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Summary of NICMOS SMOV4 Plans

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ABSTRACT

This ISR outlines the NICMOS plan for Servicing Mission Observatory Verification 4 (SMOV4). It presents the NICMOS requirements, the planned activities to fulfill these requirements and a brief plan for the data reduction and analysis.

1. Introduction

HST Servicing Mission 4 (SM4) is currently planned for October 8 2008. During this mission HST will undergo a major upgrade: Two new instruments will be installed, The Wide Field Camera 3 (WFC3) and the Cosmic Origin Spectrograph (COS). In addition, repairs are planned for the two on-board instruments ACS and STIS. One new FGS instrument will be installed, and, after 15 years of service, WFPC2 and COSTAR will be decommissioned and removed from the telescope. Furthermore, new batteries and an entire set of six new gyros will be installed, as well as several thermal blankets.

While no astronaut activities are planned for NICMOS and the NICMOS Cooling System (NCS), it is nevertheless of critical importance to verify the functionality of the NICMOS instrument and its components during the following Servicing Mission Observatory Verification (a.k.a. SMOV4). The NCS will be turned off prior to capture of the HST and will remain off until the observatory is released from the space shuttle Atlantis. The total time the NCS will be off, and consequently, the NICMOS dewar containing the

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instrument's detectors and cold optics will warm up, will be approximately 9 days.

Subsequent cool-down will commence during the Health and Safety Check following release.

Once the cool-down is complete and the nominal NICMOS internal operating temperatures are reached, a suite of tests will be done to verify the functionality of the NICMOS detectors/readout electronics and the instrument's electro-mechanical and optical subsystems and components (e.g., the filter wheels, field-offset mirror, pupil alignment mirror mechanisms and internal flat field illumination module). During the SMOV there will be repeated measurements of the detector dark currents and telescope+instrument thermal background in order to characterize the operational environment with the newly added (and resurrected) instruments. Special care is given to 'NICMOS unique' capabilities, such as coronagraphic observations. The NICMOS SMOV4 plan is based on previous verification programs following SM2, SM3b and post-SM3b NICMOS and NCS safing events. A suite of 'post-SMOV4' calibrations will be done as a special part of the normal cycle 17 calibration program.

2. Goals of the NICMOS SMOV4 Plan

The principal goals of the SMOV4 NICMOS plan are to: (a) verify the functionality of the entire NICMOS instrument after the thermal re-equilibration following the NCS power down and restart, (b) characterize the new thermal environment, (c) re-establish the instrument's optical alignments, and (d) to re-enable coronagraphic observations. The actual instrumental sensitivity and absolute photometric re-calibration will be done outside of SMOV4, as a special part of the Cycle 17 calibration program.

2.1 Cool Down After the Start of the NCS

The warm-up and subsequent cool-down of NICMOS and its cryogenic sub-systems is the most crucial NICMOS aspect of SM4. All of the NICMOS SMOV activities are based on the presumption that the thermal cycling can cause effects that need to be corrected and/or characterized for the safe operation of NICMOS in the post-SM4 era.

The NCS will be turned off 24 hours prior to capture and remain off until about 1–2 days after release from the space shuttle Atlantis. The estimated time the NCS will be off is ~216 hours and the dewar temperature, measured at the NICMOS detectors, is likely to increase by $\Delta T \sim 120$ K. This estimate is uncertain due to the complexity of the thermo-mechanical system. The only time the dewar has warmed up to this level was after the solid nitrogen was depleted in January 1999, but the actual warm-up process was different from the SM4 event as it involved the sublimation of cryogenics. The few occasions when the NCS has been put in safe mode after SM3b have all resulted in modest warming and those experiences cannot be used to *robustly* estimate the temperature rise during SM4.

We will nevertheless make a rough estimate of the warm-up expected during SM4 by extrapolating from the two NICMOS safing events in August 2003 and February 2007 and using the dewar equilibrium temperature reached following the depletion of cryogenics in 1999 of 229 K (as measured 9 months after the beginning of the warm-up

phase). Based on the two warm-up events involving NCS safings and assuming a functional form of the warm-up as:

$$T = A[1 - \exp(-t/\tau)] + B \text{ K (} t \text{ in hours),}$$

where B is the nominal dewar temperature as measured by the NIC1 Mounting Cup sensor (77.15 K), and τ is a warm-up time scale coefficient. Assuming an equilibrium temperature in the absence of cooling of 229 K, the A coefficient is 151.85. The warm-up time scale coefficient (τ) can then be derived by a least-square fit to the warm-up curves from the August 2003 and February 2007 NCS safings (Fig. 1), giving $\tau = 219$ for the 2003 event and $\tau = 143$ for the 2007 event. The corresponding warm-up curves are shown as blue and red lines in Fig. 1, respectively. The green curve represents an average of the two events.

