

MISSION SUMMARY

MISSION OPERATIONS DIRECTORATE FLIGHT DIRECTOR OFFICE



STS-103 (HST SM3A) MISSION OVERVIEW

FLIGHT READINESS REVIEW

November 19, 1999

**JSC/DA8/Linda J. Ham
STS-103 Lead Flight Director**

Agenda

- Flight Design Summary
- Payload Bay Configuration
- Personnel
- Timeline Overview
- Mission Priorities
- Special Topic: Rndz/Grapple of HST in Hardware Sunpoint or Zero Gyro Sunpoint

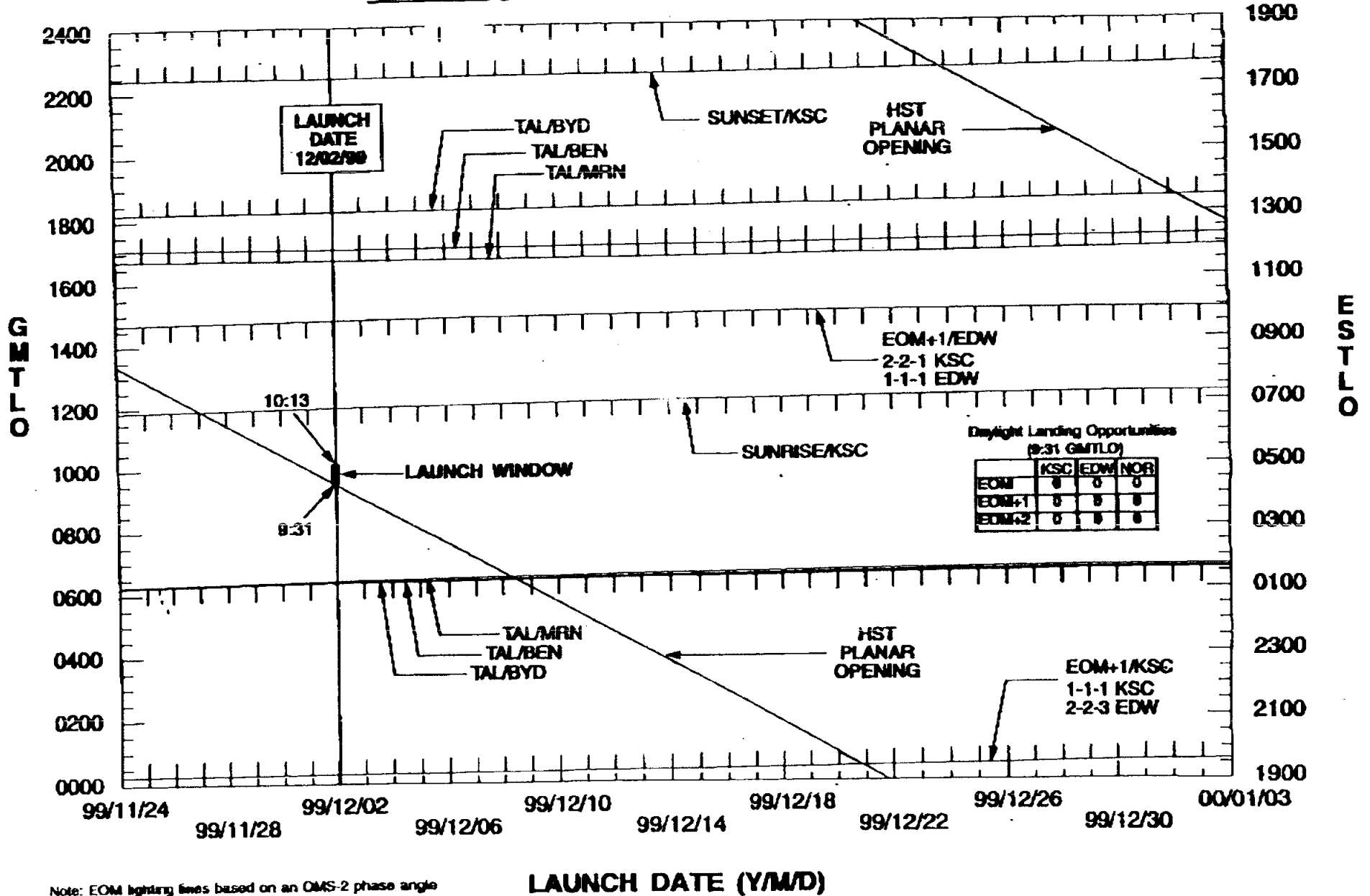
Flight Design Summary

- Launch Date: 12/6/99
- Launch Time: 7:37 GMT (2:37 EST)
- Launch Window Duration: 42 minutes
- APM: 11,766 lbs.
- Mission Duration: 10+2
- No. of EVA's: 4 scheduled, 1 unscheduled for HST deploy (if required)
- Orbiter Software: OI26B
- Launch, RTLS, EOM Dark
- TAL: BYD, BEN Light
- Landing (~9/21:20 MET) 12/15/99 23:57 EST
(12/16/99 4:57 GMT)

Flight Design Summary

- Propulsive Consumables Summary
 - OMS Load/Margin: 25064 lbs./75 lbs.
 - ARCS Load/Margin: 4970 lbs./20 lbs.
 - FRCS Load/Margin: 2446 lbs./630 lbs.
- Non-Propulsive Consumables Summary
 - Cryo H2 (# tanks/Margin/Launch hold): 5/74.2 lbm/203.9
 - Cryo O2 (# tanks/Margin/Launch hold): 5/498.5 lbm/476.7
 - N2 (# tanks/Margin): 6/128.3 lbm
 - LIOH: 42 cans (covers EOM+3)

STS-103 Launch Window



Note: EOM lighting lines based on an OMS-2 phase angle of 82.2° and are representative only.

LAUNCH DATE (Y/M/D)

STS-103 Launch Window Digital Data

Nominal Flight Duration = 9:21:20 (D:H:M) MET

WINDOW OPENINGS

WINDOW CLOSINGS

DATE AT Greenwich (MD/Y)	WINDOW OPENINGS						WINDOW CLOSINGS					
