updated: 07/08/1999

Editorial/Technical Comments: ShuttlePresskit

Launch Countdown

STS-93

DATE TIME (EST)	MET	EVENT
07/19/99 3:46:00 PM	T - 000/06:00:00	Verification of the launch commit criteria is complete at this time. The liquid oxygen and liquid hydrogen systems chill-down commences in order to condition the ground line and valves as well as the external tank (ET) for cryo loading. Orbiter fuel cell power plant activation is performed.
07/19/99 3:56:00 PM	T - 000/05:50:00	The space shuttle main engine (SSME) liquid hydrogen chill-down sequence is initiated by the launch processing system (LPS). The liquid hydrogen recirculation valves are opened and start the liquid hydrogen recirculation pumps. As part of the chill-down sequence, the liquid hydrogen prevalves are closed and remain closed until T minus 9.5 seconds.
07/19/99 4:16:00 PM	T - 000/05:30:00	Liquid oxygen chill-down is complete. The liquid oxygen loading begins. The liquid oxygen loading starts with a "slow fill" in order to acclimate the ET. Slow fill continues until the tank is 2-percent full.
07/19/99 4:31:00 PM	T - 000/05:15:00	The liquid oxygen and liquid hydrogen slow fill is complete and the fast fill begins. The liquid oxygen and liquid hydrogen fast fill will continue until that tank is 98-percent full.
07/19/99 4:46:00 PM	T - 000/05:00:00	The calibration of the inertial measurement units (IMUs) starts. The three IMUs are used by the orbiter navigation systems to determine the position of the orbiter in flight.
07/19/99 5:16:00 PM	T - 000/04:30:00	The orbiter fuel cell power plant activation is complete.
07/19/99 5:46:00 PM	T - 000/04:00:00	The Merritt Island (MILA) antenna, which transmits and receives communications, telemetry and ranging information, alignment verification begins.
07/19/99 6:01:00 PM	T - 000/03:45:00	The liquid hydrogen fast fill to 98 percent is complete, and a slow topping-off process is begun and stabilized to 100 percent.
07/19/99 6:16:00 PM	T - 000/03:30:00	The liquid oxygen fast fill is complete to 98 percent.
07/19/99 6:26:00 PM	T - 000/03:20:00	The main propulsion system (MPS) helium tanks begin filling from 2,000 psi to their full pressure of 4,500 psi.

07/19/99 6:31:00 PM	T - 000/03:15:00	Liquid hydrogen stable replenishment begins and continues until just minutes prior to T minus zero.
07/19/99 6:36:00 PM	T - 000/03:10:00	Liquid oxygen stable replenishment begins and continues until just minutes prior to T minus zero.
07/19/99 6:46:00 PM	T - 000/03:00:00	Begin 2-hour planned hold. An inspection team examines the ET for ice or frost formation on the launch pad during this hold. The MILA antenna alignment is completed. The orbiter closeout crew goes to the launch pad and prepares the orbiter crew compartment for flight crew ingress.
07/19/99 8:46:00 PM	T - 000/03:00:00	Two-hour planned hold ends.
07/19/99 8:51:00 PM	T - 000/02:55:00	Flight crew departs Operations and Checkout (O&C) Building for launch pad.
07/19/99 9:21:00 PM	T - 000/02:25:00	Flight crew orbiter and seat ingress occurs.
07/19/99 9:36:00 PM	T - 000/02:10:00	Post ingress software reconfiguration occurs.
07/19/99 9:46:00 PM	T - 000/02:00:00	Checking of the launch commit criteria starts at this time.
07/19/99 9:46:00 PM	T - 000/02:00:00	The ground launch sequencer (GLS) software is initialized.
07/19/99 9:56:00 PM	T - 000/01:50:00	The solid rocket boosters' (SRBs') hydraulic pumping units' gas generator heaters are turned on and the SRBs' aft skirt gaseous nitrogen purge starts.
07/19/99 9:56:00 PM	T - 000/01:50:00	The SRB rate gyro assemblies (RGAs) are turned on. The RGAs are used by the orbiter's navigation system to determine rates of motion of the SRBs during first-stage flight.
07/19/99 10:11:00 PM	T - 000/01:35:00	The flight crew starts the communications checks. The orbiter reaction control system (RCS) control drivers are powered up. The orbiter reaction control system (RCS) control drivers are powered up.
07/19/99 10:21:00 PM	T - 000/01:25:00	The SRB RGA torque test begins.
07/19/99 10:26:00 PM	T - 000/01:20:00	Orbiter side hatch is closed.
07/19/99 10:36:00 PM	T - 000/01:10:00	Orbiter side hatch seal and cabin leak checks are performed.
07/19/99 10:45:00 PM	T - 000/01:01:00	IMU preflight align begins. Flight crew functions from this point on will be initiated by a call from the orbiter test conductor (OTC) to proceed. The flight crew will report back to the OTC after completion.
07/19/99 10:46:00 PM	T - 000/01:00:00	The orbiter RGAs and AAs are tested.
07/19/99 10:56:00 PM	T - 000/00:50:00	The orbiter RGAs and AAs are tested.
07/19/99 11:01:00 PM	T - 000/00:45:00	Cabin vent redundancy check is performed. The GLS mainline activation is performed.

07/19/99 11:06:00 PM	T - 000/00:40:00	The eastern test range (ETR) shuttle range safety system (SRSS) terminal count closed-loop test is accomplished. Cabin leak check is completed.
07/19/99 11:14:00 PM	T - 000/00:32:00	The backup flight control system (BFS) computer is configured.
07/19/99 11:16:00 PM	T - 000/00:30:00	The gaseous nitrogen system for the orbital maneuvering system (OMS) engines is pressurized for launch. Crew compartment vent valves are opened.
07/19/99 11:20:00 PM	T - 000/00:26:00	The ground pyro initiator controllers (PICs) are powered up. They are used to fire the SRB hold-down posts, liquid oxygen and liquid hydrogen tail service mast (TSM), and ET vent arm system pyros at lift-off and the SSME hydrogen gas burn system prior to SSME ignition.
07/19/99 11:21:00 PM	T - 000/00:25:00	Simultaneous air-to-ground voice communications are checked. Weather aircraft are launched.
07/19/99 11:24:00 PM	T - 000/00:22:00	The primary avionics software system (PASS) is transferred to the BFS computer in order for both systems to have the same data. In case of a PASS computer system failure, the BFS computer will take over control of the shuttle vehicle during flight.
07/19/99 11:25:00 PM	T - 000/00:21:00	The crew compartment cabin vent valves are closed.
07/19/99 11:26:00 PM	T - 000/00:20:00	A 10-minute planned hold starts. All computer programs in the firing room are verified to ensure that the proper programs are available for the final countdown. The test team is briefed on the recycle options in case of an unplanned hold. The landing convoy status is again verified and the landing sites are verified ready for launch. The IMU preflight alignment is verified coming out of the hold. This configures the computer memory to a terminal countdown configuration.complete. Preparations are made to transition the orbiter onboard computers to Major Mode (MM) 101 upon
07/19/99 11:36:00 PM	T - 000/00:20:00	The 10-minute hold ends. Transition to MM-101. The PASS onboard computers are dumped and compared to verify the proper onboard computer configuration for launch.
07/19/99 11:37:00 PM	T - 000/00:19:00	The flight crew configures the backup computer to MM-101 and the test team verifies the BFS computer is tracking the PASS computer systems. The flight crew members configure their instruments for launch.

07/19/99 11:38:00 PM	T - 000/00:18:00	The Mission Control Center-Houston (MCC-H) now loads the onboard computers with the proper guidance parameters based on the prestated lift-off time.
07/19/99 11:40:00 PM	T - 000/00:16:00	The MPS helium system is reconfigured by the flight crew for launch.
07/19/99 11:41:00 PM	T - 000/00:15:00	The OMS/RCS crossfeed valves are configured for launch. All test support team members verify they are "go for launch."
07/19/99 11:44:00 PM	T - 000/00:12:00	Emergency aircraft and personnel are verified on station.
07/19/99 11:46:00 PM	T - 000/00:10:00	All orbiter aerosurfaces and actuators are verified to be in the proper configuration for hydraulic pressure application. The NASA test director gets a "go for launch" verification from the launch team.
07/19/99 11:47:00 PM	T - 000/00:09:00	A planned 40-minute hold starts. NASA and contractor project managers will be formally polled by the deputy support team members verify that they are "go for launch." Final GLS configuration is complete.
07/20/99 12:27:00 AM	T - 000/00:09:00	The GLS auto sequence starts and the terminal countdown begins. Counting From this point, the GLSs in the integration and backup consoles are the primary control until T-0 in conjunction with the onboard orbiter PASS redundant-set computers.
07/20/99 12:27:00 AM	T - 000/00:09:00	Operations recorders are on. MCC-H, Johnson Space Center, sends a command to turn these recorders on. They record shuttle system performance during ascent and are dumped to the ground once orbit is achieved.
07/20/99 12:28:00 AM	T - 000/00:08:00	Payload and stored prelaunch commands proceed.
07/20/99 12:28:30 AM	T - 000/00:07:30	The orbiter access arm (OAA) connecting the access tower and the orbiter side hatch is retracted. If an emergency arises requiring flight crew activation, the arm can be extended either manually or by GLS computer control in approximately 30 seconds or less.
07/20/99 12:30:00 AM	T - 000/00:06:00	APU prestart occurs.
07/20/99 12:31:00 AM	T - 000/00:05:00	Orbiter APUs start. The orbiter APUs provide pressure to the three orbiter hydraulic systems. These systems are used to move the SSME engine nozzles and aerosurfaces.
07/20/99 12:31:00 AM	T - 000/00:05:00	ET/SRB range safety system (RSS) is armed. At this point, the firing circuit for SRB ignition and destruct devices is mechanically enabled by a motor-driven switch called a safe and arm device (S&A).

07/20/99 12:31:30 AM	T - 000/00:04:30	As a preparation for engine start, the SSME main fuel valve heaters are turned off.
07/20/99 12:32:00 AM	T - 000/00:04:00	The final helium purge sequence, purge sequence 4, on the SSMEs is started in preparation for engine start.
07/20/99 12:32:05 AM	T - 000/00:03:55	At this point, all of the elevons, body flap, speed brake, and rudder are moved through a preprogrammed pattern. This is to ensure that they will be ready for use in flight.
07/20/99 12:32:30 AM	T - 000/00:03:30	Transfer to internal power is done. Up to this point, power to the space vehicle has been shared between ground power supplies and the onboard fuel cells. The ground power is disconnected and the vehicle goes on internal power at this time. It will remain on internal power through the rest of the mission.
07/20/99 12:32:35 AM	T - 000/00:03:25	The SSMEs' nozzles are moved (gimbaled) through a preprogrammed pattern to ensure that they will be ready for ascent flight control. At completion of the gimbal profile, the SSMEs' nozzles are in the start position.
07/20/99 12:33:05 AM	T - 000/00:02:55	ET liquid oxygen prepressurization is started. At this point, the liquid oxygen tank vent valve is closed and the ET liquid oxygen tank is pressurized to its flight pressure of 21 psi.
07/20/99 12:33:10 AM	T - 000/00:02:50	The gaseous oxygen arm is retracted. The cap that fits over the ET nose cone to prevent ice buildup on the oxygen vents is raised off the nose cone and retracted.
07/20/99 12:33:25 AM	T - 000/00:02:35	Up until this time, the fuel cell oxygen and hydrogen supplies have been adding to the onboard tanks so that a full load at lift-off is assured. This filling operation is terminated at this time.
07/20/99 12:33:30 AM	T - 000/00:02:30	The caution/warning memory is cleared.
07/20/99 12:34:03 AM	T - 000/00:01:57	Since the ET liquid hydrogen tank was filled, some of the liquid hydrogen has turned into gas. In order to keep pressure in the ET liquid hydrogen tank low, this gas was vented off and piped out to a flare stack and burned. In order to maintain flight level, liquid hydrogen was continuously added to the tank to replace the vented hydrogen. This operation terminates, the liquid hydrogen tank vent valve is closed, and the tank is brought up to a flight pressure of 44 psia at this time.
07/20/99 12:34:45 AM	T - 000/00:01:15	The sound suppression system will dump water onto the mobile launcher platform (MLP) at ignition in order to dampen vibration and noise in the space shuttle. The firing system for this dump, the sound suppression water power bus, is armed at this time.

07/20/99 12:35:00 AM	T - 000/00:01:00	The SRB joint heaters are deactivated.
07/20/99 12:35:05 AM	T - 000/00:00:55	The SRB MDM critical commands are verified.
07/20/99 12:35:13 AM	T - 000/00:00:47	The liquid oxygen and liquid hydrogen outboard fill and drain valves are closed.
07/20/99 12:35:20 AM	T - 000/00:00:40	The external tank bipod heaters are turned off.
07/20/99 12:35:22 AM	T - 000/00:00:38	The onboard computers position the orbiter vent doors to allow payload bay venting upon lift-off and ascent in the payload bay at SSME ignition. The SRB forward MDM is locked out.
07/20/99 12:35:23 AM	T - 000/00:00:37	The gaseous oxygen ET arm retract is confirmed.
07/20/99 12:35:29 AM	T - 000/00:00:31	The GLS sends "go for redundant set launch sequence start." At this point, the four PASS computers take over main control of the terminal count. Only one further command is needed from the ground, "go for main engine start," at approximately T minus 9.7 seconds. The GLS in the integration console in the launch control center still continues to monitor several hundred launch commit criteria and can issue a cutoff if a discrepancy is observed. The GLS also sequences ground equipment and sends selected vehicle commands in the last 31 seconds.
07/20/99 12:35:32 AM	T - 000/00:00:28	Two hydraulic power units in each SRB are started by the GLS. These provide hydraulic power for SRB nozzle gimbaling for ascent first-stage flight control. The orbiter vent door sequence starts.
07/20/99 12:35:39 AM	T - 000/00:00:21	The SRB gimbal profile is complete. As soon as SRB hydraulic power is applied, the SRB engine nozzles are commanded through a preprogrammed pattern to assure that they will be ready for ascent flight control during first stage.
07/20/99 12:35:39 AM	T - 000/00:00:21	The liquid hydrogen high-point bleed valve is closed. The SRB gimbal test begins.
07/20/99 12:35:42 AM	T - 000/00:00:18	The onboard computers arm the explosive devices, the pyrotechnic initiator controllers, that will separate the T-0 umbilicals, the SRB hold-down posts, and SRB ignition, which is the final electrical connection between the ground and the shuttle vehicle.
07/20/99 12:35:44 AM	T - 000/00:00:16	The sound suppression system water is activated.
07/20/99 12:35:45 AM	T - 000/00:00:15	If the SRB pyro initiator controller (PIC) voltage in the redundant-set launch sequencer (RSLS) is not within limits in 3 seconds, SSME start commands are not issued and the onboard computers proceed to a countdown hold.

07/20/99 12:35:47 AM	T - 000/00:00:13	The aft SRB MDM units are locked out. This is to protect against electrical interference during flight. The electronic lock requires an unlock command before it will accept any other command. SRB SRSS inhibits are removed. The SRB destruct system is now live.
07/20/99 12:35:48 AM	T - 000/00:00:12	The MPS helium fill is terminated. The MPS helium system flows to the pneumatic control system at each SSME inlet to control various essential functions.
07/20/99 12:35:50 AM	T - 000/00:00:10	LPS issues a "go" for SSME start. This is the last required ground command. The ground computers inform the orbiter onboard computers that they have a "go" for SSME start. The GLS retains hold capability until just prior to SRB ignition.
07/20/99 12:35:51 AM	T - 000/00:00:09.7	In preparation for SSME ignition, flares are ignited under the SSMEs. This burns away any free gaseous hydrogen that may have collected under the SSMEs during prestart operations. The orbiter goes on internal cooling at this time; the ground coolant units remain powered on until lift-off as a contingency for an aborted launch. The orbiter will redistribute heat within the orbiter until approximately 125 seconds after lift-off, when the orbiter flash evaporators will be turned on.
07/20/99 12:35:51 AM	T - 000/00:00:09.7	Liquid hydrogen recirculation pumps are turned off. The recirculation pumps provide for flow of fuel through the SSMEs during the terminal count. These are supplied by ground power and are powered in preparation for SSME start.
07/20/99 12:35:51 AM	T - 000/00:00:09.5	The SSME engine chill-down sequence is complete and the onboard computers command the three MPS liquid hydrogen prevalves to open. (The MPS's three liquid oxygen prevalves were opened during ET tank loading to permit engine chill-down.) These valves allow liquid hydrogen and oxygen flow to the SSME turbopumps.
07/20/99 12:35:51 AM	T - 000/00:00:09.5	Command decoders are powered off. The command decoders are units that allow ground control of some onboard components. These units are not needed during flight.
07/20/99 12:35:54 AM	T - 000/00:00:06.6	The main fuel and oxidizer valves in each engine are commanded open by the onboard computers, permitting fuel and oxidizer flow into each SSME

07/20/99 12:35:56 AM	T - 000/00:00:04.6	All three SSMEs are verified to be at 100-percent thrust and the SSMEs are gimbaled to the lift-off position. If one or more of the three SSMEs does not reach 100-percent thrust at this time, all SSMEs are shut down, the SRBs are not ignited, and an RSLS pad abort occurs. The GLS RSLS will perform shuttle and ground systems safing. Vehicle bending loads caused by SSME thrust buildup are allowed to initialize before SRB ignition. The vehicle moves towards ET including ET approximately 25.5 inches.
07/20/99 12:36:00 AM	T - 000/00:00:00	The two SRBs are ignited under command of the four onboard PASS computers, the four hold-down explosive bolts on each SRB are initiated (each bolt is 28 inches long and 3.5 inches in diameter), and the two T-0 umbilicals on each side of the spacecraft are retracted. The onboard timers are started and the ground launch sequence is terminated. All three SSMEs are at 104-percent thrust. Boost guidance in attitude hold.
07/20/99 12:36:00 AM	T - 000/00:00	Lift-off.

Updated: 07/08/1999

Editorial/Technical Comments: ShuttlePresskit

MET	GMT	CT	DOY	BETA	MOON	FLIGHT DAY	HOUSTON DATE	IDENTIFIER	EDITION	PUB. DATE
000/00:00 000/12:00	201/04:36 201/16:36	200/23:36 201/11:36	200 CT	48.31	◐	1	19 Jul 1999	STS-93	FINAL A	06/25/99

CT 07/19/99 — 07/20, 01, 02, 03, 04, 05, 06, 07, 08, 09, 10, 11, 12

FD01 MET Day 000 — 000/00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 10, 11, 12

2 hr no -ZDS

LAUNCH — DIRECT INSERTION — OMS 2

CDR E. Collins: PLBD MNVR; ACIS Vent Vlv Open; POST INSERTION; AFT CNTLR; CCM INIT; PCS CNFG; LAMP; SMOKE; MEAL; FES OFF; IMU MNVR; IMU; MNVR DPY; ATT; DPY CNTDOWN; DPY IUS; OMS TIG; FES A ON; SRM IGN; MNVR COMM; ATT; FUT MNVR; GRP B PWR DN; PMC; Rev 7 B/U Dpy - 8:46 SRM - 9:46; PRE SLEEP; SLEEP

PLT J. Ashby: POST INSERTION; LOAD DAPS; GIRA INSTALL; P/TV 15 SETUP; MEAL; SEE SETUP; APU RCNFG; DPY CNTDOWN; DPY IUS; CLR PRTR S/U; KU ACT; OCA S/U; * PRE SLEEP; SLEEP

MS1 C. Coleman: POST INSERTION; AXAF PWR; COMM ACT; PNL & SPEC C/O; IUS PDCO; ACT ENG; RMV INH; UPR RF; XFER SV; MEAL; TILT 29; AXAF LWR; RF; XFER SV; IUS/PI; DPY CNTDOWN; DPY IUS; TILT -6; CLOSEOUT; VTR S/U; VTR PLBK; PRE SLEEP; SLEEP

MS2 S. Hawley: POST INSERTION; PTV 08; SETUP; PTV 08 OPS; MEMS STL; STAT; PGIM CGBA STAT; PGSC SETUP; MEAL; PTV 08 OPS; PTV 08 OPS; CLR PRTR S/U; KU ACT; OCA S/U; PRE SLEEP; SLEEP

MS3 M. Tognini: POST INSRT; PLBD OPS; COMM ACT; PNL & SPEC C/O; IUS PDCO; CGBA PWR; ACT ENG; RMV INH; UPR RF; PGSC SETUP; XFER SV; MEAL; TILT 29; AXAF LWR; RF; XFER SV; IUS/PI; DPY CNTDOWN; DPY IUS; TILT -6; CLOSEOUT; VTR S/U; VTR PLBK; PRE SLEEP; SLEEP; AXAF Cmd Window

DAY/NIGHT

ORBIT: 2, 3, 4, 5, 6, 7, 8, 9

TDRS: E, W, Z

GND: MIL, CTS, HTS, VTS; GTS, MIL, CTS, HTS, VTS; DGS, GTS, HTS, VTS; DGS, HTS, GTS-VTS; DGS, HTS, GTS; DGS, HTS, GTS; GTS

ATTITUDE: -ZLV +XVV; IMU; DPY; SEP; VW; WPA; Max Ku; -ZLV -XVV

Notes: Tracking Arc; *CHECK HUMIDITY SEPARATORS

MET	GMT	CT	DOY	BETA	MOON	FLIGHT DAY	HOUSTON DATE	IDENTIFIER	EDITION	PUB. DATE
000/12:00 001/00:00	201/16:36 202/04:36	201/11:36 201/23:36	201 CT	47.53		1/2	20 Jul 1999	STS-93	FINAL A	06/25/99

CT 07/20/99 — 12 13 14 15 16 17 18 19 20 21 22 23
FD 01 — 12 13 14 15 16 17 18 19 20 21 22 23 001/00
MET Day 000

FD02

Crew	Activities
CDR E. Collins	SLEEP; DSO 493; -ZLV; +YVV; POST SLEEP; FC PURGE; ORB ADJ OMS BURN; -ZLV -XVV; SAREX SETUP; LOAD; DAPS; FLYCAST; SGL PLS; MNVR -Y; MOON; FES OFF; CCM STAT
PLT J. Ashby	SLEEP; DSO 493; H2O INIT; POST SLEEP; H2O TERM; ORB ADJ OMS BURN; ERGO S/U; LOAD; DAPS; FLYCAST; SGL PLS; EXERCISE; H2O SAMP
MS1 C. Coleman	SLEEP; DSO 493; POST SLEEP; OCA DNLK; ERGO S/U; EXERCISE; PGIM; STAT; PGF HARVEST
MS2 S. Hawley	SLEEP; DSO 493; POST SLEEP; SWUIS TSM SETUP; CGBA; STAT; MEMS STL; STAT; SWUIS; MOON 1
MS3 M. Tognini	SLEEP; DSO 493; POST SLEEP; SWUIS TSM SETUP; BRIC S/U; P/TV 13 SETUP

DAY/NIGHT	
ORBIT	9 10 11 12 13 14 15 16 17
MOON UP/DOWN	
TDRS E / W	
SPX SITES	-KWJ -JIC -ARC
ATTITUDE	-ZLV -XVV; -ZLV +YVV; OMS; MANUAL; -ZLV -XVV; -Y Moon
Notes	

MET	GMT	CT	DOY	BETA	MOON	FLIGHT DAY	HOUSTON DATE	IDENTIFIER	EDITION	PUB. DATE
001/00:00 001/12:00	202/04:36 202/16:36	201/23:36 202/11:36	201 CT	46.56	◐	2	20 Jul 1999	STS-93	FINAL A	06/25/99

CT 07/20/99 — 07/21 — 01 — 02 — 03 — 04 — 05 — 06 — 07 — 08 — 09 — 10 — 11

FD 02 — MET Day 001 — 001/00 — 01 — 02 — 03 — 04 — 05 — 06 — 07 — 08 — 09 — 10 — 11 — 12

Crew	Activities (in time order)
CDR E. Collins	SAREX; TEST; EXERCISE; MEAL; OMS RAM ALS; MNVR -Y; JUPITER; MNVR -Y; CAL; CCM BRIC; STAT; STL TAPE; PAO EVENT; MNVR MSX; MSX PRCS; OMS WAKE JIC; -ZLV; -XVV; SAREX; SCHOOL; PRE SLEEP; PMC; PRE SLEEP; SLEEP
PLT J. Ashby	WSB SWAP; O2 SNSR; MNVR -Y; VENUS; MEAL; OMS RAM ALS; STL TAPE; FILTER CLEANING; FCMS OPS; MNVR MSX; MSX PRCS; OMS WAKE JIC; FES AON; STL TAPE; * PRE SLEEP; SLEEP
MS1 C. Coleman	PGF HARVEST; MEAL; HDTV; P/TV 04 SETUP; PAO EVENT; HDTV; PGIM; STAT; AEROGEL; PRE SLEEP; OCA DNLK; PRE SLEEP; SLEEP
MS2 S. Hawley	SWUIS; MOON 1; STL RCD & TV S/U; STL INIT; SWUIS; VENUS 1; STL DNLK; STL RCD S/U; MEAL; SWUIS 1; JUPITER; SWUIS CAL 1; TEMP STOW; EXERCISE; MEMS STL; STAT; PRE SLEEP; SLEEP
MS3 M. Tognini	CGBA TV; CGBA; INIT; RAD DPY; BRIC FRZ 1; MEAL; EXERCISE; P/TV13; CGBA TV; CGBA; STAT; BRIC FRZ 2; PRE SLEEP ⊕; SLEEP

DAY/NIGHT	
ORBIT	17, 18, 19, 20, 21, 22, 23, 24, 25
MOON UP/DOWN	
TDRS E / W	
SPX SITES	-ARC; -JIC
ATTITUDE	-Y Moon; -Y Venus; SPX; -Y Jup; -Y Cal; MSX; SPX; -ZLV -XVV
Notes	*CHECK HUMIDITY SEPARATORS ⊕ CGBA Overnight TV

06/25/99 15:57:02

MET	GMT	CT	DOY	BETA	MOON	FLIGHT DAY	HOUSTON DATE	IDENTIFIER	EDITION	PUB. DATE
001/12:00 002/00:00	202/16:36 203/04:36	202/11:36 202/23:36	202 CT	45.41		2/3	21 Jul 1999	STS-93	FINAL A	06/25/99

CT 07/21/99: 12 13 14 15 16 17 18 19 20 21 22 23
FD 02
MET Day 001: 12 13 14 15 16 17 18 19 20 21 22 23 002/00

Crew	Activities (in time order)
CDR E. Collins	SLEEP; FD03; DSO 493; POST SLEEP; -ZLV +YVV; H2O INIT; POST SLEEP; H2O TERM; MNVR -Y; VENUS; CCM BRIC; STAT; SAREX; SCHOOL; EXERCISE; MEAL; MNVR -Y; CAL
PLT J. Ashby	SLEEP; DSO 493; STL TAPE; POST SLEEP; FES OFF; STL TAPE; SAREX; PERSONAL; STL RCD & TV S/U; MNVR -Y; CAL; STL RCD S/U; STL TAPE; PTV 15 S/U; MNVR -Y; SATURN; HDTV; STL TAPE; MEAL
MS1 C. Coleman	SLEEP; DSO 493; POST SLEEP; OCA DNLK; POST SLEEP; CMD STR 1; PGIM; STAT; HDTV; EXERCISE
MS2 S. Hawley	SLEEP; DSO 493; POST SLEEP; SWUIS SETUP; SWUIS; VENUS 2; SWUIS; CAL 2; MEMS STL; STAT; SWUIS SATURN 1
MS3 M. Tognini	SLEEP; DSO 493; POST SLEEP; EXERCISE; CGBA; STAT; P/TV 13; CGBA TV; BRIC FRZ 3; SAREX; SCHOOL; DTO 631

DAY/NIGHT

ORBIT: 25 26 27 28 29 30 31 32 33

MOON UP/DOWN

TDRS E W

SPX SITES

ATTITUDE: -ZLV -XVV; -ZLV +YVV; Venus; Cal; Sat; Cal

Notes

MET	GMT	CT	DOY	BETA	MOON	FLIGHT DAY	HOUSTON DATE	IDENTIFIER	EDITION	PUB. DATE
002/00:00 002/12:00	203/04:36 203/16:36	202/23:36 203/11:36	202 CT	44.10		3	21 Jul 1999	STS-93	FINAL A	06/25/99

CT 07/21/99 07/22 01 02 03 04 05 06 07 08 09 10 11
FD 03 002/00 01 02 03 04 05 06 07 08 09 10 11 12
MET Day 002

Crew	Activities
CDR E. Collins	MNVR -Y; VULCAN; OMS RAM BURN KWJ; MNVR -Y; CAL; MNVR -Y; VULCAN; OMS WAKE BURN ALS; MNVR -Y; MOON; PCS CNFG; HTR CNFG; RCS; CAB TEMP; MNVR -Y; VENUS; CCM BRIC; STAT; PAO EVENT; MSX 90 DEG BURN; IMU MNVR; IMU; HUD CAL; -ZLV -XVV; PMC; SAREX; PERSONAL; PRE SLEEP; SLEEP
PLT J. Ashby	MEAL; OMS RAM BURN KWJ; HDTV; OMS WAKE BURN ALS; APU HTR; MNVR -Y; VULCAN; EXERCISE; PAO EVENT; MSX 90 DEG BURN; FES A ON; PRE SLEEP; STL TAPE; PRE SLEEP; STL TAPE; SLEEP
MS1 C. Coleman	EXERCISE; MEAL; LFSAH; HDTV; STL TAPE; P/TV 04 SETUP; PGIM; STAT; STL TAPE; PRE SLEEP; OCA DNLK; PRE SLEEP; SLEEP
MS2 S. Hawley	SWUIS CAL 3; SWUIS 1; VULCAN; MEAL; STL TAPE; SWUIS CAL 4; SWUIS 2; VULCAN; SWUIS MOON 2; SWUIS 3; VULCAN; SWUIS; VENUS 3; TEMP STOW; MEMS STL; STAT; PRE SLEEP; SLEEP
MS3 M. Tognini	MEAL; P/TV 11 SETUP; LFSAH; DTO 631; P/TV 16; DOWNLINK; P/TV 13; CGBA TV; CGBA; STAT; PRE SLEEP; SLEEP
DAY/NIGHT	
ORBIT	33; 34; 35; 36; 37; 38; 39; 40; 41
MOON UP/DOWN	
TDRS E / W	
SPX SITES	-KWJ; -ARC; -JIC; -KWJ
ATTITUDE	Vul; SPX; Cal; SPX Moon; Vul; Venus; MSX; HUD; -ZLV -XVV
Notes	CABIN TEMP CNTL RECONFIG

