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WHT Acquisition Tool User Guide

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Chapter 1 Introduction

The purpose of this document is to provide a user guide to the new WHT acquisition tool which was developed to facilitate the acquisition process during AO operations. The application is based on the realtime display software that was developed by ESO and has been customised to provide acquisition functionality for the AO system and the OASIS instrument at the WHT.

The user documentation is split across two documents. This document explains the process of performing acquisition using the customisations that have been incorporated into the ESO standard software. The second document [1] outlines the functionality provided by the standard ESO Realtime Display Software provided by ESO.

Chapter 2 A Guide To The Acquisition Tool

This chapter provides a guide to the features of the application that are to be used to perform acquisition related activities.

2.1 Starting the Tool

This section outlines how the Observer will start the acquisition tool from the observing system command line on the WHT ICS computer.

2.1.1 Preconditions for use

There are a number of prerequisites that need to be satisfied before the observer can successfully use the acquisition tool. These are as follows :

- It is necessary that the Observer has configured and started the observing system on the WHT ICS console.
- The NAOMI mechanical control system must be fully operational, specifically the WFS pickoff probe.
- The telescope control system should be operational. To actually perform acquisition, the telescope *must* be tracking also.
- The Observer has, for the acquisition detector to be used, to have *calibrated* the acquisition tool correctly. The tool will not work successfully unless this has been done. This process only needs to be performed once per acquisition detector. It should be noted however though, that if the acquisition camera is *physically* moved, it is advisable that the calibration process be **repeated** by the Observer to ensure accurate acquisition.
- Any camera servers that are to be used to provide acquisition frames should be running and configured into the observing system.

For AO related acquisition :

- The NCU slide must be in the *acquisition* position for acquisition.
- The telescope operator must have temporarily *suspended* framing on the television application associated with the acquisition camera server. Whilst this TV application is in *continuous* framing mode, the acquisition tool *cannot access* the camera server in order to retrieve its acquisition frames
- Windowing **must be disabled** on the camera server that is to provide the *AO mode* related acquisition frames. This mode of acquisition expects *full frame* images from the acquisition camera server.

For OASIS related acquisition :

- Windowing **must be enabled** on the OASIS camera server if *OASIS acquisition* is to be used. The chip should be windowed according to the following parameters **[1:2059,1035:3140]**
- OASIS must be in imaging mode prior to acquiring acquisition frames.

2.2 Running the application

The acquisition tool can be started from the *whtics* observing system command line using the following command;

acqtool &

After a short period of time the main application window will appear on the console display and will look as follows :

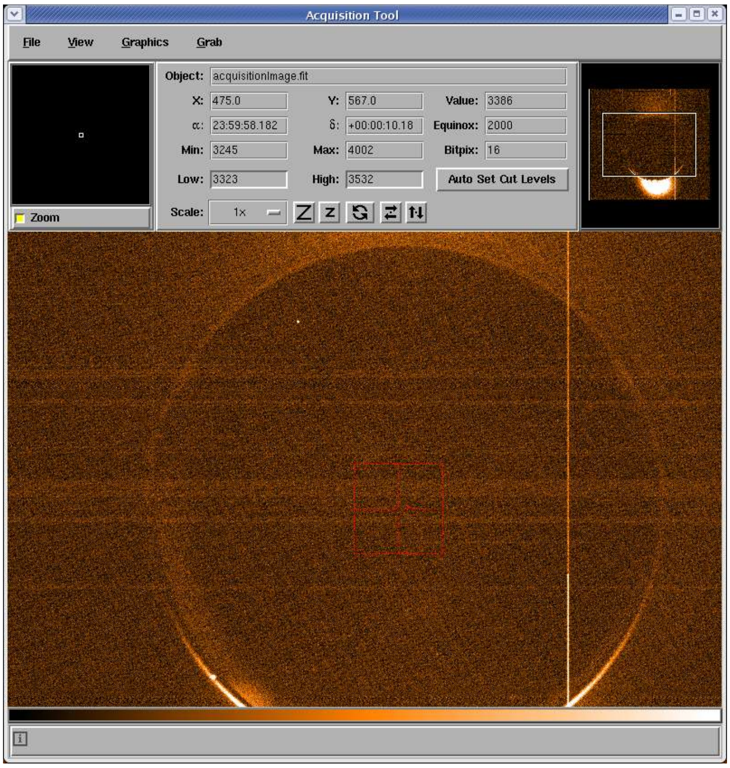


Illustration 1Main Application Window

2.2.1 The Main Display Page

The main window of the acquisition tool is broadly divided up into four segments.

