

Hubble Space Telescope  
High Speed Photometer  
Final Report

Space Science and Engineering Center  
and  
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University of Wisconsin  
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## 1. Purpose of the HSP Final Report

This HSP Final Report is the third of a series of three reports covering the mission of the HSP on the Hubble Space Telescope. The first report, *Hubble Space Telescope High Speed Photometer Orbital Verification Test Report, November 1991*, covers the Orbital Verification (OV) test activities. It includes the early Science Verification (SV) and Science Assessment Observation (SAO) beginning with launch in April 1990 and ending with the phase III alignment completed on June 8, 1991. The second report, *Hubble Space Telescope High Speed Photometer Science Verification Test Report, July 1992*, covers the period June 9, 1991 through May 1992. It includes Science Verification tests, some Guaranteed Time Observations (GTO), General Observer (GO) Observations, and calibration Tests. This final report concentrates on the activities subsequent to the period covered by the earlier reports, and also summarizes the overall experience, lessons learned, and important conclusions.

## 2. Executive Summary

The HSP performed as designed without failure during the HST mission. Although one of the five detectors, the VIS image dissector, exhibited a loss of throughput for most of the mission, it returned to nominal values near the end. The reason for this behavior is not understood. In all other respects, there were no failures or anomalies. The redundant electronics were not needed during the mission. Post mission inspections and tests suggest the HSP suffered no degradation during the mission and is a viable candidate for reflight.

## 3. HSP Performance

The HSP performed as designed during the period of this report with the exception of the gain of detector #3, the VIS detector. It continued to degrade until the fall of 1993 when it suddenly returned to the value typical of the early portion of the mission. The reason for this behavior is not understood. In all other respects, HSP performance was uneventful.

### 3.1. Thermal

The HSP thermal design requirements centered around three major considerations:

1. Running the detectors (four image dissector tubes and one photomultiplier tube) as cool as possible to keep the detector dark noise as low as possible.
2. Maintaining the electronics temperatures within a reasonable operating range by dissipating the electronics subsystem power.
3. Maintaining the external surfaces and latch fittings (the thermal interfaces) within the limits specified in the ICD (Interface Control Document).

The first two were generally satisfied using passive design elements: conducting and radiating heat to external radiating surfaces to keep electronics and detectors cool, thermally isolating the detectors from electronics having large power consumption to keep heat away from the detectors, and minimizing heat flow with low emissivity surfaces where required. The third, maintaining specified interface temperatures (and related requirements placing limits on heat flow through the latch fittings and external surface temperature gradients) required an active solution using heaters.

The active thermal control is designed to maintain the interface bulkhead temperatures within the required limits and to control the detector temperature by minimizing the warm-up time from the start of operations. The active system uses resistive heaters mounted on the forward and aft bulkheads and on the image dissector tubes. There are nine separate heater circuits, three each on the forward bulkhead, the aft bulkhead, and the detectors. The size of the bulkhead heaters is based on the instrument thermal model and is chosen to maintain satisfactory thermal performance with only one of the three circuits operable on each bulkhead at minimum bus voltage. The bulkhead heaters operate from unregulated, input bus voltage; the detector heaters are powered from a pre-regulated bus.

Satisfying the interface temperature requirements with available power was impossible with mechanical thermostats controlling the bulkhead heaters. The input bus voltage variations resulted in either excessive power consumption at maximum bus voltage, or interface temperatures below limits at minimum bus voltage, depending on the size of heaters. However, if the power applied to the heaters was controlled by software having knowledge of the input bus voltage, the interface requirements were satisfied. A software controlled, active system was therefore designed.

This system controlled the HSP heater circuits according to the desired power profile. It was designed to have great operational flexibility to meet unexpected needs during the mission. Although only a portion of the capability of the system was ever exercised, that portion performed as designed. (The thermal control system is described in: Richards, E.E., Percival, J.W., Sitzman, J.C., Jones, T.E. Thermal control of the space telescope high-speed photometer, SPIE Volume 1945 Space Astronomical Telescopes and Instruments II, pp 224-232, 1993.)

The flexibility designed into the system was exploited early in the mission when the HSP hold mode was redefined. The original HSP hold mode was all electronic power off except for the remote interface units (RIUs) and heaters activated on the forward and aft bulkheads to maintain interface temperatures. The hold mode was defined this way because it satisfied the cold hold thermal model case runs. As expected in actual practice, cold limits were not as severe as the worst case models predicted, so it was possible to satisfy the interface temperature requirements with a new configuration that offered several operational advantages.

The new hold mode did not use the HSP heaters, but instead left some of the core electronics powered on. The power required was actually slightly less than the original hold mode and the HSP electronics temperatures were nearly the same in hold and operate modes. This not only eliminated considerations of time required to reach thermal stability but also increased system reliability by eliminating the one factor most likely to induce failures in the system: many large amplitude thermal cycles. The temperature change in the core electronics from the original hold to operate mode was about 40 degrees C, but from new hold to operate was less than 5 degrees C. Considering the number of times this transition was made, the new hold mode provided significantly improved reliability.

The HSP thermal control system was also more reliable because it did not use mechanical thermostats. It also provided power conservation because there was no hard wired thermal set point at which heater circuits would be turned on. The thermal control system also included a capability for inhibiting heater switching during observations if the observer was concerned about EMI. The system could also control heaters in response to temperature limits of selected thermal sensors, in effect, a "software thermostat". This mode has the capability for very fine control of a selected area but was never exercised in the mission.

### **3.2. Power**

Power consumed by the HSP throughout the mission was stable and as expected. The HSP bus current monitor is included in the engineering telemetry (V375) and, except for data dropouts caused by problems downstream of the HSP in the data processing channel, there are no anomalous values. Because the HSP has no thermostats, the power consumption was determined only by the HSP operating mode and the input bus voltage which was therefore stable. HSP input bus current was monitored throughout the mission and was consistent with the operating mode.

### **3.3. Electrical and Mechanical**

#### **3.3.1. Electrical**

No electrical problems occurred during the entire mission. There was concern before the mission that the relatively high levels of conducted emission produced by the reply bus driver in the RIU might produce interference in the science data. No evidence of the reply bus driver noise was ever detected in the HSP data.

A scheme was devised to turn off the reply bus driver if its noise caused interference, or might cause interference with a particularly sensitive observation. A SV test was written and submitted (SV 2749) but was not implemented by the ST ScI. The required commanding was not incorporated into SOGS.

#### **3.3.2. Mechanical**

No mechanical problems or anomalies were noted during or after the mission. The stability of the aperture locations in the focal plane indicates no change in the positions of the critical elements (apertures, mirrors, and detectors) of the HSP to the extent possible to detect with the degraded HST primary mirror.

### **3.4. Depressurization**

The HSP has no pressure sensor. The structure is predominantly aluminum with a small amount of fiberglass in areas where low thermal conductivity is required. Because there was minimal outgassing potential, a large vent area, and a conservative outgassing time planned in the mission before turning on high voltage, no problems were encountered. There is no evidence of any problems with depressurization or partial pressures due to ram effects.

### **3.5. Flight Software**

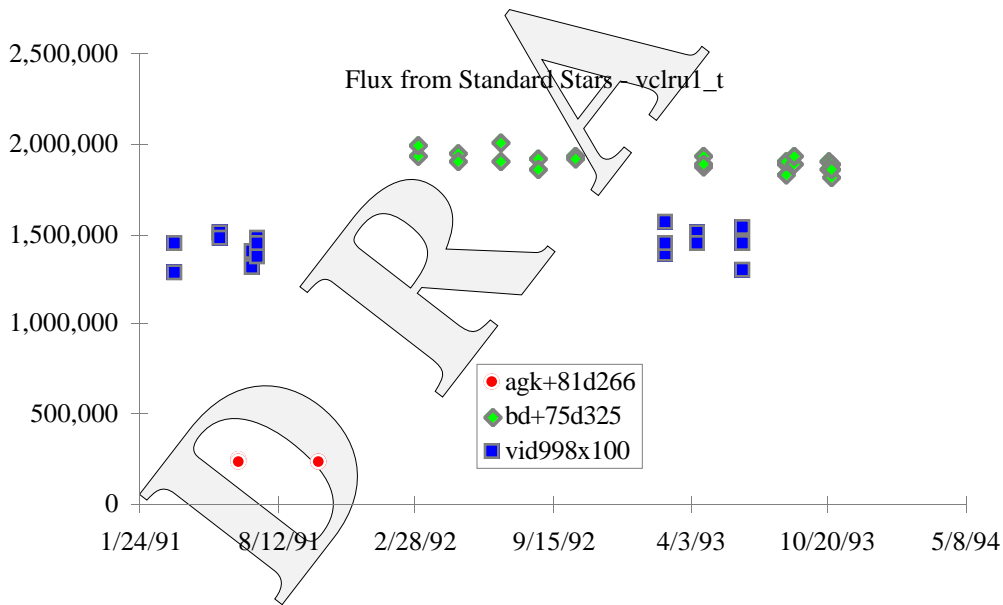
Flight software remained stable and operated as designed throughout the mission. Some of the flight software features, such as the (thermostat) heater control mode, were not exercised although were available to meet possible operational scenarios.

### **3.6. Detectors**

HSP detector performance, with the exception of the VIS detector (detector #3), was stable throughout the mission. The HSP has five detectors: four image dissector tubes (IDTs) and one photomultiplier tube. The photomultiplier tube had a red sensitive photocathode (GaAs)

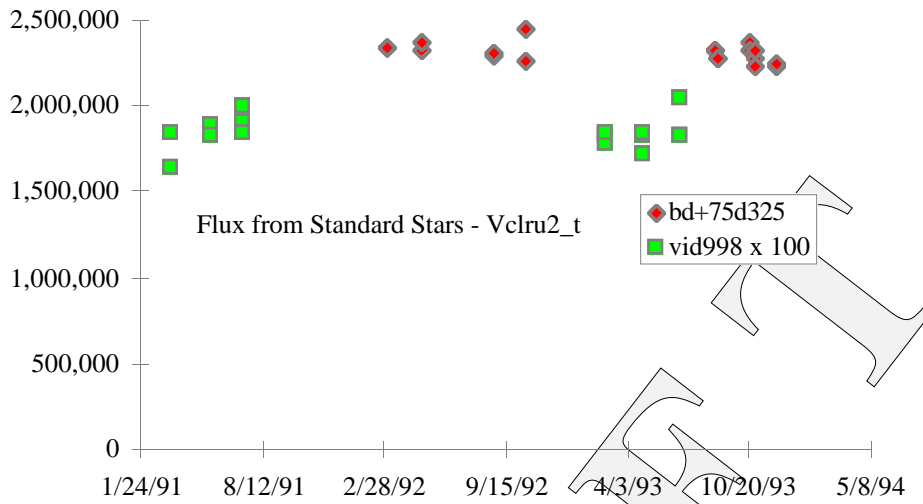
and was used primarily for occultation observations. Two of the IDTs have a visual sensitive photocathode (MA1), and two have a near-UV sensitive photocathode (CsTe). The dark count rate of the detectors was a good indicator of general health; all five detectors had stable dark counts during the mission. Detector gain was determined by observing standard stars at various times during the mission. Three of the IDTs, both UV detectors and the POL detector, maintained constant gain over the life of the mission. The VIS detector gain began decreasing at a linear rate soon after launch and continued to near the end of the mission. But in the fall of 1993, the gain suddenly returned to its early mission value and remained at that level until the end of the mission. The best indication of the gain trend of the IDTs was obtained from observations of standard stars over time taken in the clear acquisition apertures of the various IDTs. Because the acquisition aperture is large (10 arc seconds for UV1,2 and VIS; 6 arc sec for POL), it is less subject to image vignetting and errors introduced by pointing jitter because the image is entirely contained within the aperture well away from the edges. Also, the acquisition observations are 20 x 20 raster scans, which scan the entire star image. A total flux can then be determined by summing all the pixels in the 20 x 20 image. The resulting total flux is much less subject to errors than single color photometry observations of the same star through one arc second apertures.

The gain of the HSP IDTs using this total flux measurement is shown on the following charts.



