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# **NAOMI Level 0 Control Software Acceptance Tests**

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## Chapter 1 Introduction

This document outlines a set of tests which are to be performed on the software that comprises the Level 0 control software for the NAOMI system in order to establish it's suitability for operational purposes.

Due to the nature of the system, the software relies on the availability and configuration of a multitude of third party software and hardware. To complete all of the tests will most likely require the assistance of a NAOMI specialist in addition to sky time at the WHT in order to ascertain that all of the requirements have been met.

For the sake of brevity, the document assumes that the tester is familiar with both the applications described within and the terminology employed. Further information relating to the applications described within this document can be found in WHT-NAOMI-15.

## Chapter 2 Acceptance Tests

The following chapters outline the tests that need to be performed on the software in order to establish it's suitability for operational use. Each test has associated with it a *purpose*, *pre-conditions*, *test procedure* and *post-conditions*.

Engineering status information can be accessed by entering the following URL into a web browser.

**<http://navis.ing.iac.es:40000/NAOMI/status>**

The resulting display will show all of the status variables which are currently known in the EPM<sup>1</sup>.

Status information relating to the EPICS system can be displayed by starting a CDE session on *navis.ing.iac.es* as user *naomi* and then starting the EPICS mechanism DM and displaying the details of the mechanism in question.

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1 Electra Process Monitor

## 2.1 Testing the NAOMI Observer GUI

The following tests relate to the observers' interface to the NAOMI system, the control GUI. Assuming that the NAOMI software and hardware systems are functioning normally, the interface can be started from the observers' interface by executing the following command from the command line.

```
naomiInterface &
```

### 2.1.1 Restore Aspect Ratio Test

#### 2.1.1.1 Purpose

To test that the original aspect ratio of the display can be restored after the application window has been resized. This is to allow the user to restore the correct dimensions of the FOV probe monitor.

#### 2.1.1.2 Pre-conditions

The *naomiInterface* application has been started and that the window has been resized such that the main window size is clearly rectangular and the dashed orange coloured line labelled *probe* within the FOV monitor is obviously oblong.

#### 2.1.1.3 Test Procedure

Select the drop down menu labelled **File** and subsequently select the option labelled **Restore Aspect Ratio**.

#### 2.1.1.4 Post-conditions

The main application window should resize such that when the FOV monitor is displayed, the dashed orange coloured line labelled *probe* should be once again be circular rather than oblong.

### 2.1.2 Close and Open Loop Test

#### 2.1.2.1 Purpose

The purpose of this test is to verify if the tester can successfully close and open the AO loop from the NAOMI Observer GUI.

#### 2.1.2.2 Pre-conditions

This test needs to be performed with the assistance of a NAOMI expert.

It will be necessary to first position the WFS either on a simulated star or alternatively have the telescope tracking an object and the WFS pick off positioned over an actual guide star of sufficient magnitude. In either case, it will be necessary to have the NAOMI expert verify that the AO loop can actually be closed on the guide object from the engineering control panel on *navis* prior to executing the test and subsequently opened afterwards.

The initial state of the loop should be *open* as indicated by both the NAOMI expert after consulting the engineering display on *navis* and by the status field located to the left of the NAOMI interface labelled **WFS Control Loop**.

### 2.1.2.3 Test Procedure

Select the drop down menu labelled **Command** from the menu bar and then select the option labelled **Close Loop**. Note the effect on the status field labelled **WFS Control Loop** located on the left of the main NAOMI interface application.

Subsequently select the option in the same drop down menu labelled **Open Loop**. Note the effect on the status field labelled **WFS Control Loop** located to the left of the main NAOMI interface application.

### 2.1.2.4 Post-conditions

Following the selection of the **Close Loop** option, the NAOMI expert should verify that the the AO loop has successfully being closed from the engineering panel. The main status panel on the left of the NAOMI interface should for the status field **WFS Control Loop**, indicate that the loop is *closed*.

Subsequently, following the selection of the **Open Loop** option, the NAOMI expert should verify that the the AO loop has successfully being opened from the engineering panel. The main status panel on the left of the NAOMI interface should for the status field **WFS Control Loop**, indicate that the loop is now *opened*.

## 2.1.3 Gain Modification Test

### 2.1.3.1 Purpose

The purpose of the test is to verify that the observer can modify the NAOMI loop gain parameter from the interface.

### 2.1.3.2 Pre-conditions

All NAOMI hardware and software systems are functioning correctly.

### 2.1.3.3 Test Procedure

Select the option **Parameters** from the menu and then select the option **Change Gain** from the subsequent drop down menu. In the resulting dialogue box enter a new value for the *global gain*. In the first instance enter a value outside of the expected range to ensure that limit checking is being performed correctly. The expected range of the parameter is *0.0* to *1.0*.

Now enter another value gain value which is different to the gain value displayed in the status display window located to the left hand side of the NAOMI GUI labelled **Loop Gain** but which is within the range *0.0* to *1.0*.

### 2.1.3.4 Post-conditions

After entering a gain value which is *out of range*, the application should return an error in the form of a dialogue window which will indicate that the demanded value is *out of range*. No further action will be taken by the application. The status value labelled **Loop Gain** in the status panel will remain the same as it was before attempting to change the value.

In the case of a *valid* gain value being entered, the status value labelled **Loop Gain** on the left hand panel of the main NAOMI interface should reflect the value that was entered into the input window.

## 2.1.4 Integration Time Modification Test

### 2.1.4.1 Purpose

The purpose of the test is to verify that the user can modify the integration time on the WFS CCD from the observer interface.

### 2.1.4.2 Pre-conditions

All NAOMI hardware and software systems are functioning correctly. The WFS camera is switched on.

### 2.1.4.3 Test Procedure

Select the option **Parameters** from the menu and then select the option **Change Integration Time** from the subsequent drop down menu. In the resulting dialogue box enter a new value for the *integration time*. In the first instance, enter a value outside of the expected range to ensure that limit checking is being performed correctly. The expected range of the parameter is greater than 0.0.

