Particle Physics and Astronomy Research Council

Isaac Newton Group

WHT-NAOMI-14

Requirements for an Observer's Interface to a NAOMI-INGRID based Observing System

Craige Bevil

Issue 1.0; 19-June-2000

Isaac Newton Group,
Apartado 321, 38700 S/C La Palma,
Tenerife , Canary Islands

Telephone +34 922 425424
Fax +34 922 425429
Internet cb@ing.iac.es

1. Introduction

1.1. Purpose

This document outlines the revised user requirements for the observer's interface to the NAOMI-INGRID based observing system. This follows a review of the initial requirements document by ING representatives and the NAOMI development team. The result of the review was to re-evaluate the priorities of the initial requirements and in the process, establish those that are critical to the commissioning of the new system. It was established that the non-critical requirements outlined in the original URD document are still relevant, and when time allows will be implemented.

1.2. Scope

The document outlines requirements for a basic tool that will enable the NAOMI project team to commission the instrument and provide observers with the base functionality for performing science observations using INGRID and NAOMI.

1.3. Abbreviations, acronyms and definitions

- **UltraDAS**

The new Ultra SPARC based data acquisition system being introduced at the ING. UltraDAS is currently being modified to control the INGRID detector array and provide support to facilitate the calibration of the NAOMI deformable mirror.

- **WFS**

The NAOMI wave front sensor contains a EEV-39 CCD camera. This is used to continuously stream wavefront data resulting from star light passing through a 8x8 lenslet array mounted on the WFS into two C40s in the DSP ring. The data is subsequently processed in real-time and corrections based on these calculations are then applied to the deformable mirror.

- **PEC**

The pre-correction camera on NAOMI located ahead of the deformable mirror in the light path. This will be used to monitor the input to the AO system of both the alignment source and uncorrected stellar images. This camera will provide a tool for optimisation of the NAOMI control loops.

- **NAOMI**

The natural guide star AO system for multiple-purpose instrumentation (NAOMI) currently in development at Durham University and the ATC in Edinburgh.

- **INGRID**

The new ING infrared camera that features a 1024 x 1024 Hawaii near-IR detector array with a pixel scale of 0.04 arcsec/pixel.

- **TCS**

The DEC Alpha/VMS based telescope control system used at the ING to control the positioning of the telescopes.

1.4. Acknowledgements

Simon Rees for helping to specify the requirements for the real time display.

Richard Myers who helped produce the original URD from which some of the material in this document is sourced.

1.5. References

- **Richard Myers *et al,*** NAOMI-INGRID-TCS Level 0 Observing System (20/05/2000)

1.6. Overview of the document

The remainder of the document outlines the requirements for an interface to a NAOMI-INGRID based observing system and the computing environment within which it will reside.

2. General Description

2.1. General Capabilities

There is a need to provide an interface through which an observing system based on NAOMI and INGRID can be managed and controlled. The system described within will provide the observer with a single point of control from where he/she can monitor the status of, and can effect control over, the components that comprise such a system. In addition, the observing system must also provide the capability to execute multi-point dithered observations using the INGRID camera, a requirement specific to infrared observing.

2.2. Operational environment

The system outlined in this document is a single component in what is a moderately complex software system. The following sections outline the other software subsystems that comprise the complete observing system and any interactions that they will have with one another.

2.2.1. UltraDAS

UltraDAS is the new data acquisition system which is gradually being introduced at the ING. It controls the San Diego State University (SDSU) CCD controllers which in turn control the CCDs or the infrared detector array of INGRID. The current modifications being made to the UltraDAS will permit science observations using the INGRID camera and will incorporate requirements specific to NAOMI. UltraDAS will be used extensively by the NAOMI subsystem to calibrate the deformable mirror ahead of an observing run. The system described in this document will interface to the UltraDAS system in order to initiate integrations as part of a dither sequence.

UltraDAS is hosted on a Ultra SPARC running Solaris and controls the SDSU camera controllers via either a SBUS or a dedicated PCI based controller card.

2.2.2. TCS

The TCS is integral to the operation of the AO system. NAOMI has it's own guiding capabilities and as such, has the ability to command the TCS. The link between the two systems is via a RS232 serial link. NAOMI achieves it's objective of improved seeing by employing a number of devices. NAOMI can cope with small telescope tracking irregularities by use of the deformable mirror. When errors become large, NAOMI will offload the error to the tip-tilt mirror for correction. The use of the tip-tilt mirror will be used to take out larger errors including slow oscillations. When the error exceeds a certain threshold above which correction using the tip-tilt mirror is not feasible, the error will then be offloaded to the TCS by sending autoguider corrections thus adjusting the position of the telescope.