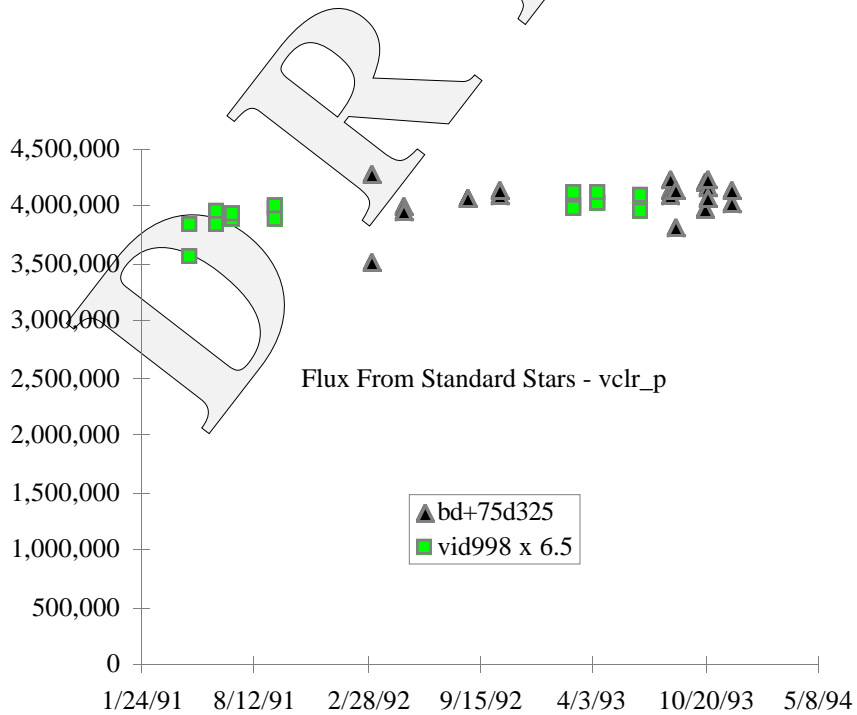
**Figure 3.6-1 Flux from Standard Stars for UV-1 Clear Aperture**

Figure 3.6-1 shows the total flux from three standard stars taken during observations spread over the duration of the mission. The three stars have different brightness and spectral characteristics; therefore, the observed flux for each is different, although over time the flux observed from a given star remains nearly constant. This indicates the gain of IDT UV-1 remained constant over the period of the mission.



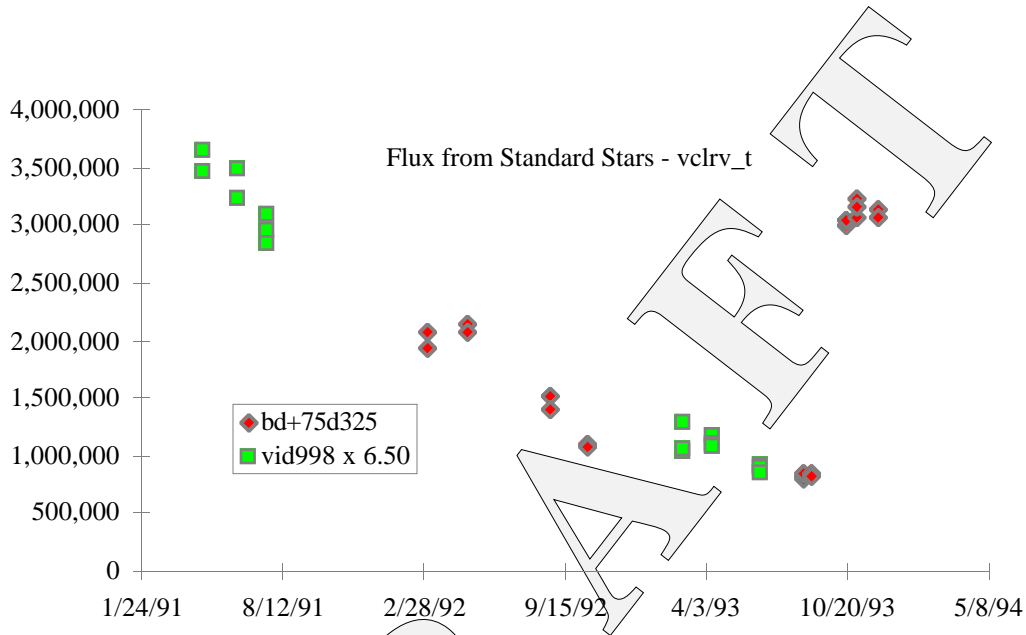
**Figure 3.6-2 Flux from Standard Stars for UV-2 Clear Aperture**

IDT UV-2 shows a similar pattern in Fig 3.6-2 to UV-1 and was stable throughout the mission.



**Figure 3.6-3 Flux from Standard Stars for POL Clear Aperture**

The two standard stars observed by the POL tube, bd+75d325 and vid998, had different total flux values as measured by the POL tube but were both reasonably stable over time. Since the VIS and POL tubes had identical photocathodes and used the same standard stars for calibration through identical faceplates and clear filters, the POL tube could be used to normalize the two standard stars for the VIS tube. As shown in Fig 3.6-3, the total flux observed by the POL detector from vid998 multiplied by 6.5 is approximately equal to the total flux from bd+75d325.



**Figure 3.6-4 Flux from Standard Stars for VIS Clear Aperture**

Applying the normalization factor of 6.5 to the vid998 flux data can determine the gain history of the VIS tube as shown in Fig 3.6-4. Note that the calibration observations of bd+75d325 beginning in October 1993 resulted in total fluxes near the level of those observed in 1991. The reasons for the drop in response between 1991 and late 1993 and the sudden reversal of that two year trend remain unknown. Many possible mechanisms were explored tested after the HSP returned from HST for post mission analysis. No anomalies in any supporting electronics were found, nor were any irregularities found in the engineering data.

### **3.7. Alignments**

The alignment of the HSP apertures to the HST focal plane was stable. During SV the positions of the HSP apertures were determined to within 0.02 arc seconds, a value much more precise than was assumed before launch. There was no need to re-determine these positions during the GTO and GO phases of the mission.

### **3.8. Magnetic Shielding and Effects**

The HSP image dissector tubes (IDT) use magnetic deflection to direct the selected portion of the electron beam from the photocathode through the IDT aperture. Magnetic shielding was incorporated in the design of the assembly to make the IDT immune to the effects of

the earth's magnetic field and other fields that may be present. No specific tests were designed to verify magnetic field immunity, but given the sensitivity of the aperture location calibrations to such effects, none were considered necessary. There was no evidence in any of the aperture calibrations or other data of any detectable effect due to magnetic fields.

### **3.9. Sensitivity to SAA**

Tests were proposed to measure HSP sensitivity to the SAA but were never approved. The HSP data was collected generally outside the SAA; no evidence emerged to indicate sensitivity to the SAA.

### **3.10. Contamination**

One of the key items of interest in the returned hardware inspection and test program was contamination. No evidence of contamination was discovered in the HSP data collected during the mission or in the post flight analysis. Evidence of contamination was found on the external HSP forward bulkhead surface exposed to the HSP focal plane and to bright earth (not shaded by focal plane structure elements). The post flight contamination inspection is described in HST FSM Contamination Report P442-0667 and a GSFC memo (Colony to Greenberg) dated 1/31/94.

The level of contamination found on HSP external surfaces in the post mission inspections would not have been detectable in the HSP observations or calibrations because the UV absorption at the wavelengths of the filters actually used was insignificant.

### **3.11. Throughput**

The HSP throughput was stable throughout the mission with the exception of the VIS detector discussed in section 3.6 above.

### **3.12. Sensitivity to Bright Objects**

There were no problems related to bright objects in the GTO/GO period. The measures taken to preclude recurrence of incidents of the type encountered in OV were effective. The early OV problems were the result of inexperience with operations, not system failures.

### **3.13. Primary Mirror Aberration**

Spherical aberration in the primary mirror had a major impact on the intended mission of the HSP. Meeting the CEI Specification requirements for the HSP for photometric stability and accuracy depended on having an image reasonably close to the intended (unaberrated) HST image. Aberration made the size of the image large relative to the HSP apertures which meant that photometry was much more sensitive to the effects of mis-centering and jitter. The ability to detect objects at the faint end of the intended magnitude range was also lost. Therefore, after the discovery of spherical aberration, the GTO program was redirected to objectives that were less sensitive to the major problems in HST: aberration and jitter.

### **3.14. Jitter**

As the HST mission evolved and pointing software was refined, jitter performance improved. The large excursions, typically encountered shortly after day-night transitions, were obvious in the HSP data and could therefore be excluded.

## **4. Program Development, Execution, and Results**

### **4.1. Program Development**

At the end of the SV period, there were several liens described in the HSP SV Report (paragraph 4.7, page 2), some of which were resolved in the GTO/GO period.

Two SV tests were not completed at the end of the SV period: 3396 and 1386. Test 3396, which tested the fine alignment of the HSP prism apertures, was never run because the alignment of the prism apertures was not sufficiently understood to assure fine alignment could be completed within a reasonable amount of time. Test 1386, the instrumental polarization test, was revised and run successfully as 3985 in June 1992.

The HSP memory dump problem was never resolved. As described in the SV Report, no mechanism was available to dump HSP memory and get the data in electronic form. Procedures were developed but implementation was never authorized because it was not considered a sufficiently high priority.

The commanding change needed to reset the frame count during a data collection was implemented and used effectively for several data collections.

Raw data in the form of .pks files was used for observations exceeding the capacity of the Post Operations Data Processing System (PODPS) s. This method was satisfactory and did not impose any difficulties in the analysis.

### **4.2. GTO/GO Events in Chronological Order**

The observations performed in the GTO/GO period are listed in section 7.4. The GTO, GO, and calibration observations are listed separately. There was one SV test, 3985 (a revised version of 1386, Instrumental Polarization), performed in June and July 1992.

### **4.3. Test Specific Performance**

In all GTO and GO observations, the HSP performed as designed, except for the VIS detector loss of throughput described in section 3.6.

### **4.4. Data Analysis and Results**

(TBS: Watch this space)

### **4.5. Database Updates**

No database updates were required after those performed during SV and previously reported.

#### **4.6. GO/GTO Anomalies**

Sixteen anomalies involving HSP observations were described in HST Observation Problem Reports (HOPR). Of the sixteen, fifteen occurred during the GTO/GO period. The HOPR reports and their dispositions are included in Appendix 7.8. The problems included: missed targets, which occurred for various reasons including fixed head star tracker update failure, target too red for exposure time specified, and incorrect coordinates supplied with proposal; pre-empted observations; scheduling errors; commanding errors; and excessive jitter. No problems attributable to the HSP occurred during the period.

#### **4.7. End of Mission Status**

The one-day delay of the shuttle launch for the HST servicing mission allowed us to perform one additional calibration which confirmed the VIS detector throughput had remained nominal. Earlier in the mission (see section 3.6), the VIS detector throughput had steadily declined until the fall of 1993 when it suddenly returned to a nearly normal value. The final calibration confirmed the return to nominal throughput. It also showed that the "restored" value was stable for the final months of the mission.

The reason for the drop in VIS detector throughput and its later return to nominal values was the only instance of HSP performance not working as designed. Two cases earlier in the OV and SV periods appeared to be single event upsets that were cleared by a reboot. No lasting effects of these events were evident and no such incidents occurred in the GTO/GO period.

#### **4.8. Future GTO Plans**

About 30 hours of unused HSP GTO time remained at the end of the HSP mission. The unused hours are from observations that could not be scheduled before the servicing mission and attempted observations that were not completed for various reasons and the time was refunded to the HSP team. This time will be redirected to observations using the post servicing mission instruments.

### **5. Post Mission Activities**

#### **5.1. Returned Hardware Inspections and Tests at GSFC**

The servicing mission returned to Kennedy Space Center with the HSP inside the SIPE (Scientific Instrument Protective Enclosure). It remained there while being transported to GSFC in January via ship to Baltimore and truck to GSFC (Goddard Space Flight Center). The GSFC activities are summarized in the HSP chronology in section 7.6.