2.2.1.1 Acquisition Image Display Area

The majority of the display is given over to *displaying* the acquisition image which can be served from one of the standard UltraDAS camera servers. Various image manipulation facilities exist to modify the appearance of the image and these are described in detail in document [1].

Overlaid on the acquisition image will be a *small red box* which represents the overlay of the *INGRID FOV* in acquisition detector space. Furthermore, there is a small red circle which is overlaid on the acquisition image which signifies the position in *acquisition detector space* of the NAOMI wavefront sensor pickoff probe when it is in its nominal acquisition position.

2.2.1.2 The Image Zoom Area

In the top left of the display is a small window which shows a *magnified* image of the area of the acquisition frame were the cursor is positioned. This image will update in real time as the cursor is moved around the acquisition image.

2.2.1.3 The Acquisition Image Information Area

Located at the upper central part of the main window is a status area which displays information about the acquisition frame.

The *RA* and *Dec* of the position on the acquisition image where the cursor lies is constantly updated as the cursor is moved around the acquisition frame.

Further information includes the X and Y pixel values that currently lie beneath the cursor when the user is moving the cursor over the acquisition image.

There are facilities at the bottom of the status area which allow the user to magnify the acquisition image.

The details of the rest of the status information displayed in this area is outlined in the document [1].

2.2.1.4 The Pan Window

This is a small window in the top right of the main application window which highlights the *actual area* displayed in the main acquisition image window. This will change depending on the level of zoom that has been applied by the user.

2.2.1.5 The Menu Bar

The menu bar across the top of the application permits the user access to most of the functionality provided by the acquisition tool. Once again, the functionality provided by the menu bar is best described in the *user guide section* of the document [1].

As part of the customisation of the ESO realtime display, an additional menu has been added which is labelled **Grab**. It is through this menu that the user will initiate frame grabs of acquisition images from the chosen camera server.

2.3 The AO Acquisition Frame Grab Window

The first step in the acquisition process is to *acquire* an acquisition frame from the chosen camera server. For normal AO acquisition, the user **should** use this dialog window in order to acquire an acquisition image.

This can be done via the *Acquisition Frame Grab Window*. The user can access this window by selecting the menu option **Grab -> Grab Image**. Alternatively, the user can press the keyboard shortcut **Ctrl-G** whilst the cursor is located over the main application window. Once done the following window will appear.

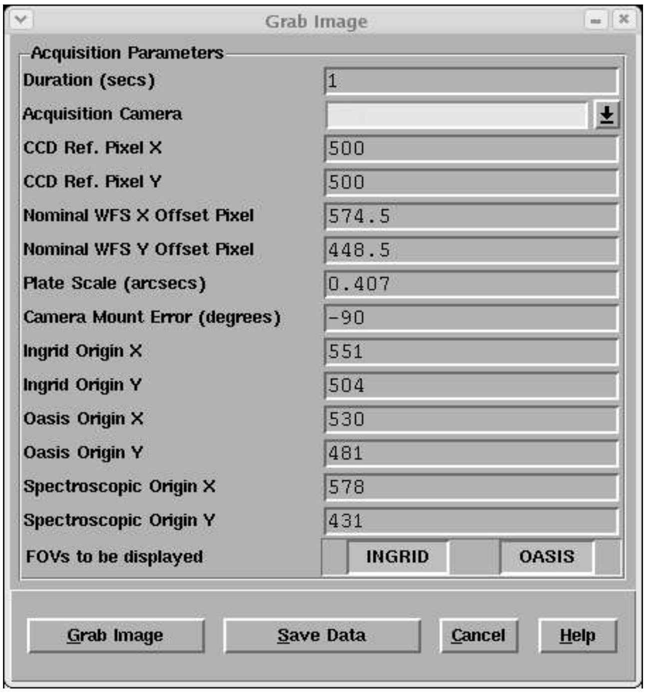


Illustration 2Grab Dialog

For *each* camera server that is configured to be used by the Observer to provide acquisition images, there is a set of *calibration constants* that need to be determined by the Observer and entered into the application and subsequently saved.

The following sections describe the purpose of each of these calibration constants. It is critical that these calibration constants are calculated **correctly** otherwise the acquisition tool will not be able to perform acquisition accurately.

2.3.1 The *Duration* Field

In this field the user can specify the *length* of the integration that is to be used by the camera server when retrieving an acquisition frame. This should be specified as a real number and expressed in units of *seconds*.

2.3.2 The *Acquisition Camera* Field

The WHT software manager can configure in the WHT ICS database the *cameras* that the acquisition tool can use to retrieve acquisition frames. The various cameras which can be used for this purpose are displayed in the selection box labelled *Acquisition Camera*. Each camera has associated with it its own unique set of *calibration constants* and as the user selects different camera servers, the user shall see that the calibration constants will change to those associated with that particular camera server.