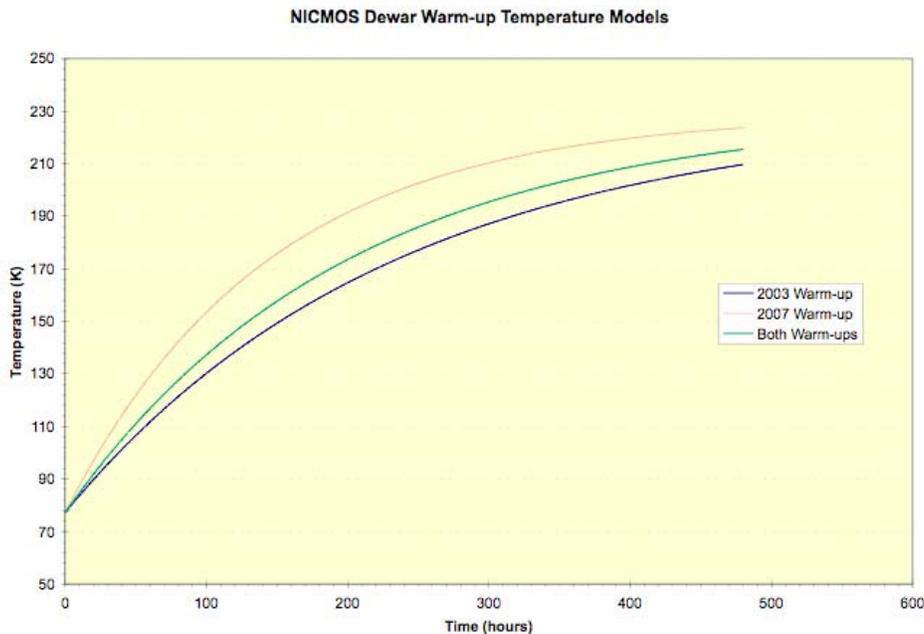


Figure 1: Warm-up of the NICMOS dewar after NCS safings in August 2003 (blue line) and January 2007 (red line) based on the model discussed in the text. The green line is an average of the two events. In neither of these events did the temperature reach the level expected during SM4.

Assuming the NCS will be off for 9 days the dewar temperature will warm up to approximately 170–195 K, with the range spanning the 2003 and 2007 events. It is important to keep in mind that this is an extrapolation from only two NICMOS safing events of shorter duration than that planned for SM4. Another factor influencing the estimate is that NICMOS was left in OPERATE mode for 15 hours following the 2003

event, and 10 hours in the 2007 event. Hence, the warm-up estimate is associated with a high degree of uncertainty.

The cool-down rate is likewise associated with a high degree of uncertainty. The cool down rate has been different in each of the previous events (e.g. Figure 1). Allowing at least 14 days for the cool down, with NICMOS in safe mode should, however, be sufficient to reach the nominal operating temperatures.

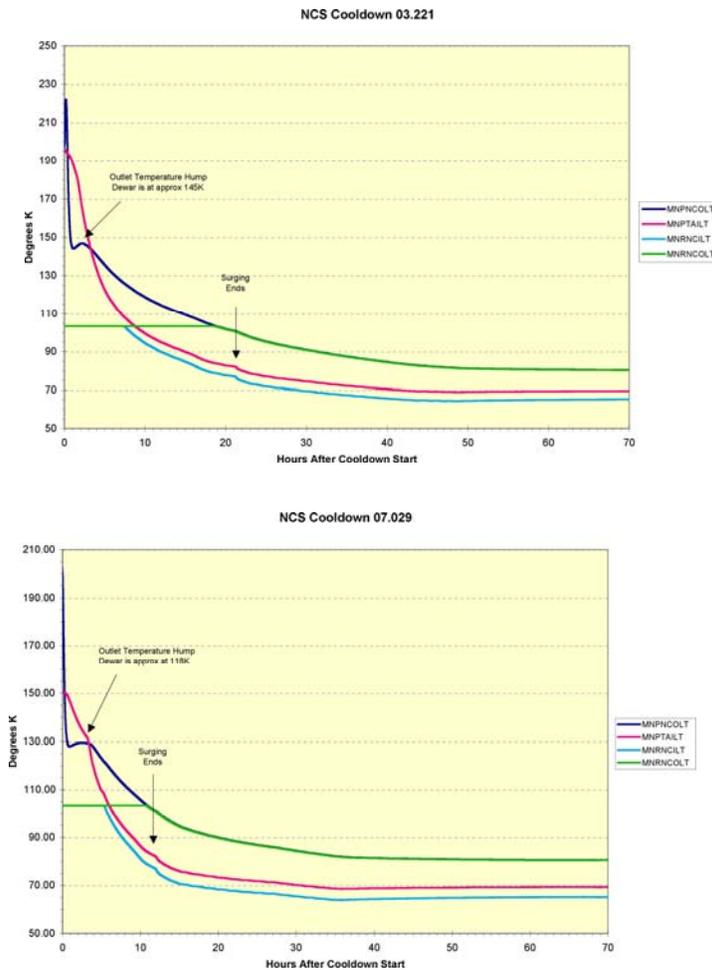


Figure 1: Cool-down of the NICMOS dewar after NCS safings in August 2003 (top panel) and January 2007 (bottom panel). In neither of these events did the temperature reach the level expected during SM4.