06/25/99 15:57:02

MET	GMT	CT	DOY	BETA	MOON	FLIGHT DAY	HOUSTON DATE	IDENTIFIER	EDITION	PUB. DATE
002/12:00 003/00:00	203/16:36 204/04:36	203/11:36 203/23:36	203 CT	42.64		3/4	22 Jul 1999	STS-93	FINAL A	06/25/99

CT 07/22/99 — 12 13 14 15 16 17 18 19 20 21 22 23
FD 03 — 12 13 14 15 16 17 18 19 20 21 22 23 003/00
MET Day 002

FD04

Crew	Activities (in time order)
CDR E. Collins	SLEEP; DSO 493; -ZLV; +YVV; SIMO INT; WASTE DUMP MONITOR; SIMO TRM; FES OFF; SAREX; SCHOOL; MNVR -Y; SATURN; CCM BRIC; STAT; PILOT; STL TAPE; SAREX; SCHOOL; EXERCISE
PLT J. Ashby	SLEEP; DSO 493; POST SLEEP; TREADMIL; S/U; EXERCISE (RME 1318); PILOT; MNVR -Y; JUPITER; HDTV
MS1 C. Coleman	SLEEP; DSO 493; POST SLEEP; PTV 03 SETUP; PGIM; STAT; OCA DNLK; PTV 15 S/U; HDTV; CMD STR2; MEAL
MS2 S. Hawley	SLEEP; DSO 493; POST SLEEP; TREADMIL; S/U; MEMS STL; STAT; SWUIS SETUP; SWUIS SATURN 2; SWUIS 2; JUPITER; MEAL
MS3 M. Tognini	SLEEP; DSO 493; POST SLEEP; SAREX; PERSONAL; POST SLEEP; TREADMIL; S/U; CGBA; STAT; P/TV 13; CGBA TV; BRIC FRZ 4 STO; EXERCISE (RME 1318)

DAY/NIGHT

ORBIT: 41, 42, 43, 44, 45, 46, 47, 48, 49

MOON UP/DOWN

TDRS E / W

SPX SITES: -JIC, -ARC

ATTITUDE: -ZLV -XVV; -ZLV +YVV; Saturn; Jupiter; -Y cal

MNVR -Y

Notes

MET	GMT	CT	DOY	BETA	MOON	FLIGHT DAY	HOUSTON DATE	IDENTIFIER	EDITION	PUB. DATE
003/00:00 003/12:00	204/04:36 204/16:36	203/23:36 204/11:36	203 CT	41.06		4	22 Jul 1999	STS-93	FINAL A	06/25/99

CT 07/22/99 07/23 01 02 03 04 05 06 07 08 09 10 11
FD 04 003/00 01 02 03 04 05 06 07 08 09 10 11 12
MET Day 003

Crew	Activities (in time order)
CDR E. Collins	EXERCISE; DTO 631; P/TV 16; DOWNLINK; MNVR -Y; CAL; MEAL; OMS 90 DEG ALS; MNVR -Y; MOON; PAO EVENT; MNVR -Y; VENUS; PAO EVENT; CCM STAT; PRE SLEEP; MSX WAKE BURN; -ZLV; -XVV; FES A ON; PMC; PRE SLEEP; SLEEP
PLT J. Ashby	ϕ; STL TAPE; MEAL; OMS 90 DEG ALS; HDTV; TRDMLL STOW; PAO EVENT; MEMS STL; STAT; PRE SLEEP; MSX WAKE BURN; PRE SLEEP; SLEEP
MS1 C. Coleman	MEAL; PGF HARVEST; EXERCISE; PGF HARVEST; P/TV 13; CGBA TV; PGIM ⊕; STAT; OCA DNLK; PRE SLEEP; SAREX; PERSONAL; PRE SLEEP; SLEEP
MS2 S. Hawley	MEAL; EXERCISE (RME 1318); SWUIS MOON 3; SWUIS; VENUS 4; TEMP STOW; PRE SLEEP; SLEEP
MS3 M. Tognini	SWUIS CAL 5; MEAL; SWUIS CAL 6; P/TV 04 SETUP; PAO EVENT; TRDMLL STOW; CGBA; STAT; PRE SLEEP; SLEEP

DAY/NIGHT
ORBIT: 49 50 51 52 53 54 55 56 57
MOON UP/DOWN
TDRS E W

SPX SITES: -ARC -KWJ -JIC KWJ

ATTITUDE: -Y cal; SPX; Moon; Venus; MSX; -ZLV -XVV

Notes:
ϕMNVR -Y CAL
⊕ CGBA OVERNIGHT TV

MET	GMT	CT	DOY	BETA	MOON	FLIGHT DAY	HOUSTON DATE	IDENTIFIER	EDITION	PUB. DATE
003/12:00 004/00:00	204/16:36 205/04:36	204/11:36 204/23:36	204 CT	39.37		4/5	23 Jul 1999	STS-93	FINAL A	06/25/99

CT 07/23/99 — 12 13 14 15 16 17 18 19 20 21 22 23
FD 04 — 12 13 14 15 16 17 18 19 20 21 22 23 004/00
MET Day 003

Crew	Activities (in time order)
CDR E. Collins	SLEEP (FD05); DSO 493; POST SLEEP; CCM BRIC; STAT; FUTURE; CREW PHOTO; CREW CONF; -ZLV; -XVV; PILOT; FCS C/O; RCS HOT; FIRE; FLYCAST; MULT PLS; L-1 COMM; CK; MEAL
PLT J. Ashby	SLEEP; DSO 493; POST SLEEP; -ZLV; +YVV; H2O INIT; POST SLEEP; H2O TERM; APU HTR; CREW PHOTO; CREW CONF; STL TAPE; PILOT; FCS C/O; RCS HOT; STL TAPE; FLYCAST; MULT PLS; MEAL; FES OFF
MS1 C. Coleman	SLEEP; DSO 493; POST SLEEP; OCA DNLK; P/TV 04 SETUP; CREW PHOTO; CREW CONF; PGIM; STAT; PTV 07 OPS; EXERCISE; DSO 631 (EOM-1); MEAL; CABIN STOW
MS2 S. Hawley	SLEEP; DSO 493; POST SLEEP; SAREX; PERSONAL; CREW PHOTO; CREW CONF; MEMS STL; STAT; FCS C/O; RCS HOT; FIRE; EXERCISE; MEAL
MS3 M. Tognini	SLEEP; DSO 493; POST SLEEP; PHOTO TO; SETUP; CREW PHOTO; CREW CONF; EXERCISE; CGBA; STAT; P/TV 13; CGBA TV; DSO 631 (EOM-1); MEAL; SAREX; STOW

DAY/NIGHT
ORBIT: 57 58 59 60 61 62 63 64 65
MOON UP/DOWN
TDRS E W

SPX & GSTDN: -JIC; —MIL -ARC; —MIL; —MIL —DFR; —MIL —DFR

ATTITUDE: -ZLV -XVV; -ZLV +YVV; -ZLV -XVV

Notes: WEST & EAST COAST PASS; CGBA video thru Middeck

06/25/99 15:57:02

MET	GMT	CT	DOY	BETA	MOON	FLIGHT DAY	HOUSTON DATE	IDENTIFIER	EDITION	PUB. DATE
004/00:00 004/12:00	205/04:36 205/16:36	204/23:36 205/11:36	204 CT	37.57		5	23 Jul 1999	STS-93	FINAL A	06/25/99

CT 07/23/99 — 07/24, 01, 02, 03, 04, 05, 06, 07, 08, 09, 10, 11
FD 05
MET Day 004 — 004/00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 10, 11, 12

Crew	Activities (in time order)
CDR E. Collins	OMS BURN ARC; EXERCISE; CCM STAT; L-1 COMM; B/U; D/O PREP REVIEW; OCAC; STOW; RCS BURN; -ZLV; -YVV; PRE SLEEP; PMC; PRE SLEEP; SLEEP
PLT J. Ashby	STL TAPE; OMS BURN ARC; -ZLV; -YVV; FES AON; EXERCISE; D/O PREP REVIEW; ERGO STOW; CABIN STOW; RCS BURN; PRE SLEEP; SLEEP
MS1 C. Coleman	CABIN STOW; PGIM; STAT; CABIN STOW; OCA DNLK; MEMS STL; STAT; D/O PREP REVIEW; ERGO STOW; OCAC; STOW; CABIN STOW; PRE SLEEP; SLEEP
MS2 S. Hawley	CABIN STOW; STL; ENTRY; PREP; OCA DACT; KU STOW; D/O PREP REVIEW; CLR P RTR; STOW; CABIN STOW; PRE SLEEP; SLEEP
MS3 M. Tognini	•; CABIN STOW; CGBA PWR; CGBA; STAT; P/TV 13; CGBA TV; D/O PREP REVIEW; CABIN STOW; H2O; SAMPLE; PRE SLEEP; SLEEP

ORBIT: 65, 66, 67, 68, 69, 70, 71, 72, 73

TDRS: E, W

SPX & GSTDN: —MIL, —DFR, -ARC, —MIL, —DFR, —DFR, -JIC, -KWJ

ATTITUDE: SPX; -ZLV -YVV

Notes:
•SAREX STOW
WEST & EAST COAST PASS
CGBA video thru Middeck

MET	GMT	CT	DOY	BETA	MOON	FLIGHT DAY	HOUSTON DATE	IDENTIFIER	EDITION	PUB. DATE
004/12:00 005/00:00	205/16:36 206/04:36	205/11:36 205/23:36	205 CT	35.70		5/6	24 Jul 1999	STS-93	FINAL A	06/25/99

CT 07/24/99: 12 13 14 15 16 17 18 19 20 21 22 23
FD 05: 12 13 14 15 16 17 18 19 20 21 22 23 005/00
MET Day 004

Crew	Activities
CDR E. Collins	SLEEP (FD06); DSO 493; POST SLEEP; PRIV MED; CONF; PWR UP GRP B; IMU ALIGN & VERIF; MNVR; -XSI; DEORBIT PREP; LANDING
PLT J. Ashby	SLEEP; DSO 493; POST SLEEP; TANK C; DEORBIT PREP; LANDING
MS1 C. Coleman	SLEEP; DSO 493; POST SLEEP; DSO 631; POST SLEEP; CCM ENT; AIR SAMPLE; DEORBIT PREP; LANDING
MS2 S. Hawley	SLEEP; DSO 493; POST SLEEP; DSO 331 PREP; DEORBIT PREP; LANDING
MS3 M. Tognini	SLEEP; DSO 493; POST SLEEP; DSO 631; DSO 331 PREP; DEORBIT PREP; LANDING

DAY/NIGHT

ORBIT: 73 74 75 76 77 78 79 80 81

MOON UP/DOWN

TDRS E / W

SPX SITES: JIC ARC KWJ

ATTITUDE: -ZLV -YVV; IMU; -XSI; COMM; D/O

Notes: Isolate Tank C

Landing: 4/22:56

Flight Plan

STS-93

Flight Day Summary

DATE TIME (EST)	DAY	MET	EVENT
07/20/99 12:36:00 AM	1	000/00:00:00	Launch
07/20/99 2:11:00 AM	1	000/01:35:00	AXAF PWRUP
07/20/99 3:06:00 AM	1	000/02:30:00	IUS PDCO
07/20/99 5:56:00 AM	1	000/05:20:00	MNVR TO DEPLOY ATT
07/20/99 6:11:00 AM	1	000/05:35:00	TILT TBL TO 29
07/20/99 7:06:00 AM	1	000/06:30:00	IUS/PI LOCK
07/20/99 7:53:00 AM	1	000/07:17:00	DEPLOY IUS
07/20/99 9:06:00 AM	1	000/08:30:00	KU-BD ACTIVATION
07/20/99 9:26:00 AM	1	000/08:50:00	PWR DOWN GRP B
07/20/99 9:31:00 AM	1	000/08:55:00	VTR PLAYBACK
07/20/99 11:36:00 AM	1	000/11:00:00	SLEEP
07/20/99 7:51:00 PM	2	000/19:15:00	WAKE
07/20/99 9:21:00 PM	2	000/20:45:00	OMS PREP BURN
07/21/99 12:15:00 AM	2	000/23:39:00	SWUIS OPS MOON
07/21/99 1:52:00 AM	2	001/01:16:00	SWUIS OPS VENUS
07/21/99 3:44:00 AM	2	001/03:08:00	SWUIS OPS JUPITER
07/21/99 4:46:00 AM	2	001/04:10:00	FCMS OPS
07/21/99 5:41:00 AM	2	001/05:05:00	PAO EVENT
07/21/99 6:46:00 AM	2	001/06:10:00	CGBA TV
07/21/99 7:33:00 AM	2	001/06:57:00	SAREX SCHOOL
07/21/99 10:36:00 AM	2	001/10:00:00	SLEEP
07/21/99 6:51:00 PM	3	001/18:15:00	WAKE
07/21/99 9:26:00 PM	3	001/20:50:00	SWUIS OPS VENUS
07/21/99 9:32:00 PM	3	001/20:56:00	SAREX SCHOOL
07/21/99 11:16:00 PM	3	001/22:40:00	SWUIS OPS SATURN 1
07/21/99 11:16:00 PM	3	001/22:40:00	SAREX SCHOOL
07/22/99 1:06:00 AM	3	002/00:30:00	SWUIS OPS VULCANOIDS
07/22/99 2:38:00 AM	3	002/02:02:00	SWUIS OPS VULCANOIDS
07/22/99 4:01:00 AM	3	002/03:25:00	SWUIS OPS VULCANOIDS
07/22/99 4:55:00 AM	3	002/04:19:00	SWUIS OPS VENUS
07/22/99 5:41:00 AM	3	002/05:05:00	PAO EVENT
07/22/99 9:36:00 AM	3	002/09:00:00	SLEEP

07/22/99 5:51:00 PM	4	002/17:15:00	WAKE
07/22/99 8:21:00 PM	4	002/19:45:00	RME 1318 TVIS
07/22/99 9:31:00 PM	4	002/20:55:00	SAREX SCHOOL
07/22/99 9:48:00 PM	4	002/21:12:00	SWUIS OPS SATURN 2
07/22/99 10:08:00 PM	4	002/21:32:00	RME 1318 TVIS
07/22/99 11:11:00 PM	4	002/22:35:00	SAREX SCHOOL
07/22/99 11:18:00 PM	4	002/22:42:00	SWUIS OPS JUPITER
07/23/99 1:05:00 AM	4	003/00:29:00	RME 1318 TVIS
07/23/99 1:49:00 AM	4	003/01:13:00	PGF HARVEST
07/23/99 3:36:00 AM	4	003/03:00:00	SWUIS OPS MOON
07/23/99 3:39:00 AM	4	003/03:03:00	PGF HARVEST
07/23/99 4:06:00 AM	4	003/03:30:00	PAO EVENT
07/23/99 5:02:00 AM	4	003/04:26:00	SWUIS OPS VENUS
07/23/99 5:06:00 AM	4	003/04:30:00	PAO EVENT
07/23/99 8:36:00 AM	4	003/08:00:00	SLEEP
07/23/99 4:51:00 PM	5	003/16:15:00	WAKE
07/23/99 7:59:00 PM	5	003/19:23:00	CREW CONF
07/23/99 9:16:00 PM	5	003/20:40:00	FCS C/O
07/23/99 10:16:00 PM	5	003/21:40:00	RCS HOT FIRE
07/24/99 12:11:00 AM	5	003/23:35:00	CABIN CONFIG/STOW
07/24/99 2:46:00 AM	5	004/02:10:00	KU-BD ANT STOW
07/24/99 7:36:00 AM	5	004/07:00:00	SLEEP
07/24/99 3:51:00 PM	6	004/15:15:00	WAKE
07/24/99 5:24:00 PM	6	004/16:48:00	PWR UP GRP B
07/24/99 6:31:00 PM	6	004/17:55:00	DEORBIT PREP
07/24/99 10:31:00 PM	6	004/21:55:00	DEORBIT BURN
07/24/99 11:32:00 PM	6	004/22:56:00	LANDING

Updated: 07/08/1999

Editorial/Technical Comments: ShuttlePresskit

STS-93 (FD01)

TDRS EWS ZSB | GND | ORB | MET Day 000 | ATT | CDR E.Collins | PLT J.Ashby | MS1 C.Coleman | MS2 S.Hawley | MS3 M.Tognini | MCC

00:00

Activities prior to MET 0/02:30 are in the Ascent and Post Insertion checklists. The Orbiter should be in a -ZLV +XVV attitude upon entering the Flight Plan.

01:00

Post Insertion

< Mnvr -ZLV +XVV

HTS V TS

CTS

MIL

TDRS EARLY H/O

AXAF POWER UP

AXAF COMM ACT

< PLBD Open

AXAF COMM ACT

TRK ARC

2

02:00

-ZLV +XVV

TDRS EARLY H/O

PCP/CIU/SSP ACT & C/O

PCP/CIU/SSP ACT & C/O

IUS/AXAF SPEC C/O

PTV 08 SETUP

IUS/AXAF SPEC C/O

GTS

A1(B1) AUTO/VERN

Config DAP A to A1

IUS PREDEPLOY C/O (TDRW) (IUS DPY, EARLY CKS)

IUS PREDEPLOY C/O (TDRW) (IUS DPY, EARLY CKS)

INFORM CREW (TDRW) GO FOR PWR XFER GO FOR PDCO

Verify STS and IUS DAPs per DAP Tables

P/TV 08 OPS (PHOTO/TV, AXAF)

AFT CONTROLLER C/O (ORB OPS, GNC)

HTS

GIRA INSTALLATION (ORB OPS, GIRA)

FD01 EZ ACTIVITIES: ESC Battery Charge

3

CGBA ON-ORB RECONFIG (PL OPS, CGBA)

03:00

STS-93 (FD01)

TDRS EWS ZS, GND, MIL, CS TS, HTS, ORB, MET, ATT

Day 000

03:00 – A1(B1) AUTO/VERN – ORB 3 – ATT: -ZLV +XVV
04:00 – DGS, GTS, HTS, VTS
05:00 – ORB 4 – ATT: IMU
A9(B1) AUTO/VERN – ATT: DPY – DGS, GTS
ORB 5 – A10(B1)
06:00

CDR E.Collins

CCM-C INITIALIZATION (PL OPS, CCM-C)

PCS 1(2) CONFIG (sys 1) (ORB OPS, ECLS)

LAMP TEST (ORB OPS, EPS)

SMOKE DETN CKT TEST (ORB OPS, ECLS)

MEAL

L1 FLASH EVAP CNTLR PRI A(B)-OFF

MNVR IMU (-Y=64, -Z=17)
R=127.0 P=10.0 Y=9.0
A/AUTO/VERN (05:00) Init MNVR

IMU ALIGN-S TRK (ORB OPS)

MNVR TO DPY ATTITUDE (IUS DPY, LATE CKS)

PLT J.Ashby

GIRA INSTALLATION (ORB OPS, GIRA)

If time available, perform P/TV 15 SETUP (HDTV) (PHOTO/TV, DTO700-17A)
Record views of IUS/AXAF as time permits

MEAL

SHUTTLE EMERG EYEWASH
Unstow, attach on or near galley.

MS1 C.Coleman

ACTUATOR ENGAGEMENT (IUS DPY, EARLY CKS)

RMV AXAF RF INH (IUS DPY, EARLY CKS)

AXAF RF CK (UPR ANT) (IUS DPY, EARLY CKS)

TRANSFER SV (TDRW) (IUS DPY, LATE CKS)

MEAL

TILT TABLE ELEV TO 29 (IUS DPY, LATE CKS)

AXAF RF CK (LWR ANT) (IUS DPY, LATE CKS)

MS2 S.Hawley

MEMS STATUS CHECK
STL-B STATUS CHECK (PL OPS, MDDK SCI)

PGIM STATUS CK (MANUAL) (PL OPS, MDDK SCI)

Setup PGSCs

MEAL

P/TV 08 OPS (PHOTO/TV, AXAF)

MS3 M.Tognini

ACTUATOR ENGAGEMENT (IUS DPY, EARLY CKS)

RMV AXAF RF INH (IUS DPY, EARLY CKS)

AXAF RF CK (UPR ANT) (IUS DPY, EARLY CKS)

Setup PGSCs

TRANSFER SV (TDRW) (IUS DPY, LATE CKS)

MEAL

TILT TABLE ELEV TO 29 (IUS DPY, LATE CKS)

AXAF RF CK (LWR ANT) (IUS DPY, LATE CKS)

MCC

TRK ARC

TDRS EARLY H/O

INFORM CREW Remove RF inh

INFORM CREW Go to restore AXAF HDLN TLM

UPDATE DPY PADS

UPLINK (TDRW) ORB & TGT SV

INFORM CREW GO FOR SV XFER

TDRS EARLY H/O

INFORM CREW AXAF XMTR-ON Restore HDLN TLM

STS-93 (FD01)

TDRS EWS / ZOE / GND / ORB / MET / ATT

Day 000

MET	Orbit/Attitude	CDR E.Collins	PLT J.Ashby	MS1 C.Coleman	MS2 S.Hawley	MS3 M.Tognini	MCC
06:00	A10(B1) AUTO/VERN		APU RECONFIG R2 BLR PWR (three) - OFF A12 APU HTR GG/FU (three) -A AUTO	TRANSFER SV (TDRW) (IUS DPY, LATE CKS) IUS/PI LOCK (IUS DPY, LATE CKS)		TRANSFER SV (TDRW) (IUS DPY, LATE CKS) IUS/PI LOCK (IUS DPY, LATE CKS)	UPDATE DPY/BURN PADS UPLINK (TDRW) ORB & TGT SV INFORM CREW Go for SV XFER Go for IUS/PI
	DPY		R2 HYD CIRC PUMP (three)-OFF				
07:00	A11(B1) AUTO/VERN	DEPLOY COUNTDOWN (IUS DPY, DPY OPS)	DEPLOY COUNTDOWN (IUS DPY, DPY OPS)	DEPLOY COUNTDOWN (IUS DPY, DPY OPS)	P/TV 08 OPS (PHOTO/TV, AXAF)	DEPLOY COUNTDOWN (IUS DPY, DPY OPS)	INFORM CREW Go for DPY
	SEP	DEPLOY IUS/AXAF (IUS DPY, DPY OPS) SEP MNVR (IUS DPY, POSTDPY OPS) < OMS Burn	DEPLOY IUS/AXAF (IUS DPY, DPY OPS)	DEPLOY IUS/AXAF (IUS DPY, DPY OPS)		DEPLOY IUS/AXAF (IUS DPY, DPY OPS)	IUS DEPLOY (07:17)
	(A11)B1	Mnvr to Viewing Att		LOWER TILT TABLE TO -6 (IUS DPY, POSTDPY OPS)		LOWER TILT TABLE TO -6 (IUS DPY, POSTDPY OPS)	
	VW	TOPPING FES STARTUP (ORB OPS, ECLS)	R2 HYD CIRC PUMP (three)-GPC				
08:00	WPA	< Mnvr to Window Prot	UNSTOW & ASSEMBLE PRINTER WARM-UP & SELF-TEST (ORB OPS FS, DTO 1215)		UNSTOW & ASSEMBLE PRINTER WARM-UP & SELF-TEST (ORB OPS FS, DTO 1215)		
	(A11)B1 INRTL/VERN	Config DAP A to A1 MNVR COMM ATT R=0 P=0 Y=0 A/AUTO/VERN Init Mnvr	KU-BD ACT (COMM mode) (ORB OPS, COMM/INST)	CLOSEOUT (IUS DPY, POST DPY OPS)	KU-BD ACT (COMM mode) (ORB OPS, COMM/INST)	CLOSEOUT (IUS DPY, POST DPY OPS)	SRM 1 IGN (08:17)
	A1(B1) AUTO/VERN Max Ku	FUTURE LOAD -ZLV -XVV TGT=2 BV=3 OM=0 A/AUTO/VERN (0/11:00) Init TRK PRIORITY PWRDN GROUP B (ORB PKT, PRIOR PWRDN)	OCA SETUP (ORB OPS, OCA)	VTR SETUP (AXAF DPY) VTR PLAYBACK (DPY) (CUE CARD, 8mm VTR) KU AVAIL: 8:40 to 11:00	OCA SETUP (ORB OPS, OCA) PRE-SLEEP ACTIVITY (ORB OPS, CREW SYS)	VTR SETUP (AXAF DPY) VTR PLAYBACK (DPY) (CUE CARD, 8mm VTR)	
09:00							

Ground station coverage: HTS, VTS, DGS, GTS, HTS, DGS. Orbits: 5, 6, 7.

STS-93 (FD01)

MET Day 000

MET	ATT	CDR E.Collins	PLT J.Ashby	MS1 C.Coleman	MS2 S.Hawley	MS3 M.Tognini	MCC
09:00	A1(B1) AUTO/VERN			VTR PLAYBACK (DPY) (CUE CARD, 8mm VTR) KU AVAIL: 8:40 to 11:00		VTR PLAYBACK (DPY) (CUE CARD, 8mm VTR)	
		06 √UHF MODE - OFF PRIVATE MEDICAL CONF					TDRS EARLY H/O
	Max Ku		PRE-SLEEP ACTIVITY (ORB OPS, CREW SYS) GALLEY OVERNIGHT CONFIG (ORB OPS, GIRA)		PRE-SLEEP ACTIVITY (ORB OPS, CREW SYS)		
10:00			√HUM SEP FOR H2O ACCUMULATION	PRE-SLEEP ACTIVITY (ORB OPS, CREW SYS)		PRE-SLEEP ACTIVITY (ORB OPS, CREW SYS)	
		PRE-SLEEP ACTIVITY (ORB OPS, CREW SYS)					
11:00	-ZLV -XVV	SLEEP	SLEEP	SLEEP	SLEEP	SLEEP	OCA OPS OST DOWN
12:00							

TDRS: E W Z S B; GND: GTS, HTS, GTS; ORB: 7, 8, 9

STS-93 (FD01)

TDRS EW	ORB	MET Day 000	ATT	CDR E.Collins	PLT J.Ashby	MS1 C.Coleman	MS2 S.Hawley	MS3 M.Tognini	MCC
		12:00 A1(B1) AUTO/VERN							
	9								
		13:00							
	10	14:00							
			-ZLV						
		15:00	-XVV	SLEEP	SLEEP	SLEEP	SLEEP	SLEEP	
	11								
		16:00							
	12	17:00							
	13	18:00							

STS-93 (FD02)

MET Day 000

MET	ATT	CDR E.Collins	PLT J.Ashby	MS1 C.Coleman	MS2 S.Hawley	MS3 M.Tognini	MCC
18:00	A1(B1) AUTO/VERN; -ZLV -XVV	SLEEP	SLEEP	SLEEP	SLEEP	SLEEP	OCA OPS OST UP Execute Pkg
19:00		MONITOR LATENT VIRUS (BIOMED, DSO 493)	MONITOR LATENT VIRUS (BIOMED, DSO 493)	MONITOR LATENT VIRUS (BIOMED, DSO 493)	MONITOR LATENT VIRUS (BIOMED, DSO 493)	MONITOR LATENT VIRUS (BIOMED, DSO 493)	TDRS EARLY H/O; OCA OPS Print Pkg
	-ZLV +YVV	MNVR -ZLV +YVV TGT=2 BV=3 OM=270 A/AUTO/VERN Init TRK	SUPPLY/WASTE WATER DUMP (ORB OPS, ECLS) Initiate Supply Dump; POST-SLEEP ACTIVITY (ORB OPS, CREW SYS); GALLEY MORNING RECONFIG (ORB OPS,GIRA)				UPDATE H2O SPLY DUMP QTY TK A & B
20:00		POST-SLEEP ACTIVITY (ORB OPS, CREW SYS)		POST-SLEEP ACTIVITY (ORB OPS, CREW SYS)	POST-SLEEP ACTIVITY (ORB OPS, CREW SYS)	POST-SLEEP ACTIVITY (ORB OPS, CREW SYS)	
	TOMS I	FC PURGE - MANUAL (ORB OPS, EPS); ON-ORBIT OMS BURN (ORB OPS, OMS)	SUPPLY/WASTE WATER DUMP (ORB OPS, ECLS) Terminate Supply Dump; ON-ORBIT OMS BURN (ORB OPS, OMS)	OCA DOWNLINK (ORB OPS, OCA) Close Outlook			UPDATE ORBITAL MNVR PAD; OCA XFER Mail ⇑⇓ Spoc ⇑
21:00							

ORB: 13, 14, 15

STS-93 (FD02)

TDRS EW | ORB | MET Day 000 | ATT

MET: 21:00, 22:00, 23:00, 00:00

ORB: 15, 16, 17

A1(B1) AUTO/VERN

A1(B5) AUTO/VERN

ATT: OMS; -ZLV -XVV; -Y Moon

CDR — E.Collins

ON-ORBIT OMS BURN
(ORB OPS, OMS)
<TIG 21:09

MNVR -ZLV -XVV
TGT=2 BV=3 OM=0
A/AUTO/VERN Init TRK

SAREX SETUP
(PL OPS, SAREX-C)

Load FLYCAST DAPs

SINGLE PLS FLYCAST MNVR
(ORB OPS FS, DTO 260)

<TIG 22:55

MNVR -Y MOON (SWUIS)
R=305.43 P=266.33 Y=336.54
A/AUTO/VERN Init MNVR
Config DAP B to B5

L1 FLASH EVAP CNTLR
PRI A(B)-OFF

CCM-C STATUS CHECK
(PL OPS, MDDK SCI)

On MS Go, DAP:B5/AUTO/VERN (NLT 23:38)

PLT — J.Ashby

ON-ORBIT OMS BURN
(ORB OPS, OMS)

CYCLE ERGOMETER OPS
(ORB OPS, CREW SYS)

Ergometer Setup

Load FLYCAST DAPS

SINGLE PLS FLYCAST MNVR
(ORB OPS FS, DTO 260)

EXERCISE

(ergometer)

GALLEY WATER SAMPLE
(ORB OPS, GIRA)

MS1 — C.Coleman

OCA DOWNLINK
(ORB OPS, OCA)
Close Outlook

CYCLE ERGOMETER OPS
(ORB OPS, CREW SYS)

Ergometer Setup

EXERCISE

(ergometer)

PGIM STATUS CK
(PL OPS, MDDK SCI)

PGIM HARVEST 1
(PL OPS, PGIM)

MS2 — S.Hawley

POST-SLEEP ACTIVITY
(ORB OPS, CREW SYS)

SWUIS TSM UNSTOW
(PL OPS, SWUIS)

Clean Hatch Window before mounting telescope.

