

# Fibre Acquisition and Autoguider User Instructions (Draft 0.4)

## 1 Prerequisites

The UDAS autoguider camera must be running on the DAS computer.

The AF2 system must be running on the AF2 control computer.

The TCS must be running on the TCS computer.

The OCSCorbaDramaBridge must be running on the Linux ICS computer. This starts up as part of the main observing system.

The connection status of the autoguider camera, AF2, and TCS is shown in the status bar at the bottom of the Fibre Guider control panel. If any of these systems are not connected, they will be displayed in RED.

### 1.1 DS9 Display Tool

The ds9 display tool must be running for the Fibre Acquisition tool to display images from the autoguider camera.

The acquisition tool also requires that the AF2 guide fibres are marked with annulus regions on the display tool. The requirements for the setting of the guide fibre regions are as follows:

1. The regions marking the guide fibres must be of shape "Annulus".
2. Each annulus region must be centred on the guide fibre centre position.
3. Each annulus region must have the text parameter set to the number of the fibre. For example, the region centred on guide fibre 16 must have the text field set to "16".

Note: The region .reg files used for the November 2012 AF2 run are of the correct format to work with the fibre acquisition tool. Only the centring of the regions on the guide fibres is needed.

## 2 Starting the Fibre Acquisition/Autoguider Software

(The SDSU autoguider should be started in the usual way with obsys, startobssy, startag.)

Start the Fibre Guider by typing the following command on the autoguider computer:

```
fibreguider &
```

This starts up the Fibre Guider control window and connects to the ds9 display tool, the autoguider camera, the AF2 system and the TCS. If any of these cannot be contacted, its status will be shown in RED in the status bar.

Note: The SDSUAutoguider can be left running, but should not be used for taking camera images simultaneously with the Fibre Guider.

## 3 Controls

### 3.1 Guiding Controls

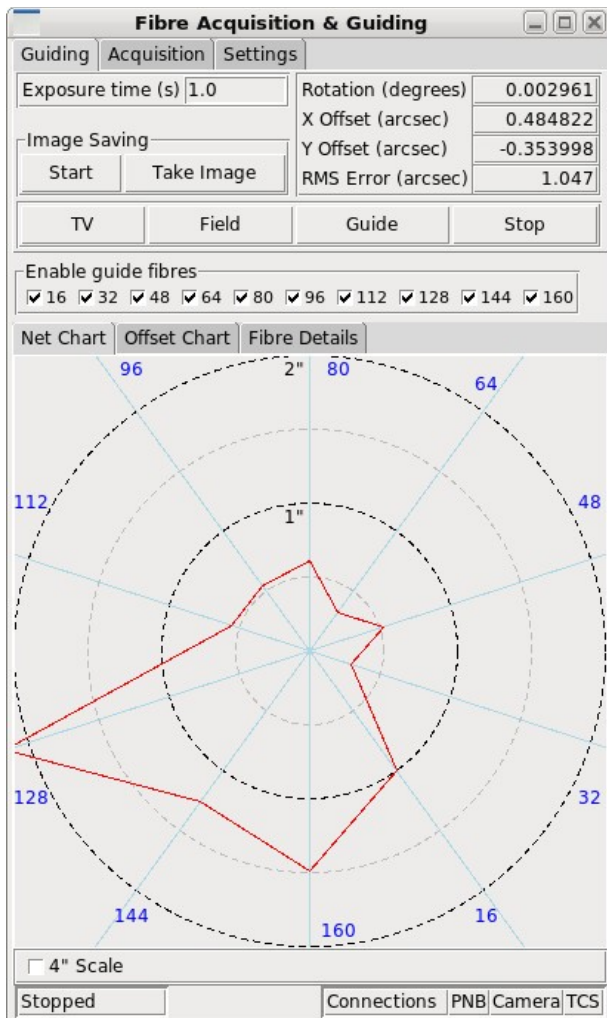


Illustration 1: Guiding Control Tab

#### 3.1.1 Exposure time

Sets the autoguider camera exposure time in seconds.

#### 3.1.2 Field

Pressing the Field button takes an image from the camera and displays the image on the ds9 display tool. The centroid positions of any stars are marked on the display with a green cross.

### 3.1.3 TV

Pressing the TV button displays a series of images from the camera on the ds9 display tool. Press the Stop button to stop the TV mode.