The most important consideration in planning the post mission activities was to preserve information. Scheduling activities was carefully considered to minimize the chance that a particular inspection, test, or operation would destroy information that might be retrieved by a later activity. The primary objectives in post mission activities were: to support GSFC requests for information (for example, system level contamination investigations); to determine if there might be additional information about the mysterious behavior of IDT 3 during the mission; to determine if problems or failures at the subsystem or component level were undetected at the system level; to compare the post mission performance of the HSP with similar tests conducted before integration into HST; to assess the condition of the

HSP for possible reflight; and to learn whatever might be usefully applied to future instruments by determining how various construction techniques, parts, materials, or processes withstood the rigors of integration, system test, flight, and return to earth.

In late January, the HSP was removed from the SIPE at GSFC and carefully inspected. Small areas around each rivet contained Bray oil deposits. These were expected and had been seen before launch. The lubricant applied to the rivets by the manufacturer is not acceptable for use on HST because it exceeds the outgassing and VCM requirements. It was therefore removed and replaced with a minute amount of Bray oil, a low outgassing lubricant that has a tendency to creep. The area affected by this creep is only the small area immediately surrounding the rivet. Except for these anticipated Bray oil stains around the rivets, there was no evidence of contamination or damage to the HSP. Contamination samples were taken and analyzed. The overall contamination found on the HSP was equal to (or in some cases less) than the level found before spacecraft integration.

Photographs of the filter aperture assemblies were taken and sketches were made of visible features. The filters had not changed in appearance since last seen at LMSC (Lockheed Missiles and Space Corporation) before integration. These inspections were made from the outside of the HSP without removing of any panels because the HSP envelope dimensions were going to be verified in the quarter panel before any mechanical operations were performed on the HSP.

Before any other tests were performed, a complete set of HSP interface and functional tests, including a very crude throughput check, was performed. All HSP functions were verified and no malfunctions or anomalies occurred. These tests included, for the first time since launch, a complete verification of all the HSP redundant electronics which was not powered during the mission because there was no need.

After the functional tests, the HSP was installed in the quarter panel for verification of envelope dimensions before any mechanical changes were made. The HSP was also installed in the FOS bay of the HST High Fidelity Mechanical Simulator to verify it's interface.

With all the interface dimensions re-verified, the first mechanical operation on the HSP was the removal of the ODS cover so that one of the filter-aperture assemblies could be removed and replaced with the focal plane tool. At this time, more interior inspections were done and a large number of photographs were taken. No anomalous conditions were found. Everything appeared to be as it was before launch.

The HSP was then installed in the quarter panel to verify the focal plane position using the tool installed in the place of the filter aperture assembly. The verification was done in both a horizontal and vertical orientation.

After removal from the quarter panel, the HSP latch fitting interfaces were tested for mechanical flaws in the same manner as before launch, using both eddy current and ultrasonic flaw detection tests. The pre-launch test methods were described in report NSI-94R-246C which is attached to the report of the April 1994 tests, Lugmayer Associates Report LAJ-1850-94. No flaws were detected. It is reasonable to conclude, therefore, that no adverse affects arose from the use of 2024 aluminum (a table 3 material as specified in MSFC-SPEC-522B) in the HSP structure. There was no evidence of stress corrosion cracking.

In late April the flight RIUs, the EU, and the latch fittings were removed from the HSP. The HSP remained at GSFC for public information purposes during May and June but was packed into the shipping container in mid-July and shipped to UW Madison.

## **5.2. Tests and Inspections at UW-Madison**

The HSP arrived in Madison on July 15, 1994, and was briefly stored in its shipping container at the Space Science and Engineering Center because the trailer could not clear the loading dock ramp at Chamberlin Hall. The following week, the HSP was moved Chamberlin Hall in a UW truck. It was then moved to the 6th floor to be stored over the weekend in a secure location in the Space Astronomy Laboratory. The plan was to return to the loading dock early the following week and use the overhead crane to remove the HSP from the shipping container and place it in the handling dolly. However, the Chamberlin Hall freight elevator failed marooning the HSP in its shipping container on the sixth floor.

HSP activities were suspended awaiting the repair of the freight elevator. Complications arose in the elevator repair project so alternative methods of handling the HSP were devised. The HSP was removed from the shipping container and moved to the SAL cleanroom on January 5, 1995.

The HST Returned Hardware Seminar held at GSFC in December 1994 had highlighted the interest in determining the source of contamination observed on the WFPC optics. Samples were taken from the HSP by Craig Chivatero of LMSC on January 18. Additional samples were taken for GSFC analysis on January 27 and February 3.

In February 1995, the HSP was subjected to a series of electrical and functional tests beginning with an EICIT (Electrical Interface Compatibility Test) and IVT (Interface Verification Test). The engineering model RIU and EU were installed so the HSP could be operated with the EGSE for a series of functional tests.

A complete, long form functional test was performed in mid-February. All functions, including the redundant units that were not operated during the mission, operated without failure or anomaly.

After the functional tests were completed and before any disassembly started, the optical filters, apertures, and prisms were inspected and photographed. There was no apparent change in their condition since the inspections performed before launch.

The major unsolved mystery of the HSP is the change in the throughput of the VIS detector (IDT #3) described earlier (paragraph 3.6). A series of tests was run in March to explore this anomaly. First the VIS detector was operated for about a week using a small light leak to room ambient lighting (which was kept on in the same configuration for the duration of the tests) for a light source. The VIS detector operated as expected with nominal noise levels and reasonable response to the light source. Next a two detector SSP (Star-Sky Photometry) data collection was run for about a week to compare the response of the POL and VIS detectors. The result was that the response of the VIS and POL detectors tracked and there was no evidence of instability or change of throughput in the VIS detector during the test. Next the high voltage power supplies (HVPS) for both the VIS and POL detectors were removed for box level testing and replaced by flight spares which had just been tested (and performed just as they did in previous tests). The VIS and POL SSP test was repeated to see if there was any HVPS dependency on performance. As far as could be determined, the results were the same as before. The final HSP system level test was a repeat of the VIS

& POL SSP with the VIS detector replaced by the flight spare. Again, no significant difference in performance could be seen.

At the end of March 1994 activities came to a halt awaiting a decision to refurbish the HSP for possible reflight with two detectors having corrective optics. Thus ended HSP hardware development, at least for the moment, which began with the submission of the proposal in the summer of 1977.

### **5.3. Reflight development status**

In May 1995, the HSP team presented a one-day review of a concept to refurbish the HSP with corrective optics for two detectors and a fiber fed spectrometer. The refurbishment could be done with relatively modest resources because much of the original HSP could be reused. This concept may be proposed in response to a future HST instrument AO.

## **6. Conclusions, lessons learned, and recommendations**

### **6.1. Thermal**

An interesting characteristic emerged from the HSP thermal data in the fall of 1994. After the servicing mission, the HSP engineering data was extracted from OMS (Observatory Management System) and archived on the Unix cluster at ST ScI. That project was a background task that took several months to complete. When all the data was archived, one HSP team member began to make plots of selected engineering data for a calendar month to look for anomalies or subtleties that may have been missed during the HSP mission. One focus of attention was the mysterious behavior of the VIS detector throughput and any engineering data that might be relevant. Nothing unexpected was found.

To see if any long term trends might be evident, plots of selected thermal monitors were made covering the entire period of HSP operations. Every plot had a common characteristic: a monotonic rise in temperature at a rate between 1.0 and 1.3 degrees C per year. That trend is not apparent in weekly, monthly, or even several month plots because the short and medium term variations are larger; for example, the changes from hot to cold orbits. When viewing the plots for more than a year, and especially those covering a three-year-plus period, the trend is immediately noticeable, even in the raw (not averaged) data. When moving average data is plotted, the trend is even more clear.

When this phenomenon was called to the attention of the system thermal engineering group, it had not been noticed because the capability of the system at that point did not allow for processing or plotting data for long periods. However, a new system was available soon thereafter and the same trend could then be seen in the other HST SIs. It is now recognized that the effective sink temperatures in the HST aft shroud are increasing at a rate between 1.0 and 1.3 degrees C per year. One possible cause of this warming is degradation of the flexible optical solar reflector (FOSR) from orbital environmental factors, an effect anticipated long ago by Lockheed thermal engineers.

The warming trend may have major significance for future HST instruments because sink temperatures could be 15 degrees C or more higher than present values. For additional information on this topic, see Richards, E.E., Townsley, L.C., Wiggins, C.L., Lessons Learned from HST/HSP thermal engineering data, SPIE Volume 2478 Space Telescopes and Instruments, pp 130-141, 1995.

## **6.2. Corrective Optics Design for Reflight**

(TBS)

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## 7. Appendices

### 7.1. HSP Proposal numbers and names

The following index lists the 160 HSP proposal numbers sorted in two ways: first by proposal number; secondly by type and name

Source: file: prop.names; sccs: @(#)prop.names 1.48 11/8/93

"pgm" symbols:

CAL Calibration Program  
DD Director's Discretion  
GO Guest Observer  
GTO Guaranteed Time Observation  
GTO+ Guaranteed Time Observation (Augmentation time)  
OV Orbital Verification  
SAO Science Assessment Observation  
SV Science Verification  
SVD Science Verification (Delta plan)  
/E Executed  
/X Canceled

prop    pgm    name  
----    ---    ----

HSP proposals by proposal number:

1079	GTO/X	Opportunity occs by small bodies (3319,4015,4193,4442,4944)
1080	GTO/E	The size and composition of planetary ring particles (3373)
1081	GTO/E	Saturn ring dynamics (3371,3375,4225)
1082	GTO/X	Helium abundances in Jovian planet upper atmospheres (3354)
1083	GTO/E	Dynamics of planetary upper atmospheres (3376,4257,5079,5197)
1084	GTO/X	Lunar occultations with the HST
1085	GTO/X	Rotation periods of cometary nuclei
1086	GTO/E	Do Neptune and Pluto have rings? (4076,4198)
1087	GTO/X	Eclipses and occultations by Pluto and Charon
1088	GTO/X	Small satellites in the Uranian system
1089	GTO/X	Captured satellites of the Jovian planets
1090	GTO/E	Periodic variations in DQ Herculis stars (3257,4945,4502)
1091	GTO/E	UV pulsations from X-ray pulsars
1092	GTO/E	Eclipses of cataclysmic variable stars (3238)
1093	GTO	Observations of ZZ Ceti stars
1094	GTO/E	Search for optical variability assoc. with black holes (3255)
1095	GTO/E	Variability of high luminosity stars (3252,3926,4946)
1096	GTO	Grav lenses (1391,3250,3321,4034,4889,5005,5231)
1097	GTO/E	X-ray binaries (2952,2958,3234,3249,3256,4036,4887,5082)
1098	GTO/E	Remnant stars in SNRs (2953,3251,4037,4083,4202,4828,4888)
1099	GTO/E	Active galactic nuclei (3248,4942,4971)
1100	GTO/X	Evolution of the nuclei of planetary nebulae
1101	GTO/E	Optical and UV observations of radio pulsars (3253,5070)
1102	GTO	UV light and polar. variations in Beta Cephei stars
1103	GTO/E	Vis/UV light curves of RR-Lyrae stars (3254,4807,5084)
1104	GTO/X	High speed photometry of GBS 0526-66