CGBA STATUS CHECK
(PL OPS, MDDK SCI)

MEMS STATUS CHECK
STL-B STATUS CHECK
(PL OPS, MDDK SCI)

FDO2 EZ ACTIVITIES:
- CPA OPS(ORB OPS,CREW SYS)
- Re-boot PGSCs
- RCD scenes with HDTV for a flight total of 5 hrs

Take 35mm photos of MS1 and PGIM

SWUIS TSM SCI RUN
(PL OPS, SWUIS)
Moon Rise=0/23:24
Set =1/00:19

MS3 — M.Tognini

POST-SLEEP ACTIVITY
(ORB OPS, CREW SYS)

SWUIS TSM UNSTOW
(PL OPS, SWUIS)

BRIC-12 HARDWARE S/U
(PL OPS, BRIC)

P/TV 13 SETUP
(PHOTO/TV, CGBA)

MCC

OCA **OPS**
OST(Mail)⇑⇓
Spoc ⇑

UPDATE
ORBITAL MNVR PAD

TDRS
EARLY H/O

TV DNLK
SWUIS (MD)

STS-93 (FD02)

MET | TDRS E W | ORB | ATT

Day 001

00:00 — (A1)B5 AUTO/VERN

01:00

02:00

03:00 — (A1)B5 AUTO/VERN

ORB: 17, 18, 19

ATT: -Y Moon; -Y Venus; SPX -Y Jup

CDR E.Collins

VOICE OPS
(PL OPS, SAREX-C)
Contact: W5RRR
HOUSTON C/O PASS
W6, AOS=00:04
LOS=00:08

EXERCISE
(ergometer)

MEAL

ON-ORBIT OMS BURN
(ORB OPS, OMS)
1 ENG BURN (2 Cmn)
Alice Springs

< TIG (02:41)

MNVR -Y JUPITER (SWUIS)
R=240.24 P=83.94 Y=26.88
A/AUTO/VERN Init MNVR
Config DAP B to B5

PLT J.Ashby

WSB CNTLR SWAP
R2 BLR CNTLR/HTR (three)-B

CRYO O2 TK HTR SNSR CK
(ORB OPS, EPS)

MNVR -Y VENUS (SWUIS)
R=166.20 P=173.95 Y=304.44
A/AUTO/VERN Init MNVR
Take 35mm photo
of STL init

On MS Go, DAP:B5/AUTO/VERN (NLT 01:30)

MEAL

ON-ORBIT OMS BURN
(ORB OPS, OMS)
1 ENG BURN (2 Cmn)
Alice Springs

MS1 C.Coleman

PGIM HARVEST 1
(PL OPS, PGIM)

Take 35mm photo
of MS3 with Bric

MEAL

MS2 S.Hawley

SWUIS TSM SCI RUN
(PL OPS, SWUIS)
Moon Rise=0/23:24
Set =1/00:19

P/TV 10 OPS
(PHOTO/TV, STL-B)
Config for Rcd & Dnlk

STL-B INIT
(PL OPS, STL-B)

SWUIS TSM SCI RUN
(PL OPS, SWUIS)
Sun set = 1/01:31
Venus set = 1/01:36

Unmount SWUIS
prior to OMS burn

P/TV 10 OPS
(PHOTO/TV, STL-B)
Config for Rcd only

MEAL

MS3 M.Tognini

P/TV 13 OPS (CGBA)
(PHOTO T/V, CGBA)
Dnlk Exp Video

INIT REMOTE ED HAB
(PL OPS, CGBA)

RAD DEPLOY
(ORB OPS, ECLS)
Deploy PORT rad

BRIC FREEZE OPS 1
(PL OPS, BRIC)

DÉJUENER

MCC

TV DNLK
SWUIS (MD)

UPDATE
FLYCAST MNVR PAD

TV DNLK
SWUIS (MD)

UPDATE
ORBITAL MNVR PAD
MCC
Go for IcCrm

STS-93 (FD02)

MET Day 001 — 03:00 / 04:00 / 05:00 / 06:00

TDRS EW | ORB: 19, 20, 21 | ATT: -Y Jup; -Y Cal; MSX

A1(B5)
AUTO/VERN

CDR E.Collins

On MS Go, DAP:B5/AUTO/VERN (NLT 03:07)

MNVR -Y CAL (SWUIS)
R=224.7 P=101.8 Y=73.8
A/AUTO/VERN Init MNVR
On MS Go,
DAP:B5/AUTO/VERN(NLT 04:35)

CCM-C STATUS CHECK
BRIC STATUS CHECK
(PL OPS, MDDK SCI)

STL Tape Change

PAO VOICE CHECK/EVENT

MNVR MSX
R=118 P=70 Y=311
A/AUTO/VERN Init MNVR

MSX PRCS BURN
(ORB OPS, MSX)
TIG (5:58)

PLT J.Ashby

STL Tape Change

FILTER CLEANING
(IFM,SCHEDULED MAINTENANCE)

EPS SSR-1: FCMS OPS
(MAL, EPS SSR)

End User PGSC:
In step 11, select
"Full Rate"

MNVR MSX

MSX PRCS BURN
(ORB OPS, MSX)

MS1 C.Coleman

MEAL

P/TV 15 OPS (HDTV)
(PHOTO/TV, DTO700-17A)
Filter Cleaning
Exercise

P/TV 04 SETUP
(PHOTO/TV, PAO)

PAO VOICE CHECK/EVENT
TV at TDRE (05:05 to 05:35)

P/TV 15 OPS (HDTV)
(PHOTO/TV, DTO700-17A)
Crew at Orbiter Controls
Config for overhead window
with camcorder

MS2 S.Hawley

MEAL

SWUIS TSM SCI RUN
(PL OPS, SWUIS)
Jupiter rise=1/03:08
Sun rise=1/03:32

SWUIS TSM SCI RUN
(PL OPS, SWUIS)
Calibration
bd +28 4211
Rise=1/04:34
SR=1/05:03

SWUIS TEMP STOW

Temp stow SWUIS for
sleep period

MS3 M.Tognini

DÉJUENER

EXERCISE
(ergometer)

MCC

TV DNLK
SWUIS (MD)

TV DNLK
SWUIS (MD)

TDRS
EARLY H/O

STS-93 (FD02)

TDRS EW | ORB | MET Day 001 | ATT

06:00 – A1(B1) AUTO/VERN

ATT: SPX; -ZLV -XVV

ORB: 21, 22, 23

MET: 06:00, 07:00, 08:00, 09:00

CDR E.Collins

MSX PRCS BURN
(ORB OPS, MSX)

ON-ORBIT OMS BURN
(ORB OPS, OMS)
1 ENG BURN (2 Cmn)
Jicamarca

< TIG (06:38)

MNVR -ZLV -XVV
TGT=2 BV=3 OM=0
A/AUTO/VERN Init TRK

VOICE OPS
(PL OPS, SAREX-C)
Contact: ZS6BTD
W6, AOS=07:03:11
LOS=07:09:36

PRE-SLEEP ACTIVITY
(ORB OPS, CREW SYS)

O6 √UHF MODE - OFF
PRIVATE MEDICAL CONF

PRE-SLEEP ACTIVITY
(ORB OPS, CREW SYS)

PLT J.Ashby

MSX PRCS BURN
(ORB OPS, MSX)

ON-ORBIT OMS BURN
(ORB OPS, OMS)
1 ENG BURN (2 Cmn)
Jicamarca

TOPPING FES STARTUP
(ORB OPS, ECLS)
STL Tape Change

PRE-SLEEP ACTIVITY
(ORB OPS, CREW SYS)
GALLEY OVERNIGHT CONFIG
(ORB OPS, GIRA)

√HUM SEP FOR H2O
ACCUMULATION

MS1 C.Coleman

P/TV 15 OPS (HDTV)
(PHOTO/TV, DTO700-17A)
Crew at Orbiter Controls
Config for overhead window
with camcorder

PGIM STATUS CK
(PL OPS, MDDK SCI)

When in attitude,
AEROGEL ACTIVATION
(PL OPS, AEROGEL)

PRE-SLEEP ACTIVITY
(ORB OPS, CREW SYS)

OCA DOWNLINK
(ORB OPS, OCA)
Close Outlook

PRE-SLEEP ACTIVITY
(ORB OPS, CREW SYS)

MS2 S.Hawley

EXERCISE
(ergometer)

MEMS STATUS CHECK
STL-B STATUS CHECK
(PL OPS, MDDK SCI)

PRE-SLEEP ACTIVITY
(ORB OPS, CREW SYS)

MS3 M.Tognini

P/TV 13 SETUP
(PHOTO/TV, CGBA)

P/TV 13 OPS (CGBA)
(PHOTO T/V, CGBA)
Dnlk Exp Video

CGBA STATUS CHECK
(PL OPS, MDDK SCI)
Leave CGBA P/TV
Configured for TV
dnlk during sleep
BRIC FREEZE OPS 2
(PL OPS, BRIC)

PRE-SLEEP ACTIVITY
(ORB OPS, CREW SYS)

MCC

UPDATE
ORBITAL MNVR PAD

TDRS
EARLY H/O

CGBA TV
Dnlk camr views
of CGBA

OCA XFER
Mail ⇑⇓
FCMS Data ⇓

STS-93 (FD02)

TDRS EW	ORB	MET Day 001	ATT	CDR E.Collins	PLT J.Ashby	MS1 C.Coleman	MS2 S.Hawley	MS3 M.Tognini	MCC
	23	09:00	A1(B1) AUTO/VERN	PRE-SLEEP ACTIVITY (ORB OPS, CREW SYS)	PRE-SLEEP ACTIVITY (ORB OPS, CREW SYS) GALLEY OVERNIGHT CONFIG (ORB OPS, GIRA) √HUM SEP FOR H2O ACCUMULATION	PRE-SLEEP ACTIVITY (ORB OPS, CREW SYS)	PRE-SLEEP ACTIVITY (ORB OPS, CREW SYS)	PRE-SLEEP ACTIVITY (ORB OPS, CREW SYS)	
		10:00	-ZLV -XVV						OCA OPS OST Down
	24	11:00		SLEEP	SLEEP	SLEEP	SLEEP	SLEEP	
	25	12:00							

STS-93 (FD02)

MET Day 001	ATT	CDR E.Collins	PLT J.Ashby	MS1 C.Coleman	MS2 S.Hawley	MS3 M.Tognini	MCC
12:00 A1(B1) AUTO/VERN							
13:00							
14:00	-ZLV						
15:00	-XVV	SLEEP	SLEEP	SLEEP	SLEEP	SLEEP	
16:00							
17:00							OCA OPS OST UP Execute Pkg
18:00							OCA OPS Print Pkg

TDRS EW; ORB 25, 26, 27, 28, 29

STS-93 (FD03)

MET Day 001

TIME	ATT	CDR E.Collins	PLT J.Ashby	MS1 C.Coleman	MS2 S.Hawley	MS3 M.Tognini	MCC
18:00 A1(B1) AUTO/VERN	-ZLV -XVV	MONITOR LATENT VIRUS (BIOMED, DSO 493)	MONITOR LATENT VIRUS (BIOMED, DSO 493)	MONITOR LATENT VIRUS (BIOMED, DSO 493)	MONITOR LATENT VIRUS (BIOMED, DSO 493)	MONITOR LATENT VIRUS (BIOMED, DSO 493)	
		POST-SLEEP ACTIVITY (ORB OPS, CREW SYS)	STL Tape Change POST-SLEEP ACTIVITY (ORB OPS, CREW SYS) GALLEY MORNING RECONFIG (ORB OPS,GIRA)				
		MNVR -ZLV +YVV TGT=2 BV=3 OM=270 A/AUTO/VERN Init TRK					
		SUPPLY/WASTE WATER DUMP (ORB OPS, ECLS) Initiate Supply Dump		POST-SLEEP ACTIVITY (ORB OPS, CREW SYS)			UPDATE H2O SPLY DUMP QTY TK A & B
19:00	-ZLV +YVV		FD03 EZ ACTIVITIES: (CREW SYS) -CPA OPS(ORB OPS,CREW SYS) -OCAC Filter Inspect -Re-boot PGSCs -RCD Scenes with HDTV for a flight total of 5 hrs		POST-SLEEP ACTIVITY (ORB OPS, CREW SYS)	POST-SLEEP ACTIVITY (ORB OPS, CREW SYS)	
		POST-SLEEP ACTIVITY (ORB OPS, CREW SYS)		OCA DOWNLINK (ORB OPS, OCA) Close Outlook			OCA OPS OST(Mail)⇑⇓ Spoc ⇑
			L1 FLASH EVAP CNTLR PRI A(B)-OFF				
20:00		SUPPLY/WASTE WATER DUMP (ORB OPS, ECLS) Terminate Supply Dump	STL Tape Change VOICE OPS (PL OPS, SAREX-C) Contact:VK6IU W1, AOS=20:16:56 LOS=20:21:01	POST-SLEEP ACTIVITY (ORB OPS, CREW SYS)	Take 35mm photo of PLT with STL SWUIS SETUP Reattach SWUIS to side hatch window.	EXERCISE (ergometer)	
(A1)B5 AUTO/VERN	Venus	MNVR -Y VENUS (SWUIS) R=146.38 P=151.44 Y=310.28 A/AUTO/VERN Init MNVR Config DAP B to B5 CCM-C STATUS CHECK BRIC STATUS CHECK (PL OPS, MDDK SCI) On MS Go, DAP:B5/AUTO/VERN (NLT 21:02)	Take 35mm Photo of CDR with CCM P/TV 10 OPS (PHOTO/TV, STL-B) Config for Rcd & Dnlk	COMM STR 1 C/O, Part A (ORB OPS, COMM) Cmd to string 1	SWUIS TSM SCI RUN (PL OPS, SWUIS) Sun Set=1/21:03 Venus Set=1/21:09		TDRS EARLY H/O TV DNLK SWUIS (MD)
21:00		VOICE OPS (PL OPS, SAREX-C) Contact: WA4NFY W1, AOS=21:06:11 LOS=21:10:13					

ORB: 29, 30, 31

STS-93 (FD03)

MET Day 001

TDRS EW | ORB | ATT

MET	ATT	CDR E.Collins	PLT J.Ashby	MS1 C.Coleman	MS2 S.Hawley	MS3 M.Tognini	MCC
21:00 (A1)B5 AUTO/VERN	Cal	VOICE OPS (PL OPS, SAREX-C) Contact: WA4NFY W1, AOS=21:06:11 LOS=21:10:13	MNVR -Y CAL (SWUIS) R=246.88 P=134.93 Y=294.03 A/AUTO/VERN Init MNVR When in Att, DAP:B5/AUTO/VERN	PGIM STATUS CK (PL OPS, MDDK SCI)	SWUIS TSM SCI RUN (PL OPS, SWUIS) Sun Set=1/21:03 Venus Set=1/21:09	CGBA STATUS CHECK (PL OPS, MDDK SCI)	TV DNLK SWUIS (MD)
					SWUIS TSM SCI RUN (PL OPS, SWUIS) Calibration 30 Doradus In Att=1/21:20 SR=1/21:35		
ORB 31		EXERCISE (ergometer)	P/TV 10 OPS (PHOTO/TV, STL-B) Config for Rcd only	P/TV 15 OPS (HDTV) (PHOTO/TV, DTO700-17A) Interviews of crew performing various tasks			
			STL Tape Change				
22:00			P/TV 15 OPS (HDTV) (PHOTO/TV, DTO 700-17A)		MEMS STATUS CHECK STL-B STATUS CHECK (PL OPS, MDDK SCI)	P/TV 13 SETUP (PHOTO/TV, CGBA) CGBA TV (PHOTO T/V, CGBA)	
	Sat		MNVR -Y SATURN (SWUIS) R=217.5 P=34.8 Y=336.4 A1/AUTO/VERN Init MNVR On MS Go, DAP:B5/AUTO/VERN (NLT 22:42)			BRIC FREEZE OPS 3 (PL OPS, BRIC)	
			P/TV 15 OPS (HDTV) (PHOTO/TV, DTO700-17A) Payload Bay terminator Zero G Effects				
					SWUIS TSM SCI RUN (PL OPS, SWUIS) Saturn Rise=1/22:43 Sun Rise=1/23:05	VOICE OPS (PL OPS, SAREX-C) Contact: WA4NFY AOS=22:36:47 LOS=22:40:52	TV DNLK SWUIS (MD)
23:00 ORB 32		MEAL					
				EXERCISE (ergometer)		P/TV 16 OPS (DCC) (PHOTO/TV, DTO 631)	
ORB 33	TCal	MNVR -Y CAL (SWUIS) R=249.2 P=32.73 Y=332.33 A/AUTO/VERN Init MNVR	**STL Tape Change**				
00:00			MEAL				

STS-93 (FD03)

TDRS EW | ORB | MET | ATT

Day 002

00:00 – 03:00

Orbit: 33, 34, 35

MET / Attitude:
- (A1)B5 AUTO/VERN (00:00)
- (A1)B5 AUTO/VERN (01:30)
- ATT: Cal, Vul, SPX, Cal, SPX, Moon

~ On MS Go, DAP:B5/AUTO/VERN (NLT 00:03)~

CDR — E.Collins

MNVR -Y VULCAN (SWUIS)
R=204.01 P=356.24 Y=15.89
A/AUTO/VERN Init MNVR
When in Att, DAP:B5/AUTO/VERN

ON-ORBIT OMS BURN
(ORB OPS, OMS)
1 ENG BURN (2 Cmn)
Kwajalein

< TIG (01:22)

MNVR -Y CAL (SWUIS)
R=248.18 P=45.86 Y=346.28
A/AUTO/VERN Init MNVR
Config DAP B to B5

On MS Go, DAP:B5/AUTO/VERN
(NLT 01:35)

MNVR -Y VULCAN (SWUIS)
R=203.23 P=1.48 Y=18.08
A/AUTO/VERN Init MNVR
When in Att, DAP:B5/AUTO/VERN

ON-ORBIT OMS BURN
(ORB OPS, OMS)
1 ENG BURN (2 Cmn)
Alice Springs

< TIG (02:42)

MNVR -Y MOON (SWUIS)
R=344.97 P=182.6 Y=32.55
A/AUTO/VERN Init MNVR
Config DAP B to B5
When in Att, DAP:B5/AUTO/VERN

PLT — J.Ashby

MEAL

ON-ORBIT OMS BURN
(ORB OPS, OMS)
1 ENG BURN (2 Cmn)
Kwajalein

P/TV 15 OPS (HDTV)
(PHOTO/TV, DTO700-17A)
Crew performing
various tasks

ON-ORBIT OMS BURN
(ORB OPS, OMS)
1 ENG BURN (2 Cmn)
Alice Springs

MS1 — C.Coleman

EXERCISE
(ergometer)

MEAL

Take 35mm photo of MS3
working with LFSAH
LFSAH SETUP
LFSAH OPS

LFSAH RESTOW
(PL OPS, LFSAH)

P/TV 15 OPS (HDTV)
(PHOTO/TV, DTO700-17A)
Crew at Orbiter
Controls

MS2 — S.Hawley

SWUIS TSM SCI RUN
(PL OPS, SWUIS)
Calibration
Vega SS=2/00:04
Vul MNVR @ 2/00:20

SWUIS TSM SCI RUN
(PL OPS, SWUIS)
Vulcanoids
Sun Rise=2/00:36
Unmount SWUIS prior
to OMS burn

MEAL

STL Tape Change

SWUIS TSM SCI RUN
(PL OPS, SWUIS)
Calibration
BD +28 4211
Rise=2/01:36
Vul MNVR=2/01:50

SWUIS TSM SCI RUN
(PL OPS, SWUIS)
Vulcanoids
Sun Rise=02/02:06

Unmount SWUIS prior
to OMS burn

SWUIS TSM SCI RUN
(PL OPS, SWUIS)
Moon
In Att @ 2/02:50
Vul MNVR @ 2/03:10

MS3 — M.Tognini

MEAL

P/TV 11 SETUP
(PHOTO/TV, LFSAH)

LFSAH SETUP
LFSAH OPS

LFSAH RESTOW
(PL OPS, LFSAH)

MCC

TV DNLK
SWUIS (MD)

UPDATE
ORBITAL MNVR PAD

TDRS
EARLY H/O
TV DNLK
SWUIS (MD)

UPDATE
ORBITAL MNVR PAD

STS-93 (FD03)

MET Day 002, 03:00–06:00

ATT: Vul (03:00–04:00); Venus (04:00–05:40); MSX (05:40–06:00)

ORB: 35, 36, 37

03:00 (A1)B5 AUTO/VERN

CDR – E.Collins

PCS 1(2) CONFIG (sys 2)
(ORB OPS, ECLS)

HEATER RECONFIG-Config B
(ORB OPS, EPS)

RCS REGULATOR RECONFIGURE
(ORB OPS, RCS)

CABIN TEMP CNTL RECONFIG
MD44F Pin CAB TEMP CNTL act link to secondary act
L1 CABIN TEMP CNTLR - 2

04:00 MNVR -Y VENUS (SWUIS)
R=161.54 P=168.44 Y=305.08
A/AUTO/VERN Init MNVR
On MS Go, DAP:B5/AUTO/VERN
(NLT 04:33)

CCM-C STATUS CHECK
BRIC STATUS CHECK
(PL OPS, MDDK SCI)

PAO VOICE CHECK/EVENT
TV at TDRW
(02:50 to 03:10)

MSX OMS/PRCS BURN
(ORB OPS, MSX)
Steps 1,2,3a,3c,4,5,6,7

PLT – J.Ashby

A12 APU HTR GG/FU (three)
- A AUTO

MNVR -Y VULCAN (SWUIS)
R=200.42 P=14.56 Y=23.01
A/AUTO/VERN Init MNVR
When in Att,DAP:B5/AUTO/VERN

EXERCISE
(ergometer)

PAO VOICE CHECK/EVENT

MSX OMS/PRCS BURN

MS1 – C.Coleman

P/TV 15 OPS (HDTV)
(PHOTO/TV, DTO700-17A)
Crew at Orbiter Controls

STL Tape Change

P/TV 04 SETUP
(PHOTO/TV, PAO)

PGIM STATUS CK
(PL OPS, MDDK SCI)

STL Tape Change

MS2 – S.Hawley

SWUIS TSM SCI RUN
(PL OPS, SWUIS)
Moon
In Att @ 2/02:50
Vul MNVR @ 2/03:10

SWUIS TSM SCI RUN
(PL OPS, SWUIS)
Vulcanoids
In Att @ 2/03:21
SR @ 2/03:36

SWUIS TSM SCI RUN
(PL OPS, SWUIS)
Sun Set=2/04:34
Venus Set=2/04:40

SWUIS TEMP STOW
Temp stow SWUIS for sleep period

MEMS STATUS CHECK
STL-B STATUS CHECK
(PL OPS, MDDK SCI)

MS3 – M.Tognini

P/TV 16 OPS (DCC)
(PHOTO/TV, DTO 631)

P/TV 16 DOWNLINK
(PHOTO/TV, DTO 631)

P/TV 13 SETUP
(PHOTO/TV, CGBA)

P/TV 13 OPS (CGBA)
(PHOTO T/V, CGBA)
Downlink Video from Experiment

CGBA STATUS CHECK
(PL OPS, MDDK SCI)

MCC

TDRS
EARLY H/O

TV DNLK
SWUIS (MD)

TV DNLK
SWUIS (MD)

STS-93 (FD03)

MET Day 002

TDRS EW | ORB | ATT

	CDR E.Collins	PLT J.Ashby	MS1 C.Coleman	MS2 S.Hawley	MS3 M.Tognini	MCC
06:00	TIG 06:01 MSX OMS/PRCS BURN (ORB OPS, MSX) Steps 1,2,3a,3c,4,5,6,7 MNVR IMU (A1) A/AUTO/VERN Init MNVR IMU ALIGN - S TRK HUD CALIBRATION (ORB OPS) Star:20 Arcturus MNVR -ZLV -XVV TGT=2 BV=3 OM=0 A/AUTO/VERN Init TRK	MSX OMS/PRCS BURN TOPPING FES STARTUP (ORB OPS, ECLS)	PRE-SLEEP ACTIVITY (ORB OPS, CREW SYS)			TDRS EARLY H/O
07:00	06 √UHF MODE - OFF PRIVATE MEDICAL CONF	PRE SLEEP ACTIVITY (ORB OPS, CREW SYS) GALLEY OVERNIGHT CONFIG (ORB OPS, GIRA) STL Tape Change	OCA DOWNLINK (ORB OPS, OCA) Close Outlook	PRE-SLEEP ACTIVITY (ORB OPS, CREW SYS)	PRE-SLEEP ACTIVITY (ORB OPS, CREW SYS)	OCA OPS OST(Mail)⇑⇓
08:00	VOICE OPS (PL OPS, SAREX-C) Contact:AH6NM W1, AOS=07:54:20 LOS=08:01:03 PRE-SLEEP ACTIVITY (ORB OPS, CREW SYS)	PRE-SLEEP ACTIVITY (ORB OPS, CREW SYS) STL Tape Change	PRE-SLEEP ACTIVITY (ORB OPS, CREW SYS)			
09:00						

A1(B1)
AUTO/VERN

ATT: HUD; -ZLV -XVV

ORB: 37, 38, 39

STS-93 (FD03)

TDRS EW	ORB	MET Day 002	ATT	CDR E.Collins	PLT J.Ashby	MS1 C.Coleman	MS2 S.Hawley	MS3 M.Tognini	MCC
		09:00 A1(B1) AUTO/VERN							
	39								
		10:00							OCA OPS OST Down
	40	11:00							
			ZLV						
		12:00	XVV	SLEEP	SLEEP	SLEEP	SLEEP	SLEEP	
	41								
		13:00							
	42	14:00							
	43	15:00							

STS-93 (FD04)

TDRS EW	ORB	MET Day 002	ATT	CDR E.Collins	PLT J.Ashby	MS1 C.Coleman	MS2 S.Hawley	MS3 M.Tognini	MCC
		15:00 A1(B1) AUTO/VERN							
	43	16:00	-ZLV -XVV	SLEEP	SLEEP	SLEEP	SLEEP	SLEEP	OCA OPS OST UP Execute Pkg
	44	17:00	-ZLV +YVV	MONITOR LATENT VIRUS (BIOMED, DSO 493)	MONITOR LATENT VIRUS (BIOMED, DSO 493)	MONITOR LATENT VIRUS (BIOMED, DSO 493)	MONITOR LATENT VIRUS (BIOMED, DSO 493)	MONITOR LATENT VIRUS (BIOMED, DSO 493)	OCA OPS Print Pkg
					POST-SLEEP ACTIVITY (ORB OPS, CREW SYS) GALLEY MORNING RECONFIG (ORB OPS,GIRA)				
				MNVR -ZLV +YVV TGT=2 BV=3 OM=270 A/AUTO/VERN Init TRK		POST-SLEEP ACTIVITY (ORB OPS, CREW SYS)	POST-SLEEP ACTIVITY (ORB OPS, CREW SYS)	POST-SLEEP ACTIVITY (ORB OPS, CREW SYS)	
	45	18:00		SUPPLY/WASTE WATER DUMP (ORB OPS, ECLS) Initiate Supply/Waste Dump					UPDATE WASTE/SUPPLY H2O DUMP QTY

STS-93 (FD04)

MET Day 002

TDRS EW | ORB | ATT | CDR E.Collins | PLT J.Ashby | MS1 C.Coleman | MS2 S.Hawley | MS3 M.Tognini | MCC

18:00

A1(B1) AUTO/VERN

ORB 45

CDR: Monitor Waste Dump

PLT: POST-SLEEP ACTIVITY (ORB OPS, CREW SYS)
GALLEY MORNING RECONFIG (ORB OPS,GIRA)

FD04 EZ ACTIVITIES:
- CPA OPS(ORB OPS,CREW SYS)
- OCAC Filter Inspect
- Re-boot PGSCs
- RCD Scenes with HDTV for a flight total of 5 hrs

MS3: POST-SLEEP ACTIVITY (ORB OPS, CREW SYS)

MS1: POST-SLEEP ACTIVITY (ORB OPS, CREW SYS)

MS2: POST-SLEEP ACTIVITY (ORB OPS, CREW SYS)

MS3: VOICE OPS (PL OPS, SAREX-C) Contact: VK6IU
W1, AOS=18:50:26 LOS=18:55:09

Prior to TVIS Setup:
Pwr off A15, ML85E-J12. Unplug ergometer. Move SAREX plug from ML85E to A15. Pwr on A15. OCAC Fan Speed - 200cfm

19:00

ATT: -ZLV +YVV

MS3: POST-SLEEP ACTIVITY (ORB OPS, CREW SYS)

MCC: TDRS EARLY H/O

MS1: P/TV 03 SETUP(TVIS) (PHOTO/TV, MIDDECK)

PLT: TREADMILL ASSEMBLY (BIOMED, TVIS)

MS2: TREADMILL ASSEMBLY (BIOMED, TVIS)

MS3: TREADMILL ASSEMBLY (BIOMED, TVIS)

CDR: SUPPLY/WASTE WATER DUMP (ORB OPS, ECLS)
Terminate Supply/Waste Dump

PLT/MS1: TVIS: TREADMILL OPS (BIOMED, TVIS)

Do not use outlets J12 & J13 on ML85E while TVIS is in use.