Now enter another value integration time which is different to the integration time currently displayed in the status display window on the NAOMI GUI labelled **WFS Int. Time** but which is greater than 0.0

### 2.1.4.4 Post-conditions

After entering a integration time which is *out of range*, the application should return an error in the form of a dialogue window which will indicate that the demanded value is *out of range*. No further action will be taken by the application. The status value labelled **WFS Int. Time** in the status panel will remain the same as it was prior to attempting to change the value.

In the case of a *valid* integration time being submitted, the status field labelled **WFS Int. Time** on the left hand panel of the main NAOMI interface should reflect the value that was entered into the input window.

The integration time should then be checked using the EPICS DM in order to ensure that the integration time has been set correctly in the relevant EPICS record.

## 2.1.5 Coarse Move of WFS Pick Off Probe in Negative Declination

### 2.1.5.1 Purpose

The purpose of the test is to ensure that the control button used to move the WFS pickoff probe in negative declination in coarse increments, functions correctly.

### 2.1.5.2 Pre-conditions

The NAOMI hardware and software control systems are functioning correctly including the EPICS system responsible for the control of the WFS probe mechanism. Any mechanism errors indicated by the EPIC WFS pickoff DM should be reset if any are in effect.

### 2.1.5.3 Test Procedure

Select the WFS FOV monitor by clicking upon the tab labelled **FOV Display** in the main NAOMI interface display. Make a note of the current position of the WFS pickoff probe which is displayed at the foot of the display in the box labelled **WFS Probe Offset**.

Press the button labelled **-DEC** located at the foot of the display on the left hand side.

### 2.1.5.4 Post-conditions

Following the test the small red cross that indicates WFS pickoff position on the FOV monitor should indicate that the WFS probe has moved 2 arc seconds in negative declination.

The status panel at the foot of the display labelled **WFS Probe Offset** should indicate that the WFS has also moved two arc seconds in negative declination.

## 2.1.6 Coarse Move of WFS Pick Off Probe in Positive Declination

### 2.1.6.1 Purpose

The purpose of the test is to ensure that the control button used to move the WFS pickoff probe in positive declination in coarse increments functions correctly.

### 2.1.6.2 Pre-conditions

The NAOMI hardware and software control systems are functioning correctly including the EPICS system responsible for the control of the WFS probe mechanism. Any mechanism errors indicated by the EPIC WFS pickoff DM should be reset if any are in effect.

### 2.1.6.3 Test Procedure

Select the WFS FOV monitor by clicking upon the tab labelled **FOV Display** in the main NAOMI interface display. Make a note of the current position of the WFS pickoff probe which is displayed at the foot of the display in the box labelled **WFS Probe Offset**. Press the button labelled **+DEC** located at the foot of the application window.

### 2.1.6.4 Post-conditions

Following the test, the small red cross that indicates WFS pickoff position on the FOV monitor should indicate that the WFS probe has moved 2 arc seconds in positive declination.

The status panel at the foot of the display labelled **WFS Probe Offset** should also indicate that the WFS has also moved two arc seconds in positive declination.

## 2.1.7 Fine Move of WFS Pick Off Probe in Negative Declination

### 2.1.7.1 Purpose

The purpose of the test is to ensure that the control button used to move the WFS pickoff probe in negative declination in fine increments functions correctly.

### 2.1.7.2 Pre-conditions

The NAOMI hardware and software control systems are functioning correctly including the EPICS system responsible for the control of the WFS probe mechanism.

Any mechanism errors indicated by the EPIC WFS pickoff DM should be reset if any are in effect.

### 2.1.7.3 Test Procedure

Select the WFS FOV monitor by clicking upon the tab labelled **FOV Display** in the main NAOMI interface display. Make a note of the current position of the WFS pickoff probe which is displayed at the foot of the display in the box labelled **WFS Probe Offset**.

Press the button labelled **-DEC** located at the foot of the display on the right hand side.

### 2.1.7.4 Post-conditions

Following the test, the small red cross that indicates WFS pickoff position on the FOV monitor should indicate that the WFS probe has moved 0.05 arc seconds in negative declination.

The status panel at the foot of the display labelled **WFS Probe Offset** should also indicate that the WFS has moved 0.05 arc seconds in negative declination.

## 2.1.8 Fine Move of WFS Pick Off Probe in Positive Declination

### 2.1.8.1 Purpose

The purpose of this test is to ensure that the control button used to move the WFS pickoff probe in positive declination in fine increments functions correctly.

### 2.1.8.2 Pre-conditions

The NAOMI hardware and software control systems are functioning correctly including the EPICS system responsible for the control of the WFS probe mechanism. Any mechanism errors indicated by the EPIC WFS pickoff DM should be reset if any are in effect.

### 2.1.8.3 Test Procedure

Select the WFS FOV monitor by clicking upon the tab labelled **FOV Display** in the main NAOMI interface display. Make a note of the current position of the WFS pickoff probe which is displayed at the foot of the display in the box labelled **WFS Probe Offset**.

Press the button labelled **+DEC** located at the foot of the display on the left hand side.

### 2.1.8.4 Post-conditions

Following the test, the small red cross that indicates WFS pickoff position on the FOV monitor should indicate that the WFS probe has moved 0.05 arc seconds in positive declination.

The status panel at the foot of the display labelled **WFS Probe Offset** should also indicate that the WFS has moved 0.05 arc seconds in positive declination.



## 2.1.9 Coarse Move of WFS Pick Off Probe in Negative RA

### 2.1.9.1 Purpose

The purpose of the test is to ensure that the control button used to move the WFS pickoff probe in negative RA in coarse increments functions correctly.

### 2.1.9.2 Pre-conditions

The NAOMI hardware and software control systems are functioning correctly including the EPICS system responsible for the control of the WFS probe mechanism. Any mechanism errors indicated by the EPIC WFS pickoff DM should be reset if any are in effect.