1379	OV/E	Detector dark count test
1380	OV/E	MSC Focus and aperture mapping I (1526,3093,3119,3120)
1381	SV/X	Target acquisition test (3071-3074)
1382	OV/E	Pulse height distribution test
1383	SV/E	Time resolved photometry
1384	SV/X	Color transformation test (2769,2770,3378,3425)
1385	SV/E	Photometric performance test (3382)
1386	SV/E	Instrumental polarization test
1387	SV/X	Stokes parameter test
1389	SV/E	Short-term photometric stability (4701)
1391	GTO	Grav lenses (1096,3250,3321,4034,4889,5005,5231)
1474	SV/E	Photometric performance test
1499	OV/X	Command response test
1500	OV/E	Detector data test
1501	OV/X	Data integrity test
1502	OV/E	High voltage turn-on test
1503	OV/E	MSC coarse FGS/HSP alignment II
1504	OV/E	MSC fine FGS/HSP alignment III (1524,2948-51,3140)
1524	SV/X	MSC fine FGS/HSP alignment III (1504,2948-51,3140)
1526	SV/E	MSC Focus and aperture mapping I (1380,3093,3119,3120)
2113	OV/X	Memory dump
2201	OV/X	Safe-to-old hold
2608	GO	Constraints on continuum models of active nuclei (4810)
2749	SV/X	RIU polling on/off test
2768	SVD/X	Pulse height distribution test
2769	SV/E	Color transformation test (1384,2770,3378,3425)
2770	SVD/X	Color transformation test (1384,2769,3378,3425)
2771	SV/E	Stellar occultation by planetary rings
2772	SVD/X	Stellar occultation by dark lunar limb
2773	SVD/X	Stellar occultation by planetary atmospheres
2912	CAL/E	Photometric calibration (4033,4166)
2948	SV/E	MSC fine FGS/HSP alignment III UV2 (1504,2949,2950,2951,3140)
2949	SV/E	MSC fine FGS/HSP alignment III UV1 (1504,2948,2950,2951,3140)
2950	SV/X	MSC fine FGS/HSP alignment III VIS (1504,2948,2949,2951,3140)
2951	SV/X	MSC fine FGS/HSP alignment III POL (1504,2948,2949,2950,3140)
2952	GTO/E	X-ray binaries (1097,2958,3234,3249,3256,4036,4887,5082)
2953	GTO/X	Remnant stars in SNRs (1098,3251,4037,4083,4202,4828,4888)
2958	GTO/X	X-ray binaries (1097,2952,3234,3249,3256,4036,4887,5082)
3006	SAO/E	Effect of centering errors on HSP photometry
3007	SAO/E	Effect of jitter on HSP photometry
3069	OV/E	10.2/Bright earth test
3071	SV/E	Target acquisition test POL (1381)
3072	SV/E	Target acquisition test UV1 (1381)
3073	SV/E	Target acquisition test UV2 (1381)
3074	SV/E	Target acquisition test VIS (1381)
3093	SV/E	MSC Focus and aperture mapping I (1380,1526,3119,3120)
3119	SV/E	MSC Focus and aperture mapping I (1380,1526,3093,3120)
3120	SV/E	MSC Focus and aperture mapping I (1380,1526,3093,3119)
3135	SV/E	The Secret Stanley Test (focus and ap. mapping, uv, revised)
3140	SV/E	MSC fine FGS/HSP alignment III (nelson plan) (1504,1524,2948-51)
3152	OV/E	MSC aperture mapping II/III (jwp plan) (3233,3362,3363)
3233	OV/E	MSC aperture mapping II/III (jwp plan) (3152,3362,3363)
3234	GTO/E	X-ray binaries (1097,2952,2958,3249,3256,4036,4887,5082)
3238	GTO	Eclipses of cataclysmic variable stars (1092)

3248	GTO/E	Active galactic nuclei (1099,4942,4971)
3249	GTO/X	X-ray binaries (1097,2952,2958,3234,3256,4036,4887,5082)
3250	GTO/E	Grav lenses (1096,1391,3321,4034,4889,5005,5231)
3251	GTO/X	Remnant stars in SNRs (1098,2953,4037,4083,4202,4828,4888)
3252	GTO/X	Variability of high luminosity stars (1095,3926,4946)
3253	GTO	Optical and UV observations of radio pulsars (1101,5070)
3254	GTO/X	Vis/UV light curves of RR-Lyrae stars (1103,4807,5084)
3255	GTO/E	Search for optical variability assoc. with black holes (1094)
3256	GTO/X	X-ray binaries (1097,2952,2958,3234,3249,4036,4887,5082)
3257	GTO/E	Periodic variations in DQ Herculis stars (1090,4945,4502)
3319	GTO/E	Opportunity occs by small bodies (1079,4015,4193,4442,4944)
3321	GTO/X	Grav Lenses (1096,1391,3250,4034,4889,5005,5231)
3354	GTO	Helium abundances in Jovian planet upper atmospheres (1082)
3362	OV/E	MSC aperture mapping II/III (jwp plan) (3152,3233,3363)
3363	OV/X	MSC aperture mapping II/III (jwp plan) (3152,3233,3362)
3371	GTO	Saturn ring dynamics (1081,3375,4225)
3373	GTO/E	The size and composition of planetary ring particles (1080)
3375	GTO/E	Saturn ring dynamics (1081,3373,4225)
3376	GTO/X	Dynamics of planetary upper atmospheres (1083,4257,5079,5197)
3377	SV/E	Pol detector test
3378	SV/E	Color transformation test (1384,2769,2770,3425)
3382	SV/E	Photometric performance test (faint end) (1385)
3383	OLT/E	The STScI jitter test
3425	SV/E	Color transformation test (1384,2769,2770,3378)
3557	GO/E	Polarimetric observations of the Crab pulsar in the UV
3607	GO/E	Quasi-periodic oscillations in AM Herculis binaries (4801)
3798	GO/E	A search for radial pulsation in white dwarfs (4307)
3926	GTO/X	Variability of high luminosity stars (1095,3252,4946)
3985	SV/E	Instrumental polarization test (revised)
3996	SV/E	Prism mode test
4015	GTO/E	Opportunity occs by small bodies (1079,3319,4193,4442,4944)
4033	CAL	Photometric calibration (2912,4166,4209,5022)
4034	GTO+	Grav lenses (1096,1391,3250,3321,4889,5005,5231)
4036	GTO+	X-ray binaries (1097,2952,2958,3234,3249,3256,4887,5082)
4037	GTO+	Remnant stars in SNRs (1098,2953,3251,4083,4202,4828,4888)
4076	GTO/E	Do Neptune and Pluto have rings? (1086,4198)
4083	GTO/E	Remnant stars in SNRs (1098,2953,3251,4037,4202,4828,4888)
4166	CAL	Photometric calibration (2912,4033,4209,5022)
4193	GTO/E	Opportunity occs by small bodies (1079,3319,4015,4442,4944)
4198	GTO/E	Do Neptune and Pluto have rings? (1086,4076)
4202	GTO	Remnant stars in SNRs (1098,2953,3251,4037,4083,4828,4888)
4209	CAL/E	Photometric calibration (2912,4033,4166,5022)
4225	GTO/E	Saturn ring dynamics (1081,3373,3375)
4247	GO/DD	UV observations of Geminga
4257	GTO/E	Dynamics of planetary upper atmospheres (1083,3376,5079,5197)
4307	GO	A search for radial pulsation in white dwarfs (3798)
4363	GTO/E	A search for UV variability in Nova Cyg 1992 (4943)
4442	GTO/E	Opportunity occs by small bodies (1079,3319,4015,4193,4944)
4502	GTO	Periodic variations in DQ Herculis stars (1090,3257,4945)
4569	GO/E	A search for microflaring activity in dwarf M stars
4701	CAL/E	Short-term photometric stability (1389)
4718	CAL/E	HSP polarization verification
4741	CAL/E	HSP orbital effects test calibration
4743	OLT	Heptathalon

4795	CAL/E	FPO test
4801	GO/E	Quasi-periodic oscillations in AM Herculis binaries (3607)
4807	GTO/E	Vis/UV light curves of RR-Lyrae stars (1103,3254,5084)
4810	GO	Constraints on continuum models of active nuclei (2608)
4820	OLT	Spring Heptathlon
4828	GTO	Remnant stars in SNRs (1098,2953,3251,4037,4083,4202,4888)
4887	GTO+/E	X-ray binaries (1097,2952,2958,3234,3249,3256,4036,5082)
4888	GTO+/E	Remnant stars in SNRs (1098,2953,3251,4037,4083,4202,4828)
4889	GTO+	Grav lenses (1096,1391,3250,3321,4034,5005,5231)
4942	GTO/E	Active galactic nuclei (1099,3248,4971)
4943	GTO/E	A search for UV variability in Nova Cyg 1992 (4363)
4944	GTO	Opportunity occs by small bodies (1079,3319,4015,4193,4442)
4945	GTO	Periodic variations in DQ Herculis stars (1090,3257,4502)
4946	GTO/E	Variability of high luminosity stars (1095,3252,3926)
4951	GO/E	Stellar populations
4971	GTO	Active galactic nuclei (1099,3248,4942)
5005	GTO/E	Grav lenses (1096,1391,3250,3321,4034,4889,5231)
5022	CAL/E	Photometric calibration (2912,4033,4166,4209)
5070	GTO/E	Optical and UV observations of radio pulsars (1101,3253)
5079	GTO/E	Dynamics of planetary upper atmospheres (1083,3376,4257,5197)
5082	GTO/E	X-ray binaries (1097,2952,2958,3234,3249,3256,4036,4887)
5084	GTO	Vis/UV light curves of RR-Lyrae stars (1103,3254,4807)
5197	GTO	Dynamics of planetary upper atmospheres (1083,3376,4257,5079)
5231	GTO	Grav Lenses (KP1635) (1096,1391,3250,3321,4034,4889,5005)
5232	OLT	Fall heptathlon
5256	GTO	A search for UV variability in GQ Muscae

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## HSP Proposals by type and name

### Calibration Proposals

4166	CAL	Photometric calibration (2912,4033,4209,5022)
4033	CAL	Photometric calibration (2912,4166,4209,5022)
4795	CAL/E	FPO test
4741	CAL/E	HSP orbital effects test calibration
4718	CAL/E	HSP polarization verification
5022	CAL/E	Photometric calibration (2912,4033,4166,4209)
4209	CAL/E	Photometric calibration (2912,4033,4166,5022)
2912	CAL/E	Photometric calibration (4033,4166)
4701	CAL/E	Short-term photometric stability (1389)

### General Observer Proposals

4307	GO	A search for radial pulsation in white dwarfs (3798)
4810	GO	Constraints on continuum models of active nuclei (2608)
2608	GO	Constraints on continuum models of active nuclei (4810)
4247	GO/DD	UV observations of Geminga
4569	GO/E	A search for microflaring activity in dwarf M stars
3798	GO/E	A search for radial pulsation in white dwarfs (4307)
3557	GO/E	Polarimetric observations of the Crab pulsar in the UV
4801	GO/E	Quasi-periodic oscillations in AM Herculis binaries (3607)
3607	GO/E	Quasi-periodic oscillations in AM Herculis binaries (4801)
4951	GO/E	Stellar populations

### Guaranteed Time Observation Proposals

5256	GTO	A search for UV variability in GQ Muscae
4971	GTO	Active galactic nuclei (1099,3248,4942)
5197	GTO	Dynamics of planetary upper atmospheres (1083,3376,4257,5079)
3238	GTO	Eclipses of cataclysmic variable stars (1092)
4889	GTO+	Grav lenses (1096,1391,3250,3321,4034,5005,5231)
4034	GTO+	Grav lenses (1096,1391,3250,3321,4889,5005,5231)
1391	GTO	Grav lenses (1096,3250,3321,4034,4889,5005,5231)
1096	GTO	Grav lenses (1391,3250,3321,4034,4889,5005,5231)
5231	GTO	Grav Lenses (KP1635) (1096,1391,3250,3321,4034,4889,5005)
3354	GTO	Helium abundances in Jovian planet upper atmospheres (1082)
1093	GTO	Observations of ZZ Ceti stars
4944	GTO	Opportunity occs by small bodies (1079,3319,4015,4193,4442)
3253	GTO	Optical and UV observations of radio pulsars (1101,5070)
4945	GTO	Periodic variations in DQ Herculis stars (1090,3257,4502)
4502	GTO	Periodic variations in DQ Herculis stars (1090,3257,4945)
4202	GTO	Remnant stars in SNRs (1098,2953,3251,4037,4083,4828,4888)
4828	GTO	Remnant stars in SNRs (1098,2953,3251,4037,4083,4202,4888)
4037	GTO+	Remnant stars in SNRs (1098,2953,3251,4083,4202,4828,4888)
3371	GTO	Saturn ring dynamics (1081,3375,4225)
1102	GTO	UV light and polar. variations in Beta Cephei stars
5084	GTO	Vis/UV light curves of RR-Lyrae stars (1103,3254,4807)
4036	GTO+	X-ray binaries (1097,2952,2958,3234,3249,3256,4887,5082)
4888	GTO+/E	Remnant stars in SNRs (1098,2953,3251,4037,4083,4202,4828)
4887	GTO+/E	X-ray binaries (1097,2952,2958,3234,3249,3256,4036,5082)
4943	GTO/E	A search for UV variability in Nova Cyg 1992 (4363)
4363	GTO/E	A search for UV variability in Nova Cyg 1992 (4943)
4942	GTO/E	Active galactic nuclei (1099,3248,4971)
3248	GTO/E	Active galactic nuclei (1099,4942,4971)