The user should select in this field, the name of the camera server that is to *serve* the acquisition frame. In the case of NAOMI, this is normally camera *AG3* and this is the default option.

2.3.3 The *CCD Ref. Pixel* Fields

The purpose of the *CCD Ref. Pixel* fields is to allow the Observer to specify the X and Y pixel on the acquisition frame that corresponds to the optical axis of the telescope. It should be noted that at this point in time, these two parameters are **not used** as part of any calculation performed during the acquisition process and therefore, for the time being at least, can be **safely ignored** by the user.

2.3.4 The *Nominal WFS Pixel Offset* Fields

The purpose of the *Nominal WFS Pixel Offset* fields is to allow the Observer to specify the X and Y pixel on the acquisition frame of the overlay of the NAOMI WFS pickoff probe in acquisition detector space when in its nominal acquisition position.

2.3.5 The *Plate Scale* Field

In this field the Observer should enter the *plate scale* of the detector at its *current* focal station on the telescope. This should be entered as a real number and expressed in *arc seconds*. It should be noted that this constant is **absolutely crucial** to the calculations that are performed by the application and therefore the observer should ensure that the value provided in this field is as accurate as possible.

2.3.6 The *Camera Mount Error* Field

In this field the Observer should enter the *mount angle* of the camera. This value should be entered as a *real number* and expressed in *degrees*.

Assuming that North is *up* on the detector, the value entered in this field should express the *number of degrees of rotation* to be applied in order to calculate *north* on the acquisition camera detector chip. The value entered can be a *positive* or *negative* real number depending on whether *North* on the detector is *clockwise* or *anticlockwise* respectively in relation to the assumption that *North* is up on the detector.

As an example, in the case of the AG3 chip, *North* is rotated 90° anticlockwise so therefore the value which will be entered into this field for the AG3 camera should be -90.

The *camera mount error* is used in the calculations that are performed during the acquisition process and therefore it is **crucial** that this constant is determined as accurately as possible by the observer ahead of any acquisition being performed.

2.3.7 The *INGRID Origin* Fields

Overlaid on the main acquisition image is a small red box which represents the *field of view of the INGRID detector*. The position of this *box* can be translated to different position on the acquisition image by specifying the *pixel coordinates* of the *top left-hand corner* of this *box*.

The software *automatically* calculates the relative size of the *field of view* of INGRID when overlaid on the acquisition image depending on the *plate scale* of the acquisition detector.

2.3.8 The *OASIS Origin* Fields

Overlaid on the main acquisition image is a green box which represents the *field of view of the OASIS detector*. The position of this *box* can be translated to different position on the acquisition image by specifying the *pixel coordinates* of the *top left-hand corner* of this *box*.

The software *automatically* calculates the relative size of the *field of view* of OASIS when overlaid on the acquisition image depending on the *plate scale* of the acquisition detector.

2.3.9 The *Spectroscopic Origin* Fields

Overlaid on the main acquisition image is a small green circle which represents the *spectroscopic centre* of OASIS. The position of this *circle* can be translated to different position on the acquisition image by specifying the *pixel coordinates* of the centre of this circle.

2.3.10 The FOV Display Selector

At the foot of the image grab dialog is a number of buttons which allow the user to select *which* of the FOVs should be overlaid on the acquisition image. Currently there are buttons to allow the user to select the OASIS and the INGRID FOV overlay. The requested changes will be invoked the *next* time an acquisition image is requested from a camera server.

2.3.11 The *Save* Button

After any changes have been made to the calibration constants, the Observer **should** press the button labelled **Save** in order to save the calibration constants in the observing system database so they are preserved across restarts of the acquisition tool.

2.3.12 The *Cancel* Button

The **Cancel** button can be used to remove the grab window from the display.

2.3.13 The *Help* Button

The button labelled **Help** can be used to display help information relating to the grab window.

2.3.14 The *Grab* Button

The button labelled **Grab** can be pressed to initiate the acquisition of a frame from the currently selected acquisition camera server. Once completed, the acquisition frame will be displayed in the main image area of the application window.

2.4 The OASIS Acquisition Frame Grab Window

The first step in the OASIS acquisition process is to *acquire* an acquisition frame from the OASIS science detector. OASIS acquisition functionality **cannot** be used unless there is a windowed OASIS image in the main acquisition image frame. The windowing of the OASIS camera server **must be** set to the following values **[1:2059,1035:3140]**

This can be done via the *Acquisition Frame Grab Window*. The user can access this window by selecting the menu option **Grab -> Grab OASIS Image**. Alternatively, the user can press the keyboard shortcut **Ctrl-o** whilst the cursor is located over the main application window. Once done the following window will appear.