2.2 Basic Approach for the NICMOS SMOV4 Activities

The NICMOS SMOV4 activities re-use the NICMOS SMOV3b requirements and proposals, whenever applicable, to verify operability, functionality and basic performance of the instrument. Some of the applicable SMOV3b requirements will be verified during the regular calibration program to follow immediately after SMOV4. The NICMOS Team has defined a minimum of verification activities that needs to be done in SMOV4 and a set of calibration programs to be done post-SMOV.

3. Formal NICMOS SMOV4 Verification Requirements

The NICMOS SMOV4 requirements are divided into six groups:

1. Engineering Activation
2. Target Acquisition
3. Optical Verification and Alignment
4. NICMOS Instrumental Calibration
5. NCS Engineering Verification
6. NICMOS/NCS Calibration and Performance

L.10.4.4.1 Engineering Activation Requirements

L.10.4.4.1.1 The ability to command NICMOS via the RIU, science data transmission via the SDF, and the ability of NICMOS to transition between primary operational states (HOLD, BOOT, SAA-OPER, OPERATE and OBSERVE) shall be verified. This test can be done before reaching nominal operating temperature.

L.10.4.4.1.2 Operation of the NICMOS mechanisms (PAM, FOM, and filter wheels) shall be tested. PAM motion over the range needed to assure focus in all three NICMOS cameras (best achievable focus for NIC3). The ability to reposition the field offset mirror (FOM) over the range needed to reduce vignetting in NIC3 shall be demonstrated. Filter wheel motion shall be verified for each camera.

L.10.4.4.1.3 Verify the basic operating characteristics of the flight detectors through a series of multiple non-destructive readouts as a function of bias voltage.

L.10.4.4.2 Target Acquisition Requirements

L.10.4.4.2.1 The location of each NICMOS camera aperture shall be determined with respect to the FGS reference frames to an accuracy of +/-2 arcseconds in V2-V3 coordinates and 7 arcminutes in aperture rotation angle for Camera 2 and 1 degree for cameras 1 and 3.

L.10.4.4.2.2 The Mode-2 coronagraphic target acquisition shall be characterized and measured with a precision of ~1/10 of a pixel. Acquisition of the target and the coronagraphic hole shall be shown to be repeatable, within the precision given, using the onboard flight software.

L.10.4.4.3 Optical Requirements

L.10.4.4.3.1 The optical plate scales at each of the detector focal planes shall be measured, with a precision of better than 0.1% in each camera.

L.10.4.4.3.2 PAM focus setting should be measured to establish the best focus for each camera. The encircled energy within 100 mas (200 mas for camera 3) radius of an unresolved point source shall be measured. In case the total wavefront error exceeds $\lambda/14$ for NIC1 and NIC2 at 1.1 and 1.6 microns, respectively, a fine optical alignment program will be implemented.

L.10.4.4.3.3 The best coronagraphic focus shall be determined. The purpose of this test is to establish the PAM position to optimize the contrast in the coronagraphic image.

L.10.4.4.4 Calibration Requirements

L.10.4.4.4.1 The performance of the NICMOS coronagraph shall be characterized. The goal is to provide the best achievable target/background contrast ratio.

L.10.4.4.4.2 NICMOS geometric stability will be characterized by measuring the lateral motion of the image in the Camera 2 focal plane.

L.10.4.4.4.3 Detector noise, read-noise and dark current shall be measured throughout the SMOV period through a series of dark exposures.

L.10.4.4.4.4 HST+NICMOS thermal emission will be characterized in a subset of spectral elements over the duration of SMOV.

L.10.4.4.5 NICMOS Cooling System (NCS) Engineering Verification Requirements

L.10.4.4.5.1 Configure the NCS to re-cool NICMOS detectors. The goal during SMOV is to verify the capability to maintain the weighted average of the neon inlet and outlet temperatures at a desired set-point in the range 72-73 K.

L.10.4.4.5.2 Verify the capability of the NCS to achieve a NICMOS Cold Well temperature (as measured by the 1-1 temperature sensor) of 77 \pm 1 degrees Kelvin (nominal 77.15K) and maintain it within 0.1K.

L.10.4.4.5.3 The NICMOS cool down profile shall be characterized.

L.10.4.4.6 NICMOS/NCS Calibration and Performance Requirements

L.10.4.4.6.1 The temperature of each NICMOS detector, along with its range of variation and the timescale of variation, shall be determined. Detector temperature stability shall be characterized over periods of 60 sec, 2000 sec, 24 hours and 30 days using available temperature sensors and temperature from detector bias.

