

NEAR INFRARED CAMERA and MULTI-OBJECT SPECTROMETER

UPDATE ON NICMOS PERFORMANCE

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To assist GOs in deciding whether and how to revise their NICMOS observing programs, this document provides the latest available information on the status of NICMOS and the first on-orbit measurements of its characteristics. It updates or corrects the information provided in the Instrument Handbook and the Call for Proposals. We have made every attempt to include the most accurate information and advice possible in this document, but users should be aware that in many cases we are presenting our current best conclusions before completing all the planned tests and calibrations included in the Science Mission Orbital Verification (SMOV). Users should bear in mind that at the time of writing, the instrument has not reached an equilibrium state but is still evolving. Thus, the final performance cannot be fully predicted. New and more complete information will be described in monthly Space Telescope Analysis electronic Newsletters (STAN) and posted to the WWW as it becomes available. ***NICMOS users should continue to consult these resources regularly.*** General help or documentation should be solicited by sending email to help@stsci.edu. If you have questions related to your Cycle

7 proposal, you should consult your Contact Scientist or Program Coordinator.

NICMOS Status Summary

Soon after launch, early tests of NICMOS revealed dynamic changes to its characteristics and performance. It is thought that thermal cycling of the NICMOS dewar during ground operations cryopumped nitrogen to one end of the dewar. On-orbit expansion of the column of solid nitrogen has deformed the dewar leading to a thermal contact between the instrument cold well and the inner vapor-cooled shield and also causing changes in focus for all three NICMOS cameras. The expected lifetime of the NICMOS cryogen has been reduced as a result. Best estimates are that, if the current rate of cryogen loss continues, the useful lifetime of NICMOS will be approximately eighteen months. If the thermal short breaks and the cryogen loss rate is decreased, that time could be longer. As described in this document, NICMOS camera 3 (NIC3) has suffered the largest loss in performance. Cameras 1 and 2 (NIC1, NIC2) are performing well and are capable of meeting most observational requirements. Details on the performance of all three cameras in NICMOS are covered in the remainder of this document. Based on our best estimates of the current situation, we will work from the following set of assumptions:

- The useful lifetime of NICMOS will be reduced; we are planning for a termination of NICMOS observations by November 1998.
- Thermal backgrounds are much lower than estimated in the Instrument Handbook.
- Image quality in NIC1 and NIC2 is excellent. Both cameras are, however, slightly vignetted.
- The best focus positions for NIC1 and NIC2 are different, but the image quality of NIC1 at NIC2's focus or NIC2 at NIC1's focus is only slightly degraded.
- The coronagraph performance in NIC2 is degraded.
- NIC3 cannot currently be focussed. The image quality is very poor when either NIC1 or NIC2 are in focus as the prime camera. NIC3 is vignetted over approximately 25% of the detector.
- NIC3 may return to focus as cryogen is depleted, but when this may occur cannot be predicted.
- The spectral resolution and sensitivity of the grisms are seriously degraded for point sources. For extended sources the loss of performance is less severe.
- A small percentage of pixels in each camera have reduced throughput, possibly from debris on the detectors. The pattern of affected pixels is time variable.
- Except as noted here, NICMOS performance is as previously described.

Policy Summary

In order to make the most efficient use of the shortened lifetime of NICMOS, the following policies have been adopted. Questions about the applicability of policies to specific proposals should be directed to your Contact Scientist or Program Coordinator.

- Observations that require prime use of NIC3 will not be supported until that camera reaches a stable configuration; these visits will be placed on hold. If not reactivated sooner, this hold will be reviewed in November 1997. Proposers who elect to have their NIC3 observations executed before the hold is lifted must provide their own calibration data from their TAC allocation. All such observations will be at the observer's risk.
- Visits that require the use of the coronagraph in NIC2 will be put on hold until the coronagraph can be characterized in a stable configuration.
- Coordinated parallel observations will be made with NIC1, NIC2, and NIC3 even though optimal focus cannot be achieved. Parallels will be executed unless explicitly directed otherwise by the observer.
- Observations will not be eligible for repeats based on degraded performance of NICMOS.
- Because of changes in performance, proposers are invited to consider modifying their programs to make the best use of cameras and observing modes that are available now. However, observers must be able to complete their observations within their original TAC allocation consistent with their original science objectives. No additional orbits will be made available for these changes.
- Revised Phase 2 proposals or directions to proceed with existing Phase 2 programs must be received at STScI no later than 16 May 1997 in order to be scheduled. Major revisions made after that date will risk long delays in the scheduling of observations, possibly resulting in the loss of the program. An opportunity for small modifications that do not affect scheduling will be available approximately 10 weeks before each visit is executed.

Recommendation Summary

We give here a summary of general recommendations. However, observers are strongly advised to read the technical sections that follow and decide an optimal observation strategy based on the demands of their individual scientific goals.

- Proposers that currently use NIC3 have the option of redesigning their proposal to use NIC2 or NIC1 if their scientific objectives can be met. If proposers decide to redesign their program for NIC2 or NIC1, they should do so by the 16 May deadline.
- Proposers who cannot meet their scientific objectives with NIC1 or NIC2 should make no changes. Their proposal will be placed on hold pending a resolution of the situation.
- Where possible, proposers should separate NIC3 exposures into separate visits from NIC1 and NIC2 exposures so that the latter may be scheduled without delay.
- Proposers who make use of the grisms in NIC3 may consider using narrow band filters in NIC2 or NIC1 to meet their science goals. Otherwise, their program will be placed on hold with other NIC3 proposals.
- Proposers that use the coronagraph should decide whether their program can be effectively done without the coronagraph. If so, the program should be redesigned by the deadline. If not, the proposal will be placed on hold pending a complete characterization of the coronagraph performance.
- Proposers that use both NIC1 and NIC2 as prime cameras should minimize the number of changes between cameras.
- Because of problems associated with darks, proposers should avoid programs that rely on single long exposures with MULTIACCUM. Exposures should be divided into smaller individual MULTIACCUMs.
- Proposers should dither observations that could be adversely affected by bad pixels. For most observations in NIC1 and NIC2, however, dithering will not result in improved resolution.
- Proposers with coordinated parallel observations should continue to use all of the NICMOS cameras where possible.
- Proposers should eliminate restrictive scheduling requirements (e.g., ORIENT) wherever possible to decrease the chance that their program will experience long delays.