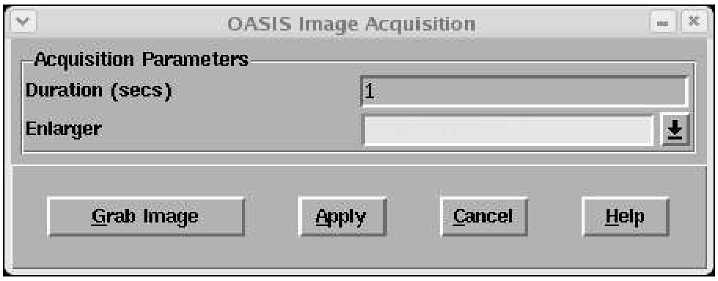


Illustration 3OASIS Image Acquisition

The user can use the dialogue to specify the *integration time* for the grab of the acquisition frame and also allow him to select the type of *image enlarger* which is currently selected in OASIS. This can be one of *8.5*, *12.5*, *22* or *33*. The purpose of selecting the image enlarger is so that the application can draw an overlay of the FOV of the enlarger over the acquisition frame once it is returned from the camera server.

To get an image from the OASIS camera server, the user should press the button labelled *Grab Image*. Given the readout time for the OASIS camera server, there will a short delay until the acquisition image is presented in the main acquisition frame in the tool.

2.5 The Acquisition Control Window

After the user has successfully retrieved an acquisition frame from the camera server (see 2.3), he is then in a position to perform acquisition. There are currently two modes of acquisition supported by the tool. In the first case, there is AO acquisition which permits the user to set up the telescope and the WFS pickoff such that the source object is positioned on the desired location on the science detector and the WFS pickoff probe positioned over the guide object.

The second mode of operation is OASIS acquisition. Use of this mode normally follows AO acquisition and allows the user to finely tune the position of the source object on the OASIS enlarger FOV.

The following sections outline the functionality in the application that will permit the observer to perform acquisition related tasks.

2.5.1 Displaying the Acquisition Control Window

There are two ways of displaying the acquisition control window. The first is to use the menu option **Graphics->Pick Object**. The second is by pressing the keyboard shortcut **Ctrl-P** whilst the mouse pointer is located over the main application window.

The following window will be displayed :

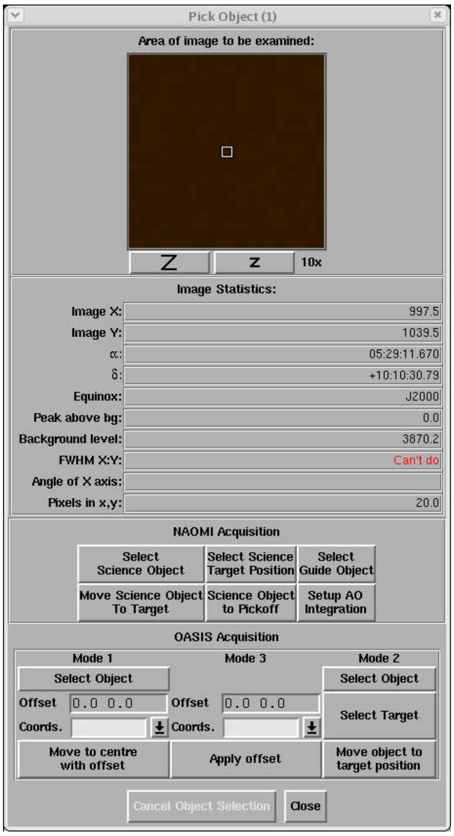


Illustration 4Acquisition Control Window

The following sections describe the various components of the *acquisition control window*.

2.5.1.1 The Magnification Window

At the top of the acquisition control window, there is a small image display which shows the *magnified area* of the acquisition image as the user moves the cursor around the main acquisition image. By default the magnification level is 10x. The user may change the level of magnification using the buttons labelled **Z** and **z** to increase and decrease the level of zoom respectively.

2.5.1.2 The Image Statistics

In the central part of the window are displayed statistics about the image. These are outlined in some detail in document [1].

The FWHM field will contain a FWHM measurement of an object *once* the user has selected a source from the main acquisition image.

2.5.2 AO Acquisition

This mode of acquisition will permit the user to perform acquisition for an AO integration. It will permit the user to select a *science object* and a *guide object* and position the science object on a selected part of the science detector and position the WFS pickoff probe over the guide object.

The following sections outline how this can be achieved.

