

# NICMOS Cycle 12 Calibration Plan

---

S.Arribas, E. Bergeron, T. Boeker, R. Bohlin, D. Calzetti, M. Dickinson, B.  
Mobasher, K. Noll, E. Roye, A. Schultz, M. Sosey, C. Xu.  
November 11, 2003

---

## ABSTRACT

*This document summarizes the NICMOS Calibration Plan for Cycle 12. (CPC12). The plan complements the SMOV3b, the Cycle 10 (interim), and the Cycle 11 calibration programs. These previous programs have shown that the instrument is very stable, which has motivated a reduction in the frequency of the monitoring programs for CPC12. Because this stable behavior, systematic errors in the calibration become more important. For this reason CPC12 includes two programs aimed at reducing such errors: the photometric and spectroscopic recalibrations. The CPC12 also includes an outsourced calibration to enable coronagraphic + polarimetric observations.*

---

## Introduction

After the successful completion of the Servicing Mission 3b, NICMOS went through an on-orbit verification phase as part of the SMOV program. This program demonstrated that the recently installed NCS (NICMOS Cooling System) was functioning as required, therefore NICMOS was recovered for science operations.

During Cycle 10 an interim calibration program (ICP) was executed. A summary of this program can be found in Arribas et al. (2002a, NICMOS ISR-002). Details on the individual programs may be obtained via the HST web site at <http://www.stsci.edu/hst/>. The objectives of ICP were to study the stability of the main properties of the instrument via four monitoring programs (focus, flats, darks, photometry), as well as to enable the imag-

## NICMOS Cycle 12 Calibration Plan

ing and grism modes for science. This required photometric zero points, darks, bad pixels masks (Sosey 2002 ISR-001), flats (Mazucca, 2002-ISR-004), linearity corrections, etc.

The NICMOS Calibration Plan for Cycle 11 is summarized in Arribas et al. (2002b, ISR-003). Apart from the standard monitoring programs, this plan included more diverse and specialized calibrations such as, for instance, the polarimetric mode, the high signal to noise regime characterization (Gilliland and Arribas, 2003 ISR-001), the Gain test (Xu and Boeker 2003 ISR-006), the intrapixel sensitivity (Xu and Mobasher, 2003 ISR-009), the removal of cosmic persistence (Bergeron and Dickinson, 2003 ISR-010), etc.

The analysis of the data corresponding to these two plans has shown that the instrument is very stable. As a consequence of the thermal stability maintained by the NCS, both the optics (Roye 2003-ISR-005) as well as the detectors (Schultz 2003-ISR-003) have kept their main properties nearly unaltered. This is also clearly shown in the analysis of the high S/N regime characterization (Gilliland and Arribas, 2003 ISR-001). These results have led us to reduce the frequency of some of the monitoring programs for the Cycle 12 Calibration Plan. Typically we have reduced the frequency by a factor 2. Although we discussed the possibility of reducing the frequency even further by combining the information from different programs (i.e. photometric stability could, in principle, be checked from the photometric monitoring data), it was considered important to maintain homogeneity in the programs across cycles.

Due to the instrument's stability, the systematic errors in the calibration become more important. For this reason the NICMOS calibration Plan for Cycle 12 includes two proposals aimed at reducing these errors. The photometric recalibration will expand the number and type of stars used for obtaining the photometric zero points for all the filters. Similarly, the spectroscopic recalibration will allow a reanalysis of the sensitivity curves for the three grisms using a larger number and variety of stars. It is important to point out that several of the selected objects are common for the two proposals. Therefore, these data will allow a complete spectro-photometric recalibration by cross-checking results obtained independently from each of these programs.

Apart from the programs mentioned above, the TAC approved a calibration proposal aimed at enabling the use of polarimetry + coronagraphy.

After the current plan was designed, on August 2, 2003, a voltage sensor in the NCS recorded an anomalous value. The NCS was shut down and NICMOS was put in safe mode. On August 7 the NCS was restarted and several calibration proposals were implemented to check NICMOS calibrations. These included: Filter Wheel Test (ID: 10062), Focus (ID:10063), and Darks (ID:10064).

