# OMC LABORATORY ASSEMBLY AND NAOMI INSTALLATION AT GHRIL

**wht-naomi-92**
Document number AOW/GEN/RAH/8.0/09/97/ NAOMI Installation

Draft version date: 24 September 1997

# 1. Introduction

### *1.1 Overview*

This document describes the initial laboratory assembly of the OMC and the installation of NAOMI at the GHRIL. The former operation will be performed at ROE using a metrological approach with a 3D measuring machine.The OMC will be disassembled when moved between various locations, e.g. from the test focal station to the GHRIL, whereas the wavefront sensor (WFS) remains as a complete assembly. The assembly of the WFS will be covered by a separate procedure to be developed by the RGO; this procedure will be primarily intended for internal use by RGO.

The installation of NAOMI at the GHRIL relies heavily on the positional repeatability of the OMC components on the OMC baseplate. Many steps in the installation procedure are designated simply as checks to insure that the OMC components are really in their correct location. Diagnostic procedures will be developed to isolate the source of the problem if the check is unsatisfactory. In later versions of this document the diagnostic procedures may be incorporated as hidden text if this approach is found to be appropriate.

### *1.2 Notation*

Alignment and performance checks are marked “CHECK:”.
Steps are marked “STEP:”.
Notes are marked “NOTE:”.
[Control system implications are indicated in square brackets as shown here.]
{A pre-configuration requirement , when not indicated as a full step, is indicated in curved brackets as shown here.}

# 2. Laboratory assembly of the OMC

This section outlines the approach to be followed by ROE during the initial assembly of the OMC at ROE. In addition to the use of a 3D measuring machine as mentioned above, the approach depends on the use of the manufacturer’s data for the powered surfaces. In particular the measured radii of curvature will be used to re-optimise the positions of the optical components. Note that a more detailed procedure will be prepared by ROE for presentation at the OMC CDR.

Components such as the off-axis paraboloids (OAPs) will be mounted in invar mounting rings with lugs attached. An adhesive will hold each component in its mounting ring. Eccentrics on each mount are adjusted so that the lugs are moved to calculated positions. The assembly of a component in its mount will usually involve the following operations that employ ROE’s 3D measuring machine:
a) Measure the mirror surface relative to its mounting ring.
b) Measure the mounting ring to the lugs.
c) Measure the relative positions of the calibrated eccentric adjustments.

When the optical components have been installed in their mounts they are assembled to the alignment jig, i.e. the baseplate, and the positions of all components are verified with the measuring machine. The location and image quality of the final image will be checked using the NCU diffraction-limited point source. Interferometric tests may also be performed to provide additional verification of satisfactory image quality.

# 3. NAOMI installation at GHRIL

## *3.1 NCU features*

The features of the Nasmyth Calibration Unit (NCU) are summarised below for information purposes only. Not all features are used in the installation of NAOMI.

1. an on-axis diffraction-limited (in visible region over full aperture) point source
2  a fast low-amplitude tip/tilt motion of the above source
3. an on-axis non-diffraction-limited source (approximately 1 arcsecond)
4. a diffraction-limited (at K band) point source close (2 -3 arcsec) to the axis for science  instrument use
5. a 40-arcsecond diameter flat-field source for IR and optical science instrument calibration
6. an on-axis f/11 laser beam for initial alignment
7. a laser pencil beam (temporarily deleted as a firm requirement but requested by RGO)
8 a WHT pupil simulator using a mask
9. a feed for a pre-correction camera
10. an array of off-axis sources for mapping the AO optical system distortion and wavefront aberrations over the field of view
11. a means of generating known static aberrations
12. a turbulence generator for use during laboratory tests
13. neutral density and spectral filters for controlling the intensity and colour of all broad band sources listed above.

## *3.2 ING dependencies*

The ING must provide an alignment telescope which views the mechanical axis of the WHT image derotator. The latter shall have been tested on sky to verify that the mechanical axis is coincident with the optical axis of derotation. The ING should also verify the stability of the WHT exit pupil with respect to the optical axis as the image rerotator is moved through its full range. The pupil stability should be better than 0.036 of the pupil diameter (preliminary specification). More detailed requirements defining the interface between the WHT and the OMC will be the subject of an interface document yet to be prepared.

## *3.3 General OMC installation methodologies*

For the initial installation the baseplate is moved around without its components but with its alignment targets installed. The GHRIL alignment telescope and the location of the Nasmyth focus are used to position the baseplate. Vertical alignment is achieved by changing the height of the GHRIL table, if required. The OMC has been designed so that all components can be removed from the baseplate and replaced with accuracies of better than ± 50 µm. Thus many steps in the installation are simply checks to insure that the alignment has not been inadvertently disturbed.