2.5.2.1 The *Select Science Object* Button

The *Select Science Object* button when pressed, will permit the Observer to select the object on the main acquisition image that represents the *science target*.

After the button is pressed, the Observer will be expected to click *once* with the *left hand mouse button* on the the main acquisition frame. Once done, the image statistics in the acquisition control windows will be updated to reflect the selected object.

Note that the application will, if possible, *automatically* centroid on a object that is selected by the observer and then perform an automatic FWHM calculation. The results of this calculation will be displayed within the *image statistics*.

In the case that the Observer incorrectly selects the wrong object, he can repeat the process by simply pressing the *Select Science Object* button.

2.5.2.2 The *Pick Science Target Position* Button

The *Pick Science Target Position* button when pressed, will permit the Observer to select the *pixel* on the main acquisition image that represents the destination pixel to which the *science object* selected will be repositioned.

After the button is pressed, the Observer will be expected to click *once* with the *left hand mouse button* on the main acquisition image that will define the *destination pixel* on the acquisition frame of the object which was selected in section 2.5.2.1.

In the case that the Observer mistakenly selects the wrong position, it is possible to perform the operation again by simply pressing the *Pick Science Target Position* button and repeating the process.

2.5.2.3 The *Select Guide Object* Button

The *Select Guide Object* button when pressed, will permit the Observer to select the object on the main acquisition image which represents the *guide object*.

After the button is pressed, the Observer will be expected to *click once* with the *left hand mouse button* on the acquisition image in order to select the *guide object*. Once this has been done, the image statistics in the *acquisition control window* will be updated to reflect the position that was selected by the Observer.

Note that the application will, if possible, *automatically* centroid on the object that is selected and perform an automatic FWHM calculation. The results of this calculation will be displayed within the *image statistics*.

In the case that the Observer mistakenly selects the wrong guide object, it is possible to repeat the process by simply pressing the *Select Guide Object* button once again.

2.5.2.4 The *Move Science object to Target* Button

The semantics associated with the *Move Science object to Target* button is to move the *science object* which was selected in section 2.5.2.1 to the *destination pixel* which was selected in section 2.5.2.2. This button will remain *insensitive* to user control until a *science object* and a *destination pixel* have been defined.

Once the button is pressed, the telescope will be instructed to *offset* by the calculated amount such that the *science object* is *shifted* such that once the next acquisition frame is taken, the *science object* will appear upon the previously selected *destination pixel* in the acquisition frame.

A new acquisition image will *automatically* be requested once the telescope offset has completed.

Once the move is completed, the *position* associated with the *science object* and the *destination pixel* will be reset. Should the Observer want to repeat the operation, he must select *anew* the science object and destination pixel.

2.5.2.5 The *Science Object to Pickoff* Button

The *Science Object to Pickoff* button can be used to reposition a *user selected science object* on the acquisition frame such that light from this object will fall on the NAOMI WFS pickoff probe should it be in its *nominal acquisition position*.

The precondition for this operation is that the observer has selected a *science object* as outlined in section 2.5.2.1. Until this has been done, this button will remain *insensitive* to user control.

Once the *Science Object to Pickoff* button has been pressed, the telescope will be *offset* such that the science object will be manoeuvred to the pixel on the acquisition frame that corresponds to the *nominal acquisition position* of the NAOMI WFS pickoff probe.

After the operation has completed, a new acquisition image will be requested from the camera server and displayed. The position associated with the *science object* will be reset. Should the user wish to repeat the operation, he must select a science source object once again.

Note that location of the *nominal acquisition position* of the wavefront sensor pickoff probe in acquisition detector space can be modified as detailed in section 2.3.4

2.5.2.6 The Setup AO Integration Button

This button will allow the user to set up an AO based integration. The tool will perform a *coordinated move* of both the *telescope* and the *wavefront sensor pickoff probe* such that the light from the *guide object* will fall upon the probe and the *science object* will be repositioned such it's light will fall on the *target pixel* in the acquisition frame.

The preconditions for this operation are that the user has selected a *science object* as detailed in section 2.5.2.1, he has selected a *target position* for the science object as detailed in section 2.5.2.2 and he has selected a *guide object* as detailed in section 2.5.2.3. Until **all** of these preconditions are met, this button will remain *insensitive* to user control.

Once the action has completed, a new acquisition frame will be requested from the camera server and displayed. The positions associated with the *science object*, the *guide object* and the *target position* will be subsequently reset. Should the Observer want to repeat the process, he must select all three positions anew.

2.5.3 OASIS Acquisition

The OASIS acquisition mode is used to finely tune the position of the *science object* on the area of the science detector which overlays that of the currently selected OASIS enlarger.