4. NICMOS SMOV4 Proposals

To fulfill the formal SMOV4 requirements, a set of 14 NICMOS Activities have been defined. These Activities and the associated proposals are listed in Table 1.

Table 1: NICMOS SMOV4 Activities

Activity ID	Proposal ID	Proposal Title	PI	Formal Requirement
NIC01	—	NICMOS/NCS Cool down	Wheeler	L.10.4.4.5.1, L.10.4.4.5.2, L.10.4.4.5.3, L.10.4.4.6.1
NIC02	—	NICMOS Activation Test	Wheeler	(contained in NIC03)
NIC03	11406	NICMOS DC Transfer Test	Schneider	L.10.4.4.1.1, L.10.4.4.1.3
NIC04	11407	NICMOS Filter Wheel Test	Wheeler	L.10.4.4.1.2
NIC05	11408	NICMOS Focus and PAM Grid Tilt Test	Wiklind	L.10.4.4.1.2, L.10.4.4.3.2
NIC06	11409	NICMOS FOM Operation Test	Dahlen	L.10.4.4.1.2
NIC07	11410	NICMOS Aperture Locations	Koekemoer	L.10.4.4.2.1
NIC08	11411	NICMOS Optical Plate Scale	Wiklind	L.10.4.4.3.1
NIC09	11412	NICMOS Geometric Stability	Wiklind	L.10.4.4.4.2
NIC10	11413	NICMOS Mode-2 Coronagraphic Target Acquisition	Schneider	L.10.4.4.2.2
NIC11	11414	NICMOS Optimum Coronagraphic Focus Determination	Schneider	L.10.4.4.3.3
NIC12	11415	NICMOS Coronagraphic Performance Assessment	Schneider	L.10.4.4.4.1
NIC13	11416	NICMOS Thermal Characterization	Barker	L.10.4.4.4.4
NIC14	11417	NICMOS Detector Read Noise and Dark Current	Dahlen	L.10.4.4.4.3

Notice that activities NIC01 and NIC02, NICMOS/NCS cool down and NICMOS Activation Test, do not have an associated proposal. The cool down will be initiated during the Health and Safety Check directly following release of the HST from the space shuttle. The dewar temperature will be monitored through regular telemetry during the 2 week cool down phase. The NICMOS Activation Test is accomplished within activity NIC03 (DC Transfer Test) and NIC04 (Filter Wheel Test) and does not require a separate proposal.

Below follows a more detailed description of each of the NICMOS SMOV4 Activities.

NIC01: *NICMOS Dewar Cool-Down* (Proposal ID: none)

Description: Configure the NCS to re-cool the NICMOS dewar and detectors. The goal is to reach the nominal detector operating temperature of 77.15 K by maintaining the Neon inlet and outlet temperatures at a desired set-point. NICMOS will be in safe mode during the cool-down. The cool-down profile will be characterized indirectly through the NCS control-law.

Implementation method: Monitored through NCS telemetry.

Dependencies: First action to be taken. No dependencies.

Duration and data requirements: Estimated time: 2 weeks ; Science bits to SSR: 0Mb

Analysis and expected results: The cool-down progress will be monitored through telemetry from the NCS. The expected result is a complete cool-down to 77.15 K, which will be verified through telemetry from the mounting cup temperature sensor once NICMOS is powered up.

Comments: First NICMOS action to be taken. The NCS should be turned on as early as possible to minimize the warm-up.

NIC02: *NICMOS Activation Test* (Proposal ID: none)

Description: Verify the ability to command NICMOS via the RIU, science data transmission via the SDF and the ability of NICMOS to transition between primary operational states (HOLD, BOOT, SAA-OPER, OPERATE and OBSERVE).

Implementation method: none

Dependencies: This activity can be done as soon NICMOS is powered up. It does not depend on any other activity.

Duration and data requirements: Internal test ; Science bits to SSR: few Mb

Analysis and expected results: This is an activation test and the expected result is the verification that the NICMOS instrument is operational.

Comments: Can be done as soon as NICMOS is powered up. This activity will be completed within the DC Transfer Test (NIC03).

NIC03: *NICMOS DC Transfer Function Check* (Proposal ID: 11406)
4 orbits, internal

Description: Verify the basic operating characteristics of the flight detectors through a series of multiple read-outs as a function of bias voltage. This activity checks the basic relation between the signal in (dark environment) and counts out in instrumental units relative to a level set by the reference voltages.

Implementation method: Special commanding. Commanding identical to SMOV3b proposal 8976.

Dependencies: This activity can be done as soon as the detectors have reached the nominal operating temperature. The Filter Wheel should be in the blank position. Hence, it can be done before the filter wheel test. All subsequent calibration tests are dependent on this activity. The detectors must be equilibrated the nominal temperature (77.15K at the 1-1 mounting cup).