### 2.1.9.3 Test Procedure

Select the WFS FOV monitor by clicking upon the tab labelled **FOV Display** in the main NAOMI interface display. Make a note of the current position of the WFS pickoff probe which is displayed at the foot of the display in the box labelled **WFS Probe Offset**.

Press the button labelled **-RA** located at the foot of the display on the left hand side.

### 2.1.9.4 Post-conditions

Following the test, the small red cross that indicates WFS pickoff position on the FOV monitor should indicate that the WFS probe has moved 2 arc seconds in negative RA. The status panel at the foot of the display labelled **WFS Probe Offset** should also indicate that the WFS has moved two arc seconds in negative RA.

## 2.1.10 Coarse Move of WFS Pick Off Probe in Positive RA

### 2.1.10.1 Purpose

The purpose of the test is to ensure that the control button used to move the WFS pickoff probe in positive RA in coarse increments functions correctly.

### 2.1.10.2 Pre-conditions

The NAOMI hardware and software control systems are functioning correctly including the EPICS system responsible for the control of the WFS probe mechanism. Any mechanism errors indicated by the EPIC WFS pickoff DM should be reset if any are in effect.

### 2.1.10.3 Test Procedure

Select the WFS FOV monitor by clicking upon the tab labelled **FOV Display** in the main NAOMI interface display. Make a note of the current position of the WFS pickoff probe which is displayed at the foot of the display in the box labelled **WFS Probe Offset**.

Press the button labelled **+RA** located at the foot of the display on the left hand side.

### 2.1.10.4 Post-conditions

Following the test, the small red cross that indicates WFS pickoff position on the FOV monitor should indicate that the WFS probe has moved 2 arc seconds in positive RA. The

status panel at the foot of the display labelled **WFS Probe Offset** should also indicate that the WFS has moved two arc seconds in positive RA.

## **2.1.11 Fine Move of WFS Pick Off Probe in Negative RA**

### **2.1.11.1 Purpose**

The purpose of the test is to ensure that the control button used to move the WFS pickoff probe in negative RA in fine increments functions correctly.

### **2.1.11.2 Pre-conditions**

The NAOMI hardware and software control systems are functioning correctly including the EPICS system responsible for the control of the WFS probe mechanism. Any mechanism errors indicated by the EPIC WFS pickoff DM should be reset if any are in effect.

### **2.1.11.3 Test Procedure**

Select the WFS FOV monitor by clicking upon the tab labelled **FOV Display** in the main NAOMI interface display. Make a note of the current position of the WFS pickoff probe which is displayed at the foot of the display in the box labelled **WFS Probe Offset**. Press the button labelled **-RA** located at the foot of the display on the right hand side.

### **2.1.11.4 Post-conditions**

Following the test, the small red cross that indicates WFS pickoff position on the FOV monitor should indicate that the WFS probe has moved 0.05 arc seconds in negative RA. The status panel at the foot of the display labelled **WFS Probe Offset** should also indicate that the WFS has moved 0.05 arc seconds in negative RA.

## **2.1.12 Fine Move of WFS Pick Off Probe in Positive RA**

### **2.1.12.1 Purpose**

The purpose of the test is to ensure that the control button used to move the WFS pickoff probe in positive RA in coarse increments functions correctly.

### **2.1.12.2 Pre-conditions**

The NAOMI hardware and software control systems are functioning correctly including the EPICS system responsible for the control of the WFS probe mechanism. Any mechanism errors indicated by the EPIC WFS pickoff DM should be reset if any are in effect.

### **2.1.12.3 Test Procedure**

Select the WFS FOV monitor by clicking upon the tab labelled **FOV Display** in the main NAOMI interface display. Make a note of the current position of the WFS pickoff probe which is displayed at the foot of the display in the box labelled **WFS Probe Offset**.

Press the button labelled **+RA** located at the foot of the display on the left hand side.

#### **2.1.12.4 Post-conditions**

Following the test the small red cross that indicates WFS pickoff position on the FOV monitor should indicate that the WFS probe has moved 0.05 arc seconds in positive RA.

The status panel at the foot of the display labelled **WFS Probe Offset** should indicate that the WFS has also moved 0.05 arc seconds in positive RA.

### **2.1.13 Testing the Axes Inversion Buttons**

#### **2.1.13.1 Purpose**

The purpose of this test is to verify that the control buttons which are provided to invert the axes displayed upon the FOV monitor, function correctly.

#### **2.1.13.2 Pre-conditions**

That the NAOMI interface application started successfully and that the FOV display monitor has been selected by clicking upon the tab labelled **FOV Display**.

#### **2.1.13.3 Test Procedure**

Note the current polarity of the axes in both RA and Dec. Now press the two buttons at the bottom of the FOV monitor labelled *Flip X* and *Flip Y* noting any effects.

#### **2.1.13.4 Post-conditions**

The tester should observe that the polarity of both axes should now be inverted.

### **2.1.14 Testing the Help Facility**

#### **2.1.14.1 Purpose**

The purpose of this test is to verify that the help facility functions correctly.

The help facility works by the user selecting the topic of interest from the drop down menu labelled **Help** which is located on the right-hand side of the main menu located at the top of the application display.

#### **2.1.14.2 Pre-conditions**

That the NAOMI interface application has been started successfully.

#### **2.1.14.3 Test procedure**

Iteratively progress through the help topics presented in the help drop down menu. For each topic selected, note the resulting topic of the help that is subsequently displayed.

#### **2.1.14.4 Post conditions**

For each help topic selected from the help drop down menu, a corresponding help topic should be displayed within a Netscape session which should be running on the same display.

If a Netscape session is not already running on the current display, there will be a slight delay whilst it is started automatically.

## 2.1.15 Positioning the WFS Pick Off

### 2.1.15.1 Purpose

The purpose of this test is verify that it is possible to position the WFS pick-off probe at a demanded position on the FOV monitor using the mouse. The test should also demonstrate that the application prevents the user from positioning the probe outside of it's physical limits.