It should be noted that in order to use any of the following modes, the image which is currently in the acquisition tool frame buffer **must be** from the OASIS science detector, MITLL3. Furthermore, the image **must** be windowed according to the following parameters **[1:2059,1035:3140]** in order for the acquisition tool to function correctly.

There are various sub-modes of OASIS acquisition which are outlined in the following sections.

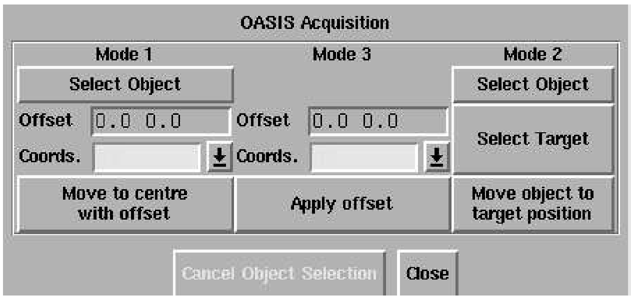


Illustration 5 OASIS Acquisition Panel

2.5.3.1 Mode 1

Mode 1 acquisition will allow the user to position a selected *source object* on the *centre* of the *currently* selected enlarger FOV subject to an *optional* offset which may be specified in arcsecs. The offset can be specified in a number of different coordinate systems (see section 2.5.3.4).

The user should first select his *source object* by pressing the button labelled *Select Object* in the column labelled *Mode 1* in the acquisition window (see 2.5). Then on the main acquisition image, the user should click on the position on the image where his source object is selected. Next he should select any offset which he wants applied (see 2.5.3.4).

The *source object* can then be relocated to the centre of the enlarger FOV by pressing the button labelled *Move To Centre With Offset.*

Note that while this operation is performed, the AO loop will be opened.

2.5.3.2 Mode 2

Mode 2 acquisition will allow the user to position a selected *source object* on a specified position of the detector (known as the *target*).

The user should first select his *source object* by pressing the button labelled *Select Object* in the column labelled *Mode 2* in the acquisition window (see 2.5). Then on the main acquisition image, the user should click on the position on the image where his *source object* is selected. Next he should select the *target* position by pressing the button labelled *Select Target* in the column labelled *Mode 2* in the acquisition window (see 2.5) and subsequently click on the main acquisition image the desired location of the chip he wants the *source object* to be relocated to.

To effect the move, the user should press the button labelled *Move Object to Target Position.*

Note that while this operation is performed, the AO loop will be opened.

2.5.3.3 Mode 3

Mode 3 OASIS acquisition will allow the user to *offset* the telescope *and pickoff* by a specified amount. The offset can be specified in a number of different coordinate systems (see section 2.5.3.4).

Once the offset has been defined then the *offset* can be applied by clicking upon the button labelled *Apply Offset.*

Note that while this operation is performed, the AO loop will be opened.