### 3.1.4 Guide

Pressing the Guide button sets the autoguider taking images from the camera. For each image, guide star centroids are found and marked on the display tool. The optimum telescope offset and rotation are calculated using a least squares fit and sent to the TCS serial port. Press the Stop button to stop the Guide mode.

While guiding, the Acquisition window will continue displaying the measured telescope translation offsets and rotation.

## 3.2 Acquisition Tab

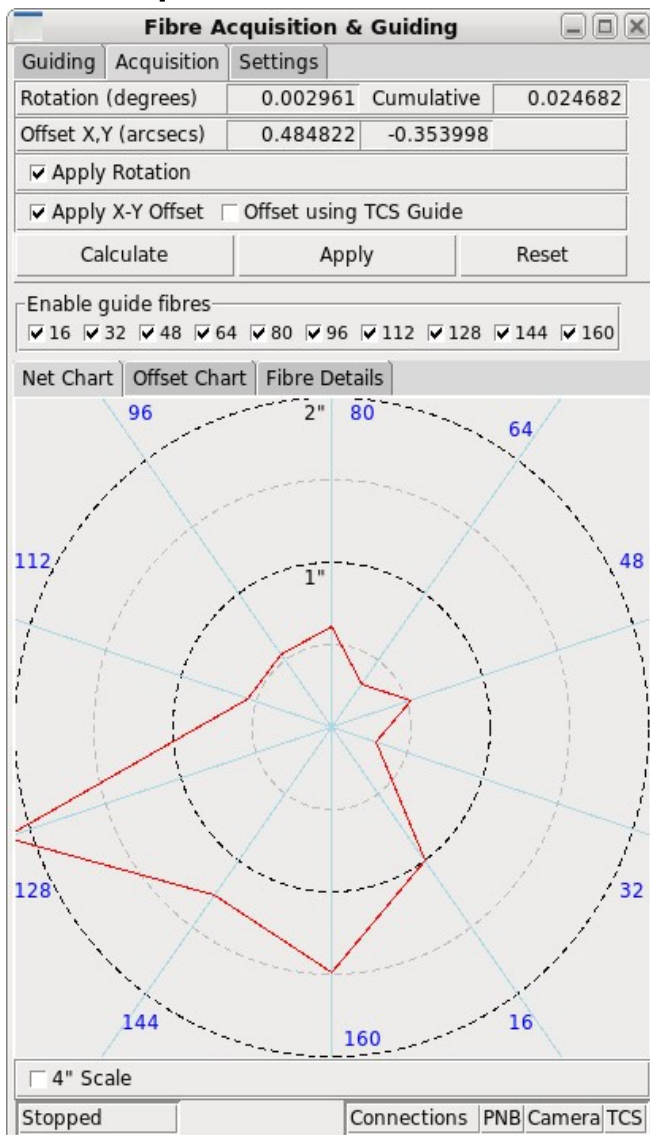


Illustration 2: Acquisition Control Tab

The Acquisition tab shows the Calculate button and the Apply button.

The Calculate button takes an image from the camera, and uses the relative positions of the Guide fibres and the Guide stars, to calculate the optimum telescope rotation and offset to centre the Guide stars on the Guide fibres.

The optimum rotation and offset required to centre the Guide stars onto the centres of the guide fibres is displayed in the Acquisition dialogue window.

The Apply button applies the calculated rotation and offsets to the TCS using the TCS "tweak" command.

Use the "**Apply Rotation**" check button to enable or disable the applying of TCS rotation offsets.

Use the "**Apply X-Y Offset**" check button to enable or disable the applying of TCS translation offsets.

Use the "**Offset Using TCS Guide**" check button to enable or disable the applying of TCS translation offsets using the TCS "guide" command.

Note: The "Offset using TCS guide" option is included for test purposes in case the calculated offsets are not in the correct direction, and will probably be removed in future releases.