### 2.1.15.2 Pre-conditions

The NAOMI hardware and software control systems are functioning correctly including the EPICS system responsible for the control of the WFS probe mechanism. Any mechanism errors indicated by the EPIC WFS pickoff DM should be reset if any are in effect.

The NAOMI interface application has been started and is functioning correctly.

### 2.1.15.3 Test Procedure

Select the FOV monitor by clicking upon the tab labelled **FOV Display** towards the top of the NAOMI interface application window. Once displayed, click on the display within the confines of the *orange* circle using the right mouse button. At the resulting dialogue window, press **Yes** in order to initiate the movement of the WFS probe.

Once control is returned to the user, verify that the application will reject a request to position the WFS probe outside of the patrol limits by clicking in the area outside of the *orange* circle using the right mouse button.

### 2.1.15.4 Post conditions

The expected result of the first test is that the WFS probe position indicator will move to the position that the mouse cursor was located *at* the time that the right mouse button was pressed. This will be indicated by the red cross displayed upon the FOV monitor moving to the location of the mouse cursor.

The result of the second test of attempting to position the WFS probe *outside* of it's patrol limits should be a dialogue window indicating that the user has requested that the probe be moved outside of it's patrol field.

### 2.1.15.5 Probe position status updates

### 2.1.15.6 Purpose

The purpose of this test is to verify that positional information relating to the location of the WFS probe is successfully being retrieved from the NAOMI system and that it is successfully being reported by the NAOMI interface application.

### 2.1.15.7 Preconditions

The NAOMI hardware and software control systems are functioning correctly including the EPICS system responsible for the control of the WFS probe mechanism. Any mechanism errors indicated by the EPIC WFS pickoff DM should be reset if any are in effect.

The NAOMI interface application has been started and is functioning correctly.

Click upon the tab labelled **FOV Display** which is situated at the top of the NAOMI interface application.

At the foot of the display is a label *Status Retrieved* with a small box to the right of it which should be coloured green in order to indicate that WFS probe location information is currently available and is being used to update the position of the probe on the display.

### 2.1.15.8 Test procedure

Log on to the NAOMI Sparc *navis.ing.iac.es* and then *kill(1)* the process named *EPMDataServer*. The result of this should be that the NAOMI interface application will be unable to retrieve status information relating to the location of the WFS probe. Note the colour of the small box described in section 2.1.15.7.

Restart the *EPMDataServer* process upon *navis.ing.iac.es* using the following command;

```
nohup EPMDataServer&
```

Note the colour of the small box described in 2.1.15.7 after restarting the process.

### 2.1.15.9 Post conditions

The result of the first test should be that the colour of the small status box described in section 2.1.15.7 should turn red after the *EPMDataServer* process is stopped. This indicates that no status information relating to the position of the WFS probe is currently being received. The application will further enter information into the *syslog* to indicate that it was unable to retrieve the status information relating to the position of the probe.

The result of the second test is that the small status box described in section 2.1.15.7 should turn green following the restart of the *EPMDataServer* process. This indicates that the *EPMDataServer* process is now receiving WFS probe position information once again.

## 2.1.16 Loading the Guide Star File

### 2.1.16.1 Purpose

The purpose of this test is to verify that the application can load a correctly prepared, user created *guide star file* and that the application will reject a *guide star file* in an incorrect format.

### 2.1.16.2 Preconditions

That the NAOMI interface application has been started successfully.

The following data should be entered into a file called *successfultest.gsf* and then stored in your home directory.

```
Star 11 12 13 20 20 20 J2000
StarGS 11 12 13 21 22 23 J2000
```

The following data should be entered into a file called *failedtest.gsf* and then stored in your home directory.

```
Star 25 12 13 20 20 20 J2000
StarGS 11 12 13 21 22 23 J2000
```

### 2.1.16.3 Test procedure

Clicking upon the tab labelled **Guide Star** which is located near the top of the NAOMI interface application window.

Now click on the button labelled *Load Guide Star File* and in the resulting file browser, select the file labelled *failedtest.gsf* from your home directory. Note the contents of any resulting dialogue window which is displayed.

Now click on the button labelled *Load Guide Star File* and in the resulting file browser, select the file labelled *successfultest.gsf* from your home directory. Note the resulting entries into the guide star selector dialogue window.

### 2.1.16.4 Post conditions

After attempting to load the guide star file labelled *failedtest.gsf*, the application should report an error to the effect that *Line 1 of the guide star file is in an incorrect format.*

After attempting to load the guide star file labelled *successfultest.gsf*, the details of the *guide star* and the *science object* present in the file should be displayed correctly according to the contents of the file, in the columns which comprise the guide star selection dialogue window.

## 2.1.17 Testing The Pointing of the Telescope

### 2.1.17.1 The purpose

The purpose of this test is to show that it is possible to point the telescope at a predetermined position using the NAOMI interface application.

### 2.1.17.2 Preconditions

The NAOMI software system based upon *navis.ing.iac.es* is operating correctly and that the TCS has been started and is in *computer* mode. For the purpose of the test, the TCS can be either in simulation mode or real mode.

In order to test the functionality, it will be necessary to create a guide star file which contains a position in the sky at which the telescope can point at during the test. In order to do this it will be necessary to calculate a test position based upon the current sidereal time. The current sidereal time is displayed at the head of the TCS status page on the TCS X-terminal.

The following file *testpoint.gsf* should be created in your home directory and should contain the following:

```
ScienceObject HH MM SS DD MM SS J2000
ScienceObjectGS HH MM SS DD MM SS J2000
```

The actual position in RA and declination entered by the tester will be influenced by the current sidereal time. The second position entered can be the same as the first position for the purpose of the test as it is irrelevant.

The test assumes that the TCS is functioning correctly and that it is capable of pointing and tracking a position on the sky.

### 2.1.17.3 Test procedure

Click upon the tab labelled **Guide Stars** which is located at the head of the NAOMI interface application. Now press the button at the foot of the display which is labelled **Load Guide Star File**. Using the file browser, select the file called *testpoint.gsf* which will be located in your home directory.

