

QUARTZ: Giraffe control software

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1 QUARTZ

1.1 Introduction

QUARTZ is a program for controlling the GIRAFFE echelle spectrograph. It will run on any PC running Real Time Linux and fitted with the appropriate custom MERLIN card. QUARTZ runs in X-window mode; the observer is free to use the PC for other tasks even when QUARTZ is running.

Besides controlling the camera shutter and the CCD readout, QUARTZ also controls the prism and camera settings. It also performs various functions on the Cassegrain unit. These include switching on/off the arc and tungsten calibration lamps, moving the mirror and setting the neutral density filter wheel to a particular position. At the end of a frame readout, it writes the image as a FITS disk file.

1.2 Starting QUARTZ

You should normally leave the PC running Linux. When the PC is switched on, it will automatically boot into Linux mode. You require a username and password to use the system. These are

```
Username: ccd  
Password: ?????
```

but you should ask the responsible astronomer for the correct username and password in case this has changed. Next you must start X-windows if it is not already running:

```
startx
```

The screen will blank out and a blue background will appear. On the top left hand of the screen you will see the **pager** form consisting of a small square subdivided into nine smaller areas. Next to it will be a display of the date and time according to the PC. The time is set at least once a night from the SAAO time servers and should be accurate to the nearest second. This is the time that will be recorded on the FITS headers.

The pager form is a visual representation of the nine virtual screens that may be used. In other words, you can click on any of the nine squares to display a different virtual screen. You can think of a virtual screen as if there are nine screens arranged in a square, only one of which is actually visible. For example, you may have QUARTZ in one screen, Netscape on a another screen and an xterm window on a third screen.

Start an xterm terminal window by clicking the left button of the mouse and choosing **Connections** and **Xterm**. At this stage you can examine the contents

of your account. The convention that we have adopted at SAAO is that users of the `ccd` account should create a sub-directory in which to store their data files. In other words, you are free to delete any loose files in the main directory, but be a little more circumspect in deleting sub-directories unless you are running short of space. The `df` command will tell you how much disk space is available.

Create your sub-directory, choosing an identifiable name (your username at SAAO or elsewhere would be a good choice) and go to that sub-directory:

```
mkdir lab
cd lab
```

(omit the `mkdir` command if you have already created the directory). This is where your setup files will be stored. It is also possible to direct QUARTZ to store the FITS files in this directory too, but this is not the default procedure. Every time you login, please make sure you are in the proper sub-directory before starting QUARTZ.

FITS files are, by default, saved on another Linux machine whose disk is mounted via NFS. This is done because the PC running QUARTZ does not have a tape unit at this stage. On the 1.9-m telescope, the machine called `s74` will allow its directory `/data/image` to be mounted on the PC running QUARTZ. `s74` not only has a DAT drive, but has software which will allow on-line reductions of your data as you observe. As new files appear from QUARTZ, the software on `s74` will produce fully reduced echelle spectra which can be viewed on-line. This software (`spec2`) is described in the *Giraffe* document which you need to study before reading this one.

1.3 Starting QUARTZ

You can start QUARTZ by simply typing:

```
quartz
```

in an xterm window. This will bring up a form which allows you to choose the particular CCD that is in use. At the moment, this is a TEK6 1024×1024 CCD called MUS1. Click on the menu to select this CCD.

If you starting QUARTZ for the very first time, you will be prompted for the run number. Look in the Giraffe log book to find out the previous run number and increment it by one. Thereafter, QUARTZ will remember the run number unless you delete the file called `disk.file` which is created in your directory. The run number is used to identify your files uniquely (see below).

Next another form will appear asking you to select the setup file. A setup file is a personal file which will allow you to keep data that you will use during the run. This includes, among other things, the positions of stars and various programs giving exposure times etc. When you first run QUARTZ you will not have a setup file, but you can select a global one which you can then modify. To do this select the button labeled **General Setups**. If you have a setup file in the current directory, you should, of course, select **Local Setups** to select that file. Note that this file must be named with the suffix `.sup` (e.g. `mysetup.sup`).

While you can modify the general setup file to taste while running QUARTZ, you may find it more convenient to copy the general setup file to your directory and modify it using any text editor. To do this use:

```
cp /usr/local/data/giraffe.sup .
```

You now have a copy of the general setup file which you can tailor to suit your needs. The file is well documented and described in detail below.