	1 TAL/BYD SR-15 min GMT (H:M)	2 TAL/BEN SR-15 min GMT (H:M)	3 TAL/MRN SR-15 min GMT (H:M)	4 Planar/ Phase Opening GMT (H:M)	5 KSC Sunrise SR-0 min GMT (H:M)	6 EOM+2/ EDW SR-10 min GMT (H:M)	7 EOM+2/ KSC SS+10 min GMT (H:M)	8 Planar/ Phase Closing GMT (H:M)	9 TAL/MRN SS+15 min GMT (H:M)	10 TAL/BEN SS+15 min GMT (H:M)	11 TAL/BYD SS+15 min GMT (H:M)	12 KSC Sunset SS+0 min GMT (H:M)
12/03/1999	06:25	06:26	06:29	09:05	12:00	15:28	00:57	**09:42	16:42	17:03	18:15	22:25
12/04/1999	06:25	06:27	06:30	08:34	12:00	15:29	00:57	09:16	16:42	17:03	18:15	22:25
12/05/1999	06:26	06:27	06:31	08:08	12:01	15:30	00:58	08:45	16:42	17:04	18:15	22:26
12/06/1999	06:26	06:28	06:32	07:37	12:02	15:30	00:58	08:19	16:42	17:04	18:15	22:26
12/07/1999	06:27	06:29	06:32	07:07	12:03	15:31	00:59	07:49	16:42	17:04	18:16	22:26
12/08/1999	06:28	06:30	06:33	*06:40	12:03	15:31	00:59	**07:18	16:42	17:04	18:16	22:26
12/09/1999	06:28	06:30	06:34	06:10	12:04	15:32	01:00	06:52	16:42	17:04	18:16	22:26
12/10/1999	06:29	06:31	06:35	05:39	12:05	15:32	01:00	06:21	16:42	17:04	18:17	22:26
12/11/1999	06:29	06:32	06:36	05:13	12:05	15:33	01:00	05:53	16:42	17:04	18:17	22:27
12/12/1999	06:30	06:33	06:36	04:42	12:06	15:33	01:01	05:24	16:42	17:04	18:17	22:27

The Launch Period begins 10 minutes before Launch Window Open and ends 10 minutes after Launch Window Close
The nominal launch window open and close times are shown in boxes

1,2,3,9,10 and 11 protect daylight TALs

4 and 6 are based on the planar or phase window open and close. Planar window duration is 42 minutes.