## NICMOS Cycle 12 Calibration Plan

ID	Proposal Title	Frequency	Estimated Time (orbits)		Scheduling Required	Resources Required (FTE)	Products	Accuracy Required	Notes
			“External”	“Internal”					
<b>Routine Monitoring Programs</b>									
9993	Multiaccum Darks	monthly		36		0.3	CDBS	4-5%	Same as in Cycles 10 and 11, but NSAMP=23 for SPARS64 (UDF Observations)
9994	Focus Stability	monthly	15			0.3	ISR	1mm	Same sequences as in C10 and C11, but NIC1 or NIC2 every month 3 NIC3 executions.
9995	Photometry Stability	bi-monthly	12			0.3	CDBS	2%	Same as in C10- C11, but bi-monthly
9996	Flats Stability	bi-monthly	6			0.3	IR / ISR	1-2%	Same as in C10- C11, but bi-monthly
<b>Special Calibration Programs</b>									
9997	Photometric Recalibration	once	15			0.4	ISR	2%	Zero phot. points using G191B(WD) 4 stars cross-check for some filters
9998	Grsm Recalibration	once	10			0.3	ISR	1%	Provide a robust absolute calibration for G096-G141 (3SA + 3WD), and G206 (1SA + 1WD) Relative fluxes of 3SA and 3WD , 1% A faint IR standard (SNAP, JWST) Abs. Calibration in the NIR ~ Visible PI R. Bohlin
9768	Enabling Coronagraphic Polarimetry	once	(6)			0.0	P. Coeff.	1%	Outsourced PI D. Hines
<b>TOTAL TIME (including all executions)</b>			<b>58 (6)</b>	<b>36</b>		<b>1.9</b>			

## Proporsal ID: 9993. NICMOS Cycle 12: MA Darks

### Plan

**Purpose** The purpose of this proposal is to monitor the dark current, read noise, and shading profile for all three NICMOS detectors throughout the duration of Cycle 12. This proposal is a continuation of PID 9321 and 9636 which cover the period between the end of SMOV3B and the end of Cycle 11.

For SPARS64, NSAMP has been changed from 19 to 23, in order to provide Superdarks for proposal 9803 (UDF).

**Description** Each iteration of this proposal consists of ten dark exposures of 1088s (sample sequence of SPARS64 and NSAMP=23) for all 3 cameras. In addition, a set of 3 SCAMRR, NSAMP=25 sequences for each camera will be obtained in order to set an accurate estimate of the read noise. Finally, in order to characterize the shading profile of the NICMOS detectors, a set of 5 STEP256, NSAMP=12 sequences for each camera will be taken. These contain all commonly used NICMOS Delta-times, except the shortest one (0.2s) which is covered by the SCAMRR sequences. As an additional benefit, the dark exposures will allow us to estimate the cosmic ray rates outside the SAA. This sequence will be repeated once a month for 12 months to allow the monitoring of NICMOS detector behavior as a function of time and temperature throughout Cycle 12.

**FractionGO-Supported** 100%

**Resources R:** Each monthly visit will require 3 internal orbits.

**Observation** Therefore 36 orbits are required to cover the cycle

**Resources :** 0.3 FTE  
**Analysis**

**Products** Darks for all readout sequences. Direct superdarks for SPARS64 (NSAMP=23)

**Accuracy** 4-5 % per visit for the linear component of the dark current. In principle S/N ~ 50, but degradation due to CR lower this figure.  
**Goals** S/N ~ 35 (12) for the amplifier glow at the corner (center).

**Scheduling** Monthly. SAA free orbits  
**Requirements**

## Proposal ID : 9994. NICMOS Cycle 12: Focus Stability

### Plan

**Purpose** The purpose of this activity is to check the focus for the three cameras

**Description** Steps:

- a) Use refined target field positions as determined in Cycle 7
- b) Use MULTIACCUM sequences of sufficient dynamic range to account for defocus
- c) Do a 17-point focus sweep, +/- 8mm about the PAM mechanical zeropoint for each cameras 1 and 2, in 1mm steps. (10-point focus sweep from -0.5 to -9.5 for camera 3).
- d) Use PAM X/Y tilt and OTA offset slew compensations refined from previous focus monitoring/optical alignment activities.
- e) Use phase retrieval algorithms to establish PAM focus for each camera.