1099 GTO/E Active galactic nuclei (3248,4942,4971)  
4198 GTO/E Do Neptune and Pluto have rings? (1086,4076)  
4076 GTO/E Do Neptune and Pluto have rings? (1086,4198)  
1086 GTO/E Do Neptune and Pluto have rings? (4076,4198)  
5079 GTO/E Dynamics of planetary upper atmospheres (1083,3376,4257,5197)  
4257 GTO/E Dynamics of planetary upper atmospheres (1083,3376,5079,5197)  
1083 GTO/E Dynamics of planetary upper atmospheres (3376,4257,5079,5197)  
1092 GTO/E Eclipses of cataclysmic variable stars (3238)  
5005 GTO/E Grav lenses (1096,1391,3250,3321,4034,4889,5231)  
3250 GTO/E Grav lenses (1096,1391,3321,4034,4889,5005,5231)  
4442 GTO/E Opportunity occs by small bodies (1079,3319,4015,4193,4944)  
4193 GTO/E Opportunity occs by small bodies (1079,3319,4015,4442,4944)  
4015 GTO/E Opportunity occs by small bodies (1079,3319,4193,4442,4944)  
3319 GTO/E Opportunity occs by small bodies (1079,4015,4193,4442,4944)  
5070 GTO/E Optical and UV observations of radio pulsars (1101,3253)  
1101 GTO/E Optical and UV observations of radio pulsars (3253,5070)  
3257 GTO/E Periodic variations in DQ Herculis stars (1090,4945,4502)  
1090 GTO/E Periodic variations in DQ Herculis stars (3257,4945,4502)  
4083 GTO/E Remnant stars in SNRs (1098,2953,3251,4037,4202,4828,4888)  
1098 GTO/E Remnant stars in SNRs (2953,3251,4037,4083,4202,4828,4888)  
4225 GTO/E Saturn ring dynamics (1081,3373,3375)  
3375 GTO/E Saturn ring dynamics (1081,3373,4225)  
1081 GTO/E Saturn ring dynamics (3371,3375,4225)  
3255 GTO/E Search for optical variability assoc. with black holes (1094)  
1094 GTO/E Search for optical variability assoc. with black holes (3255)  
3373 GTO/E The size and composition of planetary ring particles (1080)  
1080 GTO/E The size and composition of planetary ring particles (3373)  
1091 GTO/E UV pulsations from X-ray pulsars  
4946 GTO/E Variability of high luminosity stars (1095,3252,3926)  
1095 GTO/E Variability of high luminosity stars (3252,3926,4946)  
4807 GTO/E Vis/UV light curves of RR-Lyrae stars (1103,3254,5084)  
1103 GTO/E Vis/UV light curves of RR-Lyrae stars (3254,4807,5084)  
5082 GTO/E X-ray binaries (1097,2952,2958,3234,3249,3256,4036,4887)  
3234 GTO/E X-ray binaries (1097,2952,2958,3249,3256,4036,4887,5082)  
2952 GTO/E X-ray binaries (1097,2958,3234,3249,3256,4036,4887,5082)  
1097 GTO/E X-ray binaries (2952,2958,3234,3249,3256,4036,4887,5082)  
1089 GTO/X Captured satellites of the Jovian planets  
3376 GTO/X Dynamics of planetary upper atmospheres (1083,4257,5079,5197)  
1087 GTO/X Eclipses and occultations by Pluto and Charon  
1100 GTO/X Evolution of the nuclei of planetary nebulae  
3321 GTO/X Grav Lenses (1096,1391,3250,4034,4889,5005,5231)  
1082 GTO/X Helium abundances in Jovian planet upper atmospheres (3354)  
1104 GTO/X High speed photometry of GBS 0526-66  
1084 GTO/X Lunar occultations with the HST  
1079 GTO/X Opportunity occs by small bodies (3319,4015,4193,4442,4944)  
3251 GTO/X Remnant stars in SNRs (1098,2953,4037,4083,4202,4828,4888)  
2953 GTO/X Remnant stars in SNRs (1098,3251,4037,4083,4202,4828,4888)  
1085 GTO/X Rotation periods of cometary nuclei  
1088 GTO/X Small satellites in the Uranian system  
3926 GTO/X Variability of high luminosity stars (1095,3252,4946)  
3252 GTO/X Variability of high luminosity stars (1095,3926,4946)  
3254 GTO/X Vis/UV light curves of RR-Lyrae stars (1103,4807,5084)  
3256 GTO/X X-ray binaries (1097,2952,2958,3234,3249,4036,4887,5082)  
3249 GTO/X X-ray binaries (1097,2952,2958,3234,3256,4036,4887,5082)

2958	GTO/X	X-ray binaries (1097,2952,3234,3249,3256,4036,4887,5082)
5232	OLT	Fall heptathalon
4743	OLT	Heptathalon
4820	OLT	Spring Heptathalon
3383	OLT/E	The STScI jitter test

#### Orbital Verification Proposals

3069	OV/E	10.2/Bright earth test
1379	OV/E	Detector dark count test
1500	OV/E	Detector data test
1502	OV/E	High voltage turn-on test
3362	OV/E	MSC aperture mapping II/III (jwp plan) (3152,3233,3363)
3233	OV/E	MSC aperture mapping II/III (jwp plan) (3152,3362,3363)
3152	OV/E	MSC aperture mapping II/III (jwp plan) (3233,3362,3363)
1503	OV/E	MSC coarse FGS/HSP alignment II
1504	OV/E	MSC fine FGS/HSP alignment III (1524,2948-51,3140)
1380	OV/E	MSC Focus and aperture mapping I (1526,3093,3119,3120)
1382	OV/E	Pulse height distribution test
1499	OV/X	Command response test
1501	OV/X	Data integrity test
2113	OV/X	Memory dump
3363	OV/X	MSC aperture mapping II/III (jwp plan) (3152,3233,3362)
2201	OV/X	Safe-to-old hold
3006	SAO/E	Effect of centering errors on HSP photometry
3007	SAO/E	Effect of jitter on HSP photometry

#### Science Verification Proposals

3425	SV/E	Color transformation test (1384,2769,2770,3378)
3378	SV/E	Color transformation test (1384,2769,2770,3425)
2769	SV/E	Color transformation test (1384,2770,3378,3425)
1386	SV/E	Instrumental polarization test
3985	SV/E	Instrumental polarization test (revised)
3140	SV/E	MSC fine FGS/HSP alignment III (nelson plan) (1504,1524,2948-51)
2949	SV/E	MSC fine FGS/HSP alignment III UV1 (1504,2948,2950,2951,3140)
2948	SV/E	MSC fine FGS/HSP alignment III UV2 (1504,2949,2950,2951,3140)
3120	SV/E	MSC Focus and aperture mapping I (1380,1526,3093,3119)
3119	SV/E	MSC Focus and aperture mapping I (1380,1526,3093,3120)
3093	SV/E	MSC Focus and aperture mapping I (1380,1526,3119,3120)
1526	SV/E	MSC Focus and aperture mapping I (1380,3093,3119,3120)
1474	SV/E	Photometric performance test
1385	SV/E	Photometric performance test (3382)
3382	SV/E	Photometric performance test (faint end) (1385)
3377	SV/E	Pol detector test
3996	SV/E	Prism mode test
1389	SV/E	Short-term photometric stability (4701)
2771	SV/E	Stellar occultation by planetary rings
3071	SV/E	Target acquisition test POL (1381)
3072	SV/E	Target acquisition test UV1 (1381)
3073	SV/E	Target acquisition test UV2 (1381)
3074	SV/E	Target acquisition test VIS (1381)
3135	SV/E	The Secret Stanley Test (focus and ap. mapping, uv, revised)

1383	SV/E	Time resolved photometry
1384	SV/X	Color transformation test (2769,2770,3378,3425)
1524	SV/X	MSC fine FGS/HSP alignment III (1504,2948-51,3140)
2951	SV/X	MSC fine FGS/HSP alignment III POL (1504,2948,2949,2950,3140)
2950	SV/X	MSC fine FGS/HSP alignment III VIS (1504,2948,2949,2951,3140)
2749	SV/X	RIU polling on/off test
1387	SV/X	Stokes parameter test
1381	SV/X	Target acquisition test (3071-3074)
2770	SVD/X	Color transformation test (1384,2769,3378,3425)
2768	SVD/X	Pulse height distribution test
2772	SVD/X	Stellar occultation by dark lunar limb
2773	SVD/X	Stellar occultation by planetary atmospheres

### **7.2. Flight SMS sequence**

The following are the Science Mission Schedules (SMS) executed during the period covered by this report. Breaks in the “in continuity with” sequence are indicated by \*\*\*\*\*.

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922194a2r  
922237i1  
922307b4  
922377bk  
922447d5  
922517e8  
922587e2  
922657cc  
922727d2r  
922797f1  
922867k6  
922937e1  
923007e4  
923077b9  
923147aa  
923217b6  
923287dj  
923357c3  
923427b4  
923497c9  
923567d2  
923637d4  
930047g5  
930117d4  
930187b9  
930252g2  
\*\*\*\*\*  
930284g1  
930327bc  
930397b7  
930467c7  
930537d2  
930607c6  
930677c4  
930747c4  
930817ei  
\*\*\*\*\*  
930862a3  
930887d5  
\*\*\*\*\*  
930914e9  
930957f2  
931027gg  
931097g1  
931167e7  
931237ah  
931307bu  
931377b1  
931447b5  
931517e1  
931583bd  
\*\*\*\*\*  
931614d1  
931657e1

\*\*\*\*\*  
931675b2r  
931727e5  
931797d9  
931867d4  
931937bo  
\*\*\*\*\*  
931955c1r  
932007c3  
932077e6  
\*\*\*\*\*  
932113a1r  
932147bb  
932217b6  
932287cd  
932357d4  
932428c3  
932506ci  
932567d6  
932637bi  
932707b1  
932777at  
932847d2  
\*\*\*\*\*  
932926bf  
932987ca  
933057d2  
933127c9  
933197bh  
933267ag  
933337c6

Servicing mission  
launched December 2,  
1993, day 93336.

DRAFT

### **7.3. SMS Activity Timelines**

The HSP parser is a collection of software tools used to analyze the SMS and produce various listings and graphical summaries. The parser and its various outputs were used to check the accuracy of the SMS. By using the parser, a complete comprehensive analysis of the SMS could be done in a short time (a few minutes) so that problems could be reported back to the ST Sci in a timely manner. One of the many useful outputs of the HSP parser is the graphic timeline of the entire SMS showing not only HSP activity, but selected spacecraft and other SI operations. The SMS graphic timelines for the period covered by this report are included in this appendix. The standard SMS covered a period of seven days but there are exceptions for special tests and operations. The first SMS after a safing recovery is usually shorter than seven days.