## *3.4 Basic installation procedure for NAOMI at GHRIL*

### *3.4.1 Install all computers: EPICS, real-time, supervisory, DM drives*

### *3.4.2 Put OMC base plate on to the GHRIL table*

STEP: Use dowels if available otherwise follow next step.
STEP: Install the two OMC alignment targets on the baseplate. The target that defines the input focus is placed in nominal position of the on-axis Nasmyth focus. Its centration is checked with the GHRIL micro-alignment telescope. The baseplate is pivoted on the bench surface about the  Nasmyth focus until the second target is coincident with the line of sight of the alignment telescope.

### *3.4.3 Mount the NCU*

CHECK: Check NCU f/11 beam and its direction using the pre-aligned mask placed on jig then removed.

### *3.4.4 Put all components on OMC (apart from DM)*

NOTE: The DM will ordinarily be replaced by a dummy flat until the operations in Section 3.4.6; this dummy flat is a replacement for the whole DM assembly with its 2-axis stage (rather than just the DM or top part of the module). This alleviates the need to maintain a flat DM during much of the installation and it allows a more reliable assessment of the image quality of the other optics.
CHECK: Check image quality after field lens using a video-camera alignment aid. The camera will have a graticule set at the desired focal position, together with suitable optics and ND filters (if needed). The camera may also be set at a pre-determined position to check the image quality with the field lens and dichroic removed.
CHECK: Put on pupil mask between fold and 2$^{nd}$ OAP slide up and down to check beam position/direction.
CHECK: Install a second video camera at the science focus and check the beam position/quality. (The possibility of using the same camera for both focus checks should be investigated.)

### *3.4.5 Mount the WFS*

NOTE: The lenslet arrays are potted into holders which are keyed into the wheel; inadvertent lenslet rotation should not be an issue.
NOTE: The atmospheric dispersion corrector (AtDC) configuration should not matter for alignment with a HeNe laser but it should be set to zero dispersion for broadband operations.
NOTE: 2-CCD issues
?? The straight-through CCD is the datum -assume using this one if not otherwise specified.
?? The top CCD is moved in x,y to take out any beamsplitter error.
STEP: Place the WFS on table using the dowels.
NOTE: Details of initial installation without dowels are required.
CHECK: Install the pupil fiducial and examine alignment with a laser.
STEP: Turn on the WFS electronics.
STEP: Set AtDC to zero deviation
CHECK: With the acquisition lens in place check the acquisition of the WFS calibration source [could use EPICS CCD test GUI to visualise].Verify that the co-ordinates of the acquisition source are correct.
NOTE: One may wish to perform other checks with the WFS calibration source at this point.
STEP: Acquire the on-axis, visible point source from the NCU.
CHECK: {acq lens} Check that the AtDC rotation gives spot elengation in the right direction
CHECK: {lenslet} Check that spot array is regular, on-axis and in focus **on both CCDs**
CHECK: {no lenslet} [ flat-field CCDs make available to RTCS?]
CHECK: {lenslet} Check that the spot illumination balanced -this verifies the pupil illumination
? ?IF NOT horizontally balanced: then move WFS "rotation" control
CHECK: {lenslet} Check the output focus signal.
CHECK: Install the NCU array of point sources Check the x-y pick-off measurements of relative-motion deltas, focus and repeatability at four field points distributed over the field.

### 3.4.6 WFS-DM alignment

NOTE: One cannot use DM dummy flat beyond this stage
NOTE: May need more frequent repetition (eg. per night)
[all control systems fully functional]
STEP: Employ 2-axis DM alignment procedure using illumination in adjacent offset segments. An automated operational procedure will be developed to cover this step.
CHECK: DM flat?

### 3.4.7 Calibration (with NCU spot array):

NOTE: May need more frequent repetition
STEP: Flat-field CCD
STEP: Calculate WFS offsets for off-axis angle [science camera] [for lab. test use 50/50 beamsplitter and visible camera at the IR science port]

### 3.4.8 Dynamic Tests

CHECK: Perform closed-loop tests [optionally without science] (remove spot array).

CHECK: Test the WFS transfer function.
CHECK: Test closed loop performance on static spot (to evaluate noise)
CHECK: Perform image-motion closed -oop test using the NCU tip/tilt mirror. Check the FSM first then all DMsegments: obtain image motion power spectra before and after - check input power spectrum, 0dB point, noise above+below 0dB, spikes?

# 4. Per-night operations

### *4.1 Find rotator centre*

CHECK: Verify that the image derotator centre is coincident with the NAOMI axis.

### *4.2 TCS calibrate [on-sky]*

NOTE: WFS {requires DM flattened and FSM mid-range} and pre-corr display (poss offset) available - as ELECTRA
STEP: Use the {zero pick-off offset} WFS display as a calibration reference. This must be equal to the derotator centre. The pre-correction camera may be used for acquisition purposes.