20:00

ORB 46

MS1: PGIM STATUS CK (PL OPS, MDDK SCI)

CDR: L1 FLASH EVAP CNTLR PRI A(B)-OFF

CDR: VOICE OPS (PL OPS, SAREX-C) Contact: VK6IU
W1, AOS=20:25:58 LOS=20:30:47

MS2: MEMS STATUS CHECK
STL-B STATUS CHECK (PL OPS, MDDK SCI)

MS1: OCA DOWNLINK (ORB OPS, OCA) Close Outlook

MCC: OCA OPS
OST(Mail)⇑⇓
Spoc ⇑

MS3: CGBA STATUS CHECK (PL OPS, MDDK SCI)

MS2: SWUIS SETUP
Reattach SWUIS to side hatch window.

A1(B5) AUTO/VERN

ATT: Saturn

CDR: Config DAP B to B5

MS1: P/TV 15 OPS (HDTV) (PHOTO/TV, DTO 700-17A)

MS3: P/TV 13 SETUP (PHOTO/TV, CGBA)

CDR: MNVR -Y SATURN (SWUIS)
R=169.19 P=175.25 Y=55.13
A/AUTO/VERN Init MNVR

MS3: P/TV 13 OPS (CGBA) (PHOTO T/V, CGBA)
Downlink Video from Experiment

ORB 47

CDR: CCM-C STATUS CHECK
BRIC STATUS CHECK (PL OPS, MDDK SCI)

MS1: P/TV 15 OPS (HDTV) (PHOTO/TV, DTO700-17A) Pilot Ops

MS3: BRIC FREEZE 4 OPS
BRIC STOW (PL OPS, BRIC)

21:00

STS-93 (FD04)

MET Day 002 — 21:00 to 00:00

ORB: 47, 48, 49

ATT: (A1)B5 AUTO/VERN; Saturn; Jupiter; -Y cal

CDR — E.Collins

21:00
CCM-C STATUS CHECK
BRIC STATUS CHECK
(PL OPS, MDDK SCI)
On MS Go, DAP:B5/AUTO/VERN (NLT 21:14)

PILOT WITH RHC
(ORB OPS, PGSC)

STL Tape Change

VOICE OPS
(PL OPS, SAREX-C)
Contact: W5ZD
W1, AOS=22:37:32
LOS=22:41:33

EXERCISE
(treadmill)

PLT — J.Ashby

TVIS: TREADMILL OPS
(BIOMED, TVIS)

PILOT WITH RHC
(ORB OPS, PGSC)

MNVR -Y JUPITER (SWUIS)
R=221.17 P=36.06 Y=321.76
A/AUTO/VERN Init MNVR
On MS Go, DAP:B5/AUTO/VERN (NLT 22:41)

P/TV 15 OPS (HDTV)
(PHOTO/TV, DTO700-17A)

MNVR -Y CAL (SWUIS)
R=237.87 P=31.79 Y=321.16
A/AUTO/VERN ~Init MNVR

MS1 — C.Coleman

P/TV 15 OPS (HDTV)
(PHOTO/TV, DTO700-17A)
Pilot Ops

COMM STR 1 C/O, Part B
(ORB OPS, COMM)
Cmd to string 2

MEAL

MS2 — S.Hawley

SWUIS TSM SCI RUN
(PL OPS, SWUIS)
Saturn Rise=2/21:15
Sun Rise=2/21:38

SWUIS TSM SCI RUN
(PL OPS, SWUIS)
Jupiter Rise=2/22:42
Sun Rise=2/23:08

MEAL

MS3 — M.Tognini

BRIC FREEZE 4 OPS
BRIC STOW
(PL OPS, BRIC)

TVIS: TREADMILL OPS
(BIOMED, TVIS)

MCC

TV DNLK
SWUIS (MD)

TV DNLK
SWUIS (MD)

UPDATE
ORBITAL MNVR PAD

Times: 21:00, 22:00, 23:00, 00:00

STS-93 (FD04)

MET Day 003 — 00:00 to 03:00

ORB: 49, 50, 51

ATT: A1(B5) AUTO/VERN (00:00); -Y cal (01:00); A1(B1) AUTO/VERN (02:15); SPX Moon (02:20)

CDR E.Collins

- 00:00 EXERCISE (treadmill)
- P/TV 16 OPS (DCC) (PHOTO/TV, DTO 631)
- P/TV 16 DOWNLINK (PHOTO/TV, DTO 631)
- 01:00 MNVR -Y CAL (SWUIS) R=253 P=61.7 Y=63.8 A/AUTO/VERN Init MNVR
- On MS Go, DAP:B5/AUTO/VERN (NLT 01:35)
- MEAL
- ON-ORBIT OMS BURN (ORB OPS, OMS) 1 ENG BURN (2 Cmn) Alice Springs
- < TIG (02:43)
- MNVR -Y MOON (SWUIS) R=331.43 P=270.79 Y=332.26 A/AUTO/VERN Init MNVR Config DAP B to B5

PLT J.Ashby

- 00:00 MNVR -Y CAL (SWUIS) R=237.87 P=31.79 Y=321.16 A/AUTO/VERN Init MNVR
- On MS Go, DAP:B5/AUTO/VERN (NLT 00:06)
- **STL Tape Change**
- MEAL
- ON-ORBIT OMS BURN (ORB OPS, OMS) 1 ENG BURN (2 Cmn) Alice Springs
- P/TV 15 OPS (HDTV) (PHOTO/TV, DTO700-17A)

MS1 C.Coleman

- MEAL
- PGIM HARVEST 2 (PL OPS, PGIM)
- EXERCISE (treadmill)

MS2 S.Hawley

- MEAL
- TVIS: TREADMILL OPS (BIOMED, TVIS)

MS3 M.Tognini

- SWUIS TSM SCI RUN (PL OPS, SWUIS) Calibration BD +28 4211 Rise=3/00:07 SR=3/00:39
- MEAL
- SWUIS TSM SCI RUN (PL OPS, SWUIS) Calibration Vega, SS=3/01:36 SR=3/02:09
- Unmount SWUIS prior to OMS burn

MCC

- TDRS EARLY H/O
- TV DNLK SWUIS (MD)
- TDRS EARLY H/O
- TV DNLK SWUIS (MD)
- UPDATE ORBITAL MNVR PAD

STS-93 (FD04)

MET Day 003

TDRS / ORB / MET / ATT	CDR E.Collins	PLT J.Ashby	MS1 C.Coleman	MS2 S.Hawley	MS3 M.Tognini	MCC
03:00 A1(B5) AUTO/VERN; ORB 51; ATT Moon	MNVR -Y MOON (SWUIS) R=331.43 P=270.79 Y=332.26 A/AUTO/VERN Init MNVR On MS Go, DAP:B5/AUTO/VERN (NLT 03:06)	P/TV 15 OPS (HDTV) (PHOTO/TV, DTO700-17A)	EXERCISE (treadmill)	SWUIS TSM SCI RUN (PL OPS, SWUIS) Moon, SS=3/03:06 SR=3/03:39	P/TV 04 SETUP (PHOTO/TV, PAO)	TV DNLK SWUIS (MD); TDRS EARLY H/O
	PAO VOICE CHECK/EVENT TV at TDRW (23:40 to 00:00)				PAO VOICE CHECK/EVENT	
04:00		TREADMILL DISASSEMBLY (BIOMED, TVIS)	PGIM-01 HARVEST (PL OPS, PGIM)		TREADMILL DISASSEMBLY (BIOMED, TVIS)	
ATT Venus	MNVR -Y VENUS (SWUIS) R=145.81 P=150.43 Y=310.31 A/AUTO/VERN Init MNVR On MS Go, DAP:B5/AUTO/VERN (NLT 04:34)					
	PAO VOICE CHECK/EVENT TV at TDRW (03:05 to 03:35)	PAO VOICE CHECK/EVENT		SWUIS TSM SCI RUN (PL OPS, SWUIS) Venus,SS=3/04:35 VS=3/04:41	CGBA STATUS CHECK (PL OPS, MDDK SCI) **After TVIS Disassembly:** Pwr off A15, Unplug ergometer. Move SAREX plug from A15 to ML85E-J12. Plug ergometer into A15. Pwr on A15 & ML85E-J12 OCAC Fan Speed - as reqd	TV DNLK SWUIS (MD)
			P/TV 13 SETUP (PHOTO/TV, CGBA)	SWUIS TEMP STOW Temp stow SWUIS for sleep period		
05:00 ORB 52	CCM-C STATUS CHECK (PL OPS, MDDK SCI)	MEMS STATUS CHECK STL-B STATUS CHECK (PL OPS, MDDK SCI)	P/TV 13 OPS (CGBA) (PHOTO T/V, CGBA) Dnlk Exp Video Leave CGBA P/TV configured for TV dnlk during sleep.			CGBA TV Dnlk camr views of CGBA
			PGIM STATUS CK (PL OPS, MDDK SCI)			
	PRE-SLEEP ACTIVITY (ORB OPS, CREW SYS)	PRE-SLEEP ACTIVITY (ORB OPS, CREW SYS)	OCA DOWNLINK (ORB OPS, OCA) Close Outlook	PRE-SLEEP ACTIVITY (ORB OPS, CREW SYS)	PRE-SLEEP ACTIVITY (ORB OPS, CREW SYS)	OCA OPS OST(Mail)⇑⇓
ORB 53; ATT MSX	MSX OMS/PRCS BURN (ORB OPS, MSX)	MSX OMS/PRCS BURN (ORB OPS, MSX) All Steps	PRE-SLEEP ACTIVITY (ORB OPS, CREW SYS)			
06:00						

STS-93 (FD04)

TDRS EW	ORB	MET Day 003	ATT	CDR E.Collins	PLT J.Ashby	MS1 C.Coleman	MS2 S.Hawley	MS3 M.Tognini	MCC
		06:00 A1(B1) AUTO/VERN	MSX	MSX OMS/PRCS BURN (ORB OPS, MSX) TIG (06:05)	MSX OMS/PRCS BURN (ORB OPS, MSX) All Steps	PRE-SLEEP ACTIVITY (ORB OPS, CREW SYS)			
				MNVR -ZLV -XVV TGT=2 BV=3 OM=0.0 A/AUTO/VERN Init TRK	PRE SLEEP ACTIVITY (ORB OPS, CREW SYS) GALLEY OVERNIGHT CONFIG (ORB OPS, GIRA)	VOICE OPS (PL OPS, SAREX-C) Contact:AH6NM W1, AOS=06:25:21 LOS=06:30:25			
	53			TOPPING FES STARTUP (ORB OPS, ECLS) 06 √UHF MODE - OFF PRIVATE MEDICAL CONF					
							PRE-SLEEP ACTIVITY (ORB OPS, CREW SYS)	PRE-SLEEP ACTIVITY (ORB OPS, CREW SYS)	
		07:00				PRE-SLEEP ACTIVITY (ORB OPS, CREW SYS)			
			-ZLV -XVV	PRE-SLEEP ACTIVITY (ORB OPS, CREW SYS)					
	54	08:00		SLEEP	SLEEP	SLEEP	SLEEP	DORMIR	OCA OPS OST Down
	55	09:00							

STS-93 (FD04)

TDRS EW	ORB	MET Day 003	ATT	CDR E.Collins	PLT J.Ashby	MS1 C.Coleman	MS2 S.Hawley	MS3 M.Tognini	MCC
	55	09:00 A1(B1) AUTO/VERN							
		10:00							
	56	11:00							
		12:00	-ZLV -XVV	SLEEP	SLEEP	SLEEP	SLEEP	DORMIR	
	57								
		13:00							
	58	14:00							
	59	15:00							

STS-93 (FD05)

TDRS EW | GND | ORB | MET | ATT

Day 003

MET	ATT	CDR E.Collins	PLT J.Ashby	MS1 C.Coleman	MS2 S.Hawley	MS3 M.Tognini	MCC
15:00	A1(B1) AUTO/VERN	SLEEP	SLEEP	SLEEP	SLEEP	DORMIR	OCA OPS OST UP Execute Pkg
16:00	-ZLV -XVV	MONITOR LATENT VIRUS (BIOMED, DSO 493)	MONITOR LATENT VIRUS (BIOMED, DSO 493)	MONITOR LATENT VIRUS (BIOMED, DSO 493)	MONITOR LATENT VIRUS (BIOMED, DSO 493)	MONITOR LATENT VIRUS (BIOMED, DSO 493)	OCA OPS Print Pkg
			POST-SLEEP ACTIVITY (ORB OPS, CREW SYS) GALLEY MORNING RECONFIG (ORB OPS,GIRA)				
17:00	-ZLV +YVV	POST-SLEEP ACTIVITY (ORB OPS, CREW SYS)	MNVR -ZLV +YVV TGT=2 BV=3 OM=270 A/AUTO/VERN Init TRK	POST-SLEEP ACTIVITY (ORB OPS, CREW SYS)	POST-SLEEP ACTIVITY (ORB OPS, CREW SYS)	POST-SLEEP ACTIVITY (ORB OPS, CREW SYS)	
			SUPPLY/WASTE WATER DUMP (ORB OPS, ECLS) Initiate Supply Dump				UPDATE H2O SPLY DUMP QTY TK A & B
			POST-SLEEP ACTIVITY (ORB OPS, CREW SYS)				
18:00							

ORB: 59, 60, 61

GND: MIL, MIL

STS-93 (FD05)

TDRS EW | GND MIL | ORB | MET Day 003 | ATT | CDR E.Collins | PLT J.Ashby | MS1 C.Coleman | MS2 S.Hawley | MS3 M.Tognini | MCC

18:00

A1(B1) AUTO/VERN

CDR: POST-SLEEP ACTIVITY (ORB OPS, CREW SYS)

PLT: POST-SLEEP ACTIVITY (ORB OPS, CREW SYS)

MS1: POST-SLEEP ACTIVITY (ORB OPS, CREW SYS)

MS2: POST-SLEEP ACTIVITY (ORB OPS, CREW SYS)

MS3: POST-SLEEP ACTIVITY (ORB OPS, CREW SYS)

MCC: UPLINK Flycast MNVR PAD

MS1: OCA DOWNLINK (ORB OPS, OCA) Close Outlook

MCC: OCA OPS OST(Mail)⇑⇓ Spoc ⇑

CDR: CCM-C STATUS CHECK, BRIC STATUS CHECK (PL OPS, MDDK SCI)

MS1: P/TV 04 SETUP (PHOTO/TV, PAO)

ORB: 61

CDR: FUTURE LOADED MNVR (COMM) R= P= Y= A/AUTO/VERN (3/19:00) Init MNVR

PLT: SUPPLY/WASTE WATER DUMP (ORB OPS, ECLS) Terminate Supply Dump; APU STEAM VENT HTR ACT R2 ✓BLR CNTLR/HTR(three) -B, PWR (three) -ON

MS2: VOICE OPS (PL OPS, SAREX-C) Contact:VK6IU W1, AOS=18:54:59 LOS=18:59:49

MS3: Setup camera for crew photo

ATT: -ZLV +YVV

19:00

CREW PHOTO (CDR, PLT, MS1, MS2, MS3)

MCC: TDRS EARLY H/O

GND: MIL

CDR: CREW CONF TV at TDRE (19:22 to 19:53)

CREW CONF (PLT, MS1, MS2, MS3)

20:00

ORB: 62

CDR: MNVR -ZLV -XVV TGT=2 BV=3 OM=0.0 A/AUTO/VERN Init TRK

PLT: **STL Tape Change**

PLT: PILOT WITH RHC (ORB OPS, PGSC)

MS1: PGIM STATUS CK (PL OPS, MDDK SCI)

MS2: MEMS STATUS CHECK, STL-B STATUS CHECK (PL OPS, MDDK SCI)

CDR: PILOT WITH RHC (ORB OPS, PGSC)

ATT: -ZLV -XVV

MS1: P/TV 07 OPS (PHOTO/TV, ENTRY VIDEO)

FD05 EZ ACTIVITIES:
- -CPA OPS(ORB OPS,CREW SYS)
- -OCAC Filter Inspect
- -Re-boot PGSCs
- -RCD Scenes with HDTV for a flight total of 5 hrs

MS3: EXERCISE (ergometer)

MS2: FCS CHECKOUT (ORB OPS, GNC) (2 Cmn)

CDR: FCS CHECKOUT (ORB OPS, GNC) (2 Cmn)

PLT: FCS CHECKOUT (ORB OPS, GNC) (2 Cmn)

MS1: EXERCISE (ergometer)

ORB: 63

21:00

STS-93 (FD05)

MET Day 003 — 21:00 to 00:00

TDRS (E W), GND (MIL, GDX MIL), ORB (63, 64, 65), ATT: A1(B1) AUTO/VERN; -ZLV-; -XVV

CDR E.Collins

- 21:00 FCS CHECKOUT (ORB OPS, GNC) (2 Cmn)
- RCS HOT FIRE TEST (ORB OPS, RCS)
  Config DAP: A/AUTO/VERN
- 22:00 MULTI PLS FLYCAST MNVR (ORB OPS FS, DTO 260)
- LANDING-1 COMM C/O (ORB OPS, COMM/INST)
- MEAL

PLT J.Ashby

- 21:00 FCS CHECKOUT (ORB OPS, GNC) (2 Cmn)
- RCS HOT FIRE TEST (ORB OPS, RCS)
- STL Tape Change
- 22:00 MULTI PLS FLYCAST MNVR (ORB OPS FS, DTO 260)
- MEAL
- L1 FLASH EVAP CNTLR PRI A(B)-OFF

MS1 C.Coleman

- EXERCISE (ergometer)
- ICMS (DSO 631) (BIOMED, ICMS)
- MEAL
- CABIN CONFIG/STOW

MS2 S.Hawley

- 21:00 FCS CHECKOUT (ORB OPS, GNC) (2 Cmn)
- RCS HOT FIRE TEST (ORB OPS, RCS)
- EXERCISE (ergometer)
- MEAL

MS3 M.Tognini

- EXERCISE (ergometer)
- CGBA STATUS CHECK (PL OPS, MDDK SCI)
- P/TV 13 SETUP (PHOTO/TV, CGBA) Plug video into M058F
- CGBA OPS (PHOTO T/V, OPS) Downlink Video from Experiment
- ICMS (DSO 631) (BIOMED, ICMS)
- MEAL
- SAREX STOW (PL OPS, SAREX-C)

MCC

- UPDATE ORBITAL MNVR PAD

STS-93 (FD05)

TDRS EW | GND | ORB | MET | ATT

Day 004

00:00 | 01:00 | 02:00 | 03:00

GDX MIL | GDX MIL

ORB: 65, 66, 67

A1(B1) AUTO/VERN

ATT: SPX, ZLV -YVV

< TIG (00:25)

CDR E.Collins

ON-ORBIT OMS BURN
(ORB OPS, OMS)
1 ENG BURN (2 Cmn)
Aricebo

EXERCISE
(ergometer)

CCM-C STATUS CHECK
(PL OPS, MDDK SCI)

LANDING-1 COMM C/O
(ORB OPS, COMM/INST)
Backup Opportunity

D/O PREP REVIEW

PLT J.Ashby

STL Tape Change

ON-ORBIT OMS BURN
(ORB OPS, OMS)
1 ENG BURN (2 Cmn)
Aricebo

MNVR -ZLV -YVV
TGT=2 BV=3 OM=90
A/AUTO/VERN Init TRK

TOPPING FES STARTUP
(ORB OPS, ECLS)

EXERCISE
(ergometer)

D/O PREP REVIEW

CYCLE ERGOMETER OPS
(ORB OPS, CREW SYS)
Reconfig/Stow

MS1 C.Coleman

CABIN CONFIG/STOW

PGIM STATUS CK
(PL OPS, MDDK SCI)

CABIN CONFIG/STOW

OCA DOWNLINK
(ORB OPS, OCA)
Close Outlook

MEMS STATUS CHECK
STL-B STATUS CHECK
(PL OPS, MDDK SCI)

D/O PREP REVIEW

CYCLE ERGOMETER OPS
(ORB OPS, CREW SYS)
Reconfig/Stow

MS2 S.Hawley

CABIN CONFIG/STOW

Pre-Deorbit Prep Activities:
- Remove loose items stored in airlock
- Perform SEAT INSTALLATION
- Perform ENTRY STOWAGE (FLTS W/RETN NET)
  (REF DATA, ENT STOW)

STL-B ENTRY PREP
(PL OPS, STL-B)

OCA DEACT
(ORB OPS FS,OCA)

KU-BD ANT STOW
(ORB OPS, COMM/INST)

D/O PREP REVIEW

STOW PRINTER
(ORB OPS FS, DTO 1215)

MS3 M.Tognini

SAREX STOW
(PL OPS, SAREX-C)

CABIN CONFIG/STOW

CGBA ENTRY RECONFIG
(PL OPS, CGBA)

CGBA STATUS CHECK
(PL OPS, MDDK SCI)
Take 35mm photo
of STL entry prep

P/TV 13 SETUP
(PHOTO/TV, CGBA)
Plug video into MO58F

P/TV 13 OPS (CGBA)
(PHOTO T/V, CGBA)
Dnlk Exp Video

D/O PREP REVIEW

CABIN CONFIG/STOW

MCC

OCA OPS
OST(Mail)⇑⇓

STS-93 (FD05)

MET Day 004

MET	ATT	CDR E.Collins	PLT J.Ashby	MS1 C.Coleman	MS2 S.Hawley	MS3 M.Tognini	MCC
03:00 (ORB 67) A1(B1) AUTO/VERN		OCAC STOW (ORB OPS, CREW SYS)	CYCLE ERGOMETER OPS (ORB OPS, CREW SYS) Reconfig/Stow	CYCLE ERGOMETER OPS (ORB OPS, CREW SYS) Reconfig/Stow	STOW PRINTER ~~(ORB OPS FS, DTO 1215)~~	CABIN CONFIG/STOW	
			CABIN CONFIG/STOW	OCAC STOW (ORB OPS, CREW SYS)	CABIN CONFIG/STOW	GALLEY WATER SAMPLE (ORB OPS, GIRA)	
		ON-ORBIT -X RCS BURN (ORB OPS, RCS)	ON-ORBIT -X RCS BURN (ORB OPS, RCS)	CABIN CONFIG/STOW			
04:00		< TIG (04:02)					
	-ZLV -YVV	MNVR -ZLV -YVV TGT=2 BV=3 OM=90 A/AUTO/VERN Init TRK	PRE SLEEP ACTIVITY (ORB OPS, CREW SYS) GALLEY OVERNIGHT CONFIG (ORB OPS, GIRA)				
05:00 (ORB 68)		PRE-SLEEP ACTIVITY (ORB OPS, CREW SYS)		PRE-SLEEP ACTIVITY (ORB OPS, CREW SYS)	PRE-SLEEP ACTIVITY (ORB OPS, CREW SYS)	PRE-SLEEP ACTIVITY (ORB OPS, CREW SYS)	
		06 √UHF MODE - OFF PRIVATE MEDICAL CONF					
(ORB 69) 06:00		PRE-SLEEP ACTIVITY (ORB OPS, CREW SYS)					

STS-93 (FD05)

TDRS EW | GND | ORB | MET | ATT

MET		CDR E.Collins	PLT J.Ashby	MS1 C.Coleman	MS2 S.Hawley	MS3 M.Tognini	MCC
Day 004 06:00	A1(B1) AUTO/VERN	PRE-SLEEP ACTIVITY (ORB OPS, CREW SYS)	PRE SLEEP ACTIVITY (ORB OPS, CREW SYS) GALLEY OVERNIGHT CONFIG (ORB OPS, GIRA)	PRE-SLEEP ACTIVITY (ORB OPS, CREW SYS)	PRE-SLEEP ACTIVITY (ORB OPS, CREW SYS)	PRE-SLEEP ACTIVITY (ORB OPS, CREW SYS)	
07:00	-ZLV- -YVV	SLEEP	SLEEP	SLEEP	SLEEP	SLEEP	
08:00							
09:00							

ORB: 69, 70, 71

STS-93 (FD05)

TDRS EW	ORB	MET Day 004	ATT	CDR E.Collins	PLT J.Ashby	MS1 C.Coleman	MS2 S.Hawley	MS3 M.Tognini	MCC
	71	09:00 A1(B1) AUTO/VERN							
		10:00							
	72	11:00	ZLV						
	73	12:00	YVV	SLEEP	SLEEP	SLEEP	SLEEP	SLEEP	
		13:00							
	74	14:00							
	75	15:00							

STS-93 (FD06)

TDRS EW | ORB | MET | ATT

CDR E.Collins	PLT J.Ashby	MS1 C.Coleman	MS2 S.Hawley	MS3 M.Tognini	MCC

Day 004

15:00 — A1(B1) AUTO/VERN

- CDR: MONITOR LATENT VIRUS (BIOMED, DSO 493)
- PLT: MONITOR LATENT VIRUS (BIOMED, DSO 493)
- MS1: MONITOR LATENT VIRUS (BIOMED, DSO 493)
- MS2: MONITOR LATENT VIRUS (BIOMED, DSO 493)
- MS3: MONITOR LATENT VIRUS (BIOMED, DSO 493)

PLT:
POST-SLEEP ACTIVITY (ORB OPS, CREW SYS)
GALLEY MORNING RECONFIG (ORB OPS,GIRA)

ORB: 75

MS3: POST-SLEEP ACTIVITY (ORB OPS, CREW SYS)

MS1: POST-SLEEP ACTIVITY (ORB OPS, CREW SYS)

CDR: POST-SLEEP ACTIVITY (ORB OPS, CREW SYS)

ATT: -ZLV -YVV

FD06 EZ ACTIVITIES:
-CPA OPS (ORB OPS,CREW SYS)
FLUID LOADING PER MCC
FILL DRINK CONTAINERS WITH WATER PER PMC INSTUCTIONS.
AFTER FLUID LOADING, PERFORM GIRA STOWAGE (ORB OPS,GIRA)

16:00

MS2: POST-SLEEP ACTIVITY (ORB OPS, CREW SYS)

MS1: ICMS (DSO 631) (BIOMED,ICMS)

MS3: ICMS (DSO 631) (BIOMED,ICMS)

CDR:
06 √UHF MODE - OFF
PRIVATE MED CONF

CDR: PRIORITY PWRUP GROUP B (ORB PKT, PRIOR PWRDN)

17:00

ORB: 76

MS1: POST-SLEEP ACTIVITY (ORB OPS, CREW SYS)

ATT: IMU

CDR:
DEORBIT IMU ALIGN [A]
IMU VERIFICATION [B]

MS2: EGRESS LOCOMOTION (BIOMED, DSO 331)

MS3: EGRESS LOCOMOTION (BIOMED, DSO 331)

MS1: CCM-C ENTRY PREP (PL OPS, CCM-C)

A5(B1) AUTO/VERN

CDR: Config DAP A to A5

CDR:
MNVR -XSI
TGT=4 BV=5 P=184 Y=0 OM=270
A/AUTO/VERN Init TRK

ATT: -XSI

ORB: 77

MS1:
AIR SAMPLE
Record MET and location on bottle

PLT:
ISOLATE TANK C
R11L √SPLY H2O TKC
INLET-CL (tb-CL)
OUTLET-CL (tb-CL)

Go to Deorbit Prep C/L at 4/17:56 MET

18:00

STS-93 (FD06)

TDRS EW	ORB	MET Day 004	ATT	CDR E.Collins	PLT J.Ashby	MS1 C.Coleman	MS2 S.Hawley	MS3 M.Tognini	MCC
	77	18:00 A1(B1) AUTO/VERN	XSI						
		19:00							
	78	20:00	COMM						
	79	21:00							

A

IMU STAR ALIGN:

MNVR TO DUAL S TRK ALIGN ATT
R=172 P=151 Y=16
A/AUTO/VERN Init MNVR

Perform IMU ALIGN-S TRK
(ORB OPS, GNC)

Star Pair B1
ID: -Y: 23, BETELGEUSE
MET: 4/17:03-17:51

-Z: 16, ACHERNAR
MET: 4/16:51-17:39

ANG DIFF: 82.9

2nd Attitude
(Single S TRK)

-Z: 23	-Y: 16
R=86	R=258
P=162	P=140
Y=6	Y=6

REQD ID:

-Y:_____, -Z:______, ANG ERR____,____ ____

ANG:	1	2	3
ΔX	( )____,____ ____	( )____,____ ____	( )____,____ ____
ΔY	( )____,____ ____	( )____,____ ____	( )____,____ ____
ΔZ	( )____,____ ____	( )____,____ ____	( )____,____ ____

EXECUTION TIME: ___/ ____:____:____ MET

B

IMU ALIGN VERIFICATION:

MNVR TO DUAL S TRK ALIGN ATT
R=115 P=133 Y=299
A/AUTO/VERN Init MNVR

Perform IMU ALIGN-S TRK
(ORB OPS, GNC)
Step 5

Star Pair C2
ID: -Y: 41, DENEBOLA
MET: 4/17:31-18:18
-Z: 50, AVIOR
MET: 4/17:05-17:54

ANG DIFF: 84.9

2nd Attitude
(Single S TRK)

-Z: 41	-Y: 50
R=24	R=179
P=126	P=108
Y=285	Y=305

REQD ID:

-Y:_____, -Z:______, ANG ERR____,____ ____

ANG:	1	2	3
ΔX	( )____,____ ____	( )____,____ ____	( )____,____ ____
ΔY	( )____,____ ____	( )____,____ ____	( )____,____ ____
ΔZ	( )____,____ ____	( )____,____ ____	( )____,____ ____

If any ΔX, ΔY, or ΔZ > 0.1 Check MCC

EXECUTION TIME: ___/ ____:____:____ MET

Payloads

STS-93

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Updated: 07/13/1999

Editorial/Technical Comments: ShuttlePresskit

Biological Research in Canisters

In-Cabin

Prime: Michel Tognini

Principal Investigator: Dr. Anireddy S. Reddy, Colorado State University, Ft. Collins, Colo., for BRIC-11; Dr. Stanley Roux, University of Texas at Austin, for BRIC-12

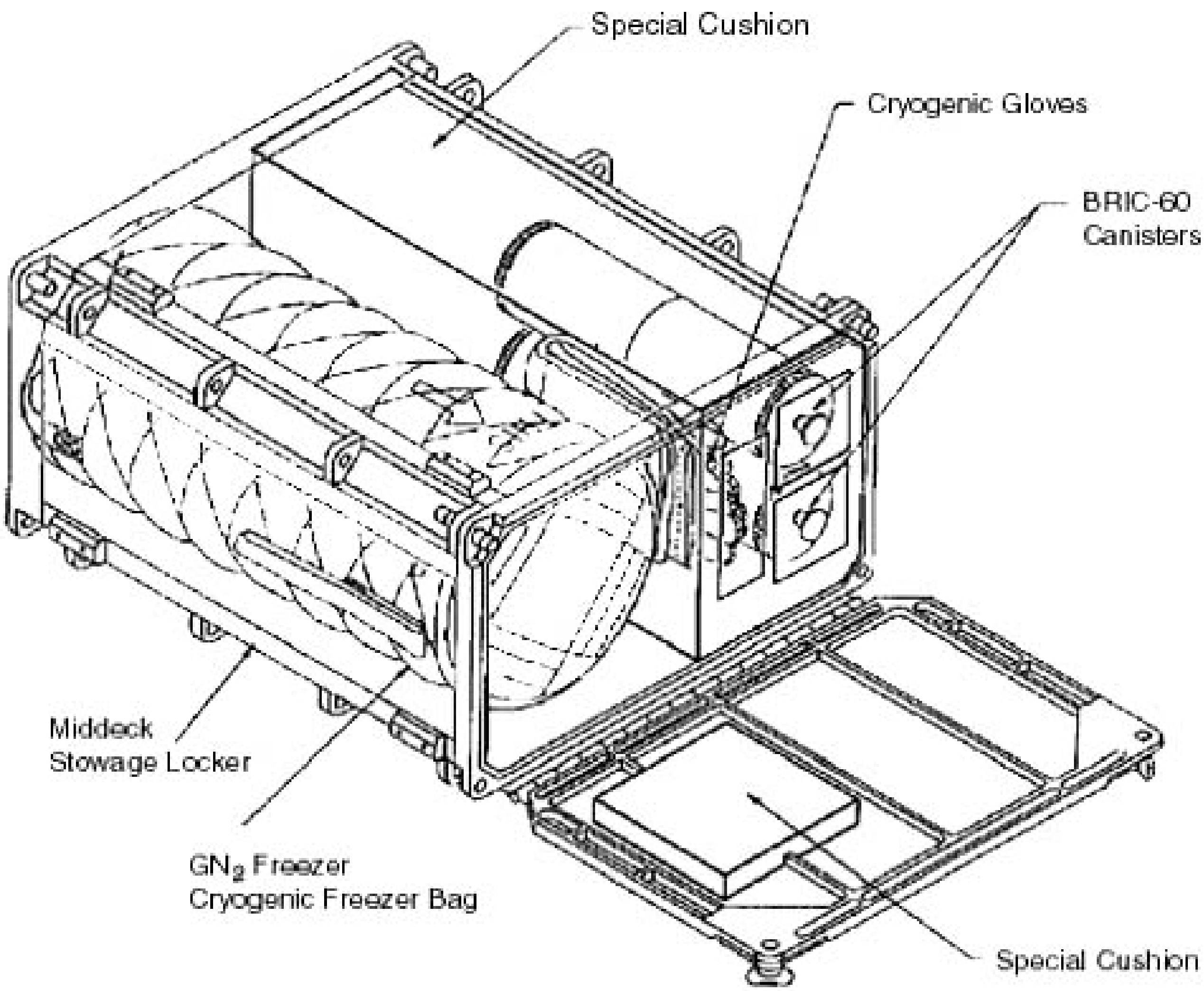
Backup: Eileen Collins

Project Scientist: Dr. William Knott, NASA Kennedy Space Center, Fla., for BRIC-11 and BRIC-12

Overview

The objective of the BRIC payload is to investigate the effects of space flight on small arthropod animal and plant specimens. The BRIC hardware has a variety of configurations, depending on the scientific requirements of each flight. The canisters contain two aluminum chambers that hold the specimen support hardware. The canisters and freezer are stowed in a standard middeck locker with at least one-half inch of Pyrell foam on each side. No orbiter power is required for any experiment configuration.

STS-93 will use the Block II configuration, which consists of two BRIC-60 (82-mm diameter) canisters, one pair of cryogenic gloves, and one gaseous nitrogen freezer (GN2) in a single middeck locker. The flight crew will be available at regular intervals to monitor and control payload/experiment operations. The Block II configuration also requires a crew member to don a pair of insulating gloves, remove a canister from the locker, and replace it in the GN2 freezer. There will be two experiments on STS-93, BRIC-11 and BRIC-12.



BRIC-11: Investigations of Global Changes in Gene Expression in Response to Gravity

Growth of plants in space is essential for long-term presence of humans in space. Plants, in addition to producing food, can replenish oxygen and remove carbon dioxide and other nitrogenous wastes. Hence, plants play a critical role in developing a self-sustained, regenerative life support system in space. Plants on Earth are constantly influenced by gravity, which controls several aspects of their growth and development. For example, the roots grow toward gravity (positive gravitropism) and the shoots grow away from gravity (negative gravitropism). The effect of reduced gravity on plants is poorly understood. Furthermore, the mechanisms by which plants sense and respond to gravity remain largely unknown. In order to grow plants in space, it is essential to understand the effects of microgravity on growth and development, especially at the molecular and cell biological level. Recent genetic studies of mutants with no response or an altered response to gravity indicate that the perception and transduction of gravity signals involve specific gene products.

The objective of BRIC-11 is to investigate gravity-regulated gene expression by using

Earth- and space-grown seedlings. These studies represent a first step toward understanding the effects of gravity on gene regulation. Arabidopsis was chosen because it offers a number of advantages for molecular genetic studies. It also allows the investigator to analyze the expression of thousands of genes simultaneously by using a DNA "chip" technology.

The experiment involves growing seedlings in microgravity on the space shuttle middeck and on Earth, and then analyzing them to determine the effects of gravity on gene expression. BRIC hardware will be used to germinate Arabidopsis seeds in the dark under sterile conditions. Each BRIC module will accommodate twelve 65-mm Petri dishes, each with about 10,000 seeds. Four such canisters will be used for germinating the seeds in the flight, and four canisters will be used as ground controls in the orbiter environment simulator at Kennedy Space Center. About four days into germination, a crew member will freeze two of the flight canisters in the gaseous nitrogen freezer and the ground crew will also freeze two of the ground canisters.

The Earth- and space-grown seedlings will be then analyzed through microarray-based monitoring for global changes in the expression of thousands of Arabidopsis genes. The RNA from the Earth- and space-grown samples will be used to synthesize fluorescent-labeled cDNAs and hybridize them to a bank of about 10,000 Arabidopsis cDNAs on DNA "chips." These chips will then be scanned to determine qualitative and quantitative changes in gene expression in response to microgravity. The microarray analysis will be performed in collaboration with the Monsanto Company, St. Louis, Mo.

The genes whose expression is affected by gravity and/or microgravity will be identified and characterized to understand their role in gravity signal transduction. In the long run, it may be possible to engineer such genes for regulation by controllable factors other than gravity.

BRIC-12: Early Development of Fern Gametophytes in Microgravity

The physiological responses of animals and plants to gravity are complex, involving the interaction of many different cell types. In order to simplify their study of the cellular basis of gravity sensing and response, biologists have recently begun studying gravity effects in single cells, where all the actions and reactions occur in one place.

One such model system for gravitational biology studies is the germinating spore cell of the fern Ceratopteris richardii. These spore cells appear to be insensitive to gravity as long as they are kept in darkness; but once induced to germinate by light, they show a characteristic gravity response. Each single-celled spore has a nucleus in the center. During the first 30 hours or so after light activation, the nucleus moves along a kind of random path restricted to a region near the cell center. Then, under the influence of 1 g on Earth, the nucleus abruptly migrates downward along a relatively straight path to the lower part of the cell. There, about 18 hours later, it divides, producing two cells--a smaller one that develops into a rootlike rhizoid and a larger one that develops into the leafy part of the plant, the prothallus. The gravity-directed migration of the nucleus exactly predicts the direction in which the rhizoid will emerge and grow after the spore germinates. In addition, the unequal cell division that results from the asymmetric positioning of the nucleus after its downward migration may be a prerequisite for the two different cell types to form (rhizoid and prothallus). Thus, within a limited period following light activation of the spores, gravity determines the polarity of each spore cell--which end will have the rhizoid and which end will have the prothallus.

On STS-93, scientists will take advantage of this simple system to study gravity effects at the most basic level. The shuttle facilities, which include the Space Tissue Loss (STL) B hardware developed at the Walter Reed Army Institute of Research, will allow them to investigate two sets of questions. One set of experiments will use the STL-B on-board video microscopy system to find out whether, in the absence of a strong gravity signal, the nucleus will migrate randomly or not at all and, if not, whether the failure to migrate will prevent normal development of the rhizoid and prothallus. Another question to be answered concerns the "random walk" of the nucleus about the center of the cell during the first 30 hours after the spore cell is activated. This movement (as well as the later downward movement of the nucleus) is driven by molecular motors, which may be "turned on" by the tension and compression forces created in the cell by gravity. Scientists want to see whether the molecular motors will operate normally in microgravity or will fail to turn on, leaving the nucleus motionless in the center of the cell. This information would give us an insight into how these molecular motors, which are common to all plant and animal cells, can be controlled.

A second set of BRIC-12 experiments will investigate whether gravity is turning on or off any specific genes during the period in which it is setting the polarity of the cell. Scientists already know that hundreds of genes are turned on (transcribed into messenger RNA) or turned off during this period, and they believe that most are programmed do so at this time whether gravity is present or not. It is possible, though, that the expression of some of these genes may require the tension and compression forces caused by gravity in the cell. To help scientists find the answer, astronauts on the STS-93 mission will freeze light-activated spores at four different time points--three during the period when gravity fixes the cell polarity on Earth and one after this period should be over (45 hours after the spores are light-activated in orbit). After the shuttle lands, the pattern of gene expression in these space-flown spores at the selected four time points will be compared to the pattern at the same four time points in spores on Earth.

The germinating spores represent a relatively uniform population of cells that have all been induced to start their development at the same time (by a light signal). Because of the cells' uniformity and the relative synchrony of their development, there is a unique opportunity to resolve subtle differences in the pattern of gene expression between cells growing in microgravity and cells on Earth. If the experiment demonstrates that any genes are regulated by gravity, it is reasonable to postulate are they are instrumental to the cells' ability to sense or respond to gravity.

History/Background

One of four BRIC payload hardware configurations is chosen for each flight to meet scientific requirements:

Block I: five 82-mm-diameter dual-chamber BRIC-60 canisters in a single middeck locker

Block II: two 82-mm-diameter dual-chamber BRIC-60 canisters, one pair of cryogenic gloves, and one gaseous-nitrogen freezer in a single middeck locker

Block III: three 114-mm-diameter single-chamber BRIC-100 canisters in a single middeck locker

Block IV: nine 114-mm-diameter single-chamber BRIC-VC canisters in a single middeck locker

Block V: three 114-mm-diameter single-chamber BRIC-100 canisters and one BRIC phase-change sleeve in a single middeck locker

The canisters are self-contained aluminum holders for the specimen support hardware and require no orbiter power. The canisters and freezer are housed in a standard middeck locker. The BRIC Block I, Block III, and Block IV experiment configurations require no crew interaction. The Block II configuration requires a crew member to put on a pair of insulating gloves, remove a canister from the locker, and replace it in the freezer.

See the STS-95 BRIC discussion for a summary of previous missions flown.

Benefits

The knowledge obtained from BRIC-11 will help us understand how plants perceive and respond to gravity signals. It will also be useful in growing plants under microgravity conditions and building life support systems in space for long-duration missions. These studies could also lead to advances in plant biotechnology and medicine.

If the BRIC-12 experiments and subsequent tests reveal the identity of genes needed for gravity sensing or response in single cells, scientists will greatly increase their understanding of how gravity alters cell growth and development.

Editorial/Technical Comments: ShuttlePresskit

Payloads

STS-93

Cell Culture Model, Configuration C

In-Cabin

Prime: Eileen Collins

Principal Investigator: Dr. Kenton Gregory, Oregon Medical Laser Center in Portland, Ore., and Dr. Eugenia Wang of McGill, University in Montreal, Quebec, Canada

Backup: Cady Coleman

Overview

The objectives of this payload are to validate cell culture models for muscle, bone, and endothelial cell biochemical and functional loss induced by microgravity stress; to evaluate cytoskeleton, metabolism, membrane integrity, and protease activity in target cells; and to test tissue loss pharmaceuticals for efficacy.

The experiment unit fits into a single standard middeck locker with the door panels removed. The unit takes in and vents air to the cabin via the front panel. The experiment is powered and functions continuously from prelaunch through postlanding. The analysis module for STS-93 is CCM Configuration C. It has a hermetically sealed fluid path assembly containing the cells under study, all media for sustained growth, automated drug delivery provisions to test candidate pharmaceuticals, in-line vital activity and physical environment monitors, integral fraction collection capabilities, and cell fixation facilities. The fluid path and media are cooled by a 4-degree Celsius active cooling chamber and associated cabling and driver circuitry. (This payload was formerly called Space Tissue Loss, Configuration A.)

STS-93 will be the maiden voyage of the Walter Reed Army Institute of Research (WRAIR) Cell Culture Module with cooling. CCM-C is the sister payload of the CCM, which has been used to support collaborative cell culture experiments since 1994. CCM-C is identical to CCM except that it reduces the number of experiment bioreactors to accommodate a resident cooling chamber. This chamber can be used to extend the life of stored fluids essential to cell culture nutrients and samples that would normally break down in the 37-degree Celsius environment of the CCM.

The CCM-C features two exciting collaborative experiments that have never been flown in space. The first, involving endothelialized elastin heterografts, seeks to demonstrate microgravity effects on blood vessel function and gene expression. The second experiment will study rapid-aging effects and genetic alterations that occur in space and are thought to correlate with aging on Earth.

CCM-C will also flight-qualify three different sensors essential for long-duration experimentation in space and useful in ground applications as well. The sensors include a miniature pH electrode developed by NASA Ames Sensors 2000 program, a noninvasive pH sensor developed by engineers at WRAIR, and a noninvasive oxygen sensor developed by Dr. Mark Arnold at the University of Iowa in Iowa City. These sensors will make it possible to determine and record cell growth and metabolism during the mission and will allow feedback control for better, more reproducible experiments.

CCM-C is integrated and flown under the direction of the DOD Space Test Program Office at the Johnson Space Center in Houston, Tex.

Payloads

STS-93

Chandra X-Ray Observatory

Payload Bay

50,162 lbs.

Prime: Cady Coleman
Backup: Michel Tognini

Project Scientist: Dr. Martin Weisskopf, Marshall Space Flight Center

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Overview

NASA's Chandra X-Ray Observatory, the world's most powerful X-Ray telescope, is the primary payload for Space Shuttle mission STS-93.
With a combination of sensitive instruments and highly X-Ray reflective mirrors, the observatory will allow scientists to study the origin, structure and evolution of our universe in greater detail than ever before.

Chandra is the third in NASA's family of "Great Observatories." Complementing the Hubble Space Telescope and the Compton Gamma Ray Observatory, which are already in Earth orbit, the Chandra X-Ray Observatory will study X-Rays rather than visible light or gamma rays.

Since X-Rays are absorbed by the Earth's atmosphere, space-based observatories are necessary to study these phenomena. By capturing images created by these invisible rays, the observatory will allow scientists to analyze some of the greatest mysteries of the universe. Chandra will serve as a unique tool to study detailed physics in a laboratory that cannot be replicated here on Earth - the universe itself.

Scientists will use the Chandra X-Ray Observatory to learn more about black holes, to study quasars at the edge of the observable universe, and even to analyze comets in our own solar system. By mapping the location of X-Ray energy throughout the universe, they hope to find clues to the identity of the missing mass - called "Dark Matter" - that must exist but cannot be seen.

Carried into space in Columbia's payload bay, Chandra will be deployed by the Space Shuttle crew, boosted to a transfer orbit by an Inertial Upper Stage, and propelled to its operating orbit by the observatory's own propulsion system. The observatory will undergo several weeks of activation and checkout before being turned over to the scientific community to begin its five-year research mission.

Named in honor of the late Indian-American Nobel Laureate Dr. Subrahmanyan Chandrasekhar, the Chandra observatory was formerly known as the Advanced X-Ray Astrophysics Facility (AXAF). The Chandra X-Ray Observatory program is managed by NASA's Marshall Space Flight Center in Huntsville, AL, for NASA's Office of Space Science.

Payload Components

The Chandra X-Ray Observatory payload includes the observatory itself, a solid fuel Inertial Upper Stage booster which will help propel Chandra to its operating orbit, and equipment which supports the payload while in the Space Shuttle payload bay.

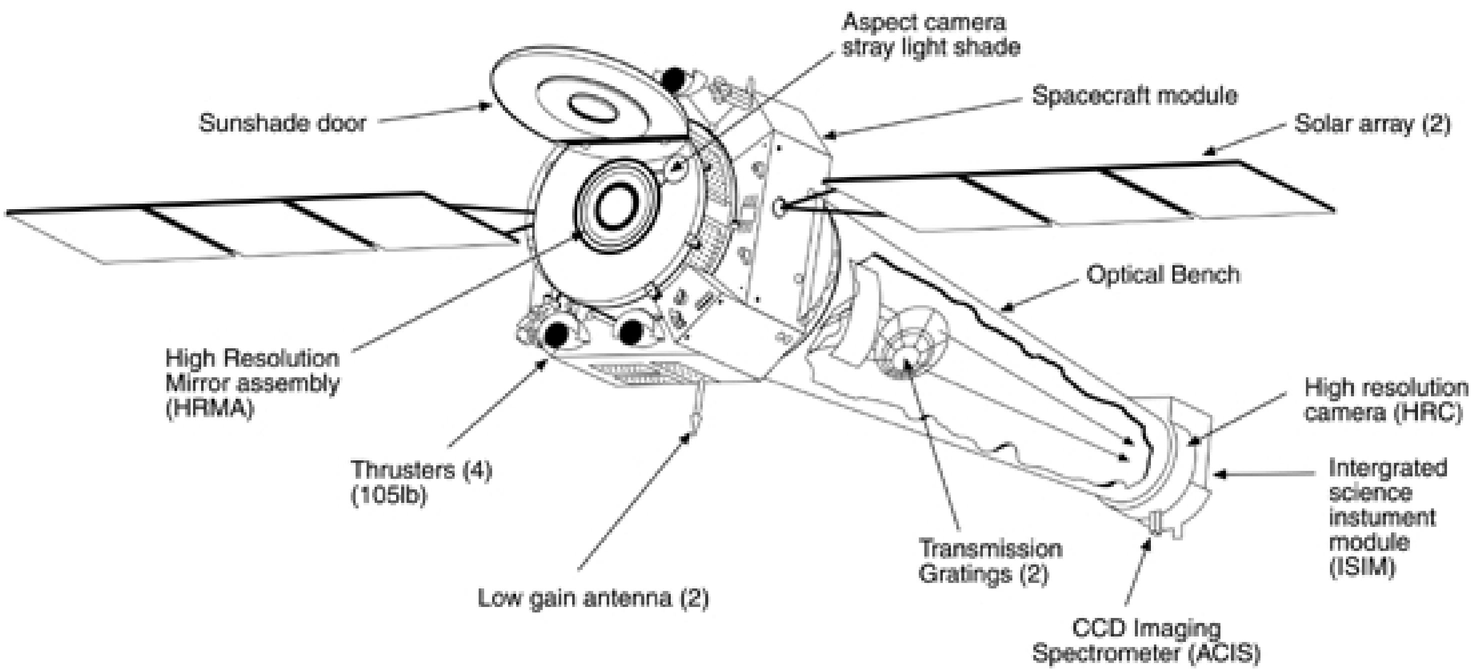
Observatory
The Chandra X-Ray Observatory is composed of three major assemblies: the spacecraft, telescope and science instrument module.

The Spacecraft
The spacecraft module contains computers, communication antennas and data recorders to transmit and receive information between the observatory and ground stations. The on-board computers and sensors - with ground-based control center assistance - command and control the observatory and monitor its health during its expected five-year lifetime.

The spacecraft module also provides rocket propulsion to move and aim the entire observatory. It contains an aspect camera that tells the observatory its position and orientation relative to the stars, and a Sun sensor that protects it from excessive light. Two three-panel solar arrays provide the observatory with 2,350 watts of electrical power and charge three nickel-hydrogen batteries that provide backup power.

The Telescope System

At the heart of the telescope system is the high-resolution mirror assembly. Since high-energy X-Rays would penetrate a normal mirror, special cylindrical mirrors were created. The two sets of four nested mirrors resemble tubes within tubes. Incoming X-Rays will graze off the highly polished mirror surfaces and be funneled to the instrument section for detection and study.



The mirrors of the X-Ray observatory are the largest of their kind and the smoothest ever created. If the state of Colorado were the same relative smoothness, Pike's Peak would be less than one inch tall. The largest of the eight mirrors is almost four feet in diameter and three feet long. Assembled, the mirror group weighs more than one ton.

The High-Resolution Mirror Assembly is contained in the cylindrical "telescope" portion of the observatory. The entire length of the telescope is covered with reflective multi-layer insulation that will assist heating elements inside the unit in keeping a constant internal temperature. By maintaining a precise temperature, the mirrors within the telescope will not be subjected to expansion and contraction - thus ensuring greater accuracy in observations.

The assembled mirrors were tested at the Marshall Center's world-class X-Ray Calibration Facility. The calibration facility verified the observatory can differentiate between objects separated by one-half arc second. This is equivalent to being able to read the letters on a stop sign from 12 miles away.

The Chandra X-Ray Observatory represents a scientific leap in ability over early X-Ray missions. With its combination of large mirror area, accurate alignment and efficient X-Ray detectors, Chandra has eight times greater resolution and is 20-to-50 times more sensitive than any previous X-Ray telescope. By seeing X-Rays rather than visible light, Chandra will examine the extremely hot and violent universe. In comparison, NASA's Hubble Space Telescope looks at visible and ultraviolet light.

Science Instruments

Within the instrument section of the observatory, two instruments at the narrow end of the telescope cylinder will collect X-Rays for study. Each instrument can serve as an imager to "take pictures," or a spectrometer, a device to measure energy levels.

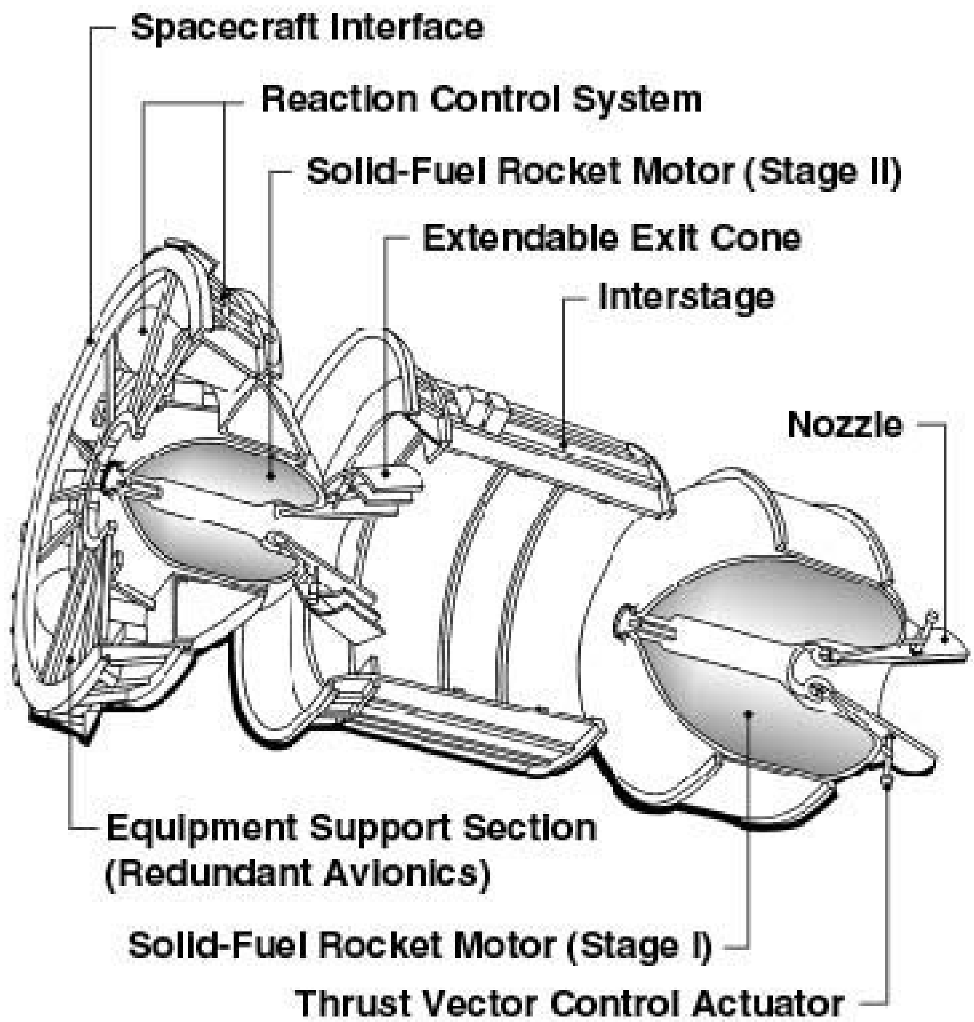
The High-Resolution Camera will record X-Ray images, giving scientists an unequaled look at violent, high-temperature occurrences like the death of stars or colliding galaxies. The High-Resolution Camera is composed of two clusters of 69 million tiny lead-oxide glass tubes. The tubes are only one-twentieth of an inch long and just one-eighth the thickness of a human hair. When X-Rays strike the tubes, particles called electrons are released. As the electrons accelerate down the tubes - driven by high voltage - they cause an avalanche of about 30 million more electrons. A grid of electrically charged wires at the end of the tube assembly detects this flood of particles and allows the position of the original X-Ray to be precisely determined. By electronically determining the entry point of the original X-Ray, the camera can reproduce a high-resolution image of the object that produced the X-Rays. The High-Resolution Camera will complement the Charge-Coupled Device Imaging Spectrometer, also contained in the science instrument module.

The AXAF CCD Imaging Spectrometer (ACIS) is capable of recording not only the position, but also the color, or energy, of the X-Rays. The ACIS is made up of 10 charge-coupled device arrays. These detectors are similar to those used in home video recorders and digital cameras, but are designed to detect X-Rays. The ACIS can distinguish up to 50 different energies within the range that the observatory operates. In order to gain even more energy information, two screen-like instruments - called diffraction gratings - can be inserted into the path of the X-Rays between the telescope and the detectors. The gratings change the path of the X-Ray depending on its energy and the X-Ray cameras record the color and position. One grating concentrates on the higher and medium energies and uses the imaging spectrometer as a detector. The other grating disperses low energies and is used in conjunction with the High Resolution Camera. Commands from the ground allow astronomers to select which grating to use.

By studying these X-Ray rainbows, or spectra, and recognizing signatures of known elements, scientists can determine the composition of the X-Ray producing objects, and learn how the X-Rays are produced.

Inertial Upper Stage

On STS-93, the Inertial Upper Stage will help propel the Chandra X-Ray Observatory from low Earth orbit into an elliptical orbit reaching one-third of the way to the Moon.



The Inertial Upper Stage is a two stage, inertially guided, three-axis stabilized, solid fuel booster used to place spacecraft into a high-Earth orbit or boost them away from the Earth on interplanetary missions. It is approximately 17 feet long and 9.25 feet in diameter, with an overall weight of approximately 32,500 pounds.

The Inertial Upper Stage first stage is comprised of a solid rocket motor and an interstage. The first stage solid rocket motor normally contains a maximum 21,580 pounds of propellant and generates an average of 44,000 pounds of thrust. For the Chandra mission, the first stage solid rocket motor propellant weight will be only 19,621 pounds due to weight constraints for the Shuttle. However, by adjusting the exhaust

nozzle on the motor, the average thrust will be increased to 46,198 pounds and the burn time will be 125 seconds.
The second stage consists of an equipment support section and a solid rocket motor. The second stage solid rocket motor has a normal maximum load of 6,000 pounds of propellant generating an average thrust of about 18,200 pounds. The Chandra mission will carry an additional 16 pounds of propellant at a reduced average thrust of 16,350 pounds. The second stage will fire for about 117 seconds.