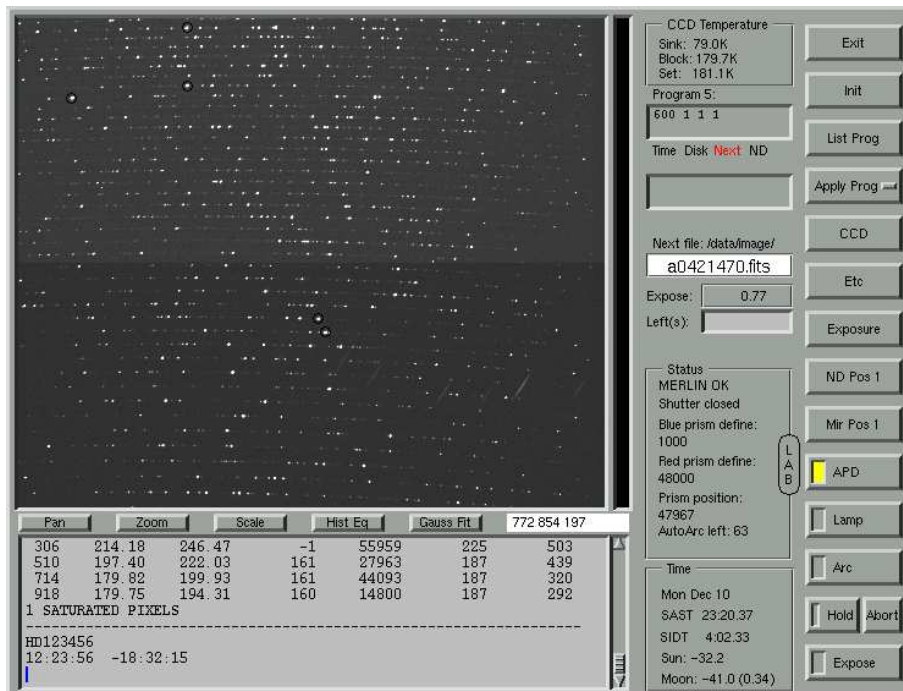


Figure 1: The QUARTZ form. The large area on the top left displays the current image. The area at the bottom of the image displays information during the readout and allows you to enter the name and position of the star to be observed. The rows of buttons and text menus on the right are described in the text. Other information is displayed in the area to the left of the buttons.

This step completes the start-up sequence. As soon as you have chosen the setup file, the QUARTZ form (Fig. 1) will appear and remain there until you exit from QUARTZ.

Whenever QUARTZ is started, it first checks if it can communicate with the controller. If there is no communication, the form will display a red label, MERLIN ERROR, and will probably freeze. If this happens, you need to go into the coude room and reset buttons on the two controllers. Then you need to exit from QUARTZ (which should now unfreeze) and restart the program.

If communication is established, QUARTZ will initialize the ND filter wheel and the mirror position. This takes a few seconds and you will see the labels on the corresponding buttons change as initialization progresses. The final state will leave the ND filter in the clear position (position 1) and the mirror in the intermediate position (position 2). Soon afterwards, the temperature of the CCD will also be displayed on the form. The temperature is monitored every few minutes and the display updated.

At this stage, you are ready to observe.

1.4 The setup file

We saw how to create a setup file by copying the global file, giraffe.sup to your directory. Now we describe what the setup file contains and how it is used. The setup file is an ordinary text file which you could edit with a text editor. Lines beginning with a hash symbol (#), are comment lines and ignored. You may include any number of these lines.

The first data line gives the desired positions of the blue and red prisms. If

you are using only one of these prisms, any number can be used for the other prism position. The correct position for the prism can be obtained from the table given in the Giraffe document.

```
#          GIRAFFE SETUP FILE
#
# Blue    Red  prism settings
    1000  48000
#
```

The next data line determines how the image is displayed. The first number is the image reduction scale which should be a power of 2. If this is 1, the image is displayed at full scale, but only a small part of the image is shown. The most convenient reduction factor is 2, which shows most of the image. Higher values display the whole image, but are of little use. The next two numbers give the pixel coordinate of the CCD image to be displayed at the centre of the image window. This could be the centre of the TEK6 chip itself (614, 512).

```
# Mag      X      Y      Image display parameters
          2      614    512
#
```