5 and 12 protect for daylight launch

6 and 7 protect at least one daylight landing opportunity to KSC and EDW for EOM, EOM+1, and EOM+2 (based on a representative OMS2 phase angle of 253.5 deg)

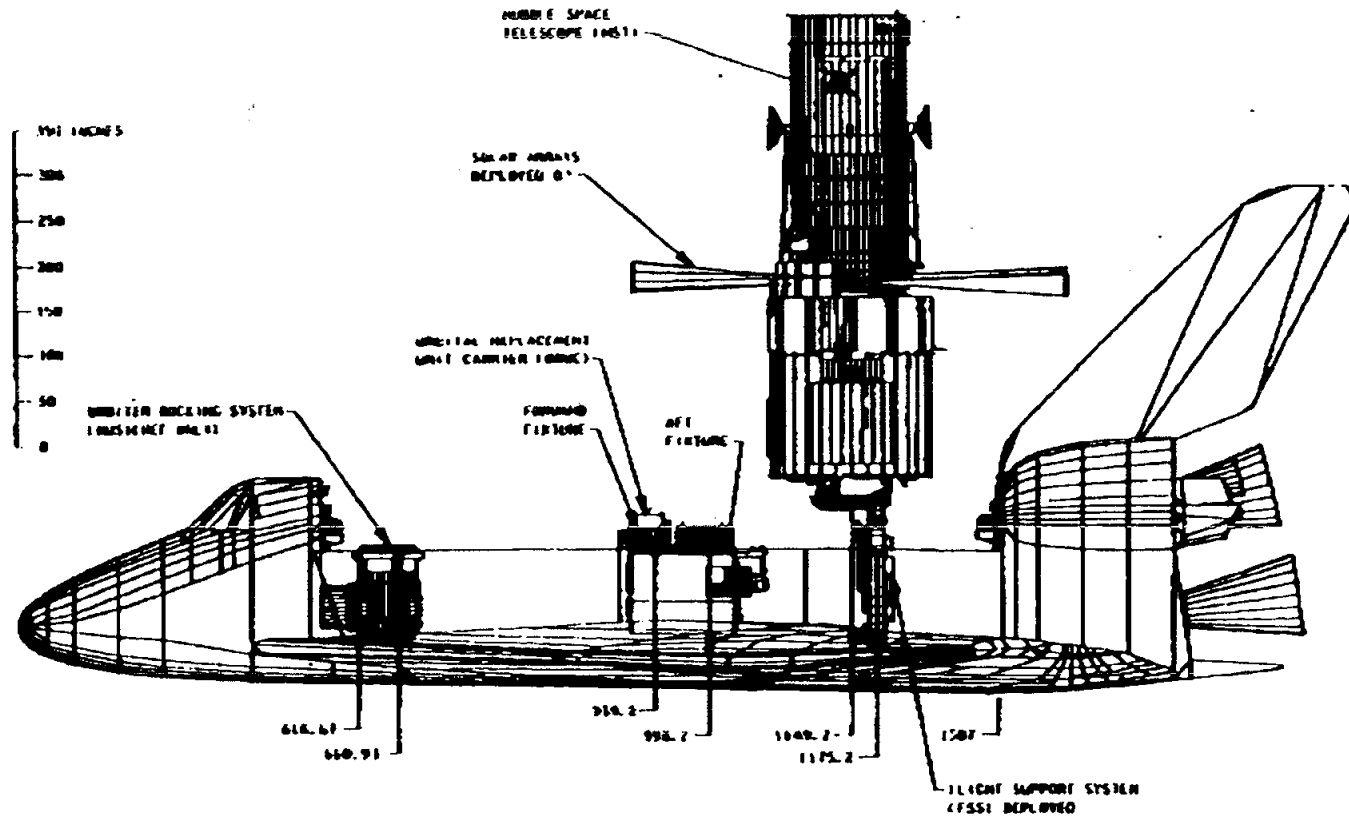
* Indicates opening on the second of the two planar launch windows