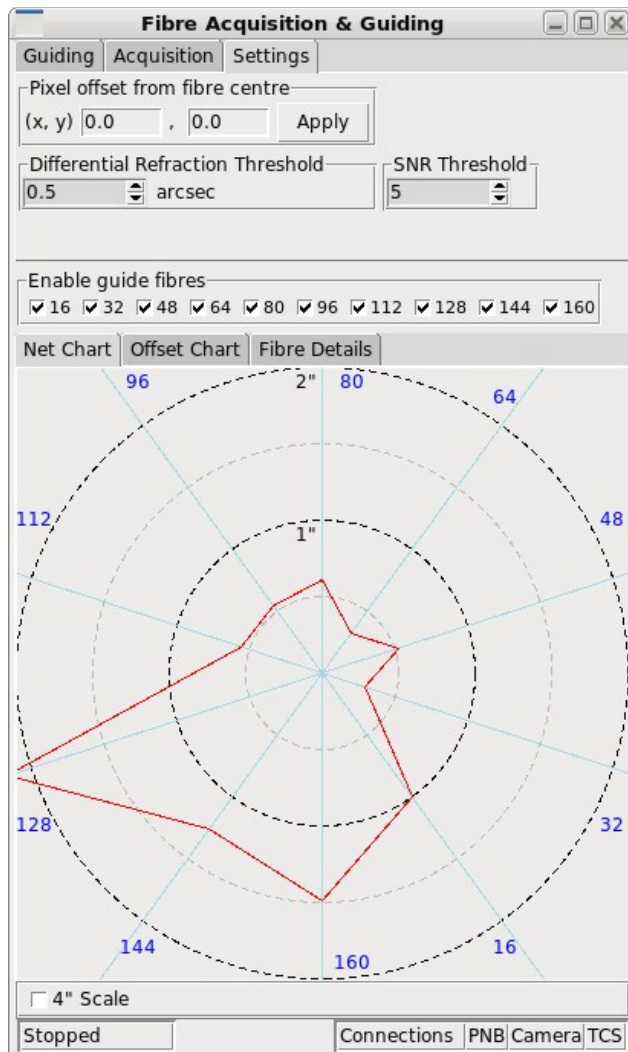
### 3.3 Enable/Disable Fiducial Fibres

Use the **Enable guide fibres** check-boxes to disable any fiducial fibres which you do not wish to use for acquisition or guiding purposes.

Fiducial fibres will be automatically disabled for acquisition or guiding purposes if:

1. No fiducial object is detected on the fibre.
2. The fibre is not positioned on the field plate within the observable field.

