NICMOS AND ITS ARRAYS
The Near Infrared Camera and Multi-Object Spectrometer

RODGER I. THOMPSON
Steward Observatory, University of Arizona

Abstract. NICMOS is a second generation instrument for the Hubble Space Telescope to provide imaging and spectroscopic capabilities in the near infrared region. NICMOS utilizes HgCdTe detectors in three cameras, one with grisms, to image in the 0.8 – 2.5 mm spectral region.

Key words: Infrared Arrays, Space

1. Introduction

NICMOS, the Near Infrared Camera and Multi-Object Spectrometer, is a second generation instrument for the Hubble Space Telescope (HST). Its primary emphasis is imaging in the 0.8 to 2.5 mm spectral region, however, grism multi-object spectroscopy in the same wavelength region is an important part of its capabilities. Under the present launch schedule NICMOS will be inserted into the HST in 1997, replacing one of the current Axial HST instruments. Expected cryogen lifetime for NICMOS is 5 years from the time of launch. The NICMOS 3 detectors are a key aspect of the NICMOS instrument and are a primary subject of this symposium. The first parts of this presentation deal with the NICMOS instrument and its capabilities while the later deal with the NICMOS 3 detector and its modes of operation.

2. NICMOS the Instrument

NICMOS is principally a set of three cameras that view adjacent areas of the sky at three different magnifications. Each of the cameras has its own detector, readout electronics, and magnification optics, but, they all share the same front end optical system. The cameras may operate independently or simultaneously as dictated by the observing opportunity. For example, one of the cameras may be centered on the nucleus of a galaxy while the other two cameras image adjacent areas of the same galaxy. The shared front end optical system forms a first pupil on a movable mirror. This mirror performs the majority of the correction for the HST spherical aberration and provides a means for moving the image for median filtering background subtraction.

All of the optics except the filter wheels, the second pupil masks and the detectors are outside the cryogenic dewar for ease of construction and

alignment. The optics are, however, cooled to approximately 2°C to reduce their background significantly below the flux contributed by the 20°C HST primary and secondary mirrors.

The dewar contains a cryogen cavity filled with solid nitrogen and an evacuated optics chamber for the filter wheels, cold pupils and detectors. The nitrogen cavity vents to space via the HST aft vents while the optics chamber has a sealed, permanent vacuum to prevent contamination of the detectors. On orbit, the cold surface obtains a 58°K equilibrium temperature with an expected detector operating temperature of 59°K. Section 5 describes the operating characteristics of the detectors at this temperature, however, the bottom line is that the detectors operate well to temperatures significantly below 40°K and have only a few percent drop in quantum efficiency at our operating temperature with a significant reduction in dark current.

Each camera has a separate 20 position filter wheel just behind the cold pupil for the camera. The cold pupils are slightly undersized and contain a secondary central mask as well. The cold mask of camera 2 carefully masks the spiders as well for coronagraphic operation. Each filter wheel contains a blank off position for dark frames along with both narrow and broad band filters. Camera 3 has grisms at two positions in the filter wheel for multi-object spectroscopy at a resolution of approximately 100. A separate study shows that the particular NICMOS grisms operate well even though the beam at that point is an f/17 converging beam rather than the usual collimated beam for spectroscopy. Higher resolution grisms with higher wedge angles would be more affected.

Table 1 gives the relevant optical properties for each of the three cameras. Camera 1 is diffraction limited at 1.0 mm and has the same pixel size on the sky as the planetary camera of WFPC. Our definition of diffraction limited is five pixels between the zeros of the point spread function for the wavelength under consideration. Camera 2 is diffraction limited at 1.75 mm and Camera 3 is a wide field camera with a field of view of 51 arc seconds. The field of view in this camera is slightly larger than the disk of Jupiter.

Optical analysis shows that all of the NICMOS cameras will operate at the diffraction limit with the calculated corrections for the HST spherical aberration. Two of the NICMOS mirrors will have on orbit alignment capabilities for pupil centering and focus.

3. Performance Characteristics

There are several ways to characterize the NICMOS performance. The following sections give information on several observing modes and performance characteristics. In the following calculations we assume an efficiency factor of 0.31 times the filter transmission. In the calculation of the point source efficiency we will use an average filter efficiency of 0.77 for a total