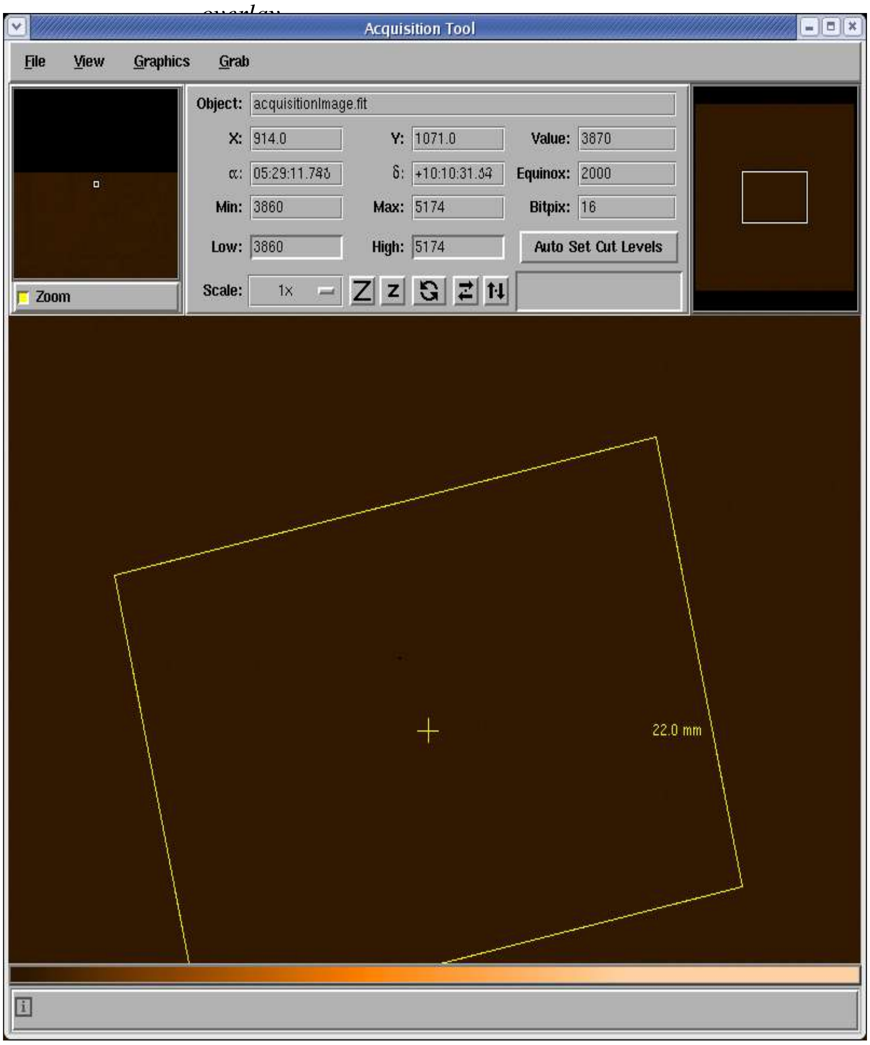
2.5.3.4 Mode Offsets

Offsets can be applied to the positional calculations for *mode 1* and *mode 2* OASIS acquisition. The offset should be specified as *two* space separated real numbers expressed in *arcsecs*.

The coordinate system which can be applied can be one of *NE*, *OASIS* and *Pickoff.*

- The NE coordinate system will be used for when the observer provides offsets relative to NE. The offset will take into account the current Sky PA as part of the calculation.
- OASIS coordinate system will be used when attempting to offset *relative* to the centre of the enlarger FOV. This will take into account the *rotational offset* between OASIS imaging mode and spectroscopic mode.
- Offset will be specified in an X & Y coordinate system.

Illustration 6Main Acquisition frame showing enlarger overlay



Chapter 3 Acquisition Scenarios

The following sections outline different acquisition scenarios and how they can be accomplished using the acquisition tool.

All of these scenarios assume that the observing system is functioning, the telescope control system is in tracking mode and that the NAOMI system is fully operational. Furthermore, the user must position the NCU slide into the *Acquisition* position using the OASIS control GUI and that the TO must **stop** the selected *acquisition camera server* from framing temporarily so that the acquisition tool can access the camera server.

A full list of all of the preconditions for the successful use of the acquisition tool are detailed in section 2.1.1

3.1 Placing a Science Object on the Pickoff Probe whilst in Nominal Acquisition Position

One of the requirements of the tool was to be able to take an *observer selected* science object and align that object upon the *wavefront sensor pickoff probe* whilst in its *nominal acquisition position*.

This task can be achieved as follows :

- Acquire an acquisition frame from the selected camera server. This procedure is outlined in section 2.3.
- Using the *acquisition control window* (see section 2.5), press the button labelled *Select Science Object* (see section 2.5.2.1). On the acquisition frame in the main application window, select the *science object* that is to be aligned with the *wavefront sensor pickoff probe* by clicking upon it with the *left mouse button*.
- To align the *science object* with the *wavefront sensor pickoff probe nominal position*, the user should press the button labelled *Science Object to Pickoff*. This will result in an *offset* being applied to the telescope such that the *starlight* from the *science object* will fall on to the *wavefront sensor pickoff probe* once the NCU slide has been moved back into the *science* position.

3.2 Placing a Science Object on an Arbitrary Part of the Acquisition Frame

The second requirement of the acquisition tool was to be able to select a *science object* in the acquisition frame and then reposition it on a *user defined position* on the acquisition frame.

This task can be accomplished as follows :

- Acquire an acquisition frame from the selected camera server. This procedure is outlined in section 2.3.
- Using the acquisition control window (see section 2.5), press the button labelled *Select Science Object* (see section 2.5.2.1). Now, on the acquisition frame in the *main application window*, select the *science object* that is to be moved onto the *wavefront sensor pickoff probe* by clicking upon it with the *left mouse* button. The position of the selected object will be displayed in the acquisition control window in addition to a magnified view of the science object.
- Using the acquisition control window (see section 2.5), press the button labelled *Pick Science Target Position* (see section 2.5.2.1). On the acquisition frame in the main application window, select the *position* on the acquisition frame to which the *science object* to be repositioned by clicking upon it with the *left mouse* button.

- By pressing the button labelled *Move Science Object to Target*, the application will apply an offset to the telescope such that the *science object* selected will be repositioned such that its starlight will subsequently fall on the target pixel that was previously selected.