## 7.4. Observation summary index

### 7.4.1. Guaranteed Time Observations (GTO)

MJD	Prop Number	Proposal Name	Type
48003			
48512	1095	Variability of high luminosity stars (3252,3926)	GTO/E
48518	1095	Variability of high luminosity stars (3252,3926)	GTO/E
48521	1095	Variability of high luminosity stars (3252,3926)	GTO/E
48530	1081	Saturn ring dynamics (3371,3375,4225)	GTO/E
48531	1081	Saturn ring dynamics (3371,3375,4225)	GTO/E
48532	1081	Saturn ring dynamics (3371,3375,4225)	GTO/E
48533	1081	Saturn ring dynamics (3371,3375,4225)	GTO/E
48642	1101	Optical and UV observations of radio pulsars (3253)	GTO/E
48652	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48654	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48658	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48662	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48665	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48666	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48670	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48674	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48677	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48678	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48682	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48686	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48689	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48690	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48694	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48698	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48701	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48702	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48707	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48711	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48713	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48715	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48720	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48723	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48725	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48726	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48727	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48730	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48734	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48735	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48737	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48738	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48742	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E

48746	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48749	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48751	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48755	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48759	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48761	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48763	1086	Do Neptune and Pluto have rings? (4076,4198)	GTO/E
48765	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48769	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48773	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48775	1098	Remnant stars in SNRs (2953,3251,4037,4083,4202,4888)	GTO/E
48776	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48777	1092	Eclipses of cataclysmic variable stars (3238)	GTO/E
48782	1094	Search for optical variability assoc. with black holes (3255)	GTO/E
48811	1083	Dynamics of planetary upper atmospheres (3376,4257)	GTO/E
48812	1083	Dynamics of planetary upper atmospheres (3376,4257)	GTO/E
48814	4076	Do Neptune and Pluto have rings? (1086,4198)	GTO/E
48816	3375	Saturn ring dynamics (1081,3373,4225)	GTO/E
48817	3375	Saturn ring dynamics (1081,3373,4225)	GTO/E
48817	1094	Search for optical variability assoc. with black holes (3255)	GTO/E
48824	4015	Opportunity occultations by small bodies (1079,3319,4193,4442)	GTO/E
48825	4015	Opportunity occultations by small bodies (1079,3319,4193,4442)	GTO/E
48837	1094	Search for optical variability assoc. with black holes (3255)	GTO/E
48844	1095	Variability of high luminosity stars (3252,3926)	GTO/E
48847	1095	Variability of high luminosity stars (3252,3926)	GTO/E
48852	1094	Search for optical variability assoc. with black holes (3255)	GTO/E
48853	1094	Search for optical variability assoc. with black holes (3255)	GTO/E
48855	1095	Variability of high luminosity stars (3252,3926)	GTO/E
48857	1095	Variability of high luminosity stars (3252,3926)	GTO/E
48858	1095	Variability of high luminosity stars (3252,3926)	GTO/E
48861	4015	Opportunity occultations by small bodies (1079,3319,4193,4442)	GTO/E
48862	4015	Opportunity occultations by small bodies (1079,3319,4193,4442)	GTO/E
48876	1103	Vis/UV light curves of short period RR-Lyrae stars (3254,4807)	GTO/E
48878	1103	Vis/UV light curves of short period RR-Lyrae stars (3254,4807)	GTO/E
48895	4225	Saturn ring dynamics (1081,3373,3375)	GTO/E
48903	3255	Search for optical variability assoc. with black holes (1094)	GTO/E
48904	4193	Opportunity occultations by small bodies (1079,3319,4015,4442)	GTO/E
48905	4442	Opportunity occultations by small bodies (1079,3319,4015,4193)	GTO/E
48906	4442	Opportunity occultations by small bodies (1079,3319,4015,4193)	GTO/E
48912	1099	Active galactic nuclei (3248)	GTO/E
48913	1090	Periodic variations in DQ Herculis stars (3257)	GTO/E
48921	1099	Active galactic nuclei (3248)	GTO/E
48939	3255	Search for optical variability assoc. with black holes (1094)	GTO/E
48943	4198	Do Neptune and Pluto have rings? (1086,4076)	GTO/E
48944	4198	Do Neptune and Pluto have rings? (1086,4076)	GTO/E
48945	4198	Do Neptune and Pluto have rings? (1086,4076)	GTO/E
48949	1098	Remnant stars in SNRs (2953,3251,4037,4083,4202,4888)	GTO/E
48956	2952	X-ray binaries (1097,2958,3234,3249,3256,4036,4887)	GTO/E
48957	2952	X-ray binaries (1097,2958,3234,3249,3256,4036,4887)	GTO/E

48958	2952	X-ray binaries (1097,2958,3234,3249,3256,4036,4887)	GTO/E
48959	2952	X-ray binaries (1097,2958,3234,3249,3256,4036,4887)	GTO/E
48960	2952	X-ray binaries (1097,2958,3234,3249,3256,4036,4887)	GTO/E
48961	2952	X-ray binaries (1097,2958,3234,3249,3256,4036,4887)	GTO/E
48962	3255	Search for optical variability assoc. with black holes (1094)	GTO/E
48963	3255	Search for optical variability assoc. with black holes (1094)	GTO/E
48981	1099	Active galactic nuclei (3248)	GTO/E
48982	3257	Periodic variations in DQ Herculis stars (1090)	GTO/E
48983	3257	Periodic variations in DQ Herculis stars (1090)	GTO/E
48986	1091	UV pulsations from X-ray pulsars	GTO/E
48988	4363	A search for UV variability in Nova Cyg 1992	GTO/E
48991	3234	X-ray binaries (1097,2952,2958,3249,3256,4036,4887)	GTO/E
48992	3234	X-ray binaries (1097,2952,2958,3249,3256,4036,4887)	GTO/E
48993	1091	UV pulsations from X-ray pulsars	GTO/E
48993	3234	X-ray binaries (1097,2952,2958,3249,3256,4036,4887)	GTO/E
48993	1091	UV pulsations from X-ray pulsars	GTO/E
48994	3234	X-ray binaries (1097,2952,2958,3249,3256,4036,4887)	GTO/E
48995	3234	X-ray binaries (1097,2952,2958,3249,3256,4036,4887)	GTO/E
48996	3234	X-ray binaries (1097,2952,2958,3249,3256,4036,4887)	GTO/E
48996	3255	Search for optical variability assoc. with black holes (1094)	GTO/E
48997	3234	X-ray binaries (1097,2952,2958,3249,3256,4036,4887)	GTO/E
48999	3234	X-ray binaries (1097,2952,2958,3249,3256,4036,4887)	GTO/E
49000	3234	X-ray binaries (1097,2952,2958,3249,3256,4036,4887)	GTO/E
49001	3234	X-ray binaries (1097,2952,2958,3249,3256,4036,4887)	GTO/E
49001	4257	Dynamics of planetary upper atmospheres (1083,3376)	GTO
49006	1095	Variability of high luminosity stars (3252,3926)	GTO/E
49007	1095	Variability of high luminosity stars (3252,3926)	GTO/E
49010	1095	Variability of high luminosity stars (3252,3926)	GTO/E
49019	4442	Opportunity occultations by small bodies (1079,3319,4015,4193)	GTO/E
49020	4442	Opportunity occultations by small bodies (1079,3319,4015,4193)	GTO/E
49043	1095	Variability of high luminosity stars (3252,3926)	GTO/E
49046	1095	Variability of high luminosity stars (3252,3926)	GTO/E
49053	4083	Remnant stars in SNRs (1098,2953,3251,4037,4202,4888)	GTO
49054	1099	Active galactic nuclei (3248)	GTO/E
49084	3248	Active galactic nuclei (1099)	GTO
49091	4257	Dynamics of planetary upper atmospheres (1083,3376)	GTO
49092	4257	Dynamics of planetary upper atmospheres (1083,3376)	GTO
49100	4807	Vis/UV light curves of short period RR-Lyrae stars (1103,3254)	GTO
49126	4888	Remnant stars in SNRs (1098,2953,3251,4037,4083,4202)	GTO+
49128	4888	Remnant stars in SNRs (1098,2953,3251,4037,4083,4202)	GTO+
49130	4888	Remnant stars in SNRs (1098,2953,3251,4037,4083,4202)	GTO+
49133	4888	Remnant stars in SNRs (1098,2953,3251,4037,4083,4202)	GTO+
49142	1091	UV pulsations from X-ray pulsars	GTO/E
49149	4943	A search for UV variability in Nova Cyg 1992 (4363)	GTO
49153	4888	Remnant stars in SNRs (1098,2953,3251,4037,4083,4202)	GTO+
49154	4946	Variability of high luminosity stars (1095,3252,3926)	GTO
49157	4946	Variability of high luminosity stars (1095,3252,3926)	GTO
49173	3319	Opportunity occultations by small bodies (1079,4015,4193,4442)	GTO
49196	1091	UV pulsations from X-ray pulsars	GTO/E

49204	1097	X-ray binaries (2952,2958,3234,3249,3256,4036,4887)	GTO
49205	1097	X-ray binaries (2952,2958,3234,3249,3256,4036,4887)	GTO
49206	1097	X-ray binaries (2952,2958,3234,3249,3256,4036,4887)	GTO
49207	1097	X-ray binaries (2952,2958,3234,3249,3256,4036,4887)	GTO
49207	1091	UV pulsations from X-ray pulsars	GTO/E
49207	1097	X-ray binaries (2952,2958,3234,3249,3256,4036,4887)	GTO
49208	1097	X-ray binaries (2952,2958,3234,3249,3256,4036,4887)	GTO
49210	1097	X-ray binaries (2952,2958,3234,3249,3256,4036,4887)	GTO
49216	4888	Remnant stars in SNRs (1098,2953,3251,4037,4083,4202)	GTO+
49217	4888	Remnant stars in SNRs (1098,2953,3251,4037,4083,4202)	GTO+
49223	5082	X-ray binaries (1097,2952,2958,3234,3249,3256,4036,4887)	GTO
49223	4887	X-ray binaries (1097,2952,2958,3234,3249,3256,4036)	GTO+
49224	4887	X-ray binaries (1097,2952,2958,3234,3249,3256,4036)	GTO+
49224	5082	X-ray binaries (1097,2952,2958,3234,3249,3256,4036,4887)	GTO
49224	4887	X-ray binaries (1097,2952,2958,3234,3249,3256,4036)	GTO+
49224	5082	X-ray binaries (1097,2952,2958,3234,3249,3256,4036,4887)	GTO
49224	4887	X-ray binaries (1097,2952,2958,3234,3249,3256,4036)	GTO+
49224	5082	X-ray binaries (1097,2952,2958,3234,3249,3256,4036,4887)	GTO
49224	4887	X-ray binaries (1097,2952,2958,3234,3249,3256,4036)	GTO+
49224	5082	X-ray binaries (1097,2952,2958,3234,3249,3256,4036,4887)	GTO
49224	4887	X-ray binaries (1097,2952,2958,3234,3249,3256,4036)	GTO+
49224	5082	X-ray binaries (1097,2952,2958,3234,3249,3256,4036,4887)	GTO
49225	5082	X-ray binaries (1097,2952,2958,3234,3249,3256,4036,4887)	GTO
49225	4887	X-ray binaries (1097,2952,2958,3234,3249,3256,4036)	GTO+
49225	5082	X-ray binaries (1097,2952,2958,3234,3249,3256,4036,4887)	GTO
49225	5070	Optical and UV Observations of Radio Pulsars	GTO
49225	5082	X-ray binaries (1097,2952,2958,3234,3249,3256,4036,4887)	GTO
49226	5082	X-ray binaries (1097,2952,2958,3234,3249,3256,4036,4887)	GTO
49235	4888	Remnant stars in SNRs (1098,2953,3251,4037,4083,4202)	GTO+
49245	5079	Dynamics of planetary upper atmospheres (1083, 3376, 4257)	GTO
49250	4888	Remnant stars in SNRs (1098,2953,3251,4037,4083,4202)	GTO+
49251	1091	UV pulsations from X-ray pulsars	GTO/E
49262	4888	Remnant stars in SNRs (1098,2953,3251,4037,4083,4202)	GTO+
49264	4887	X-ray binaries (1097,2952,2958,3234,3249,3256,4036)	GTO+
49264	4942	Active galactic nuclei (1099,3248,4971)	GTO
49264	5005	Gravitational Lenses (1391, 1096,3250,3321,4034,4889)	GTO
49265	5005	Gravitational Lenses (1391, 1096,3250,3321,4034,4889)	GTO
49265	1091	UV pulsations from X-ray pulsars	GTO/E
49266	4887	X-ray binaries (1097,2952,2958,3234,3249,3256,4036)	GTO+
49266	4943	A search for UV variability in Nova Cyg 1992 (4363)	GTO
49266	4942	Active galactic nuclei (1099,3248,4971)	GTO
49267	4887	X-ray binaries (1097,2952,2958,3234,3249,3256,4036)	GTO+
49268	4942	Active galactic nuclei (1099,3248,4971)	GTO
49268	4887	X-ray binaries (1097,2952,2958,3234,3249,3256,4036)	GTO+
49269	4887	X-ray binaries (1097,2952,2958,3234,3249,3256,4036)	GTO+
49270	4887	X-ray binaries (1097,2952,2958,3234,3249,3256,4036)	GTO+
49270	4942	Active galactic nuclei (1099,3248,4971)	GTO
49271	3250	Gravitational lenses (1096,1391,3321,4034,4889)	GTO
49271	4888	Remnant stars in SNRs (1098,2953,3251,4037,4083,4202)	GTO+
49271	4887	X-ray binaries (1097,2952,2958,3234,3249,3256,4036)	GTO+
49272	4887	X-ray binaries (1097,2952,2958,3234,3249,3256,4036)	GTO+
49272	4942	Active galactic nuclei (1099,3248,4971)	GTO
49272	3373	The size and composition of planetary ring particles (1080)	GTO