NICMOS Camera 3

The Pupil Alignment Mechanism (PAM)

The Pupil Alignment Mechanism, or PAM, consists of an adjustable mirror in the NICMOS optical train that can be moved to make small corrections to the NICMOS focus. The motion of the PAM is limited to ± 10 mm from its zero position. The NICMOS cameras were designed to share a common focus with the PAM close to its zero position. In the current state of the dewar, cameras 1 and 2 (NIC1 and NIC2) can each be focussed within the range of the PAM. Camera 3 (NIC3), however, cannot be focussed by motions of the PAM alone. Throughout this document we will use the PAM mirror position as the measure of focus position of the three NICMOS cameras.

Figure 1: A series of NIC3 images of two stars at different PAM positions ranging from +8 mm to -8 mm (left to right). The upper star is located near the top of NIC 3 ($y=225$). The lower star is located near the bottom of NIC3 ($y=15$) in the vignetted region of the detector. Each subimage is centered in a 20 by 20 pixel box (i.e. 4 by 4 arcsec). These images were obtained during the coarse alignment test before the peak expansion of the dewar. The NIC3 focus was estimated to be at a PAM mirror offset of -14.8 mm at that time, similar to the focus at the time of this writing. An image of a point source in NIC3 when NIC2 is prime would be similar to the star images in the sixth or seventh subimage from the left. When NIC1 is prime a NIC3 point source image will be similar to the image in the eighth or ninth subimage from the left. The full range of the PAM mirror extends to -10 mm or two steps farther to the right than covered by this focus sweep.

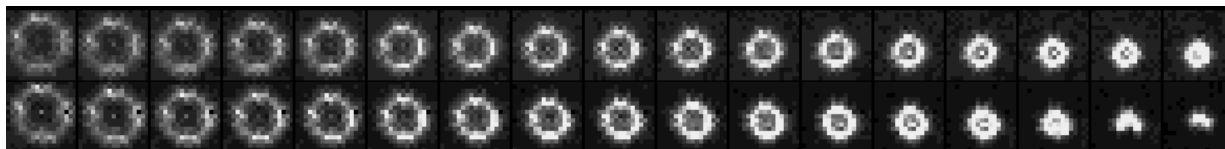
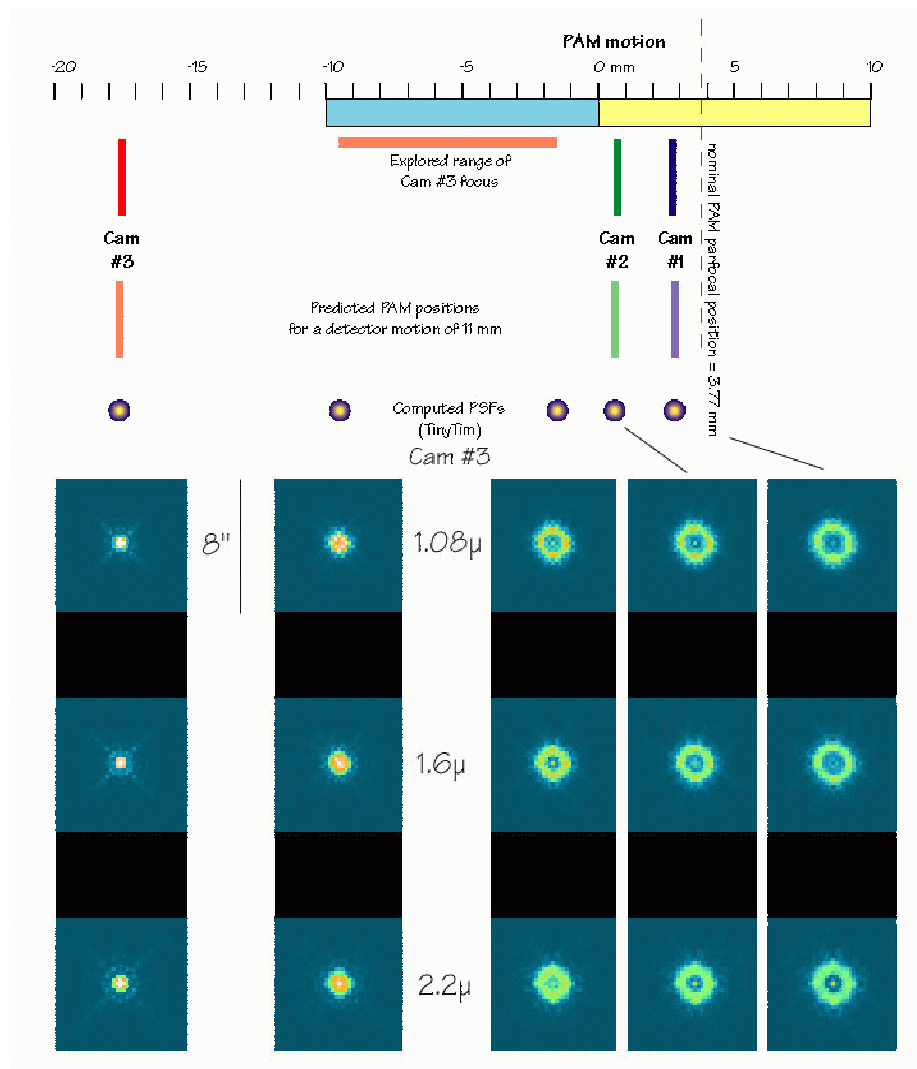


Figure 2: Model PSFs computed for NIC3 and several positions of the PAM mirror are shown in the figure reproduced below. The original figure can be seen on the ST-ECF NICMOS WWW page at http://ns3.hq.eso.org/nicmos/nicmos_c3/



NIC3 Defocus

Because of its fast beam, NIC3 has suffered the largest shift in focus, now estimated to be at a location equivalent to a -15.1 mm motion of the PAM from its nominal position after reaching a maximum of -17.7 mm in late March. Because the PAM is limited to motions of ± 10 mm, NIC3 cannot now be focussed with the PAM alone.