### 3.4 Apply an Offset from the Fibre Centres

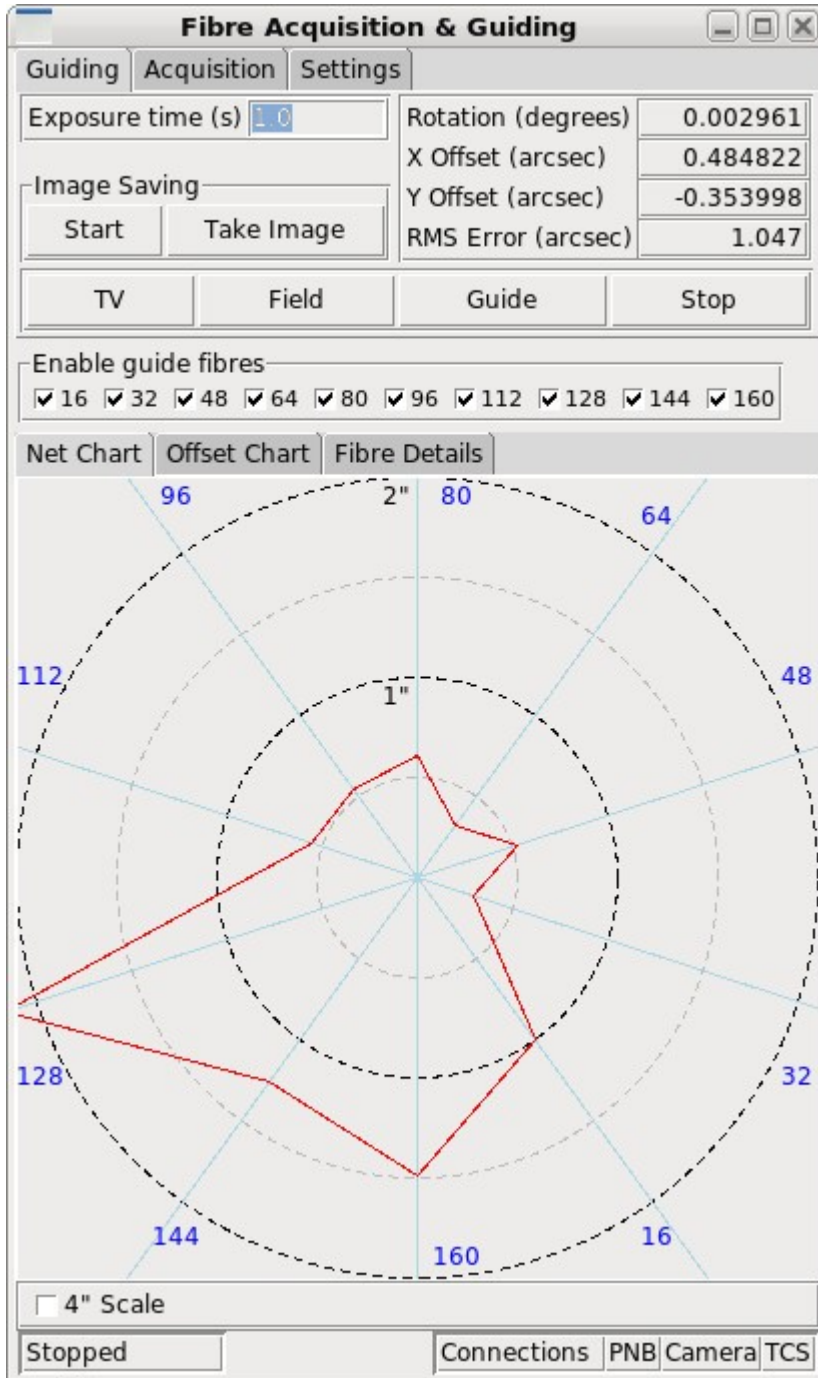


*Illustration 3: Pixel Offsets Control*

Use the **Pixel Offsets** control in **Settings** to set an x and y offset from the central fibre position in autoguider camera pixels. This can be used to provide accurate autoguiding for dither observations. With the current autoguider camera scale of 11.5 pixels/arcsec, setting the x and y offsets to 5.75 pixels, will provide a 0.5 arcsec offset of the guide objects in both x and y with respect to the centres of the guide fibres.