** Indicates closing on the first of the two planar launch windows

Payload Bay Configuration

- External Airlock
- Orbital Replacement Unit Carrier (ORUC)
- Flight Support System (FSS)

HST SM Flight Phase Configuration



(a) Side view

Figure 1-5. HST SM flight phase configuration

Personnel

Flight Crew

Curt Brown CDR

Scott Kelly PLT

Steven Smith (Payload CDR) EV1

John Grunsfeld EV2

Michael Foale EV3

Claude Nicollier EV4

Jean-Francois Clervoy Prime RMS operator

Flight Directors

Linda J. Ham Lead FD/Orbit 1

Bryan Austin Orbit 2 FD

Jeff Hanley Planning FD

Wayne Hale Ascent/Entry FD

Mission Timeline

- FD1: Launch and Post Insertion
Space Support Equipment (SSE) Activation
RNDZ Phasing Burn
- FD2: RMS C/O, PLB Survey
10.2 psi Cabin Depress
SSE C/O
EMU C/O
2 Phasing Burns
- FD3: RNDZ, Grapple & Berth HST
HST Survey
- FD4: EVA1
- Replace 3 Rate Sensor Units (6 gyros)
 - Install Voltage/Temperature Improvement Kits

Mission Timeline

FD5: EVA2

- Replace computer with 486
- Replace Fine Guidance Sensor 2

FD6: EVA3

- Install Optical Control Electronics Enhancement Kit
- Replace the S-band Single Access Transmitter 2
- Replace ESTR-3 with Solid State Recorder
- Install New Outer Blanket Layer (NOBL) (MLI on bays 5-10)

FD7: EVA4

- Install Shell/Shield Replacement Fabric (SSRF)
- Install handrail covers
- Install Aft Shroud Door Repair Kit for +V2 door
- High Gain Antenna Deploy, Solar Arrays to 90 deg, -V3 fwd

Mission Timeline

- FD8: Aperture Door Open
Deploy HST
Flight Servicing Structure (FSS) Stow
Cabin Repress
- FD9: Post EVA Stow
Crew Off Duty
- FD10: Orbiter Flight Control System C/O
RCS Hotfire
GPS Test
Cabin Stow
- FD11: Entry

STS-103 HST-SM3 Overview Timeline

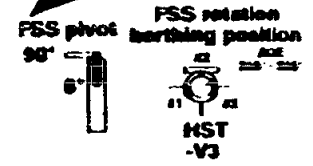
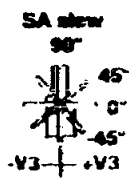
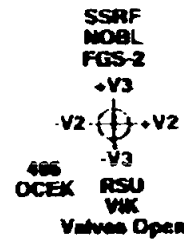
10+2 Day Mission, 2 EVA Crews, 4 EVA's