Figure 1 shows a series of measured star images over a range of PAM focus positions. The images were taken in steps of 1 mm of PAM motion from +8 mm on the left to -8 mm on the right. The current NIC1 best focus is at $+2.34 \pm 0.22$ mm, NIC2 at $+0.45 \pm 0.22$ mm, and NIC3 at -15.14 ± 0.07 mm. At either the NIC1 or NIC2 focus positions, the NIC3 image quality is very poor.

Using the TinyTIM software package it is possible to calculate model PSFs for any PAM position, including positions not reachable by the actual PAM mechanism. The model PSFs produced in this way agree well with the observed PSFs as shown in Figure 2, produced by R. Fosbury, R. Hook, and W. Freudling of the ST-ECF.

NIC3 Vignetting

In addition to the loss of focus, there is evidence of significant vignetting of the NIC3 field of view. As the PAM mirror is moved to shift the focus forwards or backwards, it simultaneously translates the field of view laterally, moving one or more obstructions into the field of view. The observed vignetting in NIC3 is most likely a combination of a warm bulkhead edge, far from focus, which affects the lower $\sim 1/4$ of the detector (in y) and a portion of a mask on the NICMOS field divider assembly (FDA) that results in a decrease in throughput over a smaller portion of the detector. The approximate extent of the warm component of the vignetting is shown in Figure 3 and Figure 4. This also delineates the portion of the detector where degraded PSFs are observed. Figure 5 shows the decrease in throughput over a smaller area caused by the FDA mask.

The vignetting is a function of the PAM mirror position. The figures shown are for a PAM position of -9.5 mm, the closest to focus position available for NIC3. At this focus the vignetting is substantial. However, when NIC3 is observed with the PAM positioned for either NIC1 or NIC2, we do not detect any evidence of vignetting. This effect can be seen in Figure 1 where the star images in the lower row show the effects of vignetting at PAM positions of -6, -7 and -8 mm. Repositioning the Field Offset Mirror (FOM) would allow observations in NIC3 with reduced vignetting. Tests sufficient to enable general use of this option are planned before restarting NIC3 prime science observations.

Figure 3: A NIC3 flat field at $2.4 \mu\text{m}$ measured on-orbit divided by a flat field measured during thermal vacuum testing shows enhanced thermal background in the lower quarter of the NIC3 detector. This emission is due to vignetting by a warm bulkhead edge that is far from focus. A line plot of a row average is shown in Figure 4. Over the same portion of the detector, the PSF is degraded, as shown by the lower set of images in Figure 1.

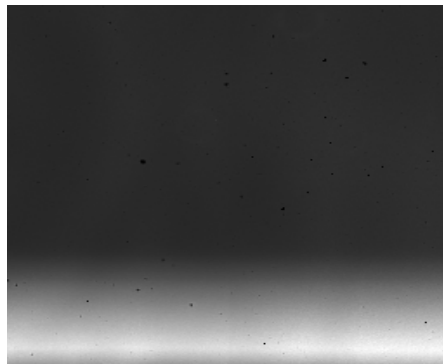


Figure 4: The average countrate as a function of row for the NIC3 2.4 μm flat field ratio shown in Figure 3 is plotted showing the range of the detector where increased thermal background and degraded PSFs occur. This component of the vignetting is thought to be produced by a warm, out-of-focus bulkhead edge.

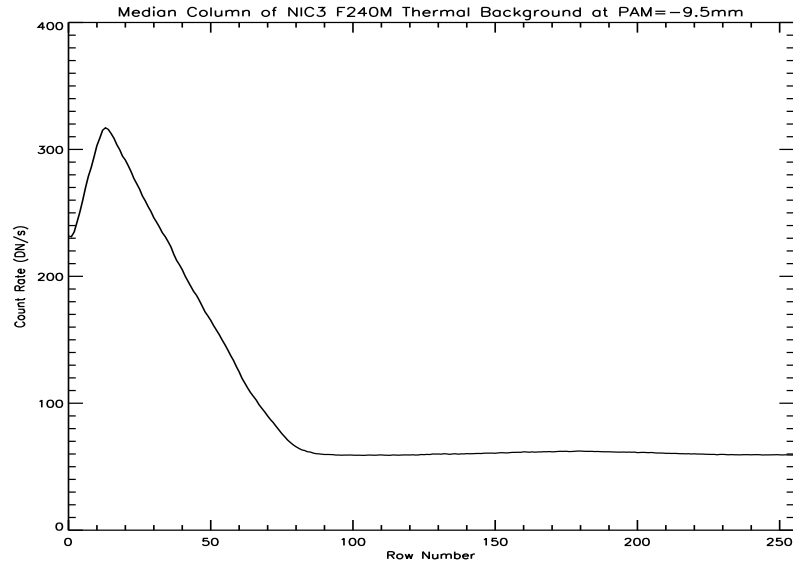
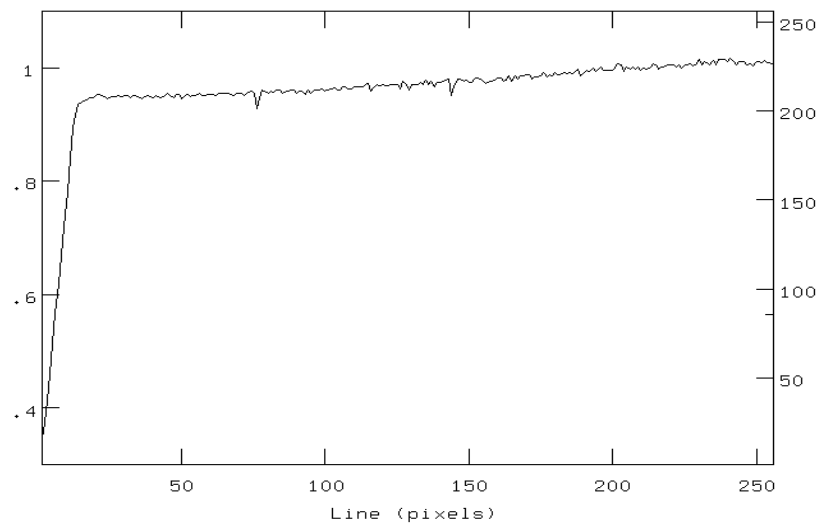