Duration and data requirements: Internal test, equivalent of 4 orbits ; Science bits to SSR: 375Mb

Analysis and expected results: The basic electrical operability of the flight detectors and associated control electronics will be tested against well established voltage and non-stimulated time-from reset dependent signal offsets. Deviations from expected and (acceptable) response can be overcome by reprogramming key detector operating voltages.

Note: A known discrepancy between commanded and output voltage was found during ground test prior to system integration. The discrepancy is believed to be due to a voltage drop in a cross coupling between the Side 1 and Side 2 electronics. This could be compensated for by commanding the DAC to give a 20% higher voltage than expected in read-back from raw telemetry.

Comments: Special commanding. Based on program 8976. The test use 2 internal orbits but 4 orbits are requested to allow for potential bias adjustment and subsequent checking.

NIC04: *NICMOS Filter Wheel Test* (Proposal ID: 11407)
6 orbits, internal

Description: Verify the mechanical integrity of the NICMOS filter wheels, their operability and electro-mechanical calibration. This test is designed to obviate concerns of possible deformation or breakage of filter wheel “soda-straw” shafts due to excessive rotational torque and/or bending motions that may be imparted due to thermal cycling of the NICMOS dewar. The initial sequence is to move each filter wheel one slot from the blank positions while acquiring and analyzing analog and digital diagnostic data. The filter wheels are then moved back to the blank positions and the filter wheel is left disabled. Lamp on/off exposures are taken to verify the filter wheel positions by throughput ratios and count rates correlated with position sensor readings. If analysis of the analog and digital data shows no abnormalities and lamp on/off exposures show that

the filter wheels are back to the blank positions, the filter wheel is enabled and moved through each filter position while taking additional lamp on/off imaging data.

Implementation method: Special commanding based on existing proposals. The first 4 orbits are interactive.

Dependencies: After NIC03. The dewar temperature, as measured at the mounting cup, or inferred from secondary temperature sensors if the mounting cup diode is not available, should ideally be less than 77.3K. This will allow a direct comparison with previous flat exposures.

Duration and data requirements: 6 internal orbits. Science bits to SSR: 939Mb + 0.5Mb of analog and digital diagnostic data.

Analysis and expected results: The results for the filter wheel movement and potential problems will be analyzed in real-time. Lamp on/off exposures will allow a quick assessment of any problems with the location of the filters.

Comments: Special commanding. Based on program 11087 (January 2007).

NIC05: *NICMOS Focus and PAM Grid Tilt Test* (Proposal ID: 11408)

8 orbits external, 2 orbits internal

Description: Determine the best focus for three cameras through a series of iterative adjustments of the NICMOS pupil alignment mechanism (PAM). This activity uses the same procedure as in the standard focus monitoring program. The optimum PAM tilt (coma minimization) will be derived after the focus is derived and possibly updated. The focus and PAM tilt tests may require an update to the PAM settings in order to optimize the NICMOS focus and minimize coma.

Implementation method: Special commanding based on existing proposals. The proposal consists of three parts: PAM focus, followed by data analysis and an opportunity for uploading new PAM settings. PAM Tilt, followed by data analysis and an opportunity to upload new tilt parameters.

Dependencies: After NIC04 (NICMOS Filter Wheel Test)

Duration and data requirements: External test, 8 external orbits, 2 internal orbits. Science bits to SSR: 838Mb

Analysis and expected results: The focus and grid tilt results will be analyzed as soon as the data is available. Data from this test may necessitate an update to the PAM settings for best focus. Time should be allowed between the PAM and Tilt tests for potential updates of the FSW.

Comments: Based on program 11088 (February 2007). The special commanding is the same as used in the normal focus monitoring program with additions for the PAM grid tilt test obtained from program 8977 and 9645.

NIC06: *NICMOS FOM Functional Test* (Proposal ID: 11409)

1 orbit external

Description: Verify the basic mechanical operating characteristics of the FOM by observing a standard star in different locations on the NIC3 detector using the FOM to offset the star. A single filter (F166N) will be used to verify the FOM movement. A set of at 6 additional FOM positions will be obtained using the F222M filter to test for the effect of warm vignetting in the NIC3 camera.

Implementation method: Standard program, no special commanding.

Dependencies: After NIC05 (Focus and PAM Tilt Test)

Duration and data requirements: External test, 1 orbit. Science bits to SSR: 145Mb

Analysis and expected results: The mechanical functionality of the FOM mechanism will be assessed. The expected result is that the correct offsets are achieved with the FOM commands.

Comments: Based on program 8973 (SMOV3b).

NIC07: *NICMOS Aperture Locations* (Proposal ID: 11410)

6 orbits external

Description: Determine the location of each NICMOS camera aperture with respect to the FGS reference frames. Observations of three stars in a standard astrometric field will be obtained. A series of exposures at offset field pointings will be taken to determine the location of the NICMOS apertures and to measure the rotation angle of the apertures.

Implementation method: Standard program, no special commanding.