	0/	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	
FD 1	Dec 02 Launch @ 08:31 GMT													POST INSERTION			Pre Sleep		Sleep							
10/2/14/7	[Redacted]																									
GRP B	[Redacted]																									
FD 2	Sleep		Post Sleep		RAM C/O, SBE C/O, EMU C/O, 10.3 DEPRESS, PRE-RNDZ										Pre Sleep		Sleep									
10/2/14/7	[Redacted]																									
GRP B	[Redacted]																									
FD 3	Sleep		Post Sleep		HST Grapple (201:07 T)										Pre Sleep		Sleep									
10/2/14/7	[Redacted]																									
GRP B	[Redacted]																									
FD 4	Sleep		Post Sleep		Pre-EVA		EVA 1 (8:00)					Post-EVA		Pre Sleep		Sleep										
10/2/14/7	[Redacted]																									
GRP B	[Redacted]																									
FD 5	Sleep		Post Sleep		Pre-EVA		EVA 2 (8:00)					Post-EVA		Pre Sleep		Sleep										
10/2/14/7	[Redacted]																									
GRP B	[Redacted]																									
FD 6	Sleep		Post Sleep		Pre-EVA		EVA 3 (8:00)					Post-EVA		Pre Sleep		Sleep										
10/2/14/7	[Redacted]																									
GRP B	[Redacted]																									
FD 7	Sleep		Post Sleep		Pre-EVA		EVA 4 (8:00)					Post-EVA		Pre Sleep		Sleep										
10/2/14/7	[Redacted]																									
GRP B	[Redacted]																									
FD 8	Sleep		Post Sleep		HST Release					P&S STOW, 14.7 REPRB					Pre Sleep		Sleep									
10/2/14/7	[Redacted]																									
GRP B	[Redacted]																									
FD 9	Sleep		Post Sleep		OFF DUTY					POST EVA INT PREP					Pre Sleep		Sleep									
10/2/14/7	[Redacted]																									
GRP B	[Redacted]																									
FD 10	Post Sleep		PCS C/O, RCS HP, GPR TEST					CABIN STOW					Pre Sleep		Sleep											
10/2/14/7	[Redacted]																									
GRP B	[Redacted]																									
FD 11	Post Sleep		EMU		D/O PREP			INT		KSC LANDING 022:07																
10/2/14/7	[Redacted]																									
GRP B	[Redacted]																									

14.7	[Redacted]
10.2	[Redacted]

Group B	[Redacted]
Group B Dual G2	[Redacted]

HST SM3A EVA Scenario



Baselined Tasks & Priorities

1. RSUs (RSU-1, -2, -3)
2. VIK
3. 486 Computer
4. FGS (FGS-2)
5. SSAT (SSAT-2)
6. SSR (ESTR-3)
7. Bay 5-10 MLI Repair
8. NICMOS valves open

(+) -20° → 0°

Optional Tasks & Priorities

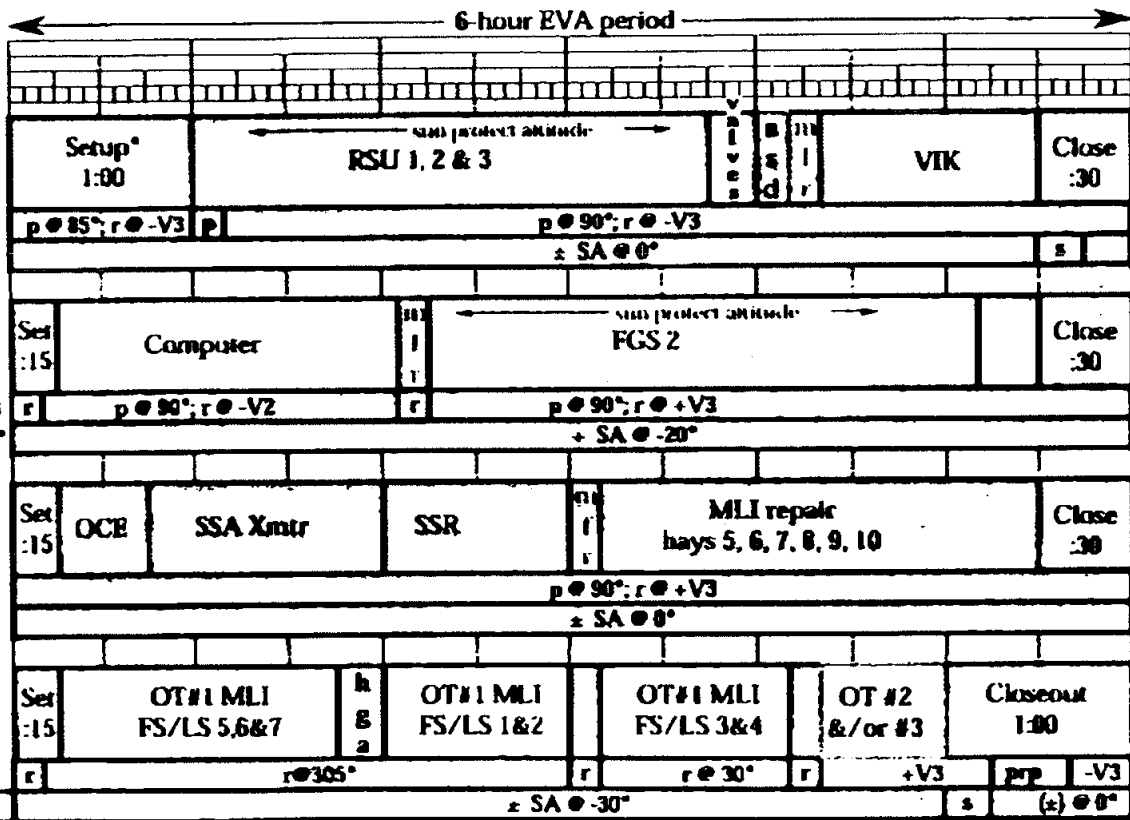
- OT#1. FS/LS MLI Repair
- OT#2. Handrail Covers
- OT#3. ASLR for +V2 Doors

