PRELIMINARY NAOMI SYSTEM INTEGRATION PLAN wht-naomi-96

AOW/GEN/RAH/1.0/07/97/System Integration Plan

DRAFT

Version Date: 30 July 97

This document is currently a top level summary of the NAOMI system integration plan. The details will be fleshed out as key project milestones, primarily the system and critical design reviews, are passed.

The general policy is not to repeat tests that have been performed at the subsystem level except where a change of equipment is involved or the performance might be affected by other factors. An example of the former might be the replacement of a simulator by the real equipment. The potential for misalignment during shipping is an example of the latter. This plan assumes that a separate system integration plan for software will be developed.

Subsystem tests are generally expected to verify all performance specifications that can be verified independently of the RTCS and other subsystems supplied under separate work packages. Note, for example, that an independent control module is required for laboratory tests of the WFS as a separate assembly. This module will exercise sufficient control to demonstrate the basic WFS functions. Limited testing of the OMC, NCU and Electra DM as an integrated assembly will be carried out prior to system integration.

(The author apologises for the incorrect use of the term “RTCS” in the early sections of this draft. This deficiency will be corrected shortly when the appropriate terminology for the various components of the RTCS has been settled.)

1. Integrate the Electra RTCS with the RTCS.

Functional and continuity checks will be performed to the extent feasible without the other major subsystems. The control functions will be tested later in stages as the various subsystems are integrated with the RTCS.

2. Set up the OMC and NCU.

The Electra DM will be replaced by a flat fold mirror at this stage. The alignment procedures developed for the OMC and NCU will be followed. The OMC wavefront quality will be determined. The exit pupil position and size will be measured. The mechanical repeatability of the NCU to the OMC will be established.

The open loop functions of the FSM will be checked using the RTCS, i.e. amplitude, frequency response, stability and angular resolution will be measured. A position-sensing detector mounted at the “corrected’ f/16.8 focus will probably be used for this purpose.

3. Integrate the NCU and the pre-correction camera with the RTCS.

All functions will be verified under RTCS control.

4. Install and align the WFS to the OMC.

This operation will be carried out using the procedure and alignment fixturing that will be developed as part of the work packages. The mechanical repeatability of alignment operation will be verified using the NCU on-axis point source as a reference. The electronics mounting procedures will be carried out. Cabling paths should, where possible, follow those to be used in the GHRIL.

5. Install and align the acquisition camera at the optical science port.

The camera will be connected to the RTCS. Function and sensitivity will be verified. The NCU will serve as the light source for these tests.

6. Perform functional tests of the WFS.

a. WFS coverage of the full field including the WFS calibration source will be verified under RTCS control. The operation and range of the focus adjustment will also be determined. Note that visual checks for potential mechanical interference must be made prior to moving WFS. The capability to achieve the rates and amplitudes needed for dithering will be demonstrated. The non-sidereal operating mode will be demonstrated.

b. The obscuration of the optical science port by the WFS pick-off will be measured.

c. The response of all other mechanical functions of the WFS to RTCS control will be determined, e.g. ADC operation, filter and lenslet changes, shutter operation.

d. The NCU and WFS calibration source will be used to check CCD camera/controller operation, noise levels and sensitivity. Satisfactory operation of all CCD modes will be confirmed, e.g. 2 CCD with 4 x 4, quad cell, single CCD, etc.

e. Simple static wavefronts generated by using the NCU, e.g. plane wave with varying amounts of tip/tilt, defocus, then higher-order aberration, will be measured and displayed. Different algorithms will be used as available. The performance variation with light level will be investigated. The ability to handle spot offsets will be evaluated.

f. The WFS dynamic response will be checked using the tip/tilt injection capability of the NCU.

g. The full field with the WFS will be mapped using the NCU distortion-measuring capability, i.e. the array of point sources.

7. Perform closed-loop tests of FSM.

The ability of the FSM to track small offsets of the WFS will be demonstrated. The tip/tilt injection capability of the NCU will be used to evaluate the dynamic response at higher frequencies. The performance under low light level conditions will be assessed. The capability to provide signals that offload large-amplitude, very low frequency tilt to the TCS will be verified.

8. Install and test the Electra DM.

a. The DM will be integrated with the Electra RTCS.

b. The mirror performance under open-loop conditions will be measured with an interferometer. Hysteresis and stability will be checked.

c. The function, range and resolution of the x and y adjustments will be determined.

d. The capability to align the DM in x,y to the WFS under RTCS control within the required accuracy will be demonstrated.

e. Compliance with Clause 23 (Removal and installation of the DM) will be demonstrated.