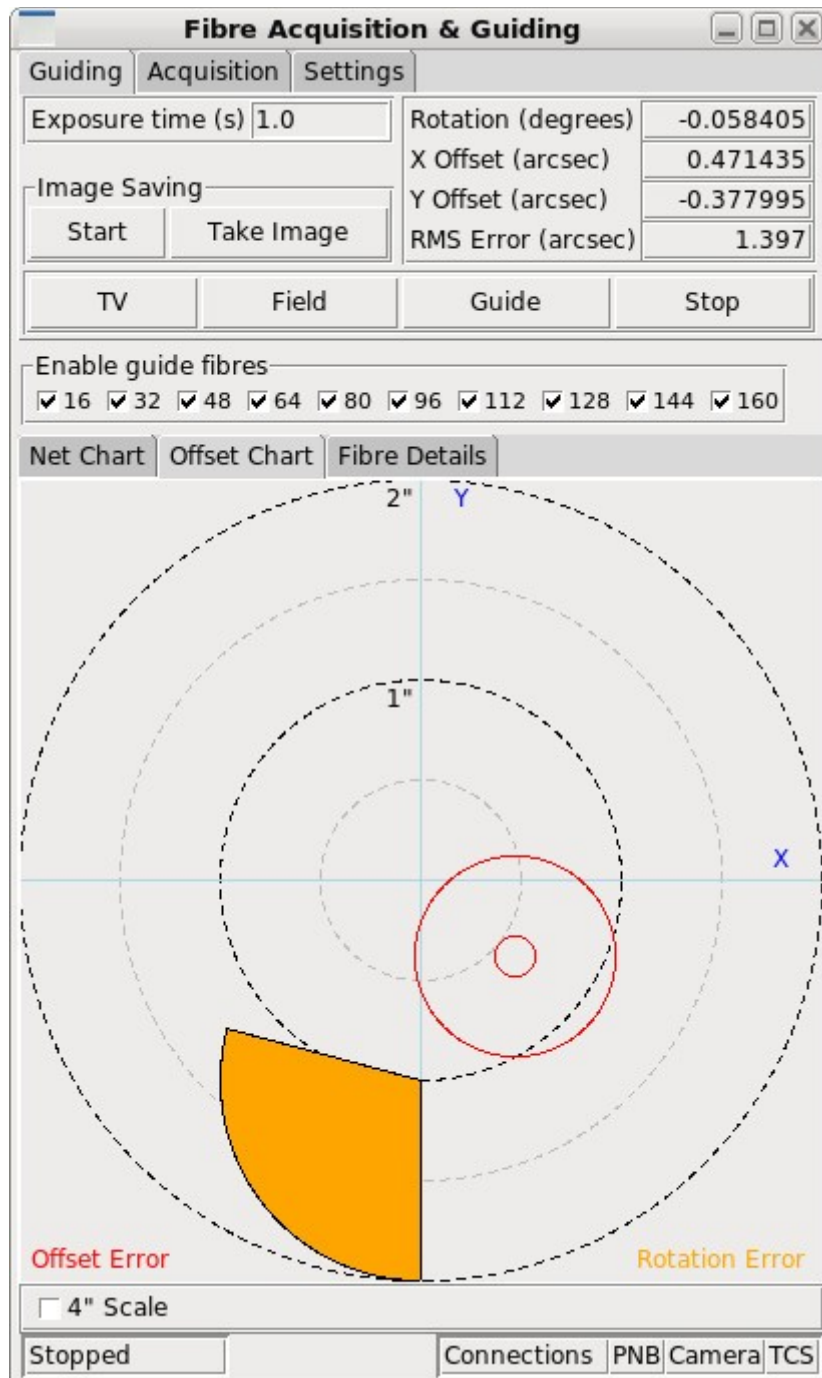
### 3.5 Guide Fibre Errors Net Chart

Use the **Net Chart** tab to bring up the net chart display showing the errors of each guide object from the centres of the guide fibre.



### 3.6 Guide Fibre Error Offset Chart

Use the **Offset Chart** tab to bring up the chart representing the average guide object error in arcsec and a representation of the rotation error from the guide fibre centres. A rotation error of 0.05 degrees is represented by an orange circular sector of angle 90 degrees.



### 3.7 Guide Fibre Error Offset Chart

Use the **Fibre Details** tab to bring up a table displaying the details for each of the guide fibres. This table is constantly updated during guiding or acquisition. Updates can be disabled using the “Disable updates” check box.

The screenshot shows the 'Fibre Acquisition & Guiding' window with the 'Settings' tab selected. The 'Fibre Details' sub-tab is active, displaying a table of fibre parameters. The table has columns for Fibre ID, Error (arcsec), FWHM (arcsec), Ellipticity (0=circle), Display (x, y), Centroid (x, y), and Diff refr (arcsec). The 'Error' column is highlighted in yellow. Below the table is a 'Disable updates' checkbox and a 'View Fibre Images' button. At the bottom, there are status indicators for 'Stopped', 'Connections', 'PNB', 'Camera', and 'TCS'.