**Fraction** 100%

**GO/GTO**

**Programs Supported**

**Resources** Every monthly visit will require 1 external orbit (if only NIC1

**Required:** or NIC2 are done) or 2 orbits if NIC3 is also done. In total 15

**Observation** orbits are needed to cover the cycle.

**Resources** 0.3 FTE

**Required:**

**Analysis**

**Products** ISR, Update of focus as needed

**Accuracy** The best focus should be known within 1 mm

**Goals**

**Scheduling&** Every month NIC1 or NIC2 (alternate their executions).

**Special** NIC3 every four months.  
**Requirements**

## Proposal ID : 9995. NICMOS Cycle 12: Photometric Stability

### Plan

**Purpose** To verify the stability of the NICMOS photometric calibration over a broad range of wavelengths.

**Description** Observations of a standard star (P330E) through the following subset of filters: F090M, F110W, F160W and F190N for NIC1; F110W, F160W, F190N, F222M for NIC2 and F110W, F160W, and F222M for NIC3. All observations are done using a spiral dither pattern, with 5 dither points for NIC1 and NIC2, and 7 dithers for NIC3 (to help reduce intrapixel sensitivity effects on the photometry). The integration times are set to achieve  $S/N \approx 200-350$  in the standard photometry apertures for each exposure, while keeping peak pixel counts to  $< 66\%$  of saturation level. The NIC1/F190N observation has somewhat lower  $S/N$  ( $\sim 110$ ) per exposure. NIC3/F110W may come slightly closer to saturation ( $\sim 73\%$  according to the ETC).

**Fraction** 100%

**GO/GTO**

**Programs**

**Supported**

**Resources** Each bi-monthly visit will require 2 external orbits. Therefore,

**Required:** 12 orbits are required for the complete period.

**Observation**

**Resources** 0.30 FTE

**Required:**

**Analysis**

**Products** Internal Report or ISR. Updated zero points for CDBS

**Accuracy** 2%.

**Goals**

**Scheduling & Special** SAA free orbits preferred.

**Requirements**

**Proposal ID : 9996. NICMOS Cycle 12: Flats Stability**

**Plan**

**Purpose** A series of camera 1, 2, & 3 flat fields will be obtained to monitor the health of the cameras.

**Description** Each 1-orbit visit will obtain pointed flat fields in each camera (NIC1 filters F110M, F110W, F160W; NIC2 filters F110W, F160W, F222M; NIC3 filters F110W, F160W, F222M). Some filters will be rotated through the sequence so that many filters will be used during a year. A four point dither pattern will be used to allow removal of background objects. At each dithered position, observations will be obtained with the lamp off and followed by lamp on observations. Every four months well exposure (saturated) observations will be taken to study the non-linearity corrections. The Cameras 1 and 2 will be used in parallel. For almost all the exposures, Lamp 1 (High Intensity) will be used. .

**Fraction** 100%

**GO/GTO**

**Programs Supported**

**Resources** Each bi-monthly visit will require one orbit. Therefore, 6 orbits  
**Required:** are needed for the complete period.

**Observation**

**Resources** 0.3 FTE

**Required:**

**Analysis**

**Products** Depending on the results an internal report or an ISR.

**Accuracy** 1-2 %

**Goals**

**Scheduling&** SAA free orbits.

**Special**

**Requirements**

## Proposal ID : 9997. NICMOS Cycle 12: Photometric Recalibration

### Plan

**Purpose** Reduce the systematic uncertainties in the photometric zero points associated to the selection of the standard stars.

**Description** Part I- In C10 the solar analog P330E was observed with all cameras and filters. The second calibration star, the white dwarf G191B2B, was observed through a subset of filters. We propose to complete the observations for G191B2B. As a cross-check, we will also reobserve with the broad and medium band filters which were done in C 10. Observations for NIC1 and NIC2 will consist of 4 dither positions per star/filter/camera. For NIC3 we will use 7 or 5 dither positions depending on the wavelength. For the broad and medium band filters (and for all NIC3 filters), each exposure will aim at reaching  $S/N=300$  in the peak pixel, providing reasonably small photometric uncertainties, and  $<0.1\%$  for the average of all exposures. For the narrow band filters, the net  $S/N$  for the average of the dithers should ensure  $<0.2\%$  accuracy for almost all filters.

