CHAPTER 1
Introduction

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The Near Infrared Camera and Multi-Object Spectrometer, NICMOS, is a second-generation instrument to be installed on the Hubble Space Telescope during the Second Servicing Mission in 1997. NICMOS will provide HST with infrared imaging and spectroscopic capabilities between 0.8 and 2.5 microns. From above the earth’s atmosphere, NICMOS will have access to this complete spectral range without hindrance from atmospheric emission or absorption at a sensitivity and angular resolution not possible from the ground. This Handbook provides the instrument specific information you need to propose for HST observations (Phase I), design accepted proposals (Phase II), and understand NICMOS in detail. This chapter explains the layout of the Handbook and how to get additional help and information through the Help Desk and World Wide Web pages at STScI.

Purpose

The NICMOS Instrument Handbook is the basic reference manual for the Near Infrared Camera and Multi-Object Spectrometer and describes the instrument’s properties, expected performance, operations, and calibration. The Handbook is maintained by scientists at STScI. Dr. R.I. Thompson, the Principal Investigator for NICMOS, and scientific staff at Steward Observatory and Ball Aerospace kindly provided information and test data in support of this Handbook.
We have designed the document to serve three purposes:

- To provide instrument-specific information for preparing Cycle 7 observing proposals with NICMOS.
- To provide instrument-specific information to support the design of Phase II proposals for accepted NICMOS proposals in Cycle 7.
- To provide technical information about the operation and performance of the instrument which can help in the understanding of problems and in the interpretation of data acquired with NICMOS.

This Handbook is not meant to serve as a manual for the reduction and analysis of data taken with NICMOS. Near the start of the NICMOS observing era, we will publish an addition to the *HST Data Handbook* describing how to work with NICMOS data.

**Document Conventions**

This document follows the usual STScI convention in which terms, words, and phrases which are to be entered by the user in a literal way on a form are shown in a typewriter font (e.g., `BRIGHT=RETURN, FP-SPLIT`). Names of software packages or commands (e.g., `synphot`) are given in bold type.

Wavelength units in this Handbook are in microns (µm) and fluxes are mainly given in Janskys (Jy).

**Layout**

NICMOS has a variety of imaging modes. The instrument provides direct imaging in broad, medium, and narrow-band filters at a range of spatial resolutions in the near infrared from 0.8 to 2.5 microns, together with broad-band imaging polarimetry, coronographic imaging and maskless grism spectroscopy. To guide you through NICMOS’s capabilities and help optimize your scientific use of the instrument we have divided this Handbook into four parts: Part I - Introduction; Part II - Users’s Guide; Part III - Supporting Material; and Part IV - Calibration. provides a roadmap to navigating the document; following the roadmap is a list of chapters and their contents.
Figure 1.1: Roadmap for Using the NICMOS Instrument Handbook

- **Start** in Chapter 1
- Review Special Cycle 7 Issues for NICMOS in Chapter 2
- Obtain Overview of NICMOS Capabilities and Operation in Chapter 3
- Information on NICMOS Detectors in Chapter 7
- Select Coronography, Polarimetry, or Grisms & Estimate Exposure Times in Chapter 5
- Detailed Exposure Time Calculations? in Chapter 6
- Additional Reference Material in Chapter 11, 12
- Select Data-Taking Mode in Chapter 8
- Determine Overheads and Calculate Phase 1 Orbit Time Request in Chapter 9
- Using NICMOS to Measure Backgrounds or Make Maps? in Chapter 10
- Chapters 4, 11
- Chapters 3
- Chapters 2
- Chapters 6
- Chapters 13, 14, 15
The chapters of this Handbook are as follows:

Part I - Introduction

- Chapter 1, *Introduction* on page 3.
- Chapter 2, *Special Considerations for Cycle 7* on page 11, describes special considerations for the use of NICMOS during Cycle 7.

Part II - Users Guide

- Chapter 3, *Overview of NICMOS* on page 17, provides an introduction to the full capabilities of NICMOS. A discussion is provided to help guide you through the technical details you will need to consider in choosing the optimum NICMOS configuration and in determining the number of orbits to request.
- Chapter 4, *Imaging* on page 35, provides a description of NICMOS’s imaging capabilities including camera resolutions and throughputs. We have designed a set of curves for each NICMOS filter that can help estimate the exposure time needed for various signal to noise observations of both point and extended sources. Those are described in this chapter, and presented in Chapter 11.
- Chapter 5, *Coronography, Polarimetry and Grism Spectroscopy* on page 51, provides detailed information on coronographic imaging, grism spectroscopy, and polarimetry.
- Chapter 6, *Exposure Time Calculations* on page 75, describes how to perform signal to noise calculations, either by using pencil and paper, or using software tools that are provided on the World Wide Web (WWW).
- Chapter 7, *NICMOS Detectors* on page 91, describes the basic properties of the detectors used in the three cameras including their physical characteristics, capabilities and limitations, including saturation and linearity.
- Chapter 8, *Detector Readout Modes* on page 105 explains the data taking modes which take advantage of the non-destructive readout capabilities of the NICMOS arrays. We give recommendations and guidelines the observer should adopt in choosing the most appropriate mode.
- Chapter 9, *Overheads and Orbit Time Determination* on page 121, provides information to convert from a series of planned science exposures to an estimate of the number of orbits, including spacecraft and NICMOS overheads. This chapter applies principally to the planning of Phase I proposals.