Dependencies: After NIC06.

Duration and data requirements: External test, 6 orbits. Science bits to SSR: 1512Mb

Analysis and expected results: The aperture locations will be determined off-line, as soon as the data becomes available. Data from this test may cause a SIAF update. A manual uplink of parameter can be done in lieu of the SIAF update.

Comments: Based on program 8981 (SMOV3b).

NIC08: *NICMOS Optical Plate Scale* (Proposal ID: 11411)

4 orbits external

Description: Measure the plate scale, field rotation and field distortion for each NICMOS camera. The intercamera astrometric solution will also be found. Observations a standard astrometric field will be obtained in all three cameras. The same filter (F160W) will be used for all three cameras. Each camera will take 5 exposures, covering the 4 quadrants and the center position with the same group of stars. Comparing the relative positions of the stars in each sector will allow the plate scale and distortions to be measured.

Implementation method: Standard proposal, no special commanding needed.

Dependencies: After NIC07.

Duration and data requirements: External test, 4 orbits. Science bits to SSR: 189Mb

Analysis and expected results: The optical plate scales will be determined. The data will be analyzed off-line, as soon as it becomes available. No special staffing requirements are needed for this activity. Potential update of the FSW with new parameters.

Comments: Based on program 8982 (SMOV3b).

NIC09: *NICMOS Geometric Stability* (Proposal ID: 11412)

2 orbits external

Description: The geometric stability will be characterized by measuring the lateral motion of the image in the NIC2 focal plane. Exposure of a star field will be obtained on a regular interval and the location of each star will be measured as a function of time. The geometric stability will be determined by repeating the NICMOS optical plate scale test two additional times during SMOV4, using the same target but only camera 2. The scheduling of this activity should be approximately mid- and end of SMOV4.

Implementation method: Standard program. No special commanding.

Dependencies: After NIC08.

Duration and data requirements: External test, 2 orbits. Science bits to SSR: 126Mb

Analysis and expected results: The test will show if there are any significant motions in the optical plate scale for NIC2 over a time scale of several weeks. This will be of importance for detecting potential stresses within the NICMOS dewar caused by thermal changes requiring regular updates to the optical plate scale.

Comments: Scheduling is to be done in two installments, one approximately 10 days after NIC09 and the last, approximately 10 days later. The idea is to obtain three measurements (including NIC08), more or less evenly distributed in time over the SMOV4.

NIC10: *NICMOS Mode-2 Coronagraphic Target Acquisition Test* (Proposal ID: 11413)
4 orbits external

Description: The mode-2 coronagraphic target acquisition will be characterized and measured. Coronagraphic observations are sensitive to small centering errors and the target acquisition needs to be re-assessed following warm-up of the dewar and detectors. Mode-2 target acquisition will be done on two bright stars of different characteristics (brightness and environment) and a faint ex-gal target. These targets were used in previous mode-2 coronagraphic target acquisition tests. The target acquisition will be tested in the domain of saturation and under-exposure as well as for optimally exposed target. Exposures at two different roll angles, for nominal exposures, will be performed, and slew maneuvers will be done to determine the occulted position for all three sets of exposures.

Implementation method: No special commanding

Dependencies: After NIC08 (NICMOS Aperture Locations).

Duration and data requirements: External test=5 orbits. Science bits to SSR: 900Mb

Analysis and expected results: The optimal parameters for target acquisition will be determined and, if necessary, changed in the FSW. Potential FSW update needed.

Comments: Based on program 8983 (SMOV3b).

NIC11: *NICMOS Optimum Coronagraphic Focus Determination* (Proposal ID: 11414)
10 orbits external

Description: The NICMOS coronagraph has by design two conjugate focii, with the coronagraphic hole at the OTA f/24 focus and the detector at the reimaged f/45 focus. Due to the displacement of the optical bench inside the dewar, the two focii are no longer conjugate. While this can be compensated for in direct imaging, using the PAM and tilt compensation, it cannot simultaneously compensate both the f/45 and f/24 focii (the PAM is upstream of the field divider mirror which houses the coronagraphic hole). Best focus at f/45 therefore results in a wavelength dependent increase in the diffracted energy in the defocused unocculted wings of the PSF of a target placed inside of the coronagraphic hole. The best coronagraphic performance is achieved when the image contrast between an unocculted target and the residual background from an occulted

source is maximized. The purpose of this test is to find the optimum PAM position that maximizes the coronagraphic image/background contrast ratio.

Implementation method: Special commanding needed based on program 8979.

Dependencies: After NIC10

Duration and data requirements: External test, 10 orbits. Science bits to SSR: 1779Mb

Analysis and expected results: The optimal parameters for the coronagraphic focus will be determined and, if necessary, changed in the FSW. Potential FSW update needed.

Comments: Based on program 8979 (SMOV3b).