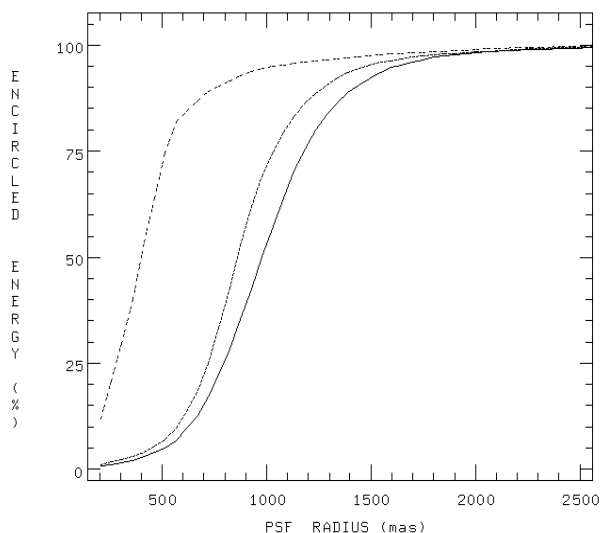
Figure 5: A second component of the vignetting in NIC3 is shown in this ratio of a recently measured NIC3 flat to a flat measured during thermal vacuum testing. At 1.1 μm no enhanced thermal emission is detected. However, at rows near the bottom of the NIC3 detector a loss of throughput as large as 60% is evident.



Encircled Energy

The predicted encircled energy for NIC3 observations of a point source at three different PAM mirror positions are shown in Figure 6. These curves have been derived from model PSFs generated by TinyTim. Observed PSFs are in good agreement with the model PSFs generated by TinyTim.

Figure 6: Three curves showing the encircled energy in NIC3 for PAM mirror positions corresponding to -9.5 mm (dashed curve) and the NIC2 (dotted curve) and NIC1 best focus positions (solid curve). The TinyTim program was used to generate the PSFs for an assumed best NIC3 focus corresponding to a PAM mirror offset of -17.5 mm.



Possible Recovery of NIC3 Capability

It is possible that at some point the ongoing, normal loss of cryogen from NICMOS will result in a relaxation of the forces on the dewar that have led to the loss of focus for NIC3. One estimate suggests this might occur after approximately 40% of the cryogen has been consumed, or approximately 8 months from launch. The current best prediction is that when this stress is relieved the NIC3 focus may return to a PAM position just short of the range of the PAM mirror. If this occurs, it may still not be possible to obtain optimal focus for NIC3, though the degradation may be smaller than the normal errors induced by telescope breathing and may therefore yield acceptable PSFs. A decision on when and how to reactivate NIC3 science will be deferred until a stable configuration has been reached.

At the time of this writing, the NIC3 focus had moved back towards the range of the PAM mirror by 2.6 mm of PAM mirror adjustment from -17.7 to -15.1 mm. While there may eventually be a return to near-focus (i.e. near -10 mm of PAM adjustment), the lack of predictability of the changes in focus makes unreliable forecasts of when this might occur.

Also of concern is the question of whether the current vignetting will remain. It is possible that vignetting will be reduced by use of the FOM, though at the moment no decision to do so has been made. If this is done, it will be implemented in such a way that there will be no need for observers to revise their Phase 2 proposals.

Recommendation

The increase in sensitivity for NICMOS due to the reduced background rates (see section on thermal background on p.17) and warmer operating temperatures means that many programs planned for NIC3 may be possible with NIC2. Observers are encouraged to consider redesigning their program to use NIC2 if this will achieve the scientific goals of their original proposal. The exposure time calculator tool on the STScI NICMOS WWW pages now accurately reflects the improved performance we expect from NIC1 and 2. Larger areas on the sky can be covered by designing mosaics using the dithering and chopping patterns described in the Phase 2 Proposal Instructions and the NICMOS Instrument Handbook documents. Observers that conclude that NIC3 is essential to their scientific objectives are allowed to keep this as their prime instrument. However, such programs will be placed on hold pending a return to a stable situation for NIC3. Observers may, at their risk, request that observations with NIC3 be made sooner than this, but observers who choose to do so will be responsible for obtaining all of their own calibration data from their TAC allocation. STScI will not provide calibration data or support for reduction and analysis of any NIC3 data obtained in this way. Proposals that have mixed observations using NIC3 and NIC1 or NIC2 should separate these into distinct visits if possible so that the NIC1 and NIC2 portion of their program will not be delayed.

Grisms

The three grisms placed in NICMOS all reside in the NIC3 filter wheel, and thus, use NIC3. The degradation of the NIC3 image quality has two serious effects on the grism observations of point sources. Observations of extended sources may, in some cases, be possible with only small losses in capabilities.

Degradation of Spectral Resolution

The degraded images produced by NIC3 at the current focus position lead to a large degradation in the spectral resolution of the grisms. Because the grism is slitless, the resolution is inversely proportional to the FWHM of the image. For point sources, this is equivalent to a reduction in resolution of at least a factor of 4. The grism resolving power is $R=100$ for a fully sampled spectrum. With the loss of resolution this will be reduced to $R=25$ or less. At this point, the resolving power of the grisms is comparable to the bandpass of the medium and narrow

band filters but with the grisms experiencing a much higher background than the discrete filters.

Loss of Sensitivity

In addition to the loss of resolution, the loss of focus results in a decrease in sensitivity for sources smaller than the FWHM of the NIC3 PSF. For a point source, the loss of sensitivity is estimated to be a factor of five based on models by Fosbury et al (see Fig. 2). These models did not include the additional loss in sensitivity caused by vignetting in NIC3.

Recommendation

Proposers that are able to do so should consider revising their grism proposal to make use of the available narrow and medium bandpass filters in NIC1 and NIC2. For a limited subset of objects, e.g., distant galaxies in the 1 arcsec diameter size range, the loss of capabilities in the grisms may be small. When coupled with the decreased background, longer wavelength grism observations may compete favorably with ground-based facilities. However, observers with extended objects should be aware that deconvolution of their spectra to obtain spatial information on their target objects may not be effective at the degraded focus of NIC3. As with NIC3 images, proposals that mix NIC3 grism observations with NIC1 and NIC2 may want to consider separating these into separate visits if possible.