In order to make an easy check that the same order is in the same position on the CCD from night to night, it is convenient to mark a few prominent arc lines on the screen. The second data block consists of the coordinates of such lines. These numbers can be obtained by reading the coordinates from the image in QUARTZ or off-line by displaying the arc image with `ds9` or `saoimage`. The marks consist of circles with a given pixel radius. The radius is the single number on the first line of the block. Thereafter each (x, y) coordinate should be entered on separate lines. Use negative coordinates to indicate the end of the table. A maximum of 100 marks can be entered.

```
# Screen marks
17
  221    242
  411    127
  410    223
  637    625
  625    603
  -1     -1
```

Next is a series of programs. A program is a sequence of one or more lines of four numbers. The first number is the integration time in seconds. The second number is 1 if the image is to be stored on disk or 0 if you require a prompt. The prompt will allow you to choose to store or discard the image. The third number is 1 if you wish the program to repeat endlessly or 0 for no repeating. In the first case, a new exposure will start as soon as the previous one has ended. In the second case you need to start the new exposure by clicking on the `Expose` button. The fourth number has no effect at present, but is meant to select an appropriate ND filter (useful only for flat fielding). Each program is numbered and this number is always on the first line. At the end of the program block, enter a negative program number. Up to 9 programs can be entered.

```
#
# Programs:
#
```

```

1
10 0 0 1
#
2
5.5 0 0 3
#
3
50 1 1 1
#
4
450 1 1 1
#
5
600 1 1 1
#
-1

```

Finally, the last line is the name of a file which is to contain the star names and positions. The file name should have suffix `.str` (e.g. `mystars.str`). QUARTZ will know the RA and Dec of any star in this file whenever the star name is entered. The star name is entered in the area just below the image area by inserting an asterisk (*) at the beginning of the name (e.g. `*HD12345`). If the star is not found in the star file, it will prompt for its RA and Dec in the indicated format. When you quit GIRAFFE, you will be asked if you wish to append these new star positions to your star file.

```
# Program star file:
giraffe.str
```

The contents of the star file itself look like this:

```
HD24712  0355.27  -1205.95
V3510RI  0544.32  +0008.67
```

The star name (without spaces) is followed by the RA and Dec as a floating point number whose meaning should be obvious (e.g. `03:55:16` and `-12° 05' 57"`). These positions are normally entered while running QUARTZ as `HH:MM:SS` and `DD:MM:SS`, but are converted to this floating point number for reasons of convenience. The epoch is always assumed to be 2000.

2 Programs

2.1 Listing/entering a program

If you want to look at a particular program or change its contents, click on the `List Prog` button and select the program number from the menu. The program, if it exists, will be displayed on the text area to the left of the button. You may edit it if it exists or type in the program from scratch if the area is blank. When you have finished, click on the bottom left text area (the area immediately below the image area) to save the contents. Please remember to type in the final enter on the last line, otherwise the program will discard this line.

2.2 Activating a program

To put a program into operation, click on the **Apply Prog** button. There are three choices for a program: it can be used for observing a star, for the arc or for the calibration lamp. Select one of these from the submenu and then select the program number. The program will be displayed in the area to the left of the button. Which program is activated depends on whether the **Arc** button or **Lamp** button is pressed (or none of these if you are observing a star) at the start of the integration. The program that is displayed may be edited in the same way described above.

To change to a new program, simply select the appropriate program from the **Apply Prog** menu.

If a program is not activated, then QUARTZ will simply prompt you for the integration time (seconds) whenever the **Expose** button is pressed. This is the simplest mode of operation. You can deactivate or re-activate programs by selecting the appropriate entry in the **Prog List** menu.

3 Recording FITS files

Normally, you will definitely want data that you acquire to be saved to a disk file in FITS format. If no program is active, you will be prompted whether you wish to save the image to disk. By convention, the FITS files are given a name beginning with “a” followed by seven digits and the `.fits` suffix (e.g. `a0420123.fits`). The first three digits refer to your *run number* and should remain the same for your run (in the example the run number is 42). The next four digits is the running number for the file. Each time a file is saved the number is incremented by one. QUARTZ will remember the number of the last file stored by reading it from the `disk.file` file in your directory.

The name of the next file to be stored is displayed in the QUARTZ form.