Required Setup
Setup

Task Times
1:00 (1st day)
0:15 (nth day)
0:30 (nth day)
1:00 (last day)

Closeup

(±) 0° → 90°



* Includes BAPS Post installation
asl - aft shroud door latch contingency
rot - crew change positions in manipulator foot restraint
lga - high gain antenna deployment

Mission Priorities

- Crew Safety
- HST SM OPS: RNDZ, Service, and Deploy HST
- DTO's: 700-14 GPS, 700-15 SIGI
- DSO's: No in-flight DSO's

Servicing Mission Priorities

- 3 Rate Sensor Units (RSU's)
- 6 Voltage/Temperature Improvement Kits (VIK's)
- 486 Computer to Replace DF224
- Fine Guidance Sensor 2 (FGS-2)
- S-band Single Access Transmitter 2 (SSAT-2)
- Solid State Recorder (SSR) to replace ESTR-3
- Bays 5-10 MLI Repair (New Outer Blanket Layer - NOBL)
- NICMOS Valve Open
- Shell/Shield Replacement Fabric (SSRF)
- Lubricate 7 Aft Shroud Door (ASD) Latches
- Handrail Covers
- ASD Latch Repair for +V2 doors
- Inspections

Minimum Success: 5 Operational Gyro's - 4 Newly Installed

Full Success: 6 Operations Gyro's, 6 VIK's, 486, and FGS

Servicing Mission Priorities

- One EVA
 - 3 RSU's
 - 6 VIK's
- Two EVA's
 - EVA 1: 3 RSU's, 6 VIK's
 - EVA 2: 486, FGS
- 486 will not be installed if inadequate EVA time exists for removal and installation of the spare 486.
- MDF on FD1
 - Attempt FD2 RNDZ, FD3 EVA and deploy, FD4 landing

MISSION OPERATIONS DIRECTORATE FLIGHT DIRECTOR OFFICE



**STS-103 FRR SPECIAL TOPIC:
RNDZ/GRAPPLE OF HST IN HARDWARE SUNPOINT
OR ZERO GYRO SUNPOINT**

Background

- 3 of 6 Rate Gyro Assemblies (RGA's) are required for nominal pointing mode and science operations.
- 4 of 6 gyros RGA's are failed onboard HST.
- Normal pointing mode is not available and science operations were terminated.
- HST is currently in "Zero Gyro Sun Point (ZGSP)"
 - Aligns +V3 with sun vector
 - Uses Course Sun Sensor (CSS), Reaction Wheel Assemblies (RWA's), etc.
 - Worse case HST rates ~ 0.15 deg/sec per axis