The TCS has been modified to provide a slow offset mode which will allow dither observations to be performed. It will be a requirement of the software described in this document to be able to perform a series of offsets on the telescope throughout a dithered observation sequence.

The TCS is hosted on a DEC Alpha machine running VMS and interfaces to the telescope control electronics via CAMAC.

2.2.3. INGRID

The INGRID mechanism control system comprises of a VxWorks based system hosting EPICS. The instrument contains a number of different mechanisms including filter wheels and a pupil stop. It is a requirement for the software described within to query the status of the various mechanisms for display purposes.

The instrument contains a SDSU controlled 1024x1024 near-infrared detector array which is used for imaging purposes. Control of the detector array will be achieved using UltraDAS.

2.2.4. NAOMI

The NAOMI computer subsystem consists of a number of distinct components. The key component of the system is a ring of Texas Instrument's C40 digital signal processors (DSPs) which calculate the corrections that need to be applied to the deformable mirror. The NAOMI mechanisms will be controlled via a VxWorks based VME system hosting the EPICS instrument control package. Software systems outside of the immediate NAOMI computing environment will interact with the system via the NAOMI sequencer program hosted on a Sun SPARC system. External software systems can request various actions to be performed by the NAOMI sequencer such as "Close the AO loop" for instance. The software described in this document will interface to the NAOMI system via the NAOMI sequencer in order to both control the AO system and query it's status.

The NAOMI system interacts with other subsystems such as the UltraDAS (see 2.2.1) and the TCS (see 2.2.2).

2.3. User characteristics

The principal user of the system will be the observer. The observer will use the system to perform science observations in the near-infrared wavelengths using INGRID coupled with the NAOMI adaptive optics system to provide enhanced resolution.

The NAOMI team will use the system described within to help commission the system when NAOMI arrives in August.

Daytime support engineers will use the system in order to fault find, calibrate and test the instrumentation.

There will be AO specialist telescope operators who will be expected have detailed knowledge of the NAOMI system and be able to offer advice to visiting astronomers.

Support astronomers will use the system to train and advise observers in both preparation and during their observing runs.

3. Specific Requirements

This section outlines the requirements of the observer's interface to a NAOMI/INGRID based observing system that can be considered essential to the commissioning of the instrument and basic science observations. The section outlines in its entirety, the scope of the functionality that the interface will provide for the initial commissioning run. It can be assumed that any requirements present in the original URD provided by Durham which are not included in this section, will not be present in the initial implementation of the observer's interface to NAOMI/INGRID.

3.1. Telescope Status Display (NAOMI-OBSINT-0)

Source: J. Knapen 14/06/2000

A real-time status display is required which displays the current RA and DEC of the telescope, the sky PA and the current source. This display will be located on the workstation that the observer uses to co-ordinate observations. For commissioning purposes, the standard TCS status display utility already offers the above functionality and will be used.

3.2. NAOMI Status Display (NAOMI-OBSINT-1)

Source: R. Myers 18/05/2000

A NAOMI status panel will be displayed upon the observer's workstation and will show the following information pertaining to the state of NAOMI.

- The state of the WFS control loop. This should state whether the AO loop is open or closed.
- Whether NAOMI is "Clear for Astronomy" (True/False). In this context *Clear for Astronomy* means that there are no alignment/acquisition beam splitters in the optical path, that the WFS is focussed and that the WFS integration time is within the nominal range, etc. It is a check that some acquisition or alignment feature of the Naomi opto-mechanical or control systems has not been left in a state inappropriate for observation (by use of the Engineering GUI for example).
- Whether NAOMI is "Idle" (True/False). In this context *idle* means that NAOMI is not acquiring and not configuring and that the control loops are open.
- Whether NAOMI is "OK" (True/False). When there are no outstanding error conditions present within the system that may need to be reset the system will be considered to be okay.
- Whether NAOMI is "Acquiring" (True/False). In this context *acquiring* means that the WFS integration time has been lengthened and either the PEC or WFS doublet has been deployed so that a guide star can be acquired onto the WFS probe. This in effect turns the WFS into a acquisition camera.
- Whether NAOMI is "Configuring" (True/False). In this context *configuring* means that mechanisms are in motion or some lengthy software configuration is in progress.

The status display will reflect within 1 second any change in value of a monitored status value.