3.3 Setting up an AO Integration

The third requirement of the acquisition tool was to be able to set up an NAOMI based integration. The requirements for this were to be able to select a *science object*, a *guide object* and a position in the *acquisition detector space* upon which the *science object* was to be positioned. The software was then to *offset* both the *telescope* and the *wavefront sensor pickoff probe* such that the *science object* was to be positioned on the user specified pixel on the acquisition frame and that the star light from the *guide object* would fall upon the *wavefront sensor pickoff probe*.

It is worth noting that it is perfectly acceptable to select the *same* object for both the *guide* and the *science* object.

The process involved in performing this task is outlined in the following sections :

- Acquire an acquisition frame from the selected camera server. This procedure is outlined in section 2.3.
- Using the acquisition control window (see section 2.5), press the button labelled *Select Science Object* (see section 2.5.2.1). In the acquisition frame in the main application window, select the *science object* by clicking upon it with the left mouse button. The position of the *selected object* will be displayed in the *acquisition control window* in addition to a magnified view of the science object.
- Using the acquisition control window (see section 2.5), press the button labelled *Pick Science Target Position* (see section 2.5.2.1). On the acquisition frame in the main application window, select the *pixel* upon which the *science object* is to be repositioned by clicking upon it with the *left mouse* button.
- Using the acquisition control window (see section 2.5), press the button labelled *Select Guide Object* (see section 2.5.2.1). On the acquisition frame in the main application window, select the *guide object* in the acquisition frame that the *wavefront sensor pickoff probe* is to be aligned with by clicking upon it with the *left mouse* button.
- Once all three positions have been selected, the button labelled *Setup AO Integration* will become sensitive to user control. By pressing this button, the tool will *offset* the telescope and the *wavefront sensor pickoff probe* such that the selected *science object* will be positioned upon the intended *target position* and that the *guide object* will be aligned with the *wavefront sensor pickoff probe*. This should be evident once the observer has changed the position of the NCU slide to *science*, and examined the wavefront sensor display area on the TopGui application.
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Chapter 4 Calibrating The Acquisition Tool

In order to ensure correct operation of the acquisition tool, the observer must ensure that the tool has been calibrated correctly *prior* to its use. Calibration only needs to be performed when engineering work has been undertaken and components which comprise the acquisition optical system have been physically moved.

The application window which contains the calibration constants may be accessed by pressing the key combination **Ctrl-G** whilst the mouse is positioned over the main window of the acquisition tool. See section 2.3 for more details.

The following sections outline the process through which an astronomer can calculate accurate values for these calibration constants.

4.1 Measuring the CCD Reference Pixels

The purpose of the CCD reference calibration constants are outlined in section 2.3.3. For AO related acquisition, these constants are ***not*** currently used and therefore do not need to be calculated.

These calibration constants are measured by determining the *rotator axis* on the acquisition camera (i.e. by rotating the derotator with a star in the field of view and determining the pixel at the centre of the circle traced).

4.2 Measuring the Nominal WFS Pickoff Offset

The purpose of these calibration constants is outlined in section 2.3.4.

They can be measured as follows.

1. Centre the WFS pickoff mirror on the *illuminated* pinhole.
2. Put the NCU in *science* position.
3. Go to a star and centre the star on the WFS by moving the telescope.
4. Change the NCU to the *acquisition* position and then note the *pixel* at which the star appears on AG3.

4.3 Measuring the Plate Scale

The purpose of this calibration constant is outlined in section 2.3.5.

The *plate scale* can be measured by shifting the telescope a number of arcsec in x and y and measuring the *number of pixels* a star moves on the AG3 image. Of course, the scale *may* change with position on AG3, especially as a function of radius, so the measurement needs to be made using the central area (within 60 arcsec) of the detector.

4.4 Measuring the *Camera Mount Error* Field

The purpose of this calibration constant is outlined in section 2.3.6.

The *Camera Mount Error* can be measured using the following recipe.

1. Direction N is measured on AG3 by pointing telescope at star.
2. Move telescope 30" N.
3. Record PA of direction moved on CCD.

4.5 Calculating *INGRID Origin* Constants

The purpose of these calibration constants is outlined in section 2.3.7.

They can be measured using the following procedure :

1. Centre a star on INGRID.
2. Set the NCU slide to the *acquisition* position.
3. Measure the pixel coords on AG3 and then calculating from the known size of INGRID field, the *coordinates* of the corner.

Bibliography

1: A.Brightman, VLT Software Realtime Display Manual, http://www.ing.iac.es/~docs/external/eso/rtd.pdf