NIC12: *NICMOS Coronagraphic Performance Assessment* (Proposal ID: 11415)
6 orbits external

Description: This test defines a coherent program designed to quantitatively measure and map out the diffractive and scattered energy rejection of occulted targets. The performance levels of the system will be assessed while exploring the observational parameter spaces and execution strategies.

Implementation method: Standard proposal.

Dependencies: After NIC11.

Duration and data requirements: External test, 6 orbits. Science bits to SSR: 1696Mb

Analysis and expected results: The optimal parameters for the coronagraphic observations will be determined and, if necessary, changed in the FSW.

Comments: Can be based on program 8984.

NIC13: *NICMOS Thermal Characterization* (Proposal ID: 11416)
100 orbits external, pure parallel

Description: Characterize the stability of the HST+NCS+Instrument thermal emission as seen by NICMOS on secular timescales. The data will be obtained using NIC3 and the F222M filter and will run throughout the SMOV4 activities as a pure parallel program.

Implementation method: Pure parallel, standard program. No special commanding.

Dependencies: This activity requires the detectors to be at nominal operating temperature. Start after NIC06 (Focus and PAM Grid Tilt Test).

Duration and data requirements: Pure parallel, 100 orbits. Estimate science bits to SSR: 126.0Mb per orbit. A total of 100 orbits over the duration of SMOV4. The total data volume will be 12.6Gb.

Analysis and expected results: The data will be used to determine dependencies on the thermal background seen by NICMOS and used as a guideline for observations at long wavelengths.

Comments: Based on program 9269 (SMOV3b).

NIC14: *NICMOS Detector Read Noise and Dark Current* (Proposal ID: 11417)
30 orbits internal

Description: The NICMOS detector characteristics will be monitored during the entire extent of the SMOV4 through a set of dark exposures. This will also allow a determination of the detector temperature from bias measurements. The data should be obtained in SAA-free orbits, approximately every 24 hours. In addition, the detector read noise and the detector shading profiles will be measured.

Implementation method: Internal orbits. No special commanding. Should be scheduled in SAA free orbits.

Dependencies: This activity requires the detectors to be at nominal operating temperature. Start after NIC06 (Focus and PAM Grid Tilt Test).

Duration and data requirements: Internal, approximately equivalent to 30 orbits. Science bits to SSR: 5000Mb per week for the duration of SMOV4. One set of darks per day (600Mb), one Read noise + Shading every 7 days (800Mb).

Analysis and expected results: The data will be used to assess the characteristics of the detectors after cool-down and to monitor detector performance over an extended time period. The darks will be used to derive detector temperature from bias.

Comments: Can be based on program 11086.

5. Time Line for NICMOS SMOV4 Activities

In Table 2 we present the time line for NICMOS SMOV4 activities. Dates are given relative to HST release (R), which is planned to occur on October 15 at 20:07UTC. The NICMOS activities commence with starting the NCS to cool down the NICMOS dewar. Slightly more than two weeks later, (R) + 16d, NICMOS will transition from SAFE mode to OPERATE. This is followed by the DC Transfer test, which will also constitute the initial functional test. Then the Filter Wheel mechanism is tested, followed by a check of

the focus and optical parameters (e.g. focus and coma). The FOM Functional Test comes next. After these functional tests and verifications we will start obtaining darks and characterizing the read noise, and obtain long wavelength data in order to characterize the thermal background. These two programs will run for the remainder of the SMOV activities. We will also determine the location of the NICMOS apertures and derive the optical plate scale. At this point NICMOS will be ERO enabled. The next activities are focused on coronagraphic capabilities. Once these are finished, NICMOS will be enabled for coronagraphic science and coronagraphic enabled. The coronagraphic activities may be moved to a later date due to a congestion of SMOV programs scheduled for weeks during 6–9. While this does not change the dates when NICMOS becomes ERO/science enabled, it would move the coronagraphic enabled date well into January 2009.

Several of the activities require FSW updates before activities can resume. These activities are:

- Focus PAM position (proposal 11408)
- PAM Tilt (proposal 11408)
- FOM Functional (proposal 11409)
- Aperture Locations (proposal 11410) (SIAF update)
- Aperture Plate Scale (proposal 11411)
- Coronagraphic Mode-2 target Acquisition (proposal 11413)
- Coronagraphic Optimal Focus (proposal 11414)

All of these updates will be done R/T, including a temporary update to the aperture locations. A SIAF update is scheduled for December 10 2008 corresponding to (R)+56d, while the aperture location update is needed at (R)+38d.

The final time line, especially for the final weeks of the SMOV is still under evaluation and may change slightly from the one presented here.