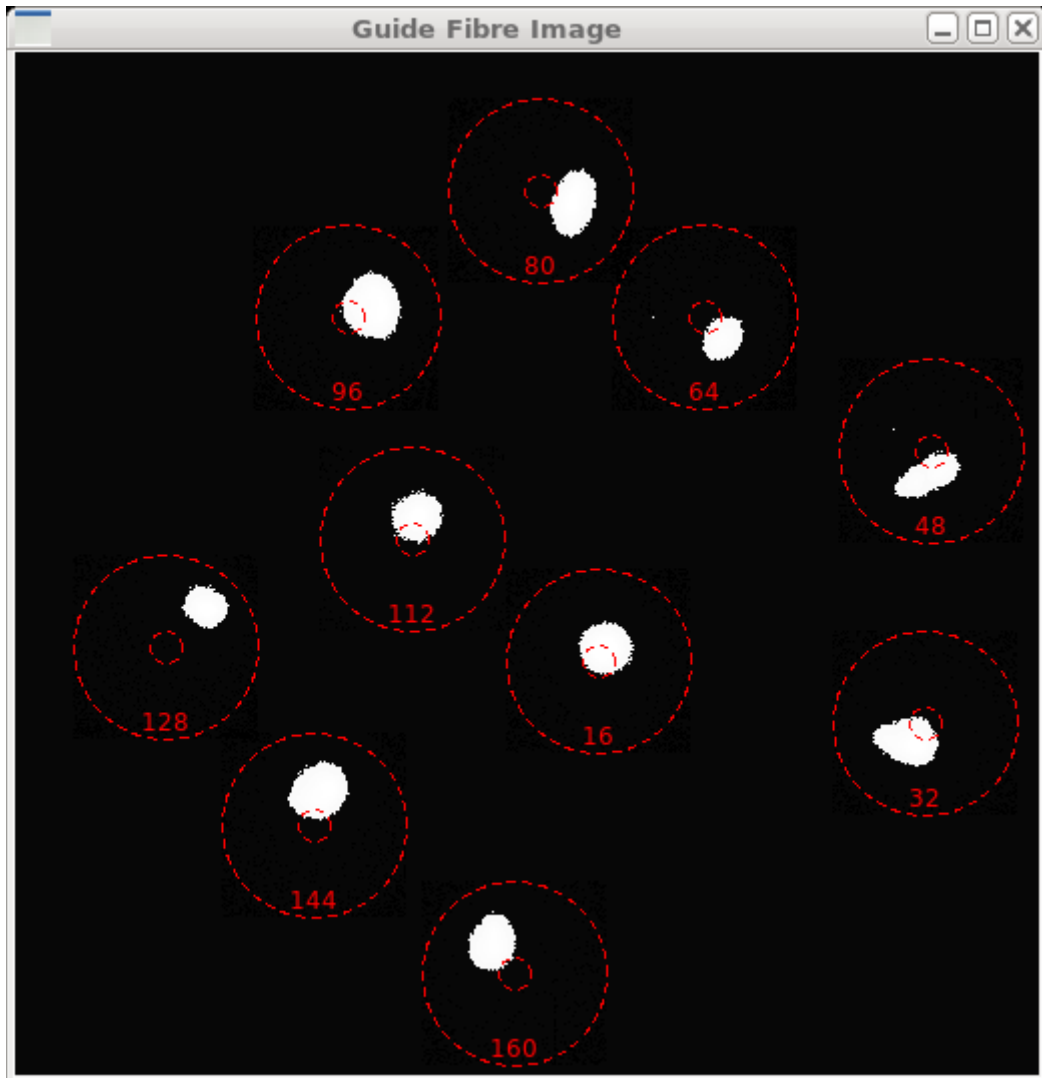
Fibre	Error	FWHM	Ellipt	Display	Centroid	Diff refr
	arcsec	arcsec	0=circle	x	y	arcsec
16	0.63	1.23	0.02	421.3	384.6	0.00
32	1.03	1.50	0.21	140.7	203.2	0.00
48	1.07	1.55	0.44	387.4	262.4	0.00
64	1.18	1.27	0.21	506.5	293.4	0.00
80	1.57	1.44	0.32	251.5	406.7	0.00
96	1.29	1.56	0.12	456.8	126.1	0.00
112	0.81	2.11	0.04	263.8	284.9	0.00
128	2.44	1.15	0.13	348.5	65.6	0.00
144	1.50	1.50	0.15	219.5	97.5	0.00
160	1.59	1.41	0.16	153.9	329.7	0.00

Illustration 4: Guide Fibre Details Table



### 3.8 Guide Fibre Images

Use the **View Fibre Images** button to bring up the display representing the guide fibre images in their relative positions on the fibre module.



*Illustration 5: Guide Fibre Image Representation*

## 4 Procedure for Acquiring an AF2 Science Field

1. Roughly acquire the fiducial stars onto the fiducial fibres. Ensure that 3 or more fiducial stars are visible on the fibres.
2. Use the **Acquisition** tab to display the Acquisition controls.
3. Press the **Calculate** button. Once the measurement of offset and rotation has been completed, the required translation offsets and rotation will be displayed above the control buttons in the Acquisition dialogue window.
4. Enable or disable the "Apply x-y offset" and "Apply rotation" check buttons as required.
5. Press the **Apply** button to send the required offsets and rotation to the TCS using the TCS "tweak" command. Alternatively, the "tweak" command can be issued manually at the TCS, to set the required offsets and rotation.
6. After the TCS rotation and offsets have been applied, press the **Calculate** button again to remeasure the offsets and rotation.
7. If the measured offsets and rotation are still large, repeat steps 5 and 6 above until they are within the required range (e.g. rotation < 0.005 degrees, offsets < 0.1 arcsecs)

Disable any fiducial fibres/stars that appear to be unsuitable for acquisition or guiding purposes using the **Enable Guide Fibres** check boxes.

## 5 TCS Communications

The fibre guider communicates with the TCS using 2 methods.

### 5.1 CORBA Interface

The following commands are sent to the TCS DRAMA interface via the CORBA-DRAMA bridge:  
AUTOGUIDE ON/OFF [x y]  
TWEAK x-off y-off [rot-off]

The AUTOGUIDE ON/OFF is used to start or stop guiding, usually on a reference pixel position of [250,250].