NICMOS Cameras 1 and 2

Separate Foci for NIC1 and NIC2

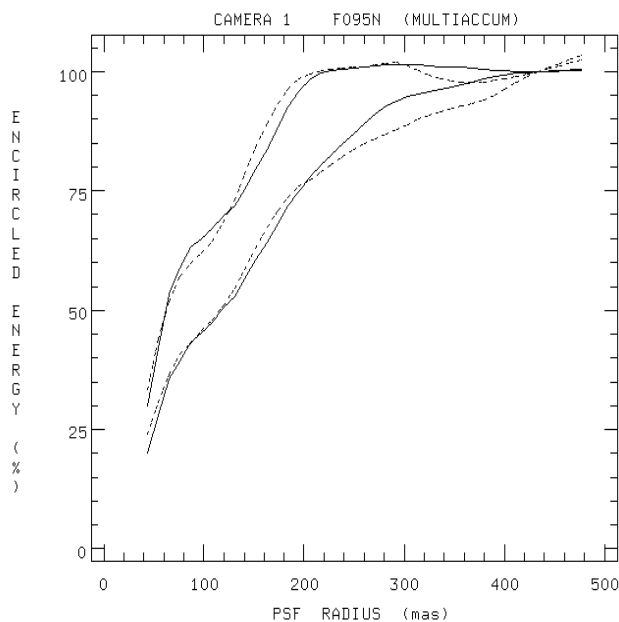
The changes in dewar geometry leading to the lack of focus in NIC3 have also affected NIC1 and NIC2. By measuring the PSFs of stars at a series of PAM positions it has been determined that the optimal focus for NIC1 occurs for a PAM position of +2.34 mm and the optimal focus for NIC2 at +0.45 mm. This difference is significant enough that NIC1 and NIC2 are no longer considered to be parfocal. A separate PAM position at the optimal focus is defined for each camera. The main effects of this decision are to degrade the image quality of either NIC1 or NIC2 when used in parallel and to add overhead associated with changes from NIC1 to NIC2.

The NIC1 and NIC2 foci are sufficiently close that reasonably good quality images will be obtained by each when the PAM is positioned at the optimal focus of the other camera. Quantitative measurements of the encircled energy at best focus of each camera are tabulated below and are shown in Figure 6. The slightly defocussed images in NIC1 or NIC2 in parallel will be sufficiently good that parallel observations are strongly encouraged, as discussed below.

The PAM mirror must be moved when switching between NIC1 and NIC2 resulting in a 240 second instrument overhead. This overhead will not have been present in Phase 2 programs prepared with RPS2. This may result in slightly less time available for science exposures, particularly if frequent shifts between NIC1 and NIC2 are made during an orbit. Efforts are now underway to reduce this additional overhead, but observers can minimize the impact of any such overheads by reducing the number of switches between NIC1 and NIC2 to a minimum.

A compromise focus that shares the wavefront error equally between NIC1 and NIC2 is not currently implemented, though it is being worked on for future availability. This option may become available by October 1997, though an exact date is impossible to predict. Characteristics of an intermediate focus are detailed in Table 1 and Table 2. If an observer concludes that such an intermediate focus is essential to their science, they may elect to place their program on hold. However, we strongly recommend against this option because it runs the risk of long or terminal delays in the program.

Figure 7: Encircled energy in NIC1 with the F095N filter at two different PAM mirror positions. The upper two curves are for the PAM position corresponding to the best NIC1 focus, the lower two curves show the degradation in performance of NIC1 when the PAM mirror is at the NIC2 focus. The solid curves are from model PSFs generated by TinyTim, the dotted curves are the average measured encircled energies of two stars.



Encircled Energy and S/N

Encircled energy curves are shown in Figure 7 and 80% encircled energy radii are listed in Table 1 below. Both measured stellar PSFs and model PSFs created with the TinyTim software tool were used to create the encircled energy curves

shown in Figure 7. The stellar encircled energies shown by the dotted curves are the average of two well isolated stars. These agree reasonably well with the encircled energy curves derived from the TinyTim PSFs shown by the solid curves. This agreement indicates that use of model PSFs to predict performance should yield accurate results.

Table 1 below lists the 80% encircled energy radius for two different PAM mirror positions. It can be seen both from Figure 7 and Table 1 that the difference between the NIC1 and NIC2 foci can be significant for programs that require the highest possible quality PSF.

Table 1: Encircled Energy for NIC1 and NIC2

PAM position	NIC1/F095N 80% encircled energy radius (arcsec)	NIC2/F110W 80% encircled energy radius (arcsec)
NIC1 best focus (+2.8 mm)	0.154	0.215
intermediate focus (+1.8 mm)	0.170	0.184
NIC2 best focus (+0.5 mm)	0.214	0.175

Estimates of the loss of sensitivity of NIC1 and NIC2 at different possible focus positions have been made for observations of point sources that are background or read-noise limited. These are tabulated in Table 2. Signal-to-noise estimates are made assuming that all available information in the PSF is used.

Table 2: Loss of S/N at alternate focus positions

focus position	% decrease in S/N in NIC1	% decrease in S/N in NIC2
NIC1 optimum focus (+0.5 mm)	0	20
intermediate focus (+1.8 mm)	8	4
NIC2 optimum focus (2.8 mm)	27	0

Vignetting in NIC1 and NIC2

The lateral shifts of the NICMOS dewar have resulted in vignetting in cameras 1 and 2 in addition to NIC3. In the case of NIC1 and NIC2, the source of the vignetting is most likely the Field Divider Assembly (FDA) mask. Relatively small losses in throughput are observed near the edges of both NIC1 and NIC2 as shown in Figure 8 and Figure 9.

Figure 8: The curve below shows one column of a ratio between a recent NIC1 flat field at 1.1 μm and a flat field taken during thermal vacuum testing before launch. The overall normalization of the y-axis ratio scale is arbitrary. The approximately 6% decrease seen in rows near the bottom of the detector (labelled Line on this figure) shows the region of the NIC1 detector where vignetting has affected the throughput. The step-like edge near $y=128$ may be related to a quadrant boundary.