Background

- A second control mode, Hardware Sunpoint (HWSP) is available
 - Uses 3 back-up gyro's: Retrieval Mode Gyro Assemblies (RMGA's)
 - Uses Pointing and Safemode Electronics Assembly(PSEA)
- Procedures and rules in place for Orbiter approach and grapple in either ZGSP or HWSP
- RNDZ training with expected HST rates was performed
 - Orbiter yaw and/or pitch may be required at 120 ft. to grapple range for alignment.
 - Orbiter rates not to exceed 0.5 deg/sec/axis.
 - Orbiter to inertial hold for grapple.
 - Track and capture HST with RMS.

Rendezvous Plan with HST Gyro Failures

In either ZGSP or HWSP, the following apply:

- Rbar Approach - No change from nominal.
- HST Appendage Configuration at Retrieval -No change from nominal.
 - HST Aperture Door (AD) is closed.
 - High Gain Antennas (HGA's)retracted on FD2.
 - Solar Arrays (SA's) at 90 deg (along the V1 axis).
- RNDZ attitude and roll maneuver for capture will not be complete.
 - Orbiter approach from any direction is acceptable
 - Orbiter will fly around HST at ~120 - 70 ft.

Rendezvous Plan with HST Gyro Failures

- Prior to TI burn, configure HST to HWSP
 - Reconfigure DF224 computer
 - ZGSP available as backup mode (ground command required)
- RNDZ, approach & grapple with HST in HWSP.
 - HST in stable configuration with minimum rates.
- If a Retrieval Mode Gyro fails, back out to safe distance, reconfigure HST to ZGSP, and continue with approach and grapple.
- If a Retrieval Mode Gyro fails prelaunch, plan for ZGSP approach and grapple.
- STS-103 flight rules reflect this philosophy

Rendezvous Options: ZGSP vs. HWSP

ZGSP

Aligns +V3 with sun

Uses Coarse Sun Sensors to align with sun

Uses no gyros

Worse cases rates ~0.15 deg/s

No correction to drift during night pass

Worse rates prior to sunrise

DF224 computer in control

Single fault tolerant (auto failover to Pointing & Safemode Electronics Assembly - PSEA)

HWSP

Aligns +V3 with sun

Uses Coarse Sun Sensors to align with sun

Uses 3 RMGA's

Single fault tolerant with gnd cmd to ZGSP

Worse case rates ~0.007 deg/s

gyro hold during night pass

PSEA in control

Single fault tolerant (auto failover to redundant side)