After loading the file, the guide star selector should contain a single entry reflecting the two positions that were entered into the file in the previous section. Using the mouse, click once using the left mouse button on the entry in the guide star selector.

Now pressed the button labelled **Point Telescope** which is located at the foot of the NAOMI interface application. This should instruct the telescope to move to the position indicated in the guide star selector.

### 2.1.17.4 Post conditions

After the test has been executed successfully, by referring to the TCS status page, the tester should be able to verify that the telescope has moved to the demanded position on sky and that it is now in tracking mode.

## 2.1.18 Positioning the WFS Probe Onto a Guide Star

### 2.1.18.1 Purpose

The purpose of this test is to show that it is possible to position the WFS probe onto a guide star whilst the telescope is tracking a science object.

### 2.1.18.2 Preconditions

This test will need to be performed on sky. All of the NAOMI hardware and software systems should be running and functioning correctly prior to the test.

This test will require expert assistance in order to set up the adaptive optics system.

The TCS should be running and in computer mode.

An astronomer will be required to provide the positions of two suitable stars taking into account the current sidereal time. One of the stars will be considered the guide star and the other will be considered the science object.

The tester will be required to create a guide star file called *testwfs.gsf* in his home directory which will contain the following;

```
ScienceObject HH MM SS DD MM SS J2000
ScienceObjectGS HH MM SS DD MM SS J2000
```

The two positions specified in the file will have been determined by astronomer. The first line will contain the position of the *science object* and the second line will contain the position of a suitable *guide star*.

As part of the set up sequence for NAOMI, the NAOMI engineers must specify the probe space offset prior to executing the test. These are internal parameters to NAOMI which are used to correctly calculate the conversion between arc seconds and engineering units. These parameters vary each time that the INGRID instrument is attached to NAOMI and is due to slight engineering imperfections. These parameters need to be established by the relevant engineers prior to a NAOMI run.

### 2.1.18.3 Test procedure

The user should click upon the tab labelled **Guide Star** located at the head of the NAOMI interface application. Next the user should press the button labelled **Load Guide Star File** and in the resulting file browser, select the file described in the previous section.

The telescope operator should be requested to position the telescope at the location of the science object.

After the telescope is successfully tracking the science object the tester must then click on the entry in the guide star selector and subsequently press the button labelled **Move WFS probe to Guide Star**.

### 2.1.18.4 Post conditions

The expected result of the test is that the WFS probe will be offset such that following successful completion of the command, the NAOMI expert should be able to verify that the WFS probe is now positioned upon the guide star using the visualisation tools available on *navis.ing.iac.es*.

The resident astronomer should be able to provide the expected offset from the science object to the guide star in RA and declination in arcsecs. This offset should be reflected by the FOV monitor by examining the WFS offset status parameters located at the foot of the NAOMI interface application following the execution of the test.

## 2.2 Testing the Seeing Indicator

### 2.2.1 Monitoring the Reported Seeing Estimates

#### 2.2.1.1 Purpose

The purpose of this test is to show that the seeing indicator updates correctly whilst the NAOMI system is in operation.

#### 2.2.1.2 Preconditions

All NAOMI hardware and software systems are running and functioning correctly.

The tester has started the observing system upon the WHT OCS machine, *taurus*, and that the *seeingLogger* task has been started. This should be done before starting the NAOMI interface application. This is normally done as part of the *startobssys* procedure.

#### 2.2.1.3 Test procedure

The tester should click upon the tab labelled **Seeing** which is located at the top of the NAOMI interface application. Subsequently, the seeing trace should be displayed and the tester should then press the button labelled **Tail** located at the foot of the NAOMI interface application window.

#### 2.2.1.4 Post conditions

The tester should observe that the seeing trace is updated at least every ten seconds and that the small status indicator located at the foot of the seeing trace is coloured green. This indicates that the seeing trace monitor is successfully retrieving seeing information from the



NAOMI system. If the status indicator is coloured red, it indicates that the application is not receiving seeing information and that the test has failed.

The seeing trace should consist of a yellow and red plot; one indicating the corrected seeing and the other the uncorrected seeing.

## 2.2.2 The Tail Facility

### 2.2.2.1 Purpose

The purpose of this test is to verify that the seeing trace tail facility functions correctly. Once selected, the application should tail the seeing trace such that the *latest* seeing information is always displayed to the right of the seeing trace monitor.

### 2.2.2.2 Preconditions

All NAOMI hardware and software systems are functioning correctly.

The tester has started the observing system upon the WHT OCS machine, *taurus*, and that the *seeingLogger* task has been started. This should be done before starting the NAOMI interface application.

### 2.2.2.3 Test procedure

The tester should click upon the tab labelled **Seeing** which is located at the top of the NAOMI interface application. This should result in the seeing trace being displayed.

The tester should then press the button labelled **Tail** located at the foot of the NAOMI interface application window.

### 2.2.2.4 Post conditions

The tester should observe that the seeing trace is frequently updated and as it does so, the seeing trace scrolls to the *left* and that the latest seeing information is permanently displayed towards right-hand side of the seeing monitor.

The status box labelled **Receiving Seeing Data** at the foot of the display should be coloured *green* to indicate that the seeing trace file is periodically being updated.

## 2.2.3 The Fit Facility

### 2.2.3.1 Purpose

The purpose of this test is to verify that the trace fit facility functions correctly. Once selected, the application should display *all* of the current seeing information present in the current seeing file in the seeing monitor window.

### 2.2.3.2 Preconditions

All NAOMI hardware and software systems are functioning correctly.

The tester has started the observing system upon the WHT OCS machine, *taurus*, and that the *seeingLogger* task has been started. This should have been done before starting the NAOMI interface application.

### 2.2.3.3 Test procedure

The tester should click upon the tab labelled **Seeing** which is located at the top of the NAOMI interface application. Subsequently the seeing trace should be displayed and the tester should press the button labelled **Fit** located at the foot of the NAOMI interface application window.