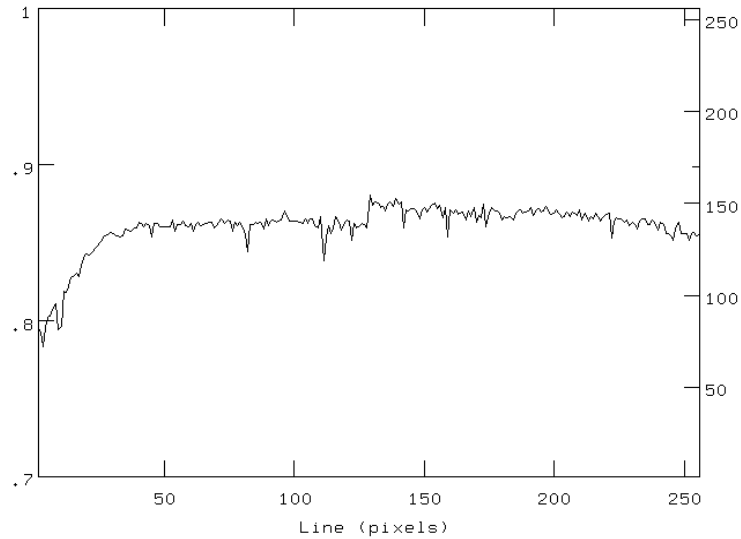
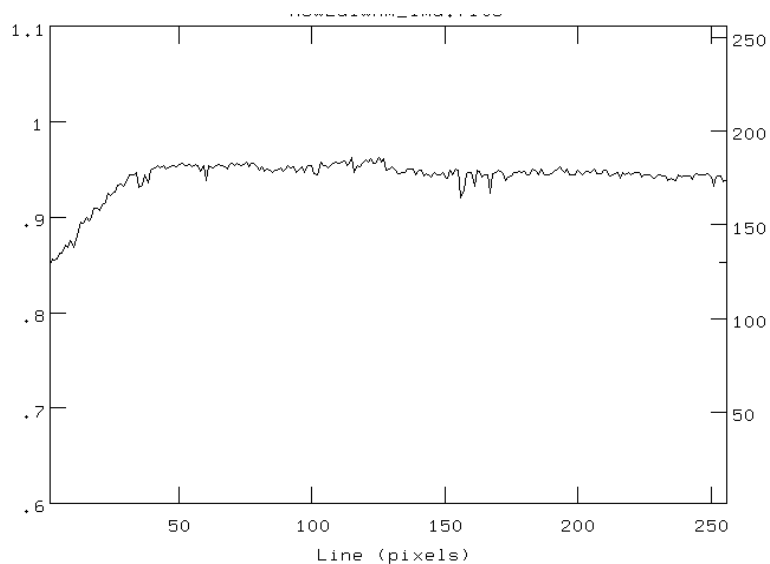


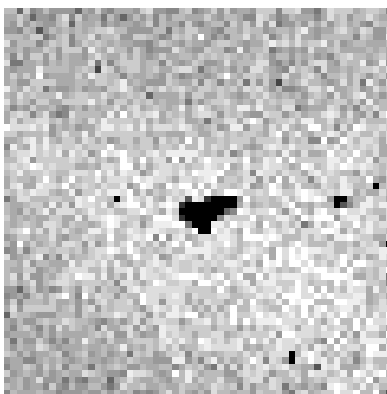
Figure 9: Similar to Figure 8, this curve shows an approximately 10% decrease in throughput in rows near the bottom of NIC2 from vignetting by the FDA mask.



Transient bad pixels

Flat fields taken on orbit show a population of pixels with very low count rates. In many cases, pixels with low count rates in one flat field will be normal in the subsequent one. A working hypothesis is that the bad pixels are caused by debris lying on top of the detectors. Paint flecks from the optical baffles are one possible source of this debris. The largest of these areas of bad pixels occurs in NIC1 and is shown in Figure 10 below. Approximately 100 pixels in each of NIC1 and NIC2 are affected by this debris and a similar number are expected to be affected in NIC3. As described below, dithering is recommended for observers who believe that these and other pixel defects could adversely affect their science goals.

Figure 10: A portion of a NIC1 flat field image shows the largest of the groups of pixels affected by debris. This bit of grot is roughly 5 by 9 pixels and is located in the upper left quadrant of NIC1. This particular group of bad pixels has remained constant for several weeks. Other features are transient on week time scales.



Recommendation

Observers using both NIC1 and NIC2 for their observations will maximize the efficient use of their time by minimizing the number of changes between NIC1 and NIC2 that occur during an orbit. Observers who believe their program might benefit from the availability of a compromise focus between NIC1 and NIC2, but can also be done with the separate foci, should make this need known to their Contact Scientist as soon as possible. In the event that such a compromise focus is implemented, there will be an opportunity to revise your program to take advantage of this feature. If you believe that a compromise focus is absolutely necessary for your proposal you should include the lines listed below in your Phase 2 proposal. In general, however, we recommend that, if your program can be executed with the current focus options, you should strongly consider designing it to do so. With a limited lifetime for NICMOS, programs that are placed on hold run a high risk of not being executed before the end of the functional lifetime of NICMOS.

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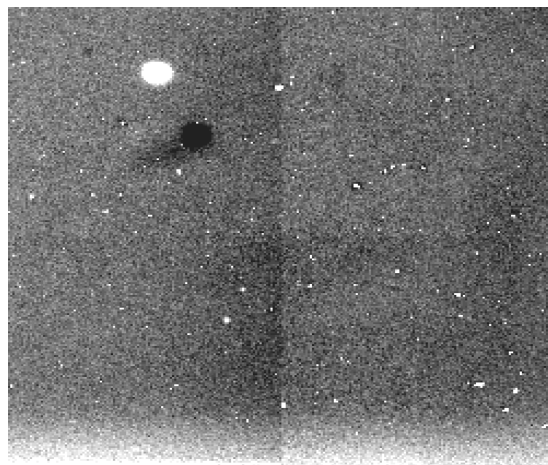
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Coronagraph

Motion of the Coronagraphic Spot

The NICMOS coronagraph consists of a laser ablated hole in the reflective optics on the field divider assembly (FDA). As the internal optics in NICMOS have continued to move, the location of the coronagraphic spot on the NIC2 detector has continued to change. Successful use of the coronagraph requires that a source be positioned accurately in the coronagraphic hole. Currently, this requires accurate knowledge of a stable coronagraph position. It will not be possible to enable routine use of the coronagraph until this lateral motion has stabilized (or until the acquisition software is modified). Figure 11 shows the cumulative motion of the coronagraphic spot on NIC2 from thermal vacuum testing up to a recent flat field measurement.