49273	3373	The size and composition of planetary ring particles (1080)	GTO
49281	5070	Optical and UV Observations of Radio Pulsars	GTO
49282	4945	Periodic variations in DQ Herculis stars (1090,4945)	GTO
49285	4888	Remnant stars in SNRs (1098,2953,3251,4037,4083,4202)	GTO+
49286	4888	Remnant stars in SNRs (1098,2953,3251,4037,4083,4202)	GTO+
49288	4888	Remnant stars in SNRs (1098,2953,3251,4037,4083,4202)	GTO+
49288	4889	Gravitational lenses (1096,1391,3250,3321,4034)	GTO+
49289	4889	Gravitational lenses (1096,1391,3250,3321,4034)	GTO+
49290	4888	Remnant stars in SNRs (1098,2953,3251,4037,4083,4202)	GTO+
49291	5084	Vis/UV light curves of RR-Lyrae stars (1103,3254,4807)	GTO
49292	4888	Remnant stars in SNRs (1098,2953,3251,4037,4083,4202)	GTO+
49294	1093	Observations of ZZ Ceti stars	GTO
49294	4888	Remnant stars in SNRs (1098,2953,3251,4037,4083,4202)	GTO+
49295	1093	Observations of ZZ Ceti stars	GTO
49296	1098	Remnant stars in SNRs (2953,3251,4037,4083,4202,4888)	GTO/E
49298	1093	Observations of ZZ Ceti stars	GTO
49300	3250	Gravitational lenses (1096,1391,3221,4034,4889)	GTO
49302	3255	Search for optical variability assoc. with black holes (1094)	GTO/E
49303	3255	Search for optical variability assoc. with black holes (1094)	GTO/E
49303	4889	Gravitational lenses (1096,1391,3250,3321,4034)	GTO+
49304	4889	Gravitational lenses (1096,1391,3250,3321,4034)	GTO+
49305	5256	A Search for UV Variability in GQ Muscae - repeat for HOPR 141	GTO
49306	5256	A Search for UV Variability in GQ Muscae - repeat for HOPR 141	GTO
49306	4888	Remnant stars in SNRs (1098,2953,3251,4037,4083,4202)	GTO+
49312	4889	Gravitational lenses (1096,1391,3250,3321,4034)	GTO+
49313	4889	Gravitational lenses (1096,1391,3250,3321,4034)	GTO+
49317	5084	Vis/UV light curves of RR-Lyrae stars (1103,3254,4807)	GTO
49318	5084	Vis/UV light curves of RR-Lyrae stars (1103,3254,4807)	GTO
49318	4946	Variability of high luminosity stars (1095,3252,3926)	GTO
49319	4946	Variability of high luminosity stars (1095,3252,3926)	GTO
49320	1091	UV pulsations from X-ray pulsars	GTO/E
49321	4946	Variability of high luminosity stars (1095,3252,3926)	GTO

### 7.4.2. Calibrations

48685	2912	Photometric calibration (4166)	CAL/E
48741	2912	Photometric calibration (4166)	CAL/E
48742	2912	Photometric calibration (4166)	CAL/E
48803	2912	Photometric calibration (4166)	CAL/E
48804	2912	Photometric calibration (4166)	CAL/E
48857	2912	Photometric calibration (4166)	CAL/E
48911	2912	Photometric calibration (4166)	CAL/E
48972	4718	HSP polarization verification	CAL/E
49042	4209	Photometric calibration (quickie)	CAL
49043	4209	Photometric calibration (quickie)	CAL
49044	4209	Photometric calibration (quickie)	CAL
49046	4209	Photometric calibration (quickie)	CAL
49089	4209	Photometric calibration (quickie)	CAL

49096	4209	Photometric calibration (quickie)	CAL
49102	4209	Photometric calibration (quickie)	CAL
49154	4209	Photometric calibration (quickie)	CAL
49163	4209	Photometric calibration (quickie)	CAL
49166	4209	Photometric calibration (quickie)	CAL
49215	4209	Photometric calibration (quickie)	CAL
49223	4209	Photometric calibration (quickie)	CAL
49228	5022	Photometric Calibration (2912,4166,5022)	CAL/E
49279	5022	Photometric Calibration (2912,4166,5022)	CAL/E
49282	4209	Photometric calibration (quickie)	CAL
49290	4209	Photometric calibration (quickie)	CAL
49293	4209	Photometric calibration (quickie)	CAL
49324	5022	Photometric Calibration (2912,4166,5022)	CAL/E

## **7.5. HSP Publications**

### **7.5.1. HSP Publications**

1. Richards, E.E., Percival, J.W., Nelson, M.J., Hatter, E., Fitch, J., White, R. Initial performance of the high speed photometer, SPIE Volume 1494 Space Astronomical Telescopes and Instruments, pp 40-49, 1991.
2. Richards, E.E., Percival, J.W., Sitzman, J.C., Jones, T.E. Thermal control of the space telescope high-speed photometer, SPIE Volume 1945 Space Astronomical Telescopes and Instruments II, pp 224-232, 1993.
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### **7.5.2. HSP Results to be published**

## **7.6. HSP Hardware and Development Chronology Summary**

### **I. HSP System Level Reviews**

Review      Date

Preliminary Requirements Review (PRR) 4-28-78  
Preliminary Design Review (PDR) 12-4-78  
Critical Design Review (CDR) 8-27/28-80  
Pre-Environmental Review (PER) 8-17-82  
Pre-Ship Review (PSR) 10-5-84

## II. Major Documentation Summary

### Document Date

HSP PRR Data Package - CM04 April 3, 1978  
HSP PDR Data Package - CM04 November 15, 1978  
HSP CDR Data Package - CM04 August 5, 1980  
HSP PER Data Package - CM04 August 17, 1982  
HSP PSR Data Package October 5, 1984  
HSP Delta Review Data Package March 13, 1986  
HSP Mechanical Rework August 1985 (included in Delta Review Data Package)  
ST/HSP Stress Analysis March 1987 Technical Report 87-006 Swales & Associates  
ST SI & SI C&DH March 1985  
Fracture Assessment Results Revised July 1985 Swales & Associates  
HSP ST TV/TB Test Report November 2, 1986 TEC, Inc

HSP Acoustic Test Report August 19, 1982  
HSP Modal Survey Test Report August 1982  
Thermal Test Results - HSP PFU February 3, 1983 TEC, Inc  
Test Results - HSP TV/TB March 1, 1983 GSFC Report STP-G-HSP-015  
STP-G VAP Test Report November 1984  
HSP Report to ST Thermal-Power Meeting March 9, 1987  
HSP Safety Reevaluation Package June 24, 1987  
ST A&V Functional Testing - HSP Summary January 5, 1987  
Nondestructive Evaluation of HSP Main Fittings September 3, 1987

HSP Logbook #1 11-19-81 to 12-8-82  
HSP Logbook #2 12-8-82 to 11-13-83  
HSP Logbook #3 2-1-83 to 5-23-84  
HSP Logbook #4 6-12-84 to 12-2-86  
HSP Logbook #5 2-17-87 to present

### Subsystem manufacturing records and test data

HVPS II CDR Data Package October 31, 1985  
HVPS III PER Data Package May 15, 1987  
HVPS III PSR Data Package November 4, 1987

## III. HSP Hardware Chronology

The HSP logbook begins with the integration of the RIU/EU to the SDU on November 14, 1981. The original HSP hardware configuration was as follows:

### Assembly Serial Number

RIU A 003  
RIU B 008  
EU 002  
SDU 001  
PCDS I 002

System Controller 001  
Detector 1  
  Detector Controller 001  
  Preamp 001  
  HVPS I 001  
  Image Dissector Assembly 004  
Detector 2  
  Detector Controller 002  
  Preamp 002  
  HVPS I 002  
  Image Dissector Assembly 005  
Detector 3  
  Detector Controller 003  
  Preamp 003  
  HVPS I 003  
  Image Dissector Assembly 003  
Detector 4  
  Detector Controller 004  
  Preamp 004  
  HVPS I 004  
  Image Dissector Assembly 006  
Detector 5  
  Detector Controller 005  
  Preamp 005  
  HVPS I 005  
  PMT Assembly 003

#### Date Event

11-14-81 Begin HSP Integration at UW/SSEC  
07-07-82 Ship HSP to GSFC (arrive at GSFC T&E on 7-9)  
07-22-82 Mass properties test  
08-19-82 Acoustic test #1  
September 1982 EMI test #1  
09-29-82 Remove ODS for rework, ship to UW  
October 1982 HSP bakeout (without ODS)  
November 1982 Reinstall ODS in HSP at GSFC  
11-30-82 Start thermal vacuum test #1  
01-05-83 Remove HVPS S/N 2 from detector 2 position, remove PCDS  
02-01-83 Install repaired PCDS I S/N 002  
02-02-83 Install HVPS S/N 7 in detector 2 position  
02-03-83 Remove System Controller for repair  
03-14-83 Install repaired System Controller S/N 001  
03-25-83 Begin Pre-VAP test (2 days)  
05-04-83 Acoustic test #2 (first acoustic test of new mirrors & mounts)  
05-25-83 PCDS S/N 002 removed for anomaly investigation  
05-31-83 PCDS S/N 002 installed  
June 1983 VAP begins - continues to April 1984  
11-11-83 Install three repaired HVPS. Configuration:

Detector HVPS S/N  
1 06  
2 02

3 03  
4 04  
5 08

01-13-84 Install two repaired HVPS. Configuration:

Detector HVPS S/N  
1 06  
2 02  
3 01  
4 05  
5 08

01-14-84 Install PCDS II S/N 01  
04-04-84 Remove PCDS II S/N 01 for functional and vibration tests  
04-25-84 Install PCDS II S/N 01  
05-07-84 Thermal vacuum test #2 begins  
05-22-84 Thermal vacuum test #2 ends  
05-23-84 Install HVPS S/N 07 in detector 2 position.  
Configuration:

Detector HVPS S/N  
1 06  
2 07  
3 01  
4 05  
5 08

06-14-84 EMI test #2 begins  
07-07-84 Calibration tests begin  
07-26-84 EMI retest  
08-06-84 Bakeout of HSP begins  
08-30-84 Install PMT pickoff mirror  
09-12-84 Quarter panel measurements  
October 1984 Calibrations tests

10-09-84 HVPS S/N 02 installed in detector 2 position.  
Configuration:

Detector HVPS S/N  
1 06  
2 02  
3 01  
4 05  
5 08

10-19-84 Ship HSP from GSFC to LMSC  
05-15-85 HSP Installed in ST  
08-02-85 HVPS S/N 03 installed in detector 2 position.  
Configuration:

Detector HVPS S/N  
1 06

2 03  
3 01  
4 05  
5 08

08-03-85 HSP envelope modifications made (to accommodate OTA)  
12-05-85 Both RIUs and EU removed from HSP for repair  
12-28-85 HVPS II S/N 22 installed. Configuration:

Detector HVPS S/N  
1 06  
2 22  
3 01  
4 05  
5 08

12-28-85 RIUs installed. Configuration:

RIU A S/N 009 ( x HRS )  
RIU B S/N 011 ( x C&DH )  
EU S/N 002

12-28-85 Detector five load resistor assembly installed  
05-06-86 ST Thermal vacuum test begins  
10-24-86 HVPS S/N 21 installed in detector 3 position.  
Configuration:

Detector HVPS S/N  
1 06  
2 22  
3 21  
4 05  
5 08

03-17-87 GST 3  
03-27-87 HSP removed from ST  
April 1987 RIU noise tests  
08-11-87 Begin two weeks of NDT  
09-01-87 Install filter in PMT CVC signal return  
09-02-87 Install RIU multiplex data bus cable  
10-12-87 Restore original RIU multiplex data bus cable  
10-12-87 Install ferrite beads on preamp input cables  
11-10-87 RIU noise tests; detector getter tests  
11-17-87 Install HVPS IIIs. Configuration:

Detector HVPS S/N  
1 32  
2 22  
3 21  
4 35  
5 36

7-6-88 Remove HVPS III S/N 36 from detector 5 position for RIU noise tests

7-7-88 HVPS III S/N 35 removed from detector 4 position, temporarily installed in detector 5 position for tests, and finally replaced back in detector 4 position  
7-26-88 HVPS III S/N 36-2 (with bypass capacitor) installed in detector 5 position  
8-7-88 HSP "dropped" while attached to SIFIG  
8-9-88 HSP reinspected for damage - none found  
8-10/11-88 HSP retested  
8-13-88 HSP installed in ST  
8-17/19-88 Post installation functional test

The launch configuration of the HSP (as of 8-19-88) is as follows:

Assembly Serial Number

RIU A 009  
RIU B 011  
EU 002  
SDU 001  
PCDS II 001  
System Controller 001  
Detector 1  
  Detector Controller 001  
  Preamp 001  
  HVPS III 032  
  Image Dissector Assembly 004  
Detector 2  
  Detector Controller 002  
  Preamp 002  
  HVPS II 022  
  Image Dissector Assembly 005  
Detector 3  
  Detector Controller 003  
  Preamp 003  
  HVPS II 021  
  Image Dissector Assembly 003  
Detector 4  
  Detector Controller 004  
  Preamp 004  
  HVPS III 035  
  Image Dissector Assembly 006  
Detector 5  
  Detector Controller 005  
  Preamp 005  
  HVPS III 036  
  PMT Assembly 003

December 2, 1993  
STS 61 (Endeavour) lifts off from KSC - HST SM 01  
HSP removed during EVA 4

### **HSP Post Flight Chronology**

January 1994  
SIPE returned to GSFC via ship to Baltimore

January 24-25, 1994

Removed HSP from SIPE at GSFC and put on SIFIG table

February 14, 1994

Performed HSP EICIT per GSFC WOA 1302

February 16, 1994

Performed HSP IVT per GSFC WOA 1303

February 17-22, 1994

Performed HSP Functional & Throughput tests per GSFC WOA 1304

February 23, 1994

HSP installed in quarter panel for verification of external envelope dimensions

March 2, 1994

HSP removed from quarter panel

March 9, 1994

HSP installed in FOS bay of HST High Fidelity Mechanical Simulator

March 14, 1994

Removed one filter aperture assembly, installed focal plane tool

March 22, 1994

HSP installed into quarter panel for horizontal focal plane measurements

March 24, 1994

Quarter panel rotated to vertical for repeat of focal plane measurements

March 28, 1994

HSP removed from quarter panel

April 4-14, 1994

Flaw detection tests, a repeat of tests performed before launch, by Lugmayer Associates including both eddy current and ultrasonic methods  
ODS cover removed for tests

April 14, 1994

HSP ODS cover replaced

April 20, 1994

Flight latch fittings removed

April 21, 1994

Removed flight RIUs and EU at GSFC. RIU A S/N 009, RIU B S/N 011, and EU 002 all removed and HSP interface left empty

July 13, 1995

HSP packed in shipping container for shipment to Madison

July 14, 1995

HSP shipped from GSFC - left at 11:50 EDT

July 15, 1994

HSP arrived at SSEC from GSFC. Moved to SAL the following week.

July 22, 1995

Chamberlin Hall freight elevator failure put activities on hold

January 5, 1995

HSP removed from shipping container, installed in handling dolly, and moved to SAL clean room

January 18, 1995

Contamination sampling by Craig Chivatero, LMSC, of HSP surfaces

January 25, 1995

Bray oil stains around skin pop rivets cleaned

January 27, 1995

Contamination samples (scrapes) collected for GSFC analysis

February 3, 1995

Contamination samples collected for GSFC analysis (repeat of 1/27 samples because samples became contaminated)

February 6-9, 1995

Performed EICIT and IVT tests

February 8-9, 1995

Installed and performed integration test on EM RIU and EU

February 10-17, 1995

Performed HSP functional tests with EGSE.

February 20, 1995

Performed functional test of HSP thermal monitors

February 22, 1995

Photographed HSP filters, apertures, and prisms

February 27 - March 2, 1995

Ran test of VIS tube data collection and response

March 2, 1995

Start two detector SSP data collection and response test (VIS & POL)

March 8, 1995

Replaced HVPS S/N 32 for Detector 1 with S/N 31

Replaced HVPS S/N 21 for Detector 3 with S/N 33

March 9-13, 1995

Ran two detector SSP data collection and response test (VIS & POL)

March 21-23, 1995

Remove detector 3, 2200-0005-002 (VIS) S/N 003 and replace with S/N 008

Remove detector 4, 2200-0005-001 (UV) S/N 006 and replace with S/N 007  
(S/N 007 had no interface connector so a flight spare connector was installed)

March 24, 1995

Repeat two detector SSP data collection test (VIS & POL)

DRAFT

## 7.7. HSP Postflight box level tests

The HSP hardware was built in the late 1970s and early 1980s with integration of the flight HSP beginning in 1981. The original ST program requirements specified "All hardware shall be designed for a service life of two and one-half years in orbit plus three years ground test time with an operating duty cycle of 50 percent in orbit, 20 percent on ground" (paragraph 4.4, attachment II, RFP, November 1977) So after about 15 years, over three and a half of which were in orbit, it is interesting to test the HSP subsystems to see how their characteristics may have changed over that time span. Also, since there were flight spare boxes manufactured at the same time as the flight units that had been kept in storage on the ground, it was possible to compare the flown units with the units that had remained on the ground to determine if there were any effects due to spacecraft integration, test, and flight.

Visual inspections and tests were performed on selected boxes from flight spare inventory and from the flight HSP. Four high voltage power supplies, two flight units and two spares, were inspected and subjected to a functional test at various temperatures over the operating range. The data were compared to similar data taken in April 1987 before the HST mission. All units functioned well within specification and comparing March 1995 and April 1987 data found only very small differences as shown in the chart below. Note the change section is express in percent. There were no changes observed in the visual inspection. It was concluded that the performance of these units were very stable and they could be reflown as is.

### HVPS Thermal Functional Test Data Summary - March 1995

S/N	Output	+24C	-40C	0C	+40C
21	Min	1480.7	1485.3	1482.1	1479.5
	Max	2522.7	2527.4	2524.1	2521.8
31	Min	1482.0	1486.2	1483.0	1491.2
	Max	2523.5	2529.0	2524.3	2521.7
32	Min	1478.4	1482.1	1479.8	1477.5
	Max	2518.6	2525.9	2521.8	2516.3
33	Min	1480.7	1484.3	1481.8	1480.3
	Max	2523.5	2527.3	2524.2	2522.7

### Change from April 1987 data, %

S/N	Output	+24C	-40C	0C	+40C
21	Min	0.01	0.03	0.03	0.03
	Max	0.12	0.11	0.08	0.10
31	Min	0.08	0.07	0.09	0.09
	Max	-0.02	-0.03	0.00	0.00
32	Min	0.04	0.07	0.04	0.04
	Max	-0.01	0.03	0.00	0.02
33	Min	0.04	0.02	0.03	0.03
	Max	0.10	0.08	0.08	0.06

The flight spare PCDS (power conditioning and distribution subsystem and its performance was indistinguishable from the original acceptanc

## 7.8. HST Observation Problem Reports (HOPR)

no number 1091 This HOPR is submitted to document the failure to obtain data. Because the problem was not the result of a spacecraft or scheduling problem, the HSP team is not requesting repeat or credit of time.

80 1103 The target acquisition was mistakenly thought to have failed. During the first (of two) acquisitions there was a loss of lock, thus the acq SAM request was rejected by the DF-224 and a status buffer error resulted. The second acquisition worked but the OSS later sent a SIP to correct for what they thought was an acq failure. The observations on this target should be repeated because the data collected during the time the target was out of the aperture are not usable.

081 1389 There about a 2.4% peak to peak orbital period sinusoid and a "ramp" (a monotonically increasing "dc" value) superimposed in the data. Also, jitter has proven to be excessive in course track so all future HSP observations are now planned in fine lock. 1389 was done in course track and was affected by jitter in addition to the ramp and sinusoid. The repeat observation should be done in fine lock (the original 1389 was done in course track). Also, the single color photometry data collection should be changed back to 1.0 millisecond integration time, the original proposed integration time. The test was executed with 82 millisecond integration time as a temporary workaround to a timing problem that is corrected by the commanding change known as the "FPO fix".

The observation takes 5.5 hours plus target acquisition, or about seven hours of spacecraft time.

093 1099 The observation was intended to be done in fine lock but was done in coarse track. The jitter in coarse track mask the variations of scientific interest in this target, NGC6814. The October 26 observation took about seven hours from initial target acquisition to completion.

94 3255 The observation was scheduled to take about nine hours from initial set up to completion. The justification for repeating is that the shuttle took the downlink and the data was therefore not obtained on the ground.

131 4257 The backscans must be repeated to properly analyze the occultation event. About six hours of spacecraft time will be required.

138 4888 SS433 has a 13 day period. 4888 was designed to observe six well separated points over one period. All six are required. The observations must be taken over a time short compared to the time in which the geometry of the scattering region changes, typically on the order of 10 days for OB stars. The loss of the one point means that the entire set of six observations must be repeated. The six should be scheduled as before: widely separated over the 13 day period of the target.

139 1091 Target was not acquired. No error could be found in target coordinate specification, guide stars, etc but no star detected in HSP finding aperture. The observations 1870301 - 303 incl should be repeated. The reason for the failed target acquisition is not known. The target coordinates have been checked and are correct, the SMS is correct, the target and guide stars appear to be properly configured using Pickles, and the target is in the correct location in the finder chart.

Failed acquisitions, although not frequent, have occurred before: V1900301 and 17W0201. Are these problems related??

0141 4943 Observations 1F30201 through 05 (observations of GQ-MUS) should be repeated with the correct coordinates. Time should be charged to HSP GTO program because error was by the HSP team. Program is needed and GTO time remains.

Time required is about 8.5 hours.

143 4946 Observation lost because of HST safing. The lost observation is part of a two observation set which must be performed at a specified time interval. Both the lost observation and the one later performed must therefore be repeated. Because the lost observation was linked to another on 6/18, both observations (1F60101-03 and 1F60201-3 must be repeated. The visibility times for the target, HD2164111 has been checked and there are two possibilities, one in early October and another in late November. Total spacecraft time required is less than 8 hours.

175 1091 No repeat or time refund is requested. This HOPR is intended to document the reason for the failure to acquire the target.

176 4888 The three minutes of data that were obtained (of a planned 20 minutes) do not show that the target was acquired. The acquisition images do not show a clear, distinct target. The next observation in the 284 SMS will have the acquisition time increased by 80 seconds, which may be sufficient to acquire the target. The observation scheduled for the 312 SMS should be cancelled. Because the target was apparently missed, the HSP team is not requesting a repeat or refund of this time. The time for the observation scheduled for the 312 SMS should be refunded.

181 1091 Fixed head star tracker failed at 09:10 UTC. FHST Map showed 100 arc second error in V2. Target was therefore missed. This observation requires about one orbit of spacecraft time.

0183 5005 The UV2 acq failed because the guide star acq failed. An attempt was made to acquire on gyros, but no target was seen in the initial pointing field of view. The Gyros had not been updated for a considerable time, so the initial pointing may not have been accurate enough for the 5" radius FOV of the UV2 tube. The missed observations lasted about 45 minutes. The missed observations require about one orbit of spacecraft time.

0192 3255 HST lost lock during the second acquisition (12O5502) and the target may have been 3 to 4 arc seconds from the intended location. Because the Servicing Mission will occur before this observation can be repeated, the team requests credit for the time

195 4946 The 4946 target acquisitions executed normally. The SCP data collection started at 12:00 UTC. Between groups 2 and 3 a number of errors were seen, all of which later cleared, with the VSERROR being the last error to clear. The HSP then went to idle at 12:03 UTC but observation was to end at around 13:20 UTC. Most of the data collection was lost. The cause of this anomaly is under investigation. HSP memory was later dumped and is being analyzed. The HSP was reset after the memory dump and HSP operation was normal during the next observation. At this time, it is not clear whether the problem was caused by some mechanism internal to the HSP or an external cause.

The spacecraft time needed is about one orbit and the official GTO time charged to the HSP team for this observation is 3.67 hours.