### 2.2.3.4 Post conditions

After the test, the tester should observe that all of the seeing information contained in the seeing file is displayed in its entirety within the seeing trace monitor.

## 2.2.4 Loading a Seeing Trace File

### 2.2.4.1 Purpose

The purpose of this test is to verify that it is possible to load into the seeing trace monitor, seeing trace information from files which were created throughout previous observing runs which used NAOMI as part of the observing configuration.

### 2.2.4.2 Preconditions

All NAOMI hardware and software systems are functioning correctly.

Seeing trace files created as a result of NAOMI operation during previous nights' NAOMI operation are present upon the system in the *default* seeing trace log directory.

### 2.2.4.3 Test procedure

The tester should click upon the tab labelled **Seeing** which is located at the top of the NAOMI interface application. Subsequently the tester should press the button labelled **Load Trace** which is located at the foot of the NAOMI interface application window. In the resulting file browser dialogue, the tester should select a seeing trace file which has a time stamp different to that of the current trace file which is currently being displayed.

### 2.2.4.4 Post conditions

Following the selection of the new seeing trace file, the seeing information contained in that file will be subsequently loaded into the application and displayed within the seeing trace monitor.

The name of the selected seeing trace file should be displayed at the foot of the seeing trace monitor display in the status window labelled **Seeing Log**.

## 2.2.5 The Centre Facility

### 2.2.5.1 Purpose

The purpose of this test is to test the centring facility of the seeing trace monitor.

### 2.2.5.2 Preconditions

That a valid seeing trace file is present in the seeing trace file directories.

### 2.2.5.3 Test Procedure

If not already loaded, the tester should load a valid seeing trace file into the seeing trace monitor using the **Load Trace** button displayed at the foot of the seeing trace monitor.

The tester should then press the button labelled **Centre**. Note the effect that pressing the button has upon the x-axis of the seeing plot.

### 2.2.5.4 Post Conditions

The time window of seeing data displayed by the seeing trace monitor should change such that it is four hours wide. The *most recent* seeing data contained in the seeing trace file should be displayed in the centre of the seeing trace file monitor.

If the file that is currently being displayed is from the current day, the tester should observe that the trace will update if all of the NAOMI hardware and software systems are active and functioning correctly.

## 2.2.6 Printing a Trace

### 2.2.6.1 Purpose

The purpose of this test is to verify that it is possible to print a seeing trace which is currently being displayed within the seeing trace monitor.

### 2.2.6.2 Preconditions

That a valid seeing trace file is present in the seeing trace file directories.

### 2.2.6.3 Test Procedure

If not already loaded, the tester should load a valid seeing trace file into the seeing trace monitor using the **Load Trace** button displayed at the foot of the seeing trace monitor.

The user should then press the button labelled **Print**. A dialogue window will then be displayed within which the tester can enter the name of a printer which is local to him.

To initiate the print, the tester should acknowledge the dialogue.

### 2.2.6.4 Post Conditions

A hard copy of the section of the seeing trace currently displayed in the seeing trace monitor should be printed on the specified printer.

## 2.2.7 The Time Window Modification Controls

### 2.2.7.1 Purpose

The purpose of this test is to verify that the functionality of the controls to modify the time window of the seeing data displayed, perform correctly. There are four control buttons located at the foot of the seeing trace monitor which can be used to change the amount of seeing data displayed within the seeing trace monitor.

### 2.2.7.2 Preconditions

That a valid seeing trace file is present in the seeing trace file directories.

### 2.2.7.3 Test procedure

If not already loaded, the tester should load a valid seeing trace file into the seeing trace monitor using the **Load Trace** button displayed at the foot of the seeing trace monitor.

Now execute the following sequences in the following order;

1. Press the button labelled **Centre** followed by the button labelled **-1hr**. Note the effect of pressing the **-1hr** button *after* pressing the **Centre** button on the width of the time window.
2. Continuously press the button labelled **-1hr** until it has no further apparent effect on the width of the seeing trace time window. Now note the effect of pressing the button labelled **-5min** on the width of the time window.
3. Press the button labelled **+5min** and note the effect on the width of the seeing trace file window.
4. Press the button labelled **+1hr** and note the effect on the width of the seeing trace file window.

### 2.2.7.4 Post Conditions

After executing step 1, the tester should observe that the width of the seeing monitor time window should *decrease* by a factor of an hour.

After executing step 2, the tester should observe that the width of the seeing monitor time window should *decrease* by a factor of 5 minutes.

After executing step 3, the tester should observe that the width of the seeing monitor time window should *increase* by a factor of 5 minutes.

After executing step 4, the tester should observe that the width of the seeing monitor time window should *increase* by a factor of one hour.

## 2.2.8 Testing the EPMDDataServer

This application is used to provide a bridge between the NAOMI related applications running upon the WHT OCS and the NAOMI system itself. It is therefore essential to have the *EPMDDataServer* running prior to attempting to use any of the NAOMI related software the WHT OCS.

The *EPMDDataServer* is a web server that accepts URLs which command it to perform a specific action. The tests outlined in this section will be used to exercise the various URL requests the *EPMDDataServer* has been designed to recognise.

## 2.2.9 Starting the EPMDDataServer

The *EPMDDataServer* can be started by logging onto *navis.ing.iac.es* and executing the following command;

```
nohup EPMDDataServer&
```

## 2.2.10 Requesting EPM Status

### 2.2.10.1 Purpose

The purpose of the test is verify that the *EPMDDataServer* can return a status page when issued with the appropriate URL.

### 2.2.10.2 Preconditions

That the *EPMDDataServer* has been started on *navis.ing.iac.es*.

You have access to a web browser such as Netscape or Internet Explorer.

### 2.2.10.3 Test procedure

Enter the following URL into the URL address field of your browser;

<http://navis.ing.iac.es:40000/NAOMI/status>

### 2.2.10.4 Post Conditions

The *EPMDDataServer* should then return a status page describing all of the parameters currently residing in the EPM as well as providing some status information relating to the *EPMDDataServer* process itself.