Part II- Only two stars (P330E and G191B2B) were systematically observed in many filters in Cycle 7. We propose to extend this to two more stars: one solar analog, P177D, and one white dwarf, GD71. These will be observed through a strategically chosen subset of broad and medium band filters. Those filters are: NIC1: F110W, F160W, F090M, F110M, F145M, F170M  
NIC2: F110W, F160W, F187W, F205W, F207M, F222M, F237M  
NIC3: F110W, F160W, F222M, F240M.

**Fraction GO** Nearly all programs will benefit from this recalibration.

**Resourc. Orb.** 15 internal orbits

**Resourc. An.a** 0.2 FTE

**Products** ISR, Improvement of pipeline

**Accu. Goals** 2 %

**Sc.. . Esp. R.** SAA-Free Orbits

**Proposal ID: 9998. NICMOS Cycle 12: Grism Recalibration**

**Plan**

- Purpose** 1. Provide a robust characterization of the absolute flux calibration for G096 and G141(3WD+3SA) and G209(1SA +1WD).  
2. Verification to < 1% accuracy of the relative fluxes of the 3 WD and the 3 solar analog (SA) standard stars to 1.9 microns.  
3. Characterization of the differences between the WD and the SA flux scales in the IR.  
4. Establishment of one fainter IR standard star .  
5. Quantify the repeatability of grism observations with P330E.  
In summary, these data will establish, for the first time, an absolute flux basis in the IR that will be of comparable fidelity to the optical flux standards..
- Description** Targets: G191B2B, GD71, GD153, P330E, P041C, P177D, Span1. Dither strategy: 15 dither positions will be used for consistency with previous observations (fewer for the faint standard). The optimum dither pattern should be local to avoid extra uncertainties due to large scale flat-field residuals. Wavelength solution: Only one observation with the broadband F160W filter is required to set the wavelength scale. Sequence: for the two shorter wavelength grisms a sequential observation of the two grisms at each pattern position seems more efficient.
- Fraction GO/GTO** ~ 8% of the programs will have a direct benefit from this proposal. However, this proposal (together with the photometric recalibration) will provide a robust basis for the NICMOS absolute calibration, which has a broader interest
- Req.: Obs.** 10 external. Each of WD or SA in G096+G141, 1 orbit (subtotal 6 orbits) . 1 SA + 1 WD in G209, 2 orbits. The faint standard (2 orbits)
- Re. Analysis** 0.30 FTE
- Products** ISR, CDBS
- Acc. Goals** < 1% relative fluxes of 3 SA and 3 WD..
- Scheduling& Spe. Requi.** SAA free orbits

## **Proposal ID 9768 : NICMOS Cycle 12: Enabling Coronagraphic Polarimetry with NICMOS**

### **Plan**

- Purpose** We propose to enable a new mode on NICMOS that combines the powerful diffracted light rejection of the coronagraph with the diagnostic power of polarimetry.
- Description** The basic calibration plan closely parallels that of Cycle 7, 7N and Cycle 11, except that the targets will be placed within the NICMOS coronagraph hole. We will use the same polarized and unpolarized standard stars that were used in Cycle 7, 7N & 11 so that; 1) we understand their characteristics as observed with NICMOS, and 2) we can evaluate directly the effect of placing the objects into the coronagraph. To mitigate bad pixels, discriminate instrumental artifacts and ghosts, and to assess any instrumental polarization structure as a function of spacecraft roll, we will apply a small spacecraft roll between two exposures of the target through each polarizer. We will also visit each target twice, but separated by sufficient time that the roll angle of the telescope is  $> 100$  degrees from the initial observations. We will also observe the face-on circumstellar disk surrounding TW Hydrae. This object is a bright T-Tauri star imbedded in a debris disk and is basically unpolarized in low (spatial) resolution images from the ground.
- Fraction GO/GTO** ~ 10 % of the programs will use the coronagraph and ~ 5 % the polarizers during Cycle 12.
- Req.: Obs.** 6 external
- Re. Analysis** 0.30 FTE
- Products** ISR
- Acc. Goals** Polarization induced by the coronagraph within 1%
- Scheduling & Spe. Requi.** PCS mode fine Sched 30% visibility interval corons