The equipment support section houses the avionics systems of the Inertial Upper Stage. These systems provide guidance, navigation, control, telemetry, command and data management, reaction control and electrical power. All vital components of the avionics system, along with thrust vector actuators, reaction control thrusters, motor igniter and pyrotechnic stage separation equipment have backups. Once deployed from the Shuttle, the Inertial Upper Stage's computers will send commands to the Chandra X-Ray Observatory. Until spacecraft separation, these commands will assist Chandra in controlling power, safety systems, recorders, propulsion and heaters.

Shuttle Flights Carrying an IUS

MISSION	PAYLOAD	DATE
STS-6	TDRS-A	4/4/83
STS-51J	DSCS III/III	10/3/85
STS-51L	TDRS B	1/28/86
STS-26	TDRS-C	9/29/88
STS-29	TDRS D	3/13/89
STS-30	Magellan	4/4/89
STS-34	Galileo	10/18/89
STS-41	Ulysses	10/6/90
STS-43	TDRS E	8/2/91
STS-44	DSP	11/24/91
STS-54	TDRS F	1/13/93
STS-70	TDRS-G	7/13/95

Airborne Support Equipment
The Inertial Upper Stage and attached Chandra Observatory use airborne support equipment installed in the Shuttle to operate and deploy into space. The Airborne Support Equipment consists of mechanical, avionics and structural equipment located in the orbiter. The structural and mechanical equipment attaches the Inertial Upper Stage and the payload to the orbiter payload bay and provides the mechanisms to elevate the

Inertial Upper Stage and the payload and deploy it from the Shuttle. The Airborne Support Equipment avionics provides command and information transfer between the Upper Stage and the Shuttle during payload checkout.

History/Background

Launch, Activation and Checkout

The Chandra X-Ray Observatory, attached to its Inertial Upper Stage will ride into space in the Space Shuttle payload bay. Once on orbit, the Shuttle crew will activate the spacecraft power system, and controllers at the Chandra X-Ray Observatory Control Center in Cambridge, MA, will begin activating and checking out key observatory systems.

Chandra controllers will activate and check out the observatory's computers, activate heaters to control the temperature of observatory systems and initiate venting of Chandra's imaging spectrometer. Controllers will also test the system that will place Chandra in a safe mode should an anomaly occur after deployment and test communications links between the observatory and the ground through Chandra's upper antenna.

Approximately five-and-a-half hours after launch, the Shuttle crew will tilt the Chandra and its Inertial Upper Stage up to 29 degrees. Chandra controllers will then check radio communications links between the observatory and the ground through Chandra's lower antenna.
Following initial activation and checkout of Chandra by the Operations Control Center, the Columbia crew will configure the Inertial Upper Stage for deployment, disconnect umbilicals between the orbiter and payload, and raise the payload to its deployment attitude of 58 degrees above the payload bay.

The crew will then deploy the observatory and its upper stage a little over seven hours after launch before maneuvering the Shuttle to a safe distance from Chandra.

About an hour later, under the watchful eye of controllers at Onizuka Air Force Base, in Sunnyvale, CA, the Inertial Upper Stage will fire its first stage solid rocket motor for about two minutes, then coast through space for about two minutes more. The first stage will separate, and the second stage will fire for almost two additional minutes. This will place the observatory into a temporary, or transitional, elliptical orbit peaking at 37,200 miles above the Earth and approaching the Earth to within 174 miles.

Chandra's twin solar arrays will then be unfolded, allowing Chandra to begin converting sunlight into 2,350 watts of electrical power to run the observatory's equipment and charge its batteries.

Next, the Inertial Upper Stage will separate from the observatory and Chandra's own propulsion system will gradually move the observatory to its final working orbit of approximately 6,214 by 86,992 miles in altitude. It will take approximately 10 days and five firings of Chandra's own propulsion system to reach its operating orbit.

Over the next two months, the observatory and its instruments will outgas, or vent, residual air and moisture trapped during its assembly on Earth, and controllers will begin the systematic process of turning on and checking out Chandra's science instruments and focusing the observatory, before it is fully commissioned to begin its five-year science mission.

Chandra Major Event Timeline

Activity	Time from launch	Time from IUS Separation
STS-93 Liftoff	00/00:00	
Activate Chandra Onboard Computers	00/02:54	
Chandra Upper Antenna Comm Check	00/03:15	
Chandra Lower Antenna Comm Check	00/05:50	
Chandra/IUS Deploy	00/07/17	
Inertial Upper Stage Burns 1 & 2	00/08:17	
Solar Array Deploy	00/08:46	
Inertial Upper Stage /Chandra Separation	00/09:18	00/00:00
Imaging Spectrometer (ACIS) Power-on	00/17:18	00/08:00
High Resolution Camera (HRC) Power-on	00/18:48	00/09:30
Integral Propulsion System Burn 1	01/21:52	01/12:34
Integral Propulsion System Burn 2	02/23:11	02/13:53
EPHIN Commissioning Sequence Begins	03/02:18	02/17:00
ACIS Checkouts Begin	04/18:48	04/09:30
Shuttle Lands	04/22:56	04/13:49
HRC Door Open		05/02:00
Integral Propulsion System Burn 3		06/10:24
HRC Checkouts Begin		06/17:30
Integral Propulsion System Burn 4		07/16:36
Integral Propulsion System Burn 5		10/07:28
Aspect Camera Activation		10/13:00
ACIS Door Opening Sequence		Day 12
Deactivate Integral Propulsionstem		Day 17
Sunshade Door Open		Day 21
Science Instruments Focus & Calibration Observations Begin		Day 24
High Energy Transmission Grating (HETG) Launch Locks Released		Day 29
Low Energy Transmission Gratin (LETG) Launch Locks Released		Day 37

NOTE: All Chandra event times after IUS separation are approximate.

Chandra's Orbital Profile

Unlike the close-to-Earth, circular orbit of the Hubble Space Telescope, the final orbit of the Chandra X-Ray Observatory will be highly elliptical. At its closest approach to Earth, the observatory will be at an altitude of about 6,200 miles. At its farthest, 87,000 miles, it will travel almost one-third of the way to the Moon. Due to this elliptical orbit, the observatory will circle the Earth every 64 hours, carrying it far outside the belts of radiation that surround our planet. This will allow for 55 hours of uninterrupted observations during each orbit. The radiation, while harmless to life on Earth, could overwhelm the observatory's sensitive instruments. To prevent interference or damage to its instruments, scientific observations will not be taken during periods of interference from Earth's radiation belts.

Observatory Operations

The Smithsonian Astrophysical Observatory in Cambridge, MA, will control science and flight operations of the Chandra X-Ray Observatory under contract to NASA's Marshall Center. The Smithsonian manages Chandra operations through two electronically linked facilities, known collectively as the Chandra X-Ray Observatory Center. The Operations Control Center is located in Kendall Square, and the Science Center is located at the Harvard-Smithsonian Center for Astrophysics on the campus of Harvard University.

The Operations Control Center will be responsible for directing the observatory's mission as it orbits Earth. Commands for executing the observatory plan will be transmitted from the control center to one of three ground stations (in Spain, Australia, or California) that make up NASA's Deep Space Network. The Deep Space Network will relay the commands to the orbiting spacecraft. The spacecraft will carry out the commands by pointing the telescope to the specified targets, and moving the science instruments and gratings in and out of the focus area of the Chandra mirrors.

During launch and on-orbit activation, the control center will be staffed around-the clock by controllers and managers from the Smithsonian, the Marshall Center, and Chandra's prime contractor, TRW. During this period, the center will remain in almost constant communication with the spacecraft.

Once operational, a Smithsonian control center team will interact with the observatory three times a day by receiving science and housekeeping information from its recorders. The team also will send new instructions to the observatory as needed, as well as transmit scientific information from the X-Ray observatory to the Chandra Science Center.

The science center is an important resource for scientists and the public. It will provide researchers with user support that includes science data processing and a science data archive. Other members of the support center team work with NASA and the scientific community to inform the public of discoveries made by scientists using the observatory.

Scientific observations will begin approximately two months after launch. The next three to four months are set aside for Guaranteed Time Observers. They are the telescope scientist, the principal investigators of the teams that built the scientific instruments, and six interdisciplinary scientists chosen in a NASA peer review competition. Seventy percent of the remaining observing time during the first year will be reserved for General Observers. Two hundred General Observer proposals were selected from 800 submissions in a competitive peer review process. About 400 astronomical targets will be observed in the first year

Program History

The Chandra X-Ray Observatory - originally known as the Advanced X-Ray Astrophysics Facility - was initially envisioned as a Space Shuttle-serviceable observatory in low Earth orbit similar to NASA's Hubble Space Telescope. Necessary mirror and instrument technologies were demonstrated in the late 1980s and plans were being made for construction.

In 1992 the observatory was restructured into a less costly program that eliminated on-orbit maintenance and simplified construction.

July 1995 - Grinding and polishing of Chandra's mirrors completed by Raytheon Optical Systems Inc., Danbury, CT.

February 1996 - Coating of the mirrors completed by Optical Coating Laboratory, Inc., Santa Rosa, CA.

December 1996 - Assembly of the mirrors completed by Eastman Kodak Co., Rochester, NY.

March 1997 - Mirror testing and calibration completed at NASA's Marshall Space Flight Center in Huntsville, AL.

May 1997 - Science instrument testing and calibration completed at NASA's Marshall Space Flight Center in Huntsville, AL.

September 1997 - Chandra Operations Control Center opens in Cambridge, MA.

March 1998 - Observatory assembly completed at TRW Space and Electronics Group, Redondo Beach, CA.

July 1998 - Thermal Vacuum Testing was completed at TRW.

December 1998 - Observatory renamed in honor of Indian-American Nobel Laureate Dr. Subrahmanyan Chandrasekhar.

Feb. 4, 1999 - Chandra shipped from TRW to the Kennedy Space Center, FL.

June 2, 1999 - Chandra mated to Inertial Upper Stage at the Kennedy Space Center.

June 18, 1999 - Chandra installed in transportation canister for transfer to the launch pad.

Benefits

Science Program

X-Rays are an invisible form of high-energy light. They are produced in the cosmos when gas is heated to millions of degrees by violent and extreme conditions. Much of the matter in the universe is so hot that it can be observed only with X-Ray telescopes. Flaring stars, exploding stars, black holes, and galaxy clusters, the most massive objects in the universe, are among the many fascinating cosmic phenomena that Chandra X-Ray Observatory is designed to study.

Images from Chandra will show up to fifty times more detail than any previous X-Ray telescope. It is a revolutionary telescope that combines the ability to make sharp images while it measures precisely the energies of X-Rays coming from cosmic sources.

SUPERFLARES, SUPERNOVAE & THE BUILDING BLOCKS FOR LIFE

Observations with Chandra will help scientists better understand the conditions that produce planets and life. Chandra's observations of superflares from young stars will give scientists a better idea of what conditions were like on Earth when the sun was young. Superflares are thousands of times more intense than the largest solar flare ever observed.

The Earth is composed primarily of heavy elements such as carbon, nitrogen, oxygen, silicon and iron. These elements, many of which are necessary for life, are created in the interior of massive stars. Eventually, they are spread throughout space when a massive star runs out of fuel and undergoes a catastrophic explosion called a supernova.

The shell of matter thrown off by the supernova creates a bubble of multimillion degree gas called a supernova remnant. This hot gas will expand and produce X-radiation for thousands of years. Chandra X-Ray Observatory images will trace the dynamics of the expanding remnant.

When heavy elements present in the hot gas are heated to high temperatures, they produce X-Rays of specific energies. Chandra detectors will precisely measure the energies of these X-Rays and tell how much of each element is present. These X-Ray "color" pictures will reveal the amounts of heavy elements that have been blown off by these stars. They could verify theories for the source of the heavy elements necessary for Earth-like planets and life.

BLACK HOLES & QUASARS

Some of the most intense X-Ray sources in the universe are caused by super-hot gas that is swirling toward a black hole. As the tremendous gravity of a black hole pulls gas and dust particles toward it, the particles speed up and form a rapidly rotating flattened disk. Friction caused by collisions between the particles heats them and they produce X-Rays as their temperatures rise to many millions of degrees.

By accurately determining the energy of individual X-Rays, the Chandra X-Ray Observatory can measure the motion of particles near the event horizon of black holes. This information will allow scientists to test theories about the gravity fields around black holes.

Astrophysicists have proposed that supermassive black holes may explain the mysterious and powerful objects called quasars. These objects radiate as much energy per second as a thousand normal galaxies from a region having a diameter less than a millionth of the size of one galaxy. Because the matter closest to the event horizon of a black hole radiates most of its energy as X-Rays and gamma rays, Chandra will present an unequaled view into the inner workings of these violent cosmic whirlpools.

One of the most intriguing features of supermassive black holes is that they do not suck up all the matter that falls within their sphere of influence. Some of the matter falls inexorably toward the black hole, and some explodes away from the black hole in high-energy jets that move at near the speed of light. Chandra will give new insight into the nature of these enigmatic cosmic jets.

GALAXY CLUSTERS, DARK MATTER & THE UNIVERSE

More than half of all galaxies in the universe are members of groups of galaxies or larger collections of galaxies, called clusters. X-Ray observations have shown that most clusters of galaxies are filled with vast clouds of multimillion degree gas. The mass of this gas is greater than all the stars in all the galaxies in a cluster of a thousand galaxies. Galaxy clusters are the largest and most massive gravitationally bound objects in the universe.

Chandra images of galaxy clusters should significantly advance our understanding of the nature and evolution of the universe in a number of ways.

The X-Ray producing hot gas found in a typical cluster of galaxies presents astronomers with a grand puzzle. Over time this extremely hot gas should escape the cluster since the galaxies and gas do not provide enough gravity to hold it in. Yet the gas remains in clusters of all ages. Scientists have concluded that some unobserved form of matter, called dark matter, is providing the gravity needed to hold the hot gas in the cluster. An enormous amount of dark matter is needed- about three to ten times as much matter as that observed in the gas and galaxies. This means that most of the matter in the universe may be dark matter.

The dark matter could be collapsed stars, planet-like objects, black holes, or exotic subatomic particles that produce no light, and can only be detected through their gravity. Detailed measurements of the size and temperature of the hot gas clouds in galaxy clusters by Chandra X-Ray Observatory could help solve the dark matter mystery.

When combined with observations from microwave telescopes, Chandra images of clusters can be used to measure the distance to the clusters. This distance measurement will give astronomers an independent measurement of the size and age of the universe to compare with measurements made with optical telescopes.

Giant galaxy clusters are formed through the merger of smaller groups and clusters over billions of years. Chandra images will show shock waves produced by these awesome energetic collisions. Estimates of the epoch when clusters were formed in the universe differ greatly, depending on the theory that is adopted. If Chandra discovers massive clusters at great distances, it would challenge theories for the origin and evolution of the universe.

NASA and its Partners

The Chandra X-Ray Observatory program is managed by the Marshall Space Flight Center for the Office of Space Science, NASA Headquarters, Washington, DC. TRW Space and Electronics Group of Redondo Beach, CA, is the prime contractor and has assembled and tested the observatory for NASA. Using glass purchased from Schott Glaswerke, Mainz, Germany, the telescope's mirrors were built by Raytheon Optical Systems Inc., Danbury, CT. The mirrors were coated by Optical Coating Laboratory, Inc., Santa Rosa, CA, and assembled by Eastman Kodak Co., Rochester, NY.

The Chandra X-Ray Observatory Charge-Coupled Device Imaging Spectrometer was developed by Pennsylvania State University, University Park, PA, and the Massachusetts Institute of Technology (MIT), Cambridge. One diffraction grating was developed by MIT, the other by the Space Research Organization Netherlands, Utrecht, Netherlands, in collaboration with the Max Planck Institute, Garching, Germany. The High Resolution Camera was built by the Smithsonian Astrophysical Observatory. Ball Aerospace & Technologies Corporation of Boulder, CO, developed the aspect camera and the Science Instrument Module.

The Smithsonian Astrophysical Observatory in Cambridge, MA will control science and flight operations. Communications and data links with Chandra will be provided by

NASA's Jet Propulsion Laboratory, Pasadena, CA, through the Deep Space Network.

Chandra at a Glance

Mission Duration

Chandra science mission	Approx. 5 yrs
Orbital Activation & Checkout period	Approx. 2 mos

Orbital Data

Inclination	28.5 degrees
Altitude at apogee	86,992 sm
Altitude at perigee	6,214 sm
Orbital period	64 hrs
Observing time per orbital period	Up to 55 hrs

Dimensions

Length - (Sun shade open)	45.3'
Length - (Sun shade closed)	38.7'
Width - (Solar arrays deployed)	64.0'
Width - (Solar arrays stowed)	14.0'

Weights

Dry	10,560 lbs
Propellant	2,153 lbs
Pressurant	10 lbs
Total at launch	12,930 lbs

Integral Propulsion System

Liquid Apogee Engines	4 engines (Only two used at a time)
Fuel	Hydrazine
Oxidizer	Nitrogen tetroxide
Thrust per engine	105 lbs

Electrical Power

Solar Arrays	2 arrays>3 panels each
Power generated	2,350 watts
Electrical power storage	3 batteries 40-ampre-hour nickel hydrogen

Communications

Antennas	2 low-gain antennas
Communication links	Shuttle Payload Interrogator Deep Space Network
Command link	2 kbs per second
Data downlink	32 kbs to 1024 kbs

On-board Data Capture

Method	Solid-state recorder
Capacity	1.8 gbs 16.8 hrs

High Resolution Mirror Assembly

Configuration	4 sets of nested, grazing incidence paraboloid/hyperboloid mirror pairs
Mirror Weight	2,093 lbs
Focal length	33 ft
Outer diameter	4 ft
Length	33.5 in
Material	Zerodur

Coating	600 angstroms of iridium

Attitude Control & Pointing

Reaction wheels	6
Inertial reference units	2
Aspect camera	1.40 deg x 1.40 deg fov

Science Instruments

Charged Coupled Imaging Spectrometer (ACIS)
High Resolution Camera (HRC)
High Energy Transmission Grating (HETG)
Low Energy Transmission Grating (LETG)

IUS

Dimensions

Length	17.0'
Diameter	9.25'

Weights

Stage 1 - Dry	2,566 lbs
Stage 1 - Propellant	19,621 lbs
Stage 1 - Total	22,187 lbs
Stage 2 - Dry	2,379 lbs
Stage 2 - Propellant	6,016 lbs
Stage 2 - Total	8,395 lbs
Total Inertial Upper Stage - At launch	30,582 lbs

Performance

Thrust - Stage 1	46,198 lbs, average
Burn Duration - Stage 1	125 seconds
Thrust - Stage 2	16,350 lbs, average
Burn Duration - Stage 2	117 seconds

Support Equipment Weights

Airborne Support Equipment	5,365 lbs
Other	1,285 lbs
Total Support Equipment	6,650 lbs

Total Payload Weight

Total Chandra/IUS/Support equipment at liftoff	50,162 lbs

Length

Total IUS/Chandra	57.0'

Did you know?

The Chandra X-Ray Observatory is the world's most powerful X-Ray telescope. It has eight times greater resolution and will be able to detect sources more than 20 times fainter than any previous X-Ray telescope.

The Chandra X-Ray Observatory, with its Inertial Upper Stage and support equipment is the largest and heaviest payload ever launched by the Space Shuttle.

The Chandra X-Ray Observatory's operating orbit will take it 200 times higher than the Hubble Space Telescope. Each orbit Chandra will travel one-third of the way to the moon.

The Chandra X-Ray Observatory's resolving power is equal to the ability to read the letters of a stop sign at a distance of 12 miles.

If the State of Colorado were as smooth as the surface of the Chandra X-Ray Observatory mirrors, Pike's Peak would be less than an inch tall.

Another of NASA's incredible time machines, the Chandra X-Ray Observatory will be able to study some quasars as they were 10 billion years ago.

The Chandra X-Ray Observatory will observe X-Rays from clouds of gas so vast that it takes light more than five million years to go from one side to the other.

Although nothing can escape the incredible gravity of a black hole, not even light, the Chandra X-Ray Observatory will be able to study particles up to the last millisecond before they are sucked inside.

Payloads

STS-93

Commercial Generic Bioprocessing Apparatus

In-Cabin

Prime: Michel Tognini

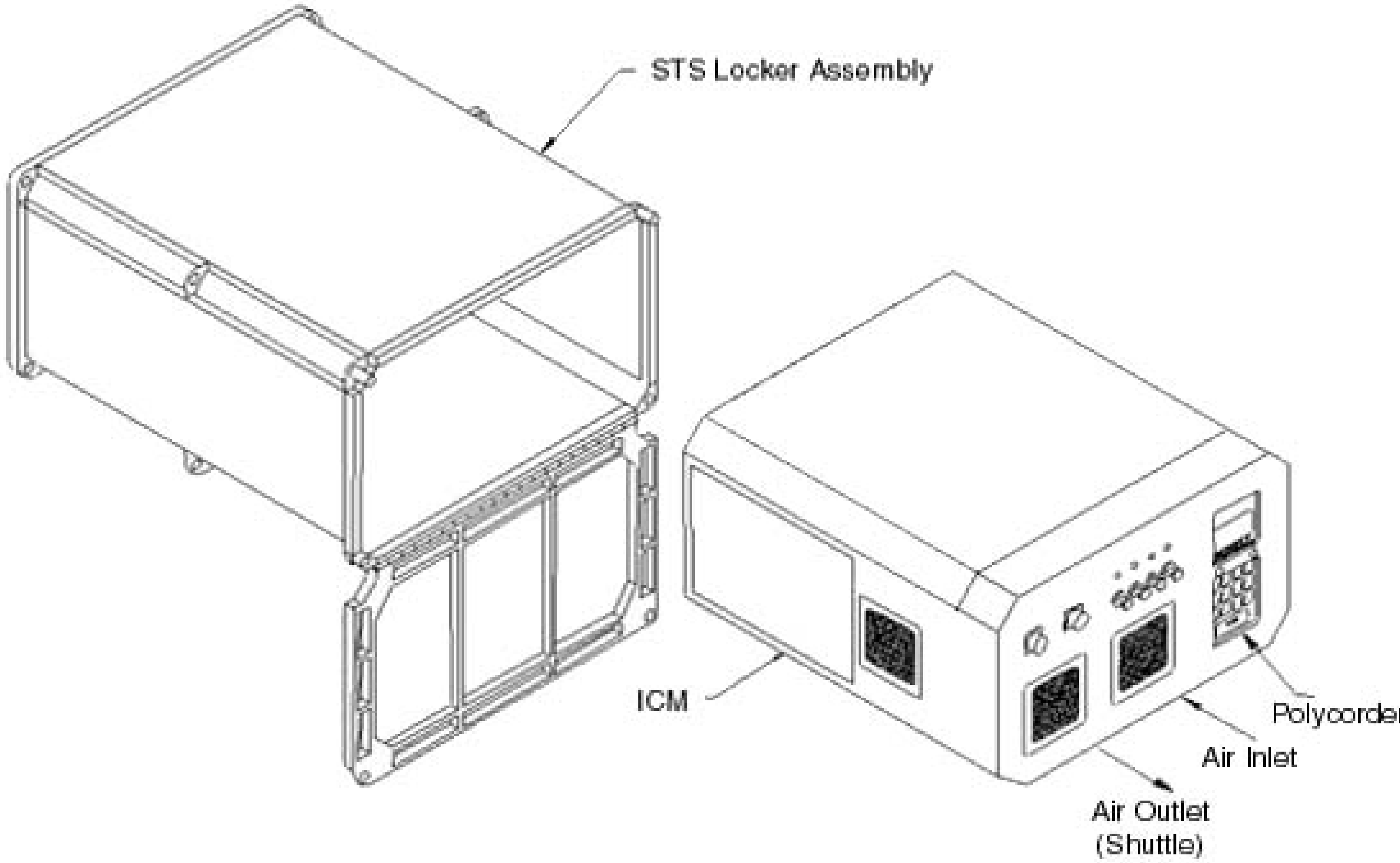
Principal Investigator: Dr. Louis Stodieck of BioServe Space Technologies, Boulder, Colo.

Backup: Steven Hawley

Overview

The CGBA payload hardware performs two functions: automated processing of biological samples and stowage in a thermally controlled environment. The generic bioprocessing apparatus (GBA) occupies a single middeck locker space and requires 28 volts dc. Stowage is mission specific. Temperature-controlled stowage is provided by the isothermal containment module (ICM), a middeck locker apparatus requiring 28 Vdc.

There are four CGBA configurations consisting of different combinations of hardware: Configuration A consists of the GBA module plus ICM and middeck stowage locker, Configuration B consists of the GBA module plus ICM, and Configuration C consists of the GBA module plus middeck stowage locker. The ICM and/or locker accommodates stowage of biological samples before and after processing in the GBA. Configuration D consists of three GBA-ICM units.



The GBA module is a self-contained mixing and heating module used to process biological fluid samples in microgravity. Up to 120 triple-contained glass syringe fluid samples (in Lexan sheaths) are stored in either the ICM or a middeck locker. These fluids are manually mixed within the syringe and transferred to a sample containment vial that is heated and incubated. At the end of the incubation period, the fluid vials are returned to the ICM or stowage locker.

The ICM maintains a preset temperature environment, controls the activation and termination of the experiment samples, and serves as an interface for crew interaction, control, and data transfer. This incubation/refrigeration module is a lightweight aluminum/insulation-clad structure. The front portion of the housing contains the electronics, thermal, and crew interface subsystems. The rear portion is the isolated, temperature-controlled area that houses the experiment sample containers, e.g., standard GSPs, T-GAPs, auto-GAPs, illuminated culture vessels, or cameras. Each ICM can be fitted with an internal light source. The fluid cooling/heating loops embedded between the aluminum casing and the foam insulation are used to maintain accurate preset temperatures.

For STS-93, the CGBA payload will be flown in Configuration D, which includes three ICM units. One of the three ICM lockers will contain industry-sponsored research projects. The commercial objective in each case is to explore how the altered behavior of a biological process observed in space might be developed into an improved application or new product that will benefit U.S. industry and, as a result,ultimately improve the quality of life for the general public. The four CGBA projects to be flown on STS-93 are summarized below:

Water Purification: Bacterial growth tends to be more difficult to control in space. From data collected in space environments, researchers are exploring methods for improving water purification processes on Earth. Applications for this technology range from small devices designed for backpacking to municipal water treatment facilities. This CGBA project (conducted by Water Technologies Corporation WTC-Ecomasters, Inc., of West St. Paul, Minn.) is focused on developing new water purification resins to combat microorganisms that are becoming resistant to iodine.

Pharmaceutical Screening: The recruitment of leukocytes, or white blood cells, from the blood is critical in fighting infection. Space flight has been shown to suppress the immune system, and studies have identified at least two aspects of leukocyte recruitment that may contribute to this phenomenon. The objective of this experiment is to characterize leukocyte adhesion in microgravity. This research (conducted by Ligocyte Pharmaceuticals, Inc., of Bozeman, Mont.) may lead to improved pharmaceutical products to treat stress-induced immunosuppression and help prevent the undesirable side effects of current broad-spectrum corticosteroid treatment.

Taxol Production: By producing the anti-cancer drug, Taxol, in the near weightlessness of space, researchers may learn how to improve drug production facilities on Earth. This experiment will explore new compounds that begin cell culture production of Taxol, which could result in more efficient proudction techniques and lower costs for consumers. This research is conducted by EnviroGen, Inc., of Ft. Collins, Colo.

Dynamic Control of Protein Crystallization: Protein crystals, which are of much higher quality when grown in the weightlessness of space, are used to design drugs based on molecular structural analysis. A small entrepreneur (BioSpace International, Inc., of College Park, Md.) is investigating methods to further enhance the quality of space-grown crystals by actively monitoring and controlling the surrounding chemical environment.

Biomacromolecule Crystallization: Protein crystals grown in space may enable researchers to develop new drugs. The higher quality crystals with better three-dimensional structure grown in space may help commercial researchers determine the medical utility of experimental products, such as artificial replacement blood, before costly clinical trials begin. Baxter Hemoglobin Pharmaceuticals of Boulder, Colo., is conducting this experiment.

Two more CGBA ICM lockers to be flown on STS-93 will support science and educational research projects:

NIH.B.1 is an experiment designed to investigate the effects of space flight on neural development in Drosophila melanogaster (fruit fly) larvae. This information may help scientists understand how gravity affects nerve growth and development and how neural connections to muscle fibers work. The experiment is sponsored by the National Space Foundation (NSF) and NASA Ames Research Center; the principal investigator is from Yale University.

STARS-1 (Space Technology and Research for Students) will investigate the predator/prey relationship between ladybugs and aphids and the chrysalis and wing development of Painted Lady butterflies in space. Farmers may use this information to take advantage of natural pest control methods to protect their crops and avoid chemical pesticides that endanger produce, water, animals, and people. The project is cosponsored by CMAT along with SPACEHAB, Inc. A number of U.S. middle and high schools, one high school from Santiago, Chile, and an educational publisher called J. Weston Walch, are involved with the ladybug experiment. Albany High School's High-Tech program is performing the butterfly experiment.

The CGBA payload was modified to accommodate various special requirements for these collaborative projects, such as independent thermal control for eight different sample containers in the NIH.B.1 locker and real-time video image downlink of the STARS-1 samples.

History/Background

The CGBA payload was designed and built by BioServe faculty, staff, and students. BioServe is a NASA Center for Space Commercialization, jointly located at the Aerospace Engineering Sciences Department of the University of Colorado and the Department of Biology at Kansas State University.

Various configurations of CGBA have flown on 12 previous shuttle missions, beginning with STS-50 in 1992 and including two 4-month stays aboard the Russian Mir space station. Current CGBA technology is being advanced and refined for future operation on the International Space Station.