The status page should periodically refresh itself

## 2.2.11 Enabling Trace Mode

### 2.2.11.1 Purpose

The purpose of the test is ensure that it is possible to enable trace mode within the *EPMDDataServer*.

### 2.2.11.2 Preconditions

That the *EPMDDataServer* has been started on *navis.ing.iac.es*.

You have access to a web browser such as Netscape or Internet Explorer.

### 2.2.11.3 Test Procedure

Enter the following URL into the URL address field of your browser;

<http://navis.ing.iac.es:40000/NAOMI/debug/on>

### 2.2.11.4 Post Conditions

Trace mode should now be enabled in the *EPMDataServer*. This can be verified by examining the file */var/log/Electra* on *navis.ing.iac.es*. At the end of the file there should be a line to the following effect

```
Jan 18 13:52:50 navis EPMDataServer[2590]: Debug has been switched on
```

The *EPMDataServer* will also return a web page informing the tester that debug was activated.

## 2.2.12 Disabling Trace Mode

### 2.2.12.1 Purpose

The purpose of the test is ensure that it is possible to disable trace mode within the *EPMDataServer*.

### 2.2.12.2 Preconditions

That the *EPMDataServer* has been started on *navis.ing.iac.es*.

You have access to a web browser such as Netscape or Internet Explorer.

### 2.2.12.3 Test Procedure

Enter the following URL into the URL address field of your browser;

<http://navis.ing.iac.es:40000/NAOMI/debug/off>

### 2.2.12.4 Post Conditions

Trace mode should now be disabled in the *EPMDataServer*. This can be verified by examining the file */var/log/Electra* on *navis.ing.iac.es*. At the end of the file there should be a line stating that debug was deactivated.

```
Jan 18 13:52:50 navis EPMDataServer[2590]: Debug has been switched off
```

The *EPMDataServer* will also return a web page informing the tester that debug was deactivated.

## 2.2.13 Issuing NAOMI Commands

### 2.2.13.1 Purpose

The purpose of this test is verify whether commands can be initiated in the NAOMI sequencer via the *EPMDataServer*. The test will issue a benign command in the sequencer which will not affect the state of NAOMI in any way. No special safety considerations need to be exercised in order to perform this test.

### 2.2.13.2 Preconditions

That the *EPMDataServer* has been started on *navis.ing.iac.es*.

### 2.2.13.3 Test Procedure

Within NAOMI source directories. Now change directory to the directory *src/testScript*.

Execute the script *testEPMCommand.tcl* from the command line.

### 2.2.13.4 Post Conditions

After the test has completed, information to the following effect should be reported on *stdout*.

```
LOGuiEPM.Test.Ping(0,'CompletedOk') initially responded with Running
Starting timeout of 15 seconds for tag tag_22
Freeing command status tag tag_22
```

The above indicates that the command was issued to the NAOMI sequencer, the test application then waited for up to 15 seconds for the test to complete and then the NAOMI sequencer acknowledged that the command had completed and subsequently the command test application released the associated command tag.

## 2.3 Testing The *Loop* Script

The tests in this section will be used by the tester to verify that it is possible to control the state of the AO loop via the command line script provided.

### 2.3.1 Purpose

The purpose of this test is verify that it is possible to open the WFS loop from the *loop* script.

### 2.3.2 Preconditions

The test may be performed in one of two ways; either on sky or in the laboratory. The following are the preconditions necessary for testing the script on sky.

All NAOMI hardware and software systems are functioning correctly.

INGRID is correctly configured for use with NAOMI.

The WHT OCS observing system on *taurus* and the DAS machine has been started and are using a NAOMI specific configuration.

An astronomer has provided the positions of two objects; one will serve as science object and the other will serve as a guide star for the AO system.

The TCS has been instructed to point at the science object.

The WFS probe has been offset such that it is positioned on the guide star. This can be accomplished using the NAOMI interface application using the guide star selection facility.

The NAOMI observer level GUI is running.

The following are the preconditions for testing the script in the laboratory using a test rig. In order to do this will require the assistance of a NAOMI specialist.

All NAOMI hardware and software systems are functioning correctly.

INGRID is correctly configured for use with NAOMI.

The WHT OCS observing system on *taurus* and the DAS machine has been started and are using a NAOMI specific configuration.

The TCS has been instructed to arbitrarily point at a position on sky.

The WFS probe has been offset such that it is positioned on a suitable light source which may be used as "artificial" guide star. This will need to be performed by a NAOMI specialist.

The NAOMI observer level GUI is running.

### 2.3.3 Test Procedure

The following command should be executed from the observer's command line interface located on *taurus*.

```
loop close
```

Note the effect of the loop status variables of executing the command.

Now execute the following command from the observer's command line interface located on *taurus*.

```
loop open
```



Note the effect of the loop status variables of executing the command.

### **2.3.3.1 Post conditions**

Following the closing of the loop, the engineering display should report that the loop is now *closed*. The status panel to the left of the NAOMI Observer's interface should also show that the loop is now *closed*.

Following the opening of the loop, the engineering display should report that the loop is now *open*. The status panel to the left of the NAOMI Observer's interface should show that the loop is now in the *opened* state.

## 2.4 Testing the Dither Script

The dither facility draws together a number of the subsystems at the WHT and attempts to control them all in concert. An exhaustive sequence of tests to fully exercise the script's capabilities will require time on sky but it is possible to perform off-sky tests in order to establish to a certain degree, correct operation of the script.

Specialist assistance in the form of NAOMI expert will be required to execute a comprehensive test of the script. An astronomer will be required to provide two positions of a science object and a guide star.

### 2.4.1 9 Point Dither Test

#### 2.4.1.1 Purpose

The purpose of the test is to verify the default 9 point dither capability. A secondary aim of the test is to show that the dither script can move both the telescope and the WFS probe in concert between dither points without breaking the AO loop and subsequently having to close it again

#### 2.4.1.2 Preconditions

All NAOMI hardware and software systems are functioning correctly.