The TWEAK command is used to tweak the telescope to the correct offsets and rotation during the acquisition process.

### 5.2 Serial Interface

During guiding, information packets are sent from the fibre guider to the TCS serial interface. The format of the serial packets is as follows:

```
XYRT xxxx.xx yyyy.yy r.rrrrr tttt.tt
```

where the character string 'XYRT' is the correction packet format specifier

where xxxx.xx is the x correction packet in pixels

where yyyy.yy is the y correction packet in pixels

where r.rrrrr is the required rotation correction in degrees (range from  $\pm 0.200000$  with the resolution down to 6 decimal places (i.e. 0.000001))

where tttt.tt is the time to next packet in seconds(+/-)

Examples:

XYRT 0123.45 0678.90 0.123456 0001.23  
XYRT 0111.11 0222.22 -0.033333 0004.44

## **6 Acquisition Method Software Description**

The following provides a basic description of the method the software uses to calculate the optimum rotation and translation to position the fiducial objects onto the centres of the fiducial fibres.

1. An image is acquired from the camera, and the centroids of any objects detected are calculated.
2. The physical (field-plate) positions in microns of the fiducial fibres are read from the AF2 instrument.
3. The centre positions in TV co-ordinates of the fiducial fibres are read from the ds9 display.
4. The positions of the object centroids relative to the centres of the fibres are converted to physical (field-plate) co-ordinates in microns, so that each fiducial fibre has 2 sets of co-ordinates, the position of the centre of the fibre, and the position of the centroid of the fiducial object on the fibre.
5. The software forms the 2 sets of co-ordinates, the object positions, and the object target positions, into a matrix. The software then uses Singular Value Decomposition (SVD) methods to compute the 3x3 transformation matrix containing the optimal translation and rotation to provide a least squares fit to transform the object co-ordinates onto the object target co-ordinates.
6. The translation and rotation values of the SVD transformation matrix are then converted into TCS parameters which can be used to apply the correction offsets and rotation to the TCS during acquisition and guiding.

## 7 Differential Atmospheric Refraction Calculation

Calculation of the differential refraction of each guide object is performed on each guide cycle during guiding. If the position of the guide object differs by more than the threshold value (default is 0.5 arcsec), the user is given a visual warning, indicated by the fibre enable check-boxes flashing red. The user then has the option to disable the fibre if required. The following explains how the differential refraction is calculated.

The FibreGuider calculates the position of the guide fibre (at the setup sidereal time) using a C function in the software library provided by the AF2 control system (libaf2.so).

The FibreGuider calculates the position of the guide fibre object (at the current sidereal time). The same software library routine from the AF2 control system is used to determine both positions.

The calculation of the differential refraction (in arcsecs) of the guide object is determined from the difference in microns between the guide fibre position (at the setup sidereal time) and the guide object position based on the current LST derived from the TCS.

The following parameters are required by the AF2 control system library function to calculate the position of a fibre/object in robot co-ordinates (microns). The sidereal time for the field setup, and the current sidereal time are obtained from 2 different parameters in the PNB:

Parameter	Parameter Source	Example	Description
RA	AF2.FIBREMODULE.nnn.RA	19 17 54.39	Object RA for fibre nnn
Dec	AF2.FIBREMODULE.nnn.DEC	15 19 07.0	Object Dec for fibre nnn
Equinox	AF2.CONFIGURATION.EQUINOX	2000.0	Object position equinox
RA_centre	AF2.CONFIGURATION.CENTRE_ RA	19 18 06.06	Centre of the field RA
Dec_centre	AF2.CONFIGURATION.CENTRE_ DEC	+15 35 35.2	Centre of the field Dec
LASidTime	AF2.CONFIGURATION.ST	15 00 0.0	Sidereal time of field setup
LASidTime	TCS.last	15 11 14.430	Current sidereal time
SkyPA	AF2.CONFIGURATION.SKY_PA	220.61	Sky PA (degrees)
UTDate	AF2.CONFIGURATION.UT	2014.58	UT Date
scale0	From /wht/etc/wht_prime.dat	17.643	Linear plate scale component (arc sec/mm) from af2 map
scale1	From /wht/etc/wht_prime.dat	320	2nd order term of plate scale from af2 map
scale2	From /wht/etc/wht_prime.dat	2.0	Power for 2nd order term

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[30-Oct-2014]