Figure 11: A ratio of a recent flat field taken on-orbit and a flat field measured during thermal vacuum testing shows the change in position of the coronagraphic hole in that interval. Approximately half of this motion was expected relaxation in zero-G, the remainder has resulted from the deformation of the NICMOS dewar. The bright spot marks the location of the spot at the time of the on-orbit flat field; the dark spot shows its location during thermal vacuum testing before launch. More recent observations show the coronagraphic spot moving back towards its expected on-orbit position. The bright region near the bottom of the detector shows the area of the detector that is vignetted by a mask on the field divider assembly.



Defocus of Coronagraph Hole on the Field Divider Assembly

NICMOS optics were designed so that both the cameras and the FDA would be in focus at the same, nominal PAM mirror position. While it has been possible to maintain focus in NIC1 and NIC2 by moving the PAM mirror, this has been at the expense of moving the FDA away from focus. The result is that the image of a point source at the FDA is significantly broader than anticipated, resulting in an increase of scattered light from the rough edges of the coronagraph hole.

The effects of this defocus are to be measured in a series of tests expected to be completed by mid-July. Results of these tests will be posted on the NICMOS WWW pages soon after.

Recommendation

Coronagraphic observations will be placed on hold until the results of tests are available. With a lag for scheduling, the soonest that coronagraph observations could be scheduled is late September 1997. Proposers that currently use the coronagraphs may change their programs to use either NIC1 or NIC2 if they believe that their scientific objectives can be achieved without use of the coronagraph.

Thermal Background

Measurement of Low Thermal Background Rates

Prior to the installation of NICMOS the emissivity of the HST optical telescope assembly (OTA) was not known accurately. In order to allow for planning with the most conservative strategy, STScI used thermal background count rates estimates using the upper end of the range of possible emissivities for the OTA, approximately 20%. On-orbit measurements now indicate that these estimates were overly conservative. The emissivity of the OTA appears to be close to 4% leading to a significant reduction in the expected thermal background for all filters longward of 1.5 microns. In addition, it appears that the contribution to the background from the zodiacal dust was overestimated by a factor of two, a change that affects all filters. These changes result in significant improvements in the sensitivity of NICMOS at the longest wavelengths where the background count rates are reduced by the largest amount.

Table 3 compares the predicted background rates in several filters in NIC2 before SMOV with the revised rates resulting from the first on orbit test. A complete listing for all camera and filter combinations is contained in the appendix. The exposure time calculator tool on the STScI NICMOS WWW page has been updated to reflect the newly measured background rates. Background count rates for any filter/camera combination may be obtained by selecting Input Info on the exposure time calculator results page. The grism software tools have

not been updated because of the special problems of the grisms as detailed in the grism section of this document on page 10.

Table 3: Background count rates for selected filters in NIC2

filter	predicted background (e-/s/pix)	revised background (e-/s/pix)
F110W	0.19	0.18
F160W	0.39	0.14
F180M	0.33	0.051
F190N	0.27	0.033
F207M	20	2.3
F215N	5.1	0.57
F222M	74	8.8
F237M	279	34

Dithering and Chopping

Strategy for Thermal Background Removal

At wavelengths where the thermal background is a significant fraction of the counts measured relative to the intended target, a strategy to remove the thermal background must be employed. When the background count rate is comparable to or greater than the source rate, and/or when the thermal background varies on short time scales, frequent and repeated measurements of the background (chopping) is recommended. When the background rates are lower and the background is not variable on time scales shorter than the measurements it is sufficient to make fewer measurements of the background. In many cases it is possible to estimate the background from regions of the detector away from the source, especially if the image is dithered.

At the time of this writing, there has been no measure of the temporal stability of the background. Therefore, we cannot advise on the possible impact of any such variability. However, because of the large reduction in the background compared to pre-launch estimates, it is possible that some programs will be able to change their strategy for background removal which may result in increased observing efficiency. It is important to note, however, that the decrease in thermal background does not require the revision of any existing, viable Phase 2 proposals.

Bad Pixel Correction

Transient bad pixels have been identified in images obtained with NIC1 and NIC2 as described above. Of order 100 pixels are affected on each camera in

recent images, but which pixels will be affected cannot be predicted. Observations that cannot tolerate the risk that one of these pixels might fall in their image should dither to reduce this risk. A two point dither of five pixels or more should be sufficient to eliminate the majority of bad pixels. Note that NICMOS is Nyquist sampled at most wavelengths. Sub-pixel dithering should not be used in such cases and will not result in improved resolution but will increase the complexity of your program and needlessly decrease the efficiency.

Observers are reminded that using MULTIACCUM sequences will allow the removal of cosmic rays which for most integrations will affect many more pixels per image than the phenomenon described above.

Darks and MULTIACCUM

An excess in the count rate has been measured in MULTIACCUM dark frames obtained as part of the NICMOS verification tests. The extra signal, amounting to a maximum count rate of 0.15 counts/sec decays pseudo-exponentially to a nominal count rate after approximately 500 seconds. The cause of this phenomenon is still under investigation. However, the fact that the excess count rate appears after the detectors have been idle for a period of time suggests that the additional signal could be associated with instabilities in the detector's amplifiers when they are turned on at the start of an observation.

Proposers with single long MULTIACCUM exposures and/or those searching for faint, extended structures should evaluate whether this phenomenon could negatively impact their science. Several observing strategies will be tested during the first week of May. The results of these tests and recommended observing strategies will be posted on the NICMOS WWW page soon after. Proposers who conclude they may be sensitive to this effect should inform their Contact Scientist and Program Coordinator and ask their program be put on hold pending the results of these tests.

Proposers who do not wish to have their program delayed should consider splitting long exposures (e.g., MIF2048 sequences) into two or more shorter MULTIACCUM sequences (e.g., 2 x MIF1024).

Parallels

With reduced expectations for the lifetime of NICMOS cryogen, the potential value of NICMOS parallel observations is increased. Parallel observations with NICMOS fall into one of three categories, NICMOS coordinated, multi-SI coordinated, or pure parallels. Suggested strategies for each are discussed in the following sections.