INGRID is correctly configured for use with NAOMI.

The WHT OCS observing system on *taurus* and the DAS machine has been started and is using a NAOMI specific configuration.

An astronomer has provided the positions of two objects; one will serve as science object and the other will serve as a guide star for the AO system.

The TCS has been instructed to point at the science object.

The WFS probe has been offset such that it is positioned on the guide star. This can be accomplished using the NAOMI interface application using the guide star selection facility.

The NAOMI expert has closed the AO loop successfully from either the engineering panel or via the NAOMI interface application.

The TCS is accepting auto-guiding instructions from the NAOMI system.

#### 2.4.1.3 Test Procedure

The following command should be executed from the command line. This will instruct the script to perform a 9 point dither command with a 5 arc second offset from the origin in both RA and DEC at each dither point.

```
dither -verbose -secs 1 -title "9pt Test Integration" -9point 5 5
```

#### 2.4.1.4 Post Conditions

At each point in the dither sequence, the program will wait until the tester has acknowledged that the dither sequence can continue. This can be done by typing *Y* followed by pressing the *<return>* key.

As the dither script moves between each of the five dither points, the tester should observe at the TCS status page that the telescope is being offset by the requested amount at each dither

point. The dither script will report the offsets that it will apply at each dither point before executing them.

The NAOMI expert should be able to confirm that the WFS pickoff probe is moving in concert with the telescope and that the guide star is still located on the WFS probe and that the loop is still closed.

After the dither script has offset the WFS probe and the telescope at each dither point, the application should be seen to initiate an integration sequence upon INGRID. This can be done by monitoring the UDAS camera mimic on the *taurus* display. Each integration should be labelled as "*9pt Test Integration*" in the observing log.

## 2.4.2 5 Point Dither Test

### 2.4.2.1 Purpose

The purpose of the test is to verify the default 5 point dither capability. A secondary aim of the test is to show that the dither script can move both the telescope and the WFS probe in concert between dither points without breaking the AO loop and subsequently having to close it again

### 2.4.2.2 Preconditions

All NAOMI hardware and software systems are functioning correctly.

INGRID is correctly configured for use with NAOMI.

The WHT OCS observing system on *taurus* and the DAS machine has been started and is using a NAOMI specific configuration.

An astronomer has provided the positions of two objects; one will serve as science object and the other will serve as a guide star for the AO system.

The TCS has been instructed to point at the science object.

The WFS probe has been offset such that it is positioned on the guide star. This can be accomplished using the NAOMI interface application using the guide star selection facility.

The NAOMI expert has closed the AO loop successfully from either the engineering panel or via the NAOMI interface application.

The TCS is accepting auto-guiding instructions from the NAOMI system.

### 2.4.2.3 Test Procedure

The following command should be executed from the command line. This will instruct the script to perform a 5 point dither command with a 5 arc second offset from the origin in both RA and DEC at each dither point.

```
dither -verbose -secs 1 -title "5pt Test Integration" -5point
```

### 2.4.2.4 Post Conditions

At each point in the dither sequence, the program will wait until the tester has acknowledged that the dither sequence can continue. This can be done by typing *Y* followed by pressing the *<return>* key.

As the dither script moves between each of the five dither points, the tester should observe at the TCS status page that the telescope is being offset by the requested amount at each dither

point. The dither script will report the offsets that it will apply at each dither point before executing them.

The NAOMI expert should be able to confirm that the WFS pickoff probe is moving in concert with the telescope and that the guide star is still located on the WFS probe and that the loop is still closed.

After the dither script has offset the WFS probe and the telescope at each dither point, the application should be seen to initiate an integration sequence upon INGRID. This can be done by monitoring the UDAS camera mimic on the *taurus* display. Each integration should be labelled as "*5pt Test Integration*" in the observing log.

## 2.5 Testing the *positionWFSProbe* Script

### 2.5.1 Purpose

The purpose of this test is to verify that the *positionWFSProbe* script can be used to offset the WFS probe such that when the telescope is pointing at a pre-defined science object, the probe can be positioned upon it's associated guide star.

### 2.5.2 Preconditions

This test will need to be performed on sky. All of the NAOMI hardware and software systems should be running and functioning correctly prior to the test.

This test will require expert assistance in order to set up the adaptive optics system.

The TCS should be running and in computer mode.

An astronomer will be required to provide the positions of two suitable stars accounting for the current sidereal time. One of the stars will be considered to be the guide star and the other will be considered to be the science object.

The positions specified in the file will have been determined by astronomer. The first line will contain the position of the science object and the second line will contain the position of a suitable guide star.

As part of the set up sequence for NAOMI, the NAOMI engineers must specify the probe space offset prior to executing the test. These are internal parameters to NAOMI which are used to correctly calculate the conversion between arc seconds and engineering units. These parameters vary each time that the INGRID instrument is attached to NAOMI and is due to slight engineering imperfections. These parameters need to be established by the relevant engineers prior to a NAOMI run.

### 2.5.3 Test procedure

The telescope operator should be requested to position the telescope at the location of the science object as specified by the astronomer. Wait until the object is being tracked.

Now execute the following command at the observer command line interface on *taurus*. It will be necessary to substitute in the co-ordinates of the science object and the guide star object as appropriate which were supplied by the astronomer.

```
PositionWFSProbe -h -target HH MM SS DD MM SS J2000
                  -guidestar HH MM SS DD MM SS J2000
```

### 2.5.4 Post conditions

The expected result of the test is that the WFS probe will be offset such that following successful completion of the command, the NAOMI expert should be able to verify that the WFS probe is now positioned upon the guide star using the visualisation tools available on *navis.ing.iac.es*.

The resident astronomer should be able to provide the expected offset from the science object to the guide star in RA and declination in arcsecs. This offset should be reflected by the FOV monitor by examining the WFS offset status parameters located at the foot of the NAOMI interface application following the execution of the test.