The statuses will use standard WHT colour coding conventions in order that the observer can at a glance, determine if the status is being received successfully from the monitored system. Green will be used to indicate status information is being received successfully. Red will be used indicate that there

is an error receiving status information. Blue will be used to indicate that there is an operation that is currently in progress.

The statuses will be logically grouped in order for the observer to quickly establish if all of the statuses necessary for science observations are good.

In addition to the status display, there will be a real-time display showing the seeing/AO performance of the system. This will take the form of a scrolling graphical display that plots the uncorrected seeing against the corrected "resolution" in order to give the observer an idea of how well the AO system is performing. There will exist some graphical indication that the performance meter is functioning correctly.

There will be the ability to launch the engineering interface to NAOMI (Top level GUI) from the NAOMI status panel. The engineering interface to NAOMI will provide in-depth information relating to the performance of the AO subsystem. The definition of the requirements for the engineering interface is outside of the scope of this document.

3.3. INGRID Status Panel (NAOMI-OBSINT-2)

Source: J. Knapen 14/06/2000

A real-time graphical display showing the status of the INGRID instrument. This will show mechanism information pertaining to INGRID which includes the following:

- Filter information.
- Pupil stop wheel information.
- Focus information.

For commissioning purposes it is intended to use the existing INGRID status display panel which already satisfies the above requirements.

3.4. INGRID Image Real-time Display (NAOMI-OBSINT-3)

Source: Chris Benn & Chris Packham 25/05/2000

A display that will show, in real-time, integrations taken using the INGRID camera. Ideally this will be based upon the real-time display (RTD) which is currently used for INGRID, modified accordingly to operate in conjunction with the new infrared version of UltraDAS.

Following is the original requirements for the INGRID real-time display, based on discussions between Chris Packham and Simon Rees.

1) To display images quickly.

2) To be simple to use and easy to change the display parameters.

3) To update automatically when a new image is taken.

4) The ability to display and calculate the following images.

    a) Post- minus pre- integration image (henceforth called S).

b) (Object S) minus (Sky S).

c) ((Object S) divided by (Flat Field)) minus ((Sky S) divided by (Flat Field)).

d) Toggle feature for the above maths.

5) Ability to toggle auto-loading features of the RTD.

6) Automatic detection of saturated pixels (toggled).

7) RTD should be displayed on the same screen as the instrument control user interface.

8) The display tool and the image arithmetic should be run from a fast data reduction SPARC, not the INGRID control SPARC.

3.5. Multi-point Dither Observation Capability (NAOMI-OBSINT-4)

Source: Chris Benn & Chris Packham 25/05/2000

The ability to specify and execute a variable multi-point dither sequence using the INGRID camera, with UltraDAS as the data acquisition system. The user will be able to specify for each dither point in the sequence, the *X* and *Y* telescope offset in arcsec, in addition to the length of the integration. It will be possible for an observer to initiate dither sequences from within user defined command scripts.

Status information will be produced throughout the execution of a dither sequence to inform the user of the progress of the operation.

3.6. Documentation Requirements (NAOMI-OBSINT-5)

Source: R. Myers 18/05/2000

The following documentation will be prepared.

- Web based on-line help documentation to assist the observer in the use of the system.
- Detailed user guide.

3.7. Data Acquisition System Status Display (NAOMI-OBSINT-6)

Source: R. Myers 18/05/2000

A data acquisition system status panel that shows the length of the current integration and the number of seconds left for the integration to run. This display will update in real-time and be located on the observer's workstation.

3.8. Field of View Display Panel (NAOMI-OBSINT-7)

Source: R. Myers 18/05/2000

A panel will exist on the observer's workstation display which shows graphically, the NAOMI probe field of view (5 arcsec) and it's current position. Overlayed upon this panel will be an indication of the following:

- The Naomi Wavefront Sensor (WFS) probe patrol limit (2.9 arcmin)
- The INGRID field of view (41 arcsec)
- The PEC field of view (20 arcsec)
- The centre of the WFS probe patrol field.

3.9. AO Loop Control (NAOMI-OBSINT-8)

Source J. Knapen 12/07/2000

There will be the ability to control the opening and closing of the AO loop from an observer prepared script which may be executed from the Unix command line prompt.

3.10. WFS Probe Positioning (NAOMI-OBSINT-9)

Source J. Knapen 12/07/2000

There will be the ability from an observer prepared script to position the WFS probe anywhere within WFS probe patrol limits. The desired position of the probe will be specified as an absolute position in RA and DEC. The current probe position will be displayed graphically by the FOV status display (see 3.8). This facility will be used primarily to position the probe over a guide star for both guiding and correction purposes.