Benefits

The interdisciplinary nature of this research offers unique educational opportunities for undergraduate and graduate students. The goal of improving applications and developing new products benefits U.S. industry, enhances quality of life for the public, and propels the field of biotechnology into new frontiers.

Editorial/Technical Comments: ShuttlePresskit

Gelation of Sols: Applied Microgravity Research

In-Cabin

Prime: Cady Coleman
Backup: Michel Tognini

Overview

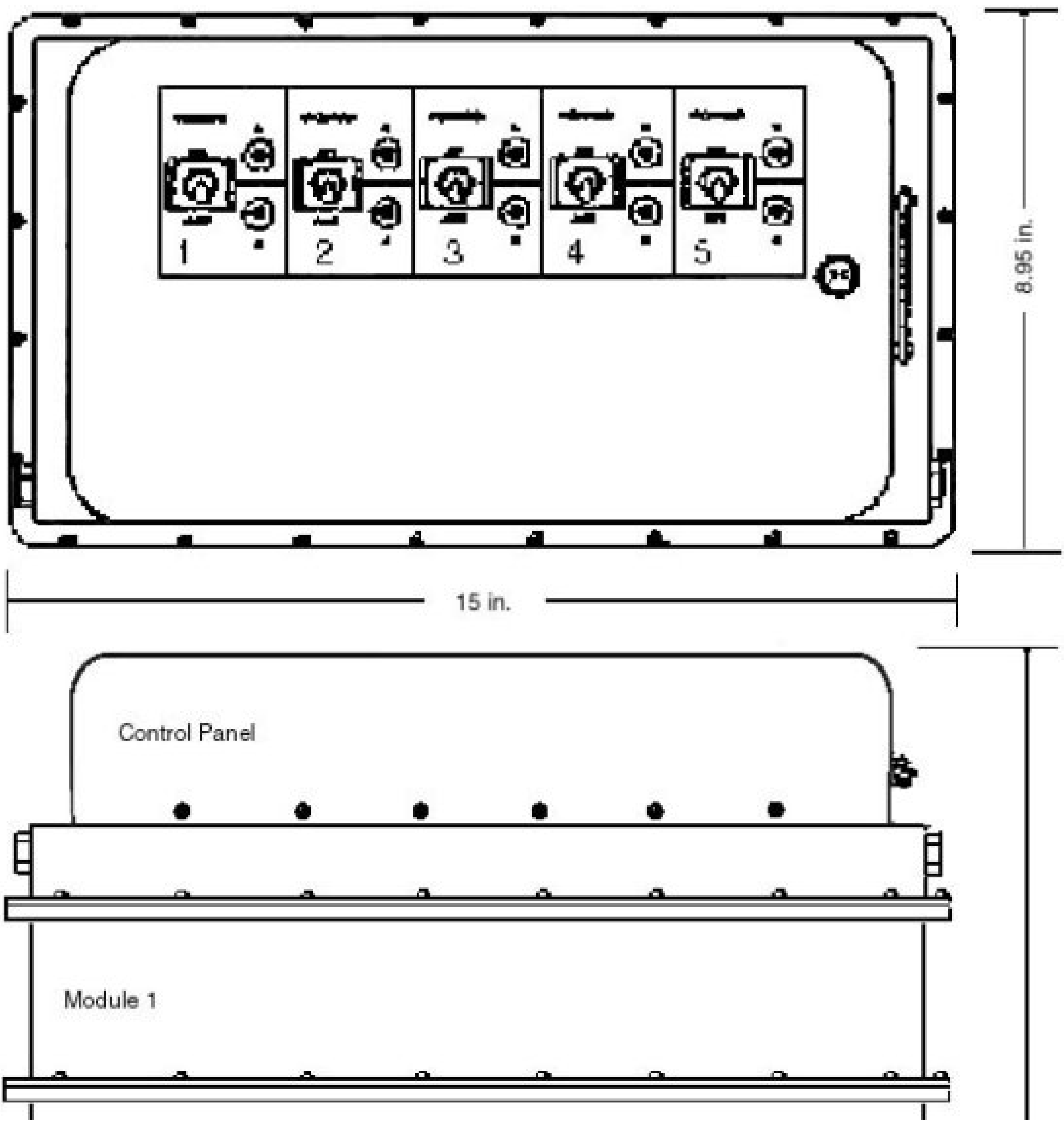
The Gelation of Sols: Applied Microgravity Research (GOSAMR) payload is a middeck materials processing experiment that will investigate the influence of microgravity on the processing of gelled sols--dispersions of solid particles in a liquid often referred to as colloids--which are used in the production of advanced ceramics materials. Stoke's law predicts that there will be more settling of the denser and larger-sized particulates in Earth's gravity as compared to the differentiation that should occur in a microgravity environment.

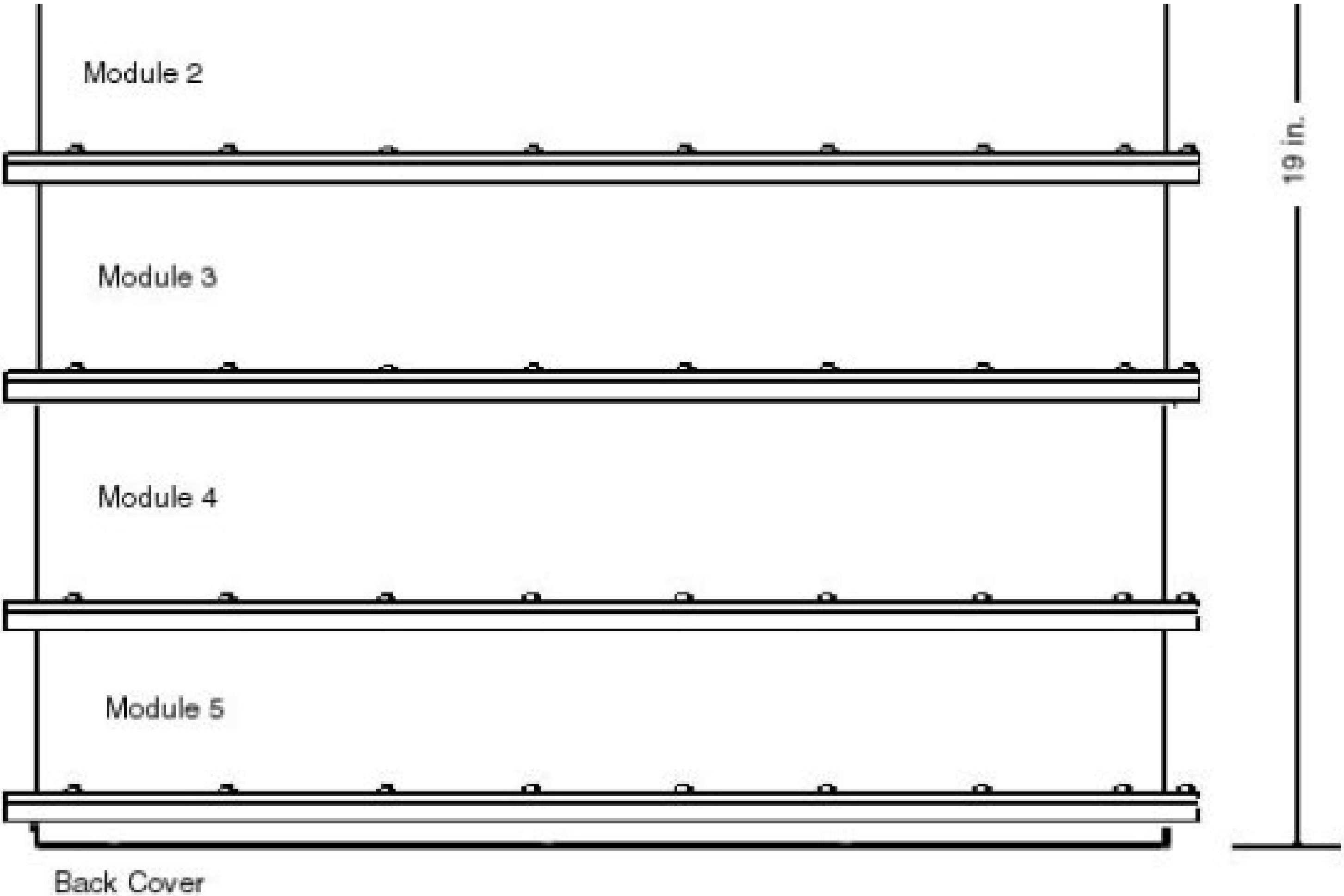
The GOSAMR experiment will attempt to form precursors for advanced ceramic materials by using chemical gelation (disrupting the stability of a sol and forming a semi-solid gel). These precursor gels will be returned to 3M Science Research Laboratories, dried, and fired to temperatures ranging from 900 to 2,900 degrees F to complete the fabrication of the ceramic composites. These composites will then be evaluated to determine if processing in space resulted in better structural uniformity and superior physical properties.

On STS-93, 50-100 samples (5 cc each) will be generated by varying the particle sizes and loadings, the length of gelation times, and the sol sizes. The chemical components will consist of either colloidal silica sols doped with diamond particles or colloidal alumina sols doped with zirconia particulates. Both sols will also be mixed with a gelling agent of aqueous ammonium acetate.

About a month before launch, the GOSAMR payload is prepacked into a middeck stowage locker and surrounded with half an inch of isolator material. The experiment contains an internal battery source and uses no power from the shuttle orbiter. The payload is designed to operate at ambient cabin temperature and pressure to ensure scientific success of the experiment, maintaining temperatures above 40 degrees F and below 120 degrees F at all times.

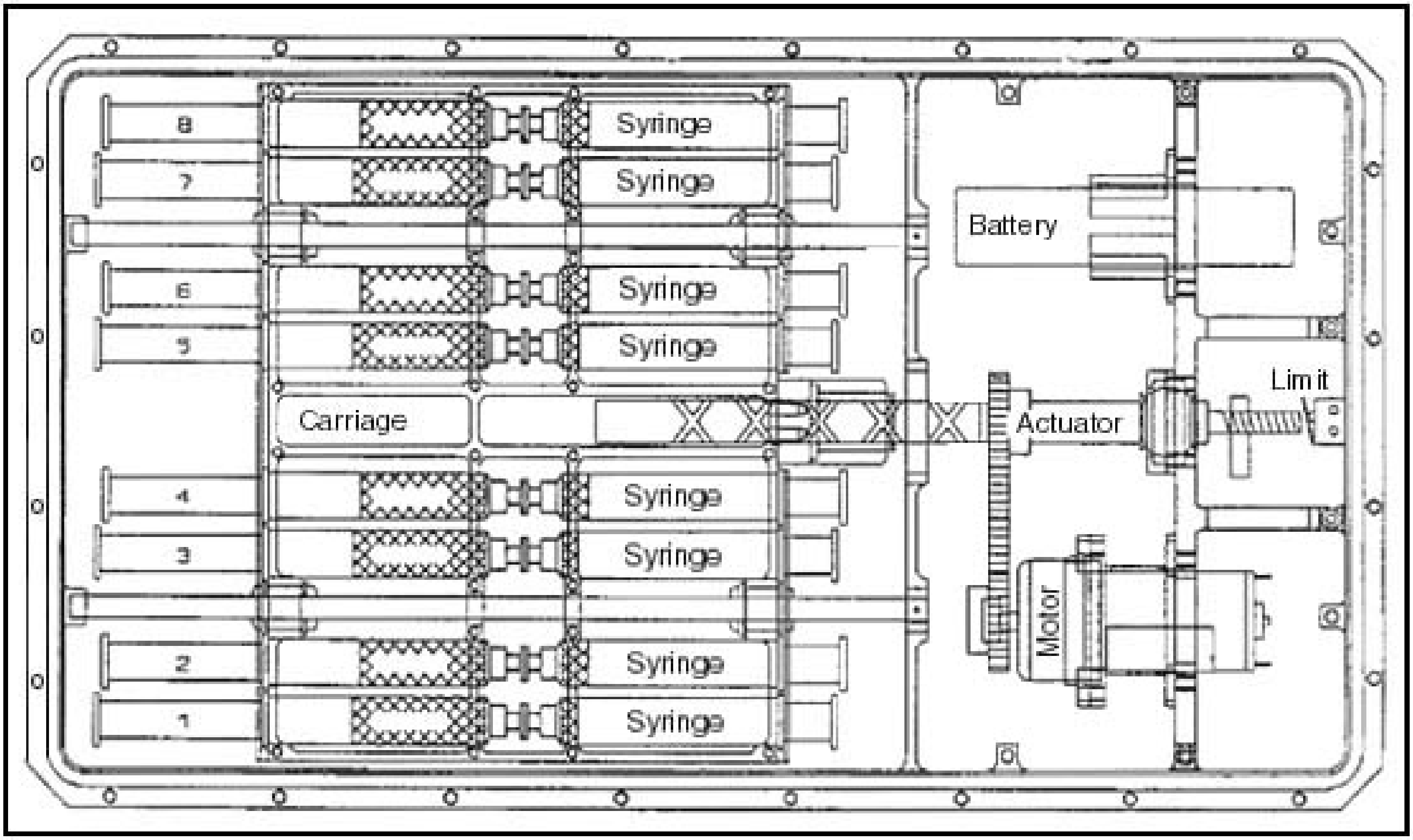
The GOSAMR container consists of a back cover, five identical and independent apparatus modules holding ten mixing systems, and a front cover. The modules and covers comprise a common sealed apparatus container that provides an outermost level of chemical containment. The front cover contains two ambient temperature-logging devices, two purge ports for venting and backfilling the container with inert gas, and the electrical feedthrough between the sealed apparatus and the control housing. The control housing at the front of the payload contains power switches for payload activation, indicator lights for payload status, and a test connector used during ground-based checkout. Once the payload is installed in the locker, the control housing will be the only portion of the payload accessible to the flight crew.





Each of GOSAMR's five modules has two mixing systems with eight double syringes (5 cc each) containing one of the two chemical components. Prior to on-orbit activation, the two components will be kept isolated from each other by a seal between the syringe couplers. The coupled syringes in each assembly will contain a gelling agent (either aqueous ammonium acetate or nitric acid) in one syringe and one of the two chemical components in the other.

Once on orbit, a crew member will sequentially activate the five power switches on the control housing. When the payload is activated, a pilot light for each module will be illuminated, indicating that mixing has begun and that the syringe-to-syringe seal has been broken. The sample mixing process for each system will last about 10 to 20 seconds; and once the mixing cycle is complete, an internal limit switch will automatically stop each mixing system.



The flight crew will monitor the experiment status by observing the control-housing indicator lights, which will be illuminated during the motor-driven mixing of each system. The pilot lights will be extinguished once the mixing is complete, and a crew member will deactivate each module. The payload will require no further crew interaction. However, physical changes in the samples will continue passively and unattended for a minimum of 24 hours in the microgravity environment. Total crew interaction will be less than 1 hour, and only during this period will the locker door be open.

After landing, the payload will be removed from the orbiter during normal destowage operations and resumed to 3M within 24 hours where postflight processing and analyses will be conducted on space- and ground-processed samples to ascertain the differences in physical structure and properties.

History/Background

The GOSAMR payload, flown under the sponsorship of a joint endeavor agreement between NASA's Office of Commercial Programs and 3M's Science Research Laboratories, St. Paul, Minn., involves chemical gelation to form precursors for advanced ceramics materials that may have a more uniform structure, finer grain size, and superior physical properties than similar materials produced on Earth. GOSAMR previously flew on STS-42 in January 1992.

Benefits

The potential commercial impact of GOSAMR-applied research on enhanced ceramic composite materials will be in the areas of abrasives and fracture-resistant materials. 3M currently sells film coated with diamond-loaded silica beads for polishing computer disk drive heads and VCR heads. Zirconia-toughened alumina is a premium performance abrasive grit and functions extremely well as a cutting tool for the machining of metals. The performance of these materials may be enhanced by improving their structural uniformity through processing in space.

Updated: 07/07/1999

Editorial/Technical Comments: ShuttlePresskit

Payloads

STS-93

Lightweight Flexible Solar Array Hinge

In-Cabin

Prime: Michel Tognini
Backup: Cady Coleman

Overview

The Lightweight Flexible Solar Array Hinge (LFSAH) consists of several hinges fabricated from shape-memory alloys, which allow controlled, shockless deployment of solar arrays and other spacecraft appendages. LFSAH will demonstrate the deployment capability of a number of hinge configurations on STS-93.

The experiment is contained in a single enclosure that requires 28-volt dc external power. The hinges are actuated by serial activation of front-panel switches. LFSAH operations are monitored and displayed on front-panel digital displays. Data are logged on a self-contained system and videotaped on a standard 8-mm camcorder.

Hinges are the primary mechanism used to deploy spacecraft solar arrays, which are folded and stowed for launch. Once the spacecraft is released into orbit, these solar array systems are deployed, or unfolded, and used to generate power for the spacecraft. Flight testing of the hinges provides an opportunity to evaluate various configurations in a realistic environment and allows investigators to verify mechanical design data and evaluate the dynamic properties of the hinges.

LFSAH consists of six hinges made of shape-memory alloys (SMA). The key advantages of SMA hinges over other hinges include low-shock controlled deployment, fewer parts, lighter weight, higher reliability, and ease of production and assembly. The LFSAH experiment on STS-93 will test this technology in a weightless environment before it is used in future spacecraft, including the New Millennium Earth Observer 1 (EO-1) experiment and the Deep Space 3 (DS3) space vehicle.

The Lightweight Flexible Solar Array Hinge experiment is sponsored by the Air Force Research Lab, Kirtland AFB, N.M. The experiment is integrated and flown under the direction of the DOD Space Test Program Office at Johnson Space Center in Houston, Tex.

History/Background

The new hinges could lower spacecraft costs and prevent damage during deployment in space.

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Updated: 07/07/1999

Payloads

STS-93

Micro-Electromechanical Systems

In-Cabin

Prime: Steven Hawley
Backup: Cady Coleman

Overview

The Micro-Electromechanical Systems experiment examines the performance of a suite of devices under launch, microgravity, and reentry conditions. These devices include accelerometers, gyros, and environmental and chemical sensors. The MEMS payload is self-contained and requires activation and deactivation only. All experiment operations are monitored and recorded by integrated components. Power, however, is required from just before ascent through deorbit.

The MEMS payload uses one middeck locker with a modified door (front panels removed). An accelerometer and mounting plate will be attached to the inside back of the middeck locker before the payload is installed. A power cable will be connected to the MEMS locker during installation.

Micro-electromechanical systems have already found their way into our lives (air bag triggers, combustion control sensors, ink-jet printer heads, etc.). Electronic fabrication technology, micromolding, and laser processing are being used to carve miniature machines out of silicon and integrate them with electronics to create MEMS. Because of their low weight, low power consumption, and low volume, MEMS devices are extremely attractive for potential spacecraft applications. They are also very reliable, low cost, and somewhat autonomous from other systems.

This program, sponsored by the Air Force Research Lab, Kirtland AFB, N.M., is the first systematic flight testing of MEMS to confirm their advantages for space applications. The experiment is basically a testbed for microdevices that have specific uses in space.

Several types of microaccelerometers and microgyros that can be used to monitor large spacecraft or navigate miniature spacecraft will be tested during the launch phase and on orbit to see if such conditions affect their performance. Chemical microsensors will monitor the middeck environment for traces of potentially harmful gases such as carbon dioxide, methane, and hydrogen. Subminiature arrays of solid rocket motors being developed for attitude control will be tested for configuration stability during launch and material stability in orbit. Very high density nanoelectronic devices will be tested for operational stability in the enhanced radiation environment of space, and the performance of a microarray of thermal control elements will be evaluated.

These devices represent functions (navigation and control, sensing, propulsion, computation, thermal control) that are required for spacecraft of any size. They were chosen for this experiment because the near-term goal is to exploit the advantages offered by MEMS for all spacecraft.

History/Background

The MEMS payload is integrated and flown under the direction of the DOD Space Test Program Office at Johnson Space Center in Houston, Tex. This is its first flight.

Benefits

Micro-electromechanical systems offer great potential benefits for spacecraft application: low weight, low power consumption, low volume, high reliability, low cost, and a certain degree of autonomy.

Payloads

STS-93

Midcourse Space Experiment

Prime: Jeffrey Ashby
Backup: Eileen Collins

Overview

The objective of the Midcourse Space Experiment (MSX) is to fire the orbiter thrusters (orbital maneuvering and primary reaction control systems) in space and use the sophisticated sensors of the orbiting MSX satellite to collect ultraviolet, infrared, and visible light data of the event.

The MSX spacecraft features an advanced multispectral imaging capability that is used to gather data on test targets and space background phenomena. This information will aid designers of future space- and ground-based surveillance and tracking systems that require simultaneous wideband optical data on midcourse missile flight, the trajectory phase between burnout and reentry. For the first time, researchers can observe missile target signatures against Earth limb, auroral, and celestial cluttered backgrounds.

In addition, MSX will investigate the composition and dynamics of Earth's atmosphere to increase our understanding of the environment. MSX can be pointed so that all its instruments simultaneously view the Earth's atmosphere in any allowed direction. This represents an unparalleled scientific opportunity to study the composition, dynamics, and energetics of the atmosphere, including small annual changes in such chemicals as ozone, carbon dioxide, and chlorofluorocarbons. Global atmospheric changes following major solar disturbances and environmental events like volcanic eruptions, forest fires, and agricultural burnoffs also can be monitored.

The MSX spacecraft includes three major sections. The versatile electronics section features state-of-the-art attitude control, power, and command and telemetry systems, including rotatable solar arrays, nickel-hydrogen battery power, steerable X-band antennas, and 108-Gbit data storage. The midsection graphite-epoxy truss supports a large cryogenic Dewar, which contains frozen hydrogen at approximately 8.5 kelvins (1 kelvin equals -273 degrees Celsius, the temperature at which water freezes). The truss thermally isolates the heat-sensitive instrument section from the much warmer spacecraft bus. The instrument section houses 11 optical sensors, which are precisely aligned so that target activity can be viewed simultaneously by multiple sensors. The primary instruments are a space infrared imaging telescope, ultraviolet and visible imagers and spectrographic imagers, a space-based visible instrument, an on-board signal and 86 data processor, and reference objects deployed from MSX for calibrating its instruments.

There are three major categories of MSX tests: plume observations, resident space object (RSO) observations, and acquisition and tracking tests. Plume observations require the firing of either an orbital maneuvering system engine or a minimum of two primary reaction control system engines. The engines fire into the ram, into the wake, or at an angle to the orbiter's velocity vector. RSO tests require the orbiter to maneuver to a specified attitude and remain there throughout the test.

During the mission, MSX sensors will obtain ultraviolet, infrared, and visible light data of orbiter thruster firings under controlled conditions. Data collection will be scheduled during any encounter opportunity when orbiter and crew support activities can be planned within primary payload or mission objectives. There are no unique altitude or inclination requirements, and no on-board flight hardware is involved.

The Sensor Technology Directorate of the BMDO has overall responsibility for MSX. Johns Hopkins University Applied Physics Laboratory serves as systems engineer and technical adviser.

History/Background

The MSX satellite was launched from Vandenberg Air Force Base in California on April 24, 1996, into a 99-degree-inclination, 485-nautical-mile orbit. Its design lifetime is four years, but its infrared telescope is limited by its coolant supply to 18 to 20 months of operation. Approximately 50 percent of MSX's weight and power is allocated to instrument use.

Benefits

The MSX observatory, a Ballistic Missile Defense Organization (BMDO) project, offers major benefits for both the defense and civilian sectors. MSX will observe firings of the orbiter maneuvering thrusters and the orbiter itself. With a solid heritage in the successful Delta series, MSX represents the first system demonstration of technology in space to identify and track ballistic missiles during their midcourse flight phase. The satellite will also collect valuable data about changes in the Earth's atmosphere.

Editorial/Technical Comments: ShuttlePresskit

Plant Growth Investigations in Microgravity 1

In-Cabin

Prime: Cady Coleman

Backup: Steven Hawley

Principal Investigator: Dr. Robert Ferl, University of Florida, Gainesville

Project Scientist: Dr. William Knott, NASA/Kennedy Space Center

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Overview

The PGIM-1 experiment will use genetically engineered plants to monitor the space flight environment for stresses that affect plant growth and gene expression. Because plants cannot get up and move away from stressful situations, they have developed exquisite sensing mechanisms that monitor their environment and direct effective physiological responses to harmful conditions.

One response is to change gene expression patterns, which allows plants to produce new suites of enzymes that allow them to accommodate an environmental perturbation. For the PGIM-1 payload, mouse-ear cress plants (*arabidopsis thaliana*) have been engineered with a reporter gene that provides visual clues to gene expression changes that will occur during space flight. When these engineered plants experience a stress, the reporter gene will be activated. The reporter gene's activity will be revealed by staining the plants.

Thirty-six nearly mature plants will be housed in the plant growth facility in a middeck locker. The PGF will facilitate crew access to the plants on orbit as well as provide all of the growing conditions required by the plants. Light, temperature, and carbon dioxide levels can be controlled, and a full set of sensors will monitor all of the growth conditions in the PGF. During the flight, samples will be grown in a duplicate PGF on the ground for comparison with the space-grown plants.

On the first day after launch and on the day before reentry, a crew member will open the PGF to harvest some of the plants and place them in fix tubes preloaded with reporter gene stain. The crew member will examine the plants for reporter gene activity.

Benefits

Investigators have learned from previous space flight experiments that plants do adapt to stress on orbit. Through the use of the reporter genes, PGIM-1 will seek to identify the sources of on-orbit stress and provide insight into methods of alleviating those stresses through better engineering of flight hardware or through genetic engineering of the plants.

Updated: 07/07/1999

Payloads

STS-93

Shuttle Amateur Radio Experiment II

In-Cabin

Prime: Michel Tognini
Backup: Eileen Collins

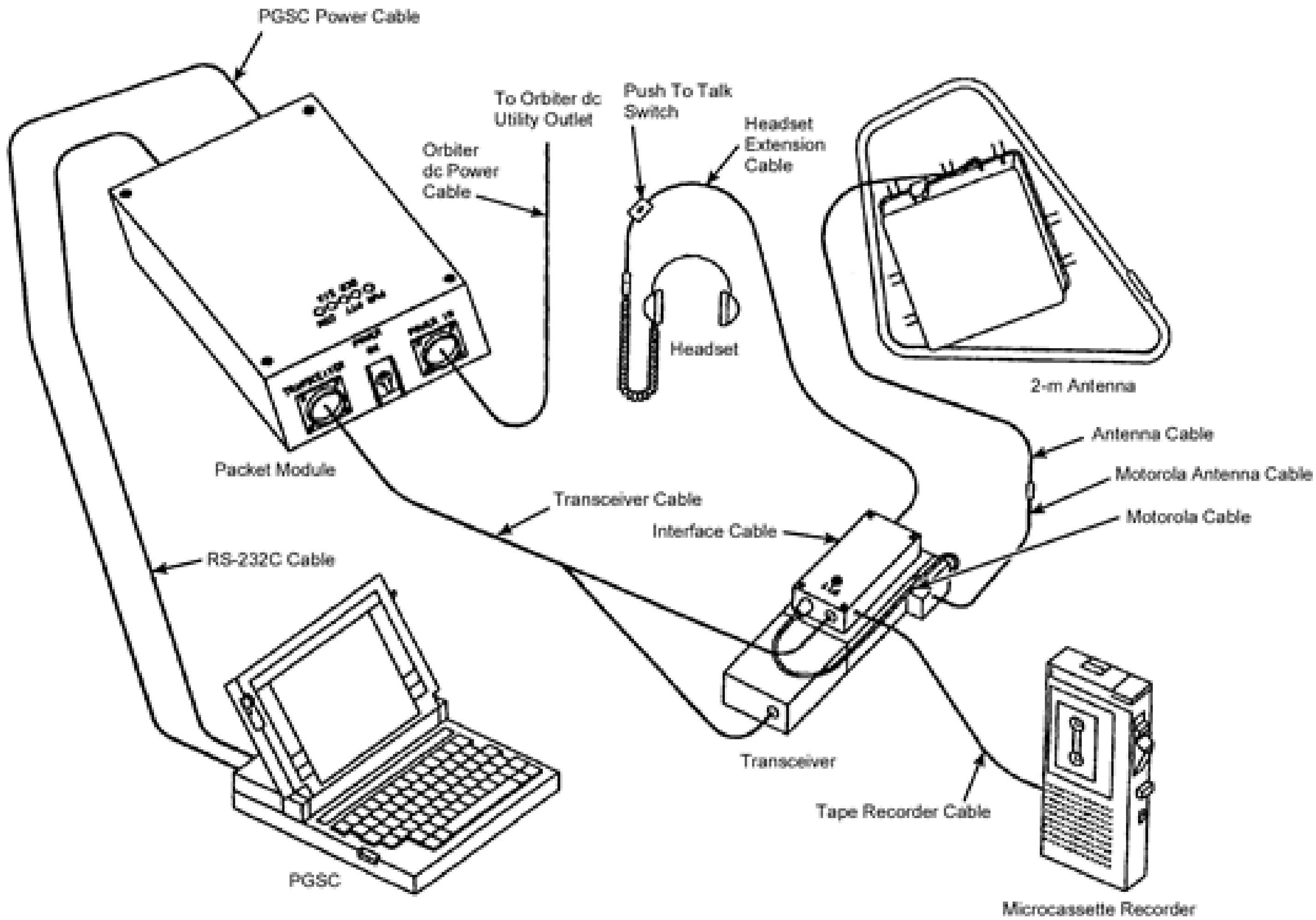
Overview

The Shuttle Amateur Radio Experiment is designed to demonstrate the feasibility of contact between the shuttle and ground-based amateur radio operators, often called "hams." SAREX also serves as an educational tool, allowing school children around the world to learn about space firsthand by speaking directly to astronauts aboard the shuttle. Ham radio operators communicate with the shuttle via VHF-FM voice transmission, a mode that makes contact widely available without the purchase of expensive equipment.