NICMOS Coordinated Parallels

NICMOS coordinated parallels are NICMOS parallel observations made with one or two of the NICMOS cameras when another one of the NICMOS cameras is being used as the prime instrument. Observers were encouraged in the phase 2 proposal instructions to make use of the opportunity to attach parallel observations with the non-prime NICMOS cameras. The PAM mirror position will be determined by the NIC camera that is being used for the prime observations. Therefore, the observations made by the other cameras will not be at their best focus. However, because of the dynamic state of the detector focus positions, we recommend that GOs with NICMOS coordinated parallels, including NIC3 parallels, make no changes to their programs at this point. A deletion of parallels may be justified if this results in a major savings in time. However, for proposals that have followed the recommended use of sparse sequences (e.g., SPARS64), this should not be an issue.

Multi-SI Coordinated Parallels

Multi-SI coordinated parallels are NICMOS parallel observations made with one or more of the NICMOS cameras when the prime observation is being made by another instrument. Coordinated parallels had to be requested by the GO and approved as part of the TAC review process. If your program has approved coordinated parallels there are several options available to you.

If your parallel program relies on NIC1 and/or NIC2, you should proceed with your observations. If you use multiple cameras, you will have to decide which to focus. This is done by ordering the parallel exposures in RPS2 such that the camera whose focus you wish is listed first. This is described in more detail below and an example is shown in the Appendix.

If your coordinated parallel program currently uses NIC3 you have two options. You may decide to place your observations on hold until the NIC3 returns to focus and make no changes to your submitted program. If you decide to do this, you must notify your Program Coordinator and Contact Scientist of your decision. If, instead, you decide to allow the program to proceed, you will have to decide which NIC camera you will choose to focus. In some cases, this might result in the need to revise the parallel portion of your proposal.

Pure Parallels

Implementation of pure parallel programs on HST is currently under review. Proposers will be notified when a decision on these observations has been made.

PAM Position for Parallels

With separate PAM positions for each NIC camera it is essential that observers with parallel programs write their phase 2 proposals in such a way as to have the PAM mirror at the optimal position for the desired camera. When NICMOS is the prime instrument, the PAM mirror will be at the position defined by the prime

camera. When NICMOS is not prime, the PAM mirror will be moved to the position corresponding to best focus for the first NICMOS camera specified in the exposure logsheet for a set of parallel exposures. The exposure logsheet lines in the Appendix below specify NICMOS parallel observations to be taken in parallel with a WFPC2 prime observation. NIC2 is listed first and the PAM mirror will be at the NIC2 optimal focus position. NIC1 and NIC3 parallels are also included.

Acknowledgments

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Appendix

Thermal Background Tables

In the three tables below we have listed the revised thermal background count rates for each filter and camera combination available. These tables should be compared with Tables 6.3 - 6.5 in the *NICMOS Instrument Handbook* to see the change in thermal background for each filter. The NICMOS exposure time calculator has been updated to reflect these revised backgrounds.

Table 4: Background count rates for NIC1

Filter	revised background count rate (e-/sec/pix)
F090M	0.013
F095N	0.0007
F097N	0.0008
F108N	0.0009
F110M	0.019
F110W	0.051
F113N	0.0010
F140W	0.078
F145M	0.016
F160W	0.042
F164N	0.0016
F165M	0.020
F166N	0.0017
F170M	0.027
F187N	0.0074
F190N	0.0096
POL0S	0.033

Table 5: Background count rates for NIC 2

Filter	revised background count rate (e-/sec/pix)
F110W	0.18
F160W	0.14
F165M	0.068
F171M	0.033
F180M	0.051
F187N	0.025
F187W	0.38
F190N	0.033
F204M	0.91
F205W	21
F207M	2.3
F212N	0.48
F215N	0.57
F216N	0.72
F222M	8.8
F237M	34
POL0L	1.4

Table 6: Background count rates for NIC3

Filter	revised background count rate (e-/sec/pix)
F108N	0.020
F110W	1.2
F113N	0.022
F150W	2.4
F160W	0.94
F164N	0.037
F166N	0.038
F175W	87
F187N	0.17
F190N	0.22
F196N	0.49
F200N	0.75
F212N	3.3
F215N	3.9
F222M	61
F240M	380

RPS2 Input for Parallel Observations

The example exposures listed below will execute a WFPC2 prime observation with all three NICMOS cameras operating in parallel. Since the NIC2 parallel exposure is listed first, the PAM mirror will be moved to the focus position for NIC2.

```

Exposure_Number: 10
Target_Name: PRIME-TARGET
Config: WFPC2
Opmode: IMAGE
Aperture: WFALL
Sp_Element: F555W
Wavelength:
Optional_Parameters: CR-SPLIT=NO
Number_of_Iterations: 1
Time_Per_Exposure: 10 M
Special_Requirements: PAR 20-50 WITH 10
Comments:

Exposure_Number: 20
Target_Name: PARALLEL-TARGET
Config: NIC2
Opmode: MULTIACCUM
Aperture: NIC2
Sp_Element: F160W
Wavelength:
Optional_Parameters: SAMP-SEQ=SPARS64,NSAMP=14
Number_of_Iterations: 1
Time_Per_Exposure: DEF
Special_Requirements:
Comments:

Exposure_Number: 30
Target_Name: PARALLEL-TARGET
Config: NIC1
Opmode: MULTIACCUM
Aperture: NIC1
Sp_Element: F160W
Wavelength:
Optional_Parameters: SAMP-SEQ=SPARS64,NSAMP=14
Number_of_Iterations: 1
Time_Per_Exposure: DEF
Special_Requirements:
Comments:

Exposure_Number: 40
Target_Name: PARALLEL-TARGET
Config: NIC3
Opmode: MULTIACCUM
Aperture: NIC3
Sp_Element: F160W
Wavelength:
Optional_Parameters: SAMP-SEQ=STEP16,NSAMP=10
Number_of_Iterations: 1
Time_Per_Exposure: DEF
Special_Requirements:
Comments: Object I.D. image for GRISM obs.

Exposure_Number: 50
Target_Name: PARALLEL-TARGET
Config: NIC3
Opmode: MULTIACCUM
Aperture: NIC3
Sp_Element: G141
Wavelength:
Optional_Parameters: SAMP-SEQ=SPARS64,NSAMP=13
Number_of_Iterations: 1
Time_Per_Exposure: DEF
Special_Requirements:
Comments:
:

```