As mentioned above, instead of storing the files on the PC which is running QUARTZ, it is convenient to store them in the `/data/image` directory on the `s74` computer. This is the default and you should ensure that `s74` is up and running and that the `/data/image` directory is emptied at the start of your run.

If you would like to change this default, copy the following file to your directory:

```
cp /usr/local/data/quartz.config .
```

Use a text editor to change the line `/data/image` to whatever you wish. If you want the files to be stored in the same directory from which you are running QUARTZ, this line should read `./`. If QUARTZ sees the `quartz.config` file in its directory, it will execute the local file in preference to the global configuration file which resides in `/usr/local/data`. Please do not change anything else in the file!

4 The image display

The image display area on QUARTZ is 480×400 pixels. You can zoom, pan and change the display scale level by pressing the appropriate button and clicking on the screen. A left click zooms the image down by a factor of two; a right click zooms it up by the same factor. Clicking while pan is pressed brings the point under the cursor to the centre of the display. The `scale` function is very crude: by clicking on various parts of the screen you choose a particular level and dynamic range. The `hist` button performs an equalization histogram display.

The `Fit Gauss` function is very useful to check the focus of the Giraffe camera. Expose an arc file and use `Fit Gauss` on a few selected arc points around the image. The display will list the rms Gaussian widths which should lie in the range between 1.5 and 2 pixels for good focus. Finally, the pixel count at a given (x, y) position is given at the bottom right of the image.

You can also read in and display a FITS image by pressing the `Etc` button and the selecting the `Read image from disk` function.

5 Starting, ending an exposure

Before you start an exposure, you should enter the star name in the text area under the image display. Remember to prefix the star name by an asterisk. The RA and Dec will be displayed if the star is in the star file, otherwise the program will prompt for the RA and Dec. The object name is not required for arc or lamp exposures.

To start, press the `Expose` button. If the program is not active, you will be prompted for the integration time. After a prepare readout, the exposure will commence. The time left is displayed in the information area. At the end of the exposure readout will commence. After readout, the file will either be stored automatically if the active program directs it so or else you will be asked if you wish the frame to be stored on disk.

During the exposure, you may press the `Hold` button to suspend the exposure (e.g. clouds passing by). Press it again to resume the exposure. Press the `Abort` button to abort altogether. If you abort, the CCD will not be read out. However, you can still force a readout by selecting `Read CCD` from the `CCD` menu button. Thereafter you can store the image on disk by selecting `Save image to disk` in the `Etc` menu.

The set integration time may be changed while the integration is in progress by selecting `Reset exposure time` from the `Exposure` menu button. Type in the new integration time (in seconds) when prompted. In the same menu button you have the option of canceling a repeat in the program. Choose `Stop/set repeat`.

Some primitive functions, such as opening and closing the shutter, are available in the `CCD` menu. These are to be used for diagnostic purposes and not normally required.

6 Starting the run

You should be familiar with the `Giraffe` manual which describes how to select a prism (blue or red) and the required setting. At the start of a run, and also probably at the start of the night, you should initialize the prism and move it to the required position. This position may be entered in the start-up file, but can also be selected from the `Init` menu in `Quartz`.

Firstly, select `Find reference`. This command will cause the prism table to rotate until it picks up the zero reference marker. It may take nearly a minute to find the reference.

When the prism table reference has been found, you may now move to the desired position. Select `Define Blue` or `Define Red` from the menu and type in the required prism position. Of course, these numbers may already have been entered in the setup file and will be displayed in the `QUARTZ` status area. If these numbers are correct, there is no need to re-define them from the menu. Having defined, these numbers, select `Blue position Go` or `Red position Go` from

the `Init` menu. This may take some time. This completes the initialization of Giraffe.

7 Starting the night

7.1 The arc calibration

At the start of the night you may wish to obtain an arc image to check for possible drifts of the spectrum on the CCD. You need to switch on the arc by pressing the `Arc` button. From reading the `Giraffe` manual you will know that the mirror in the Cassegrain unit needs to be in position 3 for the arc and calibration lamp and in position 1 while observing a star. Therefore you could press the `Mir` button and select position 3 from the menu. However, this is redundant because `QUARTZ` will automatically do this selection if `Arc` is on when you press the `Expose` button.