The SAREX-II payload comes in three configurations: Configuration A for communicating with amateur radio stations within the orbiter line of sight (LOS) in one of three modes--voice, SSTV, or data; Configuration B for voice communication only; and Configuration C for communicating in either voice or data mode with amateur stations within orbiter LOS. The C-configuration can also operate in the attended mode for voice communication and either attended or automatic mode for data communication.

For STS-93, SAREX-II will use Configuration C-Q, which is the same as Configuration C with the addition of a new digital signal processor (DSP) unit installed between the headset and the SAREX interface module. The DSP unit is an electronic box that performs digital signal processing of the downlink and uplink audio transmissions to enhance the voice clarity and quality.

SAREX II C-Q includes all the Configuration C components: hand-held FM transceiver, interface module, payload and general support computer (PGSC), spare battery set, window antenna, packet module, headset assembly, personal recorder, and the required cable assemblies. The packet module contains a power supply and packet terminal node controller (TNC). The power supply provides power for the TNC and the hand-held transceiver. The TNC interconnects with a radio transceiver that enables data to and from the computer to be transmitted to and received from other amateur radio stations.



Five schools will be participating in SAREX-II communications during STS-93:

Memorial Middle School in Pharr, Tex.
Ponaganset Middle School in North Scituate, R.I.
Awty International School in Houston, Tex.
Buzz Aldrin Elementary School in Reston, Va.
Osceola Elementary School in Ormond Beach, Fla.

History/Background

SAREX has flown on 19 previous shuttle missions.

The new DSP Quintronics box flying on this mission was developed by a company called Spacetec, which was purchased and became the Space Operations Division of Zeltech.

Benefits

SAREX allows amateur radio operators to participate in shuttle missions and serves as an educational stimulus by giving schools direct access to astronauts in space. The new digital signal processor will enhance voice communications by eliminating background noise.

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Updated: 07/08/1999

Editorial/Technical Comments: ShuttlePresskit

Payloads

STS-93

Shuttle Ionospheric Modification With Pulsed Localized Exhaust

Prime: Jeffrey Ashby

Principal Investigator: Dr. Paul Bernhardt, Naval Research Laboratory

Backup: Eileen Collins

Overview

SIMPLEX is actually a "simple experiment" to study the complex interactions of exhaust vapors with the background atmosphere. This understanding will someday help us to detect, identify, and track the flight of unfriendly space vehicles with instruments that characterize and interpret the vehicle's exhaust plume.

The firing of the shuttle's orbital maneuvering system (OMS) jets causes very high frequency (VHF) radar echoes. The SIMPLEX investigation will seek to determine the source of those VHF echoes.

The Earth is surrounded by a layer of electrons and ions called the ionosphere, which ranges in altitude from 30 to 250 miles. This layer becomes disturbed when gaseous materials released in engine exhaust, like those from the space shuttle OMS, burn in the ionosphere. The gases react chemically with the ions to produce ion beams, which move at orbital speeds, leaving a trail of turbulence in their wake. Eventually, the ions recombine with electrons to produce an ionospheric hole covering an area of 30 by 30 miles or greater.

The flight crew will fire the orbiter's OMS thrusters to create ionospheric disturbances that will be observed by SIMPLEX radars at four sites on Earth: Arecibo, Puerto Rico; Kwajalein, Marshall Islands; Milestone Hill, Mass.; and Jicamarca, Peru. A low-level laser at Arecibo will also observe the effects of the thruster firings on the ionosphere.

The SIMPLEX engine burns are scheduled over each radar site. The radar will send up radio wave pulses that scatter off of the electrons in the ionosphere. Radar will monitor both the turbulence produced by the ion beams and the ultimate reduction in electron density that causes the ionospheric hole.

The SIMPLEX payload has no flight hardware. The principal investigator will analyze the collected data to determine the effects of orbital kinetic energy on ionospheric irregularities and to understand the processes involved when exhaust materials are vented by the orbiter.

History/Background

SIMPLEX is integrated and flown under the direction of the DOD Space Test Program Office at Johnson Space Center in Houston, Tex. STS-93 is the fourth flight of SIMPLEX.

Benefits

Information from SIMPLEX will someday help the U.S. detect, identify, and track the flight of unfriendly space vehicles.

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Updated: 07/07/1999

Editorial/Technical Comments: ShuttlePresskit

Payloads

STS-93

Southwest Ultraviolet Imaging System

In-Cabin

60 lb.

Prime: Steven Hawley

Backup: Michel Tognini

Principal Investigator: Dr. Alan Stern, Southwest Research Institute, San Antonio, Texas

Project Scientist: Dr. David Slater, Southwest Research Institute, San Antonio, Texas

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Overview

The Southwest Ultraviolet Imaging System (SWUIS) is an innovative telescope/charge-coupled device (CCD) camera system that operates from inside the shuttle cabin. SWUIS is used to image planets and other solar system bodies in order to explore their atmospheres and surfaces in the ultraviolet (UV) region of the spectrum, which astronomers value for its diagnostic power.

SWUIS will fly its second space shuttle mission on STS-93. This mission will focus on obtaining UV imagery of an array of planetary and astrophysical targets. The specific objectives of SWUIS during this flight are to (i) obtain the mid-UV albedo (reflected light) from Mercury for the first time and search for spatial variations across the planet; (ii) record mid-UV dynamic movies of the upper atmospheres of Venus and Jupiter; (iii) establish the morphological appearance and phase curve of the moon in the mid-UV for the first time; (iv) search for vulcanoids, a putative population of small, asteroid-like bodies residing interior to Mercury's orbit; and (v) obtain mid-UV dynamic movies of the airglow along the Earth's limb (in camera science mode [CSM]).

SWUIS is stored in the orbiter middeck lockers during launch and entry and is assembled for on-orbit operations. Video data from the SWUIS intensified charge-coupled device (ICCD) camera are recorded on the camcorder and also downlinked to the SWUIS ground personnel located in the JSC Payload Operations Control Center (POCC)

SWUIS presently has two hardware configurations for space shuttle missions: (1) telescope science mode (TSM) and (2) camera science mode. TSM uses a telescope for high-spatial resolution imaging of faint object targets such as planets, comets, and space debris. CSM uses a wide-field camera lens for imaging bright targets that occupy larger swaths of the sky such as aurora and lightning sprites. Both TSM and CSM hardware are sensitive to UV, visible (VIS), and infrared (IR) wavelengths.

The SWUIS TSM hardware is composed of three major elements: the telescope, the ICCD camera, and the electronics that provides power and control of the ICCD camera. In addition to these major components, SWUIS uses a custom-built mounting bracket that couples the telescope to the space shuttle side-hatch window for UV observations; a telescope optical coupling assembly (TOCA) that physically and optically couples the ICCD camera to the telescope and which can hold up to three imaging filters in the optical path; a filter caddy that holds the filters and lenses used in the TOCA; and associated power and data cables. The data from the ICCD camera are an analog video signal that is recorded on-board the shuttle with a portable camcorder and which can be downlinked from the shuttle to the ground for real-time assessment.

The telescope, built by Questar Corporation, is a custom 7-inch-diameter (18 cm) Maksutov-Cassegrain design ruggedized for space flight use. It incorporates a UV transmissive front-end corrector lens made of magnesium fluoride, and mirror optical coatings composed of aluminum overcoated with magnesium fluoride for enhanced sensitivity at UV/VIS/IR wavelengths (200-1000 nm). The telescope incorporates a small 6x30 mm finder telescope that allows the shuttle mission specialist to make fine pointing adjustments to the telescope during target acquisition. The telescope is hard mounted to the side-hatch window in the shuttle mid-deck area via a custom two-axis mounting bracket with manual slow motion controls for fine-pointing. A light shield made of Pyrell foam is placed between the window and the telescope to block unwanted cabin light from entering the telescope. The telescope and mounting bracket weigh approximately 30 lb.

A variety of ruggedized ICCD cameras, built by Xybion Inc., which are sensitive to UV, VIS, and near-IR (NIR) wavelengths, can fly as part of the SWUIS hardware complement. The wavelength sensitivity of each ICCD camera is determined by the type of photocathode material used in the camera's design. The UV/VIS version uses a Generation II photocathode with a sensitivity in the 180-820 nm wavelength range. A second VIS version uses an extended blue Generation III photocathode with high sensitivity between 450 and 910 nm. The NIR version has high sensitivity between 600 and 1000 nm. The output of the ICCD camera is a standard RS-170 video signal at an interlaced frame rate of 60 Hz with 370 lines of horizontal resolution. The camera weighs 2.75 lb. and draws about 5 watts.

The TOCA is a mechanical interface between the telescope and the ICCD camera. It is designed to hold both imaging filters and lenses. The effective focal length of the SWUIS TSM system can be varied between 105 and 257 cm for a FOV range between 0.3 and 0.6 deg (full cone). The power interface box (PIB) provides power conditioning from the shuttle orbiter's video interface unit to the ICCD camera. The PIB also has manual adjustment controls of the ICCD camera's internal sensitivity (gain) and video output signal. The video output signal is buffered by the PIB to allow multiple data paths to camcorders, monitors, and to the shuttle's video downlink system. During shuttle missions, SWUIS data are recorded on board with a portable camcorder and can also be sent to the ground via satellite link.

SWUIS TSM mode provides astronomers and planetary scientists with a small but highly capable space telescope. Although far less sensitive than the Hubble Space Telescope, SWUIS has its own advantages. These include a far wider FOV and the capability to study objects that are much closer to the sun, such as the inner planets and comets.

The SWUIS CSM configuration is very similar to the TSM mode except the ICCD camera is used with a UV transmissive wide-field lens, instead of the main telescope. A mini-TOCA is used to hold filter combinations. The CSM can be mounted to any of the shuttle windows including the side-hatch window and the nine flight deck windows, using a Bogan bracket camera mount. The wide-field lens assembly provides a FOV of approximately 12.5 deg (full cone).

History/Background

SWUIS made its first flight on STS-85 in August 1997. On that mission, SWUIS obtained over 400,000 images of the Hale-Bopp Comet at a time when the Hubble Space Telescope could not observe the comet because it was lost in the glare of the sun. These images have already revealed important insights into the comet's water and dust production rates as it left the sun on its return to the Oort Cloud of comets, 10,000 times as far away as Pluto.

Benefits

Although small, the sensitive SWUIS system has some unique attributes that make it a valuable complement to more expensive space observatories such as the Hubble Space Telescope. Among these attributes are SWUIS's unusually wide field of view (FOV) (up to 30 times Hubble's) and its ability to observe objects much closer to the sun than most space observatories. This latter capability allows SWUIS to explore the inner solar system, which few other instruments can.

Editorial/Technical Comments: ShuttlePresskit

Space Tissue Loss

In-Cabin

Prime: Steven Hawley
Backup: Jeffrey Ashby

Overview

The Space Tissue Loss hardware will be used on STS-93 to support two sets of experiments. STL-A will support the CCM experiment with micromolecular investigations to validate models for tissue loss in space. STL-B will support the BRIC-12 experiment by observing cells in culture with a video microscope imaging system to record near-real-time interactions of detecting and inducing cellular responses (macromorphological changes).

Experiment activities can be performed without any crew intervention other than initiation of the experiment at the beginning of on-orbit payload operations and termination of the experiment before deorbit preparation. STL operates continuously from prelaunch through postlanding.

STL is integrated and flown under the direction of the DOD Space Test Program Office at Johnson Space Center in Houston, Tex.

History/Background

This is the ninth flight of STL hardware.

Updated: 07/07/1999

DTO/DSO/RME

STS-93

DSO 496	Individual Susceptibility to Postflight Orthostatic Intolerance
DSO 631	Integrated Measurement of the Cardiovascular Effects of Space Flight
DSO 331	Interaction of the Space Shuttle Launch and Entry Suit and Sustained Weightlessness on Egress Locomotion
DSO 493	Monitoring Latent Virus Reactivation and Shedding in Astronauts
DSO 498	Space Flight Immune Function
DTO 805	Crosswind Landing Performance
DTO 631	Digital Video Camcorder Demonstration
DTO 700-17A	High-Definition Television Camcorder Demonstration
DTO 260	Shuttle Radar Topography Mission Fly Casting Maneuver
RME 1318	Treadmill Vibration Isolation and Stabilization System

DTO = Detailed Test Objective   DSO = Detailed Supplementary Objective   RME = Risk Mitigation Experiment

Updated: 07/07/1999

Editorial/Technical Comments: ShuttlePresskit

Individual Susceptibility to Postflight Orthostatic Intolerance
DSO 496

Prime: Cady Coleman
Backup: Jeffrey Ashby

Overview

Susceptibility to postflight orthostatic intolerance is highly individual. Some astronauts are little affected; others have severe symptoms. Women are more often affected than men. The goal of this DSO is to discover the mechanisms responsible for these differences in order to customize countermeasure protocols.

History/Background

It has been well documented that space flight significantly alters cardiovascular function. One of the most important changes from a crew safety standpoint is postflight loss of orthostatic tolerance, which causes astronauts to have difficulty walking independently and induces lightheadedness or fainting. These may impair their ability to leave the orbiter after it lands. Recent evidence indicates that postflight autonomic dysfunction contributes to orthostatic intolerance.

Updated: 07/07/1999

Editorial/Technical Comments: ShuttlePresskit

Integrated Measurement of the Cardiovascular Effects of Space Flight
DSO 631

Prime: Michel Tognini

Overview

The purpose of this DSO is to assess the stroke volume changes during early exposure to microgravity, assess the flow redistribution through the body during the acceleration phases of launch, and quantify the peripheral vasomotor response during the launch and entry into microgravity phase.

Updated: 07/07/1999

Interaction of the Space Shuttle Launch and Entry Suit and Sustained Weightlessness on Egress Locomotion

DSO 331

In-Cabin

Prime: Steven Hawley
Backup: Michel Tognini

Overview

This DSO will identify the impact of the launch and entry suit (LES)/advanced crew escape suit (ACES) and sustained weightlessness on the mechanical efficiency of astronauts' egress locomotion as measured by oxygen consumption and gait alteration; identify the impact of the LES/ACES on physiological responses as measured by oxygen consumption, increased body temperature, heart rate, and ventilatory equivalent; and determine if crew members can sustain a uniform speed for 400 meters when they leave the orbiter.

Crew members participating in this DSO will attach the egress monitor assembly to themselves before they put on the LES/ACES for reentry. As soon after the flight as possible, they will walk 400 meters on a treadmill at 3.5 mph with the LES/ACES on.

History/Background

One important unanswered question about space flight is whether astronauts wearing the launch and entry suit are able to leave the orbiter at wheel stop in an emergency and walk to safety. Past investigations have demonstrated that astronauts moving at even a medium pace while wearing the LES experience an increase in energy expenditure of as much as 55 percent. Other studies have indicated that even short-duration space flights can reduce astronauts' aerobic capacity and cause a significant loss of strength and function, especially in astronauts' lower limbs and back. The combined effect of reduced muscle function and aerobic capacity may be great enough to negatively affect astronauts' ability to safely leave the orbiter at wheel stop in an emergency.

Updated: 07/07/1999

Editorial/Technical Comments: ShuttlePresskit

Monitoring Latent Virus Reactivation and Shedding in Astronauts
DSO 493
In-Cabin

Overview

This DSO will attempt to determine the frequency of induced reactivation of latent viruses, latent virus shedding, and clinical disease after exposure to the physical, physiological, and psychological stressors associated with space flight.

Saliva samples are collected from the participating astronauts every other day from six to four months before the launch to establish shedding profiles. Ten milliliters of blood and urine are collected during a routine preflight physical. During the flight, saliva specimens are collected once each day and stored for postflight evaluation.

History/Background

Space flight-induced alterations of immune response will become increasingly important on long-duration missions, including the possible reactivation and shedding (dissemination) of latent viruses. One type of latent virus is herpes simplex type 1 (HSV-1), which infects 70-80 percent of all adults. Its manifestation is classically associated with cold sores, pharyngitis, and tonsillitis, and it is usually acquired through contact with the saliva, skin, or mucous membranes of an infected individual. However, many recurrences are asymptomatic, resulting in shedding of the virus.

Space Flight Immune Function

DSO 498

In-Cabin

Overview

Astronauts working and living in relatively crowded conditions in the closed environment of spacecraft for longer and longer missions face an increasing risk of contracting infectious diseases. The human immune system plays a pivotal role in the prevention of infectious illnesses, and the effects of space flight on the immune response are not fully understood.

History/Background

It is suspected that exposure to the weightlessness of space alters the essential functions of neutrophils, monocytes, and cytotoxic cells (lymphokine-activated and natural killer cells). This DSO will characterize the effects of space flight on selected immune elements that are important in maintaining an effective defense against infectious agents. The roles of neutrophils, monocytes, and cytotoxic cells, which are important elements of the immune response, have not been studied adequately. These studies will complement ongoing and previous space immunology investigations.

This DSO will prove or disprove the hypothesis that space flight alters the immune response to infectious agents by analyzing neutrophils and monocytes and assessing cytotoxic cells and cytokine production before and after the mission.

Editorial/Technical Comments: ShuttlePresskit

Crosswind Landing Performance
DTO 805

Prime: Eileen Collins
Backup: Jeffrey Ashby

Overview

This DTO will demonstrate the capability to land the orbiter manually with a 10- to 15-knot crosswind.

Updated: 07/07/1999

Digital Video Camcorder Demonstration
DTO 631

Prime: Eileen Collins
Backup: Michel Tognini

Overview

This experiment will test and demonstrate state-of-the-art digital camcorder and video recorder technology that can complement or replace the aging, obsolete Canon analog camcorders currently used on the shuttle program. The long-term objective is to select a replacement that has the same or superior capabilities as the Canon's. It is expected that a digital camcorder will significantly improve the quality of shuttle video.

A primary objective of DTO 631 is to demonstrate that a digital video camcorder or recorder is easy to use on orbit, has interfaces that are identical to those of the standard camcorder, and is a beneficial addition to the shuttle program.

This is the first of two planned flights of this DTO.

History/Background

Although analog camcorders have performed adequately on most shuttle flights, they lack the resolution and quality available in other formats and cannot be replaced. New state-of-the-art digital video recording formats are now becoming readily available.

Updated: 07/07/1999

High-Definition Television Camcorder Demonstration
DTO 700-17A
In-Cabin

Prime: Cady Coleman
Backup: Jeffrey Ashby

Overview

The objectives of this DTO are to verify that integrating this new capability with the existing system causes no engineering anomalies, determine how well this technology meets NASA's goal and any changes required or desired in the operational hardware, compare the shuttle's current analog video capability and the High-Definition Television (HDTV) format, and provide shuttle HDTV source material to the news media and broadcasters in a format that can be produced in the U.S. HDTV format.

The analog-to-digital comparison will be produced by recording the same scenes simultaneously with one of the shuttle analog camcorders and the HDTV camcorder and with a payload bay still camera and the HDTV camcorder. The still camera's images will be recorded on a videotape recorder.

Various scenes that are typical sources of video on shuttle missions will be shot with the HDTV camcorder to assess its performance. The goal is to capture images of dynamic events such as a payload deployment or observe lightning and other atmospheric phenomena.

After the mission, NASA will compare size measurements of objects from each image format with known standards and make qualitative assessments of color and the ability of an interpreter to distinguish contaminants, damage, and discoloration of external surfaces on the basis of color.

Only one flight of this DTO is planned.

History/Background

The United States is moving from analog television to the digital format adopted by the Federal Communications Commission. In order to provide images in this new format, NASA needs to upgrade its shuttle video system. A minimal upgrade of existing shuttle hardware will be a first step toward giving the shuttle program some digital television capability.

Updated: 07/07/1999

Shuttle Radar Topography Mission Fly Casting Maneuver
DTO 260

Prime: Eileen Collins
Backup: Jeffrey Ashby

Overview

The Shuttle Radar Topography Mission (SRTM) fly casting technique is designed to minimize structural loading of the 60-meter extendible boom antenna during the STS-99 mission in September. During this experiment, Columbia's crew will conduct a sequence of orbiter jet firings that will minimize the dynamics of the orbiter during trim burns. This investigation of the optimum settings and timing of trim burns must be conducted--before the flight of the SRTM--to verify the on-orbit feasibility of the ground-developed technique. Only one flight of this experiment is planned.

Updated: 07/07/1999

Treadmill Vibration Isolation and Stabilization System
RME 1318

Prime: Steven Hawley
Backup: Michel Tognini

Overview

An in-flight evaluation of the Treadmill Vibration Isolation and Stabilization (TVIS) system must be performed to guarantee successful operation as an exercise device, while meeting International Space Station (ISS) load transmission requirements, prior to installation as an exercise countermeasures device on ISS.

Updated: 07/07/1999

Media Contacts

STS-93

NASA PAO CONTACTS

Wallace Tucker Chandra X-Ray Observatory Center,Smithsonian Astrophysical Observatory Cambridge, MA wtucker@cfa.harvard.edu	Chandra Science Operations, X-Ray Science	617-496-7998
David Drachlis Marshall Space Flight Center Huntsville, AL Dave.Drachlis@msfc.nasa.gov	Chandra X-Ray Observatory	205-544-6538
June Malone Marshall Space Flight Center Huntsville, AL June.Malone@msfc.nasa.gov	External Tank/SRBs/SSMEs	256/544-0034
Bruce Buckingham Kennedy Space Center , FL bruce.buckingham-1@ksc.nasa.gov	Launch Processing, KSC Landing Information	407/867-2468
Eileen Hawley Johnson Space Houston, TX eileen.hawley1@jsc.nasa.gov	Mission Operations/Astronauts	281/483-5111
Dwayne Brown, NASA Headquarters, Washington, DC dwayne.brown@hq.nasa.gov	Policy/Management	202/358-1726

Don Savage
NASA Headquarters
Washington, DC
donald.savage@hq.nasa.gov Space Science Policy/Management 202-358-1727

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Updated: 07/09/1999

Editorial/Technical Comments: ShuttlePresskit

Crew Members

STS-93

Commander: Eileen M. Collins

Collins is responsible for the overall success of the mission and the safety of the crew. She will also be responsible for an engineering test, referred to as the flycast maneuver, to assess the jet firing technique that will be used in September's Shuttle Radar Topography mission. This technique will be used on STS-99 to maintain the stability of a 200-foot radar mast which will tower above the cargo bay of the shuttle Endeavour.

Previous Space Flights:
Collins was the pilot on the STS-63 mission in February, 1995 and the STS-84 mission in May, 1997.

Ascent Seating: Flight Deck - Port Forward
Entry Seating: Flight Deck - Port Forward

Pilot: Jeffrey S. Ashby

Ashby will be responsible for key shuttle systems during launch and landing, will lead any in-flight maintenance work which may be required and would serve as overall coordinator for any unplanned spacewalk which might be required. Ashby will also conduct a series of jet firings in an Air Force experiment in which an orbiting satellite will monitor the characteristics of jet plumes in space.

Previous Space Flights:
STS-93 will be Ashby's first flight.

Ascent Seating: Flight Deck - Starboard Forward
Entry Seating: Flight Deck - Starboard Forward

Mission Specialist 1: Cady G. Coleman

Coleman's primary responsibility on STS-93 is the deployment of the Chandra X-Ray Observatory. She will insure that all systems associated with Chandra and its Inertial Upper Stage booster are in readiness for deployment and that the telescope is ready to begin its five-year astronomical mission.

Coleman will also conduct a number of scientific and engineering experiments during the flight in the days following Chandra's deployment. Coleman would be one of the space walkers in the event an unplanned space walk is required during the flight.

Previous Space Flights:
Coleman's first flight occurred on the STS-73 mission in Oct./Nov., 1995.

Ascent Seating: Mid Deck - Port
Entry Seating: Flight Deck - Starboard Aft

Mission Specialist 2: Steven A. Hawley

As flight engineer for Columbia, Hawley will be responsible for helping to monitor shuttle systems on the flight deck behind Collins and Ashby during launch and landing.

Hawley will assist Coleman and Tognini during the deployment of the Chandra X-Ray Observatory. He will also be the primary operator of the Southwest Ultraviolet Imaging System, a small telescope which will be used to study the ultraviolet characteristics of planetary bodies.

Hawley will conduct other secondary experiments during the course of the five-day mission.

Previous Space Flights:
Hawley has flown four previous missions, STS-41D, in Aug./Sept., 1984, STS-61C in January, 1986, STS-31 in April, 1990 and STS-82 in February, 1997.

Ascent Seating: Flight Deck - Center Aft
Entry Seating: Flight Deck - Center Aft

Mission Specialist 3: Michel Tognini

Tognini will back up Coleman during the deployment of the Chandra X-Ray Observatory and would be the lead space walker in the event an unplanned space walk is required. In addition, Tognini will conduct a number of secondary experiments, including the operation of the Southwest Ultraviolet Imaging System and the shuttle's ham radio.

Previous Space Flights:
Tognini's first space flight occurred in July/Aug., 1992 when he was launched on a Russian Soyuz rocket to spend two weeks aboard the Mir Space Station conducting a number of French science experiments.

Ascent Seating: Flight Deck - Starboard Aft
Entry Seating: Mid Deck - Port

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Shuttle Reference

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Space Shuttle Orbiter Systems

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- AUXILIARY POWER UNIT/HYDRAULICS (APU/HYD) *(900K pdf)*
- CAUTION AND WARNING SYSTEM (C/W) *(850K pdf)*
- CLOSED CIRCUIT TELEVISION (CCTV) *(900K pdf)*
- COMMUNICATIONS *(1.8M pdf)*
- CREW SYSTEMS *(1M pdf)*
- DATA PROCESSING SYSTEMS (DPS) *(1M pdf)*
- DEDICATED DISPLAY SYSTEMS *(1.1M pdf)*
- ELECTRIC POWER SYSTEM (EPS) *(1.4M pdf)*
- ENVIRONMENTAL CONTROL AND LIFE SUPPORT SYSTEM (ECLSS *(2.3M pdf)*
- ESCAPE SYSTEMS *(1.2M pdf)*
- EXTRAVEHICULAR ACTIVITY (EVA) *(800K pdf)*
- GALLEY/FOOD *(800K pdf)*
- GUIDANCE, NAVIGATION, AND CONTROL (GNC) *(2.1M pdf)*
- LANDING/DECELERATION SYSTEM *(750K pdf)*
- LIGHTING SYSTEM *(700K pdf)*
- MAIN PROPULSION SYSTEM (MPS) *(1M pdf)*
- MECHANICAL SYSTEMS *(600K pdf)*
- ORBITAL MANEUVERING SYSTEM (OMS) *(870K pdf)*
- PAYLOAD DEPLOYMENT AND RETRIEVAL SYSTEM (PDRS) *(1.1M pdf)*
- REACTION CONTROL SYSTEM (RCS) *(900K pdf)*
- SPACELAB *(400K pdf)*
- SPACEHAB *(100K pdf)*
- ORBITER DOCKING SYSTEM *(270K pdf)*
- STOWAGE *(300K pdf)*
- WASTE MANAGEMENT SYSTEM (WMS) *(300K pdf)*
- PAYLOAD AND GENERAL SUPPORT COMPUTER *(130K pdf)*
- SPACE SHUTTLE ORBITER SYSTEMS (entire manual) *(20M pdf)*

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Internet Links

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General Mission Links:

- NASA Headquarters
- NASA Headquarters Office of Space Flight (Code M)
- Lyndon B. Johnson Space Center
- John F. Kennedy Space Center
- Goddard Space Flight Center
- Marshall Space Flight Center
- Boeing
- Lockheed Martin
- United Space Alliance
- Thiokol Aerospace & Industrial Technologies
- SPACEHAB
- European Space Agency
- Japanese Space Agency
- Canadian Space Agency

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Media Assistance

STS-93

NASA Television Transmission

NASA Television is available through the GE2 satellite system which is located on Transponder 9C, at 85 degrees west longitude, frequency 3880.0 MHz, audio 6.8 MHz.

The schedule for television transmissions from the orbiter and for mission briefings will be available during the mission at Kennedy Space Center, FL; Marshall Space Flight Center, Huntsville, AL; Dryden Flight Research Center, Edwards, CA; Johnson Space Center, Houston, TX; and NASA Headquarters, Washington, DC. The television schedule will be updated to reflect changes dictated by mission operations.

Status Reports

Status reports on countdown and mission progress, on-orbit activities and landing operations will be produced by the appropriate NASA newscenter

Briefings

A mission press briefing schedule will be issued before launch. During the mission, status briefings by a flight director or mission operations representative and when appropriate, representatives from the payload team, will occur at least once each day. The updated NASA television schedule will indicate when mission briefings are planned.

Internet Information

Information is available through several sources on the Internet. The primary source for mission information is the NASA Shuttle Web, part of the World Wide Web. This site contains information on the crew and its mission and will be updated regularly with status reports, photos and video clips throughout the flight. The NASA Shuttle Web's address is:

http://spaceflight.nasa.gov

General information on NASA and its programs is available through the NASA Home Page and the NASA Public Affairs Home Page:

http://www.nasa.gov

or

http://www.nasa.gov/newsinfo/index.html

Shuttle Pre-Launch Status Reports

http://www-pao.ksc.nasa.gov/kscpao/status/stsstat/current.htm

Information on other current NASA activities is available through the Today@NASA page:

http://www.nasa.gov/today/index.html

The NASA TV schedule is available from the NTV Home Page:

http://spaceflight.nasa.gov/realdata/nasatv/schedule.html

Resources for educators can be found at the following address:

http://education.nasa.gov

Access by Compuserve

Users with Compuserve accounts can access NASA press releases by typing "GO NASA" (no quotes) and making a selection from the categories offered.

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