Table 2: NICMOS SMOV4 Activity Time Line

Time	Activity	Proposal ID	Description	Comments
(R)	HST Release		NCS OFF, NICMOS in safe mode	
(R) + 2d	NCS START		NICMOS in safe mode	
(R) + 16d	Cool down complete			
(R) + 16d	NICMOS SAFE to OPERATE			
(R) + 19d	DC Transfer Test	11406	Real time	
(R) + 21d	Filter Wheel Test	11407	Real time	

(R) + 22d	Focus PAM Position	11408:1	First part	
(R) + 25d	PAM update	11408:2	Update PAM parameters if needed	
(R) + 25d	Tilt PAM	11408:3	Second part	
(R) + 27d	PAM update	11408:4	Update PAM parameters if needed	
(R) + 28d	FOM Functional Test	11409:1		
(R) + 28d	Read Noise and Dark Current starts	11417	Will continue on a regular basis	
(R) + 29d	Thermal Characterization	11416	Will continue as pure parallel program	
(R) + 30d	FOM update	11409:2	Update FOM position if needed	
(R) + 31d	Aperture Location	11410:1	May require FSW update	
(R) + 31d	Optical Plate Scale	1411:1	May require FSW update	
(R) + 38d	Aperture Location update	11410:2		
(R) + 39d	NICMOS ERO enabled		Milestone	After Optical Plate Scale update
(R) + 43d	Optical Plate Scale update	11411:2		
(R) + 43d	Coronagraphic Mode-2 Target Acquisition	11413		Will move to (R)+70 or later
(R) + 45d	Coronagraphic Optimal Focus	11414:1	May require FSW update	Will move to (R)+70 or later
(R) + 47d	Coronagraphic Optimal Focus	11414:2	FSW update if needed	
(R) + 55d	Coronagraphic Performance Assessment	11415		Will move to (R)+70 or later
(R) + 56d	NICMOS Coronagraphy enabled		Milestone	Will move to (R)+70 or later
(R) + 57d	NICMOS GO Science enabled		Milestone	
(R) + 57d	SIAF Update			
(R) + 65d	Geometric stability	11412	Repeat of 11411	Place towards the end of SMOV4
(R) + 73d	NICMOS SMOV Complete			Projected date 12/27/08

6. Data Analysis Plan

In Table 3 we identify the teams responsible for the data analysis, including backups, and the time scale for delivering the final data product. A few activities are time critical, with turn-around times of just a few days. This is the case when an update to the flight software might be needed before proceeding with subsequent activities. The turn-around times given in Table 3 are after data are down linked. Activities for which expedited downlinks are needed are identified in Table 3. The DC Bias Test and the Filter Wheel Test involve REAL-TIME commanding.

The data will be stored in the centralized storage area, under */grp/hst/nicmos/calibration/smov4/<prop#>* and will be accessible to the entire NICMOS Team.

During the NICMOS SMOV4 activities the instrument will be mechanically verified and the optical parameters defined. It will not, however, be fully calibrated. In order to accomplish this we have defined a set of programs that will run as a special part of the regular Cycle 17 calibration program. The relevant activities are: (1) Photometric calibration: de Jong (PI), Viana; (2) Grism calibration: Thompson (PI), Bohlin, Pirzkal; and (3) Polarization calibration (TBD).

Table 3: Data analysis teams and time requirements

Activity	Proposal	Primary Responsibility	Backup	Turn-around time	Fast download
DC Transfer Function Test	11406	Schneider	TBD	Real Time	NA
Filter Wheel Test	11407	Wheeler, Wiklind, Pirzkal, Thatte, Schneider, Dashevsky	Long	Real Time for A/D data, 12 hours for flat fields	Yes for flat fields
PAM Focus and Grid Tilt Test	11408	Wiklind, Thatte, Schneider, Dashevsky	Bergeron, Pirzkal Koekemoer	2 days for focus 2 days for tilt	Yes
FOM Functional Test	11409	Dahlen, Bergeron, de Jong, Schneider, Thompson	Barker, Thatte, Pirzkal	2 days for deciding on nominal NIC3 FOM position	Yes
Aperture Locations	11410	Koekemoer, Bergeron, Wiklind	Barker, Thatte, Dahlen	5 days	Yes
Optical Plate Scale	11411	Wiklind,, Thatte, Koekemoer	Dahlen, Barker, Bergeron	10 days	Yes
Geometric Stability	11412	Wiklind, Koekemoer	Thatte, de Jong	TBD	No
Mode-2 Target Acquisition	11413	Schneider, Dahlen, Golimowski	Thompson, Bergeron, Wiklind, Barker	TBD	Yes
Coronagraphic Optimum Focus	11414	Schneider, Dahlen, Golimowski	Thompson, Bergeron, Wiklind, Barker	TBD	TBD
Coronagraphic Performance Assessment	11415	Schneider, Dahlen, Golimowski	Thompson, Bergeron, Wiklind, Barker	TBD	TBD

Thermal Background characterization	11416	Barker, Dahlen, Bergeron	Thatte, Pirzkal, Viana de Jong	Analysis to be completed after SMOV	No
Darks and read noise characterization	11417	Dahlen, Barker	Thatte, Pirzkal, Viana de Jong	Analysis to be completed after SMOV	No

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