DF224 operating for TLM

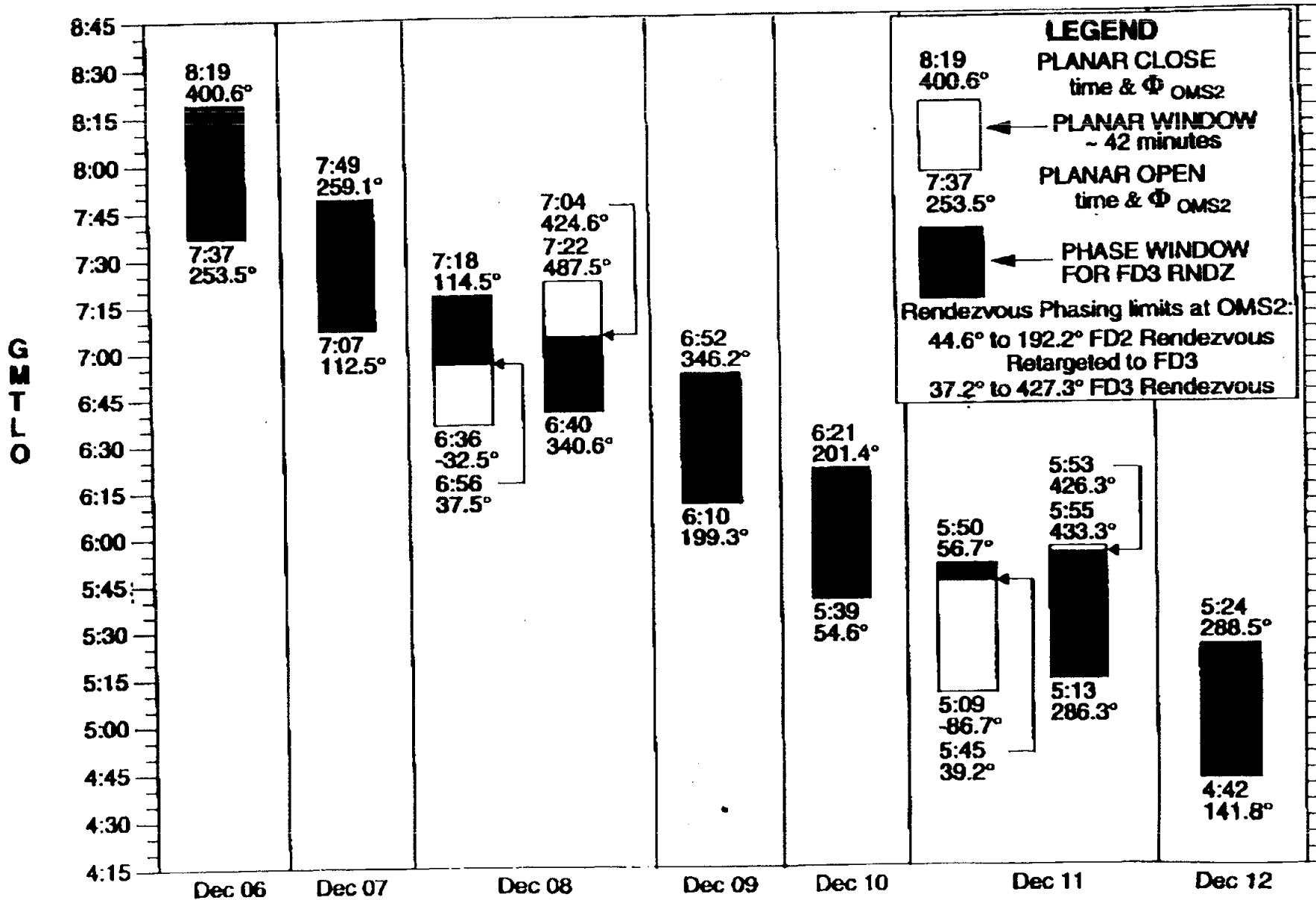
Other Considerations

- EVA timelines may require modification to replace Electronics Control Unit (ECU).
 - ~ 1 hour task.
 - Crew trained for task.
- Orbiter SM software patch required for onboard HST drift command.
 - Command allows the crew to power off the PSEA's after grapple (HST to drift mode).
 - Prevents saturation of the Reaction Wheel Assemblies and solar array slew.
 - Plan to add command to SPEC 210

Open Work

- HST to explain ZGSP attitude excursions.
- Additional training runs with HST in both control modes.
- Implement/validate Orbiter software patch to add drift cmd.
- Space Telescope Operations Control Center prelaunch test of HWSP with Retrieval Mode Gyros in control.
- Update HST ground command plan.
- Update EVA plan/timeline to include Electronics Control Unit changeout
-

STS-103 Daily Planar/Phase Window (Back-Up Chart)



Rendezvous Options: ZGSP vs. HWSP

ZGSP Risks

High rates increase difficulty of
HST track and capture
Timing of arrival critical
Rates build during night pass
Best time for capture is prior to
sunset
Attitude excursion periodically
exceeds predictions

ZGSP Advantages

DF224 in control
Nominal drift cmd operational
Crew and gnd receive feedback
that cmd to drift was successful
Weeks of operations in ZGSP

HWSP Risks

RMGA limited life
No experience in HWSP with
RMGA's for control (plan to test
prelaunch)
Initial gnd cmd in the blind required
to recover comm post HWSP
Orbiter software patch required for
onboard drift CMD

HWSP Advantages

Insignificant rates for track and
capture