9. Perform AO System Tests.

a. Noise checks of the integrated system will be carried out and the performance will be compared with relevant data available for the subsystems alone. Any ground-loop problems will be identified and corrected.

b. Simple tests will be performed to identify any sources of vibration that affect performance. As a goal, tests should be performed using vibrometers and accelerometers.

c. The source(s) of any local turbulence within the optical path will be identified and corrected.

d. All measures needed to protect NAOMI from damage or failure will be checked. Fault conditions should be simulated where appropriate to verify safe operation and orderly shutdown without damage. The ability to recover from faults, e.g. operator errors, will be demonstrated.

e. Closed-loop tests that demonstrate the capability to handle low-order aberrations, as in Step 6 (e), over a range of light levels will be performed. The maximum operational bandwidth at each light level shall be determined. The limiting sensitivity of the system in equivalent stellar magnitude will be established. The ability to maintain closed-loop performance over a 1-hour period will be demonstrated; this test will be designed to verify compliance with Clause 5 to the extent possible under laboratory conditions. All diagnostic functions will be checked. If available, a turbulence generator will be used to evaluate performance.

10. Install INGRID and integrate with its CIA.

INGRID will be aligned to the science instrument port using the NCU as an alignment aid. Tests will be carried out to verify that operation of INGRID has no adverse effects on the performance of NAOMI. Particular attention will be paid to any induced vibrations, ground loops and EMC problems. Corrective measures will be taken where required.

11. Demonstrate optimisation of IR image and determine non-common path errors.

The capability to optimise the IR image in the presence of low-order aberration will be demonstrated, i.e. produce an aberrated image and then demonstrate that the system can optimise the AO-corrected image. The NCU will be used as the test source. The magnitude of the non common path errors will be determined.

12. Evaluate system sensitivity to temperature changes.

The laboratory temperature will be varied over a range of at least 10^{o}C. The effect of the temperature change on the relative alignment and focus of the WFS, OMC and NCU will be determined. Checks will be made to assess any effects on calibration, function and noise levels.

13. Demonstrate software and display capabilities.

To the extent feasible without the use of the telescope and TCS, tests will be performed to verify that the URD requirements have been satisfied. Requirements addressed in previous system integration tests would be omitted.

14. Ship and set-up at Test Focal Station

On completion of the integration tests in the UK ship the subsystems to La Palma and set up on Test Focal Station Bench. Integrate with appropriate facilities at this station including links to WHT control room and the TCS. The first installation will be monitored to confirm that the installation procedures are satisfactory. Any required changes to procedures must be approved by the project and properly documented.

15. Align the OMC and WFS.

The global alignment procedure will be followed during this operation.

16. Perform checks of function and performance.

Tests shall confirm that all basic subsystems are functional and that the performance is consistent with that obtained in the UK. In particular the tests must confirm that noise levels have not increased. A subset (TBD) of the UK tests will suffice.
Tests will verify that the interfaces with the TCS and the WHT control room are fully operational. This step should include checking the ADC prisms respond appropriately to changes in the WHT zenith angle.

17. Install in GHRIL.

When satisfactory performance has been demonstrated at the Test Focal Station install the subsystems in the GHRIL and the WHT control room as appropriate. Note that all handling equipment and procedures will be checked for potential problems and hazards prior to moving any NAOMI components to the GHRIL.

18. Implement global alignment procedure.

The global alignment procedure to align NAOMI to the Nasmyth focus will be followed. Note that prior to implementation of this procedure one must confirm that the WHT optics and the image derotator are correctly aligned. This step should include confirming the position/deviation of the optical axis and the stability of the WHT exit pupil as the image derotator is rotated.

19. Perform limited functional and performance tests.

A brief subset of tests performed at Test Focal Station will be carried out. Checks will be made for EMI/EMC problems in GHRIL environment. The signals to offload tip/tilt to TCS will be checked for the correct polarity. All safety functions and protective measures must be shown to perform satisfactorily. Compliance with Clause 21 (Degradation of local seeing) will be verified.

20. Perform on-sky, closed loop tests.

On-sky tests with various test objects giving an appropriate range of brightnesses and zenith angles will be performed. Initial operation will involve the acquisition of various guide stars and science objects over a range of angular separations. Tip/tilt correction will demonstrated before full closed-loop operation. The dithering capability will be demonstrated as well as operation with non-sidereal objects. Within the limits set by prevailing turbulence conditions, the tests will be designed to show compliance with science clauses not verified earlier by tests or inspection. When alignment and operation of NAOMI becomes routine, compliance with Clause 6 (Observational efficiency) and Clause 13 (Time to install and remove) will be demonstrated.