Part III - Supporting Material

- Chapter 10, *Techniques for Background Measurement and Mosaicing* on page 139, gives a guide to measuring the sky background when observing with NICMOS. This chapter describes the implementation of a pre-defined set of patterns which accomplish dithering and chopping from the field of interest, and allow easy generation of large mosaic images.
• Chapter 11, Imaging Reference Material on page 155, provides sensitivity information for each imaging filter, ordered by camera and increasing wavelength.

• Chapter 12, Flux Units and Line Lists on page 253, provides formulae and tables for the conversion of flux units, and a list of common infrared spectral lines.

Part IV - Calibration

• Chapter 13, Calibration Pipeline on page 275, briefly describes the processing of NICMOS data by the STScI pipeline and the data that will be sent to observers.

• Chapter 14, Expected Calibration Accuracies on page 285 summarizes the accuracies expected for NICMOS data calibrated by the STScI pipeline in Cycle 7.

• Chapter 15, Calibration Plans on page 289, provides an overview of the planned thermal vacuum (ground), SMOV (commissioning phase) and Cycle 7 calibration and verification plans.

NICMOS Proposal Preparation

Use the NICMOS Instrument Handbook and the Cycle 7 Call for Proposals & Phase I Proposal Instructions (CP) when assembling your NICMOS Phase I Proposal. The CP provides policy and instructions for proposing; the NICMOS Instrument Handbook contains technical information about NICMOS, describing its expected performance, and presenting suggestions for use. The next chapter in the Handbook describes special considerations for Cycle 7.

If your Phase I proposal is accepted, you will be asked to submit a Phase II proposal in which you specify the exact configurations, exposure times and sequences of observations that NICMOS and the telescope should perform. To assemble your Phase II proposal, you should use the NICMOS Instrument Handbook in conjunction with the Phase II Proposal Instructions. These instructions describe the rules and syntax that apply to the planning and scheduling of NICMOS observations and provide relevant observatory information.

Our current understanding of NICMOS as an instrument is in its formative stages as the flight detectors have yet to be fully calibrated and we are currently in the middle of the development of the ground system to support NICMOS operations.

At this time, predictions of the performance of NICMOS should be treated as provisional, and users should adopt conservative expectations for the performance of the instrument in Cycle 7.
The Help Desk at STScI

STScI maintains a Help Desk. The Help Desk staff at STScI quickly provide answers to any HST-related topic, including questions regarding NICMOS and the Cycle 7 Proposal Process. The Help Desk staff has access to all of the resources available at the Institute, and they maintain a database of answers so that frequently asked questions can be immediately answered. The Help Desk staff also provide STScI documentation, in either hardcopy or electronic form, including instrument science reports, instrument handbooks, and the like. Questions sent to the Help Desk during normal business hours are answered within one hour. Questions received outside normal business hours will be answered the next business day. Usually, the Help Desk staff will reply with the answer to a question, but occasionally they will need more time to investigate the answer. In these cases, they will reply with an estimate of the time needed to supply a full answer.

We ask that you please send all initial inquiries to the Help Desk. If your question requires a NICMOS Instrument Scientist to answer it, the Help Desk staff will put a NICMOS Instrument Scientist in contact with you. By sending your request to the Help Desk, you are guaranteed that someone will provide you with a timely response.

To contact the Help Desk at STScI:

- **Send e-mail**: help@stsci.edu
- **Phone**: 1-410-338-1082

The Space Telescope European Coordinating Facility (ST-ECF) also maintains a help desk. European users should generally contact the ST-ECF for help: all other users should contact STScI. To contact the ST-ECF Help Desk:

- **Send e-mail**: stdesk@eso.org

The NICMOS Instrument Team at STScI

STScI maintains a team of Instrument Scientists, Scientific Programmers and Data Analysts who support the development, operation and calibration of NICMOS. The team is also responsible for supporting NICMOS users. The table inside the front cover of this Handbook lists the current members of the NICMOS Instrument Team at STScI.
Supporting Information and the NICMOS Web Site

The NICMOS Instrument Team at STScI maintains a World Wide Web page, as part of the STScI home page. The URL for the STScI NICMOS page is:


The STScI NICMOS web page includes:

- **Advisories**: This is where we will post updates to instrument performance as these are produced through ground testing and on-orbit investigations.

- **Documentation**: An electronic version of this Handbook will be maintained on the WWW site. In addition, more detailed technical information (not needed to propose for Cycle 7) concerning the development, performance, ground testing, operation and calibration of NICMOS itself are found in a series of NICMOS instrument science and calibration reports maintained on the web, while others can be obtained upon request from the Help Desk.

- **User Support**: Will contain general information on data reductions and support for HST users.

- **Software**: Some software can be retrieved or run directly over the web, including an exposure time calculator, and a flux units conversion program.

- **Frequently Asked Questions**: A list of frequently asked questions about NICMOS, and their answers, ranging from proposal preparation to data analysis.