Also, the name of the object should be typed in the space below the image area so that the FITS header will contain the appropriate information. This is only required when you observe a star because `QUARTZ` knows that it is an arc or flat if the corresponding button is on.

Pressing the `Expose` button will prompt you for the exposure time if the program is not active. Otherwise, the exposure will commence with the exposure time listed in the program. Before the actual exposure starts, however, a *prepare* readout of the CCD is done. This cleans out any previous image residuals and takes a few seconds. During this interval the `Expose` button will change its label to `Prepare` and its colour will change to red.

At the end of the exposure, the CCD readout will begin. This takes nearly 40 sec. The image will be slowly built up on the image window as the CCD is read out. Lastly, you will be prompted to save the image on disk if appropriate.

With the arc image visible on the screen and with the markers in place you should be able to see at a glance whether a drift has occurred and to adjust the prism setting slightly if required.

7.2 The flatfield calibration

As described in the `Giraffe` manual, there are two types of flatfield. One type is made by simply illuminating a diffusing screen and taking an image of the screen (bypassing all dispersive optics). We call this a *camera* flatfield and need only be performed at the start of a run. The second type of flatfield involves illuminating the end of the fibre by a tungsten lamp and taking a spectrum as if it were a star. This is mostly used for blaze correction. It is this type of flatfield, called *flat*, which we are now discussing. You need to take some of these flats at the start of the night and again at the end of the night.

Because the tungsten lamp emits far more in the red than in the blue, you will have a rather uneven exposure unless you introduce a filter to balance the intensities. Do this by moving the filter control knob by hand at the Cassegrain head, as described in the `Giraffe` manual. Remember to remove this filter when you have finished the flats as otherwise you will obtain grossly underexposed arcs!

When you are ready, make sure the APD is off. The APD is a highly sensitive device which monitors the star light and is easily damaged. If the APD is off, press the `Lamp` button to switch on the tungsten lamp. As in the case of the arc, the mirror needs to be in position 3 to direct the light into the fibre, but this is done automatically when you start the exposure. Before doing so, however, you need to introduce a ND filter into the beam as the light is otherwise too

bright for the CCD. The choice of ND and integration time is selected by trial and error. Typically, you need to move the ND filter wheel to position 3 and integrate for about 5 - 10 seconds. Do this by selecting the required ND filter position from the CVF menu. (CVF stands for “circular variable filter”).

Make sure that there are no saturated pixels on the frame, otherwise it is useless. Image statistics are displayed in the text area just below the image window. One of the columns gives the maximum count in five different regions. This count should be high, but less than about 60 000. A maximum count of between 40 000 and 60 000 is ideal. If there are saturate pixels, a line giving the number of such pixels will be displayed. Note that it is quite in order to have many saturated pixels while in the arc frame, but not in flat or star frames.

You should obtain two or three flat fields at the start of the night and the same number at the end of the night. If for any reason there is a power failure or program crash, it is advisable to repeat the flatfields.

7.3 Observing routine

After setting on the first star, take at least two consecutive arc frames to serve as your wavelength calibration frames. Thereafter, obtain an arc approximately every 40 min or so to monitor drifts through the night.

It does no harm to have the APD on during the arc exposure. It is only the flatfield lamp which will cause problems. You need to have the APD switched on so that you can maximize the count rate on the star using the EXPOSE program discussed in the Giraffe manual.

8 Automatic arc calibrations

As mentioned above, it is important to take regular arc frames during the night because there is normally a drift of about 0.2 - 0.5 pixels during the night. It is convenient to have this task automated as one sometimes forgets. To do this, press the Etc button and select **Set arc period**. Type in the interval (in minutes) at which the arc frames should be taken. A good choice will be 20 min at the start of the night (soon after filling) and 40 min thereafter. The arc will be taken at the end of an exposure if that time has elapsed. This feature may be canceled by selecting the appropriate item in the Etc menu.

9 Terminating QUARTZ

QUARTZ can be terminated gracefully at any stage by clicking on the Exit button. Before exiting, QUARTZ will prompt you for the name of the setup file and the program star file that will be created in your local directory. Remember that setup files should end in `.sup` and program star files in `.str` (Examples: `mysetup.sup`, `mystars.str`). Any files of the same name will be overwritten. Be sure to save these data. If you fail to do this, any modifications and additions you have made since you started running QUARTZ will be lost.